FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN

RIVERBEND LANDFILL
MCMINNVILLE, OREGON

Prepared for

Riverbend Landfill Co.
13469 SW Highway
McMinnville, Oregon 97128

Compiled by

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ac	acre
BMP	Best Management Practice
CFR	Code of Federal Regulations
CPCP	Closure and Post-Closure Plan
CQA	Construction Quality Assurance
cy	cubic yard
DEQ	(Oregon) Department of Environmental Quality
DM	District Manager
EMP	Environmental Monitoring Plan
EPM	Environmental Protection Manager
EPA	Environmental Protection Agency
FECP	Final Engineered Closure Plan
FESCPP	Final Engineered Site Closure and Post-Closure Plans
FEPP	Final Engineered Post-Closure Plan
ft	foot or feet
g	Acceleration Due to Gravity (= 9.81 m/s^2)
GCCS	Gas Collection and Control System
Geosyntec	Geosyntec Consultants, Inc.
HDPE	High Density Polyethylene
HDR	HDR Engineering, Inc.
HELP	Hydrologic Evaluation of Landfill Performance
in.	inch(es)
lb	pound
LCRS	Leachate Collection and Removal System
LFG	Landfill Gas
LFGTEF	Landfill Gas to Energy Facility
LLDPE	Linear Low Density Polyethylene
LSCS	Leachate Secondary Containment System
MSW	Municipal Solid Waste
MW	Monitoring Well
No.	Number
NPDES	National Pollutant Discharge Elimination System
NSPS	New Source Performance Standard

OAR	Oregon Administrative Rule
OM	Operations Manager
ORS	Oregon Revised Statues
oz	Ounce
P.E. or PE	Professional Engineer
QA	Quality Assurance
RCRA	Resource Conservation and Recovery Act
RL	Riverbend Landfill
RLC	Riverbend Landfill Co.
s	second
SCADA	Supervisory Control and Data Acquisition
SCS	Soil Conservation Service or SCS Engineers, Inc.
Subtitle D	Part 258 of Title 40 of the Code of Federal Regulations
SWDP	Solid Waste Disposal Permit
SWDSCP	Solid Waste Disposal Site Closure Permit
SWMS	Storm Water Management System
SY or sy	Square yard
USEPA	United States Environmental Protection Agency
Vista	Vista GeoEnvironmental Services
WM	WM (formerly Waste Management, Inc.)
yr	year

1. INTRODUCTION

1.1 Background

The Riverbend Landfill (RL) is located at 13469 S.W. Highway 18, McMinnville, in Yamhill County, Oregon, and is owned and operated by the Riverbend Landfill Co. (RLC), an operating subsidiary of WM[1]. The RL is a municipal solid waste (MSW) landfill that is regulated by the Oregon Department of Environmental Quality (DEQ) under the Code of Federal Regulations (CFR) Chapter 40, Section 258 (Criteria for Municipal Solid Waste Landfills), Oregon Revised Statutes (ORS) 459 (Solid Waste Management), and Oregon Administrative Rules (OAR) 340-94 (Solid Waste: Municipal Solid Waste Landfills). A Solid Waste Disposal Site Closure Permit (SWDSCP) was issued on 31 August 2022 with an expiration date of 30 June 2032.

Vista Consultants, LLC (Vista) prepared the 2013 Closure and Post-Closure Plans (CPCPs) for RL [Vista, 2013]. The 2013 CPCPs were revised to reflect 2014 updates by HDR [HDR, 2014]. Both documents, reflecting Subtitle D (worst-case)[2] closure and post-closure scenarios, were reviewed and approved by the DEQ. In December 2014, Geosyntec Consultants, Inc. (Geosyntec) submitted the *Final Engineered Site Closure and Post-Closure Plan* [Geosyntec, 2014] to the DEQ. In August 2017, HDR prepared a *Closure and Post-Closure Plan, Riverbend Landfill, McMinnville, Oregon* [HDR, 2017] to reflect Subtitle D's (worst-case) for the most-recent closure and post-closure scenarios. RLC has had the *Closure and Post-Closure Plan* updated annually as part of the Financial Assurance Recertification required under site SWDP # 345; this annual update will continue under the SWDSCP #345. Geosyntec understands that these more recent documents were reviewed and approved by the DEQ.

This Final Engineered Site Closure and Post-Closure Plan (FESCPP or the Plan) is a revision compiled from multiple documents from multiple consultants and has been prepared to comply with the requirements for final closure and post-closure activities and associated financial assurance criteria specified in ORS 459.272, OAR 340-94-100 through 145, and the Section 11.1 of the SWDSCP No. 345. The Plan relates to a closure permit, which must be obtained at least five (5) years prior to anticipated final closure, or at a date specified in the permittee's closure permit pursuant to OAR 340-094-0100(2)(a). The Plan reflects the intended closure design and will replace the most recent Subtitle D (worst-case) CPCP[3].

1.2 Main Objective

The main objective of the Plan is to describe final closure and post-closure activities that will be implemented at the RL to meet (or exceed) regulatory requirements and to ensure the long-term integrity of the facility following closure.

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[1] Formerly Waste Management, Inc.
[2] Subtitle D (worst-case) closure and post-closure plans are based on a hypothetical worst-case scenario for closure and post-closure costs and is intended to establish a conservative basis for estimating financial assurance funding requirements, and subsequently, a Final Engineered Closure Plan (FECP), as required by OAR 340-094-0100(2)(a), which shall include the elements of and replace the worst-case closure plan.
[3] The Plan follows the layout and the assumptions made in HDR [2017].

1.3 Organization of Report

The remainder of this report is organized as follows:

- Federal and state regulations, related to landfill closure and post-closure, are reviewed in Section 2
- General site information about the RL is summarized in Section 3
- Physical setting at the RL is described in Section 4
- The Closure Plan for the RL is presented in Section 5
- The Post-Closure Plan for the RL is presented in Section 6
- The closure and post-closure financial assurance mechanism is discussed in Section 7
- A list of references cited in the report is included in Section 8
- Limitations on the application of information presented in this report are described in Section 9

Figures, tables, and appendices contain supplemental maps, plans, analyses, data, and other information pertinent to the content of this Plan.

2. REVIEW OF CLOSURE AND POST-CLOSURE REGULATIONS

The applicable federal regulations, which fall under Subtitle D of the Resource Conservation and Recovery Act (RCRA) and contained in Part 258, Title 40 of the CFR, are referred to herein as "Subtitle D" regulations. The set of applicable state regulations is contained in Division 94 (Solid Waste: Municipal Solid Waste Landfills) of the OARs. In addition, the site permit (SWDSCP #345) issued by the DEQ provides site-specific requirements related to landfill construction, operations, closure, and post-closure care. The specific regulatory requirements cited in this report are shown in *italics*.

2.1 Closure and Post-Closure Plans

2.1.1 Federal Requirements

2.1.1.1 Closure Plans

The Subtitle D regulations specify that a closure plan must be prepared for all MSW landfills. The minimum requirements for the closure plan are contained in §258.60(c):

"(c) The owner or operator must prepare a written closure plan that describes the steps necessary to close all MSWLF units at any point during its active life in accordance with the design requirements in §258.60 (a) or (b) as applicable. The closure plan, at a minimum, must include the following information:

(1) A description of the final cover, designed in accordance with §258.60 (a) and the methods and procedures to be used to install the cover;

(2) An estimate of the largest area of the MSWLF unit ever requiring a final cover as required under §258.60(a) at any time during the active life;

(3) An estimate of the maximum inventory of wastes ever on-site over the active life of the landfill facility; and

(4) A schedule for completing all activities necessary to satisfy the closure criteria in §258.60."

2.1.1.2 Post-Closure Plans

The Subtitle D regulations specify that a post-closure care plan must be prepared for all MSW landfills. The minimum requirements for the post-closure plan are contained in §258.61(c) of Title 40 of the CFR (Subtitle D):

"(c) The owner or operator of all MSWLF units must prepare a written post-closure plan that includes, at a minimum, the following information:

(1) A description of the monitoring and maintenance activities. . . for each MSWLF unit, and the frequency at which these activities will be performed;

(2) Name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and

> *(3) A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the monitoring systems. . ."*

Further, §258.61(a) of Subtitle D requires that *"Post-closure care must be conducted for 30 years."*

2.1.2 Oregon-Specific Requirements

The FESCPP for the RL is required by Part 340-094-100(1)(a) of the OARs. According to this rule,

"At least five years prior to anticipated closure of a municipal solid waste landfill, the person holding the disposal site permit shall apply to renew the permit to cover the period of time remaining for site operations, closure of the site, and all or part of the time that active post-closure site maintenance is required by the Department. This last permit issued before final closure of the landfill is scheduled to occur shall be called a "closure permit."

According to this rule, the "closure permit" to be issued before final closure of the landfill must include: (i) a Final Engineered Closure Plan (FECP), and (ii) a Final Engineered Post-Closure Plan (FEPP). Both of these documents are included herein.

According to Part 340-094-110 of the OARs, the FECP shall consist of at least the following elements:

- A description of the steps necessary to close all MSW landfill units at any point during their active life
- A description of the final cover system that is designed to minimize infiltration and erosion
- An estimate of the largest area of the landfill requiring a final cover
- An estimate of the maximum inventory of wastes ever on site over the active life of the landfill
- A schedule for completing all activities necessary to satisfy the applicable closure criteria in 40 CFR 258.60
- Detailed design plans and specifications consistent with the applicable requirements of OARs 340-093-0140 and 340-94-0060(2), i.e., design plans and specifications for the closure improvements, including final cover system, gas control system, runoff/run-on control system, and leachate treatment and disposal system
- An updated final grading (topographic) plan for the site
- An end use plan
- A landscaping plan

- An assessment of long-term settlement and its potential effects on the integrity of the closure
- A description of the design, function, and operation of all environmental control systems
- A description (plan) of how and when the facility will be closed (i.e., the procedures that will be used to ensure that facility operations are compatible with closure objectives and requirements)
- A detailed description of the environmental monitoring system
- A schedule for implementing the closure plan
- A detailed closure cost estimate
- Other information requested in the closure permit or otherwise required to comply with all applicable DEQ and federal regulations

According to Part 340-094-115 of the OARs, the FEPP shall consist of at least the following elements:

- Procedures for maintaining the integrity and effectiveness of the final cover system
- Procedures for maintaining and operating the leachate collection, treatment, and disposal systems
- Procedures for maintaining and operating the environmental monitoring systems
- Procedures for conducting environmental quality monitoring (e.g., groundwater, surface water, landfill gas, leachate, etc.)
- Procedures for maintaining and operating the landfill gas control system
- Procedures for maintaining and operating the storm water runoff/run-on control systems
- Procedures for providing overall, site-wide monitoring and security
- Establishing appropriate uses of the property during the post-closure care period
- A detailed schedule for post-closure monitoring, inspection, and maintenance and repairs
- Description of operation and maintenance procedures for all environmental monitoring and control systems that will be in active use during the post¬-closure period
- A detailed post-closure cost estimate
- Any other information required to comply with DEQ and federal regulations

2.2 Financial Assurance Requirements

2.2.1 Federal Requirements

2.2.1.1 Closure

Federal closure requirements are contained in Part 258.71 of Title 40 of the CFR:

"(a) The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to close the largest area of all MSWLF units ever requiring a final cover as required under §258.60 at any time during the active life in accordance with the closure plan. The owner or operator must notify the State Director that the estimate has been placed in the operating record.

(1) The cost estimate must equal the cost of closing the largest area of all MSWLF units ever requiring a final cover at any time during the active life when the extent and manner of its operation would make closure the most expensive, as indicated by its closure plan (see §258.60(c)(2) of this part).

(2) During the active life of the MSWLF unit, the owner or operator must annually adjust the post-closure cost estimate for inflation.

(3) The owner or operator must increase the closure care cost estimate and the amount of financial assurance provided under paragraph (b) of this section if changes to the closure plan or MSWLF unit conditions increase the maximum cost of closure at any time during the remaining active life.

(4) The owner or operator may reduce the closure cost estimate and the amount of financial assurance provided under paragraph (b) of this section if the cost estimate exceeds the maximum cost of closure care remaining at any time during the remaining active life of the MSWLF unit. The owner or operator must notify the State Director that the justification for the reduction of the closure cost estimate and the amount of financial assurance has been placed in the operating record."

2.2.1.2 Post-Closure Care

Federal financial assurance requirements for post-closure care are specified in Part 258.72 of Title 40 of the CFR as follows:

"(a) The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to conduct post-closure care for the MSWLF unit in compliance with the post-closure plan developed under §258.61 of this part. The post-closure cost estimate used to demonstrate financial assurance in paragraph (b) of this section must account for the total costs of conducting post-closure care, including annual and periodic costs as described in the post-closure plan over the entire post-closure care period. The owner or operator must notify the State Director that the estimate has been placed in the operating record.

(1) The cost estimate for post-closure care must be based on the most expensive costs of post-closure care during the post-closure care period.

(2) During the active life of the MSWLF unit and during the post-closure care period, the owner or operator must annually adjust the post-closure cost estimate for inflation.

(3) The owner or operator must increase the post-closure care cost estimate and the amount of financial assurance provided under paragraph (b) of this section if changes in the post-closure plan or MSWLF unit conditions increase the maximum costs of post-closure care.

(4) The owner or operator may reduce the post-closure cost estimate and the amount of financial assurance provided under paragraph (b) of this section if the cost estimate exceeds the maximum costs of post-closure care remaining over the post-closure care period. The owner or operator must notify the State Director that the justification for the reduction of the post-closure cost estimate and the amount of financial assurance has been placed in the operating record."

2.2.2 Oregon-Specific Requirements

Oregon adopts the federal requirements described above, and has additional Financial Assurance Criteria in OAR 340-94-140:

"(1) Financial Assurance Required. The owner or operator of a municipal solid waste landfill shall maintain a financial assurance plan with detailed written cost estimates of the amount of financial assurance that is necessary and shall provide evidence of financial assurance for the costs of:

(a) Closure of the municipal solid waste landfill;

(b) Post-closure maintenance of the municipal solid waste landfill; and

(c) Any corrective action required by the Department to be taken at the municipal solid waste landfill, pursuant to OAR 340-094-0080(3)…

(4) Financial assurance plans. The financial assurance plan is a vehicle for determining the amount of financial assurance necessary and demonstrating that financial assurance is being provided. A financial assurance plan shall include but not be limited to the following, as applicable:

(a) Cost Estimates. A detailed written estimate of the third-party costs in current dollars according to the provisions of 40 CFR, §258.75. A landfill owner or operator meeting the criteria in 40 CFR §258.75 (a) through (c) may estimate the current dollar cost using a discount rate no greater than the Department's current reference rate. The Department shall determine the reference rate annually during the month of June. It shall be in effect for the fiscal year beginning on the first day of July immediately following the determination date and ending on June 30 of the following calendar year. (The reference rate shall be based on the current yield of composite long-term U.S. Treasury Bonds as published in the Federal Reserve's H.15 (519) Selected Interest Rates for the first full week of the month in which the reference rate is determined, less the annualized Gross Domestic Product implicit price deflator as published in the most recent U.S. Bureau of Economic Analysis

Survey of Current Business). The written estimate shall be prepared by a Registered Professional Engineer and shall include costs of:

(A) Closing the municipal solid waste landfill;

(B) Providing post-closure care, including installing, operating and maintaining any environmental control system required on the landfill site;

(C) Performing required corrective action activities; and

(D) Complying with any other requirement the Department may impose as a condition of issuing a closure permit, closing the site, maintaining a closed facility, or implementing corrective action.

(b) The source of the cost estimates;

(c) A detailed description of the form of the financial assurance and a copy of the financial assurance mechanism;

(d) A method and schedule for providing for or accumulating any required amount of funds which may be necessary to meet the financial assurance requirement;

(5) Amount of Financial Assurance Required. The amount of financial assurance required shall be established as follows:

(a) Closure. Detailed cost estimates for closure shall be based on the "worst-case" closure plan or the Final Engineered Site Closure Plan, as applicable. Cost estimates for the Final Engineered Site Closure Plan shall take into consideration at least the following:

(A) Amount and type of solid waste deposited in the site;

(B) Amount and type of buffer from adjacent land and from drinking water sources;

(C) Amount, type, availability and cost of required cover;

(D) Seeding, grading, erosion control and surface water diversion required;

(E) Planned future use of the disposal site property;

(F) The portion of the site property closed before final closure of the entire site; and

(G) Any other conditions imposed on the permit relating to closure of the site.

(b) Post-closure care. Detailed cost estimates for post-closure care shall be based on the "Subtitle D" post-closure plan or the Final Engineered Post-Closure Plan, as applicable. Cost estimates for the Final Engineered Post-Closure Plan shall also take into consideration at least the following:

(A) Type, duration of use, initial cost and maintenance cost of any active system necessary for controlling or stopping discharges; and

(B) Any other conditions imposed on the permit relating to post-closure care of the site.

(c) Corrective action. Estimated total costs of required corrective action activities for the entire corrective action period, as described in a corrective action report pursuant to requirements of OAR 340-094-0080(3) and 40 CFR, §258. 73;

(d) If a permittee is responsible for providing financial assurance for closure, post-closure care and/or corrective action activities at more than one municipal solid waste landfill, the amount of financial assurance required is equal to the sum of all cost estimates for each activity at each facility.

2.2.3 Cost Estimates

The estimated closure and post-closure costs are presented in Sections 5 and 6 and contained in the tables in Appendix H. The closure and post closure financial assistance was certified by WM and submitted to Oregon DEQ in April 2022 and approved by DEQ on July 11, 2022.

3. GENERAL SITE INFORMATION

3.1 Facility Introduction

The RL is a MSW landfill located in McMinnville, Oregon, that has been in operation since 1982. The landfill is owned and operated by RLC and is permitted by the DEQ to receive MSW and approved special waste [DEQ, 2022].

In March 2012, RLC applied to DEQ for a permit that would allow construction of a mechanically stabilized earthen (MSE) berm. Construction of the berm provided approximately 1.0 million cubic yards (cy) of additional disposal capacity though it did not increase the landfill's overall permitted height. The berm construction, approved by DEQ on 30 May 2013,[4] increased the area of the landfill to a total footprint of approximately 87.4 acres.

In 2017, RLC applied to DEQ for a permit to allow additional waste filling within the permitted footprint of the landfill and generally covering previously-closed portions of Modules 1, 2, and 3. The Final Grading Plan Modification (FGPM) project included: (i) Using the existing final cover system of the landfill over previously closed areas as an overliner system over which new waste fill would be placed, (ii) Retrofitting areas of the final cover system that included a linear low density polyethylene (LLDPE) geomembrane by removing the LLDPE geomembrane and installing a high density polyethylene (HDPE) geomembrane, and (iii) Constructing a new overliner system over areas of Modules 2 and 3 that had not been closed, consisting of HDPE geomembrane. Construction of the FGPM provides approximately 0.5 million cubic yards of additional disposal capacity within the landfill footprint.

3.2 Site Location

The landfill is located off Highway 18, approximately 3 miles southwest of McMinnville, Oregon (Drawing No. 1 in Appendix E). The site address is 13469 SW Highway 18, McMinnville, Oregon 97128. The RLC office phone number is 503-472-8788. The site is in Sections 1 and 12, Township T5S, Range R5W, W.M., of Yamhill County.

To the south the landfill is bordered by the floodplain of the South Yamhill River, farmlands and forest to the north and west, and an unnamed tributary of the South Yamhill River on the east. Vehicular traffic enters the landfill property at the northwest side of the property from State Route 18.

3.3 Current Land Use

The floodplain of the South Yamhill River borders the landfill on the south. Agricultural lands and buildings surround the site on the north, west and east. A recreational vehicle (RV) park was located to the southwest of the landfill but is now closed.

[4] Letter from Oregon DEQ to WM, Approval of Mechanically Stabilized Earthen Berm, Riverbend Landfill, Solid Waste Permit No. 345, Yamhill County, 30 May 2013.

3.4 Landfill Development

The landfill was developed by constructing a series of waste disposal cells designated as Modules 1 through 9 (Drawing No. 3 in Appendix E). The construction of each new Module involved excavation of soils underlying the site. The plan area permitted for waste disposal is approximately 87.4 acres. The FGPM project did not expand the permitted footprint of the waste disposal area.

The landfill is protected from flooding of the South Yamhill River by a flood control berm located along the south and east portions of the north boundaries of the landfill. The flood control berm was constructed to a nominal elevation of 145 feet, which exceeds the design 100-year flood elevation [EMCON, 1994].

Information summarized below is based on information provided by RLC [2022].

3.4.1 Modules 1, 2 and 3

Modules 1, 2, and 3 were constructed sequentially from 1982 to 1993. These Modules were developed successively from west to east. A final cover system and a landfill gas collection system were constructed over the southern side of these Modules during 1994 and 1995. The northern side of Modules 1, 2, and 3 were covered with overliner systems as part of developing the Modules to the north. The overliners drain to the northern modules. Figures 1 and 2 show the configurations of the liner, final cover, and the overliner systems. The new FGPM area overlies areas covering portions of Modules 1, 2, and 3 and some adjacent Module areas.

3.4.2 Module 4

Module 4 was built in 1994 east of the south part of Module 3. It contains a double composite liner system, a primary leachate collection and recovery system (LCRS) and a leachate secondary collection system (LSCS). A ridge is aligned from the north to south along the approximate centerline of Module 4. The LCRS and LSCS consist of two parallel trench systems aligned from the north to south on each side of the central ridge.

The two LCRS and LSCS trenches in Module 4 drain into two sumps located on the south side of the Module. The east sump drains by gravity to the west sump. In addition, the LCRS in Modules 1, 2, 3, and a portion of Module 5 drain to the Module 4 LCRS sump. The west sump has pumps to remove the liquids. The liquids are conveyed to a force main that conveys the leachate to the leachate pond, which represents the storage portion of the landfill leachate management system.

Figures 1 and 2 show the configurations of the liner and final cover systems.

3.4.3 Module 5

Module 5 was built in 1995 north of Module 4 and east of the northern part of Module 3. Module 5 is contiguous with Module 4. A ridge is aligned from north to south along the approximate centerline of Module 5, which is a continuation of the Module 4 ridge. The LCRS and LSCS in Module 5 consist of two parallel trench systems aligned on either side of the central ridge. The LCRS and LSCS of Module 5 drain by gravity into the LCRS and LSCS of Module 4. Figure 1 shows the configurations of the liner systems.

3.4.4 Modules 6 and 7

Modules 6 and 7 were constructed in 1997 and 1998 respectively. Module 6 adjoins the northeastern edges of Modules 4 and 5, and Module 7 adjoins the east edge of Module 6. Both Modules have composite liners that incorporate a LCRS and a LSCS. A geosynthetic clay liner was used in lieu of low permeability soil in the primary composite liner on the side slopes. Figures 1 and 2 show the configurations of the liner and final cover systems.

Module 7 drains to Module 6, which in turn has a sump on the south side of the landfill. This sump is equipped with pumps that transfer liquids from the LCRS and LSCS to a force main that conveys the leachate to the existing leachate pond, which represents the storage portion of the landfill leachate management system.

3.4.5 Module 8

Module 8 was constructed in four stages designated 8A, 8B, 8C and 8D along with associated overliners for the areas that are adjacent to Modules 1, 2, and 3. Module 8 (A, B, C and D) was constructed between 2002 and 2009, from east to west. Each Module stage includes a composite liner. Figure 1 shows the configurations of the liner systems.

3.4.6 Module 9

Module 9 was developed by constructing a mechanically stabilized earthen (MSE) berm along the west side of Modules 1 and 8D. The MSE berm reaches a maximum height of approximately 40 feet along the western portion of Module 8D and decreases in height to ramps located at the northwestern and southwestern ends of the landfill. The outside slope of the MSE berm is vegetated and the inside slope consists of engineered fill. The width at the top of the MSE berm accommodates a landfill perimeter drainage ditch, two-way road traffic (highway vehicles only), and the anchor trench for the composite liner and the future final cover system. The outside slope of the MSE berm is 1H:3V (horizontal to vertical) whereas the inside slope is generally 1H:1V, or flatter.

The southern half of the area drains to a sump located in the southwest corner of the Module. The northern half of the area drains to Module 8D. The liner systems are connected to provide waste and liquid containment.

The liner system for Module 9 is the same as the liner system for Module 8D. On the southeastern side of Module 9, the final cover system for Modules 1 and 2 also functions as a liner system and leachate collection system for the disposed waste. The water that percolates through the new waste placed in the FGPM area will drain to the Module 9 sump and to a new sump located near the eastern side of the FGPM area.[5]

To monitor the performance of the MSE berm, an instrumentation program was developed and implemented by RLC. Instrumentation consists of:

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[5] The sump for the eastern portion of FGPM will be designated 3A P and 3A S.

- Slope Inclinometers (SI) used to measure the magnitude and rate of shear strain to provide information regarding slope movement;
- Vibrating Wire Piezometers (PZ) used to measure the pore pressure at a specific depth in the soil stratum; and
- Extensometers (EX) used to monitor vertical displacement (settlement or heave) in the foundation soil and MSE berm.

Leachate from the Module 9 sump is pumped to the landfill leachate pond.

3.5 Monitoring and Control Systems

3.5.1 Environmental Monitoring Programs

The monitoring programs at the RL, including (i) groundwater monitoring, (ii) leachate management system monitoring, (iii) surface water monitoring, and (iv) landfill gas monitoring programs, are performed as part of the Environmental Monitoring Plan (EMP) requirements. The current EMP was updated and submitted to the DEQ in response to the SWDSCP #345.

3.5.2 Storm Water Management System

To accommodate the MSE berm design, the permanent storm water management system (SWMS) for the landfill was designed for the 100-year, 24-hour storm event instead of the 25-year, 24-hour storm required by the Subtitle D regulations. The SWMS elements on the landfill include collection ditches, downdrains[6], and culverts[7].

The landfill ditches, downdrains, and culverts discharge to storm water ponds. One pond is located near the northwest corner of the MSE berm and south of the entrance facilities (referenced as Detention Basin 4A). The second pond is located south of Modules 1, 2, and 3 (referenced as Detention Basin 1). The third pond is located north of Module 8 (referenced as Detention Basin 3). Each pond has an outlet control structure.

Ground cover, temporary covers, and storm water diversion systems are used during the landfill operations to control and manage storm water. Details of the SWMS during operations are covered in the current Stormwater Pollution Control Plan (SWPCP) available at the site and upon request. The SWPCP includes a description of the site storm water systems and monitoring requirements, best management practices (BMPs), and the site National Pollutant Discharge Elimination System (NPDES) 1200-Z Permit.

As part of site closure, remaining elements of the permanent SWMS will be constructed, if needed. Appendix A includes the information for the permanent SWMS. The permanent SWMS incorporates the existing ponds, pipes, ditches on the MSE berm, and additional features for the final grades such as additional ditches, downdrains, culverts, and pipes. Prior to closure

[6] Also referred to as downchutes.
[7] The existing surface water infrastructure that can be used or retrofitted will become a part of the SWMS at the Landfill after closure. As part of the final closure design, the existing surface water infrastructure will be evaluated and modified or enhanced as needed to meet the goals at the time of closure.

construction, the verification of existing conditions at the time of closure, and the findings presented in Appendix A will be reviewed and updated as needed to comply with future goals and site conditions.

After the permanent SWMS elements have been constructed, water will discharge to the landfill ditches, downdrains, and culverts that discharge to the storm water ponds[8].

3.5.3 Leachate Management System

Leachate is generated from moisture in waste and when water, such as precipitation, percolates through or purges out of disposed materials. This percolation can occur when precipitation infiltrates directly into the waste and/or when moisture in the material (whether present before or after landfilling) filters or leaches out. The leachate management system (LMS) consists of leachate collection trenches inside the modules, primary and secondary leachate collection sumps, and a double-lined leachate storage pond. Leachate is collected above the baseliner of each module and directed to lined sumps where liquid is pumped out of the landfill via the leachate risers which sends the leachate to the on-site leachate pond located southwest of the landfill via a dual-contained forcemain. The flow from each leachate riser is recorded using the site Supervisory Control and Data Acquisition (SCADA) system.

3.5.3.1 Leachate Monitoring

Leachate samples from the LCRSs are monitored to: (i) comply with the requirements of the SWDSCP, and leachate disposal permits; (ii) provide comparative data for interpreting monitoring data collected from the secondary collection systems; and (iii) provide a basis for the selection of long-term groundwater monitoring indicator parameters.

Liquid samples from the LSCSs are monitored to: (i) detect and if present, characterize the liquid in the LSCS; and (ii) determine whether the detected liquid consists of leachate from the primary liner or liquid from other sources.

RL groundwater sampling activities along with the corresponding primary and secondary leachate sump sampling activities are performed pursuant to the current RL EMP, which describes the RL leachate monitoring system, including, but not limited to, leachate monitoring locations, monitoring parameters, data evaluation methods, and sampling and analytical procedures. This information is reported to the DEQ in the Annual Environmental Monitoring Report (AEMR).

In addition to the leachate sampling and monitoring activities discussed above, leachate sampling requirements may vary depending on the sampling location and permit revisions.

The LCRS and LSCS are currently sampled at 10 locations, including (i) leachate pond; (ii) leachate pond secondary collection system; and (iii) 8 sump side-slope riser locations (i.e., 1/5P, 6/7P, 8P, 9P, 4/5S, 6/7S, 8S and 9S). After FGPM's Phase 2 construction is completed in the future, RLC will add two new monitoring locations at the new sump that will be located in the east side of the FGPM area, which will be designated 3A P and 3A S for the LCRS and LSCS, respectively.

3.5.3.2 Leachate Extraction System

The LCRS sumps collect leachate from landfill modules and pumps in the sumps discharge the leachate to a double-lined collection pond for treatment and disposal. The LSCSs are a system used to detect and contain potential leaks through the landfill primary liner.

Leachate Sumps

Leachate in Modules 1 through 5 drains to a primary leachate sump (Sump 1/5 P) on the south side of Module 4. This sump was constructed with dual side-slope riser pipes and is equipped with a dedicated electric submersible pump that discharges to a dual-contained force main that is directed into the leachate pond.

Leachate in Modules 6 and 7 drains to a primary leachate sump (Sump 6/7 P) on the south side of the modules. Sump 6/7 P is equipped with a dedicated electric submersible pump that discharges to a dual-contained force main that is directed into the leachate pond.

Leachate in Module 8 drains to a primary leachate sump (Sump 8P) located near the northeast corner of this module. Sump 8P is equipped with a dedicated electric submersible pump that discharges into a dual-contained force main that is directed into the leachate pond.

Leachate in Module 9 drains to a primary leachate sump (Sump 9P) located in the southwest corner of this module. Sump 9P is equipped with a dedicated electric submersible pump that discharges into a dual-contained force main that is directed into the leachate pond.

Future construction of Phase 2 FGPM will add a new sump in the eastern portion of the FGPM area to collect leachate from the Phase 2 FGPM area. Once constructed a dedicated electric submersible pump will discharge into the dual-contained force main that is directed to the leachate pond. The western portion (Phase 1) of the FGPM currently area drains by gravity to the Sump 9.

Each LCRS sump is equipped with a flow meter and monitored with the SCADA system [RLC, 2022].

Modules 4, 5, 6, 7, 8, and 9 have a LSCS that drains to secondary collection sumps, named 4/5 S, 6/7 S, 8S, 9S, which are located below the primary leachate sumps for the various Modules and are also equipped with electrical pumps discharging to the primary leachate sumps named 1/5 P, 6/7 P, 8P, 9P.

Leachate Storage Pond

The leachate pond is located near the southwestern corner of the landfill and has a surface area of approximately 4.6 acres at the pond’s full elevation 153.0 feet. The maximum operational level is at 150.0 feet (providing a three-foot freeboard). At the designed maximum permitted liquid depth of approximately 18 feet, the leachate pond has a storage capacity of approximately 20 million gallons.

The leachate pond liner is comprised of a primary 60-mil thick HDPE liner as well as a composite secondary leak detection liner system. The composite secondary leak detection liner system consists of a 60-mil thick HDPE liner located on top of 2 feet of low hydraulic conductivity soil.

The secondary leak detection system can convey potential leakage through the primary liner system to a secondary sump that is approximately 12 inches deep and 18 feet square [RLC, 2022]. Within this secondary sump is a 12–inch diameter side-slope riser pipe that lies in the eastern slope of the pond. The secondary sump pump is accessed from the end of the side-slope riser pipe sticking out above ground on the eastern side of the leachate pond berm.

In 2017, an additional layer of geomembrane liner was installed along the upper portions of the pond, down to approximately elevation 139 ft as an enhancement to the leachate pond.

Leachate Operations

The SCADA system monitors and logs leachate sump levels and the pumped leachate volumes. This system is designed to send notifications to key personnel in the case of pump failures and/or compliance level exceedances.

The primary and secondary leachate sump pumps are designed to run in an automatic mode to manage collected leachate. Each sump has a pressure transducer that senses the level of leachate in the sump. Each sump has its specific setting for high leachate level pump-on, low leachate level pump-off, and leachate alarm level which triggers a beacon light. Sump pumps run automatically based on pre-programmed set points to convey leachate from the sumps into the force main system.

Leachate Inspection

The SCADA system is the primary method of monitoring leachate at RLC. However, site personnel visually monitor the LCRS during normal daily operations. LCRS maintenance items are documented on the Daily Item Inspection Form.

At each primary and secondary leachate sump, the site technician inspects the following:

1. Observe exterior plumbing connections of the leachate sump for leachate leaks, verify that the sump has no alarms, check the control panels for proper function and display, and correct valve positions at each sump riser.
2. After examination of each location, review the SCADA information from each primary & secondary sump for:
   a. Level reading at sump.
   b. Hour meter reading at sump.
   c. Totalizer reading for gallons pumped.
3. Initially evaluate level data to confirm compliance at each sump. Provide timely notification to RL management if the liquid levels are near, or exceed, compliance levels.
4. Evaluate if there are maintenance or repairs needed to any sump location; document any conditions/adjustments/repairs needed on the daily inspection form.

The SCADA system logs and stores leachate volumes and liquid levels for review and reporting purposes.

<u>LCRS Maintenance and Repairs</u>

RL personnel typically perform repairs and maintenance needed for the leachate pump systems and associated equipment. Should there be an electrical or pump issue that cannot be repaired by RL personnel, third party contractors are contracted to repair the identified issue.

Routine maintenance includes testing and review of all panel electricity and alarm settings for proper system function/operation and detection of any failures. All observation work activity is documented and outlines in detail findings and recommendations for repair or maintenance. Based on reported findings, RL management determine best plan/schedule for repairs/activities to address noted issues.

3.5.4 Landfill Gas Management System

RL has an active gas collection and control system (GCCS) designed to limit landfill gas (LFG) migration and fugitive emissions. LFG is generated by anaerobic decomposition of organic materials in the landfill. The major components of LFG are methane, carbon dioxide, nitrogen and hydrogen with minor amounts of other trace gases. The methane and hydrogen gases are of most concern because they can ignite at concentration levels between 5 and 15 percent, and between 4 and 75 percent, respectively. LFG is managed and monitored using the landfill containment system (liner and final cover), a LFG extraction system, cover placement, and LFG monitoring probes.

The GCCS is designed to extract LFG at a sufficient rate to minimize the subsurface lateral migration and surface emissions of LFG. This is achieved by sizing, installing, and operating collection elements (which are discussed in the sections below) that sufficiently collects the landfill gas, which include, adequately sized transmission headers and laterals (pipe network), gas moving equipment (blower(s)), and controlled in a manner that is expected to handle the estimated LFG flow rate. The following sections address the monitoring, extraction systems.

3.5.4.1 Landfill Gas Monitoring

The LFG monitoring network consists of a series of LFG probes and monitored structures as described in the sections below. If the landfill expands or additional facility structures are added, additional LFG probes or structure monitoring locations will be added, as needed, in consultation with and approval by the DEQ. Additional details of the monitoring program are included in Appendix B of the current EMP, the RL Title V Permit (#36-0011-TV-01), and the most current version of the RL GCCS Design Plan[9].

3.5.4.2 Landfill Gas Extraction

To comply with the federal MSW landfill New Source Performance Standards (NSPS), an active LFG GCCS was installed to manage emissions while collecting methane for electrical energy generation by the LFG to Energy Facility (LFGTEF).

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[9] The GCCS Design Plan is updated as needed and according to regulatory changes for air permitting and is available for review upon request.

The GCCS includes a combination of vertical gas extraction wells, horizontal gas collectors, temporary and intermediate cover over parts of the landfill, the LFGTEF, and LFG flares. The primary enclosed flare has a 1,000 standard cubic-feet-per-minute (scfm) rated capacity and is used to destroy excess LFG that is not able to be combusted by the LFGTEF and the secondary enclosed flare is a 4,500 scfm rated flare used as a backup control device. The flare system works in conjunction with the LFGTEF and is designed to manage the LFG in the event the LFGTEF is not in service.

The GCCS is designed to limit LFG migration, fugitive emissions and to reduce odors. The following are general components that comprise RL’s GCCS:

- Vertical gas extraction wells
- Horizontal gas collectors
- Condensate sumps
- Six 3516 Caterpillar Engines located in the LFGTEF
- Two enclosed LFG Flares

Current LFG collection rates are declining as expected, regulatory requirements for decommissioning the collection system over time will be followed.

3.6 Containment System Configurations

The RL containment systems isolate waste from the surrounding environment and provide containment, collection, and removal of leachate and LFG. Drawing No. 3 in Appendix E presents the boundaries of landfill disposal Modules 1 through 9. Figures 1 and 2 show the containment system elements (composite liner and final cover) for the landfill Modules presented on Figure 2. As shown on Figure 1, with the exception of clay-lined Modules 1, 2 and 3, Modules 4 through 9 feature Subtitle D composite liner systems. The FGPM area that overlies portions of Modules 1, 2, and 3 has a geomembrane liner.

3.7 Site Facilities

On-site structures are located in the southwestern portion of the landfill site (leachate pond) and adjacent to the RL entrance which include administrative buildings, scale house, recycling and drop-off facilities, storage, and the LFGTEF.

4. PHYSICAL SETTING

4.1 Topography

The natural, predevelopment topography at of the landfill site was relatively flat with elevation ranging between 150 feet and 130 feet. The landfill is designed with a maximum fill contour elevation of 284 feet (Drawing No. 3 in Appendix E).

4.2 Site Geology

In the general vicinity of the landfill, the following geologic units, from oldest to youngest (bottom to top), are present:

- Nestucca Formation (upper Eocene-age), which is composed predominantly of basaltic lava flows with localized occurrences of marine sediments.
- Pliocene-age sands and gravels, which overlie the Nestucca Formation and underlie more recent alluvial sediments, which consist mostly of sandy gravels and gravelly sands, with localized interbeds of clayey and silty gravels and clay and silt lenses. The sand-and-gravel material is generally well-graded, angular to subrounded, and in places, cemented.
- Alluvial Willamette Silt (early to middle Quaternary-age) associated with the Willamette River and its tributaries. The Willamette Silt composes the upper and lower river terraces near the landfill and consists of bedded silts, clays, clayey silts and silty clays.
- Late alluvium (Quaternary-age) associated with the recent floodplain of the South Yamhill River. These materials are similar to the Willamette Silt described above.

4.3 Seismicity

Title 40 of the Code of Federal Regulations (CFR), Part 258 (40CFR258 or Subtitle D) requires MSW landfills located in a seismic impact zone to be designed to resist the maximum horizontal acceleration in lithified earth material (i.e., bedrock) for the site. A “Seismic impact zone” is defined as an area with a ten percent, or greater, probability that the maximum horizontal acceleration in lithified earth material expressed as a percentage of the earth’s gravitational pull will exceed 0.10g (10 percent of gravity) in 250 years. The maximum horizontal acceleration is depicted on a seismic hazard map with a 90 percent or greater probability that the acceleration of 0.10g will not be exceeded in 250 years, or the maximum expected horizontal acceleration based on site-specific seismic hazard assessment. To meet the Subtitle D requirements cited above, a probabilistic seismic hazard analysis (PSHA) is required.

The PSHA complies with the requirements in Subtitle D (i.e., 40CFR258) and was used to characterize the maximum horizontal acceleration in lithified earth material for the site (i.e., 0.10g in 250 years). Following Subtitle D, the ground motion with a 90 percent chance of not being exceeded in 250 years is estimated using the site-specific PSHA. This hazard level corresponds to an annual probability of exceedance of 0.00042.

Following the Subtitle D requirements, the estimated acceleration at RL is 0.415g (41.5% of gravity) and the design earthquake is a magnitude 8.5. This design earthquake was used to design the base liner. Further details are presented in the Geosyntec [2012] report.

In 2015, the DEQ requested that the new portions of the Landfill such as the FGPM area and the final cover for the areas of the Landfill that have not been closed, be designed to a higher level of acceleration and a magnitude 9.0 earthquake to address the Oregon Resilience Plan. The selected higher level of acceleration was the 84th percentile ground motion which corresponds to the median plus one standard deviation ground motion. The resulting peak ground acceleration for lithified earth material in this scenario was predicted to be 0.44g. Further details are presented in the Geosyntec [2016] report.

4.4 Hydrogeology

At the RL, groundwater occurs in two water bearing zones (WBZs): (i) upper (shallow) silt-clay alluvial deposits (both the Willamette Silt and the late-Quaternary alluvium); and (ii) lower (deep) sand-gravel deposits. Groundwater elevations measured in site groundwater monitoring wells and piezometers since January 1993 have been used to evaluate the hydraulic parameters and flow characteristics of both WBZs. Details regarding the hydrogeology of the site are covered in the current EMP.

4.5 Wetlands and Floodplain

The RL is located in the vicinity of wetlands and adjacent to the 100-year floodplain of the South Yamhill River.

The landfill is protected from river flooding by a flood control berm constructed along the south, east, and north boundaries of the landfill. Floodplain information is documented in Federal Emergency Management Agency Panel 41071C0415D; Rev. 12-10-1146P-410249 05/09/2013 and via the Yamhill County web-based GIS located at: https://www.co.yamhill.or.us/gis.

Wetlands information for the RL is presented in the documents below and is incorporated by reference:

- Wetland Delineation Report for the Riverbend Landfill (Module 11 Expansion), Yamhill County; T5S R5W S1 TL 100 and 200; WD#2012-0149. Oregon Department of State Lands (DSL) concurrence October 1, 2015.
- Wetland Delineation Report for the Riverbend Landfill (Riverbend Floodplain Enhancement), Yamhill County; T5S R5W S1 TL 100 and 200; WD#2012-0149. DSL concurrence August 31, 2012.
- Wetland Delineation Report for the Riverbend Landfill Expansion Project, Yamhill County; T5S R5W S1 Portion of Tax Lots 101, 200, 400, 401 & 500; S11 Portion of Tax Lots 100 & 600; WD#07-0733. DSL concurrence 21 April 2009.
- Onsite Wetland Determination Report for the Riverbend Landfill Stormwater Construction Facility, Yamhill County, T5S R5W S1 TL 400. DSL jurisdictional determination, February 10, 2022.

5. FINAL ENGINEERED CLOSURE PLAN

5.1 Closure Requirements

5.1.1 Federal Requirements

Federal closure requirements are contained in Part 258.60(a)-(b):

"(a) Owners or operators of all MSWLF units must install a final cover system that is designed to minimize infiltration and erosion. The final cover system must be designed and constructed to:

(1) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5}cm/sec, whichever is less, and

(2) Minimize infiltration through the closed MSWLF by the use of an infiltration layer that contains a minimum 18-inches of earthen material, and

(3) Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6 inches of earthen material that is capable of sustaining native plant growth.

(b) The Director of an approved State may approve an alternative final cover design."

5.1.2 Oregon-Specific Requirements

Oregon adopts the above federal requirements, and has additional closure requirements in Section 34 94 0110(2) of the OARs:

"(2) Requirements for closure plans. A closure plan shall specify the procedures necessary to completely close the municipal solid waste landfill at the end of its intended operating life.

(a) Requirements for the "worst-case" closure plan shall include all elements specified in 40 CFR §258.60, and consist of at least the following:

(A) A description of the steps necessary to close all municipal solid waste landfill units at any point during their active life;

(B) A description of the final cover system that is designed to minimize infiltration and erosion;

(C) An estimate of the largest area of the municipal solid waste landfill unit ever requiring a final cover;

(D) An estimate of the maximum inventory of wastes ever on-site over the active life of the landfill facility; and

(E) A schedule for completing all activities necessary to satisfy the closure criteria in 40 CFR §258.60."

Section 340-94-0120(2) of the OARs also requires that:

"(2) Unless otherwise approved or required in writing by the Department, no person shall permanently close or abandon a municipal solid waste landfill, except in the following manner:

(a) All areas containing solid waste not already closed in a manner approved by the Department shall be covered with at least three feet of compacted soil of a type approved by the Department graded to a minimum two percent and maximum 30 percent slope unless the Department authorizes a lesser depth or an alternative final cover design. In applying this standard, the Department will consider the potential for adverse impact from the disposal site on public health, safety or the environment, and the ability for the permittee to generate the funds necessary to comply with this standard before the disposal site closes. A permittee may request that the Department approve a lesser depth of cover material or an alternative final cover design based on the type of waste, climate, geological setting, degree of environmental impact;

(b) Final cover material shall be applied to each portion of a municipal solid waste landfill within 60 days after said portion reaches approved maximum fill elevation, except in the event of inclement weather, in which case final cover shall be applied as soon as practicable;

(c) The finished surface of the closed areas shall consist of soils of a type or types consistent with the planned future use and approved by the Department. Unless otherwise approved by the Department, a vegetative cover of native grasses shall be promptly established over the finished surface of the closed site;

(d) All surface water must be diverted around the area of the disposal site used for waste disposal or in some other way prevented from contacting the waste material;

(e) All systems required by the Department to control or contain discharges to the environment must be completed and operational."

5.2 Objectives

The main objectives of this FECP are:

- To allow the operator to update the RL closure schedule
- To allow the operator to update an estimate of closure costs
- To enable the regulatory agencies to assess the reasonableness of the closure schedule and cost estimate

- To allow an Oregon licensed professional engineer to certify the accuracy of the cost estimate

5.3 Largest Area Requiring Closure

The landfill's footprint is approximately 87.4 acres, and the area of the landfill that needs to be closed is approximately 59.5 acres (Drawing No. 3 in Appendix E) and is subject of this FECP.

5.4 Maximum Inventory of Waste

RLC [2022] Disposal records indicate that approximately 12,603,820 cy of waste[10] have been disposed at RL as of January 1, 2022. The estimated remaining available permitted airspace capacity, including all areas of settlement, as of January 1, 2022, is approximately 395,400 cy, however the available, permitted airspace noted increases over time as ongoing settlement of the landfill occurs.

5.5 Remaining Capacity and Site Life

RLC [2022] states that final closure of RL is not anticipated to take place in the next five years, based on the following:

- RLC received an expansion on May 30, 2013 for the RL which increased the site's permitted airspace by 984,086 cubic yards (cy) and increased the area of the landfill to a total footprint of approximately 87.4 acres of the 700-plus acre property. A final grading plan modification was approved by DEQ in a letter dated June 29, 2017, which increased the landfill's airspace by approximately 490,000 cy. As of July 1, 2021 the site discontinued placing MSW at the facility and transitioned to metering in materials and/or disposal of approved solid waste projects to prioritize the structural needs of the site.
- Remaining permitted capacity for the site as of January 1, 2022 is approximately 395,400 cy which includes all available permitted airspace including areas of settlement. The remaining airspace is expected to be filled in a timeframe contingent on available project volumes and as projects arise.

Therefore, since it is anticipated that more than five years of capacity remain, Subtitle D ("worst-case") CPCP is appropriate at this time.

5.6 Estimated Closure Schedule

RLC has submitted to ODEQ an estimated closure schedule for the facility on March 11th, 2022. This estimated closure schedule contains areas to be closed once they are brought up to final grades. Recent decisions by Oregon Metro may impact this proposed schedule. The March 11th letter and figure is included as Appendix I.

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[10] Permitted volume is determined by comparing the baseliner to the top of waste (which is 3 feet below top of final cover layer). This volume does not take into account compaction or settlement of waste over time. As material is compacted through operations or settlement, the effective available volume increases allowing for additional material placement within the permitted airspace.

5.7 Closure Components

Closure components and activities at the RL will include the following:

- Final grading
- Construction of the final cover system
- Construction of the remaining portion of the LFG extraction system
- Construction of the final SWMS

5.7.1 Final Grading

The final grading plan for the RL is presented on Drawing No. 3 in Appendix E. In conformance with the final cover design, prior to constructing the final cover, the landfill surface will be graded to:

- A maximum slope of 3H:1V[11] or flatter
- A minimum slope of 2 percent

Together with the perimeter road on the flood control berm and on the MSE berm, access roads on the waste slopes will be continued to the top deck to provide post-closure access to the site. As designed, the highest elevation of the closed landfill will be about 284feet.

5.7.2 Final Cover Objectives

A final cover will be placed over the final lift of waste at the RL to perform the following functions:

- Separates the waste from the environment
- Adjusts the landfill surface topography to provide appropriate slopes to promote run-off and controlled drainage of storm water
- Controls erosion by conveying run-off at non-scouring flow rates
- Minimizes storm water infiltration into the waste
- Minimizes leachate generation
- Controls and contains LFG

5.7.3 Regulatory Criteria for Final Covers

5.7.3.1 General

The federal (Subtitle D) regulations, as a minimum, require two layers in the final cover system for a MSW landfill, i.e., an infiltration (barrier) layer and an erosion (vegetation, protective) layer. The State of Oregon states that *"If a municipal solid waste landfill is subject to 40 CFR, Part 258 as provided in 40 CFR §258.1, the owner or operator shall comply with closure and post-closure*

[11] In a portion of the FGPM area, the slopes are 3H:1V and are expected to flatten over time.

care requirements in 40 CFR, Part 258, Subpart F. All municipal solid waste permittees shall also comply with this rule." Thus, the federal and state requirements will be discussed for each layer separately[12].

5.7.3.2 Foundation Layer

A foundation layer for the final cover is not required by Subtitle D. Section 340-94-120(2)(a) of the OARs requires that *"All areas containing solid waste… shall be covered with at least three feet of compacted soil of a type approved by the Department graded to a minimum two percent and maximum 30 percent slope…"* Thus, the foundation layer is not required by the DEQ.

The foundation layer for the final cover provides a firm, smooth surface for the placement of the barrier layer and limits the effects of subsequent differential settlement and subsidence acting on the barrier layer.[13]

5.7.3.3 Infiltration Layer

The infiltration (barrier) layer of the final cover system limits the potential for infiltration of moisture into the landfill and contains landfill gases.

Subtitle D requirements for the infiltration (barrier) layer in the final cover are contained in §258.60(a)(1) and (b)(1). Applicable portions of these regulations are cited below.

"(a) Owner or operator of all MSWLF units must install. . . an infiltration layer as follows:

(1) The infiltration layer must be comprised of a minimum of 18 inches of earthen material that has a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5} cm/sec, whichever is less. . .

(b) The Director of an approved State may approve an alternative final cover design that includes:

(1) An infiltration layer that achieves an equivalent reduction in infiltration as the infiltration layer specified in paragraph (a)(1) of this section. . ."

Based on the above description, both a prescriptive final cover system (§258.60(a)(1)), and a performance-based alternative final cover system (§258.60(b)(1)), that provides an equivalent reduction in infiltration through the final cover, are allowed by the regulations.

In 2005, EMCON[14] evaluated a performance-based alternative final cover system that included an infiltration study through the proposed final cover system using the Hydrologic Evaluation of

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[12] As will be discussed in Section 5.6.4, two final cover alternatives are presented herein and other equivalent engineered alternatives such as Closure Turf by AGRU may be considered at the time of closure.
[13] Via a 17 March 2020 letter, the DEQ approved RL's request to remove the maximum allowable hydraulic conductivity requirement (i.e., 10^{-5} cm/sec) from the RL's cover system construction specifications.
[14] EMCON/OWT, Inc. (2005). *2005 Final Cover Design Report, Riverbend Landfill, McMinnville, Oregon*; project 115581/03000000; prepared for Waste Management, Inc., July.

Landfill Performance (HELP3) model[15,16]. The evaluation compared the estimated infiltration rate through the proposed final cover system to the infiltration rates through typical base liner systems during the post-closure period as documented by the USEPA in *Assessment and Recommendations for Improving the Performance of Waste Containment Systems (EPA/600/R-02/099 – December 2002)* for landfills throughout the United States (USEPA, 2002).

Based on the HELP modelling by EMCON (2005), the estimated infiltration through the alternative final cover system was about 1.2 gallons per acre per year for sloping areas and about 18.6 gallons per acre per year for top deck areas.

Using the information from USEPA (2002), for infiltration through a typical base liner system, EMCON (2005) interpreted a value of about 1 liters per hectare per day (lphd), which is approximately 39 gallons per acre per year[17].

Since the estimated infiltration through the alternative final cover system was lower than the observed performance through the base liner systems reported by USEPA in 2002, the alternative final cover system was approved for use at the Landfill by ODEQ in 2005. The same approach was followed in 2006 by Geosyntec [Geosyntec, 2006] and is proposed for future areas requiring closure.

The barrier layer should also be in compliance with the regulations previously mentioned in Section 340-94-120(2)(a) of the OARs, which requires that *"All areas containing solid waste… shall be covered with at least three feet of compacted soil of a type approved by the Department graded to a minimum two percent and maximum 30 percent slope…"*

5.7.3.4 Drainage Layer

Oregon and federal regulations do not specifically require a drainage layer in the final cover system. However, construction of a drainage layer improves the slope stability of the landfill final cover system by removing the infiltration water that passes through the erosion (vegetative) cover and thus minimizing the hydraulic head over the barrier layer.

5.7.3.5 Erosion Layer

Subtitle D requirements for the erosion (protective, vegetative) layer of the final cover are contained in §258.60(a)(2) and §258.60(b)(2). Applicable portions of these regulations are given below.

> *"(a) Owner or operator of all MSWLF units must install. . . an erosion layer. . . as follows:. . .*

[15] Schroeder, P. R., Aziz, N. M., Lloyd, C. M. and Zappi, P. A. (1994). *The Hydrologic Evaluation of Landfill Performance (HELP) Model: User's Guide for Version 3,* EPA/600/R-94/168a, September 1994, U.S. Environmental Protection Agency Office of Research and Development, Washington, DC.
[16] HELP v3.07 was used by EMCON (2005). The currently (2017) available HELP model (v3.07) was developed for the U.S. EPA by the U.S. Army Corps of Engineers Waterways Experiment Station. HELP v3.07 is a DOS executable program, A Microsoft Excel-based application (v3.5) is being developed and will be available in the near future.
[17] Previous designers used a value of 36.5 gallons per acre per year instead of 39 gallons per acre per year.

(2) The erosion layer must consist of a minimum of 6 inches of earthen material that is capable of sustaining native plant growth. . .

(b) The Director of an approved State may approve an alternative final cover design that includes. . .

(2) An erosion layer that provides equivalent protection from wind and water erosion as the erosion layer specified in paragraph (a)(2) of this section."

Section 340-94-120(2)(c) of the OARs requires that *"...a vegetative cover of native grasses shall be promptly established over the finished surface of the closed site. . ."* This language can be interpreted as the DEQ requirement for the vegetative layer.

5.7.3.6 Interpretation

Based on the above review of the state and federal criteria for the design of final covers, and the review of the state-approved final cover system for the 2005 and 2006 closure areas, Geosyntec concludes that the final cover system for the RL FECP will consist of (from bottom to top): (i) a foundation layer; (ii) a geomembrane infiltration (barrier) layer; (iii) a drainage layer; and (iv) an earthen vegetative layer.

5.7.4 Final Cover System Configuration

Two alternative final cover configurations meeting the regulatory requirements of the final cover system are proposed for the RL. The selection of the configuration will depend on interface strength testing results that allow the configuration to meet the static and seismic slope stability requirements for the site.

The first configuration of the final cover system will consist of the following elements (in order from bottom to top) (Figure 2):

- Foundation Layer* – an 18-in. thick foundation soil layer
- Barrier Layer – a 60-mil thick LLDPE geomembrane with ridges on one side and studs on the other
- Drainage Layer – an 8-oz/sy geotextile placed over the studded surface of the LLDPE geomembrane creates a drainage channel between the geomembrane and the geotextile
- Erosion (Vegetative) Layer – an 18-in. thick soil layer, the top 6 in. of which is capable of supporting vegetation

*Note: Foundation layer may be made up of 12 in. of approved Alternative Daily Cover (contaminated Soils) and at least 6 in. of uncontaminated soils.

The second configuration of the final cover system will consist of the following elements (in order from bottom to top) (Figure 2):

- Foundation Layer* – an 18-in. thick foundation soil layer

- Barrier Layer – a 60-mil thick linear LLDPE geomembrane textured on both sides
- Drainage Layer – a 12-in. thick gravel layer with an 8-oz/sy geotextile placed over the layer
- Erosion (Vegetative) Layer – an 18-in. thick soil layer, the top 6 in. of which is capable of supporting vegetation

*Note: Foundation layer may be made up of 12 in. of approved Alternative Daily Cover (contaminated Soils) and at least 6 in. of uncontaminated soils.

The erosion layer will be vegetated with native vegetation that is similar to the vegetation that grows in the areas surrounding the landfill. Plants will be selected for their suitability to local climate, percentage of surface coverage, root zone depths, hardiness and low maintenance requirements.

5.8 Landfill Gas Management System Components

The GCCS is expected to be expanded generally as presented in Appendix C. Updates to the proposed final layout may be made as regulations change or site conditions dictate in order to maintain sufficient coverage and collection efficiency. As shown, the majority of the GCCS is installed by the time final closure begins. The GCCS components are:

- Vertical LFG collection wells
- Well-head assemblies to permit the conditions at each LFG collection well to be monitored (well pressure and LFG composition) and the LFG collection rate to be controlled
- LFG lateral pipes connecting the LFG well-head assemblies to the main LFG header pipes
- LFG header pipes connecting the lateral pipes to the LFGTEF and flare station
- LFGTEF and LFG flare station
- Condensate collection and control system

Since most components of the GCCS are installed and constructed during the operation of the landfill, the components required for the FECP include:

- LFG collection wells
- Well-head assemblies
- LFG lateral pipes

5.9 Leachate Management System Components

The leachate management system will remain in operation during closure of the RL. No major modifications to the leachate management system are anticipated during closure activities.

5.10 Permanent Storm Water Management System Components

The SWMS components required for additional areas of final cover include the following:

- Ditches located on, or around the perimeter of, the final cover
- Culverts, headwalls, splash wall, and drop inlets
- Lined conveyance downdrains[18] constructed on the final cover surface
- Vegetation

Appendix A includes the information for the permanent SWMS. The permanent SWMS incorporates three ponds; and pipes, ditches, downdrains, drop inlets, and headwalls. Prior to closure construction, the basis of design, a verification of existing conditions at the time that closure is ready to take place, and the findings presented in Appendix A will be revisited, and the design revised as needed, to comply with future goals and site conditions at the time.

5.11 Slope Stability Analyses

This section first summarizes the landfill mass slope stability analyses followed by the landfill final cover system slope stability analyses. Both static and seismic slope stability analyses are addressed.

5.11.1.1 Landfill Mass Stability

The report entitled *Phase 1 MSE Berm Updated Permit Design Report, Riverbend Landfill, McMinnville, Oregon*, prepared by Geosyntec and dated 22 March 2012 [Geosyntec, 2012] presents the static and seismic slope stability evaluation for the landfill to the grades presented in the report.

The report entitled *Final Grading Plan Modification Permit Application Report, Riverbend Landfill, McMinnville, Oregon*, prepared by Geosyntec and dated 14 November 2016 [Geosyntec, 2016] presents the static and seismic slope stability evaluation for the FGPM grades presented in the report.

Slope stability was evaluated using the limit equilibrium procedures based on the Spencer [1967] method of slices. Spencer's method satisfies all conditions of force and moment equilibrium [Duncan, 1992]. Two-dimensional slope stability analyses were performed using the software program SLOPE/W [Geo-Slope International, Ltd., 2004]. The program employs a user-directed search routine to determine the potential critical slip surface with the minimum factor of safety. SLOPE/W was used to automatically search for critical shear surfaces through the berm, the waste, through the subgrade, and through the liner system.

To estimate seismic deformations, Geosyntec followed the procedures developed by Newmark [1965] and modified by Makdisi and Seed [1978]. The procedures are based on the concept of yield acceleration (k_y or the horizontal coefficient that results in a static factor of safety of 1.0). The shear stress time histories computed by DMOD at the level of the potential failure surfaces were divided by the overlying mass and double-integrated using the computer software

[18] Articulated Concrete Block (ACB), Gabion Mattress, and HydroTurf®.

YSLIP_PM [Yan et al., 1997] for different yield accelerations to generate graphs of yield acceleration versus seismic deformation.

The design earthquake for the site was estimated based on the results of a seismic hazard evaluation that satisfies Subtitle D and Oregon requirements which is presented in Appendix D of the Geosyntec [2012] report. The seismic deformations were estimated for the design earthquake for the site and presented in Appendix E of the Geosyntec [2012] report.

In 2015, in addition to the Subtitle D requirements, the DEQ requested that the new portions of the landfill such as the FGPM area and the final cover for the areas of the landfill that have not been closed be designed to a higher level of acceleration associated with a magnitude 9.0 earthquake to address the Oregon Resilience Plan. The selected higher level of acceleration was the 84th percentile ground motion which corresponds to the median plus one standard deviation ground motion. The resulting peak ground acceleration for lithified earth material in this scenario is predicted to be 0.44g. Further details are presented in the Geosyntec [2016] report.

The slope stability analysis results showed that static factors of safety exceeded the minimum acceptable factor of safety of 1.5 and the seismic deformations meet the acceptable limit equal to or less than 12 inches.

The slope stability presented in the Geosyntec [2012] report was further supported by numerous supplemental evaluations which were performed and presented in the following reports listed below that are incorporated by reference:

- Geosyntec Consultants, Inc., *Letter-Report: Response to Comments Related to: Seismicity and Seismic Slope Stability – Phase 1 MSE Berm, Riverbend Landfill, McMinnville, Oregon*; Geosyntec Project WG1597; 22 June 2012
- Geosyntec Consultants, Inc., *Letter-Report: Response to Comments Related to: Review comments provided by Hart Crowser, Inc. dated 14 August 2012; Riverbend Landfill, McMinnville, Oregon*; Geosyntec Project WG1597; 26 September 2012
- Geosyntec Consultants, Inc., *Letter-Report: Response to Comments Related to Review Comments Provided by Hart Crowser, Inc., Dated 5 October 2012; Riverbend Landfill; McMinnville, Oregon*; Geosyntec Project No. WG1597; 23 October 2012
- Geosyntec Consultants, Inc., *Letter-Report: Reply to Review Comments provided by Kleinfelder West, Inc.; Supplemental Third-Party Technical Review Comments on Geotechnical/Seismic Aspects for Application for Phase 1 MSE Berm and Application for Final Grading Plan; Riverbend Landfill, McMinnville, Oregon; DEQ Solid Waste Permit Number 345*; 7 November 2012
- Geosyntec Consultants, Inc., *Letter-Report: Reply to Review Comments provided by Hart Crowser dated 9 November 2012, Riverbend Landfill, McMinnville, Oregon, DEQ Solid Waste Permit Number 345*; 7 December 2012
- Geosyntec Consultants, Inc., *Letter-Report: Response to 18 December 2012 Comments by Mr. Doug Lindquist (Hart Crowser)*; 26 December 2012

- Geosyntec Consultants, Inc., *Letter-Report: Response to 2 January 2013 Comments by Mr. Doug Lindquist (Hart Crowser)*; 9 January 2013
- Geosyntec Consultants, Inc., *Letter-Report: Response to 11 January, 2013 email from Bob Schwarz (ODEQ) Regarding Item 5 on Kleinfelder December 21st, 2012 Letter*; 16 January 2013
- Geosyntec Consultants, Inc., *Letter-Report: Response to Comments from Dr. Zia Zafir and Mr. Peter Stroud (Kleinfelder) in Letter Dated 6 February 2013*; 13 February 2013
- Geosyntec Consultants, Inc., *Letter-Report: Response to prioritized questions from Mr. Bob Schwarz (Oregon Department of Environmental Quality - ODEQ) transmitted by e-mail on 5 February 2013*; 14 February 2013
- Geosyntec Consultants, Inc., *Letter-Report: Response to Request for Information on Effect of Unit Weight on Slope Stability by Mr. Bob Schwarz (Oregon Department of Environmental Quality) During 25 March 2013 Phone Call*; 27 March 2013
- Geosyntec Consultants, Inc., *Letter-Report: Response to Request for Information on Deterministic M9.0 earthquake by Mr. Doug Lindquist (Hart Crowser)*; 27 March 2013
- Geosyntec Consultants, Inc., *Letter-Report: Response to 1 November 2013 Comments by Kleinfelder on Slope Deformation report by Geosyntec*; 30 January 2014

Appendix D supplements the landfill stability analyses presented previously for the permitted grades. The slope stability presented in the Geosyntec [2016] report supports the slope stability of the FGPM and is also incorporated.

5.11.1.2 Landfill Final Cover Stability

Both static and seismic slope stability of the final cover system were also performed as a part of this FECP; detailed analyses are presented in Appendix D-2. Static stability analysis was evaluated for the cover system under short-term and long-term static conditions. The evaluation was based on the procedures presented by Matasovic [1991].

The generally-accepted static slope stability factors of safety are equal to or greater than 1.3 for short-term, and equal to or greater than 1.5 for long-term. Seismic stability analysis evaluated the potential displacements caused by the design earthquake; the estimated deformations at the final cover level under seismic loading from the Subtitle D design earthquake are between 7 and 36 inches for the final cover alternative that includes an Agru Supergripnet geomembrane. The U.S. EPA [1995] states *"As cover deformations are readily observable and damage to the cover is repairable, larger deformations are typically considered acceptable along interfaces in the cover system than along liner system interfaces."*

The results of both static and seismic slope stability analyses for the final cover system are presented in Appendix D. Based on these results, it can be concluded that the final cover slopes are stable.

On a long-term basis, the 3H:1V or flatter slopes will further flatten with time due to waste settlement; the flattening will improve static and seismic slope stability of the cover system.

5.12 Settlement Analyses

The decomposition of waste over time results in settlement of the landfill grades. Waste settlement has two components: primary settlement and secondary settlement. Primary settlement is assumed to continue for a few months after waste placement whereas secondary settlement continues for a long period of time. Therefore, the final grades will be mostly affected by secondary settlement.

Appendix B includes the settlement evaluation for the final grading plan, which includes estimated settlements at the end of the 30-year post-closure maintenance period. Based on the settlement calculations, over time, the final slopes are expected to flatten from the permitted final grades. However, positive drainage flow is maintained after settlement so the surface water can flow to the outside perimeter and be collected by the permanent storm water management system. Thus, the analysis indicates that the final cover system will perform as designed under anticipated settlements of waste and foundation. As part of post-closure maintenance, areas of ponding that may develop will need to be repaired due to settlements (e.g., reestablishment of pipe slopes and channels transitions and connections to address landfill settlement).

5.13 Final Cover Construction Considerations

The final cover will be designed and constructed to function with the minimum maintenance possible. A construction quality assurance (CQA) program will be instituted prior to final cover construction to document that proper construction techniques and procedures are used and to verify that the materials and installation techniques used meet the project and regulatory agency specifications. The CQA program will be carried out in compliance with an approved CQA Manual (Appendix G). After completion of the final cover construction, a CQA report will be prepared and submitted to the DEQ for approval. The final CQA report will be signed and sealed by a State of Oregon licensed professional engineer.

5.14 Additional Closure Activities

5.14.1 Decommissioning of Environmental Control Systems

It is planned for the environmental control systems existing at the time of closure will be left in place during closure and none will be decommissioned. However, if decommissioning is required due to closure activities, components of environmental control systems which have come in contact with leachate or LFG will be cleaned and reused or disposed of appropriately at the time of closure. Should the decommissioning of groundwater, leachate, or LFG monitoring wells become necessary, the appropriate regulatory agencies will be notified, permits obtained, and appropriate procedures employed.

5.14.2 Structure Removal

As part of closure activities, structures not required for post-closure care activities, post-closure land uses, or other post-closure uses will be dismantled and removed. Dismantling and removal of these structures will occur progressively as landfill closure operations are performed in accordance with the closure schedule. All personal property will be removed, office supplies recovered, and utilities disconnected as appropriate. Temporary structures will be cleaned as necessary before they are removed. Any monitoring facilities requiring off-site disposal will be cleaned on-site, residues will be hauled off for off-site disposal at a suitable site/facility.

5.14.3 Site Security and Access

The landfill site is secured by a fence restricting accessible locations with a lockable gate at the entrance and signs identifying the site as a landfill. The remainder of the site is inaccessible to vehicles. These facilities will remain in-place during closure. Groundwater monitoring wells are secured with locking caps.

The site security system of perimeter fencing, access gates with locks, and informational signs will already be established at the time of closure. Sixty (60) days prior to closure, signs will be placed at points of access to the site stating the intended date of closure as well as the location of alternative permitted solid waste management facilities. After the final receipt of waste, points of access to the site shall be restricted to authorized traffic only. Locked gates will be periodically monitored by security personnel and entry will only be permitted to authorized personnel throughout the closure period.

5.15 Closure Administrative Activities

5.15.1 Notification of Closure

In accordance with §258.60(e) of Subtitle D, before beginning closure, RLC will notify the DEQ that a notice of the intent to close the unit has been placed in the operating record.

5.15.2 Recording

Before closing the landfill, the Plan will be submitted to the DEQ. The Plan may require an update to include items specified under applicable closure regulations in effect when closure of the landfill occurs.

Closure construction of the RL will be conducted under the supervision of a CQA Officer who will be an Oregon licensed professional engineer. The CQA Officer will direct and certify preparation of the closure report for submission to the DEQ. The report will contain the following:

- A description of the closure activities and principal events;
- Construction record drawings;
- Applicable test results;
- The date closure was completed;
- A description and discussion of deviations from the approved FECP;
- Topographic map;
- Location and telephone number where the FECP can be obtained; and
- Drawings, specifications, and approved revisions.

The reports will contain a certification that the information presented is accurate to the best of the CQA Officer's knowledge, and a professional opinion as to whether the closure meets the requirements and intent of the approved FECP and associated construction documents.

Upon closure of the RL, a notation will be placed on the deed or title to the landfill facility in perpetuity, to notify potential purchasers of the property that the site is a landfill, and that future use of the site is restricted under §258.61(c)(3) of Title 40 of the CFR (i.e., Subtitle D).

5.15.3 General Closure Process

The closure work will be performed in accordance with the FECP and modifications to closure activities set forth in this FECP shall be limited to minor design changes and unforeseen events during closure. No changes that may affect the performance of the closure design will be implemented without prior approval of the regulatory agencies. The final CQA report submitted to the regulatory agencies after closure construction will document relevant changes to the design.

Pursuant to OAR 340-94-110(2)(a)(A), listed below is a general schedule of activities necessary to close the landfill in accordance with this FECP.

- Preparatory Grading – Grading of the areas to be closed may not be compatible with FECP design requirements. Time may be required for placing or re-grading waste or soil to an acceptable closure configuration.
- Contractor Selection – Following DEQ approval of this FECP, contract documents, including construction drawings and specifications, would be issued for bid to select a contractor to perform the closure construction.
- Closure Construction – Construction will begin following contractor selection and contract execution. However, construction will be weather-dependent because most construction activities can effectively only be performed between June and October. Therefore, depending on the timing of the preceding activities, there could be a discontinuity before construction can start.
- Preparation of Construction Report – After construction, a third-party professional engineer licensed in the State of Oregon will prepare a report documenting that closure construction complied with the approved final engineered closure plan.
- DEQ Inspection – Pursuant to OAR 340-94-120(4)(b), and within 30 days of receipt of the closure report requesting approval of the closure, DEQ shall inspect the facility to verify that closure was completed consistent with the approved FECP and the provisions of OAR 340 93 and -94. If DEQ determines that closure was properly completed, DEQ will approve the closure in writing. Closure will not be considered complete until such approval has been made. The date of the approval notice will also represent the date of commencement of the post-closure period.

5.15.4 Cost Estimate for Closure

The closure cost is primarily attributed to the construction of the final cover layers and ancillary facilities, such as LFG monitoring and control system, SWMS components, and security/structure components. Construction quality assurance (CQA) costs are also included in the closure cost estimate. The closure cost estimate includes construction of:

- The final cover system
- SWMS elements (e.g., downdrains, channels, energy dissipaters, etc.)
- Final LFG extraction system elements
- Hydroseeding

Closure components listed above are itemized in the "FECP" cost estimate presented in Appendix H. Individual items are summarized in the following categories:

- Earthwork
- Geosynthetics
- SWMS
- Temporary and Permanent Erosion Controls
- LFG Management System
- CQA, Engineering, Surveying, and Other Professional Services
- Miscellaneous

The closure cost estimate is based on the following assumptions:

- The area of the RL to receive final cover is approximately 59.5 acres
- Some unit costs were adjusted for inflation from the DEQ-approved April 2022 RL Closure and Post-Closure Plans [RLC, 2022]
- Available third-party pricing
- Professional engineering judgment of current costs

Actual costs will likely vary because of factors beyond the reasonable control of RLC, including market conditions, construction conditions, material availability, oil prices, labor relations, and other unforeseeable events at the time of closure construction. Therefore, the FECP cost estimate will be amended for those factors or changes in landfill operations, the change in the anticipated closure date, or at a minimum, annually to adjust for inflation.

The 2022 cost to close the remaining areas of the RL (i.e., approximately 59.5 acres) is estimated to be $10,542,666. Details of the FECP closure cost estimate are presented in Appendix H.

5.15.5 Maintenance of Closure Plan

To comply with the State (OARs 340) and Federal (Subtitle D) regulations, this document, once approved by the DEQ, will be kept by RLC in the RL operating record and updated as needed. The FECP will be accessible at the RLC office (13469 SW Highway 18, McMinnville, Oregon 97128;

phone number 503-472-8788) during landfill operating hours. Once the landfill is closed, the documentation will be available at the RLC/WM office in Portland.

5.15.6 Change of Ownership

If RLC transfers ownership of the RL to another party during closure, RLC will notify the DEQ of the transfer at least 10 days in advance of ownership change or operator change [DEQ, 2022] and will notify the new owner of the existence of the standards and of the conditions and agreements signed to assure compliance.

6. FINAL ENGINEERED POST-CLOSURE PLAN

6.1 Final Engineered Post-Closure Requirements

6.1.1 Federal Requirements

Federal post-closure plan requirements are specified in 40 CFR 258.61(a)-(c) below:

(a) Following closure of each MSWLF unit, the owner or operator must conduct post-closure care. Post-closure care must be conducted for 30 years, except as provided under paragraph (b) of this section, and consist of at least the following:

(1) Maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;

(2) Maintaining and operating the leachate collection system in accordance with the requirements in §258.40, if applicable. The Director of an approved State may allow the owner or operator to stop managing leachate if the owner or operator demonstrates that leachate no longer poses a threat to human health and the environment;

(3) Monitoring the ground water in accordance with the requirements of subpart E of this part and maintaining the ground-water monitoring system, if applicable; and

(4) Maintaining and operating the gas monitoring system in accordance with the requirements of §258.23.

6.1.2 Oregon-Specific Requirements

Oregon adopts the federal requirements described above, and has additional post-closure requirements in OAR 340-94-115(3):

(3) Requirements for post-closure plans. Post-closure plans shall identify the post-closure activities which will be carried on to properly monitor and maintain the closed municipal solid waste landfill site:

(a) Requirements for the "Subtitle D" post-closure plan shall include all elements specified in 40 CFR §258.61, and consist of at least the following:

(A) Maintaining the integrity and effectiveness of any final cover;

(B) Maintaining and operating the leachate collection system;

(C) Monitoring the groundwater;

(D) Maintaining and operating the gas monitoring system;

(E) Monitoring and providing security for the landfill site; and

(F) Description of the planned uses of the property during the post-closure care period.

And in OAR 340-94-130(b):

(1) Post-closure requirements:

(a) Upon completion or closure of a landfill, a detailed description of the site including a plat shall be filed with the appropriate county land recording authority by the permittee. The description should include the general types and location of wastes deposited, depth of waste and other information of probable interest to future land owners;

(b) During the post-closure care period, the permittee must, at a minimum:

(A) Maintain the approved final contours and drainage system of the site;

(B) Consistent with final use, ensure that a healthy vegetative cover is established and maintained over the site;

(C) Operate and maintain each leachate and gas collection, removal and treatment system present at the site;

(D) Operate and maintain each groundwater and surface water monitoring system present at the site;

(E) Comply with all conditions of the closure permit issued by the Department.

(2) Post-closure care period. Post-closure care must continue for 30 years after the date of completion of closure of the land disposal site, unless otherwise approved or required by the Department according to OAR 340-094-100(4) and (5).

6.2 Objectives

The main objectives of the FEPP are:

- To provide a basis for the operator to establish a preliminary estimate of post-closure monitoring, maintenance, and inspection costs;
- To allow a licensed professional to certify to the accuracy of the cost estimate; and
- To enable the regulatory agencies to evaluate the reasonableness of the cost estimate.

6.3 Post-Closure Activities

The following activities are expected to be performed during the post-closure period to check that environmental protection systems continue to function as intended.

6.3.1 Operations, Maintenance and Administrative Requirements

As required in Part 340-094-115 of the OARs, the following general operations, maintenance, and administrative requirements are anticipated:

- Final cover maintenance, including; labor, equipment, and supplies for minor re-grading, re-seeding, and fertilizing;
- Final cover surveying (either ground or aerial survey) to check settlement and grades;
- MSE berm stability monitoring;
- MSE berm inspections;
- MSE berm maintenance (vegetated face seeding, pavement crack sealing, surface water improvements cleaning, etc.)
- General facility and final cover mowing;
- Maintenance of surface water management features;
- Building security, repairs, and demolition;
- Fence and road maintenance;
- On-site utilities (excluding LFG and leachate equipment);
- Third-party inspections, reports and management;
- Internal administration;
- Insurance; and
- Permitting costs.

6.3.2 Groundwater and Storm Water Monitoring

The following activities, associated with groundwater and storm water monitoring, are anticipated:

- Semi-annual groundwater sampling, sample analyses, quality assurance review, statistical evaluation, and reporting
- Monthly storm water observations, inspections and documentation, if applicable, will be performed as part of routine cover inspections.
- Contingency for the redevelopment of groundwater monitoring wells
- Contingency for groundwater monitoring well decommissioning and replacement as needed

6.3.3 Leachate Collection, Treatment, and Disposal

The leachate collection and removal system is expected to remain active for the 30-year post-closure period. However, leachate production is expected to decrease during that period because the Modules would be covered with a geomembrane. The following general activities associated with the collection, treatment and disposal of leachate and the maintenance and repair of the systems are anticipated:

- Leachate sampling, sample analyses, quality assurance review, and reporting; and
- Leachate hauling for off-site treatment and disposal at approved facilities.

6.3.4 Landfill Gas Collection and Control System

RL's infrastructure includes a LFGTEF that is operated by a separate financial entity within WM. It has been assumed that the revenue from operating the facility will compensate for associated operational and decommissioning costs of the facility. Therefore, this facility has not been included in this plan.

The following GCCS operations, maintenance, monitoring, and decommissioning items are included in the post-closure cost estimate:

- Surface emissions monitoring and reporting
- LFG migration monitoring and reporting
- LFG probe repair and contingency for replacement
- GCCS operation, inspection, maintenance and repairs
- Blower maintenance and repairs
- Blower replacement contingency
- Electric power
- Flare maintenance and repair
- One-time conversion from active to passive operation
- One-time system decommissioning
- Annual NSPS and Oregon Landfill Methane Reduction monitoring
- Title V Air Operating Permit compliance, reporting and fees

6.4 Post-Closure Landfill Inspection and Maintenance

6.4.1 General

This section describes the inspection and maintenance procedures and methods to be used during post-closure care at the RL. These procedures will be used for the final cover, SWMS, leachate management system, LFG management system (or GCCS), and groundwater quality monitoring systems.

Post-closure care at the RL will be provided by RLC for at least 30 years from the date of the landfill final closure or as required by the DEQ.

During the 30-year post-closure maintenance period, the RL will be periodically inspected, maintained and repaired, as necessary. Inspection of the closed RL will be performed by RLC personnel to meet post-closure requirements.

6.4.2 Inspection Frequency

Generally, during the first years after landfill closure, the frequency of inspections will be at least quarterly and adjusted as necessary based on results of initial inspections and landfill conditions. After conditions are confirmed to be stable, semiannual and then annual general inspections will be performed throughout the post-closure care period.

Additional inspections will be scheduled as needed after periods of extremely wet or dry weather, extreme storm events, and major seismic events (magnitude 5.0 or larger) to verify there has been no damage from the event.

6.4.3 Reporting Procedures

The inspection and maintenance procedures depend upon timely and accurate reporting of inspections and timely implementation of maintenance and repair actions. An inspection report shall be prepared following each inspection giving a detailed description and approximate location of deficiencies. Corrective measures taken to remedy each deficiency shall also be described in the inspection report.

Post-Closure inspection reports will be generated and entered into the operating record of the RL. A Post-Closure Inspection Log presented in Table 1 (or similar) will be used to document inspection activities.

If the periodic inspection at the RL indicates that corrective action is required to repair or restore a component, maintenance will be performed. A Post-Closure Maintenance Log presented in Table 2 (or similar) will be used to document maintenance and repair activities at the RL. The table lists specific problems that may occur and the corresponding maintenance procedures, heavy equipment, and materials that may be required to perform maintenance.

When a problem is noted, corrective action will be taken as soon as practicable. Maintenance work will be documented, and documentation will be physically attached to the inspection records that noted the required work. This documentation should include the type of maintenance performed, how it was performed, and a list of materials and equipment used to perform the maintenance.

The operating record shall be maintained at the RL by RLC for the duration of the post-closure maintenance period. The operating record will be available to local, state, and federal regulatory agencies upon request.

6.4.4 Post-Closure Maintenance Equipment

RLC will obtain necessary construction equipment from local rental agencies or contractors to perform required post-closure maintenance activities. Alternatively, RLC may retain certain construction equipment at the RL during the post-closure maintenance period.

Additional equipment or other resources necessary for inspection and maintenance procedures will be available during the RL post-closure maintenance period.

6.4.5 Final Cover

6.4.5.1 General

The Subtitle D requirements in Section 258.61(a)(1) state that post-closure maintenance should include: *". . .maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover. . ."*

The functions of the final cover are to: (i) limit liquid infiltration; (ii) control LFG emissions; (iii) isolate the buried wastes; and (iv) promote surface water runoff while controlling erosion and accommodating settlement and subsidence. The purpose of the post-closure maintenance procedures described herein is to maintain the integrity of the completed final cover system throughout the post-closure maintenance period.

Post-closure maintenance activities are anticipated as a result of the following conditions:

- Elective intrusion into or through the final cover system associated with maintenance of environmental control systems
- Settlement-related depressions and SWMS interruptions that interfere with the controlled runoff of surface waters from the closed landfill surface
- Surface erosion
- Cracking of final cover soils
- Local surficial slumping on slopes
- Any condition that compromises the integrity of the final closure system

6.4.5.2 Inspection Procedures

Routine inspection of the final cover will be conducted to identify areas where maintenance is required to minimize the effect and extent of the above conditions. During cover inspections, the following particular areas will be noted:

- Areas where vegetation has died off
- Areas where erosion is apparent
- Areas where seepage is apparent
- Areas where odors are emitted from the surface

The following action items and inspection practices and procedures will be instituted following closure:

- Routine inspections will be performed by WM staff or designated third parties and the inspector will be responsible for inventorying, monitoring, and coordinating repair of final cover irregularities
- Employees with access to the site will be instructed to identify, observe, and report, in writing, to the final cover performance officer unusual surface conditions at the time they are observed
- Top deck and side-slope areas will be visually inspected by grid walking as needed and a report of findings will be prepared

6.4.5.3 Maintenance and Repair Procedures

Final cover maintenance activities will be conducted in a manner to maintain the integrity of the as-built final cover system. Repair materials will be placed in a manner consistent with the original final cover design. If repairs to the final cover impact the LFG management system, repairs to the GCCS will be conducted in accordance with Section 6.4.8.

Repairs of LFG headers and LFG wells may be necessary to maintain proper functioning of the environmental monitoring and control systems. Such repairs may necessitate intrusion into the final cover system. If intrusion into the final cover is required, procedures that may include cutting existing geosynthetics and installing new ones shall conform to the requirements of the final cover construction specifications and drawings. Repairs of the geomembrane shall be subjected to CQA testing in accordance with the CQA Manual for construction of the final cover. Depressions, ponding, surface erosion, or other settlement features will also be repaired in a reasonable and timely manner and as weather allows for safe access to the areas with equipment.

6.4.6 Final Grading, Slope Protection, and Erosion Control

6.4.6.1 General

Repair or amending grades, slope protection, or erosion control will be conducted in accordance with the specifications and repair procedures for final cover presented below and in Section 6.4.5. Maintaining sufficient vegetation over the surface of the landfill is an integral component in maintaining adequate erosion protection.

6.4.6.2 Inspection Procedures

The vegetation will be inspected for landfill surface coverage and stress indications. The causes of these irregularities or deficiencies shall be ascertained at the time of environmental monitoring wherever possible. Landscaping monitoring parameters also include soil quality control, rodent control, and a reseeding program, if necessary. Corrective action will be taken to remedy observed deficiencies.

Inspections of the vegetative (erosion control) layer will be conducted in conjunction with the final cover inspections discussed in Section 6.4.5. The inspector shall also be responsible for documenting and monitoring the following procedures:

- Employees with access to the site will be instructed to identify, observe, and report in writing any unusual landfill surface conditions

- The vegetative layer of the landfill will be visually inspected, and a report of findings will be prepared
- The vegetative layer of the landfill will be visually inspected following unusual events and a report of findings will be prepared following any such unusual event

The landscaping will be inspected for landfill surface coverage and stress indications. The causes of irregularities shall be ascertained at the time of environmental monitoring whenever possible.

6.4.6.3 Maintenance and Repair Procedures

Maintenance of the vegetative layer and the landscaping will be conducted by qualified personnel. Maintenance efforts are expected to be greatest during the vegetation establishment period and are projected to lessen thereafter. The inspection schedule after the establishment period is expected to decrease accordingly.

Vegetative (Erosion Control) Layer

It is anticipated that the 18 in. thick vegetative (erosion control) layer will require periodic maintenance throughout the post-closure maintenance period. Repairs to the vegetative layer will be performed in a manner consistent with the original vegetative layer construction procedures. Clean fill will be placed in loose lifts of 6 to 8 in. in thickness to re-establish grades to appropriate elevations, as necessary.

Landscaping

Landscaping will be established to promote long-term erosion control and to protect the final cover system. Routine inspection of the vegetation should be conducted during and after the plant establishment period.

Reseeding of the vegetated area will occur on an as needed basis. Reseeding may be necessary if slope reworking has occurred or in the event that weed pulling has caused the death or sparseness of the native vegetation. The reseeding efforts will be consistent with the intent of the original vegetation.

Inspection for the existence of a rodent population at the closed RL will be made routinely. If it is suspected that rodents are threatening the integrity of the vegetative (erosion control) layer, extermination procedures will commence. A qualified professional will be contracted to perform the necessary services.

6.4.7 Storm Water Management System

6.4.7.1 General

Post-closure inspection and maintenance of the SWMS will continue to be implemented during the post-closure maintenance period. The inspection and maintenance programs outlined below provide a comprehensive set of procedures to monitor and maintain the integrity of the SWMS as necessary during the post-closure maintenance period.

Control of runoff, erosion and sediment during the landfill post-closure maintenance period will be accomplished through the use of drainage ditches, channels and culverts, diversion dikes, straw bale barriers, seeding, and ponds. Flow from the developed areas will be intercepted by the channels and routed to the ponds. The channels or ditches will be periodically maintained. Erosion will also be controlled during the landfill post-closure maintenance period by using permanent seeding of landfill slopes.

Maintenance and inspection of the SWMS also includes the ditches, headwalls, splash walls, and drop inlets constructed in the MSE berm. The inspection procedures will be the same as for the other portions of the closed landfill.

6.4.7.2 Inspection Procedures

An inspection report will be prepared following each inspection giving a description and approximate location of deficiencies. Corrective measures taken to remedy each deficiency shall also be described in the inspection report. Infrastructure repairs will be performed in accordance with manufacturer recommendations.

Inspection procedures for ditches, ditches, and channels include checking for erosion ruts, settlement cracks, and maintenance of positive flow.

Each culvert and drainage structure at the landfill will be inspected to identify any of the following deficiencies:

- Joint separation
- Invert failure
- Structural failure
- Perforations
- Presence of silt and/or debris

Corrective measures taken to remedy each deficiency shall also be described in the inspection report.

Downdrains convey storm flow from the top deck and from side slope swales into perimeter drainage channels or culverts. These downdrains are constructed on the exterior face of the finished slopes. An inlet apron will be constructed of rock around each inlet to serve as a non-erodible approach for deck and bench runoff.

The top deck areas will be graded to allow for sheet flow away from the center of the deck area to the edges of the deck. The berms, if present, on the top deck will be inspected and repaired with soil of suitable properties in a manner consistent with the repair of the final cover system and the vegetation (erosion control) layer.

The storm water ponds are equipped with low-level water outlets and emergency spillways. A visual inspection of each pond component will be conducted to identify deficiencies such as structural failure and presence of silt and/or debris.

6.4.7.3 Maintenance and Repair Procedures

Bench maintenance will consist of erosion control along the toe of the slope and re-grading of areas, which have been subjected to differential settlement. Re-grading will control ponding and help maintain drainage into the inlet structures. In areas where landfill settlement affects the bench grades, additional vegetative layer soil cover material will be placed and compacted to re-establish positive drainage, as needed.

Maintenance activities will include, as necessary, drainage channel and downdrain repairs, removal of silt and debris along drainage channels and in the storm water ponds, repair and replacement of erosion and sediment controls (e.g., silt fences, straw bales, riprap), and grading of the final cover erosion layer.

Typical culvert, downdrain, and perimeter channel corrective measures for deficiencies include the following; other methods may be employed based on current industry practices available at the time of repair:

- Joint separation:
    - Use wider CSP band couplers, where applicable, with mastic or pumped grout
    - Attach patches with self-drilling/self-tapping screws or welds
- Invert failure:
    - Replace unit
    - Replace piping
    - Patch pipe as necessary
- Structural failure:
    - Replace unit
    - Reinstall pipe anchor supports
    - Replace section of drain
- Clogging by silt/debris:
    - Use vacuum pumps, or equivalent, to clear extensively clogged culverts
    - Use a waterjet spray, or equivalent, to force debris out of the drains
    - For smaller amounts of debris, use a bucket line, or similar
    - Use a fire hose to flush out debris

Small amounts of silt and debris may be removed by buckets or waterjet flushing. Extensive clogging may require either vacuum pump or waterjet spray.

Access roads for maintenance will be provided on the decks to reduce interference with any surface flows. It is important that maintenance vehicles utilize access roads and benches whenever possible to reduce surface rutting that could interfere with normal drainage patterns.

For open channels and the storm water ponds, the following are examples of corrective measures that can be taken for deficiencies identified during the inspection:

- Cracking:
  - Construction of expansion/control joints
  - Placement of sealants such as epoxy resins, asphaltic material, thermoplastics or silicones
- Settlement:
  - Grouting injection
  - Removal of modular concrete blocks
  - Completion of replacement with subgrade work

6.4.7.4 Storm Water Monitoring System

The maintenance required for the surface water monitoring system is that required for the SWMS (Section 6.4.7). The required inspection and maintenance programs will maintain the drainage system in proper working order and facilitate post-closure surface water monitoring activities.

6.4.8 Landfill Gas Management System

6.4.8.1 General

The federal requirements for post-closure care as specified in 40 CFR 258.61(a)(4) of Subpart F require *"… maintaining and operating the gas monitoring system. . ."* a minimum of 30 years after the site is closed in accordance with the requirements of 40 CFR 258.23.

The GCCS is an environmental control system at the RL that will be in operation for the 30-year post-closure maintenance period, or as long as is required. The corresponding inspection and maintenance program includes maintenance requirements for pipe breakage due to landfill settlement and pipe blockage due to the formation of condensate, as well as management of the condensate.

Current LFG flows are declining and are expected to continue to decrease over time. Inspection and monitoring of the system will continue throughout the post closure period or until such time the system can be decommissioned and removed in compliance with the regulatory requirements.

6.4.8.2 Landfill Gas Extraction System

The LFG system has been installed throughout the filling process after the waste has been in place for 5 years, within 2 years of reaching final grades, or as needed to control LFG. Collectors have been installed to address odor issues or to address migration detected by the perimeter monitoring system. The system is composed of the LFG vertical extraction wells, horizontal collectors, and associated piping. The system will be inspected and maintained throughout the 30-year post-closure period or until the site meets the requirements for decommissioning and removal of the system.

Inspection Procedures

The LFG management system will be inspected with a focus on well head assemblies, pipeline couplings, connections, pipeline leaks (which may be indicated by a methane odor, hissing sounds, elevated methane concentrations in surface air samples, or elevated oxygen readings in the collection system), pipeline breakage, cracking, abnormalities, or deformations. Regular inspections of the blower/flare station will also be performed to verify adequate and safe operation.

Maintenance Procedures

Maintenance procedures for elevated subsurface temperature regulations pertain to surface emissions monitoring and sealing of landfill surface cracks. Sealing surface cracks greatly reduces the ability of oxygen intrusion to occur. Wellhead monitoring of the LFG temperature and gas composition serves as an indicator of elevated subsurface temperatures.

Routine inspection and maintenance of the LFG extraction system will include adjustment to valves, testing of well pressures, checking for LFG leakage at the well-head, and checking the integrity of well penetrations through the final cover.

Surface repairs will be conducted in accordance with the final cover repair procedures. LFG wellhead flows can be reduced or completely shut off by valve adjustments to reduce oxygen intrusion, and therefore, lower subsurface temperatures.

Cracked, broken, or malfunctioning portions of the GCCS will be repaired upon detection in accordance with industry standards. GCCS repairs are dependent on the nature and extent of damages and may include removal and replacement of solid-wall sections of pipe, soil backfill, bentonite grout, and/or geomembrane boots. If it is determined that LFG wells are damaged beyond repair, they will be abandoned and/or re-drilled. Repairs to the LFG headers may include removal and replacement of damaged header pipe. These repair activities will be conducted in compliance with applicable state and federal regulations.

6.4.8.3 Landfill Gas Monitoring System

Inspection Procedures

The current LFG monitoring system consists of the LFG monitoring probes installed at strategic locations along the perimeter of the landfill footprint. Details of the system and the monitoring program are provided in Appendix B of the EMP [SCS, 2022]. Visual inspections of the LFG monitoring probes will be conducted during the post-closure maintenance period with attention to broken probes, end caps, sampling ports, and valve boxes.

Maintenance Procedures

Repairs will be conducted upon detection. Monitoring probes may be re-drilled if they have sustained excessive damage. Repairs will be conducted in accordance with industry standards.

6.4.8.4 Landfill Gas Condensate

Inspection Procedures

The LFG condensate management system will be inspected monthly, in conjunction with the monthly inspections of the GCCS. LFG condensate piping and storage tanks will be visually inspected for leaks or breakage, and condensate pumps will be checked for proper operation. Detection of odor and evidence of condensate leakage or minor spillage are indicators of the malfunctioning of the LFG condensate management system.

Maintenance Procedures

Maintenance and repairs to the LFG condensate management system will be made upon detection. Cracked, broken, or malfunctioning portions of the LFG condensate management system will be repaired in accordance with industry standards. If maintenance is required, RL personnel may be assisted by contractors as necessary to complete repairs as rapidly as possible.

6.4.9 Leachate Management System

6.4.9.1 General

The federal requirements in §258.61(a)(2) of Subtitle D state that post-closure maintenance, which must be conducted for at least 30 years, should include *". . .maintaining and operating the leachate collection system in accordance with requirements of §258.40. The Director of an approved State may allow the owner or operator to stop managing leachate if the owner or operator demonstrates that leachate no longer poses a threat to human health and the environment."*

The leachate management system (LMS) at the RL consists of a leachate storage pond and sumps, HDPE pipes, and pumps designed to transfer leachate from the leachate collection sumps to the leachate pond via a dual-contained forcemain. The leachate in the pond either evaporates during warm weather or is transferred to tanker trucks and shipped to offsite wastewater treatment plants or to Hillsboro Landfill (a WM facility). After closure, the leachate will continue to be shipped to offsite wastewater treatment plants or another WM landfill.

LCRS side-slope risers and sump pumps will be operated, inspected, maintained, and tested regularly as long as there appears to be a potential for liquid flow into the LCRS sumps. Monitoring during post-closure will vary depending on conditions encountered during the year. In this regard, leachate production generally decreases with time after a final cover has been installed. Nonetheless, a certain period of time may be necessary for the moisture content to stabilize and for actual decreases in leachate production to occur.

At this time, it is anticipated that leachate will be transported to an approved waste-water treatment facility for treatment and disposal. Both the quantity and quality of leachate shall be monitored. Therefore, the frequency of monitoring and testing to be performed will be determined at the time of closure based on results of current monitoring as outlined in the current EMP.

6.4.9.2 Inspection Procedures

A visual inspection of the LMS will be made by qualified RLC personnel or contracted maintenance crews. If repairs to the system are required, the necessary personnel will be notified. The focus of the inspections will be on the LCRS pumping equipment and leachate evaporation pond.

As part of the visual inspection, the following items should be checked:

- Motor/pump electrical control panel for tripped breakers;
- Float switch settings;
- Leachate piping for evidence of any leakage;
- Valve inspection for damage and/or leaks;
- Leachate storage ponds for evidence of leakage or damage; and
- Discharge piping for clogging or buildup of particulate matter on pipe walls (this type of inspection would be conducted only during a more invasive inspection).

6.4.9.3 Maintenance and Repair Procedures

Based on the results of the inspection activities, repairs and/or replacement of components of the LMS will be made as necessary. Identified worn or malfunctioning elements of the LMS will be repaired or replaced, as appropriate. The repair will be performed by qualified RLC personnel or contracted firm.

6.4.10 Groundwater Monitoring System

6.4.10.1 General

Water quality monitoring and reporting during the post-closure maintenance period will initially be conducted with the same frequency, at the same monitoring points, and for the same constituents as for the landfill when active. The current groundwater monitoring system is presented and described in detail in the current EMP. The EMP will be updated as needed to reflect the required groundwater monitoring activities and document any adjustments that recommended and approved by DEQ.

6.4.10.2 Inspection Procedures

The groundwater monitoring network will be inspected each time groundwater samples are collected from the wells. The sampling technician will inspect well caps, casings, and protective post-structures for signs of damage or deterioration and missing padlocks.

6.4.10.3 Maintenance and Repair Procedures

Depending upon the extent of deterioration or damage, the monitoring well will be either repaired or replaced as soon as practical after detecting the problem. During inspections any damaged or inoperative caps and locks will be replaced as required. Other repairs, including possible well abandonment and re-drilling, will be conducted in accordance with regulatory standards.

6.4.11 Mechanically Stabilized Earthen (MSE) Berm

6.4.11.1 General

The MSE berm inspection and monitoring includes such items as stability monitoring, inspection of the surface water features and visual reconnaissance of the berm, and maintenance. Inspection and monitoring will be conducted in accordance with the most current version of the *Riverbend Landfill Phase 1 MSE Berm Stability Monitoring Plan* [Geosyntec, 2013; and updated 2019] and as described below.

6.4.11.2 MSE Stability Monitoring

Stability monitoring includes field work and data acquisition, data evaluation and reporting, and instrumentation repairs. Stability monitoring is performed to detect movement. As part of monitoring, the following items would be checked:

- Slope inclinometers
- Vibrating Wire Piezometers
- Extensometers

A report would be prepared and submitted by RLC. If the instrumentation were to stop working, it would be repaired.

6.4.11.3 Berm Inspection

Inspection of the MSE berm storm water control features would be performed during inspection of the landfill following similar procedures as described in Section 6.4.7. The MSE berm would also be inspected for movement (see Section 6.4.11.2), erosion, condition of the facing (e.g., welded wire forms, geogrids, vegetation, etc.), seepage, and condition of other features such as the asphalt paving. Based on the findings of the inspections, repairs will be made as necessary. The repair will be performed by qualified RLC personnel or contracted firm.

6.5 Security

During the post-closure maintenance period exposed waste will not be observable and no uncontrolled health hazards will exist. However, to protect and maintain the integrity of the closed landfill, the security measures, implemented at closure, will continue through the post-closure maintenance period. These measures are expected to include maintenance of the fences and gates to restrict access to unauthorized personnel.

6.6 Post-Closure Land Use

There are no specific development plans for post-closure use of the closed RL. Until there are specific plans, approvals, and assurances for public use of the former landfill, site access will be restricted to authorized personnel.

6.7 Post-Closure Cost Estimate

Part 258.72 of Subtitle D requires that *"The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to conduct post-closure care for the MSWLF unit in compliance with the post-closure plan developed under §258.61 of this part. The post-closure cost estimate used to demonstrate financial assurance in paragraph (b) of this section must account for the total costs of conducting post-closure care, including annual and periodic costs as described in the post-closure plan over the entire post-closure care period. . .*

(1) The cost estimate for post-closure care must be based on the most expensive costs of post-closure care during the post-closure care period."

The costs of post-closure maintenance at the RL will be primarily attributable to the inspection and maintenance of the systems and structures described in this plan.

The post-closure activities discussed in this FEPP are itemized in the Post-Closure Cost Estimate presented in Appendix H. Annual costs are estimated to be approximately $769,592. The estimated 30-year post-closure cost is $23,087,752.

Actual costs will vary because of factors beyond the reasonable control of RLC, including market conditions, construction conditions, material availability, labor relations, and other unforeseeable events. Therefore, the estimate will be amended for those factors or changes in landfill operations, the change in the anticipated closure date, a change in the approved financial mechanism, or at a minimum, annually to adjust for inflation.

Post-Closure care cost estimates are based on the cost of hiring a third party to maintain, monitor, and inspect the closed landfill in accordance with the FECP and reflect the costs for design, materials, equipment, labor, administration, and quality assurance. The cost estimate used to demonstrate financial assurance was obtained by multiplying the annual cost of maintenance and monitoring anticipated during the post-closure period by 30 years. The cost estimate will be modified when changes to this FEPP or the landfill indicate an increase or decrease in post-closure maintenance costs.

6.8 Maintenance of Post-Closure Plan

The FEPP will be maintained at RL as long as the facility is open, during closure activities and for the post-closure maintenance period. However, if there are no offices located at RL during the post-closure period, the FEPP will be maintained at the WM office in Portland, Oregon.

6.9 Change of Ownership

RLC and WM are responsible for post-closure maintenance activities at the RL and related costs. If a change in ownership occurs during the post-closure maintenance period, RLC/WM will notify the new owner concerning the existence of the conditions, regulatory standards and requirements relating to post-closure maintenance of RL, and signed agreements that are in place to assure continued compliance. RLC/WM will also notify the DEQ and other appropriate regulatory agencies of the change in title within 30 days.

6.10 Completion of Post-Closure Care Period

Part 258.61(e) of Subtitle D and Section 17(b)((3)(5) of Title 11 of the HAR require that *"Following completion of the post-closure care period…, the owner or operator must notify the State Director that a certification, signed by an independent registered professional engineer…, verifying that post-closure care has been completed in accordance with the post-closure plan, has been placed in the operating record."*

Following completion of the post-closure maintenance period, RLC will submit a certification verifying that post-closure maintenance period was completed in accordance with the FEPP. The certificate, signed by a licensed professional engineer, will be submitted to the DEQ, the State enforcement agency for the landfill.

7. CLOSURE AND POST-CLOSURE CARE FUND

The federal (Subtitle D) and state (OAR 340) regulations require that RLC demonstrate the availability of financial resources to conduct closure and post-closure maintenance activities. Financial responsibility is essential for providing long-term assurance that the site will be closed and maintained during the 30-year post-closure period in a manner that continues to protect public health and safety, and the environment from pollution due to disposal of solid waste at the RL.

Part 258.74 of Subtitle D states that *"The mechanisms used to demonstrate financial assurance. . . must ensure that the funds necessary to meet the costs of closure, post-closure. . . will be available whenever they are needed. . ."*

RLC currently employs both Trust Fund and Surety Payment Bonds to satisfy the financial assurance obligations for closure and post-closure maintenance.

The current financial assurance status, current trust account statements (showing balances and transactions over the previous year), and bonds are provided in Appendix H.

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9. LIMITATIONS

Geosyntec has prepared this report by compiling information from other sources and updating the historic document based on currently available information. RLC staff have provided guidance on which sections of the report to update and have contributed to the updating of the document. It is expected RLC personnel will notify involved parties should relevant changes occur that would require this document to be modified.

TABLES

Table 1
POST-CLOSURE INSPECTION LOG
Riverbend Landfill

Item	Problem	Acceptable		Observations	Date and Nature of Repairs/Action
		Yes	No		
Cover Material	Erosion, inadequate protective vegetation, ponding				
Run-off Diversion Channels	Obstructions to flow, bank erosion, deterioration, excessive silting				
Drainage Ditches	Erosion, clogging, obstruction of culverts				
Area Inlet to and Outlet From Storm-Water Piping System	Erosion, deterioration, silting, blockage, clogging, damage to riprap at inlet and outlet				
Stormwater Run-off Piping (Onsite Stormwater Management)	Silting, deterioration, blockage, clogging, joints				
Stormwater Run-off Piping (Western Bypass Channel)	Silting, deterioration, blockage, clogging, joints				
Leachate Collection/Removal System	Cracks, deterioration, clogging, and blockage				
Leachate Collection and Removal System - Liquid Level Indicator Gauges	Inoperative, sticking				
MSE berm stability monitoring	Documentation of settlement and movement; trouble-shooting of instrumentation				
MSE berm inspection	Erosion of vegetated face, condition of facing elements, geosynthetics; cracking of pavement; silting, clogging of storm water control features				
Benchmarks	Dislocation, damage				
Facility Fence	Corrosion, damage, vandalism				
Gates and Locks	Corrosion, damage, vandalism				
Access Roads	Erosion, cracks, deterioration, excess rutting, loss of aggregate (where used)				
Warning Signs	Damaged, deteriorated, missing				
Locks on Groundwater and Gas Monitoring Wells	Corroded, broken				

Table 2
POST-CLOSURE MAINTENANCE LOG
Riverbend Landfill

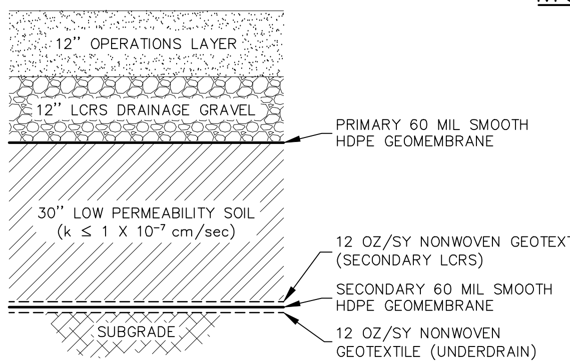
Problem	Maintenance Procedure	Equipment Requirements	Materials Requirements
SECURITY CONTROL:			
Fallen or broken fence	Repair or replace fence. Add fence post(s), if necessary	None	Fence, fence post, wire, concrete
EROSION DAMAGE:			
Bare spots on final cover or MSE berm	Revegetate; if unsuccessful use erosion mat and revegetate, check for landfill gas.	None	Erosion mat, seed, fertilizer mulch
Soil loss or along MSE berm	Backfill and place erosion mat and revegetate	Backhoe, front end loader, or grader	Backfill, erosion mat, seed, backfill mulch
CAP DEFORMATION RESULTING FROM SETTLEMENT, SUBSIDENCE, OR DEFORMATION:			
Cracks or Fissures	Backfill, revegetate	Grader, backhoe, front end loader	Backfill, seed, fertilizer mulch
Ponding	Backfill, revegetate	Grader, backhoe, front end loader	Backfill, seed, fertilizer mulch
Access Road	Backfill, repair	Grader, backhoe, front end loader	Backfill
RUNOFF CONTROL STRUCTURES:			
Clogged soil drainage ditches	Clear debris	Backhoe, grader, hand tools	Backfill, riprap
Clogged culvert, water quality units	Clear debris	Hand tools, vacuum truck	None
Clogged Inlet and Outlet structures	Clear debris	Hand tools, backhoe	None
Blocked channel and pipe	Clear debris	Hand tools, backhoe	None
Deteriorated culverts and pipe	Repair or replace culvert	Backhoe, hand tools	In accordance with manufacturer recommendations
Eroded soil drainage ditches	Regrade, place riprap or erosion mat, revegetate	Bulldozer , grader, or backhoe	Backfill soil, seed, fertilizer, mulch, erosion mat, riprap, geotextile

Table 2 (cont'd)
POSTCLOSURE MAINTENANCE LOG
Riverbend Landfill

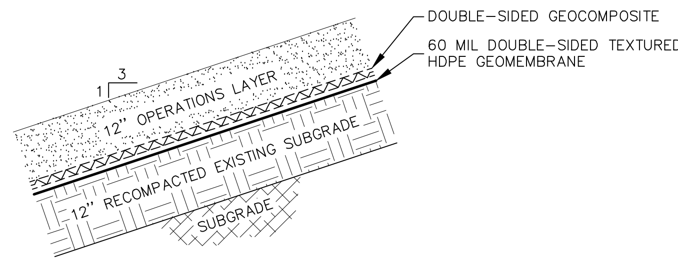
Problem	Maintenance Procedure	Equipment Requirements	Materials Requirements
LEACHATE COLLECTION AND REMOVAL SYSTEM:			
Leachate header clogged Broken sump pump Faulty liquid level indicator gauge Cracked or deteriorating structures	Flush, clear obstruction Repair or replace Repair or replace Repair or replace	Water truck or sewer rodder Light crane None None	Water Sump pump New gauge Mortar
MSE BERM:			
Stormwater pipes, ditches, or drop inlets clogged	Flush, clear obstruction	Water truck or sewer rodder	Water
Stormwater ditches, headwalls, splash walls damaged	Repair asphalt or lining	Paver, light truck, hand tools	Asphalt or articulated concrete block, ready mix concrete, mastic, epoxy
Pavement cracked	Fill cracks	Light truck	Asphalt sealant
Facing damage	Repair	Light crane or lift, front end loader, hand compactor	Wire basket, geogrid, ersoion mat, backfill, hydroseed
Vegetation Dead or Large Size	Revegetate or remove	Hand tools, light crane or lift, front end loader or equivalent, hydroseeder	Seed, backfill
Instrumentation	Repair or replace	Drill rig	Casing
LANDFILL GAS MONITORING AND RECOVERY SYSTEM			
Corroded, broken well cap, casing or lock	Repair or replace	Hand tools	New cap, well casing, lock, lubricant
GROUNDWATER MONITORING			
Faulty pump operation Corroded, broken well cap, or lock	Repair of pump Repair or replace	Hand tools Hand tools	Pump, wiring New cap, lock, lubricant
SURVEY MONUMENTS			
Covered with debris, sod, etc. Damaged, destroyed	Relocate, clean around, mark with visible marker Replace, resurvey	Hand tools Mixer, hand tools	Wooden or metal markers Monument, concrete

FIGURES

MODULE 4



FLOOR LINER

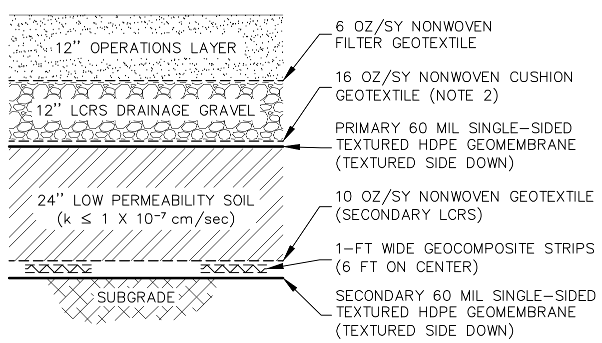


SIDESLOPE LINER

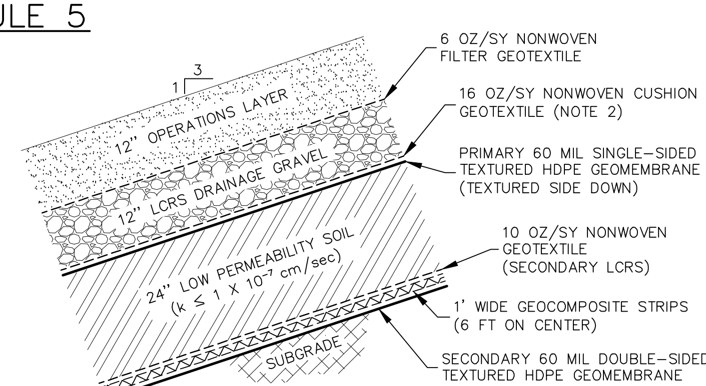
NOTE: MODULE 4 ALSO INCLUDES AN UNDERDRAIN SYSTEM.

SOURCES: *"RIVERBEND LANDFILL MODULE 4 LINER AND MODULE 5 EXCAVATION, ENGINEERING DESIGN REPORT,"* BY EMCON NORTHWEST, INC., JULY 1993; "CONTRACT DOCUMENTS FOR THE CONSTRUCTION OF MODULE 4 LINER AND MODULE 5 EXCAVATION PLANS, RIVERBEND SANITARY LANDFILL," BY EMCON NORTHWEST, INC., MAY 1993; LETTER FROM MARK SADLER OF EMCON NORTHWEST, INC. TO MONTY MORSHED OF OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY "RIVERBEND LANDFILL MODULE 4 CONSTRUCTION: DESIGN CLARIFICATIONS," 9 AUGUST 1993; AND "MODULE 4 LINING AND MODULE 5 EXCAVATION CONSTRUCTION REPORT," BY EMCON NORTHWEST, INC., 8 NOVEMBER 1993.

MODULE 5



FLOOR LINER



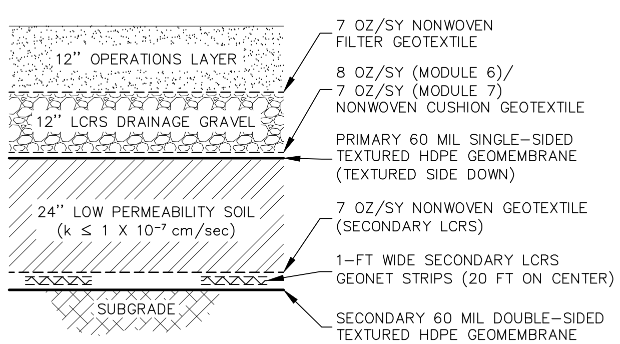
SIDESLOPE LINER

NOTES:

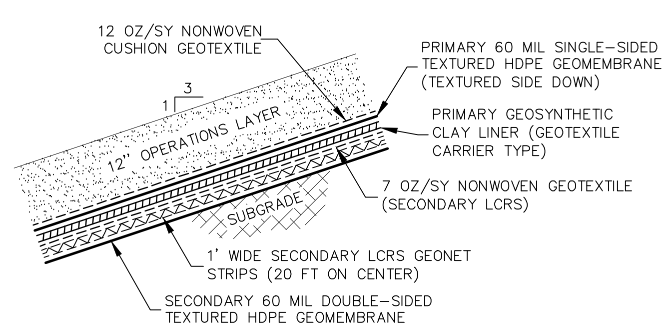
1. MODULE 5 ALSO INCLUDES AN UNDERDRAIN SYSTEM.
2. 16 OZ/SY NONWOVEN GEOTEXTILE SHOWN IN DESIGN DOCUMENTS BUT NOT IN CQA DOCUMENTS.

SOURCES: "ENGINEERING DESIGN REPORT, RIVERBEND LANDFILL: MODULE 5, McMINNVILLE, OREGON," BY DAMES & MOORE, 22 FEBRUARY 1995; "SPECIFICATIONS, RIVERBEND LANDFILL MODULE 5, McMINNVILLE, OREGON," BY DAMES & MOORE, 6 APRIL 1995, REVISION 1 - 30 MAY 1995; AND "REPORT ON CONSTRUCTION QUALITY ASSURANCE, RIVERBEND LANDFILL, MODULE 5 CONSTRUCTION, McMINNVILLE, OREGON," BY GOLDER CONSTRUCTION SERVICES, INC., 8 SEPTEMBER 1995.

MODULES 6 & 7



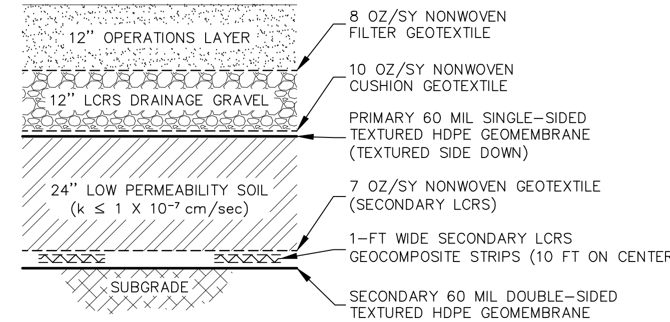
FLOOR LINER



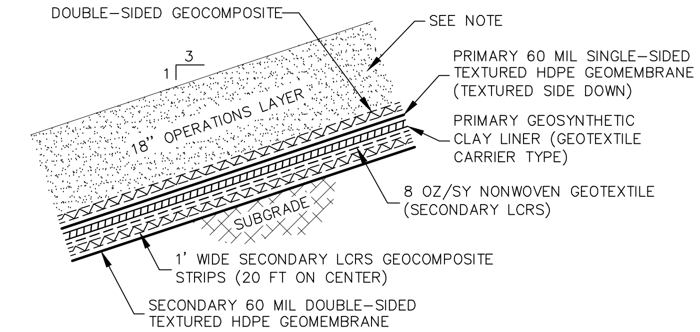
SIDESLOPE LINER

SOURCES: "DESIGN REPORT, MODULES 6 AND 7 EXPANSION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY GEOSYNTEC CONSULTANTS, INC, 26 MARCH 1997; "REPORT OF CONSTRUCTION QUALITY ASSURANCE (CQA), MODULE 6 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY GEOSYNTEC CONSULTANTS, INC., 30 SEPTEMBER 1997; "FINAL REPORT, CONSTRUCTION QUALITY ASSURANCE, MODULE 7 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY GEOSYNTEC CONSULTANTS, INC., 7 OCTOBER 1998.

MODULE 8A



FLOOR LINER

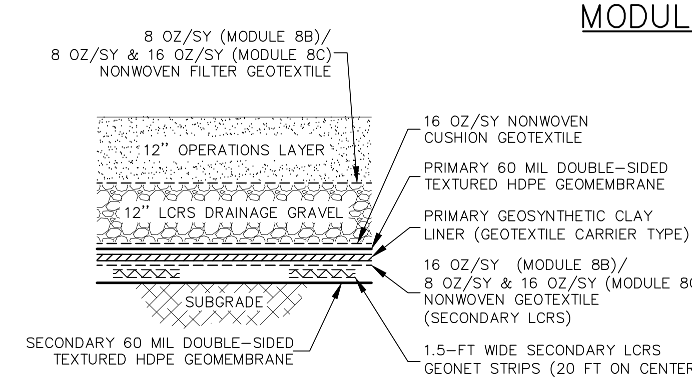


SIDESLOPE LINER

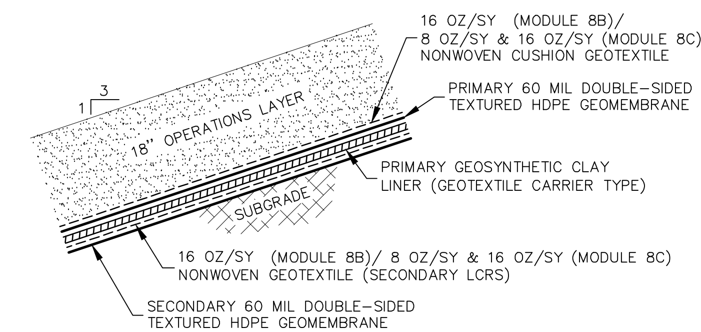
NOTE: DESIGN DOCUMENTS STATE THICKNESS OF OPERATIONS LAYER IS 12 INCHES; HOWEVER, CQA DOCUMENTS AND REDLINE DRAWINGS SHOW 18 INCHES.

SOURCES: "MODULE 8A DESIGN REPORT, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT SOLID WASTE SERVICES, APRIL 2002; "CONSTRUCTION CERTIFICATION REPORT, MODULE 8A CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT, INC., NOVEMBER 2002.

MODULES 8B & 8C



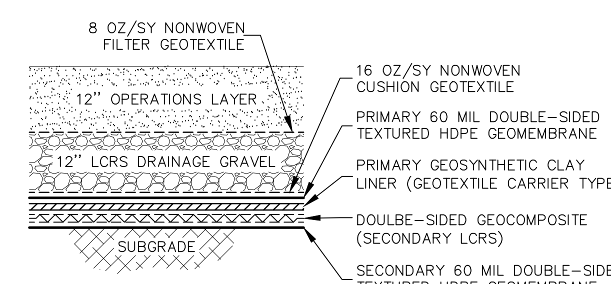
FLOOR LINER



SIDESLOPE LINER

SOURCES: "CONSTRUCTION REPORT, MODULE 8B COMPOSITE LINER AND PHASE 2 OVERLINER CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY SHAW ENVIRONMENTAL, INC., SEPTEMBER 2005; "CONSTRUCTION REPORT, MODULE 8C AND PHASE 3 CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY KENNEC, INC., 4 OCTOBER 2007.

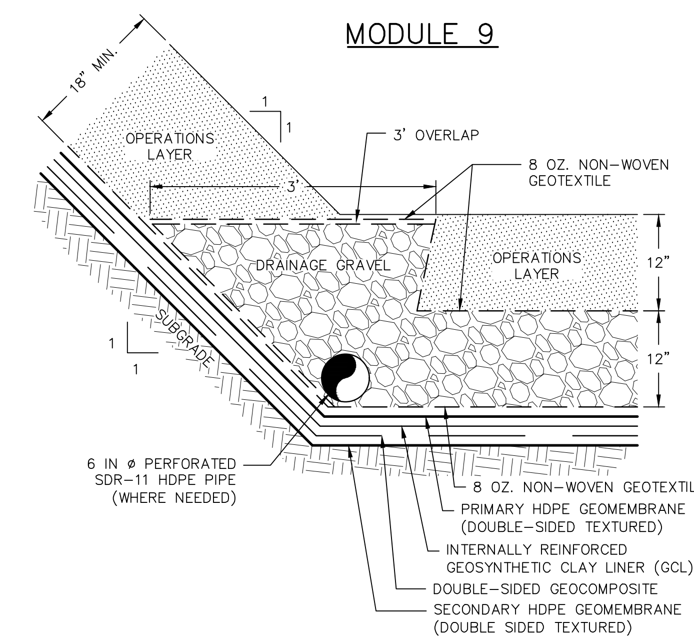
MODULE 8D



FLOOR & SIDESLOPE LINERS

SOURCES: "DESIGN REPORT, MODULE 8D AND PHASE 4 OVERLINER DESIGN REPORT, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY ENVIRONMENTAL INFORMATION LOGISTICS, LLC AND VISTA CONSULTANTS, LLC, MAY 2009; "CONSTRUCTION REPORT, MODULE 8D AND PHASE 4 OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY VISTA CONSULTANTS, LLC, OCTOBER 2009.

MODULE 9



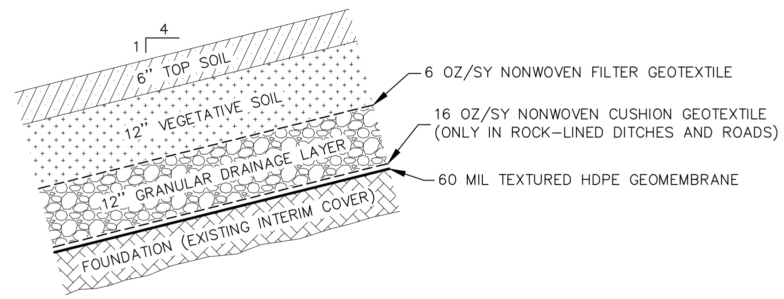
NOTES:

1. BASE CONTAINMENT SYSTEM INFORMATION FOR MODULES 1 AND 2 ARE NOT AVAILABLE.

2. MODULE 3 IS NOTED TO HAVE A 1-FT THCIK SOIL LINER (MAXIMUM PERMEABILITY OF 1 X 10^{-7} CM/SEC) OVERLAIN WITH A GEOTEXTILE, OVERLAIN WITH A 1-FT THICK GRAVEL LAYER, OVERLAIN WITH A GEOTEXTILE (SOURCES: "CONSTRUCTION REPORT, CONTRACT NO. 1, EXCAVATION PLAN, LINING PLAN, AND FLOOD CONTROL BERM EMBANKMENT, RIVERBEND SANITARY LANDFILL, YAMHILL, OREGON," BY SWEET-EDWARDS/EMCON, INC., 18 MAY 1990, AND 10 AUGUST 1993 FILE MEMO BY MARK SADLER OF EMCON, INCLUDED AS PART OF THE "RIVERBEND LANDFILL MODULE 4 CONSTRUCTION: DESIGN CLARIFICATIONS" LETTER FROM MARK SADLER OF EMCON NORTHWEST, INC. TO MONTY MORSHED OF THE OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY.

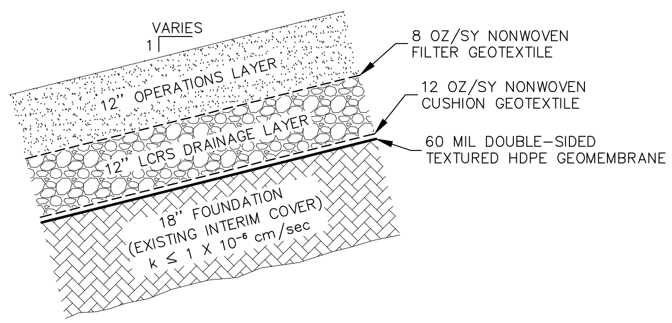
Geosyntec consultants	
BASE CONTAINMENT SYSTEM DETAILS	FIGURE NO. 1
RIVERBEND LANDFILL McMINNVILLE, OREGON	PROJECT NO. BE0209I
	DATE: DECEMBER 2022

MODULES 1, 2, 3 SOUTH SLOPES
(1995 CLOSURE)

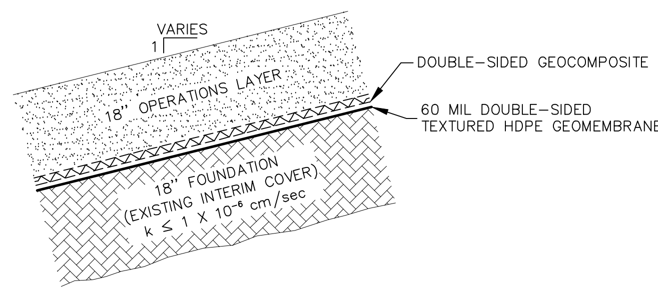


SOURCE: "CONSTRUCTION REPORT FOR CLOSURE OF MODULES 1, 2, AND 3, RIVERBEND LANDFILL," BY EMCON, 3 APRIL 1995.

MODULES 1, 2, 3 NORTH SLOPE – PHASES 1A AND 1B OVERLINERS
(2003 & 2004 CLOSURES)



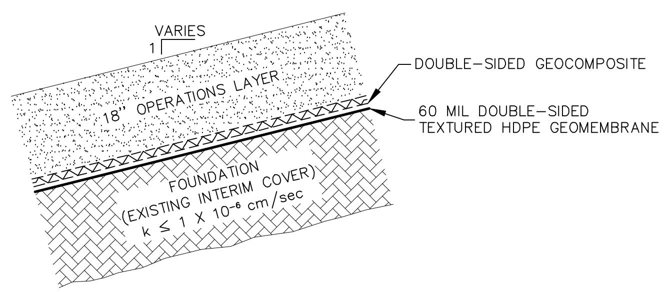
PHASE 1A OVERLINER



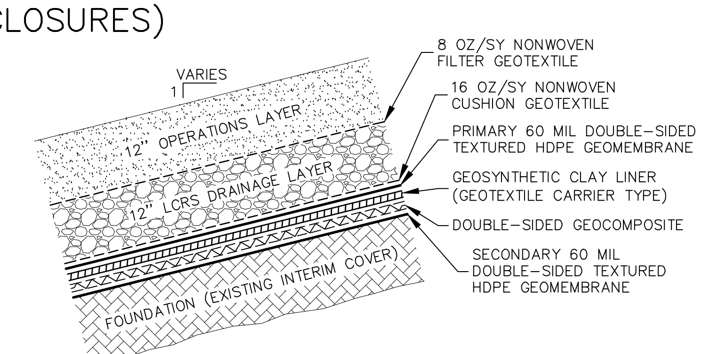
PHASE 1B OVERLINER

SOURCES: "CONSTRUCTION REPORT, PHASE 1A OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT, INC., 11 NOVEMBER 2003; "CONSTRUCTION REPORT, PHASE 1B OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT, INC., SEPTEMBER 2004.

MODULES 1, 2, 3 NORTH SLOPE – PHASES 2, 3, & 4 OVERLINERS
(2003 & 2004 CLOSURES)



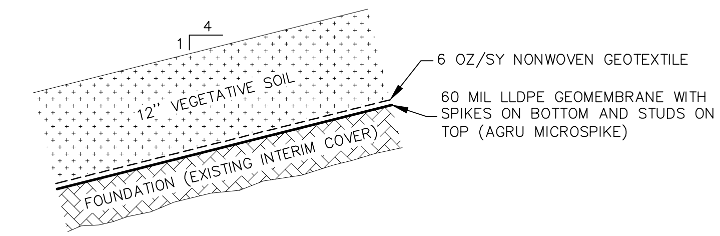
PHASES 2 & 3 OVERLINERS



PHASE 1B OVERLINER

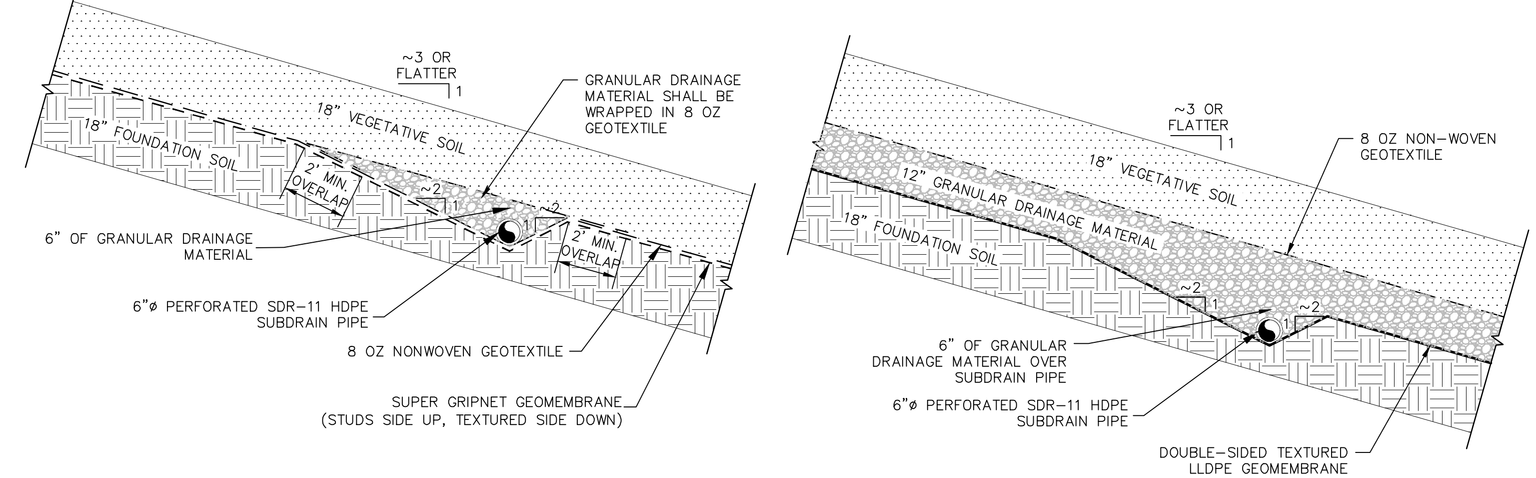
SOURCES: "CONSTRUCTION REPORT, MODULE 8B COMPOSITE LINER AND PHASE 2 OVERLINER CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY SHAW ENVIRONMENTAL, INC., SEPTEMBER 2005; "CONSTRUCTION REPORT, MODULE 8C AND PHASE 3 OVERLINER CONSTRUCTION, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY KENNEC, INC., 4 OCTOBER 2007; "CONSTRUCTION REPORT, MODULE 8D AND PHASE 4 OVERLINER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY VISTA CONSULTANTS, LLC, OCTOBER 2009.

MODULES 3, 4, 6 & 7 LOWER SLOPES
(2005 & 2006 CLOSURES)



SOURCES: "CONSTRUCTION REPORT, 2005 CLOSURE FINAL COVER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY EMCON/OWT, INC., 20 DECEMBER 2005; "2006 FINAL CLOSURE DESIGN REPORT, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY GEOSYNTEC CONSULTANTS, INC., JUNE 2006; "CONSTRUCTION REPORT, 2006 FINAL COVER, RIVERBEND LANDFILL, McMINNVILLE, OREGON," BY KENNEC, INC., APRIL 2007.

FINAL COVER ALTERNATIVES FOR AREAS OF LANDFILL
THAT HAVE NOT BEEN CLOSED



NOTE: TWO FINAL COVER CONFIGURATIONS ARE PROPOSED FOR THE AREAS OF THE LANDFILL THAT HAVE NOT BEEN CLOSED. THE SELECTION OF THE CONFIGURATION WILL DEPEND ON THE RESULTS OF INTERFACE STRENGTH TESTS TO MEET THE STATIC AND SEISMIC SLOPE STABILITY REQUIREMENTS FOR THE SITE.

Geosyntec consultants

FINAL COVER AND OVERLINER SYSTEM DETAILS RIVERBEND LANDFILL McMINNVILLE, OREGON	FIGURE NO.	2
	PROJECT NO.	BE0209I
	DATE:	DECEMBER 2022

T:\projects\Geosyntec\Riverbend-Lateral Expansion\dwg\Final Closure\2423-Figure 3-4.dwg 11-02-17 neil

APPENDIX A

Storm Water Management System

Geosyntec consultants

COMPUTATION COVER SHEET

Client: **WM – RLC OREGON** **Project:** **RIVERBEND LANDFILL** **Project #:** **BE0209I**

TITLE OF COMPUTATION **STORMWATER MANAGEMENT CALCULATION PACKAGE FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN**

COMPUTATIONS BY: (Originator)

Signature Erin Grimes — DATE: 11/16/2022

Name: Erin Grimes
Title: Senior Staff Professional

ASSUMPTIONS & PROCEDURES CHECKED BY:

Signature Julia M. Keay — DATE: 12/23/2022

Name: Julia Keay, PE (MA), CPESC
Title: Project Engineer

COMPUTATIONS CHECKED BY:

Signature Julia M. Keay — DATE: 12/23/2022

Name: Julia Keay, PE (MA), CPESC
Title: Project Engineer

COMPUTATIONS BACKCHECKED BY: (Originator)

Signature Erin Grimes — DATE: 11/17/2022

Name: Erin Grimes
Title: Senior Staff Professional

APPROVED BY: (Project Director)

Signature David J. Bonnett — DATE: 12/27/2022

Name: David J. Bonnett
Title: Sr Principal

APPROVAL NOTES:

Written by:	**E. Grimes**	Date:	**Nov 2022**	Reviewed by:	**J. Keay**	Date:	**Dec 2022**
Client:	**Riverbend Landfill Co.**	Project:	**Final Engineered Site Closure and Post-Closure Plan**	Project No:	**BE0209I**		

PERMIT-LEVEL STORMWATER MANAGEMENT CALCULATION PACKAGE FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN

PURPOSE

The purpose of this calculation package is to evaluate the surface water management system based on the Final Engineered Site Closure and Post-Closure Plan (FESCPP) for the Riverbend Landfill (Site) in McMinnville, Oregon. The FESCPP surface water management plan is shown on Drawing 9 of the 2022 Final Closure Drawings and is considered the most likely-case scenario. The proposed surface water management features include ditches, downchutes, drop inlets, stormwater detention ponds, road culvert crossings, and subdrains.

DESIGN CRITERIA

This calculation package presents the following analyses to evaluate the existing and final surface water management features at the Site:

- Evaluate the flow depth in the existing and final downchutes and ditches to demonstrate that the conveyance systems are not expected to overtop during the 100-year, 24-hour design storm event

- Evaluate the flow capacity and headwater of culverts to demonstrate that the culverts are adequately sized to pass the 100-year, 24-hour storm without overtopping

- Evaluate the shear stress in downchutes and ditches to demonstrate that the conveyance systems are expected to withstand the shear stress during the 25-year, 24-hour design storm event

- Evaluate the stormwater detention ponds to demonstrate that the ponds are adequately sized to contain the stormwater inflow during the 100-year, 24-hour storm event without overtopping

- Evaluate the maximum possible flow through existing and final subsurface perforated pipes (i.e., subdrains) that discharge to downchutes to demonstrate that the downchutes are expected to contain this flow

Written by:	**E. Grimes**	Date:	**Nov 2022**	Reviewed by:	**J. Keay**	Date:	**Dec 2022**
Client:	**Riverbend Landfill Co.**	Project:	**Final Engineered Site Closure and Post-Closure Plan**	Project No:	**BE0209I**		

METHODOLOGY

Components of the surface water management system, (i.e., downchutes, ditches, culverts, drop inlets, stormwater detention ponds, and subdrains) were previously designed, installed, or will be constructed in the future. Based on the anticipated final closure condition, the surface water management system is evaluated in this calculation package to assess compliance with design criteria. Design characteristics of the surface water management system were confirmed by Site personnel with details obtained from the following documents:

- 2022 South Slope Capping[1] & Lining Project Construction Drawings prepared by Vista GeoEnvironmental Services, dated May 2022;

- 2019 North and East Final Closure Construction Drawings prepared by Geosyntec Consultants, dated April 2019; and

- *Permit Level Storm Water Design – Closure Update*[2] prepared by Geosyntec Consultants, dated October 2017.

For purposes of this FESCPP, the above were compiled to create the 2022 Final Closure Drawings.

Hydrologic modeling of the proposed surface water management system was performed using HydroCAD™ software (SCS TR-55, 1986; HydroCAD, 2011). The HydroCAD™ model was set up to model runoff utilizing the Soil Conservation Service (SCS) Curve Number (CN) method. The HydroCAD™ output is included in Attachment 1. Input parameters for the model and calculations are described below.

<u>Drainage Area Delineation</u>

The proposed surface water management system consists of 75 drainage areas, on average each has an area of 1.33 acres. Drainage area delineations are presented on Drawing 10 of the 2022 Final Closure Drawings. Each drainage area is associated with a slope ditch or road ditch that

[1] Only the Southwest Capping portion of these plans was applied. The capping project in this area was started in 2022 and is currently in progress. The South Central Lining portion of these plans have not been approved by DEQ or constructed.

[2] Appendix B of the Final Engineered Site Closure Plan and Post Closure Plan package, prepared Geosyntec, dated 9 November 2017. This package was submitted to DEQ for review, but the review by DEQ was not completed during RLC's activities related to seeking an expansion permit.

collects shallow surface water sheet flow and directs the flow into a downchute or culvert for delivery to an outfall or detention pond.

Rainfall Distribution and Depths

The site is characterized by SCS Type IA 24-hour Rainfall Distribution (HydroCAD, 2022). The 100-year 24-hour and 25-year 24-hour design storm depths were estimated using National Oceanic and Atmospheric Administration (NOAA) isopluvial maps of the 100-year 24-hour precipitation depths and the 25-year 24-hour precipitation depths (NOAA, 1973) included in Attachment 2. The 100-year 24-hour design storm depth was estimated as 5.5 inches and the 25-year 24-hour design storm depth was estimated as 4.3 inches.

Curve Number (CN)

The soils in the drainage areas were conservatively assumed as HSG D with good grass cover and were assigned a CN of 80. Portions of the drainage areas covered by access roads, paved road ditches, or detention ponds were assigned a CN of 98, which is representative of an impervious area (HydroCAD, 2022).

Time of Concentration

The drainage areas were estimated to have time of concentration flow paths less than five minutes, which is the minimum recommended time of concentration for small drainage areas (FHWA, 2008). A time of concentration of five minutes was therefore assigned for all drainage areas.

Downchutes and Ditches

The surface water management system consists of downchutes (DC) that convey surface water from ditches to culverts and/or outfalls. The Site is or is planning to utilize various types of materials to construct the downchutes. Downchute characteristics are summarized in Table 2.

Slope and road ditches convey surface flow to downchutes at conversion points (CP). Individual downchutes were modeled in multiple segments, separated by conversion points to evaluate the addition of surface flow from the contributing ditches. Due to the separation of downchutes by conversion points, lengths and longitudinal slopes vary throughout individual downchutes and were measured using topographic data.

The Manning's roughness coefficient for the proposed HydroTurf® downchutes was selected based on values obtained from the HydroTurf® product data sheet (for Turf Type 1) and was assigned a value of 0.018 (HydroTurf, 2022). Riprap gabion mattresses were assigned a Manning's roughness coefficient of 0.041 which is representative of riprap with a median diameter (D50) of 2-inches (FHWA, 2008). Downchutes lined with grass and articulated concrete blocks were assigned a Manning's roughness coefficients of 0.070 and 0.030, respectively (ODOT, 2014). Locations of downchutes within the stormwater management system are shown on Drawings 9 and 10 of the 2022 Final Closure Drawings.

Table 2: Summary of Downchute Characteristics

Downchute ID	Side Slopes (H:V)	Bottom Width (ft)	Depth (ft)	Lining	Manning's Roughness, *n*
DC-1	2:1	2	1.5	HydroTurf®	0.018
DC-2	2:1	4	2.5	HydroTurf®	0.018
DC-4	2:1	4	1.5	HydroTurf®	0.018
DC-5	2:1	4	1.5	HydroTurf®	0.018
DC-6A, DC-6B	2:1	2	1.6	Riprap Gabion Mattress	0.041
DC-6C, DC-6D, DC-6E	2:1	2	1.6	Articulated Concrete Block	0.030
DC-7A	2:1	2	1.6	Riprap Gabion Mattress	0.041
DC-7B	2:1	2	1.6	Articulated Concrete Block	0.030
DC-8A	2:1	2	1.6	Riprap Gabion Mattress	0.041
DC-8B	2:1	2	1.6	Articulated Concrete Block	0.030
DC-8C	2:1	2	1.6	Grass	0.070
DC-9	2:1	2	1.5	HydroTurf®	0.018
DC-10	2:1	2	1.5	HydroTurf®	0.018
DC-11	2:1	2	1.75	HydroTurf®	0.018
DC-12	2:1	5	1.5	Grass	0.070

Stormwater ditches collect shallow surface water sheet flow and direct the flow into downchutes or culverts. Based on previous design documents, the various ditches used in the surface water management system are defined as follows:

- **Slope ditches (R)**: Slope ditches transect the top of the capped area and convey surface flow to downchutes at conversion points. The surface water management system includes 57 slope ditches of varying lengths and longitudinal slopes. Slope ditches are referred to as 1R through 55R, 75R, and 76R on Drawing 10 of the 2022 Final Closure Drawings.

- **Road ditches (RD)**: Road ditches were designed to manage surface water flow from drainage areas, including sheet flow across access roads, to conversion points in downchutes. A total of 8 road ditches (referred to as RD-1 through RD-8) are included in the surface water management system.

- **Ditches (DITCH)**: Two ditches (DITCH-1 and DITCH-2) convey surface water from the capped area to Stormwater Detention Pond 1, located on the southern side of the Site.

- **Northern Pond Inlet Swale (NPIS)**: The NPIS is broken into three segments (NPIS-1, NPIS-2, and NPIS-3) and conveys surface water to Stormwater Detention Pond 3, located north of the landfill final closure area.

The appropriate Manning's roughness coefficients for the paved and grassed ditches were selected based on values obtained from the ODOT Hydraulics Design Manual (ODOT, 2014). A Manning's roughness coefficient of 0.070 and 0.016 was assigned for grassed and paved ditches, respectively. Table 3 summarizes cross-sectional geometry and lining characteristics of the various ditch types in the surface water management system.

Table 3: Summary of Ditch Characteristics

Ditch Type	Left Side Slope (H:V)	Right Side Slope (H:V)	Bottom Width (ft)	Depth (ft)	Lining	Manning's Roughness, *n*
Slope Ditches	2:1	2:1	0	1.5	Grass	0.070
RD-1	2:1	2:1	0	2	Paved	0.016
RD-2	2:1	2:1	0	2	Paved	0.016
RD-3	2:1	2:1	0	1.5	Paved	0.016
RD-4	2:1	2:1	0	1	Paved	0.016
RD-5	2:1	2:1	0	1.5	Grass	0.070
RD-6	2:1	2:1	0	1.5	Paved	0.016
RD-7	2:1	2:1	0	1.5	Grass	0.070
RD-8	2:1	2:1	0	1.5	Grass	0.070
DITCH-2	2:1	2:1	0	2.5	Grass	0.070
DITCH-1	2:1	2:1	0	1.5	Grass	0.070
NPIS-1	3:1	2:1	0	2	Grass	0.070
NPIS-2	3:1	2:1	0	2	Grass	0.070
NPIS-3	3:1	2:1	0	2	Grass	0.070

Downchutes and ditches were also evaluated by calculating the peak shear stress during the 25-year, 24-hour design storm event with the formula:

$$\tau_d = \gamma d S_o$$

where, τ_d=Peak shear stress [pounds/square feet (lb/ft^2)]
d=maximum flow height (ft)
γ= the unit weight of water [62.4 pounds/cubic feet (lb/ft^3)]
S_o=the road crossing bottom slope (ft/ft)

The resulting peak shear stress was compared to the permissible shear stress of the channel lining material. Permissible shear stresses for the various lining materials are presented in Table 4.

Table 4: Summary of Downchute/Ditch Lining Permissible Shear Stress

Lining Material	Permissible Shear Stress (lb/ft^2)	Reference
HydroTurf®	45[1]	ODOT, 2014
Grass	3.7	ODOT, 2014
Riprap Gabion Mattress	35	ODOT, 2014
Articulated Concrete Block	11	ODOT, 2014
Pavement	12	ODOT, 2014

Notes:
1. The permissible shear stress value used for HydroTurf® was the value presented for "Soil Cement (8% cement) in ODOT, 2014, because a permissible shear stress value for HydroTurf® was not found in the publicly available product technical literature.
2. The permissible shear stress value used for the paved roadside ditches was the value presented for "Concrete Construction" in ODOT, 2014, because a permissible shear stress value was not available for pavement in the reference. The actual shear stress value of the paved ditches is likely higher.

Culverts

Culverts were evaluated to confirm they are capable of conveying the discharge from the 100-year, 24-hour storm without overtopping. Manning's roughness coefficients were obtained from the ODOT Hydraulics Design Manual (ODOT, 2014). Smooth, high-density polyethylene (HDPE) culverts were assigned a Manning's coefficient of 0.013, corrugated plastic pipes (CPP) were assigned a coefficient of 0.024, corrugated metal pipes (CMP) were assigned a coefficient of 0.017, and reinforced concrete pipes (RCP) were assigned a coefficient of 0.011. A summary of the culvert properties is presented in Table 5.

Table 5: Summary of Culvert Characteristics

Culvert ID	Length (ft)	Slope (%)	Diameter (in)	Material	Manning's Roughness, *n*
CULV-1	53	5.0	24	HDPE	0.013
CULV-2[1]	139	2.1	30	HDPE	0.013
CULV-2.2	87	0.6	36	HDPE	0.013
CULV-3[2]	88	1.54	24	CMP	0.017
CULV-4	69	4.5	24	HDPE	0.013
CULV-5	84	8.9	24	CPP	0.024
CULV-7	128	3.13	24	Corrugated HDPE	0.024

Notes:

3. Due to the geometry of the surface water management system, Culvert 2 was modeled as two separate segments (CULV-2 and CULV-2.2) divided by a conversion point (CP).
4. Culvert-3 consists of two 18-inch diameter pipes. Due to limitations within the HydroCAD™ modeling software, Culvert-3 was modeled as a 24-inch diameter pipe, which provides a similar cross-sectional flow area.

The flow capacity and velocity in the culverts were determined using Manning's equation (FHWA, 2008):

$$Q = \frac{1.49}{n} a r^{2/3} s^{1/2} \; ; \; v = \frac{1.49}{n} r^{2/3} s^{1/2}$$

where Q = discharge (cfs)

n = Manning's roughness coefficient

V = mean velocity (fps)

s = slope (ft/ft)

r = hydraulic radius (ft)

a = cross-sectional flow area (sq-ft)

The capacity of the culverts was evaluated using the Federal Highway Administration Chart 2: Headwater Depth for Concrete Pipe Culverts with Inlet Control of the HEC-5 Circular. The nomograph in Chart 2 gives the headwater-discharge relationship for a conventional pipe culvert with inlet control based on laboratory research. Evaluations used to confirm the capacity of flow in the culverts are included in Attachment 3.

Drop Inlets

A total of 6 drop inlets (DI-1 through DI-6) are included in the surface water management system. Drop inlet characteristics were obtained from previous design documents and are summarized in Table 6.

Table 6: Summary of Drop Inlet Characteristics

Drop Inlet ID	Rim Elevation (ft)	Vertical Pipe Diameter (in)	Invert Elevation (ft)	Horizontal Pipe Diameter (in)	Material
DI-1	165.73	48	150.97	24	RCP
DI-2	156.46	48	151.71	30	RCP
DI-3	153.30	48	149.87	18	RCP
DI-4	-	-	139.96	24	RCP
DI-5	234.57	36	231.41	24	HDPE
DI-6	177	30	263	30	RCP

Stormwater Detention Ponds

The sizes of the detention ponds were evaluated to confirm that runoff from the 100-year 24-hour storm event does not exceed the top of pond. Detention ponds (identified as Stormwater Detention Ponds 1, 3, and 4a on Drawing 10) were modelled in HydroCAD™ using custom stage-storage information generated from topographic data. Outlet structures were identified at each detention basin and were modeled as outlet pipes. In addition to the outlet pipe, an emergency spillway is included as part of Stormwater Detention Pond 3. Details, including elevations, slope, and lengths, were estimated based on available as-built drawings.

Hydrologic modeling was performed up until the outlet structure of each Stormwater Detention Pond. Hydrologic modeling was not evaluated for the downstream portions of the Site, including the additional Stormwater Detention Pond 4B, located to the north of the capped area.

Subdrains

To improve the closure drainage, subdrains are designed along the stormwater berms to collect and transmit run off. With the closure being performed in multiple stages, parts of the closure have used subdrains. The existing perforated pipes underneath the existing ditches were evaluated to determine the maximum flow rate through the perforated pipe. The maximum flow through the perforated pipes to the existing downchute was used to estimate the corresponding flow depth in the downchute to determine if the downchute was expected to contain this flow. The most conservative-scenario downchute with respect to flow capacity for each material liner i.e., HydroTurf® or riprap gabion mattress) was determined by evaluating the number of subdrains conveying flow to the downchute and the downchute dimensions. DC-8 and DC-10 were determined to represent the most conservative-case scenario for riprap-lined and HydroTurf®-lined downchutes, respectively. The spreadsheet calculation is included in Attachment 3.

The flow depth generated by the peak discharge from runoff over the surface of the landfill closure was added to the flow depth associated with the subdrains to evaluate whether the downchutes were adequately sized to handle the combined flow depth.

RESULTS

The results of the surface water management system analysis are presented in the HydroCAD™ output and supplemental calculations, included in Attachment 1 and Attachment 3. A summary of the results pertaining to the design criteria is provided below.

- The flow depths associated with the 100-year, 24-hour storm do not overtop the existing and final downchutes and ditches. Conveyance systems have been designed to sufficiently convey the flow capacity associated with the 100-year, 24-hour storm event.

- Downchute and ditch linings are expected to withstand the shear stress from the 25-year, 24-hour design storm event. Additionally, the roadside ditches adjacent to the mechanically stabilized earthen (MSE) berm are paved with asphalt concrete and are expected to withstand shear stress from the 100-year, 24-hour design storm event.

- Culverts have been adequately sized to pass the 100-year, 24-hour storm event without overtopping.

- The existing stormwater detention ponds have outlet structures that are designed to discharge stormwater over time. The inclusion of outlet structures allows the stormwater detention ponds to sufficiently manage the 100-year, 24-hour storm. The calculated discharge from the stormwater detention ponds ranged from 4.22 to 5.88 cubic feet per second during the regulatory storm event.

- Downchutes are expected to handle discharge generated from the maximum possible flow through existing perforated pipes located underneath existing stormwater ditches (i.e., subdrains). Calculations and results are included in Attachment 3.

SUMMARY AND CONCLUSION

The surface water management system at the Site for the final closure consists of ditches, downchutes, drop inlets, stormwater detention ponds, road culvert crossings, and subdrains. Based on the calculations, the conveyance systems are not expected to overtop during the 100-year 24-hour design storm event and are expected to withstand shear stress from the 25-year 24-hour design storm event. As are the MSE roadside ditches which are paved with asphalt concrete. The expected maximum flow through the existing and proposed subdrains to the existing and proposed downchutes are expected to be contained. Based on the current size of the stormwater detention ponds, their outlet structures will help manage the 100-year, 24-hour storm to prevent the ponds from overtopping.

Written by:	**E. Grimes**	Date:	**Nov 2022**	Reviewed by:	**J. Keay**	Date:	**Dec 2022**
Client:	**Riverbend Landfill Co.**	Project:	**Final Engineered Site Closure and Post-Closure Plan**			Project No:	**BE0209I**

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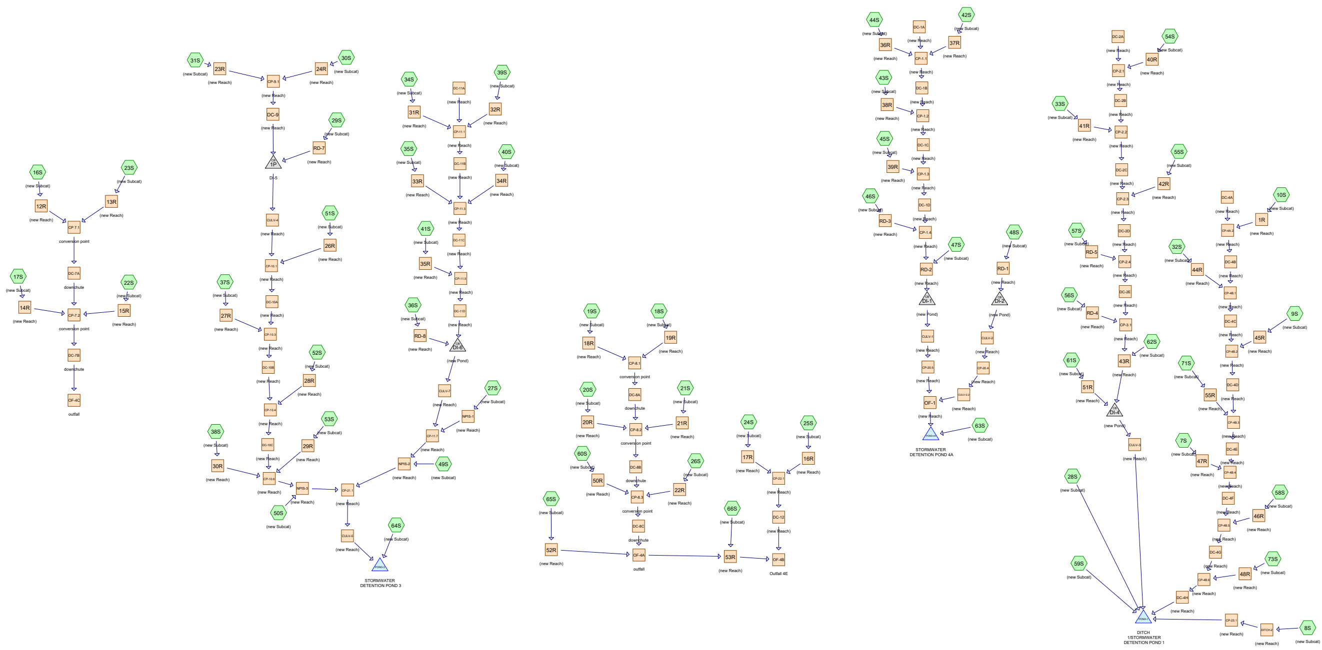
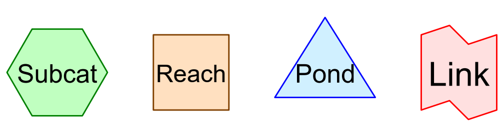
ATTACHMENT 1

HydroCAD Output





Routing Diagram for FESCPCP Stormwater_12202022
Prepared by SCCM, Printed 12/28/2022
HydroCAD® 10.00 s/n 03895 © 2012 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.140	98	(28S)
70.710	80	>75% Grass cover, Good, HSG D (7S, 8S, 9S, 10S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S, 25S, 26S, 27S, 28S, 29S, 30S, 31S, 32S, 33S, 34S, 35S, 36S, 37S, 38S, 39S, 40S, 41S, 42S, 43S, 44S, 45S, 46S, 47S, 48S, 49S, 50S, 51S, 52S, 53S, 54S, 55S, 56S, 57S, 58S, 59S, 60S, 61S, 62S, 65S, 66S, 71S, 73S)
1.640	98	>75% Grass cover, Good, HSG D (63S)
1.150	98	Pond (59S)
4.700	98	Pond 3 and roads (64S)
1.270	98	Road (29S, 57S, 61S, 62S, 65S, 66S)
0.550	98	Roads (27S, 36S)
80.160	**82**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
72.350	HSG D	7S, 8S, 9S, 10S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S, 25S, 26S, 27S, 28S, 29S, 30S, 31S, 32S, 33S, 34S, 35S, 36S, 37S, 38S, 39S, 40S, 41S, 42S, 43S, 44S, 45S, 46S, 47S, 48S, 49S, 50S, 51S, 52S, 53S, 54S, 55S, 56S, 57S, 58S, 59S, 60S, 61S, 62S, 63S, 65S, 66S, 71S, 73S
7.810	Other	27S, 28S, 29S, 36S, 57S, 59S, 61S, 62S, 64S, 65S, 66S
80.160		**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	0.000	0.140	0.140		28S
0.000	0.000	0.000	72.350	0.000	72.350	>75% Grass cover, Good	7S, 8S, 9S, 10S, 16S, 17S, 18S, 19S, 20S, 21S, 22S, 23S, 24S, 25S, 26S, 27S, 28S, 29S, 30S, 31S, 32S, 33S, 34S, 35S, 36S, 37S, 38S, 39S, 40S, 41S, 42S, 43S, 44S, 45S, 46S, 47S, 48S, 49S, 50S, 51S, 52S, 53S, 54S, 55S, 56S, 57S, 58S,

Ground Covers (all nodes) (continued)

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	0.000	1.150	1.150	Pond	59S
0.000	0.000	0.000	0.000	4.700	4.700	Pond 3 and roads	64S
0.000	0.000	0.000	0.000	1.270	1.270	Road	29S, 57S, 61S, 62S, 65S, 66S
0.000	0.000	0.000	0.000	0.550	0.550	Roads	27S, 36S
0.000	**0.000**	**0.000**	**72.350**	**7.810**	**80.160**	**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	CULV-1	150.97	148.31	53.0	0.0502	0.013	24.0	0.0	0.0
2	CULV-2	151.71	148.79	139.0	0.0210	0.013	30.0	0.0	0.0
3	CULV-2.2	148.79	148.25	87.0	0.0062	0.013	36.0	0.0	0.0
4	CULV-3	140.30	138.00	196.0	0.0117	0.017	24.0	0.0	0.0
5	CULV-4	231.41	228.33	69.0	0.0446	0.013	24.0	0.0	0.0
6	CULV-5	153.00	145.50	84.0	0.0893	0.012	24.0	0.0	0.0
7	CULV-7	162.00	158.00	128.0	0.0313	0.012	24.0	0.0	0.0
8	POND-1	128.00	120.11	105.0	0.0751	0.017	30.0	0.0	0.0
9	POND-3	140.00	139.00	104.0	0.0096	0.017	24.0	0.0	0.0
10	POND-4A	148.00	147.00	130.0	0.0077	0.024	24.0	0.0	0.0

Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 7S: (new Subcat) Runoff Area=0.960 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.53 cfs 0.183 af

Subcatchment 8S: (new Subcat) Runoff Area=1.250 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.69 cfs 0.239 af

Subcatchment 9S: (new Subcat) Runoff Area=0.740 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.41 cfs 0.141 af

Subcatchment 10S: (new Subcat) Runoff Area=1.920 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=1.07 cfs 0.367 af

Subcatchment 16S: (new Subcat) Runoff Area=0.910 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.51 cfs 0.174 af

Subcatchment 17S: (new Subcat) Runoff Area=1.770 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.98 cfs 0.338 af

Subcatchment 18S: (new Subcat) Runoff Area=0.880 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.49 cfs 0.168 af

Subcatchment 19S: (new Subcat) Runoff Area=1.440 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.80 cfs 0.275 af

Subcatchment 20S: (new Subcat) Runoff Area=0.860 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.48 cfs 0.164 af

Subcatchment 21S: (new Subcat) Runoff Area=1.810 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=1.01 cfs 0.346 af

Subcatchment 22S: (new Subcat) Runoff Area=1.540 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.86 cfs 0.294 af

Subcatchment 23S: (new Subcat) Runoff Area=0.080 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.04 cfs 0.015 af

Subcatchment 24S: (new Subcat) Runoff Area=0.560 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.31 cfs 0.107 af

Subcatchment 25S: (new Subcat) Runoff Area=0.510 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.28 cfs 0.097 af

Subcatchment 26S: (new Subcat) Runoff Area=1.880 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=1.04 cfs 0.359 af

Subcatchment 27S: (new Subcat) Runoff Area=0.260 ac 19.23% Impervious Runoff Depth=2.55"
Tc=5.0 min CN=83 Runoff=0.17 cfs 0.055 af

Subcatchment 28S: (new Subcat) Runoff Area=1.810 ac 7.73% Impervious Runoff Depth=2.38"
Tc=5.0 min CN=81 Runoff=1.05 cfs 0.358 af

Subcatchment 29S: (new Subcat) Runoff Area=1.840 ac 16.85% Impervious Runoff Depth=2.55"
Tc=5.0 min CN=83 Runoff=1.17 cfs 0.391 af

Subcatchment 30S: (new Subcat) Runoff Area=1.550 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.86 cfs 0.296 af

Subcatchment 31S: (new Subcat) Runoff Area=2.110 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=1.17 cfs 0.403 af

Subcatchment 32S: (new Subcat) Runoff Area=2.170 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=1.21 cfs 0.414 af

Subcatchment 33S: (new Subcat) Runoff Area=3.920 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=2.18 cfs 0.749 af

Subcatchment 34S: (new Subcat) Runoff Area=2.030 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=1.13 cfs 0.388 af

Subcatchment 35S: (new Subcat) Runoff Area=2.410 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=1.34 cfs 0.460 af

Subcatchment 36S: (new Subcat) Runoff Area=3.010 ac 16.61% Impervious Runoff Depth=2.55"
Tc=5.0 min CN=83 Runoff=1.92 cfs 0.639 af

Subcatchment 37S: (new Subcat) Runoff Area=0.590 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.33 cfs 0.113 af

Subcatchment 38S: (new Subcat) Runoff Area=1.760 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.98 cfs 0.336 af

Subcatchment 39S: (new Subcat) Runoff Area=0.450 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.25 cfs 0.086 af

Subcatchment 40S: (new Subcat) Runoff Area=0.430 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.24 cfs 0.082 af

Subcatchment 41S: (new Subcat) Runoff Area=0.440 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.24 cfs 0.084 af

Subcatchment 42S: (new Subcat) Runoff Area=0.560 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.31 cfs 0.107 af

Subcatchment 43S: (new Subcat) Runoff Area=0.880 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.49 cfs 0.168 af

Subcatchment 44S: (new Subcat) Runoff Area=0.910 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.51 cfs 0.174 af

Subcatchment 45S: (new Subcat) Runoff Area=1.150 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.64 cfs 0.220 af

Subcatchment 46S: (new Subcat) Runoff Area=1.870 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=1.04 cfs 0.357 af

Subcatchment 47S: (new Subcat) Runoff Area=0.420 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.23 cfs 0.080 af

Subcatchment 48S: (new Subcat) Runoff Area=1.500 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.83 cfs 0.287 af

Subcatchment 49S: (new Subcat) Runoff Area=0.490 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.27 cfs 0.094 af

Subcatchment 50S: (new Subcat) Runoff Area=0.260 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.14 cfs 0.050 af

Subcatchment 51S: (new Subcat) Runoff Area=0.920 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.51 cfs 0.176 af

Subcatchment 52S: (new Subcat) Runoff Area=1.370 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.76 cfs 0.262 af

Subcatchment 53S: (new Subcat) Runoff Area=1.010 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.56 cfs 0.193 af

Subcatchment 54S: (new Subcat) Runoff Area=1.440 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.80 cfs 0.275 af

Subcatchment 55S: (new Subcat) Runoff Area=1.680 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.93 cfs 0.321 af

Subcatchment 56S: (new Subcat) Runoff Area=1.770 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.98 cfs 0.338 af

Subcatchment 57S: (new Subcat) Runoff Area=2.740 ac 16.79% Impervious Runoff Depth=2.55"
Tc=5.0 min CN=83 Runoff=1.75 cfs 0.582 af

Subcatchment 58S: (new Subcat) Runoff Area=1.490 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.83 cfs 0.285 af

Subcatchment 59S: (new Subcat) Runoff Area=3.820 ac 30.10% Impervious Runoff Depth=2.73"
Tc=5.0 min CN=85 Runoff=2.65 cfs 0.868 af

Subcatchment 60S: (new Subcat) Runoff Area=0.930 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.52 cfs 0.178 af

Subcatchment 61S: (new Subcat) Runoff Area=0.560 ac 23.21% Impervious Runoff Depth=2.64"
Tc=5.0 min CN=84 Runoff=0.37 cfs 0.123 af

Subcatchment 62S: (new Subcat) Runoff Area=0.470 ac 8.51% Impervious Runoff Depth=2.46"
Tc=5.0 min CN=82 Runoff=0.29 cfs 0.096 af

Subcatchment 63S: (new Subcat) Runoff Area=1.640 ac 100.00% Impervious Runoff Depth=4.06"
Tc=5.0 min CN=98 Runoff=1.69 cfs 0.555 af

Subcatchment 64S: (new Subcat) Runoff Area=4.700 ac 100.00% Impervious Runoff Depth=4.06"
Tc=5.0 min CN=98 Runoff=4.84 cfs 1.592 af

Subcatchment 65S: (new Subcat) Runoff Area=1.960 ac 7.65% Impervious Runoff Depth=2.38"
Tc=5.0 min CN=81 Runoff=1.14 cfs 0.388 af

Subcatchment 66S: (new Subcat) Runoff Area=2.600 ac 6.92% Impervious Runoff Depth=2.38"
Tc=5.0 min CN=81 Runoff=1.51 cfs 0.515 af

Subcatchment 71S: (new Subcat) Runoff Area=0.830 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.46 cfs 0.159 af

Subcatchment 73S: (new Subcat) Runoff Area=0.300 ac 0.00% Impervious Runoff Depth=2.29"
Tc=5.0 min CN=80 Runoff=0.17 cfs 0.057 af

Reach 1R: (new Reach) Avg. Flow Depth=0.62' Max Vel=1.39 fps Inflow=1.07 cfs 0.367 af
n=0.070 L=254.0' S=0.0236 '/' Capacity=11.25 cfs Outflow=1.06 cfs 0.367 af

Reach 12R: (new Reach) Avg. Flow Depth=0.45' Max Vel=1.26 fps Inflow=0.51 cfs 0.174 af
n=0.070 L=332.0' S=0.0301 '/' Capacity=12.70 cfs Outflow=0.50 cfs 0.174 af

Reach 13R: (new Reach) Avg. Flow Depth=0.17' Max Vel=0.81 fps Inflow=0.04 cfs 0.015 af
n=0.070 L=107.0' S=0.0467 '/' Capacity=15.82 cfs Outflow=0.04 cfs 0.015 af

Reach 14R: (new Reach) Avg. Flow Depth=0.49' Max Vel=2.01 fps Inflow=0.98 cfs 0.338 af
n=0.070 L=344.0' S=0.0669 '/' Capacity=18.93 cfs Outflow=0.98 cfs 0.338 af

Reach 15R: (new Reach) Avg. Flow Depth=0.46' Max Vel=2.00 fps Inflow=0.86 cfs 0.294 af
n=0.070 L=491.0' S=0.0733 '/' Capacity=19.82 cfs Outflow=0.85 cfs 0.294 af

Reach 16R: (new Reach) Avg. Flow Depth=0.32' Max Vel=1.35 fps Inflow=0.28 cfs 0.097 af
n=0.070 L=299.0' S=0.0535 '/' Capacity=16.93 cfs Outflow=0.28 cfs 0.097 af

Reach 17R: (new Reach) Avg. Flow Depth=0.33' Max Vel=1.42 fps Inflow=0.31 cfs 0.107 af
n=0.070 L=315.0' S=0.0571 '/' Capacity=17.50 cfs Outflow=0.31 cfs 0.107 af

Reach 18R: (new Reach) Avg. Flow Depth=0.52' Max Vel=1.47 fps Inflow=0.80 cfs 0.275 af
n=0.070 L=241.0' S=0.0332 '/' Capacity=13.34 cfs Outflow=0.80 cfs 0.275 af

Reach 19R: (new Reach) Avg. Flow Depth=0.45' Max Vel=1.22 fps Inflow=0.49 cfs 0.168 af
n=0.070 L=355.0' S=0.0282 '/' Capacity=12.29 cfs Outflow=0.48 cfs 0.168 af

Reach 20R: (new Reach) Avg. Flow Depth=0.42' Max Vel=1.34 fps Inflow=0.48 cfs 0.164 af
n=0.070 L=245.0' S=0.0367 '/' Capacity=14.03 cfs Outflow=0.48 cfs 0.164 af

Reach 21R: (new Reach) Avg. Flow Depth=0.61' Max Vel=1.31 fps Inflow=1.01 cfs 0.346 af
n=0.070 L=563.0' S=0.0213 '/' Capacity=10.69 cfs Outflow=0.98 cfs 0.346 af

Reach 22R: (new Reach) Avg. Flow Depth=0.54' Max Vel=1.76 fps Inflow=1.04 cfs 0.359 af
n=0.070 L=596.0' S=0.0453 '/' Capacity=15.58 cfs Outflow=1.03 cfs 0.359 af

Reach 23R: (new Reach) Avg. Flow Depth=0.70' Max Vel=1.18 fps Inflow=1.17 cfs 0.403 af
n=0.070 L=410.0' S=0.0146 '/' Capacity=8.86 cfs Outflow=1.15 cfs 0.403 af

Reach 24R: (new Reach) Avg. Flow Depth=0.54' Max Vel=1.46 fps Inflow=0.86 cfs 0.296 af
n=0.070 L=257.0' S=0.0311 '/' Capacity=12.92 cfs Outflow=0.86 cfs 0.296 af

Reach 26R: (new Reach) Avg. Flow Depth=0.47' Max Vel=1.16 fps Inflow=0.51 cfs 0.176 af
n=0.070 L=417.0' S=0.0240 '/' Capacity=11.34 cfs Outflow=0.50 cfs 0.176 af

Reach 27R: (new Reach) Avg. Flow Depth=0.39' Max Vel=1.05 fps Inflow=0.33 cfs 0.113 af
n=0.070 L=323.0' S=0.0248 '/' Capacity=11.52 cfs Outflow=0.32 cfs 0.113 af

Reach 28R: (new Reach) Avg. Flow Depth=0.56' Max Vel=1.18 fps Inflow=0.76 cfs 0.262 af
n=0.070 L=410.0' S=0.0195 '/' Capacity=10.23 cfs Outflow=0.75 cfs 0.262 af

Reach 29R: (new Reach) Avg. Flow Depth=0.54' Max Vel=0.93 fps Inflow=0.56 cfs 0.193 af
n=0.070 L=394.0' S=0.0127 '/' Capacity=8.25 cfs Outflow=0.55 cfs 0.193 af

Reach 30R: (new Reach) Avg. Flow Depth=0.59' Max Vel=1.34 fps Inflow=0.98 cfs 0.336 af
n=0.070 L=645.0' S=0.0233 '/' Capacity=11.16 cfs Outflow=0.95 cfs 0.336 af

Reach 31R: (new Reach) Avg. Flow Depth=0.61' Max Vel=1.49 fps Inflow=1.13 cfs 0.388 af
n=0.070 L=363.0' S=0.0275 '/' Capacity=12.15 cfs Outflow=1.12 cfs 0.388 af

Reach 32R: (new Reach) Avg. Flow Depth=0.29' Max Vel=1.47 fps Inflow=0.25 cfs 0.086 af
n=0.070 L=96.0' S=0.0729 '/' Capacity=19.77 cfs Outflow=0.25 cfs 0.086 af

Reach 33R: (new Reach) Avg. Flow Depth=0.62' Max Vel=1.69 fps Inflow=1.34 cfs 0.460 af
n=0.070 L=720.0' S=0.0347 '/' Capacity=13.64 cfs Outflow=1.31 cfs 0.460 af

Reach 34R: (new Reach) Avg. Flow Depth=0.32' Max Vel=1.20 fps Inflow=0.24 cfs 0.082 af
n=0.070 L=115.0' S=0.0435 '/' Capacity=15.26 cfs Outflow=0.24 cfs 0.082 af

Reach 35R: (new Reach) Avg. Flow Depth=0.32' Max Vel=1.22 fps Inflow=0.24 cfs 0.084 af
n=0.070 L=134.0' S=0.0448 '/' Capacity=15.49 cfs Outflow=0.24 cfs 0.084 af

Reach 36R: (new Reach) Avg. Flow Depth=0.38' Max Vel=1.70 fps Inflow=0.51 cfs 0.174 af
n=0.070 L=328.0' S=0.0671 '/' Capacity=18.96 cfs Outflow=0.50 cfs 0.174 af

Reach 37R: (new Reach) Avg. Flow Depth=0.31' Max Vel=1.61 fps Inflow=0.31 cfs 0.107 af
n=0.070 L=227.0' S=0.0793 '/' Capacity=20.61 cfs Outflow=0.31 cfs 0.107 af

Reach 38R: (new Reach) Avg. Flow Depth=0.50' Max Vel=0.95 fps Inflow=0.49 cfs 0.168 af
n=0.070 L=341.0' S=0.0147 '/' Capacity=8.86 cfs Outflow=0.48 cfs 0.168 af

Reach 39R: (new Reach) Avg. Flow Depth=0.46' Max Vel=1.49 fps Inflow=0.64 cfs 0.220 af
n=0.070 L=540.0' S=0.0407 '/' Capacity=14.78 cfs Outflow=0.63 cfs 0.220 af

Reach 40R: (new Reach) Avg. Flow Depth=0.46' Max Vel=1.92 fps Inflow=0.80 cfs 0.275 af
n=0.070 L=395.0' S=0.0684 '/' Capacity=19.14 cfs Outflow=0.80 cfs 0.275 af

Reach 41R: (new Reach) Avg. Flow Depth=0.66' Max Vel=2.48 fps Inflow=2.18 cfs 0.749 af
n=0.070 L=675.0' S=0.0696 '/' Capacity=19.32 cfs Outflow=2.16 cfs 0.749 af

Reach 42R: (new Reach) Avg. Flow Depth=0.49' Max Vel=1.93 fps Inflow=0.93 cfs 0.321 af
n=0.070 L=573.0' S=0.0628 '/' Capacity=18.35 cfs Outflow=0.92 cfs 0.321 af

Reach 43R: (new Reach) Avg. Flow Depth=0.55' Max Vel=11.17 fps Inflow=6.81 cfs 2.361 af
n=0.016 L=257.0' S=0.0934 '/' Capacity=97.87 cfs Outflow=6.81 cfs 2.361 af

Reach 44R: (new Reach) Avg. Flow Depth=0.70' Max Vel=1.21 fps Inflow=1.21 cfs 0.414 af
n=0.070 L=265.0' S=0.0151 '/' Capacity=8.99 cfs Outflow=1.20 cfs 0.414 af

Reach 45R: (new Reach) Avg. Flow Depth=0.45' Max Vel=1.02 fps Inflow=0.41 cfs 0.141 af
n=0.070 L=254.0' S=0.0197 '/' Capacity=10.27 cfs Outflow=0.41 cfs 0.141 af

Reach 46R: (new Reach) Avg. Flow Depth=0.51' Max Vel=1.58 fps Inflow=0.83 cfs 0.285 af
n=0.070 L=550.0' S=0.0400 '/' Capacity=14.64 cfs Outflow=0.81 cfs 0.285 af

Reach 47R: (new Reach) Avg. Flow Depth=0.38' Max Vel=1.82 fps Inflow=0.53 cfs 0.183 af
n=0.070 L=247.0' S=0.0769 '/' Capacity=20.30 cfs Outflow=0.53 cfs 0.183 af

Reach 48R: (new Reach) Avg. Flow Depth=0.23' Max Vel=1.60 fps Inflow=0.17 cfs 0.057 af
n=0.070 L=227.0' S=0.1189 '/' Capacity=25.25 cfs Outflow=0.17 cfs 0.057 af

Reach 50R: (new Reach) Avg. Flow Depth=0.39' Max Vel=1.72 fps Inflow=0.52 cfs 0.178 af
n=0.070 L=280.0' S=0.0679 '/' Capacity=19.07 cfs Outflow=0.51 cfs 0.178 af

Reach 51R: (new Reach) Avg. Flow Depth=0.30' Max Vel=2.05 fps Inflow=0.37 cfs 0.123 af
n=0.070 L=148.0' S=0.1351 '/' Capacity=26.91 cfs Outflow=0.37 cfs 0.123 af

Reach 52R: (new Reach) Avg. Flow Depth=0.48' Max Vel=0.78 fps Inflow=1.14 cfs 0.388 af
n=0.070 L=352.0' S=0.0057 '/' Capacity=10.86 cfs Outflow=1.11 cfs 0.388 af

Reach 53R: (new Reach) Avg. Flow Depth=1.17' Max Vel=1.22 fps Inflow=6.69 cfs 2.393 af
n=0.070 L=762.0' S=0.0052 '/' Capacity=10.44 cfs Outflow=6.17 cfs 2.392 af

Reach 55R: (new Reach) Avg. Flow Depth=0.38' Max Vel=1.55 fps Inflow=0.46 cfs 0.159 af
n=0.070 L=179.0' S=0.0559 '/' Capacity=17.30 cfs Outflow=0.46 cfs 0.159 af

Reach CP 7.1: conversion point Inflow=0.54 cfs 0.189 af
Outflow=0.54 cfs 0.189 af

Reach CP-1.1: (new Reach) Inflow=0.81 cfs 0.281 af
Outflow=0.81 cfs 0.281 af

Reach CP-1.2: (new Reach) Inflow=1.29 cfs 0.449 af
Outflow=1.29 cfs 0.449 af

Reach CP-1.3: (new Reach) Inflow=1.91 cfs 0.669 af
Outflow=1.91 cfs 0.669 af

Reach CP-1.4: (new Reach) Inflow=2.94 cfs 1.026 af
Outflow=2.94 cfs 1.026 af

Reach CP-10.1: (new Reach)	Inflow=3.66 cfs 1.266 af Outflow=3.66 cfs 1.266 af
Reach CP-10.3: (new Reach)	Inflow=3.98 cfs 1.378 af Outflow=3.98 cfs 1.378 af
Reach CP-10.4: (new Reach)	Inflow=4.73 cfs 1.640 af Outflow=4.73 cfs 1.640 af
Reach CP-10.6: (new Reach)	Inflow=6.20 cfs 2.169 af Outflow=6.20 cfs 2.169 af
Reach CP-11.1: (new Reach)	Inflow=1.36 cfs 0.474 af Outflow=1.36 cfs 0.474 af
Reach CP-11.3: (new Reach)	Inflow=2.87 cfs 1.016 af Outflow=2.87 cfs 1.016 af
Reach CP-11.5: (new Reach)	Inflow=3.11 cfs 1.100 af Outflow=3.11 cfs 1.100 af
Reach CP-11.7: (new Reach)	Inflow=5.16 cfs 1.795 af Outflow=5.16 cfs 1.795 af
Reach CP-2.1: (new Reach)	Inflow=0.80 cfs 0.275 af Outflow=0.80 cfs 0.275 af
Reach CP-2.2: (new Reach)	Inflow=2.95 cfs 1.024 af Outflow=2.95 cfs 1.024 af
Reach CP-2.3: (new Reach)	Inflow=3.88 cfs 1.345 af Outflow=3.88 cfs 1.345 af
Reach CP-2.4: (new Reach)	Inflow=5.60 cfs 1.927 af Outflow=5.60 cfs 1.927 af
Reach CP-20.4: (new Reach)	Inflow=0.83 cfs 0.287 af Outflow=0.83 cfs 0.287 af
Reach CP-20.5: (new Reach)	Inflow=3.15 cfs 1.106 af Outflow=3.15 cfs 1.106 af
Reach CP-21.1: (new Reach)	Inflow=11.59 cfs 4.107 af Outflow=11.59 cfs 4.107 af
Reach CP-22.1: (new Reach)	Inflow=0.59 cfs 0.204 af Outflow=0.59 cfs 0.204 af
Reach CP-23.1: (new Reach)	Inflow=0.60 cfs 0.239 af Outflow=0.60 cfs 0.239 af

Reach CP-3.1: (new Reach) Inflow=6.56 cfs 2.265 af
Outflow=6.56 cfs 2.265 af

Reach CP-4A.2: (new Reach) Inflow=1.06 cfs 0.367 af
Outflow=1.06 cfs 0.367 af

Reach CP-4B.1: (new Reach) Inflow=2.26 cfs 0.781 af
Outflow=2.26 cfs 0.781 af

Reach CP-4B.2: (new Reach) Inflow=2.67 cfs 0.923 af
Outflow=2.67 cfs 0.923 af

Reach CP-4B.3: (new Reach) Inflow=3.12 cfs 1.081 af
Outflow=3.12 cfs 1.081 af

Reach CP-4B.4: (new Reach) Inflow=3.65 cfs 1.264 af
Outflow=3.65 cfs 1.264 af

Reach CP-4B.5: (new Reach) Inflow=4.46 cfs 1.549 af
Outflow=4.46 cfs 1.549 af

Reach CP-4B.6: (new Reach) Inflow=4.62 cfs 1.606 af
Outflow=4.62 cfs 1.606 af

Reach CP-7.2: conversion point Inflow=2.37 cfs 0.821 af
Outflow=2.37 cfs 0.821 af

Reach CP-8.1: conversion point Inflow=1.28 cfs 0.443 af
Outflow=1.28 cfs 0.443 af

Reach CP-8.2: conversion point Inflow=2.71 cfs 0.953 af
Outflow=2.71 cfs 0.953 af

Reach CP-8.3: conversion point Inflow=4.24 cfs 1.490 af
Outflow=4.24 cfs 1.490 af

Reach CP-9.1: (new Reach) Inflow=2.00 cfs 0.699 af
Outflow=2.00 cfs 0.699 af

Reach CULV-1: (new Reach) Avg. Flow Depth=0.34' Max Vel=8.97 fps Inflow=3.15 cfs 1.106 af
24.0" Round Pipe n=0.013 L=53.0' S=0.0502 '/' Capacity=50.68 cfs Outflow=3.15 cfs 1.106 af

Reach CULV-2: (new Reach) Avg. Flow Depth=0.21' Max Vel=4.31 fps Inflow=0.83 cfs 0.287 af
30.0" Round Pipe n=0.013 L=139.0' S=0.0210 '/' Capacity=59.45 cfs Outflow=0.83 cfs 0.287 af

Reach CULV-2.2: (new Reach) Avg. Flow Depth=0.26' Max Vel=2.75 fps Inflow=0.83 cfs 0.287 af
36.0" Round Pipe n=0.013 L=87.0' S=0.0062 '/' Capacity=52.55 cfs Outflow=0.83 cfs 0.287 af

Reach CULV-3: (new Reach) Avg. Flow Depth=0.86' Max Vel=5.57 fps Inflow=7.17 cfs 2.484 af
24.0" Round Pipe n=0.017 L=196.0' S=0.0117 '/' Capacity=18.74 cfs Outflow=7.17 cfs 2.484 af

Reach CULV-4: (new Reach) Avg. Flow Depth=0.35' Max Vel=8.62 fps Inflow=3.16 cfs 1.090 af
24.0" Round Pipe n=0.013 L=69.0' S=0.0446 '/' Capacity=47.80 cfs Outflow=3.16 cfs 1.090 af

Reach CULV-5: (new Reach) Avg. Flow Depth=0.54' Max Vel=17.03 fps Inflow=11.59 cfs 4.107 af
24.0" Round Pipe n=0.012 L=84.0' S=0.0893 '/' Capacity=73.23 cfs Outflow=11.59 cfs 4.107 af

Reach CULV-7: (new Reach) Avg. Flow Depth=0.46' Max Vel=9.19 fps Inflow=4.99 cfs 1.739 af
24.0" Round Pipe n=0.012 L=128.0' S=0.0313 '/' Capacity=43.32 cfs Outflow=4.99 cfs 1.739 af

Reach DC-10A: (new Reach) Avg. Flow Depth=0.14' Max Vel=11.07 fps Inflow=3.66 cfs 1.266 af
n=0.018 L=108.0' S=0.2870 '/' Capacity=300.28 cfs Outflow=3.66 cfs 1.266 af

Reach DC-10B: (new Reach) Avg. Flow Depth=0.16' Max Vel=10.89 fps Inflow=3.98 cfs 1.378 af
n=0.018 L=40.0' S=0.2500 '/' Capacity=280.24 cfs Outflow=3.98 cfs 1.378 af

Reach DC-10C: (new Reach) Avg. Flow Depth=0.17' Max Vel=11.83 fps Inflow=4.73 cfs 1.640 af
n=0.018 L=100.0' S=0.2700 '/' Capacity=291.24 cfs Outflow=4.73 cfs 1.640 af

Reach DC-11A: (new Reach) Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=115.0' S=0.1391 '/' Capacity=292.33 cfs Outflow=0.00 cfs 0.000 af

Reach DC-11B: (new Reach) Avg. Flow Depth=0.08' Max Vel=7.76 fps Inflow=1.36 cfs 0.474 af
n=0.018 L=161.0' S=0.2795 '/' Capacity=414.33 cfs Outflow=1.36 cfs 0.474 af

Reach DC-11C: (new Reach) Avg. Flow Depth=0.13' Max Vel=10.02 fps Inflow=2.87 cfs 1.016 af
n=0.018 L=150.0' S=0.2733 '/' Capacity=409.73 cfs Outflow=2.87 cfs 1.016 af

Reach DC-11D: (new Reach) Avg. Flow Depth=0.13' Max Vel=10.19 fps Inflow=3.11 cfs 1.100 af
n=0.018 L=34.0' S=0.2647 '/' Capacity=403.22 cfs Outflow=3.11 cfs 1.100 af

Reach DC-12: (new Reach) Avg. Flow Depth=0.07' Max Vel=1.75 fps Inflow=0.59 cfs 0.204 af
n=0.070 L=107.0' S=0.2617 '/' Capacity=132.47 cfs Outflow=0.59 cfs 0.204 af

Reach DC-1A: (new Reach) Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=242.0' S=0.1694 '/' Capacity=230.70 cfs Outflow=0.00 cfs 0.000 af

Reach DC-1B: (new Reach) Avg. Flow Depth=0.07' Max Vel=5.48 fps Inflow=0.81 cfs 0.281 af
n=0.018 L=206.0' S=0.1699 '/' Capacity=231.03 cfs Outflow=0.81 cfs 0.281 af

Reach DC-1C: (new Reach) Avg. Flow Depth=0.14' Max Vel=4.02 fps Inflow=1.29 cfs 0.449 af
n=0.018 L=77.0' S=0.0390 '/' Capacity=110.63 cfs Outflow=1.29 cfs 0.449 af

Reach DC-1D: (new Reach) Avg. Flow Depth=0.10' Max Vel=8.49 fps Inflow=1.91 cfs 0.669 af
n=0.018 L=98.0' S=0.2551 '/' Capacity=283.09 cfs Outflow=1.91 cfs 0.669 af

Reach DC-2A: (new Reach) Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=165.0' S=0.2242 '/' Capacity=1,143.46 cfs Outflow=0.00 cfs 0.000 af

Reach DC-2B: (new Reach) Avg. Flow Depth=0.04' Max Vel=4.59 fps Inflow=0.80 cfs 0.275 af
n=0.018 L=35.0' S=0.2000 '/' Capacity=1,079.89 cfs Outflow=0.80 cfs 0.275 af

Reach DC-2C: (new Reach) Avg. Flow Depth=0.10' Max Vel=7.39 fps Inflow=2.95 cfs 1.024 af
n=0.018 L=199.0' S=0.1960 '/' Capacity=1,068.98 cfs Outflow=2.95 cfs 1.024 af

Reach DC-2D: (new Reach) Avg. Flow Depth=0.12' Max Vel=7.90 fps Inflow=3.88 cfs 1.345 af
n=0.018 L=40.0' S=0.1750 '/' Capacity=1,010.14 cfs Outflow=3.87 cfs 1.345 af

Reach DC-2E: (new Reach) Avg. Flow Depth=0.12' Max Vel=10.71 fps Inflow=5.60 cfs 1.927 af
n=0.018 L=50.0' S=0.3000 '/' Capacity=1,322.58 cfs Outflow=5.60 cfs 1.927 af

Reach DC-4A: (new Reach) Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=134.0' S=0.0821 '/' Capacity=245.13 cfs Outflow=0.00 cfs 0.000 af

Reach DC-4B: (new Reach) Avg. Flow Depth=0.06' Max Vel=4.26 fps Inflow=1.06 cfs 0.367 af
n=0.018 L=17.0' S=0.1176 '/' Capacity=293.45 cfs Outflow=1.06 cfs 0.367 af

Reach DC-4C: (new Reach) Avg. Flow Depth=0.10' Max Vel=5.38 fps Inflow=2.26 cfs 0.781 af
n=0.018 L=102.0' S=0.0980 '/' Capacity=267.89 cfs Outflow=2.26 cfs 0.781 af

Reach DC-4D: (new Reach) Avg. Flow Depth=0.08' Max Vel=8.47 fps Inflow=2.67 cfs 0.923 af
n=0.018 L=49.0' S=0.3469 '/' Capacity=503.94 cfs Outflow=2.67 cfs 0.923 af

Reach DC-4E: (new Reach) Avg. Flow Depth=0.09' Max Vel=8.72 fps Inflow=3.12 cfs 1.081 af
n=0.018 L=96.0' S=0.3125 '/' Capacity=478.27 cfs Outflow=3.12 cfs 1.081 af

Reach DC-4F: (new Reach) Avg. Flow Depth=0.09' Max Vel=9.38 fps Inflow=3.65 cfs 1.264 af
n=0.018 L=61.0' S=0.3279 '/' Capacity=489.89 cfs Outflow=3.65 cfs 1.264 af

Reach DC-4G: (new Reach) Avg. Flow Depth=0.10' Max Vel=10.26 fps Inflow=4.46 cfs 1.549 af
n=0.018 L=93.0' S=0.3441 '/' Capacity=501.86 cfs Outflow=4.46 cfs 1.549 af

Reach DC-4H: (new Reach) Avg. Flow Depth=0.13' Max Vel=8.03 fps Inflow=4.62 cfs 1.606 af
n=0.018 L=53.0' S=0.1509 '/' Capacity=332.40 cfs Outflow=4.62 cfs 1.606 af

Reach DC-7A: downchute Avg. Flow Depth=0.05' Max Vel=2.46 fps Inflow=0.54 cfs 0.189 af
n=0.041 L=279.0' S=0.2330 '/' Capacity=205.90 cfs Outflow=0.54 cfs 0.189 af

Reach DC-7B: downchute Avg. Flow Depth=0.18' Max Vel=5.69 fps Inflow=2.37 cfs 0.821 af
n=0.030 L=24.0' S=0.1667 '/' Capacity=157.85 cfs Outflow=2.37 cfs 0.821 af

Reach DC-8A: downchute Avg. Flow Depth=0.13' Max Vel=4.32 fps Inflow=1.28 cfs 0.443 af
n=0.041 L=157.0' S=0.2548 '/' Capacity=142.80 cfs Outflow=1.28 cfs 0.443 af

Reach DC-8B: downchute Avg. Flow Depth=0.17' Max Vel=6.77 fps Inflow=2.71 cfs 0.953 af
n=0.030 L=163.0' S=0.2454 '/' Capacity=191.54 cfs Outflow=2.71 cfs 0.953 af

Reach DC-8C: downchute Avg. Flow Depth=0.35' Max Vel=4.46 fps Inflow=4.24 cfs 1.490 af
n=0.070 L=105.0' S=0.2571 '/' Capacity=84.03 cfs Outflow=4.24 cfs 1.490 af

Reach DC-9: (new Reach) Avg. Flow Depth=0.10' Max Vel=8.79 fps Inflow=2.00 cfs 0.699 af
n=0.018 L=137.0' S=0.2701 '/' Capacity=291.28 cfs Outflow=2.00 cfs 0.699 af

Reach DITCH-2: (new Reach) Avg. Flow Depth=0.72' Max Vel=0.58 fps Inflow=0.69 cfs 0.239 af
n=0.070 L=580.0' S=0.0034 '/' Capacity=4.30 cfs Outflow=0.60 cfs 0.239 af

Reach NPIS-1: (new Reach) Avg. Flow Depth=0.29' Max Vel=0.79 fps Inflow=0.17 cfs 0.055 af
n=0.070 L=120.0' S=0.0200 '/' Capacity=28.53 cfs Outflow=0.17 cfs 0.055 af

Reach NPIS-2: (new Reach) Avg. Flow Depth=1.13' Max Vel=1.67 fps Inflow=5.38 cfs 1.888 af
n=0.070 L=343.0' S=0.0146 '/' Capacity=24.35 cfs Outflow=5.33 cfs 1.888 af

Reach NPIS-3: (new Reach) Avg. Flow Depth=1.14' Max Vel=1.93 fps Inflow=6.30 cfs 2.219 af
n=0.070 L=363.0' S=0.0193 '/' Capacity=28.01 cfs Outflow=6.26 cfs 2.219 af

Reach OF-1: (new Reach) Inflow=3.97 cfs 1.392 af
Outflow=3.97 cfs 1.392 af

Reach OF-4A: outfall Inflow=5.34 cfs 1.878 af
Outflow=5.34 cfs 1.878 af

Reach OF-4B: Outfall 4E Inflow=6.54 cfs 2.597 af
Outflow=6.54 cfs 2.597 af

Reach OF-4C: outfall Inflow=2.37 cfs 0.821 af
Outflow=2.37 cfs 0.821 af

Reach RD-1: (new Reach) Avg. Flow Depth=0.30' Max Vel=4.65 fps Inflow=0.83 cfs 0.287 af
n=0.016 L=253.0' S=0.0366 '/' Capacity=132.03 cfs Outflow=0.83 cfs 0.287 af

Reach RD-2: (new Reach) Avg. Flow Depth=0.43' Max Vel=8.45 fps Inflow=3.15 cfs 1.106 af
n=0.016 L=152.0' S=0.0741 '/' Capacity=187.81 cfs Outflow=3.15 cfs 1.106 af

Reach RD-3: (new Reach) Avg. Flow Depth=0.36' Max Vel=3.91 fps Inflow=1.04 cfs 0.357 af
n=0.016 L=650.0' S=0.0200 '/' Capacity=45.29 cfs Outflow=1.04 cfs 0.357 af

Reach RD-4: (new Reach) Avg. Flow Depth=0.33' Max Vel=4.63 fps Inflow=0.98 cfs 0.338 af
n=0.016 L=617.0' S=0.0324 '/' Capacity=19.56 cfs Outflow=0.98 cfs 0.338 af

Reach RD-5: (new Reach) Avg. Flow Depth=0.59' Max Vel=2.49 fps Inflow=1.75 cfs 0.582 af
n=0.070 L=795.0' S=0.0818 '/' Capacity=20.93 cfs Outflow=1.73 cfs 0.582 af

Reach RD-7: (new Reach) Avg. Flow Depth=0.49' Max Vel=2.39 fps Inflow=1.17 cfs 0.391 af
n=0.070 L=485.0' S=0.0948 '/' Capacity=22.54 cfs Outflow=1.17 cfs 0.391 af

Reach RD-8: (new Reach) Avg. Flow Depth=0.62' Max Vel=2.50 fps Inflow=1.92 cfs 0.639 af
n=0.070 L=840.0' S=0.0774 '/' Capacity=20.36 cfs Outflow=1.89 cfs 0.639 af

Pond 1P: DI-5 Peak Elev=231.70' Inflow=3.16 cfs 1.090 af
Outflow=3.16 cfs 1.090 af

Pond DI-1: (new Pond) Peak Elev=151.26' Inflow=3.15 cfs 1.106 af
Outflow=3.15 cfs 1.106 af

Pond DI-2: (new Pond) Peak Elev=151.81' Inflow=0.83 cfs 0.287 af
Outflow=0.83 cfs 0.287 af

Pond DI-4: (new Pond) Peak Elev=147.23' Inflow=7.17 cfs 2.484 af
Outflow=7.17 cfs 2.484 af

Pond DI-6: (new Pond) Peak Elev=163.34' Inflow=4.99 cfs 1.739 af
Outflow=4.99 cfs 1.739 af

Pond POND-1: DITCH 1/STORMWATER Peak Elev=135.43' Storage=3.131 af Inflow=15.65 cfs 5.556 af
Outflow=3.17 cfs 2.572 af

Pond POND-3: STORMWATER DETENTION Peak Elev=141.47' Storage=0.568 af Inflow=15.11 cfs 5.699 af
Primary=9.23 cfs 5.697 af Secondary=0.00 cfs 0.000 af Outflow=9.23 cfs 5.697 af

Pond POND-4A: STORMWATER Peak Elev=151.68' Storage=0.675 af Inflow=5.55 cfs 1.948 af
Outflow=1.63 cfs 1.331 af

Total Runoff Area = 80.160 ac Runoff Volume = 16.621 af Average Runoff Depth = 2.49"
88.21% Pervious = 70.710 ac 11.79% Impervious = 9.450 ac

Summary for Subcatchment 7S: (new Subcat)

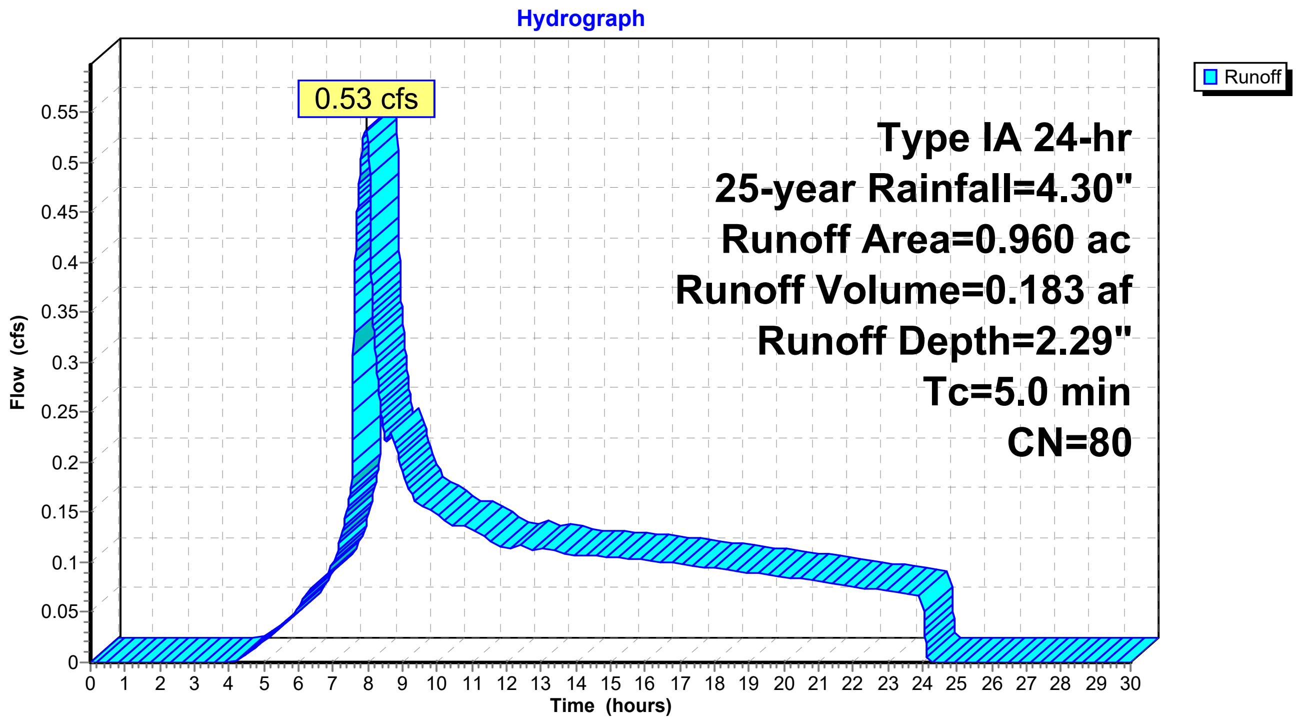
Runoff = 0.53 cfs @ 7.95 hrs, Volume= 0.183 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.960	80	>75% Grass cover, Good, HSG D
0.960		100.00% Pervious Area

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

Subcatchment 7S: (new Subcat)



Summary for Subcatchment 8S: (new Subcat)

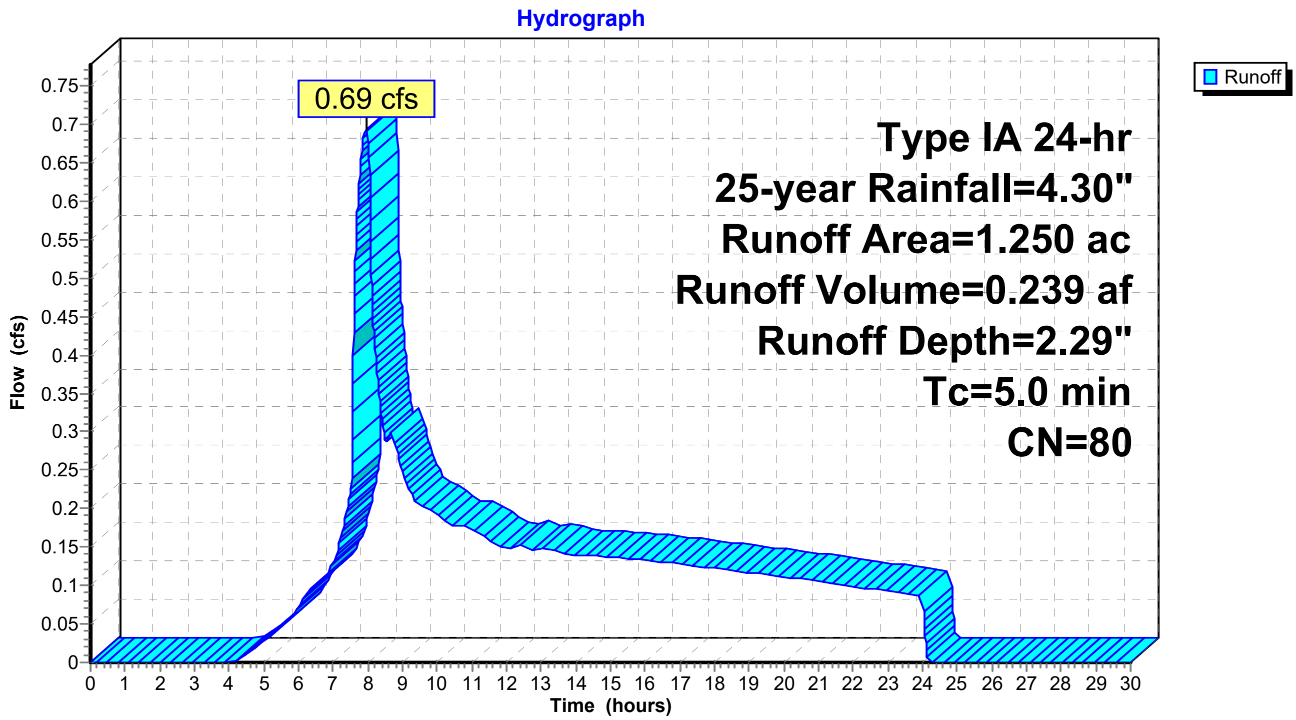
Runoff = 0.69 cfs @ 7.95 hrs, Volume= 0.239 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.250	80	>75% Grass cover, Good, HSG D
1.250		100.00% Pervious Area

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

Subcatchment 8S: (new Subcat)



Summary for Subcatchment 9S: (new Subcat)

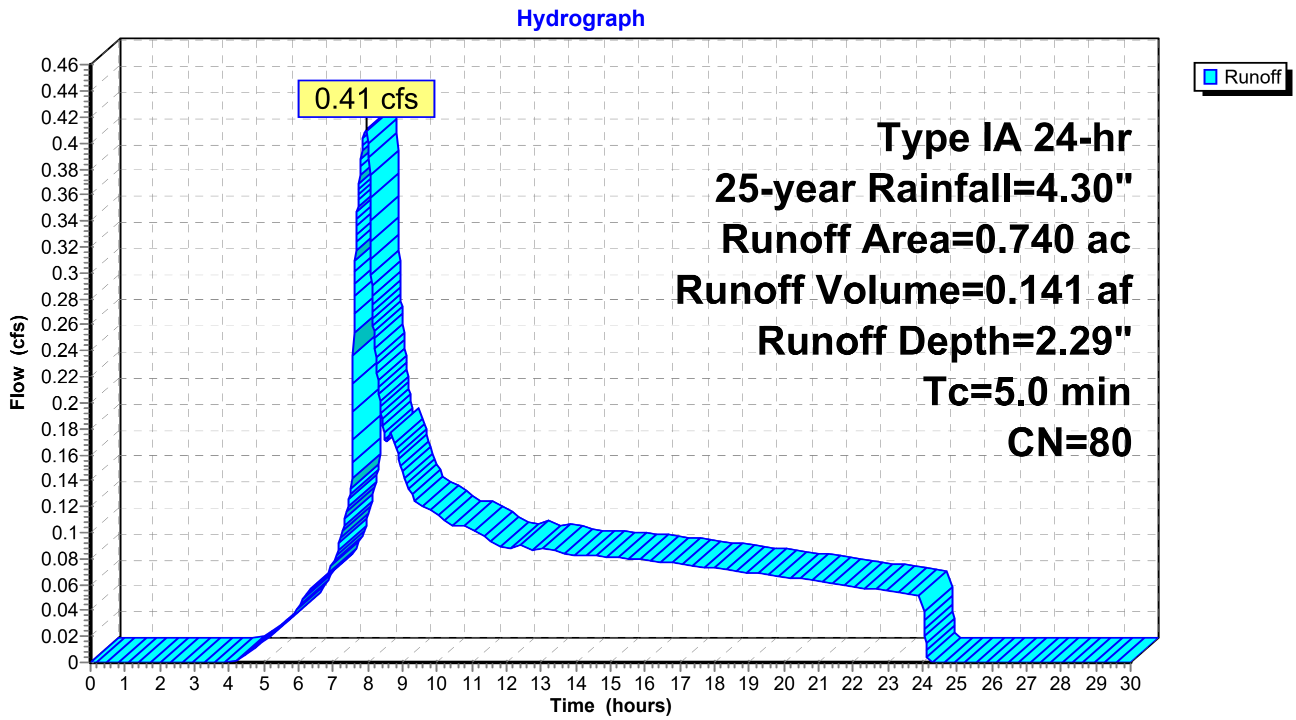
Runoff = 0.41 cfs @ 7.95 hrs, Volume= 0.141 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.740	80	>75% Grass cover, Good, HSG D
0.740		100.00% Pervious Area

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

Subcatchment 9S: (new Subcat)



Summary for Subcatchment 10S: (new Subcat)

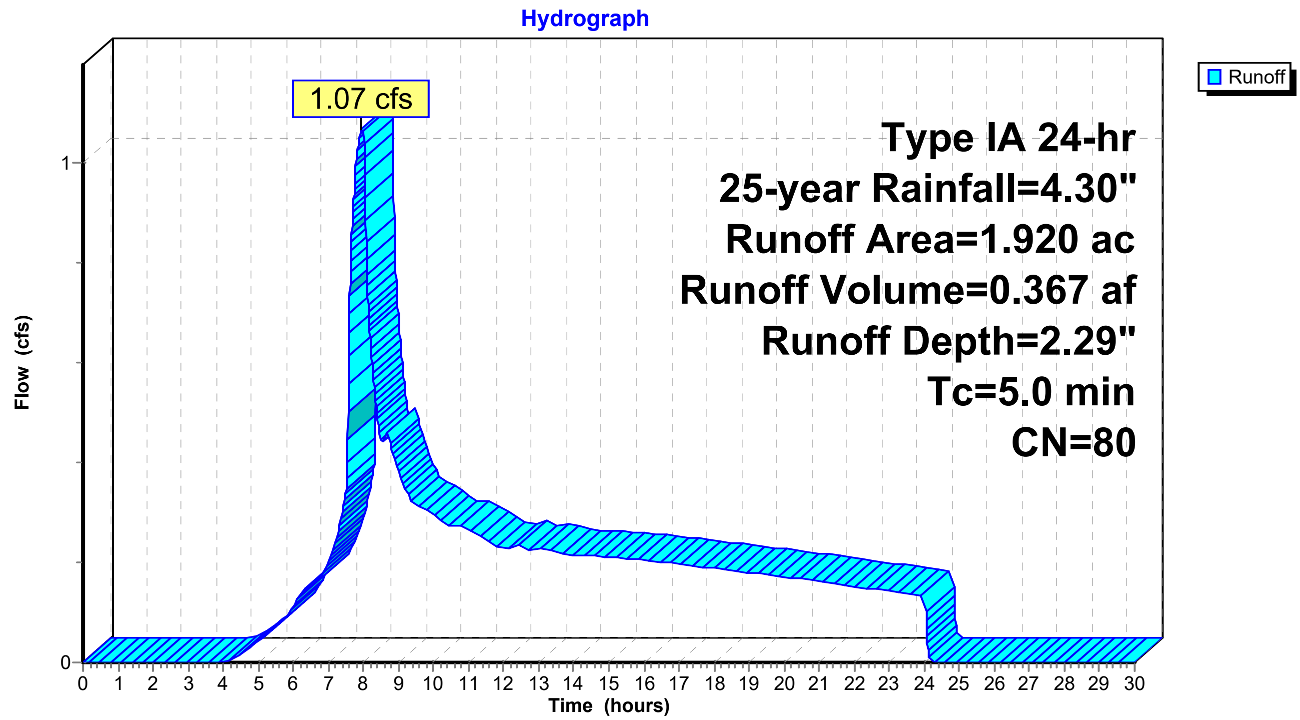
Runoff = 1.07 cfs @ 7.95 hrs, Volume= 0.367 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.920	80	>75% Grass cover, Good, HSG D
1.920		100.00% Pervious Area

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

Subcatchment 10S: (new Subcat)



Summary for Subcatchment 16S: (new Subcat)

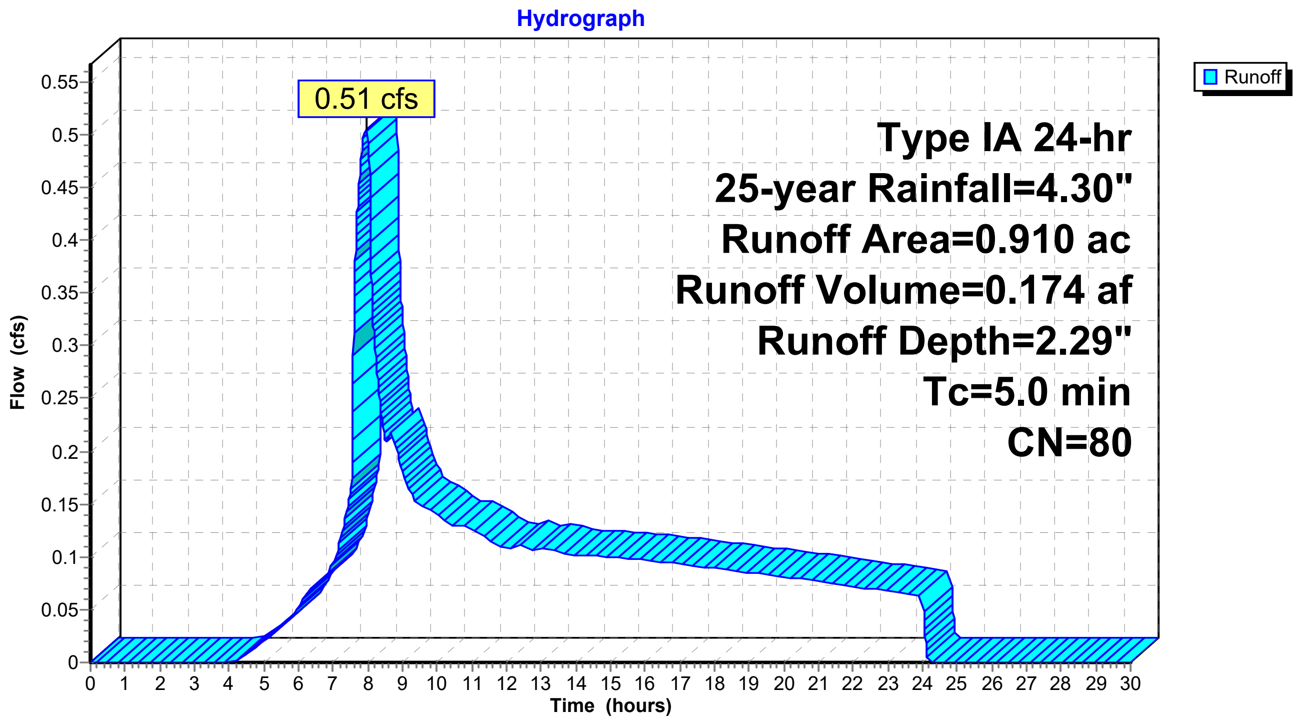
Runoff = 0.51 cfs @ 7.95 hrs, Volume= 0.174 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.910	80	>75% Grass cover, Good, HSG D
0.910		100.00% Pervious Area

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

Subcatchment 16S: (new Subcat)



Summary for Subcatchment 17S: (new Subcat)

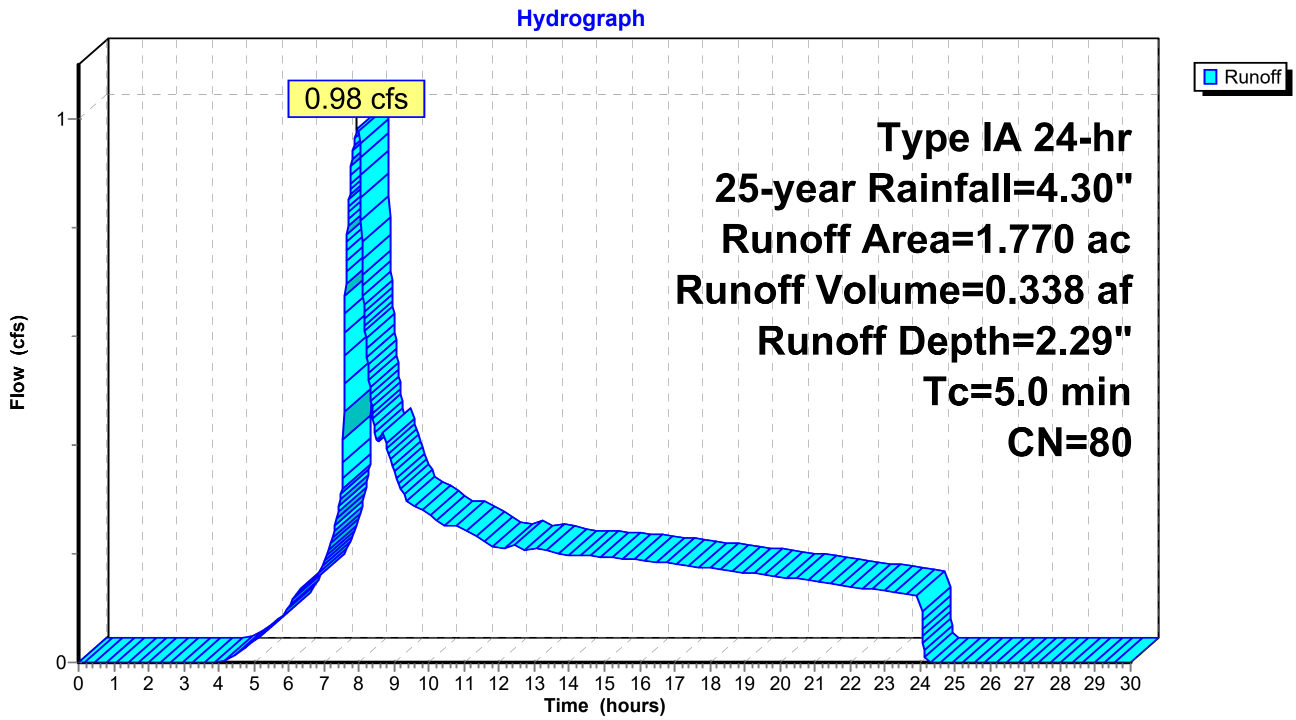
Runoff = 0.98 cfs @ 7.95 hrs, Volume= 0.338 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.770	80	>75% Grass cover, Good, HSG D
1.770		100.00% Pervious Area

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

Subcatchment 17S: (new Subcat)



Summary for Subcatchment 18S: (new Subcat)

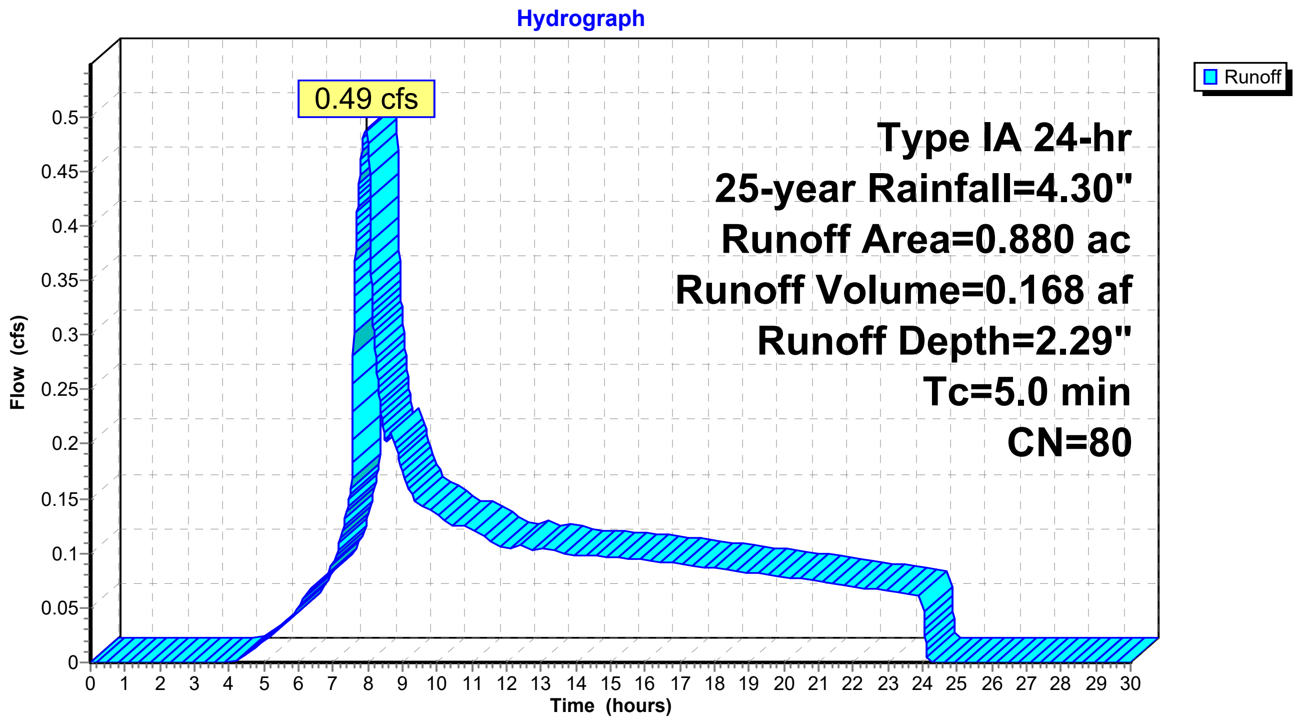
Runoff = 0.49 cfs @ 7.95 hrs, Volume= 0.168 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.880	80	>75% Grass cover, Good, HSG D
0.880		100.00% Pervious Area

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

Subcatchment 18S: (new Subcat)



Summary for Subcatchment 19S: (new Subcat)

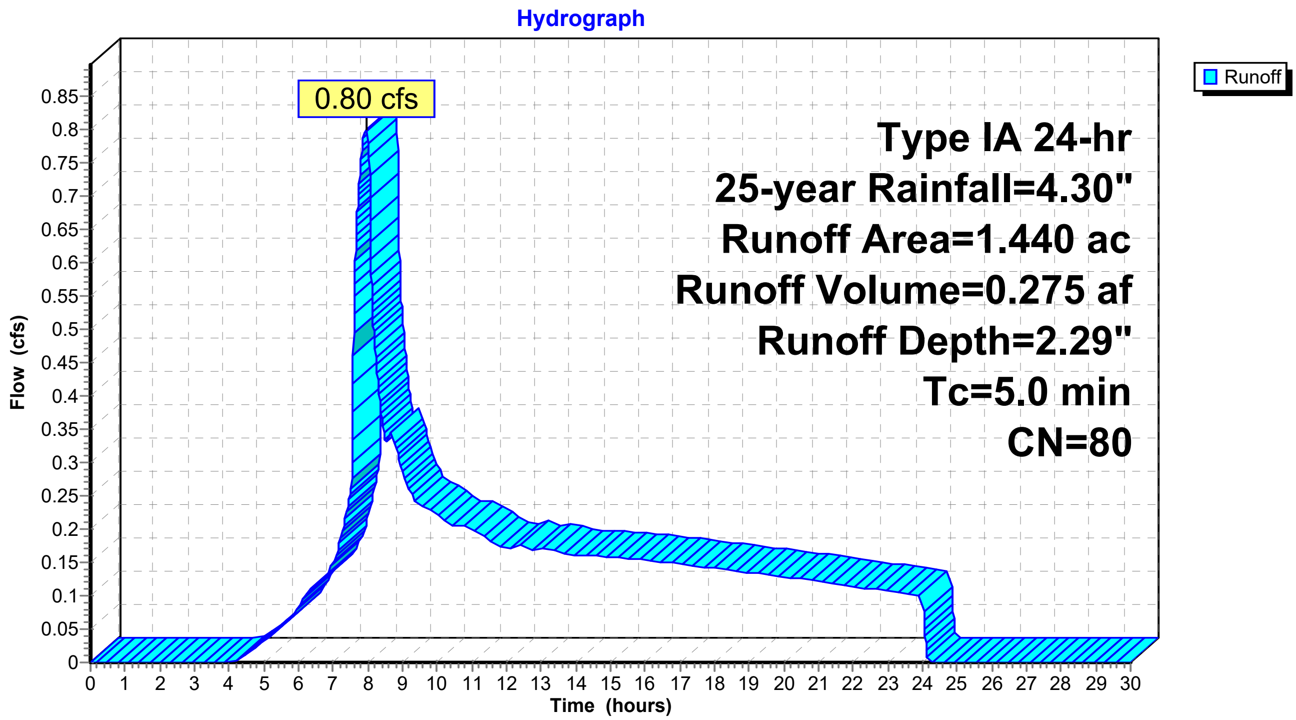
Runoff = 0.80 cfs @ 7.95 hrs, Volume= 0.275 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.440	80	>75% Grass cover, Good, HSG D
1.440		100.00% Pervious Area

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

Subcatchment 19S: (new Subcat)



Summary for Subcatchment 20S: (new Subcat)

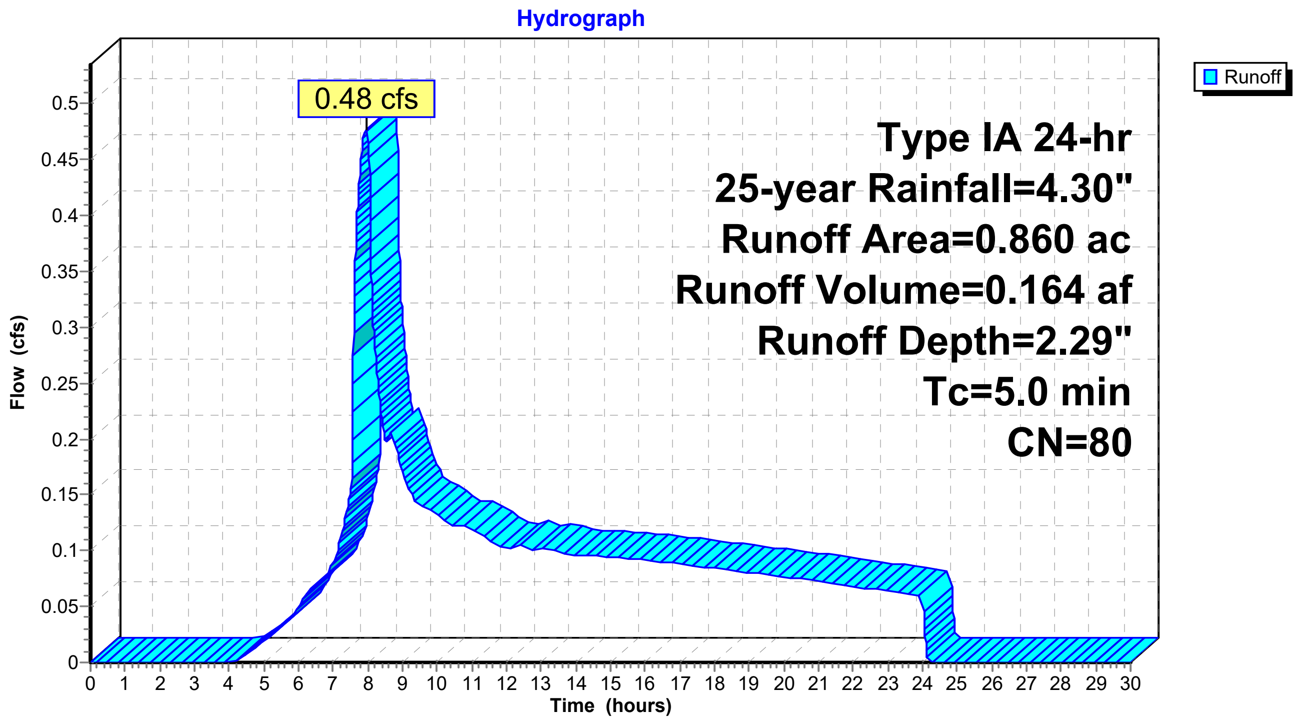
Runoff = 0.48 cfs @ 7.95 hrs, Volume= 0.164 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.860	80	>75% Grass cover, Good, HSG D
0.860		100.00% Pervious Area

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

Subcatchment 20S: (new Subcat)



Summary for Subcatchment 21S: (new Subcat)

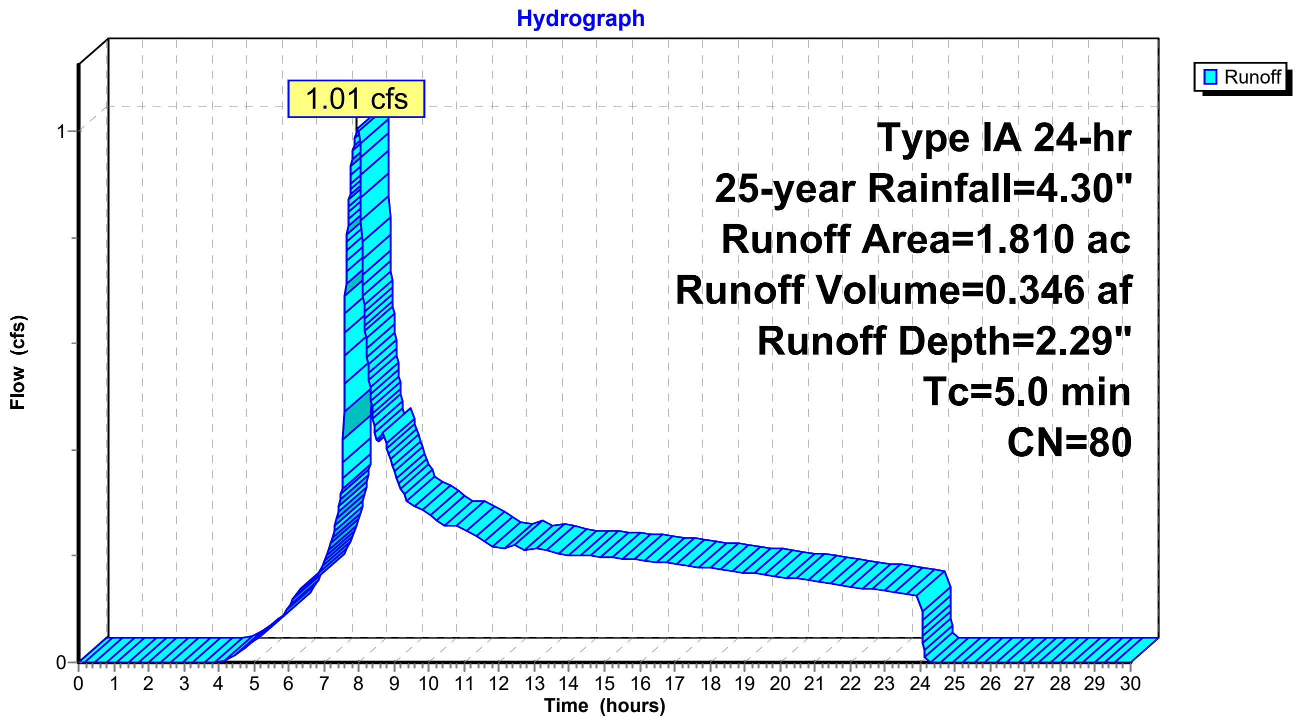
Runoff = 1.01 cfs @ 7.95 hrs, Volume= 0.346 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.810	80	>75% Grass cover, Good, HSG D
1.810		100.00% Pervious Area

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

Subcatchment 21S: (new Subcat)



Summary for Subcatchment 22S: (new Subcat)

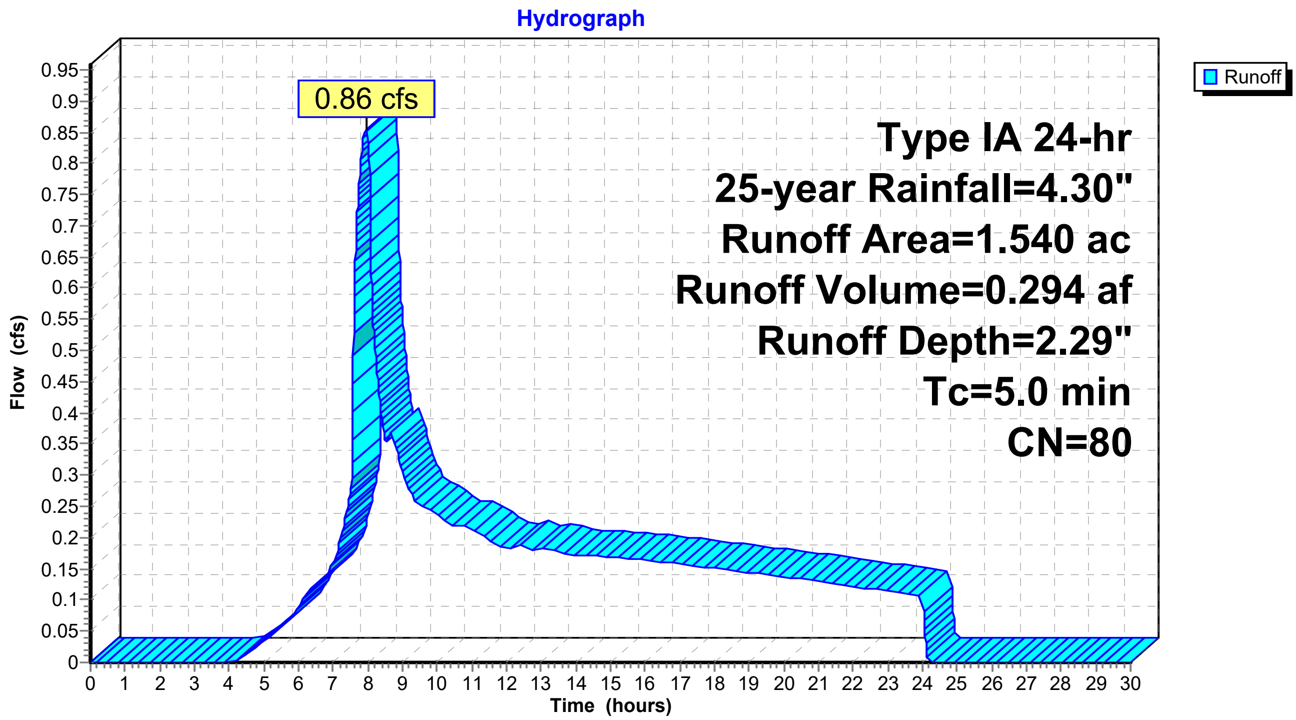
Runoff = 0.86 cfs @ 7.95 hrs, Volume= 0.294 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.540	80	>75% Grass cover, Good, HSG D
1.540		100.00% Pervious Area

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

Subcatchment 22S: (new Subcat)



Summary for Subcatchment 23S: (new Subcat)

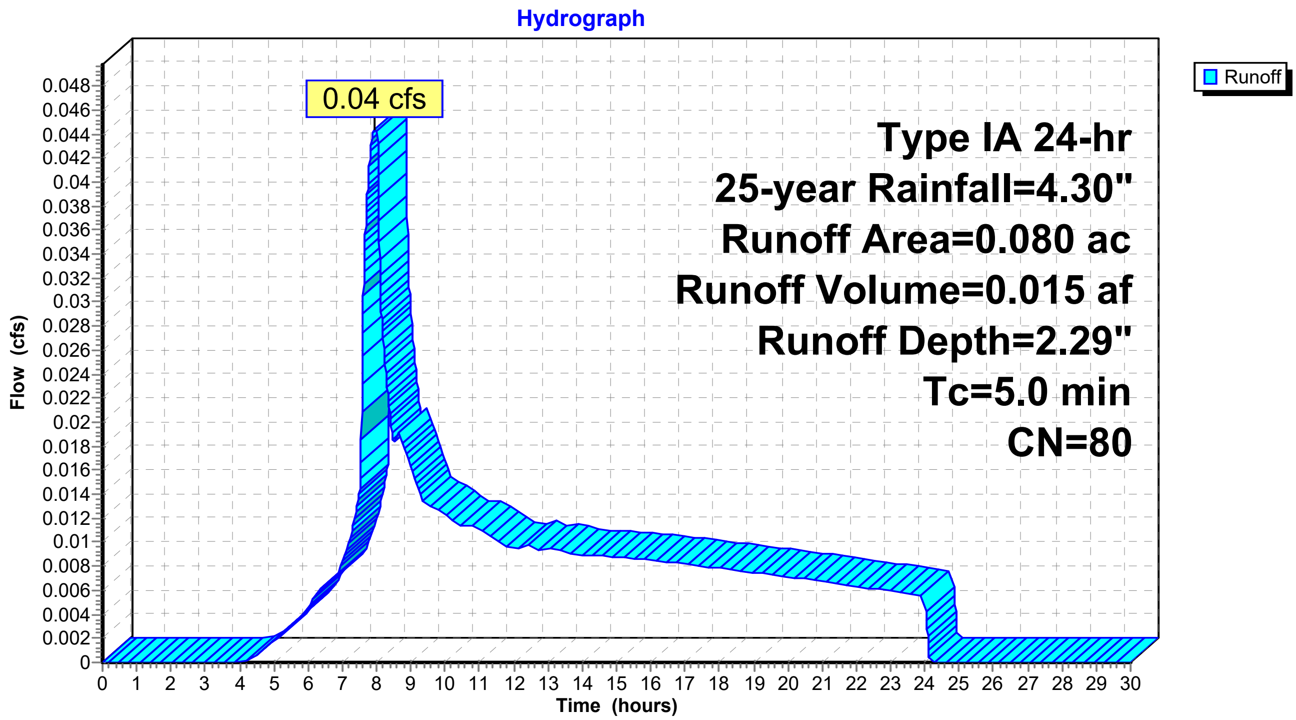
Runoff = 0.04 cfs @ 7.95 hrs, Volume= 0.015 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.080	80	>75% Grass cover, Good, HSG D
0.080		100.00% Pervious Area

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

Subcatchment 23S: (new Subcat)



Summary for Subcatchment 24S: (new Subcat)

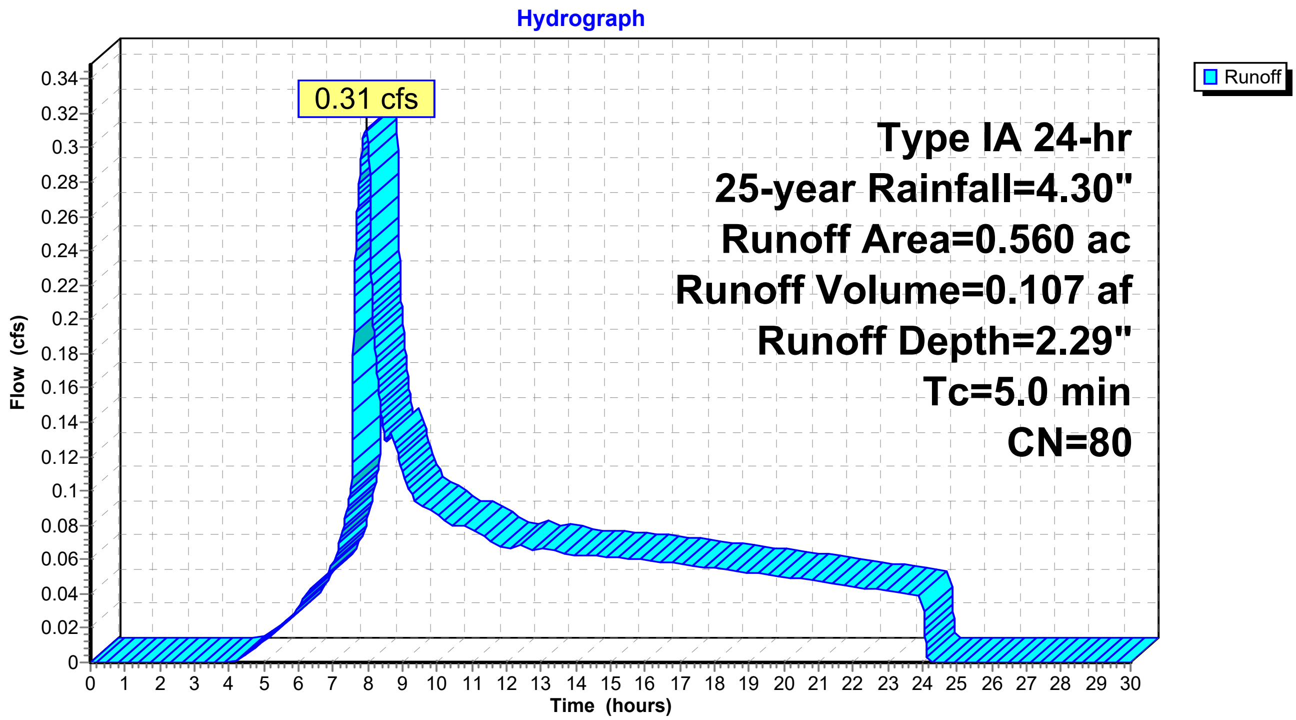
Runoff = 0.31 cfs @ 7.95 hrs, Volume= 0.107 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.560	80	>75% Grass cover, Good, HSG D
0.560		100.00% Pervious Area

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

Subcatchment 24S: (new Subcat)



Summary for Subcatchment 25S: (new Subcat)

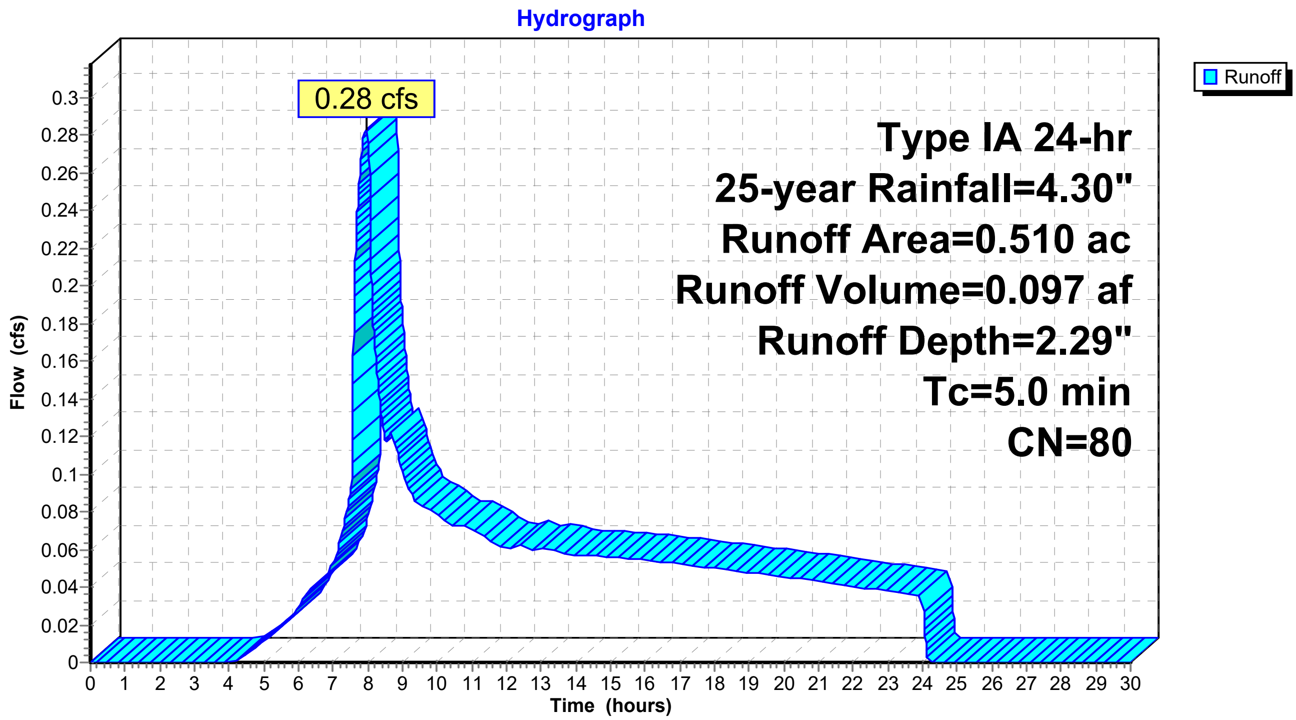
Runoff = 0.28 cfs @ 7.95 hrs, Volume= 0.097 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.510	80	>75% Grass cover, Good, HSG D
0.510		100.00% Pervious Area

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

Subcatchment 25S: (new Subcat)



Summary for Subcatchment 26S: (new Subcat)

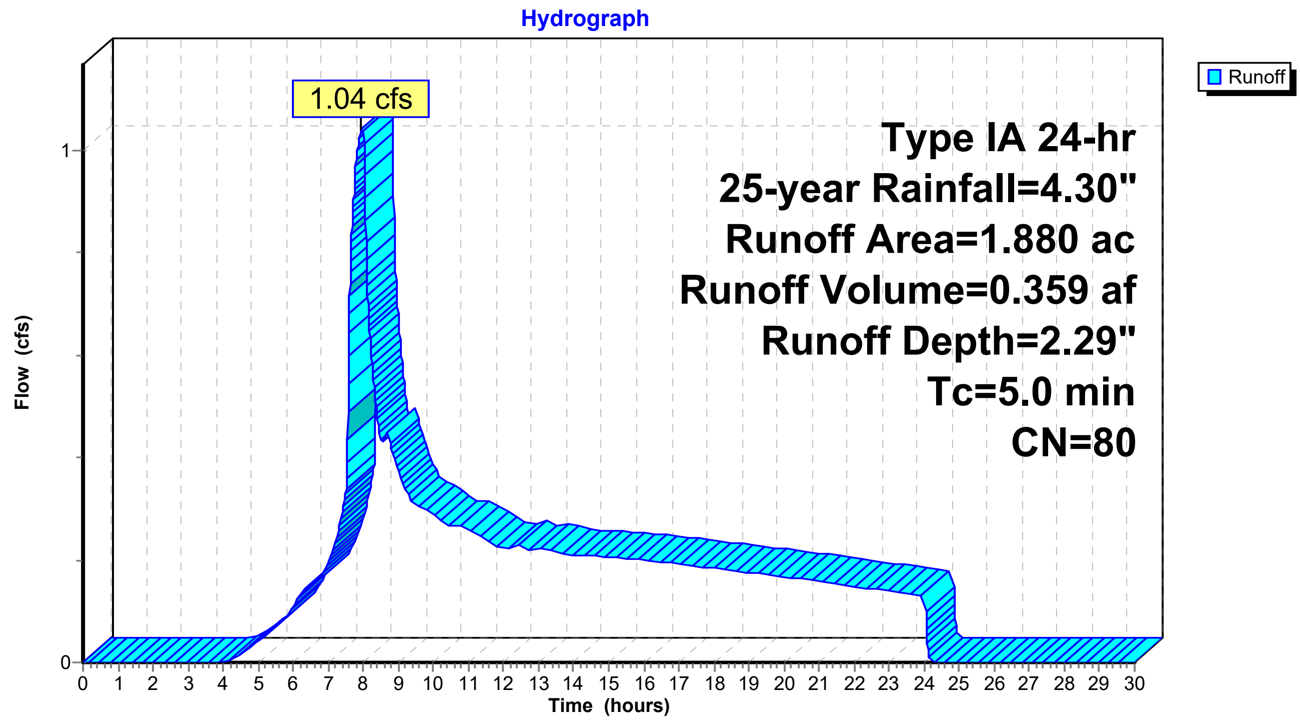
Runoff = 1.04 cfs @ 7.95 hrs, Volume= 0.359 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.880	80	>75% Grass cover, Good, HSG D
1.880		100.00% Pervious Area

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

Subcatchment 26S: (new Subcat)



Summary for Subcatchment 27S: (new Subcat)

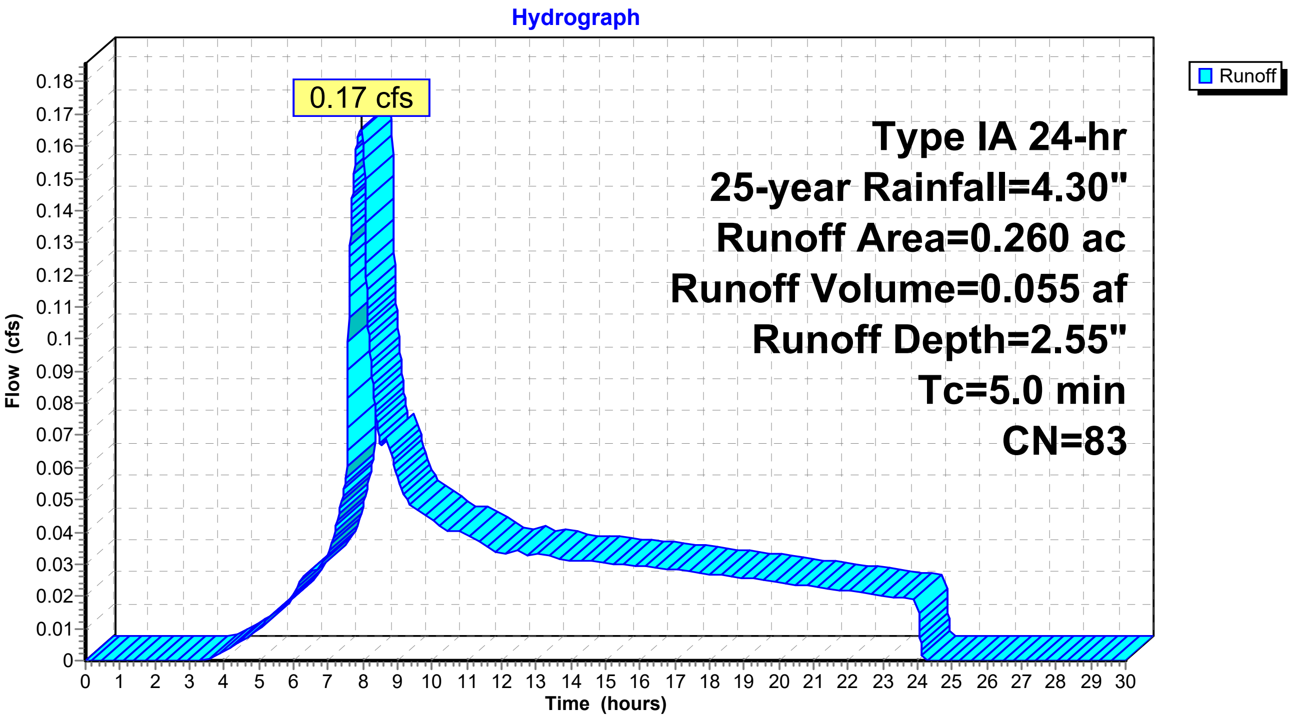
Runoff = 0.17 cfs @ 7.94 hrs, Volume= 0.055 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	0.210	80	>75% Grass cover, Good, HSG D
*	0.050	98	Roads
	0.260	83	Weighted Average
	0.210		80.77% Pervious Area
	0.050		19.23% Impervious Area

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

Subcatchment 27S: (new Subcat)



Summary for Subcatchment 28S: (new Subcat)

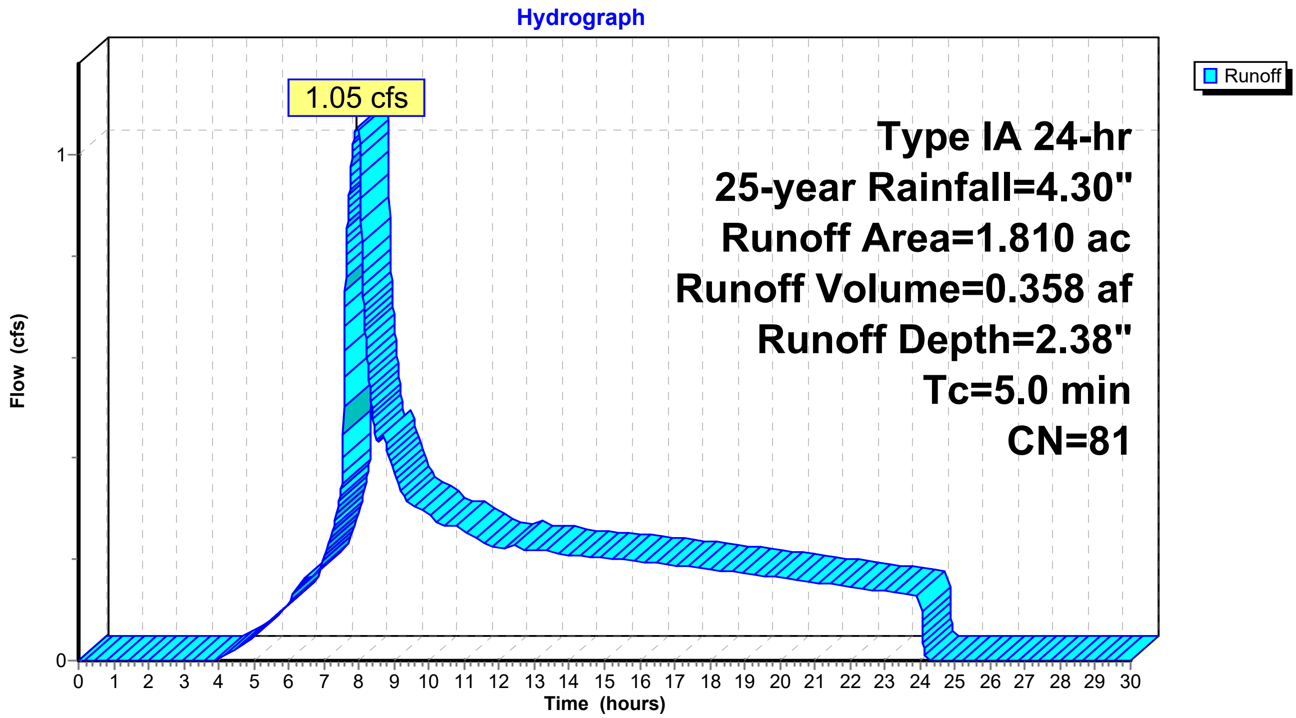
Runoff = 1.05 cfs @ 7.95 hrs, Volume= 0.358 af, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	1.670	80	>75% Grass cover, Good, HSG D
*	0.140	98	
	1.810	81	Weighted Average
	1.670		92.27% Pervious Area
	0.140		7.73% Impervious Area

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

Subcatchment 28S: (new Subcat)



Summary for Subcatchment 29S: (new Subcat)

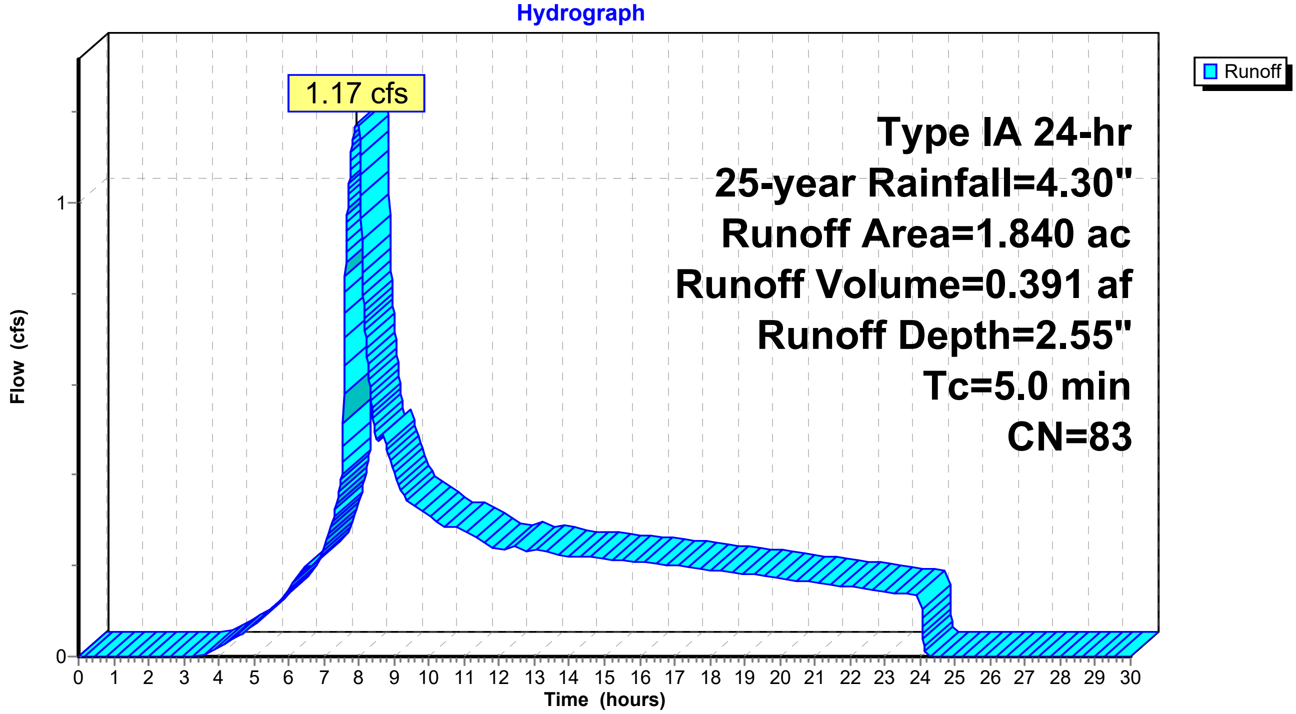
Runoff = 1.17 cfs @ 7.94 hrs, Volume= 0.391 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	1.530	80	>75% Grass cover, Good, HSG D
*	0.310	98	Road
	1.840	83	Weighted Average
	1.530		83.15% Pervious Area
	0.310		16.85% Impervious Area

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

Subcatchment 29S: (new Subcat)



Summary for Subcatchment 30S: (new Subcat)

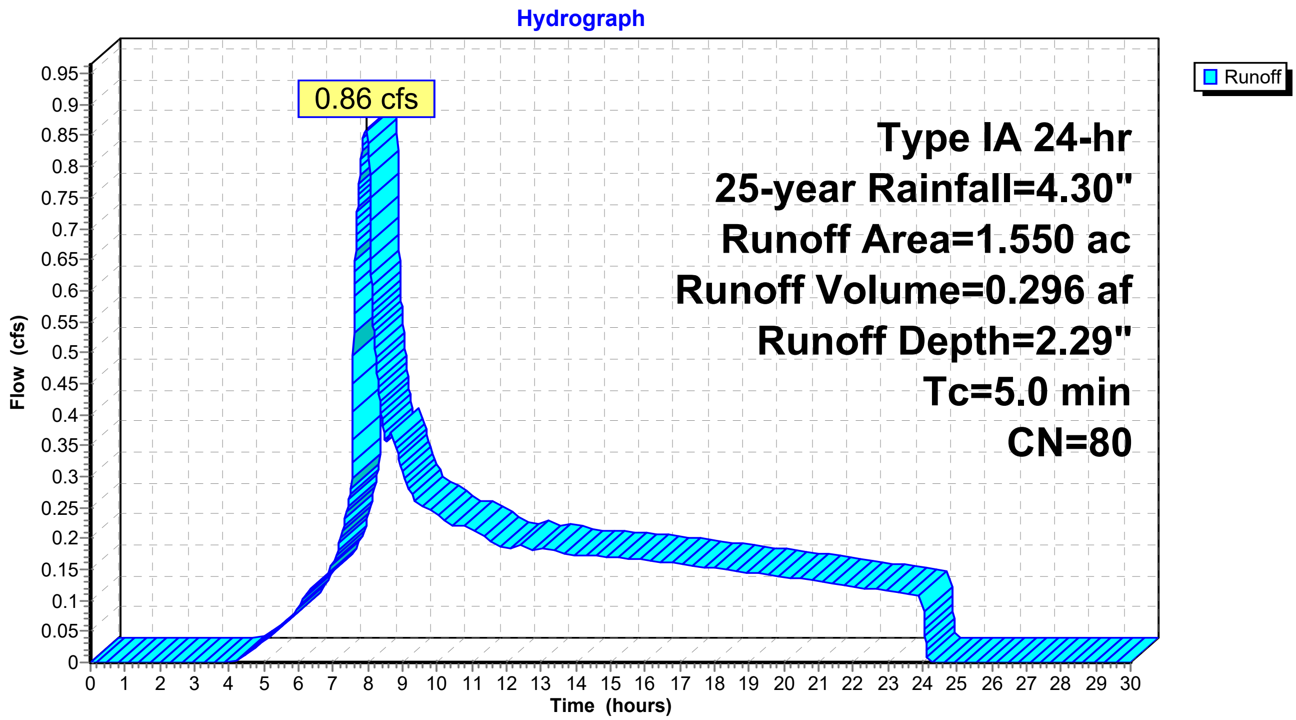
Runoff = 0.86 cfs @ 7.95 hrs, Volume= 0.296 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.550	80	>75% Grass cover, Good, HSG D
1.550		100.00% Pervious Area

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

Subcatchment 30S: (new Subcat)



Summary for Subcatchment 31S: (new Subcat)

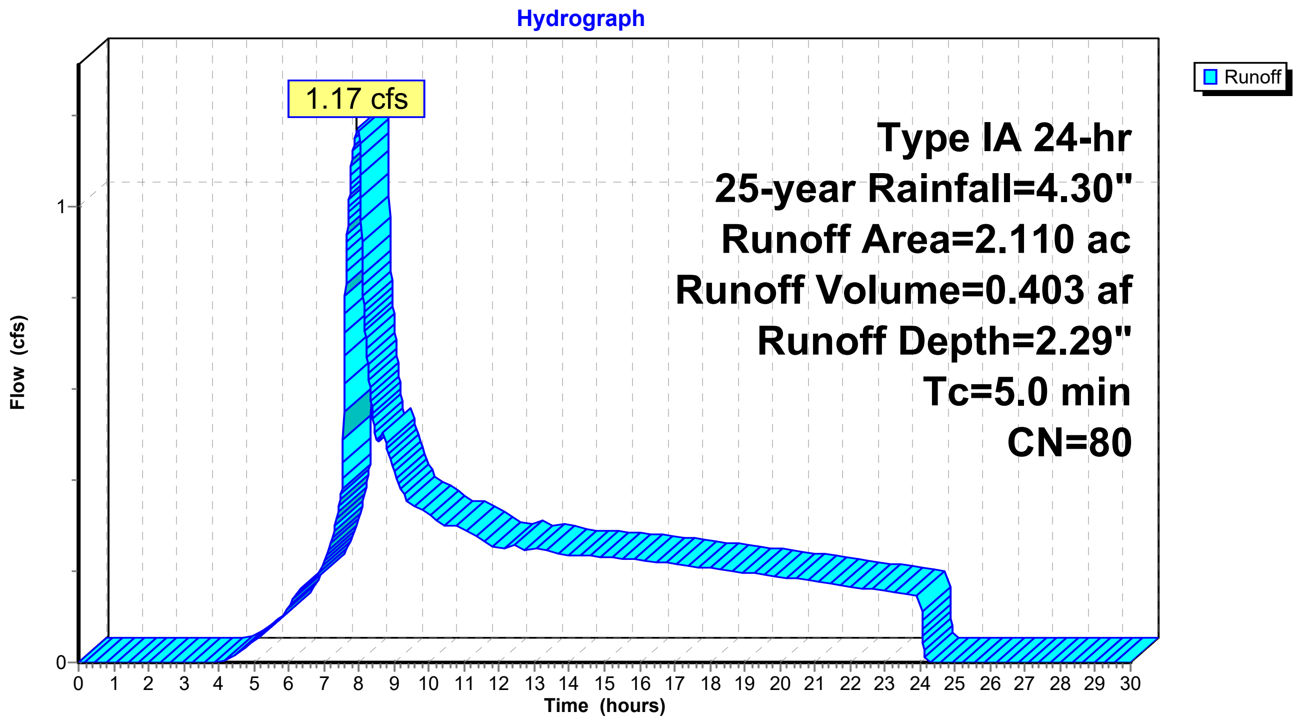
Runoff = 1.17 cfs @ 7.95 hrs, Volume= 0.403 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
2.110	80	>75% Grass cover, Good, HSG D
2.110		100.00% Pervious Area

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

Subcatchment 31S: (new Subcat)



Summary for Subcatchment 32S: (new Subcat)

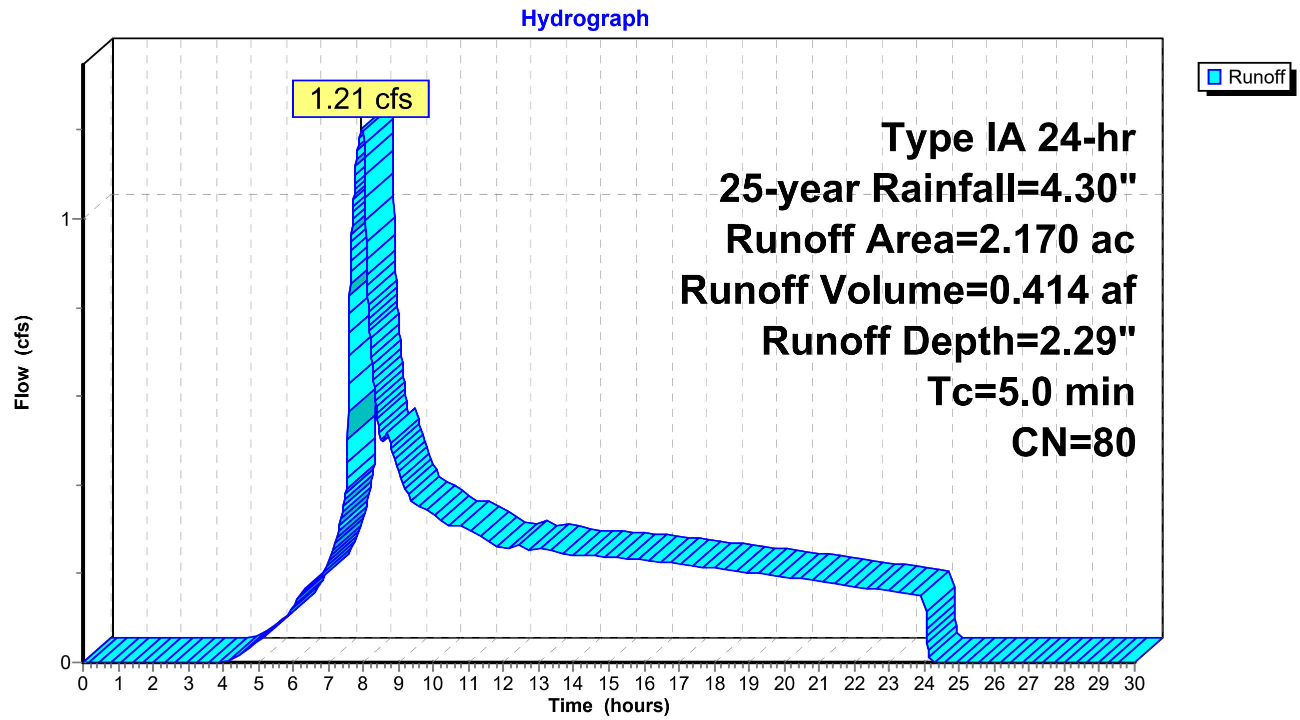
Runoff = 1.21 cfs @ 7.95 hrs, Volume= 0.414 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
2.170	80	>75% Grass cover, Good, HSG D
2.170		100.00% Pervious Area

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

Subcatchment 32S: (new Subcat)



Summary for Subcatchment 33S: (new Subcat)

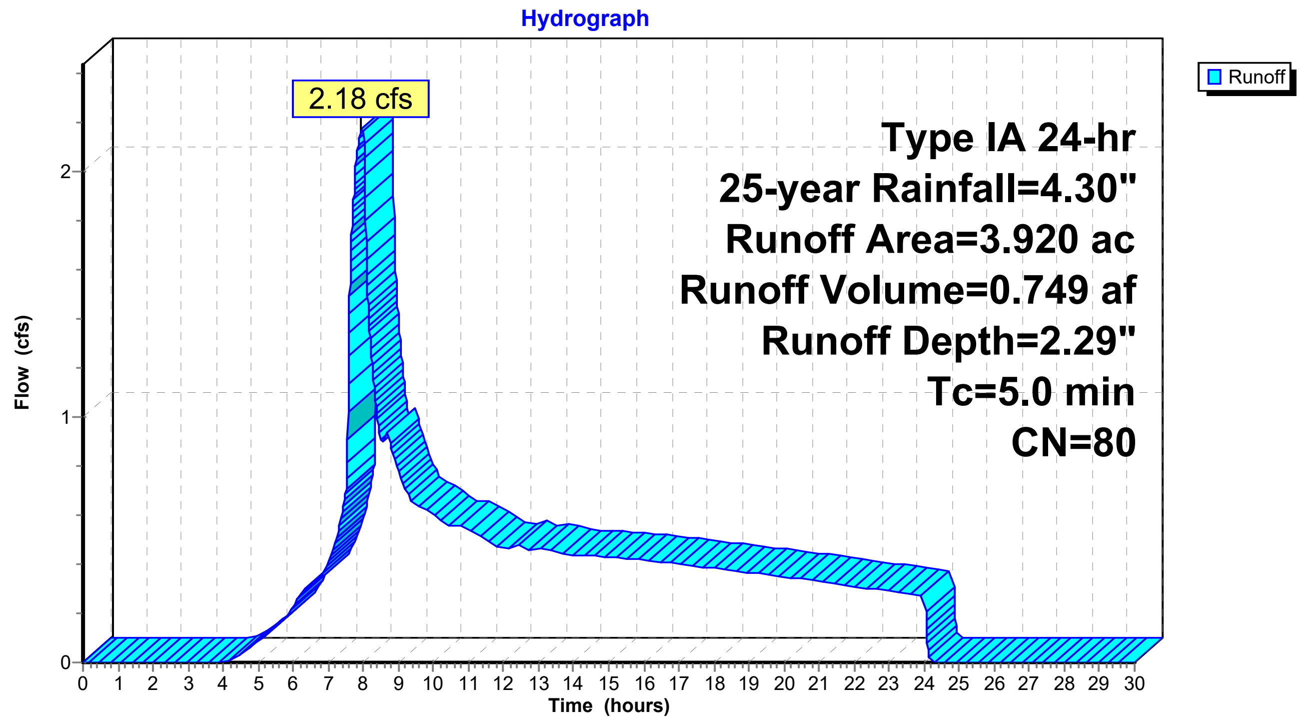
Runoff = 2.18 cfs @ 7.95 hrs, Volume= 0.749 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
3.920	80	>75% Grass cover, Good, HSG D
3.920		100.00% Pervious Area

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

Subcatchment 33S: (new Subcat)



Summary for Subcatchment 34S: (new Subcat)

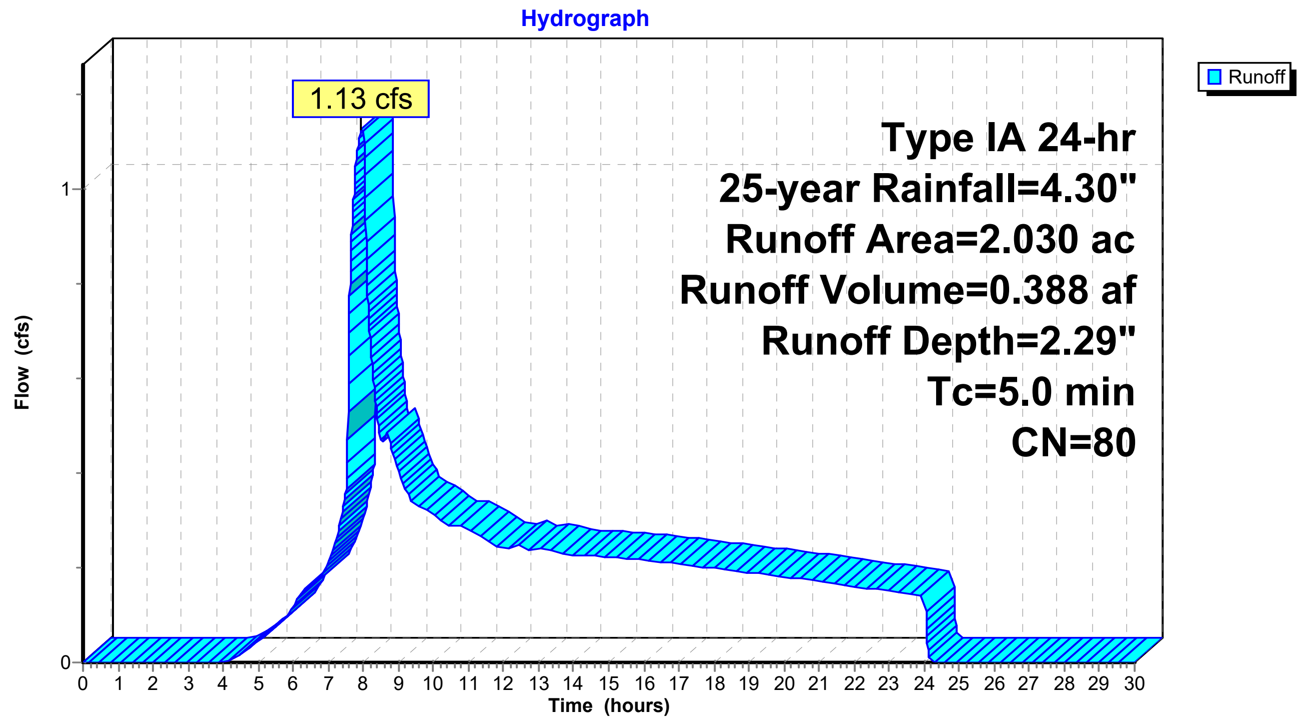
Runoff = 1.13 cfs @ 7.95 hrs, Volume= 0.388 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
2.030	80	>75% Grass cover, Good, HSG D
2.030		100.00% Pervious Area

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

Subcatchment 34S: (new Subcat)



Summary for Subcatchment 35S: (new Subcat)

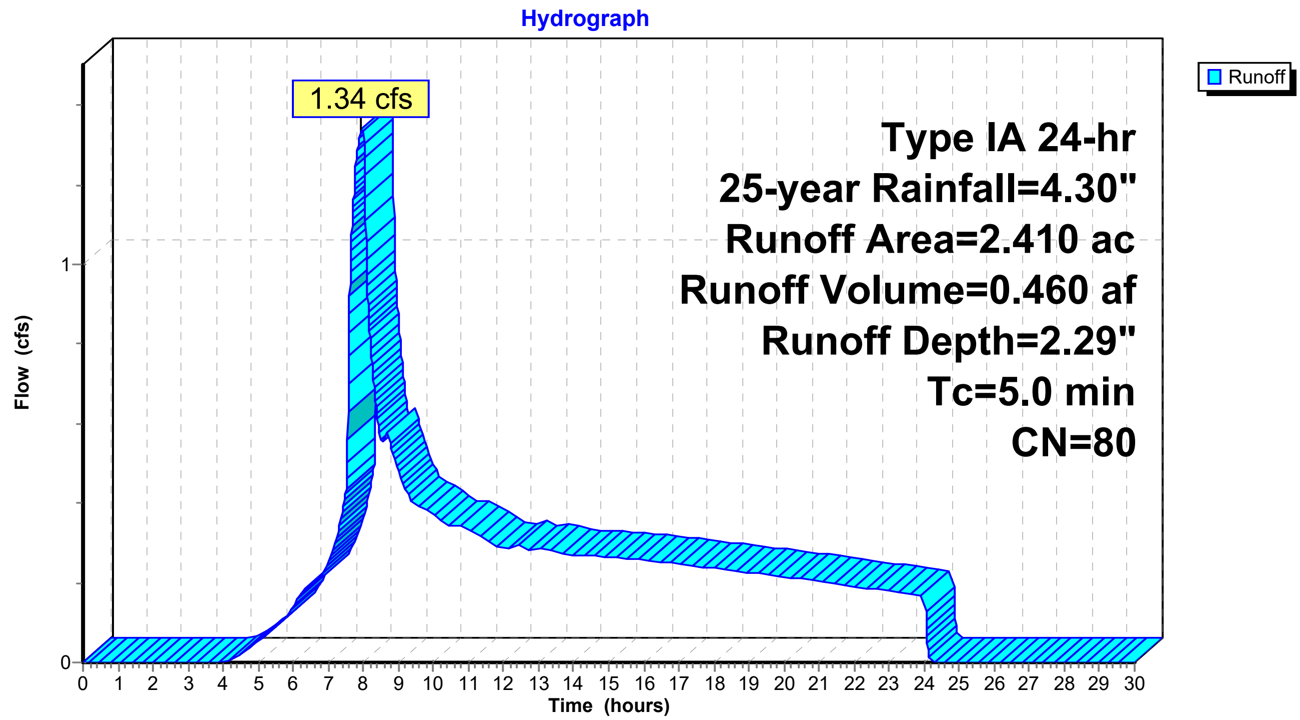
Runoff = 1.34 cfs @ 7.95 hrs, Volume= 0.460 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
2.410	80	>75% Grass cover, Good, HSG D
2.410		100.00% Pervious Area

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

Subcatchment 35S: (new Subcat)



Summary for Subcatchment 36S: (new Subcat)

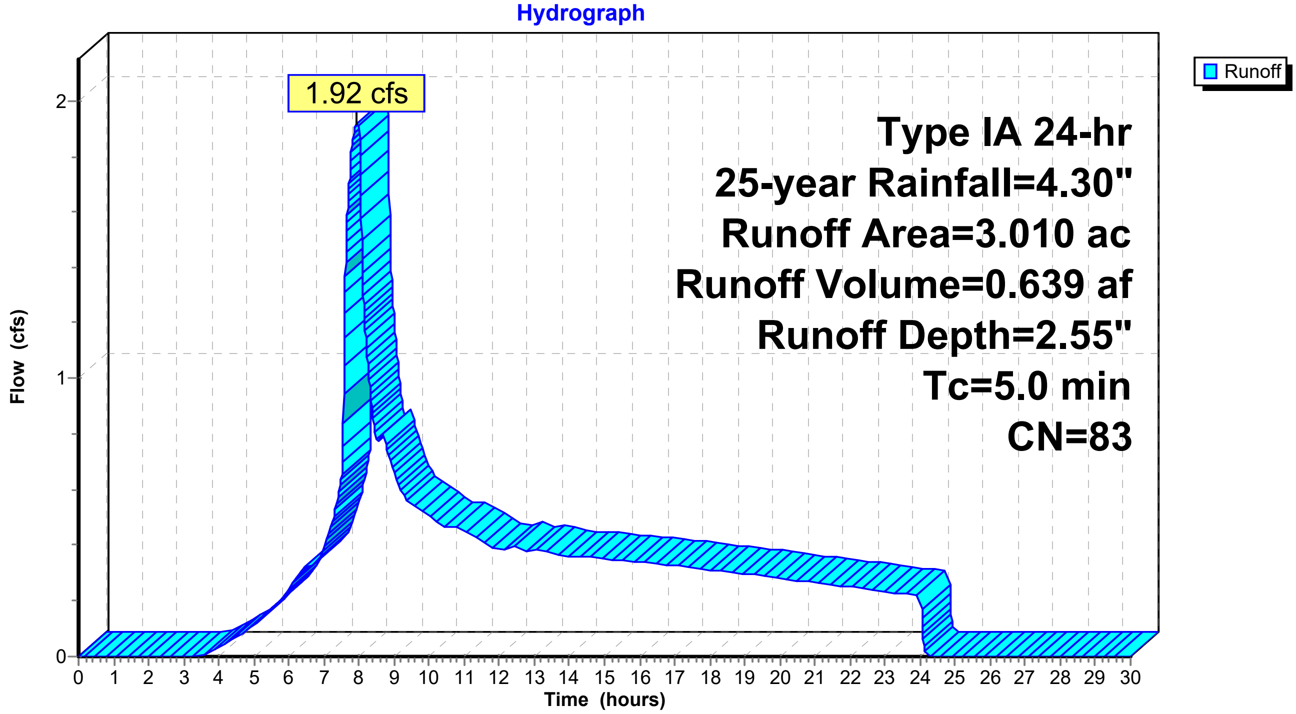
Runoff = 1.92 cfs @ 7.94 hrs, Volume= 0.639 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	2.510	80	>75% Grass cover, Good, HSG D
*	0.500	98	Roads
	3.010	83	Weighted Average
	2.510		83.39% Pervious Area
	0.500		16.61% Impervious Area

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

Subcatchment 36S: (new Subcat)



Summary for Subcatchment 37S: (new Subcat)

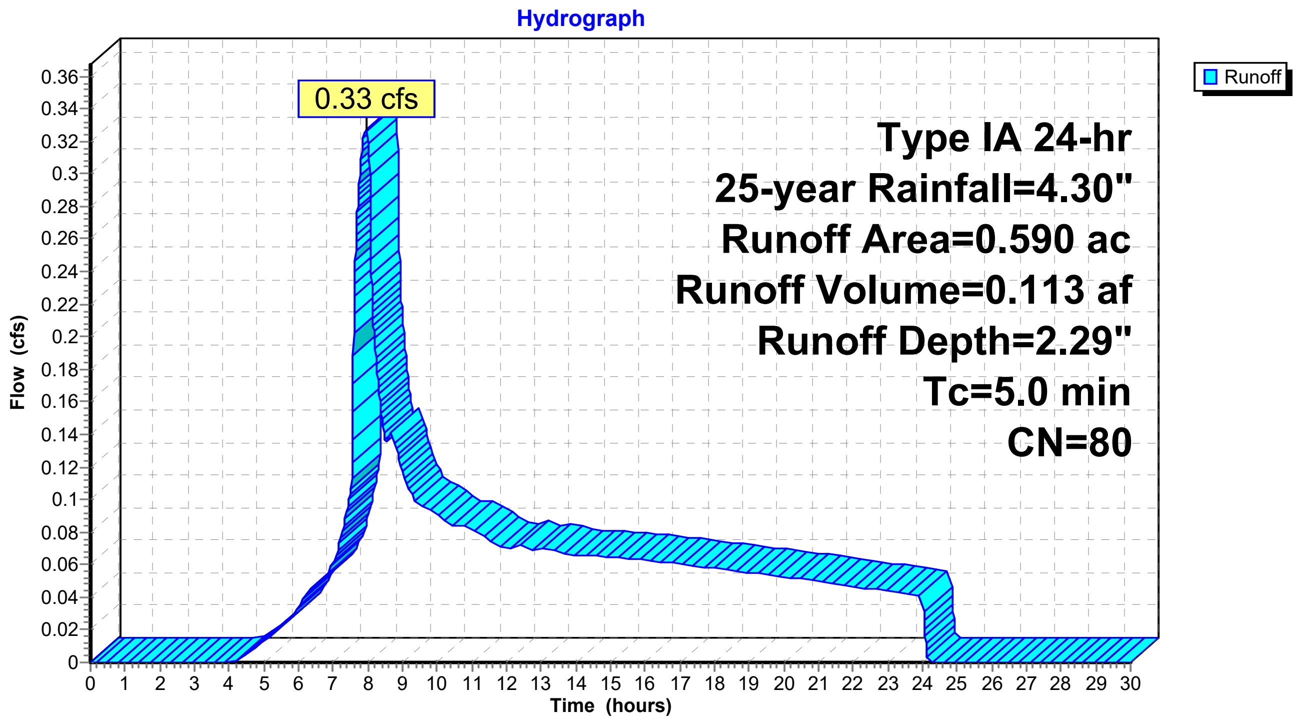
Runoff = 0.33 cfs @ 7.95 hrs, Volume= 0.113 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.590	80	>75% Grass cover, Good, HSG D
0.590		100.00% Pervious Area

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

Subcatchment 37S: (new Subcat)



Summary for Subcatchment 38S: (new Subcat)

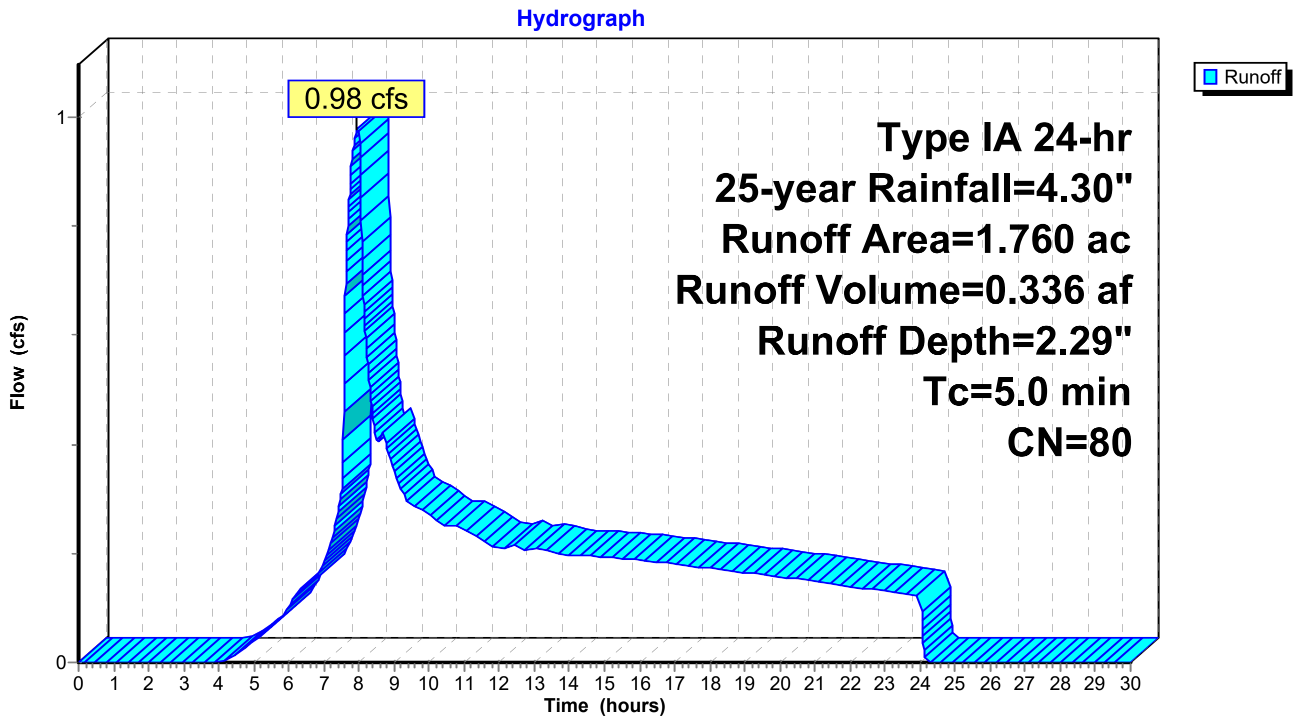
Runoff = 0.98 cfs @ 7.95 hrs, Volume= 0.336 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.760	80	>75% Grass cover, Good, HSG D
1.760		100.00% Pervious Area

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

Subcatchment 38S: (new Subcat)



Summary for Subcatchment 39S: (new Subcat)

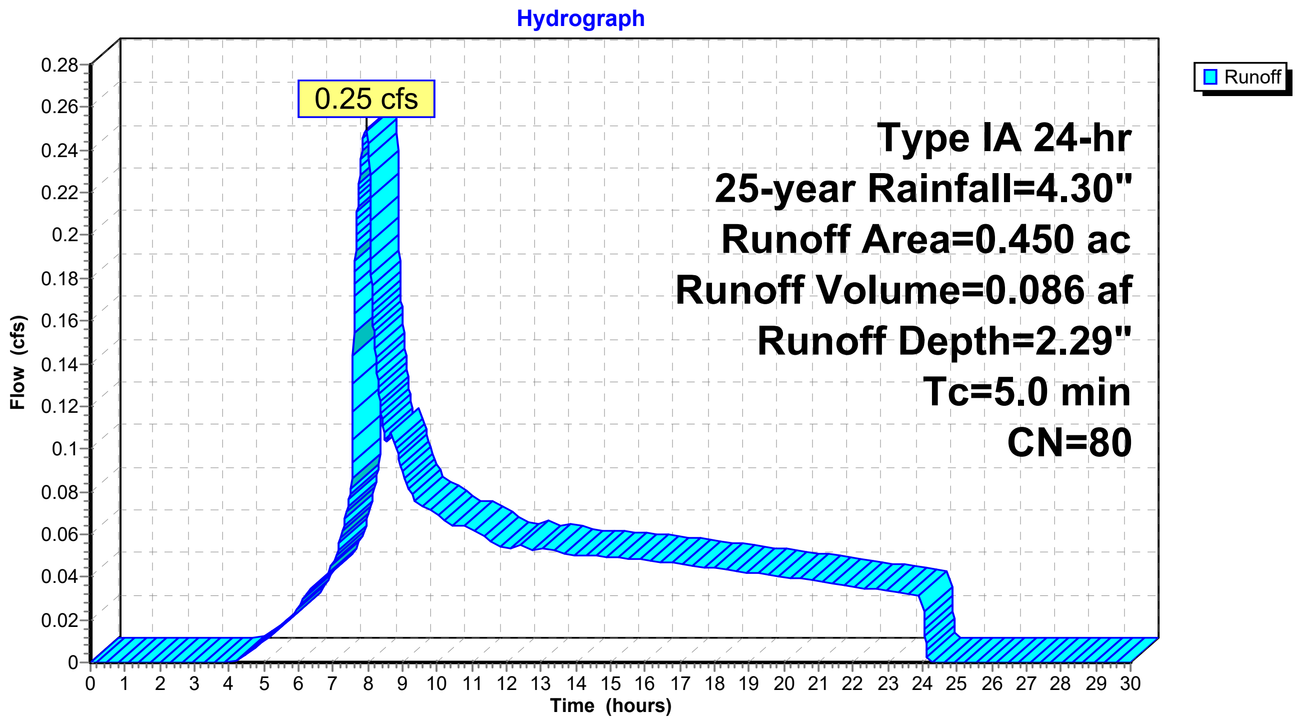
Runoff = 0.25 cfs @ 7.95 hrs, Volume= 0.086 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.450	80	>75% Grass cover, Good, HSG D
0.450		100.00% Pervious Area

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

Subcatchment 39S: (new Subcat)



Summary for Subcatchment 40S: (new Subcat)

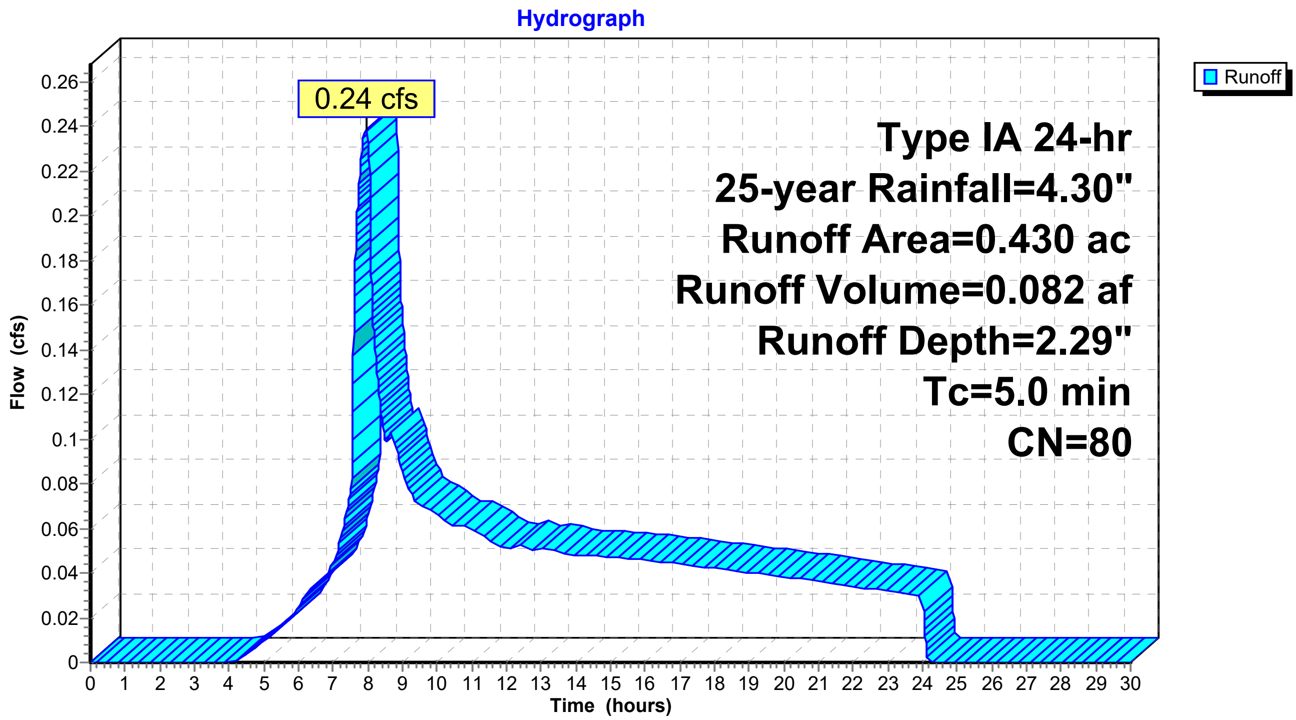
Runoff = 0.24 cfs @ 7.95 hrs, Volume= 0.082 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.430	80	>75% Grass cover, Good, HSG D
0.430		100.00% Pervious Area

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

Subcatchment 40S: (new Subcat)



Summary for Subcatchment 41S: (new Subcat)

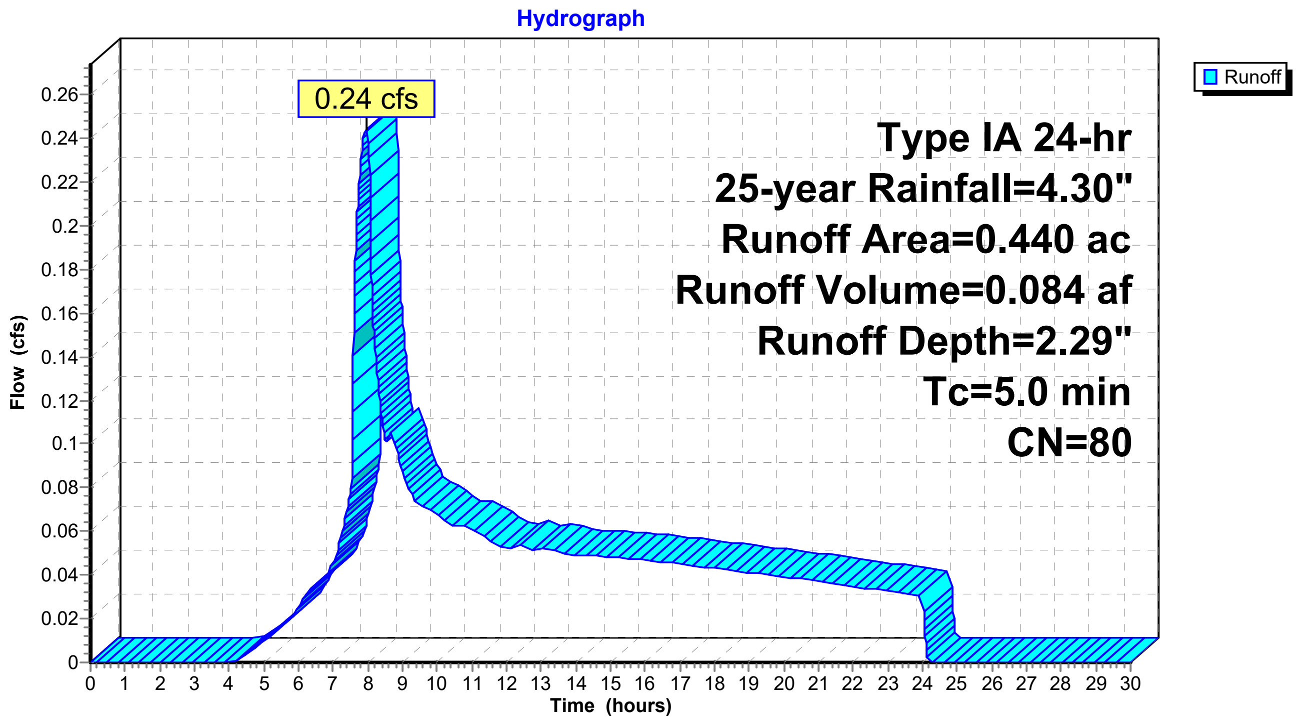
Runoff = 0.24 cfs @ 7.95 hrs, Volume= 0.084 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.440	80	>75% Grass cover, Good, HSG D
0.440		100.00% Pervious Area

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

Subcatchment 41S: (new Subcat)



Summary for Subcatchment 42S: (new Subcat)

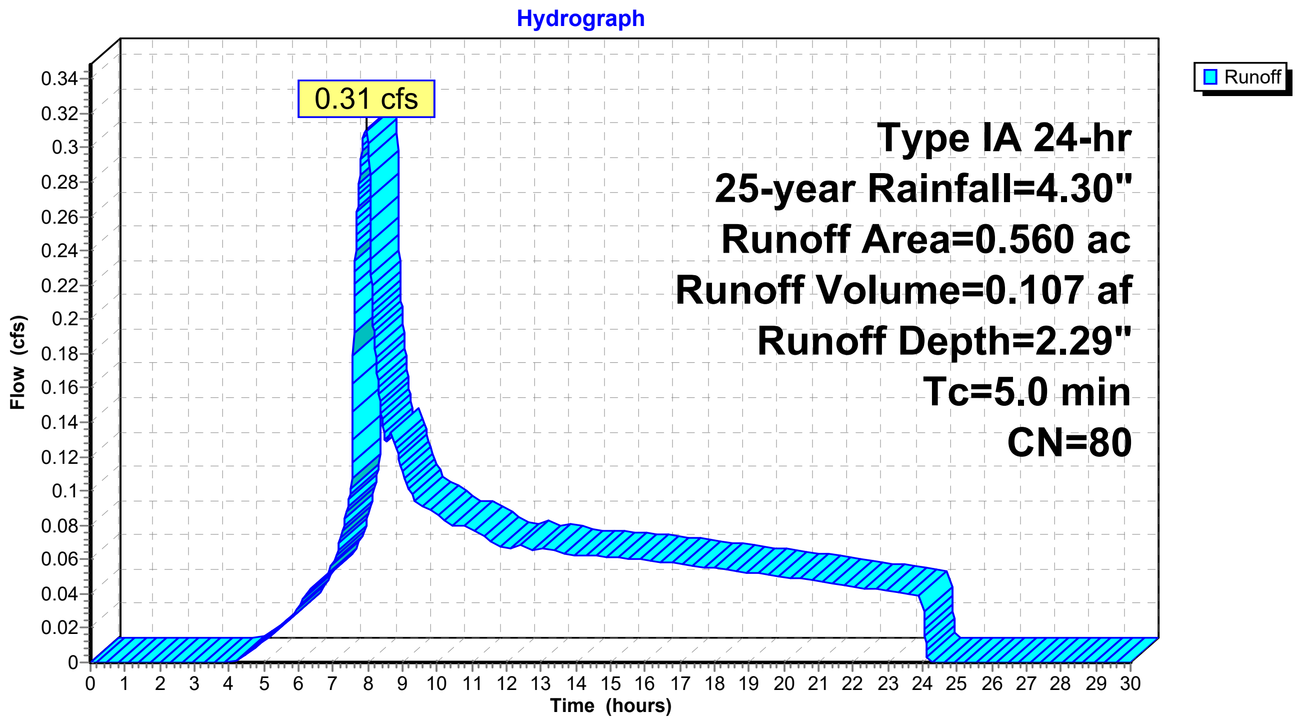
Runoff = 0.31 cfs @ 7.95 hrs, Volume= 0.107 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.560	80	>75% Grass cover, Good, HSG D
0.560		100.00% Pervious Area

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

Subcatchment 42S: (new Subcat)



Summary for Subcatchment 43S: (new Subcat)

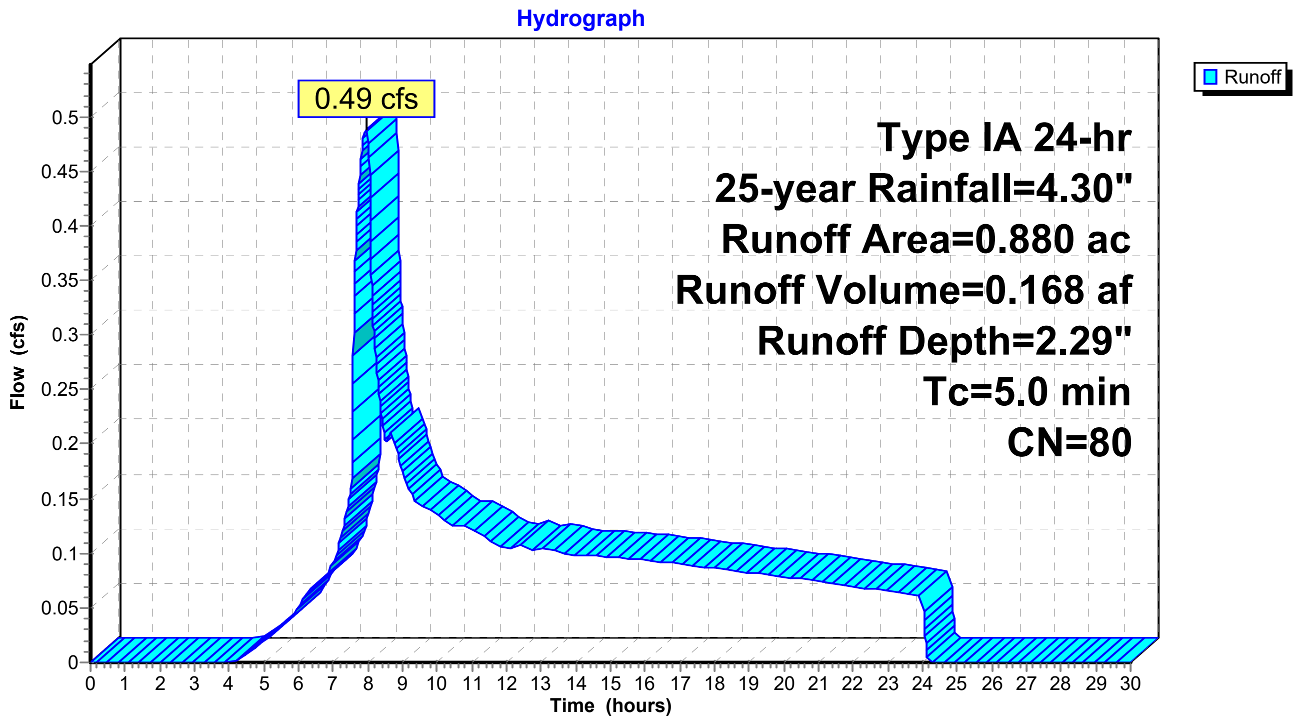
Runoff = 0.49 cfs @ 7.95 hrs, Volume= 0.168 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.880	80	>75% Grass cover, Good, HSG D
0.880		100.00% Pervious Area

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

Subcatchment 43S: (new Subcat)



Summary for Subcatchment 44S: (new Subcat)

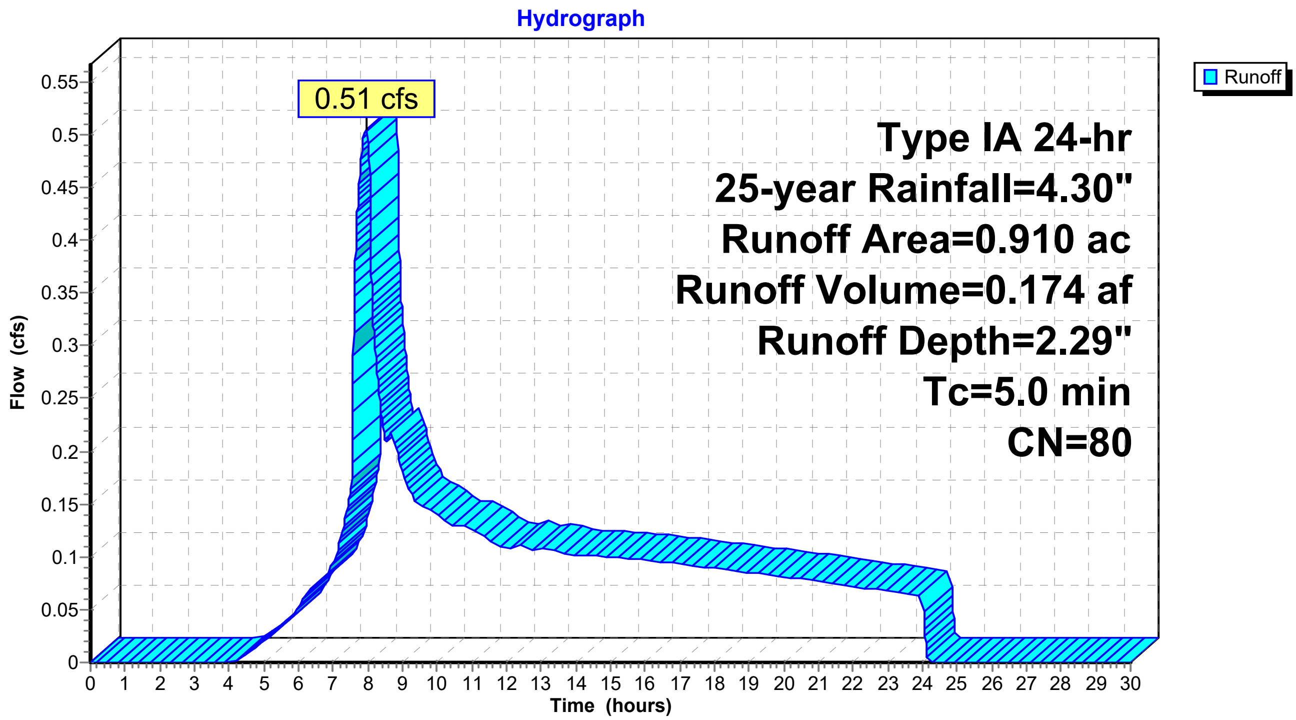
Runoff = 0.51 cfs @ 7.95 hrs, Volume= 0.174 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.910	80	>75% Grass cover, Good, HSG D
0.910		100.00% Pervious Area

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

Subcatchment 44S: (new Subcat)



Summary for Subcatchment 45S: (new Subcat)

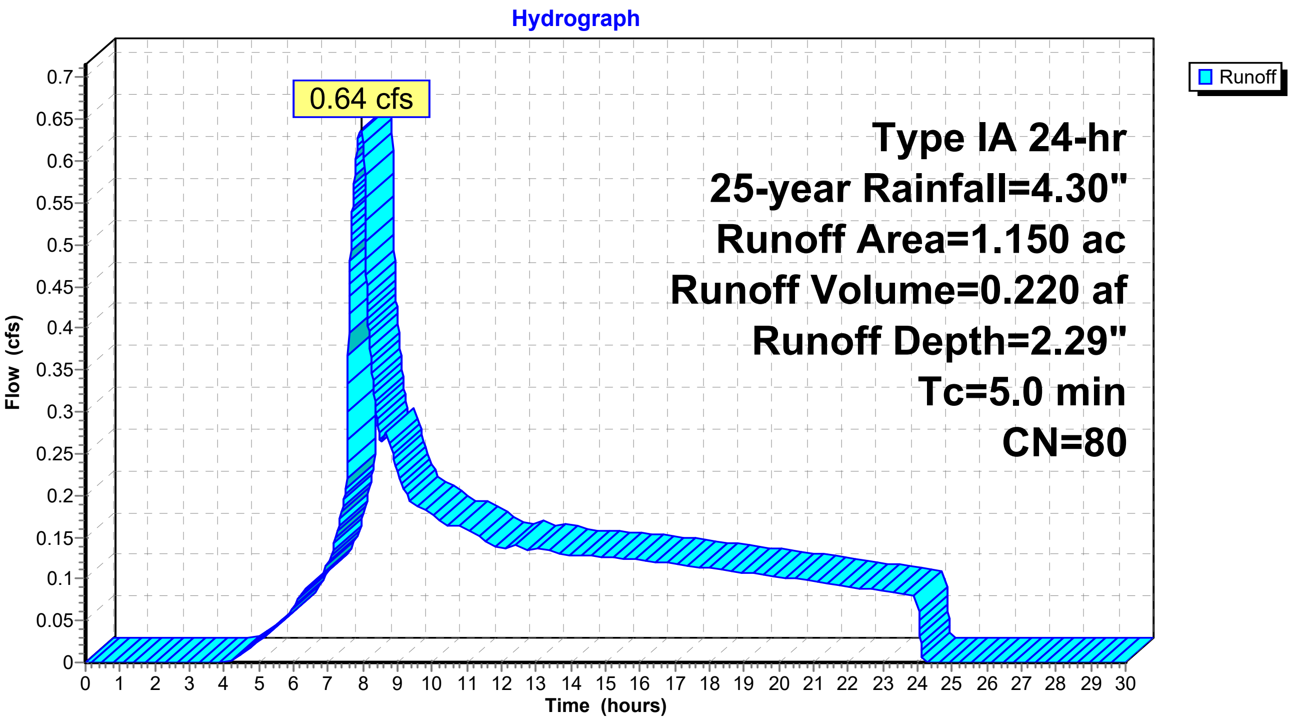
Runoff = 0.64 cfs @ 7.95 hrs, Volume= 0.220 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.150	80	>75% Grass cover, Good, HSG D
1.150		100.00% Pervious Area

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

Subcatchment 45S: (new Subcat)



Summary for Subcatchment 46S: (new Subcat)

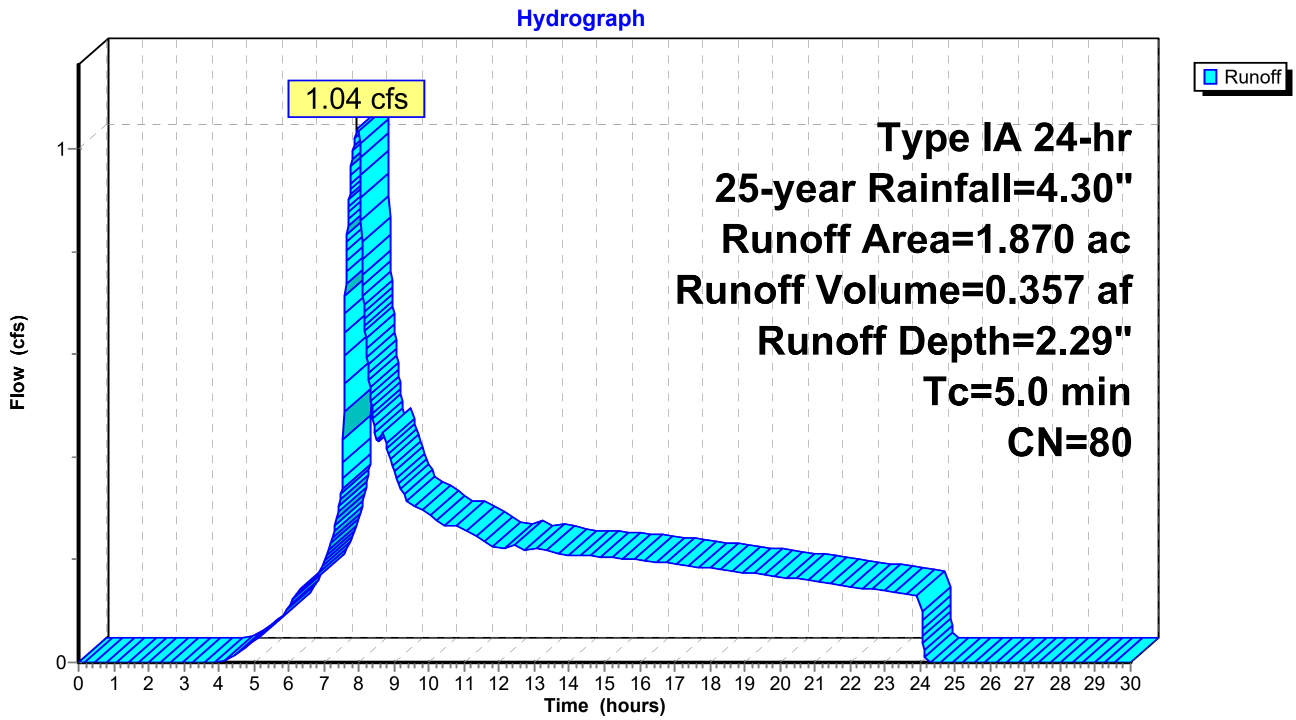
Runoff = 1.04 cfs @ 7.95 hrs, Volume= 0.357 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.870	80	>75% Grass cover, Good, HSG D
1.870		100.00% Pervious Area

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

Subcatchment 46S: (new Subcat)



Summary for Subcatchment 47S: (new Subcat)

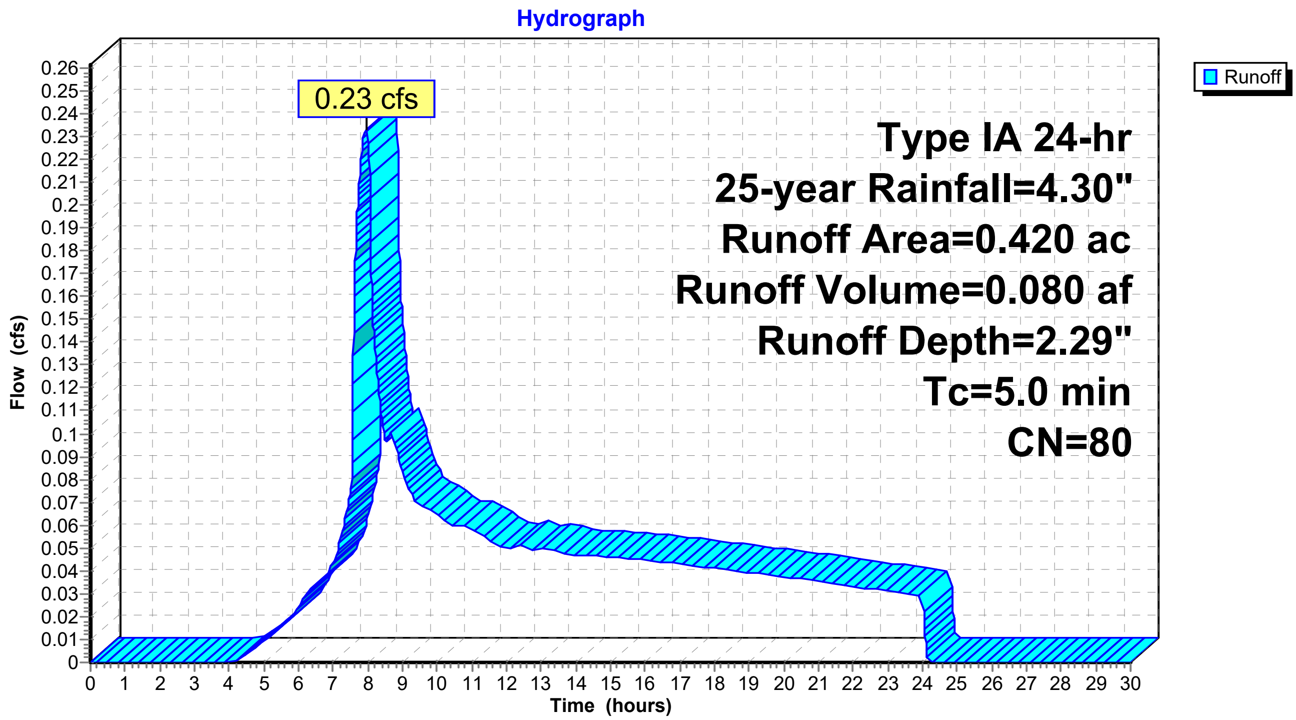
Runoff = 0.23 cfs @ 7.95 hrs, Volume= 0.080 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.420	80	>75% Grass cover, Good, HSG D
0.420		100.00% Pervious Area

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

Subcatchment 47S: (new Subcat)



Summary for Subcatchment 48S: (new Subcat)

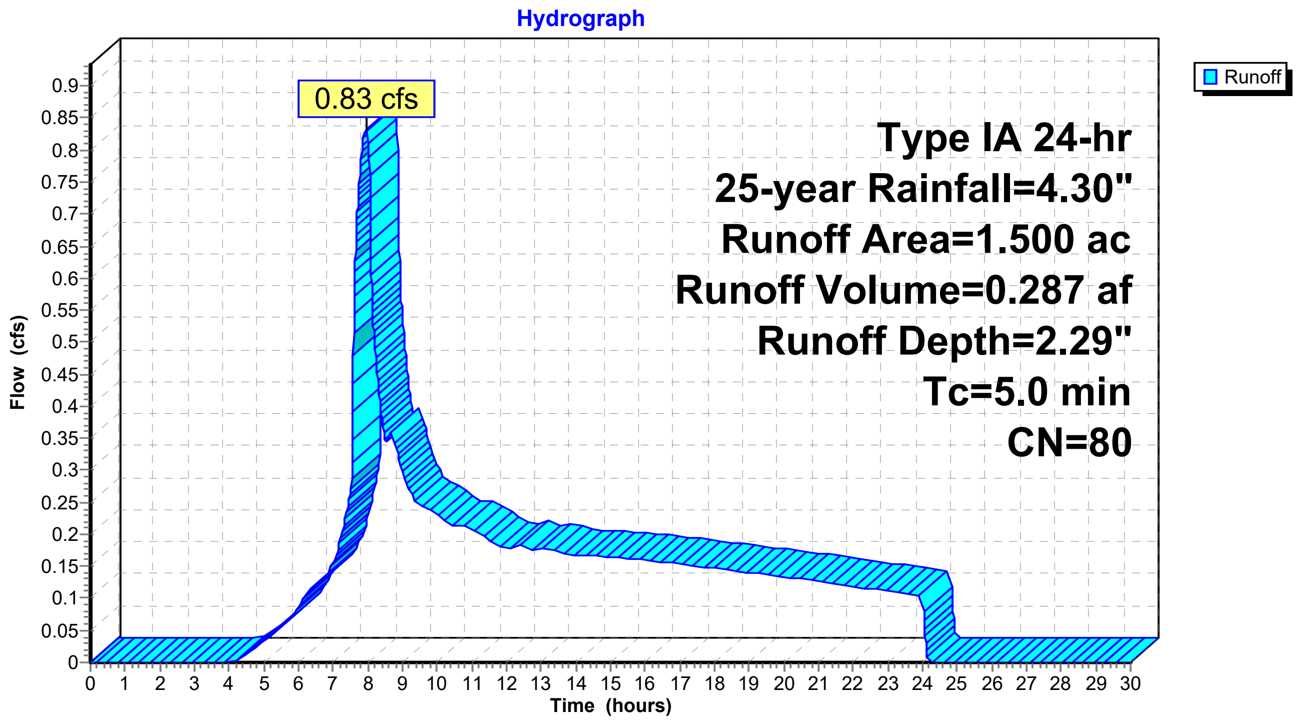
Runoff = 0.83 cfs @ 7.95 hrs, Volume= 0.287 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.500	80	>75% Grass cover, Good, HSG D
1.500		100.00% Pervious Area

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

Subcatchment 48S: (new Subcat)



Summary for Subcatchment 49S: (new Subcat)

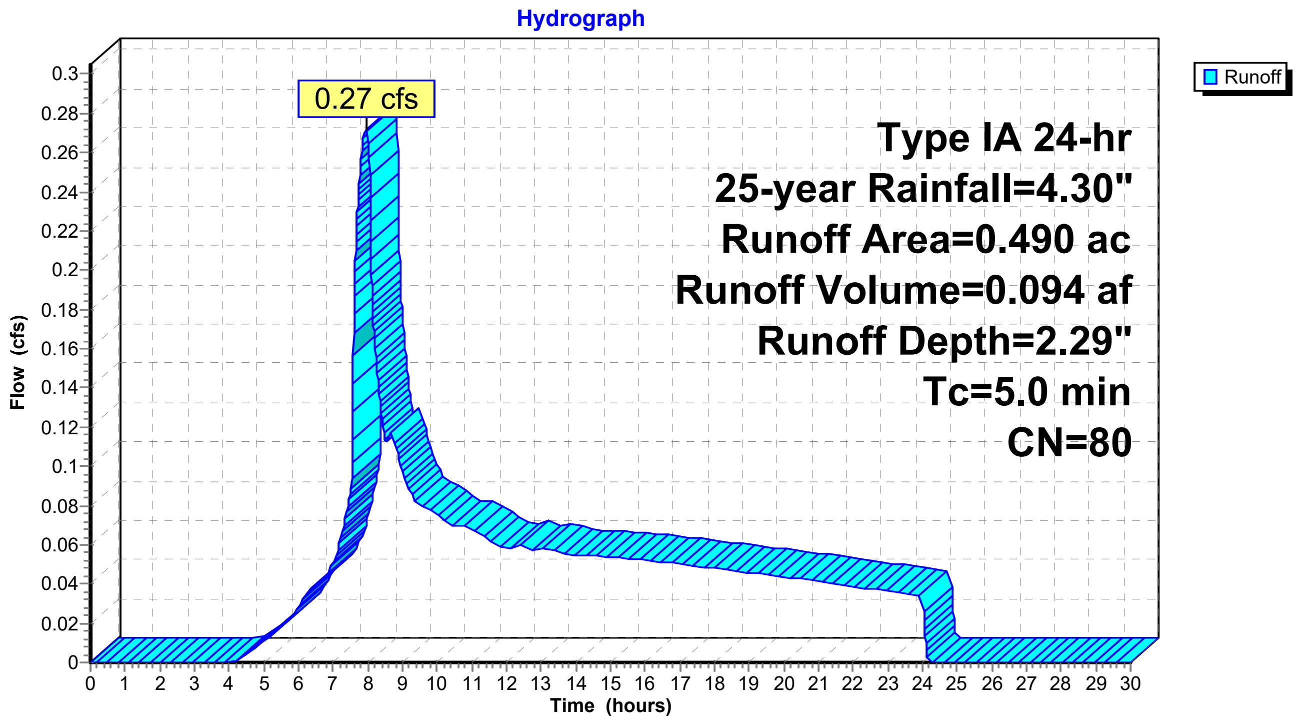
Runoff = 0.27 cfs @ 7.95 hrs, Volume= 0.094 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.490	80	>75% Grass cover, Good, HSG D
0.490		100.00% Pervious Area

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

Subcatchment 49S: (new Subcat)



Summary for Subcatchment 50S: (new Subcat)

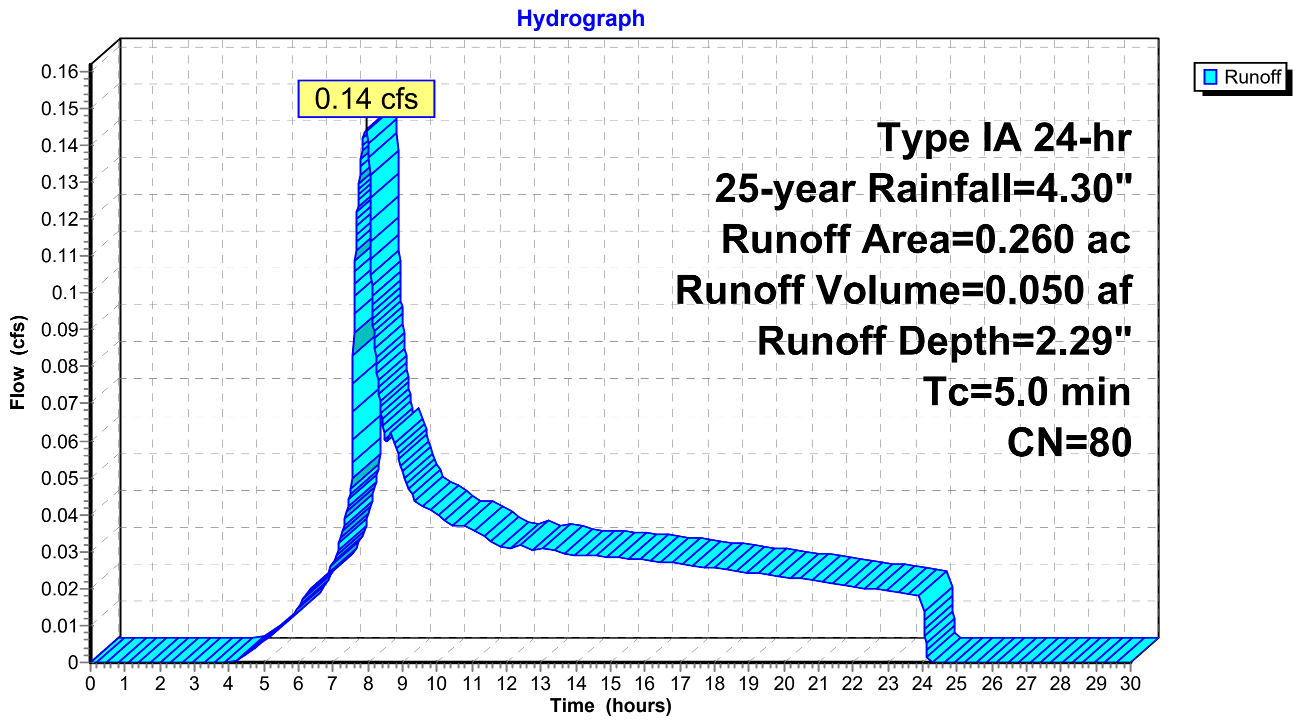
Runoff = 0.14 cfs @ 7.95 hrs, Volume= 0.050 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.260	80	>75% Grass cover, Good, HSG D
0.260		100.00% Pervious Area

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

Subcatchment 50S: (new Subcat)



Summary for Subcatchment 51S: (new Subcat)

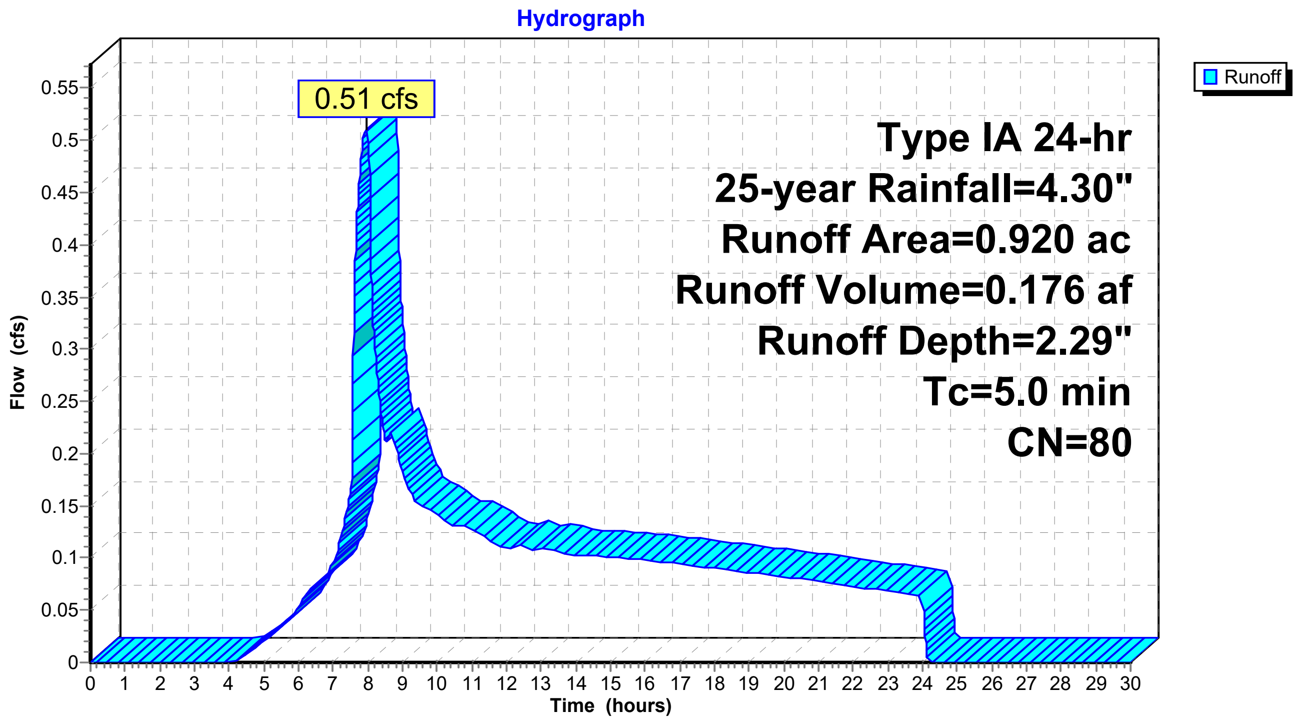
Runoff = 0.51 cfs @ 7.95 hrs, Volume= 0.176 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.920	80	>75% Grass cover, Good, HSG D
0.920		100.00% Pervious Area

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

Subcatchment 51S: (new Subcat)



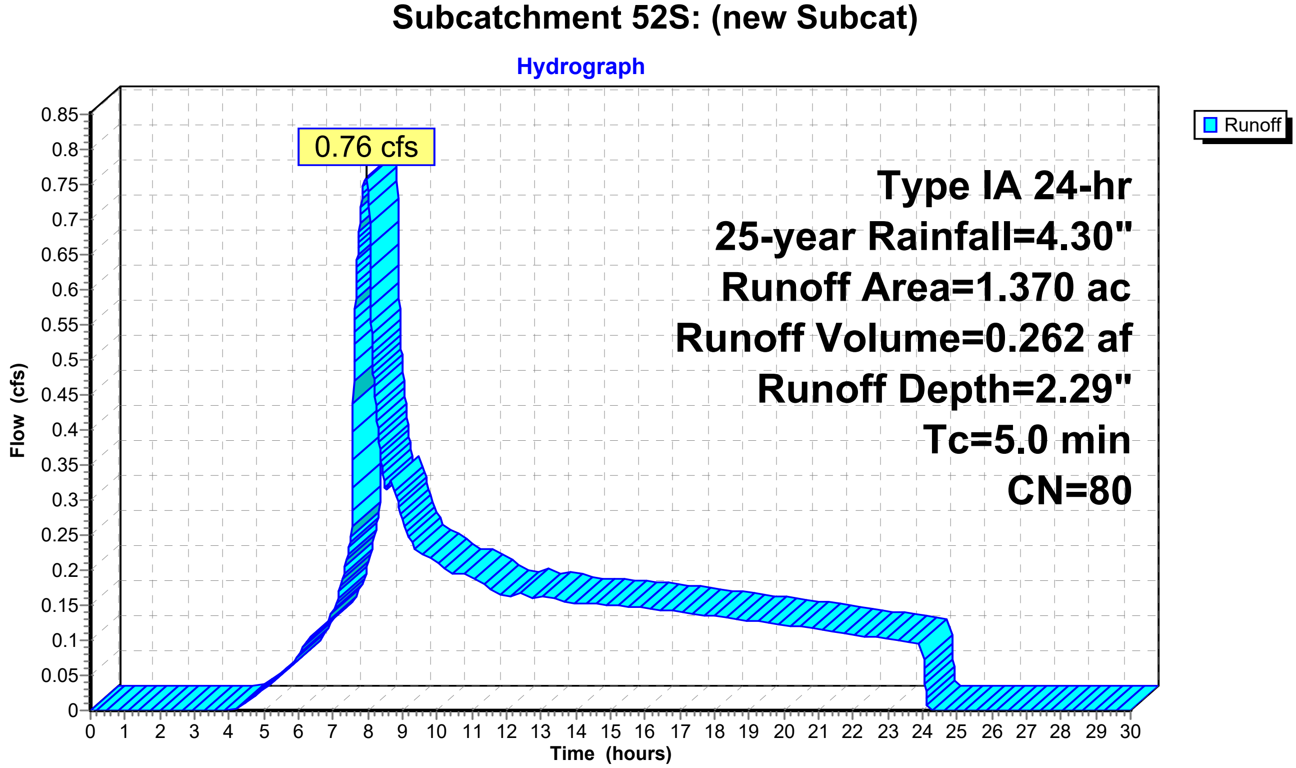
Summary for Subcatchment 52S: (new Subcat)

Runoff = 0.76 cfs @ 7.95 hrs, Volume= 0.262 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.370	80	>75% Grass cover, Good, HSG D
1.370		100.00% Pervious Area

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



Summary for Subcatchment 53S: (new Subcat)

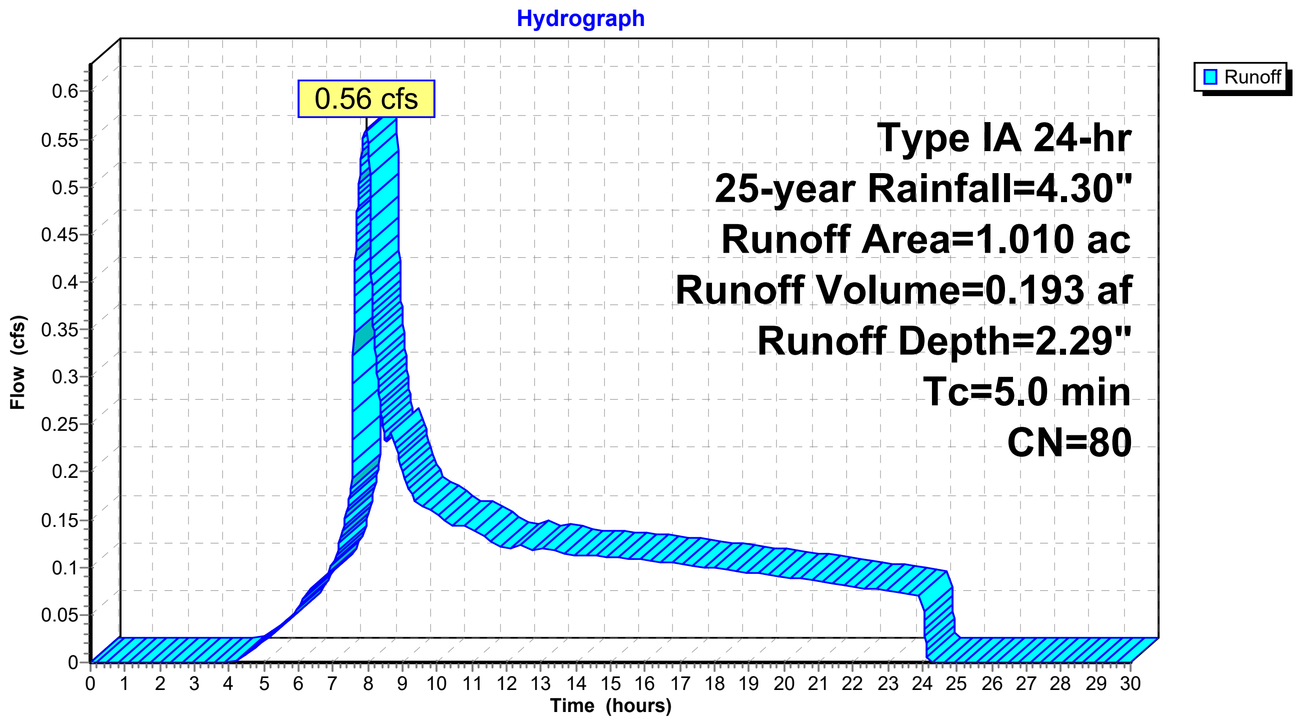
Runoff = 0.56 cfs @ 7.95 hrs, Volume= 0.193 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.010	80	>75% Grass cover, Good, HSG D
1.010		100.00% Pervious Area

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

Subcatchment 53S: (new Subcat)



Summary for Subcatchment 54S: (new Subcat)

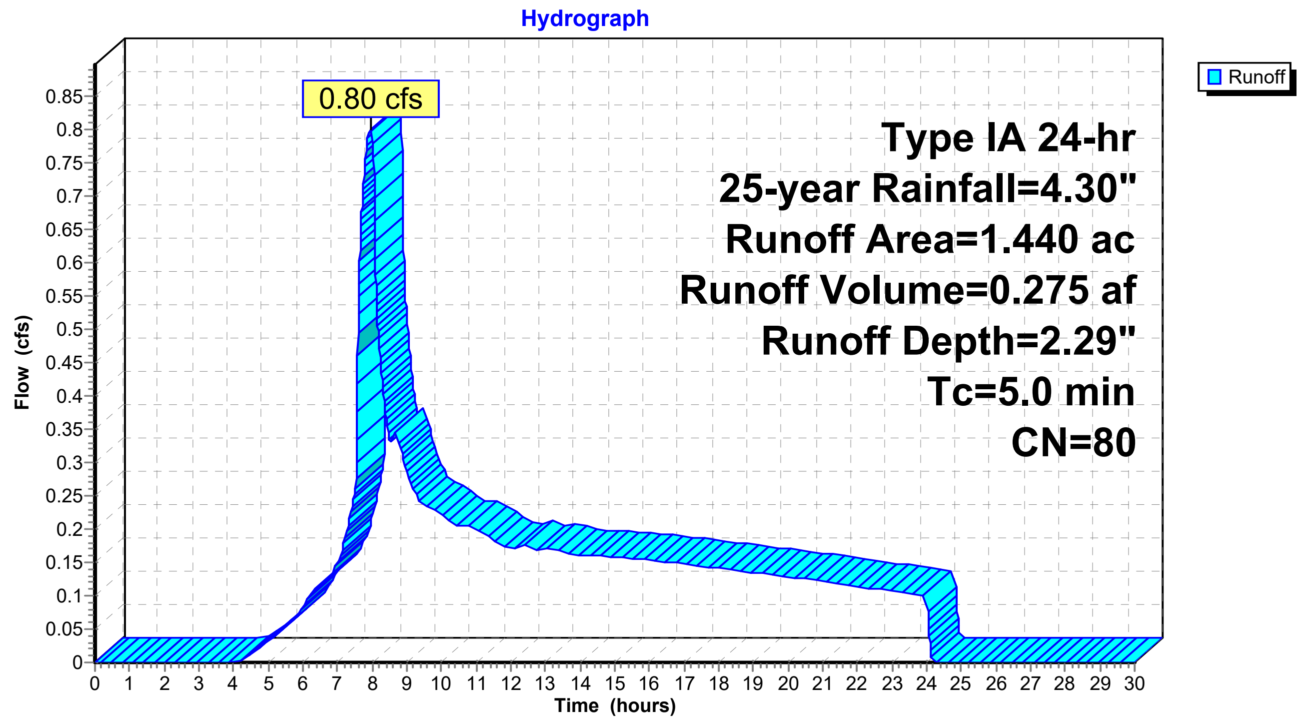
Runoff = 0.80 cfs @ 7.95 hrs, Volume= 0.275 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.440	80	>75% Grass cover, Good, HSG D
1.440		100.00% Pervious Area

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

Subcatchment 54S: (new Subcat)



Summary for Subcatchment 55S: (new Subcat)

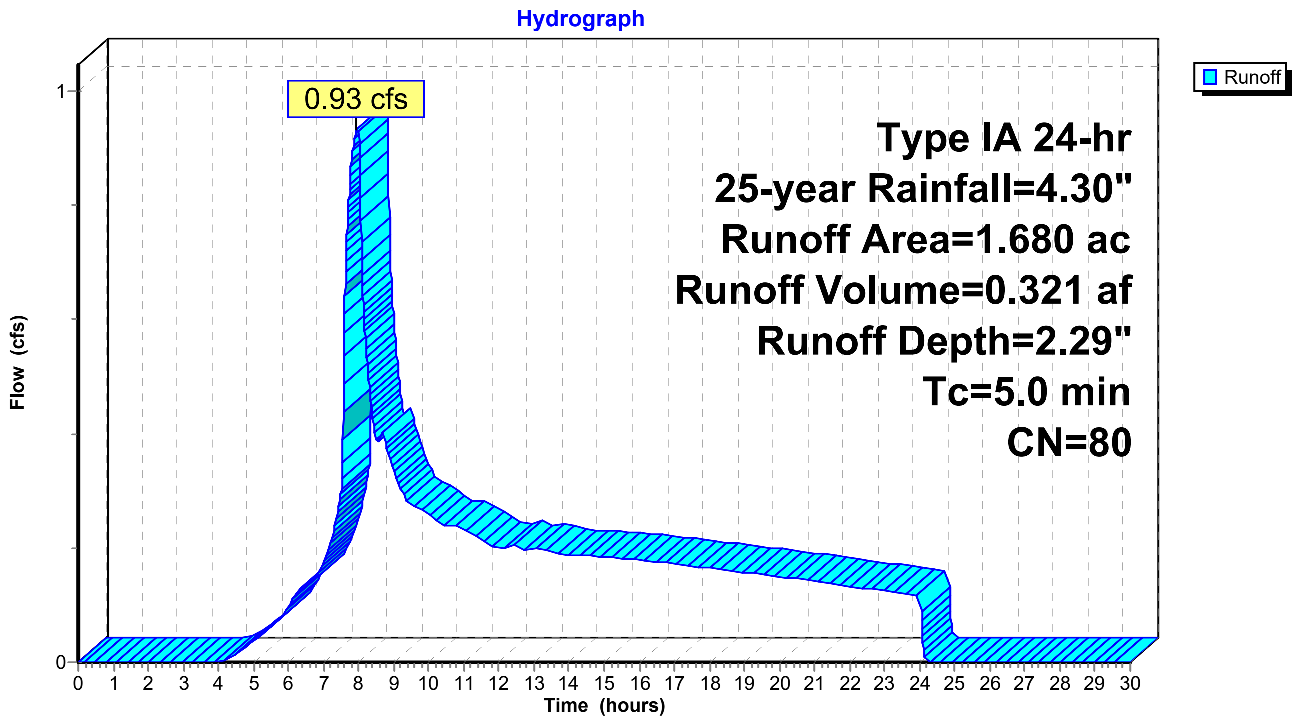
Runoff = 0.93 cfs @ 7.95 hrs, Volume= 0.321 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.680	80	>75% Grass cover, Good, HSG D
1.680		100.00% Pervious Area

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

Subcatchment 55S: (new Subcat)



Summary for Subcatchment 56S: (new Subcat)

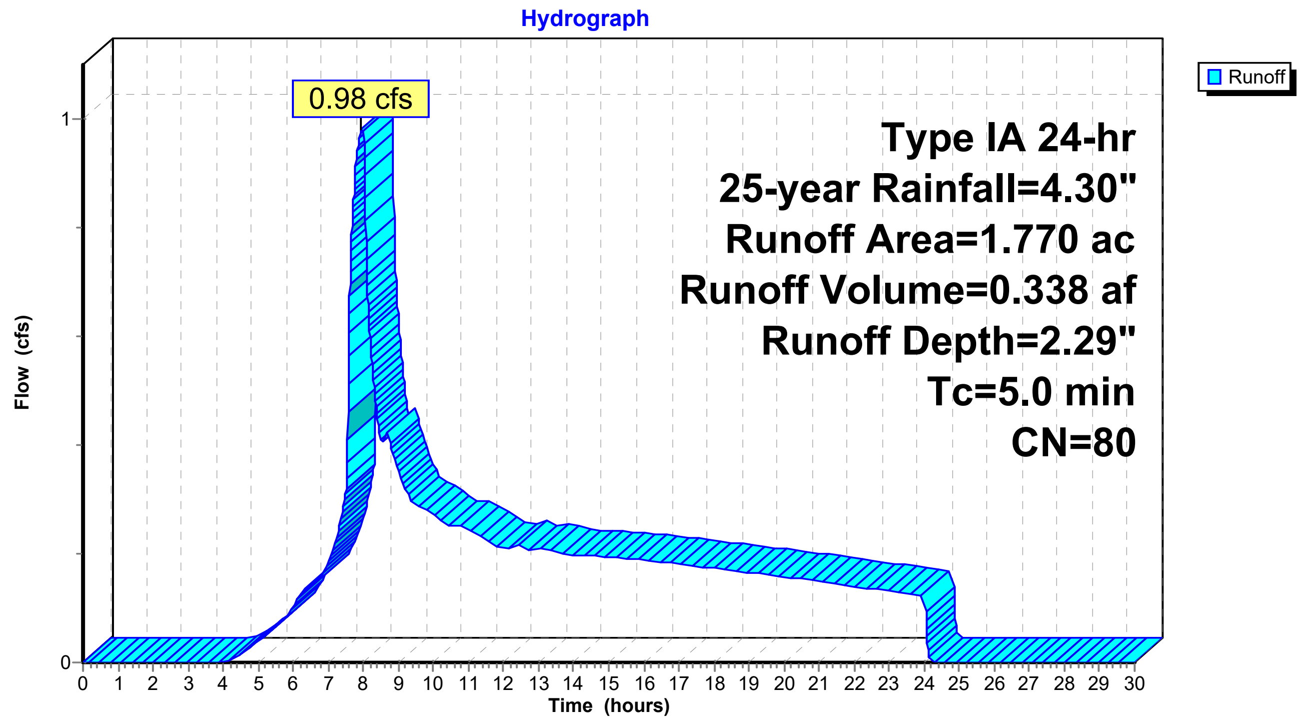
Runoff = 0.98 cfs @ 7.95 hrs, Volume= 0.338 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.770	80	>75% Grass cover, Good, HSG D
1.770		100.00% Pervious Area

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

Subcatchment 56S: (new Subcat)



Summary for Subcatchment 57S: (new Subcat)

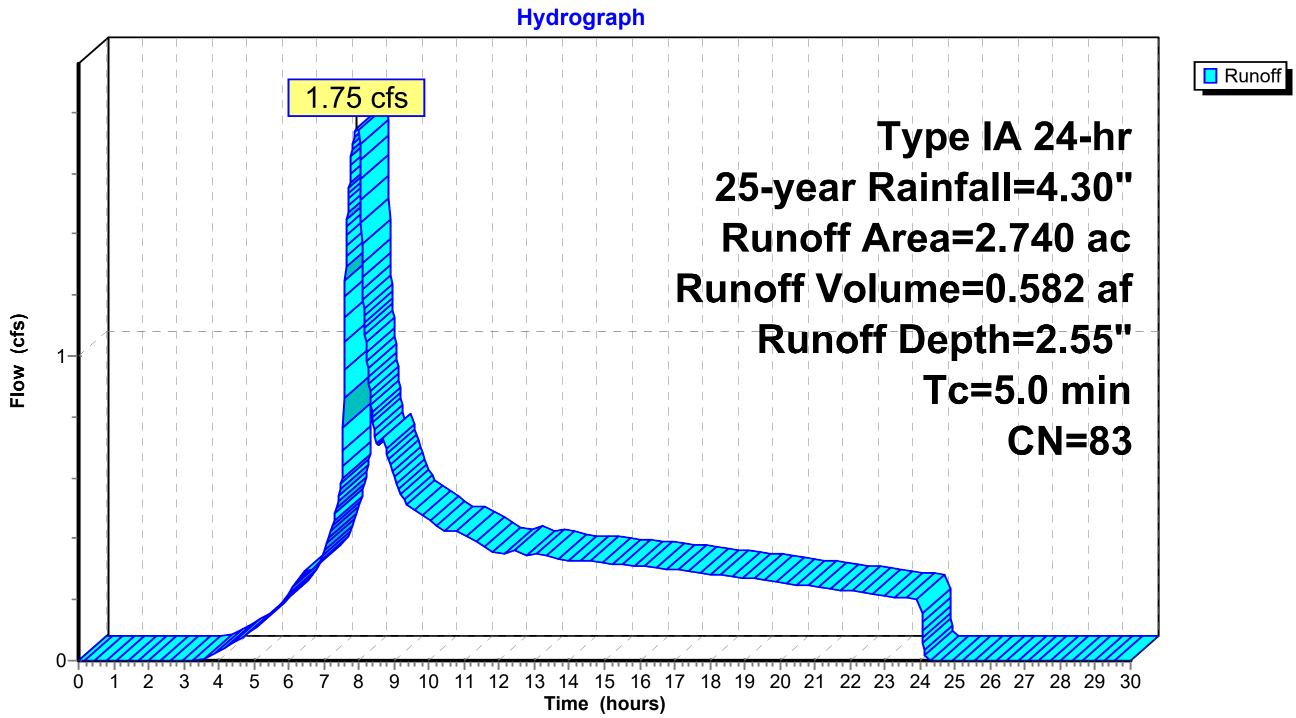
Runoff = 1.75 cfs @ 7.94 hrs, Volume= 0.582 af, Depth= 2.55"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	2.280	80	>75% Grass cover, Good, HSG D
*	0.460	98	Road
	2.740	83	Weighted Average
	2.280		83.21% Pervious Area
	0.460		16.79% Impervious Area

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

Subcatchment 57S: (new Subcat)



Summary for Subcatchment 58S: (new Subcat)

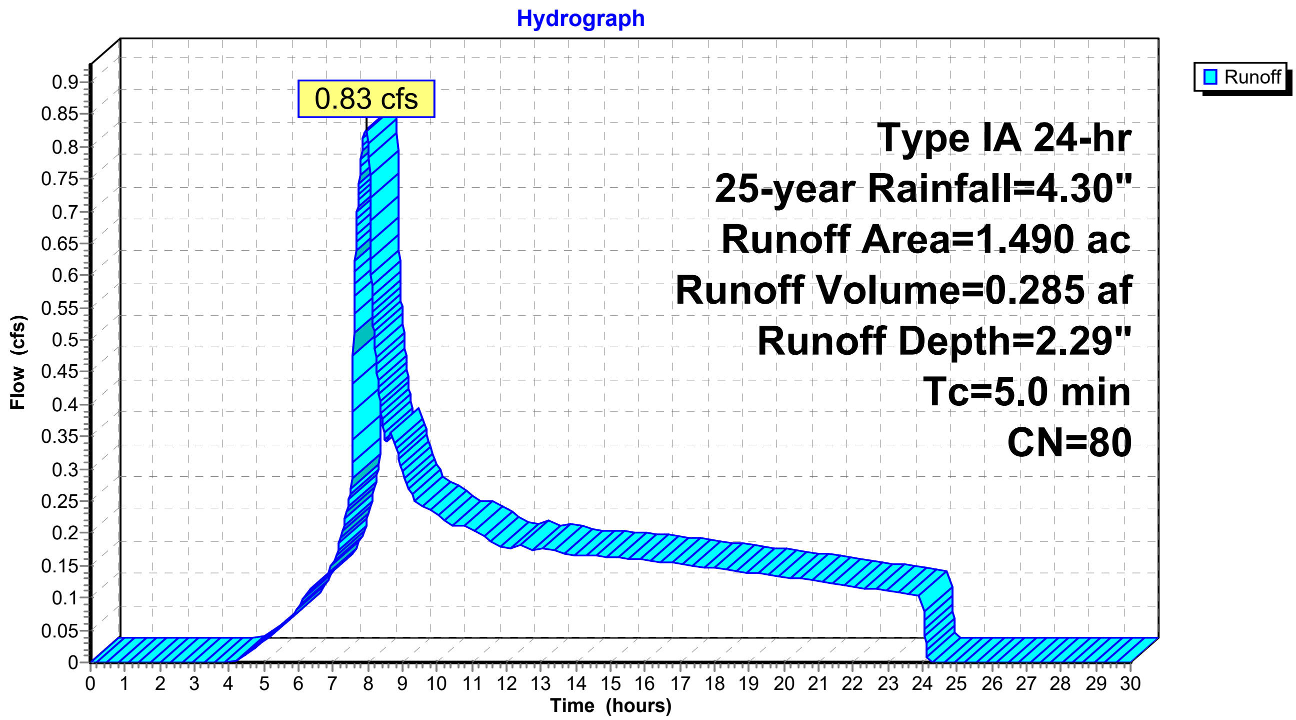
Runoff = 0.83 cfs @ 7.95 hrs, Volume= 0.285 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
1.490	80	>75% Grass cover, Good, HSG D
1.490		100.00% Pervious Area

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

Subcatchment 58S: (new Subcat)



Summary for Subcatchment 59S: (new Subcat)

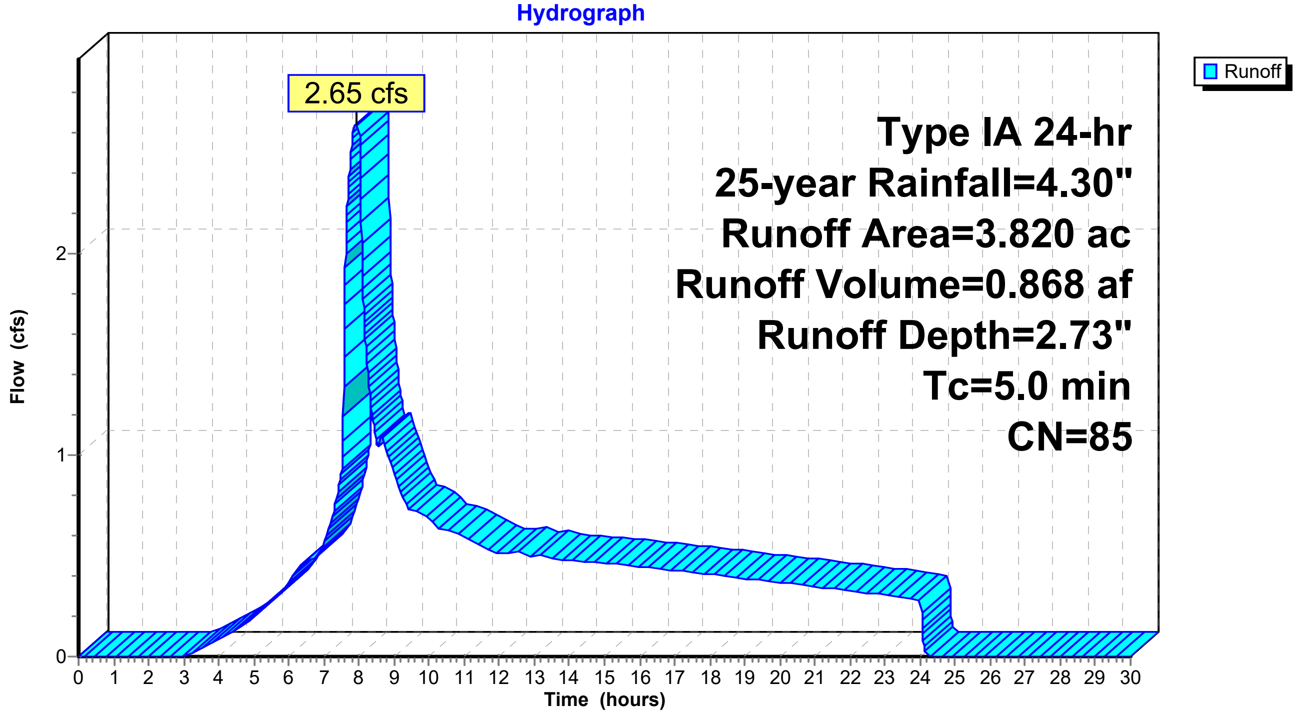
Runoff = 2.65 cfs @ 7.92 hrs, Volume= 0.868 af, Depth= 2.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	2.670	80	>75% Grass cover, Good, HSG D
*	1.150	98	Pond
	3.820	85	Weighted Average
	2.670		69.90% Pervious Area
	1.150		30.10% Impervious Area

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

Subcatchment 59S: (new Subcat)



Summary for Subcatchment 60S: (new Subcat)

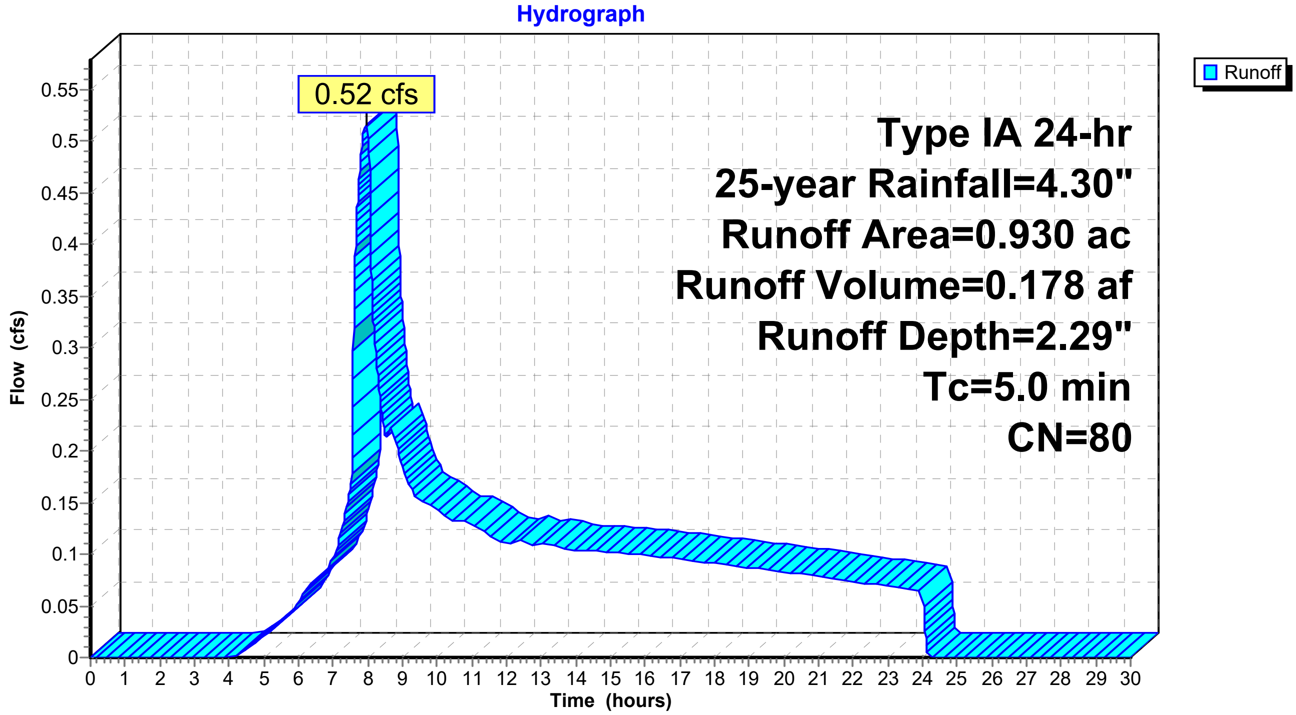
Runoff = 0.52 cfs @ 7.95 hrs, Volume= 0.178 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.930	80	>75% Grass cover, Good, HSG D
0.930		100.00% Pervious Area

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

Subcatchment 60S: (new Subcat)



Summary for Subcatchment 61S: (new Subcat)

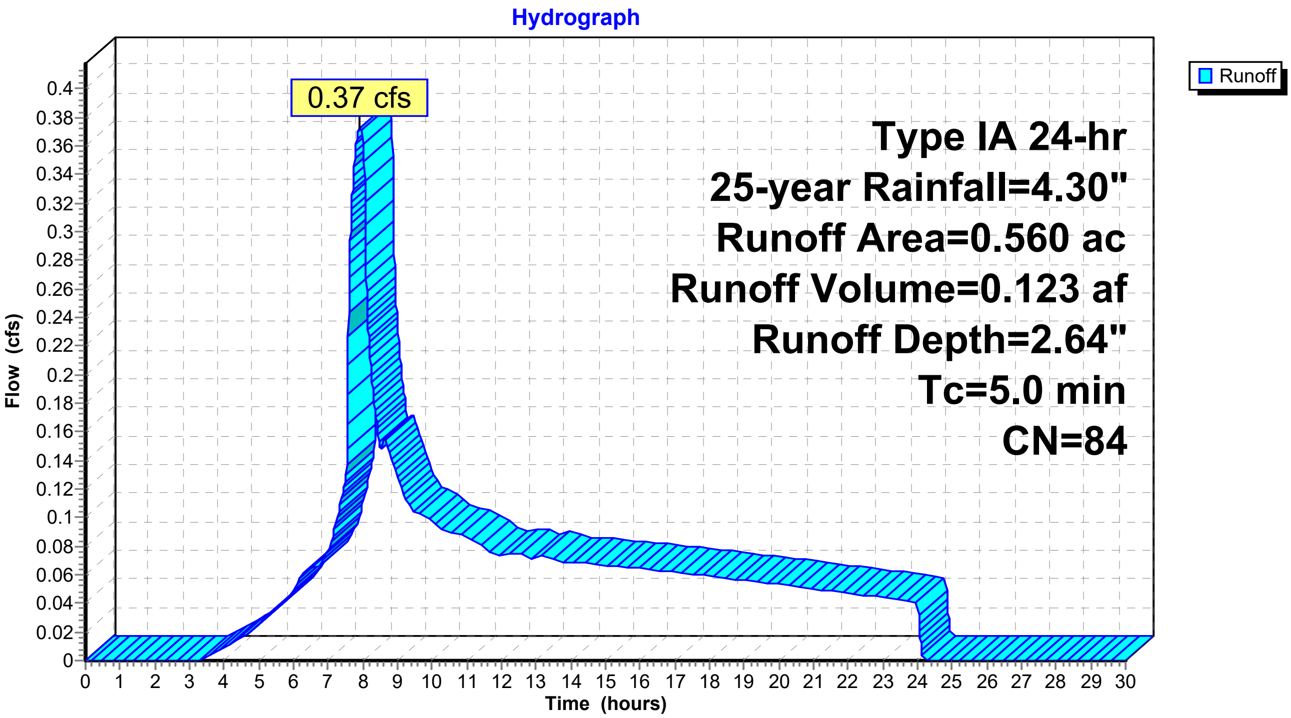
Runoff = 0.37 cfs @ 7.93 hrs, Volume= 0.123 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	0.430	80	>75% Grass cover, Good, HSG D
*	0.130	98	Road
	0.560	84	Weighted Average
	0.430		76.79% Pervious Area
	0.130		23.21% Impervious Area

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

Subcatchment 61S: (new Subcat)



Summary for Subcatchment 62S: (new Subcat)

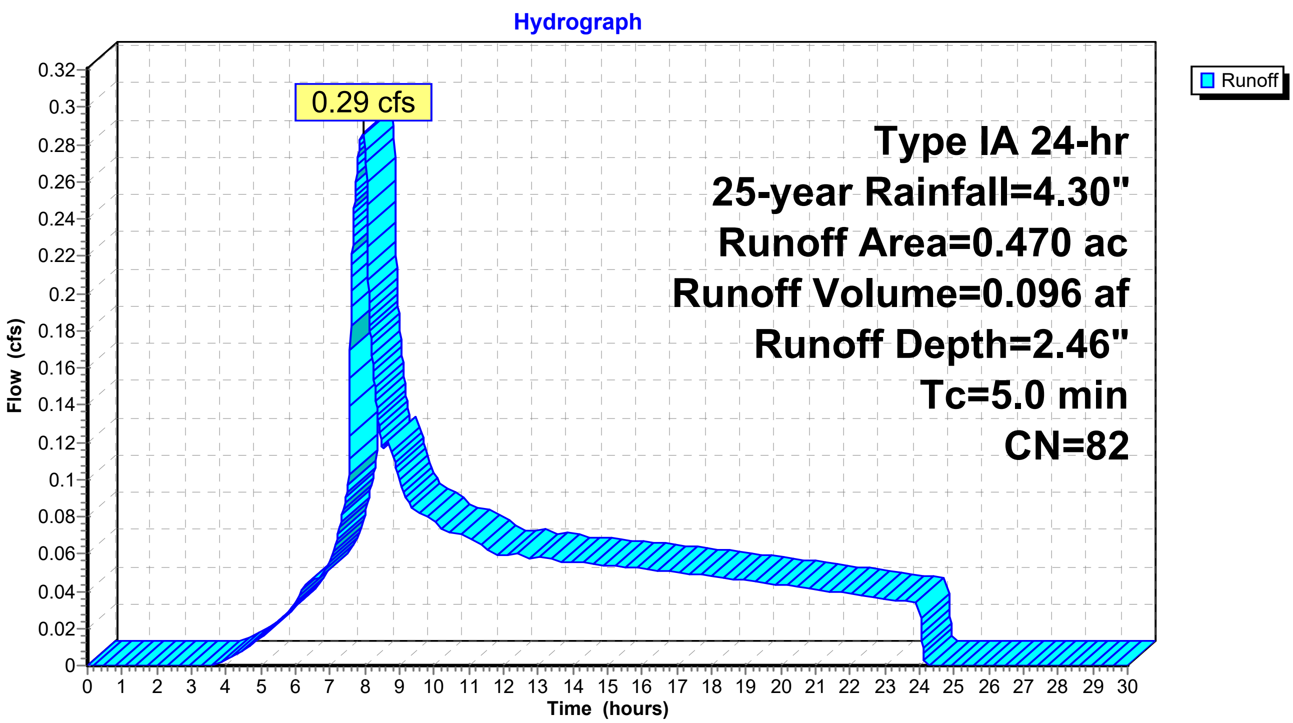
Runoff = 0.29 cfs @ 7.94 hrs, Volume= 0.096 af, Depth= 2.46"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	0.430	80	>75% Grass cover, Good, HSG D
*	0.040	98	Road
	0.470	82	Weighted Average
	0.430		91.49% Pervious Area
	0.040		8.51% Impervious Area

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

Subcatchment 62S: (new Subcat)



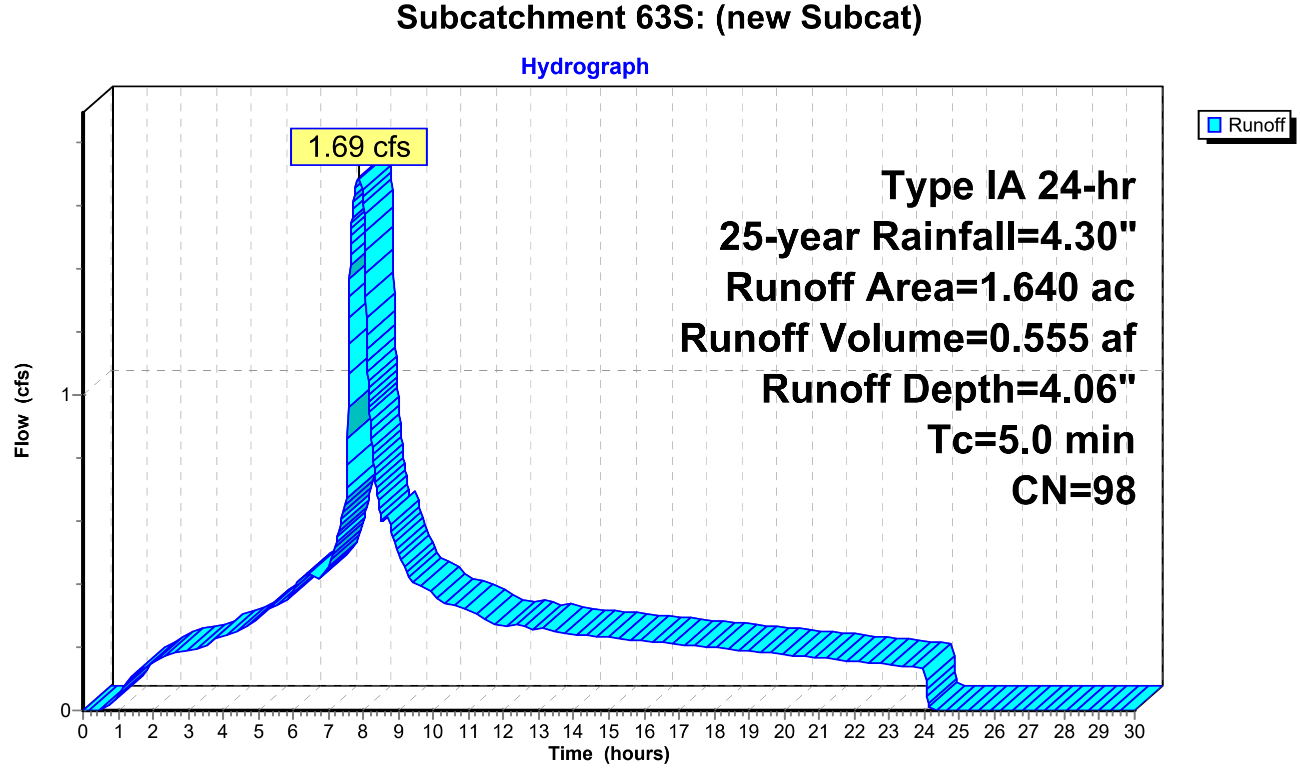
Summary for Subcatchment 63S: (new Subcat)

Runoff = 1.69 cfs @ 7.85 hrs, Volume= 0.555 af, Depth= 4.06"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
*	1.640	98	>75% Grass cover, Good, HSG D
	1.640		100.00% Impervious Area

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



Summary for Subcatchment 64S: (new Subcat)

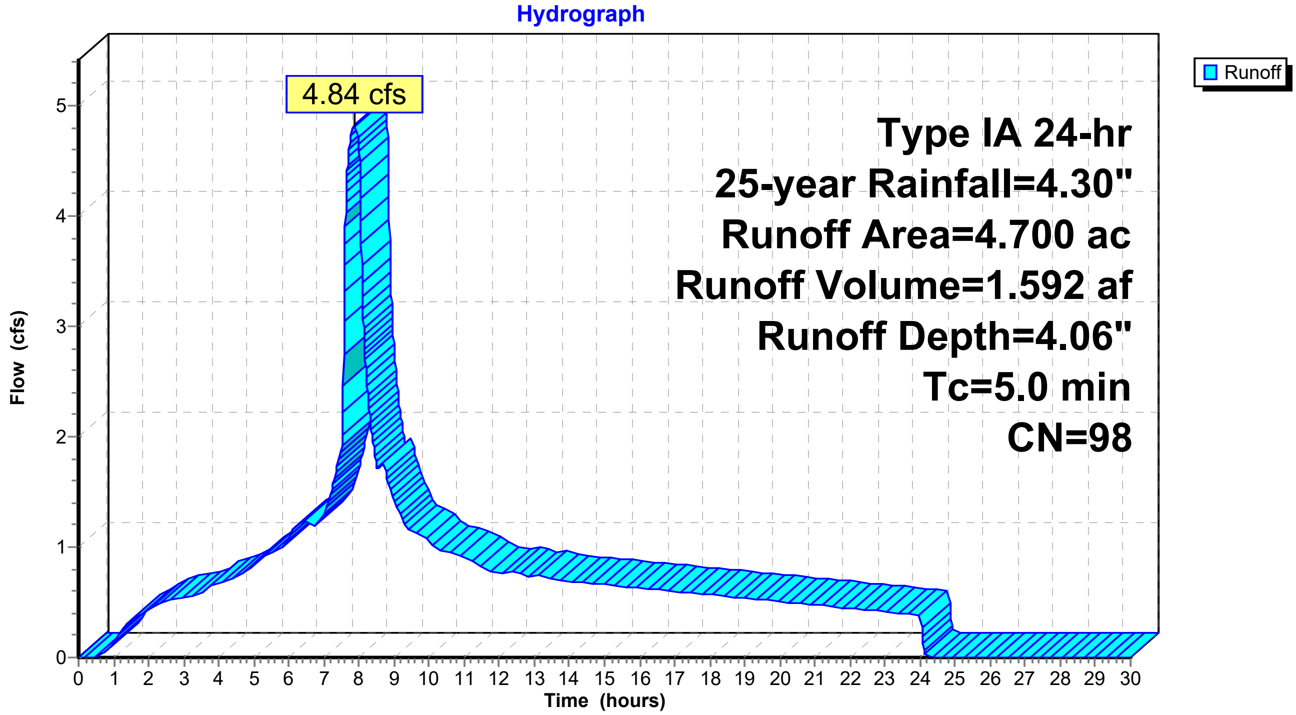
Runoff = 4.84 cfs @ 7.85 hrs, Volume= 1.592 af, Depth= 4.06"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
*	4.700	98	Pond 3 and roads
	4.700		100.00% Impervious Area

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

Subcatchment 64S: (new Subcat)



Summary for Subcatchment 65S: (new Subcat)

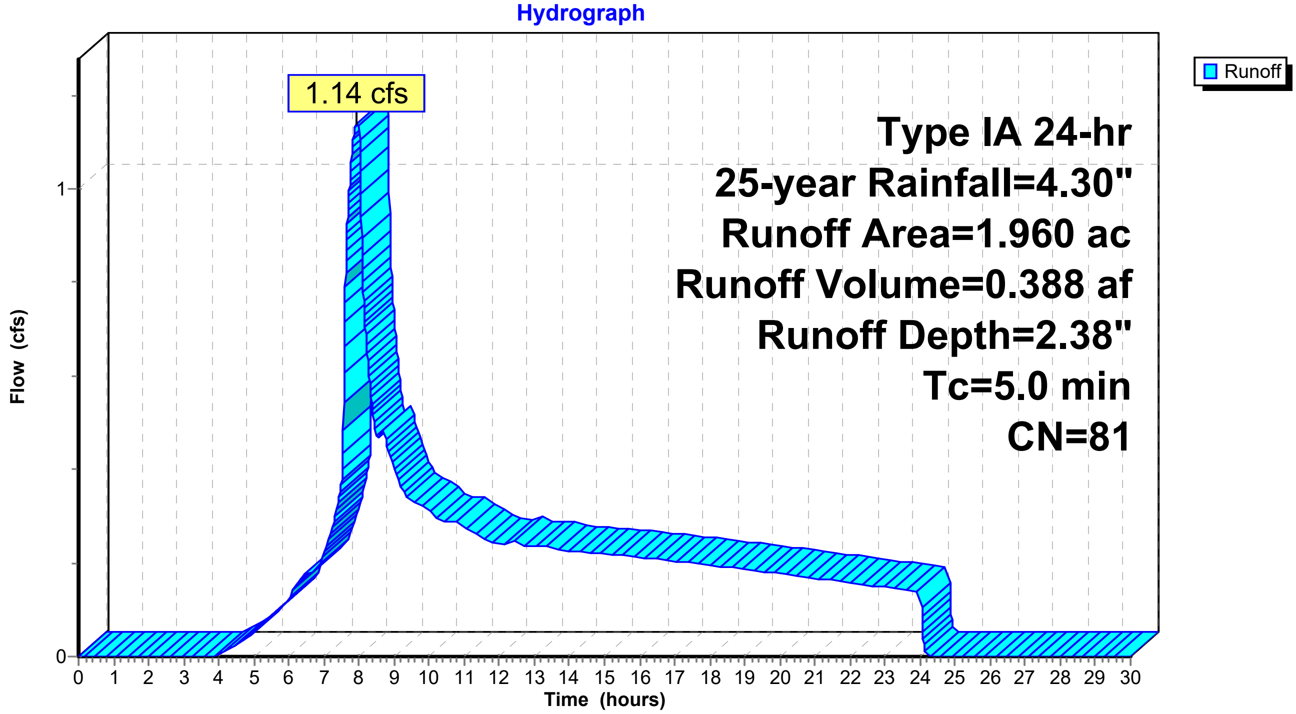
Runoff = 1.14 cfs @ 7.95 hrs, Volume= 0.388 af, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	1.810	80	>75% Grass cover, Good, HSG D
*	0.150	98	Road
	1.960	81	Weighted Average
	1.810		92.35% Pervious Area
	0.150		7.65% Impervious Area

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

Subcatchment 65S: (new Subcat)



Summary for Subcatchment 66S: (new Subcat)

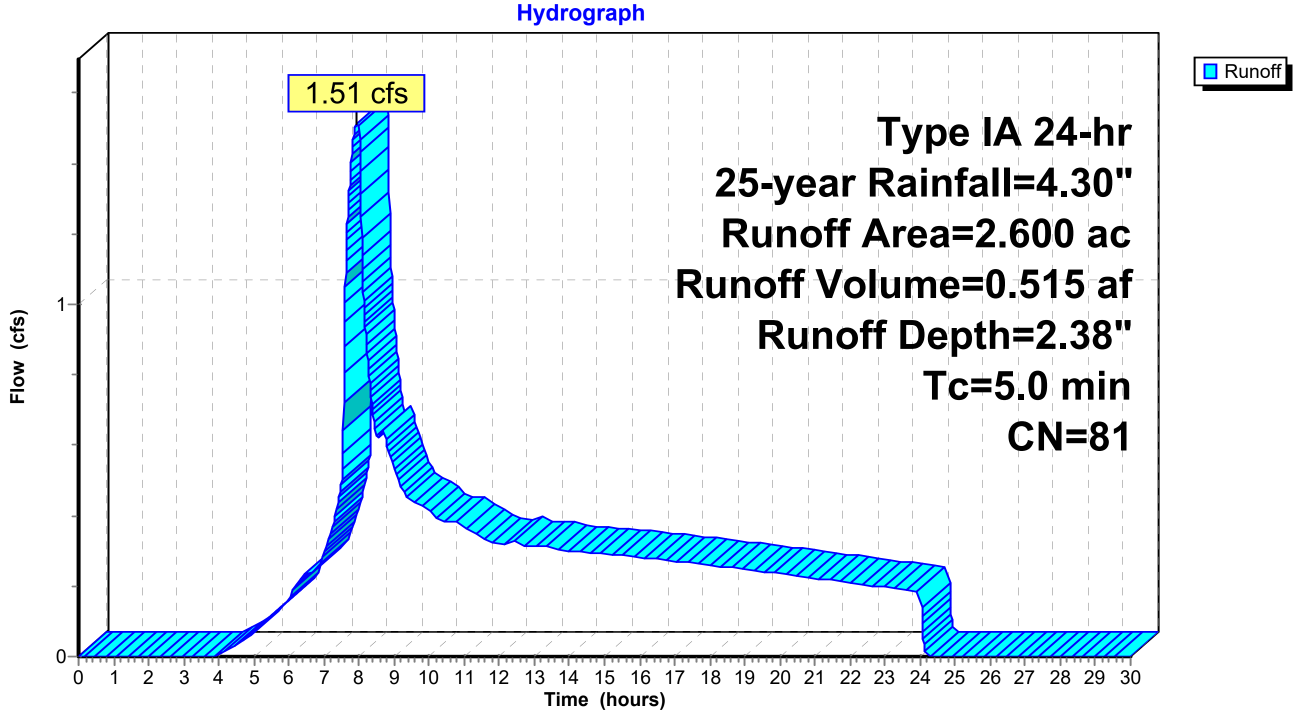
Runoff = 1.51 cfs @ 7.95 hrs, Volume= 0.515 af, Depth= 2.38"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

	Area (ac)	CN	Description
	2.420	80	>75% Grass cover, Good, HSG D
*	0.180	98	Road
	2.600	81	Weighted Average
	2.420		93.08% Pervious Area
	0.180		6.92% Impervious Area

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

Subcatchment 66S: (new Subcat)



Summary for Subcatchment 71S: (new Subcat)

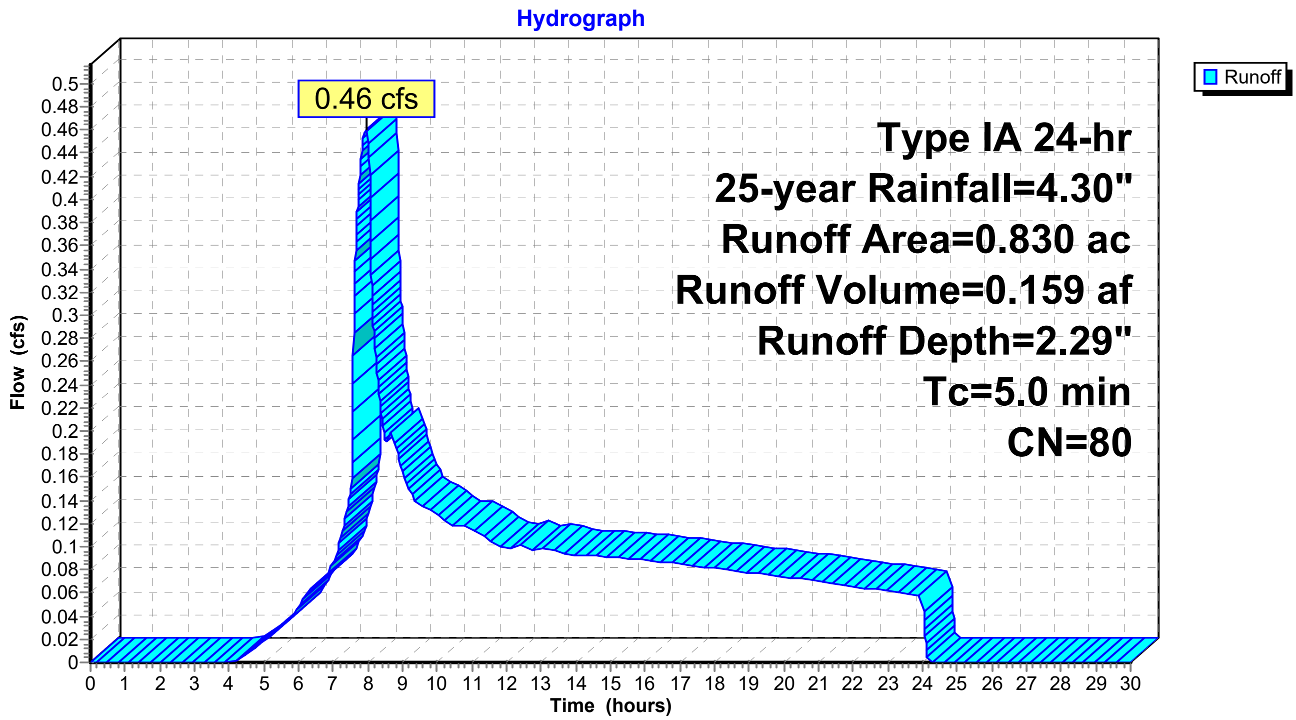
Runoff = 0.46 cfs @ 7.95 hrs, Volume= 0.159 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.830	80	>75% Grass cover, Good, HSG D
0.830		100.00% Pervious Area

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

Subcatchment 71S: (new Subcat)



Summary for Subcatchment 73S: (new Subcat)

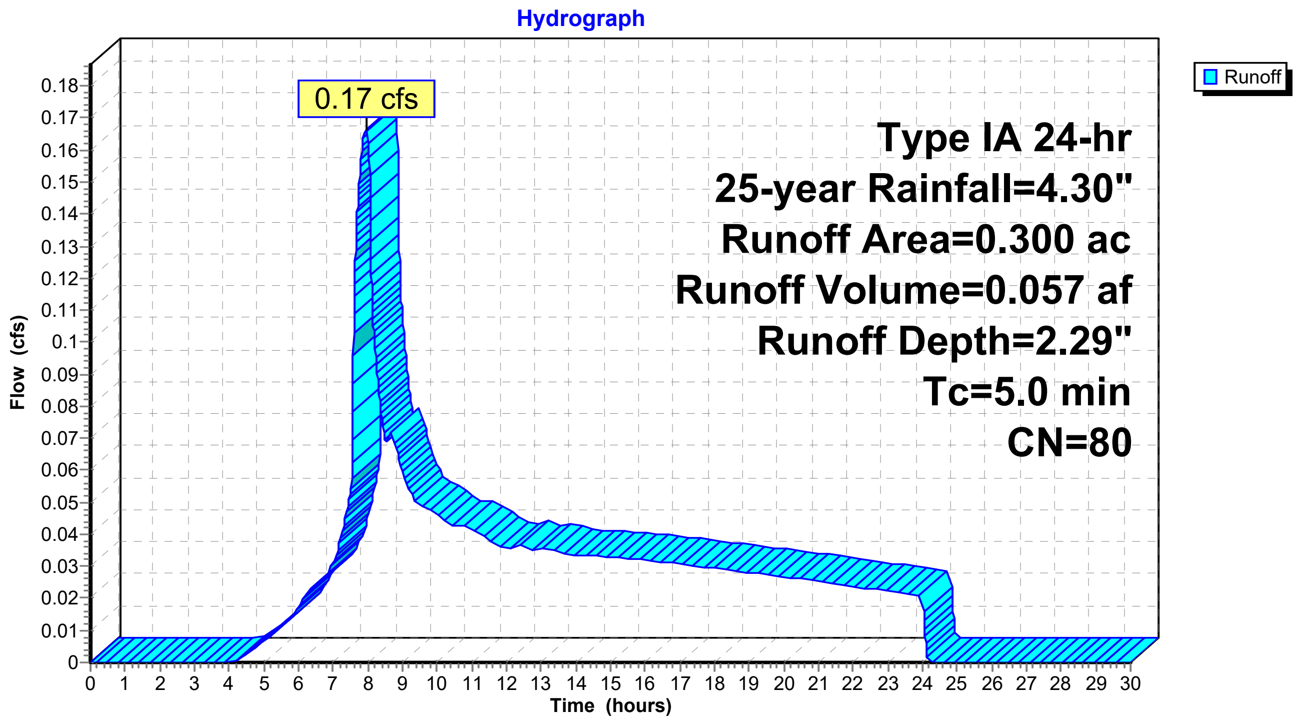
Runoff = 0.17 cfs @ 7.95 hrs, Volume= 0.057 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 25-year Rainfall=4.30"

Area (ac)	CN	Description
0.300	80	>75% Grass cover, Good, HSG D
0.300		100.00% Pervious Area

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

Subcatchment 73S: (new Subcat)



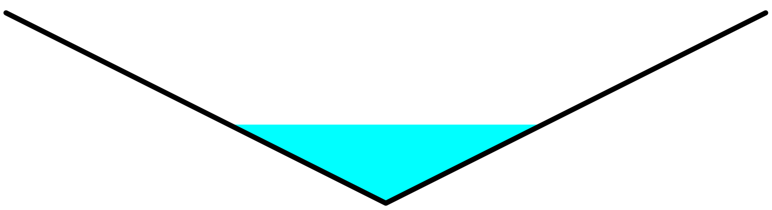
Summary for Reach 1R: (new Reach)

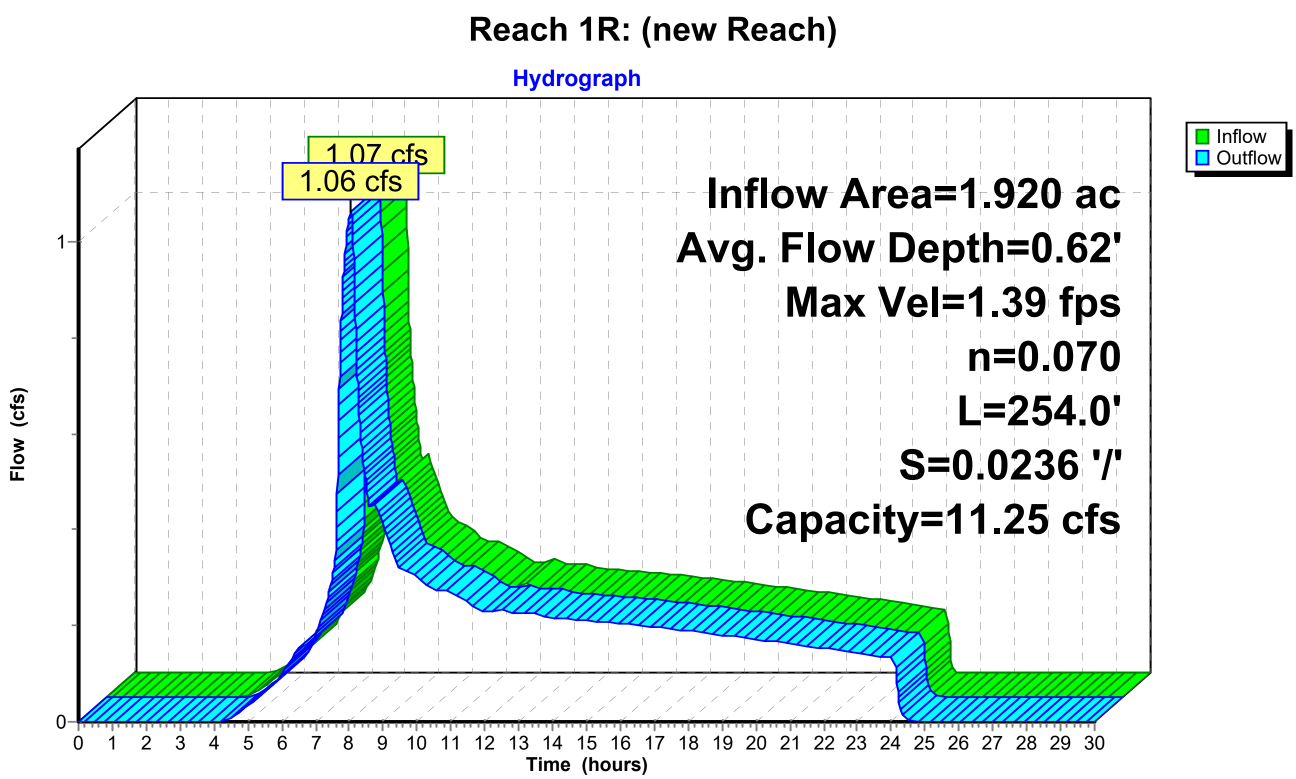
Inflow Area = 1.920 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.07 cfs @ 7.95 hrs, Volume= 0.367 af
Outflow = 1.06 cfs @ 8.04 hrs, Volume= 0.367 af, Atten= 0%, Lag= 5.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.39 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.83 fps, Avg. Travel Time= 5.1 min

Peak Storage= 195 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.62'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.25 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 254.0' Slope= 0.0236 '/'
Inlet Invert= 275.00', Outlet Invert= 269.00'





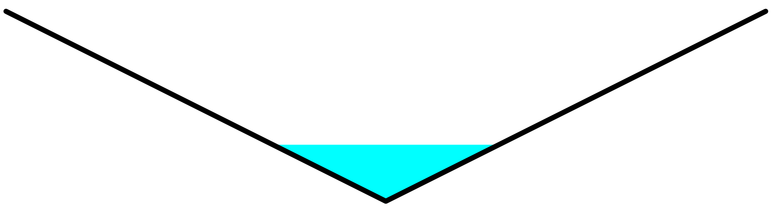
Summary for Reach 12R: (new Reach)

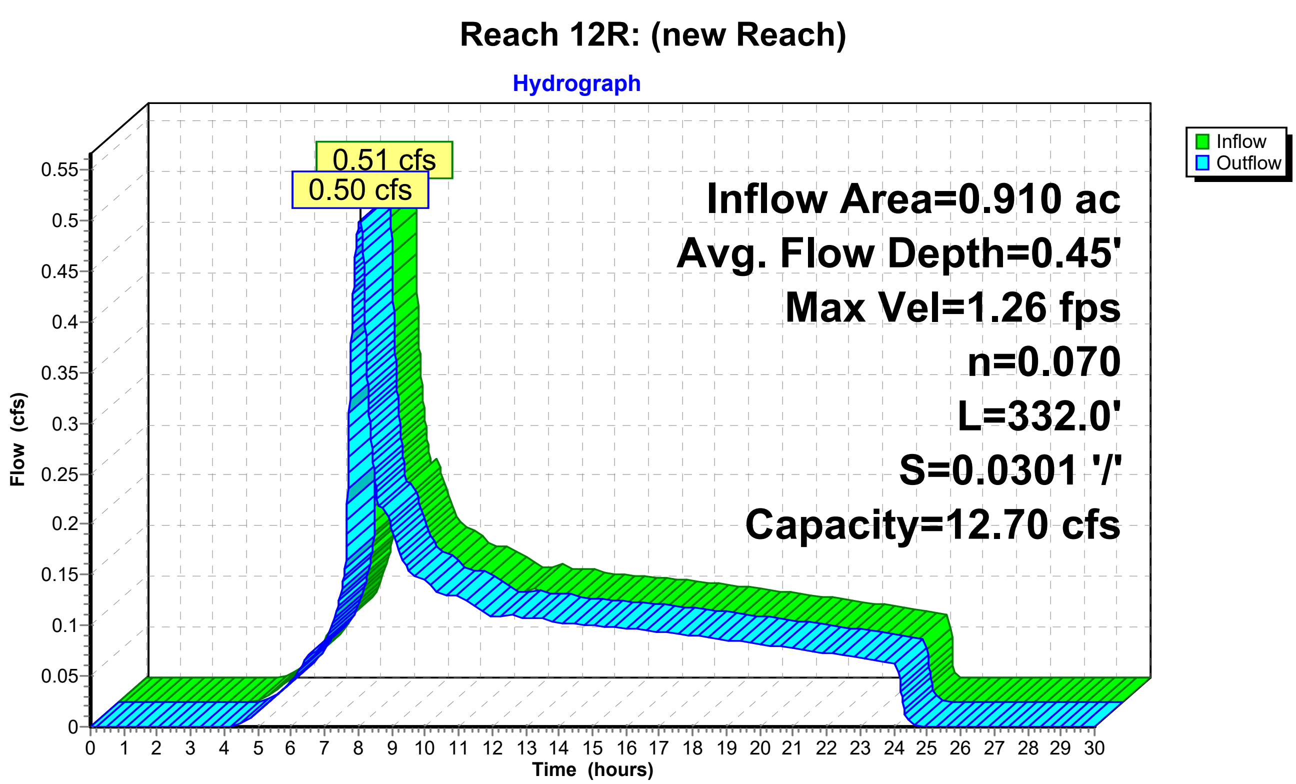
Inflow Area = 0.910 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.51 cfs @ 7.95 hrs, Volume= 0.174 af
Outflow = 0.50 cfs @ 8.08 hrs, Volume= 0.174 af, Atten= 1%, Lag= 7.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.26 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 0.75 fps, Avg. Travel Time= 7.4 min

Peak Storage= 132 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.70 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 332.0' Slope= 0.0301 '/'
Inlet Invert= 227.00', Outlet Invert= 217.00'





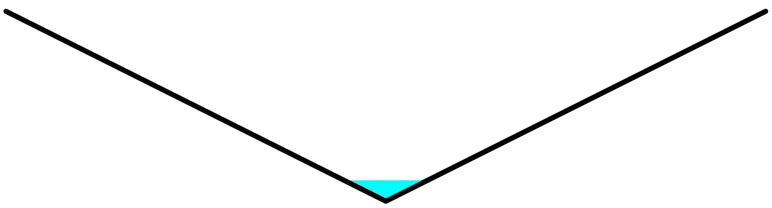
Summary for Reach 13R: (new Reach)

Inflow Area = 0.080 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.04 cfs @ 7.95 hrs, Volume= 0.015 af
Outflow = 0.04 cfs @ 8.02 hrs, Volume= 0.015 af, Atten= 0%, Lag= 3.8 min

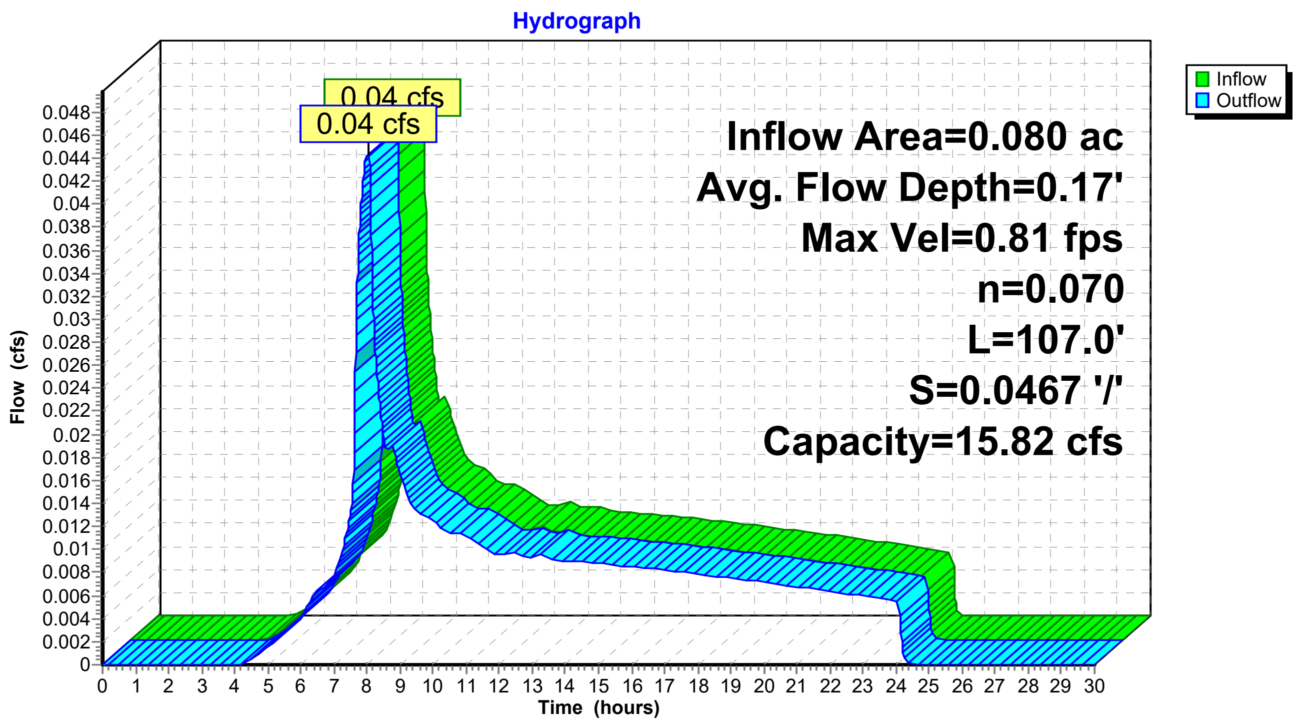
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.81 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 0.52 fps, Avg. Travel Time= 3.4 min

Peak Storage= 6 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 15.82 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 107.0' Slope= 0.0467 '/'
Inlet Invert= 222.00', Outlet Invert= 217.00'



Reach 13R: (new Reach)



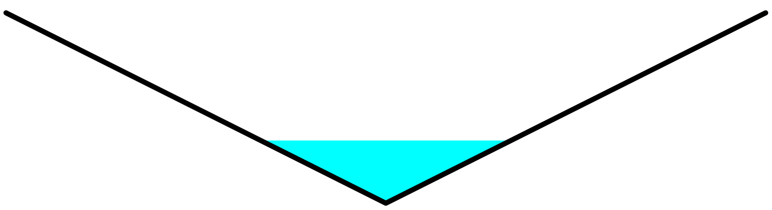
Summary for Reach 14R: (new Reach)

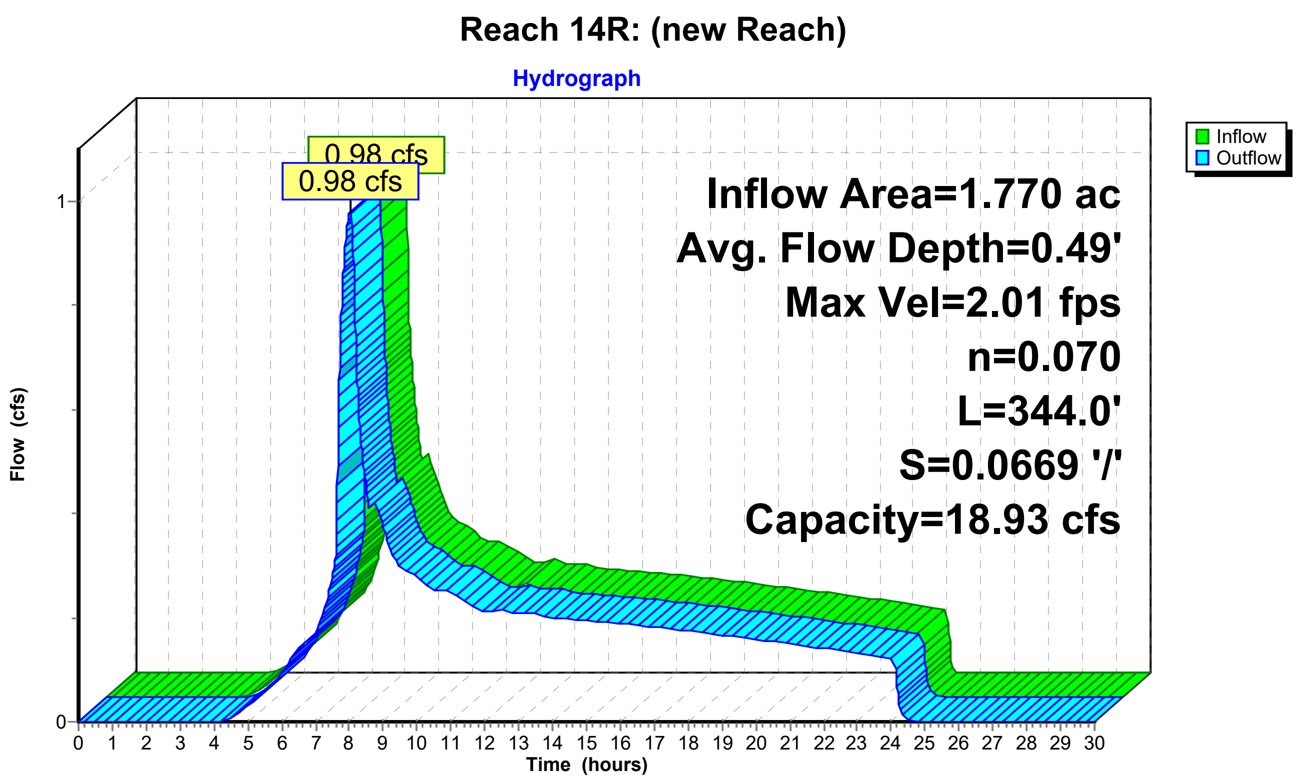
Inflow Area = 1.770 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.98 cfs @ 7.95 hrs, Volume= 0.338 af
Outflow = 0.98 cfs @ 8.03 hrs, Volume= 0.338 af, Atten= 0%, Lag= 5.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.01 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 4.7 min

Peak Storage= 168 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 18.93 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 344.0' Slope= 0.0669 '/'
Inlet Invert= 175.00', Outlet Invert= 152.00'





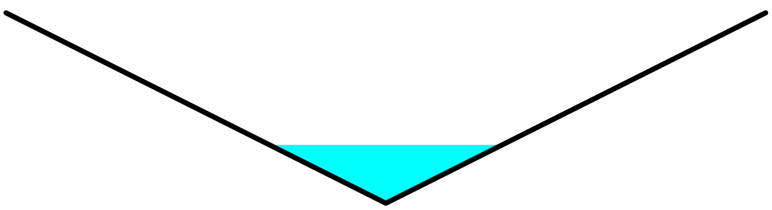
Summary for Reach 15R: (new Reach)

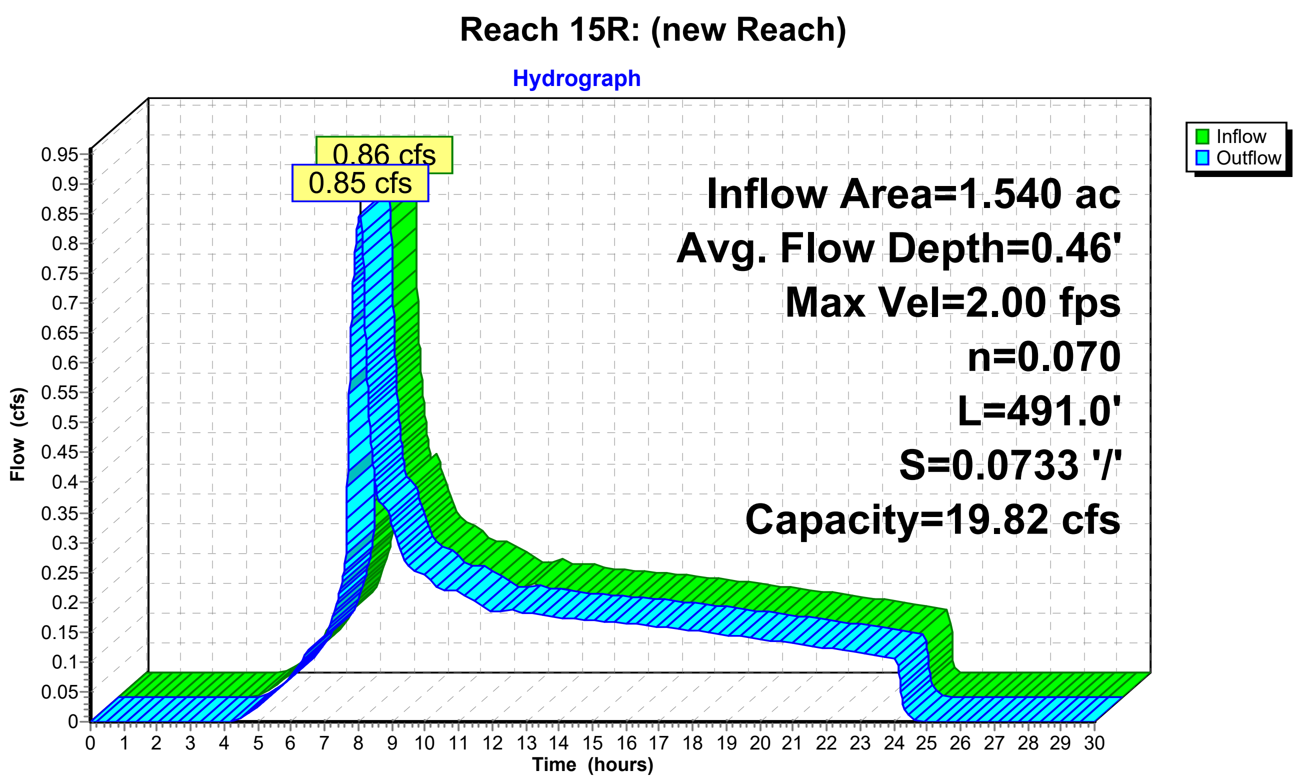
Inflow Area = 1.540 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.86 cfs @ 7.95 hrs, Volume= 0.294 af
Outflow = 0.85 cfs @ 8.07 hrs, Volume= 0.294 af, Atten= 1%, Lag= 7.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.00 fps, Min. Travel Time= 4.1 min
Avg. Velocity = 1.19 fps, Avg. Travel Time= 6.8 min

Peak Storage= 208 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.82 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 491.0' Slope= 0.0733 '/'
Inlet Invert= 188.00', Outlet Invert= 152.00'





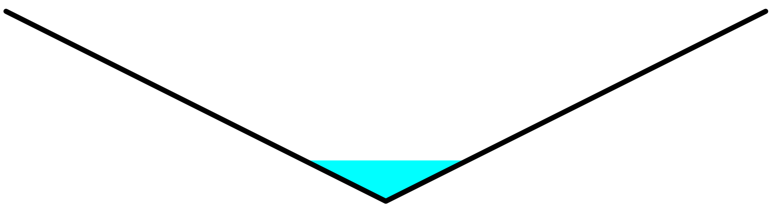
Summary for Reach 16R: (new Reach)

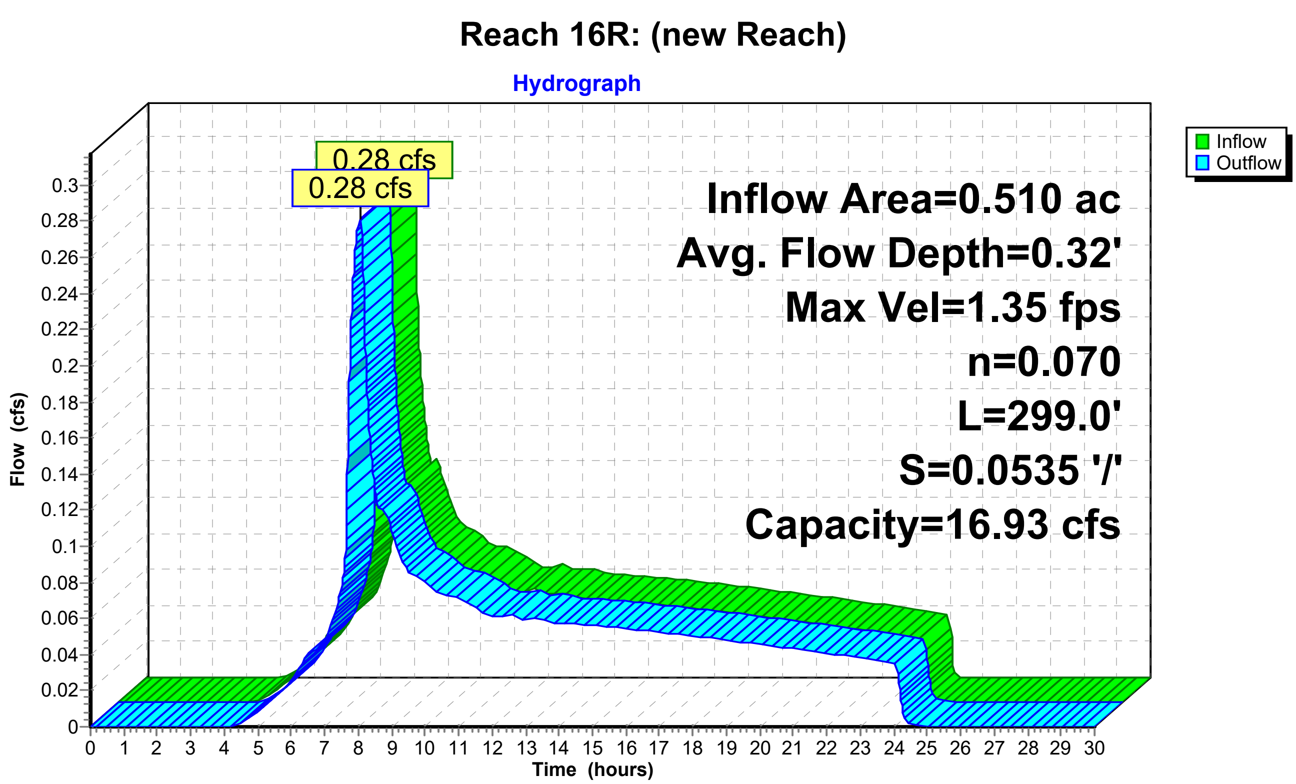
Inflow Area = 0.510 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.28 cfs @ 7.95 hrs, Volume= 0.097 af
Outflow = 0.28 cfs @ 8.06 hrs, Volume= 0.097 af, Atten= 1%, Lag= 6.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.35 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.83 fps, Avg. Travel Time= 6.0 min

Peak Storage= 62 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 16.93 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 299.0' Slope= 0.0535 '/'
Inlet Invert= 168.00', Outlet Invert= 152.00'





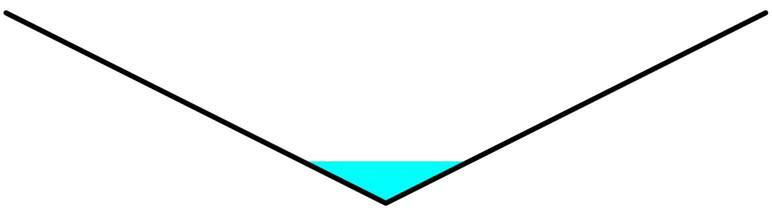
Summary for Reach 17R: (new Reach)

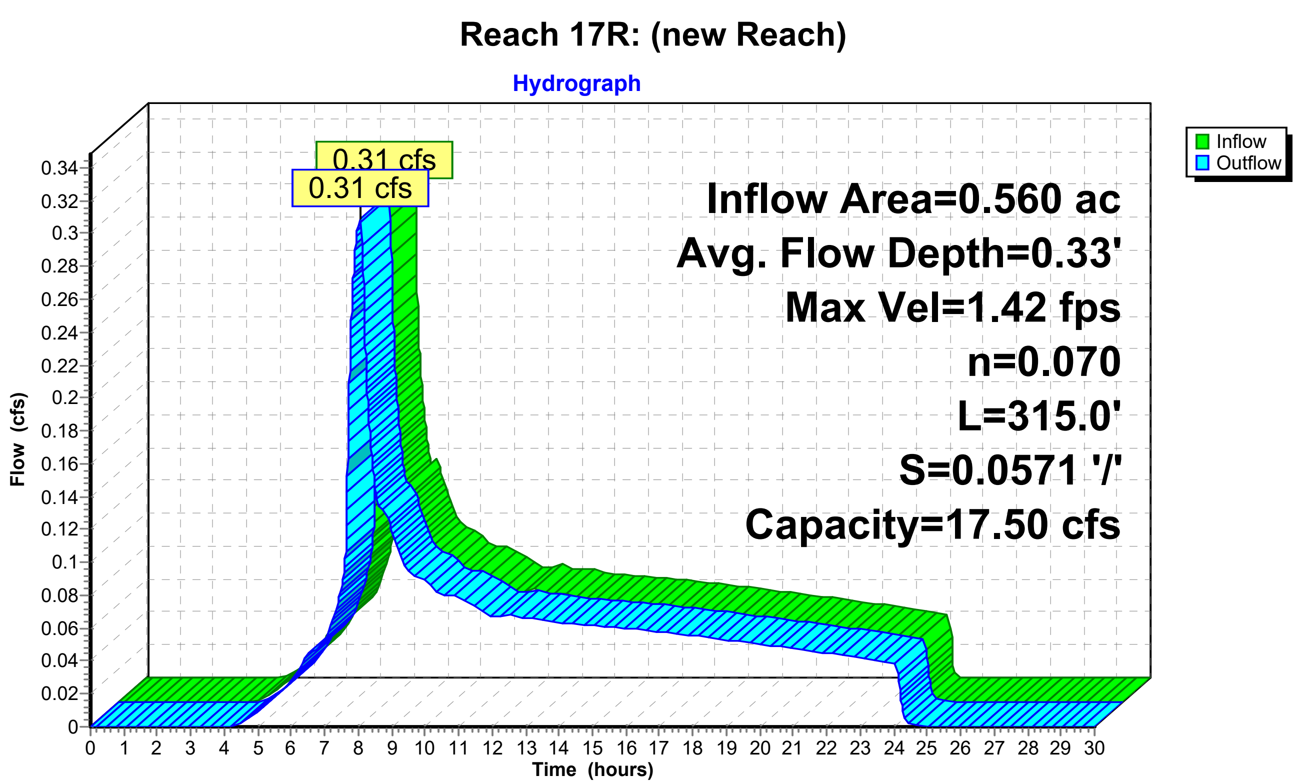
Inflow Area = 0.560 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.31 cfs @ 7.95 hrs, Volume= 0.107 af
Outflow = 0.31 cfs @ 8.06 hrs, Volume= 0.107 af, Atten= 1%, Lag= 6.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.42 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.87 fps, Avg. Travel Time= 6.0 min

Peak Storage= 69 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 17.50 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 315.0' Slope= 0.0571 '/'
Inlet Invert= 170.00', Outlet Invert= 152.00'





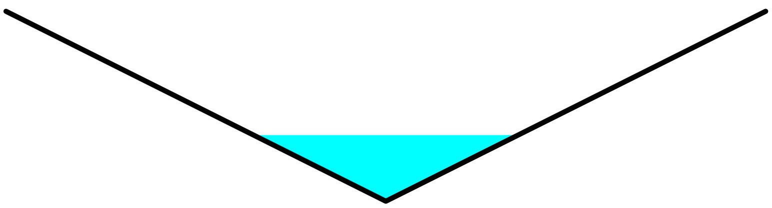
Summary for Reach 18R: (new Reach)

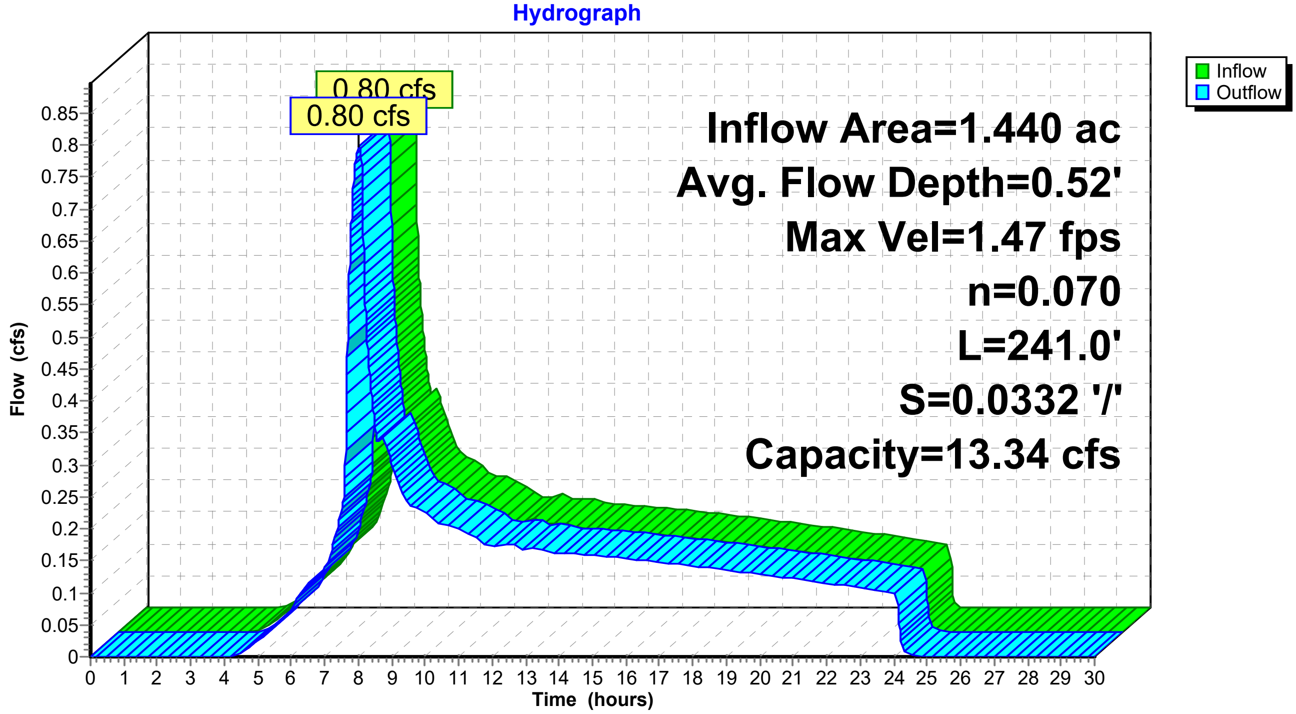
Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.80 cfs @ 7.95 hrs, Volume= 0.275 af
Outflow = 0.80 cfs @ 8.03 hrs, Volume= 0.275 af, Atten= 0%, Lag= 4.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.47 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 4.5 min

Peak Storage= 131 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.52'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 13.34 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 241.0' Slope= 0.0332 '/'
Inlet Invert= 243.00', Outlet Invert= 235.00'





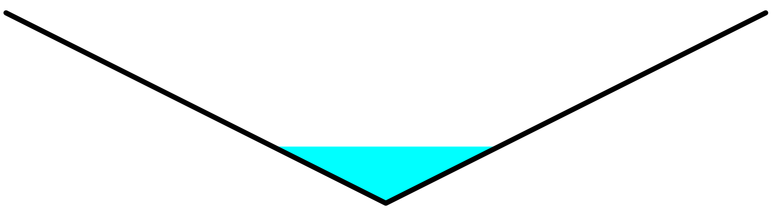
Summary for Reach 19R: (new Reach)

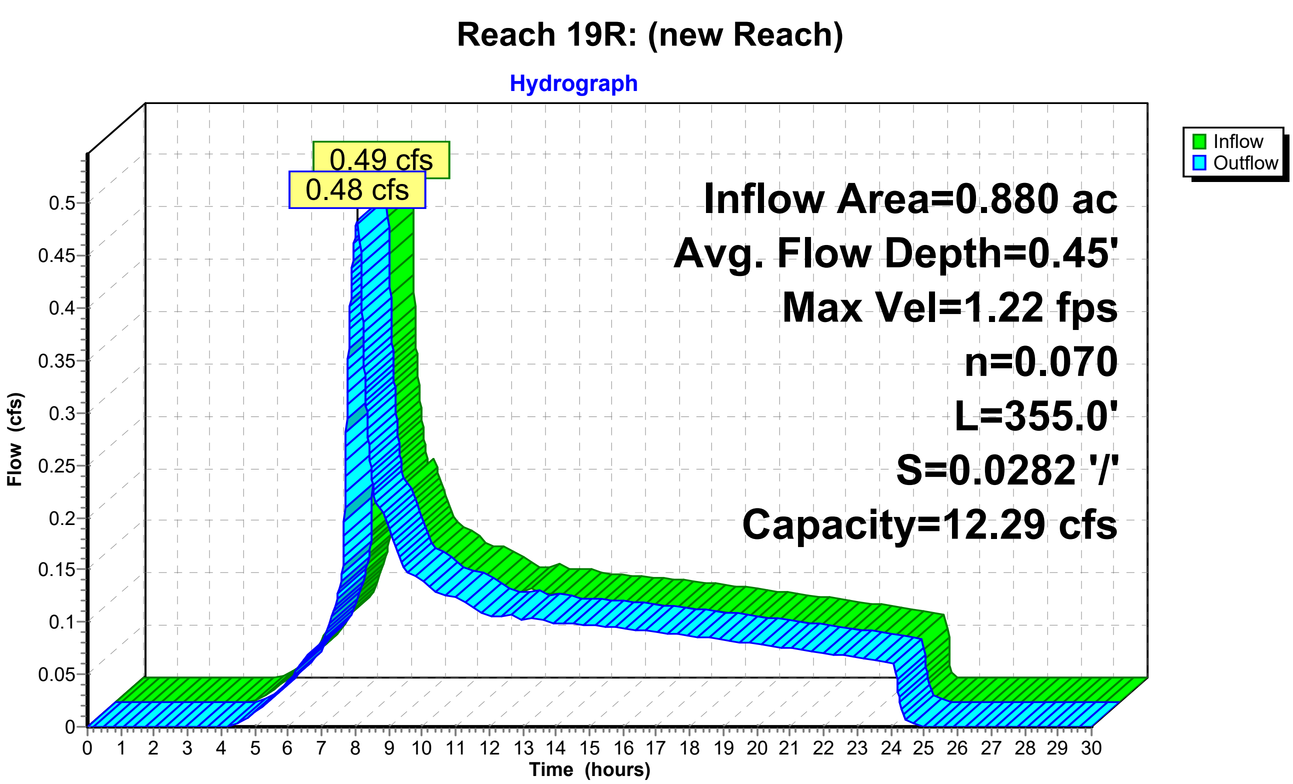
Inflow Area = 0.880 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.49 cfs @ 7.95 hrs, Volume= 0.168 af
Outflow = 0.48 cfs @ 8.09 hrs, Volume= 0.168 af, Atten= 1%, Lag= 8.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.22 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 8.3 min

Peak Storage= 141 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.29 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 355.0' Slope= 0.0282 '/'
Inlet Invert= 245.00', Outlet Invert= 235.00'





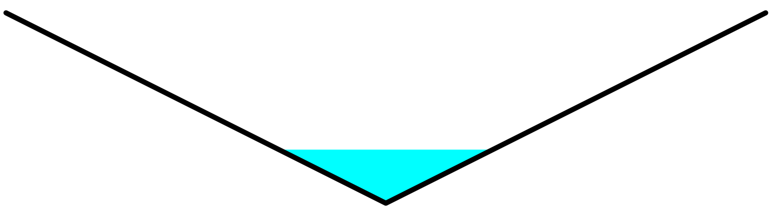
Summary for Reach 20R: (new Reach)

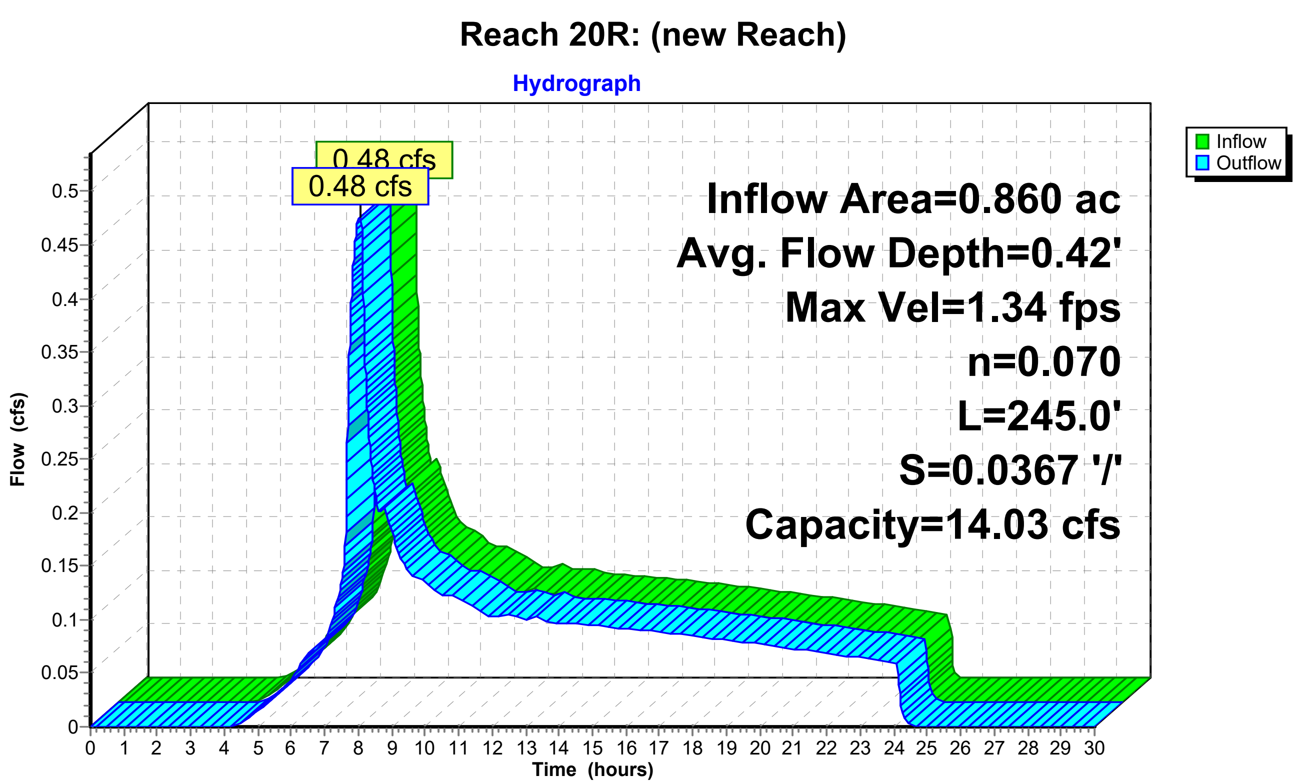
Inflow Area = 0.860 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.48 cfs @ 7.95 hrs, Volume= 0.164 af
Outflow = 0.48 cfs @ 8.04 hrs, Volume= 0.164 af, Atten= 0%, Lag= 5.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.34 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.82 fps, Avg. Travel Time= 5.0 min

Peak Storage= 87 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 14.03 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 245.0' Slope= 0.0367 '/'
Inlet Invert= 209.00', Outlet Invert= 200.00'





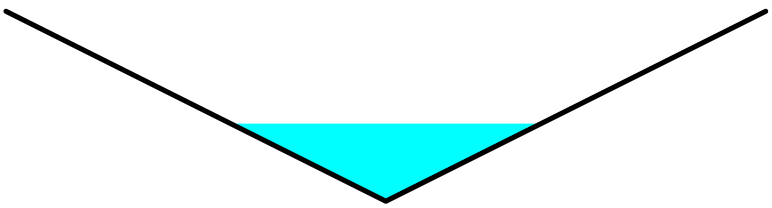
Summary for Reach 21R: (new Reach)

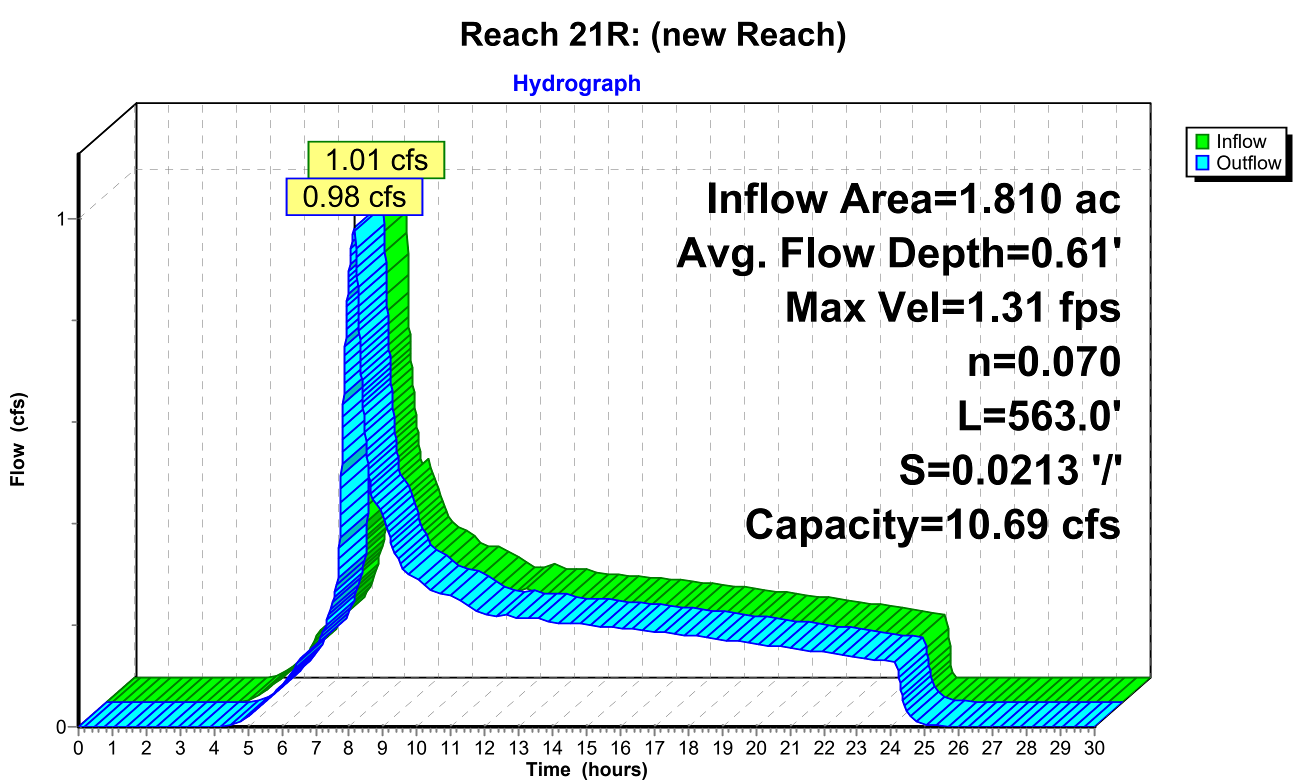
Inflow Area = 1.810 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.01 cfs @ 7.95 hrs, Volume= 0.346 af
Outflow = 0.98 cfs @ 8.15 hrs, Volume= 0.346 af, Atten= 2%, Lag= 11.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.31 fps, Min. Travel Time= 7.2 min
Avg. Velocity = 0.71 fps, Avg. Travel Time= 13.2 min

Peak Storage= 422 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.61'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 10.69 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 563.0' Slope= 0.0213 '/'
Inlet Invert= 212.00', Outlet Invert= 200.00'





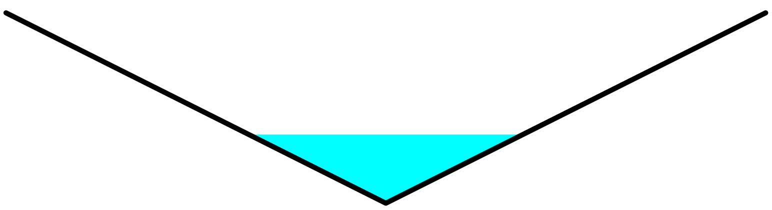
Summary for Reach 22R: (new Reach)

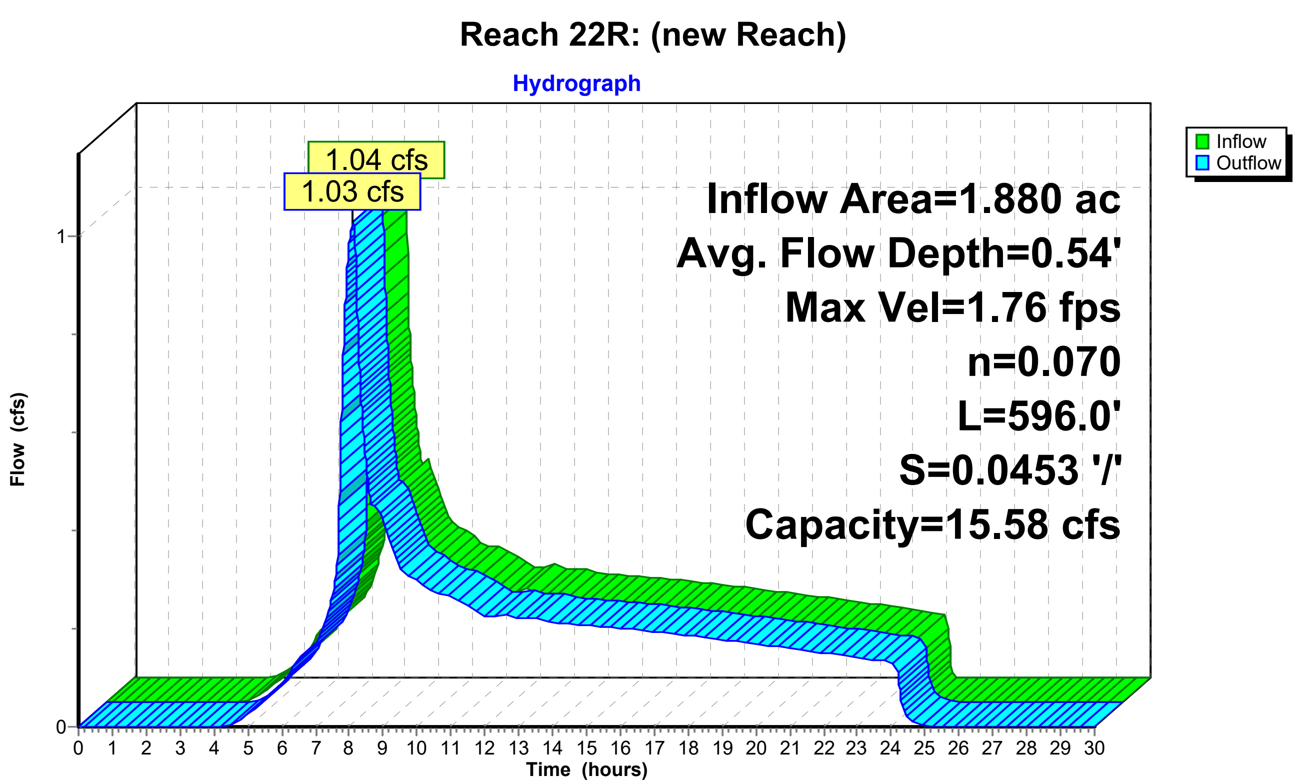
Inflow Area = 1.880 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.04 cfs @ 7.95 hrs, Volume= 0.359 af
Outflow = 1.03 cfs @ 8.11 hrs, Volume= 0.359 af, Atten= 1%, Lag= 9.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.76 fps, Min. Travel Time= 5.7 min
Avg. Velocity = 1.00 fps, Avg. Travel Time= 10.0 min

Peak Storage= 349 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 15.58 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 596.0' Slope= 0.0453 '/'
Inlet Invert= 182.00', Outlet Invert= 155.00'





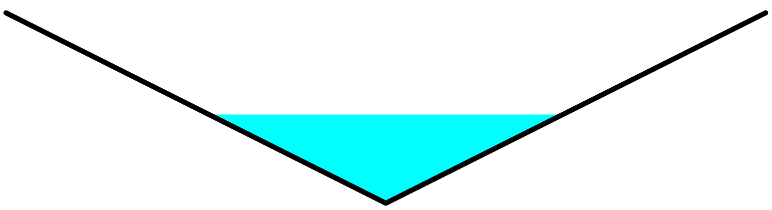
Summary for Reach 23R: (new Reach)

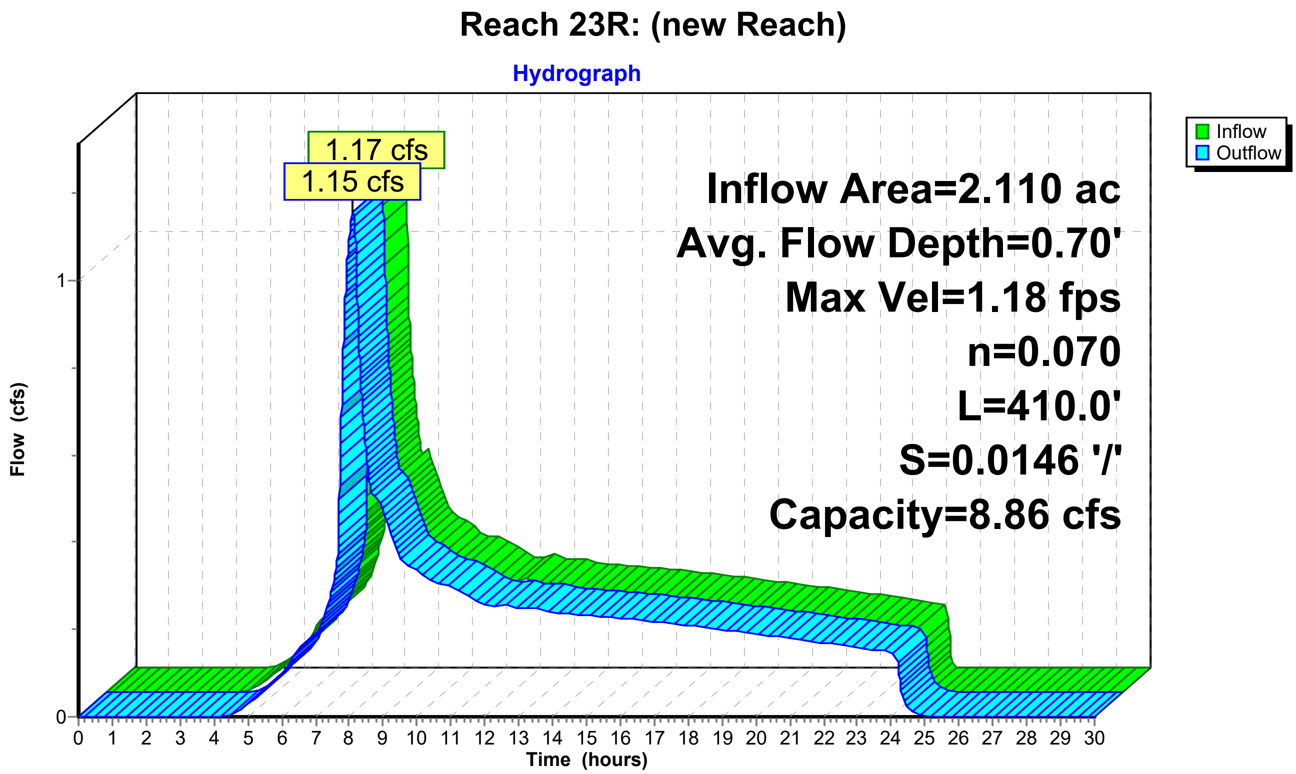
Inflow Area = 2.110 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.17 cfs @ 7.95 hrs, Volume= 0.403 af
Outflow = 1.15 cfs @ 8.11 hrs, Volume= 0.403 af, Atten= 2%, Lag= 9.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.18 fps, Min. Travel Time= 5.8 min
Avg. Velocity = 0.65 fps, Avg. Travel Time= 10.5 min

Peak Storage= 400 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.70'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 8.86 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 410.0' Slope= 0.0146 '/'
Inlet Invert= 278.00', Outlet Invert= 272.00'





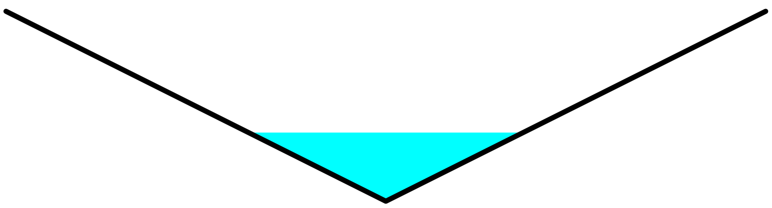
Summary for Reach 24R: (new Reach)

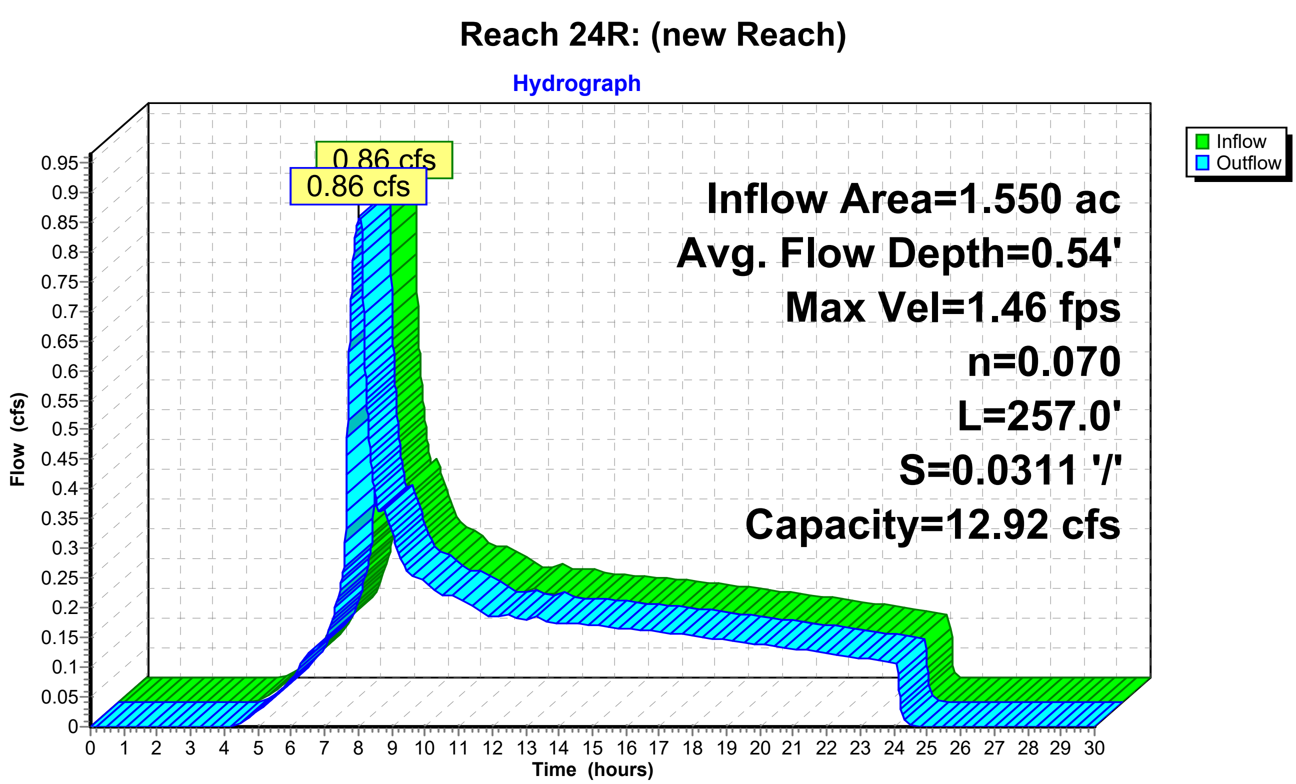
Inflow Area = 1.550 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.86 cfs @ 7.95 hrs, Volume= 0.296 af
Outflow = 0.86 cfs @ 8.04 hrs, Volume= 0.296 af, Atten= 0%, Lag= 5.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.46 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 0.88 fps, Avg. Travel Time= 4.9 min

Peak Storage= 151 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.92 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 257.0' Slope= 0.0311 '/'
Inlet Invert= 280.00', Outlet Invert= 272.00'





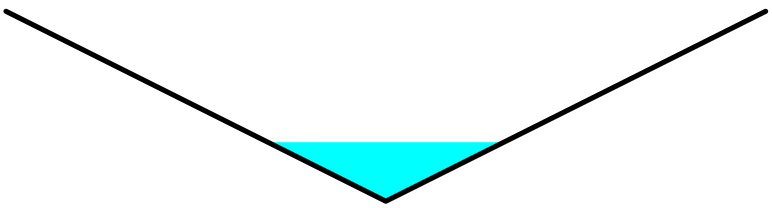
Summary for Reach 26R: (new Reach)

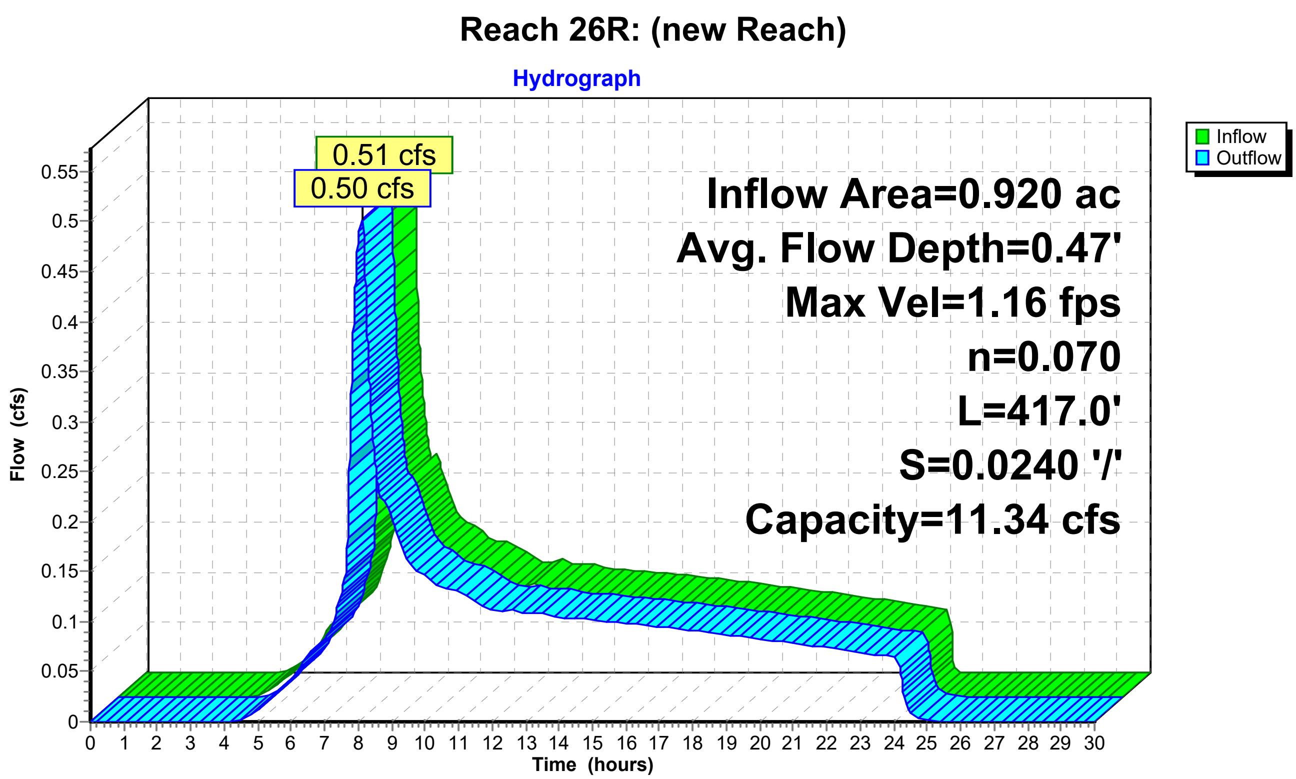
Inflow Area = 0.920 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.51 cfs @ 7.95 hrs, Volume= 0.176 af
Outflow = 0.50 cfs @ 8.12 hrs, Volume= 0.176 af, Atten= 2%, Lag= 10.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.16 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 10.5 min

Peak Storage= 181 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.47'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.34 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 417.0' Slope= 0.0240 '/'
Inlet Invert= 235.00', Outlet Invert= 225.00'





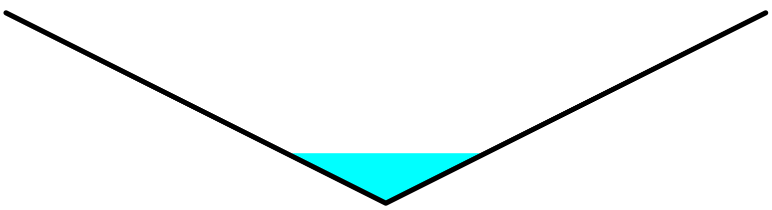
Summary for Reach 27R: (new Reach)

Inflow Area = 0.590 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.33 cfs @ 7.95 hrs, Volume= 0.113 af
Outflow = 0.32 cfs @ 8.10 hrs, Volume= 0.113 af, Atten= 1%, Lag= 8.7 min

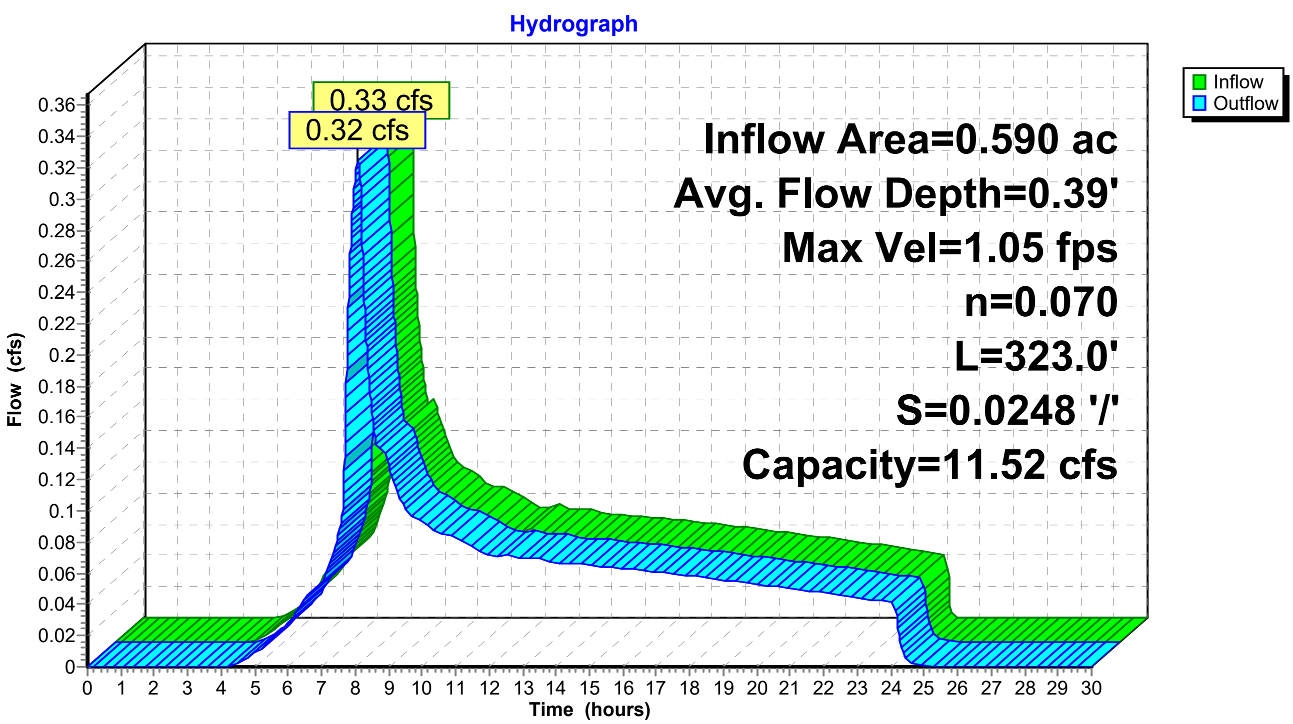
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.05 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 0.62 fps, Avg. Travel Time= 8.7 min

Peak Storage= 100 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.52 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 323.0' Slope= 0.0248 '/'
Inlet Invert= 205.00', Outlet Invert= 197.00'



Reach 27R: (new Reach)



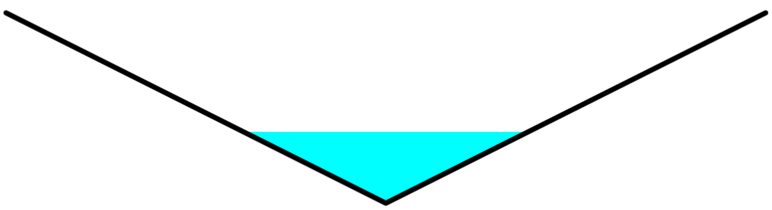
Summary for Reach 28R: (new Reach)

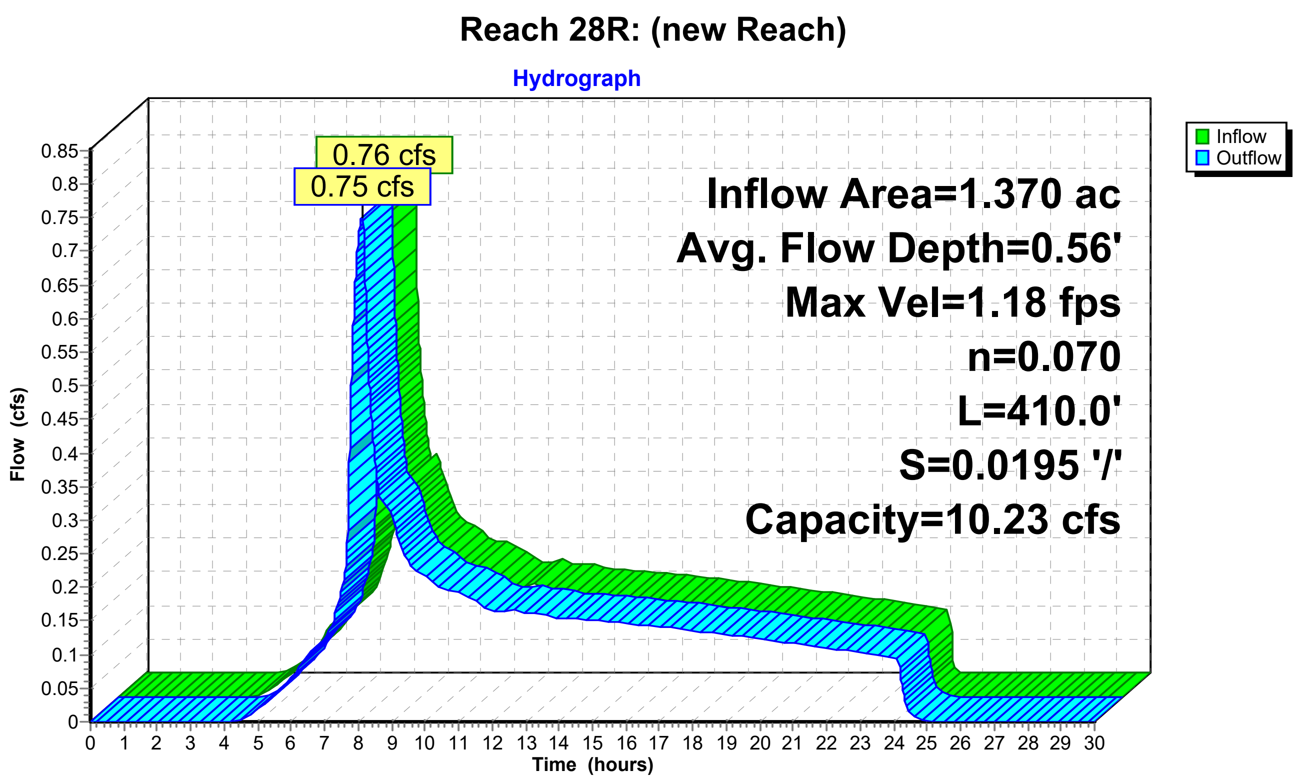
Inflow Area = 1.370 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.76 cfs @ 7.95 hrs, Volume= 0.262 af
Outflow = 0.75 cfs @ 8.11 hrs, Volume= 0.262 af, Atten= 2%, Lag= 9.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.18 fps, Min. Travel Time= 5.8 min
Avg. Velocity = 0.67 fps, Avg. Travel Time= 10.2 min

Peak Storage= 260 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 10.23 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 410.0' Slope= 0.0195 '/'
Inlet Invert= 195.00', Outlet Invert= 187.00'





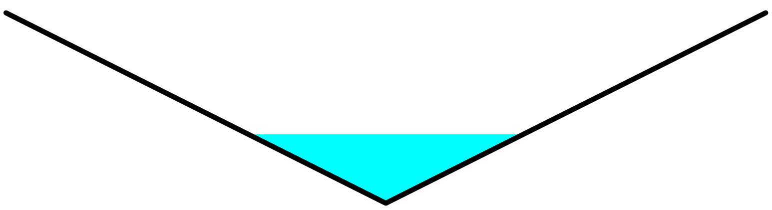
Summary for Reach 29R: (new Reach)

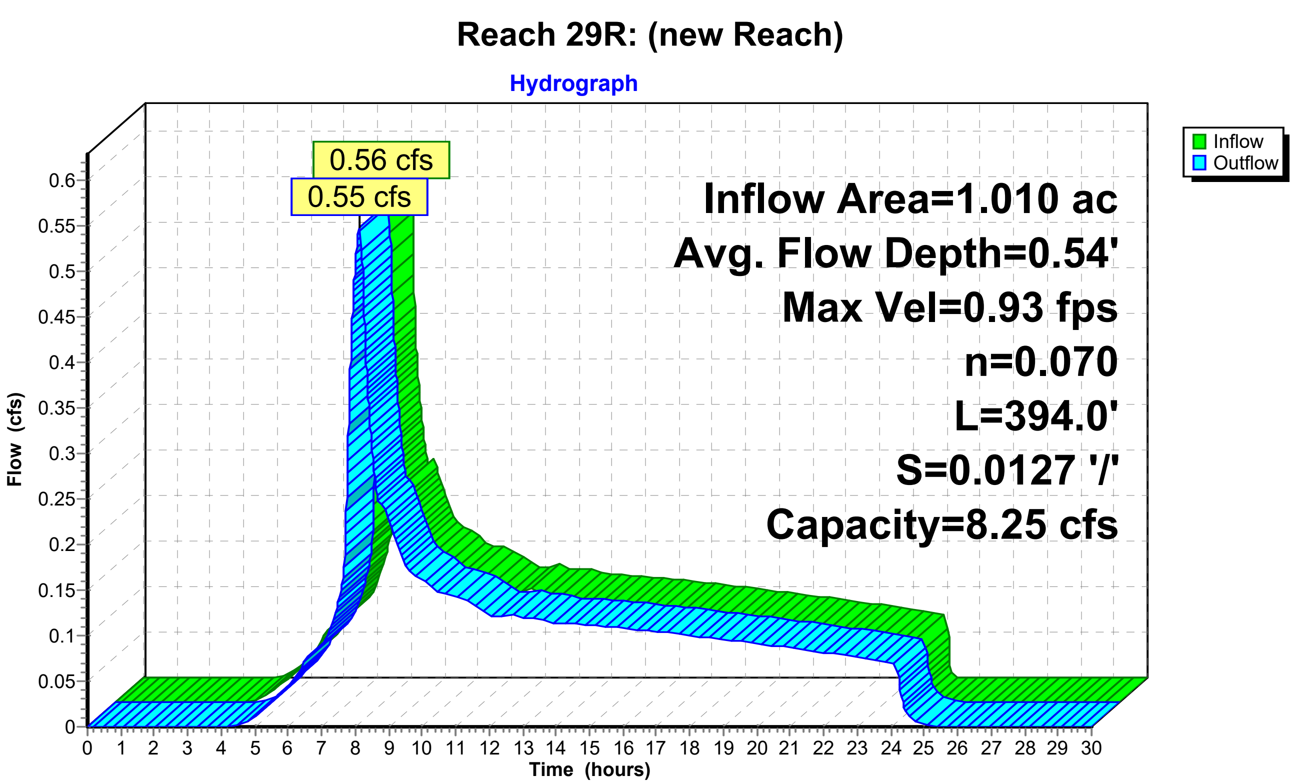
Inflow Area = 1.010 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.56 cfs @ 7.95 hrs, Volume= 0.193 af
Outflow = 0.55 cfs @ 8.14 hrs, Volume= 0.193 af, Atten= 2%, Lag= 11.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.93 fps, Min. Travel Time= 7.1 min
Avg. Velocity = 0.51 fps, Avg. Travel Time= 12.8 min

Peak Storage= 232 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 8.25 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 394.0' Slope= 0.0127 '/'
Inlet Invert= 165.00', Outlet Invert= 160.00'





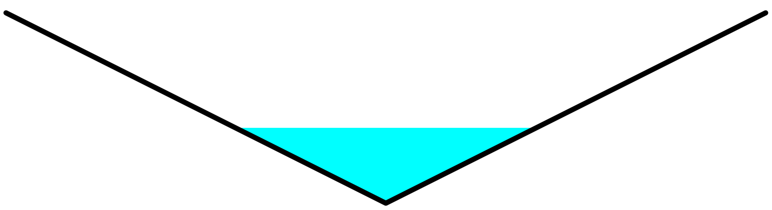
Summary for Reach 30R: (new Reach)

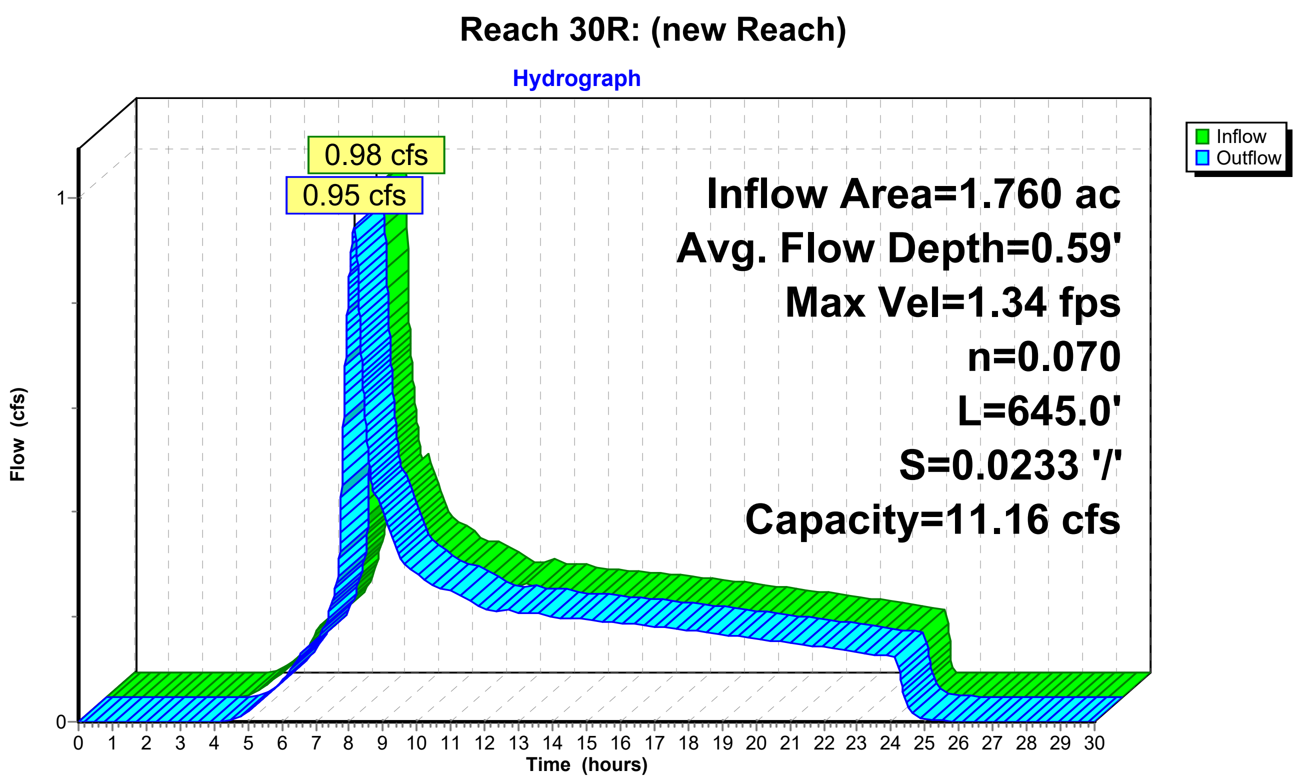
Inflow Area = 1.760 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.98 cfs @ 7.95 hrs, Volume= 0.336 af
Outflow = 0.95 cfs @ 8.16 hrs, Volume= 0.336 af, Atten= 3%, Lag= 12.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.34 fps, Min. Travel Time= 8.0 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 14.9 min

Peak Storage= 456 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.16 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 645.0' Slope= 0.0233 '/'
Inlet Invert= 175.00', Outlet Invert= 160.00'





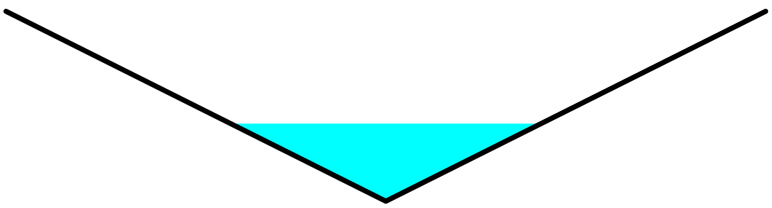
Summary for Reach 31R: (new Reach)

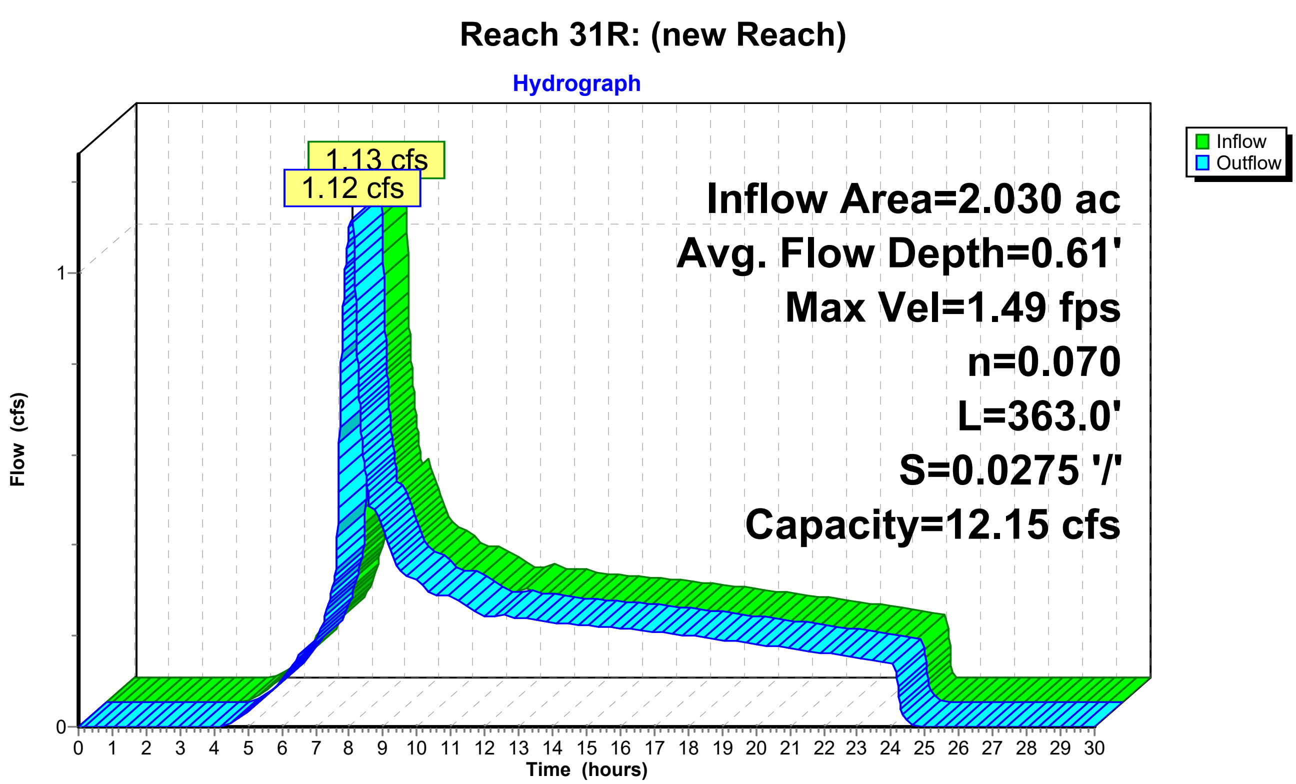
Inflow Area = 2.030 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.13 cfs @ 7.95 hrs, Volume= 0.388 af
Outflow = 1.12 cfs @ 8.07 hrs, Volume= 0.388 af, Atten= 1%, Lag= 7.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.49 fps, Min. Travel Time= 4.1 min
Avg. Velocity = 0.87 fps, Avg. Travel Time= 7.0 min

Peak Storage= 273 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.61'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.15 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 363.0' Slope= 0.0275 '/'
Inlet Invert= 275.00', Outlet Invert= 265.00'





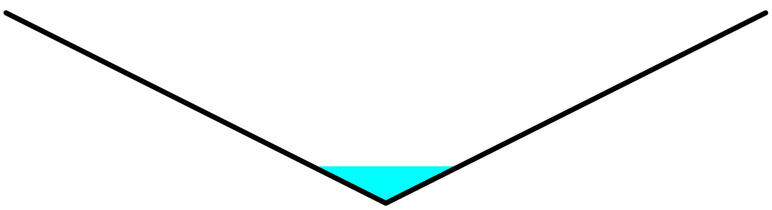
Summary for Reach 32R: (new Reach)

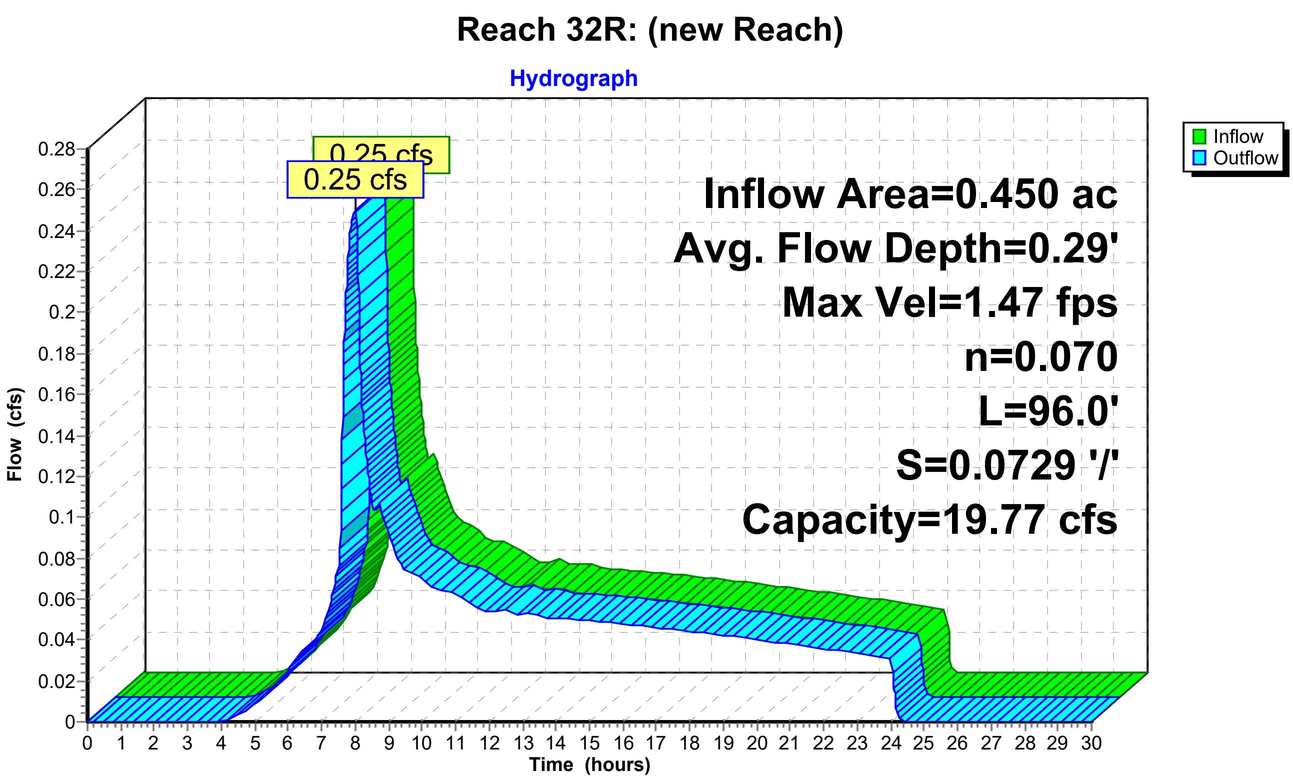
Inflow Area = 0.450 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.25 cfs @ 7.95 hrs, Volume= 0.086 af
Outflow = 0.25 cfs @ 7.98 hrs, Volume= 0.086 af, Atten= 0%, Lag= 1.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.47 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 0.94 fps, Avg. Travel Time= 1.7 min

Peak Storage= 16 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.29'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.77 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 96.0' Slope= 0.0729 '/'
Inlet Invert= 272.00', Outlet Invert= 265.00'





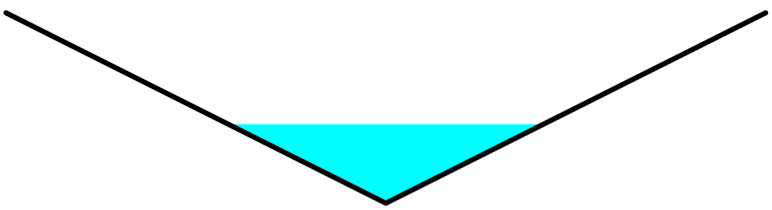
Summary for Reach 33R: (new Reach)

Inflow Area = 2.410 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.34 cfs @ 7.95 hrs, Volume= 0.460 af
Outflow = 1.31 cfs @ 8.14 hrs, Volume= 0.460 af, Atten= 2%, Lag= 11.5 min

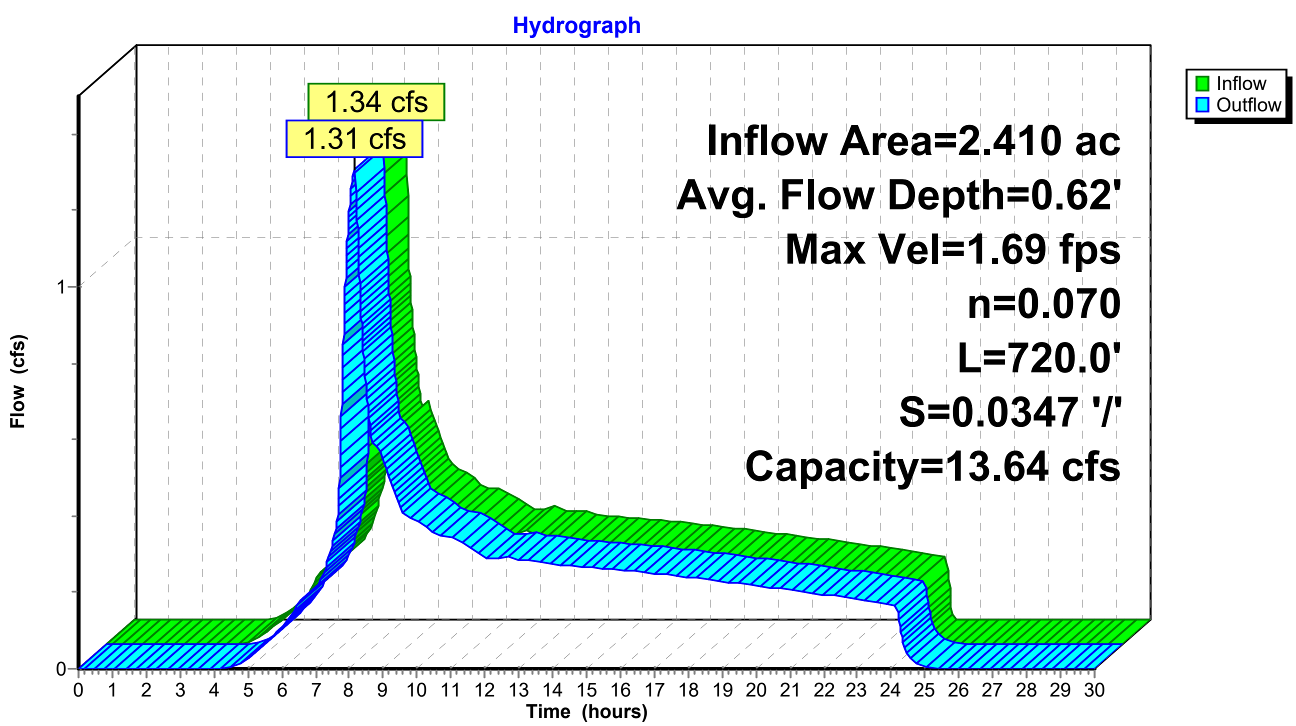
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.69 fps, Min. Travel Time= 7.1 min
Avg. Velocity = 0.91 fps, Avg. Travel Time= 13.1 min

Peak Storage= 558 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.62'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 13.64 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 720.0' Slope= 0.0347 '/'
Inlet Invert= 245.00', Outlet Invert= 220.00'



Reach 33R: (new Reach)



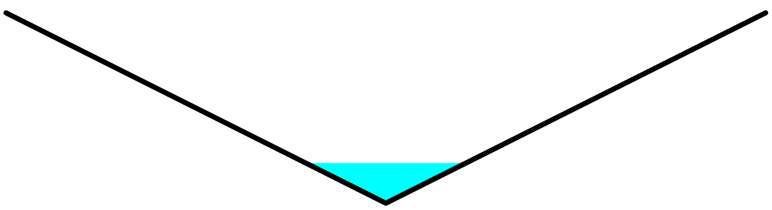
Summary for Reach 34R: (new Reach)

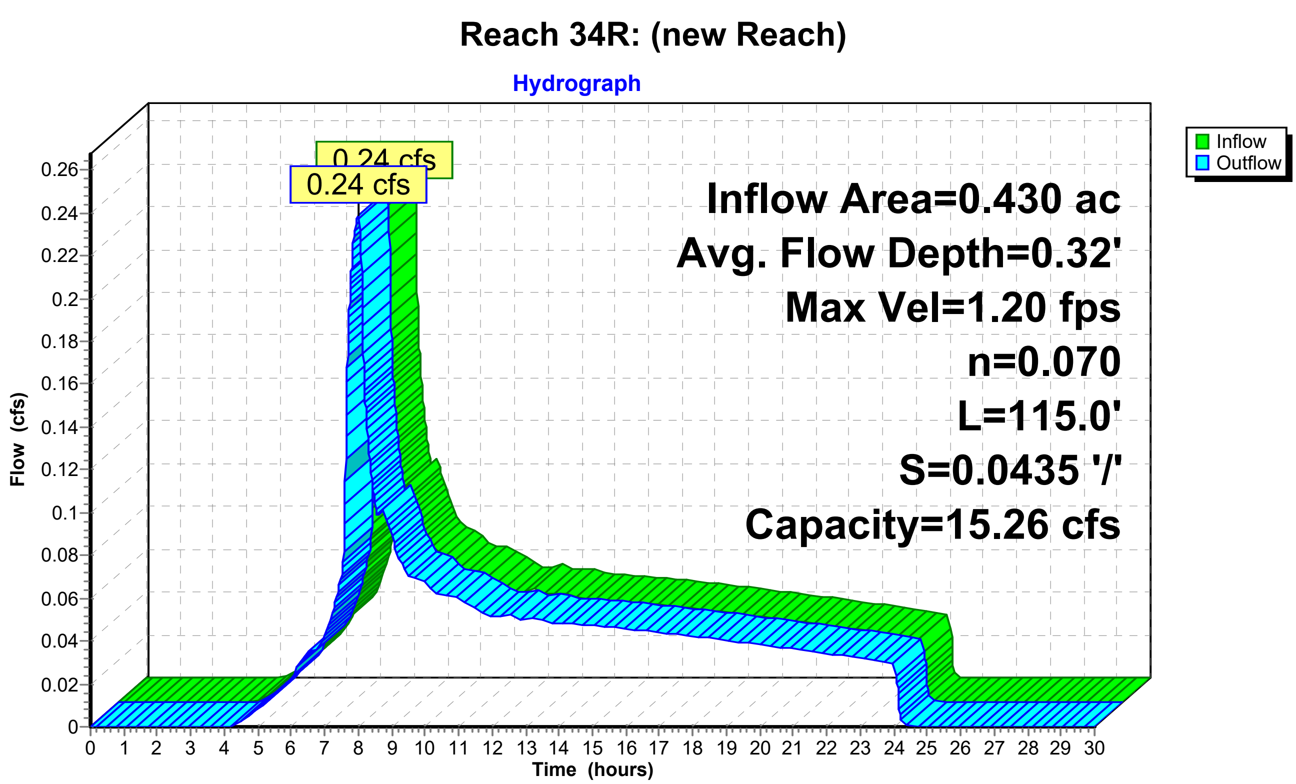
Inflow Area = 0.430 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.24 cfs @ 7.95 hrs, Volume= 0.082 af
Outflow = 0.24 cfs @ 8.00 hrs, Volume= 0.082 af, Atten= 0%, Lag= 2.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.20 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 2.5 min

Peak Storage= 23 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 15.26 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 115.0' Slope= 0.0435 '/'
Inlet Invert= 225.00', Outlet Invert= 220.00'





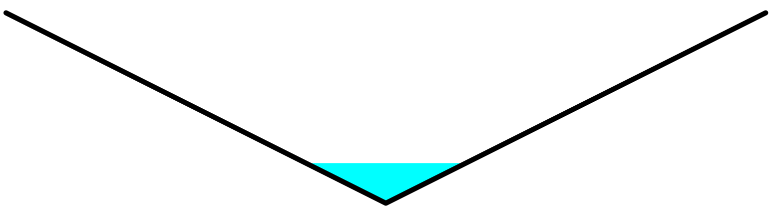
Summary for Reach 35R: (new Reach)

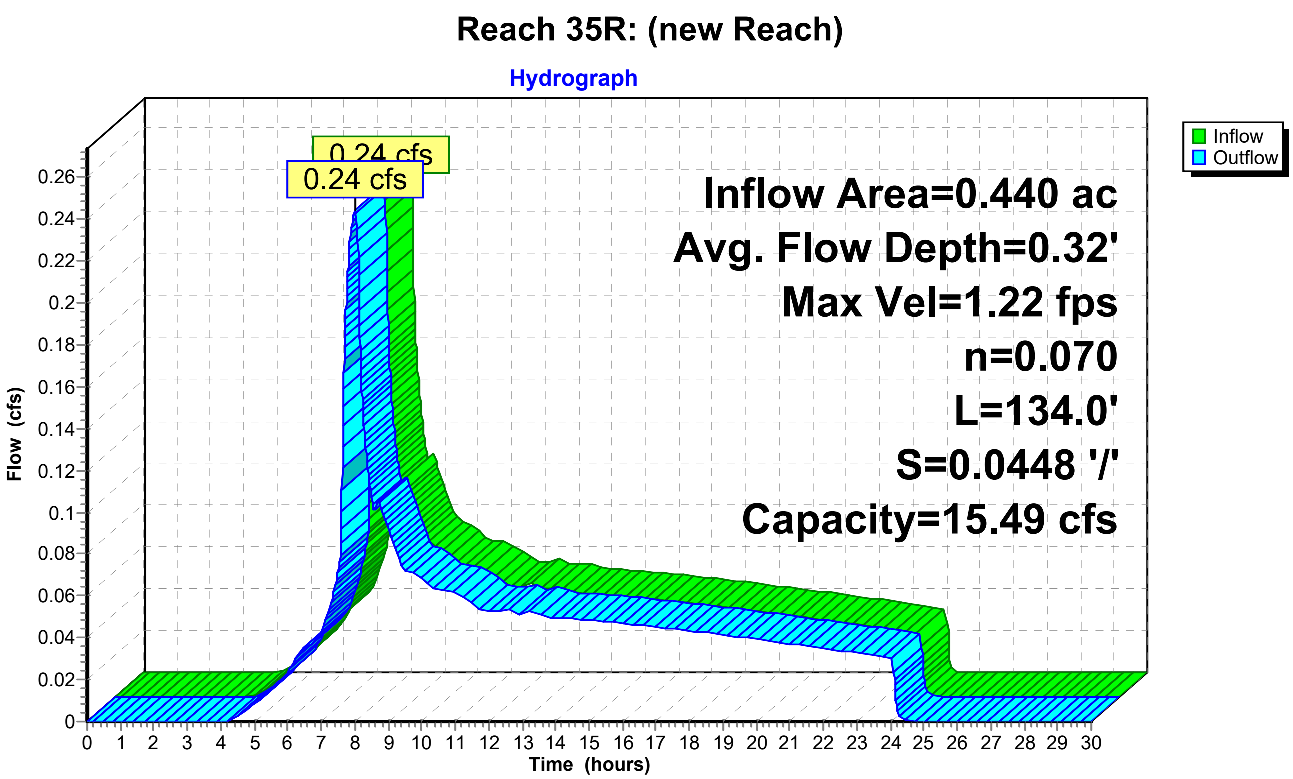
Inflow Area = 0.440 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.24 cfs @ 7.95 hrs, Volume= 0.084 af
Outflow = 0.24 cfs @ 8.00 hrs, Volume= 0.084 af, Atten= 0%, Lag= 3.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.22 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 0.77 fps, Avg. Travel Time= 2.9 min

Peak Storage= 27 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 15.49 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 134.0' Slope= 0.0448 '/'
Inlet Invert= 185.00', Outlet Invert= 179.00'





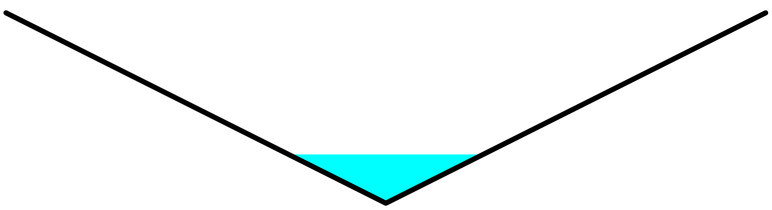
Summary for Reach 36R: (new Reach)

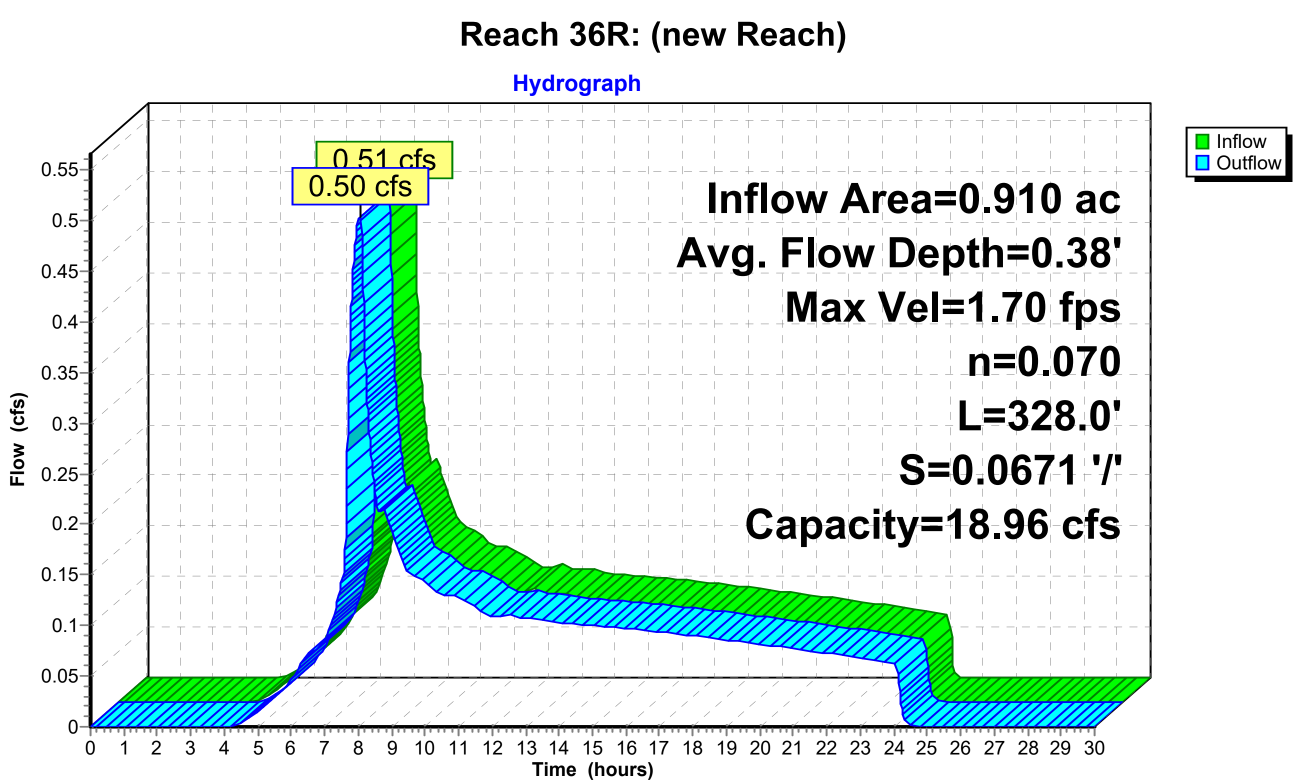
Inflow Area = 0.910 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.51 cfs @ 7.95 hrs, Volume= 0.174 af
Outflow = 0.50 cfs @ 8.04 hrs, Volume= 0.174 af, Atten= 0%, Lag= 5.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.70 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 1.04 fps, Avg. Travel Time= 5.2 min

Peak Storage= 97 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 18.96 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 328.0' Slope= 0.0671 '/'
Inlet Invert= 262.00', Outlet Invert= 240.00'





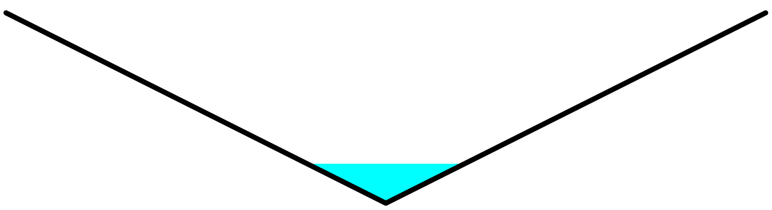
Summary for Reach 37R: (new Reach)

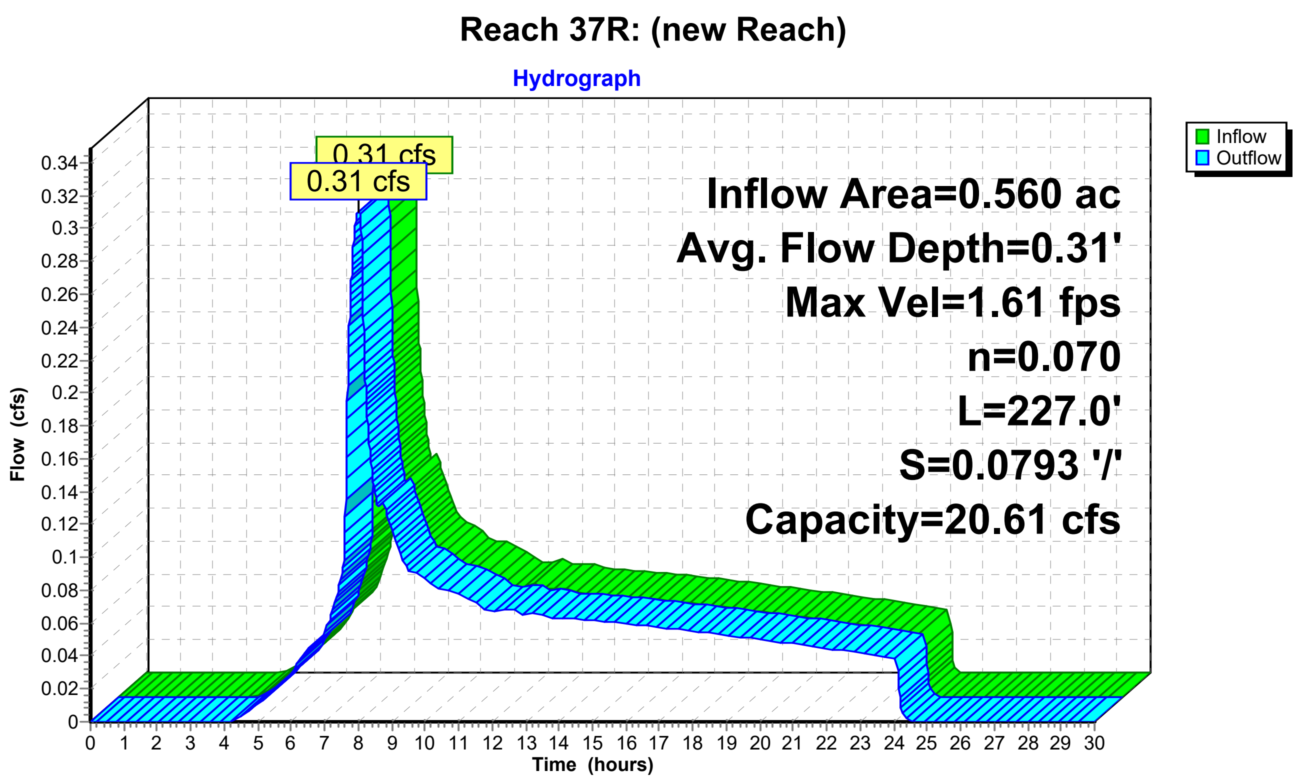
Inflow Area = 0.560 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.31 cfs @ 7.95 hrs, Volume= 0.107 af
Outflow = 0.31 cfs @ 8.02 hrs, Volume= 0.107 af, Atten= 0%, Lag= 4.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.61 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 1.01 fps, Avg. Travel Time= 3.8 min

Peak Storage= 44 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.31'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 20.61 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 227.0' Slope= 0.0793 '/'
Inlet Invert= 258.00', Outlet Invert= 240.00'





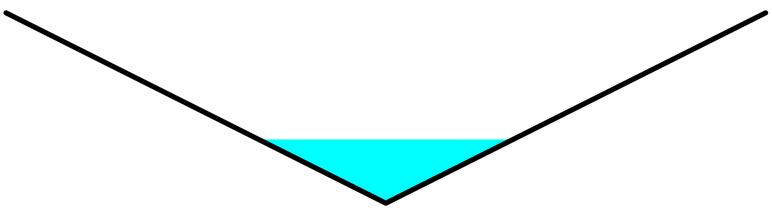
Summary for Reach 38R: (new Reach)

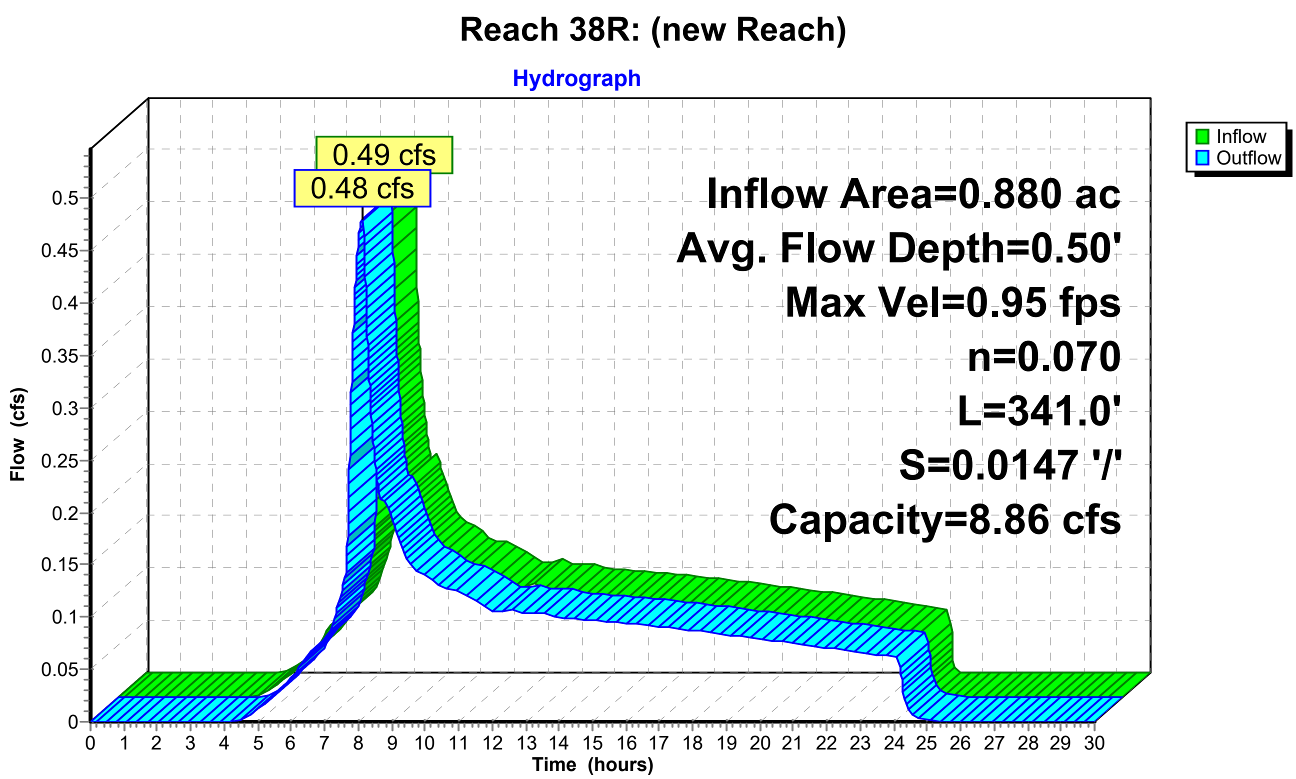
Inflow Area = 0.880 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.49 cfs @ 7.95 hrs, Volume= 0.168 af
Outflow = 0.48 cfs @ 8.12 hrs, Volume= 0.168 af, Atten= 2%, Lag= 10.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.95 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 0.54 fps, Avg. Travel Time= 10.5 min

Peak Storage= 172 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.50'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 8.86 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 341.0' Slope= 0.0147 '/'
Inlet Invert= 210.00', Outlet Invert= 205.00'





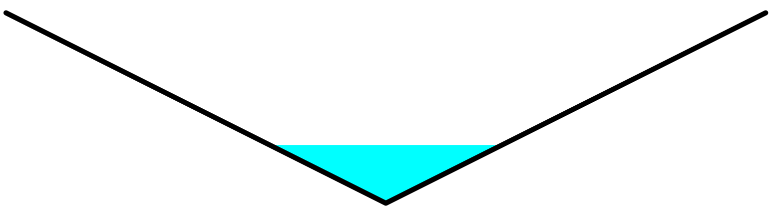
Summary for Reach 39R: (new Reach)

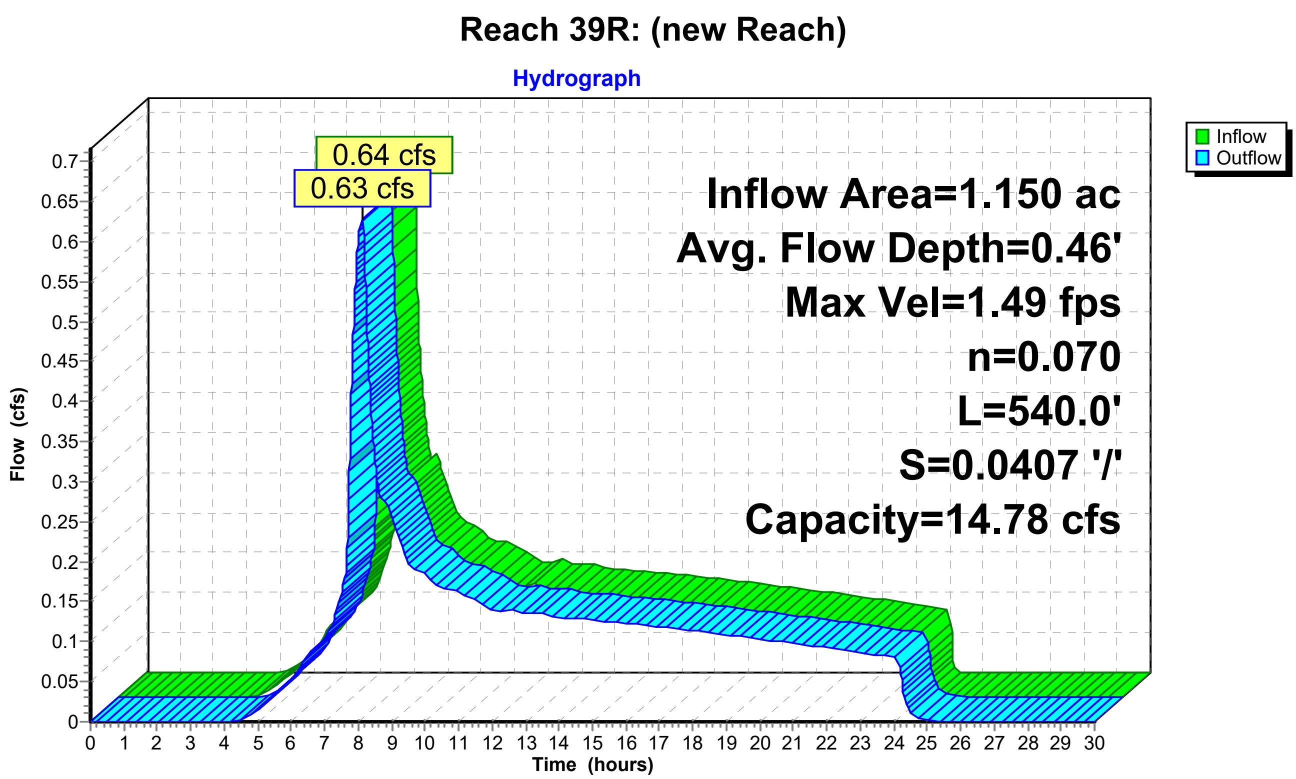
Inflow Area = 1.150 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.64 cfs @ 7.95 hrs, Volume= 0.220 af
Outflow = 0.63 cfs @ 8.12 hrs, Volume= 0.220 af, Atten= 2%, Lag= 10.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.49 fps, Min. Travel Time= 6.0 min
Avg. Velocity = 0.86 fps, Avg. Travel Time= 10.5 min

Peak Storage= 227 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 14.78 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 540.0' Slope= 0.0407 '/'
Inlet Invert= 224.00', Outlet Invert= 202.00'





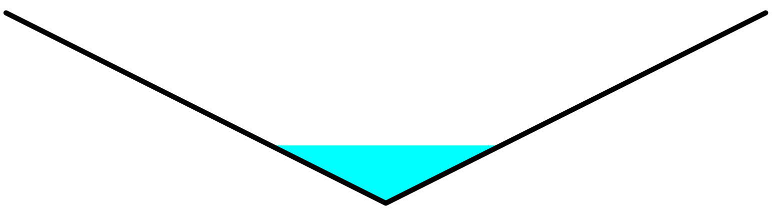
Summary for Reach 40R: (new Reach)

Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.80 cfs @ 7.95 hrs, Volume= 0.275 af
Outflow = 0.80 cfs @ 8.05 hrs, Volume= 0.275 af, Atten= 1%, Lag= 5.9 min

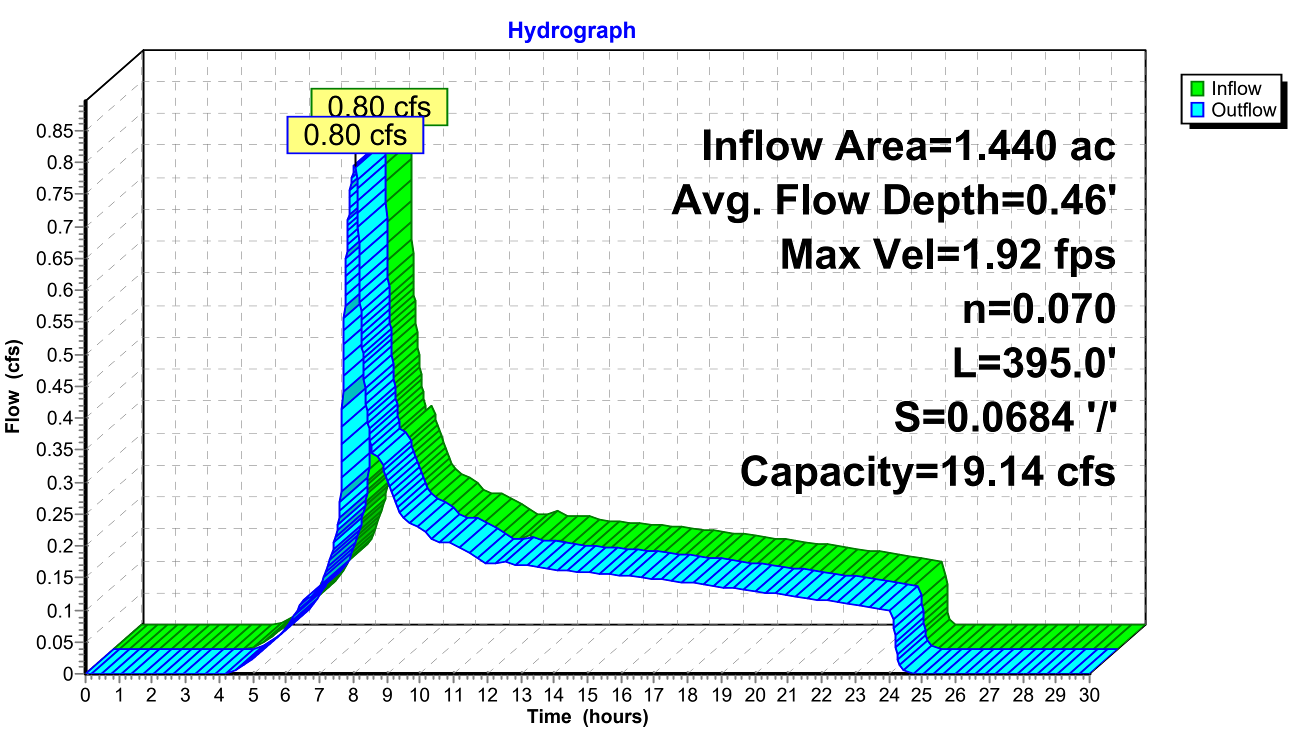
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.92 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 1.16 fps, Avg. Travel Time= 5.7 min

Peak Storage= 164 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.14 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 395.0' Slope= 0.0684 '/'
Inlet Invert= 265.00', Outlet Invert= 238.00'



Reach 40R: (new Reach)



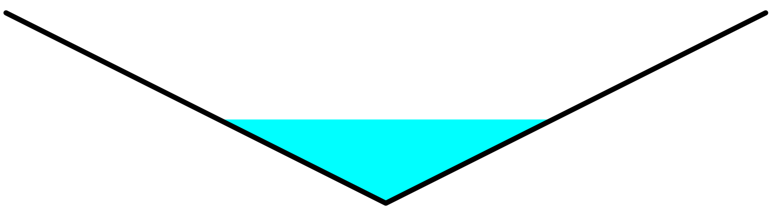
Summary for Reach 41R: (new Reach)

Inflow Area = 3.920 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.18 cfs @ 7.95 hrs, Volume= 0.749 af
Outflow = 2.16 cfs @ 8.08 hrs, Volume= 0.749 af, Atten= 1%, Lag= 7.8 min

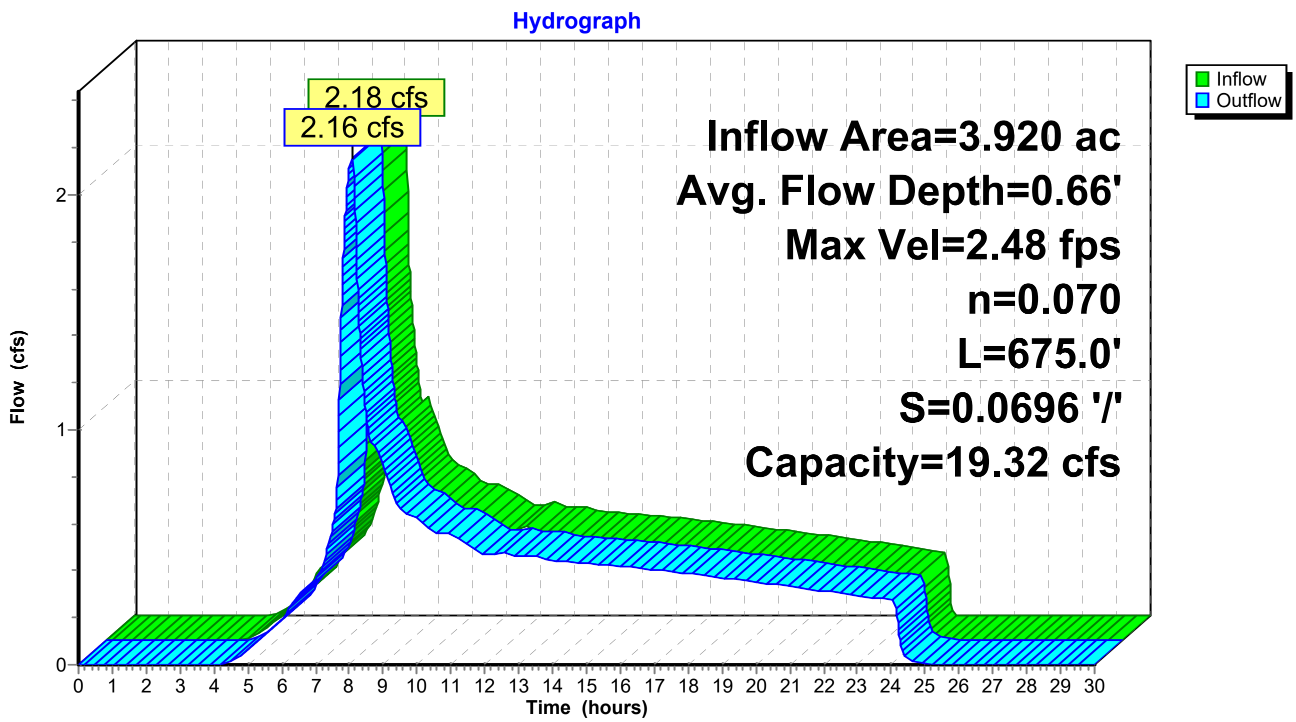
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.48 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 7.9 min

Peak Storage= 587 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.32 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 675.0' Slope= 0.0696 '/'
Inlet Invert= 278.00', Outlet Invert= 231.00'



Reach 41R: (new Reach)



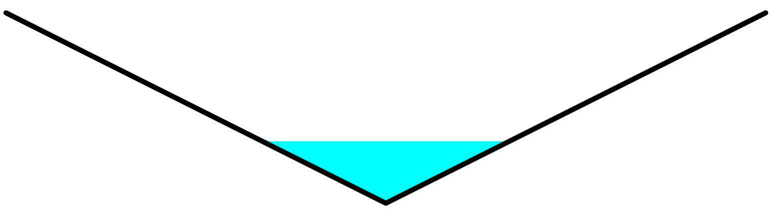
Summary for Reach 42R: (new Reach)

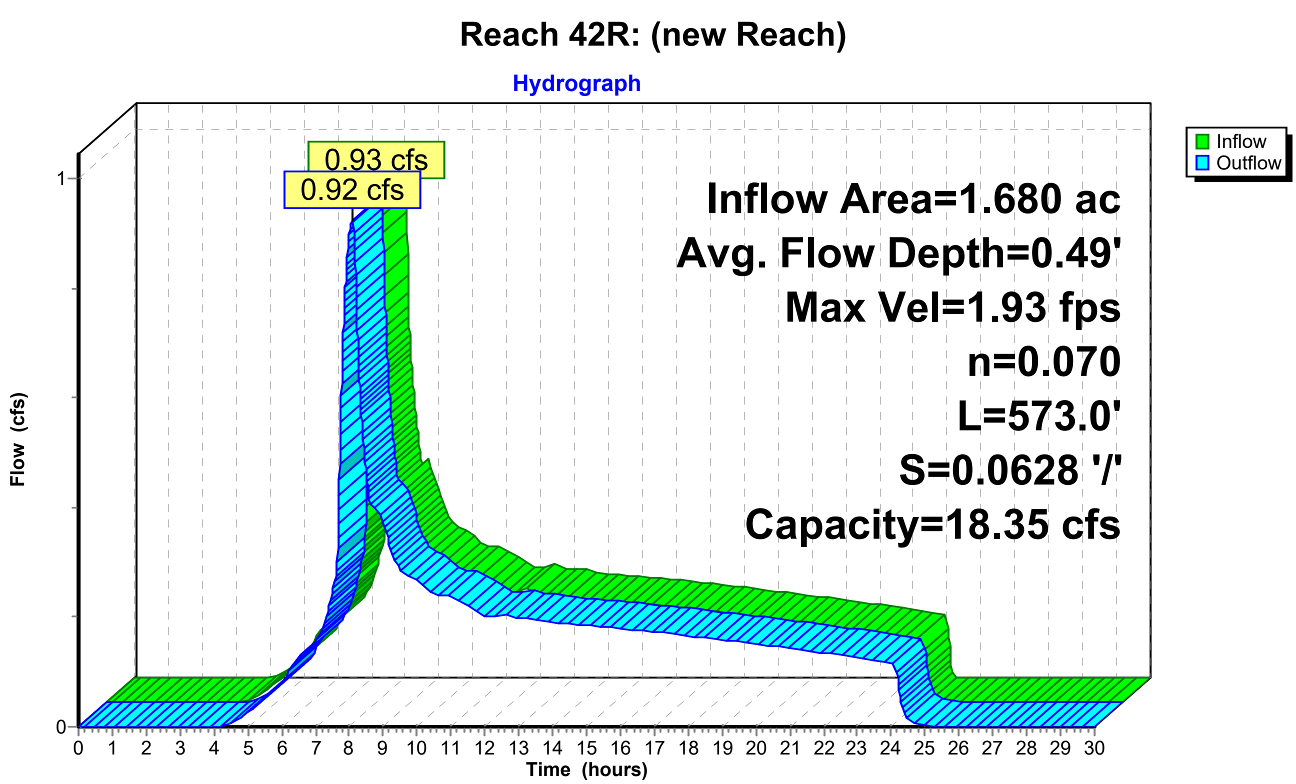
Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.93 cfs @ 7.95 hrs, Volume= 0.321 af
Outflow = 0.92 cfs @ 8.09 hrs, Volume= 0.321 af, Atten= 1%, Lag= 8.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.93 fps, Min. Travel Time= 4.9 min
Avg. Velocity = 1.13 fps, Avg. Travel Time= 8.5 min

Peak Storage= 274 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 18.35 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 573.0' Slope= 0.0628 '/'
Inlet Invert= 228.00', Outlet Invert= 192.00'





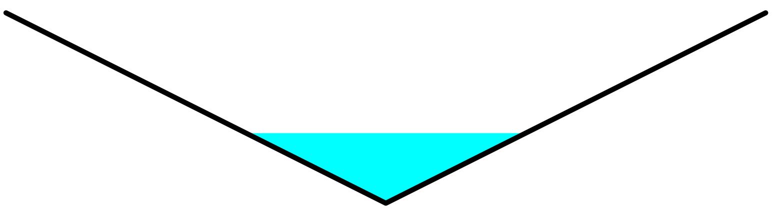
Summary for Reach 43R: (new Reach)

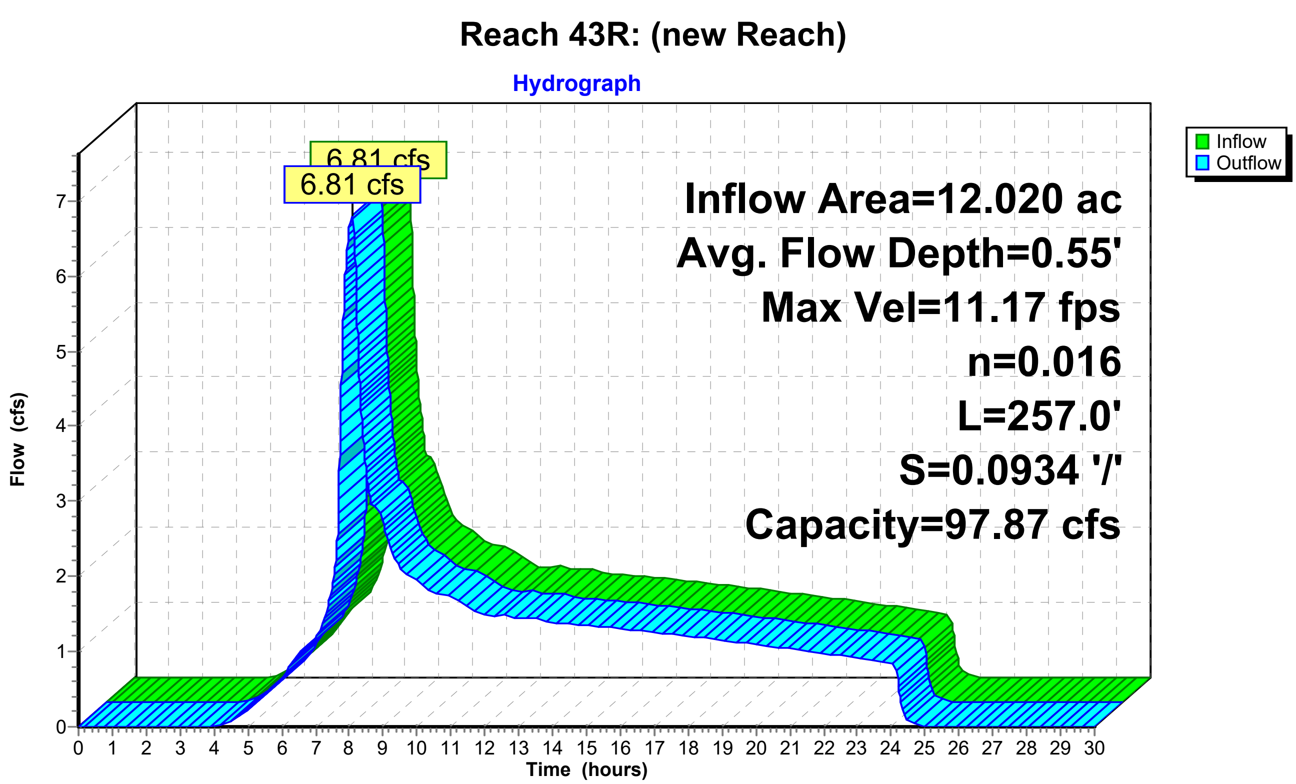
Inflow Area = 12.020 ac, 4.16% Impervious, Inflow Depth = 2.36" for 25-year event
Inflow = 6.81 cfs @ 8.05 hrs, Volume= 2.361 af
Outflow = 6.81 cfs @ 8.06 hrs, Volume= 2.361 af, Atten= 0%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.17 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 6.41 fps, Avg. Travel Time= 0.7 min

Peak Storage= 157 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.55'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 97.87 cfs

0.00' x 1.50' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 257.0' Slope= 0.0934 '/'
Inlet Invert= 174.00', Outlet Invert= 150.00'





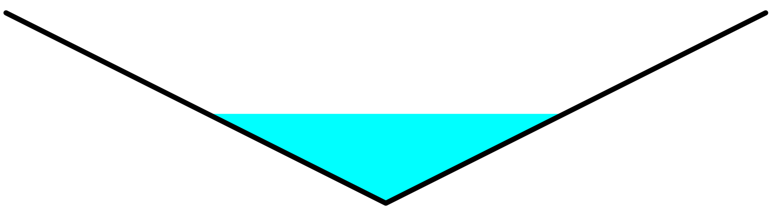
Summary for Reach 44R: (new Reach)

Inflow Area = 2.170 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.21 cfs @ 7.95 hrs, Volume= 0.414 af
Outflow = 1.20 cfs @ 8.06 hrs, Volume= 0.414 af, Atten= 1%, Lag= 6.4 min

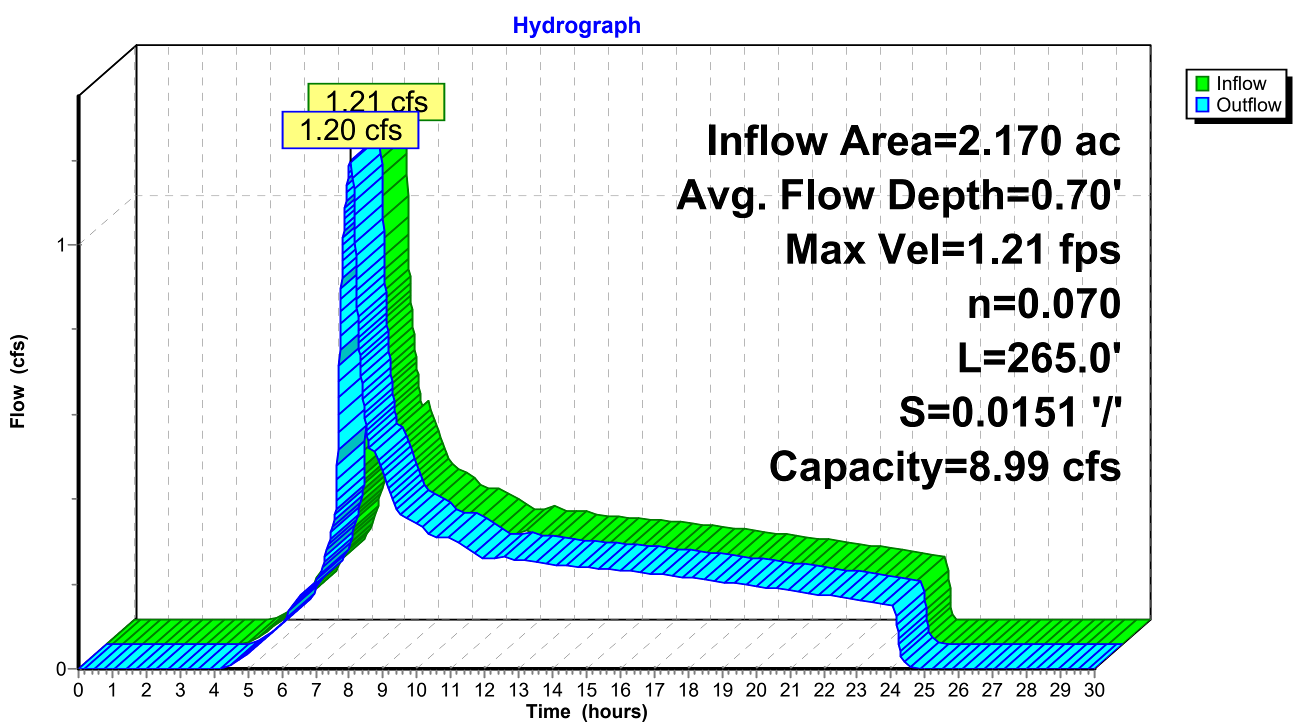
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.21 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 6.3 min

Peak Storage= 263 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.70'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 8.99 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 265.0' Slope= 0.0151 '/'
Inlet Invert= 271.00', Outlet Invert= 267.00'



Reach 44R: (new Reach)



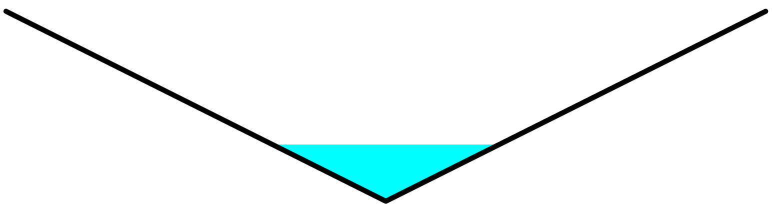
Summary for Reach 45R: (new Reach)

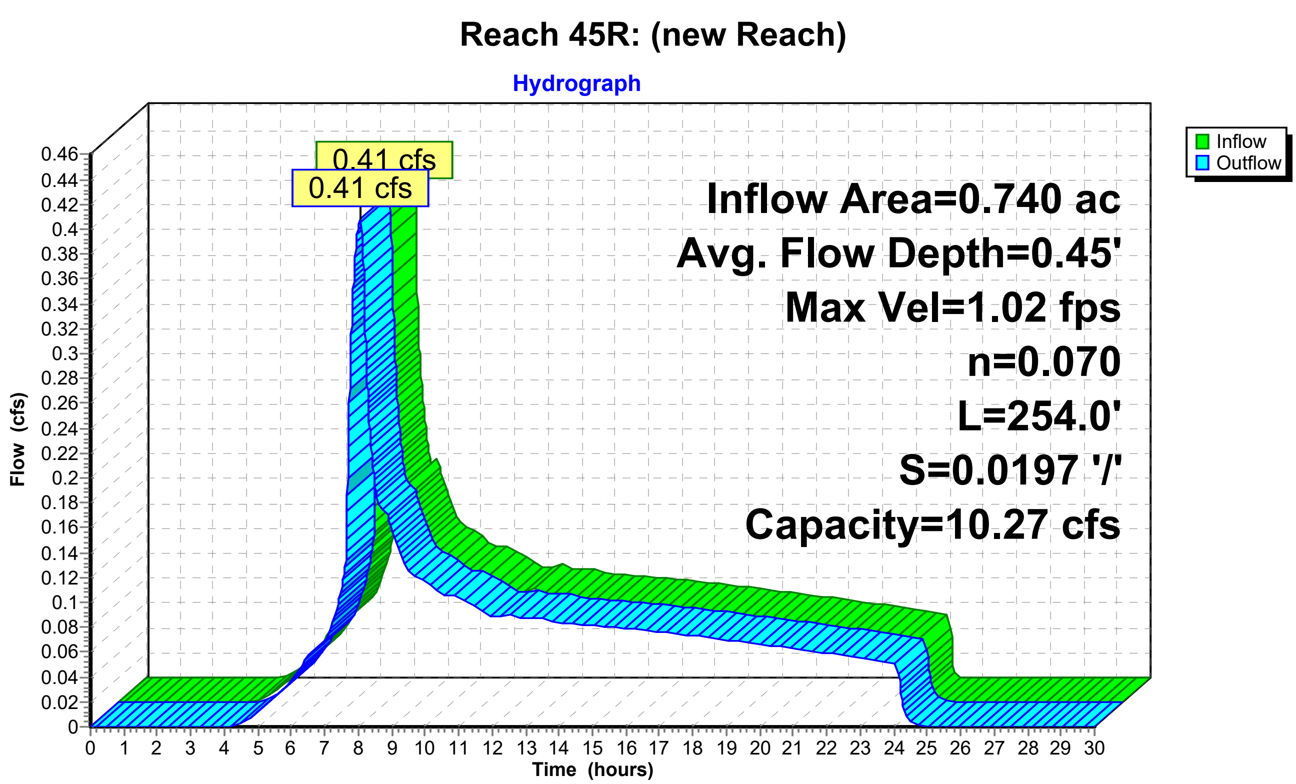
Inflow Area = 0.740 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.41 cfs @ 7.95 hrs, Volume= 0.141 af
Outflow = 0.41 cfs @ 8.07 hrs, Volume= 0.141 af, Atten= 1%, Lag= 7.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.02 fps, Min. Travel Time= 4.2 min
Avg. Velocity = 0.61 fps, Avg. Travel Time= 7.0 min

Peak Storage= 102 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 10.27 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 254.0' Slope= 0.0197 '/'
Inlet Invert= 262.00', Outlet Invert= 257.00'





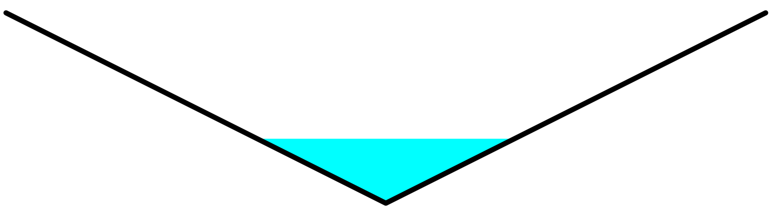
Summary for Reach 46R: (new Reach)

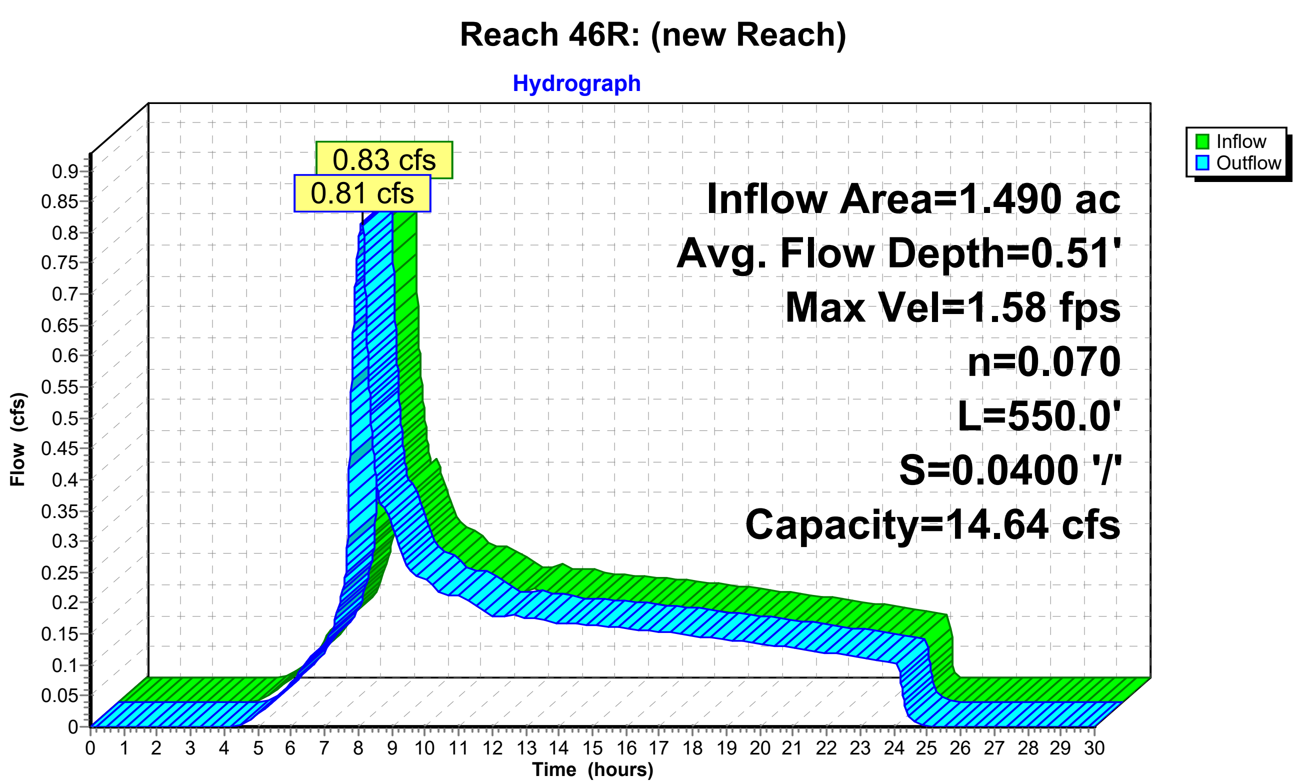
Inflow Area = 1.490 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.83 cfs @ 7.95 hrs, Volume= 0.285 af
Outflow = 0.81 cfs @ 8.11 hrs, Volume= 0.285 af, Atten= 2%, Lag= 9.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.58 fps, Min. Travel Time= 5.8 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 10.2 min

Peak Storage= 284 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.51'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 14.64 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 550.0' Slope= 0.0400 '/'
Inlet Invert= 212.00', Outlet Invert= 190.00'





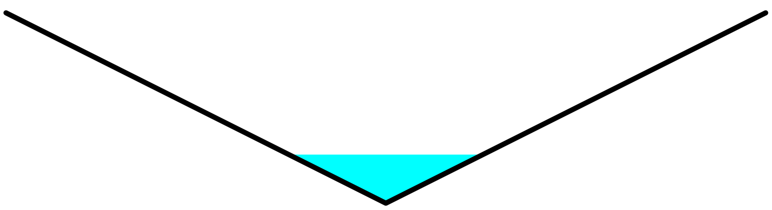
Summary for Reach 47R: (new Reach)

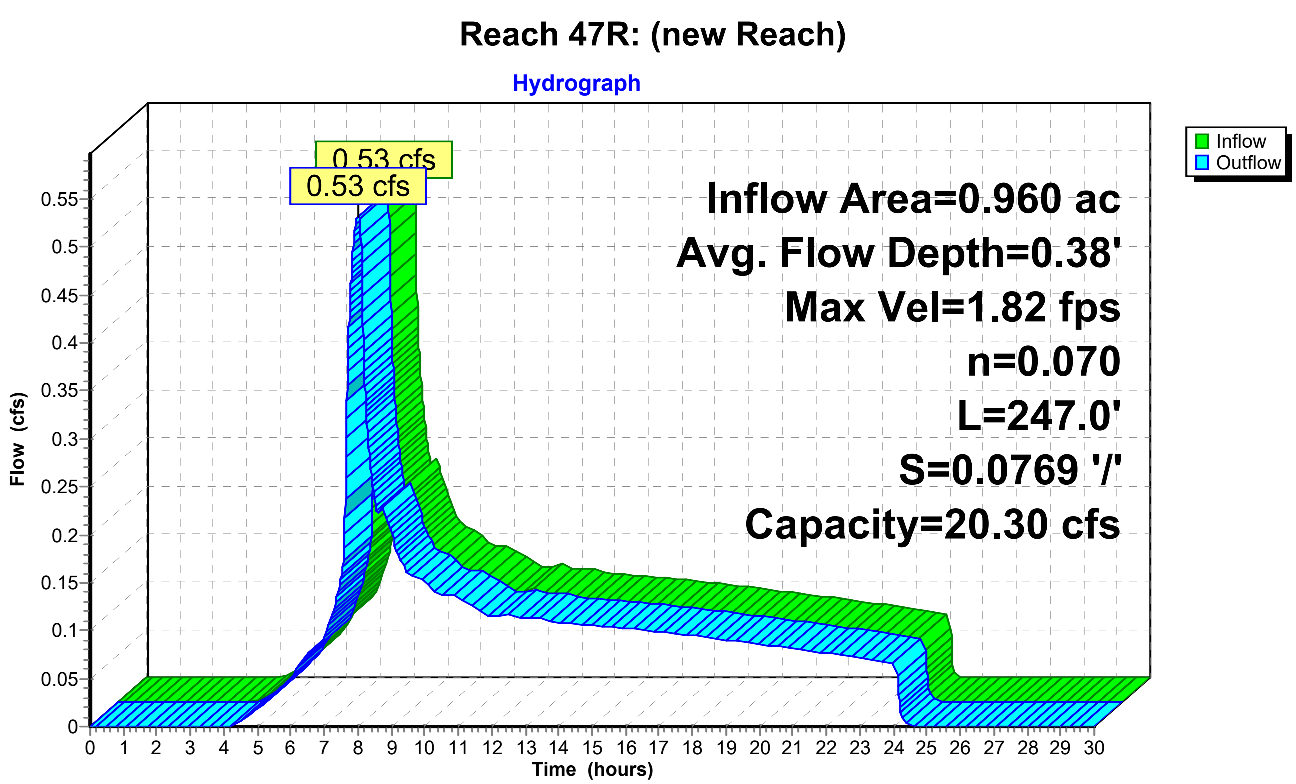
Inflow Area = 0.960 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.53 cfs @ 7.95 hrs, Volume= 0.183 af
Outflow = 0.53 cfs @ 8.02 hrs, Volume= 0.183 af, Atten= 0%, Lag= 3.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.82 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.13 fps, Avg. Travel Time= 3.6 min

Peak Storage= 72 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 20.30 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 247.0' Slope= 0.0769 '/'
Inlet Invert= 229.00', Outlet Invert= 210.00'





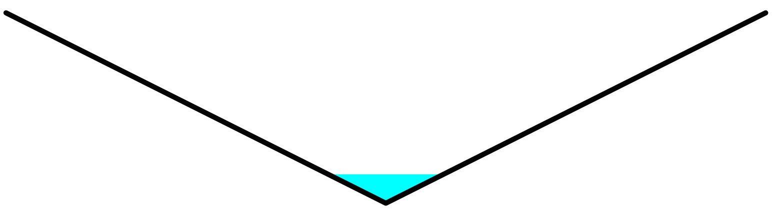
Summary for Reach 48R: (new Reach)

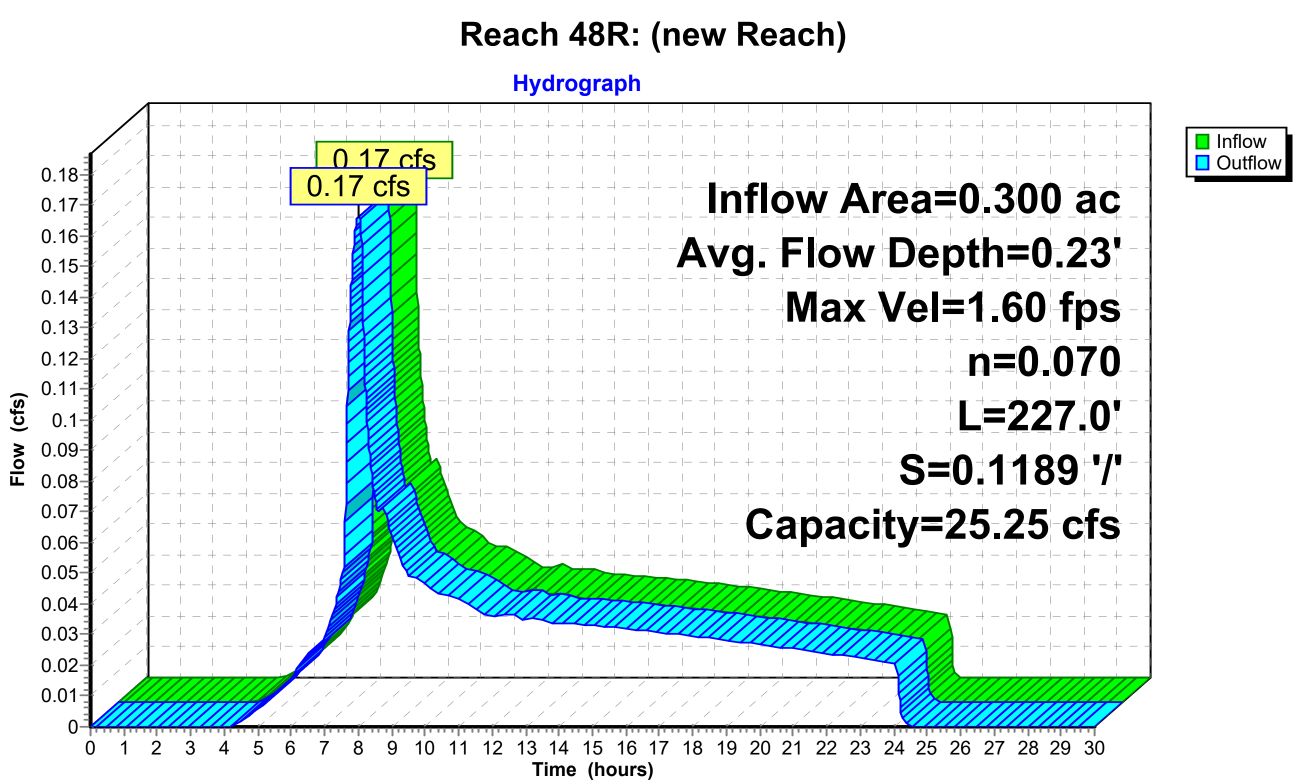
Inflow Area = 0.300 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.17 cfs @ 7.95 hrs, Volume= 0.057 af
Outflow = 0.17 cfs @ 8.02 hrs, Volume= 0.057 af, Atten= 0%, Lag= 4.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.60 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 3.7 min

Peak Storage= 24 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 25.25 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 227.0' Slope= 0.1189 '/'
Inlet Invert= 185.00', Outlet Invert= 158.00'





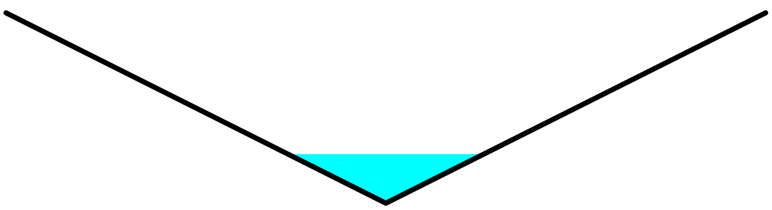
Summary for Reach 50R: (new Reach)

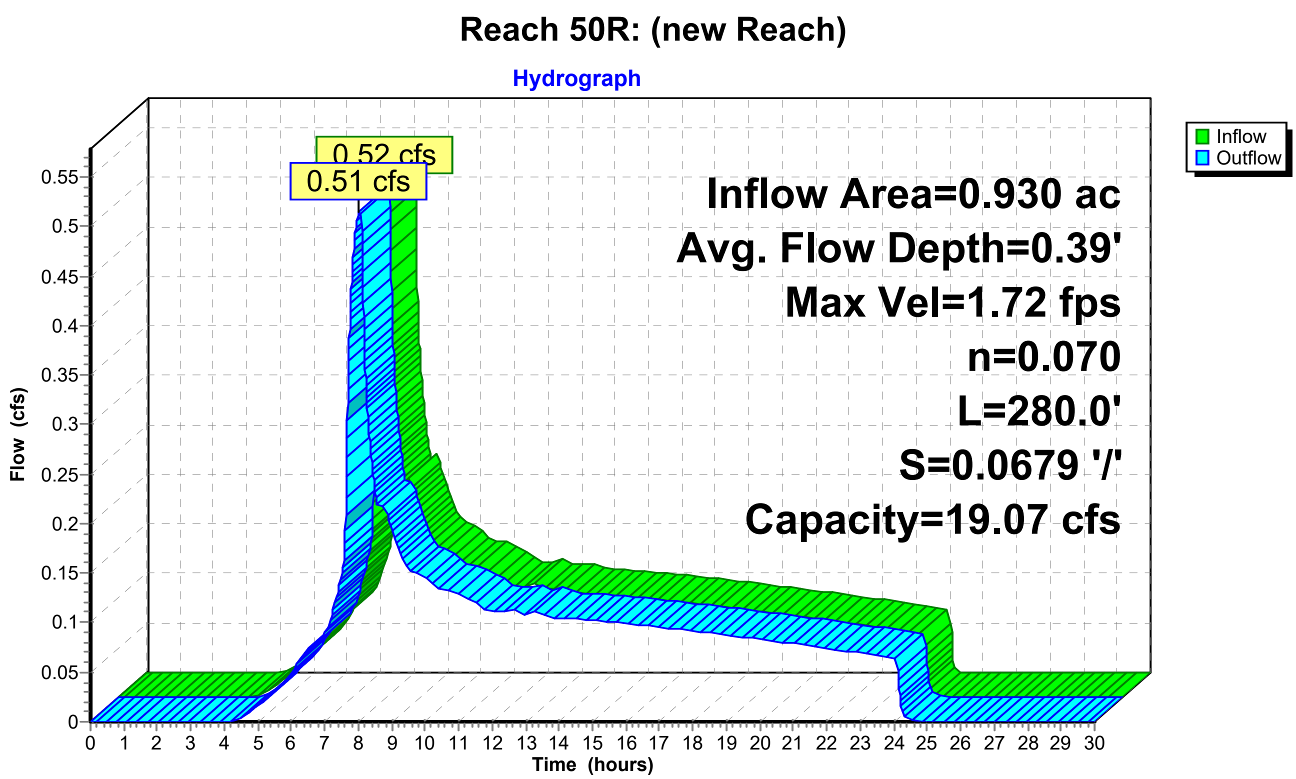
Inflow Area = 0.930 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.52 cfs @ 7.95 hrs, Volume= 0.178 af
Outflow = 0.51 cfs @ 8.03 hrs, Volume= 0.178 af, Atten= 0%, Lag= 4.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.72 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 4.4 min

Peak Storage= 84 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.07 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 280.0' Slope= 0.0679 '/'
Inlet Invert= 174.00', Outlet Invert= 155.00'





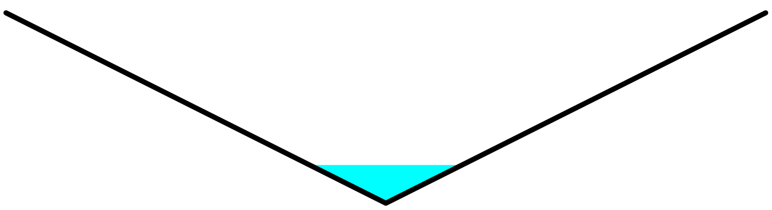
Summary for Reach 51R: (new Reach)

Inflow Area = 0.560 ac, 23.21% Impervious, Inflow Depth = 2.64" for 25-year event
Inflow = 0.37 cfs @ 7.93 hrs, Volume= 0.123 af
Outflow = 0.37 cfs @ 7.96 hrs, Volume= 0.123 af, Atten= 0%, Lag= 2.1 min

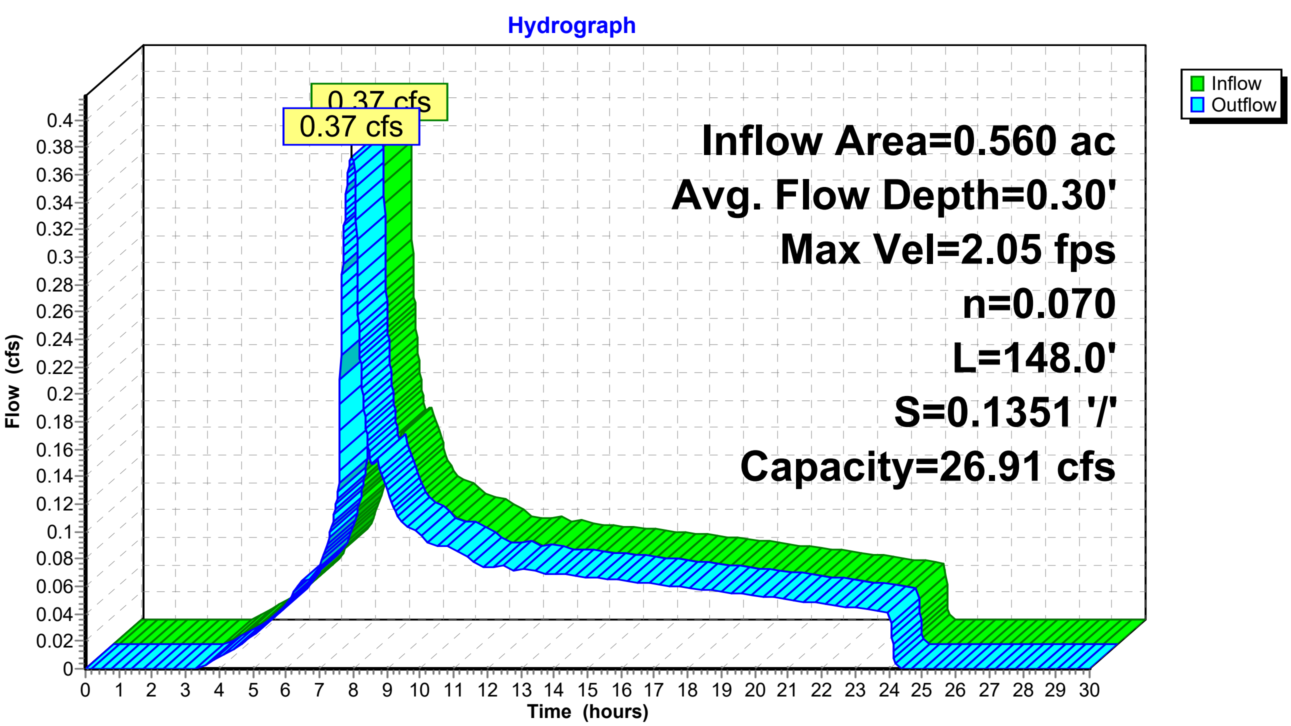
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.05 fps, Min. Travel Time= 1.2 min
Avg. Velocity = 1.28 fps, Avg. Travel Time= 1.9 min

Peak Storage= 27 cf @ 7.94 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 26.91 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 148.0' Slope= 0.1351 '/'
Inlet Invert= 170.00', Outlet Invert= 150.00'



Reach 51R: (new Reach)



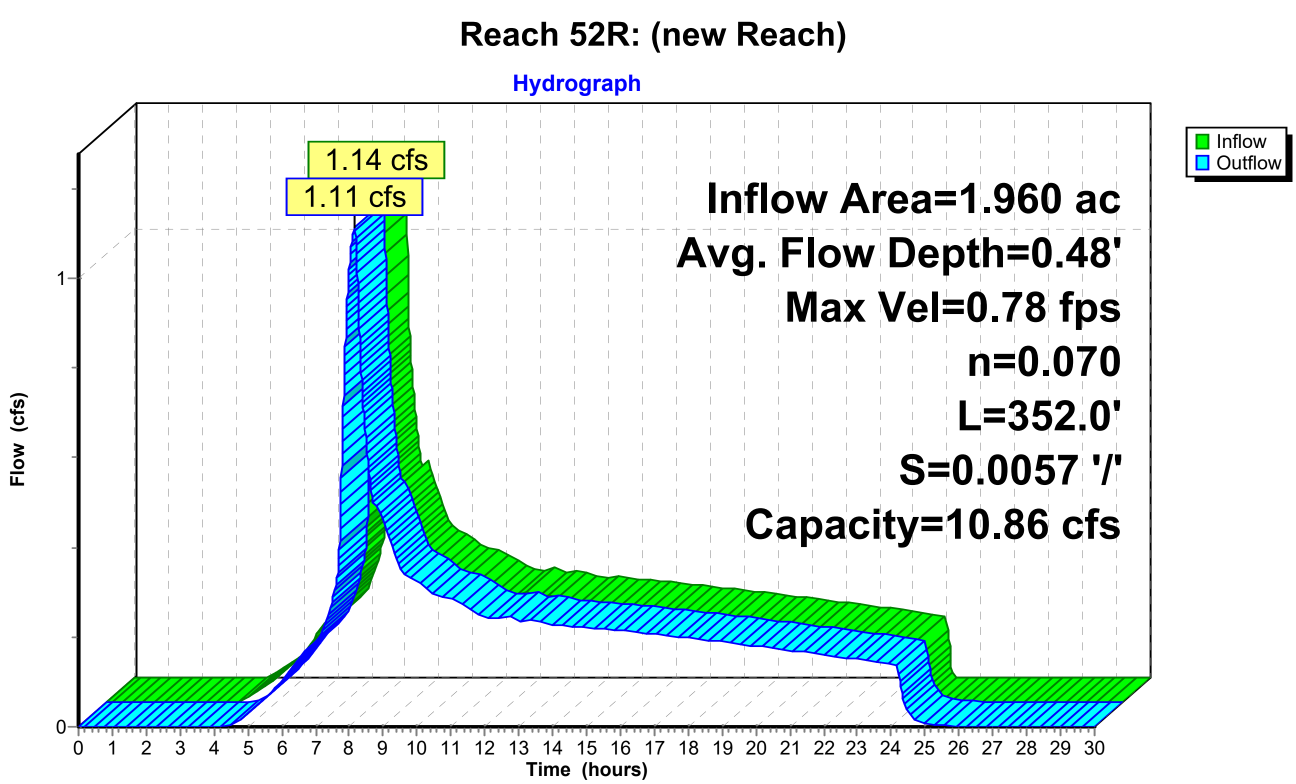
Summary for Reach 52R: (new Reach)

Inflow Area = 1.960 ac, 7.65% Impervious, Inflow Depth = 2.38" for 25-year event
Inflow = 1.14 cfs @ 7.95 hrs, Volume= 0.388 af
Outflow = 1.11 cfs @ 8.15 hrs, Volume= 0.388 af, Atten= 2%, Lag= 12.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.78 fps, Min. Travel Time= 7.5 min
Avg. Velocity = 0.38 fps, Avg. Travel Time= 15.4 min

Peak Storage= 501 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.48'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 10.86 cfs

2.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 352.0' Slope= 0.0057 '/'
Inlet Invert= 130.00', Outlet Invert= 128.00'



Summary for Reach 53R: (new Reach)

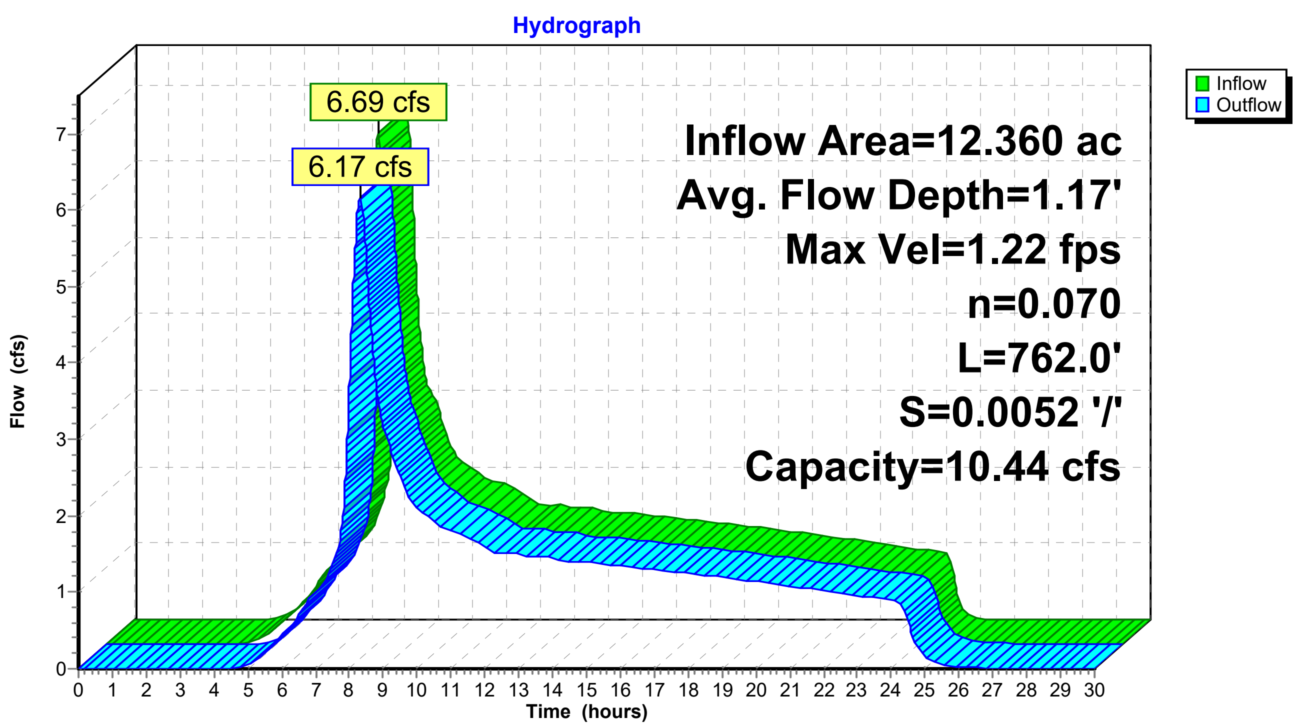
Inflow Area = 12.360 ac, 2.67% Impervious, Inflow Depth = 2.32" for 25-year event
Inflow = 6.69 cfs @ 8.03 hrs, Volume= 2.393 af
Outflow = 6.17 cfs @ 8.33 hrs, Volume= 2.392 af, Atten= 8%, Lag= 17.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.22 fps, Min. Travel Time= 10.5 min
Avg. Velocity = 0.64 fps, Avg. Travel Time= 19.9 min

Peak Storage= 3,870 cf @ 8.15 hrs
Average Depth at Peak Storage= 1.17'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 10.44 cfs

2.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 762.0' Slope= 0.0052 '/'
Inlet Invert= 128.00', Outlet Invert= 124.00'

Reach 53R: (new Reach)



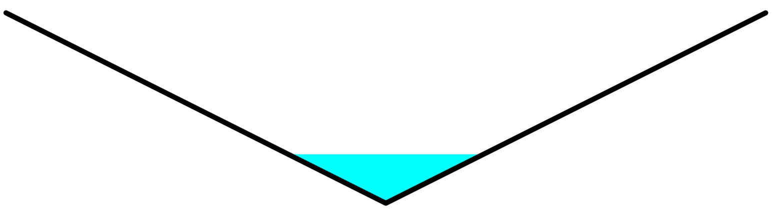
Summary for Reach 55R: (new Reach)

Inflow Area = 0.830 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.46 cfs @ 7.95 hrs, Volume= 0.159 af
Outflow = 0.46 cfs @ 8.01 hrs, Volume= 0.159 af, Atten= 0%, Lag= 3.3 min

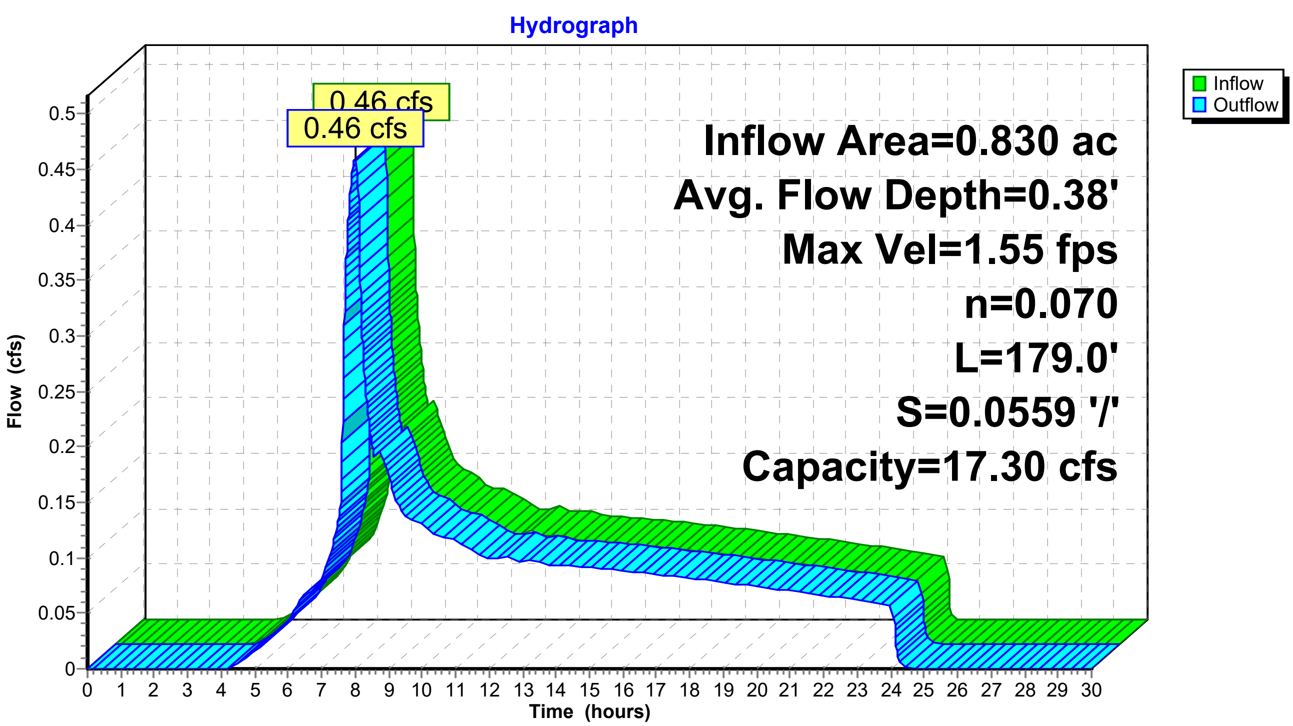
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.55 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 0.97 fps, Avg. Travel Time= 3.1 min

Peak Storage= 53 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 17.30 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 179.0' Slope= 0.0559 '/'
Inlet Invert= 250.00', Outlet Invert= 240.00'



Reach 55R: (new Reach)

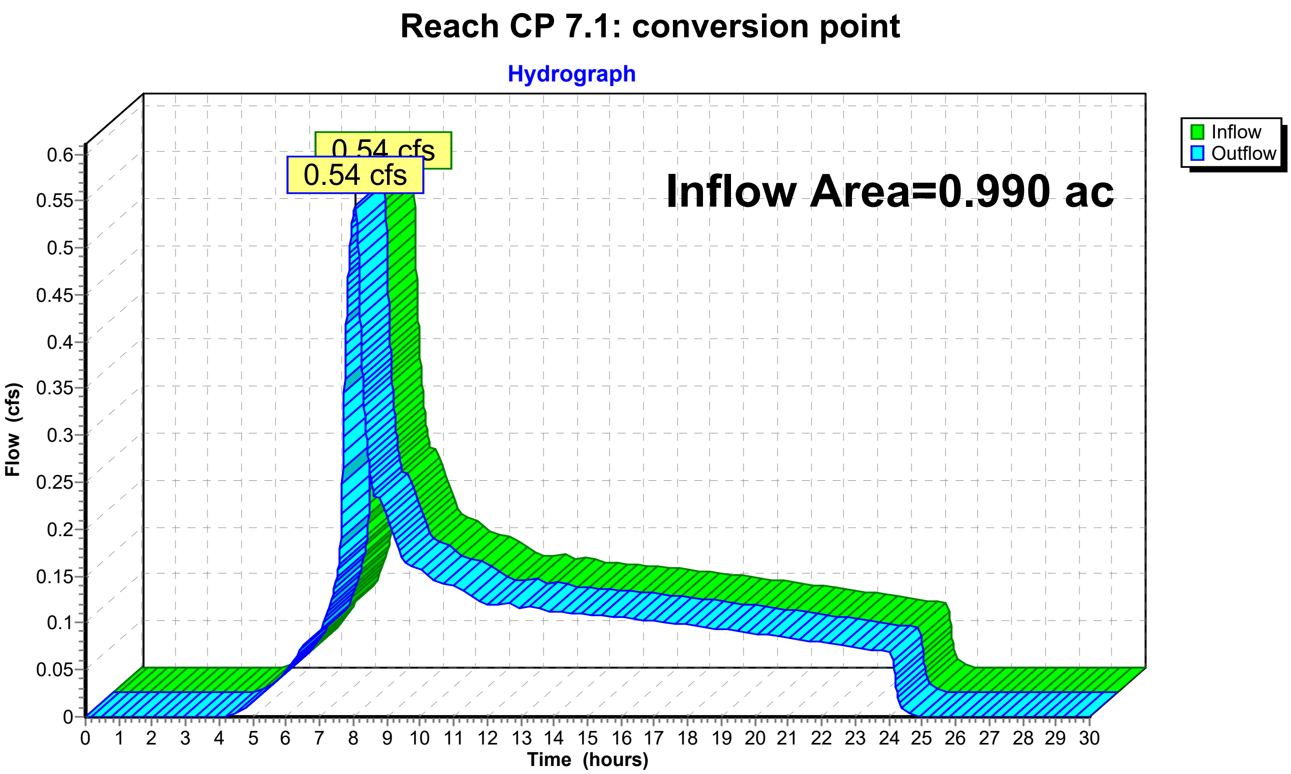


Summary for Reach CP 7.1: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	0.990 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	0.54 cfs @	8.07 hrs,	Volume=	0.189 af	
Outflow =	0.54 cfs @	8.07 hrs,	Volume=	0.189 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

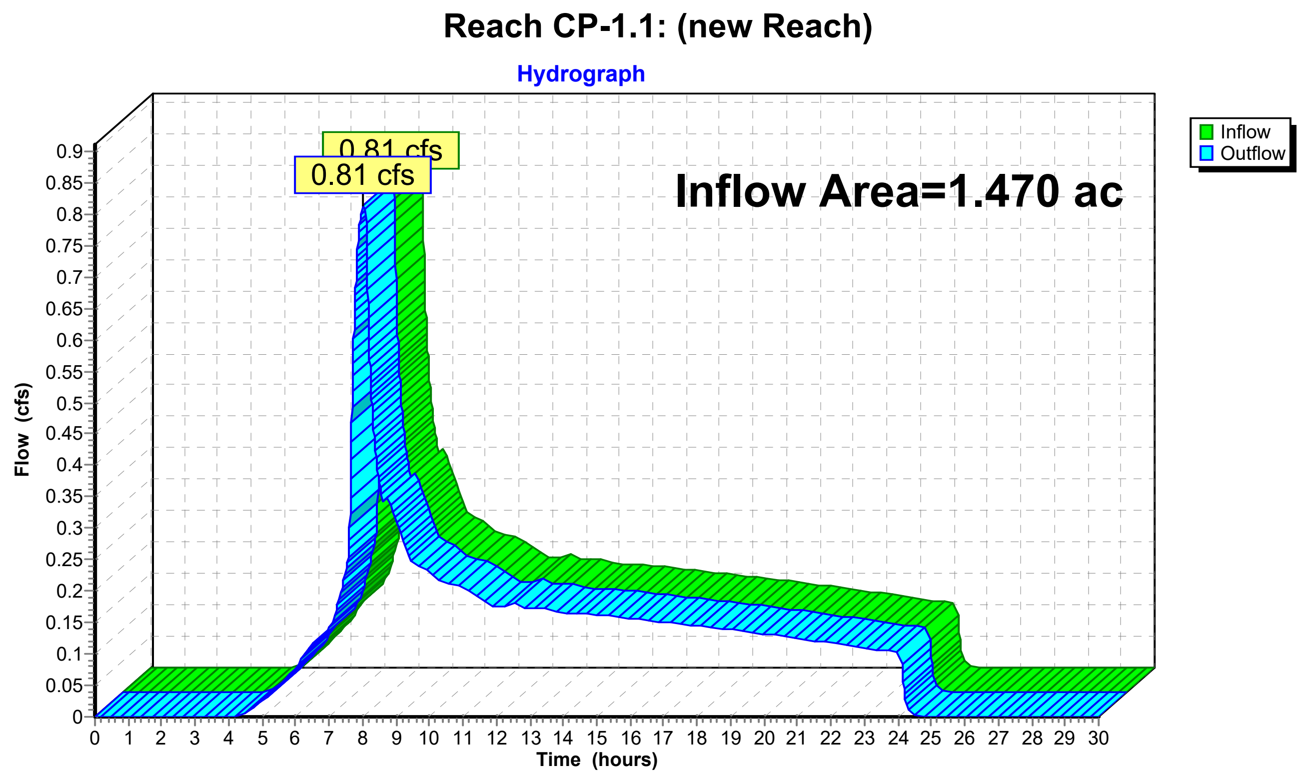


Summary for Reach CP-1.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.81 cfs @ 8.04 hrs, Volume= 0.281 af
Outflow = 0.81 cfs @ 8.04 hrs, Volume= 0.281 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

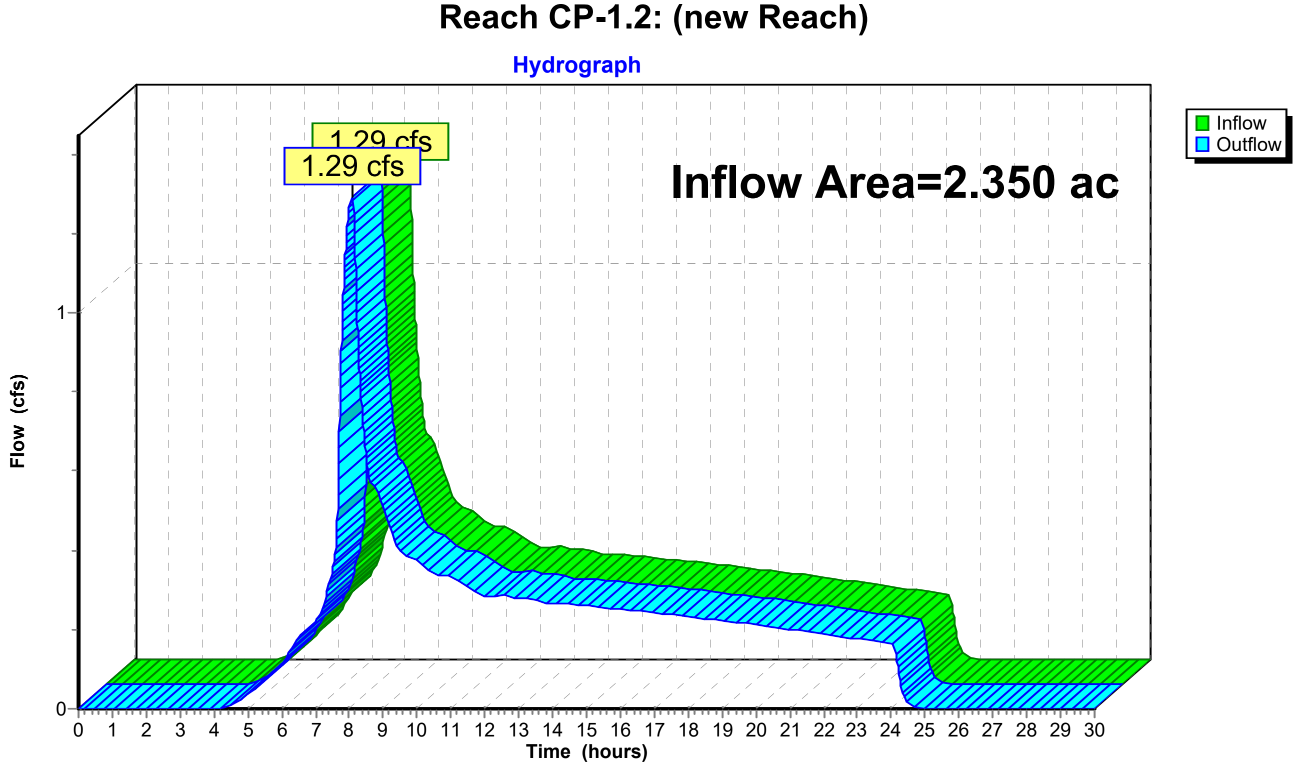


Summary for Reach CP-1.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	2.350 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	1.29 cfs @	8.07 hrs,	Volume=	0.449 af	
Outflow =	1.29 cfs @	8.07 hrs,	Volume=	0.449 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



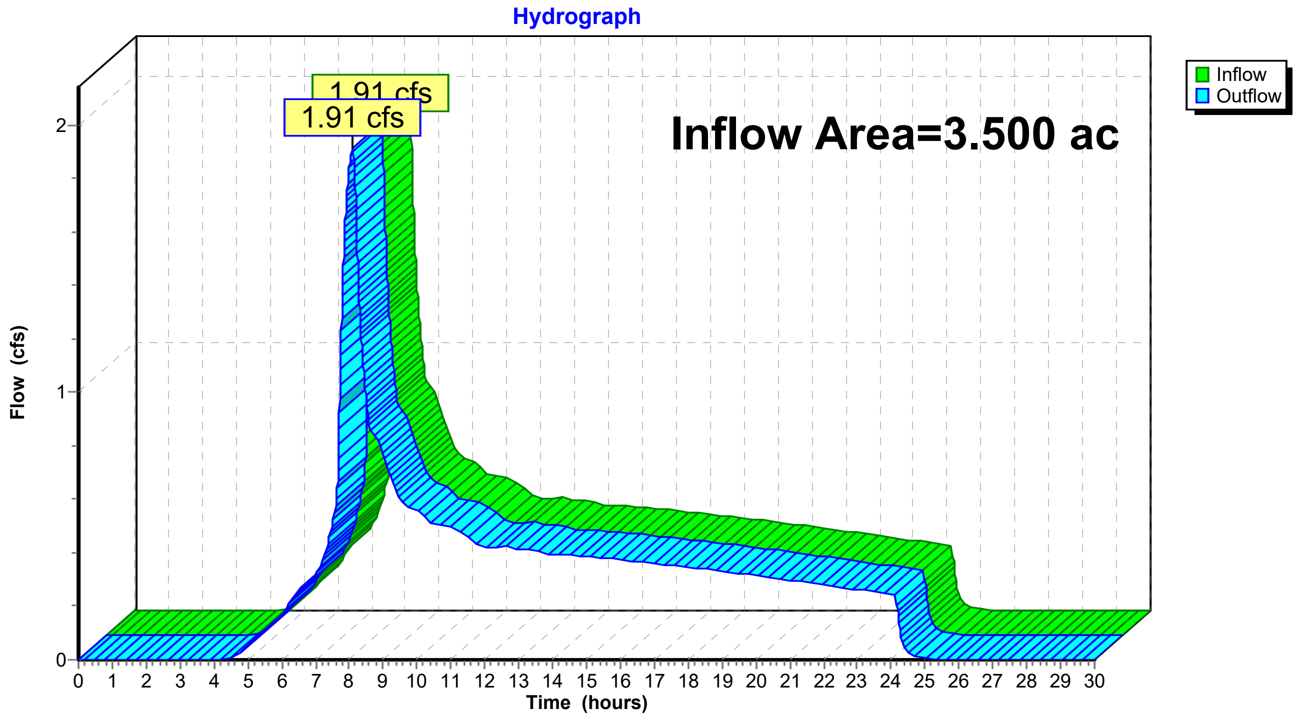
Summary for Reach CP-1.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.91 cfs @ 8.09 hrs, Volume= 0.669 af
Outflow = 1.91 cfs @ 8.09 hrs, Volume= 0.669 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-1.3: (new Reach)

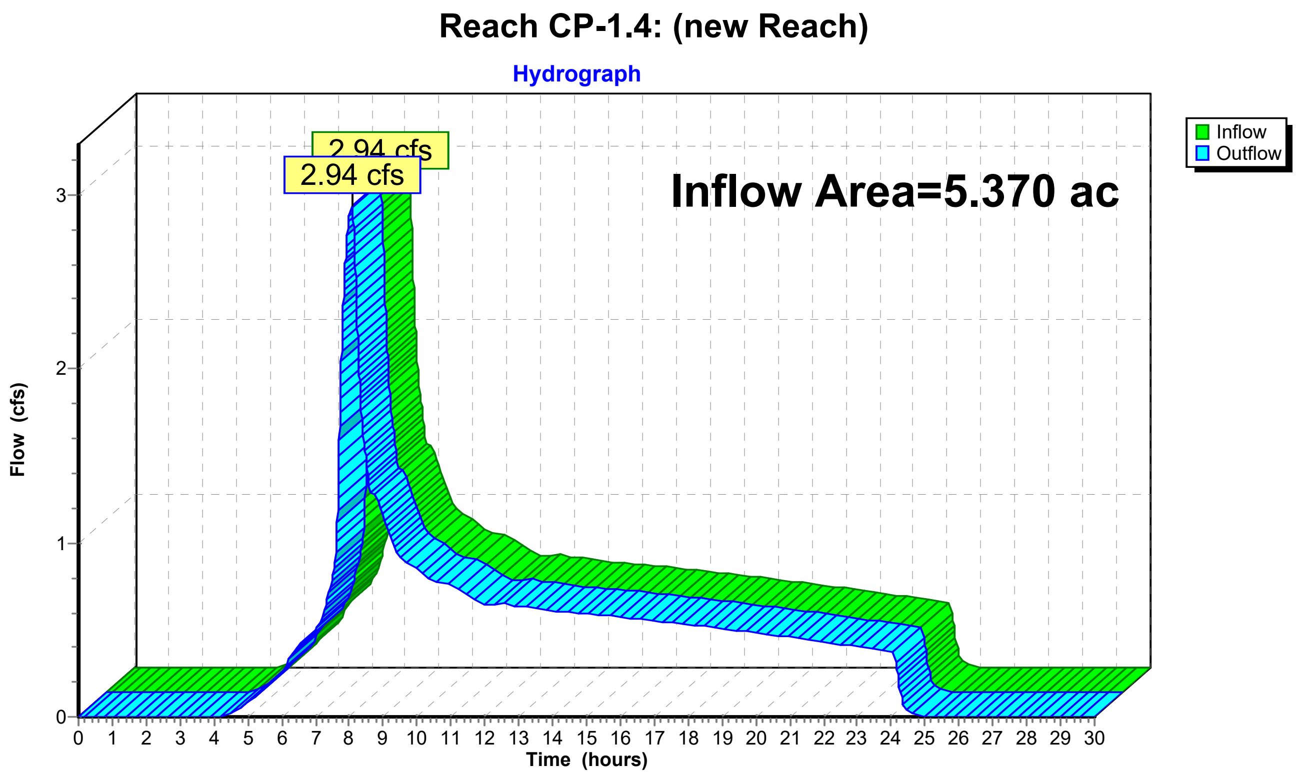


Summary for Reach CP-1.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.370 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.94 cfs @ 8.07 hrs, Volume= 1.026 af
Outflow = 2.94 cfs @ 8.07 hrs, Volume= 1.026 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



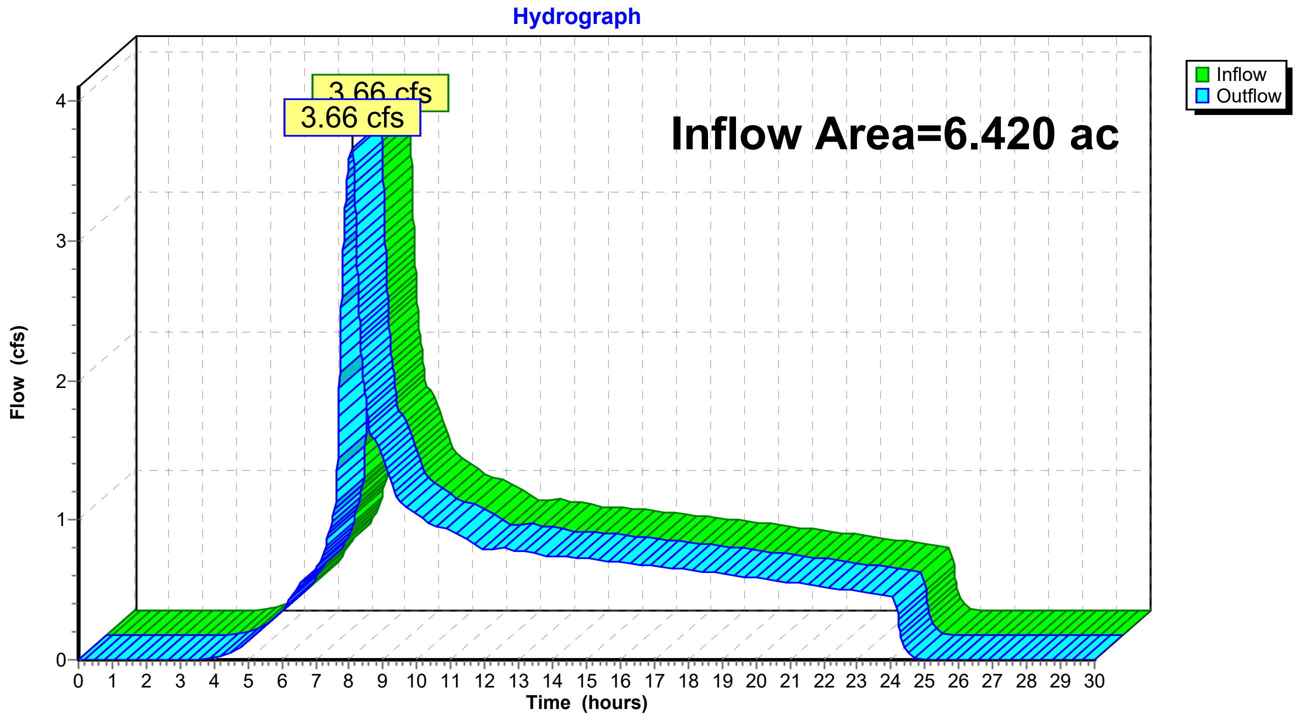
Summary for Reach CP-10.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	6.420 ac,	4.83% Impervious, Inflow Depth = 2.37"		for 25-year event
Inflow =	3.66 cfs @	8.08 hrs, Volume=	1.266 af	
Outflow =	3.66 cfs @	8.08 hrs, Volume=	1.266 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-10.1: (new Reach)



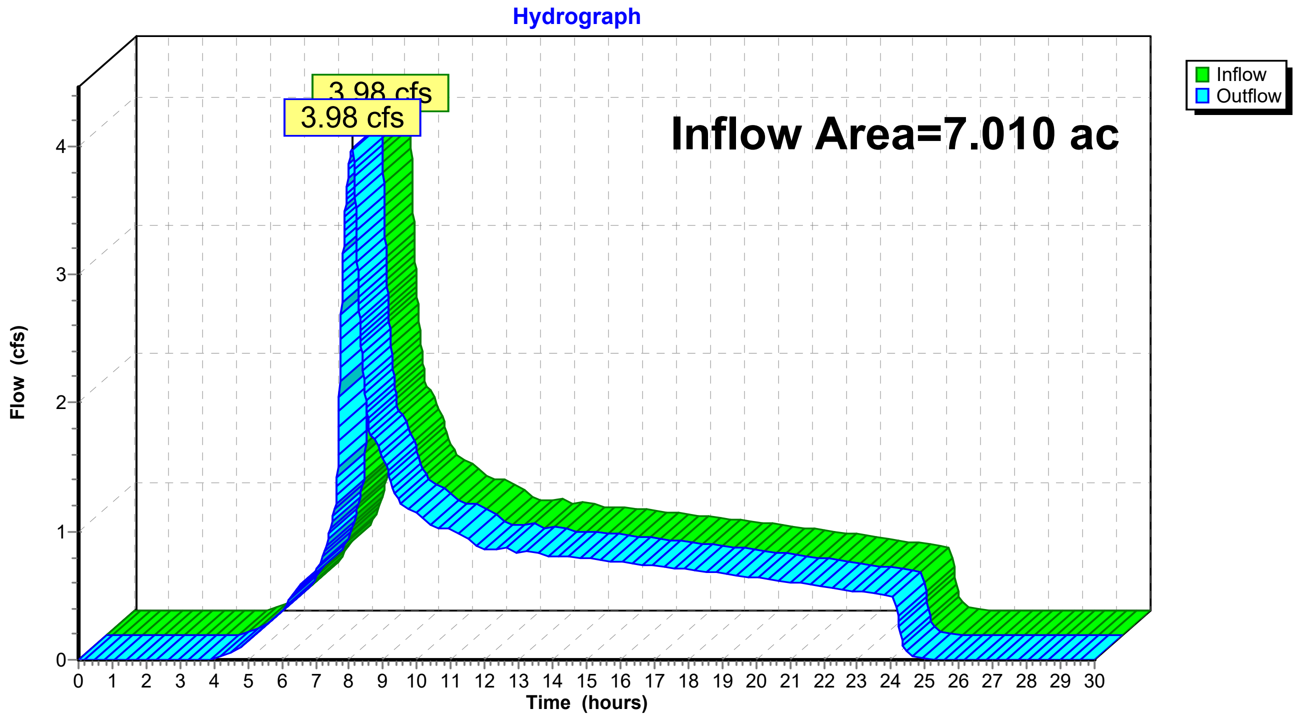
Summary for Reach CP-10.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	7.010 ac,	4.42% Impervious, Inflow Depth = 2.36"	for 25-year event
Inflow =	3.98 cfs @	8.08 hrs, Volume=	1.378 af
Outflow =	3.98 cfs @	8.08 hrs, Volume=	1.378 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-10.3: (new Reach)



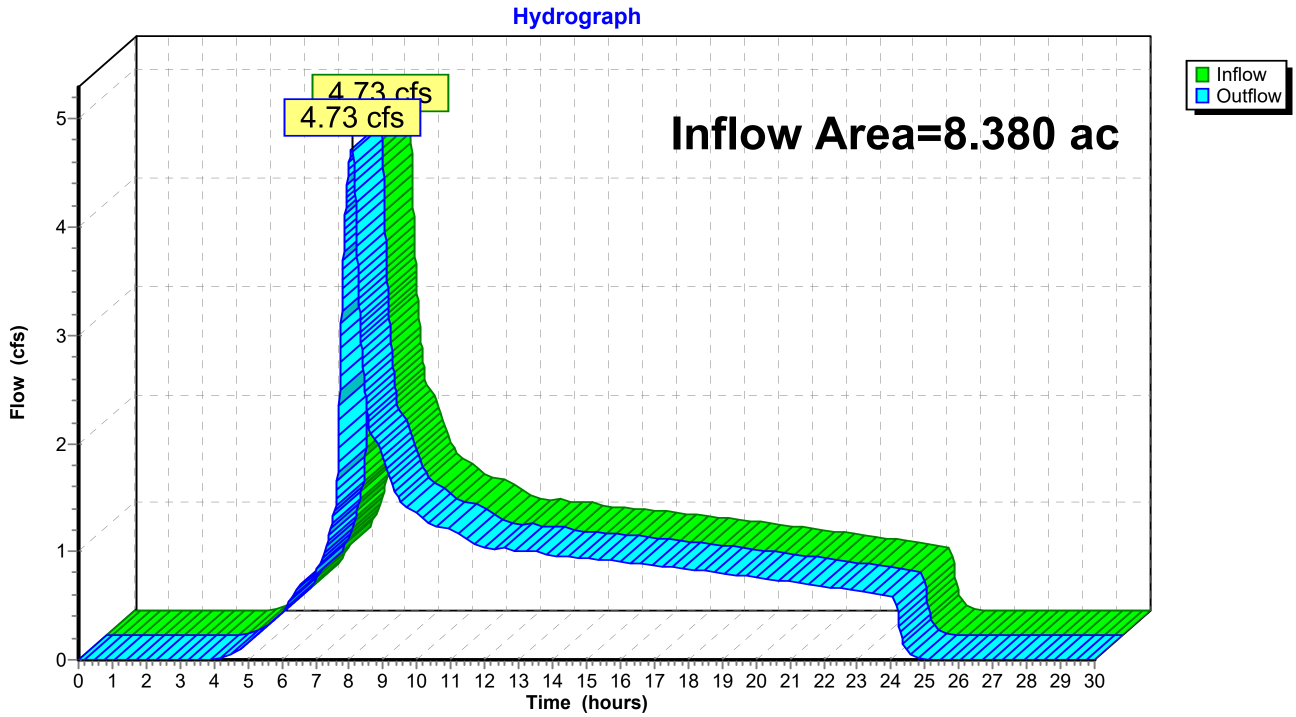
Summary for Reach CP-10.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8.380 ac, 3.70% Impervious, Inflow Depth = 2.35" for 25-year event
Inflow = 4.73 cfs @ 8.09 hrs, Volume= 1.640 af
Outflow = 4.73 cfs @ 8.09 hrs, Volume= 1.640 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-10.4: (new Reach)

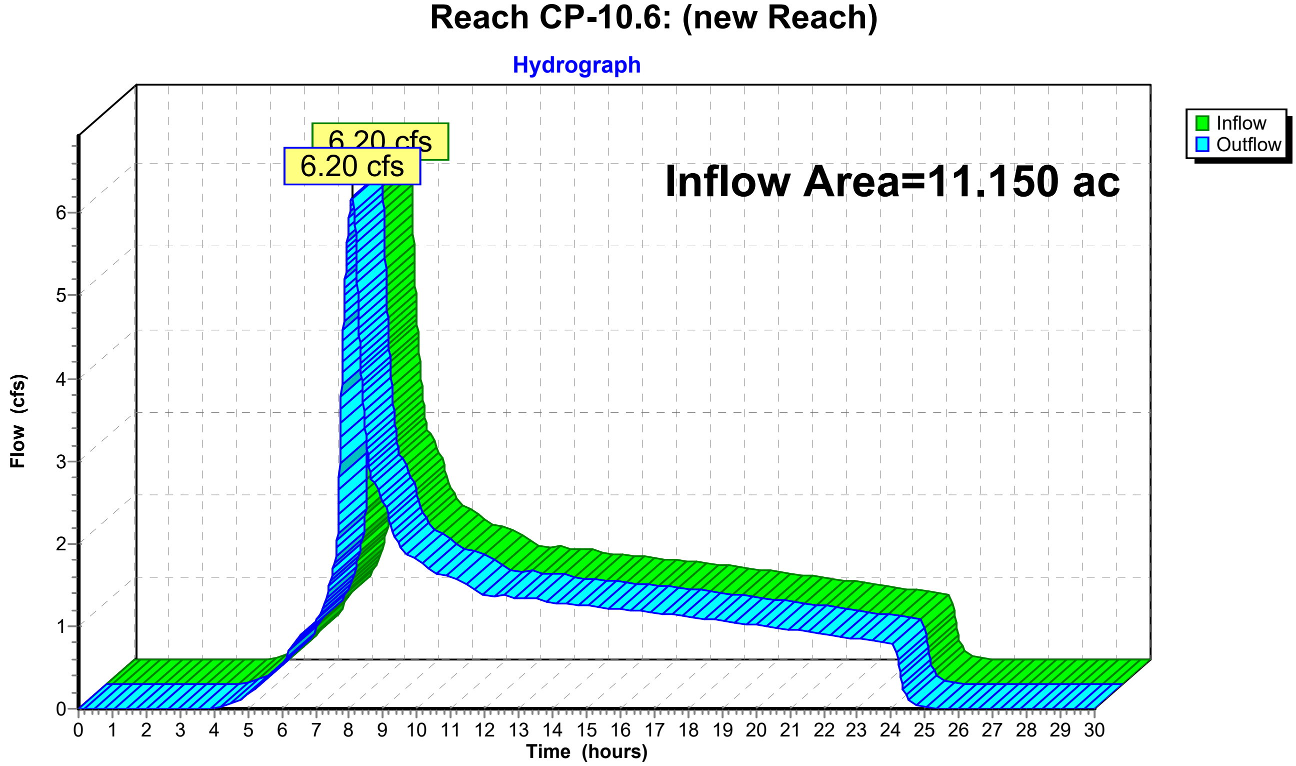


Summary for Reach CP-10.6: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	11.150 ac,	2.78% Impervious,	Inflow Depth = 2.33"	for 25-year event	
Inflow =	6.20 cfs @	8.10 hrs,	Volume=	2.169 af	
Outflow =	6.20 cfs @	8.10 hrs,	Volume=	2.169 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

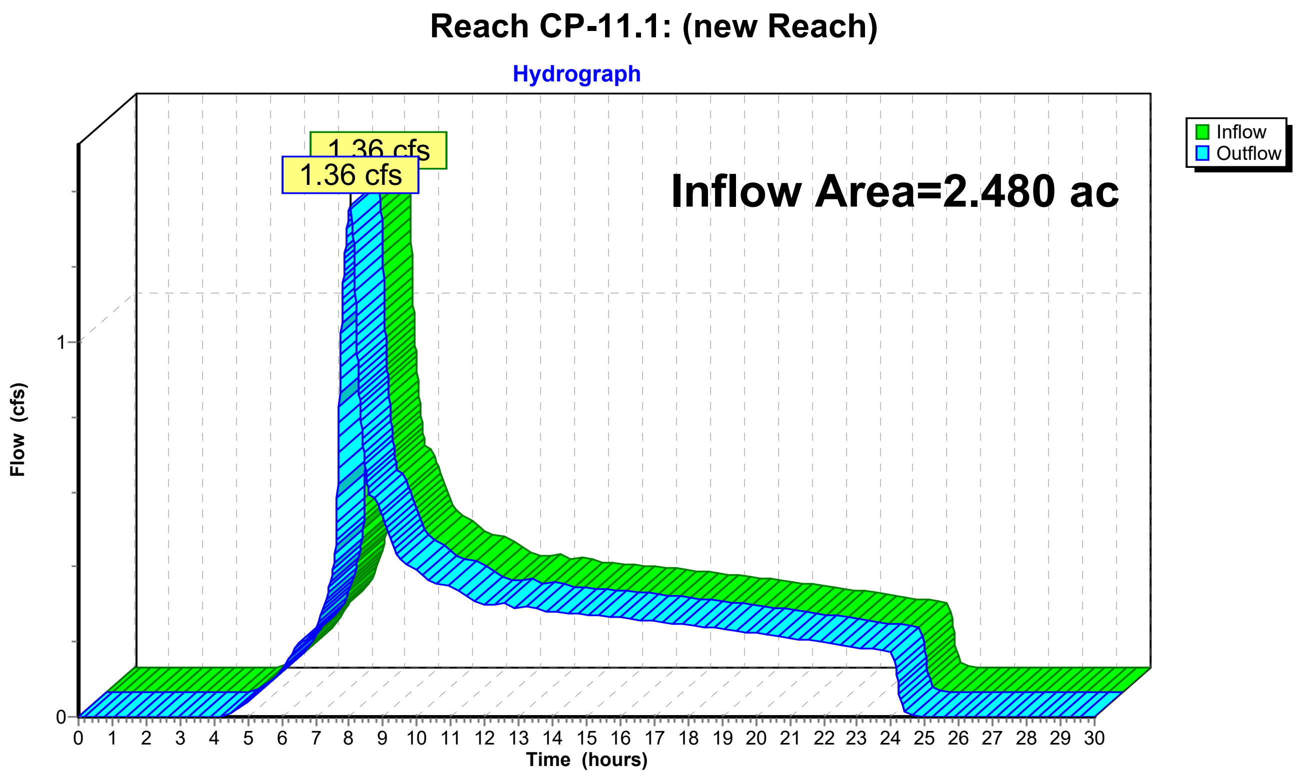


Summary for Reach CP-11.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.480 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.36 cfs @ 8.04 hrs, Volume= 0.474 af
Outflow = 1.36 cfs @ 8.04 hrs, Volume= 0.474 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

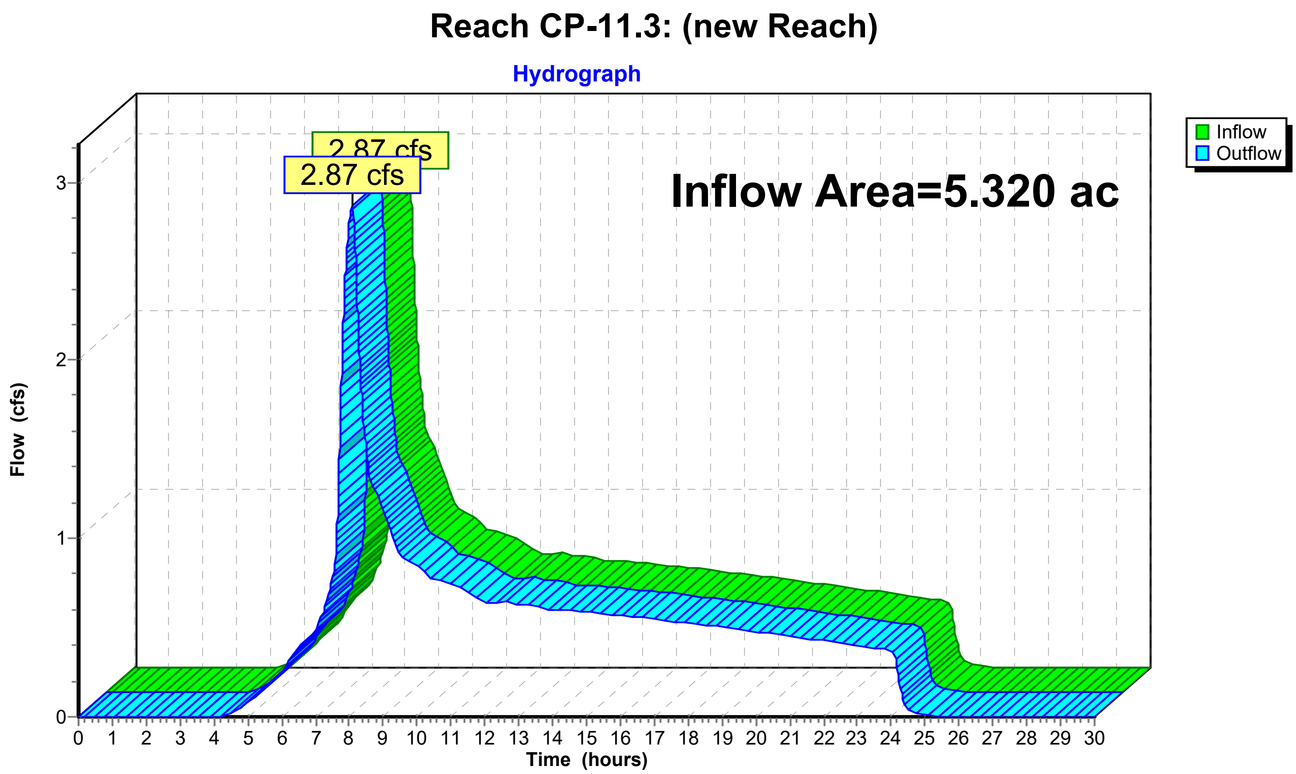


Summary for Reach CP-11.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.320 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.87 cfs @ 8.07 hrs, Volume= 1.016 af
Outflow = 2.87 cfs @ 8.07 hrs, Volume= 1.016 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

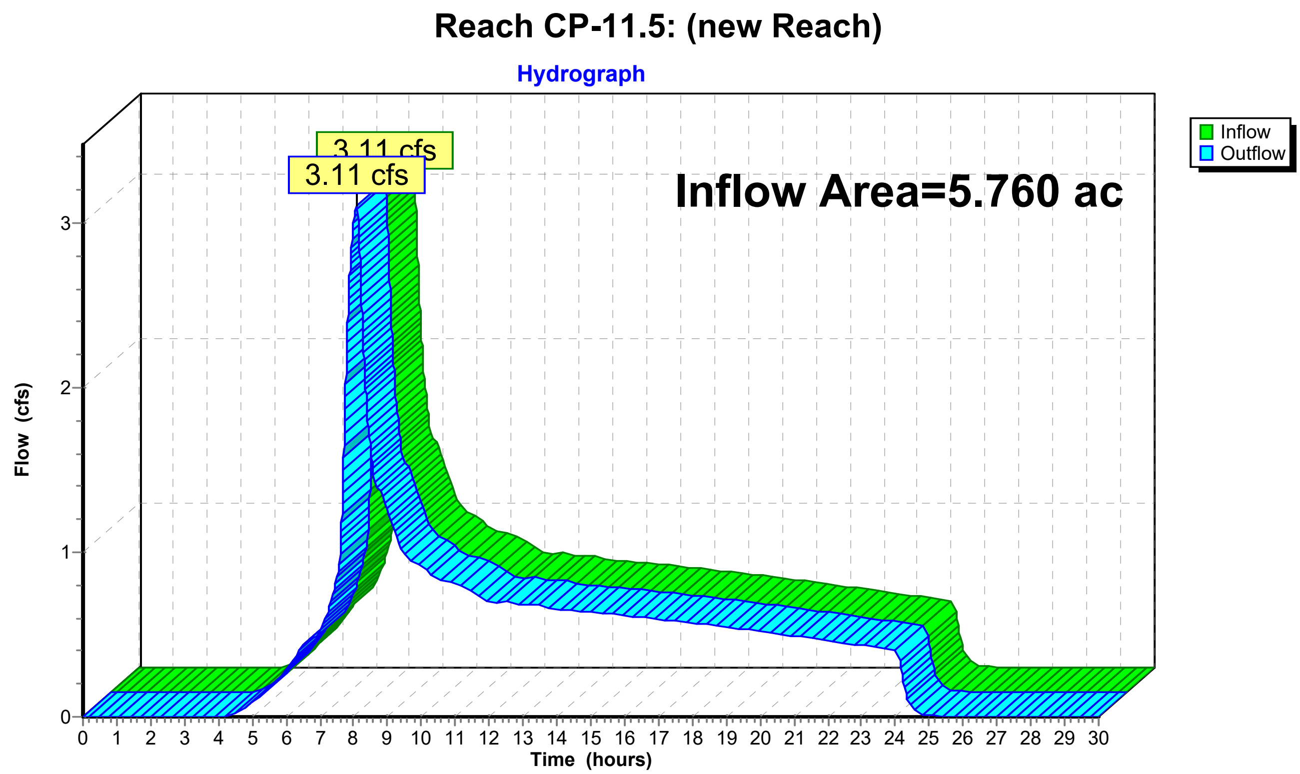


Summary for Reach CP-11.5: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.760 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.11 cfs @ 8.07 hrs, Volume= 1.100 af
Outflow = 3.11 cfs @ 8.07 hrs, Volume= 1.100 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

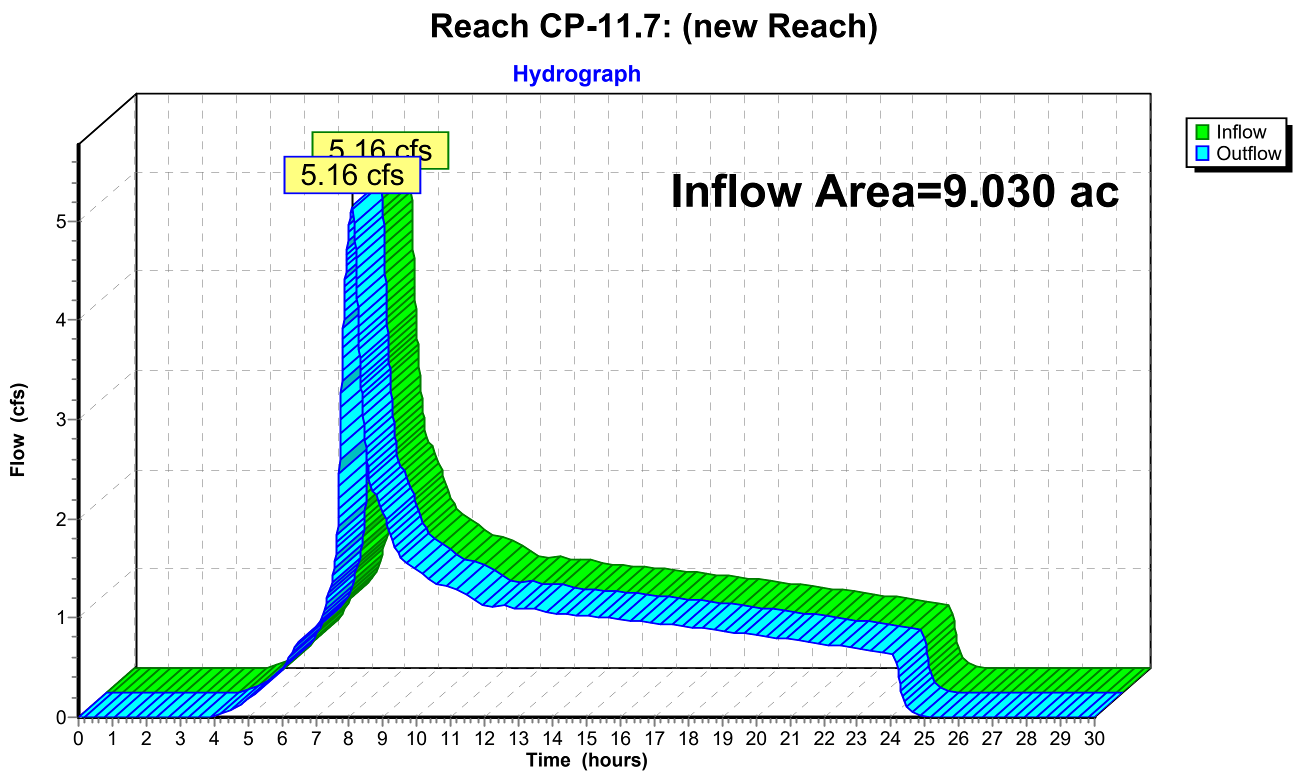


Summary for Reach CP-11.7: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 9.030 ac, 6.09% Impervious, Inflow Depth = 2.38" for 25-year event
Inflow = 5.16 cfs @ 8.08 hrs, Volume= 1.795 af
Outflow = 5.16 cfs @ 8.08 hrs, Volume= 1.795 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



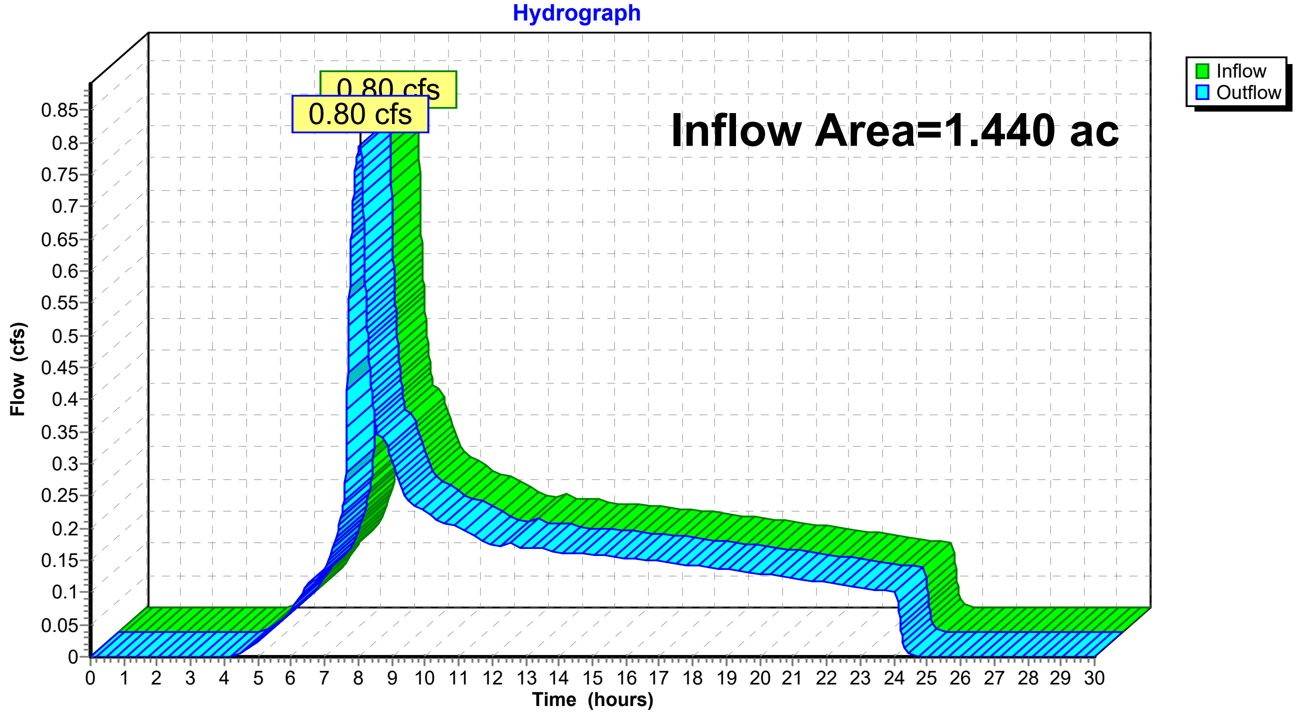
Summary for Reach CP-2.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	1.440 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	0.80 cfs @	8.05 hrs,	Volume=	0.275 af	
Outflow =	0.80 cfs @	8.05 hrs,	Volume=	0.275 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-2.1: (new Reach)

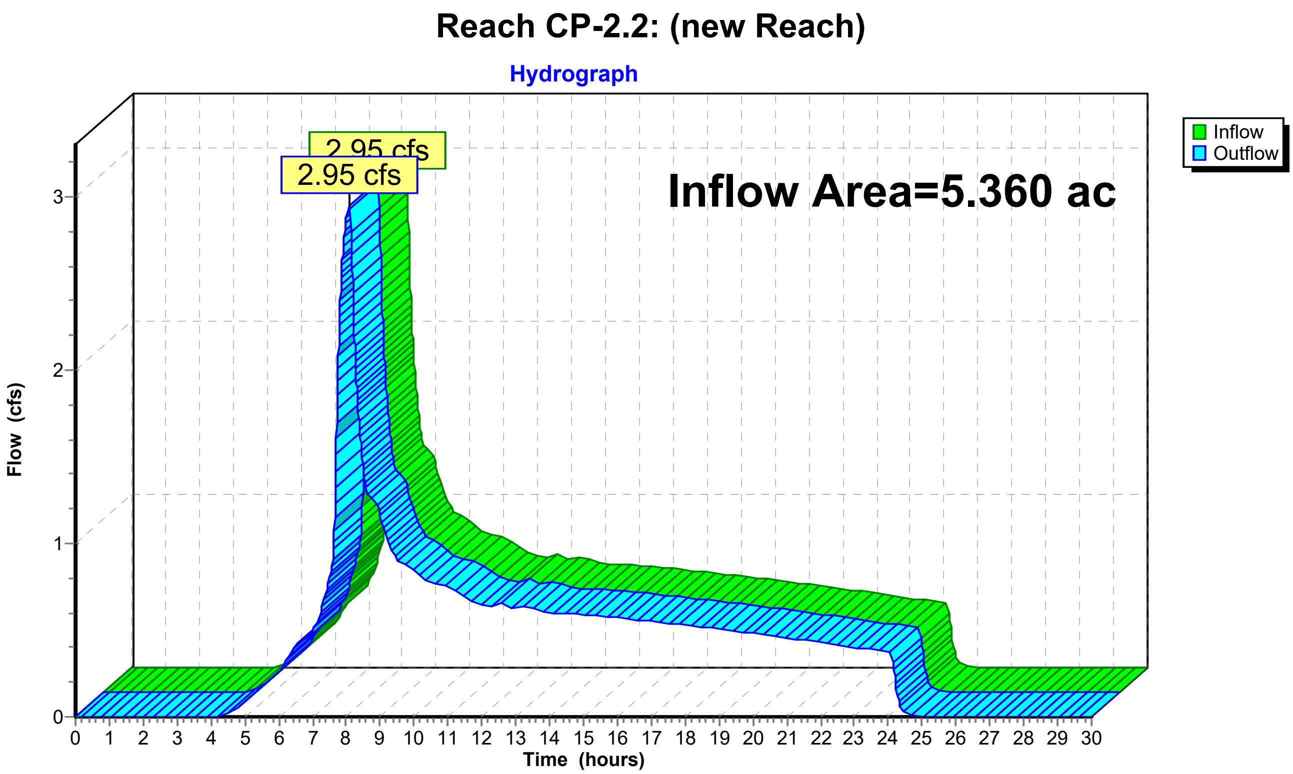


Summary for Reach CP-2.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	5.360 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event
Inflow =	2.95 cfs @	8.07 hrs, Volume=	1.024 af	
Outflow =	2.95 cfs @	8.07 hrs, Volume=	1.024 af, Atten= 0%, Lag= 0.0 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



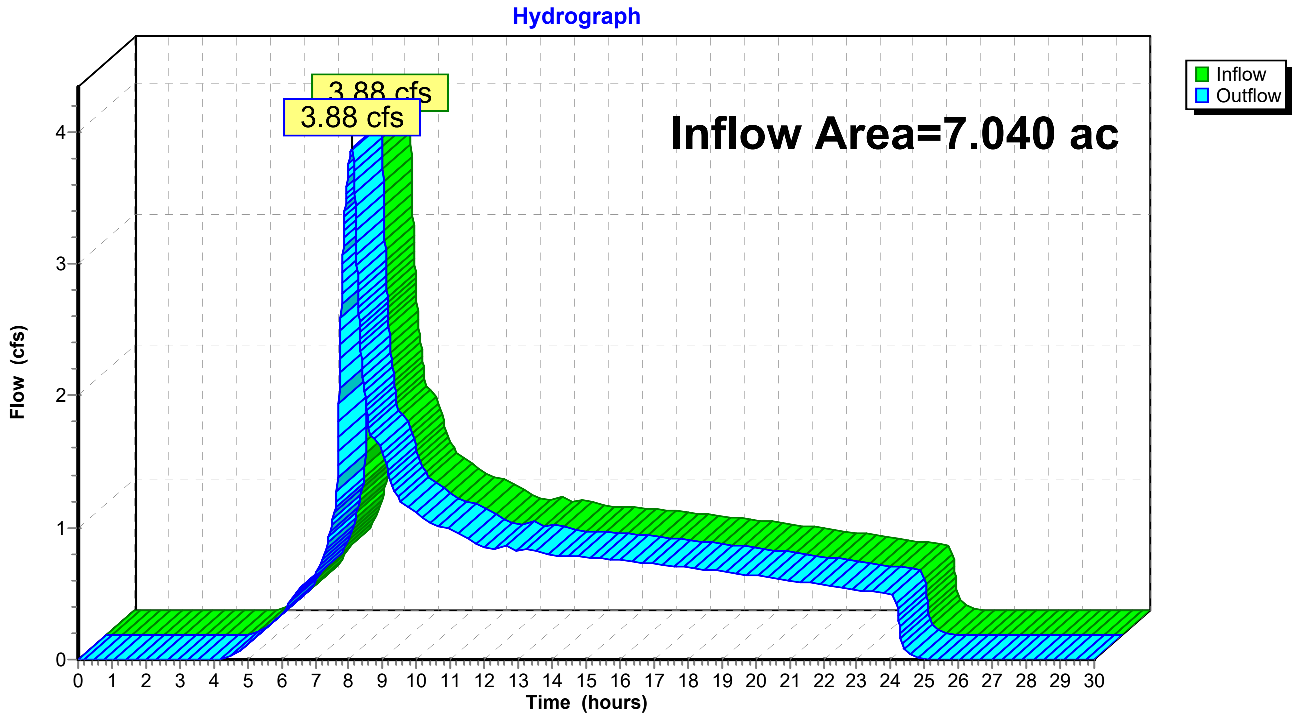
Summary for Reach CP-2.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7.040 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.88 cfs @ 8.09 hrs, Volume= 1.345 af
Outflow = 3.88 cfs @ 8.09 hrs, Volume= 1.345 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-2.3: (new Reach)

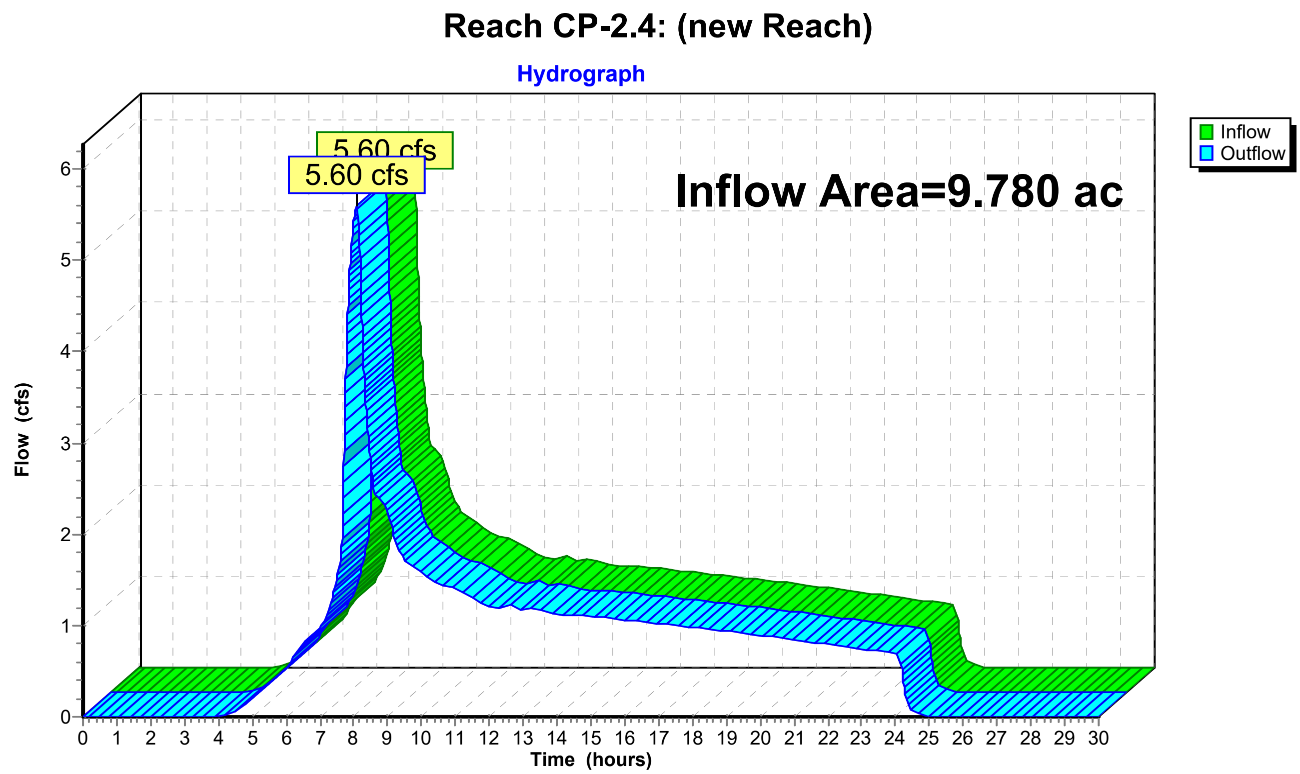


Summary for Reach CP-2.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 9.780 ac, 4.70% Impervious, Inflow Depth = 2.36" for 25-year event
Inflow = 5.60 cfs @ 8.09 hrs, Volume= 1.927 af
Outflow = 5.60 cfs @ 8.09 hrs, Volume= 1.927 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



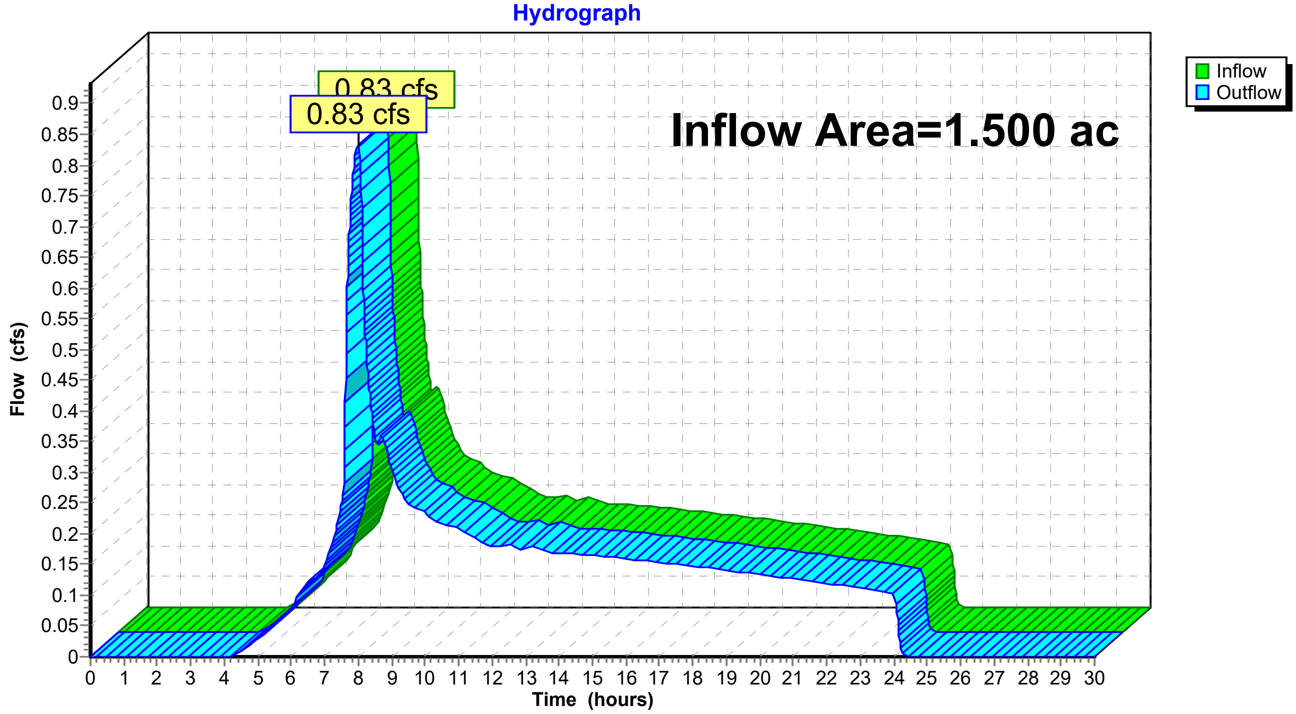
Summary for Reach CP-20.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.83 cfs @ 7.99 hrs, Volume= 0.287 af
Outflow = 0.83 cfs @ 7.99 hrs, Volume= 0.287 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-20.4: (new Reach)

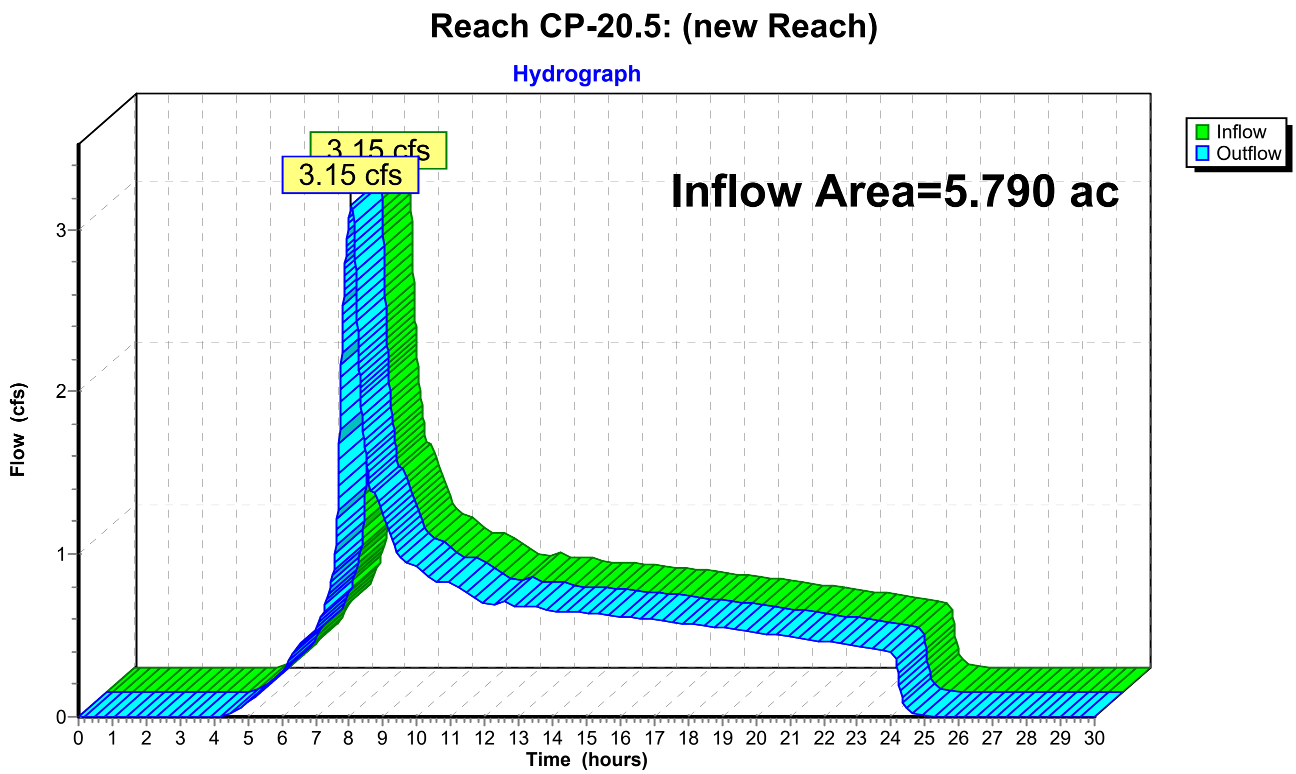


Summary for Reach CP-20.5: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	5.790 ac,	0.00% Impervious, Inflow Depth = 2.29"		for 25-year event
Inflow =	3.15 cfs @	8.05 hrs, Volume=	1.106 af	
Outflow =	3.15 cfs @	8.05 hrs, Volume=	1.106 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



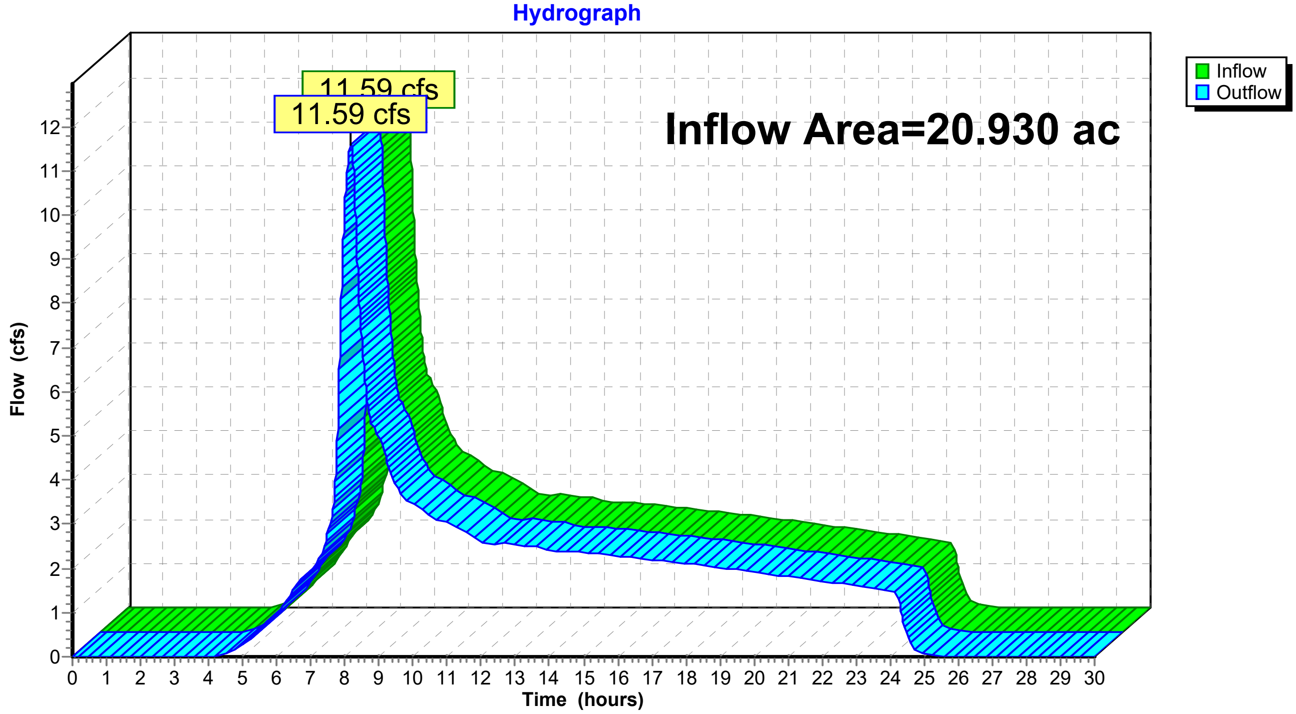
Summary for Reach CP-21.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 20.930 ac, 4.11% Impervious, Inflow Depth = 2.35" for 25-year event
Inflow = 11.59 cfs @ 8.17 hrs, Volume= 4.107 af
Outflow = 11.59 cfs @ 8.17 hrs, Volume= 4.107 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-21.1: (new Reach)



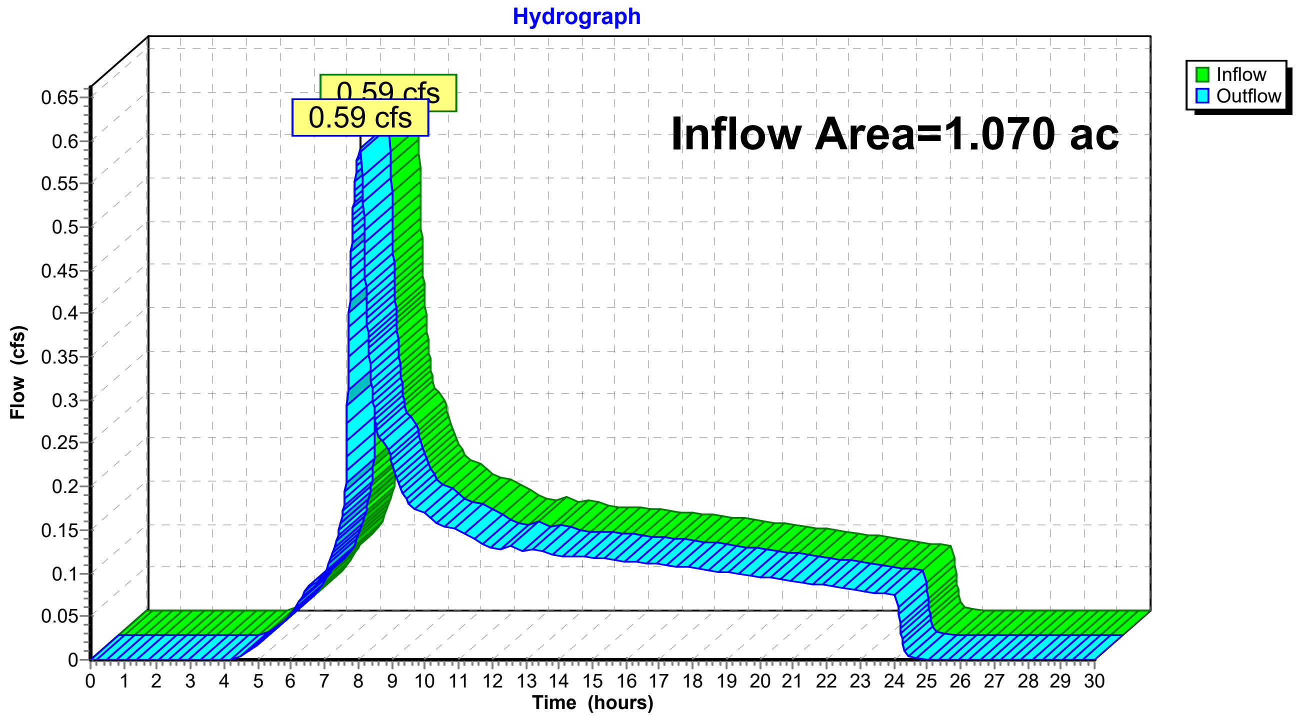
Summary for Reach CP-22.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	1.070 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	0.59 cfs @	8.06 hrs,	Volume=	0.204 af	
Outflow =	0.59 cfs @	8.06 hrs,	Volume=	0.204 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-22.1: (new Reach)



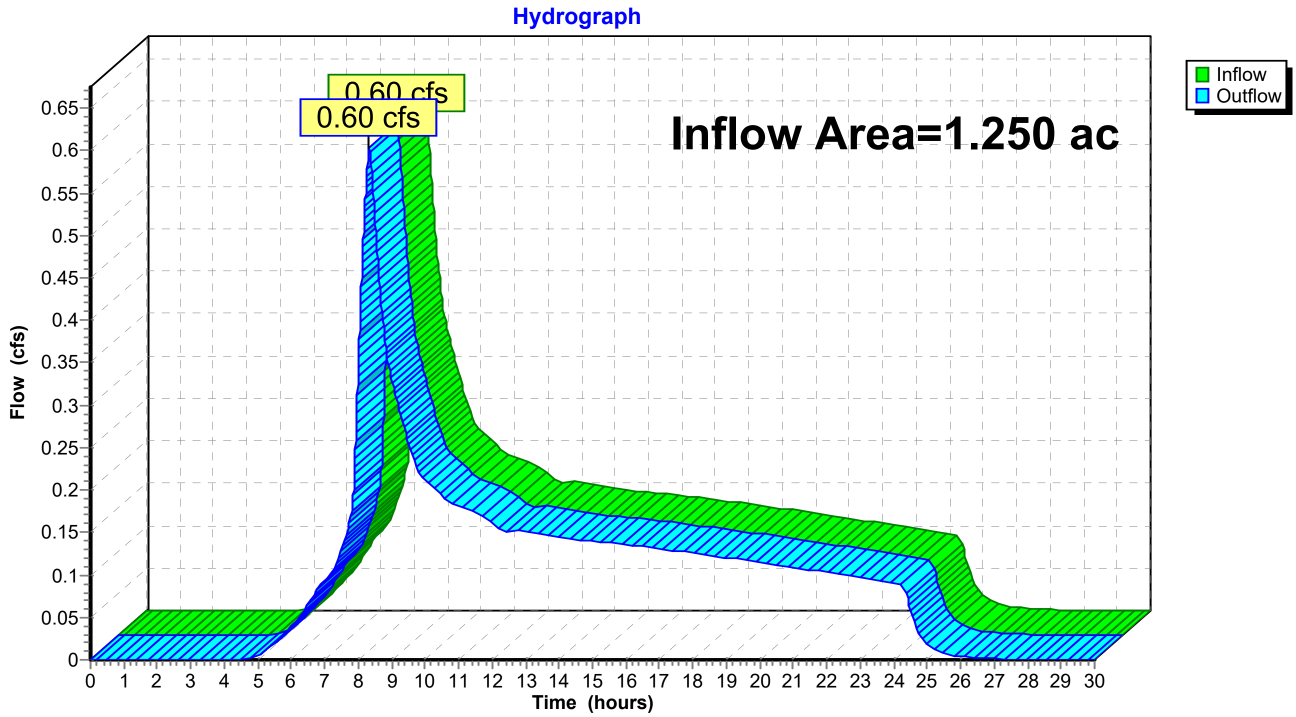
Summary for Reach CP-23.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.250 ac, 0.00% Impervious, Inflow Depth > 2.29" for 25-year event
Inflow = 0.60 cfs @ 8.34 hrs, Volume= 0.239 af
Outflow = 0.60 cfs @ 8.34 hrs, Volume= 0.239 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-23.1: (new Reach)



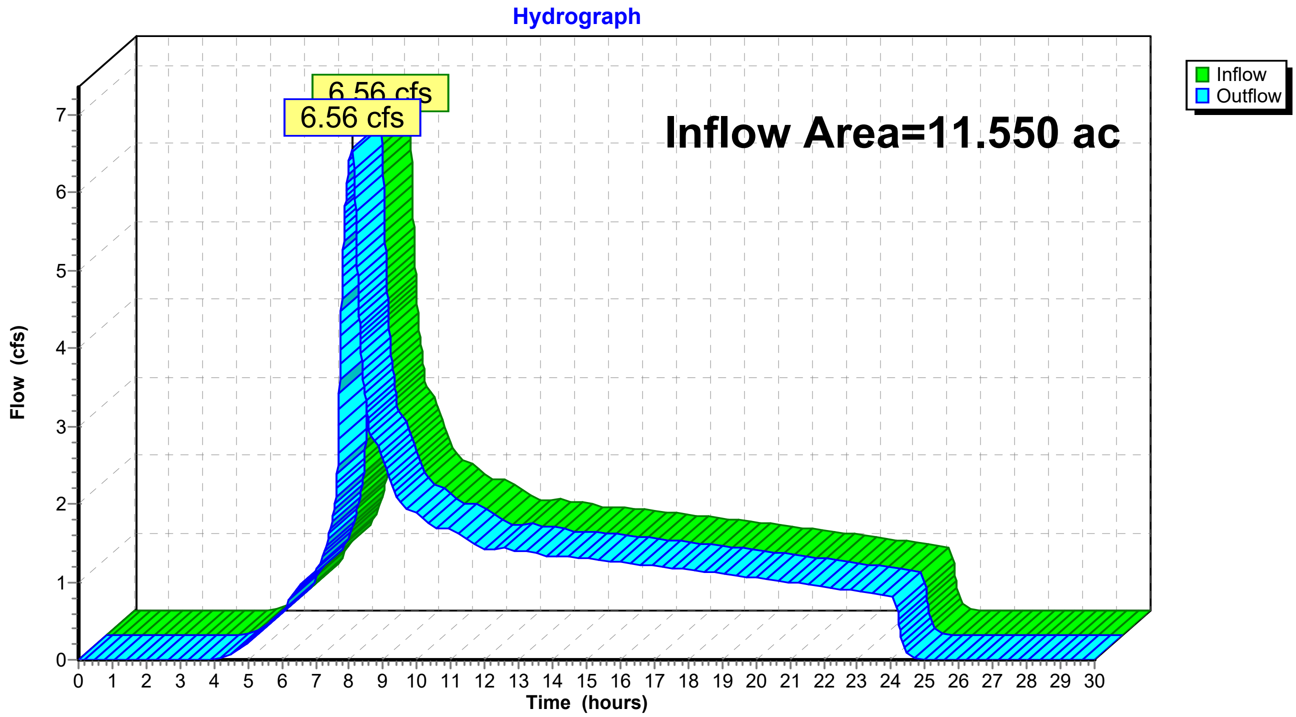
Summary for Reach CP-3.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.550 ac, 3.98% Impervious, Inflow Depth = 2.35" for 25-year event
Inflow = 6.56 cfs @ 8.07 hrs, Volume= 2.265 af
Outflow = 6.56 cfs @ 8.07 hrs, Volume= 2.265 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-3.1: (new Reach)



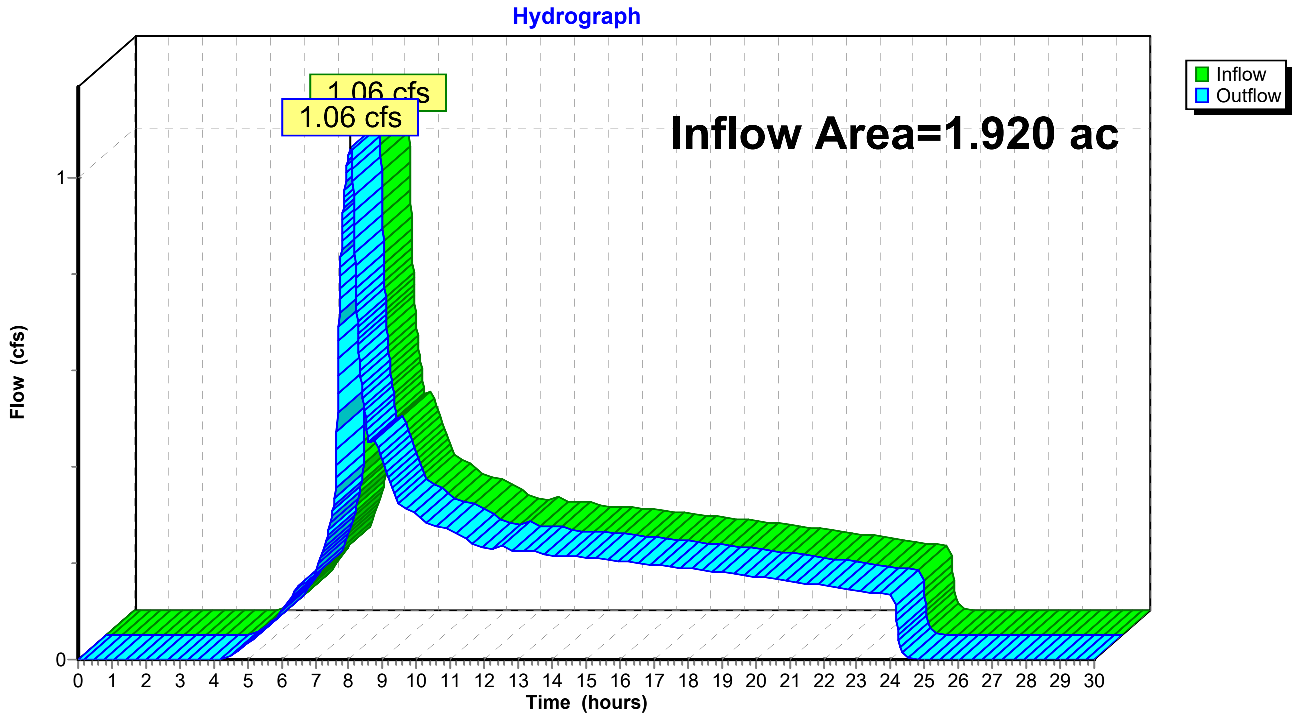
Summary for Reach CP-4A.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	1.920 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	1.06 cfs @	8.04 hrs,	Volume=	0.367 af	
Outflow =	1.06 cfs @	8.04 hrs,	Volume=	0.367 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-4A.2: (new Reach)



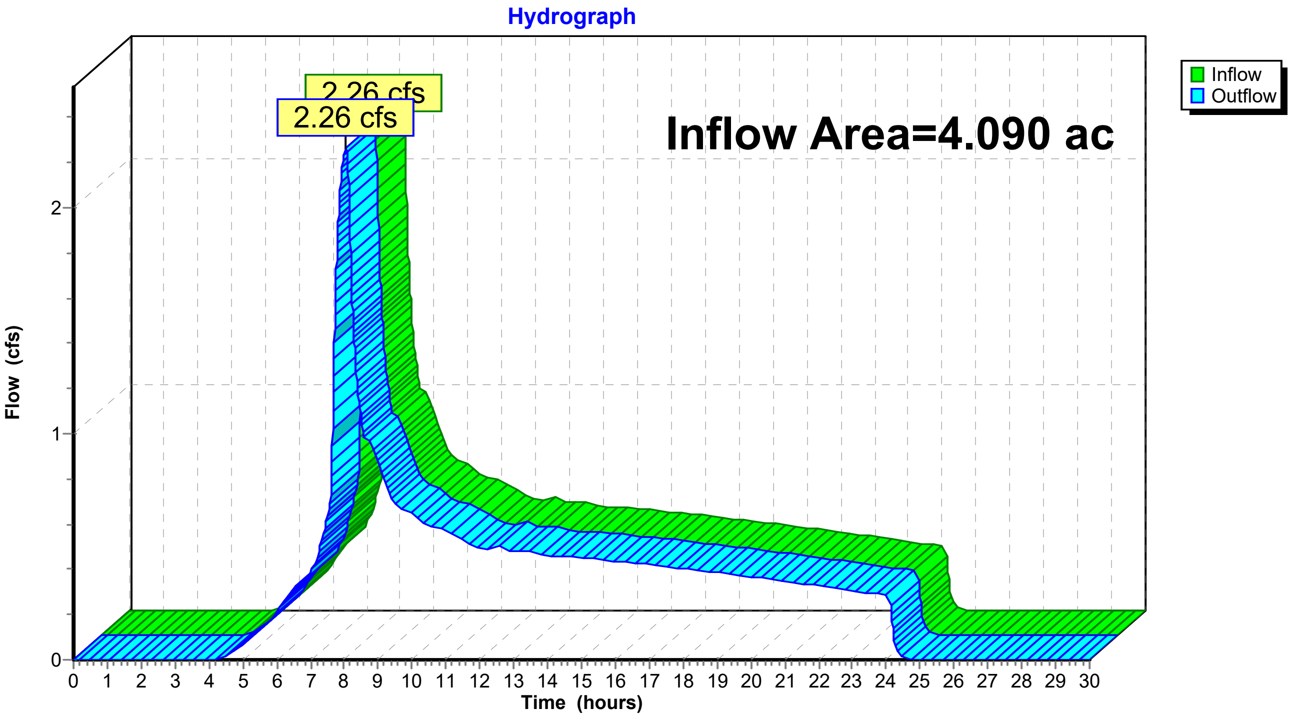
Summary for Reach CP-4B.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	4.090 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	2.26 cfs @	8.05 hrs,	Volume=	0.781 af	
Outflow =	2.26 cfs @	8.05 hrs,	Volume=	0.781 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-4B.1: (new Reach)

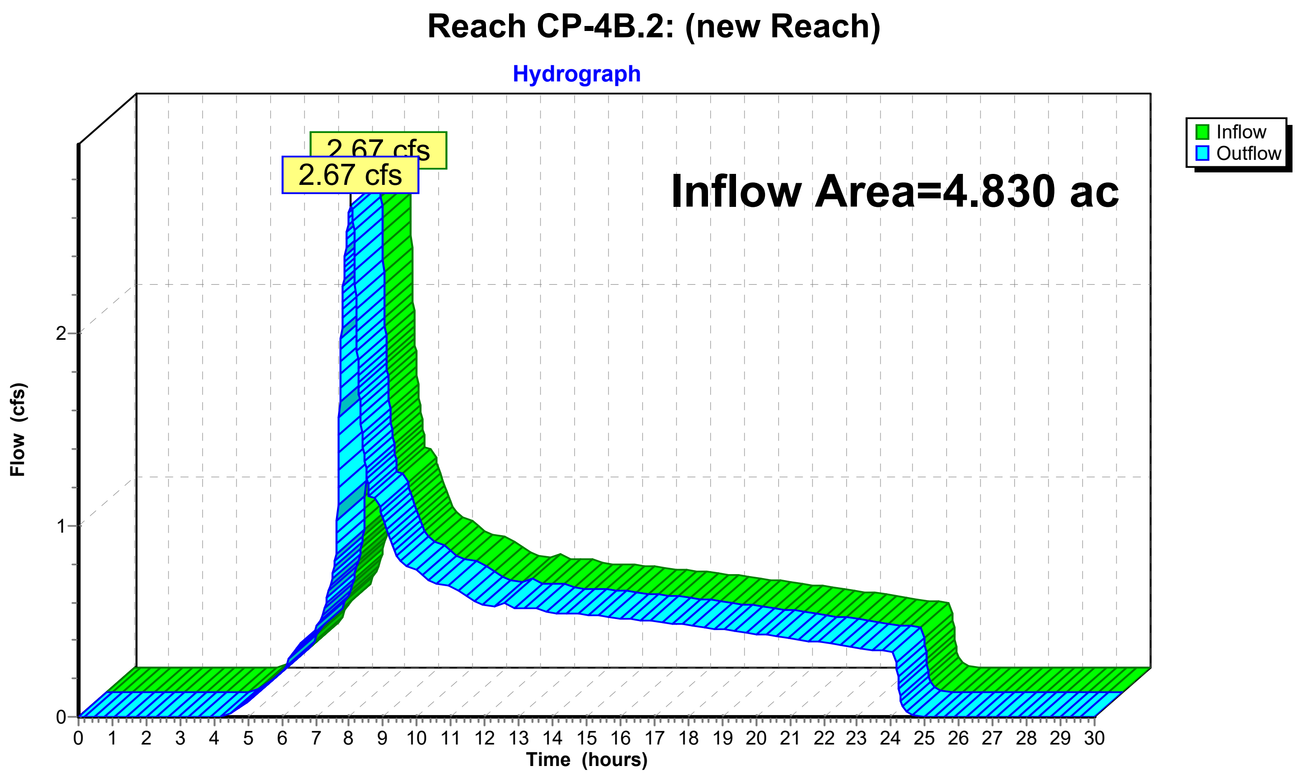


Summary for Reach CP-4B.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	4.830 ac,	0.00% Impervious, Inflow Depth = 2.29"	for 25-year event
Inflow =	2.67 cfs @	8.06 hrs, Volume=	0.923 af
Outflow =	2.67 cfs @	8.06 hrs, Volume=	0.923 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

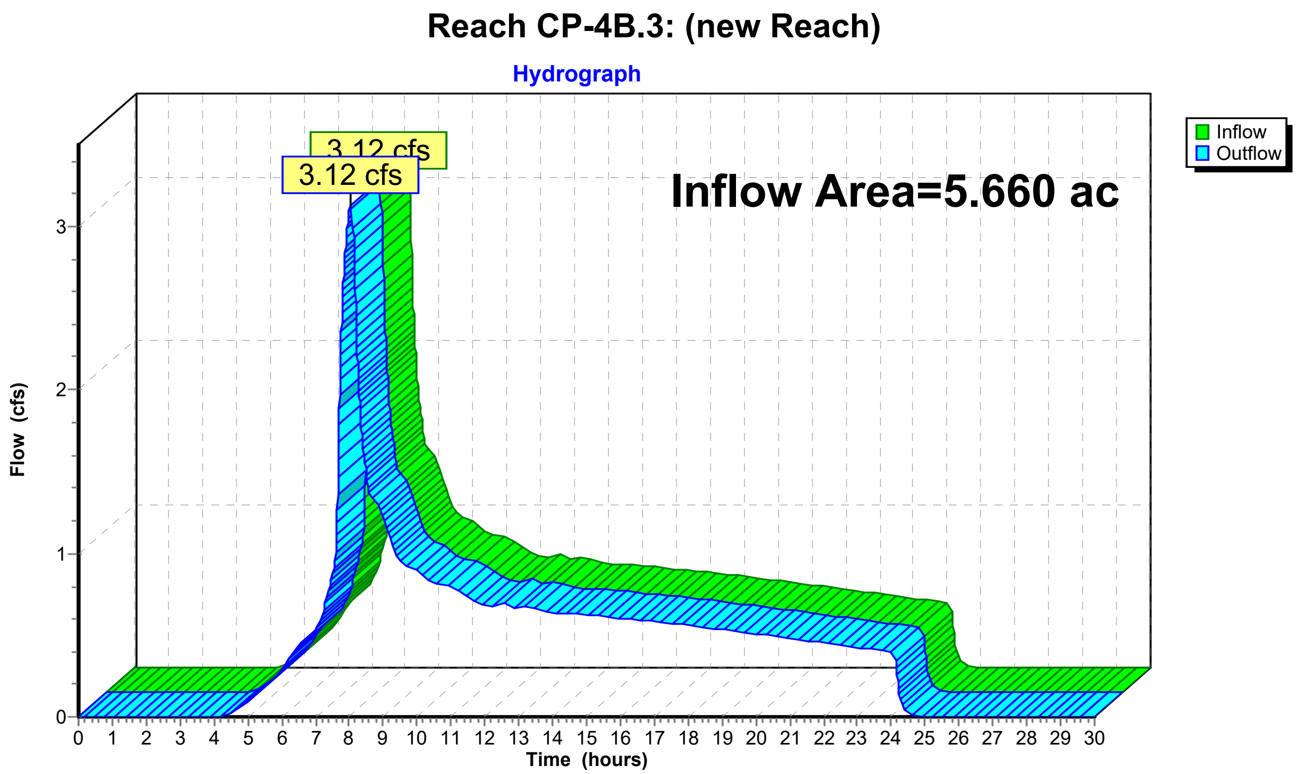


Summary for Reach CP-4B.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.660 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.12 cfs @ 8.05 hrs, Volume= 1.081 af
Outflow = 3.12 cfs @ 8.05 hrs, Volume= 1.081 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

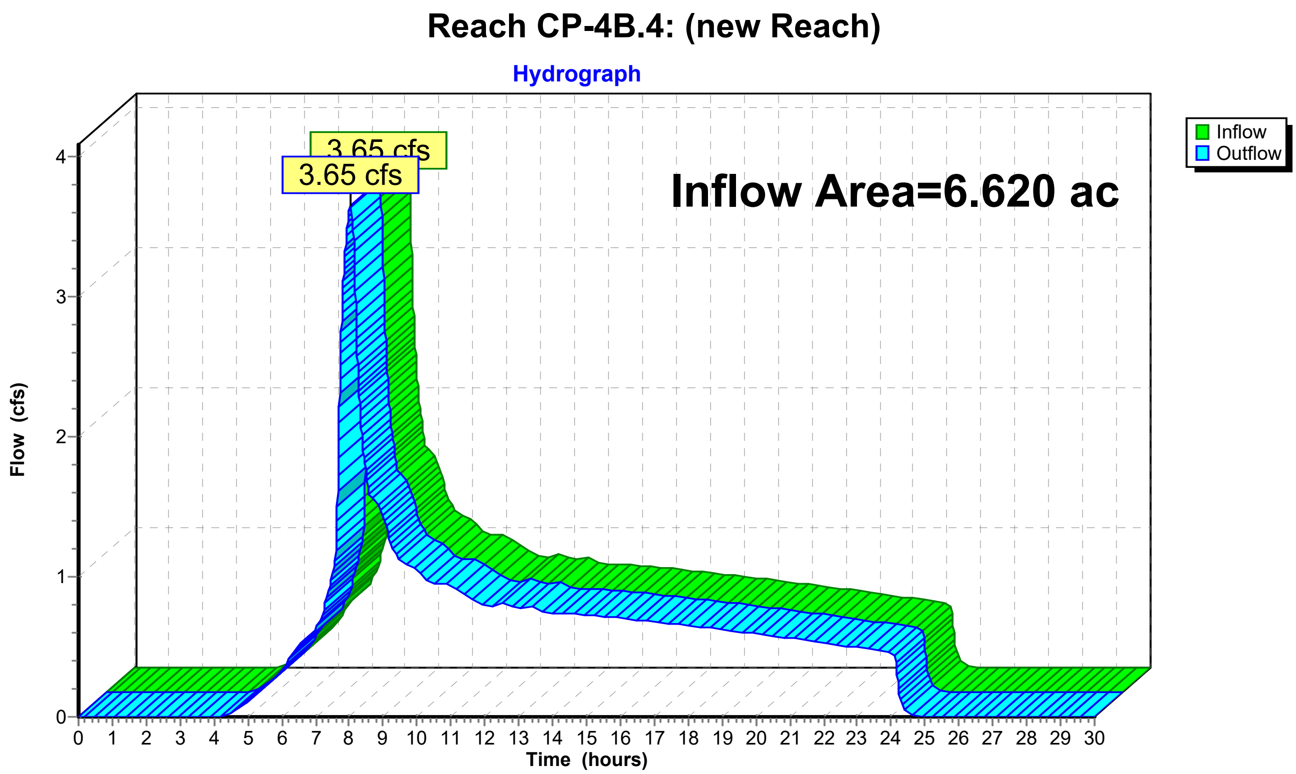


Summary for Reach CP-4B.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	6.620 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	3.65 cfs @	8.05 hrs,	Volume=	1.264 af	
Outflow =	3.65 cfs @	8.05 hrs,	Volume=	1.264 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

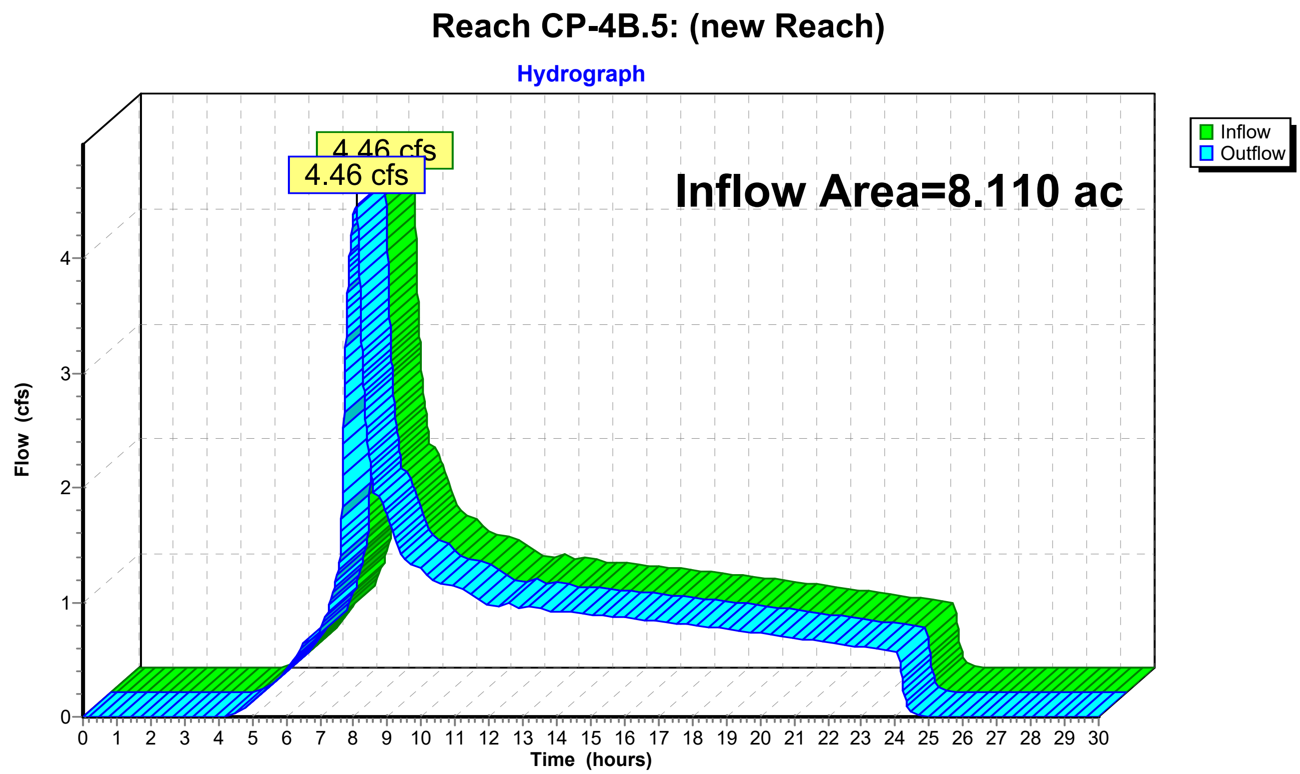


Summary for Reach CP-4B.5: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	8.110 ac,	0.00% Impervious, Inflow Depth = 2.29"	for 25-year event
Inflow =	4.46 cfs @	8.06 hrs, Volume=	1.549 af
Outflow =	4.46 cfs @	8.06 hrs, Volume=	1.549 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

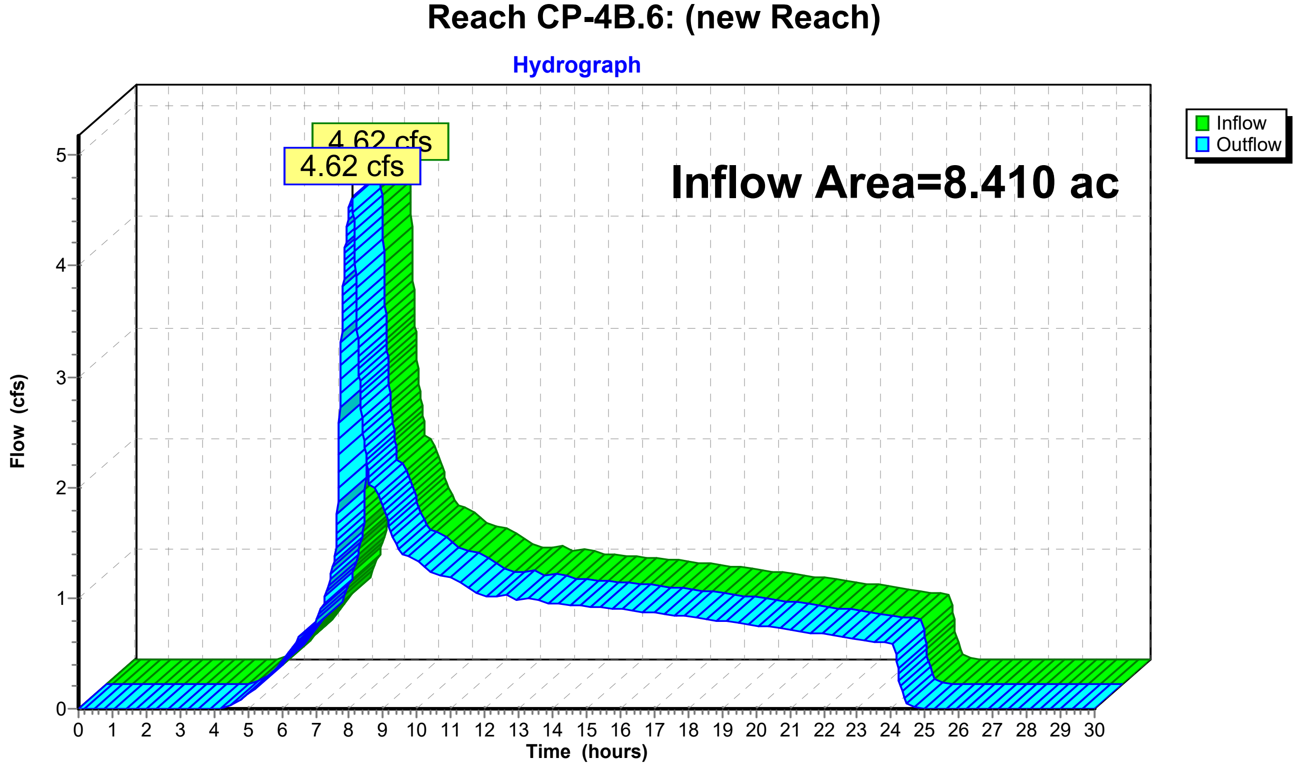


Summary for Reach CP-4B.6: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	8.410 ac,	0.00% Impervious, Inflow Depth = 2.29"	for 25-year event
Inflow =	4.62 cfs @	8.06 hrs, Volume=	1.606 af
Outflow =	4.62 cfs @	8.06 hrs, Volume=	1.606 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

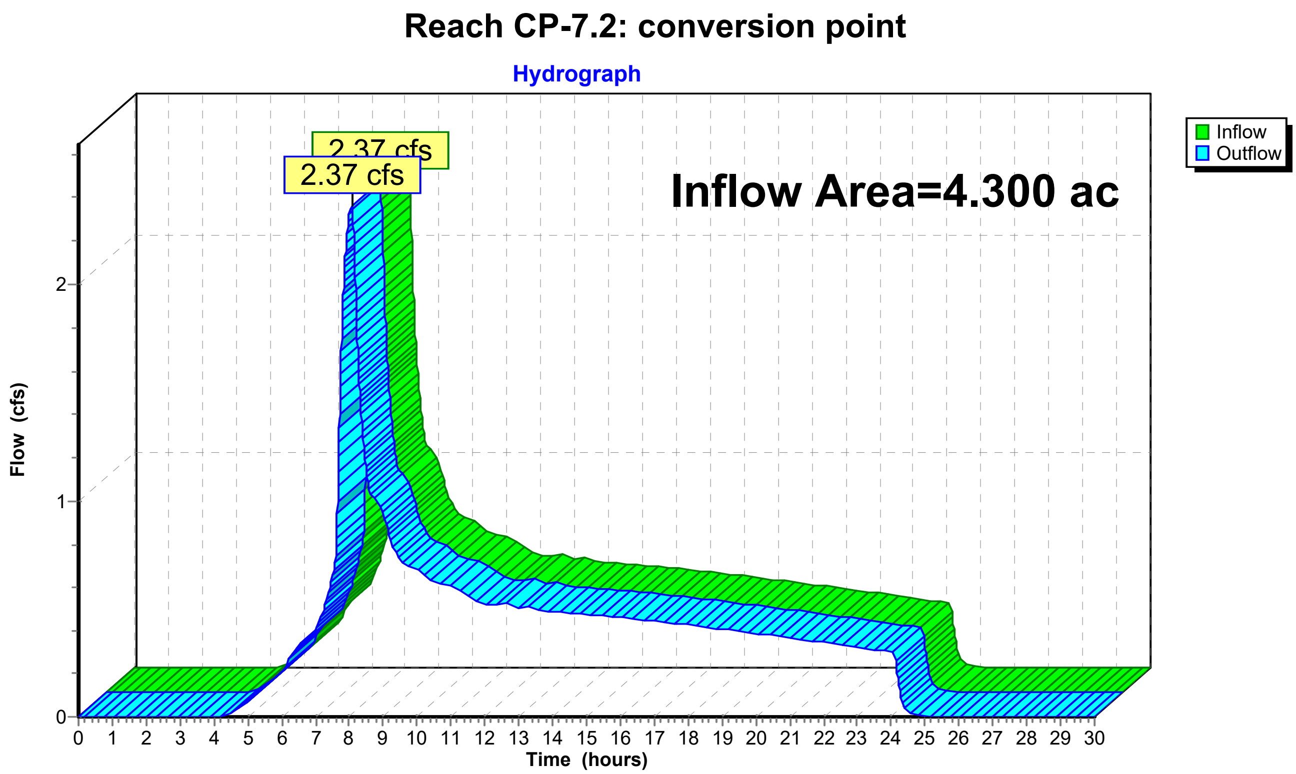


Summary for Reach CP-7.2: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	4.300 ac,	0.00% Impervious, Inflow Depth = 2.29"	for 25-year event	
Inflow =	2.37 cfs @	8.06 hrs, Volume=	0.821 af	
Outflow =	2.37 cfs @	8.06 hrs, Volume=	0.821 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



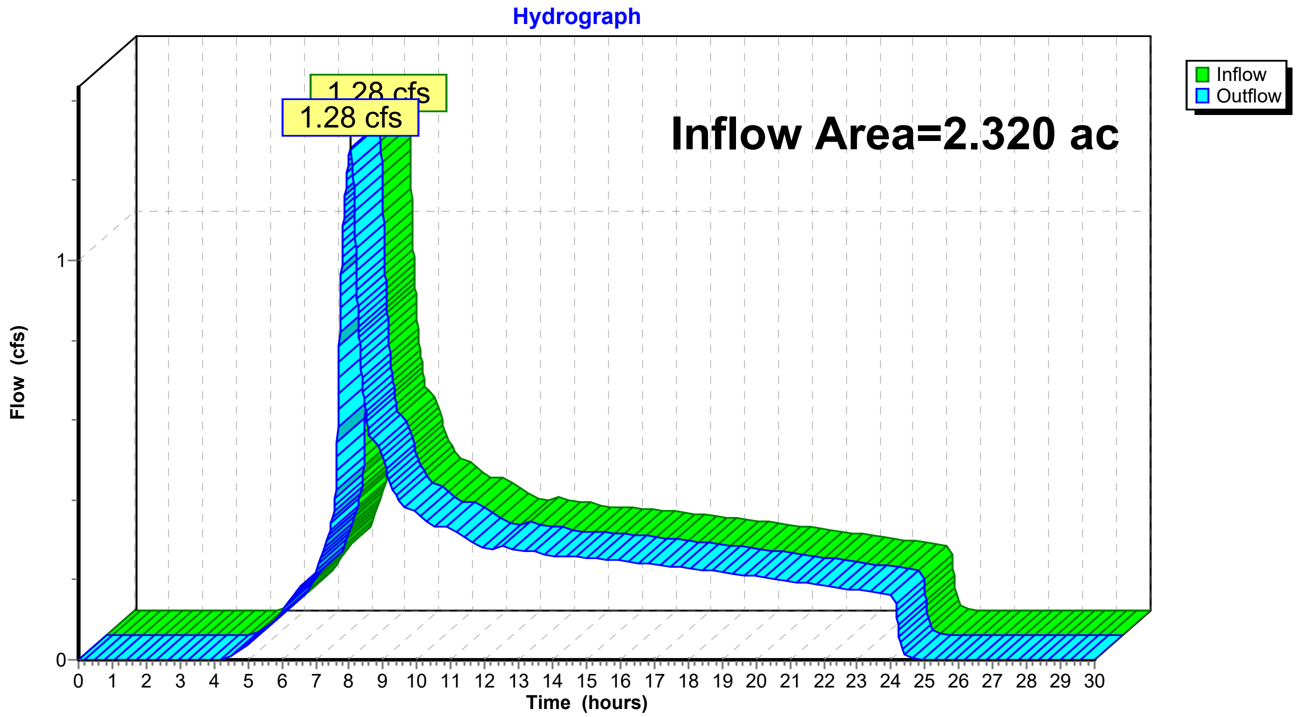
Summary for Reach CP-8.1: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.320 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.28 cfs @ 8.05 hrs, Volume= 0.443 af
Outflow = 1.28 cfs @ 8.05 hrs, Volume= 0.443 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-8.1: conversion point



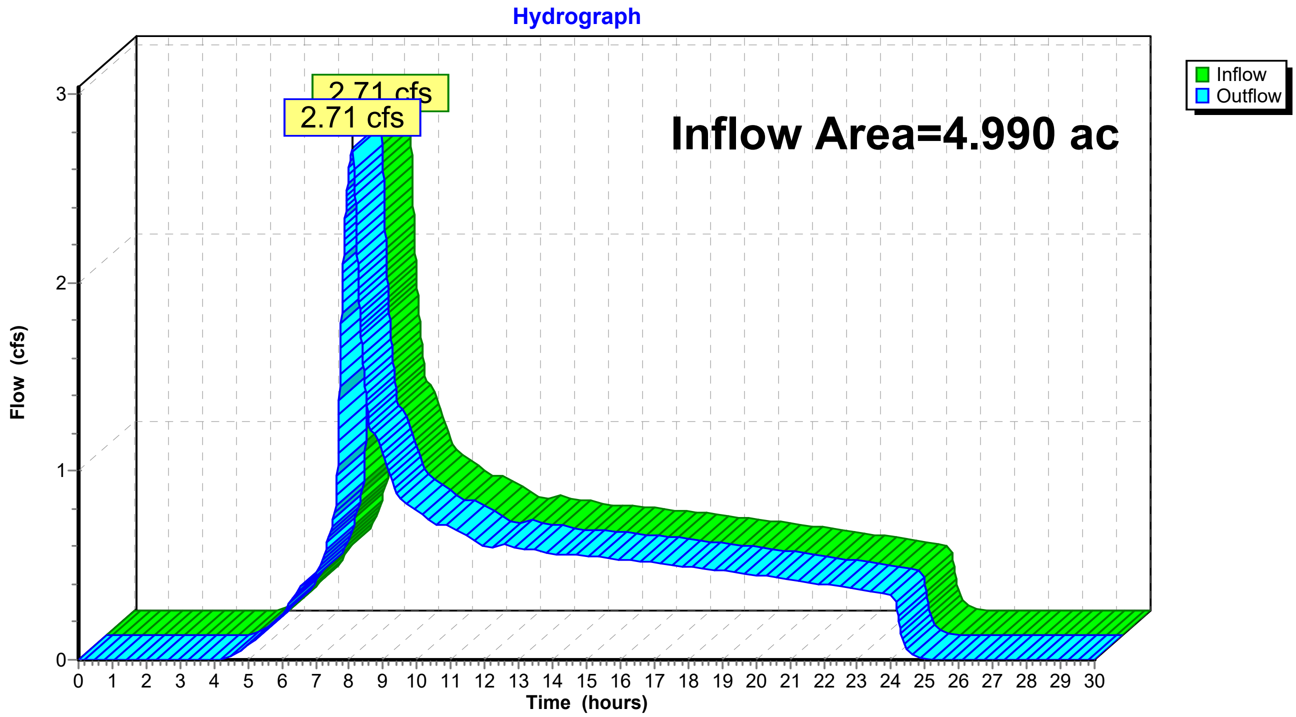
Summary for Reach CP-8.2: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	4.990 ac,	0.00% Impervious, Inflow Depth = 2.29"	for 25-year event	
Inflow =	2.71 cfs @	8.08 hrs, Volume=	0.953 af	
Outflow =	2.71 cfs @	8.08 hrs, Volume=	0.953 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-8.2: conversion point

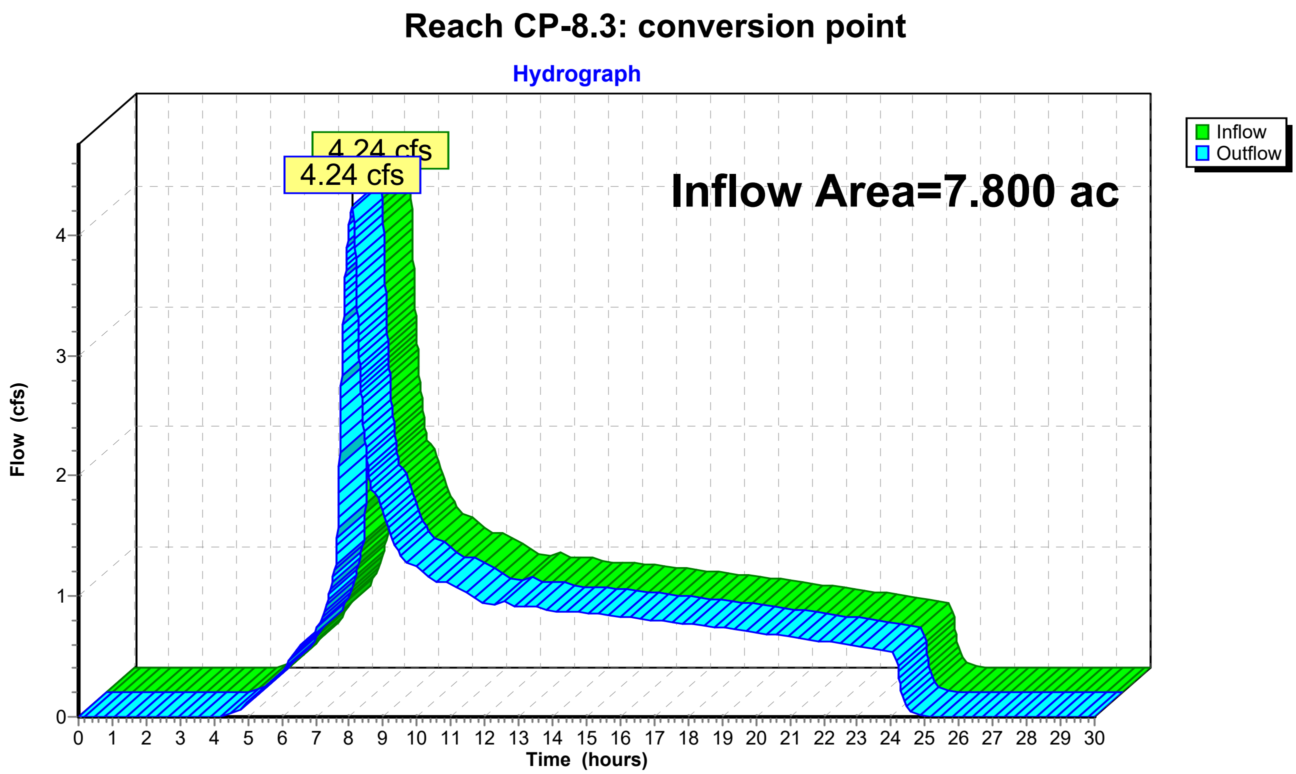


Summary for Reach CP-8.3: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	7.800 ac,	0.00% Impervious, Inflow Depth = 2.29"	for 25-year event	
Inflow =	4.24 cfs @	8.08 hrs, Volume=	1.490 af	
Outflow =	4.24 cfs @	8.08 hrs, Volume=	1.490 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



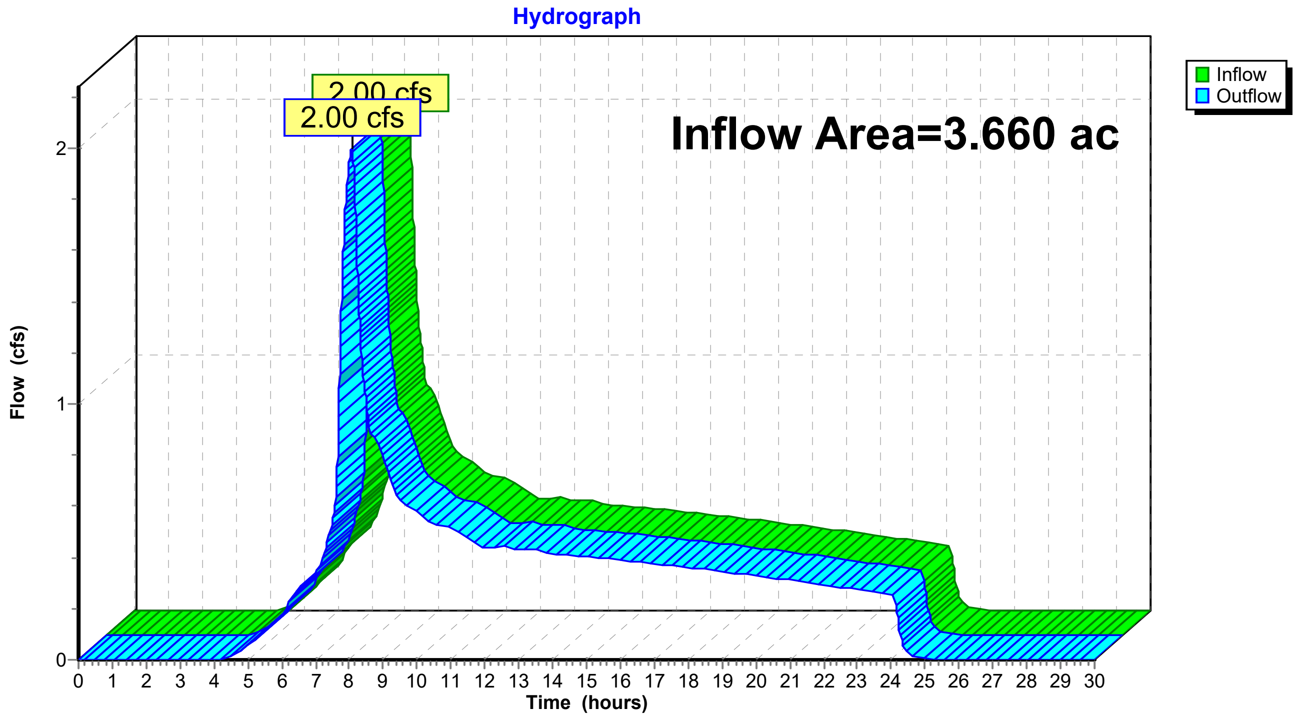
Summary for Reach CP-9.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.660 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.00 cfs @ 8.07 hrs, Volume= 0.699 af
Outflow = 2.00 cfs @ 8.07 hrs, Volume= 0.699 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-9.1: (new Reach)



Summary for Reach CULV-1: (new Reach)

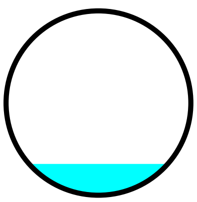
[52] Hint: Inlet/Outlet conditions not evaluated
[81] Warning: Exceeded Pond DI-1 by 0.06' @ 8.94 hrs

Inflow Area = 5.790 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.15 cfs @ 8.05 hrs, Volume= 1.106 af
Outflow = 3.15 cfs @ 8.05 hrs, Volume= 1.106 af, Atten= 0%, Lag= 0.2 min

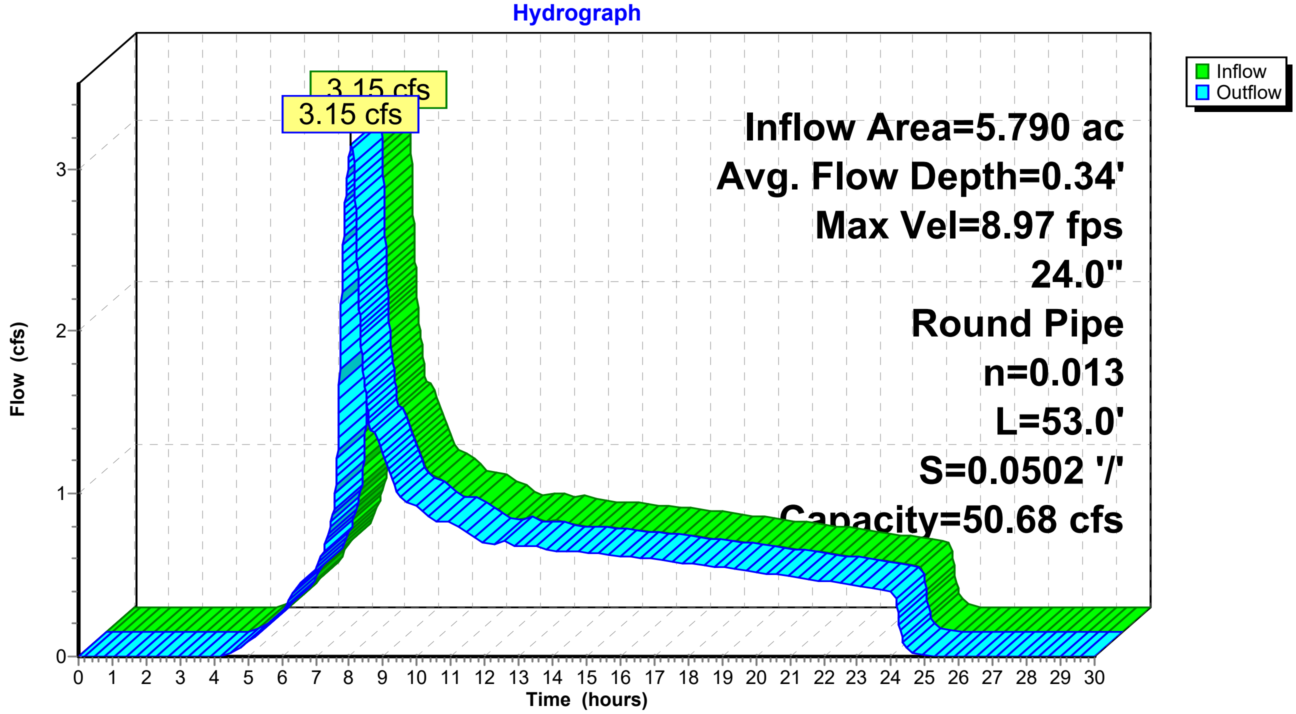
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.97 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.00 fps, Avg. Travel Time= 0.2 min

Peak Storage= 19 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 50.68 cfs

24.0" Round Pipe
n= 0.013
Length= 53.0' Slope= 0.0502 '/'
Inlet Invert= 150.97', Outlet Invert= 148.31'



Reach CULV-1: (new Reach)



Summary for Reach CULV-2: (new Reach)

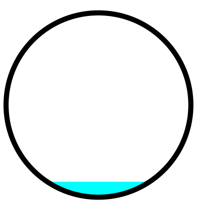
[52] Hint: Inlet/Outlet conditions not evaluated
[81] Warning: Exceeded Pond DI-2 by 0.10' @ 8.00 hrs

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.83 cfs @ 7.98 hrs, Volume= 0.287 af
Outflow = 0.83 cfs @ 7.99 hrs, Volume= 0.287 af, Atten= 0%, Lag= 0.9 min

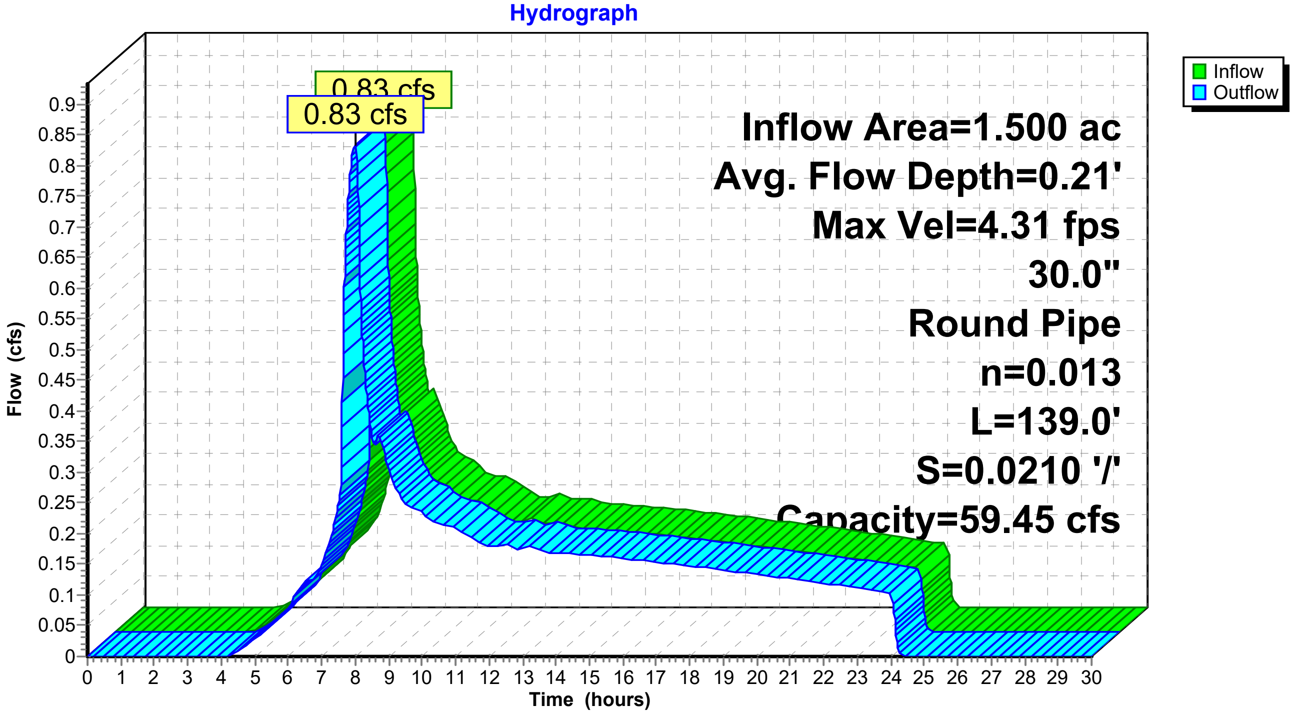
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.31 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 2.56 fps, Avg. Travel Time= 0.9 min

Peak Storage= 27 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.21'
Bank-Full Depth= 2.50' Flow Area= 4.9 sf, Capacity= 59.45 cfs

30.0" Round Pipe
n= 0.013
Length= 139.0' Slope= 0.0210 '/'
Inlet Invert= 151.71', Outlet Invert= 148.79'



Reach CULV-2: (new Reach)



Summary for Reach CULV-2.2: (new Reach)

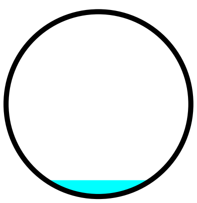
[52] Hint: Inlet/Outlet conditions not evaluated

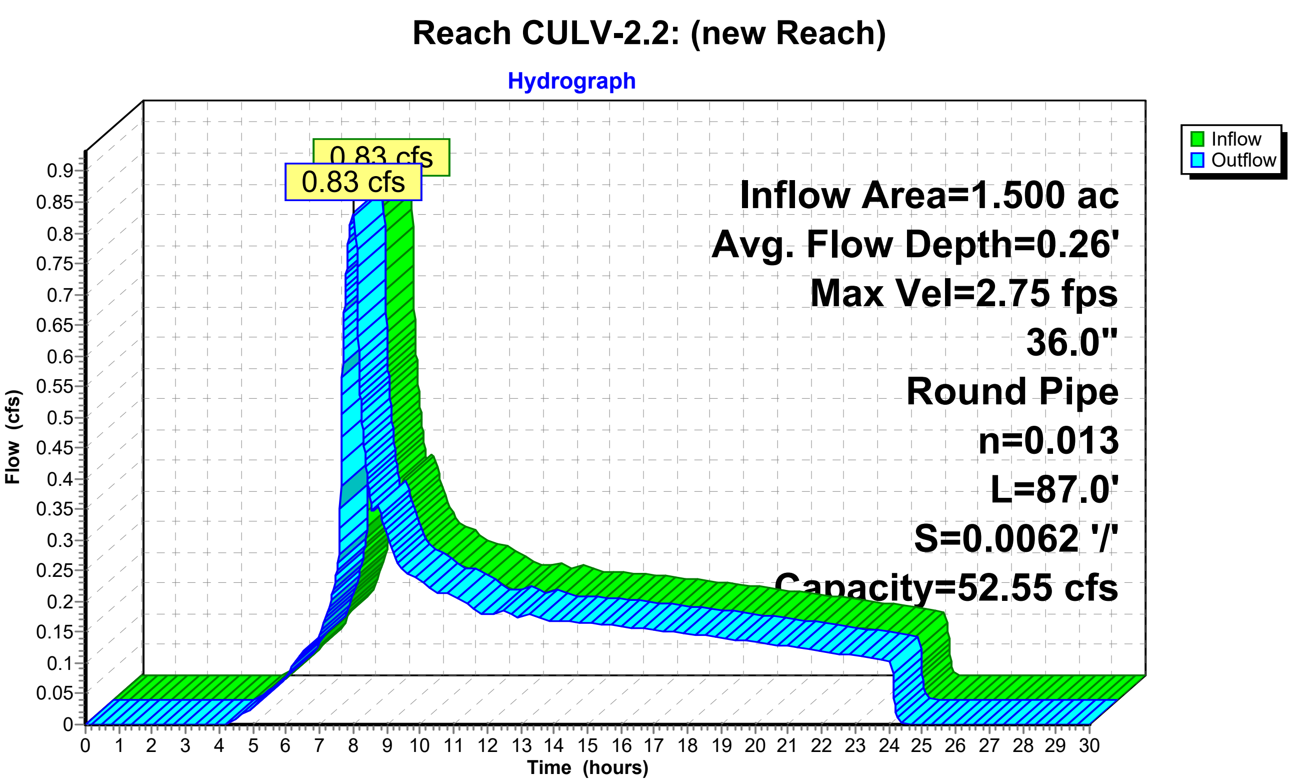
Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.83 cfs @ 7.99 hrs, Volume= 0.287 af
Outflow = 0.83 cfs @ 8.01 hrs, Volume= 0.287 af, Atten= 0%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.75 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.62 fps, Avg. Travel Time= 0.9 min

Peak Storage= 26 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 52.55 cfs

36.0" Round Pipe
n= 0.013
Length= 87.0' Slope= 0.0062 '/'
Inlet Invert= 148.79', Outlet Invert= 148.25'





Summary for Reach CULV-3: (new Reach)

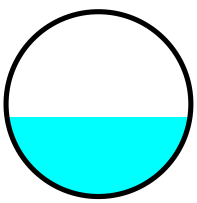
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 12.580 ac, 5.01% Impervious, Inflow Depth = 2.37" for 25-year event
Inflow = 7.17 cfs @ 8.05 hrs, Volume= 2.484 af
Outflow = 7.17 cfs @ 8.07 hrs, Volume= 2.484 af, Atten= 0%, Lag= 1.0 min

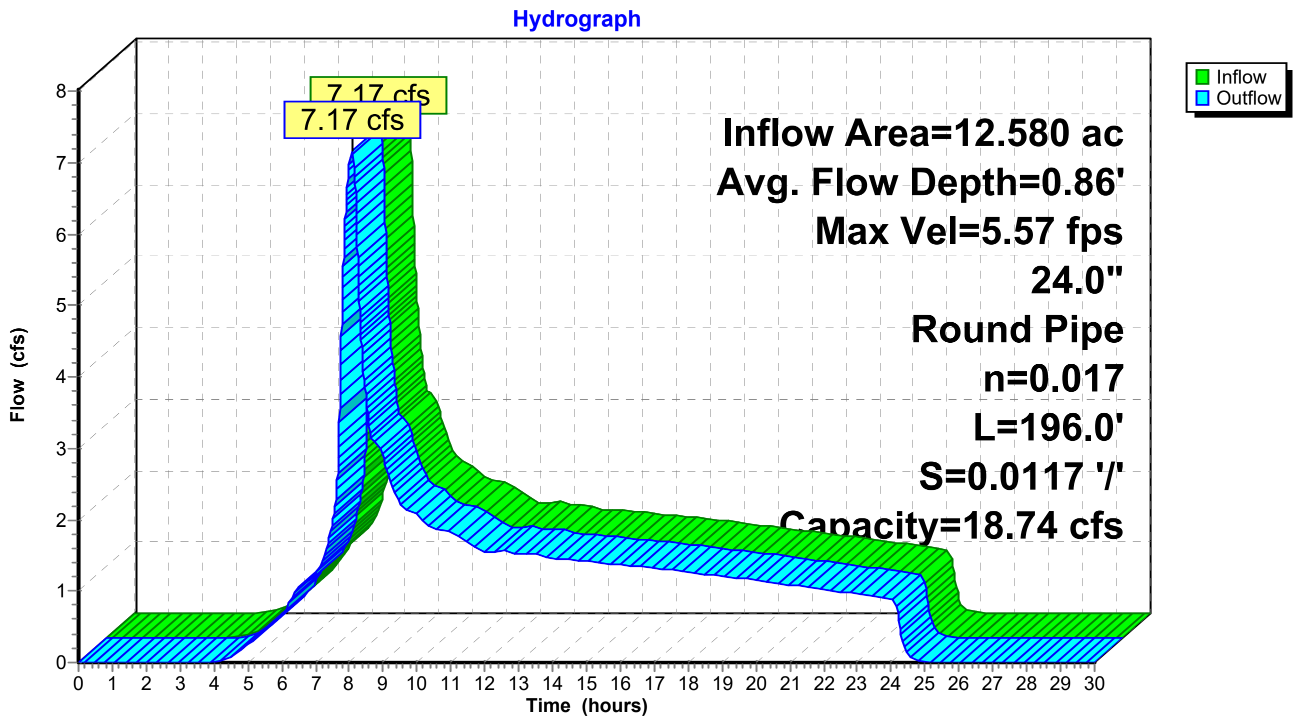
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.57 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 2.90 fps, Avg. Travel Time= 1.1 min

Peak Storage= 252 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.86'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 18.74 cfs

24.0" Round Pipe
n= 0.017
Length= 196.0' Slope= 0.0117 '/'
Inlet Invert= 140.30', Outlet Invert= 138.00'



Reach CULV-3: (new Reach)



Summary for Reach CULV-4: (new Reach)

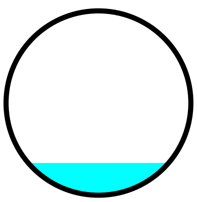
[52] Hint: Inlet/Outlet conditions not evaluated
[81] Warning: Exceeded Pond 1P by 0.07' @ 8.54 hrs

Inflow Area = 5.500 ac, 5.64% Impervious, Inflow Depth = 2.38" for 25-year event
Inflow = 3.16 cfs @ 8.07 hrs, Volume= 1.090 af
Outflow = 3.16 cfs @ 8.07 hrs, Volume= 1.090 af, Atten= 0%, Lag= 0.2 min

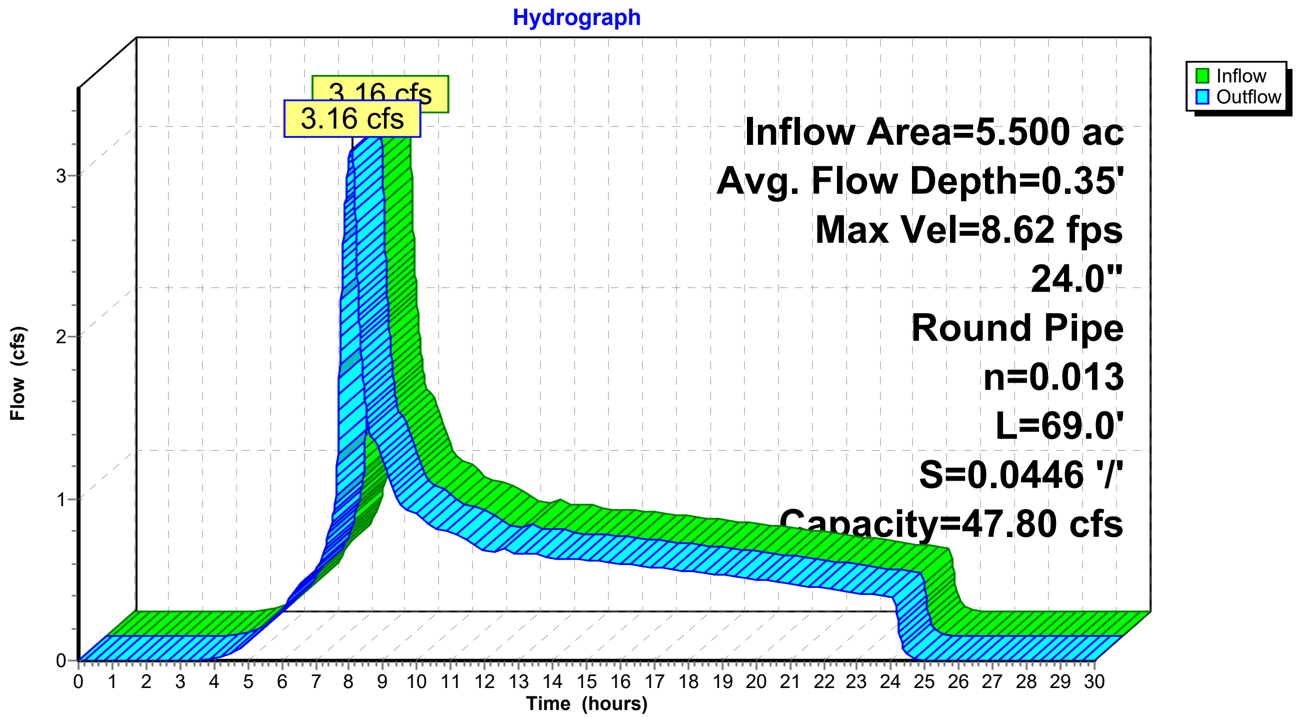
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.62 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.71 fps, Avg. Travel Time= 0.2 min

Peak Storage= 25 cf @ 8.07 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 47.80 cfs

24.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 69.0' Slope= 0.0446 '/'
Inlet Invert= 231.41', Outlet Invert= 228.33'



Reach CULV-4: (new Reach)



Summary for Reach CULV-5: (new Reach)

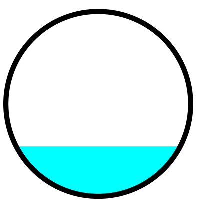
[52] Hint: Inlet/Outlet conditions not evaluated

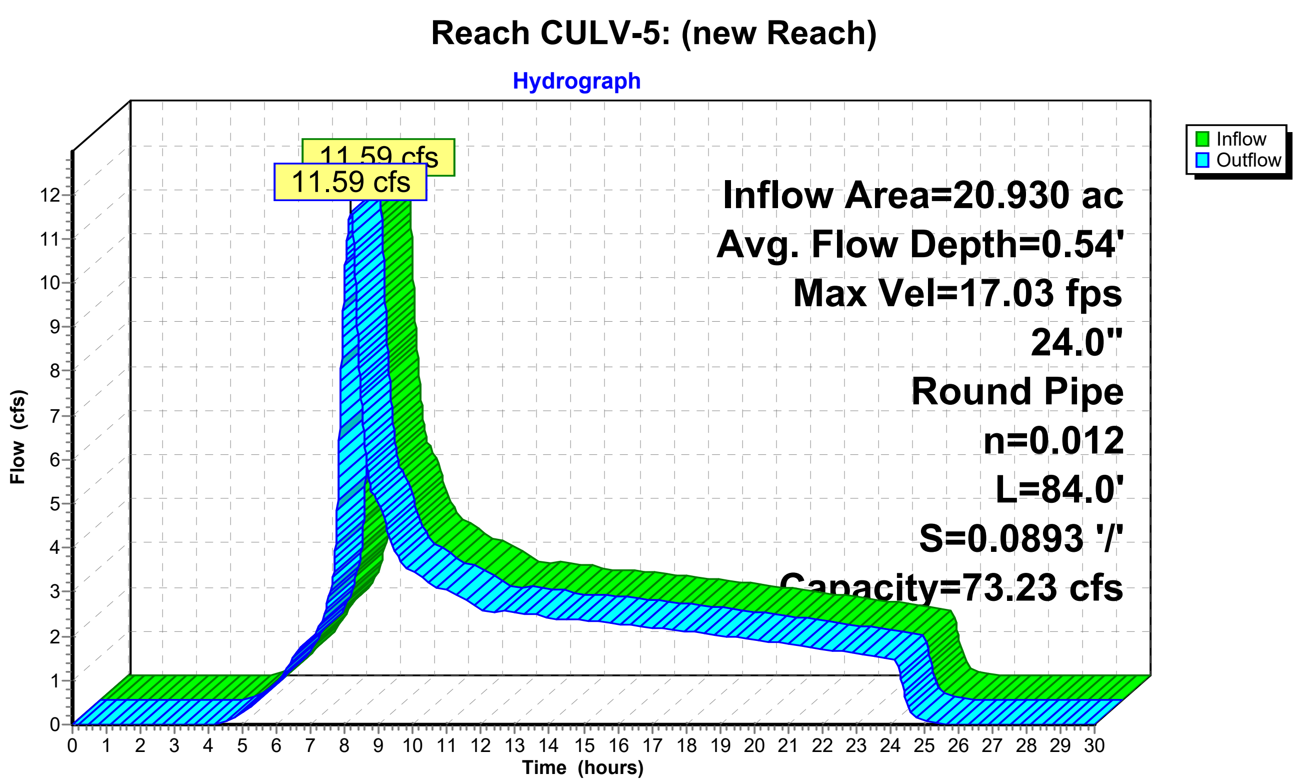
Inflow Area = 20.930 ac, 4.11% Impervious, Inflow Depth = 2.35" for 25-year event
Inflow = 11.59 cfs @ 8.17 hrs, Volume= 4.107 af
Outflow = 11.59 cfs @ 8.17 hrs, Volume= 4.107 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 17.03 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 8.79 fps, Avg. Travel Time= 0.2 min

Peak Storage= 57 cf @ 8.17 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 73.23 cfs

24.0" Round Pipe
n= 0.012 Corrugated PP, smooth interior
Length= 84.0' Slope= 0.0893 '/'
Inlet Invert= 153.00', Outlet Invert= 145.50'





Summary for Reach CULV-7: (new Reach)

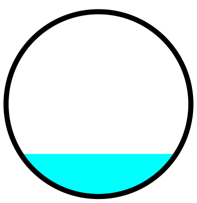
[52] Hint: Inlet/Outlet conditions not evaluated

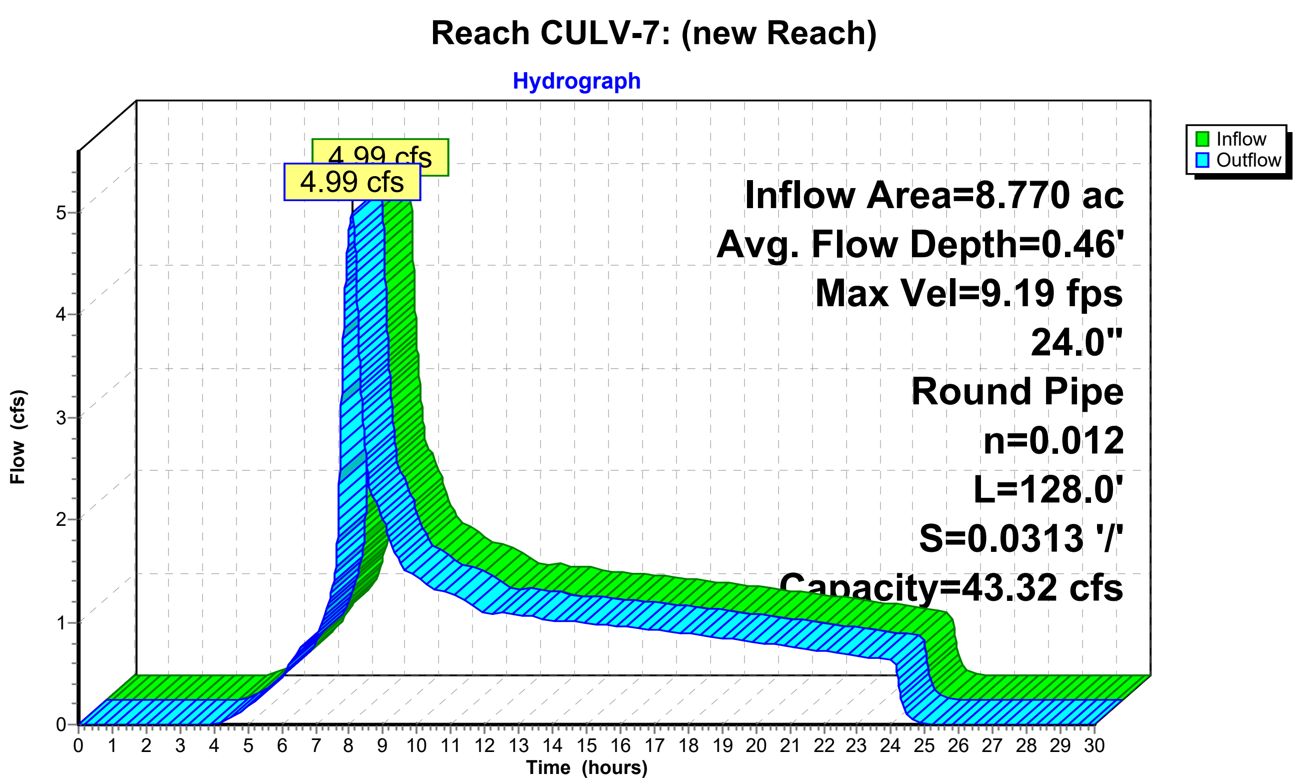
Inflow Area = 8.770 ac, 5.70% Impervious, Inflow Depth = 2.38" for 25-year event
Inflow = 4.99 cfs @ 8.07 hrs, Volume= 1.739 af
Outflow = 4.99 cfs @ 8.08 hrs, Volume= 1.739 af, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.19 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 4.88 fps, Avg. Travel Time= 0.4 min

Peak Storage= 70 cf @ 8.08 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 43.32 cfs

24.0" Round Pipe
n= 0.012
Length= 128.0' Slope= 0.0313 '/'
Inlet Invert= 162.00', Outlet Invert= 158.00'





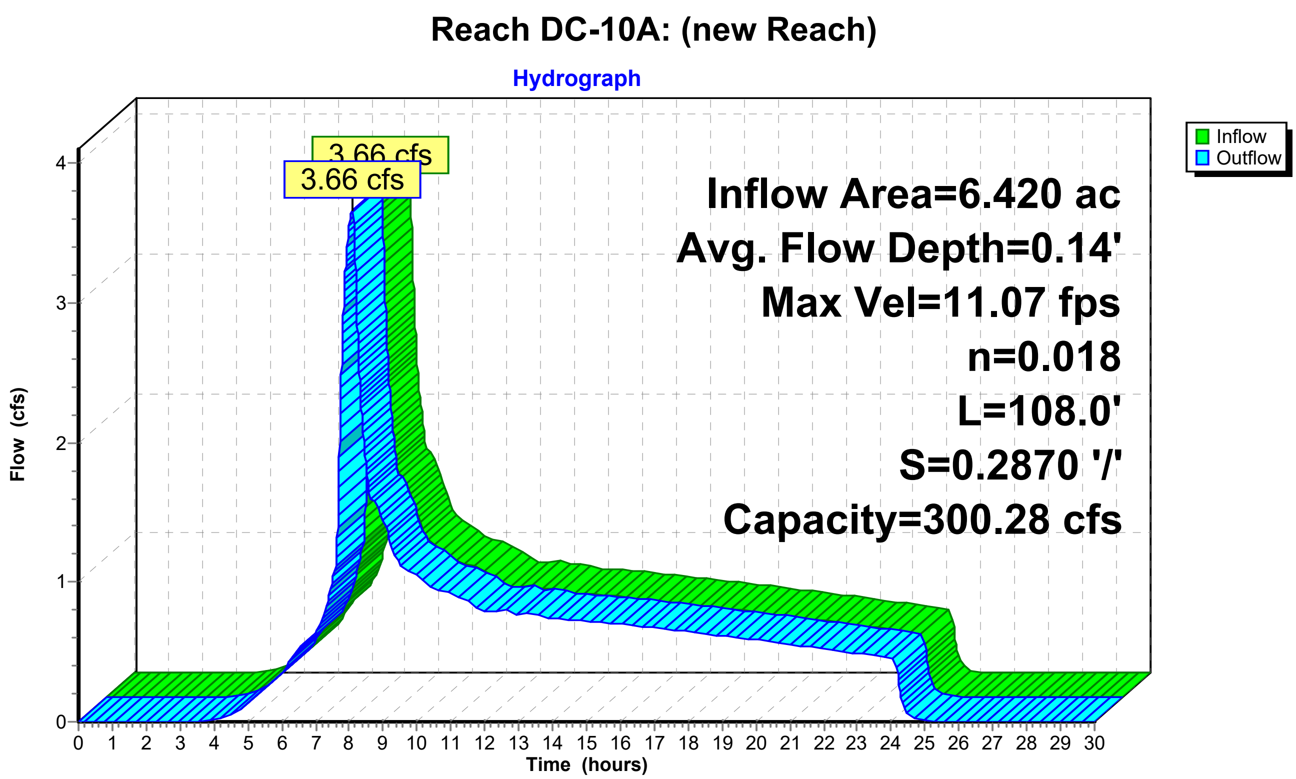
Summary for Reach DC-10A: (new Reach)

Inflow Area = 6.420 ac, 4.83% Impervious, Inflow Depth = 2.37" for 25-year event
Inflow = 3.66 cfs @ 8.08 hrs, Volume= 1.266 af
Outflow = 3.66 cfs @ 8.08 hrs, Volume= 1.266 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.07 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 5.66 fps, Avg. Travel Time= 0.3 min

Peak Storage= 36 cf @ 8.08 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 300.28 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 108.0' Slope= 0.2870 '/'
Inlet Invert= 228.00', Outlet Invert= 197.00'



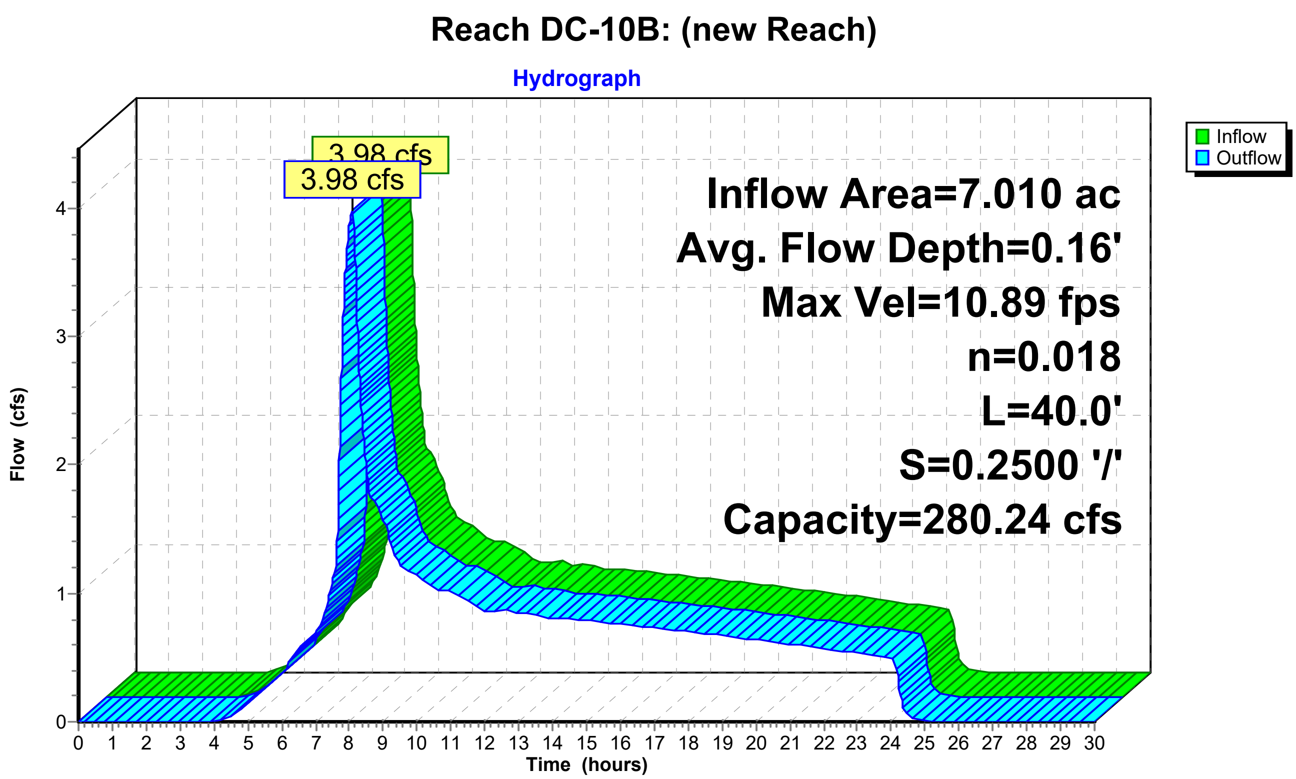
Summary for Reach DC-10B: (new Reach)

Inflow Area = 7.010 ac, 4.42% Impervious, Inflow Depth = 2.36" for 25-year event
Inflow = 3.98 cfs @ 8.08 hrs, Volume= 1.378 af
Outflow = 3.98 cfs @ 8.08 hrs, Volume= 1.378 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.89 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.55 fps, Avg. Travel Time= 0.1 min

Peak Storage= 15 cf @ 8.08 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 280.24 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 40.0' Slope= 0.2500 '/'
Inlet Invert= 197.00', Outlet Invert= 187.00'



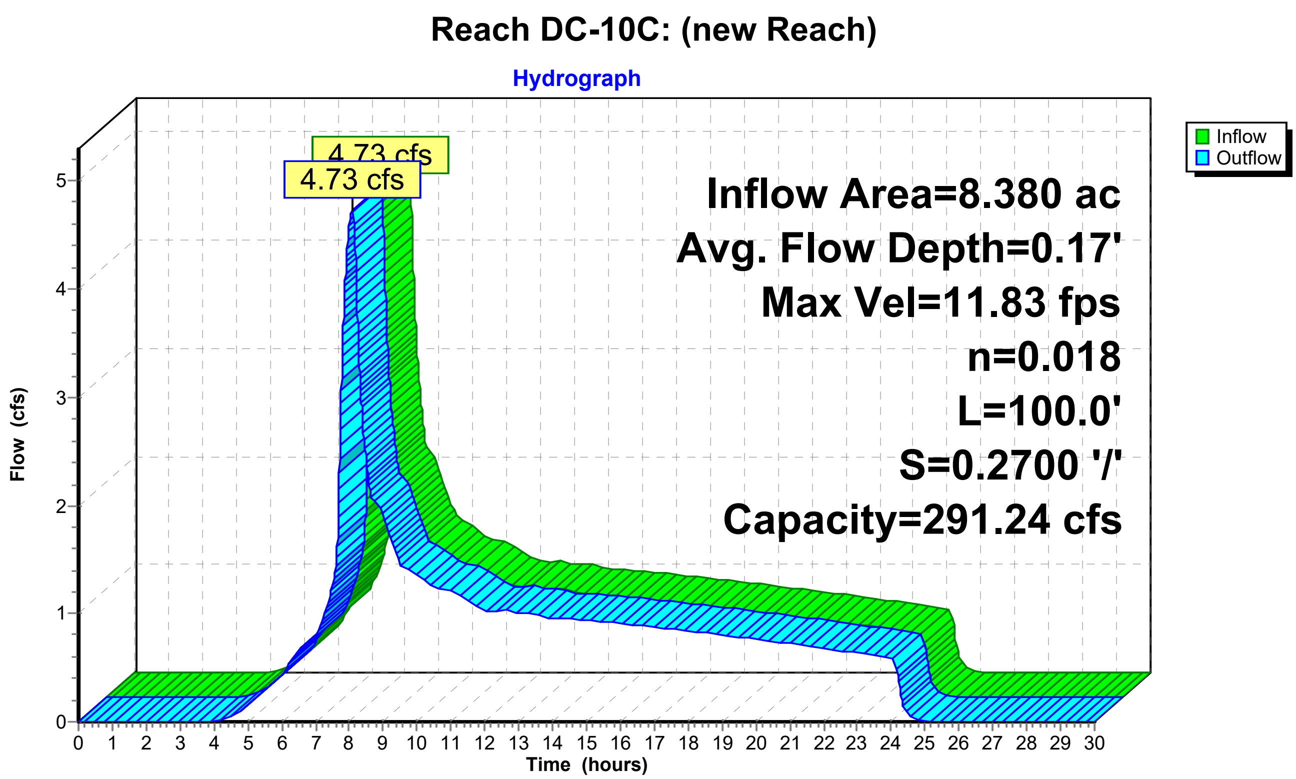
Summary for Reach DC-10C: (new Reach)

Inflow Area = 8.380 ac, 3.70% Impervious, Inflow Depth = 2.35" for 25-year event
Inflow = 4.73 cfs @ 8.09 hrs, Volume= 1.640 af
Outflow = 4.73 cfs @ 8.09 hrs, Volume= 1.640 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.83 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.02 fps, Avg. Travel Time= 0.3 min

Peak Storage= 40 cf @ 8.09 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 291.24 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 100.0' Slope= 0.2700 '/'
Inlet Invert= 187.00', Outlet Invert= 160.00'



Summary for Reach DC-11A: (new Reach)

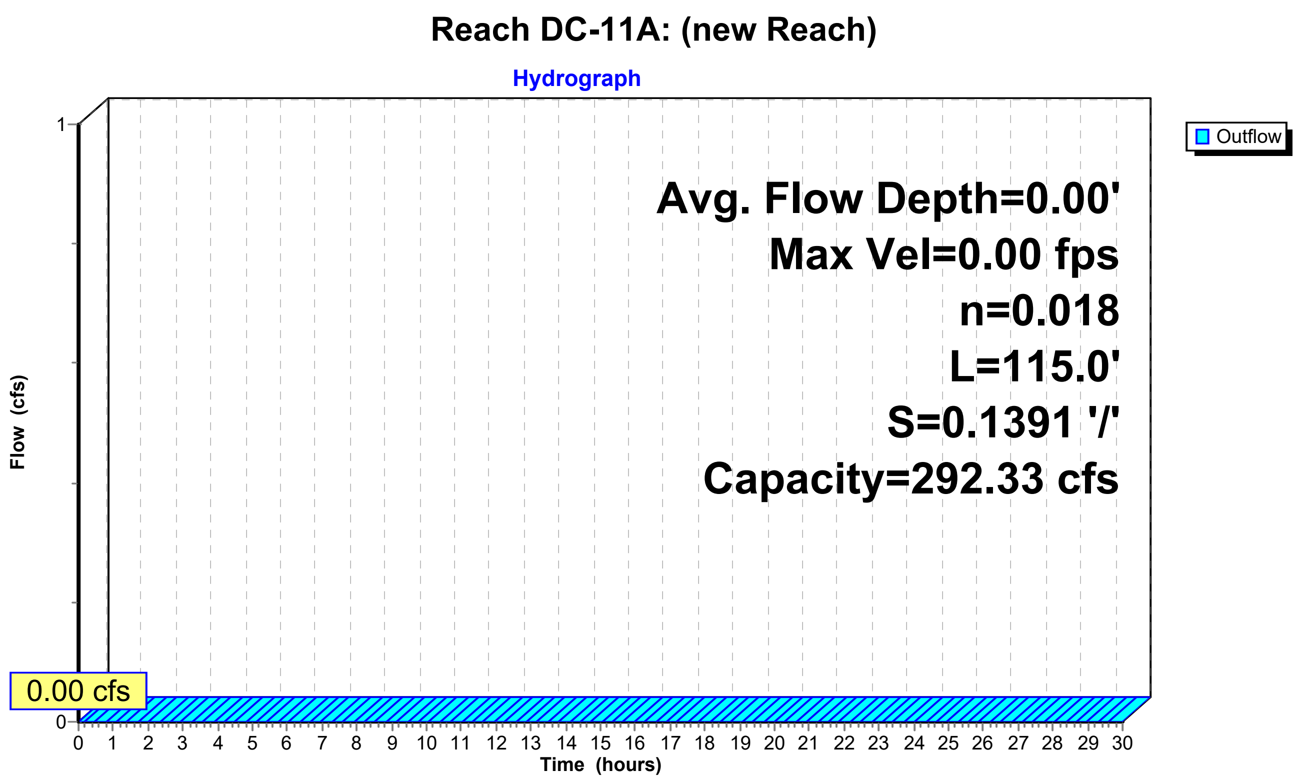
[43] Hint: Has no inflow (Outflow=Zero)

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.75' Flow Area= 9.6 sf, Capacity= 292.33 cfs

2.00' x 1.75' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 115.0' Slope= 0.1391 '/'
Inlet Invert= 281.00', Outlet Invert= 265.00'



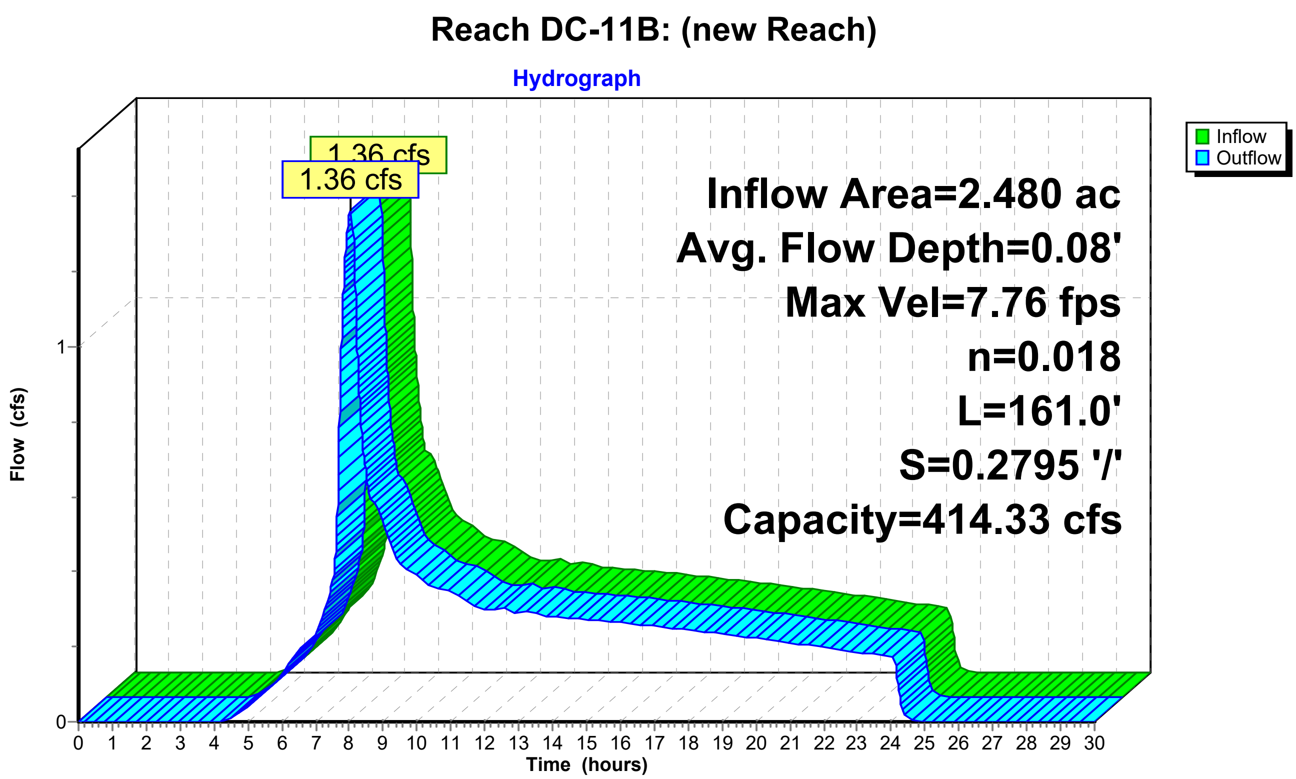
Summary for Reach DC-11B: (new Reach)

Inflow Area = 2.480 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.36 cfs @ 8.04 hrs, Volume= 0.474 af
Outflow = 1.36 cfs @ 8.05 hrs, Volume= 0.474 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.76 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 4.19 fps, Avg. Travel Time= 0.6 min

Peak Storage= 28 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.75' Flow Area= 9.6 sf, Capacity= 414.33 cfs

2.00' x 1.75' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 161.0' Slope= 0.2795 '/'
Inlet Invert= 265.00', Outlet Invert= 220.00'



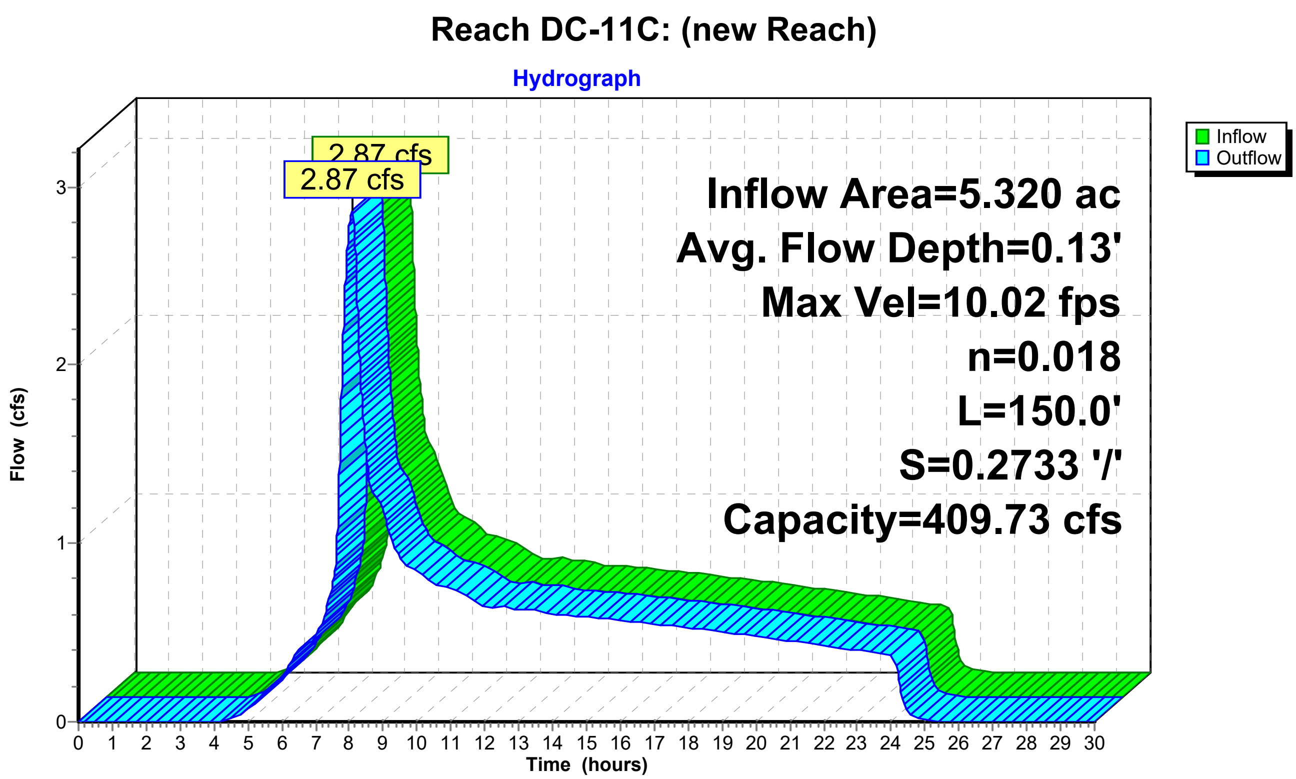
Summary for Reach DC-11C: (new Reach)

Inflow Area = 5.320 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.87 cfs @ 8.07 hrs, Volume= 1.016 af
Outflow = 2.87 cfs @ 8.07 hrs, Volume= 1.016 af, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.02 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 5.25 fps, Avg. Travel Time= 0.5 min

Peak Storage= 43 cf @ 8.07 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.75' Flow Area= 9.6 sf, Capacity= 409.73 cfs

2.00' x 1.75' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 150.0' Slope= 0.2733 '/'
Inlet Invert= 220.00', Outlet Invert= 179.00'



Summary for Reach DC-11D: (new Reach)

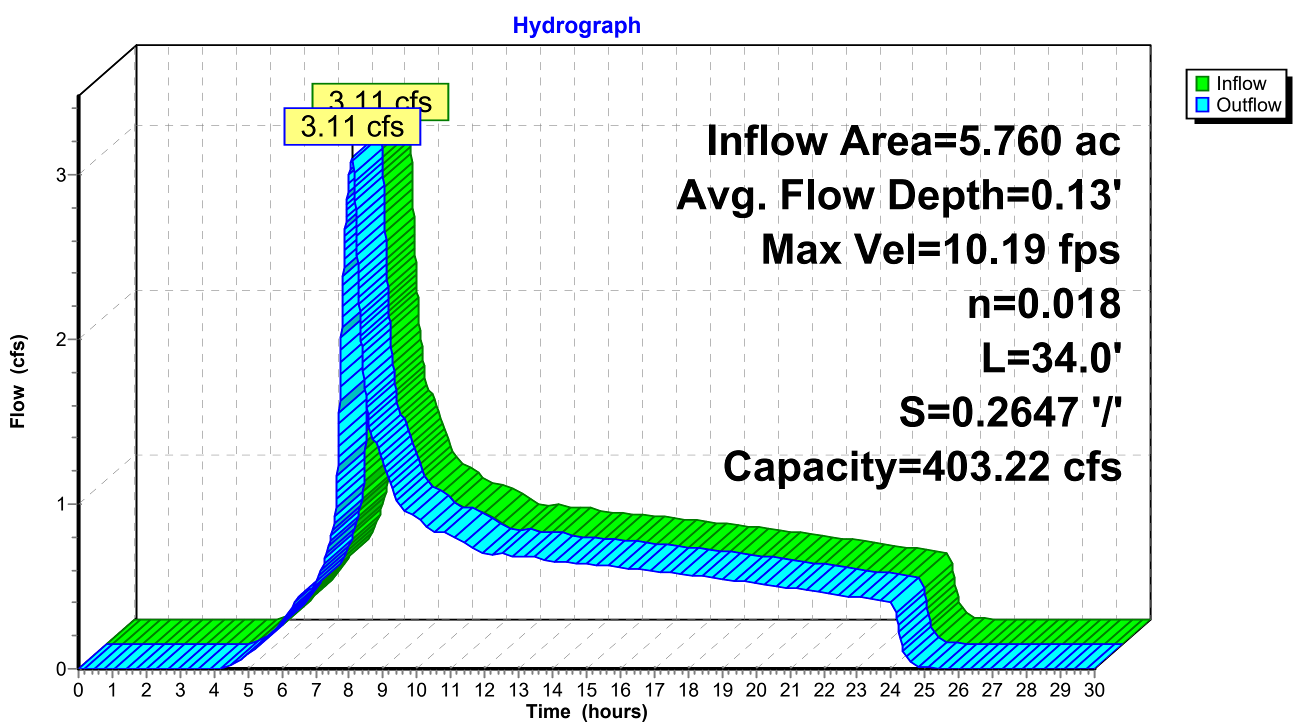
Inflow Area = 5.760 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.11 cfs @ 8.07 hrs, Volume= 1.100 af
Outflow = 3.11 cfs @ 8.07 hrs, Volume= 1.100 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.19 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.33 fps, Avg. Travel Time= 0.1 min

Peak Storage= 10 cf @ 8.07 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.75' Flow Area= 9.6 sf, Capacity= 403.22 cfs

2.00' x 1.75' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 34.0' Slope= 0.2647 '/'
Inlet Invert= 179.00', Outlet Invert= 170.00'

Reach DC-11D: (new Reach)



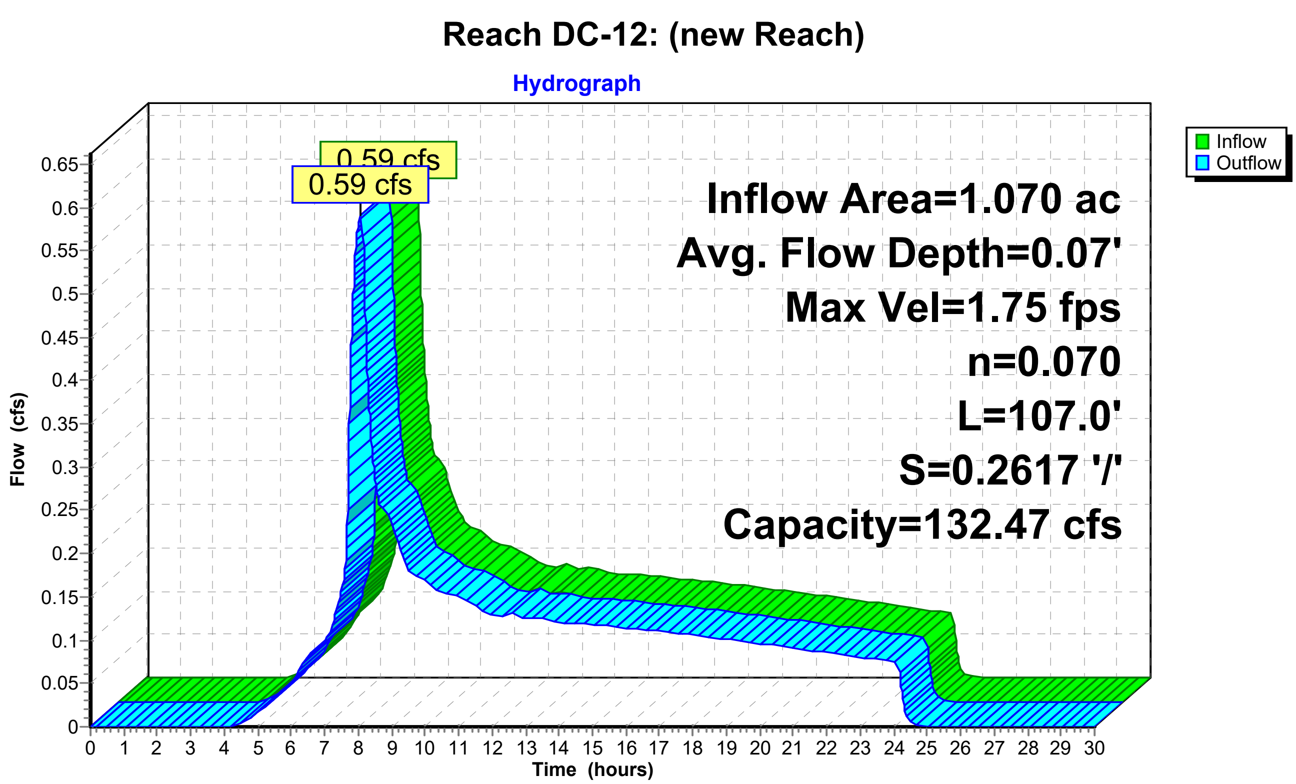
Summary for Reach DC-12: (new Reach)

Inflow Area = 1.070 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.59 cfs @ 8.06 hrs, Volume= 0.204 af
Outflow = 0.59 cfs @ 8.09 hrs, Volume= 0.204 af, Atten= 0%, Lag= 1.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.75 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 0.92 fps, Avg. Travel Time= 1.9 min

Peak Storage= 36 cf @ 8.07 hrs
Average Depth at Peak Storage= 0.07'
Bank-Full Depth= 1.50' Flow Area= 12.0 sf, Capacity= 132.47 cfs

5.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 11.00'
Length= 107.0' Slope= 0.2617 '/'
Inlet Invert= 152.00', Outlet Invert= 124.00'



Summary for Reach DC-1A: (new Reach)

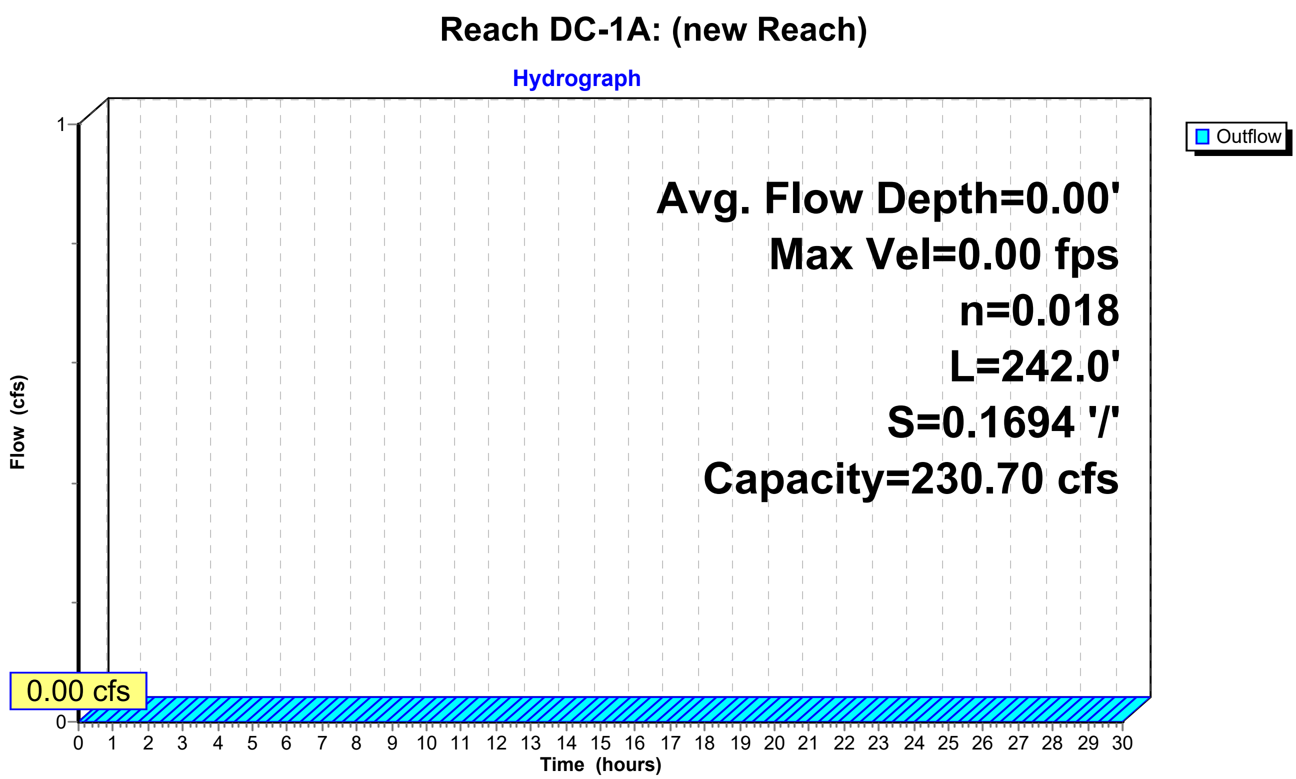
[43] Hint: Has no inflow (Outflow=Zero)

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 230.70 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 242.0' Slope= 0.1694 '/'
Inlet Invert= 281.00', Outlet Invert= 240.00'



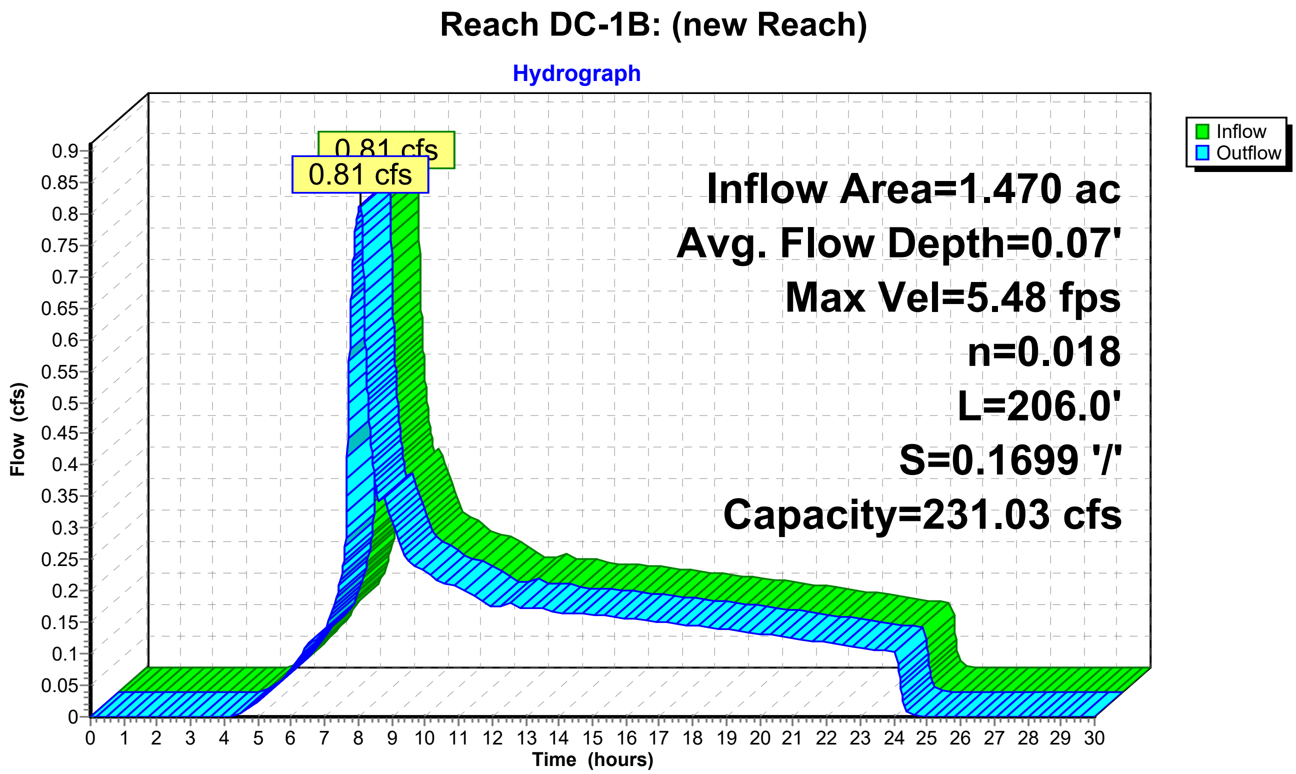
Summary for Reach DC-1B: (new Reach)

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.81 cfs @ 8.04 hrs, Volume= 0.281 af
Outflow = 0.81 cfs @ 8.05 hrs, Volume= 0.281 af, Atten= 0%, Lag= 1.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.48 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 2.96 fps, Avg. Travel Time= 1.2 min

Peak Storage= 31 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.07'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 231.03 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 206.0' Slope= 0.1699 '/'
Inlet Invert= 240.00', Outlet Invert= 205.00'



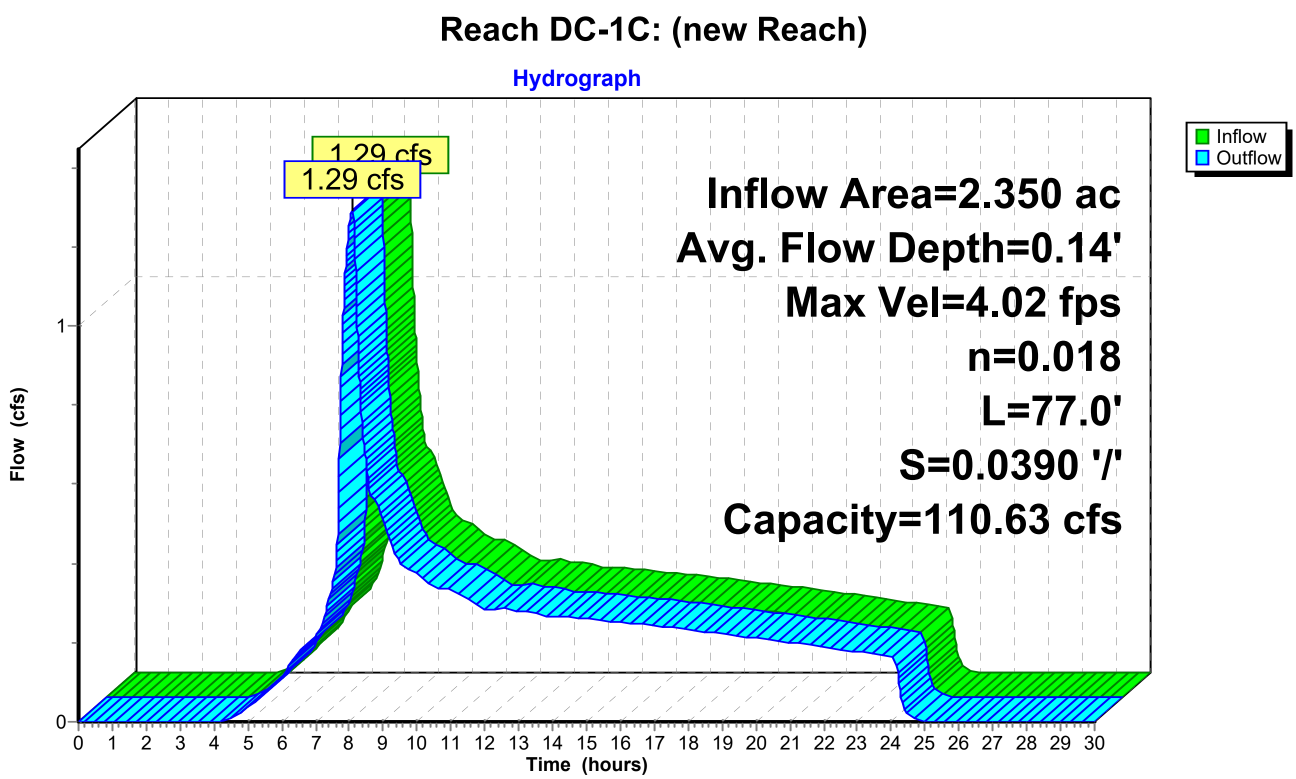
Summary for Reach DC-1C: (new Reach)

Inflow Area = 2.350 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.29 cfs @ 8.07 hrs, Volume= 0.449 af
Outflow = 1.29 cfs @ 8.08 hrs, Volume= 0.449 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.02 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.09 fps, Avg. Travel Time= 0.6 min

Peak Storage= 25 cf @ 8.08 hrs
Average Depth at Peak Storage= 0.14'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 110.63 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 77.0' Slope= 0.0390 '/'
Inlet Invert= 205.00', Outlet Invert= 202.00'



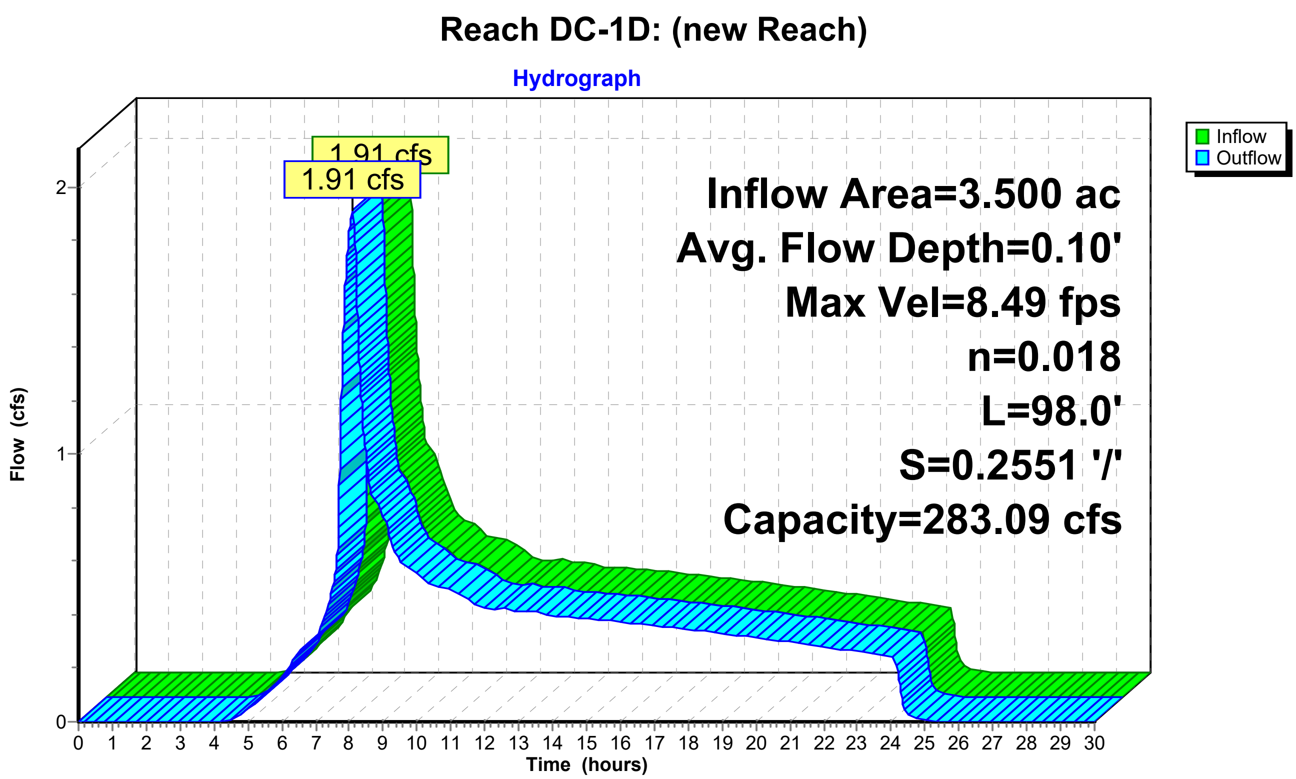
Summary for Reach DC-1D: (new Reach)

Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.91 cfs @ 8.09 hrs, Volume= 0.669 af
Outflow = 1.91 cfs @ 8.10 hrs, Volume= 0.669 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.49 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 4.45 fps, Avg. Travel Time= 0.4 min

Peak Storage= 22 cf @ 8.09 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 283.09 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 98.0' Slope= 0.2551 '/'
Inlet Invert= 202.00', Outlet Invert= 177.00'



Summary for Reach DC-2A: (new Reach)

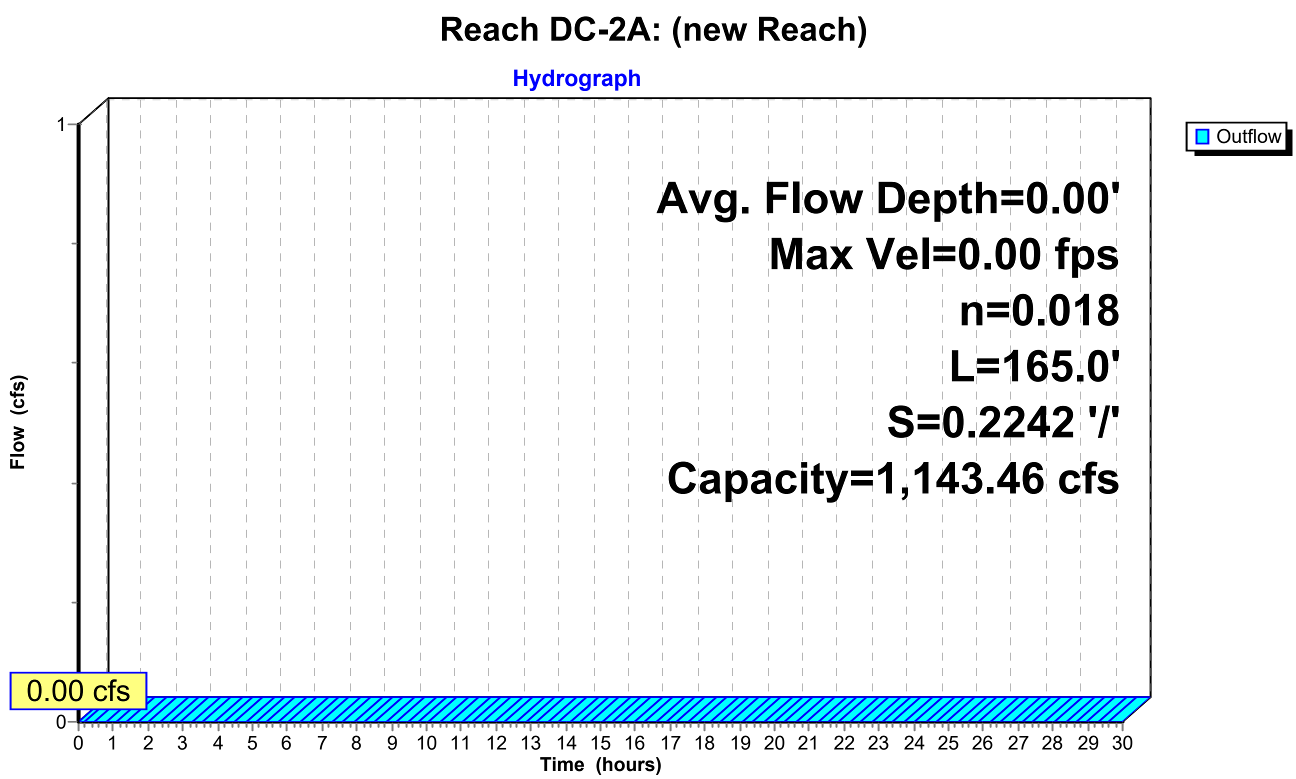
[43] Hint: Has no inflow (Outflow=Zero)

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,143.46 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 165.0' Slope= 0.2242 '/'
Inlet Invert= 275.00', Outlet Invert= 238.00'



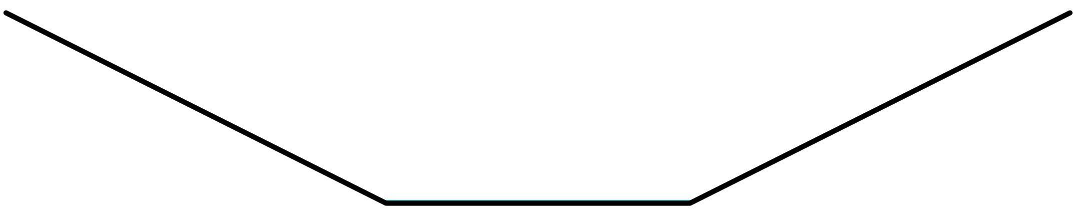
Summary for Reach DC-2B: (new Reach)

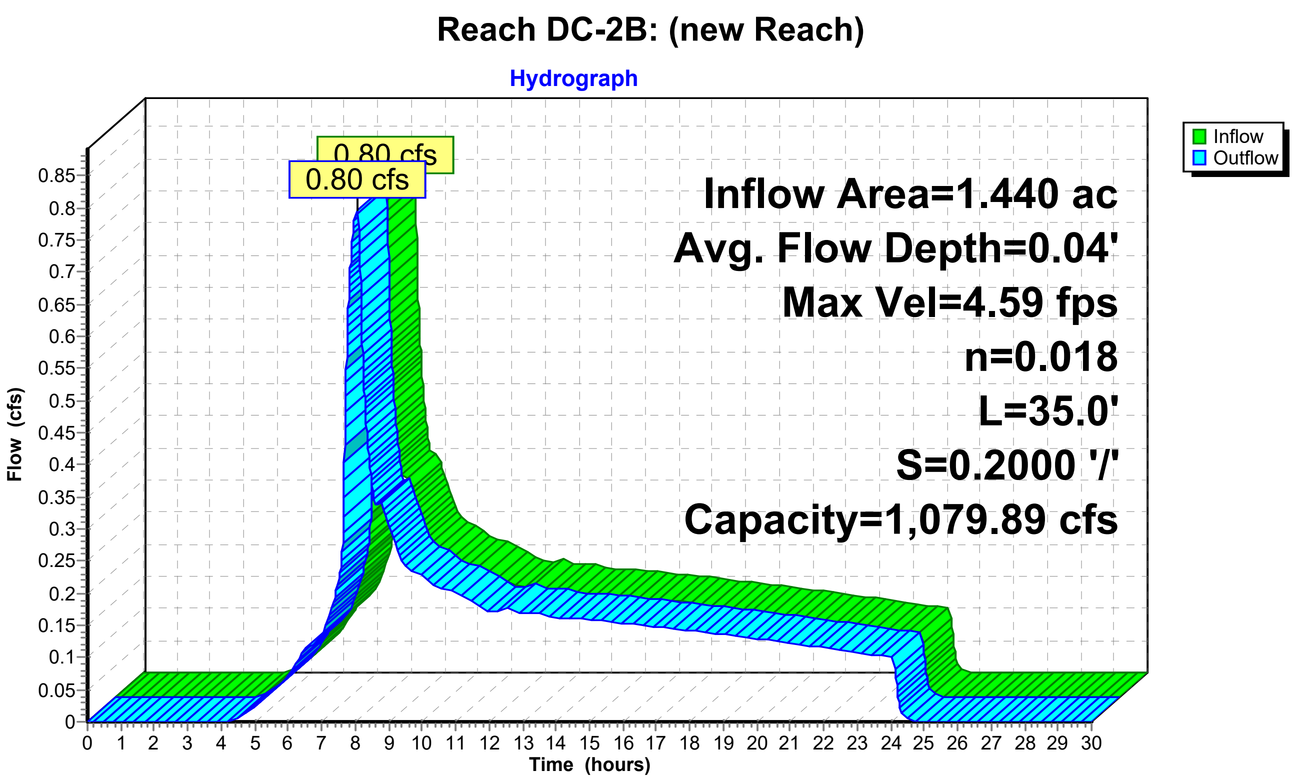
Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.80 cfs @ 8.05 hrs, Volume= 0.275 af
Outflow = 0.80 cfs @ 8.05 hrs, Volume= 0.275 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.59 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.17 fps, Avg. Travel Time= 0.2 min

Peak Storage= 6 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.04'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,079.89 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 35.0' Slope= 0.2000 '/'
Inlet Invert= 238.00', Outlet Invert= 231.00'





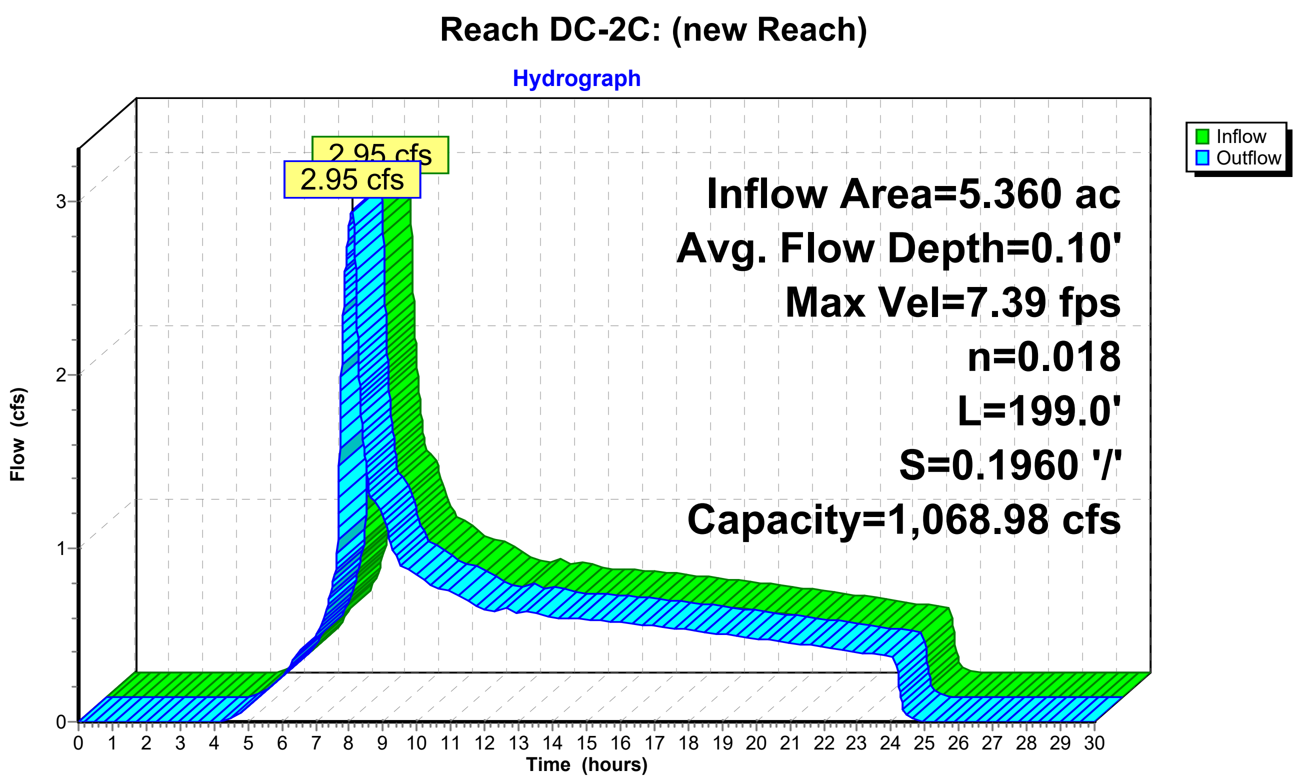
Summary for Reach DC-2C: (new Reach)

Inflow Area = 5.360 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.95 cfs @ 8.07 hrs, Volume= 1.024 af
Outflow = 2.95 cfs @ 8.09 hrs, Volume= 1.024 af, Atten= 0%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.39 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 3.99 fps, Avg. Travel Time= 0.8 min

Peak Storage= 79 cf @ 8.08 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,068.98 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 199.0' Slope= 0.1960 '/'
Inlet Invert= 231.00', Outlet Invert= 192.00'



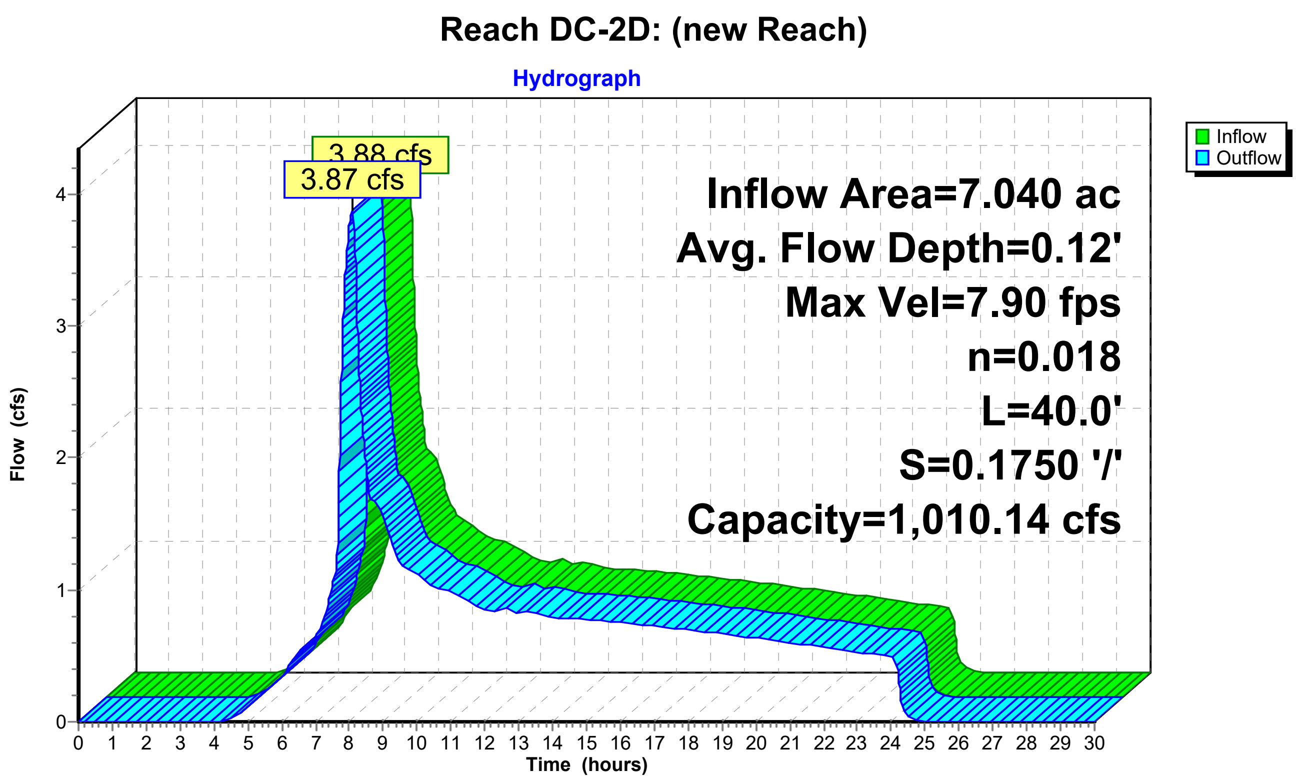
Summary for Reach DC-2D: (new Reach)

Inflow Area = 7.040 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.88 cfs @ 8.09 hrs, Volume= 1.345 af
Outflow = 3.87 cfs @ 8.09 hrs, Volume= 1.345 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.90 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.18 fps, Avg. Travel Time= 0.2 min

Peak Storage= 20 cf @ 8.09 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,010.14 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 40.0' Slope= 0.1750 '/'
Inlet Invert= 192.00', Outlet Invert= 185.00'



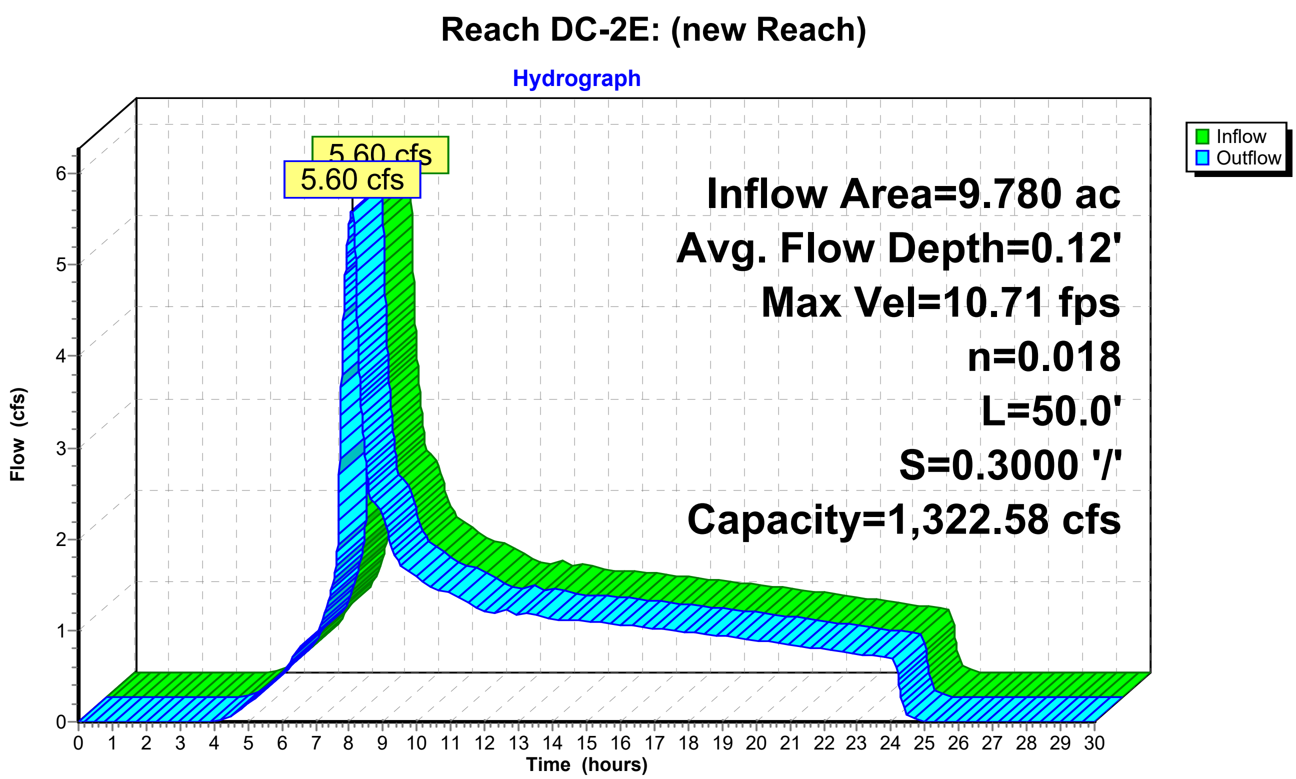
Summary for Reach DC-2E: (new Reach)

Inflow Area = 9.780 ac, 4.70% Impervious, Inflow Depth = 2.36" for 25-year event
Inflow = 5.60 cfs @ 8.09 hrs, Volume= 1.927 af
Outflow = 5.60 cfs @ 8.09 hrs, Volume= 1.927 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.71 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.57 fps, Avg. Travel Time= 0.1 min

Peak Storage= 26 cf @ 8.09 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,322.58 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 50.0' Slope= 0.3000 '/'
Inlet Invert= 185.00', Outlet Invert= 170.00'



Summary for Reach DC-4A: (new Reach)

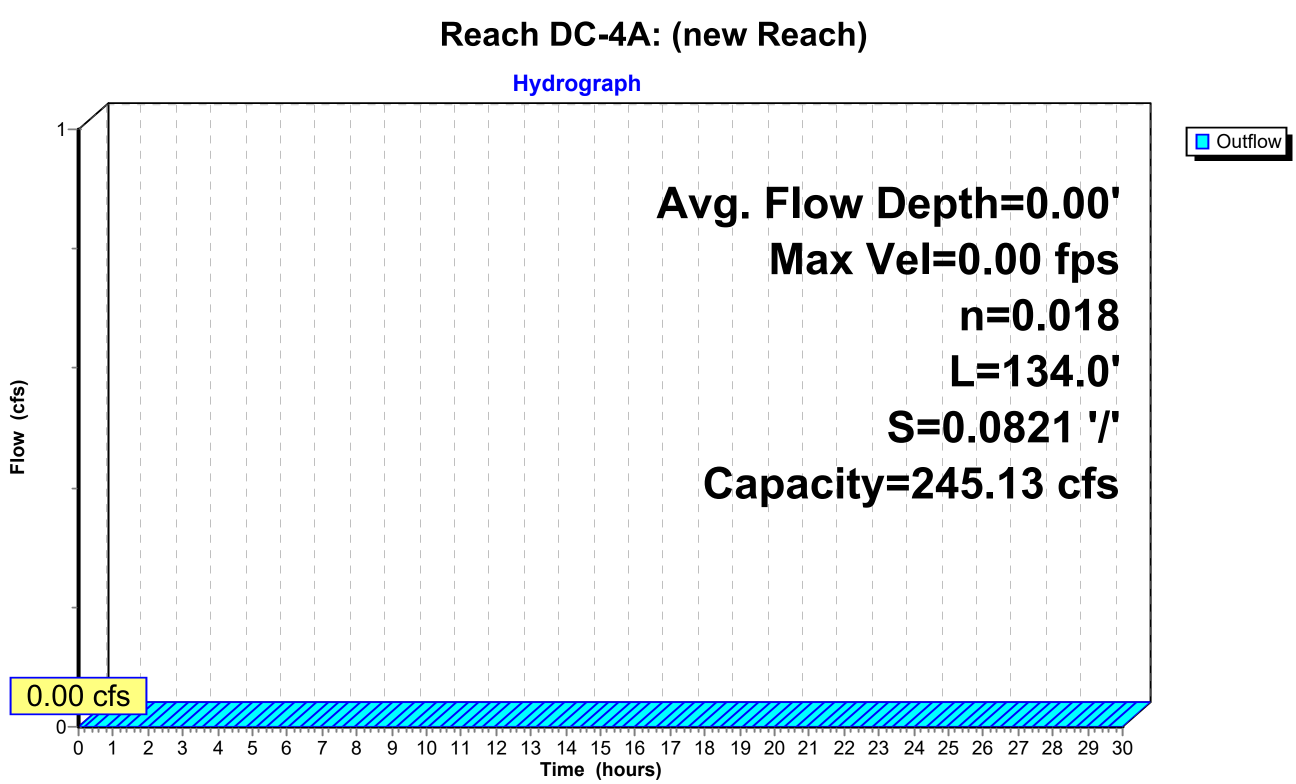
[43] Hint: Has no inflow (Outflow=Zero)

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 245.13 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 134.0' Slope= 0.0821 '/'
Inlet Invert= 280.00', Outlet Invert= 269.00'



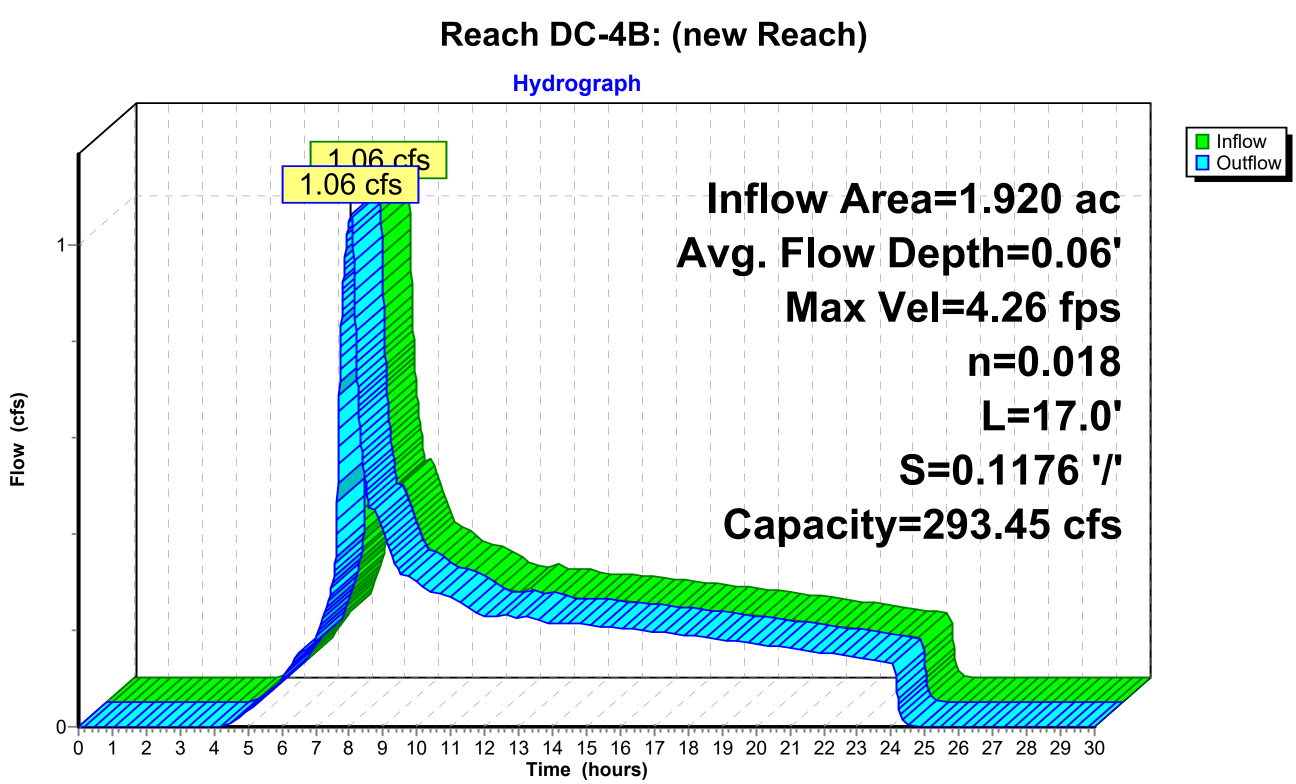
Summary for Reach DC-4B: (new Reach)

Inflow Area = 1.920 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.06 cfs @ 8.04 hrs, Volume= 0.367 af
Outflow = 1.06 cfs @ 8.04 hrs, Volume= 0.367 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.26 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.29 fps, Avg. Travel Time= 0.1 min

Peak Storage= 4 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 293.45 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 17.0' Slope= 0.1176 '/'
Inlet Invert= 269.00', Outlet Invert= 267.00'



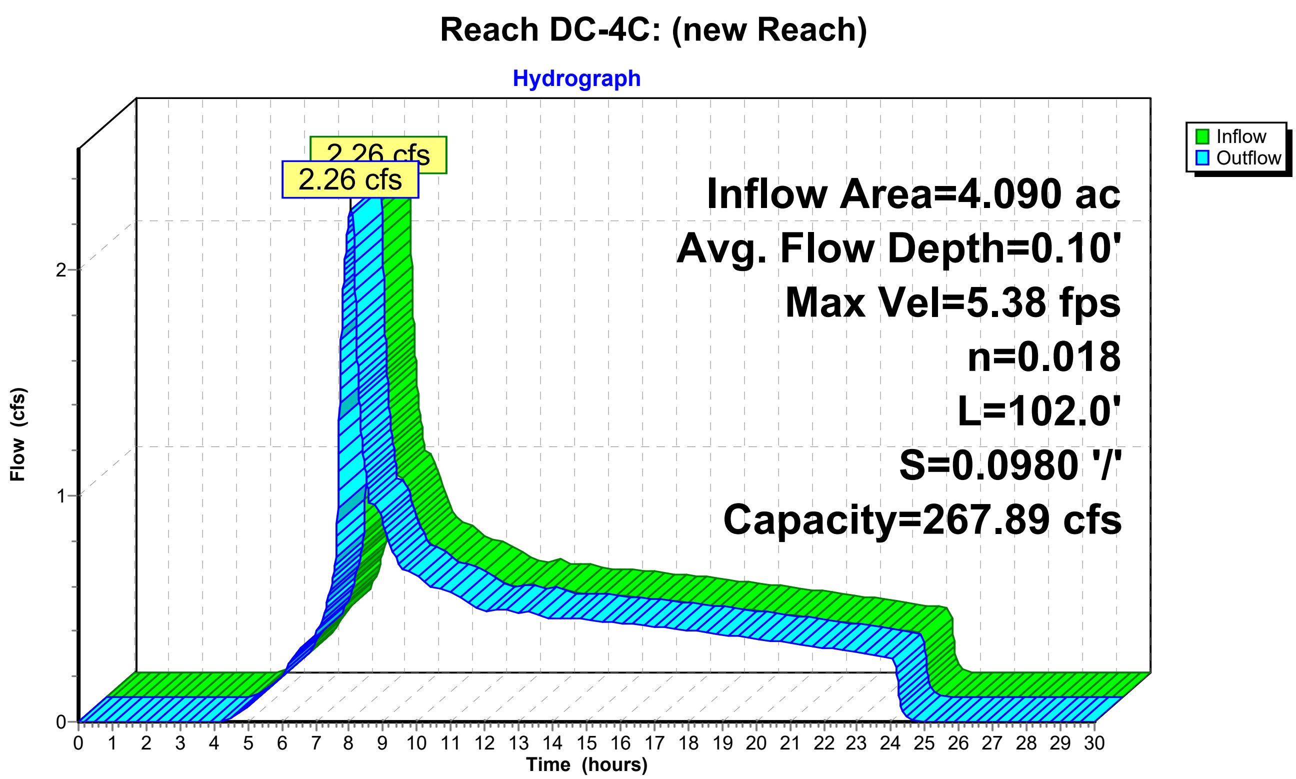
Summary for Reach DC-4C: (new Reach)

Inflow Area = 4.090 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.26 cfs @ 8.05 hrs, Volume= 0.781 af
Outflow = 2.26 cfs @ 8.06 hrs, Volume= 0.781 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.38 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.77 fps, Avg. Travel Time= 0.6 min

Peak Storage= 43 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 267.89 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 102.0' Slope= 0.0980 '/'
Inlet Invert= 267.00', Outlet Invert= 257.00'



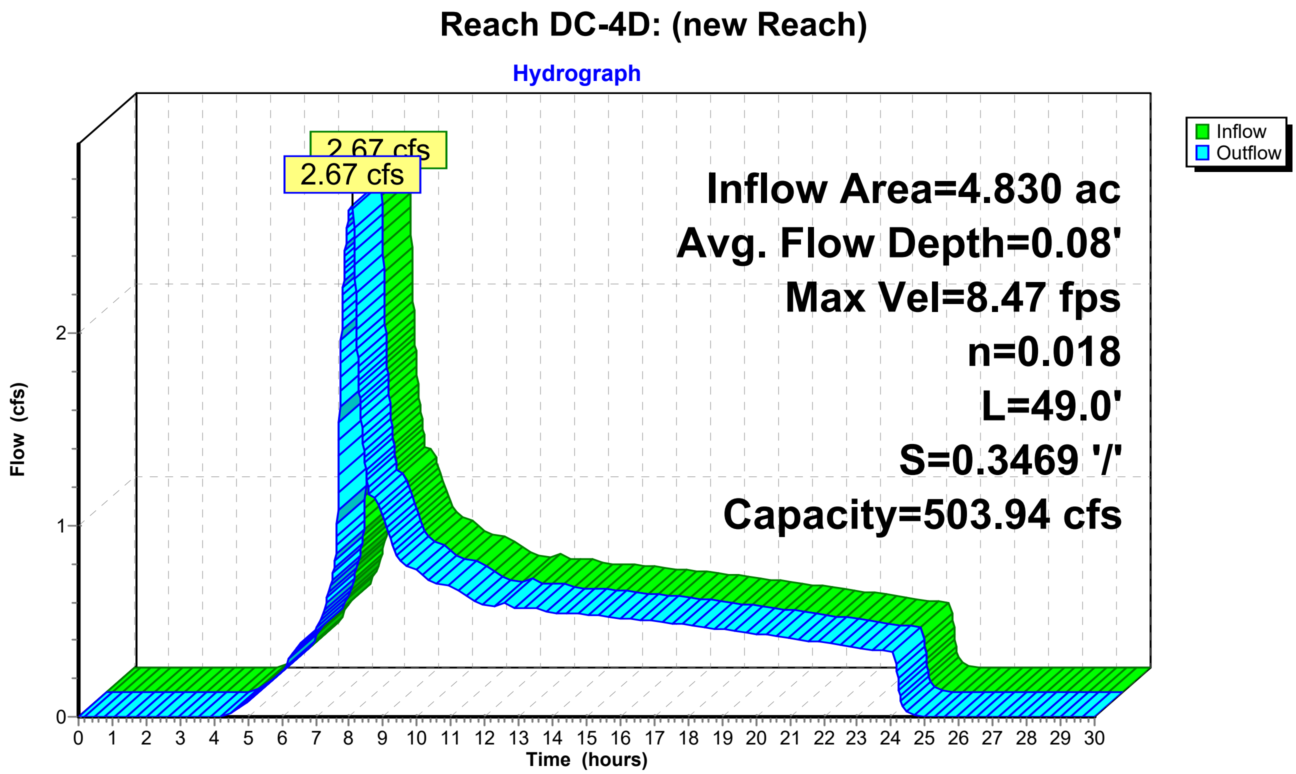
Summary for Reach DC-4D: (new Reach)

Inflow Area = 4.830 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.67 cfs @ 8.06 hrs, Volume= 0.923 af
Outflow = 2.67 cfs @ 8.06 hrs, Volume= 0.923 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.47 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.44 fps, Avg. Travel Time= 0.2 min

Peak Storage= 15 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 503.94 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 49.0' Slope= 0.3469 '/'
Inlet Invert= 257.00', Outlet Invert= 240.00'



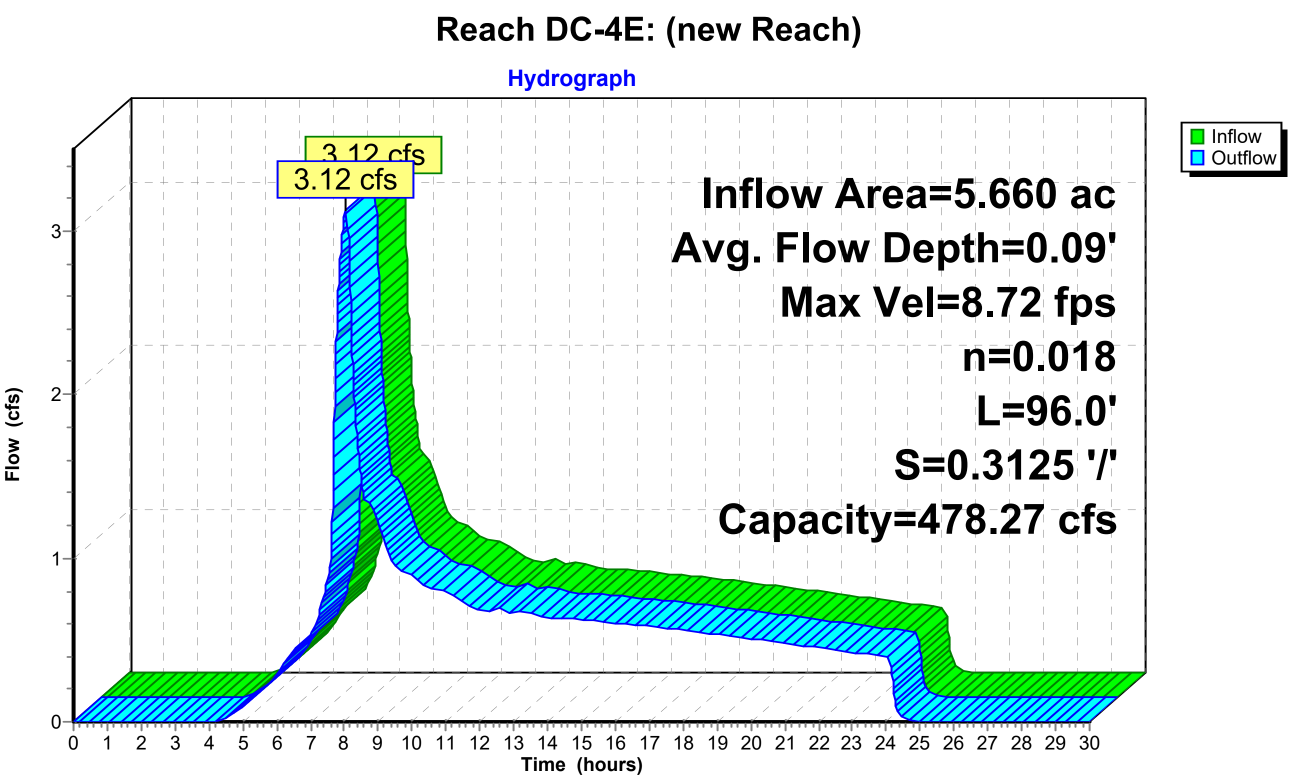
Summary for Reach DC-4E: (new Reach)

Inflow Area = 5.660 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.12 cfs @ 8.05 hrs, Volume= 1.081 af
Outflow = 3.12 cfs @ 8.06 hrs, Volume= 1.081 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.72 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 4.52 fps, Avg. Travel Time= 0.4 min

Peak Storage= 34 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 478.27 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 96.0' Slope= 0.3125 '/'
Inlet Invert= 240.00', Outlet Invert= 210.00'



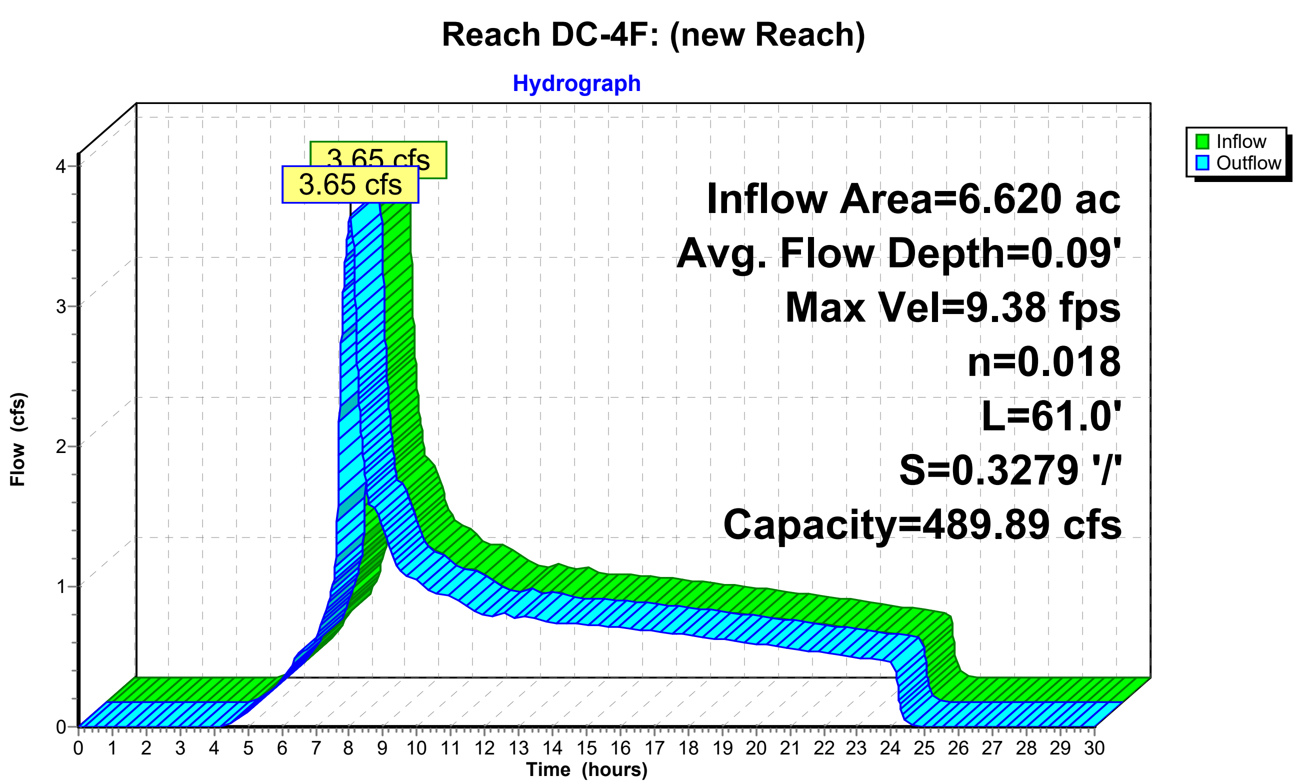
Summary for Reach DC-4F: (new Reach)

Inflow Area = 6.620 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.65 cfs @ 8.05 hrs, Volume= 1.264 af
Outflow = 3.65 cfs @ 8.05 hrs, Volume= 1.264 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.38 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.85 fps, Avg. Travel Time= 0.2 min

Peak Storage= 24 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 489.89 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 61.0' Slope= 0.3279 '/'
Inlet Invert= 210.00', Outlet Invert= 190.00'



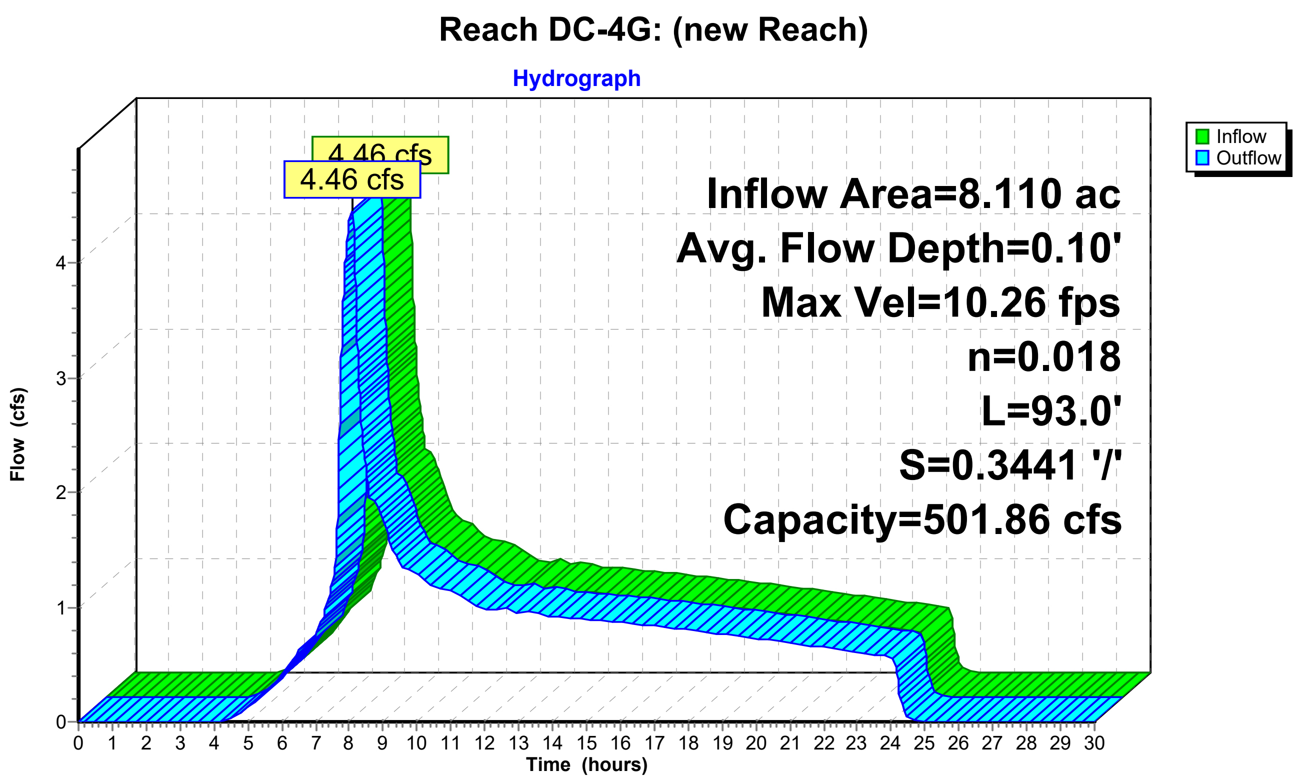
Summary for Reach DC-4G: (new Reach)

Inflow Area = 8.110 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 4.46 cfs @ 8.06 hrs, Volume= 1.549 af
Outflow = 4.46 cfs @ 8.07 hrs, Volume= 1.549 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.26 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 5.26 fps, Avg. Travel Time= 0.3 min

Peak Storage= 40 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 501.86 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 93.0' Slope= 0.3441 '/'
Inlet Invert= 190.00', Outlet Invert= 158.00'



Summary for Reach DC-4H: (new Reach)

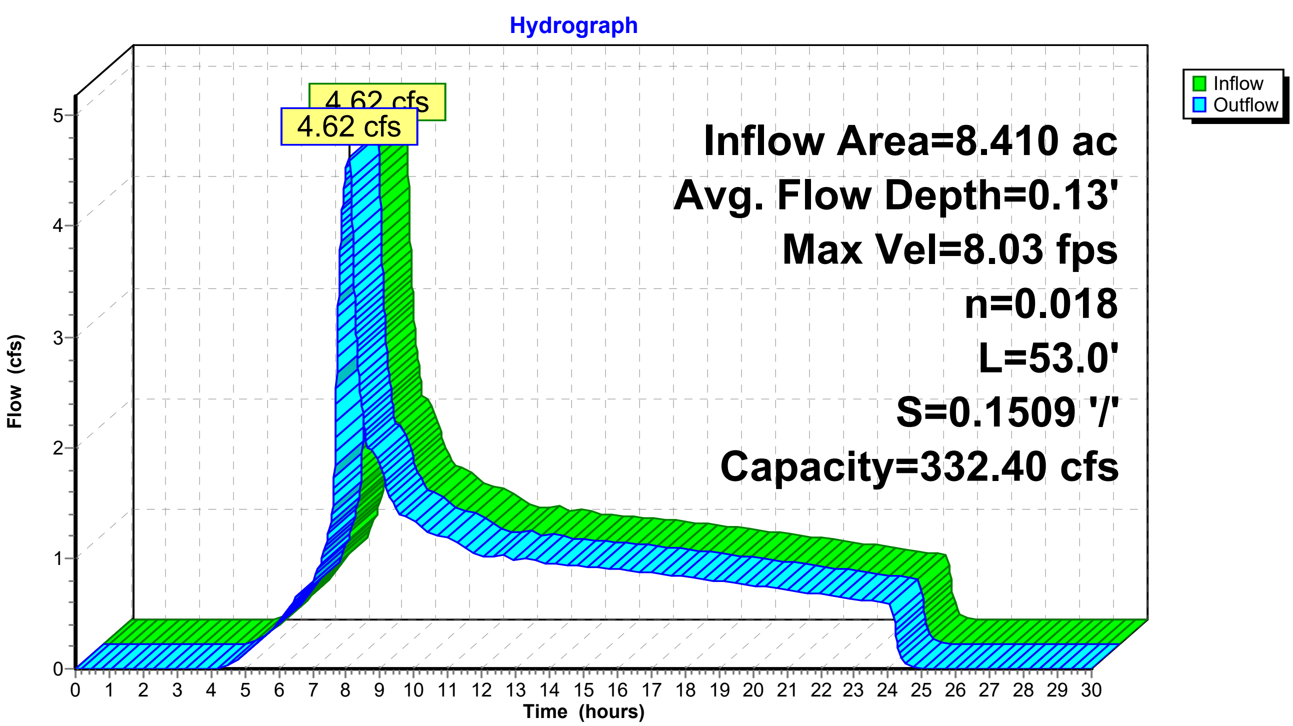
Inflow Area = 8.410 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 4.62 cfs @ 8.06 hrs, Volume= 1.606 af
Outflow = 4.62 cfs @ 8.07 hrs, Volume= 1.606 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.03 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.06 fps, Avg. Travel Time= 0.2 min

Peak Storage= 31 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 332.40 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 53.0' Slope= 0.1509 '/'
Inlet Invert= 158.00', Outlet Invert= 150.00'

Reach DC-4H: (new Reach)



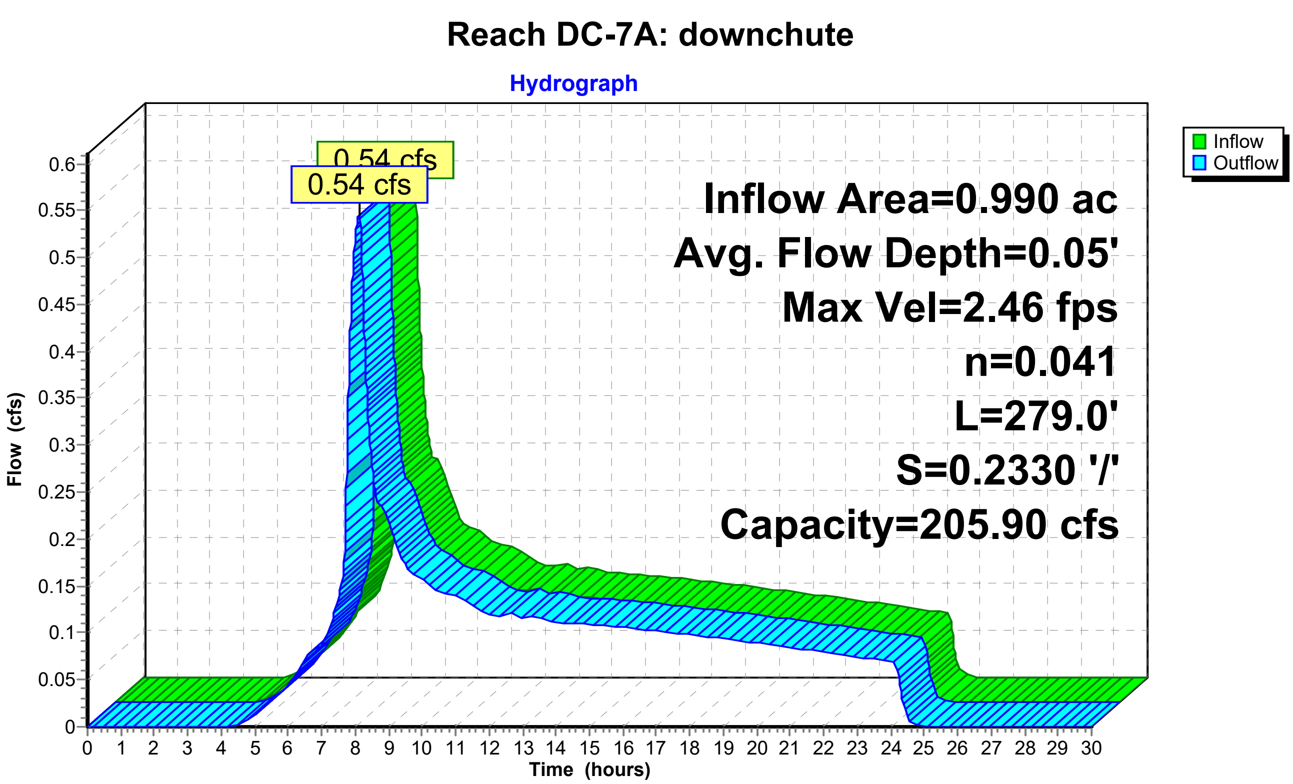
Summary for Reach DC-7A: downchute

Inflow Area = 0.990 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.54 cfs @ 8.07 hrs, Volume= 0.189 af
Outflow = 0.54 cfs @ 8.12 hrs, Volume= 0.189 af, Atten= 0%, Lag= 2.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.46 fps, Min. Travel Time= 1.9 min
Avg. Velocity = 1.33 fps, Avg. Travel Time= 3.5 min

Peak Storage= 62 cf @ 8.08 hrs
Average Depth at Peak Storage= 0.05'
Bank-Full Depth= 1.60' Flow Area= 11.5 sf, Capacity= 205.90 cfs

4.00' x 1.60' deep channel, n= 0.041
Side Slope Z-value= 2.0 '/' Top Width= 10.40'
Length= 279.0' Slope= 0.2330 '/'
Inlet Invert= 217.00', Outlet Invert= 152.00'



Summary for Reach DC-7B: downchute

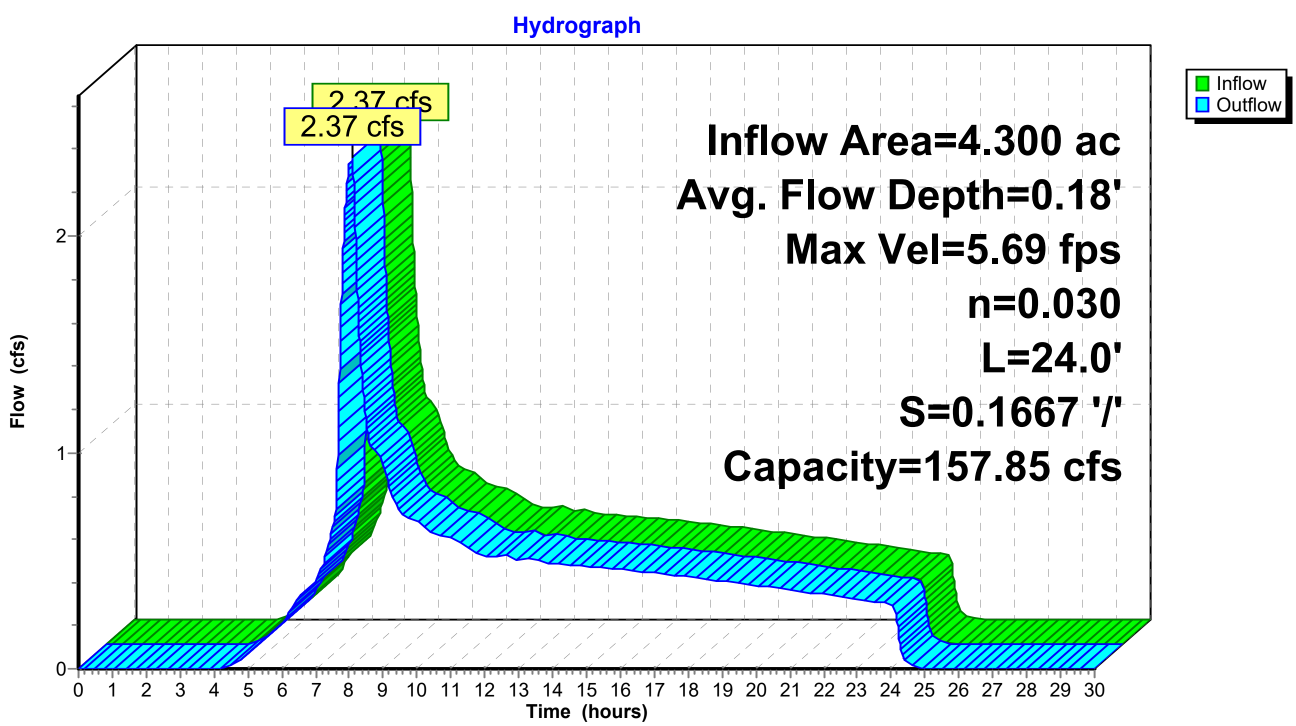
Inflow Area = 4.300 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.37 cfs @ 8.06 hrs, Volume= 0.821 af
Outflow = 2.37 cfs @ 8.07 hrs, Volume= 0.821 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.69 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.99 fps, Avg. Travel Time= 0.1 min

Peak Storage= 10 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 157.85 cfs

2.00' x 1.60' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 24.0' Slope= 0.1667 '/'
Inlet Invert= 152.00', Outlet Invert= 148.00'

Reach DC-7B: downchute



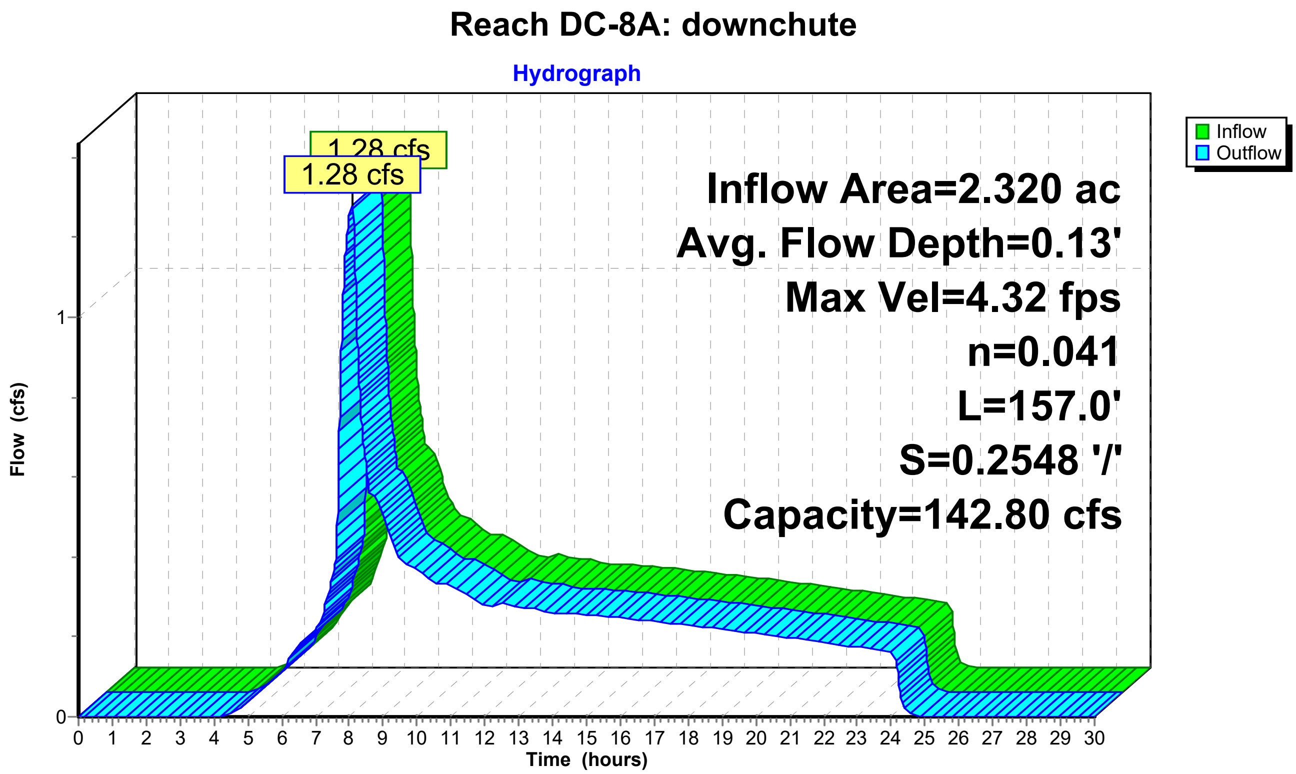
Summary for Reach DC-8A: downchute

Inflow Area = 2.320 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.28 cfs @ 8.05 hrs, Volume= 0.443 af
Outflow = 1.28 cfs @ 8.07 hrs, Volume= 0.443 af, Atten= 0%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.32 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 2.27 fps, Avg. Travel Time= 1.2 min

Peak Storage= 46 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 142.80 cfs

2.00' x 1.60' deep channel, n= 0.041
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 157.0' Slope= 0.2548 '/'
Inlet Invert= 235.00', Outlet Invert= 195.00'



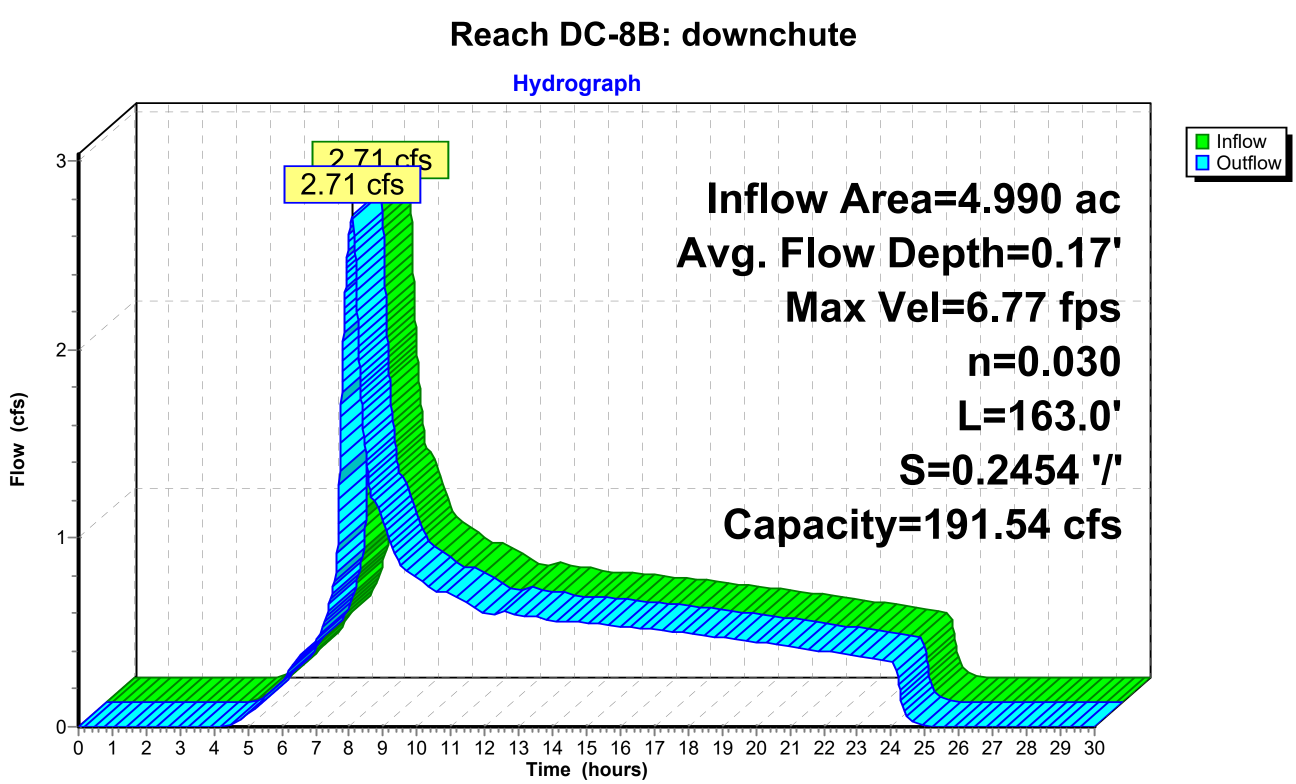
Summary for Reach DC-8B: downchute

Inflow Area = 4.990 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.71 cfs @ 8.08 hrs, Volume= 0.953 af
Outflow = 2.71 cfs @ 8.09 hrs, Volume= 0.953 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.77 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 3.49 fps, Avg. Travel Time= 0.8 min

Peak Storage= 65 cf @ 8.09 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 191.54 cfs

2.00' x 1.60' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 163.0' Slope= 0.2454 '/'
Inlet Invert= 195.00', Outlet Invert= 155.00'



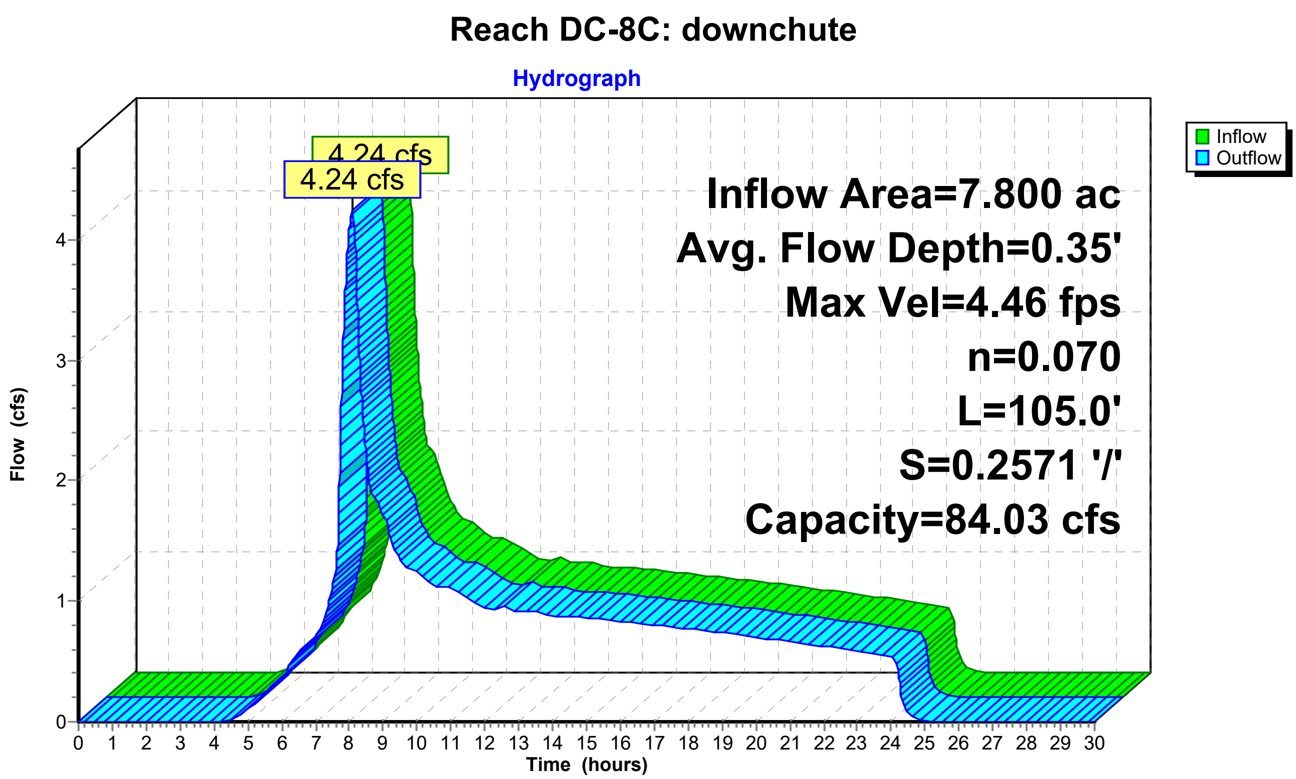
Summary for Reach DC-8C: downchute

Inflow Area = 7.800 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 4.24 cfs @ 8.08 hrs, Volume= 1.490 af
Outflow = 4.24 cfs @ 8.09 hrs, Volume= 1.490 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.46 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.28 fps, Avg. Travel Time= 0.8 min

Peak Storage= 100 cf @ 8.09 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 84.03 cfs

2.00' x 1.60' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 105.0' Slope= 0.2571 '/'
Inlet Invert= 155.00', Outlet Invert= 128.00'



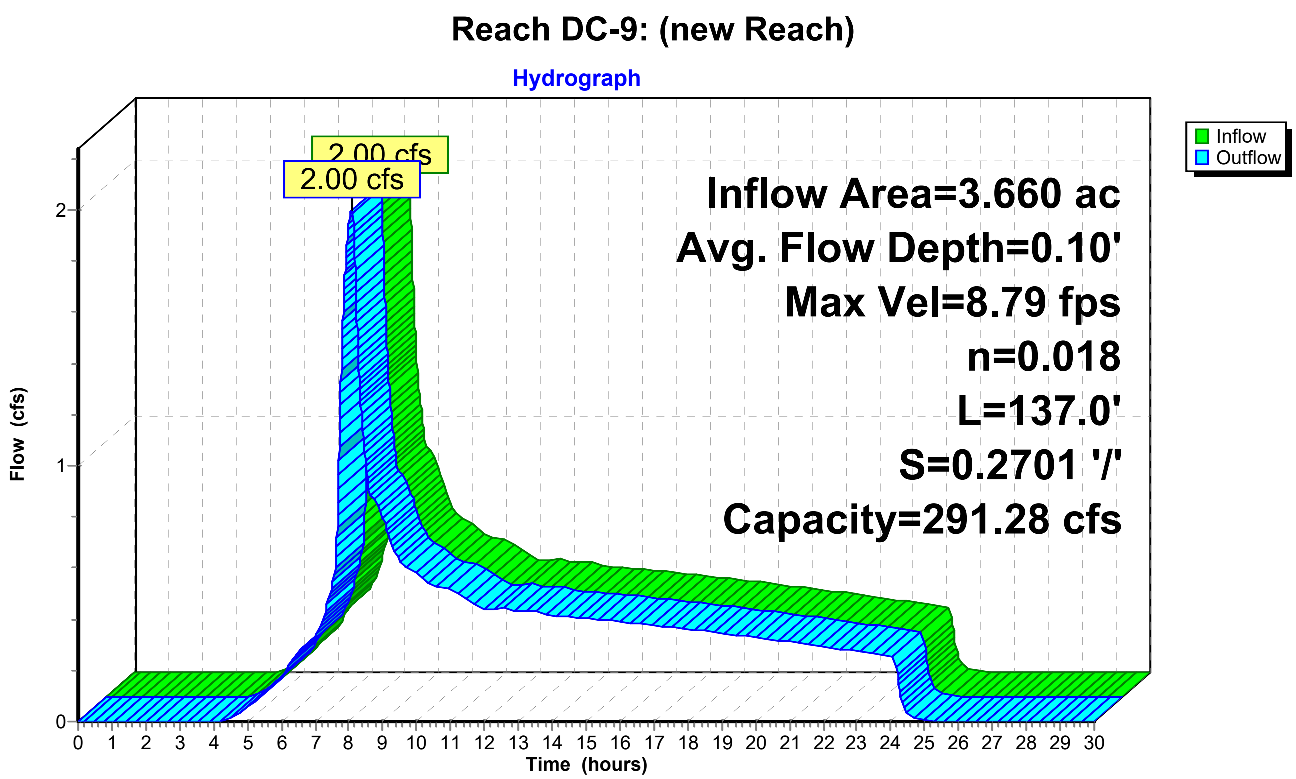
Summary for Reach DC-9: (new Reach)

Inflow Area = 3.660 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.00 cfs @ 8.07 hrs, Volume= 0.699 af
Outflow = 2.00 cfs @ 8.08 hrs, Volume= 0.699 af, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.79 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 4.61 fps, Avg. Travel Time= 0.5 min

Peak Storage= 31 cf @ 8.08 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 291.28 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 137.0' Slope= 0.2701 '/'
Inlet Invert= 272.00', Outlet Invert= 235.00'



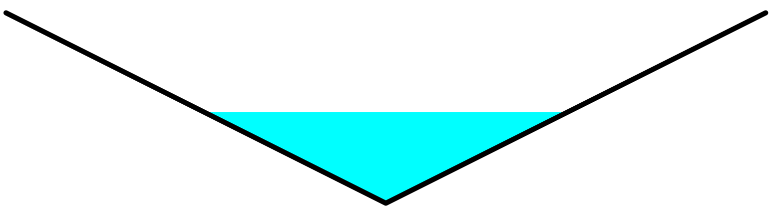
Summary for Reach DITCH-2: (new Reach)

Inflow Area = 1.250 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.69 cfs @ 7.95 hrs, Volume= 0.239 af
Outflow = 0.60 cfs @ 8.34 hrs, Volume= 0.239 af, Atten= 13%, Lag= 23.1 min

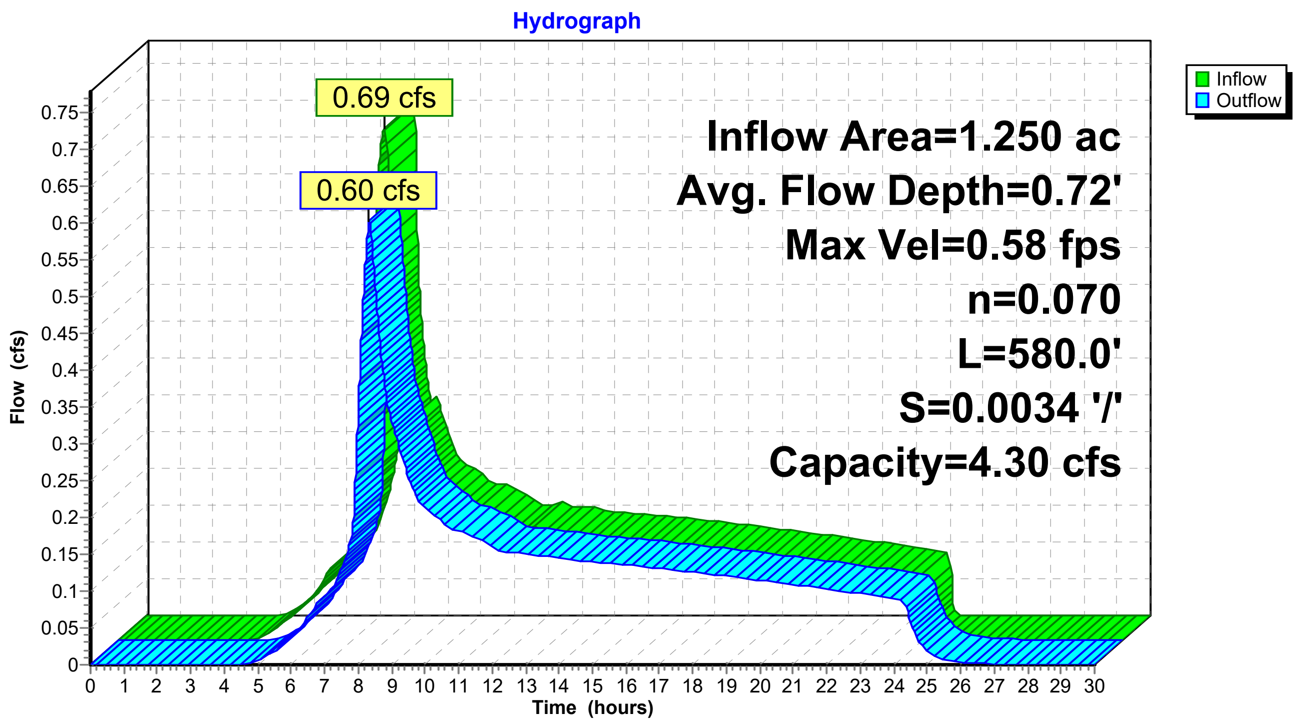
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.58 fps, Min. Travel Time= 16.5 min
Avg. Velocity = 0.33 fps, Avg. Travel Time= 29.1 min

Peak Storage= 598 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 4.30 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 580.0' Slope= 0.0034 '/'
Inlet Invert= 150.00', Outlet Invert= 148.00'



Reach DITCH-2: (new Reach)



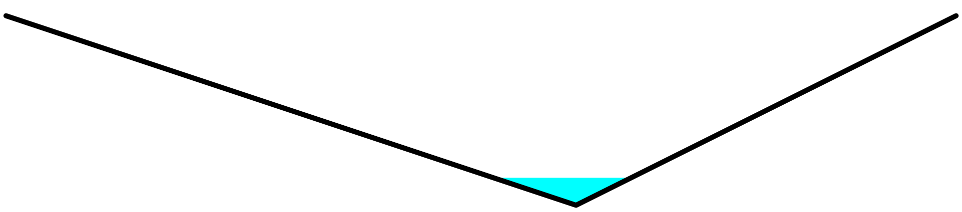
Summary for Reach NPIS-1: (new Reach)

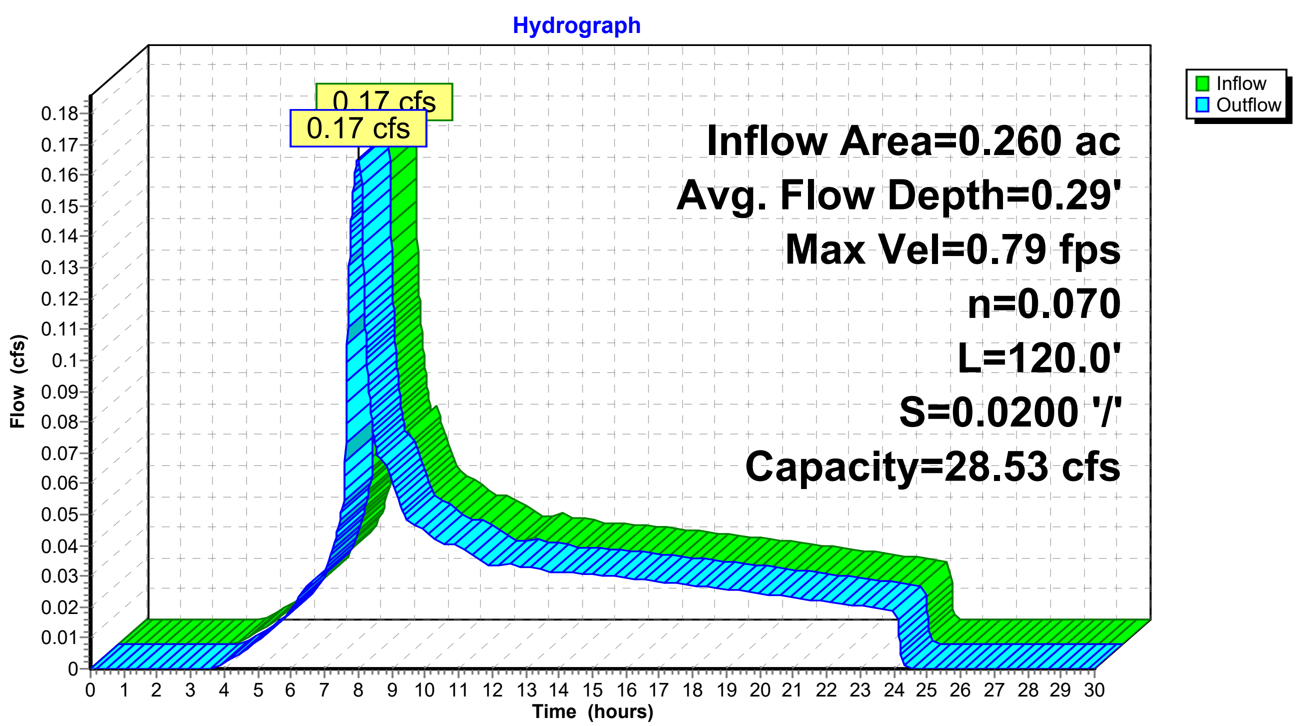
Inflow Area = 0.260 ac, 19.23% Impervious, Inflow Depth = 2.55" for 25-year event
Inflow = 0.17 cfs @ 7.94 hrs, Volume= 0.055 af
Outflow = 0.17 cfs @ 8.01 hrs, Volume= 0.055 af, Atten= 0%, Lag= 4.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.79 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.49 fps, Avg. Travel Time= 4.1 min

Peak Storage= 25 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.29'
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 28.53 cfs

0.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 120.0' Slope= 0.0200 '/'
Inlet Invert= 160.00', Outlet Invert= 157.60'





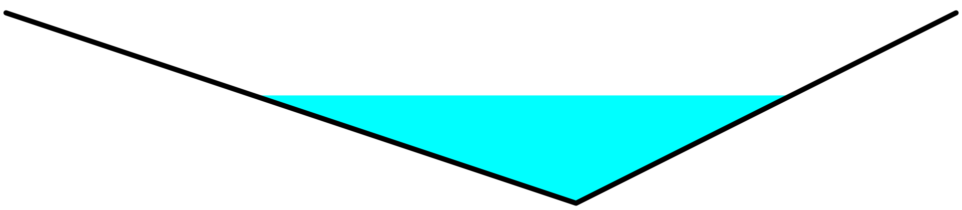
Summary for Reach NPIS-2: (new Reach)

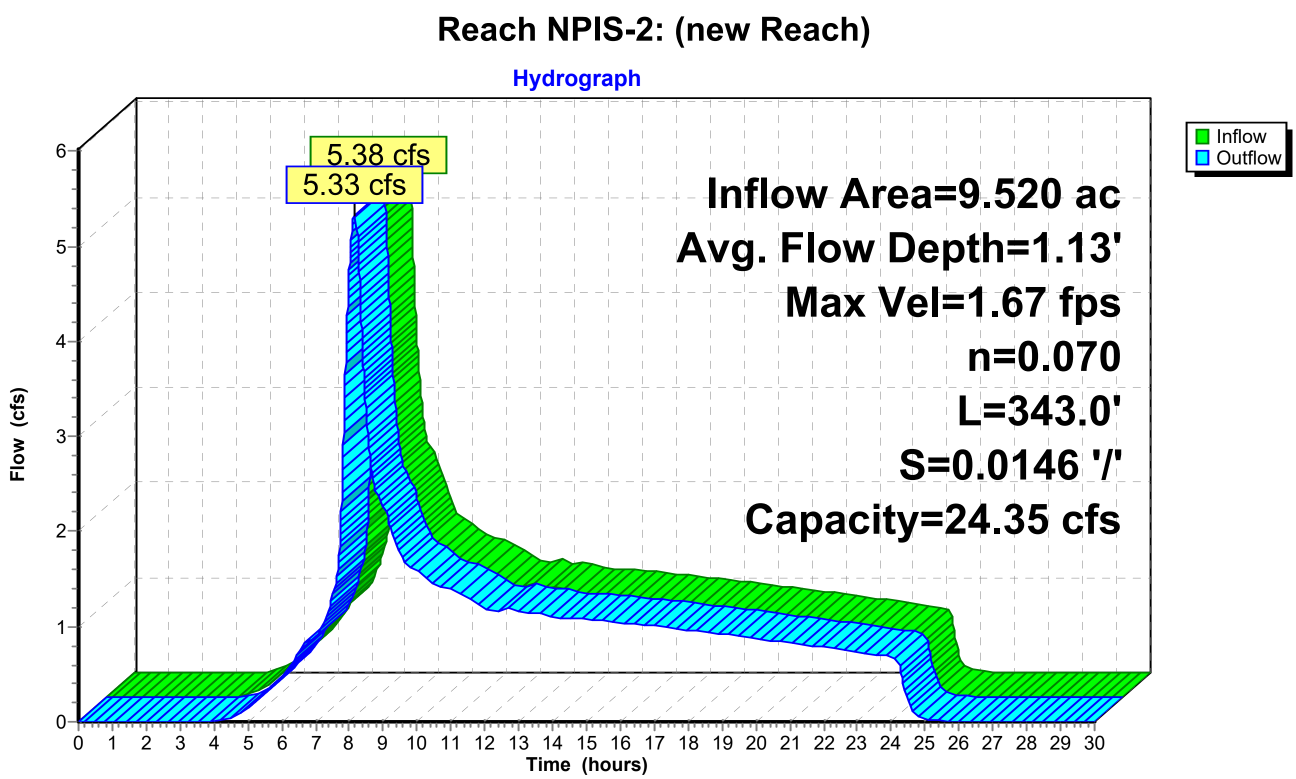
Inflow Area = 9.520 ac, 5.78% Impervious, Inflow Depth = 2.38" for 25-year event
Inflow = 5.38 cfs @ 8.06 hrs, Volume= 1.888 af
Outflow = 5.33 cfs @ 8.16 hrs, Volume= 1.888 af, Atten= 1%, Lag= 5.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.67 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 6.4 min

Peak Storage= 1,098 cf @ 8.10 hrs
Average Depth at Peak Storage= 1.13'
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 24.35 cfs

0.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 343.0' Slope= 0.0146 '/'
Inlet Invert= 158.00', Outlet Invert= 153.00'





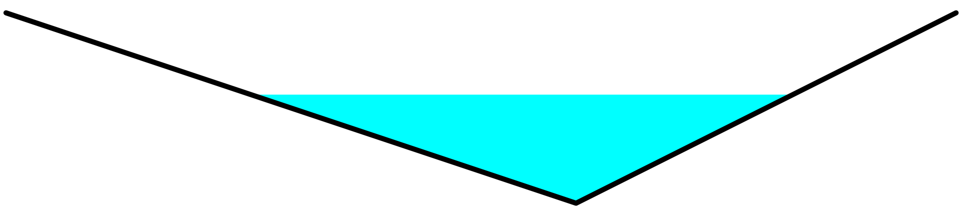
Summary for Reach NPIS-3: (new Reach)

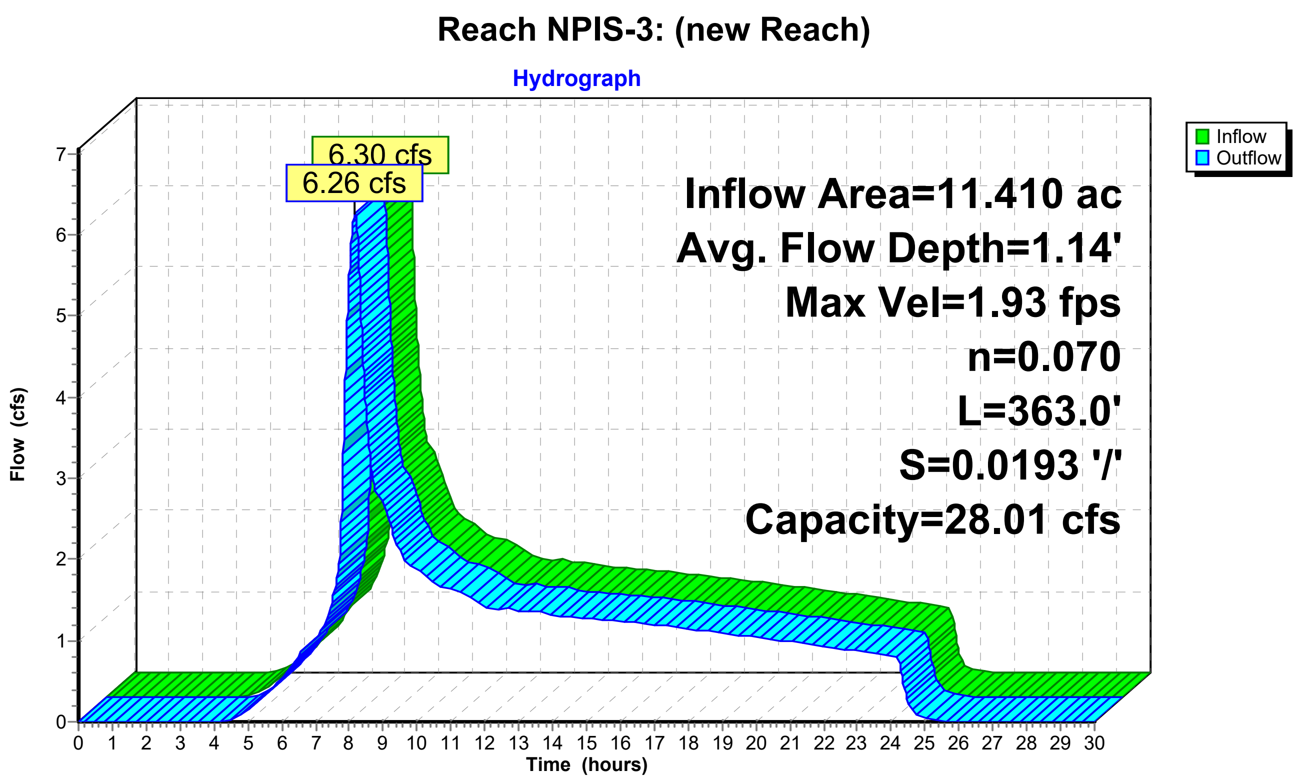
Inflow Area = 11.410 ac, 2.72% Impervious, Inflow Depth = 2.33" for 25-year event
Inflow = 6.30 cfs @ 8.09 hrs, Volume= 2.219 af
Outflow = 6.26 cfs @ 8.18 hrs, Volume= 2.219 af, Atten= 1%, Lag= 4.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.93 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 1.03 fps, Avg. Travel Time= 5.9 min

Peak Storage= 1,180 cf @ 8.12 hrs
Average Depth at Peak Storage= 1.14'
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 28.01 cfs

0.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 363.0' Slope= 0.0193 '/'
Inlet Invert= 160.00', Outlet Invert= 153.00'



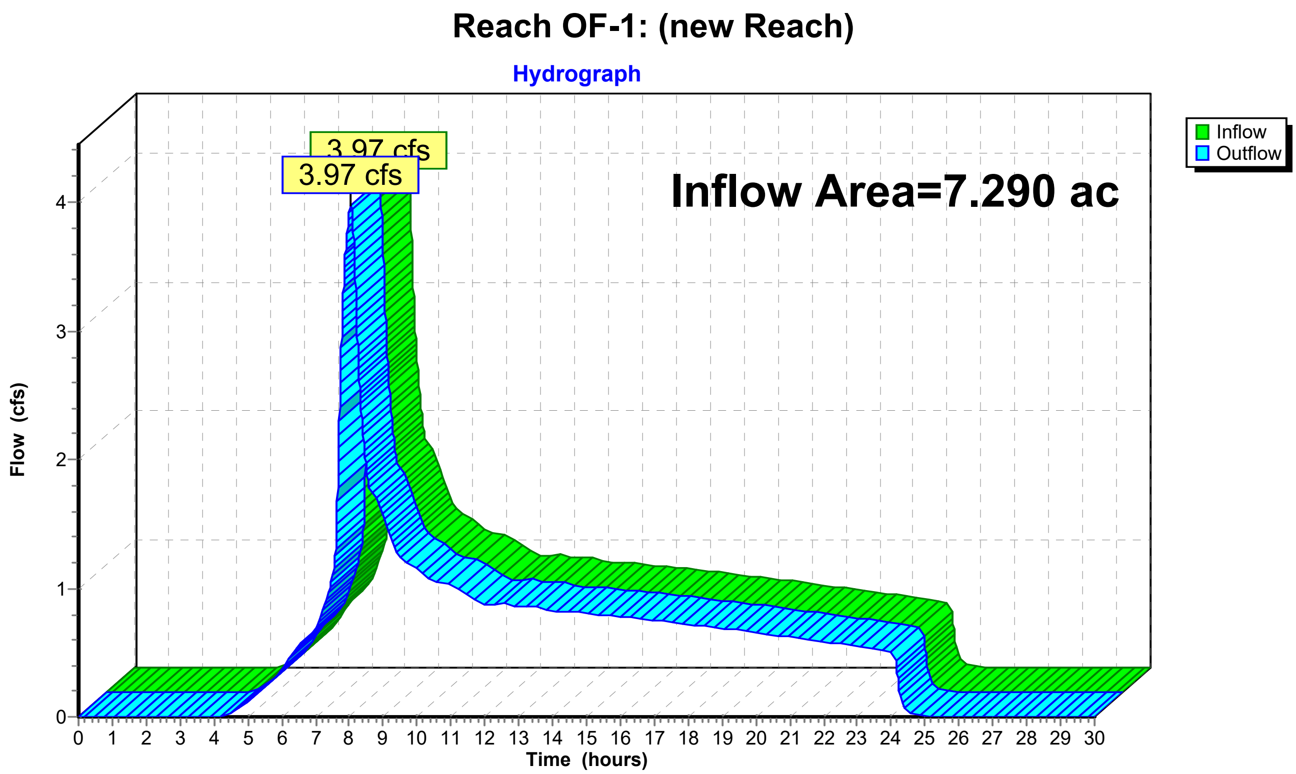


Summary for Reach OF-1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	7.290 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	3.97 cfs @	8.05 hrs,	Volume=	1.392 af	
Outflow =	3.97 cfs @	8.05 hrs,	Volume=	1.392 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

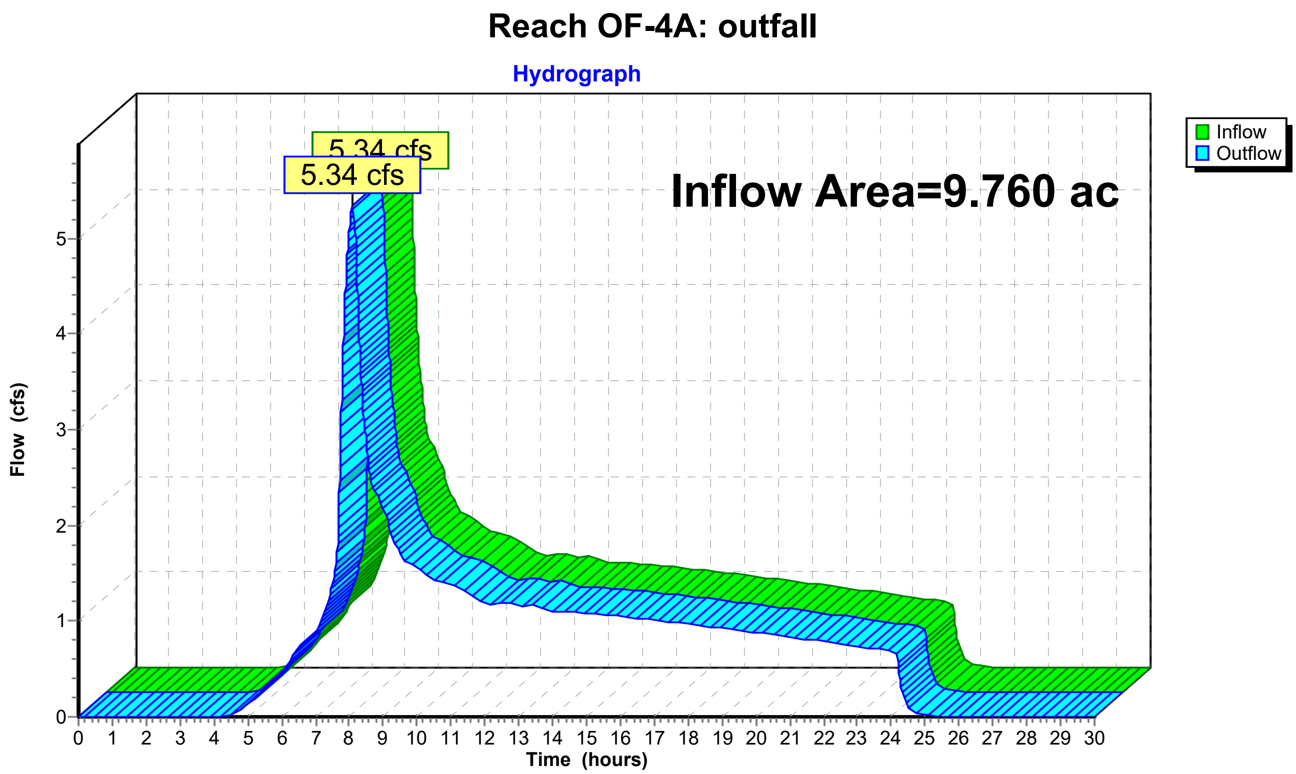


Summary for Reach OF-4A: outfall

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	9.760 ac,	1.54% Impervious,	Inflow Depth = 2.31"	for 25-year event	
Inflow =	5.34 cfs @	8.10 hrs,	Volume=	1.878 af	
Outflow =	5.34 cfs @	8.10 hrs,	Volume=	1.878 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

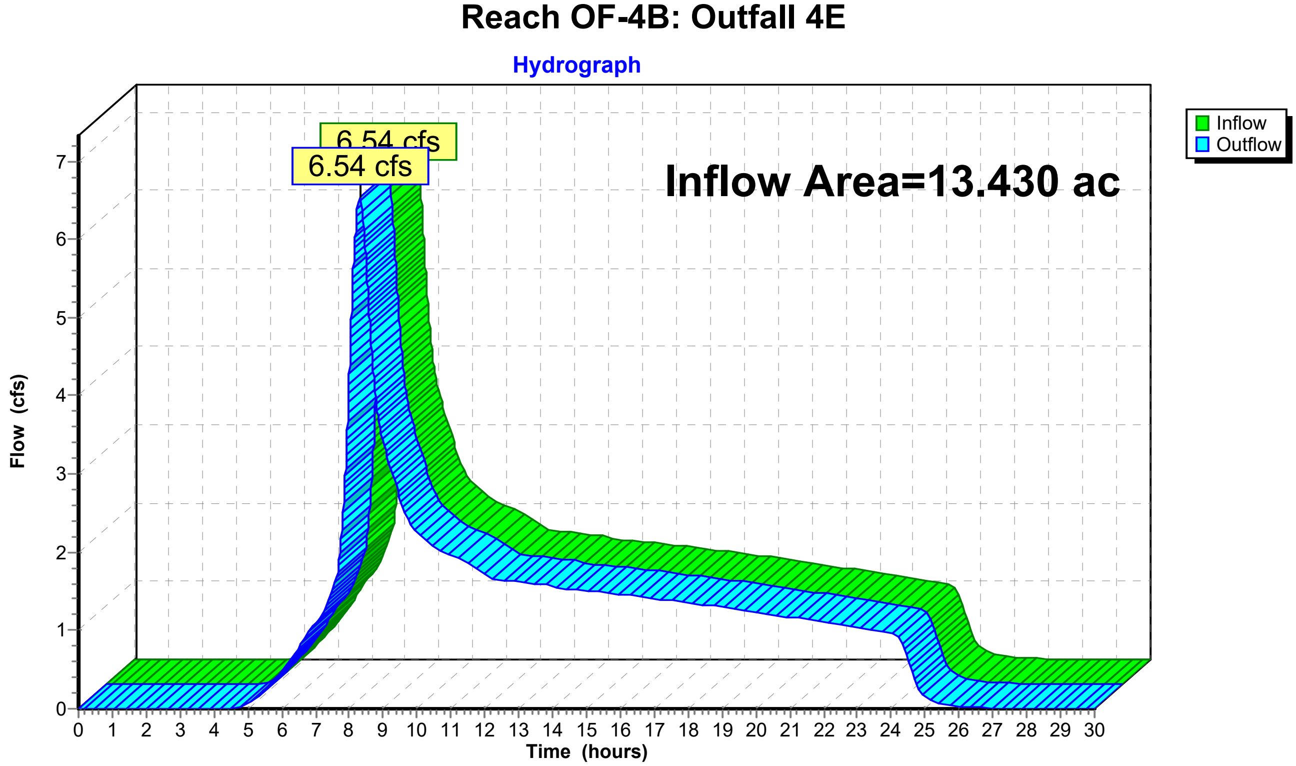


Summary for Reach OF-4B: Outfall 4E

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	13.430 ac,	2.46% Impervious, Inflow Depth > 2.32"	for 25-year event	
Inflow =	6.54 cfs @	8.31 hrs, Volume=	2.597 af	
Outflow =	6.54 cfs @	8.31 hrs, Volume=	2.597 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



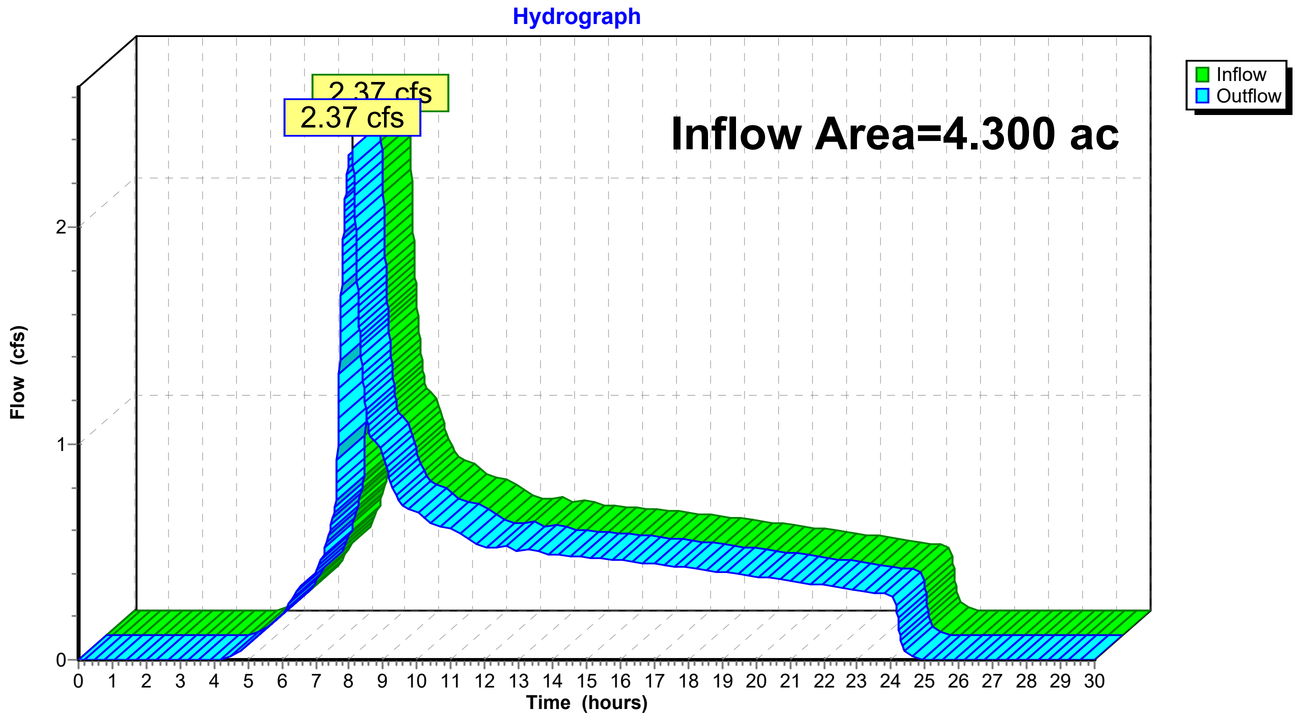
Summary for Reach OF-4C: outfall

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.300 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 2.37 cfs @ 8.07 hrs, Volume= 0.821 af
Outflow = 2.37 cfs @ 8.07 hrs, Volume= 0.821 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach OF-4C: outfall



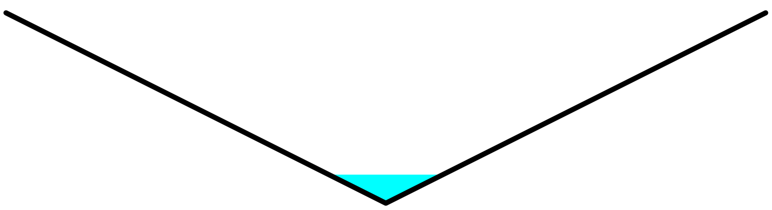
Summary for Reach RD-1: (new Reach)

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.83 cfs @ 7.95 hrs, Volume= 0.287 af
Outflow = 0.83 cfs @ 7.98 hrs, Volume= 0.287 af, Atten= 0%, Lag= 1.6 min

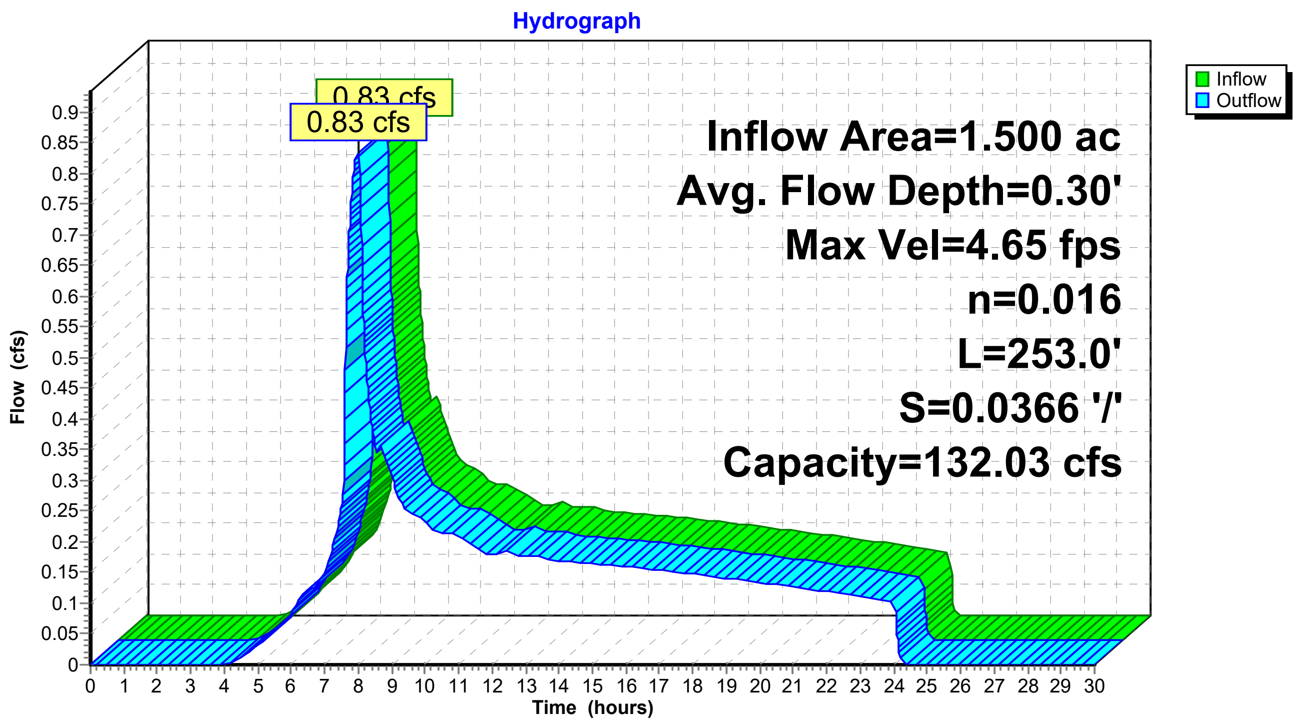
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.65 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 3.00 fps, Avg. Travel Time= 1.4 min

Peak Storage= 45 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.30'
Bank-Full Depth= 2.00' Flow Area= 8.0 sf, Capacity= 132.03 cfs

0.00' x 2.00' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 253.0' Slope= 0.0366 '/'
Inlet Invert= 165.73', Outlet Invert= 156.46'



Reach RD-1: (new Reach)



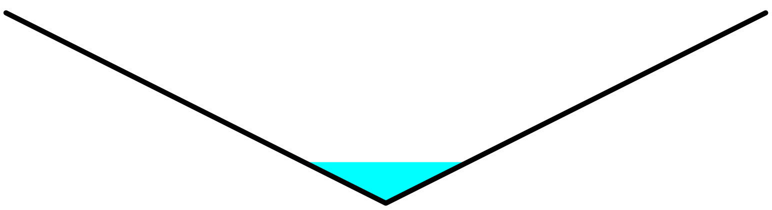
Summary for Reach RD-2: (new Reach)

Inflow Area = 5.790 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 3.15 cfs @ 8.04 hrs, Volume= 1.106 af
Outflow = 3.15 cfs @ 8.05 hrs, Volume= 1.106 af, Atten= 0%, Lag= 0.5 min

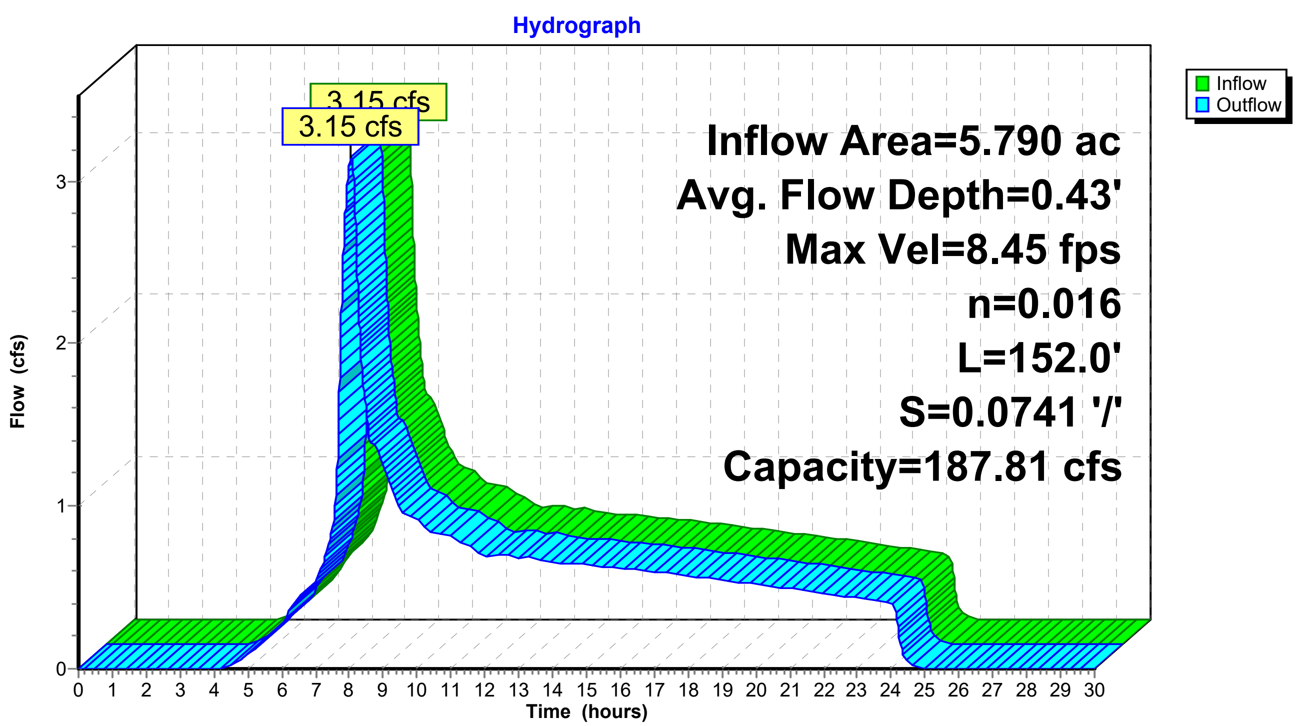
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.45 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 5.07 fps, Avg. Travel Time= 0.5 min

Peak Storage= 57 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 2.00' Flow Area= 8.0 sf, Capacity= 187.81 cfs

0.00' x 2.00' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 152.0' Slope= 0.0741 '/'
Inlet Invert= 177.00', Outlet Invert= 165.73'



Reach RD-2: (new Reach)



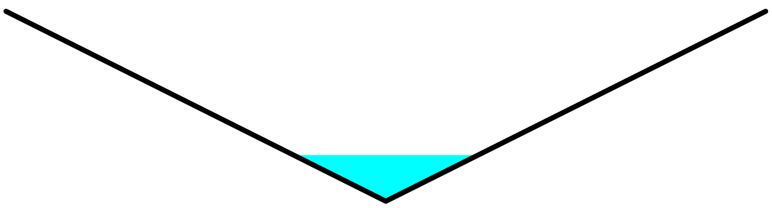
Summary for Reach RD-3: (new Reach)

Inflow Area = 1.870 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 1.04 cfs @ 7.95 hrs, Volume= 0.357 af
Outflow = 1.04 cfs @ 8.03 hrs, Volume= 0.357 af, Atten= 0%, Lag= 4.8 min

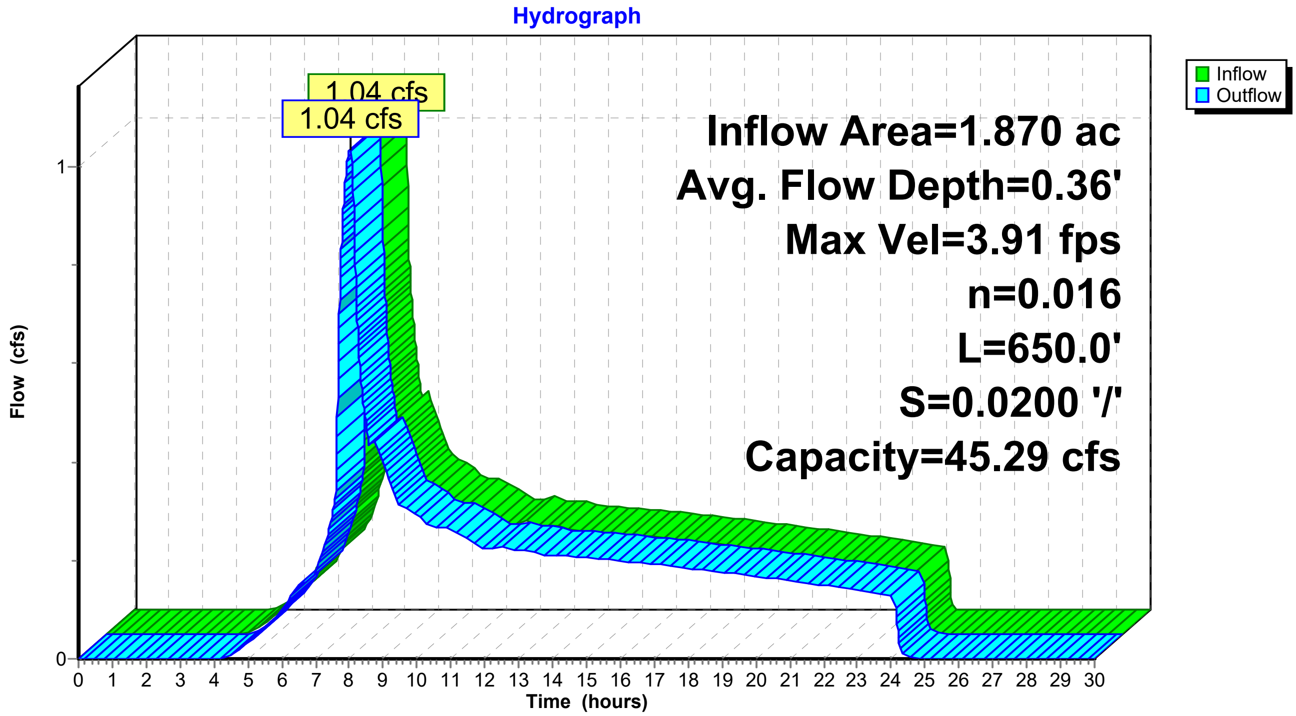
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.91 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 2.43 fps, Avg. Travel Time= 4.5 min

Peak Storage= 172 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 45.29 cfs

0.00' x 1.50' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 650.0' Slope= 0.0200 '/'
Inlet Invert= 190.00', Outlet Invert= 177.00'



Reach RD-3: (new Reach)



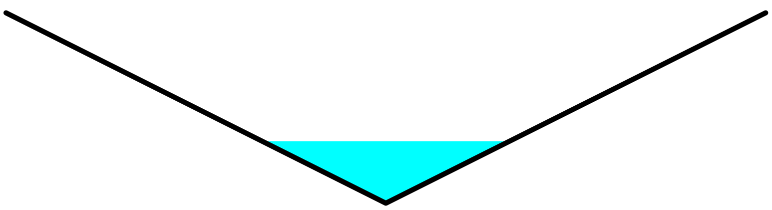
Summary for Reach RD-4: (new Reach)

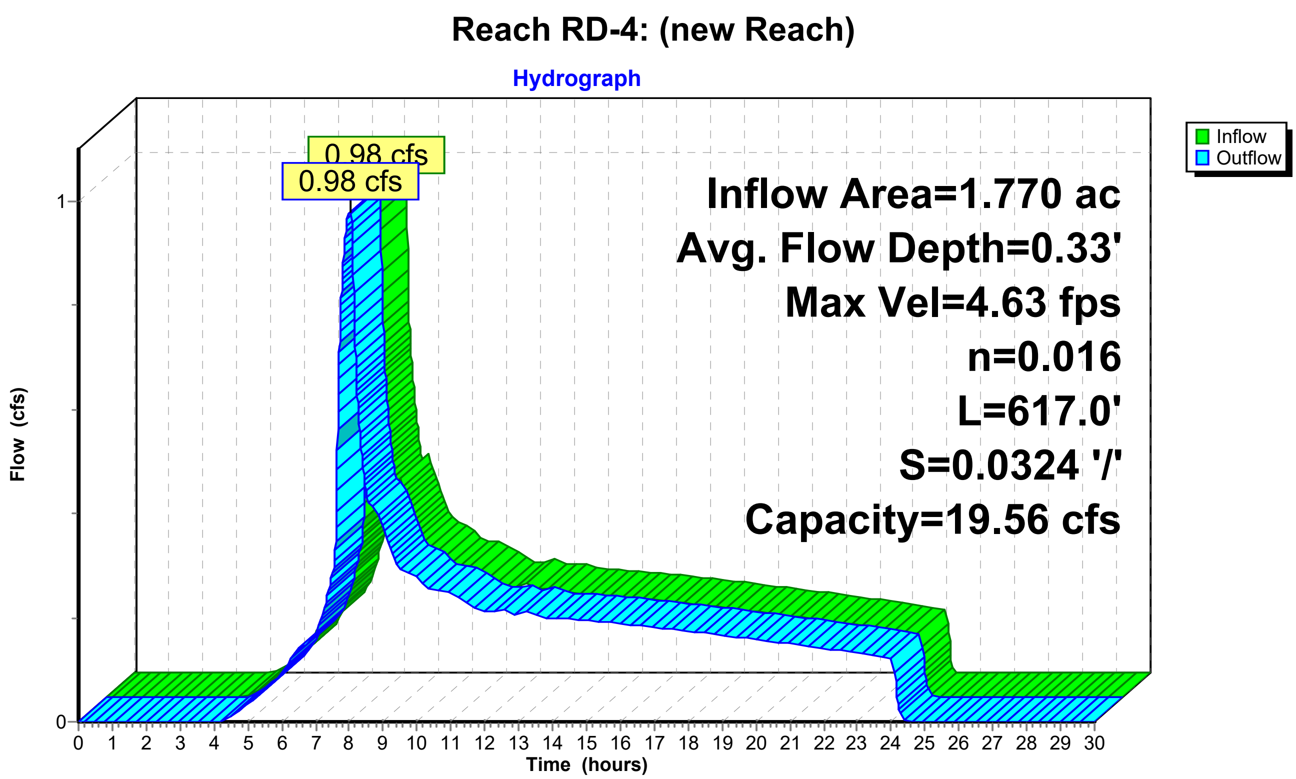
Inflow Area = 1.770 ac, 0.00% Impervious, Inflow Depth = 2.29" for 25-year event
Inflow = 0.98 cfs @ 7.95 hrs, Volume= 0.338 af
Outflow = 0.98 cfs @ 8.02 hrs, Volume= 0.338 af, Atten= 0%, Lag= 3.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.63 fps, Min. Travel Time= 2.2 min
Avg. Velocity = 2.89 fps, Avg. Travel Time= 3.6 min

Peak Storage= 131 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 1.00' Flow Area= 2.0 sf, Capacity= 19.56 cfs

0.00' x 1.00' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 4.00'
Length= 617.0' Slope= 0.0324 '/'
Inlet Invert= 190.00', Outlet Invert= 170.00'





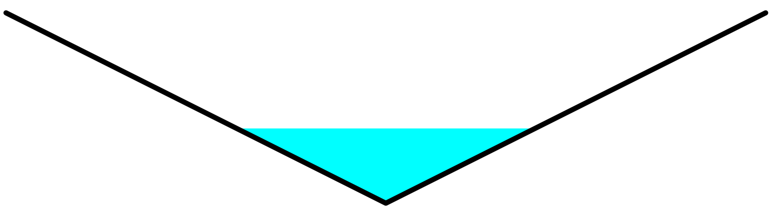
Summary for Reach RD-5: (new Reach)

Inflow Area = 2.740 ac, 16.79% Impervious, Inflow Depth = 2.55" for 25-year event
Inflow = 1.75 cfs @ 7.94 hrs, Volume= 0.582 af
Outflow = 1.73 cfs @ 8.09 hrs, Volume= 0.582 af, Atten= 1%, Lag= 9.3 min

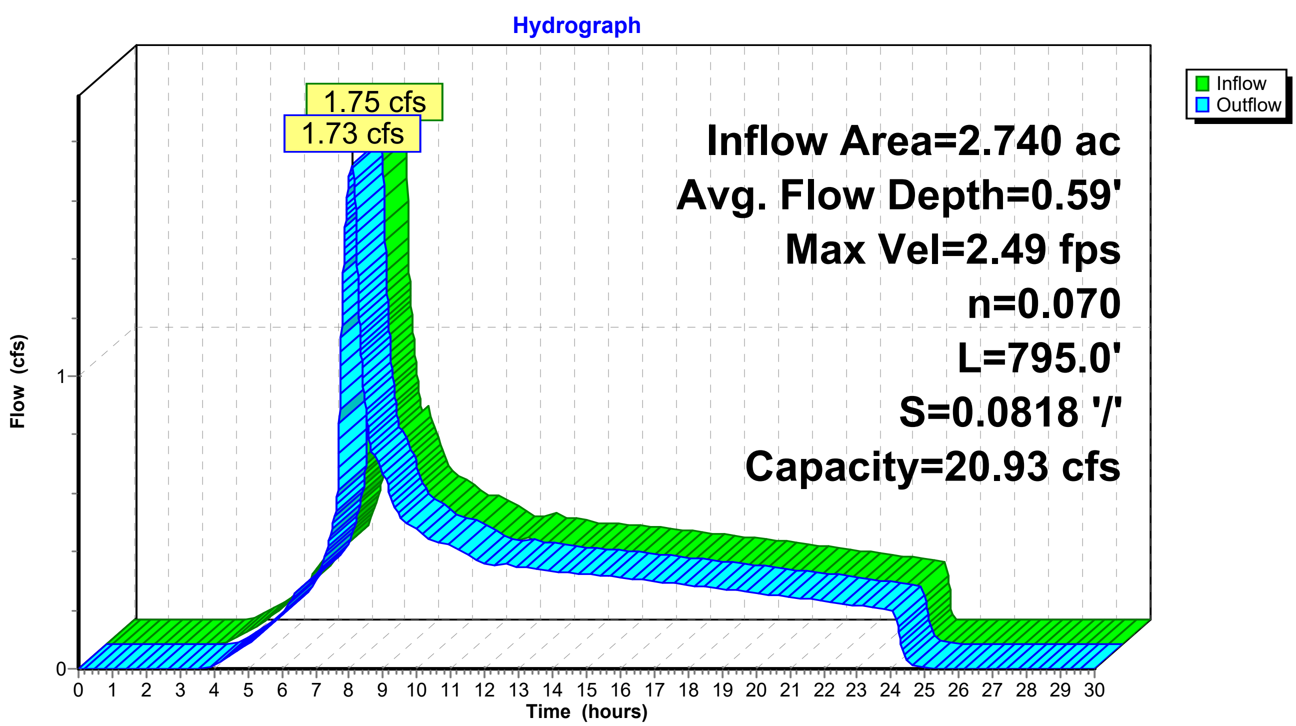
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.49 fps, Min. Travel Time= 5.3 min
Avg. Velocity = 1.39 fps, Avg. Travel Time= 9.5 min

Peak Storage= 550 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 20.93 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 795.0' Slope= 0.0818 '/'
Inlet Invert= 250.00', Outlet Invert= 185.00'



Reach RD-5: (new Reach)



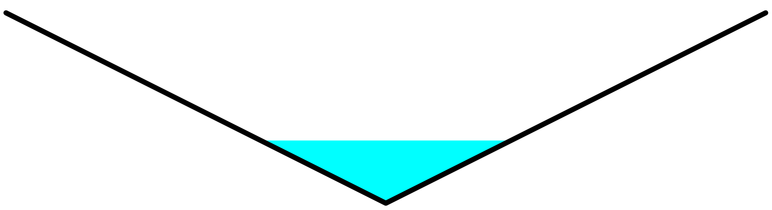
Summary for Reach RD-7: (new Reach)

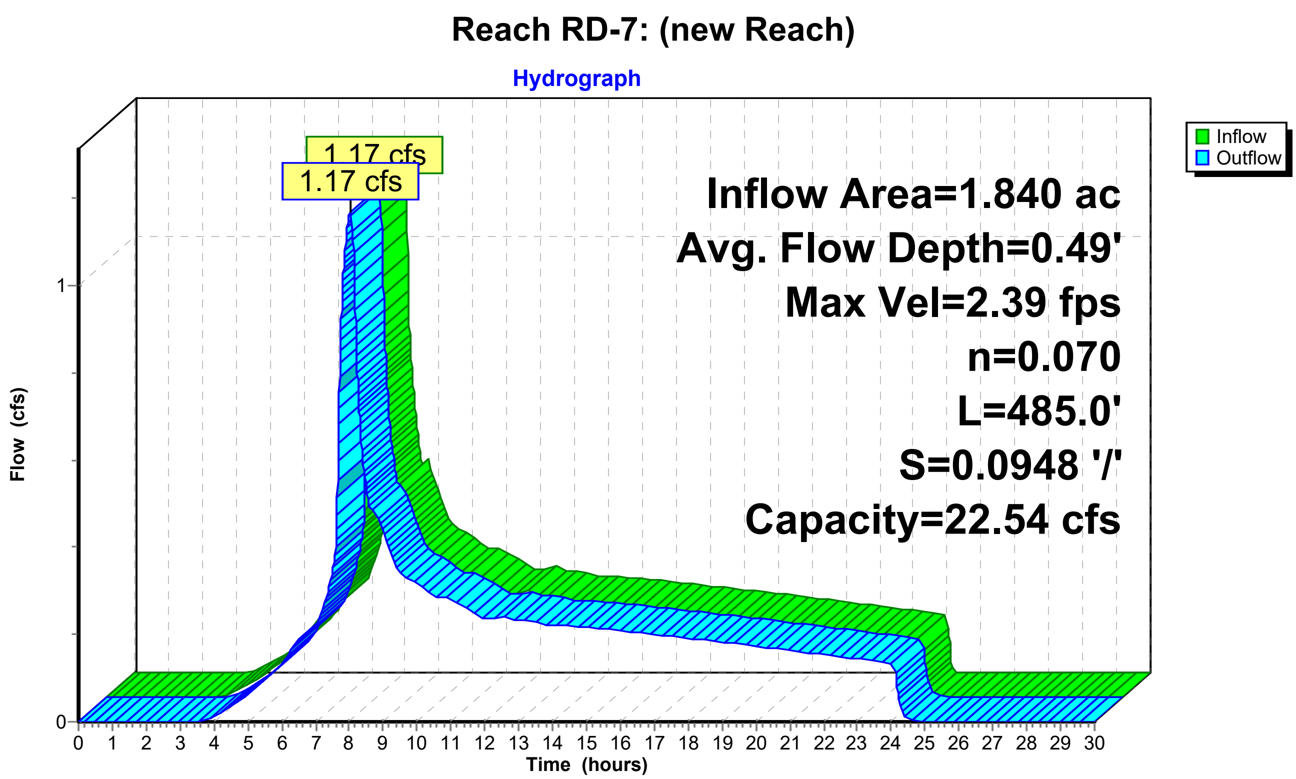
Inflow Area = 1.840 ac, 16.85% Impervious, Inflow Depth = 2.55" for 25-year event
Inflow = 1.17 cfs @ 7.94 hrs, Volume= 0.391 af
Outflow = 1.17 cfs @ 8.03 hrs, Volume= 0.391 af, Atten= 0%, Lag= 5.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.39 fps, Min. Travel Time= 3.4 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 5.7 min

Peak Storage= 237 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 22.54 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 485.0' Slope= 0.0948 '/'
Inlet Invert= 281.00', Outlet Invert= 235.00'





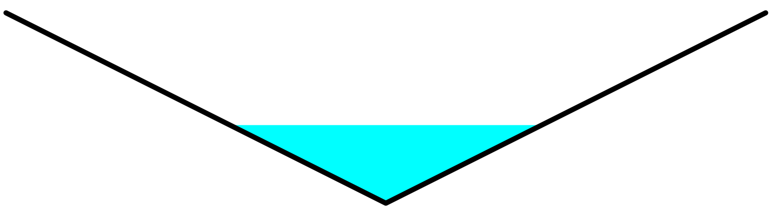
Summary for Reach RD-8: (new Reach)

Inflow Area = 3.010 ac, 16.61% Impervious, Inflow Depth = 2.55" for 25-year event
Inflow = 1.92 cfs @ 7.94 hrs, Volume= 0.639 af
Outflow = 1.89 cfs @ 8.10 hrs, Volume= 0.639 af, Atten= 1%, Lag= 9.8 min

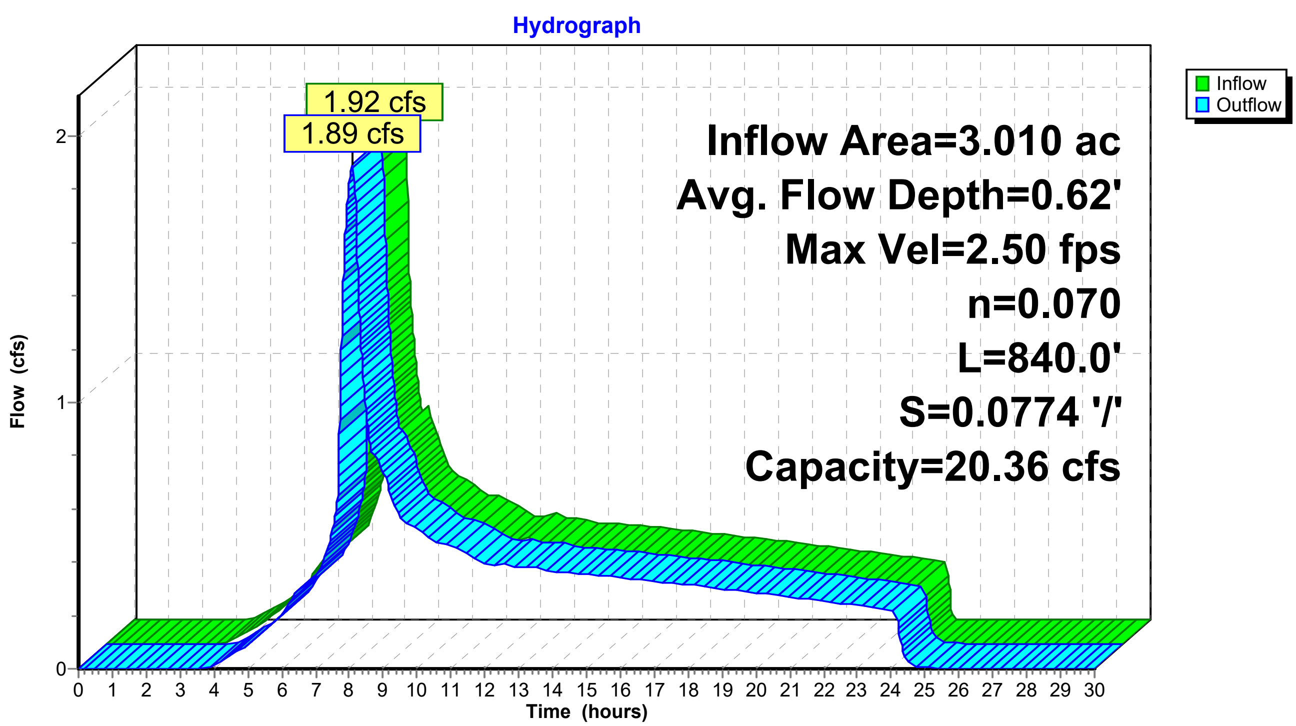
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.50 fps, Min. Travel Time= 5.6 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 10.1 min

Peak Storage= 636 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.62'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 20.36 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 840.0' Slope= 0.0774 '/'
Inlet Invert= 235.00', Outlet Invert= 170.00'



Reach RD-8: (new Reach)



Summary for Pond 1P: DI-5

[57] Hint: Peaked at 231.70' (Flood elevation advised)

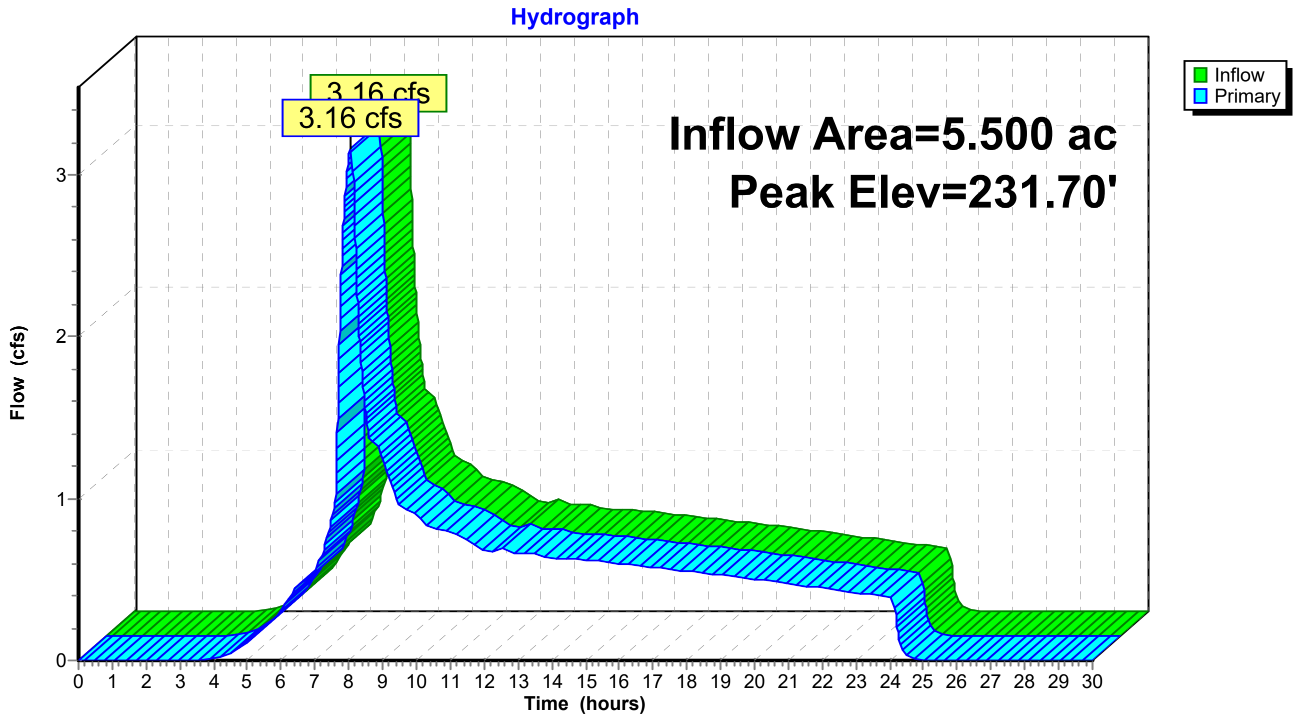
Inflow Area = 5.500 ac, 5.64% Impervious, Inflow Depth = 2.38" for 25-year event
Inflow = 3.16 cfs @ 8.07 hrs, Volume= 1.090 af
Outflow = 3.16 cfs @ 8.07 hrs, Volume= 1.090 af, Atten= 0%, Lag= 0.0 min
Primary = 3.16 cfs @ 8.07 hrs, Volume= 1.090 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 231.70' @ 8.07 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	231.41'	**24.0" Horiz. Bottom** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.16 cfs @ 8.07 hrs HW=231.70' (Free Discharge)
└─**1=Bottom** (Weir Controls 3.16 cfs @ 1.75 fps)

Pond 1P: DI-5



Summary for Pond DI-1: (new Pond)

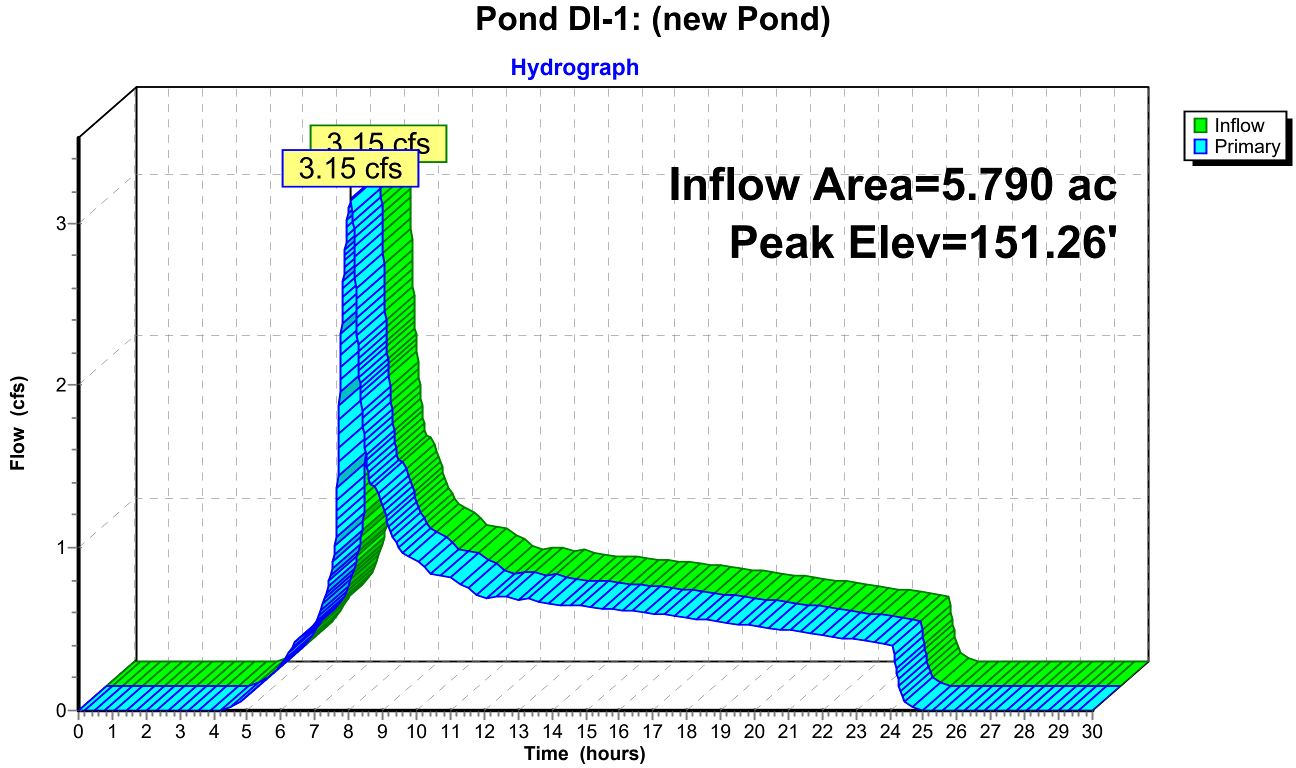
[57] Hint: Peaked at 151.26' (Flood elevation advised)

Inflow Area =	5.790 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	3.15 cfs @	8.05 hrs,	Volume=	1.106 af	
Outflow =	3.15 cfs @	8.05 hrs,	Volume=	1.106 af,	Atten= 0%, Lag= 0.0 min
Primary =	3.15 cfs @	8.05 hrs,	Volume=	1.106 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 151.26' @ 8.05 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	150.97'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=3.15 cfs @ 8.05 hrs HW=151.26' (Free Discharge)
↑—**1=Orifice/Grate** (Weir Controls 3.15 cfs @ 1.75 fps)



Summary for Pond DI-2: (new Pond)

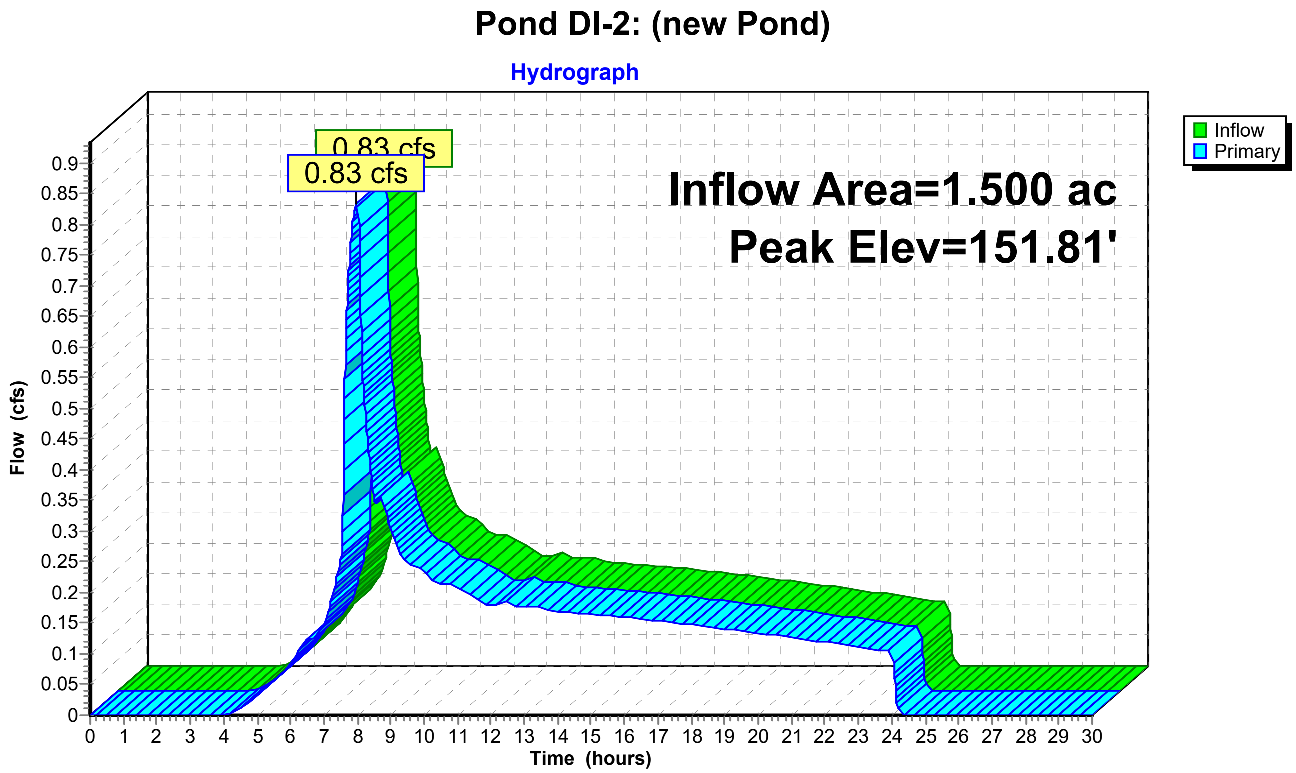
[57] Hint: Peaked at 151.81' (Flood elevation advised)

Inflow Area =	1.500 ac,	0.00% Impervious,	Inflow Depth = 2.29"	for 25-year event	
Inflow =	0.83 cfs @	7.98 hrs,	Volume=	0.287 af	
Outflow =	0.83 cfs @	7.98 hrs,	Volume=	0.287 af,	Atten= 0%, Lag= 0.0 min
Primary =	0.83 cfs @	7.98 hrs,	Volume=	0.287 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 151.81' @ 7.98 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	151.71'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.83 cfs @ 7.98 hrs HW=151.81' (Free Discharge)
└─**1=Orifice/Grate** (Weir Controls 0.83 cfs @ 1.04 fps)



Summary for Pond DI-4: (new Pond)

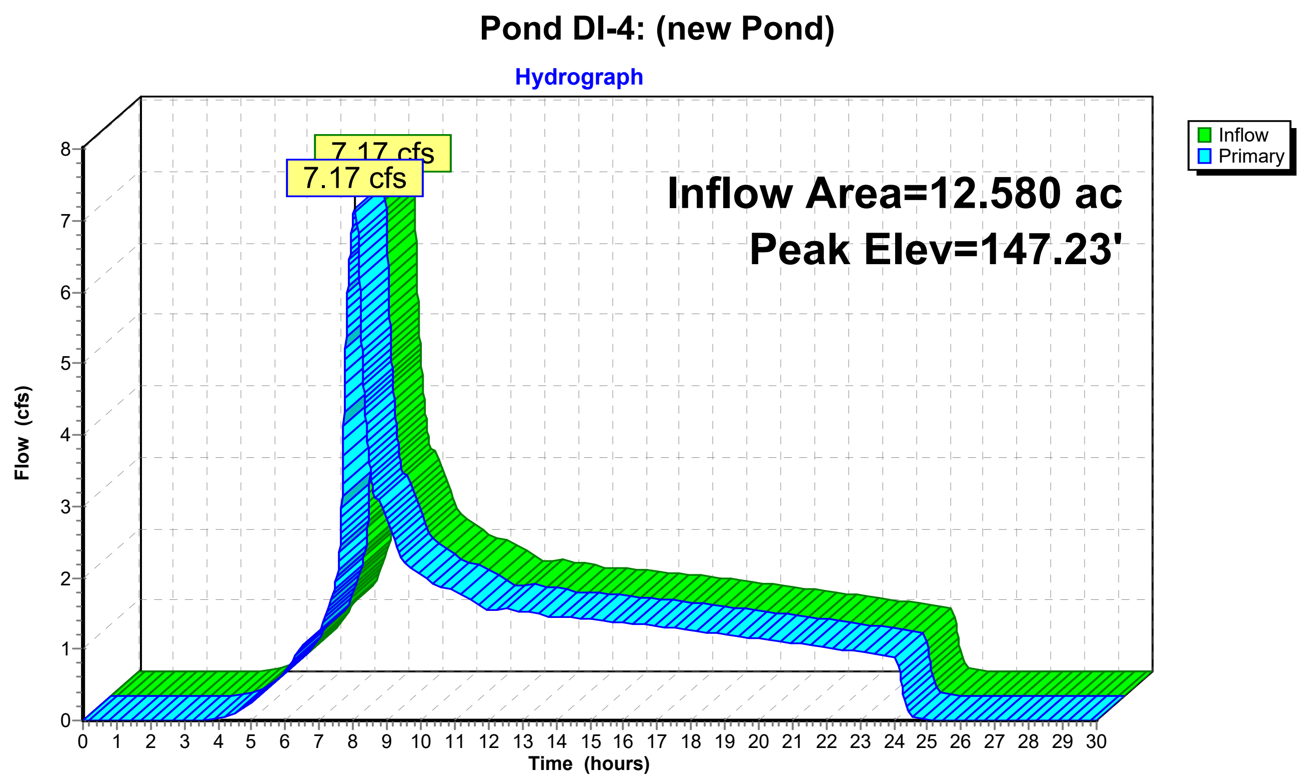
[57] Hint: Peaked at 147.23' (Flood elevation advised)

Inflow Area =	12.580 ac,	5.01% Impervious,	Inflow Depth = 2.37"	for 25-year event
Inflow =	7.17 cfs @	8.05 hrs, Volume=	2.484 af	
Outflow =	7.17 cfs @	8.05 hrs, Volume=	2.484 af,	Atten= 0%, Lag= 0.0 min
Primary =	7.17 cfs @	8.05 hrs, Volume=	2.484 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 147.23' @ 8.05 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	140.30'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=7.18 cfs @ 8.05 hrs HW=147.23' TW=147.00' (Fixed TW Elev= 147.00')
↑—**1=Orifice/Grate** (Orifice Controls 7.18 cfs @ 2.29 fps)



Summary for Pond DI-6: (new Pond)

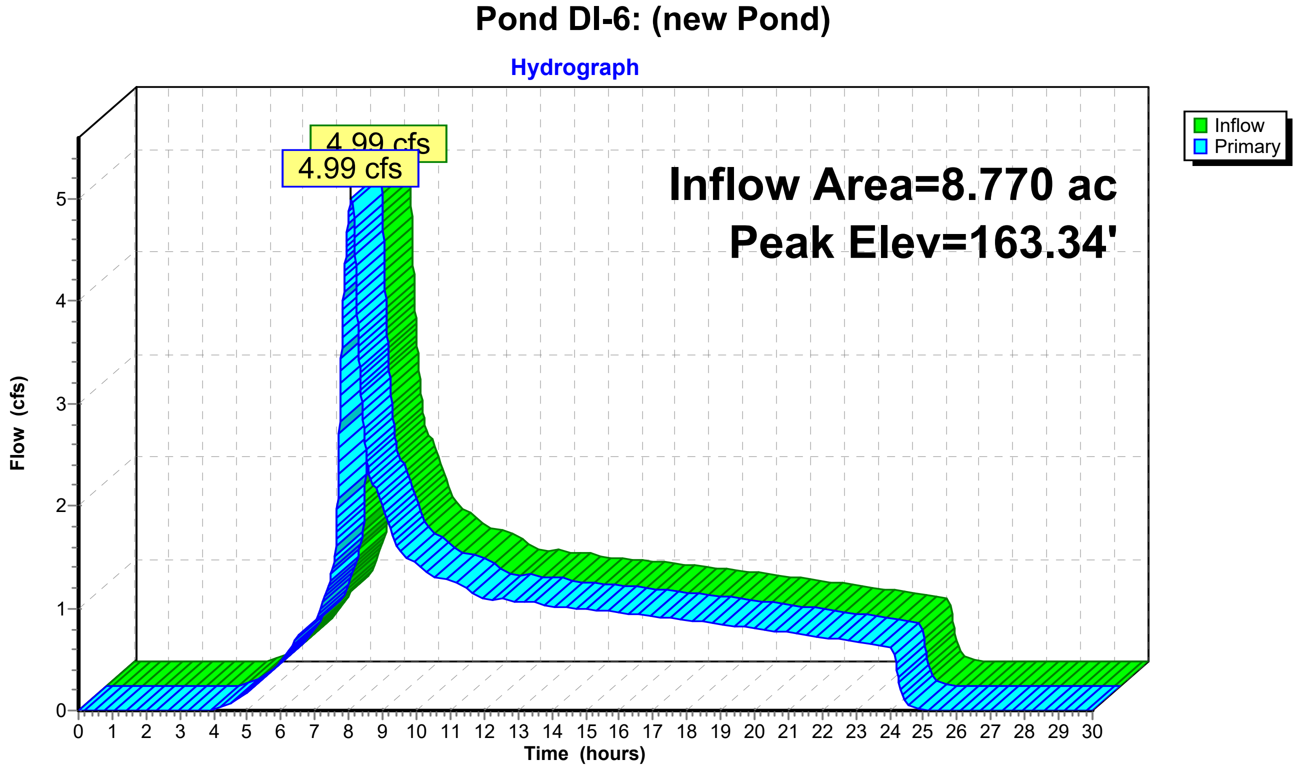
[57] Hint: Peaked at 163.34' (Flood elevation advised)

Inflow Area =	8.770 ac,	5.70% Impervious, Inflow Depth = 2.38"	for 25-year event	
Inflow =	4.99 cfs @	8.07 hrs, Volume=	1.739 af	
Outflow =	4.99 cfs @	8.07 hrs, Volume=	1.739 af,	Atten= 0%, Lag= 0.0 min
Primary =	4.99 cfs @	8.07 hrs, Volume=	1.739 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 163.34' @ 8.07 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	163.00'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.99 cfs @ 8.07 hrs HW=163.34' (Free Discharge)
└─**1=Orifice/Grate** (Weir Controls 4.99 cfs @ 1.89 fps)



Summary for Pond POND-1: DITCH 1/STORMWATER DETENTION POND 1

Inflow Area = 27.870 ac, 6.89% Impervious, Inflow Depth = 2.39" for 25-year event
Inflow = 15.65 cfs @ 8.03 hrs, Volume= 5.556 af
Outflow = 3.17 cfs @ 14.85 hrs, Volume= 2.572 af, Atten= 80%, Lag= 409.4 min
Primary = 3.17 cfs @ 14.85 hrs, Volume= 2.572 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 135.43' @ 14.85 hrs Surf.Area= 0.613 ac Storage= 3.131 af

Plug-Flow detention time= 604.7 min calculated for 2.572 af (46% of inflow)
Center-of-Mass det. time= 326.0 min (1,118.5 - 792.4)

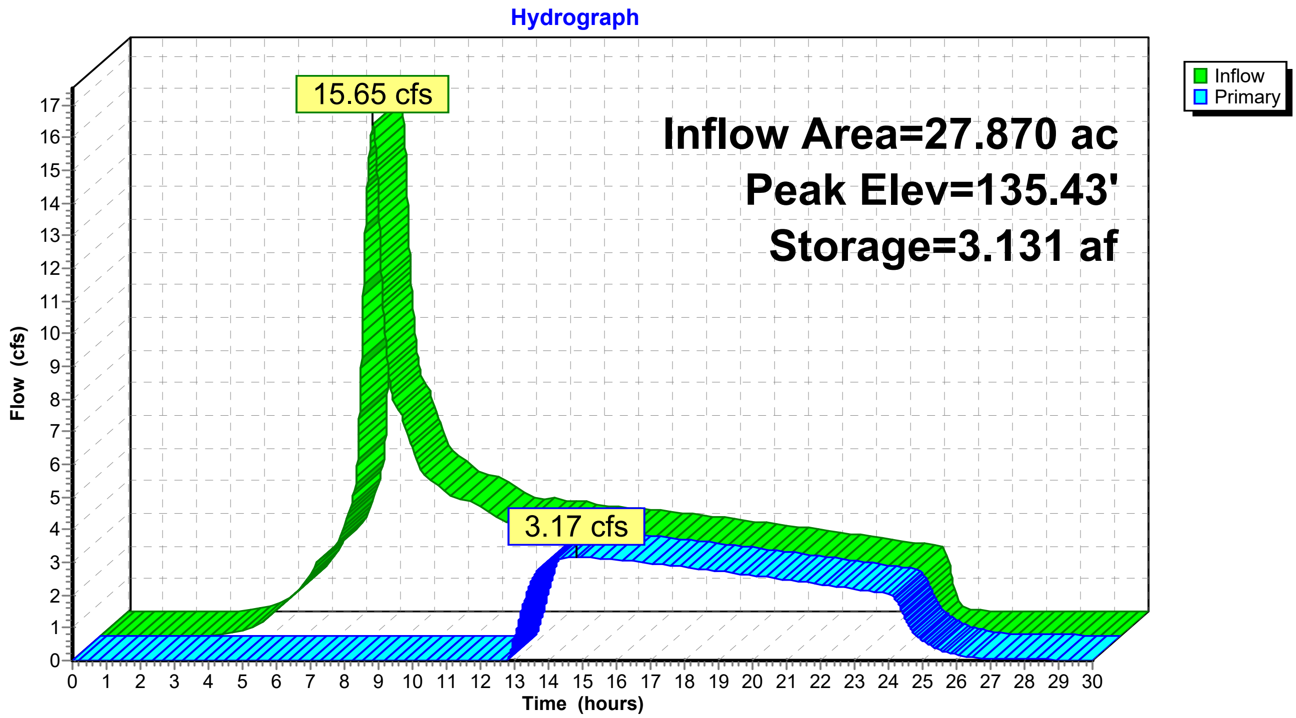
Volume	Invert	Avail.Storage	Storage Description
#1	128.00'	3.490 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
128.00	0.020	0.000	0.000
129.00	0.310	0.165	0.165
136.00	0.640	3.325	3.490

Device	Routing	Invert	Outlet Devices
#1	Device 2	135.18'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	128.00'	**30.0" Round Culvert** L= 105.0' Ke= 0.200 Inlet / Outlet Invert= 128.00' / 120.11' S= 0.0751 '/' Cc= 0.900 n= 0.017, Flow Area= 4.91 sf

Primary OutFlow Max=3.15 cfs @ 14.85 hrs HW=135.43' (Free Discharge)
↑—**2=Culvert** (Passes 3.15 cfs of 73.43 cfs potential flow)
  ↑—**1=Orifice/Grate** (Weir Controls 3.15 cfs @ 1.62 fps)

Pond POND-1: DITCH 1/STORMWATER DETENTION POND 1



Summary for Pond POND-3: STORMWATER DETENTION POND 3

Inflow Area = 25.630 ac, 21.69% Impervious, Inflow Depth = 2.67" for 25-year event
Inflow = 15.11 cfs @ 8.03 hrs, Volume= 5.699 af
Outflow = 9.23 cfs @ 8.47 hrs, Volume= 5.697 af, Atten= 39%, Lag= 25.9 min
Primary = 9.23 cfs @ 8.47 hrs, Volume= 5.697 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 141.47' @ 8.47 hrs Surf.Area= 0.761 ac Storage= 0.568 af

Plug-Flow detention time= 42.0 min calculated for 5.697 af (100% of inflow)
Center-of-Mass det. time= 41.8 min (806.6 - 764.8)

Volume	Invert	Avail.Storage	Storage Description
#1	140.00'	7.590 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

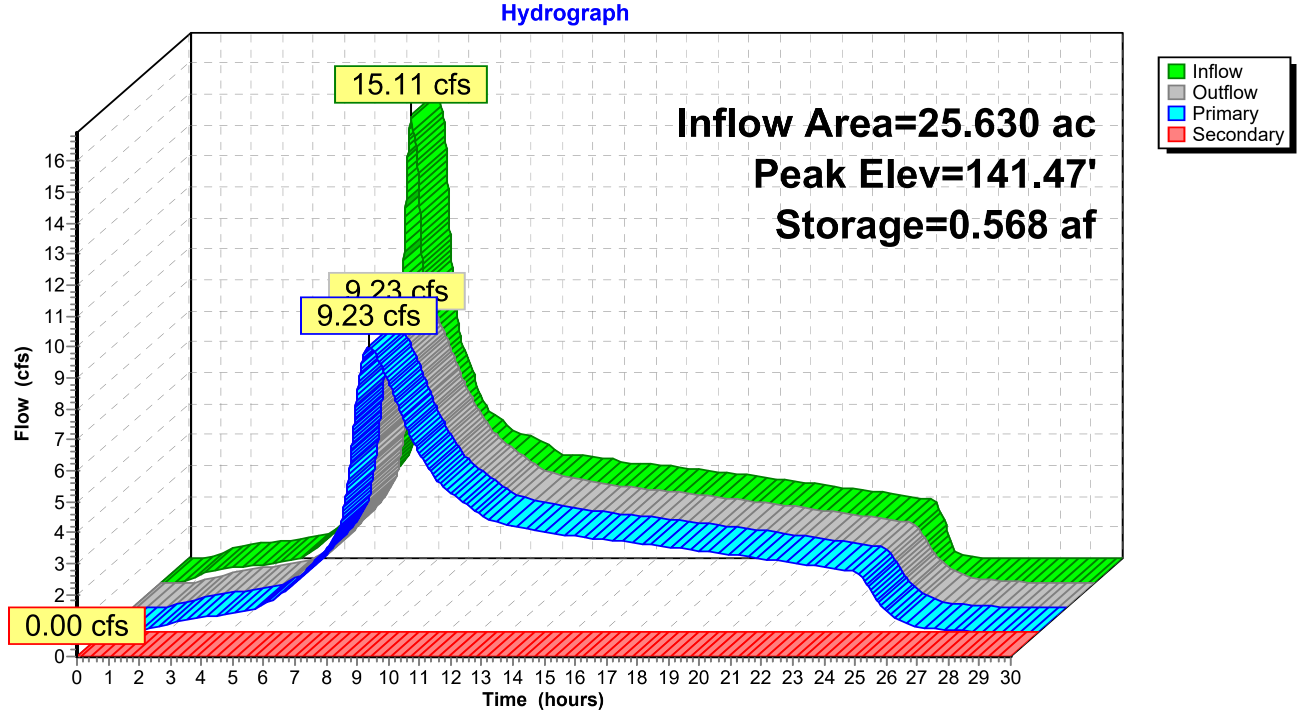
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
140.00	0.030	0.000	0.000
141.00	0.510	0.270	0.270
143.00	1.580	2.090	2.360
144.00	1.680	1.630	3.990
146.00	1.920	3.600	7.590

Device	Routing	Invert	Outlet Devices
#1	Secondary	145.50'	**39.0' long x 15.0' 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
#2	Primary	145.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	140.00'	**24.0" Round Culvert** L= 104.0' Ke= 0.200 Inlet / Outlet Invert= 140.00' / 139.00' S= 0.0096 '/' Cc= 0.900 n= 0.017, Flow Area= 3.14 sf

Primary OutFlow Max=9.23 cfs @ 8.47 hrs HW=141.47' (Free Discharge)
├─**2=Orifice/Grate** (Controls 0.00 cfs)
└─**3=Culvert** (Barrel Controls 9.23 cfs @ 5.20 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=140.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond POND-3: STORMWATER DETENTION POND 3



Summary for Pond POND-4A: STORMWATER DETENTION POND 4A

Inflow Area = 8.930 ac, 18.37% Impervious, Inflow Depth = 2.62" for 25-year event
Inflow = 5.55 cfs @ 8.01 hrs, Volume= 1.948 af
Outflow = 1.63 cfs @ 9.49 hrs, Volume= 1.331 af, Atten= 71%, Lag= 89.0 min
Primary = 1.63 cfs @ 9.49 hrs, Volume= 1.331 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 151.68' @ 9.49 hrs Surf.Area= 0.323 ac Storage= 0.675 af

Plug-Flow detention time= 373.1 min calculated for 1.331 af (68% of inflow)
Center-of-Mass det. time= 185.1 min (944.1 - 759.0)

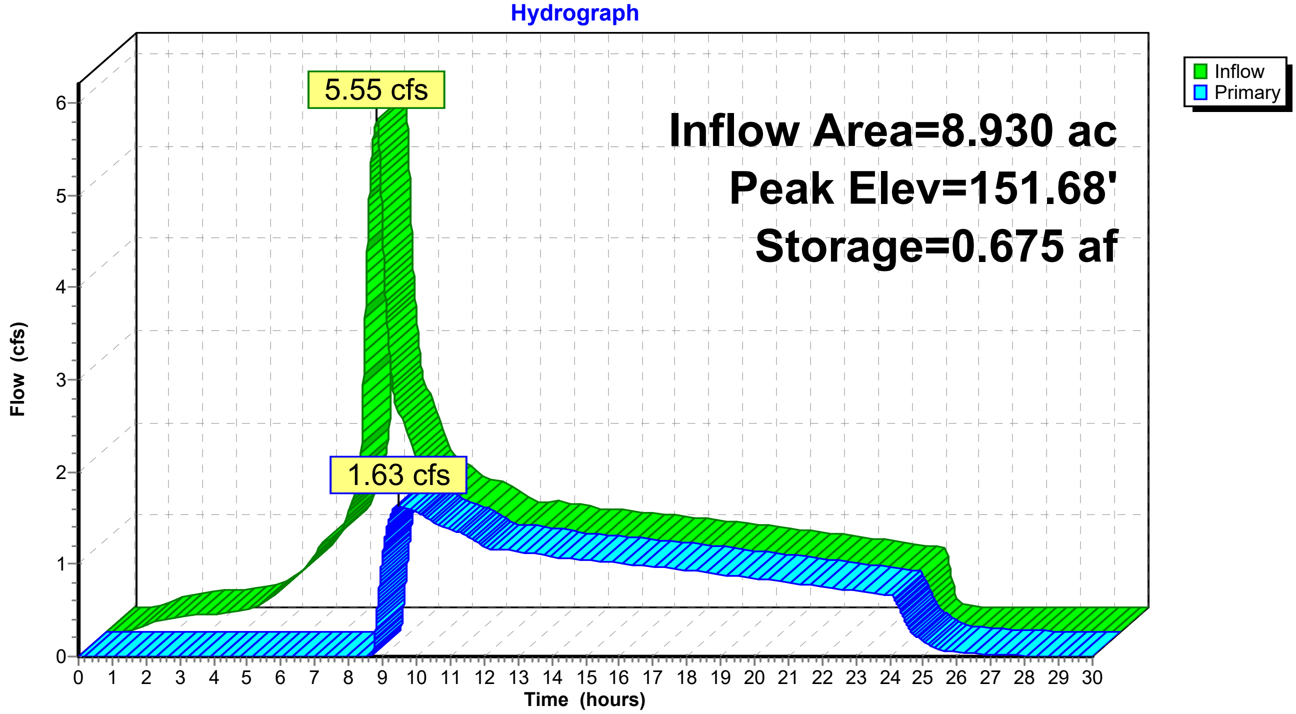
Volume	Invert	Avail.Storage	Storage Description
#1	149.00'	0.780 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
149.00	0.180	0.000	0.000
152.00	0.340	0.780	0.780

Device	Routing	Invert	Outlet Devices
#1	Device 2	151.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	148.00'	**24.0" Round Culvert** L= 130.0' Ke= 0.200 Inlet / Outlet Invert= 148.00' / 147.00' S= 0.0077 '/' Cc= 0.900 n= 0.024, Flow Area= 3.14 sf

Primary OutFlow Max=1.63 cfs @ 9.49 hrs HW=151.68' (Free Discharge)
↑—**2=Culvert** (Passes 1.63 cfs of 15.93 cfs potential flow)
↑—**1=Orifice/Grate** (Weir Controls 1.63 cfs @ 1.40 fps)

Pond POND-4A: STORMWATER DETENTION POND 4A



Time span=0.00-30.00 hrs, dt=0.01 hrs, 3001 points
Runoff by SCS TR-20 method, UH=SCS
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 7S: (new Subcat) Runoff Area=0.960 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.81 cfs 0.267 af

Subcatchment 8S: (new Subcat) Runoff Area=1.250 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.05 cfs 0.347 af

Subcatchment 9S: (new Subcat) Runoff Area=0.740 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.62 cfs 0.206 af

Subcatchment 10S: (new Subcat) Runoff Area=1.920 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.61 cfs 0.533 af

Subcatchment 16S: (new Subcat) Runoff Area=0.910 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.76 cfs 0.253 af

Subcatchment 17S: (new Subcat) Runoff Area=1.770 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.49 cfs 0.492 af

Subcatchment 18S: (new Subcat) Runoff Area=0.880 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.74 cfs 0.244 af

Subcatchment 19S: (new Subcat) Runoff Area=1.440 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.21 cfs 0.400 af

Subcatchment 20S: (new Subcat) Runoff Area=0.860 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.72 cfs 0.239 af

Subcatchment 21S: (new Subcat) Runoff Area=1.810 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.52 cfs 0.503 af

Subcatchment 22S: (new Subcat) Runoff Area=1.540 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.29 cfs 0.428 af

Subcatchment 23S: (new Subcat) Runoff Area=0.080 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.07 cfs 0.022 af

Subcatchment 24S: (new Subcat) Runoff Area=0.560 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.47 cfs 0.156 af

Subcatchment 25S: (new Subcat) Runoff Area=0.510 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.43 cfs 0.142 af

Subcatchment 26S: (new Subcat) Runoff Area=1.880 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.58 cfs 0.522 af

Subcatchment 27S: (new Subcat) Runoff Area=0.260 ac 19.23% Impervious Runoff Depth=3.63"
Tc=5.0 min CN=83 Runoff=0.24 cfs 0.079 af

Subcatchment 28S: (new Subcat) Runoff Area=1.810 ac 7.73% Impervious Runoff Depth=3.43"
Tc=5.0 min CN=81 Runoff=1.57 cfs 0.518 af

Subcatchment 29S: (new Subcat) Runoff Area=1.840 ac 16.85% Impervious Runoff Depth=3.63"
Tc=5.0 min CN=83 Runoff=1.72 cfs 0.557 af

Subcatchment 30S: (new Subcat) Runoff Area=1.550 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.30 cfs 0.431 af

Subcatchment 31S: (new Subcat) Runoff Area=2.110 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.77 cfs 0.586 af

Subcatchment 32S: (new Subcat) Runoff Area=2.170 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.82 cfs 0.603 af

Subcatchment 33S: (new Subcat) Runoff Area=3.920 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=3.29 cfs 1.089 af

Subcatchment 34S: (new Subcat) Runoff Area=2.030 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.70 cfs 0.564 af

Subcatchment 35S: (new Subcat) Runoff Area=2.410 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=2.02 cfs 0.669 af

Subcatchment 36S: (new Subcat) Runoff Area=3.010 ac 16.61% Impervious Runoff Depth=3.63"
Tc=5.0 min CN=83 Runoff=2.81 cfs 0.910 af

Subcatchment 37S: (new Subcat) Runoff Area=0.590 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.50 cfs 0.164 af

Subcatchment 38S: (new Subcat) Runoff Area=1.760 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.48 cfs 0.489 af

Subcatchment 39S: (new Subcat) Runoff Area=0.450 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.38 cfs 0.125 af

Subcatchment 40S: (new Subcat) Runoff Area=0.430 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.36 cfs 0.119 af

Subcatchment 41S: (new Subcat) Runoff Area=0.440 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.37 cfs 0.122 af

Subcatchment 42S: (new Subcat) Runoff Area=0.560 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.47 cfs 0.156 af

Subcatchment 43S: (new Subcat) Runoff Area=0.880 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.74 cfs 0.244 af

Subcatchment 44S: (new Subcat) Runoff Area=0.910 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.76 cfs 0.253 af

Subcatchment 45S: (new Subcat) Runoff Area=1.150 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.96 cfs 0.319 af

Subcatchment 46S: (new Subcat) Runoff Area=1.870 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.57 cfs 0.519 af

Subcatchment 47S: (new Subcat) Runoff Area=0.420 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.35 cfs 0.117 af

Subcatchment 48S: (new Subcat) Runoff Area=1.500 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.26 cfs 0.417 af

Subcatchment 49S: (new Subcat) Runoff Area=0.490 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.41 cfs 0.136 af

Subcatchment 50S: (new Subcat) Runoff Area=0.260 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.22 cfs 0.072 af

Subcatchment 51S: (new Subcat) Runoff Area=0.920 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.77 cfs 0.256 af

Subcatchment 52S: (new Subcat) Runoff Area=1.370 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.15 cfs 0.381 af

Subcatchment 53S: (new Subcat) Runoff Area=1.010 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.85 cfs 0.281 af

Subcatchment 54S: (new Subcat) Runoff Area=1.440 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.21 cfs 0.400 af

Subcatchment 55S: (new Subcat) Runoff Area=1.680 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.41 cfs 0.467 af

Subcatchment 56S: (new Subcat) Runoff Area=1.770 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.49 cfs 0.492 af

Subcatchment 57S: (new Subcat) Runoff Area=2.740 ac 16.79% Impervious Runoff Depth=3.63"
Tc=5.0 min CN=83 Runoff=2.55 cfs 0.829 af

Subcatchment 58S: (new Subcat) Runoff Area=1.490 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.25 cfs 0.414 af

Subcatchment 59S: (new Subcat) Runoff Area=3.820 ac 30.10% Impervious Runoff Depth=3.83"
Tc=5.0 min CN=85 Runoff=3.80 cfs 1.220 af

Subcatchment 60S: (new Subcat) Runoff Area=0.930 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.78 cfs 0.258 af

Subcatchment 61S: (new Subcat) Runoff Area=0.560 ac 23.21% Impervious Runoff Depth=3.73"
Tc=5.0 min CN=84 Runoff=0.54 cfs 0.174 af

Subcatchment 62S: (new Subcat) Runoff Area=0.470 ac 8.51% Impervious Runoff Depth=3.53"
Tc=5.0 min CN=82 Runoff=0.42 cfs 0.138 af

Subcatchment 63S: (new Subcat) Runoff Area=1.640 ac 100.00% Impervious Runoff Depth=5.26"
Tc=5.0 min CN=98 Runoff=2.17 cfs 0.719 af

Subcatchment 64S: (new Subcat) Runoff Area=4.700 ac 100.00% Impervious Runoff Depth=5.26"
Tc=5.0 min CN=98 Runoff=6.22 cfs 2.061 af

Subcatchment 65S: (new Subcat) Runoff Area=1.960 ac 7.65% Impervious Runoff Depth=3.43"
Tc=5.0 min CN=81 Runoff=1.71 cfs 0.560 af

Subcatchment 66S: (new Subcat) Runoff Area=2.600 ac 6.92% Impervious Runoff Depth=3.43"
Tc=5.0 min CN=81 Runoff=2.26 cfs 0.743 af

Subcatchment 71S: (new Subcat) Runoff Area=0.830 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.70 cfs 0.231 af

Subcatchment 73S: (new Subcat) Runoff Area=0.300 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.25 cfs 0.083 af

Reach 1R: (new Reach) Avg. Flow Depth=0.72' Max Vel=1.54 fps Inflow=1.61 cfs 0.533 af
n=0.070 L=254.0' S=0.0236 '/' Capacity=11.25 cfs Outflow=1.61 cfs 0.533 af

Reach 12R: (new Reach) Avg. Flow Depth=0.52' Max Vel=1.40 fps Inflow=0.76 cfs 0.253 af
n=0.070 L=332.0' S=0.0301 '/' Capacity=12.70 cfs Outflow=0.76 cfs 0.253 af

Reach 13R: (new Reach) Avg. Flow Depth=0.19' Max Vel=0.90 fps Inflow=0.07 cfs 0.022 af
n=0.070 L=107.0' S=0.0467 '/' Capacity=15.82 cfs Outflow=0.07 cfs 0.022 af

Reach 14R: (new Reach) Avg. Flow Depth=0.58' Max Vel=2.23 fps Inflow=1.49 cfs 0.492 af
n=0.070 L=344.0' S=0.0669 '/' Capacity=18.93 cfs Outflow=1.48 cfs 0.492 af

Reach 15R: (new Reach) Avg. Flow Depth=0.54' Max Vel=2.22 fps Inflow=1.29 cfs 0.428 af
n=0.070 L=491.0' S=0.0733 '/' Capacity=19.82 cfs Outflow=1.29 cfs 0.428 af

Reach 16R: (new Reach) Avg. Flow Depth=0.38' Max Vel=1.50 fps Inflow=0.43 cfs 0.142 af
n=0.070 L=299.0' S=0.0535 '/' Capacity=16.93 cfs Outflow=0.43 cfs 0.142 af

Reach 17R: (new Reach) Avg. Flow Depth=0.39' Max Vel=1.57 fps Inflow=0.47 cfs 0.156 af
n=0.070 L=315.0' S=0.0571 '/' Capacity=17.50 cfs Outflow=0.47 cfs 0.156 af

Reach 18R: (new Reach) Avg. Flow Depth=0.61' Max Vel=1.63 fps Inflow=1.21 cfs 0.400 af
n=0.070 L=241.0' S=0.0332 '/' Capacity=13.34 cfs Outflow=1.21 cfs 0.400 af

Reach 19R: (new Reach) Avg. Flow Depth=0.52' Max Vel=1.35 fps Inflow=0.74 cfs 0.244 af
n=0.070 L=355.0' S=0.0282 '/' Capacity=12.29 cfs Outflow=0.73 cfs 0.244 af

Reach 20R: (new Reach) Avg. Flow Depth=0.49' Max Vel=1.48 fps Inflow=0.72 cfs 0.239 af
n=0.070 L=245.0' S=0.0367 '/' Capacity=14.03 cfs Outflow=0.72 cfs 0.239 af

Reach 21R: (new Reach) Avg. Flow Depth=0.72' Max Vel=1.45 fps Inflow=1.52 cfs 0.503 af
n=0.070 L=563.0' S=0.0213 '/' Capacity=10.69 cfs Outflow=1.49 cfs 0.503 af

Reach 22R: (new Reach) Avg. Flow Depth=0.63' Max Vel=1.95 fps Inflow=1.58 cfs 0.522 af
n=0.070 L=596.0' S=0.0453 '/' Capacity=15.58 cfs Outflow=1.56 cfs 0.522 af

Reach 23R: (new Reach) Avg. Flow Depth=0.82' Max Vel=1.31 fps Inflow=1.77 cfs 0.586 af
n=0.070 L=410.0' S=0.0146 '/' Capacity=8.86 cfs Outflow=1.75 cfs 0.586 af

Reach 24R: (new Reach) Avg. Flow Depth=0.63' Max Vel=1.62 fps Inflow=1.30 cfs 0.431 af
n=0.070 L=257.0' S=0.0311 '/' Capacity=12.92 cfs Outflow=1.30 cfs 0.431 af

Reach 26R: (new Reach) Avg. Flow Depth=0.54' Max Vel=1.28 fps Inflow=0.77 cfs 0.256 af
n=0.070 L=417.0' S=0.0240 '/' Capacity=11.34 cfs Outflow=0.76 cfs 0.256 af

Reach 27R: (new Reach) Avg. Flow Depth=0.46' Max Vel=1.16 fps Inflow=0.50 cfs 0.164 af
n=0.070 L=323.0' S=0.0248 '/' Capacity=11.52 cfs Outflow=0.49 cfs 0.164 af

Reach 28R: (new Reach) Avg. Flow Depth=0.66' Max Vel=1.31 fps Inflow=1.15 cfs 0.381 af
n=0.070 L=410.0' S=0.0195 '/' Capacity=10.23 cfs Outflow=1.14 cfs 0.381 af

Reach 29R: (new Reach) Avg. Flow Depth=0.63' Max Vel=1.03 fps Inflow=0.85 cfs 0.281 af
n=0.070 L=394.0' S=0.0127 '/' Capacity=8.25 cfs Outflow=0.83 cfs 0.281 af

Reach 30R: (new Reach) Avg. Flow Depth=0.70' Max Vel=1.49 fps Inflow=1.48 cfs 0.489 af
n=0.070 L=645.0' S=0.0233 '/' Capacity=11.16 cfs Outflow=1.44 cfs 0.489 af

Reach 31R: (new Reach) Avg. Flow Depth=0.72' Max Vel=1.65 fps Inflow=1.70 cfs 0.564 af
n=0.070 L=363.0' S=0.0275 '/' Capacity=12.15 cfs Outflow=1.69 cfs 0.564 af

Reach 32R: (new Reach) Avg. Flow Depth=0.34' Max Vel=1.63 fps Inflow=0.38 cfs 0.125 af
n=0.070 L=96.0' S=0.0729 '/' Capacity=19.77 cfs Outflow=0.38 cfs 0.125 af

Reach 33R: (new Reach) Avg. Flow Depth=0.73' Max Vel=1.87 fps Inflow=2.02 cfs 0.669 af
n=0.070 L=720.0' S=0.0347 '/' Capacity=13.64 cfs Outflow=1.99 cfs 0.669 af

Reach 34R: (new Reach) Avg. Flow Depth=0.37' Max Vel=1.33 fps Inflow=0.36 cfs 0.119 af
n=0.070 L=115.0' S=0.0435 '/' Capacity=15.26 cfs Outflow=0.36 cfs 0.119 af

Reach 35R: (new Reach) Avg. Flow Depth=0.37' Max Vel=1.35 fps Inflow=0.37 cfs 0.122 af
n=0.070 L=134.0' S=0.0448 '/' Capacity=15.49 cfs Outflow=0.37 cfs 0.122 af

Reach 36R: (new Reach) Avg. Flow Depth=0.45' Max Vel=1.89 fps Inflow=0.76 cfs 0.253 af
n=0.070 L=328.0' S=0.0671 '/' Capacity=18.96 cfs Outflow=0.76 cfs 0.253 af

Reach 37R: (new Reach) Avg. Flow Depth=0.36' Max Vel=1.78 fps Inflow=0.47 cfs 0.156 af
n=0.070 L=227.0' S=0.0793 '/' Capacity=20.61 cfs Outflow=0.47 cfs 0.156 af

Reach 38R: (new Reach) Avg. Flow Depth=0.59' Max Vel=1.06 fps Inflow=0.74 cfs 0.244 af
n=0.070 L=341.0' S=0.0147 '/' Capacity=8.86 cfs Outflow=0.73 cfs 0.244 af

Reach 39R: (new Reach) Avg. Flow Depth=0.54' Max Vel=1.65 fps Inflow=0.96 cfs 0.319 af
n=0.070 L=540.0' S=0.0407 '/' Capacity=14.78 cfs Outflow=0.95 cfs 0.319 af

Reach 40R: (new Reach) Avg. Flow Depth=0.53' Max Vel=2.13 fps Inflow=1.21 cfs 0.400 af
n=0.070 L=395.0' S=0.0684 '/' Capacity=19.14 cfs Outflow=1.20 cfs 0.400 af

Reach 41R: (new Reach) Avg. Flow Depth=0.77' Max Vel=2.75 fps Inflow=3.29 cfs 1.089 af
n=0.070 L=675.0' S=0.0696 '/' Capacity=19.32 cfs Outflow=3.27 cfs 1.089 af

Reach 42R: (new Reach) Avg. Flow Depth=0.57' Max Vel=2.14 fps Inflow=1.41 cfs 0.467 af
n=0.070 L=573.0' S=0.0628 '/' Capacity=18.35 cfs Outflow=1.40 cfs 0.467 af

Reach 43R: (new Reach) Avg. Flow Depth=0.64' Max Vel=12.37 fps Inflow=10.26 cfs 3.414 af
n=0.016 L=257.0' S=0.0934 '/' Capacity=97.87 cfs Outflow=10.26 cfs 3.414 af

Reach 44R: (new Reach) Avg. Flow Depth=0.82' Max Vel=1.34 fps Inflow=1.82 cfs 0.603 af
n=0.070 L=265.0' S=0.0151 '/' Capacity=8.99 cfs Outflow=1.81 cfs 0.603 af

Reach 45R: (new Reach) Avg. Flow Depth=0.52' Max Vel=1.13 fps Inflow=0.62 cfs 0.206 af
n=0.070 L=254.0' S=0.0197 '/' Capacity=10.27 cfs Outflow=0.62 cfs 0.206 af

Reach 46R: (new Reach) Avg. Flow Depth=0.59' Max Vel=1.75 fps Inflow=1.25 cfs 0.414 af
n=0.070 L=550.0' S=0.0400 '/' Capacity=14.64 cfs Outflow=1.24 cfs 0.414 af

Reach 47R: (new Reach) Avg. Flow Depth=0.45' Max Vel=2.01 fps Inflow=0.81 cfs 0.267 af
n=0.070 L=247.0' S=0.0769 '/' Capacity=20.30 cfs Outflow=0.80 cfs 0.267 af

Reach 48R: (new Reach) Avg. Flow Depth=0.27' Max Vel=1.77 fps Inflow=0.25 cfs 0.083 af
n=0.070 L=227.0' S=0.1189 '/' Capacity=25.25 cfs Outflow=0.25 cfs 0.083 af

Reach 50R: (new Reach) Avg. Flow Depth=0.45' Max Vel=1.90 fps Inflow=0.78 cfs 0.258 af
n=0.070 L=280.0' S=0.0679 '/' Capacity=19.07 cfs Outflow=0.78 cfs 0.258 af

Reach 51R: (new Reach) Avg. Flow Depth=0.35' Max Vel=2.25 fps Inflow=0.54 cfs 0.174 af
n=0.070 L=148.0' S=0.1351 '/' Capacity=26.91 cfs Outflow=0.54 cfs 0.174 af

Reach 52R: (new Reach) Avg. Flow Depth=0.60' Max Vel=0.88 fps Inflow=1.71 cfs 0.560 af
n=0.070 L=352.0' S=0.0057 '/' Capacity=10.86 cfs Outflow=1.67 cfs 0.560 af

Reach 53R: (new Reach) Avg. Flow Depth=1.44' Max Vel=1.36 fps Inflow=10.22 cfs 3.470 af
n=0.070 L=762.0' S=0.0052 '/' Capacity=10.44 cfs Outflow=9.57 cfs 3.470 af

Reach 55R: (new Reach) Avg. Flow Depth=0.45' Max Vel=1.72 fps Inflow=0.70 cfs 0.231 af
n=0.070 L=179.0' S=0.0559 '/' Capacity=17.30 cfs Outflow=0.70 cfs 0.231 af

Reach CP 7.1: conversion point Inflow=0.83 cfs 0.275 af
Outflow=0.83 cfs 0.275 af

Reach CP-1.1: (new Reach) Inflow=1.23 cfs 0.408 af
Outflow=1.23 cfs 0.408 af

Reach CP-1.2: (new Reach) Inflow=1.95 cfs 0.653 af
Outflow=1.95 cfs 0.653 af

Reach CP-1.3: (new Reach) Inflow=2.90 cfs 0.972 af
Outflow=2.90 cfs 0.972 af

Reach CP-1.4: (new Reach) Inflow=4.46 cfs 1.492 af
Outflow=4.46 cfs 1.492 af

Reach CP-10.1: (new Reach)	Inflow=5.49 cfs 1.829 af Outflow=5.49 cfs 1.829 af
Reach CP-10.3: (new Reach)	Inflow=5.98 cfs 1.993 af Outflow=5.98 cfs 1.993 af
Reach CP-10.4: (new Reach)	Inflow=7.12 cfs 2.373 af Outflow=7.12 cfs 2.373 af
Reach CP-10.6: (new Reach)	Inflow=9.37 cfs 3.143 af Outflow=9.37 cfs 3.143 af
Reach CP-11.1: (new Reach)	Inflow=2.07 cfs 0.689 af Outflow=2.07 cfs 0.689 af
Reach CP-11.3: (new Reach)	Inflow=4.37 cfs 1.478 af Outflow=4.37 cfs 1.478 af
Reach CP-11.5: (new Reach)	Inflow=4.74 cfs 1.600 af Outflow=4.74 cfs 1.600 af
Reach CP-11.7: (new Reach)	Inflow=7.75 cfs 2.589 af Outflow=7.75 cfs 2.589 af
Reach CP-2.1: (new Reach)	Inflow=1.20 cfs 0.400 af Outflow=1.20 cfs 0.400 af
Reach CP-2.2: (new Reach)	Inflow=4.47 cfs 1.489 af Outflow=4.47 cfs 1.489 af
Reach CP-2.3: (new Reach)	Inflow=5.87 cfs 1.956 af Outflow=5.87 cfs 1.956 af
Reach CP-2.4: (new Reach)	Inflow=8.40 cfs 2.784 af Outflow=8.40 cfs 2.784 af
Reach CP-20.4: (new Reach)	Inflow=1.26 cfs 0.417 af Outflow=1.26 cfs 0.417 af
Reach CP-20.5: (new Reach)	Inflow=4.79 cfs 1.608 af Outflow=4.79 cfs 1.608 af
Reach CP-21.1: (new Reach)	Inflow=17.56 cfs 5.940 af Outflow=17.56 cfs 5.940 af
Reach CP-22.1: (new Reach)	Inflow=0.89 cfs 0.297 af Outflow=0.89 cfs 0.297 af
Reach CP-23.1: (new Reach)	Inflow=0.94 cfs 0.347 af Outflow=0.94 cfs 0.347 af

Reach CP-3.1: (new Reach) Inflow=9.86 cfs 3.276 af
Outflow=9.86 cfs 3.276 af

Reach CP-4A.2: (new Reach) Inflow=1.61 cfs 0.533 af
Outflow=1.61 cfs 0.533 af

Reach CP-4B.1: (new Reach) Inflow=3.42 cfs 1.136 af
Outflow=3.42 cfs 1.136 af

Reach CP-4B.2: (new Reach) Inflow=4.04 cfs 1.342 af
Outflow=4.04 cfs 1.342 af

Reach CP-4B.3: (new Reach) Inflow=4.73 cfs 1.572 af
Outflow=4.73 cfs 1.572 af

Reach CP-4B.4: (new Reach) Inflow=5.53 cfs 1.839 af
Outflow=5.53 cfs 1.839 af

Reach CP-4B.5: (new Reach) Inflow=6.75 cfs 2.253 af
Outflow=6.75 cfs 2.253 af

Reach CP-4B.6: (new Reach) Inflow=7.00 cfs 2.336 af
Outflow=7.00 cfs 2.336 af

Reach CP-7.2: conversion point Inflow=3.58 cfs 1.194 af
Outflow=3.58 cfs 1.194 af

Reach CP-8.1: conversion point Inflow=1.93 cfs 0.644 af
Outflow=1.93 cfs 0.644 af

Reach CP-8.2: conversion point Inflow=4.12 cfs 1.386 af
Outflow=4.12 cfs 1.386 af

Reach CP-8.3: conversion point Inflow=6.45 cfs 2.167 af
Outflow=6.45 cfs 2.167 af

Reach CP-9.1: (new Reach) Inflow=3.04 cfs 1.017 af
Outflow=3.04 cfs 1.017 af

Reach CULV-1: (new Reach) Avg. Flow Depth=0.42' Max Vel=10.15 fps Inflow=4.79 cfs 1.608 af
24.0" Round Pipe n=0.013 L=53.0' S=0.0502 '/' Capacity=50.68 cfs Outflow=4.79 cfs 1.608 af

Reach CULV-2: (new Reach) Avg. Flow Depth=0.25' Max Vel=4.88 fps Inflow=1.26 cfs 0.417 af
30.0" Round Pipe n=0.013 L=139.0' S=0.0210 '/' Capacity=59.45 cfs Outflow=1.26 cfs 0.417 af

Reach CULV-2.2: (new Reach) Avg. Flow Depth=0.32' Max Vel=3.11 fps Inflow=1.26 cfs 0.417 af
36.0" Round Pipe n=0.013 L=87.0' S=0.0062 '/' Capacity=52.55 cfs Outflow=1.26 cfs 0.417 af

Reach CULV-3: (new Reach) Avg. Flow Depth=1.09' Max Vel=6.17 fps Inflow=10.78 cfs 3.588 af
24.0" Round Pipe n=0.017 L=196.0' S=0.0117 '/' Capacity=18.74 cfs Outflow=10.78 cfs 3.588 af

Reach CULV-4: (new Reach) Avg. Flow Depth=0.43' Max Vel=9.70 fps Inflow=4.74 cfs 1.573 af
24.0" Round Pipe n=0.013 L=69.0' S=0.0446 '/' Capacity=47.80 cfs Outflow=4.74 cfs 1.573 af

Reach CULV-5: (new Reach) Avg. Flow Depth=0.67' Max Vel=19.15 fps Inflow=17.56 cfs 5.940 af
24.0" Round Pipe n=0.012 L=84.0' S=0.0893 '/' Capacity=73.23 cfs Outflow=17.56 cfs 5.940 af

Reach CULV-7: (new Reach) Avg. Flow Depth=0.56' Max Vel=10.34 fps Inflow=7.51 cfs 2.510 af
24.0" Round Pipe n=0.012 L=128.0' S=0.0313 '/' Capacity=43.32 cfs Outflow=7.51 cfs 2.510 af

Reach DC-10A: (new Reach) Avg. Flow Depth=0.18' Max Vel=12.69 fps Inflow=5.49 cfs 1.829 af
n=0.018 L=108.0' S=0.2870 '/' Capacity=300.28 cfs Outflow=5.49 cfs 1.829 af

Reach DC-10B: (new Reach) Avg. Flow Depth=0.20' Max Vel=12.47 fps Inflow=5.98 cfs 1.993 af
n=0.018 L=40.0' S=0.2500 '/' Capacity=280.24 cfs Outflow=5.98 cfs 1.993 af

Reach DC-10C: (new Reach) Avg. Flow Depth=0.22' Max Vel=13.54 fps Inflow=7.12 cfs 2.373 af
n=0.018 L=100.0' S=0.2700 '/' Capacity=291.24 cfs Outflow=7.12 cfs 2.373 af

Reach DC-11A: (new Reach) Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=115.0' S=0.1391 '/' Capacity=292.33 cfs Outflow=0.00 cfs 0.000 af

Reach DC-11B: (new Reach) Avg. Flow Depth=0.10' Max Vel=8.98 fps Inflow=2.07 cfs 0.689 af
n=0.018 L=161.0' S=0.2795 '/' Capacity=414.33 cfs Outflow=2.07 cfs 0.689 af

Reach DC-11C: (new Reach) Avg. Flow Depth=0.16' Max Vel=11.57 fps Inflow=4.37 cfs 1.478 af
n=0.018 L=150.0' S=0.2733 '/' Capacity=409.73 cfs Outflow=4.37 cfs 1.478 af

Reach DC-11D: (new Reach) Avg. Flow Depth=0.17' Max Vel=11.76 fps Inflow=4.74 cfs 1.600 af
n=0.018 L=34.0' S=0.2647 '/' Capacity=403.22 cfs Outflow=4.74 cfs 1.600 af

Reach DC-12: (new Reach) Avg. Flow Depth=0.08' Max Vel=2.04 fps Inflow=0.89 cfs 0.297 af
n=0.070 L=107.0' S=0.2617 '/' Capacity=132.47 cfs Outflow=0.89 cfs 0.297 af

Reach DC-1A: (new Reach) Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=242.0' S=0.1694 '/' Capacity=230.70 cfs Outflow=0.00 cfs 0.000 af

Reach DC-1B: (new Reach) Avg. Flow Depth=0.09' Max Vel=6.36 fps Inflow=1.23 cfs 0.408 af
n=0.018 L=206.0' S=0.1699 '/' Capacity=231.03 cfs Outflow=1.23 cfs 0.408 af

Reach DC-1C: (new Reach) Avg. Flow Depth=0.18' Max Vel=4.62 fps Inflow=1.95 cfs 0.653 af
n=0.018 L=77.0' S=0.0390 '/' Capacity=110.63 cfs Outflow=1.95 cfs 0.653 af

Reach DC-1D: (new Reach) Avg. Flow Depth=0.13' Max Vel=9.83 fps Inflow=2.90 cfs 0.972 af
n=0.018 L=98.0' S=0.2551 '/' Capacity=283.09 cfs Outflow=2.90 cfs 0.972 af

Reach DC-2A: (new Reach) Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=165.0' S=0.2242 '/' Capacity=1,143.46 cfs Outflow=0.00 cfs 0.000 af

Reach DC-2B: (new Reach) Avg. Flow Depth=0.06' Max Vel=5.32 fps Inflow=1.20 cfs 0.400 af
n=0.018 L=35.0' S=0.2000 '/' Capacity=1,079.89 cfs Outflow=1.20 cfs 0.400 af

Reach DC-2C: (new Reach) Avg. Flow Depth=0.12' Max Vel=8.61 fps Inflow=4.47 cfs 1.489 af
n=0.018 L=199.0' S=0.1960 '/' Capacity=1,068.98 cfs Outflow=4.47 cfs 1.489 af

Reach DC-2D: (new Reach) Avg. Flow Depth=0.15' Max Vel=9.18 fps Inflow=5.87 cfs 1.956 af
n=0.018 L=40.0' S=0.1750 '/' Capacity=1,010.14 cfs Outflow=5.87 cfs 1.956 af

Reach DC-2E: (new Reach) Avg. Flow Depth=0.16' Max Vel=12.43 fps Inflow=8.40 cfs 2.784 af
n=0.018 L=50.0' S=0.3000 '/' Capacity=1,322.58 cfs Outflow=8.40 cfs 2.784 af

Reach DC-4A: (new Reach) Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=134.0' S=0.0821 '/' Capacity=245.13 cfs Outflow=0.00 cfs 0.000 af

Reach DC-4B: (new Reach) Avg. Flow Depth=0.08' Max Vel=5.00 fps Inflow=1.61 cfs 0.533 af
n=0.018 L=17.0' S=0.1176 '/' Capacity=293.45 cfs Outflow=1.61 cfs 0.533 af

Reach DC-4C: (new Reach) Avg. Flow Depth=0.13' Max Vel=6.27 fps Inflow=3.42 cfs 1.136 af
n=0.018 L=102.0' S=0.0980 '/' Capacity=267.89 cfs Outflow=3.42 cfs 1.136 af

Reach DC-4D: (new Reach) Avg. Flow Depth=0.10' Max Vel=9.92 fps Inflow=4.04 cfs 1.342 af
n=0.018 L=49.0' S=0.3469 '/' Capacity=503.94 cfs Outflow=4.03 cfs 1.342 af

Reach DC-4E: (new Reach) Avg. Flow Depth=0.11' Max Vel=10.18 fps Inflow=4.73 cfs 1.572 af
n=0.018 L=96.0' S=0.3125 '/' Capacity=478.27 cfs Outflow=4.73 cfs 1.572 af

Reach DC-4F: (new Reach) Avg. Flow Depth=0.12' Max Vel=10.95 fps Inflow=5.53 cfs 1.839 af
n=0.018 L=61.0' S=0.3279 '/' Capacity=489.89 cfs Outflow=5.53 cfs 1.839 af

Reach DC-4G: (new Reach) Avg. Flow Depth=0.13' Max Vel=11.98 fps Inflow=6.75 cfs 2.253 af
n=0.018 L=93.0' S=0.3441 '/' Capacity=501.86 cfs Outflow=6.75 cfs 2.253 af

Reach DC-4H: (new Reach) Avg. Flow Depth=0.17' Max Vel=9.35 fps Inflow=7.00 cfs 2.336 af
n=0.018 L=53.0' S=0.1509 '/' Capacity=332.40 cfs Outflow=7.00 cfs 2.336 af

Reach DC-7A: downchute Avg. Flow Depth=0.07' Max Vel=2.88 fps Inflow=0.83 cfs 0.275 af
n=0.041 L=279.0' S=0.2330 '/' Capacity=205.90 cfs Outflow=0.82 cfs 0.275 af

Reach DC-7B: downchute Avg. Flow Depth=0.22' Max Vel=6.52 fps Inflow=3.58 cfs 1.194 af
n=0.030 L=24.0' S=0.1667 '/' Capacity=157.85 cfs Outflow=3.58 cfs 1.194 af

Reach DC-8A: downchute Avg. Flow Depth=0.17' Max Vel=4.97 fps Inflow=1.93 cfs 0.644 af
n=0.041 L=157.0' S=0.2548 '/' Capacity=142.80 cfs Outflow=1.93 cfs 0.644 af

Reach DC-8B: downchute Avg. Flow Depth=0.22' Max Vel=7.78 fps Inflow=4.12 cfs 1.386 af
n=0.030 L=163.0' S=0.2454 '/' Capacity=191.54 cfs Outflow=4.12 cfs 1.386 af

Reach DC-8C: downchute Avg. Flow Depth=0.44' Max Vel=5.05 fps Inflow=6.45 cfs 2.167 af
n=0.070 L=105.0' S=0.2571 '/' Capacity=84.03 cfs Outflow=6.45 cfs 2.167 af

Reach DC-9: (new Reach) Avg. Flow Depth=0.13' Max Vel=10.17 fps Inflow=3.04 cfs 1.017 af
n=0.018 L=137.0' S=0.2701 '/' Capacity=291.28 cfs Outflow=3.03 cfs 1.017 af

Reach DITCH-2: (new Reach) Avg. Flow Depth=0.85' Max Vel=0.65 fps Inflow=1.05 cfs 0.347 af
n=0.070 L=580.0' S=0.0034 '/' Capacity=4.30 cfs Outflow=0.94 cfs 0.347 af

Reach NPIS-1: (new Reach) Avg. Flow Depth=0.33' Max Vel=0.87 fps Inflow=0.24 cfs 0.079 af
n=0.070 L=120.0' S=0.0200 '/' Capacity=28.53 cfs Outflow=0.24 cfs 0.079 af

Reach NPIS-2: (new Reach) Avg. Flow Depth=1.32' Max Vel=1.85 fps Inflow=8.12 cfs 2.725 af
n=0.070 L=343.0' S=0.0146 '/' Capacity=24.35 cfs Outflow=8.06 cfs 2.725 af

Reach NPIS-3: (new Reach) Avg. Flow Depth=1.33' Max Vel=2.14 fps Inflow=9.54 cfs 3.215 af
n=0.070 L=363.0' S=0.0193 '/' Capacity=28.01 cfs Outflow=9.50 cfs 3.215 af

Reach OF-1: (new Reach) Inflow=6.04 cfs 2.025 af
Outflow=6.04 cfs 2.025 af

Reach OF-4A: outfall Inflow=8.11 cfs 2.727 af
Outflow=8.11 cfs 2.727 af

Reach OF-4B: Outfall 4E Inflow=10.17 cfs 3.767 af
Outflow=10.17 cfs 3.767 af

Reach OF-4C: outfall Inflow=3.58 cfs 1.194 af
Outflow=3.58 cfs 1.194 af

Reach RD-1: (new Reach) Avg. Flow Depth=0.35' Max Vel=5.16 fps Inflow=1.26 cfs 0.417 af
n=0.016 L=253.0' S=0.0366 '/' Capacity=132.03 cfs Outflow=1.26 cfs 0.417 af

Reach RD-2: (new Reach) Avg. Flow Depth=0.51' Max Vel=9.38 fps Inflow=4.79 cfs 1.608 af
n=0.016 L=152.0' S=0.0741 '/' Capacity=187.81 cfs Outflow=4.79 cfs 1.608 af

Reach RD-3: (new Reach) Avg. Flow Depth=0.42' Max Vel=4.34 fps Inflow=1.57 cfs 0.519 af
n=0.016 L=650.0' S=0.0200 '/' Capacity=45.29 cfs Outflow=1.57 cfs 0.519 af

Reach RD-4: (new Reach) Avg. Flow Depth=0.38' Max Vel=5.13 fps Inflow=1.49 cfs 0.492 af
n=0.016 L=617.0' S=0.0324 '/' Capacity=19.56 cfs Outflow=1.48 cfs 0.492 af

Reach RD-5: (new Reach) Avg. Flow Depth=0.68' Max Vel=2.74 fps Inflow=2.55 cfs 0.829 af
n=0.070 L=795.0' S=0.0818 '/' Capacity=20.93 cfs Outflow=2.53 cfs 0.829 af

Reach RD-7: (new Reach) Avg. Flow Depth=0.57' Max Vel=2.63 fps Inflow=1.72 cfs 0.557 af
n=0.070 L=485.0' S=0.0948 '/' Capacity=22.54 cfs Outflow=1.71 cfs 0.557 af

Reach RD-8: (new Reach) Avg. Flow Depth=0.71' Max Vel=2.75 fps Inflow=2.81 cfs 0.910 af
n=0.070 L=840.0' S=0.0774 '/' Capacity=20.36 cfs Outflow=2.78 cfs 0.910 af

Pond 1P: DI-5 Peak Elev=231.79' Inflow=4.74 cfs 1.573 af
Outflow=4.74 cfs 1.573 af

Pond DI-1: (new Pond) Peak Elev=151.35' Inflow=4.79 cfs 1.608 af
Outflow=4.79 cfs 1.608 af

Pond DI-2: (new Pond) Peak Elev=151.84' Inflow=1.26 cfs 0.417 af
Outflow=1.26 cfs 0.417 af

Pond DI-4: (new Pond) Peak Elev=147.51' Inflow=10.78 cfs 3.588 af
Outflow=10.78 cfs 3.588 af

Pond DI-6: (new Pond) Peak Elev=163.44' Inflow=7.51 cfs 2.510 af
Outflow=7.51 cfs 2.510 af

Pond POND-1: DITCH 1/STORMWATER Peak Elev=135.55' Storage=3.206 af Inflow=23.59 cfs 8.009 af
Outflow=5.78 cfs 5.026 af

Pond POND-3: STORMWATER DETENTION Peak Elev=141.82' Storage=0.867 af Inflow=22.50 cfs 8.001 af
Primary=12.78 cfs 8.000 af Secondary=0.00 cfs 0.000 af Outflow=12.78 cfs 8.000 af

Pond POND-4A: STORMWATER Peak Elev=151.86' Storage=0.733 af Inflow=8.09 cfs 2.744 af
Outflow=4.44 cfs 2.127 af

Total Runoff Area = 80.160 ac Runoff Volume = 23.717 af Average Runoff Depth = 3.55"
88.21% Pervious = 70.710 ac 11.79% Impervious = 9.450 ac

Summary for Subcatchment 7S: (new Subcat)

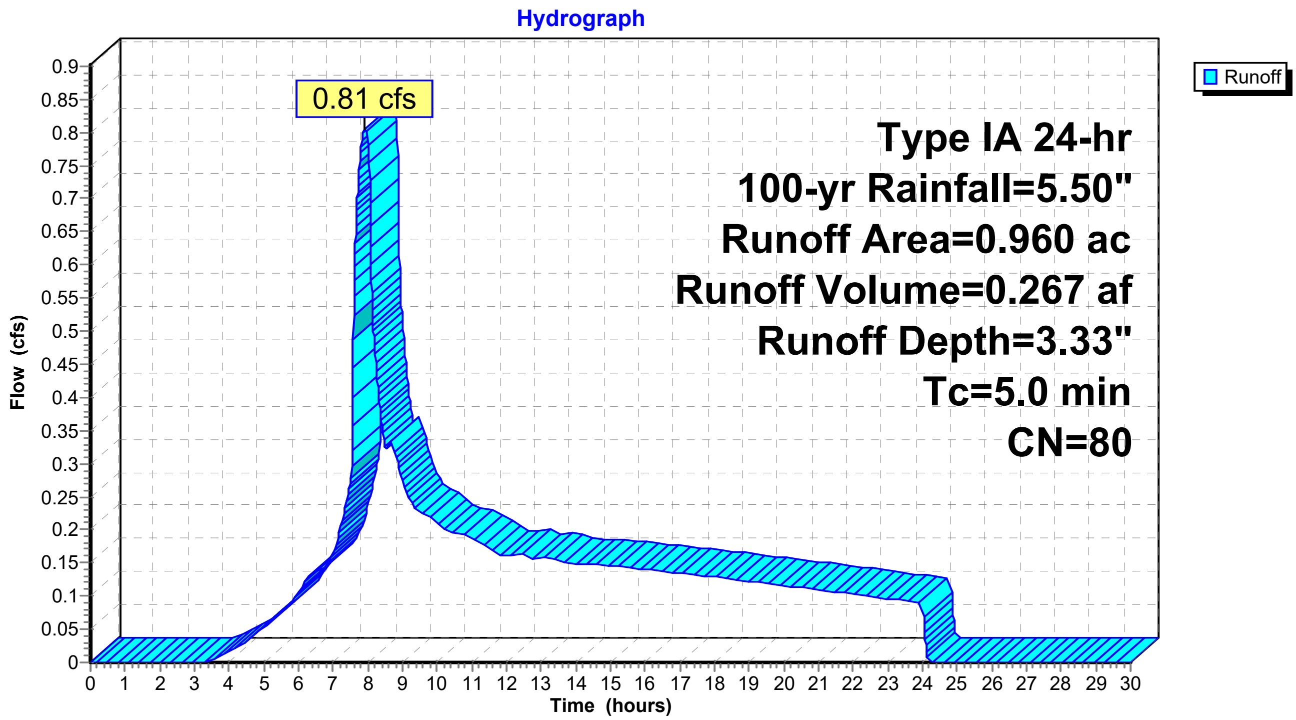
Runoff = 0.81 cfs @ 7.93 hrs, Volume= 0.267 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.960	80	>75% Grass cover, Good, HSG D
0.960		100.00% Pervious Area

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

Subcatchment 7S: (new Subcat)



Summary for Subcatchment 8S: (new Subcat)

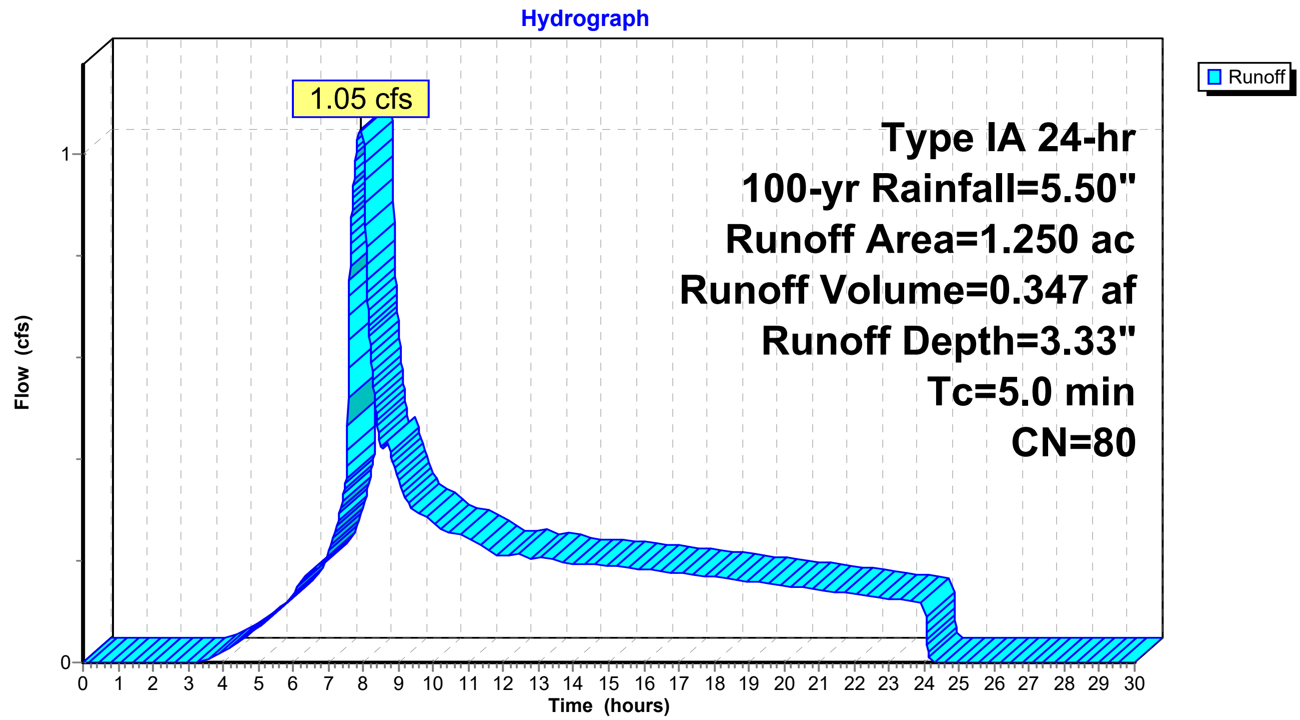
Runoff = 1.05 cfs @ 7.93 hrs, Volume= 0.347 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.250	80	>75% Grass cover, Good, HSG D
1.250		100.00% Pervious Area

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

Subcatchment 8S: (new Subcat)



Summary for Subcatchment 9S: (new Subcat)

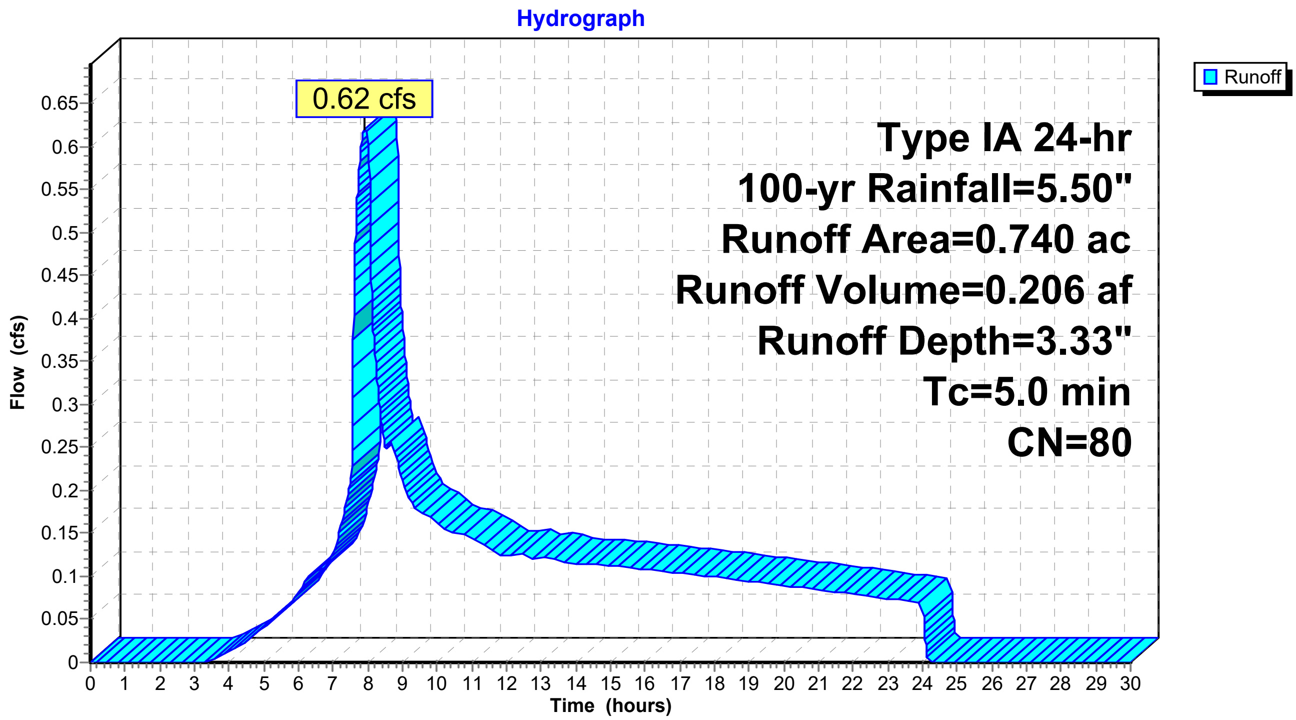
Runoff = 0.62 cfs @ 7.93 hrs, Volume= 0.206 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.740	80	>75% Grass cover, Good, HSG D
0.740		100.00% Pervious Area

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

Subcatchment 9S: (new Subcat)



Summary for Subcatchment 10S: (new Subcat)

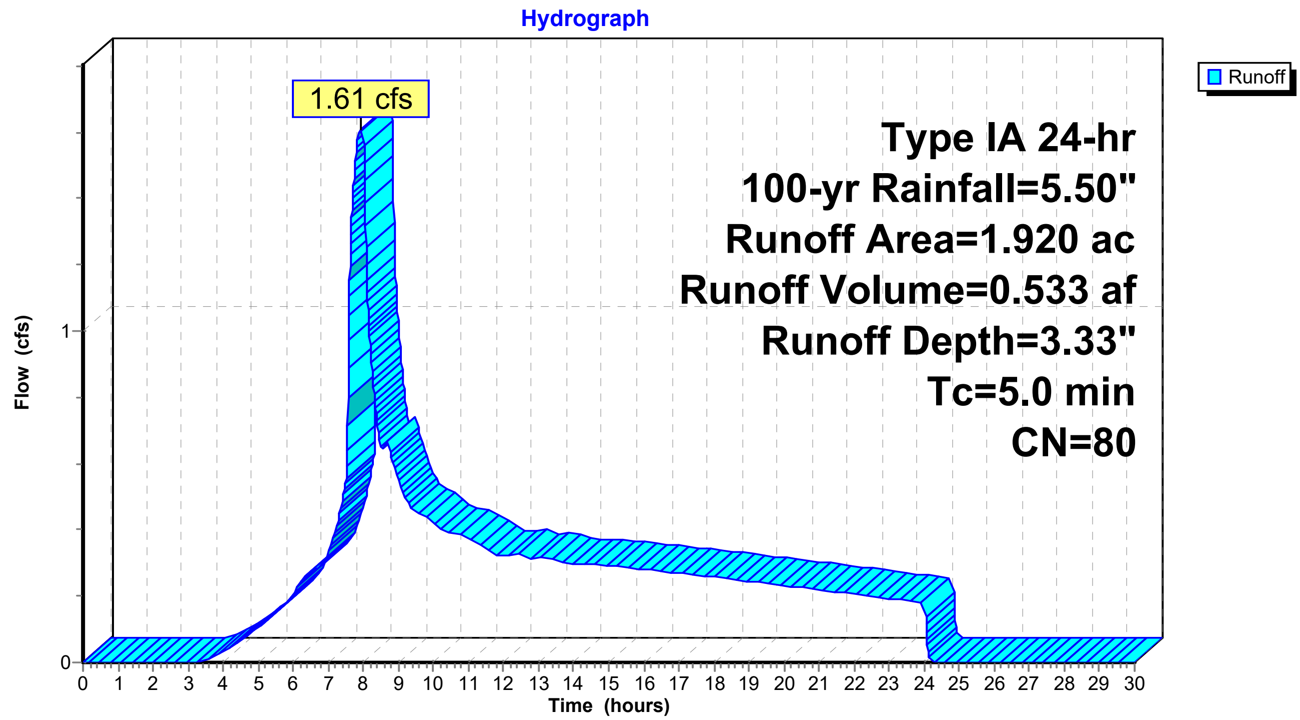
Runoff = 1.61 cfs @ 7.93 hrs, Volume= 0.533 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.920	80	>75% Grass cover, Good, HSG D
1.920		100.00% Pervious Area

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

Subcatchment 10S: (new Subcat)



Summary for Subcatchment 16S: (new Subcat)

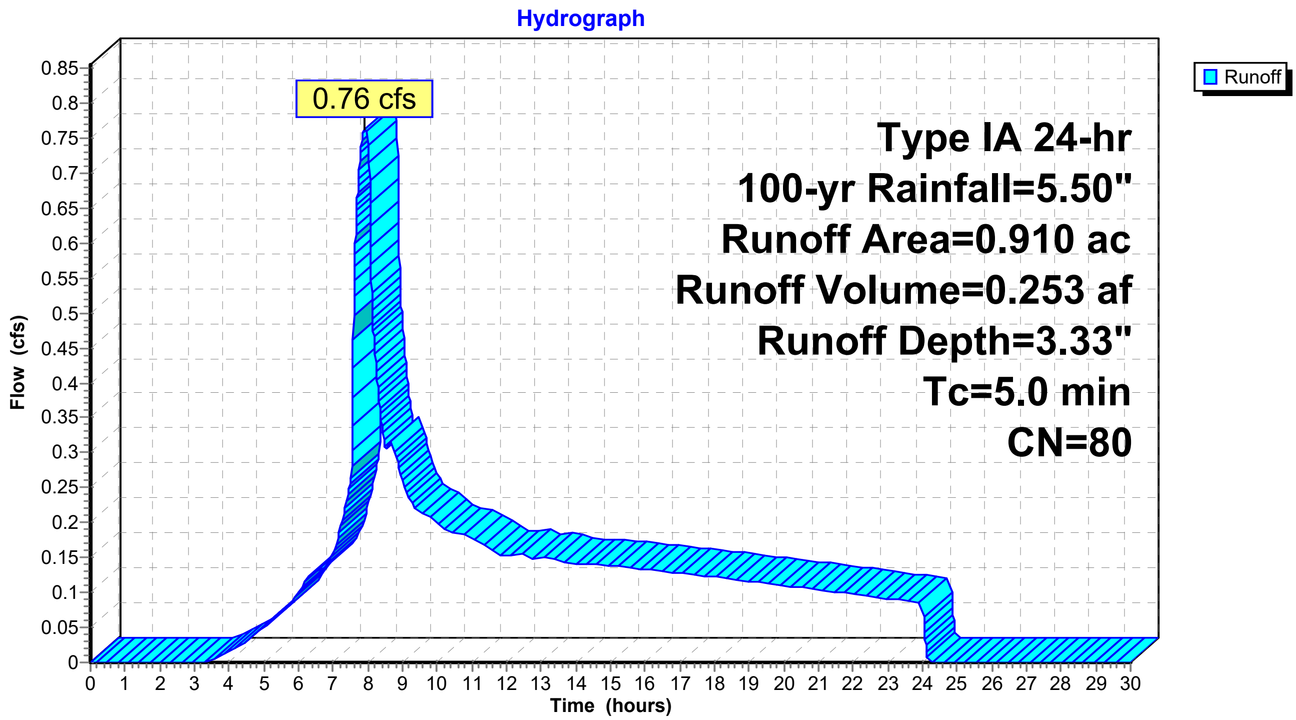
Runoff = 0.76 cfs @ 7.93 hrs, Volume= 0.253 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.910	80	>75% Grass cover, Good, HSG D
0.910		100.00% Pervious Area

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

Subcatchment 16S: (new Subcat)



Summary for Subcatchment 17S: (new Subcat)

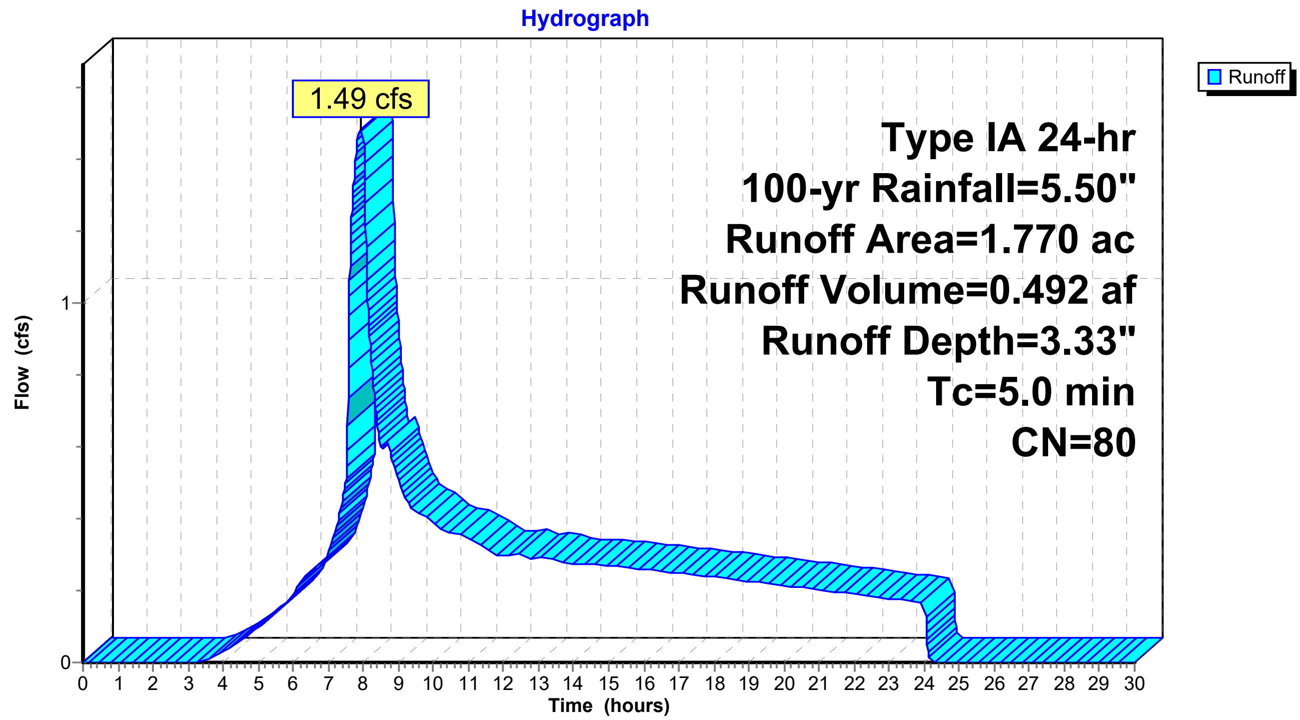
Runoff = 1.49 cfs @ 7.93 hrs, Volume= 0.492 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.770	80	>75% Grass cover, Good, HSG D
1.770		100.00% Pervious Area

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

Subcatchment 17S: (new Subcat)



Summary for Subcatchment 18S: (new Subcat)

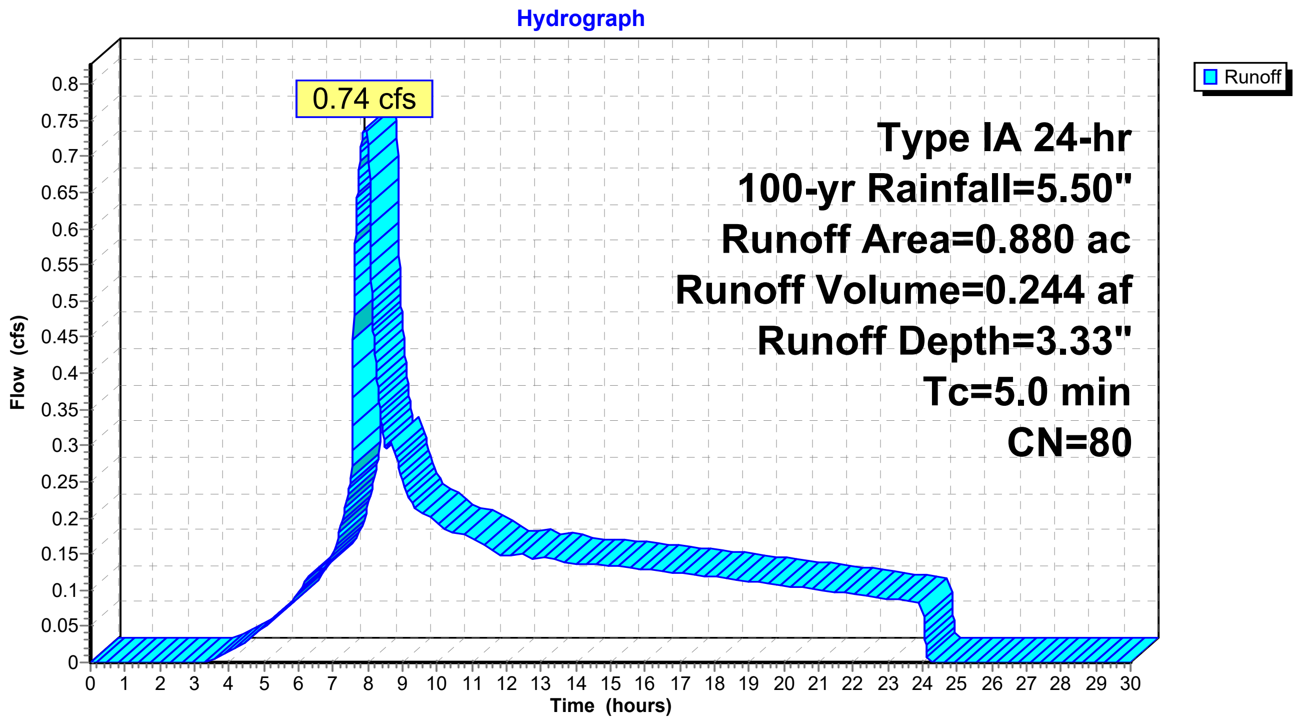
Runoff = 0.74 cfs @ 7.93 hrs, Volume= 0.244 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.880	80	>75% Grass cover, Good, HSG D
0.880		100.00% Pervious Area

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

Subcatchment 18S: (new Subcat)



Summary for Subcatchment 19S: (new Subcat)

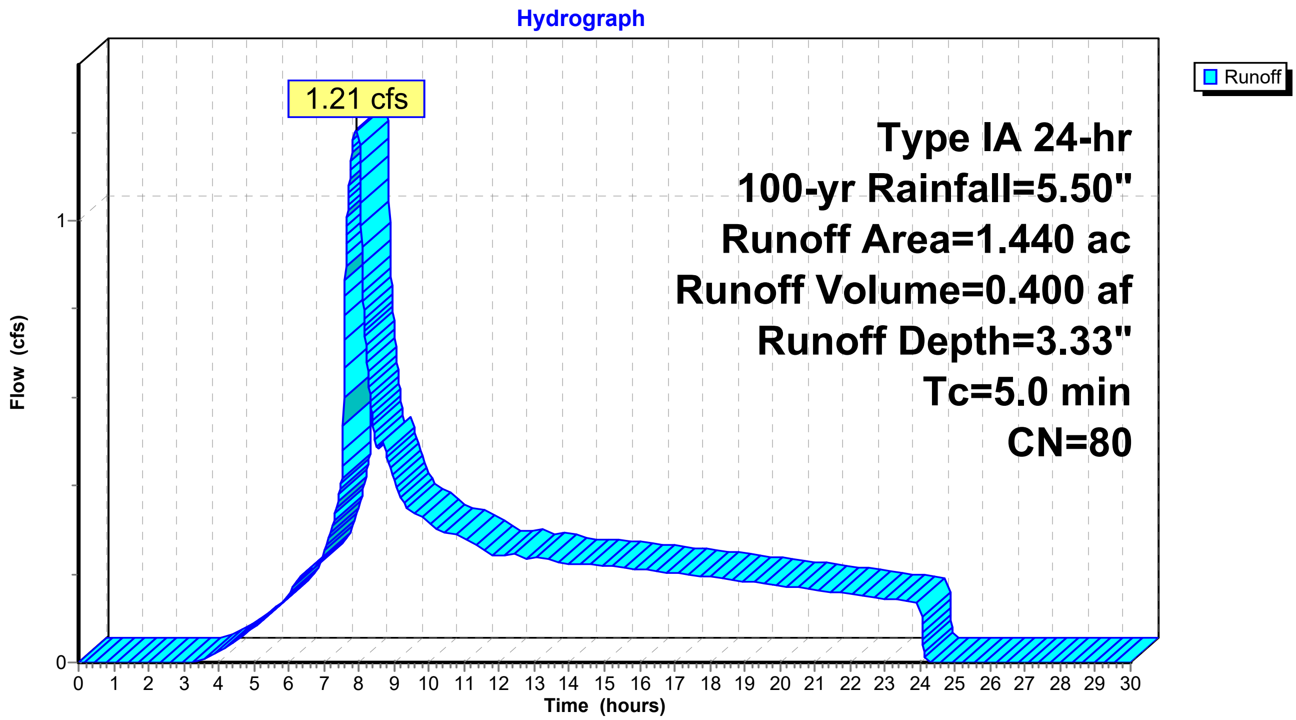
Runoff = 1.21 cfs @ 7.93 hrs, Volume= 0.400 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.440	80	>75% Grass cover, Good, HSG D
1.440		100.00% Pervious Area

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

Subcatchment 19S: (new Subcat)



Summary for Subcatchment 20S: (new Subcat)

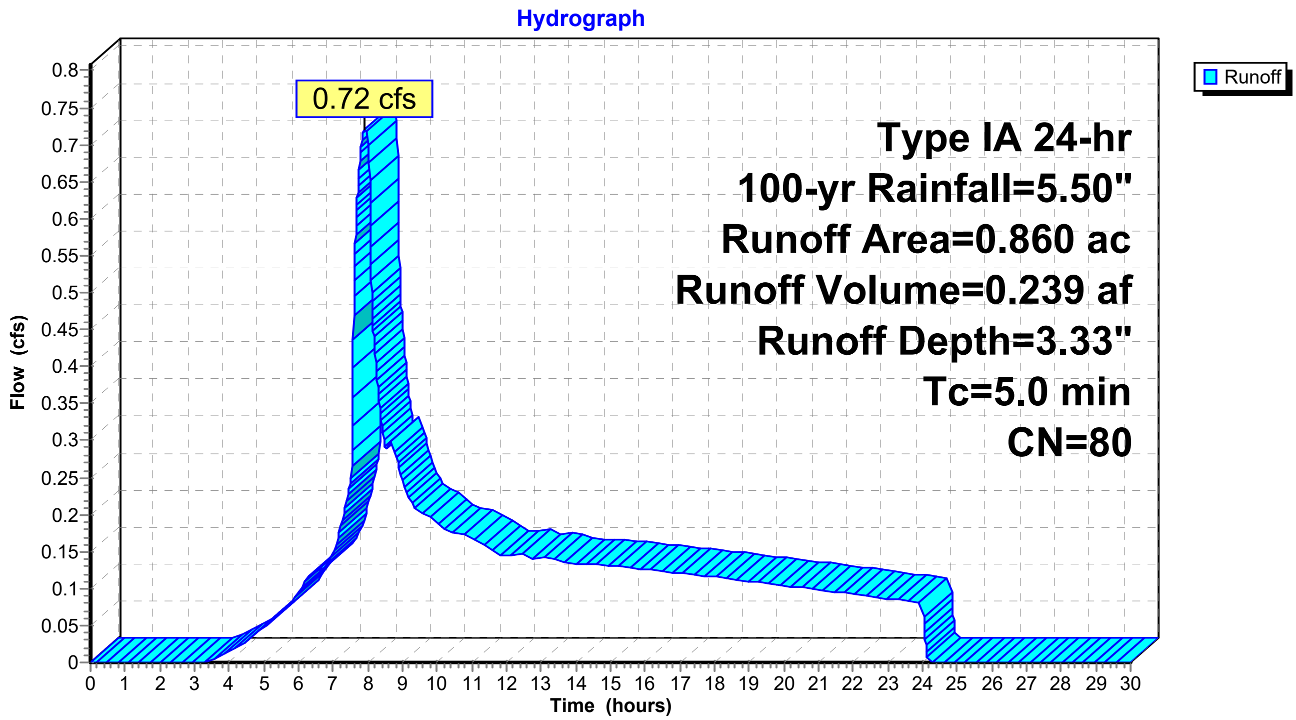
Runoff = 0.72 cfs @ 7.93 hrs, Volume= 0.239 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.860	80	>75% Grass cover, Good, HSG D
0.860		100.00% Pervious Area

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

Subcatchment 20S: (new Subcat)



Summary for Subcatchment 21S: (new Subcat)

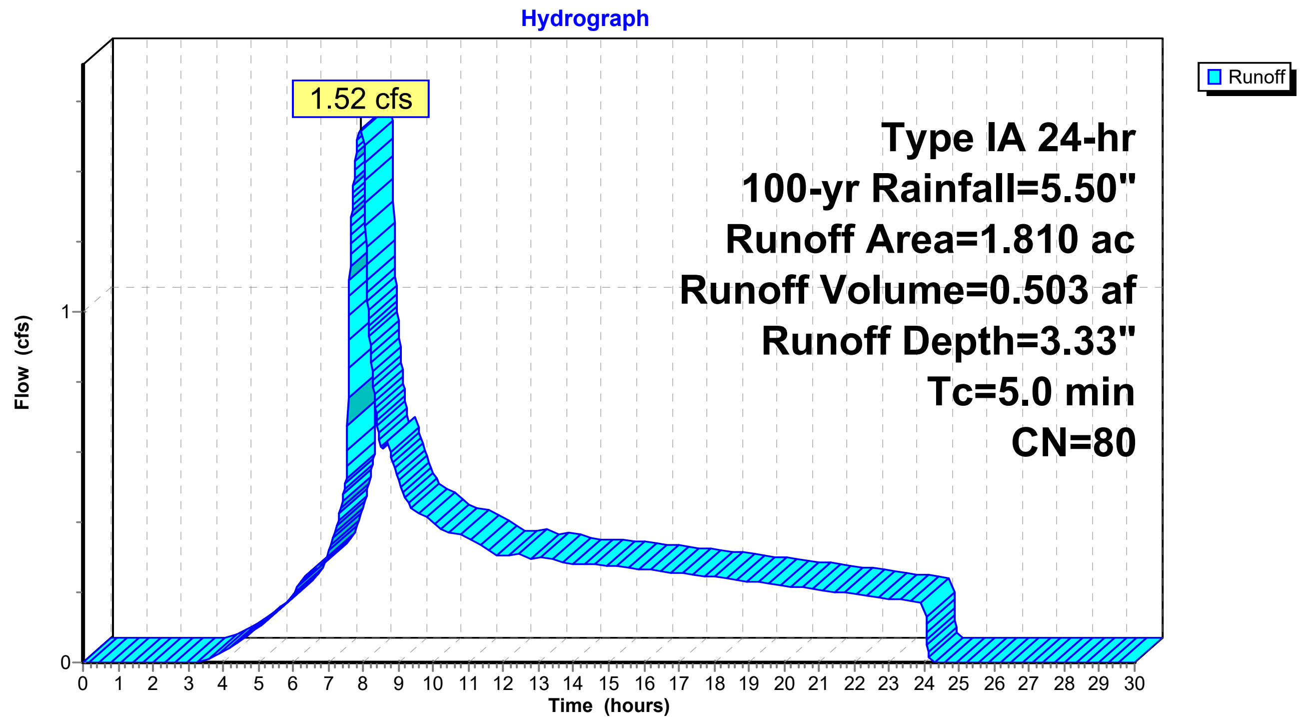
Runoff = 1.52 cfs @ 7.93 hrs, Volume= 0.503 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.810	80	>75% Grass cover, Good, HSG D
1.810		100.00% Pervious Area

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

Subcatchment 21S: (new Subcat)



Summary for Subcatchment 22S: (new Subcat)

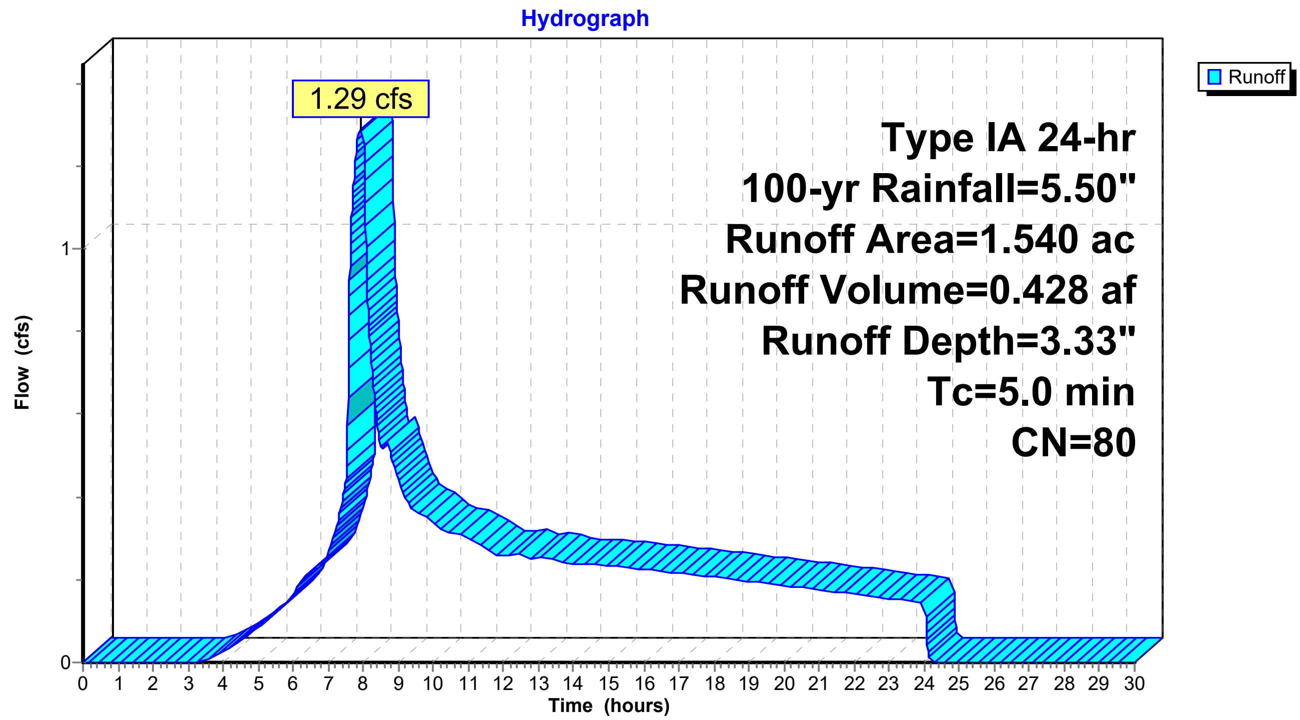
Runoff = 1.29 cfs @ 7.93 hrs, Volume= 0.428 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.540	80	>75% Grass cover, Good, HSG D
1.540		100.00% Pervious Area

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

Subcatchment 22S: (new Subcat)



Summary for Subcatchment 23S: (new Subcat)

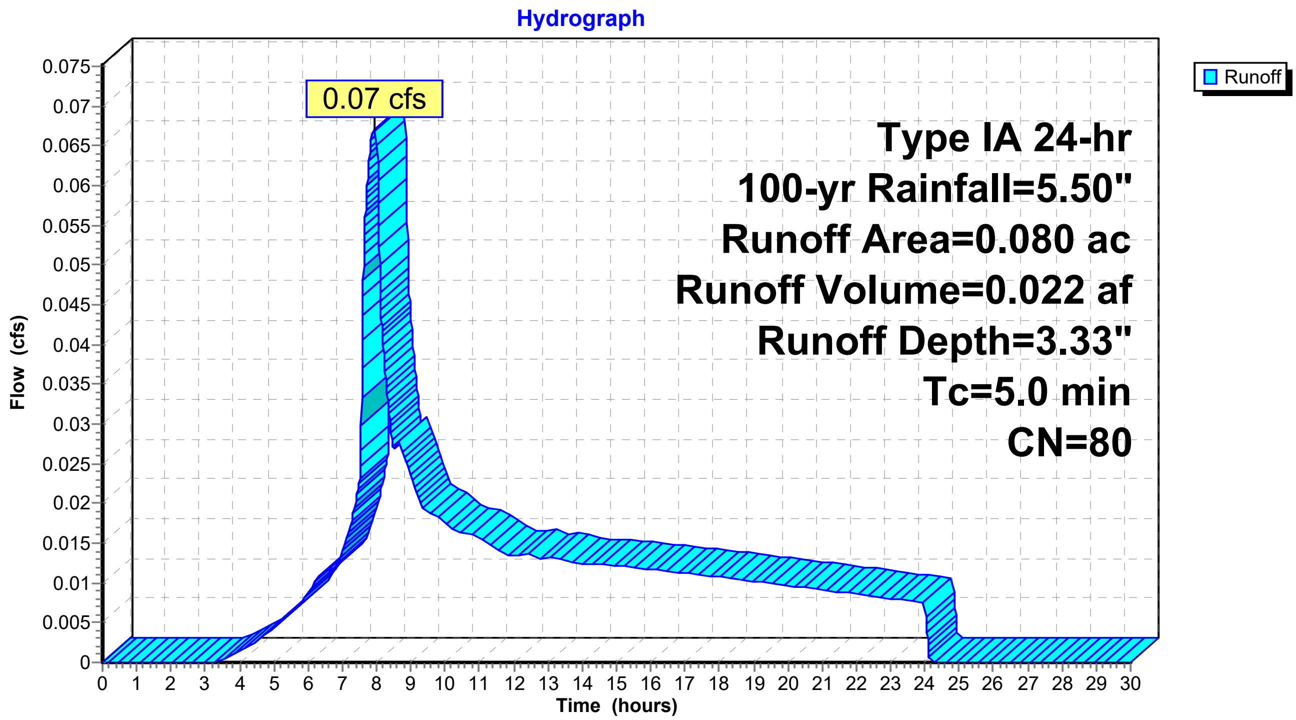
Runoff = 0.07 cfs @ 7.93 hrs, Volume= 0.022 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.080	80	>75% Grass cover, Good, HSG D
0.080		100.00% Pervious Area

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

Subcatchment 23S: (new Subcat)



Summary for Subcatchment 24S: (new Subcat)

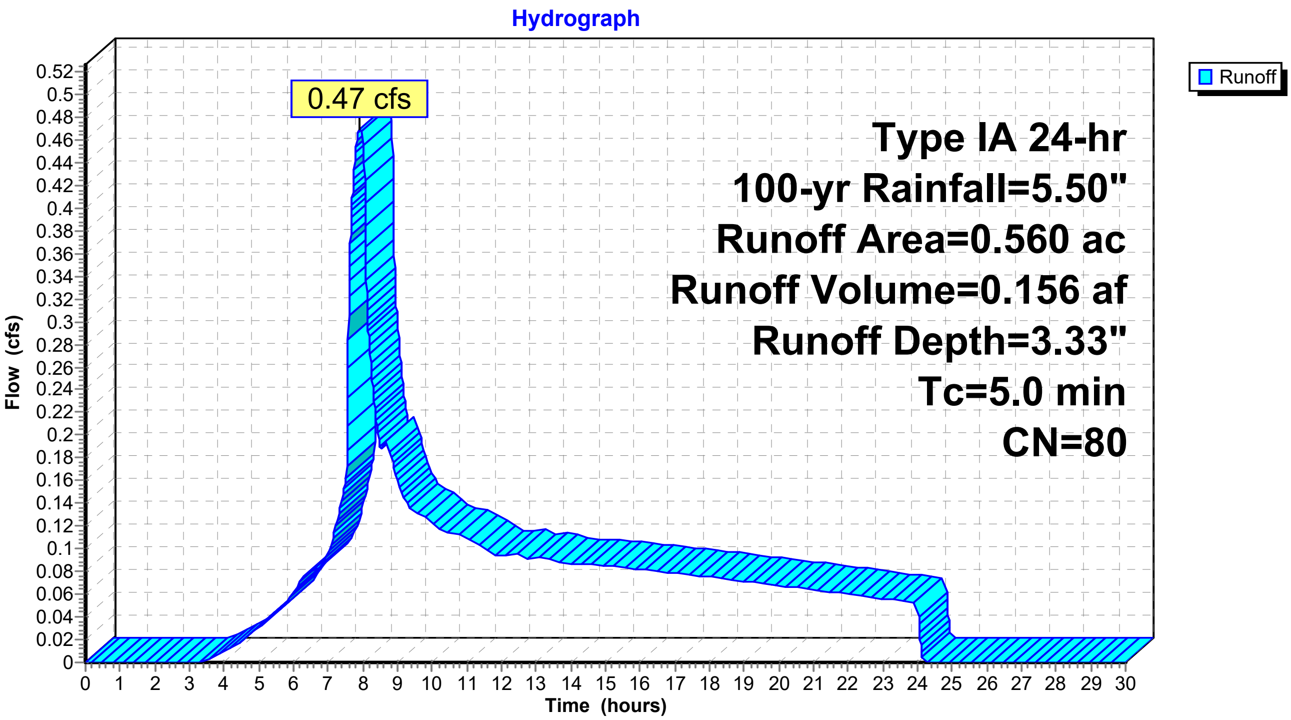
Runoff = 0.47 cfs @ 7.93 hrs, Volume= 0.156 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.560	80	>75% Grass cover, Good, HSG D
0.560		100.00% Pervious Area

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

Subcatchment 24S: (new Subcat)



Summary for Subcatchment 25S: (new Subcat)

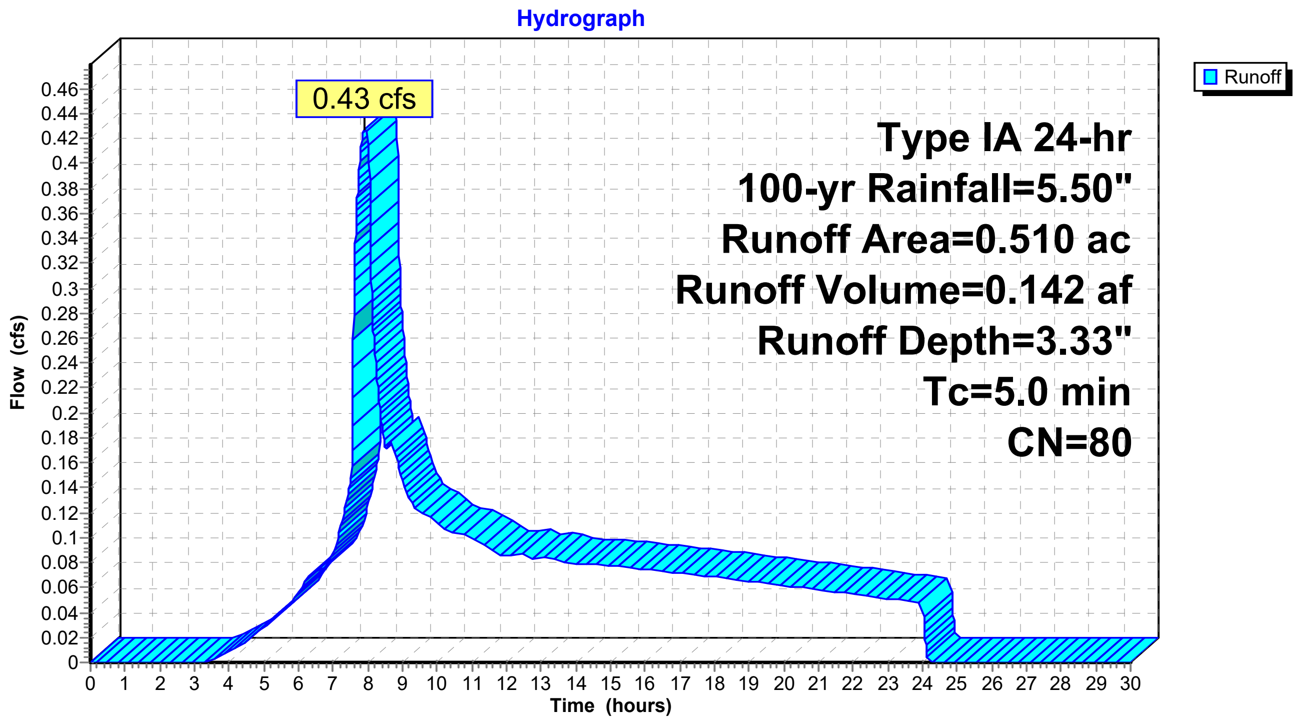
Runoff = 0.43 cfs @ 7.93 hrs, Volume= 0.142 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.510	80	>75% Grass cover, Good, HSG D
0.510		100.00% Pervious Area

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

Subcatchment 25S: (new Subcat)



Summary for Subcatchment 26S: (new Subcat)

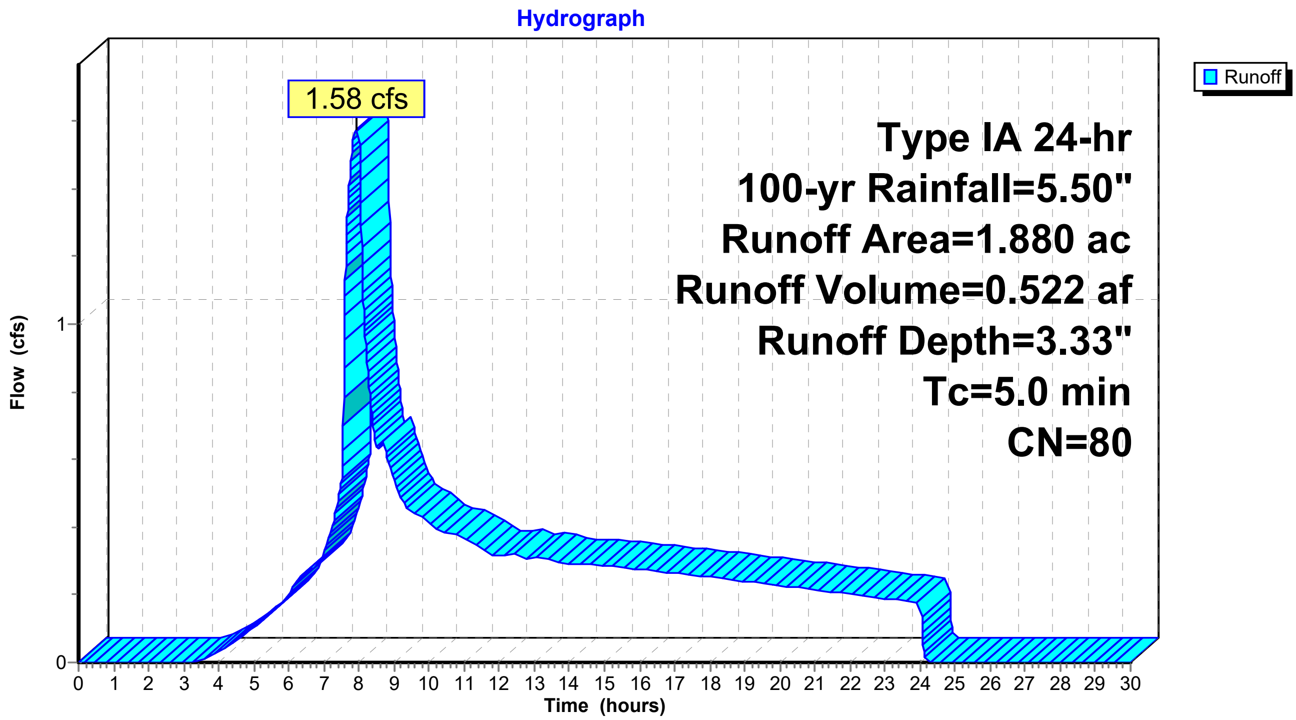
Runoff = 1.58 cfs @ 7.93 hrs, Volume= 0.522 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.880	80	>75% Grass cover, Good, HSG D
1.880		100.00% Pervious Area

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

Subcatchment 26S: (new Subcat)



Summary for Subcatchment 27S: (new Subcat)

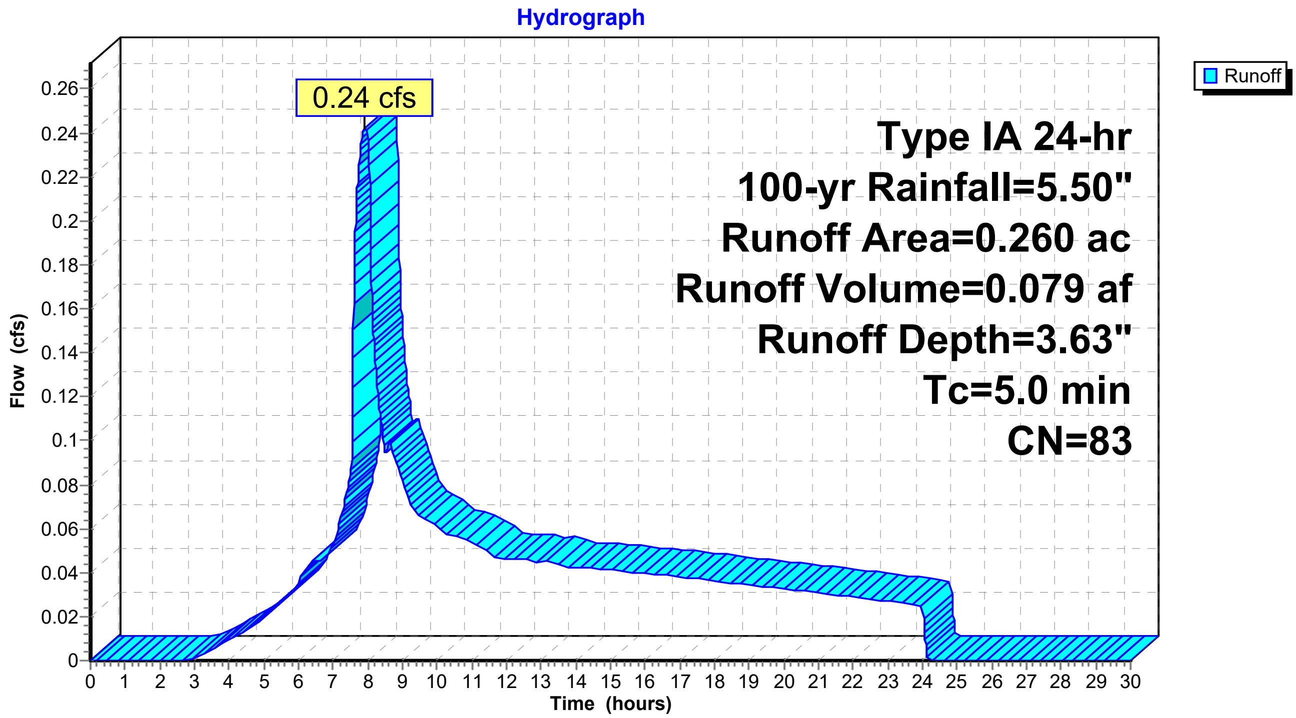
Runoff = 0.24 cfs @ 7.92 hrs, Volume= 0.079 af, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	0.210	80	>75% Grass cover, Good, HSG D
*	0.050	98	Roads
	0.260	83	Weighted Average
	0.210		80.77% Pervious Area
	0.050		19.23% Impervious Area

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

Subcatchment 27S: (new Subcat)



Summary for Subcatchment 28S: (new Subcat)

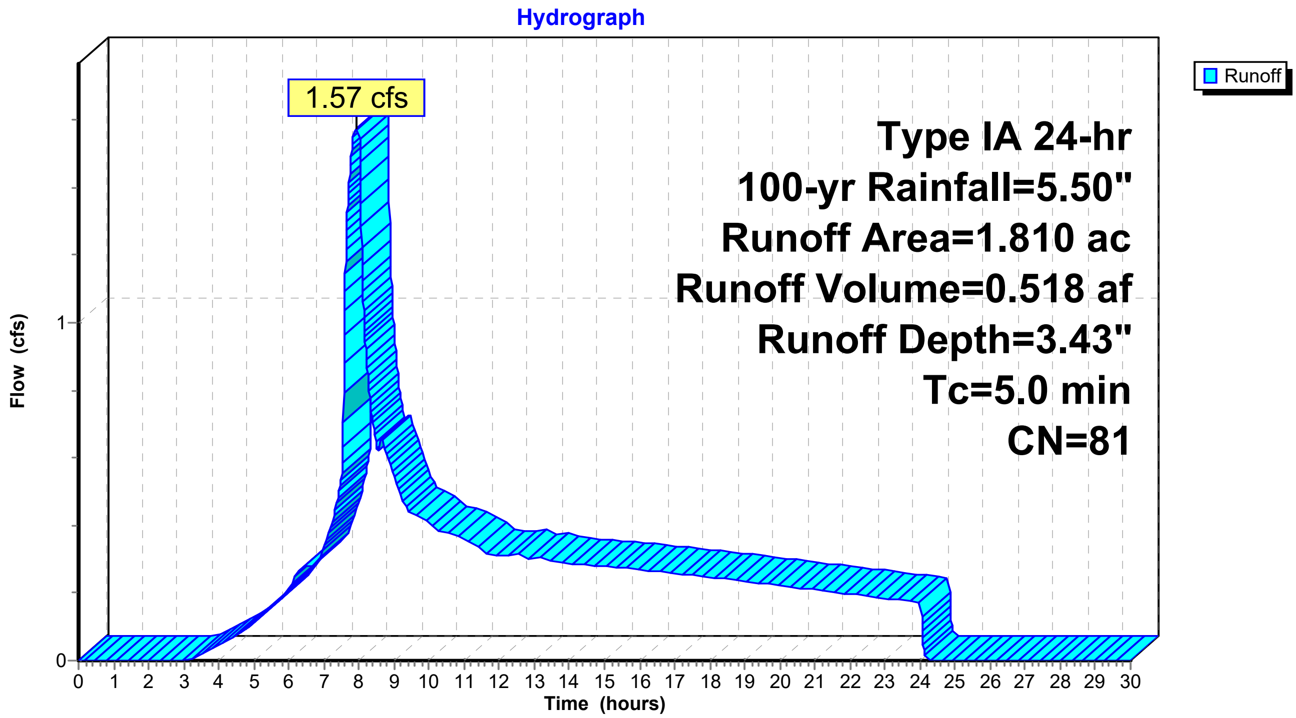
Runoff = 1.57 cfs @ 7.93 hrs, Volume= 0.518 af, Depth= 3.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	1.670	80	>75% Grass cover, Good, HSG D
*	0.140	98	
	1.810	81	Weighted Average
	1.670		92.27% Pervious Area
	0.140		7.73% Impervious Area

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

Subcatchment 28S: (new Subcat)



Summary for Subcatchment 29S: (new Subcat)

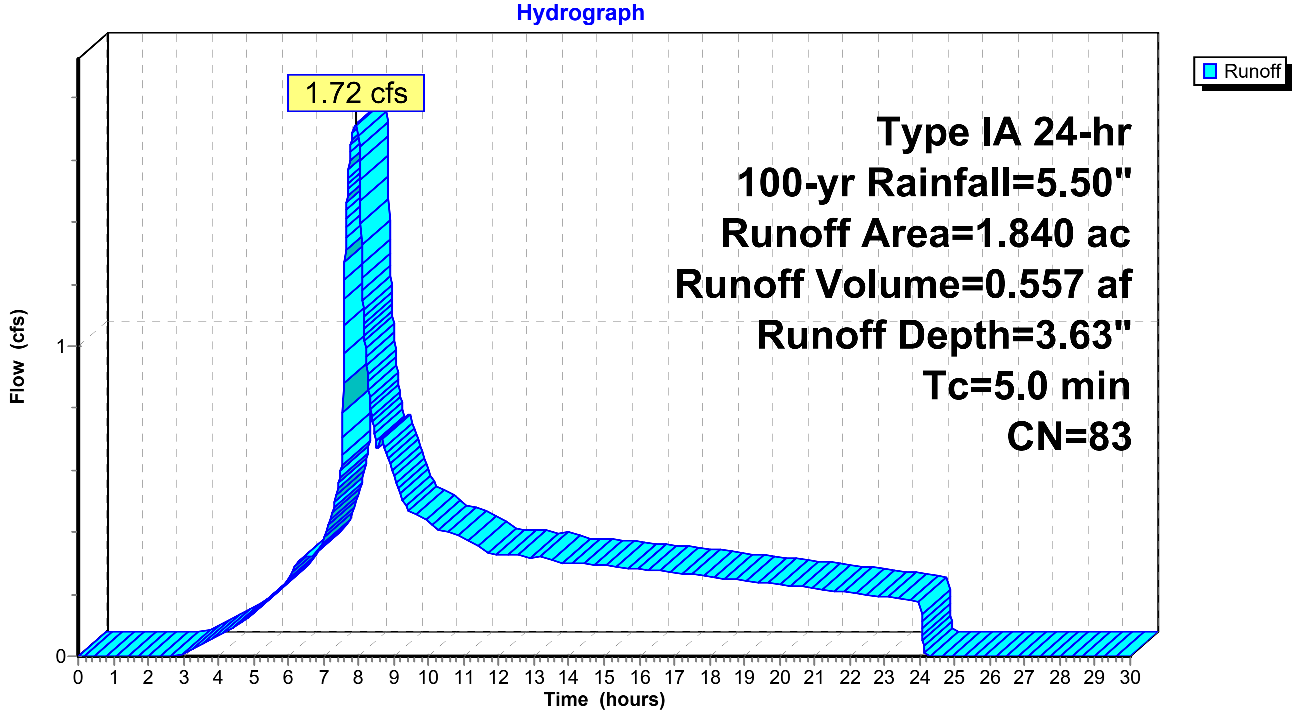
Runoff = 1.72 cfs @ 7.92 hrs, Volume= 0.557 af, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	1.530	80	>75% Grass cover, Good, HSG D
*	0.310	98	Road
	1.840	83	Weighted Average
	1.530		83.15% Pervious Area
	0.310		16.85% Impervious Area

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

Subcatchment 29S: (new Subcat)



Summary for Subcatchment 30S: (new Subcat)

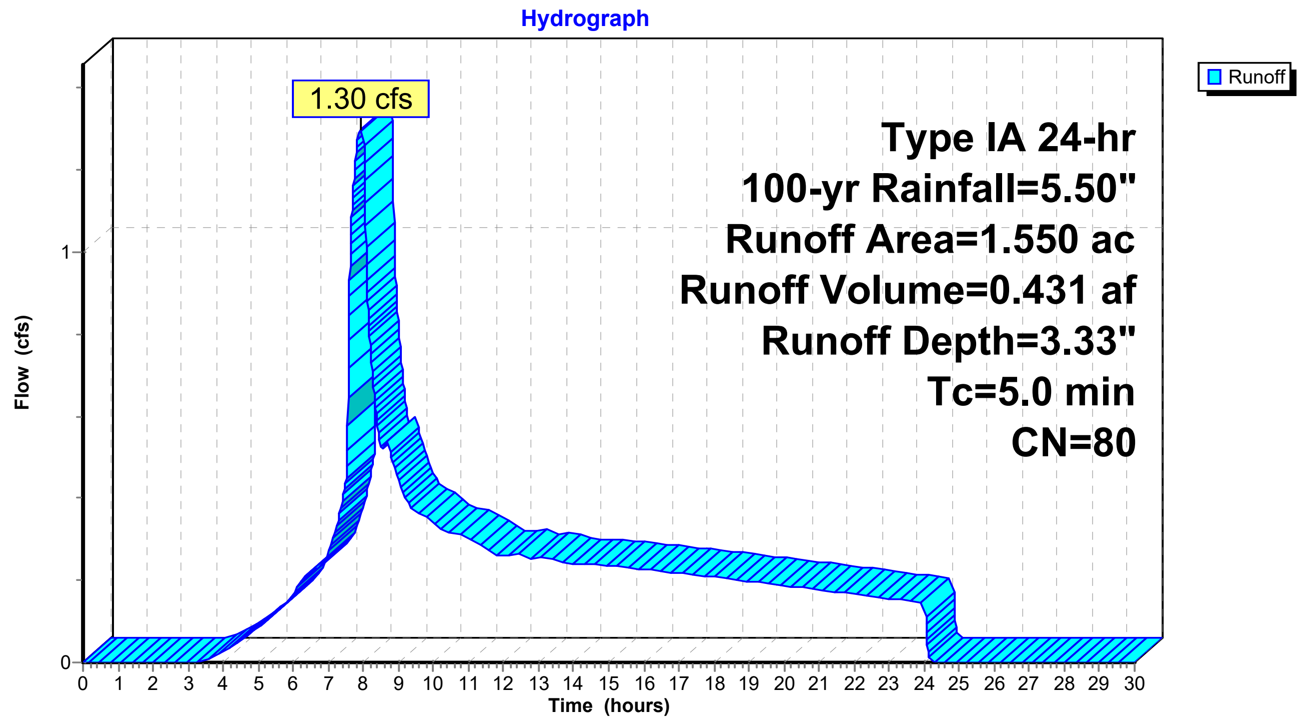
Runoff = 1.30 cfs @ 7.93 hrs, Volume= 0.431 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.550	80	>75% Grass cover, Good, HSG D
1.550		100.00% Pervious Area

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

Subcatchment 30S: (new Subcat)



Summary for Subcatchment 31S: (new Subcat)

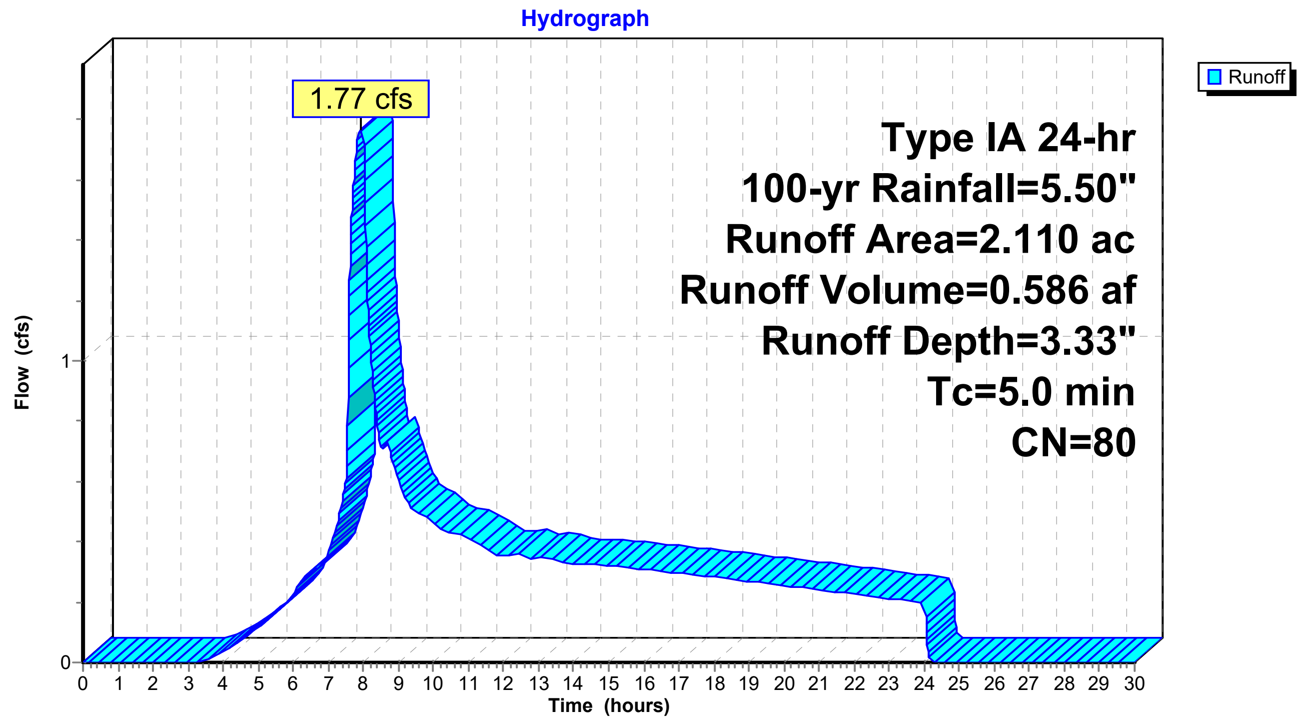
Runoff = 1.77 cfs @ 7.93 hrs, Volume= 0.586 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
2.110	80	>75% Grass cover, Good, HSG D
2.110		100.00% Pervious Area

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

Subcatchment 31S: (new Subcat)



Summary for Subcatchment 32S: (new Subcat)

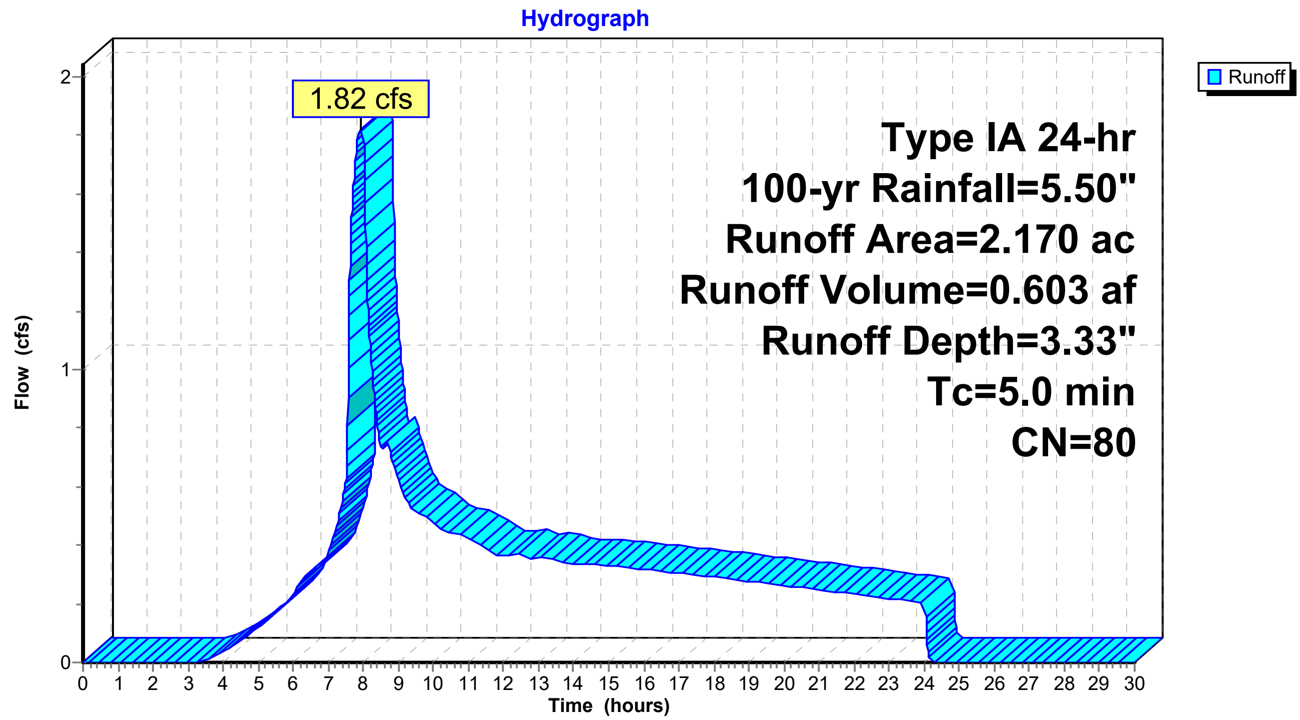
Runoff = 1.82 cfs @ 7.93 hrs, Volume= 0.603 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
2.170	80	>75% Grass cover, Good, HSG D
2.170		100.00% Pervious Area

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

Subcatchment 32S: (new Subcat)



Summary for Subcatchment 33S: (new Subcat)

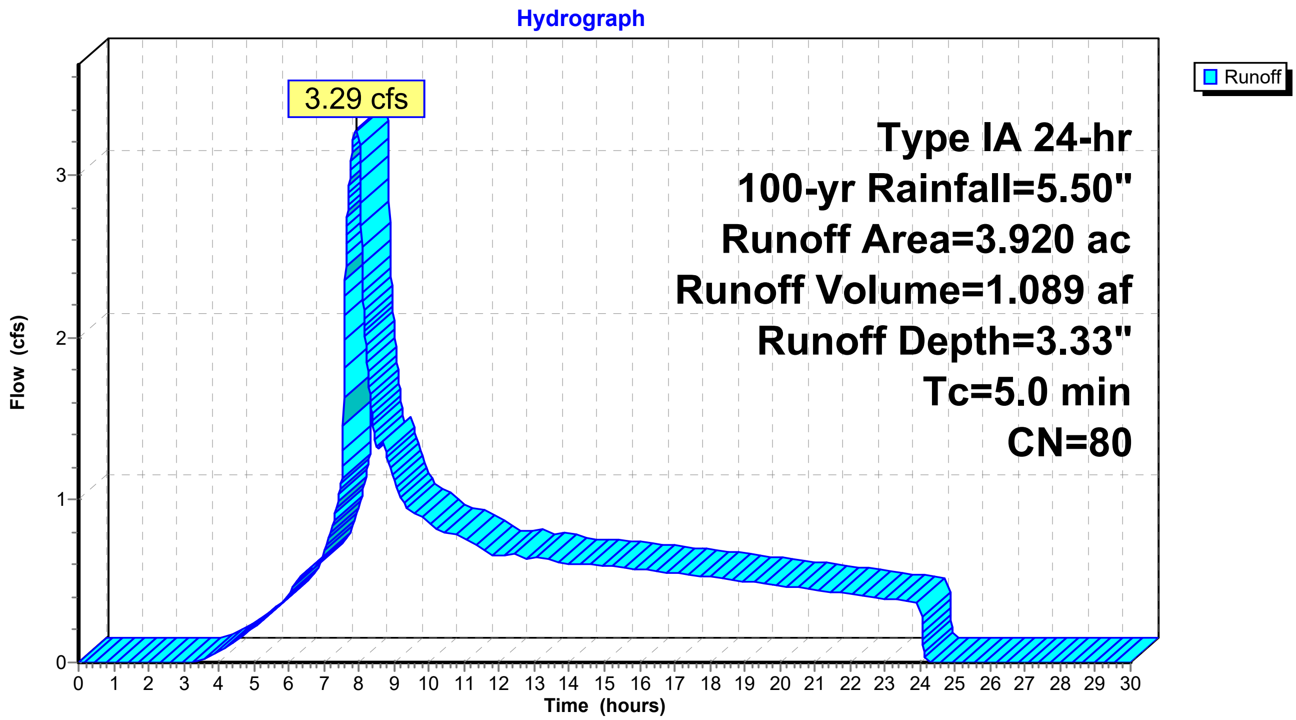
Runoff = 3.29 cfs @ 7.93 hrs, Volume= 1.089 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
3.920	80	>75% Grass cover, Good, HSG D
3.920		100.00% Pervious Area

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

Subcatchment 33S: (new Subcat)



Summary for Subcatchment 34S: (new Subcat)

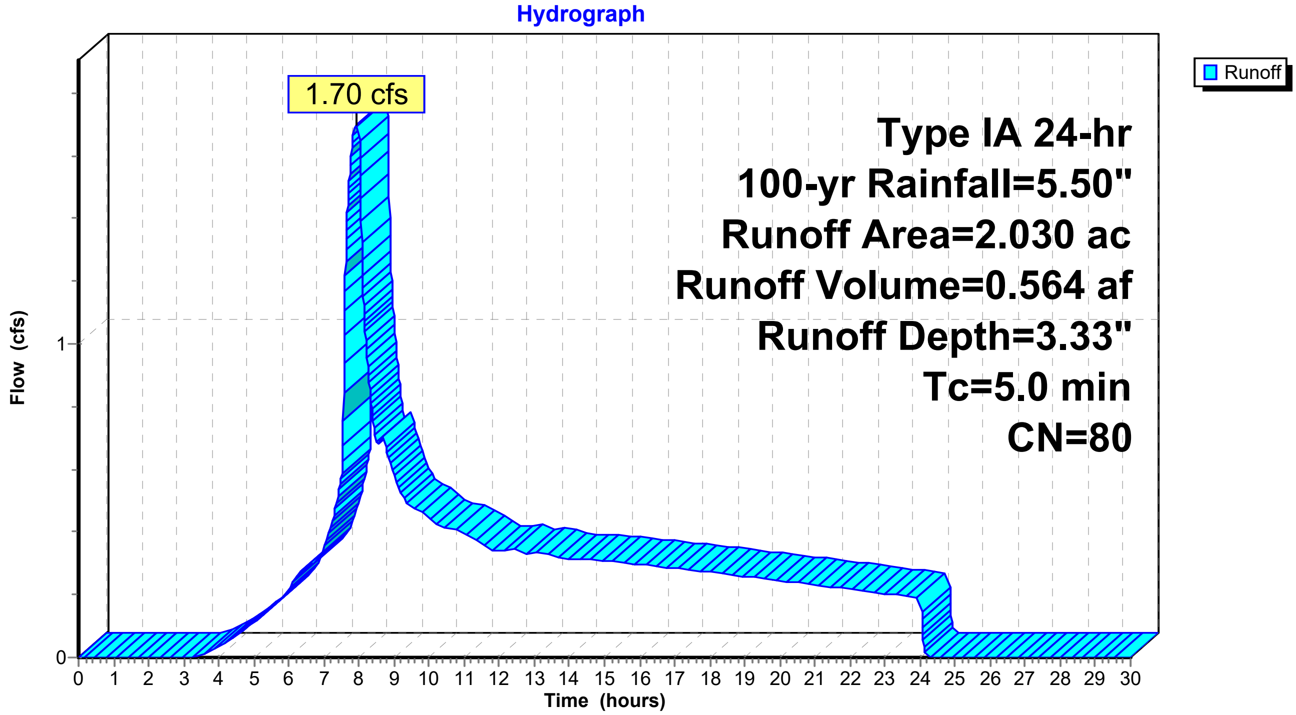
Runoff = 1.70 cfs @ 7.93 hrs, Volume= 0.564 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
2.030	80	>75% Grass cover, Good, HSG D
2.030		100.00% Pervious Area

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

Subcatchment 34S: (new Subcat)



Summary for Subcatchment 35S: (new Subcat)

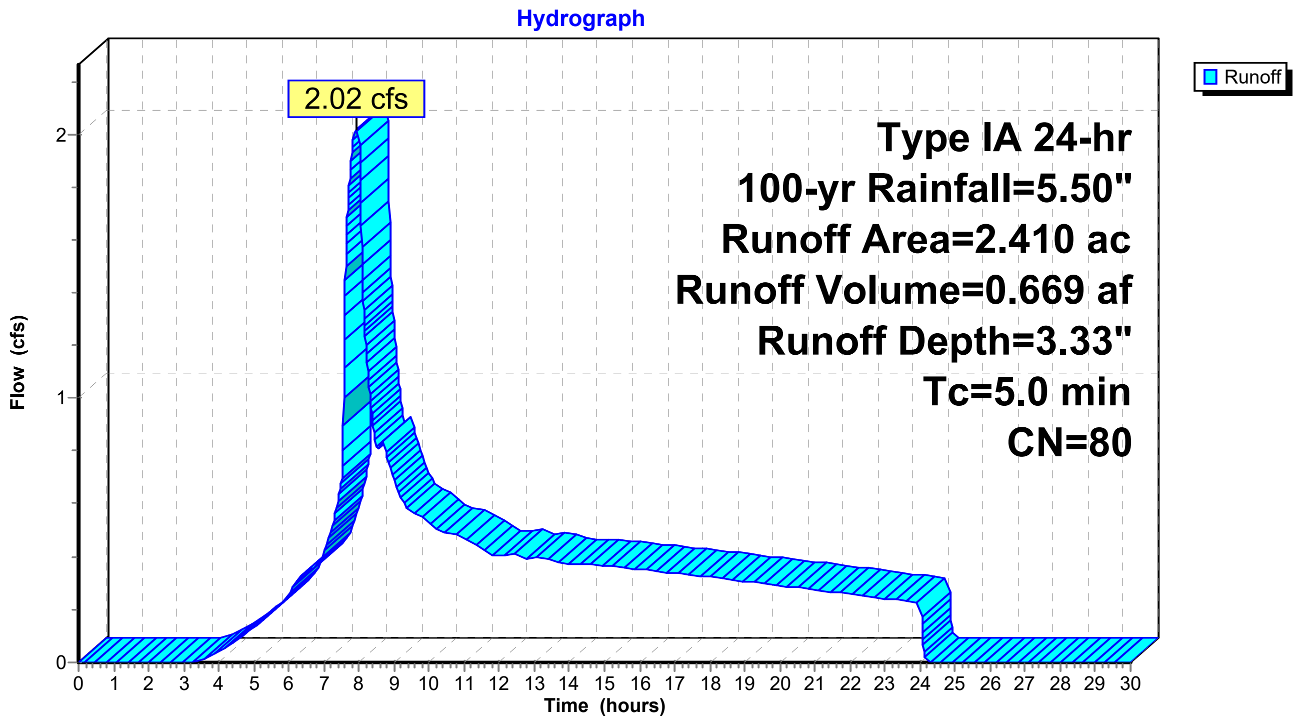
Runoff = 2.02 cfs @ 7.93 hrs, Volume= 0.669 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
2.410	80	>75% Grass cover, Good, HSG D
2.410		100.00% Pervious Area

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

Subcatchment 35S: (new Subcat)



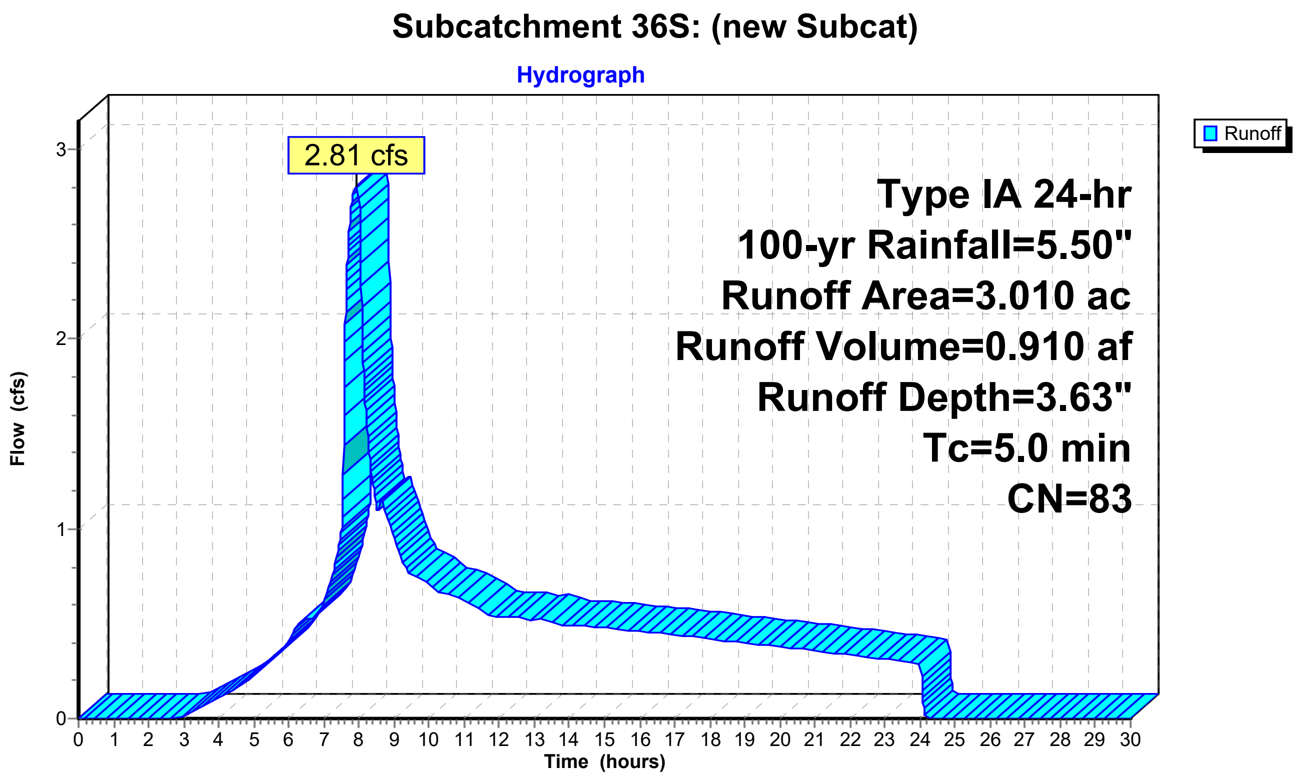
Summary for Subcatchment 36S: (new Subcat)

Runoff = 2.81 cfs @ 7.92 hrs, Volume= 0.910 af, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	2.510	80	>75% Grass cover, Good, HSG D
*	0.500	98	Roads
	3.010	83	Weighted Average
	2.510		83.39% Pervious Area
	0.500		16.61% Impervious Area

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



Summary for Subcatchment 37S: (new Subcat)

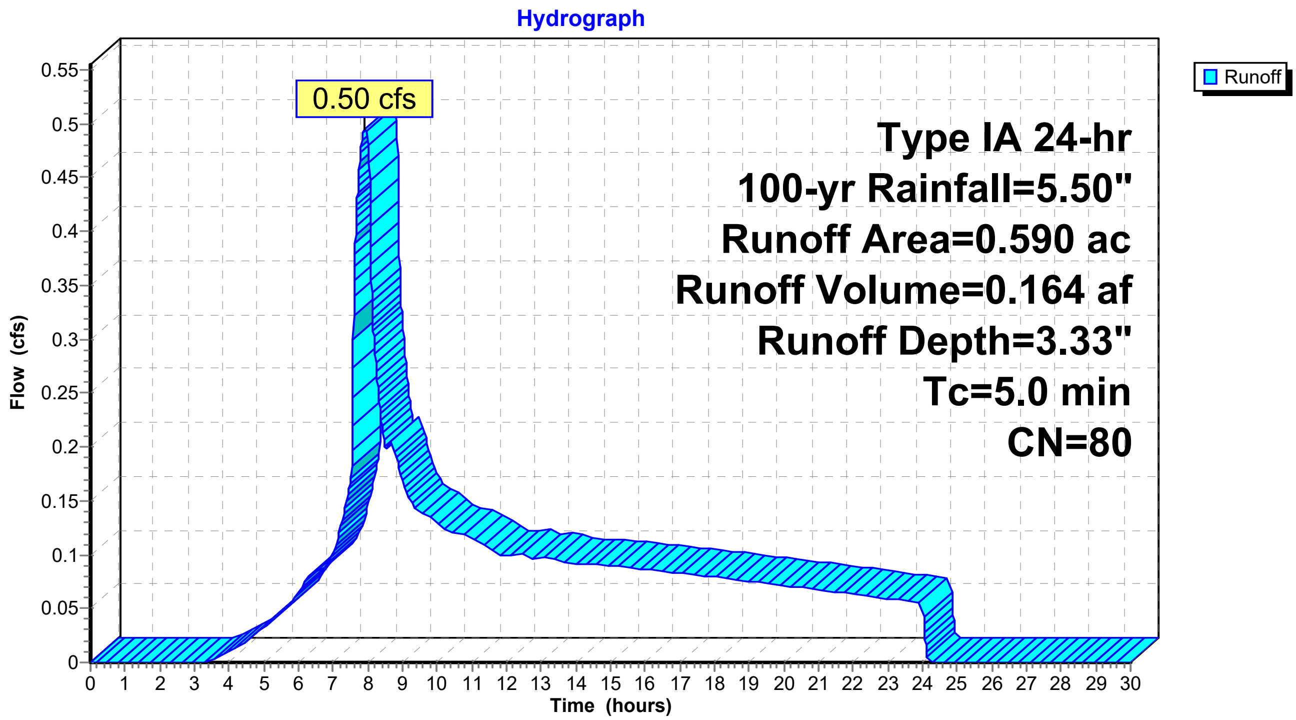
Runoff = 0.50 cfs @ 7.93 hrs, Volume= 0.164 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.590	80	>75% Grass cover, Good, HSG D
0.590		100.00% Pervious Area

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

Subcatchment 37S: (new Subcat)



Summary for Subcatchment 38S: (new Subcat)

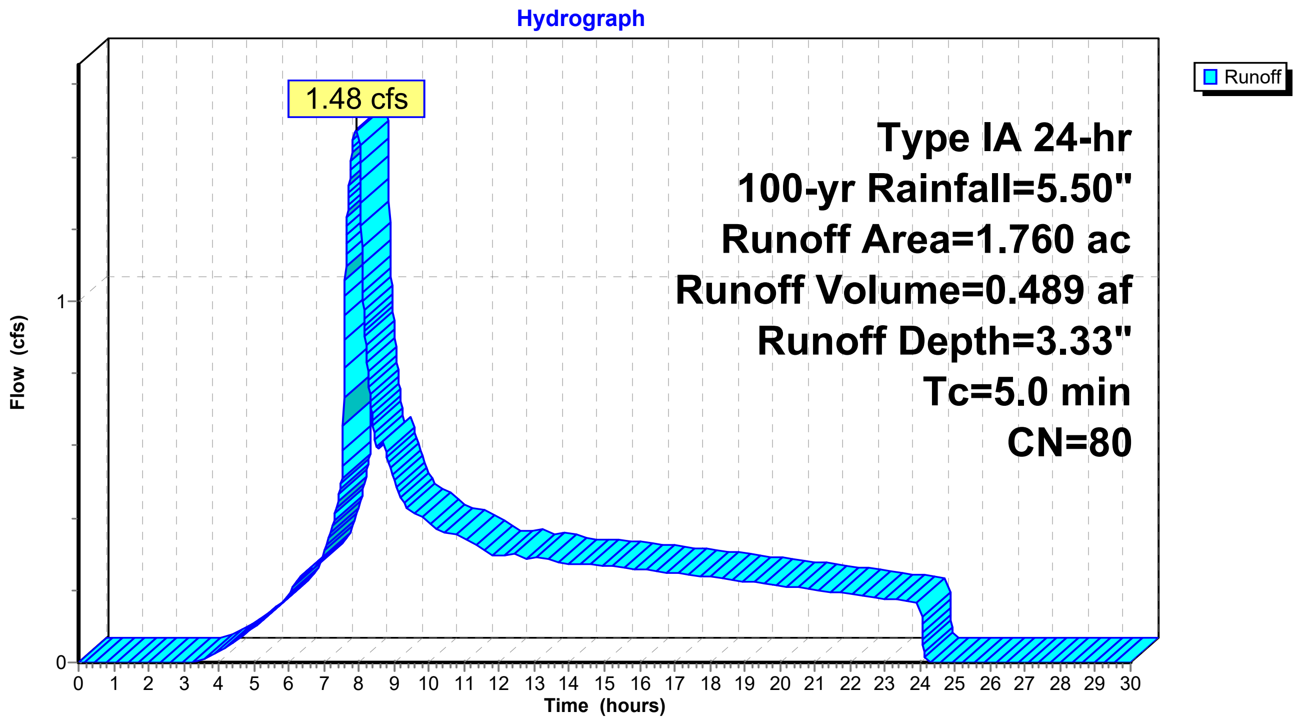
Runoff = 1.48 cfs @ 7.93 hrs, Volume= 0.489 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.760	80	>75% Grass cover, Good, HSG D
1.760		100.00% Pervious Area

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

Subcatchment 38S: (new Subcat)



Summary for Subcatchment 39S: (new Subcat)

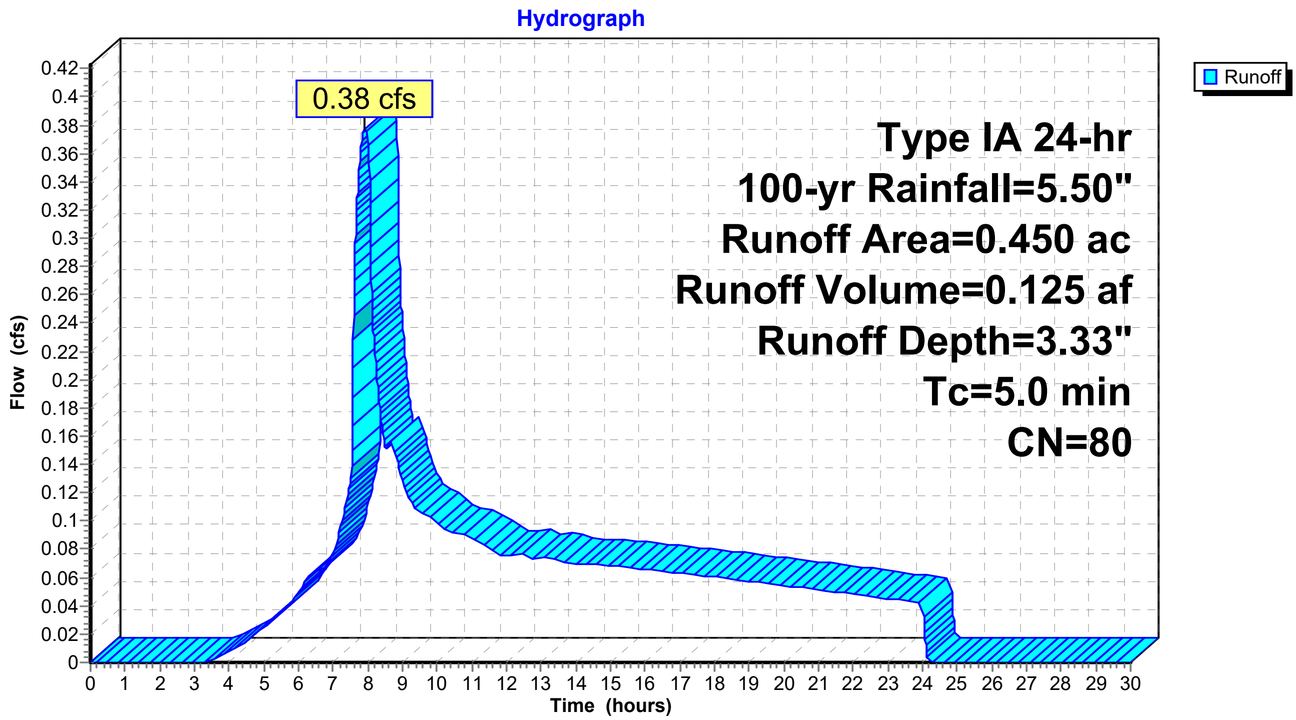
Runoff = 0.38 cfs @ 7.93 hrs, Volume= 0.125 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.450	80	>75% Grass cover, Good, HSG D
0.450		100.00% Pervious Area

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

Subcatchment 39S: (new Subcat)



Summary for Subcatchment 40S: (new Subcat)

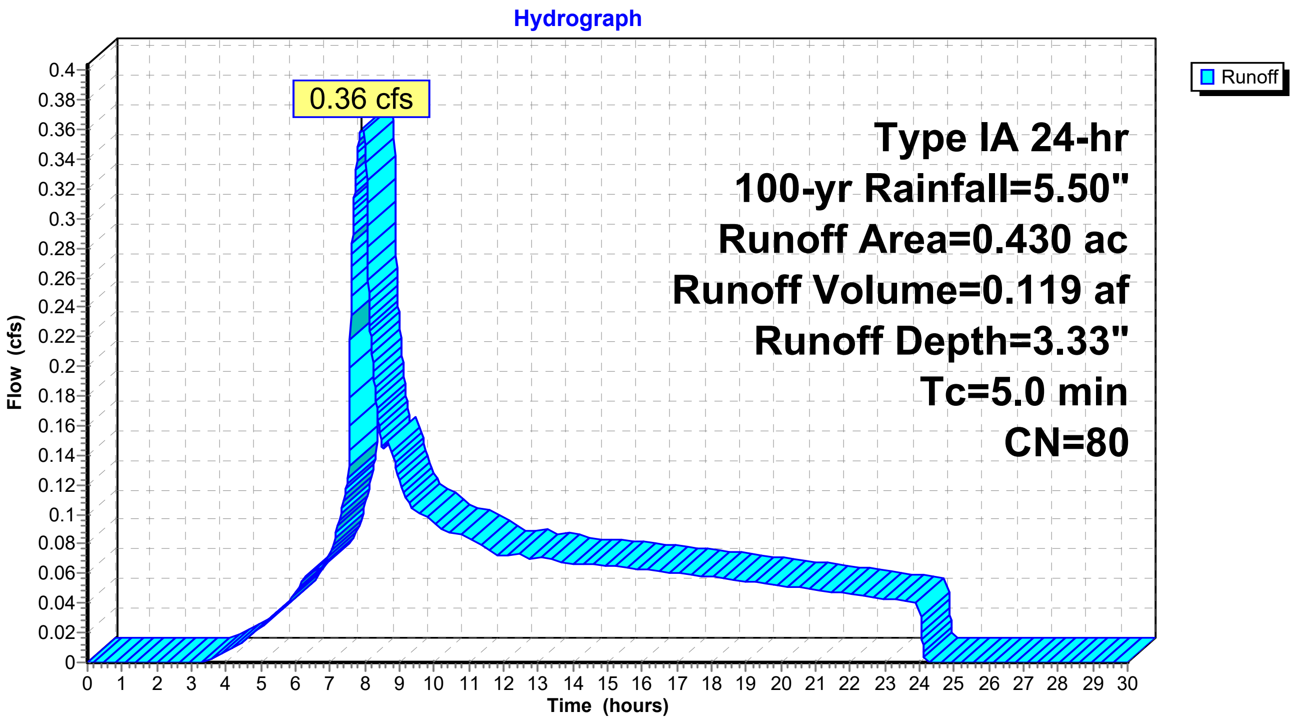
Runoff = 0.36 cfs @ 7.93 hrs, Volume= 0.119 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.430	80	>75% Grass cover, Good, HSG D
0.430		100.00% Pervious Area

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

Subcatchment 40S: (new Subcat)



Summary for Subcatchment 41S: (new Subcat)

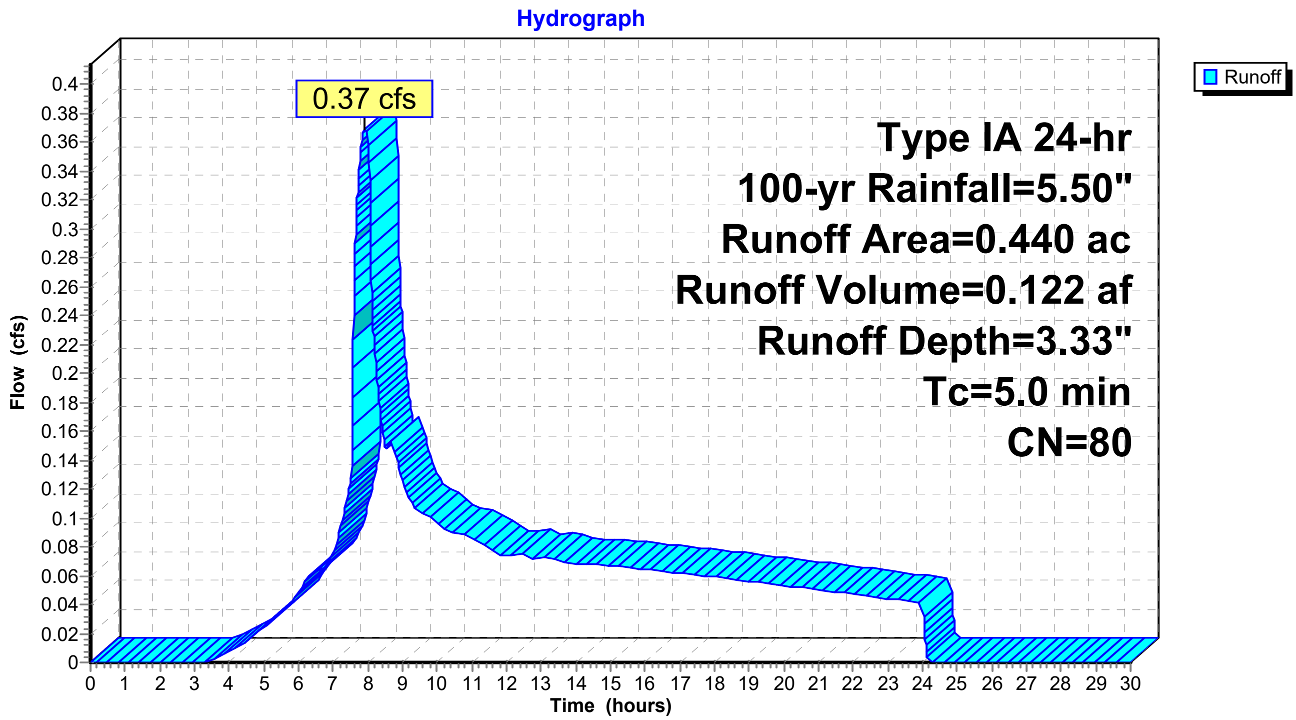
Runoff = 0.37 cfs @ 7.93 hrs, Volume= 0.122 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.440	80	>75% Grass cover, Good, HSG D
0.440		100.00% Pervious Area

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

Subcatchment 41S: (new Subcat)



Summary for Subcatchment 42S: (new Subcat)

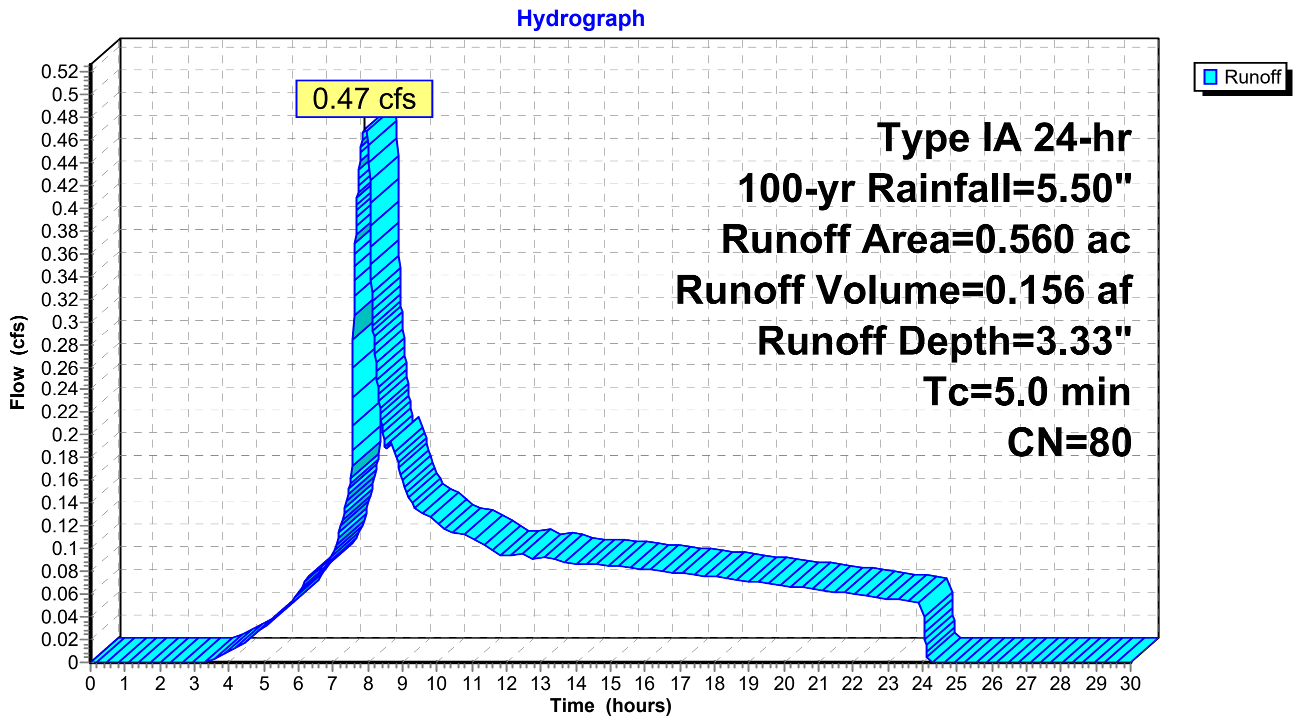
Runoff = 0.47 cfs @ 7.93 hrs, Volume= 0.156 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.560	80	>75% Grass cover, Good, HSG D
0.560		100.00% Pervious Area

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

Subcatchment 42S: (new Subcat)



Summary for Subcatchment 43S: (new Subcat)

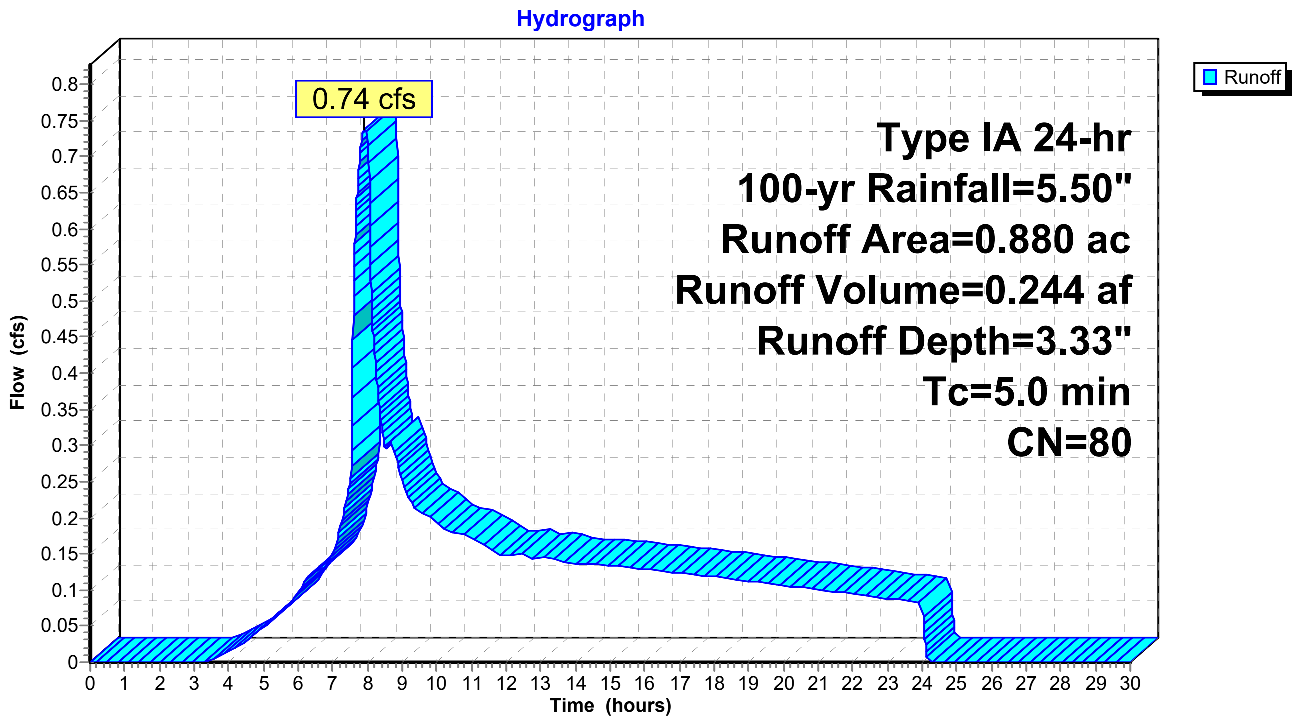
Runoff = 0.74 cfs @ 7.93 hrs, Volume= 0.244 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.880	80	>75% Grass cover, Good, HSG D
0.880		100.00% Pervious Area

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

Subcatchment 43S: (new Subcat)



Summary for Subcatchment 44S: (new Subcat)

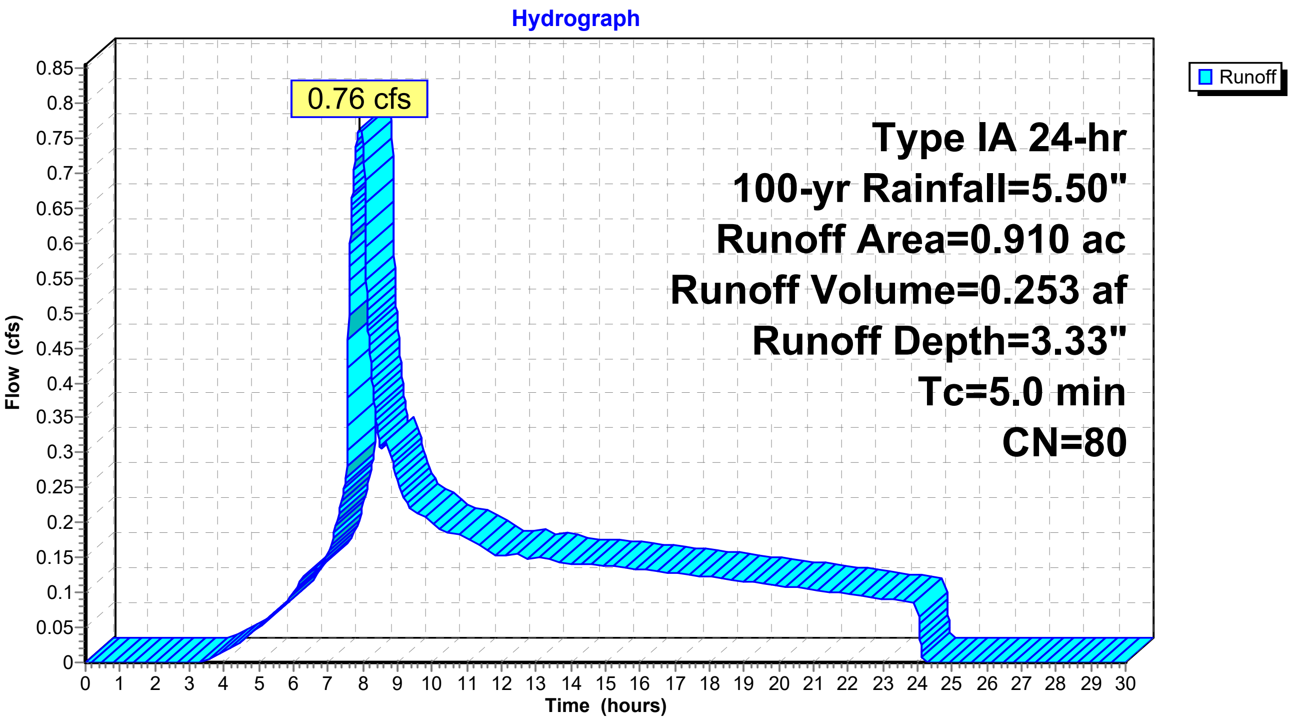
Runoff = 0.76 cfs @ 7.93 hrs, Volume= 0.253 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.910	80	>75% Grass cover, Good, HSG D
0.910		100.00% Pervious Area

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

Subcatchment 44S: (new Subcat)



Summary for Subcatchment 45S: (new Subcat)

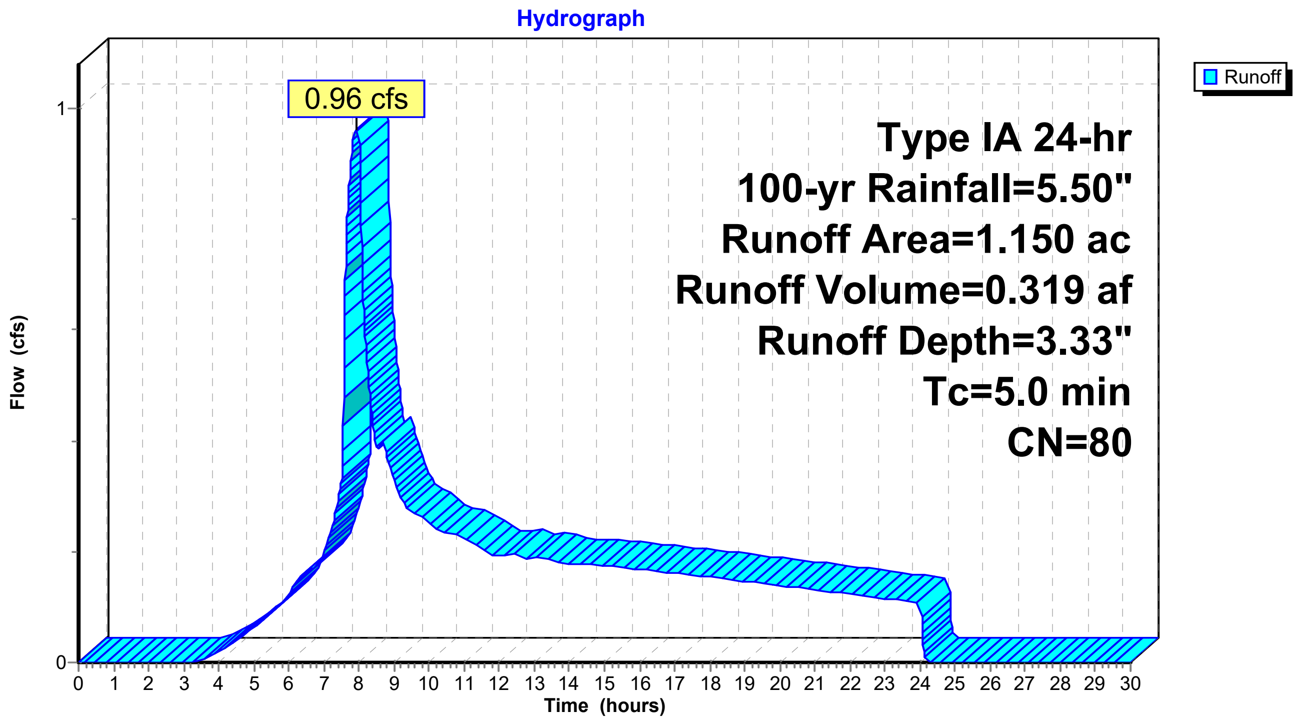
Runoff = 0.96 cfs @ 7.93 hrs, Volume= 0.319 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.150	80	>75% Grass cover, Good, HSG D
1.150		100.00% Pervious Area

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

Subcatchment 45S: (new Subcat)



Summary for Subcatchment 46S: (new Subcat)

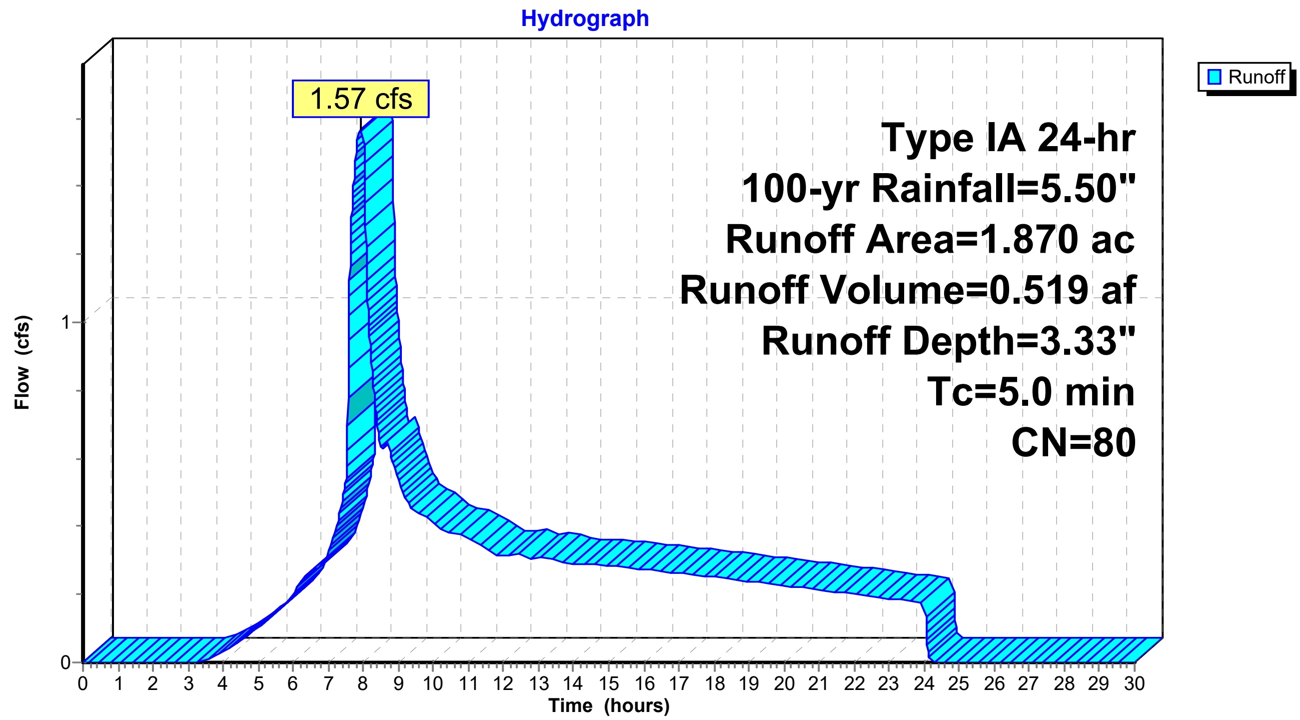
Runoff = 1.57 cfs @ 7.93 hrs, Volume= 0.519 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.870	80	>75% Grass cover, Good, HSG D
1.870		100.00% Pervious Area

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

Subcatchment 46S: (new Subcat)



Summary for Subcatchment 47S: (new Subcat)

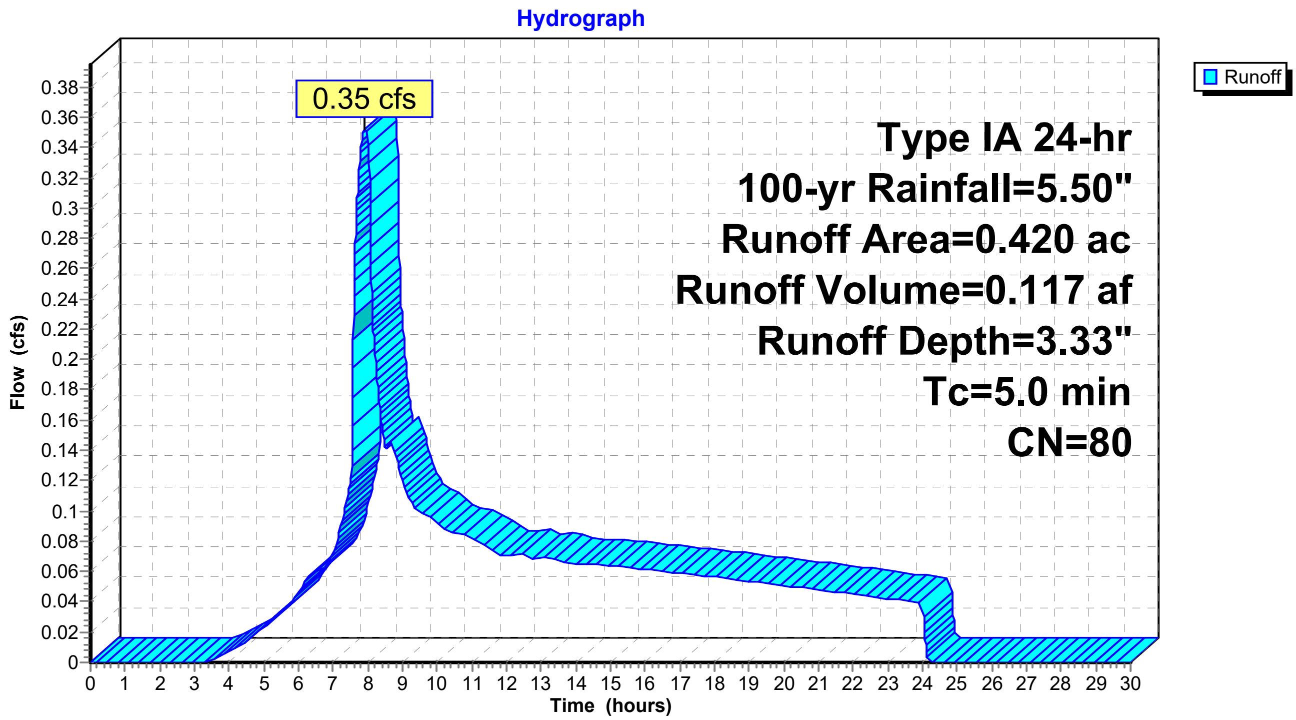
Runoff = 0.35 cfs @ 7.93 hrs, Volume= 0.117 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.420	80	>75% Grass cover, Good, HSG D
0.420		100.00% Pervious Area

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

Subcatchment 47S: (new Subcat)



Summary for Subcatchment 48S: (new Subcat)

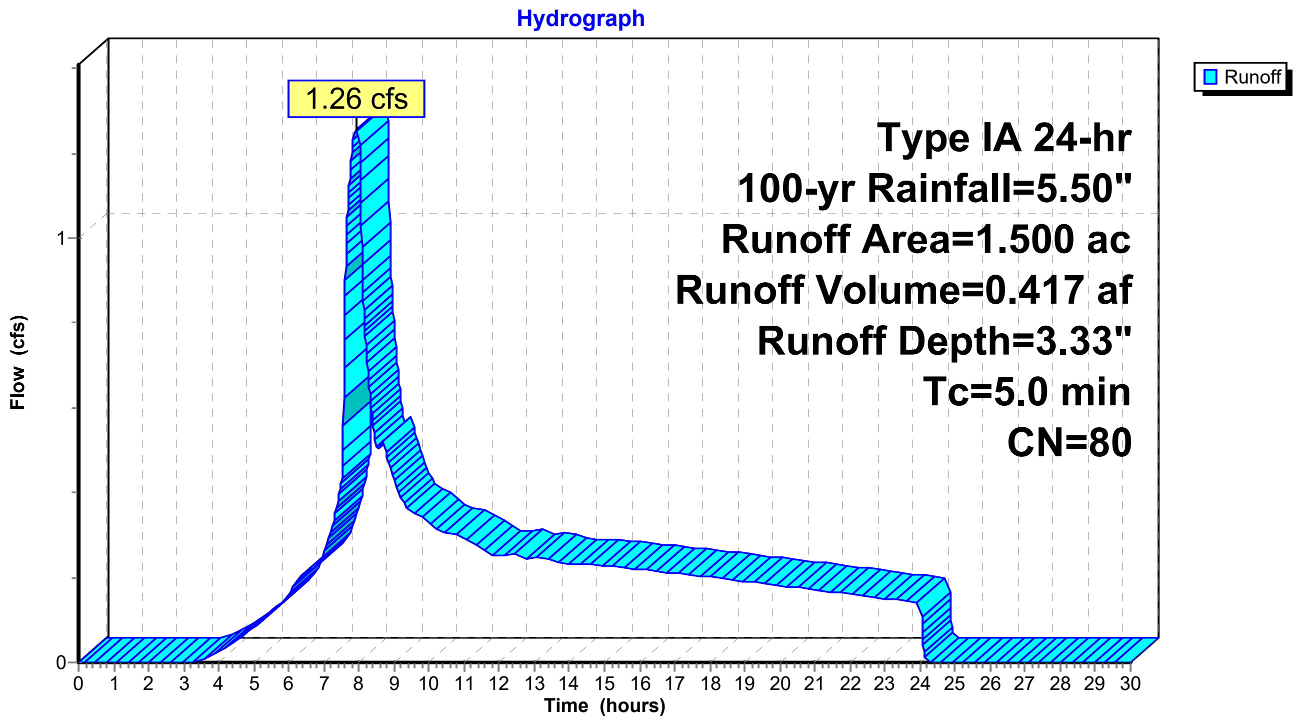
Runoff = 1.26 cfs @ 7.93 hrs, Volume= 0.417 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.500	80	>75% Grass cover, Good, HSG D
1.500		100.00% Pervious Area

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

Subcatchment 48S: (new Subcat)



Summary for Subcatchment 49S: (new Subcat)

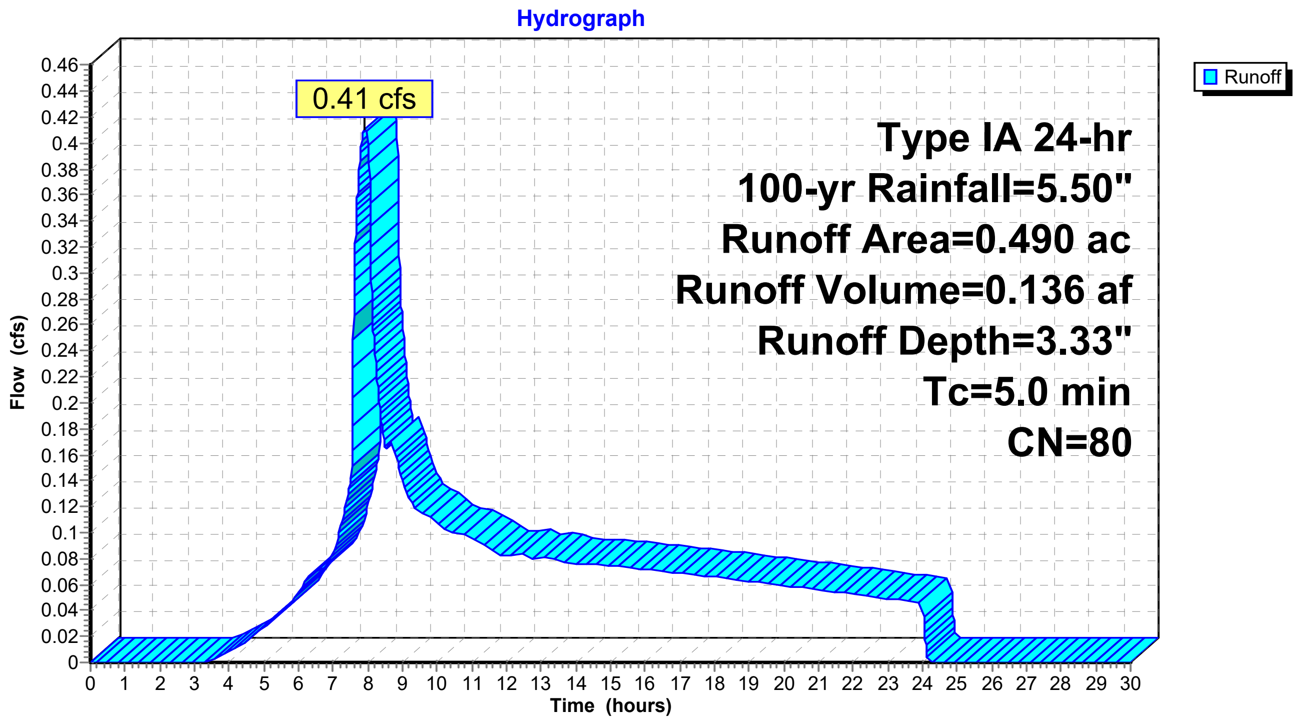
Runoff = 0.41 cfs @ 7.93 hrs, Volume= 0.136 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.490	80	>75% Grass cover, Good, HSG D
0.490		100.00% Pervious Area

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

Subcatchment 49S: (new Subcat)



Summary for Subcatchment 50S: (new Subcat)

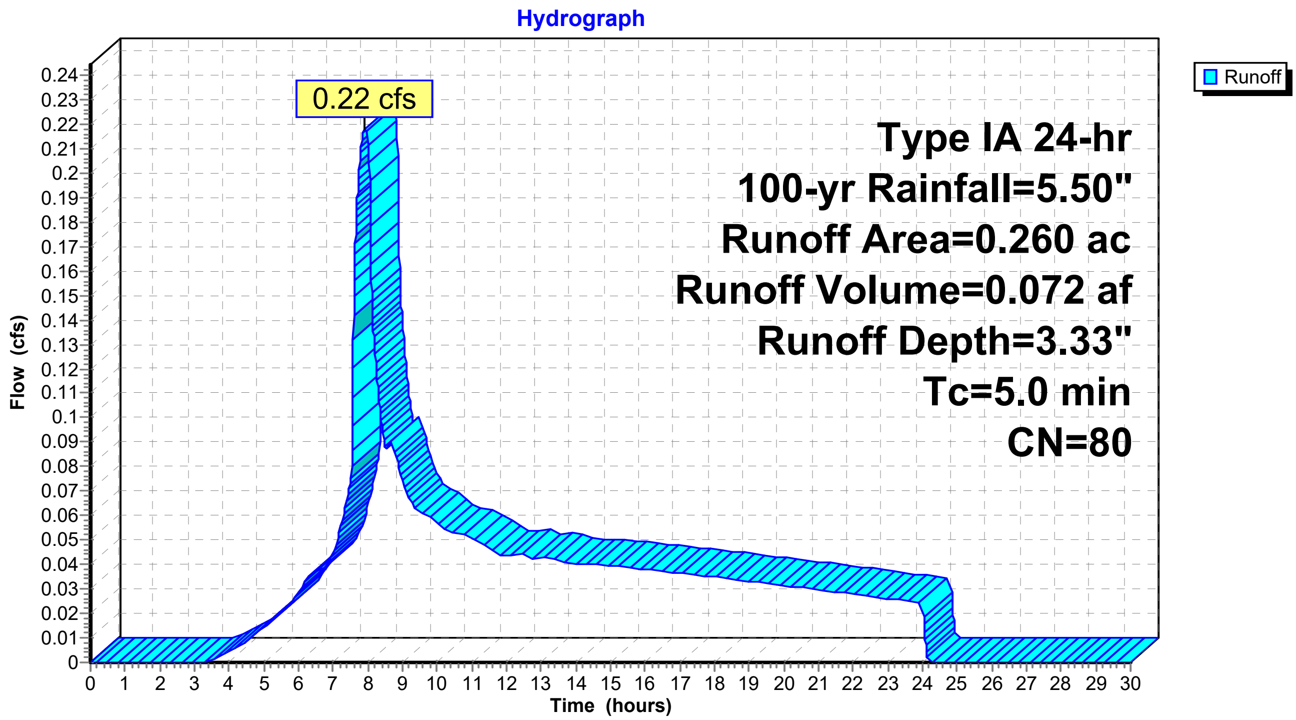
Runoff = 0.22 cfs @ 7.93 hrs, Volume= 0.072 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.260	80	>75% Grass cover, Good, HSG D
0.260		100.00% Pervious Area

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

Subcatchment 50S: (new Subcat)



Summary for Subcatchment 51S: (new Subcat)

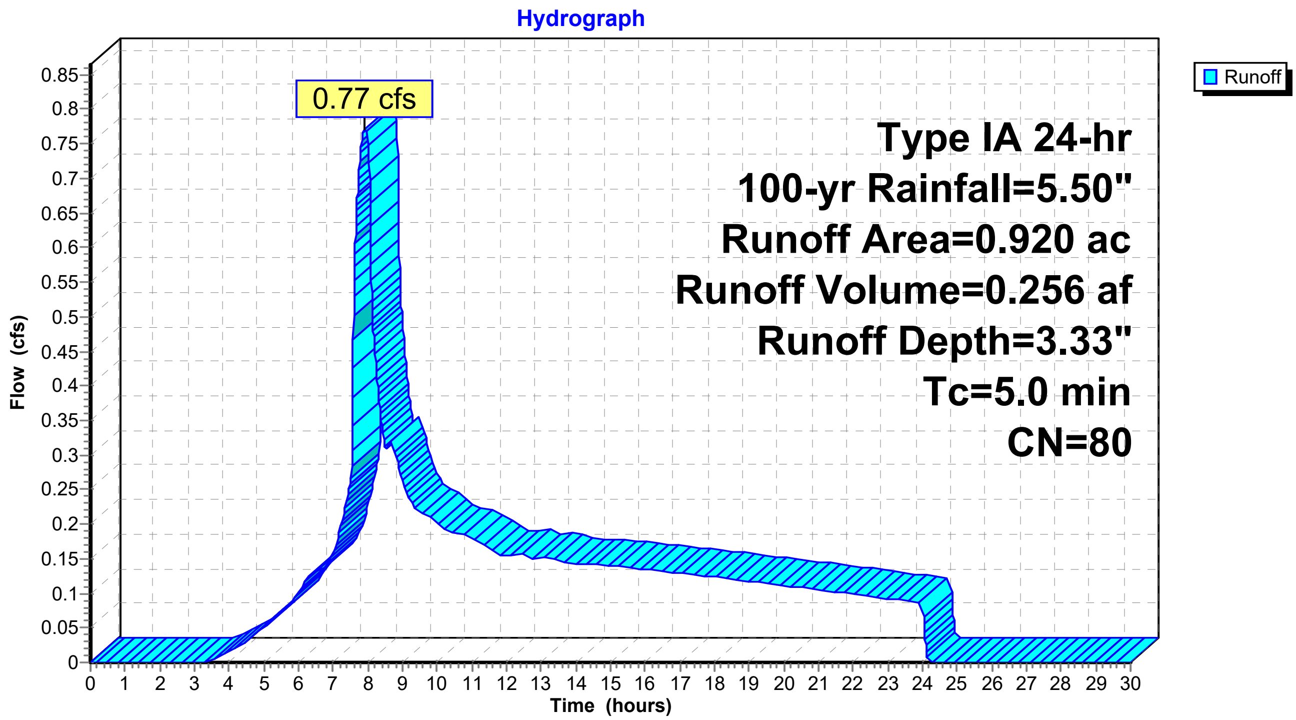
Runoff = 0.77 cfs @ 7.93 hrs, Volume= 0.256 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.920	80	>75% Grass cover, Good, HSG D
0.920		100.00% Pervious Area

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

Subcatchment 51S: (new Subcat)



Summary for Subcatchment 52S: (new Subcat)

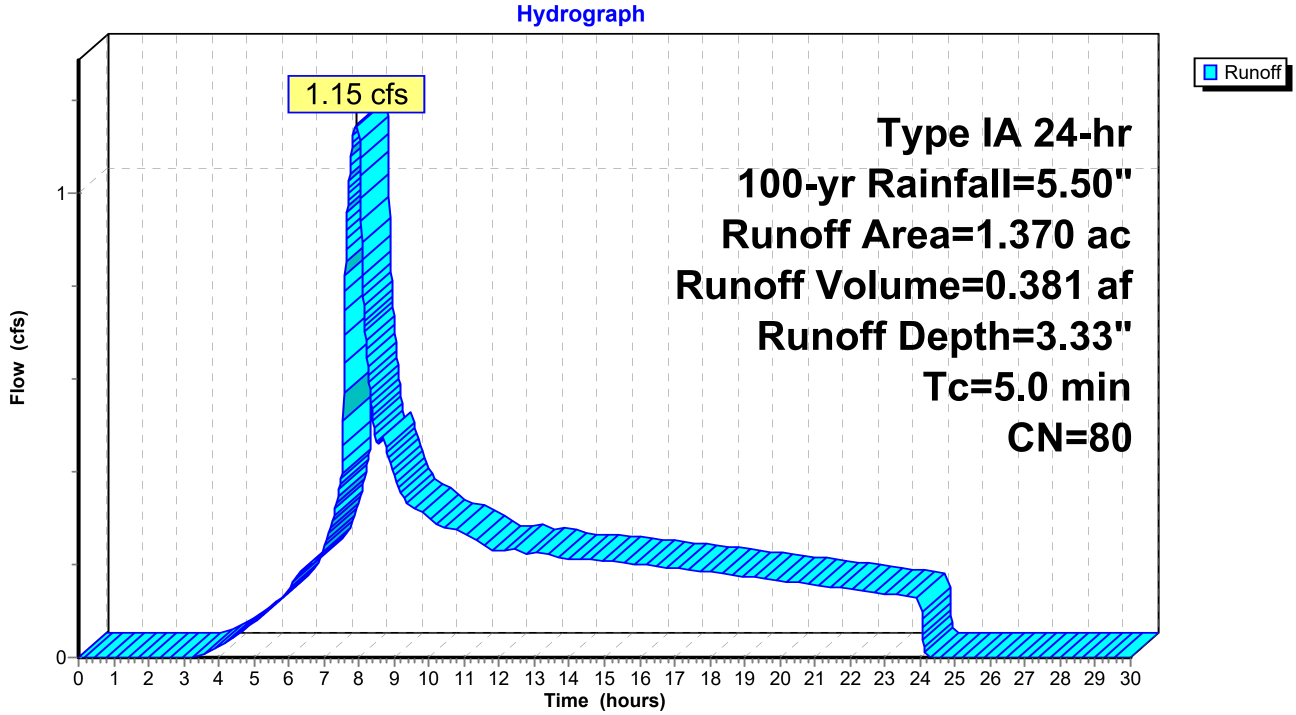
Runoff = 1.15 cfs @ 7.93 hrs, Volume= 0.381 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.370	80	>75% Grass cover, Good, HSG D
1.370		100.00% Pervious Area

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

Subcatchment 52S: (new Subcat)



Summary for Subcatchment 53S: (new Subcat)

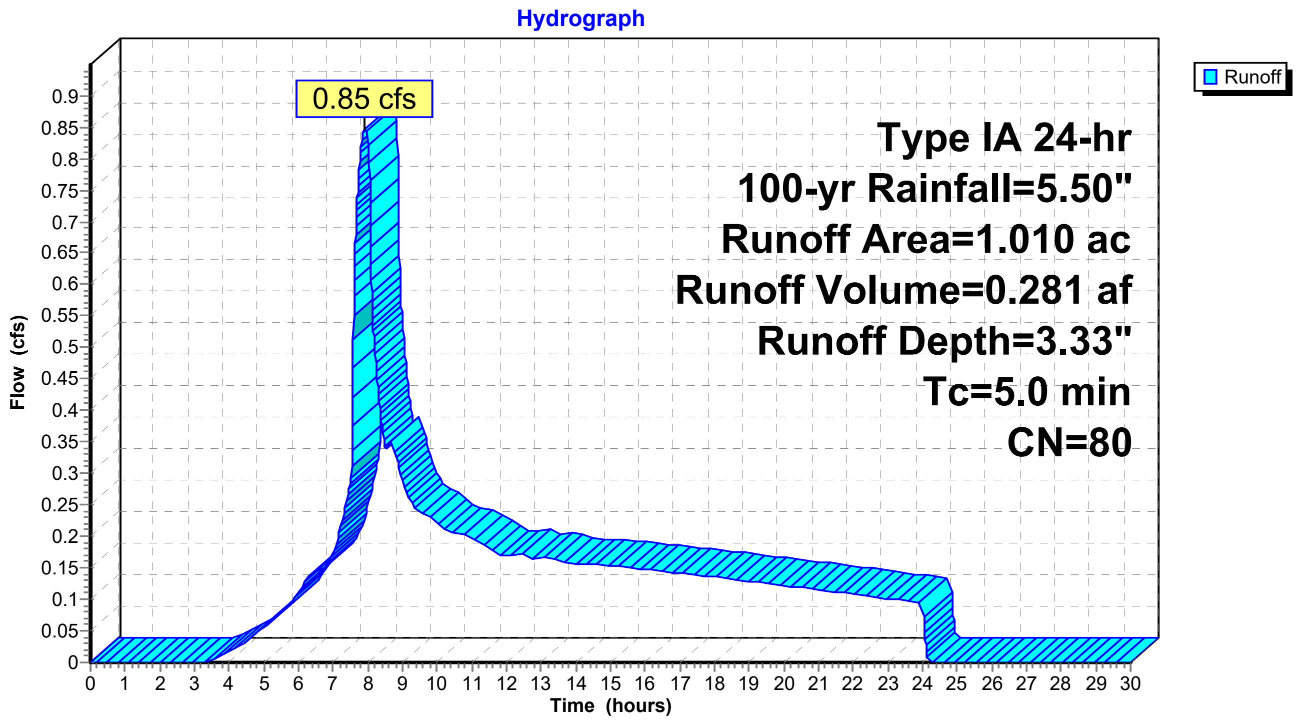
Runoff = 0.85 cfs @ 7.93 hrs, Volume= 0.281 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.010	80	>75% Grass cover, Good, HSG D
1.010		100.00% Pervious Area

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

Subcatchment 53S: (new Subcat)



Summary for Subcatchment 54S: (new Subcat)

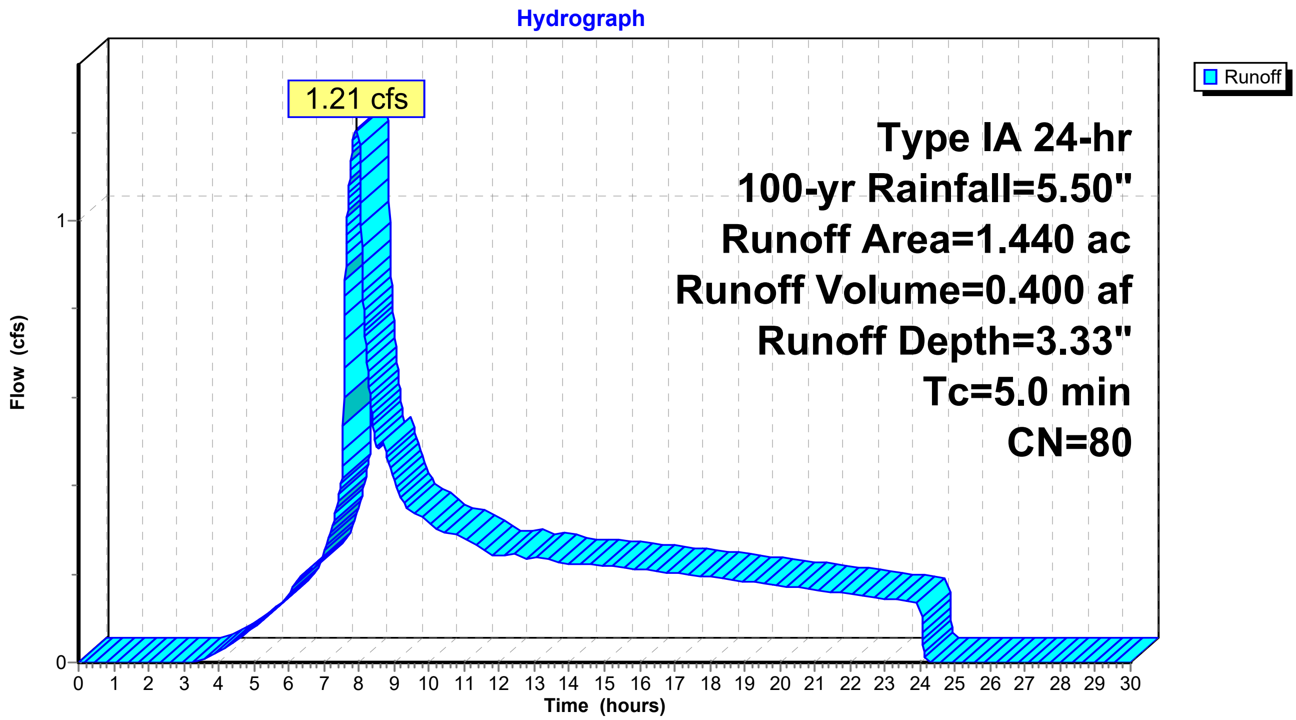
Runoff = 1.21 cfs @ 7.93 hrs, Volume= 0.400 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.440	80	>75% Grass cover, Good, HSG D
1.440		100.00% Pervious Area

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

Subcatchment 54S: (new Subcat)



Summary for Subcatchment 55S: (new Subcat)

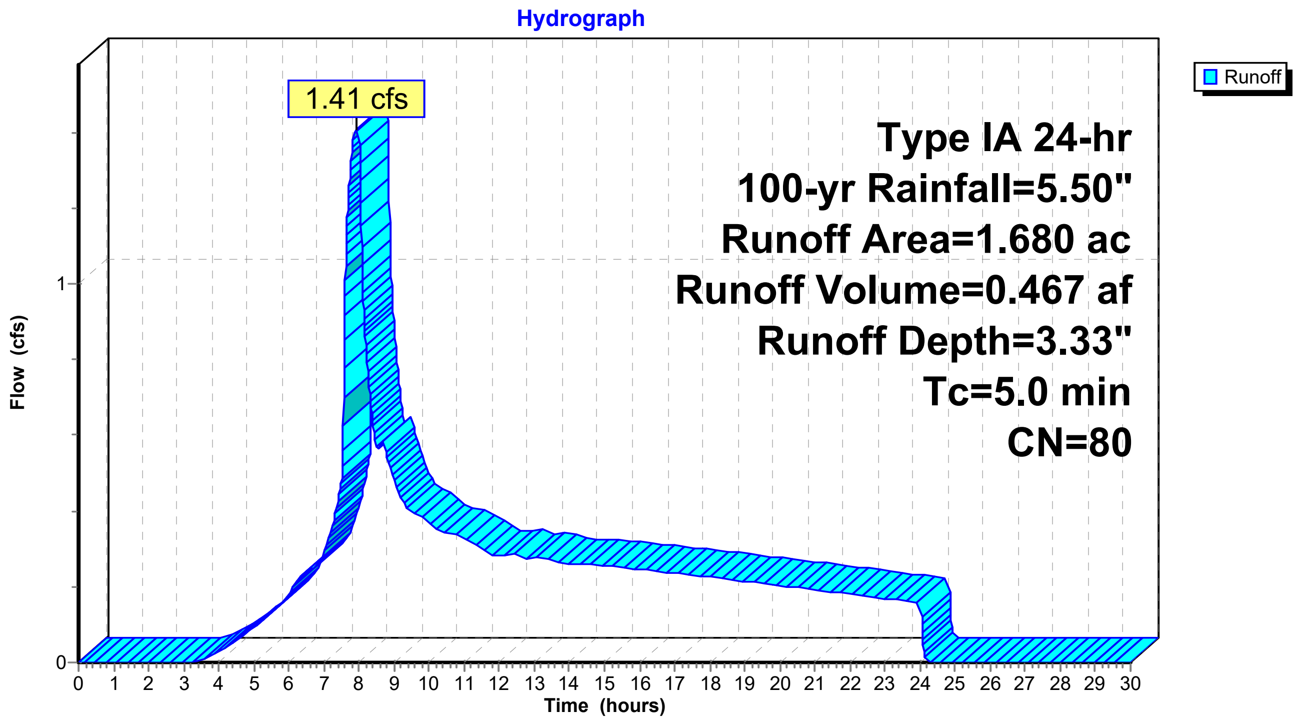
Runoff = 1.41 cfs @ 7.93 hrs, Volume= 0.467 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.680	80	>75% Grass cover, Good, HSG D
1.680		100.00% Pervious Area

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

Subcatchment 55S: (new Subcat)



Summary for Subcatchment 56S: (new Subcat)

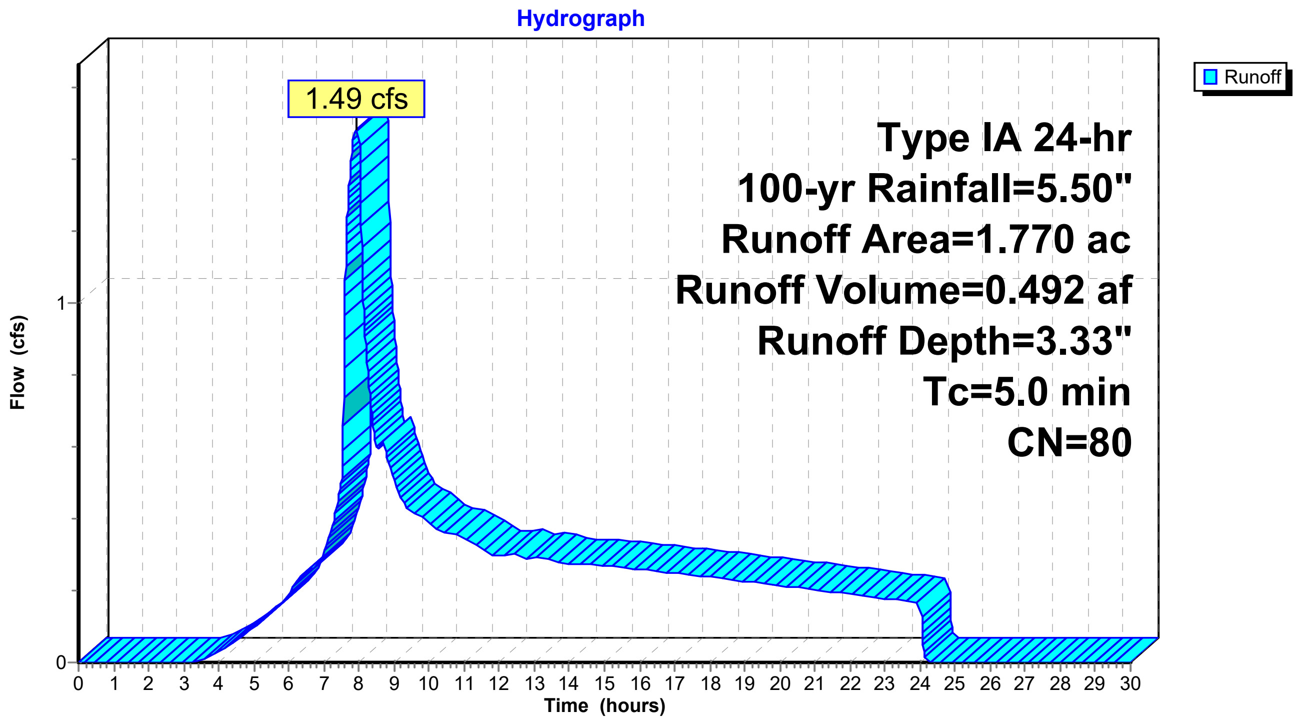
Runoff = 1.49 cfs @ 7.93 hrs, Volume= 0.492 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.770	80	>75% Grass cover, Good, HSG D
1.770		100.00% Pervious Area

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

Subcatchment 56S: (new Subcat)



Summary for Subcatchment 57S: (new Subcat)

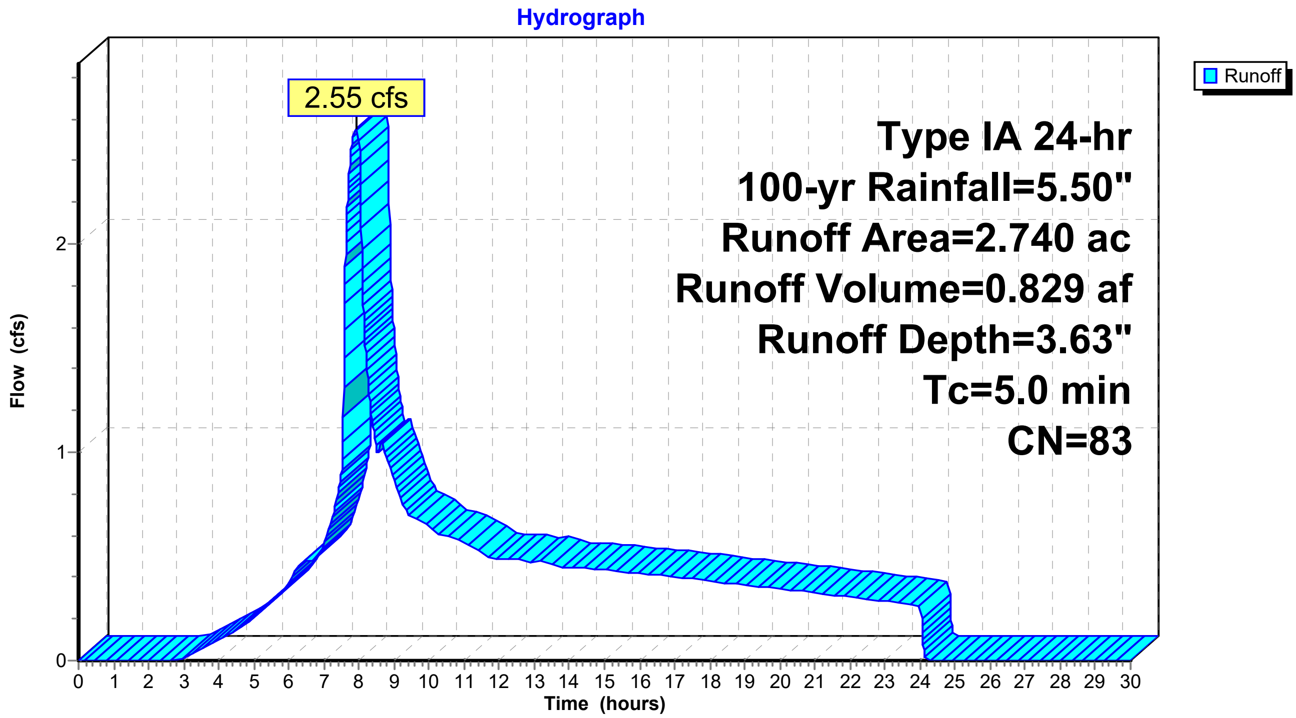
Runoff = 2.55 cfs @ 7.92 hrs, Volume= 0.829 af, Depth= 3.63"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	2.280	80	>75% Grass cover, Good, HSG D
*	0.460	98	Road
	2.740	83	Weighted Average
	2.280		83.21% Pervious Area
	0.460		16.79% Impervious Area

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

Subcatchment 57S: (new Subcat)



Summary for Subcatchment 58S: (new Subcat)

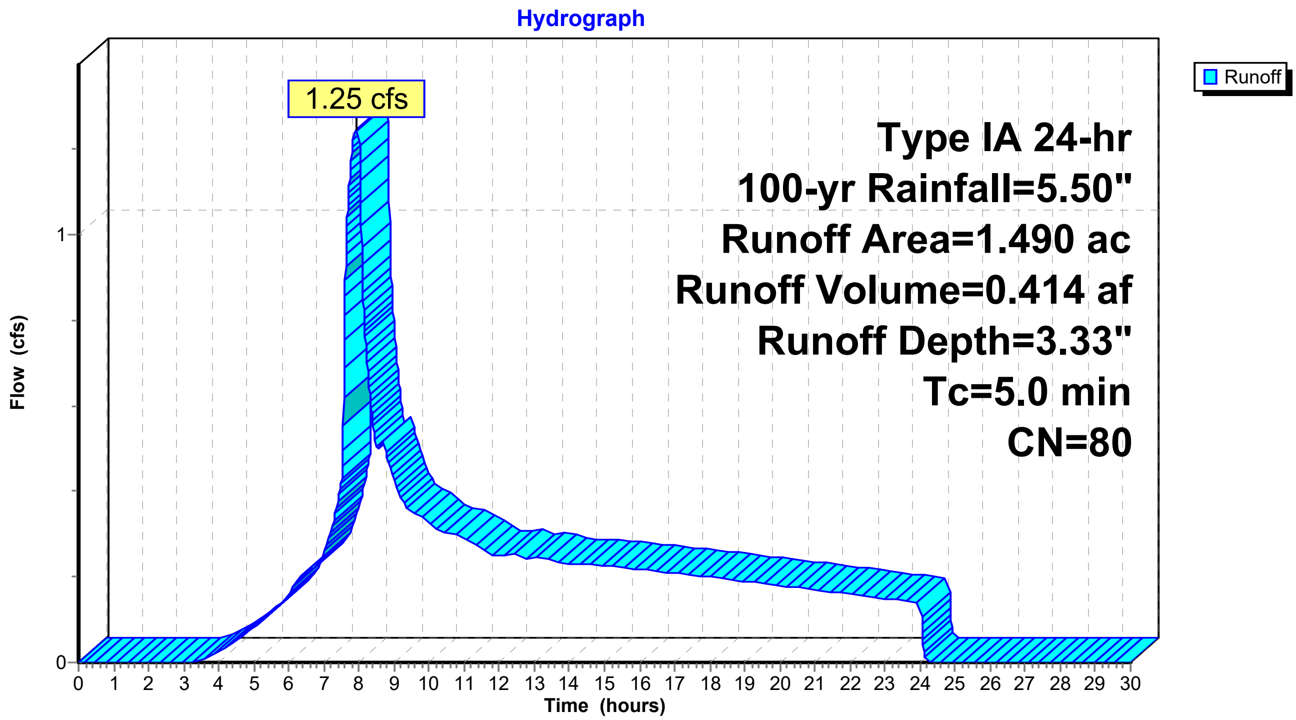
Runoff = 1.25 cfs @ 7.93 hrs, Volume= 0.414 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
1.490	80	>75% Grass cover, Good, HSG D
1.490		100.00% Pervious Area

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

Subcatchment 58S: (new Subcat)



Summary for Subcatchment 59S: (new Subcat)

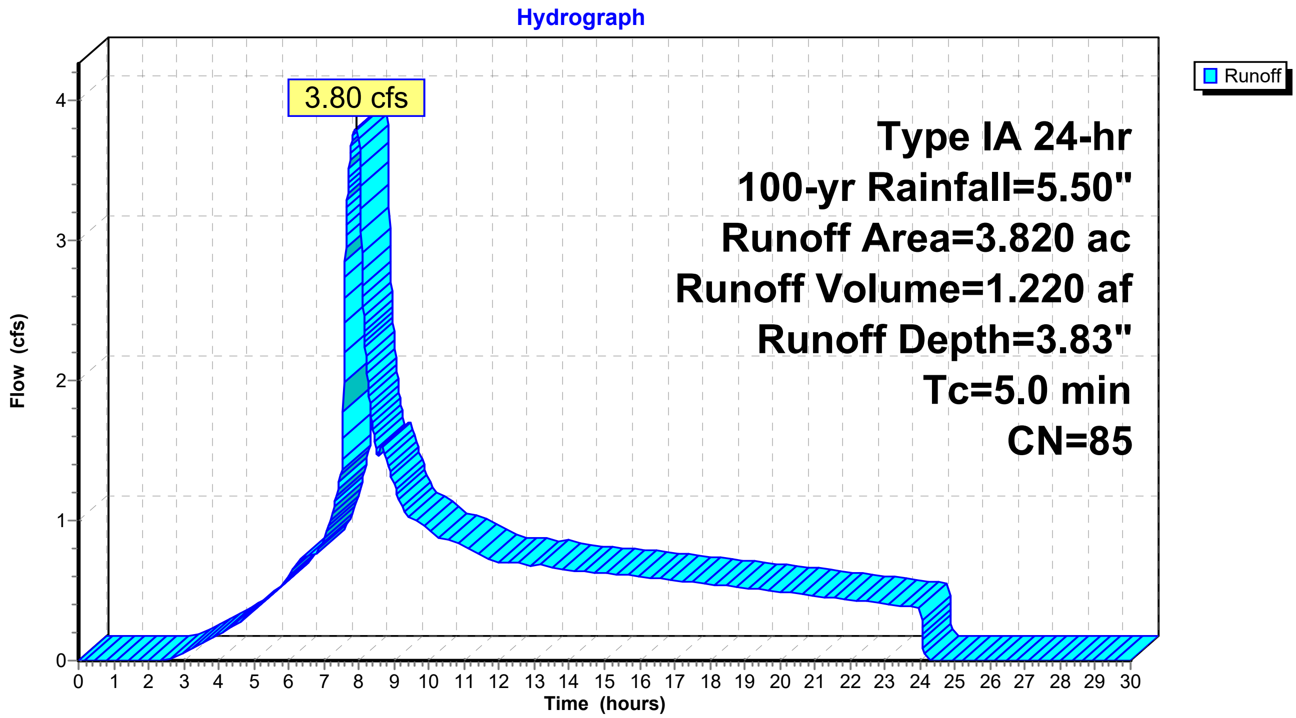
Runoff = 3.80 cfs @ 7.91 hrs, Volume= 1.220 af, Depth= 3.83"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	2.670	80	>75% Grass cover, Good, HSG D
*	1.150	98	Pond
	3.820	85	Weighted Average
	2.670		69.90% Pervious Area
	1.150		30.10% Impervious Area

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

Subcatchment 59S: (new Subcat)



Summary for Subcatchment 60S: (new Subcat)

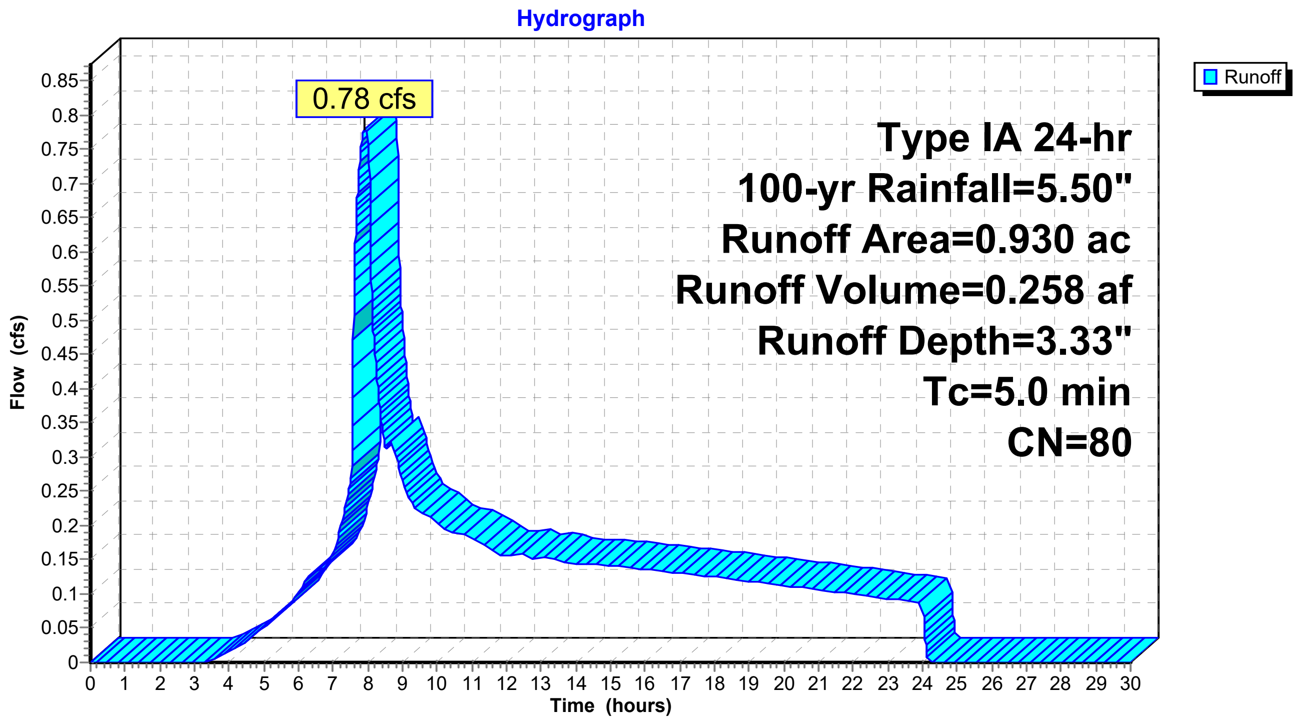
Runoff = 0.78 cfs @ 7.93 hrs, Volume= 0.258 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.930	80	>75% Grass cover, Good, HSG D
0.930		100.00% Pervious Area

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

Subcatchment 60S: (new Subcat)



Summary for Subcatchment 61S: (new Subcat)

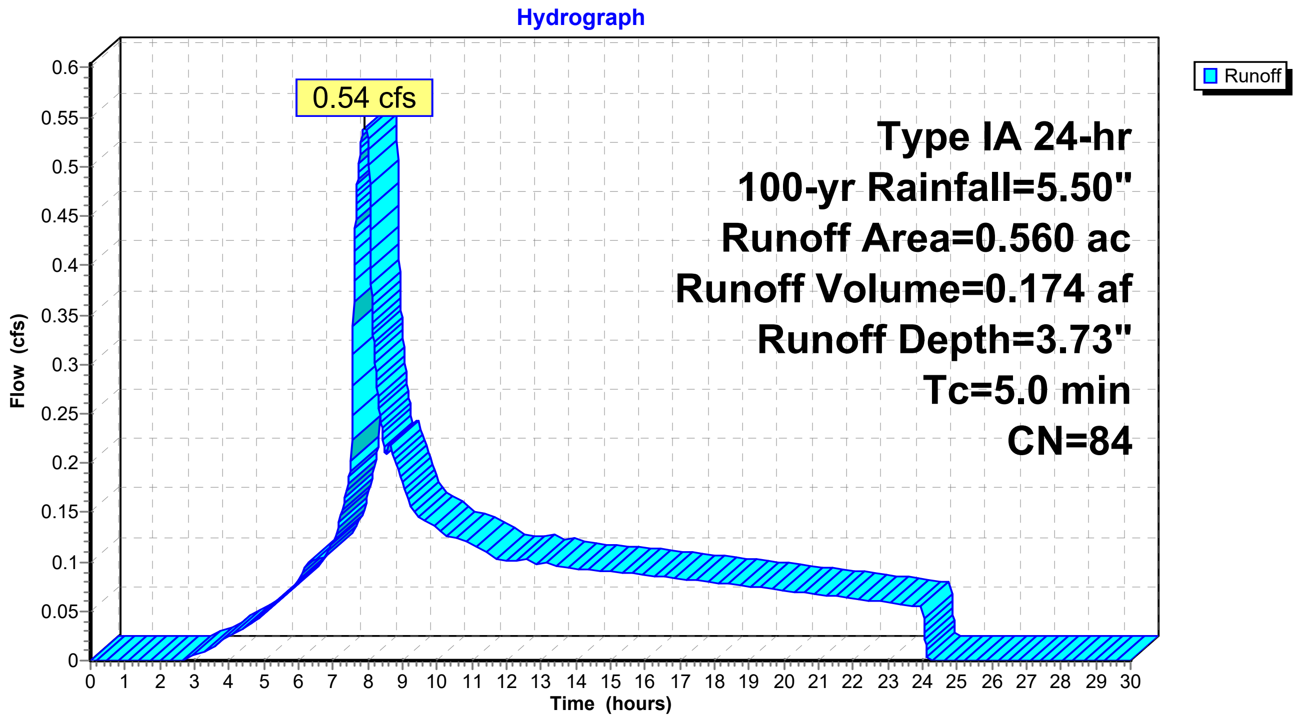
Runoff = 0.54 cfs @ 7.91 hrs, Volume= 0.174 af, Depth= 3.73"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	0.430	80	>75% Grass cover, Good, HSG D
*	0.130	98	Road
	0.560	84	Weighted Average
	0.430		76.79% Pervious Area
	0.130		23.21% Impervious Area

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

Subcatchment 61S: (new Subcat)



Summary for Subcatchment 62S: (new Subcat)

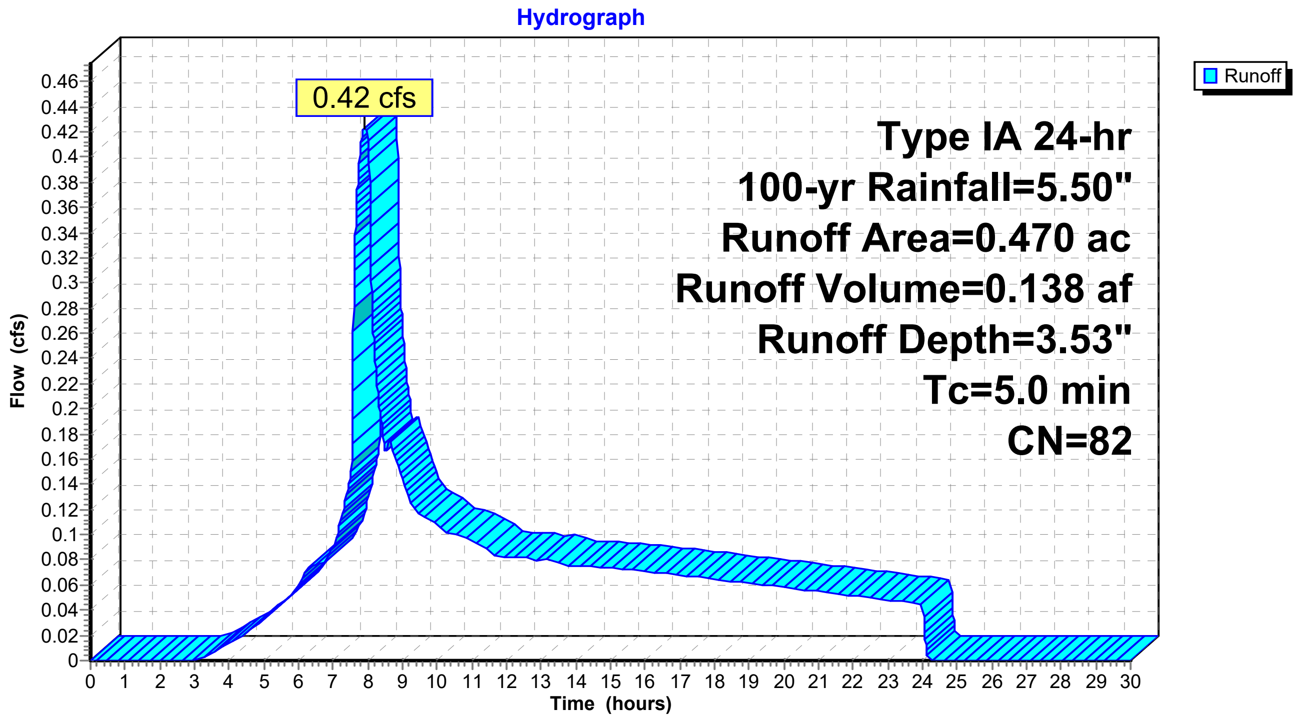
Runoff = 0.42 cfs @ 7.92 hrs, Volume= 0.138 af, Depth= 3.53"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	0.430	80	>75% Grass cover, Good, HSG D
*	0.040	98	Road
	0.470	82	Weighted Average
	0.430		91.49% Pervious Area
	0.040		8.51% Impervious Area

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

Subcatchment 62S: (new Subcat)



Summary for Subcatchment 63S: (new Subcat)

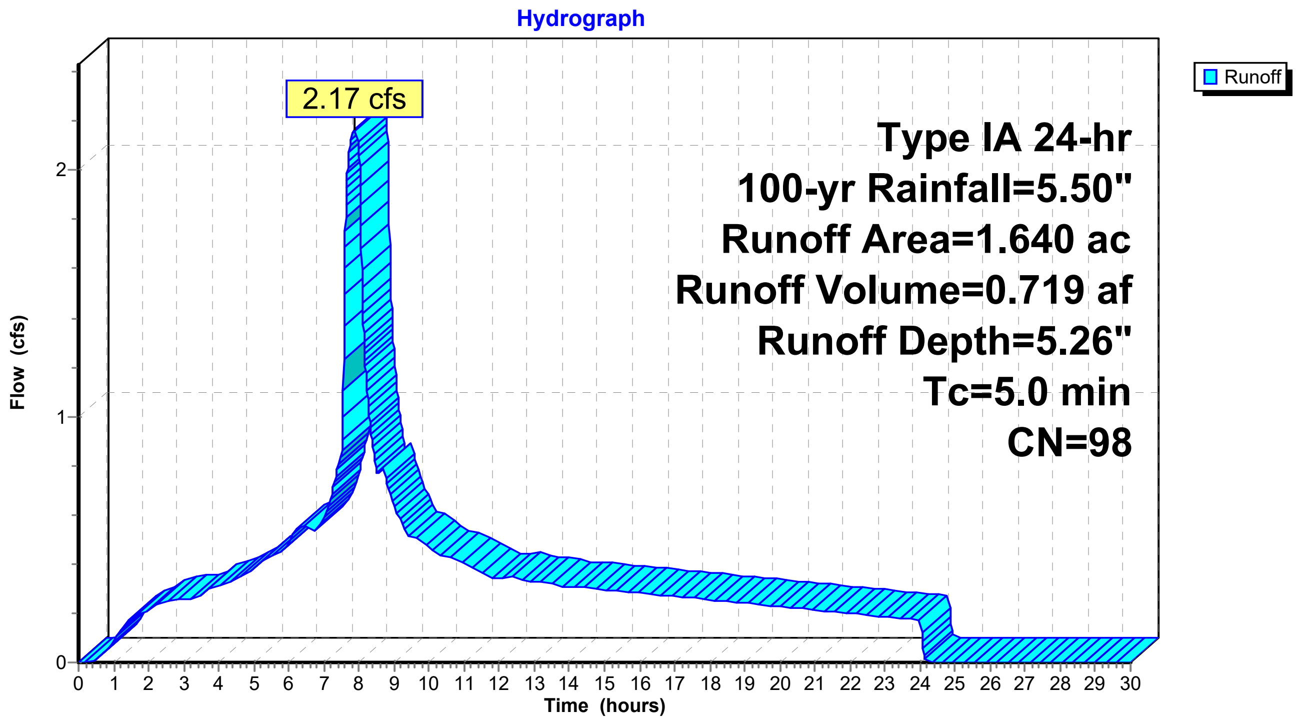
Runoff = 2.17 cfs @ 7.85 hrs, Volume= 0.719 af, Depth= 5.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
*	1.640	98	>75% Grass cover, Good, HSG D
	1.640		100.00% Impervious Area

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

Subcatchment 63S: (new Subcat)



Summary for Subcatchment 64S: (new Subcat)

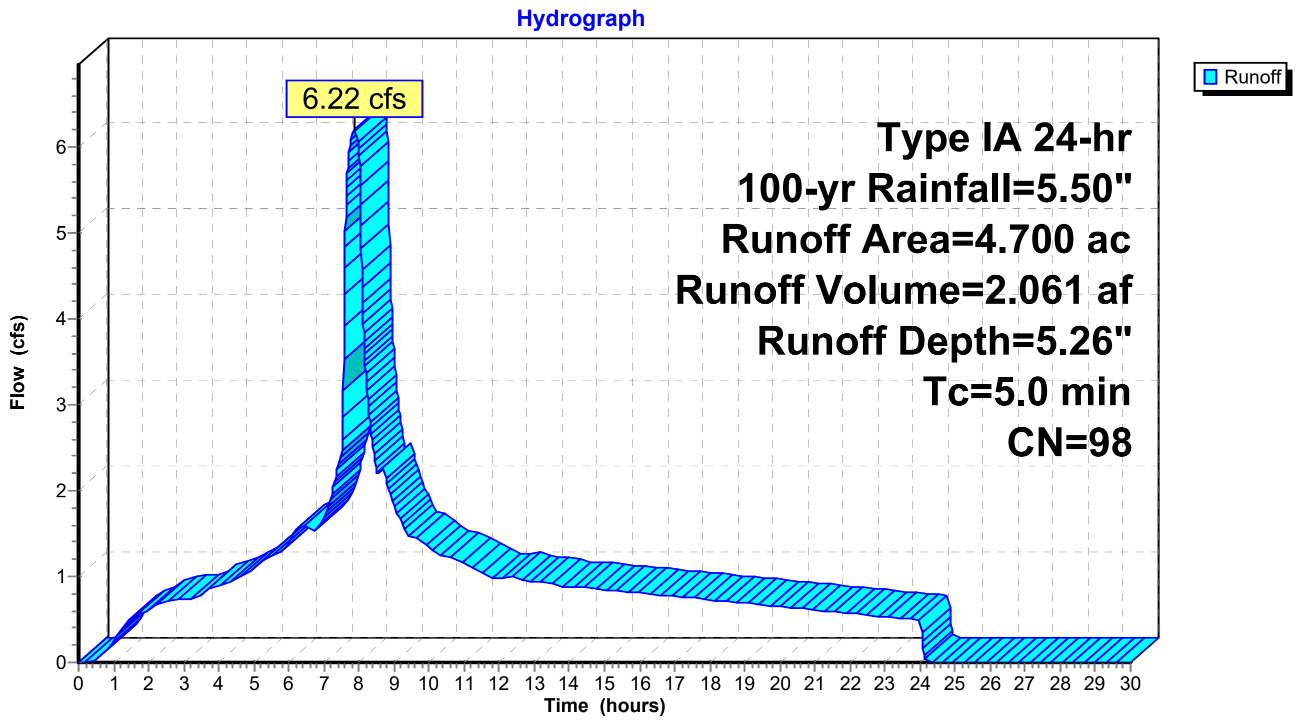
Runoff = 6.22 cfs @ 7.85 hrs, Volume= 2.061 af, Depth= 5.26"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
*	4.700	98	Pond 3 and roads
	4.700		100.00% Impervious Area

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

Subcatchment 64S: (new Subcat)



Summary for Subcatchment 65S: (new Subcat)

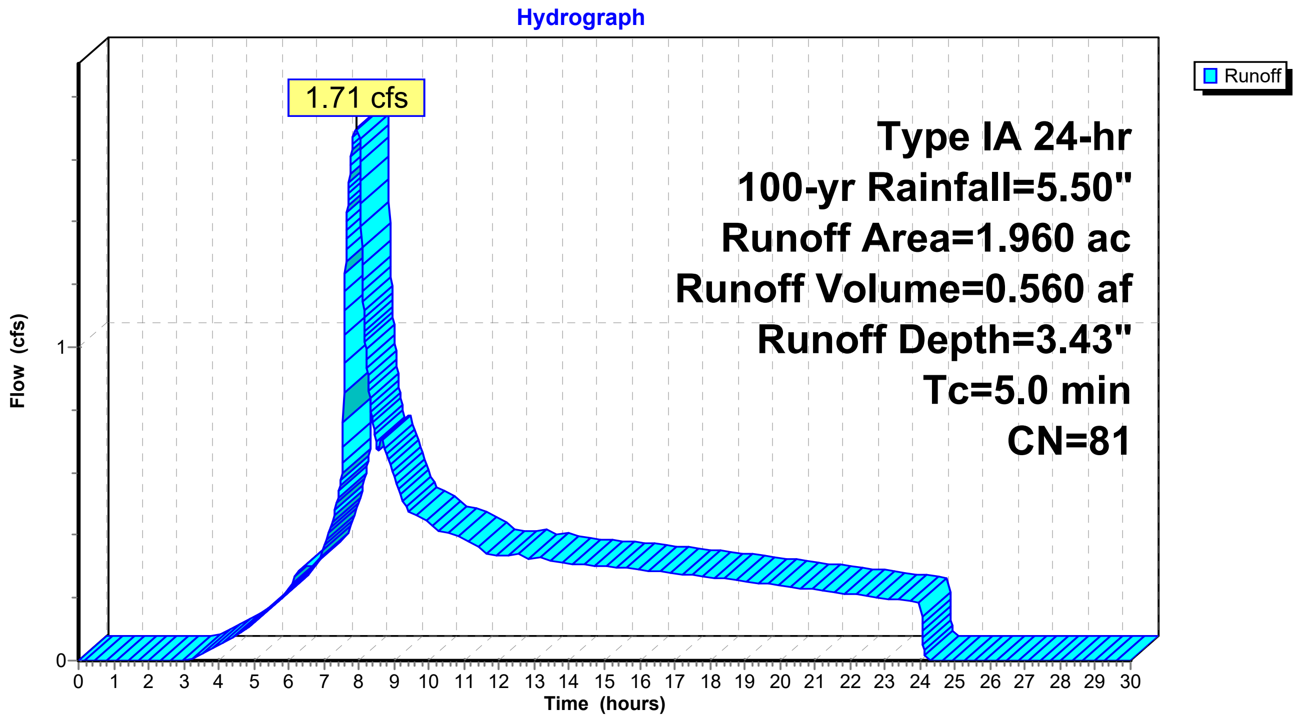
Runoff = 1.71 cfs @ 7.93 hrs, Volume= 0.560 af, Depth= 3.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	1.810	80	>75% Grass cover, Good, HSG D
*	0.150	98	Road
	1.960	81	Weighted Average
	1.810		92.35% Pervious Area
	0.150		7.65% Impervious Area

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

Subcatchment 65S: (new Subcat)



Summary for Subcatchment 66S: (new Subcat)

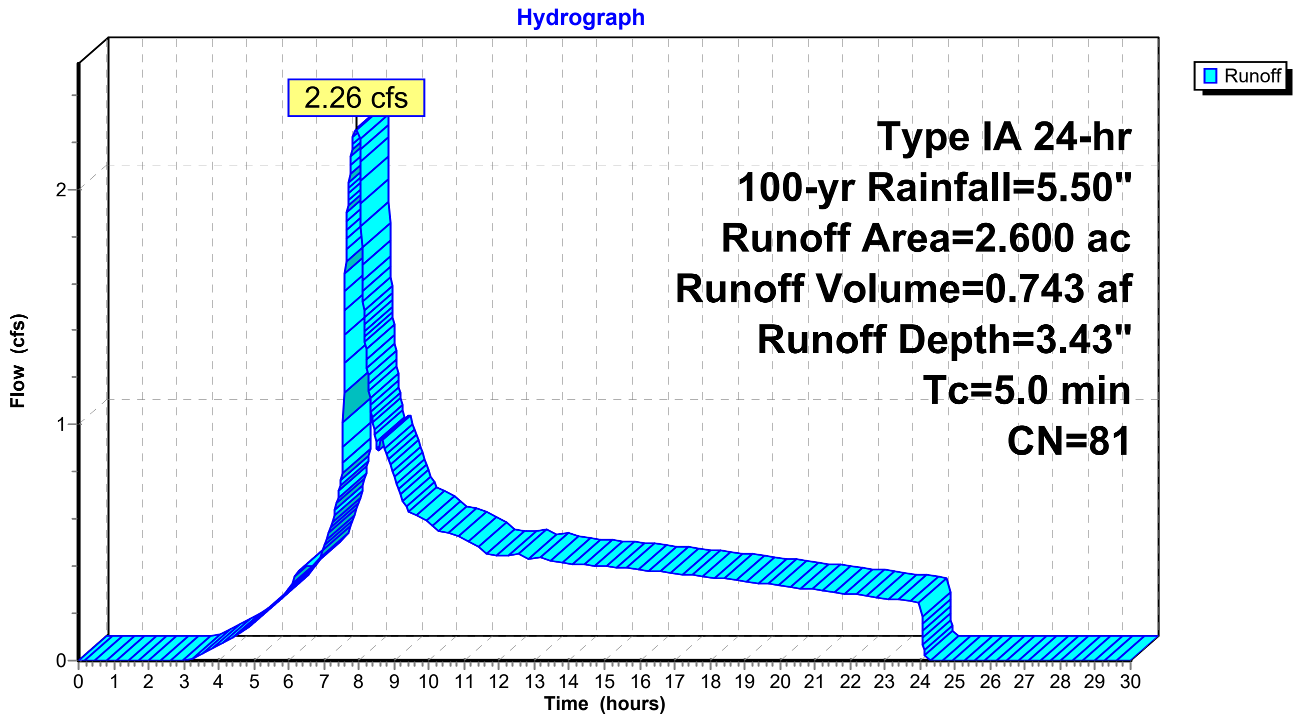
Runoff = 2.26 cfs @ 7.93 hrs, Volume= 0.743 af, Depth= 3.43"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

	Area (ac)	CN	Description
	2.420	80	>75% Grass cover, Good, HSG D
*	0.180	98	Road
	2.600	81	Weighted Average
	2.420		93.08% Pervious Area
	0.180		6.92% Impervious Area

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

Subcatchment 66S: (new Subcat)



Summary for Subcatchment 71S: (new Subcat)

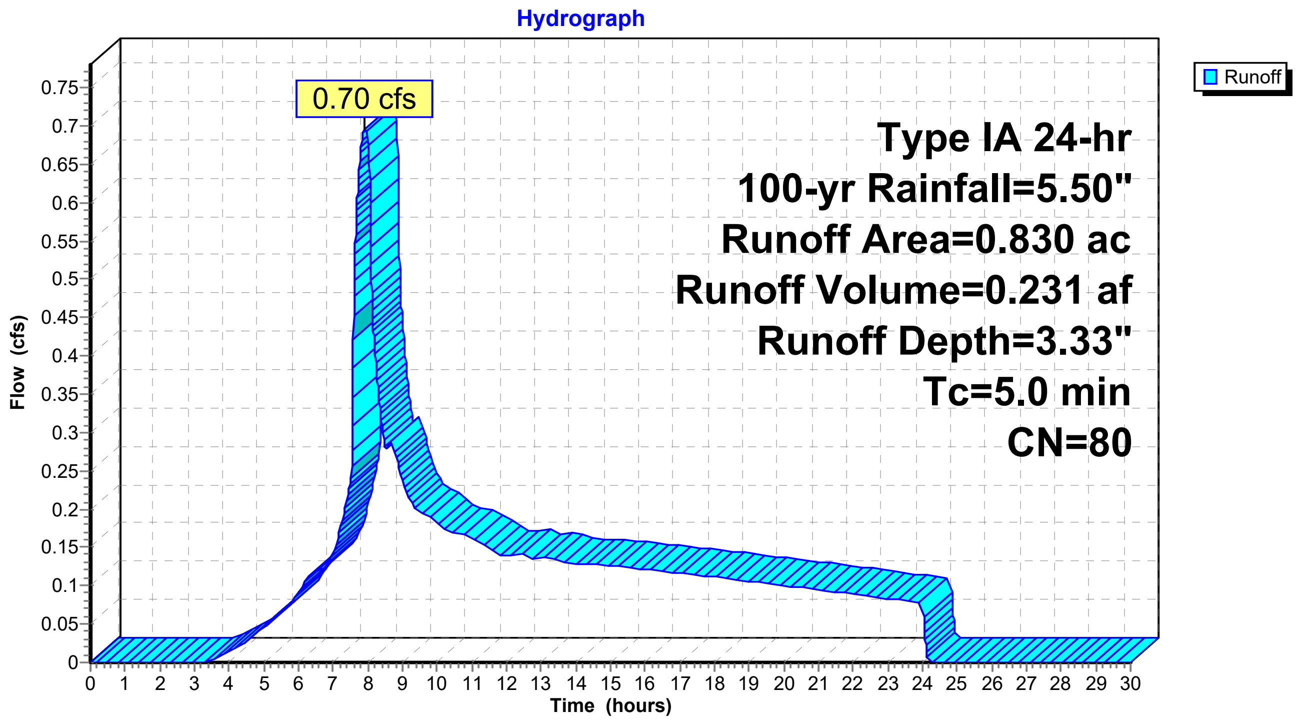
Runoff = 0.70 cfs @ 7.93 hrs, Volume= 0.231 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.830	80	>75% Grass cover, Good, HSG D
0.830		100.00% Pervious Area

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

Subcatchment 71S: (new Subcat)



Summary for Subcatchment 73S: (new Subcat)

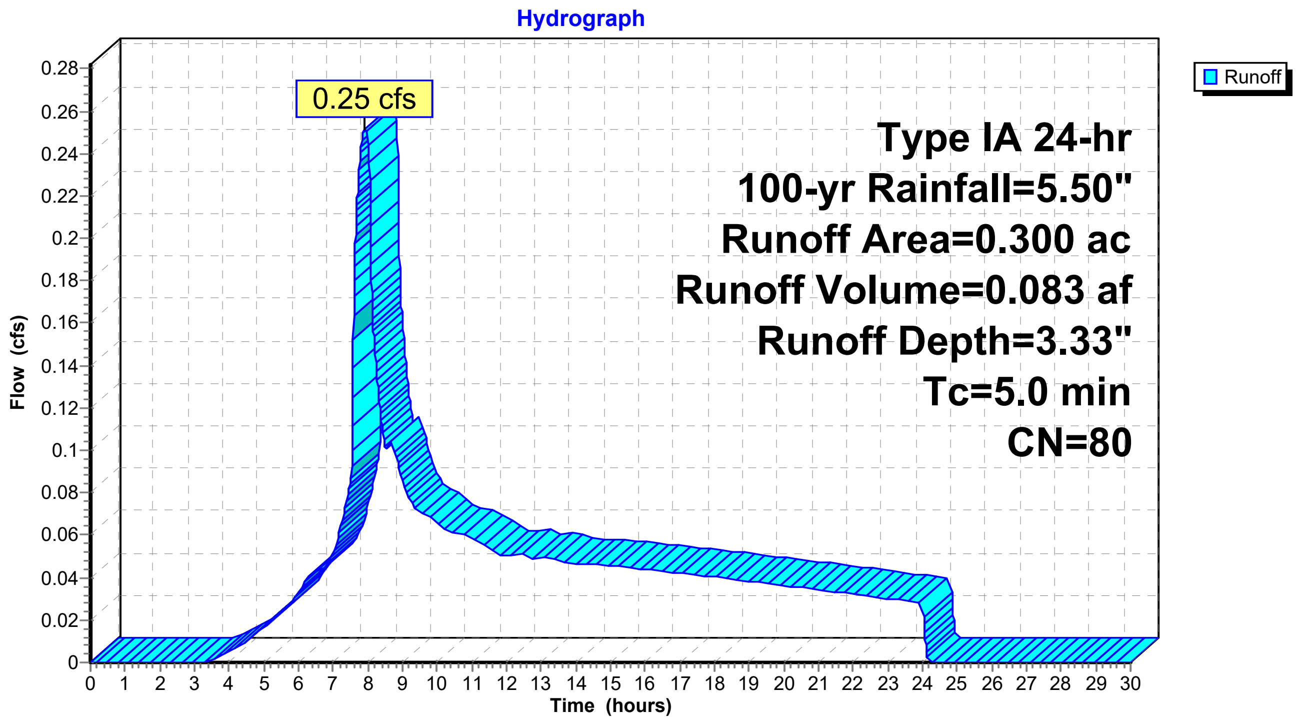
Runoff = 0.25 cfs @ 7.93 hrs, Volume= 0.083 af, Depth= 3.33"

Runoff by SCS TR-20 method, UH=SCS, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Type IA 24-hr 100-yr Rainfall=5.50"

Area (ac)	CN	Description
0.300	80	>75% Grass cover, Good, HSG D
0.300		100.00% Pervious Area

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

Subcatchment 73S: (new Subcat)



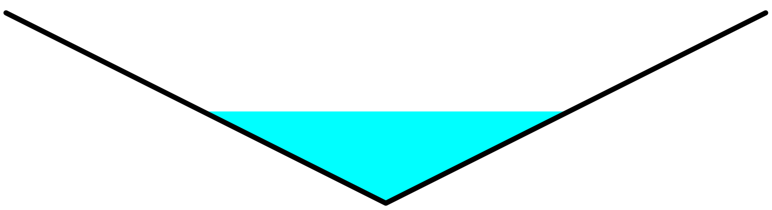
Summary for Reach 1R: (new Reach)

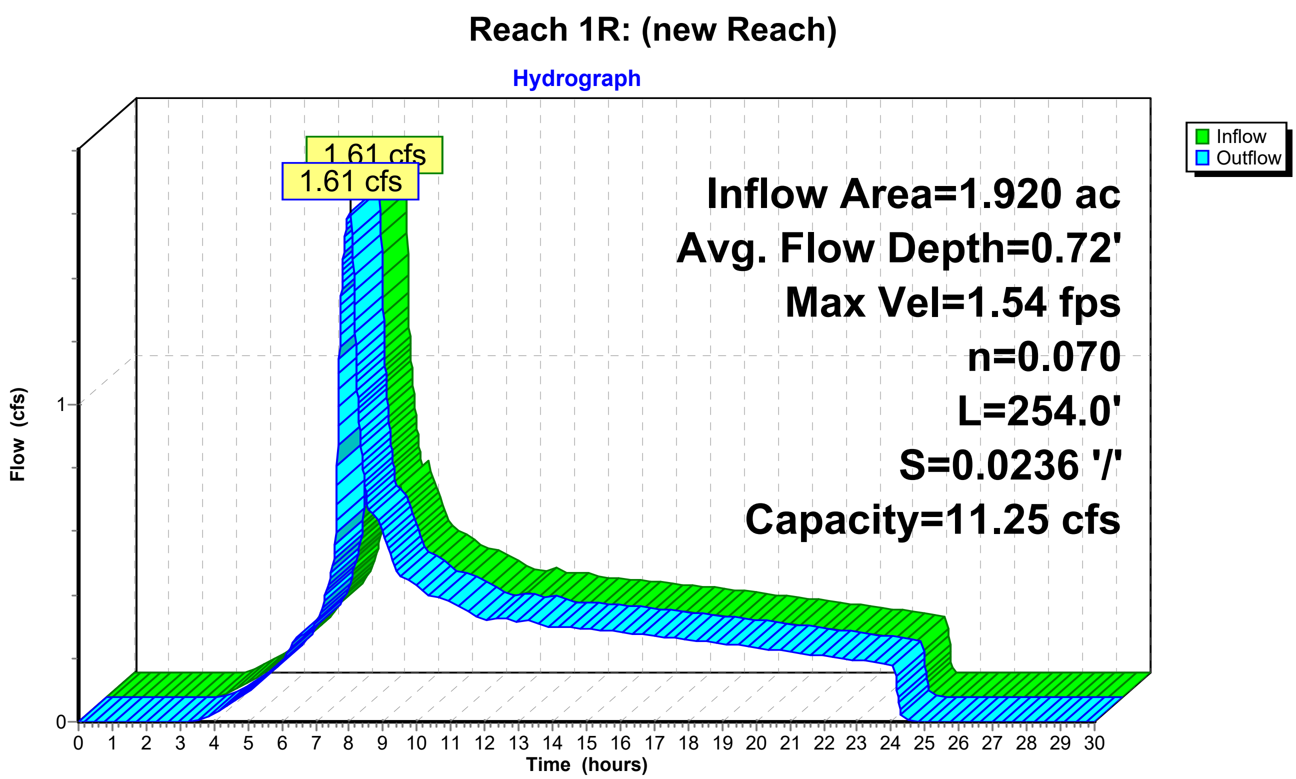
Inflow Area = 1.920 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.61 cfs @ 7.93 hrs, Volume= 0.533 af
Outflow = 1.61 cfs @ 8.01 hrs, Volume= 0.533 af, Atten= 0%, Lag= 4.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.54 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 4.7 min

Peak Storage= 265 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.25 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 254.0' Slope= 0.0236 '/'
Inlet Invert= 275.00', Outlet Invert= 269.00'





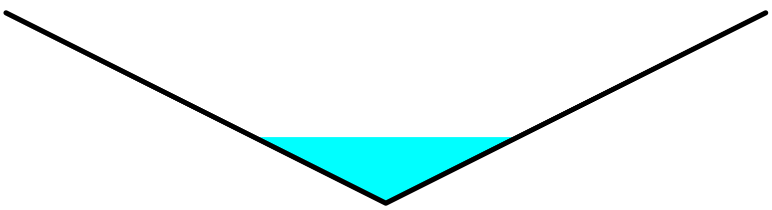
Summary for Reach 12R: (new Reach)

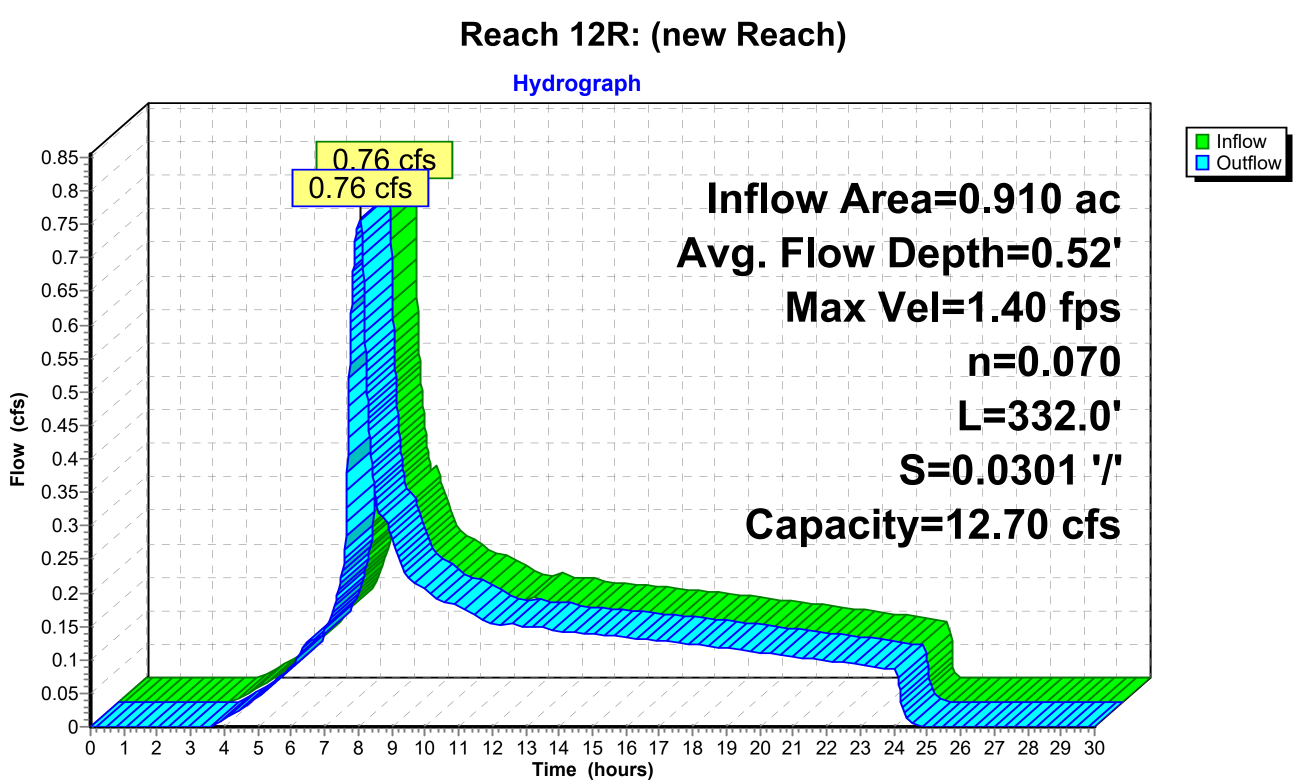
Inflow Area = 0.910 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.76 cfs @ 7.93 hrs, Volume= 0.253 af
Outflow = 0.76 cfs @ 8.05 hrs, Volume= 0.253 af, Atten= 1%, Lag= 6.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.40 fps, Min. Travel Time= 4.0 min
Avg. Velocity = 0.81 fps, Avg. Travel Time= 6.8 min

Peak Storage= 180 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.52'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.70 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 332.0' Slope= 0.0301 '/'
Inlet Invert= 227.00', Outlet Invert= 217.00'





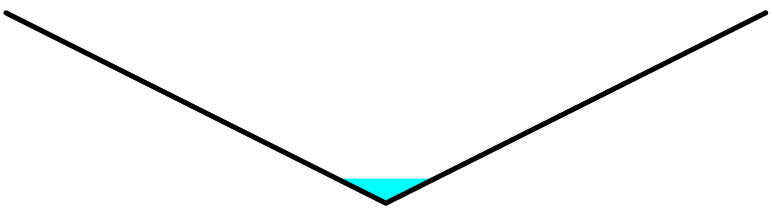
Summary for Reach 13R: (new Reach)

Inflow Area = 0.080 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.07 cfs @ 7.93 hrs, Volume= 0.022 af
Outflow = 0.07 cfs @ 7.99 hrs, Volume= 0.022 af, Atten= 0%, Lag= 3.5 min

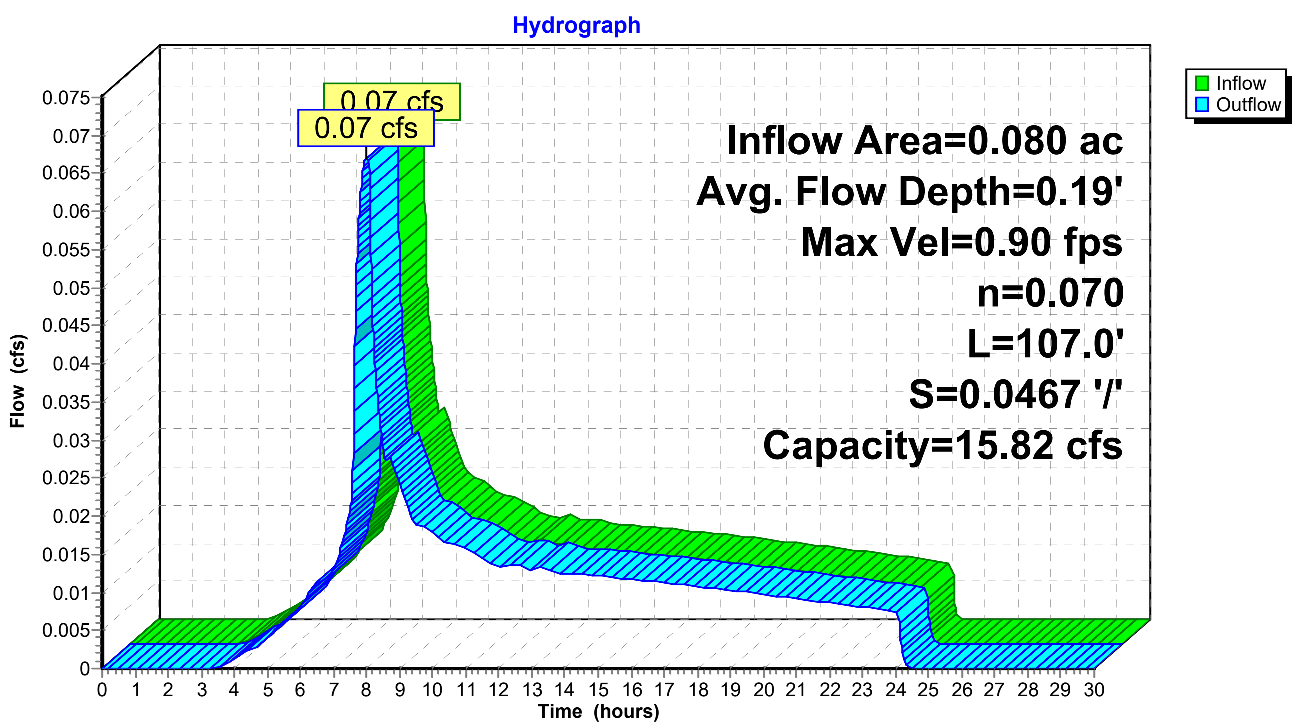
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.90 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 3.2 min

Peak Storage= 8 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.19'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 15.82 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 107.0' Slope= 0.0467 '/'
Inlet Invert= 222.00', Outlet Invert= 217.00'



Reach 13R: (new Reach)



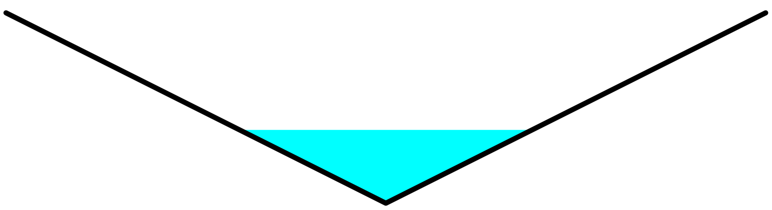
Summary for Reach 14R: (new Reach)

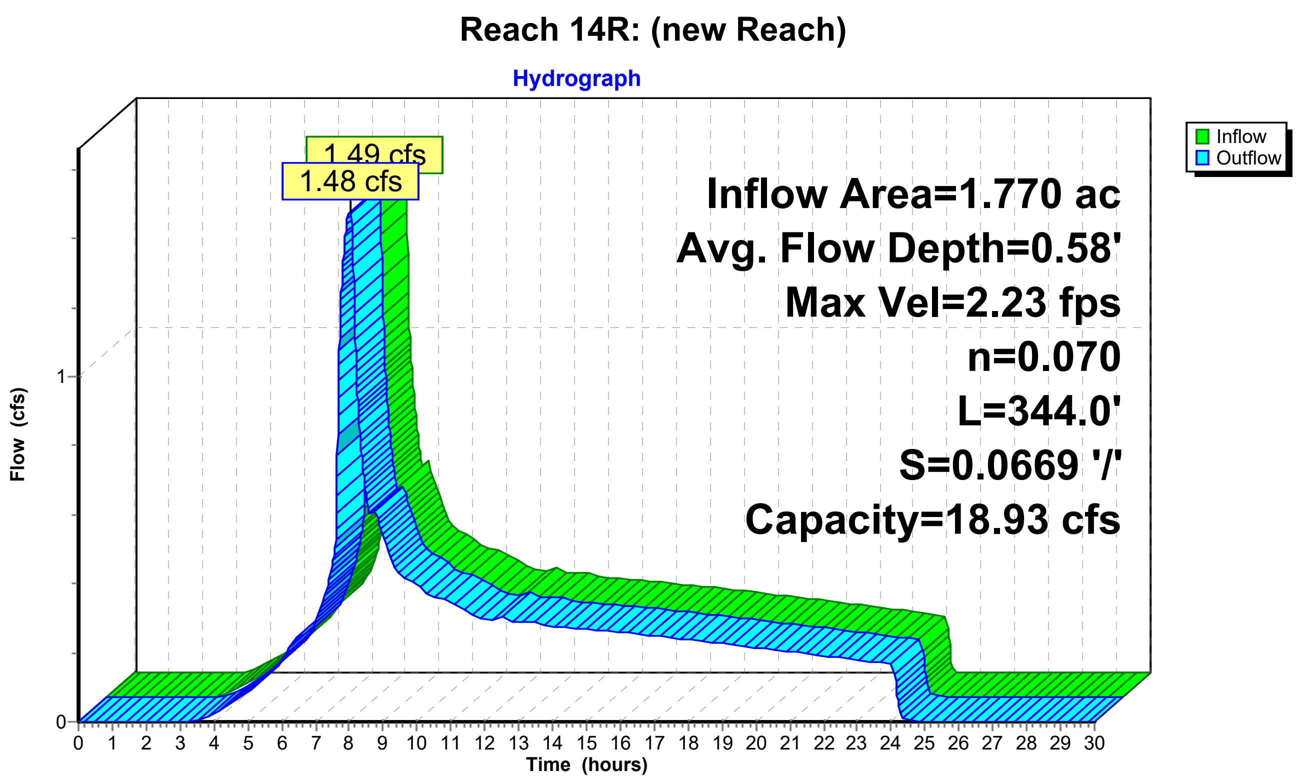
Inflow Area = 1.770 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.49 cfs @ 7.93 hrs, Volume= 0.492 af
Outflow = 1.48 cfs @ 8.01 hrs, Volume= 0.492 af, Atten= 0%, Lag= 4.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.23 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 1.32 fps, Avg. Travel Time= 4.3 min

Peak Storage= 229 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.58'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 18.93 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 344.0' Slope= 0.0669 '/'
Inlet Invert= 175.00', Outlet Invert= 152.00'





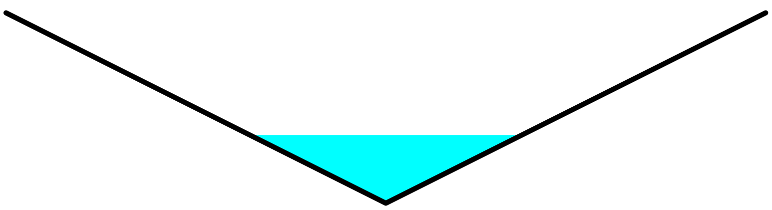
Summary for Reach 15R: (new Reach)

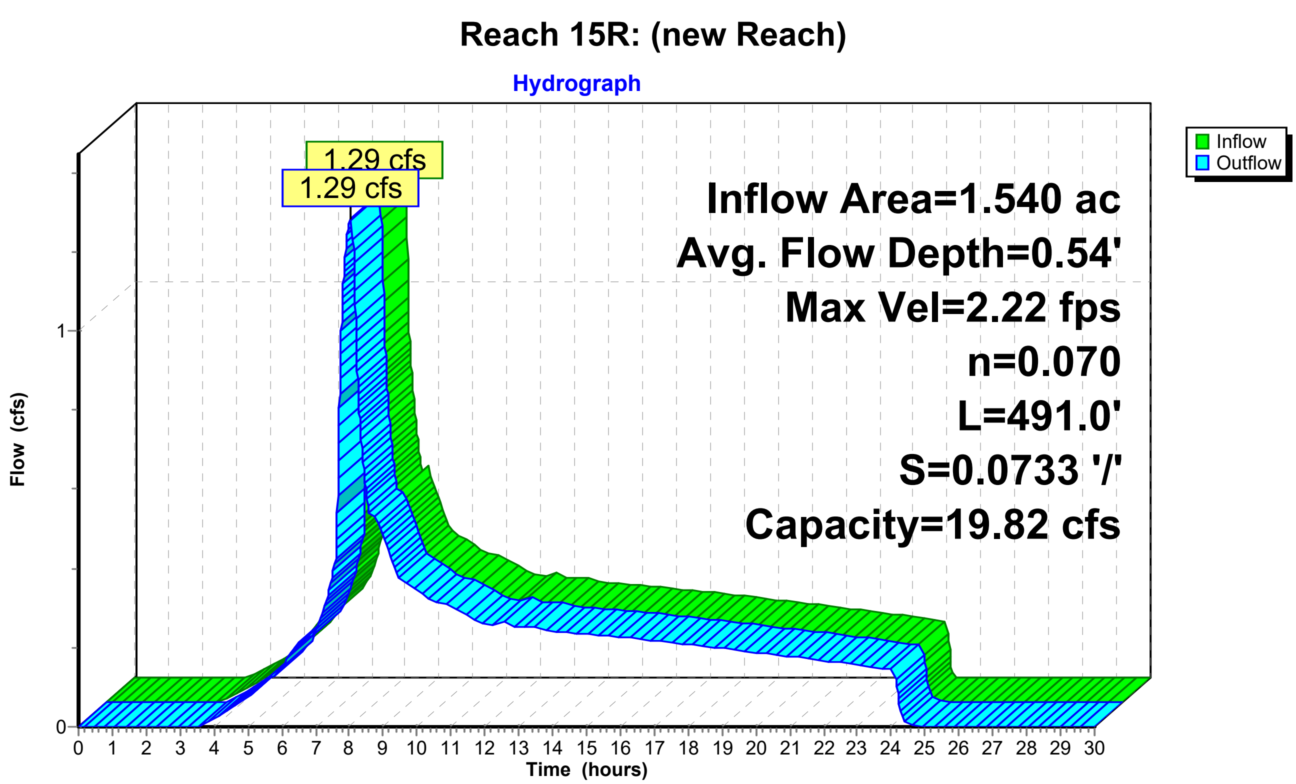
Inflow Area = 1.540 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.29 cfs @ 7.93 hrs, Volume= 0.428 af
Outflow = 1.29 cfs @ 8.04 hrs, Volume= 0.428 af, Atten= 1%, Lag= 6.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.22 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 1.30 fps, Avg. Travel Time= 6.3 min

Peak Storage= 284 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.82 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 491.0' Slope= 0.0733 '/'
Inlet Invert= 188.00', Outlet Invert= 152.00'





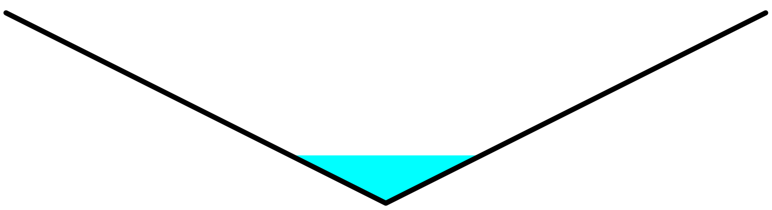
Summary for Reach 16R: (new Reach)

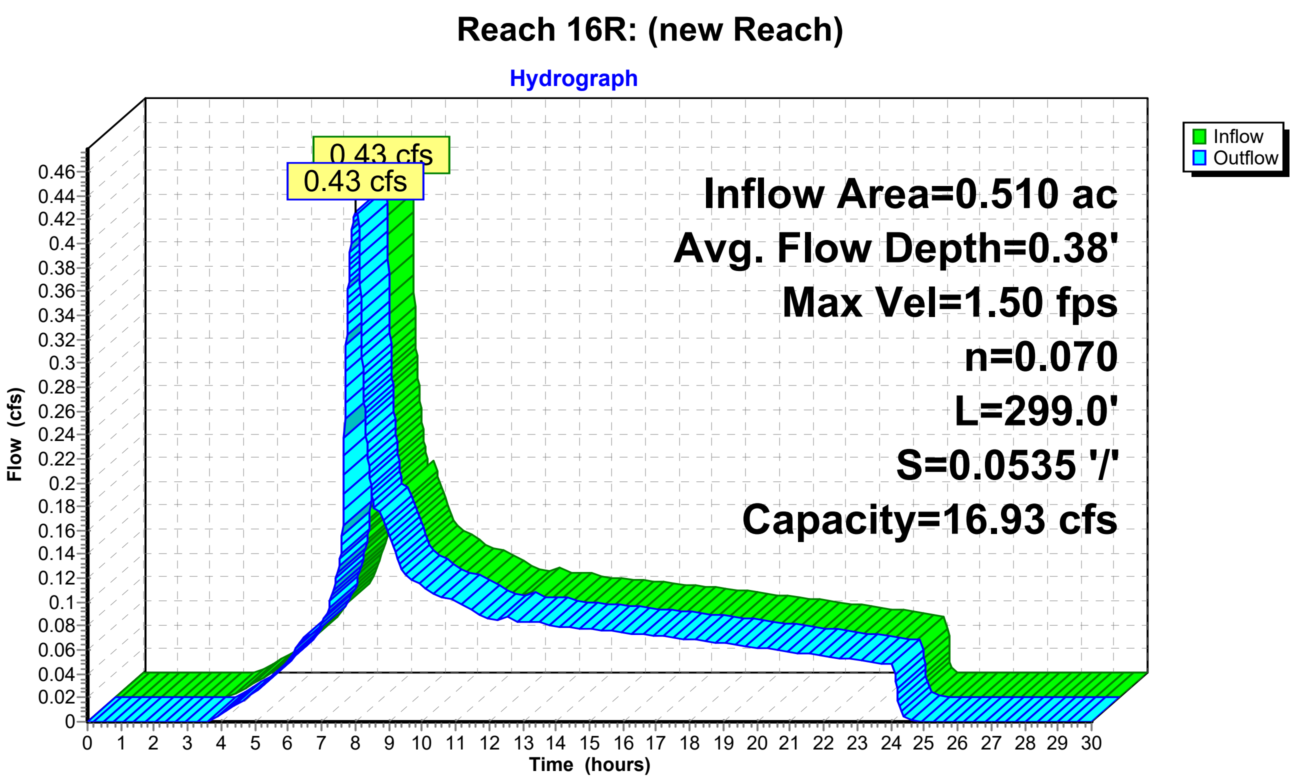
Inflow Area = 0.510 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.43 cfs @ 7.93 hrs, Volume= 0.142 af
Outflow = 0.43 cfs @ 8.03 hrs, Volume= 0.142 af, Atten= 0%, Lag= 5.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.50 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 0.90 fps, Avg. Travel Time= 5.5 min

Peak Storage= 85 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 16.93 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 299.0' Slope= 0.0535 '/'
Inlet Invert= 168.00', Outlet Invert= 152.00'





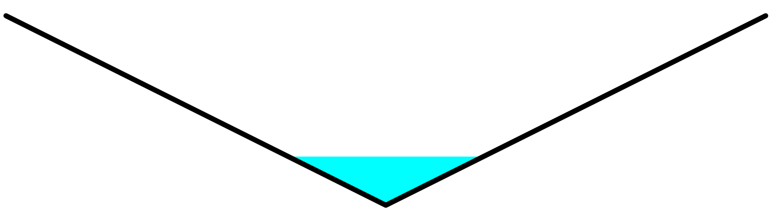
Summary for Reach 17R: (new Reach)

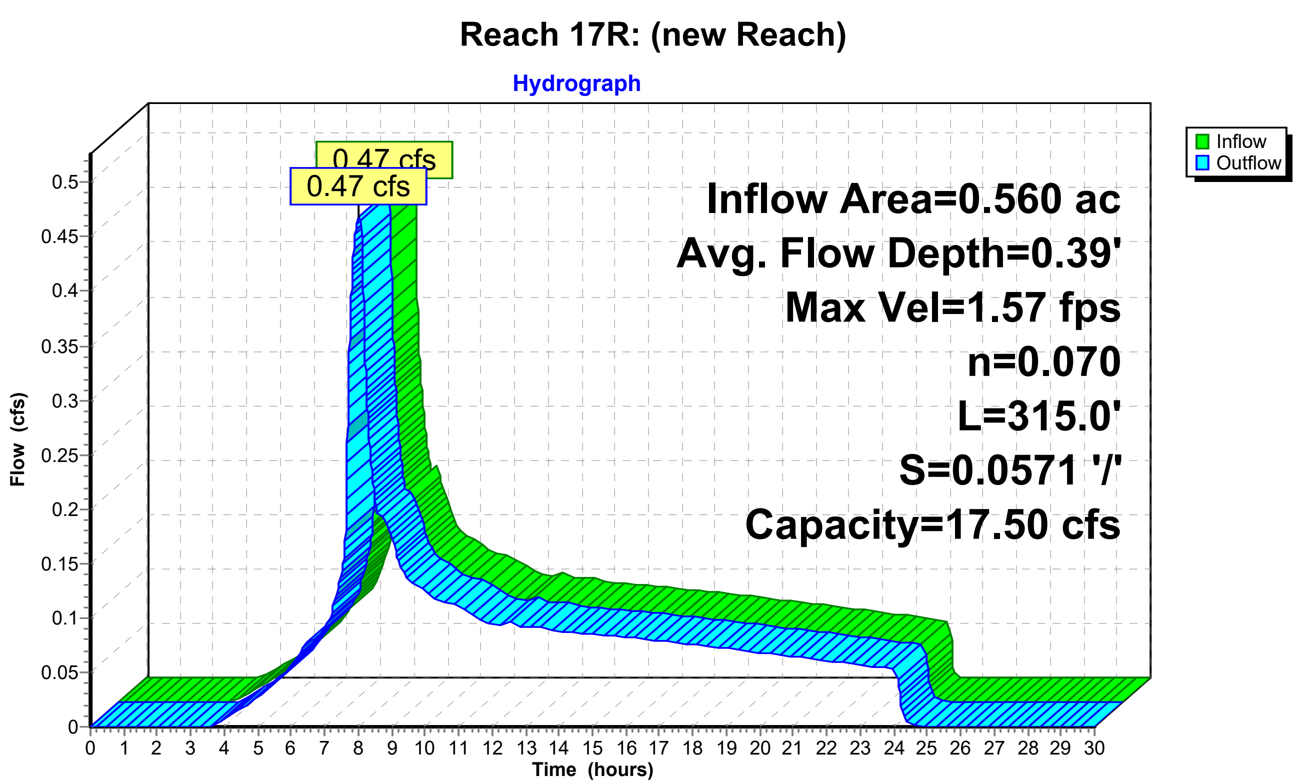
Inflow Area = 0.560 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.47 cfs @ 7.93 hrs, Volume= 0.156 af
Outflow = 0.47 cfs @ 8.03 hrs, Volume= 0.156 af, Atten= 0%, Lag= 5.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.57 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 0.94 fps, Avg. Travel Time= 5.6 min

Peak Storage= 94 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.39'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 17.50 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 315.0' Slope= 0.0571 '/'
Inlet Invert= 170.00', Outlet Invert= 152.00'





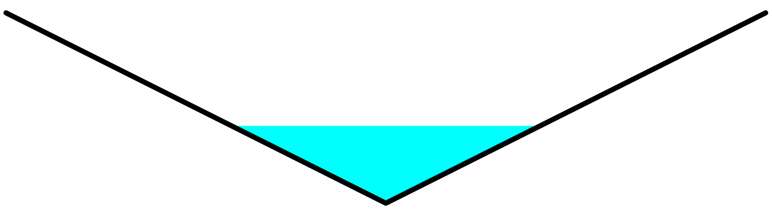
Summary for Reach 18R: (new Reach)

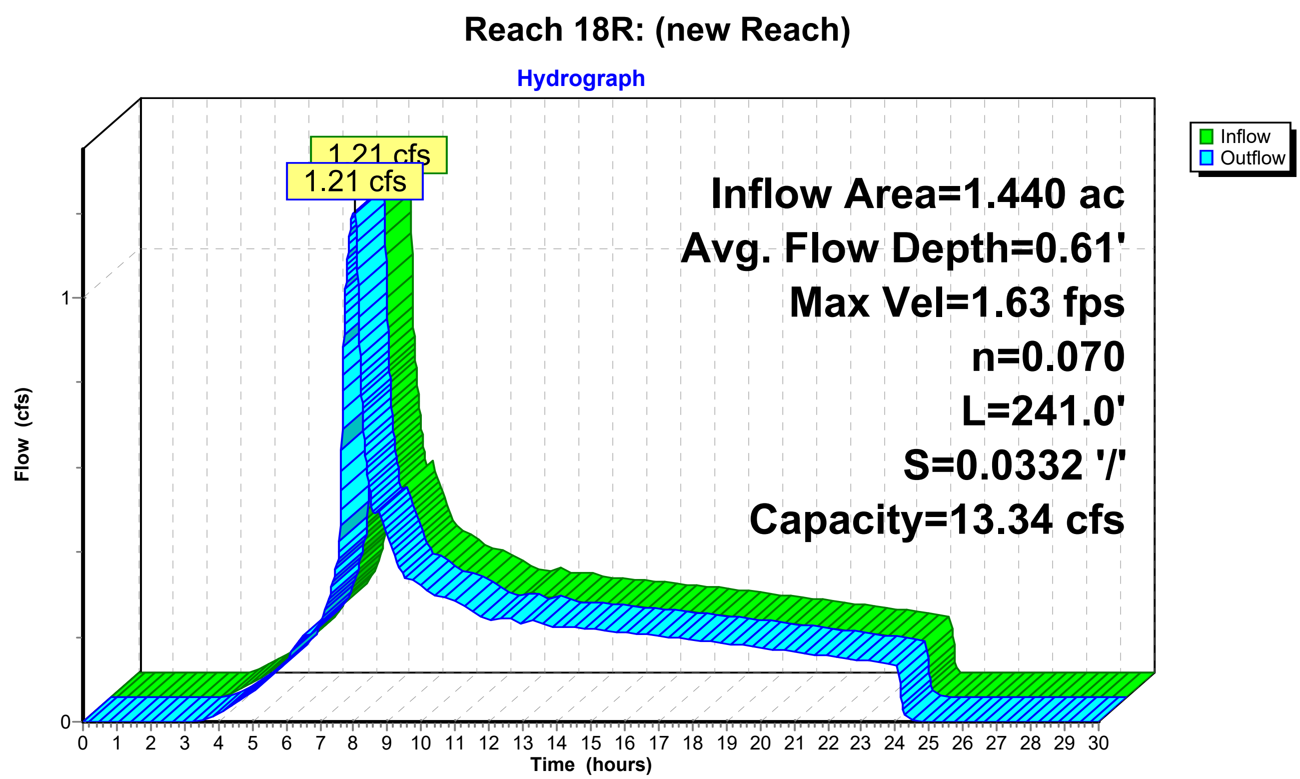
Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.21 cfs @ 7.93 hrs, Volume= 0.400 af
Outflow = 1.21 cfs @ 8.00 hrs, Volume= 0.400 af, Atten= 0%, Lag= 4.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.63 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 0.97 fps, Avg. Travel Time= 4.2 min

Peak Storage= 179 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.61'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 13.34 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 241.0' Slope= 0.0332 '/'
Inlet Invert= 243.00', Outlet Invert= 235.00'





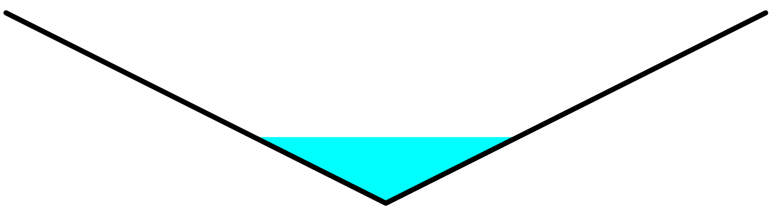
Summary for Reach 19R: (new Reach)

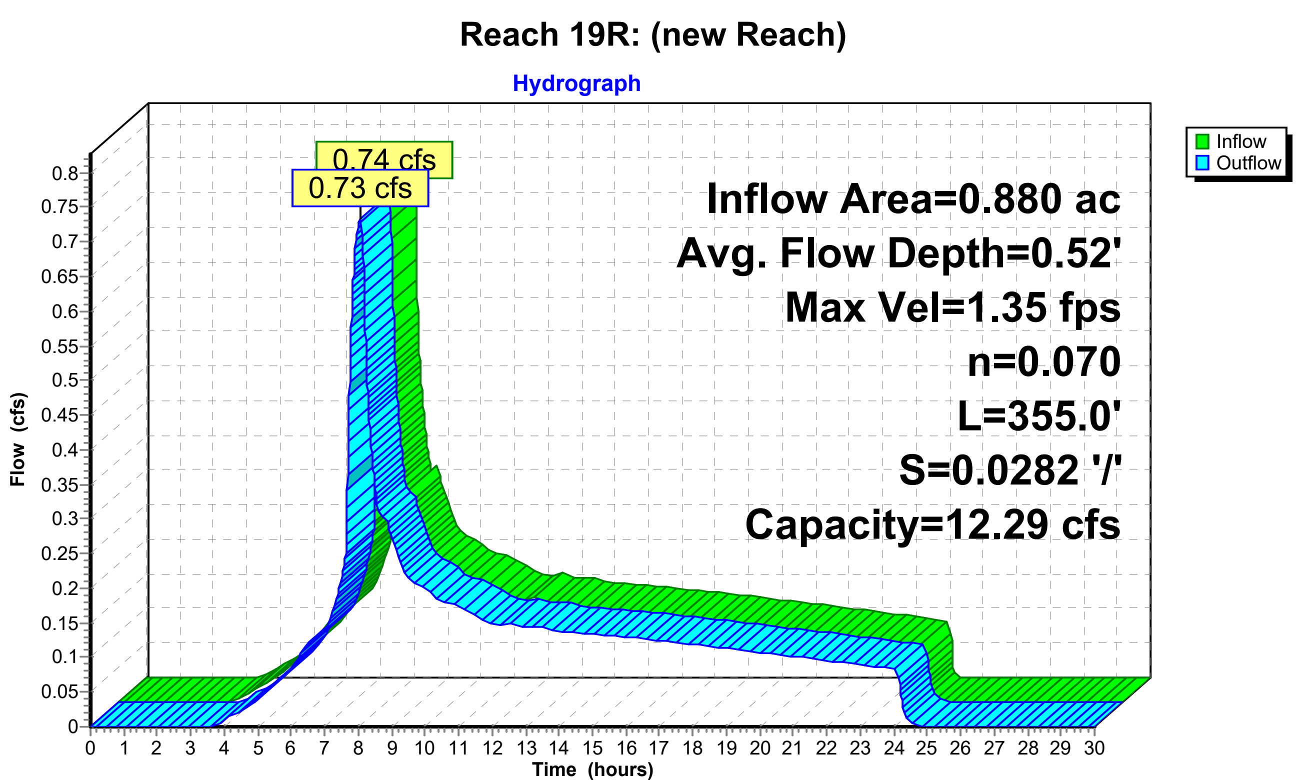
Inflow Area = 0.880 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.74 cfs @ 7.93 hrs, Volume= 0.244 af
Outflow = 0.73 cfs @ 8.06 hrs, Volume= 0.244 af, Atten= 1%, Lag= 7.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.35 fps, Min. Travel Time= 4.4 min
Avg. Velocity = 0.78 fps, Avg. Travel Time= 7.6 min

Peak Storage= 193 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.52'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.29 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 355.0' Slope= 0.0282 '/'
Inlet Invert= 245.00', Outlet Invert= 235.00'





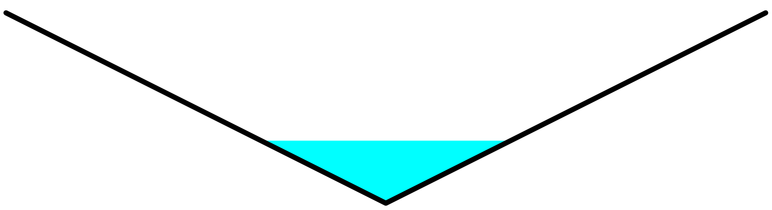
Summary for Reach 20R: (new Reach)

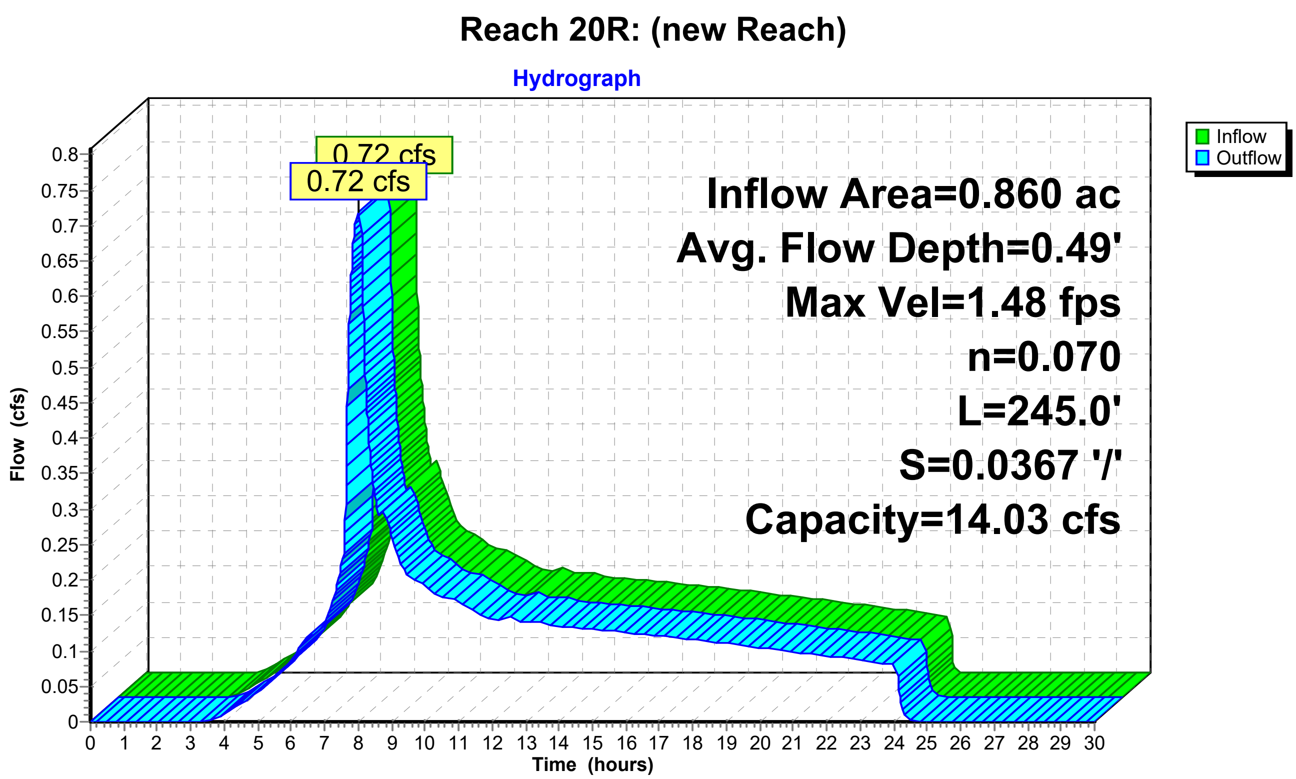
Inflow Area = 0.860 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.72 cfs @ 7.93 hrs, Volume= 0.239 af
Outflow = 0.72 cfs @ 8.01 hrs, Volume= 0.239 af, Atten= 0%, Lag= 4.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.48 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.89 fps, Avg. Travel Time= 4.6 min

Peak Storage= 119 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.49'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 14.03 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 245.0' Slope= 0.0367 '/'
Inlet Invert= 209.00', Outlet Invert= 200.00'





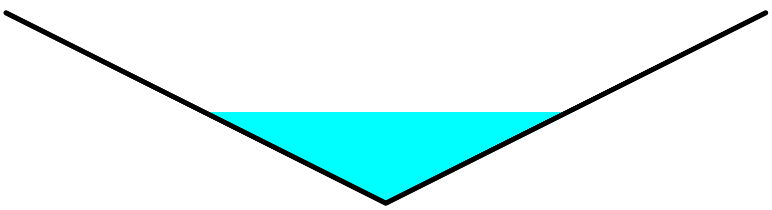
Summary for Reach 21R: (new Reach)

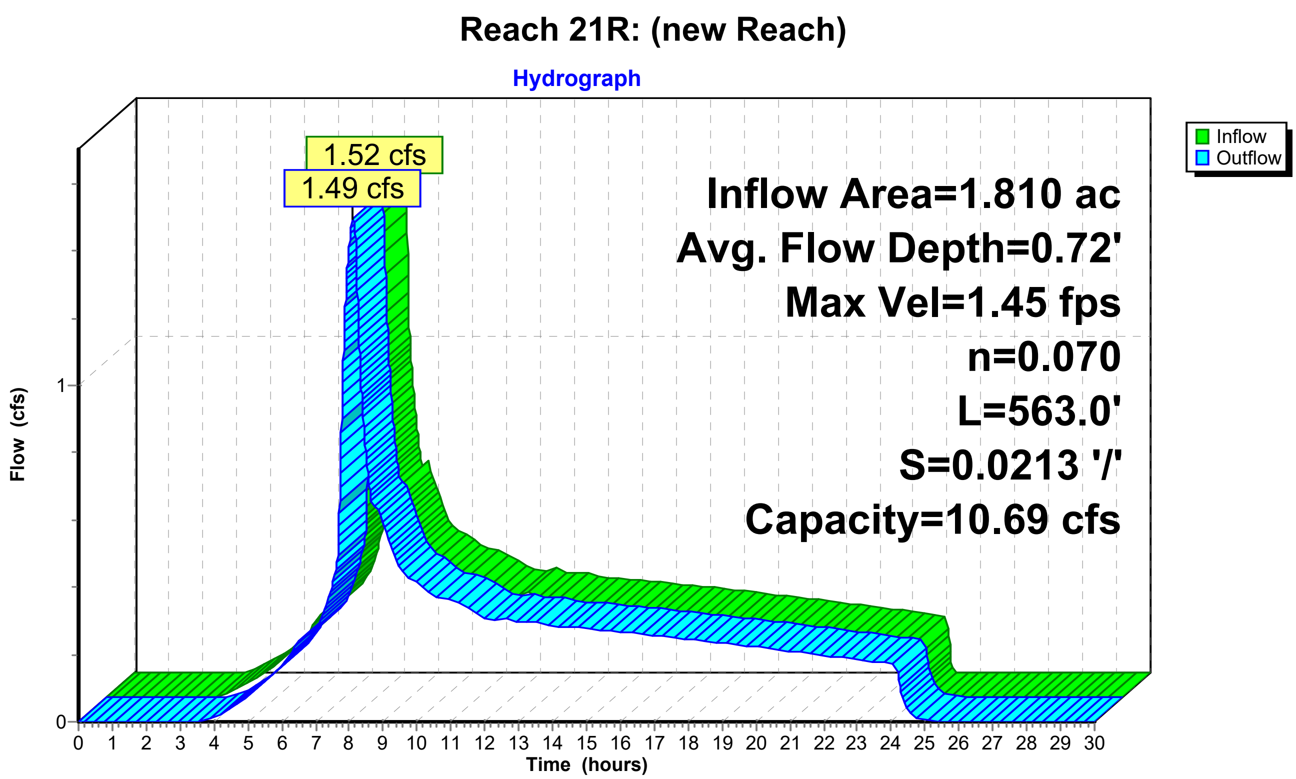
Inflow Area = 1.810 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.52 cfs @ 7.93 hrs, Volume= 0.503 af
Outflow = 1.49 cfs @ 8.12 hrs, Volume= 0.503 af, Atten= 2%, Lag= 11.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.45 fps, Min. Travel Time= 6.5 min
Avg. Velocity = 0.77 fps, Avg. Travel Time= 12.2 min

Peak Storage= 578 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 10.69 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 563.0' Slope= 0.0213 '/'
Inlet Invert= 212.00', Outlet Invert= 200.00'





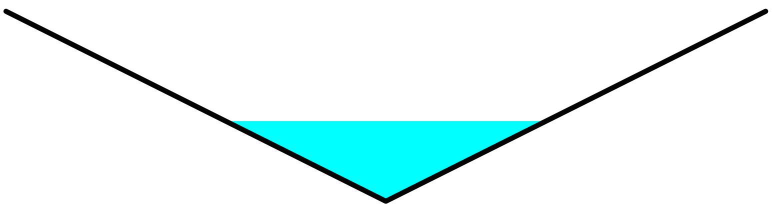
Summary for Reach 22R: (new Reach)

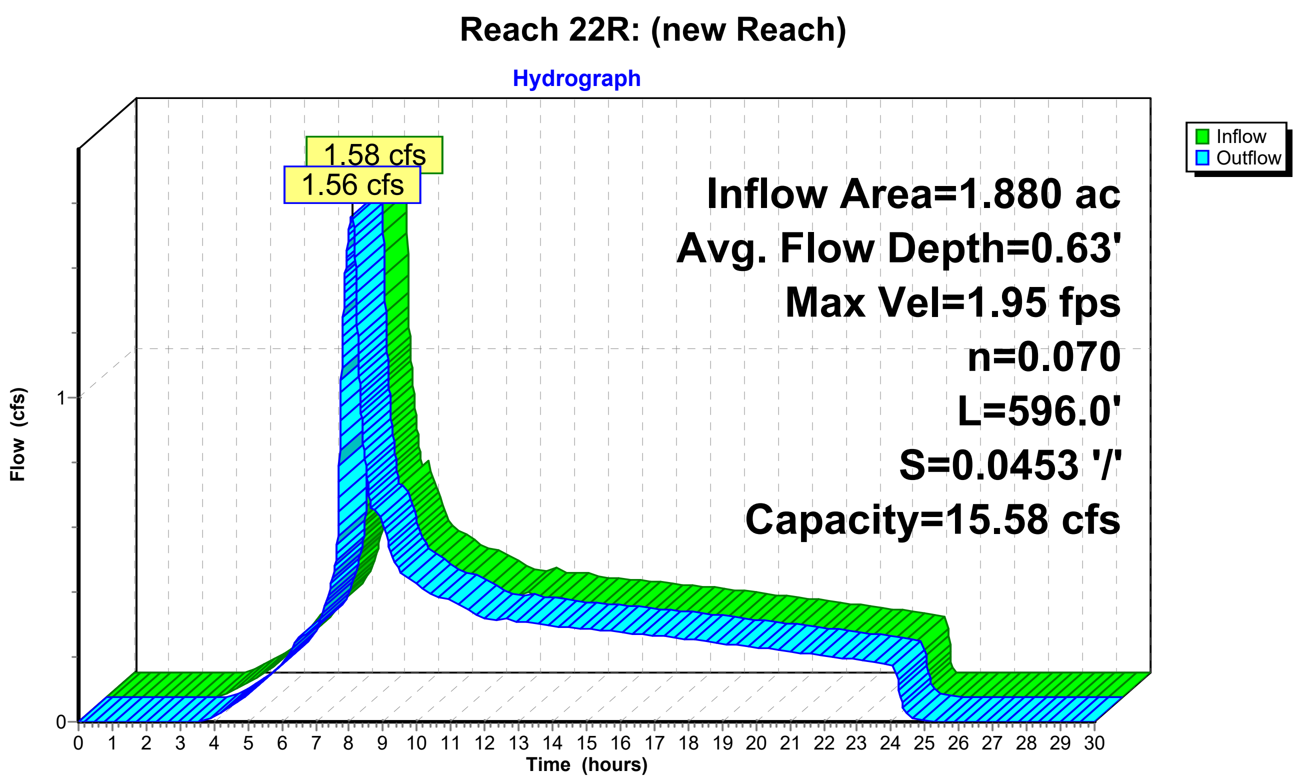
Inflow Area = 1.880 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.58 cfs @ 7.93 hrs, Volume= 0.522 af
Outflow = 1.56 cfs @ 8.08 hrs, Volume= 0.522 af, Atten= 1%, Lag= 8.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.95 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 1.08 fps, Avg. Travel Time= 9.2 min

Peak Storage= 477 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 15.58 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 596.0' Slope= 0.0453 '/'
Inlet Invert= 182.00', Outlet Invert= 155.00'





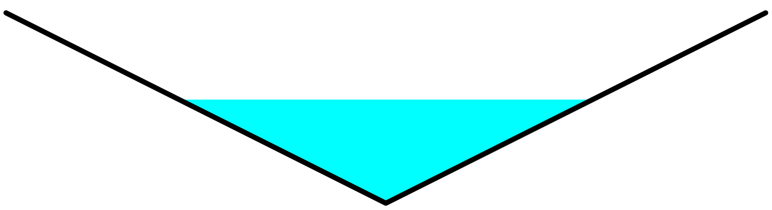
Summary for Reach 23R: (new Reach)

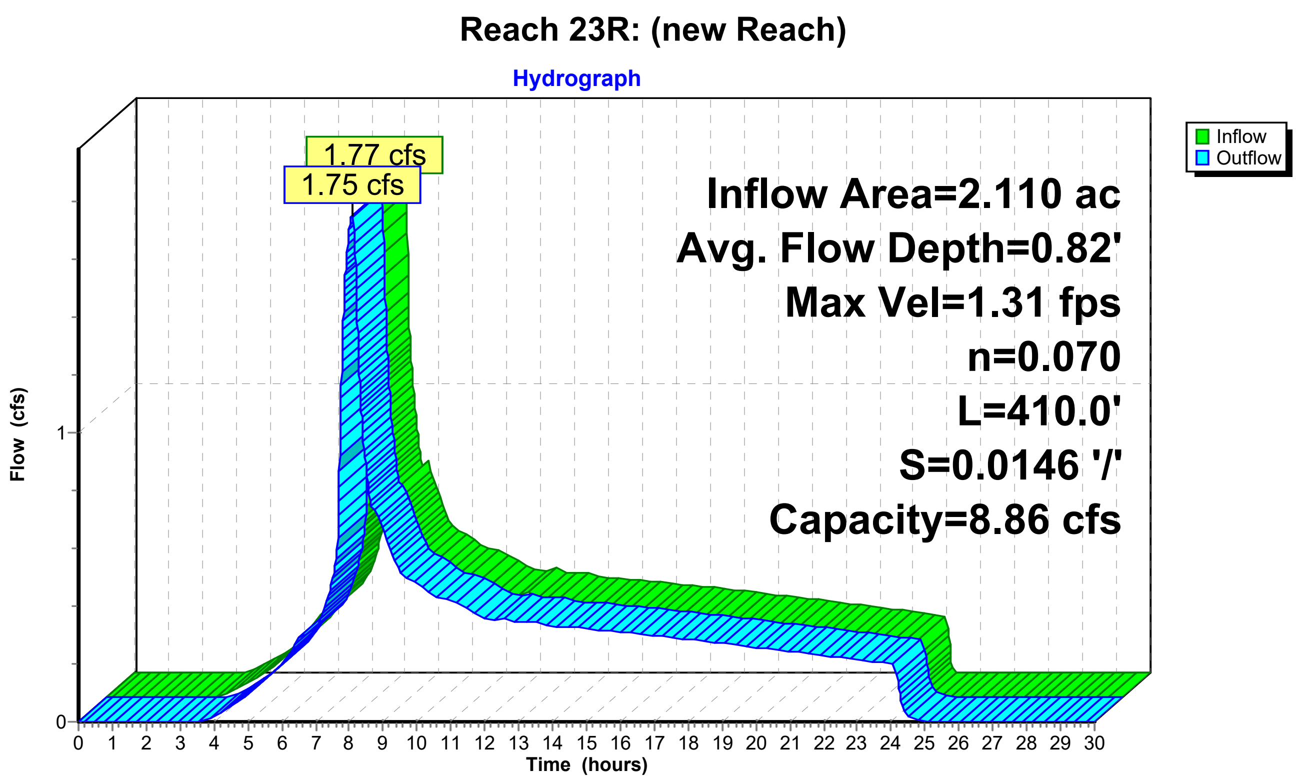
Inflow Area = 2.110 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.77 cfs @ 7.93 hrs, Volume= 0.586 af
Outflow = 1.75 cfs @ 8.08 hrs, Volume= 0.586 af, Atten= 1%, Lag= 9.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.31 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 0.71 fps, Avg. Travel Time= 9.7 min

Peak Storage= 547 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.82'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 8.86 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 410.0' Slope= 0.0146 '/'
Inlet Invert= 278.00', Outlet Invert= 272.00'





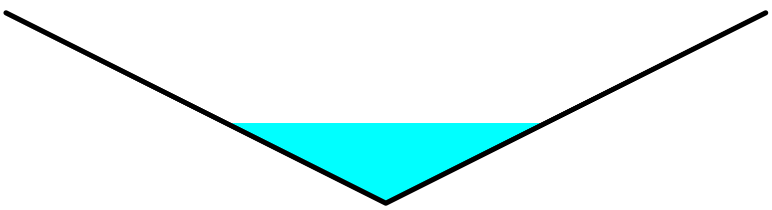
Summary for Reach 24R: (new Reach)

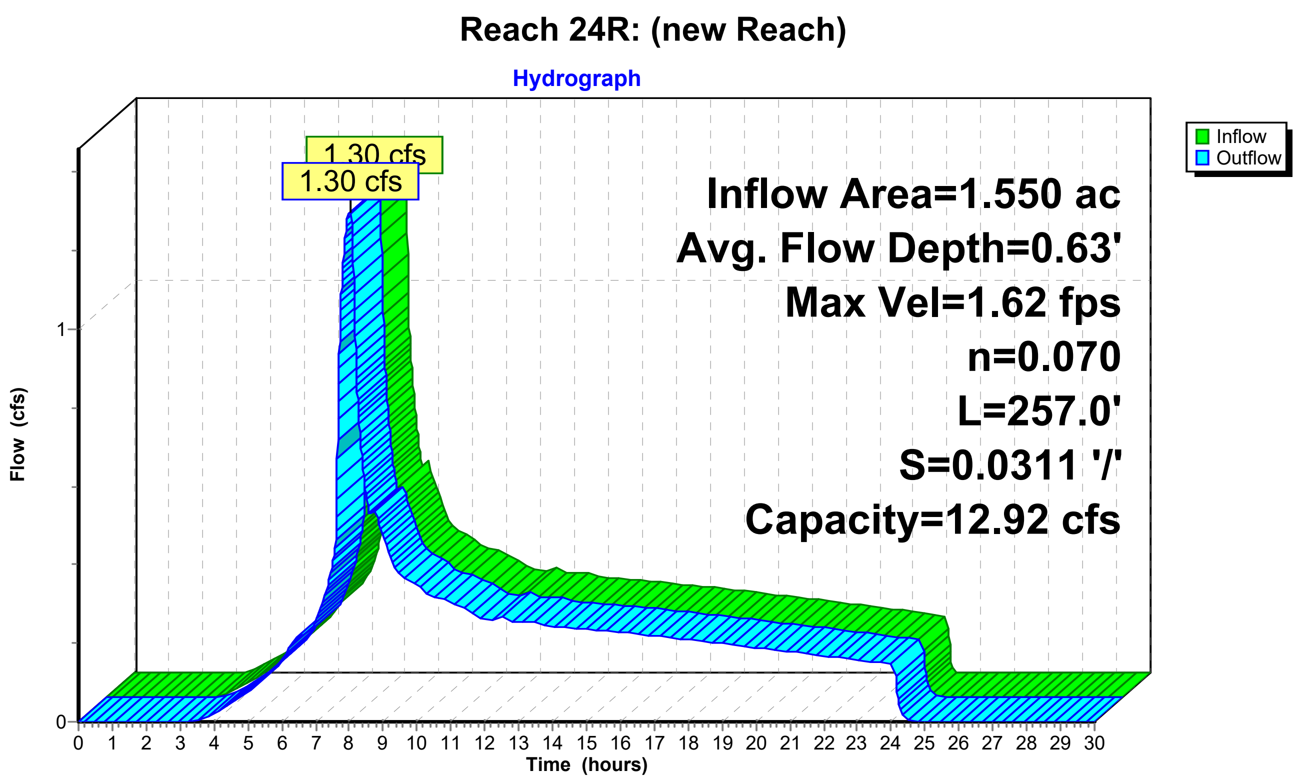
Inflow Area = 1.550 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.30 cfs @ 7.93 hrs, Volume= 0.431 af
Outflow = 1.30 cfs @ 8.01 hrs, Volume= 0.431 af, Atten= 0%, Lag= 4.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.62 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.95 fps, Avg. Travel Time= 4.5 min

Peak Storage= 206 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.92 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 257.0' Slope= 0.0311 '/'
Inlet Invert= 280.00', Outlet Invert= 272.00'





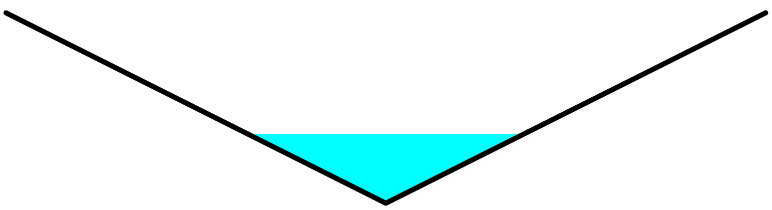
Summary for Reach 26R: (new Reach)

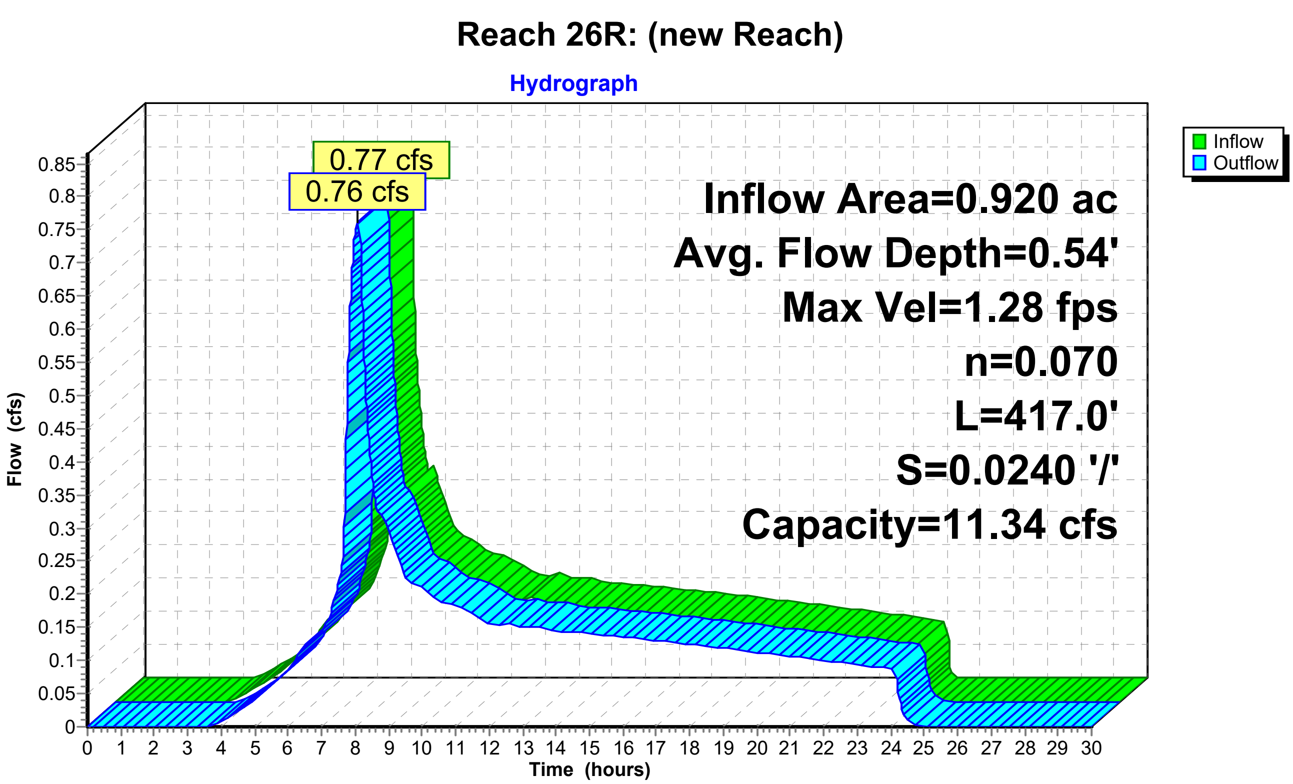
Inflow Area = 0.920 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.77 cfs @ 7.93 hrs, Volume= 0.256 af
Outflow = 0.76 cfs @ 8.09 hrs, Volume= 0.256 af, Atten= 1%, Lag= 9.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.28 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 9.6 min

Peak Storage= 248 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.34 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 417.0' Slope= 0.0240 '/'
Inlet Invert= 235.00', Outlet Invert= 225.00'





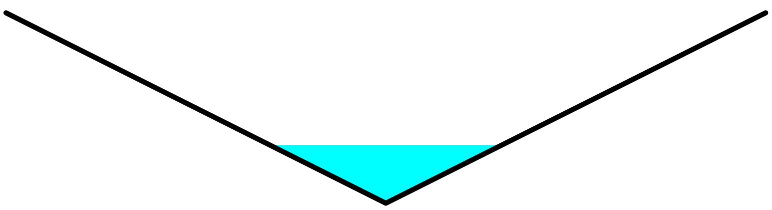
Summary for Reach 27R: (new Reach)

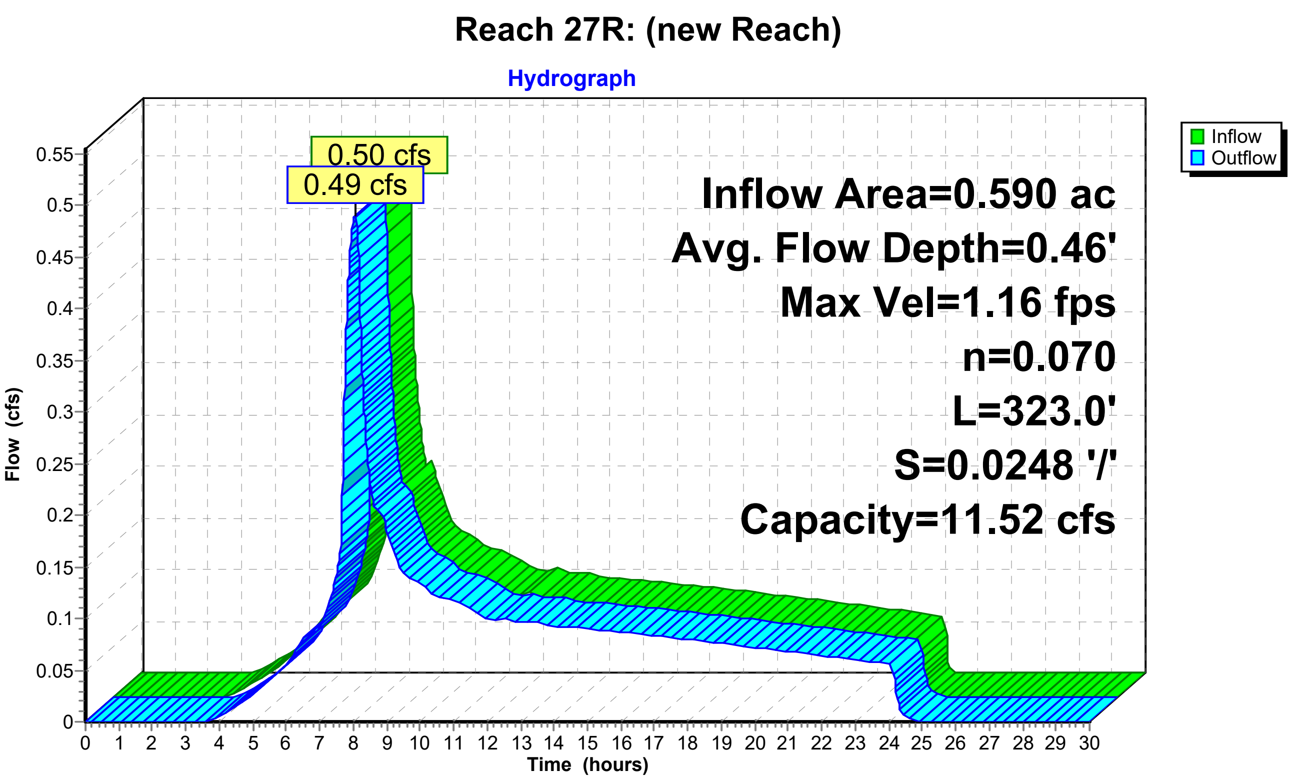
Inflow Area = 0.590 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.50 cfs @ 7.93 hrs, Volume= 0.164 af
Outflow = 0.49 cfs @ 8.07 hrs, Volume= 0.164 af, Atten= 1%, Lag= 8.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.16 fps, Min. Travel Time= 4.6 min
Avg. Velocity = 0.67 fps, Avg. Travel Time= 8.0 min

Peak Storage= 136 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.46'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.52 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 323.0' Slope= 0.0248 '/'
Inlet Invert= 205.00', Outlet Invert= 197.00'





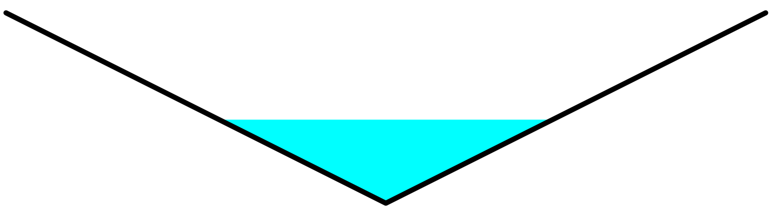
Summary for Reach 28R: (new Reach)

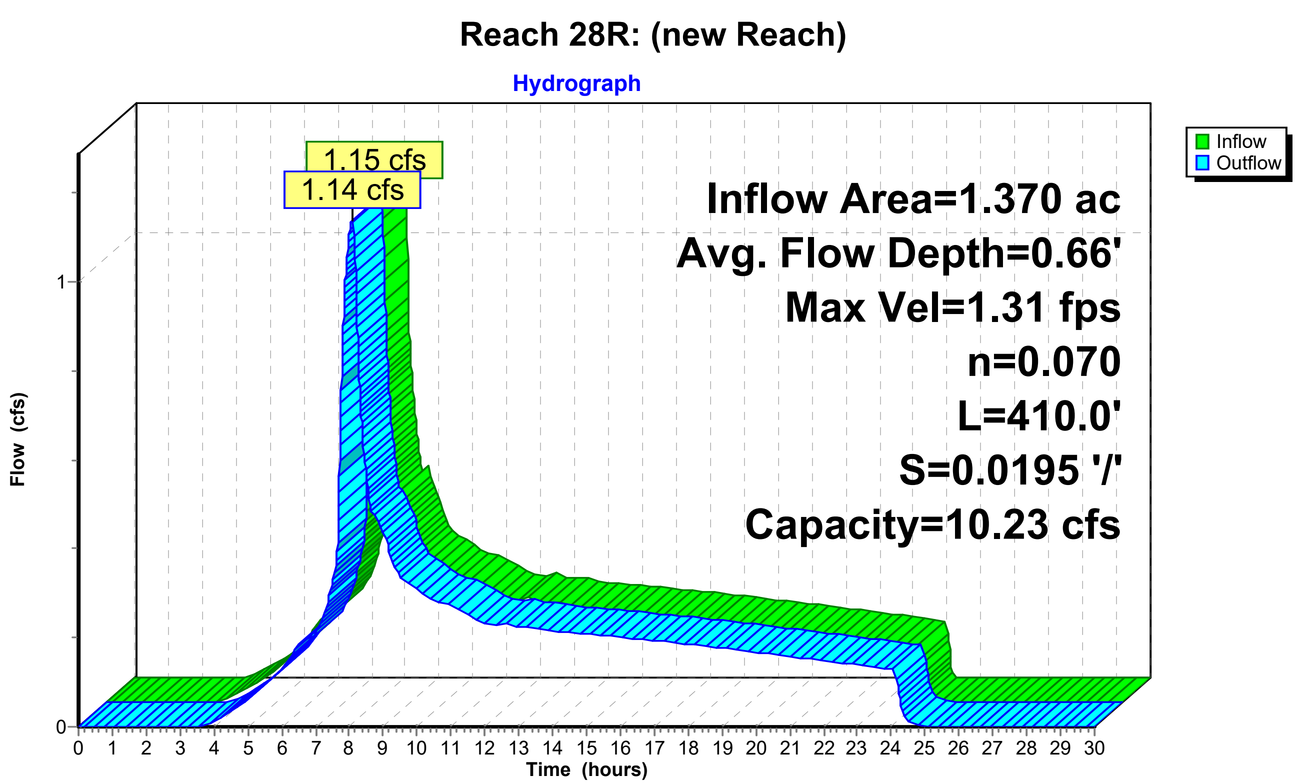
Inflow Area = 1.370 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.15 cfs @ 7.93 hrs, Volume= 0.381 af
Outflow = 1.14 cfs @ 8.08 hrs, Volume= 0.381 af, Atten= 1%, Lag= 9.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.31 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 0.72 fps, Avg. Travel Time= 9.4 min

Peak Storage= 355 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.66'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 10.23 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 410.0' Slope= 0.0195 '/'
Inlet Invert= 195.00', Outlet Invert= 187.00'





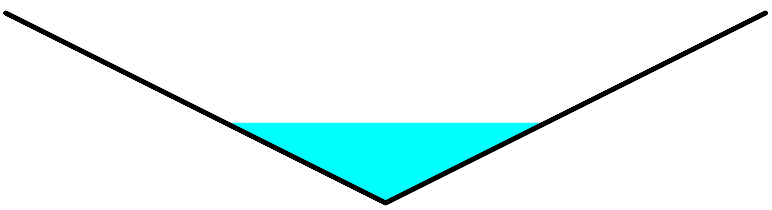
Summary for Reach 29R: (new Reach)

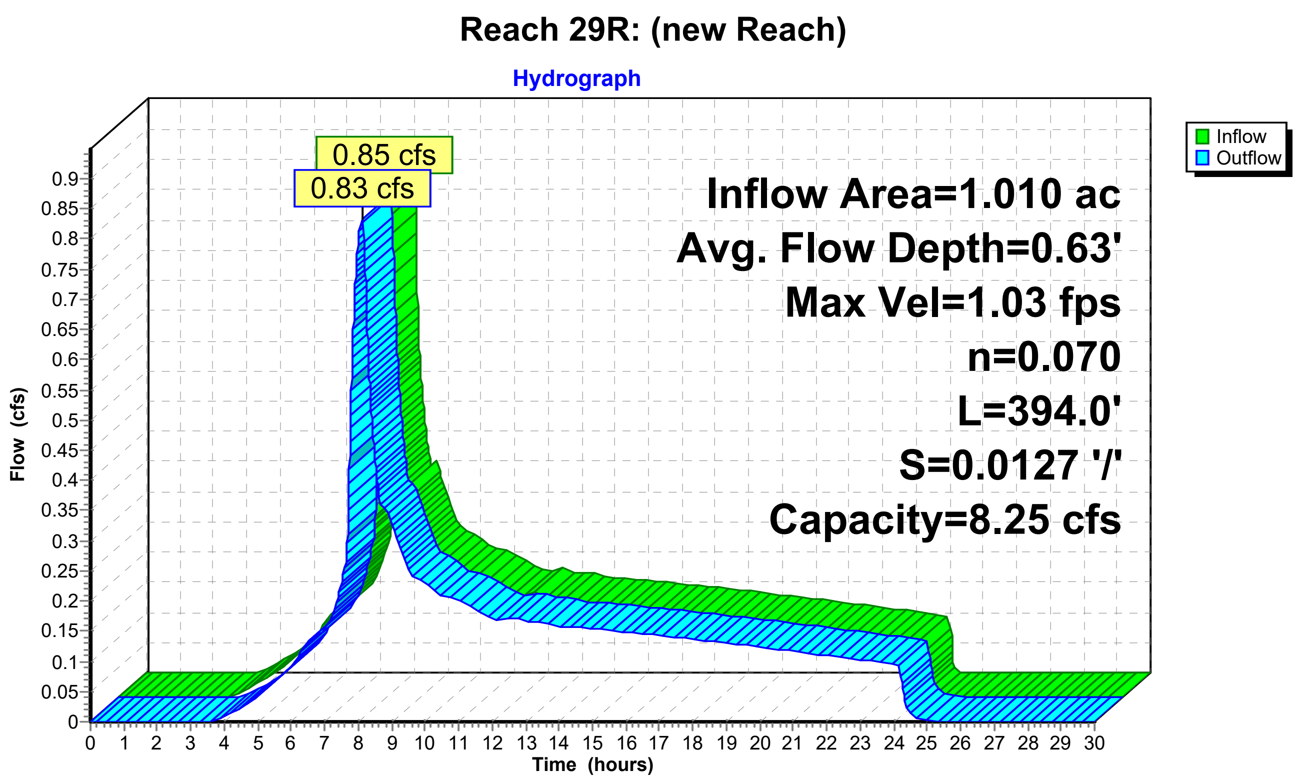
Inflow Area = 1.010 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.85 cfs @ 7.93 hrs, Volume= 0.281 af
Outflow = 0.83 cfs @ 8.12 hrs, Volume= 0.281 af, Atten= 2%, Lag= 11.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.03 fps, Min. Travel Time= 6.4 min
Avg. Velocity = 0.56 fps, Avg. Travel Time= 11.8 min

Peak Storage= 317 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.63'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 8.25 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 394.0' Slope= 0.0127 '/'
Inlet Invert= 165.00', Outlet Invert= 160.00'





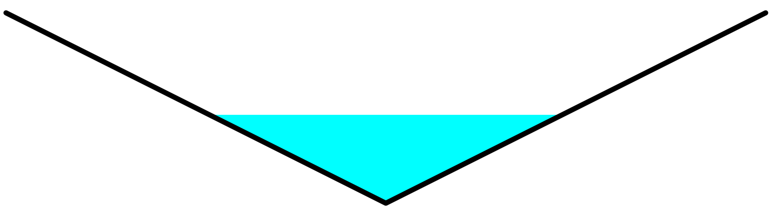
Summary for Reach 30R: (new Reach)

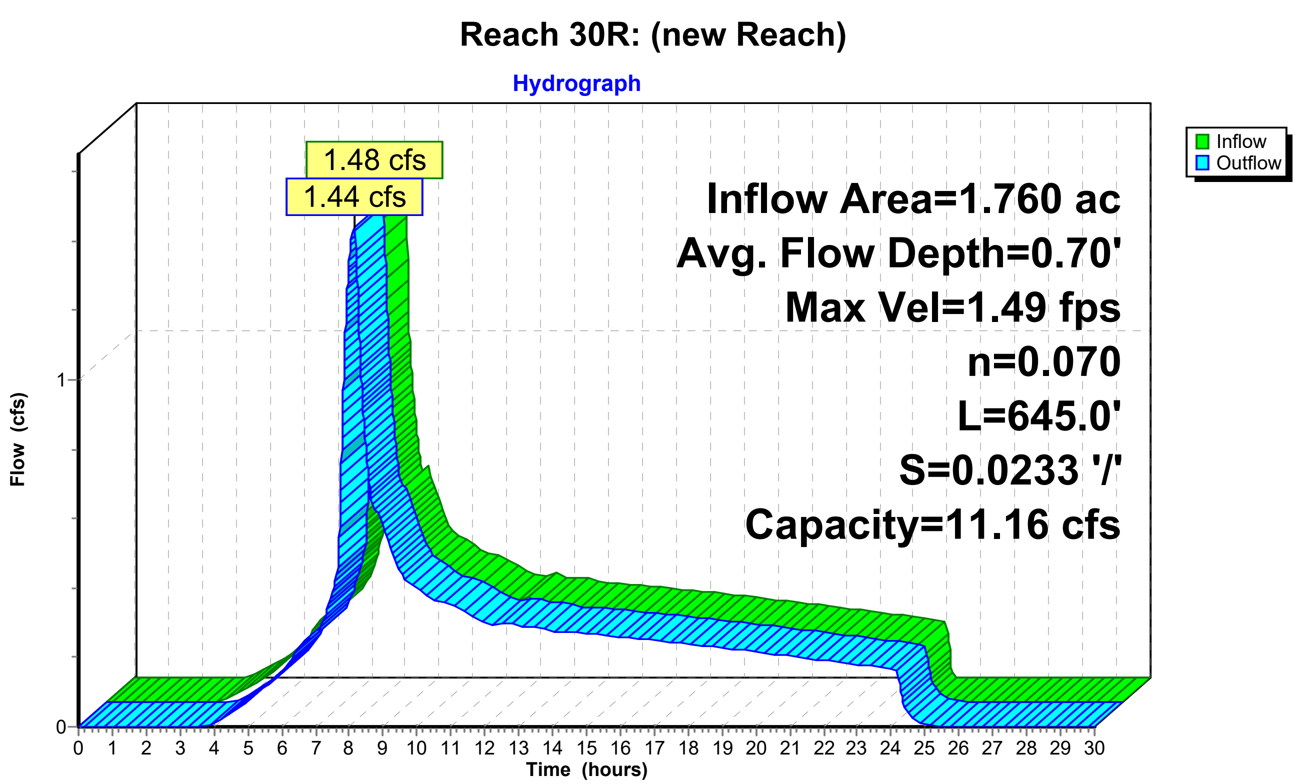
Inflow Area = 1.760 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.48 cfs @ 7.93 hrs, Volume= 0.489 af
Outflow = 1.44 cfs @ 8.14 hrs, Volume= 0.489 af, Atten= 2%, Lag= 12.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.49 fps, Min. Travel Time= 7.2 min
Avg. Velocity = 0.79 fps, Avg. Travel Time= 13.7 min

Peak Storage= 625 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.70'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.16 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 645.0' Slope= 0.0233 '/'
Inlet Invert= 175.00', Outlet Invert= 160.00'





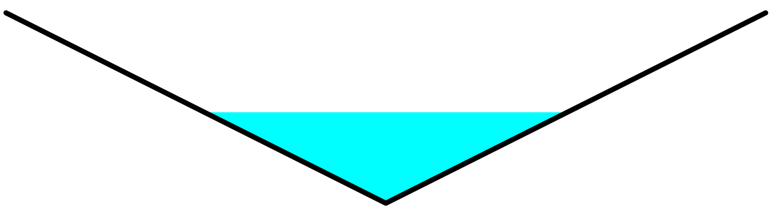
Summary for Reach 31R: (new Reach)

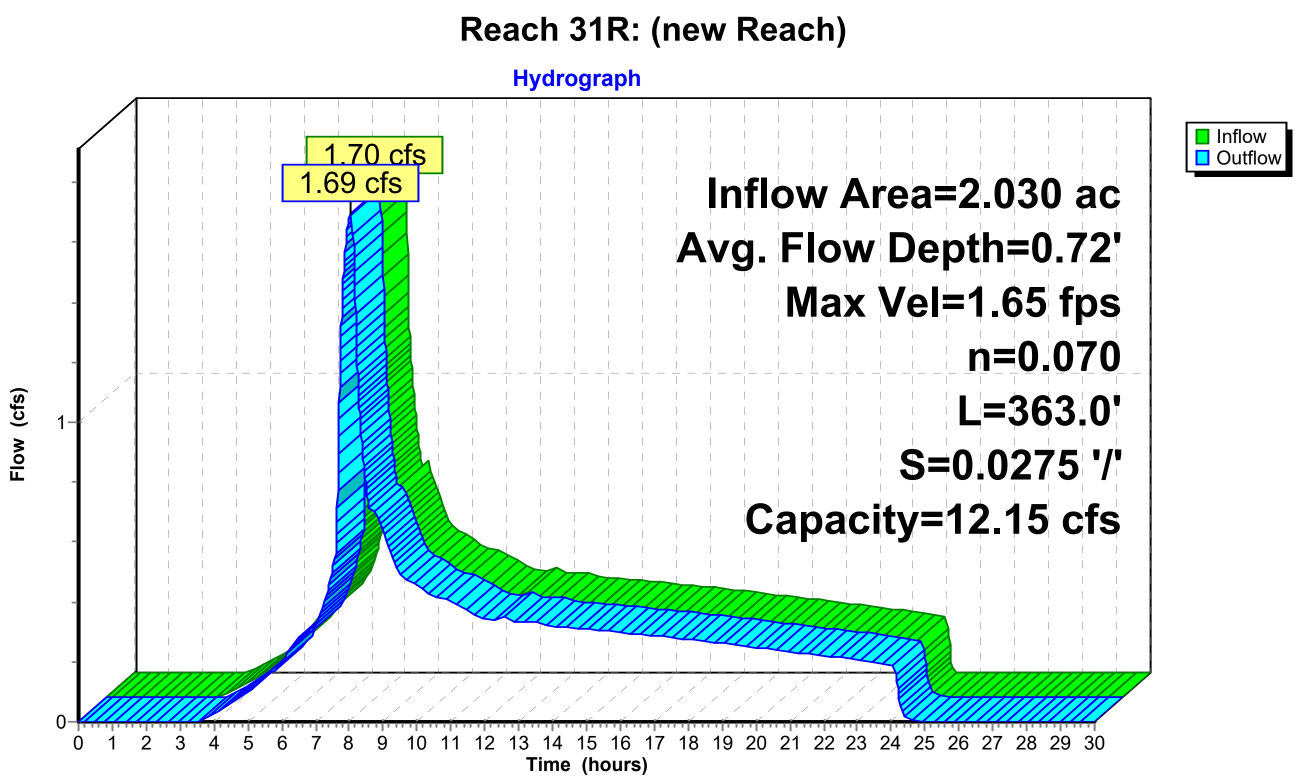
Inflow Area = 2.030 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.70 cfs @ 7.93 hrs, Volume= 0.564 af
Outflow = 1.69 cfs @ 8.04 hrs, Volume= 0.564 af, Atten= 1%, Lag= 6.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.65 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.94 fps, Avg. Travel Time= 6.4 min

Peak Storage= 373 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.72'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.15 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 363.0' Slope= 0.0275 '/'
Inlet Invert= 275.00', Outlet Invert= 265.00'





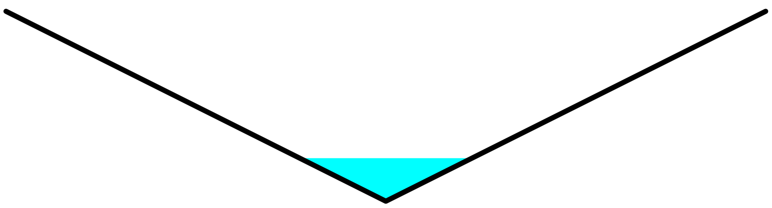
Summary for Reach 32R: (new Reach)

Inflow Area = 0.450 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.38 cfs @ 7.93 hrs, Volume= 0.125 af
Outflow = 0.38 cfs @ 7.96 hrs, Volume= 0.125 af, Atten= 0%, Lag= 1.7 min

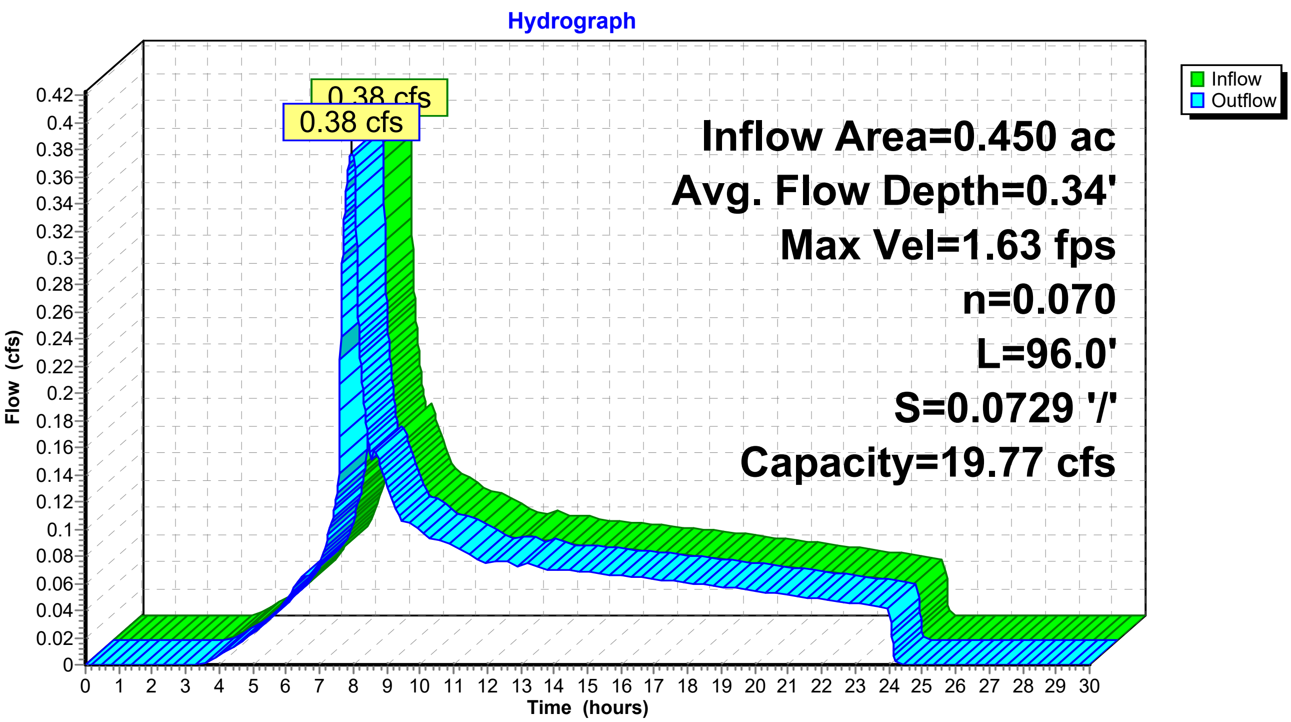
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.63 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 1.6 min

Peak Storage= 22 cf @ 7.94 hrs
Average Depth at Peak Storage= 0.34'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.77 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 96.0' Slope= 0.0729 '/'
Inlet Invert= 272.00', Outlet Invert= 265.00'



Reach 32R: (new Reach)



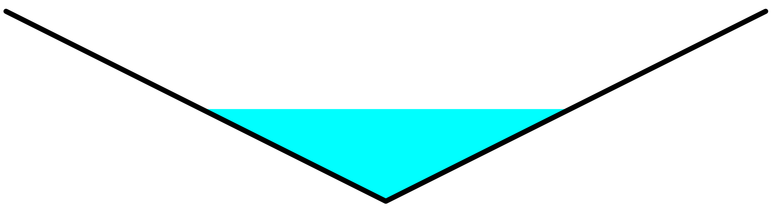
Summary for Reach 33R: (new Reach)

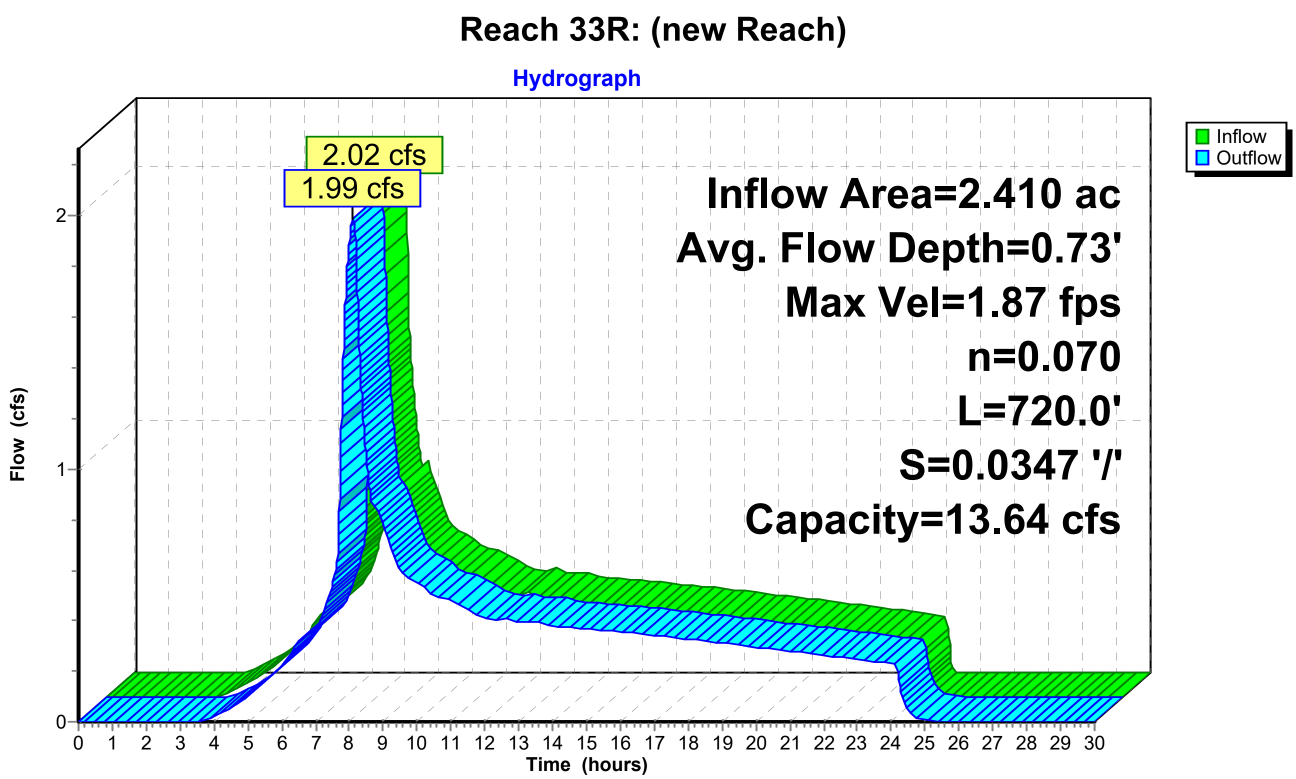
Inflow Area = 2.410 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 2.02 cfs @ 7.93 hrs, Volume= 0.669 af
Outflow = 1.99 cfs @ 8.12 hrs, Volume= 0.669 af, Atten= 2%, Lag= 11.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.87 fps, Min. Travel Time= 6.4 min
Avg. Velocity = 0.99 fps, Avg. Travel Time= 12.1 min

Peak Storage= 763 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.73'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 13.64 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 720.0' Slope= 0.0347 '/'
Inlet Invert= 245.00', Outlet Invert= 220.00'





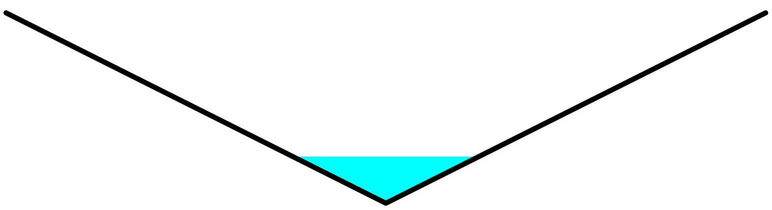
Summary for Reach 34R: (new Reach)

Inflow Area = 0.430 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.36 cfs @ 7.93 hrs, Volume= 0.119 af
Outflow = 0.36 cfs @ 7.97 hrs, Volume= 0.119 af, Atten= 0%, Lag= 2.5 min

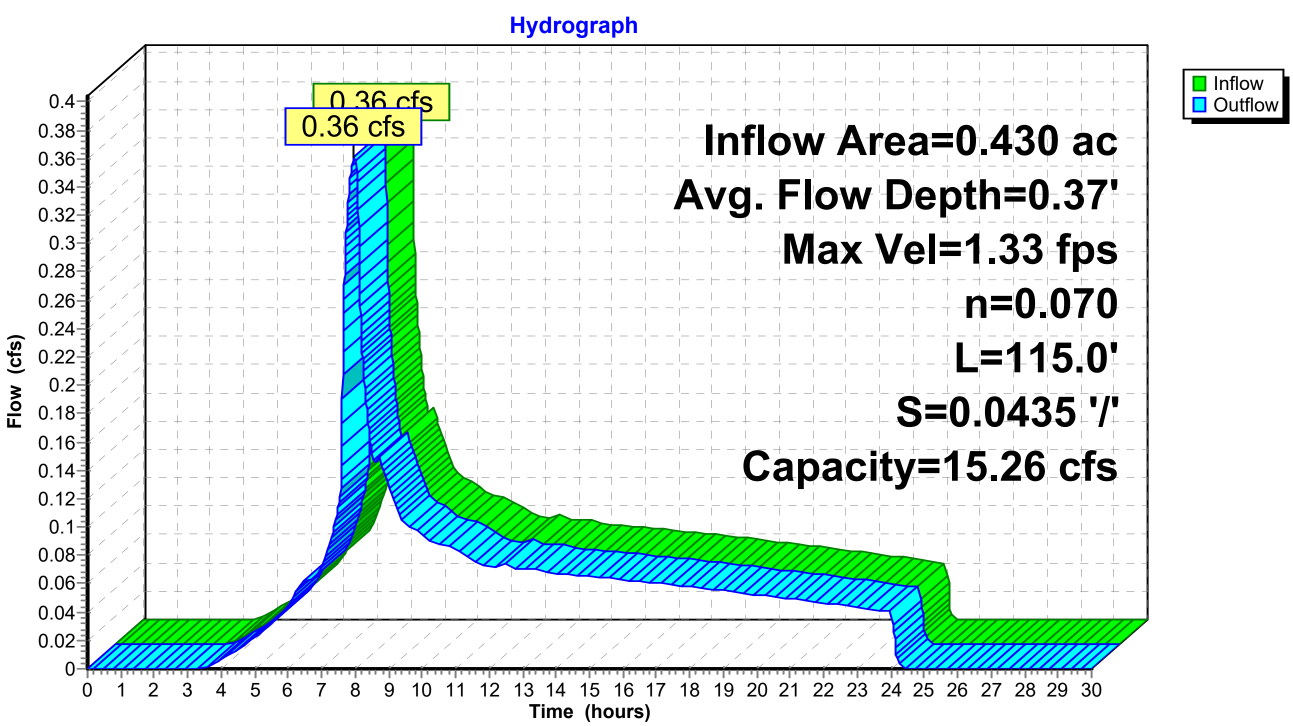
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.33 fps, Min. Travel Time= 1.4 min
Avg. Velocity = 0.83 fps, Avg. Travel Time= 2.3 min

Peak Storage= 31 cf @ 7.95 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 15.26 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 115.0' Slope= 0.0435 '/'
Inlet Invert= 225.00', Outlet Invert= 220.00'



Reach 34R: (new Reach)



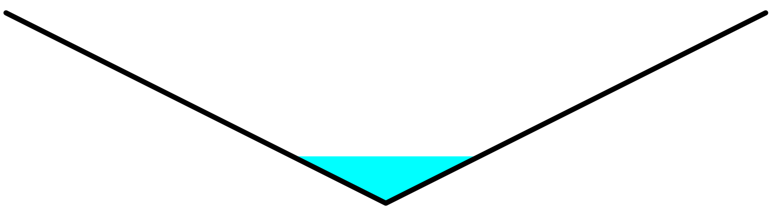
Summary for Reach 35R: (new Reach)

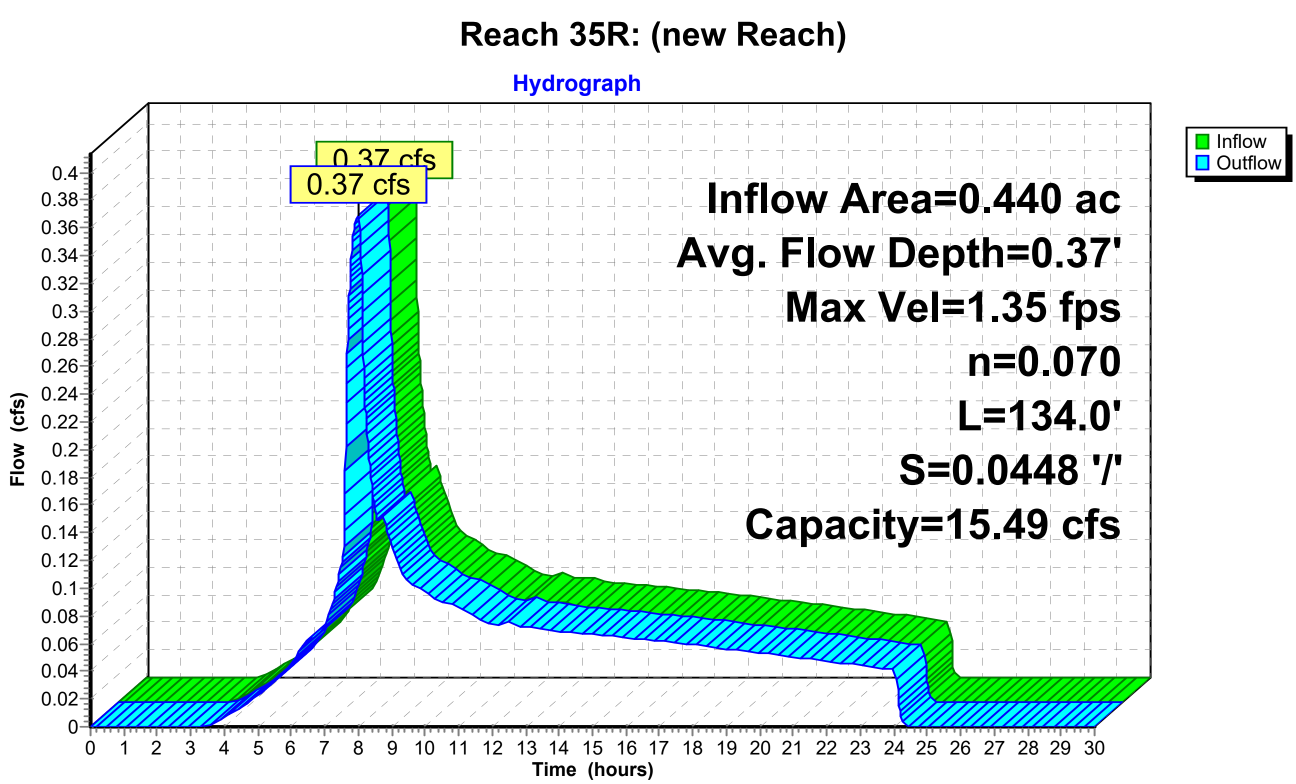
Inflow Area = 0.440 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.37 cfs @ 7.93 hrs, Volume= 0.122 af
Outflow = 0.37 cfs @ 7.98 hrs, Volume= 0.122 af, Atten= 0%, Lag= 2.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.35 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 0.84 fps, Avg. Travel Time= 2.7 min

Peak Storage= 37 cf @ 7.95 hrs
Average Depth at Peak Storage= 0.37'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 15.49 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 134.0' Slope= 0.0448 '/'
Inlet Invert= 185.00', Outlet Invert= 179.00'





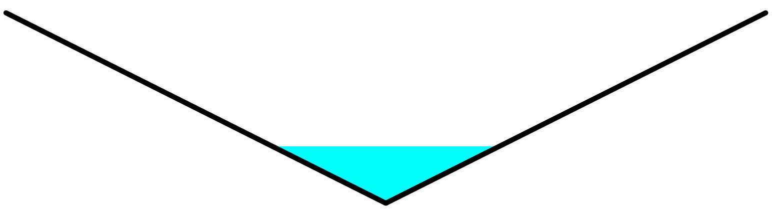
Summary for Reach 36R: (new Reach)

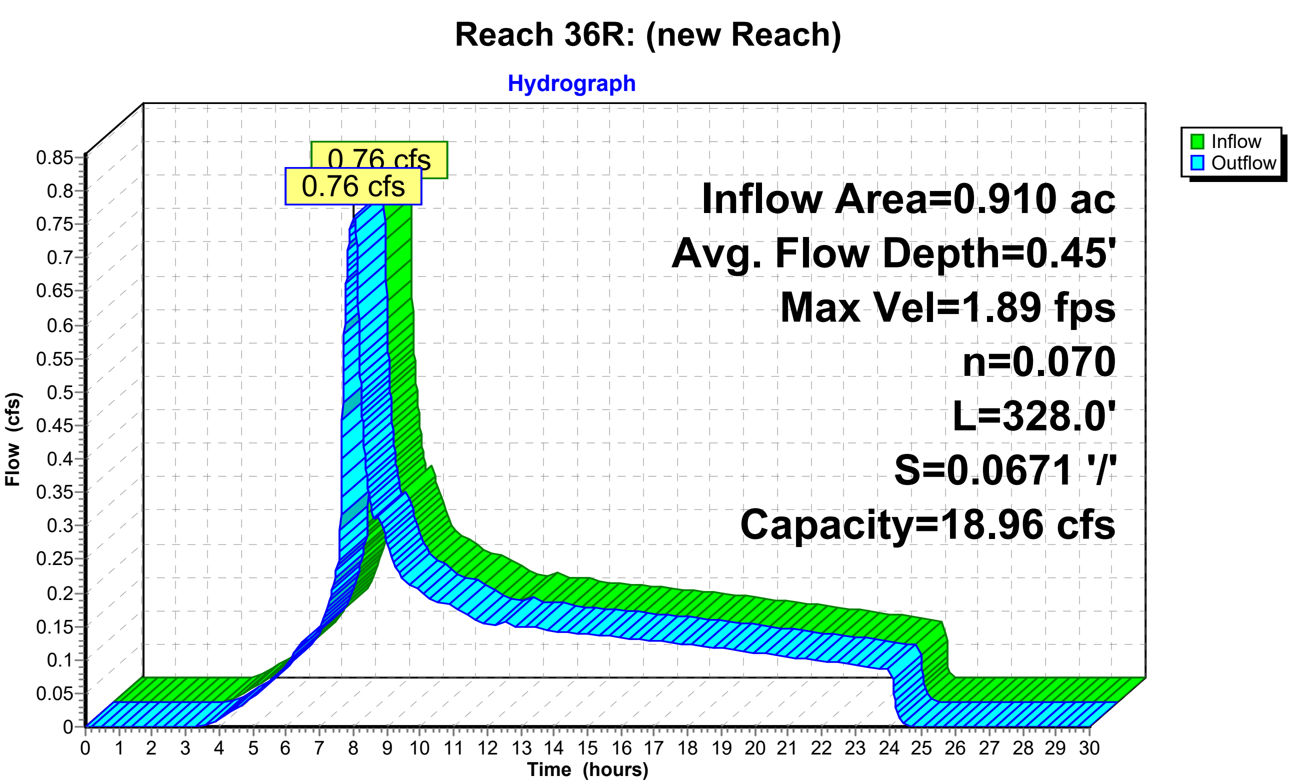
Inflow Area = 0.910 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.76 cfs @ 7.93 hrs, Volume= 0.253 af
Outflow = 0.76 cfs @ 8.02 hrs, Volume= 0.253 af, Atten= 0%, Lag= 5.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.89 fps, Min. Travel Time= 2.9 min
Avg. Velocity = 1.13 fps, Avg. Travel Time= 4.8 min

Peak Storage= 132 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 18.96 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 328.0' Slope= 0.0671 '/'
Inlet Invert= 262.00', Outlet Invert= 240.00'





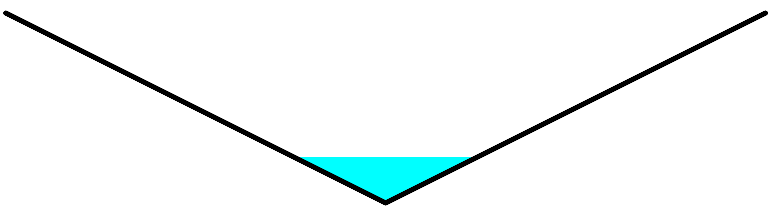
Summary for Reach 37R: (new Reach)

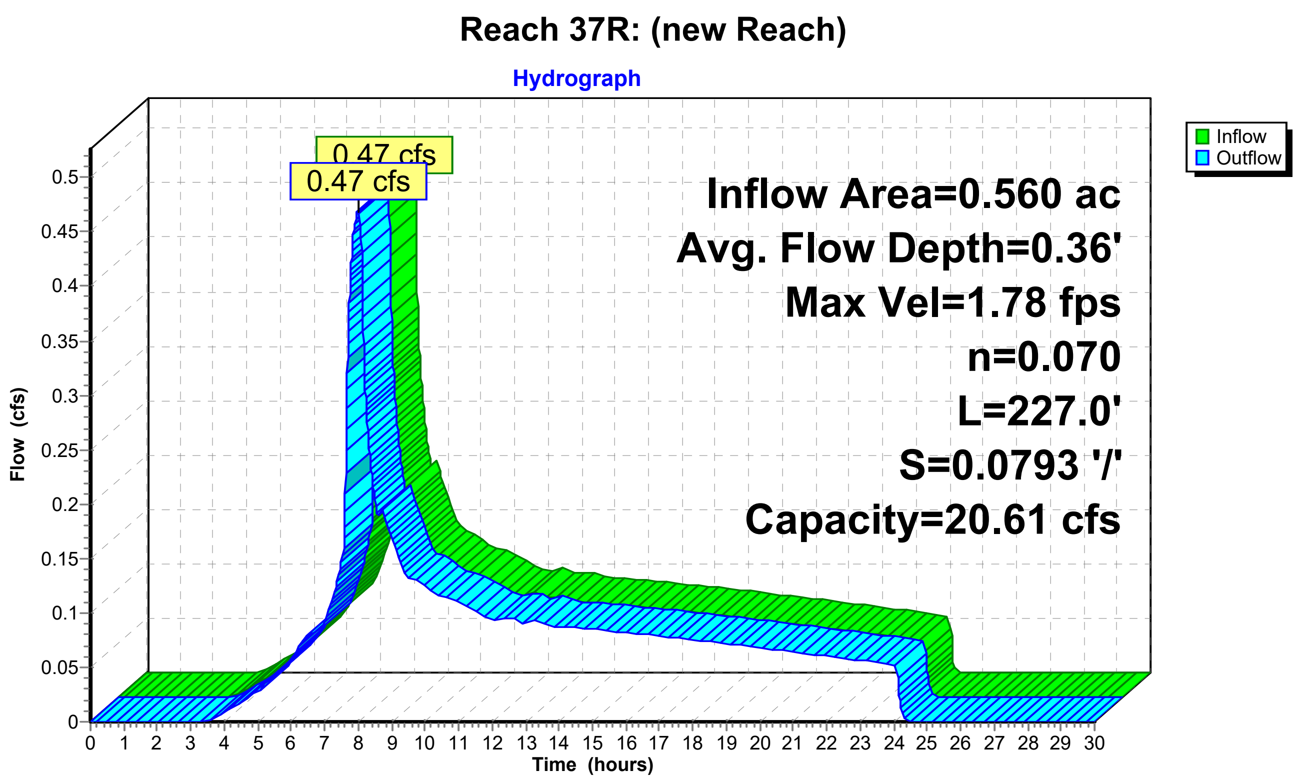
Inflow Area = 0.560 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.47 cfs @ 7.93 hrs, Volume= 0.156 af
Outflow = 0.47 cfs @ 7.99 hrs, Volume= 0.156 af, Atten= 0%, Lag= 3.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.78 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 1.09 fps, Avg. Travel Time= 3.5 min

Peak Storage= 60 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 20.61 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 227.0' Slope= 0.0793 '/'
Inlet Invert= 258.00', Outlet Invert= 240.00'





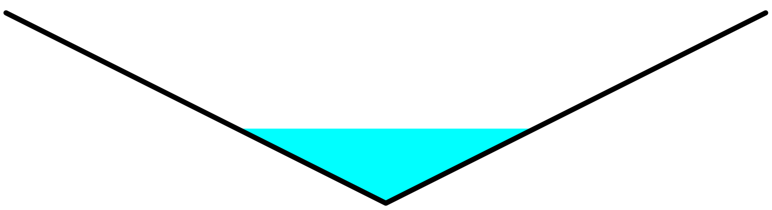
Summary for Reach 38R: (new Reach)

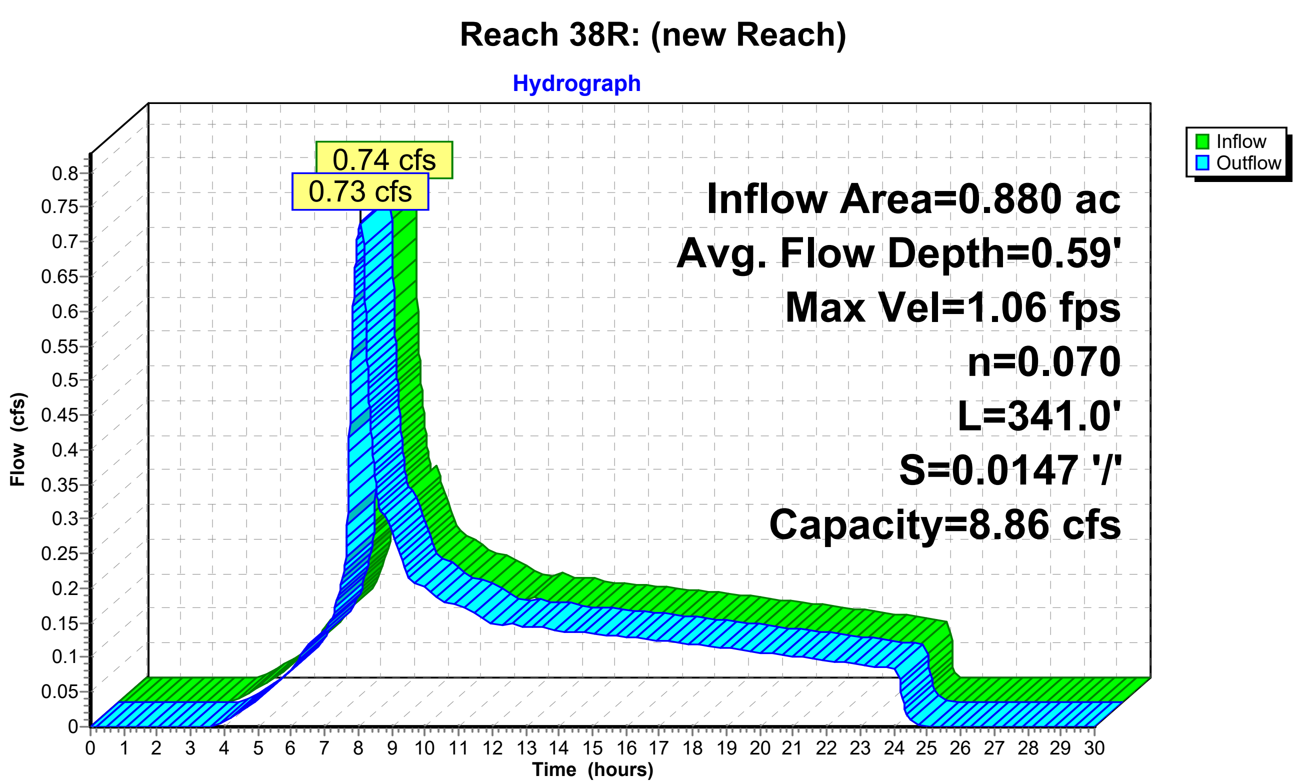
Inflow Area = 0.880 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.74 cfs @ 7.93 hrs, Volume= 0.244 af
Outflow = 0.73 cfs @ 8.09 hrs, Volume= 0.244 af, Atten= 1%, Lag= 9.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.06 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 0.59 fps, Avg. Travel Time= 9.7 min

Peak Storage= 236 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 8.86 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 341.0' Slope= 0.0147 '/'
Inlet Invert= 210.00', Outlet Invert= 205.00'





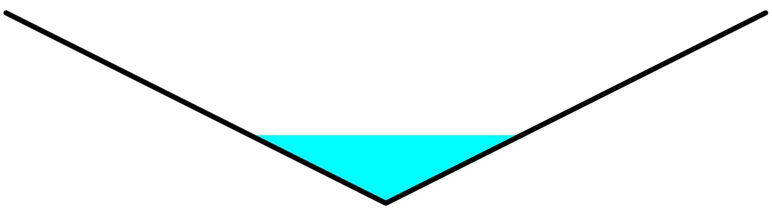
Summary for Reach 39R: (new Reach)

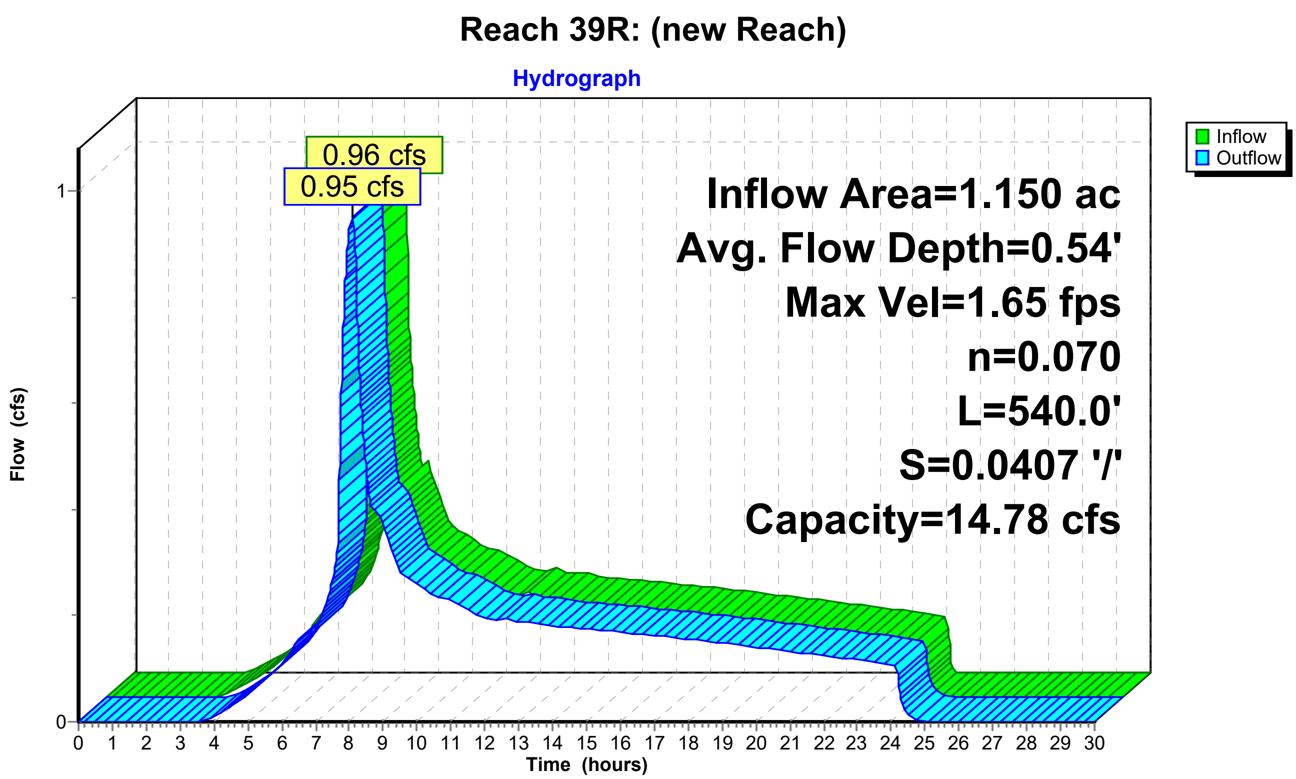
Inflow Area = 1.150 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.96 cfs @ 7.93 hrs, Volume= 0.319 af
Outflow = 0.95 cfs @ 8.09 hrs, Volume= 0.319 af, Atten= 1%, Lag= 9.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.65 fps, Min. Travel Time= 5.4 min
Avg. Velocity = 0.93 fps, Avg. Travel Time= 9.7 min

Peak Storage= 311 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.54'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 14.78 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 540.0' Slope= 0.0407 '/'
Inlet Invert= 224.00', Outlet Invert= 202.00'





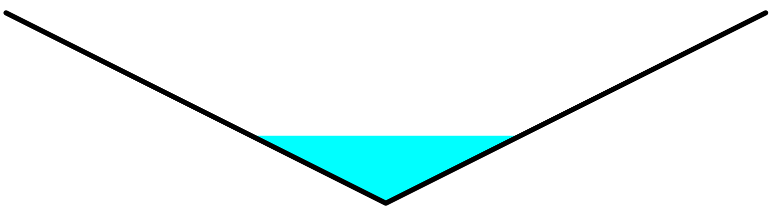
Summary for Reach 40R: (new Reach)

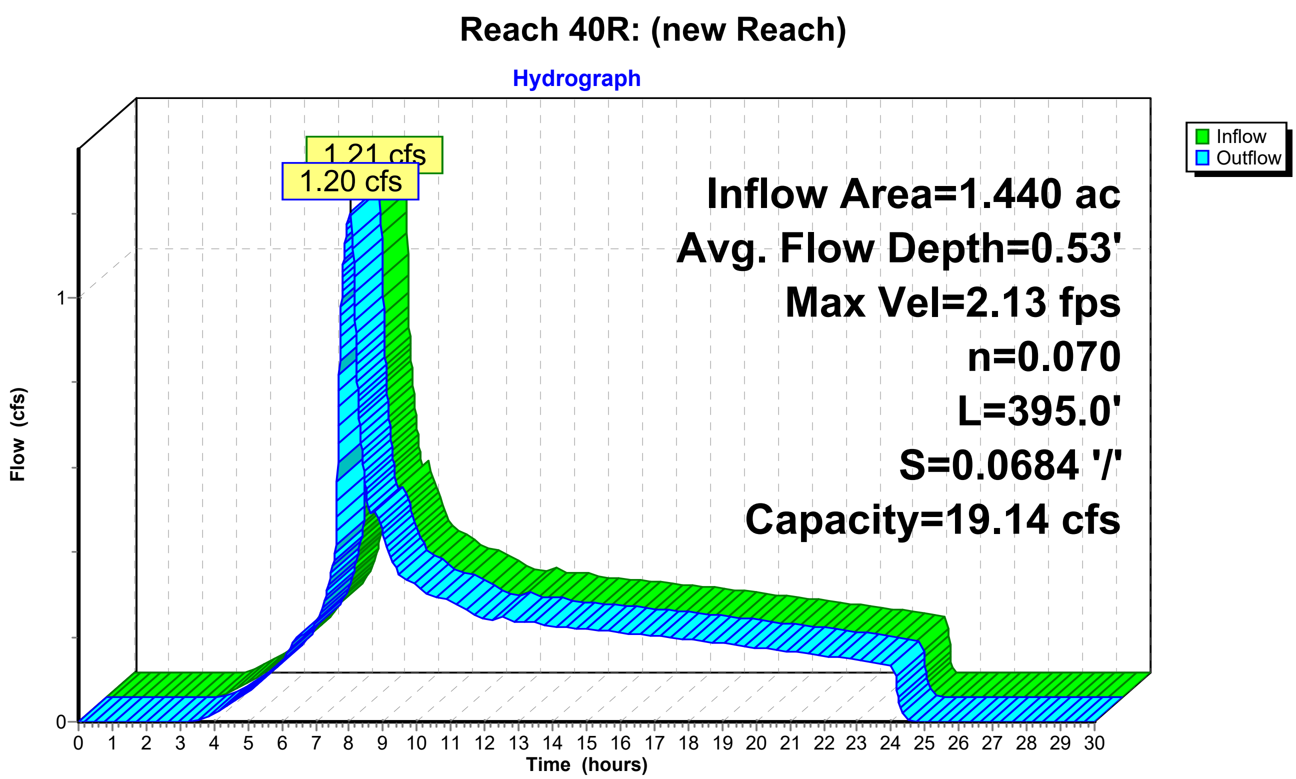
Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.21 cfs @ 7.93 hrs, Volume= 0.400 af
Outflow = 1.20 cfs @ 8.02 hrs, Volume= 0.400 af, Atten= 0%, Lag= 5.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.13 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 5.2 min

Peak Storage= 223 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.53'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.14 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 395.0' Slope= 0.0684 '/'
Inlet Invert= 265.00', Outlet Invert= 238.00'





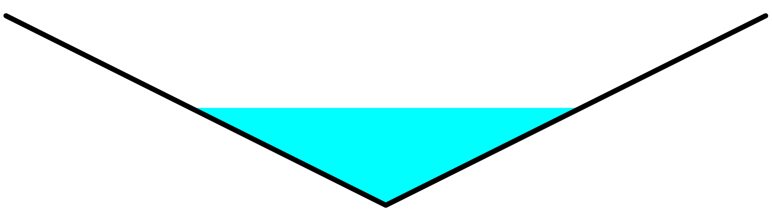
Summary for Reach 41R: (new Reach)

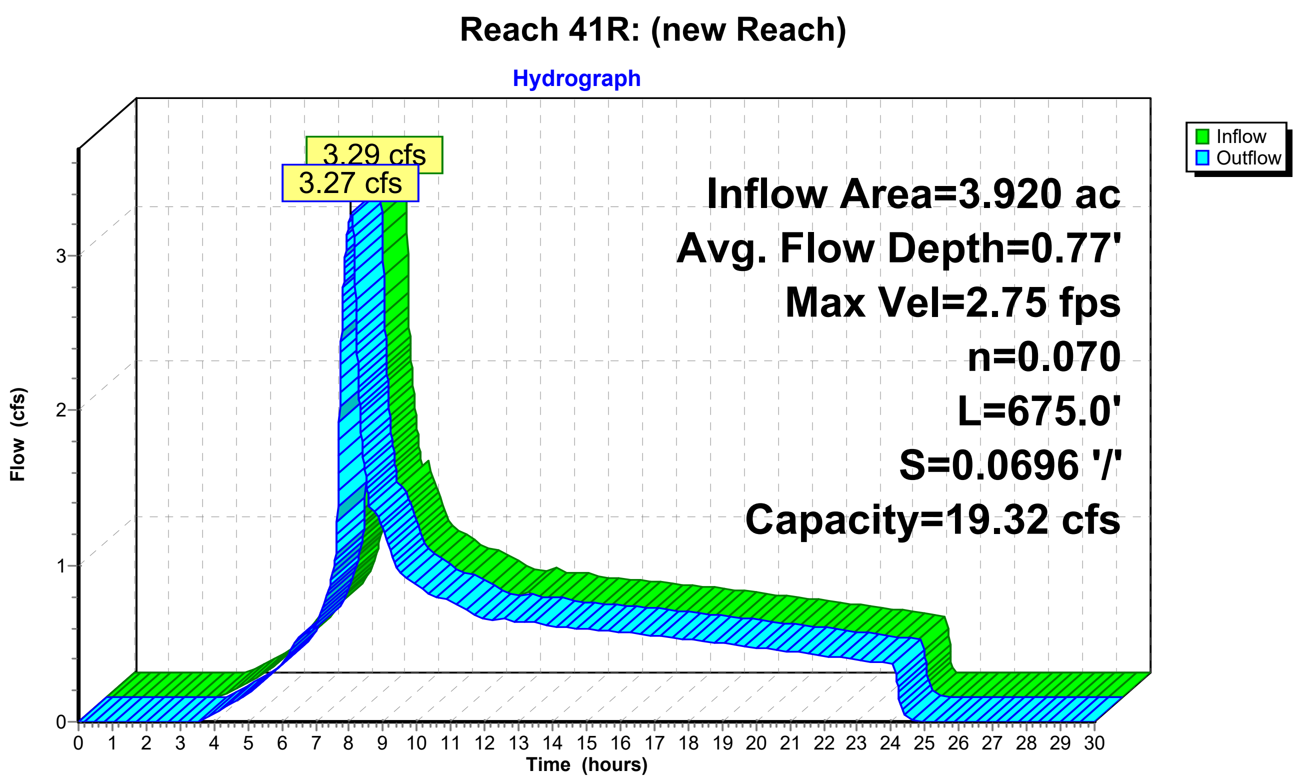
Inflow Area = 3.920 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 3.29 cfs @ 7.93 hrs, Volume= 1.089 af
Outflow = 3.27 cfs @ 8.05 hrs, Volume= 1.089 af, Atten= 1%, Lag= 7.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.75 fps, Min. Travel Time= 4.1 min
Avg. Velocity = 1.54 fps, Avg. Travel Time= 7.3 min

Peak Storage= 801 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.77'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.32 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 675.0' Slope= 0.0696 '/'
Inlet Invert= 278.00', Outlet Invert= 231.00'





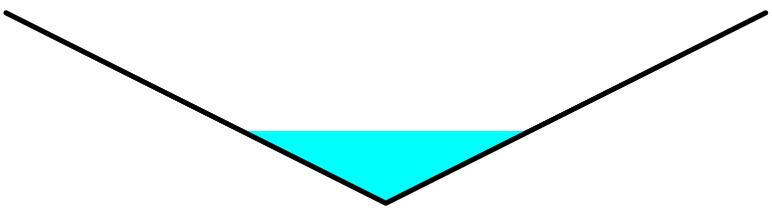
Summary for Reach 42R: (new Reach)

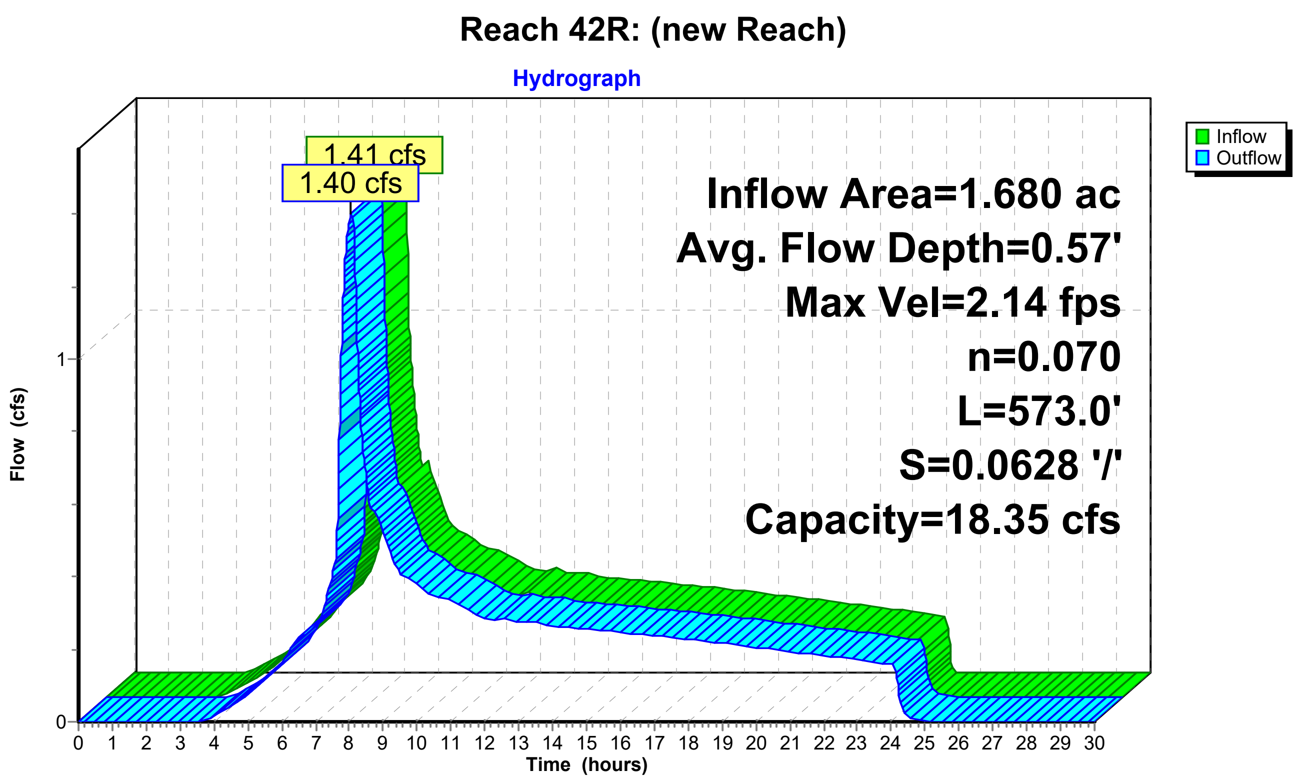
Inflow Area = 1.680 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.41 cfs @ 7.93 hrs, Volume= 0.467 af
Outflow = 1.40 cfs @ 8.06 hrs, Volume= 0.467 af, Atten= 1%, Lag= 7.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.14 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 1.22 fps, Avg. Travel Time= 7.8 min

Peak Storage= 374 cf @ 7.99 hrs
Average Depth at Peak Storage= 0.57'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 18.35 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 573.0' Slope= 0.0628 '/'
Inlet Invert= 228.00', Outlet Invert= 192.00'





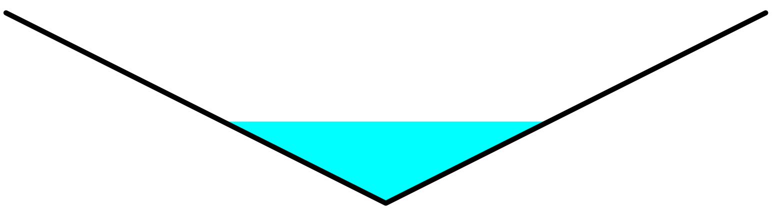
Summary for Reach 43R: (new Reach)

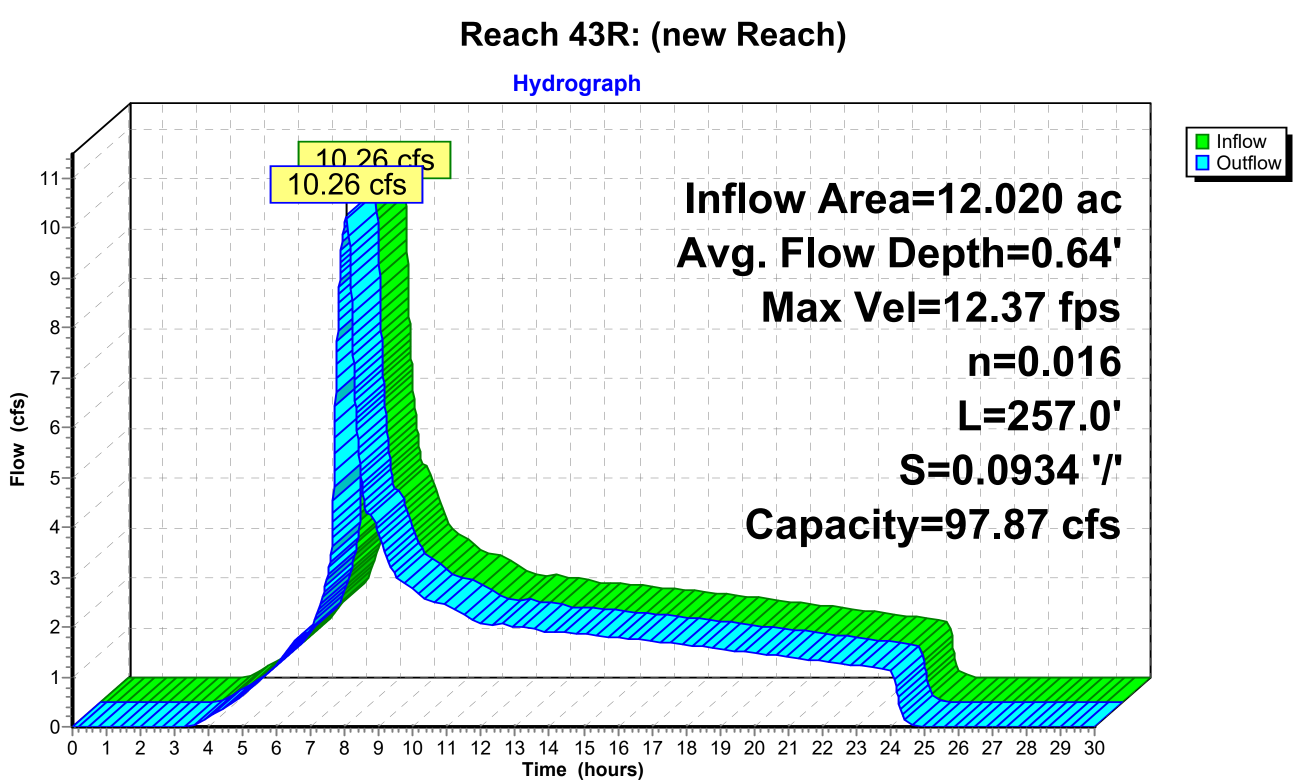
Inflow Area = 12.020 ac, 4.16% Impervious, Inflow Depth = 3.41" for 100-yr event
Inflow = 10.26 cfs @ 8.03 hrs, Volume= 3.414 af
Outflow = 10.26 cfs @ 8.04 hrs, Volume= 3.414 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.37 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 6.96 fps, Avg. Travel Time= 0.6 min

Peak Storage= 213 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.64'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 97.87 cfs

0.00' x 1.50' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 257.0' Slope= 0.0934 '/'
Inlet Invert= 174.00', Outlet Invert= 150.00'





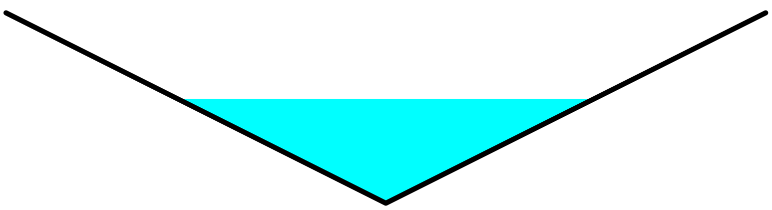
Summary for Reach 44R: (new Reach)

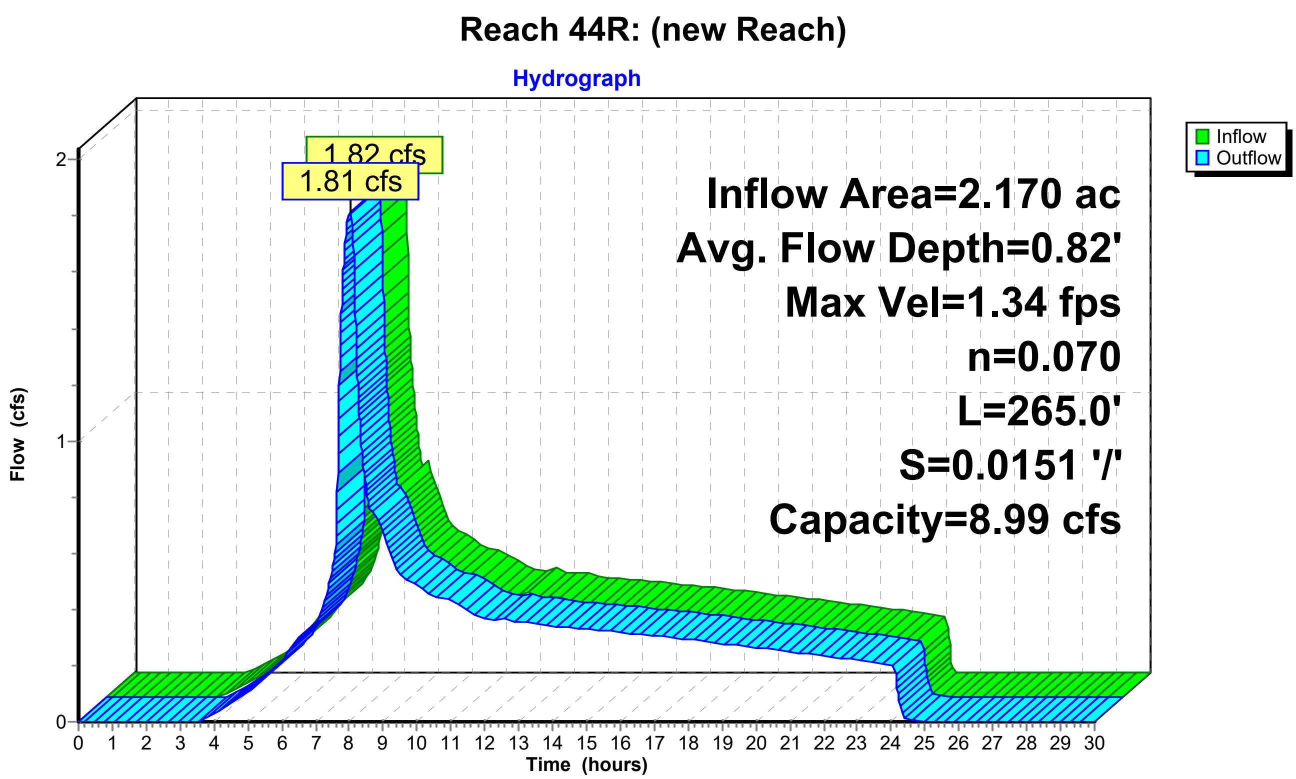
Inflow Area = 2.170 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.82 cfs @ 7.93 hrs, Volume= 0.603 af
Outflow = 1.81 cfs @ 8.03 hrs, Volume= 0.603 af, Atten= 0%, Lag= 5.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.34 fps, Min. Travel Time= 3.3 min
Avg. Velocity = 0.76 fps, Avg. Travel Time= 5.8 min

Peak Storage= 359 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.82'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 8.99 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 265.0' Slope= 0.0151 '/'
Inlet Invert= 271.00', Outlet Invert= 267.00'





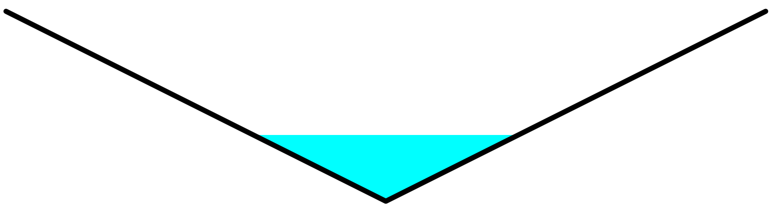
Summary for Reach 45R: (new Reach)

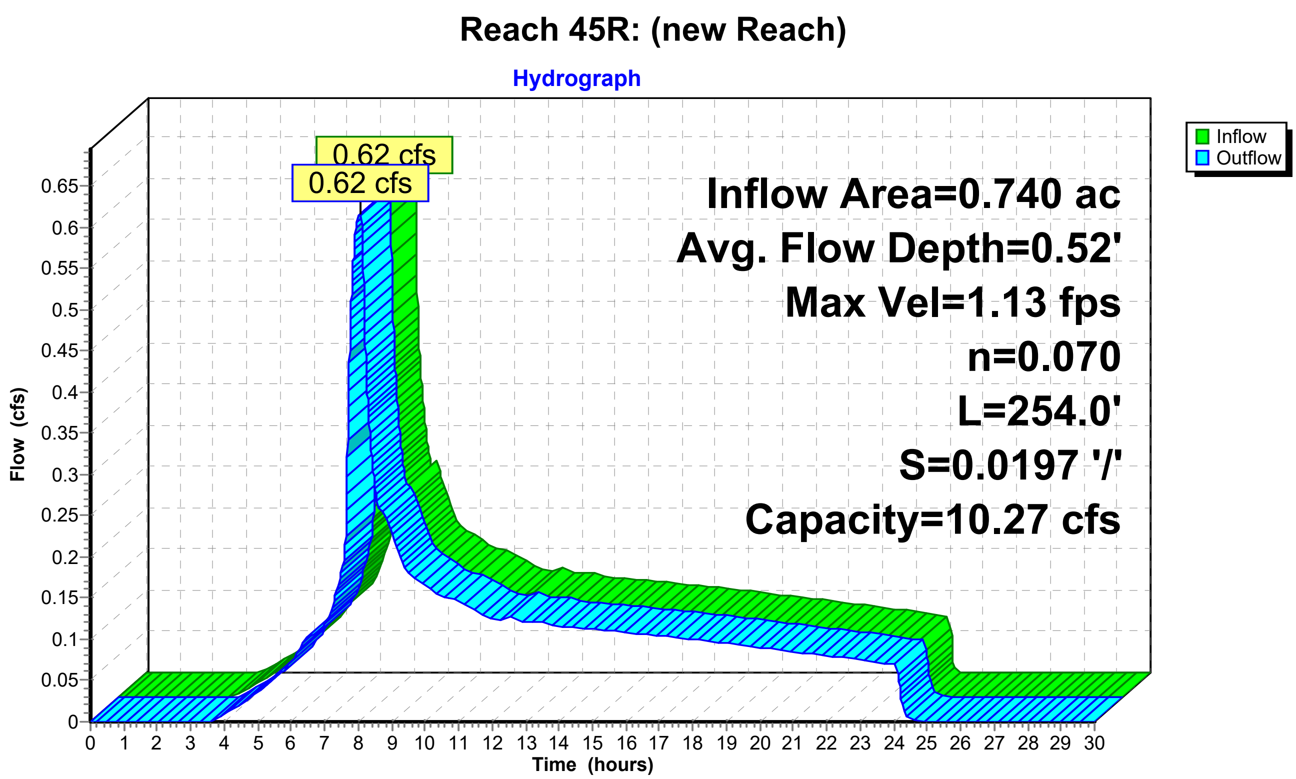
Inflow Area = 0.740 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.62 cfs @ 7.93 hrs, Volume= 0.206 af
Outflow = 0.62 cfs @ 8.04 hrs, Volume= 0.206 af, Atten= 1%, Lag= 6.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.13 fps, Min. Travel Time= 3.7 min
Avg. Velocity = 0.66 fps, Avg. Travel Time= 6.4 min

Peak Storage= 139 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.52'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 10.27 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 254.0' Slope= 0.0197 '/'
Inlet Invert= 262.00', Outlet Invert= 257.00'





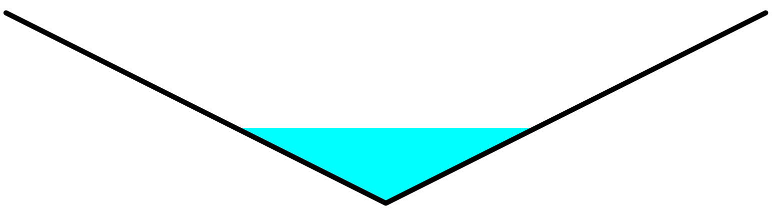
Summary for Reach 46R: (new Reach)

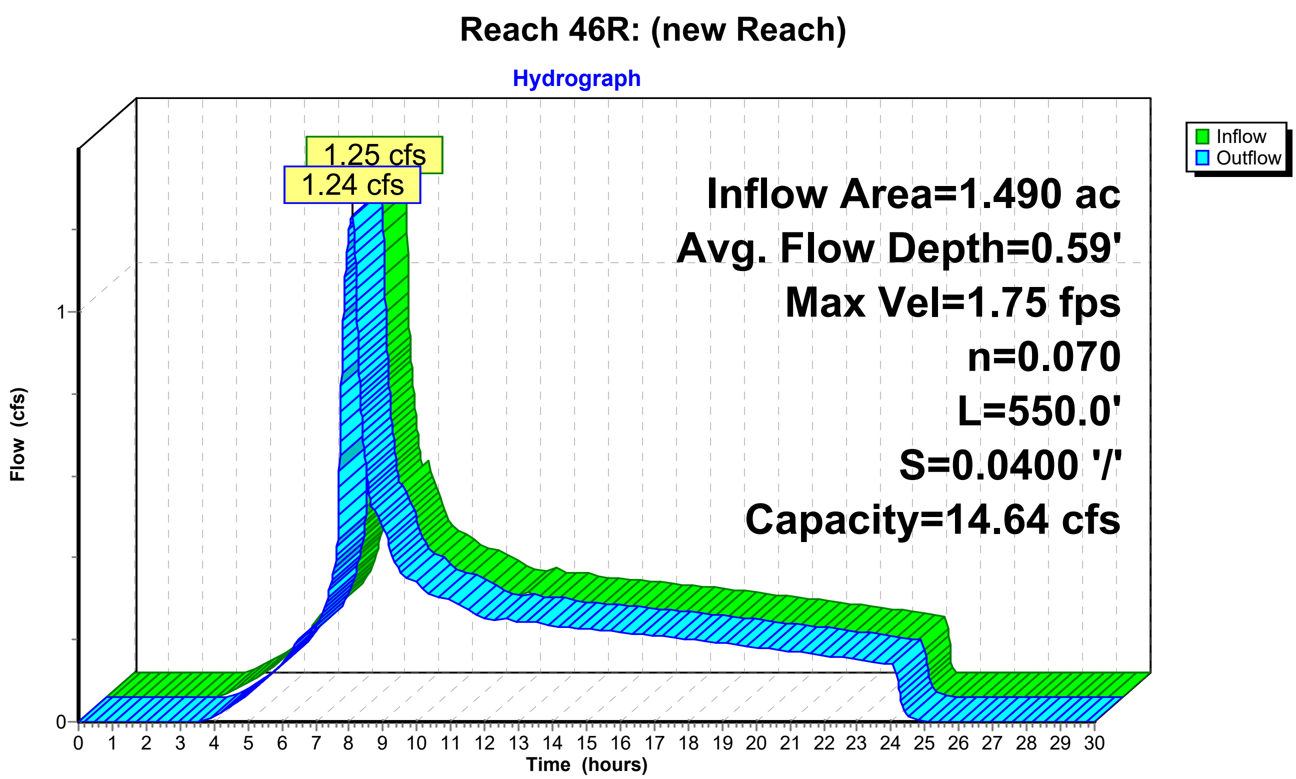
Inflow Area = 1.490 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.25 cfs @ 7.93 hrs, Volume= 0.414 af
Outflow = 1.24 cfs @ 8.08 hrs, Volume= 0.414 af, Atten= 1%, Lag= 9.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.75 fps, Min. Travel Time= 5.2 min
Avg. Velocity = 0.98 fps, Avg. Travel Time= 9.4 min

Peak Storage= 388 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.59'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 14.64 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 550.0' Slope= 0.0400 '/'
Inlet Invert= 212.00', Outlet Invert= 190.00'





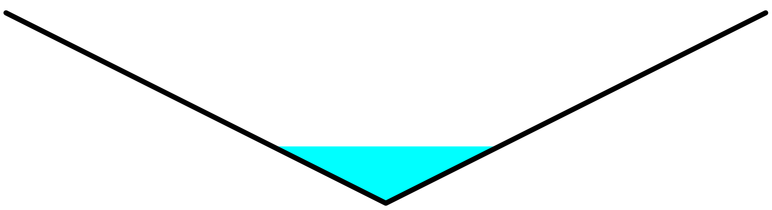
Summary for Reach 47R: (new Reach)

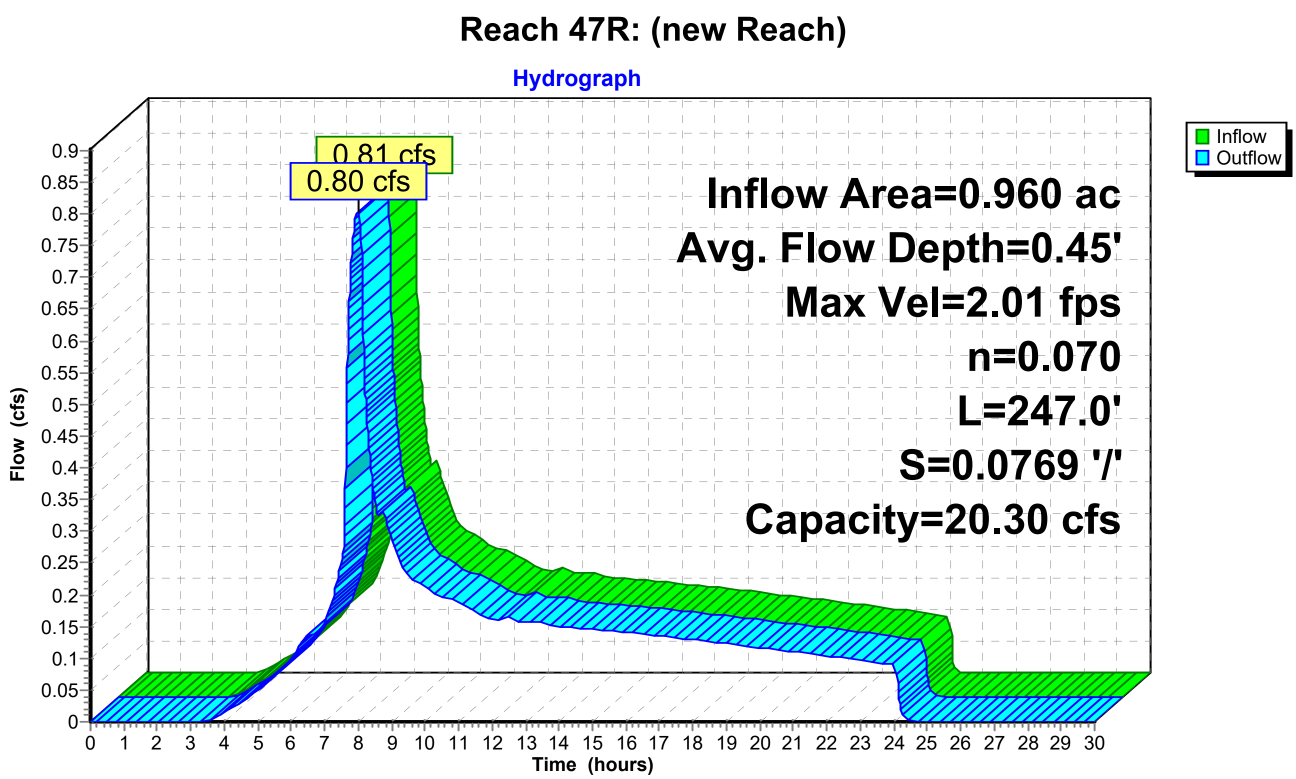
Inflow Area = 0.960 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.81 cfs @ 7.93 hrs, Volume= 0.267 af
Outflow = 0.80 cfs @ 7.99 hrs, Volume= 0.267 af, Atten= 0%, Lag= 3.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.01 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 1.23 fps, Avg. Travel Time= 3.4 min

Peak Storage= 99 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 20.30 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 247.0' Slope= 0.0769 '/'
Inlet Invert= 229.00', Outlet Invert= 210.00'





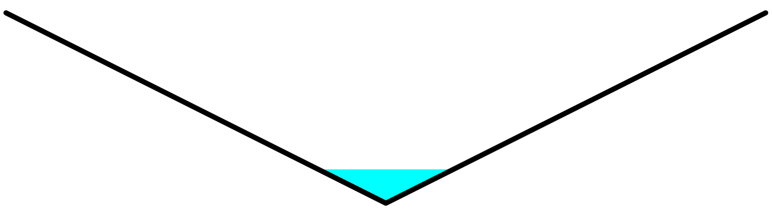
Summary for Reach 48R: (new Reach)

Inflow Area = 0.300 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.25 cfs @ 7.93 hrs, Volume= 0.083 af
Outflow = 0.25 cfs @ 7.99 hrs, Volume= 0.083 af, Atten= 0%, Lag= 3.7 min

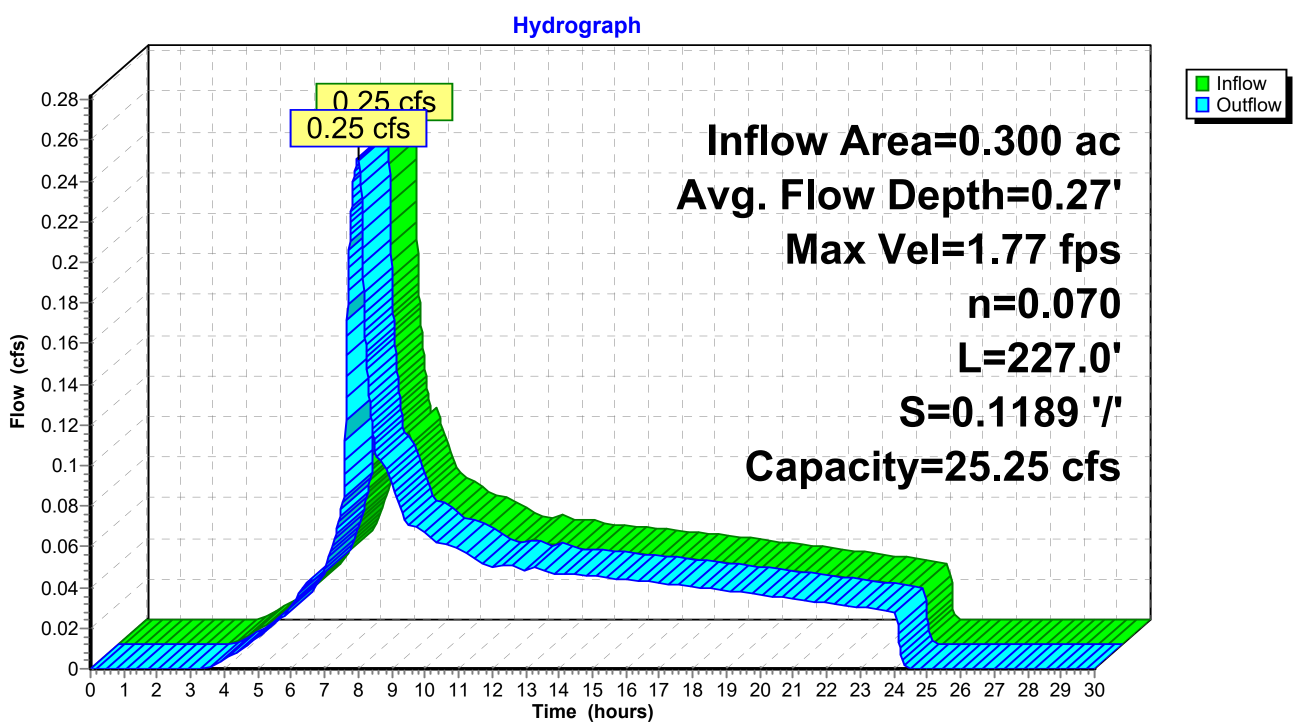
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.77 fps, Min. Travel Time= 2.1 min
Avg. Velocity = 1.10 fps, Avg. Travel Time= 3.4 min

Peak Storage= 32 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.27'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 25.25 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 227.0' Slope= 0.1189 '/'
Inlet Invert= 185.00', Outlet Invert= 158.00'



Reach 48R: (new Reach)



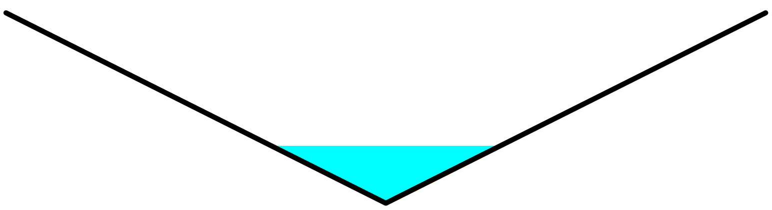
Summary for Reach 50R: (new Reach)

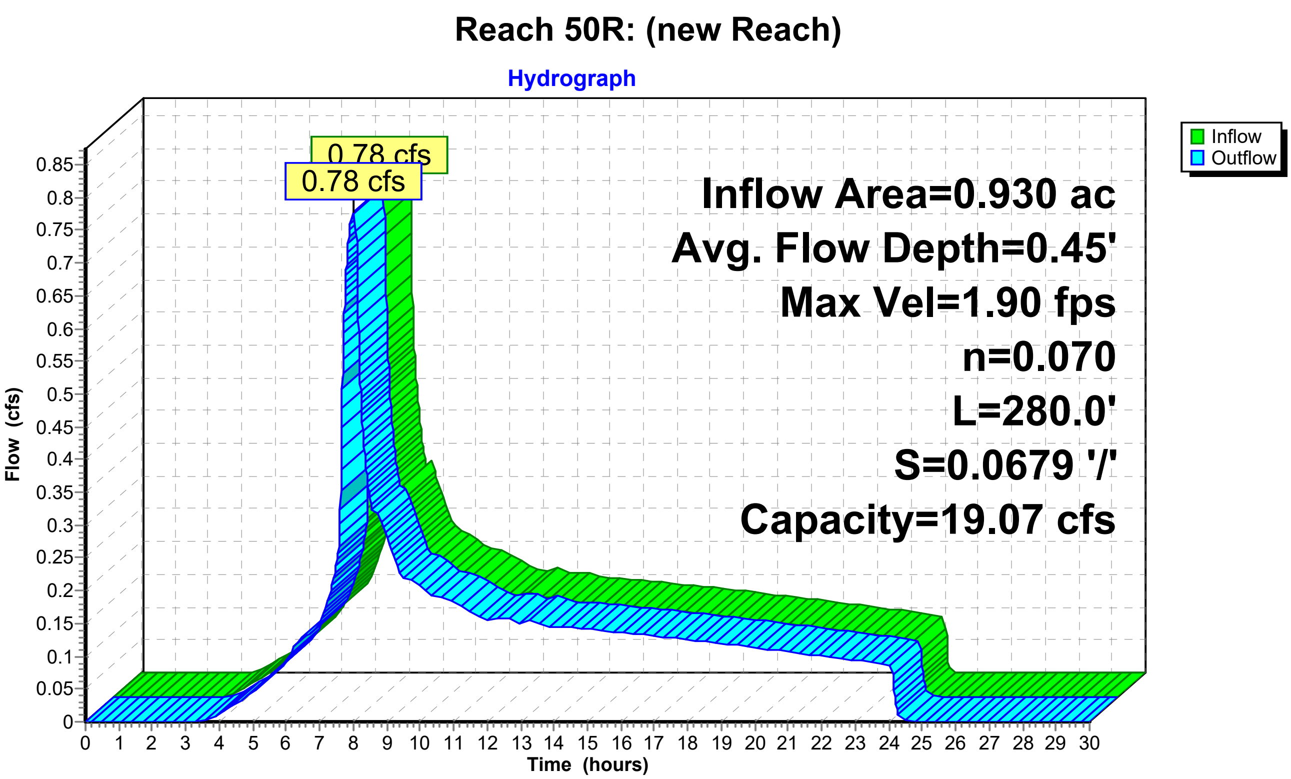
Inflow Area = 0.930 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.78 cfs @ 7.93 hrs, Volume= 0.258 af
Outflow = 0.78 cfs @ 8.00 hrs, Volume= 0.258 af, Atten= 0%, Lag= 4.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.90 fps, Min. Travel Time= 2.4 min
Avg. Velocity = 1.15 fps, Avg. Travel Time= 4.1 min

Peak Storage= 114 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 19.07 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 280.0' Slope= 0.0679 '/'
Inlet Invert= 174.00', Outlet Invert= 155.00'





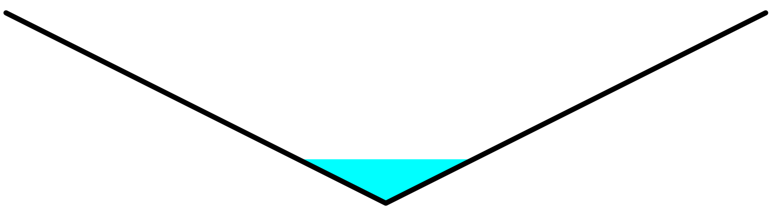
Summary for Reach 51R: (new Reach)

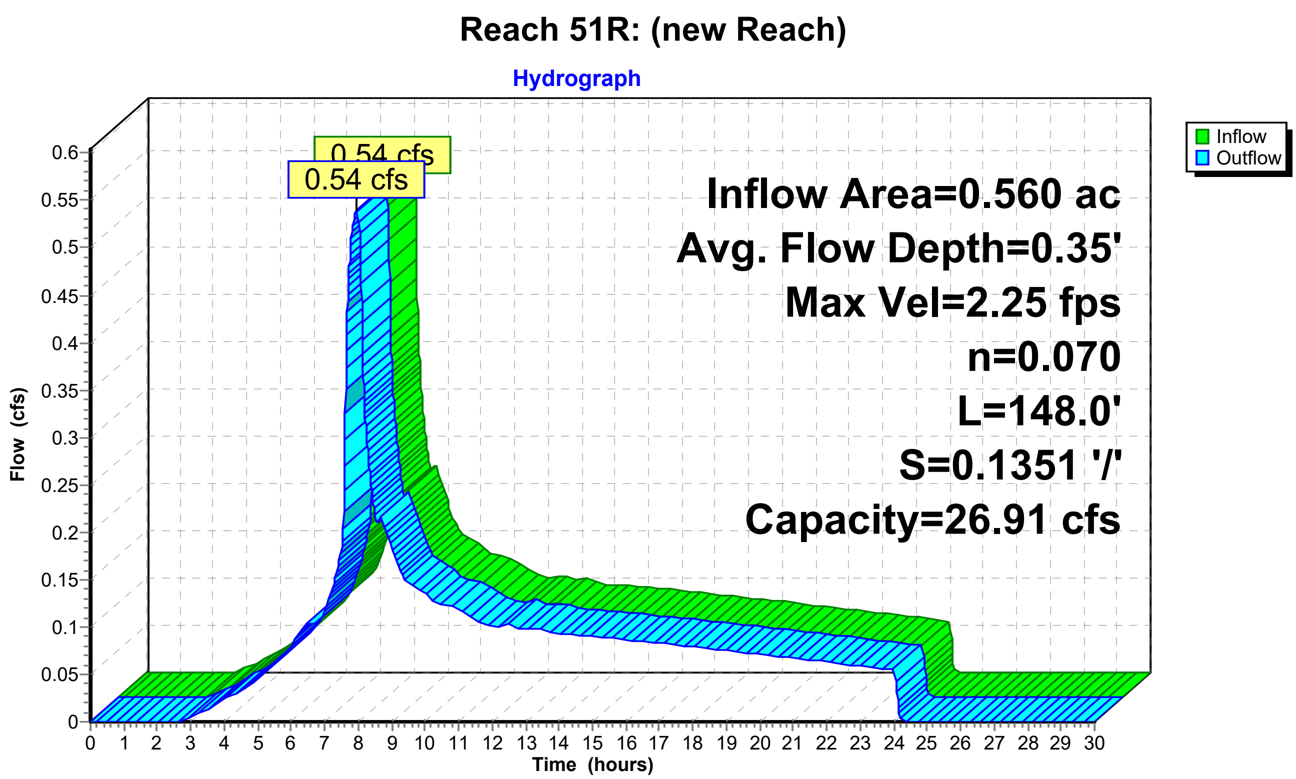
Inflow Area = 0.560 ac, 23.21% Impervious, Inflow Depth = 3.73" for 100-yr event
Inflow = 0.54 cfs @ 7.91 hrs, Volume= 0.174 af
Outflow = 0.54 cfs @ 7.94 hrs, Volume= 0.174 af, Atten= 0%, Lag= 1.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.25 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 1.38 fps, Avg. Travel Time= 1.8 min

Peak Storage= 35 cf @ 7.93 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 26.91 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 148.0' Slope= 0.1351 '/'
Inlet Invert= 170.00', Outlet Invert= 150.00'





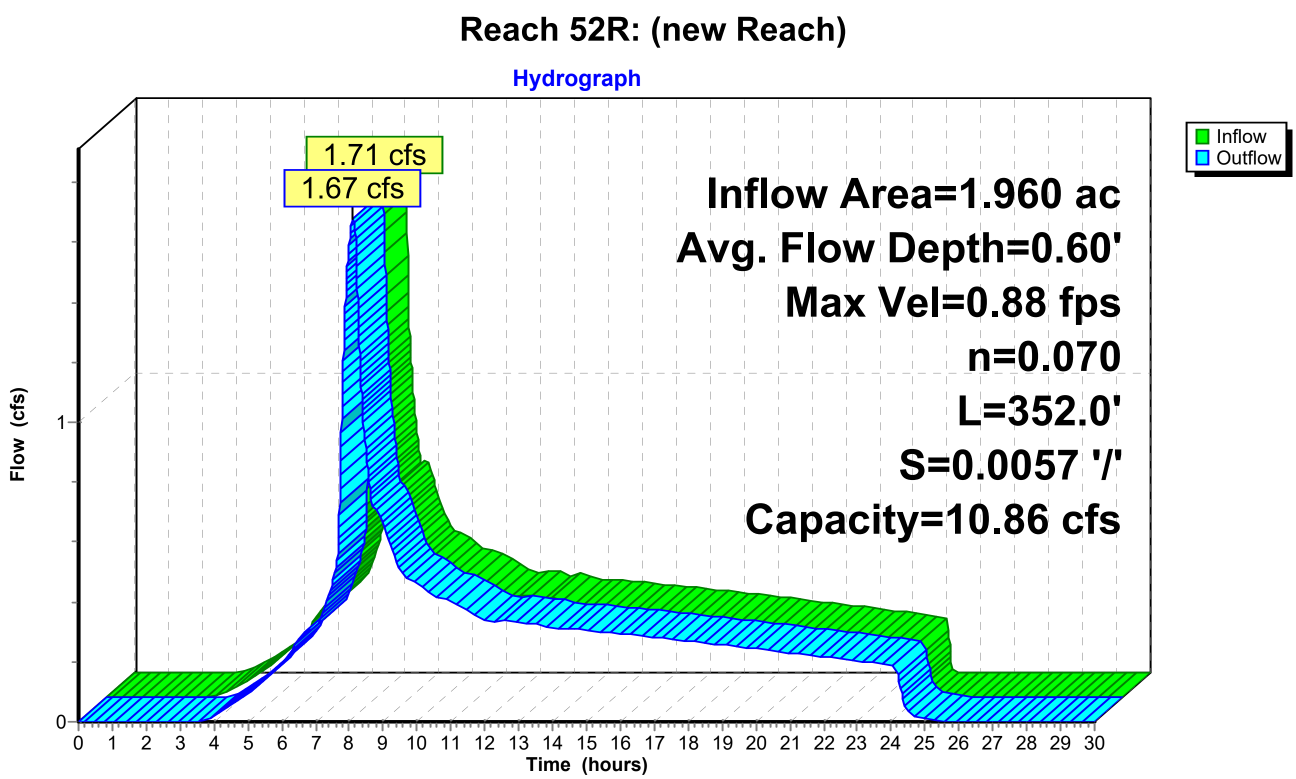
Summary for Reach 52R: (new Reach)

Inflow Area = 1.960 ac, 7.65% Impervious, Inflow Depth = 3.43" for 100-yr event
Inflow = 1.71 cfs @ 7.93 hrs, Volume= 0.560 af
Outflow = 1.67 cfs @ 8.12 hrs, Volume= 0.560 af, Atten= 2%, Lag= 11.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.88 fps, Min. Travel Time= 6.7 min
Avg. Velocity = 0.42 fps, Avg. Travel Time= 13.9 min

Peak Storage= 670 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.60'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 10.86 cfs

2.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 352.0' Slope= 0.0057 '/'
Inlet Invert= 130.00', Outlet Invert= 128.00'



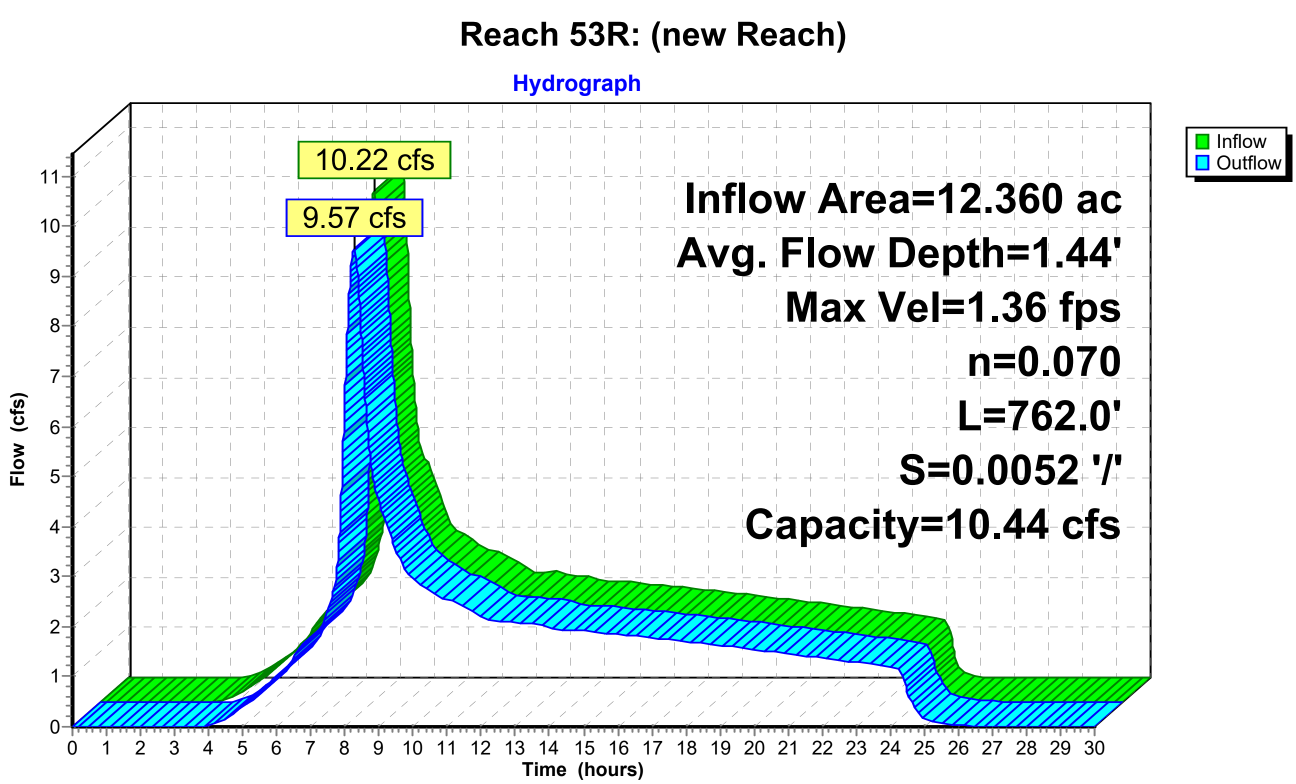
Summary for Reach 53R: (new Reach)

Inflow Area = 12.360 ac, 2.67% Impervious, Inflow Depth = 3.37" for 100-yr event
Inflow = 10.22 cfs @ 8.02 hrs, Volume= 3.470 af
Outflow = 9.57 cfs @ 8.27 hrs, Volume= 3.470 af, Atten= 6%, Lag= 14.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.36 fps, Min. Travel Time= 9.3 min
Avg. Velocity = 0.70 fps, Avg. Travel Time= 18.1 min

Peak Storage= 5,357 cf @ 8.12 hrs
Average Depth at Peak Storage= 1.44'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 10.44 cfs

2.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 762.0' Slope= 0.0052 '/'
Inlet Invert= 128.00', Outlet Invert= 124.00'



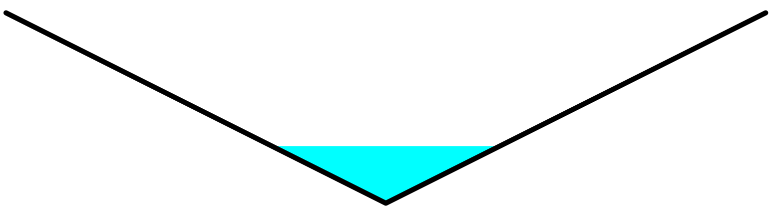
Summary for Reach 55R: (new Reach)

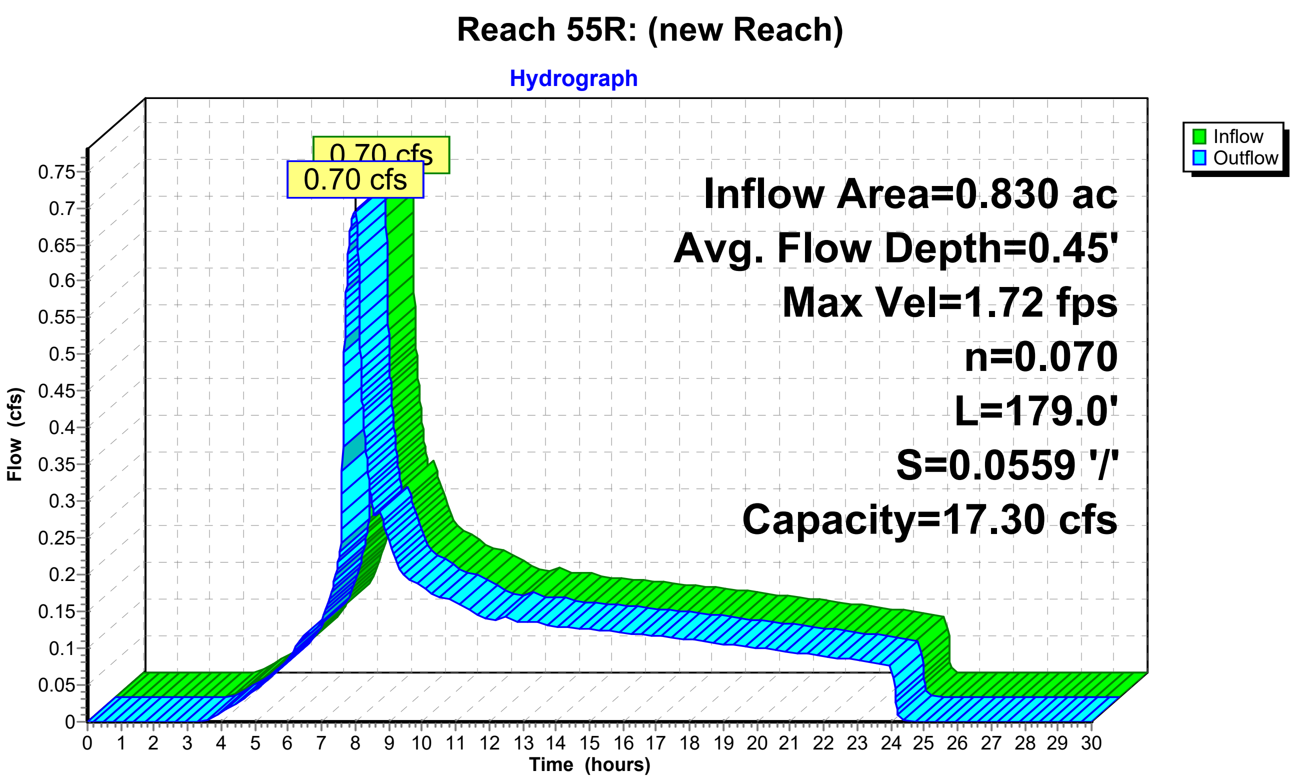
Inflow Area = 0.830 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.70 cfs @ 7.93 hrs, Volume= 0.231 af
Outflow = 0.70 cfs @ 7.98 hrs, Volume= 0.231 af, Atten= 0%, Lag= 3.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.72 fps, Min. Travel Time= 1.7 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 2.8 min

Peak Storage= 72 cf @ 7.95 hrs
Average Depth at Peak Storage= 0.45'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 17.30 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 179.0' Slope= 0.0559 '/'
Inlet Invert= 250.00', Outlet Invert= 240.00'



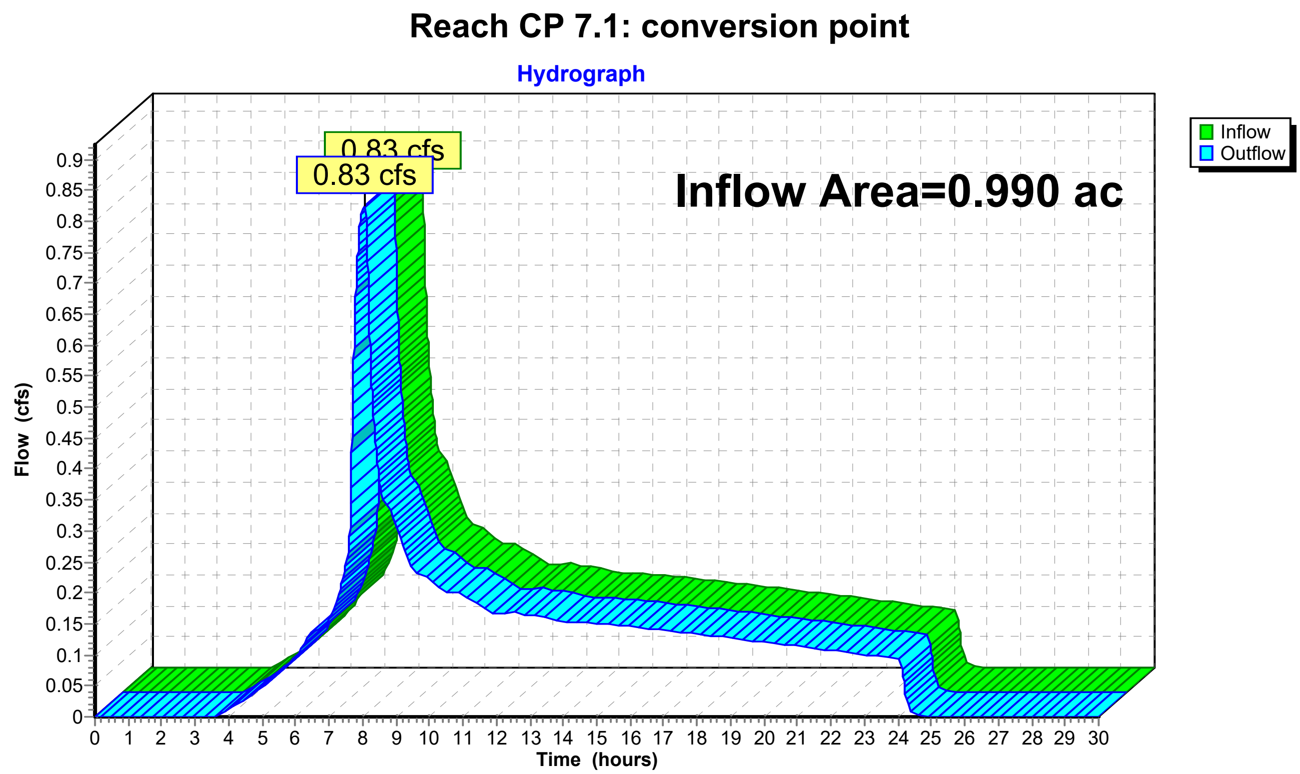


Summary for Reach CP 7.1: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.990 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.83 cfs @ 8.04 hrs, Volume= 0.275 af
Outflow = 0.83 cfs @ 8.04 hrs, Volume= 0.275 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

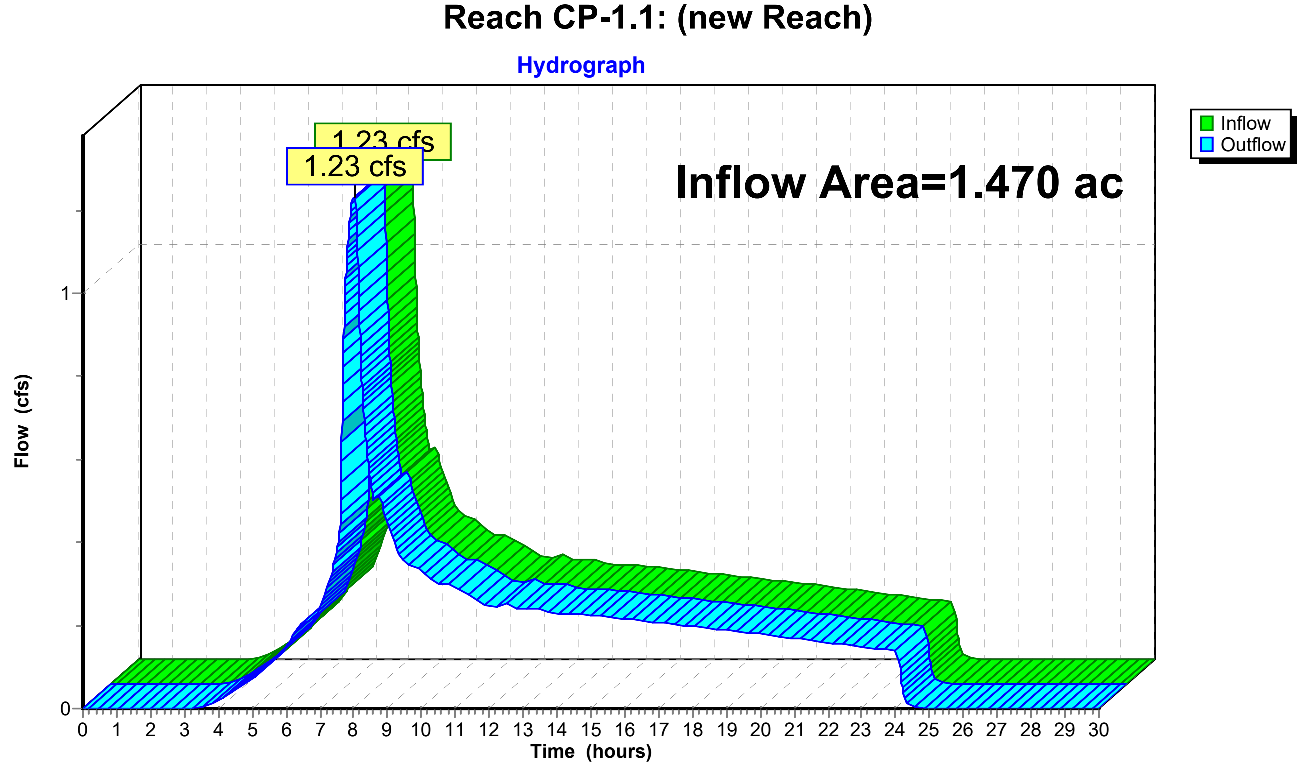


Summary for Reach CP-1.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.23 cfs @ 8.01 hrs, Volume= 0.408 af
Outflow = 1.23 cfs @ 8.01 hrs, Volume= 0.408 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



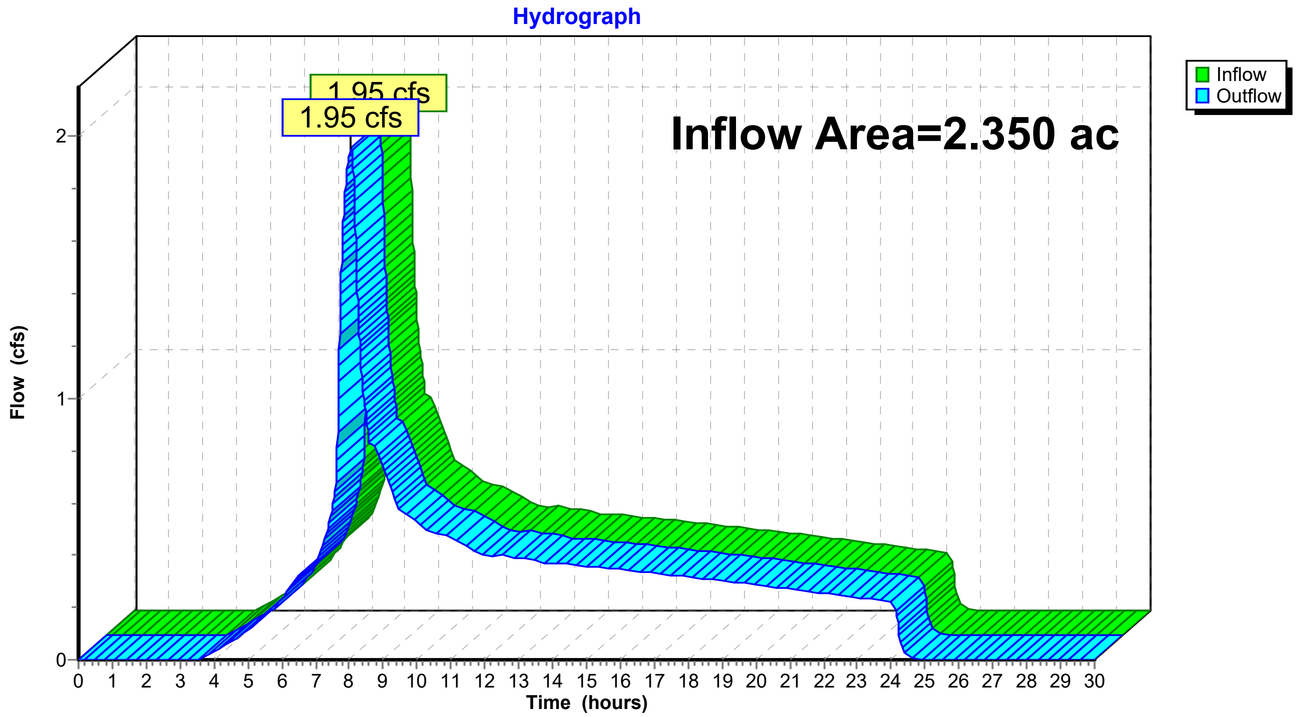
Summary for Reach CP-1.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.350 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.95 cfs @ 8.05 hrs, Volume= 0.653 af
Outflow = 1.95 cfs @ 8.05 hrs, Volume= 0.653 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-1.2: (new Reach)



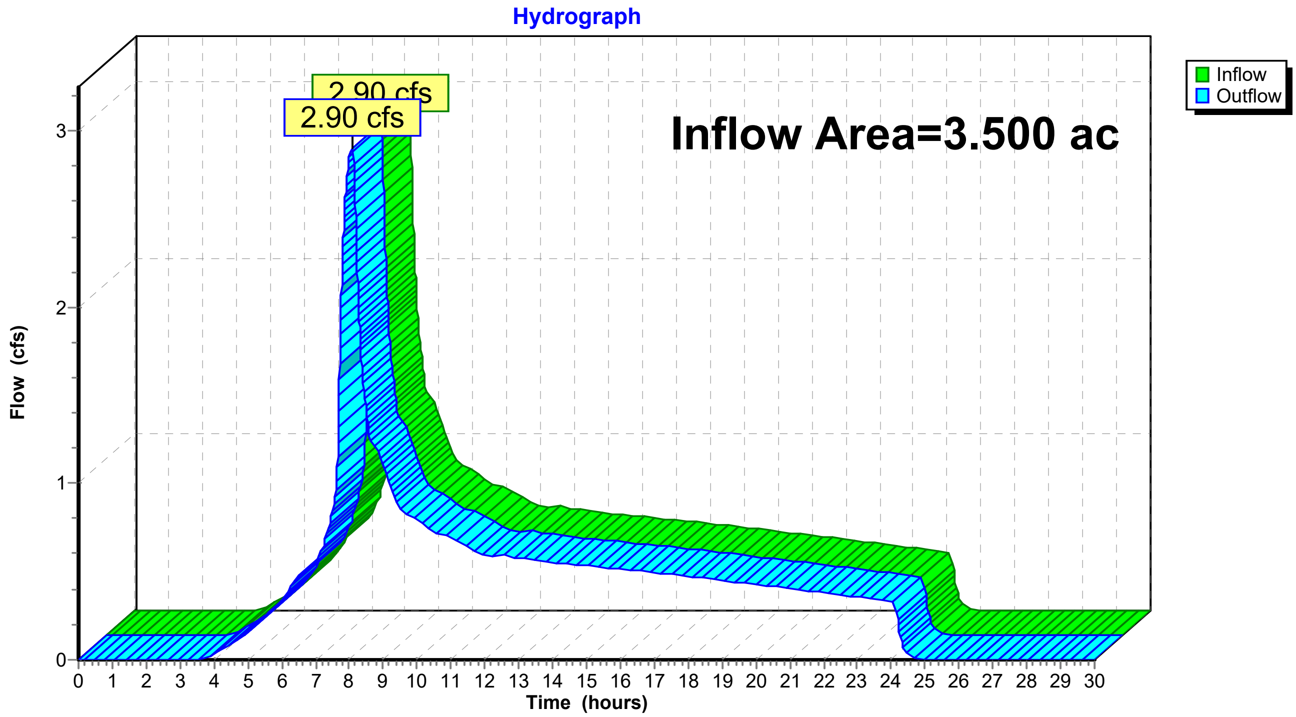
Summary for Reach CP-1.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 2.90 cfs @ 8.07 hrs, Volume= 0.972 af
Outflow = 2.90 cfs @ 8.07 hrs, Volume= 0.972 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-1.3: (new Reach)



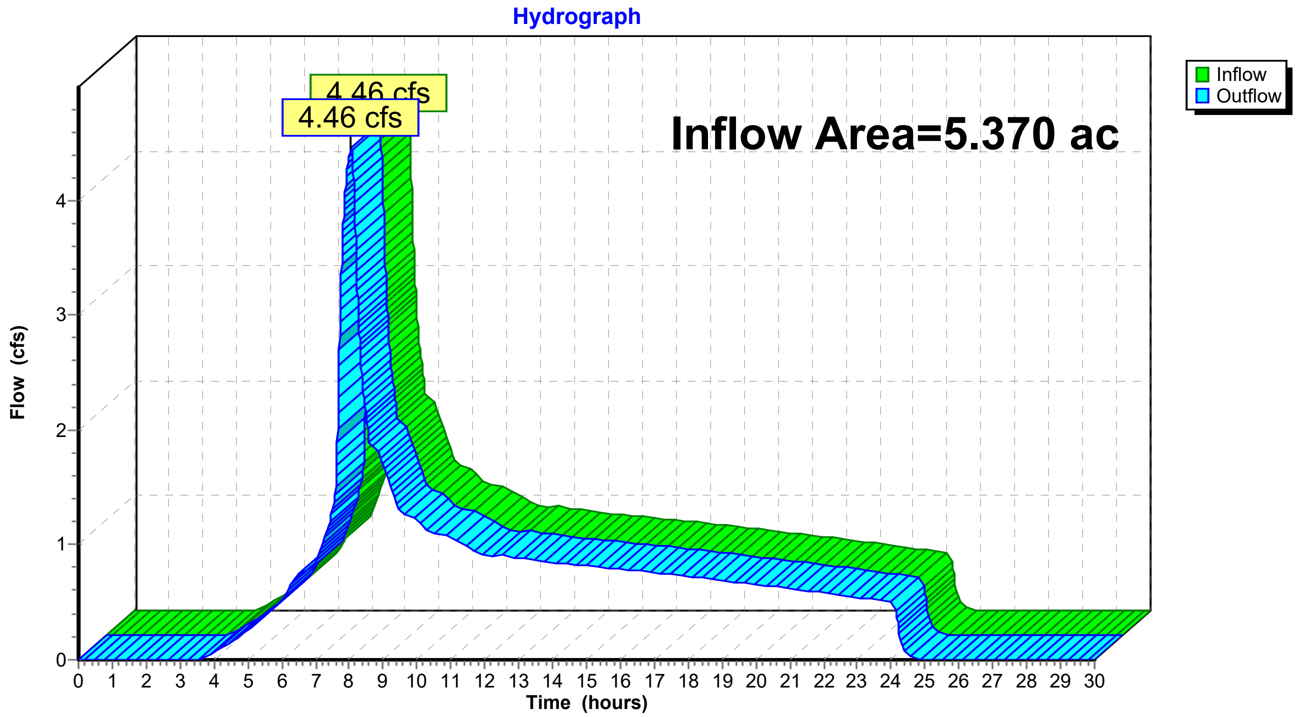
Summary for Reach CP-1.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.370 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.46 cfs @ 8.05 hrs, Volume= 1.492 af
Outflow = 4.46 cfs @ 8.05 hrs, Volume= 1.492 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-1.4: (new Reach)

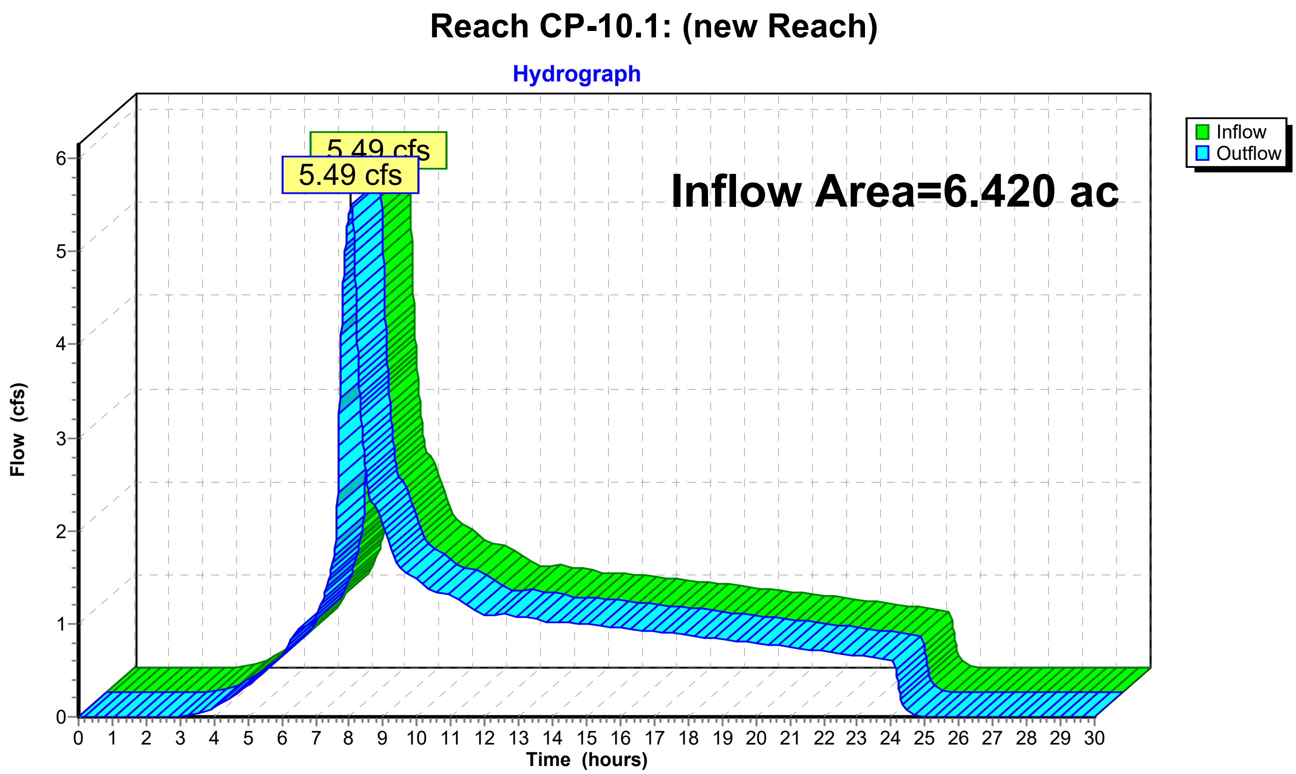


Summary for Reach CP-10.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.420 ac, 4.83% Impervious, Inflow Depth = 3.42" for 100-yr event
Inflow = 5.49 cfs @ 8.05 hrs, Volume= 1.829 af
Outflow = 5.49 cfs @ 8.05 hrs, Volume= 1.829 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

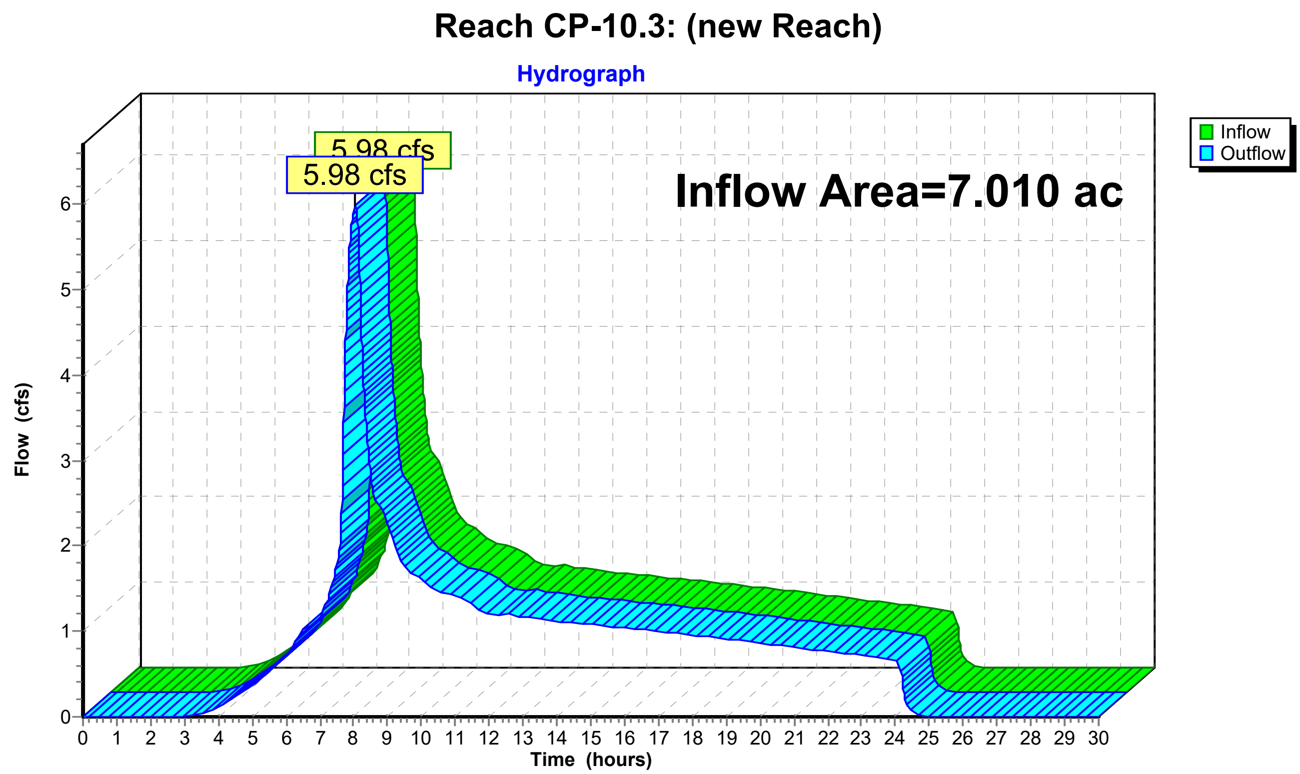


Summary for Reach CP-10.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7.010 ac, 4.42% Impervious, Inflow Depth = 3.41" for 100-yr event
Inflow = 5.98 cfs @ 8.05 hrs, Volume= 1.993 af
Outflow = 5.98 cfs @ 8.05 hrs, Volume= 1.993 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

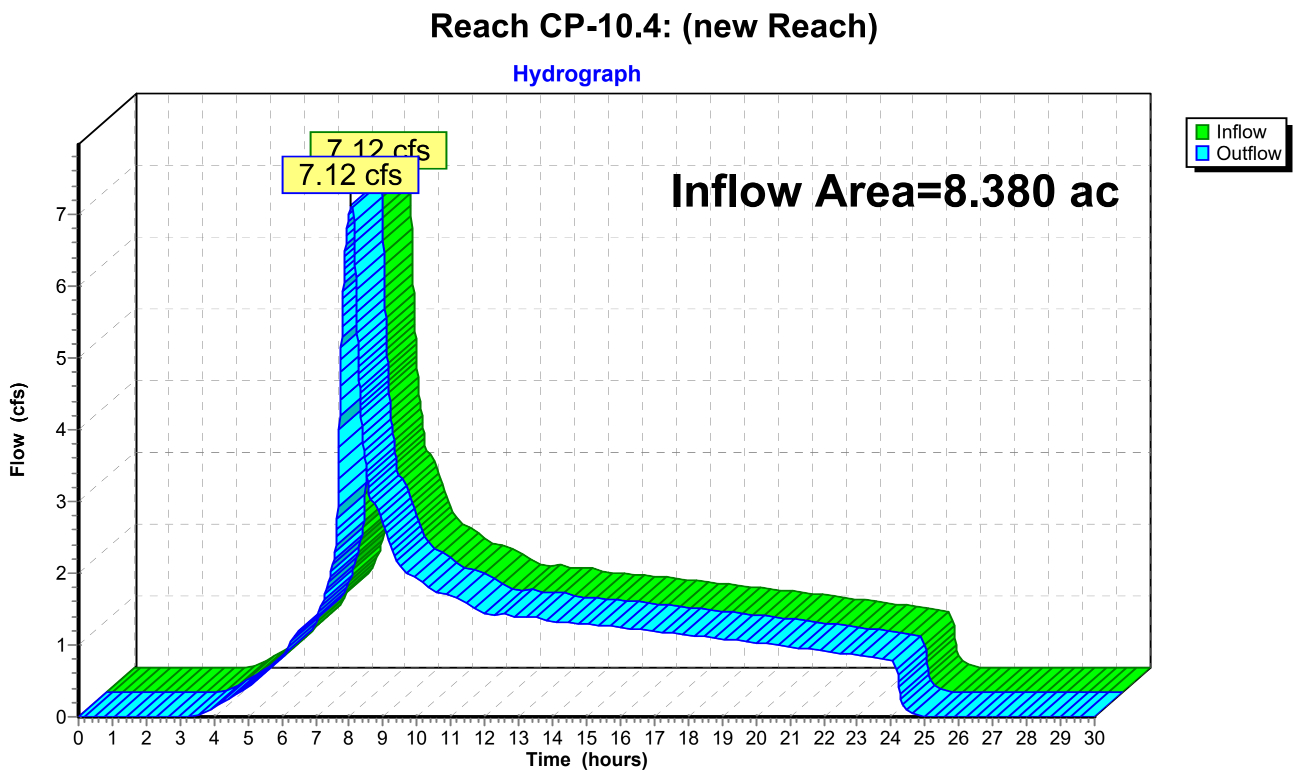


Summary for Reach CP-10.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8.380 ac, 3.70% Impervious, Inflow Depth = 3.40" for 100-yr event
Inflow = 7.12 cfs @ 8.06 hrs, Volume= 2.373 af
Outflow = 7.12 cfs @ 8.06 hrs, Volume= 2.373 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



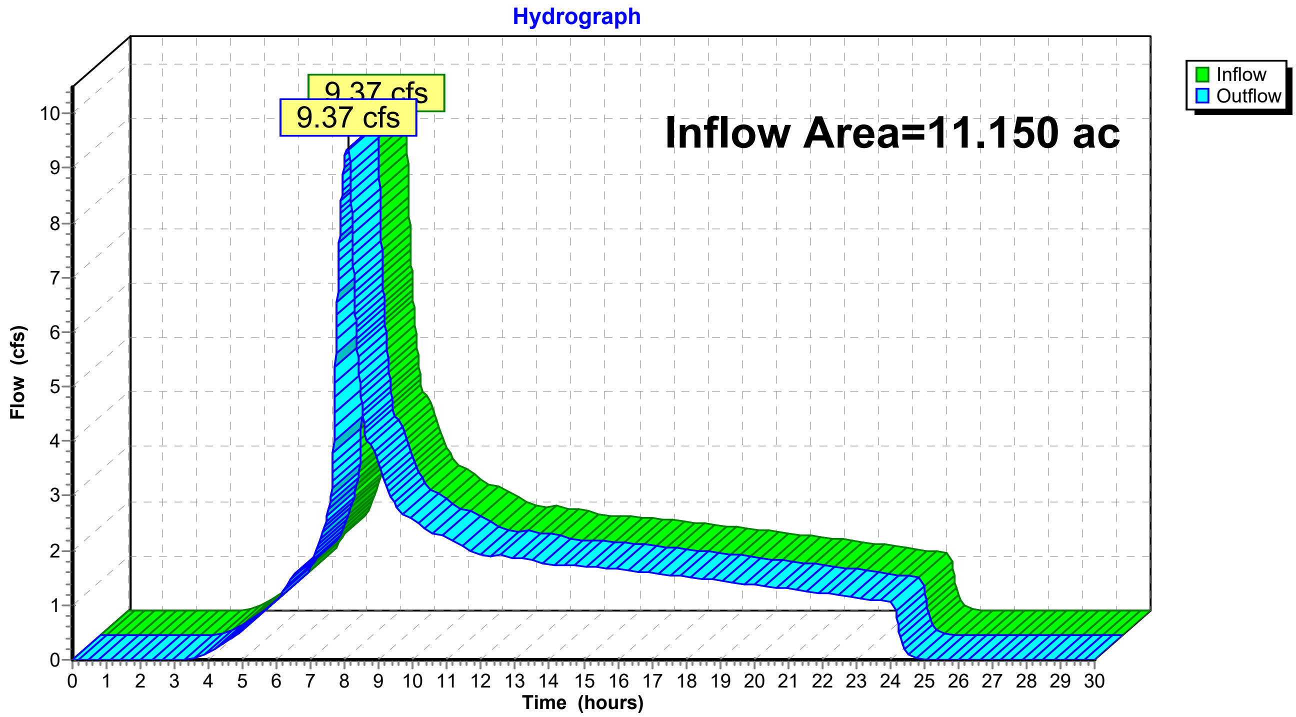
Summary for Reach CP-10.6: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	11.150 ac,	2.78% Impervious, Inflow Depth = 3.38"	for 100-yr event
Inflow =	9.37 cfs @	8.08 hrs, Volume=	3.143 af
Outflow =	9.37 cfs @	8.08 hrs, Volume=	3.143 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-10.6: (new Reach)

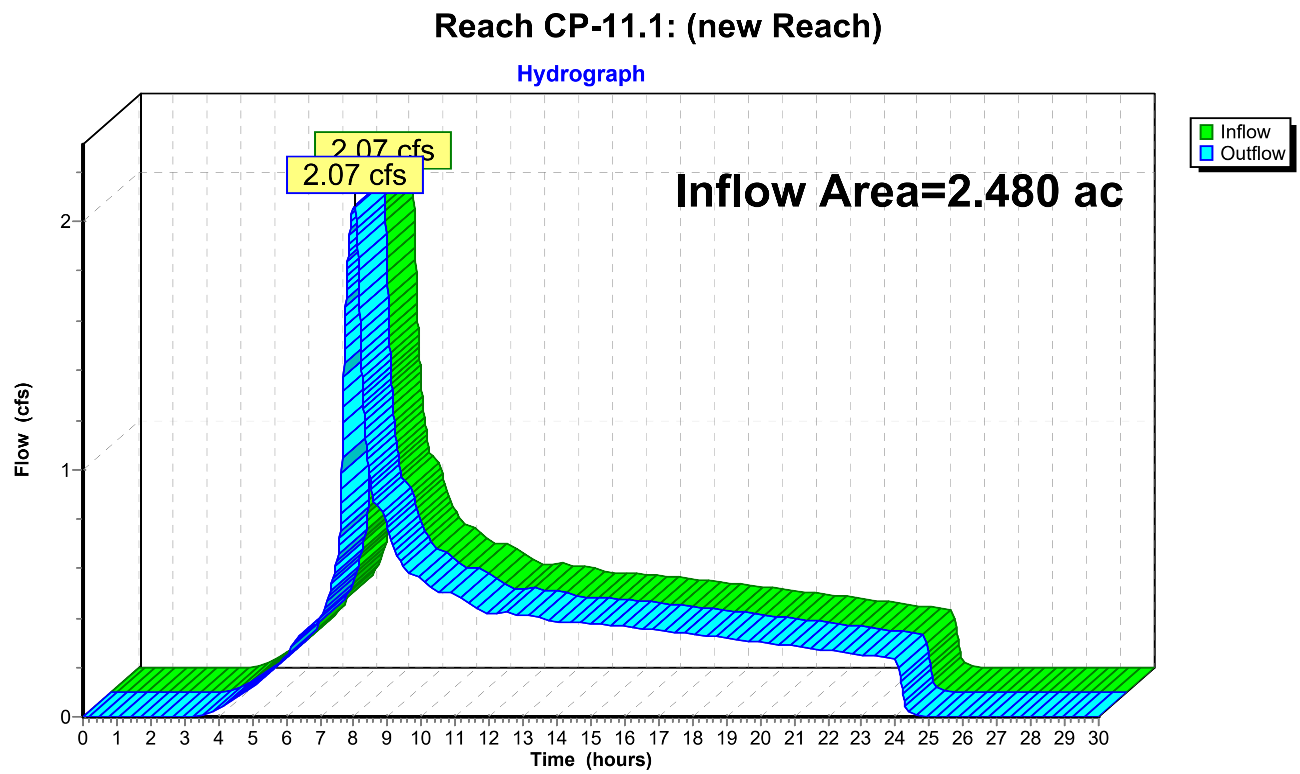


Summary for Reach CP-11.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.480 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 2.07 cfs @ 8.02 hrs, Volume= 0.689 af
Outflow = 2.07 cfs @ 8.02 hrs, Volume= 0.689 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

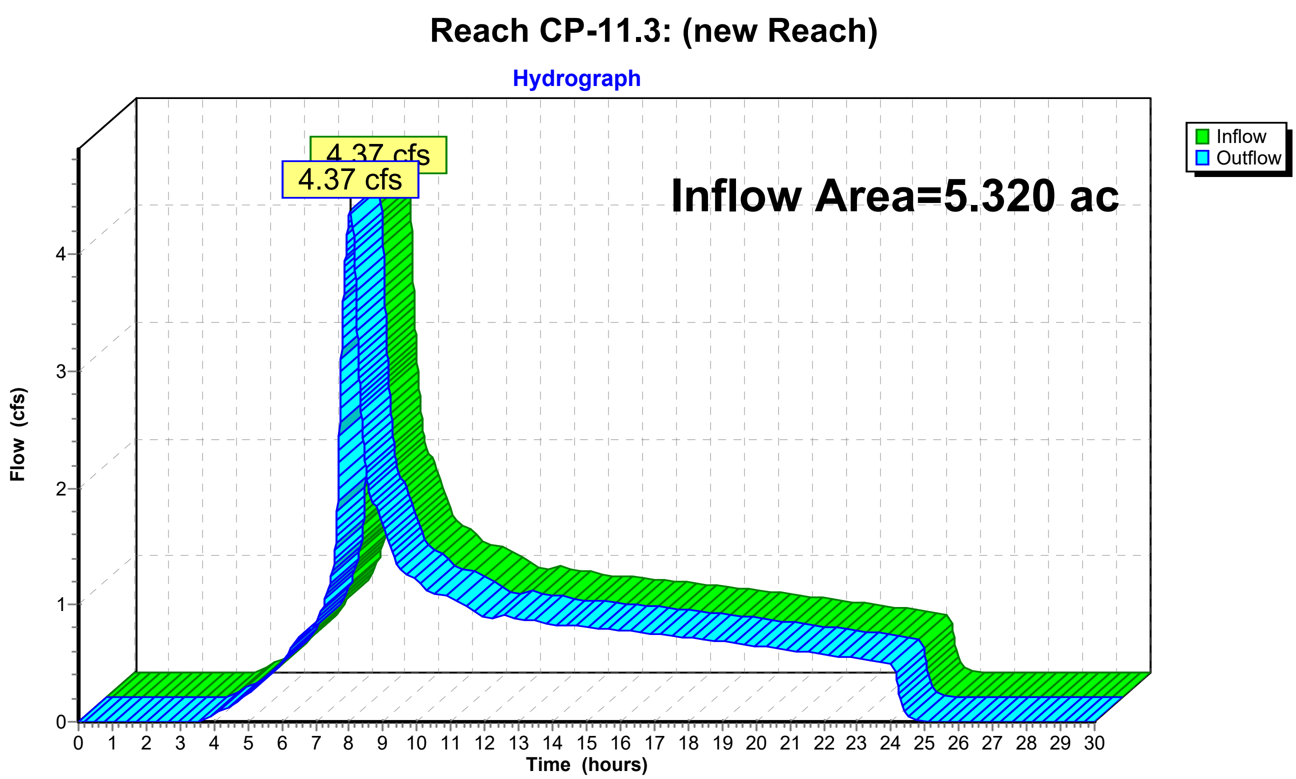


Summary for Reach CP-11.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.320 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.37 cfs @ 8.05 hrs, Volume= 1.478 af
Outflow = 4.37 cfs @ 8.05 hrs, Volume= 1.478 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



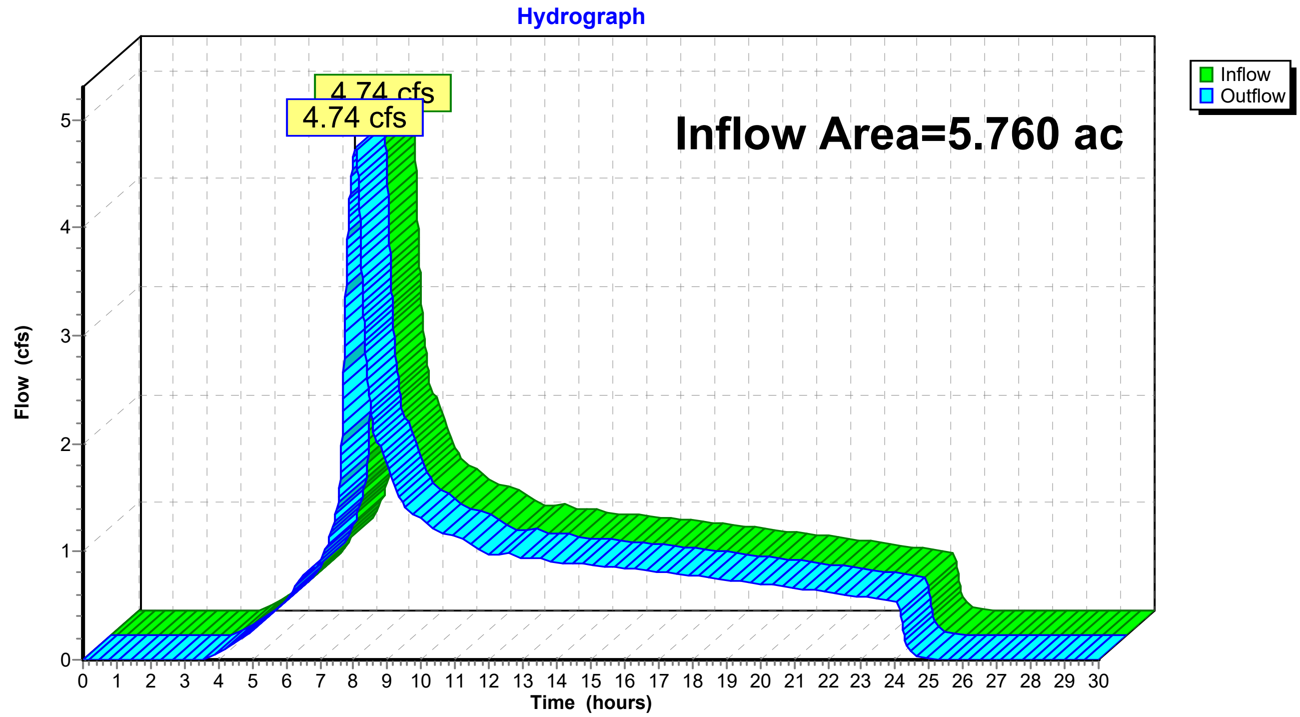
Summary for Reach CP-11.5: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.760 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.74 cfs @ 8.05 hrs, Volume= 1.600 af
Outflow = 4.74 cfs @ 8.05 hrs, Volume= 1.600 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-11.5: (new Reach)

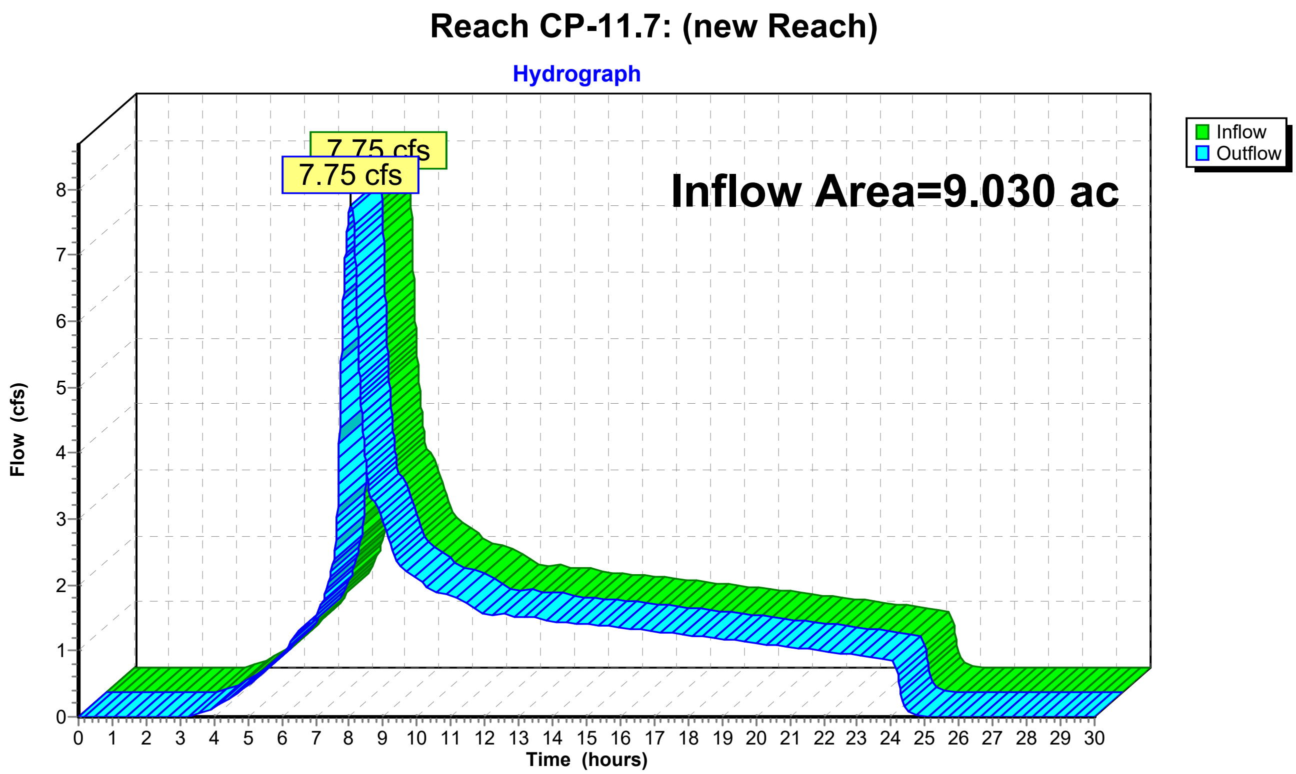


Summary for Reach CP-11.7: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 9.030 ac, 6.09% Impervious, Inflow Depth = 3.44" for 100-yr event
Inflow = 7.75 cfs @ 8.06 hrs, Volume= 2.589 af
Outflow = 7.75 cfs @ 8.06 hrs, Volume= 2.589 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



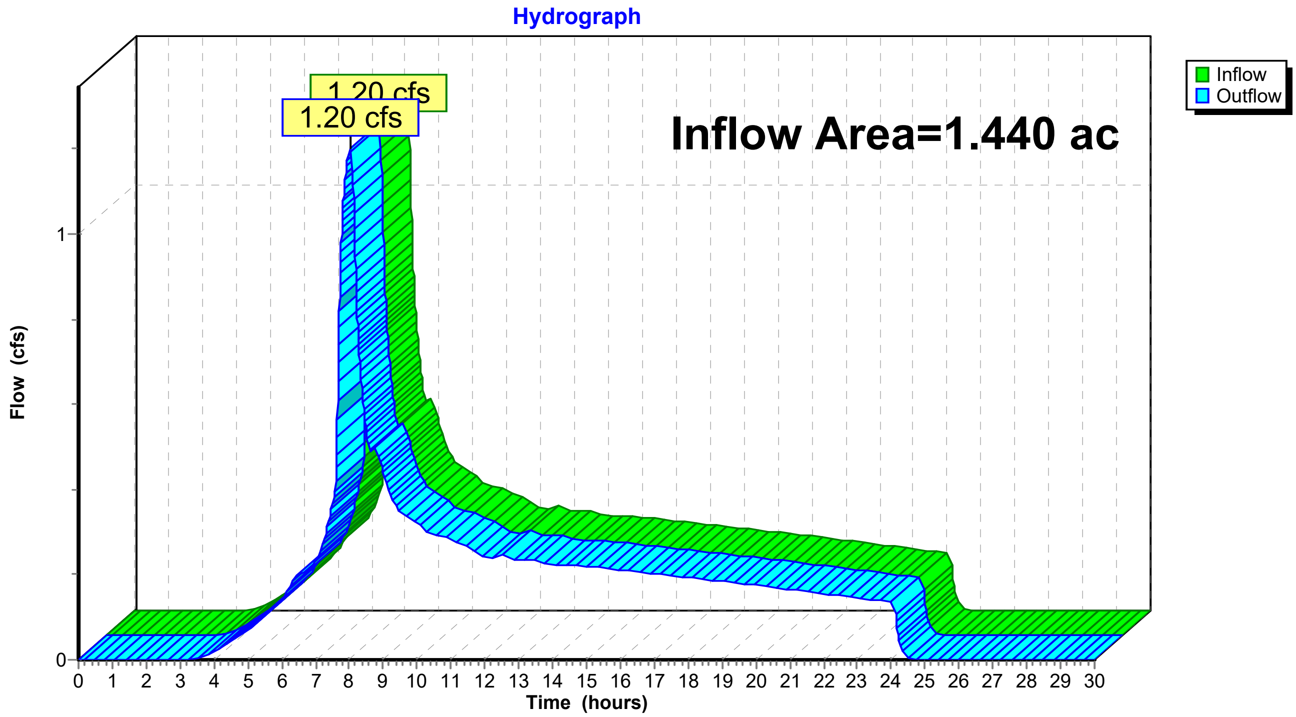
Summary for Reach CP-2.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	1.440 ac,	0.00% Impervious, Inflow Depth = 3.33"	for 100-yr event	
Inflow =	1.20 cfs @	8.02 hrs, Volume=	0.400 af	
Outflow =	1.20 cfs @	8.02 hrs, Volume=	0.400 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-2.1: (new Reach)



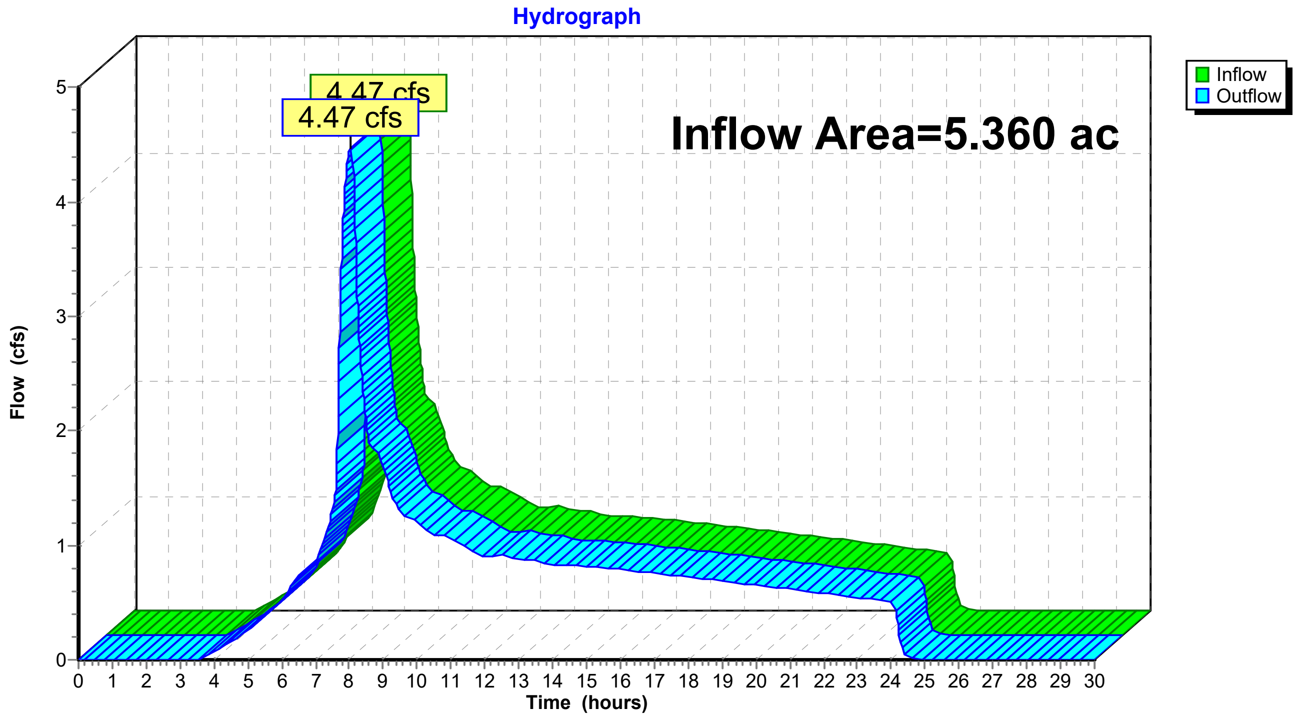
Summary for Reach CP-2.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	5.360 ac,	0.00% Impervious, Inflow Depth = 3.33"	for 100-yr event	
Inflow =	4.47 cfs @	8.04 hrs, Volume=	1.489 af	
Outflow =	4.47 cfs @	8.04 hrs, Volume=	1.489 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-2.2: (new Reach)



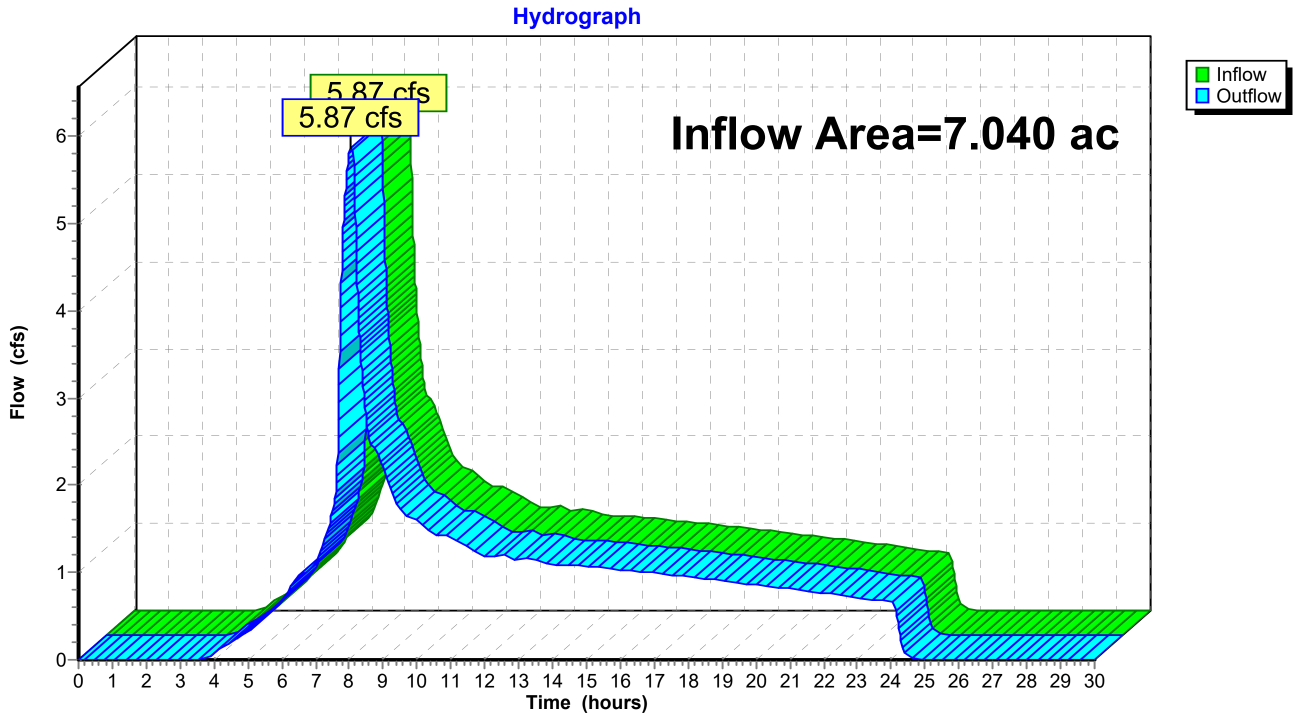
Summary for Reach CP-2.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7.040 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 5.87 cfs @ 8.06 hrs, Volume= 1.956 af
Outflow = 5.87 cfs @ 8.06 hrs, Volume= 1.956 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-2.3: (new Reach)

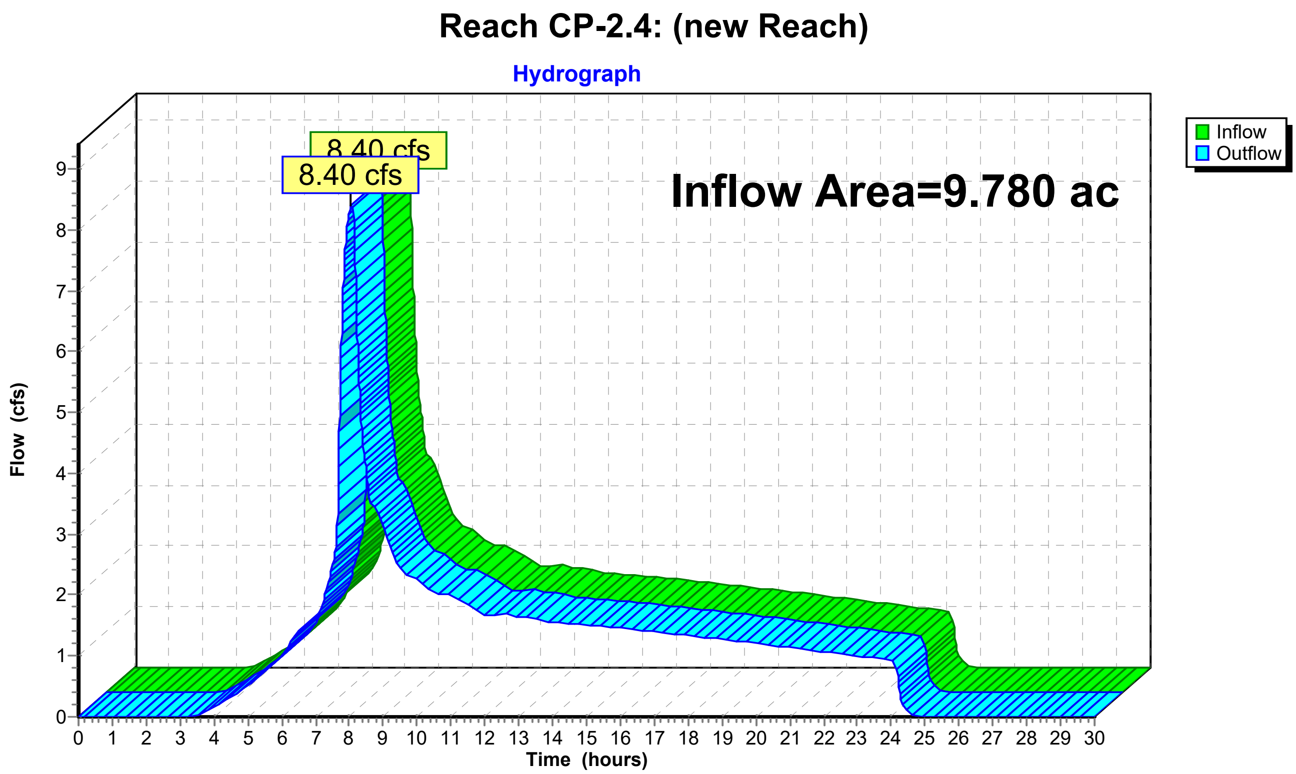


Summary for Reach CP-2.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 9.780 ac, 4.70% Impervious, Inflow Depth = 3.42" for 100-yr event
Inflow = 8.40 cfs @ 8.06 hrs, Volume= 2.784 af
Outflow = 8.40 cfs @ 8.06 hrs, Volume= 2.784 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



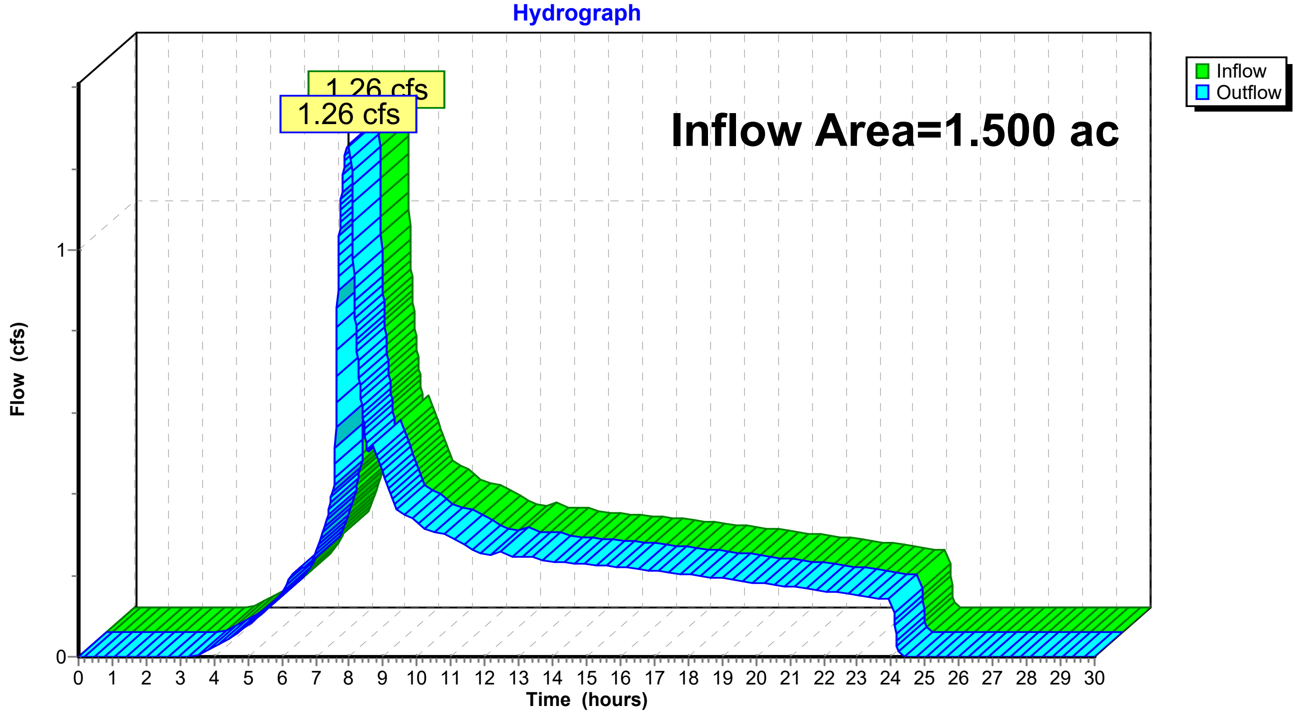
Summary for Reach CP-20.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.26 cfs @ 7.97 hrs, Volume= 0.417 af
Outflow = 1.26 cfs @ 7.97 hrs, Volume= 0.417 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-20.4: (new Reach)

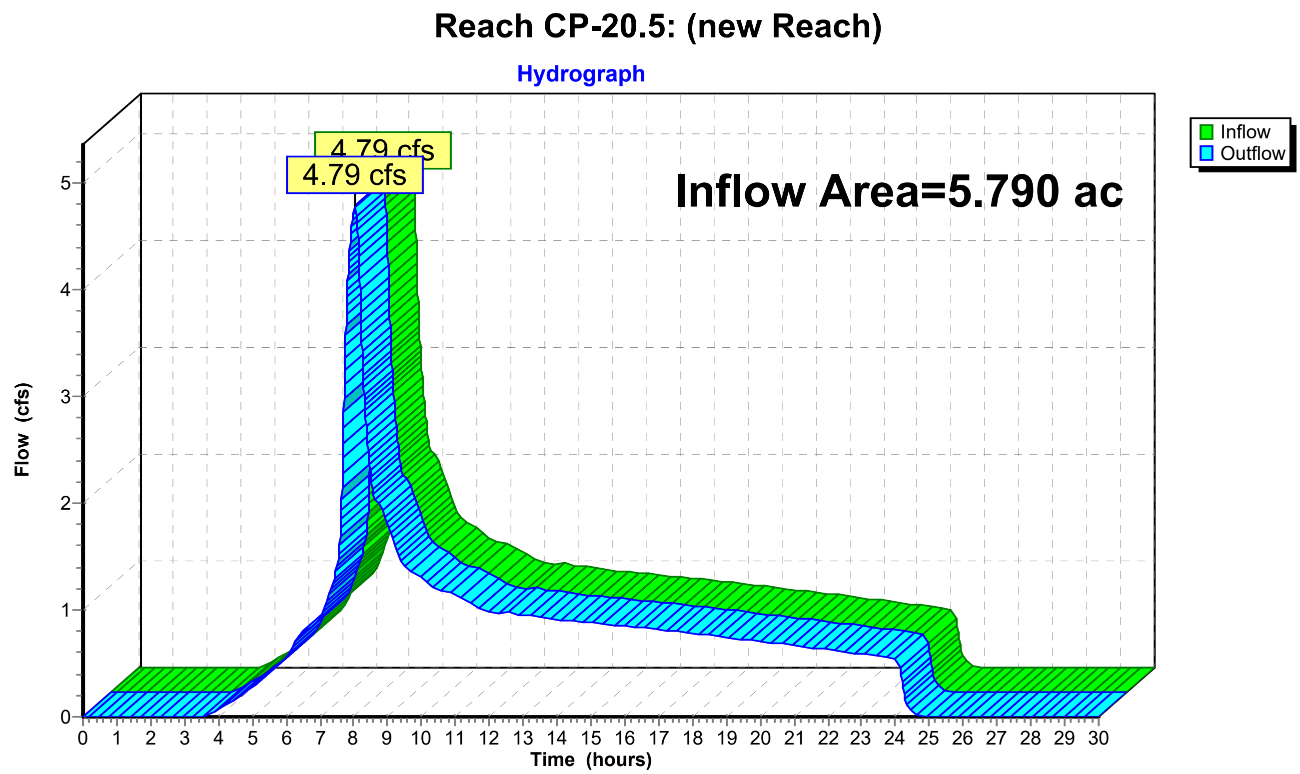


Summary for Reach CP-20.5: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.790 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.79 cfs @ 8.04 hrs, Volume= 1.608 af
Outflow = 4.79 cfs @ 8.04 hrs, Volume= 1.608 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



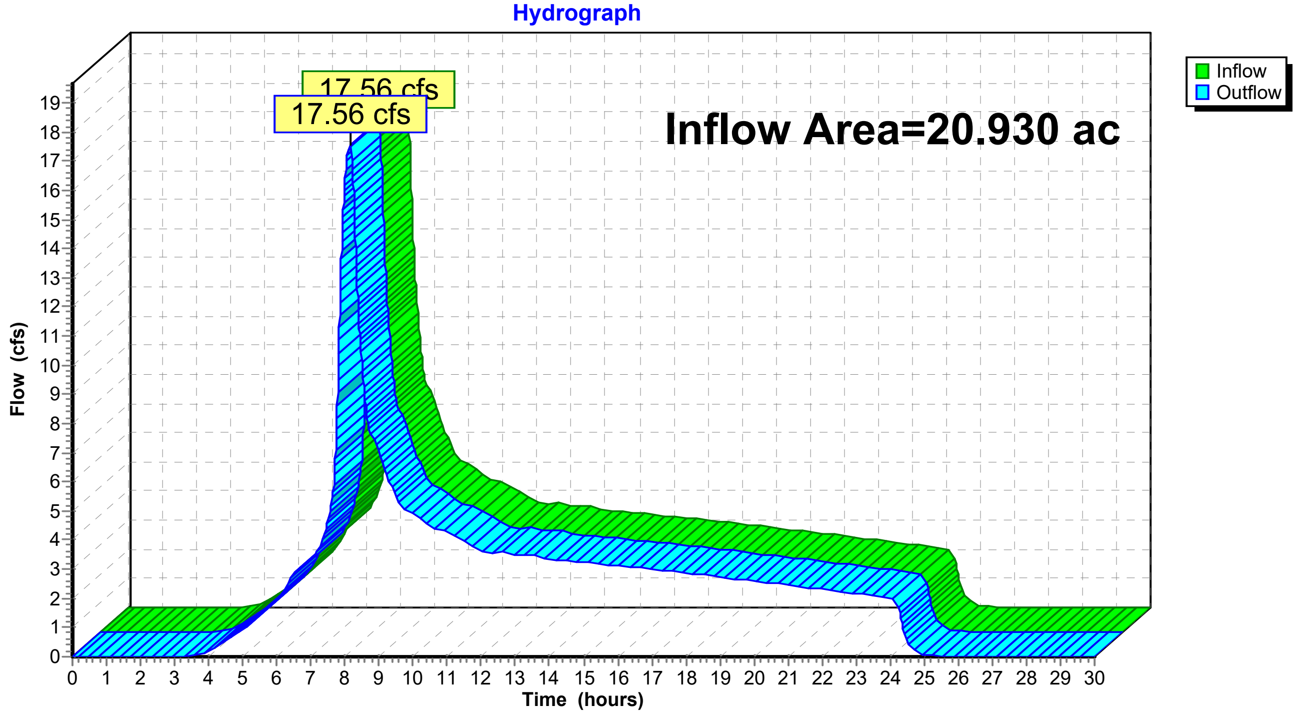
Summary for Reach CP-21.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 20.930 ac, 4.11% Impervious, Inflow Depth = 3.41" for 100-yr event
Inflow = 17.56 cfs @ 8.14 hrs, Volume= 5.940 af
Outflow = 17.56 cfs @ 8.14 hrs, Volume= 5.940 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-21.1: (new Reach)



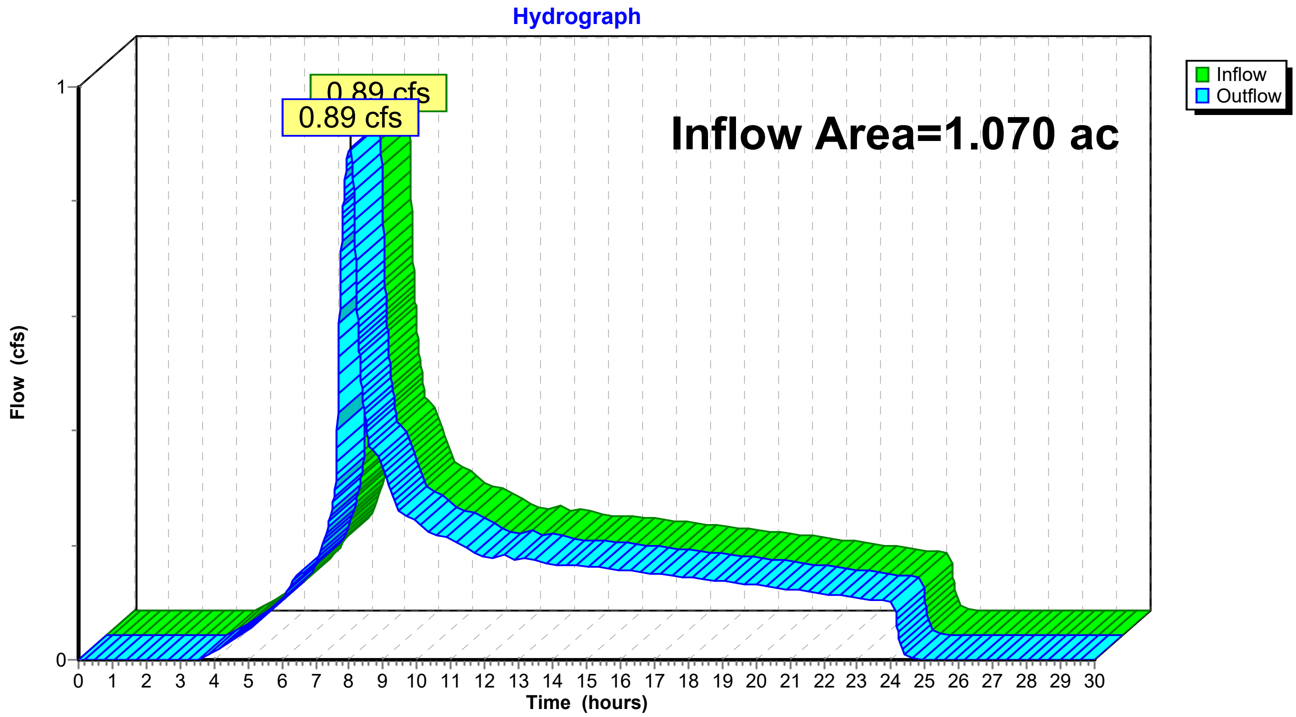
Summary for Reach CP-22.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.070 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.89 cfs @ 8.03 hrs, Volume= 0.297 af
Outflow = 0.89 cfs @ 8.03 hrs, Volume= 0.297 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-22.1: (new Reach)

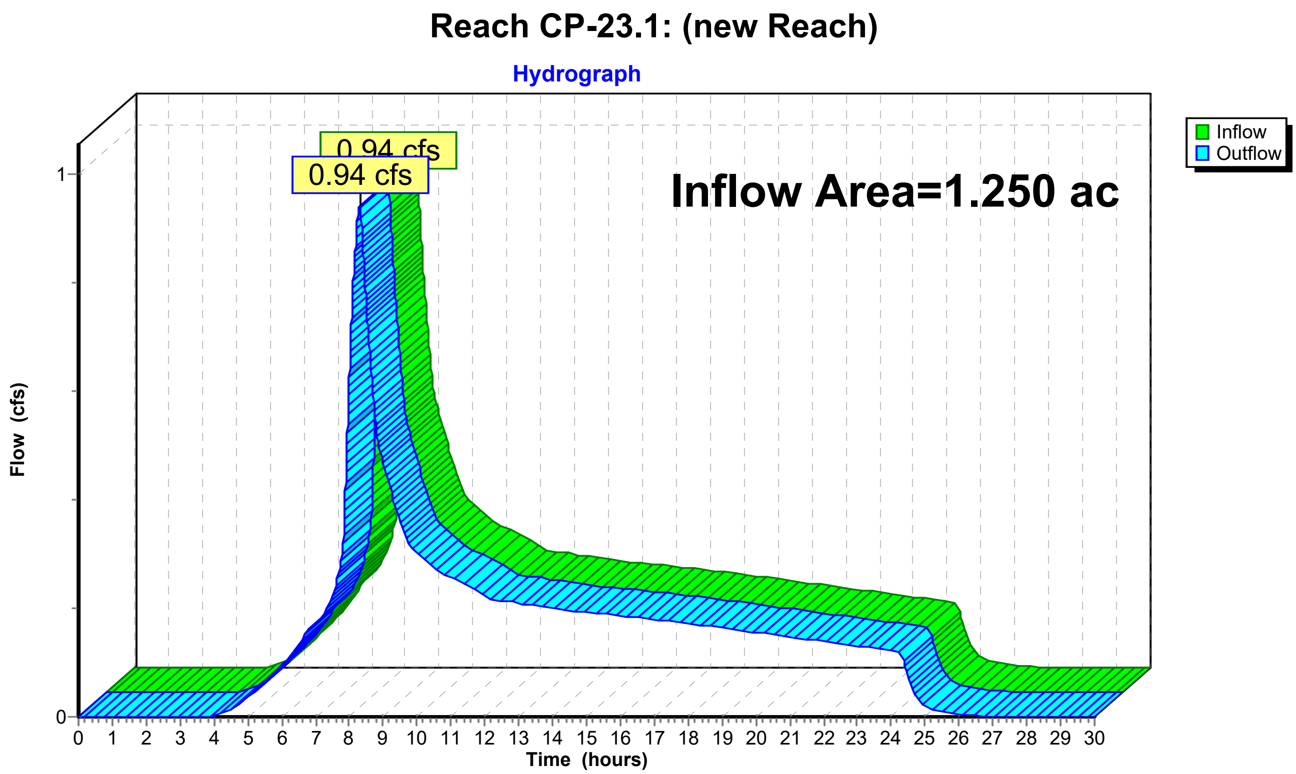


Summary for Reach CP-23.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.250 ac, 0.00% Impervious, Inflow Depth > 3.33" for 100-yr event
Inflow = 0.94 cfs @ 8.30 hrs, Volume= 0.347 af
Outflow = 0.94 cfs @ 8.30 hrs, Volume= 0.347 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



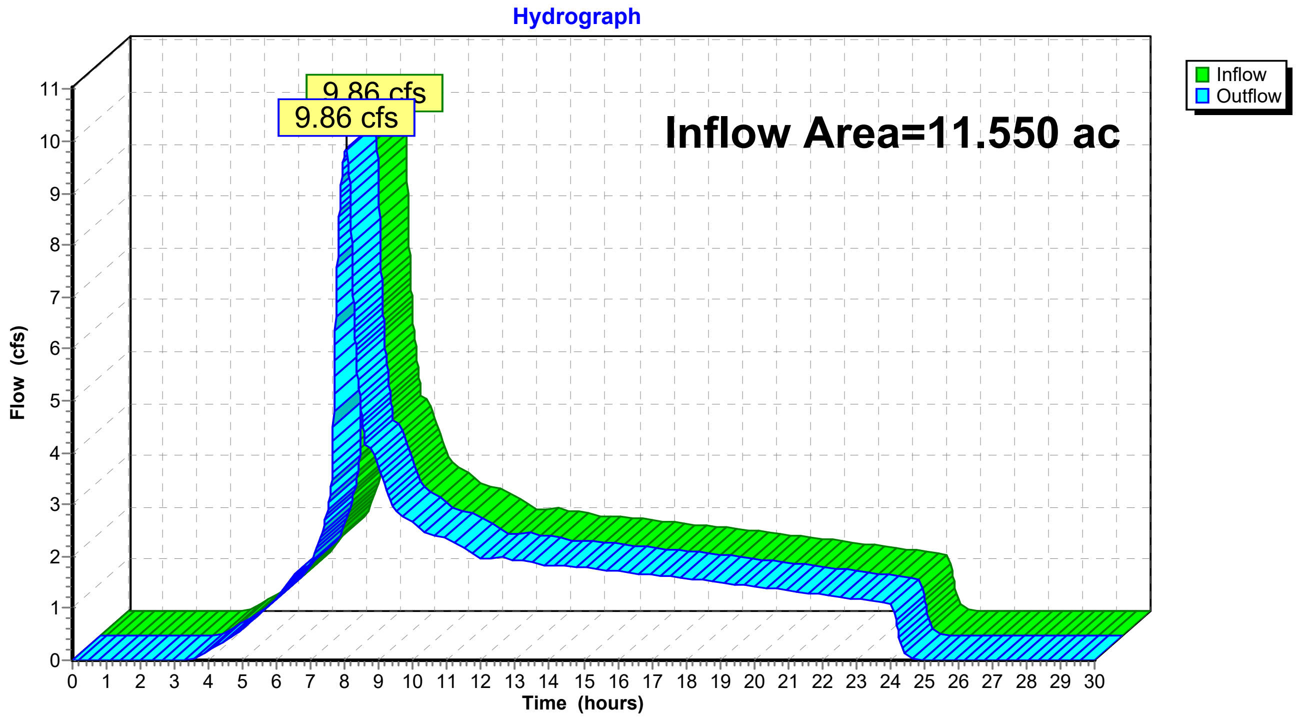
Summary for Reach CP-3.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.550 ac, 3.98% Impervious, Inflow Depth = 3.40" for 100-yr event
Inflow = 9.86 cfs @ 8.05 hrs, Volume= 3.276 af
Outflow = 9.86 cfs @ 8.05 hrs, Volume= 3.276 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-3.1: (new Reach)



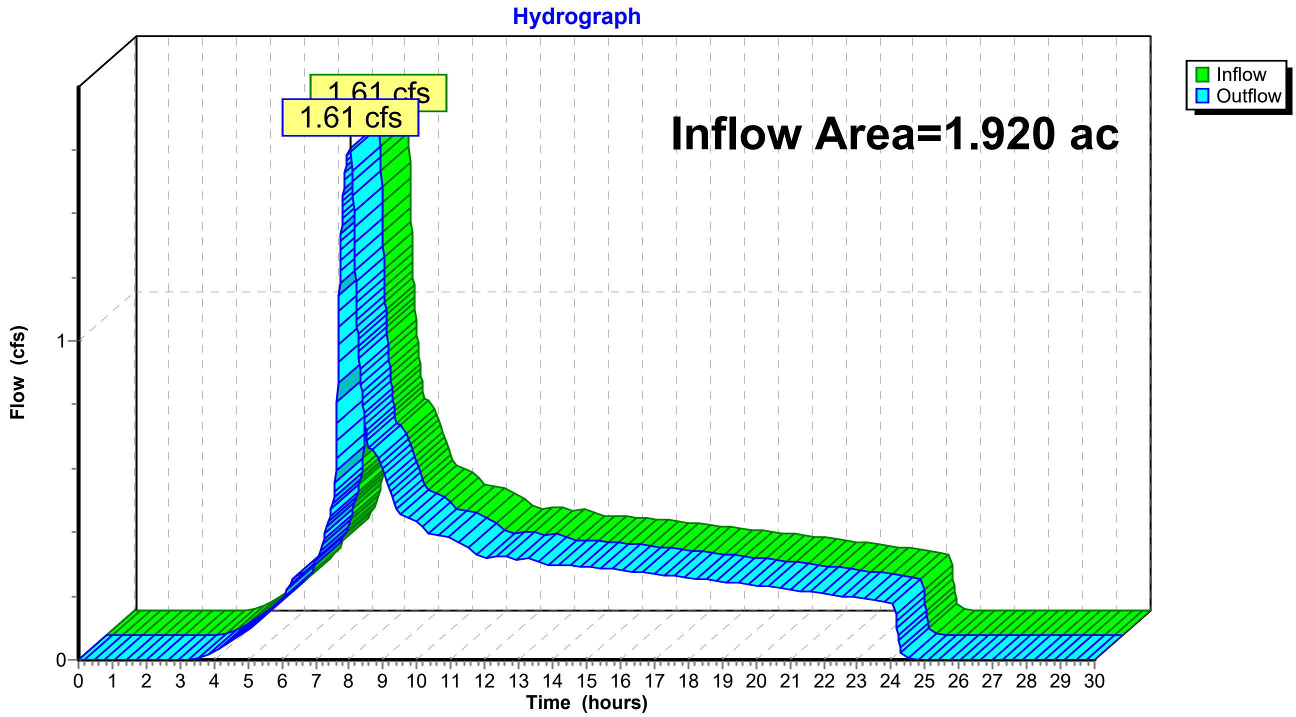
Summary for Reach CP-4A.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.920 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.61 cfs @ 8.01 hrs, Volume= 0.533 af
Outflow = 1.61 cfs @ 8.01 hrs, Volume= 0.533 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-4A.2: (new Reach)

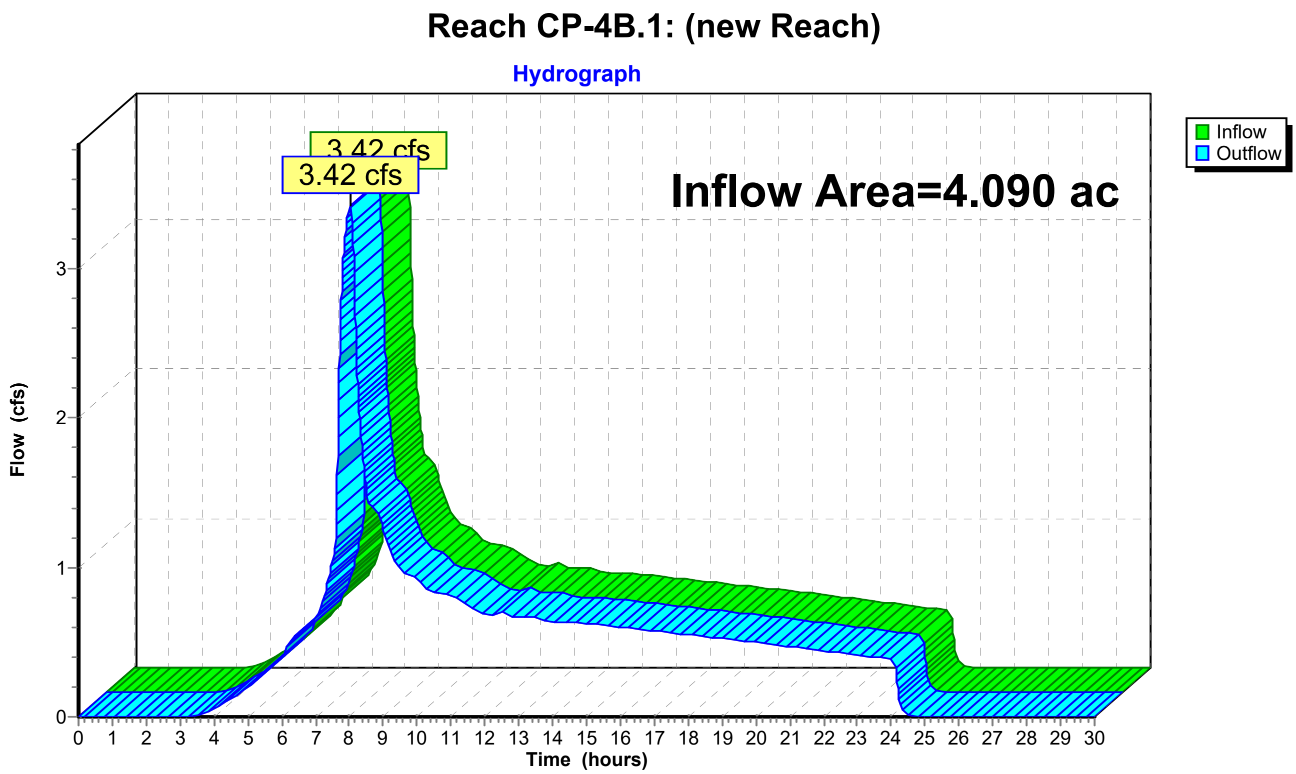


Summary for Reach CP-4B.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	4.090 ac,	0.00% Impervious,	Inflow Depth = 3.33"	for 100-yr event
Inflow =	3.42 cfs @	8.02 hrs, Volume=	1.136 af	
Outflow =	3.42 cfs @	8.02 hrs, Volume=	1.136 af, Atten= 0%, Lag= 0.0 min	

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



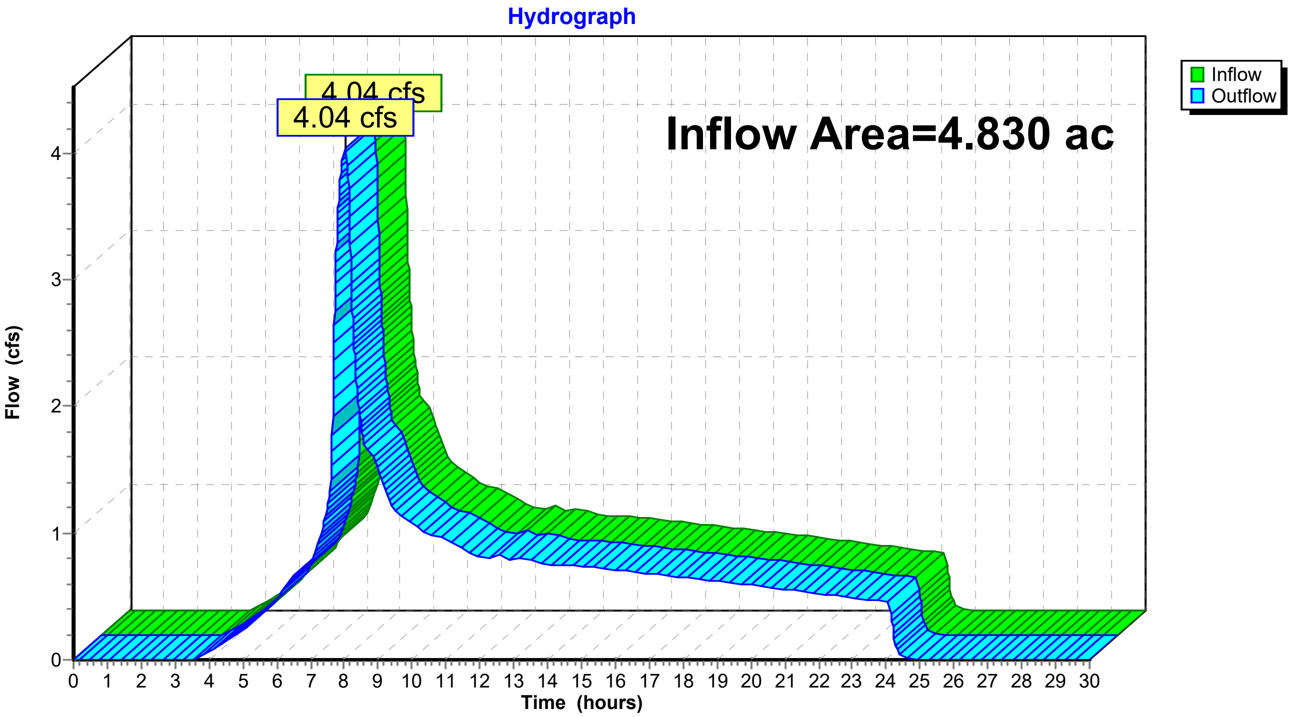
Summary for Reach CP-4B.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.830 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.04 cfs @ 8.03 hrs, Volume= 1.342 af
Outflow = 4.04 cfs @ 8.03 hrs, Volume= 1.342 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-4B.2: (new Reach)

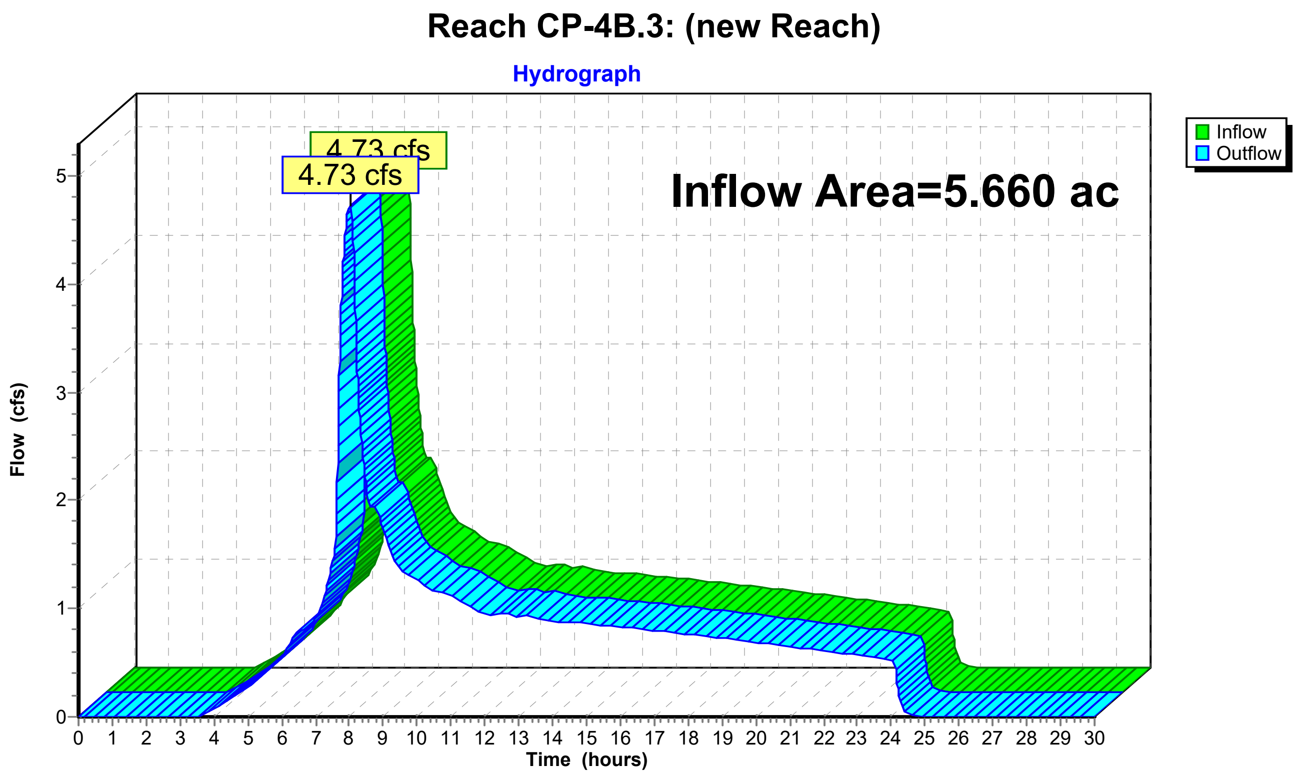


Summary for Reach CP-4B.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.660 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.73 cfs @ 8.02 hrs, Volume= 1.572 af
Outflow = 4.73 cfs @ 8.02 hrs, Volume= 1.572 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



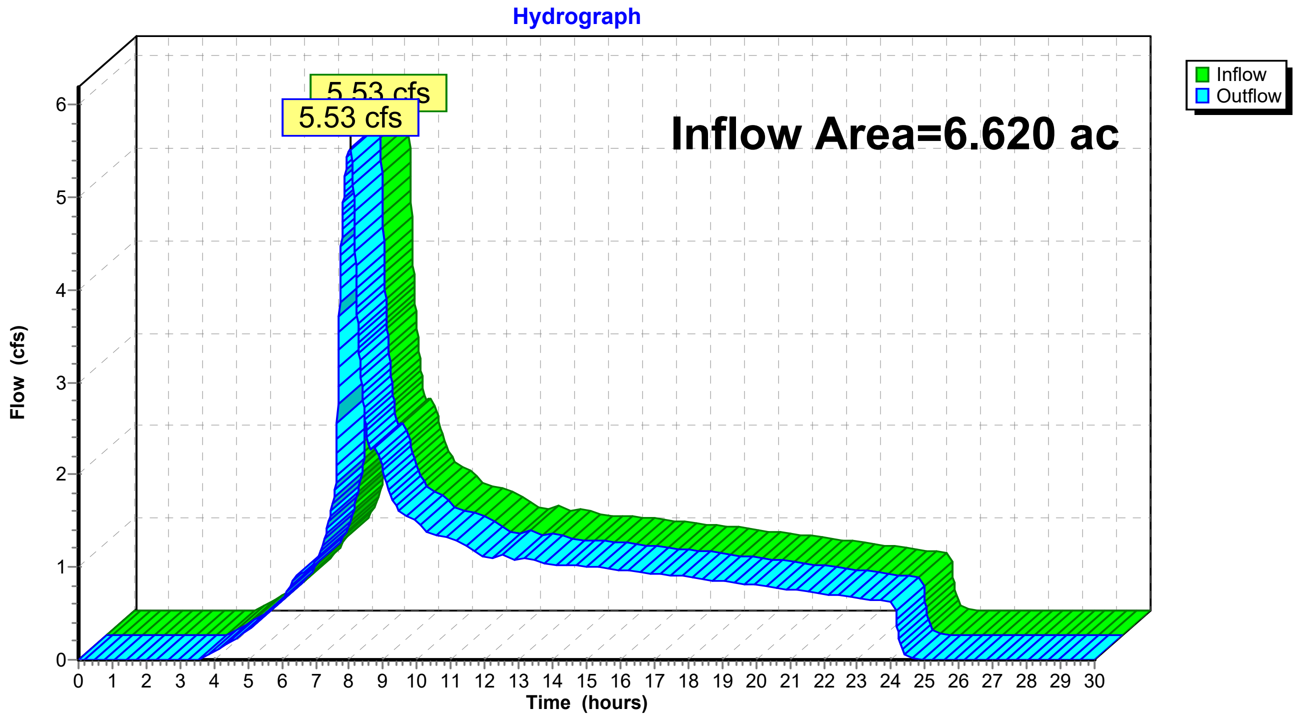
Summary for Reach CP-4B.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.620 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 5.53 cfs @ 8.02 hrs, Volume= 1.839 af
Outflow = 5.53 cfs @ 8.02 hrs, Volume= 1.839 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-4B.4: (new Reach)



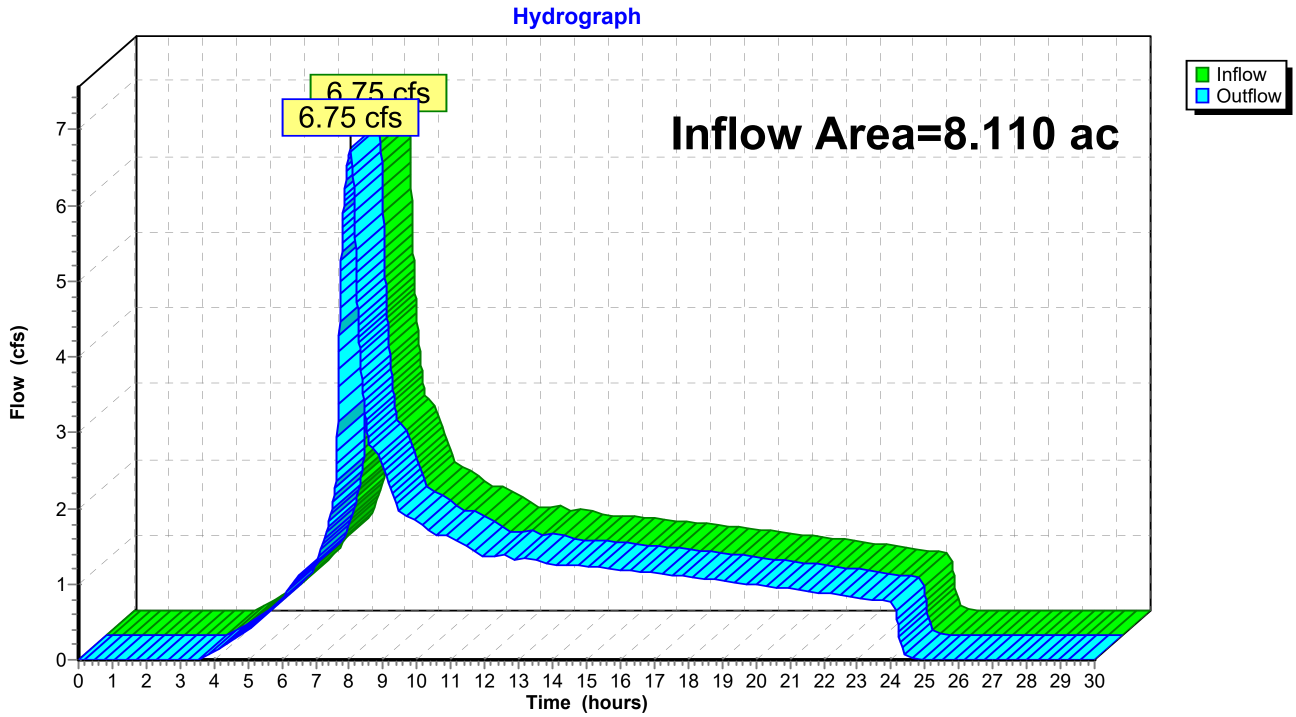
Summary for Reach CP-4B.5: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	8.110 ac,	0.00% Impervious, Inflow Depth = 3.33"	for 100-yr event
Inflow =	6.75 cfs @	8.04 hrs, Volume=	2.253 af
Outflow =	6.75 cfs @	8.04 hrs, Volume=	2.253 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-4B.5: (new Reach)

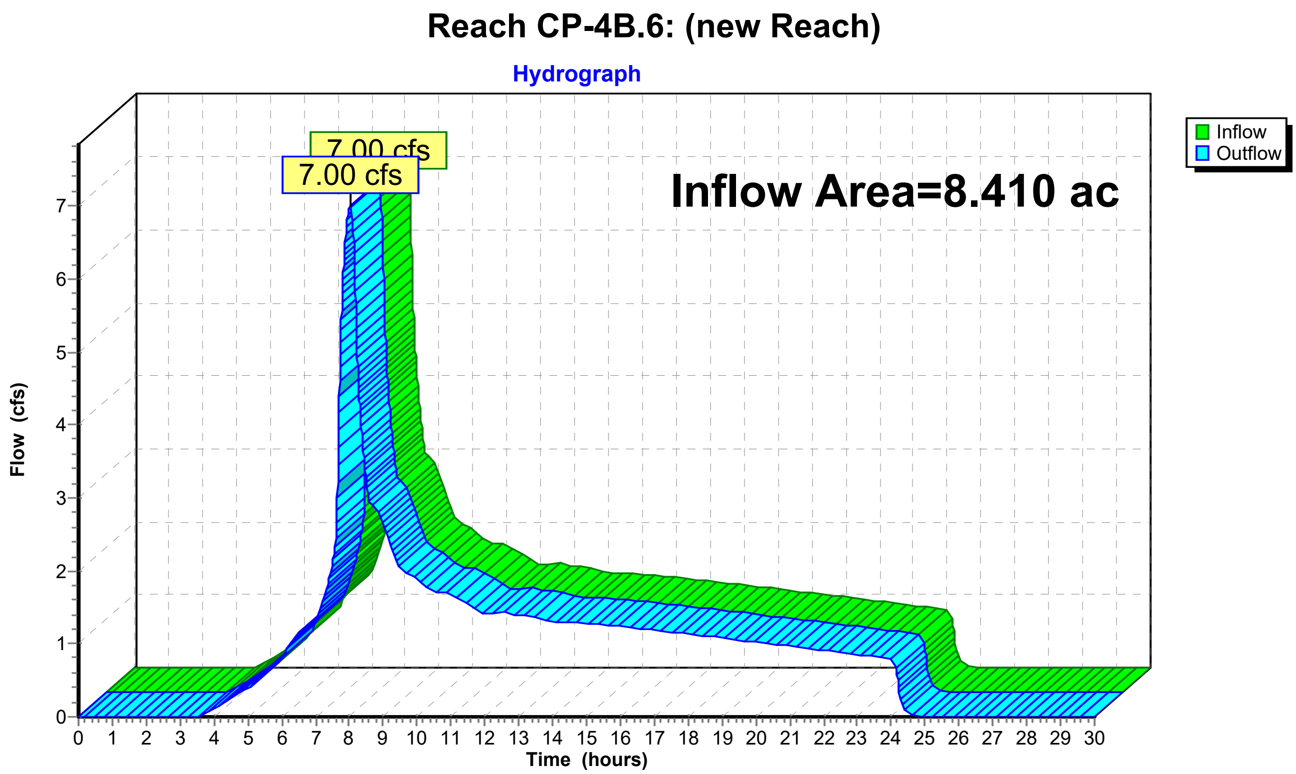


Summary for Reach CP-4B.6: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 8.410 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 7.00 cfs @ 8.04 hrs, Volume= 2.336 af
Outflow = 7.00 cfs @ 8.04 hrs, Volume= 2.336 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

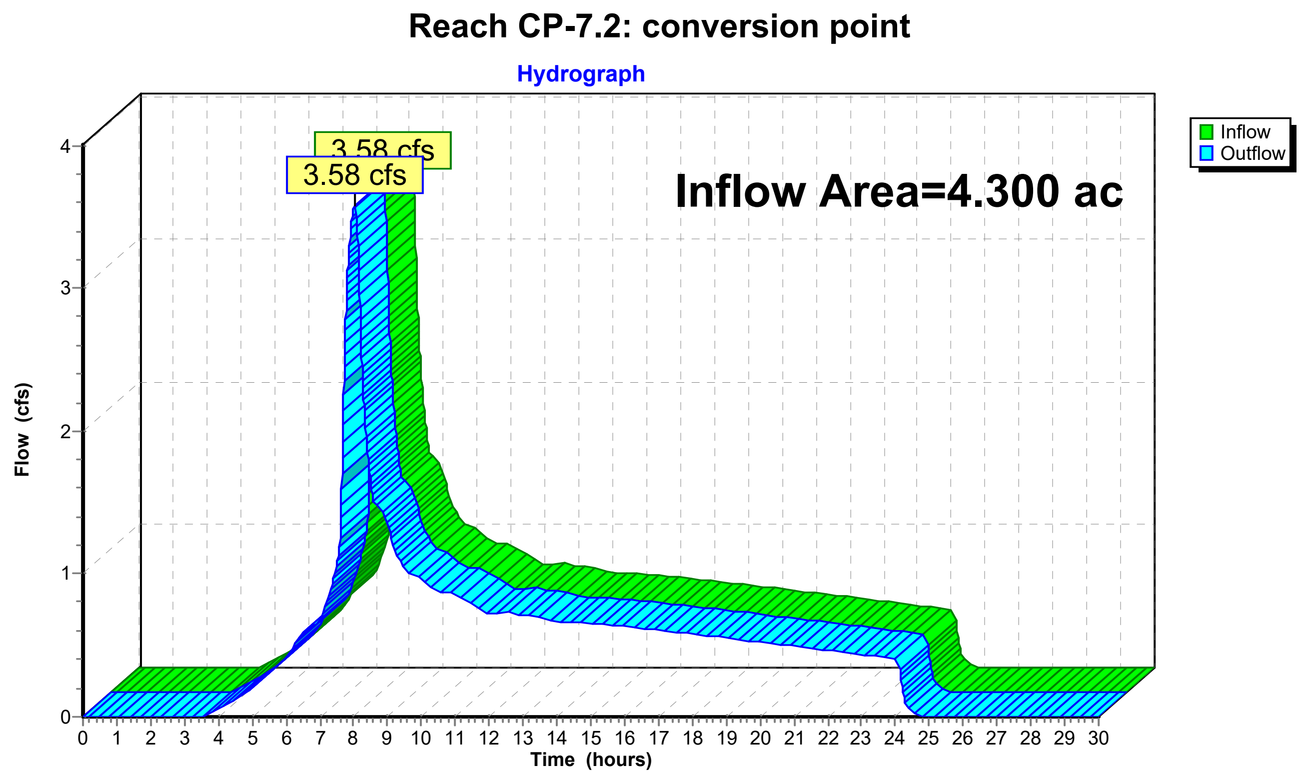


Summary for Reach CP-7.2: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.300 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 3.58 cfs @ 8.04 hrs, Volume= 1.194 af
Outflow = 3.58 cfs @ 8.04 hrs, Volume= 1.194 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



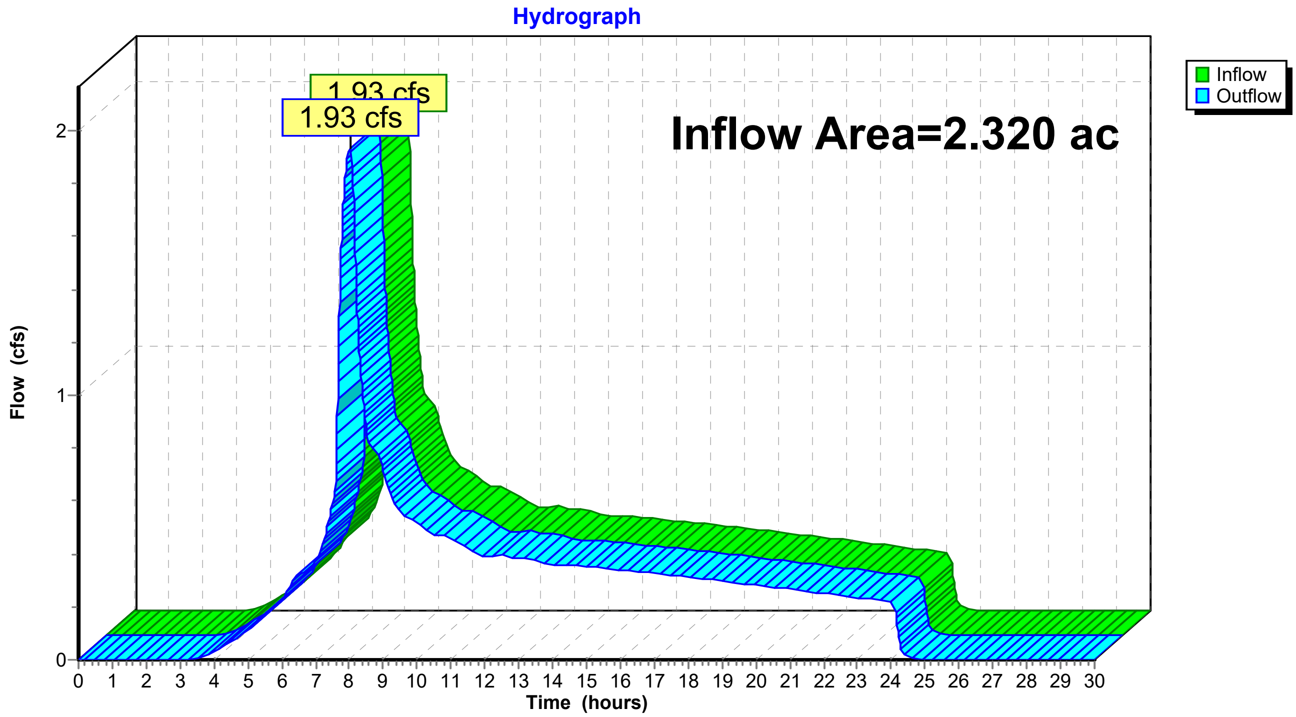
Summary for Reach CP-8.1: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.320 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.93 cfs @ 8.02 hrs, Volume= 0.644 af
Outflow = 1.93 cfs @ 8.02 hrs, Volume= 0.644 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach CP-8.1: conversion point

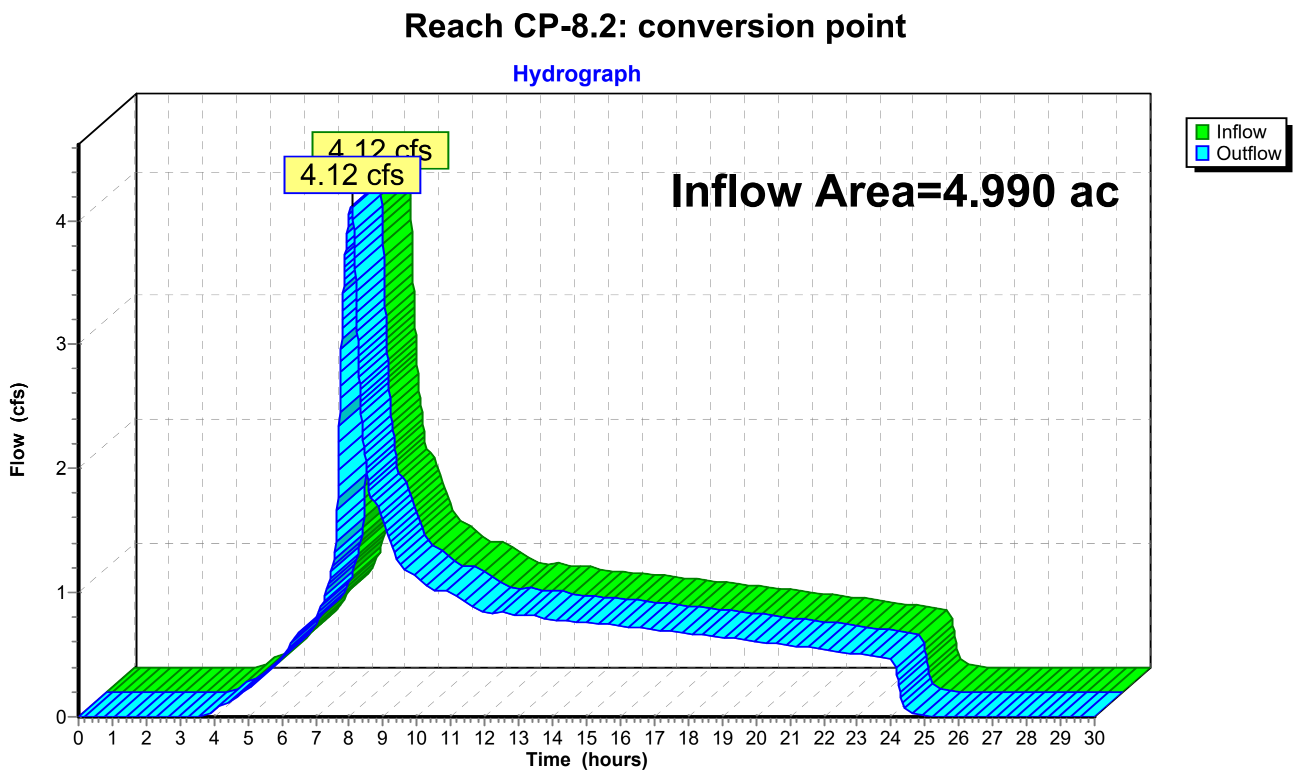


Summary for Reach CP-8.2: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.990 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.12 cfs @ 8.06 hrs, Volume= 1.386 af
Outflow = 4.12 cfs @ 8.06 hrs, Volume= 1.386 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

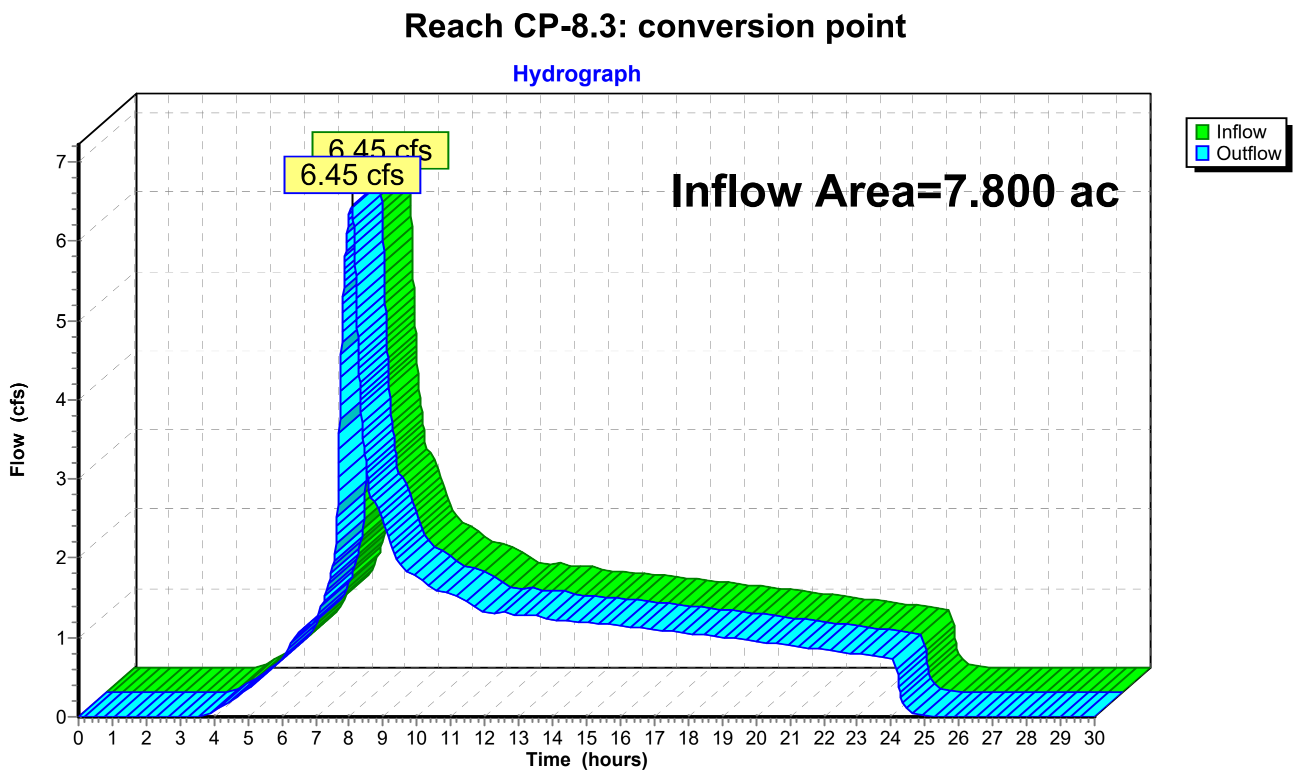


Summary for Reach CP-8.3: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7.800 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 6.45 cfs @ 8.06 hrs, Volume= 2.167 af
Outflow = 6.45 cfs @ 8.06 hrs, Volume= 2.167 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

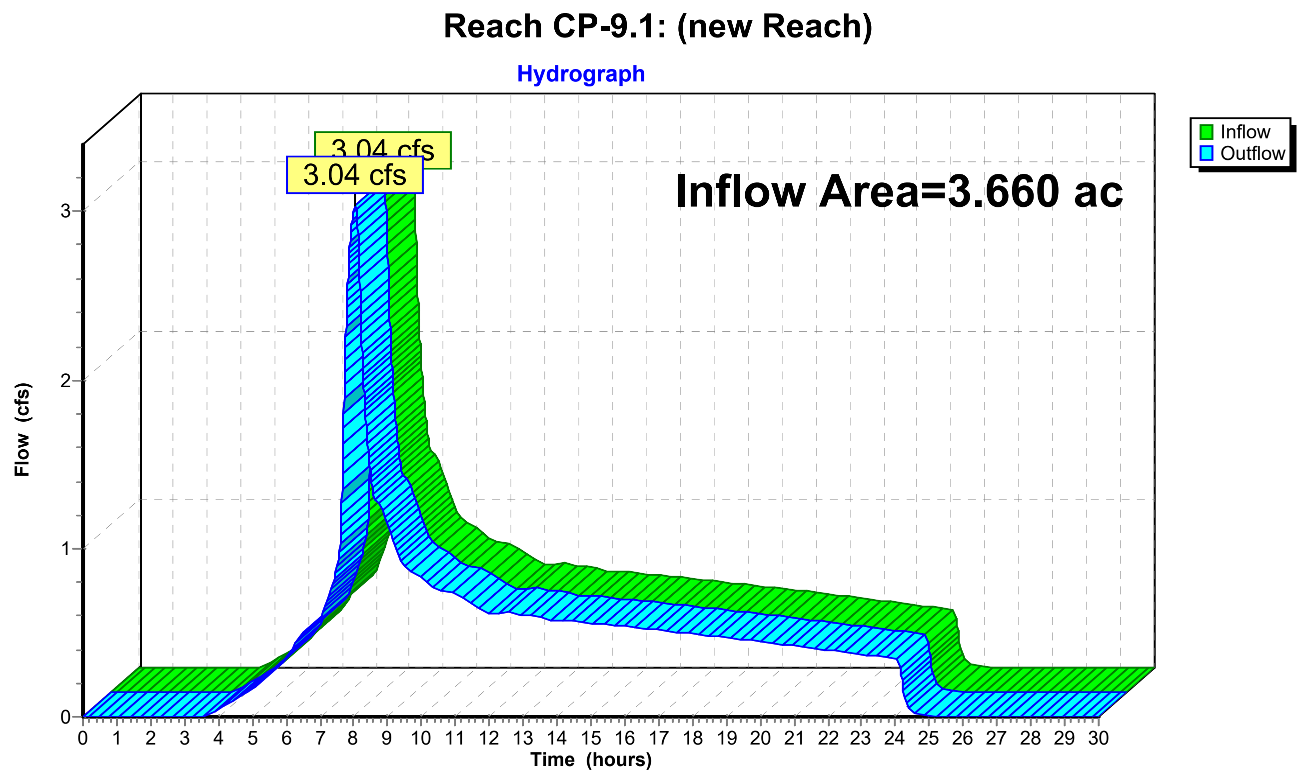


Summary for Reach CP-9.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	3.660 ac,	0.00% Impervious, Inflow Depth = 3.33"	for 100-yr event
Inflow =	3.04 cfs @	8.05 hrs, Volume=	1.017 af
Outflow =	3.04 cfs @	8.05 hrs, Volume=	1.017 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



Summary for Reach CULV-1: (new Reach)

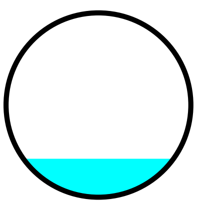
[52] Hint: Inlet/Outlet conditions not evaluated
[81] Warning: Exceeded Pond DI-1 by 0.06' @ 10.07 hrs

Inflow Area = 5.790 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.79 cfs @ 8.03 hrs, Volume= 1.608 af
Outflow = 4.79 cfs @ 8.04 hrs, Volume= 1.608 af, Atten= 0%, Lag= 0.1 min

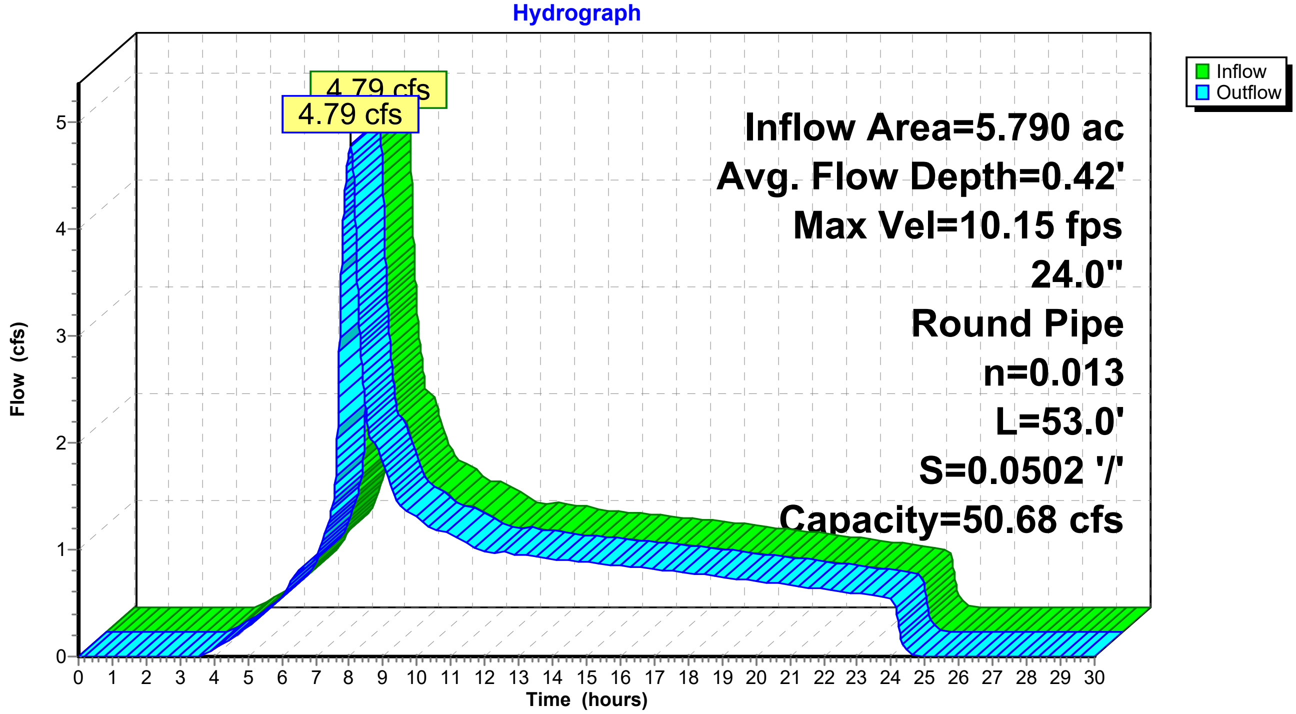
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.15 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.51 fps, Avg. Travel Time= 0.2 min

Peak Storage= 25 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 50.68 cfs

24.0" Round Pipe
n= 0.013
Length= 53.0' Slope= 0.0502 '/'
Inlet Invert= 150.97', Outlet Invert= 148.31'



Reach CULV-1: (new Reach)



Summary for Reach CULV-2: (new Reach)

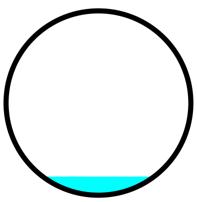
[52] Hint: Inlet/Outlet conditions not evaluated
[81] Warning: Exceeded Pond DI-2 by 0.12' @ 7.98 hrs

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.26 cfs @ 7.96 hrs, Volume= 0.417 af
Outflow = 1.26 cfs @ 7.97 hrs, Volume= 0.417 af, Atten= 0%, Lag= 0.8 min

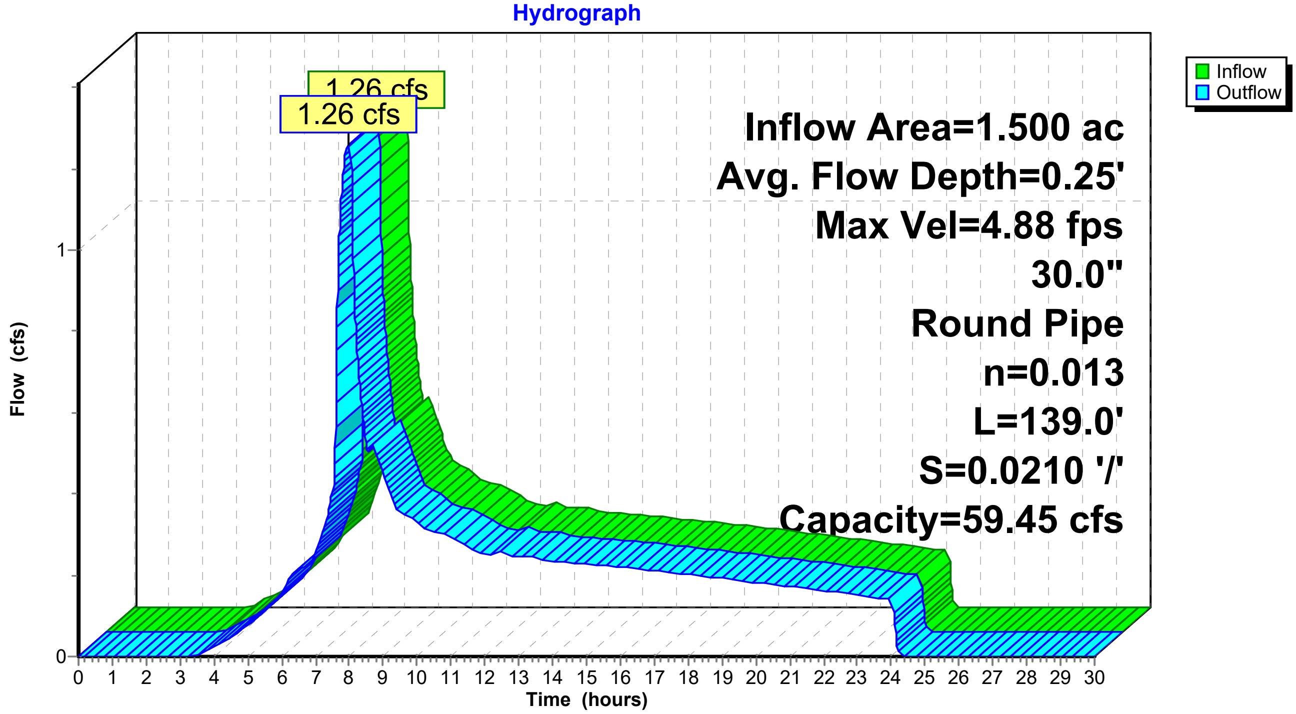
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.88 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 2.82 fps, Avg. Travel Time= 0.8 min

Peak Storage= 36 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 2.50' Flow Area= 4.9 sf, Capacity= 59.45 cfs

30.0" Round Pipe
n= 0.013
Length= 139.0' Slope= 0.0210 '/'
Inlet Invert= 151.71', Outlet Invert= 148.79'



Reach CULV-2: (new Reach)



Summary for Reach CULV-2.2: (new Reach)

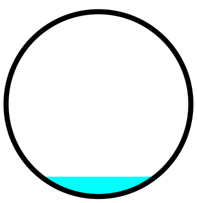
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.26 cfs @ 7.97 hrs, Volume= 0.417 af
Outflow = 1.26 cfs @ 7.98 hrs, Volume= 0.417 af, Atten= 0%, Lag= 0.8 min

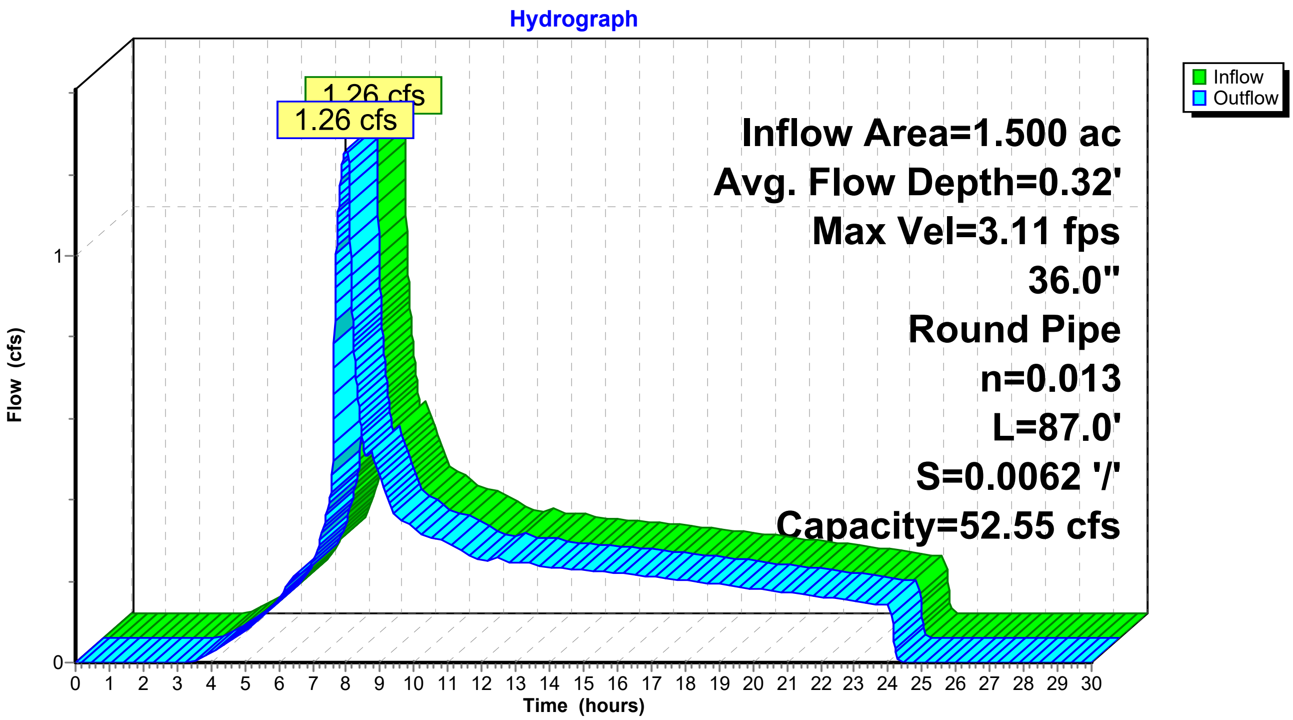
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 3.11 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 1.79 fps, Avg. Travel Time= 0.8 min

Peak Storage= 35 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 3.00' Flow Area= 7.1 sf, Capacity= 52.55 cfs

36.0" Round Pipe
n= 0.013
Length= 87.0' Slope= 0.0062 '/'
Inlet Invert= 148.79', Outlet Invert= 148.25'



Reach CULV-2.2: (new Reach)



Summary for Reach CULV-3: (new Reach)

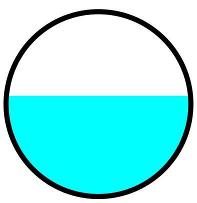
[52] Hint: Inlet/Outlet conditions not evaluated

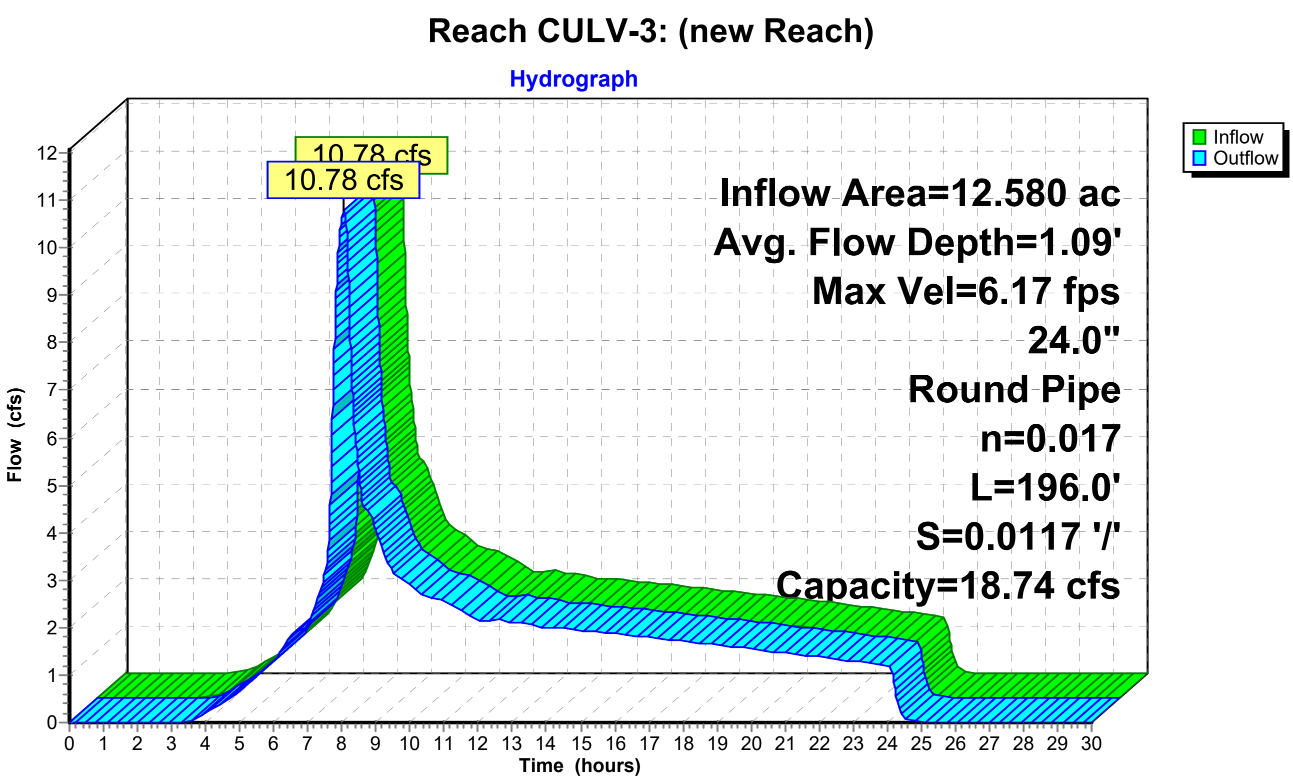
Inflow Area = 12.580 ac, 5.01% Impervious, Inflow Depth = 3.42" for 100-yr event
Inflow = 10.78 cfs @ 8.04 hrs, Volume= 3.588 af
Outflow = 10.78 cfs @ 8.05 hrs, Volume= 3.588 af, Atten= 0%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.17 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.20 fps, Avg. Travel Time= 1.0 min

Peak Storage= 342 cf @ 8.04 hrs
Average Depth at Peak Storage= 1.09'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 18.74 cfs

24.0" Round Pipe
n= 0.017
Length= 196.0' Slope= 0.0117 '/'
Inlet Invert= 140.30', Outlet Invert= 138.00'





Summary for Reach CULV-4: (new Reach)

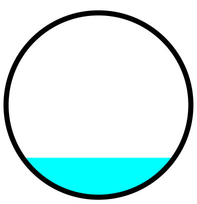
[52] Hint: Inlet/Outlet conditions not evaluated
[81] Warning: Exceeded Pond 1P by 0.07' @ 9.34 hrs

Inflow Area = 5.500 ac, 5.64% Impervious, Inflow Depth = 3.43" for 100-yr event
Inflow = 4.74 cfs @ 8.04 hrs, Volume= 1.573 af
Outflow = 4.74 cfs @ 8.04 hrs, Volume= 1.573 af, Atten= 0%, Lag= 0.2 min

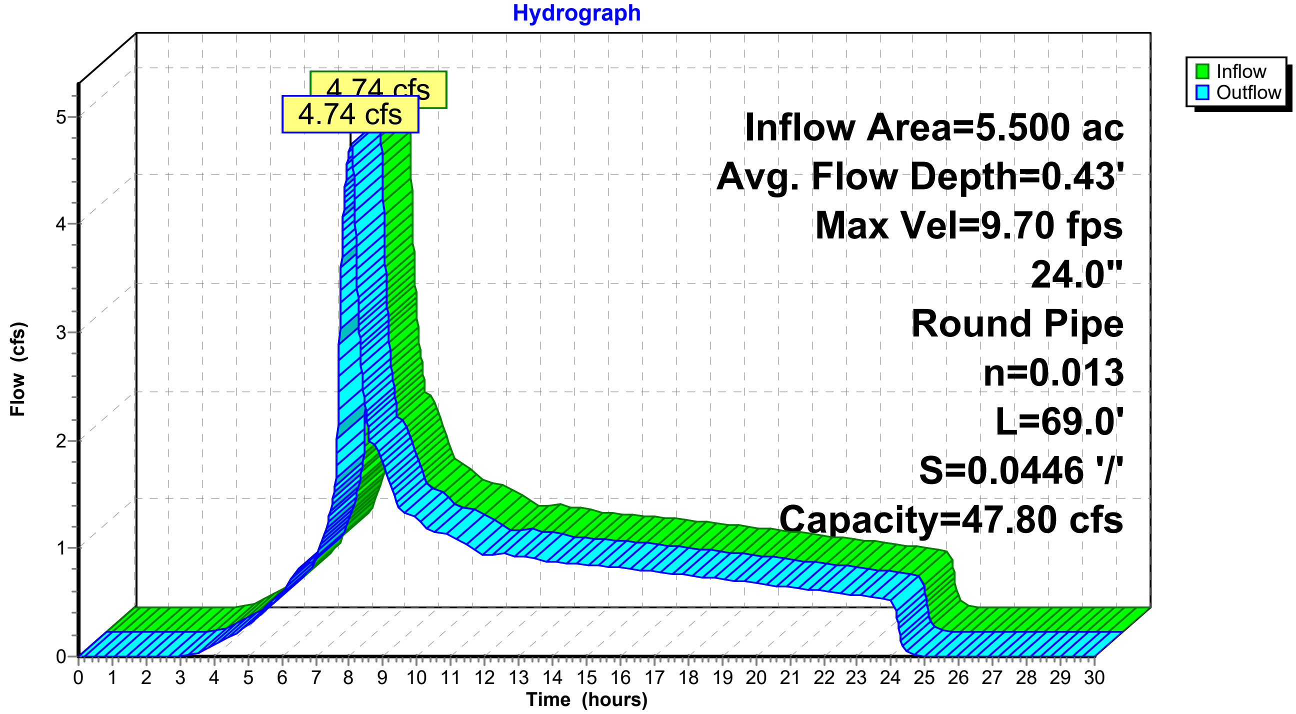
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.70 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.19 fps, Avg. Travel Time= 0.2 min

Peak Storage= 34 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 47.80 cfs

24.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 69.0' Slope= 0.0446 '/'
Inlet Invert= 231.41', Outlet Invert= 228.33'



Reach CULV-4: (new Reach)



Summary for Reach CULV-5: (new Reach)

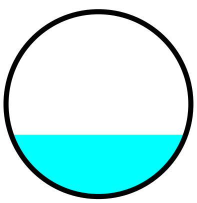
[52] Hint: Inlet/Outlet conditions not evaluated

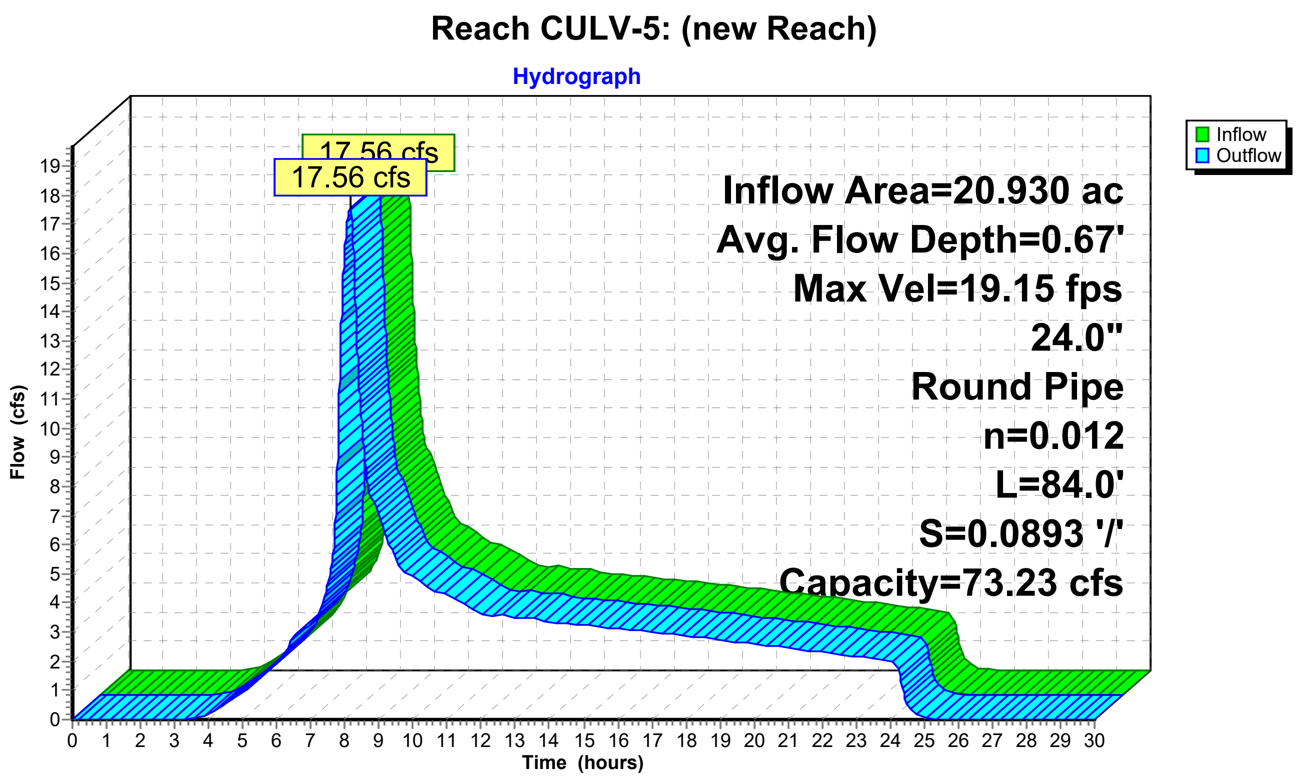
Inflow Area = 20.930 ac, 4.11% Impervious, Inflow Depth = 3.41" for 100-yr event
Inflow = 17.56 cfs @ 8.14 hrs, Volume= 5.940 af
Outflow = 17.56 cfs @ 8.14 hrs, Volume= 5.940 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 19.15 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 9.68 fps, Avg. Travel Time= 0.1 min

Peak Storage= 77 cf @ 8.14 hrs
Average Depth at Peak Storage= 0.67'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 73.23 cfs

24.0" Round Pipe
n= 0.012 Corrugated PP, smooth interior
Length= 84.0' Slope= 0.0893 '/'
Inlet Invert= 153.00', Outlet Invert= 145.50'





Summary for Reach CULV-7: (new Reach)

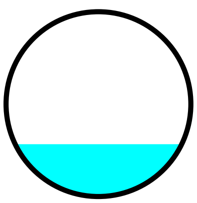
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 8.770 ac, 5.70% Impervious, Inflow Depth = 3.44" for 100-yr event
Inflow = 7.51 cfs @ 8.06 hrs, Volume= 2.510 af
Outflow = 7.51 cfs @ 8.06 hrs, Volume= 2.510 af, Atten= 0%, Lag= 0.3 min

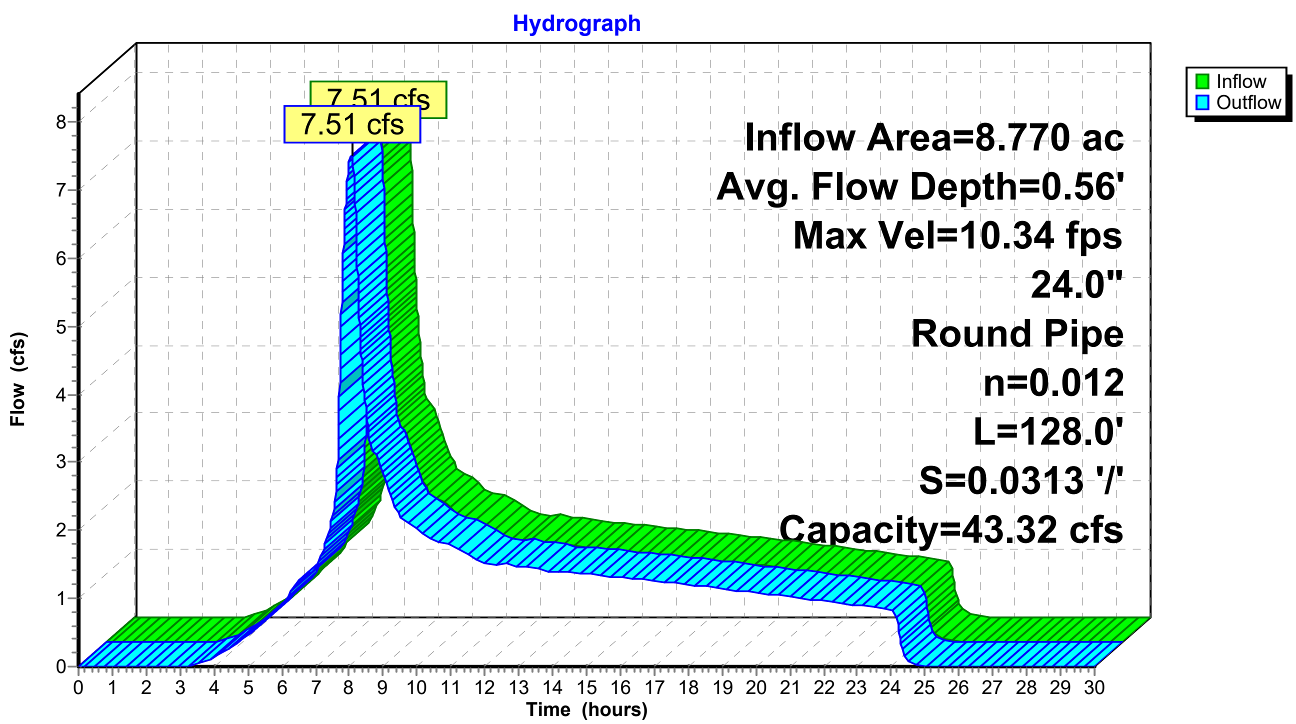
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.34 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 5.37 fps, Avg. Travel Time= 0.4 min

Peak Storage= 93 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.56'
Bank-Full Depth= 2.00' Flow Area= 3.1 sf, Capacity= 43.32 cfs

24.0" Round Pipe
n= 0.012
Length= 128.0' Slope= 0.0313 '/'
Inlet Invert= 162.00', Outlet Invert= 158.00'



Reach CULV-7: (new Reach)



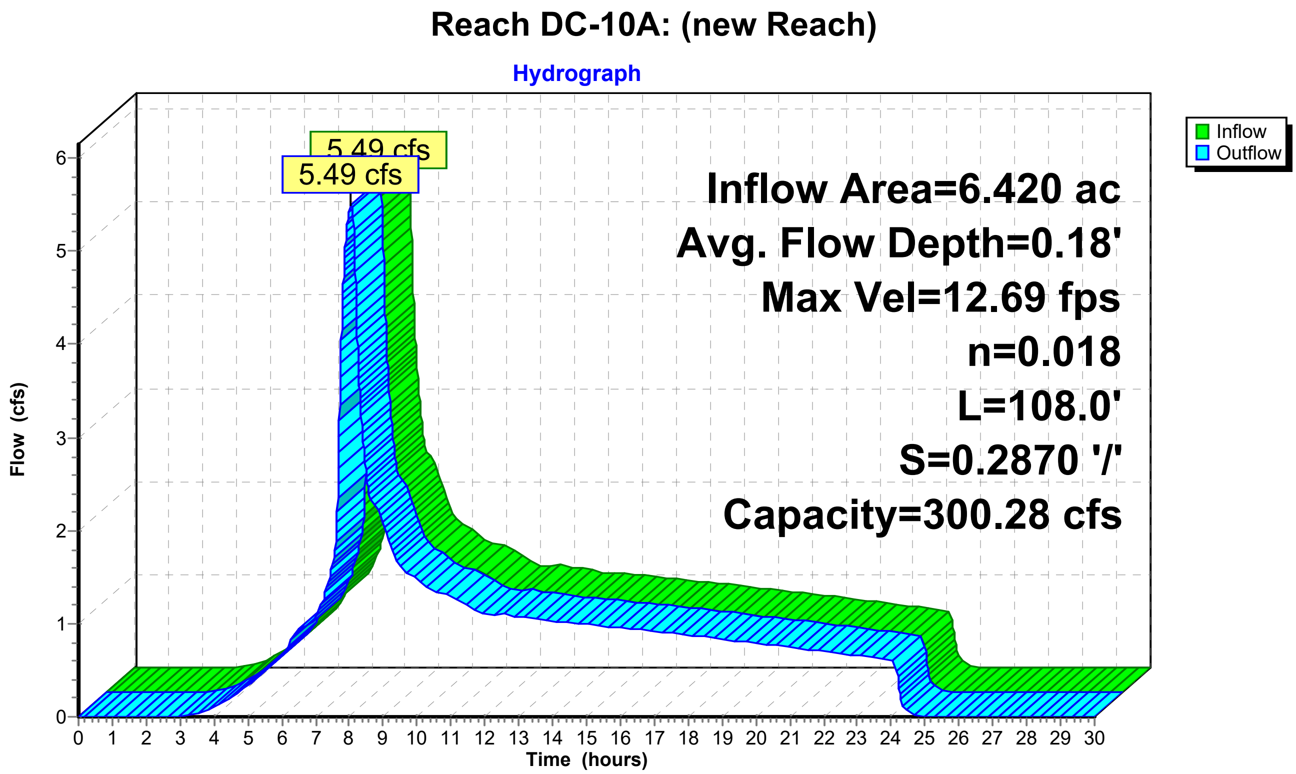
Summary for Reach DC-10A: (new Reach)

Inflow Area = 6.420 ac, 4.83% Impervious, Inflow Depth = 3.42" for 100-yr event
Inflow = 5.49 cfs @ 8.05 hrs, Volume= 1.829 af
Outflow = 5.49 cfs @ 8.05 hrs, Volume= 1.829 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.69 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.33 fps, Avg. Travel Time= 0.3 min

Peak Storage= 47 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 300.28 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 108.0' Slope= 0.2870 '/'
Inlet Invert= 228.00', Outlet Invert= 197.00'



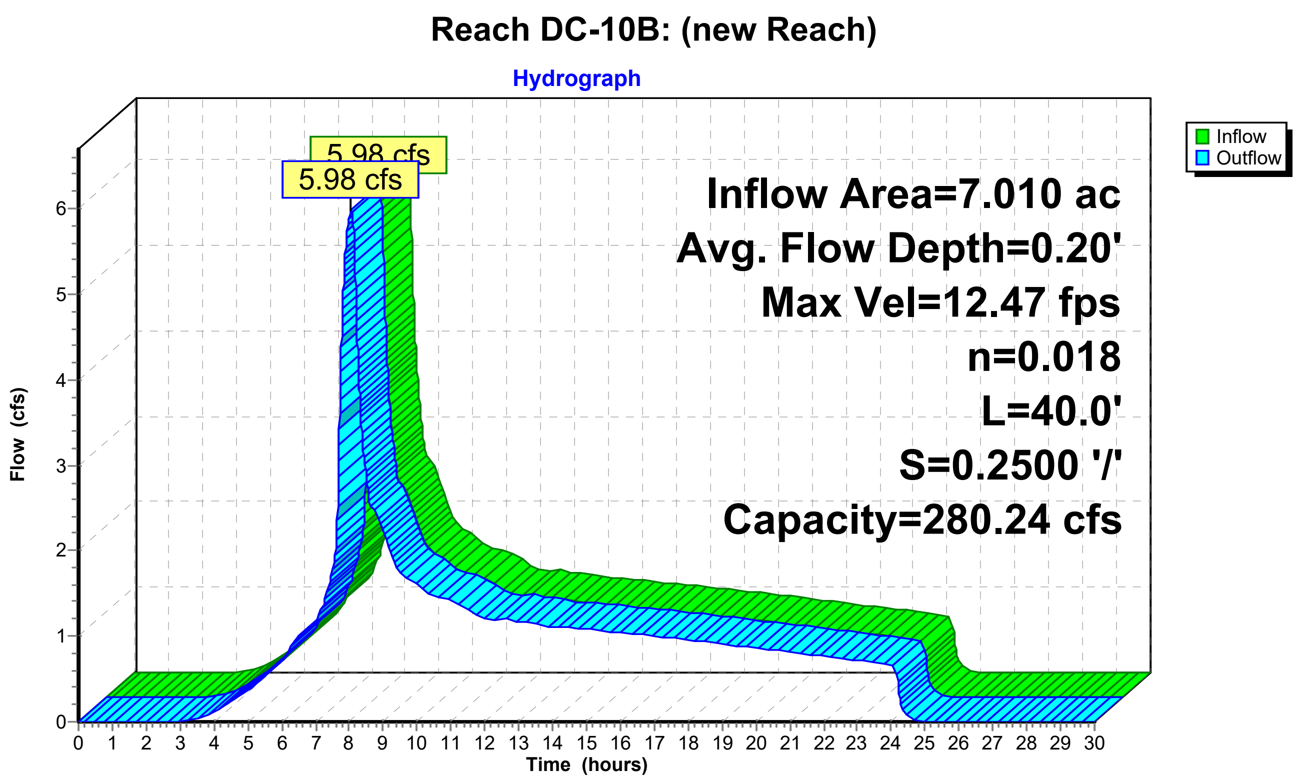
Summary for Reach DC-10B: (new Reach)

Inflow Area = 7.010 ac, 4.42% Impervious, Inflow Depth = 3.41" for 100-yr event
Inflow = 5.98 cfs @ 8.05 hrs, Volume= 1.993 af
Outflow = 5.98 cfs @ 8.06 hrs, Volume= 1.993 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.47 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.22 fps, Avg. Travel Time= 0.1 min

Peak Storage= 19 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 280.24 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 40.0' Slope= 0.2500 '/'
Inlet Invert= 197.00', Outlet Invert= 187.00'



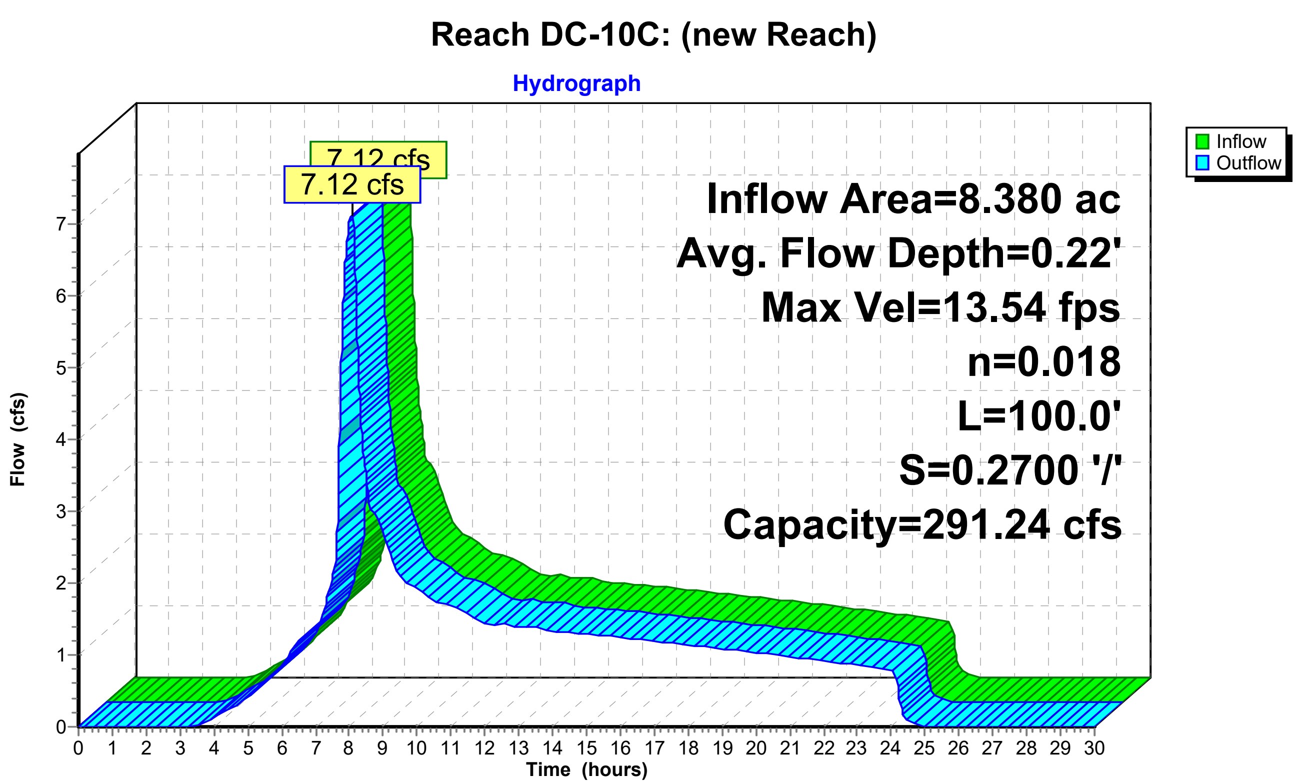
Summary for Reach DC-10C: (new Reach)

Inflow Area = 8.380 ac, 3.70% Impervious, Inflow Depth = 3.40" for 100-yr event
Inflow = 7.12 cfs @ 8.06 hrs, Volume= 2.373 af
Outflow = 7.12 cfs @ 8.06 hrs, Volume= 2.373 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 13.54 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.74 fps, Avg. Travel Time= 0.2 min

Peak Storage= 53 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 291.24 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 100.0' Slope= 0.2700 '/'
Inlet Invert= 187.00', Outlet Invert= 160.00'



Summary for Reach DC-11A: (new Reach)

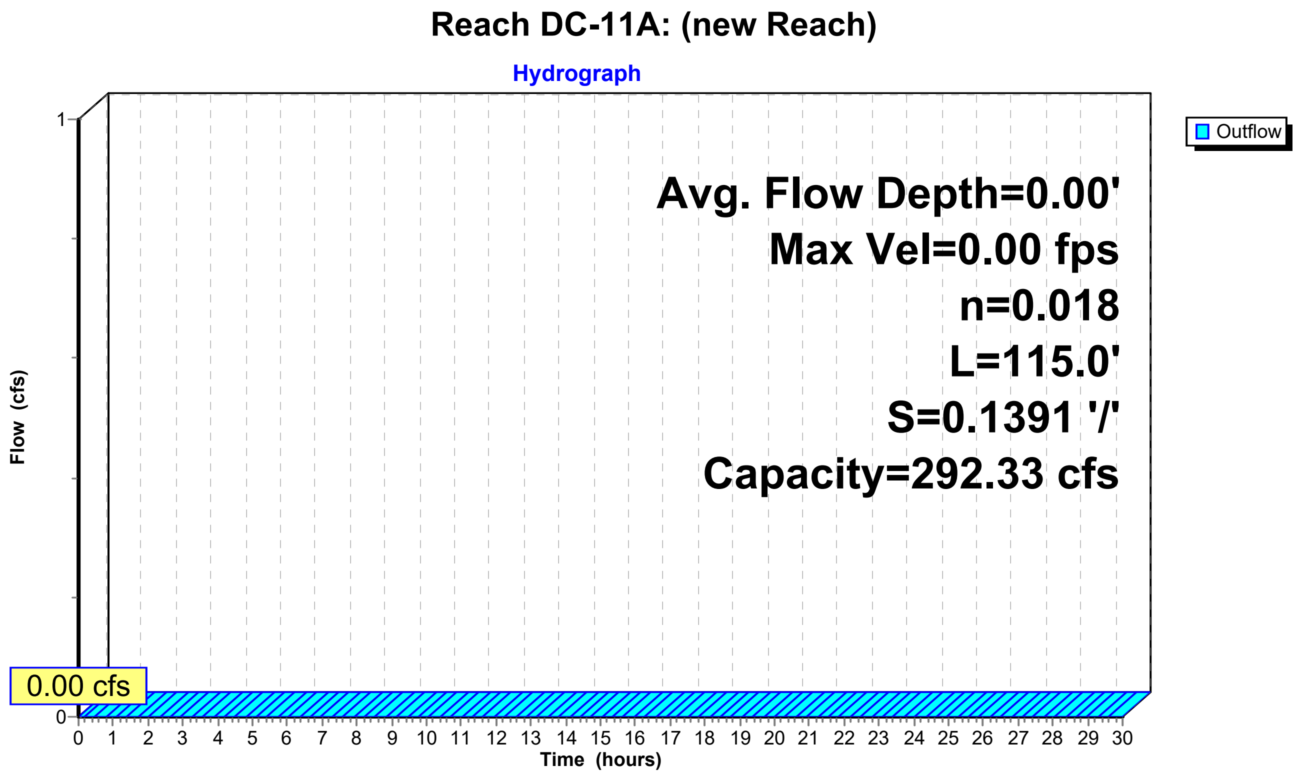
[43] Hint: Has no inflow (Outflow=Zero)

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.75' Flow Area= 9.6 sf, Capacity= 292.33 cfs

2.00' x 1.75' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 115.0' Slope= 0.1391 '/'
Inlet Invert= 281.00', Outlet Invert= 265.00'



Summary for Reach DC-11B: (new Reach)

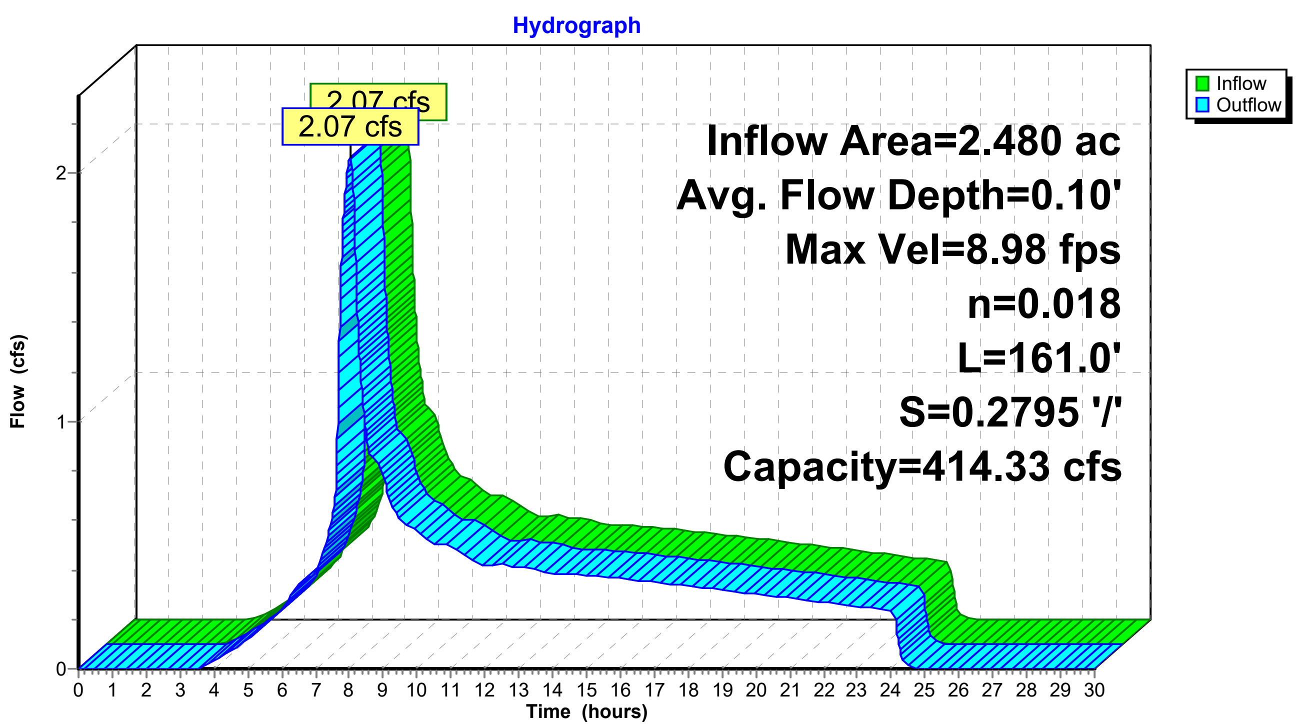
Inflow Area = 2.480 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 2.07 cfs @ 8.02 hrs, Volume= 0.689 af
Outflow = 2.07 cfs @ 8.03 hrs, Volume= 0.689 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.98 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 4.66 fps, Avg. Travel Time= 0.6 min

Peak Storage= 37 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.75' Flow Area= 9.6 sf, Capacity= 414.33 cfs

2.00' x 1.75' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 161.0' Slope= 0.2795 '/'
Inlet Invert= 265.00', Outlet Invert= 220.00'

Reach DC-11B: (new Reach)



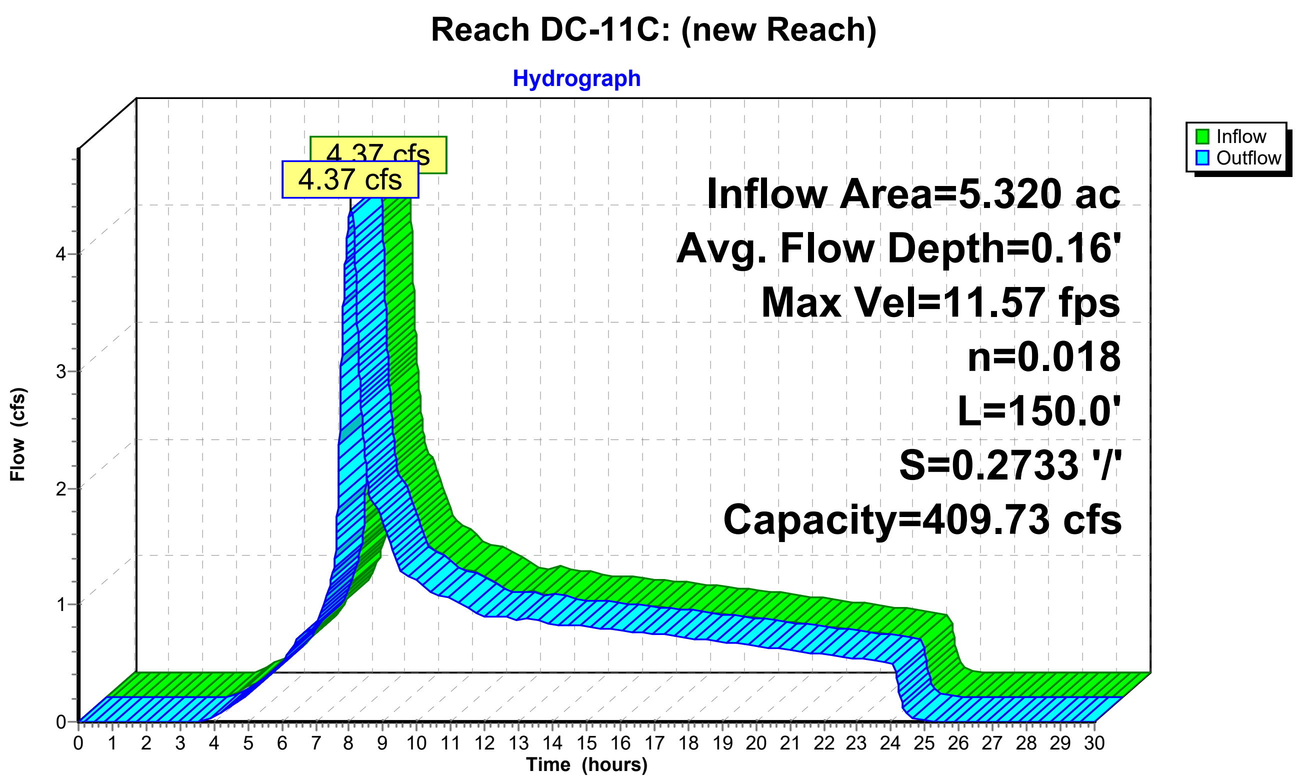
Summary for Reach DC-11C: (new Reach)

Inflow Area = 5.320 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.37 cfs @ 8.05 hrs, Volume= 1.478 af
Outflow = 4.37 cfs @ 8.06 hrs, Volume= 1.478 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.57 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 5.86 fps, Avg. Travel Time= 0.4 min

Peak Storage= 57 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 1.75' Flow Area= 9.6 sf, Capacity= 409.73 cfs

2.00' x 1.75' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 150.0' Slope= 0.2733 '/'
Inlet Invert= 220.00', Outlet Invert= 179.00'



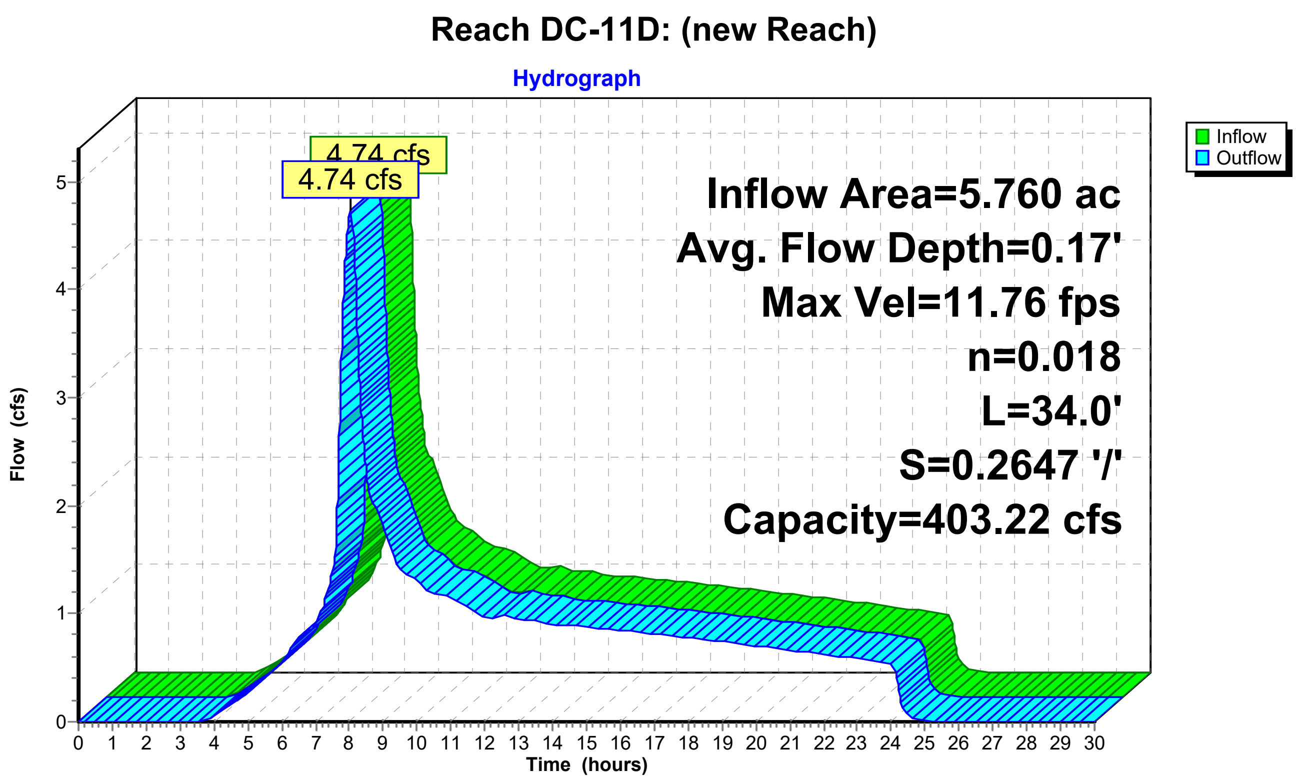
Summary for Reach DC-11D: (new Reach)

Inflow Area = 5.760 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.74 cfs @ 8.05 hrs, Volume= 1.600 af
Outflow = 4.74 cfs @ 8.05 hrs, Volume= 1.600 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.76 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 5.96 fps, Avg. Travel Time= 0.1 min

Peak Storage= 14 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.75' Flow Area= 9.6 sf, Capacity= 403.22 cfs

2.00' x 1.75' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 9.00'
Length= 34.0' Slope= 0.2647 '/'
Inlet Invert= 179.00', Outlet Invert= 170.00'



Summary for Reach DC-12: (new Reach)

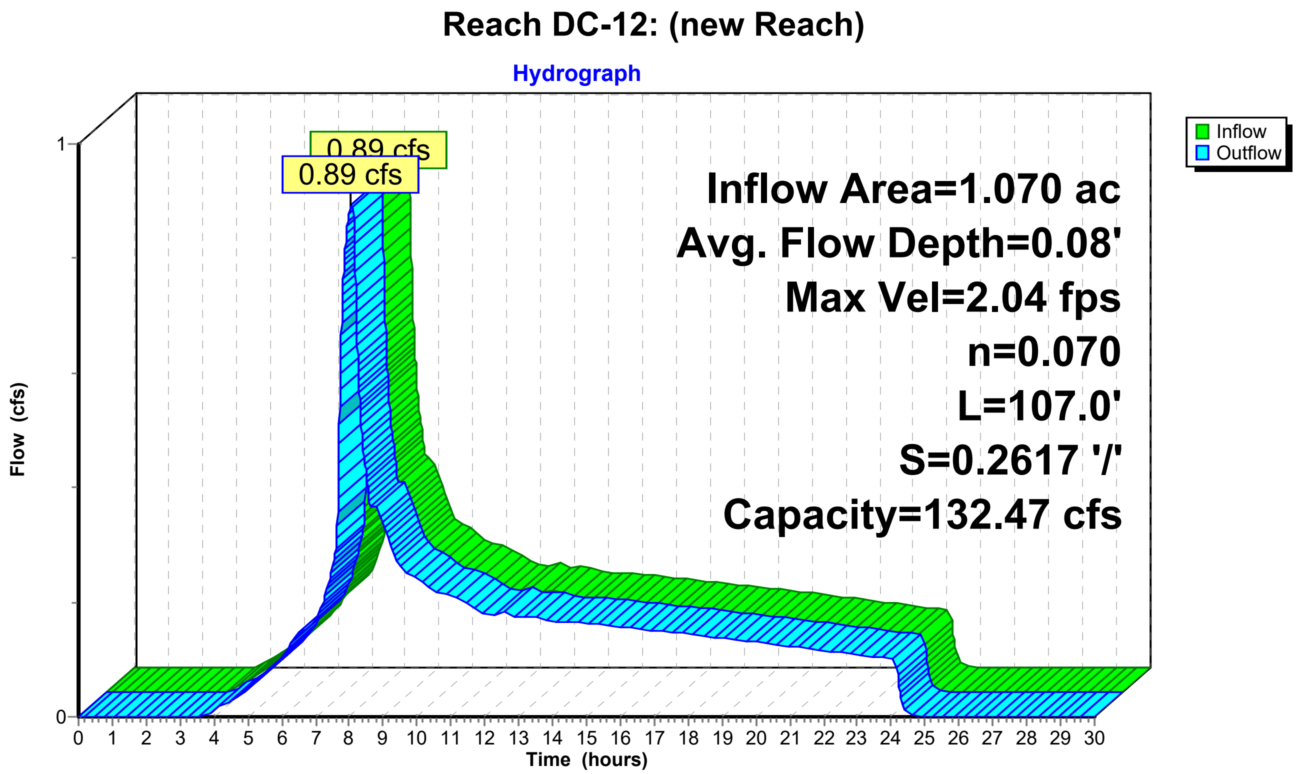
Inflow Area = 1.070 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.89 cfs @ 8.03 hrs, Volume= 0.297 af
Outflow = 0.89 cfs @ 8.05 hrs, Volume= 0.297 af, Atten= 0%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.04 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.03 fps, Avg. Travel Time= 1.7 min

Peak Storage= 47 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.50' Flow Area= 12.0 sf, Capacity= 132.47 cfs

5.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 11.00'
Length= 107.0' Slope= 0.2617 '/'
Inlet Invert= 152.00', Outlet Invert= 124.00'

‡



Summary for Reach DC-1A: (new Reach)

[43] Hint: Has no inflow (Outflow=Zero)

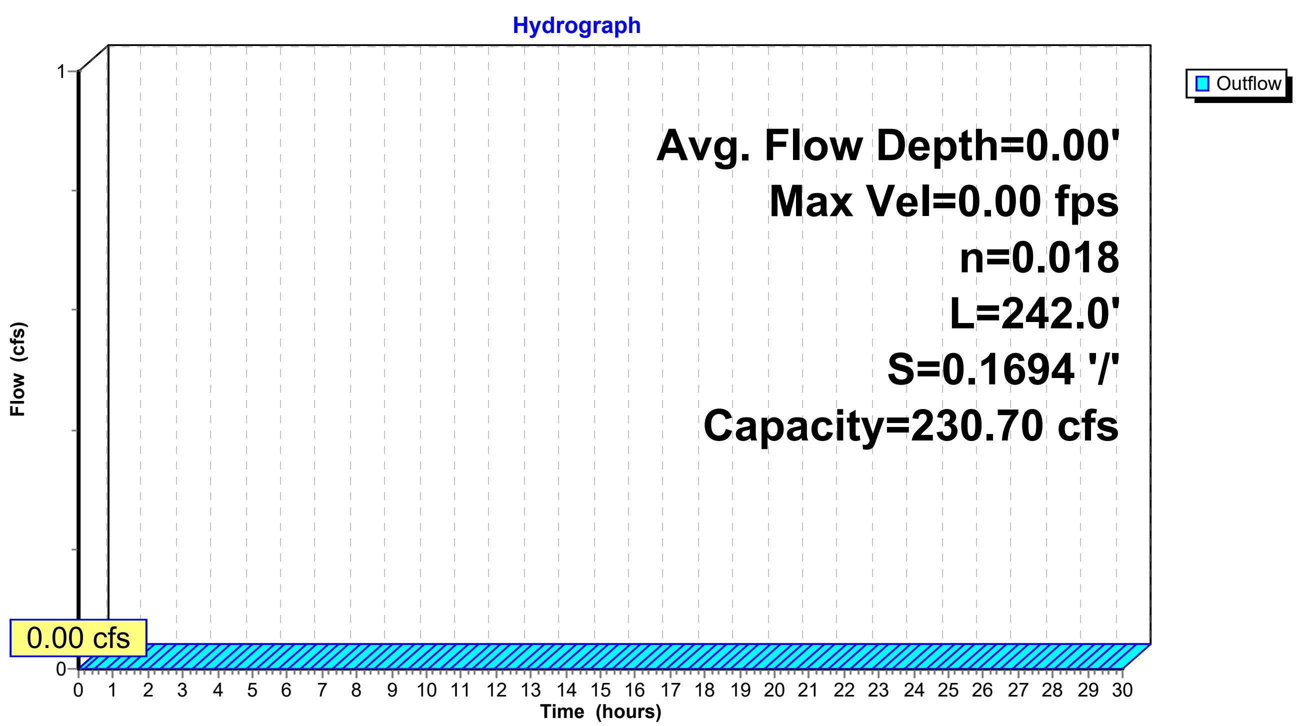
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 230.70 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 242.0' Slope= 0.1694 '/'
Inlet Invert= 281.00', Outlet Invert= 240.00'

Reach DC-1A: (new Reach)



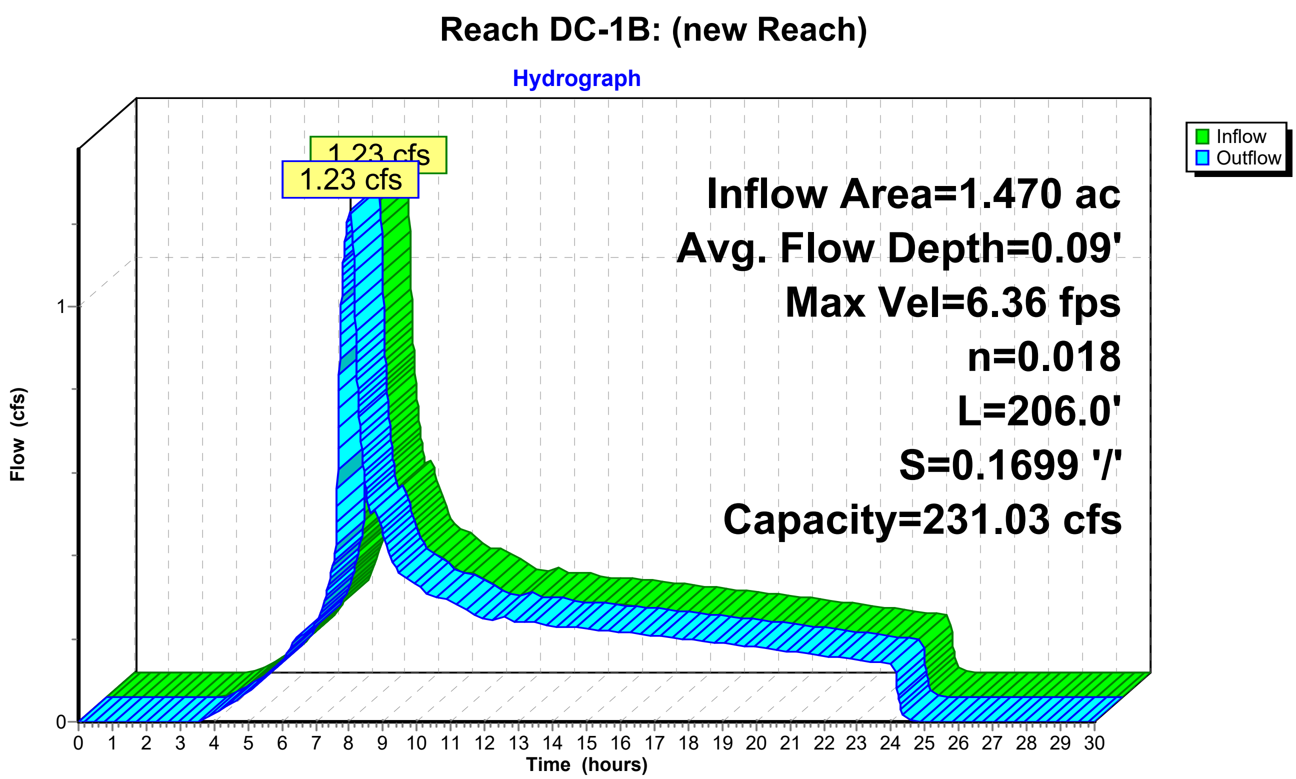
Summary for Reach DC-1B: (new Reach)

Inflow Area = 1.470 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.23 cfs @ 8.01 hrs, Volume= 0.408 af
Outflow = 1.23 cfs @ 8.02 hrs, Volume= 0.408 af, Atten= 0%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.36 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.30 fps, Avg. Travel Time= 1.0 min

Peak Storage= 40 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 231.03 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 206.0' Slope= 0.1699 '/'
Inlet Invert= 240.00', Outlet Invert= 205.00'



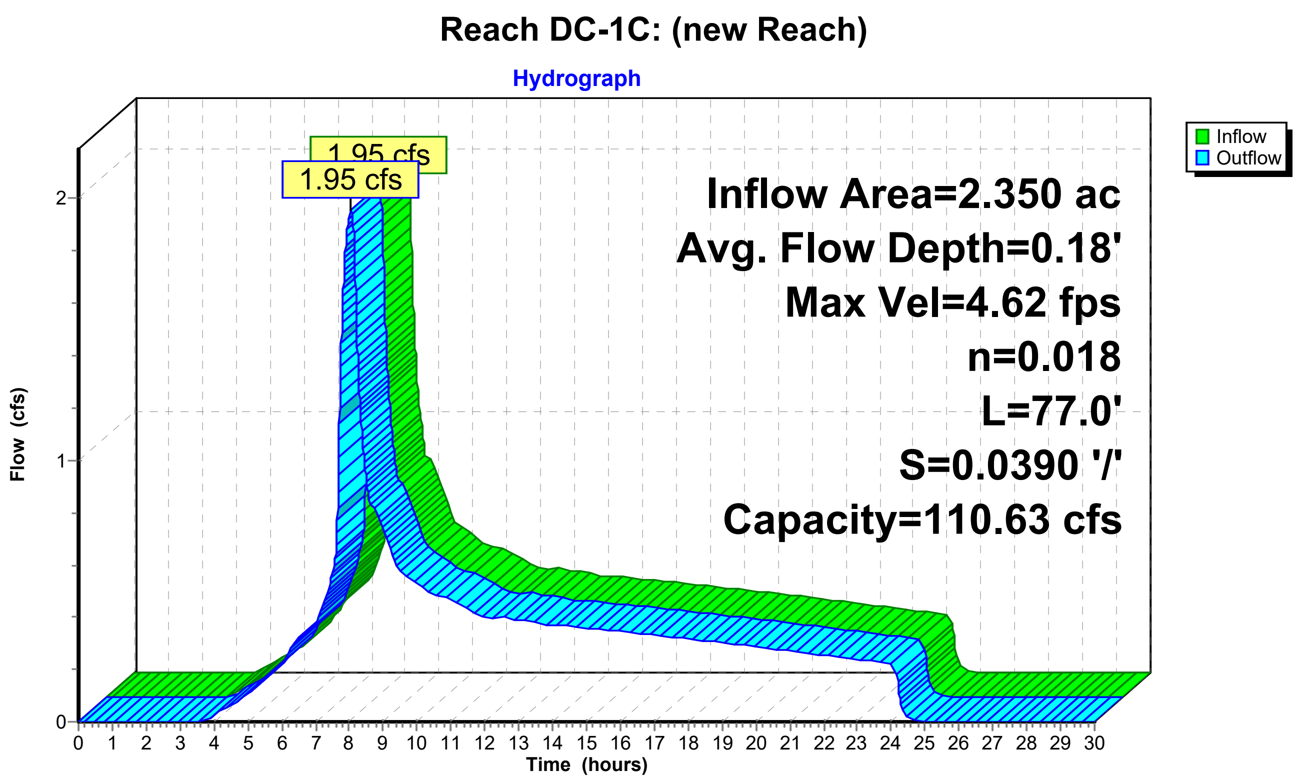
Summary for Reach DC-1C: (new Reach)

Inflow Area = 2.350 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.95 cfs @ 8.05 hrs, Volume= 0.653 af
Outflow = 1.95 cfs @ 8.05 hrs, Volume= 0.653 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.62 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.34 fps, Avg. Travel Time= 0.5 min

Peak Storage= 33 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.18'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 110.63 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 77.0' Slope= 0.0390 '/'
Inlet Invert= 205.00', Outlet Invert= 202.00'



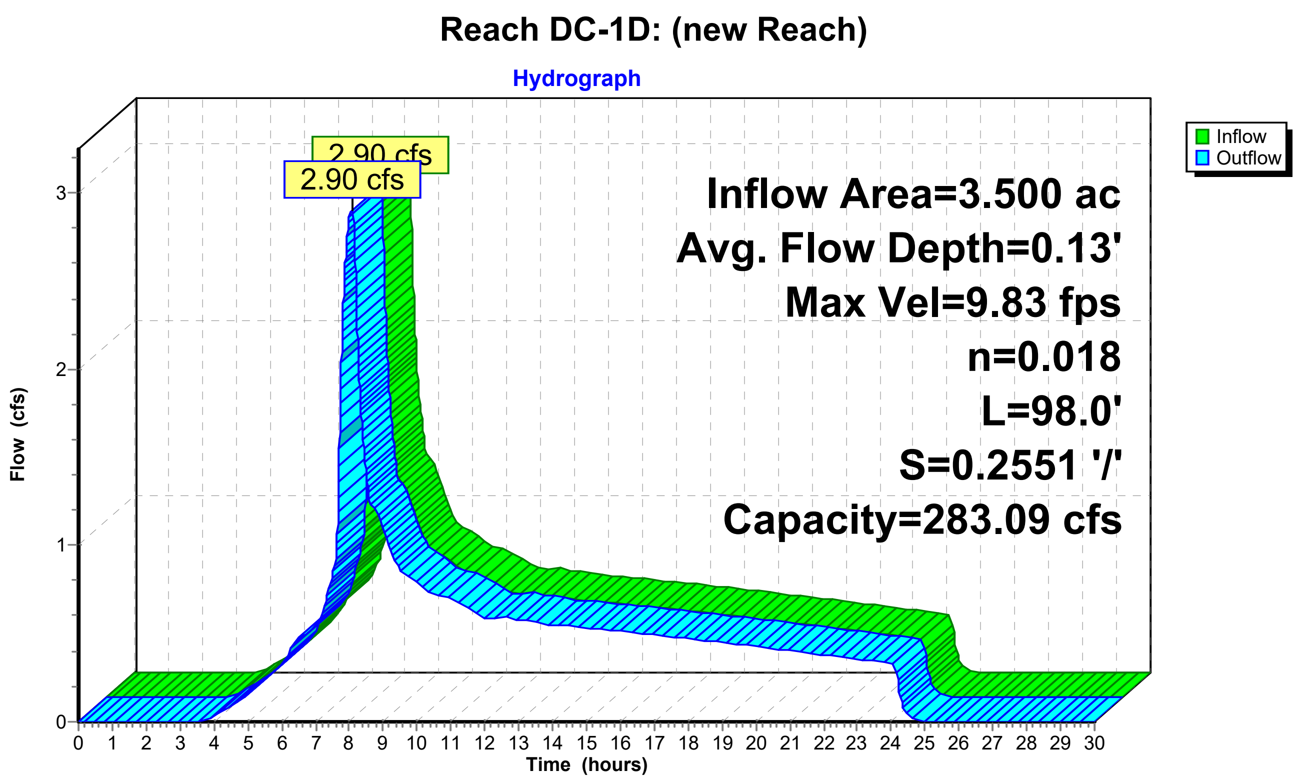
Summary for Reach DC-1D: (new Reach)

Inflow Area = 3.500 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 2.90 cfs @ 8.07 hrs, Volume= 0.972 af
Outflow = 2.90 cfs @ 8.07 hrs, Volume= 0.972 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.83 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 4.98 fps, Avg. Travel Time= 0.3 min

Peak Storage= 29 cf @ 8.07 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 283.09 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 98.0' Slope= 0.2551 '/'
Inlet Invert= 202.00', Outlet Invert= 177.00'



Summary for Reach DC-2A: (new Reach)

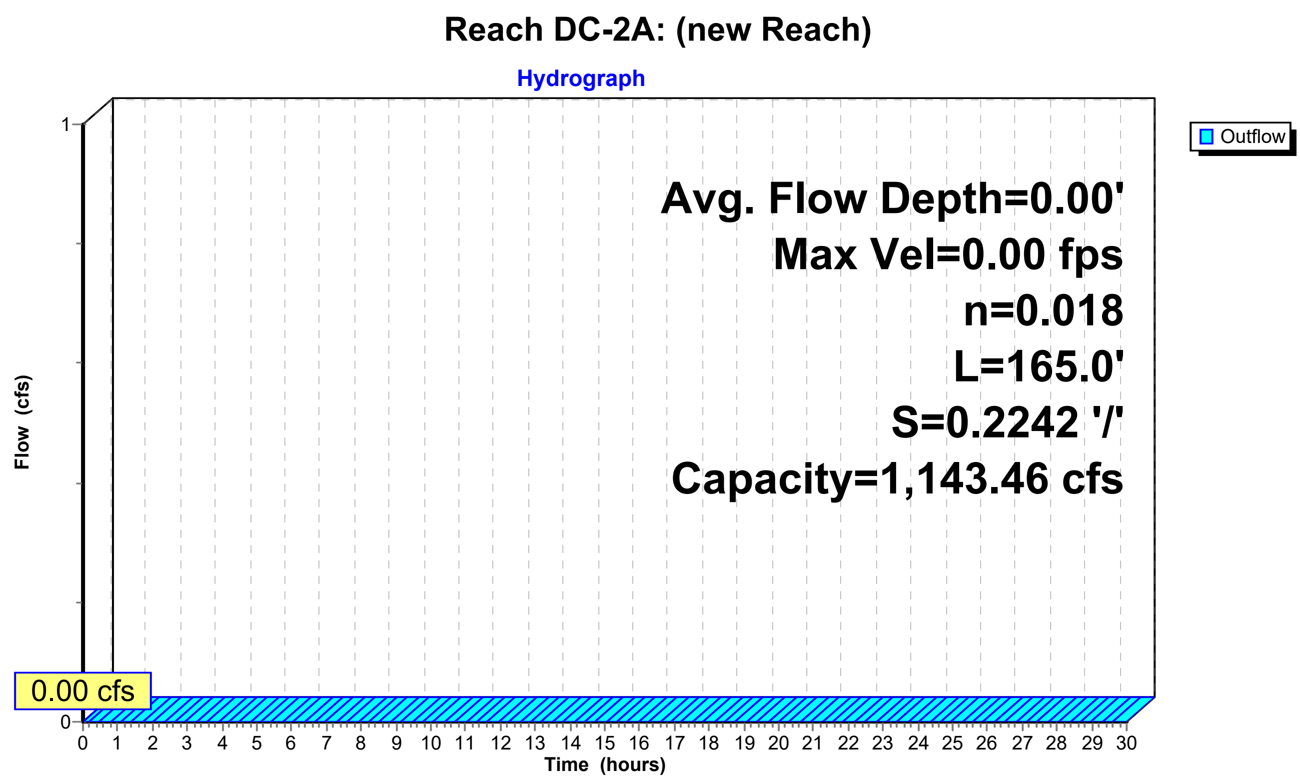
[43] Hint: Has no inflow (Outflow=Zero)

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,143.46 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 165.0' Slope= 0.2242 '/'
Inlet Invert= 275.00', Outlet Invert= 238.00'



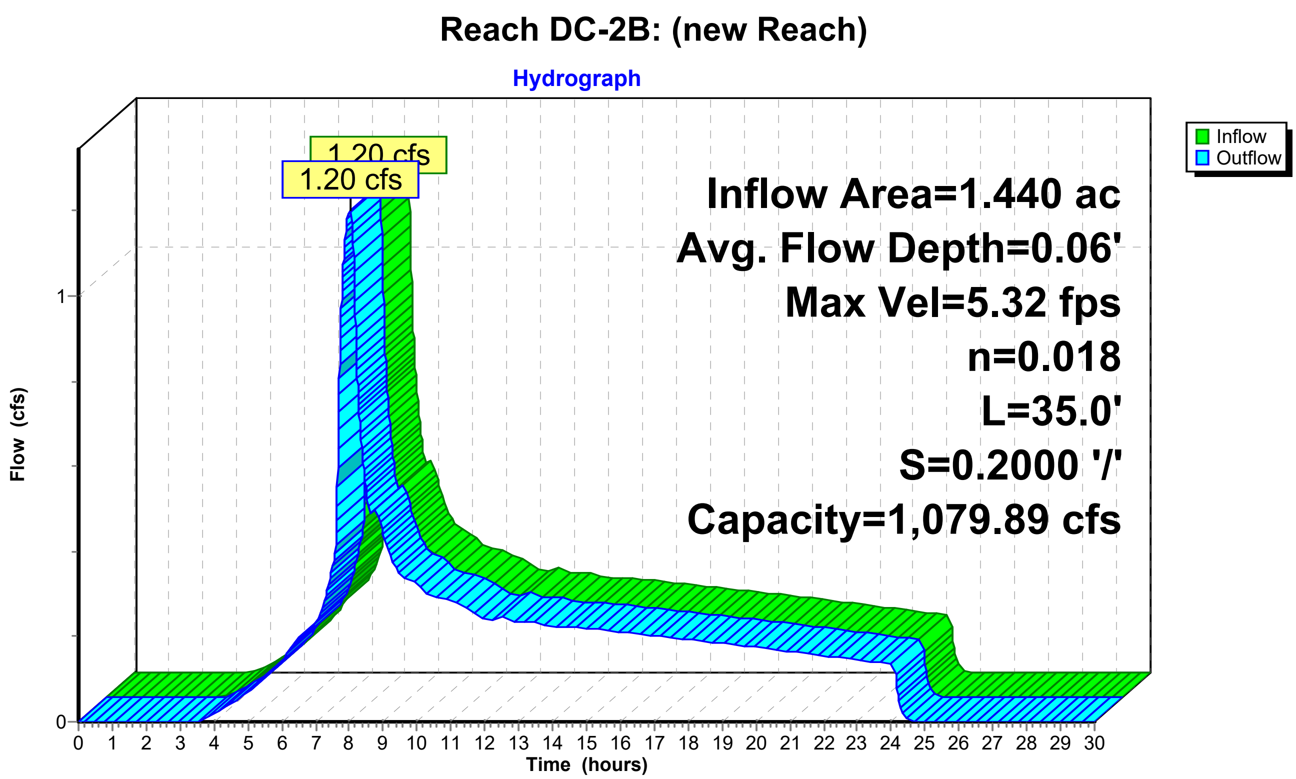
Summary for Reach DC-2B: (new Reach)

Inflow Area = 1.440 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.20 cfs @ 8.02 hrs, Volume= 0.400 af
Outflow = 1.20 cfs @ 8.02 hrs, Volume= 0.400 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.32 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.22 fps, Avg. Travel Time= 0.2 min

Peak Storage= 8 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.06'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,079.89 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 35.0' Slope= 0.2000 '/'
Inlet Invert= 238.00', Outlet Invert= 231.00'



Summary for Reach DC-2C: (new Reach)

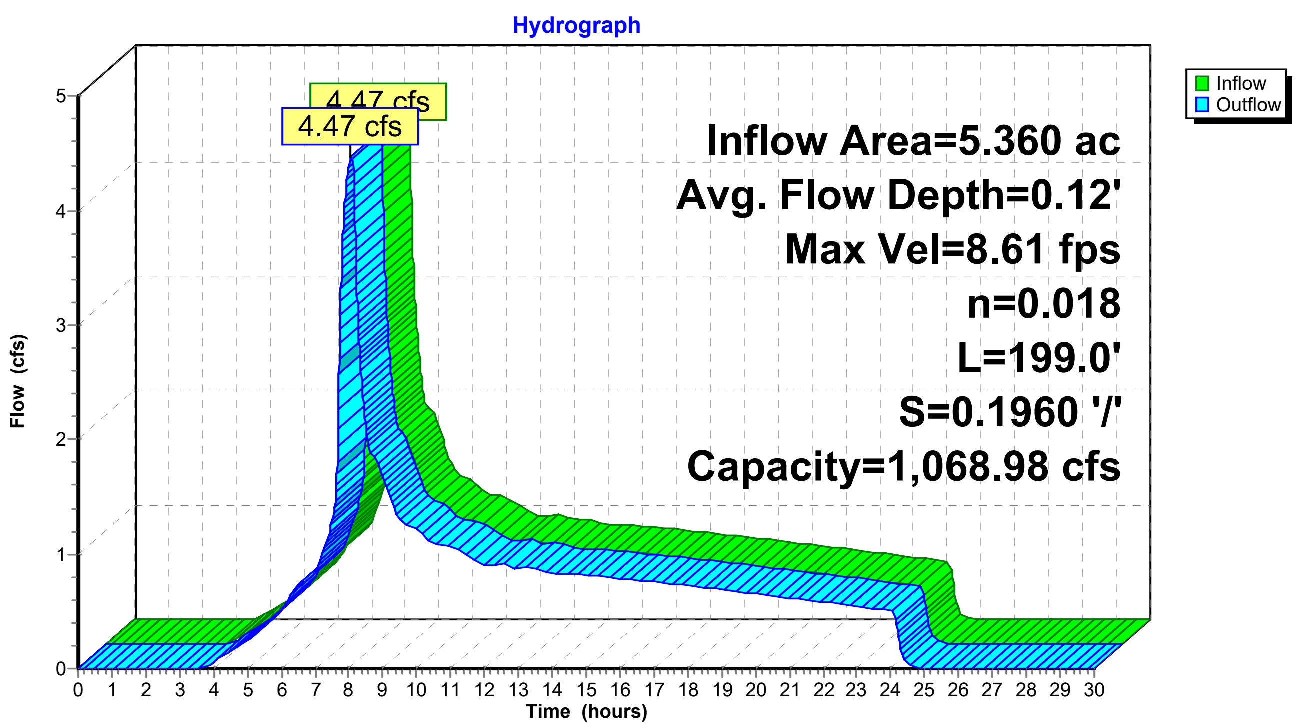
Inflow Area = 5.360 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.47 cfs @ 8.04 hrs, Volume= 1.489 af
Outflow = 4.47 cfs @ 8.05 hrs, Volume= 1.489 af, Atten= 0%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 8.61 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 4.44 fps, Avg. Travel Time= 0.7 min

Peak Storage= 103 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,068.98 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 199.0' Slope= 0.1960 '/'
Inlet Invert= 231.00', Outlet Invert= 192.00'

Reach DC-2C: (new Reach)



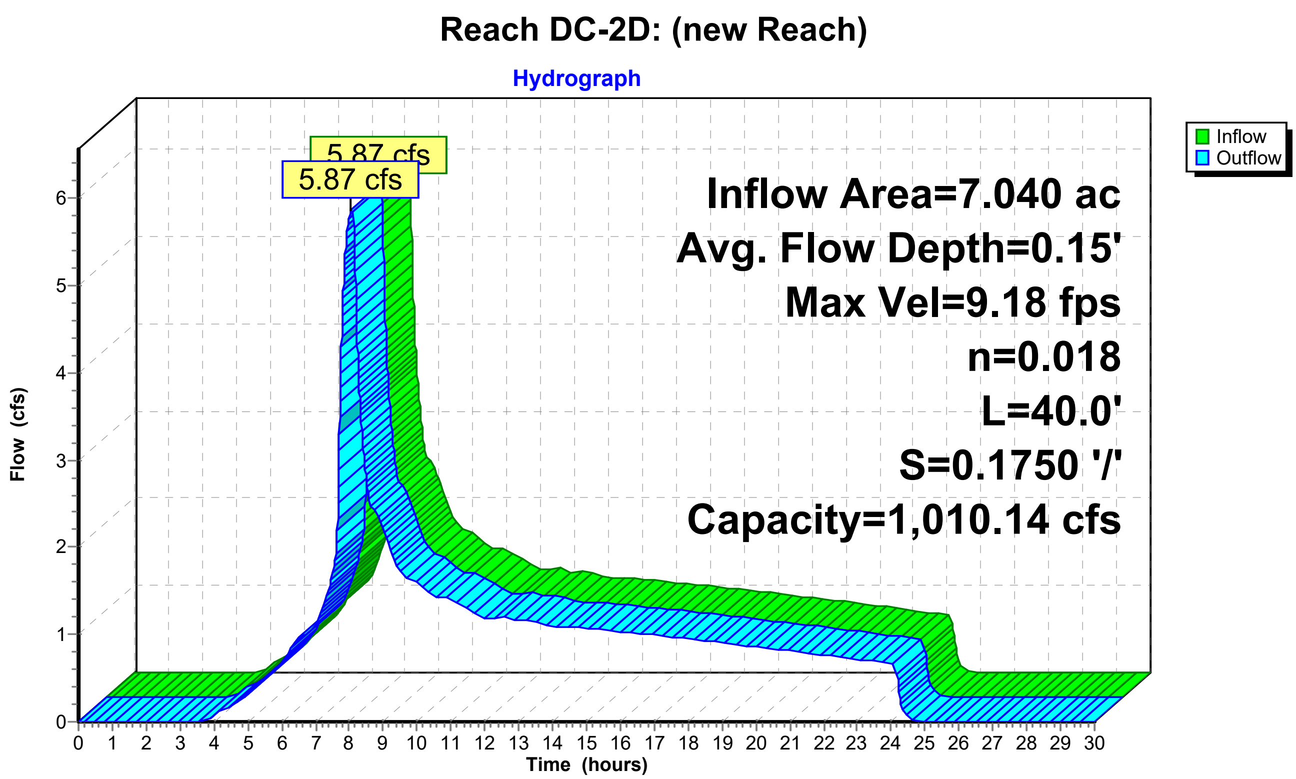
Summary for Reach DC-2D: (new Reach)

Inflow Area = 7.040 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 5.87 cfs @ 8.06 hrs, Volume= 1.956 af
Outflow = 5.87 cfs @ 8.06 hrs, Volume= 1.956 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.18 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.65 fps, Avg. Travel Time= 0.1 min

Peak Storage= 26 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.15'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,010.14 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 40.0' Slope= 0.1750 '/'
Inlet Invert= 192.00', Outlet Invert= 185.00'



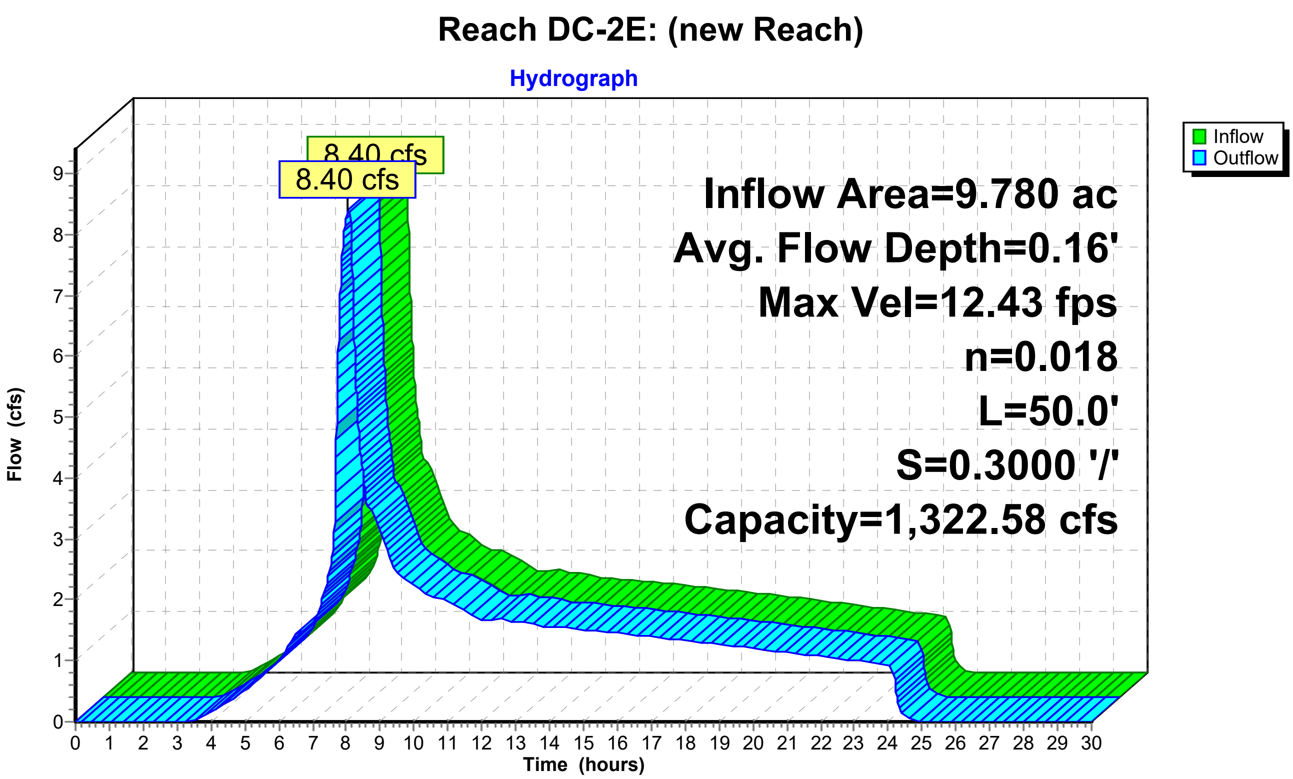
Summary for Reach DC-2E: (new Reach)

Inflow Area = 9.780 ac, 4.70% Impervious, Inflow Depth = 3.42" for 100-yr event
Inflow = 8.40 cfs @ 8.06 hrs, Volume= 2.784 af
Outflow = 8.40 cfs @ 8.06 hrs, Volume= 2.784 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 12.43 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 6.19 fps, Avg. Travel Time= 0.1 min

Peak Storage= 34 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.16'
Bank-Full Depth= 2.50' Flow Area= 22.5 sf, Capacity= 1,322.58 cfs

4.00' x 2.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 14.00'
Length= 50.0' Slope= 0.3000 '/'
Inlet Invert= 185.00', Outlet Invert= 170.00'



Summary for Reach DC-4A: (new Reach)

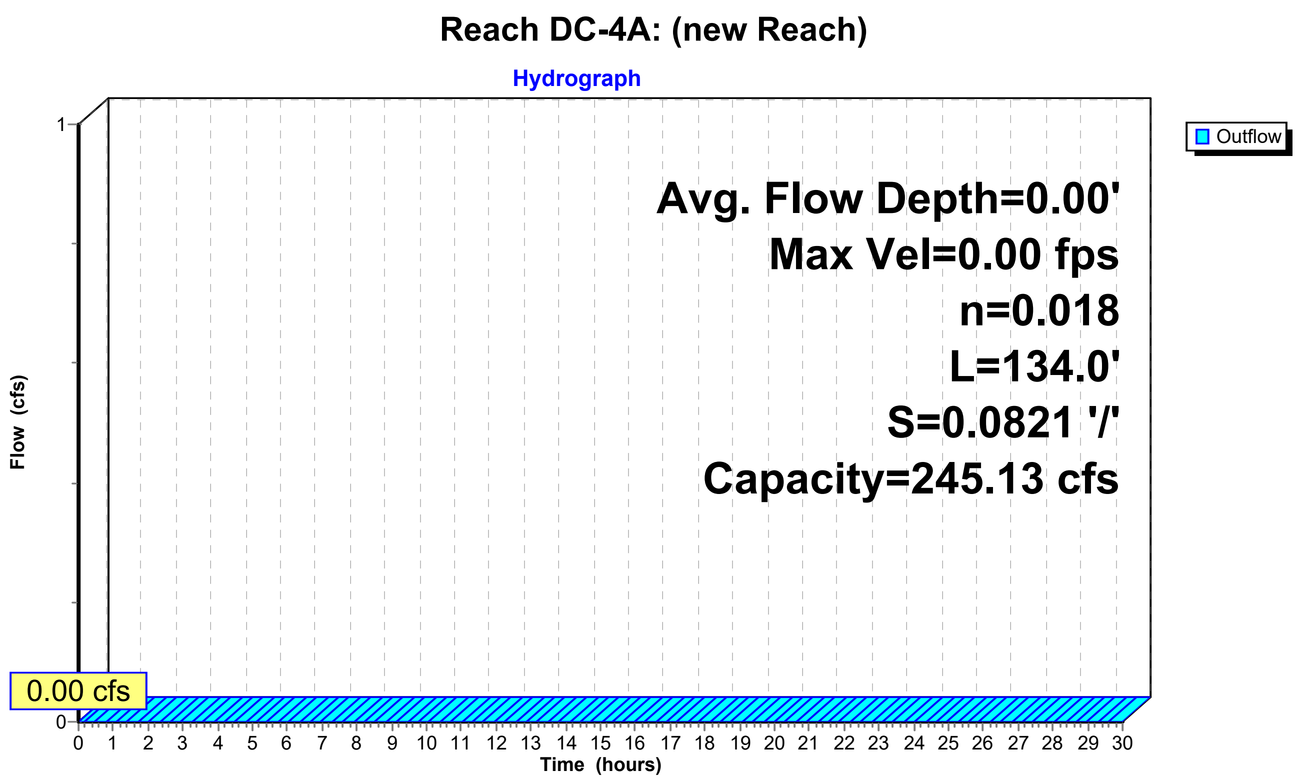
[43] Hint: Has no inflow (Outflow=Zero)

Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 0.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 245.13 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 134.0' Slope= 0.0821 '/'
Inlet Invert= 280.00', Outlet Invert= 269.00'



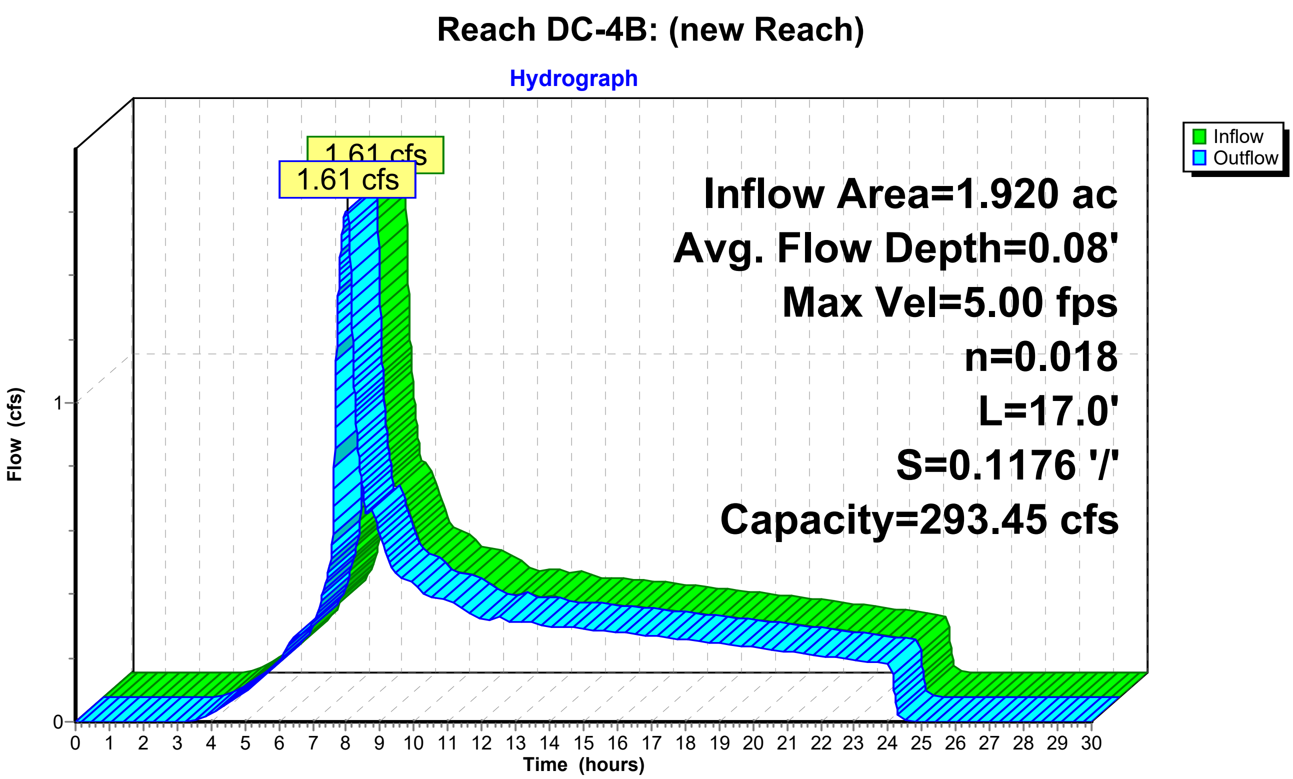
Summary for Reach DC-4B: (new Reach)

Inflow Area = 1.920 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.61 cfs @ 8.01 hrs, Volume= 0.533 af
Outflow = 1.61 cfs @ 8.01 hrs, Volume= 0.533 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.00 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.56 fps, Avg. Travel Time= 0.1 min

Peak Storage= 5 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 293.45 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 17.0' Slope= 0.1176 '/'
Inlet Invert= 269.00', Outlet Invert= 267.00'



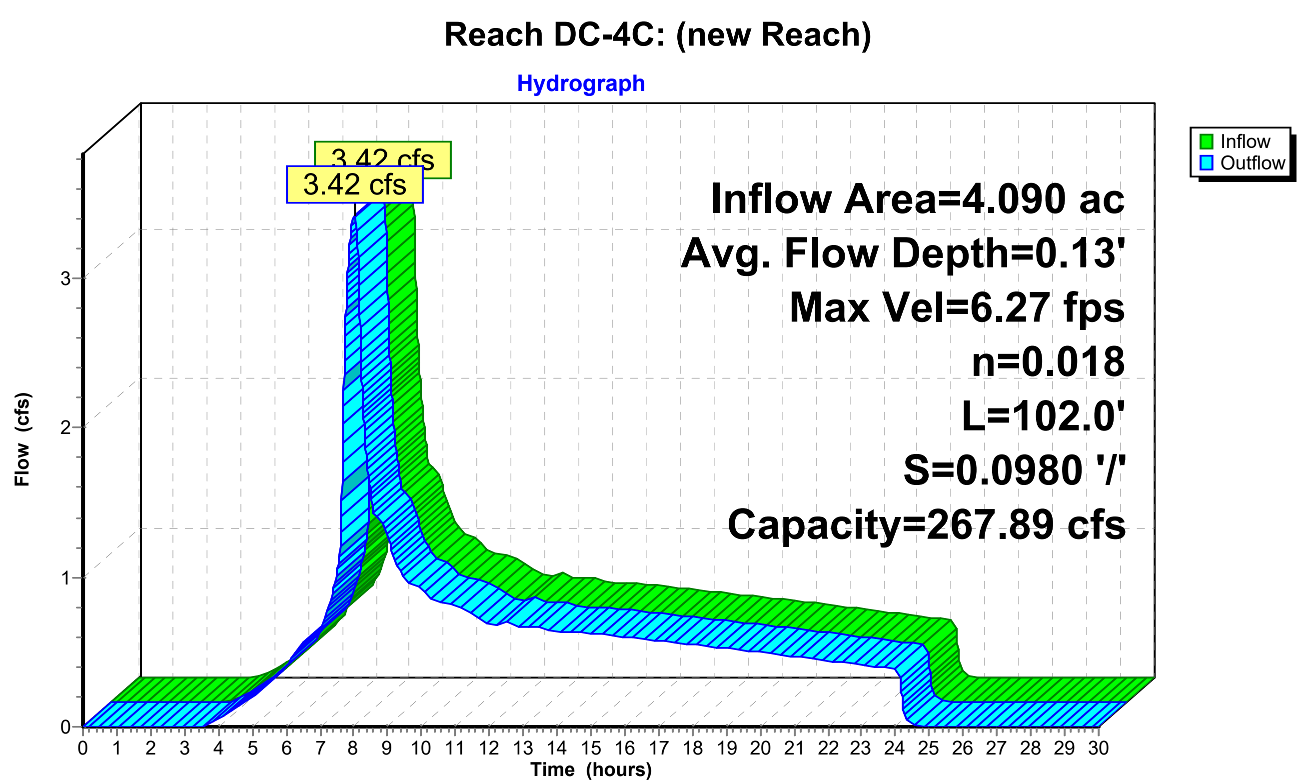
Summary for Reach DC-4C: (new Reach)

Inflow Area = 4.090 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 3.42 cfs @ 8.02 hrs, Volume= 1.136 af
Outflow = 3.42 cfs @ 8.03 hrs, Volume= 1.136 af, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.27 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.11 fps, Avg. Travel Time= 0.5 min

Peak Storage= 56 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 267.89 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 102.0' Slope= 0.0980 '/'
Inlet Invert= 267.00', Outlet Invert= 257.00'



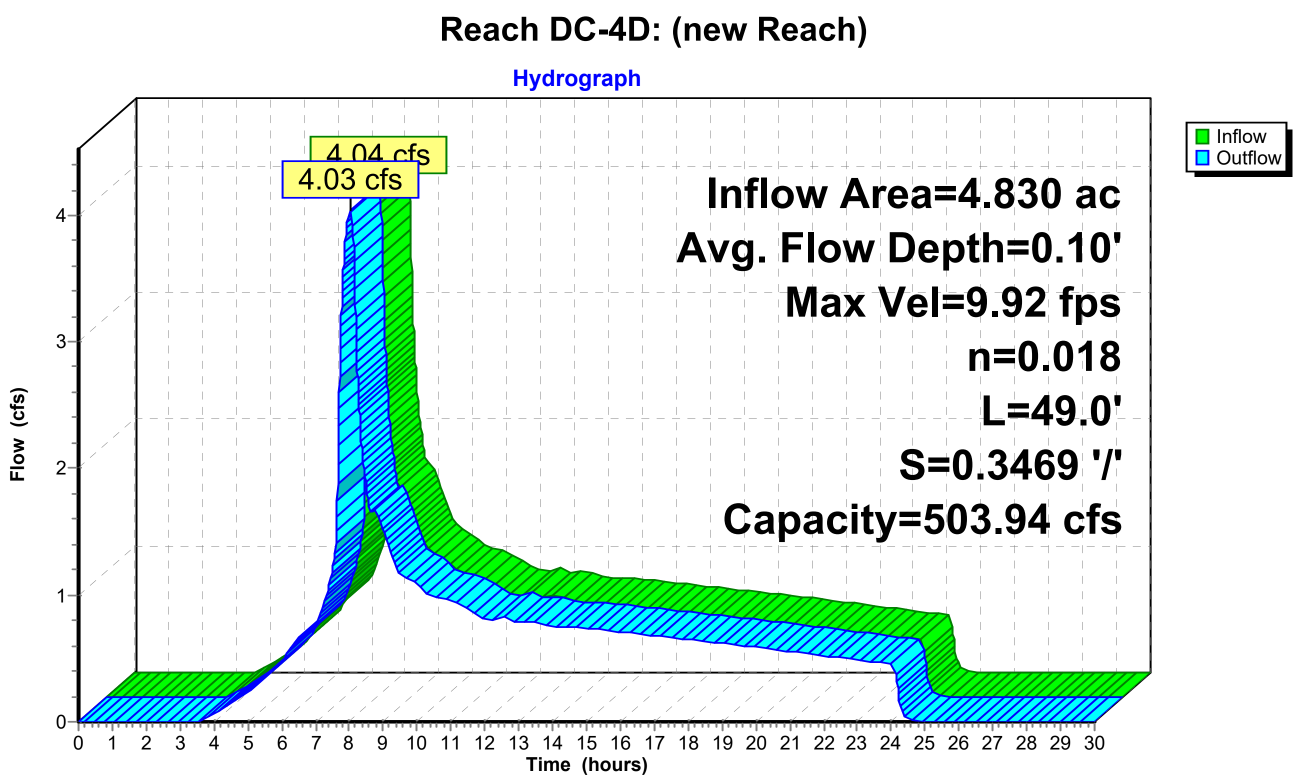
Summary for Reach DC-4D: (new Reach)

Inflow Area = 4.830 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.04 cfs @ 8.03 hrs, Volume= 1.342 af
Outflow = 4.03 cfs @ 8.03 hrs, Volume= 1.342 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.92 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.97 fps, Avg. Travel Time= 0.2 min

Peak Storage= 20 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 503.94 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 49.0' Slope= 0.3469 '/'
Inlet Invert= 257.00', Outlet Invert= 240.00'



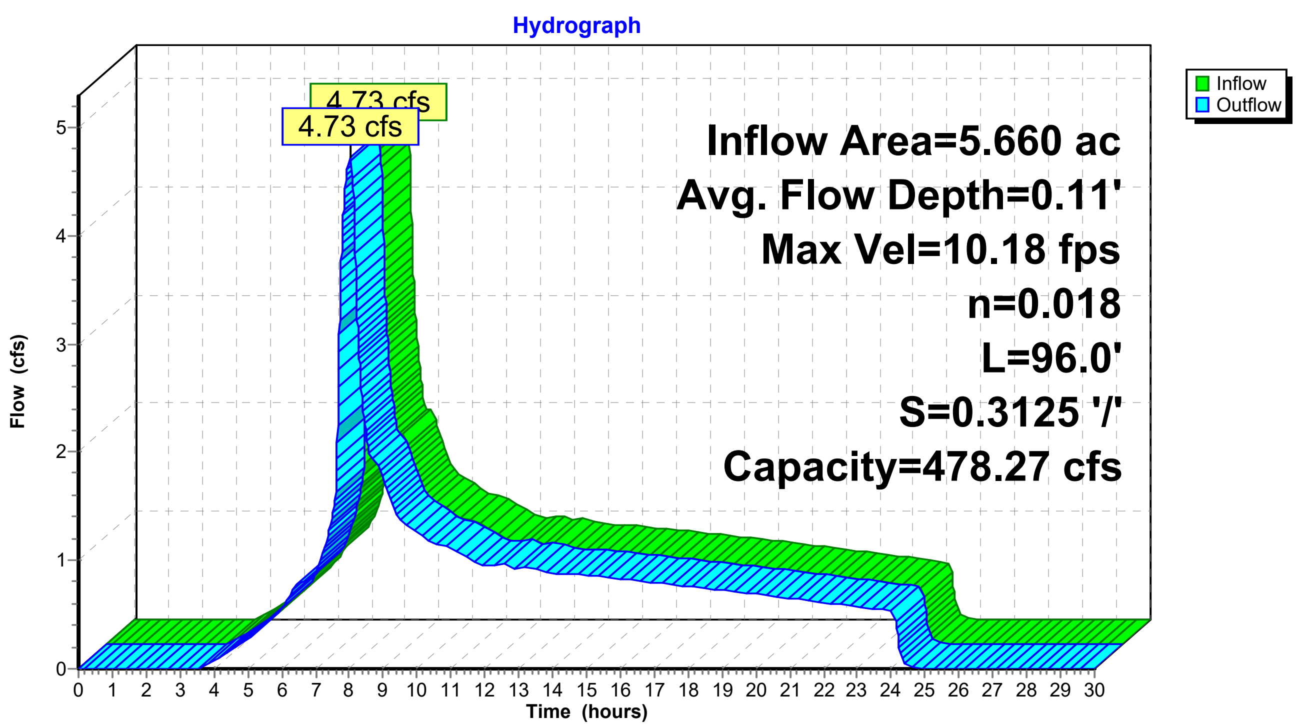
Summary for Reach DC-4E: (new Reach)

Inflow Area = 5.660 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.73 cfs @ 8.02 hrs, Volume= 1.572 af
Outflow = 4.73 cfs @ 8.03 hrs, Volume= 1.572 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.18 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 5.09 fps, Avg. Travel Time= 0.3 min

Peak Storage= 45 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.11'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 478.27 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 96.0' Slope= 0.3125 '/'
Inlet Invert= 240.00', Outlet Invert= 210.00'



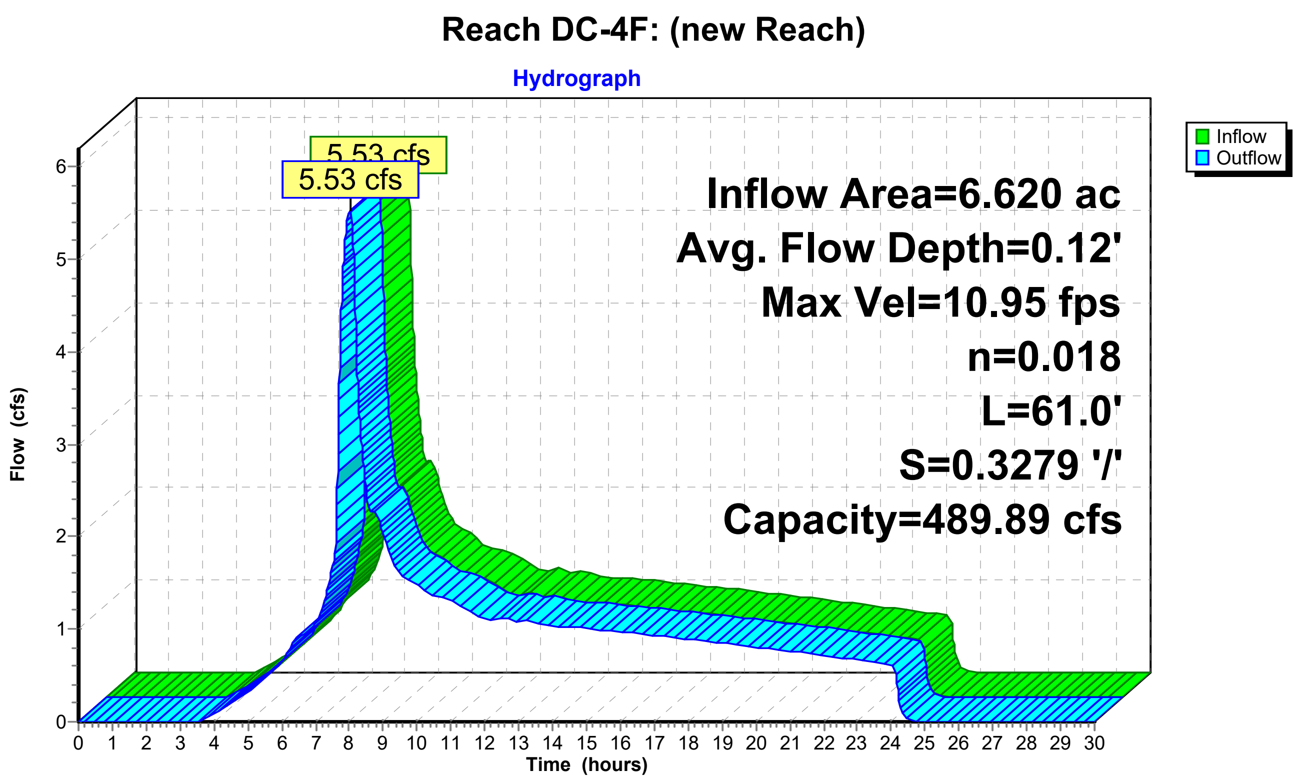
Summary for Reach DC-4F: (new Reach)

Inflow Area = 6.620 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 5.53 cfs @ 8.02 hrs, Volume= 1.839 af
Outflow = 5.53 cfs @ 8.03 hrs, Volume= 1.839 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.95 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.46 fps, Avg. Travel Time= 0.2 min

Peak Storage= 31 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.12'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 489.89 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 61.0' Slope= 0.3279 '/'
Inlet Invert= 210.00', Outlet Invert= 190.00'



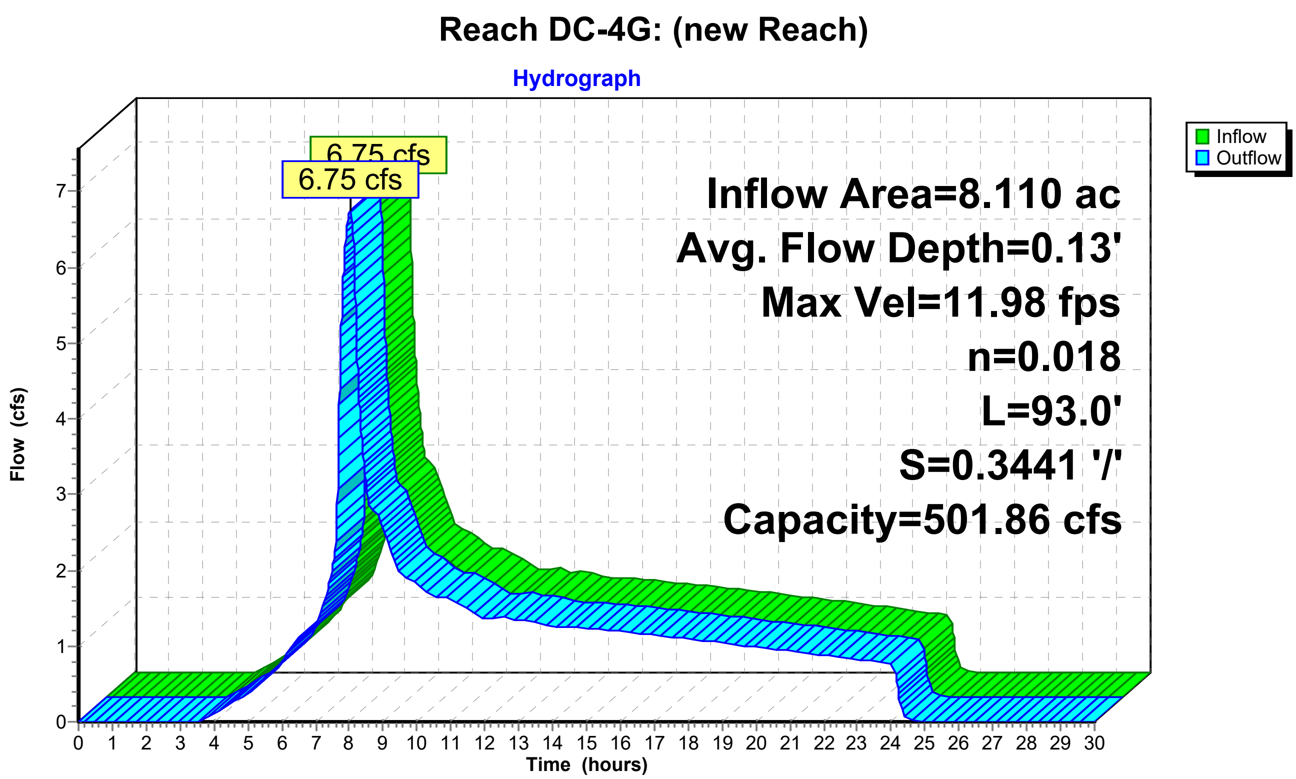
Summary for Reach DC-4G: (new Reach)

Inflow Area = 8.110 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 6.75 cfs @ 8.04 hrs, Volume= 2.253 af
Outflow = 6.75 cfs @ 8.04 hrs, Volume= 2.253 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 11.98 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 5.90 fps, Avg. Travel Time= 0.3 min

Peak Storage= 52 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 501.86 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 93.0' Slope= 0.3441 '/'
Inlet Invert= 190.00', Outlet Invert= 158.00'



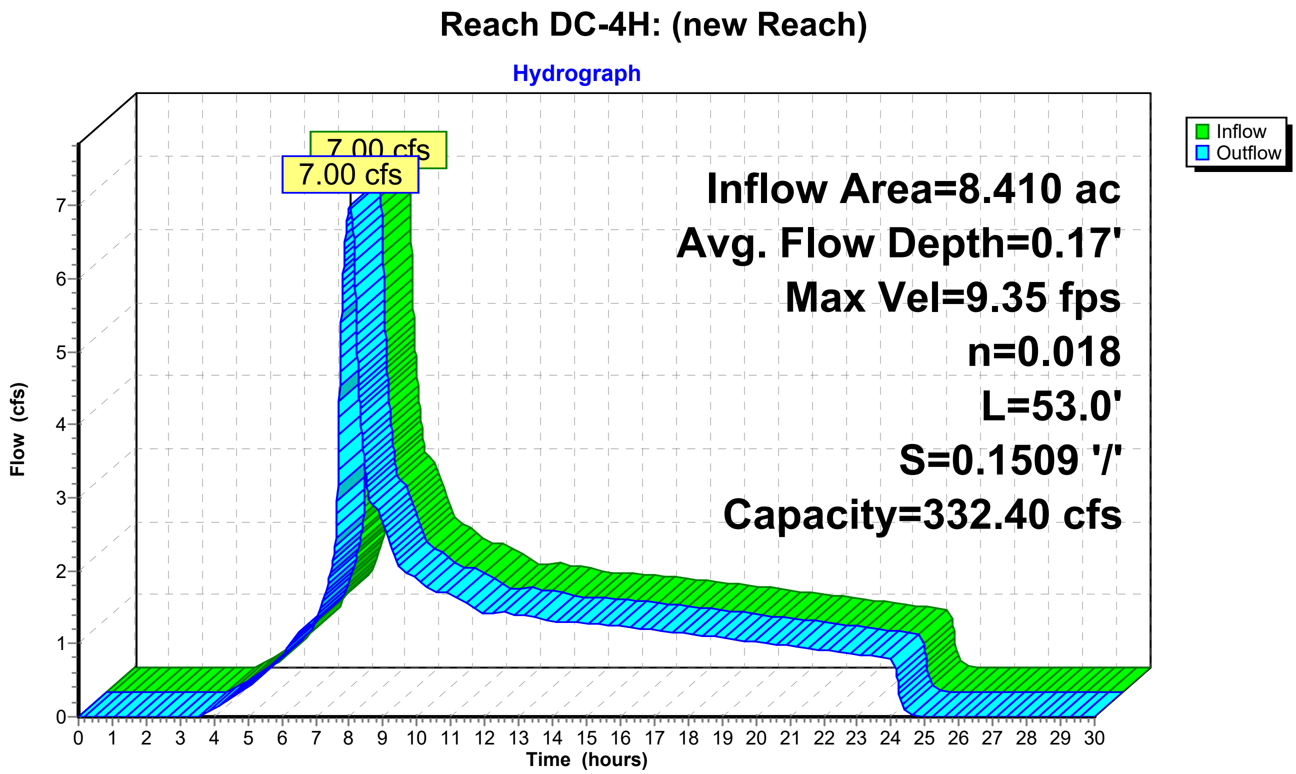
Summary for Reach DC-4H: (new Reach)

Inflow Area = 8.410 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 7.00 cfs @ 8.04 hrs, Volume= 2.336 af
Outflow = 7.00 cfs @ 8.04 hrs, Volume= 2.336 af, Atten= 0%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.35 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.57 fps, Avg. Travel Time= 0.2 min

Peak Storage= 40 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 332.40 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 53.0' Slope= 0.1509 '/'
Inlet Invert= 158.00', Outlet Invert= 150.00'



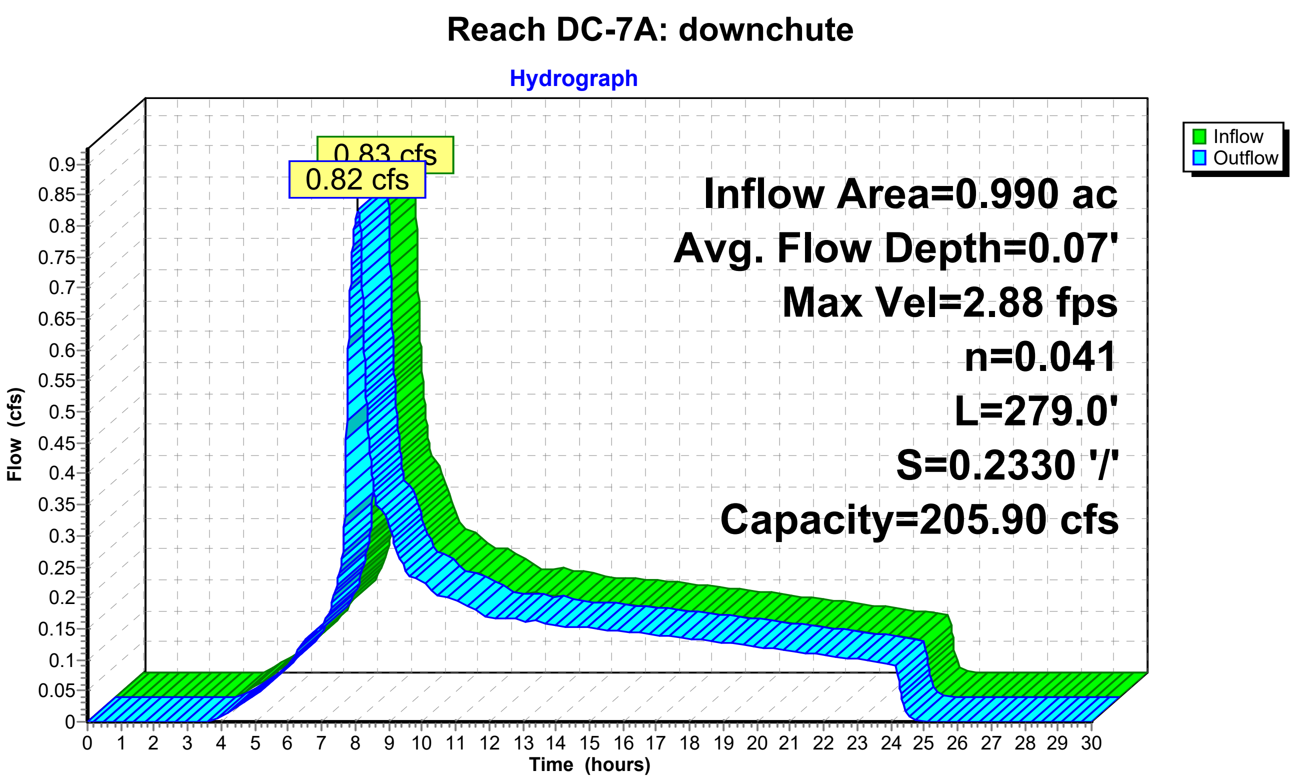
Summary for Reach DC-7A: downchute

Inflow Area = 0.990 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 0.83 cfs @ 8.04 hrs, Volume= 0.275 af
Outflow = 0.82 cfs @ 8.08 hrs, Volume= 0.275 af, Atten= 0%, Lag= 2.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.88 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 3.1 min

Peak Storage= 80 cf @ 8.06 hrs
Average Depth at Peak Storage= 0.07'
Bank-Full Depth= 1.60' Flow Area= 11.5 sf, Capacity= 205.90 cfs

4.00' x 1.60' deep channel, n= 0.041
Side Slope Z-value= 2.0 '/' Top Width= 10.40'
Length= 279.0' Slope= 0.2330 '/'
Inlet Invert= 217.00', Outlet Invert= 152.00'



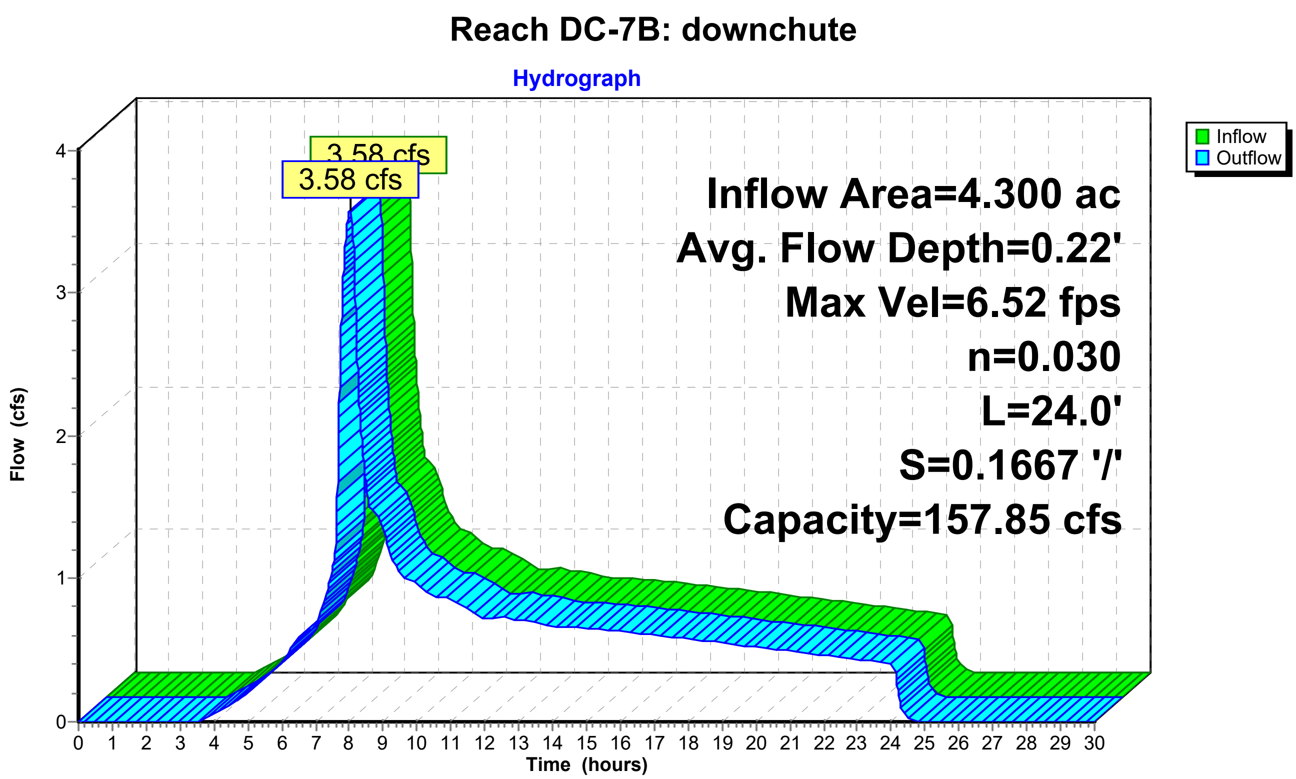
Summary for Reach DC-7B: downchute

Inflow Area = 4.300 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 3.58 cfs @ 8.04 hrs, Volume= 1.194 af
Outflow = 3.58 cfs @ 8.04 hrs, Volume= 1.194 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 6.52 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.35 fps, Avg. Travel Time= 0.1 min

Peak Storage= 13 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 157.85 cfs

2.00' x 1.60' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 24.0' Slope= 0.1667 '/'
Inlet Invert= 152.00', Outlet Invert= 148.00'



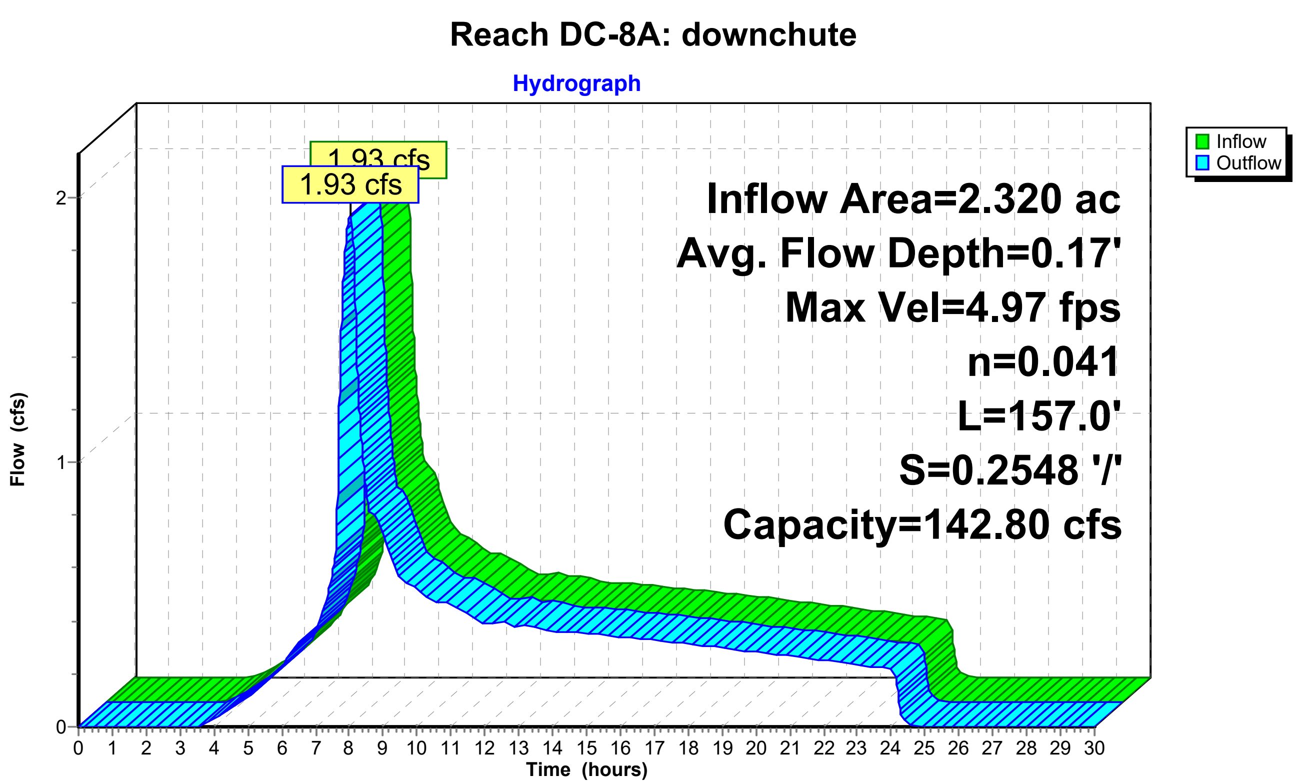
Summary for Reach DC-8A: downchute

Inflow Area = 2.320 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.93 cfs @ 8.02 hrs, Volume= 0.644 af
Outflow = 1.93 cfs @ 8.04 hrs, Volume= 0.644 af, Atten= 0%, Lag= 0.9 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.97 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 2.55 fps, Avg. Travel Time= 1.0 min

Peak Storage= 61 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.17'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 142.80 cfs

2.00' x 1.60' deep channel, n= 0.041
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 157.0' Slope= 0.2548 '/'
Inlet Invert= 235.00', Outlet Invert= 195.00'



Summary for Reach DC-8B: downchute

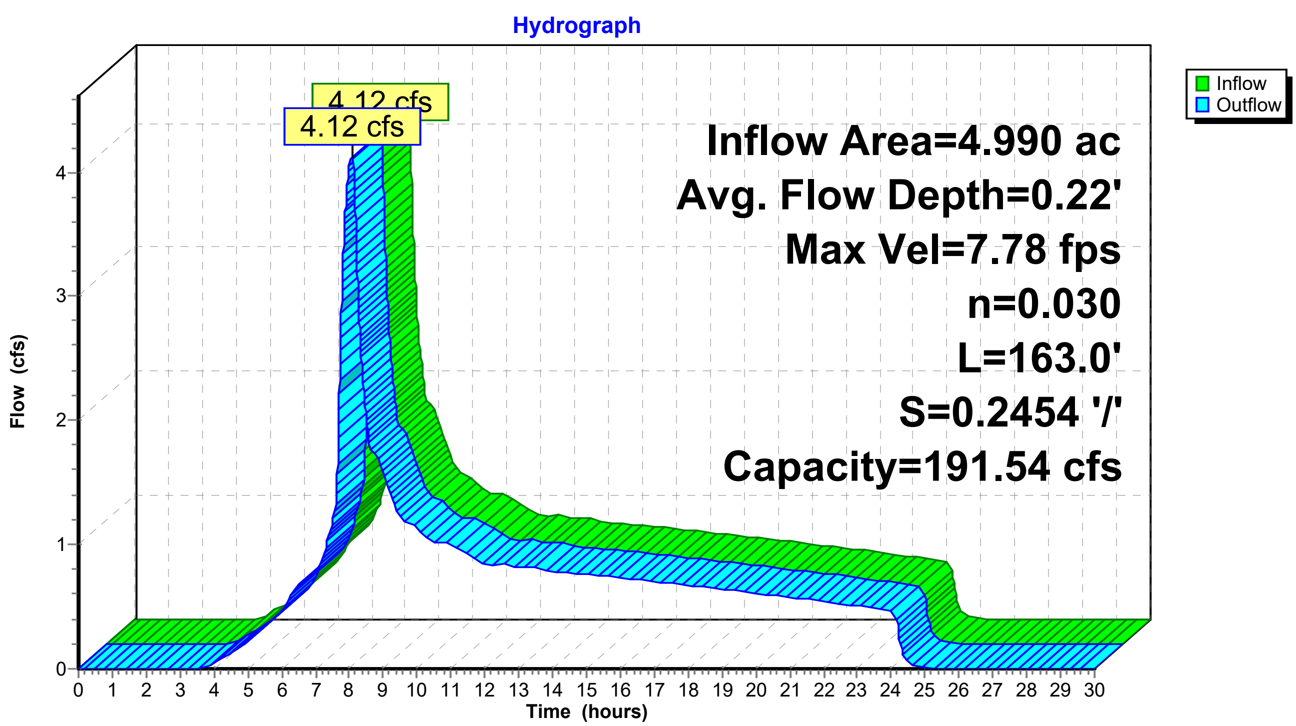
Inflow Area = 4.990 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.12 cfs @ 8.06 hrs, Volume= 1.386 af
Outflow = 4.12 cfs @ 8.07 hrs, Volume= 1.386 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 7.78 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.91 fps, Avg. Travel Time= 0.7 min

Peak Storage= 86 cf @ 8.07 hrs
Average Depth at Peak Storage= 0.22'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 191.54 cfs

2.00' x 1.60' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 163.0' Slope= 0.2454 '/'
Inlet Invert= 195.00', Outlet Invert= 155.00'

Reach DC-8B: downchute



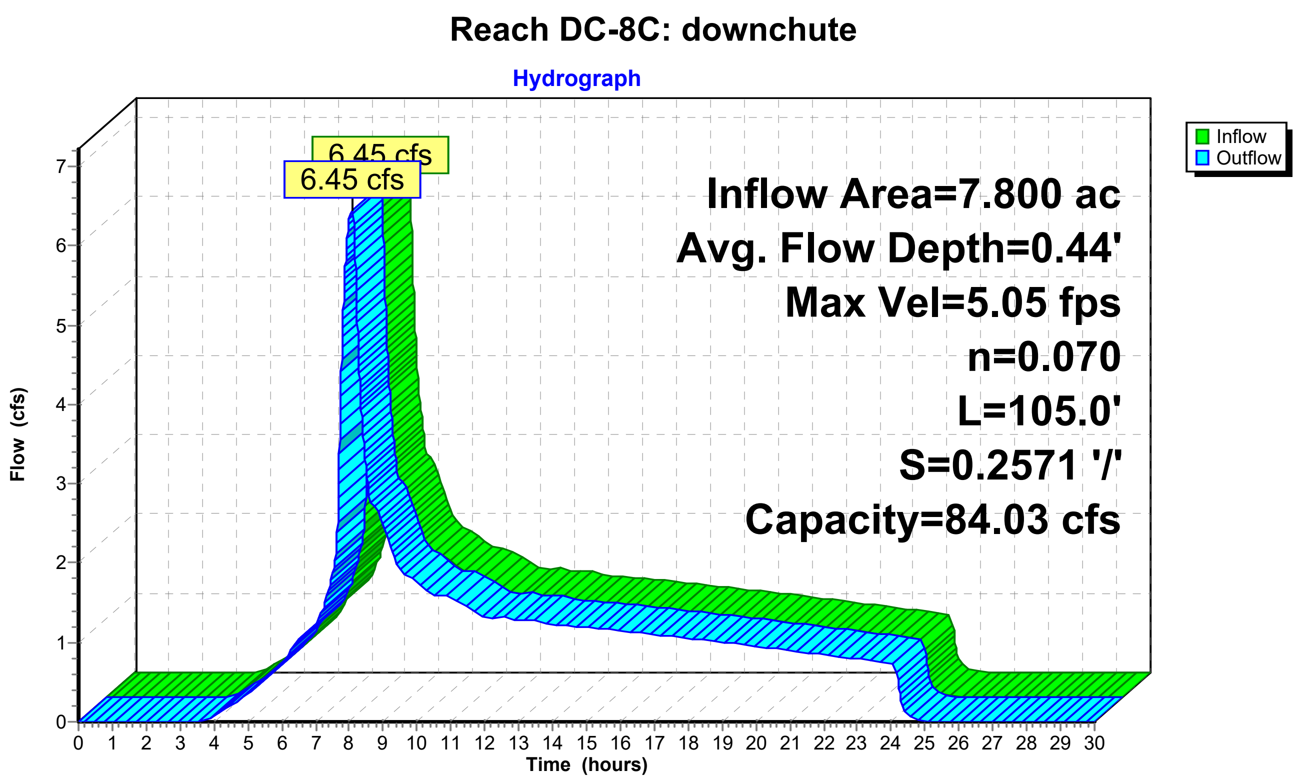
Summary for Reach DC-8C: downchute

Inflow Area = 7.800 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 6.45 cfs @ 8.06 hrs, Volume= 2.167 af
Outflow = 6.45 cfs @ 8.07 hrs, Volume= 2.167 af, Atten= 0%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.05 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 2.54 fps, Avg. Travel Time= 0.7 min

Peak Storage= 134 cf @ 8.07 hrs
Average Depth at Peak Storage= 0.44'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 84.03 cfs

2.00' x 1.60' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 105.0' Slope= 0.2571 '/'
Inlet Invert= 155.00', Outlet Invert= 128.00'



Summary for Reach DC-9: (new Reach)

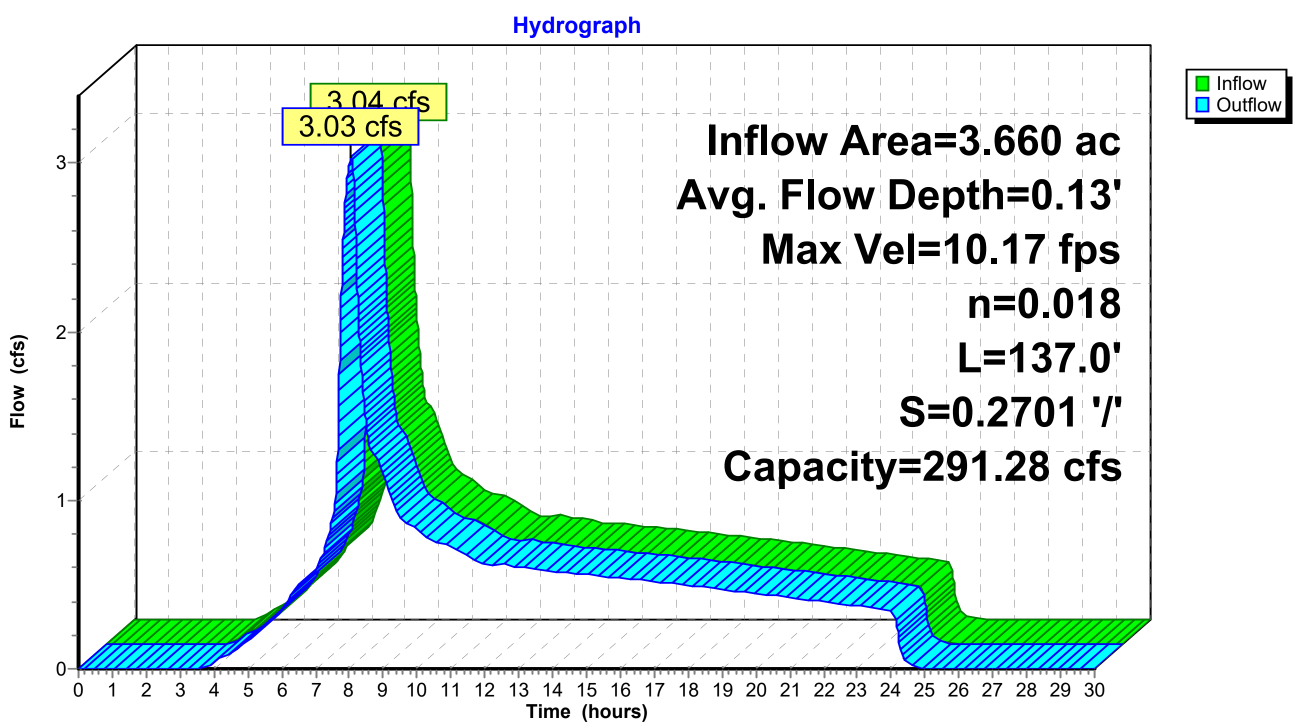
Inflow Area = 3.660 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 3.04 cfs @ 8.05 hrs, Volume= 1.017 af
Outflow = 3.03 cfs @ 8.06 hrs, Volume= 1.017 af, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 10.17 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 5.16 fps, Avg. Travel Time= 0.4 min

Peak Storage= 41 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.13'
Bank-Full Depth= 1.50' Flow Area= 7.5 sf, Capacity= 291.28 cfs

2.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 137.0' Slope= 0.2701 '/'
Inlet Invert= 272.00', Outlet Invert= 235.00'

Reach DC-9: (new Reach)



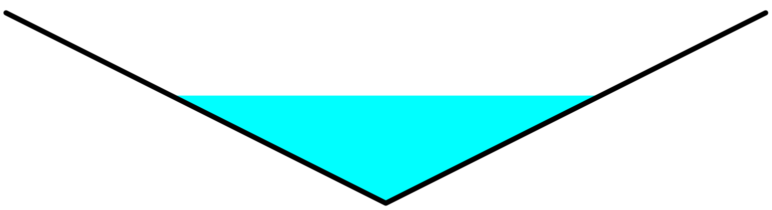
Summary for Reach DITCH-2: (new Reach)

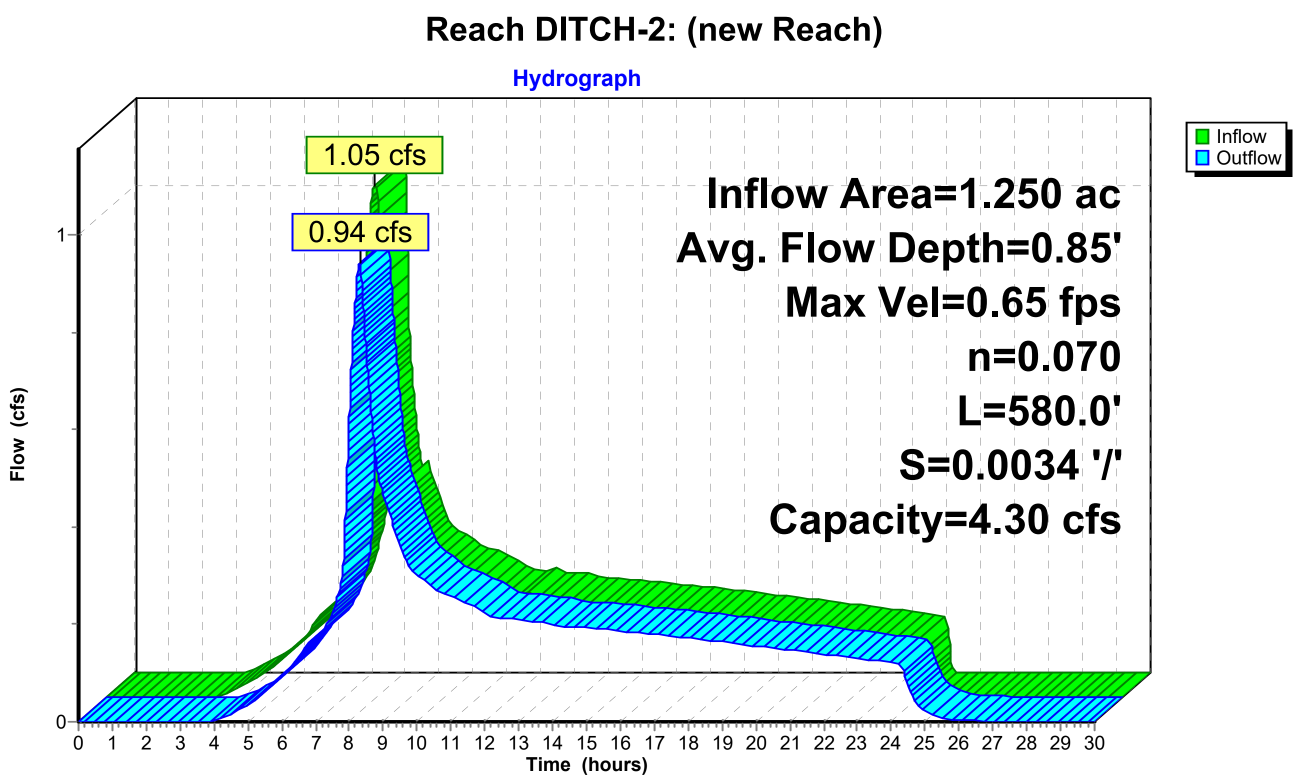
Inflow Area = 1.250 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.05 cfs @ 7.93 hrs, Volume= 0.347 af
Outflow = 0.94 cfs @ 8.30 hrs, Volume= 0.347 af, Atten= 10%, Lag= 22.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.65 fps, Min. Travel Time= 14.8 min
Avg. Velocity = 0.36 fps, Avg. Travel Time= 26.8 min

Peak Storage= 835 cf @ 8.05 hrs
Average Depth at Peak Storage= 0.85'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 4.30 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 580.0' Slope= 0.0034 '/'
Inlet Invert= 150.00', Outlet Invert= 148.00'





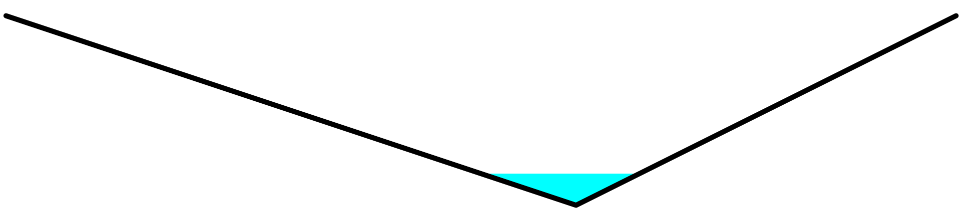
Summary for Reach NPIS-1: (new Reach)

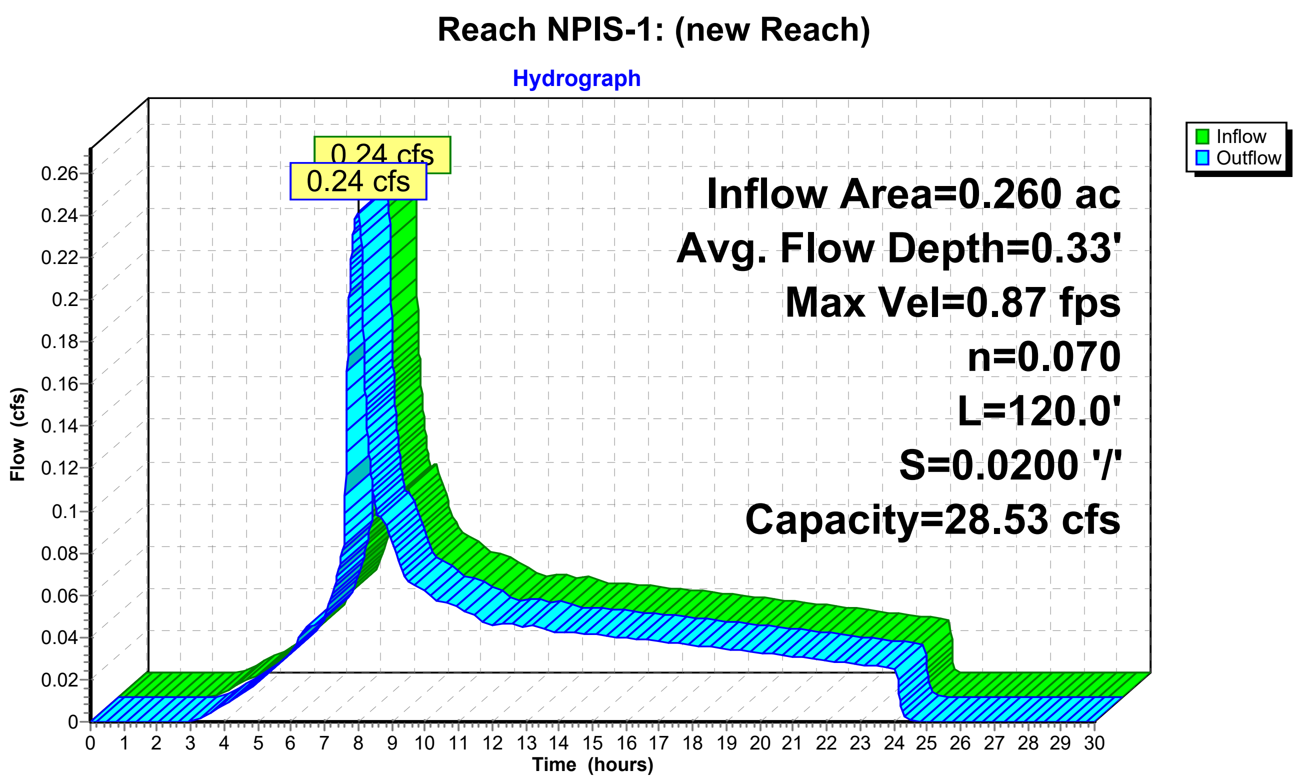
Inflow Area = 0.260 ac, 19.23% Impervious, Inflow Depth = 3.63" for 100-yr event
Inflow = 0.24 cfs @ 7.92 hrs, Volume= 0.079 af
Outflow = 0.24 cfs @ 7.98 hrs, Volume= 0.079 af, Atten= 0%, Lag= 4.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 0.87 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 0.53 fps, Avg. Travel Time= 3.8 min

Peak Storage= 34 cf @ 7.95 hrs
Average Depth at Peak Storage= 0.33'
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 28.53 cfs

0.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 120.0' Slope= 0.0200 '/'
Inlet Invert= 160.00', Outlet Invert= 157.60'





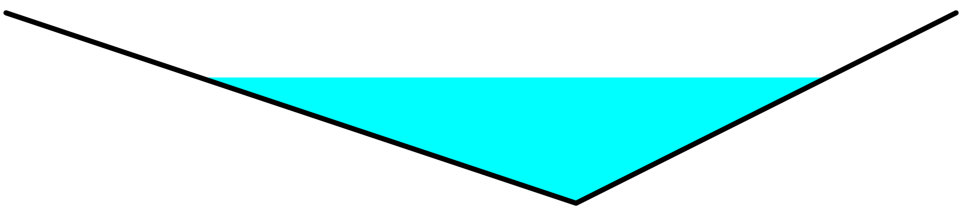
Summary for Reach NPIS-2: (new Reach)

Inflow Area = 9.520 ac, 5.78% Impervious, Inflow Depth = 3.44" for 100-yr event
Inflow = 8.12 cfs @ 8.04 hrs, Volume= 2.725 af
Outflow = 8.06 cfs @ 8.13 hrs, Volume= 2.725 af, Atten= 1%, Lag= 5.2 min

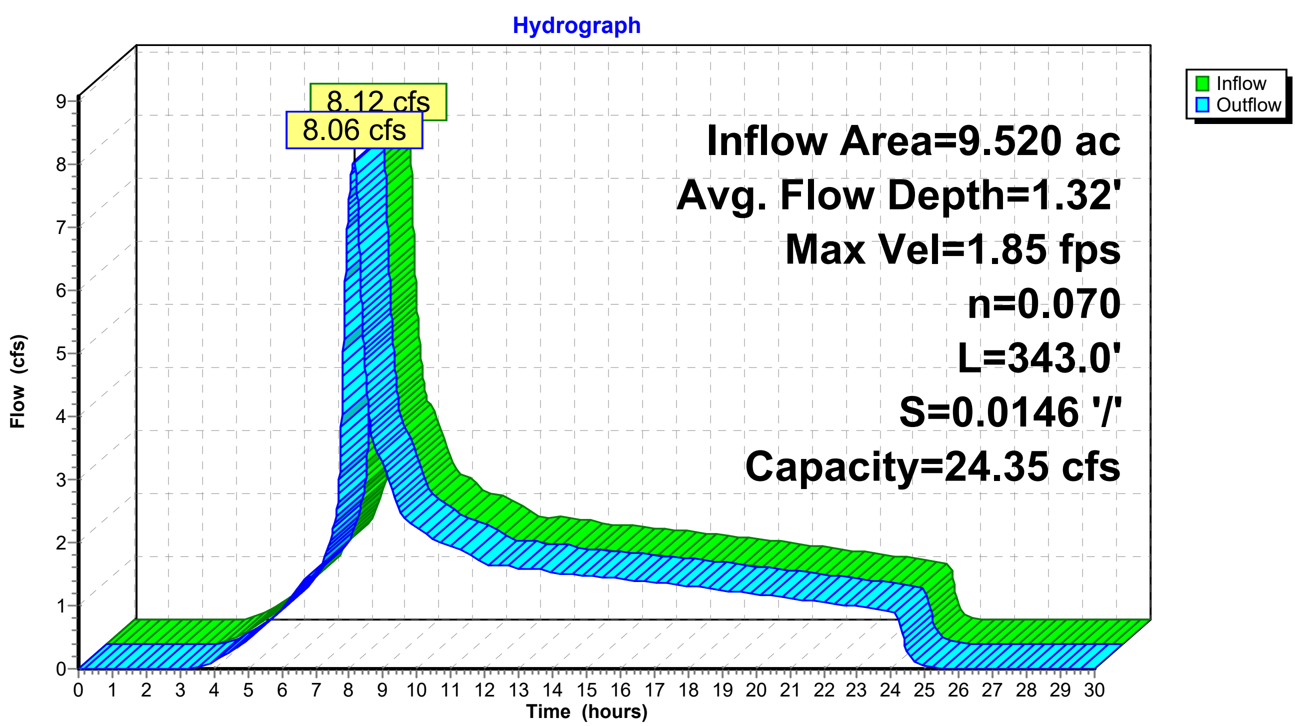
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 1.85 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 0.96 fps, Avg. Travel Time= 5.9 min

Peak Storage= 1,497 cf @ 8.08 hrs
Average Depth at Peak Storage= 1.32'
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 24.35 cfs

0.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 343.0' Slope= 0.0146 '/'
Inlet Invert= 158.00', Outlet Invert= 153.00'



Reach NPIS-2: (new Reach)



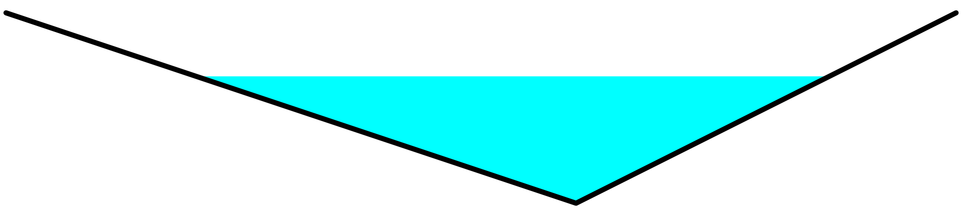
Summary for Reach NPIS-3: (new Reach)

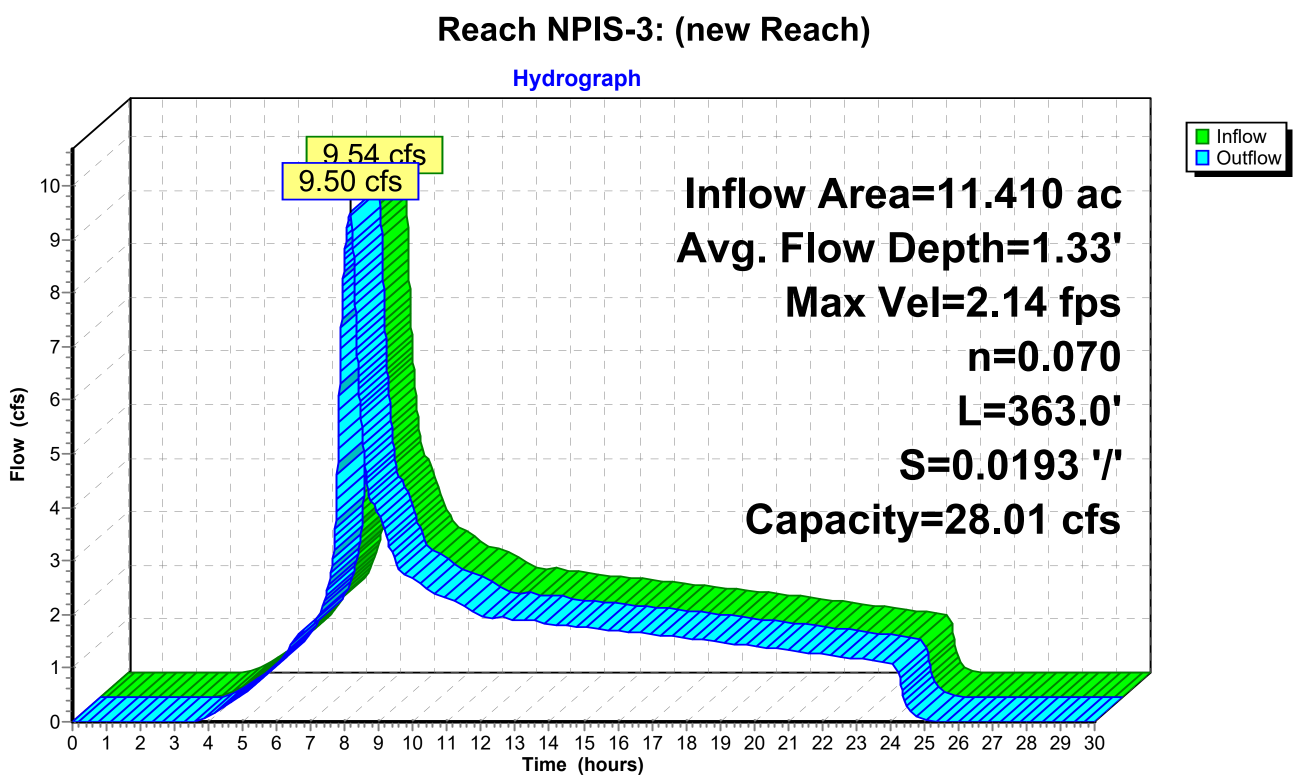
Inflow Area = 11.410 ac, 2.72% Impervious, Inflow Depth = 3.38" for 100-yr event
Inflow = 9.54 cfs @ 8.06 hrs, Volume= 3.215 af
Outflow = 9.50 cfs @ 8.14 hrs, Volume= 3.215 af, Atten= 0%, Lag= 4.8 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.14 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 1.12 fps, Avg. Travel Time= 5.4 min

Peak Storage= 1,613 cf @ 8.10 hrs
Average Depth at Peak Storage= 1.33'
Bank-Full Depth= 2.00' Flow Area= 10.0 sf, Capacity= 28.01 cfs

0.00' x 2.00' deep channel, n= 0.070
Side Slope Z-value= 3.0 2.0 '/' Top Width= 10.00'
Length= 363.0' Slope= 0.0193 '/'
Inlet Invert= 160.00', Outlet Invert= 153.00'





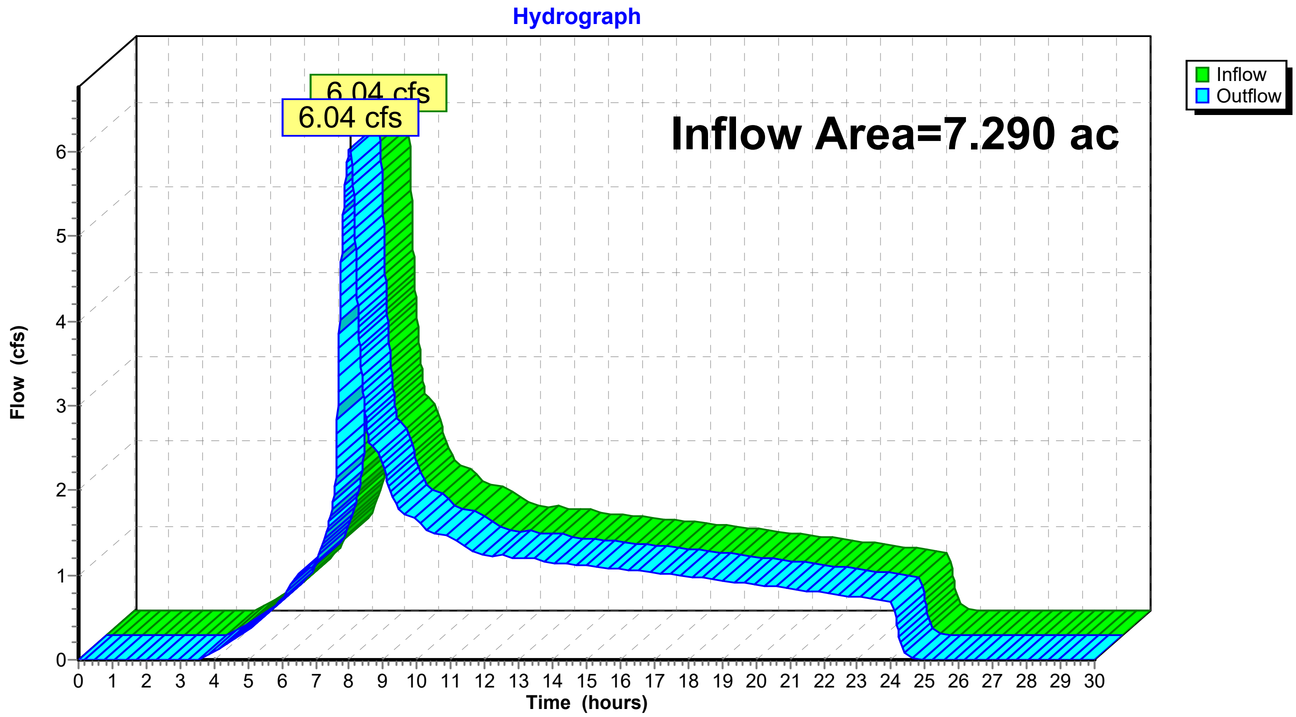
Summary for Reach OF-1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7.290 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 6.04 cfs @ 8.03 hrs, Volume= 2.025 af
Outflow = 6.04 cfs @ 8.03 hrs, Volume= 2.025 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach OF-1: (new Reach)

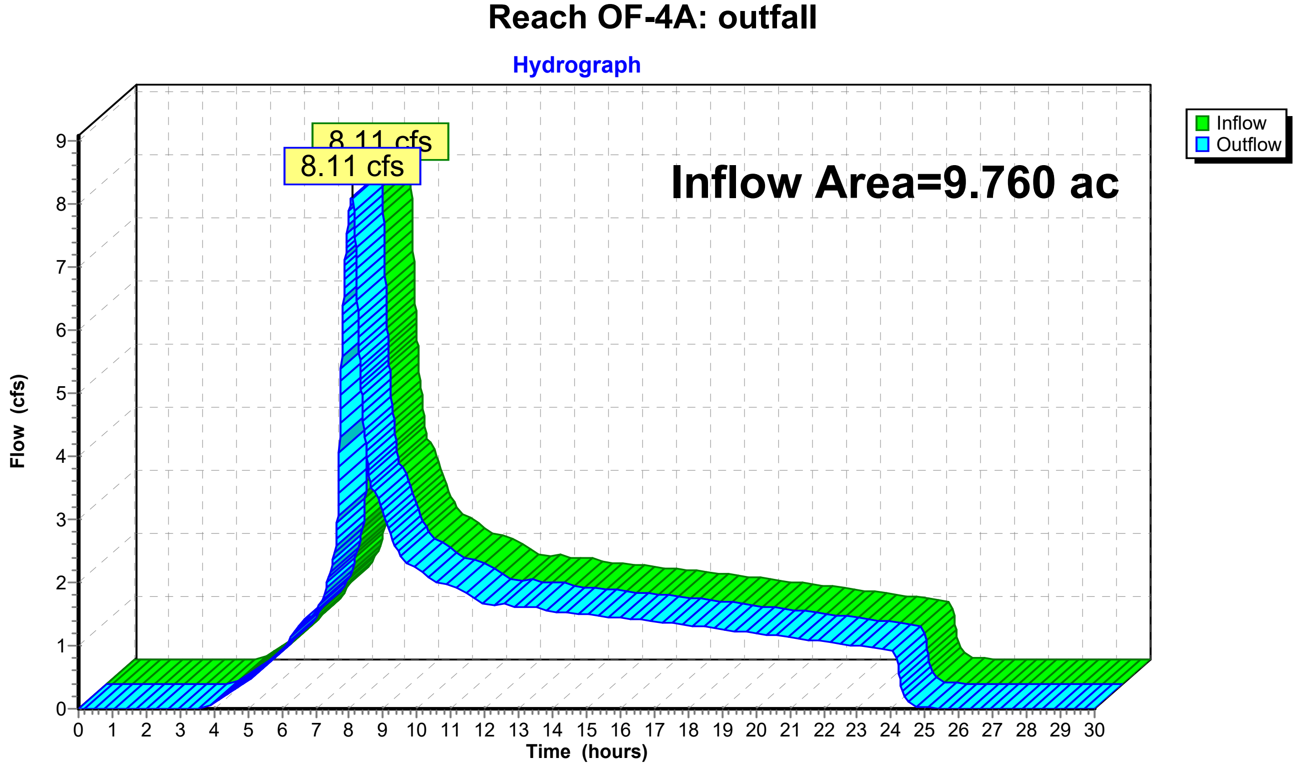


Summary for Reach OF-4A: outfall

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	9.760 ac,	1.54% Impervious, Inflow Depth = 3.35"	for 100-yr event	
Inflow =	8.11 cfs @	8.08 hrs, Volume=	2.727 af	
Outflow =	8.11 cfs @	8.08 hrs, Volume=	2.727 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



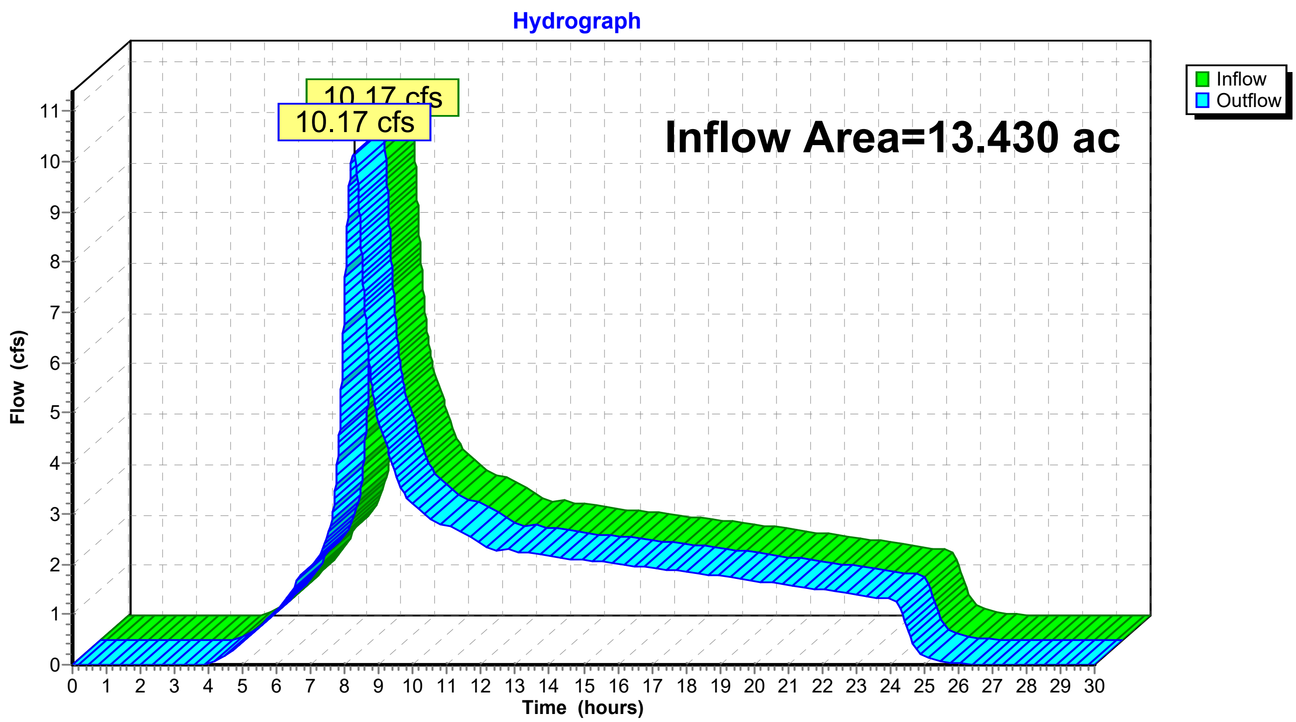
Summary for Reach OF-4B: Outfall 4E

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 13.430 ac, 2.46% Impervious, Inflow Depth > 3.37" for 100-yr event
Inflow = 10.17 cfs @ 8.25 hrs, Volume= 3.767 af
Outflow = 10.17 cfs @ 8.25 hrs, Volume= 3.767 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs

Reach OF-4B: Outfall 4E

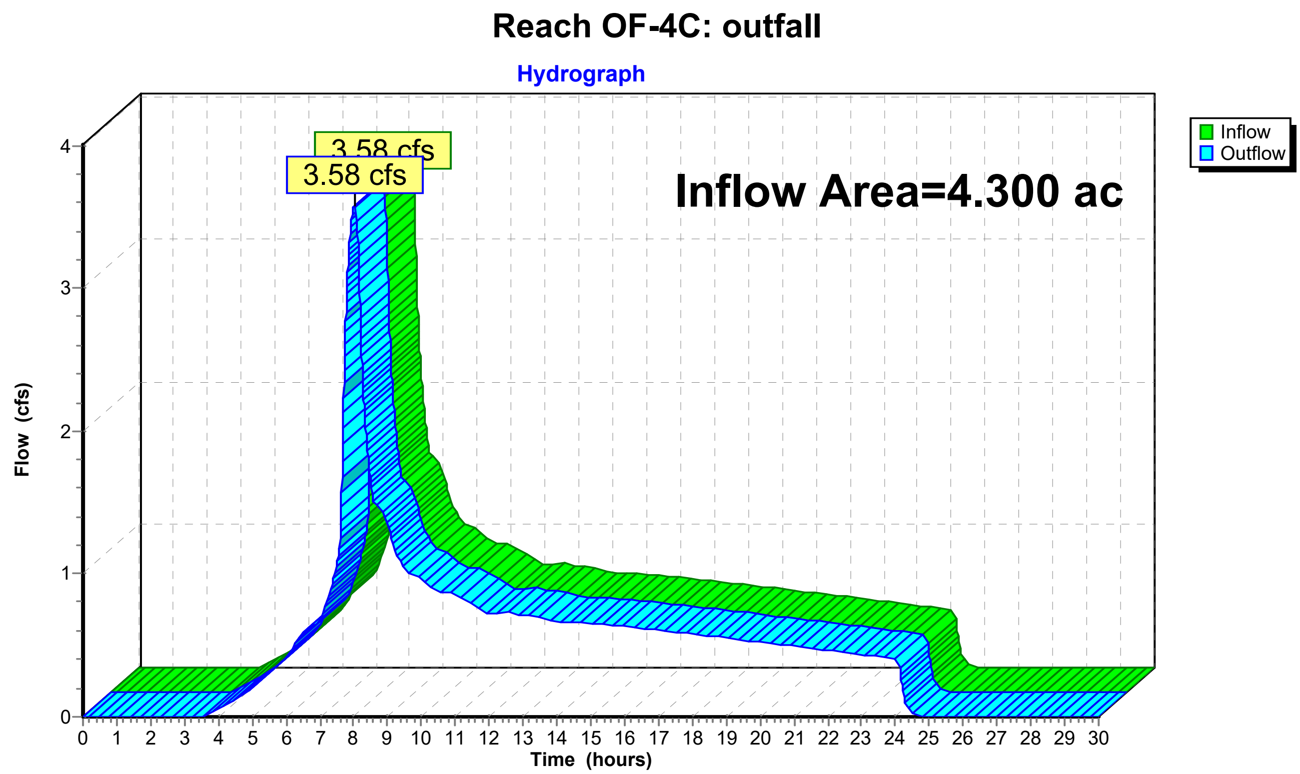


Summary for Reach OF-4C: outfall

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.300 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 3.58 cfs @ 8.04 hrs, Volume= 1.194 af
Outflow = 3.58 cfs @ 8.04 hrs, Volume= 1.194 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs



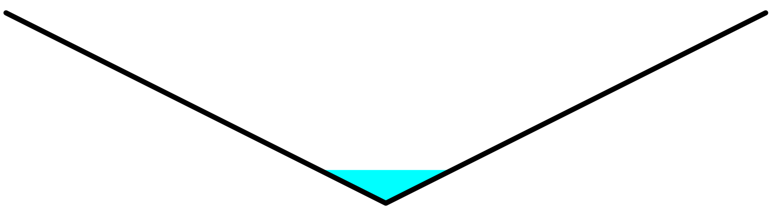
Summary for Reach RD-1: (new Reach)

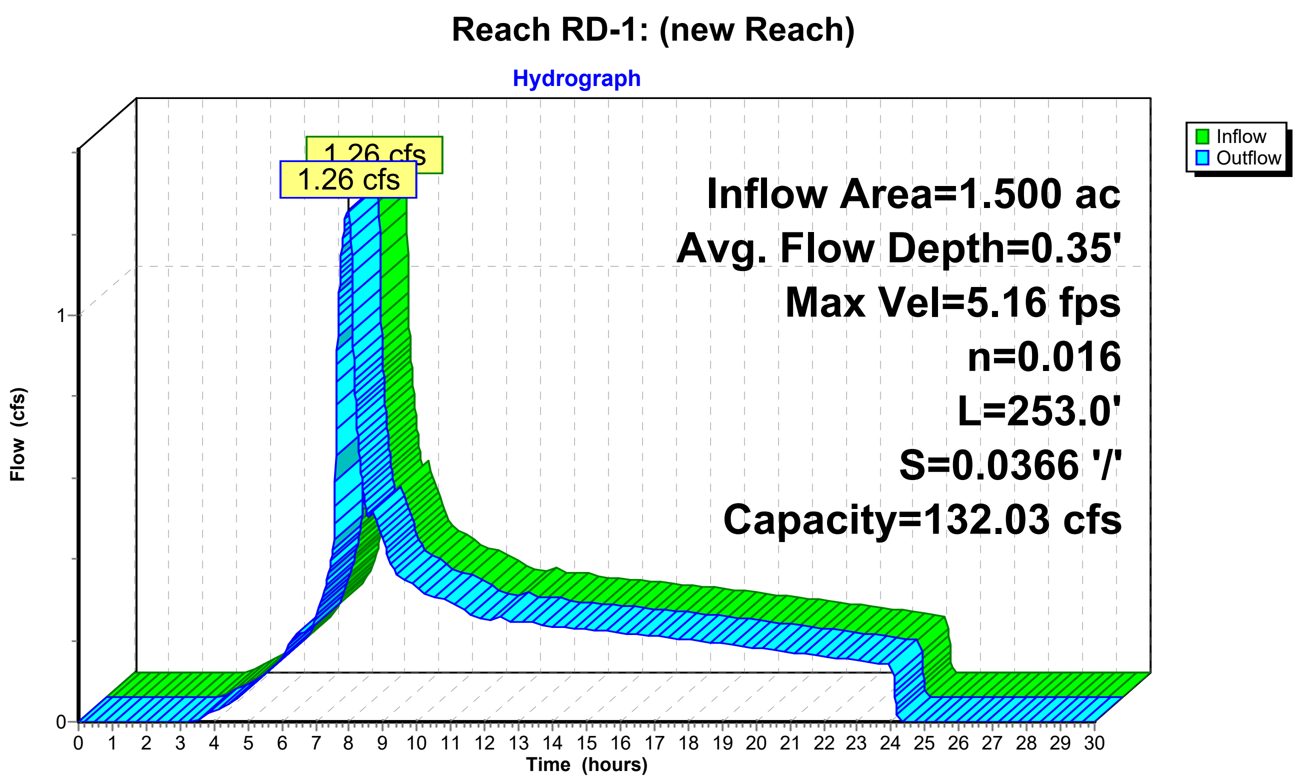
Inflow Area = 1.500 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.26 cfs @ 7.93 hrs, Volume= 0.417 af
Outflow = 1.26 cfs @ 7.96 hrs, Volume= 0.417 af, Atten= 0%, Lag= 1.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.16 fps, Min. Travel Time= 0.8 min
Avg. Velocity = 3.25 fps, Avg. Travel Time= 1.3 min

Peak Storage= 62 cf @ 7.94 hrs
Average Depth at Peak Storage= 0.35'
Bank-Full Depth= 2.00' Flow Area= 8.0 sf, Capacity= 132.03 cfs

0.00' x 2.00' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 253.0' Slope= 0.0366 '/'
Inlet Invert= 165.73', Outlet Invert= 156.46'





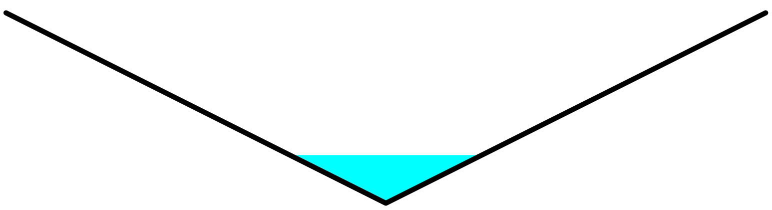
Summary for Reach RD-2: (new Reach)

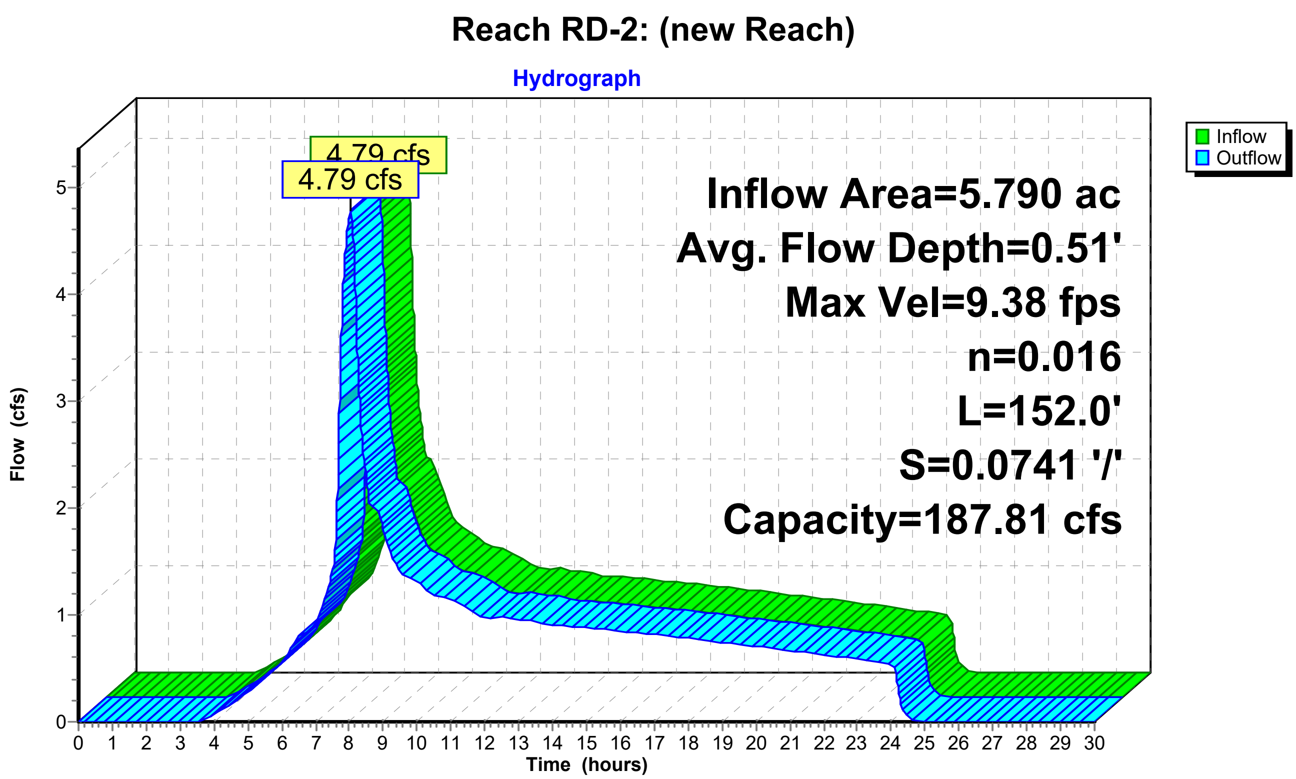
Inflow Area = 5.790 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 4.79 cfs @ 8.03 hrs, Volume= 1.608 af
Outflow = 4.79 cfs @ 8.03 hrs, Volume= 1.608 af, Atten= 0%, Lag= 0.4 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 9.38 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 5.49 fps, Avg. Travel Time= 0.5 min

Peak Storage= 78 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.51'
Bank-Full Depth= 2.00' Flow Area= 8.0 sf, Capacity= 187.81 cfs

0.00' x 2.00' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 8.00'
Length= 152.0' Slope= 0.0741 '/'
Inlet Invert= 177.00', Outlet Invert= 165.73'





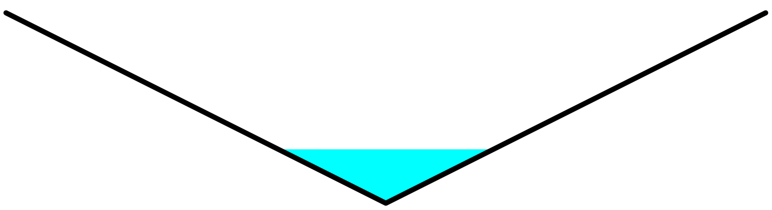
Summary for Reach RD-3: (new Reach)

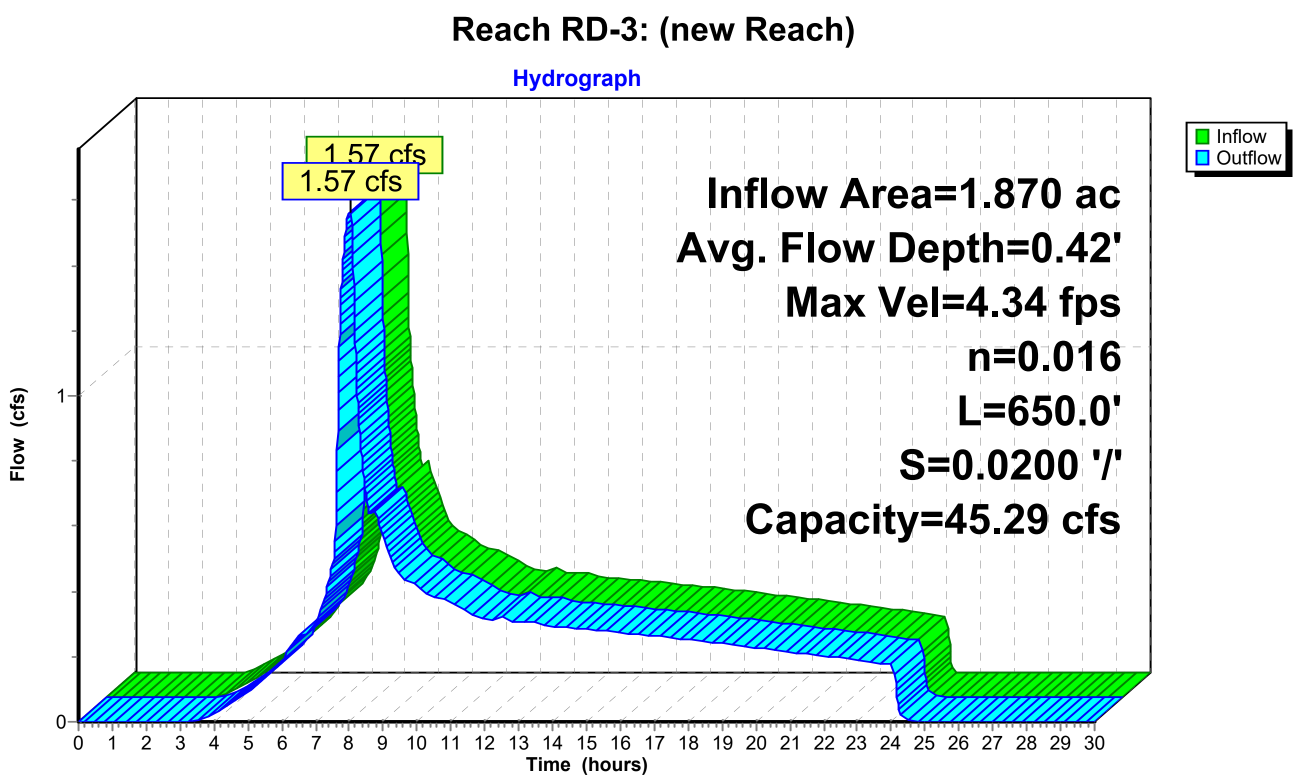
Inflow Area = 1.870 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.57 cfs @ 7.93 hrs, Volume= 0.519 af
Outflow = 1.57 cfs @ 8.00 hrs, Volume= 0.519 af, Atten= 0%, Lag= 4.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 4.34 fps, Min. Travel Time= 2.5 min
Avg. Velocity = 2.63 fps, Avg. Travel Time= 4.1 min

Peak Storage= 234 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 45.29 cfs

0.00' x 1.50' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 650.0' Slope= 0.0200 '/'
Inlet Invert= 190.00', Outlet Invert= 177.00'





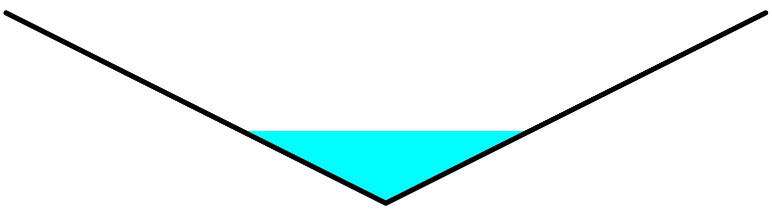
Summary for Reach RD-4: (new Reach)

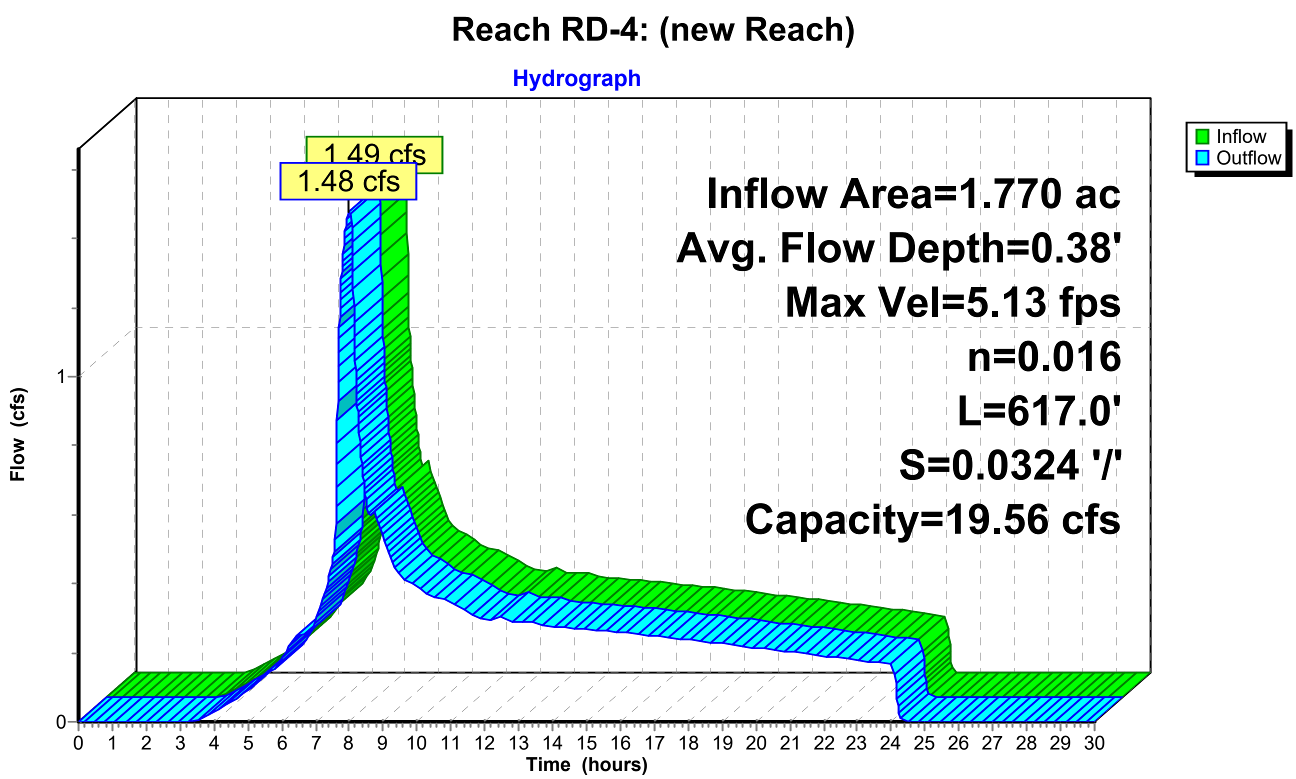
Inflow Area = 1.770 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-yr event
Inflow = 1.49 cfs @ 7.93 hrs, Volume= 0.492 af
Outflow = 1.48 cfs @ 7.99 hrs, Volume= 0.492 af, Atten= 0%, Lag= 3.5 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 5.13 fps, Min. Travel Time= 2.0 min
Avg. Velocity = 3.14 fps, Avg. Travel Time= 3.3 min

Peak Storage= 178 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.38'
Bank-Full Depth= 1.00' Flow Area= 2.0 sf, Capacity= 19.56 cfs

0.00' x 1.00' deep channel, n= 0.016
Side Slope Z-value= 2.0 '/' Top Width= 4.00'
Length= 617.0' Slope= 0.0324 '/'
Inlet Invert= 190.00', Outlet Invert= 170.00'





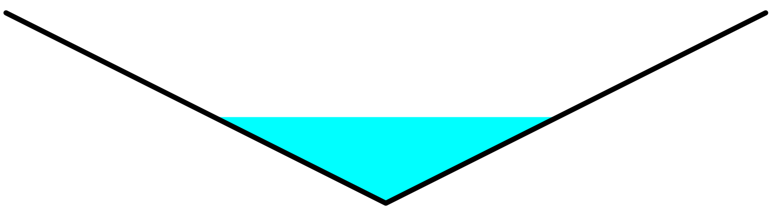
Summary for Reach RD-5: (new Reach)

Inflow Area = 2.740 ac, 16.79% Impervious, Inflow Depth = 3.63" for 100-yr event
Inflow = 2.55 cfs @ 7.92 hrs, Volume= 0.829 af
Outflow = 2.53 cfs @ 8.06 hrs, Volume= 0.829 af, Atten= 1%, Lag= 8.5 min

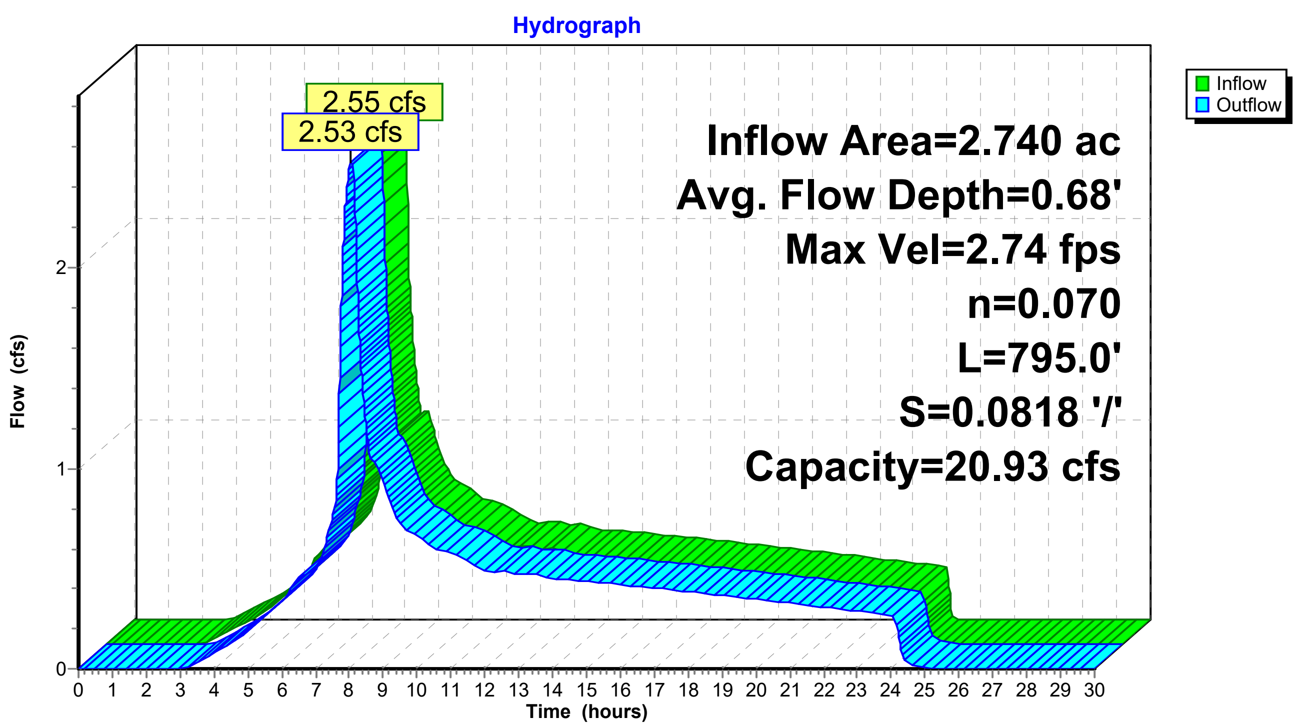
Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.74 fps, Min. Travel Time= 4.8 min
Avg. Velocity = 1.51 fps, Avg. Travel Time= 8.8 min

Peak Storage= 733 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.68'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 20.93 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 795.0' Slope= 0.0818 '/'
Inlet Invert= 250.00', Outlet Invert= 185.00'



Reach RD-5: (new Reach)



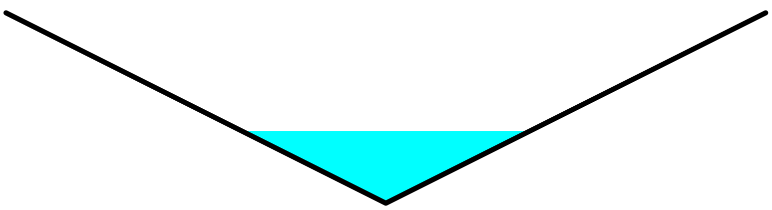
Summary for Reach RD-7: (new Reach)

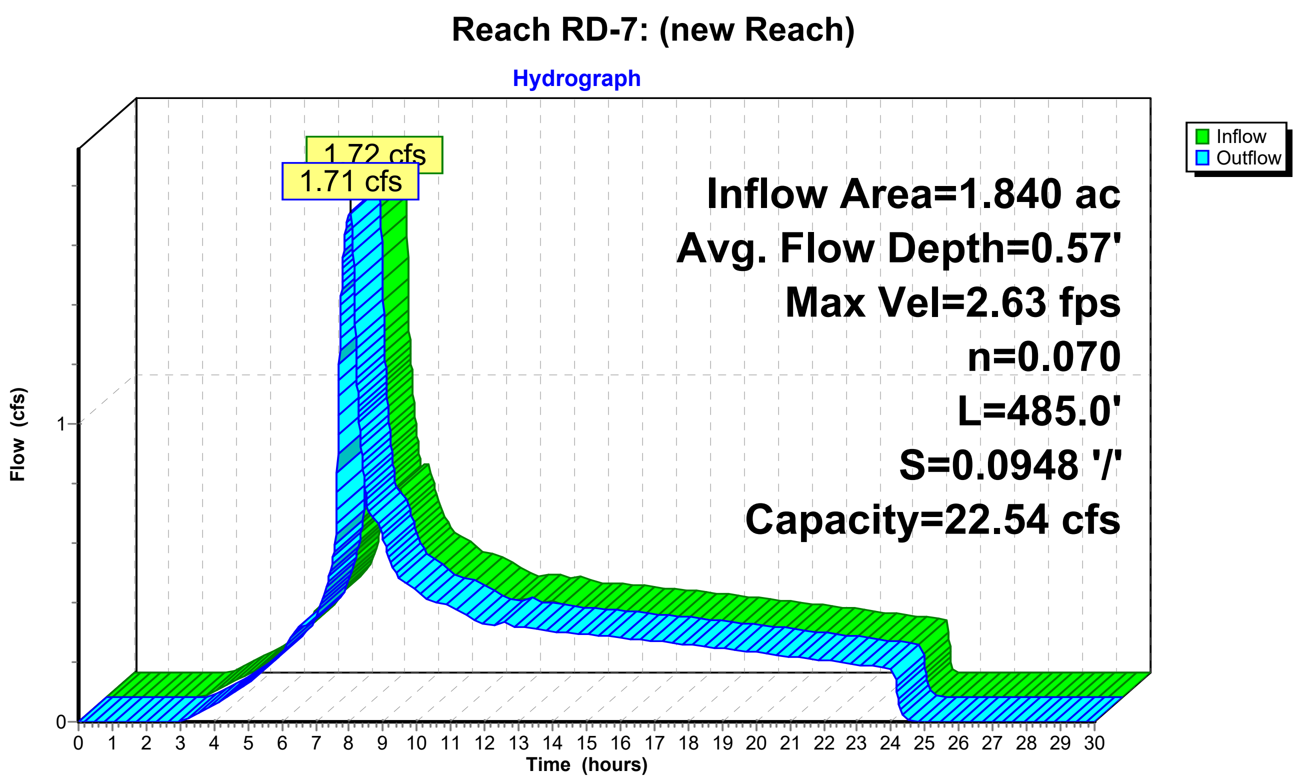
Inflow Area = 1.840 ac, 16.85% Impervious, Inflow Depth = 3.63" for 100-yr event
Inflow = 1.72 cfs @ 7.92 hrs, Volume= 0.557 af
Outflow = 1.71 cfs @ 8.01 hrs, Volume= 0.557 af, Atten= 0%, Lag= 5.3 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.63 fps, Min. Travel Time= 3.1 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 5.3 min

Peak Storage= 315 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.57'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 22.54 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 485.0' Slope= 0.0948 '/'
Inlet Invert= 281.00', Outlet Invert= 235.00'





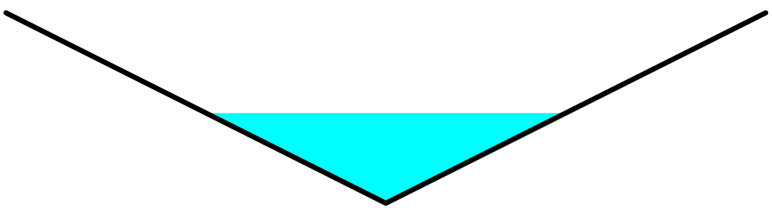
Summary for Reach RD-8: (new Reach)

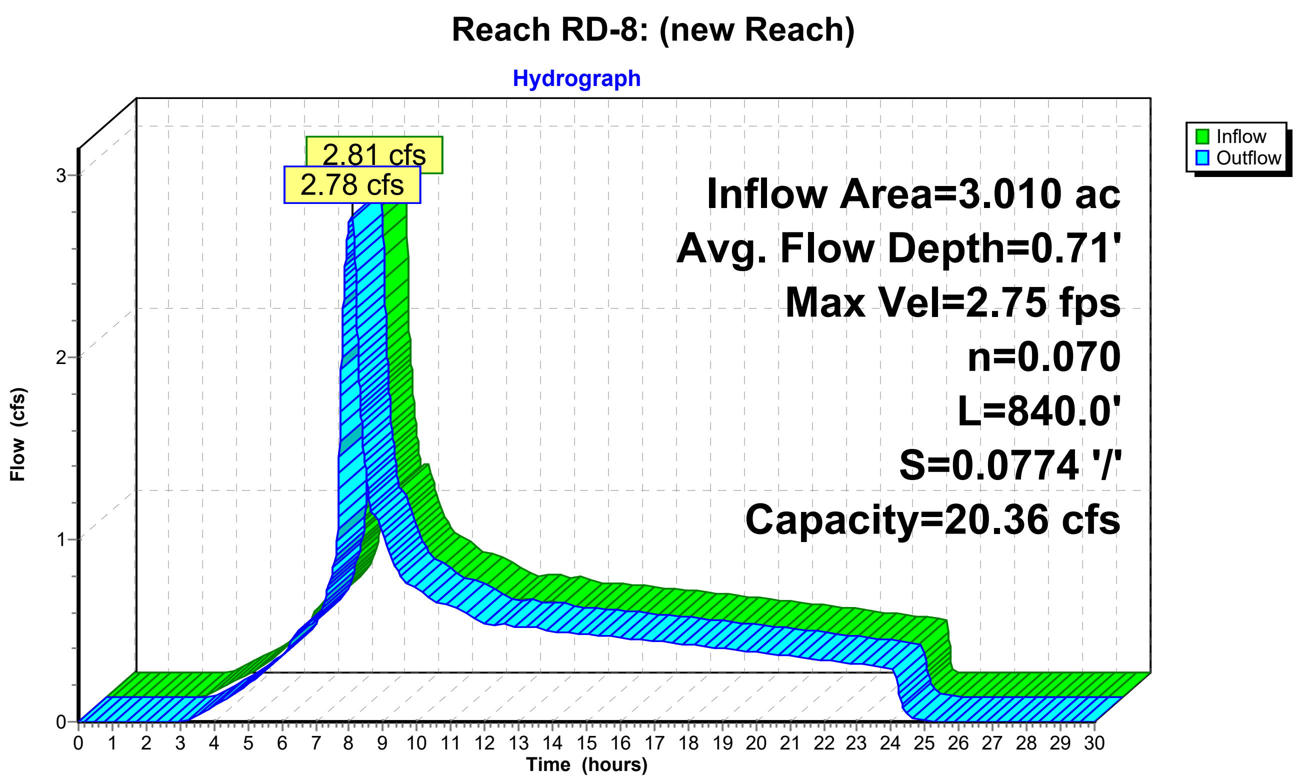
Inflow Area = 3.010 ac, 16.61% Impervious, Inflow Depth = 3.63" for 100-yr event
Inflow = 2.81 cfs @ 7.92 hrs, Volume= 0.910 af
Outflow = 2.78 cfs @ 8.07 hrs, Volume= 0.910 af, Atten= 1%, Lag= 9.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Max. Velocity= 2.75 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 1.49 fps, Avg. Travel Time= 9.4 min

Peak Storage= 848 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.71'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 20.36 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 840.0' Slope= 0.0774 '/'
Inlet Invert= 235.00', Outlet Invert= 170.00'





Summary for Pond 1P: DI-5

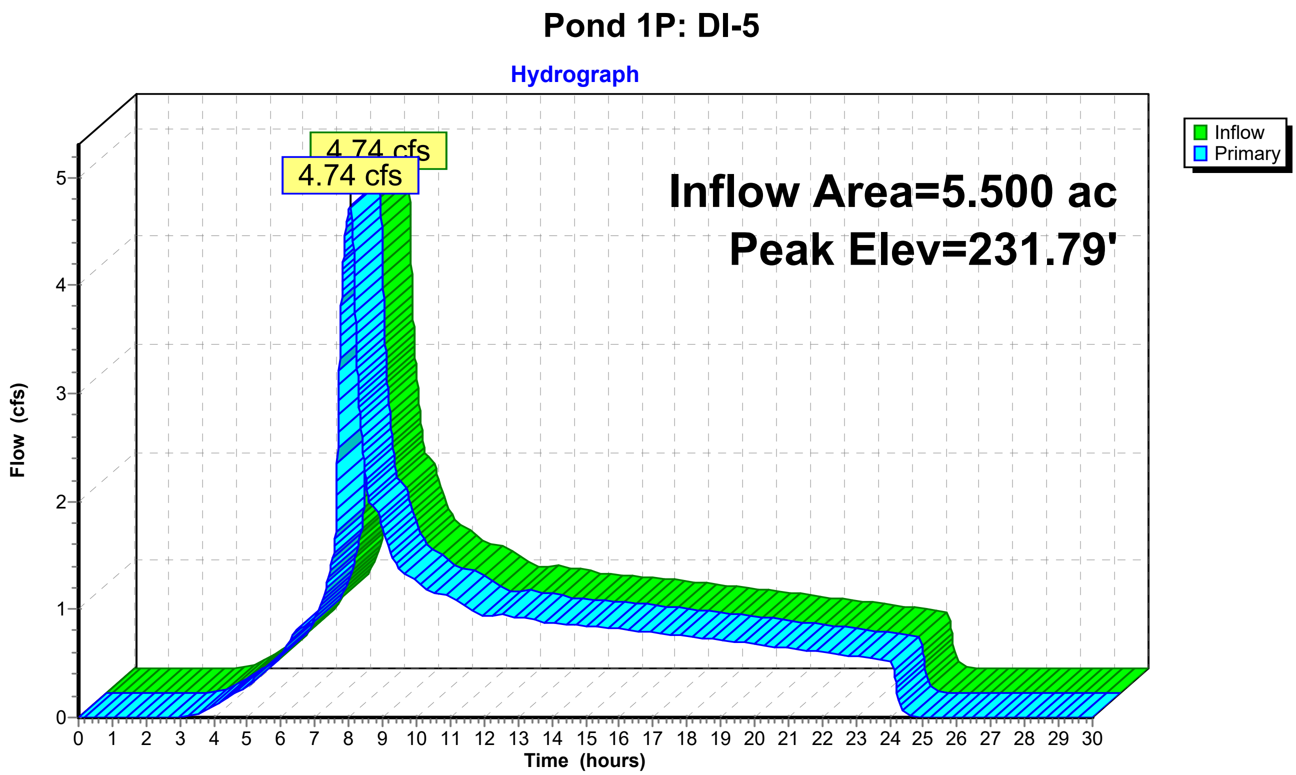
[57] Hint: Peaked at 231.79' (Flood elevation advised)

Inflow Area =	5.500 ac,	5.64% Impervious,	Inflow Depth =	3.43"	for 100-yr event
Inflow =	4.74 cfs @	8.04 hrs,	Volume=	1.573 af	
Outflow =	4.74 cfs @	8.04 hrs,	Volume=	1.573 af,	Atten= 0%, Lag= 0.0 min
Primary =	4.74 cfs @	8.04 hrs,	Volume=	1.573 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 231.79' @ 8.04 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	231.41'	**24.0" Horiz. Bottom** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.74 cfs @ 8.04 hrs HW=231.79' (Free Discharge)
└─**1=Bottom** (Weir Controls 4.74 cfs @ 2.01 fps)



Summary for Pond DI-1: (new Pond)

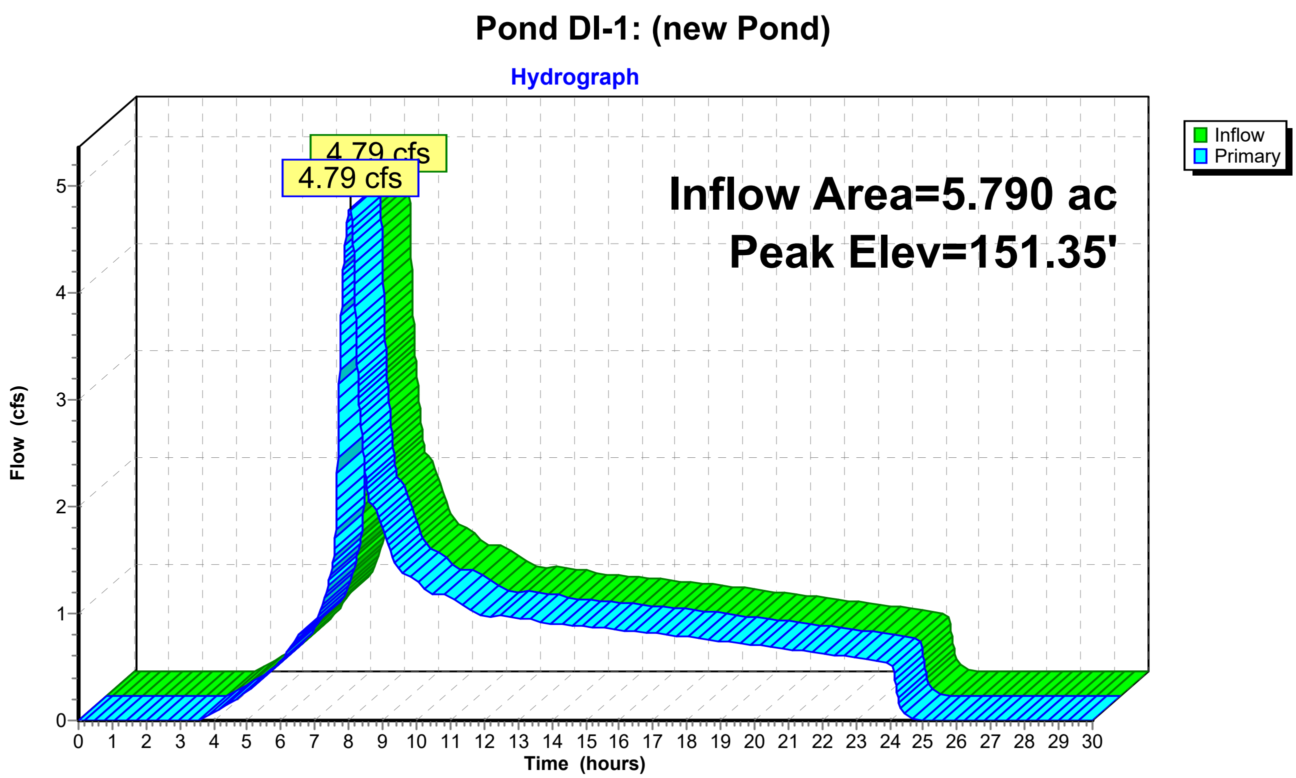
[57] Hint: Peaked at 151.35' (Flood elevation advised)

Inflow Area =	5.790 ac,	0.00% Impervious, Inflow Depth = 3.33"	for 100-yr event
Inflow =	4.79 cfs @	8.03 hrs, Volume=	1.608 af
Outflow =	4.79 cfs @	8.03 hrs, Volume=	1.608 af, Atten= 0%, Lag= 0.0 min
Primary =	4.79 cfs @	8.03 hrs, Volume=	1.608 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 151.35' @ 8.03 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	150.97'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=4.79 cfs @ 8.03 hrs HW=151.35' (Free Discharge)
└─**1=Orifice/Grate** (Weir Controls 4.79 cfs @ 2.01 fps)



Summary for Pond DI-2: (new Pond)

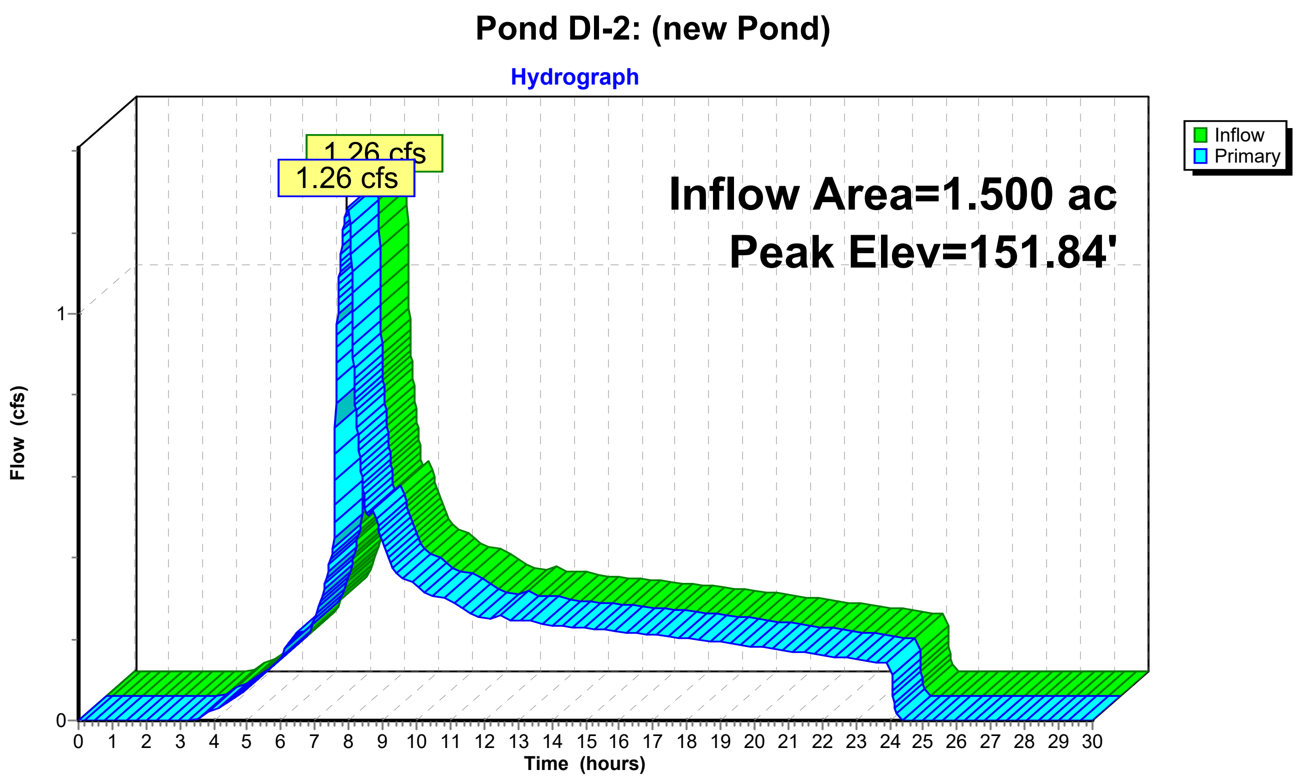
[57] Hint: Peaked at 151.84' (Flood elevation advised)

Inflow Area =	1.500 ac,	0.00% Impervious,	Inflow Depth = 3.33"	for 100-yr event
Inflow =	1.26 cfs @	7.96 hrs, Volume=	0.417 af	
Outflow =	1.26 cfs @	7.96 hrs, Volume=	0.417 af,	Atten= 0%, Lag= 0.0 min
Primary =	1.26 cfs @	7.96 hrs, Volume=	0.417 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 151.84' @ 7.96 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	151.71'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.26 cfs @ 7.96 hrs HW=151.84' (Free Discharge)
└─**1=Orifice/Grate** (Weir Controls 1.26 cfs @ 1.20 fps)



Summary for Pond DI-4: (new Pond)

[57] Hint: Peaked at 147.51' (Flood elevation advised)

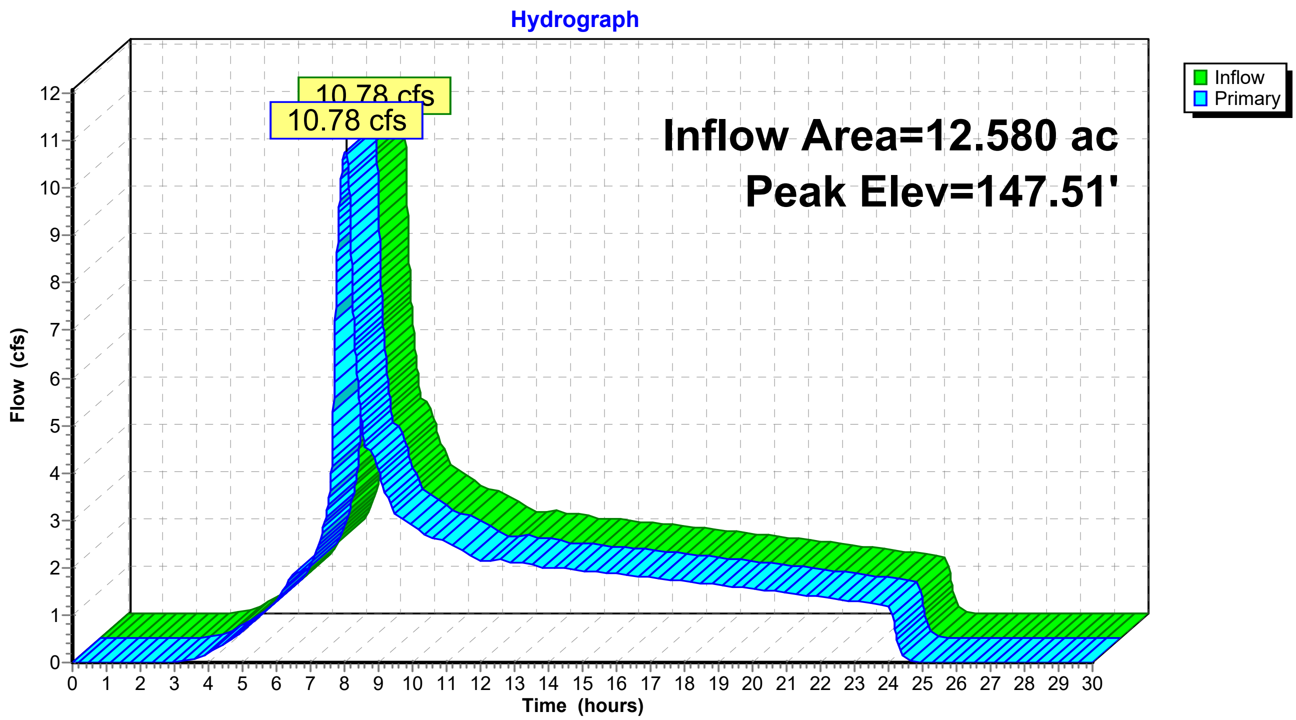
Inflow Area =	12.580 ac,	5.01% Impervious,	Inflow Depth = 3.42"	for 100-yr event	
Inflow =	10.78 cfs @	8.04 hrs,	Volume=	3.588 af	
Outflow =	10.78 cfs @	8.04 hrs,	Volume=	3.588 af,	Atten= 0%, Lag= 0.0 min
Primary =	10.78 cfs @	8.04 hrs,	Volume=	3.588 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 147.51' @ 8.04 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	140.30'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=10.79 cfs @ 8.04 hrs HW=147.51' TW=147.00' (Fixed TW Elev= 147.00')
└─**1=Orifice/Grate** (Orifice Controls 10.79 cfs @ 3.43 fps)

Pond DI-4: (new Pond)



Summary for Pond DI-6: (new Pond)

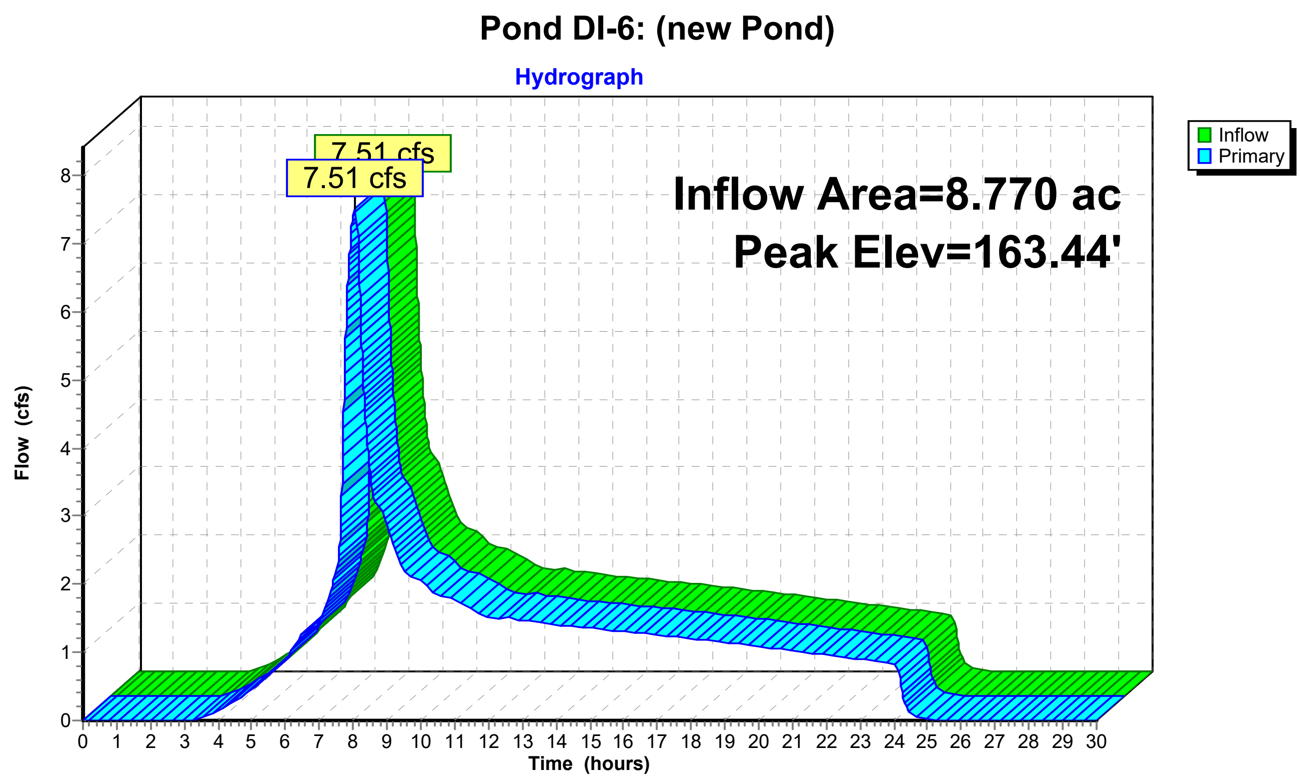
[57] Hint: Peaked at 163.44' (Flood elevation advised)

Inflow Area =	8.770 ac,	5.70% Impervious,	Inflow Depth = 3.44"	for 100-yr event
Inflow =	7.51 cfs @	8.06 hrs, Volume=	2.510 af	
Outflow =	7.51 cfs @	8.06 hrs, Volume=	2.510 af, Atten= 0%, Lag= 0.0 min	
Primary =	7.51 cfs @	8.06 hrs, Volume=	2.510 af	

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 163.44' @ 8.06 hrs

Device	Routing	Invert	Outlet Devices
#1	Primary	163.00'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=7.51 cfs @ 8.06 hrs HW=163.44' (Free Discharge)
└─**1=Orifice/Grate** (Weir Controls 7.51 cfs @ 2.17 fps)



Summary for Pond POND-1: DITCH 1/STORMWATER DETENTION POND 1

Inflow Area = 27.870 ac, 6.89% Impervious, Inflow Depth = 3.45" for 100-yr event
Inflow = 23.59 cfs @ 8.02 hrs, Volume= 8.009 af
Outflow = 5.78 cfs @ 10.85 hrs, Volume= 5.026 af, Atten= 76%, Lag= 169.7 min
Primary = 5.78 cfs @ 10.85 hrs, Volume= 5.026 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 135.55' @ 10.85 hrs Surf.Area= 0.619 ac Storage= 3.206 af

Plug-Flow detention time= 424.8 min calculated for 5.026 af (63% of inflow)
Center-of-Mass det. time= 213.6 min (984.1 - 770.5)

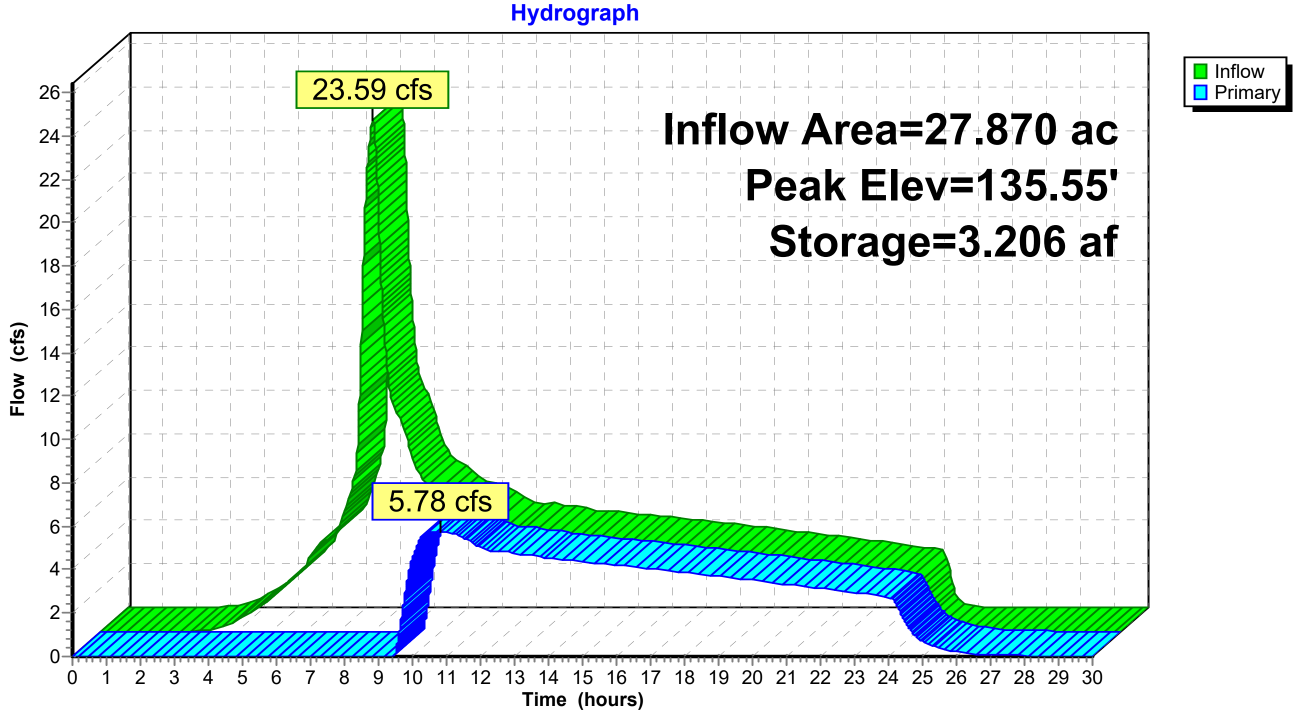
Volume	Invert	Avail.Storage	Storage Description
#1	128.00'	3.490 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
128.00	0.020	0.000	0.000
129.00	0.310	0.165	0.165
136.00	0.640	3.325	3.490

Device	Routing	Invert	Outlet Devices
#1	Device 2	135.18'	**30.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	128.00'	**30.0" Round Culvert** L= 105.0' Ke= 0.200 Inlet / Outlet Invert= 128.00' / 120.11' S= 0.0751 '/' Cc= 0.900 n= 0.017, Flow Area= 4.91 sf

Primary OutFlow Max=5.75 cfs @ 10.85 hrs HW=135.55' (Free Discharge)
└─**2=Culvert** (Passes 5.75 cfs of 74.15 cfs potential flow)
  └─**1=Orifice/Grate** (Weir Controls 5.75 cfs @ 1.99 fps)

Pond POND-1: DITCH 1/STORMWATER DETENTION POND 1



Summary for Pond POND-3: STORMWATER DETENTION POND 3

Inflow Area = 25.630 ac, 21.69% Impervious, Inflow Depth = 3.75" for 100-yr event
Inflow = 22.50 cfs @ 8.03 hrs, Volume= 8.001 af
Outflow = 12.78 cfs @ 8.47 hrs, Volume= 8.000 af, Atten= 43%, Lag= 26.1 min
Primary = 12.78 cfs @ 8.47 hrs, Volume= 8.000 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 141.82' @ 8.47 hrs Surf.Area= 0.948 ac Storage= 0.867 af

Plug-Flow detention time= 42.9 min calculated for 8.000 af (100% of inflow)
Center-of-Mass det. time= 42.8 min (792.1 - 749.4)

Volume	Invert	Avail.Storage	Storage Description
#1	140.00'	7.590 af	**Custom Stage Data (Prismatic)** Listed below (Recalc)

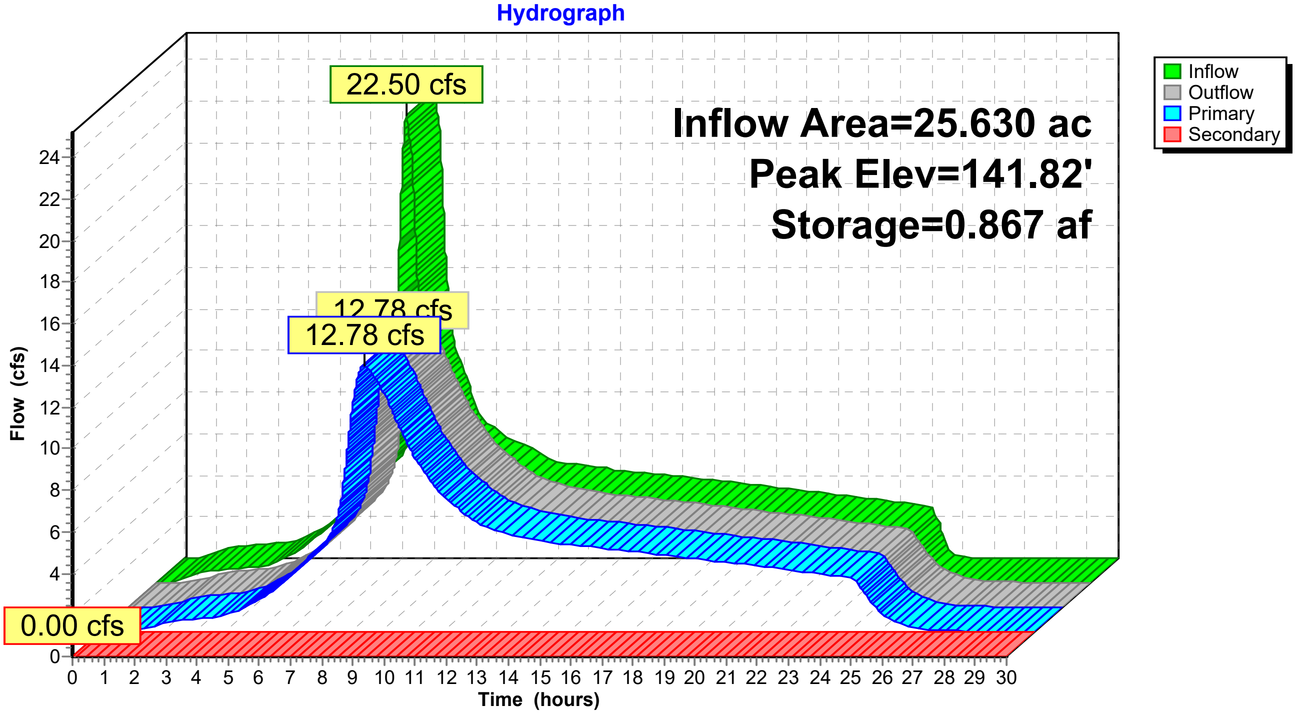
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
140.00	0.030	0.000	0.000
141.00	0.510	0.270	0.270
143.00	1.580	2.090	2.360
144.00	1.680	1.630	3.990
146.00	1.920	3.600	7.590

Device	Routing	Invert	Outlet Devices
#1	Secondary	145.50'	**39.0' long x 15.0' 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
#2	Primary	145.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#3	Primary	140.00'	**24.0" Round Culvert** L= 104.0' Ke= 0.200 Inlet / Outlet Invert= 140.00' / 139.00' S= 0.0096 '/' Cc= 0.900 n= 0.017, Flow Area= 3.14 sf

Primary OutFlow Max=12.78 cfs @ 8.47 hrs HW=141.82' (Free Discharge)
├─**2=Orifice/Grate** (Controls 0.00 cfs)
└─**3=Culvert** (Barrel Controls 12.78 cfs @ 5.60 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=140.00' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond POND-3: STORMWATER DETENTION POND 3



Summary for Pond POND-4A: STORMWATER DETENTION POND 4A

Inflow Area = 8.930 ac, 18.37% Impervious, Inflow Depth = 3.69" for 100-yr event
Inflow = 8.09 cfs @ 7.99 hrs, Volume= 2.744 af
Outflow = 4.44 cfs @ 8.34 hrs, Volume= 2.127 af, Atten= 45%, Lag= 20.6 min
Primary = 4.44 cfs @ 8.34 hrs, Volume= 2.127 af

Routing by Stor-Ind method, Time Span= 0.00-30.00 hrs, dt= 0.01 hrs
Peak Elev= 151.86' @ 8.34 hrs Surf.Area= 0.333 ac Storage= 0.733 af

Plug-Flow detention time= 271.0 min calculated for 2.127 af (78% of inflow)
Center-of-Mass det. time= 130.4 min (874.4 - 744.0)

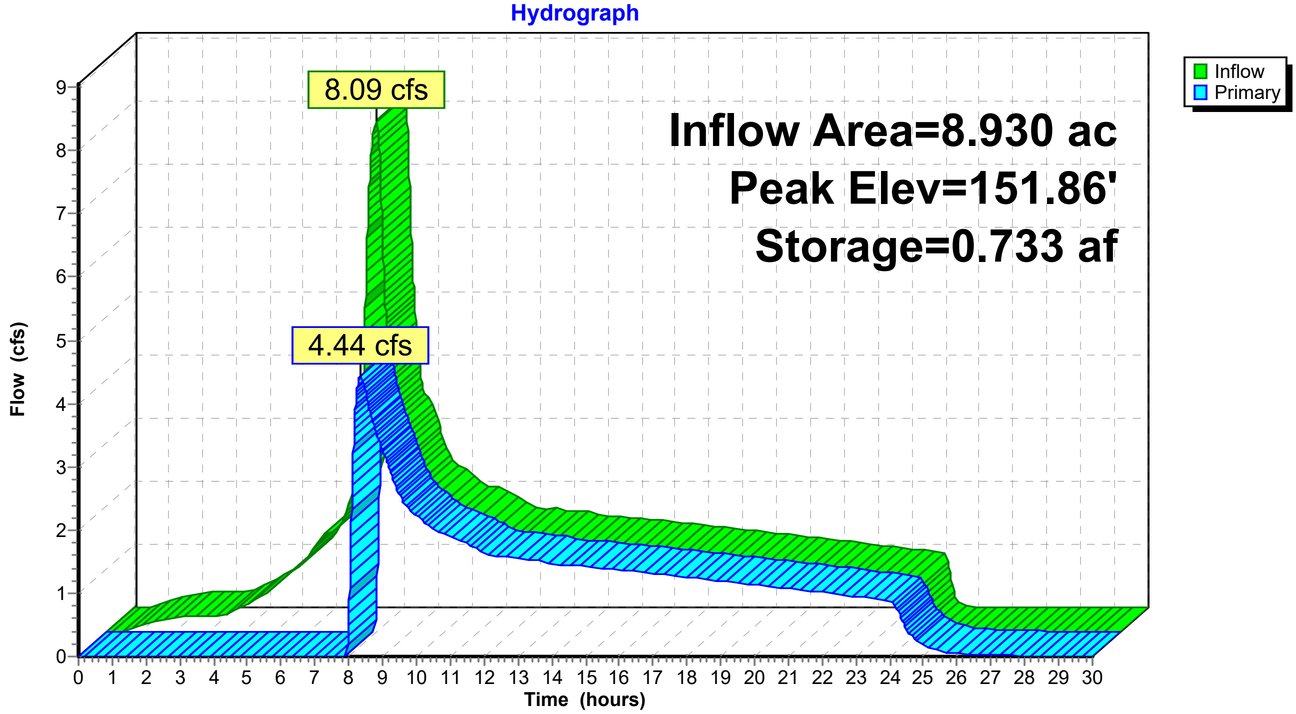
Volume	Invert	Avail.Storage	Storage Description
#1	149.00'	0.780 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)

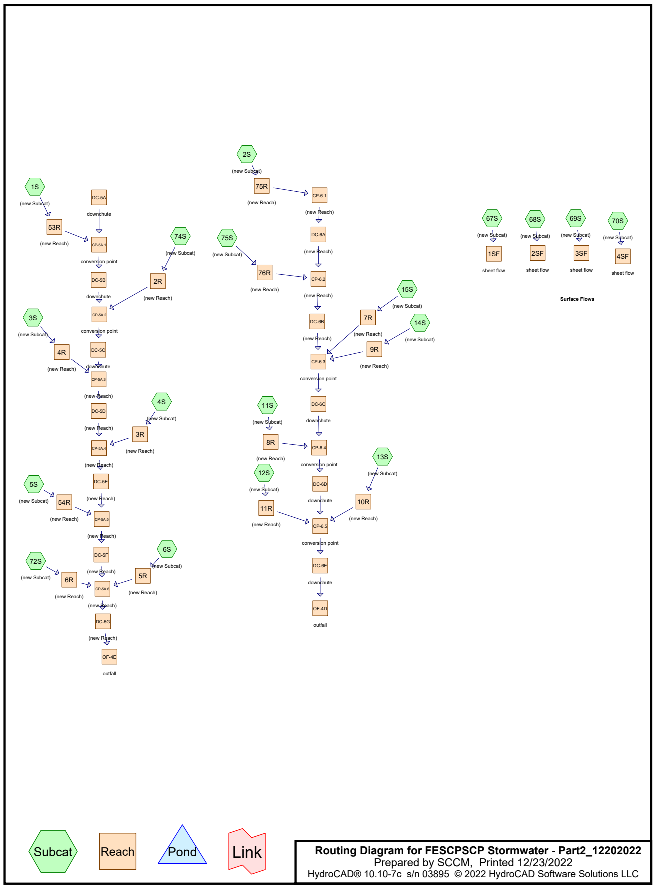
Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
149.00	0.180	0.000	0.000
152.00	0.340	0.780	0.780

Device	Routing	Invert	Outlet Devices
#1	Device 2	151.50'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	148.00'	**24.0" Round Culvert** L= 130.0' Ke= 0.200 Inlet / Outlet Invert= 148.00' / 147.00' S= 0.0077 '/' Cc= 0.900 n= 0.024, Flow Area= 3.14 sf

Primary OutFlow Max=4.44 cfs @ 8.34 hrs HW=151.86' (Free Discharge)
↑—**2=Culvert** (Passes 4.44 cfs of 16.44 cfs potential flow)
  ↑—**1=Orifice/Grate** (Weir Controls 4.44 cfs @ 1.96 fps)

Pond POND-4A: STORMWATER DETENTION POND 4A





Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	100-YR 24-HR	Type IA 24-hr		Default	24.00	1	5.50	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
18.810	80	>75% Grass cover, Good, HSG D (1S, 2S, 3S, 4S, 5S, 6S, 11S, 12S, 13S, 14S, 15S, 67S, 68S, 69S, 70S, 72S, 74S, 75S)
0.750	98	Road (67S, 68S, 69S, 70S)
19.560	**81**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
0.000	HSG B	
0.000	HSG C	
18.810	HSG D	1S, 2S, 3S, 4S, 5S, 6S, 11S, 12S, 13S, 14S, 15S, 67S, 68S, 69S, 70S, 72S, 74S, 75S
0.750	Other	67S, 68S, 69S, 70S
19.560		**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	18.810	0.000	18.810	>75% Grass cover, Good	1S, 2S, 3S, 4S, 5S, 6S, 11S, 12S, 13S, 14S, 15S, 67S, 68S, 69S, 70S, 72S, 74S, 75S
0.000	0.000	0.000	0.000	0.750	0.750	Road	67S, 68S, 69S, 70S
0.000	**0.000**	**0.000**	**18.810**	**0.750**	**19.560**	**TOTAL AREA**	

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 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: (new Subcat) Runoff Area=0.590 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.49 cfs 0.164 af

Subcatchment 2S: (new Subcat) Runoff Area=0.940 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.79 cfs 0.261 af

Subcatchment 3S: (new Subcat) Runoff Area=0.640 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.54 cfs 0.178 af

Subcatchment 4S: (new Subcat) Runoff Area=1.320 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.11 cfs 0.367 af

Subcatchment 5S: (new Subcat) Runoff Area=1.110 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.93 cfs 0.308 af

Subcatchment 6S: (new Subcat) Runoff Area=0.970 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.81 cfs 0.269 af

Subcatchment 11S: (new Subcat) Runoff Area=0.880 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.74 cfs 0.244 af

Subcatchment 12S: (new Subcat) Runoff Area=0.880 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.74 cfs 0.244 af

Subcatchment 13S: (new Subcat) Runoff Area=1.530 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.28 cfs 0.425 af

Subcatchment 14S: (new Subcat) Runoff Area=0.360 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.30 cfs 0.100 af

Subcatchment 15S: (new Subcat) Runoff Area=1.700 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.43 cfs 0.472 af

Subcatchment 67S: (new Subcat) Runoff Area=1.440 ac 14.58% Impervious Runoff Depth=3.63"
Tc=5.0 min CN=83 Runoff=1.34 cfs 0.436 af

Subcatchment 68S: (new Subcat) Runoff Area=1.400 ac 11.43% Impervious Runoff Depth=3.53"
Tc=5.0 min CN=82 Runoff=1.26 cfs 0.412 af

Subcatchment 69S: (new Subcat) Runoff Area=1.380 ac 12.32% Impervious Runoff Depth=3.53"
Tc=5.0 min CN=82 Runoff=1.24 cfs 0.406 af

Subcatchment 70S: (new Subcat) Runoff Area=0.800 ac 26.25% Impervious Runoff Depth=3.83"
Tc=5.0 min CN=85 Runoff=0.80 cfs 0.256 af

Subcatchment 72S: (new Subcat) Runoff Area=1.550 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.30 cfs 0.431 af

Subcatchment 74S: (new Subcat) Runoff Area=1.550 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=1.30 cfs 0.431 af

Subcatchment 75S: (new Subcat) Runoff Area=0.520 ac 0.00% Impervious Runoff Depth=3.33"
Tc=5.0 min CN=80 Runoff=0.44 cfs 0.144 af

Reach 1SF: sheet flow Inflow=1.34 cfs 0.436 af
Outflow=1.34 cfs 0.436 af

Reach 2R: (new Reach) Avg. Flow Depth=0.69' Max Vel=1.38 fps Inflow=1.30 cfs 0.431 af
n=0.070 L=295.0' S=0.0203 '/' Capacity=10.44 cfs Outflow=1.29 cfs 0.431 af

Reach 2SF: sheet flow Inflow=1.26 cfs 0.412 af
Outflow=1.26 cfs 0.412 af

Reach 3R: (new Reach) Avg. Flow Depth=0.63' Max Vel=1.38 fps Inflow=1.11 cfs 0.367 af
n=0.070 L=395.0' S=0.0228 '/' Capacity=11.05 cfs Outflow=1.09 cfs 0.367 af

Reach 3SF: sheet flow Inflow=1.24 cfs 0.406 af
Outflow=1.24 cfs 0.406 af

Reach 4R: (new Reach) Avg. Flow Depth=0.41' Max Vel=1.59 fps Inflow=0.54 cfs 0.178 af
n=0.070 L=260.0' S=0.0538 '/' Capacity=16.99 cfs Outflow=0.53 cfs 0.178 af

Reach 4SF: sheet flow Inflow=0.80 cfs 0.256 af
Outflow=0.80 cfs 0.256 af

Reach 5R: (new Reach) Avg. Flow Depth=0.48' Max Vel=1.74 fps Inflow=0.81 cfs 0.269 af
n=0.070 L=287.0' S=0.0523 '/' Capacity=16.74 cfs Outflow=0.81 cfs 0.269 af

Reach 6R: (new Reach) Avg. Flow Depth=0.61' Max Vel=1.73 fps Inflow=1.30 cfs 0.431 af
n=0.070 L=532.0' S=0.0376 '/' Capacity=14.19 cfs Outflow=1.28 cfs 0.431 af

Reach 7R: (new Reach) Avg. Flow Depth=0.53' Max Vel=2.56 fps Inflow=1.43 cfs 0.472 af
n=0.070 L=402.0' S=0.0995 '/' Capacity=23.09 cfs Outflow=1.42 cfs 0.472 af

Reach 8R: (new Reach) Avg. Flow Depth=0.47' Max Vel=1.69 fps Inflow=0.74 cfs 0.244 af
n=0.070 L=329.0' S=0.0517 '/' Capacity=16.64 cfs Outflow=0.73 cfs 0.244 af

Reach 9R: (new Reach) Avg. Flow Depth=0.37' Max Vel=1.11 fps Inflow=0.30 cfs 0.100 af
n=0.070 L=299.0' S=0.0301 '/' Capacity=12.70 cfs Outflow=0.30 cfs 0.100 af

Reach 10R: (new Reach) Avg. Flow Depth=0.55' Max Vel=2.11 fps Inflow=1.28 cfs 0.425 af
n=0.070 L=297.0' S=0.0640 '/' Capacity=18.52 cfs Outflow=1.28 cfs 0.425 af

Reach 11R: (new Reach) Avg. Flow Depth=0.46' Max Vel=1.75 fps Inflow=0.74 cfs 0.244 af
n=0.070 L=320.0' S=0.0563 '/' Capacity=17.36 cfs Outflow=0.74 cfs 0.244 af

Reach 53R: (new Reach) Avg. Flow Depth=0.47' Max Vel=1.13 fps Inflow=0.49 cfs 0.164 af
n=0.070 L=174.0' S=0.0230 '/' Capacity=11.10 cfs Outflow=0.49 cfs 0.164 af

Reach 54R: (new Reach) Avg. Flow Depth=0.51' Max Vel=1.81 fps Inflow=0.93 cfs 0.308 af
n=0.070 L=380.0' S=0.0526 '/' Capacity=16.79 cfs Outflow=0.93 cfs 0.308 af

Reach 75R: (new Reach) Avg. Flow Depth=0.42' Max Vel=2.22 fps Inflow=0.79 cfs 0.261 af
n=0.070 L=217.0' S=0.1014 '/' Capacity=23.31 cfs Outflow=0.79 cfs 0.261 af

Reach 76R: (new Reach) Avg. Flow Depth=0.36' Max Vel=1.64 fps Inflow=0.44 cfs 0.144 af
n=0.070 L=180.0' S=0.0667 '/' Capacity=18.90 cfs Outflow=0.44 cfs 0.144 af

Reach CP-5A.1: conversion point Inflow=0.49 cfs 0.164 af
Outflow=0.49 cfs 0.164 af

Reach CP-5A.2: conversion point Inflow=1.78 cfs 0.594 af
Outflow=1.78 cfs 0.594 af

Reach CP-5A.3: (new Reach) Inflow=2.32 cfs 0.772 af
Outflow=2.32 cfs 0.772 af

Reach CP-5A.4: (new Reach) Inflow=3.41 cfs 1.139 af
Outflow=3.41 cfs 1.139 af

Reach CP-5A.5: (new Reach) Inflow=4.34 cfs 1.447 af
Outflow=4.34 cfs 1.447 af

Reach CP-5A.6: (new Reach) Inflow=6.42 cfs 2.147 af
Outflow=6.42 cfs 2.147 af

Reach CP-6.1: (new Reach) Inflow=0.79 cfs 0.261 af
Outflow=0.79 cfs 0.261 af

Reach CP-6.2: (new Reach) Inflow=1.22 cfs 0.406 af
Outflow=1.22 cfs 0.406 af

Reach CP-6.3: conversion point Inflow=2.94 cfs 0.978 af
Outflow=2.94 cfs 0.978 af

Reach CP-6.4: conversion point Inflow=3.67 cfs 1.222 af
Outflow=3.67 cfs 1.222 af

Reach CP-6.5: conversion point Inflow=5.67 cfs 1.892 af
Outflow=5.67 cfs 1.892 af

Reach DC-5A: downchute Avg. Flow Depth=0.00' Max Vel=0.00 fps
n=0.018 L=132.0' S=0.0833 '/' Capacity=246.98 cfs Outflow=0.00 cfs 0.000 af

Reach DC-5B: downchute Avg. Flow Depth=0.03' Max Vel=4.57 fps Inflow=0.49 cfs 0.164 af
n=0.018 L=27.0' S=0.3704 '/' Capacity=520.68 cfs Outflow=0.49 cfs 0.164 af

Reach DC-5C: downchute Avg. Flow Depth=0.07' Max Vel=6.45 fps Inflow=1.78 cfs 0.594 af
n=0.018 L=47.0' S=0.2340 '/' Capacity=413.90 cfs Outflow=1.78 cfs 0.594 af

Reach DC-5D: (new Reach) Avg. Flow Depth=0.07' Max Vel=7.44 fps Inflow=2.32 cfs 0.772 af
n=0.018 L=121.0' S=0.2727 '/' Capacity=446.80 cfs Outflow=2.32 cfs 0.772 af

Reach DC-5E: (new Reach) Avg. Flow Depth=0.09' Max Vel=8.57 fps Inflow=3.41 cfs 1.139 af
n=0.018 L=30.0' S=0.2667 '/' Capacity=441.81 cfs Outflow=3.41 cfs 1.139 af

Reach DC-5F: (new Reach) Avg. Flow Depth=0.10' Max Vel=9.85 fps Inflow=4.34 cfs 1.447 af
n=0.018 L=150.0' S=0.3133 '/' Capacity=478.91 cfs Outflow=4.33 cfs 1.447 af

Reach DC-5G: (new Reach) Avg. Flow Depth=0.15' Max Vel=10.02 fps Inflow=6.42 cfs 2.147 af
n=0.018 L=72.0' S=0.2083 '/' Capacity=390.51 cfs Outflow=6.42 cfs 2.147 af

Reach DC-6A: (new Reach) Avg. Flow Depth=0.10' Max Vel=3.75 fps Inflow=0.79 cfs 0.261 af
n=0.041 L=125.0' S=0.2800 '/' Capacity=149.70 cfs Outflow=0.79 cfs 0.261 af

Reach DC-6B: (new Reach) Avg. Flow Depth=0.14' Max Vel=3.93 fps Inflow=1.22 cfs 0.406 af
n=0.041 L=30.0' S=0.2000 '/' Capacity=126.52 cfs Outflow=1.22 cfs 0.406 af

Reach DC-6C: downchute Avg. Flow Depth=0.18' Max Vel=6.92 fps Inflow=2.94 cfs 0.978 af
n=0.030 L=128.0' S=0.2422 '/' Capacity=190.28 cfs Outflow=2.93 cfs 0.978 af

Reach DC-6D: downchute Avg. Flow Depth=0.13' Max Vel=6.38 fps Inflow=3.67 cfs 1.222 af
n=0.030 L=121.0' S=0.2645 '/' Capacity=299.81 cfs Outflow=3.66 cfs 1.222 af

Reach DC-6E: downchute Avg. Flow Depth=0.27' Max Vel=8.36 fps Inflow=5.67 cfs 1.892 af
n=0.030 L=49.0' S=0.2245 '/' Capacity=183.20 cfs Outflow=5.67 cfs 1.892 af

Reach OF-4D: outfall Inflow=5.67 cfs 1.892 af
Outflow=5.67 cfs 1.892 af

Reach OF-4E: outfall Inflow=6.42 cfs 2.147 af
Outflow=6.42 cfs 2.147 af

Total Runoff Area = 19.560 ac Runoff Volume = 5.548 af Average Runoff Depth = 3.40"
96.17% Pervious = 18.810 ac 3.83% Impervious = 0.750 ac

Summary for Subcatchment 1S: (new Subcat)

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

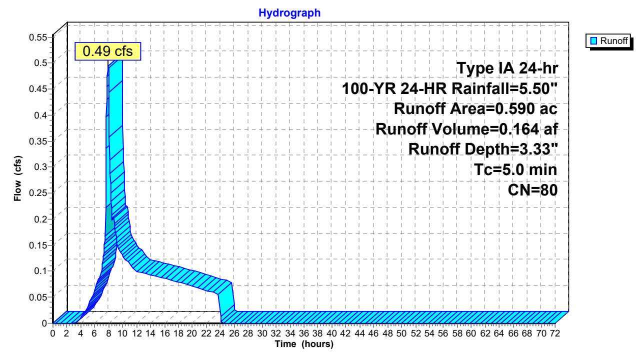
Runoff = 0.49 cfs @ 7.93 hrs, Volume= 0.164 af, Depth= 3.33"
Routed to Reach 53R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.590	80	>75% Grass cover, Good, HSG D
0.590		100.00% Pervious Area

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

Subcatchment 1S: (new Subcat)



Summary for Subcatchment 2S: (new Subcat)

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

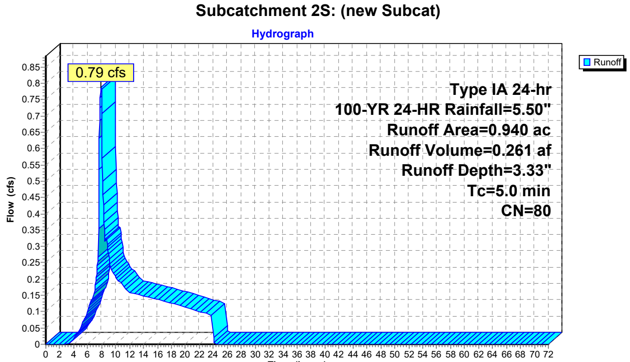
Runoff = 0.79 cfs @ 7.93 hrs, Volume= 0.261 af, Depth= 3.33"
Routed to Reach 75R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.940	80	>75% Grass cover, Good, HSG D
0.940		100.00% Pervious Area

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

Subcatchment 2S: (new Subcat)



Summary for Subcatchment 3S: (new Subcat)

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

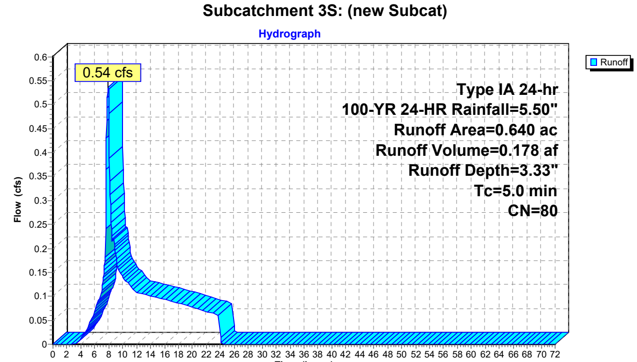
Runoff = 0.54 cfs @ 7.93 hrs, Volume= 0.178 af, Depth= 3.33"
Routed to Reach 4R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.640	80	>75% Grass cover, Good, HSG D
0.640		100.00% Pervious Area

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

Subcatchment 3S: (new Subcat)



Summary for Subcatchment 4S: (new Subcat)

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

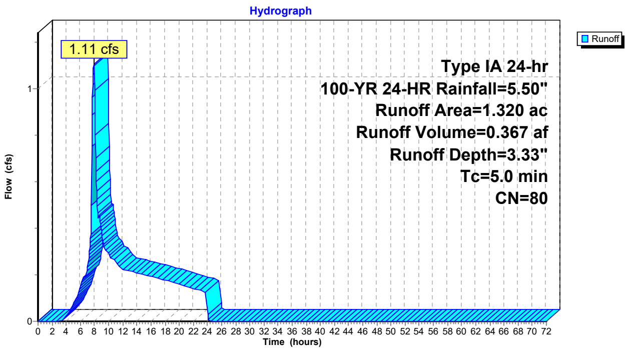
Runoff = 1.11 cfs @ 7.93 hrs, Volume= 0.367 af, Depth= 3.33"
Routed to Reach 3R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
1.320	80	>75% Grass cover, Good, HSG D
1.320		100.00% Pervious Area

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

Subcatchment 4S: (new Subcat)



Summary for Subcatchment 5S: (new Subcat)

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

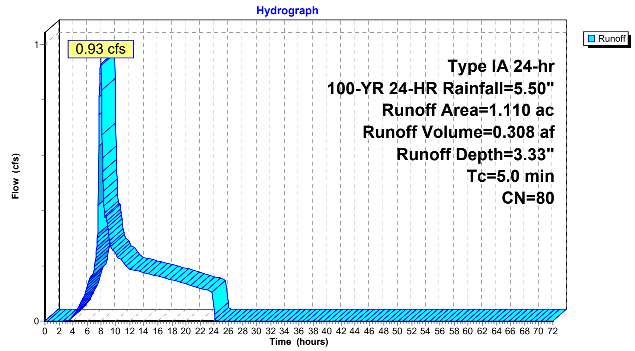
Runoff = 0.93 cfs @ 7.93 hrs, Volume= 0.308 af, Depth= 3.33"
Routed to Reach 54R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
1.110	80	>75% Grass cover, Good, HSG D
1.110		100.00% Pervious Area

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

Subcatchment 5S: (new Subcat)



Summary for Subcatchment 6S: (new Subcat)

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

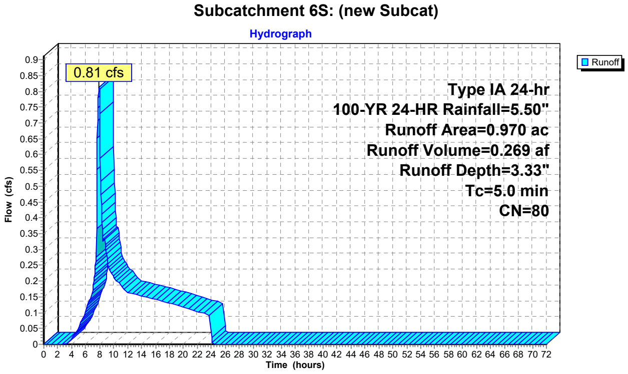
Runoff = 0.81 cfs @ 7.93 hrs, Volume= 0.269 af, Depth= 3.33"
Routed to Reach 5R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.970	80	>75% Grass cover, Good, HSG D
0.970		100.00% Pervious Area

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

Subcatchment 6S: (new Subcat)



Summary for Subcatchment 11S: (new Subcat)

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

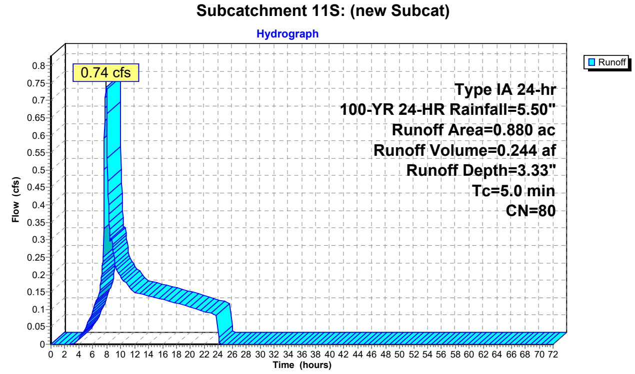
Runoff = 0.74 cfs @ 7.93 hrs, Volume= 0.244 af, Depth= 3.33"
Routed to Reach 8R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.880	80	>75% Grass cover, Good, HSG D
0.880		100.00% Pervious Area

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

Subcatchment 11S: (new Subcat)



Summary for Subcatchment 12S: (new Subcat)

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

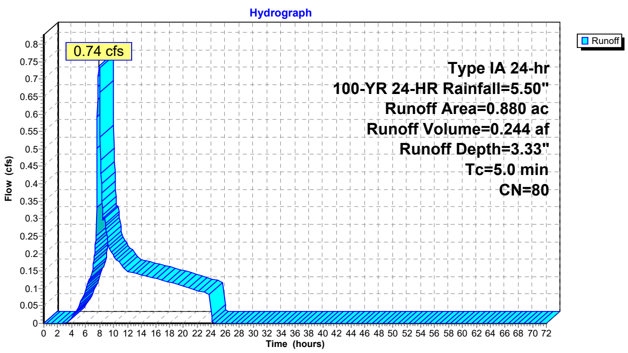
Runoff = 0.74 cfs @ 7.93 hrs, Volume= 0.244 af, Depth= 3.33"
Routed to Reach 11R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.880	80	>75% Grass cover, Good, HSG D
0.880		100.00% Pervious Area

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

Subcatchment 12S: (new Subcat)



Summary for Subcatchment 13S: (new Subcat)

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

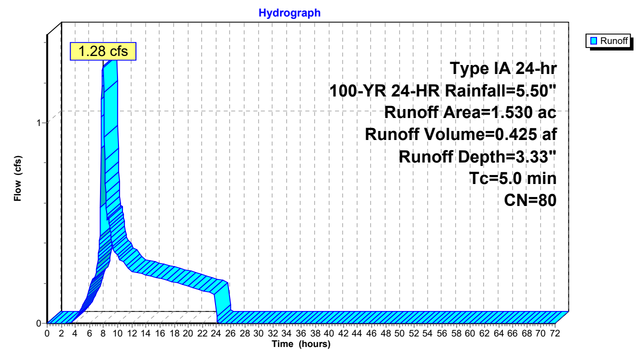
Runoff = 1.28 cfs @ 7.93 hrs, Volume= 0.425 af, Depth= 3.33"
Routed to Reach 10R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
1.530	80	>75% Grass cover, Good, HSG D
1.530		100.00% Pervious Area

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

Subcatchment 13S: (new Subcat)



Summary for Subcatchment 14S: (new Subcat)

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

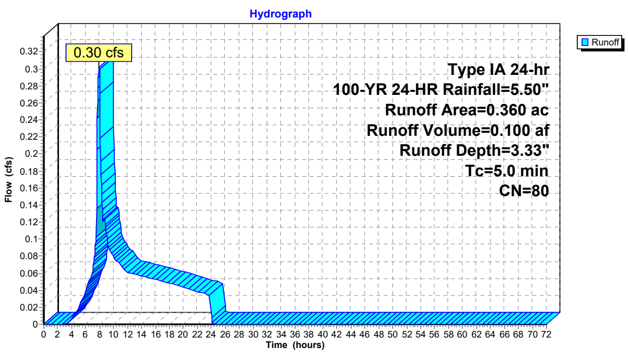
Runoff = 0.30 cfs @ 7.93 hrs, Volume= 0.100 af, Depth= 3.33"
Routed to Reach 9R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.360	80	>75% Grass cover, Good, HSG D
0.360		100.00% Pervious Area

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

Subcatchment 14S: (new Subcat)



Summary for Subcatchment 15S: (new Subcat)

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

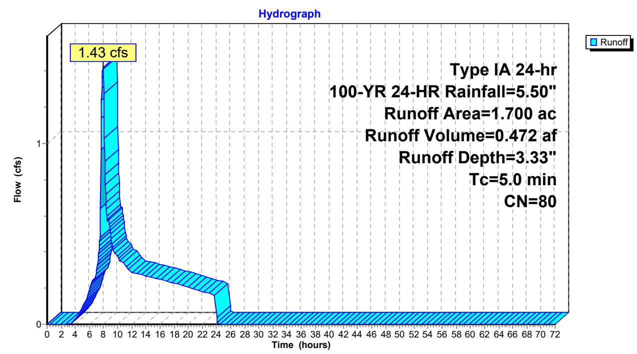
Runoff = 1.43 cfs @ 7.93 hrs, Volume= 0.472 af, Depth= 3.33"
Routed to Reach 7R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
1.700	80	>75% Grass cover, Good, HSG D
1.700		100.00% Pervious Area

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

Subcatchment 15S: (new Subcat)



Summary for Subcatchment 67S: (new Subcat)

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

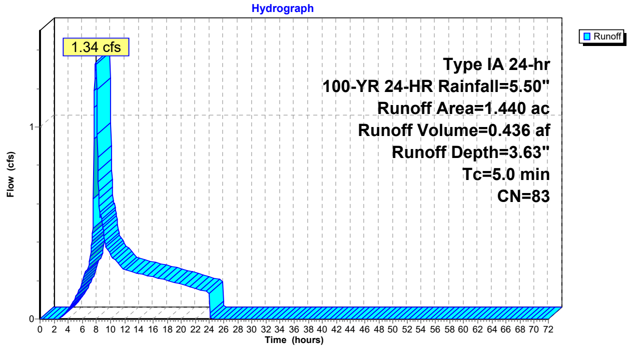
Runoff = 1.34 cfs @ 7.92 hrs, Volume= 0.436 af, Depth= 3.63"
Routed to Reach 1SF : sheet flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

	Area (ac)	CN	Description
	1.230	80	>75% Grass cover, Good, HSG D
*	0.210	98	Road
	1.440	83	Weighted Average
	1.230		85.42% Pervious Area
	0.210		14.58% Impervious Area

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

Subcatchment 67S: (new Subcat)



Summary for Subcatchment 68S: (new Subcat)

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

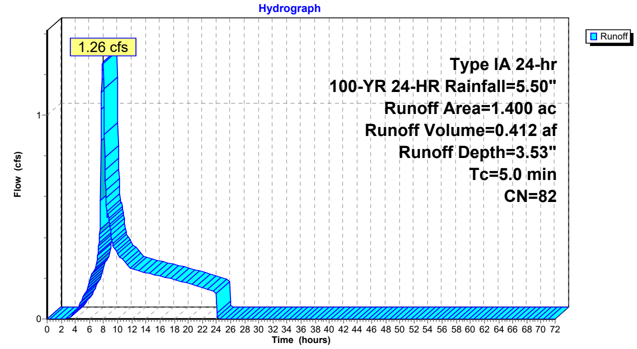
Runoff = 1.26 cfs @ 7.92 hrs, Volume= 0.412 af, Depth= 3.53"
Routed to Reach 2SF : sheet flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

	Area (ac)	CN	Description
	1.240	80	>75% Grass cover, Good, HSG D
*	0.160	98	Road
	1.400	82	Weighted Average
	1.240		88.57% Pervious Area
	0.160		11.43% Impervious Area

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

Subcatchment 68S: (new Subcat)



Summary for Subcatchment 69S: (new Subcat)

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

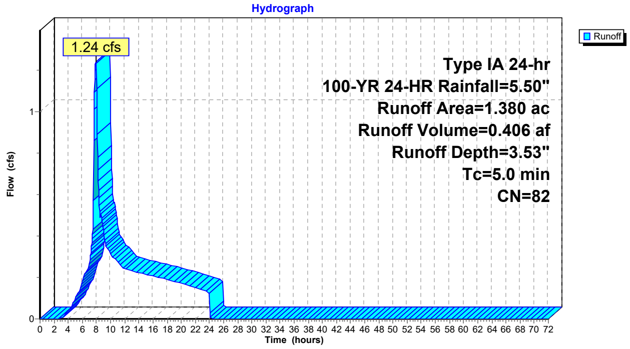
Runoff = 1.24 cfs @ 7.92 hrs, Volume= 0.406 af, Depth= 3.53"
Routed to Reach 3SF : sheet flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

	Area (ac)	CN	Description
	1.210	80	>75% Grass cover, Good, HSG D
*	0.170	98	Road
	1.380	82	Weighted Average
	1.210		87.68% Pervious Area
	0.170		12.32% Impervious Area

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

Subcatchment 69S: (new Subcat)



Summary for Subcatchment 70S: (new Subcat)

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

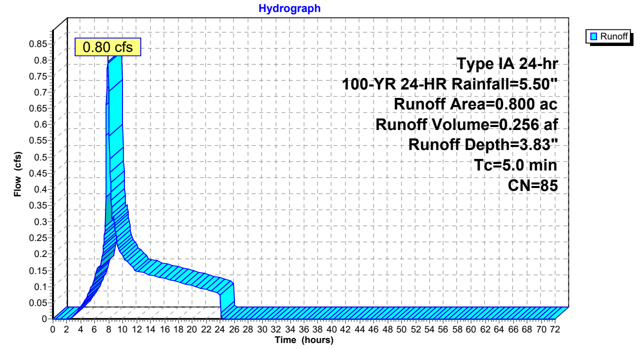
Runoff = 0.80 cfs @ 7.91 hrs, Volume= 0.256 af, Depth= 3.83"
Routed to Reach 4SF : sheet flow

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

	Area (ac)	CN	Description
	0.590	80	>75% Grass cover, Good, HSG D
*	0.210	98	Road
	0.800	85	Weighted Average
	0.590		73.75% Pervious Area
	0.210		26.25% Impervious Area

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

Subcatchment 70S: (new Subcat)



Summary for Subcatchment 72S: (new Subcat)

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

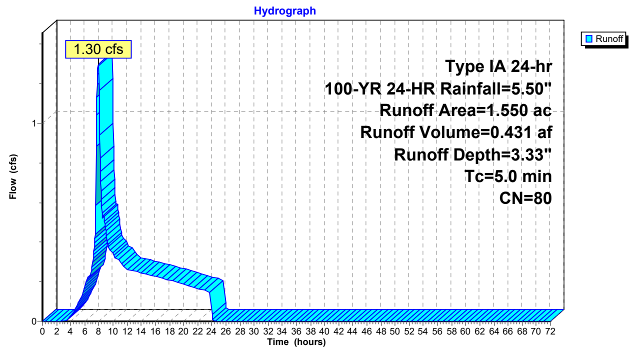
Runoff = 1.30 cfs @ 7.93 hrs, Volume= 0.431 af, Depth= 3.33"
Routed to Reach 6R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
1.550	80	>75% Grass cover, Good, HSG D
1.550		100.00% Pervious Area

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

Subcatchment 72S: (new Subcat)



Summary for Subcatchment 74S: (new Subcat)

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

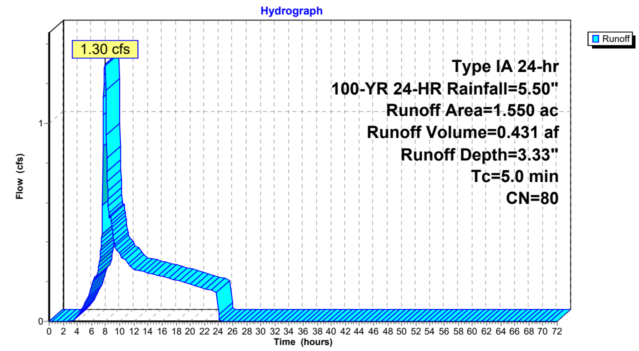
Runoff = 1.30 cfs @ 7.93 hrs, Volume= 0.431 af, Depth= 3.33"
Routed to Reach 2R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
1.550	80	>75% Grass cover, Good, HSG D
1.550		100.00% Pervious Area

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

Subcatchment 74S: (new Subcat)



Summary for Subcatchment 75S: (new Subcat)

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

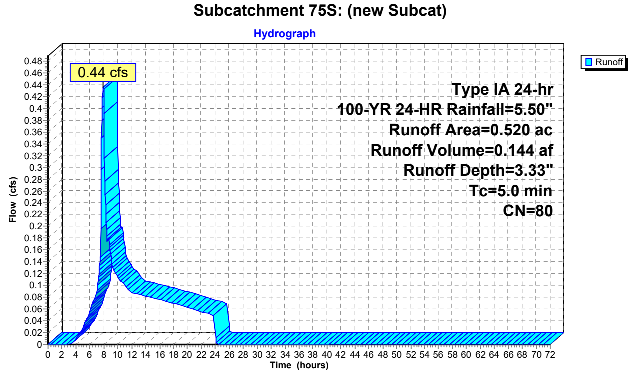
Runoff = 0.44 cfs @ 7.93 hrs, Volume= 0.144 af, Depth= 3.33"
Routed to Reach 76R : (new Reach)

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type IA 24-hr 100-YR 24-HR Rainfall=5.50"

Area (ac)	CN	Description
0.520	80	>75% Grass cover, Good, HSG D
0.520		100.00% Pervious Area

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

Subcatchment 75S: (new Subcat)



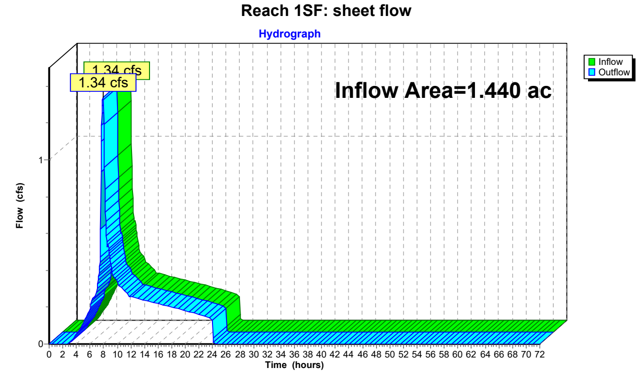
Summary for Reach 1SF: sheet flow

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.440 ac, 14.58% Impervious, Inflow Depth = 3.63" for 100-YR 24-HR event
Inflow = 1.34 cfs @ 7.92 hrs, Volume= 0.436 af
Outflow = 1.34 cfs @ 7.92 hrs, Volume= 0.436 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach 1SF: sheet flow



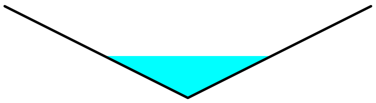
Summary for Reach 2R: (new Reach)

Inflow Area = 1.550 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.30 cfs @ 7.93 hrs, Volume= 0.431 af
Outflow = 1.29 cfs @ 8.03 hrs, Volume= 0.431 af, Atten= 0%, Lag= 5.9 min
Routed to Reach CP-5A.2 : conversion point

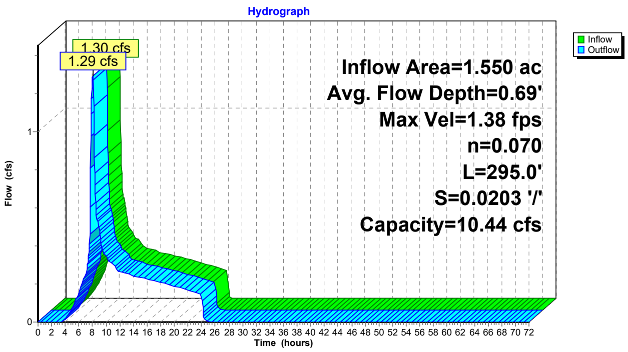
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.38 fps, Min. Travel Time= 3.6 min
Avg. Velocity = 0.79 fps, Avg. Travel Time= 6.2 min

Peak Storage= 277 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.69' , Surface Width= 2.74'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 10.44 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 295.0' Slope= 0.0203 '/'
Inlet Invert= 265.00', Outlet Invert= 259.00'



Reach 2R: (new Reach)



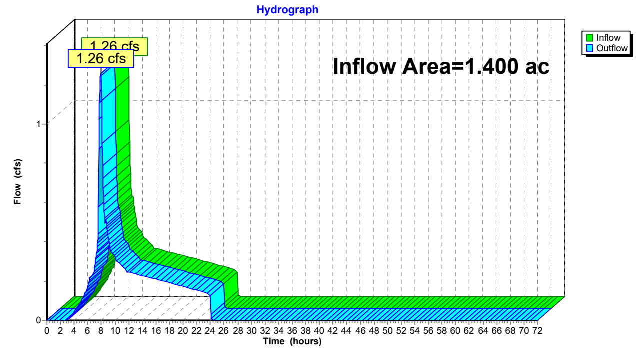
Summary for Reach 2SF: sheet flow

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.400 ac, 11.43% Impervious, Inflow Depth = 3.53" for 100-YR 24-HR event
Inflow = 1.26 cfs @ 7.92 hrs, Volume= 0.412 af
Outflow = 1.26 cfs @ 7.92 hrs, Volume= 0.412 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach 2SF: sheet flow



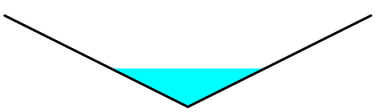
Summary for Reach 3R: (new Reach)

Inflow Area = 1.320 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.11 cfs @ 7.93 hrs, Volume= 0.367 af
Outflow = 1.09 cfs @ 8.05 hrs, Volume= 0.367 af, Atten= 1%, Lag= 7.4 min
Routed to Reach CP-5A.4 : (new Reach)

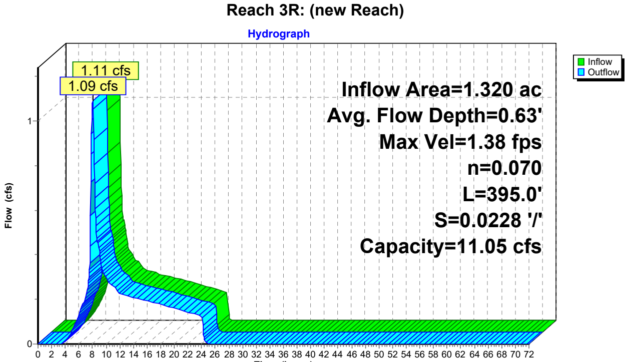
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.38 fps, Min. Travel Time= 4.8 min
Avg. Velocity = 0.77 fps, Avg. Travel Time= 8.5 min

Peak Storage= 315 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.63' , Surface Width= 2.52'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.05 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 395.0' Slope= 0.0228 '/'
Inlet Invert= 224.00', Outlet Invert= 215.00'



Reach 3R: (new Reach)



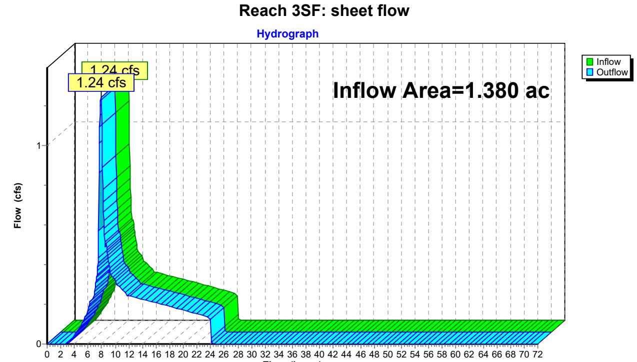
Summary for Reach 3SF: sheet flow

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.380 ac, 12.32% Impervious, Inflow Depth = 3.53" for 100-YR 24-HR event
Inflow = 1.24 cfs @ 7.92 hrs, Volume= 0.406 af
Outflow = 1.24 cfs @ 7.92 hrs, Volume= 0.406 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach 3SF: sheet flow



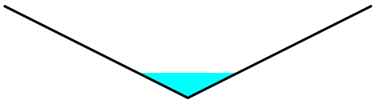
Summary for Reach 4R: (new Reach)

Inflow Area = 0.640 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.54 cfs @ 7.93 hrs, Volume= 0.178 af
Outflow = 0.53 cfs @ 8.00 hrs, Volume= 0.178 af, Atten= 0%, Lag= 4.4 min
Routed to Reach CP-5A.3 : (new Reach)

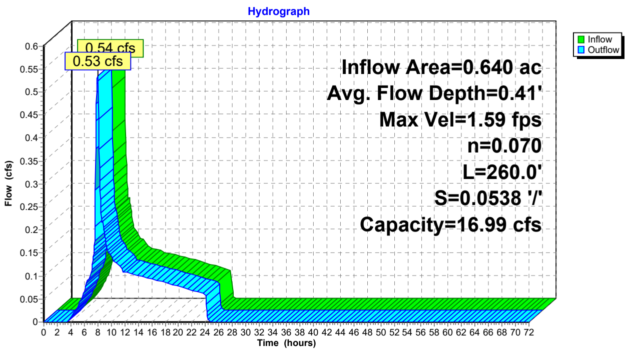
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.59 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 0.96 fps, Avg. Travel Time= 4.5 min

Peak Storage= 87 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.41' , Surface Width= 1.64'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 16.99 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 260.0' Slope= 0.0538 '/'
Inlet Invert= 262.00', Outlet Invert= 248.00'



Reach 4R: (new Reach)



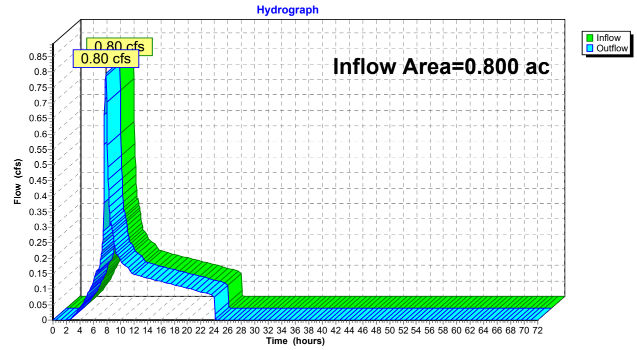
Summary for Reach 4SF: sheet flow

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.800 ac, 26.25% Impervious, Inflow Depth = 3.83" for 100-YR 24-HR event
Inflow = 0.80 cfs @ 7.91 hrs, Volume= 0.256 af
Outflow = 0.80 cfs @ 7.91 hrs, Volume= 0.256 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach 4SF: sheet flow



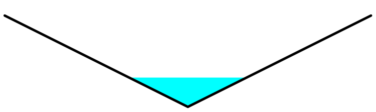
Summary for Reach 5R: (new Reach)

Inflow Area = 0.970 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.81 cfs @ 7.93 hrs, Volume= 0.269 af
Outflow = 0.81 cfs @ 8.00 hrs, Volume= 0.269 af, Atten= 0%, Lag= 4.4 min
Routed to Reach CP-5A.6 : (new Reach)

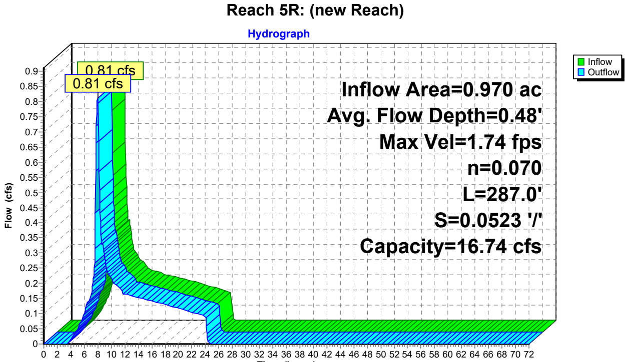
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.74 fps, Min. Travel Time= 2.7 min
Avg. Velocity = 1.05 fps, Avg. Travel Time= 4.6 min

Peak Storage= 133 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.48' , Surface Width= 1.93'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 16.74 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 287.0' Slope= 0.0523 '/'
Inlet Invert= 175.00', Outlet Invert= 160.00'



Reach 5R: (new Reach)



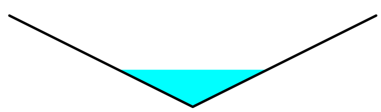
Summary for Reach 6R: (new Reach)

Inflow Area = 1.550 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.30 cfs @ 7.93 hrs, Volume= 0.431 af
Outflow = 1.28 cfs @ 8.06 hrs, Volume= 0.431 af, Atten= 1%, Lag= 8.0 min
Routed to Reach CP-5A.6 : (new Reach)

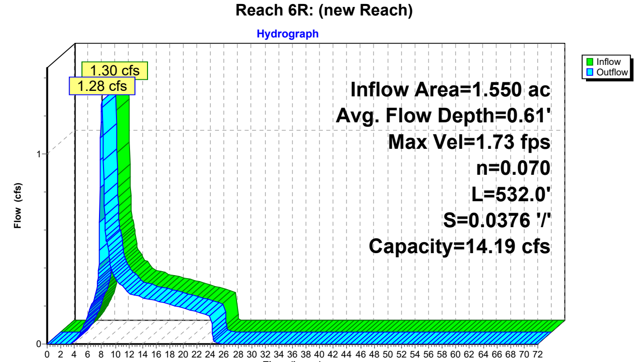
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.73 fps, Min. Travel Time= 5.1 min
Avg. Velocity = 0.97 fps, Avg. Travel Time= 9.2 min

Peak Storage= 396 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.61' , Surface Width= 2.44'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 14.19 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 532.0' Slope= 0.0376 '/'
Inlet Invert= 180.00', Outlet Invert= 160.00'



Reach 6R: (new Reach)



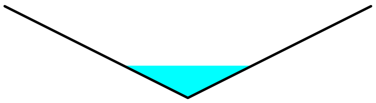
Summary for Reach 7R: (new Reach)

Inflow Area = 1.700 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.43 cfs @ 7.93 hrs, Volume= 0.472 af
Outflow = 1.42 cfs @ 8.00 hrs, Volume= 0.472 af, Atten= 0%, Lag= 4.1 min
Routed to Reach CP-6.3 : conversion point

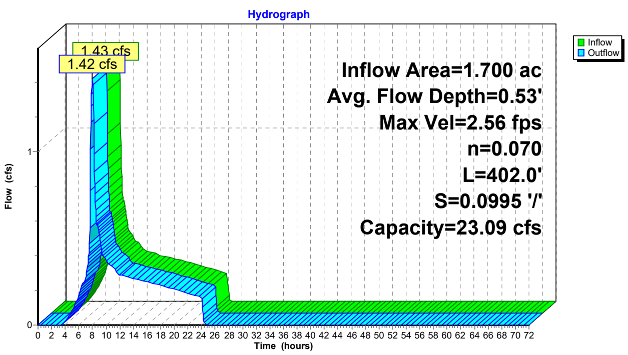
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.56 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 1.53 fps, Avg. Travel Time= 4.4 min

Peak Storage= 224 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.53' , Surface Width= 2.11'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 23.09 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 402.0' Slope= 0.0995 '/'
Inlet Invert= 260.00', Outlet Invert= 220.00'



Reach 7R: (new Reach)



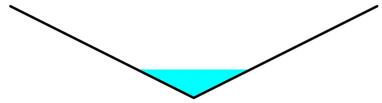
Summary for Reach 8R: (new Reach)

Inflow Area = 0.880 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.74 cfs @ 7.93 hrs, Volume= 0.244 af
Outflow = 0.73 cfs @ 8.02 hrs, Volume= 0.244 af, Atten= 0%, Lag= 5.6 min
Routed to Reach CP-6.4 : conversion point

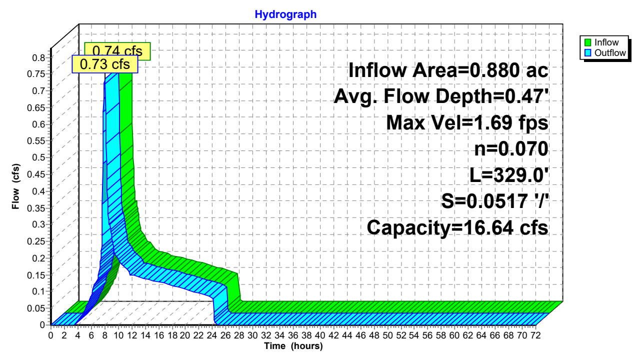
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.69 fps, Min. Travel Time= 3.2 min
Avg. Velocity = 1.01 fps, Avg. Travel Time= 5.4 min

Peak Storage= 143 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.47' , Surface Width= 1.86'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 16.64 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 329.0' Slope= 0.0517 '/'
Inlet Invert= 207.00', Outlet Invert= 190.00'



Reach 8R: (new Reach)



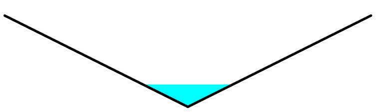
Summary for Reach 9R: (new Reach)

Inflow Area = 0.360 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.30 cfs @ 7.93 hrs, Volume= 0.100 af
Outflow = 0.30 cfs @ 8.05 hrs, Volume= 0.100 af, Atten= 1%, Lag= 6.9 min
Routed to Reach CP-6.3 : conversion point

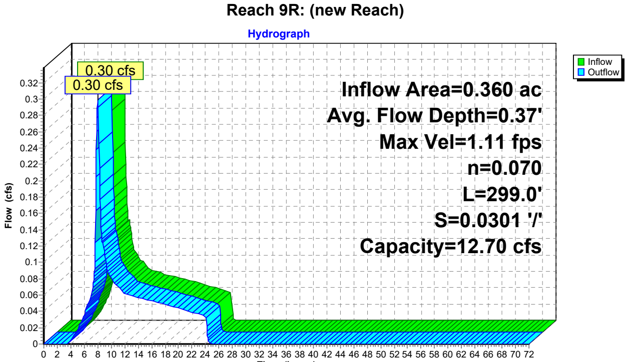
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.11 fps, Min. Travel Time= 4.5 min
Avg. Velocity = 0.65 fps, Avg. Travel Time= 7.6 min

Peak Storage= 81 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.37' , Surface Width= 1.47'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 12.70 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 299.0' Slope= 0.0301 '/'
Inlet Invert= 227.00', Outlet Invert= 218.00'



Reach 9R: (new Reach)



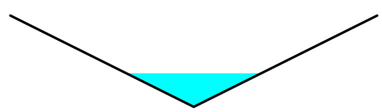
Summary for Reach 10R: (new Reach)

Inflow Area = 1.530 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.28 cfs @ 7.93 hrs, Volume= 0.425 af
Outflow = 1.28 cfs @ 7.99 hrs, Volume= 0.425 af, Atten= 0%, Lag= 3.6 min
Routed to Reach CP-6.5 : conversion point

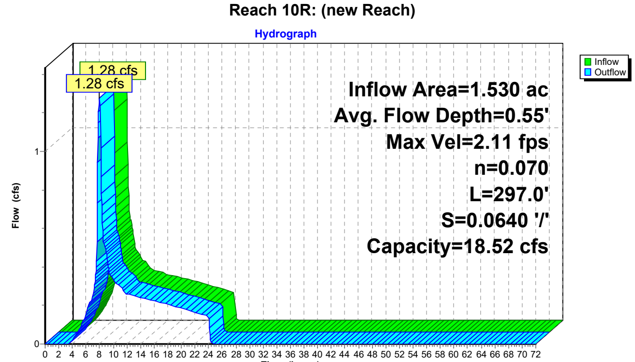
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.11 fps, Min. Travel Time= 2.3 min
Avg. Velocity = 1.27 fps, Avg. Travel Time= 3.9 min

Peak Storage= 180 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.55' , Surface Width= 2.20'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 18.52 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 297.0' Slope= 0.0640 '/'
Inlet Invert= 176.00', Outlet Invert= 157.00'



Reach 10R: (new Reach)



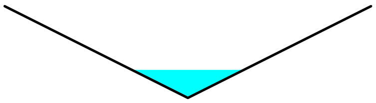
Summary for Reach 11R: (new Reach)

Inflow Area = 0.880 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.74 cfs @ 7.93 hrs, Volume= 0.244 af
Outflow = 0.74 cfs @ 8.02 hrs, Volume= 0.244 af, Atten= 0%, Lag= 5.3 min
Routed to Reach CP-6.5 : conversion point

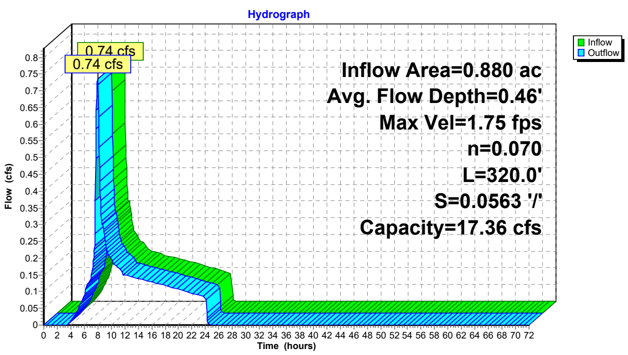
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.75 fps, Min. Travel Time= 3.0 min
Avg. Velocity = 1.05 fps, Avg. Travel Time= 5.1 min

Peak Storage= 134 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.46' , Surface Width= 1.83'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 17.36 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 320.0' Slope= 0.0563 '/'
Inlet Invert= 175.00', Outlet Invert= 157.00'



Reach 11R: (new Reach)



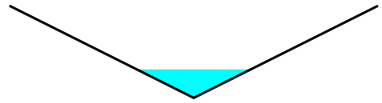
Summary for Reach 53R: (new Reach)

Inflow Area = 0.590 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.49 cfs @ 7.93 hrs, Volume= 0.164 af
Outflow = 0.49 cfs @ 8.00 hrs, Volume= 0.164 af, Atten= 0%, Lag= 4.0 min
Routed to Reach CP-5A.1 : conversion point

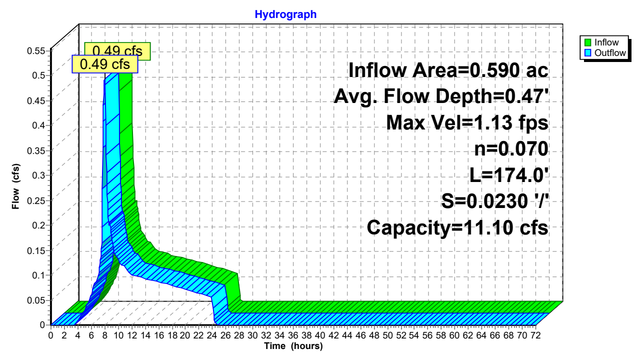
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.13 fps, Min. Travel Time= 2.6 min
Avg. Velocity = 0.68 fps, Avg. Travel Time= 4.2 min

Peak Storage= 76 cf @ 7.96 hrs
Average Depth at Peak Storage= 0.47' , Surface Width= 1.87'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 11.10 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 174.0' Slope= 0.0230 '/'
Inlet Invert= 273.00', Outlet Invert= 269.00'



Reach 53R: (new Reach)



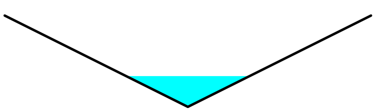
Summary for Reach 54R: (new Reach)

Inflow Area = 1.110 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.93 cfs @ 7.93 hrs, Volume= 0.308 af
Outflow = 0.93 cfs @ 8.03 hrs, Volume= 0.308 af, Atten= 0%, Lag= 5.8 min
Routed to Reach CP-5A.5 : (new Reach)

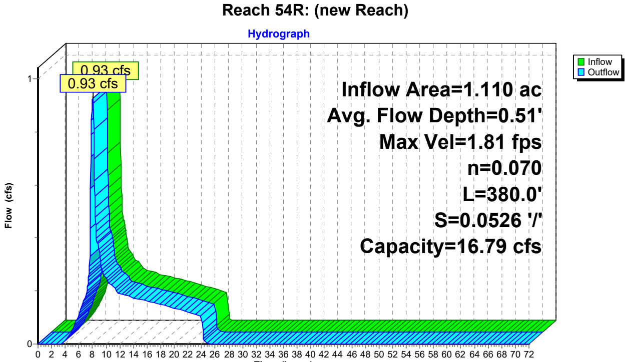
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.81 fps, Min. Travel Time= 3.5 min
Avg. Velocity = 1.06 fps, Avg. Travel Time= 6.0 min

Peak Storage= 195 cf @ 7.97 hrs
Average Depth at Peak Storage= 0.51' , Surface Width= 2.02'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 16.79 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 380.0' Slope= 0.0526 '/'
Inlet Invert= 227.00', Outlet Invert= 207.00'



Reach 54R: (new Reach)



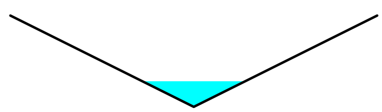
Summary for Reach 75R: (new Reach)

Inflow Area = 0.940 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.79 cfs @ 7.93 hrs, Volume= 0.261 af
Outflow = 0.79 cfs @ 7.98 hrs, Volume= 0.261 af, Atten= 0%, Lag= 2.7 min
Routed to Reach CP-6.1 : (new Reach)

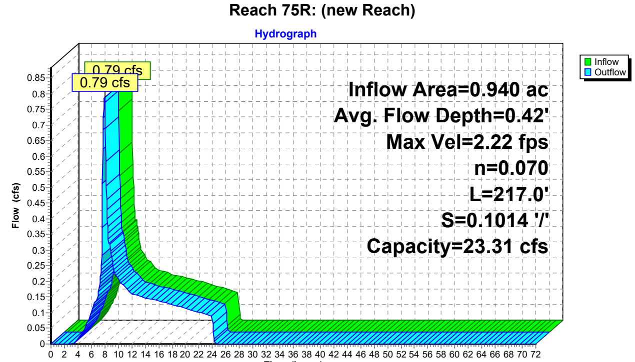
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.22 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 1.37 fps, Avg. Travel Time= 2.6 min

Peak Storage= 77 cf @ 7.95 hrs
Average Depth at Peak Storage= 0.42' , Surface Width= 1.68'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 23.31 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 217.0' Slope= 0.1014 '/'
Inlet Invert= 280.00', Outlet Invert= 258.00'



Reach 75R: (new Reach)



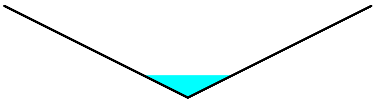
Summary for Reach 76R: (new Reach)

Inflow Area = 0.520 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.44 cfs @ 7.93 hrs, Volume= 0.144 af
Outflow = 0.44 cfs @ 7.98 hrs, Volume= 0.144 af, Atten= 0%, Lag= 2.9 min
Routed to Reach CP-6.2 : (new Reach)

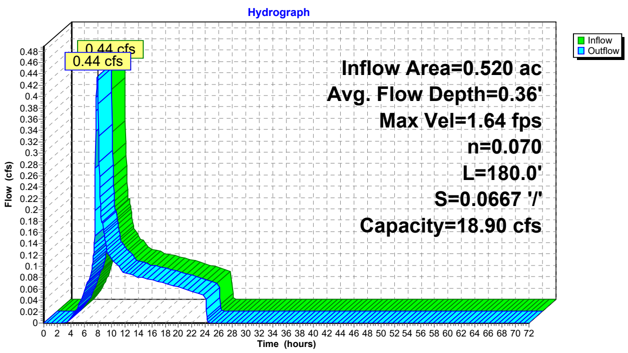
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.64 fps, Min. Travel Time= 1.8 min
Avg. Velocity = 1.01 fps, Avg. Travel Time= 3.0 min

Peak Storage= 48 cf @ 7.95 hrs
Average Depth at Peak Storage= 0.36' , Surface Width= 1.46'
Bank-Full Depth= 1.50' Flow Area= 4.5 sf, Capacity= 18.90 cfs

0.00' x 1.50' deep channel, n= 0.070
Side Slope Z-value= 2.0 '/' Top Width= 6.00'
Length= 180.0' Slope= 0.0667 '/'
Inlet Invert= 238.00', Outlet Invert= 226.00'



Reach 76R: (new Reach)



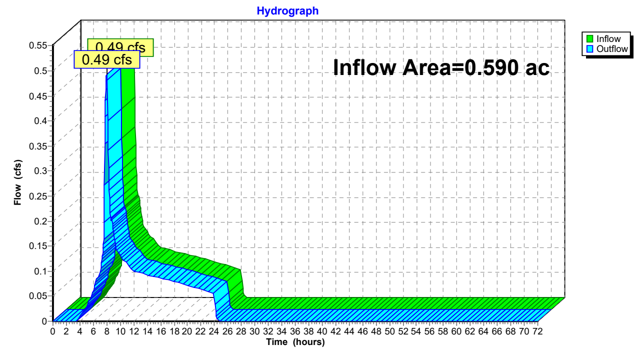
Summary for Reach CP-5A.1: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.590 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.49 cfs @ 8.00 hrs, Volume= 0.164 af
Outflow = 0.49 cfs @ 8.00 hrs, Volume= 0.164 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-5B : downchute

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-5A.1: conversion point



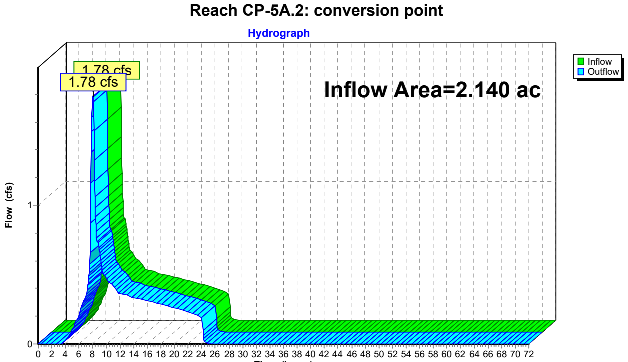
Summary for Reach CP-5A.2: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.140 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.78 cfs @ 8.02 hrs, Volume= 0.594 af
Outflow = 1.78 cfs @ 8.02 hrs, Volume= 0.594 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-5C : downchute

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-5A.2: conversion point



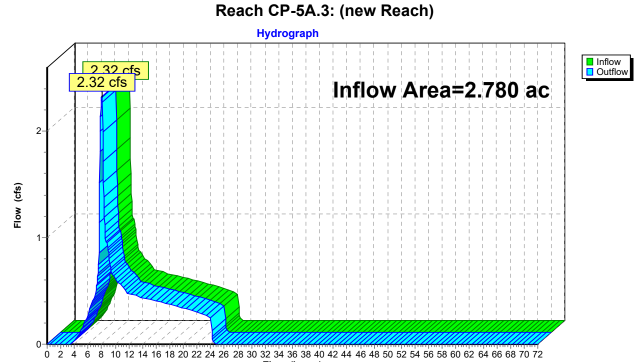
Summary for Reach CP-5A.3: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.780 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 2.32 cfs @ 8.02 hrs, Volume= 0.772 af
Outflow = 2.32 cfs @ 8.02 hrs, Volume= 0.772 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-5D : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-5A.3: (new Reach)



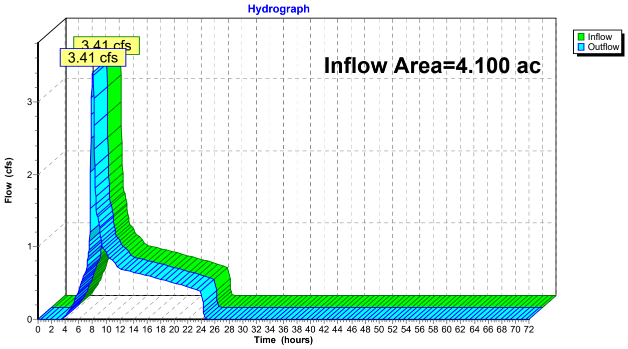
Summary for Reach CP-5A.4: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.100 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 3.41 cfs @ 8.03 hrs, Volume= 1.139 af
Outflow = 3.41 cfs @ 8.03 hrs, Volume= 1.139 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-5E : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-5A.4: (new Reach)



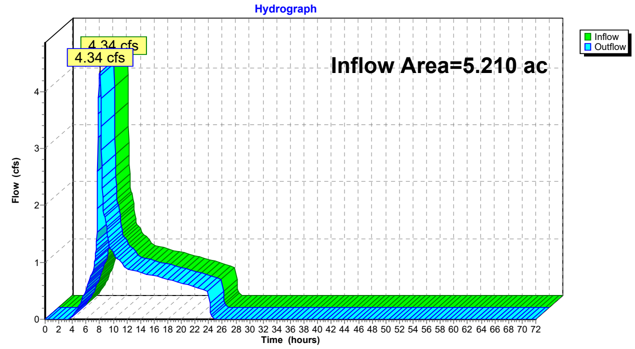
Summary for Reach CP-5A.5: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 5.210 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 4.34 cfs @ 8.03 hrs, Volume= 1.447 af
Outflow = 4.34 cfs @ 8.03 hrs, Volume= 1.447 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-5F : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-5A.5: (new Reach)



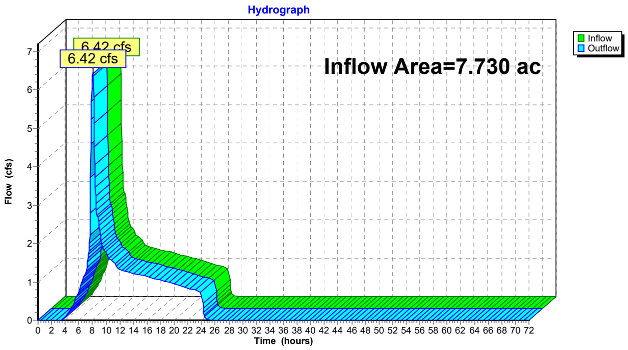
Summary for Reach CP-5A.6: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7.730 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 6.42 cfs @ 8.04 hrs, Volume= 2.147 af
Outflow = 6.42 cfs @ 8.04 hrs, Volume= 2.147 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-5G : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-5A.6: (new Reach)



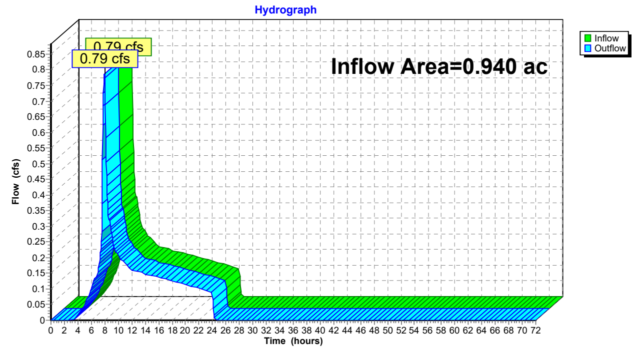
Summary for Reach CP-6.1: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.940 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.79 cfs @ 7.98 hrs, Volume= 0.261 af
Outflow = 0.79 cfs @ 7.98 hrs, Volume= 0.261 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-6A : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-6.1: (new Reach)



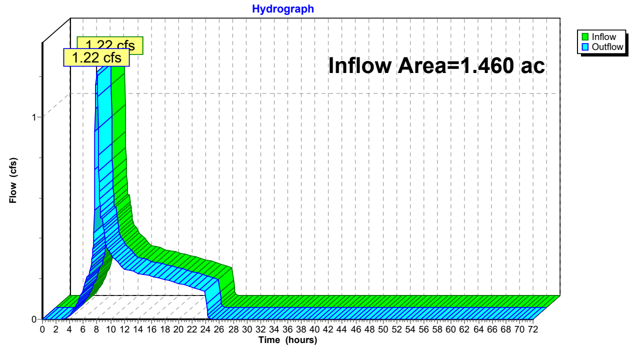
Summary for Reach CP-6.2: (new Reach)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.460 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.22 cfs @ 7.98 hrs, Volume= 0.406 af
Outflow = 1.22 cfs @ 7.98 hrs, Volume= 0.406 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-6B : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-6.2: (new Reach)



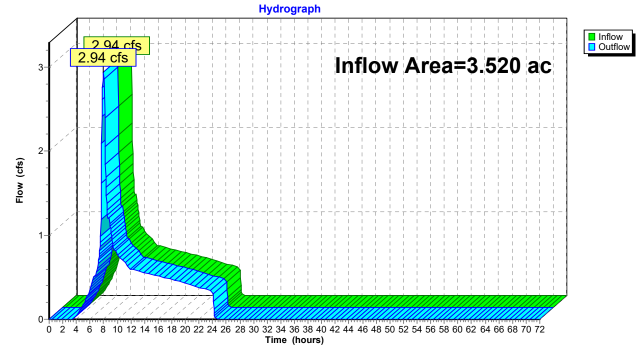
Summary for Reach CP-6.3: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.520 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 2.94 cfs @ 8.00 hrs, Volume= 0.978 af
Outflow = 2.94 cfs @ 8.00 hrs, Volume= 0.978 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-6C : downchute

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-6.3: conversion point



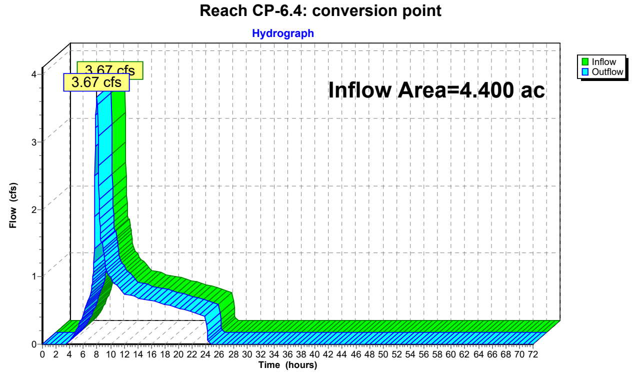
Summary for Reach CP-6.4: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.400 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 3.67 cfs @ 8.01 hrs, Volume= 1.222 af
Outflow = 3.67 cfs @ 8.01 hrs, Volume= 1.222 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-6D : downchute

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-6.4: conversion point



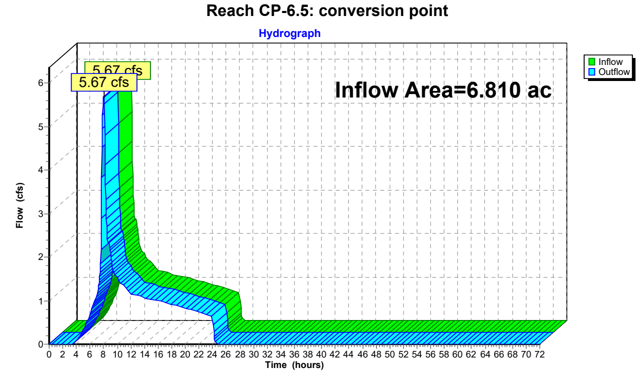
Summary for Reach CP-6.5: conversion point

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.810 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 5.67 cfs @ 8.01 hrs, Volume= 1.892 af
Outflow = 5.67 cfs @ 8.01 hrs, Volume= 1.892 af, Atten= 0%, Lag= 0.0 min
Routed to Reach DC-6E : downchute

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach CP-6.5: conversion point



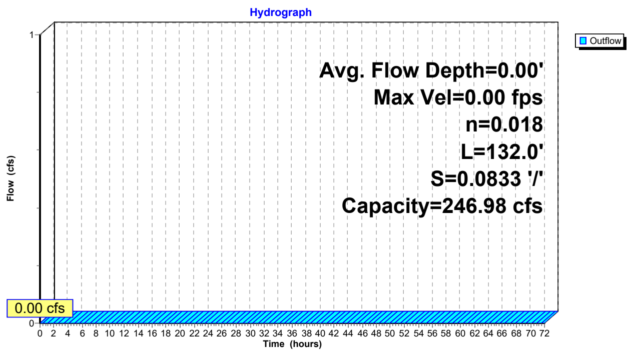
Summary for Reach DC-5A: downchute

[43] Hint: Has no inflow (Outflow=Zero)

Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 246.98 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 132.0' Slope= 0.0833 '/'
Inlet Invert= 280.00', Outlet Invert= 269.00'

Reach DC-5A: downchute



Summary for Reach DC-5B: downchute

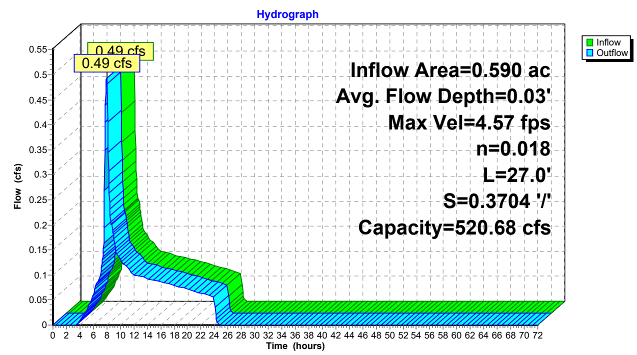
Inflow Area = 0.590 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.49 cfs @ 8.00 hrs, Volume= 0.164 af
Outflow = 0.49 cfs @ 8.00 hrs, Volume= 0.164 af, Atten= 0%, Lag= 0.1 min
Routed to Reach CP-5A.2 : conversion point

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.57 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.08 fps, Avg. Travel Time= 0.1 min

Peak Storage= 3 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.03' , Surface Width= 4.11'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 520.68 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 27.0' Slope= 0.3704 '/'
Inlet Invert= 269.00', Outlet Invert= 259.00'

Reach DC-5B: downchute



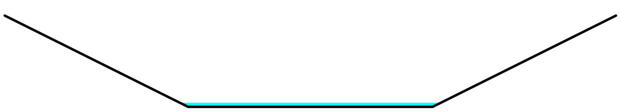
Summary for Reach DC-5C: downchute

Inflow Area = 2.140 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.78 cfs @ 8.02 hrs, Volume= 0.594 af
Outflow = 1.78 cfs @ 8.02 hrs, Volume= 0.594 af, Atten= 0%, Lag= 0.0 min
Routed to Reach CP-5A.3 : (new Reach)

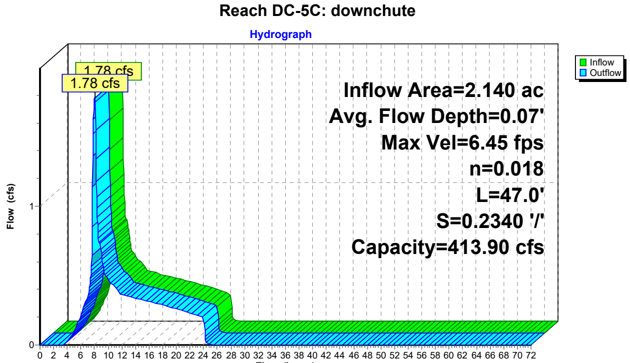
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.45 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 3.33 fps, Avg. Travel Time= 0.2 min

Peak Storage= 13 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.07' , Surface Width= 4.27'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 413.90 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 47.0' Slope= 0.2340 '/'
Inlet Invert= 259.00', Outlet Invert= 248.00'



Reach DC-5C: downchute



Summary for Reach DC-5D: (new Reach)

[88] Warning: Qout>Qin may require smaller dt or Finer Routing

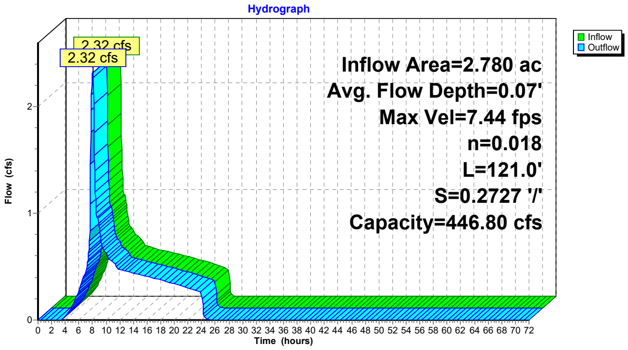
Inflow Area = 2.780 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 2.32 cfs @ 8.02 hrs, Volume= 0.772 af
Outflow = 2.32 cfs @ 8.03 hrs, Volume= 0.772 af, Atten= 0%, Lag= 0.4 min
Routed to Reach CP-5A.4 : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.44 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.82 fps, Avg. Travel Time= 0.5 min

Peak Storage= 38 cf @ 8.02 hrs
Average Depth at Peak Storage= 0.07' , Surface Width= 4.30'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 446.80 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 121.0' Slope= 0.2727 '/'
Inlet Invert= 248.00', Outlet Invert= 215.00'

Reach DC-5D: (new Reach)



Summary for Reach DC-5E: (new Reach)

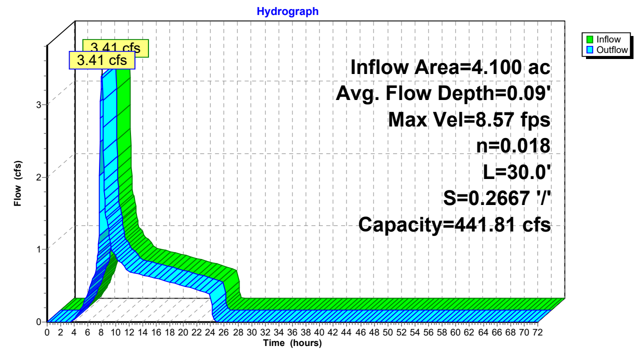
Inflow Area = 4.100 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 3.41 cfs @ 8.03 hrs, Volume= 1.139 af
Outflow = 3.41 cfs @ 8.03 hrs, Volume= 1.139 af, Atten= 0%, Lag= 0.0 min
Routed to Reach CP-5A.5 : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.57 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.29 fps, Avg. Travel Time= 0.1 min

Peak Storage= 12 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.09' , Surface Width= 4.38'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 441.81 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 30.0' Slope= 0.2667 '/'
Inlet Invert= 215.00', Outlet Invert= 207.00'

Reach DC-5E: (new Reach)



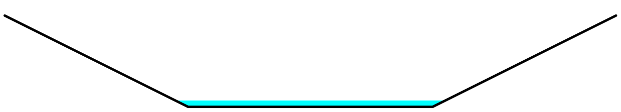
Summary for Reach DC-5F: (new Reach)

Inflow Area = 5.210 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 4.34 cfs @ 8.03 hrs, Volume= 1.447 af
Outflow = 4.33 cfs @ 8.04 hrs, Volume= 1.447 af, Atten= 0%, Lag= 0.3 min
Routed to Reach CP-5A.6 : (new Reach)

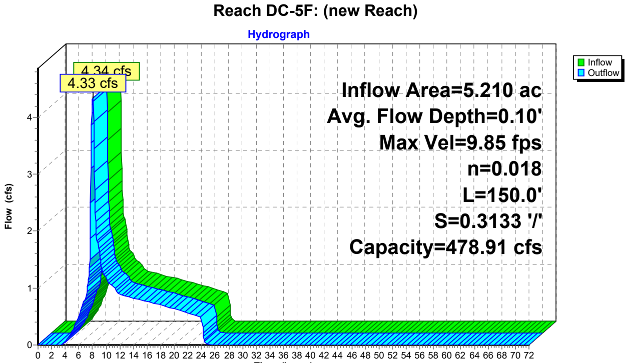
Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 9.85 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 4.91 fps, Avg. Travel Time= 0.5 min

Peak Storage= 66 cf @ 8.03 hrs
Average Depth at Peak Storage= 0.10' , Surface Width= 4.42'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 478.91 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 150.0' Slope= 0.3133 '/'
Inlet Invert= 207.00', Outlet Invert= 160.00'



Reach DC-5F: (new Reach)



Summary for Reach DC-5G: (new Reach)

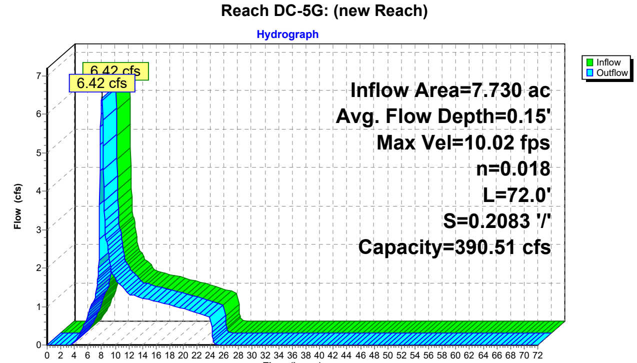
Inflow Area = 7.730 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 6.42 cfs @ 8.04 hrs, Volume= 2.147 af
Outflow = 6.42 cfs @ 8.04 hrs, Volume= 2.147 af, Atten= 0%, Lag= 0.1 min
Routed to Reach OF-4E : outfall

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 10.02 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.91 fps, Avg. Travel Time= 0.2 min

Peak Storage= 46 cf @ 8.04 hrs
Average Depth at Peak Storage= 0.15' , Surface Width= 4.60'
Bank-Full Depth= 1.50' Flow Area= 10.5 sf, Capacity= 390.51 cfs

4.00' x 1.50' deep channel, n= 0.018
Side Slope Z-value= 2.0 '/' Top Width= 10.00'
Length= 72.0' Slope= 0.2083 '/'
Inlet Invert= 160.00', Outlet Invert= 145.00'

Reach DC-5G: (new Reach)



Summary for Reach DC-6A: (new Reach)

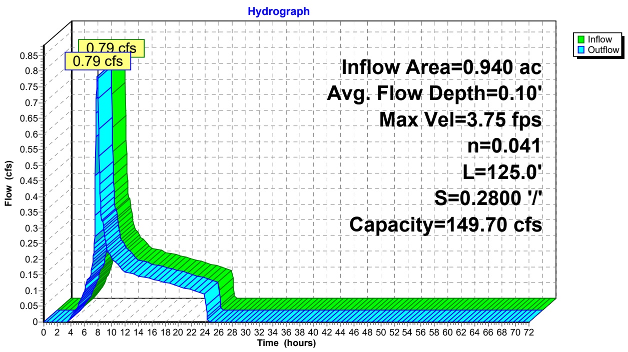
Inflow Area = 0.940 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 0.79 cfs @ 7.98 hrs, Volume= 0.261 af
Outflow = 0.79 cfs @ 7.98 hrs, Volume= 0.261 af, Atten= 0%, Lag= 0.5 min
Routed to Reach CP-6.2 : (new Reach)

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.75 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.96 fps, Avg. Travel Time= 1.1 min

Peak Storage= 26 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.10' , Surface Width= 2.38'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 149.70 cfs

2.00' x 1.60' deep channel, n= 0.041
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 125.0' Slope= 0.2800 '/'
Inlet Invert= 260.00', Outlet Invert= 225.00'

Reach DC-6A: (new Reach)



Summary for Reach DC-6B: (new Reach)

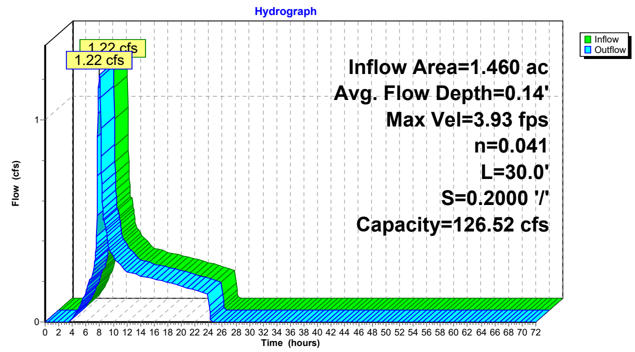
Inflow Area = 1.460 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 1.22 cfs @ 7.98 hrs, Volume= 0.406 af
Outflow = 1.22 cfs @ 7.98 hrs, Volume= 0.406 af, Atten= 0%, Lag= 0.1 min
Routed to Reach CP-6.3 : conversion point

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.93 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.05 fps, Avg. Travel Time= 0.2 min

Peak Storage= 9 cf @ 7.98 hrs
Average Depth at Peak Storage= 0.14' , Surface Width= 2.55'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 126.52 cfs

2.00' x 1.60' deep channel, n= 0.041
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 30.0' Slope= 0.2000 '/'
Inlet Invert= 225.00', Outlet Invert= 219.00'

Reach DC-6B: (new Reach)



Summary for Reach DC-6C: downchute

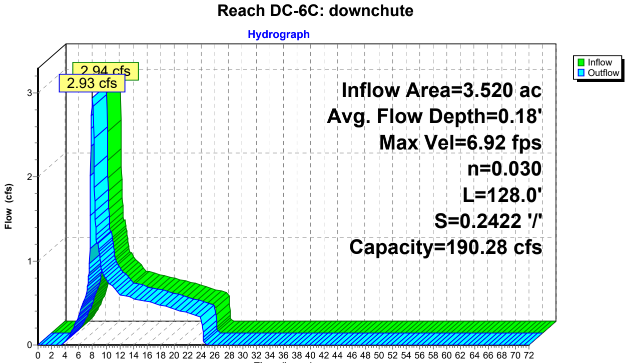
Inflow Area = 3.520 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 2.94 cfs @ 8.00 hrs, Volume= 0.978 af
Outflow = 2.93 cfs @ 8.00 hrs, Volume= 0.978 af, Atten= 0%, Lag= 0.5 min
Routed to Reach CP-6.4 : conversion point

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.92 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.58 fps, Avg. Travel Time= 0.6 min

Peak Storage= 54 cf @ 8.00 hrs
Average Depth at Peak Storage= 0.18' , Surface Width= 2.72'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 190.28 cfs

2.00' x 1.60' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 128.0' Slope= 0.2422 '/'
Inlet Invert= 219.00', Outlet Invert= 188.00'

Reach DC-6C: downchute



Summary for Reach DC-6D: downchute

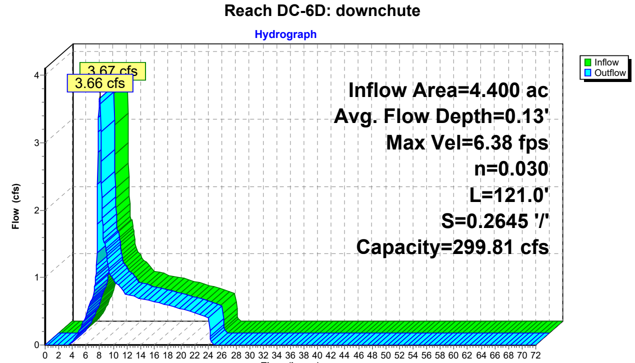
Inflow Area = 4.400 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 3.67 cfs @ 8.01 hrs, Volume= 1.222 af
Outflow = 3.66 cfs @ 8.02 hrs, Volume= 1.222 af, Atten= 0%, Lag= 0.5 min
Routed to Reach CP-6.5 : conversion point

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.38 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 3.18 fps, Avg. Travel Time= 0.6 min

Peak Storage= 70 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.13' , Surface Width= 4.54'
Bank-Full Depth= 1.60' Flow Area= 11.5 sf, Capacity= 299.81 cfs

4.00' x 1.60' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 10.40'
Length= 121.0' Slope= 0.2645 '/'
Inlet Invert= 188.00', Outlet Invert= 156.00'

Reach DC-6D: downchute



Summary for Reach DC-6E: downchute

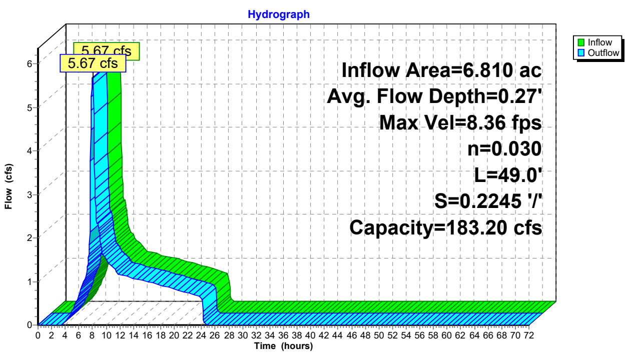
Inflow Area = 6.810 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 5.67 cfs @ 8.01 hrs, Volume= 1.892 af
Outflow = 5.67 cfs @ 8.01 hrs, Volume= 1.892 af, Atten= 0%, Lag= 0.2 min
Routed to Reach OF-4D : outfall

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Max. Velocity= 8.36 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 4.35 fps, Avg. Travel Time= 0.2 min

Peak Storage= 33 cf @ 8.01 hrs
Average Depth at Peak Storage= 0.27' , Surface Width= 3.07'
Bank-Full Depth= 1.60' Flow Area= 8.3 sf, Capacity= 183.20 cfs

2.00' x 1.60' deep channel, n= 0.030
Side Slope Z-value= 2.0 '/' Top Width= 8.40'
Length= 49.0' Slope= 0.2245 '/'
Inlet Invert= 156.00', Outlet Invert= 145.00'

Reach DC-6E: downchute



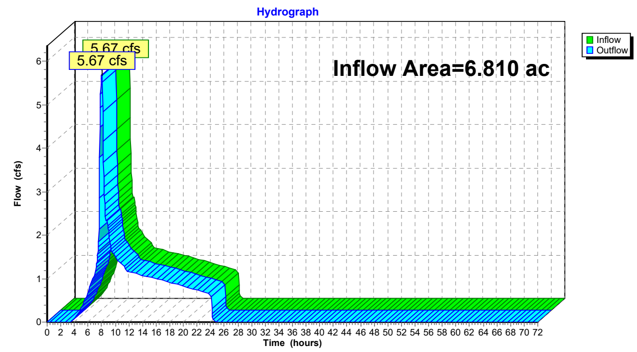
Summary for Reach OF-4D: outfall

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.810 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 5.67 cfs @ 8.01 hrs, Volume= 1.892 af
Outflow = 5.67 cfs @ 8.01 hrs, Volume= 1.892 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach OF-4D: outfall



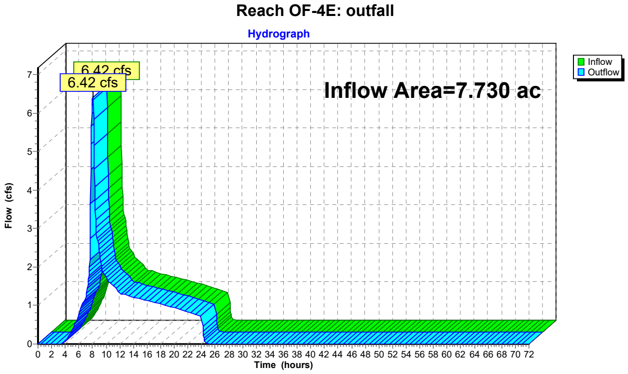
Summary for Reach OF-4E: outfall

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 7.730 ac, 0.00% Impervious, Inflow Depth = 3.33" for 100-YR 24-HR event
Inflow = 6.42 cfs @ 8.04 hrs, Volume= 2.147 af
Outflow = 6.42 cfs @ 8.04 hrs, Volume= 2.147 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach OF-4E: outfall



ATTACHMENT 2

NOAA Isopluvial Map

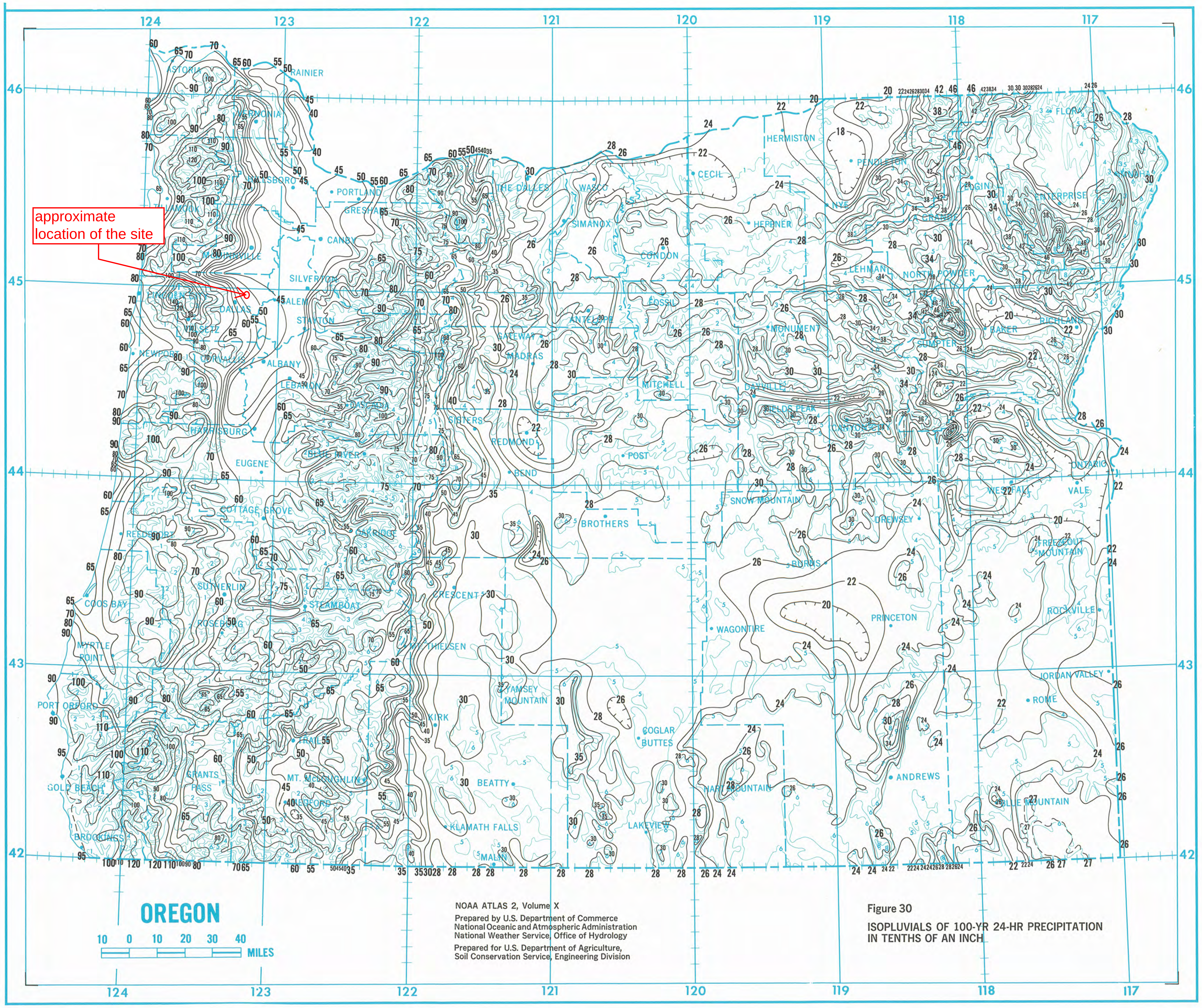


Figure 30

ISOPLUVIALS OF 100-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

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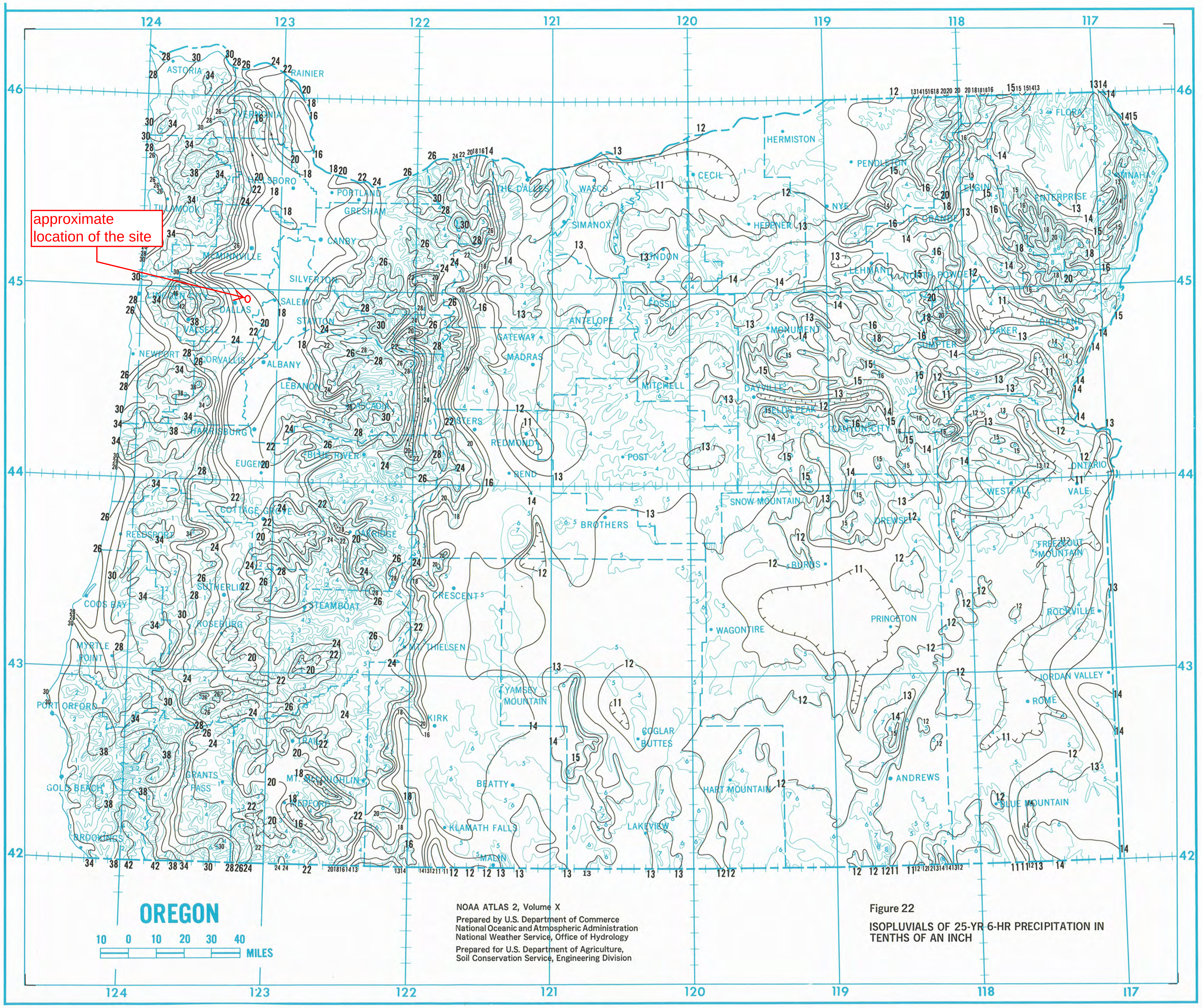

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Prepared by U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Weather Service, Office of Hydrology
Prepared for U.S. Department of Agriculture,
Soil Conservation Service, Engineering Division

Figure 22
ISOPLUVIALS OF 25-YR 6-HR PRECIPITATION IN TENTHS OF AN INCH

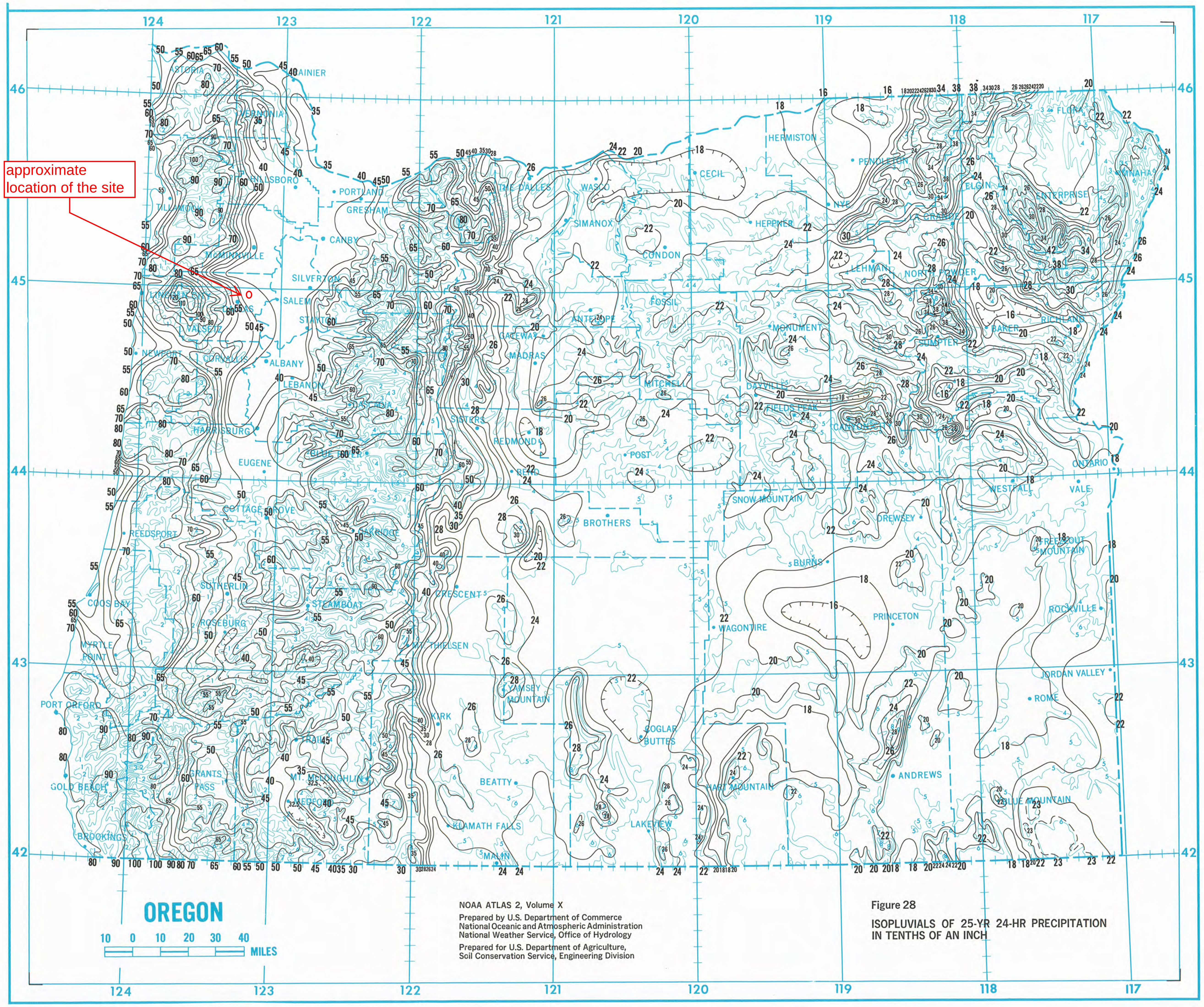


Figure 28

ISOPLUVIALS OF 25-YR 24-HR PRECIPITATION IN TENTHS OF AN INCH

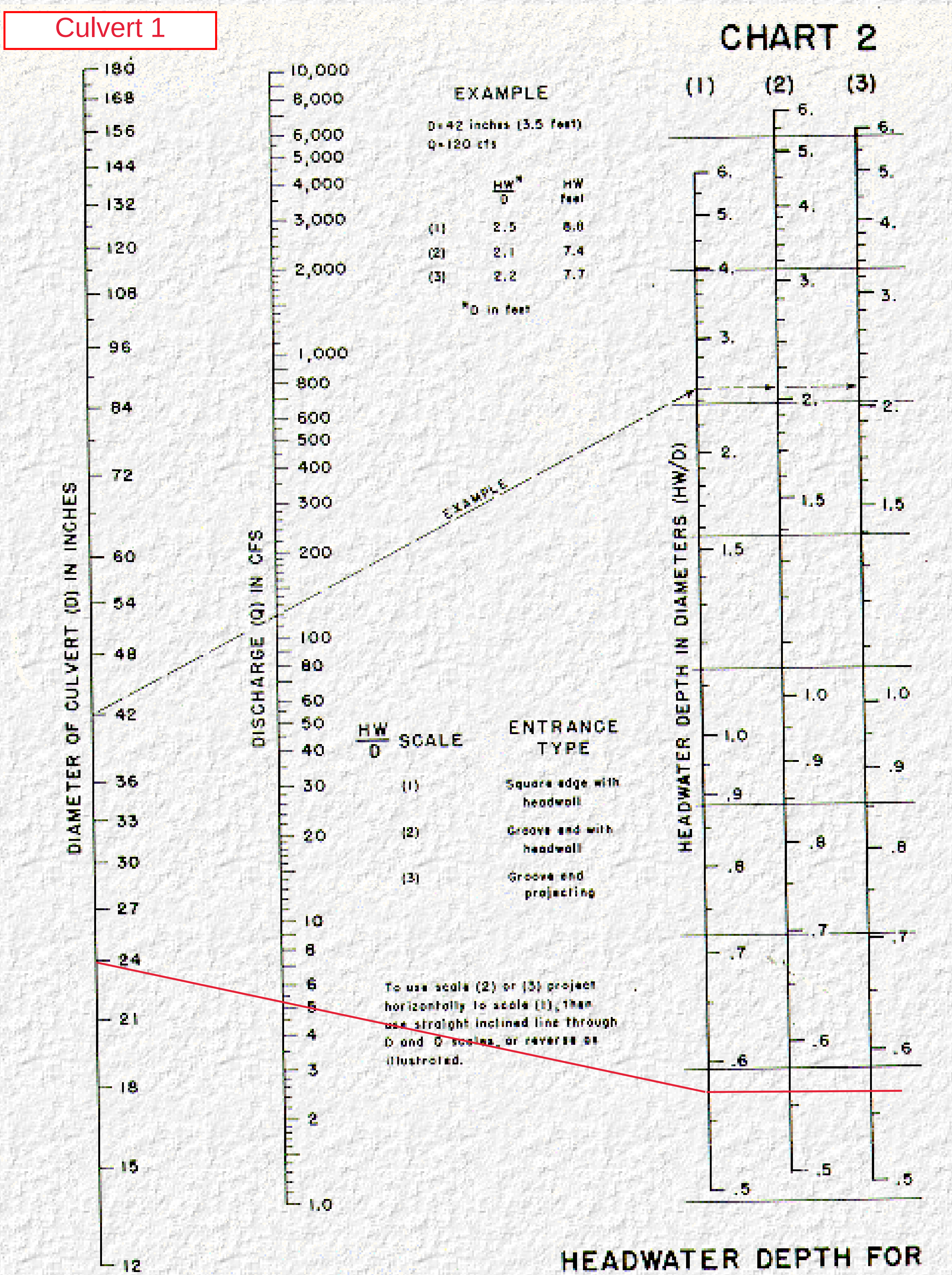
ATTACHMENT 3

Supplemental Calculations

Go Back to Part II

Go to Chart 3

CHART 2



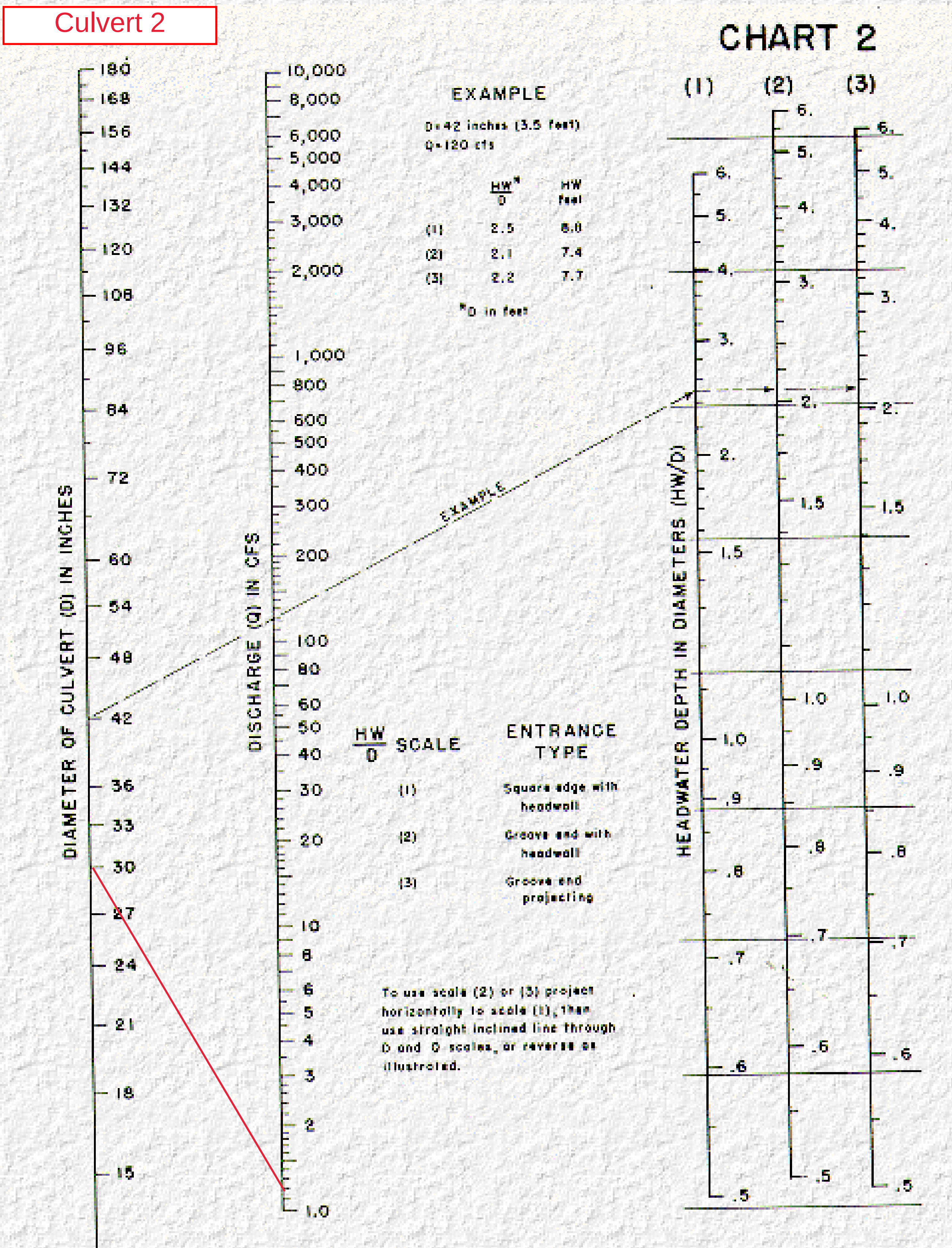
HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

Go Back to Part II

Go to Chart 3



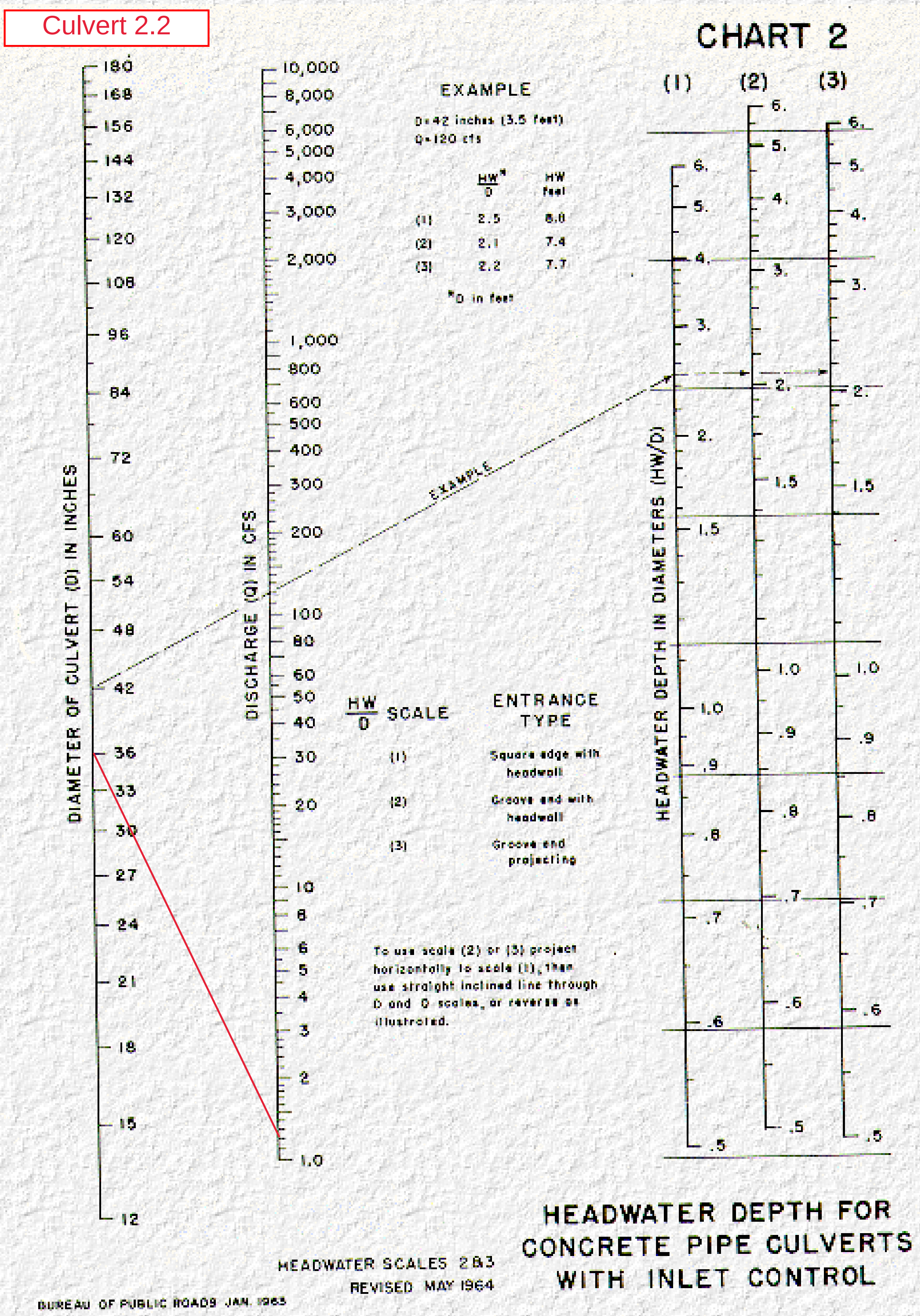
HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

BUREAU OF PUBLIC ROADS JAN. 1963

Go Back to Part II

Go to Chart 3

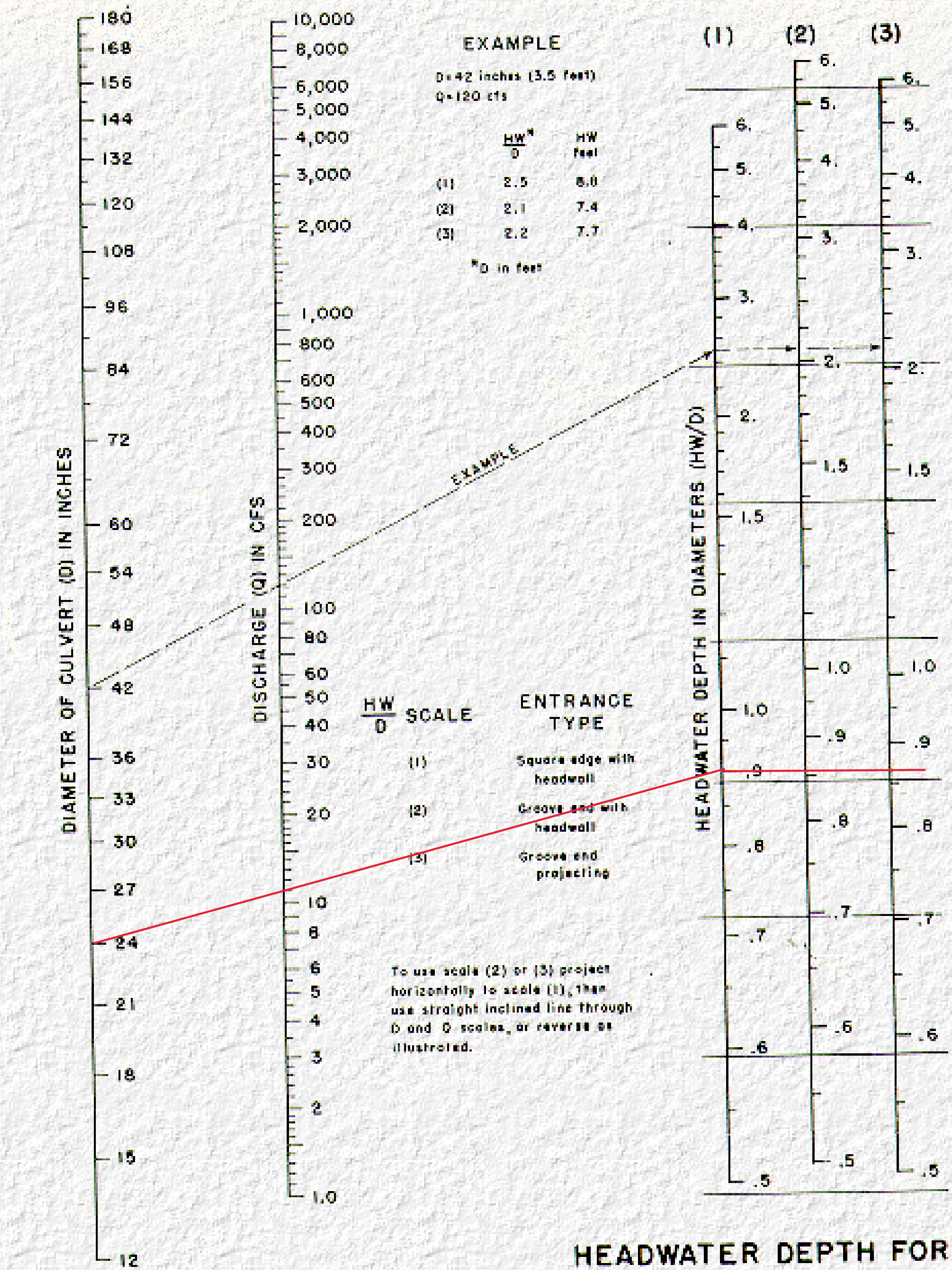


Go Back to Part II

Go to Chart 3

Culvert 3

CHART 2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

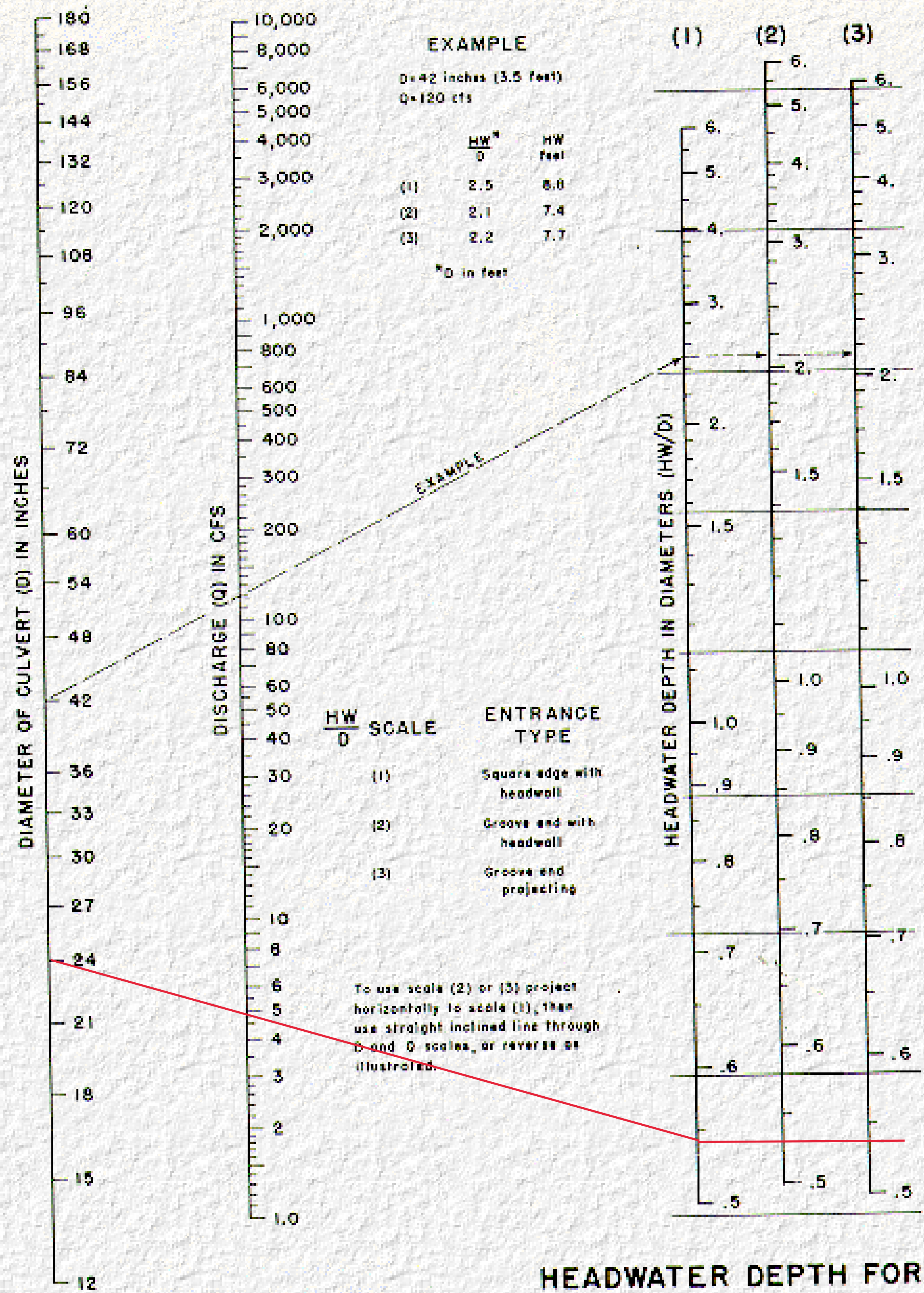
BUREAU OF PUBLIC ROADS JAN. 1963

Go Back to Part II

Go to Chart 3

Culvert 4

CHART 2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3 REVISED MAY 1964

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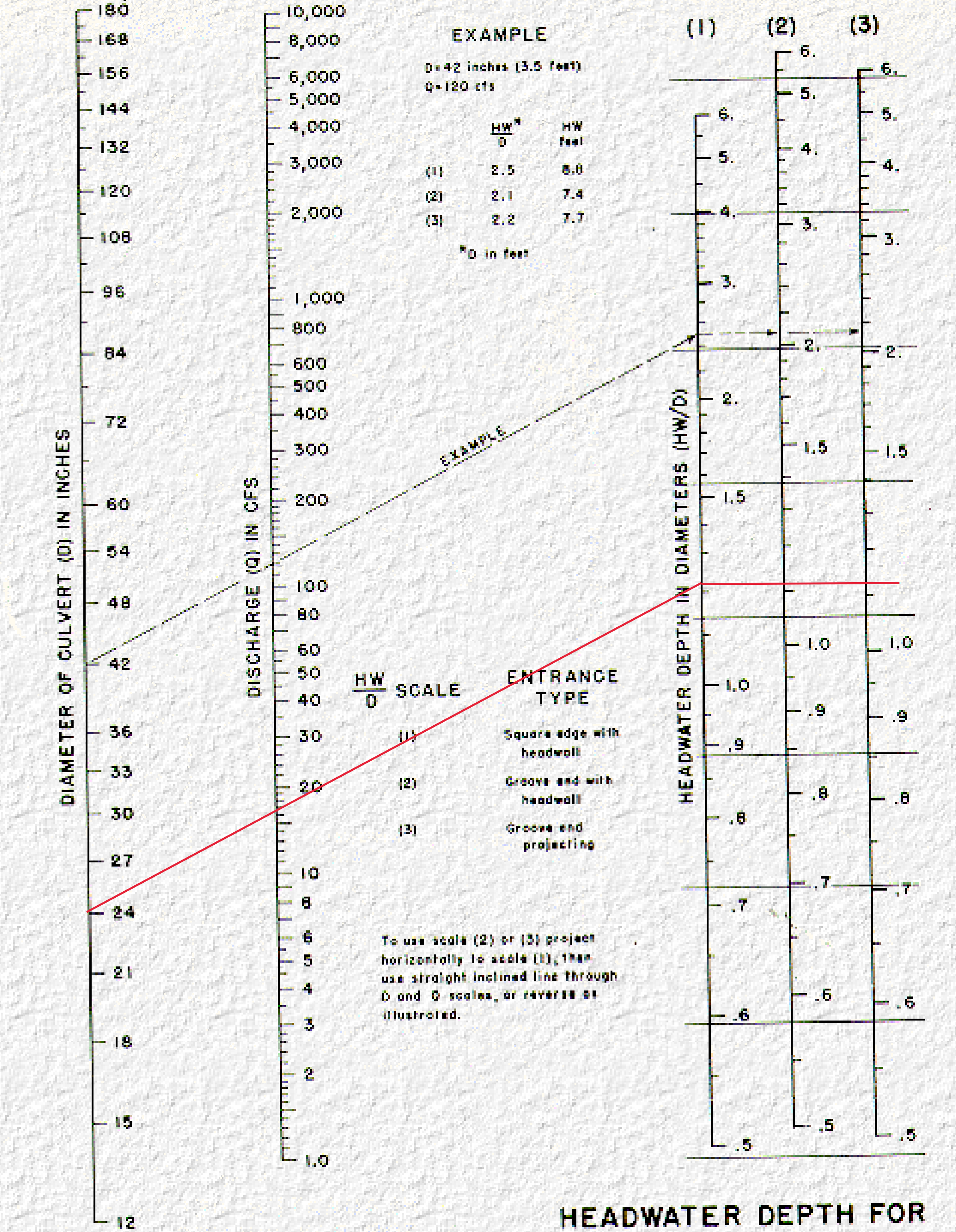
Go Back to Part II
Go to Chart 3

Culvert 5

CHART 2



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

HEADWATER SCALES 2&3
REVISED MAY 1964

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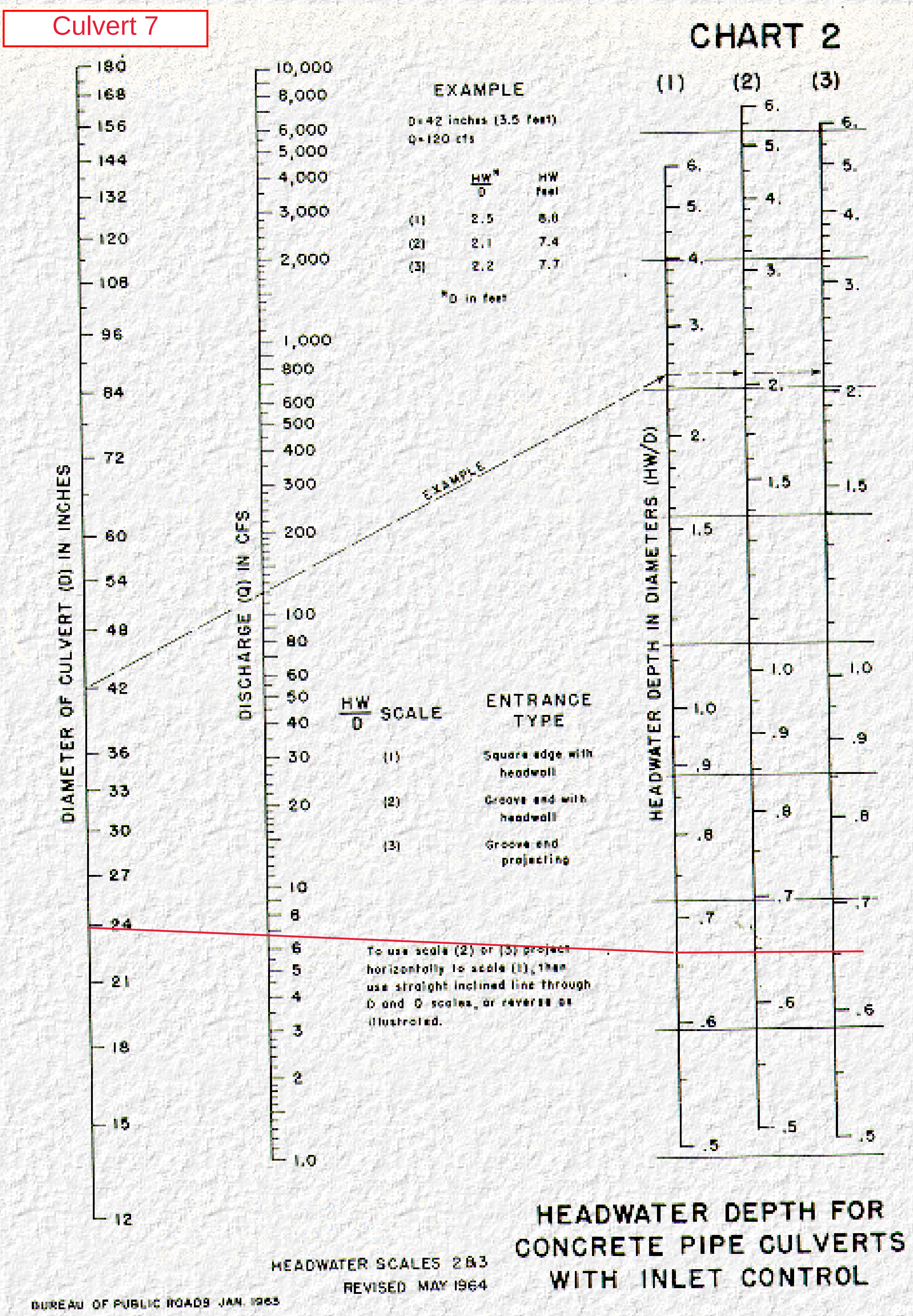
Go Back to Part II

Go to Chart 3

Culvert 7



HEADWATER DEPTH FOR CONCRETE PIPE CULVERTS WITH INLET CONTROL

1. Check Maximum flow through Perforated Pipes located underneath existing stormwater swales and discharging to existing HydroTurf downchutes.

Pipe Diameter (ft)	0.33
Pipe Radius (ft)	0.17
Flow Area (ft^2)	0.09
Hydraulic Radius (ft)	0.08
Pipe Slope (ft/ft) (most conservative)	0.11
Manning's n	0.012
Wetted Perimeter (ft)	1.05
Flow (ft^3/s)	0.69
Number of Pipes (most conservative)	6
Total Flow (ft^3/s) (pipes * flow)	4.14

RESULT: The maximum expected flow through the perforated pipes to a downchute is approximately 4.14 ft^3/s

2. Check Downchute Capacity to contain flow calculated above (4.14 ft^3/s) using Manning's Equation

Flow (ft^3/s)	**4.14**	
Flow Area (ft^2)	0.37	
Hydraulic Radius (ft)	0.14	
Channel Slope (ft/ft)	0.26	
Manning's n	0.018	*HydroTurf
Wetted Perimeter (ft)	2.71	
Flow Depth from Subdrain (ft)	**0.16**	
Flow Depth from 100-YR Storm Surface Runoff (ft)	**0.22**	
Combined Flow Depth (ft)	**0.38**	
Side Slope (run/rise) (most conservative)	2.00	
Bottom Width (ft)	2.00	

RESULT: Shallowest HydroTurf-lined downchute is 1.5 ft deep so downchute depth is sufficient to contain the flow depth of 0.38 ft

1. Check Maximum flow through Perforated Pipes located underneath existing stormwater swales and discharging to existing Rip-rap Gabion Mattress downchutes.

Pipe Diameter (ft)	0.33
Pipe Radius (ft)	0.17
Flow Area (ft^2)	0.09
Hydraulic Radius (ft)	0.08
Pipe Slope (ft/ft) (most conservative)	0.11
Manning's n	0.012
Wetted Perimeter (ft)	1.05
Flow (ft^3/s)	0.69
Number of Pipes (most conservative)	2
Total Flow (ft^3/s) (pipes * flow)	1.38

RESULT: The maximum expected flow through the perforated pipes to a downchute is approximately 1.38 ft^3/s

2. Check Downchute Capacity to contain flow calculated above (1.38 ft^3/s) using Manning's Equation

Flow (ft^3/s)	**1.38**	
Flow Area (ft^2)	0.31	
Hydraulic Radius (ft)	0.12	
Channel Slope (ft/ft)	0.25	
Manning's n	0.041	*Rip-rap Gabion Mattress
Wetted Perimeter (ft)	2.61	
Flow Depth from Subdrain (ft)	**0.14**	
Flow Depth from 100-YR Storm Surface Runoff (ft)	**0.44**	
Combined Flow Depth (ft)	**0.58**	
Side Slope (run/rise) (most conservative)	2.00	
Bottom Width (ft)	2.00	

RESULT: Shallowest rip-rap lined downchute is 1.6 ft deep so downchute depth is sufficient to contain the flow depth of 0.58 ft

Conveyance ID	Material	Slope (ft/ft)	Flow Depth (ft) (25-year, 24-hour design storm)	Shear Stress (lb/ft2)	Permissible Shear Stress	Permissible shear > shear stress?
DC-5A	HydroTurf	0.08	0	0.00	10	yes
53R	Grass	0.02	0.4	0.57	3.7	yes
DC-5B	HydroTurf	0.37	0.02	0.46	45	yes
2R	Grass	0.02	0.59	0.75	3.7	yes
DC-5C	HydroTurf	0.23	0.05	0.73	45	yes
4R	Grass	0.05	0.35	1.18	3.7	yes
DC-5D	HydroTurf	0.27	0.06	1.02	45	yes
3R	Grass	0.02	0.54	0.77	3.7	yes
DC-5E	HydroTurf	0.27	0.07	1.16	45	yes
54R	Grass	0.05	0.43	1.41	3.7	yes
DC-5F	HydroTurf	0.31	0.08	1.56	45	yes
5R	Grass	0.05	0.41	1.34	3.7	yes
6R	Grass	0.04	0.52	1.22	3.7	yes
DC-5G	HydroTurf	0.21	0.12	1.56	45	yes
7R	Grass	0.10	0.45	2.79	3.7	yes
75R	Grass	0.10	0.36	2.28	3.7	yes
76R	Grass	0.07	0.31	1.29	3.7	yes
9R	Grass	0.03	0.31	0.58	3.7	yes
DC6-A	Riprap Gabion Mattress	0.28	0.07	1.22	35	yes
8R	Grass	0.05	0.4	1.29	3.7	yes
DC-6B	Riprap Gabion Mattress	0.20	0.11	1.37	35	yes
10R	Grass	0.06	0.47	1.88	3.7	yes
11R	Grass	0.06	0.39	1.37	3.7	yes
DC-6C	ACB	0.24	0.14	2.12	11	yes
DC-6D	ACB	0.26	0.11	1.82	11	yes
DC-6E	ACB	0.22	0.21	2.94	11	yes
13R	Grass	0.05	0.17	0.48	3.7	yes
12R	Grass	0.03	0.45	0.85	3.7	yes
DC-7A	Riprap Gabion Mattress	0.23	0.05	0.73	35	yes
14R	Grass	0.07	0.49	2.04	3.7	yes
15R	Grass	0.07	0.46	2.10	3.7	yes
DC-7B	ACB	0.17	0.18	1.87	11	yes
16R	Grass	0.05	0.32	1.07	3.7	yes
17R	Grass	0.06	0.33	1.18	3.7	yes
DC-12	Grass	0.26	0.07	1.14	3.7	yes
53R	Grass	0.01	1.17	0.38	3.7	yes
18R	Grass	0.03	0.52	1.08	3.7	yes
19R	Grass	0.03	0.45	0.79	3.7	yes
DC-8A	Riprap Gabion Mattress	0.25	0.13	2.07	35	yes
20R	Grass	0.04	0.42	0.96	3.7	yes
21R	Grass	0.02	0.61	0.81	3.7	yes
DC-8B	ACB	0.25	0.17	2.60	11	yes
22R	Grass	0.05	0.54	1.53	3.7	yes
50R	Grass	0.07	0.39	1.65	3.7	yes
DC-8C	Riprap Gabion Mattress	0.26	0.35	5.62	35	yes
52R	Grass	0.01	0.48	0.17	3.7	yes
23R	Grass	0.01	0.7	0.64	3.7	yes
24R	Grass	0.03	0.54	1.05	3.7	yes
DC-9	HydroTurf	0.27	0.1	1.69	45	yes
RD-7	Grass	0.09	0.49	2.90	3.7	yes
26R	Grass	0.02	0.47	0.70	3.7	yes
DC-10A	HydroTurf	0.29	0.14	2.51	45	yes
27R	Grass	0.02	0.39	0.60	3.7	yes
DC-10B	HydroTurf	0.25	0.16	2.50	45	yes
28R	Grass	0.02	0.56	0.68	3.7	yes
DC-10C	HydroTurf	0.27	0.17	2.86	45	yes
29R	Grass	0.01	0.54	0.43	3.7	yes
30R	Grass	0.02	0.59	0.86	3.7	yes
NPIS-3	Grass	0.02	1.14	1.37	3.7	yes

Conveyance ID	Material	Slope (ft/ft)	Flow Depth (ft) (25-year, 24-hour design storm)	Shear Stress (lb/ft2)	Permissible Shear Stress	Permissible shear > shear stress?
DC-11A	HydroTurf	0.14	0	0.00	45	yes
31R	Grass	0.03	0.61	1.05	3.7	yes
32R	Grass	0.07	0.29	1.32	3.7	yes
DC-11B	HydroTurf	0.28	0.08	1.40	45	yes
33R	Grass	0.03	0.62	1.34	3.7	yes
34R	Grass	0.04	0.32	0.87	3.7	yes
DC-11C	HydroTurf	0.27	0.13	2.22	45	yes
35R	Grass	0.04	0.32	0.89	3.7	yes
DC-11D	HydroTurf	0.26	0.13	2.15	45	yes
RD-8	Grass	0.08	0.62	2.99	3.7	yes
NPIS-1	Grass	0.02	0.29	0.30	3.7	yes
NPIS-2	Grass	0.01	1.13	1.03	3.7	yes
DC-1A	HydroTurf	0.17	0	0.00	45	yes
36R	Grass	0.07	0.38	1.59	3.7	yes
37R	Grass	0.08	0.31	1.53	3.7	yes
DC-1B	HydroTurf	0.17	0.07	0.74	45	yes
38R	Grass	0.01	0.5	0.46	3.7	yes
DC-1C	HydroTurf	0.04	0.14	0.34	45	yes
39R	Grass	0.04	0.46	1.17	3.7	yes
DC-1D	HydroTurf	0.26	0.1	1.59	45	yes
RD-3	Paved	0.02	0.36	0.45	12	yes
RD-2	Paved	0.07	0.43	1.99	12	yes
RD-1	Paved	0.04	0.3	0.69	12	yes
DC-2A	HydroTurf	0.22	0	0.00	45	yes
40R	Grass	0.07	0.46	1.96	3.7	yes
DC-2B	HydroTurf	0.20	0.04	0.50	45	yes
41R	Grass	0.07	0.66	2.87	3.7	yes
DC-2C	HydroTurf	0.20	0.1	1.22	45	yes
42R	Grass	0.06	0.49	1.92	3.7	yes
DC-2D	HydroTurf	0.18	0.12	1.31	45	yes
RD-5	Grass	0.08	0.59	3.01	3.7	yes
DC-2E	HydroTurf	0.30	0.12	2.25	45	yes
RD-4	Paved	0.03	0.33	0.67	12	yes
43R	Grass	0.09	0.55	3.20	3.7	yes
51R	Grass	0.14	0.3	2.53	3.7	yes
DC-4A	HydroTurf	0.08	0	0.00	45	yes
1R	Grass	0.02	0.62	0.91	3.7	yes
DC-4B	HydroTurf	0.12	0.06	0.44	45	yes
44R	Grass	0.02	0.7	0.66	3.7	yes
DC-4C	HydroTurf	0.10	0.1	0.61	45	yes
45R	Grass	0.02	0.45	0.55	3.7	yes
DC-4D	HydroTurf	0.35	0.08	1.73	45	yes
55R	Grass	0.06	0.38	1.32	3.7	yes
DC-4E	HydroTurf	0.31	0.09	1.76	45	yes
47R	Grass	0.08	0.38	1.82	3.7	yes
DC-4F	HydroTurf	0.33	0.09	1.84	45	yes
46R	Grass	0.04	0.51	1.27	3.7	yes
DC-4G	HydroTurf	0.34	0.1	2.15	45	yes
48R	Grass	0.12	0.23	1.71	3.7	yes
DC-4H	HydroTurf	0.15	0.13	1.22	45	yes

APPENDIX B

Settlement Evaluation

The work in this Appendix was performed by Amy Padovani and Fabrizio Settepani under the supervision of Hari Sharma, P.E.

SETTLEMENT OF FINAL COVER SYSTEM

RIVERBEND LANDFILL

McMinnville, Oregon

Geosyntec estimated secondary settlements of the final cover at Riverbend Landfill to check if the final grading plan will maintain positive grading (i.e., allow for surface water runoff) after closure. Geosyntec assumed that the closure date for the landfill is 2019 and the post-closure period is 30 years (i.e., settlements up to the year 2049 were estimated).

SETTLEMENT THEORY

Waste settlement has two components: primary settlement and secondary settlement.

Primary settlement is assumed to stop a few months after final grades have been reached (0.4 year); therefore, it was not added to the settlement expected to occur during the 30-year closure period.

Secondary settlement depends on time (i.e., consolidation under self-weight [sw] because of decomposition) and also on the effect, over time, of any external loads [el] such as construction of the final cover.

The procedures presented in Sharma and Reddy (2004) and Sharma and De (2007) were used to estimate secondary settlement.

Because secondary settlement is independent of stress within the waste column, the waste was modeled as a single layer for estimating the secondary settlement. Therefore, H represents the entire column of waste between base and final grades.

$$S_{\text{SECONDARY}} = S_{\text{SELF WEIGHT}} + S_{\text{EXTERNAL LOADS}}$$

$$S_{\text{SELF WEIGHT}} = H * C_{\alpha(sw)} * \log\left(\frac{t_{2(sw)}}{t_{1(sw)}}\right)$$

$$S_{\text{EXTERNAL LOADS}} = H * C_{\alpha(el)} * \log\left(\frac{t_{2(el)}}{t_{1(el)}}\right)$$

S = settlement
H = height of waste column
$C_{\alpha(sw)}$= coefficient of secondary compression due to self weight. We assumed 0.25 for our evaluation.

$C_{\alpha\,(el)}$ = coefficient of secondary compression due to external loads. We assumed 0.03 for our evaluation.
$t_{2(sw)}$ = time after waste placement
$t_{1(sw)}$ = initial period of settlement
$t_{2(el)}$ = time after external load application
$t_{1(el)}$ = time for primary settlement

The coefficients of secondary compression depend on the age of the waste. Older waste has lower coefficients, whereas newer waste has higher coefficients.

LIFE OF EACH MODULE AND AGE OF WASTE

Geosyntec understands that the approximate dates for development of Module 1 through Module 3 are between 1982 and 1993. Landfill records from WM estimate that the landfill accepted the following tonnages listed below:

Year	Tons
1982	150,000
1985	200,000
1989	250,000
1993	300,000

Based on the above and the relative size of each Module, Geosyntec has assumed that filling started:

- in 1982 in Module 1,
- in 1985 in Module 2, and
- in 1989 in Module 3.

Portions of Modules 1, 2, and 3 were closed in 1994. Portions of Modules 4, 5, 6, and 7 were closed at various times in 2005 and 2006.

Portions of Modules 1, 2, and 3 that were not closed in 1994 remained open and overliners were constructed in the areas adjacent to the new modules to the north. Also, as part of the recent expansion project on the west side of the landfill (2013-2017) and the final grading plan modification on the south side of the landfill (i.e., FGPM), a portion of the closed areas of Modules 1, 2 and 3 will receive new waste. The new waste will be placed over the existing final cover which will act as an overliner. For reference, the existing final cover (i.e., now acting as an overliner) has a drainage layer which acts as the leachate collection layer.

Table 1 below lists the assumed dates when each module was constructed and filling started. Filling in all modules is estimated to be finished by 2019. Assuming a post-closure period of 30 years, the estimated date at which settlement was estimated is 2049 for all modules and settlement was estimated for the period between 2019 and 2049.

TABLE 1

Module	Start Filling
1	1982
2	1985
3	1989
4	1993
5	1995
6	1997
7	1998
8A	2002
8B	2005
8C	2007
8D	2009
9	2014
FGPM	2017

Geosyntec assumed that the year that filling started in each module was the same as the year that the construction drawings were prepared for it.

To calculate time inputs for secondary compression the following equations were used:

$t_{2(sw)}$ = Year of Interest– [½(Year of Closure +Year that filling begins)]
$t_{1(sw)}$ = average time during which waste has been settling under self weight = [½(Year that filling ends – Year that filling begins)]
$t_{2(el)}$ = time between cover construction and time of interest = closure period
$t_{1(el)}$ = time until end of primary compression due to final cover construction = 0.4 year

For reference, we assumed that leachate levels would not affect the settlement estimates because (i) the secondary settlement parameters/coefficients/unit weights indirectly address leachate, (ii) the landfill has an active leachate collection and removal system that is expected to function after closure and (iii) final cover construction results in decreased leachate production after closure. Furthermore, in composite-lined modules, the landfill operator maintains the head of leachate to within 1 foot of the base as required by the regulations.

GRADES

The base grades were estimated based on as-built and design grades received from Waste Management for the various Modules. For Modules 1, 2, and 3, the base grades were estimated based on information provided by Waste Management.

Figure 1 presents the proposed final grades and the location of points used in the settlement analysis. A total of 60 points were placed across the site based on the locations of benches, roads, and top decks.

RESULTS

Tables 2 and 3 present the input information, the estimated settlements at the end of the 30-year post-closure maintenance period, and the estimated slopes after settlement. As can be observed, the estimated slopes at the end of the 30-year post-closure maintenance period are flatter than 3.4:1 (horizontal to vertical) and positive flow is maintained after settlement (i.e., surface water flows to the outside perimeter).

TABLE 2 - TOTAL SECONDARY SETTLEMENT ESTIMATES

Closure for all cells: 2019.0 (assumed closure date)
Closure period: 30.0 years or 2049
Time for secondary settlement to start: 0.4 yrs (after placement of final cover)

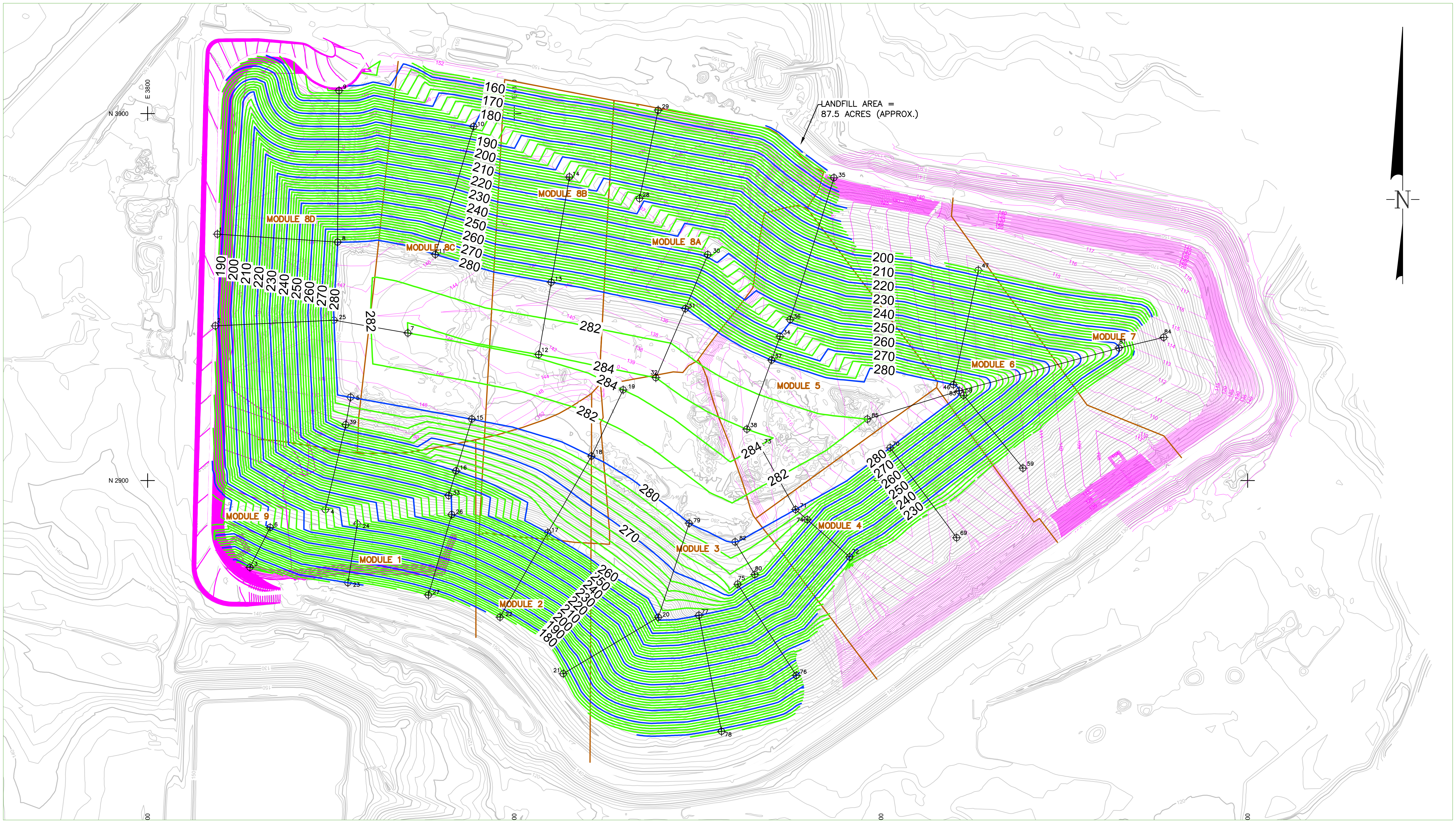
Secondary compression ratios for MSW:
$C_{\alpha SW}$ 0.25
$C_{\alpha EL}$ 0.03

Point Number*	Located within Module	Base Elevation (ft)	Top Elevation (ft)	Thickness of waste-H (ft)	Start of Filling	t_2 (total)	t_1 (present)	S_{sw} (ft)	S_{el} (ft)	Total Secondary Settlement (ft)	Comments
1	8d	186.0	186	0	2009	35	5	0	0	0	
2	8d	188.0	188	0	2009	35.0	5	0	0	0	
3	9/FGPM	146.0	148	2	2014	32.5	3	1	0	1	Selected Module 9 for calculations
4	1/9/FGPM	135.0	206	71	1982	48.5	19	7	4	11	Selected Module 1 for calculations
5	8d/FGPM	150.0	280	130	2009	35	5	27	7	35	Selected Module 8d for calculations
6	9/FGPM	144.5	190	46	2014	32.5	3	13	3	15	Selected Module 9 for calculations
7	8c	145.0	284	139	2007	36	6	27	8	35	
8	8c	149.0	280	131	2007	36	6	25	7	33	
9	8c	162.0	162	0	2007	36	6	0	0	0	
10	8c	144.0	180	36	2007	36	6	7	2	9	
11	8c	146.0	280	134	2007	36	6	26	8	34	
12	8b	143.0	284	141	2005	37	7	25	8	33	
13	8b	141.0	280	139	2005	37	7	25	8	33	
14	8b	140.0	203	63	2005	37	7	11	4	15	
15	8b/FGPM	148.0	280	132	2005	37	7	24	7	31	Selected Module 8b for calculations
16	1/8c/FGPM	135.0	260	125	1982	48.5	19	13	7	20	Selected Module 1 for calculations
17	2/8b/FGPM	110.0	260	150	1985	47	17	17	8	25	Selected Module 2 for calculations
18	3/8c/FGPM	110.0	280	170	1989	45	15	20	10	30	Selected Module 3 for calculations
19	3/8a	110.0	284	174	1989	45	15	21	10	31	Selected Module 3 for calculations
20	3/FGPM	110.0	260	150	1989	45	15	18	8	26	Selected Module 3 for calculations
21	3/FGPM	110.0	174	64	1989	45	15	8	4	11	Selected Module 3 for calculations
22	3/FGPM	110.0	172	62	1989	45	15	7	3	11	Selected Module 3 for calculations
23	1/9/FGPM	135.0	160	25	1982	48.5	19	3	1	4	Selected Module 1 for calculations
24	1/9/FGPM	135.0	214	79	1982	48.5	19	8	4	13	Selected Module 1 for calculations
25	8d	147.0	280	133	2009	35	5	28	7	36	
26	1/FGPM	135.0	240	105	1982	48.5	19	11	6	17	Selected Module 1 for calculations
27	1/FGPM	135.0	164	29	1982	48.5	19	3	2	5	Selected Module 1 for calculations
28	8a	137.0	219	82	2002	38.5	9	13	5	18	
29	8a	149.0	154	5	2002	38.5	9	1	0	1	
30	8a	133.0	238	105	2002	38.5	9	17	6	23	
31	8a	135.0	280	145	2002	38.5	9	24	8	32	
32	8a	139.0	284	145	2002	38.5	9	24	8	32	
33	1/FGPM	135.0	240	105	1982	48.5	19	11	6	17	Selected Module 1 for calculations
34	5	121.0	262	141	1995	42	12	19	8	27	
35	6	144.0	153	9	1997	41	11	1	1	2	
36	5	120.5	258	138	1995	42	12	19	8	26	
37	5	119.0	280	161	1995	42	12	22	9	31	
38	5	115.0	284	169	1995	42	12	23	10	32	
39	8d/FGPM	151.0	274	123	2009	35	5	26	7	33	Selected Module 8d for calculations
46	6	116.0	280	164	1997	41	11	23	9	33	
47	6	113.5	196	83	1997	41	11	12	5	16	
58	6	115.0	278	163	1997	41	11	23	9	32	
59	6	112.0	206	94	1997	41	11	13	5	19	
69	4	113.0	198	85	1993	43	13	11	5	16	
70	4	116.0	280	164	1993	43	13	21	9	31	
71	4/FGPM	116.0	280	164	1993	43	13	21	9	31	Selected Module 4 for calculations
72	4/FGPM	110.5	230	120	1993	43	13	16	7	22	Selected Module 4 for calculations
73	5	115.0	284	169	1995	42	12	23	10	32	
74	4/FGPM	111.5	274	163	1993	43	13	21	9	30	Selected Module 4 for calculations
75	3/FGPM	110.0	274	164	1989	45	15	20	9	29	Selected Module 3 for calculations
76	3/FGPM	110.0	190	80	1989	45	15	10	5	14	Selected Module 3 for calculations
77	3/FGPM	110.0	260	150	1989	45	15	18	8	26	Selected Module 3 for calculations
78	3/FGPM	110.0	168	58	1989	45	15	7	3	10	Selected Module 3 for calculations
79	3/FGPM	110.0	280	170	1989	45	15	20	10	30	Selected Module 3 for calculations
80	3/FGPM	110.0	274	164	1989	45	15	20	9	29	Selected Module 3 for calculations
81	7	113.0	230	117	1998	40.5	11	17	7	24	
82	3/FGPM	110.0	280	170	1989	45	15	20	10	30	Selected Module 3 for calculations
83	6	113.0	280	167	1997	41	11	24	9	33	
84	7	114.0	194	80	1998	40.5	11	12	5	16	
85	5	117.0	282	165	1995	42	12	22	9	32	

*** Point numbers are not consecutive.**

TABLE 3 - ESTIMATED SLOPE BETWEEN POINTS AFTER SETTLEMENT

Upper Point	Original Elevation at Upper Point	Settlement at Upper Point (feet)	New Elevation at Upper Point	Lower Point	Original Elevation at Lower Point	Settlement at Lower Point (feet)	New Elevation at Lower Point	Delta Elevation	Distance Between Points	Slope = Delta Elevation/Distance	Estimated Slope After Settlement is __ to 1
6	190	15	175	**3**	148	1	147	27	121	0.23	4.4
24	214	13	201	**23**	160	4	156	45	162	0.28	3.6
26	240	17	223	**27**	164	5	159	64	228	0.28	3.6
5	280	35	245	**39**	274	33	241	4	76	0.05	18.4
39	274	33	241	**4**	206	11	195	47	238	0.20	5.1
15	280	31	249	**16**	260	20	240	9	148	0.06	16.8
16	260	20	240	**33**	240	17	223	17	70	0.24	4.2
19	284	31	253	**18**	280	30	250	3	200	0.02	60.6
18	280	30	250	**17**	260	25	235	15	241	0.06	15.9
79	280	30	250	**20**	260	26	234	16	270	0.06	16.4
20	260	26	234	**21**	174	11	163	71	245	0.29	3.5
17	260	25	235	**22**	172	11	161	74	252	0.29	3.4
82	280	30	250	**80**	274	29	245	5	104	0.05	21.0
85	282	32	250	**83**	280	33	247	4	262	0.01	74.3
73	284	32	252	**71**	280	31	249	2	200	0.01	98.4
71	280	31	249	**74**	274	30	244	6	42	0.14	7.3
74	274	30	244	**72**	230	22	208	36	154	0.23	4.3
75	274	29	245	**76**	190	14	176	69	296	0.23	4.3
77	260	26	234	**78**	168	10	158	76	332	0.23	4.4
25	280	36	244	**2**	188	0	188	56	324	0.17	5.7
70	280	31	249	**69**	198	16	182	67	305	0.22	4.5
58	278	32	246	**59**	206	19	187	58	256	0.23	4.4
83	280	33	247	**81**	230	24	206	40	451	0.09	11.1
81	230	24	206	**84**	194	16	178	28	125	0.23	4.4
46	280	33	247	**47**	196	16	180	68	319	0.21	4.7
38	284	32	252	**37**	280	31	249	2	200	0.01	81.2
37	280	31	249	**34**	262	27	235	14	68	0.21	4.8
36	258	26	232	**35**	153	2	151	80	405	0.20	5.0
32	284	32	252	**31**	280	32	248	4	204	0.02	51.0
31	280	32	248	**30**	238	23	215	33	160	0.21	4.8
28	219	18	201	**29**	154	1	153	48	246	0.20	5.1
12	284	33	251	**13**	280	33	247	4	200	0.02	56.7
13	280	33	247	**14**	203	15	188	59	291	0.20	4.9
11	280	34	246	**10**	180	9	171	75	364	0.21	4.8
8	280	33	247	**9**	162	0	162	85	413	0.21	4.9
8	280	33	247	**1**	186	0	186	61	329	0.19	5.4
7	284	35	249	**25**	280	36	244	5	205	0.02	43.4



LEGEND:

- 19 MARCH 2017 TOPOGRAPHY
- TOP OF FINAL GRADES 10-FT CONTOURS
- TOP OF FINAL GRADES 2-FT CONTOURS
- AS-BUILT BASE GRADES
- ⌖ 22 SETTLEMENT POINTS (NOT SEQUENTIAL)

0 125 250
SCALE IN FEET

Geosyntec consultants

FINAL GRADING PLAN & SETTLEMENT POINTS
RIVERBEND LANDFILL
MCMINNVILLE, OREGON

FIGURE NO.	1
PROJECT NO.	WG2423
DATE:	OCTOBER 2017

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APPENDIX C

Landfill Gas Extraction System

December 22, 2022

MEMORANDUM

From: Seth A. Nunes, P.E., CEC

To: Melody Adams, Riverbend Landfill Co.

Subject: Proposed Final Gas Collection and Control System (GCCS)
Riverbend Landfill – McMinnville, Oregon

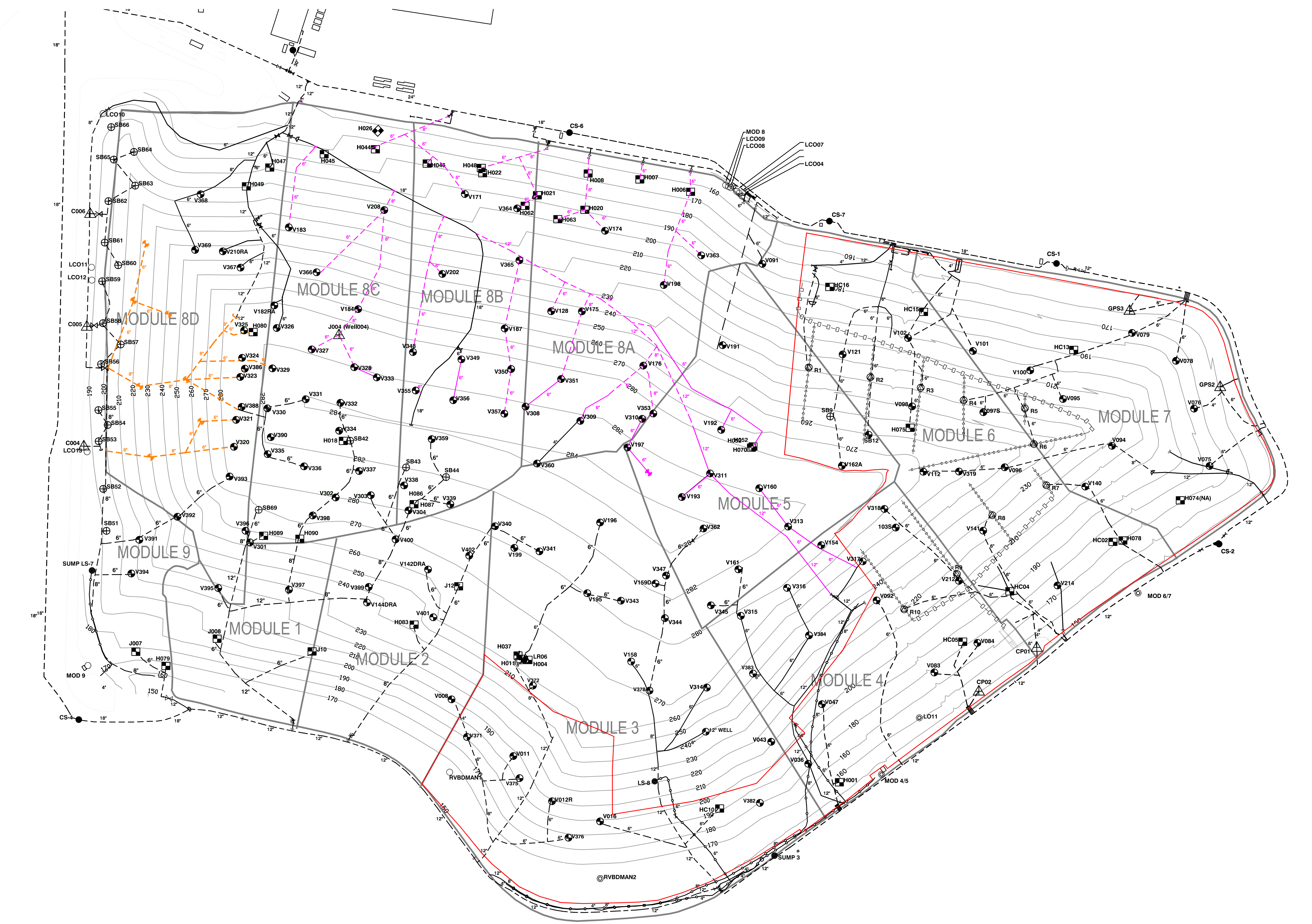
Carlson Environmental Consultants, PC (CEC) prepared this memorandum to summarize the proposed conceptual design for the landfill gas (LFG) collection and control system (GCCS) at the Riverbend Landfill (RLC) located in McMinnville, Oregon. The design is presented on the enclosed drawing "Riverbend Landfill Final Closure Conceptual Design." The design is based on the final fill contours provided by Geosyntec Consultants, Inc., information provided by RLC, and as-built information compiled by CEC regarding the existing GCCS. The GCCS is designed to meet the operational performance standards of the 40 CFR 63 Subpart AAAA (NESHAP AAAA) and the requirements of other applicable regulations, which include preventing LFG migration, reducing fugitive emissions, and preventing objectionable odors. Portions of the final GCCS that remain to be installed will be comprised of vertical LFG extraction wells, horizontal LFG collectors, and associated header and lateral pipe lines. The existing GCCS that will remain, as well as proposed expansions, are shown on the drawing overlaying the proposed future fill contours and are grouped by general area of the landfill with variations in color.

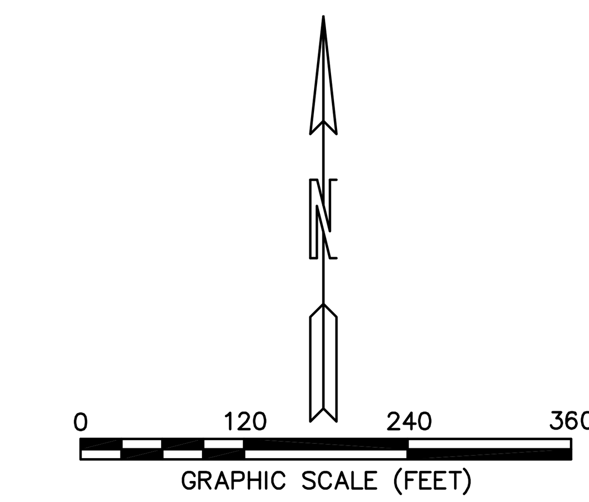
- Existing GCCS to Remain (Black): The black features are the existing GCCS components compiled from information provided by RLC. Abandoned and decommissioned GCCS features have been omitted from this drawing. Horizontal perforated pipe has been removed from the drawings for clarity purposes. Some existing GCCS has been removed from these drawings to depict the final closure conditions more appropriately. Existing GCCS components prior to 2017 are taken from Cornerstone Engineering, Inc drawings titled "2016 GCCS Improvements As-Built." Some of these features are based off RLC recommendations and have not been surveyed.

- North Side Expansion (Magenta): The magenta GCCS is projected future construction generally along the north side of the landfill. The future construction will replace some existing GCCS features in these areas and those features have been omitted from these drawings. Final conditions may be slightly different from those displayed on this conceptual GCCS design.

- West Side Expansion (Orange): The orange GCCS is projected future construction generally along the west side of the landfill. The future construction will replace some existing GCCS features in these areas and those features have been omitted from these drawings. Final conditions may be slightly different from those displayed on this conceptual GCCS design.

The GCCS system will be inspected and maintained throughout the 30-year post-closure period or as long as LFG continues to be detected at levels requiring control. At the discretion of RLC, additional GCCS expansion within the current permitted footprint and may be needed to sufficiently collect LFG. Additionally, the design shown is conceptual in nature and final design details may differ slightly from what is shown.





LEGEND

EXISTING FEATURES

- ABOVE GRADE HEADER/LATERAL
- BELOW GRADE HEADER/LATERAL
- FM OR DRAINLINE
- SUB-CAP COLLECTOR
- SUB-CAP COLLECTOR DRAIN LINE
- EXTRACTION WELL
- EXTRACTION WELL - REDUCED BOREHOLE
- WELLHEAD MANIFOLD
- HORIZONTAL COLLECTOR WELLHEAD
- SUB-CAP COLLECTOR WELLHEAD
- CONDENSATE SUMP
- FRENCH DRAIN
- LIMIT OF WASTE
- EXISTING LLDPE FINAL CAP
- LFG VALVE
- BLIND FLANGE
- LFG PIPE REDUCER
- MODULE LIMITS
- PREVIOUSLY CLOSED AREA (27.9 ACRES)
- NORTH SIDE FINAL CONSTRUCTION
- WEST SIDE FINAL CONSTRUCTION

NOTES:

1. FINAL GRADING CONTOURS PROVIDED BY GEOSYNTEC CONSULTANTS, INC ON 12/21/20222.
2. AS-BUILT LFG SYSTEM INFORMATION PROVIDED BY RIVERBEND LANDFILL CO. AND SURVEYED BY LELAND MACDONALD & ASSOCIATES, LLC. EXISTING GCCS FEATURES PRIOR TO 2017 PROVIDED BY CORNERSTONE ENGINEERING, INC DRAWINGS TITLED "2016 GCCS IMPROVEMENTS AS-BUILT SITE PLAN".
3. SOME GCCS FEATURES HAVE NOT BEEN SURVEYED OR HAVE BEEN MOVED FROM THEIR ORIGINAL SURVEYED LOCATION. THESE CHANGES HAVE BEEN MADE BASED ON INFORMATION PROVIDED BY RLC.
4. SOME GCCS FEATURES ARE CURRENTLY PRESENT AT THE LANDFILL BUT ARE NOT SHOWN ON THIS DRAWING AS THEY ARE INTENDED TO BE REMOVED FOR FINAL CLOSURE. THIS DRAWING IS NOT AN AS-BUILT FOR CURRENT OR FUTURE CONDITIONS.
5. NOTE THAT SOME GCCS FEATURES MAY BE DIFFERENT THAN SHOWN HERE DUE TO MODIFICATIONS MADE BY OWNER OR THEIR CONTRACTORS TO ACCOMMODATE LANDFILL OPERATIONS OR COMPLIANCE.

FOR PLANNING PURPOSES ONLY

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CEC COA#: 1192731-91

DECEMBER 2022

RIVERBEND LANDFILL FINAL CLOSURE CONCEPTUAL GCCS DESIGN

RIVERBEND LANDFILL

APPENDIX D

Slope Stability Evaluation

Slope Stability Analyses

2017 Closure and Post Closure Report

Riverbend Landfill

This appendix includes the results of slope stability for the landfill mass and includes files that were presented in the *Final Engineered Site Closure and Postclosure Plan, Riverbend Landfill, McMinnville, Oregon,* (2014 FESCPP Report) prepared by Geosyntec Consultants, Inc. (Geosyntec) and dated 30 December 2014 for the Riverbend Landfill (Landfill).

The 2014 FESCPP Report presented cross sections, labelled Sections 20, 21, 22, 23, and 24, that evaluate the stability of the landfill mass along the north, east, and south sides of the Landfill. For the stability analyses along the western side of the Landfill, the reader is referred to the reports and letters related to the design of the mechanically stabilized earthen (MSE) berm.

In 2014, the landfill mass was evaluated for M8.5, rock acceleration = 0.415g design earthquake.

In 2016, Geosyntec designed the fill grading plan modification (FGPM) project along the southwestern side of the Landfill. The slope stability for the FGPM project was presented in *Final Grading Plan Modification Permit Application Report, Riverbend Landfill, McMinnville, Oregon* dated 14 November 2016 (FGPM Report). Because the landfill grades changed along the southwestern side of the Landfill, Section 24 which was presented in the 2014 FESCPP Report has been superseded and is replaced with the the slope stability analyses for the FGPM area presented in the FGPM report.

Since the grades in the FGPM area changes in 2016, the landfill mass was evaluated for M9, rock acceleration = 0.44g design earthquake.

For the areas that have not closed at the time of preparing this report, the final cover was also evaluated for the M9, rock acceleration = 0.44g design earthquake.

The following appendices are included:

- Appendix D-1: 2014 Landfill Mass Slope Stability Evaluation.
- Appendix D-2: 2016 FGPM Slope Stability Evaluation (includes Appendices E and F of the FGPM Report which include slope stability analyses and deformation estimates for M9, rock acceleration = 0.44g).

- Appendix D-3: 2017 Final Cover Slope Stability Evaluation (includes infinite slope analyses and deformation estimates for M9, rock acceleration = 0.44g at the final cover level).

- Appendix D-4: Summary Memorandum with 2017 Evaluation of Seismic Deformations at the Final Cover Level by Geo-Logic Associates for M9, rock acceleration = 0.44g.

APPENDIX D-1

2014 Landfill Mass Slope Stability Evaluation

The work in this Appendix was performed by David Umberg and Fabrizio Settepani under the supervision of Hari Sharma, P.E.

SLOPE STABILITY ANALYSES: FINAL WASTE FILL GRADES - SUMMARY

PURPOSE

This calculation package summarizes the slope stability analyses for the final fill grades at the Riverbend Landfill (Riverbend) located in McMinnville, Oregon. These analyses supplement slope stability analyses previously performed for the Western portion of the Landfill and presented in other documents.

ANALYSES

Static and pseudo-static slope stability analyses were performed for the final fill grades on the eastern side of Riverbend Landfill, as shown on Figure 1. Five representative cross sections, Section 20, 21, 22, 23, and 24, were evaluated for slope stability. Leachate level was assumed to be within 12 inches of the base liner system. Slope stability was analyzed using the Spencer Method (Spencer, 1967)[1], which satisfies both moment and force equilibrium conditions. The analyses were performed using the Slope/W software (GEO-SLOPE 2012)[2], a program which generates potential slip surfaces using a user-defined grid of circle centers and corresponding series of lines to which the failure surfaces are tangent. The minimum acceptable factor of safety (FS) for the final waste fill grades is 1.5 and the maximum acceptable seismic deformation was assumed to be 12 inches.

RESULTS

Tables 1 and 2 summarize the results of the slope stability analyses. The sections evaluated achieve the minimum required factor of safety of 1.5 and seismic deformations are within the acceptable limits.

The slope stability output files from Slope/W are provided in Attachment A. Curves to estimate seismic deformations are included in Attachment B.

[1] Spencer, E. 1967. *"A Method of Analysis of the Stability of Embankments Assuming Parallel Interslice Forces,"* Geotechnique, Vol. 17, No. 1, March, pp. 11-26.

[2] GEO-SLOPE International Limited [GEO-SLOPE]. 2012. *GeoStudio for slope stability analysis, Version 8.0.10.6504*. Calgary, Alberta, Canada.

Table 1. Slope Stability Evaluation through Liner System

Section	Slope grade H:V	FS through liner	Yield coefficient through liner ky	Estimated Liner Deformation (inches)	Model[1]	Filename	Description
20	3.5 to 1	1.5	0.09	6	2	River_Section 20_liner slip - 3.5 to 1	Slip through Module 4
21	3.8 to 1	1.5	0.09	11	1	River_Section 21_liner slip - 3.8 to 1	Slip through Module 8A
22	3.8 to 1	1.5	0.09	6	2	River_Section 22_liner slip - 3.8 to 1	Slip through Module 6
23	3.8 to 1	1.7	0.12	3	2	River_Section 23_liner slip - 3.8 to 1	Slip through Module 7

Model 1: 75' MSW over 45' clayey soil over 20' sand over bedrock - evaluated at the liner level
Model 2: 125' MSW over 20' clayey soil over 15' sand over bedrock - evaluated at the liner level

Table 2. Slope Stability Evaluation through Foundation Soils

Section	Slope grade H:V	FS through foundation	Yield coefficient through foundation ky	Estimated Foundation Deformation (inches)	Model[1]	Filename	Description
20	3.5 to 1	2.1	0.18	<1	2	River_Section 20_foundation slip - 3.5 to 1	Slip through Module 4
21	3.8 to 1	1.8	0.08	8	1	River_Section 21_foundation slip - 3.8 to 1	Slip through Module 8A
22	3.8 to 1	1.9	0.11	2	2	River_Section 22_foundation slip - 3.8 to 1	Slip through Module 6
23	3.8 to 1	2.2	0.18	<1	2	River_Section 23_foundation slip - 3.8 to 1	Slip through Module 7
24	3.5 to 1	1.9	0.11	4	1	River_Section 24_foundation slip - 3.5 to 1	Slip through Module 2

Model 1: 75' MSW over 45' clayey soil over 20' sand over bedrock - evaluated at foundation level
Model 2: 125' MSW over 20' clayey soil over 15' sand over bedrock - evaluated at foundation level

FIGURES

NOTES:

1. SITE TOPOGRAPHY BASED ON AERIAL PHOTOGRAPHY BY AERO-METRIC, INC. DATED 9 APRIL 2012.

2. MODULE AND PREVIOUSLY-CLOSED AREA BOUNDARIES COMPILED BY GEOSYNTEC BASED ON DATA PROVIDED BY RIVERBEND LANDFILL COMPANY, INC.

3. NORTHINGS, EASTINGS, AND ELEVATIONS ARE IN LOCAL COORDINATE SYSTEM AS DETERMINED BY LELAND A. MACDONAL AND ASSOCIATES, LLC, MCMINNVILLE, OREGON. TO CONVERT FROM NAVD88 TO LOCAL ELEVATIONS, SUBTRACT 2.78 FEET FROM NAVD88 ELEVATIONS.

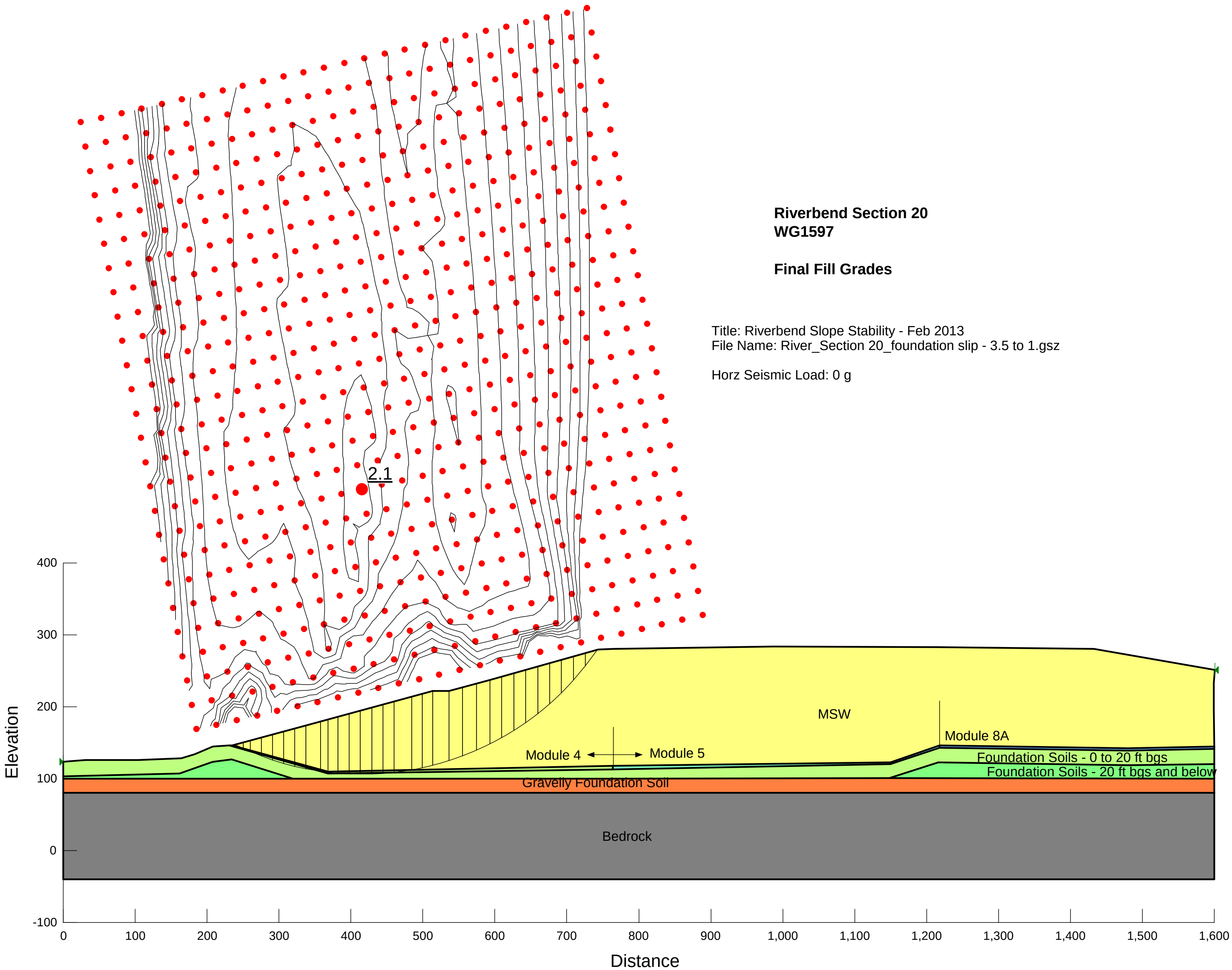
Geosyntec consultants

SLOPE STABILITY CROSS-SECTION LOCATIONS
RIVERBEND LANDFILL
YAHHILL COUNTY, OREGON

FIGURE NO.	1
PROJECT NO.	WG1597
DATE:	APRIL–2013

Attachment A

Slope Stability Output Files



Riverbend Section 20
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 20_foundation slip - 3.5 to 1.gsz

Horz Seismic Load: 0 g

Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 4 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 10 °

Name: Module 5 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 5 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

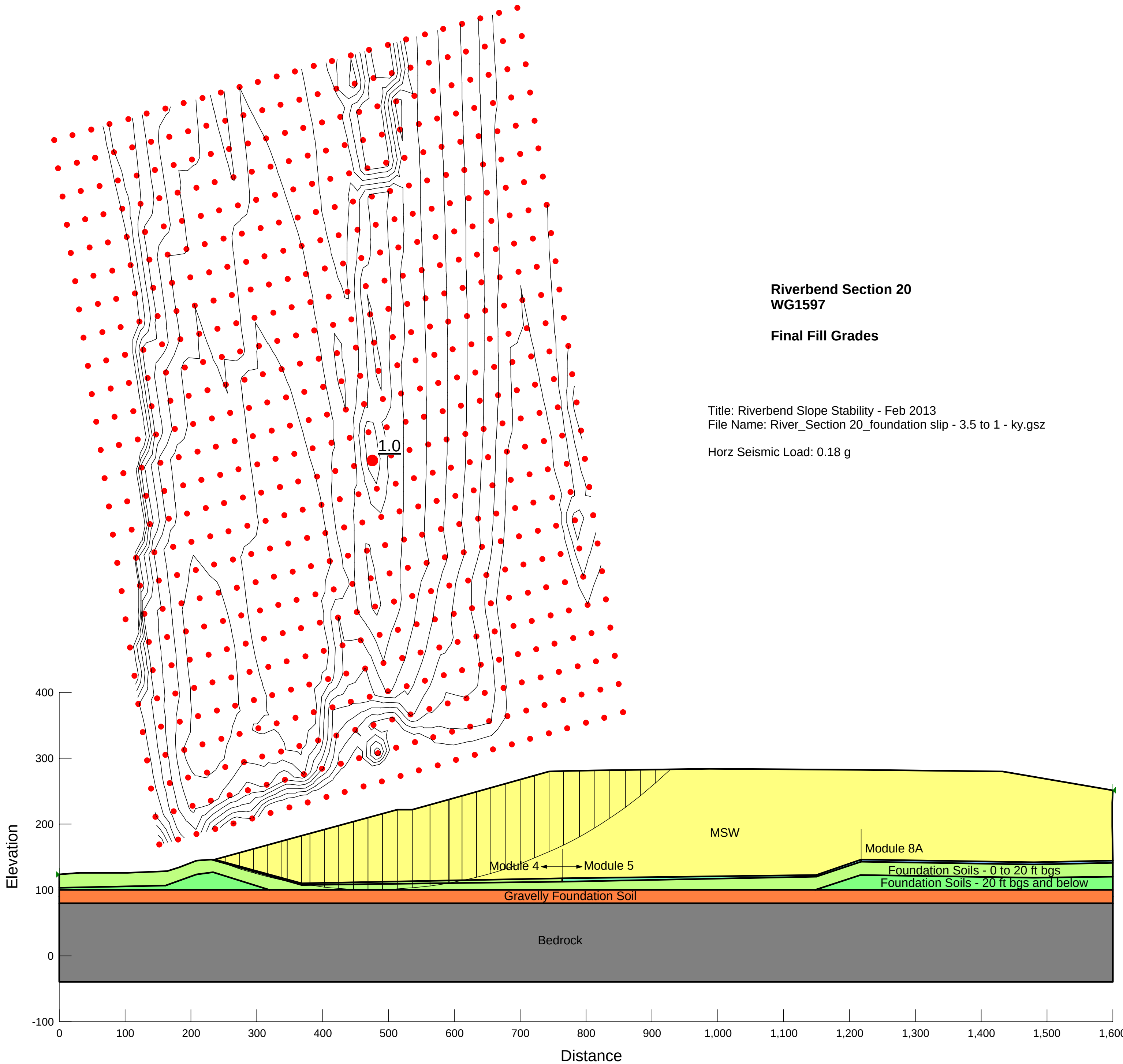
Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,000 psf
C-Rate of Change: 15 (lbs/ft²)/ft
C-Maximum: 1,300 psf

Name: Foundation Soils - 20 ft bgs and below
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,300 psf
C-Rate of Change: 20 (lbs/ft²)/ft
C-Maximum: 4,000 psf

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Gravelly Foundation Soil
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\



Riverbend Section 20
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 20_foundation slip - 3.5 to 1 - ky.gsz

Horz Seismic Load: 0.18 g

Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 4 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 10 °

Name: Module 5 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 5 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 800 psf
C-Rate of Change: 12 (lbs/ft²)/ft
C-Maximum: 1,040 psf

Name: Foundation Soils - 20 ft bgs and below
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,040 psf
C-Rate of Change: 16 (lbs/ft²)/ft
C-Maximum: 4,000 psf

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Gravelly Foundation Soil
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

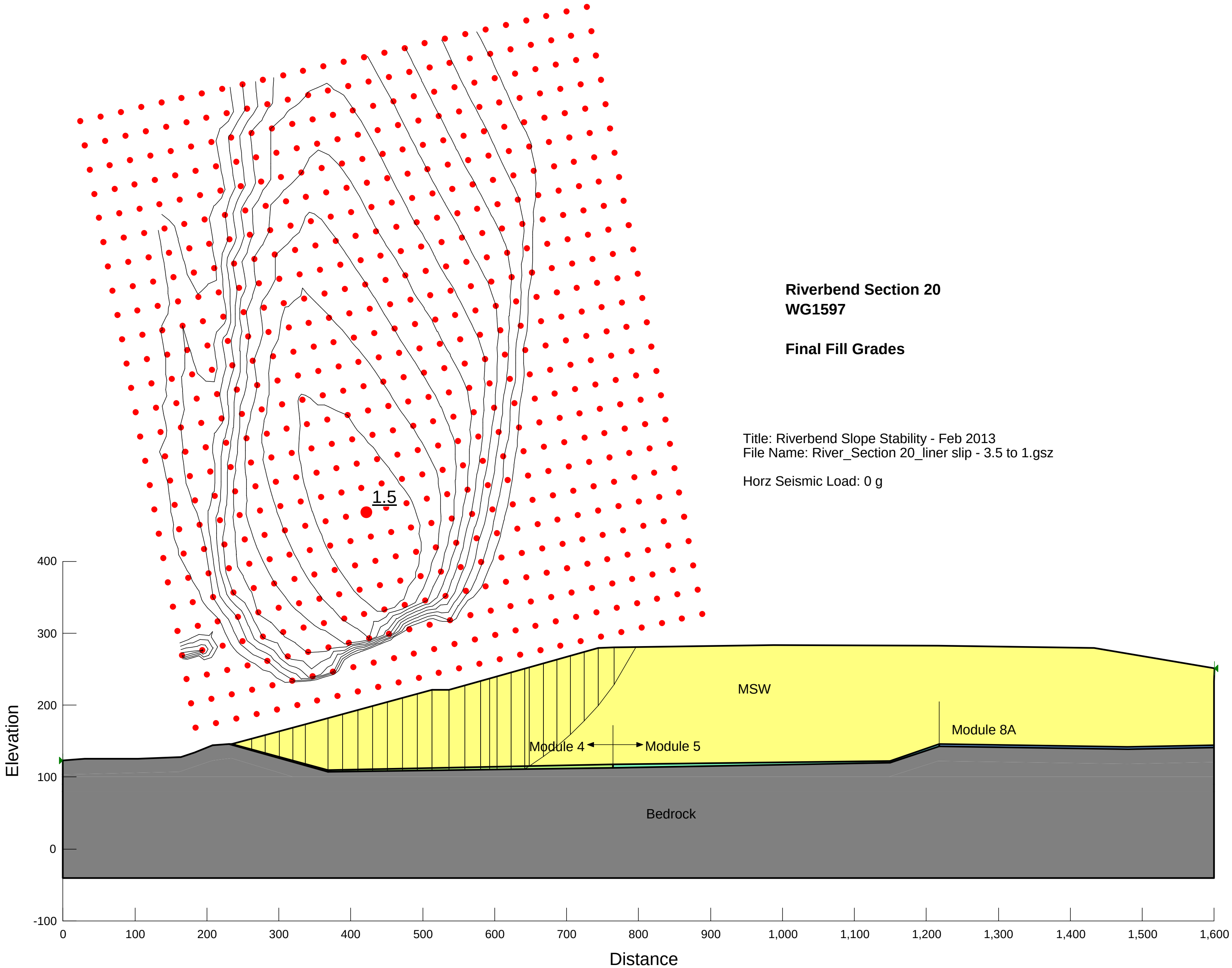
P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\

Riverbend Section 20
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 20_liner slip - 3.5 to 1.gsz

Horz Seismic Load: 0 g



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Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 4 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 10 °

Name: Module 5 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 5 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Riverbend Section 20
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 20_liner slip - 3.5 to 1_ky.gsz

Horz Seismic Load: 0.09 g

Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

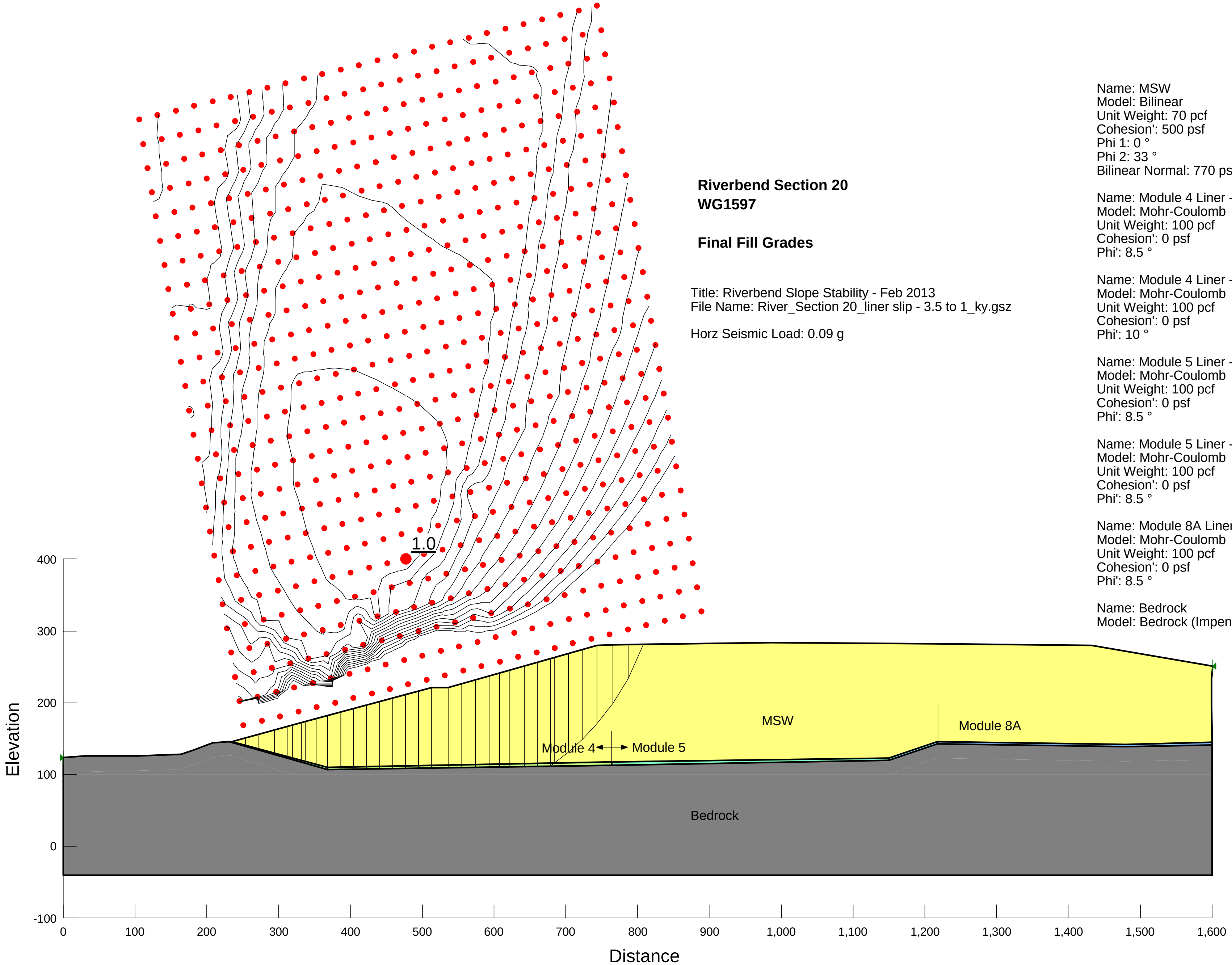
Name: Module 4 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 10 °

Name: Module 5 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 5 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Bedrock
Model: Bedrock (Impenetrable)



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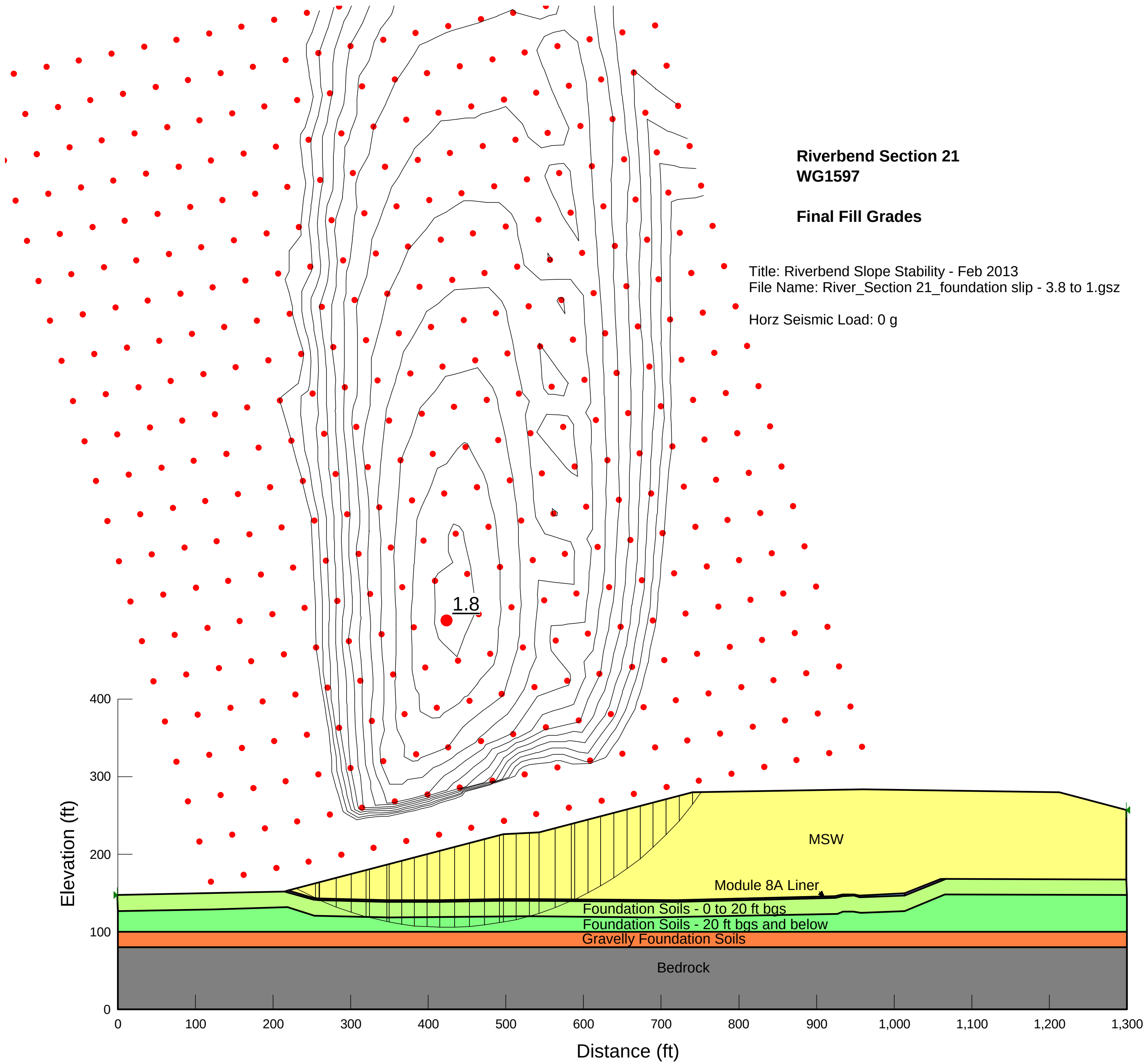
Riverbend Section 21
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 21_foundation slip - 3.8 to 1.gsz

Horz Seismic Load: 0 g



Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 8A Liner - Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf

Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,000 psf
C-Rate of Change: 15 (lbs/ft²)/ft
C-Maximum: 1,300 psf

Name: Foundation Soils - 20 ft bgs and below
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,300 psf
C-Rate of Change: 20 (lbs/ft²)/ft
C-Maximum: 4,000 psf

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Gravelly Foundation Soil
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

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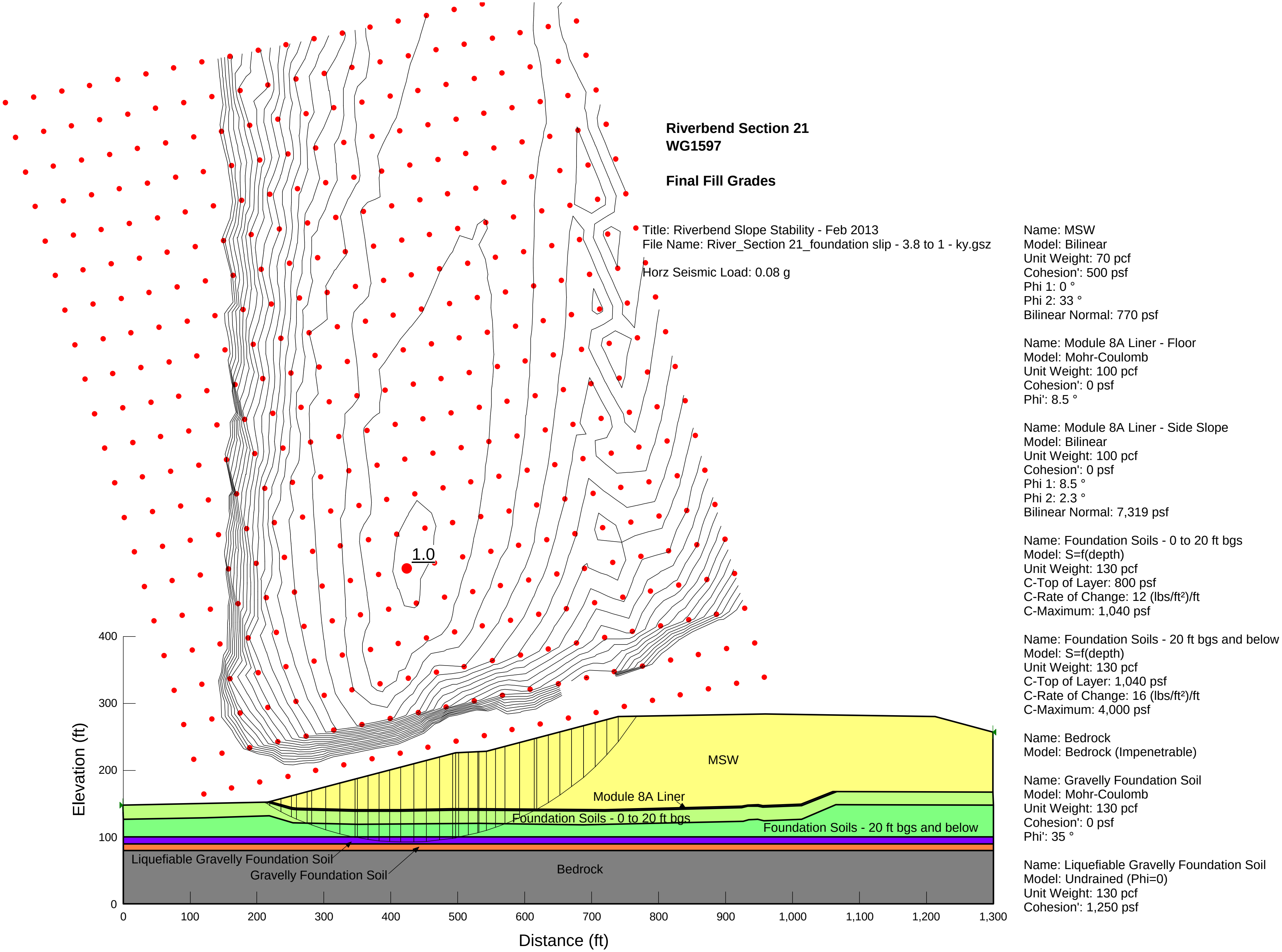

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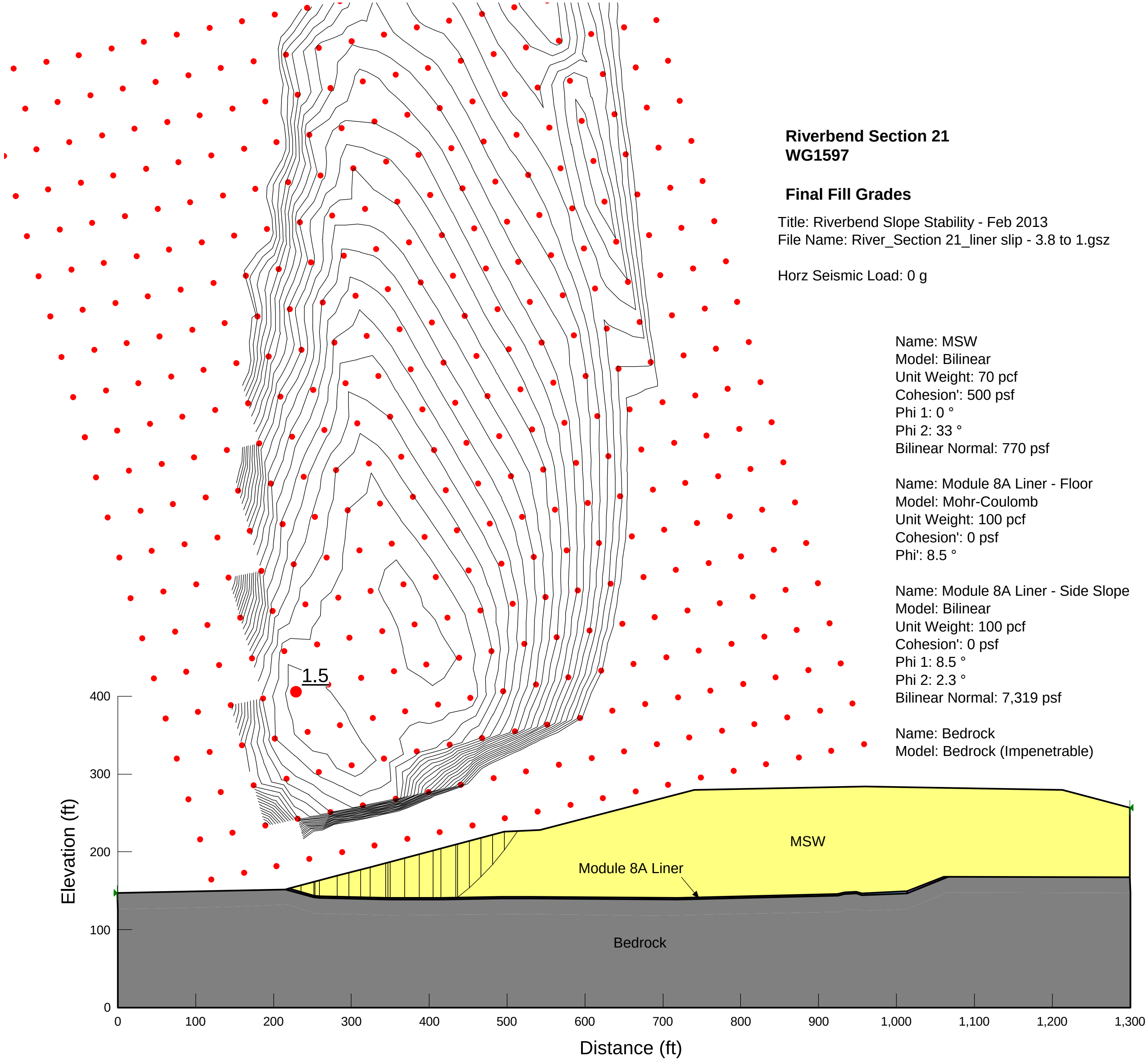

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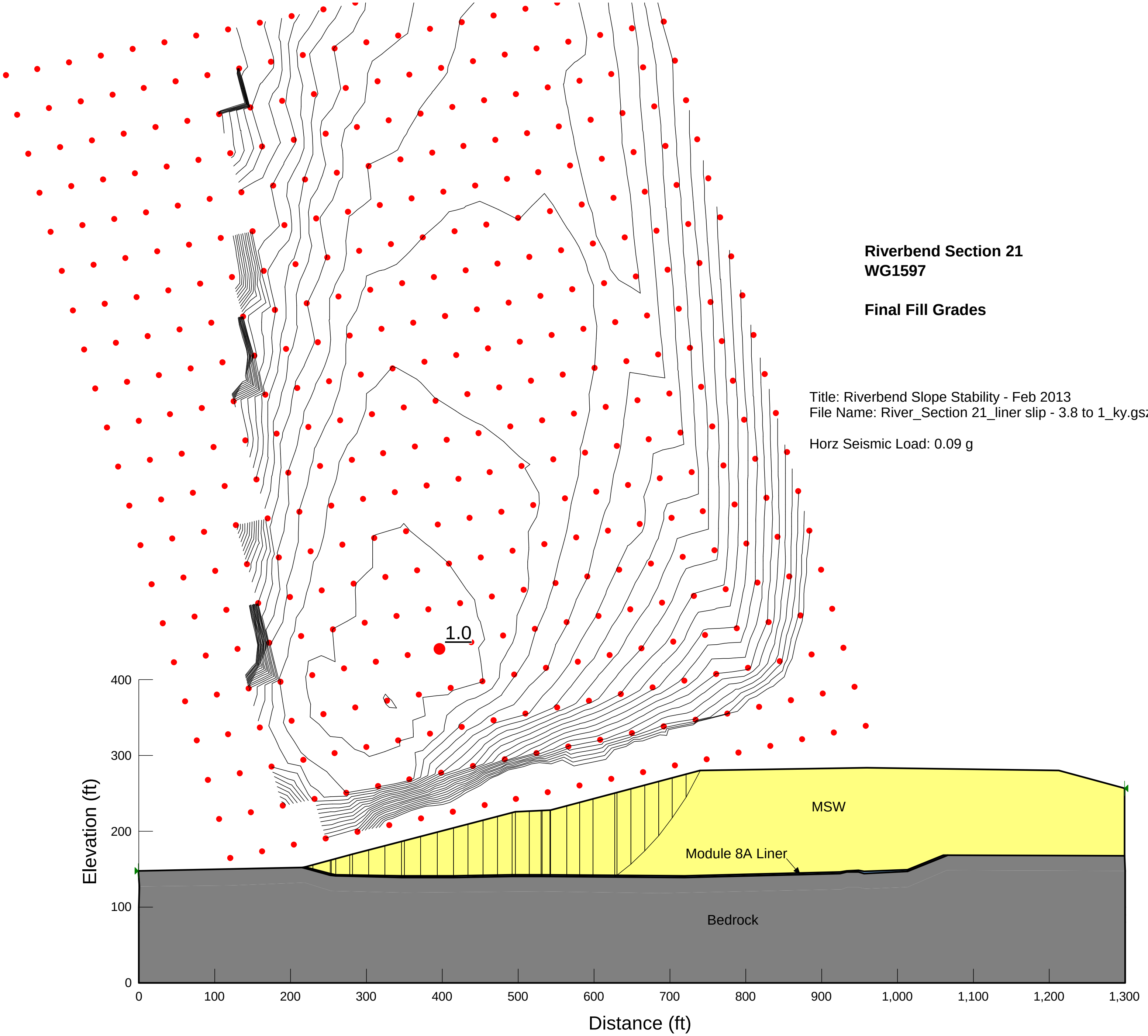


Riverbend Section 21
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 21_liner slip - 3.8 to 1_ky.gsz

Horz Seismic Load: 0.09 g

Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 8A Liner - Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf

Name: Bedrock
Model: Bedrock (Impenetrable)

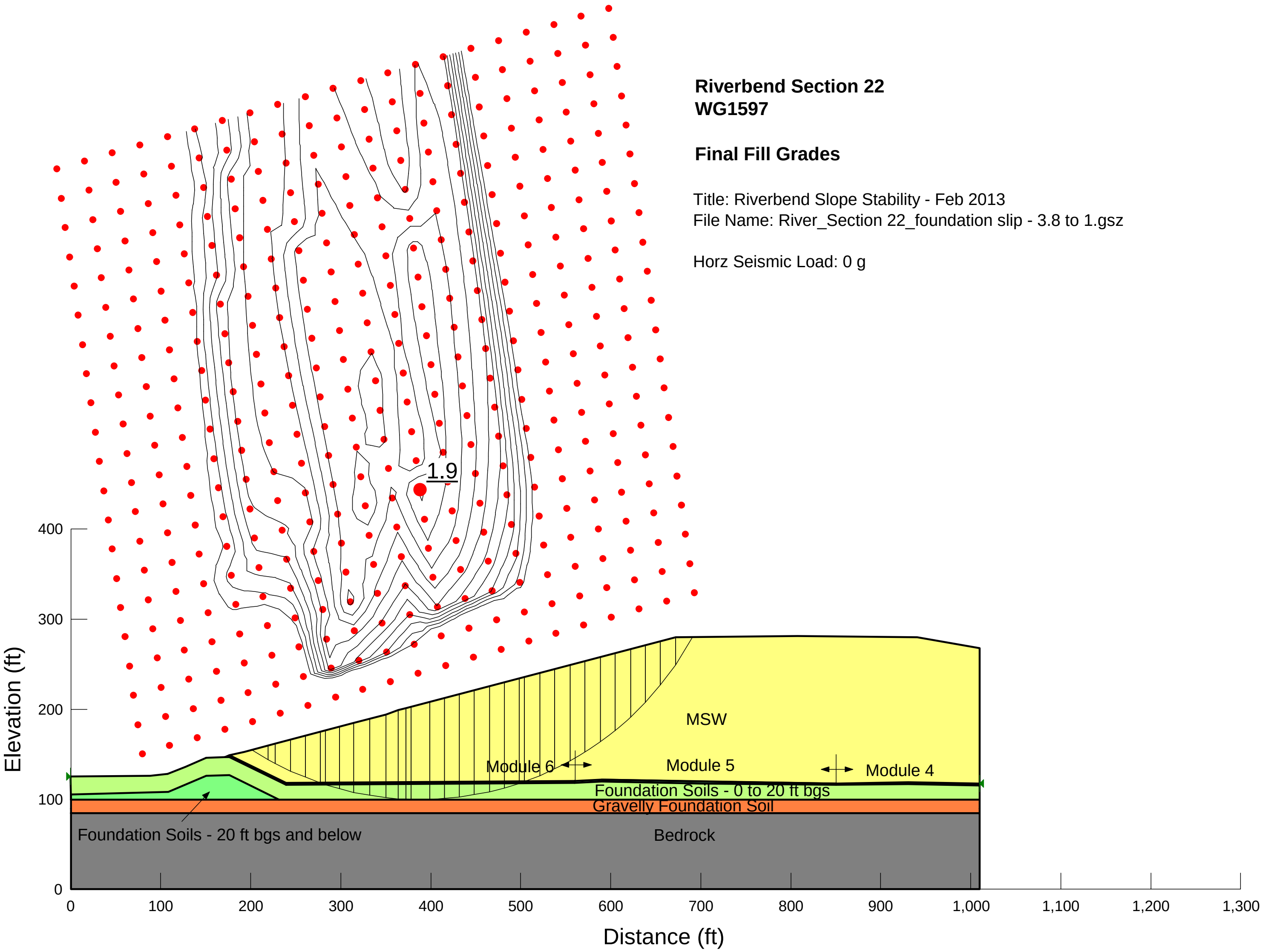
P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\

Riverbend Section 22
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 22_foundation slip - 3.8 to 1.gsz

Horz Seismic Load: 0 g



P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\

Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 5 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,000 psf
C-Rate of Change: 15 (lbs/ft²)/ft
C-Maximum: 1,300 psf

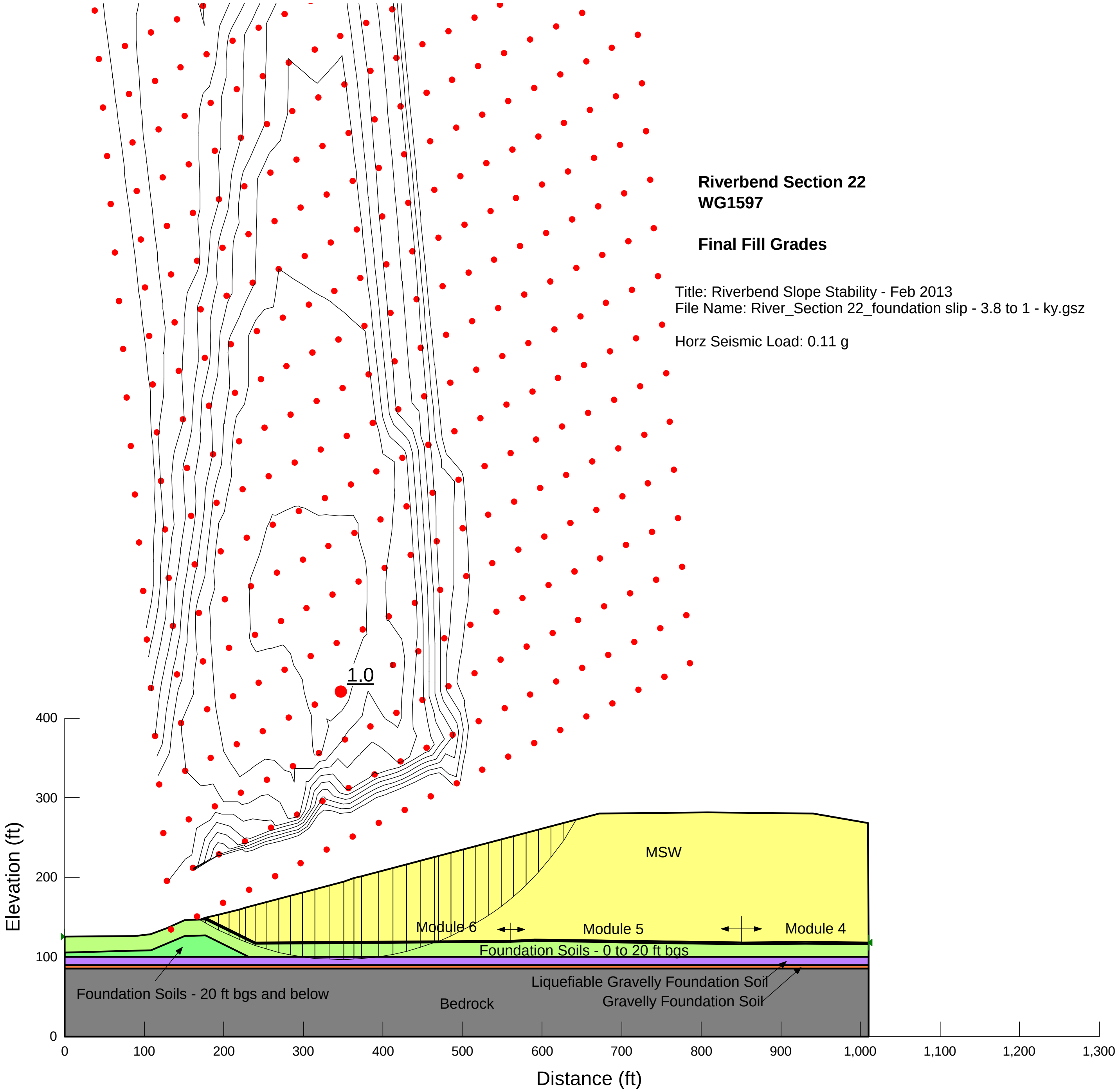
Name: Foundation Soils - 20 ft bgs and below
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,300 psf
C-Rate of Change: 20 (lbs/ft²)/ft
C-Maximum: 4,000 psf

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Gravelly Foundation Soil
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Module 6 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 6 Liner - Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf



Riverbend Section 22
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 22_foundation slip - 3.8 to 1 - ky.gsz

Horz Seismic Load: 0.11 g

P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\

Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 5 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 800 psf
C-Rate of Change: 12 (lbs/ft²)/ft
C-Maximum: 1,040 psf

Name: Foundation Soils - 20 ft bgs and below
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,040 psf
C-Rate of Change: 16 (lbs/ft²)/ft
C-Maximum: 4,000 psf

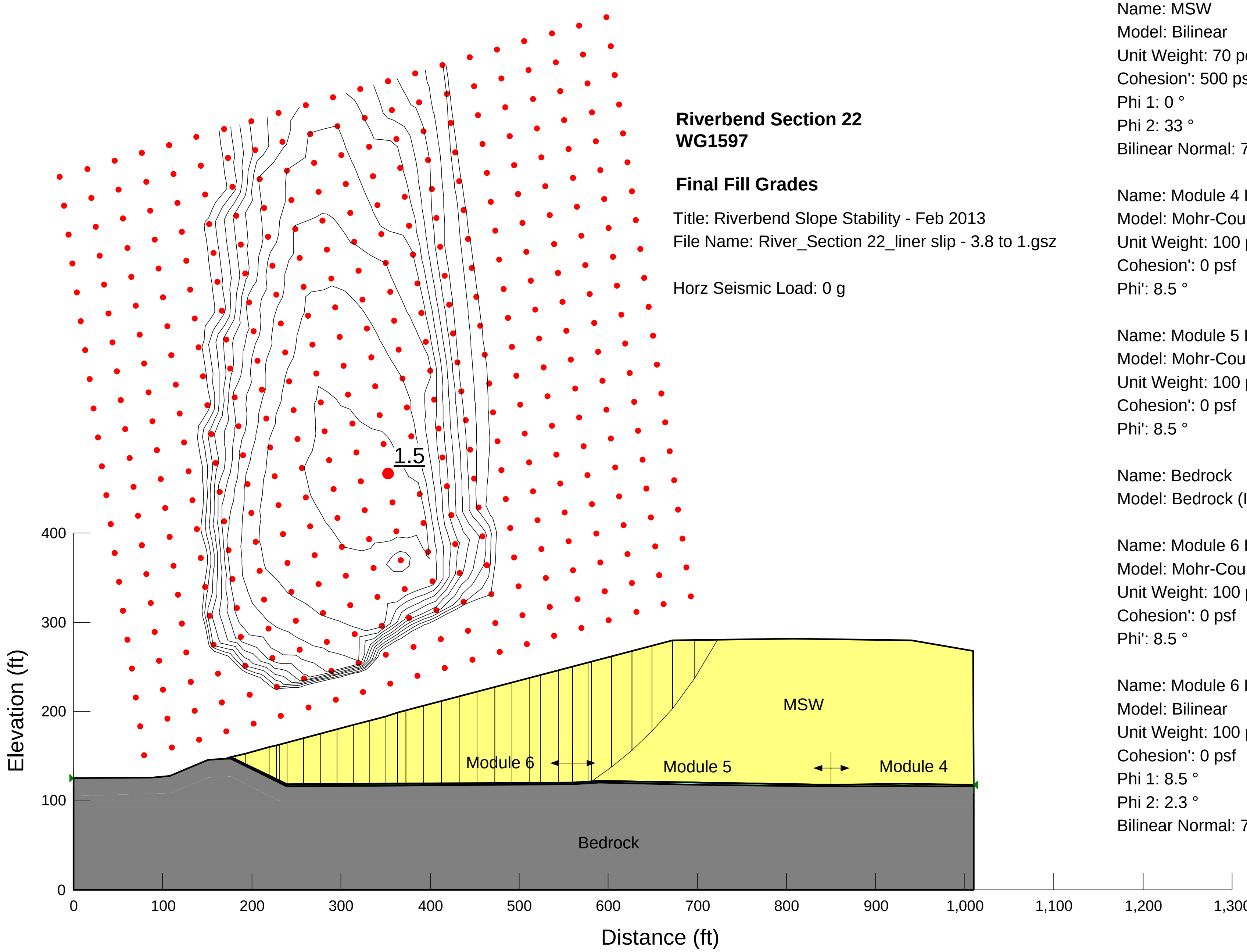
Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Gravelly Foundation Soil
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Module 6 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 6 Liner - Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf

Name: Liquefiable Gravelly Foundation Soil
Model: Undrained (Phi=0)
Unit Weight: 130 pcf
Cohesion': 1,100 psf



Riverbend Section 22
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 22_liner slip - 3.8 to 1.gsz

Horz Seismic Load: 0 g

Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

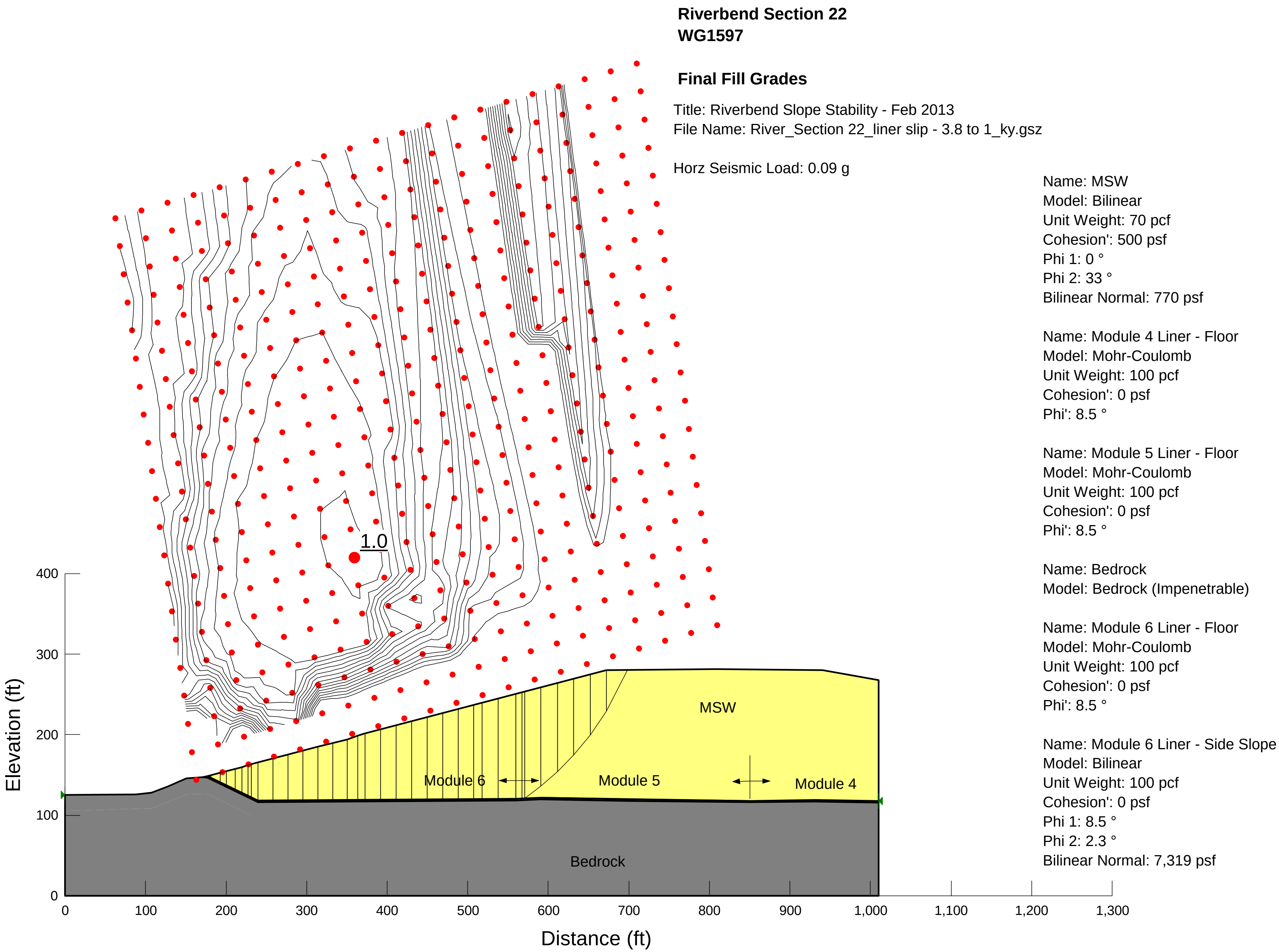
Name: Module 5 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Module 6 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 6 Liner - Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf

P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\



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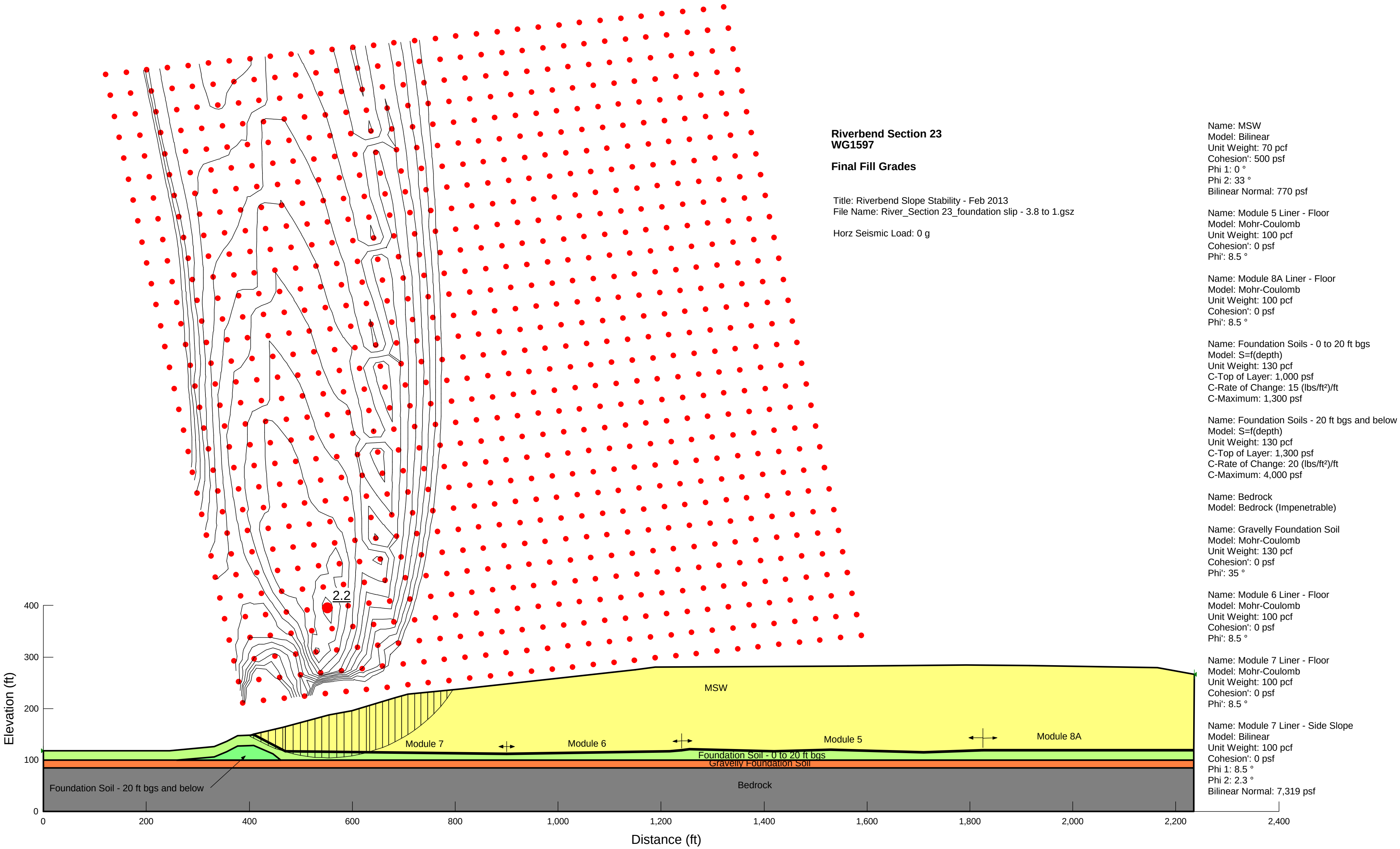

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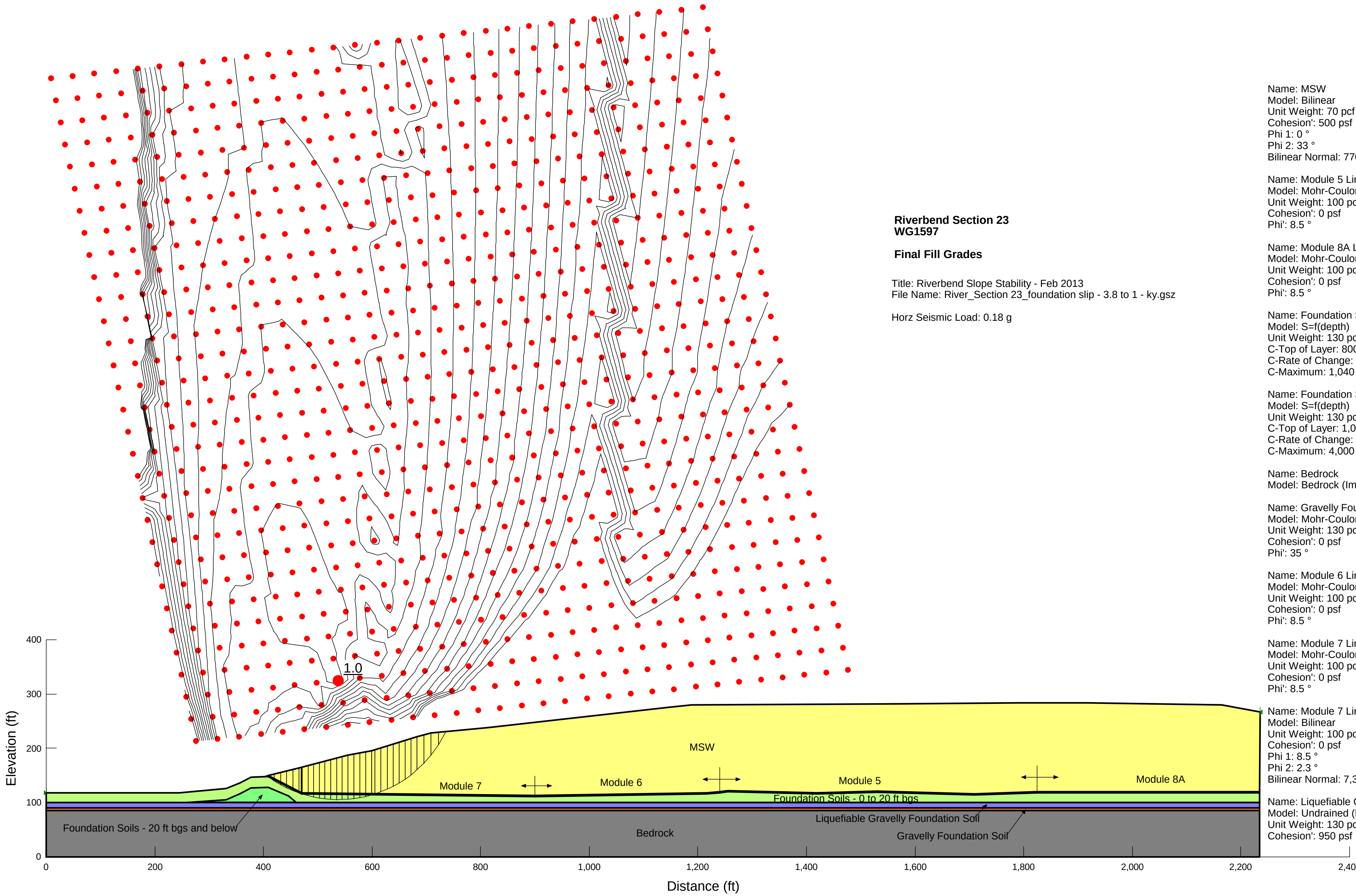


Riverbend Section 23
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 23_foundation slip - 3.8 to 1 - ky.gsz

Horz Seismic Load: 0.18 g

Name: MSW
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 5 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 800 psf
C-Rate of Change: 12 (lbs/ft²)/ft
C-Maximum: 1,040 psf

Name: Foundation Soils - 20 ft bgs and below
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,040 psf
C-Rate of Change: 16 (lbs/ft²)/ft
C-Maximum: 4,000 psf

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Gravelly Foundation Soil
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

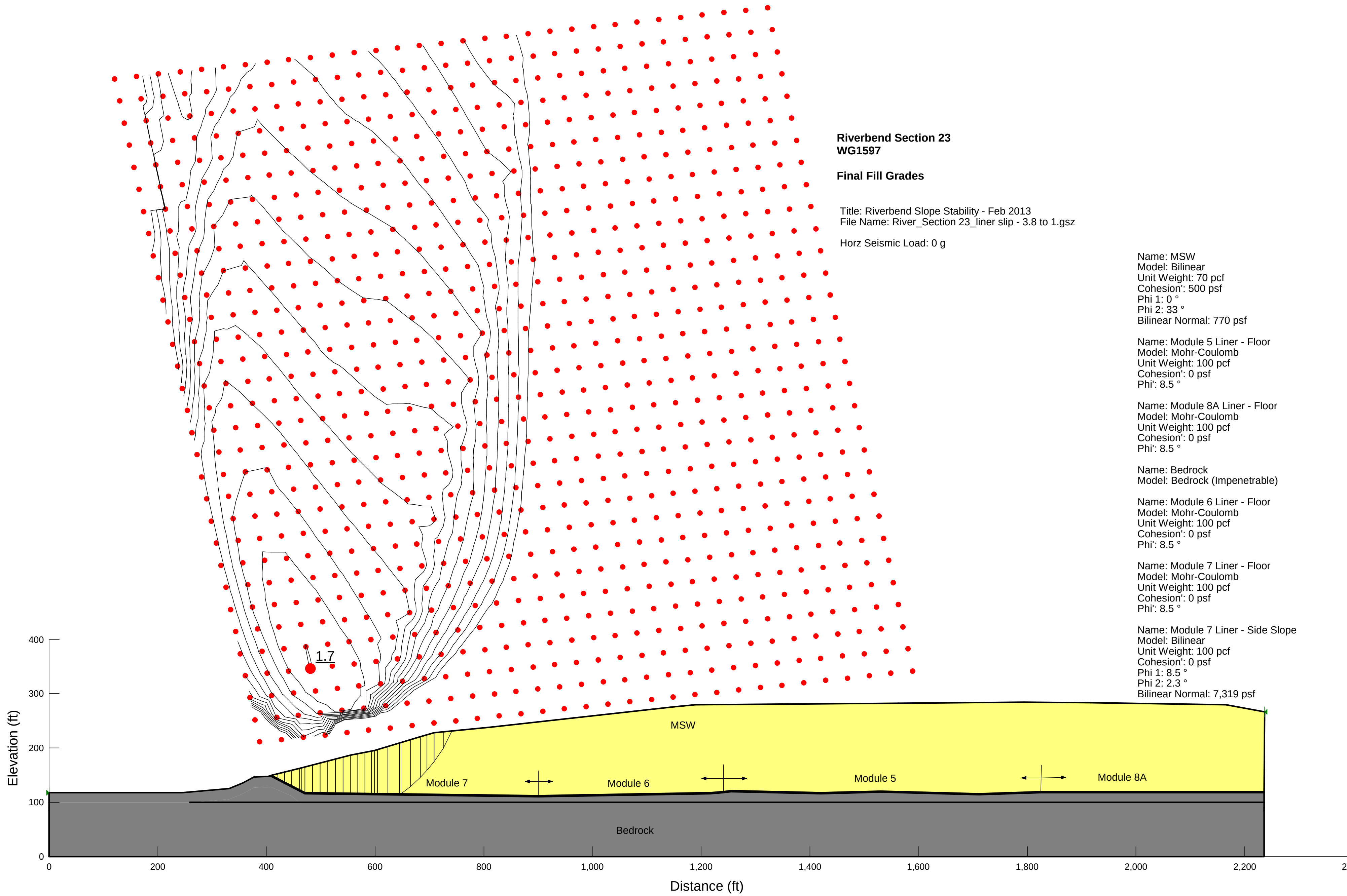
Name: Module 6 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 7 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 7 Liner - Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf

Name: Liquefiable Gravelly Foundation Soil
Model: Undrained (Phi=0)
Unit Weight: 130 pcf
Cohesion': 950 psf

P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\



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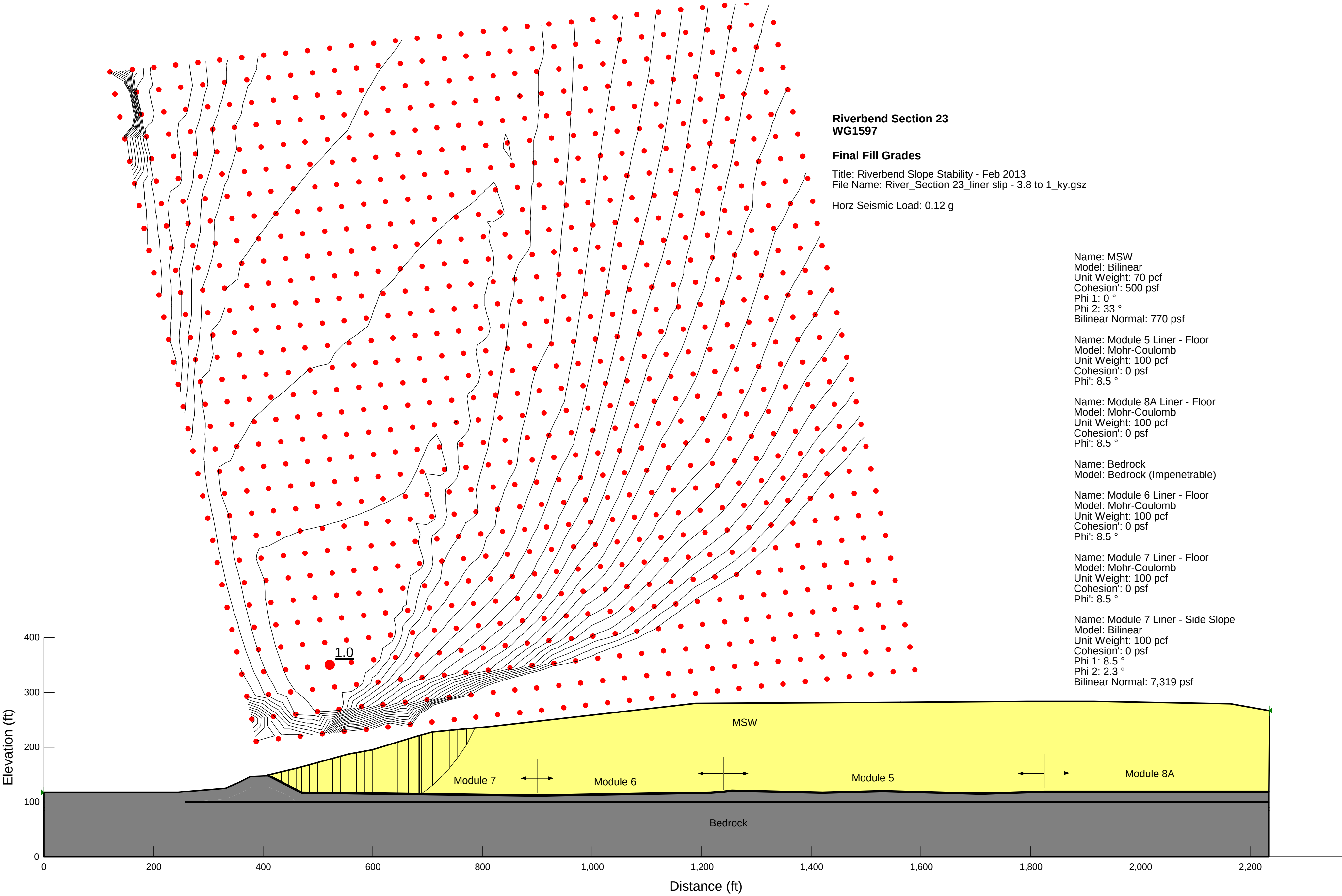


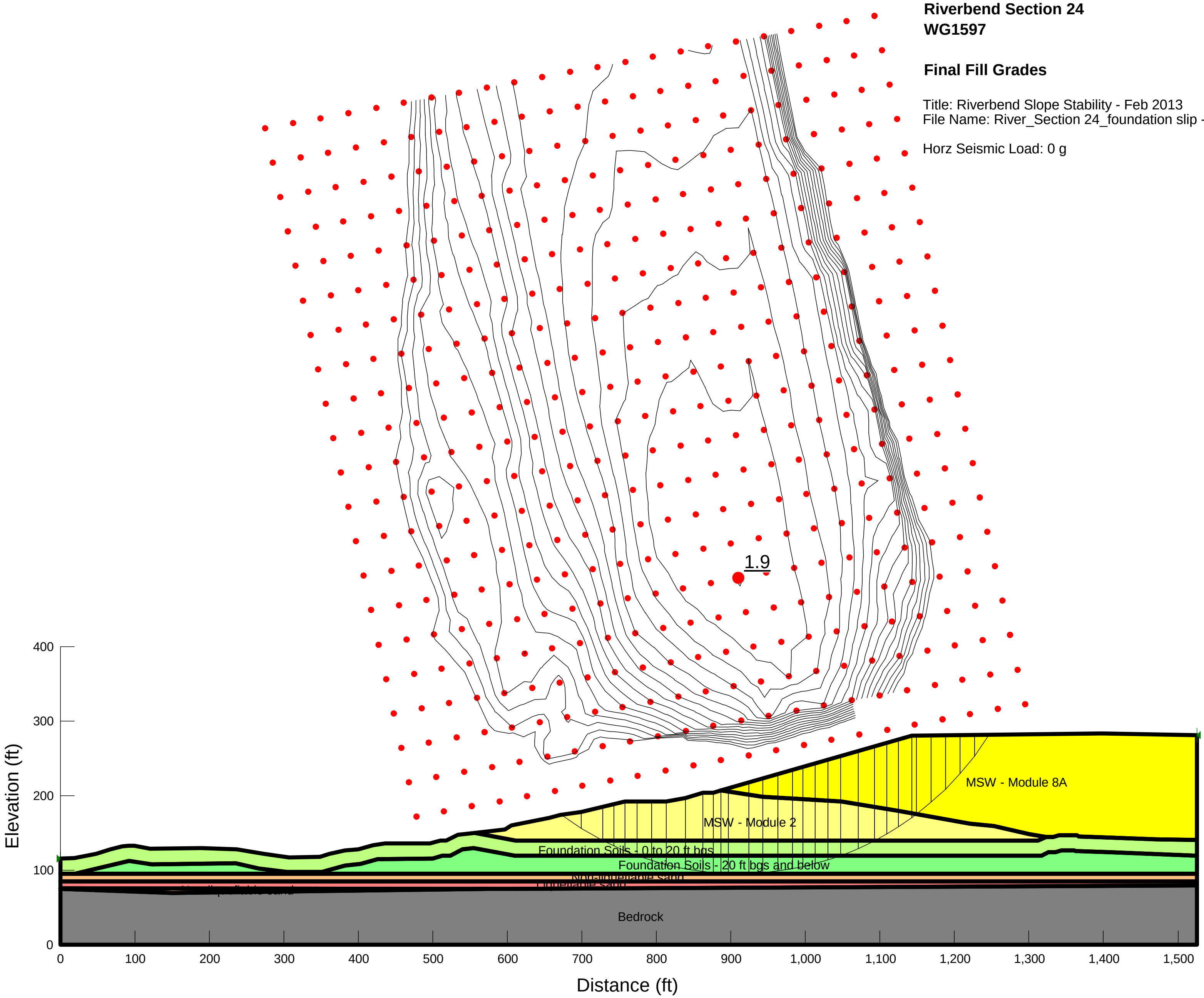
P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\

Riverbend Section 24
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 24_foundation slip - 3.5 to 1.gsz

Horz Seismic Load: 0 g



Name: MSW - Module 2
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,000 psf
C-Rate of Change: 15 (lbs/ft²)/ft
C-Maximum: 1,300 psf

Name: Foundation Soils - 20 ft bgs and below
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,300 psf
C-Rate of Change: 20 (lbs/ft²)/ft
C-Maximum: 4,000 psf

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW - Module 8A
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Non-liquefiable sand
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Liquefiable sand
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

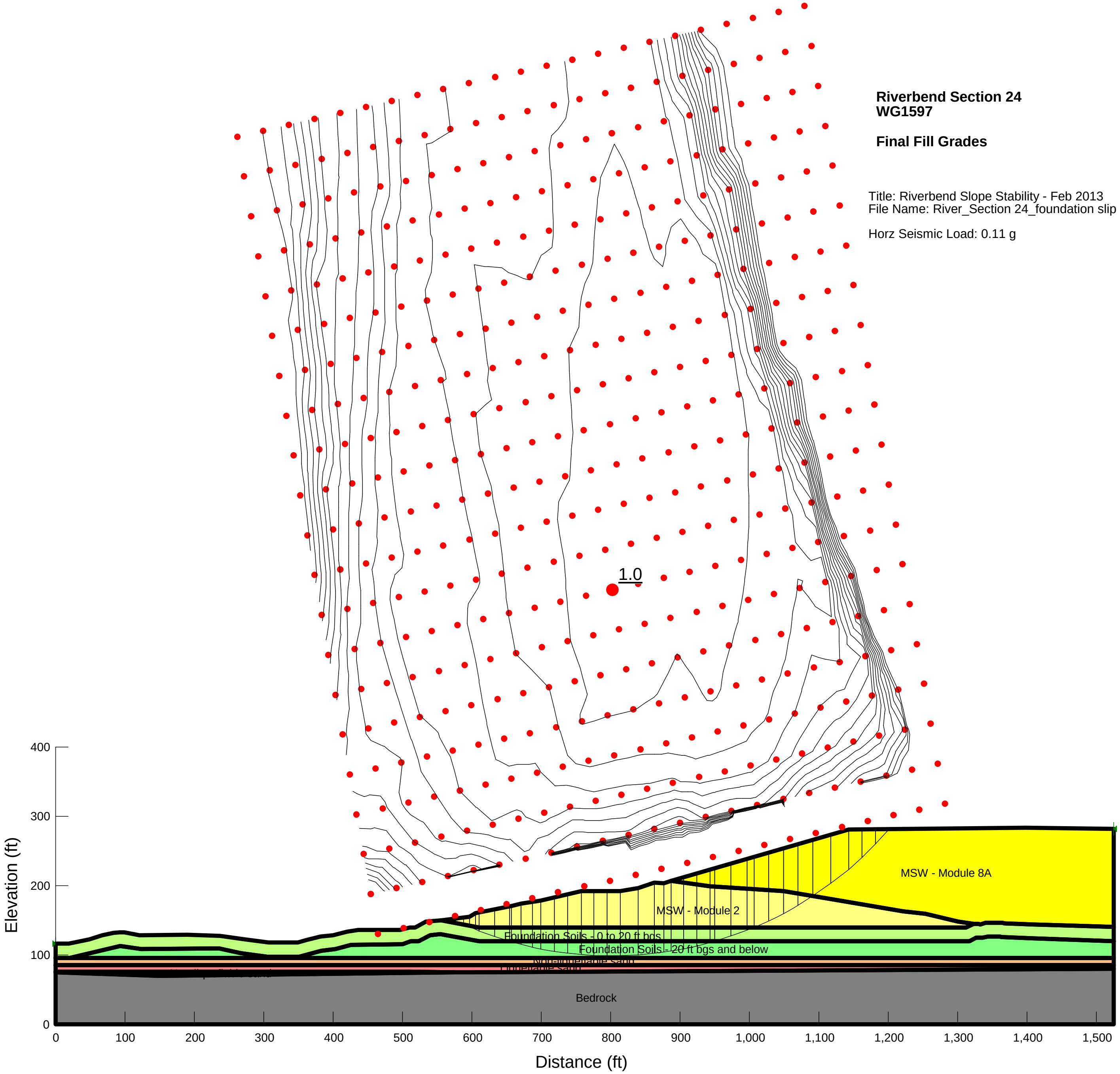
P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\

Riverbend Section 24
WG1597

Final Fill Grades

Title: Riverbend Slope Stability - Feb 2013
File Name: River_Section 24_foundation slip - 3.5 to 1_ky.gsz

Horz Seismic Load: 0.11 g



Name: MSW - Module 2
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 800 psf
C-Rate of Change: 12 (lbs/ft²)/ft
C-Maximum: 1,040 psf

Name: Foundation Soils - 20 ft bgs and below
Model: S=f(depth)
Unit Weight: 130 pcf
C-Top of Layer: 1,040 psf
C-Rate of Change: 16 (lbs/ft²)/ft
C-Maximum: 3,200 psf

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW - Module 8A
Model: Bilinear
Unit Weight: 70 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

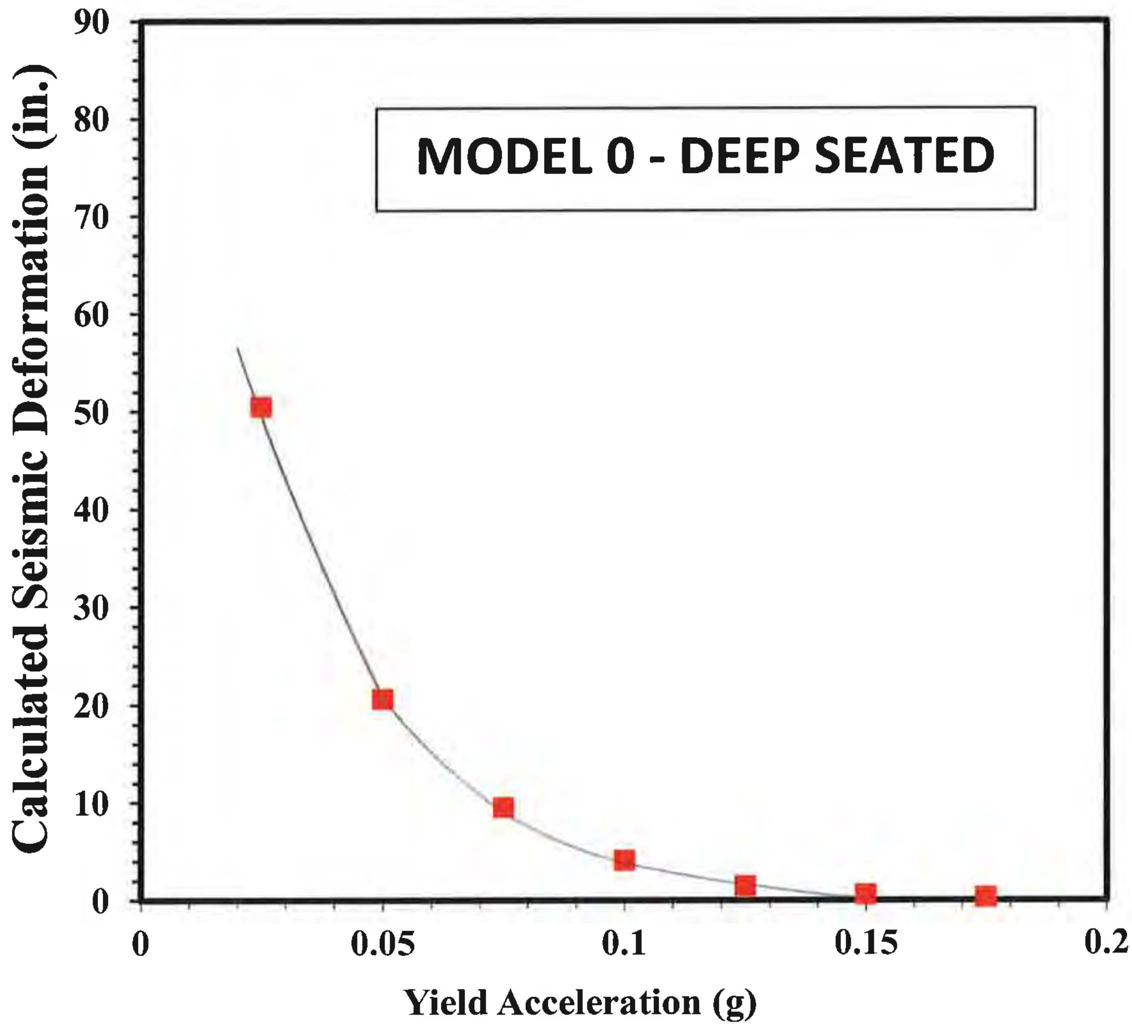
Name: Non-liquefiable sand
Model: Mohr-Coulomb
Unit Weight: 130 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Liquefiable sand
Model: Undrained (Phi=0)
Unit Weight: 130 pcf
Cohesion': 1,450 psf

P:\PRJ2003Geo\WMI\Riverbend\1597 (former 1555) (MSE Berm Construction Documents)\Slope Stability\East Side\SlopeW files\

Attachment B

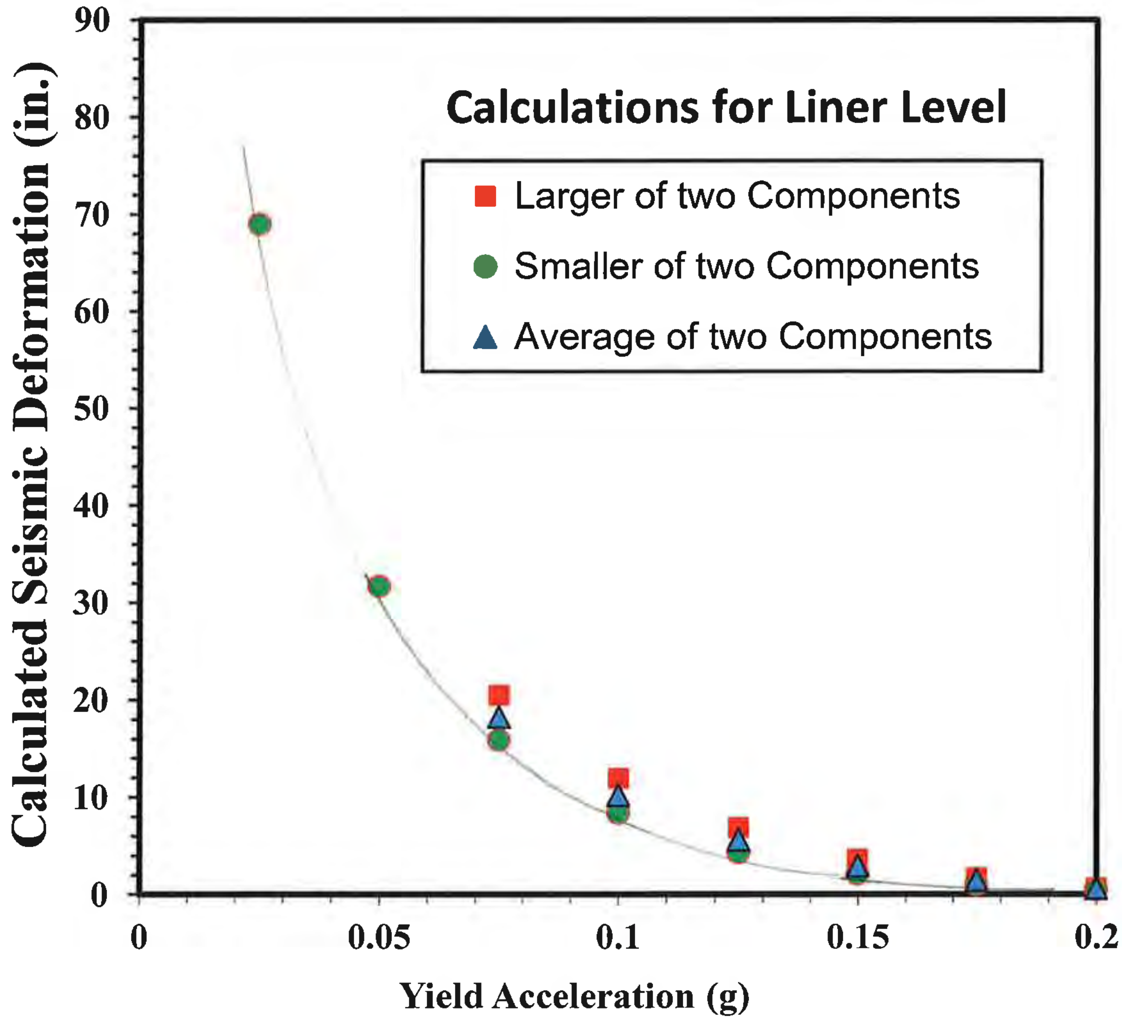
Curves to Estimate Seismic Deformations



Geosyntec consultants

SEISMIC DEFORMATION CHART: MODEL 0, FOUNDATION LEVEL
RIVERBEND LANDFILL
YAMHILL COUNTY, OREGON

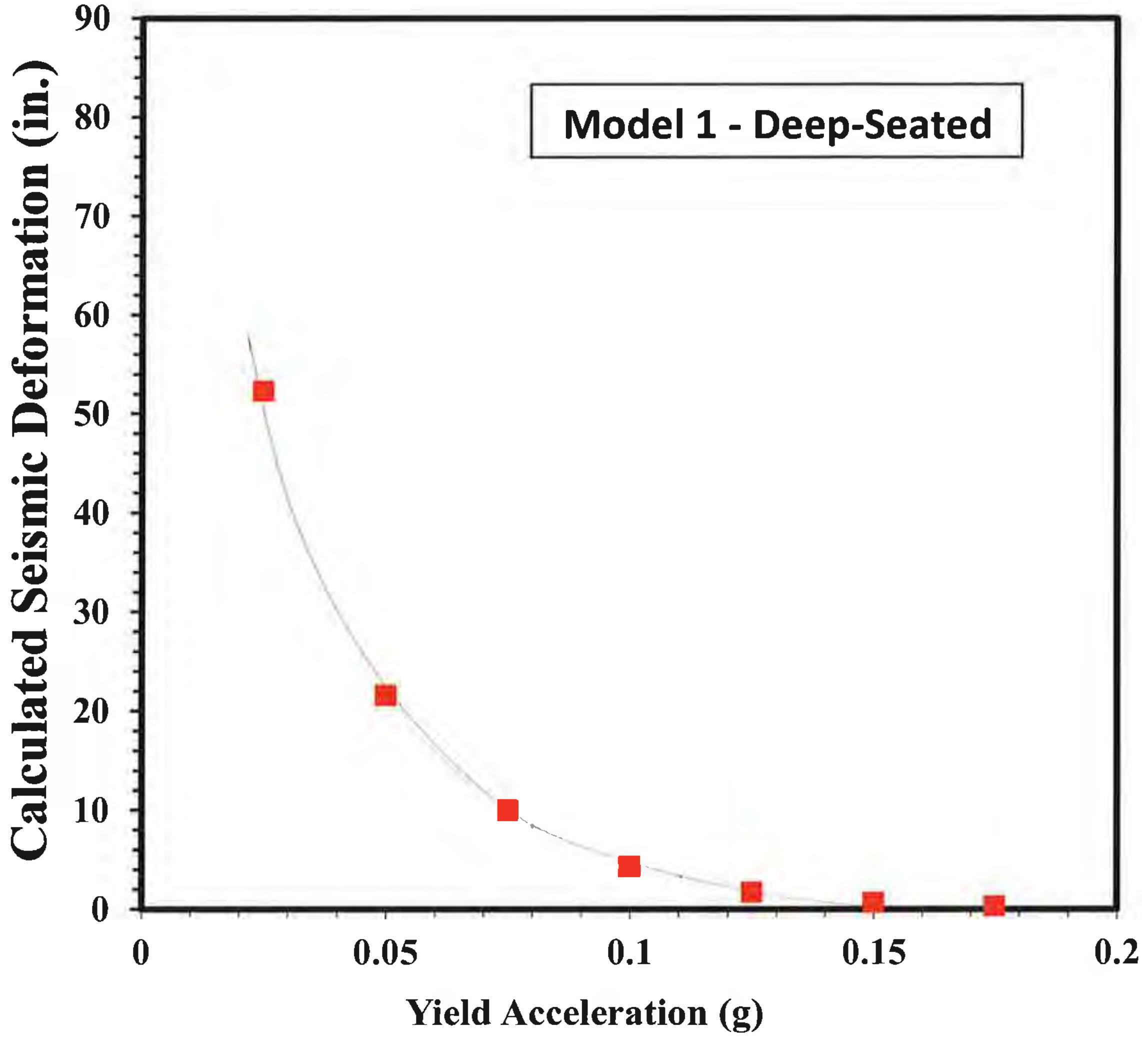
DATE:	APRIL 2013	FILE NO.	
PROJECT	WG1597	FIGURE	2



Geosyntec consultants

SEISMIC DEFORMATION CHART: MODEL 0, LINER LEVEL
RIVERBEND LANDFILL
YAMHILL COUNTY, OREGON

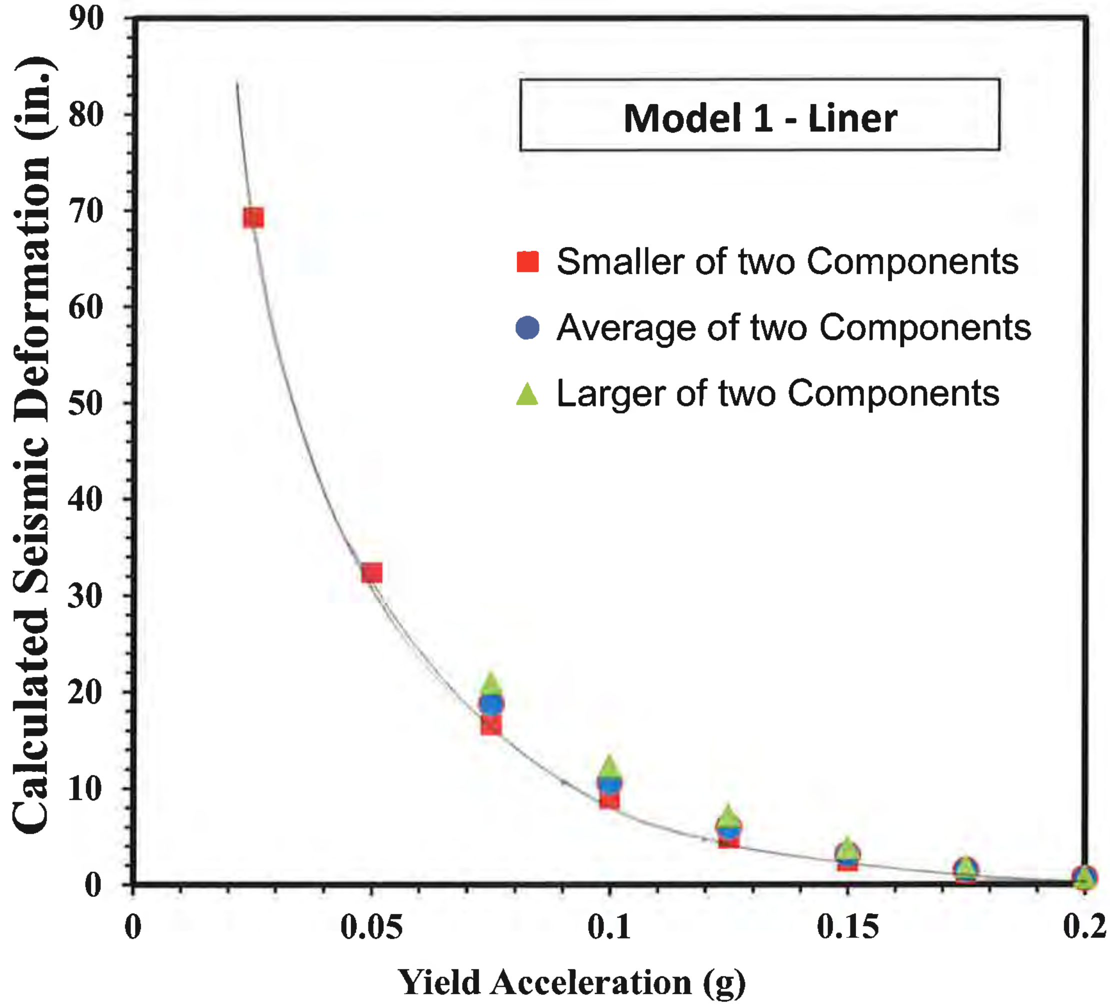
DATE:	APRIL 2013	FILE NO.	
PROJECT	WG1597	FIGURE	3



Geosyntec consultants

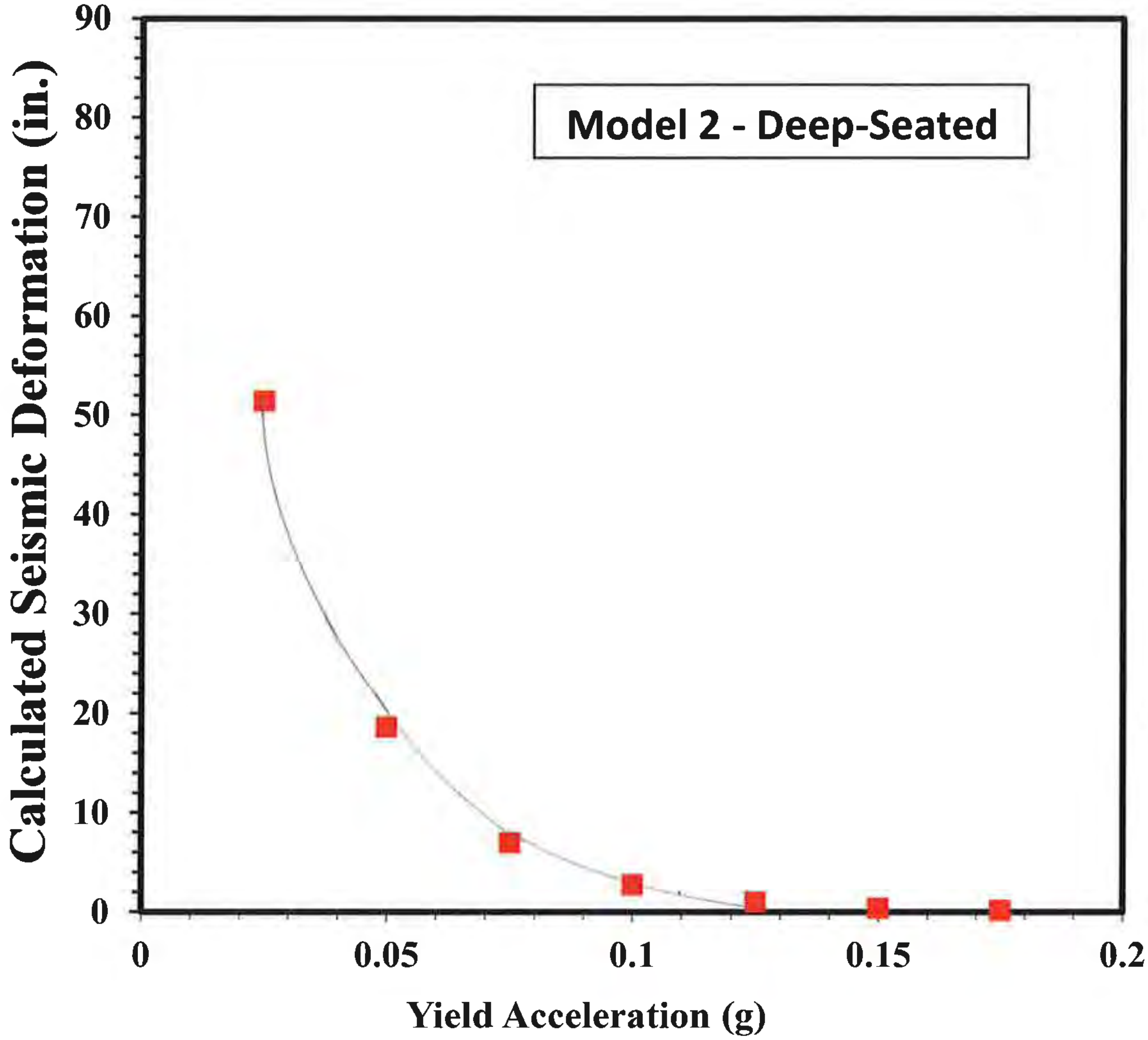
SEISMIC DEFORMATION CHART: MODEL 1, FOUNDATION LEVEL
RIVERBEND LANDFILL
YAMHILL COUNTY, OREGON

DATE:	APRIL 2013	FILE NO.	
PROJECT	WG1597	FIGURE	5



Geosyntec consultants

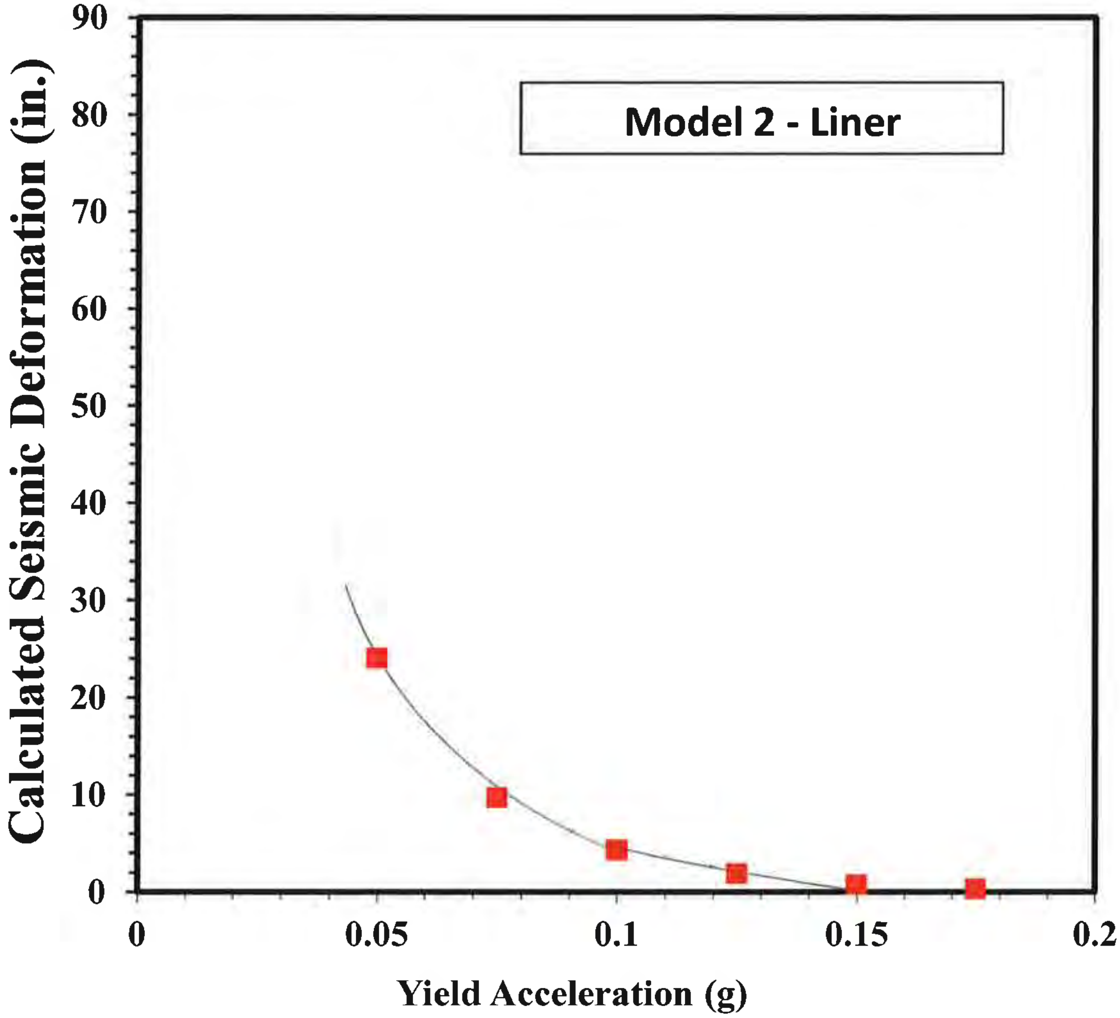
SEISMIC DEFORMATION CHART: MODEL 1, LINER LEVEL RIVERBEND LANDFILL YAMHILL COUNTY, OREGON			
DATE:	APRIL 2013	FILE NO.	
PROJECT	WG1597	FIGURE	6



Geosyntec consultants

SEISMIC DEFORMATION CHART: MODEL 2, FOUNDATION LEVEL
RIVERBEND LANDFILL
YAMHILL COUNTY, OREGON

DATE:	APRIL 2013	FILE NO.	
PROJECT	WG1597	FIGURE	8



Geosyntec consultants

SEISMIC DEFORMATION CHART: MODEL 2, LINER LEVEL
RIVERBEND LANDFILL
YAMHILL COUNTY, OREGON

DATE:	APRIL 2013	FILE NO.	
PROJECT	WG1597	FIGURE	9

APPENDIX D-2

2016 FGPM Landfill Mass Slope Stability Evaluation

The slope stability analyses work in this Appendix was performed by David Umberg and Fabrizio Settepani under the supervision of Hari Sharma, P.E.

THE INFORMATION THAT FOLLOWS INCLUDES APPENDICES PRESENTED IN THE REPORT ENTITLED *FINAL GRADING PLAN MODIFICATION PERMIT APPLICATION REPORT, RIVERBEND LANDFILL, MCMINNVILLE, OREGON* DATED 14 NOVEMBER 2016 PREPARED BY GEOSYNTEC CONSULTANTS FOR DYNAMIC RESPONSE ANALYSES AND SLOPE STABILITY ANALYSES FOR THE FGPM AREA.

APPENDIX D

Dynamic Response Analyses

APPENDIX D.1

June 29, 2015

Geosyntec Consultants, Inc.
1111 Broadway, 6th Floor
Oakland, CA 94607

Attention: Dr. Hari D. Sharma, P.E.

SITE RESPONSE ANALYSIS FOR LEVEL GROUND: MODULE 11 – JUNE 2015
RIVERBEND LANDFILL
MCMINNVILLE, OREGON

Dear Dr. Sharma:

As requested, Geo-Logic Associates, Inc. (GLA) has performed seismic response analysis for level ground for the Module 11 area at the Riverbend Landfill (Landfill), located in McMinnville, Oregon. The analysis was performed using the updated results of the seismic hazard analysis for the Landfill that is documented in GLA [2015].

To perform the seismic response analysis GLA used the computer program DMOD-2000 (www.GeoMotions.com). D-MOD2000 is one-dimensional (1-D) nonlinear effective-stress computer program for calculation of seismic response of natural and man-made soil deposits, earthfill/rockfill dams and solid waste landfills. The program is based upon lumped-mass dynamic response model and set of constitutive models. Required input includes dynamic excitation (accelerogram or program-generated sinusoidal motion), unit weight and shear wave velocity profiles, and parameters of constitutive models (generic model parameters are available for many soils, including sands subject to various confining stresses, and clays of various plasticities). The program output includes time histories (and tabulated peak values) of acceleration, average acceleration (seismic coefficient), velocity, displacement, and porewater pressure.

SUBSURFACE PROFILES

Geosyntec provided the following two subsurface profiles to GLA to perform the response analysis for level ground (free-field site conditions):

- Column 1: 30 ft of silts and clays over 30 ft of sands and gravels.

- Column 2: 25 ft of silts and clays over 45 ft of sands and gravels.

The assumed total unit weight for the silts and clays was 115 pounds per cubic foot (pcf). The assumed total unit weight of the sands and gravels was 125 pcf.

The dynamic properties (i.e., shear modulus reduction and damping) for the materials are based on the generic curves developed by Vucetic and Dobry (1991). Vucetic and Dobry relate the dynamic properties to plasticity index (PI). For the Module 11 area, Geosyntec developed the profile of PI with depth shown in Figure 1 that served as a basis for selection of modulus reduction and damping curves.

The shear wave velocities for the soils were based on geophysical investigations conducted by Zonge in 2012 and 2013 using multichannel analysis of surface waves (MASW) techniques and seismic cone penetration tests (CPTs) conducted by Oregon Geotechnical Explorations of Keizer, Oregon in 2015 for Geosyntec. For the Module 11 area, Geosyntec provided the profile for shear wave velocities with depth shown in Figure 2. The shear wave velocity of weathered bedrock was assumed to be 1,800 feet per second (ft/sec) based on Zonge in 2012 and 2013.

ACCELERATION TIME HISTORIES

GLA used five time histories (accelerograms Set 1 – Set 5, see Table 1) to characterize **M** 9 event in time domain. These accelerograms were provided to Geosyntec by Dr. Abrahamson for the Riverbend Landfill in 2013 and were used in the previous studies at the site. For this study, these accelerograms were scaled to 0.44 g for use in site response analysis. The 0.44 g value was based on the 2014 United States Geological Survey (USGS) seismic hazard maps and work performed by GLA [2015].

ESTIMATED ACCELERATIONS FOR LEVEL GROUND

GLA performed nonlinear total-stress analysis of two representative columns (Columns 1 and 2). The results are presented for each accelerogram considered in a form of free-field (ground surface) peak ground acceleration (PGA) and are tabulated in Table 1 below.

Table 1 – Results of Nonlinear Total-Stress Site Response Analysis (Free-Field Conditions; Bedrock Motion Scaled to 0.44 g, applied as outcrop motion)

Accelerogram	PGA top of 60-ft Column 1	PGA top of 70-ft Column 2
Set 1.sar @ 0.44 g	0.295 g	0.281 g
Set 2.sar @ 0.44 g	0.339 g	0.312 g
Set 3.sar @ 0.44 g	0.346 g	0.443 g
Set 4.sar @ 0.44 g	0.381 g	0.353 g
Set 5.sar @ 0.44 g	0.443 g	0.416 g

Geo-Logic ASSOCIATES

CLOSURE

As can be observed in Table 1, depending on the time history (accelerograms 1 through 5) and the profile assumed (Columns 1 and 2), the estimated peak horizontal ground acceleration ranges between 0.28 g and 0.44 g. For both profiles, the average peak ground acceleration is 0.36 g. The D-MOD2000 output files which also include input parameters are included in Attachment A.

Should you have any questions or require additional explanation, please do not hesitate to contact me.

Sincerely,

Neven Matasovic, Ph.D., P.E., G.E. (California and Alaska)
Principal
nmatasovic@geo-logic.com / 714-465-8240

ATTACHMENTS

Attachment A – D-MOD2000 Output Files (Input Reproduced in Output)

REFERENCES

Abrahamson, N. (2013). "Deterministic Analysis and Time Histories for Riverbend Landfill," Letter Report, February 13.

Geo-Logic Associates (2015). "Letter: Seismic Hazard Analysis – June 2015, Riverbend Landfill, McMinnville, Oregon," prepared for Geosyntec Consultants, Inc., June 28, 2015.

Vucetic, M. and Dobry, R. (1991), "Effect of Soil Plasticity on Cyclic Response." *Journal of the Geotechnical Engineering*, ASCE, Vol. 117, No. 1, 89-107.

Zonge International, Inc. (2012). "Final Geophysical Investigation Report - Riverbend Landfill, McMinnville, Oregon," Project 12173, September 21.

Zonge International, Inc. (2013). "Final Report, MASW Survey, Riverbend Landfill, Yamhill County, Oregon," Project 13138, November 6, 2013.

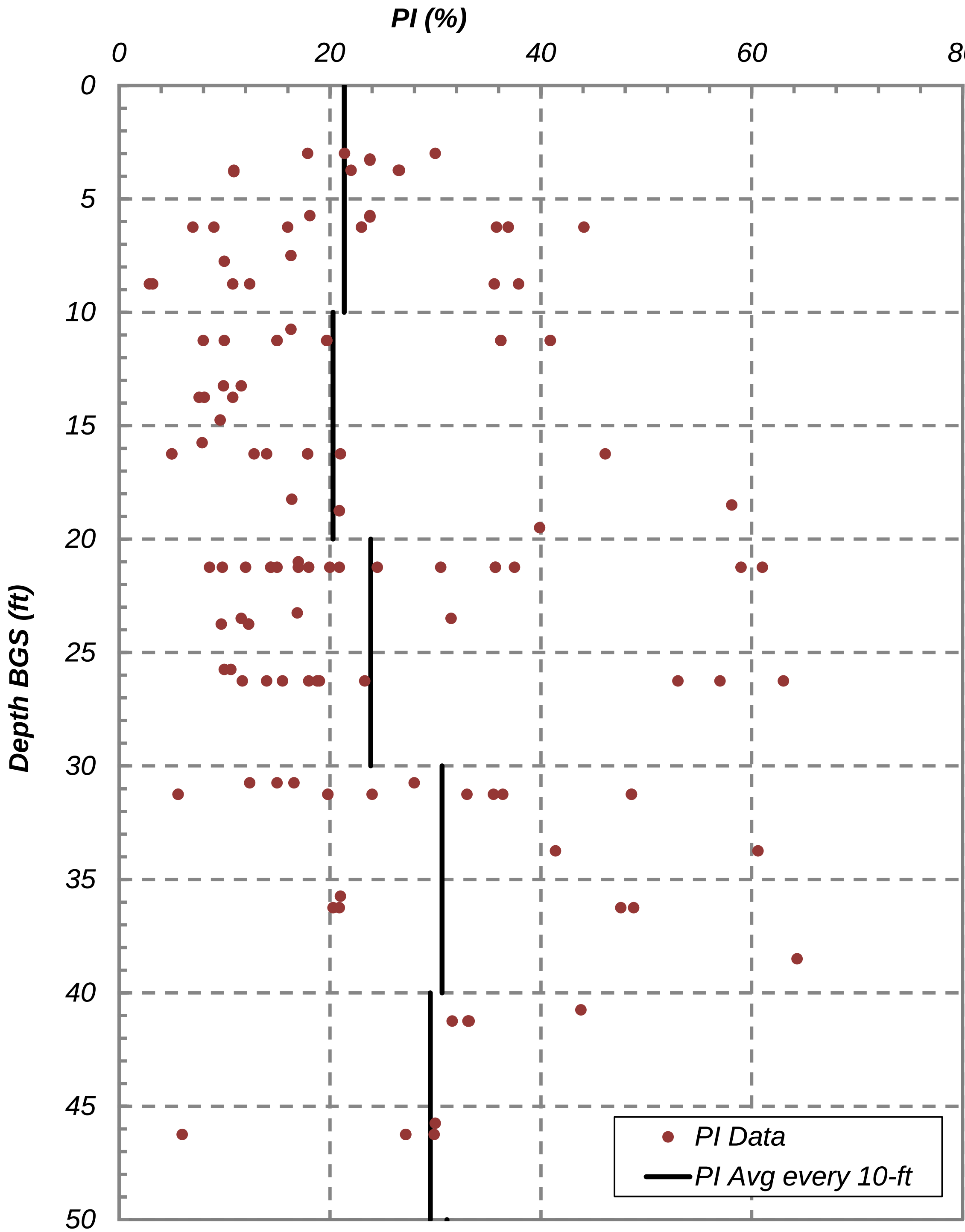


Figure 1 - PI Data with Average at 10-ft Depth Intervals

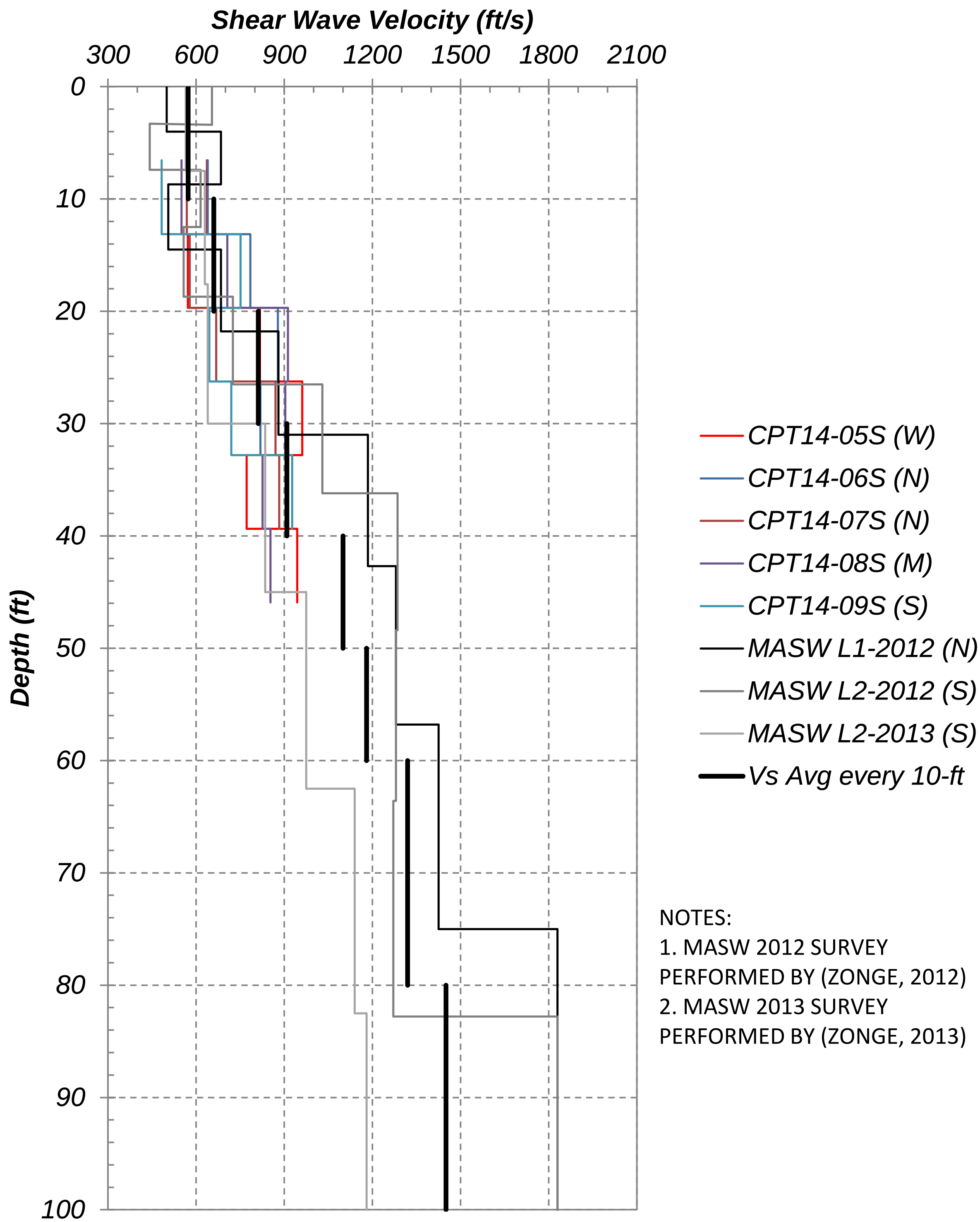


Figure 2 - Shear Wave Velocity Data with Average at 10-ft Depth Intervals

ATTACHMENT A

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                        º  D - M O D_2  º
                        ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
                              ³
                          ³    ³³  ³
                          ³   ³³o³o³  ³  ³
                 á 9.03   ÀÄÄÅ×××××××ÅÅÅÄÄ
              N. Matasovic    ³³o³o³  ³  ³
                              ³³  ³
                                ³
                 A Computer  Program for Seismic
                Response Analyses of Horizontally
                Layered Soil  Deposits, Earthfill
                 Dams and  Solid Waste Landfills
                               by
                    Neven Matasovic, 1993;`06

            The following models are incorporated in this
                          computer program:
            Dynamic Response  Model by Lee & Finn (1978);
            Stress-Strain Model by Matasovic and Vucetic
            (1993);  Cyclic Degradation - PWP Generation
            Model for Clay by Matasovic & Vucetic (1995);
            PWP Model for Sand by Vucetic & Dobry (1988);
            PWP Dissipation-PWP Redistribution Model for
            Composite Soil  Deposits by Matasovic (1993).
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Input file name = riv-60-3.inp         Output file name = riv-60-3.out
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

****************************************************
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****************************************************

Riverbend Landfill Module 11 - 60-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

NPTYPE =  1 ;   NLINEL =  1 ;   NMAT   =  6 ;   NLAYER = 12 ;   NDAMP  =  2
ITMBY  =  1 ;   NBT    =  0 ;   NBB    =  1 ;   ITERRV =  1 ;   ICKFB  =  1

***********************************************************
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
***********************************************************

************* STRESS - STRAIN MODEL *************
```

LAYER	G_mo (psf)	T_mo (psf)	á (-)	s (-)
1	1173551.	1079.67	1.30	.85
2	1173551.	1079.67	1.30	.85
3	1561693.	1436.76	1.30	.85
4	1561693.	1436.76	1.30	.85
5	2356703.	3770.72	1.10	.85
6	2356703.	3770.72	1.10	.85
7	3210205.	1040.11	1.10	.90
8	3210205.	1040.11	1.10	.90
9	4701001.	1523.12	1.10	.90
10	4701001.	1523.12	1.10	.90
11	5409648.	1752.73	1.10	.90
12	5409648.	1752.73	1.10	.90

****** PWP DISSIPATION MODEL ******   *** PHYSICAL PROPERTIES OF SOIL ***

LAYER	E_r (psf)	K_2 (-)	m (-)	n (-)	UW_sat (pcf)	UW_wet (pcf)	k (ft/sec)
1	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
2	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00

5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv	f	p	F	s	v
	(%)	(-)	(-)	(-)	(-)	(-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR	s_t	r_t	A	B	C	D
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000

```
**************************************************************************
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
**************************************************************************
```

LAYER	MAT. TYPE	NSUBDIV	THICK	WIDTH	MODEL(S)
			(ft)	(ft)	
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	3	2	5.00	1.00	0
7	4	2	5.00	1.00	0
8	4	2	5.00	1.00	0
9	5	2	5.00	1.00	0
10	5	2	5.00	1.00	0
11	6	2	5.00	1.00	0
12	6	2	5.00	1.00	0

```
** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
   UNIT WEIGHT OF BASE,  UW =      131. (pcf)
   SHEAR WAVE VELOCITY, V_s =    1820. (ft/sec)


************************
*  INITIAL CONDITIONS  *
************************
```

```
** FUNDAMENTAL PERIOD OF THE DEPOSIT IS:    .275 sec
   TOTAL THICKNESS OF THE DEPOSIT IS:      60.0 ft
   WT. AVERAGE SHEAR WAVE VELOCITY IS:    872.5 ft/sec)

     DEPTH       å`vo      V_s      REF. STRAIN           c
      (ft)      (psf)   (ft/sec)        (-)              (%)

      2.50     287.50    573.00        .00092          1.00
      7.50     862.50    573.00        .00092          1.00
     12.50    1437.50    661.00        .00092          1.00
     17.50    2012.50    661.00        .00092          1.00
     22.50    2587.50    812.00        .00160          1.00
     27.50    3162.50    812.00        .00160          1.00
     32.50    3762.50    909.00        .00032          1.00
     37.50    4387.50    909.00        .00032          1.00
     42.50    5012.50   1100.00        .00032          1.00
     47.50    5637.50   1100.00        .00032          1.00
     52.50    6262.50   1180.00        .00032          1.00
     57.50    6887.50   1180.00        .00032          1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
   VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
   SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****************************************************
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****************************************************

LAYER   à_R        á_R          {k}        {c}         {m}
        (-)        (-)         (psf)       (-)    (lb sý/ftýft)

  1  0.000E+00  8.750E-04   1.174E+06  1.027E+03    8.94E+00
  2  0.000E+00  8.750E-04   1.174E+06  1.027E+03    1.79E+01
  3  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  4  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  5  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  6  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  7  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.86E+01
  8  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.94E+01
  9  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 10  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 11  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01
 12  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01

   (N+1)TH MASS FOR TRANSMITTING BOUNDARY =   9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

   DIAGONAL TERMS:
   2.347E+05  4.694E+05  5.470E+05  6.247E+05  7.837E+05  9.427E+05  1.113E+06  1.284E+06  1.582E+0
   2.022E+06  2.164E+06  1.082E+06

   OFF-DIAGONAL TERMS:
  -2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -4.713E+05 -6.420E+05 -6.420E+05 -9.402E+0
  -1.082E+06 -1.082E+06

** INITIAL DAMPING MATRIX, [C] **

   DIAGONAL TERMS:
   2.054E+02  4.107E+02  4.787E+02  5.466E+02  6.857E+02  8.248E+02  9.742E+02  1.124E+03  1.384E+0
   1.769E+03  1.893E+03  8.374E+03

   OFF-DIAGONAL TERMS:
  -2.054E+02 -2.054E+02 -2.733E+02 -2.733E+02 -4.124E+02 -4.124E+02 -5.618E+02 -5.618E+02 -8.227E+0
  -9.467E+02 -9.467E+02

******************************************************
* DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
******************************************************

** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
```

```
   NEQ    =    1 ;   INTYP  =    1 ;   NC     =17900
   NCPR   =17900 ;   NCPRM  =17900 ;   NPLD   =    1

** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
   NCARD  =17900 ;   NREC   =    8 ;   NFTS   =    0

   INPUT ACC. VALUES ARE MULTIPLIED BY:     1.781384
   ACCELERATION VALUES ARE DIGITIZED @:   .010 (sec)
   ACCELERATION VALUES  ARE  READ FROM: set3_sluc.eq

** ACCELEROGRAM HEADER:

   Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
   SHAKE2000 Conversion:    17896     .01       6        8        9       (8
   Acceleration Units: (g's) - No. Values: 17896 - Time Step: .01 (secs)
   Data Format: (8f9.6) - No. Header Lines:  6
    Time history matched to spectrum:../target/M9R50-tw2.tgt
    17900    0.0100


****************************************************
* DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
****************************************************


** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

   FILE NAME:     CONTENTS:                            UNITS:

   i-time.prn     Time axis                             (sec)
   i-baccel.prn   (Scaled) base (input) acceleration      (g)
   i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
   i-accel.prn    Acceleration in layer "i"               (g)
   i-veloc.prn    Velocity in layer "i"              (ft/sec)
   i-displ.prn    Displacement in layer "i"              (ft)
   i-gamma%.prn   Shear strain in layer "i"               (%)
   i-tau.prn      Shear stress in layer "i"             (psf)
   i-ustar.prn    Normalized PWP in layer "i"             (-)
   i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
   i-taustr.prn   Normalized shear stress in layer "i"     (-)


** RESULTS AT TIME =179.000 (sec), WHEN INPUT ACC. =  .000000 (g)

   LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
            (g)       (ft/sec)     (ft)         (%)        (psf)

     1   -.000146    -.328E-02    .281E+01    .525E-04    .463E-01
     2    .000160    -.332E-02    .281E+01    .510E-03   -.505E-01
     3   -.000219    -.325E-02    .281E+01    .558E-03    .906E-01
     4    .000256    -.326E-02    .281E+01    .110E-02   -.673E-01
     5   -.000439    -.323E-02    .281E+01    .148E-03    .117E+00
     6    .000368    -.328E-02    .281E+01    .238E-03   -.245E-01
     7    .000108    -.329E-02    .281E+01    .402E-01   -.104E+00
     8    .000066    -.324E-02    .281E+01    .808E-01   -.735E-01
     9   -.000195    -.325E-02    .281E+01    .102E-01   -.115E+00
    10    .000060    -.323E-02    .281E+01    .171E-01   -.190E+00
    11   -.000005    -.334E-02    .281E+01    .127E-01    .293E+00
    12   -.000328    -.322E-02    .280E+01    .196E-01   -.487E-01
    13   -.732921    -.325E-02    .280E+01    .000E+00    .000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
   EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
   "NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
   NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
   IN A TOTAL STRESS ANALYSIS.


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* MAXIMUM VALUES OCCURRED FROM .000 TO 179.000 sec *
****

LAYER	TIME (sec)	^{3}ACC.^{3} (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	93.08	.346189	93.08	.010161	93.08	99.38	.00	.000
2	107.06	.342845	93.08	.041973	93.08	295.45	.00	.000
3	107.08	.339432	107.08	.057454	107.08	479.49	.00	.000
4	107.08	.301439	107.08	.099683	107.08	650.89	.00	.000
5	93.02	.299433	93.07	.047050	93.07	798.50	.00	.000
6	93.02	.293660	93.07	.059142	93.06	946.65	.00	.000
7	112.48	.291185	93.08	.322352	93.08	1067.09	.00	.000
8	93.00	.292938	93.07	.497051	93.07	1152.68	.00	.000
9	92.99	.322115	93.03	.165492	93.03	1347.59	.00	.000
10	92.96	.307193	93.03	.231858	93.02	1459.68	.00	.000
11	92.97	.300055	93.01	.182891	93.01	1590.01	.00	.000
12	92.94	.308459	93.00	.228021	93.00	1673.90	.00	.000
13	101.92	4.724655	.00	.000000	.00	.00	.00	.000

** MAX ^{3}VALUE^{3} OF BASE (input) ACC = .440000 (g) AT TIME = 106.960 (sec) **

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 179.010 sec *
****

LAYER	TIME (sec)	^{3}ACC.^{3} (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	93.08	.346189	93.08	.010161	93.08	.34568	.00	.00000
2	107.06	.342845	93.08	.041973	93.08	.34256	.00	.00000
3	107.08	.339432	107.08	.057454	107.08	.33356	.00	.00000
4	107.08	.301439	107.08	.099683	107.08	.32343	.00	.00000
5	93.02	.299433	93.07	.047050	93.07	.30860	.00	.00000
6	93.02	.293660	93.07	.059142	93.06	.29933	.00	.00000
7	112.48	.291185	93.08	.322352	93.08	.28361	.00	.00000
8	93.00	.292938	93.07	.497051	93.07	.26272	.00	.00000
9	92.99	.322115	93.03	.165492	93.03	.26885	.00	.00000
10	92.96	.307193	93.03	.231858	93.02	.25892	.00	.00000
11	92.97	.300055	93.01	.182891	93.01	.25389	.00	.00000
12	92.94	.308459	93.00	.228021	93.00	.24303	.00	.00000
13	101.92	4.724655	.00	.000000	.00	.00000	.00	.00000

** MAX ^{3}VALUE^{3} OF BASE (input) ACC = .440000 (g) AT TIME = 106.960 (sec) **

****
* N O R M A L T E R M I N A T I O N *
* NUMBER OF INCREMENTAL CALCULATIONS:17900 *
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         N. Matasovic     33O3O3 3 3
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A Computer Program for Seismic
Response Analyses of Horizontally
Layered Soil Deposits, Earthfill
Dams and Solid Waste Landfills
by
Neven Matasovic, 1993;`06

The following models are incorporated in this
computer program:
Dynamic Response Model by Lee & Finn (1978);
Stress-Strain Model by Matasovic and Vucetic
(1993); Cyclic Degradation - PWP Generation
Model for Clay by Matasovic & Vucetic (1995);
PWP Model for Sand by Vucetic & Dobry (1988);
PWP Dissipation-PWP Redistribution Model for
Composite Soil Deposits by Matasovic (1993).

ÄÄ
Input file name = riv-60-4.inp   Output file name = riv-60-4.out
ÄÄ

****
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****

Riverbend Landfill Module 11 - 60-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

```
NPTYPE =  1 ;   NLINEL =  1 ;   NMAT   =  6 ;   NLAYER = 12 ;   NDAMP  =  2
ITMBY  =  1 ;   NBT    =  0 ;   NBB    =  1 ;   ITERRV =  1 ;   ICKFB  =  1
```

****
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
****

************* STRESS - STRAIN MODEL *************

LAYER	G_mo (psf)	T_mo (psf)	á (-)	s (-)
1	1173551.	1079.67	1.30	.85
2	1173551.	1079.67	1.30	.85
3	1561693.	1436.76	1.30	.85
4	1561693.	1436.76	1.30	.85
5	2356703.	3770.72	1.10	.85
6	2356703.	3770.72	1.10	.85
7	3210205.	1040.11	1.10	.90
8	3210205.	1040.11	1.10	.90
9	4701001.	1523.12	1.10	.90
10	4701001.	1523.12	1.10	.90
11	5409648.	1752.73	1.10	.90
12	5409648.	1752.73	1.10	.90

****** PWP DISSIPATION MODEL ******   *** PHYSICAL PROPERTIES OF SOIL ***

LAYER	E_r (psf)	K_2 (-)	m (-)	n (-)	UW_sat (pcf)	UW_wet (pcf)	k (ft/sec)
1	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
2	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00

5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv	f	p	F	s	v
	(%)	(-)	(-)	(-)	(-)	(-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR	s_t	r_t	A	B	C	D
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000

****
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
****

LAYER	MAT. TYPE	NSUBDIV	THICK	WIDTH	MODEL(S)
			(ft)	(ft)	
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	3	2	5.00	1.00	0
7	4	2	5.00	1.00	0
8	4	2	5.00	1.00	0
9	5	2	5.00	1.00	0
10	5	2	5.00	1.00	0
11	6	2	5.00	1.00	0
12	6	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW = 131. (pcf)
SHEAR WAVE VELOCITY, V_s = 1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

```
** FUNDAMENTAL PERIOD OF THE DEPOSIT IS:   .275 sec
   TOTAL THICKNESS OF THE DEPOSIT IS:      60.0 ft
   WT. AVERAGE SHEAR WAVE VELOCITY IS:    872.5 ft/sec)

     DEPTH       å`vo      V_s      REF. STRAIN           c
      (ft)      (psf)   (ft/sec)        (-)              (%)

      2.50     287.50     573.00         .00092          1.00
      7.50     862.50     573.00         .00092          1.00
     12.50    1437.50     661.00         .00092          1.00
     17.50    2012.50     661.00         .00092          1.00
     22.50    2587.50     812.00         .00160          1.00
     27.50    3162.50     812.00         .00160          1.00
     32.50    3762.50     909.00         .00032          1.00
     37.50    4387.50     909.00         .00032          1.00
     42.50    5012.50    1100.00         .00032          1.00
     47.50    5637.50    1100.00         .00032          1.00
     52.50    6262.50    1180.00         .00032          1.00
     57.50    6887.50    1180.00         .00032          1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
   VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
   SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****************************************************
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****************************************************

LAYER   à_R        á_R         {k}        {c}         {m}
        (-)        (-)        (psf)       (-)    (lb sý/ftýft)

  1  0.000E+00  8.750E-04   1.174E+06  1.027E+03    8.94E+00
  2  0.000E+00  8.750E-04   1.174E+06  1.027E+03    1.79E+01
  3  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  4  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  5  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  6  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  7  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.86E+01
  8  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.94E+01
  9  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 10  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 11  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01
 12  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01

   (N+1)TH MASS FOR TRANSMITTING BOUNDARY =   9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

   DIAGONAL TERMS:
   2.347E+05  4.694E+05  5.470E+05  6.247E+05  7.837E+05  9.427E+05  1.113E+06  1.284E+06  1.582E+0
   2.022E+06  2.164E+06  1.082E+06

   OFF-DIAGONAL TERMS:
  -2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -4.713E+05 -6.420E+05 -6.420E+05 -9.402E+0
  -1.082E+06 -1.082E+06

** INITIAL DAMPING MATRIX, [C] **

   DIAGONAL TERMS:
   2.054E+02  4.107E+02  4.787E+02  5.466E+02  6.857E+02  8.248E+02  9.742E+02  1.124E+03  1.384E+0
   1.769E+03  1.893E+03  8.374E+03

   OFF-DIAGONAL TERMS:
  -2.054E+02 -2.054E+02 -2.733E+02 -2.733E+02 -4.124E+02 -4.124E+02 -5.618E+02 -5.618E+02 -8.227E+0
  -9.467E+02 -9.467E+02

******************************************************
* DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
******************************************************

** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
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   NEQ    =    1 ;   INTYP  =    1 ;   NC     =24000
   NCPR   =24000 ;   NCPRM  =24000 ;   NPLD   =    1

** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
   NCARD  =24000 ;   NREC   =    8 ;   NFTS   =    0

   INPUT ACC. VALUES ARE MULTIPLIED BY:     1.634290
   ACCELERATION VALUES ARE DIGITIZED @:   .010 (sec)
   ACCELERATION VALUES  ARE  READ FROM: set4_tcg.eq

** ACCELEROGRAM HEADER:

   Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
   SHAKE2000 Conversion:    24000     .01       6        8        9       (8
   Acceleration Units: (g's) - No. Values: 24000 - Time Step: .01 (secs)
   Data Format: (8f9.6) - No. Header Lines:  6
     Time history matched to spectrum:../target/M9R50.tgt
    24000    0.0100


****************************************************
* DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
****************************************************


** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

   FILE NAME:     CONTENTS:                             UNITS:

   i-time.prn     Time axis                              (sec)
   i-baccel.prn   (Scaled) base (input) acceleration       (g)
   i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
   i-accel.prn    Acceleration in layer "i"                (g)
   i-veloc.prn    Velocity in layer "i"                (ft/sec)
   i-displ.prn    Displacement in layer "i"               (ft)
   i-gamma%.prn   Shear strain in layer "i"                (%)
   i-tau.prn      Shear stress in layer "i"              (psf)
   i-ustar.prn    Normalized PWP in layer "i"              (-)
   i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
   i-taustr.prn   Normalized shear stress in layer "i"     (-)


** RESULTS AT TIME =240.000 (sec), WHEN INPUT ACC. = -.000002 (g)

   LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
            (g)       (ft/sec)     (ft)         (%)        (psf)

     1    .002370    -.812E-01   -.893E+01   -.134E-03   -.477E+00
     2   -.001521    -.807E-01   -.893E+01   -.149E-02    .128E+00
     3   -.000177    -.809E-01   -.893E+01   -.214E-02    .274E+00
     4    .000678    -.809E-01   -.893E+01   -.471E-02   -.474E-01
     5   -.000062    -.808E-01   -.893E+01   -.267E-03   -.164E+00
     6    .000266    -.809E-01   -.893E+01   -.153E-03   -.646E-01
     7   -.001659    -.808E-01   -.893E+01   -.137E-01    .750E+00
     8    .003134    -.808E-01   -.893E+01   -.885E-02   -.131E+01
     9   -.004135    -.809E-01   -.893E+01    .164E-02    .170E+01
    10    .004103    -.807E-01   -.893E+01   -.525E-02   -.158E+01
    11   -.004033    -.810E-01   -.893E+01   -.137E-02    .180E+01
    12    .004395    -.807E-01   -.893E+01   -.467E-02   -.190E+01
    13   5.080791    -.811E-01   -.893E+01    .000E+00    .000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
   EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
   "NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
   NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
   IN A TOTAL STRESS ANALYSIS.


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* MAXIMUM VALUES OCCURRED FROM .000 TO 240.000 sec *
****

LAYER	TIME (sec)	^{3}ACC.^{3} (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	113.20	.380709	113.21	.011146	113.21	107.56	.00	.000
2	113.22	.373988	113.22	.046840	113.22	317.30	.00	.000
3	113.23	.337610	113.23	.060446	113.22	494.20	.00	.000
4	113.24	.295323	113.23	.100773	113.23	654.47	.00	.000
5	113.25	.282805	113.23	.044693	113.23	767.26	.00	.000
6	113.26	.283083	113.24	.052714	113.24	869.92	.00	.000
7	112.96	.284377	113.26	.195873	113.26	959.27	.00	.000
8	113.27	.291897	112.80	.337925	112.80	1076.75	.00	.000
9	112.84	.430675	112.79	.116541	112.79	1222.56	.00	.000
10	112.85	.757288	112.78	.158929	112.78	1333.58	.00	.000
11	112.85	.825171	112.78	.132088	112.77	1458.69	.00	.000
12	112.84	.439697	112.77	.176523	112.77	1576.18	.00	.000
13	131.17	5.548913	.00	.000000	.00	.00	.00	.000

** MAX ^{3}VALUE^{3} OF BASE (input) ACC = .440000 (g) AT TIME = 113.120 (sec) **

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 240.010 sec *
****

LAYER	TIME (sec)	^{3}ACC.^{3} (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	113.20	.380709	113.21	.011146	113.21	.37411	.00	.00000
2	113.22	.373988	113.22	.046840	113.22	.36788	.00	.00000
3	113.23	.337610	113.23	.060446	113.22	.34379	.00	.00000
4	113.24	.295323	113.23	.100773	113.23	.32520	.00	.00000
5	113.25	.282805	113.23	.044693	113.23	.29653	.00	.00000
6	113.26	.283083	113.24	.052714	113.24	.27507	.00	.00000
7	112.96	.284377	113.26	.195873	113.26	.25495	.00	.00000
8	113.27	.291897	112.80	.337925	112.80	.24541	.00	.00000
9	112.84	.430675	112.79	.116541	112.79	.24390	.00	.00000
10	112.85	.757288	112.78	.158929	112.78	.23655	.00	.00000
11	112.85	.825171	112.78	.132088	112.77	.23292	.00	.00000
12	112.84	.439697	112.77	.176523	112.77	.22885	.00	.00000
13	131.17	5.548913	.00	.000000	.00	.00000	.00	.00000

** MAX ^{3}VALUE^{3} OF BASE (input) ACC = .440000 (g) AT TIME = 113.120 (sec) **

****
* N O R M A L T E R M I N A T I O N *
* NUMBER OF INCREMENTAL CALCULATIONS:24000 *
****

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               ÉÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ»
               º  D - M O D_2  º
               ÈÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍÍ¼
                      3
                  3   33  3
                  3  33O3O3  3  3
        á 9.03    ÀÄÄÅ×××××××ÅÅÅÄÄ
    N. Matasovic     33O3O3  3  3
                      33  3
                        3

         A Computer  Program for Seismic
        Response Analyses of Horizontally
        Layered Soil  Deposits, Earthfill
         Dams and  Solid Waste Landfills
                       by
            Neven Matasovic, 1993;`06

    The following models are incorporated in this
                  computer program:
    Dynamic Response  Model by Lee & Finn (1978);
    Stress-Strain Model by Matasovic and Vucetic
    (1993);  Cyclic Degradation - PWP Generation
    Model for Clay by Matasovic & Vucetic (1995);
    PWP Model for Sand by Vucetic & Dobry (1988);
    PWP Dissipation-PWP Redistribution Model for
    Composite Soil  Deposits by Matasovic (1993).
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Input file name = riv-60-5.inp         Output file name = riv-60-5.out
ÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄÄ

****************************************************
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****************************************************

Riverbend Landfill Module 11 - 60-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

NPTYPE =  1 ;   NLINEL =  1 ;   NMAT   =  6 ;   NLAYER = 12 ;   NDAMP  =  2
ITMBY  =  1 ;   NBT    =  0 ;   NBB    =  1 ;   ITERRV =  1 ;   ICKFB  =  1

***********************************************************
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
***********************************************************

************* STRESS - STRAIN MODEL *************
```

LAYER	G_mo (psf)	T_mo (psf)	á (-)	s (-)
1	1173551.	1079.67	1.30	.85
2	1173551.	1079.67	1.30	.85
3	1561693.	1436.76	1.30	.85
4	1561693.	1436.76	1.30	.85
5	2356703.	3770.72	1.10	.85
6	2356703.	3770.72	1.10	.85
7	3210205.	1040.11	1.10	.90
8	3210205.	1040.11	1.10	.90
9	4701001.	1523.12	1.10	.90
10	4701001.	1523.12	1.10	.90
11	5409648.	1752.73	1.10	.90
12	5409648.	1752.73	1.10	.90

```
****** PWP DISSIPATION MODEL ******     *** PHYSICAL PROPERTIES OF SOIL ***
```

LAYER	E_r (psf)	K_2 (-)	m (-)	n (-)	UW_sat (pcf)	UW_wet (pcf)	k (ft/sec)
1	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
2	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00

5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv	f	p	F	s	v
	(%)	(-)	(-)	(-)	(-)	(-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR	s_t	r_t	A	B	C	D
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000

****
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
****

LAYER	MAT. TYPE	NSUBDIV	THICK	WIDTH	MODEL(S)
			(ft)	(ft)	
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	3	2	5.00	1.00	0
7	4	2	5.00	1.00	0
8	4	2	5.00	1.00	0
9	5	2	5.00	1.00	0
10	5	2	5.00	1.00	0
11	6	2	5.00	1.00	0
12	6	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW = 131. (pcf)
SHEAR WAVE VELOCITY, V_s = 1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

```
** FUNDAMENTAL PERIOD OF THE DEPOSIT IS:   .275 sec
   TOTAL THICKNESS OF THE DEPOSIT IS:      60.0 ft
   WT. AVERAGE SHEAR WAVE VELOCITY IS:    872.5 ft/sec)

     DEPTH       å`vo      V_s      REF. STRAIN           c
      (ft)      (psf)   (ft/sec)       (-)               (%)

      2.50     287.50     573.00        .00092          1.00
      7.50     862.50     573.00        .00092          1.00
     12.50    1437.50     661.00        .00092          1.00
     17.50    2012.50     661.00        .00092          1.00
     22.50    2587.50     812.00        .00160          1.00
     27.50    3162.50     812.00        .00160          1.00
     32.50    3762.50     909.00        .00032          1.00
     37.50    4387.50     909.00        .00032          1.00
     42.50    5012.50    1100.00        .00032          1.00
     47.50    5637.50    1100.00        .00032          1.00
     52.50    6262.50    1180.00        .00032          1.00
     57.50    6887.50    1180.00        .00032          1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
   VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
   SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****************************************************
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****************************************************

LAYER   à_R        á_R         {k}        {c}         {m}
        (-)        (-)        (psf)       (-)    (lb sý/ftýft)

  1  0.000E+00  8.750E-04   1.174E+06  1.027E+03    8.94E+00
  2  0.000E+00  8.750E-04   1.174E+06  1.027E+03    1.79E+01
  3  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  4  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  5  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  6  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  7  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.86E+01
  8  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.94E+01
  9  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 10  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 11  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01
 12  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01

   (N+1)TH MASS FOR TRANSMITTING BOUNDARY =   9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

   DIAGONAL TERMS:
   2.347E+05  4.694E+05  5.470E+05  6.247E+05  7.837E+05  9.427E+05  1.113E+06  1.284E+06  1.582E+0
   2.022E+06  2.164E+06  1.082E+06

   OFF-DIAGONAL TERMS:
  -2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -4.713E+05 -6.420E+05 -6.420E+05 -9.402E+0
  -1.082E+06 -1.082E+06

** INITIAL DAMPING MATRIX, [C] **

   DIAGONAL TERMS:
   2.054E+02  4.107E+02  4.787E+02  5.466E+02  6.857E+02  8.248E+02  9.742E+02  1.124E+03  1.384E+0
   1.769E+03  1.893E+03  8.374E+03

   OFF-DIAGONAL TERMS:
  -2.054E+02 -2.054E+02 -2.733E+02 -2.733E+02 -4.124E+02 -4.124E+02 -5.618E+02 -5.618E+02 -8.227E+0
  -9.467E+02 -9.467E+02

******************************************************
* DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
******************************************************

** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
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```
   NEQ    =    1 ;   INTYP  =    1 ;   NC     =24000
   NCPR   =24000 ;   NCPRM  =24000 ;   NPLD   =    1

** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
   NCARD  =24000 ;   NREC   =    8 ;   NFTS   =    0

   INPUT ACC. VALUES ARE MULTIPLIED BY:     1.877774
   ACCELERATION VALUES ARE DIGITIZED @:   .010 (sec)
   ACCELERATION VALUES  ARE  READ FROM: set5_ibr8.eq

** ACCELEROGRAM HEADER:

   Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
   SHAKE2000 Conversion:    24000     .01       6         8         9        (8
   Acceleration Units: (g's) - No. Values: 24000 - Time Step: .01 (secs)
   Data Format: (8F9.6) - No. Header Lines:  6
     Time history matched to spectrum:../target/M9R50.tgt
    24000    0.0100


****************************************************
* DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
****************************************************


** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

   FILE NAME:     CONTENTS:                             UNITS:

   i-time.prn     Time axis                              (sec)
   i-baccel.prn   (Scaled) base (input) acceleration       (g)
   i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
   i-accel.prn    Acceleration in layer "i"                (g)
   i-veloc.prn    Velocity in layer "i"               (ft/sec)
   i-displ.prn    Displacement in layer "i"               (ft)
   i-gamma%.prn   Shear strain in layer "i"                (%)
   i-tau.prn      Shear stress in layer "i"              (psf)
   i-ustar.prn    Normalized PWP in layer "i"              (-)
   i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
   i-taustr.prn   Normalized shear stress in layer "i"     (-)


** RESULTS AT TIME =240.000 (sec), WHEN INPUT ACC. = -.000002 (g)

   LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
             (g)      (ft/sec)     (ft)         (%)        (psf)

     1   -.001386     .926E-01    .140E+02   -.954E-04    .150E+00
     2    .001275     .928E-01    .140E+02   -.687E-03   -.154E+00
     3   -.001351     .932E-01    .140E+02    .477E-03    .447E+00
     4    .000405     .929E-01    .140E+02    .137E-02    .937E-01
     5   -.000670     .931E-01    .140E+02    .229E-03    .617E+00
     6    .001835     .932E-01    .140E+02    .458E-03   -.365E+00
     7   -.001083     .934E-01    .140E+02    .180E-01   -.314E+00
     8    .001443     .927E-01    .140E+02    .493E-01   -.594E+00
     9   -.000380     .928E-01    .140E+02    .109E-01   -.409E+00
    10   -.001710     .931E-01    .140E+02    .197E-01    .129E+01
    11   -.001013     .934E-01    .140E+02    .134E-01    .119E+01
    12    .003366     .927E-01    .140E+02    .234E-01   -.137E+01
    13   4.435894     .929E-01    .140E+02    .000E+00    .000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
   EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
   "NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
   NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
   IN A TOTAL STRESS ANALYSIS.


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 * MAXIMUM VALUES OCCURRED FROM    .000  TO 240.000  sec *
 *********************************************************

 LAYER  TIME    ³ACC.³    TIME     STRAIN   TIME      STRESS    TIME       PWP
       (sec)     (g)    (sec)       (%)   (sec)       (psf)   (sec)      (psf)

   1 104.60    .442681 104.61    .013580 104.61      126.92    .00        .000
   2 104.60    .384782 104.61    .051768 104.61      338.00    .00        .000
   3 107.40    .319117 109.47    .055051 109.47      467.20    .00        .000
   4 107.41    .303128 107.41    .095212 107.41      635.85    .00        .000
   5 104.56    .385214 107.41    .045097 107.41      773.00    .00        .000
   6 104.55    .371172 107.41    .055010 107.41      897.88    .00        .000
   7 104.55    .968825 107.44    .236652 107.44     1001.50    .00        .000
   8 104.55   1.013228 104.49    .343568 104.49     1080.12    .00        .000
   9 104.49    .302002 104.47    .124629 104.47     1247.10    .00        .000
  10 117.89    .283492 104.47    .171626 104.46     1359.04    .00        .000
  11 117.89    .265797 104.46    .136554 104.46     1473.03    .00        .000
  12 107.31    .276922 104.45    .170658 104.45     1562.89    .00        .000
  13 146.39   5.030109    .00    .000000    .00         .00    .00        .000

 ** MAX ³VALUE³ OF BASE (input) ACC =  .440000 (g)  AT TIME = 111.000 (sec) **


 *********************************************************
 * MAXIMUM VALUES OCCURRED FROM    .000  TO 240.010  sec *
 *********************************************************

 LAYER  TIME    ³ACC.³    TIME     STRAIN   TIME  NORM. STRESS  TIME  NORM. PWP
       (sec)     (g)    (sec)       (%)   (sec)        (-)     (sec)      (-)

   1 104.60    .442681 104.61    .013580 104.61      .44146    .00      .00000
   2 104.60    .384782 104.61    .051768 104.61      .39189    .00      .00000
   3 107.40    .319117 109.47    .055051 109.47      .32501    .00      .00000
   4 107.41    .303128 107.41    .095212 107.41      .31595    .00      .00000
   5 104.56    .385214 107.41    .045097 107.41      .29874    .00      .00000
   6 104.55    .371172 107.41    .055010 107.41      .28391    .00      .00000
   7 104.55    .968825 107.44    .236652 107.44      .26618    .00      .00000
   8 104.55   1.013228 104.49    .343568 104.49      .24618    .00      .00000
   9 104.49    .302002 104.47    .124629 104.47      .24880    .00      .00000
  10 117.89    .283492 104.47    .171626 104.46      .24107    .00      .00000
  11 117.89    .265797 104.46    .136554 104.46      .23521    .00      .00000
  12 107.31    .276922 104.45    .170658 104.45      .22692    .00      .00000
  13 146.39   5.030109    .00    .000000    .00      .00000    .00      .00000

 ** MAX ³VALUE³ OF BASE (input) ACC =  .440000 (g)  AT TIME = 111.000 (sec) **

 ********************************************
 * N O R M A L   T E R M I N A T I O N      *
 * NUMBER OF INCREMENTAL CALCULATIONS:24000 *
 ********************************************
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    ³    ³³ ³
    ³   ³³o³o³ ³ ³
á 9.03   ÀÄÅÅ×××××××ÅÅÅÄÄ
N. Matasovic    ³³o³o³ ³ ³
        ³³ ³
         ³
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A Computer Program for Seismic
Response Analyses of Horizontally
Layered Soil Deposits, Earthfill
Dams and Solid Waste Landfills
by
Neven Matasovic, 1993;`06

The following models are incorporated in this computer program:
Dynamic Response Model by Lee & Finn (1978);
Stress-Strain Model by Matasovic and Vucetic (1993); Cyclic Degradation - PWP Generation Model for Clay by Matasovic & Vucetic (1995);
PWP Model for Sand by Vucetic & Dobry (1988);
PWP Dissipation-PWP Redistribution Model for Composite Soil Deposits by Matasovic (1993).

ÄÄÄ
Input file name = riv-70-1.inp   Output file name = riv-70-1.out
ÄÄÄ

****
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****

Riverbend Landfill Module 11 - 70-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

NPTYPE = 1 ; NLINEL = 1 ; NMAT = 8 ; NLAYER = 14 ; NDAMP = 2
ITMBY = 1 ; NBT = 0 ; NBB = 1 ; ITERRV = 1 ; ICKFB = 1

****
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
****

************* STRESS - STRAIN MODEL *************

LAYER	G_mo (psf)	T_mo (psf)	á (-)	s (-)
1	1173551.	1079.67	1.30	.85
2	1173551.	1079.67	1.30	.85
3	1561693.	1436.76	1.30	.85
4	1561693.	1436.76	1.30	.85
5	2356703.	3770.72	1.10	.85
6	2561634.	829.97	1.10	.90
7	3210205.	1040.11	1.10	.90
8	3210205.	1040.11	1.10	.90
9	4701001.	1523.12	1.10	.90
10	4701001.	1523.12	1.10	.90
11	5409648.	1752.73	1.10	.90
12	5409648.	1752.73	1.10	.90
13	6769441.	2193.30	1.10	.90
14	6769441.	2193.30	1.10	.90

****** PWP DISSIPATION MODEL ******   *** PHYSICAL PROPERTIES OF SOIL ***

LAYER	E_r (psf)	K_2 (-)	m (-)	n (-)	UW_sat (pcf)	UW_wet (pcf)	k (ft/sec)
1	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
2	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00

3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
13	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
14	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv	f	p	F	s	v
	(%)	(-)	(-)	(-)	(-)	(-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00
13	.100	2.000	1.005	3.000	1.700	1.00
14	.100	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR	s_t	r_t	A	B	C	D
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000
13	.00	.000	.000	.0000	.0000	.0000	.0000
14	.00	.000	.000	.0000	.0000	.0000	.0000

```
***************************************************************************
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
***************************************************************************
```

LAYER	MAT. TYPE	NSUBDIV	THICK	WIDTH	MODEL(S)
			(ft)	(ft)	
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	4	2	5.00	1.00	0
7	5	2	5.00	1.00	0
8	5	2	5.00	1.00	0
9	6	2	5.00	1.00	0
10	6	2	5.00	1.00	0
11	7	2	5.00	1.00	0
12	7	2	5.00	1.00	0
13	8	2	5.00	1.00	0
14	8	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW = 131. (pcf)
SHEAR WAVE VELOCITY, V_s = 1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

** FUNDAMENTAL PERIOD OF THE DEPOSIT IS: .299 sec
TOTAL THICKNESS OF THE DEPOSIT IS: 70.0 ft
WT. AVERAGE SHEAR WAVE VELOCITY IS: 936.4 ft/sec)

DEPTH (ft)	å`vo (psf)	V_s (ft/sec)	REF. STRAIN (-)	c (%)
2.50	287.50	573.00	.00092	1.00
7.50	862.50	573.00	.00092	1.00
12.50	1437.50	661.00	.00092	1.00
17.50	2012.50	661.00	.00092	1.00
22.50	2587.50	812.00	.00160	1.00
27.50	3187.50	812.00	.00032	1.00
32.50	3812.50	909.00	.00032	1.00
37.50	4437.50	909.00	.00032	1.00
42.50	5062.50	1100.00	.00032	1.00
47.50	5687.50	1100.00	.00032	1.00
52.50	6312.50	1180.00	.00032	1.00
57.50	6937.50	1180.00	.00032	1.00
62.50	7562.50	1320.00	.00032	1.00
67.50	8187.50	1320.00	.00032	1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****

LAYER	à_R (-)	á_R (-)	{k} (psf)	{c} (-)	{m} (lb sý/ftýft)
1	0.000E+00	9.520E-04	1.174E+06	1.117E+03	8.94E+00
2	0.000E+00	9.520E-04	1.174E+06	1.117E+03	1.79E+01
3	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
4	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
5	0.000E+00	9.520E-04	2.357E+06	2.244E+03	1.79E+01
6	0.000E+00	9.520E-04	2.562E+06	2.439E+03	1.86E+01
7	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
8	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
9	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
10	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
11	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
12	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
13	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01
14	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01

(N+1)TH MASS FOR TRANSMITTING BOUNDARY = 9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

DIAGONAL TERMS:
2.347E+05 4.694E+05 5.470E+05 6.247E+05 7.837E+05 9.837E+05 1.154E+06 1.284E+06 1.582E+0
2.022E+06 2.164E+06 2.436E+06 2.708E+06 1.354E+06

OFF-DIAGONAL TERMS:
-2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -5.123E+05 -6.420E+05 -6.420E+05 -9.402E+0
-1.082E+06 -1.082E+06 -1.354E+06 -1.354E+06

** INITIAL DAMPING MATRIX, [C] **

```
    DIAGONAL TERMS:
    2.234E+02  4.469E+02  5.208E+02  5.947E+02  7.461E+02  9.365E+02  1.099E+03  1.222E+03  1.506E+0
    1.925E+03  2.060E+03  2.319E+03  2.578E+03  8.716E+03

    OFF-DIAGONAL TERMS:
   -2.234E+02 -2.234E+02 -2.973E+02 -2.973E+02 -4.487E+02 -4.877E+02 -6.112E+02 -6.112E+02 -8.951E+0
   -1.030E+03 -1.030E+03 -1.289E+03 -1.289E+03

 ******************************************************
 * DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
 ******************************************************

 ** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
    NEQ    =    1 ;   INTYP  =    1 ;   NC     =22000
    NCPR   =22000 ;   NCPRM  =22000 ;   NPLD   =    1

 ** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
    NCARD  =22000 ;   NREC   =    8 ;   NFTS   =    0

    INPUT ACC. VALUES ARE MULTIPLIED BY:     1.604850
    ACCELERATION VALUES ARE DIGITIZED @:   .005 (sec)
    ACCELERATION VALUES  ARE  READ FROM: set1_hual.eq

 ** ACCELEROGRAM HEADER:

    Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
    SHAKE2000 Conversion:    22000     .005      6         8         9        (8
    Acceleration Units: (g's) - No. Values: 22000 - Time Step: .005 (secs)
    Data Format: (8F9.6) - No. Header Lines:  6
     Time history matched to spectrum:../target/M9R50-tw1.tgt by NA
     22000    0.0050


 ****************************************************
 * DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
 ****************************************************


 ** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

    FILE NAME:     CONTENTS:                             UNITS:

    i-time.prn     Time axis                              (sec)
    i-baccel.prn   (Scaled) base (input) acceleration       (g)
    i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
    i-accel.prn    Acceleration in layer "i"                (g)
    i-veloc.prn    Velocity in layer "i"               (ft/sec)
    i-displ.prn    Displacement in layer "i"               (ft)
    i-gamma%.prn   Shear strain in layer "i"                (%)
    i-tau.prn      Shear stress in layer "i"              (psf)
    i-ustar.prn    Normalized PWP in layer "i"              (-)
    i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
    i-taustr.prn   Normalized shear stress in layer "i"     (-)


 ** RESULTS AT TIME =110.000 (sec), WHEN INPUT ACC. =  .000037 (g)
```

LAYER	ACCEL. (g)	VELOCITY (ft/sec)	DISPL. (ft)	STRAIN (%)	STRESS (psf)
1	.000134	-.151E-01	-.228E+01	-.525E-04	-.546E-01
2	-.000056	-.152E-01	-.228E+01	-.539E-03	-.139E-02
3	.000106	-.152E-01	-.228E+01	-.887E-03	-.379E-01
4	-.000033	-.151E-01	-.228E+01	-.168E-02	-.905E-01
5	.000053	-.152E-01	-.228E+01	-.281E-03	-.724E-01
6	.000001	-.151E-01	-.228E+01	-.205E-01	-.221E-01
7	.000265	-.152E-01	-.228E+01	-.192E-01	-.272E+00
8	-.000200	-.152E-01	-.228E+01	-.349E-01	-.120E+00
9	.000008	-.152E-01	-.228E+01	-.550E-02	-.168E+00
10	.000010	-.152E-01	-.228E+01	-.747E-02	-.143E+00

11	.000191	-.152E-01	-.228E+01	-.439E-02	-.856E-01
12	-.000052	-.151E-01	-.228E+01	-.442E-02	-.195E+00
13	-.000165	-.151E-01	-.228E+01	-.954E-03	-.222E+00
14	.000342	-.152E-01	-.228E+01	.548E-03	-.432E+00
15	5.444489	-.152E-01	-.228E+01	.000E+00	.000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
"NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
IN A TOTAL STRESS ANALYSIS.

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 110.000 sec *
****

LAYER	TIME (sec)	^{3}ACC.^{3} (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	27.82	.280618	27.82	.007996	27.82	80.69	.00	.000
2	27.81	.276170	27.81	.030676	27.81	238.24	.00	.000
3	27.81	.267168	27.81	.041074	27.81	387.58	.00	.000
4	27.45	.259343	27.81	.067726	27.81	528.31	.00	.000
5	27.41	.264133	27.80	.036814	27.80	658.89	.00	.000
6	27.42	.266726	27.45	.224812	27.45	790.14	.00	.000
7	24.19	.277977	27.44	.175893	27.44	934.51	.00	.000
8	29.48	.255460	27.44	.277472	27.44	1035.78	.00	.000
9	29.47	.291181	27.42	.099654	27.42	1164.26	.00	.000
10	29.46	.300603	27.41	.128852	27.41	1259.18	.00	.000
11	29.45	.308196	27.40	.102099	27.40	1350.27	.00	.000
12	29.44	.326215	27.41	.123468	27.39	1432.84	.00	.000
13	29.43	.340587	27.40	.075353	27.40	1522.13	.00	.000
14	29.43	.319993	29.45	.088724	29.45	1613.00	.00	.000
15	84.99	5.816190	.00	.000000	.00	.00	.00	.000

** MAX ^{3}VALUE^{3} OF BASE (input) ACC = .440000 (g) AT TIME = 29.415 (sec) **

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 110.005 sec *
****

LAYER	TIME (sec)	^{3}ACC.^{3} (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	27.82	.280618	27.82	.007996	27.82	.28065	.00	.00000
2	27.81	.276170	27.81	.030676	27.81	.27622	.00	.00000
3	27.81	.267168	27.81	.041074	27.81	.26962	.00	.00000
4	27.45	.259343	27.81	.067726	27.81	.26251	.00	.00000
5	27.41	.264133	27.80	.036814	27.80	.25464	.00	.00000
6	27.42	.266726	27.45	.224812	27.45	.24789	.00	.00000
7	24.19	.277977	27.44	.175893	27.44	.24512	.00	.00000
8	29.48	.255460	27.44	.277472	27.44	.23341	.00	.00000
9	29.47	.291181	27.42	.099654	27.42	.22998	.00	.00000
10	29.46	.300603	27.41	.128852	27.41	.22139	.00	.00000
11	29.45	.308196	27.40	.102099	27.40	.21390	.00	.00000
12	29.44	.326215	27.41	.123468	27.39	.20654	.00	.00000
13	29.43	.340587	27.40	.075353	27.40	.20127	.00	.00000
14	29.43	.319993	29.45	.088724	29.45	.19701	.00	.00000
15	84.99	5.816190	.00	.000000	.00	.00000	.00	.00000

** MAX ^{3}VALUE^{3} OF BASE (input) ACC = .440000 (g) AT TIME = 29.415 (sec) **

****
* N O R M A L T E R M I N A T I O N *
* NUMBER OF INCREMENTAL CALCULATIONS:22000 *
****

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á 9.03   ÀÄÄÅ×××××××ÅÅÅÄÄ
N. Matasovic    ³³O³O³ ³ ³
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A Computer Program for Seismic
Response Analyses of Horizontally
Layered Soil Deposits, Earthfill
Dams and Solid Waste Landfills
by
Neven Matasovic, 1993;`06

The following models are incorporated in this computer program:
Dynamic Response Model by Lee & Finn (1978);
Stress-Strain Model by Matasovic and Vucetic (1993); Cyclic Degradation - PWP Generation Model for Clay by Matasovic & Vucetic (1995);
PWP Model for Sand by Vucetic & Dobry (1988);
PWP Dissipation-PWP Redistribution Model for Composite Soil Deposits by Matasovic (1993).

ÄÄÄ
Input file name = riv-70-2.inp Output file name = riv-70-2.out
ÄÄÄ

****
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****

Riverbend Landfill Module 11 - 70-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

NPTYPE = 1 ; NLINEL = 1 ; NMAT = 8 ; NLAYER = 14 ; NDAMP = 2
ITMBY = 1 ; NBT = 0 ; NBB = 1 ; ITERRV = 1 ; ICKFB = 1

****
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
****

************* STRESS - STRAIN MODEL *************

LAYER	G_mo (psf)	T_mo (psf)	á (-)	s (-)
1	1173551.	1079.67	1.30	.85
2	1173551.	1079.67	1.30	.85
3	1561693.	1436.76	1.30	.85
4	1561693.	1436.76	1.30	.85
5	2356703.	3770.72	1.10	.85
6	2561634.	829.97	1.10	.90
7	3210205.	1040.11	1.10	.90
8	3210205.	1040.11	1.10	.90
9	4701001.	1523.12	1.10	.90
10	4701001.	1523.12	1.10	.90
11	5409648.	1752.73	1.10	.90
12	5409648.	1752.73	1.10	.90
13	6769441.	2193.30	1.10	.90
14	6769441.	2193.30	1.10	.90

****** PWP DISSIPATION MODEL ****** *** PHYSICAL PROPERTIES OF SOIL ***

LAYER	E_r (psf)	K_2 (-)	m (-)	n (-)	UW_sat (pcf)	UW_wet (pcf)	k (ft/sec)
1	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
2	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00

3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
13	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
14	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv	f	p	F	s	v
	(%)	(-)	(-)	(-)	(-)	(-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00
13	.100	2.000	1.005	3.000	1.700	1.00
14	.100	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR	s_t	r_t	A	B	C	D
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000
13	.00	.000	.000	.0000	.0000	.0000	.0000
14	.00	.000	.000	.0000	.0000	.0000	.0000

****
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
****

LAYER	MAT. TYPE	NSUBDIV	THICK	WIDTH	MODEL(S)
			(ft)	(ft)	
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	4	2	5.00	1.00	0
7	5	2	5.00	1.00	0
8	5	2	5.00	1.00	0
9	6	2	5.00	1.00	0
10	6	2	5.00	1.00	0
11	7	2	5.00	1.00	0
12	7	2	5.00	1.00	0
13	8	2	5.00	1.00	0
14	8	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW = 131. (pcf)
SHEAR WAVE VELOCITY, V_s = 1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

** FUNDAMENTAL PERIOD OF THE DEPOSIT IS: .299 sec
TOTAL THICKNESS OF THE DEPOSIT IS: 70.0 ft
WT. AVERAGE SHEAR WAVE VELOCITY IS: 936.4 ft/sec)

DEPTH (ft)	å`vo (psf)	V_s (ft/sec)	REF. STRAIN (-)	c (%)
2.50	287.50	573.00	.00092	1.00
7.50	862.50	573.00	.00092	1.00
12.50	1437.50	661.00	.00092	1.00
17.50	2012.50	661.00	.00092	1.00
22.50	2587.50	812.00	.00160	1.00
27.50	3187.50	812.00	.00032	1.00
32.50	3812.50	909.00	.00032	1.00
37.50	4437.50	909.00	.00032	1.00
42.50	5062.50	1100.00	.00032	1.00
47.50	5687.50	1100.00	.00032	1.00
52.50	6312.50	1180.00	.00032	1.00
57.50	6937.50	1180.00	.00032	1.00
62.50	7562.50	1320.00	.00032	1.00
67.50	8187.50	1320.00	.00032	1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****

LAYER	à_R (-)	á_R (-)	{k} (psf)	{c} (-)	{m} (lb sý/ftýft)
1	0.000E+00	9.520E-04	1.174E+06	1.117E+03	8.94E+00
2	0.000E+00	9.520E-04	1.174E+06	1.117E+03	1.79E+01
3	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
4	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
5	0.000E+00	9.520E-04	2.357E+06	2.244E+03	1.79E+01
6	0.000E+00	9.520E-04	2.562E+06	2.439E+03	1.86E+01
7	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
8	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
9	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
10	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
11	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
12	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
13	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01
14	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01

(N+1)TH MASS FOR TRANSMITTING BOUNDARY = 9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

DIAGONAL TERMS:
2.347E+05 4.694E+05 5.470E+05 6.247E+05 7.837E+05 9.837E+05 1.154E+06 1.284E+06 1.582E+0
2.022E+06 2.164E+06 2.436E+06 2.708E+06 1.354E+06

OFF-DIAGONAL TERMS:
-2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -5.123E+05 -6.420E+05 -6.420E+05 -9.402E+0
-1.082E+06 -1.082E+06 -1.354E+06 -1.354E+06

** INITIAL DAMPING MATRIX, [C] **

```
    DIAGONAL TERMS:
    2.234E+02  4.469E+02  5.208E+02  5.947E+02  7.461E+02  9.365E+02  1.099E+03  1.222E+03  1.506E+0
    1.925E+03  2.060E+03  2.319E+03  2.578E+03  8.716E+03

    OFF-DIAGONAL TERMS:
   -2.234E+02 -2.234E+02 -2.973E+02 -2.973E+02 -4.487E+02 -4.877E+02 -6.112E+02 -6.112E+02 -8.951E+0
   -1.030E+03 -1.030E+03 -1.289E+03 -1.289E+03

 ******************************************************
 * DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
 ******************************************************

 ** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
    NEQ    =    1 ;   INTYP  =    1 ;   NC     =24000
    NCPR   =24000 ;   NCPRM  =24000 ;   NPLD   =    1

 ** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
    NCARD  =24000 ;   NREC   =    8 ;   NFTS   =    0

    INPUT ACC. VALUES ARE MULTIPLIED BY:     1.695111
    ACCELERATION VALUES ARE DIGITIZED @:   .010 (sec)
    ACCELERATION VALUES  ARE  READ FROM: set2_sit7.eq

 ** ACCELEROGRAM HEADER:

    Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
    SHAKE2000 Conversion:    24000     .01       6         8         9        (6
    Acceleration Units: (g's) - No. Values: 24000 - Time Step: .01 (secs)
    Data Format: (6F15.8) - No. Header Lines:  6
     Time history matched to spectrum:../target/M9R50.tgt
     24000    0.0100


 ****************************************************
 * DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
 ****************************************************


 ** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

    FILE NAME:     CONTENTS:                             UNITS:

    i-time.prn     Time axis                              (sec)
    i-baccel.prn   (Scaled) base (input) acceleration       (g)
    i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
    i-accel.prn    Acceleration in layer "i"                (g)
    i-veloc.prn    Velocity in layer "i"                (ft/sec)
    i-displ.prn    Displacement in layer "i"               (ft)
    i-gamma%.prn   Shear strain in layer "i"                (%)
    i-tau.prn      Shear stress in layer "i"              (psf)
    i-ustar.prn    Normalized PWP in layer "i"              (-)
    i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
    i-taustr.prn   Normalized shear stress in layer "i"     (-)


 ** RESULTS AT TIME =240.000 (sec), WHEN INPUT ACC. = -.000002 (g)

    LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
             (g)       (ft/sec)     (ft)         (%)        (psf)

      1    .000397     .524E-01    .717E+01    .000E+00   -.117E+00
      2    .000122     .524E-01    .717E+01   -.954E-05   -.247E+00
      3   -.000200     .524E-01    .717E+01    .191E-04   -.883E-01
      4   -.000197     .523E-01    .717E+01    .620E-03    .796E-01
      5    .000506     .525E-01    .717E+01    .172E-03   -.395E+00
      6   -.000317     .523E-01    .717E+01    .132E-01    .103E+00
      7    .000230     .523E-01    .717E+01    .453E-02   -.231E+00
      8   -.000593     .525E-01    .717E+01   -.677E-02    .807E-01
      9   -.000647     .524E-01    .717E+01   -.484E-02    .761E+00
     10    .000958     .524E-01    .717E+01   -.103E-01   -.138E+00
```

11	.000328	.522E-01	.717E+01	-.723E-02	-.380E+00
12	.000173	.523E-01	.717E+01	-.938E-02	.174E+00
13	-.000268	.524E-01	.717E+01	-.403E-02	-.469E+00
14	-.001477	.523E-01	.717E+01	-.377E-02	.102E+01
15	-6.815697	.525E-01	.717E+01	.000E+00	.000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
"NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
IN A TOTAL STRESS ANALYSIS.

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 240.000 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	114.74	.311944	114.74	.008523	114.74	85.82	.00	.000
2	114.76	.283525	120.63	.030694	120.63	238.34	.00	.000
3	114.77	.272609	120.63	.041597	120.63	390.84	.00	.000
4	120.61	.265435	120.62	.070145	120.62	539.01	.00	.000
5	114.82	.260998	120.61	.038366	120.61	681.49	.00	.000
6	114.80	.274310	120.62	.242484	120.61	799.54	.00	.000
7	122.61	.261159	120.61	.186219	120.60	947.12	.00	.000
8	122.61	.274045	120.60	.302708	120.60	1054.07	.00	.000
9	118.66	.340927	120.58	.118358	120.58	1228.24	.00	.000
10	120.52	.263583	120.57	.166802	120.57	1350.30	.00	.000
11	120.51	.265447	120.56	.140641	120.56	1485.13	.00	.000
12	120.51	.274558	120.56	.184181	120.56	1592.74	.00	.000
13	122.53	.288972	120.54	.112121	120.54	1739.95	.00	.000
14	116.49	.297965	120.53	.139310	120.53	1853.57	.00	.000
15	120.38	7.962042	.00	.000000	.00	.00	.00	.000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 117.210 (sec) **

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 240.010 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	114.74	.311944	114.74	.008523	114.74	.29850	.00	.00000
2	114.76	.283525	120.63	.030694	120.63	.27633	.00	.00000
3	114.77	.272609	120.63	.041597	120.63	.27189	.00	.00000
4	120.61	.265435	120.62	.070145	120.62	.26783	.00	.00000
5	114.82	.260998	120.61	.038366	120.61	.26338	.00	.00000
6	114.80	.274310	120.62	.242484	120.61	.25084	.00	.00000
7	122.61	.261159	120.61	.186219	120.60	.24842	.00	.00000
8	122.61	.274045	120.60	.302708	120.60	.23754	.00	.00000
9	118.66	.340927	120.58	.118358	120.58	.24262	.00	.00000
10	120.52	.263583	120.57	.166802	120.57	.23742	.00	.00000
11	120.51	.265447	120.56	.140641	120.56	.23527	.00	.00000
12	120.51	.274558	120.56	.184181	120.56	.22958	.00	.00000
13	122.53	.288972	120.54	.112121	120.54	.23008	.00	.00000
14	116.49	.297965	120.53	.139310	120.53	.22639	.00	.00000
15	120.38	7.962042	.00	.000000	.00	.00000	.00	.00000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 117.210 (sec) **

****
* N O R M A L T E R M I N A T I O N *
* NUMBER OF INCREMENTAL CALCULATIONS:24000 *
****

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        N. Matasovic      ³³o³o³ ³ ³
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A Computer Program for Seismic
Response Analyses of Horizontally
Layered Soil Deposits, Earthfill
Dams and Solid Waste Landfills
by
Neven Matasovic, 1993;`06

The following models are incorporated in this computer program:
Dynamic Response Model by Lee & Finn (1978);
Stress-Strain Model by Matasovic and Vucetic (1993); Cyclic Degradation - PWP Generation Model for Clay by Matasovic & Vucetic (1995);
PWP Model for Sand by Vucetic & Dobry (1988);
PWP Dissipation-PWP Redistribution Model for Composite Soil Deposits by Matasovic (1993).

ÄÄÄ
Input file name = riv-70-3.inp   Output file name = riv-70-3.out
ÄÄÄ

****
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****

Riverbend Landfill Module 11 - 70-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

```
NPTYPE =  1 ;   NLINEL =  1 ;   NMAT   =  8 ;   NLAYER = 14 ;   NDAMP  =  2
ITMBY  =  1 ;   NBT    =  0 ;   NBB    =  1 ;   ITERRV =  1 ;   ICKFB  =  1
```

****
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
****

************* STRESS - STRAIN MODEL *************

LAYER	G_mo (psf)	T_mo (psf)	á (-)	s (-)
1	1173551.	1079.67	1.30	.85
2	1173551.	1079.67	1.30	.85
3	1561693.	1436.76	1.30	.85
4	1561693.	1436.76	1.30	.85
5	2356703.	3770.72	1.10	.85
6	2561634.	829.97	1.10	.90
7	3210205.	1040.11	1.10	.90
8	3210205.	1040.11	1.10	.90
9	4701001.	1523.12	1.10	.90
10	4701001.	1523.12	1.10	.90
11	5409648.	1752.73	1.10	.90
12	5409648.	1752.73	1.10	.90
13	6769441.	2193.30	1.10	.90
14	6769441.	2193.30	1.10	.90

****** PWP DISSIPATION MODEL ******   *** PHYSICAL PROPERTIES OF SOIL ***

LAYER	E_r (psf)	K_2 (-)	m (-)	n (-)	UW_sat (pcf)	UW_wet (pcf)	k (ft/sec)
1	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
2	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00

3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
13	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
14	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv	f	p	F	s	v
	(%)	(-)	(-)	(-)	(-)	(-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00
13	.100	2.000	1.005	3.000	1.700	1.00
14	.100	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR	s_t	r_t	A	B	C	D
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000
13	.00	.000	.000	.0000	.0000	.0000	.0000
14	.00	.000	.000	.0000	.0000	.0000	.0000

****
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
****

LAYER	MAT. TYPE	NSUBDIV	THICK	WIDTH	MODEL(S)
			(ft)	(ft)	
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	4	2	5.00	1.00	0
7	5	2	5.00	1.00	0
8	5	2	5.00	1.00	0
9	6	2	5.00	1.00	0
10	6	2	5.00	1.00	0
11	7	2	5.00	1.00	0
12	7	2	5.00	1.00	0
13	8	2	5.00	1.00	0
14	8	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW = 131. (pcf)
SHEAR WAVE VELOCITY, V_s = 1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

** FUNDAMENTAL PERIOD OF THE DEPOSIT IS: .299 sec
TOTAL THICKNESS OF THE DEPOSIT IS: 70.0 ft
WT. AVERAGE SHEAR WAVE VELOCITY IS: 936.4 ft/sec)

DEPTH (ft)	å`vo (psf)	V_s (ft/sec)	REF. STRAIN (-)	c (%)
2.50	287.50	573.00	.00092	1.00
7.50	862.50	573.00	.00092	1.00
12.50	1437.50	661.00	.00092	1.00
17.50	2012.50	661.00	.00092	1.00
22.50	2587.50	812.00	.00160	1.00
27.50	3187.50	812.00	.00032	1.00
32.50	3812.50	909.00	.00032	1.00
37.50	4437.50	909.00	.00032	1.00
42.50	5062.50	1100.00	.00032	1.00
47.50	5687.50	1100.00	.00032	1.00
52.50	6312.50	1180.00	.00032	1.00
57.50	6937.50	1180.00	.00032	1.00
62.50	7562.50	1320.00	.00032	1.00
67.50	8187.50	1320.00	.00032	1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****

LAYER	à_R (-)	á_R (-)	{k} (psf)	{c} (-)	{m} (lb sý/ftýft)
1	0.000E+00	9.520E-04	1.174E+06	1.117E+03	8.94E+00
2	0.000E+00	9.520E-04	1.174E+06	1.117E+03	1.79E+01
3	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
4	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
5	0.000E+00	9.520E-04	2.357E+06	2.244E+03	1.79E+01
6	0.000E+00	9.520E-04	2.562E+06	2.439E+03	1.86E+01
7	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
8	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
9	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
10	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
11	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
12	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
13	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01
14	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01

(N+1)TH MASS FOR TRANSMITTING BOUNDARY = 9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

DIAGONAL TERMS:
2.347E+05 4.694E+05 5.470E+05 6.247E+05 7.837E+05 9.837E+05 1.154E+06 1.284E+06 1.582E+0
2.022E+06 2.164E+06 2.436E+06 2.708E+06 1.354E+06

OFF-DIAGONAL TERMS:
-2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -5.123E+05 -6.420E+05 -6.420E+05 -9.402E+0
-1.082E+06 -1.082E+06 -1.354E+06 -1.354E+06

** INITIAL DAMPING MATRIX, [C] **

```
   DIAGONAL TERMS:
   2.234E+02  4.469E+02  5.208E+02  5.947E+02  7.461E+02  9.365E+02  1.099E+03  1.222E+03  1.506E+0
   1.925E+03  2.060E+03  2.319E+03  2.578E+03  8.716E+03

   OFF-DIAGONAL TERMS:
  -2.234E+02 -2.234E+02 -2.973E+02 -2.973E+02 -4.487E+02 -4.877E+02 -6.112E+02 -6.112E+02 -8.951E+0
  -1.030E+03 -1.030E+03 -1.289E+03 -1.289E+03

******************************************************
* DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
******************************************************

** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
   NEQ    =    1 ;   INTYP  =    1 ;   NC     =17900
   NCPR   =17900 ;   NCPRM  =17900 ;   NPLD   =    1

** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
   NCARD  =17900 ;   NREC   =    8 ;   NFTS   =    0

   INPUT ACC. VALUES ARE MULTIPLIED BY:     1.781384
   ACCELERATION VALUES ARE DIGITIZED @:   .010 (sec)
   ACCELERATION VALUES  ARE  READ FROM: set3_sluc.eq

** ACCELEROGRAM HEADER:

   Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
   SHAKE2000 Conversion:    17896     .01       6         8         9        (8
   Acceleration Units: (g's) - No. Values: 17896 - Time Step: .01 (secs)
   Data Format: (8f9.6) - No. Header Lines:  6
    Time history matched to spectrum:../target/M9R50-tw2.tgt
    17900    0.0100


****************************************************
* DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
****************************************************


** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

   FILE NAME:     CONTENTS:                             UNITS:

   i-time.prn     Time axis                              (sec)
   i-baccel.prn   (Scaled) base (input) acceleration       (g)
   i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
   i-accel.prn    Acceleration in layer "i"                (g)
   i-veloc.prn    Velocity in layer "i"               (ft/sec)
   i-displ.prn    Displacement in layer "i"               (ft)
   i-gamma%.prn   Shear strain in layer "i"                (%)
   i-tau.prn      Shear stress in layer "i"              (psf)
   i-ustar.prn    Normalized PWP in layer "i"              (-)
   i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
   i-taustr.prn   Normalized shear stress in layer "i"     (-)


** RESULTS AT TIME =179.000 (sec), WHEN INPUT ACC. =  .000000 (g)

   LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
            (g)       (ft/sec)     (ft)         (%)        (psf)

     1   -.000006    -.535E-01    .438E+00   -.614E-04    .188E-02
     2    .000002    -.535E-01    .438E+00   -.106E-03    .362E-02
     3   -.000016    -.535E-01    .438E+00    .564E-03    .665E-02
     4    .000023    -.535E-01    .438E+00    .121E-02    .309E-02
     5    .000014    -.535E-01    .438E+00    .187E-03   -.247E-01
     6    .000004    -.535E-01    .438E+00    .514E-01   -.838E-02
     7   -.000036    -.535E-01    .435E+00    .365E-01    .135E-01
     8   -.000002    -.535E-01    .433E+00    .508E-01    .115E-01
     9   -.000035    -.535E-01    .431E+00    .709E-02    .150E-01
    10    .000031    -.535E-01    .430E+00    .132E-01    .224E-01
```

11	.000045	-.535E-01	.430E+00	.108E-01	-.191E-01
12	-.000010	-.535E-01	.429E+00	.178E-01	-.105E-01
13	.000025	-.535E-01	.428E+00	.844E-02	-.376E-01
14	-.000020	-.535E-01	.428E+00	.110E-01	-.238E-02
15	5.179142	-.535E-01	.427E+00	.000E+00	.000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
"NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
IN A TOTAL STRESS ANALYSIS.

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 179.000 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	82.45	.442920	82.45	.013161	82.45	124.54	.00	.000
2	82.45	.383597	82.45	.049298	82.45	332.61	.00	.000
3	93.10	.302923	93.11	.050720	93.11	444.08	.00	.000
4	93.10	.294522	93.11	.088423	93.11	611.85	.00	.000
5	82.41	.435541	93.10	.044677	93.10	767.29	.00	.000
6	82.40	.651778	93.12	.376527	93.12	876.62	.00	.000
7	82.40	.653548	93.09	.260866	93.09	1022.62	.00	.000
8	93.03	.285014	93.08	.407146	93.08	1114.08	.00	.000
9	93.01	.289906	93.05	.145639	93.05	1302.97	.00	.000
10	93.00	.291189	93.04	.204414	93.04	1418.90	.00	.000
11	92.99	.292047	93.03	.164438	93.03	1548.20	.00	.000
12	92.98	.288448	93.02	.205426	93.02	1634.68	.00	.000
13	92.95	.311071	93.00	.115052	93.00	1753.68	.00	.000
14	92.94	.314416	93.00	.134006	93.00	1833.57	.00	.000
15	108.37	6.220881	.00	.000000	.00	.00	.00	.000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 106.960 (sec) **

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 179.010 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	82.45	.442920	82.45	.013161	82.45	.43318	.00	.00000
2	82.45	.383597	82.45	.049298	82.45	.38564	.00	.00000
3	93.10	.302923	93.11	.050720	93.11	.30893	.00	.00000
4	93.10	.294522	93.11	.088423	93.11	.30403	.00	.00000
5	82.41	.435541	93.10	.044677	93.10	.29654	.00	.00000
6	82.40	.651778	93.12	.376527	93.12	.27502	.00	.00000
7	82.40	.653548	93.09	.260866	93.09	.26823	.00	.00000
8	93.03	.285014	93.08	.407146	93.08	.25106	.00	.00000
9	93.01	.289906	93.05	.145639	93.05	.25738	.00	.00000
10	93.00	.291189	93.04	.204414	93.04	.24948	.00	.00000
11	92.99	.292047	93.03	.164438	93.03	.24526	.00	.00000
12	92.98	.288448	93.02	.205426	93.02	.23563	.00	.00000
13	92.95	.311071	93.00	.115052	93.00	.23189	.00	.00000
14	92.94	.314416	93.00	.134006	93.00	.22395	.00	.00000
15	108.37	6.220881	.00	.000000	.00	.00000	.00	.00000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 106.960 (sec) **

****
* N O R M A L T E R M I N A T I O N *
* NUMBER OF INCREMENTAL CALCULATIONS:17900 *
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             N. Matasovic     ³³o³o³  ³  ³
                               ³³  ³
                                ³
                 A Computer  Program for Seismic
                Response Analyses of Horizontally
                Layered Soil  Deposits, Earthfill
                 Dams and  Solid Waste Landfills
                               by
                    Neven Matasovic, 1993;`06

          The following models are incorporated in this
                        computer program:
          Dynamic Response  Model by Lee & Finn (1978);
          Stress-Strain Model by Matasovic and Vucetic
          (1993);  Cyclic Degradation - PWP Generation
          Model for Clay by Matasovic & Vucetic (1995);
          PWP Model for Sand by Vucetic & Dobry (1988);
          PWP Dissipation-PWP Redistribution Model for
          Composite Soil  Deposits by Matasovic (1993).


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Input file name = riv-70-4.inp         Output file name = riv-70-4.out
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****************************************************
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****************************************************

Riverbend Landfill Module 11 - 70-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

NPTYPE =  1 ;   NLINEL =  1 ;   NMAT   =  8 ;   NLAYER = 14 ;   NDAMP  =  2
ITMBY  =  1 ;   NBT    =  0 ;   NBB    =  1 ;   ITERRV =  1 ;   ICKFB  =  1

***********************************************************
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
***********************************************************

************* STRESS - STRAIN MODEL *************

LAYER    G_mo        T_mo          á          s
        (psf)       (psf)         (-)        (-)
  1    1173551.     1079.67       1.30        .85
  2    1173551.     1079.67       1.30        .85
  3    1561693.     1436.76       1.30        .85
  4    1561693.     1436.76       1.30        .85
  5    2356703.     3770.72       1.10        .85
  6    2561634.      829.97       1.10        .90
  7    3210205.     1040.11       1.10        .90
  8    3210205.     1040.11       1.10        .90
  9    4701001.     1523.12       1.10        .90
 10    4701001.     1523.12       1.10        .90
 11    5409648.     1752.73       1.10        .90
 12    5409648.     1752.73       1.10        .90
 13    6769441.     2193.30       1.10        .90
 14    6769441.     2193.30       1.10        .90

****** PWP DISSIPATION MODEL ******     *** PHYSICAL PROPERTIES OF SOIL ***

LAYER     E_r       K_2      m     n        UW_sat      UW_wet          k
         (psf)      (-)     (-)   (-)       (pcf)       (pcf)       (ft/sec)
  1   0.000E+00   .0000    .00   .00       115.00      115.00      0.000E+00
  2   0.000E+00   .0000    .00   .00       115.00      115.00      0.000E+00
```

3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
13	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
14	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv (%)	f (-)	p (-)	F (-)	s (-)	v (-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00
13	.100	2.000	1.005	3.000	1.700	1.00
14	.100	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR (-)	s_t (-)	r_t (-)	A (-)	B (-)	C (-)	D (-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000
13	.00	.000	.000	.0000	.0000	.0000	.0000
14	.00	.000	.000	.0000	.0000	.0000	.0000

****
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
****

LAYER	MAT. TYPE	NSUBDIV	THICK (ft)	WIDTH (ft)	MODEL(S)
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	4	2	5.00	1.00	0
7	5	2	5.00	1.00	0
8	5	2	5.00	1.00	0
9	6	2	5.00	1.00	0
10	6	2	5.00	1.00	0
11	7	2	5.00	1.00	0
12	7	2	5.00	1.00	0
13	8	2	5.00	1.00	0
14	8	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW = 131. (pcf)
SHEAR WAVE VELOCITY, V_s = 1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

** FUNDAMENTAL PERIOD OF THE DEPOSIT IS: .299 sec
TOTAL THICKNESS OF THE DEPOSIT IS: 70.0 ft
WT. AVERAGE SHEAR WAVE VELOCITY IS: 936.4 ft/sec)

DEPTH (ft)	å`vo (psf)	V_s (ft/sec)	REF. STRAIN (-)	c (%)
2.50	287.50	573.00	.00092	1.00
7.50	862.50	573.00	.00092	1.00
12.50	1437.50	661.00	.00092	1.00
17.50	2012.50	661.00	.00092	1.00
22.50	2587.50	812.00	.00160	1.00
27.50	3187.50	812.00	.00032	1.00
32.50	3812.50	909.00	.00032	1.00
37.50	4437.50	909.00	.00032	1.00
42.50	5062.50	1100.00	.00032	1.00
47.50	5687.50	1100.00	.00032	1.00
52.50	6312.50	1180.00	.00032	1.00
57.50	6937.50	1180.00	.00032	1.00
62.50	7562.50	1320.00	.00032	1.00
67.50	8187.50	1320.00	.00032	1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****

LAYER	à_R (-)	á_R (-)	{k} (psf)	{c} (-)	{m} (lb sý/ftýft)
1	0.000E+00	9.520E-04	1.174E+06	1.117E+03	8.94E+00
2	0.000E+00	9.520E-04	1.174E+06	1.117E+03	1.79E+01
3	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
4	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
5	0.000E+00	9.520E-04	2.357E+06	2.244E+03	1.79E+01
6	0.000E+00	9.520E-04	2.562E+06	2.439E+03	1.86E+01
7	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
8	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
9	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
10	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
11	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
12	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
13	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01
14	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01

(N+1)TH MASS FOR TRANSMITTING BOUNDARY = 9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

DIAGONAL TERMS:
```
2.347E+05  4.694E+05  5.470E+05  6.247E+05  7.837E+05  9.837E+05  1.154E+06  1.284E+06  1.582E+0
2.022E+06  2.164E+06  2.436E+06  2.708E+06  1.354E+06
```

OFF-DIAGONAL TERMS:
```
-2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -5.123E+05 -6.420E+05 -6.420E+05 -9.402E+0
-1.082E+06 -1.082E+06 -1.354E+06 -1.354E+06
```

** INITIAL DAMPING MATRIX, [C] **

```
   DIAGONAL TERMS:
   2.234E+02  4.469E+02  5.208E+02  5.947E+02  7.461E+02  9.365E+02  1.099E+03  1.222E+03  1.506E+0
   1.925E+03  2.060E+03  2.319E+03  2.578E+03  8.716E+03

   OFF-DIAGONAL TERMS:
  -2.234E+02 -2.234E+02 -2.973E+02 -2.973E+02 -4.487E+02 -4.877E+02 -6.112E+02 -6.112E+02 -8.951E+0
  -1.030E+03 -1.030E+03 -1.289E+03 -1.289E+03

******************************************************
* DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
******************************************************

** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
   NEQ    =    1 ;   INTYP  =    1 ;   NC     =24000
   NCPR   =24000 ;   NCPRM  =24000 ;   NPLD   =    1

** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
   NCARD  =24000 ;   NREC   =    8 ;   NFTS   =    0

   INPUT ACC. VALUES ARE MULTIPLIED BY:     1.634290
   ACCELERATION VALUES ARE DIGITIZED @:   .010 (sec)
   ACCELERATION VALUES  ARE  READ FROM: set4_tcg.eq

** ACCELEROGRAM HEADER:

   Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
   SHAKE2000 Conversion:    24000     .01       6         8         9        (8
   Acceleration Units: (g's) - No. Values: 24000 - Time Step: .01 (secs)
   Data Format: (8f9.6) - No. Header Lines:  6
     Time history matched to spectrum:../target/M9R50.tgt
    24000    0.0100


****************************************************
* DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
****************************************************


** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

   FILE NAME:     CONTENTS:                            UNITS:

   i-time.prn     Time axis                             (sec)
   i-baccel.prn   (Scaled) base (input) acceleration      (g)
   i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
   i-accel.prn    Acceleration in layer "i"               (g)
   i-veloc.prn    Velocity in layer "i"               (ft/sec)
   i-displ.prn    Displacement in layer "i"              (ft)
   i-gamma%.prn   Shear strain in layer "i"               (%)
   i-tau.prn      Shear stress in layer "i"             (psf)
   i-ustar.prn    Normalized PWP in layer "i"             (-)
   i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
   i-taustr.prn   Normalized shear stress in layer "i"    (-)


** RESULTS AT TIME =240.000 (sec), WHEN INPUT ACC. = -.000002 (g)

   LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
            (g)       (ft/sec)     (ft)         (%)        (psf)

     1   -.000428     .267E-01    .428E+01   -.572E-04    .101E+00
     2    .000172     .267E-01    .428E+01   -.103E-02    .589E-01
     3   -.000049     .267E-01    .429E+01   -.152E-02    .248E-01
     4    .000157     .266E-01    .429E+01   -.159E-02   -.732E-01
     5   -.000079     .266E-01    .429E+01    .191E-03    .117E+00
     6    .000324     .266E-01    .429E+01    .379E-02   -.135E+00
     7   -.000377     .266E-01    .428E+01    .679E-02   -.117E+00
     8    .000137     .267E-01    .428E+01    .236E-01    .177E+00
     9   -.000091     .267E-01    .428E+01    .327E-02   -.196E+00
    10   -.000766     .267E-01    .428E+01    .157E-02    .664E+00
```

11	.001729	.267E-01	.428E+01	-.544E-03	-.763E+00
12	-.001665	.267E-01	.428E+01	-.139E-02	.750E+00
13	.000369	.267E-01	.428E+01	-.118E-02	-.315E+00
14	.000506	.267E-01	.428E+01	-.315E-02	.729E-01
15	.693275	.266E-01	.428E+01	.000E+00	.000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
"NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
IN A TOTAL STRESS ANALYSIS.

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 240.000 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	113.20	.353061	113.21	.010159	113.21	99.37	.00	.000
2	113.22	.346204	113.22	.040629	113.22	289.15	.00	.000
3	113.22	.312372	113.22	.053399	113.22	458.53	.00	.000
4	113.24	.269597	113.23	.080776	113.23	582.97	.00	.000
5	113.25	.274528	113.23	.037763	113.23	672.99	.00	.000
6	113.26	.302658	112.83	.239077	112.82	800.27	.00	.000
7	113.28	.261019	112.82	.183178	112.82	943.91	.00	.000
8	113.13	.283821	112.81	.308530	112.81	1058.03	.00	.000
9	113.14	.295274	112.80	.110557	112.80	1203.09	.00	.000
10	113.15	.297905	112.80	.150414	112.80	1314.33	.00	.000
11	113.14	.303567	112.79	.127629	112.79	1445.03	.00	.000
12	113.14	.331433	112.78	.169352	112.78	1559.86	.00	.000
13	113.13	.321800	112.77	.104393	112.77	1701.67	.00	.000
14	113.13	.328091	112.77	.130441	112.77	1819.60	.00	.000
15	114.88	2.025449	.00	.000000	.00	.00	.00	.000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 113.120 (sec) **

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 240.010 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	113.20	.353061	113.21	.010159	113.21	.34563	.00	.00000
2	113.22	.346204	113.22	.040629	113.22	.33524	.00	.00000
3	113.22	.312372	113.22	.053399	113.22	.31898	.00	.00000
4	113.24	.269597	113.23	.080776	113.23	.28967	.00	.00000
5	113.25	.274528	113.23	.037763	113.23	.26009	.00	.00000
6	113.26	.302658	112.83	.239077	112.82	.25107	.00	.00000
7	113.28	.261019	112.82	.183178	112.82	.24758	.00	.00000
8	113.13	.283821	112.81	.308530	112.81	.23843	.00	.00000
9	113.14	.295274	112.80	.110557	112.80	.23765	.00	.00000
10	113.15	.297905	112.80	.150414	112.80	.23109	.00	.00000
11	113.14	.303567	112.79	.127629	112.79	.22892	.00	.00000
12	113.14	.331433	112.78	.169352	112.78	.22484	.00	.00000
13	113.13	.321800	112.77	.104393	112.77	.22501	.00	.00000
14	113.13	.328091	112.77	.130441	112.77	.22224	.00	.00000
15	114.88	2.025449	.00	.000000	.00	.00000	.00	.00000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 113.120 (sec) **

****
* N O R M A L T E R M I N A T I O N *
* NUMBER OF INCREMENTAL CALCULATIONS:24000 *
****

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            á 9.03   ÀÄÄÅ×××××××ÅÅÅÄÄ
        N. Matasovic     ³³o³o³  ³  ³
                        ³³ ³
                          ³
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A Computer Program for Seismic
Response Analyses of Horizontally
Layered Soil Deposits, Earthfill
Dams and Solid Waste Landfills
by
Neven Matasovic, 1993;`06

The following models are incorporated in this
computer program:
Dynamic Response Model by Lee & Finn (1978);
Stress-Strain Model by Matasovic and Vucetic
(1993); Cyclic Degradation - PWP Generation
Model for Clay by Matasovic & Vucetic (1995);
PWP Model for Sand by Vucetic & Dobry (1988);
PWP Dissipation-PWP Redistribution Model for
Composite Soil Deposits by Matasovic (1993).

ÄÄÄ
Input file name = riv-70-5.inp   Output file name = riv-70-5.out
ÄÄÄ

****
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****

Riverbend Landfill Module 11 - 70-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

```
NPTYPE =  1 ;   NLINEL =  1 ;   NMAT   =  8 ;   NLAYER = 14 ;   NDAMP  =  2
ITMBY  =  1 ;   NBT    =  0 ;   NBB    =  1 ;   ITERRV =  1 ;   ICKFB  =  1
```

****
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
****

************* STRESS - STRAIN MODEL *************

LAYER	G_mo (psf)	T_mo (psf)	á (-)	s (-)
1	1173551.	1079.67	1.30	.85
2	1173551.	1079.67	1.30	.85
3	1561693.	1436.76	1.30	.85
4	1561693.	1436.76	1.30	.85
5	2356703.	3770.72	1.10	.85
6	2561634.	829.97	1.10	.90
7	3210205.	1040.11	1.10	.90
8	3210205.	1040.11	1.10	.90
9	4701001.	1523.12	1.10	.90
10	4701001.	1523.12	1.10	.90
11	5409648.	1752.73	1.10	.90
12	5409648.	1752.73	1.10	.90
13	6769441.	2193.30	1.10	.90
14	6769441.	2193.30	1.10	.90

****** PWP DISSIPATION MODEL ******   *** PHYSICAL PROPERTIES OF SOIL ***

LAYER	E_r (psf)	K_2 (-)	m (-)	n (-)	UW_sat (pcf)	UW_wet (pcf)	k (ft/sec)
1	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
2	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00

3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
13	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
14	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv	f	p	F	s	v
	(%)	(-)	(-)	(-)	(-)	(-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00
13	.100	2.000	1.005	3.000	1.700	1.00
14	.100	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR	s_t	r_t	A	B	C	D
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000
13	.00	.000	.000	.0000	.0000	.0000	.0000
14	.00	.000	.000	.0000	.0000	.0000	.0000

****
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
****

LAYER	MAT. TYPE	NSUBDIV	THICK	WIDTH	MODEL(S)
			(ft)	(ft)	
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	4	2	5.00	1.00	0
7	5	2	5.00	1.00	0
8	5	2	5.00	1.00	0
9	6	2	5.00	1.00	0
10	6	2	5.00	1.00	0
11	7	2	5.00	1.00	0
12	7	2	5.00	1.00	0
13	8	2	5.00	1.00	0
14	8	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW =   131. (pcf)
SHEAR WAVE VELOCITY, V_s =   1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

** FUNDAMENTAL PERIOD OF THE DEPOSIT IS: .299 sec
TOTAL THICKNESS OF THE DEPOSIT IS: 70.0 ft
WT. AVERAGE SHEAR WAVE VELOCITY IS: 936.4 ft/sec)

DEPTH (ft)	å`vo (psf)	V_s (ft/sec)	REF. STRAIN (-)	c (%)
2.50	287.50	573.00	.00092	1.00
7.50	862.50	573.00	.00092	1.00
12.50	1437.50	661.00	.00092	1.00
17.50	2012.50	661.00	.00092	1.00
22.50	2587.50	812.00	.00160	1.00
27.50	3187.50	812.00	.00032	1.00
32.50	3812.50	909.00	.00032	1.00
37.50	4437.50	909.00	.00032	1.00
42.50	5062.50	1100.00	.00032	1.00
47.50	5687.50	1100.00	.00032	1.00
52.50	6312.50	1180.00	.00032	1.00
57.50	6937.50	1180.00	.00032	1.00
62.50	7562.50	1320.00	.00032	1.00
67.50	8187.50	1320.00	.00032	1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****

LAYER	à_R (-)	á_R (-)	{k} (psf)	{c} (-)	{m} (lb sý/ftýft)
1	0.000E+00	9.520E-04	1.174E+06	1.117E+03	8.94E+00
2	0.000E+00	9.520E-04	1.174E+06	1.117E+03	1.79E+01
3	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
4	0.000E+00	9.520E-04	1.562E+06	1.487E+03	1.79E+01
5	0.000E+00	9.520E-04	2.357E+06	2.244E+03	1.79E+01
6	0.000E+00	9.520E-04	2.562E+06	2.439E+03	1.86E+01
7	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
8	0.000E+00	9.520E-04	3.210E+06	3.056E+03	1.94E+01
9	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
10	0.000E+00	9.520E-04	4.701E+06	4.475E+03	1.94E+01
11	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
12	0.000E+00	9.520E-04	5.410E+06	5.150E+03	1.94E+01
13	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01
14	0.000E+00	9.520E-04	6.769E+06	6.445E+03	1.94E+01

(N+1)TH MASS FOR TRANSMITTING BOUNDARY =   9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

DIAGONAL TERMS:
2.347E+05 4.694E+05 5.470E+05 6.247E+05 7.837E+05 9.837E+05 1.154E+06 1.284E+06 1.582E+0
2.022E+06 2.164E+06 2.436E+06 2.708E+06 1.354E+06

OFF-DIAGONAL TERMS:
-2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -5.123E+05 -6.420E+05 -6.420E+05 -9.402E+0
-1.082E+06 -1.082E+06 -1.354E+06 -1.354E+06

** INITIAL DAMPING MATRIX, [C] **

```
   DIAGONAL TERMS:
   2.234E+02  4.469E+02  5.208E+02  5.947E+02  7.461E+02  9.365E+02  1.099E+03  1.222E+03  1.506E+0
   1.925E+03  2.060E+03  2.319E+03  2.578E+03  8.716E+03

   OFF-DIAGONAL TERMS:
  -2.234E+02 -2.234E+02 -2.973E+02 -2.973E+02 -4.487E+02 -4.877E+02 -6.112E+02 -6.112E+02 -8.951E+0
  -1.030E+03 -1.030E+03 -1.289E+03 -1.289E+03

******************************************************
* DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
******************************************************

** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
   NEQ    =    1 ;   INTYP  =    1 ;   NC     =24000
   NCPR   =24000 ;   NCPRM  =24000 ;   NPLD   =    1

** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
   NCARD  =24000 ;   NREC   =    8 ;   NFTS   =    0

   INPUT ACC. VALUES ARE MULTIPLIED BY:     1.877774
   ACCELERATION VALUES ARE DIGITIZED @:   .010 (sec)
   ACCELERATION VALUES  ARE  READ FROM: set5_ibr8.eq

** ACCELEROGRAM HEADER:

   Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
   SHAKE2000 Conversion:    24000     .01       6         8         9        (8
   Acceleration Units: (g's) - No. Values: 24000 - Time Step: .01 (secs)
   Data Format: (8F9.6) - No. Header Lines:  6
     Time history matched to spectrum:../target/M9R50.tgt
    24000    0.0100


****************************************************
* DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
****************************************************


** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

   FILE NAME:     CONTENTS:                              UNITS:

   i-time.prn     Time axis                               (sec)
   i-baccel.prn   (Scaled) base (input) acceleration        (g)
   i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
   i-accel.prn    Acceleration in layer "i"                 (g)
   i-veloc.prn    Velocity in layer "i"                (ft/sec)
   i-displ.prn    Displacement in layer "i"                (ft)
   i-gamma%.prn   Shear strain in layer "i"                 (%)
   i-tau.prn      Shear stress in layer "i"               (psf)
   i-ustar.prn    Normalized PWP in layer "i"               (-)
   i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
   i-taustr.prn   Normalized shear stress in layer "i"     (-)


** RESULTS AT TIME =240.000 (sec), WHEN INPUT ACC. = -.000002 (g)

   LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
            (g)       (ft/sec)     (ft)         (%)        (psf)

     1     .000146    -.566E-02    .229E+01    .906E-04    .180E-01
     2   -.000011    -.574E-02    .229E+01    .567E-03   -.946E-01
     3   -.000175    -.572E-02    .229E+01    .496E-03    .169E+00
     4     .000231    -.574E-02    .229E+01    .114E-02   -.162E+00
     5   -.000140    -.576E-02    .229E+01    .196E-03    .321E-01
     6   -.000089    -.580E-02    .229E+01    .323E-01   -.830E-02
     7     .000206    -.581E-02    .229E+01    .191E-01   -.110E-01
     8     .000010    -.575E-02    .228E+01    .423E-01   -.634E-02
     9   -.000302    -.577E-02    .228E+01    .848E-02    .306E+00
    10     .000113    -.580E-02    .228E+01    .150E-01   -.169E+00
```

11	-.000001	-.579E-02	.228E+01	.119E-01	.140E+00
12	.000188	-.577E-02	.228E+01	.191E-01	-.175E+00
13	-.000515	-.571E-02	.228E+01	.762E-02	.225E+00
14	.000661	-.575E-02	.228E+01	.903E-02	.466E+00
15	3.071265	-.579E-02	.228E+01	.000E+00	.000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
"NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
IN A TOTAL STRESS ANALYSIS.

```
*********************************************************
* MAXIMUM VALUES OCCURRED FROM    .000  TO 240.000  sec *
*********************************************************
```

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	107.58	.415581	107.58	.012364	107.58	117.39	.00	.000
2	107.58	.326456	107.58	.043368	107.58	301.87	.00	.000
3	106.49	.306362	109.48	.044889	109.48	410.83	.00	.000
4	107.55	.348776	107.43	.072868	107.43	550.73	.00	.000
5	107.54	.555131	107.44	.039260	107.44	693.99	.00	.000
6	107.55	.489223	107.47	.276902	107.47	826.17	.00	.000
7	107.53	.327615	107.46	.190618	107.46	953.06	.00	.000
8	107.54	.566533	104.50	.282364	104.50	1039.48	.00	.000
9	104.50	.272191	104.48	.109031	104.48	1197.93	.00	.000
10	117.91	.258858	104.48	.148139	104.48	1308.97	.00	.000
11	116.67	.252065	104.47	.121458	104.47	1424.29	.00	.000
12	109.57	.272443	104.46	.149443	104.46	1509.85	.00	.000
13	109.56	.273330	104.45	.087397	104.45	1604.69	.00	.000
14	111.01	.299237	107.78	.100408	107.78	1681.80	.00	.000
15	203.42	3.185687	.00	.000000	.00	.00	.00	.000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 111.000 (sec) **

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*********************************************************
* MAXIMUM VALUES OCCURRED FROM    .000  TO 240.010  sec *
*********************************************************
```

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	107.58	.415581	107.58	.012364	107.58	.40831	.00	.00000
2	107.58	.326456	107.58	.043368	107.58	.34999	.00	.00000
3	106.49	.306362	109.48	.044889	109.48	.28579	.00	.00000
4	107.55	.348776	107.43	.072868	107.43	.27365	.00	.00000
5	107.54	.555131	107.44	.039260	107.44	.26821	.00	.00000
6	107.55	.489223	107.47	.276902	107.47	.25919	.00	.00000
7	107.53	.327615	107.46	.190618	107.46	.24998	.00	.00000
8	107.54	.566533	104.50	.282364	104.50	.23425	.00	.00000
9	104.50	.272191	104.48	.109031	104.48	.23663	.00	.00000
10	117.91	.258858	104.48	.148139	104.48	.23015	.00	.00000
11	116.67	.252065	104.47	.121458	104.47	.22563	.00	.00000
12	109.57	.272443	104.46	.149443	104.46	.21764	.00	.00000
13	109.56	.273330	104.45	.087397	104.45	.21219	.00	.00000
14	111.01	.299237	107.78	.100408	107.78	.20541	.00	.00000
15	203.42	3.185687	.00	.000000	.00	.00000	.00	.00000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 111.000 (sec) **

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********************************************
* N O R M A L  T E R M I N A T I O N       *
* NUMBER OF INCREMENTAL CALCULATIONS:24000 *
********************************************
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             á 9.03   ÀÄÄÅ×××××××ÅÅÅÄÄ
         N. Matasovic      ³³o³o³  ³  ³
                            ³³  ³
                              ³
```

A Computer Program for Seismic Response Analyses of Horizontally Layered Soil Deposits, Earthfill Dams and Solid Waste Landfills
by
Neven Matasovic, 1993;`06

The following models are incorporated in this computer program:
Dynamic Response Model by Lee & Finn (1978);
Stress-Strain Model by Matasovic and Vucetic (1993); Cyclic Degradation - PWP Generation Model for Clay by Matasovic & Vucetic (1995);
PWP Model for Sand by Vucetic & Dobry (1988);
PWP Dissipation-PWP Redistribution Model for Composite Soil Deposits by Matasovic (1993).

ÄÄÄ
Input file name = riv-60-1.inp   Output file name = riv-60-1.out
ÄÄÄ

****
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****

Riverbend Landfill Module 11 - 60-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

```
NPTYPE =  1 ;   NLINEL =  1 ;   NMAT   =  6 ;   NLAYER = 12 ;   NDAMP  =  2
ITMBY  =  1 ;   NBT    =  0 ;   NBB    =  1 ;   ITERRV =  1 ;   ICKFB  =  1
```

****
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
****

************* STRESS - STRAIN MODEL *************

LAYER	G_mo (psf)	T_mo (psf)	á (-)	s (-)
1	1173551.	1079.67	1.30	.85
2	1173551.	1079.67	1.30	.85
3	1561693.	1436.76	1.30	.85
4	1561693.	1436.76	1.30	.85
5	2356703.	3770.72	1.10	.85
6	2356703.	3770.72	1.10	.85
7	3210205.	1040.11	1.10	.90
8	3210205.	1040.11	1.10	.90
9	4701001.	1523.12	1.10	.90
10	4701001.	1523.12	1.10	.90
11	5409648.	1752.73	1.10	.90
12	5409648.	1752.73	1.10	.90

****** PWP DISSIPATION MODEL ******   *** PHYSICAL PROPERTIES OF SOIL ***

LAYER	E_r (psf)	K_2 (-)	m (-)	n (-)	UW_sat (pcf)	UW_wet (pcf)	k (ft/sec)
1	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
2	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
3	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
4	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00

5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv	f	p	F	s	v
	(%)	(-)	(-)	(-)	(-)	(-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR	s_t	r_t	A	B	C	D
	(-)	(-)	(-)	(-)	(-)	(-)	(-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000

****
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
****

LAYER	MAT. TYPE	NSUBDIV	THICK	WIDTH	MODEL(S)
			(ft)	(ft)	
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	3	2	5.00	1.00	0
7	4	2	5.00	1.00	0
8	4	2	5.00	1.00	0
9	5	2	5.00	1.00	0
10	5	2	5.00	1.00	0
11	6	2	5.00	1.00	0
12	6	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW = 131. (pcf)
SHEAR WAVE VELOCITY, V_s = 1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

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** FUNDAMENTAL PERIOD OF THE DEPOSIT IS:   .275 sec
   TOTAL THICKNESS OF THE DEPOSIT IS:      60.0 ft
   WT. AVERAGE SHEAR WAVE VELOCITY IS:    872.5 ft/sec)

     DEPTH       å`vo      V_s      REF. STRAIN           c
      (ft)      (psf)   (ft/sec)        (-)              (%)

      2.50     287.50    573.00        .00092           1.00
      7.50     862.50    573.00        .00092           1.00
     12.50    1437.50    661.00        .00092           1.00
     17.50    2012.50    661.00        .00092           1.00
     22.50    2587.50    812.00        .00160           1.00
     27.50    3162.50    812.00        .00160           1.00
     32.50    3762.50    909.00        .00032           1.00
     37.50    4387.50    909.00        .00032           1.00
     42.50    5012.50   1100.00        .00032           1.00
     47.50    5637.50   1100.00        .00032           1.00
     52.50    6262.50   1180.00        .00032           1.00
     57.50    6887.50   1180.00        .00032           1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
   VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
   SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****************************************************
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****************************************************

LAYER   à_R        á_R         {k}        {c}         {m}
        (-)        (-)        (psf)       (-)    (lb sý/ftýft)

  1  0.000E+00  8.750E-04   1.174E+06  1.027E+03    8.94E+00
  2  0.000E+00  8.750E-04   1.174E+06  1.027E+03    1.79E+01
  3  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  4  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  5  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  6  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  7  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.86E+01
  8  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.94E+01
  9  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 10  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 11  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01
 12  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01

   (N+1)TH MASS FOR TRANSMITTING BOUNDARY =   9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

   DIAGONAL TERMS:
   2.347E+05  4.694E+05  5.470E+05  6.247E+05  7.837E+05  9.427E+05  1.113E+06  1.284E+06  1.582E+0
   2.022E+06  2.164E+06  1.082E+06

   OFF-DIAGONAL TERMS:
  -2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -4.713E+05 -6.420E+05 -6.420E+05 -9.402E+0
  -1.082E+06 -1.082E+06

** INITIAL DAMPING MATRIX, [C] **

   DIAGONAL TERMS:
   2.054E+02  4.107E+02  4.787E+02  5.466E+02  6.857E+02  8.248E+02  9.742E+02  1.124E+03  1.384E+0
   1.769E+03  1.893E+03  8.374E+03

   OFF-DIAGONAL TERMS:
  -2.054E+02 -2.054E+02 -2.733E+02 -2.733E+02 -4.124E+02 -4.124E+02 -5.618E+02 -5.618E+02 -8.227E+0
  -9.467E+02 -9.467E+02

******************************************************
* DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
******************************************************

** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
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```
   NEQ    =    1 ;   INTYP  =    1 ;   NC     =22000
   NCPR   =22000 ;   NCPRM  =22000 ;   NPLD   =    1

** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
   NCARD  =22000 ;   NREC   =    8 ;   NFTS   =    0

   INPUT ACC. VALUES ARE MULTIPLIED BY:     1.604850
   ACCELERATION VALUES ARE DIGITIZED @:   .005 (sec)
   ACCELERATION VALUES  ARE  READ FROM: set1_hual.eq

** ACCELEROGRAM HEADER:

   Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
   SHAKE2000 Conversion:    22000     .005      6        8        9        (8
   Acceleration Units: (g's) - No. Values: 22000 - Time Step: .005 (secs)
   Data Format: (8F9.6) - No. Header Lines:  6
    Time history matched to spectrum:../target/M9R50-tw1.tgt by NA
    22000    0.0050


****************************************************
* DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
****************************************************


** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

   FILE NAME:     CONTENTS:                             UNITS:

   i-time.prn     Time axis                              (sec)
   i-baccel.prn   (Scaled) base (input) acceleration       (g)
   i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
   i-accel.prn    Acceleration in layer "i"                (g)
   i-veloc.prn    Velocity in layer "i"              (ft/sec)
   i-displ.prn    Displacement in layer "i"              (ft)
   i-gamma%.prn   Shear strain in layer "i"               (%)
   i-tau.prn      Shear stress in layer "i"             (psf)
   i-ustar.prn    Normalized PWP in layer "i"             (-)
   i-dindex.prn   Degrad. index in layer "i" (clay only)  (-)
   i-taustr.prn   Normalized shear stress in layer "i"    (-)


** RESULTS AT TIME =110.000 (sec), WHEN INPUT ACC. =  .000037 (g)

   LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
            (g)       (ft/sec)     (ft)         (%)        (psf)

     1    .000002     .981E-02   -.321E+00   -.453E-04   -.116E-02
     2    .000059     .982E-02   -.321E+00   -.547E-03   -.346E-01
     3    .000041     .982E-02   -.321E+00   -.832E-03   -.554E-01
     4    .000014     .982E-02   -.321E+00   -.136E-02   -.598E-01
     5    .000041     .983E-02   -.320E+00   -.242E-03   -.104E+00
     6    .000052     .982E-02   -.320E+00   -.306E-03   -.116E+00
     7    .000030     .982E-02   -.320E+00   -.165E-01   -.130E+00
     8    .000033     .982E-02   -.320E+00   -.374E-01   -.165E+00
     9    .000042     .982E-02   -.318E+00   -.470E-02   -.174E+00
    10    .000026     .983E-02   -.318E+00   -.493E-02   -.194E+00
    11    .000031     .982E-02   -.317E+00   -.329E-02   -.235E+00
    12    .000076     .982E-02   -.317E+00   -.392E-02   -.268E+00
    13   3.012693     .982E-02   -.317E+00    .000E+00    .000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
   EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
   "NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
   NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
   IN A TOTAL STRESS ANALYSIS.


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* MAXIMUM VALUES OCCURRED FROM .000 TO 110.000 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	54.20	.294901	54.20	.008452	54.20	84.71	.00	.000
2	54.21	.285952	54.21	.032380	54.21	247.53	.00	.000
3	27.80	.271899	36.76	.042477	36.76	396.27	.00	.000
4	49.31	.273793	27.80	.070360	27.80	539.95	.00	.000
5	27.41	.263648	27.78	.038314	27.78	680.75	.00	.000
6	27.41	.268834	27.78	.048450	27.78	816.48	.00	.000
7	27.41	.272443	27.43	.192534	27.43	955.35	.00	.000
8	36.22	.256606	27.43	.312784	27.43	1060.87	.00	.000
9	29.45	.292173	27.41	.102162	27.41	1173.62	.00	.000
10	29.45	.301969	27.38	.131381	27.38	1266.20	.00	.000
11	29.43	.316340	27.36	.103679	27.36	1356.90	.00	.000
12	29.42	.346158	27.40	.123528	27.40	1431.38	.00	.000
13	49.86	5.115381	.00	.000000	.00	.00	.00	.000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 29.415 (sec) **

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 110.005 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	54.20	.294901	54.20	.008452	54.20	.29466	.00	.00000
2	54.21	.285952	54.21	.032380	54.21	.28699	.00	.00000
3	27.80	.271899	36.76	.042477	36.76	.27567	.00	.00000
4	49.31	.273793	27.80	.070360	27.80	.26830	.00	.00000
5	27.41	.263648	27.78	.038314	27.78	.26309	.00	.00000
6	27.41	.268834	27.78	.048450	27.78	.25817	.00	.00000
7	27.41	.272443	27.43	.192534	27.43	.25391	.00	.00000
8	36.22	.256606	27.43	.312784	27.43	.24179	.00	.00000
9	29.45	.292173	27.41	.102162	27.41	.23414	.00	.00000
10	29.45	.301969	27.38	.131381	27.38	.22460	.00	.00000
11	29.43	.316340	27.36	.103679	27.36	.21667	.00	.00000
12	29.42	.346158	27.40	.123528	27.40	.20782	.00	.00000
13	49.86	5.115381	.00	.000000	.00	.00000	.00	.00000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 29.415 (sec) **

****
* N O R M A L T E R M I N A T I O N *
* NUMBER OF INCREMENTAL CALCULATIONS:22000 *
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         N. Matasovic      33O3O3  3  3
                            33  3
                             3
              A Computer  Program for Seismic
             Response Analyses of Horizontally
             Layered Soil  Deposits, Earthfill
              Dams and  Solid Waste Landfills
                             by
                 Neven Matasovic, 1993;`06

     The following models are incorporated in this
                    computer program:
     Dynamic Response  Model by Lee & Finn (1978);
     Stress-Strain Model by Matasovic and Vucetic
     (1993);  Cyclic Degradation - PWP Generation
     Model for Clay by Matasovic & Vucetic (1995);
     PWP Model for Sand by Vucetic & Dobry (1988);
     PWP Dissipation-PWP Redistribution Model for
     Composite Soil  Deposits by Matasovic (1993).


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Input file name = riv-60-2.inp         Output file name = riv-60-2.out
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****************************************************
* PROBLEM DESCRIPTION & ANALYSIS CONTROL VARIABLES *
****************************************************

Riverbend Landfill Module 11 - 60-ft Alluvium (SCPT & MASW) - F-F @ 0.440 g

NPTYPE =  1 ;   NLINEL =  1 ;   NMAT   =  6 ;   NLAYER = 12 ;   NDAMP  =  2
ITMBY  =  1 ;   NBT    =  0 ;   NBB    =  1 ;   ITERRV =  1 ;   ICKFB  =  1

***********************************************************
* MATERIAL PROPERTIES & PARAMETERS OF CONSTITUTIVE MODELS *
***********************************************************

************* STRESS - STRAIN MODEL *************

LAYER    G_mo        T_mo         á         s
        (psf)       (psf)        (-)       (-)
  1    1173551.     1079.67       1.30        .85
  2    1173551.     1079.67       1.30        .85
  3    1561693.     1436.76       1.30        .85
  4    1561693.     1436.76       1.30        .85
  5    2356703.     3770.72       1.10        .85
  6    2356703.     3770.72       1.10        .85
  7    3210205.     1040.11       1.10        .90
  8    3210205.     1040.11       1.10        .90
  9    4701001.     1523.12       1.10        .90
 10    4701001.     1523.12       1.10        .90
 11    5409648.     1752.73       1.10        .90
 12    5409648.     1752.73       1.10        .90

****** PWP DISSIPATION MODEL ******     *** PHYSICAL PROPERTIES OF SOIL ***

LAYER      E_r       K_2      m      n        UW_sat      UW_wet         k
          (psf)      (-)     (-)    (-)        (pcf)       (pcf)      (ft/sec)
  1    0.000E+00   .0000    .00    .00       115.00      115.00      0.000E+00
  2    0.000E+00   .0000    .00    .00       115.00      115.00      0.000E+00
  3    0.000E+00   .0000    .00    .00       115.00      115.00      0.000E+00
  4    0.000E+00   .0000    .00    .00       115.00      115.00      0.000E+00
```

5	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
6	0.000E+00	.0000	.00	.00	115.00	115.00	0.000E+00
7	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
8	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
9	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
10	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
11	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00
12	0.000E+00	.0000	.00	.00	125.00	125.00	0.000E+00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 1 ****

LAYER	ç_tv (%)	f (-)	p (-)	F (-)	s (-)	v (-)
1	.100	2.000	1.040	3.000	1.800	1.00
2	.100	2.000	1.040	3.000	1.800	1.00
3	.025	2.000	1.005	3.000	1.800	1.00
4	.025	2.000	1.005	3.000	1.800	1.00
5	.025	2.000	1.005	3.000	1.800	1.00
6	.025	2.000	1.005	3.000	1.800	1.00
7	.025	2.000	1.005	3.000	1.800	1.00
8	.025	2.000	1.005	3.000	1.800	1.00
9	.025	2.000	1.005	3.000	1.800	1.00
10	.025	2.000	1.005	3.000	1.800	1.00
11	.025	2.000	1.005	3.000	1.700	1.00
12	.025	2.000	1.005	3.000	1.700	1.00

**** PORE WATER PRESSURE (DEGRADATION) MODEL 2 ****

LAYER	OCR (-)	s_t (-)	r_t (-)	A (-)	B (-)	C (-)	D (-)
1	.00	.000	.000	.0000	.0000	.0000	.0000
2	.00	.000	.000	.0000	.0000	.0000	.0000
3	.00	.000	.000	.0000	.0000	.0000	.0000
4	.00	.000	.000	.0000	.0000	.0000	.0000
5	.00	.000	.000	.0000	.0000	.0000	.0000
6	.00	.000	.000	.0000	.0000	.0000	.0000
7	.00	.000	.000	.0000	.0000	.0000	.0000
8	.00	.000	.000	.0000	.0000	.0000	.0000
9	.00	.000	.000	.0000	.0000	.0000	.0000
10	.00	.000	.000	.0000	.0000	.0000	.0000
11	.00	.000	.000	.0000	.0000	.0000	.0000
12	.00	.000	.000	.0000	.0000	.0000	.0000

****
* PROFILE GEOMETRY & FLAGS ON PWP (DEGRADATION) MODEL(S) TO BE ACTIVATED *
****

LAYER	MAT. TYPE	NSUBDIV	THICK (ft)	WIDTH (ft)	MODEL(S)
1	1	2	5.00	1.00	0
2	1	2	5.00	1.00	0
3	2	2	5.00	1.00	0
4	2	2	5.00	1.00	0
5	3	2	5.00	1.00	0
6	3	2	5.00	1.00	0
7	4	2	5.00	1.00	0
8	4	2	5.00	1.00	0
9	5	2	5.00	1.00	0
10	5	2	5.00	1.00	0
11	6	2	5.00	1.00	0
12	6	2	5.00	1.00	0

** PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE **
UNIT WEIGHT OF BASE, UW = 131. (pcf)
SHEAR WAVE VELOCITY, V_s = 1820. (ft/sec)

****
* INITIAL CONDITIONS *
****

```
** FUNDAMENTAL PERIOD OF THE DEPOSIT IS:   .275 sec
   TOTAL THICKNESS OF THE DEPOSIT IS:      60.0 ft
   WT. AVERAGE SHEAR WAVE VELOCITY IS:    872.5 ft/sec)

     DEPTH       å`vo      V_s      REF. STRAIN           c
      (ft)      (psf)   (ft/sec)        (-)              (%)

      2.50     287.50     573.00         .00092          1.00
      7.50     862.50     573.00         .00092          1.00
     12.50    1437.50     661.00         .00092          1.00
     17.50    2012.50     661.00         .00092          1.00
     22.50    2587.50     812.00         .00160          1.00
     27.50    3162.50     812.00         .00160          1.00
     32.50    3762.50     909.00         .00032          1.00
     37.50    4387.50     909.00         .00032          1.00
     42.50    5012.50    1100.00         .00032          1.00
     47.50    5637.50    1100.00         .00032          1.00
     52.50    6262.50    1180.00         .00032          1.00
     57.50    6887.50    1180.00         .00032          1.00

** NORMAL EFFECTIVE STRESS (å`vo) IS CALCULATED IN LAYER MIDHEIGHTS
   VISCOUS DAMPING COEFFICIENT (c) IS CALCULATED FROM á_R ONLY
   SHEAR WAVE VELOCITY (V_s) IS CALCUALTED FROM G_mo AND UW_sat

****************************************************
* INITIAL PROPERTIES OF THE DYNAMIC RESPONSE MODEL *
****************************************************

LAYER   à_R        á_R         {k}        {c}         {m}
        (-)        (-)        (psf)       (-)    (lb sý/ftýft)

  1  0.000E+00  8.750E-04   1.174E+06  1.027E+03    8.94E+00
  2  0.000E+00  8.750E-04   1.174E+06  1.027E+03    1.79E+01
  3  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  4  0.000E+00  8.750E-04   1.562E+06  1.366E+03    1.79E+01
  5  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  6  0.000E+00  8.750E-04   2.357E+06  2.062E+03    1.79E+01
  7  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.86E+01
  8  0.000E+00  8.750E-04   3.210E+06  2.809E+03    1.94E+01
  9  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 10  0.000E+00  8.750E-04   4.701E+06  4.113E+03    1.94E+01
 11  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01
 12  0.000E+00  8.750E-04   5.410E+06  4.733E+03    1.94E+01

   (N+1)TH MASS FOR TRANSMITTING BOUNDARY =   9.713E+00

** INITIAL STIFFNESS MATRIX, [K] **

   DIAGONAL TERMS:
   2.347E+05  4.694E+05  5.470E+05  6.247E+05  7.837E+05  9.427E+05  1.113E+06  1.284E+06  1.582E+0
   2.022E+06  2.164E+06  1.082E+06

   OFF-DIAGONAL TERMS:
  -2.347E+05 -2.347E+05 -3.123E+05 -3.123E+05 -4.713E+05 -4.713E+05 -6.420E+05 -6.420E+05 -9.402E+0
  -1.082E+06 -1.082E+06

** INITIAL DAMPING MATRIX, [C] **

   DIAGONAL TERMS:
   2.054E+02  4.107E+02  4.787E+02  5.466E+02  6.857E+02  8.248E+02  9.742E+02  1.124E+03  1.384E+0
   1.769E+03  1.893E+03  8.374E+03

   OFF-DIAGONAL TERMS:
  -2.054E+02 -2.054E+02 -2.733E+02 -2.733E+02 -4.124E+02 -4.124E+02 -5.618E+02 -5.618E+02 -8.227E+0
  -9.467E+02 -9.467E+02

******************************************************
* DYNAMIC EXCITATION INPUT - FLAGS AND CONTROL  DATA *
******************************************************

** CONTROL FLAGS FOR DYNAMIC RESPONSE CALCULATION **
```

```
   NEQ    =    1 ;   INTYP  =    1 ;   NC     =24000
   NCPR   =24000 ;   NCPRM  =24000 ;   NPLD   =    1

** CONTROL  DATA OF THE ACCELERATION TIME HISTORY **
   NCARD  =24000 ;   NREC   =    8 ;   NFTS   =    0

   INPUT ACC. VALUES ARE MULTIPLIED BY:     1.695111
   ACCELERATION VALUES ARE DIGITIZED @:   .010 (sec)
   ACCELERATION VALUES  ARE  READ FROM: set2_sit7.eq

** ACCELEROGRAM HEADER:

   Source File: H:\My Accelerograms\9 - Synthetic Records\Abrahamson\Riverbend
   SHAKE2000 Conversion:    24000     .01       6         8         9        (6
   Acceleration Units: (g's) - No. Values: 24000 - Time Step: .01 (secs)
   Data Format: (6F15.8) - No. Header Lines:  6
    Time history matched to spectrum:../target/M9R50.tgt
    24000    0.0100


****************************************************
* DYNAMIC RESPONSE OF THE MODEL - SELECTED RESULTS *
****************************************************


** TIME-DEPENDANT RESULTS FOR LAYER i =   2  ARE STORED IN THE FOLLOWING FILES:

   FILE NAME:     CONTENTS:                             UNITS:

   i-time.prn     Time axis                              (sec)
   i-baccel.prn   (Scaled) base (input) acceleration       (g)
   i-saccel.prn   Surface accel. (same as in layer i = 1)  (g)
   i-accel.prn    Acceleration in layer "i"                (g)
   i-veloc.prn    Velocity in layer "i"               (ft/sec)
   i-displ.prn    Displacement in layer "i"               (ft)
   i-gamma%.prn   Shear strain in layer "i"                (%)
   i-tau.prn      Shear stress in layer "i"              (psf)
   i-ustar.prn    Normalized PWP in layer "i"              (-)
   i-dindex.prn   Degrad. index in layer "i" (clay only)   (-)
   i-taustr.prn   Normalized shear stress in layer "i"     (-)


** RESULTS AT TIME =240.000 (sec), WHEN INPUT ACC. = -.000002 (g)

   LAYER   ACCEL.     VELOCITY     DISPL.      STRAIN      STRESS
            (g)       (ft/sec)     (ft)         (%)        (psf)

     1    .000686    -.552E-01   -.931E+01    .191E-04    .211E-01
     2   -.000685    -.552E-01   -.931E+01    .172E-03    .304E+00
     3    .000259    -.553E-01   -.931E+01    .324E-03    .752E-01
     4    .000519    -.553E-01   -.931E+01    .896E-03   -.510E+00
     5   -.000547    -.552E-01   -.931E+01    .210E-03    .379E+00
     6    .000135    -.551E-01   -.931E+01    .153E-03   -.557E+00
     7   -.000629    -.554E-01   -.931E+01    .643E-02    .741E+00
     8    .000310    -.553E-01   -.931E+01   -.147E-02   -.753E-01
     9    .000906    -.552E-01   -.931E+01   -.656E-02    .778E+00
    10   -.001449    -.553E-01   -.931E+01   -.180E-01   -.122E+00
    11    .000505    -.552E-01   -.931E+01   -.140E-01    .676E-02
    12    .000104    -.554E-01   -.931E+01   -.171E-01    .405E-01
    13   -.066938    -.552E-01   -.931E+01    .000E+00    .000E+00

** DISPLACEMENTS ARE REFERRED TO THE TOP OF THE LAYER
   EVERYTHING ELSE IS REF. TO THE CENTER OF THE LAYER

** "STRAIN" & "STRESS" REFER TO THE SHEAR STRAIN & SHEAR STRESS, RESPECTIVELY
   "NORM." REFERS TO NORMALIZATION BY INITIAL VERTICAL EFFECTIVE STRESS, å`vo
   NOTE THAT "NORM. STRESS" EQUALS TO THE AVERAGE ACCELERATION (IN g UNITS)
   IN A TOTAL STRESS ANALYSIS.


*********************************************************
```

* MAXIMUM VALUES OCCURRED FROM .000 TO 240.000 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	STRESS (psf)	TIME (sec)	PWP (psf)
1	114.73	.339157	114.73	.009420	114.73	93.87	.00	.000
2	114.75	.314116	117.32	.036175	117.32	267.34	.00	.000
3	114.76	.295342	117.32	.048859	117.32	433.75	.00	.000
4	120.59	.280244	117.32	.081024	117.32	583.94	.00	.000
5	114.79	.276448	120.60	.040517	120.60	710.91	.00	.000
6	114.79	.285727	120.59	.051842	120.59	859.15	.00	.000
7	114.80	.294604	120.60	.221088	120.59	985.55	.00	.000
8	122.59	.287543	120.59	.360312	120.59	1089.75	.00	.000
9	124.72	.443262	120.57	.131502	120.57	1266.53	.00	.000
10	124.73	.434881	120.56	.186763	120.56	1388.78	.00	.000
11	120.50	.282163	120.55	.151742	120.55	1516.02	.00	.000
12	120.50	.289931	120.54	.197370	120.54	1619.42	.00	.000
13	119.89	2.329801	.00	.000000	.00	.00	.00	.000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 117.210 (sec) **

****
* MAXIMUM VALUES OCCURRED FROM .000 TO 240.010 sec *
****

LAYER	TIME (sec)	³ACC.³ (g)	TIME (sec)	STRAIN (%)	TIME (sec)	NORM. STRESS (-)	TIME (sec)	NORM. PWP (-)
1	114.73	.339157	114.73	.009420	114.73	.32649	.00	.00000
2	114.75	.314116	117.32	.036175	117.32	.30996	.00	.00000
3	114.76	.295342	117.32	.048859	117.32	.30174	.00	.00000
4	120.59	.280244	117.32	.081024	117.32	.29015	.00	.00000
5	114.79	.276448	120.60	.040517	120.60	.27475	.00	.00000
6	114.79	.285727	120.59	.051842	120.59	.27167	.00	.00000
7	114.80	.294604	120.60	.221088	120.59	.26194	.00	.00000
8	122.59	.287543	120.59	.360312	120.59	.24838	.00	.00000
9	124.72	.443262	120.57	.131502	120.57	.25267	.00	.00000
10	124.73	.434881	120.56	.186763	120.56	.24635	.00	.00000
11	120.50	.282163	120.55	.151742	120.55	.24208	.00	.00000
12	120.50	.289931	120.54	.197370	120.54	.23512	.00	.00000
13	119.89	2.329801	.00	.000000	.00	.00000	.00	.00000

** MAX ³VALUE³ OF BASE (input) ACC = .440000 (g) AT TIME = 117.210 (sec) **

****
* N O R M A L T E R M I N A T I O N *
* NUMBER OF INCREMENTAL CALCULATIONS:24000 *
****

Geosyntec consultants

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11 August 2015

Mr. Tim Watson
Riverbend Landfill Company
Waste Management – Pacific Northwest
7227 NE 55th Avenue
Portland, Oregon 97218

Subject: Response to comments from Hart Crowser dated July 27, 2015 on behalf of Oregon Department of Environmental Quality (ODEQ) regarding Riverbend Landfill Document Review

Dear Mr. Watson:

Geosyntec Consultants, Inc. (Geosyntec) has reviewed the comments by Hart Crowser dated 27 July 2015. The comments are related to the Riverbend Landfill Document Review performed by Hart Crowser on behalf of the Oregon Department of Environmental Quality (ODEQ).

This letter provides the responses to the questions/comments. Below we have copied the various questions/comments in **bold** (also included in Attachment A of this letter) followed by responses to each comment.

Hart Crowser Review Comment 1: The cone penetration tests (CPTs) with seismic shear wave velocity testing that extend to stiff/dense materials were provided and show beneficial information on subsurface soils. In our opinion, these CPTs, in combination with the existing soil borings and shear wave testing, are a suitable exploration program for final design unless a deeper shear wave velocity profile is needed (see Comment 3).

Geosyntec response to Comment 1: Geosyntec concurs with this comment by Hart Crowser.

Hart Crowser Review Comment 2: Ground motions for ground response are scaled to a response spectrum developed using a deterministic seismic hazard analysis (DSHA) for a Magnitude 9.0 at a distance of 50 kilometers. We expected that ground motions would to be scaled to the full uniform hazard spectrum (UHS) with a 10 percent probability of exceedance in 250 years consistent with landfill design practice. The 50th-percentile DSHA is significantly lower than the probabilistic seismic hazard analysis (PSHA) UHS developed

by Norm Abrahamson in 2011. However, the ground motions were scaled up to the 84th percentile of the DSHA by Dr. Neven Matasovic. To understand the significance of the different ground motion levels, we developed Figure 1, which plots the PSHA UHS developed in 2011, the DSHA spectrum developed in 2013, the 84th-percentile DSHA, and the PSHA UHS scaled up to the 2014 US Geologic Survey (USGS) peak ground acceleration (PGA) of 0.44 g. After review of Figure 1, we do not take exception to the use of the 84th-percentile DSHA for rock ground motion scaling as it is generally consistent with the UHS scaled to the USGS hazard level with a PGA of 0.44 g.

Geosyntec response to Comment 2: No comments.

Hart Crowser Review Comment 3: The DSHA target spectrum developed for ground motion scaling is a rock hazard (generally considered to have a shear wave velocity of 760 m/s or 2,500 ft/s). The half-space used in the DMOD computer model presented has a velocity of 1,820 ft/sec. We would expect to see the soil column used in the ground response analysis to be extended down to the velocity for which the target was developed (i.e., 2,500 ft/s). Alternatively, the PSHA and DSHA could be performed or modified for the lower D-MOD velocity, which we expect would lead to a higher seismic hazard. Please update the analysis or provide justification for the different shear wave velocities.

Geosyntec response to Comment 3: In the June 30, 2015 report by Geosyntec[1], the shear wave velocity (V_s) profile developed based on site-specific shear wave velocities using (i) CPT[2], and (ii) geophysical MASW methods was presented and is also presented herein in Exhibit 1.

Exhibit 1 shows that the V_s values measured at the site range between 600 ft/sec near the surface to 1,820 ft/sec to a depth of 100 feet. These values were measured at the site using seismic CPTs[3] and geophysical MASW methods. This was the reason that a V_s of 1,820 ft/sec was used at depth.

---

[1] Figure 5-5 in *Module 11: Seismic Design, Analyses, and Supporting Information Report, Riverbend Landfill*; prepared by Geosyntec Consultants, Inc., 30 June 2015.

[2] As discussed with Hart Crowser during the preparation of the CPT work plan, the CPT work was to be performed from the ground surface to a firm and/or dense stratum. As shown in Exhibit 1, the V_s from the CPT and the MASW were comparable where both were available.

[3] Extended to stiff/dense materials when refusal was met.

To respond to the comment *"we would expect to see the soil column used in the ground response analyses to be extended down to the velocity for which the target was developed (i.e., 2,500 ft/sec)"*, ground response analyses using V_s = 1,820 ft/sec and V_s = 2,500 ft/sec were performed by Dr. Neven Matasovic, results of which are presented below, in which V_s at the base of the site response models (Columns 1 and 2) was increased from 1,820 ft/sec to 2,500 ft/sec. The results are summarized below:

Accelerogram (scaled to 0.44 g)	**PGA @ top of 60-ft Column 1**		**PGA @ top of 70-ft Column 2**	
	Bedrock V_s = 1,820 ft/s	**Bedrock V_s = 2,500 ft/s**	**Bedrock V_s = 1,820 ft/s**	**Bedrock V_s = 2,500 ft/s**
Set 1.sar	0.295 g	0.318 g	0.281 g	0.285 g
Set 2.sar	0.339 g	0.351 g	0.312 g	0.332 g
Set 3.sar	0.346 g	0.390 g	0.443 g	0.546 g
Set 4.sar	0.381 g	0.508 g	0.353 g	0.369 g
Set 5.sar	0.443 g	0.371 g	0.416 g	0.324 g
Average =	**0.361 g**	**0.388 g**	**0.361 g**	**0.371 g**

The calculated average PGA for both columns 1 and 2 are comparable and relative to the uncertainty related to other input parameters, these variations are small.

Hart Crowser Review Comment 4: Attenuation of PGA from bedrock (0.44 g) to the ground surface (average PGA of 0.36 g) is larger than we would expect from code-based procedures using FPGA (ASCE 7-10 Table 11.8-1). An ASCE 7-10 code-based procedure for Site Class D, would result in an increase in PGA of 6 percent (0.47 g). ASCE 7-10 allows a maximum reduction of 20 percent from the code-based spectrum for site-specific ground response analyses. In this case, a PGA of 0.36 g corresponds to a reduction of 23 percent from the Site Class D PGA of 0.47 g. However, this reduction may be less if modifications

are made in response to Comment 3. Please describe the reasons for the different PGAs calculated from D-MOD versus a code-based procedure using FPGA.

Geosyntec response to Comment 4: Site response analysis was performed in accordance with the Subtitle D regulations, not IBC/ASCE 7-10[4]. Federal regulation called Subtitle D regulations govern seismic design of landfills in the State of Oregon. There are no restrictions with respect to the maximum and the minimum amplification of bedrock motions for landfills in Subtitle D.

With respect to the shear wave velocity profile, rather than use a table such as Table 20-3.1 in ASCE 7-10 for soil classification, the practice in landfill design is to use site specific data from field investigations for PGA estimation which has been followed at the Riverbend Landfill.

Hart Crowser Review Comment 5: Please provide response spectra of ground surface output motions versus input bedrock motions (or rock target spectrum) to aid in visualizing period specific soil amplification when presenting site response results.

Geosyntec response to Comment 5: Dr. Neven Matasovic performed the analyses and developed the attached Exhibits 2 through 5 to aid in visualizing the site response results.

Exhibit 2 shows acceleration response spectra of input (bedrock) motions scaled to 0.44 g, average of these spectra (thick black line) and the target bedrock spectrum that served as a basis for development of design (i.e., bedrock motions).

Exhibit 3 compares free-field surface response of Column 1 (60-ft) to processed information shown in Exhibit 2 (average of bedrock time histories and input bedrock spectrum). Exhibit 4 shows the same information as Exhibit 3, but for Column 2 (70 ft). Exhibit 5 shows comparisons of these cases.

Hart Crowser Review Comment 6: Depth profiles of Maximum Horizontal Equivalent Acceleration (MHEA) or "Norm. Stress" in D-MOD output files seem appropriate and follow the expected trend.

Geosyntec response to Comment 6: Geosyntec concurs.

[4] Please note that code-based procedures are applicable to buildings, not landfills.

Please let me know if there are any questions.

REGISTERED PROFESSIONAL ENGINEER
19601PE
Hari D. Sharma
OREGON
JAN. 20, 1998
HARI DUTT SHARMA
Expires: 6/30/2016

Respectfully submitted,

Hari D. Sharma

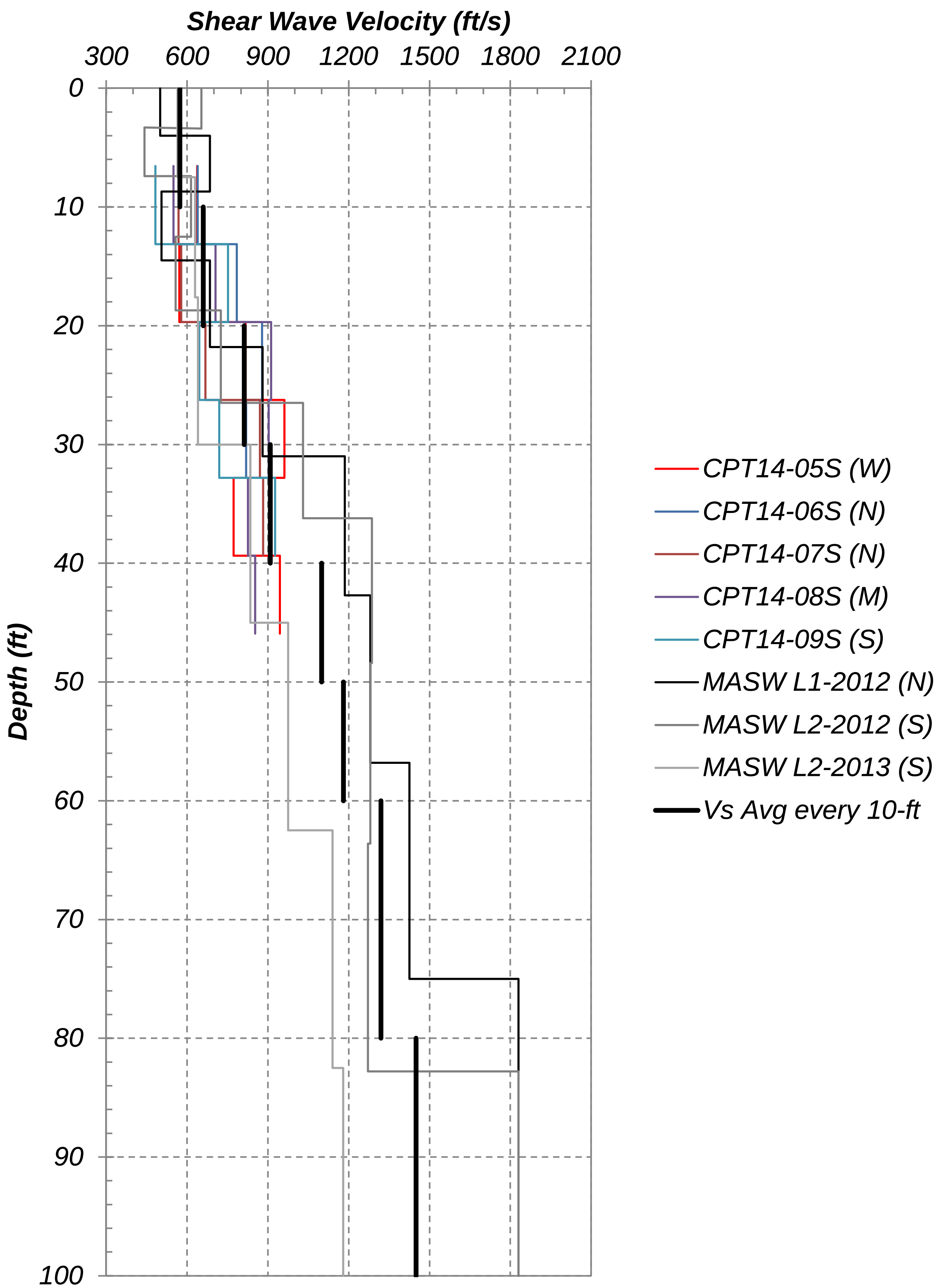
Hari D. Sharma, Ph.D., P.E.
Principal

Copy to:

Frank Willmann (WM)

Attachments:

Exhibit 1 – Shear Wave Velocity Data with Average at 10-ft Depth Intervals.
Exhibit 2 – Response Spectra: Target Bedrock, Spectra of Motions Fitted to Target, and Average of Fitted Motions.
Exhibit 3 - Response Spectra: Target Bedrock, Average of Fitted Motions, and Response of 60-ft Column.
Exhibit 4 - Response Spectra: Target Bedrock, Average of Fitted Motions, and Response of 70-ft Column.
Exhibit 5 - Response Spectra: Target Bedrock, Average of Fitted Motions, and Average of Site Response.
Attachment A - Hart Crowser Memorandum to ODEQ dated 27 July 2015

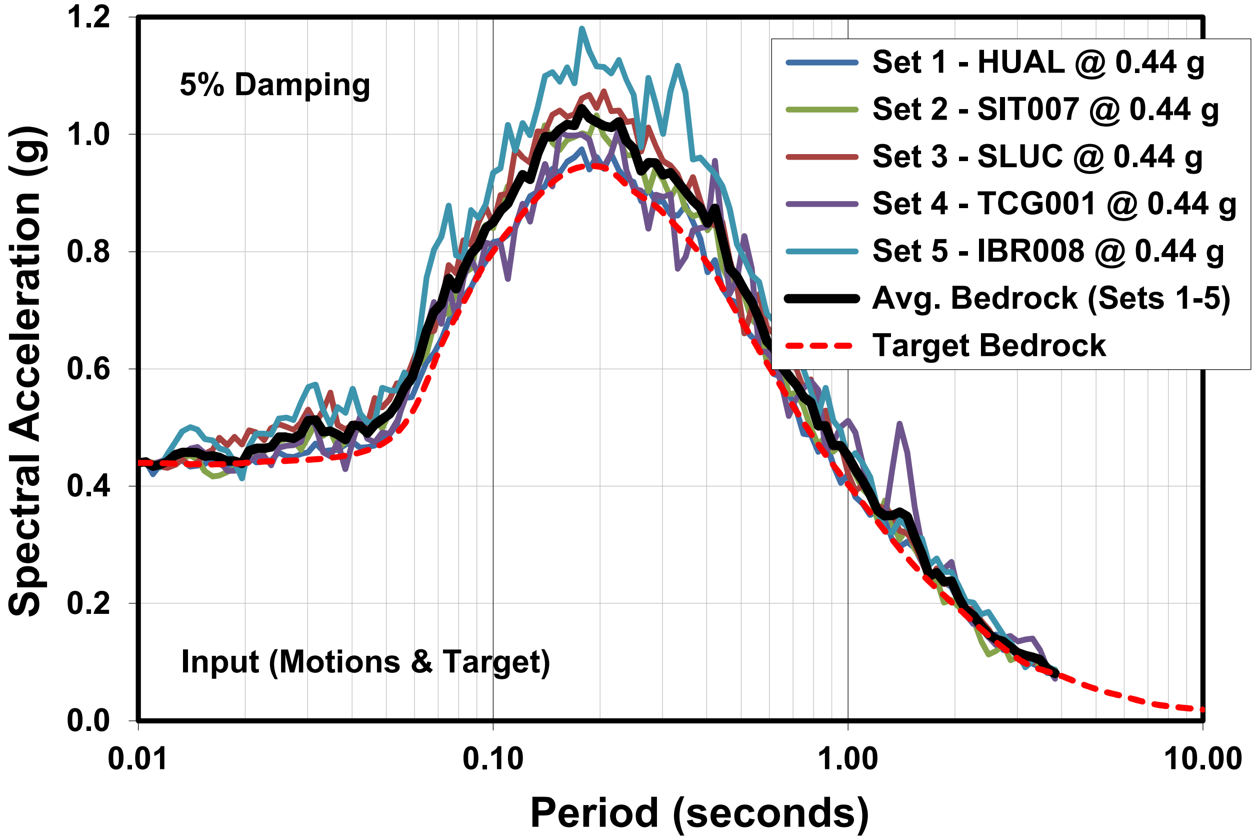


NOTE:

1. MASW 2012 SURVEY PERFORMED BY (ZONGE, 2012)
2. MASW 2013 SURVEY PERFORMED BY (ZONGE, 2013)

Shear Wave Velocity Data with Average at 10-ft Depth Intervals 1111 Broadway Oakland, California		
Geosyntec consultants		**Exhibit** **1**
Oakland	August 2015	

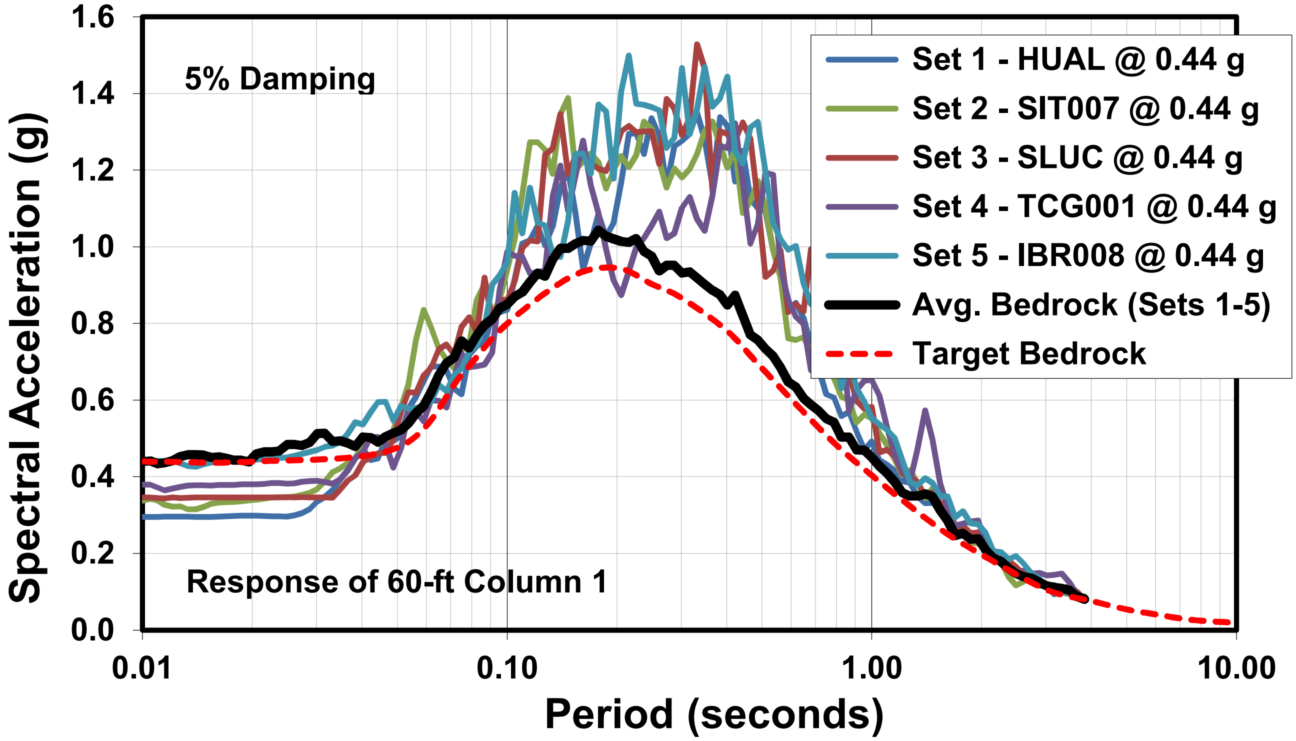
P:\PRJ2003Geo\WMI\Riverbend\1866 (Phase II MSE Berm Western Northern Expansion)\Dynamic Response Evaluation - DMOD\[Materi



Geo-Logic ASSOCIATES

RESPONSE SPECTRA: TARGET BEDROCK, SPECTRA OF MOTIONS FITTED TO TARGET, AND AVERAGE OF FITTED MOTIONS
RIVERBEND LANDFILL, MCMINNVILLE, OREGON

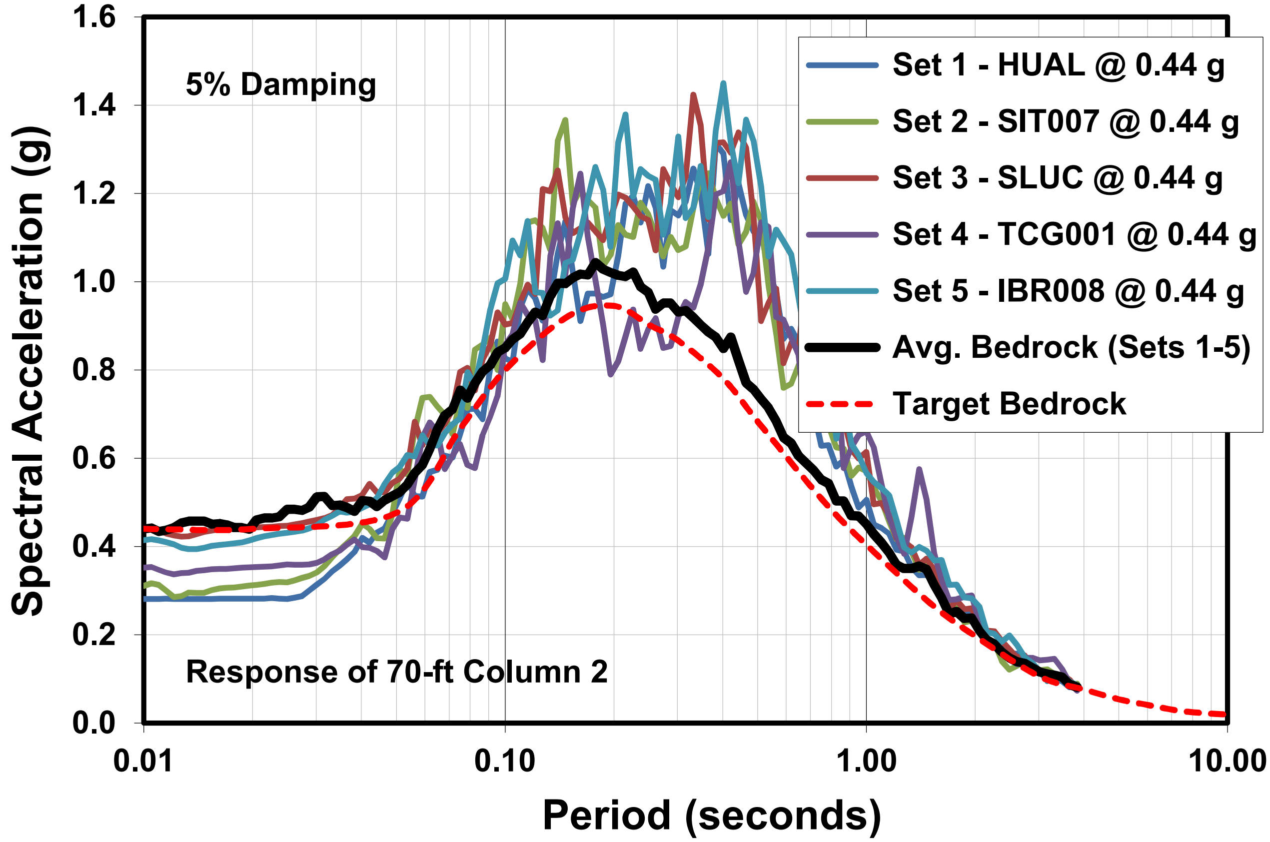
DATE:	August 2015	
PROJECT NO.	2015.0074	EXHIBIT 2



Geo-Logic ASSOCIATES

RESPONSE SPECTRA: TARGET BEDROCK, AVERAGE OF FITTED MOTIONS, AND RESPONSE OF 60-FT COLUMN
RIVERBEND LANDFILL, MCMINNVILLE, OREGON

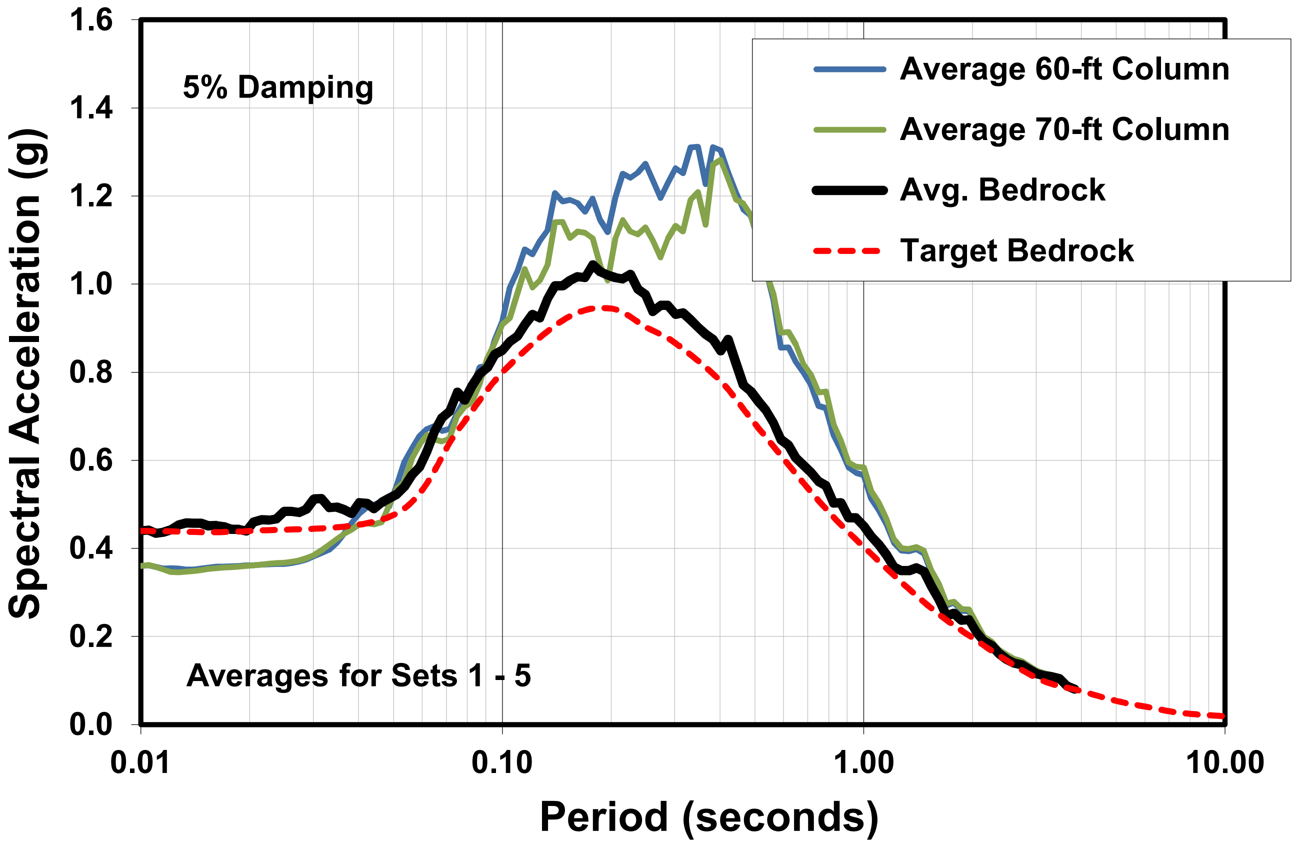
DATE:	August 2015	
PROJECT NO.	2015.0074	EXHIBIT 3



Geo-Logic ASSOCIATES

RESPONSE SPECTRA: TARGET BEDROCK, AVERAGE OF FITTED MOTIONS, AND RESPONSE OF 70-FT COLUMN
RIVERBEND LANDFILL, MCMINNVILLE, OREGON

DATE:	August 2015		
PROJECT NO.	2015.0074	EXHIBIT	4



Geo-Logic ASSOCIATES

RESPONSE SPECTRA: TARGET BEDROCK, AVERAGE OF FITTED MOTIONS, AND AVERAGE OF SITE RESPONSE
RIVERBEND LANDFILL, MCMINNVILLE, OREGON

DATE:	August 2015		
PROJECT NO.	2015.0074	EXHIBIT	5

ATTACHMENT A

HART CROWER MEMORANDUM TO ODEQ DATED 27 JULY 2015

MEMORANDUM

DATE: July 27, 2015

TO: Bob Schwarz, Oregon Department of Environmental Quality (DEQ)

FROM: Doug Lindquist, PE, and Allison Pyrch, PE, GE

RE: **Riverbend Landfill Document Review**
McMinnville, Oregon
15762-02 / Task 2

As requested by DEQ, this memorandum presents our review comments on a summary information report for geotechnical work associated with Module 11. This module is a 29-acre westward expansion of the Riverbend Landfill located near McMinnville, Oregon. The following document was reviewed.

- Geosyntec Consultants, June 30, 2015. Riverbend Landfill, Module 11: Seismic Design, Analysis, and Supporting Information Report.

Our comments on this document are as follows.

1. The cone penetration tests (CPTs) with seismic shear wave velocity testing that extend to stiff/dense materials were provided and show beneficial information on subsurface soils. In our opinion, these CPTs, in combination with the existing soil borings and shear wave testing, are a suitable exploration program for final design unless a deeper shear wave velocity profile is needed (see Comment 3).

2. Ground motions for ground response are scaled to a response spectrum developed using a deterministic seismic hazard analysis (DSHA) for a Magnitude 9.0 at a distance of 50 kilometers. We expected that ground motions would to be scaled to the full uniform hazard spectrum (UHS) with a 10 percent probability of exceedance in 250 years consistent with landfill design practice. The 50th-percentile DSHA is significantly lower than the probabilistic seismic hazard analysis (PSHA) UHS developed by Norm Abrahamson in 2011. However, the ground motions were scaled up to the 84th percentile of the DSHA by Dr. Neven Matasovic. To understand the significance of the different ground motion levels, we developed Figure 1, which plots the PSHA UHS developed in 2011, the DSHA spectrum developed in 2013, the 84th-percentile DSHA, and the PSHA UHS scaled up to the 2014 US Geologic Survey (USGS) peak ground acceleration (PGA) of 0.44 g. After

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Beaverton, OR 97008-7123
Fax 503.620.6918
Tel 503.620.7284

review of Figure 1, we do not take exception to the use of the 84th-percentile DSHA for rock ground motion scaling as it is generally consistent with the UHS scaled to the USGS hazard level with a PGA of 0.44 g.

3. The DSHA target spectrum developed for ground motion scaling is a rock hazard (generally considered to have a shear wave velocity of 760 m/s or 2,500 ft/s). The half-space used in the DMOD computer model presented has a velocity of 1,820 ft/sec. We would expect to see the soil column used in the ground response analysis to be extended down to the velocity for which the target was developed (i.e., 2,500 ft/s). Alternatively, the PSHA and DSHA could be performed or modified for the lower D-MOD velocity, which we expect would lead to a higher seismic hazard. Please update the analysis or provide justification for the different shear wave velocities.

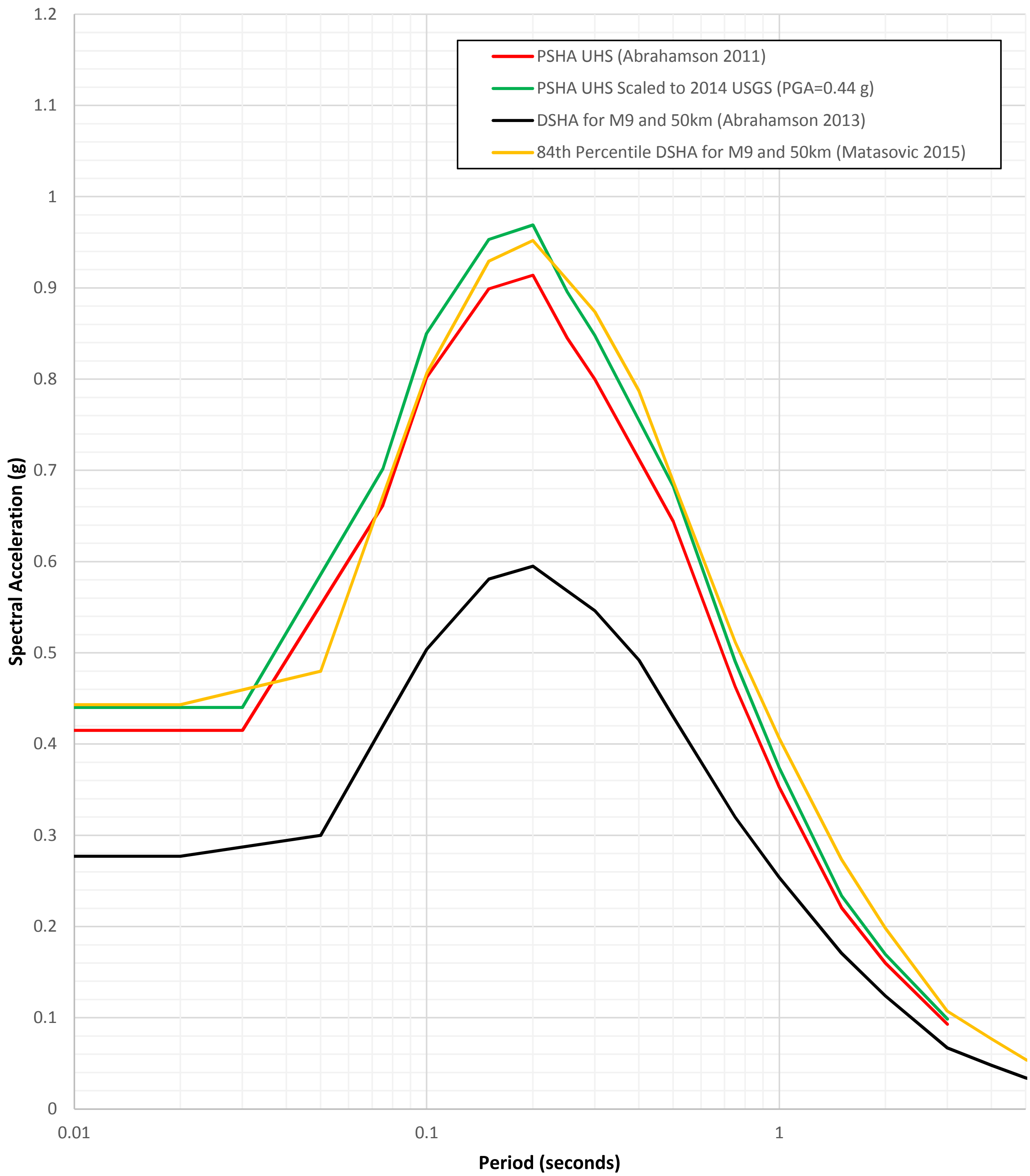
4. Attenuation of PGA from bedrock (0.44 g) to the ground surface (average PGA of 0.36 g) is larger than we would expect from code-based procedures using F_{PGA} (ASCE 7-10 Table 11.8-1). An ASCE 7-10 code-based procedure for Site Class D, would result in an increase in PGA of 6 percent (0.47 g). ASCE 7-10 allows a maximum reduction of 20 percent from the code-based spectrum for site-specific ground response analyses. In this case, a PGA of 0.36 g corresponds to a reduction of 23 percent from the Site Class D PGA of 0.47 g. However, this reduction may be less if modifications are made in response to Comment 3. Please describe the reasons for the different PGAs calculated from D-MOD versus a code-based procedure using F_{PGA}.

5. Please provide response spectra of ground surface output motions versus input bedrock motions (or rock target spectrum) to aid in visualizing period specific soil amplification when presenting site response results.

6. Depth profiles of Maximum Horizontal Equivalent Acceleration (MHEA) or "Norm. Stress" in D-MOD output files seem appropriate and follow the expected trend.

Attachments:
Figure 1 – Comparison of Response Spectra for Seismic Analysis

F:\Data\Jobs\DEQ\15762-02 Riverbend Landfill\Phase2-Jan2015-Task 2 Geotech Review\Finals\Memo-Document Review-3 07-27-15\Riverbend Landfill-Document Review-3.docx



Riverbend Landfill
McMinnville, Oregon

Comparison of Response Spectra for Seismic Analysis

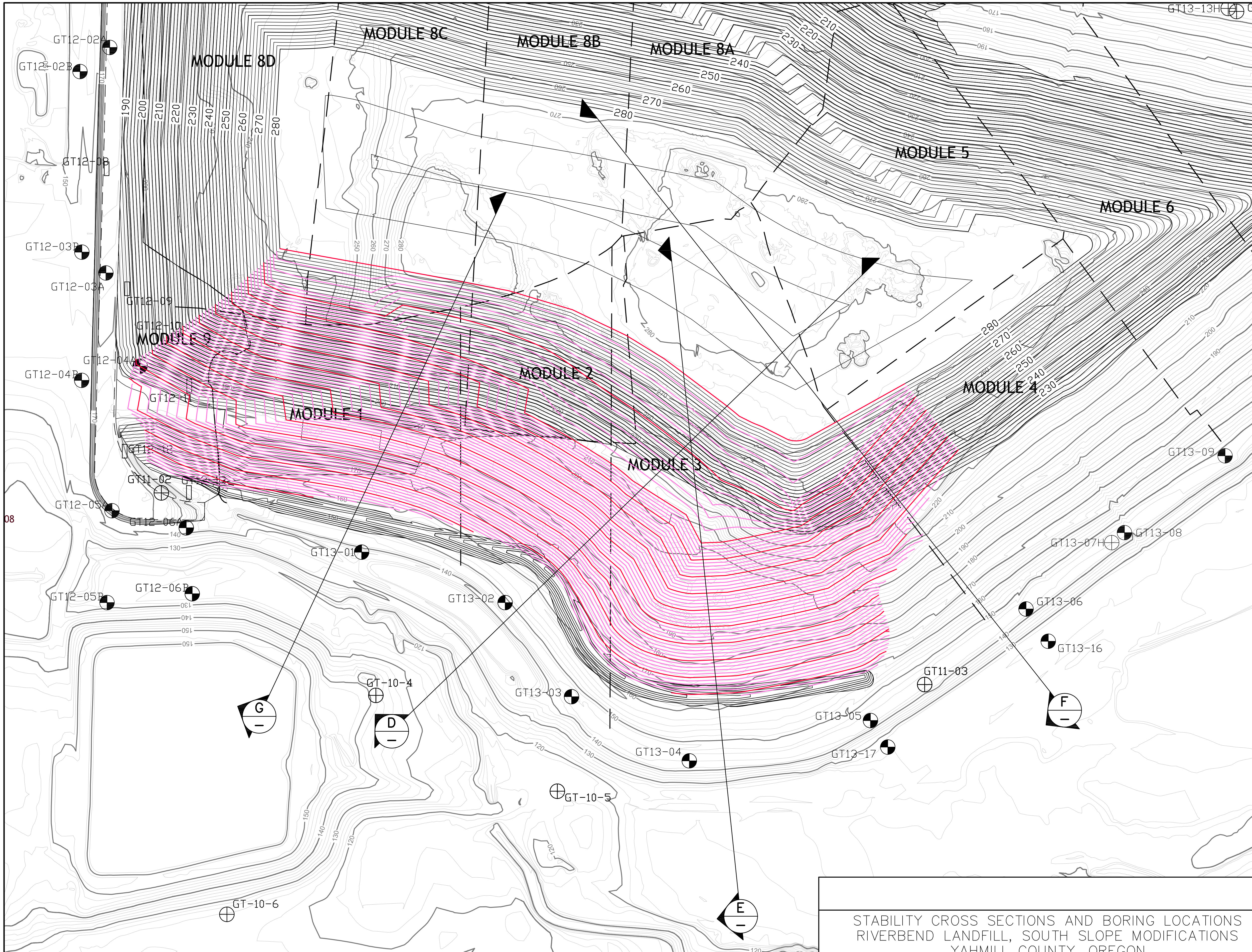
15762-02 7/15

HARTCROWSER

Figure 1

APPENDIX D.2

SLOPE STABILITY CROSS SECTIONS



LEGEND:

- EXISTING TOPOGRAPHY - 10 FT CONTOUR
- EXISTING TOPOGRAPHY - 2 FT CONTOUR
- FINAL GRADES - 10 FT CONTOUR
- FINAL GRADES - 2 FT CONTOUR
- SOUTH SLOPE MODIFICATION - 10 FT CONTOUR
- SOUTH SLOPE MODIFICATION - 2 FT CONTOUR
- APPROXIMATE EXISTING MODULE BOUNDARY
- BORING LOCATION
- SLOPE STABILITY CROSS SECTION

NOTES:

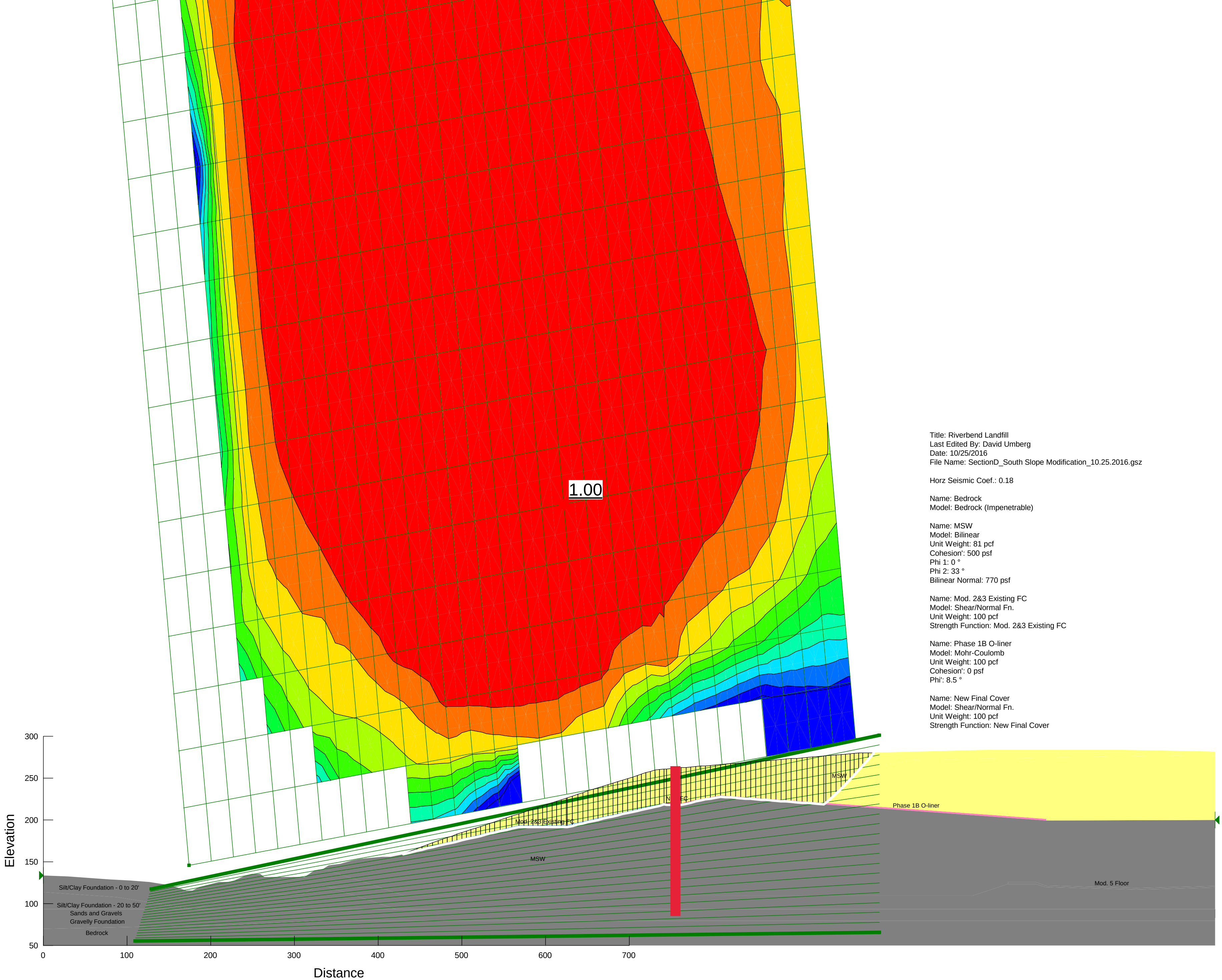
1. SITE TOPOGRAPHY PROVIDED BY WM (AERIAL PHOTOGRAPHY BY MILLER CREEK AERIAL MAPPING, DATED 8 AUGUST 2016). AS THE SITE IS AN ACTIVE LANDFILL, TOPOGRAPHY MAY HAVE CHANGED SINCE THE SURVEY DATE SHOWN.
2. DISPOSAL MODULE BOUNDARIES COMPILED BY GEOSYNTEC BASED ON DATA PROVIDED BY RIVERBEND LANDFILL COMPANY, INC.
3. NORTHINGS, EASTINGS, AND ELEVATIONS ARE IN LOCAL COORDINATE SYSTEM AS DETERMINED BY LELAND A. MACDONALD AND ASSOCIATES, LLC, McMINNVILLE, OREGON.

Geosyntec consultants

STABILITY CROSS SECTIONS AND BORING LOCATIONS
RIVERBEND LANDFILL, SOUTH SLOPE MODIFICATIONS
YAHMILL COUNTY, OREGON

FIGURE NO.	1
PROJECT NO.	WG1866G
DATE:	OCTOBER 2016

P:\CADD\CIVIL 3D\WM\RIVERBEND\WG1866A\South Slope Stability - Oct. 2016 - 10.25.16.dwg



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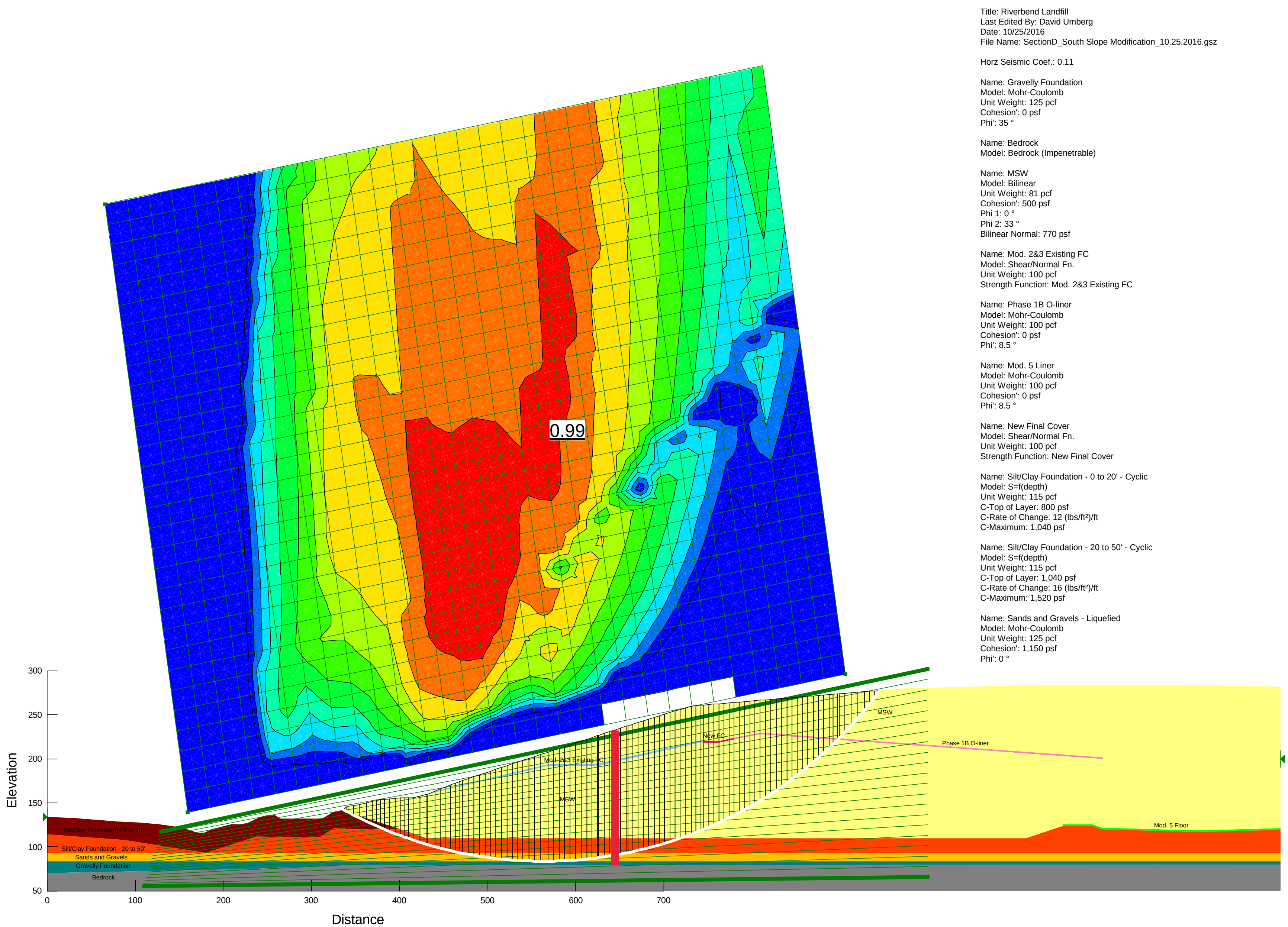

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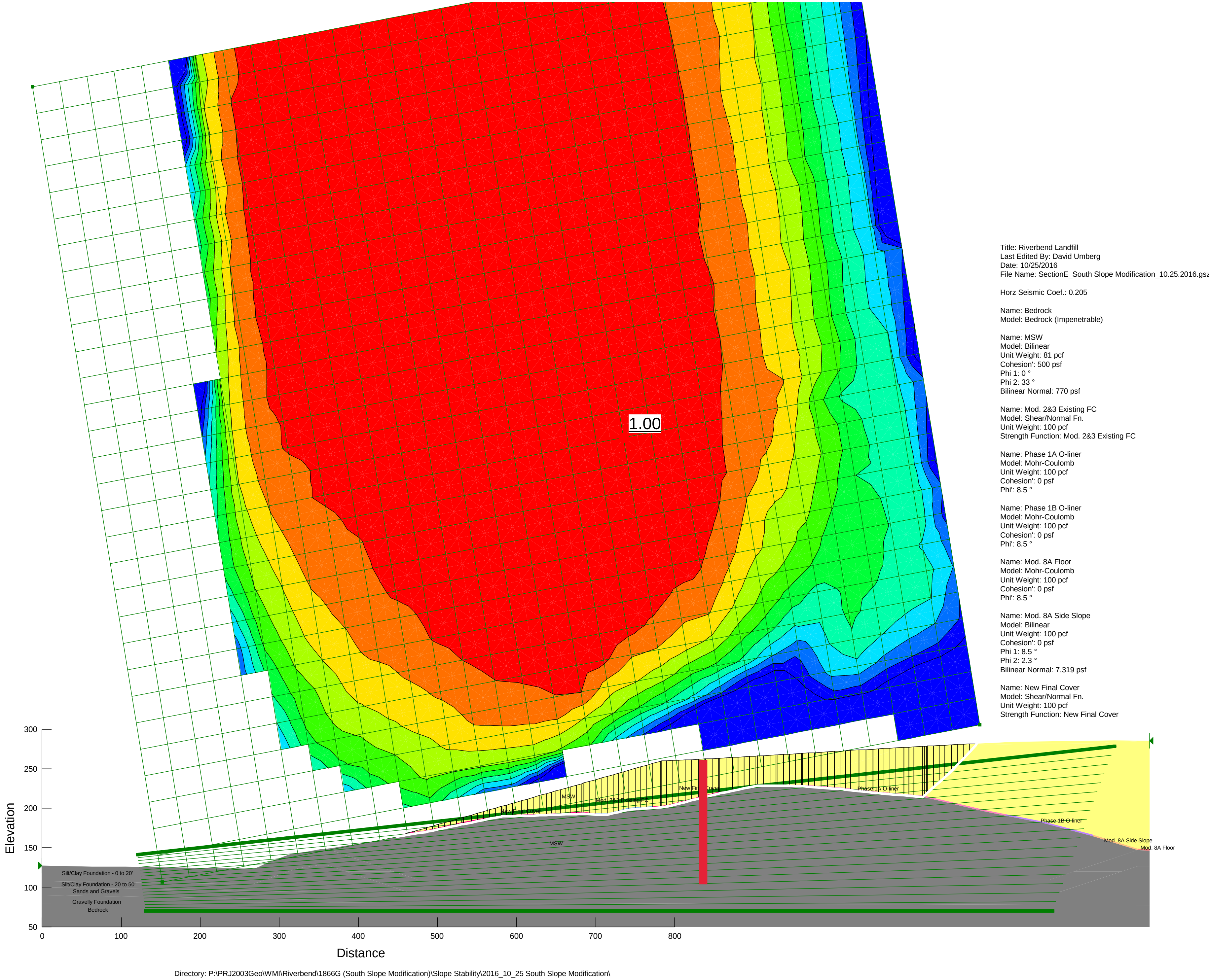
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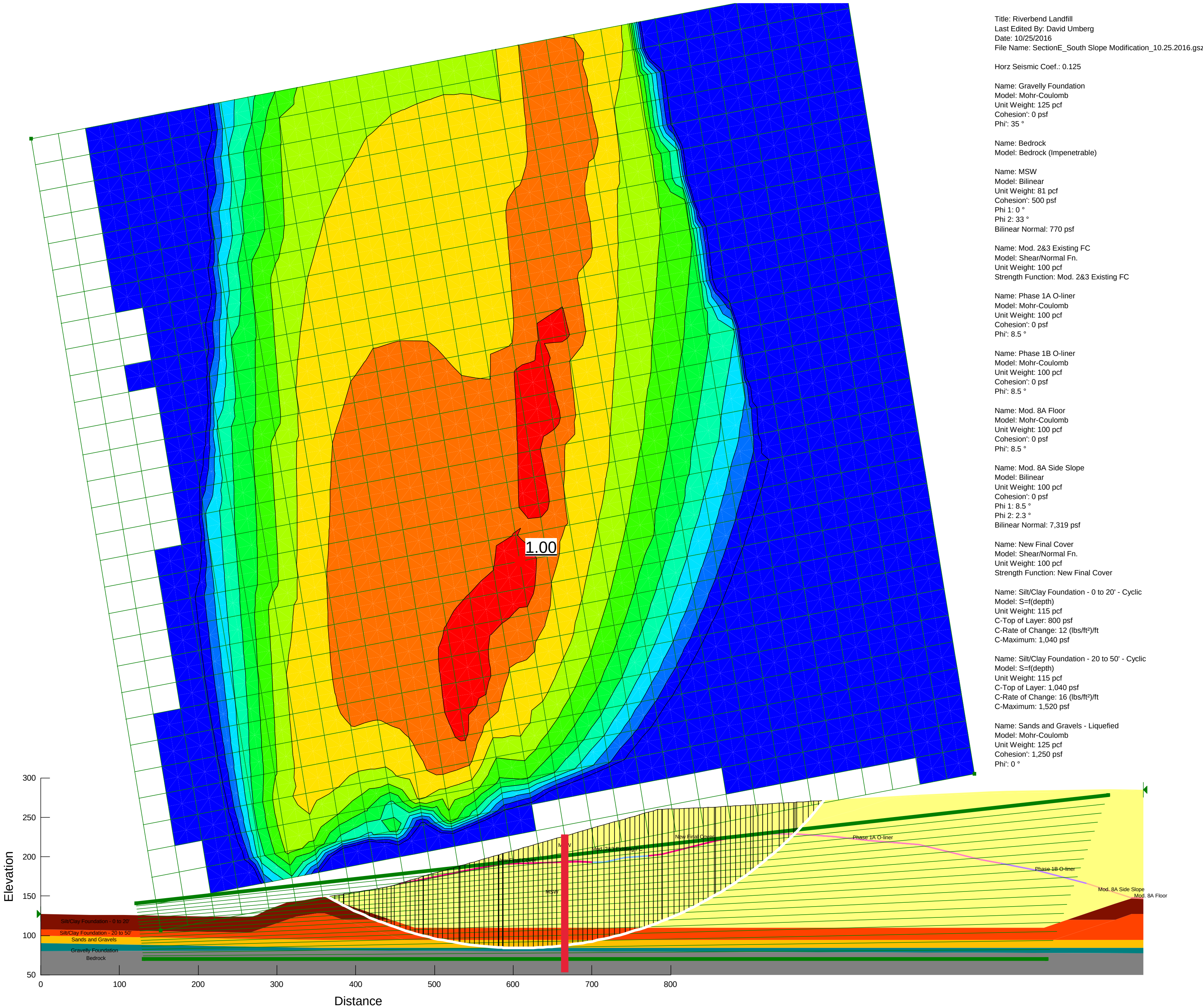
Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionE_South Slope Modification_10.25.2016.gsz
Horz Seismic Coef.: 0.205
Name: Bedrock
Model: Bedrock (Impenetrable)
Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf
Name: Mod. 2&3 Existing FC
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 2&3 Existing FC
Name: Phase 1A O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °
Name: Phase 1B O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °
Name: Mod. 8A Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °
Name: Mod. 8A Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf
Name: New Final Cover
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: New Final Cover
MSW
Phase 1A O-liner
Phase 1B O-liner
Mod. 8A Side Slope
Mod. 8A Floor
Silt/Clay Foundation - 0 to 20'
Silt/Clay Foundation - 20 to 50'
Sands and Gravels
Gravelly Foundation
Bedrock
Elevation
300
250
200
150
100
50
0
100
200
300
400
500
600
700
800
Distance
Directory: P:\PRJ2003Geo\WMI\Riverbend\1866G (South Slope Modification)\Slope Stability\2016_10_25 South Slope Modification\



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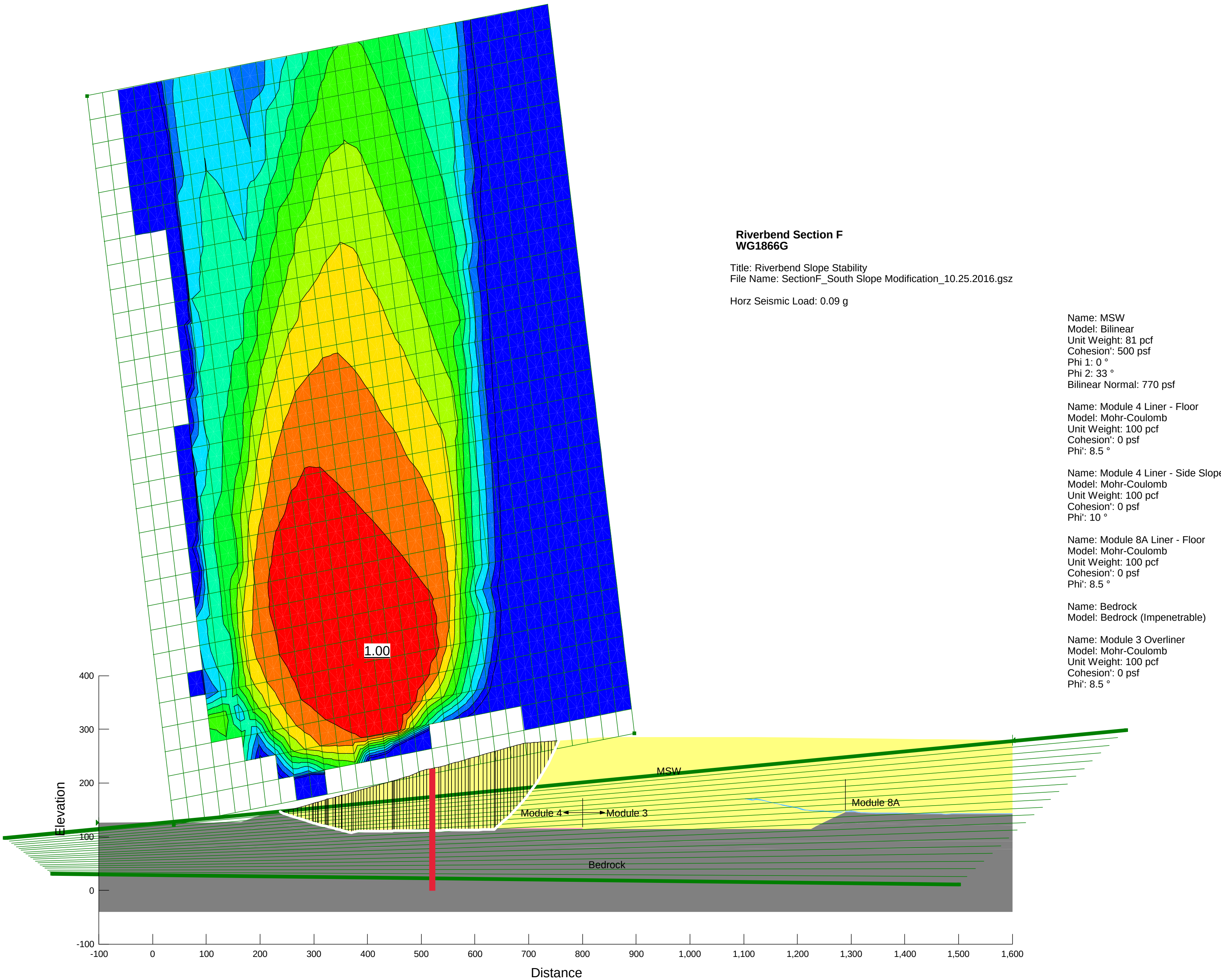

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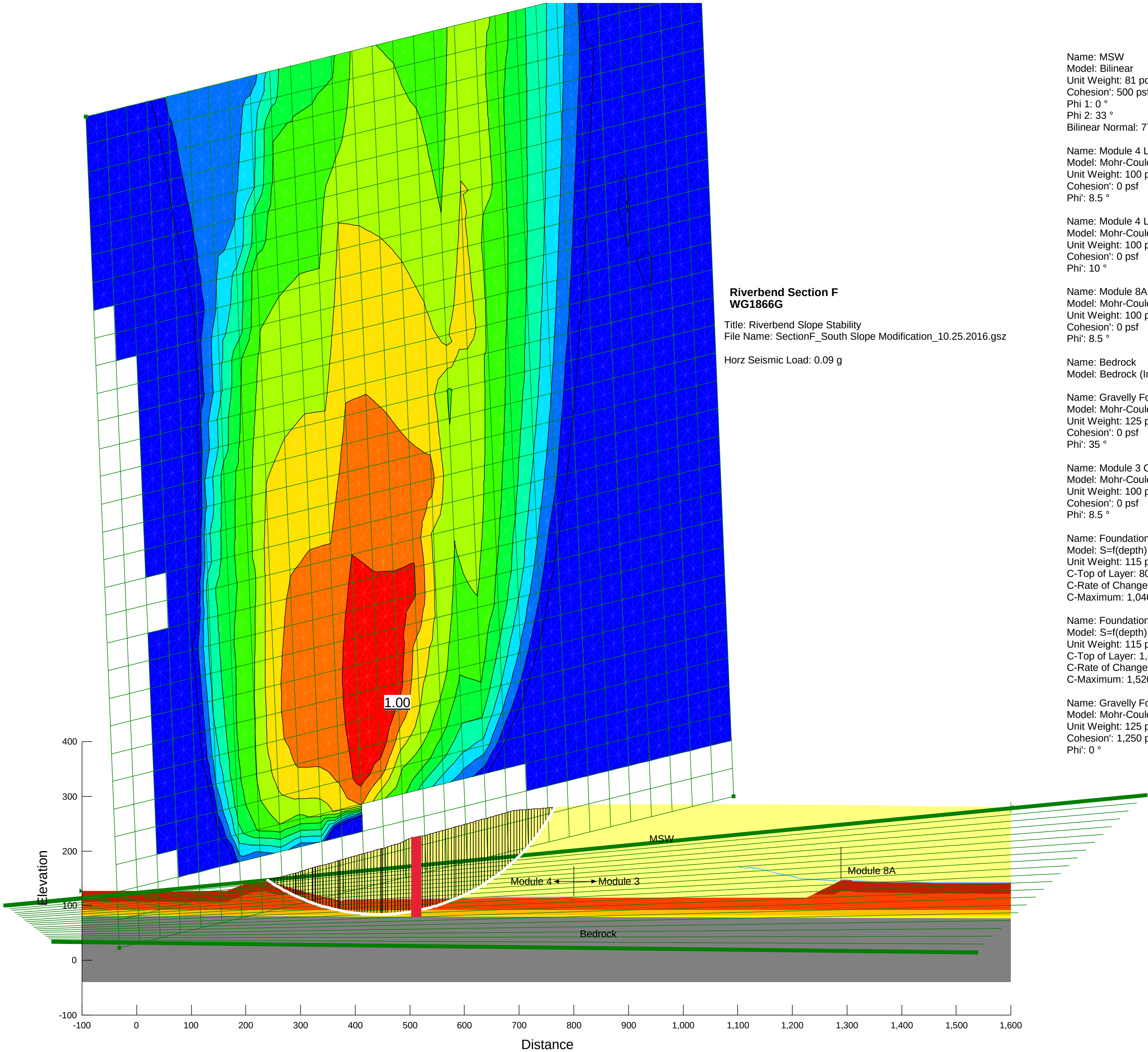


Riverbend Section F
WG1866G

Title: Riverbend Slope Stability
File Name: SectionF_South Slope Modification_10.25.2016.gsz

Horz Seismic Load: 0.09 g

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 4 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 10 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Gravelly Foundation Soil
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °

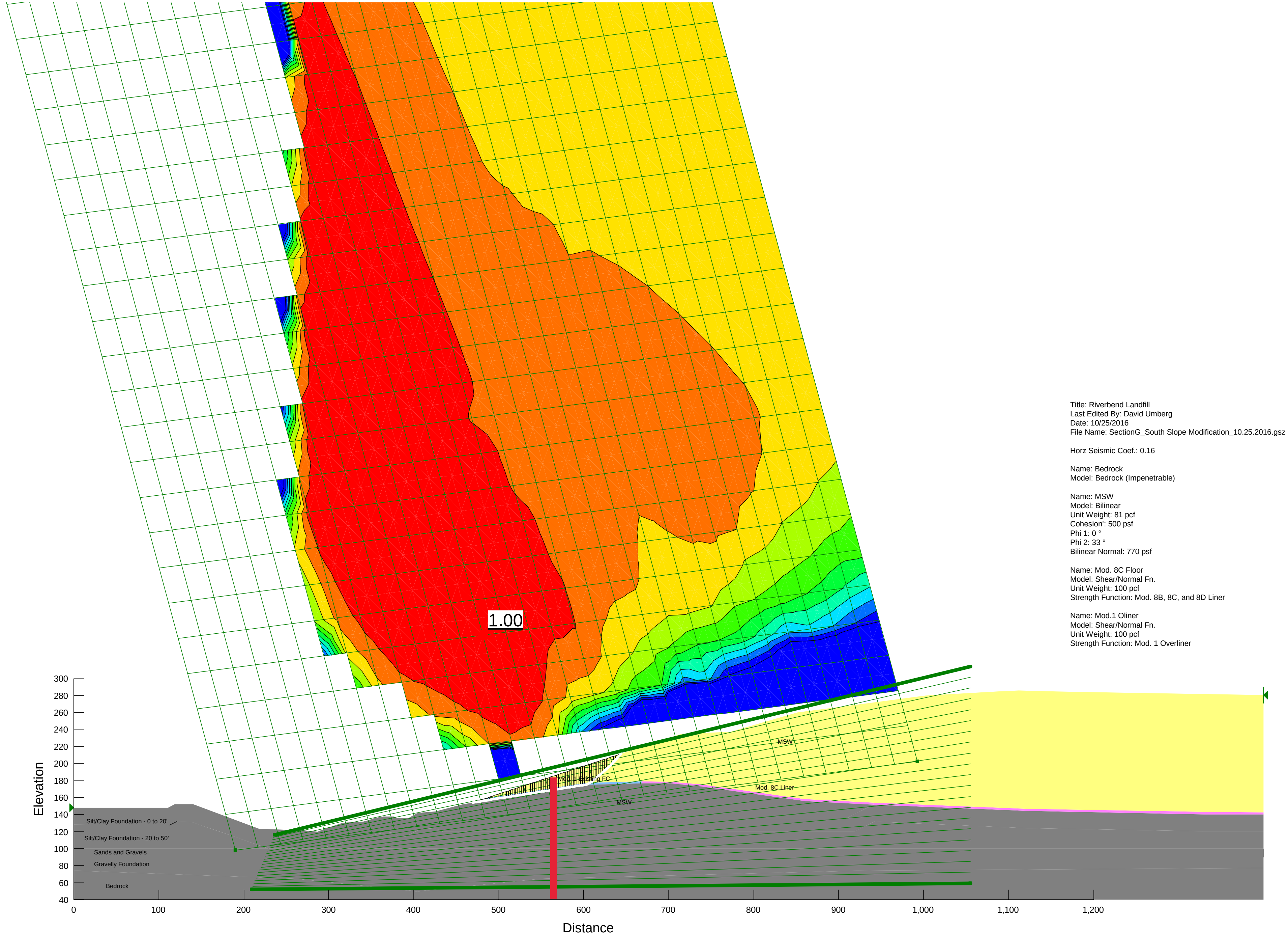
Name: Module 3 Overliner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Foundation Soils - 0 to 20 ft bgs - Cyclic
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 800 psf
C-Rate of Change: 12 (lbs/ft²)/ft
C-Maximum: 1,040 psf

Name: Foundation Soils - 20 to 50 ft bgs - Cyclic
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,040 psf
C-Rate of Change: 16 (lbs/ft²)/ft
C-Maximum: 1,520 psf

Name: Gravelly Foundation Soil - Liquefied
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 1,250 psf
Phi': 0 °

P:\PRJ2003Geo\WMI\Riverbend\1866G (South Slope Modification)\Slope Stability\2016_10_25 South Slope Modification\



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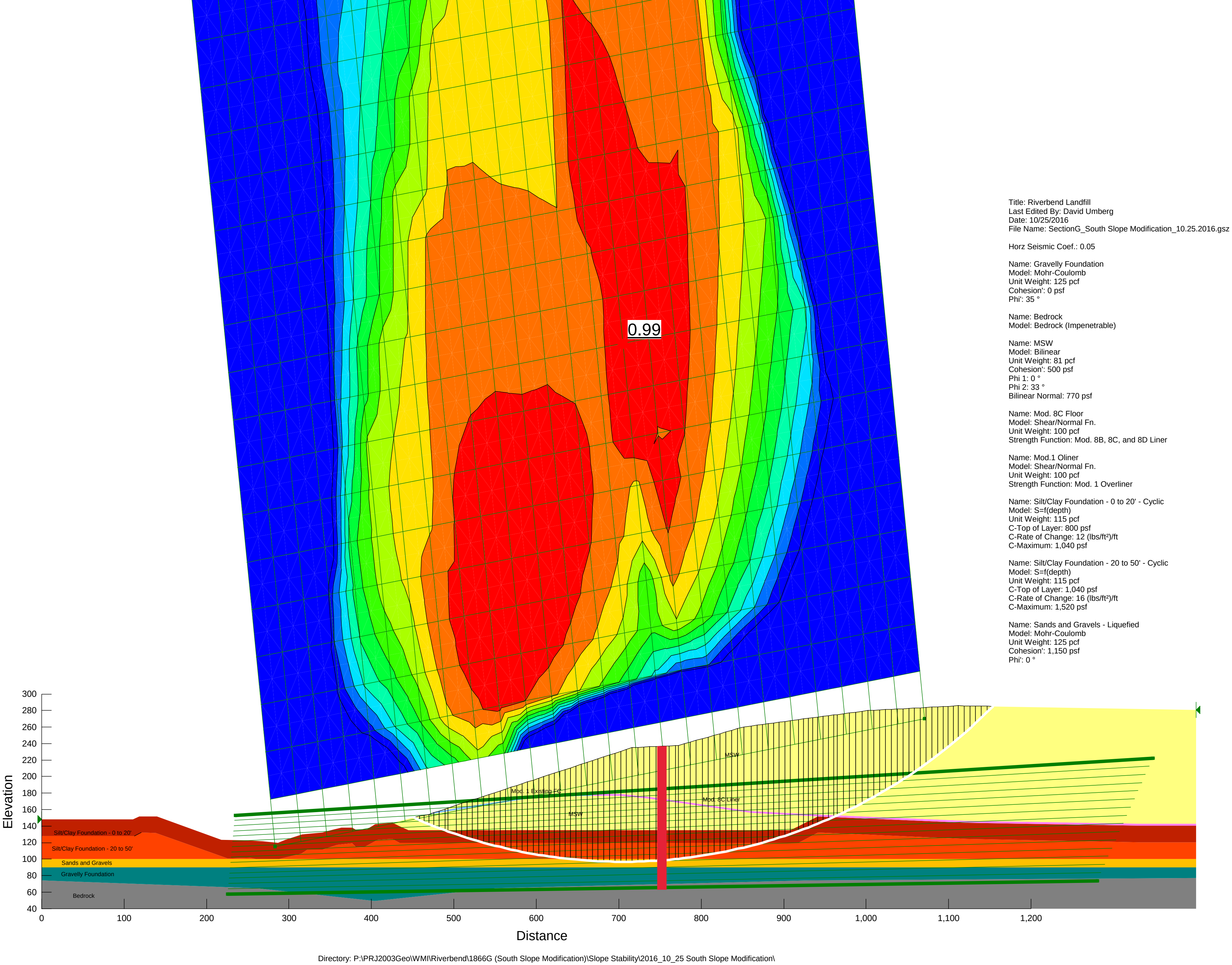

0.99
Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionG_South Slope Modification_10.25.2016.gsz
Horz Seismic Coef.: 0.05
Name: Gravelly Foundation
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °
Name: Bedrock
Model: Bedrock (Impenetrable)
Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf
Name: Mod. 8C Floor
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 8B, 8C, and 8D Liner
Name: Mod.1 Oliner
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 1 Overliner
Name: Silt/Clay Foundation - 0 to 20' - Cyclic
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 800 psf
C-Rate of Change: 12 (lbs/ft²)/ft
C-Maximum: 1,040 psf
Name: Silt/Clay Foundation - 20 to 50' - Cyclic
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,040 psf
C-Rate of Change: 16 (lbs/ft²)/ft
C-Maximum: 1,520 psf
Name: Sands and Gravels - Liquefied
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 1,150 psf
Phi': 0 °
MSW
Mod. 1 Existing FC
Mod. 8C Liner
MSW
Silt/Clay Foundation - 0 to 20'
Silt/Clay Foundation - 20 to 50'
Sands and Gravels
Gravelly Foundation
Bedrock
Elevation
300
280
260
240
220
200
180
160
140
120
100
80
60
40
0
100
200
300
400
500
600
700
800
900
1,000
1,100
1,200
Distance
Directory: P:\PRJ2003Geo\WMI\Riverbend\1866G (South Slope Modification)\Slope Stability\2016_10_25 South Slope Modification\

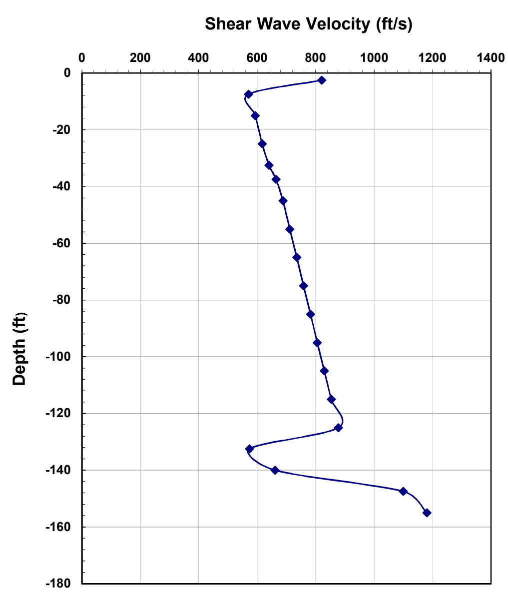
DMOD MODELS

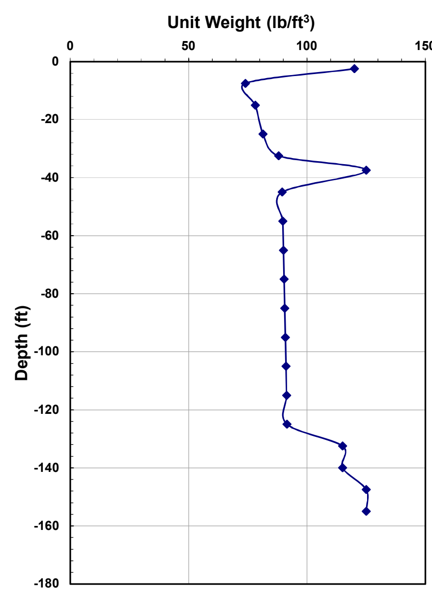
Riverbend Module 11 - D-MOD / Section D / 40' MSW, Overliner, 90' MSW, 30' Alluvium - Liner

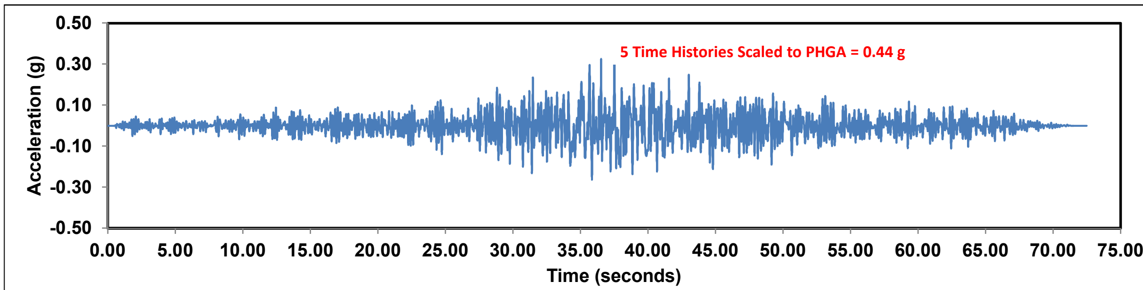
Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer (-)	Description (-)	Thickness (ft)	Depth (ft)	V_s [ft/s]	V_s (m/s)	γ (lb/ft^3)	γ (kN/m^3)	Curves (-)	γ_r (-)	β (-)	s (-)	G_{mo} (psf)	τ_{mo} (psf)
1	CL	5.0	-2.5	820.21	250.0	120.00	18.8	PI = 30	0.0016	1.10	0.85	2,509,148	4,014.64
2	MSW	5.0	-7.5	569.55	173.6	73.95	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	10.0	-15.0	593.18	180.8	78.15	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	10.0	-25.0	616.80	188.0	81.46	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	5.0	-32.5	640.42	195.2	88.03	13.8	M & K	0.00316	0.50	1.10	1,122,104	3,545.85
6	CH (Liner)	5.0	-37.5	664.04	202.4	125.00	19.6	PI = 50	0.00244	1.00	0.85	1,713,142	4,180.07
7	MSW	10.0	-45.0	687.66	209.6	89.49	14.1	M & K	0.00316	0.50	1.10	1,315,283	4,156.29
8	MSW	10.0	-55.0	711.29	216.8	89.75	14.1	M & K	0.00316	0.50	1.10	1,411,236	4,459.51
9	MSW	10.0	-65.0	734.91	224.0	90.06	14.1	M & K	0.00316	0.50	1.10	1,511,865	4,777.49
10	MSW	10.0	-75.0	758.53	231.2	90.32	14.2	M & K	0.00316	0.50	1.10	1,615,166	5,103.92
11	MSW	10.0	-85.0	782.15	238.4	90.57	14.2	M & K	0.00316	0.50	1.10	1,722,166	5,442.04
12	MSW	10.0	-95.0	805.26	245.4	90.83	14.3	M & K	0.00316	0.50	1.10	1,830,573	5,784.61
13	MSW	10.0	-105.0	829.40	252.8	91.08	14.3	M & K	0.00316	0.50	1.10	1,947,402	6,153.79
14	MSW	10.0	-115.0	853.00	260.0	91.34	14.3	M & K	0.00316	0.50	1.10	2,065,582	6,527.24
15	MSW	10.0	-125.0	877.00	267.3	91.59	14.4	M & K	0.00316	0.50	1.10	2,189,542	6,918.95
16	W. Silt (ML/CL)	5.0	-132.5	573.0	174.7	115.00	18.1	PI = 15	0.00092	1.30	0.85	1,173,551	1,079.67
17	W. Silt (ML/CL)	10.0	-140.0	661.0	201.5	115.00	18.1	PI = 15	0.00092	1.30	0.85	1,561,693	1,436.76
18	SM/SW	5.0	-147.5	1100.0	335.3	125.00	19.6	PI = 0	0.000324	1.10	0.90	4,701,001	1,523.12
19	SM/SW	10.0	-155.0	1180.0	359.7	125.00	19.6	PI = 0	0.000324	1.10	0.90	5,409,648	1,752.73

H (ft) = **160.0** $(V_s)_{avg}$ (ft/s) = **760.92** T (s) = **0.841** n (-) = 0 c (%) = 1 α_R = **0.00** β_R = **0.002677**





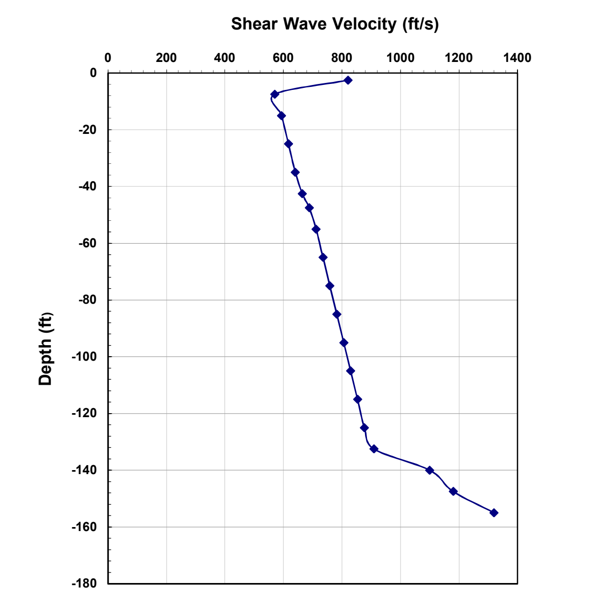


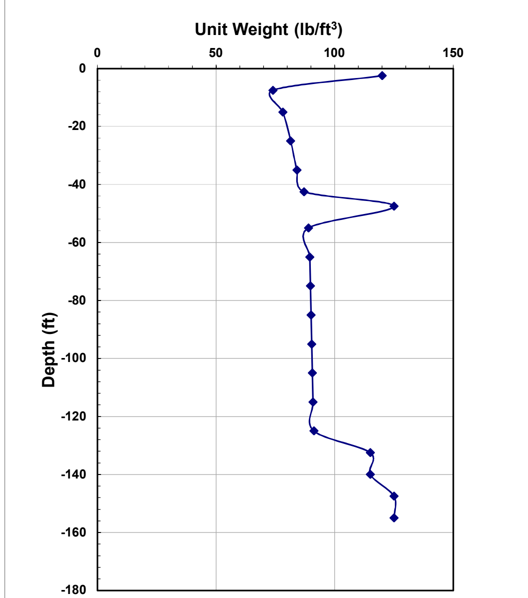
Riverbend Module 11 - D-MOD / Section E / 50' MSW, Overliner, 60' MSW, 30' Alluvium - Liner

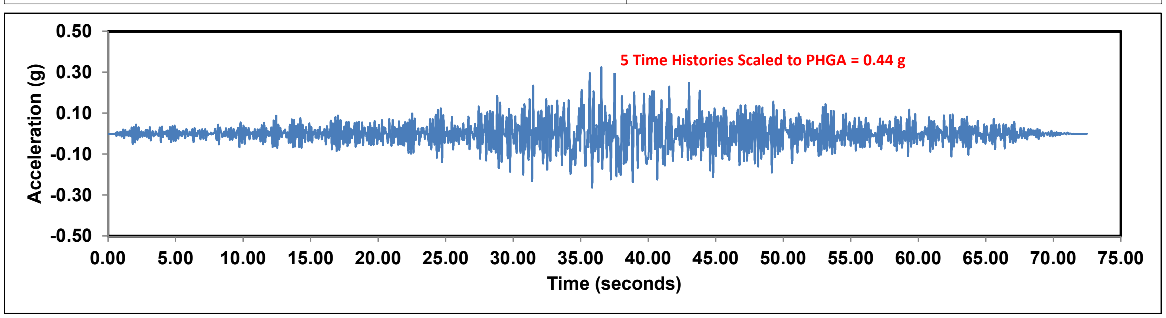
Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer	Description	Thickness	Depth	V_s	V_s	γ	γ	Curves	γ_r	β	s	G_{mo}	τ_{mo}
(-)	(-)	(ft)	(ft)	[ft/s]	(m/s)	(lb/ft^3)	(kN/m^3)	(-)	(-)	(-)	(-)	(psf)	(psf)
1	CL	5.0	-2.5	820.2	250.0	120.0	18.8	PI = 30	0.0016	1.10	0.85	2,509,148	4,014.64
2	MSW	5.0	-7.5	569.6	173.6	73.9	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	10.0	-15.0	593.2	180.8	78.2	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	10.0	-25.0	616.8	188.0	81.5	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	10.0	-35.0	640.4	195.2	84.1	13.2	M & K	0.00316	0.50	1.10	1,071,763	3,386.77
6	MSW	5.0	-42.5	664.0	202.4	87.1	13.7	M & K	0.00316	0.50	1.10	1,194,036	3,773.15
7	CH (Liner)	5.0	-47.5	687.7	209.6	125.0	19.6	PI = 50	0.00244	1.00	0.85	1,837,397	4,483.25
8	MSW	10.0	-55.0	711.3	216.8	88.9	14.0	M & K	0.00316	0.50	1.10	1,398,255	4,418.49
9	MSW	10.0	-65.0	734.9	224.0	89.5	14.1	M & K	0.00316	0.50	1.10	1,502,201	4,746.96
10	MSW	10.0	-75.0	758.5	231.2	89.7	14.1	M & K	0.00316	0.50	1.10	1,604,787	5,071.13
11	MSW	10.0	-85.0	782.2	238.4	90.1	14.1	M & K	0.00316	0.50	1.10	1,712,696	5,412.12
12	MSW	10.0	-95.0	805.8	245.6	90.3	14.2	M & K	0.00316	0.50	1.10	1,822,746	5,759.88
13	MSW	10.0	-105.0	829.4	252.8	90.6	14.2	M & K	0.00316	0.50	1.10	1,937,886	6,123.72
14	MSW	10.0	-115.0	853.0	260.0	90.9	14.3	M & K	0.00316	0.50	1.10	2,055,499	6,495.38
15	MSW	10.0	-125.0	876.6	267.2	91.2	14.3	M & K	0.00316	0.50	1.10	2,178,418	6,883.80
16	W. Silt (ML/CL)	5.0	-132.5	909.0	277.1	115.0	18.1	PI = 30	0.0016	1.10	0.85	2,953,388	4,725.42
17	W. Silt (ML/CL)	10.0	-140.0	1100.0	335.3	115.0	18.1	PI = 30	0.0016	1.10	0.85	4,324,921	6,919.87
18	SM/SW	5.0	-147.5	1180.0	359.7	125.0	19.6	PI = 0	0.000324	1.10	0.90	5,409,648	1,752.73
19	SM/SW	10.0	-155.0	1320.0	402.3	125.0	19.6	PI = 0	0.000324	1.10	0.90	6,769,441	2,193.30

H (ft) = 160.0 $(V_s)_{avg}$ (ft/s) = 813.29   T (s) = 0.787   n (-) = 0   c (%) = 1 α_R = 0.00 β_R = 0.002505





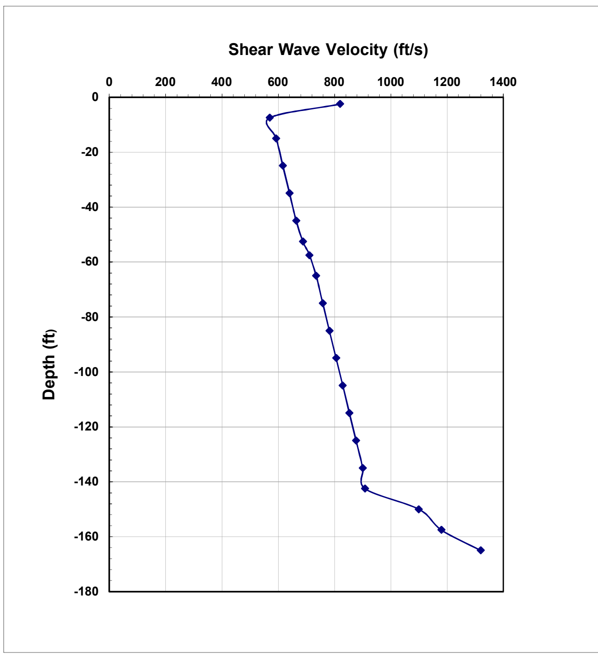


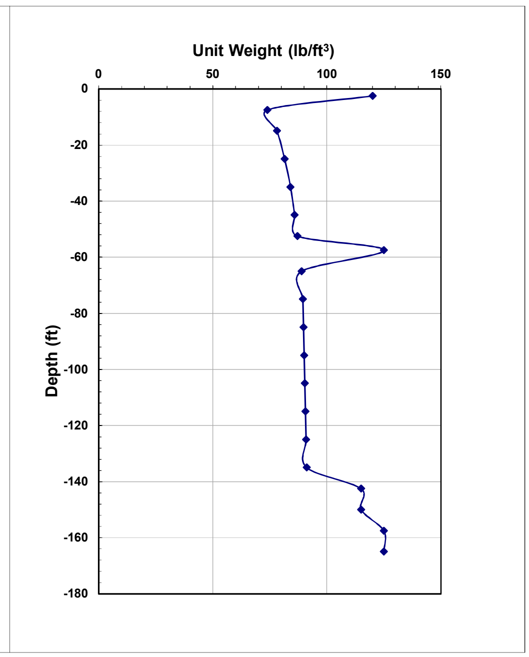
Riverbend Module 11 - D-MOD / Section E / 60' MSW, Overliner, 80' MSW, 30' Alluvium - Deep

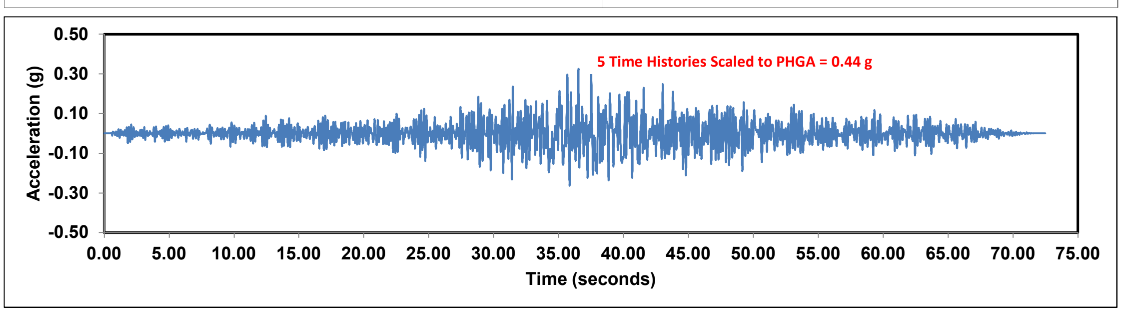
Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer (-)	Description (-)	Thickness (ft)	Depth (ft)	V_s [ft/s]	V_s (m/s)	γ (lb/ft^3)	γ (kN/m^3)	Curves (-)	γ_r (-)	β (-)	s (-)	G_{mo} (psf)	τ_{mo} (psf)
1	CL	5.0	-2.5	820.2	250.0	120.0	18.8	PI = 30	0.0016	1.10	0.85	2,509,148	4,014.64
2	MSW	5.0	-7.5	569.6	173.6	73.9	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	10.0	-15.0	593.2	180.8	78.2	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	10.0	-25.0	616.8	188.0	81.5	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	10.0	-35.0	640.4	195.2	84.1	13.2	M & K	0.00316	0.50	1.10	1,071,763	3,386.77
6	MSW	10.0	-45.0	664.0	202.4	85.9	13.5	M & K	0.00316	0.50	1.10	1,176,729	3,718.46
7	MSW	5.0	-52.5	687.7	209.6	87.1	13.7	M & K	0.00316	0.50	1.10	1,280,661	4,046.89
8	CH (Liner)	5.0	-57.5	711.3	216.8	125.0	19.6	PI = 50	0.00244	1.00	0.85	1,965,593	4,796.05
9	MSW	10.0	-65.0	734.9	224.0	88.9	14.0	M & K	0.00316	0.50	1.10	1,492,612	4,716.65
10	MSW	10.0	-75.0	758.5	231.2	89.5	14.1	M & K	0.00316	0.50	1.10	1,600,359	5,057.13
11	MSW	10.0	-85.0	782.2	238.4	89.7	14.1	M & K	0.00316	0.50	1.10	1,706,432	5,392.32
12	MSW	10.0	-95.0	805.8	245.6	90.1	14.1	M & K	0.00316	0.50	1.10	1,817,488	5,743.26
13	MSW	10.0	-105.0	829.4	252.8	90.3	14.2	M & K	0.00316	0.50	1.10	1,931,060	6,102.15
14	MSW	10.0	-115.0	853.0	260.0	90.6	14.2	M & K	0.00316	0.50	1.10	2,049,826	6,477.45
15	MSW	10.0	-125.0	876.6	267.2	90.9	14.3	M & K	0.00316	0.50	1.10	2,171,012	6,860.40
16	MSW	10.0	-135.0	900.3	274.4	91.2	14.3	M & K	0.00316	0.50	1.10	2,297,612	7,260.45
17	W. Silt (ML/CL)	5.0	-142.5	909.0	277.1	115.0	18.1	PI = 30	0.0016	1.10	0.85	2,953,388	4,725.42
18	W. Silt (ML/CL)	10.0	-150.0	1100.0	335.3	115.0	18.1	PI = 30	0.0016	1.10	0.85	4,324,921	6,919.87
19	SM/SW	5.0	-157.5	1180.0	359.7	125.0	19.6	PI = 0	0.000324	1.10	0.90	5,409,648	1,752.73
20	SM/SW	10.0	-165.0	1320.0	402.3	125.0	19.6	PI = 0	0.000324	1.10	0.90	6,769,441	2,193.30

H (ft) = 170.0   **$(V_s)_{avg}$ (ft/s) =** 817.64   **T (s) =** 0.832   **n (-) =** 0   **c (%) =** 1   **α_R =** 0.00   **β_R =** 0.002648





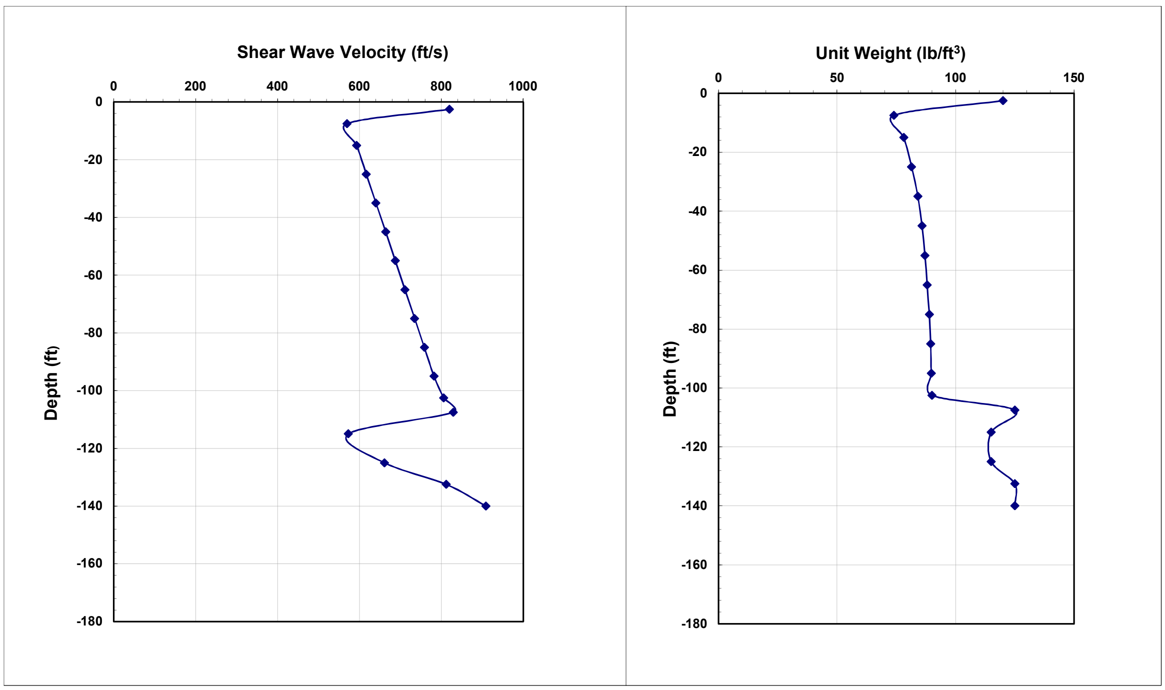


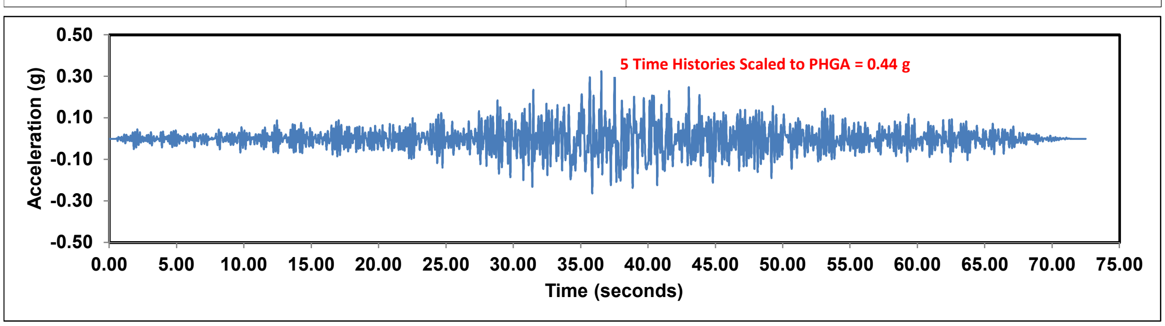
Riverbend Module 11 - D-MOD / Section F / 110' MSW, 35' Alluvium - Deep

Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer (-)	Description (-)	Thickness (ft)	Depth (ft)	V_s [ft/s]	V_s (m/s)	γ (lb/ft^3)	γ (kN/m^3)	Curves (-)	γ_r (-)	β (-)	s (-)	G_{mo} (psf)	τ_{mo} (psf)
1	CL	5.0	-2.5	820.00	249.9	120.00	18.8	PI = 30	0.0016	1.10	0.85	2,507,863	4,012.58
2	MSW	5.0	-7.5	569.55	173.6	73.95	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	10.0	-15.0	593.18	180.8	78.15	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	10.0	-25.0	616.80	188.0	81.46	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	10.0	-35.0	640.42	195.2	84.08	13.2	M & K	0.00316	0.50	1.10	1,071,763	3,386.77
6	MSW	10.0	-45.0	664.04	202.4	85.86	13.5	M & K	0.00316	0.50	1.10	1,176,729	3,718.46
7	MSW	10.0	-55.0	687.66	209.6	87.13	13.7	M & K	0.00316	0.50	1.10	1,280,661	4,046.89
8	MSW	10.0	-65.0	711.29	216.8	88.03	13.8	M & K	0.00316	0.50	1.10	1,384,178	4,374.00
9	MSW	10.0	-75.0	734.91	224.0	88.92	14.0	M & K	0.00316	0.50	1.10	1,492,612	4,716.65
10	MSW	10.0	-85.0	758.53	231.2	89.49	14.1	M & K	0.00316	0.50	1.10	1,600,359	5,057.13
11	MSW	10.0	-95.0	782.15	238.4	89.75	14.1	M & K	0.00316	0.50	1.10	1,706,432	5,392.32
12	MSW	5.0	-102.5	805.77	245.6	90.06	14.1	M & K	0.00316	0.50	1.10	1,817,488	5,743.26
13	CH (Liner)	5.0	-107.5	829.40	252.8	125.00	19.6	PI = 50	0.00244	1.00	0.85	2,672,571	6,521.07
14	W. Silt (ML/CL)	10.0	-115.0	573.0	174.7	115.00	18.1	PI = 30	0.0016	1.10	0.85	1,173,551	1,877.68
15	W. Silt (ML/CL)	10.0	-125.0	661.0	201.5	115.00	18.1	PI = 30	0.0016	1.10	0.85	1,561,693	2,498.71
16	SM/SW	5.0	-132.5	812.0	247.5	125.00	19.6	PI = 0	0.000324	1.10	0.90	2,561,634	829.97
17	SM/SW	10.0	-140.0	909.0	277.1	125.00	19.6	PI = 0	0.000324	1.10	0.90	3,210,205	1,040.11

H (ft) = **145.0** $(V_s)_{avg}$ (ft/s) = **715.81** T (s) = **0.810** n (-) = **0** c (%) = **1** α_R = **0.00** β_R = **0.002578**



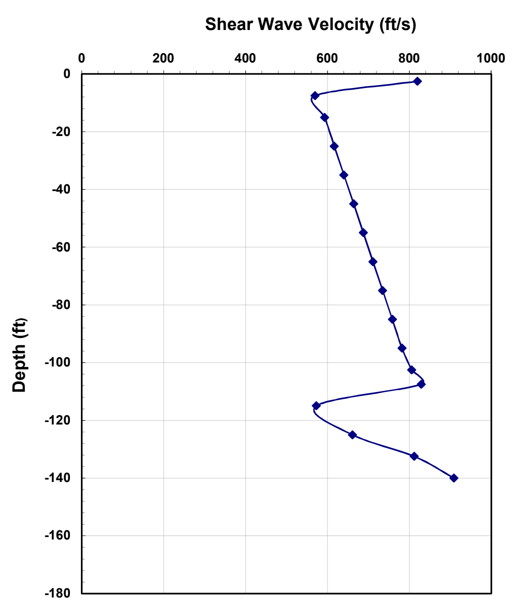


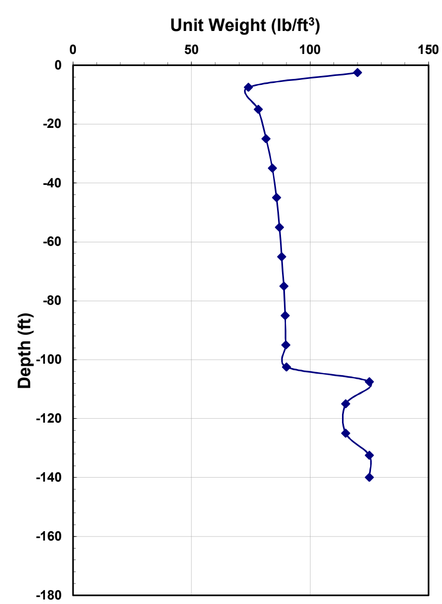
Riverbend Module 11 - D-MOD / Section F / 110' MSW, 35' Alluvium - Liner

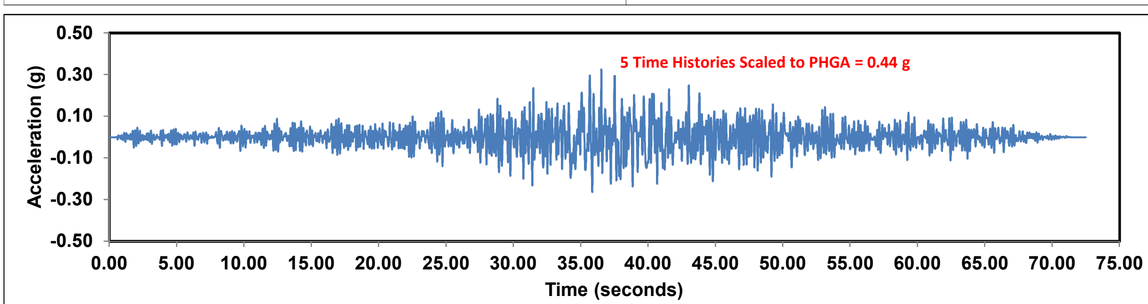
Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer (-)	Description (-)	Thickness (ft)	Depth (ft)	V_s [ft/s]	V_s (m/s)	γ (lb/ft^3)	γ (kN/m^3)	Curves (-)	γ_r (-)	β (-)	s (-)	G_{mo} (psf)	τ_{mo} (psf)
1	CL	5.0	-2.5	820.00	249.9	120.00	18.8	PI = 30	0.0016	1.10	0.85	2,507,863	4,012.58
2	MSW	5.0	-7.5	569.55	173.6	73.95	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	10.0	-15.0	593.18	180.8	78.15	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	10.0	-25.0	616.80	188.0	81.46	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	10.0	-35.0	640.42	195.2	84.08	13.2	M & K	0.00316	0.50	1.10	1,071,763	3,386.77
6	MSW	10.0	-45.0	664.04	202.4	85.86	13.5	M & K	0.00316	0.50	1.10	1,176,729	3,718.46
7	MSW	10.0	-55.0	687.66	209.6	87.13	13.7	M & K	0.00316	0.50	1.10	1,280,661	4,046.89
8	MSW	10.0	-65.0	711.29	216.8	88.03	13.8	M & K	0.00316	0.50	1.10	1,384,178	4,374.00
9	MSW	10.0	-75.0	734.91	224.0	88.92	14.0	M & K	0.00316	0.50	1.10	1,492,612	4,716.65
10	MSW	10.0	-85.0	758.53	231.2	89.49	14.1	M & K	0.00316	0.50	1.10	1,600,359	5,057.13
11	MSW	10.0	-95.0	782.15	238.4	89.75	14.1	M & K	0.00316	0.50	1.10	1,706,432	5,392.32
12	MSW	5.0	-102.5	805.77	245.6	90.06	14.1	M & K	0.00316	0.50	1.10	1,817,488	5,743.26
13	CH (Liner)	5.0	-107.5	829.40	252.8	125.00	19.6	PI = 50	0.00244	1.00	0.85	2,672,571	6,521.07
14	W. Silt (ML/CL)	10.0	-115.0	573.0	174.7	115.00	18.1	PI = 30	0.0016	1.10	0.85	1,173,551	1,877.68
15	W. Silt (ML/CL)	10.0	-125.0	661.0	201.5	115.00	18.1	PI = 30	0.0016	1.10	0.85	1,561,693	2,498.71
16	SM/SW	5.0	-132.5	812.0	247.5	125.00	19.6	PI = 0	0.000324	1.10	0.90	2,561,634	829.97
17	SM/SW	10.0	-140.0	909.0	277.1	125.00	19.6	PI = 0	0.000324	1.10	0.90	3,210,205	1,040.11

H (ft) = 145.0 | $(V_s)_{avg}$ (ft/s) = 715.81 | T (s) = 0.810 | n (-) = 0 | c (%) = 1 | α_R = 0.00 | β_R = 0.002578





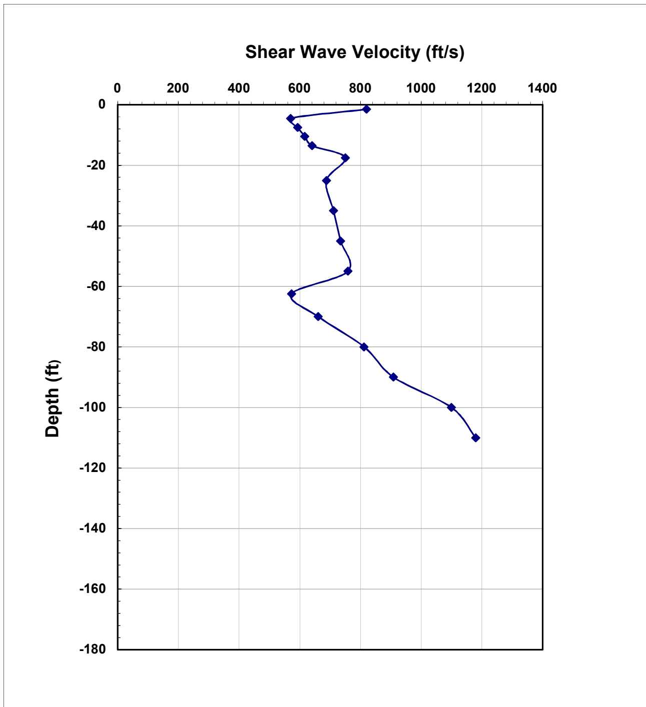


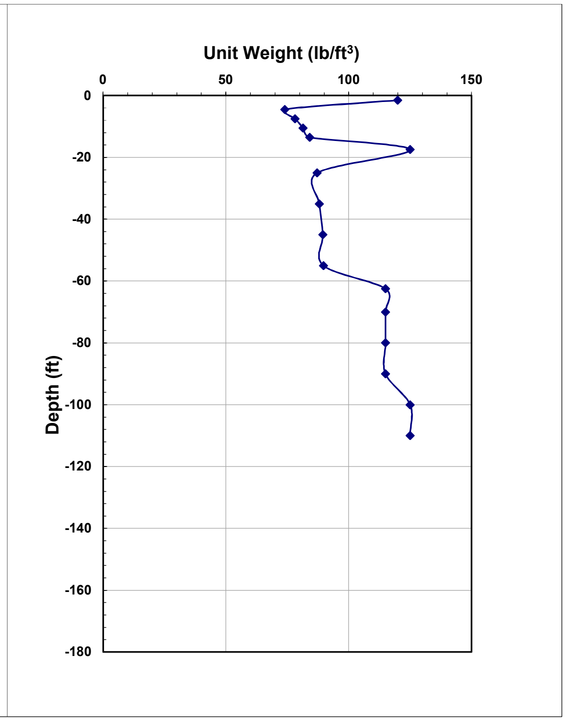
Riverbend Module 11 - D-MOD / Section G / 20' MSW, Overliner, 40' MSW, 65' Alluvium - Liner

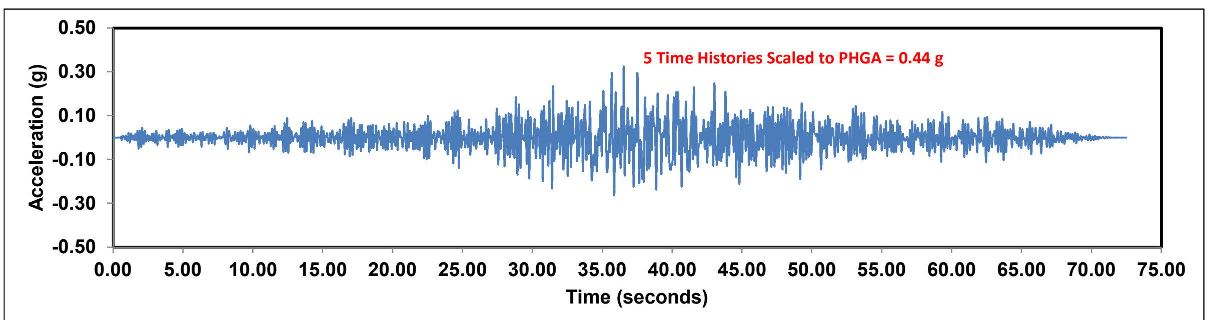
Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer	Description	Thickness	Depth	V_s	V_s	γ	γ	Curves	γ_r	β	s	G_{mo}	τ_{mo}
(-)	(-)	(ft)	(ft)	[ft/s]	(m/s)	(lb/ft^3)	(kN/m^3)	(-)	(-)	(-)	(-)	(psf)	(psf)
1	CL	3.0	-1.5	820.21	250.0	120.00	18.8	PI = 30	0.0016	1.10	0.85	2,509,148	4,014.64
2	MSW	3.0	-4.5	569.55	173.6	73.95	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	3.0	-7.5	593.18	180.8	78.15	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	3.0	-10.5	616.80	188.0	81.46	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	3.0	-13.5	640.42	195.2	84.08	13.2	M & K	0.00316	0.50	1.10	1,071,809	3,386.92
6	CH (Liner)	5.0	-17.5	750.00	228.6	125.00	19.6	PI = 50	0.00244	1.00	0.85	2,185,383	5,332.33
7	MSW	10.0	-25.0	687.66	209.6	87.13	13.7	M & K	0.00316	0.50	1.10	1,280,590	4,046.67
8	MSW	10.0	-35.0	711.29	216.8	88.03	13.8	M & K	0.00316	0.50	1.10	1,384,264	4,374.28
9	MSW	10.0	-45.0	734.91	224.0	89.49	14.0	M & K	0.00316	0.50	1.10	1,502,235	4,747.06
10	MSW	10.0	-55.0	758.53	231.2	89.75	14.1	M & K	0.00316	0.50	1.10	1,605,000	5,071.80
11	W. Silt (ML/CL)	5.0	-62.5	573.0	174.7	115.00	18.1	PI = 15	0.00092	1.30	0.85	1,173,551	1,079.67
12	W. Silt (ML/CL)	10.0	-70.0	661.0	201.5	115.00	18.1	PI = 15	0.00092	1.30	0.85	1,561,693	1,436.76
13	W. Silt (ML/CL)	10.0	-80.0	812.0	247.5	115.00	18.1	PI = 15	0.00092	1.30	0.85	2,356,703	2,168.17
14	W. Silt (ML/CL)	10.0	-90.0	909.0	277.1	115.00	18.1	PI = 30	0.00092	1.10	0.85	2,953,388	2,717.12
15	SM/SW	10.0	-100.0	1100.0	335.3	125.00	19.6	PI = 0	0.000324	1.10	0.90	4,701,001	1,523.12
16	SM/SW	10.0	-110.0	1180.0	359.7	125.00	19.6	PI = 0	0.000324	1.10	0.90	5,409,648	1,752.73
17	SM/SW	10.0	-120.0	1320.0	402.3	125.00	19.6	PI = 0	0.000324	1.10	0.90	6,769,441	2,193.30

H (ft) = 125.0 $(V_s)_{avg}$ (ft/s) = 790.44   T (s) = 0.633   n (-) = 0   c (%) = 1 α_R = 0.00 β_R = 0.002015





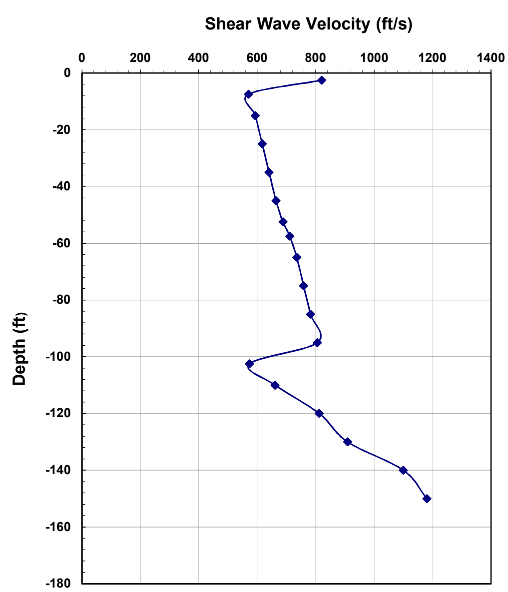


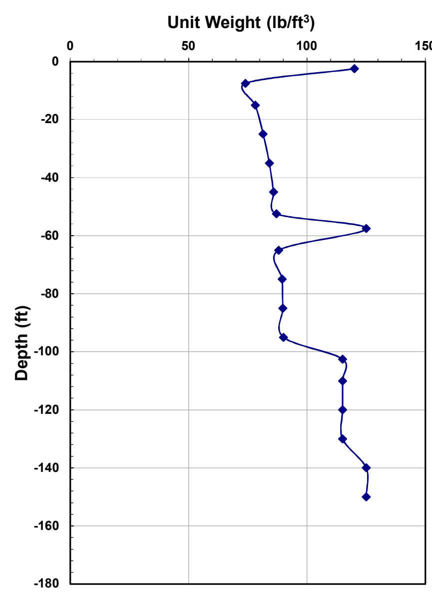
Riverbend Module 11 - D-MOD / Section G / 60' MSW, Overliner, 40' MSW, 65' Alluvium - Deep

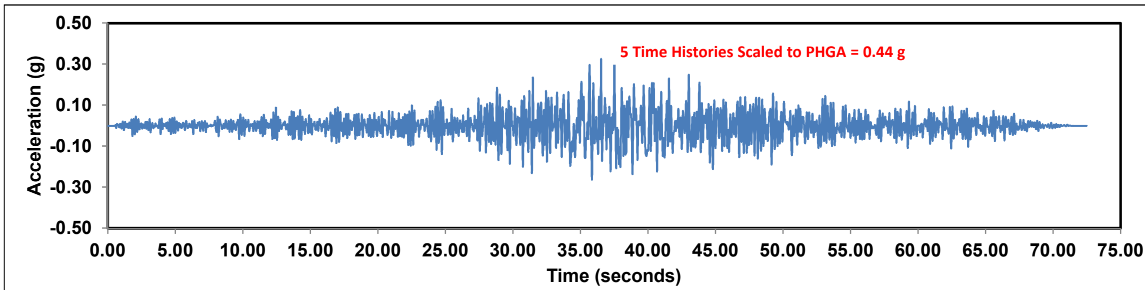
Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer	Description	Thickness	Depth	V_s	V_s	γ	γ	Curves	γ_r	β	s	G_{mo}	τ_{mo}
(-)	(-)	(ft)	(ft)	[ft/s]	(m/s)	(lb/ft^3)	(kN/m^3)	(-)	(-)	(-)	(-)	(psf)	(psf)
1	CL	5.0	-2.5	820.21	250.0	120.00	18.8	PI = 30	0.0016	1.10	0.85	2,509,148	4,014.64
2	MSW	5.0	-7.5	569.55	173.6	73.95	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	10.0	-15.0	593.18	180.8	78.15	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	10.0	-25.0	616.80	188.0	81.46	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	10.0	-35.0	640.42	195.2	84.08	13.2	M & K	0.00316	0.50	1.10	1,071,763	3,386.77
6	MSW	10.0	-45.0	664.04	202.4	85.86	13.5	M & K	0.00316	0.50	1.10	1,176,729	3,718.46
7	MSW	5.0	-52.5	687.66	209.6	87.13	13.7	M & K	0.00316	0.50	1.10	1,280,590	4,046.67
8	CH (Liner)	5.0	-57.5	711.29	216.8	125.00	19.6	PI = 50	0.00244	1.00	0.85	1,965,615	4,796.10
9	MSW	10.0	-65.0	734.91	224.0	88.03	13.8	M & K	0.00316	0.50	1.10	1,477,726	4,669.61
10	MSW	10.0	-75.0	758.53	231.2	89.49	14.0	M & K	0.00316	0.50	1.10	1,600,350	5,057.11
11	MSW	10.0	-85.0	782.15	238.4	89.75	14.1	M & K	0.00316	0.50	1.10	1,706,513	5,392.58
12	MSW	10.0	-95.0	805.77	245.6	90.06	14.1	M & K	0.00316	0.50	1.10	1,817,394	5,742.96
13	W. Silt (ML/CL)	5.0	-102.5	573.0	174.7	115.00	18.1	PI = 15	0.00092	1.30	0.85	1,173,551	1,079.67
14	W. Silt (ML/CL)	10.0	-110.0	661.0	201.5	115.00	18.1	PI = 15	0.00092	1.30	0.85	1,561,693	1,436.76
15	W. Silt (ML/CL)	10.0	-120.0	812.0	247.5	115.00	18.1	PI = 15	0.00092	1.30	0.85	2,356,703	2,168.17
16	W. Silt (ML/CL)	10.0	-130.0	909.0	277.1	115.00	18.1	PI = 30	0.00092	1.10	0.85	2,953,388	2,717.12
17	SM/SW	10.0	-140.0	1100.0	335.3	125.00	19.6	PI = 0	0.000324	1.10	0.90	4,701,001	1,523.12
18	SM/SW	10.0	-150.0	1180.0	359.7	125.00	19.6	PI = 0	0.000324	1.10	0.90	5,409,648	1,752.73
19	SM/SW	10.0	-160.0	1320.0	402.3	125.00	19.6	PI = 0	0.000324	1.10	0.90	6,769,441	2,193.30

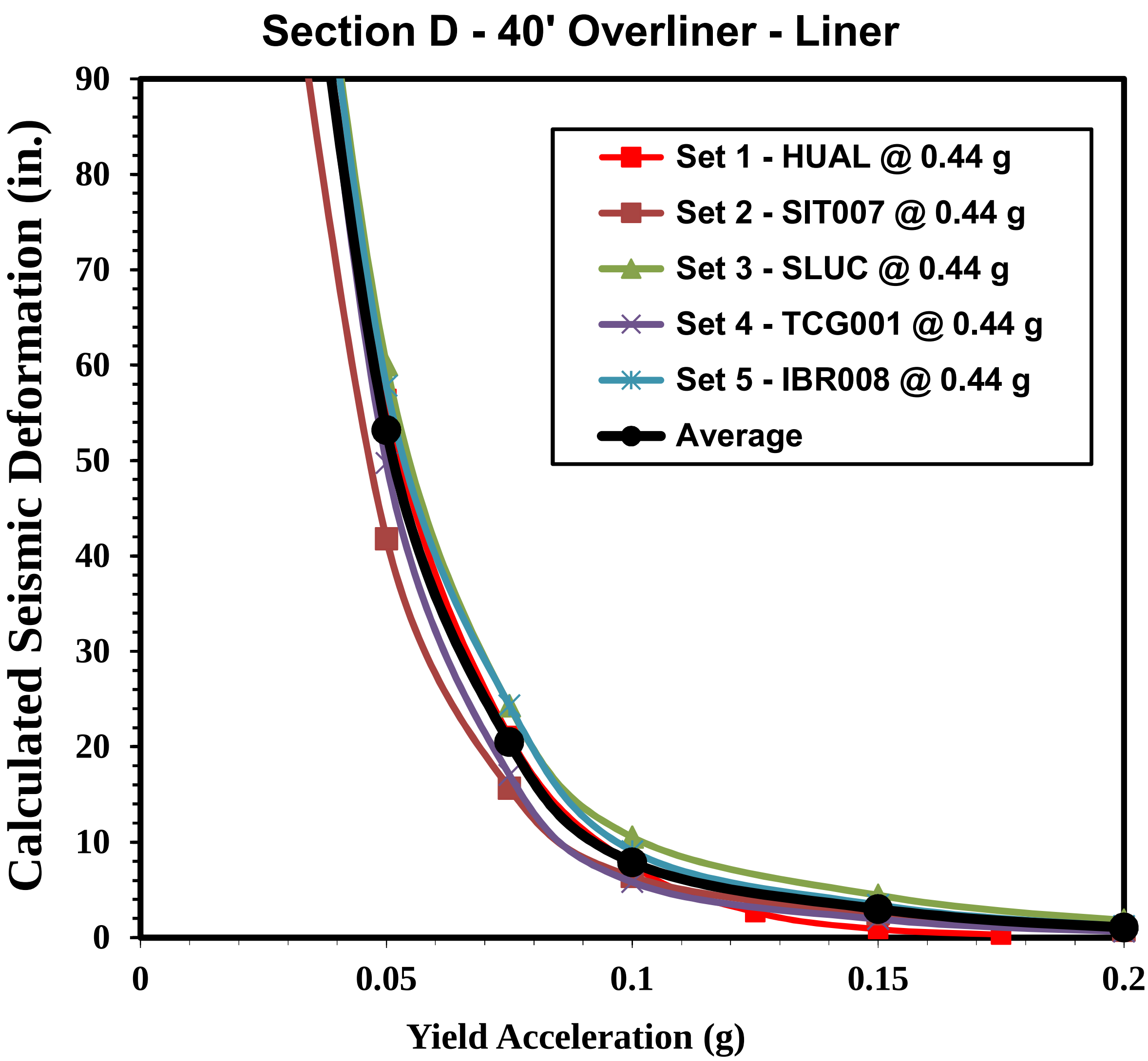
H (ft) = 165.0 $(V_s)_{avg}$ (ft/s) = 786.29 T (s) = 0.839 n (-) = 0 c (%) = 1 α_R = 0.00 β_R = 0.002671



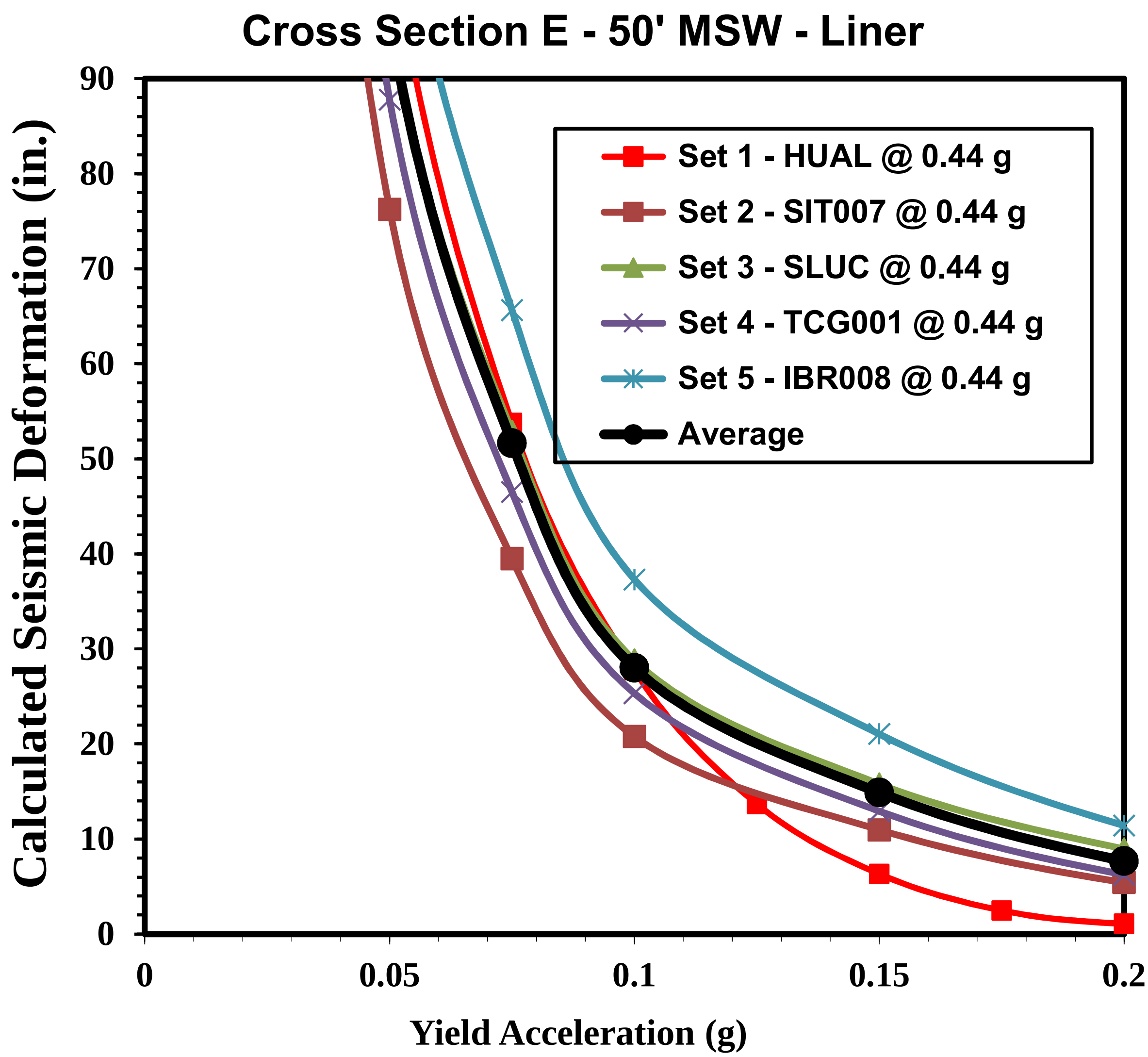




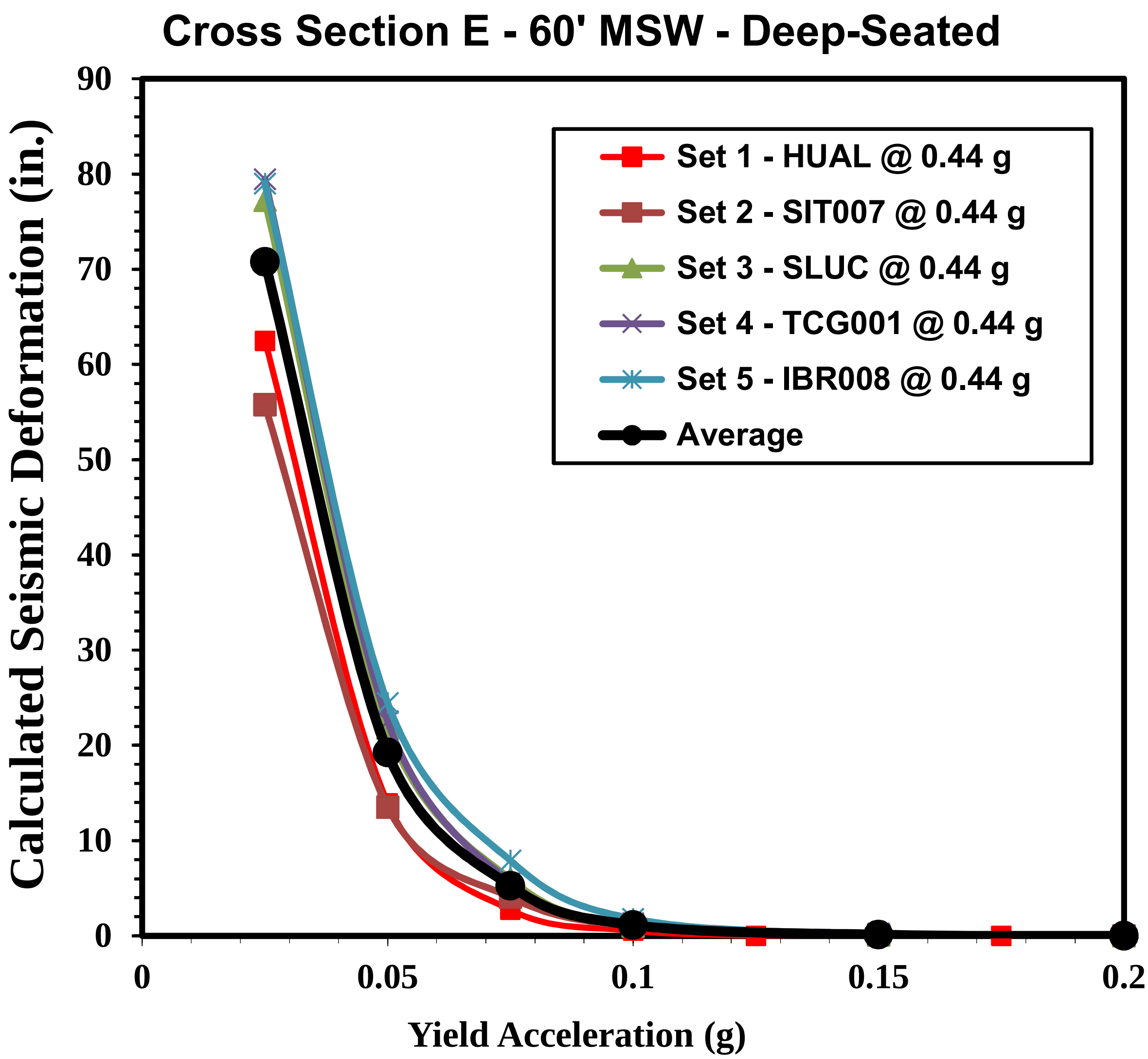
DEFORMATION CHARTS



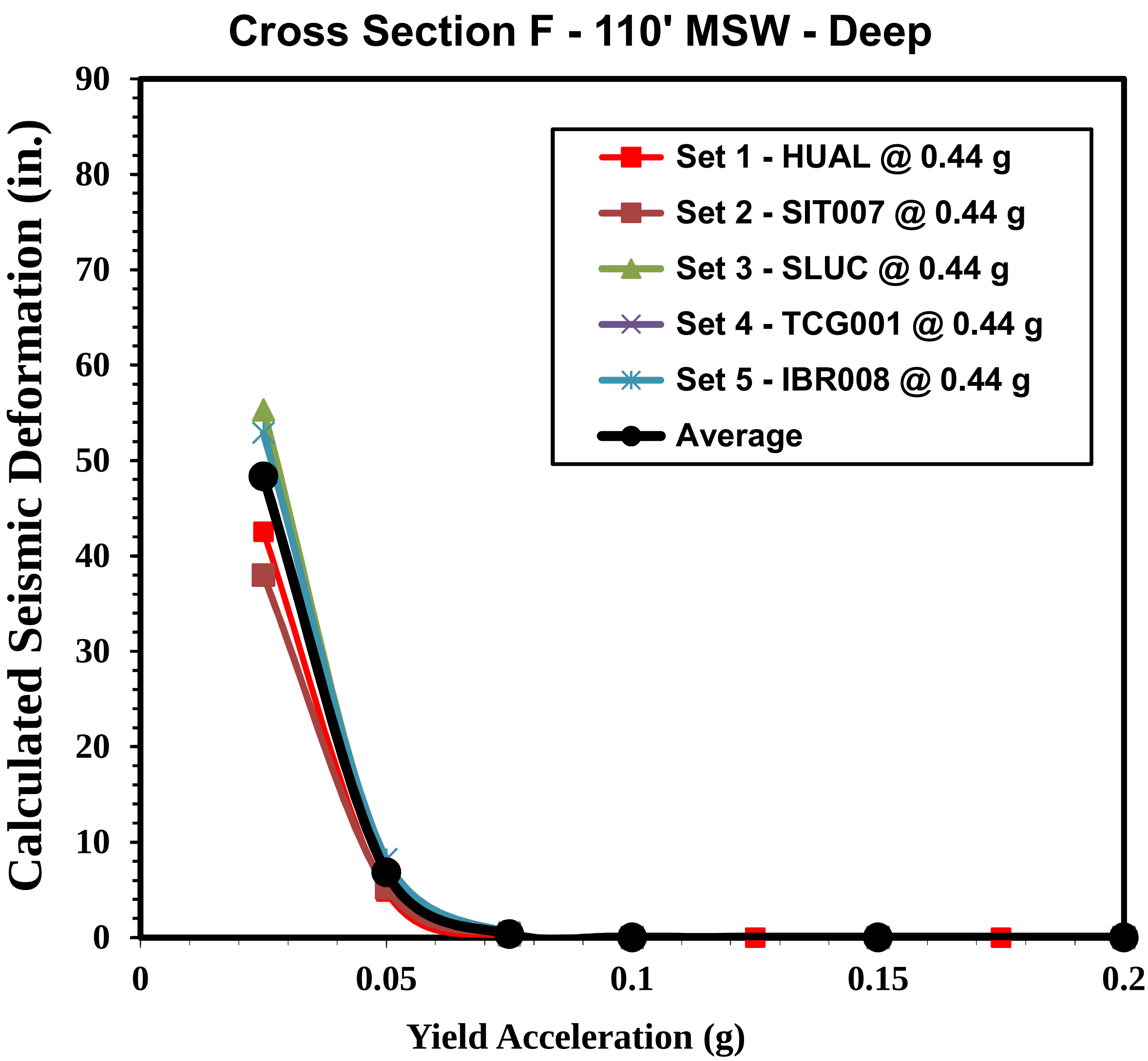
Section D - 40' Overliner - Liner
Calculated Seismic Deformation (in.)
90
80
70
60
50
40
30
20
10
0
0
0.05
0.1
0.15
0.2
Yield Acceleration (g)
Set 1 - HUAL @ 0.44 g
Set 2 - SIT007 @ 0.44 g
Set 3 - SLUC @ 0.44 g
Set 4 - TCG001 @ 0.44 g
Set 5 - IBR008 @ 0.44 g
Average



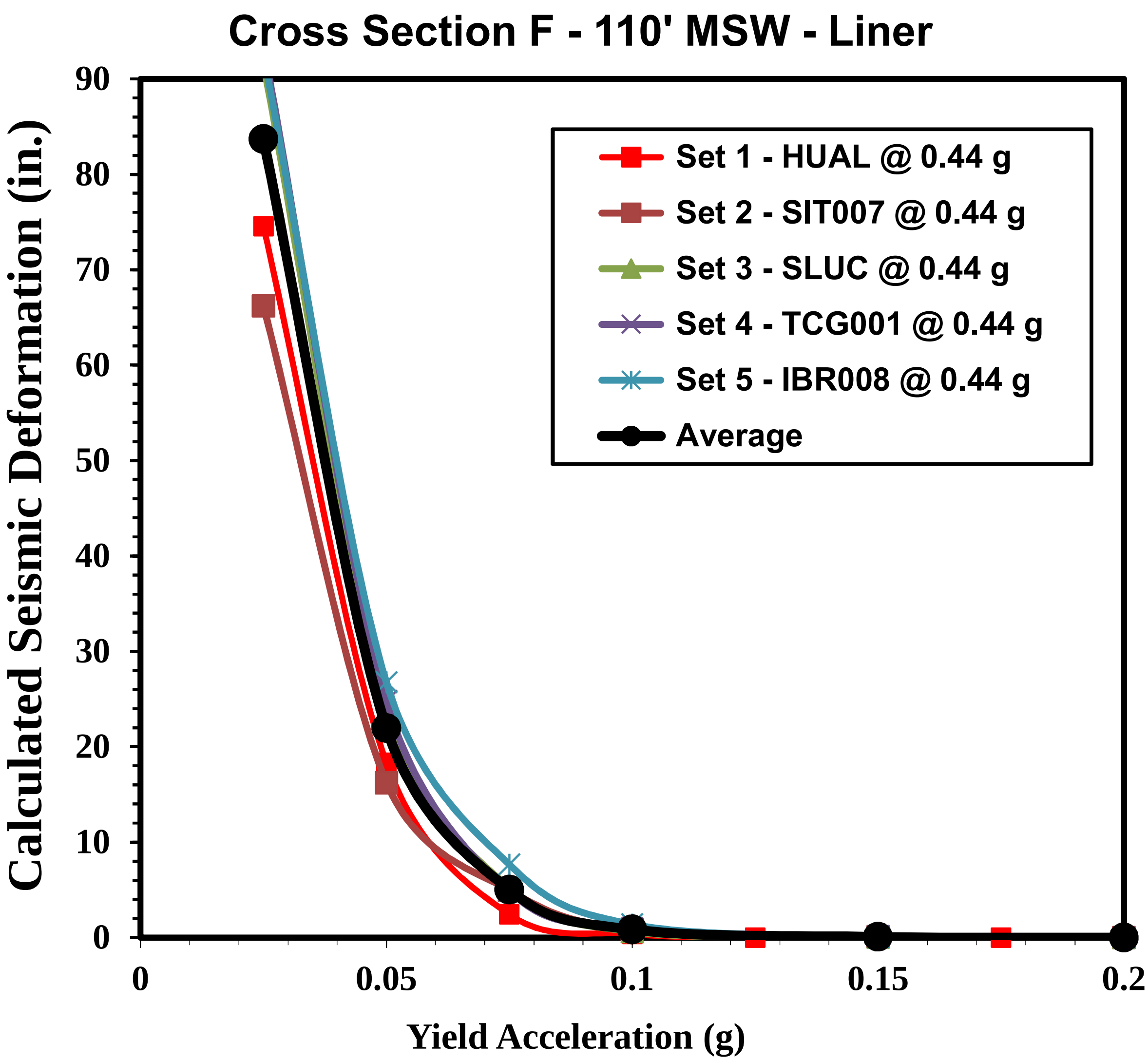
Cross Section E - 50' MSW - Liner
Calculated Seismic Deformation (in.)
90
80
70
60
50
40
30
20
10
0
0
0.05
0.1
0.15
0.2
Yield Acceleration (g)
Set 1 - HUAL @ 0.44 g
Set 2 - SIT007 @ 0.44 g
Set 3 - SLUC @ 0.44 g
Set 4 - TCG001 @ 0.44 g
Set 5 - IBR008 @ 0.44 g
Average

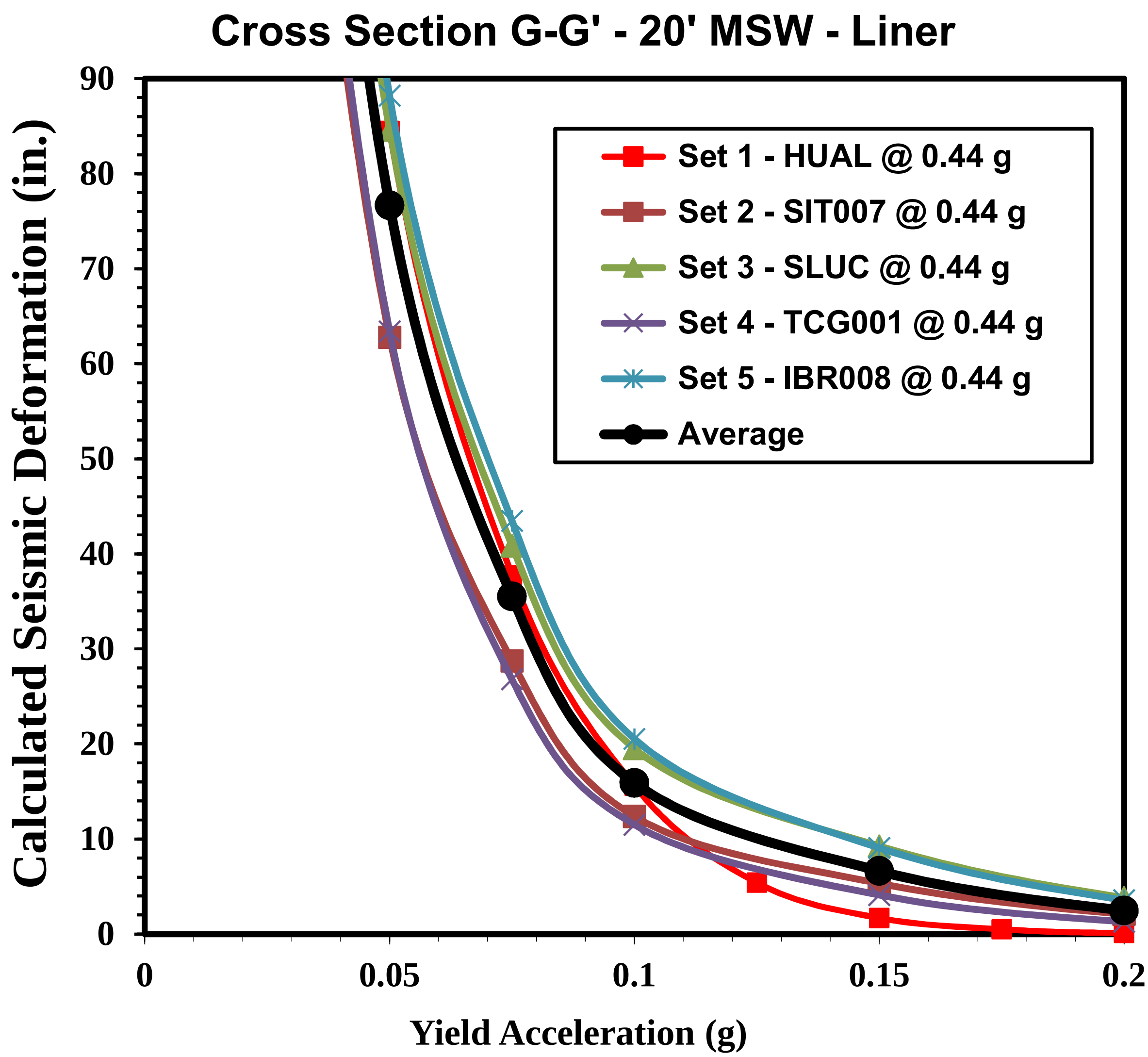


Cross Section E - 60' MSW - Deep-Seated
Calculated Seismic Deformation (in.)
Yield Acceleration (g)
Set 1 - HUAL @ 0.44 g
Set 2 - SIT007 @ 0.44 g
Set 3 - SLUC @ 0.44 g
Set 4 - TCG001 @ 0.44 g
Set 5 - IBR008 @ 0.44 g
Average
0
10
20
30
40
50
60
70
80
90
0
0.05
0.1
0.15
0.2

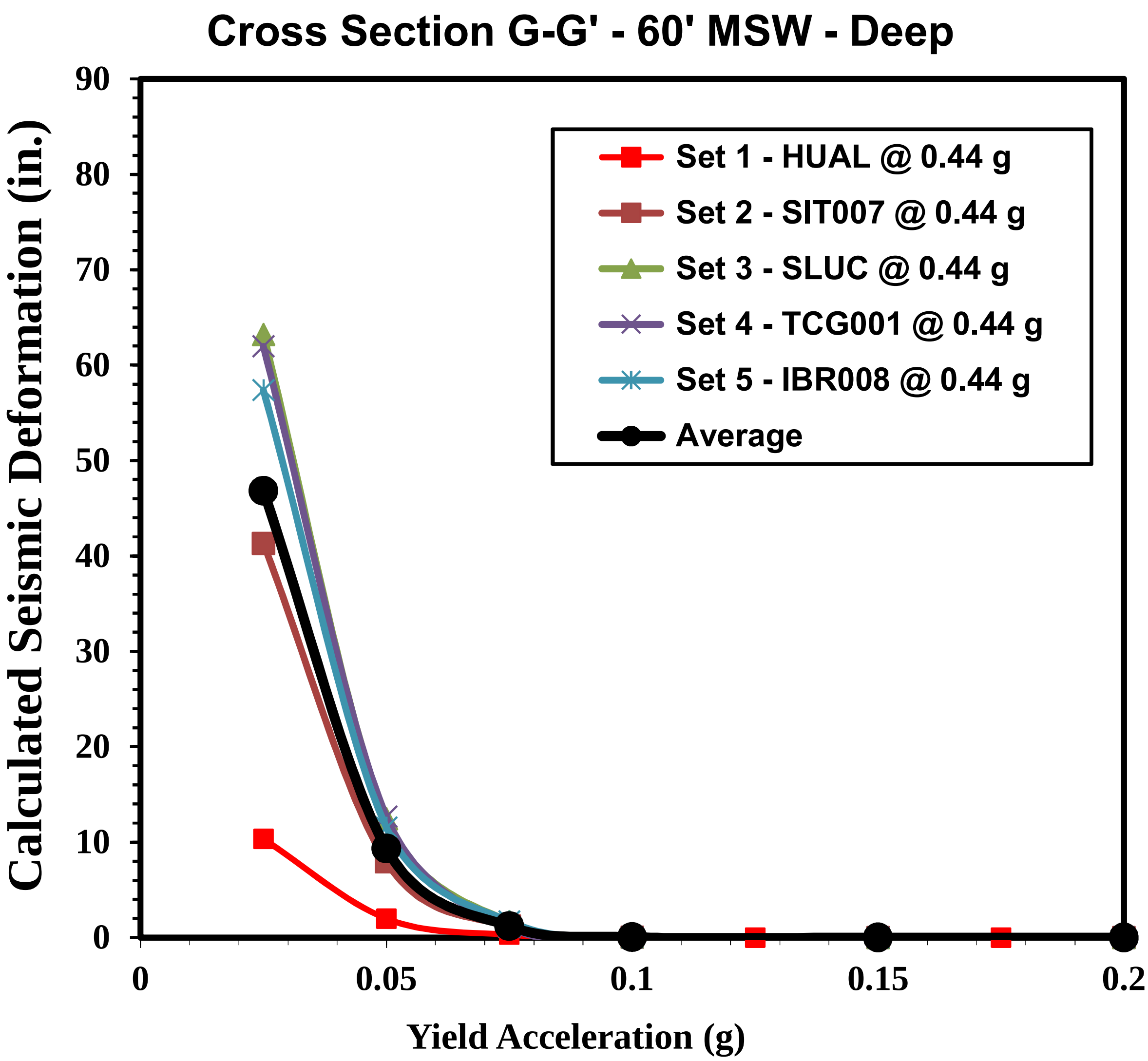


Cross Section F - 110' MSW - Deep
Calculated Seismic Deformation (in.)
Yield Acceleration (g)
90
80
70
60
50
40
30
20
10
0
0
0.05
0.1
0.15
0.2
Set 1 - HUAL @ 0.44 g
Set 2 - SIT007 @ 0.44 g
Set 3 - SLUC @ 0.44 g
Set 4 - TCG001 @ 0.44 g
Set 5 - IBR008 @ 0.44 g
Average


Cross Section F - 110' MSW - Liner
Calculated Seismic Deformation (in.)
Yield Acceleration (g)
0
10
20
30
40
50
60
70
80
90
0
0.05
0.1
0.15
0.2
Set 1 - HUAL @ 0.44 g
Set 2 - SIT007 @ 0.44 g
Set 3 - SLUC @ 0.44 g
Set 4 - TCG001 @ 0.44 g
Set 5 - IBR008 @ 0.44 g
Average



Cross Section G-G' - 20' MSW - Liner
Calculated Seismic Deformation (in.)
Yield Acceleration (g)
0
10
20
30
40
50
60
70
80
90
0
0.05
0.1
0.15
0.2
Set 1 - HUAL @ 0.44 g
Set 2 - SIT007 @ 0.44 g
Set 3 - SLUC @ 0.44 g
Set 4 - TCG001 @ 0.44 g
Set 5 - IBR008 @ 0.44 g
Average



Cross Section G-G' - 60' MSW - Deep
Calculated Seismic Deformation (in.)
90
80
70
60
50
40
30
20
10
0
0
0.05
0.1
0.15
0.2
Yield Acceleration (g)
Set 1 - HUAL @ 0.44 g
Set 2 - SIT007 @ 0.44 g
Set 3 - SLUC @ 0.44 g
Set 4 - TCG001 @ 0.44 g
Set 5 - IBR008 @ 0.44 g
Average

APPENDIX D

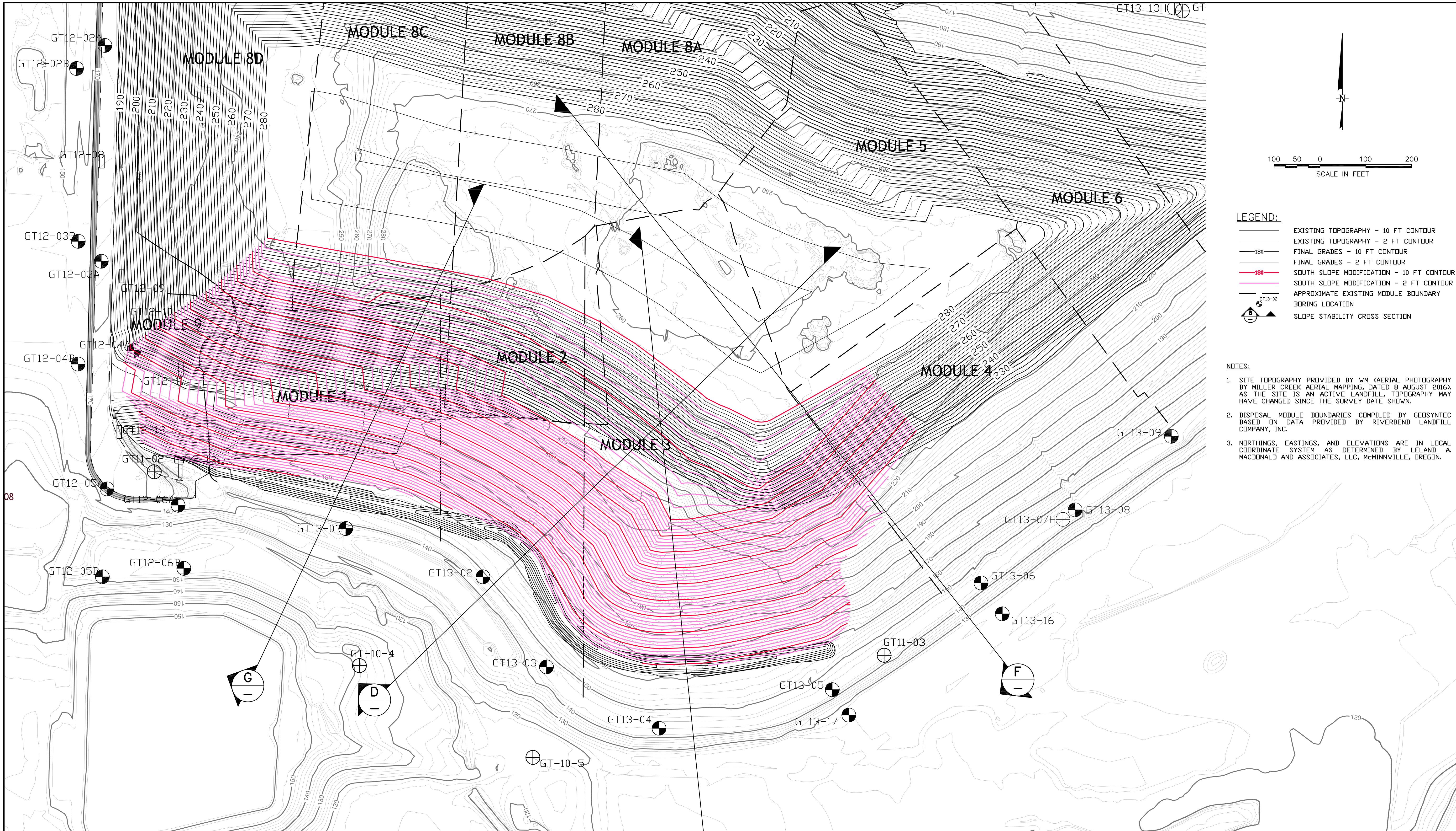
Slope Stability Analyses

Table 1
Results of Slope Stability Analyses
South Slope Modification
Riverbend Landfill
Yamhill County, Oregon

Section[1]	Case Descriptors		Post-Liquefaction Residual Shear Strength (psf)	Static FS[2]	Yield Acceleration, ky[3]	Seismic Displacement, D (in)	Description
	Location	Foundation					
SECTION D							
D	N-S Across Existing South Berm	Overliner - Mod. 2&3		**1.70**	**0.18**	**2**	Potential slip surface through waste and liner - 40' MSW - Section D - 40' overliner, liner
D	N-S Across Existing South Berm	Soil Berm, Foundation Soils	1150	**1.77**	**0.11**	**Small**	Potential slip surface through waste and foundation - Section F - 110' MSW - deep [4]
SECTION E							
E	N-S Across Existing South Berm	New Overliner - Mod. 3		**1.98**	**0.21**	**8**	Potential slip surface through waste and liner - 50' MSW - Section E - 50' MSW - Liner
E	N-S Across Existing South Berm	Soil Berm, Foundation Soils	1250	**1.95**	**0.13**	**Small**	Potential slip surface through waste and foundation - 60' MSW - Section E - 60' MSW - deep
SECTION F							
F	N-S Across Existing South Berm	Liner - Module 4		**1.47**	**0.09**	**2**	Potential slip surface through waste and liner - 110' MSW - Section F - 110' MSW - Liner
F	N-S Across Existing South Berm	Soil Berm, Foundation Soils	1250	**1.71**	**0.09**	**Small**	Potential slip surface through waste and liner - 110' MSW - Section F - 110' MSW - Deep
SECTION G							
G	N-S Across Existing South Berm	Overliner - Mod. 1		**1.55**	**0.16**	**6**	Potential slip surface through waste and liner - 20' MSW - Section G - 20' MSW - Liner
G	N-S Across Existing South Berm	Soil Berm, Foundation Soils	1150	**1.54**	**0.05**	**9**	Potential slip surface through waste and foundation - 60' MSW - Section G - 60' MSW - Deep

Notes:
[1] Cross-sections were selected based on the proposed base grades, final grades, and as-built conditions of the site.
[2] Factor of safety was evaluated with the Slope/W software using the Spencer method of slices and selecting the critical slip surface.
[3] Yield acceleration is the horizontal seismic coefficient required to achieve a factor of safety (FS) of 1.0.

[4] In this scenario, for the slip surface through the foundation, conditions are similar for Section D and for Section F; therefore, the Section F file is applicable.



Geosyntec consultants

STABILITY CROSS SECTIONS AND BORING LOCATIONS
RIVERBEND LANDFILL, SOUTH SLOPE MODIFICATIONS
YAHMILL COUNTY, OREGON

FIGURE NO.	1
PROJECT NO.	WG1866G
DATE:	OCTOBER 2016

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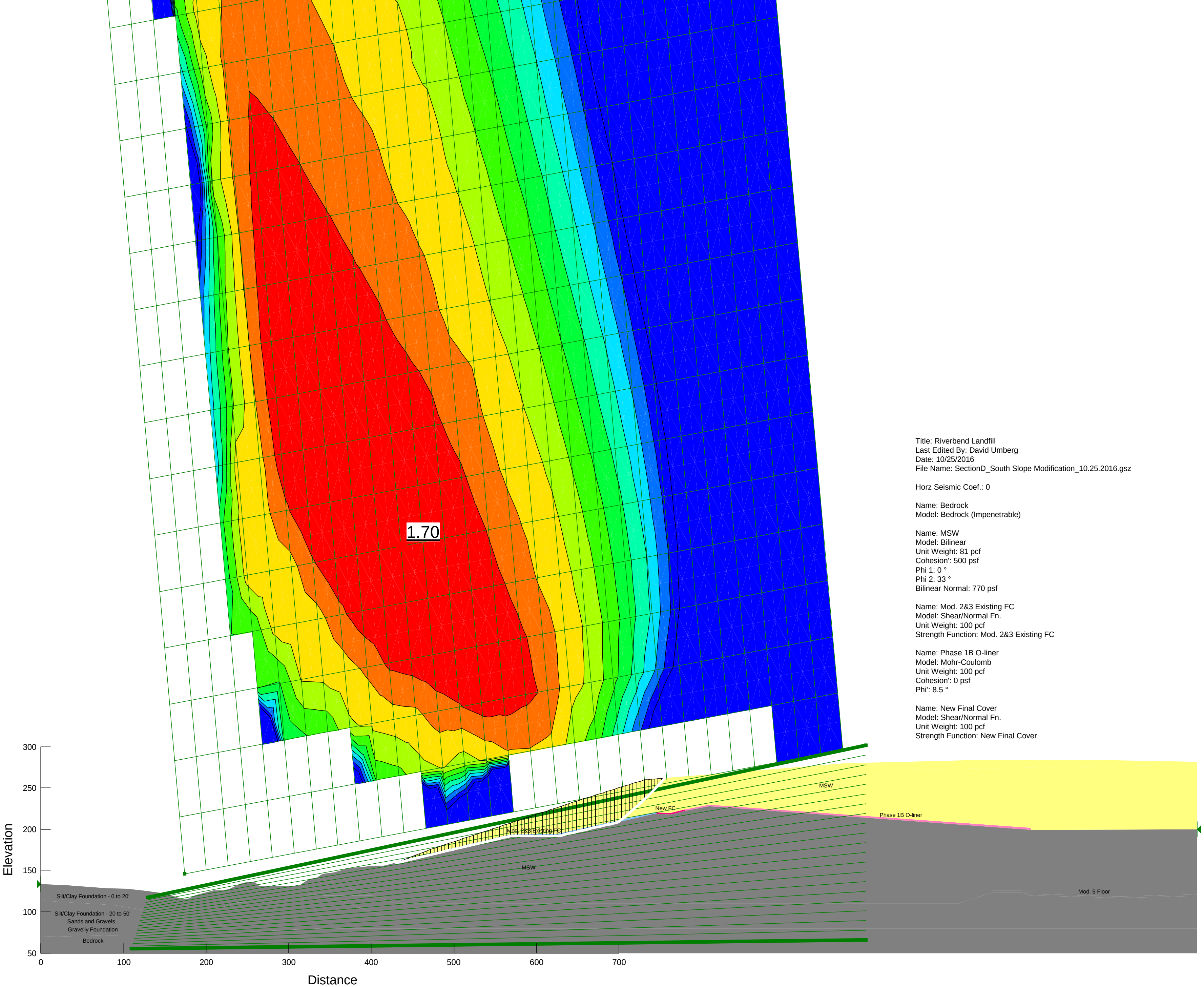

Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionD_South Slope Modification_10.25.2016.gsz

Horz Seismic Coef.: 0

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Mod. 2&3 Existing FC
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 2&3 Existing FC

Name: Phase 1B O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: New Final Cover
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: New Final Cover

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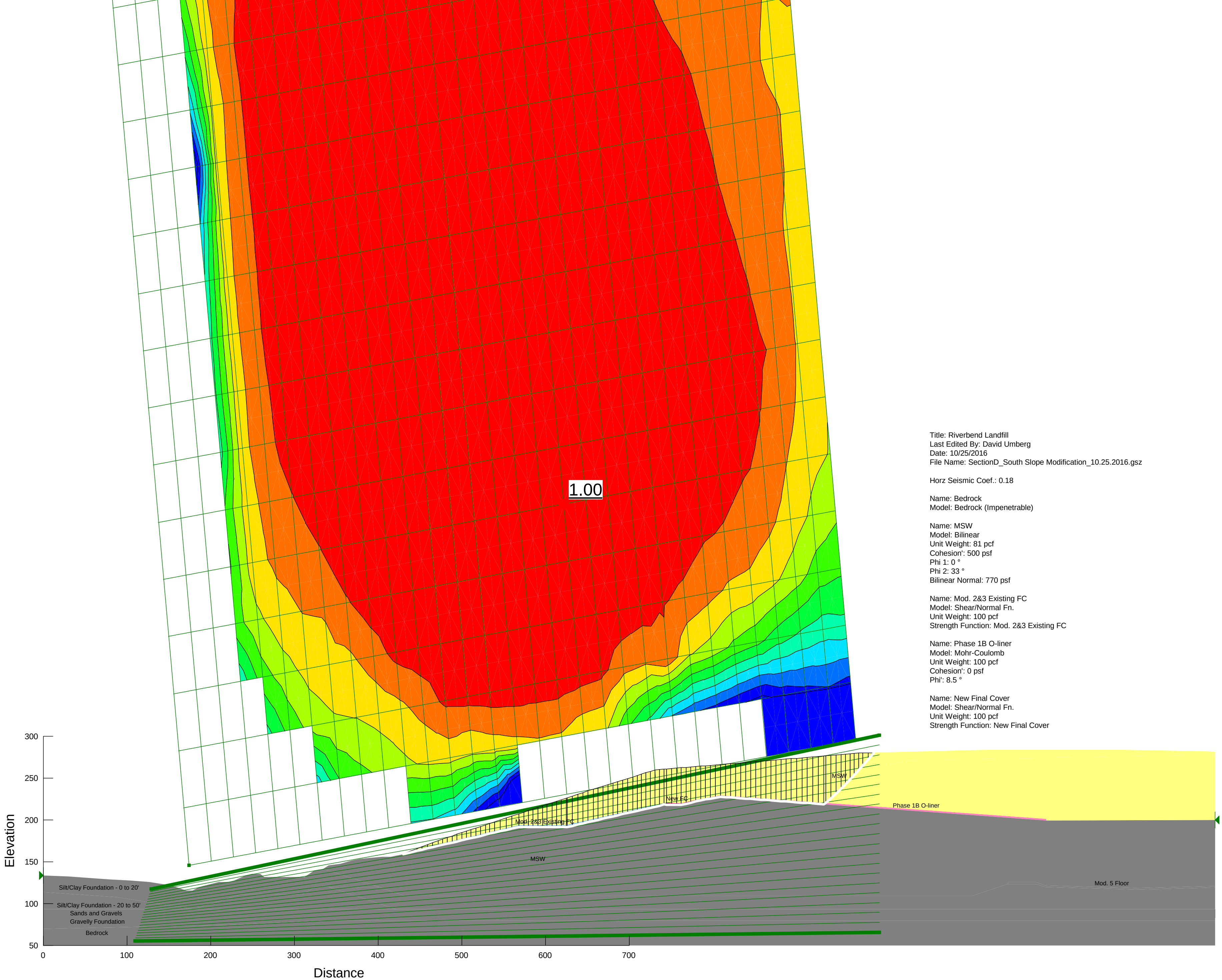

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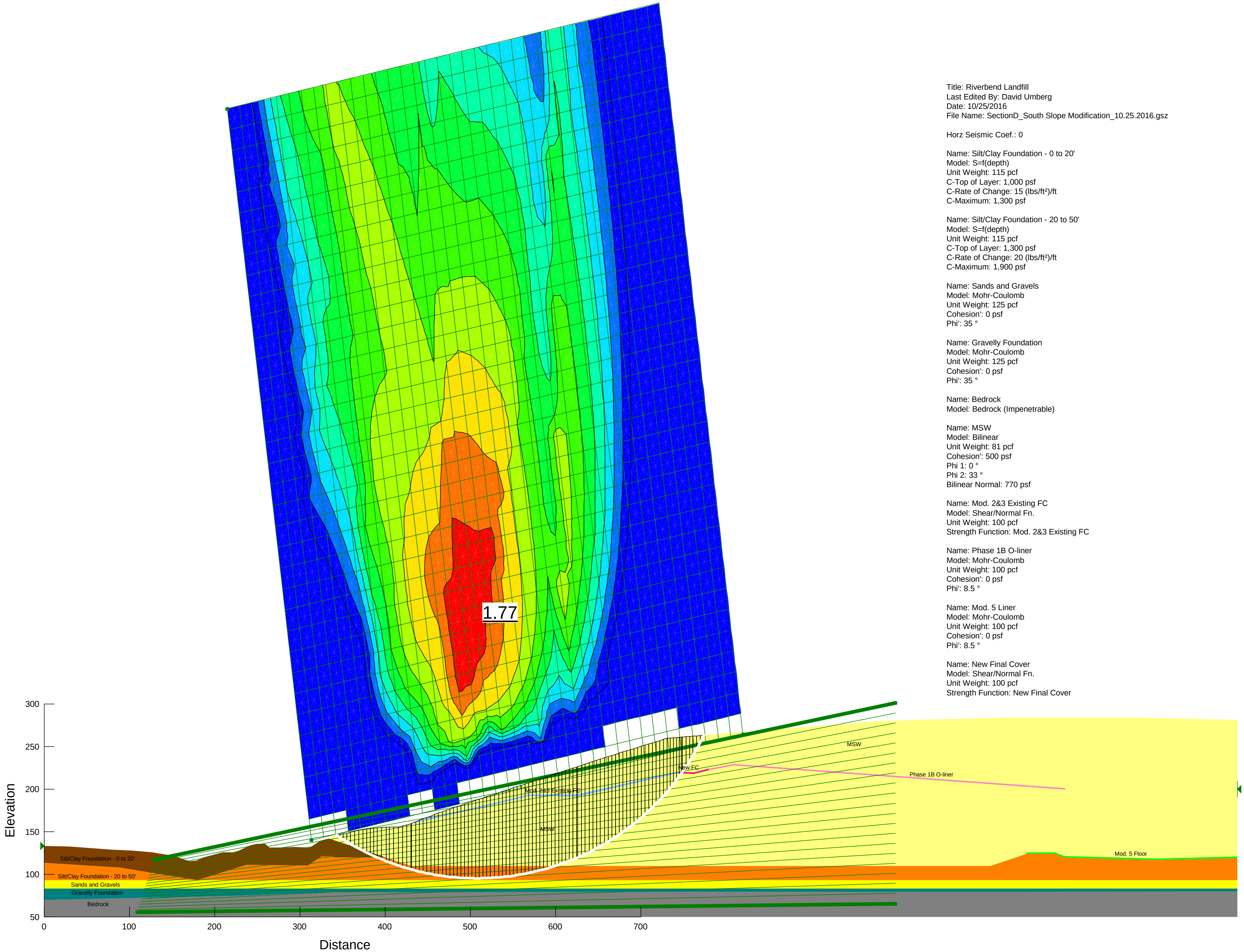


Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionD_South Slope Modification_10.25.2016.gsz

Horz Seismic Coef.: 0

Name: Silt/Clay Foundation - 0 to 20'
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,000 psf
C-Rate of Change: 15 (lbs/ft²)/ft
C-Maximum: 1,300 psf

Name: Silt/Clay Foundation - 20 to 50'
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,300 psf
C-Rate of Change: 20 (lbs/ft²)/ft
C-Maximum: 1,900 psf

Name: Sands and Gravels
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Gravelly Foundation
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Mod. 2&3 Existing FC
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 2&3 Existing FC

Name: Phase 1B O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Mod. 5 Liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: New Final Cover
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: New Final Cover

Directory: P:\PRJ2003Geo\WMI\Riverbend\1866G (South Slope Modification)\Slope Stability\2016_10_25 South Slope Modification\

Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionD_South Slope Modification_10.25.2016.gsz

Horz Seismic Coef.: 0.11

Name: Gravelly Foundation
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Mod. 2&3 Existing FC
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 2&3 Existing FC

Name: Phase 1B O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

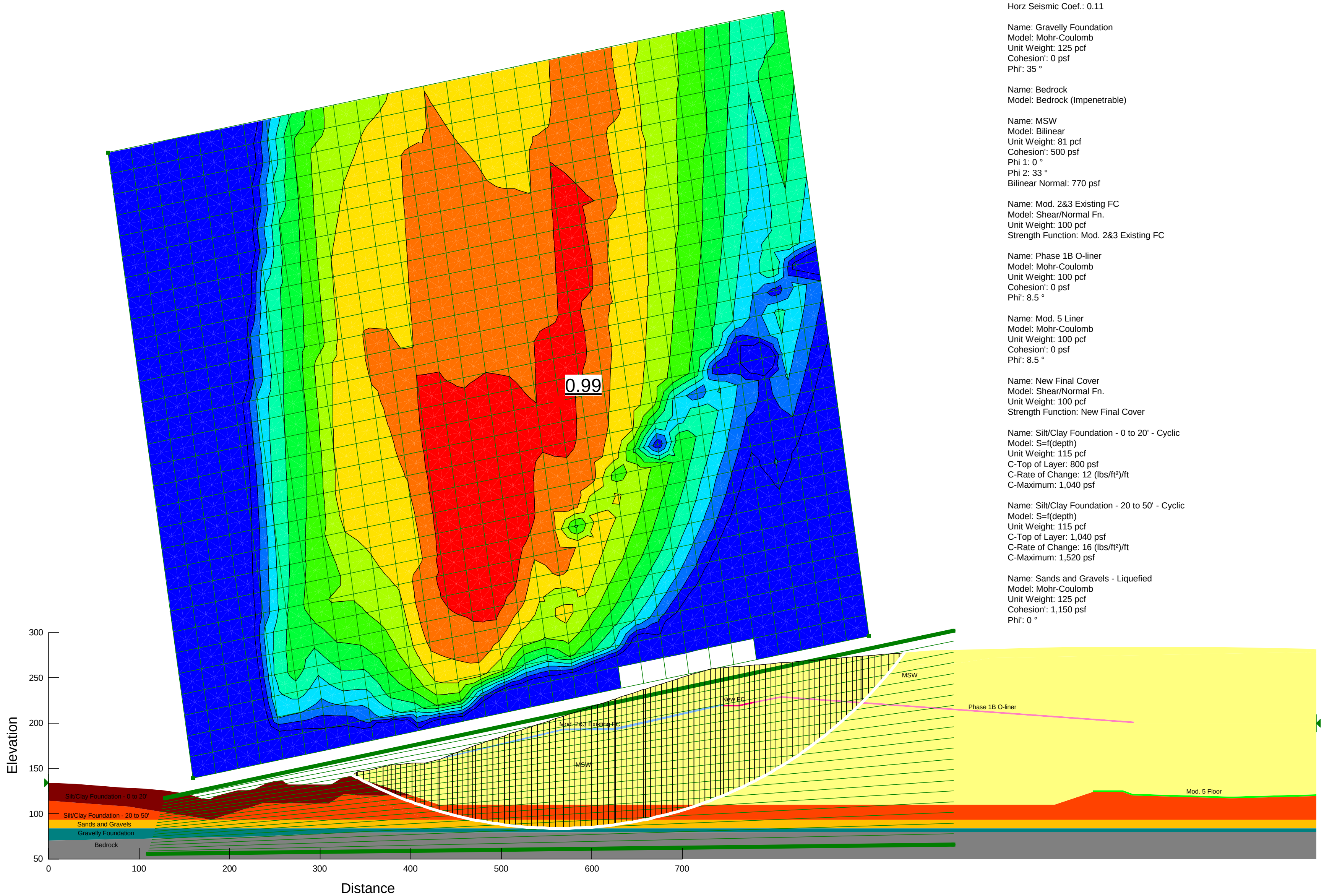
Name: Mod. 5 Liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: New Final Cover
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: New Final Cover

Name: Silt/Clay Foundation - 0 to 20' - Cyclic
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 800 psf
C-Rate of Change: 12 (lbs/ft²)/ft
C-Maximum: 1,040 psf

Name: Silt/Clay Foundation - 20 to 50' - Cyclic
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,040 psf
C-Rate of Change: 16 (lbs/ft²)/ft
C-Maximum: 1,520 psf

Name: Sands and Gravels - Liquefied
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 1,150 psf
Phi': 0 °



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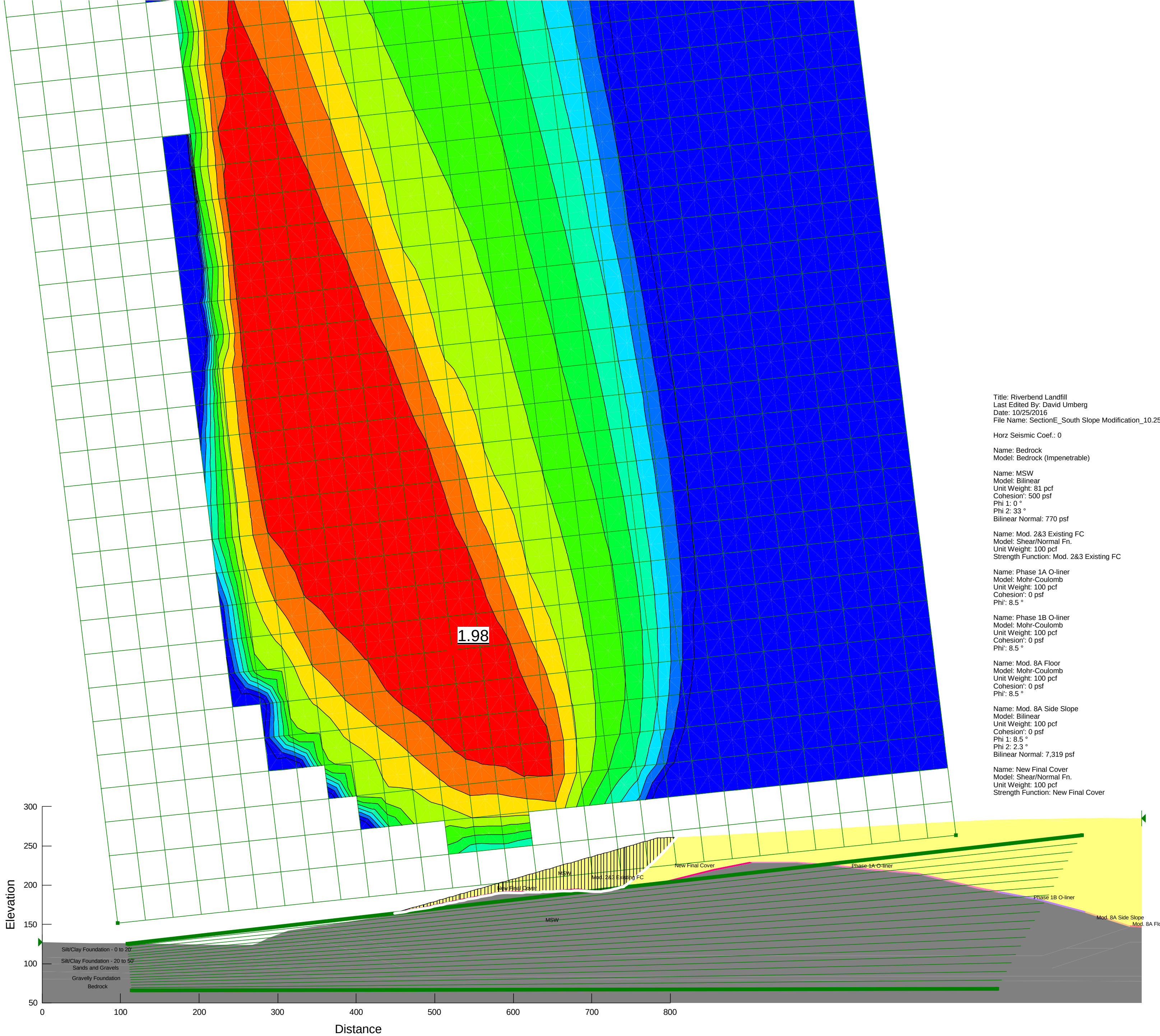


Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionE_South Slope Modification_10.25.2016.gsz

Horz Seismic Coef.: 0

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Mod. 2&3 Existing FC
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 2&3 Existing FC

Name: Phase 1A O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

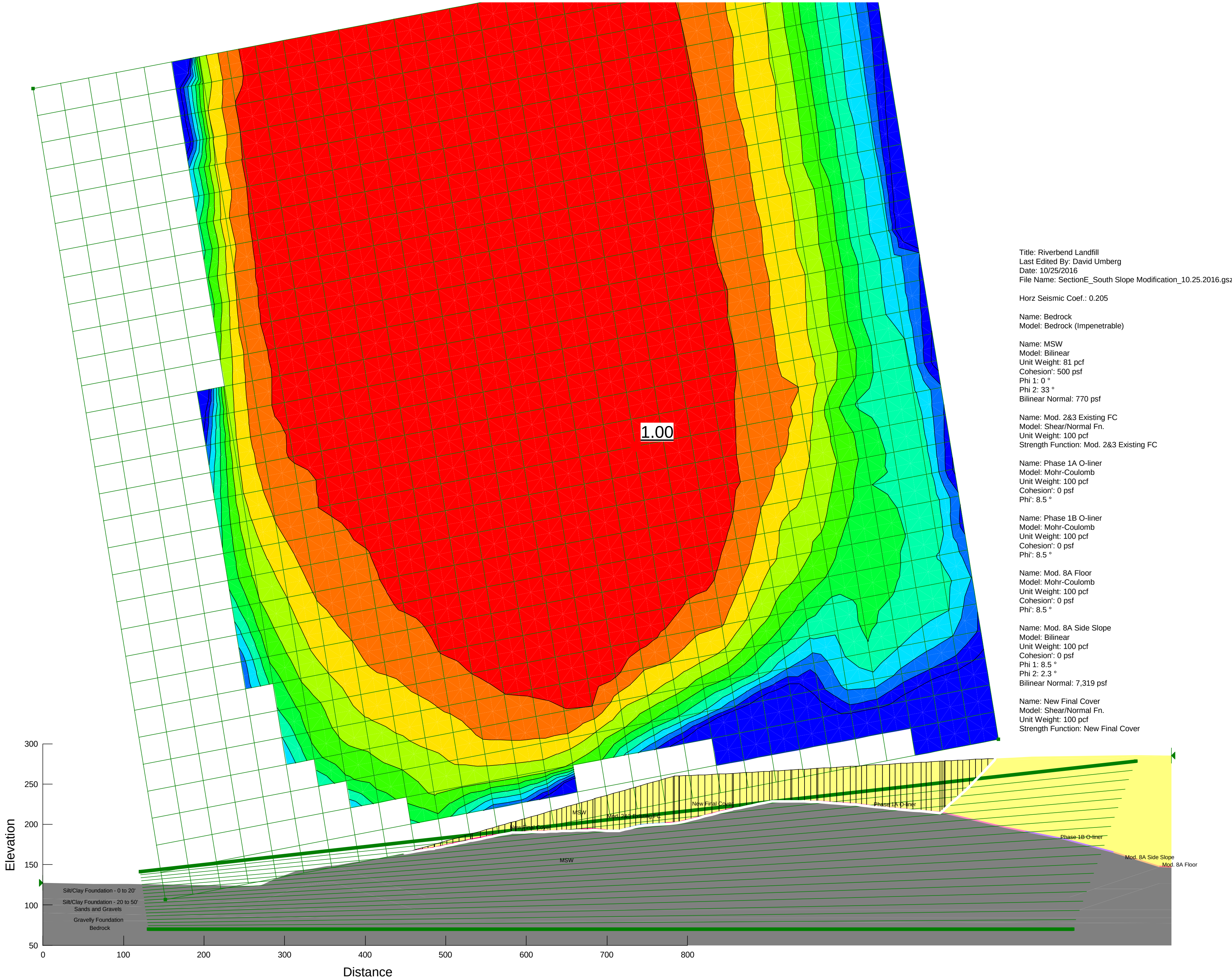
Name: Phase 1B O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Mod. 8A Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Mod. 8A Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf

Name: New Final Cover
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: New Final Cover

Directory: P:\PRJ2003Geo\WMI\Riverbend\1866G (South Slope Modification)\Slope Stability\2016_10_25 South Slope Modification\



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Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionE_South Slope Modification_10.25.2016.gsz

Horz Seismic Coef.: 0

Name: Silt/Clay Foundation - 0 to 20'
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,000 psf
C-Rate of Change: 15 (lbs/ft²)/ft
C-Maximum: 1,300 psf

Name: Silt/Clay Foundation - 20 to 50'
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,300 psf
C-Rate of Change: 20 (lbs/ft²)/ft
C-Maximum: 1,900 psf

Name: Sands and Gravels
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Gravelly Foundation
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Mod. 2&3 Existing FC
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 2&3 Existing FC

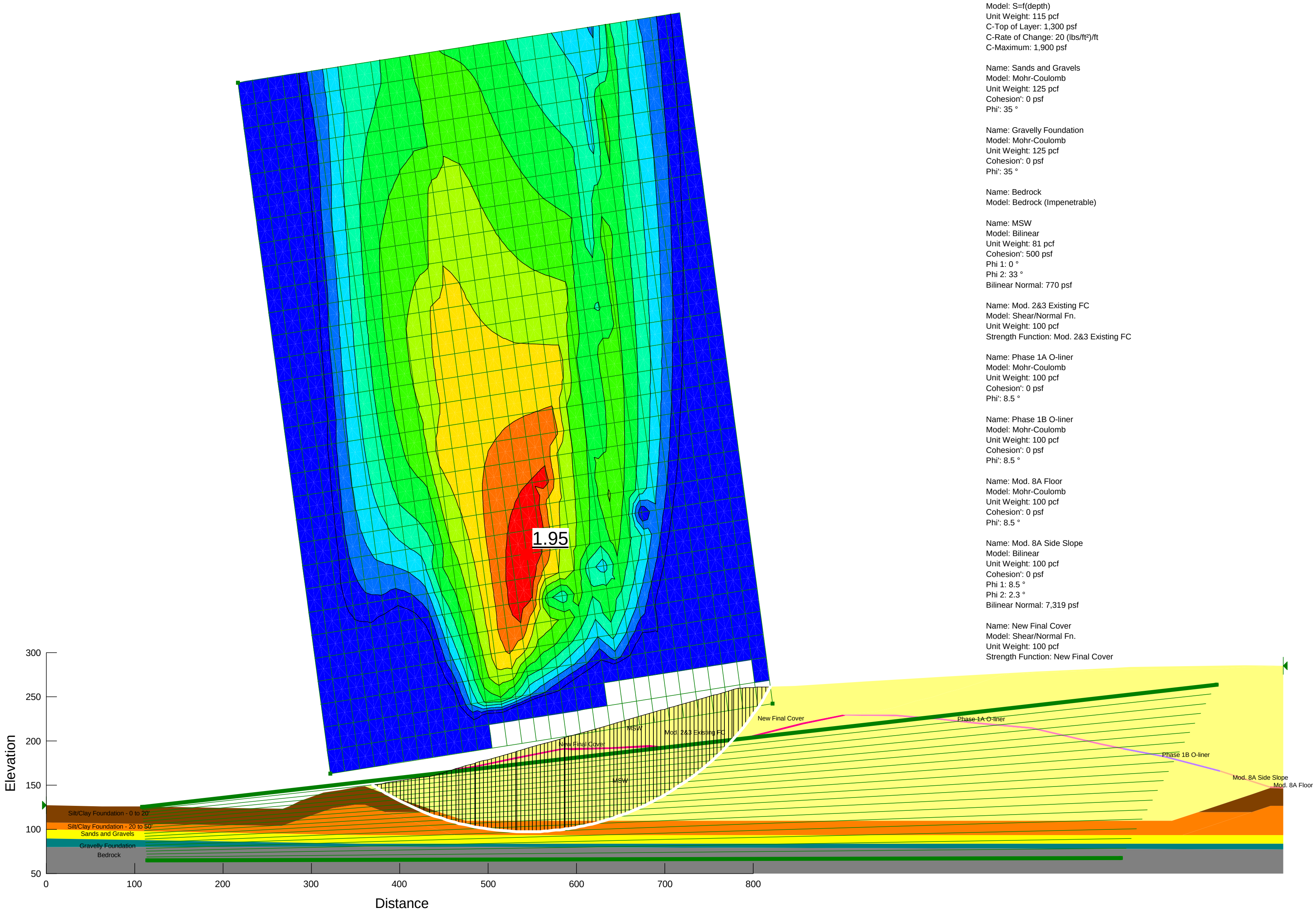
Name: Phase 1A O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Phase 1B O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Mod. 8A Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Mod. 8A Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf

Name: New Final Cover
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: New Final Cover



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Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionE_South Slope Modification_10.25.2016.gsz

Horz Seismic Coef.: 0.125

Name: Gravelly Foundation
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Mod. 2&3 Existing FC
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 2&3 Existing FC

Name: Phase 1A O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Phase 1B O-liner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Mod. 8A Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

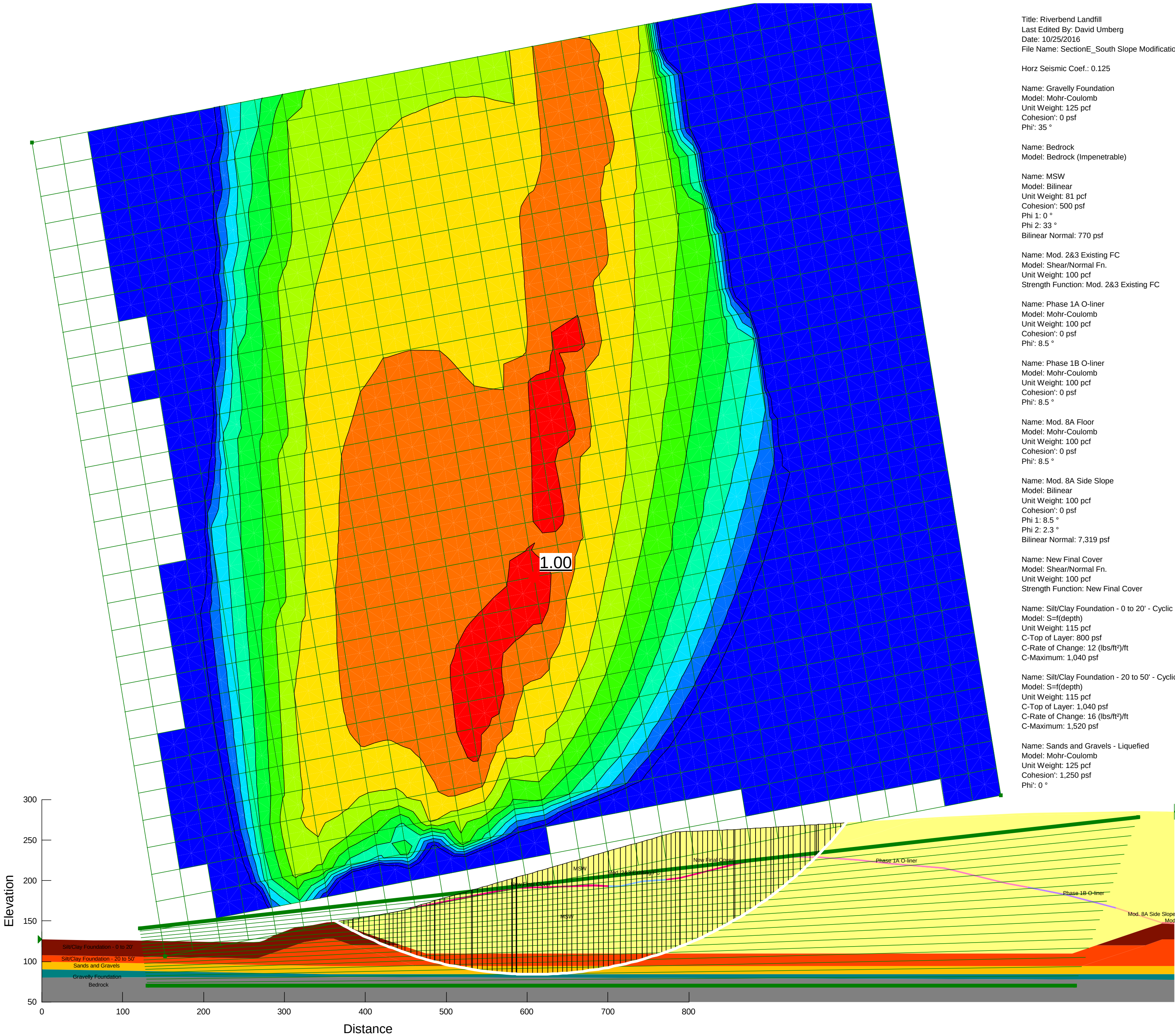
Name: Mod. 8A Side Slope
Model: Bilinear
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi 1: 8.5 °
Phi 2: 2.3 °
Bilinear Normal: 7,319 psf

Name: New Final Cover
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: New Final Cover

Name: Silt/Clay Foundation - 0 to 20' - Cyclic
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 800 psf
C-Rate of Change: 12 (lbs/ft²)/ft
C-Maximum: 1,040 psf

Name: Silt/Clay Foundation - 20 to 50' - Cyclic
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,040 psf
C-Rate of Change: 16 (lbs/ft²)/ft
C-Maximum: 1,520 psf

Name: Sands and Gravels - Liquefied
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 1,250 psf
Phi': 0 °



Directory: P:\PRJ2003Geo\WMI\Riverbend\1866G (South Slope Modification)\Slope Stability\2016_10_25 South Slope Modification\

Riverbend Section F
WG1866G

Title: Riverbend Slope Stability
File Name: SectionF_South Slope Modification_10.25.2016.gsz

Horz Seismic Load: 0 g

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

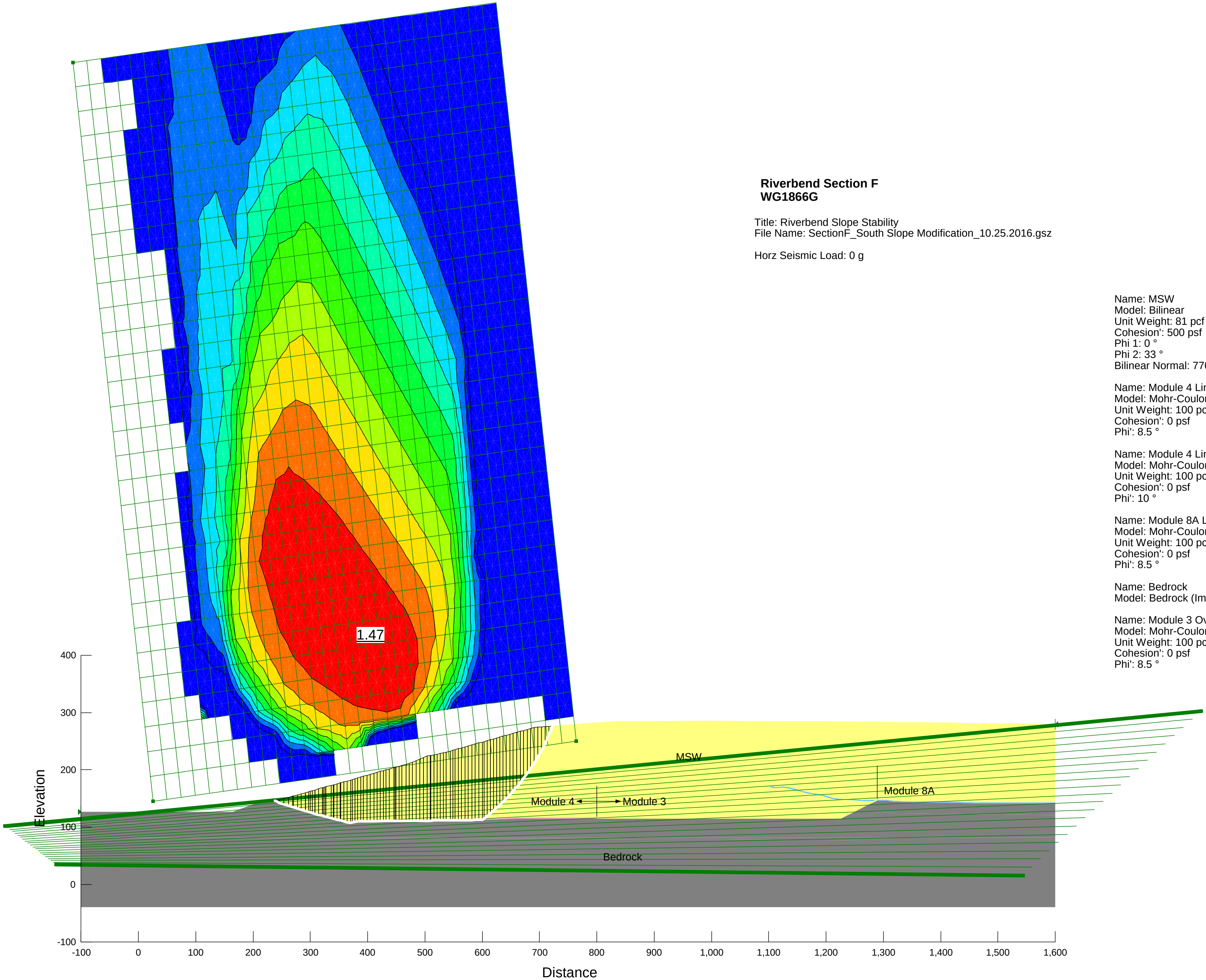
Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 4 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 10 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Module 3 Overliner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °



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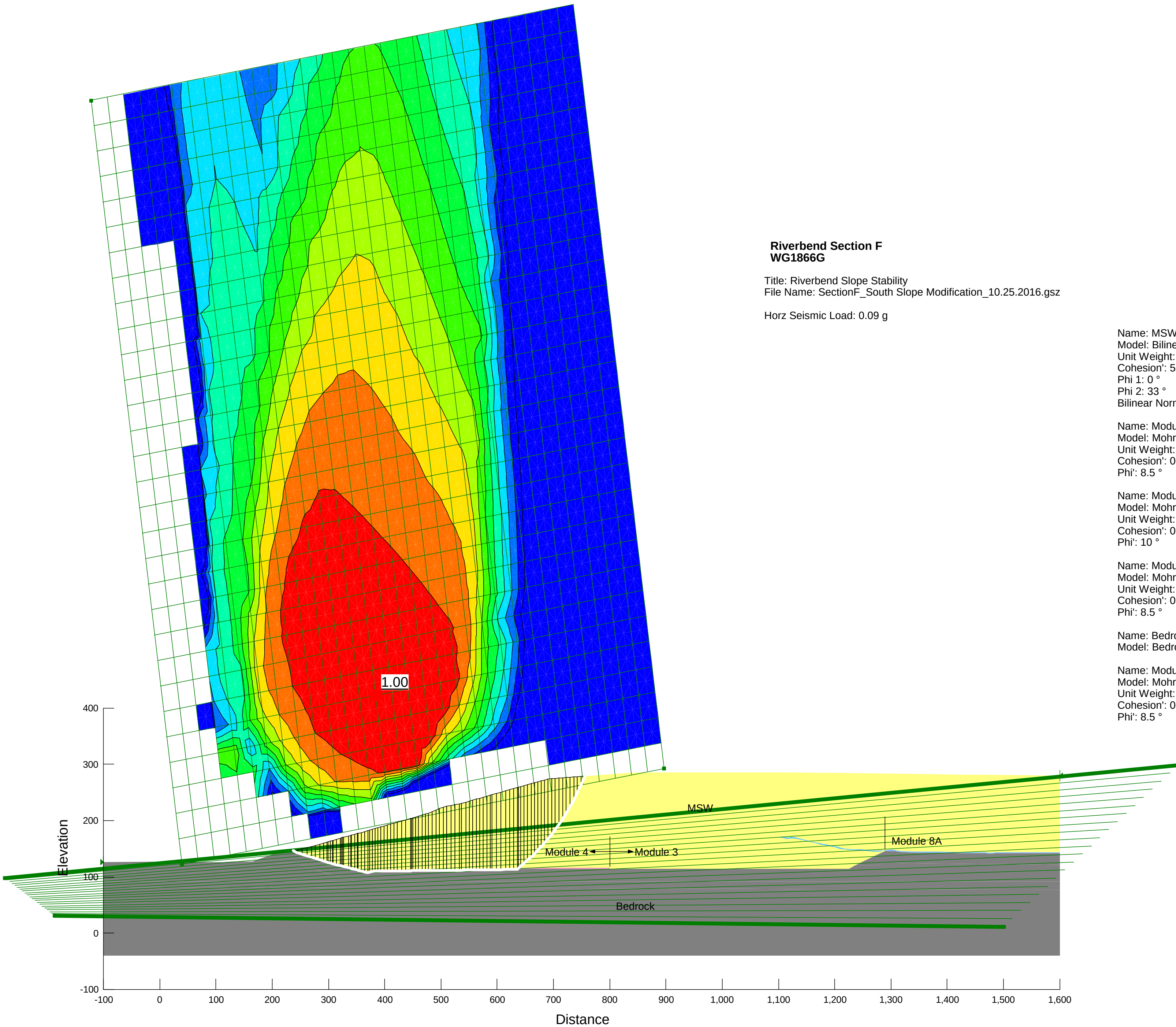

Riverbend Section F
WG1866G

Title: Riverbend Slope Stability
File Name: SectionF_South Slope Modification_10.25.2016.gsz

Horz Seismic Load: 0.09 g

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 4 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 10 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Module 3 Overliner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

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Riverbend Section F
WG1866G

Title: Riverbend Slope Stability
File Name: SectionF_South Slope Modification_10.25.2016.gsz

Horz Seismic Load: 0 g

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Module 4 Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

Name: Module 4 Liner - Side Slope
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 10 °

Name: Module 8A Liner - Floor
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °

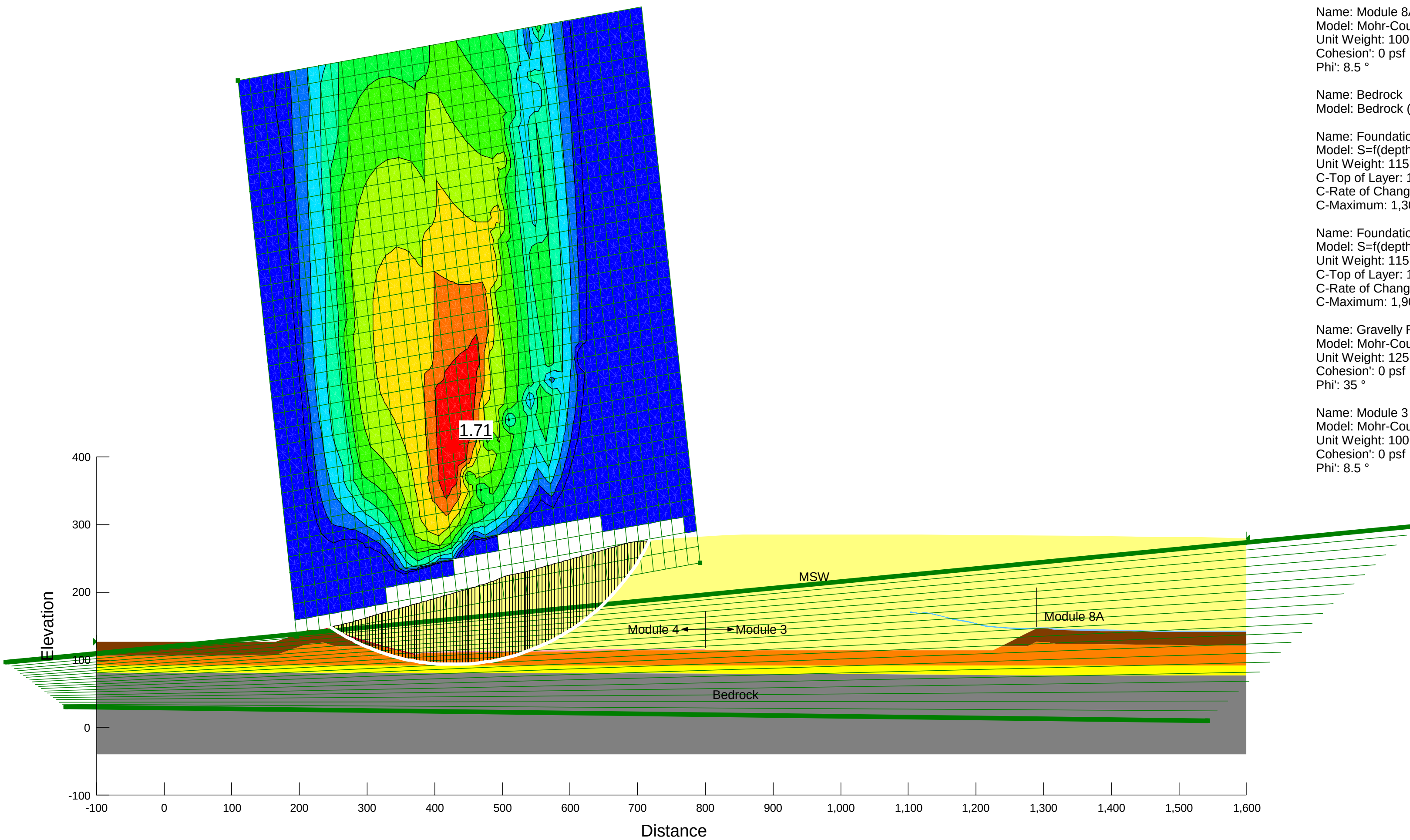
Name: Bedrock
Model: Bedrock (Impenetrable)

Name: Foundation Soils - 0 to 20 ft bgs
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,000 psf
C-Rate of Change: 15 (lbs/ft²)/ft
C-Maximum: 1,300 psf

Name: Foundation Soils - 20 to 50 ft bgs
Model: S=f(depth)
Unit Weight: 115 pcf
C-Top of Layer: 1,300 psf
C-Rate of Change: 20 (lbs/ft²)/ft
C-Maximum: 1,900 psf

Name: Gravelly Foundation Soil
Model: Mohr-Coulomb
Unit Weight: 125 pcf
Cohesion': 0 psf
Phi': 35 °

Name: Module 3 Overliner
Model: Mohr-Coulomb
Unit Weight: 100 pcf
Cohesion': 0 psf
Phi': 8.5 °



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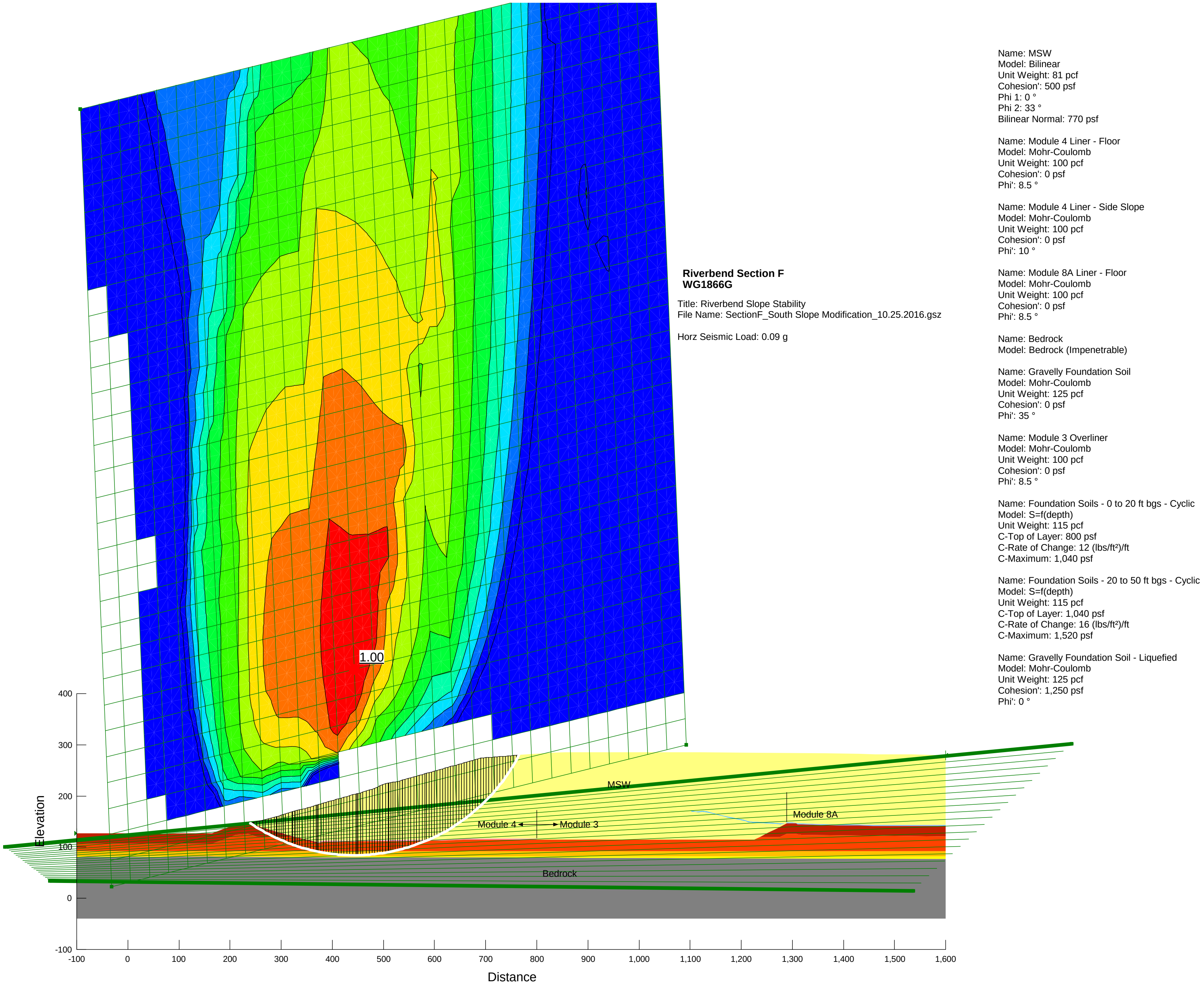

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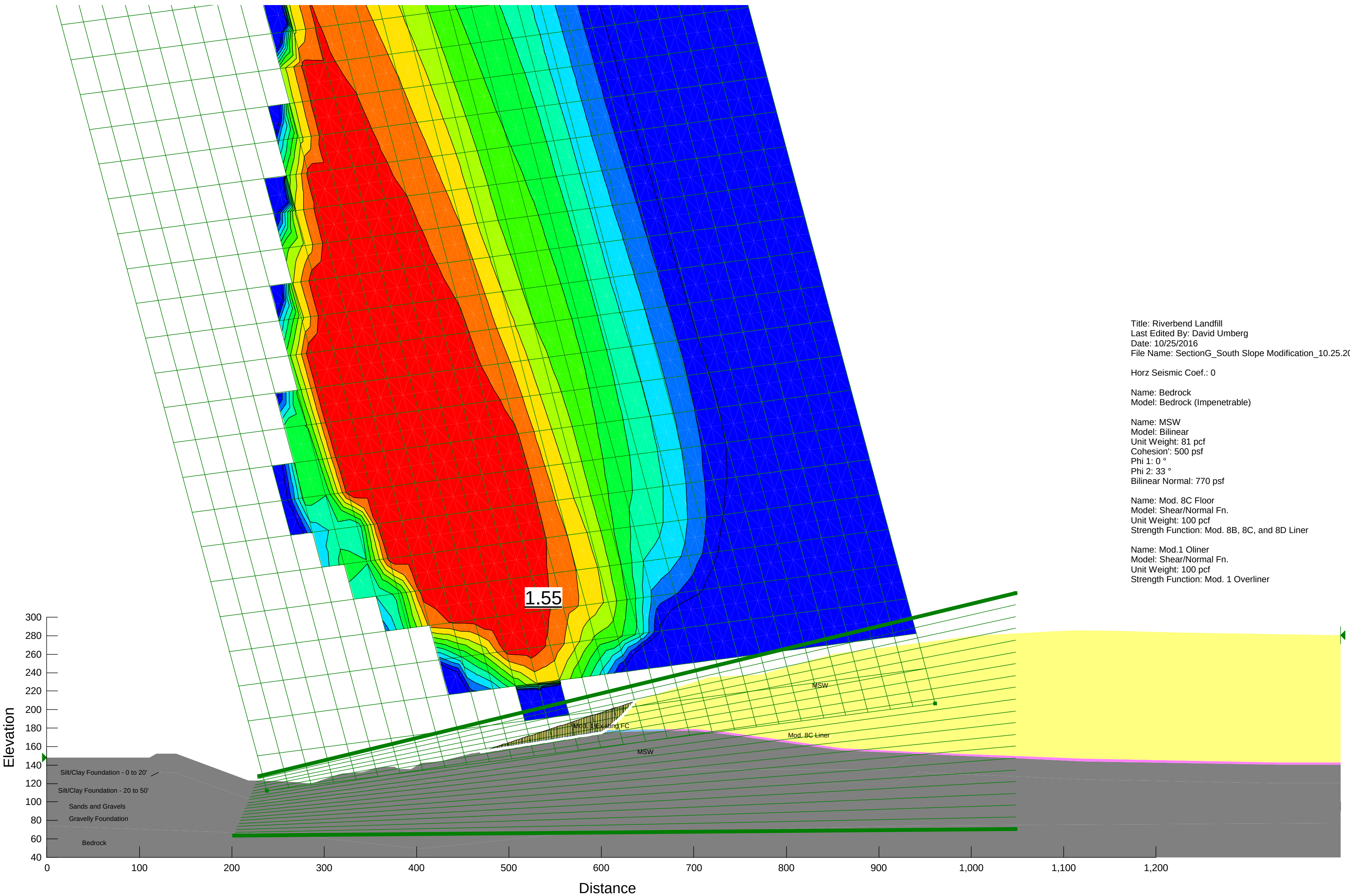


Title: Riverbend Landfill
Last Edited By: David Umberg
Date: 10/25/2016
File Name: SectionG_South Slope Modification_10.25.2016.gsz

Horz Seismic Coef.: 0

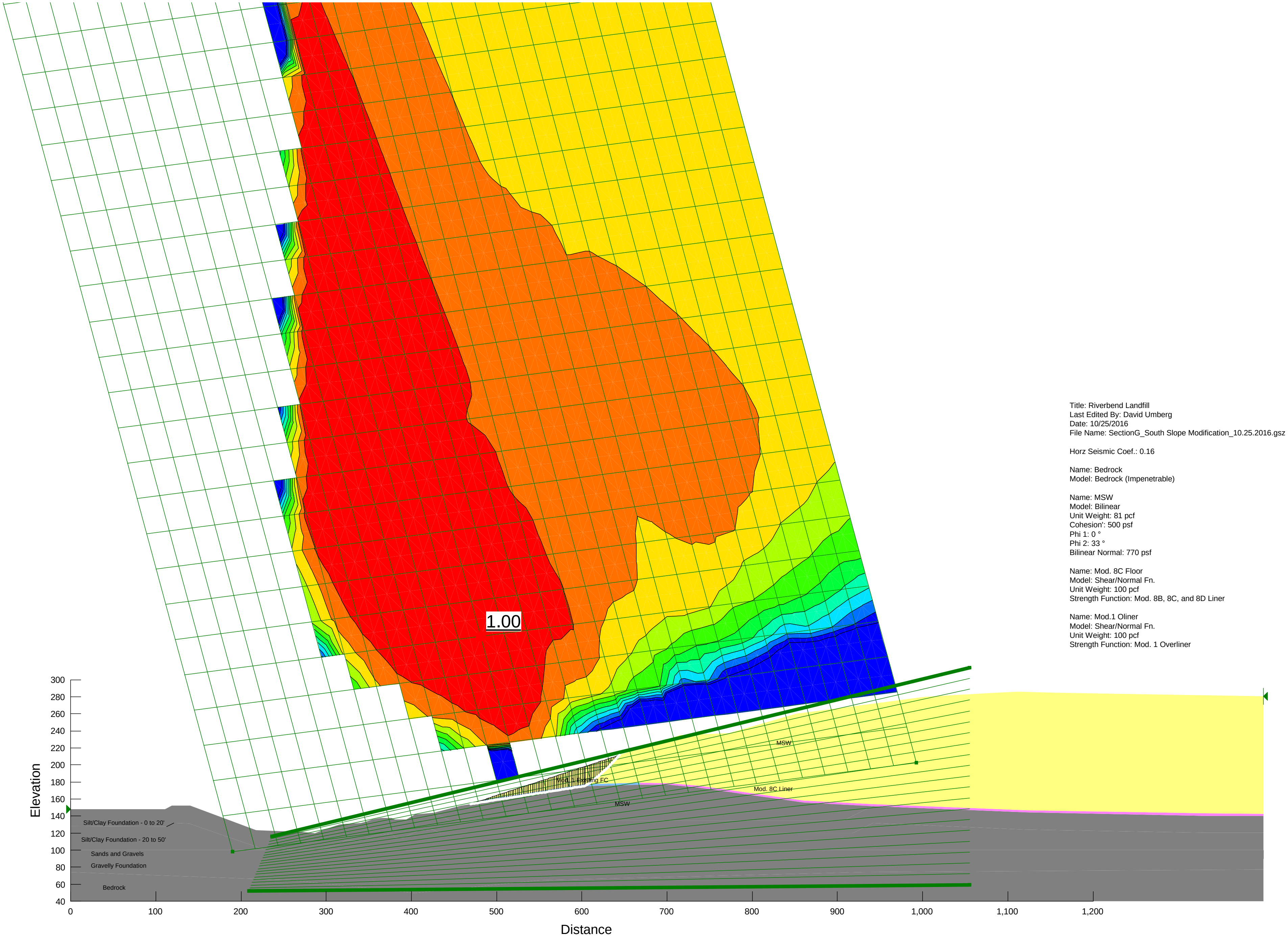
Name: Bedrock
Model: Bedrock (Impenetrable)

Name: MSW
Model: Bilinear
Unit Weight: 81 pcf
Cohesion': 500 psf
Phi 1: 0 °
Phi 2: 33 °
Bilinear Normal: 770 psf

Name: Mod. 8C Floor
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 8B, 8C, and 8D Liner

Name: Mod.1 Oliner
Model: Shear/Normal Fn.
Unit Weight: 100 pcf
Strength Function: Mod. 1 Overliner

Directory: P:\PRJ2003Geo\WMI\Riverbend\1866G (South Slope Modification)\Slope Stability\2016_10_25 South Slope Modification\



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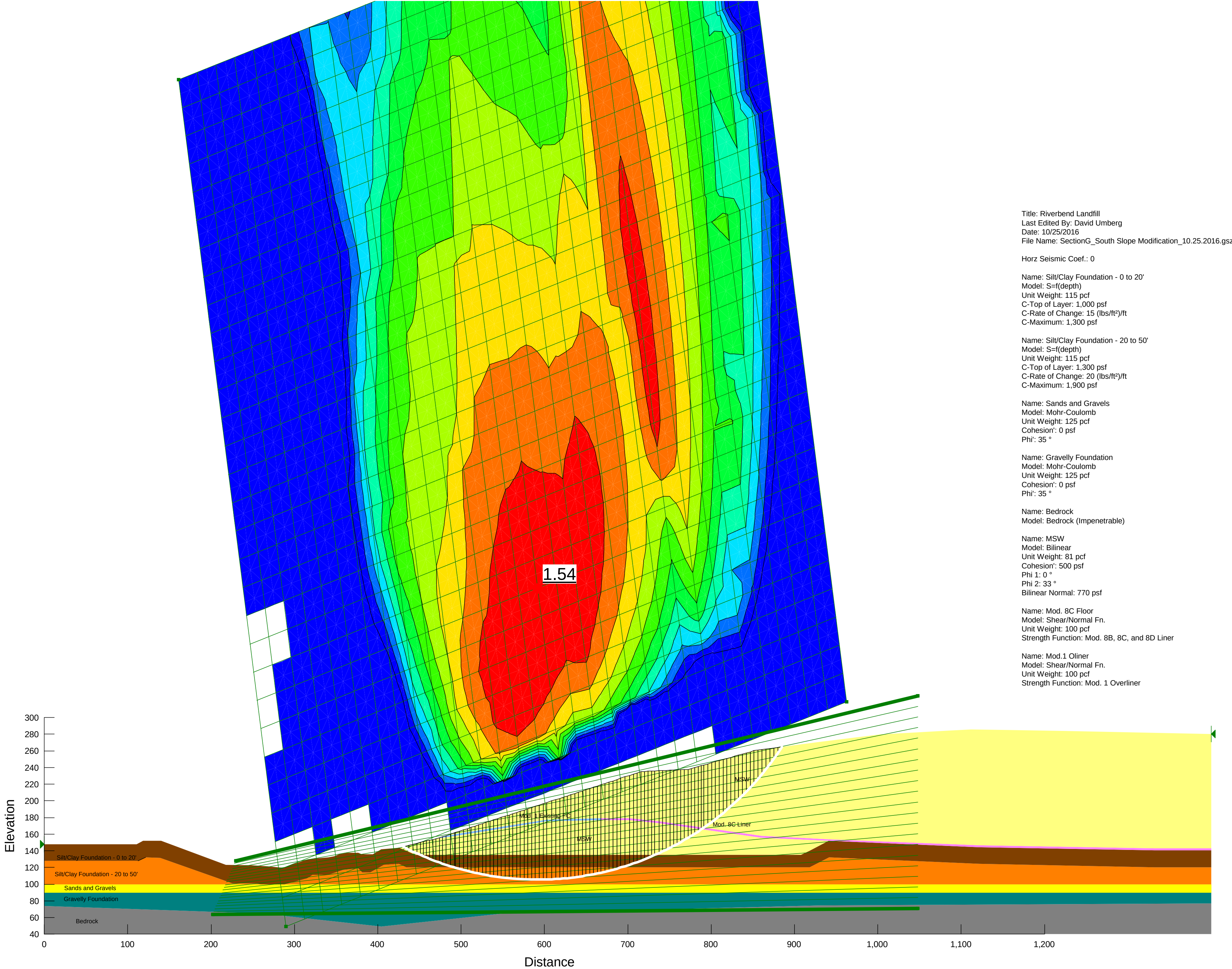

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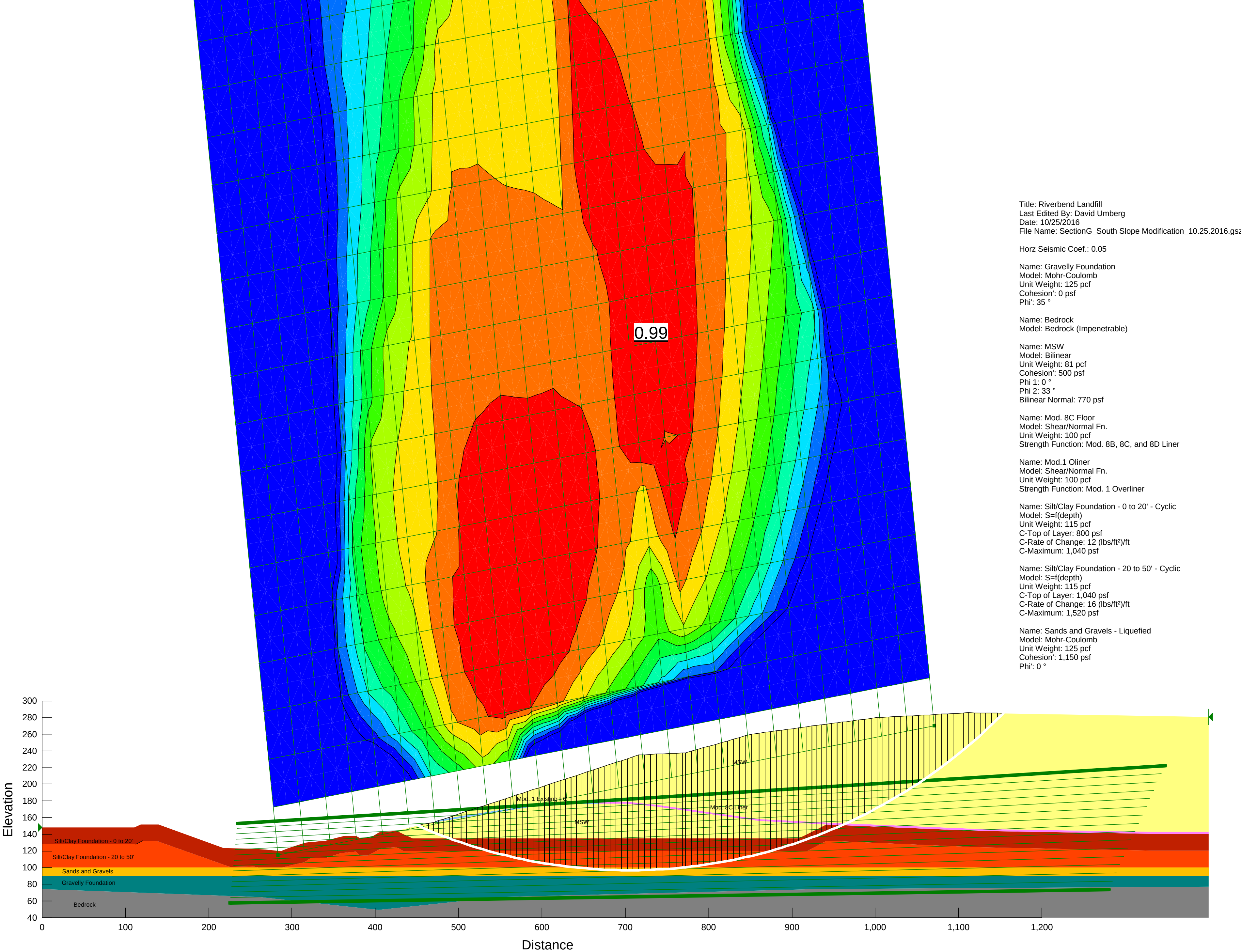

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APPENDIX D-3

2017 Final Cover Slope Stability Evaluation

The work in this Appendix was performed by Fabrizio Settepani under the supervision of Hari Sharma, P.E.

Cover Stability Analyses

The cover stability analyses is performed using the infinite slope approach. The expression for the factor of safety is provided by Matasovic [1991] as follows:

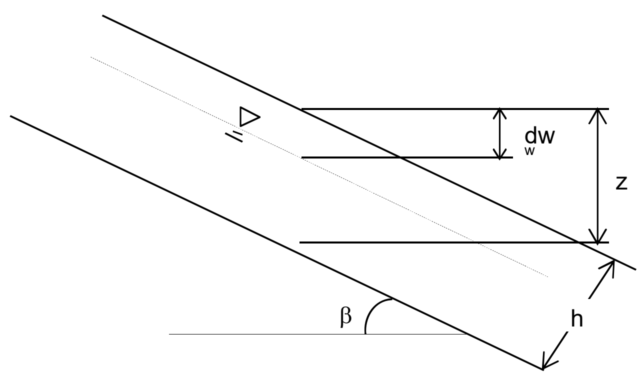
$$FS = \frac{\left(\frac{c}{\gamma \; z \cos^2 \beta}\right) + \tan\phi \left[1 - \left(\frac{\gamma_w (z - d_w)}{\gamma \; z}\right)\right] - k_s \tan\beta \; \tan\phi}{k_s + \tan\beta}$$

Equation (1)

where:

- c = cohesion / adhesion (psf)
- γ = unit weight of cover soil (pcf)
- γ_w = unit weight of water (pcf)
- z = vertical thickness of the layer (ft)
- β = slope angle (degrees)
- ϕ = friction angle (degrees)
- d_w = vertical depth to water table (ft)
- k_s = seismic coefficient
- FS = factor of safety

The expressions are explained in the figure.



And based on geometry:

$$z = \frac{h}{\cos \beta}$$

Equation (2)

Static Condition:

Under static conditions, the value of $k_s = 0$. Therefore, equation (1) can be modified to the following form:

$$FS = \frac{\left(\frac{c}{\gamma \; z\cos^2\beta}\right) + \tan\phi \left[1 - \left(\frac{\gamma_w (z - d_w)}{\gamma \; z}\right)\right]}{\tan\beta}$$

Equation (3)

Case A: No water table is present on the slope, i.e. dw = z. This is considered to be a long-term condition. Consequently, equation (3) is modified to the following form:

$$FS = \frac{\left(\frac{c}{\gamma \; z\cos^2\beta}\right) + \tan\phi}{\tan\beta}$$

Equation (4)

Case B: Water table is assumed to be at ground surface. This is considered to be a short-term condition, therefore, Equation (3) is used.

Seismic Condition:

The value of seismic coeffcient, k_s is estimated considering factor of safety, FS = 1. (Note: seismic coefficient = yield acceleration, i.e. $k_s = k_y$). The seismic coefficient is calculated only for the long-term condition, i.e. it has been assumed that seismicity and seepage will not occur simultaneously. Therefore, equation (1) can be modified to provide an expression for k_s, as follows:

$$k_s = \frac{\left(\frac{c}{\gamma \; z\cos^2\beta}\right) + \tan\phi - \tan\beta}{1 + \tan\phi \; \tan\beta}$$

Equation (5)

Reference:

Matasovic, N., "Selection of Method for Seismic Slope Stability Analyses", *Proceedings of Second International Conference on Recent Advances in Geotechnical Engineering and Soil Dynamics,* St. Louis, Missouri, Paper No. 7.20, 1991, pp. 1057-1062.

Calculations **Applicable to 3 to 1 (H:V) slopes in FGPM area of the Landfill**

The following values have been assumed in the analyses:

γ =	120	pcf
γ_w =	62.4	pcf
h =	1.5	ft
dw =	0	ft
c =	0 to 67	psf
ϕ =	20 to 27	degrees

Assumes 18 inches of vegetative layer above a non-heat burnished geotextile, and Agru Supergripnet geomembrane

Other combinations of c and ϕ may meet static factor of safety and seismic yield acceleration requirements

Calculation of slope angle

Horizontal	Vertical	tanβ	Slope Angle (β) rad	Slope Angle (β) degrees	z ft
3	1	0.333	0.3218	18.435	1.581

Static Conditions:

Case A: No seepage (long-term condition). Equation (4) is used to calculate FS:

c (psf)	ϕ =	Factor of Safety 20	22	24	25	26	27
0		1.1	1.2	1.3	1.4	1.5	1.5
10		1.3	1.4	1.5	1.6	1.6	1.7
20		1.4	1.6	1.7	1.8	1.8	1.9
30		1.6	1.7	1.9	1.9	2.0	2.1
50		2.0	2.1	2.2	2.3	2.3	2.4
67		2.4	2.4	2.5	2.6	2.6	2.7

Case B: Seepage (water at final cover surface) (short-term condition). Equation (3) is used to calculate FS:

c (psf)	ϕ =	Factor of Safety 20	22	24	25	26	27
0		0.5	0.6	0.6	0.7	0.7	0.7
10		0.7	0.8	0.8	0.8	0.9	0.9
20		0.9	0.9	1.0	1.0	1.1	1.1
30		1.1	1.1	1.2	1.2	1.2	1.3
50		1.4	1.5	1.5	1.5	1.6	1.6
67		1.7	1.8	1.8	1.8	1.9	1.9

Based on above, need a drainage layer that maintains the final cover layer unsaturated.

Seismic Condition:

Only long-term condition is considered (it is assumed that seepage and seismicity do not occur simultaneously). Equation (5) is used to calculate ks:

c (psf)	ϕ =	k_s 20	22	24	25	26	27
0		0.03	0.06	0.10	0.12	0.13	0.15
10		0.08	0.11	0.15	0.17	0.18	0.20
20		0.13	0.17	0.20	0.22	0.23	0.25
30		0.18	0.22	0.25	0.27	0.28	0.30
50		0.29	0.32	0.35	0.37	0.38	0.40
67		0.38	0.41	0.44	0.45	0.47	0.49

Calculations

Applicable to 3.5 to 1 (H:V) slopes in FGPM area, west (MSE Berm), north, east, and south sides of the Landfill

The following values have been assumed in the analyses:

γ =	120	pcf
γ_w =	62.4	pcf
h =	1.5	ft
dw =	0	ft
c =	0 to 67	psf
ϕ =	20 to 27	degrees

Assumes 18 inches of vegetative layer above a non-heat burnished geotextile, and Agru Supergripnet geomembrane

Other combinations of c and ϕ may meet static factor of safety and seismic yield acceleration requirements

Calculation of slope angle

Horizontal	Vertical	tanβ	Slope Angle (β)		z
			rad	degrees	ft
3.5	1	0.286	0.2783	15.945	1.560

Static Conditions:

Case A: No seepage (long-term condition). Equation (4) is used to calculate FS:

c		Factor of Safety					
(psf)	ϕ =	20	22	24	25	26	27
0		1.3	1.4	1.6	1.6	1.7	1.8
10		1.5	1.6	1.8	1.8	1.9	2.0
20		1.7	1.8	2.0	2.0	2.1	2.2
30		1.9	2.0	2.2	2.2	2.3	2.4
50		2.3	2.4	2.6	2.6	2.7	2.8
67		2.6	2.8	2.9	3.0	3.1	3.1

Case B: Seepage (water at final cover surface) (short-term condition). Equation (3) is used to calculate FS:

c		Factor of Safety					
(psf)	ϕ =	20	22	24	25	26	27
0		0.6	0.7	0.7	0.8	0.8	0.9
10		0.8	0.9	1.0	1.0	1.0	1.1
20		1.0	1.1	1.2	1.2	1.2	1.3
30		1.2	1.3	1.4	1.4	1.4	1.5
50		1.6	1.7	1.8	1.8	1.8	1.9
67		2.0	2.0	2.1	2.1	2.2	2.2

Based on above, need a drainage layer that maintains the final cover layer unsaturated.

Seismic Condition:

Only long-term condition is considered (it is assumed that seepage and seismicity do not occur simultaneously). Equation (5) is used to calculate ks:

c		k_s					
(psf)	ϕ =	20	22	24	25	26	27
0		0.07	0.11	0.14	0.16	0.18	0.20
10		0.12	0.16	0.19	0.21	0.23	0.25
20		0.18	0.21	0.24	0.26	0.28	0.30
30		0.23	0.26	0.30	0.31	0.33	0.35
50		0.33	0.37	0.40	0.41	0.43	0.45
67		0.42	0.45	0.48	0.50	0.52	0.53

Calculations **Applicable to 3.8 to 1 (H:V) slopes in north side of the Landfill**

The following values have been assumed in the analyses:

γ =	120	pcf
γ_w =	62.4	pcf
h =	1.5	ft
dw =	0	ft
c =	0 to 67	psf
ϕ =	20 to 27	degrees

Assumes 18 inches of vegetative layer above a non-heat burnished geotextile, and Agru Supergripnet geomembrane

Other combinations of c and ϕ may meet static factor of safety and seismic yield acceleration requirements

Calculation of slope angle

Horizontal	Vertical	tanβ	Slope Angle (β)		z
			rad	degrees	ft
3.8	1	0.263	0.2573	14.744	1.551

Static Conditions:

Case A: No seepage (long-term condition). Equation (4) is used to calculate FS:

c		Factor of Safety					
(psf)	ϕ =	20	22	24	25	26	27
0		1.4	1.5	1.7	1.8	1.9	1.9
10		1.6	1.8	1.9	2.0	2.1	2.2
20		1.8	2.0	2.1	2.2	2.3	2.4
30		2.0	2.2	2.3	2.4	2.5	2.6
50		2.5	2.6	2.8	2.9	2.9	3.0
67		2.8	3.0	3.2	3.2	3.3	3.4

Case B: Seepage (water at final cover surface) (short-term condition). Equation (3) is used to calculate FS:

c		Factor of Safety					
(psf)	ϕ =	20	22	24	25	26	27
0		0.7	0.7	0.8	0.9	0.9	0.9
10		0.9	1.0	1.0	1.1	1.1	1.1
20		1.1	1.2	1.2	1.3	1.3	1.4
30		1.3	1.4	1.5	1.5	1.5	1.6
50		1.8	1.8	1.9	1.9	2.0	2.0
67		2.1	2.2	2.3	2.3	2.4	2.4

Based on above, need a drainage layer that maintains the final cover layer unsaturated.

Seismic Condition:

Only long-term condition is considered (it is assumed that seepage and seismicity do not occur simultaneously). Equation (5) is used to calculate ks:

c		k_s					
(psf)	ϕ =	20	22	24	25	26	27
0		0.09	0.13	0.16	0.18	0.20	0.22
10		0.14	0.18	0.21	0.23	0.25	0.27
20		0.20	0.23	0.27	0.28	0.30	0.32
30		0.25	0.28	0.32	0.33	0.35	0.37
50		0.35	0.39	0.42	0.44	0.45	0.47
67		0.44	0.48	0.51	0.52	0.54	0.56

Geosyntec consultants

Written by: FWS Date: 27/10/17 Reviewed by: Date: / /

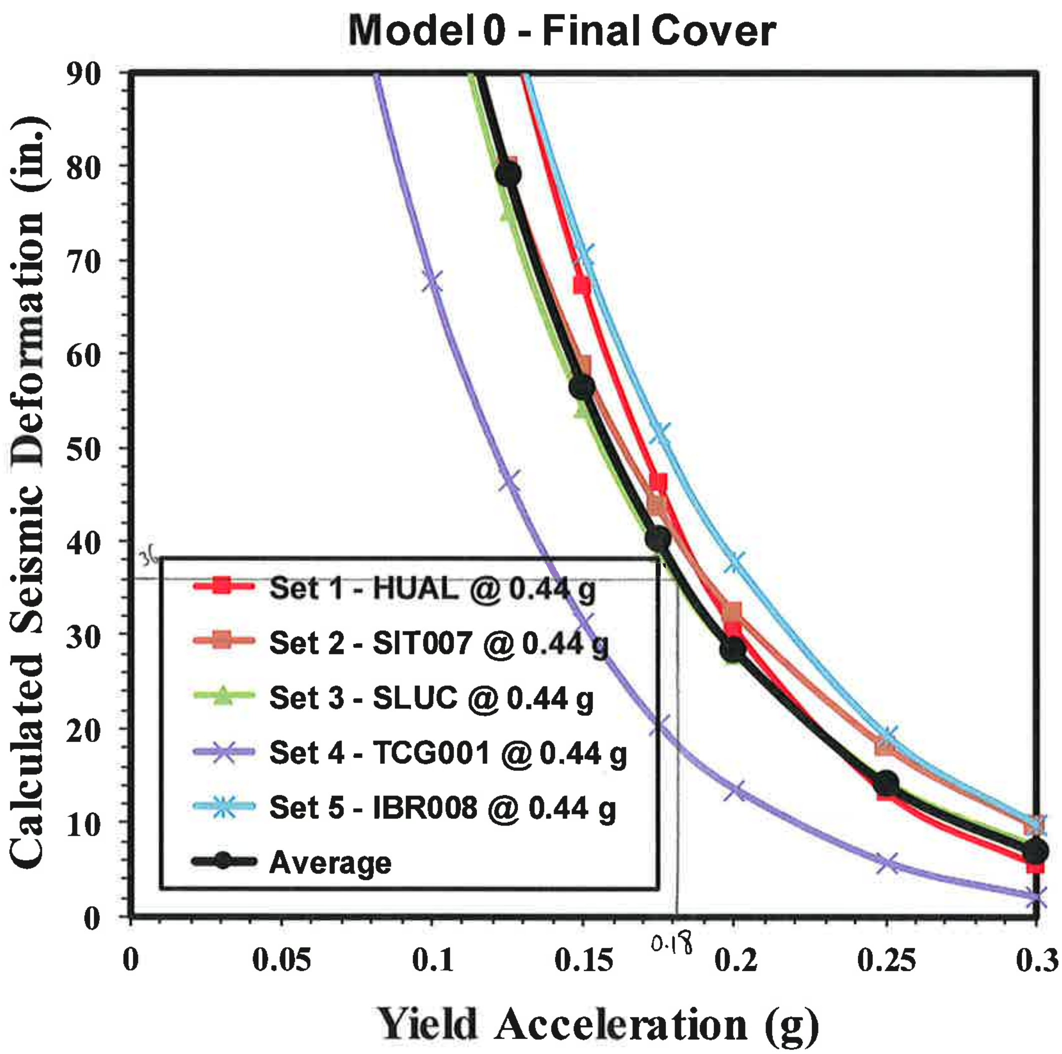
Client: WM Project: Riverbend Project/Proposal No. WG2423 Task No.

SUMMARY OF DEFORMATIONS M=9, rock = 0.44g – Final Cover

Slope	Location	Final Cover	Model	ky	DEF (INCHES)
3 to 1	FGPM	W. AGW Superground	G	0.13	12
3.5 to 1	WEST (MSE)	↓	0	0.18	36
	FGPM		G	0.18	7
	EAST		2	0.18	36
	SOUTH		E	0.18	26
3.8 to 1	NORTH		1	0.20	27

RANGE FOR AGW SUPERGROUND/GT/VEG LAYER 7 to 36"

3.5 to 1 (H:V)
MSE Berm (west side)

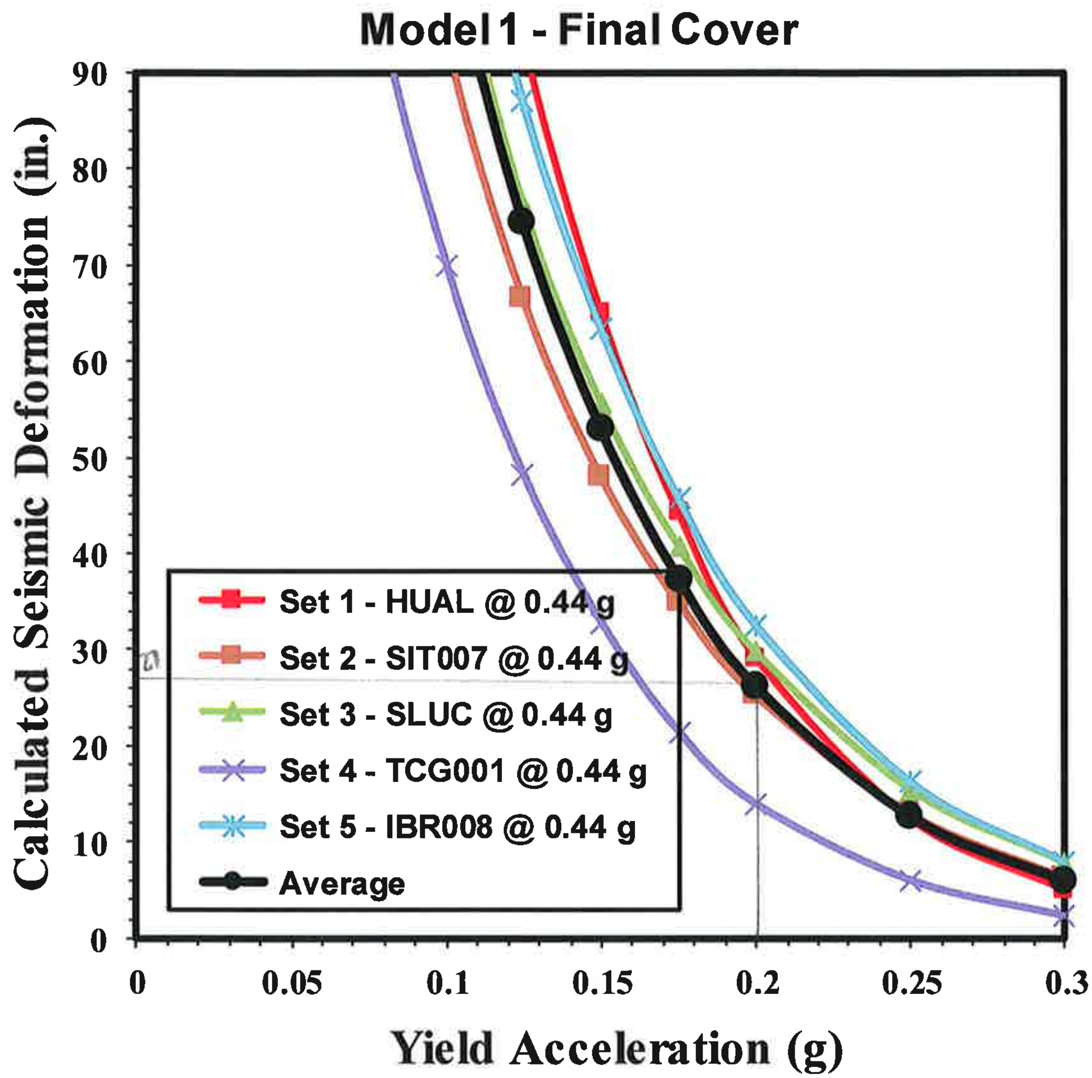


Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL 0
RIVERBEND LANDFILL
McMINNVILLE, OREGON

DATE:	October 2017	FIGURE NO.	2
PROJECT NO.	2015.0074 - 200		

3.8 to 1 (H:V)
North Side

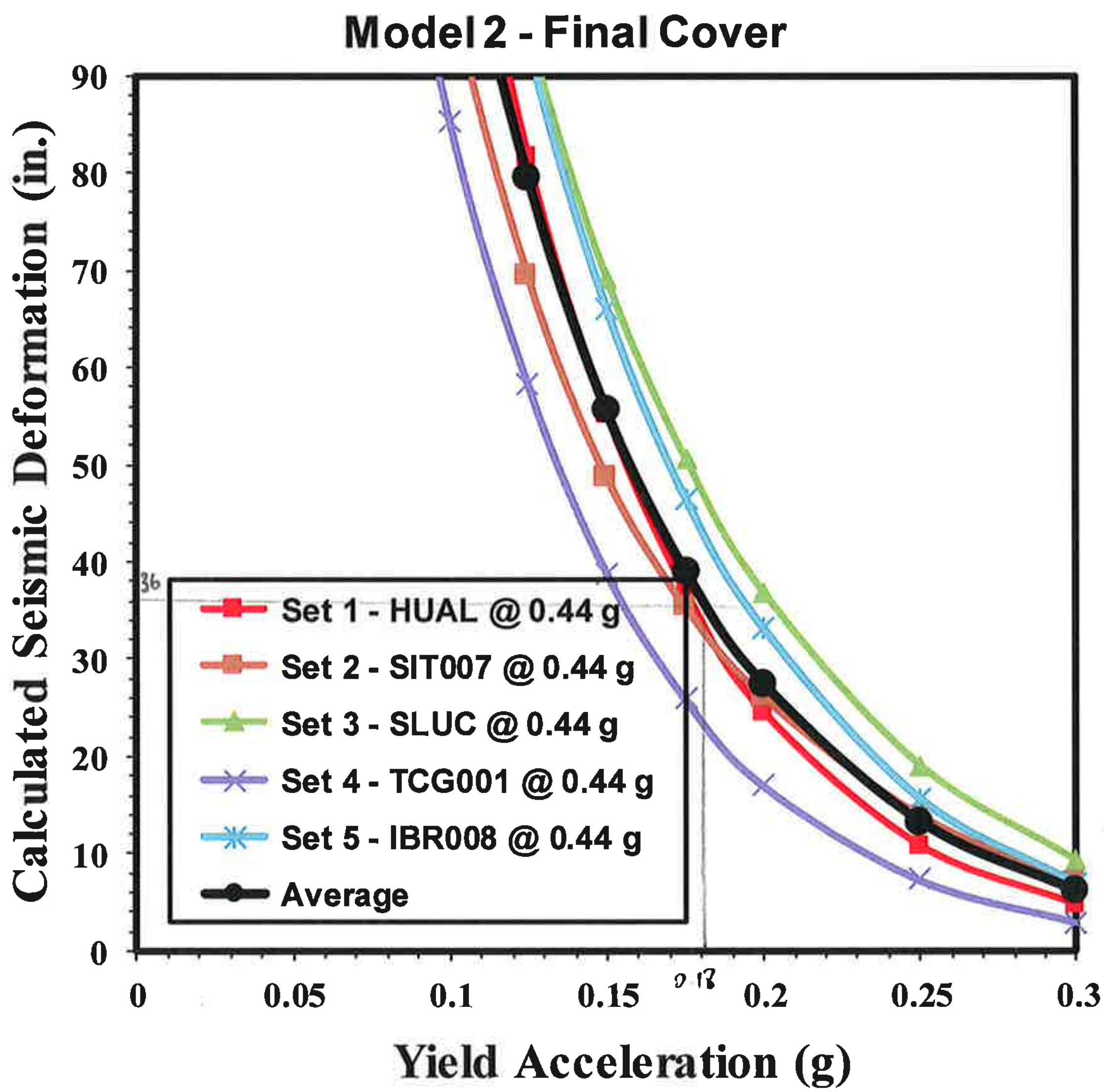


Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL 1
RIVERBEND LANDFILL
McMINNVILLE, OREGON

DATE:	October 2017	FIGURE NO.	3
PROJECT NO.	2015.0074 - 200		

3.5 to 1 (H:V)
East Side

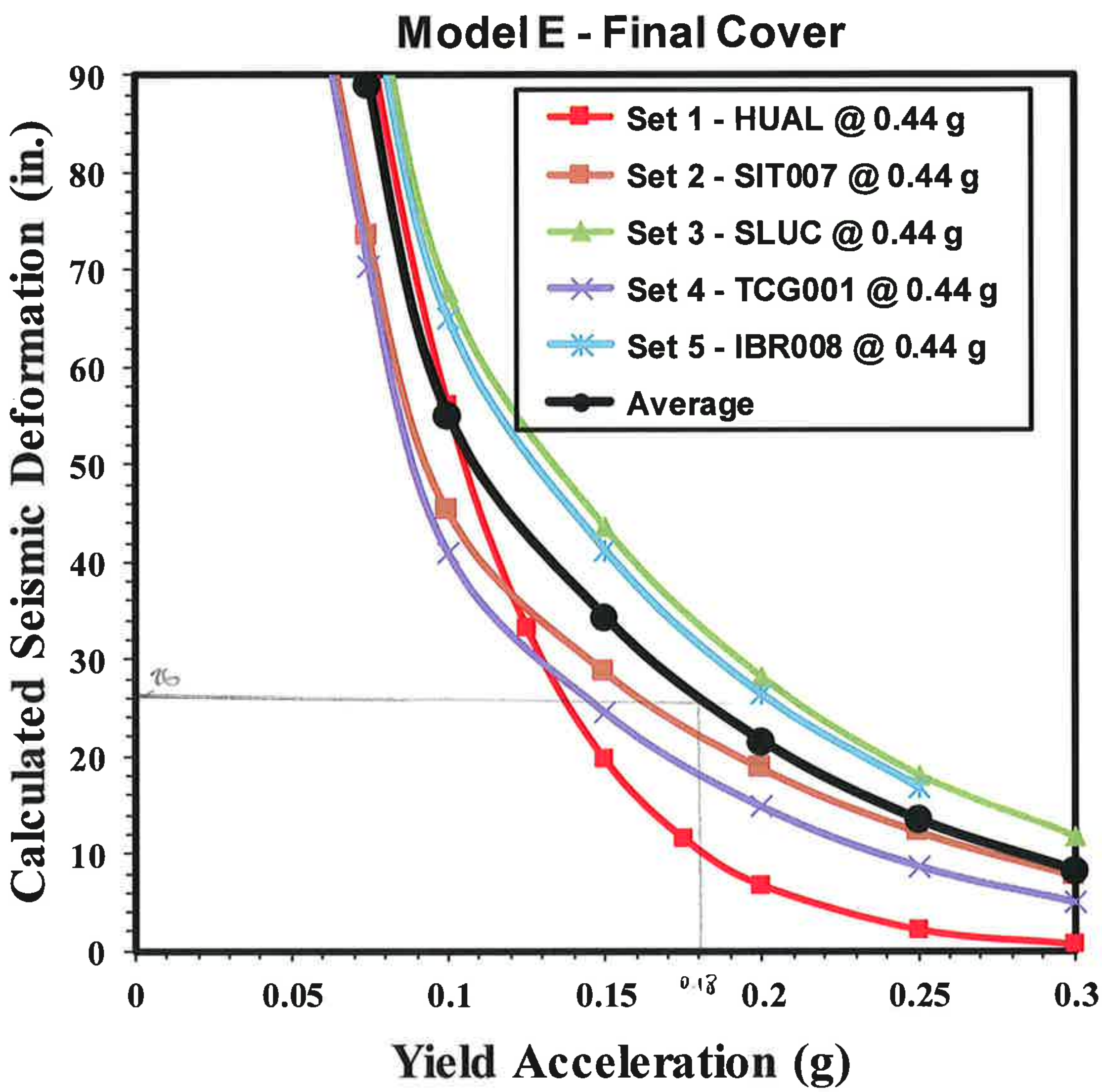


Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL 2
RIVERBEND LANDFILL
McMINNVILLE, OREGON

DATE:	October 2017	FIGURE NO.	4
PROJECT NO.	2015.0074 - 200		

3.5 to 1 (H:V)
South side · FGPM

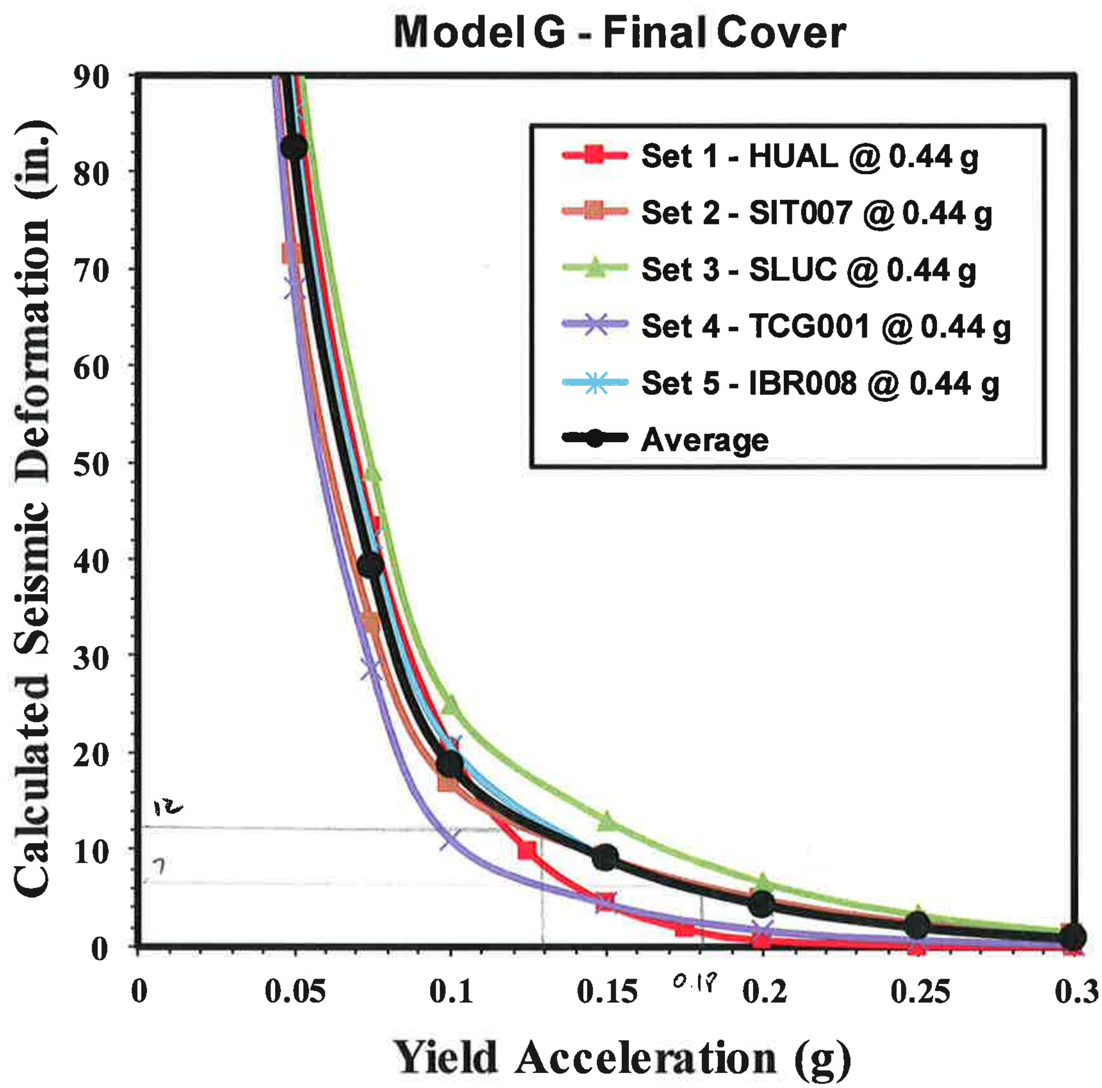


Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL E
RIVERBEND LANDFILL
McMINNVILLE, OREGON

DATE:	October 2017	FIGURE NO.	5
PROJECT NO.	2015.0074 - 200		

3 to 1 (H:V)
3.5 to 1 (H:V)
South Side FGPM



Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL G
RIVERBEND LANDFILL
McMINNVILLE, OREGON

DATE:	October 2017	FIGURE NO.	6
PROJECT NO.	2015.0074 - 200		

Geosyntec consultants

Written by: FWS Date: 05/12/14 Reviewed by: Date: / /

Client: WM Project: Riverbend LF Closure Project/Proposal No. WG1915 Task No.

ESTIMATE GEOCOMPOSITE TRANSMISSIVITY FOR FINAL COVER

(1) Final cover will consist of:

- 18" vegetative layer - on site soil
- NON WOVEN GEOTEXTILE (8 oz)
- AGRU SUPERGRIPNET (STUDS UP / SPIKES DOWN)
- 18" foundation layer

(2) Final cover configuration approved for partial closures of Modules 4, 5, 6, 7. Assume same configuration will be approved.

(3) ONSITE SOIL is primarily clayey (CL/CH/MH/ML) Soil will be lightly compacted to allow vegetation to grow → 85% relative compaction (ASTM D1557). Max. estimated hydraulic conductivity = 1×10^{-4} cm/sec (MAX)

(4) Follow unit gradient method to estimate transmissivity required.

$$FS_{GC} = \frac{\theta \tan\beta}{k_{veg} L}$$

where FS_{GC} = factor of safety for drainage capacity

β = slope inclination; max inclination at time of closure is 3.5:1 (horizontal to vertical) which will become flatter over time → $\tan\beta = 1/3.5 = 0.285$

Geosyntec consultants

Written by: FWS Date: 05/12/14 (DD MM YY) Reviewed by: ______ Date: __/__/__ (DD MM YY)

Client: WM Project: Riverbend CF Closure Project/Proposal No. WG1915 Task No. ______

$k_{VEG} = 1 \times 10^{-4} \frac{cm}{sec} \times \frac{1\,m}{100\,cm} = 1 \times 10^{-6}\ m/sec$

Let FS = 9 (see Koerner and GC-8 by GRI)

$L = 50' \times 12''/1' \times 2.54 \frac{cm}{''} \times \frac{1\,m}{100\,cm} = 15\,m$

Solving for $\theta \geq \frac{FS \times k_{VEG} \times L}{\tan \beta}$

$$\theta \geq \frac{9 \times 1 \times 10^{-6}\ m/sec \times 15\,m}{0.285}$$

$$\theta \geq 5 \times 10^{-4}\ m^2/sec$$

CONCLUSION – based on the maximum hydraulic conductivity of 1×10^{-4} cm/sec for the onsite soil, a pipe spacing of 50' has been selected and a transmissivity of $6 \times 10^{-4}\ m^2/sec$ has been selected.

ited for geonets because of the very low head associated with these products. It should be noted, however, that the simple model developed by Thiel and Stewart is conservative at the flatter slopes and therefore could be used in design of such slopes.

A factor of safety for the drainage capacity, FS_{dc}, of the geocomposite drainage layer can be defined as follows

$$FS_{dc} = \frac{Q_{out}}{Q_{in}} = \frac{\theta i}{k_{veg} L \cos \beta} = \frac{\theta \tan \beta}{k_{veg} L}$$

The first author recommends a minimum factor of safety of 8 (overall drainage safety factor plus reduction factors) for lateral drainage systems in final covers.

Comparison of HELP model prediction and measured final cover performance

Total infiltration was estimated using the HELP model for the design cover section on the 2% grade erosion control bench and the 3.5H:1V side slope. The total annual infiltration as a percentage of annual precipitation calculated by the HELP model was 6.3% for the side slopes and 0.2% for the 2% bench. For the three-year average, the annual infiltration as a percentage of annual precipitation measured was 6.31% for the side slopes and 0.33% for the 2% bench. While the HELP model gave a very accurate prediction of the average total infiltration, it failed to predict the prolonged periods of saturation of the VSL. This is in agreement with the observations of Koerner and Soong, (1998) who observed that the HELP model can underestimate the quantity of water collected in lateral drainage systems by up to two orders of magnitude. The impact of this error on slope stability can be catastrophic.

Summary

The use of the unit-gradient design method is supported by field data obtained in the mid-Atlantic region. Conversely, the HELP model is shown to provide an accurate prediction of the long-term average annual infiltration but does not accurately predict the peak flows in lateral drainage systems in final covers. Since such peak flows can adversely impact the slope stability of a final cover, the use of the HELP model in stability evaluations is not recommended.

The authors would like to acknowledge the assistance of Duane Jarman and Perry Kairis, P.E., with the City of High Point for the assistance and support in this study. GFR

References

Koerner, R.M and T.Y. Soong. 1998. "Analysis and Design of Veneer Cover Soils," Proceedings of 6th International Geosynthetic Conference, Atlanta, vol. 1, pp. 1-23.

NOAA, National Oceanic And Atmospheric Administration, www.ncdc.noaa.gov.

Table 4.2 Recommended preliminary factor of safety values for determining allowable flow rate or transmissivity of geonets

	Partial Factor of Safety Value in Equation 4.5			
Application Area	FS_{IN}	FS_{CR}*	FS_{CC}	FS_{BC}
Sport fields	1.0 to 1.2	1.0 to 1.5	1.0 to 1.2	1.1 to 1.3
Capillary breaks	1.1 to 1.3	1.0 to 1.2	1.1 to 1.5	1.1 to 1.3
Roof and plaza decks	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock and soil slopes	1.3 to 1.5	1.2 to 1.4	1.1 to 1.5	1.0 to 1.5
Drainage blankets	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.0 to 1.2
Surface water drains for landfill caps	1.3 to 1.5	1.2 to 1.4	1.0 to 1.2	1.2 to 1.5
Secondary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0
Primary leachate collection (landfills)	1.5 to 2.0	1.4 to 2.0	1.5 to 2.0	1.5 to 2.0

*These values assume that the q_{ult} value was obtained using an applied normal pressure of 1.5 to 2 times the field-anticipated maximum value. If not, values must be increased.

done at the proper design load and hydraulic gradient and that this testing yielded a short-term between-rigid-plates value of 1.2 gal./min.-ft.

Solution: Since better information is not known, average values from Table 4.2 are used.

$$q_{allow} = q_{ult}\left[\frac{1}{FS_{IN} \times FS_{CR} \times FS_{CC} \times FS_{BC}}\right] \qquad (4.5)$$

$$= 1.2\left[\frac{1}{1.1 \times 1.1 \times 1.1 \times 1.2}\right]$$

$$= 1.2\left[\frac{1}{1.60}\right]$$

$$= 0.75 \text{ gal./min.-ft.}$$

Example:

What is the allowable geonet flow rate to be used in the design of a secondary leachate collection system? Assume that laboratory testing at proper design load and proper hydraulic gradient gave a short-term between-rigid-plates value of 1.2 gal./min.-ft.

Solution: Average values from Table 4.2 are used; however, note the large reduction.

Koerner, R; Designing w. Geosynthetics, 3rd Ed, Prentice Hall, NY.

Range of Clogging Reduction Factors (modified from Koerner, 1998)

Application	Chemical Clogging (RF_{CC})	Biological Clogging (RF_{BC})
Sport fields	1.0 to 1.2	1.1 to 1.3
Capillary breaks	1.0 to 1.2	1.1 to 1.3
Roof and plaza decks	1.0 to 1.2	1.1 to 1.3
Retaining walls, seeping rock and soil slopes	1.1 to 1.5	1.0 to 1.2
Drainage blankets	1.0 to 1.2	1.0 to 1.2
Landfill caps	1.0 to 1.2	1.2 to 3.5
Landfill leak detection	1.1 to 1.5	1.1 to 1.3
Landfill leachate collection	1.5 to 2.0	1.1 to 1.3

9. Polymer Degradation

9.1 Degradation of the materials from which the drainage geocomposite are made, with respect to the site-specific liquid being transmitted, is a polymer issue. Most geocomposite drainage cores are made from polyethylene, polypropylene, polyamide or polystyrene. Most geotextile filter/separators covering the drainage cores are made from polypropylene, polyester or polyethylene.

Note 8: It is completely inappropriate to strip the factory bonded geotextile off of the drainage core and then test one or the other component. The properties of both the geotextile and drainage core will be altered in the lamination process from their original values.

9.2 If polymer degradation testing is recommended, the drainage core and the geotextile should be tested separately in their as-received condition before lamination and bonding.

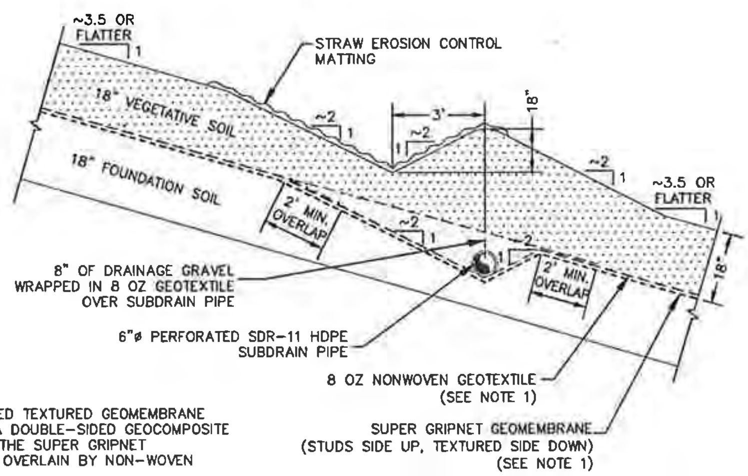
9.3 The incubation of the drainage cores and/or geotextile coupons is to be done according to the ASTM D5322 immersion procedure.

9.4 The testing of the incubated drainage cores is to be done according to ASTM D6388 which stipulates various test methods for evaluation of incubated geonets.

Note 9: For drainage cores other than geonets, e.g., columnar, cuspated, meshes, etc., it may be necessary to conduct additional tests than appear in ASTM D6388. These tests, and their procedures, should be discussed and agreed upon by the project designer, testing organization, and manufacturer.

9.5 The testing of the incubated geotextiles is to be done according to ASTM D6389 which stipulates various test methods for evaluation of incubated geotextiles.

Note 10: The information obtained in testing the drainage core (Section 9.4) and the geotextile (Section 9.5) result in a "go-no go" situation and not in a reduction factor, per se. If an adverse chemical reaction is indicated, one must select a different type of geocomposite material (drainage core and/or geotextile).



NOTES:

1. A DOUBLE-SIDED TEXTURED GEOMEMBRANE OVERLAIN BY A DOUBLE-SIDED GEOCOMPOSITE MAY REPLACE THE SUPER GRIPNET GEOMEMBRANE OVERLAIN BY NON-WOVEN GEOTEXTILE.

A / 1 FINAL COVER SYSTEM (TYP)

NOT TO SCALE

- SUBDRAIN PIPE SPACED EVERY 50'.
- TRANSMISSIVITY $\geq 5\times10^{-4}$ m²/sec

\\preserver\techstorage\projects\Geosyntec\Riverbend\dwg\Final Closure\1915-Figure 2 - Final Cover Details.dwg 11-25-14 03:56:58 PM MSparks

APPENDIX D-4

Summary Memorandum with 2017 Evaluation of Seismic Deformations at the Final Cover Level By Geo-Logic Associates for M9, rock acceleration = 0.44g

Memorandum

Date: October 20, 2017

To: Dr. Hari Sharma, PE (Geosyntec Consultants, Inc.)

Copies to: Mr. Fabrizio Settepani, PE, GE (California) (Geosyntec Consultants, Inc.)

From: Neven Matasovic, PhD, PE, GE (California) (Geo-Logic Associates, Inc.)

Subject: Riverbend Landfill
Seismic Displacement Estimate at the Final Cover Level
Geo-Logic Associates Project Number: 2015.0074

GENERAL

As requested by Geosyntec, Geo-Logic Associates, Inc. (GLA) has performed site response and seismic deformation analysis for five (5) representative configurations of the Riverbend Landfill (site). The evaluations were performed in support of the design of the composite final cover system that will be placed over select areas of the site, as indicated by shading in Figure 1.

MODEL AND CONFIGURATIONS

To perform the site response analysis, GLA used the computer program D-MOD2000 (Matasovic, 1993; www.GeoMotions.com). D-MOD2000 is one-dimensional (1-D) nonlinear effective-stress program for calculation of seismic response of natural and man-made soil deposits, earthfill /rockfill dams, and solid waste landfills. The program is based upon lumped mass dynamic response model. Soil and waste behavior is modeled by a set of nonlinear and effective-stress constitutive models developed by Matasovic and Vucetic (1993). Required input includes dynamic excitation (accelerogram or program-generated sinusoidal motion), unit weight and shear wave velocity profiles, and parameters of constitutive models (generic model parameters are available for many soils, including sands subject to various confining stresses, and clays of various plasticities). The program output includes reprint of input values, printout of peak values of acceleration, average acceleration (i.e., seismic coefficient), velocity, displacement, and porewater pressure within the profile, and the corresponding time histories.

The analyses were performed for representative site response configurations labelled Models 0, 1, 2, E, and G. Figure 1 shows the areas of the site represented by each Model.

To perform the seismic deformation analysis, GLA used the computer program SLIP2000 (Matasovic et al., 1998; www.GeoMotions.com). For a given yield acceleration, SLIP2000 performs double integration of the average acceleration time histories evaluated in site response analysis above the yield acceleration. The double integration is conducted following the principles expounded by Newmark (1965).

The inputs to the site response analysis are presented in Attachment 1 of this report. The results of seismic deformation analysis (maximum calculated permanent seismic displacement of sliding mass) are presented, for a range of yield accelerations (k_y) expected at this site, in a chart form.

DESIGN GROUND MOTIONS AND ACCELERATION TIME HISTORIES

For this study, design ground motions were scaled to Peak Horizontal Ground Acceleration, PHGA = 0.44 g before applying at the transmitting base of the nonlinear site response model (corresponds to "outcrop" motion). The PHGA = 0.44 g corresponds to the 84th percentile motion for the deterministic seismic hazard analysis (Abrahamson, 2013; GLA, 2015).

GLA used five acceleration time histories (suite of accelerograms; Set 1.sar – Set 5.sar) to represent the design earthquake in time domain. The design earthquake is a Magnitude (**M)** 9 event at an approximate site-to-source distance (R) of 50 km. These accelerograms are representative of on-site bedrock conditions. They were developed by advanced modification (spectral matching) of seed motions by Abrahamson (2013). Three of the seed motions in this suite are from the 2011 **M** 9.0 Tohoku, Japan earthquake and two are from the 2010 **M** 8.8 Maule, Chile earthquake.

SITE RESPONSE ANALYSIS MODELS

Geosyntec provided GLA with the subsurface, engineered fill, and waste mass profiles that represent the Landfill. GLA used this information to develop representative site response models, assign constitutive model parameters to materials in the profile(s), and perform de-coupled site response - seismic deformation analysis.

A detailed summary of input information provided by Geosyntec and the corresponding D-MOD2000 input files are presented in Attachment. The summaries include information on stratification (i.e., thickness of individual layers), representative material classification (i.e., description and a note on generic material parameters selected), and information on representative shear wave velocity and unit weight assigned to each layer. The input into the analyses included the latest update of design ground motions (GLA, 2015),

ANALYSIS AND RESULTS

GLA performed decoupled site response - seismic deformation analysis. Each of representative model was excited by a suite of 5 design ground motions scaled to bedrock PHGA = 0.44 g. The results were monitored as Peak Ground Acceleration (PGA) at the model surface and as average acceleration time histories at the final cover level. The average acceleration time histories were used as an input into Newmark-type site response analysis with SLIP2000.

The results of seismic deformation analysis are shown on Figures 2, 3, 4, 5, and 6 in the form of the site-specific seismic deformation charts, each corresponding to a site response analysis column evaluated for each model. The average value of five design ground motions is recommended for use by Geosyntec to estimate displacement response.

CLOSURE

This report is based on the data provided to Geo-Logic Associates, Inc. (GLA) by Geosyntec, GLA's processing and evaluation of the data, and the results of the analyses described herein. GLA should be notified of any conditions that differ from those described herein since this may require a reevaluation of the data, conclusions, and recommendations presented.

This report has been prepared in accordance with generally accepted geotechnical and earthquake engineering practices. GLA makes no other warranties, either expressed or implied, as to the professional data and the results presented herein.

Should you have any questions or require additional explanation, please do not hesitate to contact me. Sincerely,

Neven Matasovic, PhD, PE, GE (California)
Principal
nmatasovic@geo-logic.com / 714.465.8240

FIGURES

ATTACHMENT

D-MOD2000 Output Files with Repeat of Input Information

REFERENCES

Abrahamson, N. (2013). "Deterministic Analysis and Time Histories for Riverbend Landfill," Letter Report, February 13.

GLA (2015). "Letter: Seismic Hazard Analysis – June 2015, Riverbend Landfill, McMinnville, Oregon," Technical Memorandum prepared for Geosyntec Consultants, Inc., June 29, 2015, Geo-Logic Associates, Anaheim, California.

Matasovic N. (1993), "Seismic Response of Composite Horizontally-Layered Soil Deposits," *Ph.D. Dissertation*, Civil Engineering Dept., University of California, Los Angeles, 483 p.

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Matasovic, N., Kavazanjian, E., Jr., and Giroud, J.P. (1998), "Newmark Seismic Deformation Analysis for Geosynthetic Covers," *Geosynthetics International*, Journal of the IGS, Vol. 5, Nos. 1 - 2, pp. 237-264, (*Invited Paper)*.

Matasovic, N. and Kavazanjian, E., Jr. (1998), "Cyclic Characterization of OII Landfill Solid Waste," *ASCE Journal of Geotechnical and Geoenvironmental Engineering*, Vol. 124, No. 3, pp. 197-210.

Newmark, N.M. (1965), "Effects of Earthquakes on Dams and Embankments," *Geótechnique* 15, No. 2, pp. 139-160.

Vucetic, M. and Dobry, R. (1991), "Effect of Soil Plasticity on Cyclic Response." *Journal of the Geotechnical Engineering*, ASCE, Vol. 117, No. 1, 89-107.

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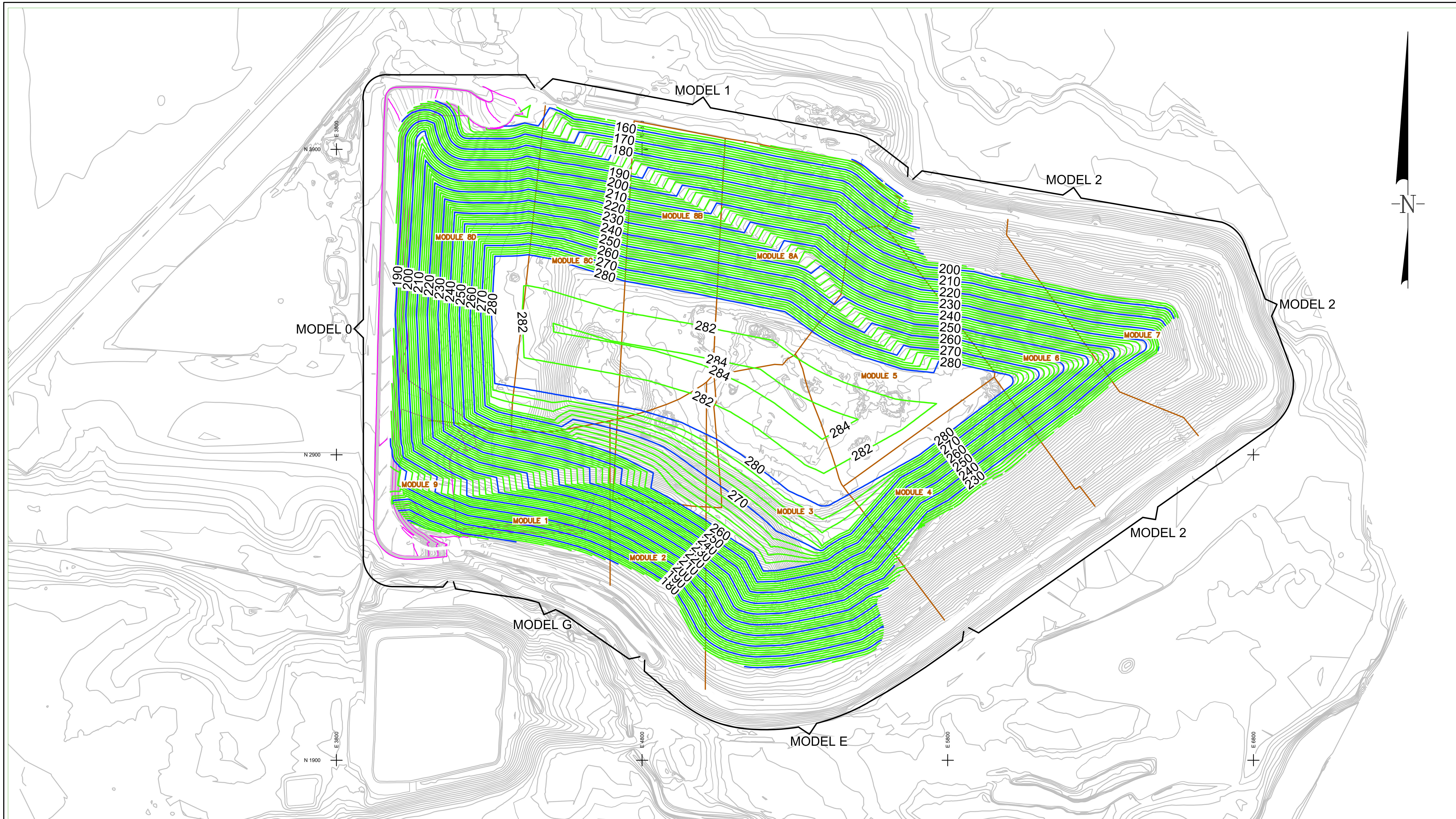


LEGEND:

11 AUGUST 2016 TOPOGRAPHY

TOP OF FINAL GRADES 10-FT CONTOURS

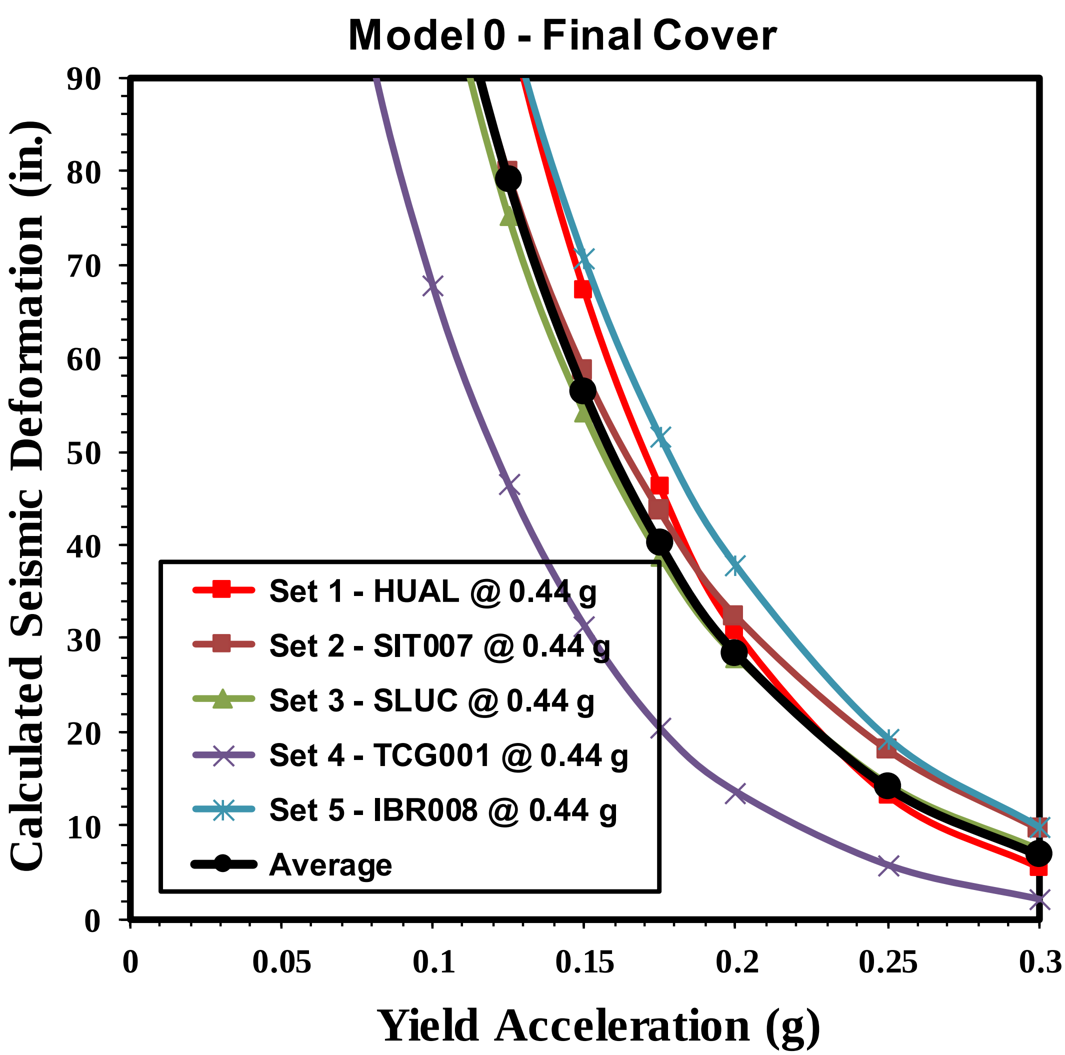
TOP OF FINAL GRADES 2-FT CONTOURS

0 300

SCALE IN FEET

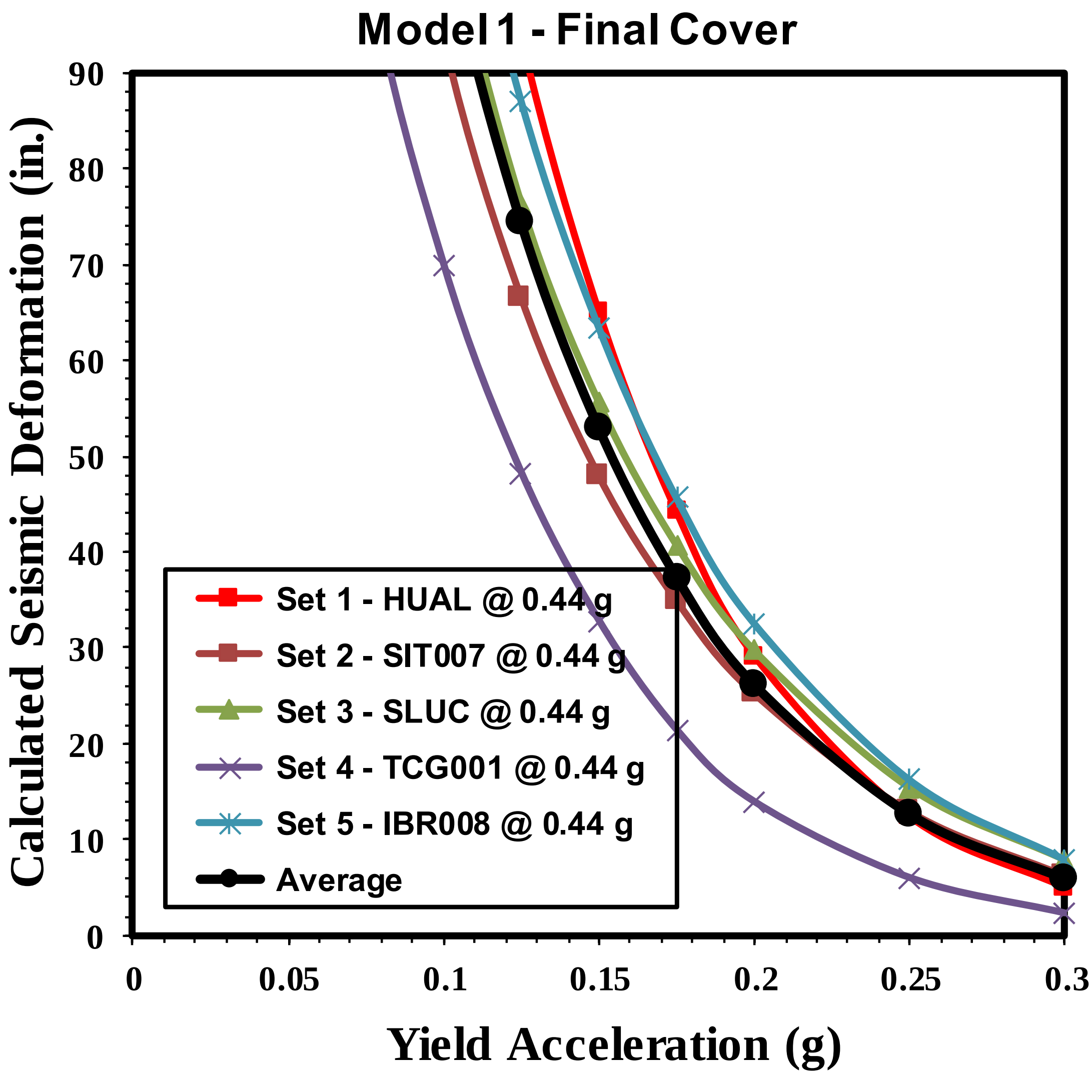
FINAL GRADING PLAN RIVERBEND LANDFILL MCMINNVILLE, OREGON	FIGURE NO. 1 PROJECT NO. DATE: OCTOBER 2017

P:\CADD\CIVIL 3D\WM\RIVERBEND\WG2423\Final Grading Plan for Geo-Logic Associates.dwg 10-19-17 11:20:11 AM skholameyzer



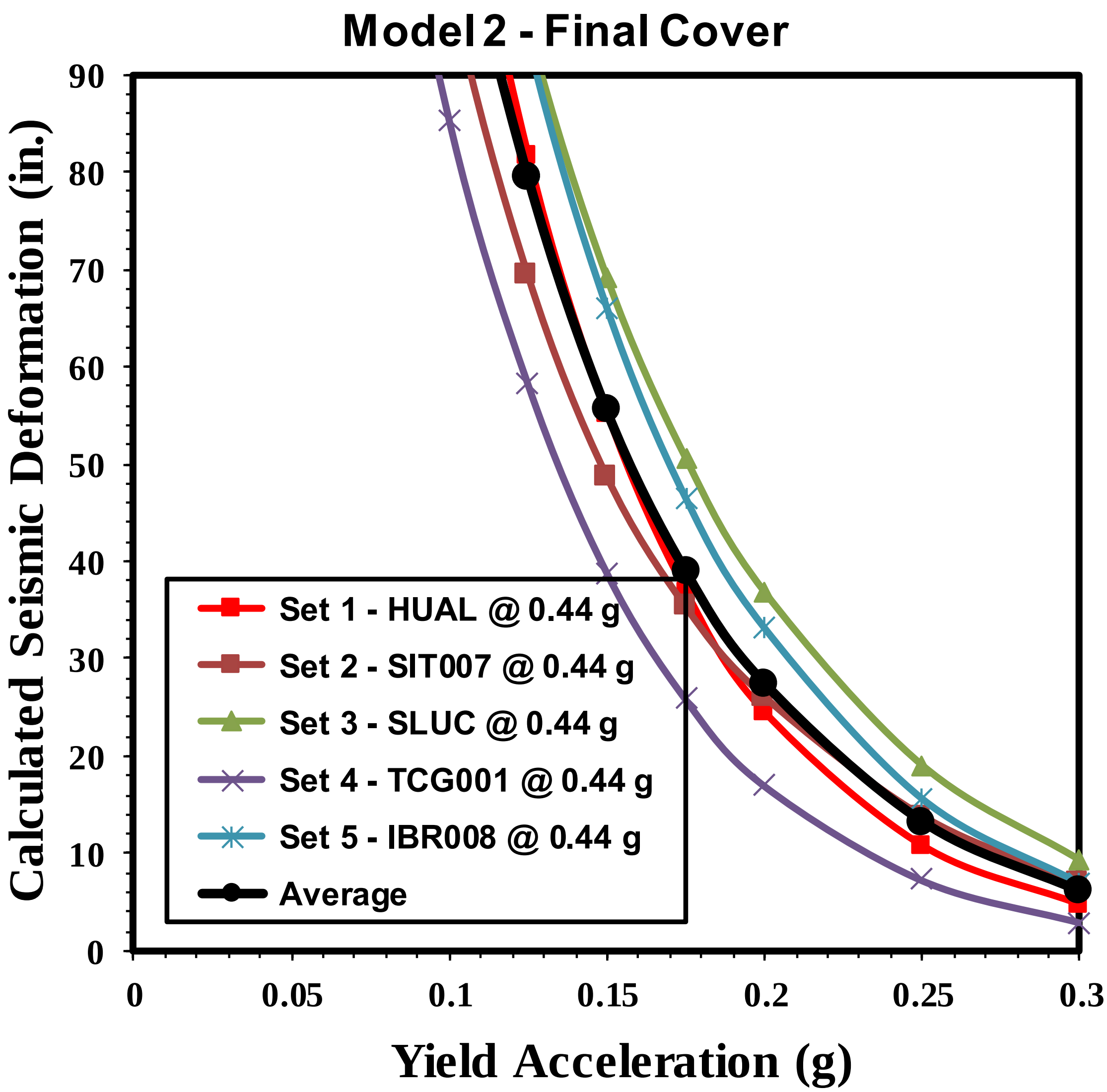
Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL 0 RIVERBEND LANDFILL McMINNVILLE, OREGON			
DATE:	October 2017	FIGURE NO.	2
PROJECT NO.	2015.0074 - 200		



Geo-Logic ASSOCIATES

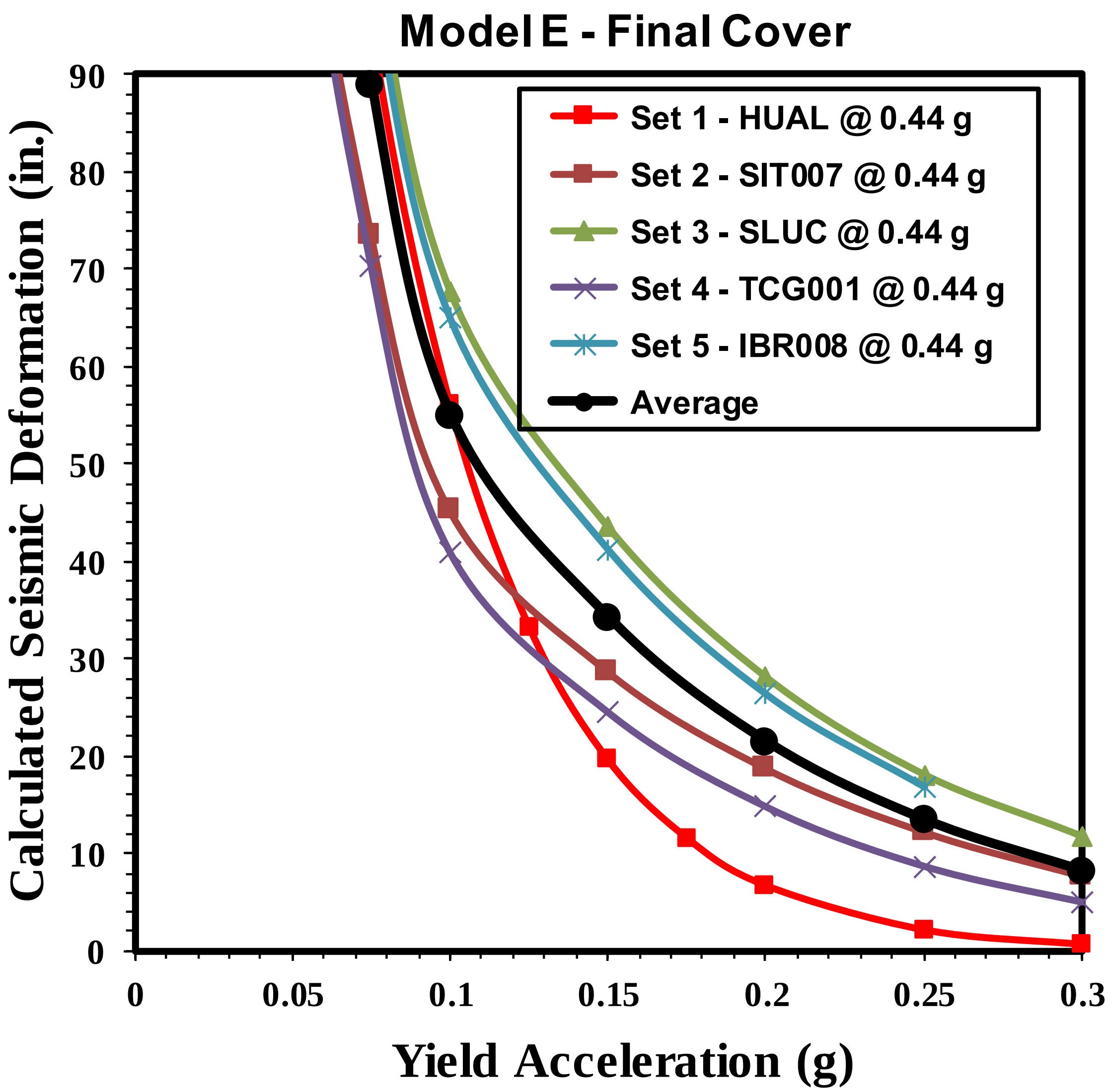
SEISMIC DEFORMATION CHART – MODEL 1 RIVERBEND LANDFILL McMINNVILLE, OREGON			
DATE:	October 2017	FIGURE NO.	3
PROJECT NO.	2015.0074 - 200		



Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL 2
RIVERBEND LANDFILL
McMINNVILLE, OREGON

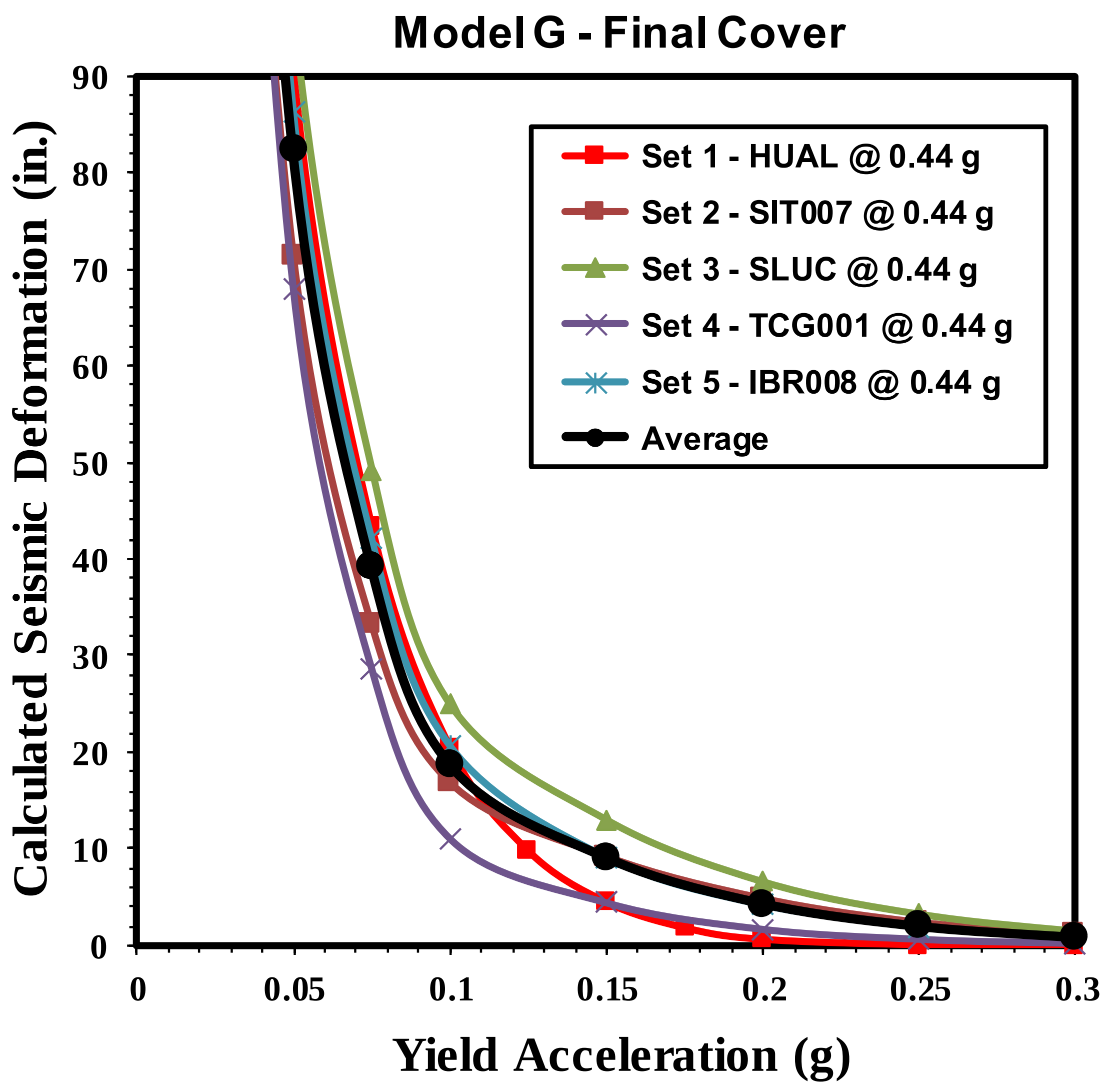
DATE:	October 2017	FIGURE NO.	4
PROJECT NO.	2015.0074 - 200		



Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL E
RIVERBEND LANDFILL
McMINNVILLE, OREGON

DATE:	October 2017	FIGURE NO.	5
PROJECT NO.	2015.0074 - 200		



Geo-Logic ASSOCIATES

SEISMIC DEFORMATION CHART – MODEL G
RIVERBEND LANDFILL
McMINNVILLE, OREGON

DATE:	October 2017	FIGURE NO.	6
PROJECT NO.	2015.0074 - 200		

A T T A C H M E N T

Appendix A

Riverbend Landfill, McMinnvile, Oregon

Nonlinear Site Response Analysis Model 0 (D-MOD)

No. (-)	Thick. (ft)	Vs (ft/s)	Unit Wt. (pcf)	Nonlinear Properties (-)
1	5.0	819.85	120.00	Cover (Vucetic and Dobry 1991 PI=30)
2	5.0	569.49	73.90	MSW (Matasovic and Kavazanjian, 1998)
3	10.0	592.74	78.20	MSW (Matasovic and Kavazanjian, 1998)
4	10.0	616.40	81.50	MSW (Matasovic and Kavazanjian, 1998)
5	10.0	640.05	84.10	MSW (Matasovic and Kavazanjian, 1998)
6	10.0	663.60	85.90	MSW (Matasovic and Kavazanjian, 1998)
7	10.0	687.50	87.10	MSW (Matasovic and Kavazanjian, 1998)
8	10.0	711.08	88.00	MSW (Matasovic and Kavazanjian, 1998)
9	5.0	1499.35	130.00	Liner (Vucetic and Dobry 1991 PI=30)
10	5.0	820.00	125.00	Foundation Fill (Gravel; Shibuya 1990)
11	5.0	820.00	125.00	Foundation Fill (Gravel; Shibuya 1990)
12	10.0	884.95	113.40	ML/CL (PI=30)
13	10.0	1134.52	113.40	ML/CL (PI=30)
14	10.0	1484.87	113.40	ML/CL (PI=30)<- Acc. @ 35' blw. liner
15	10.0	1676.60	124.70	SM/SW (PI=0)
16	10.0	1622.10	124.70	SM/SW (PI=0)
17	10.0	1666.96	124.70	SM/SW (PI=0)
18	10.0	1633.07	124.70	Soft Rock (Shibuya et al., 1990)
19	10.0	2147.46	131.30	Soft Rock (Shibuya et al., 1990)
20	10.0	2114.33	131.30	Soft Rock (Shibuya et al., 1990)
21	10.0	2407.19	136.50	Soft Rock (Shibuya et al., 1990)
22	5.0	2378.52	136.50	Soft Rock (Shibuya et al., 1990)

PROPERTIES OF THE VISCO-ELASTIC HALF-SPACE:
UNIT WEIGHT OF BASE, UW = 140. (pcf)
SHEAR WAVE VELOCITY, V_s = 2500. (ft/s)

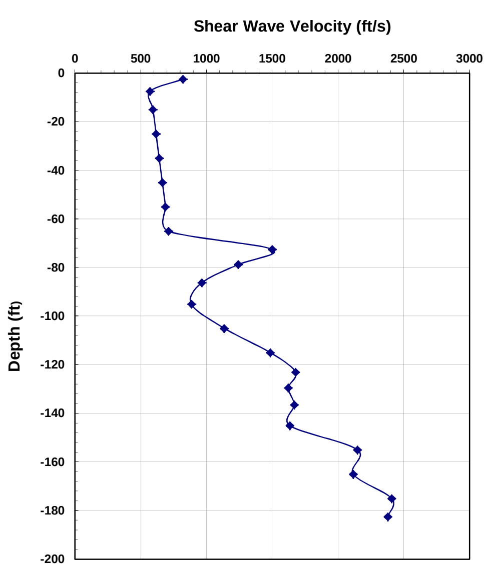
Riverbend Landfill, OR; D-MOD - MSW on top of Alluvium (avg of 2 MASW Profiles; corrected for overburden)

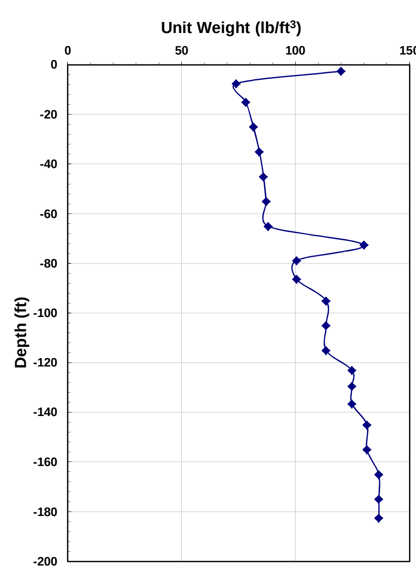
Model 1

Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer	Description	Thickness	Depth	V_s	V_s	γ	γ	Curves	γ_r	β	s	G_{mo}	τ_{mo}
(-)	(-)	(ft)	(ft)	[ft/s]	(m/s)	(lb/ft^3)	(kN/m^3)	(-)	(-)	(-)	(-)	(psf)	(psf)
1	PI = 30 (Cover)	5	-2.5	819.85	249.9	120.00	18.8	PI = 30	0.0016	1.10	0.90	2,506,946	4,011.11
2	MSW	5	-7.5	569.49	173.6	73.90	11.6	MSW	0.00316	0.50	1.10	744,923	2,353.96
3	MSW	10	-15.0	592.74	180.7	78.20	12.3	MSW	0.00316	0.50	1.10	853,946	2,698.47
4	MSW	10	-25.0	616.40	187.9	81.50	12.8	MSW	0.00316	0.50	1.10	962,449	3,041.34
5	MSW	10	-35.0	640.05	195.1	84.10	13.2	MSW	0.00316	0.50	1.10	1,070,826	3,383.81
6	MSW	10	-45.0	663.60	202.3	85.90	13.5	MSW	0.00316	0.50	1.10	1,175,712	3,715.25
7	MSW	10	-55.0	687.50	209.5	87.10	13.7	MSW	0.00316	0.50	1.10	1,279,554	4,043.39
8	MSW	10	-65.0	711.08	216.7	88.00	13.8	MSW	0.00316	0.50	1.10	1,382,976	4,370.20
9	PI = 30 (Liner)	5	-72.5	1499.35	457.0	130.00	20.4	PI = 30	0.0016	1.10	0.85	9,083,314	14,533.30
10	W. Silt (ML/CL)	7.5	-78.8	1241.00	378.3	100.40	15.8	PI = 30	0.0016	1.10	0.85	4,805,872	7,689.40
11	W. Silt (ML/CL)	7.5	-86.3	964.00	293.8	100.40	15.8	PI = 30	0.0016	1.10	0.85	2,899,898	4,639.84
12	W. Silt (ML/CL)	10.0	-95.0	884.95	269.7	113.40	17.8	PI = 30	0.0016	1.10	0.85	2,760,231	4,416.37
13	W. Silt (ML/CL)	10.0	-105.0	1134.52	345.8	113.40	17.8	PI = 30	0.0016	1.10	0.85	4,536,619	7,258.59
14	W. Silt (ML/CL)	10.0	-115.0	1484.87	452.6	113.40	17.8	PI = 30	0.0016	1.10	0.85	7,771,142	12,433.83
15	SM/SW	6.0	-123.0	1676.60	511.0	124.73	19.6	PI = 0	0.000324	1.10	0.90	10,897,157	3,530.68
16	SM/SW	7.0	-129.5	1622.10	494.4	124.73	19.6	PI = 0	0.000324	1.10	0.90	10,200,220	3,304.87
17	SM/SW	7.0	-136.5	1666.96	508.1	124.73	19.6	PI = 0	0.000324	1.10	0.90	10,772,206	3,490.19
18	Weathered Siltstone	10.0	-145.0	1633.07	497.8	131.30	20.6	Shibuya	0.000722	0.36	0.40	10,883,517	7,857.90
19	Weathered Siltstone	10.0	-155.0	2147.46	654.5	131.30	20.6	Shibuya	0.000722	0.36	0.40	18,819,576	13,587.73
20	Weathered Rock	10.0	-165.0	2114.33	644.4	136.50	21.4	Shibuya	0.000722	0.36	0.40	18,965,886	13,693.37
21	Weathered Rock	10.0	-175.0	2407.19	733.7	136.50	21.4	Shibuya	0.000722	0.36	0.40	24,583,762	17,749.48
22	Weathered Rock	5.0	-182.5	2378.52	725.0	136.50	21.4	Shibuya	0.000722	0.36	0.40	24,001,656	17,329.20

H (ft) = 185.0 $(V_s)_{avg}$ (ft/s) = 1279.80 T (s) = 0.578 n (-) = 0 c (%) = 0.5 α_R = 0.000000 β_R = 0.000920





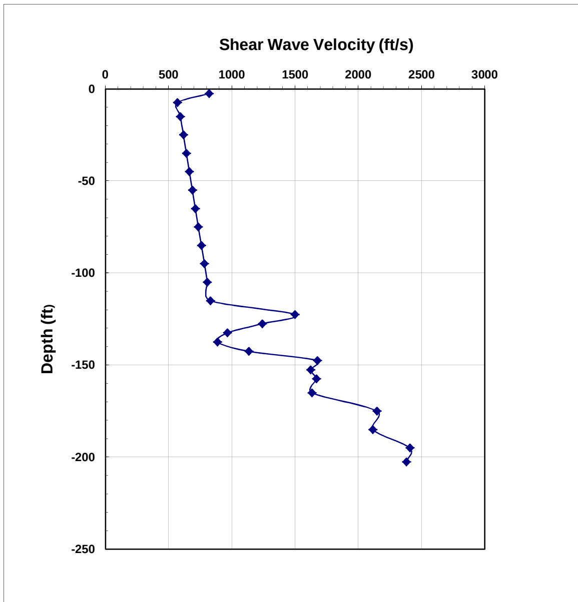
Riverbend Landfill, OR; D-MOD - MSW on top of Alluvium (avg of 2 MASW Profiles; corrected for overburden)

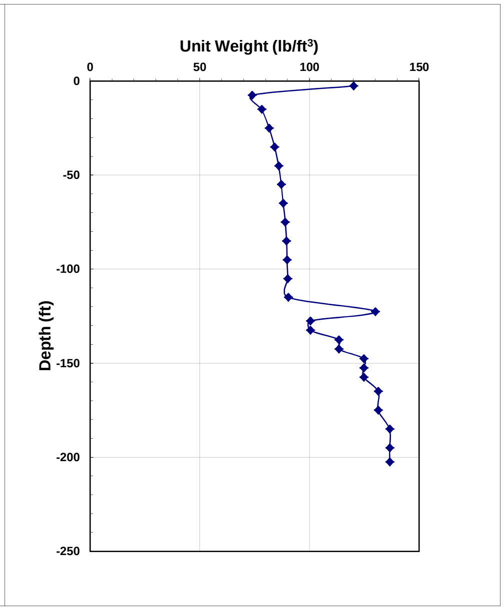
Model 2

Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer	Description	Thickness	Depth	V_s	V_s	γ	γ	Curves	γ_r	β	s	G_{mo}	τ_{mo}
(-)	(-)	(ft)	(ft)	[ft/s]	(m/s)	(lb/ft^3)	(kN/m^3)	(-)	(-)	(-)	(-)	(psf)	(psf)
1	PI = 30 (Cover)	5	-2.5	819.85	249.9	120.00	18.8	PI = 30	0.0016	1.10	0.90	2,506,946	4,011.11
2	MSW	5	-7.5	569.49	173.6	73.90	11.6	MSW	0.00316	0.50	1.10	744,923	2,353.96
3	MSW	10	-15.0	592.74	180.7	78.20	12.3	MSW	0.00316	0.50	1.10	853,946	2,698.47
4	MSW	10	-25.0	616.40	187.9	81.50	12.8	MSW	0.00316	0.50	1.10	962,449	3,041.34
5	MSW	10	-35.0	640.05	195.1	84.10	13.2	MSW	0.00316	0.50	1.10	1,070,826	3,383.81
6	MSW	10	-45.0	663.60	202.3	85.90	13.5	MSW	0.00316	0.50	1.10	1,175,712	3,715.25
7	MSW	10	-55.0	687.50	209.5	87.10	13.7	MSW	0.00316	0.50	1.10	1,279,554	4,043.39
8	MSW	10	-65.0	711.08	216.7	88.00	13.8	MSW	0.00316	0.50	1.10	1,382,976	4,370.20
9	MSW	10	-75.0	734.91	224.0	88.92	14.0	MSW	0.00316	0.50	1.10	1,492,612	4,716.65
10	MSW	10	-85.0	758.53	231.2	89.49	14.1	MSW	0.00316	0.50	1.10	1,600,359	5,057.13
11	MSW	10	-95.0	782.15	238.4	89.75	14.1	MSW	0.00316	0.50	1.10	1,706,432	5,392.32
12	MSW	10	-105.0	805.77	245.6	90.06	14.1	MSW	0.00316	0.50	1.10	1,817,488	5,743.26
13	MSW	10	-115.0	829.40	252.8	90.32	14.2	MSW	0.00316	0.50	1.10	1,931,060	6,102.15
14	PI = 30 (Liner)	5	-122.5	1499.35	457.0	130.00	20.4	PI = 30	0.0016	1.10	0.85	9,083,314	14,533.30
15	W. Silt (ML/CL)	5.0	-127.5	1241.00	378.3	100.40	15.8	PI = 30	0.0016	1.10	0.85	4,805,872	7,689.40
16	W. Silt (ML/CL)	5.0	-132.5	964.00	293.8	100.40	15.8	PI = 30	0.0016	1.10	0.85	2,899,898	4,639.84
17	W. Silt (ML/CL)	5.0	-137.5	884.95	269.7	113.40	17.8	PI = 30	0.0016	1.10	0.85	2,760,231	4,416.37
18	W. Silt (ML/CL)	5.0	-142.5	1134.52	345.8	113.40	17.8	PI = 30	0.0016	1.10	0.85	4,536,619	7,258.59
19	SM/SW	5.0	-147.5	1676.60	511.0	124.73	19.6	PI = 0	0.000324	1.10	0.90	10,897,157	3,530.68
20	SM/SW	5.0	-152.5	1622.10	494.4	124.73	19.6	PI = 0	0.000324	1.10	0.90	10,200,220	3,304.87
21	SM/SW	5.0	-157.5	1666.96	508.1	124.73	19.6	PI = 0	0.000324	1.10	0.90	10,772,206	3,490.19
22	Weathered Siltstone	10.0	-165.0	1633.07	497.8	131.30	20.6	Shibuya	0.000722	0.36	0.40	10,883,517	7,857.90
23	Weathered Siltstone	10.0	-175.0	2147.46	654.5	131.30	20.6	Shibuya	0.000722	0.36	0.40	18,819,576	13,587.73
24	Weathered Rock	10.0	-185.0	2114.33	644.4	136.50	21.4	Shibuya	0.000722	0.36	0.40	18,965,886	13,693.37
25	Weathered Rock	10.0	-195.0	2407.19	733.7	136.50	21.4	Shibuya	0.000722	0.36	0.40	24,583,762	17,749.48
26	Weathered Rock	5.0	-202.5	2378.52	725.0	136.50	21.4	Shibuya	0.000722	0.36	0.40	24,001,656	17,329.20

H (ft) = **205.0** $(V_s)_{avg}$ (ft/s) = **1176.21** T (s) = **0.697** n (-) = 0 c (%) = 0.5 α_R = **0.000000** β_R = **0.001109**





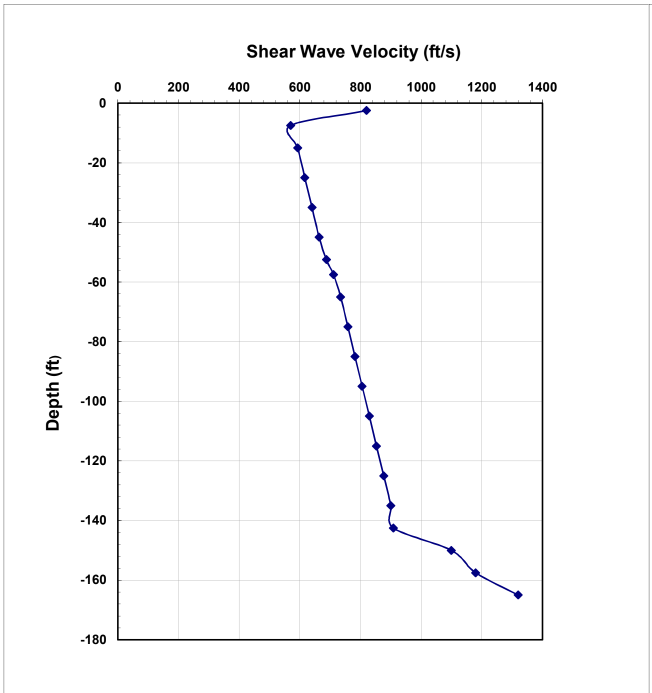
Riverbend Module 11 - D-MOD2000 Model E

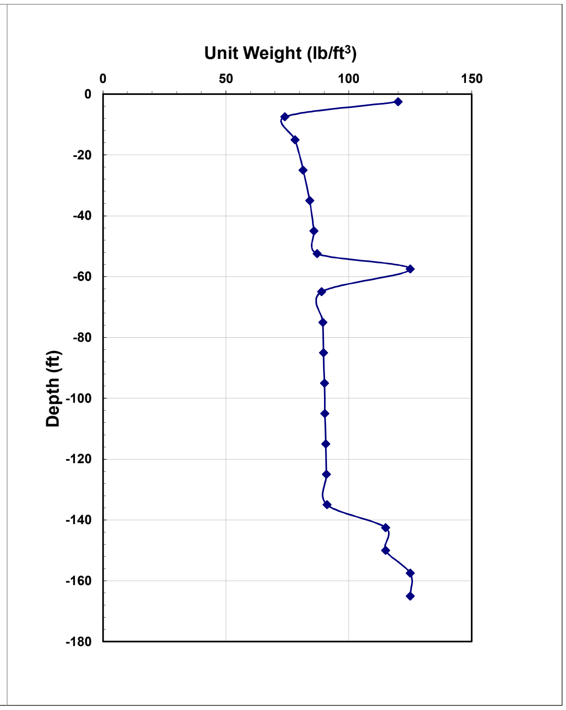
Geo-Logic Associates

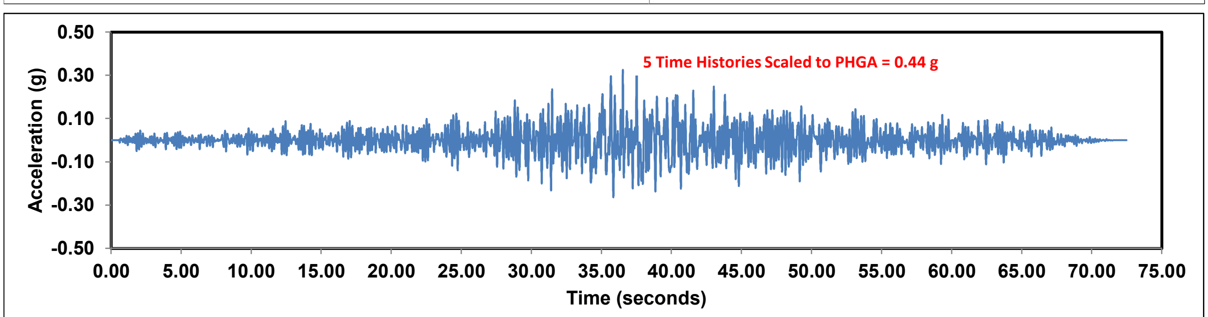
Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer	Description	Thickness	Depth	V_s	V_s	γ	γ	Curves	γ_r	β	s	G_{mo}	τ_{mo}
(-)	(-)	(ft)	(ft)	[ft/s]	(m/s)	(lb/ft³)	(kN/m³)	(-)	(-)	(-)	(-)	(psf)	(psf)
1	CL	5.0	-2.5	820.2	250.0	120.0	18.8	PI = 30	0.0016	1.10	0.85	2,509,148	4,014.64
2	MSW	5.0	-7.5	569.6	173.6	73.9	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	10.0	-15.0	593.2	180.8	78.2	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	10.0	-25.0	616.8	188.0	81.5	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	10.0	-35.0	640.4	195.2	84.1	13.2	M & K	0.00316	0.50	1.10	1,071,763	3,386.77
6	MSW	10.0	-45.0	664.0	202.4	85.9	13.5	M & K	0.00316	0.50	1.10	1,176,729	3,718.46
7	MSW	5.0	-52.5	687.7	209.6	87.1	13.7	M & K	0.00316	0.50	1.10	1,280,661	4,046.89
8	CH (Liner)	5.0	-57.5	711.3	216.8	125.0	19.6	PI = 50	0.00244	1.00	0.85	1,965,593	4,796.05
9	MSW	10.0	-65.0	734.9	224.0	88.9	14.0	M & K	0.00316	0.50	1.10	1,492,612	4,716.65
10	MSW	10.0	-75.0	758.5	231.2	89.5	14.1	M & K	0.00316	0.50	1.10	1,600,359	5,057.13
11	MSW	10.0	-85.0	782.2	238.4	89.7	14.1	M & K	0.00316	0.50	1.10	1,706,432	5,392.32
12	MSW	10.0	-95.0	805.8	245.6	90.1	14.1	M & K	0.00316	0.50	1.10	1,817,488	5,743.26
13	MSW	10.0	-105.0	829.4	252.8	90.3	14.2	M & K	0.00316	0.50	1.10	1,931,060	6,102.15
14	MSW	10.0	-115.0	853.0	260.0	90.6	14.2	M & K	0.00316	0.50	1.10	2,049,826	6,477.45
15	MSW	10.0	-125.0	876.6	267.2	90.9	14.3	M & K	0.00316	0.50	1.10	2,171,012	6,860.40
16	MSW	10.0	-135.0	900.3	274.4	91.2	14.3	M & K	0.00316	0.50	1.10	2,297,612	7,260.45
17	W. Silt (ML/CL)	5.0	-142.5	909.0	277.1	115.0	18.1	PI = 30	0.0016	1.10	0.85	2,953,388	4,725.42
18	W. Silt (ML/CL)	10.0	-150.0	1100.0	335.3	115.0	18.1	PI = 30	0.0016	1.10	0.85	4,324,921	6,919.87
19	SM/SW	5.0	-157.5	1180.0	359.7	125.0	19.6	PI = 0	0.000324	1.10	0.90	5,409,648	1,752.73
20	SM/SW	10.0	-165.0	1320.0	402.3	125.0	19.6	PI = 0	0.000324	1.10	0.90	6,769,441	2,193.30

H (ft) = 170.0 $(V_s)_{avg}$ (ft/s) = 817.64 T (s) = 0.832 n (-) = 0 c (%) = 1 α_R = 0.00 β_R = 0.002648







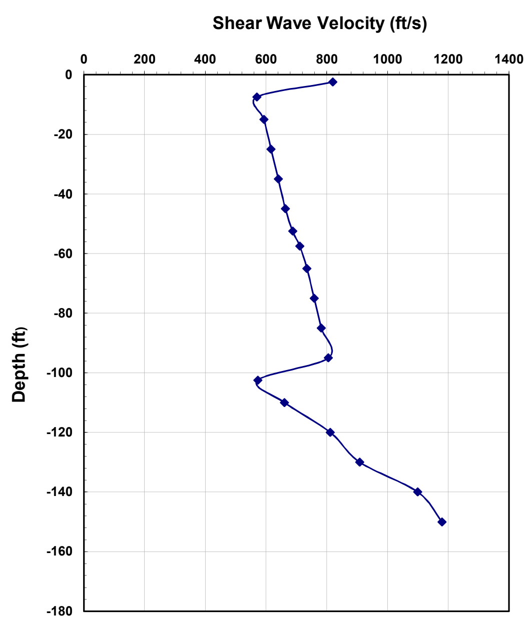
Riverbend Module 11 - D-MOD2000 Model G

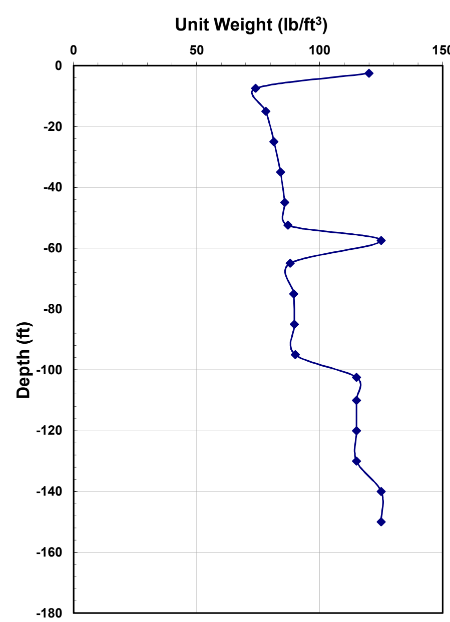
Geo-Logic ASSOCIATES

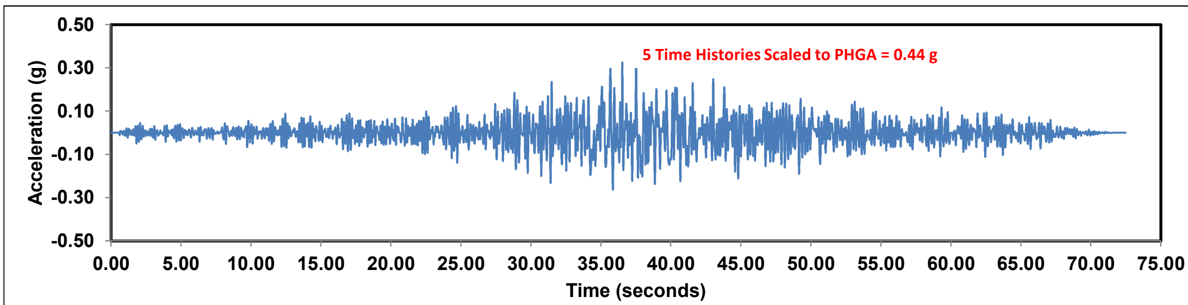
Use this spreadsheet to calculate G_{mo}, τ_{mo}, and T. Input is in blue, calculated values show in red, and descriptive labels are in green.

Layer	Description	Thickness	Depth	V_s	V_s	γ	γ	Curves	γ_r	β	s	G_{mo}	τ_{mo}
(-)	(-)	(ft)	(ft)	[ft/s]	(m/s)	(lb/ft^3)	(kN/m^3)	(-)	(-)	(-)	(-)	(psf)	(psf)
1	CL	5.0	-2.5	820.21	250.0	120.00	18.8	PI = 30	0.0016	1.10	0.85	2,509,148	4,014.64
2	MSW	5.0	-7.5	569.55	173.6	73.95	11.6	M & K	0.00316	0.50	1.10	745,585	2,356.05
3	MSW	10.0	-15.0	593.18	180.8	78.15	12.3	M & K	0.00316	0.50	1.10	854,686	2,700.81
4	MSW	10.0	-25.0	616.80	188.0	81.46	12.8	M & K	0.00316	0.50	1.10	963,278	3,043.96
5	MSW	10.0	-35.0	640.42	195.2	84.08	13.2	M & K	0.00316	0.50	1.10	1,071,763	3,386.77
6	MSW	10.0	-45.0	664.04	202.4	85.86	13.5	M & K	0.00316	0.50	1.10	1,176,729	3,718.46
7	MSW	5.0	-52.5	687.66	209.6	87.13	13.7	M & K	0.00316	0.50	1.10	1,280,590	4,046.67
8	CH (Liner)	5.0	-57.5	711.29	216.8	125.00	19.6	PI = 50	0.00244	1.00	0.85	1,965,615	4,796.10
9	MSW	10.0	-65.0	734.91	224.0	88.03	13.8	M & K	0.00316	0.50	1.10	1,477,726	4,669.61
10	MSW	10.0	-75.0	758.53	231.2	89.49	14.0	M & K	0.00316	0.50	1.10	1,600,350	5,057.11
11	MSW	10.0	-85.0	782.15	238.4	89.75	14.1	M & K	0.00316	0.50	1.10	1,706,513	5,392.58
12	MSW	10.0	-95.0	805.77	245.6	90.06	14.1	M & K	0.00316	0.50	1.10	1,817,394	5,742.96
13	W. Silt (ML/CL)	5.0	-102.5	573.0	174.7	115.00	18.1	PI = 15	0.00092	1.30	0.85	1,173,551	1,079.67
14	W. Silt (ML/CL)	10.0	-110.0	661.0	201.5	115.00	18.1	PI = 15	0.00092	1.30	0.85	1,561,693	1,436.76
15	W. Silt (ML/CL)	10.0	-120.0	812.0	247.5	115.00	18.1	PI = 15	0.00092	1.30	0.85	2,356,703	2,168.17
16	W. Silt (ML/CL)	10.0	-130.0	909.0	277.1	115.00	18.1	PI = 30	0.00092	1.10	0.85	2,953,388	2,717.12
17	SM/SW	10.0	-140.0	1100.0	335.3	125.00	19.6	PI = 0	0.000324	1.10	0.90	4,701,001	1,523.12
18	SM/SW	10.0	-150.0	1180.0	359.7	125.00	19.6	PI = 0	0.000324	1.10	0.90	5,409,648	1,752.73
19	SM/SW	10.0	-160.0	1320.0	402.3	125.00	19.6	PI = 0	0.000324	1.10	0.90	6,769,441	2,193.30

H (ft) = 165.0 $(V_s)_{avg}$ (ft/s) = 786.29 T (s) = 0.839 n (-) = 0 c (%) = 1 α_R = 0.00 β_R = 0.002671





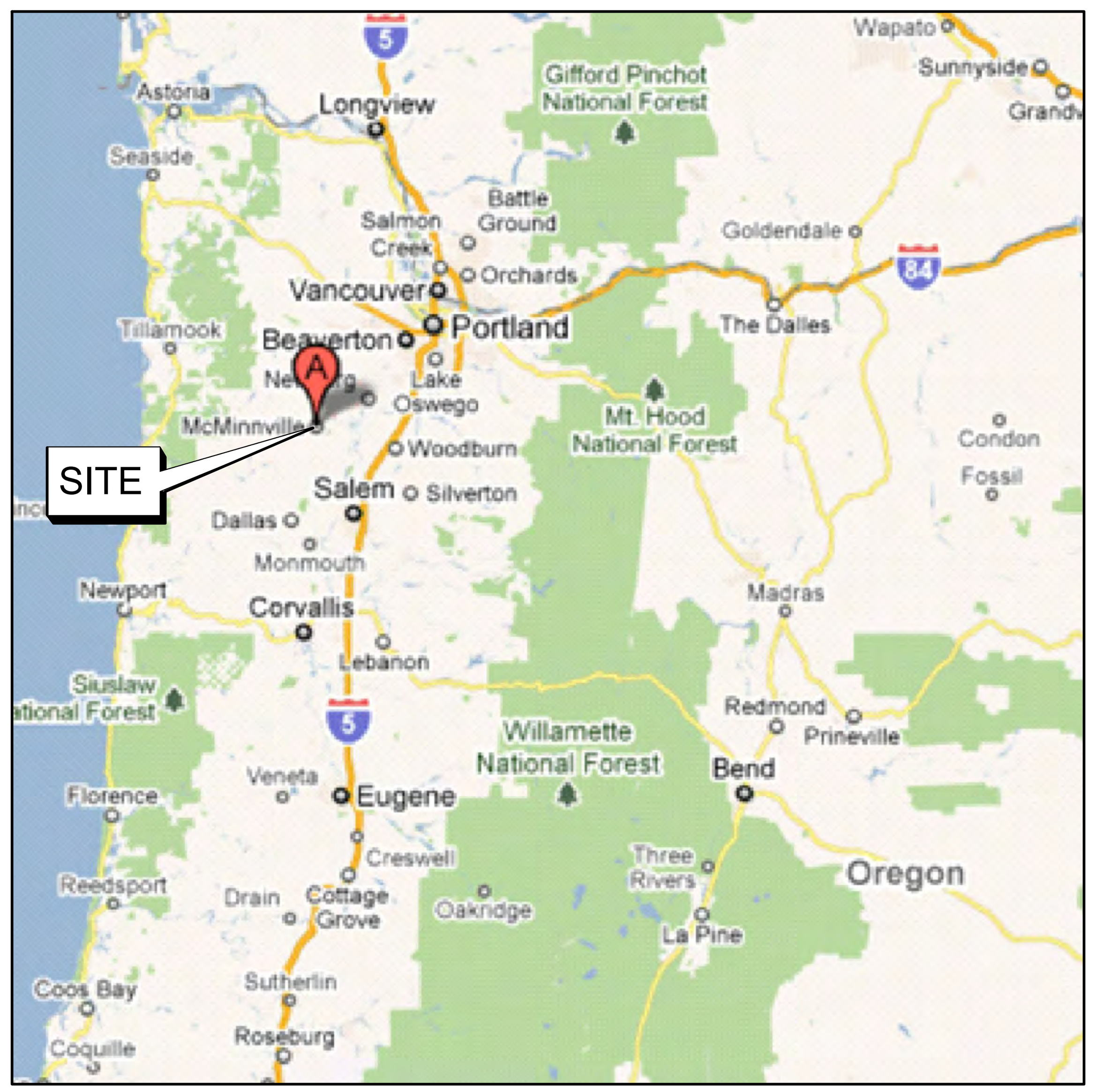


APPENDIX E

Drawings

FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN DRAWINGS RIVERBEND LANDFILL McMINNVILLE, OREGON

DECEMBER 2022

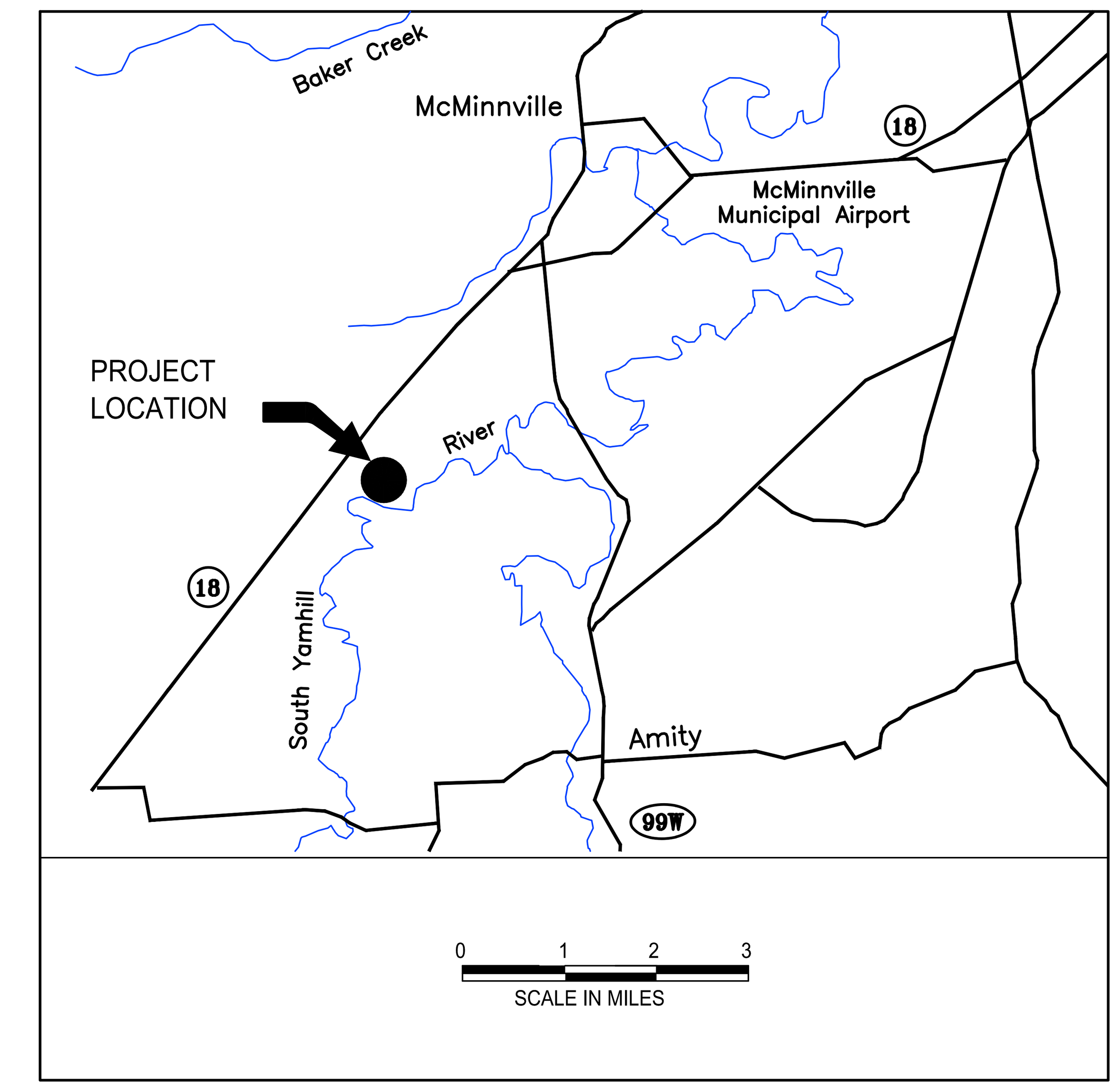


SOURCE: BY GOOGLE MAPS.

VICINITY MAP
NOT TO SCALE

DRAWING INDEX

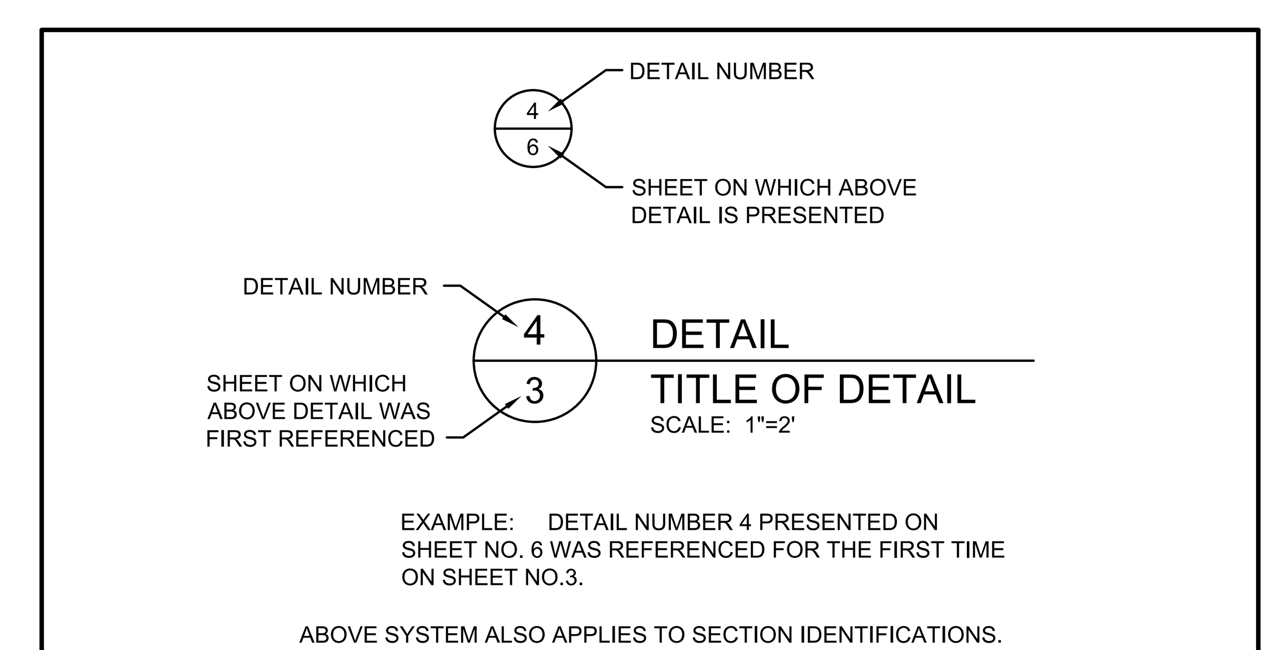
SHEET NUMBER	SHEET TITLE
1	COVER AND INDEX SHEET
2	NOTES & ABBREVIATIONS
3	GENERAL SITE AND FINAL GRADING PLAN
4	DETAILS – COVER SYSTEMS
5	DETAILS – ACCESS ROADS AND CLOSURE TERMINATIONS
6	DETAILS – ACCESS ROADS
7	DETAILS – ROAD CROSSING AND NORTH POND INLET SWALE
8	DETAILS – PHASE I FGPM BERM TERMINATION
9	SURFACE WATER DRAINAGE PLAN
10	SURFACE WATER SCHEMATIC FLOW DIAGRAM
11	CULVERT PLAN
12	CULVERT PROFILES
13	DETAILS – CULVERT-7
14	DETAILS – SPLASH WALL AND TRENCH
15	DETAILS – DROP HEADWALL AND DROP INLET
16	DETAILS – HEADWALL AND APRON
17	DETAILS – DROP INLET, TRASH RACK, AND ROAD DITCH
18	DETAILS – DOWNCHUTE
19	DETAILS – HYDROTURF CS SYSTEM



LOCATION MAP
NOT TO SCALE

PREPARED FOR:

RIVERBEND LANDFILL CO.
13469 HIGHWAY 18
McMINNVILLE, OREGON 97128



DETAIL IDENTIFICATION LEGEND

(1in) (2in) (3in) (4in)
SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

NOT FOR BID OR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP
A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION, UNLESS SEALED.
SIGNATURE
DATE

DESIGN BY: YMC
DRAWN BY: BEG
CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: COVER AND INDEX SHEET
PROJECT: 2022 FINAL CLOSURE
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P001
DRAWING NO.: 1 OF 19

GENERAL NOTES

1. BASE MAP, SURVEY CONTROL POINTS, AND EXISTING TOPOGRAPHY FROM CAD FILE "6FINAL GRADING PLAN.DWG" OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS BY VISTA GEOENVIRONMENTAL SERVICES, OF LAKE OSWEGO, OREGON, DATED MAY 2022. AS THE SITE IS AN ACTIVE LANDFILL, TOPOGRAPHY MAY HAVE CHANGED SINCE THE SURVEY DATE SHOWN.
2. NORTHINGS, EASTINGS, AND ELEVATIONS ARE IN LOCAL COORDINATE SYSTEM AS DETERMINED BY LELAND A. MACDONALD AND ASSOCIATES, LLC, MCMINNVILLE, OREGON. TO CONVERT FROM NAVD88 TO LOCAL ELEVATIONS, SUBTRACT 2.78 FEET FROM NAVD88 ELEVATIONS. VERTICAL AND HORIZONTAL SITE DATUM IS LOCAL, PROVIDED BY LELAND A. MACDONALD AND ASSOCIATES, LLC, MCMINNVILLE, OREGON.
3. REFER TO INDIVIDUAL SHEETS FOR DRAWING-SPECIFIC NOTES AND LEGEND.
4. THIS DRAWING SET IS DEVELOPED FOR THE PERMITTING OF THE FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN AND SHALL NOT BE USED FOR BIDDING OR CONSTRUCTION PURPOSES. THIS DRAWING SET WAS DEVELOPED BY ADAPTING THE FOLLOWING PREVIOUS DESIGN/AS-BUILT DRAWINGS: (I) "RIVERBEND LANDFILL TIER II CORRECTIVE ACTION RESPONSE," PREPARED BY GEO-LOGIC ASSOCIATES, DATED 9 JUNE 2017; (II) "RIVERBEND LANDFILL NORTHERN STORMWATER POND," PREPARED BY GEO-LOGIC ASSOCIATES, DATED 19 SEPTEMBER 2017; (III) "FINAL CLOSURE DRAWINGS, RIVERBEND LANDFILL," PREPARED BY GEOSYNTEC CONSULTANTS, DATED OCTOBER 2017; (IV) "RIVERBEND LANDFILL TOP DECK DRAINAGE SYSTEM," PREPARED BY GEO-LOGIC ASSOCIATES, DATED 6 SEPTEMBER 2018; (V) "2019 NORTH AND EAST FINAL CLOSURE RIVERBEND LANDFILL," PREPARED BY GEOSYNTEC CONSULTANTS, DATED APRIL 2019; AND (VI) "2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS FOR RIVERBEND LANDFILL," PREPARED BY VISTA GEOENVIRONMENTAL SERVICES, DATED MAY 2022. THE CAD FILES OF THE ABOVE-LISTED DRAWINGS THAT WERE NOT GENERATED BY GEOSYNTEC CONSULTANTS ARE PROVIDED BY RIVERBEND LANDFILL CO.

SURVEY NOTES

1. SURVEY CONTROL POINT INFORMATION IS ADAPTED FROM THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS FOR RIVERBEND LANDFILL, MCMINNVILLE, OR, PREPARED BY VISTA GEOENVIRONMENT SERVICES, DATED MAY 2022. SURVEY PROVIDED BY LELAND A. MACDONALD AND ASSOCIATES, LLC (LMA), MCMINNVILLE, OREGON. THE DRAWINGS ARE IN LOCAL COORDINATE SYSTEM AS ESTABLISHED BY LMA. SEE LATIMER ENVIRONMENTAL, INC., 4/3/2015 TECHNICAL MEMORANDUM FOR ADDITIONAL DETAILS.
2. THE EXISTING TOPOGRAPHY IS BASED ON AN AERIAL SURVEY PERFORMED BY MILLER CREEK ASSOCIATES (SEATAC, WASHINGTON) ON 2022-01-27. TOPOGRAPHY MAY HAVE CHANGED SINCE THE AERIAL SURVEY.

ABBREVIATIONS

2D	2-DIMENSIONAL
3D	3-DIMENSIONAL
AASHTO	AMERICAN ASSOCIATION OF HIGHWAY AND TRANSPORTATION OFFICIALS
AC	ASPHALT CONCRETE
ACB	ARTICULATED CONCRETE BLOCK
APWA	AMERICAN PUBLIC WORKS ASSOCIATION
ASTM	AMERICAN SOCIETY FOR TESTING AND MATERIALS
CO	CLEANOUT
CF	CUBIC FEET
CL	CONSTRUCTION LINE OR CENTERLINE
CMP	CORRUGATED METAL PIPE
CPP	CONCRETE PRESSURE PIPE
CY	CUBIC YARDS
DIA or Ø	DIAMETER
DMS	DEGREES / MINUTES / SECONDS
DWG	DRAWING
E	EAST/EASTING
ECB	EROSION CONTROL BLANKET
ECM	EROSION CONTROL MATTING
ELEV or EL	ELEVATION
ESC	EROSION & SEDIMENT CONTROL
EX	EXISTING
FT	FOOT OR FEET
FG	FINISHED GRADE
FGPM	FINAL GRADING PLAN MODIFICATION
H OR h	HEIGHT
HDPE	HIGH-DENSITY POLYETHYLENE
HORIZ	HORIZONTAL
H:V	HORIZONTAL:VERTICAL
HP	HIGH POINT
ID	INSIDE DIAMETER
I	INCHES
INV	INVERT
L	LENGTH
LF	LINEAR FEET
LP	LOW POINT
LFG	LANDFILL GAS
LCRS	LEACHATE COLLECTION & REMOVAL SYSTEM
LDS	LEAK DETECTION SYSTEM
LLDPE	LINEAR LOW-DENSITY POLYETHYLENE
MAX	MAXIMUM
MH	MANHOLE
MIL	UNIT OF MEASURE OF THICKNESS
MIN	MINIMUM
MSE	MECHANICALLY STABILIZED EARTH
MSW	MUNICIPAL SOLID WASTE
MW	MONITORING WELL
N	NORTH/NORTHING
NAD	NORTH AMERICAN DATUM
NAVD	NORTH AMERICAN VERTICAL DATUM
NGVD	NATIONAL GEODETIC VERTICAL DATUM
NIC	NOT IN CONTRACT
NO	NUMBER
OC	ON CENTER
OD	OUTSIDE DIAMETER
ODOT	OREGON DEPARTMENT OF TRANSPORTATION
OZ	OUNCE
PID	POINT IDENTIFICATION
PSI	POUNDS PER SQUARE INCH
RCP	REINFORCED CONCRETE PIPE
S	SLOPE IN FEET/FOOT
SDR	STANDARD DIMENSION RATIO
SF	SQUARE FEET
SPEC	SPECIFICATION
SQ IN	SQUARE INCHES
STA	STATION
TF	TOP OF FOOTING
TW	TOP OF WALL
TYP	TYPICAL
UTM	UNIVERSAL TRANSVERSE MERCATOR
VERT	VERTICAL

SURVEY CONTROL POINTS (IN FEET)

PID	NAD 83/91				NAVD88	RLC LOCAL DATUM			UTM ZONE 10		NGVD29	
Point#	Northing	Easting	Latitude (DMS)	Longitude (DMS)	Elevation	Northing	Easting	Elevation	Northing	Easting	Elevation	Description
1	558,022.4942	7,492,117.4138	N45°09'50.78512"	W123°15'11.83095"	154.51	4,000.0000	4,000.0000	151.80	5,000,994.7360	480,093.6380	151.50	1"IP WYPC Rydell
16	557,619.3982	7,494,514.5173	N45°09'47.61220"	W123°14'38.20049"	148.86	3,625.0064	6,401.9419	146.21	5,000,894.5660	480,827.5360	145.91	5/8" Iron Rod
26	558,490.3382	7,492,030.5173	N45°09'55.37289"	W123°15'13.26567"	150.89	4,466.8460	3,907.6111	148.14	5,001,136.4050	480,062.7610	147.84	IPBC WTNSSCOR
52	556,848.3945	7,492,103.6409	N45°09'39.19363"	W123°15'11.46472"	150.17	2,825.6850	4,000.0000	147.42	5,000,637.0180	480,100.5120	147.12	1"IP WYPC Rydell
102	556,095.9500	7,492,468.6200	N45°09'31.89073"	W123°15'06.01597"	156.71	2,077.4643	4,373.8656	153.93	5,000,411.2920	480,218.7700	153.63	dea cp#3 MAGNAIL
107	557,947.3061	7,493,204.1834	N45°09'50.40847"	W123°14'56.63493"	157.52	3,937.5575	5,087.7013	154.77	5,000,982.0820	480,425.3490	154.47	HUB&MINI MAG
114	558,543.7562	7,492,600.7989	N45°09'56.09188"	W123°15'05.33553"	145.78	4,526.9565	4,477.2921	143.03	5,001,158.0500	480,235.9500	142.73	MAGSPIKE
115	558,429.1092	7,492,325.2027	N45°09'54.86778"	W123°15'09.12565"	151.57	4,409.0711	4,203.0283	148.82	5,001,120.5350	480,153.0920	148.52	MAGNAIL
139	556,076.6536	7,491,952.5210	N45°09'31.52670"	W123°15'13.20564"	155.78	2,052.1359	3,857.9266	153.03	5,000,400.5500	480,061.7610	152.73	MAG NAIL CONC
200	558,104.4741	7,493,141.0873	N45°09'51.93832"	W123°14'57.58975"	150.82	4,093.9925	5,022.7586	148.13	5,001,029.3550	480,404.6500	147.83	BC LMAC IN CONC
201	558,424.2600	7,492,319.4477	N45°09'54.81799"	W123°15'09.20362"	152.10	4,404.1542	4,197.3299	149.36	5,001,119.0040	480,151.3850	149.06	1" COP PLUG TC
202	557,150.8318	7,490,747.5591	N45°09'41.72162"	W123°15'30.52487"	152.27	3,112.2276	2,640.3082	149.52	5,000,716.3450	479,684.6330	149.22	1" COP PLUG AC
203	557,803.1151	7,494,517.0244	N45°09'49.42610"	W123°14'38.25259"	128.93	3,808.7611	6,402.2939	126.18	5,000,950.5430	480,826.5670	125.88	BC LMAC IN CONC
204	555,566.1101	7,494,366.6736	N45°09'27.29924"	W123°14'39.28957"	127.78	1,569.8900	6,278.1790	125.10	5,000,267.8160	480,801.8650	124.80	DEA BC CP#4 (2012)
205	556,209.4268	7,494,484.4681	N45°09'33.68747"	W123°14'37.95141"	129.50	2,214.6180	6,388.4320	126.83	5,000,464.8570	480,831.6760	126.53	DEA BC CP#5 (2012)
206	556,659.1342	7,495,105.4663	N45°09'38.33366"	W123°14'29.50218"	129.40	2,671.6310	7,004.1830	126.72	5,000,607.6760	481,016.5770	126.42	1"COPPER/CONC
207	558,562.3338	7,490,227.7811	N45°09'55.47601"	W123°15'38.44842"	156.27	4,517.6966	2,103.9479	153.48	5,001,141.3370	479,513.0140	153.18	BC DLC COR -1.0
208	558,522.6173	7,492,101.2182	N45°09'55.71523"	W123°15'12.29474"	152.12	4,499.9559	3,977.9366	149.36	5,001,146.9020	480,083.9900	149.06	P1< DEA#8
209	557,235.3787	7,488,825.3018	N45°09'41.90716"	W123°15'57.37916"	155.48	3,174.2281	716.9712	152.73	5,000,723.9730	479,098.3640	152.43	1" COP PLUG TC
210	555,740.8282	7,488,905.1130	N45°09'27.18492"	W123°15'55.55198"	155.38	1,680.5455	814.3189	152.68	5,000,269.5400	479,136.7630	152.38	1" COP PLUG TC
211	555,370.4127	7,490,553.9909	N45°09524.08596"	W123°15532.37653"	152.72	1,329.4563	2,467.6176	150.00	5,000,172.2690	479,642.4630	149.70	DEA CP#11
212	553,547.1330	7,494,621.7087	N45°09'07.45994"	W123°14'34.77576"	155.36	-446.1876	6,556.9107	152.61	4,999,655.3140	480,898.5770	152.31	DEA BC CP#12
213	554,485.3500	7,492,087.1191	N45°09'15.86786"	W123°15'10.57156"	130.99	462.3386	4,011.1988	128.24	4,999,917.1660	480,117.7590	127.94	DEA BC CP#13
214	555,029.8737	7,490,223.0957	N45°09'20.61370"	W123°15'36.82952"	150.16	985.0199	2,140.7022	147.47	5,000,065.4340	479,544.8910	147.17	1" COPPER/CONC
215	554,636.5746	7,489,850.7170	N45°09'16.60672"	W123°15'41.83579"	151.23	587.3345	1,772.9203	148.53	4,999,942.1390	479,435.1820	148.23	1" COPPER/CONC
218	561,102.8626	7,490,315.9113	N45°10520.57737"	W123°15138.43049"	155.69	7,059.3755	2,162.2787	152.83	5,001,915.9200	479,515.9040	152.53	BC YCGPS #27
224	555,388.0171	7,489,045.8214	N45°09'23.75068"	W123°15'53.42087"	154.02	1,329.3689	959.1726	151.30	5,000,163.4130	479,182.9460	151.00	PK DEA CP#24
453	555,963.2247	7,491,968.5732	N45°09'30.41270"	W123°15'12.92779"	156.20	1,938.8902	3,875.3102	153.45	5,000,366.1540	480,067.7200	153.15	BS & WASHER
456	556,056.6742	7,492,448.9009	N45°09'31.49650"	W123°15'06.27236"	156.47	2,037.9788	4,354.5636	153.72	5,000,399.1440	480,213.1340	153.42	BS & WASHER

NOTE:
THE SURVEY CONTROL POINT INFORMATION IS ADAPTED FROM THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS FOR RIVERBEND LANDFILL, MCMINNVILLE, OR, PREPARED BY VISTA GEOENVIRONMENT SERVICES, DATED MAY 2022.

NOT FOR BID OR CONSTRUCTION

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

REV	DATE	DESCRIPTION	DRN	APP
A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

THIS DRAWING MAY NOT BE ISSUED FOR PROJECT TENDER OR CONSTRUCTION UNLESS SEALED.

SIGNATURE / DATE

DESIGN BY: YMC
DRAWN BY: BEG
CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: NOTES & ABBREVIATIONS
PROJECT: 2022 FINAL CLOSURE
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P002
DRAWING NO.: 2 OF 19

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LEGEND

- 120 — EXISTING 10-FOOT CONTOUR
- 120 — PROPOSED 10-FOOT CONTOUR
- APPROXIMATE MODULE BOUNDARY
- LIMIT OF WASTE
- PROPOSED ACCESS ROAD
- #16 △ EXISTING SURVEY CONTROL POINT (SEE NOTE 5)
- PREVIOUSLY CLOSED AREA (27.9 ACRES)

NOTES:

1. BASE MAP, SURVEY CONTROL POINTS, AND EXISTING TOPOGRAPHY FROM CAD FILE "6 FINAL GRADING PLAN.DWG" OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS BY VISTA GEOENVIRONMENTAL SERVICES, OF LAKE OSWEGO, OREGON, DATED MAY 2022.
2. MODULE BOUNDARIES FROM CAD FILE "2-4 NOTES & SITE PLAN.DWG" OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS BY VISTA GEOENVIRONMENTAL SERVICES, OF LAKE OSWEGO, OREGON, DATED MAY 2022.
3. THE PROPOSED FINAL GRADES WITHIN THE GRAY BOUNDARY OBTAINED FROM CAD FILE "6 FINAL GRADING PLAN.DWG" OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS, BY VISTA GEOENVIRONMENTAL SERVICES, OF LAKE OSWEGO, OREGON, DATED MAY 2022.
4. THE PROPOSED FINAL GRADES WITHIN AREA TO BE CLOSED OUTSIDE THE GRAY BOUNDARY OBTAINED FROM CAD FILE "2423-LF-02.DWG" OF THE 2017 FINAL CLOSURE DRAWINGS, BY GEOSYNTEC CONSULTANTS, OF ACTON, MASSACHUSETTS, DATED OCTOBER 2017.
5. NORTHING, EASTING, AND ELEVATIONS ARE IN LOCAL COORDINATE SYSTEM AS DETERMINED BY LELAND A. MACDONALD AND ASSOCIATES, LLC, MCMINNVILLE, OREGON. TO CONVERT FROM NAVD88 TO LOCAL ELEVATIONS, SUBTRACT 2.78 FEET FROM NAVD88 ELEVATIONS. SEE SHEET 2 FOR DETAILED SURVEY INFORMATION AND SURVEY CONTROL POINTS.
6. THE REMAINING DEVELOPED AREA THAT WOULD REQUIRE CLOSURE UNDER A WORST-CASE SCENARIO IS APPROXIMATELY 59.5 ACRES. THE PREVIOUSLY CLOSED AREA IS 27.9 ACRES.

0 150 300
SCALE IN FEET

NOT FOR BID OR CONSTRUCTION

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A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

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DRAWN BY:	BEG
CHECKED BY:	YMC
REVIEWED BY:	DJB
APPROVED BY:	DJB

Geosyntec consultants
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ACTON, MA 01720
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TITLE: GENERAL SITE AND FINAL GRADING PLAN

PROJECT: 2022 FINAL CLOSURE

SITE: RIVERBEND LANDFILL CO.
MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P003
DRAWING NO.: 3 OF 19

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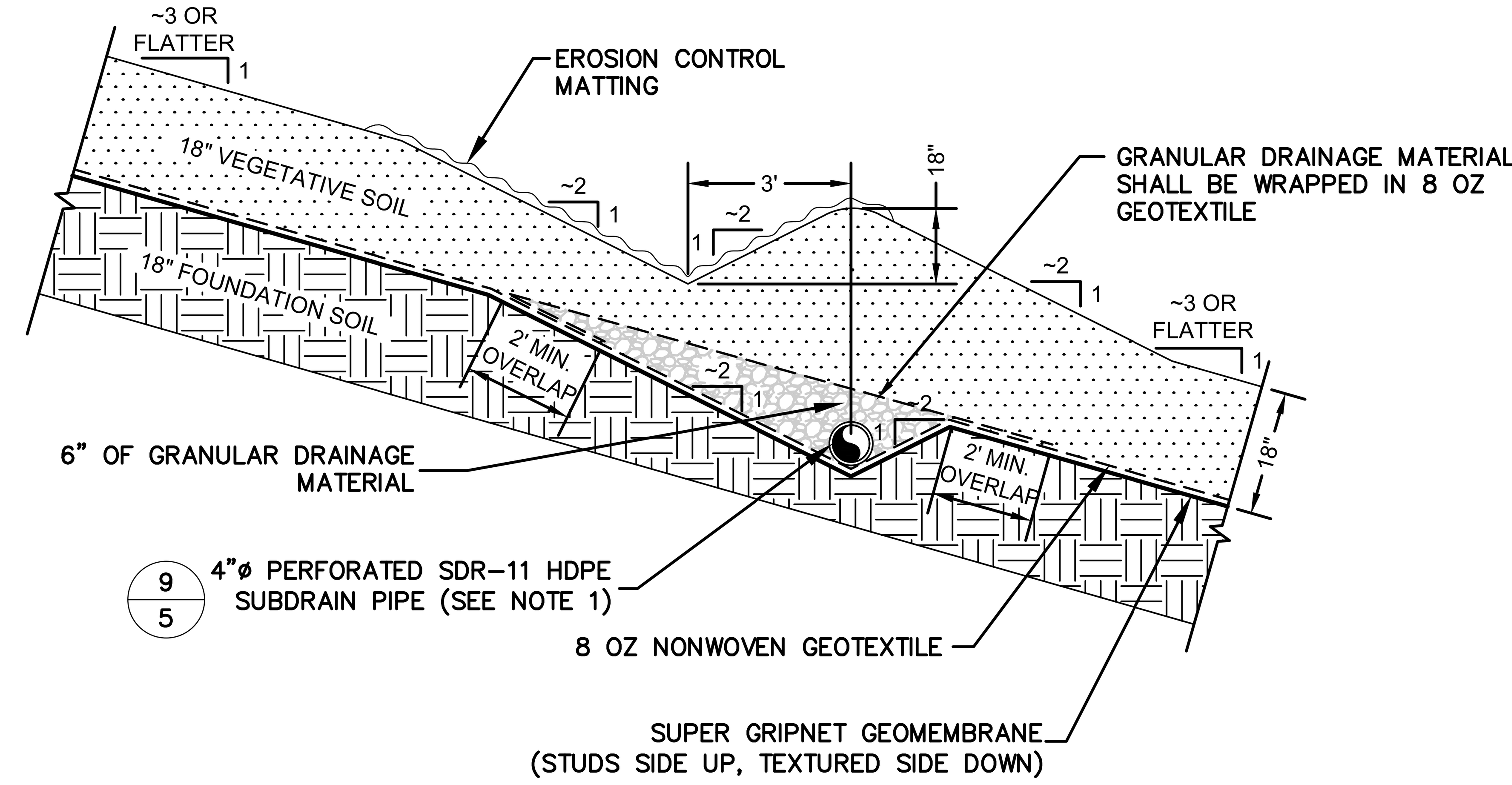
NOTES:

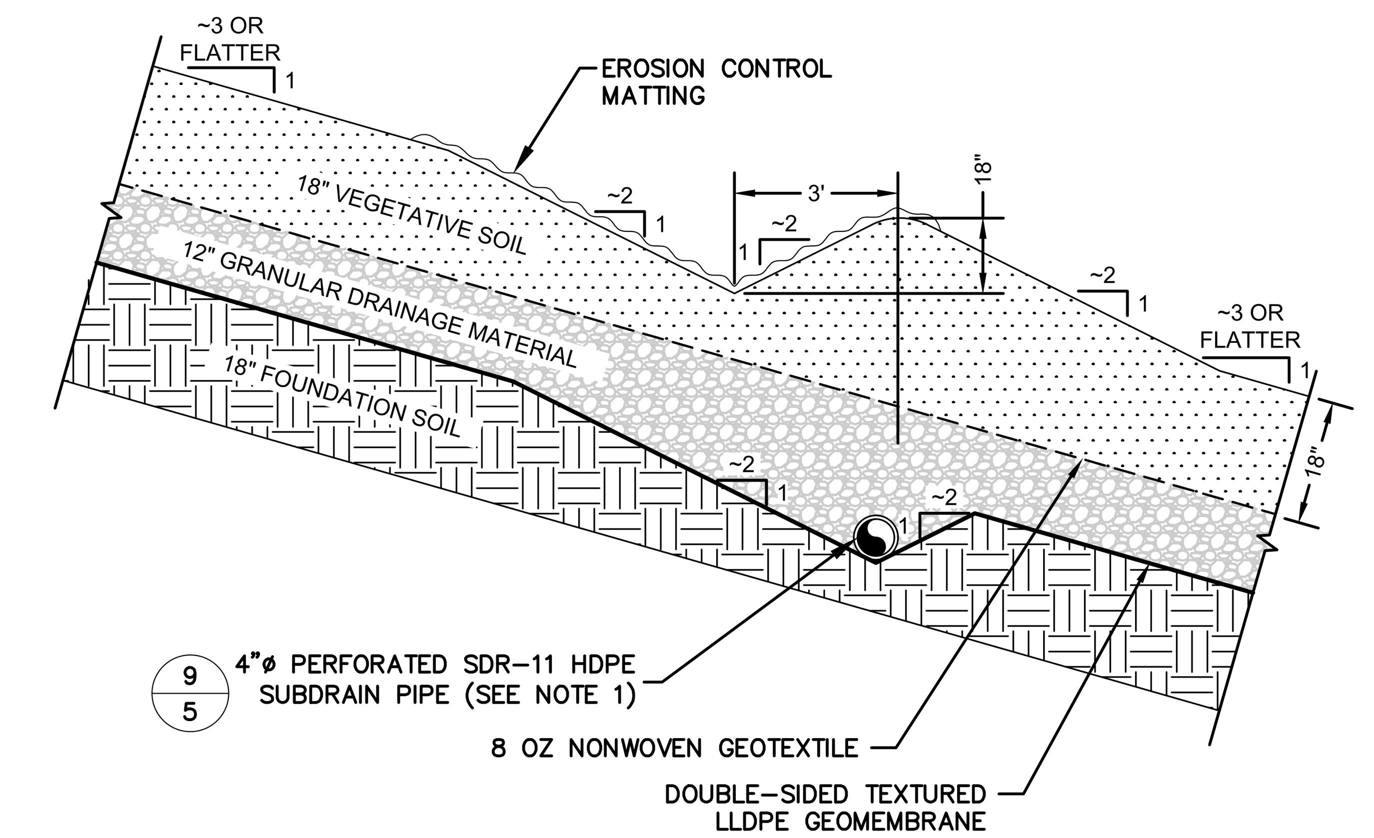
1. SUBDRAIN PERFORATED DRAINAGE PIPES SHALL BE SPACED A MAXIMUM OF 150 FEET MEASURED ALONG THE FINAL COVER SLOPE. PERFORATED PIPES SHALL BE CONNECTED TO SOLID DRAINAGE PIPES THAT WILL DISCHARGE TO EXISTING DITCH(ES) OR DOWNCHUTE(S).
2. EXISTING INTERIM COVER ABOVE MSW MAY ACCOUNT FOR A PORTION OF THE FOUNDATION SOIL LAYER THICKNESS.



1
9
FINAL COVER SYSTEM WITH DITCH (TYP)
NOT TO SCALE

NOTES:

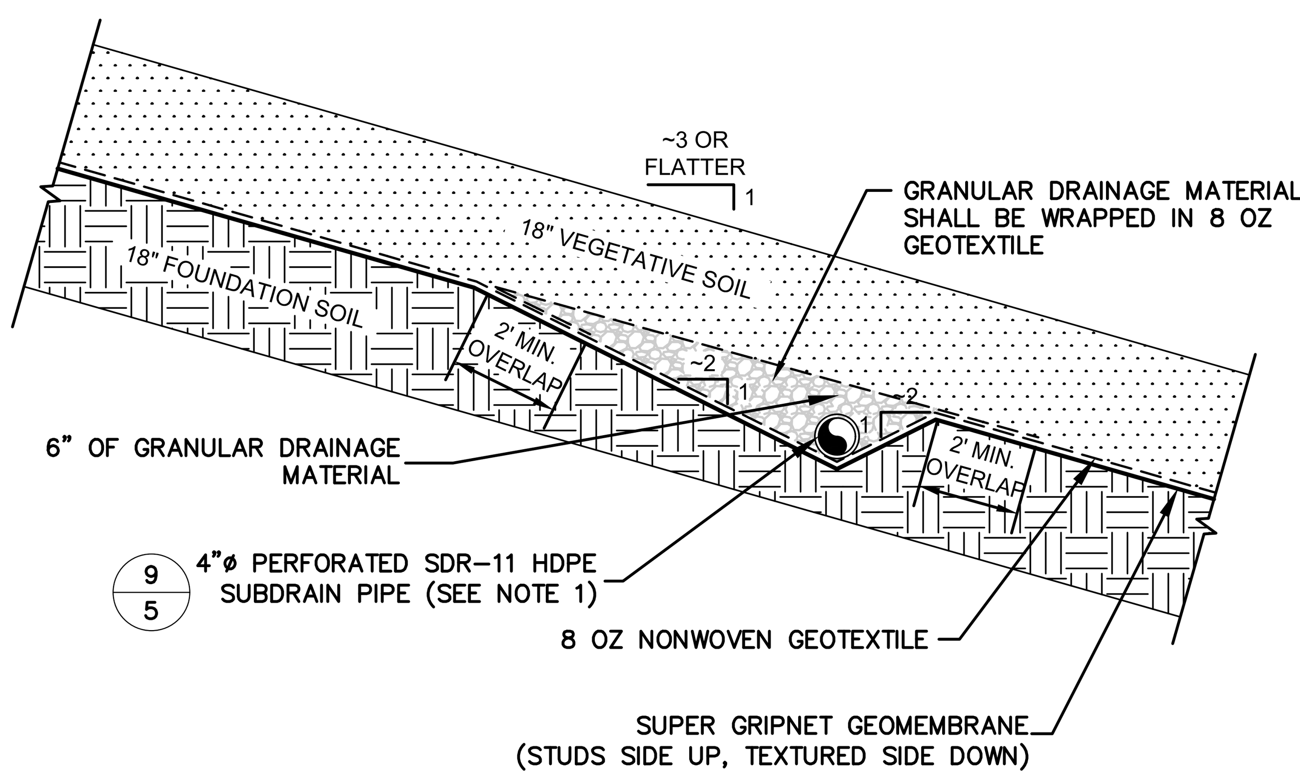
1. SUBDRAIN PERFORATED DRAINAGE PIPES SHALL BE SPACED A MAXIMUM OF 150 FEET MEASURED ALONG THE FINAL COVER SLOPE. PERFORATED PIPES SHALL BE CONNECTED TO SOLID DRAINAGE PIPES THAT WILL DISCHARGE TO EXISTING DITCH(ES) OR DOWNCHUTE(S).
2. EXISTING INTERIM COVER ABOVE MSW MAY ACCOUNT FOR A PORTION OF THE FOUNDATION SOIL LAYER THICKNESS.



2
9
FINAL COVER SYSTEM WITH DITCH (TYP)
NOT TO SCALE

NOTES:

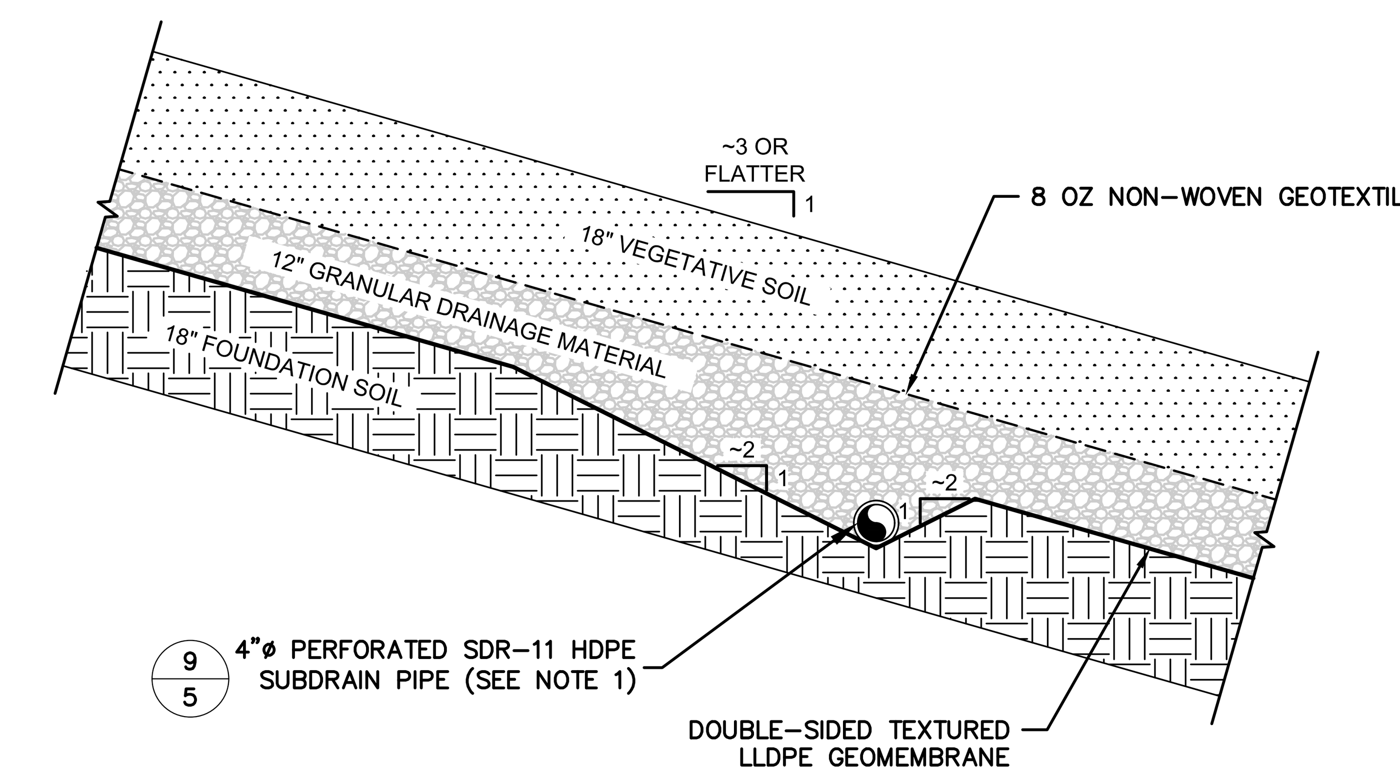
1. SUBDRAIN PERFORATED DRAINAGE PIPES SHALL BE SPACED A MAXIMUM OF 150 FEET MEASURED ALONG THE FINAL COVER SLOPE. PERFORATED PIPES SHALL BE CONNECTED TO SOLID DRAINAGE PIPES THAT WILL DISCHARGE TO EXISTING DITCH(ES) OR DOWNCHUTE(S).
2. EXISTING INTERIM COVER ABOVE MSW MAY ACCOUNT FOR A PORTION OF THE FOUNDATION SOIL LAYER THICKNESS.



3
9
FINAL COVER SYSTEM WITH SUBDRAIN (TYP)
NOT TO SCALE

NOTES:

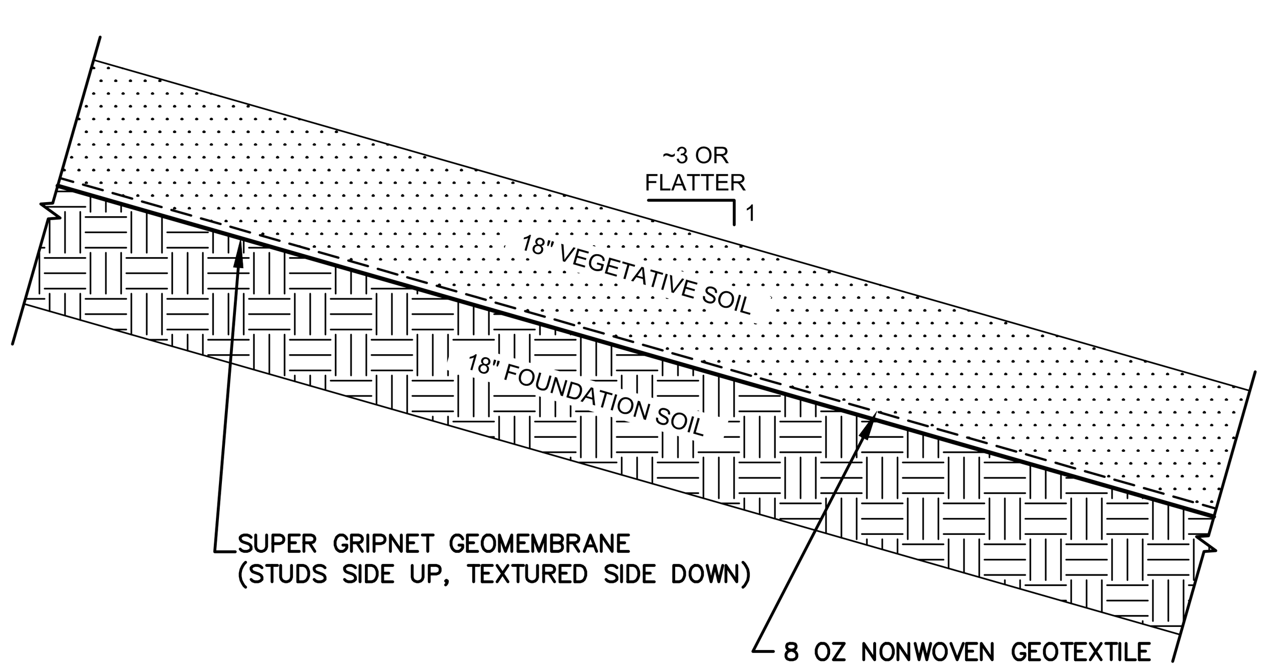
1. SUBDRAIN PERFORATED DRAINAGE PIPES SHALL BE SPACED A MAXIMUM OF 150 FEET MEASURED ALONG THE FINAL COVER SLOPE. PERFORATED PIPES SHALL BE CONNECTED TO SOLID DRAINAGE PIPES THAT WILL DISCHARGE TO EXISTING DITCH(ES) OR DOWNCHUTE(S).
2. EXISTING INTERIM COVER ABOVE MSW MAY ACCOUNT FOR A PORTION OF THE FOUNDATION SOIL LAYER THICKNESS.



4
9
FINAL COVER SYSTEM WITH SUBDRAIN (TYP)
NOT TO SCALE

NOTE:

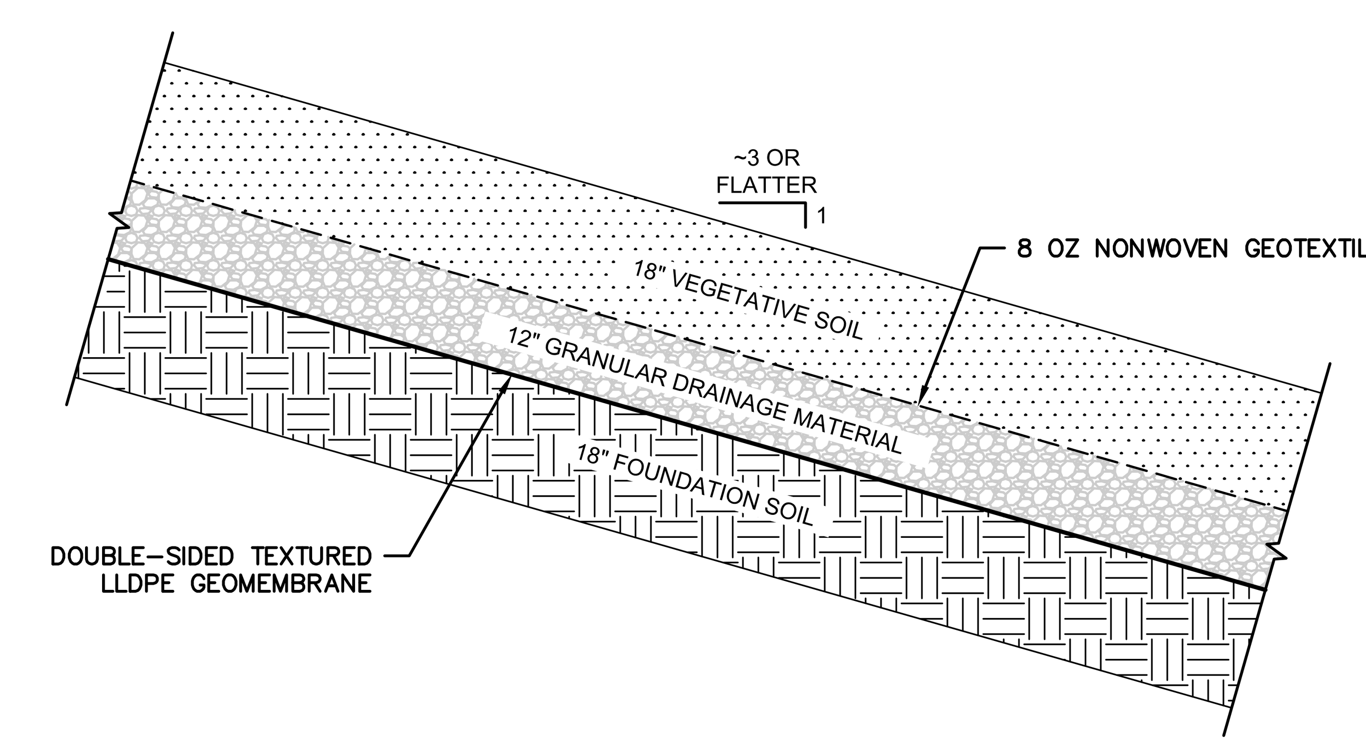
1. EXISTING INTERIM COVER ABOVE MSW MAY ACCOUNT FOR A PORTION OF THE FOUNDATION SOIL LAYER THICKNESS.



5
3
FINAL COVER SYSTEM (TYP)
NOT TO SCALE

NOTE:

1. EXISTING INTERIM COVER ABOVE MSW MAY ACCOUNT FOR A PORTION OF THE FOUNDATION SOIL LAYER THICKNESS.



6
3
FINAL COVER SYSTEM (TYP)
NOT TO SCALE

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

NOT FOR BID OR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP
A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

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SIGNATURE | DATE

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CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

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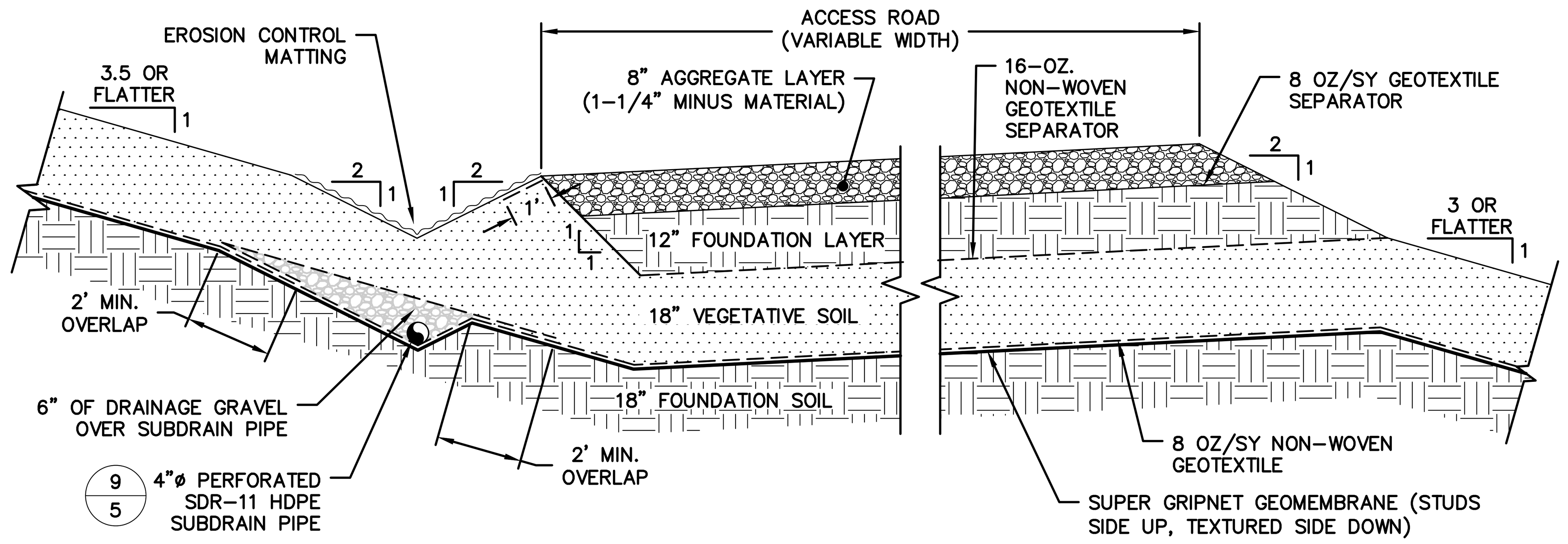
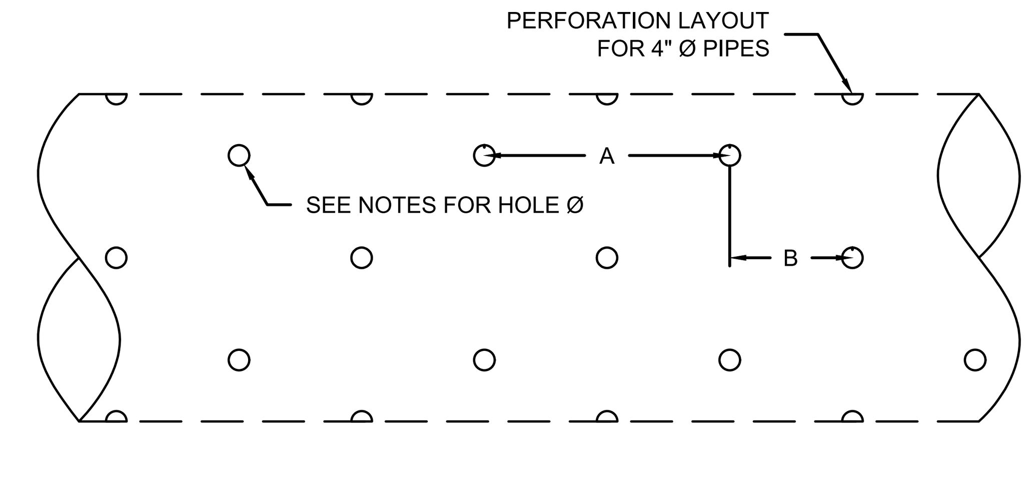
TITLE: DETAILS - COVER SYSTEMS
PROJECT: 2022 FINAL CLOSURE
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P004
DRAWING NO.: 4 OF 19



7/9 STORM WATER DITCH & SUBDRAIN TRENCH DETAIL ALONG ACCESS ROADS

NOT TO SCALE

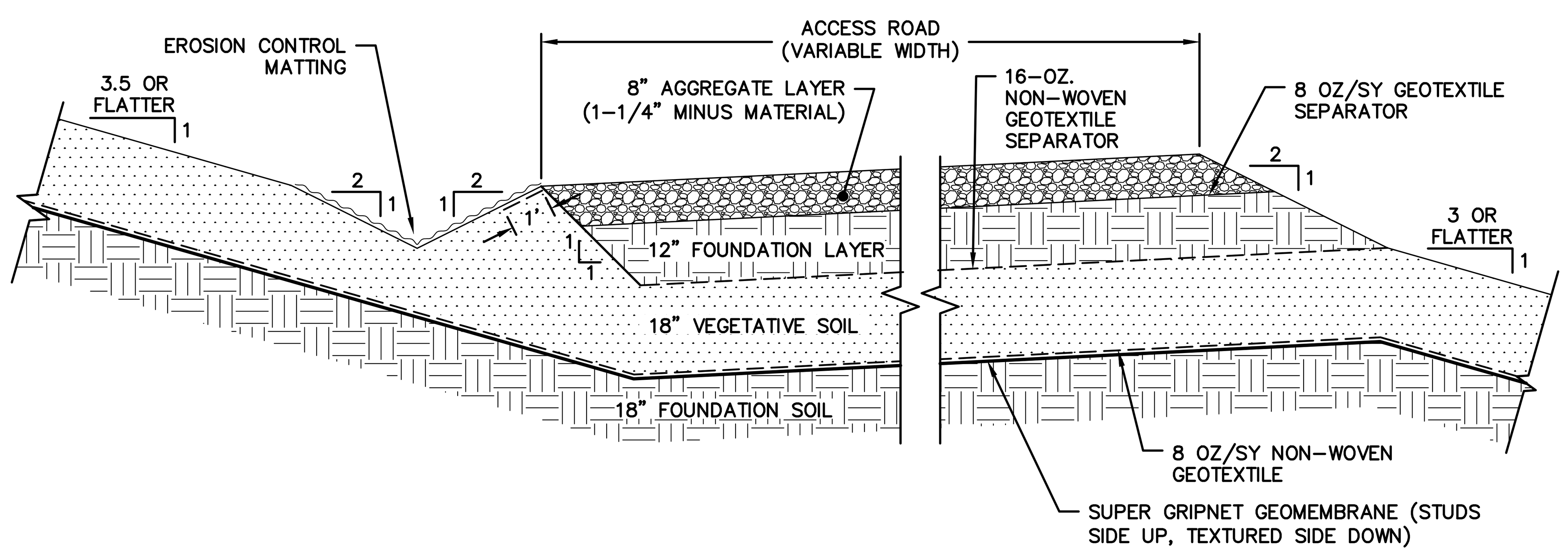


PERFORATED PIPE NOTES:

1. HOLE DIAMETER SHALL BE 3/8" FOR 4" Ø PERFORATED HDPE PIPES.
2. HOLES SHALL BE DRILLED AT 90° CIRCUMFERENCE AROUND PIPES. SUCCESSIVE ROWS SHALL BE SEPARATED BY 3" AND EVENLY STAGGERED.
3. A = 6" AND B = 3" FOR ALL PERFORATED PIPES.
4. CONTRACTOR IS RESPONSIBLE FOR REMOVING ANY MATERIALS DISCOVERED INSIDE PIPES.
5. PIPE WELDING TO BE PERFORMED IMMEDIATELY ADJACENT TO INSTALLATION LOCATION UNLESS APPROVED BY OWNER AND ENGINEER.
6. TEMPORARY CAPS TO BE PLACED OVER PIPE ENDS AT ALL TIMES.
7. DO NOT DRAG PIPES ACROSS SUBGRADE.

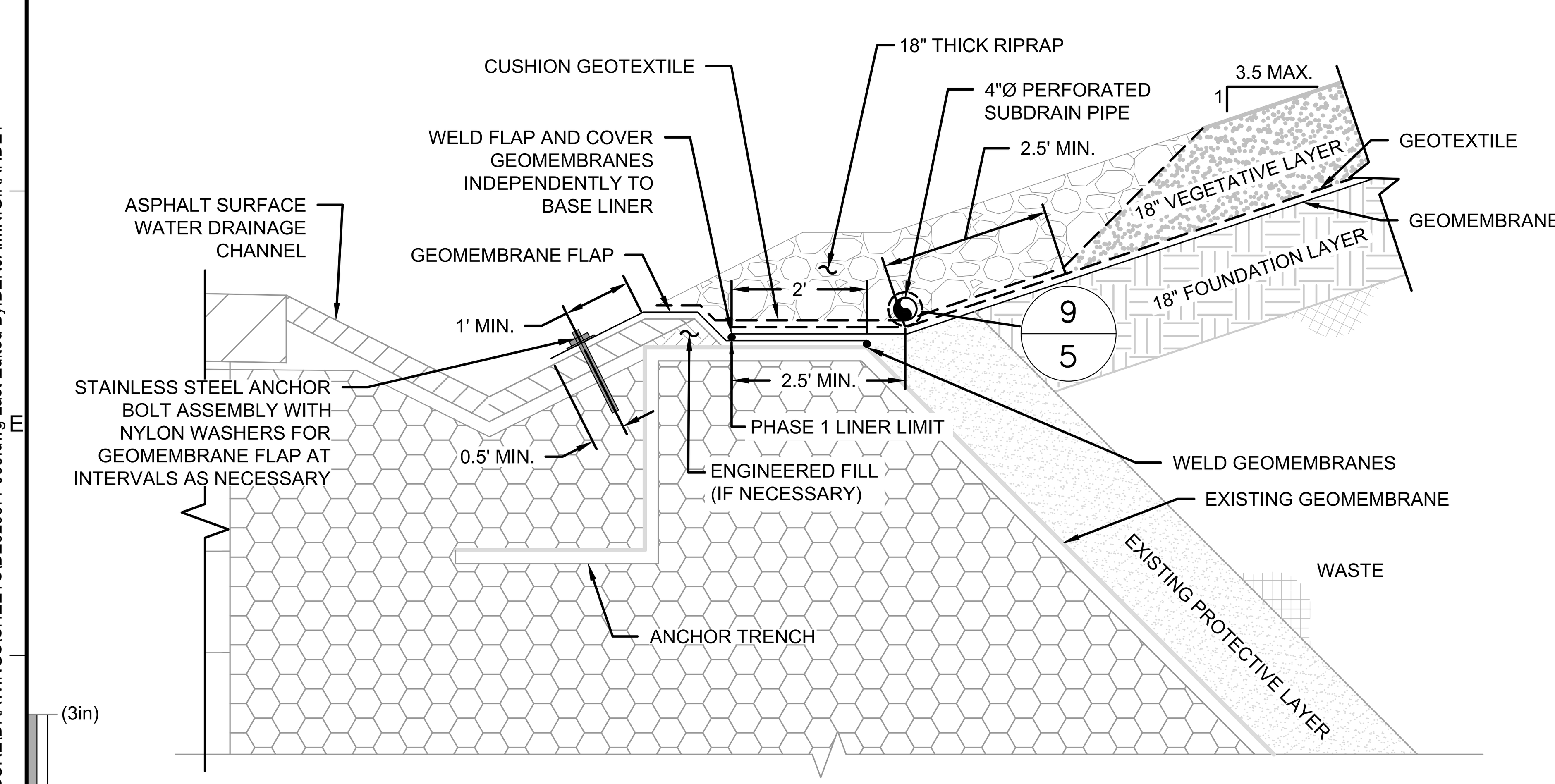
9/4 PERFORATED PIPE

NOT TO SCALE



8/9 PERMANENT ACCESS ROAD WITH DITCH

NOT TO SCALE

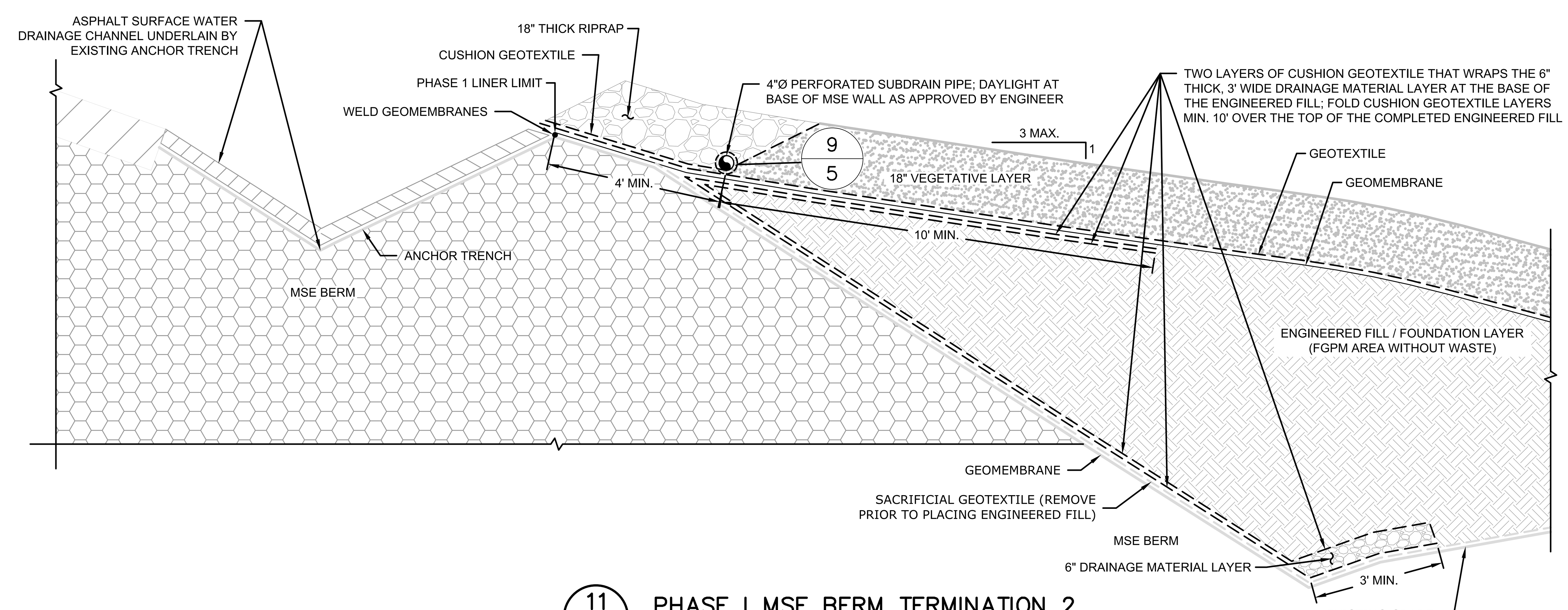


10/9 PHASE I MSE BERM TERMINATION 1

NOT TO SCALE

NOTE:

THIS DETAIL IS ADAPTED FROM CAD FILES OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS, VISTA GEOENVIRONMENTAL SERVICES, DATED MAY 2022.



11/9 PHASE I MSE BERM TERMINATION 2

NOT TO SCALE

NOTE:

THIS DETAIL IS ADAPTED FROM CAD FILES OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS, VISTA GEOENVIRONMENTAL SERVICES, DATED MAY 2022.

NOT FOR BID OR CONSTRUCTION

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

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DRAWN BY: BEG
CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

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289 GREAT ROAD, SUITE 202
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TITLE: DETAILS - ACCESS ROADS AND CLOSURE TERMINATIONS

PROJECT: 2022 FINAL CLOSURE

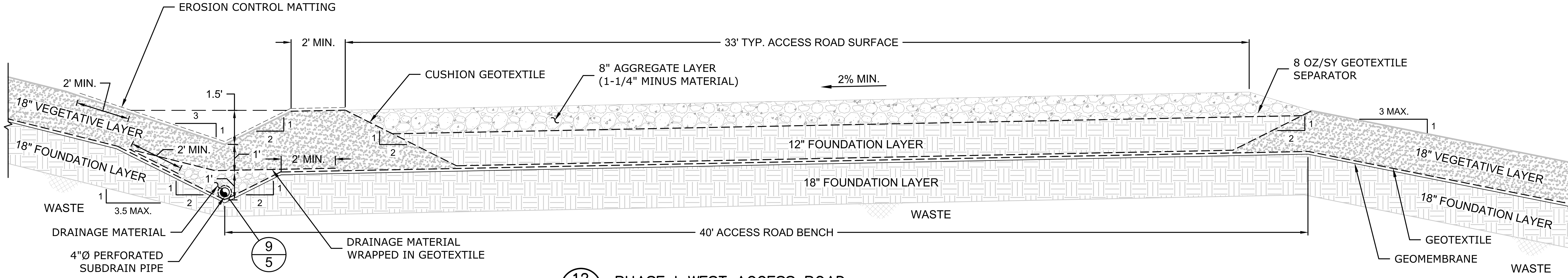
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022

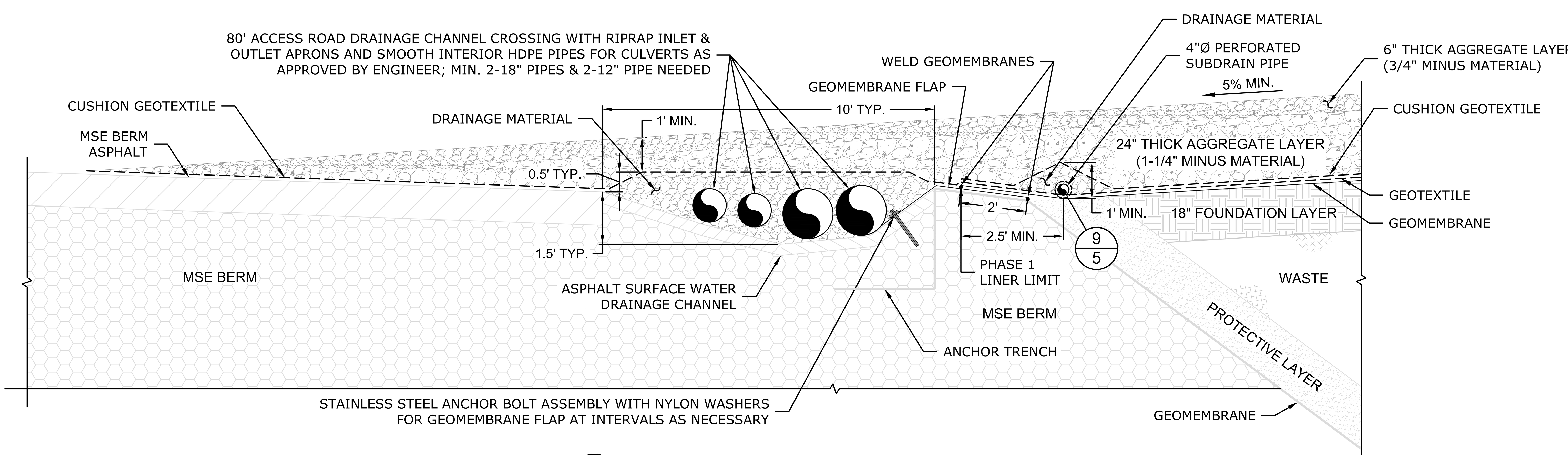
PROJECT NO.: BE0209I

FILE: BE0209I P005

DRAWING NO.: 5 OF 19



12 / 9 PHASE I WEST ACCESS ROAD & DRAINAGE CHANNEL (TYP)
NOT TO SCALE



13 / 9 PHASE I WEST ACCESS ROAD DRAINAGE CHANNEL CROSSING (TYP)
NOT TO SCALE

NOTE:

THE DETAILS ON THIS SHEET ARE ADAPTED FROM CAD FILES OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS, VISTA GEOENVIRONMENTAL SERVICES, DATED MAY 2022.

NOT FOR BID OR CONSTRUCTION

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

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A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

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DRAWN BY:	BEG
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REVIEWED BY:	DJB
APPROVED BY:	DJB

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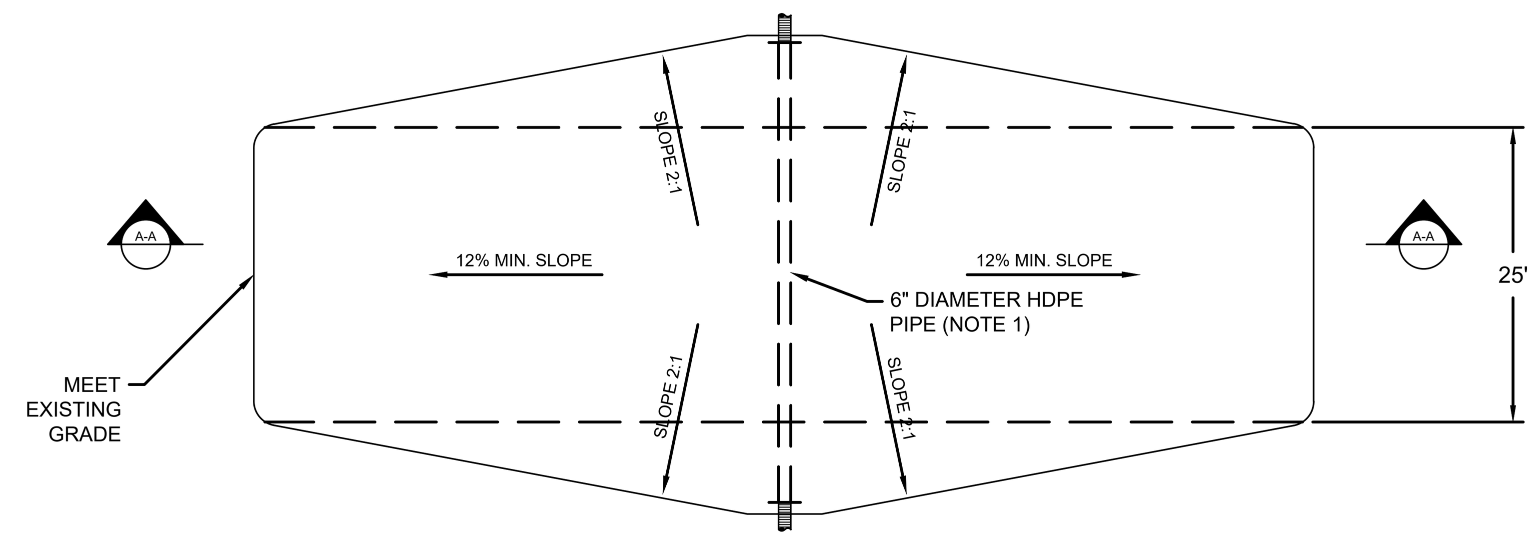
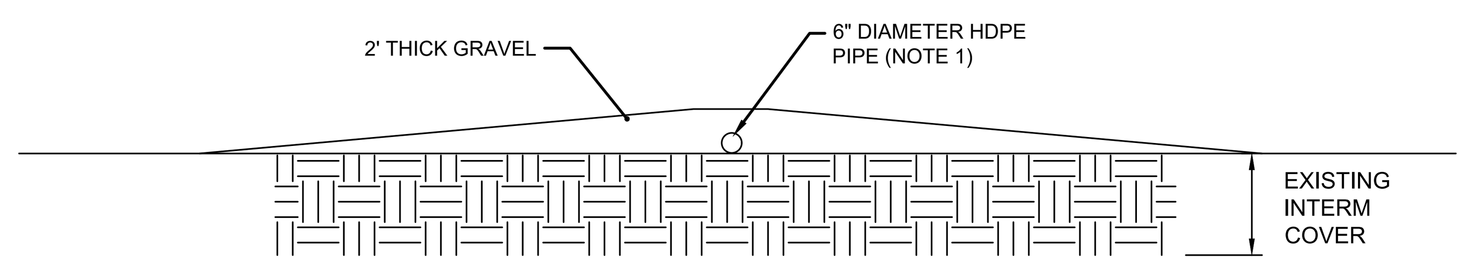
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: DETAILS - ACCESS ROADS
PROJECT: 2022 FINAL CLOSURE
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P006
DRAWING NO.: 6
6 OF 19



PLAN VIEW

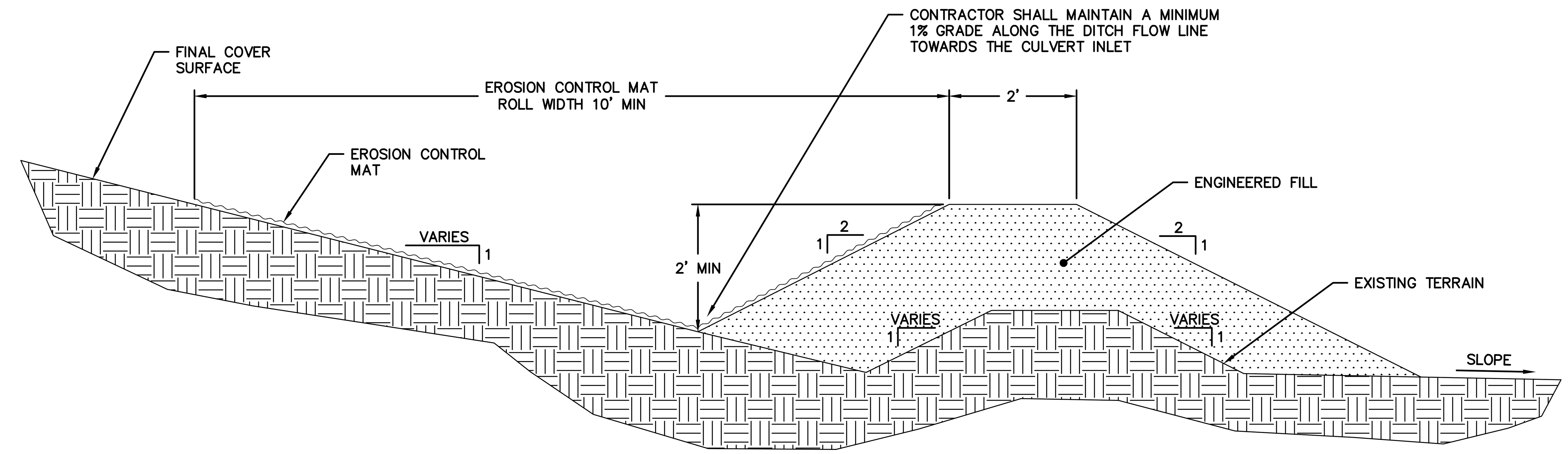


SECTION A–A

NOTE:

HDPE PIPE RATED FOR AASHTO H-20 LOADING.

14 / 9 **CULVERT ROAD CROSSING**
NOT TO SCALE



15 / 9 **NORTH POND INLET SWALE**
NOT TO SCALE

NOTE:

THIS DETAIL IS ADAPTED FROM THE RIVERBEND LANDFILL NORTHERN STORMWATER POND DRAWINGS, BY GEO–LOGIC ASSOCIATES, DATED 19 SEPTEMBER 2017.

(1in) (2in) (3in) (4in)
SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

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A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

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SIGNATURE / DATE

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DRAWN BY:	BEG
CHECKED BY:	YMC
REVIEWED BY:	DJB
APPROVED BY:	DJB

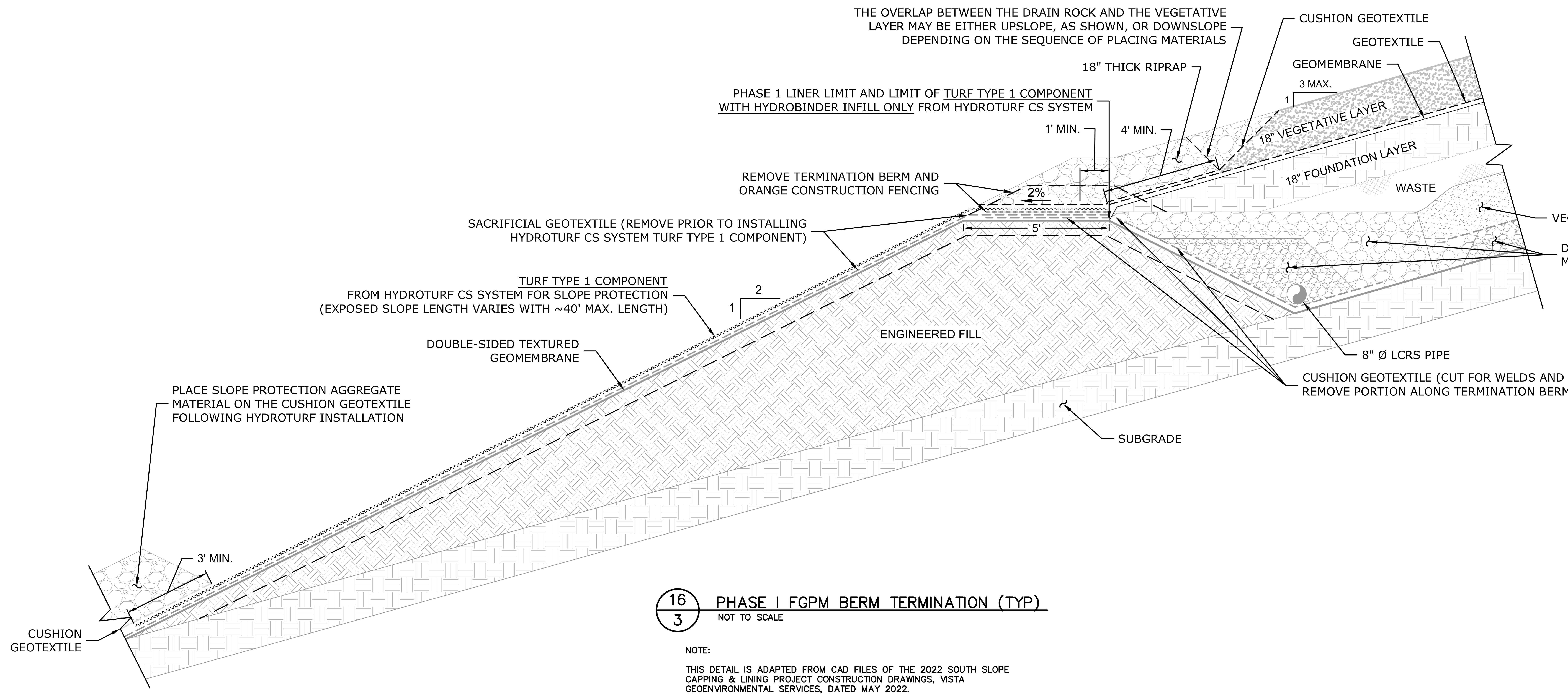
Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: DETAILS - ROAD CROSSING AND NORTH POND INLET SWALE

PROJECT: 2022 FINAL CLOSURE

SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P007
DRAWING NO.: 7 OF 19



16 / 3 PHASE I FGPM BERM TERMINATION (TYP)

NOT TO SCALE

NOTE:

THIS DETAIL IS ADAPTED FROM CAD FILES OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS, VISTA GEOENVIRONMENTAL SERVICES, DATED MAY 2022.

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CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

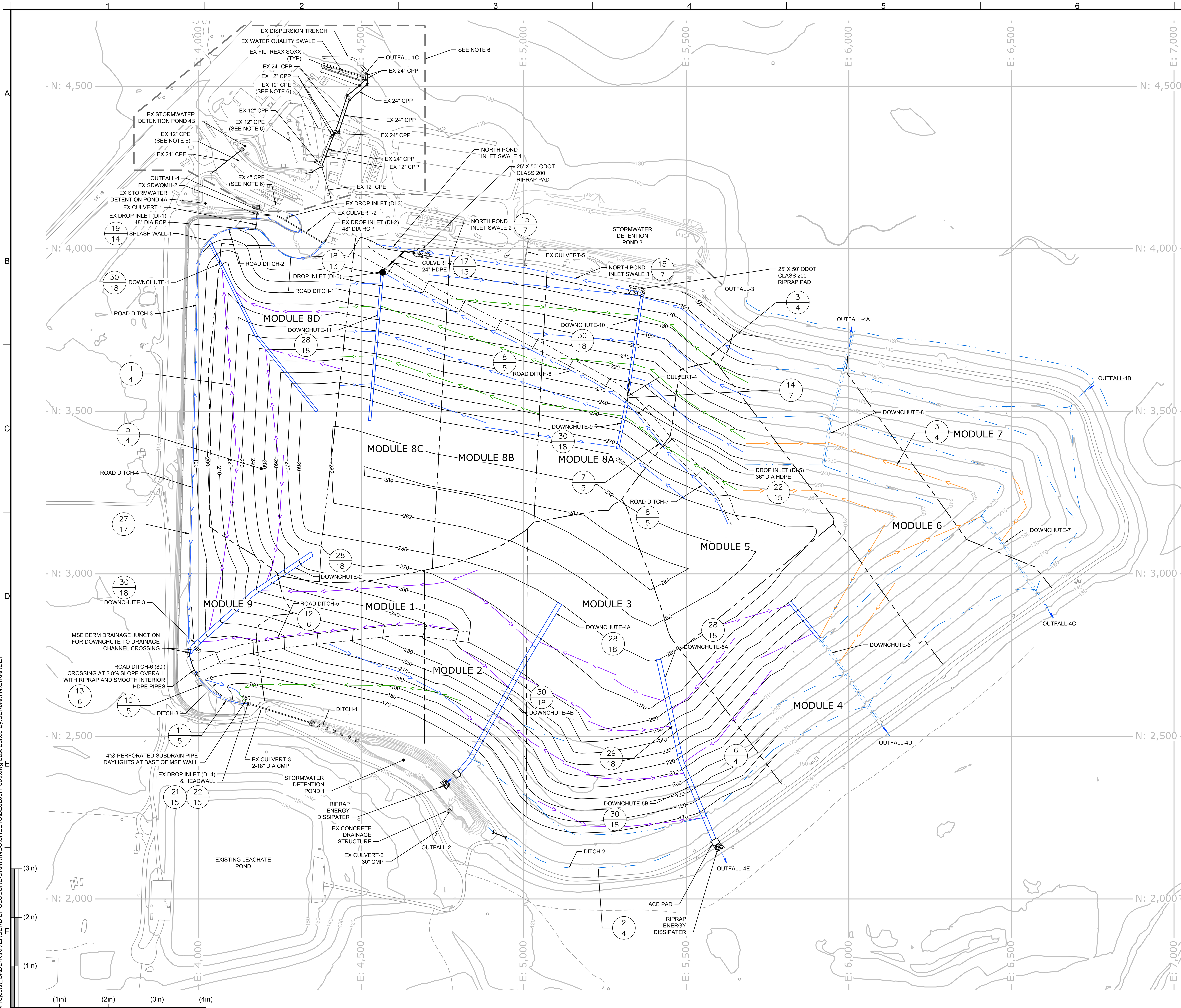
Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: DETAILS - PHASE I FGPM BERM TERMINATION

PROJECT: 2022 FINAL CLOSURE

SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P008
DRAWING NO.: 8 OF 19



LEGEND

120	EXISTING 10-FOOT CONTOUR
120	PROPOSED 10-FOOT CONTOUR
	EXISTING SURFACE WATER DITCH
	EXISTING DOWNCHUTE
	PROPOSED ACCESS ROAD
	APPROXIMATE MODULE BOUNDARY
	EXISTING SUBDRAIN
	PROPOSED SURFACE WATER DITCH
	PROPOSED SURFACE WATER DITCH / SUBDRAIN COMBINATION
	PROPOSED SUBDRAIN
	PROPOSED DOWNCHUTE
	EXISTING CATCH BASIN
	EXISTING MANHOLE

N

NOTES:

1. BASE MAP, EXISTING TOPOGRAPHY, AND SOUTHWEST CAPPING PORTION FROM CAD FILE "6 FINAL GRADING PLAN.DWG" OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS BY VISTA GEOENVIRONMENTAL SERVICES, OF LAKE OSWEGO, OREGON, DATED MAY 2022.
2. SEE DRAWING NO. 3 FOR THE EXISTING CLOSED AREA AND PROPOSED CLOSED AREA EXTENTS.
3. STORMWATER MANAGEMENT FEATURES WITHIN THE AREAS TO BE CLOSED ARE PROPOSED UNLESS LABELED AS EXISTING ("EX").
4. DIMENSIONS OF THE STORMWATER MANAGEMENT FEATURES ARE PRESENTED IN APPENDIX B - STORMWATER MANAGEMENT SYSTEM OF THE FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN.
5. LELAND A. MACDONALD AND ASSOCIATES, LCC, MCMINNVILLE, OREGON, PROVIDED THE VARIOUS INVERTS AND LOCATIONS OF THE INFRASTRUCTURE.
6. STORMWATER STRUCTURES SHOWN AS GRAY DASHED LINES WITHIN AND NORTHEAST OF THE LANDFILL ENTRANCE AND SCALE AREA ARE TO BE DECOMMISSIONED DURING THE LANDFILL CLOSURE. ONLY THE CONVEYANCE LINES FROM DETENTION POND 4B MAY BE MAINTAINED AS NEEDED.

0 150 300
SCALE IN FEET

NOT FOR BID OR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP
A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

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DRAWN BY:	BEG
CHECKED BY:	YMC
REVIEWED BY:	DJB
APPROVED BY:	DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: SURFACE WATER DRAINAGE PLAN

PROJECT: 2022 FINAL CLOSURE

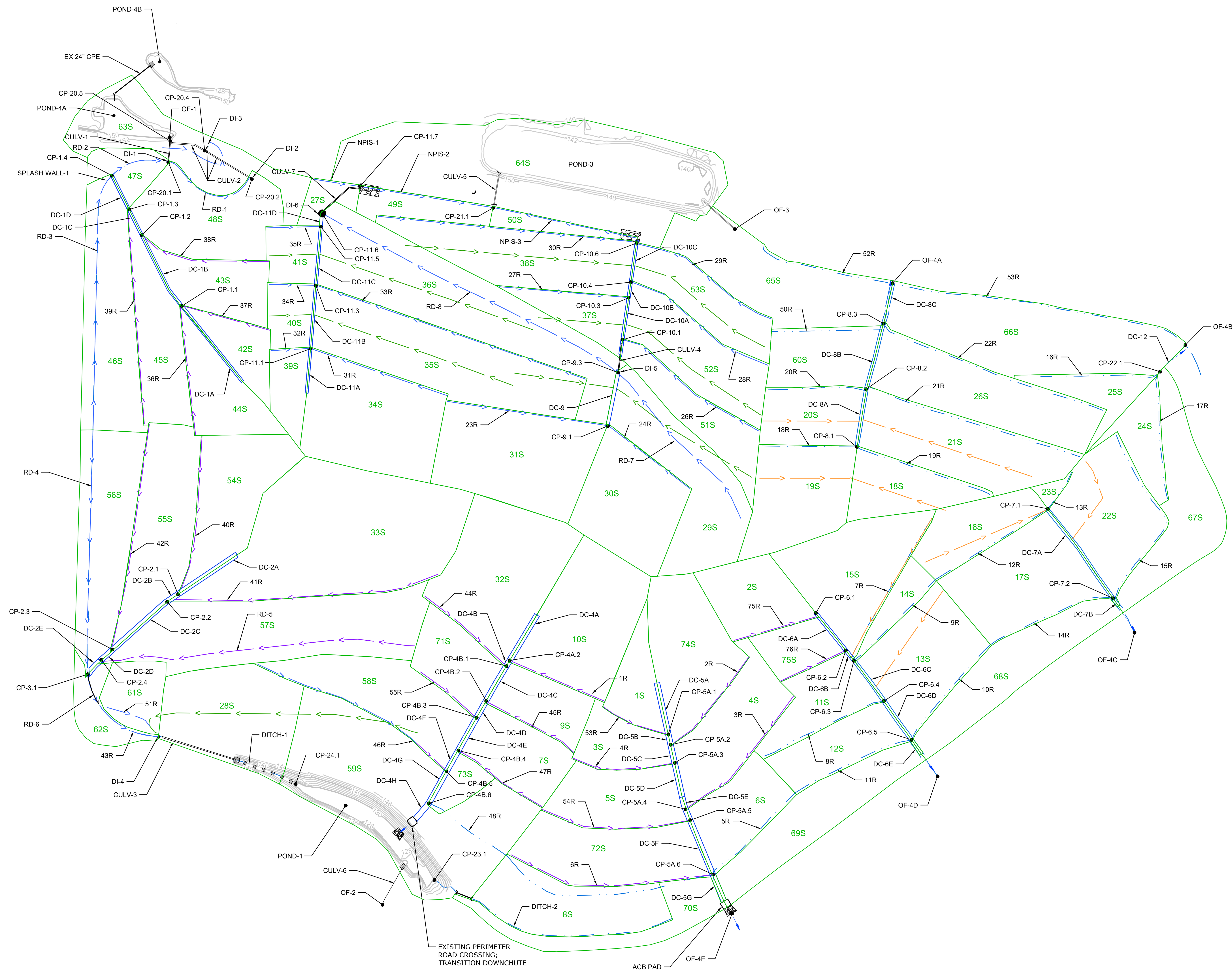
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022

PROJECT NO.: BE0209I

FILE: BE0209I P009

DRAWING NO.: 9 OF 19



LEGEND

- EXISTING SURFACE WATER DITCH
- EXISTING DOWNCHUTE
- EXISTING SUBDRAIN
- PROPOSED SURFACE WATER DITCH
- PROPOSED SURFACE WATER DITCH / SUBDRAIN COMBINATION
- PROPOSED SUBDRAIN
- PROPOSED DOWNCHUTE
- FLOW ARROW

N

ABBREVIATIONS:

CULV	CULVERT
CP	CONCENTRATION POINT
DC	DOWNCHUTE
DI	DROP INLET
NPIS	NORTH POND INLET SWALE
OF	OUTFALL
RD	ROAD DITCH

NOTES:

1. SEE DRAWING NO. 9 FOR THE FINAL GRADES AND STORMWATER MANAGEMENT FEATURE LAYOUT.
2. SEE DRAWING NO. 3 FOR THE EXISTING CLOSED AREA AND PROPOSED CLOSED AREA EXTENTS.
3. DIMENSIONS OF THE STORMWATER MANAGEMENT FEATURES ARE PRESENTED IN APPENDIX B - STORMWATER MANAGEMENT SYSTEM OF THE FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN.

0 150 300
SCALE IN FEET

NOT FOR BID OR CONSTRUCTION

(1in) (2in) (3in) (4in)
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REVIEWED BY:	DJB
APPROVED BY:	DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: SURFACE WATER SCHEMATIC FLOW DIAGRAM

PROJECT: 2022 FINAL CLOSURE

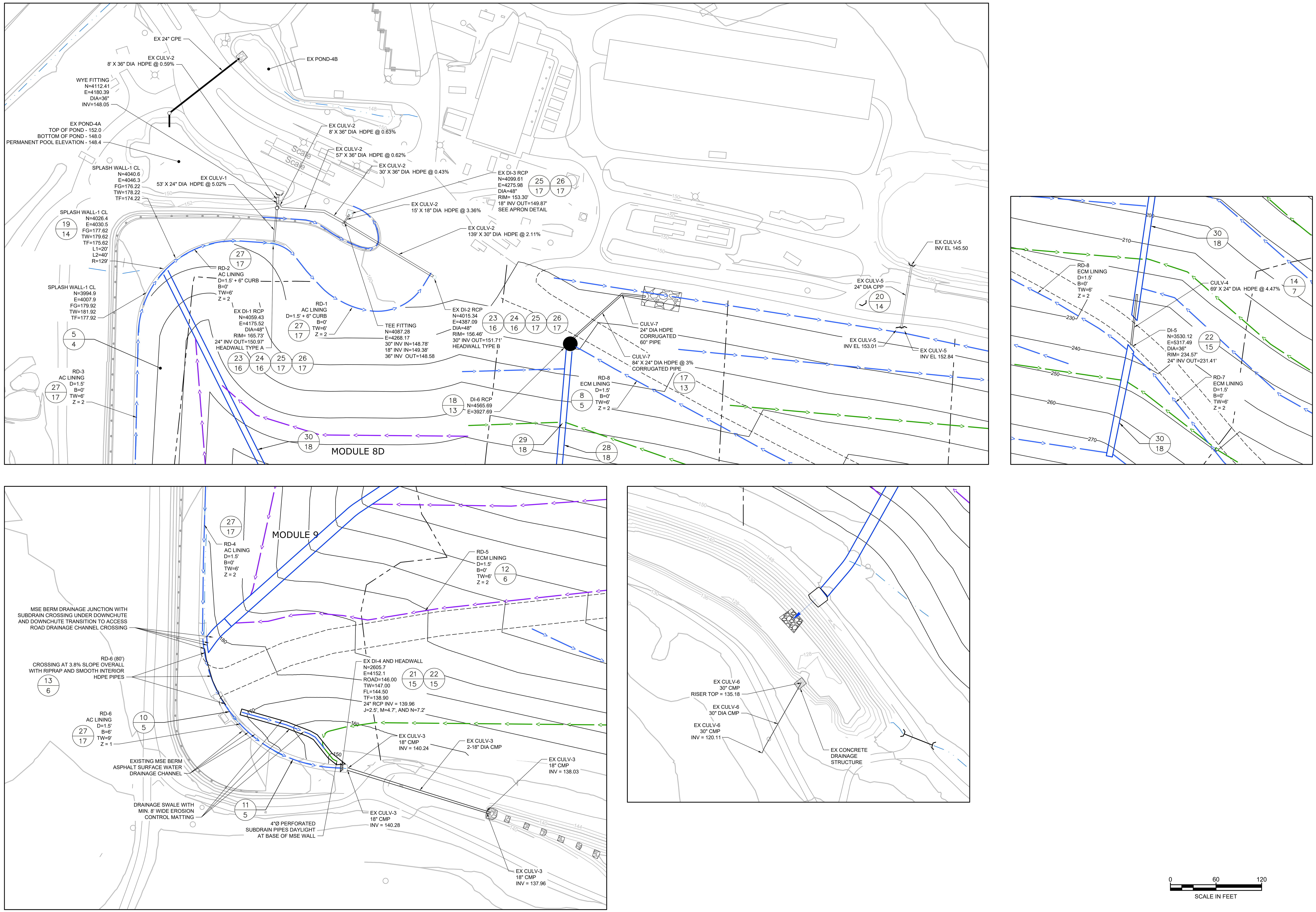
SITE: RIVERBEND LANDFILL CO.
MCMINNVILLE, OREGON

DATE: DECEMBER 2022

PROJECT NO.: BE0209I

FILE: BE0209I P010

DRAWING NO.: 10 OF 19



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CHECKED BY:	YMC
REVIEWED BY:	DJB
APPROVED BY:	DJB

Geosyntec consultants
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ACTON, MA 01720
PHONE: 978.263.9588

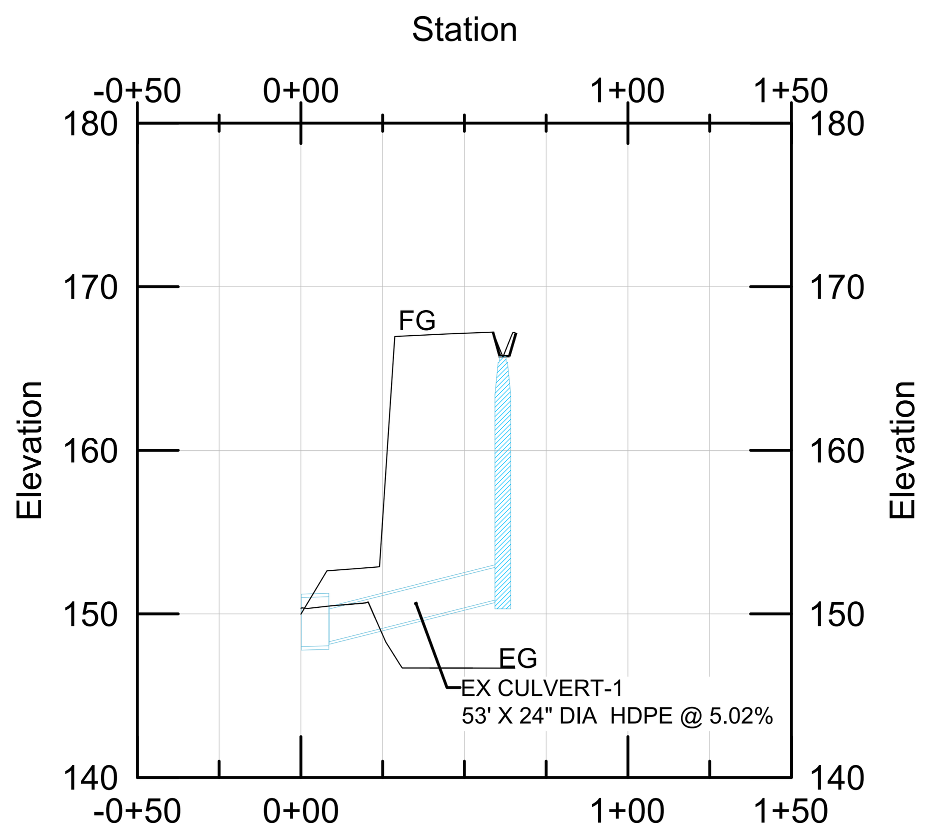
TITLE: CULVERT PLAN

PROJECT: 2022 FINAL CLOSURE

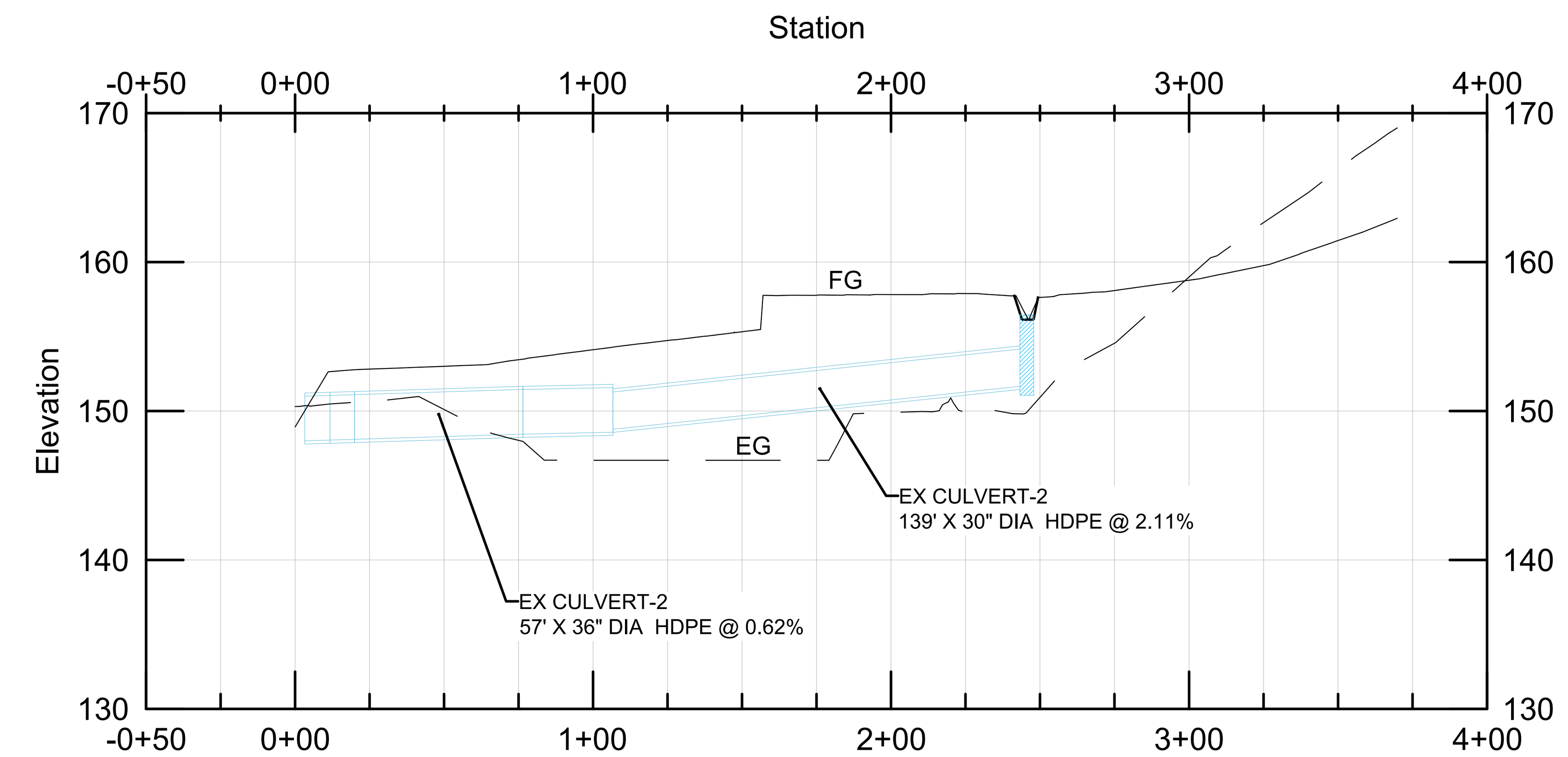
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P011
DRAWING NO.: 11 OF 19

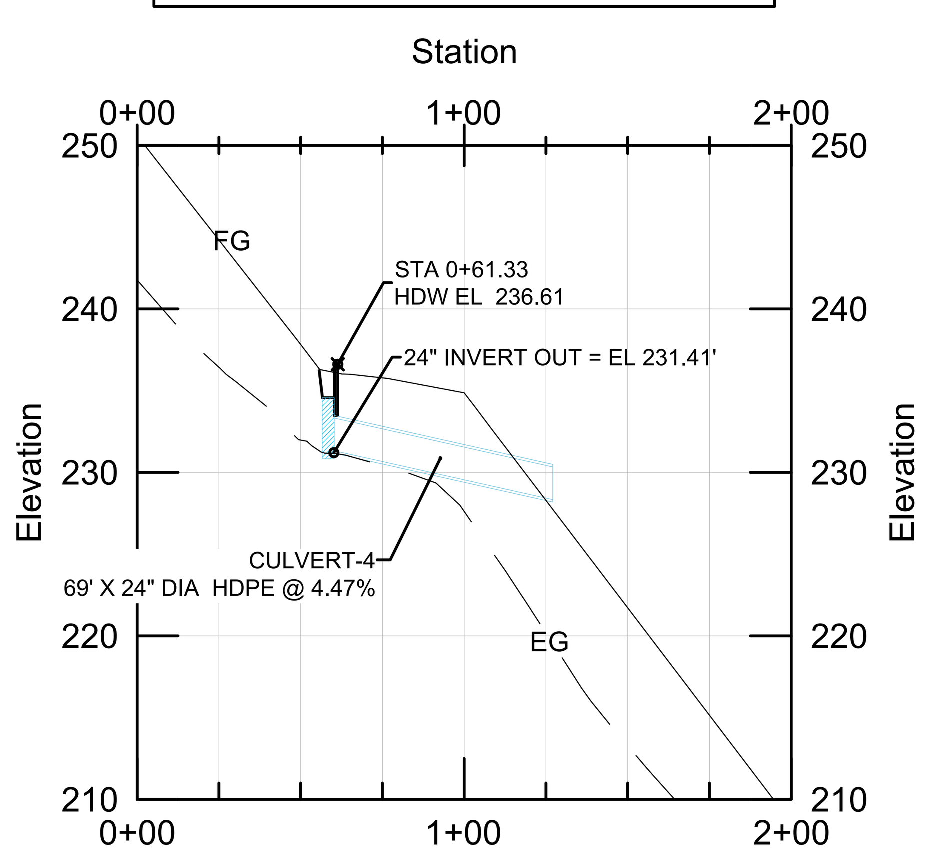
EX CULVERT-1 PROFILE



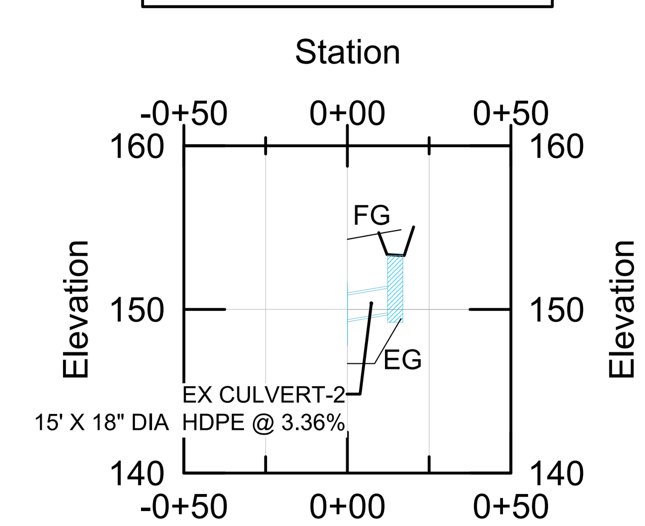
CULVERT-2 PROFILE



CULVERT-4 PROFILE



DI-4 PROFILE



NOTE:

SEE DRAWING 11 FOR CULVERT LOCATIONS AND ADDITIONAL CULVERT DATA.

NOT FOR BID OR CONSTRUCTION

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

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SIGNATURE DATE

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CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

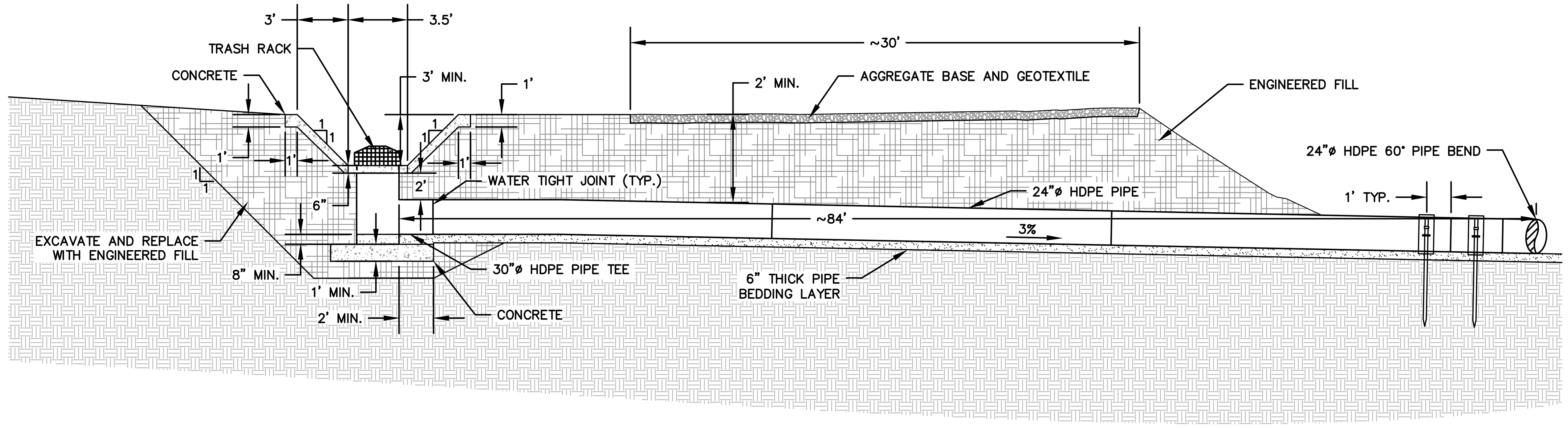
Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: CULVERT PROFILES

PROJECT: 2022 FINAL CLOSURE

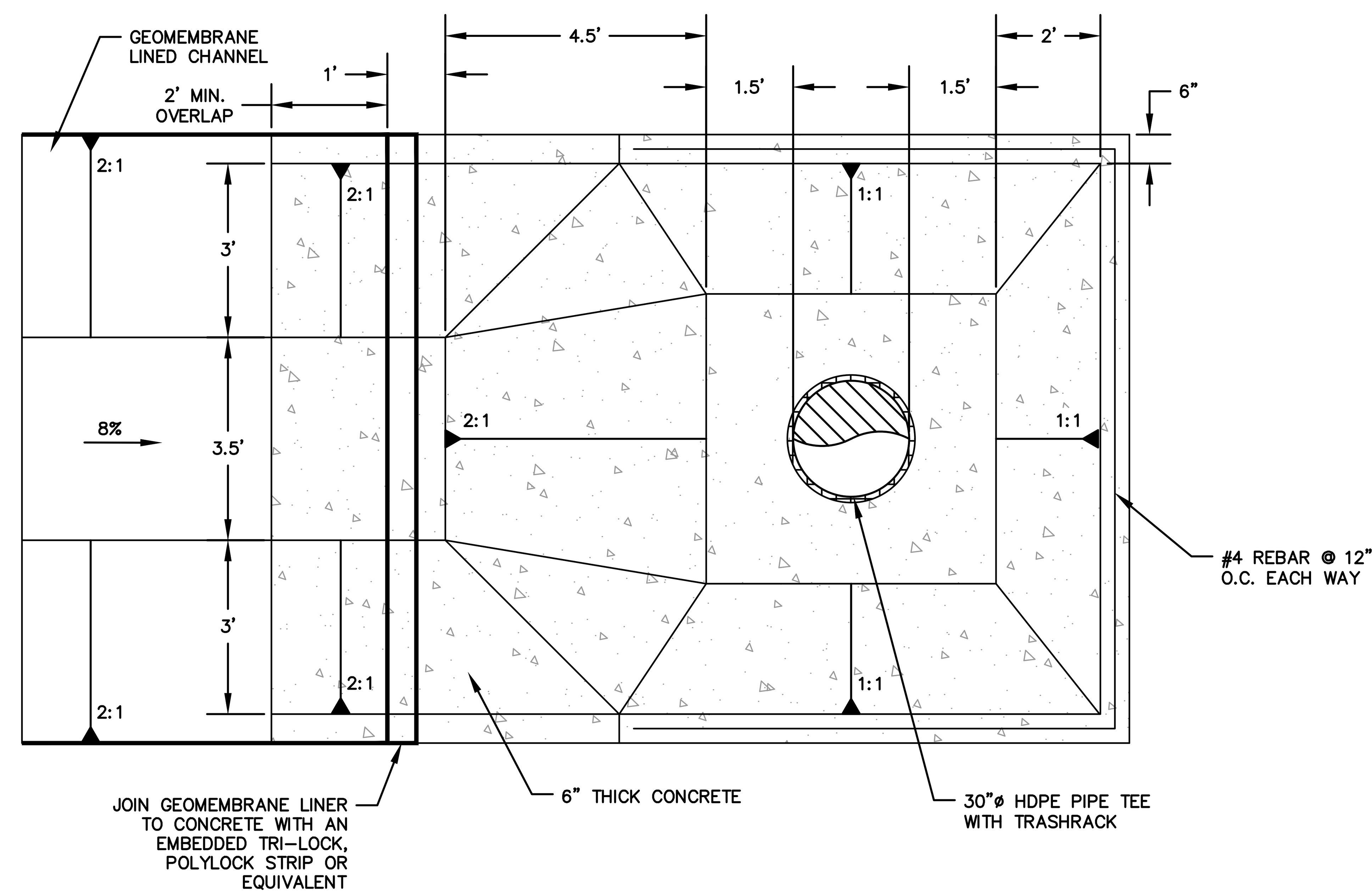
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P012
DRAWING NO.: 12 OF 19



17/9 DOWNCHUTE CULVERT CROSSING SECTION

NOT TO SCALE



18/9 DOWNCHUTE DROP INLET

NOT TO SCALE

NOTE:

THIS DETAIL IS ADAPTED FROM THE RIVERBEND LANDFILL TOP DECK DRAINAGE SYSTEM DRAWINGS, BY GEO–LOGIC ASSOCIATES, DATED 6 SEPTEMBER 2018.

NOT FOR BID OR CONSTRUCTION

REV	DATE	DESCRIPTION	DRN	APP
A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

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DRAWN BY: BEG

CHECKED BY: YMC

REVIEWED BY: DJB

APPROVED BY: DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: DETAILS - CULVERT-7

PROJECT: 2022 FINAL CLOSURE

SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022

PROJECT NO.: BE0209I

FILE: BE0209I P013

DRAWING NO.: 13 OF 19

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

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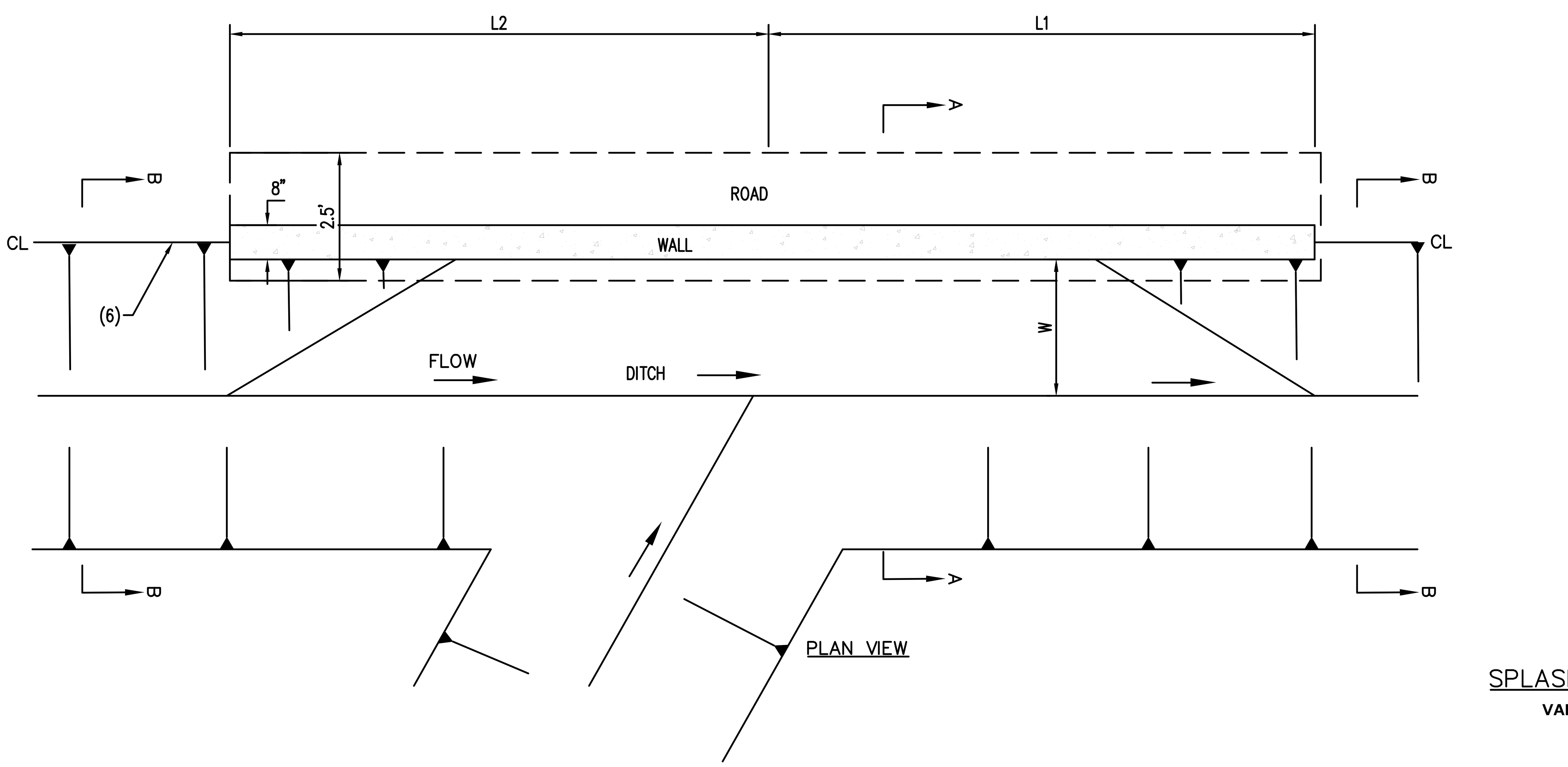
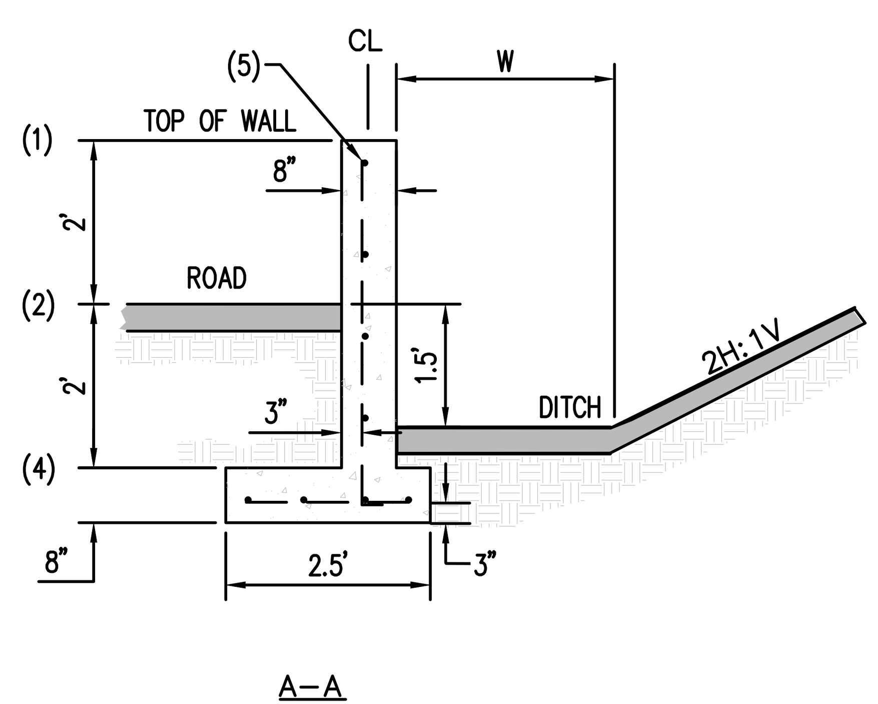
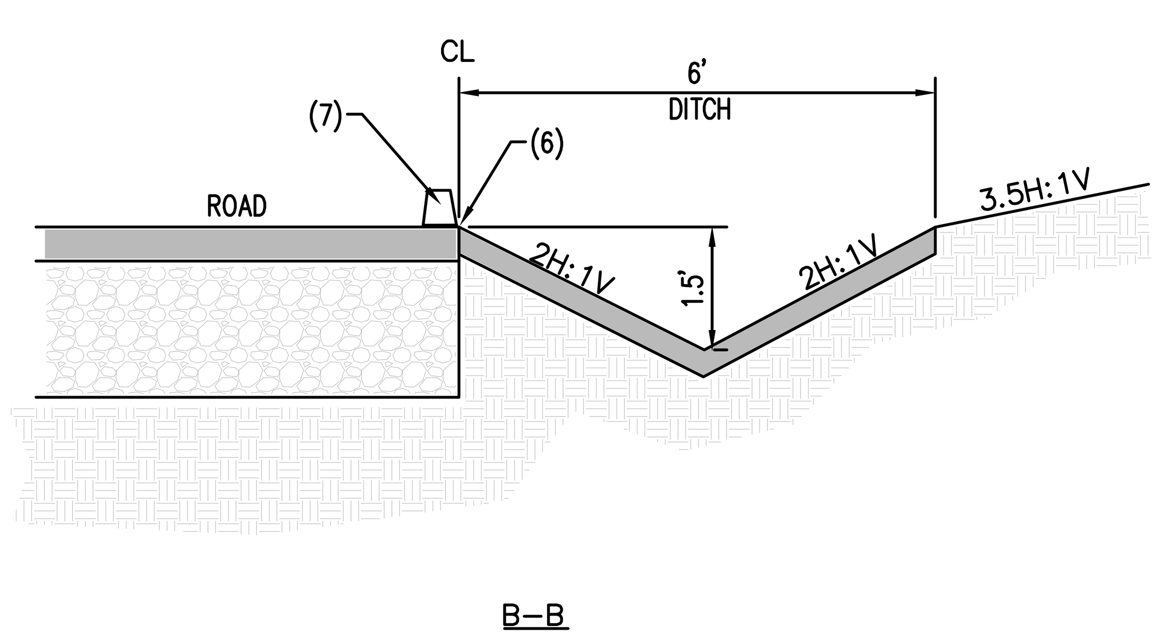


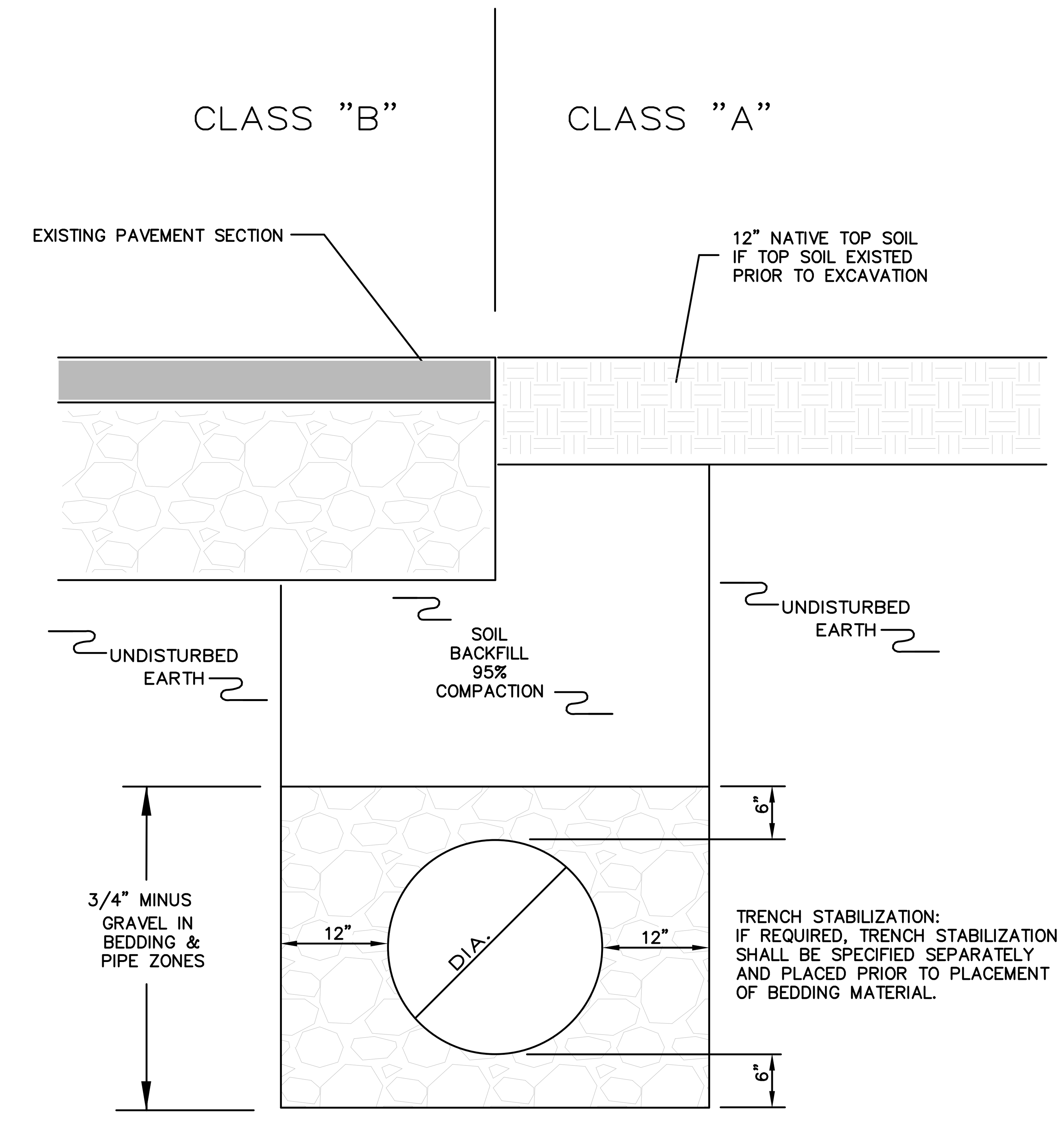
SPLASH WALL DATA TABLE

VARIABLE	UNIT	SW-1
W	FEET	2.67
L1	FEET	20
L2	FEET	40





19 / 9 SPLASH WALL DETAILS
NOT TO SCALE



20 / 9 TRENCH DETAIL (TYP)
NOT TO SCALE

NOT FOR BID OR CONSTRUCTION

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

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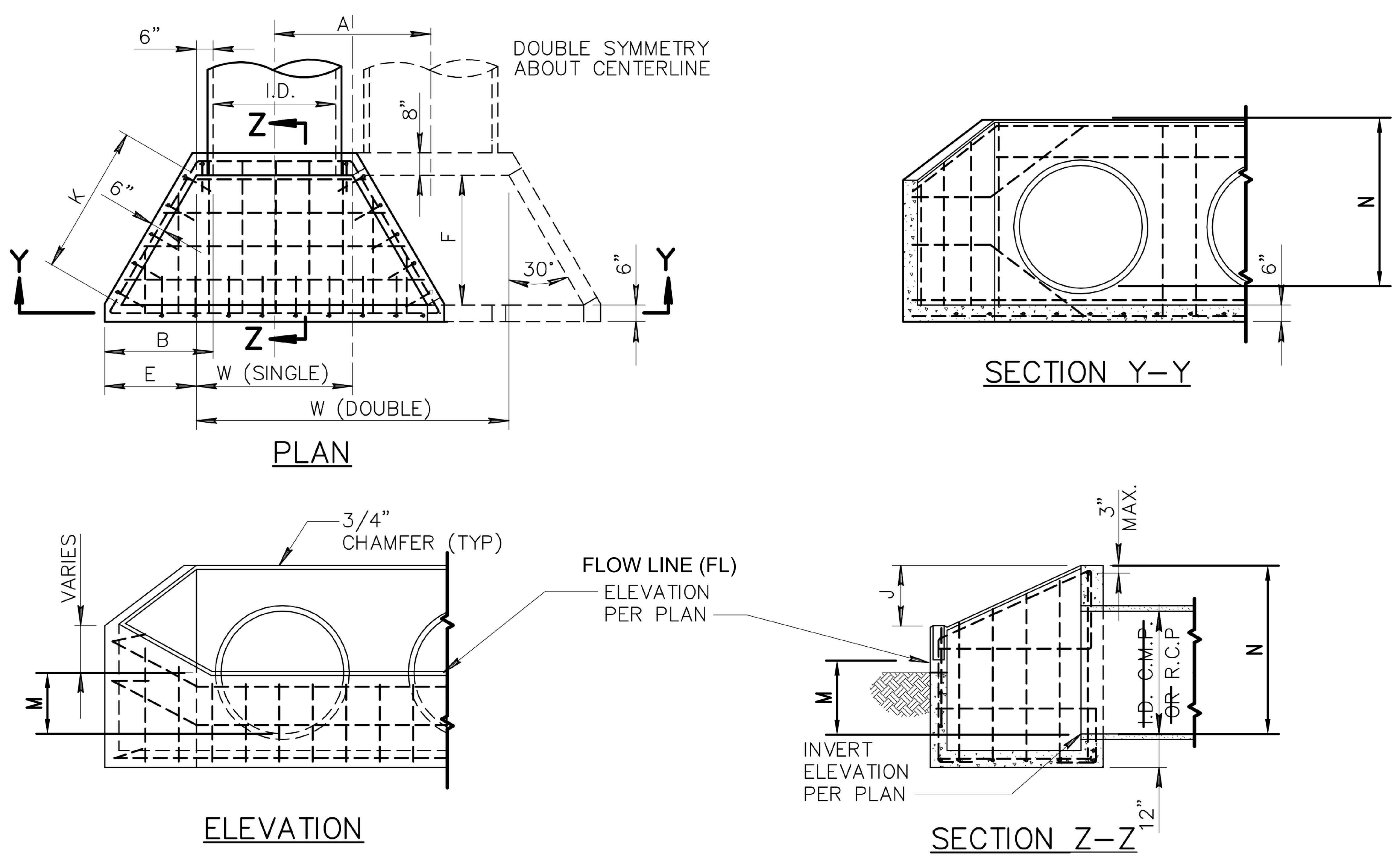
CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

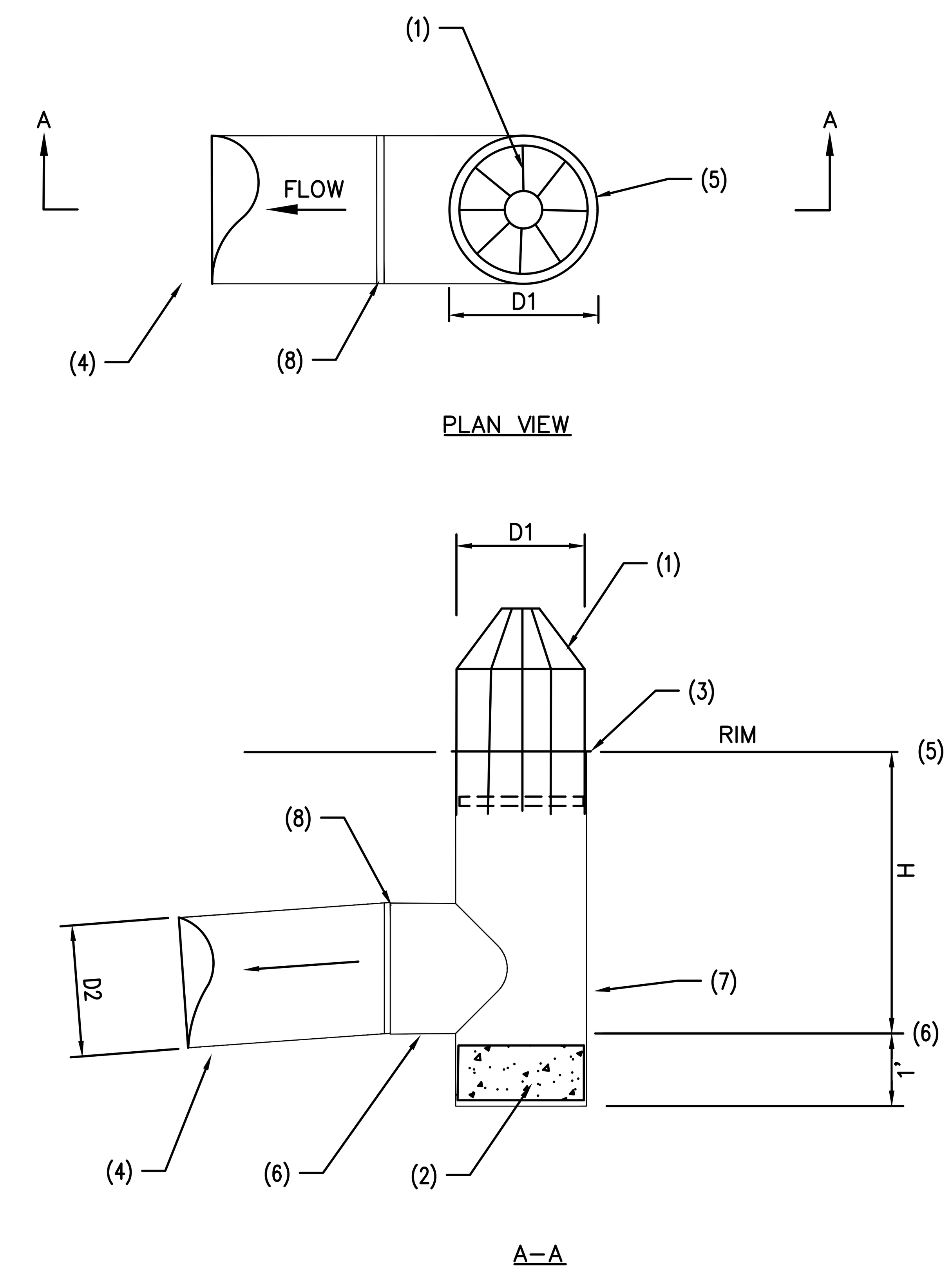
TITLE: DETAILS - SPLASH WALL AND TRENCH
PROJECT: 2022 FINAL CLOSURE
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P014
DRAWING NO.: 14 — 14 OF 19



PIPE	DIMENSIONS									
I.D.	W SINGLE	W DOUBLE	A	B	E	F	J	K	M	N
~~18"~~	~~2'-6"~~	~~5'-2"~~	~~2'-8"~~	~~1'-3"~~	~~0'-9"~~	~~1'-3·5/8"~~	~~9"~~	~~1'-6"~~		
24"	~~3'-0"~~	6'-6"	3'-6"	1'-7·1/2"	1'-1·1/2"	1'-11·3/8"	2.5'	2'-3"	4.7'	7.2'
~~30"~~	~~3'-6"~~	~~7'-10"~~	~~4'-4"~~	~~2'-0"~~	~~1'-6"~~	~~2'-7·1/4"~~	~~1'-1"~~	~~3'-0"~~		
~~36"~~	~~4'-0"~~	~~9'-2"~~	~~5'-2"~~	~~2'-4·1/2"~~	~~1'-10·1/2"~~	~~3'-3"~~	~~1'-4"~~	~~3'-9"~~		
~~42"~~	~~4'-6"~~	~~10'-6"~~	~~6'-0"~~	~~2'-9"~~	~~2'-3"~~	~~3'-10·3/4"~~	~~1'-6"~~	~~4'-6"~~		

21/9 **DROP HEADWALL**
NOT TO SCALE



NOTE:

1. THE DROP INLET CHARACTERISTICS ARE PROVIDED IN APPENDIX A – STORM WATER MANAGEMENT SYSTEM OF THE FINAL ENGINEERED SITE CLOSURE AND POST-CLOSURE PLAN, DATED DECEMBER 2022.

22/9 **HDPE DROP INLET DETAIL**
NOT TO SCALE

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

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DRAWN BY: BEG
CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: DETAILS - DROP HEADWALL AND DROP INLET

PROJECT: 2022 FINAL CLOSURE

SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022

PROJECT NO.: BE0209I

FILE: BE0209I P015

DRAWING NO.: 15 OF 19

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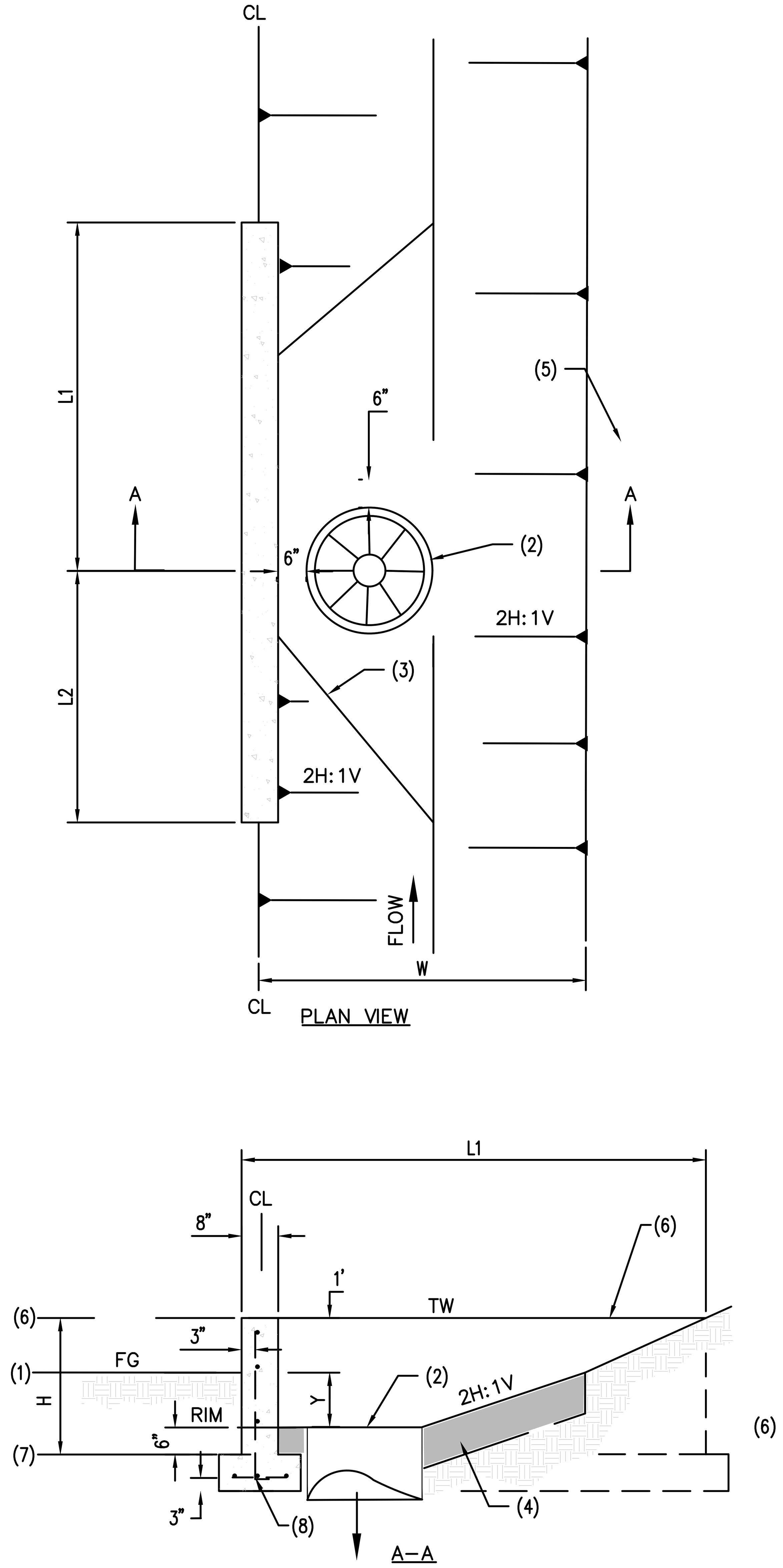

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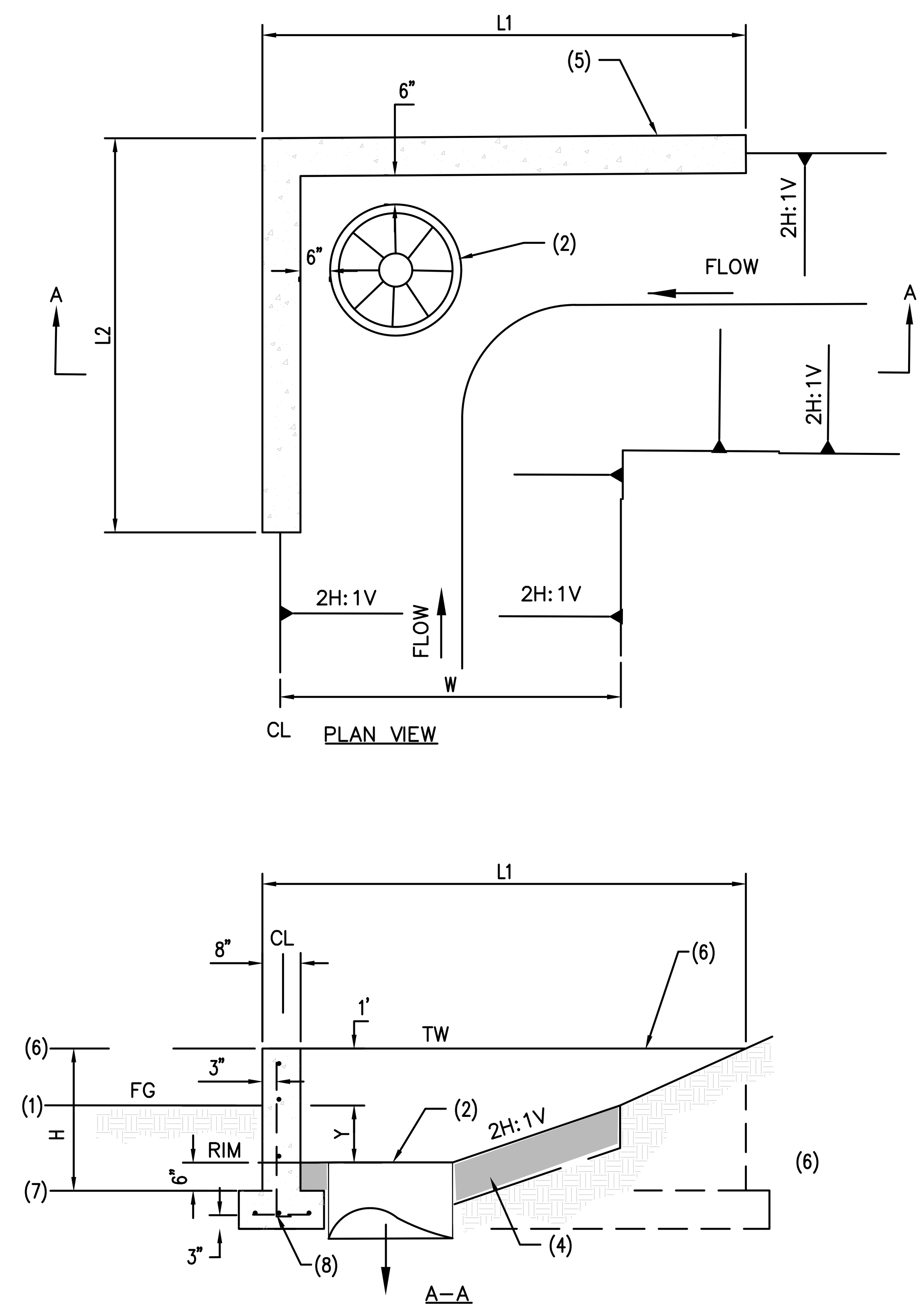
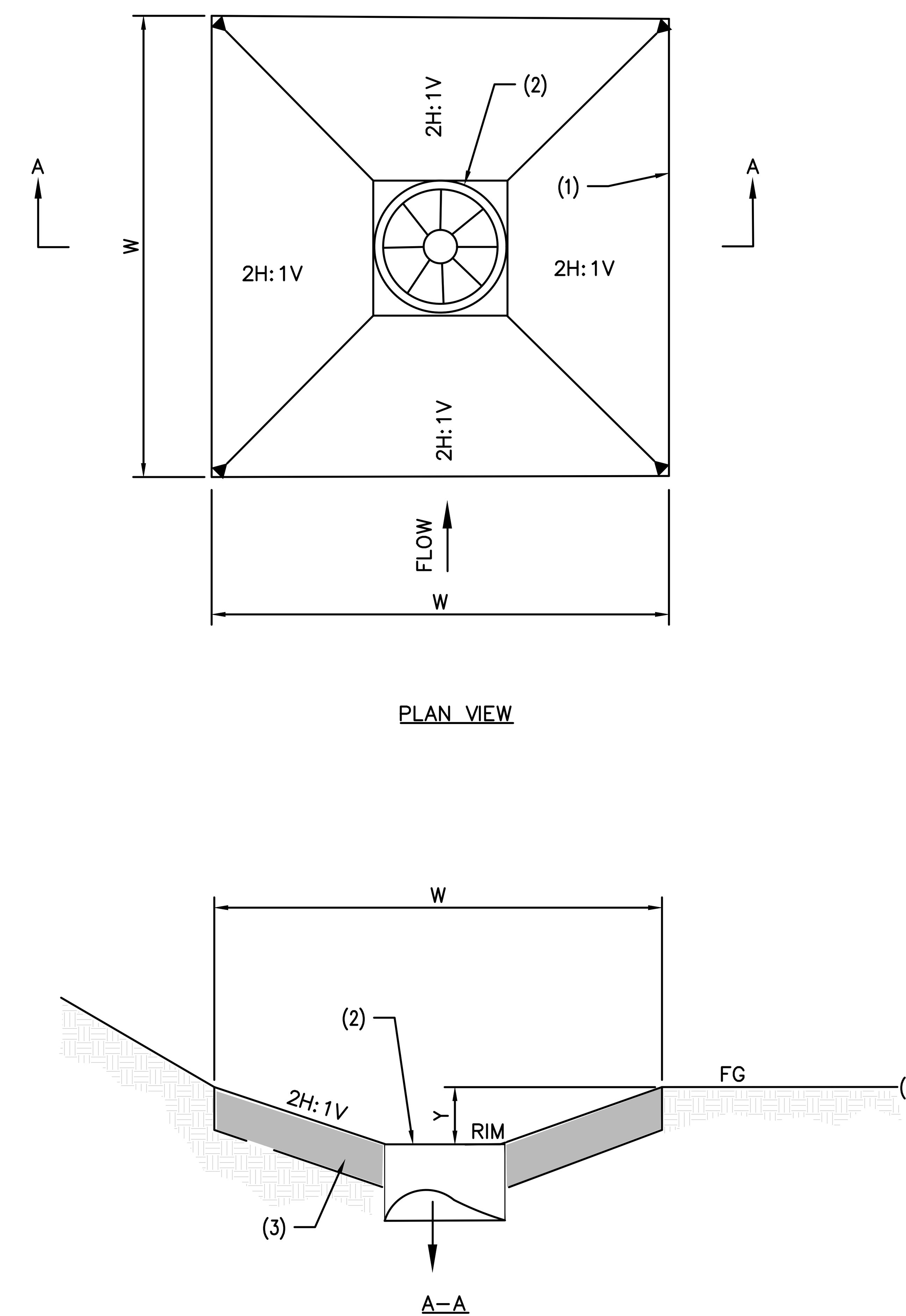


TYPE-B

23 / 11 HEADWALL DETAILS
NOT TO SCALE



24 / 11 APRON DETAIL
NOT TO SCALE

REV	DATE	DESCRIPTION	DRN	APP
A	12/21/22	ISSUED FOR PERMITTING	BEG	DJB

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DATE

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DRAWN BY: BEG
CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: DETAILS - HEADWALL AND APRON

PROJECT: 2022 FINAL CLOSURE

SITE: RIVERBEND LANDFILL CO.
MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P016
DRAWING NO.: 16 OF 19

(1in) (2in) (3in) (4in)
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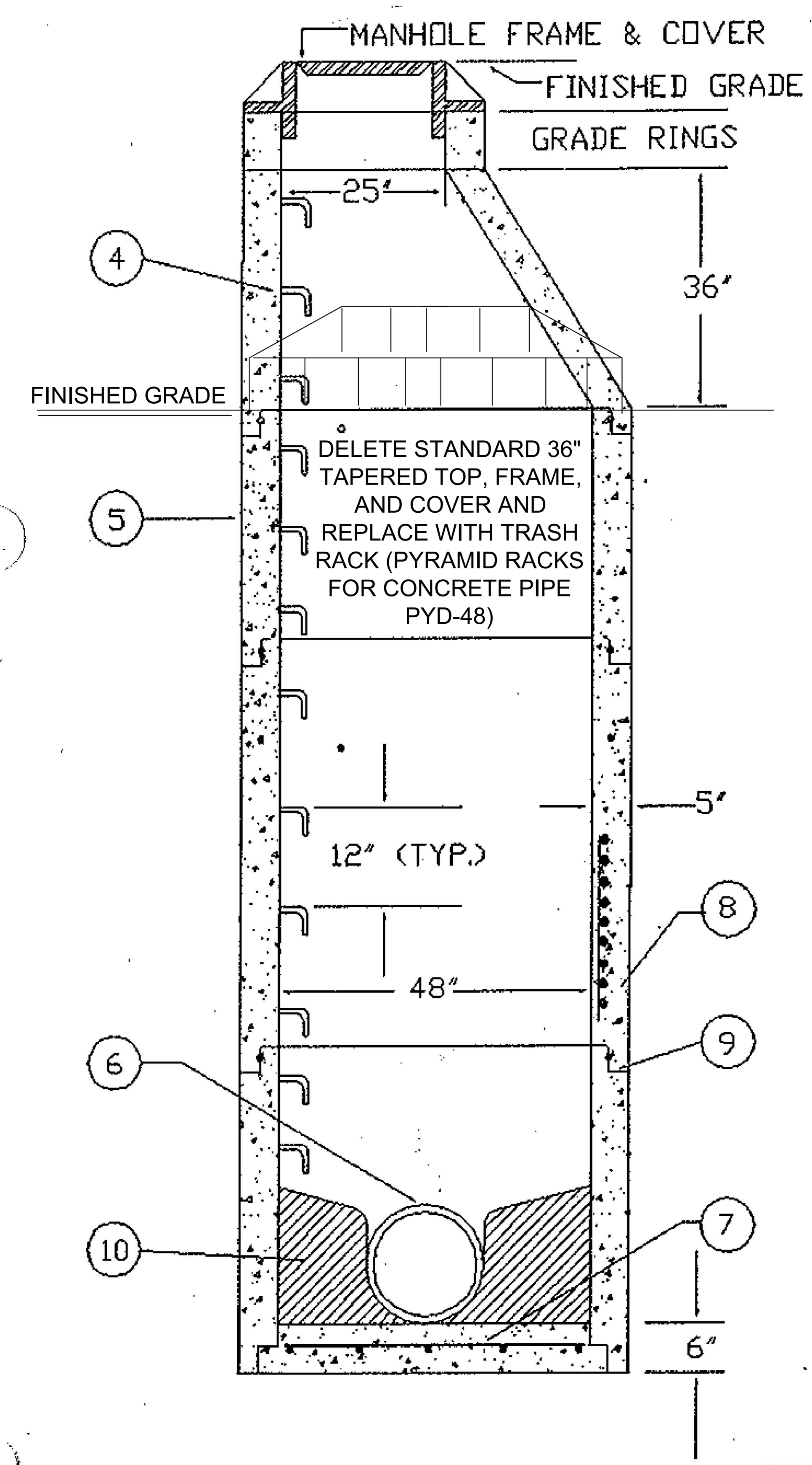
DESIGN BASED ON 48" MANHOLE MANUFACTURED BY

CASCADE CONCRETE PRODUCTS, INC.

P.O. Box 1245 • 33605 E. Crown Zellerbach Road
Scappoose, Oregon 97056
Office (503) 543-5213

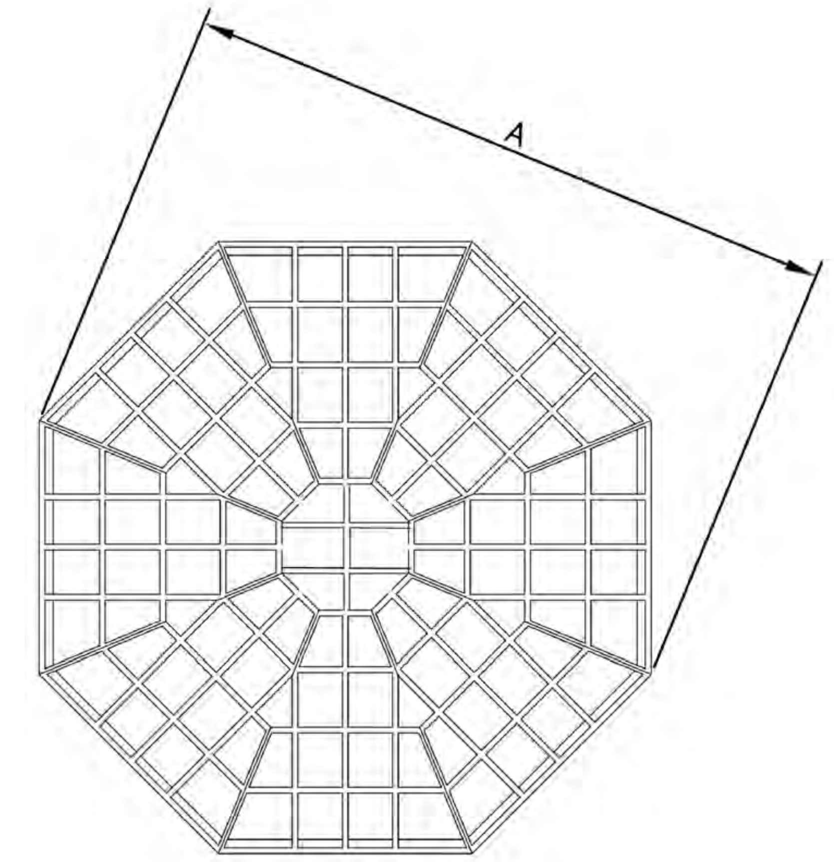


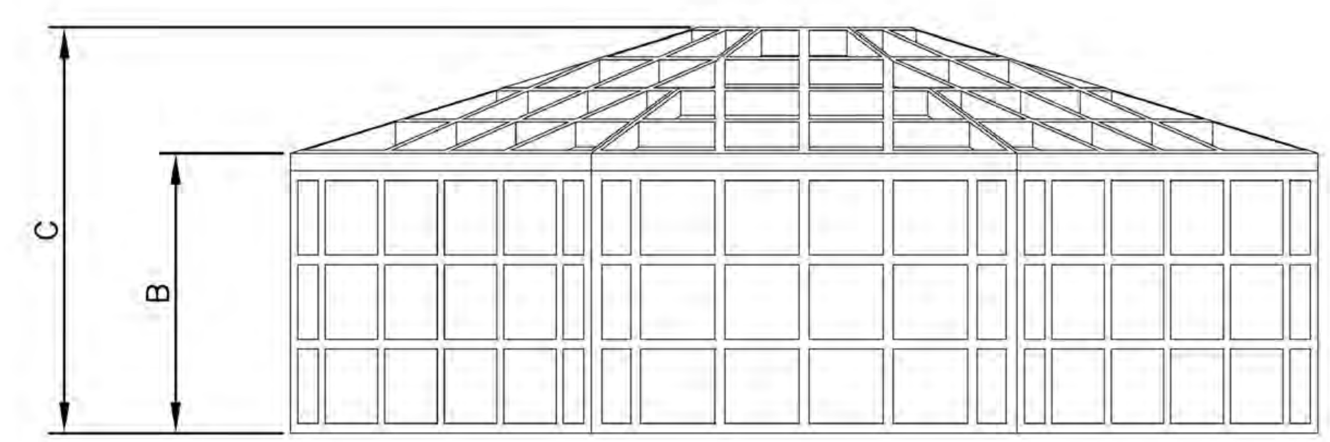
NOTES:

1. ALL MANHOLE SECTIONS, CONES, BASES AND FLATTOPS SHALL BE IN ACCORDANCE WITH ASTM C- 478
2. ALL REINFORCEMENT SHALL BE GRADE 60.
3. ALL CONCRETE WILL HAVE A 28 DAY ULTIMATE STRENGTH OF 4000 PSI.
4. ~~REINFORCED POLYPROPYLENE STEPS.~~
5. STANDARED BARRELL SECTION. AVAILABLE IN LENGTHS 1'- 4'
6. BREAKOUT MANHOLE WALL 2" MIN. CLEAR OF PIPE WALL.
7. REBAR OR WELDED WIRE MESH PER ASTM C-478 STEEL AREA.
8. SECTION REINFORCMENT. 1 CAGE D3 X D2 3" X 8" SPACING. STEEL AREA = 0.19 SQ.IN./ FT.
9. KEYLOCK JOINTS AVAILABLE.
10. CHANNEL PRECAST OR POURED IN PLACE @ CONTRACTORS DISCRETION.

TITLE: 48" RUBBER GASKET MH. W / PRECAST BASE.	DATE: 2-11-98	DWG. No.
	SCALE: NONE	PAGE No. 3-1

25/11 **48" RCP DROP INLET (EXISTING)**
NOT TO SCALE





PYRAMID STRUCTURES (STANDARD SIZES)

DIMENSIONS IN INCHES TO THE NEAREST 1/4"

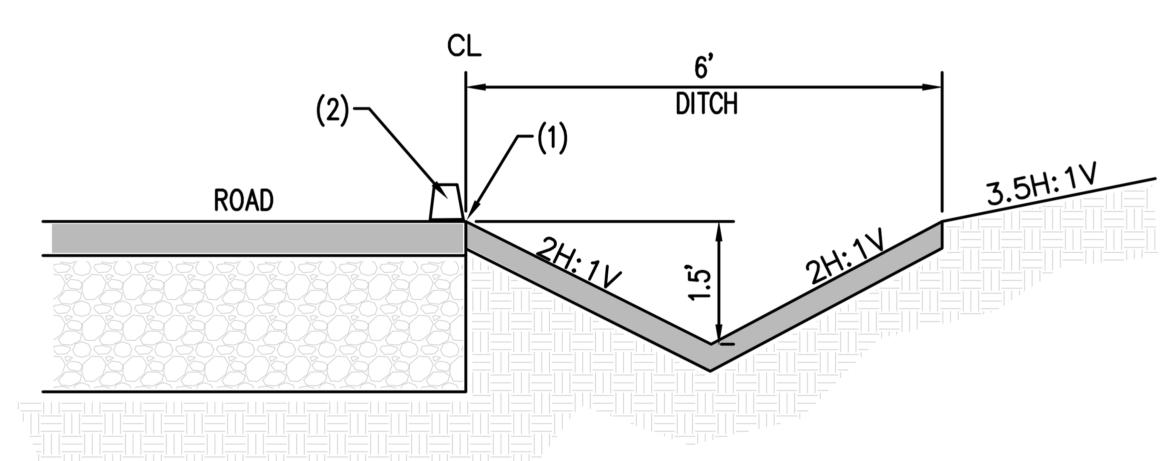
AS DISTRIBUTED BY CONTECH CONSTRUCTION PRODUCTS NATIONALLY

HOST STRUCTURE INSIDE DIMENSIONS
PART NUMBER:________
TYPE OF PIPE MOUNTING TO:________
INSIDE DIAMTER OF PIPE:________

PYRAMID RACKS FOR CONCRETE PIPE

PART NO.	PIPE I.D."	PIPE O.D."	A"	B"	C"
PYD-24	24	30	33 1/2	12 1/2	15 3/4
PYD-36	36	44	43	12 1/2	19 1/4
PYD-48	48	58	57	12 1/2	20 1/4
PYD-60	60	72	68 1/2	12 1/2	20 1/2

26/11 **TRASH RACK FOR 48" RCP DROP INLET (EXISTING)**
NOT TO SCALE



27/11 **ROAD DITCH DETAIL**
NOT TO SCALE

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

T:\Projects_CADD\R\RIVERBEND LF CLOSURE\DRAWINGS\SHEETS\BE0209I P017.dwg Last Edited By:BENJAMIN.GIRARDET

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SIGNATURE / DATE

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DRAWN BY:	BEG
CHECKED BY:	YMC
REVIEWED BY:	DJB
APPROVED BY:	DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: DETAILS - DROP INLET, TRASH RACK, AND ROAD DITCH

PROJECT: 2022 FINAL CLOSURE

SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P017
DRAWING NO.: 17 OF 19

NOT FOR BID OR CONSTRUCTION

NOTE:

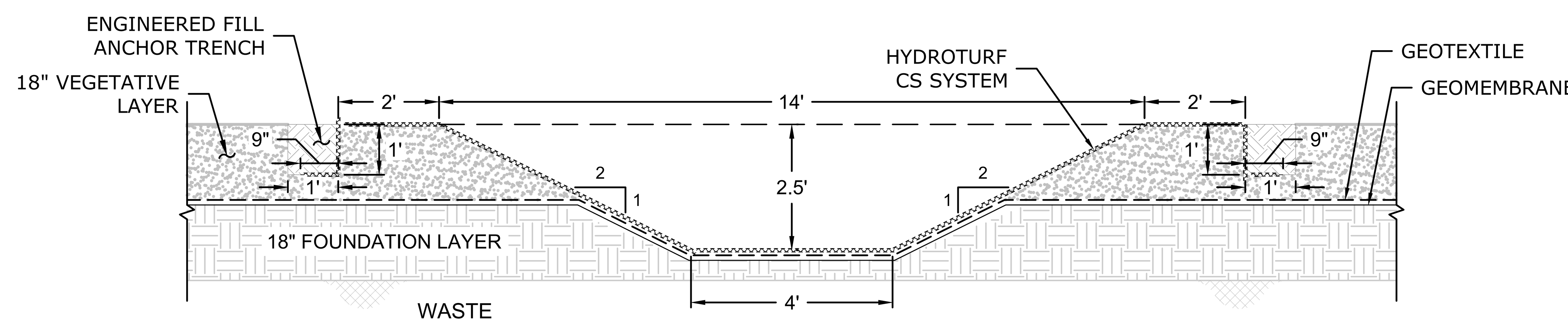
THE DETAILS ON THIS SHEET ARE ADAPTED FROM CAD FILES OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS, VISTA GEOENVIRONMENTAL SERVICES, DATED MAY 2022.

WG WatershedGeo® Unearthing Solutions

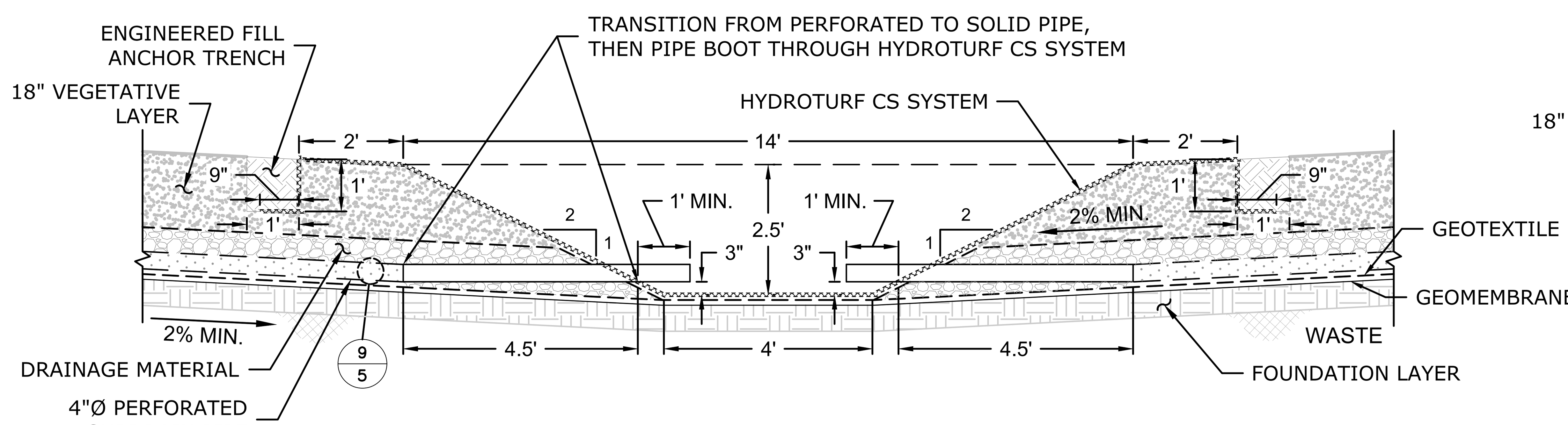
HydroTurf®

HYDROTURF CS SYSTEM NOTES:

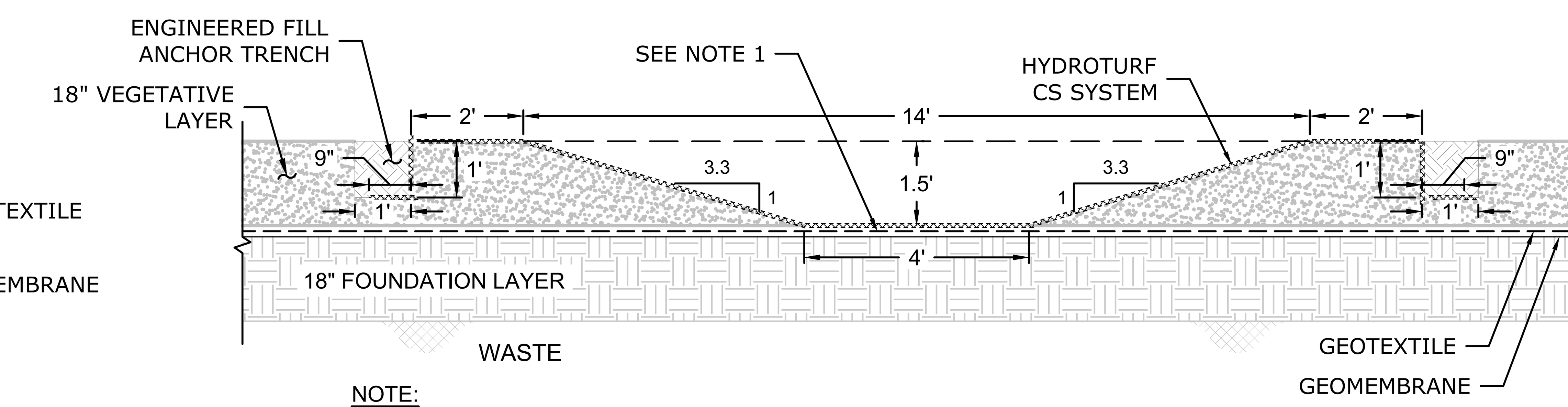
1. WATERSHED GEO IN ALPHARETTA, GEORGIA, DESIGNED AND DEVELOPED THE HYDROTURF CS SYSTEM AND DETAILS. FOR FURTHER INFORMATION, REFERENCE WATERSHED GEO'S AVAILABLE HYDROTURF TECHNICAL INSTALLATION, MONITORING, AND MAINTENANCE GUIDELINES, MANUALS, AND SPECIFICATIONS AT WATERSHEDGEO.COM.
2. THE DOWNCHUTE CONFIGURATIONS WITH ANCHOR TRENCHES AS SHOWN INDICATE A HYDROTURF CS SYSTEM LINING WIDTH OF 22.7' AND 22.2' FOR 2.5' DEEP AND 1.5' DEEP DOWNCHUTES, RESPECTIVELY. IF PRACTICAL AND FEASIBLE, USE 1-PANEL WIDTH OF THE 23' WIDE GEOMEMBRANE ROLLS FOR THE HYDROTURF CS SYSTEM.



28/9 PHASES 1 & 2 UPPER DRAINAGE DOWNCHUTE (TYP)
NOT TO SCALE



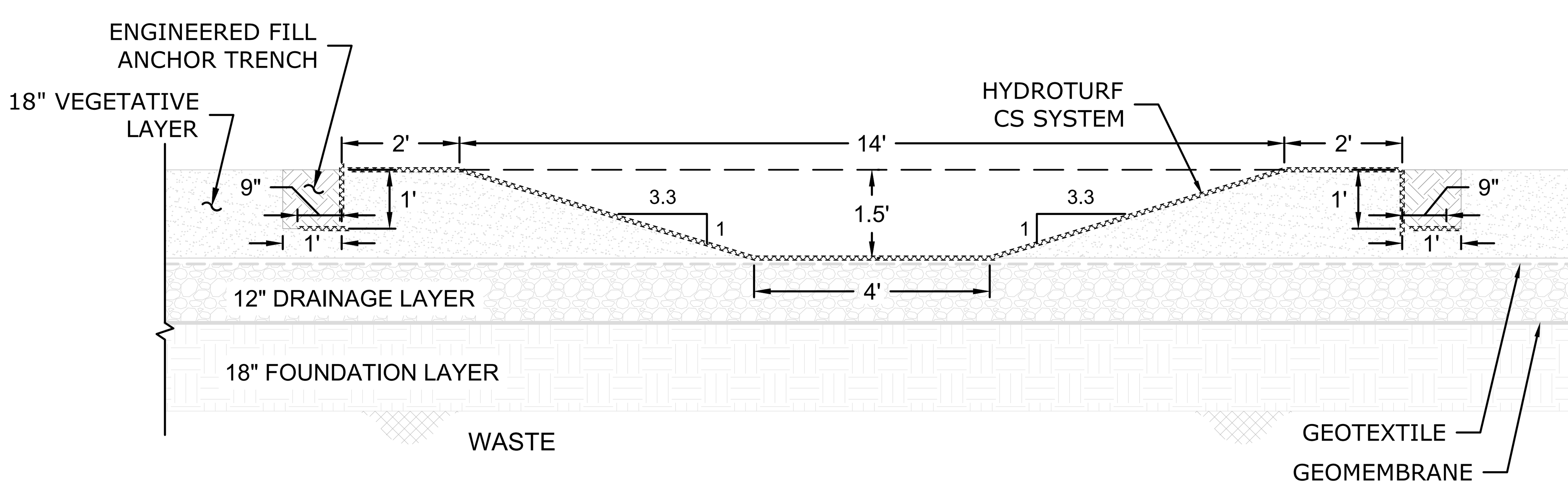
29/9 PHASES 1 & 2 UPPER DRAINAGE DOWNCHUTE WITH SUBDRAIN CONNECTION (TYP)
NOT TO SCALE



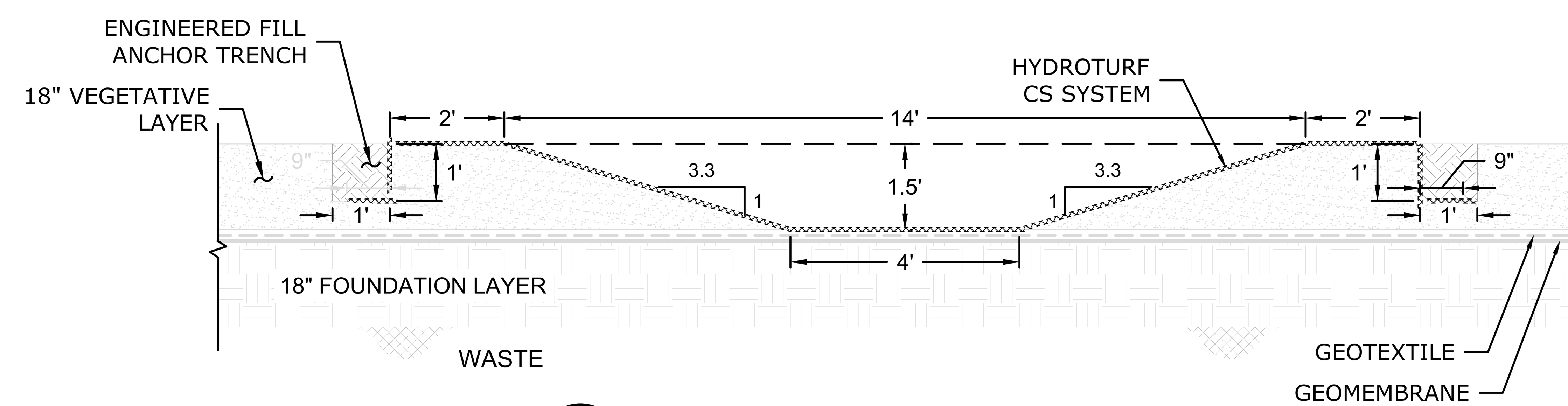
NOTE:

1. PLACE DRAINAGE GRAVEL BETWEEN DOWNCHUTE GEOMEMBRANE/COVER AND GEOTEXTILE/GEOMEMBRANE AS NEEDED TO TERMINATE DOWNCHUTE GEOMEMBRANE AT TOP OF PERIMETER DITCH ASPHALT. SECURE DOWNCHUTE GEOMEMBRANE ABOVE FLAP TO SIDEWALL OF DITCH, SEE DETAIL 10 ON SHEET 5.

30/9 PHASES 1 & 2 LOWER DRAINAGE DOWNCHUTE (TYP)
NOT TO SCALE



31/-- EXISTING CLOSURE AREA DRAINAGE DOWNCHUTE 1 (TYP)
NOT TO SCALE



32/-- EXISTING CLOSURE AREA DRAINAGE DOWNCHUTE 2 (TYP)
NOT TO SCALE

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

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DRAWN BY: BEG
CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

WM

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PHONE: 978.263.9588

TITLE: DETAILS - DOWNCHUTE
PROJECT: 2022 FINAL CLOSURE
SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P018
DRAWING NO.: 18 OF 19

WatershedGeo® Unearthing Solutions

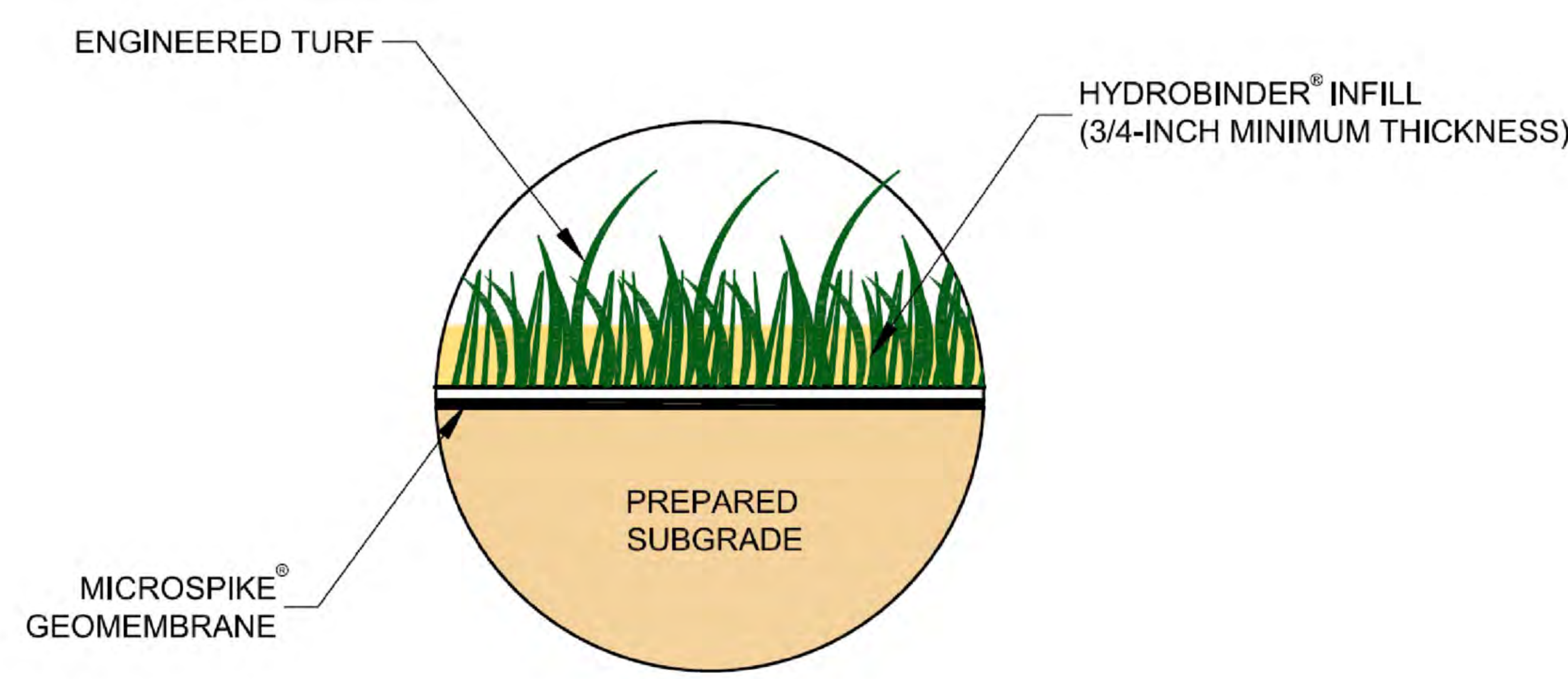
HydroTurf®

HYDROTURF CS SYSTEM NOTES:

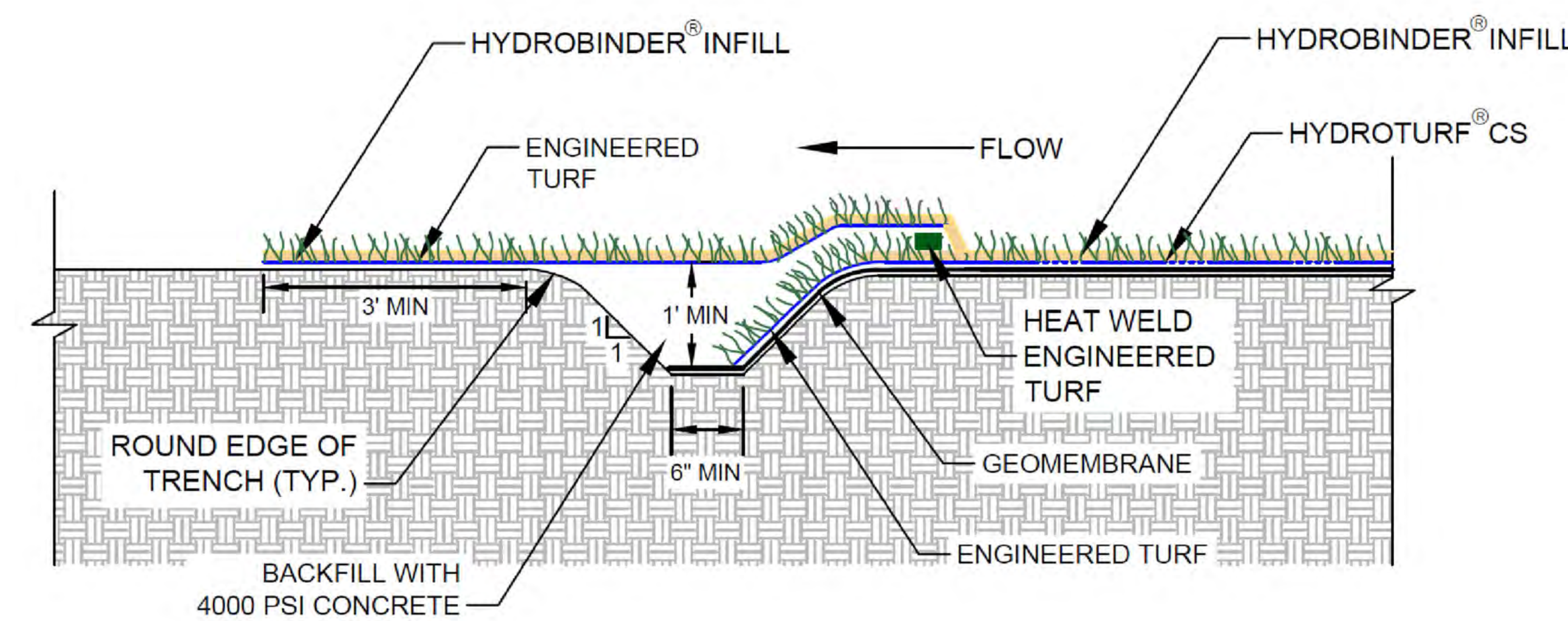
1. WATERSHED GEO IN ALPHARETTA, GEORGIA, DESIGNED AND DEVELOPED THE HYDROTURF CS SYSTEM AND DETAILS. FOR FURTHER INFORMATION, REFERENCE WATERSHED GEO'S AVAILABLE HYDROTURF TECHNICAL INSTALLATION, MONITORING, AND MAINTENANCE GUIDELINES, MANUALS, AND SPECIFICATIONS AT WATERSHEDGEO.COM.
2. USE ENGINEERED FILL FOR ALL HYDROTURF CS SYSTEM ANCHOR TRENCHES INSTEAD OF THE NOTED BACKFILL OF 4,000 PSI CONCRETE.

NOTE:

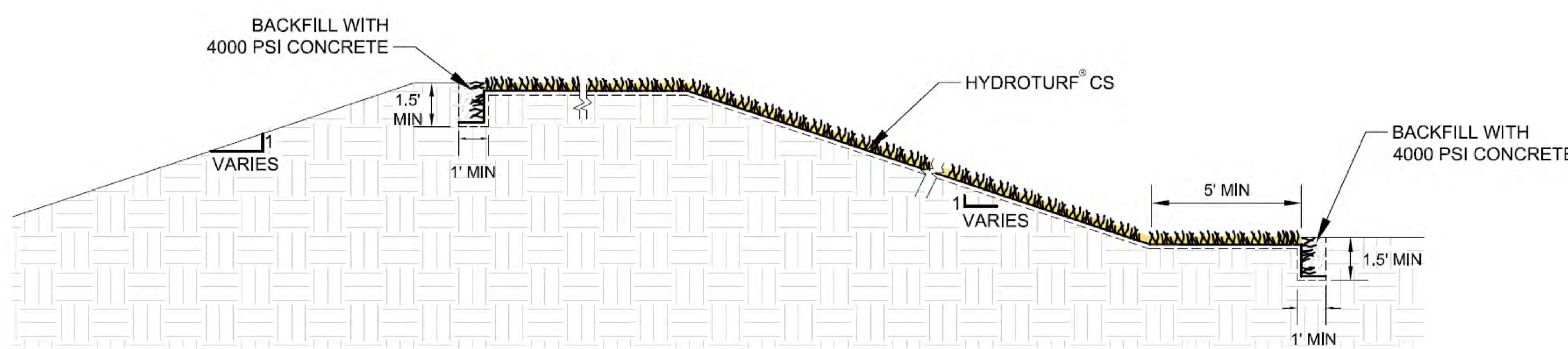
THE DETAILS ON THIS SHEET ARE ADAPTED FROM CAD FILES OF THE 2022 SOUTH SLOPE CAPPING & LINING PROJECT CONSTRUCTION DRAWINGS, VISTA GEOENVIRONMENTAL SERVICES, DATED MAY 2022.



33 HYDROTURF CS SYSTEM (TYP)
NOT TO SCALE



34 HYDROTURF CS SYSTEM DOWNSTREAM TERMINATION (TYP)
NOT TO SCALE



35 HYDROTURF CS SYSTEM PROFILE (TYP)
NOT TO SCALE

SCALE IS BASED ON 22" X 34" NON-REDUCED SHEET SIZE

NOT FOR BID OR CONSTRUCTION

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CHECKED BY: YMC
REVIEWED BY: DJB
APPROVED BY: DJB

Geosyntec consultants
289 GREAT ROAD, SUITE 202
ACTON, MA 01720
PHONE: 978.263.9588

TITLE: DETAILS - HYDROTURF CS SYSTEM

PROJECT: 2022 FINAL CLOSURE

SITE: RIVERBEND LANDFILL CO. MCMINNVILLE, OREGON

DATE: DECEMBER 2022
PROJECT NO.: BE0209I
FILE: BE0209I P019
DRAWING NO.: 19

19 OF 19

APPENDIX F

Specifications

TECHNICAL SPECIFICATIONS
2022 SOUTH SLOPE CAPPING AND LINING PROJECT

RIVERBEND LANDFILL
MCMINNVILLE, OREGON

MAY 2022

PREPARED FOR

RIVERBEND LANDFILL CO.

13469 HIGHWAY 18
MCMINNVILLE, OREGON 97128

PREPARED BY

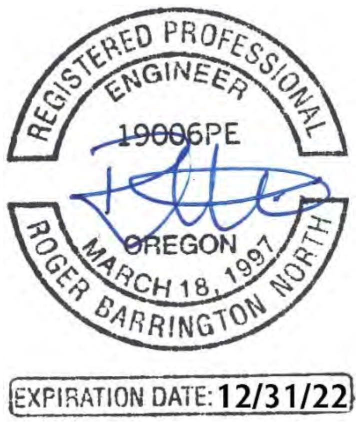
VISTA GEOENVIRONMENTAL SERVICES

LAKE OSWEGO, OREGON 97034

VISTA

CERTIFICATION PAGE

These Technical Specifications were prepared under the supervision and direction of the undersigned, whose seal as a registered Professional Engineer in the State of Oregon is affixed below.



Roger B. North, P.E.
Design Engineer of Record

SPECIFICATIONS

VISTA

TABLE OF CONTENTS

DIVISION 1 – GENERAL REQUIREMENTS

DIVISION 2 – SITE WORK

VISTA

DIVISION 2

SITE WORK

SECTION 02110

CLEARING, STRIPPING, AND GRUBBING

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Stripping and grubbing the grass, roots, plants, trees and debris from the limits of earthwork for construction as shown on the Construction Drawings and/or outlined in the Technical Specifications.

1.2 RELATED SECTIONS

A. Section 01052 – Surveying.

B. Section 02219 – Stockpiling and Soil Management.

C. Section 02221 – Excavating and Trenching.

D. Section 02225 – Subgrade Preparation.

E. Section 02370 - Erosion and Sediment Control.

1.3 DEFINITIONS

A. Clearing: Clearing is defined as removing all organic and deleterious materials from the surface of the soil layers. Clearing shall consist of removal of trees, logs, upturned stumps, roots of downed trees, brush, grass, weeds, and all other like materials, within the limits of construction. All such materials shall be cleared down to the natural ground surface. Clearing shall be performed within the limits of the Project as required to perform the Work.

B. Stripping: Removal of a maximum of the upper 6-inches of vegetative soil containing organics. Stripping shall be performed within the limits of clearing as required to perform the Work.

C. Grubbing: Grubbing is defined as removal of all stumps, roots, buried logs, and all other like material up to the depth of 2-feet below the existing ground surface. Grubbing shall be performed within the limits of clearing as required to perform the work.

PART 2 – PRODUCTS

[NOT USED]

PART 3 - EXECUTION

3.1 PREPARATION

A. Verify that any existing plant life designated to remain, is tagged or identified.

B. Verify plants to be salvaged are tagged or identified.

C. Prepare a stockpile area for materials from clearing, stripping, and grubbing at an OWNER-approved location on the top deck of the landfill.

D. Survey the surface of the prepared OWNER-approved stockpile area.

E. Install erosion and sediment control measures as shown on the Construction Drawings.

F. Utilities:

1. Coordinate Site clearing, stripping and grubbing work in advance with applicable utility companies and any necessary government agency.
2. Notify the OWNER/Engineer not less than two working days prior to commencement of work.
3. Where utility cutting, capping, or plugging is required, perform such work consistent with the requirements of the utility company or governmental agency having jurisdiction.

3.2 PROTECTION

A. Protect plant growth and any features designated to remain.

B. Protect survey benchmarks from damage or displacement.

C. Protect existing landfill gas and leachate management infrastructure located within the project area.

D. Use means necessary to prevent visible dust from becoming a nuisance to the public, neighbors, or other work being performed on or near the Site.

E. Maintain access to the Site at all times.

3.3 REMOVAL

A. Clear and strip grass, roots, organic soils prior to excavating subsurface materials.

B. Strip to a maximum depth of 6 inches below existing ground surface or as necessary to remove organic materials.

C. Grub stumps, logs, and other like materials to a maximum depth of 2 feet below the existing ground surface.

3.4 DISPOSAL OF CLEARED, STRIPPED, AND GRUBBED MATERIAL

A. Stockpile removed material in the OWNER-approved stockpile area.

B. Do not store or permit debris to accumulate on the Project Site.

C. Do not burn debris.

3.5 SURVEYS FOLLOWING REMOVAL

A. Survey the surface of the Project area following the completion of clearing, stripping, and grubbing activities in preparation for grading.

END OF SECTION

SECTION 02219

STOCKPILING AND SOIL MANAGEMENT

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Work under this section includes importing, loading, hauling, placing, and constructing temporary stockpiles as needed for completion of the Work including temporary erosion and sediment controls. This also includes stockpiles of material provided by the OWNER for the CONTRACTOR's use.

B. Soil management required to process in-place soils or stockpiled soils so they can be used for earthwork in accordance with project Documents.

C. Management of soil is the CONTRACTOR's responsibility; there will not be an extension of the contract time or additional compensation due to the moisture content of the in-place, imported, or stockpiled soils.

1.2 RELATED SECTIONS

A. Section 02110 – Clearing, Stripping, and Grubbing

B. Section 02221 – Excavating and Trenching

C. Section 02300 – Earthwork

1.3 SUBMITTALS

A. CONTRACTOR shall submit a Stockpile Work Plan a minimum of 7 workdays prior to receipt of any soil or use of stockpile areas. The plan should include locations for stockpiling each material type, specific erosion and sediment control measures that will be implemented, and general management of these areas. Modifications to this plan may be submitted for review and approval throughout the project as needed.

PART 2 – PRODUCTS

2.1 FOUNDATION SOIL

A. Soil obtained from on-site or off-site sources that meet the requirements of Section 02300 for Foundation Layer.

2.2 STRIPPED MATERIALS

A. Grass, roots, plants, and organic soils resulting from work under Section 02110.

2.3 DEBRIS

A. Material consisting of organic soils, trees, stumps, poles, brush mat, reinforced concrete, and paving rubble that cannot be used for the project.

2.4 VEGETATIVE SOIL

A. Soil that meets the requirements of Section 02300 for Vegetative Layer in the final cover system.

2.5 GRANULAR DRAINAGE MATERIAL

A. Granular material obtained from off-site sources that meets the requirements of Section 02300 for Granular Drainage Material.

PART 3 – EXECUTION

3.1 STOCKPILING MATERIALS

A. Debris and stripped materials shall be disposed at the locations selected by the OWNER. Do not mix organic materials with non-organic debris.

B. Stockpiles shall be established in consultation with the OWNER. **Stockpiles shall not be located on top of the MSE berm, or along the toe of the MSE berm unless otherwise approved by the OWNER.**

C. CONTRACTOR shall load and haul surplus materials to stockpile location(s).

D. Stockpiles shall be setback a minimum of 50 ft (15 m) from the property lines.

E. Stockpiles on the Top Deck of the Landfill shall be set back a minimum of 30 ft from side slopes.

F. Stockpiles of surplus soil shall be no higher than 20 ft (6.5 m), bladed smooth, and graded to drain. The stockpiles shall have 3H:1V (horizontal to vertical) side-slopes or flatter. The tops of the stockpiles shall be graded to drain.

G. Provide control to assure that materials go to appropriate stockpiles.

H. Provide separation between stockpiles to allow equipment access.

I. All surfaces shall be graded to drain.

J. Place in loose layers not greater than 12 in. (300 mm) and compact by track-walking with dozers.

K. Shape each stockpile to uniform lines and grades.

L. Water or cover stockpiles as necessary to control dust, prevent erosion, and control sediment transport.

M. Slope stability, erosion control, and drainage of slopes are the CONTRACTOR's responsibility.

3.2 SOIL MANAGEMENT

A. Process excavated materials as necessary in stockpiles or in-place, if possible.

B. As part of the project, plan for soil processing in stockpile areas to process excavated soils.

C. Processing to meet the project requirements in these specifications may be required for, but not necessarily limited to, the following: (i) clod size reduction; and (ii) conditioning soil to decrease or increase moisture content.

D. Monitor organic material stockpiles to detect and control fires.

3.3 CONSTRUCTION QUALITY CONTROL (CQC)

A. CONTRACTOR may perform sampling and testing of materials, as deemed appropriate, to evaluate material types at the stockpile, at the material source, or at the place of use.

B. OWNER will obtain samples and perform conformance testing as part of the CQA program.

END OF SECTION

SECTION 02221

EXCAVATING AND TRENCHING

PART 1 - GENERAL

1.1 WORK INCLUDED

A. All excavation and grading required to achieve the design slopes, widths, grades, and elevations shown on the Construction Drawings.

B. On-site excavated materials will need to be processed and stockpiled for other uses such as Foundation Layer and Vegetative Soil.

C. Dewatering of excavations as needed to complete the Work.

D. Shoring of excavations as needed to complete the Work.

E. Field construction quality control (CQC) and surveying.

1.2 RELATED SECTIONS

A. Section 02110 – Clearing, Stripping, and Grubbing

B. Section 02223 – Refuse Removal

C. Section 02225 – Subgrade Preparation

D. Section 02300 – Earthwork

E. Section 02710 – Polyethylene Pipe

1.3 SUBMITTALS

A. Submit to OWNER, at least 7 calendar days before commencing any excavation, documentation that utility clearance was performed in accordance with Part 3.1 of this Section.

B. Submit a Dewatering Plan for the various phases of the Work to OWNER for approval within 10 business days of contract authorization. This Dewatering Plan may require updating as needed to address site conditions after the start of Work. The CONTRACTOR must comply with local, state, and federal guidelines for water management where applicable.

PART 2 - PRODUCTS

[Not Used]

PART 3 - EXECUTION

3.1 PREPARATION

A. CONTRACTOR is responsible for all aspects of worker safety during excavation and grading activities.

B. Institute health and safety monitoring (i.e., air quality monitoring) if excavating through waste.

C. Identify required lines, levels, grades, and datum by survey.

D. Establish by survey the control for excavation shown on the grading plan.

E. Locate, identify, and protect Site and public utilities from damage. Notify Utility Notification Center to locate public utilities, if applicable.

F. Implement erosion and sedimentation control plan before beginning excavations.

G. Prior to any excavation notify OWNER.

H. Provide dust control to prevent visible dust.

I. Protect benchmarks and erosion control facilities from excavation equipment and vehicular traffic.

J. Protect all existing infrastructure located within the Work area.

K. Notify OWNER of unexpected subsurface conditions and discontinue affected Work until notified by OWNER to resume.

L. Complete all required clearing, stripping, and grubbing per Section 02110.

M. Survey surface of project area to establish basis for determining excavation and fill quantities.

3.2 SUBGRADE EXCAVATION AND GRADING

A. Grade top perimeter of excavation to prevent surface water from draining into excavation.

B. Excavate to the lines, grades, and elevations shown on the Construction Drawings.

C. Haul and stockpile excavated materials to the locations selected by the OWNER. CONTRACTOR can reuse excavated soil provided the material meets the requirements listed in the respective technical specifications.

D. Remove lumped subsoil, boulders, and rocks greater than 3 inches in largest dimension from completed subgrade surface.

E. Over-excavated or eroded areas below the subgrade elevation shall be backfilled in accordance with the requirements of Section 02300.

3.3 TRENCH EXCAVATION

A. Trench excavation shall follow the alignment shown on the Construction Drawings

B. Excavation to a greater depth than shown on the Construction Drawings may be required if the native material at the bottom of the trench will not provide proper support for the structure. The need for over excavation shall be demonstrated through relevant field testing and approved by the CQA Organization.

C. The CONTRACTOR shall use appropriate means, methods and/or techniques to control the widths of trenches and roughness of trench walls

D. If the trench width exceeds the limits shown on the Construction Drawings, the CONTRACTOR shall be responsible for all extra Work and changed conditions resulting from widening the excavation.

E. The CONTRACTOR is responsible for all extra Work or changed conditions resulting from inadequate dewatering techniques which cause the trench bottom to fail to provide proper support for the structure.

F. Excavations shall be large enough to make joints and permit inspection by the OWNER or Engineer.

3.4 DEWATERING

A. CONTRACTOR shall be prepared to dewater during the duration of the project and shall follow the approved Dewatering Plan as needed.

B. CONTRACTOR dewatering shall consider construction sequencing and seasons.

C. CONTRACTOR dewatering shall not affect existing structures and improvements.

D. CONTRACTOR dewatering liquids within the Landfill footprint shall be considered leachate and will be disposed of as directed by the OWNER.

E. CONTRACTOR shall dispose of groundwater resulting from excavations as required by state and federal regulations and as approved by the OWNER.

F. Dewatering is considered incidental to the project Work and its cost shall be included in appropriate Bid Items.

3.5 FIELD CONSTRUCTION QUALITY CONTROL (CQC)

A. Provide for visual inspection of surfaces.

B. No earthwork or bedding or backfill shall be placed on any excavated subgrade or trench bottom until the excavated subgrade is approved by the OWNER.

C. Perform as-built surveys as required to document excavation limits.

D. Unless otherwise noted, tolerances are:

1. 1. Horizontal ≤0.5 foot
2. 2. Vertical ≤0.1 foot

E. Field Measurements

1. Verify that survey benchmarks are consistent with the design.
2. Verify quantities of excavation as required by the Measurement & Payment requirements of the Contract Documents.

END OF SECTION

SECTION 02223

REFUSE REMOVAL

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Refuse removal and relocation that is required during excavating, grading, trenching, or other construction activities.

1.2 RELATED SECTIONS

A. Section 02221 – Excavating and Trenching

B. Section 02225 – Subgrade Preparation

C. Section 02350 – Odor Control During Construction

PART 2 – MATERIALS

[Not Used]

PART 3 – EXECUTION

3.1 REFUSE REMOVAL AND RELOCATION

A. Refuse may be encountered during construction.

B. CONTRACTOR shall attempt to use excavated refuse as fill to regrade areas where fill is required as part of the Initial Grading to prepare the subgrade for placement of the Foundation Layer soil.

C. Dispose of refuse that cannot be used to regrade subgrade area per Part 3.1(B) at OWNER-approved location on the top deck.

D. CONTRACTOR shall control surface water in areas of open excavation so that leachate generation and leachate run-off is avoided.

E. CONTRACTOR shall be ready to control odors in accordance with Section 02350 and shall pump liquids as needed.

F. CONTRACTOR shall dispose of liquids at locations approved by the OWNER.

G. Areas of excavated refuse that have reached design slopes shall be covered at the end of each working day with appropriate soil (e.g., Foundation Soil) as shown on the Construction Drawings.

H. Areas of excavated refuse that have not reached design slopes shall be covered at the end of each working day with soil or methods such as tarps, etc., as approved by the OWNER.

I. Relocated refuse below the Foundation Layer shall be placed in lifts no thicker than 1-foot. The lifts shall be compacted using a CAT 826 compactor, or OWNER approved equivalent, to make a minimum 5 passes over the relocated refuse lifts.

END OF SECTION

VISTA

SECTION 02225

SUBGRADE PREPARATION

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Final grading the Foundation Layer soil to prepare for placement of geosynthetics.

1.2 RELATED SECTIONS

A. Section 02221 – Excavating and Trenching.

B. Section 02300 – Earthwork.

C. Section 02771 – Geotextile.

D. Section 02778 – Geomembrane.

1.3 REFERENCES

A. ASTM D1557 - Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort [56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)].

B. ASTM D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.

C. ASTM D2937 - Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.

D. ASTM D4318 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.

E. ASTM D4643 - Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating.

F. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

G. Unified Soil Classification System.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Earthwork: Section 02300.

B. Excavating and Trenching: Section 02221.

2.2 UNSUITABLE MATERIAL

A. Soil existing within the limits of Work that is unsuitable for composite liner subgrade material as determined by OWNER. Examples of unsuitable soil include soil contaminated by organic materials or soil that has become saturated due to rainfall.

B. Material with an exposed protruding particle size larger than 0.5 inches.

PART 3 – EXECUTION

3.1 FINAL GRADING

A. Grade subgrade (i.e., Foundation Layer) surface to vertical tolerances based on slope grades as follows:

1. Minimum slope grade of 5 percent, 10 percent preferred.
2. Maximum slope grade of 3H to 1V or 3.5H to 1V, as appropriate for areas shown on the Construction Drawings.

B. Prepared subgrade shall be compacted as specified in Section 02300.

C. Finish surface by rolling with a steel drum roller or other method that removes vertical surface protrusions, ruts, and holes greater than 0.5 inches.

D. Excavated areas not satisfying the compaction requirement or yielding excessively when rolled with smooth drum roller shall be over-excavated 6 inches or more, as determined by the OWNER, and backfilled with compacted clean soil material, per Section 02300.

E. Before placing any materials in areas of the subgrade where excessive moisture is encountered, place a separator geotextile, gravel, and another separator geotextile (Note: pipes to drain the water may also be necessary). CONTRACTOR may need to dewater the area during construction.

F. Remove all debris and observable rocks or clods greater than 0.5 inches protruding from the completed subgrade surface.

G. Completed surface should provide for continuous, intimate contact with the overlying geosynthetics.

H. All grade breaks must have a minimum radius of 1 foot.

I. CONTRACTOR is responsible for maintaining the prepared subgrade until the INSTALLER has accepted the subgrade for the overlying geosynthetics.

J. After acceptance of the subgrade, the CONTRACTOR is responsible for surface water control so that run-off or run-on do not damage the already-deployed geosynthetics or the prepared subgrade. Coordination with the INSTALLER is required.

3.2 ANCHOR TRENCH PREPARATION

A. Anchor trenches shall be excavated to the grades and dimensions as specified on the construction plans.

B. Anchor trenches shall be straight and uniform with no rough edges.

C. The inside edge of the anchor trench shall be rounded and smooth.

D. Anchor trenches shall be free of sharp objects and other deleterious material.

3.3 FIELD CONSTRUCTION QUALITY ASSURANCE

A. CQA Monitor will determine optimum moisture content and maximum density of finished subgrade per ASTM D1557.

B. CQA Monitor will determine in place density and moisture content of engineered fills using one or more of the following methods: ASTM D2937, or ASTM D6938.

C. Cooperate fully with the CQA Monitor in their performance of soil sampling and compaction control tests.

3.4 RECORD SURVEY

A. Perform a record survey of completed subgrade surface per the requirements outlined in Section 01052.

B. Document as-built elevations at a minimum 50-feet grid and at grade breaks.

C. Review survey data to confirm grading criteria and tolerances have been met before covering with geosynthetic materials.

D. Submit final data to OWNER within three days of confirming grading criteria is met.

END OF SECTION

SECTION 02300

EARTHWORK

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, equipment and incidentals necessary to perform all excavation, backfill, fill, and grading required to complete the work shown on the Construction Drawings and specified herein.

B. Placing and compacting soil for earthen fill, which includes:

1. Anchor trench backfill.
2. Foundation layer soil (final cover).
3. Vegetative layer soil (final cover).

C. Work includes the excavation, moisture-conditioning (disking, drying, etc.), segregation, stockpiling, placing, and handling of soils to allow the construction of the project.

D. Installing drainage gravel above and below the subdrain pipes.

E. Installing granular drainage material at other locations shown on the Construction Drawings.

F. Installing rip rap along the cover termination at the top of the MSE wall.

G. Installing rip rap in swales and stone in the gabion baskets.

H. Installing rip rap lined low-water crossings, downchutes, and outlet protection aprons.

1.2 RELATED SECTIONS

A. Section 02219 – Stockpiling and Soil Management

B. Section 02221 – Excavating and Trenching

C. Section 02223 – Refuse Removal

D. Section 02225 – Subgrade Preparation

E. Section 02235 – Dust Control and Work Area Maintenance

F. Section 02350 – Odor Control

G. Section 02370 – Erosion and Sedimentation Control

H. Section 02580 – Gabions

I. Section 02610 – Culvert Pipe

J. Section 02710 – Polyethylene Pipe

K. Section 02771 – Geotextile

L. Section 02779 – Geomembrane

M. Section 02920 - Vegetative Soil, Hydroseeding and Turf Establishment

N. Section 02950 - Cleanup and Site Restoration

1.3 REFERENCES

A. Construction Drawings.

B. Latest (and applicable, depending on materials being tested) version of the ASTM International standards:

1. ASTM D 422 – Standard Test Method for Particle-Size Analysis of Soils.
2. ASTM D 1140 – Standard Test Methods for Determining the Amount of Material Finer than 75-µm (No. 200) Sieve in Soils by Washing.
3. ASTM D 1556 – Standard Test Method for Density and Unit Weight of Soil in Place by Sand-Cone Method.
4. ASTM D 1557 – Standard Test Method for Laboratory Compaction Characteristics of Soil using Modified Effort (56,000 ft-lb f/ft^3 (2,700 kN-m/m^3)).
5. ASTM D 2216 – Standard Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
6. ASTM D 2434 – Standard Test Method for Permeability of Granular Soils (Constant Head).
7. ASTM D 2487 – Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).
8. ASTM D 2488 – Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
9. ASTM D 2937 – Standard Test Method for Density of Soils by the Drive Cylinder Method.
10. ASTM D 4221 – Standard Test Method for Dispersive Characteristics of Clay Soil by Double Hydrometer.
11. ASTM D 4318 – Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
12. ASTM D4643 - Standard Test Method for Determination of Water (Moisture) Content of Soil by the Microwave Oven Heating.
13. ASTM D 5084 – Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials using a Flexible Wall Permeameter ASTM D-5321 Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by Direct Shear.
14. ASTM D 6243 – Standard Test Method for Determining the Internal and Interface Shear Strength of Geosynthetic Clay Liner by the Direct Shear Method.
15. ASTM D 6913 – Standard Test Methods for Particle-Size Distribution (Gradation of Soils Using Sieve Analysis.
16. ASTM D6938 - Standard Test Methods for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

C. Unified Soil Classification System.

1.4 SUBMITTALS

A. Submit representative 50 pound samples of the proposed material within 10 calendar days after Contract award.

PART 2 – MATERIALS

2.1 ANCHOR TRENCH BACKFILL

A. Anchor trench backfill shall consist of soils free from landfill waste, organic materials, and other materials that may be highly compressible, or that cannot be properly compacted.

B. Shall not contain blocks, broken concrete, masonry rubble, debris, expansive soil, or other deleterious material.

C. Maximum particle size of ⅜ in. in largest dimension.

2.2 FOUNDATION LAYER SOIL

A. Foundation layer soil shall be used to provide an 18-inch-thick soil layer above the top of waste, which may include the existing intermediate cover soil.

B. Due to the nature of the Project, localized deviations from the target thickness will be accepted.

C. Foundation layer soil shall be composed of general fill consisting of soil free from organic materials, loam, wood, rubble, broken concrete, trash, and other objectionable materials that may be compressible, or that cannot be properly compacted or can damage the overlying geomembrane.

D. In the top 6 inches of compacted foundation layer, the maximum particle size shall not exceed ⅜-inch in largest dimension. Below the top 6 inches of compacted foundation layer, the maximum particle size shall not exceed 3 inches.

2.3 VEGETATIVE LAYER SOIL

A. Organic soil placed above the final cover geosynthetics to provide an 18-inch thick layer for the purpose of supporting vegetation.

B. Due to the nature of the Project, localized deviations from the target thickness will be accepted.

C. Natural soil (i.e., not recycled or from waste materials), from off-site sources, and free of excess moisture.

D. Classified as a CL or ML by the Unified Soil Classification System.

E. Maximum particle size shall not exceed 2-inch in largest dimension.

F. Free of wood, rubble, broken concrete, trash, and other objectionable materials that can damage the underlying geosynthetics.

G. Free from ice, snow, roots, sod, rubbish, and other deleterious matter.

H. Hydraulic conductivity $\leq 1.4 \times 10^{-4}$ cm/sec under 5 psi confining pressure, when compacted at 85 percent of the maximum dry density per ASTM D1557 at the optimum moisture content.

2.4 SUBDRAIN GRAVEL

A. Material to be used to construct the subdrain trenches and surround the subdrain pipes.

B. Free of organic or other deleterious material.

C. Material shall be within the following gradation limits:

U.S. Sieve Size	Percent Passing
1 -inch	100
⅜-inch	0-5
No. 200	0-2

D. D85 size is greater than ½-inch.

2.5 ROAD BASE COURSE

A. The material used to surface the access ramp.

B. Conforming to Oregon Standard Specifications for Construction (2018) Section 02630.

C. Free of organic or other deleterious material.

D. Manufactured from ledge rock, talus, or gravel.

E. The material shall consist of crushed gravel within the gradation limits of the following table.

U.S. Sieve Size	Percent Passing
1 1/2 -inch	100
¾-inch	55 - 75
1/4-inch	35-50
No. 10	40 to 60 percent of material finer than ¼ inch to pass No. 10

2.1 ROAD CRUSHED GRAVEL

A. The material used to surface the access ramp.

B. Free of organic or other deleterious material.

C. The material shall consist of crushed gravel within the gradation limits of the following table.

D. At least 40 percent by weight of the particles retained on the Number 4 sieve shall have at least one fractured face. Naturally fractured faces may be included in the 40 percent requirement, provided the roughness and angularity produce strength characteristics equivalent to mechanically fractured faces.

U.S. SIEVE SIZE	PERCENT PASSING
1-inch	100
3/8-inch	55-75
¼-inch	40-60
No. 10	40 to 60 percent of material finer than ¼ inch to pass No. 10

2.2 DRAINAGE STONE

A. Drainage Stone shall be used for the construction of the access road crossing of the asphalt ditch and fill the space around the culvert pipes.

B. Drainage stone shall be well-graded crushed or uncrushed rock or gravel meeting the requirements of the Oregon Department of Transportation (ODOT) Standard Specifications for Construction Section 02690.20(d) and the following gradation requirements, as specified under Section 00430.11 Granular Drain Backfill Material:

SIEVE SIZE	PERCENT FINER BY WEIGHT
2-inch	100
1-1/2-inch	95-100
3/4-inch	0-15
1/2-inch	0 – 2

2.3 RIP RAP AND ROCK EROSION PROTECTION

A. Rip rap shall be used for final cover terminations as indicated on the Construction Drawings.

B. Free of organic material, debris, excessive moisture, and other deleterious material.

C. Do not use materials that break up when alternatively frozen and thawed or wetted and dried.

D. Comprised of angular to sub-angular hard basalt rock or approved alternative and processed as needed to meet the following gradation.

U.S. SIEVE SIZE	PERCENT PASSING BY WEIGHT
6 – inch	100
3 – inch	0 – 25
1 – inch	0 – 10
#200	3 maximum

PART 3 – EXECUTION

3.1 PREPARATION

A. Verify soil meets requirements for compacted soil before commencing work.

B. Where excessive moisture is encountered in the subgrade, consider installing a dewatering system before placing any material above areas of the subgrade.

C. CONTRACTOR shall be prepared to shore the excavations.

D. Liquids from dewatering shall be disposed as required by the State of Oregon regulations and the CONTRACTOR's Dewatering Plan.

E. If required by OWNER, prior to beginning soil placement, demonstrate that placement techniques will not damage the adjacent geosynthetic materials.

F. Prior to beginning granular drainage material placement, CONTRACTOR shall provide methodology for placing granular drainage material so that the underlying geosynthetic materials are not damaged.

3.2 EXCAVATION BELOW GRADE

A. Excavation shall be made to the grades shown on the Drawings and to such widths as will give suitable room for construction of the structures and for bracing and supporting (if necessary) or cutting back to safe slopes. The bottom of the excavations shall be rendered firm and dry and, in all respects, acceptable to the Engineer and OWNER.

B. When excavation has reached prescribed depths, the Engineer shall be notified and will inspect conditions. If materials and conditions are not satisfactory to the Engineer and OWNER, the Engineer or OWNER will notify the CONTRACTOR to correct the condition(s).

C. If, in the opinion of the Engineer or OWNER, the material in its undisturbed natural condition, at or below the normal grade of the excavation as indicated on the Drawings is unsuitable, it shall be removed to such depth and width and replaced with suitable material as directed by the Engineer or OWNER. The CONTRACTOR shall be responsible for the removal, relocation and stockpiling of unsuitable material in the area designated by the OWNER or Engineer. Unsuitable material is classified here as stumps, excessively wet soil, ledge rock, ice, topsoil, subsoil, organics, existing fill, or other deleterious material.

D. If the bottom of an excavation within the landfill area is extended below the limits shown on the Drawings or specified or directed by the Engineer or OWNER, it shall be refilled at the CONTRACTOR's expense with fill specified by the Engineer.

E. The CONTRACTOR shall use a flat-edge excavator or backhoe bucket and may need to use hand shovels to excavate to expose the existing geosynthetic materials at the connection to existing geomembrane liner or cap material. This excavation activity shall not damage the existing geosynthetics. Damage to geosynthetics will be repaired at the CONTRACTOR's expense. This excavation shall be maintained accessible and free of excessive water, soil, or other deleterious material until the new geosynthetics can be installed.

3.3 PLACEMENT – GENERAL REQUIREMENTS

A. Perform dust control and odor control as required incidental to actual earthwork component.

B. Scarify, moisture-condition, and compact surfaces that will receive fill to a minimum of 90 percent of maximum dry density in accordance with ASTM D 1557. CQA Organization shall perform the modified Proctor test (ASTM D 1557) for the existing interim cover soil and nuclear density-moisture testing after compaction (ASTM D 6938).

C. Scarify (and moisture-condition if needed) the top of each compacted lift before placing subsequent lift.

D. Bench or key compacted soil into existing subgrades and side slopes. Provide bench widths equal to or greater than the compaction equipment.

E. Areas inaccessible to large compaction equipment shall be compacted with small mechanical or vibratory compactors.

F. Do not place fill under water.

G. Repair all eroded or desiccated soil areas before placing subsequent lifts.

H. Compacted lift thickness shall not exceed 6 inches.

I. Loose lift thickness shall not exceed 8 inches.

J. Grade final compacted soil surfaces to remove ruts and gouges. Finish compacted soil above grade by track-walking perpendicular to slope contours so that track marks are parallel to the contours.

K. Smooth-drum-roll the top of the foundation layer.

L. Tolerances:
   1. Minimum slope = 5%
   2. Maximum slope = 3.5H to 1V or 3H to 1V, as shown on Construction Drawings.

M. CONTRACTOR shall sequence the work so that the various materials can be placed in tandem and alternate lifts.

N. Backfill surface shall be graded to avoid ponding or overtopping by stormwater run-off. At the end of each day's work, the fill shall be worked such that positive drainage off the working platform is maintained.

O. CONTRACTOR is made aware that piping and other appurtenances such as anchor trenches and liner components need to be placed as the final cover is constructed; therefore, staging and sequencing of the various materials will be necessary.

P. Surfaces that will receive liner components need to meet the requirements for subgrade preparation in Section 02225.

3.4 PLACEMENT - ANCHOR TRENCHES (AND TERMINATIONS)

A. Place geosynthetic materials in the anchor trenches as shown in the Construction Drawings.

B. Compact backfill to a minimum of 90 percent of maximum dry density and at moisture contents between –3 and +3 percentage points of the optimum moisture content as determined by ASTM D1557.

C. Do not place fill if anchor trench has water in it.

D. Scarify the top of each compacted lift before placing subsequent lift.

E. Place and compact fill to the lines, grades, cross sectional requirements, and dimensions shown on the Construction Drawings.

F. Grade final fill surfaces to remove ruts and gouges.

G. Finish fill above grade by wheel-rolling with an articulating dump truck (ADT), or OWNER approved equivalent, along the length of the anchor trench.

3.5 PLACEMENT –FOUNDATION LAYER AND VEGETATIVE LAYER SOILS

A. Foundation Layer Soil - shall be placed in maximum 8-inch thick loose lift and compacted to 90 percent of the maximum dry density as determined by ASTM D 1557.

B. Vegetative Layer Soil - shall be placed and compacted to 85 percent of the maximum dry density as determined by ASTM D 1557.

C. Construction equipment shall not be operated directly upon geosynthetics – see Part 3.7 of this Section for more details.

D. Manual compaction equipment shall be used within 4 feet of the face of the MSE Wall.

E. A loose soil thickness of at least 12 inches shall be maintained over the geosynthetics in order to operate low ground pressure (LGP) tracked vehicles. Turning of tracked vehicles should be limited to prevent tracks from displacing the soil and damaging the underlying geosynthetics.

F. Backfill surface shall be graded to avoid ponding or overtopping by stormwater run-off.

G. Soil shall be placed over the geosynthetics in a manner that minimizes the development of wrinkles in and/or movement of the geosynthetics. At the end of each day's work, the fill shall be worked such that positive drainage off the working platform is maintained.

3.6 PLACEMENT – GRANULAR MATERIAL

A. Place materials only when underlying excavations, foundations, and geosynthetic installations are complete and accepted by OWNER in accordance with Specifications.

B. Place to lines and grades shown on the Construction Drawings.

C. Place to the uniform thickness shown on the Construction Drawings.

D. Place without damaging underlying geosynthetics.

E. Do not cause underlying geosynthetics to bridge across ditch alignments or pipe alignments. If bridging does occur, repair by installing additional compensating geosynthetic materials at no additional cost to the OWNER.

3.7 EQUIPMENT FOR PLACING SOIL AND GRANULAR MATERIAL OVER GEOSYNTHETICS

A. Equipment used for placing soil and granular material shall not be driven directly over geosynthetics. A minimum thickness of 1 foot of soil material is required between an LGP bulldozer (Caterpillar D-4H LGP bulldozer or equivalent) and underlying geosynthetics. A minimum thickness of 3-feet of material is required between rubber-tired vehicles and underlying geosynthetics. Equipment shall place material without braking. In areas of heavy vehicle traffic, such as access ramps, the material thickness should be at least 3 feet. In all circumstances, the following table shall be complied with during construction:

MAXIMUM EQUIPMENT GROUND PRESSURE (PSI)	INITIAL LIFT THICKNESS (FT)
5	1.0
10	1.5
20	2.0
>20	>3.0

3.8 FIELD CONSTRUCTION QUALITY ASSURANCE (CQA)

A. The OWNER will perform CQA services (observation, inspection, testing) during earth-fill and granular drainage material placement in accordance with the CQA Plan.

B. CONTRACTOR shall cooperate fully with the OWNER in scheduling and performing field CQA tests and inspections, including the collection of samples. Include costs for coordination and assistance in unit prices.

END OF SECTION

SECTION 02350

ODOR CONTROL DURING CONSTRUCTION

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. The CONTRACTOR shall conduct operations to control odors during construction activities.

1.2 RELATED SECTIONS

A. Section 02221 – Excavating and Trenching

B. Section 02223 – Refuse Removal

C. Section 02225 – Subgrade Preparation

PART 2 - PRODUCTS

2.1 MATERIALS

A. Odor neutralizing agents and portable misting system shall be provided by OWNER for use by CONTRACTOR as needed. CONTRACTOR to verify equipment is operational prior to use.

PART 3 - EXECUTION

3.1 GENERAL

A. The CONTRACTOR shall implement odor control measures during any construction activities that cause odors, especially before and during intrusive work.

B. The CONTRACTOR shall be responsible for ensuring the odor control equipment is available and in working condition available on all working days, maneuvering the equipment as necessary based on wind direction or source of odor, and replenishing the equipment with water and odor control agent.

C. The CONTRACTOR shall be responsible for locating the portable misting system downwind of their operations on a daily basis. The system shall be moved as the construction location changes.

D. The area of exposed refuse shall be limited to the degree practical. Trench excavations shall be limited to the length of trench that may be backfilled in the same day. Waste shall not be left exposed overnight.

E. Odor neutralizing agent shall be applied directly onto odorous spoils in accordance with the manufacturer's specifications.

F. Excavated refuse shall be hauled promptly areas in the Project area requiring fill material to develop required slopes or to OWNER-designated location on the top deck outside the Project area.

G. All excavated refuse shall be placed and covered in a designated area before the end of each working day.

H. In lieu of the misting system, odor control may be accomplished by spraying directly on odorous spoils, into trenches, and at the top of well boreholes. This method shall be used on odorous spoil piles if the misting system is not effective. To limit potential implications to worker health and safety, spraying an odor neutralizing solution directly in the Work area shall not occur while construction activity (i.e., header pipe installation, gas well installation, etc.) is in progress at such locations. In those instances, the portable misting system shall be positioned downwind of the construction activity and located only as close to active work areas as possible without creating a potential hazard for workers working in those areas.

END OF SECTION

SECTION 02370

EROSION AND SEDIMENTATION CONTROL

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. Furnish all labor, materials, tools, and equipment, and perform all operations necessary for erosion and sedimentation control work indicated on the Construction Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED ELSEWHERE

A. Section 02300 – Earthwork

B. Section 02920 – Vegetative Soil, Hydroseeding and Turf Establishment

C. Section 02223 – Refuse Handling

1.3 REFERENCES

A. Facility Industrial Stormwater General Permit No. 1200-Z

1.4 PROJECT CONDITIONS

A. The site operates under Oregon NPDES 1200-Z Permit. As of August 1, 2017, the state has issued coverage under NPDES 1200-Z Industrial Stormwater General Permit, EPA Number ORR501547, File Number 106959. The CONTRACTOR shall review approved site Stormwater Pollution Control Plan (SWPCP), dated December 2017 (Revised June 2021). The SWPCP contains a detailed description of the site stormwater management system and monitoring requirements. A copy of the plan is available from the OWNER.

B. A construction-specific SWPCP shall be prepared by the CONTRACTOR and submitted to the OWNER for approval.

C. The CONTRACTOR shall implement and maintain erosion and sedimentation control measures as shown on the Construction Drawings, and as required by the OWNER or Engineer from the start of construction until provisional acceptance of seeded areas, to prevent erosion and sedimentation.

D. No stockpiling or staging of materials or equipment shall be allowed within the flood plain.

E. Earthmoving activities in the project area, the surrounding landfill areas, and the stockpile areas shall be conducted in such a manner as to prevent erosion and the resulting sedimentation.

F. The CONTRACTOR shall perform erosion and sediment (E&S) inspections and maintain documentation throughout construction. The CONTRACTOR shall perform routine housekeeping, implement a preventative maintenance program, and properly document his activities. Inspections shall occur at a minimum of once every two weeks or during/after a run-off-producing storm, including run-off from snow melt.

G. The CONTRACTOR shall use Best Management Practices (BMPs) to prevent or minimize stormwater exposure to pollutants from waste handling, spills, equipment fueling, etc.

H. At the end of each work day, soil stockpiles shall be stabilized, covered, or other BMPs implemented to prevent discharges to surface waters. The CONTRACTOR shall prevent tracking of sediment onto roads using BMPs. The CONTRACTOR shall notify the OWNER immediately of any release of sediment or spills and the methods to be used to remediate the impacted area.

I. Disturbed areas shall be revegetated in accordance with Section 02920.

1.5 GENERAL METHODOLOGY

A. Erosion and sedimentation control methods shall consider all factors that contribute to erosion and sedimentation including, but not limited to, the following:

1. Topographic features of the Project area.
2. Types, depth, slope, and areal extent of the soils.
3. Proposed alteration of the area.
4. Amount of run-off from the Project area, borrow areas, and the upgradient watershed areas.
5. Staging of earthmoving activities.
6. Temporary control measures and facilities for use during earthmoving.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Hay Bales.

1. Consist of rectangular-shaped bales of straw weighing at least 40 pounds per bale.
2. Free of primary noxious weed seeds.

B. Fiber Rolls (Straw Wattles)

1. Fiber Rolls or Straw Wattles shall be a minimum 8 inches in diameter.
2. Install perpendicular to water movement (parallel to the slope contour).
3. Roll ends shall be overlapped 12 inches to ensure no gaps in protection and turned up-slope to prevent runoff from flowing downslope.
4. Rolls shall be adequately fastened to surfaces in accordance with Oregon Department of Transportation's (ODOT's) Erosion Control Manual.
5. Installation and removal of wattles shall be completed in such a way as to prevent damaging materials below the ground surface (e.g., geomembrane).

C. Erosion Control Matting

1. Erosion Control Matting shall be a Type B fully biodegradable slope protection mat for slopes 1H:3V or flatter, in accordance with ODOT's Erosion Control Manual.
   a. Channel or Swale Liner Matting Applications:
      1) Seed prior to installation of matting.
      2) Lengthwise overlap: Min. 12-inch shingle type overlap starting at bottom of channel. Crosswise overlap: Min. 6-inch.
      3) Staple all matting edges at 12-inch O.C. Staple matting field in triangle pattern at 24-inch O.C.

4) Anchor upstream end of mat in anchor trench. Do not join material in center of ditch or swale.
5) Install matting so it has intimate contact with the soil surface.

b. Slope Matting Applications:
1) Seed prior to installation of matting.
2) Lengthwise overlap: Min. 2-feet. Crosswise overlap: Min. 6-inch.
3) Staple all matting edges at 12-inch O.C. Staple matting field in triangle pattern at 24-inch O.C. On slopes flatter than 1H:3V, rolls can be placed in horizontal strips.
4) At top of slope, entrench material in an anchor trench per ODOT's Erosion Control Manual.
5) At bottom of slope, extend mat 2-feet. beyond the toe of the slope, turn material under 4-inch.
6) Install matting so it has intimate contact with the soil surface.

D. Hydroseeding

1. See Section 02920 for hydroseeding.

E. Mulch

1. Consist of cured straw free from primary noxious weed seeds, twigs, debris and rough or woody materials.
2. Free from rot or mold and shall be acceptable to the Engineer or OWNER.
3. Alternately, mulch shall be specially processed cellulose homogeneous fiber containing no growth or germination-inhibiting factors. Processed cellulose fiber shall be manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material become uniformly suspended to form a slurry when sprayed on the ground. The material shall allow homogeneous absorption and percolation of moisture. Each package of the cellulose fiber shall be marked by the manufacturer to show the air-dry weight content.
4. Mulch shall be used on all newly graded subgrade and vegetative soil areas that cannot be seeded within five (5) days.

F. Silt Fence

1. Silt Fence shall only be installed with OWNER permission.
2. Silt Fence shall be a woven polypropylene and/or polyester material that meets the requirements tabulated below as determined according to ASTM D 4759 "Practice for Determining the Specification Conformance of Geosynthetics."
3. The geotextile shall be securely fastened to posts a minimum of 4 feet long spaced between 4 and 6 feet apart.

Fabric Property	Test Method	Fabric Requirement
Tensile strength, lbs	ASTM D 4632 Grab	100 minimum
Elongation at 50% minimum tensile strength	ASTM D 4632 Grab	50% maximum

FABRIC PROPERTY	TEST METHOD	FABRIC REQUIREMENT
Permittivity, gal/min/ft^2	ASTM D 4491	5 minimum
Apparent opening size, mm	ASTM D 4751	0.85 maximum
Ultraviolet degradation at 500 hours	ASTM D 4355	minimum 70% strength retained

PART 3 – EXECUTION

3.1 CONSTRUCTION SEQUENCE

A. Construction of erosion control measures will be completed prior to any other site work.

B. Install erosion and sediment control best management practices (BMPs) according to the most current edition of the Oregon Department of Environmental Quality's (ODEQ) Erosion and Sediment Control Manual.

C. Sediment barriers shall be used at storm drain inlets; across minor swales and ditches; and at other applications where the structure is temporary and structural strength is not required. Sediment barriers are temporary berms, diversions, or other barriers that are constructed to retain sediment on-site by retarding and filtering storm run-off.

D. All temporary erosion control measures will be maintained throughout the course of site construction activities until provisional acceptance of the site vegetation by the Engineer or OWNER, at which time the CONTRACTOR shall remove all remaining temporary erosion control structures, and properly dispose of accumulated sediment at temporary or permanent erosion control structures on-site in areas approved by the OWNER.

E. The Engineer or OWNER may order that additional erosion and sediment controls be installed or that temporary erosion and sediment controls be replaced. The CONTRACTOR shall comply with Engineer's or OWNER's request and immediately install the required controls.

3.2 CONSTRUCTION METHODS

A. Silt fence, straw wattles, and/or staked hay bales shall be installed at the site down-gradient of work areas as directed by OWNER or Engineer in the field and as shown on the project drawings.

1. The silt fence shall be installed in accordance with manufacturer's instructions.
2. Hay bales shall be staked as shown on the Drawings or approved by the Engineer.
3. The base of all hay bales and silt fencing shall be embedded to the depths shown on the Drawings.
4. **Staked hay bales and silt fence shall not be installed above geomembrane covered areas.**

B. Straw mulch shall be applied at a rate of 100 lbs/1,000 ft^2. Straw mulch shall be 100% tracked-in using a bulldozer traveling up and down the fall line of the slope.

C. On slopes, the CONTRACTOR shall provide protection against washouts by an approved method. Any washout that occurs either in the CONTRACTOR's work area or in areas topographically below his work shall be regraded and if the area had been seeded, it shall be re-seeded at the CONTRACTOR's expense until an accepted vegetative stand is established.

END OF SECTION

SECTION 02402

HYDROTURF® CS ENGINEERED TURF

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes:

1. Specifications for the Engineered Turf component (Turf Type 1) of the HydroTurf® CS System.
2. Installation.

1.2 RELATED SECTIONS

A. Section 02778 – Geomembrane

B. Section 02225 – Subgrade Preparation

C. Section 02300 – Earthwork

D. Section 02401 – HydroTurf Hydrobinder Infill

1.3 SUBMITTALS

A. MANUFACTURER

1. MQC Testing – Engineered Turf Component
   a. Certificate of Compliance: Certificate of Compliance shall indicate that the engineered turf meets or exceeds the property values in Table 1. Also, the turf fiber color / blend shall be indicated.
   b. Provide inspection records of the tufting procedures for every 300,000 sq.ft. of Engineered Turf, including:
      1) Inspection records that indicate the following properties as they relate to Section 2.01 – Engineered Turf:
         a) Tufting Gauge.
         b) Pile height.
         c) Roll length and roll numbers.
         d) Total product weight.
         e) Tensile Strength Product (lbs./ft.) (MARV) ASTM D 4595.
         f) Tensile Strength of Yarn (lbs.) (MARV) ASTM D 2256.

B. GEOSYNTHETICS INSTALLER

1. Prior to beginning the installation of the HydroTurf CS System, INSTALLER shall submit the following:
   a. Verify in writing that INSTALLER'S personnel have the following experience:
      1) Geotextile seamers shall have installed at least 1,000,000 square feet of like materials.
   b. OWNER shall be responsible for approving resumes and qualifications of INSTALLER personnel.

c. INSTALLER personneL shall attend HydroTurf CS orientation prior to starting the work.

C. PRODUCT DATA

1. Refer to Section 2.0 for the Engineered Turf specifications applicable to this project and an integral part of the product specifications.

PART 2: PRODUCTS

2.1 ENGINEERED TURF – HYDROTURF CS

A. Manufacturer: Shaw Industries, Inc.

1. The engineered turf component shall meet or exceed property values listed in Table 1 as an individual component and as the performance property for the HydroTurf CS system.
2. Engineered synthetic turf shall be supplied by Watershed Geosynthetics as a component of the HydroTurf CS Revetment System.

B. Substitutions

1. None

C. The engineered synthetic turf shall be comprised of the following components:

1. Polyethylene slit tape fibers; and
2. Two polypropylene backing geotextiles.

D. The polyethylene yarn shall conform to the color selected by the Owner per color coding provided under Section 1.04(A)(1).

Table 1 – Property Values for Engineered Turf Component (Turf Type 1) of HydroTurf CS System.

PROPERTY	TEST METHOD	VALUE
Engineered Turf Component		
Tufted Pile Height (inches)	ASTM D 5823	1.25 ± 0.25
CBR Puncture, lbs	ASTM D6241	800 (MARV)
Tensile Strength, MD/XMD, lbs/ft	ASTM D4595	1000 (MARV)
Pile Weight	ASTM D5848	19 ± 2.0 oz./sq. yd
Total Product Weight		25 ± 2.0 oz./sq. yd
Yarn	ASTM D 1577	Polyethylene Fibrillated Tape Fiber
Tensile Strength of Yarn	ASTM D2256	15 lbs min
Aerodynamic Evaluation	GTRI Wind Tunnel	120 mph with max. uplift of 0.12 lb/sf
UV Resistance and Stability of Synthetic Turf	ASTM G147 ASTM G7	>60% Retained Tensile Strength at 100-year exposure (projected)
Standard Roll Dimensions	15-ft (4.57-m) Wide x 300-ft (91.4-m) Long	
Roll Area (approximate)	4500 ft^2 (418-m^2)	

PROPERTY	TEST METHOD	VALUE
HydroTurf CS System Performance Properties		
Full-Scale Steady State Overtop Test	ASTM D7277 / ASTM D7276	40 ft/s of velocity
Manning's N Value	ASTM D7277 / ASTM D7276	0.017 – 0.020
Full-Scale Steady State Hydraulic Jump Test	Colorado State University (CSU)	Dissipates 30 horsepower per ft (min)
Full-Scale Wave Overtopping Test – Cumulative Volume	CSU Wave Simulator	165,000 ft^3/ft (min)
Full-Scale Wave Overtopping Test – Maximum Average Wave Discharge	CSU Wave Simulator	4.0 cfs/ft
Internal Friction of Combined Components (Low Confining Stress)	ASTM D 5321	23° min (peak) MicroSpike 33° min (peak) Super GripNet

PART 3: EXECUTION

3.1 INSTALLERS

A. Installer shall be trained by Watershed Geosynthetics, LLC.

3.2 INSTALLATION

A. Engineered turf component:

1. CQA Monitor shall verify that:

   a. Engineered Turf tufts are not excessively pulled out by the installation process; and

   b. After the first panel is deployed, all subsequent panels are deployed on top of the previous panel, seamed, and then flipped into position.

3.3 ENGINEERED TURF COMPONENT DEPLOYMENT

A. Prior to installation of Engineered Turf Component, the CQA Monitor must observe the following:

1. HydroTurf CS geomembrane component is complete.
2. The supporting surface (e.g., the geomembrane) is substantially free of debris or large scraps.

B. During deployment of Engineered Turf, the CQA Monitor must observe the following:

1. Observe the turf as it is deployed and record defects and disposition of the defects (i.e., panel rejected, patch installed, etc.).
2. That repairs are made in accordance with Section 3.05 and the HydroTurf Installation Guidelines.
3. Equipment used does not damage the turf or underlying geomembrane.
4. That all panels are deployed from the top of the slope in a way that the Engineered Turf filaments are pointing upslope after deployment is complete.
5. That the turf is anchored to prevent movement by the wind (the INSTALLER is responsible for any damage resulting to or from windblown Engineered Turf).
6. That the turf remains substantially free of contaminants.

7. That the turf is laid substantially smooth.
8. That on slopes, the turf is secured with sandbag anchoring at the top of the slope after deployment.
9. Fusion Seaming Method
    a. Engineered Turf fusion seaming device will be a DemTech VM20/4/A (Model No. VM-20/4/A Pro-Wedge Welder 120V, VM20 Outfitted with 100-KIT/4S/VC/A.2 Welding Kit, 4-in, 220V, S.S.) fusion welder only.
    b. Fusion seams require a minimum of 5 inches of overlap.
    c. Demonstrate the preparation methods and equipment utilized for removal of the salvage from the outside edge of the rolls of turf (i.e. trimming & cutting devices). Mechanical trimming and cutting devices will be utilized for salvage trimming. Box blades and knives shall not be utilized for salvage preparations. Fraying of geotextile strands when performing the removal of salvage is not acceptable.
    d. Frayed or loose edges and/or geotextile strands shall be cut off or removed.
    e. Since the temperature and speed controls of the DemTech VM-20 wedge welder are variable and can be increased / decreased depending on weather and environment conditions, the temperature and speed shall be confirmed with a trial seam. This trial seam shall be field tested. Trial seams shall be performed at the being of each day and during the day when the weather (i.e., temperature, humidity, etc.) conditions change.
    f. Trial seams shall be performed as outlined in the HydroTurf Installation Guidelines (most recent revision).
    g. Production field seaming shall be performed and verified in the same manner as trial seams. The field seams shall be inspected every hour at a minimum. This inspection of the field seams shall be the same as the inspection for the trial seams.
    h. Production fusion seams shall be continuous and have no gaps.
    i. Any damage and defects (including burnouts) that occur during production seaming will be repaired as outlined in Section 3.05 and HydroTurf Installation Guidelines (most recent revision).
    j. All seams not passing the visual inspection shall be repaired.
10. After seaming operations, the edges of the synthetic turf panels shall be sufficiently anchored with sandbags in the top of slope perimeter anchor trenches unless otherwise noted on the construction drawings.

3.4 EQUIPMENT ON THE TURF:

A. Construction equipment on the deployed synthetic turf shall be minimized to reduce the potential for synthetic turf material puncture. Small equipment such as generators shall be placed on scrap synthetic turf / geosynthetic material (rub sheets) above engineered synthetic turf.

B. During Construction:

1. On slopes exceeding 15%:
    a. No equipment will be allowed until HydroBinder Infill is in place.
2. On slopes less than 15%:

a. ATV type vehicles and/or rubber tracked skid steer machines will be allowed prior to infill placement if the tire / track ground pressure is less than 5 psi.

3. Equipment operators shall inspect equipment rubber tires or tracks for sharp protrusions from foreign matter or tire/track damage, embedded rocks, or other foreign materials protruding from tires/track prior to driving on the synthetic turf. Equipment travel paths driven on synthetic turf shall be as straight as possible with no sharp turns, sudden stops or quick starts.
4. Damage caused by having equipment on the engineered synthetic turf (i.e., tears, rips, punctures, wrinkles, ripples, movement, etc.) shall be the responsibility of the installer to repair.

C. Post installation, no equipment shall be allowed on the HydroTurf until HydroBinder Infill is fully cured for 28 days:

1. Driving should be limited and only in areas where the subgrade under the HydroTurf is well-compacted, firm and unyielding.
2. Drivability tire / track (ground) pressures should be limited to less than 35 psi. Rubber tire and/or tracked vehicles or equipment only.
3. On slopes flatter than 10%, allowable ground pressures may only be increased with the written approval of the CQA Organization.

D. Any activity that may be identified during construction by OWNER or CQA Organization as being a possible danger to the integrity of the HydroTurf CS system will prohibited regardless of any prior approval.

3.5 REPAIR AND TIE-IN PROCEDURES

A. ENGINEERED TURF COMPONENT:

1. When Repairs and Tie-Ins of Engineered Turf occur, the CQA Monitor must observe the following:
   a. Repairs to Engineered Turf are completed by using a 4-in overlapped heat-bonded seam.
   b. All tie-in seams along flatter slopes (i.e. 15% or less) with length greater than 25 feet will use an approved fusion welding machine so that consistent pressure is achieved throughout the seam.
   c. A hand-held heat gun or leister with hand pressure will be used in smaller/concentrated areas. Passing trial seams using the hand-held heat gun shall be performed prior to production seaming. Trial seams shall be performed as outlined in the HydroTurf Installation Guidelines (most recent revision).
2. INSTALLER may also demonstrate techniques and practices as follows:
   a. Field demonstration and approval by the OWNER is required before incorporating any alternative technique.

3.6 INSTALLATION ACCEPTANCE

A. The Geosynthetics Installer retains all ownership and responsibility for the HydroTurf CS system until acceptance by the Owner.

1. After HydroTurf CS components are deployed, seamed, has passed required testing successfully, and any repairs are made.
   a. The completed installation will be inspected by the OWNER and the INSTALLER's construction quality control supervisor.
   b. Damage and/or defects found during this inspection will be repaired by the INSTALLER.
   c. The installation will not be accepted until it meets the requirements of these specifications and any applicable State, Federal or Local Regulations.

B. Installation of the HydroTurf CS system will be accepted by the OWNER only when the following has been completed:
   1. The installation is complete.
   2. Seams have been observed, documented, and accepted by the CQA Organization.
   3. Required independent testing laboratory and field tests have been completed, reviewed and approved.
   4. Required INSTALLER supplied documentation has been received, reviewed and approved.
   5. As built record drawings have been completed and verified by the CQA Organization.

END OF SECTION

SECTION 02401

HYDROTURF® HYDROBINDER® INFILL

PART 1: GENERAL

1.1 SUMMARY

A. Section Includes:

1. Specifications for the HydroBinder® Infill Component of the patented HydroTurf® System.

1.2 RELATED SECTIONS

A. Section 02400 - Hydroturf® CS Engineered Turf

1.3 SUBMITTALS

A. HydroBinder INSTALLER

1. HydroBinder INSTALLER shall submit a certificate stating that the HydroBinder meets or exceeds the requirements outlined in the project specifications, including:

   a. The type of cement meets the requirements of ASTM C150 (AASHTO M85) Type I or Type II.

   b. That the cementitious infill mix shall have a minimum 28-day compressive strength of 5,000 psi in accordance with ASTM C 387 as tested in accordance with ASTM C 109.

PART 2: PRODUCTS

2.1 HYDROTURF HYDROBINDER INFILL COMPONENT

A. Description

1. HydroBinder is a proprietary cementitious product used as the infill component of the HydroTurf system.
2. HydroBinder shall be supplied by Watershed Geosynthetics as a component of the HydroTurf Revetment System.

B. MATERIALS

1. The infill will be HydroBinder Cementitious Infill.
2. The infill material may be delivered in either pallet form of 80 lb. bags or 3000 lb. bulk bag super sacks.
3. Cement, except as otherwise specified herein, will be a brand of Portland Cement, meeting ASTM C 150 and will be Type I or Type II.
4. Only one brand of cement will be used throughout the duration of this Contract.
5. The cementitious infill mix will conform to the requirements of ASTM C 387 for high strength mortars.
6. The cementitious infill mix will have a minimum 28-day compressive strength of 5,000 psi as measured in accordance with ASTM C 109.

PART 3: EXECUTION:

3.1 INSTALLER

A. INSTALLER shall be trained by Watershed Geosynthetics, LLC.

3.2 HYDROBINDER PLACEMENT

A. Placement of HydroBinder infill shall be performed as follows:

1. HydroBinder is typically delivered to the jobsite on pallets in either 3,000 pound bulk bags (1 per pallet) or 80 pound bags (42 per pallet). It is delivered on a flatbed with 16 pallets (typical) per truckload.
2. HydroBinder shall be installed into the turf while it is in a dry state.
3. Prior to placing the HydroBinder, the engineered turf shall be dry. If the turf is wet from rain or dew, the installer shall wait until it is dry. The installer may attempt to speed up the drying process by using a blower (i.e., leaf blower, industrial blower, etc.).
4. HydroBinder shall not be installed in inclement, wet or rainy weather, or the threat of inclement weather.
5. HydroBinder shall not be installed in cold weather as defined by American Concrete Institute (ACI) 306.
6. HydroBinder infill shall be placed at a minimum thickness of 7/8-inch dry thickness and a ¾-inch minimum finished thickness after hydration and curing. This thickness is achieved by placing dry HydroBinder at a rate of approximately 7 lbs/sf over the engineered synthetic turf.
7. HydroBinder infill is to be placed / spread using a manual drop spreader, top-dresser and/or drop spreader attached to low ground pressure equipment with adequate dust control. Alternative methods can be used to spread and place the infill as approved by the OWNER and/or Engineer. INSTALLER shall explain in detail in the pre-construction meeting the method of infill deployment to be used. The OWNER and/or Engineer shall approve the method.
8. Manual hand spreading is acceptable when equipment use is not practical.

B. HydroBinder infill will need to be worked into the turfs of the engineered turf such that the turf fibers are in an upright position. This can be achieved as follows:

1. HydroBinder infill shall be worked into the tuft fibers so the tuft fibers are in an upright position with the infill at a measurable 7/8-inch minimum depth in the dry state. This is typically achieved with common mechanical turf broom, power broom, shop broom, yard rakes, or greens groomer rakes.
2. Brushing of the HydroBinder infill shall be performed such that the fibers of the engineered turf are upright and trapped fibers are minimal. This shall be confirmed by visual inspection. Multiple brushing passes in multiple directions may be required to achieve this.
3. HydroBinder infill may need to be placed in 2 to 4 lifts with brushing in between lifts to effectively work the material into the tufts and achieve upright fibers.

4. HydroBinder infill thickness shall be measured using a caliper or equivalent device. Measurements shall be taken at a minimum frequency of 5 measurements per 1,000 sf (for smaller projects) or 20 per acre (for larger projects) of installed area.
5. The desired HydroBinder infill thickness shall be achieved prior to hydration.

C. The HydroBinder infill shall be hydrated in place as follows:
1. The hydration shall occur on the same day as the HydroBinder infill placement.
2. HydroBinder infill shall be hydrated thoroughly with a light and consistent spray of water to avoid displacement of the non-hydrated infill. Estimated application rate is between 0.12 and 0.20 gallons per square foot of area. During hot temperatures and/or in dry climates, additional water may be needed.
3. The INSTALLER shall not overhydrate the HydroBinder infill so that water begins to runoff and cause loss of cement infill during the process. The general objective is to soak the area to start the hydration process but not to inundate with water beyond saturation of the HydroBinder infill.
4. The CQA Monitor shall observe that the HydroBinder infill has been fully hydrated, and not over hydrated. Observe that the top of the HydroBinder infill has a wet sheen (denoting saturation) but that water is not ponding on top. Also, excavate (with finger or small tool) into the HydroBinder infill to confirm full hydration of the section has been achieved.
5. To improve curing, the hydrated area may be covered with plastic sheeting.
6. If cold weather temperatures are expected, the hydrated area should be covered with heated blankets and plastic sheeting. Procedures in ACI 306 shall be followed for cold weather HydroBinder installation.
7. The HydroBinder infill shall harden within 24 hours following hydration and shall reach its maximum compressive strength at 28 days. If the HydroBinder has not hardened in 24 hours, it will need to be removed and replaced.
8. Personnel access on the HydroTurf infill shall be prohibited following the hydration of the HydroBinder infill until it sets up hard.

D. After hydration is completed and the HydroBinder infill has set up (min. 24 hours); backfill and compaction of the remaining perimeter anchor trenches may be performed.

3.3 CQA MONITOR SHALL VERIFY THE FOLLOWING:

A. INSTALLER shall explain in detail in the pre-construction meeting the method of HydroBinder infill deployment.

B. Installation of HydroBinder infill will only be performed by a Watershed Geosynthetics' trained installer.

C. HydroBinder shall not be installed in inclement, wet or rainy weather, or the threat of inclement weather.

D. The HydroBinder shall not be installed in freezing temperatures.

E. The HydroBinder will be installed into the turf while it is in a dry state.

F. The HydroBinder will be worked into the tufts so the tufts are in an upright position.

G. The HydroBinder infill will be placed dry at a minimum thickness of 7/8 inch.

H. Do not backfill and compact anchor trenches until turf has been infilled with HydroBinder infill.

I. The hydration process must occur the day of the HydroBinder infill placement.

J. The desired HydroBinder infill thickness will be achieved and confirmed by measurements prior to the hydration process.

K. The cemented infill is hydrated thoroughly; however, care must be taken to avoid displacement of the non-hydrated infill.

L. Hydration shall start at the upstream or upslope portion and move downstream or downslope.

M. The objective is to soak the area to start the hydration process but not to inundate with water beyond saturation.

N. Once hydration is completed as described, backfill and compaction of the anchor trenches should take place.

O. HydroBinder infill that does not set up within 24 hours on account of improper hydration shall be removed and replaced.

P. Cold weather installation of HydroBinder shall be performed in accordance with American Concrete Institute (ACI) - 306R-10 Guide to Cold Weather Concreting.

END OF SECTION

SECTION 02610

CULVERT PIPE

PART 1 – GENERAL

1.1 SCOPE OF WORK

A. The CONTRACTOR shall provide all labor, tools, and equipment, and perform all operations necessary to install culvert pipe including necessary joints and connections as required. Culvert pipe shall consist of sections of pipe of the kinds and sizes shown on the Construction Drawings and as specified, laid on a firm foundation in a trench in accordance with these Specifications.

B. Material will be purchased by the OWNER based on quantities determined by the Engineer. Material supplier and CONTRACTOR shall coordinate with OWNER for delivery of material to the site for installation.

1.2 RELATED SECTIONS

A. Section 02300 - Earthwork

1.3 REFERENCES

J. Standard Specification for Corrugated Polyethylene Pipe, 300- to 1500-mm (12- to 60-in.) Diameter

L.

M. Standard Specification for Reinforced Concrete Culvert, Storm Drain, and Sewer Pipe

N. Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.

1.4 PRODUCT DELIVERY, STORAGE, AND HANDLING

A. Inspection of Material:

1. When delivered to the site and prior to unloading, the CONTRACTOR shall inspect all pipe, and accessories for loss, damage, or lack of specified identification and markings.
2. Any defective or improper material shall be immediately marked and shall not be unloaded.

B. In shipping, storing, and installing, pipe shall be kept in a sound, undamaged condition. It shall at all times be handled with care and shall not be dropped, dumped, or bumped against any other object. Any material(s) damaged shall be marked and immediately removed from the job site.

C. All materials found at any time during the progress of the work to have cracks, flaws, or other defects will be rejected and marked and the CONTRACTOR shall promptly remove such defective material from the work site.

PART 2 – PRODUCTS

2.1 PIPE AND FITTINGS

A. Corrugated Polyethylene Pipe (CPP).

1. CPP shall be made of high density polyethylene material conforming to the requirements of cell classification 435400C as defined in ASTM D3350. The pipe shall have smooth inner walls.

2. HDPE End Sections: The method of fabrication and materials used shall conform to the applicable requirements of AASHTO M294. The connection of the end section to the pipe shall be made in accordance with the manufacturer's recommendations.
3. Coupling bands shall be provided by the manufacturer of the pipe and shall meet the soil-tight requirements of AASHTO M294.

B. Reinforced Concrete Pipe (RCP).

1. RCP shall conform to ASTM Specifications for Reinforced Concrete Culvert, Storm Drain and Sewer Pipe Designation C76 and shall be of the diameter shown on the Plans. Reinforced concrete pipe shall be AASHTO designated Class IV.
2. Joints shall be tongue and groove or bell and spigot type of joint with provisions for using a round rubber "O-ring" gasket in a recess in the spigot end of the pipe. The bevel of the bell of the pipe shall be between 1½ and 2½ degrees. The diameter of the joint surfaces which compress the gasket shall not vary from the true diameter by more than $^{1}/_{16}$-inch.

C. Corrugated Metal Pipe (CMP).

1. CMP may be galvanized steel, aluminized steel, aluminum or precoated galvanized steel as indicated on Drawings and conforming to following:
   a. Galvanized Steel
   b. Aluminized Steel
   c. Aluminum
   d. Precoated Galvanized Steel
   e. AASHTO M 197
   f. AASHTO M 218
   g. AASHTO M 246
   h. AASHTO M 274
2. Reference to gauge of metal is to U.S. Standard Gauge for uncoated sheets. Tables in AASHTO M218 and AASHTO M274 list thicknesses for coated sheets in inches. Tables in AASHTO M197 list thicknesses in inches for clad aluminum sheets.
3. Coupling bands and other hardware for galvanized or aluminized steel pipe shall conform to requirements of AASHTO M36 for steel pipe and AASHTO M196 for aluminum pipe.
   a. Coupling bands shall be not more than 3 nominal sheet thicknesses lighter than thickness of pipe to be connected and in no case lighter than 0.052 inch for steel or 0.048 inch for aluminum.
   b. Coupling bands shall be made of same base metal and coating (metallic or otherwise) as pipe.
   c. Minimum width of corrugated locking bands shall be as shown below for corrugations which correspond to end circumferential corrugations on pipes being joined:
      1) 10 inches wide for 2-2/3 inch by 2 inch corrugations.
      2) 12 inches wide for 3 inch by 1 inch corrugations.

d. Helical pipe without circumferential end corrugations will be permitted only when it is necessary to join new pipe to existing pipe which was installed with no circumferential end corrugations. In this event pipe furnished with helical corrugations at ends shall be field jointed with either helically corrugated bands or with bands with projections (dimples). Minimum width of helical corrugated bands shall conform to following:
   1) 12 inches wide for 2 inch deep helical end corrugations.
   2) 14 inches wide for 1 inch deep helical end corrugations.
e. Bands with projections shall have circumferential rows of projections with one projection for each corrugation. Width of bands with projections shall be not less than following:
   1) 12 inches wide for pipe diameters up to and including 72 inches. Bands shall have two circumferential rows of projections.
   2) 16 inches wide for pipe diameters of 78 inches and greater. Bands shall have four circumferential rows of projections.
f. Bolts for coupling bands shall be 2-inch diameter. Bands 12 inches wide or less will have minimum of 2 bolts per end at each connection, and bands greater than 12 inches wide shall have minimum of 3 bolts at each connection.
g. Galvanized bolts may be hot dip galvanized in accordance with requirements of AASHTO M 232, mechanically galvanized to provide same requirements as AASHTO M232, or electrogalvanized per ASTM B 633, Type RS.

PART 3 – EXECUTION

3.1 GENERAL

A. Pipes and appurtenances shall be installed true to lines, grades, and locations indicated on the Drawings. Any deviations must be approved by the Engineer before installation.

B. The design intent for culvert pipes proposed to have inverts installed in swales and ditches is that the invert of the culvert pipe be installed with the same, or nearly the same, elevation as the swale or ditch at that location. If at the time of installation it becomes clear that the design invert of the culvert pipe and the invert of the swale or ditch in which the culvert pipe is to be installed are significantly different, the CONTRACTOR shall notify the Engineer prior to backfilling the culvert pipe trench.

3.2 BACKFILL AND COMPACTION

A. Backfill and compaction shall be as specified in Section 02300.

3.3 PIPE BEDDING CONDITIONS

A. Pipe laid in open trench excavations shall be bedded in and uniformly supported over their full length on a bedding of compacted Granular Fill.

3.4 INSTALLATION OF PIPE AND FITTINGS

A. Lay the pipe only after the trench, swale, or ditch is at the proper grade and the bedding material is placed as specified. Pipe laying shall be performed only in the presence of the CQA Monitor, and the CONTRACTOR shall give ample notice of schedule of pipe laying operations to the CQA Organization.

B. All pipe and fittings shall be carefully lowered into the trench by hand or by the proper equipment. Pipe becoming cracked or otherwise damaged during or following installation shall be marked by the CONTRACTOR or the CQA Monitor and removed from the site at no cost to the OWNER.

C. Each section of pipe shall rest upon the pipe bedding for the full length of its barrel, with recesses excavated to accommodate joints. Blocking will not be permitted. Any pipe that has its grade or joints disturbed after laying shall be taken up and re-laid.

D. The pipe ends shall be thoroughly cleaned before the joint is made. All connections shall be made in accordance with instructions supplied by the manufacturer.

END OF SECTION

SECTION 02711

POLYETHYLENE PIPE

PART 1 – GENERAL

1.1 SECTION INCLUDES

A. Installing solid (non-perforated) and perforated High Density Polyethylene (HDPE), associated pipe fittings, caps, and connections as shown in the Construction Drawings for landfill liquids and surface water applications.

B. Material will be purchased by the OWNER based on quantities determined by the Engineer. Material supplier and CONTRACTOR shall coordinate with OWNER for delivery of material to the site for installation.

C. Installation of geotextiles associated with pipes will be by the INSTALLER in coordination with the CONTRACTOR unless otherwise approved by the ONER.

1.2 RELATED SECTIONS

A. Section 02221 – Excavating and Trenching

B. Section 02300 – Earthwork

C. Section 02771 – Geotextile

1.3 REFERENCES

A. ASTM International.

1. ASTM D 638 – Standard Test Method for Tensile Properties of Plastics.
2. ASTM D 696 – Standard Test Method for Coefficient of Linear Thermal Expansion of Plastics between –30˚ C and 30˚ C with a Vitreous Silica Dilatometer.
3. ASTM D 746 – Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
4. ASTM D 790 – Standard Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
5. ASTM D 1238 – Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
6. ASTM D 1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique.
7. ASTM D 1525 – Standard Test Method for Vicat Softening Temperature of Plastics.
8. ASTM D 1603 – Standard Test Method for Carbon Black Content in Olefin Plastics.
9. ASTM D 2240 – Standard Test Method for Rubber Property-Durometer Hardness.
10. ASTM D 2657 – Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
11. ASTM D 2837 – Standard Test Method for Obtaining Hydrostatic Design Basis for Thermoplastic Pipe Materials or Pressure Design Basis for Thermoplastic Pipe Products.

12. ASTM D 3035 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Controlled Outside Diameter.
13. ASTM D 3261 – Standard Specification for Butt Heat Fusion Polyethylene (PE) Plastic Fittings for Polyethylene (PE) Plastic Pipe and Tubing.
14. ASTM D 3350 – Standard Specification for Polyethylene Plastics Pipe and Fittings Materials.
15. ASTM F 714 – Standard Specification for Polyethylene (PE) Plastic Pipe (DR-PR) Based on Outside Diameter.
16. ASTM F 1473 – Standard Test Method for Notch Tensile Test to Measure the Resistance to Slow Crack Growth of Polyethylene Pipes and Resins.

B. National Sanitation Foundation (NSF).
   1. NSF Standard Number 14 – Plastics Piping Components and Related Materials.

C. PPI – Plastic Pipe Institute.

D. ANSI – American National Standards Institute.

E. Construction Quality Assurance (CQA) Plan.

1.4 SUBMITTALS

A. Provide written certification for qualified HDPE pipe fusion welders.

PART 2 – PRODUCTS

2.1 PIPE AND FITTINGS

A. HDPE. Polyethylene resin shall meet or exceed the requirements of ASTM D 3350 for PE 4710 material with a Cell Classification of 445464C, or better.

B. All pipe sizes shown on the Construction Drawings and specified in this Section reference nominal diameter, unless otherwise indicated on the Construction Drawings or in this Section. Pipe sizing and workmanship are to be in accordance with ASTM F 714 and ASTM D 3035.

C. Conforming to the following minimum requirements:
   1. Containing no recycled compound except that generated in the Manufacturer's own plant and from resin of the same specification from the same raw material supplier.
   2. Resin for pipe and fittings to be listed by both N.S.F. and P.P.I. and manufactured in accordance with ASTM D 3350 and ASTM F 714.
   3. Homogeneous throughout and free of visible cracks, holes (except where specified or shown), foreign inclusions or other injurious defects. Being uniform in color, capacity, density, and other physical properties.

Property	ASTM Test Designation	Unit	Minimum Requirements
Pipe Properties			
Density	D 1505	gm/cm^3	0.947
Melt Index	D 1238	gm/10 min	<0.15
Hydrostatic Design Basis 73°F (23°C)	D 2837	psi	1,600
UV Stabilizer	D 1603	% Carbon Black	2%
Material Properties			
Flexural Modulus	D 790	psi	110,000
Tensile Strength at yield	D 638	psi	3,000
Elongation at Break 2 in/min., Type IV bar	ASTM D638	%	>800
Elastic Modulus	D 638	psi	130,000
Hardness	D 2240	Shore "D"	65
PENT (Notch Tensile)	F 1473	Hrs.	>100
Thermal Properties			
Vicat Softening Temperature	D 1525	°F	+255°F
Brittleness Temperature	D 746	°F	<-180°F
Thermal Expansion Coefficient	D 696	in/in/°F	$1.2x10^{-4}$

D. Provide pipe with the following information continuously marked on the pipe or spaced at intervals not exceeding 5-feet.

1. Name and/or trademark of the pipe manufacturer.
2. Nominal pipe size.
3. Standard Dimensional Ratio (SDR).
4. PE Designation.
5. Manufacturer's Standard Reference.
6. A production code, from which the date and place of manufacture can be determined.

2.2 FITTINGS

A. Provide fittings, manufactured from the same class of materials and fully compatible with the HDPE pipe.

B. Provide fittings manufactured in accordance with ASTM D 3350 and ASTM D 3261. Provide fabricated fittings with pressure ratings matching or exceeding the HDPE pipe.

2.3 PERFORATED PIPE

A. Perforations: As shown on the Construction Drawings.

B. OWNER CQA will visually inspect all pipe prior to installation or fusion welding.

C. Perforations shall be clean of drilling shavings.

PART 3 – EXECUTION

3.1 PIPE INSTALLATION GENERAL REQUIREMENTS

A. When shipping, delivering, moving, and installing pipe, fittings, and accessories, do so in such manner to ensure a sound, undamaged installation.

B. Provide adequate storage for all materials and equipment delivered to the job site.

C. Handle and store pipe and fittings in accordance with the manufacturer's recommendations.

3.2 PLACING AND LAYING PIPE

A. Provide required maintenance of all such materials and equipment used to handle, place, and lay pipe.

B. Follow the manufacturer's recommendations when hauling, unloading, and stringing the pipe.

C. Take precautions to prevent damage to the pipe.

D. Do not push, pull, or drag pipe and fittings over sharp projections, or drop or have objects dropped on the pipe and fittings.

E. Inspect for defects before and during installation. Remove any piping showing kinks, buckles, cuts, gouges, or any other damage, which, in the opinion of the OWNER or CQA, will affect performance of the pipe.

F. Replace material found to be defective before or after laying with sound material without additional expense to the OWNER.

G. Place pipe bedding material in trench.

H. Carefully lower pipe and accessories into the trench.

I. Under no circumstances drop or dump materials into the trench.

J. Rest the full length of each section of pipe solidly upon the pipe bedding.

K. Take up or relay pipe that has had the grade disturbed while joining or laying the pipe.

3.3 FUSION WELDING PIPE

A. Join the HDPE pipe by the method of thermal butt- or side-wall fusion, as outlined in ASTM D 2657 or as recommended by the pipe manufacturer. Perform fusion joining of pipe and fittings in accordance with the procedures established by the pipe manufacturer. Of particular importance is the use of proper interface pressures and heater plate temperatures.

B. Use fusion pressures, temperatures, and cycle times according to pipe manufacturer's recommendations. Use only personnel adequately trained and qualified in the technique involved.

C. Do not perform pipe fusion in water or when trench conditions are unsuitable for the work. Keep water out of the trench until joining is completed. Secure open ends of pipe and close valves when work is not in progress, so that no trench water, earth, animals, or other substance will enter the pipe or fittings. Plug, cap, or valve off pipe ends left for future connections as shown on the Construction Drawings.

D. Clear and grade fusion welding sites, if necessary, to provide enough space for pipe storage and fusion equipment. Keep the site free of rocks, stumps, and debris that could cut, scar, or gouge the pipe.

E. To allow the joining operation to continue in adverse weather conditions, a shelter may be required for the joining machine. Particular caution should be exercised to prevent water from entering the inside of the pipe and from coming in contact with the heater plate.

F. Properly clamp pipe to be fused, and clean and prepare faces being fused. Apply heat source to melt the pipe properly followed by pressure to create roll back bead and allow to cool properly in accordance with the pipe manufacturer's recommendations. Pressure testing of fabricated pipe section is required for a pressurized system.

G. All pipe shavings shall be removed from the pipe prior to fusing each joint.

H. Polyethylene Fusion Welder's Qualification: All pipe fusion welding must be performed by a Manufacturer-certified fusion welding operator.

I. Provide for instruction, testing, and installation training sessions as required to obtain training for welding personnel, including quality control personnel, in polyethylene fusion machine operation, instruction and familiarization with HDPE pipe, and fitting fusion for the project. Only fully trained personnel will be allowed to perform the installation, supervision, or inspection of polyethylene-fusion joints. Submit to the OWNER, at least five business days prior to beginning fusion welding, a list of those personnel authorized, instructed, and certified for polyethylene fusion. Make all on-site training sessions conducted during this Contract available to CQA personnel at no charge to the OWNER.

J. Training: Provide assistance from the manufacturer/supplier in instructing welding personnel in proper fusion welding procedures and techniques. Notifications will be required in writing, listing the names of those persons so familiarized. A manufacturer's representative shall be certified in writing by the Manufacturer to be technically qualified and experienced in fusion welding of HDPE pipe.

3.4 INSTALLING FLANGED CONNECTIONS

A. Bolt flanges using an evenly torqued crossing pattern. Re-torque after 1 hour in the same crossing pattern.

B. Polyethylene flanges must be at the ambient temperature of the surrounding soil at the time they are bolted tight to prevent relaxation of the flange bolts and loosening of the joint due to thermal contraction of the polyethylene materials. Wait at least 24 hours after initial flange bolt tightening, then re-tighten flange bolts again.

3.5 FIELD CONSTRUCTION QUALITY ASSURANCE (CQA)

A. The OWNER will perform CQA testing during polyethylene pipe installation in accordance with the CQA Plan.

B. Cooperate fully with the OWNER in obtaining samples and performing tests and inspection/observation. Include all costs for assistance in unit prices for work.

END OF SECTION

SECTION 02771

GEOTEXTILE

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Installing OWNER-supplied non-woven geotextile separator as components of the cap and liner system.

B. Installing OWNER-supplied non-woven geotextile cushion on the face of the MSE wall to facilitate placement of foundation layer soil in the area.

C. For sewing geotextile materials furnish polymeric thread having chemical resistance and strength properties equal to or exceeding those of geotextile.

1.2 RELATED SECTIONS

A. Section 01010 – Summary of Work.

B. Section 01025 – Measurement and Payment.

C. Section 01300 – Submittals.

D. Section 02711 – Polyethylene Pipe.

E. Section 02778 – Geomembrane.

F. Section 02300 – Earthwork.

1.3 REFERENCES

A. ASTM D1777 – Standard Test Method for Measuring Thickness of Textile Materials.

B. ASTM D4355 - Standard Test Methods for Deterioration of Geotextiles by Exposure to Light, Moisture and Heat in a Xenon Arc-Type Apparatus.

C. ASTM D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.

D. ASTM D4533 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles.

E. ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.

F. ASTM D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.

G. ASTM D4873 - Standard Guide for Identification, Storage, and Handling of Geosynthetic Rolls and Samples.

H. ASTM D4884 - Standard Test Method for Strength of Sewn or Thermally Bonded Seams of Geotextiles.

I. ASTM D5261- Standard Test Methods for Measuring Mass Per Unit Area of Geotextiles.

J. ASTM D6241 - Standard Test Method for Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

1.4 SUBMITTALS BY MANUFACTURER

A. Manufacturer to submit the following before factory sampling of conformance samples or a minimum of 7 days prior to transporting materials to Site if conformance samples are not required or if conformance samples to be obtained on site:

1. Manufacturer's Certification that material meets or exceeds the specified material properties.
2. Roll list and MQC test results.

B. Manufacturer to submit the following if requested by OWNER:

1. A sample of the product (minimum size to be roll width by 3 feet) to the laboratory perfoming interface friction testing. Provide the roll and lot number from which the geosynthetic sample is taken, and MQC test data for the lot. Submit the sample at the time in plant conformance sampling is performed, or as soon as practicable following manufacture if material is shipped to site prior to conformance sampling.
2. Written instructions for storage, handling installation, seaming, and repair of proposed material. Submit a minimum of 5 days prior to shipping.

C. Submittals Upon Completing Installation:

1. Manufacturer's Warranty against manufacturer defects (material not in compliance with the Technical Specifications), covering the full material replacement cost not including installation.

1.5 SUBMITTALS BY INSTALLER

A. Submit prior to sewing geotextile:

1. Details of the thread to be used documenting compliance with Part 2.5.

B. Submittals Upon Completing Installation:

1. INSTALLER's Certification stating the material has been installed per the Contract Documents.

1.6 QUALITY ASSURANCE (PERFORMED BY OWNER)

A. For monitoring the quality and installation of the GCL OWNER will engage and pay for the services of:

1. The CQA Organization.
2. A CQA Laboratory.

B. If required, the INSTALLER shall aid the CQA Monitor with product sampling by providing personnel and equipment necessary to move, cut, and protect material rolls and panels.

1.7 CONFORMANCE TESTING (PERFORMED BY OWNER)

A. OWNER will perform conformance testing on geotextile material as outlined in the CQA Manual and will review and approve the test data before material is shipped.

B. OWNER will perform and review interface shear tests as outlined in the CQA Manual.

1. Tests will consider the following materials and interfaces: Subgrade soil / geomembrane / geotextile / vegetative layer soil.

2. The results of the interface shear testing will be used as one basis for accepting geosynthetic materials for the Project.

1.8 DELIVERY, STORAGE AND HANDLING

A. Ship geotextile in closed trailer.

B. Comply with ASTM D4873.

C. Comply with Manufacturer's instructions.

D. Provide straps for unloading geotextile.

E. During shipment and storage, elevate material rolls off the ground and adequately cover to protect them from the following:

1. Ultraviolet light exposure, precipitation, inundation, mud, dirt, dust, puncture, cutting, site construction activities, chemicals that are strong acids or strong bases, flames including welding sparks, temperatures in excess of 160°F (71°C).
2. Any other environmental condition that may damage the property values of the geotextile.

F. Immediately restore any damaged protective covering.

PART 2 PRODUCTS

2.1 LABELING

A. Mark or tag material rolls with the following information:

1. Manufacturer's name.
2. Product identification.
3. Lot number.
4. Roll number.
5. Roll dimensions.
6. Mark special handling requirements on rolls.

2.2 MANUFACTURER SOURCE QUALITY CONTROL

A. Perform MQC tests necessary to verify geotextile manufactured for this Project meets the Technical Specifications. Perform each MQC test, at a minimum, at the frequencies listed in this Section.

B. Provide the following information with MQC test data:

1. Roll numbers and identification.
2. Results of quality control tests, including a description of test methods used.

C. OWNER will reject rolls for which quality control requirements are not met.

2.3 NON-WOVEN GEOTEXTILE CUSHION

A. Products comprised of non-woven, continuous-filament needle punched polypropylene or polyester fabric; staple-filament needle punched yarn oriented into a staple network that maintains its structure during handling, placement, and long-term service.

B. Resistant to soil chemicals.

C. New product made from virgin materials.

D. Geotextile used for cushion conforming to the following minimum average roll value (MARV) property values:

TEST	ASTM METHOD	MINIMUM MQC TEST FREQUENCY	UNIT	MIN. MARV REQUIREMENT
1. Mass/Area	D5261	1/100,000 sf	oz/yd^2	16.0
2. Grab Tensile Strength	D4632	1/100,000 sf	lbs.	390
3. CBR Puncture Strength	D6241	1/100,000 sf	lbs.	1,125
4. Trapezoidal Tear Strength	D4533	1/100,000 sf	lbs.	150
5. UV Resistance (500 hours)	D4355	Historical Data on Similar Product		70% of strength

2.4 NON-WOVEN GEOTEXTILE SEPARATOR

A. Products comprised of non-woven, continuous-filament needle punched polypropylene or polyester fabric; staple-filament needle punched yarn oriented into a staple network that maintains its structure during handling, placement, and long-term service.

B. Not heat burnished.

C. Resistant to soil chemicals.

D. New product made from virgin materials.

E. Geotextile used for separation conforming to the following minimum average roll value (MARV) property values:

TEST	ASTM METHOD	MINIMUM MQC TEST FREQUENCY	UNIT	MIN. MARV REQUIREMENT
Mass/Area	D5261	1/100,000 sf	oz/yd^2	8.0
Grab Tensile Strength	D4632	1/100,000 sf	lbs.	220
Trapezoidal Tear Strength	D4533	1/100,000 sf	lbs.	95
CBR Puncture Strength	D6241	1/540,000 sf	lbs.	575
Permittivity	D4491	1/540,000 sf	sec^{-1}	1.3
Apparent Opening Size	D4751	1/540,000 sf	mm	<0.18
UV Resistance (500 Hours)	D4355	Historical Data for Similar Product		70% of Strength

2.5 THREAD

A. For sewing, supply and use polymeric thread having chemical resistance and strength properties equal to or exceeding those of geotextile.

PART 3 EXECUTION

3.1 SEWING EQUIPMENT AND ACCESSORIES

A. Provide equipment that meets the following requirements:
   1. Capable of developing seams with a minimum of 80 percent of material strength.
   2. Maintained in adequate number to avoid delaying Work.
   3. Supplied by a power source capable of providing constant voltage under a combined-line load.
   4. Provided with a protective lining and splash pad large enough to catch spilled fuel under an electric generator, if used on geotextile.

3.2 EXAMINATION

A. Examine underlying construction of the geotextile materials for conformance with the Technical Specifications before installation.

B. Verify all underlying installations are complete and all required MQC and CQA data has been provided to OWNER.

3.3 DEPLOYMENT

A. Use adequate numbers of workmen who are trained and supervised to install the material.

B. Follow Manufacturer's recommendations, standards, and guidelines.

C. Anchor geotextile on slopes greater than 10 percent. Roll geotextile down slope in such a manner as to continually keep the geotextile sheet in sufficient tension to prevent folds and wrinkles.

D. Weight geotextile with sandbags or equivalent as ballast during deployment. Leave ballast in place until geotextile is covered with succeeding construction layer.

E. Cut geotextile using approved cutter only. Take care to protect other in-place geosynthetic materials when cutting geotextile.

F. Do not entrap in geotextile excessive dust, stones, or moisture that could damage or clog drains or filters or hamper subsequent seaming.

G. Examine geotextile over entire completed surface to ensure that no potentially harmful foreign objects, such as needles, are present. Remove any foreign objects.

H. Do not drag geotextile across rough or textured surfaces to avoid damage to the geotextile. Use a smooth geosynthetic slip sheet or rub sheet as necessary to reduce friction damage during deployment.

I. Cover geotextile within a time frame acceptable to the Manufacturer.

3.4 SEAMS AND OVERLAPS

A. Sew or heat wedge weld all geotextile separator seams. Overlap geotextile 3 inches minimum before seaming.

B. Geotextile cushion on the face of the MSE wall may be overlapped 12-inches in lieu of seaming.

C. Do not seam horizontally on slopes steeper than 10 percent (i.e., seam along, not across slopes).

D. Ensure that no soil materials are inserted into the seams of geotextiles.

E. For sewing, use polymeric thread having chemical resistance and strength properties equal to or exceeding those of geotextile.

F. For sewing, use a 401 two-thread chain stitch, or equivalent.

3.5 PROTECTION

A. When placing soil materials over geotextile, ensure the following:
   1. No damage to geotextile.
   2. No slippage of geotextile on underlying layers.
   3. No excessive tensile stresses are applied to the geotextile.

3.6 REPAIRS

A. Repair holes or tears in geotextiles with a patch from the same geotextile material.

B. Continually sew or heat-bond in place with a minimum seam overlap of 12 inches in all directions.

C. Sew or heat-bond the geotextile within one inch of the outside edge of the patch materials.

D. Remove any soil or other material that may have penetrated the torn geotextile.

3.7 ACCEPTANCE

A. CONTRACTOR retains all Ownership and responsibility for geotextile until accepted by OWNER.

B. OWNER accepts geotextile when:
   1. The installation is complete.
   2. Conformance tests verify product requirements.
   3. Documentation of installation is complete, including the CQA Organization's final report.
   4. Verification of the adequacy of all seams and repairs, including associated testing, is complete.
   5. Written Manufacturer's Certification has been received by OWNER.

END OF SECTION

SECTION 02778

GEOMEMBRANE

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Installing OWNER-supplied high-density polyethylene (HDPE) and/or linear low density polyethylene (LLDPE) geomembrane as a component of the Work.

B. OWNER will supply geomembrane materials for the Work.

C. Unless specifically noted otherwise, OWNER will contract directly with the INSTALLER to install the geomembrane for this project.

D. The CONTRACTOR is responsible for unloading, inventorying, and storing the delivered geomembrane and coordinating the deployment of geomembrane with other portions of the Work.

E. The INSTALLER shall be prepared to install the geomembrane in conjunction with the earthwork and other components of the final cover system.

1.2 RELATED SECTIONS

A. Section 02225 – Subgrade Preparation

B. Section 02300 - Earthwork.

C. Section 02771 - Geotextile

1.3 REFERENCES

A. Latest version of ASTM International Standards

1. ASTM D746 - Standard Test Method for Brittleness Temperature of Plastics and Elastomers by Impact.
2. ASTM D792 – Specific Gravity (Relative Density) and Density of Plastics by Displacement.
3. ASTM D1004 – Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
4. ASTM D1238 – Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
5. ASTM D1505 – Standard Test Method for Density of Plastics by the Density-Gradient Technique.
6. ASTM D1603 – Standard Test Method for Carbon Black in Olefin Plastics.
7. ASTM D3895 – Standard Test Method for Oxidative Induction Time of Polyolefins by Differential Scanning Calorimetry.
8. ASTM D4218 – Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
9. ASTM D4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
10. ASTM D4716 - Standard Test Method for Determining the (In-plane) Flow Rate per Unit Width and Hydraulic Transmissivity of a Geosynthetic using a Constant Head.

11. ASTM D4833 - Test Method for Index Puncture Resistance of Geotextiles, Geomembranes and Related Products.
12. ASTM D5199 - Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
13. ASTM D5321 – Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.
14. ASTM D5397 – Standard Test Method for Evaluation of Stress Crack Resistance of Polyolefin Geomembranes Using Notched Constant Tensile Load Test.
15. ASTM D5596 -Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
16. ASTM D5641 - Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
17. ASTM D5820 - Standard Practice for Pressurized Air Channel Evaluation of Dual-Seamed Geomembranes.
18. ASTM D5885 - Standard Test Method for Oxidative Induction Time of Polyolefin Geosynthetics by High-Pressure Differential Scanning Calorimetry.
19. ASTM D5994 - Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
20. ASTM D6365 - Standard Practice for the Nondestructive Testing of Geomembrane Seams using the Spark Test.
21. ASTM D6392 - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams Produced Using Thermo-Fusion Methods.
22. ASTM D6693 - Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
23. ASTM D7466 - Standard Test Method for Measuring the Asperity Height of Textured Geomembrane.

B. Geosynthetics Research Institute (GRI) Standards.

1. Test Method GM6 – Pressurized Air Channel Test for Dual Seamed Geomembranes.
2. Test Method GM11 – Accelerated Weathering of Geomembranes Using a Fluorescent UVA-Condensation Exposure Device.
3. Test Method GM13 - Test Properties, Testing Frequency and Recommended Warranty for HDPE (HDPE) Geomembranes.
4. Test Method GM-14. - Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes.
5. Test Method GM17 – Test Methods, Test Properties, Testing Frequency for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.
6. Test Method GM19 - Seam Strength and Related Properties of Thermally Bonded Polyolefin Geomembranes.

1.4 DEFINITIONS

A. Batch: A quantity of resin, usually the capacity of one rail car, used in the fabrication of HDPE geomembrane sheet; a roll number corresponding to the quantity of resin used will identify the finished sheet.

B. Bridging: The condition when geomembrane becomes suspended over its subgrade due to contraction of the Material or poor installation.

C. Construction Quality Assurance Organization (CQA Organization): The Party, independent from the Manufacturer or INSTALLER, responsible for observing and documenting activities related to the quality assurance of the production and installation of the geomembrane in accordance with the CQA Manual and Technical Specifications and issuing a Final Construction Certification Report with a Statement of Compliance by the CQA Engineer of Record, a Registered Professional Engineer.

D. Construction Quality Assurance Monitor (CQA Monitor): The CQA Organization's site representative and OWNER's authorized representative, responsible for on-site implementation of CQA procedures defined by the CQA Manual.

E. Geosynthetic Quality Assurance (GQA) Laboratory: The Party, independent from OWNER, Manufacturer, Fabricator, and INSTALLER, responsible for conducting tests on samples of geosynthetics obtained at the Site.

F. Extrudate: The molten polymer, initially in the form of a ribbon rod, bead, or pellets, that is emitted from an extruder during seaming using either extrusion fillet or extrusion flat methods.

G. Fabricator: The Party responsible for the fabrication of geomembrane panels constructed from rolls received from the Manufacturer.

H. Geomembrane: An essentially impermeable membrane used as a solid or liquid barrier. Synonymous term for flexible membrane liner (FML).

I. Geomembrane Subsurface: The soil or geosynthetic surface on which the geomembrane lies.

J. INSTALLER: The Party responsible for field handling, transporting, storing, deploying, seaming, temporary restraining (against wind), and installing the geomembrane.

K. Lot: A quantity of resin (usually a rail car) used in the manufacture of geomembranes. Finished roll will be identified by a roll number traceable to the resin lot used.

L. Manufacturer: The Party responsible to produce the geomembrane rolls from resin and for the quality of the resin.

M. Manufacturing Quality Assurance (MQA): A planned system of facility inspections, verifications, audits, and raw material (resins and additives) and geosynthetic product evaluations performed by the MQA Organization to assess the quality of the manufactured product and to verify if the Manufacturer is in compliance with the Technical Specifications and Manufacturer's Certification. Ref. EPA/600/R-93-182.

N. Manufacturing Quality Control (MQC): A planned system of factory inspections conducted by the Manufacturer to directly monitor and control the manufacture of a Material to ensure minimum (or maximum) specified values in the manufactured product are attained and to determine compliance with the requirements of Materials and workmanship as stated in the Manufacturer's Certification and OWNER's Technical Specifications. Ref. EPA/600/R-93/182.

O. Panel: The unit area of geomembrane that will be seamed in the field. If the geomembrane is not fabricated into panels at the factory, a panel is identified as a roll or portion of a roll without any seams.

1.5 SUBMITTALS BY MANUFACTURER

A. Submit the following before factory sampling of conformance samples or a minimum of 7 days prior to transporting materials to Site if conformance samples are not required or if conformance samples to be obtained on site:

1. Manufacturer's Certification that material meets or exceeds the specified material properties.
2. Resin Data:
   a. Statement of production date or dates.
   b. Copy of quality control certificates issued by Manufacturer.
   c. Test reports from Manufacturer.
   d. Correlation of resin batches to geomembrane rolls.
3. Roll list and MQC test results. Provide the following information with MQC test data:
   a. Manufacturer's names, product identification, lot numbers, roll numbers, roll dimensions and roll weight.
   b. Results of MQC tests reported by roll number.
   c. Perform the MQC tests listed in Article 2.4 of this section.
4. OWNER will reject rolls for which quality control requirements are not met or MQC data is not provided.
5. Written instructions for storage, handling installation, seaming, and repair of proposed material.

B. Submit the following for Interface Shear Strength Testing (unless not requested by OWNER)

1. A sample of the product (minimum size to be roll width by 3 feet) to the laboratory performing Interface Shear Strength testing. Submit the sample at the time in plant conformance sampling is performed.
2. Provide the roll and lot number from which the geosynthetic sample is taken, and MQC test data for the roll and lot.

C. Submit Upon Completing Installation:

1. Minimum 20-year pro rata warranty against manufacturing defects (material not in compliance with the Technical Specifications), covering the full material replacement cost, excluding installation.

1.6 SUBMITTALS BY INSTALLER

A. Submit a minimum of 14 days before INSTALLER mobilizes to Site:

1. Proposed Panel Layout drawing including field seams and details.
2. INSTALLER Personnel qualifications documenting:
   a. Supervisor: completed at least two jobs of similar scope, complexity, and size.

b. Master Seamer: completed a minimum of 5,000,000 square feet of PE geomembrane seaming using welding techniques described in this Section.

c. Other seamers: completed a minimum of 1,000,000 square feet of PE geomembrane seaming using welding techniques described in this Section.

B. Submit the following before seaming:

1. Calibration certificate obtained within prior 12 months of tensiometer to be used to perform field seam testing, showing equipment is accurate to within 2 pounds.

C. Submit the following for installation:

1. Subgrade acceptance certificate signed by the installation supervisor for each area to be covered by the geomembrane.
2. Copies of QC seam test results before performing repairs.

D. Submit Upon Completing Installation:

1. As-Built Drawings showing location of panels, seams, repairs, patches, and destructive samples.
2. INSTALLER's Minimum two-year non-pro rata warranty for the installation against defects.

1.7 QUALITY ASSURANCE (PERFORMED BY OWNER)

A. For monitoring the quality and installation of the geomembrane OWNER will engage and pay for the services of:

1. CQA Organization.
2. CQA Laboratory.

B. If required, the INSTALLER shall aid the CQA Monitor with product sampling by providing personnel and equipment necessary to move, cut, and protect material rolls and panels.

1.8 CONFORMANCE TESTING (PERFORMED BY OWNER)

A. OWNER will perform conformance testing on geomembrane as outlined in the CQA Manual and will review and approve the test data before material is shipped.

B. OWNER will perform and review interface shear tests as outlined in the CQA Manual.

1. Tests will consider the following materials and interfaces: Subgrade soil / geomembrane / geotextile / vegetative layer soil.
2. The results of the interface shear testing will be used as one basis for accepting geosynthetic materials for the Project.

1.9 DELIVERY, STORAGE, AND HANDLING

A. Conform to the Manufacturer's requirements.

B. Deliver Materials to the Site only after OWNER accepts required submittals.

C. Separate damaged rolls from undamaged rolls and store damaged rolls at locations designated by OWNER.

D. Store geomembrane rolls in a location designated by OWNER.

E. Store geomembrane rolls to protect them from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat or other damage.

F. Store geomembrane rolls on prepared surface (not on wooden pallets).

G. Stack geomembrane no more than three rolls high.

H. Use appropriate handling equipment to unload and store geomembrane rolls. Appropriate equipment includes cloth chokers and spreader bars. Do not drag panels on ground surface.

I. Do not fold geomembrane Material; folded Material will be rejected.

PART 2 PRODUCTS (MANUFACTURER)

2.1 RESIN

A. Use new resin products compounded and manufactured specifically for producing PE geomembrane.

B. Do not add any post-consumer resin (PCR) of any type to the formulation.

C. Raw resin shall comply with the following properties:

PROPERTY	TEST METHOD	HDPE	LLDPE
Density (g/cc)	ASTM D792, Method B	≥0.932	≥0.915
Melt Flow Index (g/10 min)	ASTM D 1238 (190/2.16)	≤1.0	≤1.0

2.2 GEOMEMBRANE

A. Manufacturing.

1. Meeting the latest requirements of GRI GM13 (HDPE) or GRI GM17 (LLDPE) except where modified by this specification.
2. Do not exceed a combined maximum total of 1 percent by weight of additives other than carbon black or pigment. Identify percentage of processing aids, antioxidants, and other additives other than carbon black.
3. Do not exceed 3.5 percent by weight of finished geomembrane for total combined processing aids, antioxidants, carbon black, and other additives.
4. All additives for UV protection, thermal stability, color, or processing agents must not "bloom" to the surface over time or inhibit welding.
5. Use Materials produced in the United States or Canada.
6. Provide finished product free from blemishes, holes, pinholes, bubbles, blisters, excessive gels, undispersed resins, and/or carbon black, contamination by foreign matter and nicks or cuts on edges.
7. Roll manufactured sheets for shipment. Provide roll identification labels indicating nominal thickness, length, width, Manufacturer, and plant location.

2.3 40-MIL THICK DOUBLE-SIDED TEXTURED HDPE GEOMEMBRANE

A. For use with Hydroturf CS Downchutes

B. Meeting the following requirements:

TEST	ASTM TEST DESIGNATION	MQC TEST FREQUENCY	REQUIREMENTS
Sheet Thickness	D5994	10 readings per roll	▪ Avg all readings >= 38 mil ▪ Lowest individual for 8 of 10 readings = 36 mil. ▪ Lowest individual for any of 10 readings = 34 mil.
Asperity Height	D7466	Every second roll (1)	≥ 20 mil. or Minimum, corresponding to asperity of material provided for preliminary interface shear strength testing and used to select material as the basis of design.
Sheet density	D792	1/250,000 sf	Minimum 0.940 g/cc
Tensile Properties (2)	D6693	1/60,000 sf	
a. Yield Strength			Min. Avg. 84 lb/in width
b. Break Strength			Min. Avg. 60 lb/in width
c. Yield Elongation			Min. Avg. 12% each sample
d. Break Elongation			Min. Avg. 100%
Tear Resistance	D1004	1/150,000 sf	Min. Avg. 28 lbs
Puncture Resistance	D4833	1/150,000 sf	Min. Avg. 60 lbs.
Stress Crack Resistance (3)	D5397	Per GRI GM10	Min. 500 hrs
Carbon Black Content	D1603 (4)	1/60,000 sf	2 to 3%
Carbon Black Dispersion	D5596	1/150,000 sf	Category 1 or 2 for 9 of 10 readings and Category 3 for 1 of 10 readings *(5)*
Oxidation Induction Time (OIT) (6) (a) Standard OIT or High-Pressure OIT	D3895 or D5885	1/680,000 sf (1/200,000 lb)	Min. Avg. 100 minutes for standard or Min. Avg. 400 minutes for high pressure
Oven Aging at 85 deg. C (6)(7) (a) Standard OIT or High-Pressure OIT	D5721 D3895 D5885	One per formulation	Min. Avg. 55% retained after 90 days or Min. Avg. 80% retained after 90 days

Test	ASTM Test Designation	MQC Test Frequency	Requirements
Ultraviolet Resistance (8) (a) Standard OIT or (b) High-Pressure OIT (10)	GRI GM 11 D3895 D5885	One per formulation	 NR (9) Min. Avg. 50% retained after 1,600 hours

Notes:

(1) Alternate the measurement side for double sided textured sheet.
(2) Machine direction (MD) and cross-machine direction (XMD) average values should be based on 5 test specimens in each direction. Yield elongation is calculated using a gauge length of 1.3 in. (33 mm). Break elongation is calculated using a gauge length of 2.0 in. (50 mm).
(3) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation used for the textured sheet. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(4) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
(5) Carbon black dispersion (only near spherical agglomerates) for 10 different views: nine in Categories 1 and 2 and one in Category 3.
(6) The Manufacturer can select either OIT method listed to evaluate the antioxidant content in the geomembrane.
(7) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(8) The condition of the test should be 20-hr. UV cycle at 75 deg. C followed by 4-hr. condensation at 60 deg. C.
(9) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(10) For High-Pressure OIT (D5885) UV resistance is based on percent retained value regardless of the original HP-OIT value.

2.4 60-MIL THICK DOUBLE-SIDED TEXTURED OR STRUCTURED HDPE GEOMEMBRANE

A. For use with cap and liner.

B. Meeting the following requirements:

Test	ASTM Test Designation	MQC Test Frequency	Requirements
Sheet Thickness	D5994	10 readings per roll	▪ Avg all readings >= 57 mil ▪ Lowest individual for 8 of 10 readings = 54 mil. ▪ Lowest individual for any of 10 readings = 51 mil.

Test	ASTM Test Designation	MQC Test Frequency	Requirements
Asperity Height	D7466	Every second roll (1)	Minimum, corresponding to asperity of material provided for preliminary interface shear strength testing and used to select material as the basis of design. ≥ 130 mil for studs on Super Gripnet. ≥ 175 mil for spikes on Super Gripnet.
Sheet density	D792	1/250,000 sf	Minimum 0.940 g/cc
Tensile Properties (2)	D6693	1/60,000 sf	
a. Yield Strength			Min. Avg. 126 lb/in width
b. Break Strength			Min. Avg. 90 lb/in width
c. Yield Elongation			Min. Avg. 12% each sample
d. Break Elongation			Min. Avg. 100%
Tear Resistance	D1004	1/150,000 sf	Min. Avg. 42 lbs
Puncture Resistance	D4833	1/150,000 sf	Min. Avg. 90 lbs.
Stress Crack Resistance (3)	D5397	Per GRI GM10	Min. 500 hrs
Carbon Black Content	D1603 (4)	1/60,000 sf	2 to 3%
Carbon Black Dispersion	D5596	1/150,000 sf	Category 1 or 2 for 9 of 10 readings and Category 3 for 1 of 10 readings *(5)*
Oxidation Induction Time (OIT) (6) (b) Standard OIT or High-Pressure OIT	D3895 or D5885	1/680,000 sf (1/200,000 lb)	Min. Avg. 100 minutes for standard or Min. Avg. 400 minutes for high pressure
Oven Aging at 85 deg. C (6)(7) (b) Standard OIT or High-Pressure OIT	D5721 D3895 D5885	One per formulation	Min. Avg. 55% retained after 90 days or Min. Avg. 80% retained after 90 days
Ultraviolet Resistance (8) (a) Standard OIT or (b) High-Pressure OIT (10)	GRI GM 11 D3895 D5885	One per formulation	NR (9) Min. Avg. 50% retained after 1,600 hours

Test	ASTM Test Designation	MQC Test Frequency	Requirements
Notes:			

(11) Alternate the measurement side for double sided textured sheet.
(12) Machine direction (MD) and cross-machine direction (XMD) average values should be based on 5 test specimens in each direction. Yield elongation is calculated using a gauge length of 1.3 in. (33 mm). Break elongation is calculated using a gauge length of 2.0 in. (50 mm).
(13) The SP-NCTL test is not appropriate for testing geomembranes with textured or irregular rough surfaces. Test should be conducted on smooth edges of textured rolls or on smooth sheets made from the same formulation used for the textured sheet. The yield stress used to calculate the applied load for the SP-NCTL test should be the manufacturer's mean value via MQC testing.
(14) Other methods such as D4218 (muffle furnace) or microwave methods are acceptable if an appropriate correlation to D1603 (tube furnace) can be established.
(15) Carbon black dispersion (only near spherical agglomerates) for 10 different views: nine in Categories 1 and 2 and one in Category 3.
(16) The Manufacturer can select either OIT method listed to evaluate the antioxidant content in the geomembrane.
(17) It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response.
(18) The condition of the test should be 20-hr. UV cycle at 75 deg. C followed by 4-hr. condensation at 60 deg. C.
(19) Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples.
(20) For High-Pressure OIT (D5885) UV resistance is based on percent retained value regardless of the original HP-OIT value.

2.5 60 MIL THICK DOUBLE-SIDED TEXTURED OR STRUCTURED LLDPE GEOMEMBRANE

A. For use with cap and liner.

B. Meeting the following requirements:

Test	ASTM Test Designation	MQC Test Frequency	Requirements
Sheet Thickness	D5994	10 readings per roll	▪ Avg all readings >= 57 mil ▪ Lowest individual for 8 of 10 readings = 54 mil. ▪ Lowest individual for any of 10 readings = 51 mil.
Asperity Height (1)	D7466	Every second roll (1)	Minimum, corresponding to asperity of material provided for preliminary interface shear strength testing and used to select material as the basis of design. ≥ 130 mil for studs on Super Gripnet. ≥ 175 mil for spikes on Super Gripnet.
Sheet density	D1505/D792	1/250,000 sf	Minimum 0.939 g/cc

TEST	ASTM TEST DESIGNATION	MQC TEST FREQUENCY	REQUIREMENTS
Tensile Properties (2)	D6693	1/60,000 sf	
Break Strength			Min. Avg. 120 lb/in width
Break Elongation			Min. Avg. 250%
2% Modulus	D5323	One per formulation	Max. 3,600 lb/in.
Tear Resistance	D1004	1/150,000 sf	Min. Avg 33lbs
Puncture Resistance	D4833	1/150,000 sf	Min. Avg. 66lbs.
Axi-symmetric Break Resistance Strain	D5617	One per formulation	Min. 30%
Carbon Black Content	D4218 (3)	1/100,000 sf	2 to 3%
Carbon Black Dispersion	D5596	1/100,000 sf	Category 1 or 2 for 9 of 10 readings and Category 3 for 1 of 10 readings *(4)*
Oxidation Induction Time (OIT) (5) (c) Standard OIT or (d) High-Pressure OIT	 D8117 or D5885	1/680,000 sf (1/200,000 lb)	Min. Avg. 100 minutes for standard or Min. Avg. 400 minutes for high pressure
Oven Aging at 85 deg. C (6) (c) Standard OIT or (a) High-Pressure OIT	D5721 D8117 D5885	One per formulation	Min. Avg. 35% retained after 90 days or Min. Avg. 60% retained after 90 days
Ultraviolet Resistance (7) (a) Standard OIT or (b) High-Pressure OIT (9)	D7238 D8117 or D5885	One per formulation	NR (8) Min. Avg. 35% retained after 1,600 hours

TEST	ASTM TEST DESIGNATION	MQC TEST FREQUENCY	REQUIREMENTS
Notes: *(1)* Alternate measurement side for double sided textured sheet. *(2)* Machine direction (MD) and cross-machine direction (XMD) average values should be based on 5 test specimens in each direction. Break elongation is calculated using a gauge length of 2.0 in. at 2.0 in/min. *(3)* Other methods such as D1603 (tube furnace) od D6370 (TGA) are acceptable if an appropriate correlation to D4218 (muffle furnace) can be established. *(4)* Carbon black dispersion (only near spherical agglomerates) for 10 different views: nine in Categories 1 and 2 and one in Category 3. *(5)* The Manufacturer can select either OIT method listed to evaluate the antioxidant content in the geomembrane. *(6)* It is also recommended to evaluate samples at 30 and 60 days to compare with the 90 day response. *(7)* The condition of the test should be 20-hr. UV cycle at 75 deg C followed by 4-hr. condensation at 60 deg C. *(8)* Not recommended since the high temperature of the Std-OIT test produces an unrealistic result for some of the antioxidants in the UV exposed samples. *(9)* UV Resistance is based on percent retained value regardless of the original HP-OIT value..			

2.6 EXTRUDATE ROD OR BEAD

A. Made from same resin type as the geomembrane.

B. Containing 2 to 3 percent carbon black.

PART 3 EXECUTION

3.1 EXAMINATION OF PRIMARY GEOMEMBRANE SUBSURFACE

A. Verify in writing to OWNER that the GCL surface or soil surface on which the geomembrane will be installed is acceptable. Installation without written acceptance means acceptance.

B. Verify that no soil particles or other debris Project from the GCL or soil surface that could puncture the primary geomembrane.

C. Correct conditions detrimental to timely and proper completion of the Work. Notify OWNER of such conditions and proposed corrective actions before correcting unsatisfactory conditions. Do not proceed until unsatisfactory conditions are corrected.

3.2 PREPARATION

A. Repair damage caused to GCL during deployment.

B. Repair damage to soil subgrade caused during deployment.

C. Round edges of anchor trenches or cushion with geotextiles.

3.3 PERFORM TRIAL SEAM WELDS AS FOLLOWS:

A. Perform trial welds on samples of geomembrane to verify the performance of welding equipment, welding personnel, seam welding methods, and weather conditions.

B. Make trial welds in the same surroundings and environmental conditions as the production welds, i.e., in contact with subgrade.

C. Do not begin production seam welding until equipment and welders have successfully completed trial welds.

D. Frequency of trial welds:

1. Minimum of two trial welds per day per equipment and per welder with one prior to the start of Work and one at mid shift.
2. When directed by the CQA Monitor.

E. Make trial weld sample at least 2-feet long and 18-inches wide (the seam shall be parallel along the length of the weld).

F. Allow welds to cool and then cut excesses Material from the ends of the welds.

G. Using a cutting die cut four one-inch specimens spaced evenly along the length of the weld.

H. Using a field tensiometer, test specimens for peel adhesion, and bonded seam strength (ASTM D6392). Alternate the specimens peel, shear, peel, and shear. Test both sides of the weld for peel strength. Test at a separation rate of two inches per minute.

I. A trial weld is considered passing when the following results are achieved.

1. Results conform to the latest version of GRI GM19 Table 1(a) for 40 mil HDPE geomembrane as summarized below.

PROPERTY	TEST DESIGNATION	REQUIRED TEST RESULTS (3)
Wedge Weld (1) and (2)	ASTM D6392	
Peel Strength		60 lb/in.
Peel Separation		25 percent maximum
Shear Strength		80 lb/in.
Extrusion Weld (2)	ASTM D6392	
Peel Strength		52 lb/in.
Peel Separation		25 percent maximum
Shear Strength		80 lb/in.

Notes:

(1) Both sides of the wedge weld shall be tested for peel properties.

(2) 5 of 5 specimens must pass all criteria.

(3) Acceptable break (failure) codes per ASTM D6392 are:

Wedge weld = AD and AD-Break <25%

Extrusion Weld = AD1, AD2 and AD-WLD (provided strength is achieved).

2. Results conform to the latest version of GRI GM19 Table 1(a) for 60 mil HDPE geomembrane as summarized below.

PROPERTY	TEST DESIGNATION	REQUIRED TEST RESULTS (3)
Wedge Weld (1) and (2) Peel Strength Peel Separation Shear Strength	ASTM D6392	 91 lb/in. 25 percent maximum 120 lb/in.
Extrusion Weld (2) Peel Strength Peel Separation Shear Strength	ASTM D6392	 78 lb/in. 25 percent maximum 120 lb/in.
Notes: (4) Both sides of the wedge weld shall be tested for peel properties. (5) 5 of 5 specimens must pass all criteria. (6) Acceptable break (failure) codes per ASTM D6392 are: Wedge weld = AD and AD-Break <25% Extrusion Weld = AD1, AD2 and AD-WLD (provided strength is achieved).		

3. Results conform to the latest version of GRI GM19 Table 2(a) for 60 mil LLDPE geomembrane as summarized below.

PROPERTY	TEST DESIGNATION	REQUIRED TEST RESULTS (3)
Wedge Weld (1) and (2) Peel Strength Peel Separation Shear Strength	ASTM D6392	 75 lb/in. 25 percent maximum 90 lb/in.
Extrusion Weld (2) Peel Strength Peel Separation Shear Strength	ASTM D6392	 66 lb/in. 25 percent maximum 90 lb/in.
Notes: (7) Both sides of the wedge weld shall be tested for peel properties. (8) 5 of 5 specimens must pass all criteria. (9) Acceptable break (failure) codes per ASTM D6392 are: Wedge weld = AD and AD-Break <25% Extrusion Weld = AD1, AD2 and AD-WLD (provided strength is achieved).		

J. Repeat the trial weld in its entirety when any of the trial weld specimens fail in either peel or shear.

K. When repeated trial welds fail, do not use welding apparatus and welder until deficiencies or conditions are corrected and two consecutive successful trial welds are achieved.

3.4 DEPLOYMENT

A. Slopes in Cell 2D will be as steep as 2H to 1V. Always provide for suitable deployment and temporary anchoring of geomembrane to prevent pull out from anchor trench and movement of the material down slope. Includes consideration for temperature changes and ballasting for wind as below.

B. Consider the timing and temperature during deployment. Focus on verifying that there is no bridging or stresses in the geomembrane and there are no wrinkles in the geomembrane that will fold over when covered with soil.

C. Ideally, deploying, welding, and covering would all occur at the same temperature. Practically, strive to perform these activities within as narrow a temperature range as practical and avoid these activities during peak hot or cold conditions.

D. Panel Identification: Assign each panel an identifying code number or letter consistent with the approved panel layout drawing. The coding is subject to approval by the CQA Monitor.

E. Repair damage to subgrade or other underlying materials prior to completing deployment of geomembrane.

F. Do not deploy more panels in one shift than can be welded or secured during that same shift.

G. Do not deploy in the presence of excessive moisture, precipitation, ponded water, or high winds.

H. Do not damage geomembrane when handling, with equipment traffic, leaking hydrocarbons, or any other means.

I. Do not wear shoes that can damage geomembrane.

J. Unroll geomembrane panels using methods that will not damage, stretch or crimp geomembrane. Protect underlying surface from damage.

K. Deploy textured geomembrane without dragging over installed GCL. Use a smooth geosynthetic slip sheet or rub sheet as necessary to reduce friction damage during deployment.

L. Place ballast on geomembrane that will prevent wind from uplifting and moving the geomembrane. Restore to its original position GCL that is displaced by shifting geomembrane to preserve the GCL overlap integrity. If the geomembrane has been observed to move due to wind, the CQA Monitor can require that geomembrane panels be cut open to verify that the GCL Materials have not been shifted due to wind action on the geomembrane. If the GCL has shifted, repair is at CONTRACTOR's expense.

M. Use ballast that will not damage geomembrane.

N. Protect geomembrane in areas of heavy traffic by placing a protective cover over the geomembrane.

O. Do not allow any vehicular traffic directly on geomembrane.

P. Remove wrinkled or folded Material.

Q. Install Material to account for shrinkage and contraction while avoiding wrinkles. Install Material stress-free with no bridging before it is covered. Add Material as needed to avoid bridging.

R. Before wrinkles fold over, attempt to push them out. For wrinkles that cannot be pushed out, cut them out and repair cuts prior to burial.

S. Visually inspect geomembrane for imperfections. Mark faulty or suspect areas for repair.

3.5 SEAM LAYOUT

A. Orient seams parallel to line of a maximum slope, i.e., orient down, not across slope.

B. Minimize number of field seams in corners, odd-shaped geometric locations and outside corners.

C. Keep horizontal seams (seams running approximately parallel to slope contours) at least 6 feet away from toe or crest of slope, unless approved by OWNER.

D. Use seam-numbering system compatible with panel number system.

E. Shingle panels on all slopes and grades to promote drainage over the seam not into the seam.

3.6 WELDING EQUIPMENT

A. Maintain sufficient operating seaming apparatus to continue work without delay.

B. Use power source capable of providing constant voltage under combined line load.

C. Provide protective lining and splash pad large enough to catch spilled fuel under electric generator, if generator is positioned on geomembrane.

D. Provide extrusion welders equipped with gauges showing temperatures in extruder apparatus and at nozzle.

E. Provide hot wedge welder meeting the following requirements:

1. Vehicular mounted.
2. Automated variable speed capability.
3. Equipped with devices for adjusting temperatures at the wedge.
4. Pressure controlled by springs, pneumatics, or other system that allows for variation in sheet thickness.
5. Rigid frame fixed position equipment is not acceptable.

3.7 TEST EQUIPMENT

A. Provide tensiometer capable of measuring seam strength. Tensiometer must be calibrated and accurate within 2 pounds.

B. Provide dies for cutting seam samples.

3.8 GENERAL WELDING PROCEDURES

A. Whenever possible use hot wedge welding (fusion welding) procedures to join adjacent panels. Limit extrusion welding to locations where hot wedge welding is not practicable.

B. Provide at least one master seamer during all production welding to supervise all other seamers.

C. Do not commence welding until trial weld test sample, made by that equipment passes.

D. Clean seam area surfaces of grease, moisture, dust, dirt, debris, or other foreign material.

E. Overlap panels a minimum 3 inches for extrusion and 4 inches for hot wedge welding.

F. Construct weld with adequate Material width on each side of weld to allow peel and shear testing.

G. Extend welding to the outside edge of all panels and to the outside edge of panels placed in anchor trenches and under termination berms.

H. If required for firm support, provide a firm subsurface under the seaming area.

I. Cut fish mouths or wrinkles along the ridge of the wrinkle to achieve a flap overlap. Extrusion-weld the cut fish mouths or wrinkles where the overlap is more than 3 inches. When there is less than 3 inches overlap, patch with an oval or round patch extending a minimum of 6 inches in all directions beyond the cut.

3.9 EXTRUSION TYPE OF WELDING

A. Use procedures to tack bond adjacent panels together that do not damage geomembrane and allow CQA tests to be performed.

B. Purge welding apparatus of heat-degraded extrudate before welding.

C. Bevel top edges of geomembrane a minimum of 45° and full thickness of geomembrane before extrusion welding.

D. Clean seam-welding surfaces of oxidation by disc grinder or equivalent not more than 30 minutes before extrusion welding. Change grinding discs frequently. Do not use clogged discs.

E. Do not remove more than four mils of Material when grinding.

F. Grind across, not parallel to, welds.

G. Cover entire width of grind area with extrudate.

H. When restarting welding, grind ends of all welds that are more than five minutes old.

3.10 HOT WEDGE WELDING

A. Place smooth insulating plate or fabric beneath hot welding apparatus after usage.

B. Protect against moisture build-up between panels.

C. If welding cross seams, conduct field test welds at least every two hours, otherwise, once prior to start of Work and once at mid-day.

D. Bevel edges of top and bottom panels on cross seams.

E. Do not weld on geomembrane until equipment has passed trial weld test.

F. Extrusion-weld a repair patch over all tee and cross-seam intersections.

3.11 INSTALLATION QUALITY CONTROL

A. Log the following every four hours:

1. Temperature on the geomembrane surface being welded.
2. Extrudate temperatures in barrel and at nozzle (extrusion welder).

3. Operating temperature of hot wedge (hot wedge welder) and any pressure adjustments made.
4. Preheat temperature.
5. Speed of hot wedge welder in feet per minute.

B. Weld only when ambient temperature, measured 6 inches above the geomembrane, is between 40°F and 104°F.

C. If seaming at ambient temperatures below 40°F (5°C) or above 104°F (40°C), demonstrate and certify that such methods produce seams that are entirely equivalent to seams produced at ambient temperatures above 40°F (5°C) and below 104°F (40°C). Certify the overall quality of the geomembrane is not adversely affected. Perform Work under contract Change Order that states the seaming procedure will not cause any physical or chemical modification to the geomembrane, which will generate short or long-term damage to the geomembrane.

D. Seaming below temperatures of 32° F must be performed under cold weather welding procedures approved by OWNER.

3.12 NON-DESTRUCTIVE TESTING (PERFORMED BY INSTALLER)

A. Non-destructively test all field seams over their full length using a vacuum test unit, air pressure (for double fusion seams only), spark testing, or other approved methods.

B. Perform testing as the seaming progresses and not at the completion of all the field seaming.

C. Note all required repairs in CQC reports and then complete all required repairs in accordance with this specification.

3.13 NON-DESTRUCTIVE VACUUM TESTING

A. Equipment

1. A vacuum box assembly consisting of a rigid housing, a transparent viewing window, a soft neoprene gasket attached to the bottom porthole, or valve assembly, and a vacuum gauge.
2. A vacuum pump assembly equipped with a pressure control.
3. A rubber pressure/vacuum hose with fittings and connections.
4. A soapy solution and an applicator.

B. Vacuum Box Test Procedures.

1. Place the box over the wetted seam area (soapy solution).
2. Ensure that a leak-tight seal is created.
3. Energize the vacuum pump and reduce the vacuum box pressure to approximately 10 inches of mercury, i.e., 5-psi gauge.
4. Examine the geomembrane through the viewing window for the presence of soap bubbles for a period of not less than ten seconds.
5. Mark areas where soap bubbles appear and repair in accordance with repair procedures described in this specification.

3.14 NON-DESTRUCTIVE AIR PRESSURE TESTING FOR DOUBLE WEDGE WELD

A. Equipment:

1. An air pump (manual or motor driven) equipped with a pressure gauge capable of generating and sustaining a pressure over 70 psi and mounted on a cushion to protect the geomembrane.
2. A rubber hose with fittings and connections.
3. A sharp hollow needle or other approved pressure feed device.
4. A pressure gauge with an accuracy of plus or minus 1 psi.

B. Test Procedures.

1. Seal both ends of the welded seam to be tested.
2. Insert needle or other approved pressure feed device into the tunnel created by the weld.
3. Energize the air pump to a minimum pressure as follows:
   a. For 60 mil HDPE - 60 psi.
   b. For 60 mil LLDPE – 30 psi.
   c. For 40 mil HDPE – 30 psi.
4. Maintain this pressure for 5 minutes, then close the valve. Then, allow 5 minutes relaxation time. During the relaxation time the air pressure cannot drop more than 2 psi.
5. If loss of pressure exceeds 2-psi, or otherwise approved, or does not stabilize, locate faulty area and repair in accordance with repair procedures described in this specification.
6. Puncture opposite end of seam to release air. If blockage is present, locate and test seam on both sides of blockage.
7. Remove needle or other approved pressure feed device and then repair the penetration holes.
8. If the testing equipment is not able to hold the 60-psi pressure (i.e., leaking needle) reduce the pressure in 2-psi increments until the equipment can sustain the pressure.

3.15 SPARK TESTING BOOTS AROUND PENETRATIONS OR OTHER DIFFICULT AREAS OR AS AN ALTERNATIVE TO VACUUM TESTING.

A. Equipment and Materials.

1. 24-gauge copper wire.
2. Low-amperage electric detector, 20,000 to 30,000 volts, with brush-type electrode capable of causing visible arc up to 3/4 inch from copper wire.

B. Spark Testing Procedures.

1. During extrusion welding, place a copper wire within 1/4 inch of the edge of extrusion weld.
2. Pass electrode over seam area and observe for spark. If a spark is detected perform a repair.

3.16 FIELD DESTRUCTIVE SEAM TESTING

A. Perform the following tests witnessed by the CQA Monitor.

1. Perform peel and shear tests on two specimens obtained from each end of a seam welded between panels (four specimens per seam).

2. Perform peel tests on one specimen taken from each butt seam.
3. Additional destructive test specimens may be obtained at the discretion of the CQA Monitor due to suspected contamination of the weld area, excess crystalline, offset welds, or other suspected defects.
4. Perform peel and shear tests in compliance with ASTM D6392. All destructive peel and shear tests are considered passing when all specimens from each test location meet required results listed in Article 3.3 of this Section.

B. If any field test sample fails, follow failed test procedures outlined in this Section.

3.17 FAILED WELD PROCEDURES

A. Follow these procedures when there is a destructive test failure. Follow one of the following two options:
   1. First option:
      a. Reconstruct the seam between any two passing test locations. Do not extrusion weld the flap.
   2. Second option:
      a. Trace the weld at least 10 feet minimum towards the opposite end of the seam from the location of the failed specimen.
      b. Obtain specimens at this location for additional field tests. Obtain specimens as described above.
      c. If this additional test specimen meets seam quality requirements, then repair the seam between passing seam specimen locations or the passing specimen location and the end of the seam.
      d. If any specimen fails to meet seam quality requirements, repeat the process to establish the zone in which the seam must be repaired.

B. Butt Seams: If a peel test taken from a butt seam fails, cap the entire butt seam. Obtain a peel specimen from the cap and perform peel test. If the peel test from the cap specimen fails, repeat the capping until a passing test is obtained from a specimen of the cap weld.

C. Whenever a sample fails, perform additional trial seams for that welder and welding apparatus.

3.18 ACCEPTABLE WELDED SEAMS

A. The weld passes all non-destructive tests.

B. The weld is bracketed by two locations from which all specimens have passed destructive tests.

C. For reconstructed seams exceeding 50 feet, a specimen taken from within the reconstructed weld passes destructive testing and all non-destructive tests pass.

3.19 SEAMS THAT CANNOT BE NON-DESTRUCTIVELY TESTED

A. If the weld cannot be tested, cap strip the weld. The welding and cap-stripping operations must be observed by the CQA Monitor and INSTALLER for uniformity and completeness.

3.20 DEFECT AND REPAIR PROCEDURES

A. Examine all welds and non-weld areas of the geomembrane for defects, holes, blister, undispersed raw materials, and any sign of contamination by foreign matter. The surface of the geomembrane must be clean at the time of the examination.

B. Repair and non-destructively test each suspect location, regardless if in a weld area or discovered in the panel. Do not cover geomembrane at locations that have been repaired until test results with passing values are available.

C. Extrusion-weld a patch over all "cross" or "tee" welds and specimen locations.

D. Remove damaged geomembrane and replace with acceptable geomembrane Materials if damage cannot be satisfactorily repaired.

E. Repair, removal, and replacement are at CONTRACTOR's expense if the damage results from CONTRACTOR's, INSTALLER's, or CONTRACTOR's subcontractor's activities.

F. Repair any portion of the geomembrane exhibiting a flaw or failing a destructive or non-destructive test. Contract upon the appropriate repair method will be determined between OWNER's Representative, the CQA Organization and the INSTALLER. Acceptable repair procedures may include:

   1. Patching: Used to repair large holes (over 3/8-inch diameter), tears (over two inches long), undispersed raw materials, contamination by foreign matter, and to cover cross and tee connections.
   2. Abrading and re-welding: Used to repair small sections of seams.
   3. Spot welding or seaming: Used to repair small tears (less than 2 inches long), pinholes or other minor localized flaws.
   4. Capping: Used to repair large lengths of failed seams.
   5. Removing the seam and replacing with a strip of new Material.

G. In addition, satisfy the following procedures:

   1. Abrade geomembrane surfaces to be repaired (extrusion welds only) no more than one hour prior to the repair.
   2. Clean and dry all surfaces at the time of repair.
   3. The repair procedures, Materials, and techniques must be accepted in advance of the specific repair by OWNER's Representative, CQA Organization, and INSTALLER.
   4. Extend patches or caps at least 6 inches beyond the edge of the defect, and round all corners of Material to be patched and the patches to a radius of at least three inches.
   5. Unless otherwise instructed by OWNER, cut geomembrane below large caps to avoid water or gas collection between the sheets.

H. Verification of repair:

   1. Number and log each repair.
   2. Non-destructively test each repair using methods specified in this Section.
   3. Destructive tests may be required at the discretion of OWNER's Representative or CQA Organization.

4. Reconstruct repairs until tests indicate passing results.

3.21 PROVISION FOR EXTRA MATERIAL

A. Upon completion of installation, provide OWNER with extra HDPE geomembrane as follows:
   1. Quantity: 1,000 square feet minimum.
   2. Material: same as specified for this Project.
   3. New, unused Material, on a roll; not scrap Material.
   4. Free of scratches, defects, mud, and contamination.

3.22 GEOMEMBRANE ACCEPTANCE

A. CONTRACTOR retains all ownership and responsibility for the geomembrane until acceptance by OWNER.

B. OWNER will accept geomembrane installation when:
   1. All required MQC and INSTALLER records have been received and accepted.
   2. The installation is finished.
   3. Test reports verifying completion of all field seams and repairs, including associated testing, is in accord with the Section.
   4. Written Manufacturer's Certification and drawings have been received by OWNER.

END OF SECTION

SECTION 02840

PROTECTIVE PLYWOOD

PART 1 GENERAL

1.1 SECTION INCLUDES:

A. Furnishing and installing plywood over geosynthetic terminations.

1.2 RELATED SECTIONS

A. Section 02300 – Earthwork.

B. Section 02771 – Geotextile.

C. Section 02778 – Geomembrane.

PART 2 PRODUCTS

2.1 MATERIALS

A. 4 feet x 8 feet x ½ inch CDX plywood (mill reject acceptable).

PART 3 EXECUTION

3.1 INSTALLATION

A. Install per the Construction Drawings.

B. Butt adjacent plywood panels. Do not overlap.

END OF SECTION

APPENDIX G

CQA Manual

CONSTRUCTION QUALITY ASSURANCE (CQA) MANUAL
2022 SOUTH SLOPE CAPPING AND LINING PROJECT

RIVERBEND LANDFILL
MCMINNVILLE, OREGON

MAY 2022

PREPARED FOR

RIVERBEND LANDFILL CO.
13469 HIGHWAY 18
MCMINNVILLE, OREGON 97128

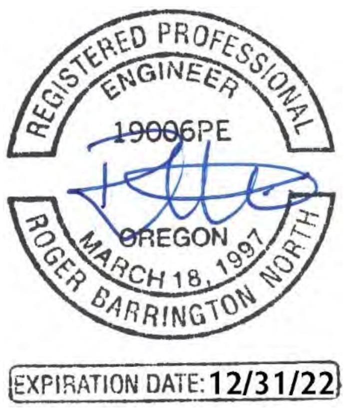
PREPARED BY

VISTA GEOENVIRONMENTAL SERVICES

LAKE OSWEGO, OREGON 97034

CERTIFICATION PAGE

This Construction Quality Assurance (CQA) Manual was prepared under the supervision and direction of the undersigned, whose seal as a registered professional engineer in the State of Oregon is affixed below.



Roger B. North, P.E.
Design Engineer of Record

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APPENDICES

LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	ASTM International
CCR	Construction Certification Report
CQA	Construction Quality Assurance
CQA Organization	Construction Quality Assurance Organization
CQC	Construction Quality Control
CY	cubic yard
DEQ	Department of Environmental Quality
FTB	Film Tearing Bond
GCL	Geosynthetic Clay Liner
KSF	Kips Per Square Foot
Landfill or RLF	Riverbend Landfill
lb	Pound(s)
MARV	Minimum Average Roll Value
mm	Millimeter(s)
MQA	Manufacturing Quality Assurance
MQC	Manufacturer Quality Control
Project	2022 South Slope Capping and Lining Project
PSF	Pounds Per Square Foot
PSI	Pounds Per Square Inch
RFI	Request For Information
RLC	Riverbend Landfill Co.
sec	Second
sf	Square Foot
VISTA	Vista GeoEnvironmental Services

1 INTRODUCTION

1.1 PURPOSE OF CQA MANUAL

Vista GeoEnvironmental Services (VISTA) has prepared this Construction Quality Assurance (CQA) Manual to describe the CQA procedures to be used by the CQA Organization during construction of the South Slope Closure (Project) at Riverbend Landfill (Landfill or RLF) in McMinnville, Oregon (Project). The CQA Manual is a guidance document that contains general and specific CQA requirements for testing materials and monitoring construction activities. General requirements include the responsibilities of CQA personnel, documentation control, and reporting procedures. Specific requirements include required observation and testing activities associated with earthwork, geosynthetic, and mechanical construction activities that will be performed by selected contractors and installers.

The CQA Manual compliments the following construction documents prepared for the Project:

- "Construction Drawings South Slope Closure, Riverbend Landfill", VISTA, May 2022.
- "Technical Specifications South Slope Closure, Riverbend Landfill", VISTA, May 2022.

CQA represents planned and systematic monitoring, testing and documentation to provide confidence that items of work or services meet the requirements of Construction Drawings and Technical Specifications issued for construction. CQA activities are separate and distinct from Construction Quality Control (CQC) activities. CQC activities provide a means to measure and regulate the characteristics of an item or service to comply with the requirements of the Construction Drawings and Technical Specifications. CQC activities are defined in the Construction Drawings and Technical Specifications and are the responsibility of organizations that are performing the construction (typically material suppliers and contractor[s]).

1.2 SUMMARY OF PROJECT CONSTRUCTION ACTIVITIES

Specific Project work elements include the following:

- Installation of temporary erosion and sediment control measures.
- Clearing, grubbing, and stripping.
- Excavation and trenching (and trench backfilling).
- Refuse removal and relocation, if necessary.
- Exposure of the existing final cover system limits.
- Existing slope grading to design slope grades.
- Construction of the final cover foundation layer.
- Installation of the final cover geomembrane cap and geotextile filter.
- Construction of subdrains above the geomembrane with pipes and gravel.

- Construction of the vegetative soil layer and associated drainage swales and downchutes. Connection of geosynthetics and other cap and liner materials to adjacent existing cap and liner materials.
- Construction of terminations for connection to future cap areas.
- Conformance testing and interface testing programs.

1.3 DOCUMENT CONTENTS

This CQA Manual is presented in the following seven sections:

- **Section 1** presents the purpose of the CQA program, summarizes the proposed Project activities, Project documents and reference documents, and lists principal contacts.
- **Section 2** presents the general organization structure and responsibilities of the Project participants and defines terms relevant to the CQA program, Technical Specifications and Construction Drawings.
- **Section 3** presents general CQA requirements including notifications, coordination, meetings, design and CQA program modifications, general reporting, material quality verification, equipment calibration and procedures for correcting non-conforming work.
- **Section 4** presents laboratory testing program to confirm that the interface shear strength properties of the proposed Project materials are consistent with the parameters assumed for cover stability.
- **Sections 5 through 7** present the specific CQA requirements for earthwork, polyethylene pipe, and geosynthetics, including procedures such as materials verification, test standards, testing frequencies, conformance and construction testing, and construction monitoring for each material.
- **Section 8** presents methods of documenting and record keeping.

1.4 REFERENCE DOCUMENTS

The following reference documents provide background information and detailed information that apply to the Project.

- Emcon/OWT, Inc., "Construction Drawings, 2005 Closure, Riverbend Landfill", July 2005.
- Emcon/OWT, Inc., "Construction Report, 2005 Closure Final Cover, Riverbend Landfill", 2005.
- Geosyntec Consultants, "2019 North and East Final Closure, Riverbend Landfill", April 2019.
- Sanborn, Head and Associates, Inc., "2020 Southeast Slope Final Closure Construction Specifications, Riverbend Landfill", April 2020.

- Sanborn, Head and Associates, Inc., "2020 Southeast Slope Final Closure Drawings, Riverbend Landfill", April 2020.
- ASTM International, Inc. (ASTM), "Annual Book of ASTM Standards," Section 4 Construction, Volume 04.02 Concrete and Aggregates, latest edition.
- ASTM, "Annual Book of ASTM Standards," Section 4 Construction, Volumes 04.08 and 04.09 Soil and Rock; Dimension Stone; Geosynthetics, latest edition.
- ASTM, "Annual Book of ASTM Standards," Section 8 Plastics, Volumes 08.01 Plastics (I), 08.02 Plastics (II), and 08.03 Plastics (III), latest edition.
- American Association of State Highway and Transportation Officials (AASHTO), "Specifications and Volume II Tests," latest edition.
- Geosynthetic Research Institute (GRI), Standard Specifications, latest editions.
- NSF International (NSF), Standard Specifications" latest editions.

1.5 CONTACTS AND ADDRESSES

The following addresses phone numbers, and contacts of organizations involved with the Project are provided for informational purposes only.

Site:	Riverbend Landfill 13469 Highway 18 McMinnville, Oregon 97128 (503) 472.8788
Owner:	Riverbend Landfill Co. (RLC)
Contact:	Melody Adams (503) 348.3781
Design Engineer:	Vista GeoEnvironmental Services P.O. Box 388 Lake Oswego, Oregon 97034 (503) 922.2522

2 ORGANIZATIONAL RESPONSIBILITIES AND DEFINITIONS

2.1 INTRODUCTION

Section 2.2 describes the duties and responsibilities of key Project stakeholders, and **Section 2.3** defines terms such as "construction quality control," "record drawings," and "Contract Documents" used in the Technical Specifications, Construction Drawings, and this CQA Manual.

2.2 PROJECT STAKEHOLDER RESPONSIBILITIES

2.2.1 OREGON DEPARTMENT OF ENVIRONMENTAL QUALITY (DEQ)

DEQ is the regulatory authority for overseeing and approving the Project. In this capacity, DEQ reviews and approves the design documents.

2.2.2 RIVERBEND LANDFILL CO. (RLC)

RLC is the owner and operator of Riverbend Landfill (Owner).

2.2.3 CONSTRUCTION MANAGER

The Construction Manager is the Owner's representative responsible for contract administration, budget, schedule, and coordination between the Parties and DEQ. The Construction Manager will request assistance from the Owner, Design Engineer, and CQA Engineer of Record to resolve construction or regulatory issues.

2.2.4 CONTRACTOR

The Contractor is responsible for coordinating the activities of its own forces and subcontractors, scheduling, performing the work within the timeframe and budget agreed to in the Contract Documents, performing the work per the Construction Drawings and Technical Specifications, and implementing CQC procedures to ensure construction complies with the Technical Specifications. The Contractor is expected to cooperate with the CQA Organization to achieve a quality product.

2.2.5 DESIGN ENGINEER OF RECORD

The representative of the Design Engineer responsible for the design as it existed at the time construction began, must approve all design changes and clarifications to design questions made during construction.

2.2.6 CQA ORGANIZATION

CQA Organization personnel include the CQA Engineer of Record and CQA Monitors. The CQA Engineer of Record, an Oregon-registered Professional Engineer is responsible for directing the CQA activities and certifying that construction was performed in accordance with the design intent, the Construction Drawings, the Technical Specifications, and any approved design changes made during construction. The CQA Engineer of Record and the Design Engineer may be the same individual.

CQA Monitors represent the Owner by observing, monitoring, testing, and documenting the Contractor's work activities in sufficient detail and continuity to provide a high level of confidence that the work product complies with the intent of the Contract Documents. Whenever CQA Monitors perform visual observation or perform tests, they are responsible for timely preparation and processing of all required documentation and reports. Accurate and concise reports must be prepared for all monitoring activities and for each test performed.

2.2.7 SURVEYOR

The Surveyor will work at the direction of the Owner or the Contractor, as the case may be, to assist in constructing the Project in accordance with the Construction Drawings and Technical Specifications and performing surveys to document as-built conditions and quantities. The Surveyor, an Oregon-registered Professional Land Surveyor (or Professional Engineer), is responsible for directing the survey activities and certifying all record drawings, quantities, and calculations.

2.3 DEFINITIONS

Whenever the terms listed below are used, the intent and meaning will be interpreted as indicated.

ASTM - ASTM International.

Construction Manager - Authorized representative of the Owner responsible for planning, and coordinating construction activities including scheduling, CQA, and contract administration.

CQA - A planned and systematic pattern of procedures and documentation designed to provide confidence that items of work or services meet the requirements of the contract documents. A third-party consultant independent of the Owner and Contractor must perform CQA.

CQA Organization – A third-party firm retained by the Owner that implements and manages the CQA program, including the preparation of a Construction Certification Report (CCR) upon completion of the Project.

CQA Engineer of Record - The CQA Organization's authorized representative responsible for certifying that construction complied with the construction documents and their approved modifications.

CQA Laboratory - Laboratory responsible for performing soil, geosynthetic, and shear testing to assure various materials used to construct components of the Project meet specified requirements and meet interface friction and slope stability requirements defined in the design report.

CQA Monitors - Authorized representatives of the CQA Organization, responsible for implementing the quality assurance program, observing, testing, and documenting construction in accordance with the Contract Documents.

Construction Quality Control (CQC) - Those actions, which provide a means to measure and regulate the characteristics of an item, or service, to comply with the requirements of the contract documents. The Contractor must perform CQC activities identified in the Technical Specifications.

Contract Documents - The Owner-issued set of documents, which include bidding requirements, contract forms, contract conditions, Technical Specifications, Construction Drawings, addenda, and contract modifications.

Construction Drawings - The official plans, profiles, typical cross-sections, elevations, and details, as well as amendments and supplemental drawings, which show the locations, character, dimensions, and details of the work to be performed. Construction Drawings may also be referred to as the "plans" or "Contract Drawings."

Construction Manager - The Construction Manager is the designated Owner representative for the Project.

Contractor - The person or persons, firm, partnership, corporation, or any combination, private, municipal, or public, who, as an independent contractor, has entered into a contract with the Owner, and who is referred to throughout the contract documents by singular number and masculine gender.

Design Engineer - The individual(s) or firm(s) responsible for the design and preparation of the Project Construction Drawings and Technical Specifications. The Design Engineer for the Project is Vista GeoEnvironmental Services (VISTA).

Design Engineer of Record - The authorized representative of the Design Engineer who is the individual responsible for design of the Project and approving any changes to the design during construction.

Earthwork - A construction activity involving the use of earthen materials as defined in the construction specifications and Section 5 of this CQA Plan.

Geosynthetic Clay Liner (GCL) - A synthetic liner material, which consists of a bentonite clay layer encapsulated between two geotextile layers.

Geocomposite - A geosynthetic material used to transmit fluids, which consists of an HDPE geonet core with a geotextile heat-bonded to both sides.

Geomembrane - A geosynthetic lining material also referred to as flexible membrane liner, membrane, liner, or sheet.

Geotextile - A fabric manufactured from synthetic fiber that is designed to achieve specific engineering objectives, including seepage control, media separation (e.g., between drainage gravel and soil), and filtration.

Installer - The person or firm responsible for installing geosynthetic materials. This definition applies to any party installing geosynthetic components, including GCL, geomembrane, geocomposite, and geotextile, even if not the primary function of the party.

Manufacturing Quality Assurance (MQA) - A planned system of facility inspections, verifications, audits, and raw material (resins and additives), and geosynthetic product evaluations performed by the MQA Organization to assess the quality of the manufactured product and to verify the Manufacturer is in compliance with the Technical Specifications and Manufacturer's Certification. Ref. EPA/600/R-93-182.

Manufacturing Quality Control (MQC) - A planned system of factory inspections conducted by the Manufacturer to directly monitor and control the manufacture of a Material to ensure minimum (or maximum) specified values in the manufactured product are attained and to determine compliance with the requirements of Materials and workmanship as stated in the Manufacturer's Certification and Owner's Technical Specifications. Ref. EPA/600/R-93/182.

Non-Conformance - A deficiency in characteristic, documentation, or procedure that renders the quality of an item or activity unacceptable or indeterminate. Examples of non-conformances include, but are not limited to, physical defects, test failures, and inadequate documentation.

Owner – Riverbend Landfill Co.

Panel - A unit area of the geosynthetics that is seamed in the field or in the fabricator's plant.

Procedure - A document that specifies or describes how an activity is to be performed.

Project Documents - The Project documents comprise the Contractor submittals, Construction Drawings, record drawings, Technical Specifications, shop drawings, CQC and CQA Manuals, safety plan, and Project schedule.

Record Drawings - Drawings recording the constructed dimensions, details, and coordinates of the Project (also referenced to as "As-Builts").

Technical Specifications - The qualitative and quantitative description for manufacturing and installing products, materials, and workmanship upon which the contract is based.

Testing - Verification that an item meets specified requirements by subjecting that item to a set of physical, chemical, environmental, or operating conditions.

Testing Laboratory - A laboratory capable of conducting the tests required by this CQA Plan and the Contract Specifications.

Third Party – The party or organization independent of the Owner and Contractor, where the Owner is the first party and the Contractor is the second party.

3 GENERAL CQA REQUIREMENTS

3.1 INTRODUCTION

Success of the CQA program requires coordinated communications, performance of the required monitoring and testing activities, documentation of completed monitoring and testing activities, and senior review of CQA documentation. Therefore, the personnel responsible for the CQA program must assure that CQA procedures are implemented, results of the program are systematically reviewed, and corrections, if necessary, are implemented.

This section of the CQA Manual describes general requirements of the CQA Organization. It includes general requirements for notifications, meetings, control of Project records and documentation, and control of nonconforming work.

3.2 NOTIFICATIONS

As stated in the Technical Specifications, the Contractor is required to notify the Owner in advance of performing any work requiring sampling, testing, and monitoring as described on the Construction Drawings, in the Technical Specifications, and/or this CQA Manual. The Contractor must also notify the Owner in advance of any sampling, testing, and monitoring activities conducted by the Contractor, so the Owner's Project Manager can observe these activities. It is the CQA Organization's responsibility to remind the Contractor of its notification requirements.

3.3 COORDINATION

Coordination includes, but is not limited to, the proper selection of equipment, materials, and labor to perform the intended task and the coordination of work activities such that work, traffic, staging, and support areas are utilized effectively and not compromised.

As stated in the Technical Specifications, the Contractor shall be aware that CQA monitoring is required as a component of many of the Contractor's work activities and these monitoring events need to be considered in developing the schedule. Failure to perform the CQA monitoring may require additional work to be performed or the removal and replacement of completed work.

3.4 MEETINGS

To facilitate construction, and to clearly define construction goals and activities, close coordination between the Owner, Construction Manager, Design Engineer, CQA Organization, and Contractor is essential. To meet this objective, pre-construction and progress meetings will be held.

3.4.1 Pre-Construction Meeting

A pre-construction meeting will be held at the site and will be attended by the Owner, Construction Manager, Design Engineer, Contractor, Installer, CQA Engineer of Record, and others designated by the Owner. The purpose of this meeting will be to:

- Confirm key personnel and roles and responsibilities.
- Present a proposed construction progress schedule.
- Discuss liquidated damages.
- Discuss procedures for handling submittals.
- Discuss the direction of correspondence, and coordinate responsibility between Owner and Contractor.
- Establish the day and for routine weekly progress meetings.
- Review testing equipment and procedures.
- Summarize the required laboratory materials testing.
- Discuss applications for payment, and progress payment procedures.
- Discuss Change Order procedures.
- Discuss Owner's site regulations.
- Review the construction documents, including Construction Drawings, Technical Specifications, and CQA Manual.
- Review Health and Safety documents, work area security, safety procedures, sign-in and sign-out procedures, working hours, and related issues.
- Agree laydown areas and procedures for equipment and material deliveries.
- Traffic control, signage, and interaction with landfill activities.
- Provide all parties with relevant documents.
- Define lines of communication and authority.
- Establish reporting and documenting procedures.
- Establish testing protocols and procedures for correcting and documenting construction or nonconformance.
- Conduct a site inspection to discuss work area, stockpile areas, laydown areas, access roads, haul roads, and related items.

The Construction Manager will take minutes of the meeting and provide copies to all relevant parties.

3.4.2 ROUTINE PROGRESS MEETINGS

Routine progress meetings will be held during the execution of the Project. These will generally be attended by the Owner, Construction Manager, Contractor, Surveyor, and CQA Engineer of Record. However, depending on the meeting agenda and stage of construction, others such as subcontractors, CQA Monitors, product suppliers, and the Design Engineer may attend. The objectives of these meetings are to:

- Review meeting minutes from the previous progress meeting.
- Review any health and safety issues for the site.
- Review the status of the Project, including outstanding action items.
- Discuss work in progress and key scheduled activities for the next one to two week period.
- Schedule deliveries.
- Address any outstanding technical concerns, issues or conflicts that may or may not interfere with work progress.
- Review and discuss any requests for information (RFIs).
- Review the submittal register to identify any outstanding submittal issues.
- Review MQC, CQC, and CQA testing completed since the previous meeting.
- Review scheduled MQC, CQC, and CQA testing.
- Review the Contractor's updated schedule.
- Review status of survey submittals, including construction quantities, and schedule required surveying tasks.

The Construction Manager or designee will prepare the agenda and meeting minutes for distribution to relevant parties.

3.4.3 DAILY COORDINATION MEETINGS

An informal daily coordination meeting is recommended before the start of work. At a minimum, the CQA Monitor and Contractor must attend this meeting. The objectives of these meetings are to:

- Discuss problems and resolutions. Determine if any issues need to be communicated to the Construction Manager or Design Engineer for resolution.
- Review test data.
- Discuss the Contractor's personnel and equipment assignments for the day.
- Review the previous day's activities and accomplishments.

The CQA Monitor will document any issues requiring resolution or follow-up.

3.4.4 Other Meetings

As required, other meetings will be held to discuss problems or non-conformances. At a minimum, the Owner, Construction Manager, CQA Monitors, and Contractor will attend these meetings. If the problem requires a design modification and subsequent change order, the Design Engineer should also be present. The Construction Manager will document the meeting.

3.5 DESIGN MODIFICATIONS

Design changes may be required during construction and are a normal part of the construction process. These changes must be made by field order, work change directive, or change order to the contract. When field orders, work change directives, or change orders are issued, the Owner, Designer, or CQA Manager will prepare them for distribution and signature by the Owner and Contractor. A copy of the design changes must also be distributed to the CQA Organization. Design change documentation must be filed in the Project record documents.

Where these change orders modify the Construction Drawings and Technical Specifications it is the responsibility of the Construction Manager to issue revised documents to the Owner, CQA Organization, and the Contractor, and to recall documents that have not been revised to reflect the change.

3.6 CQA PROGRAM MODIFICATIONS

Changes to CQA procedures may be required during construction. These changes must be made in writing by the Design Engineer and must identify the CQA procedural change and its justification. The Design Engineer will distribute CQA procedural changes to the Owner, Construction Manager, CQA Organization, and Contractor. CQA procedural changes must be filed in the Project record documents.

3.7 CONTROL OF CONSTRUCTION DOCUMENTS, AS-BUILT RECORDS, AND FORMS

3.7.1 Control of Construction Documents

The Construction Manager will control construction documents, including Technical Specifications, Construction Drawings, and change orders. The Construction Manager maintains one or more copies of the most current set of contract documents for use by the Contractor and CQA Monitors. Upon issuance of new copies or revisions, it is the responsibility of the Construction Manager to notify the Contractor and CQA Organization of the revisions, to provide revised contract documents and order the recall of all copies of the contract documents that do not include the latest revisions.

3.7.2 Control of As-Built Information

CQA Monitors, the Contractor, and the Surveyor collect as-built information. During the Work the Construction Manager is responsible for compiling this information into one set of Construction Drawings and Technical Specifications, which will be maintained at the Project site. These Construction Drawings and

Technical Specifications will be clearly marked as "Project Record Drawings and Technical Specifications." At the completion of the Project, all as-built information will be provided to the CQA Engineer of Record for use in preparing the CCR.

3.7.3 PROJECT CONTROL OF FORMS

CQA Organization will maintain a master of each CQA form used on the Project, including daily progress report forms, test report forms, and other Project forms. Upon issuance of a new or modified CQA form, the CQA Organization will recall and remove all superseded forms along with the master, notify the CQA Monitors, and provide new or revised forms for their use.

3.8 PROCESSING REPORTS AND RECORDS

3.8.1 DAILY REPORTS

The CQA Monitor prepares a daily report that must be reviewed by the CQA Engineer of Record for clarity and completeness. CQA Organization maintains a file of all daily reports.

3.8.2 CQA TEST REPORTS

The CQA Monitor or CQA laboratory must complete a test report whenever testing is performed. The test reports must be peer reviewed or reviewed by the CQA Engineer of Record. The review includes a check for mathematical accuracy, conformance to test requirements, conformance to the Technical Specifications, clarity, legibility, traceability, and completeness. Copies of all test reports must be transmitted to the CQA Engineer of Record.

3.8.3 MQC AND CQC TEST REPORTS

The contractual responsibilities for MQC and CQC tests to determine the quality of products manufactured for this Project and the quality of its subsequent installation are presented in the Technical Specifications. The Design Engineer or CQA Organization must review MQC and CQC data to assure manufactured products meet specified requirements.

The Design Engineer must review MQC data for conformance with specified material quality requirements within three working days of receiving the data. The review must be documented and provided to Contractor, Owner, Construction Manager, and CQA Organization as relevant. The CQA Manager must file this information in the form it was received in the Project files. If the MQC data does not verify product quality the CQA Manager must immediately notify the Owner, Construction Manager, Contractor, manufacturer, and / or supplier as appropriate for the product.

The Contractor shall provide CQC data following completion of construction material installation to the CQA Organization. The CQA Organization shall review the CQC data for conformance with specified installation requirements. When this review is complete, the CQA Organization files this information in the form it was received in the CQA Organization Project files. Summarizing CQC data is not required. If the

CQC data does not verify product installation in accordance with specified requirements, the CQA Organization must immediately notify the Construction Manager and Contractor.

3.8.4 Processing Project Records

CQA Organization Project records will be completed as needed. Use of the Project records is limited to the scope for which they are intended. The record must be completed by filling in all the blanks provided on the form, followed by the signature of the individual completing the form. All CQA Organization Project records must be maintained at the site.

3.9 MATERIALS QUALITY VERIFICATION

3.9.1 Samples

The Contractor will identify sources and samples of various materials. The CQA Organization must test samples to determine if each material meets quality requirements defined in the Technical Specifications. A representative example of each sample with corresponding test results must be maintained on site by the CQA Organization to visually compare it with actual materials delivered to the Project.

3.9.2 Materials Submittals

The Contractor will submit submittals required to establish the acceptability of materials to the Construction Manager and the CQA Organization for distribution to the Design Engineer. The Design Engineer is responsible for reviewing and accepting the submittals.

3.9.3 Certificates of Compliance

Where allowed in the Technical Specifications, certificates of compliance may be used by the CQA Organization to establish the acceptability of materials in lieu of testing. These certificates generally state the material is in compliance with a particular code, standard, or specification.

3.10 CALIBRATION OF EQUIPMENT AND MATERIALS

Each piece of testing equipment shall be calibrated annually by a third party prior to Project use. Types of equipment requiring calibration include nuclear gauges, tensiometers, and scales. The calibration procedures and frequencies must be per the manufacturer's instructions or ASTM standards. Whenever equipment is suspect or producing questionable results, it must be removed from service immediately and re-calibrated.

3.11 CORRECTING NON-CONFORMING WORK

3.11.1 Observation of Non-Conformance

Whenever defective, substandard, or non-conforming work is discovered the Construction Manager or CQA Monitor must notify the Contractor as soon as possible. The CQA Monitor should first notify the foreman or superintendent supervising the work in question. The CQA Monitor must then notify the Construction Manager and CQA Engineer of Record.

3.11.2 Determining Extent of Nonconformance

Whenever nonconformance is discovered the Construction Manager or CQA Monitor must determine the extent of the nonconforming work. Additional sampling, testing, and observations must be performed to determine the extent of the deficiency.

3.11.3 Documenting Nonconformance

The CQA Monitor must document all non-conformances on Daily Reports, test reports, or by other means, as appropriate. The documentation must occur immediately upon determining the extent of the nonconformance. The CQA Monitor shall initiate and issue a Non-Conformance Report to the CQA Engineer of Record for distribution to the Construction Manager, Design Engineer, and Contractor for any non-conformance that is considered serious or complex in nature, or which requires an engineering evaluation.

3.11.4 Corrective Measures

For simple or routine non-conformance, corrective measures must be determined by the Technical Specifications. If none exist, the CQA Monitor, Construction Manager, and Contractor will discuss standard construction methods to correct the deficiency. For non-conformances that require a Non-Conformance Report, the Design Engineer must determine corrective measures. A copy of the Non-Conformance Report and the Design Engineer's corrective measure determination must be forwarded to the CQA Monitor and Contractor for implementation of the corrective action.

Any defective, substandard, or nonconforming work or materials furnished by the Contractor, which is discovered before the final acceptance of the work, as established by the Certificate of Substantial Completion, or during the subsequent guarantee period, shall be brought to the attention of the Contractor for immediate removal or correction, even though it had been overlooked by the Owner's Representative and CQA Organization and recommended for payment.

3.11.5 Verification of Corrective Measures

Upon Contractor's notification to the CQA Monitor that corrective measures are complete, the CQA Monitor must verify its completion. The verification must be accomplished by observations or re-testing and photographs. The CQA Monitor must prepare written documentation of the corrective measures on Daily Reports, logs, forms, and the Non-Conformance Report. All the non-conformance documentation is filed with the CQA Organization Project files.

4 INTERFACE TESTING

Before construction the soil and geosynthetic materials intended for this Project must be tested to confirm liner interface shear strength parameters. Test procedures are summarized in **Table 4-1**. The following test standards apply as modified by **Table 4-1.**

ASTM D7466 Standard Test Method for Measuring the Asperity Height of Textured Geomembrane.

ASTM D5321 Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

The Design Engineer must review the test results.

TABLE 4-1 INTERFACE SHEAR TESTING SUMMARY

MATERIALS BEING TESTED	TEST PARAMETERS					TEST FREQUENCY
	SOIL CONDITIONS	NORMAL LOAD (PSF)	MOISTURE CONDITION	CONSOLIDATION LOADS (PSF) HOLD EACH LOAD FOR 12 HOURS	SHEAR RATE (IN./MIN.)	
Foundation Layer/ Geomembrane with spikes against Foundation Layer and studs against Geotextile/ Geotextile / Vegetative Layer Soil	Foundation Layer at **90**% of MDD and 2% above OMC per ASTM D1557 **Vegetative layer** at 85% of MDD and 2% above OMC per ASTM D1557	100	Wet surface of GM and soil.	100	0.04 to displacement of 3 in. min.	One for each geomembrane material type (HDPE & LLDPE)
		200		200		
		400		400		

Also perform following tests:

FOUNDATION LAYER SOIL:
ASTM D1557 – Moisture-density curve
ASTM D4318 – Atterberg Limits
ASTM D7928/D6913 – Gradation

VEGETATIVE LAYER SOIL:
ASTM D1557 – Moisture-density curve
ASTM D4318 – Atterberg Limits
ASTM D7928/D6913 – Gradation
ASTM D2434 - Permeability

GEOMEMBRANE:
ASTM D7466 - Asperity

5 CONSTRUCTION QUALITY ASSURANCE FOR EARTHWORK

5.1 INTRODUCTION

This section describes the monitoring and testing that must be performed to assure earthwork construction meets specified requirements. Earthwork for this Project includes:

- Clearing and grubbing of vegetative materials.
- Excavation and fill placement in areas indicated on Construction Drawings requiring specific guidance grading, such as behind the MSE wall.
- Overall grading to achieve a minimum design foundation layer thickness and constructed slopes within design slope limits.
- Confirmation of existing soil and fill placement to construct the foundation layer.
- Preparation of foundation layer for geomembrane placement.
- Construction of vegetative soil layer.
- Drainage gravel for subdrains.
- Earthwork for stormwater swales and downchutes.

5.2 EARTHWORK TEST STANDARDS

Earthwork test standards that could apply to this section are presented in **Table 5-1.**:

TABLE 5-1 EARTHWORK TEST STANDARDS

TEST STANDARD	TEST DESCRIPTION
ASTM C136	Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM D422	Standard Test Method for Particle-Size Analysis of Soils.
ASTM D1557	Standard Test Methods for Laboratory Compaction Characteristics of Soil Using Modified Effort (56,000 ft-lbf/ft^3 (2,700 kN-m/m^3)).
ASTM D2216	Standard Test Methods for Laboratory Determination of Water (Moisture) Content of Soil and Rock by Mass.
ASTM D2434	Standard Test Method for Permeability of Granular Soils (Constant Head).
ASTM D2487	Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System).

TABLE 5-1 EARTHWORK TEST STANDARDS

TEST STANDARD	TEST DESCRIPTION
ASTM D2488	Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).
ASTM D2937	Standard Test Method for Density of Soil in Place by the Drive-Cylinder Method.
ASTM D3080	Standard Test Method for Direct Shear Test of Soils Under Consolidated Drained Conditions
ASTM D4318	Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
ASTM D4643	Standard Test Method for Determination of Water (Moisture) Content of Soil by Microwave Oven Heating.
ASTM D5084	Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
ASTM D5321	Standard Test Method for Determining the Shear Strength of Soil-Geosynthetic and Geosynthetic-Geosynthetic Interfaces by the Direct Shear Method.
ASTM D6938	Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).

5.3 SAMPLE PROCESSING

5.3.1 SOIL SAMPLES

The CQA Monitors must maintain documentation of all soil samples obtained for the Project. These samples include those obtained prior to construction for conformance or slope stability testing (**Section 4**) and samples obtained during construction such as samples obtained for moisture-density relationship testing.

5.3.2 SAMPLE TAGGING

The CQA Monitors are responsible for maintaining identification for all samples obtained throughout the Project from the time it is sampled to the time testing is completed. The CQA Monitor must place an identifying tag on the sample or mark the sample container with the sample number immediately upon sampling. The tag or identifying container must remain with the sample throughout processing.

5.3.3 SAMPLE PROCESSING

The CQA Monitors are responsible for the timely processing and testing of soil samples.

5.4 CONFORMANCE AND CONSTRUCTION PHASE TESTING

Table 5-2 establishes test frequencies for earthwork CQA testing. It includes conformance tests that must be performed prior to soil installation to assure soil materials meet quality standards established in the Technical Specifications and construction testing to assure installed materials meet specified installation requirements. The test frequencies listed establish a minimum number of required tests. Extra testing must be conducted whenever work or materials are suspect, marginal, or of poor quality. Extra testing may also be performed to provide additional data for engineering evaluation. Any re-tests performed as a result of a failing test cannot contribute to the total number of tests performed in satisfying the minimum test frequency.

TABLE 5-2 SOIL TESTING

REQUIRED TESTS	SPECIFICATION SECTION	ASTM METHOD	TEST FREQUENCY (1 PER)	REQUIREMENT
FOUNDATION LAYER – CONFORMANCE TESTING	02300			
Visual classification		D2488	Visual	
Sample for Interface Testing			Project	Two 5-gal. buckets to testing laboratory
Gradation (with hydrometer)		D7928 D6913	5,000 cy & Material Type	Max. <3/8 in. (top 6 in.) Max. <3 in. (bottom 12 in.)
Atterberg Limits		D4318	5,000 cy & Material Type	
Moisture/Density Relations		D1557	Material Type	
FOUNDATION LAYER – CONSTRUCTION TESTING	02300			
Thickness		Visual	Continuous	Nominal 18 in.
Moisture Content/Density, Nuclear Method (Note 1)		D6938	1,500 cy & 1/lift & 2/day	90% MDD
Drive Cylinder (or Sand Cone)		D2937 or D1556	20 MDT	
Oven Moisture Content Verification		D4643 or D2216	20 MDT	
VEGETATIVE LAYER – CONFORMANCE TESTING	02300			
Visual classification		D2488	Visual	
Sample for Interface Testing			Project	Two 5-gal. buckets to testing laboratory

TABLE 5-2 SOIL TESTING

REQUIRED TESTS	SPECIFICATION SECTION	ASTM METHOD	TEST FREQUENCY (1 PER)	REQUIREMENT
Gradation (with hydrometer)		D7928 D6913	5,000 cy & Material Type	Max. <2 in.
Atterberg Limits		D4318	5,000 cy & Material Type	
Moisture/Density Relations		D1557	Material Type	
Hydraulic Conductivity (remolded to 85% MDD at 0% above OMC)		D5084	5,000 cy & Material Type	≤ 1.4E-04 cm/sec at 5 psi
VEGETATIVE LAYER – CONSTRUCTION TESTING	02222			
Thickness		Visual	Continuous	Nominal 18 in.
Moisture Content/Density, Nuclear Method		D6938	1/acre, 1/lift & 2/day	85% MDD
Hydraulic Conductivity (remolded to 85% MDD at 0% above OMC)		D5084	5,000 cy & Material Type	≤ 1.4E-04 cm/sec at 5 psi
SUBDRAIN GRAVEL – CONFORMANCE TESTING	02300			
Gradation		D422	Material Source	
SUBDRAIN GRAVEL – CONSTRUCTION TESTING	02222			
Gradation		D422	Material Source	
ROAD BASE COURSE – CONFORMANCE TESTING	02300			
Gradation		D422	Material Source	
ROAD BASE COURSE – CONSTRUCTION TESTING	02222			
Gradation		D422	Material Source	
ROAD CRUSHED GRAVEL – CONFORMANCE TESTING	02300			
Gradation		D422	Material Source	
ROAD CRUSHED GRAVEL – CONSTRUCTION TESTING	02222			
Gradation		D422	Material Source	
RIP RAP – CONFORMANCE TESTING	02300			
Visual classification		D2488	Material Source	Angular
Gradation		D422	Material Source	3 ½ to 1 ½ inch.
RIP RAP – CONSTRUCTION TESTING	02222			
Thickness		Visual	Continuous	Min. 18 in.

TABLE 5-2 SOIL TESTING

REQUIRED TESTS	SPECIFICATION SECTION	ASTM METHOD	TEST FREQUENCY (1 PER)	REQUIREMENT
Visual Classification		Visual	Continuous	Angular
NOTES: 1. Proof rolling permitted at discretion of the CQA Engineer of Record.				

5.5 MONITORING REQUIREMENTS

The following paragraphs list monitoring requirements for each type of earthwork.

5.5.1 PROJECT AREA PREPARATION

The CQA Monitor must verify:

- Any required erosion and sediment control features are installed and maintained.
- All infrastructure scheduled to be removed by Owner has been removed (e.g., GCCS, LCRS, stormwater, electrical, etc.).
- Any infrastructure items to remain in place are identified and protected.
- Existing erosion and sediment control items (e.g., check dams, hay bales, wattles, etc.,) are removed from the Project area.
- Existing intermediate cover geosynthetic materials, including the sacrificial geotextile above the geomembrane on the exposed landfill-side face of the MSE Wall, are removed and placed in Owner-supplied roll-off boxes.
- Verify that all clearing, stripping, and grubbing, and removal of unsuitable soils to a maximum depth of 6 inches is performed, and materials are placed in Owner-designated area.
- Other items identified for removal or abandonment are removed from the Project area and disposed appropriately.
- Following the preparation activities ensure the project area is track walked or otherwise made suitable for a topographic survey.
- A topographic survey of the Project area is performed to enable Initial Grading excavation and fill quantities to be determined.

5.5.2 INITIAL GRADING

The CQA Monitor must verify:

- Dust and odor control is implemented as needed.
- Areas, including areas identified as Focused Grading Areas on the Construction Drawings are graded to achieve the design grades for the cover (5 percent minimum [10 percent preferred] and 3H to 1V or 3.5H to 1V, as appropriate).
- Refuse encountered in excavation areas is incorporated into fill areas when practical.
- Refuse that cannot be incorporated into fill area is hauled to the top deck.
- Following Initial Grading the Project area is surveyed to document the Initial Grading excavation and fill volumes.

5.5.3 EXPLORATORY POTHOLES AND TEST PITS

Following the initial grading CQA Monitor must ensure that

- Potholes are excavated to adequately characterize the existing depth of soil above refuse that can contribute to the required 18-inch thick Foundation Layer and the corresponding thickness of additional soil required to complete the Foundations Layer.
- Test pits are excavated along alignments of tie-ins to existing geomembrane liner to determine excavation requirements and status of current termination details.
- Survey is performed to document all pothole and test pit locations and corresponding depths at each location.

5.5.4 FOUNDATION LAYER

The CQA Monitor must:

- Verify dust and odor control is implemented as needed.
- Verify that material source is suitable for the Foundation Layer, is free of organic and oversized materials (as described in Specification Section 02225) and meets the grading requirements of the Contract Specifications.
- Perform moisture-density relationship testing (ASTM D1557) to determine the maximum dry density and OMC as shown in **Table 5-2**.
- Verify that soil materials that are processed to bring the moisture content of the material into the acceptable range of the optimum moisture content (OMC).
- Verify fill is keyed into subgrade on slopes of 3 horizontal to 1 vertical or steeper.

- Ensure fill is placed from lower to higher elevations.
- Verify that compacted soil materials are placed and compacted in maximum 8-inch thick loose lifts. If a sheepsfoot compactor is not used, verify that the top of each compacted lift is scarified before placing the subsequent lift.
- Perform observation and testing as shown in **Table 5-2** to confirm compaction meets specified requirements.
- Verify that desiccated compacted soil fills are properly repaired or removed before placing subsequent lifts.
- Verify that subdrain ditch alignments are excavated into the Foundation Layer at a minimum longitudinal slope of 5 percent.
- Verify that downchute alignments are excavated into the Foundation Layer at the required cross-sectional profile.

5.5.5 Foundation Layer For MSE Wall

In addition to the requirements of **Section 5.5.2** for the foundation layer in the CQA Monitor must also verify:

- The existing sacrificial geotextile is removed from above the geomembrane on the exposed landfill-side face of the MSE Wall.
- Two new layers of non-woven geotextile are installed to replace the removed sacrificial geotextile.
- The lower ends of the geotextile layers are used to "burrito wrap" drainage gravel at the base.
- The geotextile layers are maintained flat against the geomembrane and tension free when the Foundation Layer soil is placed.
- Only hand-held compaction equipment is used within 4-feet of the face of the wall.
- The top ends of the geotextile layers are folded over the top of the completed Foundation Layer prior to deploying cap geomembrane.

5.5.6 Subgrade Preparation

Following the completion of the Foundation Layer, the CQA Monitor must:

- Verify dust and odor control is implemented as needed.
- Verify that the subgrade is free of irregularities and is steel-drum rolled smooth prior to geomembrane placement to provides continuous and intimate contact with the overlying geomembrane.
- Verify no areas that yield excessively are present.

- Verify no seeps or liquid breakouts are present.
- Verify no soil particles greater than that specified are exposed on the finished surface, there are no protrusions greater than 0.5 inches.
- Verify that any angular or sharp rocks, and other debris that could damage the geomembrane, are removed from the surface of the subgrade.
- Coordinate with the Contractor to perform material thickness and slope verifications or verification surveys upon completion.
- Verify survey is performed of the completed surface and subdrain alignments and the final surface meets the design intent for minimum and maximum slope grades. The survey must establish the horizontal and vertical location at a 50-feet maximum grid, and at all grade beaks for all areas that will be covered with geomembrane.

5.5.7 VEGETATIVE SOIL LAYER

During the placement of the operations layer the CQA Monitor must:

- Verify dust control is continuous.
- Verify that material source is suitable for the vegetative soil layer and meets the visual classification, grading, hydraulic conductivity, and Atterberg limits requirements of the Contract Specifications.
- Verify that grade control is established.
- Ensure soil is placed in minimum 1-foot thick layer from lower to higher elevations and is not pushed downhill.
- Perform moisture-density relationship testing (ASTM D1557) to determine the maximum dry density and OMC as shown in **Table 5-2**.
- Perform observation and testing as shown in **Table 5-2** to confirm compaction meets specified requirements.
- Verify that angular or sharp rocks, and other debris that could damage the geomembrane and geotextile, are removed from the vegetative soil layer.
- Verify the surface swales are constructed in accordance with the Construction Drawings at a minimum slope of 5 percent.
- Verify that downchute alignments are excavated into the Vegetative Layer at the required cross-sectional profile.
- Verify survey is performed of the completed surface and swale alignments and the final surface meets the design intent for minimum and maximum slope grades. The survey must establish the horizontal and vertical location at a 50-feet maximum grid, and at all grade beaks for all areas that will be covered with geomembrane.

5.5.8 SUBDRAIN GRAVEL

During the placement of subdrain gravel the CQA Monitor must verify:

- Subdrain trenches are excavated to the correct dimensions.
- Geomembrane and geotextile are in place and have been approved.
- Subdrain pipe is placed in the flow line of the geomembrane in the ditch.
- The crown of the pipe is surveyed at 25 feet intervals.
- Perform visual classification of the subdrain gravel to ensure the material complies with **Table 5-2.**
- Subdrain gravel is placed to surround and cover the pipe.
- Geotextile separator is placed over the gravel.

5.5.9 ROAD BASE COURSE

During the placement of road base course, the CQA Monitor must verify:

- By visual classification that the base-course aggregate complies with **Table 5-2.**
- Geomembrane and geotextile are in place and have been approved.
- Sufficient material is present above the geomembrane for truck traffic to deliver the base-course aggregate.
- Monitor placement operations to verify that underlying geosynthetics installations are not damaged during placement operations.
- Verify the placement of the materials is to the required thickness and limits shown on the Construction Drawings.

5.5.10 ROAD CRUSHED GRAVEL

During the placement of road crushed gravel surface layer, the CQA Monitor must verify:

- By visual classification of that the crushed gravel complies with **Table 5-2.**
- Base course has been completed and approved.
- Sufficient material is present above the geomembrane for truck traffic.
- Verify the placement of the materials is to the required thickness and limits shown on the Construction Drawings.

5.5.11 RIP RAP

During the placement of rip rap the CQA Monitor must:

- Perform visual classification of the rip rap to ensure material is angular and in compliance with **Table 5-2.**
- Monitor placement operations to verify that underlying geosynthetics installations are not damaged during placement operations.
- Mark damaged geosynthetics and verify that damage is repaired and documented.
- Verify the placement of the materials is to the required thickness and limits shown on the Construction Drawings.
- Verify geotextile is placed between rip rap and adjacent soil and geosynthetic materials.
- Verify that unconfined faces of rip rap are stable and material is interlocked.
- Verify that construction staking is performed before starting work and that survey benchmarks with elevations are secured outside the work area.
- Perform conformance testing at the frequencies listed in Table 1 to verify that the materials comply with the Construction Specifications.

6 CONSTRUCTION QUALITY ASSURANCE FOR GEOSYNTHETICS

6.1 GENERAL

The objectives of the geosynthetics CQA program are to:

- Assure materials manufactured for the Project meet slope stability requirements defined in the Technical Specifications through interface shear strength testing (**Section 4**).
- Assure geosynthetic materials manufactured for the Project meet quality standards defined in the Technical Specifications.
- Assure proper construction techniques and procedures are used during installation of geosynthetics.
- Assure the Project is completed in accordance with the Project Construction Drawings and Technical Specifications.
- Identify and define problems that may occur during construction and then verify these problems are corrected before construction is complete.

The following geosynthetics will be utilized for this Project:

- HDPE and LLDPE 60-mil thick structured geomembrane (studs on the upper surface and spikes on the lower surface) (Agru America [AGRU] Super Gripnet).
- Non-woven geotextile above the Super Gripnet geomembrane, along subdrain alignments, and between rip rap and adjacent earthen materials.
- Limited quantities of non-woven geotextile cushion on the landfill side of the MSE wall.

6.2 GEOMEMBRANE QUALITY ASSURANCE

6.2.1 GEOMEMBRANE TEST STANDARDS

Geomembrane test standards are presented in **Table 6-1.**

TABLE 6-1 GEOMEMBRANE TEST STANDARDS

3	TEST DESCRIPTION
ASTM D792	Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastics by Displacement.
ASTM D1505	Standard Test Method for Density of Plastics by the Density-Gradient Technique.
ASTM D1603	Standard Test Method for Carbon Black Content in Olefin Plastics.

TABLE 6-1 GEOMEMBRANE TEST STANDARDS

3	TEST DESCRIPTION
ASTM D5596	Standard Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
ASTM D5994	Standard Test Method for Measuring Core Thickness of Textured Geomembrane.
ASTM D5641	Standard Practice for Geomembrane Seam Evaluation by Vacuum Chamber.
ASTM D6693	Standard Test Method for Determining Tensile Properties of Nonreinforced Polyethylene and Nonreinforced Flexible Polypropylene Geomembranes.
GRI GM12	Asperity Measurement of Textured Geomembranes Using a Depth Gauge

6.2.2 PRE-CONSTRUCTION SUBMITTAL REVIEW

The Manufacturer must submit the following items to the CQA Organization for review and testing:

- A sample of the geomembrane proposed for the Project. A minimum 3-foot by 9-foot sample must be provided for interface shear strength testing as outlined in **Section 4**.
- Manufacturer's description (cut sheet) of the proposed geomembrane documenting it will meet or exceed specified material requirements.
- Written instructions for storage, handling, installation, seaming and repair of the proposed geomembrane.

The Installer must submit shop drawings consistent with the Technical Specifications. The shop drawings must show the proposed layout of the panels, including field seam types, and any other details that do not conform to the Construction Drawings. The CQA Monitor must review these drawings prior to geomembrane installation.

6.2.3 CONFORMANCE TESTING

The CQA Organization must ensure geomembrane conformance samples are obtained and sent to the CQA Laboratory for conformance testing as detailed in **Table 6-2**. The conformance samples may be obtained at the manufacturing plant prior to shipping or at the site after shipping. Samplers must mark the machine direction and the manufacturer's roll identification number on each conformance sample. The CQA Organization must review all conformance test results and report any non-conformance to the Owner.

TABLE 6-2 60-MIL GEOMEMBRANE CONFORMANCE TESTING

TEST	STANDARD	FREQUENCY (MINIMUM 1 PER RESIN BATCH)	REQUIREMENT
Sheet Thickness	ASTM D5994	250,000 sf – minimum 10 measurements per sample.	Avg all >= 57 mil. 8 of 10 >= 54 mil. All values >= 51 mil
Asperity Height	GRI GM12	250,000 sf – minimum 10 measurements per sample, both sides of sample.	≥ 20 mil for standard textured. ≥ 130 mil for studs. ≥ 175 mil for spikes on Super Gripnet
Carbon Black Content	ASTM D1603	250,000 sf.	2 to 3%
Carbon Black Dispersion	ASTM D5596	250,000 sf.	Category 1 or 2 for 9 of 10 readings and Category 3 for 1 of 10 readings *(6)*
Tensile			
Yield Strength	ASTM D6693	250,000 sf	Min. 126 lb/in width
Break Strength	ASTM D6693	250,000 sf	Min. 90 lb/in width
Yield Elongation	ASTM D6693	250,000 sf	Min. 12% each sample
Break Elongation	ASTM D6693	250,000 sf	Min. 100%
Transmissivity (Structured GM Only)	ASTM D4716	500,000 sf	>= 6.0E-04 m^2/sec

6.2.4 DELIVERY

Upon delivery of geomembrane, the CQA Monitor must:

- Verify all manufacturing documentation required by the Technical Specifications has been received.
- Verify each roll is marked or tagged with the manufacturer's name; Project identification; lot number; roll number; roll dimensions and that this information is documented on a geosynthetic receipt form.
- Inspect geomembrane rolls for damage potentially occurring during shipping and/or handling, then identify damaged materials and verify damaged materials are set aside and not installed.

- Verify the geomembrane is stored in accordance with the Technical Specifications and is protected from puncture, dirt, grease, water, moisture, mud, mechanical abrasions, excessive heat, direct sunlight, and other damage.
- Verify a log of geosynthetics received is completed for all geomembrane materials received.

Damaged geomembrane must be rejected. If rejected, verify material is removed from the site or stored at a location, separate from accepted geomembrane. A material nonconformance tag, or other clearly identifiable indelible marks, shall be attached to the damaged material. Geomembrane that does not have proper manufacturer's documentation must be stored at a separate location, until all documentation has been received, reviewed, and accepted.

6.2.5 SUBGRADE PREPARATION

Prior to geomembrane deployment, the surface on which the geomembrane will be installed must be prepared in accordance with the Technical Specifications. Before geomembrane installation, the CQA Monitor and Installer must inspect the surface. The CQA Monitor must verify the following:

- The GCL underlying the geomembrane has been completed and accepted; and
- No sharp objects or other materials that could puncture the geomembrane are present on the GCL surface; and
- There are no excessively soft areas.
- All construction stakes have been removed.
- The Installer has certified in writing on a form acceptable to the CQA Engineer of Record that the surface on which the geomembrane will be installed is acceptable.

6.2.6 PANEL LAYOUT AS-BUILT

During installation, the CQA Monitor must maintain an up to date panel layout drawing that shows the following as-built information:

- Orientation and size of each geomembrane panel.
- Roll numbers associated with each panel.
- Assigned panel numbers.
- Assigned seam numbers.
- Destructive test locations.
- Repair locations.

6.2.7 Panel Placement Documentation

During panel placement operations, the CQA Monitor must:

- Record panel numbers and dimensions on a panel/seam log.
- Observe the panel surface as it is deployed and record all panel defects and defect corrective actions (panel rejected, patch installed, extrudate placed over the defect, etc.) on a repair sheet.
- Verify, where required, corrective actions are made in accordance with the Technical Specifications.
- Verify equipment used during deployment operations does not damage the geomembrane.
- Verify equipment used on the geomembrane does not leak hydrocarbons onto the geomembrane and preventative measures are taken to prevent leakage.
- Verify the surface beneath the geomembrane has not deteriorated since previous acceptance.
- Verify no stones, construction debris, or other items are beneath the geomembrane that could damage the geomembrane.
- Verify a slip sheet is used to deploy geomembrane over GCL.
- Verify the geomembrane is not dragged across a potentially damaging surface. If the geomembrane is dragged across a surface that could damage the geomembrane, the geomembrane is inspected for scratches and repaired or rejected, if necessary.
- Verify the geomembrane is not deployed in the presence of excess moisture (fog, dew, mist, etc.).
- Verify the geomembrane is not placed when the air temperature is less than 40°F, or when standing water or frost is on the subgrade.
- Verify crews working on the geomembrane do not smoke, wear shoes that could damage the liner, or engage in activities that could damage the geomembrane.
- Verify methods used to deploy the geomembrane minimize wrinkles and that panels are anchored to prevent movement by the wind.
- Verify Installer repairs or replaces any damaged geomembrane.
- Verify no more panels are deployed than can be seamed on the same day.

The CQA Monitor must inform both the CQA Manager and Contractor if any of the above conditions are not met and must document the condition with a nonconformance report if construction proceeds without correcting the condition.

6.2.8 Trial Welding Documentation

Before the start of geomembrane welding and during welding operations, each welder and welding apparatus must be tested in accordance with the Technical Specifications to verify the equipment is functioning properly. One trial weld must be taken before the start of work and one at mid-shift. The trial weld sample must be 6 feet long and 12 inches wide, with the seam centered lengthwise. The trail weld must be allowed to cool to ambient temperature before it is tested.

The CQA Monitor must observe all trial welding operations and verify that the Installer quantitatively tests each trial weld for peel adhesion and bonded seam strength (ASTM D6392). (Peel adhesion tests will be referred to as “peel” and bonded seam strength tests will be referred to as “shear” in this manual.) The purpose of peel and shear tests is to evaluate seam strength as an indicator of long-term performance. Shear strength measures the continuity of tensile strength through the seam and into the parent material. Peel adhesion measures the strength of the bond created by the welding process. Results of peel and shear tests must be recorded on a trial weld form.

Trial welds must be completed under conditions like those under which production seams will be welded. Trial welds must meet specified requirements for peel and shear and the failure must be ductile or a film tearing bond (FTB) for a wedge weld. An FTB means the test specimen breaks at the edge of the outside of the seam, but not in the seam.

If at any time the CQA Monitor believes that a welding apparatus is not functioning properly, a trail weld must be performed. If there are wide changes in temperature (±25°F.), humidity, or wind speed, another trail weld must be performed.

6.2.9 PRODUCTION WELDING DOCUMENTATION

During geomembrane production welding operations, the CQA Monitor must:

- Verify the Installer has the number of welding apparatuses and spare parts necessary to continuously perform the work.
- Verify equipment used for welding will not damage the geomembrane.
- Verify extrusion welders are purged before beginning a weld so that all heat-degraded extrudate is removed from the nozzle of the welder.
- Verify seam grinding is completed less than 1 hour before seam welding, and the upper sheet is beveled (extrusion welding only).
- Verify ambient temperature is measured 6 inches above the geomembrane surface is between 40° and 130° Fahrenheit.
- Verify ends of extrusion welds that are more than 5 minutes old, are ground to expose new material before restarting a weld.
- Verify contact surfaces of the panels are clean, and free of dust, grease, dirt, debris, and moisture before welding.
- Verify welds are free of dust, rocks, and other debris.

- Verify cross seams are ground to a smooth incline before welding (fusion welding only).
- Verify all seams are overlapped a minimum of 3 inches or in accordance with manufacturer's recommendations, whichever is more stringent.
- Verify solvents or adhesives are not present in the seam area.
- Verify procedures used to temporarily hold the panels together do not damage the panels and do not preclude CQA testing.
- Verify panels are being welded in accordance with the plans and Technical Specifications.
- Verify there is no free moisture in the weld area.

6.2.10 NON DESTRUCTIVE SEAM TESTING

The purpose of nondestructive geomembrane seam testing is to detect discontinuities or holes in the seams. Nondestructive geomembrane tests include vacuum and air pressure testing. Nondestructive testing must be performed over the entire length of the seam.

It is the Installer's responsibility to perform all nondestructive testing as part of his QC program, record the results and report the results to the CQA Monitor. The CQA Monitor's responsibility is to observe and independently document that the Installer's QC testing complies with the Technical Specifications and to independently document seam defects and panel defects that the Installer detects.

Nondestructive testing procedures are described below:

- For welds tested by vacuum method (ASTM D5641) the weld is placed under suction utilizing a vacuum box constructed with rigid sides, a transparent top for viewing the seams, a neoprene rubber gasket attached to the bottom of the rigid sides, a vacuum gauge on the inside, and a valve assembly attached to a vacuum hose connection. The box is placed over a seam section that has been thoroughly saturated with a soapy water solution (1 ounce soap to 1 gallon water). The rubber gasket on the bottom of the box must fit snugly against the soaped seam section of the panel, to ensure a leak-tight seal. A vacuum pump is energized and the vacuum box pressure reduced to approximately 5-psi gauge. Any pinholes, porosity or non-bonded areas are detected by the appearance of soap bubbles in the vicinity of the defect. Dwell time must not be less than 10 seconds.
- Air pressure testing is used to test double seams that have an enclosed air space between them. Both ends of the air channel must be sealed. A pressure feed device, usually a needle equipped with a pressure gauge, is inserted into one end of the channel. Air is then pumped into the channel to a minimum specified pressure. A five-minute relaxing period is allowed for the pressure to stabilize. The air chamber must sustain the pressure as specified in the Technical Specifications. Following a passed pressure test, the opposite end of the tested seam must be punctured to release the air. The pressure gauge must return to zero, if not, a blockage is likely in the seam channel.

When a blockage is detected it must be located and the seam re-tested on both sides of the blockage. The penetration holes must be repaired after testing.

During nondestructive testing, the CQA Monitor must:

- Review Technical Specifications regarding test procedures and verify all testing is completed in accordance with the Technical Specifications
- Verify equipment operators are fully trained and qualified to perform their work
- Verify test equipment meets Project Technical Specifications
- Verify the entire length of each seam is tested in accordance with the Technical Specifications
- Observe all testing and independently record results on the panel/seam log and the panel layout drawing
- Identify any failed areas detected by the Installer by marking the area with a waterproof marker, verify the Installer is aware of the required repair, and record completion of the repair on the repair log
- Verify all repairs are completed and tested in accordance with the Project Technical Specifications
- Record non-destructive testing of the repairs on the repair log

6.2.11 Destructive Seam Sampling and Field Testing

The purpose of destructive seam sampling and testing is to assure seam quality. Two seam specimens must be taken for destructive testing (peel and shear) as follows:

- At the beginning and end of each seam; or
- A spacing of 500 feet or less, covering each technician and each piece of equipment; or
- In accordance with Geosynthetic Research Institute guide GM-14. "Selecting Variable Intervals for Taking Geomembrane Destructive Seam Samples Using the Method of Attributes", (March 27, 1998).

Additional specimens may be taken if the CQA Monitor suspects that a seam does not meet specification requirements. Reasons for taking additional samples may include, but are not limited to:

- Wrinkling in seam area.
- Excess crystallinity.
- Suspect seaming equipment or techniques.
- Weld contamination.
- Insufficient overlap.

- Adverse weather conditions.
- Failing tests.

The Installer must remove specimens identified by the CQA Monitor and then test the specimens for peel and shear. During sampling the CQA Monitor must:

- Observe sample cutting.
- Mark each specimen with an identifying number and record the seam number, welder, weld date and weld time relative to the specimen number.
- Record specimen locations on the panel layout drawing and panel-seam logs.
- Record the specimen locations, weather conditions, and reason specimens were taken (e.g., random specimen, visual appearance, result of a previous failure).

The Installer must test seam specimens at the Project site using a tensiometer capable of quantitatively measuring shear and peel strengths in accordance with ASTM D6392. For double wedge welding both sides of the air channel must be tested for peel strength. The CQA Monitor must observe the tests. A specimen passes when the break is a ductile FTB. An FTB means the test specimen breaks at the edge or the outside of the seam, but not in the seam. In addition, the seam strength must meet specified values.

If any of the specimens fail to meet specified seam quality, the Installer can, at his discretion, reconstruct the entire seam, or take another test sample ten feet towards the other end of the seam from the point of the failed specimen. At that point the Installer can repeat the field peel and shear tests. If subsequent specimens fail to meet specified seam quality, this procedure must be repeated until the length of poor quality seam is established. Repeated failures indicate that the seaming equipment or operator is not performing properly, and appropriate corrective action must be taken immediately.

In the case of butt seams, if the peel test fails, the entire butt seam must be capped.

All seams must be bounded by specimens from which passing peel and shear tests have been documented. In the case of butt seams, one passing peel test is required in either the original weld or the cap seam.

6.2.12 Repairs

Repairs are required where geomembrane panels and/or seams contain a flaw, where a destructive test sample has been taken, and where a "T" intersection exists at corners of welded panels. All repairs must be made in accordance with the Technical Specifications. The CQA Monitor must locate required repairs and record completion of repair work on a repair log. Acceptable repair techniques include the following:

- Patching — used to repair large holes, tears, large panel defects, undispersed raw materials, welds, contamination by foreign matter, destructive sample locations, and "T" locations in panel welds.

- Extrusion — used to repair small defects in the panels and seams. In general, this procedure should be used for defects less than ½-inch in the largest dimension.
- Capping — used to repair failed welds or to cover seams where welds cannot be non-destructively tested.
- Removal — used to replace areas with large defects where the preceding methods are not appropriate. Also used to remove excess material (wrinkles, fish mouths, intersections, etc.) from the installed geomembrane. Areas of removal must be patched or capped.

6.2.13 WRINKLES

During placement of soil materials over geomembrane, temperature changes or creep may cause wrinkles to develop in the geomembrane. Any wrinkles which can fold over must be repaired either by cutting out excess material or, if possible, by allowing the geomembrane to contract by temperature reduction. In no case can material be placed over the geomembrane that could result in the geomembrane folding. The CQA Monitor must monitor geomembrane for wrinkles and notify the Installer if wrinkles are being covered by soil. The CQA Monitor is then responsible for documenting corrective action to remove the wrinkles.

6.2.14 GEOMEMBRANE ACCEPTANCE

Geomembrane installation is accepted when the following conditions are met:

- The installation is finished.
- All seams have been inspected and tested, all required tests have been completed, the tests pass, and test data has been reviewed and approved.
- All required Installer and manufacturer-supplied documentation has been received and reviewed; and
- All as-built record drawings have been completed and verified by the CQA Monitor to show the true panel dimensions, the locations of all seams, trenches, pipes, appurtenances, and repairs.

6.3 GEOTEXTILE QUALITY ASSURANCE

6.3.1 GEOTEXTILE TEST STANDARDS

Geotextile test standards are presented in **Table 6-3**.

TABLE 6-3 GEOTEXTILE TEST STANDARDS

STANDARD	TEST DESCRIPTION
ASTM D3786	Standard Test Method for Bursting Strength of Textile Fabrics—Diaphragm Bursting Strength Tester Method.

TABLE 6-3 GEOTEXTILE TEST STANDARDS

STANDARD	TEST DESCRIPTION
ASTM D4491	Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
ASTM D4533	Standard Test Method for Trapezoid Tearing Strength of Geotextile.
ASTM D4632	Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
ASTM D4751	Standard Test Method for Determining Apparent Opening Size of a Geotextile.
ASTM D4833	Standard Test Method for Index Puncture Resistance of Geomembranes and Related Products
ASTM D5261	Standard Test Method for Measuring Mass per Unit Area of Geotextiles.
ASTM D6241	Standard Test Method for the Static Puncture Strength of Geotextiles and Geotextile-Related Products Using a 50-mm Probe.

6.3.2 PRE-CONSTRUCTION SUBMITTAL REVIEW

The Manufacturer must submit the following items to the CQA Organization for review and testing:

- Manufacturer's description (cut sheet) of the proposed geotextile documenting it will meet or exceed specified requirements.
- Written instructions for storage, handling, installation, seaming and repair of the proposed geotextile.

6.3.3 CONFORMANCE TESTING

The CQA Organization must obtain geotextile separator samples[1] and send the samples to the CQA Laboratory for conformance testing as detailed in **Table 6-4**. The samples may be obtained at the manufacturing plant prior to shipping or at the site after shipping. The CQA Organization must review all conformance test results and report any non-conformance to the Owner.

[1] A limited quantity of geotextile cushion will be used to act as a slip plane between the geomembrane and soil on the face of the MSE Wall. MQC testing is considered adequate for this material and CQA conformance testing is not required.

TABLE 6-4 GEOTEXTILE SEPARATOR CONFORMANCE TESTING

TEST	STANDARD	FREQUENCY	REQUIREMENT (MINIMUM AVERAGE ROLL VALUE [MARV])
Mass Per Unit Area	ASTM D5261	1 per 250,000 sf.	8.0 oz/sy
Grab Tensile Strength	ASTM D4632	1 per 250,000 sf.	220 lb
CBR Puncture Strength	ASTM D6241	1 per 250,000 sf.	600 lb
Permittivity	ASTM D4491	1 per 500,000 sf.	1.3 sec^{-1}
Apparent Opening Size – AOS	ASTM D4751	1 per 500,000 sf.	<0.180 mm

6.3.4 DELIVERY

Upon delivery of geotextile the CQA Monitor must verify:

- All manufacturing documentation required by the Technical Specifications has been received.
- Each roll is marked or tagged with manufacturer's name; Project identification; lot number; roll number; roll dimensions and this information is documented on a geosynthetic receipt form.
- Rolls are wrapped in impermeable and opaque protective covers.
- Care is used to unload the rolls.
- Equipment used to unload the rolls will not damage the material.
- Materials are stored in a location that is protected from ultraviolet light exposure, precipitation, mud, dirt, dust, puncture, cutting, or any other damaging or deleterious conditions.

Damaged rolls must be rejected. If rejected, verify rejected material is removed from the site or stored at a location separate from accepted rolls. A material nonformance tag, or other clearly identifiable indelible marks, shall be attached to the damaged material. Geotextile rolls that do not have proper manufacturer's documentation must also be stored at a separate location, until all documentation has been received and approved.

6.3.5 SURFACE PREPARATION

Before geotextile installation, the CQA Monitor must:

- Verify the surface on which geotextile is to be deployed will not damage the geotextile.

6.3.6 Placement and Seaming

During geotextile placement and seaming operations, the CQA Monitor must:

- Observe the geotextile, as it is deployed and record all defects and defect corrective actions (panel rejected, patch installed, etc.), and verify corrective actions are performed in accordance with the Technical Specifications.
- Verify equipment used to install geotextile does not damage it during deployment.
- Verify crews working on the geotextile do not smoke, wear shoes that could damage the geotextile, or engage in activities that could damage the geotextile.
- Verify the geotextile is securely anchored to prevent movement by the wind.
- Verify adjacent panels are overlapped and seamed in accordance with the Technical Specifications.
- Verify the geotextile was not exposed to direct sunlight for more than the number of days recommended by the manufacturer.
- Examine the geotextile after installation to ensure that no potentially harmful foreign objects are present.

The CQA Monitor must inform both the CQA Manager and Contractor if any of the above conditions are not met and must document the condition with a nonconformance report if construction proceeds without correcting the condition.

6.3.7 Repairs

Where repairs are necessary the CQA Monitor must verify the following methods are used:

- Patching — used to repair large holes, tears, and small defective areas.
- Removal — used to replace large defective areas where the preceding method is not appropriate.

6.4 ENGINEERED HYDROTURF® QUALITY ASSURANCE

6.4.1 Pre-construction Submittal Review

The Manufacturer must submit the following items to the CQA Organization for review and testing:

- Manufacturer's description (cut sheet) of the proposed HydroTurf® documenting it will meet or exceed specified requirements.
- Written instructions for storage, handling, installation, seaming and repair of the proposed HydroTurf®.

6.4.2 CONFORMANCE TESTING

6.4.3 CONFORMANCE TESTING

Acceptance of HydroTurf® will be based on MQC test data. Separate conformance testing is not proposed.

6.4.4 DEPLOYMENT

CQA Monitor shall verify that:

- Engineered Turf tufts are not excessively pulled out during deployment.
- After the first panel is deployed, all subsequent panels are deployed on top of the previous panel, seamed, and then flipped into position.

6.4.5 INSTALLATION

Prior to installation of Engineered Turf Component, the CQA Monitor must observe the following:

- HydroTurf® CS geomembrane component has been seamed, tested, approved, and is released for further component deployment by the POR.
- The supporting surface (e.g., the geomembrane) is substantially free of debris or large scraps.

During deployment of Engineered Turf, the CQA Monitor must observe the following:

- Observe the turf as it is deployed and record defects and disposition of the defects (i.e., panel rejected, patch installed, etc.).
- That repairs are made in accordance with Section 3.05 and the HydroTurf® Installation Guidelines.
- Equipment used does not damage the turf or underlying geomembrane.
- That all panels are deployed from the top of the slope in a way that the Engineered Turf filaments are pointing upslope after deployment is complete.
- That the turf is anchored to prevent movement by the wind (the Installer is responsible for any damage resulting to or from windblown Engineered Turf).
- That the turf remains substantially free of contaminants.
- That the turf is laid substantially smooth.
- That on slopes, the turf is secured with sandbag anchoring at the top of the slope after deployment.

6.5 HYDROBINDER® QUALITY ASSURANCE

6.5.1 INSTALLATION

CQA Monitor shall verify the following:

- Installer shall explain in detail in the pre-construction meeting the method of HydroBinder® infill installation.
- Installation of HydroBinder® infill will only be performed by a Watershed Geosynthetics' trained Installer.
- HydroBinder® shall not be installed in inclement, wet or rainy weather, or the threat of inclement weather.
- The HydroBinder® shall not be installed in freezing temperatures.
- The HydroBinder® will be installed into the turf while it is in a dry state.
- The HydroBinder® will be worked into the tufts so the tufts are in an upright position.
- The HydroBinder® infill will be placed dry at a minimum thickness of 7/8 inch.
- Do not backfill anchor trenches until turf has been infilled with HydroBinder® infill.
- The hydration process must occur the day of the HydroBinder® infill placement.
- The desired HydroBinder® infill thickness will be achieved and confirmed by measurements prior to the hydration process.
- The cemented infill is hydrated thoroughly; however, care must be taken to avoid displacement of the non-hydrated infill.
- Hydration shall start at the upstream or upslope portion and move downstream or downslope.
- The objective is to soak the area to start the hydration process but not to inundate with water beyond saturation.
- Once hydration is completed as described, backfill and compaction of the anchor trenches should take place.
- HydroBinder® that does not set up within 24 hours on account of improper hydration shall be removed and replaced.
- Cold weather installation of HydroBinder® shall be performed in accordance with American Concrete Institute (ACI) - 306R-10 Guide to Cold Weather Concreting.

7 CONSTRUCTION QUALITY ASSURANCE FOR POLYETHYLENE PIPE

7.1 INTRODUCTION

This section describes CQA procedures for perforated and solid-wall high density polyethylene (HDPE) pipe installations. Installation requirements are specified in the Technical Specifications.

7.2 MATERIALS QUALITY VERIFICATIONS

Before pipe installations the Design Engineer of Record and CQA Organization must review material submittals to verify that each type of pipe proposed for the Project meets specified requirements. Material submittals include product samples, shop drawings, manufacturer specifications, and certificates of compliance.

After the pipe is delivered, the CQA Monitor must confirm by observation that the supplied materials comply with the approved submittals and the Technical Specifications.

7.3 HDPE PIPE CONSTRUCTION MONITORING

Before pipe fusion welding and installation operations begin, the CQA Monitor must verify that qualified fusion welding technicians are performing the work. The CQA Monitor must verify:

- During pipe fusion welding operations, the CQA Monitor must verify the following:
  - Hot plate temperatures are maintained between 410°F and 420°F.
  - Pipe ends are squarely faced and cuttings are removed before fusion welding occurs.
  - Fusion weld time is approximately 55 seconds.
  - Cooling time of the fusion-welded pipe is approximately five minutes before release from the weld machine.
  - Fusion weld roll-back (melted HDPE) is approximately as shown below for different pipe sizes after the pipe ends are jointed.

PIPE SIZE	DIAMETER OF MELT BEAD
2-inch and smaller	1/16-inch
3-inch to 5-inch	1/18-inch
5-inch to 12-inch	3/16-inch
12-inch to 22-inch	1/4-inch to 5/16-inch
24-inch to 54-inch	5/16-inch to 7/16-inch

- Pipes are properly aligned and are at the design grade.
- All cleaning cables are removed from the entire pipe run.

- Where Fernco couplings are used to join pipe sections:
  - The pipe ends are installed the correct distance into the Fernco coupling.
  - The couplings are tightened to the manufacturer recommended torque with a tool capable of being used at the correct torque.
- Drainage gravel is placed around the pipes per Technical Specifications.

8 DOCUMENTATION

The quality assurance plan depends on thorough monitoring and documentation of all construction activities. Therefore, the CQA Engineer of Record and CQA Monitors must document that all quality assurance requirements have been implemented. Documentation must consist of daily record keeping, daily test reports and installation reports, nonconformance reports (if necessary), progress reports, design and specification revisions, test data summaries and a CCR. Example report forms are presented in Appendices A, B, and C. Forms may be substituted or modified as deemed appropriate by the CQA Monitor or CQA Engineer of Record

8.1 DAILY RECORD KEEPING

At a minimum, daily records must consist of a daily record of construction progress, daily construction report, and observation and test data sheets and as needed, nonconformance/ corrective measure reports. Copies of all reports must be submitted to the Construction Manager on no less than a weekly basis.

8.1.1 DAILY RECORD OF CONSTRUCTION PROGRESS

The daily field report must summarize ongoing construction activities and discussions with the Contractor. At a minimum, the report must include the following:

- Date, Project name, Project number, and location.
- A unique number for cross-referencing and document control.
- Weather data.
- A description of all ongoing construction for the day in the area of the CQA Monitor's responsibility.
- An inventory of equipment utilized by the Contractor.
- Items of discussion and names of parties involved in discussions.
- A brief description of tests and observations, identified as passing or failing, or, in the event of failure, a retest.
- Areas of nonconformance/corrective actions, if any, (nonconformance and/or corrective action form to be attached).
- Summary of materials received and quality documentation.
- Follow-up information on previously reported problems or deficiencies.
- Record of any site visitors.

8.1.2 OBSERVATION AND TEST DATA SHEETS

Observation and test data sheets should include the following information as appropriate for the form being used:

- Date, Project name, and location.
- A unique number for cross-referencing and document control.
- Weather data, as applicable.
- A reduced scale site plan showing sample and test locations.
- Test equipment calibrations, if applicable.
- A summary of test results identified as passing, failing, or, in the event of a failed test, retest.
- Completed calculations.
- Signature of the CQA Monitor; and
- Signature of the peer reviewer.

8.1.3 NON-CONFORMANCE REPORTS

In the event of a nonconformance event, a nonconformance verification report form must be included with the daily report. Procedures for implementing and resolving any nonconformance to the contract are outlined in Section 2 of this CQA manual.

8.2 PHOTOGRAPHS

Construction activities must be photographed utilizing a digital camera. Photographs must include any significant problems encountered and corrective actions, and to document construction progress. The CQA Monitor must identify each photograph with a number, a location, time, date, and photographer. The photographer should document the subject of the photograph, either on the back of the picture, or in a photograph log. Electronic copies of all digital photographs must be given to the Construction Manager.

8.3 DESIGN AND SPECIFICATION CHANGES

Design and specification changes may be required during construction. Design and specification changes must only be made with written agreement of the Design Engineer of Record, Owner, and Contractor. These changes must be made by change order to the contract. When change orders are issued, the Construction Manager must prepare them with technical input from the Design Engineer of Record. The Construction Manager must distribute change orders for signature and execution to the required parties.

8.4 CONSTRUCTION CERTIFICATION REPORT (CCR)

At the completion of the Project, the CQA Engineer of Record must submit a CCR. This report must document that the Project has been constructed in compliance with the Construction Drawings, Technical Specifications and design intent.

At a minimum, the report must contain:

- A summary of major construction activities.
- A summary of laboratory and field test results.
- Sampling and testing location drawings.
- A description of significant construction problems and the resolution of these problems.
- A list of changes from the Construction Drawings and specifications and the justification for these changes.
- As-built record drawings.
- A statement of compliance with the drawings, Technical Specifications, and design intent signed and stamped by a professional engineer registered in the state of Oregon.

The as-built record drawings must accurately locate the constructed location of all work items, including the location of piping, anchor trenches, geosynthetics limits, etc. All surveying and base maps required for development of the record drawings must be prepared by the Project surveyor. The CQA Engineer of Record, CQA Monitors, and Contractors must review and verify that as-built drawings are correct. As-built drawings must be included in the CCR.

APPENDIX A

DAILY REPORT FORMS

APPENDIX B

EARTHWORK TESTING DOCUMENTATION FORMS

Appendix C

Geosynthetic Documentation Forms

APPENDIX H

2022 Annual Financial Assurance Update and Recertification

Riverbend Landfill Company
13469 SW Highway 18
McMinnville, OR 97128
(503) 472-8788

April 27, 2022

Ms. Denise Miller
Permit Coordinator
Oregon Department of Environmental Quality (DEQ)
DEQ Western Region
165 E. 7th Ave., Ste. 100
Eugene, OR 97401-3049

RE: 2022 Annual Financial Assurance Update and Recertification
Riverbend Landfill; Solid Waste Disposal Permit No. 345 Yamhill County

Ms. Miller:

In accordance with Oregon Revised Statutes (ORS) 459.272, Oregon Administrative Rules (OAR) 340-94-100 through 145, and Solid Waste Disposal Permit (SWDP) No. 345, Section 20, we are submitting this Financial Assurance update for Riverbend Landfill Co. (RLC).

Since the last update in 2021, no additional final cover was constructed, so the worst-case closure remained the same as 2021. Riverbend Landfill Co. (RLC) updated the Closure and Post Closure Plan that was previously prepared by HDR Engineering (HDR) in 2018. Once updated, RLC then retained consultants to review and certify that the costs were updated by RLC in accordance with the Oregon Department of Environmental Quality (DEQ) guidelines for preparing a Financial Assurance Update for recertification. The updated 2022 Closure and Post-Closure Plan (Plan) is attached to this submittal.

The current worst-case closure cost estimate is $10,542,666, which equates to a cost of approximately $177,188 per acre for the 59.5 acres that require closure. The current closure balance in the U.S. Bank, NA Funded Trust Account (#246912000) is $11,776,470 through April 8, 2022, which exceeds the current worst-case closure cost estimate by $1,233,804. Therefore, the closure Surety Payment Bond provided by LEXON Insurance Company (#1037710) continues to equal $0.

The current worst-case 30-year post-closure cost estimate is $23,087,752. Based on the DEQ Worksheet for Municipal Solid Waste (MSW) Facilities and utilizing the MSW Reference Rate provided by the DEQ as presented in the Plan's Appendix B, the estimated 30- year post-closure cost was not discounted this year as discounting did not offer a benefit. The post-closure cost equates to a cost of approximately $264,162 per acre for 87.40 acres. The current post-closure balance in the U.S. Bank, NA Funded Trust Account (#246912001) is $2,086,344 through March 31, 2022, which is coupled with a post-closure Surety Bond Guaranteeing Payment provided by LEXON Insurance Company (#1037710) that is $21,001,408. The resulting total post-closure financial assurance is $23,087,752 and matches the current worst-case post-closure cost estimate provided in the updated Plan.

In summary, the financial assurance mechanisms in place for RLC are Funded Trust Accounts held at U.S. Bank, NA and a Surety Payment Bond provided by LEXON Insurance Company as summarized on the following page. Copies of these documents are attached; the originals will be mailed to DEQ on April 26, 2021.

CLOSURE FINANCIAL ASSURANCE	
US Bank Funded Trust Account (#246912000)	$11,776,470
LEXON Surety Payment Bond (#1037710)	$0
Total Closure Financial Assurance Provided by RLC	*$11,776,470*
Total Closure Financial Assurance Estimated by RLC/SCS	*$10,542,666*
Total Closure Financial Assurance Excess	***($1,233,804)***

POST-CLOSURE FINANCIAL ASSURANCE	
US Bank Funded Trust Account (#246912001)	$ 2,086,344
LEXON Surety Payment Bond (#1037710)	$21,001,408
Total Post-Closure Financial Assurance Provided by RLC	***$23,087,752***
Total Post-Closure Financial Assurance Estimated by RLC/Vista w/o Discount	*$23,087,752*
Total Post-Closure Financial Assurance Excess	***$0***

I certify that the financial assurance plan and financial assurance mechanism have been reviewed, updated, and found adequate, and that the updated documents have been placed in the facility operating record. I also certify that the landfill closure date is certain and there are no currently foreseeable factors that will change the estimate of site life. If such changes do occur, the Department of Environmental Quality will be notified, and a revised financial assurance plan and financial assurance mechanism will be prepared.

If you have any questions, please contact me at (503) 348-3781 (email: madams13@wm.com) or Diana Seng at (713) 265-1322 (email: dseng@wm.com).

Sincerely,

Melody A. Adams
PNW/BC Area Project Manager

Enclosures:
- Annual Recertification of Financial Assurance
- Updated Surety Bond Guaranteeing Payment (#1037710) Rider issued by LEXON Insurance Company with the Standby Trust Agreements as Schedule A and B;
- Funded Trust Agreement issued by U.S. Bank, NA with the Funded Trust Account Summaries (#246912000 and #246912001);
- "*2022 Closure and Post-Closure Plan*", Updated by Riverbend Landfill Co. (April 2022), Cost Estimate Certified by Vista GeoEnvironmental Inc (April 2022)

Electronic Copy only:
James McCourt, DEQ – Western Region
David Lowe, WM
David Rettell, WM
Adam Winston, WM
Nicholas Godfrey, WM
Diane Seng, WM

ENCLOSURE 1

Riverbend Landfill Co.
13469 SW Highway 18
McMinnville, OR 97128
(503) 472-8788

Annual Recertification of Financial Assurance

I am the ***Pacific Northwest / British Columbia (PNW/BC) Area Director of Collection Operations*** of ***Riverbend Landfill Co.*** of ***13469 SW Highway 18, McMinnville, OR 97128*** (hereinafter "Permittee") By this letter I certify that Permittee continues to assure payment of all costs associated with closure and post-closure care (together hereinafter "Costs") of the solid waste facility specified in DEQ Permit Number **345**, as required by OAR 340-094-0140 and 0145 (or for non-MSW landfills or other SW Disposal Sites, OAR 340-095-0090 and 0095.) As ***PNW/BC Area Director of Collection Operations,*** I possess the requisite authority to commit Permittee to this certification and acknowledge that this certification is an ongoing, continuing and binding obligation of Permittee.

Permittee certifies that all Costs have been derived using the best procedures available, that all factors affecting Costs have been reviewed within the past twelve months and that all required changes or modifications to Costs have been made. If any future costs have been discounted to present value, the discount rate applied is less than or equal to the DEQ Reference Rate for the current year (or for non-MSW landfills, a discount rate equal to the current yield on a 5-year U.S. Treasury Note as required by OAR 340-095-0090), and all other discounting requirements contained in OAR 340 have been met.

Permittee has chosen to assure payment of Costs through use of a ***Funded Trust Accounts (Riverbend Landfill Co. Closure Trust and Riverbend Landfill Co. Post-Closure Trust)*** issued by ***U.S. Bank, N.A.*** and ***LEXON Insurance Company, respectively***. Permittee certifies that the ***Funded Trust Accounts*** and ***Surety Bond*** are adequate in amount to cover Costs, including any required changes or additions thereto, is in the exact format specified and in all other respects continues to meet the requirements of OAR 340. Permittee certifies further that ***U.S. Bank, N.A.*** and ***LEXON Insurance Company*** continue to meet all federal and State of Oregon requirements for issuance of and performance on the ***Funded Trust Accounts and Surety Bond***.

Permittee certifies that it continues to meet all federal and State of Oregon requirements of whatever nature to assure the payment of Costs.

I attest that the foregoing statement is true, accurate and complete.

[signature]
Adam Winston

Date: 4/25/22

STATE OF OREGON)
) ss.
County of Multnomah)

OFFICIAL STAMP
KIMBERLY CAROLINA SOTO
NOTARY PUBLIC - OREGON
COMMISSION NO. 1010018
MY COMMISSION EXPIRES MARCH 10, 2025

Before me this 25 day of April, 2022 personally appeared ***Adam Winston*** who, first being duly sworn, did say that he is the ***PNW/BC Area Director of Collection Operations*** of ***Riverbend Landfill Co.*** and executed the foregoing document on behalf of ***Riverbend Landfill Co.*** by authorization of its governing board.

Before me: [signature]

Notary Public for Oregon
My Commission expires: 03-10-2025

ENCLOSURE 2

LEXON INSURANCE
10002 Shelbyville Road, Suite 100
Louisville, KY 40223

April 26, 2022

Ms. Denise Miller
Permit Coordinator
Oregon Department of Environmental Quality (ODEQ)
DEQ Western Region
165 E. 7th Avenue, Suite 100
Eugene, OR 97401-3049
(541) 687-7465

RE: Riverbend Landfill
Solid Waste Disposal Permit No. 345

Dear Ms. Miller:

Enclosed please find updated financial assurance for the above-referenced facility. If you have any questions, please feel free to contact -

Diana Seng, Director of Treasury and Financial Assurance
Waste Management
800 Capitol, Suite 3000
Houston, TX 77002
(713) 265-1322
dseng@wm.com

Sincerely,

Theresa Pickerell

Bond No. 1037710

RIDER

To be attached to and form a part of Closure/Post-Closure Bond, No. 1037710

dated the 13th day of January, 2010 issued by

LEXON Insurance Company, 10002 Shelbyville Road, Louisville, KY 40223 as Surety, on behalf of

Riverbend Landfill Co., 13469 SW Highway 18, McMinnville, OR 97128, as Principal,

in the penal sum of Four Million One Hundred Fifteen Thousand One Hundred Thirty-Six and 75/100

Dollars ($ 4,115,136.75), and in favor of Oregon DEQ 2020 SW 4th Street, Suite 400, Portland, OR 97201

In consideration of the premium charged for the attached bond, it is hereby agreed that the attached bond be amended as follows:

This rider will increase the bond amount as follows:

Current Bond Amount: $13,267,834.10

New Bond Amount: $21,001,408.00

Provided, However, that the attached bond shall be subject to all its agreements, limitations and conditions except as herein expressly modified, and further that the liability of the Surety under the attached bond and the attached bond as amended by this rider shall not be cumulative.

This rider shall become effective as of the 26th day of April, 2022

Signed, sealed and dated this 26th day of April, 2022

WITNESS:

Sandra L Fusinetti

PRINCIPAL

Riverbend Landfill Co.

By [signature]

Susan Ritter, Attorney-in-Fact

WITNESS:

Sandra L Fusinetti

LEXON Insurance Company

By Theresa Pickerell

Theresa Pickerell, Attorney-in-Fact

POWER OF ATTORNEY

KNOWN ALL MEN BY THESE PRESENTS that Waste Management, Inc. and each of its direct and indirect majority owned subsidiaries (the "WM Entities"), have constituted and appointed and do hereby appoint Theresa Pickerrell, Sandra L. Fusinetti, and Susan Ritter of Acrisure, LLC DBA Smith Manus, each its true and lawful Attorney-in-fact to execute under such designation in its name, to affix the corporate seal approved by the WM Entities for such purpose, and to deliver for and on its behalf as surety thereon or otherwise, bonds of any of the following classes, to wit:

1. Surety bonds to the United States of America or any agency thereof, and lease and miscellaneous surety bonds required or permitted under the laws, ordinances or regulations of any State, City, Town, Village, Board or any other body or organization, public or private.

2. Bonds on behalf of WM Entities in connection with bids, proposals or contracts.

The foregoing powers granted by the WM Entities shall be subject to and conditional upon the written direction of a duly appointed officer of the applicable WM Entity (or any designee of any such officer) to execute and deliver any such bonds.

The signatures and attestations of such Attorneys-in-fact and the seal of the WM Entity may be affixed to any such bond, policy or to any certificate relating thereto by facsimile and any such bond, policy or certificate bearing such facsimile signatures or facsimile seal shall be valid and binding upon the applicable WM Entity when so affixed.

IN WITNESS WHEREOF, the WM Entities have caused these presents to be signed by the Vice President and Treasurer and its corporate seal to be hereto affixed. This power of attorney is in effect as of April 26, 2022.

Witness:

[signature]

On behalf of Waste Management, Inc. and each of the other WM Entities

[signature]

David Reed
Vice President and Treasurer

SOMPO INTERNATIONAL
INSURANCE

11078

POWER OF ATTORNEY

KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation**, a Delaware corporation, **Endurance American Insurance Company**, a Delaware corporation, **Lexon Insurance Company**, a Texas corporation, and/or **Bond Safeguard Insurance Company**, a South Dakota corporation, each, a "Company" and collectively, "**Sompo International**," do hereby constitute and appoint: **Brook T. Smith, Raymond M. Hundley, Jason D. Cromwell, James H. Martin, Barbara Duncan, Sandra L. Fusinetti, Mark A. Guidry, Jill Kemp, Lynnette Long, Amy Bowers, Deborah Neichter, Theresa Pickerrell, Sheryon Quinn, Beth Frymire, Leigh McCarthy, Michael Dix, Susan Ritter, Ryan Britt** as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million Dollars ($100,000,000.00).**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the sole shareholder of each Company by unanimous written consent effective the 15th day of June, 2019, a copy of which appears below under the heading entitled "Certificate".

This Power of Attorney is signed and sealed by facsimile under and by authority of the following resolution adopted by the sole shareholder of each Company by unanimous written consent effective the 15th day of June, 2019 and said resolution has not since been revoked, amended or repealed:

RESOLVED, that the signature of an individual named above and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signature or seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached.

IN WITNESS WHEREOF, each Company has caused this instrument to be signed by the following officers, and its corporate seal to be affixed this 15th day of June, 2019.

Endurance Assurance Corporation	Endurance American Insurance Company	Lexon Insurance Company	Bond Safeguard Insurance Company
By: Richard M Appel	By: Richard M Appel	By: Richard M Appel	By: Richard M Appel
Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel
Endurance Assurance Corporation CORPORATE SEAL 2002 DELAWARE	Endurance American Insurance Company CORPORATE SEAL 1996 DELAWARE	LEXON INSURANCE COMPANY CORPORATE SEAL MARCH 16, 1984 STATE OF TEXAS	BOND SAFEGUARD INSURANCE COMPANY A SOUTH DAKOTA INSURANCE COMPANY

ACKNOWLEDGEMENT

On this 15th day of June, 2019, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is an officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor, Notary Public – My Commission Expires 5/9/23

AMY TAYLOR STATE OF TENNESSEE NOTARY PUBLIC DAVIDSON COUNTY

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
2. The following are resolutions which were adopted by the sole shareholder of each Company by unanimous written consent effective June 15, 2019 and said resolutions have not since been revoked, amended or modified:

   "RESOLVED, that each of the individuals named below is authorized to make, execute, seal and deliver for and on behalf of the Company any and all bonds, undertakings or obligations in surety or co-surety with others: RICHARD M. APPEL, BRIAN J. BEGGS, CHRISTOPHER DONELAN, SHARON L. SIMS, CHRISTOPHER L. SPARRO, MARIANNE L. WILBERT

   ; and be it further

   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds, undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 26th day of April, 2022.

By: [signature]
Daniel S. Lurie, Secretary

NOTICE: U. S. TREASURY DEPARTMENT'S OFFICE OF FOREIGN ASSETS CONTROL (OFAC)

No coverage is provided by this Notice nor can it be construed to replace any provisions of any surety bond or other surety coverage provided. This Notice provides information concerning possible impact on your surety coverage due to directives issued by OFAC. **Please read this Notice carefully.**

The Office of Foreign Assets Control (OFAC) administers and enforces sanctions policy, based on Presidential declarations of "national emergency". OFAC has identified and listed numerous foreign agents, front organizations, terrorists, terrorist organizations, and narcotics traffickers as "Specially Designated Nationals and Blocked Persons". This list can be located on the United States Treasury's website – https://www.treasury.gov/resource-center/sanctions/SDN-List.

In accordance with OFAC regulations, if it is determined that you or any other person or entity claiming the benefits of any coverage has violated U.S. sanctions law or is a Specially Designated National and Blocked Person, as identified by OFAC, any coverage will be considered a blocked or frozen contract and all provisions of any coverage provided are immediately subject to OFAC. When a surety bond or other form of surety coverage is considered to be such a blocked or frozen contract, no payments nor premium refunds may be made without authorization from OFAC. Other limitations on the premiums and payments may also apply.

Any reproductions are void.
Surety Claims Submission: LexonClaimAdministration@sompo-intl.com
Telephone: 615-553-9500 Mailing Address: Sompo International; 12890 Lebanon Road; Mount Juliet, TN 37122-2870

Standby Trust Agreement Dated April 12, 2010
Trust Agreement Supplement and Addendum Dated September 23, 2013
Riverbend Landfill Co., Grantor
JPMorgan Chase Bank, N.A., Trustee
Wells Fargo Bank, N.A., Successor Trustee

SCHEDULE A

(Revised 4/26/2022)

Facility Name:	**Riverbend Landfill Co.**
Facility Address:	**13469 SW Highway 18, McMinnville, OR 97128**
DEQ Solid Waste Permit Number/s:	**345**
Current Closure Cost Estimate/s:	**$ 10,542,666.00**
Current Post-Closure Cost Estimate/s:	**$ 23,087,752.00**
Current Corrective Action Cost Estimate/s:	**$0.00**
Total Current Cost Estimate/s:	**$ 33,630,418.00**

Post-Closure provided by Payment Bond #1037710:	**$ 21,001,408.00**
Total Payment Bond Amount:	**$ 21,001,408.00**

Standby Trust Agreement Dated April 12, 2010
Trust Agreement Supplement and Addendum Dated September 23, 2013
Riverbend Landfill Co., Grantor
JPMorgan Chase Bank, N.A., Trustee
Wells Fargo Bank, N.A., Successor Trustee

SCHEDULE B

(Revised 4/26/2022)

Type of Financial Instrument:	**Surety Bond Guaranteeing Payment**		
Executed by:	**Lexon Insurance Company** **10002 Shelbyville Road, Suite 100** **Louisville, Kentucky 40223**		
Date of Bond Execution:	**January 13, 2010**		
Bond Number:	**1037710**		
Bond Amount:	**Closure:**	**$**	**.00**
	Post Closure:	**$**	**21,001,408.00**
	Penal Sum:	**$**	**21,001,408.00**

FACULTATIVE SURETY BOND EXCESS REINSURANCE CONTRACT
By and Between

Direct Writing Company:
Lexon Insurance Company
10002 Shelbyville Road, Suite 100
Louisville, KY 40223

Reinsuring Company:
Endurance Assurance Corporation
4 Manhattanville Road
Purchase, NY 10577

In consideration of these DECLARATIONS and payment of reinsurance premium, the Reinsuring Company does hereby agree to reinsure the Direct Writing Company's Bond on an excess of loss basis as follows:

DECLARATIONS

Name and Address of Principal:

Riverbend Landfill Co.
13469 SW Highway 18
McMinnville, OR 97128

Name and Address of Obligee:

Oregon DEQ
2020 SW 4th Street
Suite 400
Portland, OR 97201

Bond No.: 1037710

Bond Effective Date: April 26, 2022

Bond Penalty: $21,001,408.00

Term: For Term of Contract

Contract Price: $21,001,408.00

State: Oregon

Type of Bond: Closure/Post Closure

Direct Writing Company's Retention:
$6,079,000.00

Reinsurance Limit in Excess of Company Retention:
$14,922,408.00

Gross Premium: $94,506.00

Gross Reinsurance Premium: Per Treaty

Ceding Commission: Per Treaty

Net Reinsurance Premium: Per Treaty

This Reinsurance shall become effective simultaneously with the liability of the Direct Writing Company.

The Direct Writing Company agrees to the terms and conditions set forth in these DECLARATIONS, this Contract and the Excess of Loss Reinsurance Contract by and between the Direct Writing Company and the Reinsuring Company.

Direct Writing Company: Lexon Insurance Company

By: Theresa Pickerell Date: April 26, 2022
Theresa Pickerell, Attorney-in-Fact

Reinsurance described in these DECLARATIONS and this contract has been offered to and accepted by:

Reinsuring Company: Endurance Assurance Corporation

By: Lynnette Long Date: April 26, 2022
Lynnette Long, Attorney-in-Fact

SOMPO INTERNATIONAL
INSURANCE

11078

POWER OF ATTORNEY

KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation**, a Delaware corporation, **Endurance American Insurance Company**, a Delaware corporation, **Lexon Insurance Company**, a Texas corporation, and/or **Bond Safeguard Insurance Company**, a South Dakota corporation, each, a "Company" and collectively, "**Sompo International**," do hereby constitute and appoint: **Brook T. Smith, Raymond M. Hundley, Jason D. Cromwell, James H. Martin, Barbara Duncan, Sandra L. Fusinetti, Mark A. Guidry, Jill Kemp, Lynnette Long, Amy Bowers, Deborah Neichter, Theresa Pickerrell, Sheryon Quinn, Beth Frymire, Leigh McCarthy, Michael Dix, Susan Ritter, Ryan Britt** as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million Dollars ($100,000,000.00).**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the sole shareholder of each Company by unanimous written consent effective the 15th day of June, 2019, a copy of which appears below under the heading entitled "Certificate".

This Power of Attorney is signed and sealed by facsimile under and by authority of the following resolution adopted by the sole shareholder of each Company by unanimous written consent effective the 15th day of June, 2019 and said resolution has not since been revoked, amended or repealed:

RESOLVED, that the signature of an individual named above and the seal of the Company may be affixed to any such power of attorney or any certificate relating thereto by facsimile, and any such power of attorney or certificate bearing such facsimile signature or seal shall be valid and binding upon the Company in the future with respect to any bond or undertaking to which it is attached.

IN WITNESS WHEREOF, each Company has caused this instrument to be signed by the following officers, and its corporate seal to be affixed this 15th day of June, 2019.

Endurance Assurance Corporation	Endurance American Insurance Company	Lexon Insurance Company	Bond Safeguard Insurance Company
By: Richard M Appel	By: Richard M Appel	By: Richard M Appel	By: Richard M Appel
Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel
Endurance Assurance Corporation SEAL 2002 DELAWARE	Endurance American Insurance Company SEAL 1996 DELAWARE	Lexon Insurance Company SEAL March 16, 1984 State of Texas	Bond Safeguard Insurance Company A South Dakota Insurance Company

ACKNOWLEDGEMENT

On this 15th day of June, 2019, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is an officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor, Notary Public – My Commission Expires 5/9/23

Amy Taylor State of Tennessee Notary Public Davidson County

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
2. The following are resolutions which were adopted by the sole shareholder of each Company by unanimous written consent effective June 15, 2019 and said resolutions have not since been revoked, amended or modified:

   "RESOLVED, that each of the individuals named below is authorized to make, execute, seal and deliver for and on behalf of the Company any and all bonds, undertakings or obligations in surety or co-surety with others: RICHARD M. APPEL, BRIAN J. BEGGS, CHRISTOPHER DONELAN, SHARON L. SIMS, CHRISTOPHER L. SPARRO, MARIANNE L. WILBERT

   ; and be it further

   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds, undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 26th day of April, 2022.

By:
Daniel S. Lurie, Secretary

NOTICE: U. S. TREASURY DEPARTMENT'S OFFICE OF FOREIGN ASSETS CONTROL (OFAC)

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Any reproductions are void.

Surety Claims Submission: LexonClaimAdministration@sompo-intl.com
Telephone: 615-553-9500 Mailing Address: Sompo International; 12890 Lebanon Road; Mount Juliet, TN 37122-2870

SOMPO INTERNATIONAL
INSURANCE

11078

POWER OF ATTORNEY

KNOW ALL BY THESE PRESENTS, that **Endurance Assurance Corporation**, a Delaware corporation, **Endurance American Insurance Company**, a Delaware corporation, **Lexon Insurance Company**, a Texas corporation, and/or **Bond Safeguard Insurance Company**, a South Dakota corporation, each, a "Company" and collectively, "**Sompo International**," do hereby constitute and appoint: **Brook T. Smith, Raymond M. Hundley, Jason D. Cromwell, James H. Martin, Barbara Duncan, Sandra L. Fusinetti, Mark A. Guidry, Jill Kemp, Lynnette Long, Amy Bowers, Deborah Neichter, Theresa Pickerrell, Sheryon Quinn, Beth Frymire, Leigh McCarthy, Michael Dix, Susan Ritter, Ryan Britt** as true and lawful Attorney(s)-In-Fact to make, execute, seal, and deliver for, and on its behalf as surety or co-surety; bonds and undertakings given for any and all purposes, also to execute and deliver on its behalf as aforesaid renewals, extensions, agreements, waivers, consents or stipulations relating to such bonds or undertakings provided, however, that no single bond or undertaking so made, executed and delivered shall obligate the Company for any portion of the penal sum thereof in excess of the sum of **One Hundred Million Dollars ($100,000,000.00).**

Such bonds and undertakings for said purposes, when duly executed by said attorney(s)-in-fact, shall be binding upon the Company as fully and to the same extent as if signed by the President of the Company under its corporate seal attested by its Corporate Secretary.

This appointment is made under and by authority of certain resolutions adopted by the sole shareholder of each Company by unanimous written consent effective the 15th day of June, 2019, a copy of which appears below under the heading entitled "Certificate".

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Endurance Assurance Corporation	Endurance American Insurance Company	Lexon Insurance Company	Bond Safeguard Insurance Company
By: Richard M Appel	By: Richard M Appel	By: Richard M Appel	By: Richard M Appel
Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel	Richard Appel; SVP & Senior Counsel
Endurance Assurance Corporation CORPORATE SEAL 2002 DELAWARE	Endurance American Insurance Company CORPORATE SEAL 1996 DELAWARE	LEXON INSURANCE COMPANY CORPORATE SEAL MARCH 16, 1984 STATE OF TEXAS	BOND SAFEGUARD INSURANCE COMPANY A SOUTH DAKOTA INSURANCE COMPANY

ACKNOWLEDGEMENT

On this 15th day of June, 2019, before me, personally came the above signatories known to me, who being duly sworn, did depose and say that he/they is an officer of each of the Companies; and that he executed said instrument on behalf of each Company by authority of his office under the by-laws of each Company.

By: Amy Taylor
Amy Taylor, Notary Public – My Commission Expires 5/9/23

AMY TAYLOR STATE OF TENNESSEE NOTARY PUBLIC DAVIDSON COUNTY

CERTIFICATE

I, the undersigned Officer of each Company, DO HEREBY CERTIFY that:

1. That the original power of attorney of which the foregoing is a copy was duly executed on behalf of each Company and has not since been revoked, amended or modified; that the undersigned has compared the foregoing copy thereof with the original power of attorney, and that the same is a true and correct copy of the original power of attorney and of the whole thereof;
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   ; and be it further

   RESOLVED, that each of the individuals named above is authorized to appoint attorneys-in-fact for the purpose of making, executing, sealing and delivering bonds, undertakings or obligations in surety or co-surety for and on behalf of the Company."
3. The undersigned further certifies that the above resolutions are true and correct copies of the resolutions as so recorded and of the whole thereof.

IN WITNESS WHEREOF, I have hereunto set my hand and affixed the corporate seal this 26th day of April, 2022.

By: [signature]
Daniel S. Lurie, Secretary

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Any reproductions are void.

Surety Claims Submission: LexonClaimAdministration@sompo-intl.com
Telephone: 615-553-9500 Mailing Address: Sompo International; 12890 Lebanon Road; Mount Juliet, TN 37122-2870

ENCLOSURE 3

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020
CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

000015297 02 SP 000638144473201 S

RIVERBEND LANDFILL CO
WM TREASURY DEPARTMENT
800 CAPITOL ST., SUITE 3000
HOUSTON, TX 77002

QUESTIONS?

If you have any questions regarding your account or this statement, please contact your Account Manager or Analyst.

Account Manager:
ALEJANDRO HOYOS
EX-TX-CGW1
8 GREENWAY PLAZA, SUITE 1100
HOUSTON TX 77046
Phone 713-212-7576
E-mail alejandro.hoyos@usbank.com

Analyst:
THANH (MARIA) BUI
Phone 651-466-6092

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

MARKET VALUE SUMMARY

	Current Period 03/01/22 to 03/31/22
Beginning Market Value	**$11,838,702.78**
Investment Results	
Interest, Dividends and Other Income	13,040.62
Net Change in Investment Value	- 75,273.50
Total Investment Results	**- $62,232.88**
Ending Market Value	**$11,776,469.90**

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from March 1, 2022 to March 31, 2022

ASSET DETAIL AS OF 03/31/22

Shares or Face Amount	*Security Description*	Market Value/ Price	Tax Cost/ Unit Cost	% of Total Yield at Market	Est Ann Inc
Cash Equivalents					
5,797,800.900	Fidelity Govt Portfolio Cl III #657 *316175603*	5,797,800.90 1.0000	5,797,800.90 1.00	49.1 .01	579.84
Total Cash Equivalents		**$5,797,800.90**	**$5,797,800.90**	**49.2**	**$579.84**
US Government Issues					
400,000.000	F N M A 1.875 04/05/2022 *3135G0T45* Standard & Poors Rating: AA+ Moodys Rating: Aaa	400,076.00 100.0190	0.00 0.00	3.4 1.88	7,500.00
300,000.000	U S Treasury Note 1.625 08/31/2022 *9128282S8* Standard & Poors Rating: N/A Moodys Rating: Aaa	300,819.00 100.2730	0.00 0.00	2.6 1.62	4,875.00
250,000.000	U S Treasury Note 1.750 09/30/2022 *912828L57* Standard & Poors Rating: N/A Moodys Rating: Aaa	250,860.00 100.3440	0.00 0.00	2.1 1.74	4,375.00
250,000.000	U S Treasury Note 2.000 11/30/2022 *912828M80* Standard & Poors Rating: N/A Moodys Rating: Aaa	251,095.00 100.4380	0.00 0.00	2.1 1.99	5,000.00
250,000.000	U S Treasury Note 2.125 12/31/2022 *912828N30* Standard & Poors Rating: N/A Moodys Rating: Aaa	251,270.00 100.5080	0.00 0.00	2.1 2.11	5,312.50
150,000.000	U S Treasury Note 2.625 02/28/2023 *9128284A5* Standard & Poors Rating: N/A Moodys Rating: Aaa	151,312.50 100.8750	0.00 0.00	1.3 2.60	3,937.50
300,000.000	U S Treasury Note 2.500 03/31/2023 *9128284D9* Standard & Poors Rating: N/A Moodys Rating: Aaa	302,298.00 100.7660	0.00 0.00	2.6 2.48	7,500.00

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

ASSET DETAIL AS OF 03/31/22 (continued)

Shares or Face Amount	*Security Description*	Market Value/ Price	Tax Cost/ Unit Cost	% of Total Yield at Market	Est Ann Inc
250,000.000	U S Treasury Note 2.750 05/31/2023 *9128284S6* Standard & Poors Rating: N/A Moodys Rating: Aaa	252,422.50 100.9690	0.00 0.00	2.2 2.72	6,875.00
150,000.000	U S Treasury Bond 1.375 06/30/2023 *912828S35* Standard & Poors Rating: N/A Moodys Rating: Aaa	148,921.50 99.2810	0.00 0.00	1.3 1.38	2,062.50
300,000.000	U S Treasury Note 1.250 07/31/2023 *912828S92* Standard & Poors Rating: N/A Moodys Rating: Aaa	296,895.00 98.9650	0.00 0.00	2.5 1.26	3,750.00
300,000.000	U S Treasury Note 1.375 08/31/2023 *9128282D1* Standard & Poors Rating: N/A Moodys Rating: Aaa	297,024.00 99.0080	0.00 0.00	2.5 1.39	4,125.00
500,000.000	U S Treasury Note 2.750 08/31/2023 *9128284X5* Standard & Poors Rating: N/A Moodys Rating: Aaa	504,590.00 100.9180	0.00 0.00	4.3 2.72	13,750.00
300,000.000	U S Treasury Note 2.625 12/31/2023 *9128285U0* Standard & Poors Rating: N/A Moodys Rating: Aaa	301,911.00 100.6370	0.00 0.00	2.6 2.61	7,875.00
150,000.000	U S Treasury Note 2.250 01/31/2024 *912828V80* Moodys Rating: Aaa	149,842.50 99.8950	0.00 0.00	1.3 2.25	3,375.00
100,000.000	U S Treasury Note 2.125 02/29/2024 *912828W48* Standard & Poors Rating: N/A Moodys Rating: Aaa	99,641.00 99.6410	0.00 0.00	0.9 2.13	2,125.00
200,000.000	U S Treasury Note 2.000 04/30/2024 *912828X70* Standard & Poors Rating: N/A Moodys Rating: Aaa	198,468.00 99.2340	0.00 0.00	1.7 2.01	4,000.00

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

ASSET DETAIL AS OF 03/31/22 (continued)

Shares or Face Amount	*Security Description*	Market Value/ Price	Tax Cost/ Unit Cost	% of Total Yield at Market	Est Ann Inc
350,000.000	U S Treasury Note 1.750 06/30/2024 *9128286Z8* Standard & Poors Rating: N/A Moodys Rating: Aaa	344,942.50 98.5550	0.00 0.00	2.9 1.78	6,125.00
300,000.000	U S Treasury Note 1.500 09/30/2024 *912828YH7* Standard & Poors Rating: N/A Moodys Rating: Aaa	292,935.00 97.6450	0.00 0.00	2.5 1.54	4,500.00
200,000.000	F N M A 1.625 10/15/2024 *3135G0W66* Standard & Poors Rating: AA+ Moodys Rating: Aaa	195,964.00 97.9820	0.00 0.00	1.7 1.66	3,250.00
350,000.000	U S Treasury Note 0.500 03/31/2025 *912828ZF0* Standard & Poors Rating: N/A Moodys Rating: Aaa	329,724.50 94.2070	0.00 0.00	2.8 .53	1,750.00
350,000.000	Federal Home Loan Bks 0.500 04/14/2025 *3130AJHU6* Standard & Poors Rating: AA+ Moodys Rating: Aaa	329,927.50 94.2650	0.00 0.00	2.8 .53	1,750.00
350,000.000	U S Treasury Note 0.375 04/30/2025 *912828ZL7* Standard & Poors Rating: N/A Moodys Rating: Aaa	327,729.50 93.6370	0.00 0.00	2.8 .40	1,312.50
Total US Government Issues		**$5,978,669.00**	**$0.00**	**50.8**	**$105,125.00**
Total Assets		**$11,776,469.90**	**$5,797,800.90**	**100.0**	**$105,704.84**

ASSET DETAIL MESSAGES

Time of trade execution and trading party (if not disclosed) will be provided upon request.

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

ASSET DETAIL MESSAGES (continued)

Publicly traded assets are valued in accordance with market quotations or valuation methodologies from financial industry services believed by us to be reliable. Assets that are not publicly traded may be reflected at values from other external sources. Assets for which a current value is not available may be reflected at a previous value or as not valued, at par value, or at a nominal value. Values shown do not necessarily reflect prices at which assets could be bought or sold. Values are updated based on internal policy and may be updated less frequently than statement generation.

For further information, please contact your Analyst.

Yield at Market and Estimated Annual Income are estimates provided for informational purposes only and should not be relied on for making investment, trading, or tax decisions. The estimates may not represent the actual value earned by your investments and they provide no guarantee of what your investments may earn in the future.

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

CASH SUMMARY

	Income Cash	Principal Cash	Total Cash
Beginning Cash Balance as of 03/01/2022	**$.00**	**$.00**	**$.00**
Taxable Interest	13,040.62		13,040.62
Transfers	- 13,040.62	13,040.62	
Sales		350,000.00	350,000.00
Net Money Market Activity		- 363,040.62	- 363,040.62
Ending Cash Balance as of 03/31/2022	**$0.00**	**$0.00**	**$0.00**

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from March 1, 2022 to March 31, 2022

TRANSACTION DETAIL

Date Posted	Description	Income Cash	Principal Cash	Tax Cost
	Beginning Balance 03/01/2022	**$.00**	**$.00**	**$5,434,760.28**
03/01/22	Interest Earned On Fidelity Govt Port Cl III Interest From 2/1/22 To 2/28/22 316175603	40.62		
03/02/22	Cash Disbursement Transfer To Principal 1	- 40.62		
03/02/22	Cash Receipt Transfer From Income 1		40.62	
03/02/22	Purchased 40.62 Units Of Fidelity Govt Port Cl III Trade Date 3/2/22 316175603		- 40.62	40.62
03/11/22	Matured 350,000 Par Value Of F H L B Deb 2.250% 3/11/22 Trade Date 3/11/22 350,000 Par Value At 100 % 313378CR0		350,000.00	
03/11/22	Interest Earned On F H L B Deb 2.250% 3/11/22 0.01125 USD/$1 Pv On 350,000 Par Value Due 3/11/22 313378CR0	3,937.50		
03/11/22	Cash Disbursement Transfer To Principal 1	- 3,937.50		
03/11/22	Cash Receipt Transfer From Income 1		3,937.50	
03/11/22	Purchased 353,937.5 Units Of Fidelity Govt Port Cl III Trade Date 3/11/22 316175603		- 353,937.50	353,937.50
03/31/22	Interest Earned On U S Treasury Nt 0.500% 3/31/25 0.0025 USD/$1 Pv On 350,000 Par Value Due 3/31/22 912828ZF0	875.00		
03/31/22	Interest Earned On U S Treasury Nt 1.500% 9/30/24 0.0075 USD/$1 Pv On 300,000 Par Value Due 3/31/22 912828YH7	2,250.00		
03/31/22	Interest Earned On U S Treasury Nt 1.750% 9/30/22 0.00875 USD/$1 Pv On 250,000 Par Value Due 3/31/22 912828L57	2,187.50		

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

TRANSACTION DETAIL (continued)

Date Posted	Description	Income Cash	Principal Cash	Tax Cost
03/31/22	Interest Earned On U S Treasury Nt 2.500% 3/31/23 0.0125 USD/$1 Pv On 300,000 Par Value Due 3/31/22 9128284D9	3,750.00		
03/31/22	Cash Disbursement Transfer To Principal 1	- 9,062.50		
03/31/22	Cash Receipt Transfer From Income 1		9,062.50	
03/31/22	Purchased 9,062.5 Units Of Fidelity Govt Port Cl III Trade Date 3/31/22 316175603		- 9,062.50	9,062.50
	Ending Balance 03/31/2022	**$0.00**	**$0.00**	**$5,797,800.90**

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

SALE/MATURITY SUMMARY

Date Posted	Description	Tax Cost	Proceeds	Estimated Gain/Loss
US Government Issues				
	Federal Home Loan Bks 2.250 03/11/2022 313378CR0			
03/11/22	Matured 350,000 Par Value Trade Date 3/11/22 350,000 Par Value At 100 %		350,000.00	350,000.00
	Total US Government Issues	**$0.00**	**$350,000.00**	**$350,000.00**
	Total Sales	**$0.00**	**$350,000.00**	**$350,000.00**

SALE/MATURITY SUMMARY MESSAGES

For information only. Not intended for tax purposes

ACCOUNT NUMBER: 246912000
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

BOND SUMMARY

	Par Value	Market Value	% of Category
MATURITY			
2022	1,450,000.00	1,454,120.00	24.33
2023	2,250,000.00	2,255,374.50	37.73
2024	1,300,000.00	1,281,793.00	21.43
2025	1,050,000.00	987,381.50	16.51
Total of Category	**$6,050,000.00**	**$5,978,669.00**	**100.00**
MOODY'S RATING			
Aaa	6,050,000.00	5,978,669.00	100.00
Total of Category	**$6,050,000.00**	**$5,978,669.00**	**100.00**
S&P RATING			
AA+	950,000.00	925,967.50	15.49
N/A	4,950,000.00	4,902,859.00	82.01
NOT RATED	150,000.00	149,842.50	2.50
Total of Category	**$6,050,000.00**	**$5,978,669.00**	**100.00**

BOND SUMMARY MESSAGES

Data contained within this section excluded Mutual Funds, Exchange Traded Funds, and Closed-Ended Funds.

Glossary

Accretion - The accumulation of the value of a discounted bond until maturity.
Adjusted Prior Market Realized Gain/Loss - The difference between the proceeds and the Prior Market Value of the transaction.
Adjusted Prior Market Unrealized Gain/Loss - The difference between the Market Value and the Adjusted Prior Market Value.
Adjusted Prior Market Value - A figure calculated using the beginning Market Value for the fiscal year, adjusted for all asset related transactions during the period, employing an average cost methodology.
Amortization - The decrease in value of a premium bond until maturity.
Asset - Anything owned that has commercial exchange value. Assets may consist of specific property or of claims against others, in contrast to obligations due to others (liabilities).
Bond Rating - A measurement of a bond's quality based upon the issuer's financial condition. Ratings are assigned by independent rating services, such as Moody's, or S&P, and reflect their opinion of the issuer's ability to meet the scheduled interest and principal repayments for the bond.
Cash - Cash activity that includes both income and principal cash categories.
Change in Unrealized Gain/Loss - Also reported as Gain/Loss in Period in the Asset Detail section. This figure shows the market appreciation (depreciation) for the current period.
Cost Basis (Book Value) - The original price of an asset, normally the purchase price or appraised value at the time of acquisition. Book Value method maintains an average cost for each asset.
Cost Basis (Tax Basis) - The original price of an asset, normally the purchase price or appraised value at the time of acquisition. Tax Basis uses client determined methods such as Last-In-First-Out (LIFO), First-In-First-Out (FIFO), Average, Minimum Gain, and Maximum Gain.
Ending Accrual - (Also reported as Accrued Income) Income earned but not yet received, or expenses incurred but not yet paid, as of the end of the reporting period.
Estimated Annual Income - The amount of income a particular asset is anticipated to earn over the next year. The shares multiplied by annual income rate.
Estimated Current Yield - The annual rate of return on an investment expressed as a percentage. For stocks, yield is calculated by taking the annual dividend payments divided by the stock's current share price. For bonds, yield is calculated by the coupon rate divided by the bond's market price.
Ex-Dividend Date - (Also reported as Ex-Date) For stock trades, the person who owns the security on the ex-dividend date will earn the dividend, regardless of who currently owns the stock.
Income Cash - A category of cash comprised of ordinary earnings derived from investments, usually dividends and interest.
Market Value - The price per unit multiplied by the number of units.
Maturity Date - The date on which an obligation or note matures.
Payable Date - The date on which a dividend, mutual fund distribution, or interest on a bond will be made.
Principal Cash - A category of cash comprised of cash, deposits, cash withdrawals and the cash flows generated from purchases or sales of investments.
Realized Gain/Loss Calculation - The Proceeds less the Cost Basis of a transaction.
Settlement Date - The date on which a trade settles and cash or securities are credited or debited to the account.
Trade Date - The date a trade is legally entered into.
Unrealized Gain/Loss - The difference between the Market Value and Cost Basis at the end of the current period.
Yield on/at Market - The annual rate of return on an investment expressed as a percentage. For stocks, yield is calculated by the annual dividend payments divided by the stock's current share price. For bonds, yield is calculated by the coupon rate divided by the bond's market price.

The terms defined in this glossary are only for use when reviewing your account statement. Please contact your Relationship Manager with any questions.

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-PF-091

U.S. Bank
1555 N. Rivercenter Dr.
Suite 300
Milwaukee, WI 53212

000015297 02 SP 000638144473201 S

RIVERBEND LANDFILL CO
WM TREASURY DEPARTMENT
800 CAPITOL ST., SUITE 3000
HOUSTON, TX 77002

ACCOUNT NUMBER: 246912001
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020
POST CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

000015298 02 SP 000638144473202 S

RIVERBEND LANDFILL CO
WM TREASURY DEPARTMENT
800 CAPITOL ST., SUITE 3000
HOUSTON, TX 77002

QUESTIONS?

If you have any questions regarding your account or this statement, please contact your Account Manager or Analyst.

Account Manager:
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8 GREENWAY PLAZA, SUITE 1100
HOUSTON TX 77046
Phone 713-212-7576
E-mail alejandro.hoyos@usbank.com

Analyst:
WAYNE A SATTLER
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US bank

ACCOUNT NUMBER: 246912001
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

POST CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

MARKET VALUE SUMMARY

	Current Period 03/01/22 to 03/31/22
Beginning Market Value	**$2,124,368.30**
Investment Results	
Interest, Dividends and Other Income	1,750.39
Net Change in Investment Value	- 39,774.50
Total Investment Results	**- $38,024.11**
Ending Market Value	**$2,086,344.19**

ACCOUNT NUMBER: 246912001
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

POST CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

ASSET DETAIL AS OF 03/31/22

Shares or Face Amount	*Security Description*	Market Value/ Price	Tax Cost/ Unit Cost	% of Total Yield at Market	Est Ann Inc
Cash Equivalents					
53,858.190	Fidelity Govt Portfolio Cl III #657 *316175603*	53,858.19 1.0000	53,858.19 1.00	2.6 .01	5.39
Total Cash Equivalents		**$53,858.19**	**$53,858.19**	**2.6**	**$5.39**
US Government Issues					
250,000.000	F N M A 1.875 04/05/2022 *3135G0T45* Standard & Poors Rating: AA+ Moodys Rating: Aaa	250,047.50 100.0190	0.00 0.00	12.1 1.88	4,687.50
200,000.000	U S Treasury Note 1.625 08/31/2022 *9128282S8* Standard & Poors Rating: N/A Moodys Rating: Aaa	200,546.00 100.2730	0.00 0.00	9.6 1.62	3,250.00
150,000.000	U S Treasury Note 2.750 05/31/2023 *9128284S6* Standard & Poors Rating: N/A Moodys Rating: Aaa	151,453.50 100.9690	0.00 0.00	7.3 2.72	4,125.00
200,000.000	U S Treasury Note 2.625 12/31/2023 *9128285U0* Standard & Poors Rating: N/A Moodys Rating: Aaa	201,274.00 100.6370	0.00 0.00	9.7 2.61	5,250.00
100,000.000	U S Treasury Note 2.250 01/31/2024 *912828V80* Moodys Rating: Aaa	99,895.00 99.8950	0.00 0.00	4.8 2.25	2,250.00
100,000.000	U S Treasury Note 1.750 06/30/2024 *9128286Z8* Standard & Poors Rating: N/A Moodys Rating: Aaa	98,555.00 98.5550	0.00 0.00	4.7 1.78	1,750.00
400,000.000	U S Treasury Note 0.375 04/30/2025 *912828ZL7* Standard & Poors Rating: N/A Moodys Rating: Aaa	374,548.00 93.6370	196,132.81 49.03	17.9 .40	1,500.00

ACCOUNT NUMBER: 246912001
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

POST CLOSURE FUND

This statement is for the period from March 1, 2022 to March 31, 2022

ASSET DETAIL AS OF 03/31/22 (continued)

Shares or Face Amount	*Security Description*	Market Value/ Price	Tax Cost/ Unit Cost	% of Total Yield at Market	Est Ann Inc
400,000.000	U S Treasury Note 0.875 09/30/2026 *91282CCZ2* Standard & Poors Rating: N/A Moodys Rating: Aaa	372,328.00 93.0820	393,953.13 98.49	17.8 .94	3,500.00
300,000.000	U S Treasury Note 1.250 11/30/2026 *91282CDK4* Standard & Poors Rating: N/A Moodys Rating: Aaa	283,839.00 94.6130	301,335.94 100.45	13.6 1.32	3,750.00
Total US Government Issues		**$2,032,486.00**	**$891,421.88**	**97.4**	**$30,062.50**
Total Assets		**$2,086,344.19**	**$945,280.07**	**100.0**	**$30,067.89**

ASSET DETAIL MESSAGES

Time of trade execution and trading party (if not disclosed) will be provided upon request.

Publicly traded assets are valued in accordance with market quotations or valuation methodologies from financial industry services believed by us to be reliable. Assets that are not publicly traded may be reflected at values from other external sources. Assets for which a current value is not available may be reflected at a previous value or as not valued, at par value, or at a nominal value. Values shown do not necessarily reflect prices at which assets could be bought or sold. Values are updated based on internal policy and may be updated less frequently than statement generation.

For further information, please contact your Analyst.

Yield at Market and Estimated Annual Income are estimates provided for informational purposes only and should not be relied on for making investment, trading, or tax decisions. The estimates may not represent the actual value earned by your investments and they provide no guarantee of what your investments may earn in the future.

ACCOUNT NUMBER: 246912001
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

POST CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

CASH SUMMARY

	Income Cash	Principal Cash	Total Cash
Beginning Cash Balance as of 03/01/2022	**$.00**	**$.00**	**$.00**
Taxable Interest	1,750.39		1,750.39
Transfers	- 1,750.39	1,750.39	
Net Money Market Activity		- 1,750.39	- 1,750.39
Ending Cash Balance as of 03/31/2022	**$0.00**	**$0.00**	**$0.00**

ACCOUNT NUMBER: 246912001
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

POST CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

TRANSACTION DETAIL

Date Posted	Description	Income Cash	Principal Cash	Tax Cost
	Beginning Balance 03/01/2022	**$.00**	**$.00**	**$943,529.68**
03/01/22	Interest Earned On Fidelity Govt Port Cl III Interest From 2/1/22 To 2/28/22 316175603	0.39		
03/02/22	Cash Disbursement Transfer To Principal 1	- 0.39		
03/02/22	Cash Receipt Transfer From Income 1		0.39	
03/02/22	Purchased 0.39 Units Of Fidelity Govt Port Cl III Trade Date 3/2/22 316175603		- 0.39	0.39
03/31/22	Interest Earned On U S Treasury Nt 0.875% 9/30/26 0.004375 USD/$1 Pv On 400,000 Par Value Due 3/31/22 91282CCZ2	1,750.00		
03/31/22	Cash Disbursement Transfer To Principal 1	- 1,750.00		
03/31/22	Cash Receipt Transfer From Income 1		1,750.00	
03/31/22	Purchased 1,750 Units Of Fidelity Govt Port Cl III Trade Date 3/31/22 316175603		- 1,750.00	1,750.00
	Ending Balance 03/31/2022	**$0.00**	**$0.00**	**$945,280.07**

ACCOUNT NUMBER: 246912001
RIVERBEND LANDFILL CO.
OREGON DEQ
TRUST AGREEMENT DATED 9-25-2020

POST CLOSURE FUND

This statement is for the period from
March 1, 2022 to March 31, 2022

BOND SUMMARY

	Par Value	Market Value	% of Category
MATURITY			
2022	450,000.00	450,593.50	22.17
2023	350,000.00	352,727.50	17.36
2024	200,000.00	198,450.00	9.77
2025	400,000.00	374,548.00	18.42
2026	700,000.00	656,167.00	32.28
Total of Category	**$2,100,000.00**	**$2,032,486.00**	**100.00**
MOODY'S RATING			
Aaa	2,100,000.00	2,032,486.00	100.00
Total of Category	**$2,100,000.00**	**$2,032,486.00**	**100.00**
S&P RATING			
AA+	250,000.00	250,047.50	12.30
N/A	1,750,000.00	1,682,543.50	82.78
NOT RATED	100,000.00	99,895.00	4.92
Total of Category	**$2,100,000.00**	**$2,032,486.00**	**100.00**

BOND SUMMARY MESSAGES

Data contained within this section excluded Mutual Funds, Exchange Traded Funds, and Closed-Ended Funds.

Glossary

Accretion - The accumulation of the value of a discounted bond until maturity.
Adjusted Prior Market Realized Gain/Loss - The difference between the proceeds and the Prior Market Value of the transaction.
Adjusted Prior Market Unrealized Gain/Loss - The difference between the Market Value and the Adjusted Prior Market Value.
Adjusted Prior Market Value - A figure calculated using the beginning Market Value for the fiscal year, adjusted for all asset related transactions during the period, employing an average cost methodology.
Amortization - The decrease in value of a premium bond until maturity.
Asset - Anything owned that has commercial exchange value. Assets may consist of specific property or of claims against others, in contrast to obligations due to others (liabilities).
Bond Rating - A measurement of a bond's quality based upon the issuer's financial condition. Ratings are assigned by independent rating services, such as Moody's, or S&P, and reflect their opinion of the issuer's ability to meet the scheduled interest and principal repayments for the bond.
Cash - Cash activity that includes both income and principal cash categories.
Change in Unrealized Gain/Loss - Also reported as Gain/Loss in Period in the Asset Detail section. This figure shows the market appreciation (depreciation) for the current period.
Cost Basis (Book Value) - The original price of an asset, normally the purchase price or appraised value at the time of acquisition. Book Value method maintains an average cost for each asset.
Cost Basis (Tax Basis) - The original price of an asset, normally the purchase price or appraised value at the time of acquisition. Tax Basis uses client determined methods such as Last-In-First-Out (LIFO), First-In-First-Out (FIFO), Average, Minimum Gain, and Maximum Gain.
Ending Accrual - (Also reported as Accrued Income) Income earned but not yet received, or expenses incurred but not yet paid, as of the end of the reporting period.
Estimated Annual Income - The amount of income a particular asset is anticipated to earn over the next year. The shares multiplied by annual income rate.
Estimated Current Yield - The annual rate of return on an investment expressed as a percentage. For stocks, yield is calculated by taking the annual dividend payments divided by the stock's current share price. For bonds, yield is calculated by the coupon rate divided by the bond's market price.
Ex-Dividend Date - (Also reported as Ex-Date) For stock trades, the person who owns the security on the ex-dividend date will earn the dividend, regardless of who currently owns the stock.
Income Cash - A category of cash comprised of ordinary earnings derived from investments, usually dividends and interest.
Market Value - The price per unit multiplied by the number of units.
Maturity Date - The date on which an obligation or note matures.
Payable Date - The date on which a dividend, mutual fund distribution, or interest on a bond will be made.
Principal Cash - A category of cash comprised of cash, deposits, cash withdrawals and the cash flows generated from purchases or sales of investments.
Realized Gain/Loss Calculation - The Proceeds less the Cost Basis of a transaction.
Settlement Date - The date on which a trade settles and cash or securities are credited or debited to the account.
Trade Date - The date a trade is legally entered into.
Unrealized Gain/Loss - The difference between the Market Value and Cost Basis at the end of the current period.
Yield on/at Market - The annual rate of return on an investment expressed as a percentage. For stocks, yield is calculated by the annual dividend payments divided by the stock's current share price. For bonds, yield is calculated by the coupon rate divided by the bond's market price.

The terms defined in this glossary are only for use when reviewing your account statement. Please contact your Relationship Manager with any questions.

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WM TREASURY DEPARTMENT
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HOUSTON, TX 77002

ENCLOSURE 4

CLOSURE AND POST-CLOSURE PLAN

RIVERBEND LANDFILL

MCMINNVILLE, OREGON

UPDATED APRIL 2022

PREPARED FOR

RIVERBEND LANDFILL CO.
13469 SW HIGHWAY 18
MCMINNVILLE, OREGON 97128

PLAN AND COST ESTIMATE UPDATED BY (2022)

RIVERBEND LANDFILL CO.
13469 SW HIGHWAY 18
MCMINNVILLE, OREGON 97128

COST ESTIMATE UPDATE CHECKED BY (2022)

VISTA GEOENVIRONMENTAL SERVICES
P.O. BOX 388
LAKE OSWEGO, OREGON 97034

UPDATE CERTIFICATION (Sections Listed Below)

The material and data updated in the sections of this plan and contained in this report were prepared under the supervision and direction of the undersigned (WM). To the best of my knowledge, the cost estimates contained herein are complete and accurate.

- Section 1.3.4 – Updated Implicit Price Deflator calculation for 2022 dollars
- Section 2.4 – Updated maximum inventory of waste through January 2022
- Section 2.5 – Updated the per acre Closure Cost value
- Section 3.3 – Updated the Post-Closure cost summary
- Appendix A – Updated Worst Case Closure Area figure
- Appendix B – Cost Estimate and relevant references

04/26/2022

Melody A. Adams, PNW/BC Area Project Manager
WM

Date

I certify that the update to the cost estimates for inflation were prepared accurately and in accordance with the Oregon Department of Environmental Quality's guidelines for preparation of financial assurance cost estimates.

04/27/2022

Roger North PE, GE / Principal
Vista GeoEnvironmental Services

Date

TABLE OF CONTENTS

ACRONYMS AND ABBREVIATIONS

CE	Cost estimate
CFR	Code of Federal Regulations
cm/sec	Centimeters per second
CPCP	Closure and Post-Closure Plan
CV	Current value
CY	Cubic yard(s)
DEQ	Oregon Department of Environmental Quality
FESCPP	2017 Final Engineered Site Closure and Post-Closure Plan
GCCS	Gas collection and control system
HDR	HDR Engineering, Inc.
IPD	Implicit Price Deflator
LFG	Landfill gas
LFGTE	Landfill Gas to Energy
MSWLF	Municipal solid waste landfill
OAR	Oregon Administrative Rules
ORS	Oregon Revised Statutes
P.E.	Professional Engineer
RB	Required trust fund balance
RLC	Riverbend Landfill Co.
RL	Riverbend Landfill
§	Section
SWDP	Solid Waste Disposal Permit
SWMS	Stormwater Management System
WM	WM (formerly Waste Management)
Y	Year(s)

1 INTRODUCTION

2022 UPDATE

Since the 2021 update of the Closure and Post-Closure Plan there have been no substantial changes in site development. The following sections were updated by WM in 2022 then reviewed and certified by Vista GeoEnvironmental Services (Vista):

- Section 1.3.4 – Updated Implicit Price Deflator calculation for 2022 dollars
- Section 2.4 – Updated maximum inventory of waste through January 2022
- Section 2.5 – Updated the per acre Closure Cost value
- Section 3.3 – Updated the Post-Closure cost summary
- Appendix A – Updated Worst Case Closure Area figure
- Appendix B – Updated Cost Estimates and relevant references

1.1 BACKGROUND

Riverbend Landfill (RL) is located at 13469 S.W. Highway 18, McMinnville, in Yamhill County, Oregon, and is owned and operated by the Riverbend Landfill Co. (RLC), which is an operating subsidiary of WM[1]. RL is a municipal solid waste landfill (MSWLF) that is regulated by the Oregon Department of Environmental Quality (DEQ) under the Code of Federal Regulations (CFR) Chapter 40, Section 258 (Criteria for Municipal Solid Waste Landfills), Oregon Revised Statutes (ORS) 459 (Solid Waste Management), and Oregon Administrative Rules (OAR) 340-094 (Solid Waste: Municipal Solid Waste Landfills). DEQ issued RLC (the permittee) solid waste disposal permit (SWDP) number 345 for RL on December 1, 1999. This permit has been administratively extended by DEQ in compliance with OAR 340-093 0070(6)(b)(C) since its expiry date of December 1, 2009. Addendum No. 4 to SWDP 345 was issued on December 12, 2012. A final grading plan modification proposal was submitted to DEQ for review and was subsequently approved in a letter dated June 29, 2017.

This Closure and Post-Closure Plan (CPCP) has been prepared to comply with the requirements for closure and post-closure activities and associated financial assurance criteria as specified in ORS 459.272 and OAR 340-94-100 through 145.

ORS 459.272 (Evidence of financial assurance for land disposal site) requires:

> *(3) The owner or operator of a land disposal site shall annually review and update the financial assurance for closure, post-closure and corrective action required under this section and cost estimates of the amount of financial assurance necessary.*

[1] In 2021 Waste Management rebranded to WM. This change will be reflected throughout this updated document.

Specifically, OAR 340-94-140(6)(e) requires the permittee to update the CPCP annually, as follows:

> *(e) Annual update. The permittee shall annually review and update the financial assurance during the operating life and post-closure care period, or until the corrective action is completed, as applicable.*
>
> > *(A) The annual review shall include:*
> >
> > > *(i) An adjustment to the cost estimate(s) for inflation and, if used, in the discount rate as specified in subsection (4)(a) of this rule;*
> > >
> > > *(ii) A review of the closure, post-closure care and corrective action (if required) plans and facility conditions to assess whether any changes have occurred which would increase or decrease the estimated maximum costs of closure, post-closure care or corrective action since the previous review;*
> > >
> > > *(iii) If a trust fund or other pay-in financial mechanism is being used, an accounting of amounts deposited and expenses drawn from the fund, as well as its current balance.*
> >
> > *(B) The financial assurance mechanism(s) shall be increased or may be reduced to take into consideration any adjustments in cost estimates identified in the annual review;*
> >
> > *(C) The annual update shall consist of a certification from the permittee submitted to the Department and placed in the facility operating record. The certification shall state that the financial assurance plan(s) and financial assurance mechanism(s) have been reviewed, updated and found adequate, and that the updated documents have been placed in the facility operating record. If a discount rate is used to estimate costs, the annual update shall include the certifications in subsection (6)(d) of this rule. The annual update shall be no later than:*
> >
> > > *(i) The facility's annual review date; or*
> > >
> > > *(ii) For a facility operating under a closure permit, by the date specified in OAR 340-094-0100(3).*

And, OAR 340-94-140(6)(d) requires:

> *(d) If a permittee uses a discount rate to estimate costs pursuant to subsection (4)(a) of this rule, the permittee shall prospectively for each year the discount rate is used:*
>
> > *(A) Certify to the Director that the landfill closure date is certain and there are no foreseeable factors that will change the estimate of site life; and*
> >
> > *(B) Submit a certification to the Director from a Registered Professional Engineer stating the cost estimates are complete and accurate.*

The SWDP requires that the annual review be performed by April 8th each year. This report provides the 2022 review and update of the CPCP and associated cost estimates. An extension request was submitted and granted moving the submission deadline to April 29th. Copies of the correspondence is included in Appendix B.

1.2 JUSTIFICATION FOR PREPARING SUBTITLE D PLANS

OAR 340-94-110(1) and OAR 340-94-115(1) establish two different categories of CPCPs:

1. **Subtitle D ("worst-case") CPCPs.** These are based on a hypothetical worst-case scenario for closure and post-closure costs. This worst-case scenario is intended to establish a conservative basis for estimating financial assurance funding requirements, and subsequently, a Final Engineered Site Closure Plan, as required by OAR 340-094-0100(2)(a), which shall include all the elements of and replace the "worst-case" closure plan. The “worst-case” closure plan drawing was prepared by Bullseye Design and is provided in Appendix A. The drawing incorporates the approved final grading plan modifications and includes the area of final cover that was repaired in 2020. No additional capping events took place since 2020.
2. **Final engineered CPCPs.** These are linked to a closure permit, which must be obtained at least five years prior to anticipated final closure, or at a date specified in the permittee's closure permit pursuant to OAR 340-094-0100(2)(a). The final engineered plans must reflect the intended closure design and will replace the Subtitle D ("worst-case") plans. A closure permit is currently being drafted for this facility but has not been issued.

Although the 2017 Final Engineered Site Closure and Post-Closure Plan (FESCPP) submitted by Geosyntec in November 2017 was prepared for RL due to the limitations of the currently permitted airspace remaining, final closure of RL is not anticipated to take place in the next five years based on the following:

- RLC received an expansion on May 30, 2013 for the RL which increased the site’s permitted airspace by 984,086 cubic yards (cy) and increased the area of the landfill to a total footprint of approximately 87.4 acres of the 700-plus acre property. A final grading plan modification was approved by DEQ in a letter dated June 29, 2017, which increased the landfill’s airspace by approximately 490,000 cy. As of July 1, 2021 the site discontinued placing MSW at the facility and transitioned to metering in materials and/or disposal of approved solid waste projects to prioritize the structural needs of the site.
- Remaining permitted capacity for the site as of January 1, 2022 is approximately 478,000 cy which includes all available permitted airspace including areas of settlement. The remaining airspace is expected to be filled in a timeframe contingent on available project volumes and as projects arise.

Therefore, since it is anticipated that more than five years of capacity remain, Subtitle D ("worst-case") CPCP is appropriate at this time.

Consistent with the above, the current worst-case closure scenario is shown on the figure provided in **Appendix A**. The remaining developed area that would require closure under a worst-case scenario is approximately 59.5 acres.

1.3 FINANCIAL ASSURANCE REQUIREMENTS

1.3.1 FEDERAL REQUIREMENTS FOR CLOSURE

Federal closure requirements are contained in 40 CFR 258.71:

> *(a) The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to close the largest area of all MSWLF units ever requiring a final cover as required under §258.60 at any time during the active life in accordance with the closure plan. The owner or operator must notify the State Director that the estimate has been placed in the operating record.*
>
> > *(1) The cost estimate must equal the cost of closing the largest area of all MSWLF units ever requiring a final cover at any time during the active life when the extent and manner of its operation would make closure the most expensive, as indicated by its closure plan (see §258.60(c)(2) of this part).*
> >
> > *(2) During the active life of the MSWLF unit, the owner or operator must annually adjust the post-closure cost estimate for inflation.*
> >
> > *(3) The owner or operator must increase the closure care cost estimate and the amount of financial assurance provided under paragraph (b) of this section if changes to the closure plan or MSWLF unit conditions increase the maximum cost of closure at any time during the remaining active life.*
> >
> > *(4) The owner or operator may reduce the closure cost estimate and the amount of financial assurance provided under paragraph (b) of this section if the cost estimate exceeds the maximum cost of closure care remaining at any time during the remaining active life of the MSWLF unit. The owner or operator must notify the State Director that the justification for the reduction of the closure cost estimate and the amount of financial assurance has been placed in the operating record.*

1.3.2 FEDERAL REQUIREMENTS FOR POST-CLOSURE CARE

Federal financial assurance requirements for post-closure care are specified in 40 CFR 258.72, as follows:

> *(a) The owner or operator must have a detailed written estimate, in current dollars, of the cost of hiring a third party to conduct post-closure care for the MSWLF unit in compliance with the post-closure plan developed under §258.61 of this part. The post-closure cost estimate used to*

demonstrate financial assurance in paragraph (b) of this section must account for the total costs of conducting post-closure care, including annual and periodic costs as described in the post-closure plan over the entire post-closure care period. The owner or operator must notify the State Director that the estimate has been placed in the operating record.

(1) The cost estimate for post-closure care must be based on the most expensive costs of post-closure care during the post-closure care period.

(2) During the active life of the MSWLF unit and during the post-closure care period, the owner or operator must annually adjust the post-closure cost estimate for inflation.

(3) The owner or operator must increase the post-closure care cost estimate and the amount of financial assurance provided under paragraph (b) of this section if changes in the post-closure plan or MSWLF unit conditions increase the maximum costs of post-closure care.

(4) The owner or operator may reduce the post-closure cost estimate and the amount of financial assurance provided under paragraph (b) of this section if the cost estimate exceeds the maximum costs of post-closure care remaining over the post-closure care period. The owner or operator must notify the State Director that the justification for the reduction of the post-closure cost estimate and the amount of financial assurance has been placed in the operating record.

1.3.3 Oregon Specific Requirements for Closure and Post-Closure Care

Oregon adopts the federal requirements described above, and has additional Financial Assurance Criteria stipulated in OAR 340-94-140:

(1) Financial Assurance Required. The owner or operator of a municipal solid waste landfill shall maintain a financial assurance plan with detailed written cost estimates of the amount of financial assurance that is necessary and shall provide evidence of financial assurance for the costs of:

(a) Closure of the municipal solid waste landfill;

(b) Post-closure maintenance of the municipal solid waste landfill; and

(c) Any corrective action required by the Department to be taken at the municipal solid waste landfill, pursuant to OAR 340-094-0080(3).

(4) Financial assurance plans. The financial assurance plan is a vehicle for determining the amount of financial assurance necessary and demonstrating that financial assurance is being provided. A financial assurance plan shall include but not be limited to the following, as applicable:

(a) Cost Estimates. A detailed written estimate of the third-party costs in current dollars according to the provisions of 40 CFR, §258.75. A landfill owner or operator meeting the

criteria in 40 CFR §258.75 (a) through (c) may estimate the current dollar cost using a discount rate no greater than the Department's current reference rate. The Department shall determine the reference rate annually during the month of June. It shall be in effect for the fiscal year beginning on the first day of July immediately following the determination date and ending on June 30 of the following calendar year. (The reference rate shall be based on the current yield of composite long-term U.S. Treasury Bonds as published in the Federal Reserve's H.15 (519) Selected Interest Rates for the first full week of the month in which the reference rate is determined, less the annualized Gross Domestic Product implicit price deflator as published in the most recent U.S. Bureau of Economic Analysis Survey of Current Business). The written estimate shall be prepared by a Registered Professional Engineer and shall include costs of:

(A) Closing the municipal solid waste landfill;

(B) Providing post-closure care, including installing, operating and maintaining any environmental control system required on the landfill site;

(C) Performing required corrective action activities; and

(D) Complying with any other requirement the Department may impose as a condition of issuing a closure permit, closing the site, maintaining a closed facility, or implementing corrective action.

(b) The source of the cost estimates;

(c) A detailed description of the form of the financial assurance and a copy of the financial assurance mechanism;

(d) A method and schedule for providing for or accumulating any required amount of funds which may be necessary to meet the financial assurance requirement;

(5) Amount of Financial Assurance Required. The amount of financial assurance required shall be established as follows:

(a) Closure. Detailed cost estimates for closure shall be based on the "worst-case" closure plan or the Final Engineered Site Closure Plan, as applicable. Cost estimates for the Final Engineered Site Closure Plan shall take into consideration at least the following:

(A) Amount and type of solid waste deposited in the site;

(B) Amount and type of buffer from adjacent land and from drinking water sources;

(C) Amount, type, availability and cost of required cover;

(D) Seeding, grading, erosion control and surface water diversion required;

(E) Planned future use of the disposal site property;

(F) The portion of the site property closed before final closure of the entire site; and

(G) Any other conditions imposed on the permit relating to closure of the site.

(b) Post-closure care. Detailed cost estimates for post-closure care shall be based on the "Subtitle D" post-closure plan or the Final Engineered Post-closure Plan, as applicable. Cost estimates for the Final Engineered Post-closure Plan shall also take into consideration at least the following:

(A) Type, duration of use, initial cost and maintenance cost of any active system necessary for controlling or stopping discharges; and

(B) Any other conditions imposed on the permit relating to post-closure care of the site.

(c) Corrective action. Estimated total costs of required corrective action activities for the entire corrective action period, as described in a corrective action report pursuant to requirements of OAR 340-094-0080(3) and 40 CFR, §258.73;

(d) If a permittee is responsible for providing financial assurance for closure, post-closure care and/or corrective action activities at more than one municipal solid waste landfill, the amount of financial assurance required is equal to the sum of all cost estimates for each activity at each facility.

1.3.4 2022 UPDATE

As noted above, DEQ allows cost estimates to be computed based on the prior year costs adjusted using a quotient derived from Implicit Price Deflator (IPD) values. IPD values are published by the Department of Commerce, Bureau of Economic Analysis on a quarterly basis. The IPD values relevant to this report are presented in **Attachment 1 of Appendix B**, and are as follows:

- For cost estimates obtained for 2013:
  - IPD for January 2013 (i.e., 1st quarter 2013), the date of the prior cost estimate = 101.141;
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of this cost estimate = 122.015;
  - The resulting quotient = 122.015/101.141 = 1.2064.
- For cost estimates obtained for 2014:
  - IPD for January 2014 (i.e., 1st quarter 2014), the date of the prior cost estimate = 102.942;
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of this cost estimate = 122.015;
  - The resulting quotient = 122.015/102.942 = 1.1853.
- For cost estimates obtained for 2015:
  - IPD for January 2015 (i.e., 1st quarter 2015), the date of the prior cost estimate = 104.113;
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of this cost estimate = 122.015;
  - The resulting quotient = 122.015 /104.113 = 1.1719.

- For cost estimates obtained for 2016:
  - IPD for January 2016 (i.e., 1st quarter 2016), the date of the prior cost estimate = 104.895;
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of this cost estimate = 122.015;
  - The resulting quotient = 122.015/104.895 = 1.1632.
- For cost estimates obtained for July 2017:
  - IPD for July 2017 (i.e., 3rd quarter 2017), the date of the prior cost estimate = 107.903;
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of this cost estimate = 122.015;
  - The resulting quotient = 122.015/107.903 = 1.1308.
- For cost estimates obtained for October 2017:
  - IPD for October 2017 (i.e., 4th quarter 2017), the date of the prior cost estimate = 108.670;
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of this cost estimate = 122.015;
  - The resulting quotient = 122.015/108.670 = 1.1228.
- For cost estimates obtained for 2018:
  - IPD for March 2018 (i.e., 1st quarter 2018), the date of the prior cost estimate = 109.261;
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of this cost estimate = 122.015;
  - The resulting quotient = 122.015/ 109.261 = 1.1167.
- For cost estimates obtained for 2022:
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of the prior cost estimate = 122.015;
  - IPD for March 2022 (i.e., 1st quarter 2022), the date of this cost estimate = 122.015;
  - The resulting quotient = 122.015 / 122.015 = 1.000.

Since 2012, RLC has hauled leachate off-site for treatment and disposal. It is assumed that this will continue under closure and post-closure conditions. The volume of leachate that will be generated will decrease over time following closure and the installation of a geomembrane-based cover system over the entire landfill. To develop appropriate post-closure costs for leachate management and treatment, RLC used recent average annual leachate quantities provided by the site management and reduced the annual quantity at closure over time at a rate that was based on the previous 2013 post-closure estimate.

1.4 PLAN ORGANIZATION

RL recently reached the point in its operational life requiring the final engineered CPCPs to be prepared, after coming within five years of anticipated remaining capacity; however, expansions have increased the remaining of the capacity of the landfill beyond five years (**Section 1.2**). Furthermore, the site is not subject to any form of corrective action. Therefore, the remainder of this plan presents those elements associated with the required Subtitle D ("worst-case") plans.

Section 2 presents closure requirements, the Subtitle D Closure Plan, and the estimated "worst-case" closure costs;

Section 3 presents post-closure requirements, the Subtitle D Post-Closure Plan, and the estimate of the "worst-case" post-closure costs; and

Section 4 presents details of allowable financial assurance mechanisms to fund the worst-case closure and post-closure costs, and the corresponding mechanisms selected by RLC.

2 CLOSURE PLAN

2.1 CLOSURE REQUIREMENTS

2.1.1 FEDERAL REQUIREMENTS

Federal closure requirements are contained in 40 CFR 258.60(a)-(b):

(a) Owners or operators of all MSWLF units must install a final cover system that is designed to minimize infiltration and erosion. The final cover system must be designed and constructed to:

(1) Have a permeability less than or equal to the permeability of any bottom liner system or natural subsoils present, or a permeability no greater than 1 x 10^{-5}cm/sec, whichever is less, and

(2) Minimize infiltration through the closed MSWLF by the use of an infiltration layer that contains a minimum 18-inches of earthen material, and

(3) Minimize erosion of the final cover by the use of an erosion layer that contains a minimum 6-inches of earthen material that is capable of sustaining native plant growth.

(b) The Director of an approved State may approve an alternative final cover design.

2.1.2 OREGON-SPECIFIC REQUIREMENTS

Oregon adopts the above federal requirements, and has additional closure requirements stipulated in OAR 340-94-0110(2):

(2) Requirements for closure plans. A closure plan shall specify the procedures necessary to completely close the municipal solid waste landfill at the end of its intended operating life.

(a) Requirements for the "worst-case" closure plan shall include all elements specified in 40 CFR §258.60, and consist of at least the following:

(A) A description of the steps necessary to close all municipal solid waste landfill units at any point during their active life;

(B) A description of the final cover system that is designed to minimize infiltration and erosion;

(C) An estimate of the largest area of the municipal solid waste landfill unit ever requiring a final cover;

(D) An estimate of the maximum inventory of wastes ever on-site over the active life of the landfill facility; and

(E) A schedule for completing all activities necessary to satisfy the closure criteria in 40 CFR §258.60.

And in OAR 340-94-0120(2):

(2) Unless otherwise approved or required in writing by the Department, no person shall permanently close or abandon a municipal solid waste landfill, except in the following manner:

(a) All areas containing solid waste not already closed in a manner approved by the Department shall be covered with at least three feet of compacted soil of a type approved by the Department graded to a minimum two percent and maximum 30 percent slope unless the Department authorizes a lesser depth or an alternative final cover design. In applying this standard, the Department will consider the potential for adverse impact from the disposal site on public health, safety or the environment, and the ability for the permittee to generate the funds necessary to comply with this standard before the disposal site closes. A permittee may request that the Department approve a lesser depth of cover material or an alternative final cover design based on the type of waste, climate, geological setting, degree of environmental impact;

(b) Final cover material shall be applied to each portion of a municipal solid waste landfill within 60 days after said portion reaches approved maximum fill elevation, except in the event of inclement weather, in which case final cover shall be applied as soon as practicable;

(c) The finished surface of the closed areas shall consist of soils of a type or types consistent with the planned future use and approved by the Department. Unless otherwise approved by the Department, a vegetative cover of native grasses shall be promptly established over the finished surface of the closed site;

(d) All surface water must be diverted around the area of the disposal site used for waste disposal or in some other way prevented from contacting the waste material;

(e) All systems required by the Department to control or contain discharges to the environment must be completed and operational.

2.2 CLOSURE COMPONENTS

The anticipated closure design for the remainder of the landfill is based on the most recently approved and constructed closure areas. Under the "worst-case" scenario the same components and concepts would be used.

Key components of the closure design are described in the subsections below and the worst-case closure area is shown in **Appendix A**. The design satisfies the federal and state requirements presented in **Section 2.1** above; in doing so the closure design is intended to minimize the need for ongoing maintenance, minimize potential landfill gas (LFG) and leachate generation, verify that environmental protection systems continue to function as intended, and to prepare the site for long-term care during the post-closure period.

2.2.1 Final Grading

In conformance with the final cover design, prior to constructing the final cover the landfill surface will be graded to:

- A maximum slope of 3 horizontally (H) to 1 vertically (V) or flatter; and
- A minimum slope of 2 percent.

The existing access road, which has been constructed above the previously closed area, will be continued into the required closure areas to provide post-closure access.

2.2.2 Final Cover Components

The final cover consists of the following major components, in order from bottom to top:

- **Foundation Soil Layer**: a 12-inch thick foundation soil layer placed on top of the 6-inch thick layer of daily cover, for a total of 18 inches of foundation soil (the 18-inch thick intermediate soil cover layer placed by RLC during landfill operations has satisfied the requirements for this layer in closed areas and may be satisfactory for future closure areas);
- **Geomembrane Barrier**: a 60-mil thick polyethylene geomembrane with ridges on one side and studs on the other; manufactured by Agru America;
- **Geosynthetic Drainage Layer**: a geotextile placed over the studded surface of the geomembrane creates a drainage channel between the geomembrane and the geotextile;
- **Drainage Layer Piping**: collection pipes placed in or on the drainage layer to reduce seepage forces in the final cover soils and maintain cover system stability;
- **Vegetative Soil Layer**: an 18-inch thick soil layer, the top 6 inches of which is capable of supporting vegetation; and
- **Vegetation**: vegetation planted on the cover.

2.2.3 Landfill Gas (LFG) System Components

The LFG collection and control system (GCCS) components will consist of the following:

- Vertical LFG collection wells;
- Well-head assemblies to allow for the conditions at each LFG collection well to be monitored (well pressure, and LFG quality and quantity) and the LFG flow rate to be controlled;

- LFG laterals connecting the LFG collection wells and well head assemblies to the main LFG headers;
- LFG headers connecting the laterals to the LFG to Energy (LFGTE) facility and flare station;
- LFGTE and LFG flare station; and
- Condensate collection and control system.

Most components of the GCCS have been progressively designed and constructed during the operation of the landfill. The components required for a "worst-case" closure include:

- LFG collection wells;
- Well-head assemblies; and
- LFG laterals.

2.2.4 Leachate Management System Components

The leachate management system will remain in operation during closure of the RL. No major modifications to the leachate management system are anticipated.

2.2.5 Permanent Stormwater Management System Components

The stormwater management system (SWMS) components required for additional areas of final cover include the following:

- Ditches located on, or around the perimeter of, the final cover;
- Culverts, headwalls, splash walls, water quality units, and drop inlets, where necessary;
- Lined conveyance downdrains constructed on the final cover surface; and
- Vegetation.

The FESCPP includes information for the permanent SWMS. Prior to closure construction, recommendations presented in the FESCPP will be revisited for the permanent SWMS, including the basis of design and the verification of existing conditions. The design will be revised as needed at the time of closure to comply with existing conditions and future goals for the site.

2.3 LARGEST AREA REQUIRING CLOSURE

As presented in **Section 1.2**, the largest area requiring final cover (i.e., "worst-case" closure scenario) is the current condition, which would require approximately 59.5 acres of closure.

2.4 MAXIMUM INVENTORY OF WASTE

Disposal records indicate that approximately 12,603,820 cy of waste[2] have been disposed at RL as of January 1, 2022. The estimated remaining available permitted airspace capacity, including all areas of settlement, as of January 1, 2022, is approximately 395,400 cy (see also **Section 1.2**).

2.5 CLOSURE COST ESTIMATE

Closure components discussed above are itemized in the "worst-case" closure cost estimate presented in **Appendix B**. Individual items are summarized in the following categories:

- Earthwork;
- Geosynthetics;
- Stormwater Management System;
- Temporary and Permanent Erosion Controls;
- LFG Management System;
- Water Monitoring System;
- Construction Quality Assurance, Engineering, Surveying and Other Professional Services; and
- Miscellaneous.

The following "worst-case" assumptions were made, or information used, in development of the closure cost estimate:

- The largest area requiring closure is the 59.5 acres of developed landfill area that have not been closed;
- Unit costs, adjusted for inflation, from previous closure work performed at the site;
- Available third-party pricing; and
- Professional engineering judgment of current costs.

The current worst-case closure cost estimate of $10,542,666 is detailed in **Appendix B.** This equates to a cost of approximately $177,188 per acre.

[2] Permitted volume is determined by comparing the baseliner to the top of waste (which is 3 feet below top of final cover layer). This volume does not take into account compaction or settlement of waste over time. As material is compacted through operations or settlement, the effective available volume increases allowing for additional material placement within the permitted airspace.

2.6 SCHEDULE OF CLOSURE ACTIVITIES

Pursuant to OAR 340-94-110(2)(a)(A), this section presents a general schedule of activities necessary to close the landfill at any point during its active life.

Preparation of Engineered Closure Plan. A "worst-case" closure would require the preparation of a final engineered closure plan based on the actual conditions at the time of closure. The final engineered closure plan would include design modifications, construction plans and specifications, and would be submitted to DEQ for review and approval. It is estimated that the design, review and approval process would take five months.

Preparatory Grading. Under a "worst-case" scenario, the configuration of waste may not be compatible with closure design requirements. For example, waste slopes may not be graded flat enough or steep enough to meet closure design requirements relative to surface water drainage, cover stability, waste stability, and anticipated settlements. Therefore, time may be required for placing or regrading waste or soil to an acceptable closure configuration. It is assumed this preparatory grading would take approximately two months.

Contractor Selection. Following DEQ approval of the final engineered closure plan, contract documents, including detailed plans and specifications, would be issued for bid to select a contractor to perform the closure construction. This process of contractor selection and contract execution is expected to take two months.

Closure Construction. Construction will begin following contractor selection and contract execution. However, construction will be weather-dependent because most construction activities can effectively only be performed between June and October. Therefore, depending on the timing of the preceding activities, there could be a discontinuity before construction can start. Construction itself is expected to take six months (or 180 calendar days).

Preparation of Construction Report. After construction, a third-party professional engineer registered in the state of Oregon will prepare a report documenting that closure construction complied with the approved final engineered closure plan. It is estimated that approximately six weeks will be required to prepare this report prior to submittal to DEQ for review and approval of the closure.

DEQ Inspection. Pursuant to OAR 340-94-120(4)(b), and within 30 days of receipt of the closure report requesting approval of the closure, DEQ shall inspect the facility to verify that closure has been completed consistent with the approved final engineered closure design and the provisions of OAR 340-93 and -94. If DEQ determines that closure has been properly completed, it will approve the closure in writing; closure will not be considered complete until such approval has been made. The date of the approval notice will also represent the date of commencement of the post-closure period.

3 POST-CLOSURE PLAN

3.1 POST-CLOSURE PLAN REQUIREMENTS

3.1.1 FEDERAL REQUIREMENTS

Federal post-closure plan requirements are specified in 40 CFR §258.61(a)-(c) and are provided below:

> *(a) Following closure of each MSWLF unit, the owner or operator must conduct post-closure care. Post-closure care must be conducted for 30 years, except as provided under paragraph (b) of this section, and consist of at least the following:*
>
> > *(1) Maintaining the integrity and effectiveness of any final cover, including making repairs to the cover as necessary to correct the effects of settlement, subsidence, erosion, or other events, and preventing run-on and run-off from eroding or otherwise damaging the final cover;*
> >
> > *(2) Maintaining and operating the leachate collection system in accordance with the requirements in §258.40, if applicable. The Director of an approved State may allow the owner or operator to stop managing leachate if the owner or operator demonstrates that leachate no longer poses a threat to human health and the environment;*
> >
> > *(3) Monitoring the ground water in accordance with the requirements of subpart E of this part and maintaining the ground-water monitoring system, if applicable; and*
> >
> > *(4) Maintaining and operating the gas monitoring system in accordance with the requirements of §258.23.*
>
> *(c) The owner or operator of all MSWLF units must prepare a written post-closure plan that includes, at a minimum, the following information:*
>
> > *(1) A description of the monitoring and maintenance activities required in §258.61(a) for each MSWLF unit, and the frequency at which these activities will be performed;*
> >
> > *(2) Name, address, and telephone number of the person or office to contact about the facility during the post-closure period; and*
> >
> > *(3) A description of the planned uses of the property during the post-closure period. Post-closure use of the property shall not disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the monitoring systems unless necessary to comply with the requirements in this part 258.*

3.1.2 OREGON-SPECIFIC REQUIREMENTS

Oregon adopts the federal requirements described above, and has additional post-closure requirements stipulated in OAR 340-94-115(3):

> *(3) Requirements for post-closure plans. Post-closure plans shall identify the post-closure activities which will be carried on to properly monitor and maintain the closed municipal solid waste landfill site:*
>
> > *(a) Requirements for the "Subtitle D" post-closure plan shall include all elements specified in 40 CFR §258.61, and consist of at least the following:*
> >
> > > *(A) Maintaining the integrity and effectiveness of any final cover;*
> > >
> > > *(B) Maintaining and operating the leachate collection system;*
> > >
> > > *(C) Monitoring the groundwater;*
> > >
> > > *(D) Maintaining and operating the gas monitoring system;*
> > >
> > > *(E) Monitoring and providing security for the landfill site; and*
> > >
> > > *(F) Description of the planned uses of the property during the post-closure care period.*

And in OAR 340-94-130(b):

> *(1) Post-closure requirements:*
>
> > *(a) Upon completion or closure of a landfill, a detailed description of the site including a plat shall be filed with the appropriate county land recording authority by the permittee. The description should include the general types and location of wastes deposited, depth of waste and other information of probable interest to future land owners;*
> >
> > *(b) During the post-closure care period, the permittee must, at a minimum:*
> >
> > > *(A) Maintain the approved final contours and drainage system of the site;*
> > >
> > > *(B) Consistent with final use, ensure that a healthy vegetative cover is established and maintained over the site;*
> > >
> > > *(C) Operate and maintain each leachate and gas collection, removal and treatment system present at the site;*
> > >
> > > *(D) Operate and maintain each groundwater and surface water monitoring system present at the site;*
> > >
> > > *(E) Comply with all conditions of the closure permit issued by the Department.*

(2) Post-closure care period. Post-closure care must continue for 30 years after the date of completion of closure of the land disposal site, unless otherwise approved or required by the Department according to OAR 340-094-100(4) and (5).

3.2 POST-CLOSURE ACTIVITIES

The following subsections describe the assumed activities that will be performed in the post-closure period to ensure the environmental protection systems continue to function as intended throughout the post-closure period.

3.2.1 OPERATIONS, MAINTENANCE AND ADMINISTRATIVE REQUIREMENTS

The following general operations, maintenance, and administrative requirements are anticipated:

- Final cover maintenance, including; labor, equipment, and supplies for minor regrading, reseeding and fertilizing;
- Final cover surveying to check settlement and grades;
- Mechanically Stabilized Earth (MSE) berm stability monitoring;
- MSE berm inspections;
- MSE berm maintenance (vegetated face seeding, pavement crack sealing, surface water improvements cleaning, etc.);
- General facility and final cover mowing;
- Maintenance of surface water management features;
- Building security, repairs, and demolition;
- Fence and road maintenance;
- Utilities (excluding LFG and leachate equipment);
- Third-party inspections, reports and management;
- Internal administration;
- Insurance; and
- Permitting costs.

3.2.2 GROUNDWATER AND STORMWATER MONITORING

The following activities associated with groundwater and stormwater monitoring are anticipated:

- Semi-annual groundwater sampling, sample analyses, quality assurance review, statistical evaluation, and reporting;

- Two stormwater sampling events per year at three sampling locations (with sample analyses for Escherichia coli (E. coli) and total suspended solids, quality assurance review, and reporting) and monthly stormwater inspections and documentation if required by the permit in post-closure;
- Monthly stormwater observations;
- Contingency for the redevelopment of groundwater monitoring wells; and
- Contingency for groundwater monitoring well decommissioning and replacement as needed.

3.2.3 Leachate Collection, Treatment, and Disposal

The leachate collection and removal system is expected to remain active for the entire 30-year post-closure period. However, leachate production is expected to decrease dramatically during that period of time, particularly in those areas of the landfill constructed with composite liner systems (e.g., Modules 4, 5, 6, 7, 8, and 9). The following general activities associated with the collection, treatment and disposal of leachate and the maintenance and repair of the systems are anticipated:

- Leachate sampling, sample analyses, quality assurance review, and reporting; and
- Leachate hauling for off-site treatment and disposal at approved facilities.

3.2.4 Gas Collection and Control System

RLC has constructed a LFGTE facility at RL. For the purposes of this plan, it has been assumed that the revenue from operating the facility would compensate for associated operational and decommissioning costs of the facility. Therefore, this facility has not been included in this plan.

The following GCCS operations, maintenance, monitoring and decommissioning items are included in the post-closure cost estimate:

- Surface emissions monitoring and reporting;
- LFG migration monitoring and reporting;
- LFG probe repair and contingency for replacement;
- GCCS operation, inspection, maintenance and repairs;
- Blower maintenance and repairs;
- Blower replacement contingency;
- Electrical power;
- Flare maintenance and repair including annual source testing and reporting;
- One-time conversion from active to passive operation;
- One-time system decommissioning;

- Annual New Source Performance Standards (NSPS) monitoring; and
- Title V Air Operating Permit compliance, reporting, and fees.

3.3 POST-CLOSURE COST ESTIMATE

The post-closure activities discussed above are itemized in the "worst-case" post-closure cost estimate presented in **Appendix B**. Annual costs are estimated to be approximately $769,592, and the estimated 30-year post-closure cost is $23,087,752. This equates to a cost of approximately $264,162 per acre.

3.4 USE OF THE LAND DURING THE POST-CLOSURE CARE PERIOD

Post-closure use of the property has not yet been determined. In any case, post-closure land uses will not disturb the integrity of the final cover, liner(s), or any other components of the containment system, or the function of the monitoring systems except as needed to comply with post-closure care requirements.

3.5 CONTACT INFORMATION

The name, address and telephone number of the person or office to contact during the post-closure care period is:

David K. Lowe
Riverbend Landfill Co.
13469 SW Highway 18
McMinnville, Oregon 97128
Tel: (503) 472-8788

This information will be kept current using the annual CPCP review and update process.

4 FINANCIAL ASSURANCE MECHANISM

4.1 ALLOWABLE FINANCIAL ASSURANCE MECHANISMS

Federal and state regulations allow permittees to use one or more financial assurance mechanisms to demonstrate that adequate funding is available to complete closure and post-closure care. The selection of financial assurance mechanism is based upon the status of the permittee as a private company or a government agency, the value of the entity, and cost. Specific requirements are provided for each type of financial assurance mechanism.

Financial assurance mechanisms allowed by 40 CFR §258.74 include the following:

- Trust Fund;
- Surety Bond Guaranteeing Payment or Performance;
- Letter of Credit;
- Insurance;
- Corporate Financial Test;
- Local Government Financial Test;
- Corporate Guarantee;
- Local Government Guarantee; and
- State Assumption of Responsibility.

4.2 SELECTED FINANCIAL ASSURANCE MECHANISMS

RL uses both trust funds and surety payment bonds to satisfy the financial assurance obligations for closure and post-closure care.

4.2.1 FEDERAL REQUIREMENTS:

Federal requirements applicable to **trust funds** used as financial assurance mechanisms are specified in 40 CFR §258.74(a) and are presented below:

(a) Trust Fund.

(1) An owner or operator may satisfy the requirements of this section by establishing a trust fund which conforms to the requirements of this paragraph. The trustee must be an entity which has the authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency. A copy of the trust agreement must be placed in the facility's operating record.

(2) Payments into the trust fund must be made annually by the owner or operator over the term of the initial permit or over the remaining life of the MSWLF unit, whichever is shorter, in the case of a trust fund for closure or post-closure care, or over one-half of the estimated length of the corrective action program in the case of corrective action for known releases. This period is referred to as the pay-in period.

(3) For a trust fund used to demonstrate financial assurance for closure and post-closure care, the first payment into the fund must be at least equal to the current cost estimate for closure or post-closure care, except as provided in paragraph (k) of this section, divided by the number of years in the pay-in period as defined in paragraph (a)(2) of this section. The amount of subsequent payments must be determined by the following formula:

Next Payment = [CE - CV]/Y

> *where CE is the current cost estimate for closure or post-closure care (updated for inflation or other changes), CV is the current value of the trust fund, and Y is the number of years remaining in the pay-in period.*

(4) For a trust fund used to demonstrate financial assurance for corrective action, the first payment into the trust fund must be at least equal to one-half of the current cost estimate for corrective action, except as provided in paragraph (k) of this section, divided by the number of years in the corrective action pay-in period as defined in paragraph (a)(2) of this section. The amount of subsequent payments must be determined by the following formula:

Next Payment = [RB - CV]/Y

> *where RB is the most recent estimate of the required trust fund balance for corrective action (i.e., the total costs that will be incurred during the second half of the corrective action period), CV is the current value of the trust fund, and Y is the number of years remaining in the pay-in period.*

(5) The initial payment into the trust fund must be made before the initial receipt of waste or before the effective date of the requirements of this section (April 9, 1997, or October 9, 1997 for MSWLF units meeting the conditions of §258.1(f)(1)), whichever is later, in the case of closure and post-closure care, or no later than 120 days after the corrective action remedy has been selected in accordance with the requirements of §258.58.

(6) If the owner or operator establishes a trust fund after having used one or more alternate mechanisms specified in this section, the initial payment into the trust fund must be at least the amount that the fund would contain if the trust fund were established initially and annual payments made according to the specifications of this paragraph and paragraph (a) of this section, as applicable.

(7) The owner or operator, or other person authorized to conduct closure, post-closure care, or corrective action activities may request reimbursement from the trustee for these expenditures. Requests for reimbursement will be granted by the trustee only if sufficient funds are remaining in the trust fund to cover the remaining costs of closure, post-closure care, or corrective action, and if justification and documentation of the cost is placed in the operating record. The owner or operator must notify the State Director that the documentation of the justification for reimbursement has been placed in the operating record and that reimbursement has been received.

(8) The trust fund may be terminated by the owner or operator only if the owner or operator substitutes alternate financial assurance as specified in this section or if he is no longer required to demonstrate financial responsibility in accordance with the requirements of §258.71(b), §258.72(b), or §258.73(b).

Federal requirements applicable to **surety bonds** used as financial assurance mechanisms are specified in 40 CFR §258.74(b) as follows:

(b) Surety Bond Guaranteeing Payment or Performance.

(1) An owner or operator may demonstrate financial assurance for closure or post-closure care by obtaining a payment or performance surety bond which conforms to the requirements of this paragraph. An owner or operator may demonstrate financial assurance for corrective action by obtaining a performance bond which conforms to the requirements of this paragraph. The bond must be effective before the initial receipt of waste or before the effective date of the requirements of this section (April 9, 1997, or October 9, 1997 for MSWLF units meeting the conditions of §258.1(f)(1)), whichever is later, in the case of closure and post-closure care, or no later than 120 days after the corrective action remedy has been selected in accordance with the requirements of §258.58. The owner or operator must notify the State Director that a copy of the bond has been placed in the operating record. The surety company issuing the bond must, at a minimum, be among those listed as acceptable sureties on Federal bonds in Circular 570 of the U.S. Department of the Treasury.

(2) The penal sum of the bond must be in an amount at least equal to the current closure, post-closure care or corrective action cost estimate, whichever is applicable, except as provided in §258.74(k).

(3) Under the terms of the bond, the surety will become liable on the bond obligation when the owner or operator fails to perform as guaranteed by the bond.

(4) The owner or operator must establish a standby trust fund. The standby trust fund must meet the requirements of §258.74(a) except the requirements for initial payment and subsequent annual payments specified in §258.74(a)(2), (3), (4) and (5).

(5) Payments made under the terms of the bond will be deposited by the surety directly into the standby trust fund. Payments from the trust fund must be approved by the trustee.

(6) Under the terms of the bond, the surety may cancel the bond by sending notice of cancellation by certified mail to the owner and operator and to the State Director 120 days in advance of cancellation. If the surety cancels the bond, the owner or operator must obtain alternate financial assurance as specified in this section.

(7) The owner or operator may cancel the bond only if alternate financial assurance is substituted as specified in this section or if the owner or operator is no longer required to demonstrate financial responsibility in accordance with §258.71(b), §258.72(b) or §258.73(b).

4.2.2 Oregon Specific Requirements

Oregon adopts the federal requirements, and specifies additional requirements, as found in OAR 340-94-140(6) and presented below:

(6) How financial assurance is to be provided and updated:

(a) The permittee shall submit to the Department a copy of the first financial assurance mechanism prepared in association with a "worst-case" closure plan, a Final Engineered Site Closure Plan, a "Subtitle D" post-closure plan, a Final Engineered Post-Closure Plan, and a corrective action report;

(b) The permittee shall also place a copy of the applicable financial assurance plan(s) in the facility operating record on the schedule specified in section (3) of this rule;

(c) The permittee shall certify to the Director at the time a financial assurance mechanism is submitted to the Department and when a financial assurance plan is placed in the facility operating record that the financial assurance mechanism meets all state and federal requirements. This date becomes the "annual review date" of the provision of financial assurance, unless a corporate guarantee is used, in which case the annual review date is 90 days after the end of the corporation's fiscal year;

(d) If a permittee uses a discount rate to estimate costs pursuant to subsection (4)(a) of this rule, the permittee shall prospectively for each year the discount rate is used:

(A) Certify to the Director that the landfill closure date is certain and there are no foreseeable factors that will change the estimate of site life; and

(*B) Submit a certification to the Director from a Registered Professional Engineer stating the cost estimates are complete and accurate.*

And, in OAR 340-94-145 (1) through (6)(c) relative to trust funds and surety payment bonds:

(1) The financial assurance mechanism shall restrict the use of the financial assurance so that the financial resources may be used only to guarantee that closure, post-closure or corrective action activities will be performed, or that the financial resources can be used only to finance closure, post-closure or corrective action activities.

(2) The financial assurance mechanism shall provide that the Department or a party approved by the Department is the beneficiary of the financial assurance.

(3) A permittee may use one financial assurance mechanism for closure, post-closure and corrective action activities, but the amount of funds assured for each activity must be specified.

(4) A permittee may demonstrate financial assurance for closure, post-closure and corrective action by establishing more than one mechanism per facility, except that mechanisms guaranteeing performance rather than payment may not be combined with other instruments.

(5) The financial assurance mechanism shall be worded as specified by the Department, unless a permittee uses an alternative financial assurance mechanism pursuant to subsection (6)(i) of this rule. The Department retains the authority to approve the wording of an alternative financial assurance mechanism.

(6) Allowable Financial Assurance Mechanisms. A permittee shall provide only the following forms of financial assurance for closure and post-closure activities:

(a) A trust fund established with an entity which has the authority to act as a trustee and whose trust operations are regulated and examined by a federal or state agency and meeting criteria in 40 CFR §258.74(a). The purpose of the trust fund is to receive and manage any funds that may be paid by the permittee and to disburse those funds only for closure, post-closure maintenance or corrective action activities which are authorized by the Department. The permittee shall notify the Department, in writing, before any expenditure of trust fund moneys is made, describing and justifying the activities for which the expenditure is to be made. If the Department does not respond to the trustee within 30 days after receiving such notification, the expenditure is deemed authorized and the trustee may make the requested reimbursements;

(b) A surety bond guaranteeing payment into a standby closure or post-closure trust fund issued by a surety company listed as acceptable in Circular 570 of the U.S. Department of the Treasury. The standby closure or post-closure trust fund must be established by the permittee. The purpose of the standby trust fund is to receive any funds that may be paid by the permittee or surety company. The penal sum of the bond must be in an amount at least equal to the current closure or post-closure care cost estimate, as applicable. The bond must guarantee that the permittee will either fund the standby trust fund in an amount equal to the penal sum

of the bond before the site stops receiving waste or within 15 days after an order to begin closure is issued by the Department or by a court of competent jurisdiction; or that the permittee will provide alternate financial assurance acceptable to the Department within 90 days after receipt of a notice of cancellation of the bond from the surety. The surety shall become liable on the bond obligation if the permittee fails to perform as guaranteed by the bond. The surety may not cancel the bond until at least 120 days after the notice of cancellation has been received by both the permittee and the Department. If the permittee has not provided alternate financial assurance acceptable to the Department within 90 days of the cancellation notice, the surety must pay the amount of the bond into the standby trust account.

4.3 DOCUMENTATION OF FINANCIAL ASSURANCE

The current financial assurance status, current trust account statements showing balances and transactions over the previous year, and bonds are provided separately to this document.

5 REFERENCES

Geosyntec Consultants. (14 November 2016). *Final Grading Plan Modification Permit Application Report, Riverbend Landfill, McMinnville, Oregon.*

Geosyntec Consultants. (9 November 2017). *Final Engineered Site Closure and Post-Closure Plan, Riverbend Landfill, McMinnville, Oregon.*

HDR. (March 2015). *2015 Revision to Closure and Post-Closure Plans, Riverbend Landfill, McMinnville, Oregon.*

HDR. (March 2016). *2016 Revision to Closure and Post-Closure Plans, Riverbend Landfill, McMinnville, Oregon.*

HDR. (March 2017). *2017 Revision to Closure and Post-Closure Plans, Riverbend Landfill, McMinnville, Oregon.*

HDR. (August 2017). *2017 Revision to Closure and Post-Closure Plans, Riverbend Landfill, McMinnville, Oregon.*

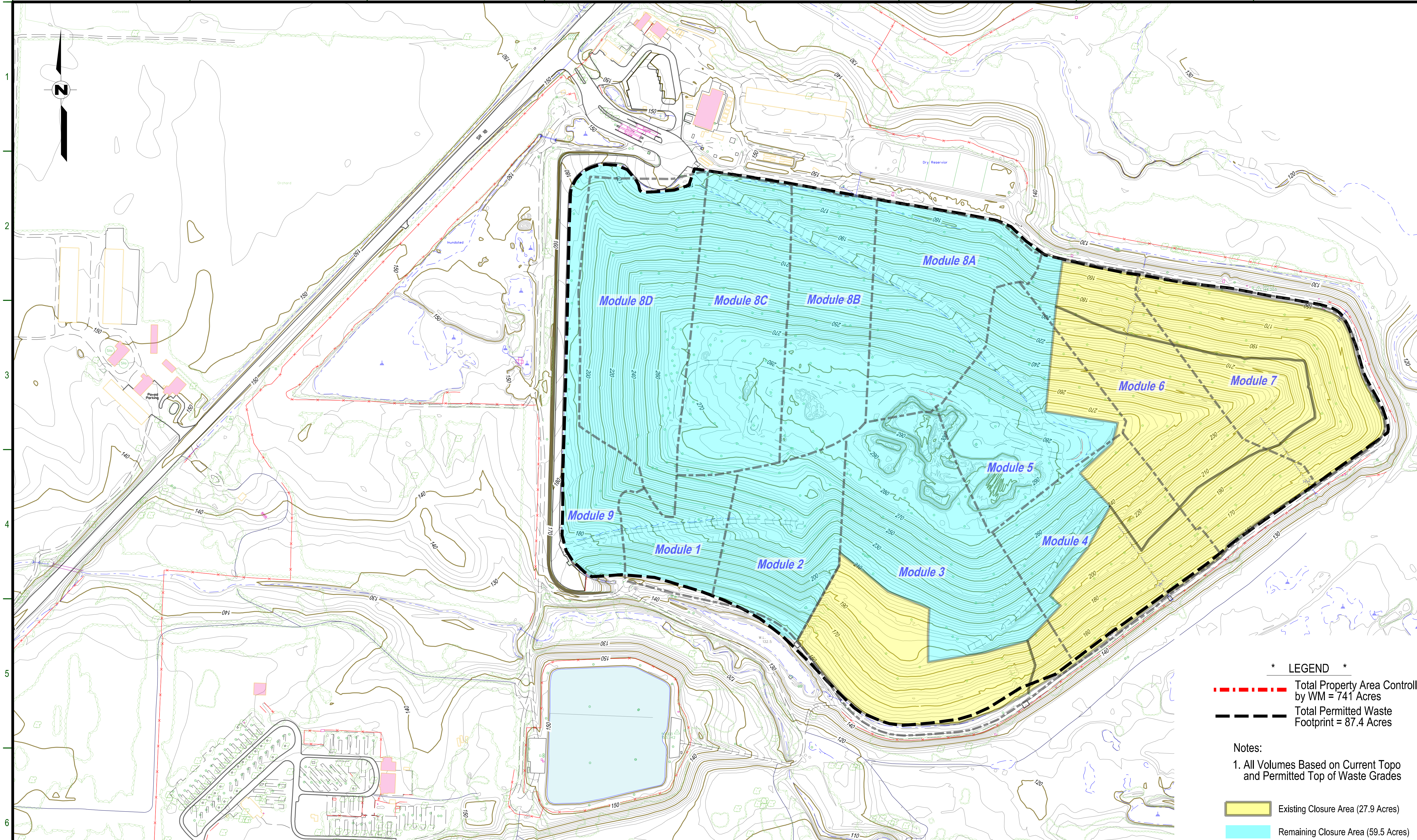
HDR. (April 2018). *2018 Revision to Closure and Post-Closure Plans, Riverbend Landfill, McMinnville, Oregon.*

Vista Consultants. (2012). *2012 Closure and Post-Closure Plans, Riverbend Landfill, McMinnville, Oregon.*

Vista Consultants. (2013). *2013 Closure and Post-Closure Plans, Riverbend Landfill, McMinnville, Oregon.*

APPENDIX A

WORST-CASE CLOSURE DRAWING



150 0 150 300
SCALE IN FEET

WASTE MANAGEMENT

For General Use

Revisions			
No.	Description	Date	By
1	Update topo	3/31/2022	GB

Approved By: Dave Rettell
Checked By: Melody Adams
Drawn By: Bullseye Design Services, Inc.

Project Location:
Riverbend Landfill
McMinnville, Oregon

2022 Wost Case Closure Areas

Site ID:	OR02 - 1509
Scale:	1" = 300'
Date:	March 2022
Drawing No.	1

APPENDIX B

CLOSURE AND POST-CLOSURE COST ESTIMATES

Attachment 1

Closure and Post-Closure Cost Estimate

2022 Riverbend Landfill Closure Cost Estimates

Site:	Riverbend Landfill	State:	Oregon	Waste:	MSW
Acreage:	59.5 Acres				

a	***Earthwork***	Quantity	Unit	Unit Cost ($)	Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Total
1	Bedding Soil (Foundation Soil)	19,967	Cubic Yards	$ 5.00	$ 99,835	2014	2022	18.53%	$ 118,334
2	General Backfill	99,833	Cubic Yards	$ 5.00	$ 499,165	2014	2022	18.53%	$ 591,660
6	Top Soil	49,917	Cubic Yards	$ 10.40	$ 519,137	2014	2022	18.53%	$ 615,333
7	Waste Grading	19,967	Cubic Yards	$ 8.41	$ 167,922	2014	2022	18.53%	$ 199,039
8	Other (Describe Below)								
	Subgrade Preparation	299,499	SY	$ 0.21	$ 62,895	2016	2022	16.32%	$ 73,159
	Mobilization Earthwork Contractor	1	LS	$ 75,000.00	$ 75,000	2015	2022	17.19%	$ 87,893
	CQA and Surveying	1	LS	$ 75,000.00	$ 75,000	2015	2022	17.19%	$ 87,893
	EARTHWORKS SUBTOTAL -								**$ 1,773,310**

b	***Geosynthetics***	Quantity	Unit	Unit Cost ($)	Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Total
1	Geotextile	316,778	Square Yards	$ 2.61	$ 826,791	2014	2022	18.53%	$ 979,995
5	Geomembrane	316,778	Square Yards	$ 6.70	$ 2,122,413	2014	2022	18.53%	$ 2,515,696
7	Other (Describe Below)								
	Contractor Mobilization	1	LS	$ 50,000.00	$ 50,000	2015	2022	17.19%	$ 58,595
	CQA and Surveying	1	LS	$ 100,000.00	$ 100,000	2015	2022	17.19%	$ 117,190
	GEOSYNTHETICS SUBTOTAL -								**$ 3,671,476**

c	***Stormwater Management System***	Quantity	Unit	Unit Cost ($)	Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Total
8	Other (Describe Below)								
	Drainage and Site Work	1	LS	$ 1,270,000.00	1,270,000	2017	2022	12.28%	$ 1,425,956
	STORMWATER MANAGEMENT SYSTEM SUBTOTAL -								**$ 1,425,956**

d	***Temporary and Permanent Erosion Controls***	Quantity	Unit	Unit Cost ($)	Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Total
7	Other (Describe Below)								
	Sediment and Erosion Control	61.88	Acres	$ 750.00	$ 46,410	2014	2022	18.53%	$ 55,010
	Vegetation and Seeding	77.35	Acres	$ 1,166.00	$ 90,190	2016	2022	16.32%	$ 104,909
	TEMPORARY AND PERMANENT EROSION CONTROLS SUBTOTAL -								**$ 159,919**

Updated by WM
March 2022

2022 Riverbend Landfill Closure Cost Estimates

e	***Landfill Gas Management System***	Quantity	Unit	Unit Cost ($)	Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Total
12	Other (Describe Below)								
	Engineering, Construction Drawings, and CQA	1	LS	$ 150,000.00	$ 150,000	2014	2022	18.53%	$ 177,795
	Remaining Well Field	59.50	Acres	$ 25,000.00	$ 1,487,500	2014	2022	18.53%	$ 1,763,134
	LANDFILL GAS MANAGEMENT SYSTEM SUBTOTAL -								**$ 1,940,929**

g	***CQA, Engineering, Surveying and Other Professional Services***	Quantity	Unit	Unit Cost ($)	Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Total
3	Construction Drawing Preparation	1	LS	$ 175,000.00	$ 175,000	2015	2022	17.19%	$ 205,083
4	Bid Package	1	LS	$ 5,000.00	$ 5,000	2015	2022	17.19%	$ 5,860
5	Construction Management	1	LS	$ 285,000.00	$ 285,000	2015	2022	17.19%	$ 333,992
6	Certification Report	1	LS	$ 30,000.00	$ 30,000	2015	2022	17.19%	$ 35,157
7	Deed Record Update	1	LS	$ 2,500.00	$ 2,500	2015	2022	17.19%	$ 2,930
	PROFESSIONAL SERVICES SUBTOTAL -								**$ 583,020**

h	***Miscellaneous***	Quantity	Unit	Unit Cost ($)	Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Total
1	Demobilization and Demolition	1	LS	$ 25,000.00	25,000	2014	2022	18.53%	$ 29,633
	MISCELLANEOUS SUBTOTAL -								**$ 29,633**

	CURRENT TOTAL -		**$ 9,584,242**
j	Contingency	10.00%	$ 958,424
	FINANCIAL ASSURANCE REQUIRED FOR CLOSURE -		**$ 10,542,666**
	Closure Cost per Acre -		$ 177,188

Updated by WM
March 2022

2022 Riverbend Landfill Post-Closure Care Cost Estimate

Site:	Riverbend Landfill					**State:**	Oregon	**Waste:**	MSW
Anticipated PCC Duration:	30 Years	**Acreage:**	87.40 Acres						

a	***Cover System Maintenance***	**Annual Quantity**	**Unit**	**Annual Unit Cost ($)**	**Annual Original Total**	**Year of Orig. Cost**	**Current Year**	**Inflation Adj. (%)**	**Adjusted Annual Total**
1	Mowing [UPDATED]	90.90	Acres	$ 300.00	$ 27,270	2022	2022	0.00%	$ 27,270
4	Revegetation	2.00	Acres	$ 1,166.00	$ 2,332	2016	2022	16.32%	$ 2,713
5	Other (Describe Below)								
	Cover System Earthwork, Labor, Equipment, Surveying	1	LS	$ 2,400.00	$ 2,400	2014	2022	18.53%	$ 2,845
	COVER SYSTEM MAINTENANCE SUBTOTAL -								**$ 32,827**

b	***Environmental Monitoring***	**Annual Quantity**	**Unit**	**Annual Unit Cost ($)**	**Annual Original Total**	**Year of Orig. Cost**	**Current Year**	**Inflation Adj. (%)**	**Adjusted Annual Total**
1	Surface Water Sampling	2	EA	$ 3,630.00	$ 7,260	2013	2022	20.64%	$ 8,758
4	Semiannual Groundwater Sampling	32	EA	$ 468.15	$ 14,981	2013	2022	20.64%	$ 18,073
6	Semiannual Groundwater Analysis	32	EA	$ 266.30	$ 8,522	2013	2022	20.64%	$ 10,280
7	Water Quality Report Preparation	1	LS	$ 9,000.00	$ 9,000	2014	2022	18.53%	$ 10,668
8	Groundwater Well Replacement	0.0333	EA	$ 7,500.00	$ 250	2014	2022	18.53%	$ 296
10	Other (Describe Below)								
	Groundwater Analytical QA and Statistics	2	EA	$ 3,080.00	$ 6,160	2013	2022	20.64%	$ 7,431
	Well Redevelopment Accrual, Each Well Every 10 Years	1.2	EA	$ 1,000.00	$ 1,200	2013	2022	20.64%	$ 1,448
	ENVIRONMENTAL MONITORING SUBTOTAL -								**$ 56,955**

c	***Leachate Monitoring***	**Annual Quantity**	**Unit**	**Annual Unit Cost ($)**	**Annual Original Total**	**Year of Orig. Cost**	**Current Year**	**Inflation Adj. (%)**	**Adjusted Annual Total**
1	Leachate Sampling	1	EA	$ 1,600.00	$ 1,600	2014	2022	18.53%	$ 1,896
2	Leachate Analysis	1	EA	$ 8,700.00	$ 8,700	2014	2022	18.53%	$ 10,312
3	Leachate Reporting	1	EA	$ 3,250.00	$ 3,250	2014	2022	18.53%	$ 3,852
4	Leachate Collection System Maintenance	1	LS	$ 4,000.00	$ 4,000	2014	2022	18.53%	$ 4,741
8	Leachate Treatment	2,780,820	Gal	$ 0.06765	$ 188,122	2018	2022	11.67%	$ 210,076
9	Leachate Evaporation Pond Repair	812	SY	$ 20.63	$ 16,760	2017	2022	13.08%	$ 18,952
11	Other (Describe Below)								
	Decommissioning	0.0333	LS	$ 15,500.00	$ 517	2016	2022	16.32%	$ 601
	LEACHATE MONITORING SUBTOTAL -								**$ 250,432**

2022 Riverbend Landfill Post-Closure Care Cost Estimate

d	***Landfill Gas Monitoring***	Annual Quantity	Unit	Annual Unit Cost ($)	Annual Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Annual Total
5	Landfill Gas System Maintenance [UPDATED]	1	LS	$ 30,000.00	$ 30,000	2022	2022	0.00%	$ 30,000
6	Landfill Gas System Operation [UPDATED]	1	LS	$ 45,000.00	$ 45,000	2022	2022	0.00%	$ 45,000
7	Convert from Active to Passive	0.0333	LS	$ 36,745.00	$ 1,225	2013	2022	20.64%	$ 1,478
8	Landfill Gas System Decommissioning	0.0333	LS	$ 18,373.00	$ 612	2013	2022	20.64%	$ 739
12	Blower Replacement	0.0667	EA	$ 19,500.00	$ 1,300	2014	2022	18.53%	$ 1,541
15	Flare Maintenance	1	LS	$ 10,000.00	$ 10,000	2014	2022	18.53%	$ 11,853
18	NSPS Monitoring [UPDATED]	1	LS	$ 107,200.00	$ 107,200	2022	2022	0.00%	$ 107,200
19	Title V Emissions Fee [UPDATED]	1	LS	$ 37,000.00	$ 37,000	2022	2022	0.00%	$ 37,000
20	Other (Describe Below)								
	Landfill Methane Rule Costs (Every 5 yrs) [NEW]	0.20	LS	$ 157,000.00	$ 31,400	2022	2022	0.00%	$ 31,400
	DEQ and CAO Fees [NEW]	1	LS	$ 16,359.00	$ 16,359	2022	2022	0.00%	$ 16,359
	Quarterly H2S & CO Monitoring [NEW]	1	LS	$ 21,300.00	$ 21,300	2022	2022	0.00%	$ 21,300
	Gas Migration Monitoring and Reporting	1	LS	$ 4,798.60	$ 4,799	2013	2022	20.64%	$ 5,789
	Blower Maintenance and Repair	1	LS	$ 4,800.00	$ 4,800	2014	2022	18.53%	$ 5,689
	Blower Electricity	1	LS	$ 12,500.00	$ 12,500	2016	2022	16.32%	$ 14,540
	LANDFILL GAS MONITORING SUBTOTAL -								**$ 329,888**

e	***General Site Maintenance***	Annual Quantity	Unit	Annual Unit Cost ($)	Annual Original Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Annual Total
2	Fence and Gate Repairs	20	LF	$ 25.00	$ 500	2014	2022	18.53%	$ 593
3	Road Maintenance	1,500	SF	$ 0.70	$ 1,050	2014	2022	18.53%	$ 1,245
4	Utilities	1	LS	$ 1,500.00	$ 1,500	2014	2022	18.53%	$ 1,778
5	Building Maintenance	1	LS	$ 1,000.00	$ 1,000	2014	2022	18.53%	$ 1,185
6	Stormwater System Maintenance	1	LS	$ 3,500.00	$ 3,500	2014	2022	18.53%	$ 4,149
7	Other (Describe Below)								
	MSE Berm Maintenance	1	LS	$ 1,560.00	$ 1,560	2015	2022	17.19%	$ 1,828
	GENERAL SITE MAINTENANCE SUBTOTAL -								**$ 10,777**

f	***Professional Services***	Annual Quantity	Unit	Annual Unit Cost ($)	Original Annual Total	Year of Orig. Cost	Current Year	Inflation Adj. (%)	Adjusted Annual Total
4	Site Inspection	1	EA	$ 16,000.00	$ 16,000	2015	2022	17.19%	$ 18,750
	PROFESSIONAL SERVICES SUBTOTAL -								**$ 18,750**

		CURRENT ANNUAL TOTAL -		**$ 699,629**
h		Contingency	10.00%	$ 69,963
		TOTAL -		**$ 769,592**
j	NOT DISCOUNTING WILL BE APPLIED THIS YEAR	Discounting	0.000000%	$ -
		Annual Post-Closure Care Costs -		**$ 769,592**
		FINANCIAL ASSURANCE REQUIRED FOR POST-CLOSURE CARE -		**$ 23,087,752**
		Post-Closure Care Cost per Acre -		$ 264,162

Updated by WM
March 2022

Current Year

Historical Year

Example

A closure-cost estimate completed in September of 2016 was $3,000,000. The scope of work, design, and facility conditions have NOT changed since the original cost estimate.

The inflation-adjusted cost for Oct 2022 (Q-IV) is calculated as follows:

Implicit price deflator value for 2022 Q-IV = 125.479

Implicit price deflator value for 2016 Q-III = 105.929

Inflation-adjusted cost estimate in current dollars =

$$\$3,000,000 \times \frac{125.479}{105.929} = \$3,553,685$$

How to submit the update

Submit the updated cost estimates to the DEQ office identified in your solid waste disposal site permit. Please include a copy of this memo and a copy of the original cost estimates with the submittal.

Alternative formats

DEQ can provide documents in an alternate format or in a language other than English upon request. Call DEQ at 800-452-4011 or email deqinfo@deq.state.or.us.

Table 1.1.9
GDP Implicit Price Deflator

Type	Year	Quarter	Value	Q to Q Rate Annualized
	2012	I	99.313	
	2012	II	99.713	1.62%
	2012	III	100.230	2.09%
	2012	IV	100.738	2.04%
	2013	I	101.141	1.61%
	2013	II	101.428	1.14%
	2013	III	101.906	1.90%
	2013	IV	102.515	2.41%
	2014	I	102.942	1.68%
	2014	II	103.525	2.28%
	2014	III	103.977	1.76%
	2014	IV	104.150	0.67%
	2015	I	104.113	-0.14%
	2015	II	104.677	2.18%
	2015	III	104.989	1.20%
	2015	IV	104.979	-0.04%
	2016	I	104.895	-0.32%
	2016	II	105.636	2.86%
	2016	III	105.929	1.11%
	2016	IV	106.487	2.12%
	2017	I	107.025	2.04%
	2017	II	107.369	1.29%
	2017	III	107.903	2.00%
	2017	IV	108.670	2.87%
	2018	I	109.261	2.19%
	2018	II	110.234	3.61%
	2018	III	110.597	1.32%
	2018	IV	111.175	2.11%
	2019	I	111.514	1.23%
	2019	II	112.152	2.31%
	2019	III	112.517	1.31%
	2019	IV	112.978	1.65%
	2020	I	113.346	1.31%
	2020	II	112.859	-1.71%
	2020	III	113.888	3.70%
	2020	IV	114.439	1.95%
	2021	I	115.652	4.31%
	2021	II	117.413	6.23%
	2021	III	119.115	5.93%
	2021	IV	121.137	6.96%
Projection	2022	I	122.015	2.93%
	2022	II	122.899	2.93%
	2022	III	123.790	2.93%
	2022	IV	124.687	2.93%
	2023	I	125.591	2.93%

2022 DEQ Guidance Inflation Rate

Attachment 2
Cost Estimate Development Backup

NOTE: This backup documentation has been updated by Riverbend Landfill Co. The changes made herein reflect the 2022 costs and calculations utilizing the original prepared by HDR in 2014 for this backup package.

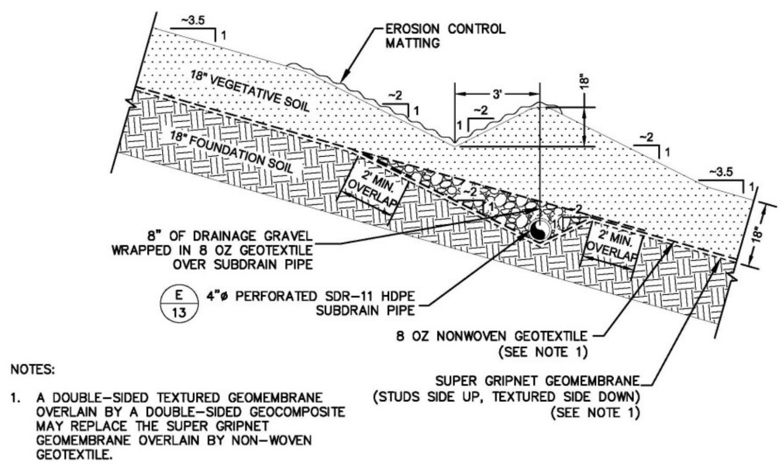
Inflation Methodology

Unless otherwise noted, the inflation adjustments for items based on prior cost estimates were made according to the instructions in the Oregon Department of Environmental Quality (DEQ) Memorandum, "Financial Assurance Update for 2022: How to adjust cost estimates for inflation," dated February 22, 2022[1] (included in Attachment 1). The inflation factor, as a percentage increase, was calculated to March 2022 (1st Quarter 2022) values by using Implicit Price Deflator (IPD) values, as shown in the following equation:

$$\left(\frac{IPD\ for\ date\ of\ current\ estimate\ (1st\ quarter\ 2022)}{IPD\ for\ date\ of\ prior\ estimate} - 1\right) * 100 = Inflation\ Adjustment$$

Final Cover Components

The final cover components are based on the description in Section 2.2.2 of the Closure and Post-Closure Plan (July 2017) and the figure below.



1. Closure Cost Estimate

The closure cost estimate includes costs associated with closing the Riverbend Landfill under the "worst-case" scenario. This "worst-case" is occurring right now, as presented in Appendix A, with 59.5 planar acres required to be closed. To account for the increased surface area on slopes, any cost quantities based on surface area use 61.88 acres (104 percent of the planar area).

[1] The date is based on what was provided on the website at; actual document does not contain a date: https://www.oregon.gov/deq/mm/swpermits/Pages/Financial-Assurance.aspx; the document was not dated.

a. Earthwork

The Earthwork section includes activities associated with procurement, delivery, excavation, moving, stockpiling, placing, and compaction of soils for the closure.

1. Bedding Soil (Foundation Soil)

Bedding Soil covers the anticipated needs for the 18-inch foundation soil layer. This covers any soil needed for repairing or grading during closure in order to bring the surface of the landfill into conformance with the final cover design. It is assumed that a minimum of 6 inches of foundation soil is already maintained over the waste across any areas of the landfill that have not been closed. It is also assumed that 80 percent of these areas will already have an 18-inch layer of intermediate soil cover that meets the requirements of the foundation layer. Therefore, the volume of bedding soil required is assumed to be approximately the amount of soil needed to add 1 foot of soil to 20 percent of the area to be closed.

$$104\% * 20\% * (59.5\ acres) * \frac{43{,}560\ SF}{acre} * 1\ foot * \frac{1\ CY}{27\ CF} = 19{,}967\ CY$$

The 2014 unit cost is per cubic yard and based on engineering judgment. It has been adjusted for inflation using the IPD values to current dollars.

2. General Backfill

General Backfill covers the lower 12 inches of the vegetative soil layer, which is a layer of the final cover that is 1.5 feet thick.

$$104\% * 59.5\ acres * \frac{43{,}560\ SF}{acre} * 1\ feet * \frac{1\ CY}{27\ CF} = 99{,}833\ CY$$

The 2014 unit cost is per cubic yard and based on engineering judgment. It has been adjusted for inflation using the IPD values to current dollars.

3. Drainage Sand – Not Used

4. Gravel – Not Used

5. Clay – Not Used

6. Top Soil

Top Soil covers the upper 6 inches of the vegetative soil layer, which is a layer of the final cover that is 1.5 feet thick, with the top 6 inches capable of supporting vegetation.

$$104\% * 59.5\ acres * \frac{43{,}560\ SF}{acre} * 0.5\ feet * \frac{1\ CY}{27\ CF} = 49{,}917\ CY$$

The 2014 unit cost is per cubic yard and based on engineering judgment. It has been adjusted for inflation using the IPD values to current dollars.

7. Waste Grading

Similar to the Bedding Soil (line item a1 above), Waste Grading assumes that wastes may need to be regraded in order to create stable final slopes and bring the surface of the landfill into conformance with the final cover design. Assumes that 6" daily cover is placed over waste as part of standard operating procedures. The volume is assumed to be approximately 1 foot of waste across 20 percent of the area to be closed.

$$104\% * 20\% * (59.5\ acres) * \frac{43{,}560\ SF}{acre} * 1\ foot * \frac{1\ CY}{27\ CF} = 19{,}967\ CY$$

The 2014 Waste Grading unit cost is per cubic yard and is based upon an average of three quotes for waste excavation provided by contractors in February 2014 for a landfill cell construction project at another Waste Management site in Oregon (Cell 6A at Hillsboro Landfill).

$$\frac{\$8.23 + \$8.00 + \$9.00}{3} = \$8.41$$

The 2014 unit cost has been adjusted for inflation using the IPD values to current dollars.

8. Other

<u>Subgrade Preparation</u>

This includes the cost for preparing the foundation soil for installation of the geosynthetics.

$$104\% * 59.5\ acres * \frac{4{,}840\ SY}{acre} = 299{,}499\ SY$$

A unit cost of $0.21 per square yard was acquired from section 31 22 16.10-3300 of the Year 2016 RS Means (Fine Grading, Slopes, Gentle, Finish Grading) for Portland, Oregon and has been adjusted for inflation using the IPD values to current dollars.

<u>Mobilization Earthwork Contractor</u>

The 2015 Mobilization cost for the earthwork contractor is based on engineering judgment and has been adjusted for inflation using the IPD values to current dollars.

<u>Construction Quality Assurance and Surveying</u>

The 2015 cost for construction quality assurance (CQA) activities, including surveying, for the earthwork portion of closure construction is based on engineering judgment and has been adjusted for inflation using the IPD values to current dollars.

b. Geosynthetics

The Geosynthetics section includes activities associated with procurement, delivery, deployment, and connection of geosynthetic materials for the closure.

1. Geotextile

The final cover system includes a geotextile placed over the studded surface of a geomembrane in order to create a drainage channel. An additional 10 percent was added in order to compensate for the increased area on slopes and for wastage.

$$110\% * 59.5\ acres * \frac{4{,}840\ SY}{acre} = 316{,}778\ SY$$

The $2.61 cost per square yard is based on a verbal cost estimate provided in 2014 by Agru America, and includes the cost to procure, ship, and install the 8 ounce/square yard geotextile. The 2014 unit cost has been adjusted for inflation using the IPD values to current dollars.

2. Composite Drainage Net – Not Used

3. Geonet – Not Used

4. Geosynthetic Clay Liner – Not Used

5. Geomembrane

The final cover system includes a 60-mil polyethylene geomembrane, assumed to be the 60 mil Super Gripnet® liner manufactured by Agru America, which has spikes on one side and studs on the other side. An additional 10 percent was added in order to compensate for the increased area on slopes and for wastage. Like the geotextile (line item b1), 316,778 square yards are estimated.

The $6.70 cost per square yard includes a cost based on a verbal cost estimate provided by Agru America, which includes the cost to procure, ship, and install the geomembrane, plus an additional cost per square yard that covers miscellaneous items such as boots, flaps, and connections. The 2014 unit cost has been adjusted for inflation using the IPD values to current dollars.

6. Geogrid – Not Used

7. Other

<u>Contractor Mobilization</u>

The 2015 Mobilization cost for the geosynthetics contractor is based on engineering judgment and has been adjusted for inflation using the IPD values to current dollars.

CQA and Surveying

The 2015 cost for CQA activities, including surveying, for the geosynthetics portion of closure construction is based on engineering judgment and has been adjusted for inflation using the IPD values to current dollars.

c. Stormwater Management System

The Stormwater Management System section includes activities associated with the procurement, delivery, and installation of structures and piping necessary to promote stormwater flow as part of closure construction.

1. **Piping – Not Used**
2. **Culverts – Not Used**
3. **Toe Drain – Not Used**
4. **Inlet Structures – Not Used**
5. **Outfall Structures – Not Used**
6. **Ditches – Not Used**
7. **Berms – Not Used**
8. **Other**

Drainage and Site Work

The costs for site work related to drainage for the final closure system and its construction are combined under one line item. This cost will include drainage ditches, culverts or pipes, down chutes, and energy dissipaters/splash walls, and water quality units.

The 2014 unit cost is lump sum, adds additional items to the system based on the Final Engineered Site Closure and Post-Closure Plan (Geosyntec, 2017), and is based on engineering judgment. It has been adjusted for inflation using the IPD values to current dollars.

d. Temporary and Permanent Erosion Controls

The Temporary and Permanent Erosion Controls section includes costs associated with procurement, delivery, installation, and maintenance during construction of temporary and permanent erosion controls necessary to mitigate sediment migration.

1. **Erosion Control Mat – Not Used**
2. **Silt Fencing – Not Used**
3. **Inlet Protection – Not Used**

4. **Hydroseeding – Not Used**
5. **Sodding – Not Used**
6. **Grout Filled Fabric Revetment – Not Used**
7. **Other**

Sediment and Erosion Control

The 2014 cost for temporary sediment and erosion control activities required during the earthwork portion of closure construction is per acre and based on engineering judgment. It has been adjusted for inflation using the IPD values to current dollars.

Vegetation and Seeding

The Closure Plan assumes that vegetation will be planted or seeded across 61.88 acres (104 percent of the area to be closed), in order to account for the increased area on slopes. Conservatively, an additional area equal to 25 percent of the area to be closed is assumed to need a second round of seeding during the closure activities. Therefore, the total quantity estimated is 77.35 acres to current dollars.

The unit cost of $1,166 per acre was acquired from section 32 92 19.13-0020 of the Year 2016 RS Means (mechanical seeding) for Portland, Oregon, and has been adjusted for inflation using the IPD values to current dollars.

e. Landfill Gas Management System

The Landfill Gas Management System section includes costs associated with closure construction for procurement, delivery, and installation of piping and structures necessary to control landfill gas and properly collect condensate.

The landfill gas collection and control system (GCCS) has primarily been constructed along with landfill expansion/development and waste placement, except for the landfill gas collection wells, the well-head assemblies, and the landfill gas laterals.

1. **Lateral Piping – Not Used**
2. **Header Piping – Not Used**
3. **Air Line – Not Used**
4. **Vertical Gas Wells – Not Used**
5. **Condensate Knockout – Not Used**
6. **Passive Gas Vents – Not Used**
7. **Condensate Pump Station – Not Used**
8. **LFG Migration Probe – Not Used**

9. Blower – Not Used

10. Air Compressor – Not Used

11. Flare – Not Used

12. Other

Engineering, Construction Drawings, and CQA

This line item covers costs associated with the engineering required for the remaining components of GCCS, the construction drawings, and the performance of construction quality assurance related to constructing the GCCS. The 2014 unit cost is lump sum and based on the engineering judgment. It has been adjusted for inflation using the IPD values to current dollars.

Remaining Well Field

This cost covers those components of the GCCS that have not been constructed during the operation of the landfill. The 2014 unit cost is per acre and based on industry knowledge. It has been adjusted for inflation using the IPD values to current dollars.

f. Water Monitoring System

The Water Monitoring System section includes construction of any groundwater wells and surface water monitoring points that will need to be constructed as part of closure. The entire Water Monitoring System at Riverbend is assumed to be in place and operational before the closure activities commence.

1. Groundwater Well – Not Used

2. Other – Not Used

g. CQA, Engineering, Surveying, and Other Professional Services

The CQA, Engineering, Surveying, and Other Professional Services section includes work related to ensuring construction meets quality standards, design intent, and legal requirements.

1. Construction Quality Assurance – Not Used

2. Surveying – Not Used

3. Construction Drawing Preparation

This line item includes the costs associated with bringing closure plans to construction level with consideration for changed conditions. The 2015 unit cost is lump sum and based on engineering judgment and the construction costs for Earthwork, Geosynthetics, Stormwater Management, and Temporary and

Permanent Erosion Controls, and has been adjusted for inflation using the IPD values to current dollars.

4. Bid Package

This line item includes the costs associated with preparing bid documents, including Divisions 0 and 1 of the Construction Specifications. The 2015 unit cost is lump sum and based on the cost estimate presented in the *Final Engineered Site Closure and Post-Closure Plan* (Geosyntec 2014) in December 2014 and has been adjusted for inflation using the IPD values to current dollars.

5. Construction Management

This line item includes costs associated with construction management services as may be deemed necessary. The 2015 unit cost is lump sum and based on engineering judgment and has been adjusted for inflation using the IPD values to current dollars.

6. Certification Report

This line item includes costs associated with preparing a CQA report at the conclusion of closure construction. The 2015 unit cost is lump sum and based on the cost estimate presented in the *Final Engineered Site Closure and Post-Closure Plan* (Geosyntec 2014) in December 2014 and has been adjusted for inflation using the IPD values to current dollars.

7. Deed Record Update

This line item includes services associated with making revisions to the property's deed to indicate that a closed landfill is on the site, as well as notes on any property use restrictions as required by law. The 2015 cost is based on engineering judgment and has been adjusted for inflation using the IPD values to current dollars.

8. Other – Not Used

h. Miscellaneous

The Miscellaneous section includes any additional costs not included in other sections, including site-specific issues that cannot be adequately addressed in the other sections.

1. Demobilization and Demolition

This line item covers the cost of Exit Closure Demobilization, which is assumed to include the cost of removing equipment, etc., from site after closure. This is not associated with contractor costs for performing the closure activities described in other line items above. The 2014 one-time cost of $25,000 is based on engineering judgment. It has been adjusted for inflation using the IPD values to current dollars.

2. Other – Not Used

i. Overhead and Profit

The Overhead and Profit section was not used because unit costs in other sections include overhead and profit.

j. Contingency

An additional 10 percent is added to the costs to account for unforeseen contingencies.

k. Taxes

The Taxes section was not used because unit costs in other sections include taxes where applicable.

l. Discounting

No discounting was used for the closure cost estimate because it is assumed that closure funds should be available for immediate use.

2. Post-Closure Care Cost Estimate

The post-closure care cost estimate includes costs associated with maintaining Riverbend Landfill for 30 years. The final build-out of the landfill is expected to be 87.4 planar acres. To account for the increased surface area on slopes, any cost quantities based on surface area use 90.9 acres (104 percent of the planar area).

a. Cover System Maintenance

The Cover System Maintenance section includes costs associated with erosion repairs, settlement issues, and general maintenance.

1. Mowing

Mowing quantities were based on assumptions that the entire grassed portion of the landfill will need to be mowed once per year. The area is assumed to be 104 percent of the area to be closed (90.9 acres), in order to account for the increased area on slopes.

Unit costs are based on costs seen by WM Environmental Legacy Management Group (ELMG); this is the team who manages landfills that are in post closure. As a result of the updated Landfill Methane Reporting requirements in Oregon and stricter Surface Emissions Monitoring under NSPS rules, mowing will be required an average of 3 times per year at a 2022 unit cost of $100/acre. This rate was not adjusted for inflation for this cost estimate but will be going forward.

The cost estimate assumes mowing activities will be necessary for 30 years of post-closure care.

2. Erosion Repair – Not Used

3. Replace Geosynthetics or Clay – Not Used

4. Revegetation

This item includes costs associated with maintaining or replacing dead or eroded vegetation during the post-closure care period. It is assumed that approximately 2 acres of the final cover will need seeding, planting, or fertilizing each year to maintain or re-establish vegetation.

The unit cost of $1,166 per acre was acquired from section 32 92 19.13-0020 of the Year 2016 RS Means (mechanical seeding) for Portland, Oregon, and has been adjusted for inflation using the IPD values to current dollars.

The cost estimate assumes revegetation activities will be necessary for 30 years of post-closure care.

5. Other

<u>Cover System Earthwork, Labor, Equipment, Surveying</u>

This line item covers additional site work related to maintaining the final cover, such as earthwork and surveying, and related labor and equipment costs. The 2014 unit cost is lump sum and based on engineering judgment, and has been adjusted for inflation using the IPD values.

b. Environmental Monitoring

The Environmental Monitoring section includes costs associated with sampling, analyzing and reporting water quality impacts from the landfill. Included in this section are costs associated with replacing wells and eventual abandonment.

1. Surface Water Sampling

The Surface Water Sampling unit cost includes costs associated with collecting samples from surface water monitoring points and with the subsequent analysis.

Unit cost is based on the Surface Water Sampling and Analysis cost estimate from January 2013, and adjusted for inflation using the IPD values. The cost was recommended by SCS Engineers for the 2013 cost estimate by Vista. The cost estimate assumes sampling and analysis activities will be necessary for 30 years of post-closure care.

2. Surface Water Analysis – Included in Surface Water Sampling Costs

3. Quarterly Groundwater Sampling – Not Used

4. Semiannual Groundwater Sampling

This item includes costs associated with sampling groundwater monitoring wells on a semiannual basis. Under its Semiannual Compliance Monitoring Program, Riverbend Landfill is required to perform semiannual sampling of 10 compliance wells (20 sampling events total per year). Under its Semiannual and Annual Detection Monitoring Program, Riverbend Landfill is required to perform semiannual sampling for 3 of its detection wells, annual sampling for the other 3 detection wells, and annual sampling for 3 detection piezometers (12 sampling events total per year).

Unit cost is based on the groundwater sampling cost estimate from January 2013, and adjusted for inflation using the IPD values. The cost estimate assumes sampling activities covering 32 sampling events per year will be necessary for 30 years of post-closure care.

5. Quarterly Groundwater Analysis– Not Used

6. Semiannual Groundwater Analysis

This item includes costs associated with analyzing groundwater monitoring well samples on a semiannual basis.

Unit cost is based on the groundwater analysis cost estimate from January 2013, and adjusted for inflation using the IPD values. The cost estimate assumes analysis activities will be necessary for 30 years of post-closure care.

7. Water Quality Report Preparation

This item includes costs associated with preparing and reporting on water quality.

Unit cost is based on the cost for preparing the water quality portion of the Annual Environmental Monitoring Report (AEMR), as estimated for Hillsboro Landfill by SCS Engineers in 2014, and adjusted for inflation using the IPD values. The cost estimate assumes report preparation will be necessary for 30 years of post-closure care.

8. Groundwater Well Replacement

This item includes costs associated with decommissioning damaged groundwater wells and replacing them with new wells as necessary during the post-closure care period. Costs are prorated in consideration of the 30 years of post-closure maintenance assumed, the number of wells in the system, and the replacement frequency assumed for each well. The cost estimate assumes that there will be 1 well replacement over the post-closure maintenance period, and assigns 3.33 percent of the replacement cost of a well to each year.

The 2014 unit cost is per well and based on engineering judgment, and has been adjusted for inflation using the IPD values.

9. Groundwater Well Abandonment – Not Used

10. Other

Groundwater Analytical QA and Statistics

This item covers the quality assurance (QA) review and statistical analysis of the results from the 32 groundwater sampling events per year.

Unit cost is based on the Groundwater Analytical QA and Statistics cost estimate from January 2013, and adjusted for inflation using the IPD values. The cost estimate assumes this work will be necessary for 30 years of post-closure care.

Well Redevelopment Accrual, Each Well Every 10 Years

This item includes costs associated with redeveloping groundwater wells as is necessary during the post-closure care period. Costs are prorated in consideration of the 30 years of post-closure maintenance assumed, the number of wells in the system and the redevelopment frequency assumed for each well. The cost estimate assumes that each well will be redeveloped every 10 years over the post-closure period resulting in 48 well redevelopments over the post-closure maintenance period, and assigns 120 percent of the redevelopment cost of a well to each year.

Unit cost is based on the well redevelopment cost estimate from January 2013 and adjusted for inflation using the IPD values to current dollars.

c. Leachate Monitoring

The Leachate Monitoring section includes costs associated with operating and maintaining the leachate collection system, routine leachate monitoring, and eventual system decommissioning.

1. Leachate Sampling

The Leachate Sampling unit cost includes costs associated with sampling leachate. Unit cost is based on the cost for leachate sampling estimated for Hillsboro Landfill by SCS Engineers in 2014, and adjusted for inflation using the IPD values. The cost estimate assumes sampling activities will be necessary for 30 years of post-closure care.

2. Leachate Analysis

This item includes all costs associated with analyzing the sampled leachate. Unit cost is based on the cost for leachate analysis estimated for Hillsboro Landfill by SCS Engineers in 2014, and adjusted for inflation using the IPD values. The cost estimate assumes analysis activities will be necessary for 30 years of post-closure care.

3. Leachate Reporting

This item includes all costs associated with reporting the results of the leachate analysis to the appropriate regulatory agency in an annual leachate management report. Unit cost is based on the cost for leachate reporting estimated for Hillsboro Landfill by SCS Engineers in 2014, and adjusted for inflation using the IPD values. The cost estimate assumes reporting activities will be necessary for 30 years of post-closure care.

4. Leachate Collection System Maintenance

This item includes all labor and parts necessary to conduct routine maintenance on the leachate collection system. Unit cost is based on the cost for leachate collection system maintenance estimated for Hillsboro Landfill by SCS Engineers in 2014, and adjusted for inflation using the IPD values. This cost includes both routine maintenance and non-routine maintenance. The cost estimate assumes routine maintenance activities will be necessary for 30 years of post-closure care. Non-routine maintenance costs include the cost of replacing two pumps every 5 years are pro-rated over the 30 year post-closure care period.

5. Leachate Collection System Operation – Not Used

6. Leachate Collection System Decommissioning – Not Used

7. Pump Replacement – Not Used

8. Leachate Treatment

Leachate is currently hauled off-site for treatment and disposal at a publicly owned treatment works and another WM landfill. The 2014 average cost was estimated to be $85 per 1,000 gallons. The total cost of leachate disposal for the 30 year period is pro-rated in consideration of the 30 years of post-closure maintenance, and adjusted for inflation using the IPD values. The cost estimate for each year is equivalent to the cost of disposing of approximately 2,780,820 gallons of leachate, which was determined by dividing the expected leachate generation over the 30 years of post-closure by the 30 year post-closure period. For the first year of post-closure it was assumed that 14.5 million gallons would be generated and then the volume would decrease by approximately 42 percent the year following closure and approximately 12 percent each year thereafter.

9. Leachate Evaporation Pond Repair

Cost assumes a full liner replacement of the leachate evaporation pond is required in year 15 of post-closure. Both the primary and secondary liners would be replaced across the approximately 24,372 square yard leachate evaporation pond area. The planar pond floor area was calculated as approximately 14,721 square yards and was adjusted to 14,722 square yards to account for the 1 percent slope of the pond floor. The planar sloped area was calculated to be approximately 7,448 square yards and was adjusted to 8,327 square yards to account for the 2:1 side slope. An additional 1,323 square yards was determined by multiplying the approximate perimeter length (1,701 feet) by 7 feet to account for the crest and anchor trench material. The 2017 cost estimate of $20.636/square yard was estimated by adding the 2014 geomembrane and geotextile costs ($6.70+$2.61) and multiplying by 2 to account for the primary and secondary liners, then multiplying by the 2014 to 2017 inflation rate and adding a mobilization cost on a square yard basis $25,000/24,372 square yards.

The cost of the leachate evaporation pond repair is pro-rated over the 30-year post-closure care period and is adjusted for inflation using the IPD values to current dollars.

10. Leachate Evaporation Pond Decommissioning – Not Used

11. Other

<u>Decommissioning</u>

This item covers the cost of decommissioning the leachate collection and storage system at the end of the post-closure maintenance period.

The 2016 unit cost is lump sum and is based on engineering judgment. This cost is pro-rated over the 30-year post-closure care period and is adjusted for inflation using the IPD values to current dollars.

d. Landfill Gas Monitoring

The Landfill Gas Monitoring section includes costs associated with routine landfill gas control system sampling, operation, maintenance, and eventual decommissioning.

1. Landfill Gas Well Sampling – Not Used

2. Landfill Gas Well Analysis – Not Used

3. Perimeter Landfill Gas Probe Sampling – Not Used

4. Perimeter Landfill Gas Probe Analysis – Not Used

5. Landfill Gas System Maintenance

This item includes labor and parts necessary to conduct routine maintenance on the landfill GCCS. Unit cost is based on the cost for landfill gas system maintenance estimated for Hillsboro Landfill by SCS Engineers in 2014, and adjusted for inflation using the IPD values. This cost includes both routine maintenance and non-routine maintenance. The non-routine maintenance assumption was increased to $26,000 per year to cover the added cost of repairs related to the NSPS monitoring. This additional amount is based on the need to utilize rental equipment and additional days for repairs above other non-routine maintenance. The cost estimate assumes routine and non-routine maintenance activities will be necessary for 30 years of post-closure care.

6. Landfill Gas System Operation

This item includes costs associated with operating the landfill GCCS including the required source testing on the flare. As of 2022 source testing frequency was increased from once every 5 yrs to annual as per the Landfill Methane Rule under OAR 340-239.

Unit cost is based on actual costs for operation and source test quotes for 2022, these were not inflated as they are current year costs. The cost estimate assumes the GCCS will be operational for 30 years of post-closure care.

7. Convert from Active to Passive

This item includes costs associated with converting an active gas extraction system to a passive system. This is a one-time cost pro-rated over the 30 year post-closure care period.

Unit cost is based on the One Time Conversion from Active to Passive Operation cost estimate from January 2013, and adjusted for inflation using the IPD values.

8. Landfill Gas System Decommissioning

This item includes costs associated with decommissioning the landfill gas system as a part of exiting post-closure care. This is a one-time cost pro-rated over the 30 year post-closure care period.

Unit cost is based on the One-time System Decommissioning cost estimate from January 2013 and adjusted for inflation using the IPD values to current dollars.

9. Landfill Gas Probe Replacement – Not Used

10. Vertical Gas Well Replacement – Not Used

11. Vertical Gas Well Abandonment – Not Used

12. Blower Replacement

This item includes the costs associated with replacing blowers for the landfill gas collection system. Replacement costs for 2 blowers are pro-rated over the 30 year post-closure care period.

Unit cost is based on the cost for blower replacement estimated for Hillsboro Landfill by SCS Engineers in 2014 and adjusted for inflation using the IPD values to current dollars.

13. Condensate Treatment – Not Used

14. Condensate Pump Replacement – Not Used

15. Flare Maintenance

This item includes labor and parts necessary to conduct routine maintenance on the flare and associated systems.

Unit cost is based on the cost for routine flare maintenance estimated for Hillsboro Landfill by SCS Engineers in 2014, and adjusted for inflation using the IPD values. The cost estimate assumes that flare maintenance activities will be necessary for 30 years of post-closure care.

16. Lateral Replacement – Not Used

17. Header Replacement – Not Used

18. NSPS Monitoring

This item includes costs necessary to conduct monitoring in compliance with NSPS grid spacing requirements (e.g., surface emission monitoring) and preparing an annual NSPS report.

Unit cost is based on engineering judgment and was increased in 2021 to account for updates to the NSPS including additional requirements for penetration monitoring, additional surface emission monitoring and the associated additional reporting. Additional cost increase in 2022 to reflect the Landfill Methane rule change in Oregon under OAR 340-239 which reduced grid spacing (thereby increasing the number of passes to monitor), added more detailed monitoring (instantaneous and consolidated), and tightening up repair timing. This rule change resulted in an increase of $93,277 per year for NSPS monitoring and reporting over previous years. No inflation adjustment was applied to this year's cost because it is based on actual 2022 dollars. The cost estimate assumes that NSPS monitoring will be necessary for 30 years of post-closure care.

19. Title V Emissions Fee

This item includes fees that must be paid in accordance with Title V requirements.

Unit cost is based on actual site costs for this permit. No inflation adjustment was applied to this year's cost because it is based on actual 2022 dollars. The cost estimate assumes that Title V emissions fees will need to be paid each year through the 30 years of post-closure care.

20. Other

<u>Landfill Methane Rule Costs – Every 5 yrs</u>

This item covers the permit preparation fees related to the Oregon Landfill Methane Rules (OAR 340-239) beginning in 2022. This is a cost that will occur every five years and is normalized over the 30 year post-closure care period.

Unit cost is based on estimated costs to update the permit every five years as system updates or changes are made. No inflation adjustment was applied to this year's cost as it is assumed to be in 2022 dollars.

<u>DEQ and Clean Air Oregon Fees</u>

This item covers permit fees associated with DEQ GHG fees and Clean Air Oregon base fees for emissions. This cost was added to address the new LMR rule.

Unit cost is based on actual costs for 2022. No inflation adjustment was applied to this year's cost as they are assumed to be in 2022 dollars.

<u>Quarterly H2S and CO Sampling & Reporting</u>

This item covers sampling and monitoring for H2S and CO per the site permit. This activity is expected to remain in place during Post-Closure.

Unit cost is based on actual costs for 2022. The current costs are for a certain number of wells to be sampled. The assumption was to reduce the number of wells to monitor over time. It was assumed that for Year 1-5 the current number of wells are monitored then reduced by 25% for the subsequent 5 yrs and then by 50% for all remaining 5 year periods of Post-closure. No inflation adjustment was applied to this year's cost as they are assumed to be in 2022 dollars.

<u>Gas Migration Monitoring and Reporting</u>

This item covers the activities associated with landfill gas migration monitoring and reporting.

Unit cost is based on the cost estimate from January 2013, and adjusted for inflation using the IPD values. The cost estimate assumes this monitoring and reporting will be necessary for 30 years of post-closure care.

Blower Maintenance and Repair

This item includes labor and parts necessary to conduct routine maintenance and repair on the blowers and associated systems.

Unit cost is based on the cost for blower maintenance and repair estimated for Hillsboro Landfill by SCS Engineers in 2014, and adjusted for inflation using the IPD values. The cost estimate assumes that blower maintenance activities will be necessary for 30 years of post-closure care.

Blower Electricity

This has traditionally been a separate line item from other utility costs, covering the electricity used for the blowers and associated systems.

Unit cost is based on engineering judgment of an average annual cost, which is expected to be higher during the early years after closure, and then decrease over time as gas flow decreases. The cost estimate assumes that the blowers will be operational for 30 years of post-closure care.

e. General Site Maintenance

The General Site Maintenance section includes costs associated with maintaining the site which aren't covered elsewhere in the cost estimate.

1. Security – Not Used

2. Fence and Gate Repairs

This includes all costs associated with annual repairs to the fence and/or gate. It is assumed that approximately 20 linear feet (10%) of the 2000 linear feet of fence will need to be replaced each year. The 2014 unit cost is per linear foot and based on engineering judgment and has been adjusted for inflation using the IPD values to current dollars.

3. Road Maintenance

It is assumed that 1,500 square feet of road will need to be repaired annually. Minimal road repair is anticipated due to limited on-site traffic and use. The 2014 unit cost is per square foot and based on engineering judgment and has been adjusted for inflation using the IPD values to current dollars.

4. Utilities

This includes utility costs associated with maintaining the site during post-closure care. This does not include utilities required to operate the landfill GCCS and leachate equipment.

The 2014 unit cost is lump sum and based on engineering judgment and has been adjusted for inflation using IPD values to current dollars.

5. Building Maintenance

This includes costs associated with maintaining any on-site buildings in usable condition, if necessary, during the post-closure care period. The costs of maintaining on-site buildings are included and pro-rated over the 30 year post-closure care period.

The 2014 unit cost is lump sum and based on engineering judgment and has been adjusted for inflation using IPD values to current dollars.

6. Stormwater System Maintenance

This includes costs associated with maintaining the stormwater system.

The 2014 unit cost is lump sum and based on engineering judgment, and has been adjusted for inflation using IPD values. The cost estimate assumes that the stormwater system will be maintained for 30 years of post-closure care.

7. Other

<u>Mechanically Stabilized Earth (MSE) Berm Maintenance</u>

This includes costs associated with maintaining the MSE Berm during the post-closure care period (vegetation, pavement, and stormwater).

Unit cost is lump sum and based on the cost estimate presented in the Final Engineered Site Closure and Post-Closure Plan (Geosyntec 2014) in December 2014 and has been adjusted for inflation using IPD values to current dollars.

f. Professional Services

The Professional Services section includes work related to ensuring the site maintains regulatory compliance and periodic review by a Professional Engineer.

1. Surveying – Not Used

2. Permit Renewals – Not Used

3. Post-Closure Care Cessation Report – Not Used

4. Site Inspection

This includes costs associated with having a third party periodically inspect the site, including stability monitoring and inspection of the MSE Berm.

Unit cost is lump sum and based on the cost estimate presented in the Final Engineered Site Closure and Post-Closure Plan (Geosyntec 2014) in December 2014 and has been adjusted for inflation using IPD values. The cost estimate assumes that these costs will be necessary for 30 years of post-closure care.

5. Other – Not Used

g. Overhead and Profit

The Overhead and Profit section was not used because unit costs in other sections include overhead and profit.

h. Contingency

An additional 10 percent is added to the costs to account for unforeseen contingencies.

i. Taxes

The Taxes section was not used because unit costs in other sections include taxes where applicable.

j. Discounting

Costs have not been discounted this year. Based on the DEQ Worksheet for MSW Facilities using the MSW Reference Rate provided by the DEQ and the approved MSW Reference Rate of -2.11% discounting the total was not beneficial.

Attachment 3
Estimated Leachate Disposal Quantities

WASTE MANAGEMENT	Riverbend Landfill Co. 13469 SW Hwy 18 McMinnville, OR 97128

Site: Riverbend Landfill
Project: 2022 Post-Closure Cost Estimate

TABLE 1
ESTIMATED PRESENT WORTH LEACHATE DISPOSAL QUANTITIES [1)]

Year	Years from 2022 (n)	Estimated Leachate Generation (gal/yr)
2023	1	14,500,000
2024	2	8,410,000
2025	3	7,449,578
2026	4	6,598,836
2027	5	5,845,249
2028	6	5,177,722
2029	7	4,586,426
2030	8	4,062,656
2031	9	3,598,701
2032	10	3,187,729
2033	11	2,823,690
2034	12	2,501,225
2035	13	2,215,585
2036	14	1,962,565
2037	15	1,738,440
2038	16	1,539,910
2039	17	1,364,053
2040	18	1,208,278
2041	19	1,070,293
2042	20	948,065
2043	21	839,796
2044	22	743,891
2045	23	658,939
2046	24	583,688
2047	25	517,031
2048	26	457,986
2049	27	405,684
2050	28	359,355
2051	29	318,317
2052	30	281,965
2053	31	249,764
	TOTALS	86,205,417
	Annual Average	2,780,820

Updated by WM
March 2021

Attachment 4
Oregon DEQ Communication and Reference Documents

2021 Condition of Approval

Adams, Melody

From: SCHWARZ Bob * DEQ <bob.schwarz@deq.state.or.us>
Sent: Friday, November 12, 2021 3:00 PM
To: Adams, Melody
Cc: SCHWARZ Bob * DEQ
Subject: [EXTERNAL] RE: Riverbend FA update
Attachments: 2021-11-12-Approval of 2021 FA updates.pdf

Hi Melody,
Here is the approval letter.
Bob

From: Adams, Melody <madams13@wm.com>
Sent: Monday, November 8, 2021 3:39 PM
To: SCHWARZ Bob * DEQ <bob.schwarz@deq.state.or.us>
Subject: RE: Riverbend FA update

Hi Bob,

I apologize for not returning a call that was an oversight on my part.

I agree, that going forward we would use the quarter in which the month exists rather than the previous quarter.

Thanks for your patience with this. I'll look for the letter.

MELODY A. ADAMS
PNW/BC Area Project Manager (Eng III)
Engineering
madams13@wm.com

T: 503.493.7854
C: 503.348.3781
7227 NE 55th Ave
Portland OR 97218

From: SCHWARZ Bob * DEQ <bob.schwarz@deq.state.or.us>
Sent: Friday, November 5, 2021 1:11 PM
To: Adams, Melody <madams13@wm.com>
Cc: SCHWARZ Bob * DEQ <bob.schwarz@deq.state.or.us>
Subject: [EXTERNAL] RE: Riverbend FA update

Hi Melody,
I had left you a phone message a week or so ago to discuss this, since I was confused by your explanation regarding terminology for the quarters. Rather than hold up my approval of the FA report any longer, can we agree that future reports will identify quarters (July is 3rd quarter, not 2nd quarter, etc.) as we would expect them to be identified? If that works for you, than I won't ask you to revise this report (and certainly not previous reports) but will note these discrepancies in the approval letter with the understanding that these issues will be addressed in future reports.

Sound good?
Bob

From: Adams, Melody <madams13@wm.com>
Sent: Tuesday, September 28, 2021 3:18 PM
To: SCHWARZ Bob * DEQ <bob.schwarz@deq.state.or.us>
Subject: RE: Riverbend FA update

Bob,

My apologies for the delay in getting you a response on this. I had prepared this response but left it in draft so I apologize for not getting this to you. See responses in red below. I can revise the text and resend once you are ok with changes.

MELODY A. ADAMS
PNW/BC Area Project Manager (Eng III)
Engineering
madams13@wm.com

T: 503.493.7854
C: 503.348.3781
7227 NE 55th Ave
Portland OR 97218

From: SCHWARZ Bob * DEQ <bob.schwarz@deq.state.or.us>
Sent: Monday, June 28, 2021 10:50 AM
To: Adams, Melody <madams13@wm.com>
Cc: SCHWARZ Bob * DEQ <bob.schwarz@deq.state.or.us>
Subject: [EXTERNAL] Riverbend FA update

Hi Melody,
I am going through the financial assurance update for Riverbend. A couple of questions for you.

Page 1-3 (pdf pg 48). The document includes two bulleted paragraphs describing why Riverbend Landfill Company concludes it has more than 5 years of remaining life. These two paragraphs are almost identical. Did you intend to replace the first bullet with the second bullet? Yes the second bullet is correct. First bullet should be deleted.

- ~~RLC received an expansion on May 30, 2013 for the RL which increased the site's permitted airspace by 984,086 cubic yards (cy) and increased the area of the landfill to a total footprint of approximately 87.4 acres of the 700-plus acre property. A final grading plan modification was approved by DEQ in a letter dated June 29, 2017, which increased the landfill's airspace by approximately 490,000 cy. As of January 1, 2021, the site continues to place waste in the approved FGPM area. Remaining permitted capacity for the site as of January 1, 2021 is 416,300 cy which includes all available permitted airspace including areas of settlement. Based the site's 5 year overall average density and current average waste receiving rate this equates to approximately 8.7 years of capacity.~~

- RLC received an expansion on May 30, 2013 for the RL which increased the site's permitted airspace by 984,086 cubic yards (cy) and increased the area of the landfill to a total footprint of approximately 87.4 acres of the 700-plus acre property. A final grading plan modification was approved by DEQ in a letter dated June 29, 2017, which increased the landfill's airspace by approximately 490,000 cy. As of March 2021, the site continues to place waste in the approved FGPM area. Remaining permitted capacity for the site as of January 1, 2021 is 416,300 cy which includes all available permitted airspace including areas of settlement. Based the site's 5 year overall average density and current average waste receiving rate this equates to approximately 8.7 years of capacity.

Pdf pg 81 and other pages. For January and July, the report consistently refers to the preceding quarter rather than the actual calendar quarter. (I have highlighted examples of these in yellow in the attachment). For example, January 2015 is identified as 4th quarter of 2014, and July 2017 is shown as 2nd quarter of 2017 rather than third quarter. But for other months, the report identifies the quarter I would expect (October is correlated to 4th quarter, March to 1st quarter). Is there a reason for this?
I checked the CPC plans prepared back to 2012 to identify where there seemed to be change in how the quarter was selected for the IDP. It appears that the reports followed a consistent protocol for selecting the IDP with two exceptions: October 2017 and May 2019. I further researched these two instances to determine why an alternate protocol was followed. Below is a summary of what I found:

- 2017 FA Update: The FESCPCP was prepared in 2017and included an update to the cost estimate documents. The cost estimate was initially prepared for and internal review by 10/25/2017 (the end of the 1st month of the quarter), after internal review was completed in early November the cost estimate was finalized. It appears that based on this, they updated the cost estimate to use the 4th quarter rather than the 3rd quarter since the work was finalized later in the 4th quarter. The use of the 4th quarter for the 2017 costs was carried through on subsequent cost estimate updates for this reason.
- 2019 FA Update: The cost estimate was prepared in early March of 2019 but the final Closure & Post-Closure Plan update was not completed until after the annual airspace report was completed which put the completion date into May 2019. The notation in the report should have said "IDP for March 2019…" rather than "IDP for May 2019". This didn't impact subsequent cost estimates.

Overall this deviation from previous protocols for selecting the quarter for the IDP was based on specific timing for when cost estimates were completed rather than when the FA package was submitted. Let me know if I need to add clarifications to the previous reports.

Bob

****

Bob Schwarz, PE
Oregon Department of Environmental Quality
700 NE Multnomah St #600
Portland, OR 97232
Office: 503-229-5128
Cell: 971-254-7493
Bob.Schwarz@deq.state.or.us

2022 DEQ Reminder Letter

Oregon
Kate Brown, Governor

Department of Environmental Quality
Western Region Eugene Office
165 East 7th Avenue, Suite 100
Eugene, OR 97401
(541) 686-7838
FAX (541) 686-7551
TTY 711

March 17, 2022

Jim Denson
Melody Adams
Riverbend Landfill Company
7227 NE 55th Ave.
Portland, OR 97218

RE: Riverbend Landfill, Solid Waste Permit No. 345, Yamhill
Financial Assurance Recertification

This letter is a reminder that your annual recertification of financial assurance for the Riverbend Landfill must be completed and a copy of your notarized annual recertification document provided to the Department of Environmental Quality **by no later than April 8, 2021**. Please keep in mind that if you are unable to meet this deadline due to unexpected circumstances that you can request an extension in writing. Failure to submit your annual recertification of financial assurance document to DEQ by this deadline, or by an approved extension deadline, will result in enforcement action being taken by DEQ.

Your annual update should include a review of your closure and/or post closure care cost estimates, and any changes in those cost estimates should be reflected in your updated financial assurance instrument. The cost estimates review and adjustments (other than a straight inflationary adjustment to tasks or unit costs) must be endorsed and stamped by a registered professional engineer.

If you choose to discount your closure and/or post-closure cost estimates, you are required to use a rate that is no greater than the current DEQ Reference Rate of -2.11 percent. This rate is effective through June 30, 2022.

Financial assurance-related worksheets, guidance and document formats are available to assist you with your annual update. These materials can be found on DEQ's website under **Financial Assurance Documentation**, at https://www.oregon.gov/deq/mm/swpermits/Pages/Financial-Assurance.aspx.

For your facility, under **Worksheets and Guidance**, please use the following:

- Compliance Checklists – for all Financial Assurance Mechanisms
- Rates for calculating Financial Assurance updates
- Corporate Financial Test Worksheet (if Corporate Financial Test Mechanism used)
- Discounting Worksheet – for MSW facilities
- Straight Inflation Adjustment to Cost Estimates Guidance for MSW and Non-MSW facilities Memo

For your facility, under **Document Formats**, please use the following;

- Annual Recertification
- Appropriate Document Format based on Mechanism you are using
- Standby Trust Amendment Format (if required by your Mechanism)
- Notary Block Format

Please send your complete financial assurance annual update, including your notarized annual recertification, a copy of your updated closure and/or post-closure care cost estimates and supporting documentation to:

Denise Miller
Permit Coordinator
DEQ Western Region
165 E 7th Ave., Suite 100
Eugene, OR 97401

Should you have any questions about your financial assurance submittal, when preparing the updated cost estimates or your other updated documents, please feel free to contact Jim McCourt our assigned engineer for Riverbend Landfill, by phone at 541-687-7438 or james.mccourt@deq.oregon.gov.

Sincerely,

Denise Miller

Denise Miller
Solid Waste Permit Coordinator
DEQ Western Region
541-687-7465
denise.miller@deq.state.or.us

WM Request for Extension & DEQ Approvals

Riverbend Landfill Company
13469 SW Highway 18
McMinnville, OR 97128
(503) 472-8788

April 1, 2022

Mr. James McCourt
Oregon Department of Environmental Quality (DEQ)
Western Region
165 East Seventh Avenue, Suite 100
Eugene, OR 97401

RE: Annual Financial Assurance Update and Recertification – Extension Request
Riverbend Landfill Solid Waste Disposal Site Permit (SWDP) No. 345
Yamhill County, Oregon

Mr. McCourt:

Riverbend Landfill Company (RLC) is requesting a 14-day extension for the submission of our Annual Financial Assurance Update and Recertification for the Riverbend Landfill. We are requesting the extension to account for the time we needed to get updated costs in relation to the upcoming rule change related to NSPS monitoring and landfill (OAR 340-239 Landfill Gas Emissions). While these rule changes don't take effect until August of 2022, we wanted to make sure they were reflected in the Post-closure cost estimate as they are expected to have an impact on Post-Closure costs. The draft update is in for review now with our certifying engineer, then we'll need time to pull together the financial documents. We are diligently working on this update now but would appreciate an extension to allow us to properly update the information and provide the necessary documentation. We hope that you will consider this request and change the deadline to April 22, 2022. Thank you for your consideration.

If you have any questions, please do not hesitate to contact me at 503.348.3781 or by email at madams13@wm.com.

Sincerely,

Melody A. Adams
PNW/BC Area Project Manager

CC: Denise Miller, DEQ
Jim Denson, WM
Dave Rettell, WM
Nicholas Godfrey, WM

Adams, Melody

From: MCCOURT James * DEQ <James.MCCOURT@deq.oregon.gov>
Sent: Tuesday, April 5, 2022 3:00 PM
To: Adams, Melody
Cc: SCHWARZ Bob * DEQ; MILLER Denise * DEQ
Subject: [EXTERNAL] RE: Riverbend LF - Financial Assurance Update Question-Extension of Date granted

Melody, An extension is granted for the FA submissions. Jim McCourt

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From: Adams, Melody <madams13@wm.com>
Sent: Friday, April 1, 2022 5:40 PM
To: MCCOURT James * DEQ <James.MCCOURT@deq.oregon.gov>
Subject: RE: Riverbend LF - Financial Assurance Update Question

Jim,

Thank you so much for this, it was confirmed what I was thinking. We are finalizing the update now, I've sent it off to Roger North to review, check and stamp. I am requesting a short extension so that we have time to get this to our corporate finance folks after it is reviewed. I've attached the formal request and explanation. We will send it in as soon as it is finished. I appreciate your consideration of this.

Hope you have a great weekend, I'm sorry we didn't connect, I will try to give you a call Monday.

Thanks.

MELODY A. ADAMS
PNW/BC Area Project Manager
Engineering
madams13@wm.com

T: 503.493.7854
C: 503.348.3781
7227 NE 55th Ave
Portland OR 97218

Adams, Melody

From:	MCCOURT James * DEQ <James.MCCOURT@deq.oregon.gov>
Sent:	Thursday, April 21, 2022 9:40 AM
To:	Adams, Melody
Cc:	SCHWARZ Bob * DEQ; MILLER Denise * DEQ
Subject:	[EXTERNAL] RE: Riverbend LF - Financial Assurance Update Question-Extension of Date granted-Granted until April 29

Thank for the update and agreed to the date change on your FA recertification submission for 2022 to April 29, 2022. Jim McCourt

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From: Adams, Melody <madams13@wm.com>
Sent: Tuesday, April 19, 2022 3:14 PM
To: MCCOURT James * DEQ <James.MCCOURT@deq.oregon.gov>
Cc: SCHWARZ Bob * DEQ <Bob.SCHWARZ@deq.oregon.gov>; MILLER Denise * DEQ <Denise.MILLER@deq.oregon.gov>
Subject: RE: Riverbend LF - Financial Assurance Update Question-Extension of Date granted

Hi Jim,

I just found out that the person who has to sign the recertification letter is out this week, may I request an additional week on the extension to 4/29? My understanding is he is back on Monday but to give a little flex room with him getting caught up I'd like to have the buffer to 4/29.

Thank you.

FYI I believe Roger North will be sending over some things for review and discussion on the capping event next week.

MELODY A. ADAMS
PNW/BC Area Project Manager
Engineering
madams13@wm.com

T: 503.493.7854
C: 503.348.3781
7227 NE 55th Ave
Portland OR 97218

From: MCCOURT James * DEQ <James.MCCOURT@deq.oregon.gov>
Sent: Tuesday, April 5, 2022 3:00 PM
To: Adams, Melody <madams13@wm.com>
Cc: SCHWARZ Bob * DEQ <Bob.SCHWARZ@deq.oregon.gov>; MILLER Denise * DEQ <Denise.MILLER@deq.oregon.gov>
Subject: [EXTERNAL] RE: Riverbend LF - Financial Assurance Update Question-Extension of Date granted

Melody, An extension is granted for the FA submissions. Jim McCourt

DEQ Guidance Documents

Rates for Calculating Financial Assurance Updates

State of Oregon
Department of Environmental Quality

Land Quality Program: Materials Management
400 E. Scenic Drive
Suite 307
The Dalles, OR 97058
Phone: 541-639-7145
Contact: Jamie Jones
www.oregon.gov/DEQ

DEQ is a leader in restoring, maintaining and enhancing the quality of Oregon's air, land and water.

Municipal Solid Waste Disposal Site Reference Rate

This information is intended to assist in calculating costs associated with closure and post-closure activities for those solid waste disposal sites that are required to submit annual financial assurance updates.

This rate combines inflation and discount rates (specified by rule) into a single inflation-adjusted rate for discounting.

For July 1, 2021 through June 30, 2022 the MSW Reference Rate is -2.11%

Non-Municipal Solid Waste Disposal Site Inflation and Discount Rates

Inflation Rate: DEQ provides inflation-rate guidance each February based on a three-year moving average. The rate for calendar year 2022 is 2.93%. However, if the discount rate (determined below) is less than the guidance inflation rate, use the discount rate as the inflation rate, as well.

Discount Rate: Non-Municipal discount rate must be taken from Federal Reserve H.15 report issued on Monday of the week when calculations are done. The correct five-year bond rate to use is found in the "Nominal" section. Use the column that shows the average rate for the previous week. Please print and submit a copy of that page of the report with your Annual Financial Assurance Recertification as the figures may change weekly.

Current H.15 report: http://www.federalreserve.gov/releases/h15/current

Note: If inflation rate is greater than discount rate contact your local permit writer or permit coordinator for additional information.

Links to Applicable Oregon Administrative Rules

For Municipal Solid Waste Landfill Sites - OAR 340-094-0140(4)(a) Cost Estimates:
https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=71246

For Non-Municipal Solid Waste Sites - OAR 340-095-0090(4)(a) Cost Estimates:
https://secure.sos.state.or.us/oard/viewSingleRule.action?ruleVrsnRsn=71300

Alternative formats

DEQ can provide documents in an alternate format or in a language other than English upon request. Call DEQ at 800-452-4011 or email deqinfo@deq.state.or.us.

Last Updated: 2/17/2022
By: Jamie Jones

State of Oregon Department of Environmental Quality

Financial Assurance Update for 2022:
How to Adjust Cost Estimates For Inflation

Contact: Jamie Jones, DEQ Solid Waste Financial Assurance Lead
Materials Management – Eastern Region

Summary

This memo provides information for permitted facilities on how to incorporate inflation into financial assurance cost estimates. Facilities must provide annual updates of cost estimates to DEQ.

Cost adjustment options

Permittees required to maintain financial assurance for estimated closure, post-closure care, and (if required) corrective action costs, are required to adjust their cost estimates annually for inflation. *Reference: OAR 340-094-0140(6)(e)(A)(i) and OAR 340-095-0090(6)(d)(A)(i)*

There are two options permittees may use to adjust their cost estimates for inflation:

- **Option 1**: Have a State of Oregon Registered Professional Engineer recalculate the cost estimates in current year dollars each year (this must be used in certain situations); or
- **Option 2:** Use the method described in this memo. DEQ developed this method based on data from the U.S. Bureau of Economic Analysis.

Please note, option 1 listed above must be used in the following situations:

- The scope of work, design, or facility conditions have changed resulting in an increase or decrease in the estimated maximum costs of closure, post-closure care, or (if required) corrective action since the previous review. Examples include (but are not limited to) the installation or removal of monitoring wells, the expansion of a surface impoundment, a stormwater or leachate collection system design change, or a change in final cover design. *Reference: OAR 340-094-0140(6)(e)(A)(ii) and OAR 340-095-0090(6)(d)(A)(ii)*
- For Municipal Solid Waste Landfills, if the permittee chooses to discount their financial assurance cost estimates. *Reference: OAR 340-094-0140(6)(d)(B)*

Calculation instructions

Refer to the table to calculate an inflation adjustment. In the “Value” column, look up the GDP implicit price deflator value for the **current** year and quarter for which you are making the calculation. Divide that by the price deflator value for the year and quarter of the original estimate. Multiply that amount by the **original** cost estimate. The result represents the original cost estimate inflation-adjusted to current dollars.

Example

A closure-cost estimate completed in September of 2016 was $3,000,000. The scope of work, design, and facility conditions have NOT changed since the original cost estimate.

The inflation-adjusted cost for Oct 2022 (Q-IV) is calculated as follows:

Implicit price deflator value for 2022 Q-IV = 125.479

Implicit price deflator value for 2016 Q-III = 105.929

Inflation-adjusted cost estimate in current dollars =

$$\$3{,}000{,}000 \times \frac{125.479}{105.929} = \$3{,}553{,}685$$

How to submit the update

Submit the updated cost estimates to the DEQ office identified in your solid waste disposal site permit. Please include a copy of this memo and a copy of the original cost estimates with the submittal.

Alternative formats

DEQ can provide documents in an alternate format or in a language other than English upon request. Call DEQ at 800-452-4011 or email deqinfo@deq.state.or.us.

Table 1.1.9
GDP Implicit Price Deflator

Type	Year	Quarter	Value	Q to Q Rate Annualized
	2012	I	99.313	
	2012	II	99.713	1.62%
	2012	III	100.230	2.09%
	2012	IV	100.738	2.04%
	2013	I	101.141	1.61%
	2013	II	101.428	1.14%
	2013	III	101.906	1.90%
	2013	IV	102.515	2.41%
	2014	I	102.942	1.68%
	2014	II	103.525	2.28%
	2014	III	103.977	1.76%
	2014	IV	104.150	0.67%
	2015	I	104.113	-0.14%
	2015	II	104.677	2.18%
	2015	III	104.989	1.20%
	2015	IV	104.979	-0.04%
	2016	I	104.895	-0.32%
	2016	II	105.636	2.86%
	2016	III	105.929	1.11%
	2016	IV	106.487	2.12%
	2017	I	107.025	2.04%
	2017	II	107.369	1.29%
	2017	III	107.903	2.00%
	2017	IV	108.670	2.87%
	2018	I	109.261	2.19%
	2018	II	110.234	3.61%
	2018	III	110.597	1.32%
	2018	IV	111.175	2.11%
	2019	I	111.514	1.23%
	2019	II	112.152	2.31%
	2019	III	112.517	1.31%
	2019	IV	112.978	1.65%
	2020	I	113.346	1.31%
	2020	II	112.859	-1.71%
	2020	III	113.888	3.70%
	2020	IV	114.439	1.95%
	2021	I	115.652	4.31%
	2021	II	117.413	6.23%
	2021	III	119.115	5.93%
	2021	IV	121.137	6.96%
Projection	2022	I	122.015	2.93%
Projection	2022	II	122.899	2.93%
Projection	2022	III	123.790	2.93%
Projection	2022	IV	124.687	2.93%
Projection	2023	I	125.591	2.93%

2022 DEQ Guidance Inflation Rate

APPENDIX I

Riverbend Landfill Co, Inc Closure Schedule

WASTE MANAGEMENT
PNW/BC
James L. Denson Jr
jdenson@mw.com
602-757-3352

March 11, 2022
VIA E-MAIL ONLY

Mr. Brian Fuller
Manager Hazardous Waste & Materials Management
165 East 7th Avenue, Suite 100
Eugene, OR 97401
Brian.FULLER@deq.oregon.gov

RE: Riverbend Landfill Co, Inc Closure Schedule

Mr. Fuller;
Pursuant to the Department's request Riverbend Landfill Co, Inc (RLC) is submitting this closure schedule for the landfill.

RLC has prepared a figure (Fig 1 attached) that depicts the areas to be closed in approximately 20-acre increments. RBL will be closing approximately 11 acres denoted as the Southwest Slope (highlighted red) in the 2022 construction season. Additionally, the 11-acre area denoted as the South Slope Phase 2 FGPM area (highlighted green) will be lined in preparation for waste acceptance as early as the 2022 construction season. This lined area adds another 278,000 yards of constructed airspace to the 200,000 yards currently available. Lining and the subsequent filling of this area is contingent on several factors including, but not limited to, construction synergies and costs with other closure areas, waste acceptance contracts, and future financial viability of the airspace. RBL regularly works with contractors that generate certain easy-to-place waste streams (soils, inert C&D, and others). RBL plans to concentrate waste placement efforts in the "West Slope", or "North Closure" areas depicted on Fig 1 to bring these areas to final grades. Timing of bringing these areas to final grade is contingent on many factors including, but not limited to, the volumes of wastes coming into the landfill over the next many years. The last area to be closed is expected to be the South Slope Phase 2 FGPM area. RBL is committed to closure of these areas as inbound waste volumes allow; this notwithstanding, final closure of all of the areas on Figure 1 will be eight years from the date of the approval of the Closure Permit.

RLC expects to be submitting the construction drawings for the Southwest Slope Final Closure area (Red Highlight) and the South Slope FGPM Liner (Highlighted Green) in the next 60 days.

Should you have any questions please feel free to contact me at jdenson@wm.com or by phone at 602-757-3352.

Sincerely,

James L. Denson Jr
Waste Management.
PNW/BC Environmental Protection Manager

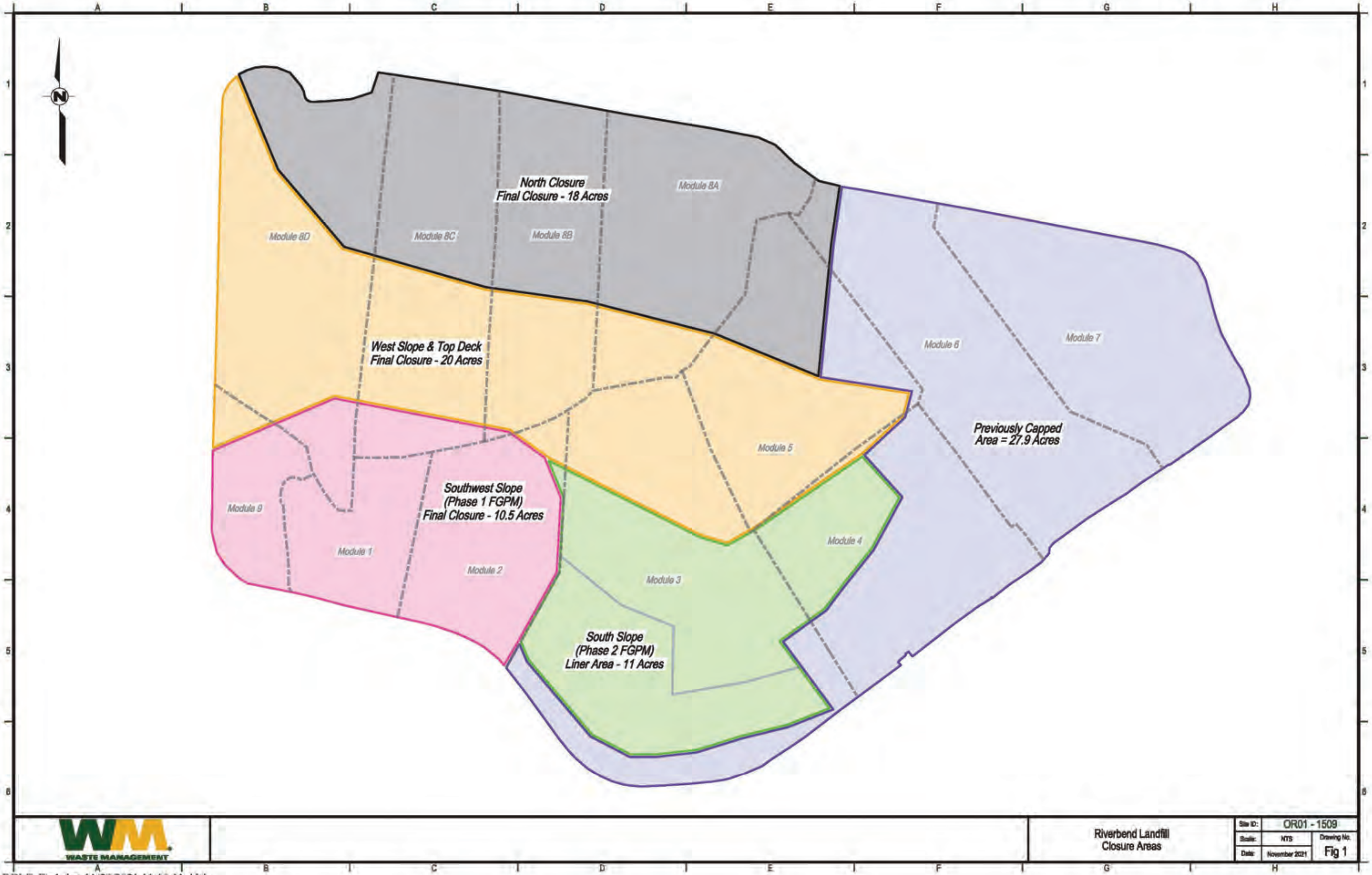
CC;

Bob Schwarz DEQ
James McCourt DEQ
Seth Sadofsky DEQ
Facility File

Attachment

Fig 1 – Closure Areas.

Figure 1 Closure Areas



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