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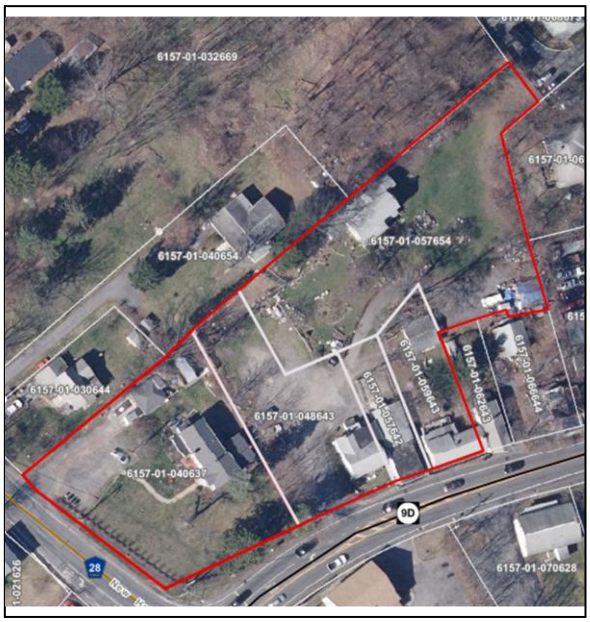
# *STORMWATER POLLUTION PREVENTION PLAN*

*for*

# ***Gas Land Route 9D Wappinger***

2361 Route 9D
Town of Wappinger
Dutchess County, New York




Issued: August 2020
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Prepared for:

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## PREPARER OF THE SWPPP

"I hereby certify that the Stormwater Pollution Prevention Plan (SWPPP) for this project has been prepared in accordance with the terms and conditions of the GP-0-20-001. Furthermore, I understand that certifying false, incorrect or inaccurate information is a violation of this permit and the laws of the State of New York and could subject me to criminal, civil and/or administrative proceedings."

Name and Title[1]: Chris Lapine, P.E. - Director

Date: Issued: August 2020 February 2021

[1] *This is a signature of a New York State licensed Professional Engineer employed by The Chazen Companies that is duly authorized to sign and seal Stormwater Pollution Prevention Plans (SWPPPs), NOIs, and NOTs prepared under their direct supervision. Refer to Appendix H for the Chazen Certifying Professionals Letter.*

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## 1.0 EXECUTIVE SUMMARY

This Stormwater Pollution Prevention Plan (SWPPP) has been prepared for major activities associated with construction of Gas Land Route 9D Wappinger in the Town of Wappinger. This SWPPP includes the elements necessary to comply with the national baseline general permit for construction activities enacted by the U.S. Environmental Protection Agency (EPA) under the National Pollutant Discharge Elimination System (NPDES) program and all local governing agency requirements. This SWPPP must be implemented and permit coverage must be obtained prior to the commencement of construction activity.

This SWPPP has been developed in accordance with the "New York State Department of Environmental Conservation (NYSDEC) State Pollutant Discharge Elimination System (SPDES) General Permit for Stormwater Discharges from Construction Activity," Permit No. GP-0-20-001, effective January 29, 2020 through January 28, 2025. The SWPPP and accompanying plans identify and detail stormwater management, pollution prevention, and erosion and sediment control measures necessary during and following completion of construction.

This SWPPP and the accompanying plans entitled " Gas Land Route 9D Wappinger" have been submitted as a set. These engineering drawings are considered an integral part of this SWPPP. Therefore, this SWPPP is not considered complete without them. References made herein to "the plans" or to a specific "sheet" refer to these drawings.

This report considers the impacts associated with the intended development with the purpose of:

1. Maintaining existing drainage patterns as much as possible while continuing the conveyance of upland watershed runoff;
2. Controlling increases in the rate of stormwater runoff resulting from the proposed development so as not to adversely alter downstream conditions; and
3. Mitigating potential stormwater quality impacts and preventing soil erosion and sedimentation resulting from stormwater runoff generated both during and after construction.

The analysis and design completed and documented in this report is intended to be part of the application made for a mixed-use redevelopment project with an increase in impervious area completed on behalf of the Owner/Operator.

### 1.1 Project Description

Gas Land Petroleum, Inc. is proposing redevelopment project with an increase in impervious area, to include: a gasoline filling station (four pumps with eight fueling stations), 2,400 square foot convenience store, 1,500 square foot liquor store, with four one-bedroom apartments located above and corresponding parking. A Site Location Map has been provided in Appendix G, as Figure 1.

This type of project is included in Table 2 of Appendix B of GP-0-20-001; and the project site is not located in one of the watersheds listed in Appendix C of GP-0-20-001. Therefore, this SWPPP includes post-construction stormwater management practices, as well as erosion and sediment controls.

This project is located within the Town of Wappinger regulated, traditional land use control Municipal Separate Stormwater Sewer System (MS4). Therefore, an MS4 SWPPP Acceptance Form is required to accompany NOIs submitted to the NYSDEC.

Runoff from the project site will discharge to the Wappinger Creek, which is not included in the list of Section 303(d) water bodies included in Appendix E of GP-0-20-001.

Project construction activities will consist primarily of site grading, paving, building construction, and the installation of storm drainage, water supply, and sanitary sewer infrastructure necessary to support the proposed redevelopment project with an increase in impervious area. Construction phase pollutant sources anticipated at the site are disturbed (exposed) soil, vehicle fuels and lubricants, chemicals associated with building construction, and building materials. Without adequate control there is the potential for each type of pollutant to be transported by stormwater.

## 1.2 Stormwater Pollution Controls

The stormwater pollution controls outlined herein have been designed and evaluated in accordance with the following standards and guidelines:

- New York State Stormwater Management Design Manual, dated January 2015 (Design Manual).
- New York State Standards and Specifications for Erosion and Sediment Control, dated November 2016 (SSESC).
- Virginia DCR Stormwater Design Specification No.9 Bioretention Version 2.0, dated January 1, 2013 (as provided by NYSDEC)

Stormwater quality will be managed through the implementation of temporary and permanent erosion and sediment control measures, the proposed stormwater management practices, and other construction-phase pollution controls outlined herein.

The proposed stormwater management approach consisting of pipes and on-site stormwater management practices will adequately collect, treat, and convey the stormwater runoff.

The proposed project area and NYS Route 9D in the vicinity of the project area is challenged by stormwater management constraints. The stormwater management constraints consist of the following existing conditions:

- Lack of available head within limited off-site drainage collection system

Stormwater management practice elevations must not be too low to preclude tying underdrains and overflow structures into a downstream point of relief. Therefore, a modified bioretention area will be used to manage and treat stormwater runoff generated by the proposed redevelopment of the site and allow a connection to downstream drainage. Supporting information is provided in Appendix M.

A modified bioretention, underground infiltration system, and underground stormwater detention system will be used to manage and treat stormwater runoff generated by the proposed redevelopment project with an increase in impervious area.

Pre- and post-development surface runoff rates have been evaluated for the 1-, 10-, and 100-year 24-hour storm events. Comparison of pre- and post-development watershed conditions demonstrates that the peak rate of runoff from the project site will not be increased.

### 1.3 Conclusion

This project is subject to the requirements of the Town of Wappinger regulated MS4, and this SWPPP has been prepared in conformance with the current Design Manual and SSESC. As such, GP-0-20-001 coverage will be effective five (5) business days from the date the NYSDEC receives the electronically submitted eNOI and signed “MS4 SWPPP Acceptance” form, or ten (10) business days from the date the NYSDEC receives the complete paper NOI and signed “MS4 SWPPP Acceptance” form.

## 2.0 SWPPP IMPLEMENTATION RESPONSIBILITIES

A summary of the responsibilities and obligations of all parties involved with compliance with the NYSDEC SPDES General Permit GP-0-20-00 conditions is outlined in the subsequent sections. For a complete listing of the definitions, responsibilities, and obligations, refer to the SPDES General Permit GP-0-20-001 presented in Appendix A.

### 2.1 Definitions

1. “General SPDES Permit” means a SPDES permit issued pursuant to 6 NYCRR Part 750-1.21 authorizing a category of discharges.

2. “Owner” or “Operator” means the person, persons, or legal entity which owns or leases the property on which the *construction activity* is occurring; and/or an entity that has operational control over the construction plans and specifications, including the ability to make modifications to the plans and specifications. There may be occasions during the course of a project in which there are multiple Owners/Operators, all of which will need to file and maintain the appropriate SWPPP documents and plans, including without limitation, the Notice of Intent (NOI) and Notice of Termination (NOT).

3. “Owner’s/Operator’s Engineer” means the person or entity retained by an Owner/Operator to design and oversee the implementation of the SWPPP.

4. “Contractor” means the person or entity identified as such in the construction contract with the Owner/Operator. The term “Contractor” shall also include the Contractor’s authorized representative, as well as any and all subcontractors retained by the Contractor.

5. “Qualified Inspector” means a person that is knowledgeable in the principles and practices of erosion and sediment control, such as licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, or other Department endorsed individual(s).

   It can also mean someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided that person has training in the principles and practices of erosion and sediment control. Training in the principles and practices of erosion and sediment control means that an individual working under the direct supervision of the licensed Professional Engineer or Registered Landscape Architect has received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity. After receiving the initial training, the individual working under the direct supervision of the licensed Professional

Engineer or Registered Landscape Architect shall receive four (4) hours of training every three (3) years.

It can also mean a person that meets the *Qualified Professional* qualifications in addition to the *Qualified Inspector* qualifications.

Note: Inspections of any post-construction stormwater management practices that include structural components, such as a dam for an impoundment, shall be performed by a licensed Professional Engineer.

6. "Qualified Professional" means a person that is knowledgeable in the principles and practices of stormwater management and treatment, such as a licensed Professional Engineer, Registered Landscape Architect, or other Department endorsed individual(s). Individuals preparing SWPPPs that require the post-construction stormwater management practice component must have an understanding of the principles of hydrology, water quality management practice design, water quantity control design, and, in many cases, the principles of hydraulics. All components of the SWPPP that involve the practice of engineering, as defined by the NYS Education Law (see Article 145), shall be prepared by, or under the direct supervision of, a professional engineer licensed to practice in the State of New York.

7. "Trained Contractor" means an employee from a contracting (construction) company, identified in Part III.A.6., that has received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity. After receiving the initial training, the *Trained Contractor* shall receive four (4) hours of training every three (3) years.

   It can also mean an employee from a contracting (construction) company, identified in Part III.A.6.,that meets the *Qualified Inspector* qualifications (e.g. licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, or someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided they have received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity.

   The "Trained Contractor(s)" will be responsible for the day to day implementation of the SWPPP.

## 2.2 Owner's/Operator's Responsibilities

1. Ensure that control measures are selected, designed, installed, implemented and maintained to minimize the discharge of pollutants and prevent a violation of the water quality standards, meeting the non-numeric effluent limitations in Part I.B.1.(a)-(f) of the SPDES General Permit and in accordance with the New York State Standards and Specifications for Erosion and Sediment Control, dated November 2016.

2. Ensure that practices are selected, designed, installed, and maintained to meet the performance criteria in the Design Manual. Practices must be designed to meet the applicable sizing criteria in Part I.C.2.a., b., c. or d. of GP-0-20-001.

3. Retain the services of a "Qualified Inspector" or "Qualified Professional" as defined under Section 2.1, to provide the services outlined in Section 2.5 "Qualified Inspector's/Qualified Professional's Responsibilities."

4. Retain the services of a "Qualified Professional," as defined under Section 2.1, to provide the services outlined in Section 2.3 "Owner's/Operator's Engineers Responsibilities."

5. Have an authorized corporate officer sign the completed NOI. A copy of the completed NOI is included in Appendix B.

6. Submit the electronic version of the NOI (eNOI) along with the MS4 SWPPP acceptance form using the NYSDEC's website (http://www.dec.ny.gov/chemical/43133.html).

7. Pay the required initial and annual fees upon receipt of invoices from NYSDEC. These invoices are generally issued in the fall of each year. The initial fee is calculated as $110.00 per acre disturbed plus $675.00 per acre of net increase in impervious cover, and the annual fee is $110.00.

8. Prior to the commencement of construction activity, identify the contractor(s) and subcontractor(s) that will be responsible for implementing the erosion and sediment control measures and stormwater management practices described in this SWPPP. Have each of these contractors and subcontractors identify at least one "Trained Contractor", as defined under Section 2.1 that will be responsible for the implementation of the SWPPP. Ensure that the Contractor has at least one "Trained Contractor" on site on a daily basis when soil disturbance activities are being performed.

9. Schedule a pre-construction meeting which shall include the Town of Wappinger representative, Owner's/Operator's Engineer, Contractor, and their sub-contractors to discuss responsibilities as they relate to the implementation of this SWPPP.

10. Retain the services of an independent certified materials testing and inspection firm operating under the direction of a licensed Professional Engineer to perform regular tests, inspections, and certifications of the construction materials used in the construction of all post-construction stormwater management practices.

11. Retain the services of a NYS licensed land surveyor to perform an as-built topographic survey of the completed post-construction stormwater management facilities.

12. Require the Contractor to fully implement the SWPPP prepared for the site by the Owner/Operator's Engineer to ensure that the provisions of the SWPPP are implemented from the commencement of construction activity until all areas of disturbance have achieved final stabilization and the Notice of Termination (NOT) has been submitted to the NYSDEC.

13. Forward a copy of the NOI Acknowledgement Letter received from the regulatory agency to the Owner's/Operator's Engineer for project records, and to the Contractor for display at the construction site.

14. Maintain a copy of the General Permit (GP-0-20-001), NOI, NOI Acknowledgement Letter, SWPPP, MS4 SWPPP Acceptance Form, inspection reports, Spill Prevention, Countermeasures, Cleanup ("SPCC") Plan, and all documentation in accordance with Part I.F.8.a.-d of GP-0-20-001 necessary to demonstrate eligibility with the permit at the construction site, until all disturbed areas have

achieved final stabilization and the NOT has been submitted to the NYSDEC. Place documents in a secure location that must be accessible during normal business hours to an individual performing a compliance inspection.

15. Prior to submitting a Notice of Termination, ensure for post-construction stormwater management practice(s) that are privately owned, the Owner/Operator has a deed restriction in place that requires operation and maintenance of the practice(s) in accordance with the operation and maintenance plan.

16. Submit a Notice of Termination (NOT) form (see Appendix B) within 48 hours of receipt of the Owner's/Operator's Engineer's certification of final site stabilization to the following:

    NOTICE OF TERMINATION
    NYS DEC, Bureau of Water Permits
    625 Broadway, 4th Floor
    Albany, New York 12233-3505

    Town of Wappinger
    Ms. Susan Dao, MS4 Officer
    20 Middlebush Road
    Wappingers Falls, NY 12590

17. Request and receive all SWPPP records from the Owner's/Operator's Engineer and archive those records for a minimum of five (5) years after the NOT is filed.

18. Implement the Post-Construction Inspections and Maintenance procedures outlined in Appendix F.

19. The NOI, SWPPP, and inspection reports required by GP-0-20-001 are public documents that the Owner/Operator must make available for review and copying by any person within five (5) business days of the Owner/Operator receiving a written request by any such person to review the NOI, SWPPP, or inspection reports. Copying of documents will be done at the requester's expense.

20. The Owner/Operator must keep the SWPPP current at all times. At a minimum, the Owner/Operator shall amend the SWPPP:
    a) Whenever the current provisions prove to be ineffective in minimizing pollutants in stormwater discharges from the project site;
    b) Whenever there is a change in design, construction, or operation at the construction site that has or could have an effect on the discharge of pollutants; and
    c) To address issues or deficiencies identified during an inspection by the "Qualified Inspector," the Department, or other Regulatory Authority.
    d) To document the final construction conditions.

## 2.3 Owner's/Operator's Engineer's Responsibilities

1. Prepare the SWPPP using good engineering practices, best management practices, and in compliance with all federal, state, and local regulatory requirements.

2. Prepare the Notice of Intent (NOI) form (see Appendix B), sign the "SWPPP Preparer Certification" section of the NOI, and forward to Owner/Operator for signature.

3. Provide copies of the SWPPP to the Town of Wappinger once all signatures and attachments are complete.

4. Enter Contractor's information in Section 2.5 "SWPPP Participants" once a Contractor is selected by the Owner/Operator.

5. Update the SWPPP each time there is a significant modification to the pollution prevention measures or a change of the principal Contractor working on the project who may disturb site soil.

## 2.4 Contractor's Responsibilities

1. Sign the SWPPP Contractor's Certification Form contained within Appendix C and forward to the Owner's/Operator's Engineer for inclusion in the Site Log Book.

2. Identify at least one Trained Contractor that will be responsible for implementation of this SWPPP. Ensure that at least one Trained Contractor is on site on a daily basis when soil disturbance activities are being performed. The Trained Contractor shall inspect the erosion and sediment control practices and pollution prevention measures being implemented within the active work area daily to ensure that they are being maintained in effective operating conditions at all times. If deficiencies are identified, the contractor shall begin implementing corrective actions within one business day and shall complete the corrective actions in a reasonable time frame.

3. Provide the names and addresses of all subcontractors working on the project site. Require all subcontractors who will be involved with construction activities that will result in soil disturbance to identify at least one Trained Contractor that will be on site on a daily basis when soil disturbance activities are being performed; and to sign a copy of the Subcontractor's Certification Form contained within Appendix C, then forward to the Owner's/Operator's Engineer for inclusion into the Site Log Book. This information must be retained as part of the Site Log Book.

4. Maintain a Spill Prevention and Response Plan in accordance with requirements outlined in Section 5 of this SWPPP. This plan shall be provided to the Owner's/Operator's Engineer for inclusion in the Site Log Book, prior to mobilization on-site.

5. Participate in a pre-construction meeting which shall include the Town of Wappinger representative, Owner/Operator, Owner's/Operator's Engineer, and all subcontractors to discuss responsibilities as they relate to the implementation of this SWPPP.

6. If Contractor plans on utilizing adjacent properties for material, waste, borrow, or equipment storage areas, or if Contractor plans to engage in industrial activity other than construction (such as operating asphalt and/or concrete plants) at the site, Contractor shall submit appropriate documentation to the Owner's/Operator's Engineer so that the SWPPP can be modified accordingly.

7. Implement site stabilization, erosion and sediment control measures, and other requirements of the SWPPP.

8. In accordance with the requirements in the most current version of the NYS Standards and Specifications for Erosion and Sediment Control, conduct inspections of erosion and sediment control measures installed at the site to ensure that they remain in effective operating condition at all times. Prepare and retain written documentation of inspections as well as of all repairs/maintenance activities performed. This information must be retained as part of the Site Log Book.

9. Begin implementing corrective actions within one (1) business day of receipt of notification by the Qualified Inspector/Qualified Professional that deficiencies exist with the erosion and sediment control measures employed at the site. Corrective actions shall be completed within a reasonable time frame.

10. Maintain a record of the date(s) and location(s) that soil restoration is performed (if required) in accordance with the accompanying plans and NYSDEC Division of Water's publication "Deep-Ripping and Decompaction," dated April 2008. A copy of this is publication is provided in Appendix E. The record that is to be maintained shall be a copy of the overall site grading plan delineating the area(s) and date(s) that the soil was restored.

11. Upon completion of all construction at the site, the contractor responsible for overall SWPPP Compliance shall sign the certification on their Contractor Certification Form indicating that: a.) all temporary erosion and sediment control measures have been removed from the site, b.) the on-site soils disturbed by construction activity have been restored in accordance with the SWPPP and the NYSDEC Division of Water's publication "Deep-Ripping and Decompaction," and c.) all permanent stormwater management practices required by the SWPPP have been installed in accordance with the contract documents.

## 2.5 Qualified Inspector's/Qualified Professional's Responsibilities

1. Participate in a pre-construction meeting with the Town of Wappinger representative, Owner/Operator, Contractor, and their subcontractors to discuss responsibilities as they relate to the implementation of this SWPPP.

2. Conduct an initial assessment of the site prior to the commencement of construction and certify in an inspection report that the appropriate erosion and sediment control measures described within this SWPPP have been adequately installed and implemented to ensure overall preparedness of the site.

3. Provide on-site inspections to determine compliance with the SWPPP. Site inspections shall occur at an interval of at least once every seven calendar days. A written inspection report shall be provided to the Owner/Operator and general contractor within one business day of the completion of the inspection, with any deficiencies identified. A sample inspection form is provided in Appendix D.

4. Prepare an inspection report subsequent to each and every inspection that shall include/address the items listed in Part IV.C.4.a-k of GP-0-20-001. Sign all inspection reports and maintain on site with the SWPPP.

5. Notify the owner/operator and appropriate contractor or subcontractor of any corrective actions that need to be taken.

6. Prepare a construction Site Log Book to be used as a record of all inspection reports generated throughout the duration of construction. Ensure that the construction Site Log Book is maintained and kept up-to-date throughout the duration of construction.

7. Review the Contractor's SWPPP records on a periodic basis to ensure compliance with the requirements for daily reports, soil restoration, inspections, and maintenance logs.

8. Based on the as-built survey and material testing certifications performed by others, perform evaluations of the completed stormwater management practices to determine whether they were constructed in accordance with this SWPPP.

9. Conduct a final site assessment and prepare a certification letter to the Owner/Operator indicating that, upon review of the material testing and inspection reports prepared by the firm retained by the Owner/Operator, review of the completed topographic survey, and evaluation of the completed stormwater management facilities, the stormwater management facilities have been constructed substantially in accordance with the contract documents and should function as designed.

10. Prepare the Notice of Termination (NOT). Sign the NOT Certifications VI (Final Stabilization) and VII (Post-construction Stormwater Management Practices), and forward the NOT to the Owner/Operator for signature on Certification VIII (Owner/Operator Certification).

11. Transfer the SWPPP documents, along with all NOI's, permit certificates, NOT's, construction Site Log Book, and written records required by the General Permit to the Owner/Operator for archiving.

## 2.6 SWPPP Participants

1. Owner's/Operator's Engineer: Chris Lapine, P.E. - Director
   The Chazen Companies
   21 Fox Street
   Poughkeepsie, NY 12601
   Phone: (845) 454-3980

2. Owner/Operator: Zeidan Nesheiwat
   Gas Land Petroleum, Inc.
   3 South Ohioville Rd
   New Paltz, NY 12561
   Phone: (845)331-7545

3. Contractor[2]: Name and Title: ______________________

   Company Name: ______________________

   Mailing Address: ______________________

   ______________________

   Phone: ______________________

   Fax: ______________________

---

[2] *Contractor's information to be entered once the Contractor has been selected.*

# 3.0 SITE CHARACTERISTICS

## 3.1 Land Use and Topography

The project site is located within the Hamlet Mixed Use (HM) zoning district. Commercial and residential uses are a permitted with special use within this district.

The overall site is moderately sloping, with slopes ranging from 1 to 6 percent. Site elevations range from approximately 64 feet above mean sea level (MSL) to 71 feet MSL. The northern portion of the site is slightly higher in elevation than the southern, western and eastern portions of the site.

## 3.2 Soils and Groundwater

The US Department of Agriculture (USDA) Web Soil Survey (http://websoilsurvey.nrcs.usda.gov/app/) was used to obtain surficial soil conditions for the study area, as follows:

**Table 1: USDA Soil Data**

| Map Symbol & Description | Hydrologic Soil Group | Permeability (inches/hour) | Erosion Factor K | Depth to Water Table (inches) | Depth to Bedrock (inches) |
|---|---|---|---|---|---|
| DwB-Dutchess-Cardigan complex, undulating, rocky | B | 0.06-1.98 | 0.32 | >80 | 20-40 |

Upon review of the soil data presented in Table 1, the project site does not contain soils with a soil slope phase of D with a map unit name that inclusive of slopes greater than 25%, and does not contain soils with a soil slope phase of E or F.

The Soil Conservation Service defines the hydrologic soil groups as follows:

- Type B Soils: Soils having a moderate infiltration rate when thoroughly wet and consisting mainly of moderately deep to deep, moderately well to well drained soils with moderately fine to moderately course textures. These soils have a moderate rate of water transmission.

The soils map for the study area is presented in Appendix G, as Figure 2.

## 3.3 Watershed Designation

The project site is not located in a restricted watershed identified in Appendix C of GP-0-20-001.

## 3.4 Receiving Water Bodies

The nearest natural classified water course into which runoff from the project site will discharge is the Wappinger Creek.

The Wappinger Creek is classified by NYSDEC as a Class C water course, and is not included in the Section 303(d) list of impaired waters found in Appendix E of GP-0-20-001.

## 3.5 Aquifer Designation

The project site is not located over a US EPA designated Sole Source aquifer; nor is it located over a Primary or Principal aquifer listed in the NYSDEC Technical and Operational Guidance Series (TOGS) 2.1.3 (1980).

## 3.6 Wetlands

A search on the NYSDEC Environmental Resource Mapper on May 14, 2020, and a review of GIS data, determined that no regulated wetlands are located on or in the vicinity of the project site.

## 3.7 Flood Plains

According to the National Flood Insurance Program Flood Insurance Rate Map (FIRM), Town of Wappinger, New York, Community Panel Number 361387, the project site lies within Flood Zone X, areas determined to be outside 500-year floodplain.

## 3.8 Listed, Endangered, or Threatened Species

A search was performed on the NYSDEC Environmental Resource Mapper on May 14, 2020, and determined that the project site does contain threatened or endangered species, or critical habitat. The NYSDEC Environmental Resource Mapper indicates that there are known occurrences of endangered, threatened, or rare (ETR) species in the vicinity of the project site, and the EAF Mapper indicates the potential for the Indiana Bat (State and Federally endangered) and Bald Eagle (State threatened). An Environmental Resource Map has been provided in Appendix G, as Figure 4.

An information request was submitted to the NYSDEC Natural Heritage Program (NHP) and it was noted the development of the site will not impact Bald Eagles. Furthermore, they recommended timing restrictions on the clearing related to bats.

The USFWS Official Species List indicates the potential for the following species in the vicinity of the project site: Indiana Bat (endangered) and Northern Long-Eared Bat (threatened). The proposed project would result in 1.13 acres of disturbance within the 1.24 acre site and will include the removal of approximately five trees. Clearing on the site would be restricted to occur between October 31 and March 31 to avoid impacts to bats.

## 3.9 Historic Places

A search on the New York State Cultural Resource Information System (CRIS) database, performed on May 14, 2020, revealed that the property is not located within an archeologically sensitive area, and is not located on or immediately adjacent to a property listed or determined to be eligible for listing on the National or State Registers of Historic Places. A printout of the historic places screening map is presented in Appendix G, as Figure 3.

A submittal was made to NYSOPRHP. They responded on April 14, 2020 indicating that no properties, including archaeological and/ or historic resources, listed in or eligible for New York State and National Registers of Historic Places will be impacted by this project.

## 3.10 Rainfall Data

Rainfall data utilized in the modeling and analysis was obtained from the Cornell University online Extreme Precipitation in New York & New England website (http://precip.eas.cornell.edu/). The standard SCS/NRCS rainfall distributions were applied to evaluate the pre- and post-development stormwater runoff characteristics. Rainfall data specific to the portion of Dutchess County under consideration, for various 24-hour storm events, is presented in the following Table:

**Table 2: Rainfall Data**

| Storm Event Return Period | 24-Hour Rainfall (inches) |
|---|---|
| 1-year | 2.61 |
| 10-year | 4.66 |
| 100-year | 8.20 |

# 4.0 CONSTRUCTION SEQUENCE

This project has not received written approval from Town of Wappinger allowing the disturbance of more than five acres of land at any one time. Therefore, if the Contractor's construction sequence requires the disturbance of more than five acres at any one time, written approval must be obtained from NYSDEC prior to disturbing more than five acres at once.

The "Erosion and Sediment Control Plan" in the accompanying drawings identifies the major construction activities that are the subject of this SWPPP. The order (or sequence) in which the major activities are expected to begin is presented on the accompanying drawings, though each activity will not necessarily be completed before the next begins. In addition, these activities could occur in a different order if necessary to maintain adequate erosion and sediment control. If this is the case, the contractor shall notify the Owner's/Operator's Engineer overseeing the implementation of the SWPPP.

The Contractor will be responsible for implementing the erosion and sediment control measures identified on the plans. The Contractor may designate these tasks to certain subcontractors as they see fit, but the ultimate responsibility for implementing these controls and ensuring their proper function remains with the Contractor.

Refer to the accompanying plans for details and specifications regarding the construction sequencing schedule.

# 5.0 CONSTRUCTION-PHASE POLLUTION CONTROL

The SWPPP and accompanying plans identify the temporary and permanent erosion and sediment control measures that have been incorporated into the design of this project. These measures will be implemented during construction, to minimize soil erosion and control sediment transport off-site, and after construction, to control the quality and quantity of stormwater runoff from the developed site.

Erosion control measures, designed to minimize soil loss, and sediment control measures, intended to retain eroded soil and prevent it from reaching water bodies or adjoining properties, have been developed in accordance with the following documents:

- NYSDEC SPDES General Permit for Stormwater Discharges From Construction Activity, Permit No. GP-0-20-001 (effective January 29, 2020 through January 28, 2025)
- New York State Standards and Specifications for Erosion and Sediment Control, NYSDEC (November 2016)

The SWPPP and accompanying plans outline the construction scheduling for implementing the erosion and sediment control measures. These documents include limitations on the duration of soil exposure, criteria and specifications for placement and installation of the erosion and sediment control measures, a maintenance schedule, and specifications for the implementation of erosion and sediment control practices and procedures.

Temporary and permanent erosion and sediment control measures that shall be applied during construction generally include:

1. Minimizing soil erosion and sedimentation by stabilization of disturbed areas and by removing sediment from construction site discharges.
2. Preservation of existing vegetation to the greatest extent practical. Following the completion of construction activities in any portion of the site, permanent vegetation shall be established on all exposed soils.
3. Site preparation activities to minimize the area and duration of soil disruption.
4. Establishment of permanent traffic corridors to ensure that “routes of convenience” are avoided.

## 5.1 Temporary Erosion and Sediment Control Measures

The temporary erosion and sediment control measures described in the following sections are included as part of the construction documents.

### *5.1.1 Stabilized Construction Access*

Prior to construction, stabilized construction access(es) will be installed, per accompanying plans, to reduce the tracking of sediment onto public roadways.

Construction traffic must enter and exit the site at the stabilized construction access(es). The intent is to trap dust and mud that would otherwise be carried off-site by construction traffic.

The access(es) shall be maintained in a condition, which will control tracking of sediment onto public rights-of-way or streets. When necessary, additional aggregate will be placed atop the filter fabric to assure the minimum thickness is maintained. All sediment and/or soil spilled, dropped, or washed onto public rights-of-way must be removed immediately. Periodic inspection and needed maintenance shall be provided after each substantial rainfall event.

### *5.1.2 Dust Control*

Water trucks shall be used as needed during construction to reduce dust generated on-site. Dust control must be provided by the Contractor(s) to a degree that is acceptable to the Owner, and in compliance with the applicable local and state dust control requirements.

### *5.1.3 Temporary Soil Stockpile*

Materials, such as topsoil, will be temporarily stockpiled (if necessary) on the site during the construction process. Stockpiles shall be located in an area away from storm drainage, water bodies and/or courses, and will be properly protected from erosion by a surrounding silt fence barrier.

### *5.1.4 Silt Fencing*

Prior to the initiation of and during construction activities, a geotextile filter fabric (or silt fence) will be established downgradient of all disturbed areas. These barriers may extend into non-impact areas to provide adequate protection of adjacent lands.

Clearing and grubbing will be performed only as necessary for the installation of the sediment control barrier. To facilitate effectiveness of the silt fencing, daily inspections and inspections immediately after significant storm events will be performed by the Contractor(s). Maintenance of the fence will be performed as needed.

### *5.1.5 Temporary Seeding*

For areas undergoing clearing, grading, and disturbance as part of construction activities, where work has temporarily ceased, temporary soil stabilization measures must be initiated by the end of the next business day and completed within fourteen (14) days from the date the soil disturbance activity has temporarily ceased.

### *5.1.6 Stone and Block Drop Inlet Protection*

Concrete blocks surrounded by wire mesh and crushed stone will be placed around both existing catch basins, and proposed catch basins once they have been installed, to prevent sediment from entering the catch basins and storm sewer system. During construction, crushed stone shall be replaced as necessary to ensure proper function.

### *5.1.7 Manufactured Insert Inlet Protection*

Install insert inlet protection beneath the grate of all catch basins, to prevent sediment from entering the catch basins and storm sewer system. Remove sediment accumulation and repair or replace insert as necessary to ensure proper function.

### *5.1.8 Filter Fabric Drop Inlet Protection*

Install filter fabric or silt fence with wooden stakes at the perimeter of existing or proposed catch basins located in lawn areas, to prevent sediment from entering the catch basins and storm sewer system. Remove sediment accumulation and repair or replace fabric as necessary to ensure proper function.

### *5.1.9 Erosion Control Blanket*

Erosion control blankets shall be installed in accordance with manufacturer's requirements on all slopes exceeding 3:1. Erosion control blankets provide temporary erosion protection, rapid vegetative establishment, and long-term erosion resistance to shear stresses generated by high runoff flow velocities associated with steep slopes.

### *5.1.10 Dewatering Operations*

Dewatering will be used to intercept sediment-laden stormwater or pumped groundwater and allow it to settle out of the pumped discharge prior to being discharged from the site. Water from dewatering operations shall be treated to eliminate the discharge of sediment and other pollutants. Water resulting from dewatering operations shall be directed to temporary sediment traps or dewatering devices. Temporary sediment traps and dewatering bags will be provided, installed, and maintained at downgradient locations to control sediment deposits to downstream surfaces.

## 5.2 Permanent Erosion and Sediment Control Measures

The permanent erosion and sediment control measures described in the following sections are included as part of the construction documents.

### *5.2.1 Establishment of Permanent Vegetation*

Disturbed areas that will be vegetated must be seeded in accordance with the contract documents. The type of seed, mulch, and maintenance measures as described in the contract documents shall also be followed.

Permanent soil stabilization measures must be initiated by the end of the next business day and completed within fourteen (14) days from the date the soil disturbance activity has permanently ceased.

Final site stabilization is achieved when all soil-disturbing activities at the site have been completed and a uniform, perennial vegetative cover with a density of 80 percent has been established or equivalent stabilization measures (such as the use of mulches or geotextiles) have been employed on all unpaved areas and areas not covered by permanent structures.

### *5.2.2 Rock Outlet Protection*

Rock outlet protection shall be installed at the locations as indicated and detailed on the accompanying plans. The installation of rock outlet protection will reduce the velocity and energy of water, such that the flow will not erode downstream surfaces.

### *5.2.3 Permanent Turf Reinforcement*

Permanent turf reinforcement mats (TRMs) provide long-term erosion protection and vegetation establishment assistance while permanently reinforcing vegetation. TRMs shall be installed on slopes/channels where specified. TRM's provide two key advantages. First, their unique fiber shape and 3-D pattern create a thick matrix of voids that trap seed, soil, and water in place for quicker, thicker vegetation growth. Secondly, they provide additional reinforcement that doubles the vegetation's natural erosion protection abilities by remaining a permanent part of the application and anchoring mature plants to the soil for superior, long-term erosion resistance.

## 5.3 Other Pollutant Controls

Other necessary pollutant controls are listed below:

### *5.3.1 Solid and Liquid Waste Disposal*

No solid or liquid waste materials, including building materials, shall be discharged from the site with stormwater. All solid waste, including disposable materials incidental to any construction activities, must be collected and placed in containers. The containers shall be emptied periodically by a licensed trash disposal service and hauled away from the site.

Substances that have the potential for polluting surface and/or groundwater must be controlled by whatever means necessary in order to ensure that they do not discharge from the site. As an example, special care must be exercised during equipment fueling and servicing operations. If a spill occurs, it must be contained and disposed of so that it will not flow from the site or enter groundwater, even if this requires removal, treatment, and disposal of soil. In this regard, potentially polluting substances should be handled in a manner consistent with the impact they represent.

### *5.3.2 Sanitary Facilities*

Temporary sanitary facilities will be provided by the Contractor throughout the construction phase. They must be utilized by all construction personnel and will be serviced by a licensed commercial Contractor. These facilities must comply with state and local sanitary or septic system regulations.

### *5.3.3 Water Source*

Non-stormwater components of site discharge must be clean water. Water used for construction, which discharges from the site, must originate from a public water supply or private well approved by the Health Department. Water used for construction that does not originate from an approved public supply must not discharge from the site; such water can be retained in temporary ponds/sediment traps until it infiltrates and/or evaporates.

## 5.4 Construction Housekeeping Practices

During the construction phase, the Contractor(s) will implement the following measures:

### *5.4.1 Material Stockpiles*

Material resulting from clearing and grubbing operations that will be stockpiled on-site, must be adequately protected with downgradient erosion and sediment controls.

### *5.4.2 Equipment Cleaning and Maintenance*

The Contractor(s) will designate areas for equipment cleaning, maintenance, and repair. The Contractor(s) and subcontractor(s) will utilize those areas. The areas will be protected by a temporary perimeter berm.

### *5.4.3 Detergents*

The use of detergents for large-scale washing is prohibited (i.e., vehicles, buildings, pavement surfaces, etc.)

### *5.4.4 Spill Prevention and Response*

A Spill Prevention and Response Plan shall be developed for the site by the Contractor(s). The plan shall detail the steps required in the event of an accidental spill and shall identify contact names and phone numbers of people and agencies that must be notified.

The plan shall include Safety Data Sheets (SDS) for all materials to be stored on-site. All workers on-site will be required to be trained on safe handling and spill prevention procedures for all materials used during construction. Regular tailgate safety meetings shall be held and all workers that are expected on the site during the week shall be required to attend.

### *5.4.5 Concrete Washout Areas*

A temporary concrete washout area shall be provided for every project where concrete will be poured or otherwise formed on-site, and shall consist of an excavated or above-ground lined construction pit where concrete trucks or equipment can be washed out after their loads have been discharged. Waste generated from concrete wash water that shall not be allowed to flow into drainage ways, inlets, receiving waters, highway right-of-way, or any location other than the designated concrete washout area(s). Proper signage shall be placed adjacent to the facility to designate the “Concrete Washout Area”. Locate the facility a minimum of 100-feet from drainage swales, storm drain inlets, wetlands, streams, and other surface waters. Prevent surface water from entering the washout area.

The hardened residue from the concrete wash areas will be disposed of in the same manner as other non-hazardous construction waste materials. Maintenance of the washout area shall include removal of hardened material when 75% of the storage capacity is filled, and a minimum freeboard of 12 inches shall be maintained. The Contractor will be responsible for seeing that these procedures are followed. The project may require the use of multiple concrete washout areas based on the frequency of concrete pours.

### *5.4.6 Material Storage*

Construction materials shall be stored in a dedicated staging area. The staging area shall be located in an area that prevents negative impacts of construction materials on stormwater quality.

Chemicals, paints, solvents, fertilizers, and other toxic material must be stored in waterproof containers. Except during application, the contents must be kept in trucks or within storage facilities. Runoff containing such material must be collected, removed from the site, treated, and disposed of at an approved solid waste or chemical disposal facility.

# 6.0 STORMWATER MANAGEMENT PLANNING

Chapter 3 of the Design Manual outlines a six-step planning process for site planning and selection of stormwater management practices that must be implemented for both new development and redevelopment projects. This process is intended to develop a design that maintains pre-construction hydrologic conditions through the application of environmentally sound development principles, as well as treatment and control of runoff discharges from the site. The following sections outline the step-by-step process and how it has been applied to this project.

The goals of this Stormwater Management Plan are to analyze the peak rate of runoff under pre- and post-development conditions, to maintain the pre-development rate of runoff in order to minimize impacts to adjacent or downstream properties, and to minimize the impact to the quality of runoff exiting the site.

The Design Manual provides both water quality and water quantity objectives to be met by projects requiring a "Full SWPPP". These objectives will be met by applying stormwater control practices to limit peak runoff rates and improve the quality of runoff leaving the developed site.

## 6.1 STEP 1 – Site Planning

During the Site Planning process, the project site is evaluated for implementation of the green infrastructure planning measures identified in Table 3.1 of the Design Manual, in order to preserve natural resources and reduce impervious cover. Table A of Appendix K provides a description of each green infrastructure planning measure, along with a project specific evaluation.

## 6.2 STEP 2 - Determine Water Quality Treatment Volume (WQv)

Stormwater runoff from impervious surfaces is recognized as a significant contributor of pollution that can adversely affect the quality of receiving water bodies. Therefore, treatment of stormwater runoff is important since most runoff related water quality contaminants are transported from land, particularly the impervious surfaces, during the initial stages of storm events.

### *6.2.1 NYSDEC Requirements for New Development*

The Design Manual requires that water quality treatment be provided for the initial flush of runoff from every storm. The NYSDEC refers to the amount of runoff to be treated as the "Water Quality Volume" (WQv). Section 4.2 of the Design Manual defines the Water Quality Volume as follows:

$$WQv = \frac{[(P)(R_V)(A)]}{12}$$

| | | | |
|---|---|---|---|
| Where: | P | = | 90% Rainfall Event Number |
| | $R_v$ | = | 0.05 + 0.009 (I) |
| | I | = | Impervious Cover (Percent) |
| | A | = | Contributing Area in Acres |

This definition ensures that, all other things being equal, the Water Quality Volume will increase along with the impervious cover percentage.

### *6.2.2 NYSDEC Requirements for Redevelopment Projects*

Chapter 9 of the Design Manual outlines alternative WQv treatment objectives for redevelopment projects.

According to Section 9.2.1.B.II., redevelopment activities can achieve the water quality treatment objective if 25% of the water quality volume associated with the disturbed, impervious area is captured and treated by implementation of standard SMPs or reduced by application of RR techniques. In this case, 100% of any new impervious area must be treated. This project will implement an underground infiltration practice and a modified bioretention area to meet the water quality objective of new and redevelopment.

### *6.2.3 Methodology*

The Water Quality Volume equation has been applied to the drainage area tributary to each of the stormwater quality practices proposed for this project. The practices have been sized to accommodate the Water Quality Volume, as per the performance criteria presented in Chapter 6 and/or Chapter 9 of the Design Manual. Water quality volume calculations for each of the proposed practices are presented in Table B of Appendix K.

## 6.3 STEP 3 – Apply Runoff Reduction Techniques and Standard SMPs with RRv Capacity to Reduce Total WQv

Land use change and development in the watershed increases the volume of runoff. As such, reductions in the amount of runoff from new development, accomplished through the implementation of a stormwater management plan for the site, will play an important role in the success or failure of the watershed-wide stormwater management plan. Runoff reduction techniques can be applied to manage, reduce, and treat stormwater, while maintaining and restoring natural hydrology through infiltration, evapo-transpiration, and the capture and reuse of stormwater. Volume reduction techniques by themselves typically are not sufficient to provide adequate attenuation of stormwater runoff, but they can decrease the size of the peak runoff rate reduction facilities.

### *6.3.1 NYSDEC Requirements for New Development*

The Design Manual states that runoff reduction shall be achieved through infiltration, groundwater recharge, reuse, recycle, and/or evaporation/evapotranspiration of 100-percent of the post-development water quality volume to replicate pre-development hydrology. Runoff control techniques provide treatment in a distributed manner before runoff reaches the collection system, by maintaining pre-construction infiltration, peak runoff flow, discharge volume, as well as minimizing concentrated flow. This can be accomplished by applying a combination of Runoff Reduction Techniques, standard Stormwater Management Practices (SMPs) with RRv capacity, and good operation and maintenance.

### *6.3.2 NYSDEC Requirements for Redevelopment*

Section 3.2 of the Design Manual indicates, “Although encouraged, meeting the RRv criteria is not required for redevelopment activities that meet the criteria in Chapter 9 of this manual.” This project involves the reconstruction of existing impervious area on a site that has inadequate space for controlling stormwater runoff from the reconstructed area which renders implementation of many RR techniques and SMPs infeasible.

Although not required, underground infiltration and a modified bioretention area are proposed for this project and will provide both WQv and RRv at the site.

### *6.3.3 Water Quality Volume*

As previously noted herein, this analysis and design completed and documented in this report is intended to be part of the application made for a mixed-use redevelopment project with an increase in impervious area completed on behalf of the Owner/Operator. As such the determination of the water quality volume considered both redevelopment and new development criteria. The water quality volume associated with this project was determined to be 2,114 cf. Supporting calculations can be found in Appendix K.

### *6.3.4 Methodology*

In order to reduce the required WQv and meet the RRv criteria, a site specific evaluation must be performed to determine the most practical means of reducing runoff volume by application of a combination of RR techniques and standard SMPs with RRv capacity.

### *6.3.5 Application of Standard Stormwater Management Practices (SMPs) with RRv Capacity*

The following Table demonstrates a summary of the standard SMP(s) with RRv capacity that have been incorporated into the stormwater management plan for this project. The standard SMP(s) with RRv capacity have been designed in accordance with Chapter 6 of the Design Manual. Refer to the contract drawings for practice dimensions, material specifications, and installation details. Practice specific calculations are presented in Appendix K.

**Table 3: Summary of Standard SMPs with RRv Capacity being Applied**

| Standard SMP with RRv | Design Variant | WQv Required (CF) | WQv Provided (CF) | Pretreatment Volume Required (% of WQv) | Pretreatment Volume Required (CF) | Pretreatment Volume Provided (CF) | RRv Capacity | RRv Provided (CF) |
|---|---|---|---|---|---|---|---|---|
| Underground Infiltration System | I-4 | 1,741 | 2,231 | 100% | 1,741 | 1,741 | 100% | 1,741 |
| Bioretention (with underdrain) | F-5 | 1,983 | 2,145 | 25% | 496 | 1,983 | 40% | 858 |

### *6.3.6 RRv Performance Summary*

A summary of the RRv provided is presented in the following table:

**Table 4: RRv Summary**

| RRv Required = WQv Required (CF) | RRv Provided (CF) | % RRv Provided |
|---|---|---|
| 2,114 | 2,599 | 123% |

As indicated in the above table, the RRv provided is greater than the RRv required for the project site. As such, the RRv criteria has been met and the designer can proceed to Step 6.

## 6.4 STEP 4 – Determine the Minimum RRv Required

As previously discussed, the RRv provided is greater than the RRv required for this project. As such, the runoff reduction volume criteria has been met, and minimum RRv is not applicable.

## 6.5 STEP 5 – Apply Standard Stormwater Management Practices to Address Remaining Water Quality Volume

As previously discussed, 100% of the required WQv is being provided and reduced through RRv practices. As such, the water quality and runoff reduction volume criteria have been met and no other standard SMPs are required.

## 6.6 STEP 6 - Apply Volume and Peak Rate Control

This report presents the pre-development and post-development features and conditions associated with the rate of surface water runoff within the study area. For both cases, the drainage patterns, drainage structures, soil types, and ground cover types are considered in this study.

### *6.6.1 NYSDEC Requirements for New Development*

Chapter 4 of the Design Manual requires that projects meet three separate stormwater quantity criteria:

1. The Channel Protection (CPv) requirement is designed to protect stream channels from erosion. This is accomplished by providing 24 hours of extended detention for the 1-year, 24-hour storm event. The Manual defines the CPv detention time as the center of mass detention time through each stormwater management practice.

2. The Overbank Flood Control (Qp) requirement is designed to prevent an increase in the frequency and magnitude of flow events that exceed the bank-full capacity of a channel, and therefore must spill over into the floodplain. This is accomplished by providing detention storage to ensure that, at each design point, the post-development 10-year 24-hour peak discharge rate does not exceed the corresponding pre-development rate.

3. The Extreme Flood Control (Qf) requirement is designed to prevent the increased risk of flood damage from large storm events, to maintain the boundaries of the pre-development 100-year floodplain, and to protect the physical integrity of stormwater management practices. This is accomplished by providing detention storage to ensure that, at each design point, the post-development 100-year 24-hour peak discharge rate does not exceed the corresponding pre-development rate.

### *6.6.2 Methodology*

In order to demonstrate that the NYSDEC detention requirements are being met, the Design Manual requires that a hydrologic and hydraulic analysis of the pre- and post-development conditions be performed using the Natural Resources Conservation Service Technical Release 20 (TR-20) and Technical Release 55 (TR-55) methodologies. HydroCAD, developed by HydroCAD Software Solutions LLC of Tamworth, New Hampshire, is a Computer-Aided-Design (CAD) program for analyzing the hydrologic and hydraulic characteristics of a given watershed and associated stormwater management facilities. HydroCAD uses the TR-20 algorithms and TR-55 methods to create and route runoff hydrographs.

HydroCAD has the capability of computing hydrographs (which represent discharge rates characteristic of specified watershed conditions, precipitation, and geologic factors) combining hydrographs and routing flows though pipes, streams and ponds. HydroCAD can also calculate the center of mass detention time for various hydraulic features. Documentation for HydroCAD can be found on their website: http://www.hydrocad.net/.

For this analysis, the watershed and drainage system was broken down into a network consisting of three types of components as described below:

1. Subcatchment: A relatively homogeneous area of land, which produces a volume and rate of runoff unique to that area.
2. Reach: Uniform streams, channels, or pipes that convey stormwater from one point to another.
3. Pond: Natural or man-made impoundment, which temporarily stores stormwater runoff and empties in a manner determined by its geometry and the hydraulic structure located at its outlets.

Subcatchments, reaches, and ponds are represented by hexagons, squares, and triangles, respectively, on the watershed routing diagrams provided with the computations included in Appendix I and Appendix J.

The analysis of hydrologic and hydraulic conditions and proposed stormwater management facilities, servicing the study area, was performed by dividing the tributary watershed into relatively homogeneous subcatchments. The separation of the watershed into subcatchments was dictated by watershed conditions, methods of collection, conveyance, and points of discharge. Watershed characteristics for each subcatchment were then assessed from United States Geological Service (USGS) 7.5-minute topographic maps, aerial photographs, a topographical survey, soil surveys, site investigations, and land use maps.

Proposed stormwater management practices were designed and evaluated in accordance with the Design Manual and local regulatory requirements. The hydrologic and hydraulic analysis considered the SCS, Type III 24-hour storm events identified in the following Table.

**Table 5: Design Events**

| Facility | 24-hour Storm Event |
|---|---|
| Storm Sewer | 10-year |
| Stormwater Management Practice(s) | 1-year |
| | 10-year |
| | 100-year |
| Flood Conditions | 100-year |

### *6.6.3 Description of Design Points*

The study area consists of an overall watershed that encompasses approximately 1.83 acres and contains the 1.80 acre project site. The overall watershed was broken down into smaller watersheds, or subcatchments, to allow for analysis of runoff conditions at several locations throughout the study area. Each of these locations was defined as a Design Point (DP) in order to compare the effects resulting from stormwater management facilities proposed as part of the project. Descriptions of each of the selected design points are provided below.

- Design Point 1: Off-site discharge to low area located along the north property line toward the neighboring property.
- Design Point 2: Off-site discharge to low area located along the northeast property line.
- Design Point 3: Off-site town drainage system.

*6.6.4 Pre-development Watershed Conditions*

The pre-development project site is covered predominantly by grass, gravel, and pavement. Analysis of pre-development conditions considered existing drainage patterns, soil types, ground cover, and topography. The Pre-Development Watershed Delineation Map has been provided in Appendix G, as Figure 4.

The results of the computer modeling used to analyze the overall watershed under pre-development conditions are presented in Appendix I. A summary of the pre-development watershed runoff rates at each design point is presented in Table 6.

*6.6.5 Post-development Watershed Conditions*

The post-development project site is covered predominantly by grass and pavement. The analysis of post-development conditions considered existing drainage patterns, soil types, ground cover to remain, planned site development, site grading and, stormwater management facilities proposed as part of site improvements. The Post-Development Watershed Delineation Map has been provided in Appendix G, as Figure 5.

The results of the computer modeling used to analyze the overall watershed under post-development conditions are presented in Appendix J. A summary of the post-development watershed runoff rates at each design point is presented in Table 6.

There are numerous locations and methods for providing controls of off-site discharge of stormwater from the project site. Each has been designed to provide the above quantity controls by attenuating stormwater runoff and releasing runoff to off-site locations at a rate equal to or less than that which existed prior to development of the site. Each device is detailed on the accompanying plans.

Underground detention has been incorporated into this project for providing control of off-site discharge of stormwater for the project.

Underground stormwater detention systems store and detain stormwater runoff in order to meet water quantity control requirements. Stormwater is stored in subsurface vaults and/or a system of large diameter interconnected storage pipes. Stored water is then released at rates designed to reduce peak run-off flows during post-development storms. Underground stormwater storage provides minimal stormwater quality benefits, but can be an effective component of a development’s overall stormwater management plan.

*6.6.6 Performance Summary*

A comparison of the pre- and post-development watershed conditions was performed for all design points and storm events evaluated herein. For all design points and design storms, this comparison demonstrates that the peak rate of runoff will not be increased. Therefore, the project will not have a significant adverse impact on the adjacent or downstream properties or receiving water courses.

The results of the computer modeling used to analyze the pre- and post-development watersheds are presented in Appendix I and Appendix J, respectively. The following Table summarizes the results of this analysis.

**Table 6: Summary of Pre- and Post-Development Peak Discharge Rates**

| | Pre- vs. Post-Development Discharge Rate (cfs) | | | | | |
|---|---|---|---|---|---|---|
| **Design Point (DP)** | **1-year 24-hour storm event** | | **10-year 24-hour storm event** | | **100-year 24-hour storm event** | |
| | **Pre** | **Post** | **Pre** | **Post** | **Pre** | **Post** |
| 1 | 0.85 | 0.06 | 2.61 | 0.26 | 6.04 | 0.72 |
| 2 | 0.86 | 0.42 | 2.73 | 1.79 | 6.41 | 5.19 |
| 3 | 0.39 | 0.34 | 0.77 | 0.67 | 1.40 | 1.38 |

## 6.7 Deviations from NYSDEC Requirements

The stormwater management approach described in this SWPPP deviates from the requirements found in the Design Manual in several ways or as follows:

1. Due to the lack of achievable head on the site combined with the lack of ability to infiltrate stormwater on the site, Micro-Bioretention areas were proposed. The Micro-Bioretention areas described above are an approved practice in the Virginia DCR stormwater Design Manual.

# 7.0 INSPECTIONS, MAINTENANCE, AND REPORTING

## 7.1 Inspection and Maintenance Requirements

### *7.1.1 Pre-Construction Inspection and Certification*

Prior to the commencement of construction, the Qualified Inspector/Qualified Professional shall conduct an assessment of the site and certify that the appropriate erosion and sediment control measures have been adequately installed and implemented. The Contractor shall contact the Qualified Inspector/Qualified Professional once the erosion and sediment control measures have been installed.

### *7.1.2 Construction Phase Inspections and Maintenance*

A Qualified Inspector/Qualified Professional, as defined in Appendix A of the General Permit GP-0-20-001, shall conduct regular site inspections between the time this SWPPP is implemented and final site stabilization.

The purpose of site inspections is to assess performance of pollutant controls. Based on these inspections, the Qualified Inspector/Qualified Professional will decide whether it is necessary to modify this SWPPP, add or relocate sediment barriers, or whatever else may be needed in order to prevent pollutants from leaving the site via stormwater runoff. The general contractor has the duty to cause pollutant control measures to be repaired, modified, maintained, supplemented, or whatever else is necessary in order to achieve effective pollutant control.

Examples of particular items to evaluate during site inspections are listed below. This list is not intended to be comprehensive. During each inspection the inspector must evaluate overall pollutant control system performance as well as particular details of individual system components. Additional factors should be considered as appropriate to the circumstances.

1. Locations where vehicles enter and exit the site must be inspected for evidence of off-site sediment tracking. A stabilized construction entrance will be constructed where vehicles enter and exit. This entrance will be maintained or supplemented as necessary to prevent sediment from leaving the site on vehicles.
2. Sediment barriers must be inspected and, if necessary, they must be enlarged or cleaned in order to provide additional capacity. All material from behind sediment barriers will be stockpiled on the up slope side. Additional sediment barriers must be constructed as needed.
3. Inspections will evaluate disturbed areas and areas used for storing materials that are exposed to rainfall for evidence of, or the potential for, pollutants entering the drainage system. If necessary, the materials must be covered or original covers must be repaired or supplemented. Also, protective berms must be constructed, if needed, in order to contain runoff from material storage areas.
4. Grassed areas will be inspected to confirm that a healthy stand of grass is maintained. The site has achieved final stabilization once all areas are covered with building foundation or pavement, or have a stand of grass with at least 80 percent density. The density of 80 percent or greater must be maintained to be considered as stabilized. Areas must be watered, fertilized, and reseeded as needed to achieve this goal.

5. All discharge points must be inspected to determine whether erosion control measures are effective in preventing significant impacts to receiving waters.

The inspection reports must be completed entirely and additional remarks should be included if needed to fully describe a situation. An important aspect of the inspection report is the description of additional measures that need to be taken to enhance plan effectiveness. The inspection report must identify whether the site was in compliance with the SWPPP at the time of inspection and specifically identify all incidents of non-compliance.

Within one (1) business day of the completion of an inspection, the *Qualified Inspector/Qualified Professional* shall notify the Owner/Operator and appropriate contractor or subcontractor of any corrective actions that need to be taken. The contractor or subcontractor shall begin implementing the corrective actions within one (1) business day of the notification and shall complete the corrective actions in a reasonable time frame.

In addition to the inspections performed by the *Qualified Inspector/Qualified Professional*, the Contractor shall perform routine inspections that include a visual check of all erosion and sediment control measures. All inspections and maintenance shall be performed in accordance with the inspection and maintenance schedule provided on the accompanying plans. Sediment removed from erosion and sediment control measures will be exported from the site, stockpiled for later use, or used immediately for general non-structural fill.

It is the responsibility of the general contractor to assure the adequacy of site pollutant discharge controls. Actual physical site conditions or contractor practices could make it necessary to install more structural controls than are shown on the accompanying plans. (For example, localized concentrations of runoff could make it necessary to install additional sediment barriers, sediment traps, etc.) Assessing the need for additional controls and implementing them or adjusting existing controls will be a continuing aspect of this SWPPP until the site achieves final stabilization.

#### *7.1.3 Temporary Suspension of Construction Activities*

For construction sites where soil disturbance activities have been temporarily suspended (e.g. Winter shutdown) and temporary stabilization measures have been applied to all disturbed areas, the frequency of Qualified Inspector/Qualified Professional inspections can be reduced to once every 30 calendar days. Prior to reducing the frequency of inspections, the Owner/Operator shall notify the NYSDEC Region 3 stormwater contact person and the Town of Wappinger in writing.

#### *7.1.4 Partial Project Completion*

For construction sites where soil disturbance activities have been shut down with partial project completion, all areas disturbed as of the project shutdown date have achieved final stabilization, and all post-construction stormwater management practices required for the completed portion of the project have been constructed in conformance with the SWPPP and are operational, the inspections by the Qualified Inspector/Qualified Professional can stop. Prior to the shutdown, the Owner/Operator shall notify the NYSDEC Region 3 stormwater contact person and the Town of Wappinger in writing.

If soil disturbance activities have not resumed within two years from the date of shutdown, a Notice of Termination (NOT) shall be properly completed and submitted to the NYSDEC.

### *7.1.5 Post-Construction Inspections and Maintenance*

Inspections and maintenance of final stabilization measures and post-construction stormwater management practices shall be performed in accordance with Appendix F, once all disturbed areas are stabilized and all stormwater management systems are in place and operable.

## 7.2 Reporting Requirements

### *7.2.1 Inspection Reports*

Pursuant to Part IV.C of GP-0-20-001, inspection reports shall be prepared for the duration of construction, as outlined herein, and shall be signed by the *Qualified Inspector* or *Qualified Professional*. A sample inspection form is provided in Appendix D.

At a minimum, each inspection report shall record the following information:

1. Date and time of inspection.
2. Name and title of person(s) performing inspection.
3. A description of the weather and soil conditions (e.g. dry, wet, saturated) at the time of the inspection.
4. A description of the condition of the runoff at all points of discharge from the construction site. This shall include identification of any discharges of sediment from the construction site. Include discharges from conveyance systems (i.e. pipes, culverts, ditches, etc.) and overland flow.
5. A description of the condition of all natural surface waterbodies located within, or immediately adjacent to, the property boundaries of the construction site which receive runoff from disturbed areas. This shall include identification of any discharges of sediment to the surface waterbody.
6. Identification of all erosion and sediment control practices and pollution prevention measures that need repair or maintenance.
7. Identification of all erosion and sediment control practices and pollution prevention measures that were not installed properly or are not functioning as designed and need to be reinstalled or replaced.
8. Description and sketch of areas with active soil disturbance activity, areas that have been disturbed but are inactive at the time of the inspection, and areas that have been stabilized (temporary and/or final) since the last inspection.
9. Indication of the current phase of construction of all post-construction stormwater management practices and identification of all construction that is not in conformance with the SWPPP and technical standards.
10. Corrective action(s) that must be taken to install, repair, replace or maintain erosion and sediment control practices and pollution prevention measures; and to correct deficiencies identified with the construction of the post-construction stormwater management practice(s).
11. Identification and status of all corrective actions that were required by previous inspection.
12. Color photographs, with date stamp, that clearly show the condition of all practices that have been identified as needing corrective actions. The *Qualified Inspector/Qualified Professional* shall attach paper color copies of the digital photographs to the inspection report being maintained onsite

within seven (7) calendar days of the date of the inspection. The *Qualified Inspector/Qualified Professional* shall also take digital photographs, with date stamp, that clearly show the condition of the practice(s) after the corrective action has been completed. The *Qualified Inspector/Qualified Professional* shall attach the paper color copies of the digital photographs to the inspection report that documents the completion of the corrective action work within seven (7) calendar days of that inspection.

### *7.2.2 Site Log Book*

Pursuant to Part II.D.2 of GP-0-20-001, the Owner/Operator shall retain a copy of the General Permit, NOI, NOI Acknowledgment Letter, MS4 SWPPP Acceptance Form (if applicable), inspection reports, contractor and subcontractor certification forms, and all documentation necessary to demonstrate eligibility under the permit, at the construction site from commencement of construction activity until the date that all areas of disturbance have achieved final stabilization and the Notice of Termination has been submitted to the NYSDEC.

The Site Log Book shall be maintained on-site in a secure location (i.e. job trailer, on-site construction office, or mailbox with lock) and must be accessible during normal business hours to an individual performing a compliance inspection.

### *7.2.3 Post Construction Records and Archiving*

Following construction, the Owner/Operator shall retain copies of the SWPPP, the complete construction Site Log Book, and records of all data used to complete the NOI to be covered by this permit, for a period of at least five years from the date that the site is finally stabilized. This period may be extended by the NYSDEC, at its sole discretion, at any time upon written notification.

Records shall be maintained of all post construction inspections and maintenance work performed in accordance with the requirements outlined in Appendix F.

# Appendix A:
# NYSDEC SPDES General Permit GP-0-20-001

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NEW YORK STATE OF OPPORTUNITY | Department of Environmental Conservation

NEW YORK STATE
DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SPDES GENERAL PERMIT
FOR STORMWATER DISCHARGES

From

**CONSTRUCTION ACTIVITY**

Permit No. GP- 0-20-001

Issued Pursuant to Article 17, Titles 7, 8 and Article 70

of the Environmental Conservation Law

Effective Date: January 29, 2020

Expiration Date: January 28, 2025

John J. Ferguson

Chief Permit Administrator

Authorized Signature

1-23-20
Date

Address: NYS DEC
Division of Environmental Permits
625 Broadway, 4th Floor
Albany, N.Y. 12233-1750

**PREFACE**

Pursuant to Section 402 of the Clean Water Act ("CWA"), stormwater *discharges* from certain *construction activities* are unlawful unless they are authorized by a *National Pollutant Discharge Elimination System ("NPDES")* permit or by a state permit program. New York administers the approved State Pollutant Discharge Elimination System (SPDES) program with permits issued in accordance with the New York State Environmental Conservation Law (ECL) Article 17, Titles 7, 8 and Article 70.

An *owner or operator* of a *construction activity* that is eligible for coverage under this permit must obtain coverage prior to the *commencement of construction activity*. Activities that fit the definition of "*construction activity*", as defined under 40 CFR 122.26(b)(14)(x), (15)(i), and (15)(ii), constitute construction of a *point source* and therefore, pursuant to ECL section 17-0505 and 17-0701, the *owner or operator* must have coverage under a SPDES permit prior to *commencing construction activity*. The *owner or operator* cannot wait until there is an actual *discharge* from the *construction site* to obtain permit coverage.

***Note: The italicized words/phrases within this permit are defined in Appendix A.**

**NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION**
**SPDES GENERAL PERMIT FOR STORMWATER DISCHARGES FROM CONSTRUCTION ACTIVITIES**

## Table of Contents

## Part 1. PERMIT COVERAGE AND LIMITATIONS

### A. Permit Application

This permit authorizes stormwater *discharges* to *surface waters of the State* from the following *construction activities* identified within 40 CFR Parts 122.26(b)(14)(x), 122.26(b)(15)(i) and 122.26(b)(15)(ii), provided all of the eligibility provisions of this permit are met:

1. *Construction activities* involving soil disturbances of one (1) or more acres; including disturbances of less than one acre that are part of a *larger common plan of development or sale* that will ultimately disturb one or more acres of land; excluding *routine maintenance activity* that is performed to maintain the original line and grade, hydraulic capacity or original purpose of a facility;

2. *Construction activities* involving soil disturbances of less than one (1) acre where the Department has determined that a *SPDES* permit is required for stormwater *discharges* based on the potential for contribution to a violation of a *water quality standard* or for significant contribution of *pollutants* to *surface waters of the State.*

3. *Construction activities* located in the watershed(s) identified in Appendix D that involve soil disturbances between five thousand (5,000) square feet and one (1) acre of land.

### B. Effluent Limitations Applicable to Discharges from Construction Activities

*Discharge*s authorized by this permit must achieve, at a minimum, the effluent limitations in Part I.B.1. (a) – (f) of this permit. These limitations represent the degree of effluent reduction attainable by the application of best practicable technology currently available.

1. Erosion and Sediment Control Requirements - The *owner or operator* must select, design, install, implement and maintain control measures to *minimize* the *discharge* of *pollutants* and prevent a violation of the *water quality standards*. The selection, design, installation, implementation, and maintenance of these control measures must meet the non-numeric effluent limitations in Part I.B.1.(a) – (f) of this permit and be in accordance with the New York State Standards and Specifications for Erosion and Sediment Control, dated November 2016, using sound engineering judgment. Where control measures are not designed in conformance with the design criteria included in the technical standard, the *owner or operator* must include in the *Stormwater Pollution Prevention Plan* ("SWPPP") the reason(s) for the





deviation or alternative design and provide information which demonstrates that the deviation or alternative design is *equivalent* to the technical standard.

a. **Erosion and Sediment Controls.** Design, install and maintain effective erosion and sediment controls to *minimize* the *discharge* of *pollutants* and prevent a violation of the *water quality standards*. At a minimum, such controls must be designed, installed and maintained to:

(i) *Minimize* soil erosion through application of runoff control and soil stabilization control measure to *minimize pollutant discharges*;

(ii) Control stormwater *discharges*, including both peak flowrates and total stormwater volume, to *minimize* channel and *streambank* erosion and scour in the immediate vicinity of the *discharge* points;

(iii) *Minimize* the amount of soil exposed during *construction activity*;

(iv) *Minimize* the disturbance of *steep slopes*;

(v) *Minimize* sediment *discharges* from the site;

(vi) Provide and maintain *natural buffers* around surface waters, direct stormwater to vegetated areas and maximize stormwater infiltration to reduce *pollutant discharges*, unless *infeasible*;

(vii) *Minimize* soil compaction. Minimizing soil compaction is not required where the intended function of a specific area of the site dictates that it be compacted;

(viii) Unless *infeasible*, preserve a sufficient amount of topsoil to complete soil restoration and establish a uniform, dense vegetative cover; and

(ix) *Minimize* dust. On areas of exposed soil, *minimize* dust through the appropriate application of water or other dust suppression techniques to control the generation of pollutants that could be discharged from the site.

b. **Soil Stabilization**. In areas where soil disturbance activity has temporarily or permanently ceased, the application of soil stabilization measures must be initiated by the end of the next business day and completed within fourteen (14) days from the date the current soil disturbance activity ceased. For construction sites that *directly discharge* to one of the 303(d) segments listed in Appendix E or is located in one of the watersheds listed in Appendix C, the application of soil stabilization measures must be initiated by the end of the next business day and completed within seven (7) days from the date the current soil disturbance activity ceased. See Appendix A for definition of *Temporarily Ceased*.

c. **Dewatering**. *Discharge*s from *dewatering* activities, including *discharge*s from *dewatering* of trenches and excavations, must be managed by appropriate control measures.

d. **Pollution Prevention Measures**. Design, install, implement, and maintain effective pollution prevention measures to *minimize* the *discharge* of *pollutants* and prevent a violation of the *water quality standards*. At a minimum, such measures must be designed, installed, implemented and maintained to:

(i) *Minimize* the *discharge* of *pollutants* from equipment and vehicle washing, wheel wash water, and other wash waters. This applies to washing operations that use clean water only. Soaps, detergents and solvents cannot be used;

(ii) *Minimize* the exposure of building materials, building products, construction wastes, trash, landscape materials, fertilizers, pesticides, herbicides, detergents, sanitary waste, hazardous and toxic waste, and other materials present on the site to precipitation and to stormwater. Minimization of exposure is not required in cases where the exposure to precipitation and to stormwater will not result in a *discharge* of *pollutants*, or where exposure of a specific material or product poses little risk of stormwater contamination (such as final products and materials intended for outdoor use) ; and

(iii) Prevent the *discharge* of *pollutants* from spills and leaks and implement chemical spill and leak prevention and response procedures.

e. **Prohibited *Discharges*.** The following *discharge*s are prohibited:

(i) Wastewater from washout of concrete;

(ii) Wastewater from washout and cleanout of stucco, paint, form release oils, curing compounds and other construction materials;





(iii) Fuels, oils, or other *pollutants* used in vehicle and equipment operation and maintenance;

(iv) Soaps or solvents used in vehicle and equipment washing; and

(v) Toxic or hazardous substances from a spill or other release.

f. Surface Outlets. When discharging from basins and impoundments, the outlets shall be designed, constructed and maintained in such a manner that sediment does not leave the basin or impoundment and that erosion at or below the outlet does not occur.

**C. Post-construction Stormwater Management Practice Requirements**

1. The *owner or operator* of a *construction activity* that requires post-construction stormwater management practices pursuant to Part III.C. of this permit must select, design, install, and maintain the practices to meet the *performance criteria* in the New York State Stormwater Management Design Manual (“Design Manual”), dated January 2015, using sound engineering judgment. Where post-construction stormwater management practices (“SMPs”) are not designed in conformance with the *performance criteria* in the Design Manual, the *owner or operator* must include in the SWPPP the reason(s) for the deviation or alternative design and provide information which demonstrates that the deviation or alternative design is *equivalent* to the technical standard.

2. The *owner or operator* of a *construction activity* that requires post-construction stormwater management practices pursuant to Part III.C. of this permit must design the practices to meet the applicable *sizing criteria* in Part I.C.2.a., b., c. or d. of this permit.

**a. Sizing Criteria for New Development**

(i) Runoff Reduction Volume (“RRv”): Reduce the total Water Quality Volume (“WQv”) by application of RR techniques and standard SMPs with RRv capacity. The total WQv shall be calculated in accordance with the criteria in Section 4.2 of the Design Manual.

(ii) Minimum RRv and Treatment of Remaining Total WQv: Construction activities that cannot meet the criteria in Part I.C.2.a.(i) of this permit due to site limitations shall direct runoff from all newly constructed impervious areas to a RR technique or standard SMP with RRv capacity unless infeasible. The specific site limitations that prevent the reduction of 100% of the WQv shall be documented in the SWPPP.

For each impervious area that is not directed to a RR technique or standard SMP with RRv capacity, the SWPPP must include documentation which demonstrates that all options were considered and for each option explains why it is considered infeasible.

**In no case shall the runoff reduction achieved from the newly constructed impervious areas be less than the Minimum RRv as calculated using the criteria in Section 4.3 of the Design Manual.** The remaining portion of the total WQv that cannot be reduced shall be treated by application of standard SMPs.

(iii) Channel Protection Volume ("Cpv"): Provide 24 hour extended detention of the post-developed 1-year, 24-hour storm event; remaining after runoff reduction. The Cpv requirement does not apply when:
(1) Reduction of the entire Cpv is achieved by application of runoff reduction techniques or infiltration systems, or
(2) The site discharges directly to tidal waters, or fifth order or larger streams.

(iv) *Overbank* Flood Control Criteria ("Qp"): Requires storage to attenuate the post-development 10-year, 24-hour peak discharge rate (Qp) to predevelopment rates. The Qp requirement does not apply when:
(1) the site discharges directly to tidal waters or fifth order or larger streams, or
(2) A downstream analysis reveals that *overbank* control is not required.

(v) Extreme Flood Control Criteria ("Qf"): Requires storage to attenuate the post-development 100-year, 24-hour peak discharge rate (Qf) to predevelopment rates. The Qf requirement does not apply when:
(1) the site discharges directly to tidal waters or fifth order or larger streams, or
(2) A downstream analysis reveals that *overbank* control is not required.

**b. *Sizing Criteria* for *New Development* in Enhanced Phosphorus Removal Watershed**

(i) Runoff Reduction Volume (RRv): Reduce the total Water Quality Volume (WQv) by application of RR techniques and standard SMPs with RRv capacity. The total WQv is the runoff volume from the 1-year, 24 hour design storm over the post-developed watershed and shall be





calculated in accordance with the criteria in Section 10.3 of the Design Manual.

(ii) Minimum RRv and Treatment of Remaining Total WQv: *Construction activities* that cannot meet the criteria in Part I.C.2.b.(i) of this permit due to *site limitations* shall direct runoff from all newly constructed *impervious areas* to a RR technique or standard SMP with RRv capacity unless *infeasible*. The specific *site limitations* that prevent the reduction of 100% of the WQv shall be documented in the SWPPP. For each *impervious area* that is not directed to a RR technique or standard SMP with RRv capacity, the SWPPP must include documentation which demonstrates that all options were considered and for each option explains why it is considered *infeasible*.

**In no case shall the runoff reduction achieved from the newly constructed *impervious areas* be less than the Minimum RRv as calculated using the criteria in Section 10.3 of the Design Manual.** The remaining portion of the total WQv that cannot be reduced shall be treated by application of standard SMPs.

(iii) Channel Protection Volume (Cpv): Provide 24 hour extended detention of the post-developed 1-year, 24-hour storm event; remaining after runoff reduction. The Cpv requirement does not apply when:
(1) Reduction of the entire Cpv is achieved by application of runoff reduction techniques or infiltration systems, or
(2) The site *discharge*s directly to tidal waters, or fifth order or larger streams.

(iv) *Overbank* Flood Control Criteria (Qp): Requires storage to attenuate the post-development 10-year, 24-hour peak *discharge* rate (Qp) to predevelopment rates. The Qp requirement does not apply when:
(1) the site *discharge*s directly to tidal waters or fifth order or larger streams, or
(2) A downstream analysis reveals that *overbank* control is not required.

(v) Extreme Flood Control Criteria (Qf): Requires storage to attenuate the post-development 100-year, 24-hour peak *discharge* rate (Qf) to predevelopment rates. The Qf requirement does not apply when:
(1) the site *discharge*s directly to tidal waters or fifth order or larger streams, or
(2) A downstream analysis reveals that *overbank* control is not required.

**c. Sizing Criteria for Redevelopment Activity**

(i) Water Quality Volume (WQv): The WQv treatment objective for *redevelopment activity* shall be addressed by one of the following options. *Redevelopment activities* located in an Enhanced Phosphorus Removal Watershed (see Part III.B.3. and Appendix C of this permit) shall calculate the WQv in accordance with Section 10.3 of the Design Manual. All other *redevelopment activities* shall calculate the WQv in accordance with Section 4.2 of the Design Manual.

(1) Reduce the existing *impervious cover* by a minimum of 25% of the total disturbed, *impervious area*. The Soil Restoration criteria in Section 5.1.6 of the Design Manual must be applied to all newly created pervious areas, or

(2) Capture and treat a minimum of 25% of the WQv from the disturbed, *impervious area* by the application of standard SMPs; or reduce 25% of the WQv from the disturbed, *impervious area* by the application of RR techniques or standard SMPs with RRv capacity., or

(3) Capture and treat a minimum of 75% of the WQv from the disturbed, *impervious area* as well as any additional runoff from tributary areas by application of the alternative practices discussed in Sections 9.3 and 9.4 of the Design Manual., or

(4) Application of a combination of 1, 2 and 3 above that provide a weighted average of at least two of the above methods. Application of this method shall be in accordance with the criteria in Section 9.2.1(B) (IV) of the Design Manual.

If there is an existing post-construction stormwater management practice located on the site that captures and treats runoff from the *impervious area* that is being disturbed, the WQv treatment option selected must, at a minimum, provide treatment equal to the treatment that was being provided by the existing practice(s) if that treatment is greater than the treatment required by options 1 – 4 above.

(ii) Channel Protection Volume (Cpv): Not required if there are no changes to hydrology that increase the *discharge* rate from the project site.

(iii) *Overbank* Flood Control Criteria (Qp): Not required if there are no changes to hydrology that increase the *discharge* rate from the project site.

(iv) Extreme Flood Control Criteria (Qf): Not required if there are no changes to hydrology that increase the *discharge* rate from the project site





**d. Sizing Criteria for Combination of Redevelopment Activity and New Development**

Construction projects that include both New Development and Redevelopment Activity shall provide post-construction stormwater management controls that meet the sizing criteria calculated as an aggregate of the Sizing Criteria in Part I.C.2.a. or b. of this permit for the New Development portion of the project and Part I.C.2.c of this permit for Redevelopment Activity portion of the project.

**D. Maintaining Water Quality**

The Department expects that compliance with the conditions of this permit will control *discharge*s necessary to meet applicable *water quality standards*. It shall be a violation of the *ECL* for any discharge to either cause or contribute to a violation of *water quality standards* as contained in Parts 700 through 705 of Title 6 of the Official Compilation of Codes, Rules and Regulations of the State of New York, such as:

1. There shall be no increase in turbidity that will cause a substantial visible contrast to natural conditions;

2. There shall be no increase in suspended, colloidal or settleable solids that will cause deposition or impair the waters for their best usages; and

3. There shall be no residue from oil and floating substances, nor visible oil film, nor globules of grease.

If there is evidence indicating that the stormwater *discharge*s authorized by this permit are causing, have the reasonable potential to cause, or are contributing to a violation of the *water quality standards*; the *owner or operator* must take appropriate corrective action in accordance with Part IV.C.5. of this general permit and document in accordance with Part IV.C.4. of this general permit. To address the *water quality standard* violation the *owner or operator* may need to provide additional information, include and implement appropriate controls in the SWPPP to correct the problem, or obtain an individual SPDES permit.

If there is evidence indicating that despite compliance with the terms and conditions of this general permit it is demonstrated that the stormwater *discharge*s authorized by this permit are causing or contributing to a violation of *water quality standards*, or if the Department determines that a modification of the permit is necessary to prevent a violation of *water quality standards*, the authorized *discharge*s will no longer be eligible for coverage under this permit. The Department may require the *owner or operator* to obtain an individual SPDES permit to continue discharging.

**E. Eligibility Under This General Permit**

1. This permit may authorize all *discharges* of stormwater from *construction activity* to *surface waters of the State* and *groundwaters* except for ineligible *discharges* identified under subparagraph F. of this Part.

2. Except for non-stormwater *discharges* explicitly listed in the next paragraph, this permit only authorizes stormwater *discharge*s; including stormwater runoff, snowmelt runoff, and surface runoff and drainage, from *construction activities*.

3. Notwithstanding paragraphs E.1 and E.2 above, the following non-stormwater discharges are authorized by this permit: those listed in 6 NYCRR 750-1.2(a)(29)(vi), with the following exception: "Discharges from firefighting activities are authorized only when the firefighting activities are emergencies/unplanned"; waters to which other components have not been added that are used to control dust in accordance with the SWPPP; and uncontaminated *discharge*s from *construction site* de-watering operations. All non-stormwater discharges must be identified in the SWPPP. Under all circumstances, the *owner or operator* must still comply with *water quality standards* in Part I.D of this permit.

4. The *owner or operator* must maintain permit eligibility to *discharge* under this permit. Any *discharges* that are not compliant with the eligibility conditions of this permit are not authorized by the permit and the *owner or operator* must either apply for a separate permit to cover those ineligible *discharges* or take steps necessary to make the *discharge* eligible for coverage.

**F. Activities Which Are Ineligible for Coverage Under This General Permit**

All of the following are **<u>not</u>** authorized by this permit:

1. *Discharge*s after *construction activities* have been completed and the site has undergone *final stabilization*;

2. *Discharge*s that are mixed with sources of non-stormwater other than those expressly authorized under subsection E.3. of this Part and identified in the SWPPP required by this permit;

3. *Discharges* that are required to obtain an individual SPDES permit or another SPDES general permit pursuant to Part VII.K. of this permit;

4. *Construction activities* or *discharges* from *construction activities* that may adversely affect an *endangered or threatened species* unless the *owner or*





*operator* has obtained a permit issued pursuant to 6 NYCRR Part 182 for the project or the Department has issued a letter of non-jurisdiction for the project. All documentation necessary to demonstrate eligibility shall be maintained on site in accordance with Part II.D.2 of this permit;

5. *Discharges* which either cause or contribute to a violation of *water quality standards* adopted pursuant to the *ECL* and its accompanying regulations;

6. *Construction activities* for residential, commercial and institutional projects:

   a. Where the *discharge*s from the *construction activities* are tributary to waters of the state classified as AA or AA-s; and

   b. Which are undertaken on land with no existing *impervious cover*; and

   c. Which disturb one (1) or more acres of land designated on the current United States Department of Agriculture ("USDA") Soil Survey as Soil Slope Phase "D", (provided the map unit name is inclusive of slopes greater than 25%), or Soil Slope Phase "E" or "F" (regardless of the map unit name), or a combination of the three designations.

7. *Construction activities* for linear transportation projects and linear utility projects:

   a. Where the *discharge*s from the *construction activities* are tributary to waters of the state classified as AA or AA-s; and

   b. Which are undertaken on land with no existing *impervious cover*; and

   c. Which disturb two (2) or more acres of land designated on the current USDA Soil Survey as Soil Slope Phase "D" (provided the map unit name is inclusive of slopes greater than 25%), or Soil Slope Phase "E" or "F" (regardless of the map unit name), or a combination of the three designations.

8. *Construction activities* that have the potential to affect an *historic property*, unless there is documentation that such impacts have been resolved. The following documentation necessary to demonstrate eligibility with this requirement shall be maintained on site in accordance with Part II.D.2 of this permit and made available to the Department in accordance with Part VII.F of this permit:

   a. Documentation that the *construction activity* is not within an archeologically sensitive area indicated on the sensitivity map, and that the *construction activity* is not located on or immediately adjacent to a property listed or determined to be eligible for listing on the National or State Registers of Historic Places, and that there is no new permanent building on the *construction site* within the following distances from a building, structure, or object that is more than 50 years old, or if there is such a new permanent building on the *construction site* within those parameters that NYS Office of Parks, Recreation and Historic Preservation (OPRHP), a Historic Preservation Commission of a Certified Local Government, or a qualified preservation professional has determined that the building, structure, or object more than 50 years old is not historically/archeologically significant.

      - 1-5 acres of disturbance - 20 feet
      - 5-20 acres of disturbance - 50 feet
      - 20+ acres of disturbance - 100 feet, or

   b. DEC consultation form sent to OPRHP, and copied to the NYS DEC Agency Historic Preservation Officer (APO), and
      (i) the State Environmental Quality Review (SEQR) Environmental Assessment Form (EAF) with a negative declaration or the Findings Statement, with documentation of OPRHP's agreement with the resolution; or
      (ii) documentation from OPRHP that the *construction activity* will result in No Impact; or
      (iii) documentation from OPRHP providing a determination of No Adverse Impact; or
      (iv) a Letter of Resolution signed by the owner/operator, OPRHP and the DEC APO which allows for this *construction activity* to be eligible for coverage under the general permit in terms of the State Historic Preservation Act (SHPA); or

   c. Documentation of satisfactory compliance with Section 106 of the National Historic Preservation Act for a coterminous project area:





      (i) No Affect
      (ii) No Adverse Affect
      (iii) Executed Memorandum of Agreement, or

   d. Documentation that:

   (i) SHPA Section 14.09 has been completed by NYS DEC or another state agency.

9. *Discharge*s from *construction activities* that are subject to an existing SPDES individual or general permit where a SPDES permit for *construction activity* has been terminated or denied; or where the *owner or operator* has failed to renew an expired individual permit.

## Part II. PERMIT COVERAGE

### A. How to Obtain Coverage

1. An *owner or operator* of a *construction activity* that is not subject to the requirements of a regulated, traditional land use control MS4 must first prepare a SWPPP in accordance with all applicable requirements of this permit and then submit a completed Notice of Intent (NOI) to the Department to be authorized to discharge under this permit.

2. An *owner or operator* of a *construction activity* that is subject to the requirements of a *regulated, traditional land use control MS4* must first prepare a SWPPP in accordance with all applicable requirements of this permit and then have the SWPPP reviewed and accepted by the *regulated, traditional land use control MS4* prior to submitting the NOI to the Department. The *owner or operator* shall have the "MS4 SWPPP Acceptance" form signed in accordance with Part VII.H., and then submit that form along with a completed NOI to the Department.

3. The requirement for an *owner or operator* to have its SWPPP reviewed and accepted by the *regulated, traditional land use control MS4* prior to submitting the NOI to the Department does not apply to an *owner or operator* that is obtaining permit coverage in accordance with the requirements in Part II.F. (Change of *Owner or Operator*) or where the *owner or operator* of the *construction activity* is the *regulated, traditional land use control MS4* . This exemption does not apply to *construction activities* subject to the New York City Administrative Code.

**B. Notice of Intent (NOI) Submittal**

1. Prior to December 21, 2020, an owner or operator shall use either the electronic (eNOI) or paper version of the NOI that the Department prepared. Both versions of the NOI are located on the Department's website (http://www.dec.ny.gov/ ). The paper version of the NOI shall be signed in accordance with Part VII.H. of this permit and submitted to the following address:

   **NOTICE OF INTENT**
   **NYS DEC, Bureau of Water Permits**
   **625 Broadway, 4th Floor**
   **Albany, New York 12233-3505**

2. Beginning December 21, 2020 and in accordance with EPA's 2015 NPDES Electronic Reporting Rule (40 CFR Part 127), the *owner or operator* must submit the NOI electronically using the *Department's* online NOI.

3. The *owner or operator* shall have the SWPPP preparer sign the "SWPPP Preparer Certification" statement on the NOI prior to submitting the form to the Department.

4. As of the date the NOI is submitted to the Department, the *owner or operator* shall make the NOI and SWPPP available for review and copying in accordance with the requirements in Part VII.F. of this permit.

**C. Permit Authorization**

1. An *owner or operator* shall not *commence construction activity* until their authorization to *discharge* under this permit goes into effect.

2. Authorization to *discharge* under this permit will be effective when the *owner or operator* has satisfied all of the following criteria:

   a. project review pursuant to the State Environmental Quality Review Act ("SEQRA") have been satisfied, when SEQRA is applicable. See the Department's website (http://www.dec.ny.gov/) for more information,

   b. where required, all necessary Department permits subject to the *Uniform Procedures Act ("UPA")* (see 6 NYCRR Part 621), or the equivalent from another New York State agency, have been obtained, unless otherwise notified by the Department pursuant to 6 NYCRR 621.3(a)(4). *Owners or operators* of *construction activities* that are required to obtain *UPA* permits





must submit a preliminary SWPPP to the appropriate DEC Permit Administrator at the Regional Office listed in Appendix F at the time all other necessary *UPA* permit applications are submitted. The preliminary SWPPP must include sufficient information to demonstrate that the *construction activity* qualifies for authorization under this permit,

   c. the final SWPPP has been prepared, and

   d. a complete NOI has been submitted to the Department in accordance with the requirements of this permit.

3. An *owner or operator* that has satisfied the requirements of Part II.C.2 above will be authorized to *discharge* stormwater from their *construction activity* in accordance with the following schedule:

   a. For *construction activities* that are not subject to the requirements of a *regulated, traditional land use control MS4*:

      (i) Five (5) business days from the date the Department receives a complete electronic version of the NOI (eNOI) for *construction activities* with a SWPPP that has been prepared in conformance with the design criteria in the technical standard referenced in Part III.B.1 and the *performance criteria* in the technical standard referenced in Parts III.B., 2 or 3, for *construction activities* that require post-construction stormwater management practices pursuant to Part III.C.; or

      (ii) Sixty (60) business days from the date the Department receives a complete NOI (electronic or paper version) for *construction activities* with a SWPPP that has not been prepared in conformance with the design criteria in technical standard referenced in Part III.B.1. or, for *construction activities* that require post-construction stormwater management practices pursuant to Part III.C., the *performance criteria* in the technical standard referenced in Parts III.B., 2 or 3, or;

      (iii) Ten (10) business days from the date the Department receives a complete paper version of the NOI for *construction activities* with a SWPPP that has been prepared in conformance with the design criteria in the technical standard referenced in Part III.B.1 and the *performance criteria* in the technical standard referenced in Parts III.B., 2 or 3, for *construction activities* that require post-construction stormwater management practices pursuant to Part III.C.

b. For *construction activities* that are subject to the requirements of a *regulated, traditional land use control MS4*:

(i) Five (5) business days from the date the Department receives both a complete electronic version of the NOI (eNOI) and signed "*MS4* SWPPP Acceptance" form, or

(ii) Ten (10) business days from the date the Department receives both a complete paper version of the NOI and signed "MS4 SWPPP Acceptance" form.

4. Coverage under this permit authorizes stormwater *discharges* from only those areas of disturbance that are identified in the NOI. If an *owner or operator* wishes to have stormwater *discharges* from future or additional areas of disturbance authorized, they must submit a new NOI that addresses that phase of the development, unless otherwise notified by the Department. The *owner or operator* shall not *commence construction activity* on the future or additional areas until their authorization to *discharge* under this permit goes into effect in accordance with Part II.C. of this permit.

**D. General Requirements For Owners or Operators With Permit Coverage**

1. The *owner or operator* shall ensure that the provisions of the SWPPP are implemented from the *commencement of construction activity* until all areas of disturbance have achieved *final stabilization* and the Notice of Termination ("NOT") has been submitted to the Department in accordance with Part V. of this permit. This includes any changes made to the SWPPP pursuant to Part III.A.4. of this permit.

2. The *owner or operator* shall maintain a copy of the General Permit (GP-0-20-001), NOI, *NOI Acknowledgment Letter*, SWPPP, MS4 SWPPP Acceptance form, inspection reports, responsible contractor's or subcontractor's certification statement (see Part III.A.6.), and all documentation necessary to demonstrate eligibility with this permit at the *construction site* until all disturbed areas have achieved *final stabilization* and the NOT has been submitted to the Department. The documents must be maintained in a secure location, such as a job trailer, on-site construction office, or mailbox with lock. The secure location must be accessible during normal business hours to an individual performing a compliance inspection.

3. The *owner or operator* of a *construction activity* shall not disturb greater than five (5) acres of soil at any one time without prior written authorization from the Department or, in areas under the jurisdiction of a *regulated, traditional land*





*use control MS4,* the *regulated, traditional land use control MS4* (provided the *regulated, traditional land use control MS4* is not the *owner or operator* of the *construction activity*). At a minimum, the *owner or operator* must comply with the following requirements in order to be authorized to disturb greater than five (5) acres of soil at any one time:

a. The *owner or operator* shall have a *qualified inspector* conduct **at least** two (2) site inspections in accordance with Part IV.C. of this permit every seven (7) calendar days, for as long as greater than five (5) acres of soil remain disturbed. The two (2) inspections shall be separated by a minimum of two (2) full calendar days.

b. In areas where soil disturbance activity has temporarily or permanently ceased, the application of soil stabilization measures must be initiated by the end of the next business day and completed within seven (7) days from the date the current soil disturbance activity ceased. The soil stabilization measures selected shall be in conformance with the technical standard, New York State Standards and Specifications for Erosion and Sediment Control, dated November 2016.

c. The *owner or operator* shall prepare a phasing plan that defines maximum disturbed area per phase and shows required cuts and fills.

d. The *owner or operator* shall install any additional site-specific practices needed to protect water quality.

e. The *owner or operator* shall include the requirements above in their SWPPP.

4. In accordance with statute, regulations, and the terms and conditions of this permit, the Department may suspend or revoke an *owner's or operator's* coverage under this permit at any time if the Department determines that the SWPPP does not meet the permit requirements or consistent with Part VII.K..

5. Upon a finding of significant non-compliance with the practices described in the SWPPP or violation of this permit, the Department may order an immediate stop to all activity at the site until the non-compliance is remedied. The stop work order shall be in writing, describe the non-compliance in detail, and be sent to the *owner or operator*.

6. For *construction activities* that are subject to the requirements of a *regulated, traditional land use control MS4*, the *owner or operator* shall notify the

*regulated, traditional land use control MS4* in writing of any planned amendments or modifications to the post-construction stormwater management practice component of the SWPPP required by Part III.A. 4. and 5. of this permit. Unless otherwise notified by the *regulated, traditional land use control MS4*, the *owner or operator* shall have the SWPPP amendments or modifications reviewed and accepted by the *regulated, traditional land use control MS4* prior to commencing construction of the post-construction stormwater management practice.

**E. Permit Coverage for Discharges Authorized Under GP-0-15-002**

1. Upon renewal of SPDES General Permit for Stormwater Discharges from *Construction Activity* (Permit No. GP-0-15-002), an *owner or operator* of a *construction activity* with coverage under GP-0-15-002, as of the effective date of GP- 0-20-001, shall be authorized to *discharge* in accordance with GP- 0-20-001, unless otherwise notified by the Department.

   An *owner or operator* may continue to implement the technical/design components of the post-construction stormwater management controls provided that such design was done in conformance with the technical standards in place at the time of initial project authorization. However, they must comply with the other, non-design provisions of GP-0-20-001.

**F. Change of Owner or Operator**

1. When property ownership changes or when there is a change in operational control over the construction plans and specifications, the original *owner or operator* must notify the new *owner or operator*, in writing, of the requirement to obtain permit coverage by submitting a NOI with the Department. For *construction activities* subject to the requirements of a *regulated, traditional land use control MS4,* the original *owner or operator* must also notify the MS4, in writing, of the change in ownership at least 30 calendar days prior to the change in ownership.

2. Once the new *owner or operator* obtains permit coverage, the original *owner or operator* shall then submit a completed NOT with the name and permit identification number of the new *owner or operator* to the Department at the address in Part II.B.1. of this permit. If the original *owner or operator* maintains ownership of a portion of the *construction activity* and will disturb soil, they must maintain their coverage under the permit.

3. Permit coverage for the new *owner or operator* will be effective as of the date the Department receives a complete NOI, provided the original *owner or*





*operator* was not subject to a sixty (60) business day authorization period that has not expired as of the date the Department receives the NOI from the new *owner or operator*.

## Part III. STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

**A. General SWPPP Requirements**

1. A SWPPP shall be prepared and implemented by the *owner or operator* of each *construction activity* covered by this permit. The SWPPP must document the selection, design, installation, implementation and maintenance of the control measures and practices that will be used to meet the effluent limitations in Part I.B. of this permit and where applicable, the post-construction stormwater management practice requirements in Part I.C. of this permit. The SWPPP shall be prepared prior to the submittal of the NOI. The NOI shall be submitted to the Department prior to the *commencement of construction activity*. A copy of the completed, final NOI shall be included in the SWPPP.

2. The SWPPP shall describe the erosion and sediment control practices and where required, post-construction stormwater management practices that will be used and/or constructed to reduce the *pollutants* in stormwater *discharges* and to assure compliance with the terms and conditions of this permit. In addition, the SWPPP shall identify potential sources of pollution which may reasonably be expected to affect the quality of stormwater *discharges*.

3. All SWPPPs that require the post-construction stormwater management practice component shall be prepared by a *qualified professional* that is knowledgeable in the principles and practices of stormwater management and treatment.

4. The *owner or operator* must keep the SWPPP current so that it at all times accurately documents the erosion and sediment controls practices that are being used or will be used during construction, and all post-construction stormwater management practices that will be constructed on the site. At a minimum, the *owner or operator* shall amend the SWPPP, including construction drawings:

   a. whenever the current provisions prove to be ineffective in minimizing *pollutants* in stormwater *discharges* from the site;

b. whenever there is a change in design, construction, or operation at the *construction site* that has or could have an effect on the *discharge* of *pollutants*;

c. to address issues or deficiencies identified during an inspection by the *qualified inspector,* the Department or other regulatory authority; and

d. to document the final construction conditions.

5. The Department may notify the *owner or operator* at any time that the SWPPP does not meet one or more of the minimum requirements of this permit. The notification shall be in writing and identify the provisions of the SWPPP that require modification. Within fourteen (14) calendar days of such notification, or as otherwise indicated by the Department, the *owner or operator* shall make the required changes to the SWPPP and submit written notification to the Department that the changes have been made. If the *owner or operator* does not respond to the Department's comments in the specified time frame, the Department may suspend the *owner's or operator's* coverage under this permit or require the *owner or operator* to obtain coverage under an individual SPDES permit in accordance with Part II.D.4. of this permit.

6. Prior to the *commencement of construction activity*, the *owner or operator* must identify the contractor(s) and subcontractor(s) that will be responsible for installing, constructing, repairing, replacing, inspecting and maintaining the erosion and sediment control practices included in the SWPPP; and the contractor(s) and subcontractor(s) that will be responsible for constructing the post-construction stormwater management practices included in the SWPPP. The *owner or operator* shall have each of the contractors and subcontractors identify at least one person from their company that will be responsible for implementation of the SWPPP. This person shall be known as the *trained contractor.* The *owner or operator* shall ensure that at least one *trained contractor* is on site on a daily basis when soil disturbance activities are being performed.

   The *owner or operator* shall have each of the contractors and subcontractors identified above sign a copy of the following certification statement below before they commence any *construction activity*:

   "I hereby certify under penalty of law that I understand and agree to comply with the terms and conditions of the SWPPP and agree to implement any corrective actions identified by the *qualified inspector* during a site inspection. I also understand that the *owner or operator* must comply with





the terms and conditions of the most current version of the New York State Pollutant Discharge Elimination System ("SPDES") general permit for stormwater *discharges* from *construction activities* and that it is unlawful for any person to cause or contribute to a violation of *water quality standards*. Furthermore, I am aware that there are significant penalties for submitting false information, that I do not believe to be true, including the possibility of fine and imprisonment for knowing violations"

   In addition to providing the certification statement above, the certification page must also identify the specific elements of the SWPPP that each contractor and subcontractor will be responsible for and include the name and title of the person providing the signature; the name and title of the *trained contractor* responsible for SWPPP implementation; the name, address and telephone number of the contracting firm; the address (or other identifying description) of the site; and the date the certification statement is signed. The *owner or operator* shall attach the certification statement(s) to the copy of the SWPPP that is maintained at the *construction site*. If new or additional contractors are hired to implement measures identified in the SWPPP after construction has commenced, they must also sign the certification statement and provide the information listed above.

7. For projects where the Department requests a copy of the SWPPP or inspection reports, the *owner or operator* shall submit the documents in both electronic (PDF only) and paper format within five (5) business days, unless otherwise notified by the Department.

**B. Required SWPPP Contents**

1. Erosion and sediment control component - All SWPPPs prepared pursuant to this permit shall include erosion and sediment control practices designed in conformance with the technical standard, New York State Standards and Specifications for Erosion and Sediment Control, dated November 2016. Where erosion and sediment control practices are not designed in conformance with the design criteria included in the technical standard, the *owner or operator* must demonstrate *equivalence* to the technical standard. At a minimum, the erosion and sediment control component of the SWPPP shall include the following:

   a. Background information about the scope of the project, including the location, type and size of project

b. A site map/construction drawing(s) for the project, including a general location map. At a minimum, the site map shall show the total site area; all improvements; areas of disturbance; areas that will not be disturbed; existing vegetation; on-site and adjacent off-site surface water(s); floodplain/floodway boundaries; wetlands and drainage patterns that could be affected by the *construction activity*; existing and final contours ; locations of different soil types with boundaries; material, waste, borrow or equipment storage areas located on adjacent properties; and location(s) of the stormwater *discharge*(s);

c. A description of the soil(s) present at the site, including an identification of the Hydrologic Soil Group (HSG);

d. A construction phasing plan and sequence of operations describing the intended order of *construction activities*, including clearing and grubbing, excavation and grading, utility and infrastructure installation and any other activity at the site that results in soil disturbance;

e. A description of the minimum erosion and sediment control practices to be installed or implemented for each *construction activity* that will result in soil disturbance. Include a schedule that identifies the timing of initial placement or implementation of each erosion and sediment control practice and the minimum time frames that each practice should remain in place or be implemented;

f. A temporary and permanent soil stabilization plan that meets the requirements of this general permit and the technical standard, New York State Standards and Specifications for Erosion and Sediment Control, dated November 2016, for each stage of the project, including initial land clearing and grubbing to project completion and achievement of *final stabilization*;

g. A site map/construction drawing(s) showing the specific location(s), size(s), and length(s) of each erosion and sediment control practice;

h. The dimensions, material specifications, installation details, and operation and maintenance requirements for all erosion and sediment control practices. Include the location and sizing of any temporary sediment basins and structural practices that will be used to divert flows from exposed soils;

i. A maintenance inspection schedule for the contractor(s) identified in Part III.A.6. of this permit, to ensure continuous and effective operation of the erosion and sediment control practices. The maintenance inspection





schedule shall be in accordance with the requirements in the technical standard, New York State Standards and Specifications for Erosion and Sediment Control, dated November 2016;

j. A description of the pollution prevention measures that will be used to control litter, construction chemicals and construction debris from becoming a *pollutant* source in the stormwater *discharges*;

k. A description and location of any stormwater *discharges* associated with industrial activity other than construction at the site, including, but not limited to, stormwater *discharges* from asphalt plants and concrete plants located on the *construction site*; and

l. Identification of any elements of the design that are not in conformance with the design criteria in the technical standard, New York State Standards and Specifications for Erosion and Sediment Control, dated November 2016. Include the reason for the deviation or alternative design and provide information which demonstrates that the deviation or alternative design is *equivalent* to the technical standard.

2. Post-construction stormwater management practice component – The *owner or operator* of any construction project identified in Table 2 of Appendix B as needing post-construction stormwater management practices shall prepare a SWPPP that includes practices designed in conformance with the applicable *sizing criteria* in Part I.C.2.a., c. or d. of this permit and the *performance criteria* in the technical standard, New York State Stormwater Management Design Manual dated January 2015

   Where post-construction stormwater management practices are not designed in conformance with the *performance criteria* in the technical standard, the *owner or operator* must include in the SWPPP the reason(s) for the deviation or alternative design and provide information which demonstrates that the deviation or alternative design is *equivalent* to the technical standard.

   The post-construction stormwater management practice component of the SWPPP shall include the following:

   a. Identification of all post-construction stormwater management practices to be constructed as part of the project. Include the dimensions, material specifications and installation details for each post-construction stormwater management practice;

b. A site map/construction drawing(s) showing the specific location and size of each post-construction stormwater management practice;

c. A Stormwater Modeling and Analysis Report that includes:
   (i) Map(s) showing pre-development conditions, including watershed/subcatchments boundaries, flow paths/routing, and design points;

   (ii) Map(s) showing post-development conditions, including watershed/subcatchments boundaries, flow paths/routing, design points and post-construction stormwater management practices;

   (iii) Results of stormwater modeling (i.e. hydrology and hydraulic analysis) for the required storm events. Include supporting calculations (model runs), methodology, and a summary table that compares pre and post-development runoff rates and volumes for the different storm events;

   (iv) Summary table, with supporting calculations, which demonstrates that each post-construction stormwater management practice has been designed in conformance with the *sizing criteria* included in the Design Manual;

   (v) Identification of any *sizing criteria* that is not required based on the requirements included in Part I.C. of this permit; and

   (vi) Identification of any elements of the design that are not in conformance with the *performance criteria* in the Design Manual. Include the reason(s) for the deviation or alternative design and provide information which demonstrates that the deviation or alternative design is *equivalent* to the Design Manual;

d. Soil testing results and locations (test pits, borings);

e. Infiltration test results, when required; and

f. An operations and maintenance plan that includes inspection and maintenance schedules and actions to ensure continuous and effective operation of each post-construction stormwater management practice. The plan shall identify the entity that will be responsible for the long term operation and maintenance of each practice.





3. Enhanced Phosphorus Removal Standards - All construction projects identified in Table 2 of Appendix B that are located in the watersheds identified in Appendix C shall prepare a SWPPP that includes post-construction stormwater management practices designed in conformance with the applicable *sizing criteria* in Part I.C.2. b., c. or d. of this permit and the *performance criteria,* Enhanced Phosphorus Removal Standards included in the Design Manual. At a minimum, the post-construction stormwater management practice component of the SWPPP shall include items 2.a - 2.f. above.

**C. Required SWPPP Components by Project Type**

Unless otherwise notified by the Department, *owners or operators* of *construction activities* identified in Table 1 of Appendix B are required to prepare a SWPPP that only includes erosion and sediment control practices designed in conformance with Part III.B.1 of this permit. *Owners or operators* of the *construction activities* identified in Table 2 of Appendix B shall prepare a SWPPP that also includes post-construction stormwater management practices designed in conformance with Part III.B.2 or 3 of this permit.

## Part IV. INSPECTION AND MAINTENANCE REQUIREMENTS

**A. General Construction Site Inspection and Maintenance Requirements**

1. The *owner or operator* must ensure that all erosion and sediment control practices (including pollution prevention measures) and all post-construction stormwater management practices identified in the SWPPP are inspected and maintained in accordance with Part IV.B. and C. of this permit.

2. The terms of this permit shall not be construed to prohibit the State of New York from exercising any authority pursuant to the ECL, common law or federal law, or prohibit New York State from taking any measures, whether civil or criminal, to prevent violations of the laws of the State of New York or protect the public health and safety and/or the environment.

**B. Contractor Maintenance Inspection Requirements**

1. The *owner or operator* of each *construction activity* identified in Tables 1 and 2 of Appendix B shall have a *trained contractor* inspect the erosion and sediment control practices and pollution prevention measures being implemented within the active work area daily to ensure that they are being maintained in effective operating condition at all times. If deficiencies are identified, the contractor shall

begin implementing corrective actions within one business day and shall complete the corrective actions in a reasonable time frame.

2. For construction sites where soil disturbance activities have been temporarily suspended (e.g. winter shutdown) and *temporary stabilization* measures have been applied to all disturbed areas, the *trained contractor* can stop conducting the maintenance inspections. The *trained contractor* shall begin conducting the maintenance inspections in accordance with Part IV.B.1. of this permit as soon as soil disturbance activities resume.

3. For construction sites where soil disturbance activities have been shut down with partial project completion, the *trained contractor* can stop conducting the maintenance inspections if all areas disturbed as of the project shutdown date have achieved *final stabilization* and all post-construction stormwater management practices required for the completed portion of the project have been constructed in conformance with the SWPPP and are operational.

**C. Qualified Inspector Inspection Requirements**

The *owner or operator* shall have a *qualified inspector* conduct site inspections in conformance with the following requirements:

[Note: The *trained contractor* identified in Part III.A.6. and IV.B. of this permit **cannot** conduct the *qualified inspector* site inspections unless they meet the *qualified inspector* qualifications included in Appendix A. In order to perform these inspections, the *trained contractor* would have to be a:

- licensed Professional Engineer,
- Certified Professional in Erosion and Sediment Control (CPESC),
- New York State Erosion and Sediment Control Certificate Program holder
- Registered Landscape Architect, or
- someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided they have received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity].

1. A *qualified inspector* shall conduct site inspections for all *construction activities* identified in Tables 1 and 2 of Appendix B, with the exception of:

   a. the construction of a single family residential subdivision with 25% or less *impervious cover* at total site build-out that involves a soil disturbance of one (1) or more acres of land but less than five (5) acres and is not located





in one of the watersheds listed in Appendix C and not directly discharging to one of the 303(d) segments listed in Appendix E;

   b. the construction of a single family home that involves a soil disturbance of one (1) or more acres of land but less than five (5) acres and is not located in one of the watersheds listed in Appendix C and not directly discharging to one of the 303(d) segments listed in Appendix E;

   c. construction on agricultural property that involves a soil disturbance of one (1) or more acres of land but less than five (5) acres; and

   d. *construction activities* located in the watersheds identified in Appendix D that involve soil disturbances between five thousand (5,000) square feet and one (1) acre of land.

2. Unless otherwise notified by the Department, the *qualified inspector* shall conduct site inspections in accordance with the following timetable:

   a. For construction sites where soil disturbance activities are on-going, the *qualified inspector* shall conduct a site inspection at least once every seven (7) calendar days.

   b. For construction sites where soil disturbance activities are on-going and the *owner or operator* has received authorization in accordance with Part II.D.3 to disturb greater than five (5) acres of soil at any one time, the *qualified inspector* shall conduct at least two (2) site inspections every seven (7) calendar days. The two (2) inspections shall be separated by a minimum of two (2) full calendar days.

   c. For construction sites where soil disturbance activities have been temporarily suspended (e.g. winter shutdown) and *temporary stabilization* measures have been applied to all disturbed areas, the *qualified inspector* shall conduct a site inspection at least once every thirty (30) calendar days. The *owner or operator* shall notify the DOW Water (SPDES) Program contact at the Regional Office (see contact information in Appendix F) or, in areas under the jurisdiction of a *regulated, traditional land use control MS4,* the *regulated, traditional land use control MS4* (provided the *regulated, traditional land use control MS4* is not the *owner or operator* of the *construction activity*) in writing prior to reducing the frequency of inspections.

d. For construction sites where soil disturbance activities have been shut down with partial project completion, the *qualified inspector* can stop conducting inspections if all areas disturbed as of the project shutdown date have achieved *final stabilization* and all post-construction stormwater management practices required for the completed portion of the project have been constructed in conformance with the SWPPP and are operational. The *owner or operator* shall notify the DOW Water (SPDES) Program contact at the Regional Office (see contact information in Appendix F) or, in areas under the jurisdiction of a *regulated, traditional land use control MS4,* the *regulated, traditional land use control MS4* (provided the *regulated, traditional land use control MS4* is not the *owner or operator* of the *construction activity*) in writing prior to the shutdown. If soil disturbance activities are not resumed within 2 years from the date of shutdown, the *owner or operator* shall have the *qualified inspector* perform a final inspection and certify that all disturbed areas have achieved *final stabilization,* and all temporary, structural erosion and sediment control measures have been removed; and that all post-construction stormwater management practices have been constructed in conformance with the SWPPP by signing the "*Final Stabilization*" and "Post-Construction Stormwater Management Practice" certification statements on the NOT. The *owner or operator* shall then submit the completed NOT form to the address in Part II.B.1 of this permit.

e. For construction sites that directly *discharge* to one of the 303(d) segments listed in Appendix E or is located in one of the watersheds listed in Appendix C, the *qualified inspector* shall conduct at least two (2) site inspections every seven (7) calendar days. The two (2) inspections shall be separated by a minimum of two (2) full calendar days.

3. At a minimum, the *qualified inspector* shall inspect all erosion and sediment control practices and pollution prevention measures to ensure integrity and effectiveness, all post-construction stormwater management practices under construction to ensure that they are constructed in conformance with the SWPPP, all areas of disturbance that have not achieved *final stabilization,* all points of *discharge* to natural surface waterbodies located within, or immediately adjacent to, the property boundaries of the *construction site*, and all points of *discharge* from the *construction site*.

4. The *qualified inspector* shall prepare an inspection report subsequent to each and every inspection. At a minimum, the inspection report shall include and/or address the following:





a. Date and time of inspection;

b. Name and title of person(s) performing inspection;

c. A description of the weather and soil conditions (e.g. dry, wet, saturated) at the time of the inspection;

d. A description of the condition of the runoff at all points of *discharge* from the *construction site*. This shall include identification of any *discharges* of sediment from the *construction site*. Include *discharges* from conveyance systems (i.e. pipes, culverts, ditches, etc.) and overland flow;

e. A description of the condition of all natural surface waterbodies located within, or immediately adjacent to, the property boundaries of the *construction site* which receive runoff from disturbed areas. This shall include identification of any *discharges* of sediment to the surface waterbody;

f. Identification of all erosion and sediment control practices and pollution prevention measures that need repair or maintenance;

g. Identification of all erosion and sediment control practices and pollution prevention measures that were not installed properly or are not functioning as designed and need to be reinstalled or replaced;

h. Description and sketch of areas with active soil disturbance activity, areas that have been disturbed but are inactive at the time of the inspection, and areas that have been stabilized (temporary and/or final) since the last inspection;

i. Current phase of construction of all post-construction stormwater management practices and identification of all construction that is not in conformance with the SWPPP and technical standards;

j. Corrective action(s) that must be taken to install, repair, replace or maintain erosion and sediment control practices and pollution prevention measures; and to correct deficiencies identified with the construction of the post-construction stormwater management practice(s);

k. Identification and status of all corrective actions that were required by previous inspection; and

l. Digital photographs, with date stamp, that clearly show the condition of all practices that have been identified as needing corrective actions. The *qualified inspector* shall attach paper color copies of the digital photographs to the inspection report being maintained onsite within seven (7) calendar days of the date of the inspection. The *qualified inspector* shall also take digital photographs, with date stamp, that clearly show the condition of the practice(s) after the corrective action has been completed. The *qualified inspector* shall attach paper color copies of the digital photographs to the inspection report that documents the completion of the corrective action work within seven (7) calendar days of that inspection.

5. Within one business day of the completion of an inspection, the *qualified inspector* shall notify the *owner or operator* and appropriate contractor or subcontractor identified in Part III.A.6. of this permit of any corrective actions that need to be taken. The contractor or subcontractor shall begin implementing the corrective actions within one business day of this notification and shall complete the corrective actions in a reasonable time frame.

6. All inspection reports shall be signed by the *qualified inspector.* Pursuant to Part II.D.2. of this permit, the inspection reports shall be maintained on site with the SWPPP.

## Part V. TERMINATION OF PERMIT COVERAGE

### A. Termination of Permit Coverage

1. An *owner or operator* that is eligible to terminate coverage under this permit must submit a completed NOT form to the address in Part II.B.1 of this permit. The NOT form shall be one which is associated with this permit, signed in accordance with Part VII.H of this permit.

2. An *owner or operator* may terminate coverage when one or more the following conditions have been met:

   a. Total project completion - All *construction activity* identified in the SWPPP has been completed; and all areas of disturbance have achieved *final stabilization*; and all temporary, structural erosion and sediment control measures have been removed; and all post-construction stormwater management practices have been constructed in conformance with the SWPPP and are operational;





   b. Planned shutdown with partial project completion - All soil disturbance activities have ceased; and all areas disturbed as of the project shutdown date have achieved *final stabilization*; and all temporary, structural erosion and sediment control measures have been removed; and all post-construction stormwater management practices required for the completed portion of the project have been constructed in conformance with the SWPPP and are operational;

   c. A new *owner or operator* has obtained coverage under this permit in accordance with Part II.F. of this permit.

   d. The *owner or operator* obtains coverage under an alternative SPDES general permit or an individual SPDES permit.

3. For *construction activities* meeting subdivision 2a. or 2b. of this Part, the *owner or operator* shall have the *qualified inspector* perform a final site inspection prior to submitting the NOT. The *qualified inspector* shall, by signing the "*Final Stabilization*" and "Post-Construction Stormwater Management Practice certification statements on the NOT, certify that all the requirements in Part V.A.2.a. or b. of this permit have been achieved.

4. For *construction activities* that are subject to the requirements of a *regulated, traditional land use control MS4* and meet subdivision 2a. or 2b. of this Part, the *owner or operator* shall have the *regulated, traditional land use control MS4* sign the "MS4 Acceptance" statement on the NOT in accordance with the requirements in Part VII.H. of this permit. The *regulated, traditional land use control MS4* official, by signing this statement, has determined that it is acceptable for the *owner or operator* to submit the NOT in accordance with the requirements of this Part. The *regulated, traditional land use control MS4* can make this determination by performing a final site inspection themselves or by accepting the *qualified inspector*'s final site inspection certification(s) required in Part V.A.3. of this permit.

5. For *construction activities* that require post-construction stormwater management practices and meet subdivision 2a. of this Part, the *owner or operator* must, prior to submitting the NOT, ensure one of the following:

   a. the post-construction stormwater management practice(s) and any right-of-way(s) needed to maintain such practice(s) have been deeded to the municipality in which the practice(s) is located,

b. an executed maintenance agreement is in place with the municipality that will maintain the post-construction stormwater management practice(s),

c. for post-construction stormwater management practices that are privately owned, the *owner or operator* has a mechanism in place that requires operation and maintenance of the practice(s) in accordance with the operation and maintenance plan, such as a deed covenant in the *owner or operator's* deed of record,

d. for post-construction stormwater management practices that are owned by a public or private institution (e.g. school, university, hospital), government agency or authority, or public utility; the *owner or operator* has policy and procedures in place that ensures operation and maintenance of the practices in accordance with the operation and maintenance plan.

## Part VI. REPORTING AND RETENTION RECORDS

### A. Record Retention

The *owner or operator* shall retain a copy of the NOI, NOI Acknowledgment Letter, SWPPP, MS4 SWPPP Acceptance form and any inspection reports that were prepared in conjunction with this permit for a period of at least five (5) years from the date that the Department receives a complete NOT submitted in accordance with Part V. of this general permit.

### B. Addresses

With the exception of the NOI, NOT, and MS4 SWPPP Acceptance form (which must be submitted to the address referenced in Part II.B.1 of this permit), all written correspondence requested by the Department, including individual permit applications, shall be sent to the address of the appropriate DOW Water (SPDES) Program contact at the Regional Office listed in Appendix F.

## Part VII. STANDARD PERMIT CONDITIONS

### A. Duty to Comply

The *owner or operator* must comply with all conditions of this permit. All contractors and subcontractors associated with the project must comply with the terms of the SWPPP. Any non-compliance with this permit constitutes a violation of the Clean Water





Act (CWA) and the ECL and is grounds for an enforcement action against the *owner or operator* and/or the contractor/subcontractor; permit revocation, suspension or modification; or denial of a permit renewal application. Upon a finding of significant non-compliance with this permit or the applicable SWPPP, the Department may order an immediate stop to all *construction activity* at the site until the non-compliance is remedied. The stop work order shall be in writing, shall describe the non-compliance in detail, and shall be sent to the *owner or operator*.

If any human remains or archaeological remains are encountered during excavation, the *owner or operator* must immediately cease, or cause to cease, all *construction activity* in the area of the remains and notify the appropriate Regional Water Engineer (RWE). *Construction activity* shall not resume until written permission to do so has been received from the RWE.

### B. Continuation of the Expired General Permit

This permit expires five (5) years from the effective date. If a new general permit is not issued prior to the expiration of this general permit, an *owner or operator* with coverage under this permit may continue to operate and *discharge* in accordance with the terms and conditions of this general permit, if it is extended pursuant to the State Administrative Procedure Act and 6 NYCRR Part 621, until a new general permit is issued.

### C. Enforcement

Failure of the *owner or operator,* its contractors, subcontractors, agents and/or assigns to strictly adhere to any of the permit requirements contained herein shall constitute a violation of this permit. There are substantial criminal, civil, and administrative penalties associated with violating the provisions of this permit. Fines of up to $37,500 per day for each violation and imprisonment for up to fifteen (15) years may be assessed depending upon the nature and degree of the offense.

### D. Need to Halt or Reduce Activity Not a Defense

It shall not be a defense for an *owner or operator* in an enforcement action that it would have been necessary to halt or reduce the *construction activity* in order to maintain compliance with the conditions of this permit.

**E. Duty to Mitigate**

The *owner or operator* and its contractors and subcontractors shall take all reasonable steps to *minimize* or prevent any *discharge* in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment.

**F. Duty to Provide Information**

The *owner or operator* shall furnish to the Department, within a reasonable specified time period of a written request, all documentation necessary to demonstrate eligibility and any information to determine compliance with this permit or to determine whether cause exists for modifying or revoking this permit, or suspending or denying coverage under this permit, in accordance with the terms and conditions of this permit. The NOI, SWPPP and inspection reports required by this permit are public documents that the *owner or operator* must make available for review and copying by any person within five (5) business days of the *owner or operator* receiving a written request by any such person to review these documents. Copying of documents will be done at the requester's expense.

**G. Other Information**

When the *owner or operator* becomes aware that they failed to submit any relevant facts, or submitted incorrect information in the NOI or in any of the documents required by this permit , or have made substantive revisions to the SWPPP (e.g. the scope of the project changes significantly, the type of post-construction stormwater management practice(s) changes, there is a reduction in the sizing of the post-construction stormwater management practice, or there is an increase in the disturbance area or *impervious area*), which were not reflected in the original NOI submitted to the Department, they shall promptly submit such facts or information to the Department using the contact information in Part II.A. of this permit. Failure of the *owner or operator* to correct or supplement any relevant facts within five (5) business days of becoming aware of the deficiency shall constitute a violation of this permit.

**H. Signatory Requirements**

1. All NOIs and NOTs shall be signed as follows:

   a. For a corporation these forms shall be signed by a responsible corporate officer. For the purpose of this section, a responsible corporate officer means:





(i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principal business function, or any other person who performs similar policy or decision-making functions for the corporation; or

(ii) the manager of one or more manufacturing, production or operating facilities, provided the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures;

   b. For a partnership or sole proprietorship these forms shall be signed by a general partner or the proprietor, respectively; or

   c. For a municipality, State, Federal, or other public agency these forms shall be signed by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes:

(i) the chief executive officer of the agency, or

(ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g., Regional Administrators of EPA).

2. The SWPPP and other information requested by the Department shall be signed by a person described in Part VII.H.1. of this permit or by a duly authorized representative of that person. A person is a duly authorized representative only if:

   a. The authorization is made in writing by a person described in Part VII.H.1. of this permit;

   b. The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a well field, superintendent, position of *equivalent* responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position) and,

c. The written authorization shall include the name, title and signature of the authorized representative and be attached to the SWPPP.

3. All inspection reports shall be signed by the *qualified inspector* that performs the inspection.

4. The MS4 SWPPP Acceptance form shall be signed by the principal executive officer or ranking elected official from the *regulated, traditional land use control MS4,* or by a duly authorized representative of that person.

   It shall constitute a permit violation if an incorrect and/or improper signatory authorizes any required forms, SWPPP and/or inspection reports.

**I. Property Rights**

The issuance of this permit does not convey any property rights of any sort, nor any exclusive privileges, nor does it authorize any injury to private property nor any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations. *Owners or operators* must obtain any applicable conveyances, easements, licenses and/or access to real property prior to *commencing construction activity*.

**J. Severability**

The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit shall not be affected thereby.

**K. Requirement to Obtain Coverage Under an Alternative Permit**

1. The Department may require any owner or operator authorized by this permit to apply for and/or obtain either an individual SPDES permit or another SPDES general permit. When the Department requires any discharger authorized by a general permit to apply for an individual SPDES permit, it shall notify the discharger in writing that a permit application is required. This notice shall





include a brief statement of the reasons for this decision, an application form, a statement setting a time frame for the owner or operator to file the application for an individual SPDES permit, and a deadline, not sooner than 180 days from owner or operator receipt of the notification letter, whereby the authorization to discharge under this general permit shall be terminated. Applications must be submitted to the appropriate Permit Administrator at the Regional Office. The Department may grant additional time upon demonstration, to the satisfaction of the Department, that additional time to apply for an alternative authorization is necessary or where the Department has not provided a permit determination in accordance with Part 621 of this Title.

2. When an individual SPDES permit is issued to a discharger authorized to *discharge* under a general SPDES permit for the same *discharge*(s), the general permit authorization for outfalls authorized under the individual SPDES permit is automatically terminated on the effective date of the individual permit unless termination is earlier in accordance with 6 NYCRR Part 750.

**L. Proper Operation and Maintenance**

The *owner or operator* shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the *owner or operator* to achieve compliance with the conditions of this permit and with the requirements of the SWPPP.

**M. Inspection and Entry**

The *owner or operator* shall allow an authorized representative of the Department, EPA, applicable county health department, or, in the case of a *construction site* which *discharges* through an *MS4*, an authorized representative of the *MS4* receiving the discharge, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the owner's or operator's premises where a regulated facility or activity is located or conducted or where records must be kept under the conditions of this permit;

2. Have access to and copy at reasonable times, any records that must be kept under the conditions of this permit; and

3. Inspect at reasonable times any facilities or equipment (including monitoring and control equipment), practices or operations regulated or required by this permit.

4. Sample or monitor at reasonable times, for purposes of assuring permit compliance or as otherwise authorized by the Act or ECL, any substances or parameters at any location.

**N. Permit Actions**

This permit may, at any time, be modified, suspended, revoked, or renewed by the Department in accordance with 6 NYCRR Part 621. The filing of a request by the *owner or operator* for a permit modification, revocation and reissuance, termination, a notification of planned changes or anticipated noncompliance does not limit, diminish and/or stay compliance with any terms of this permit.

**O. Definitions**

Definitions of key terms are included in Appendix A of this permit.

**P. Re-Opener Clause**

1. If there is evidence indicating potential or realized impacts on water quality due to any stormwater discharge associated with construction activity covered by this permit, the owner or operator of such discharge may be required to obtain an individual permit or alternative general permit in accordance with Part VII.K. of this permit or the permit may be modified to include different limitations and/or requirements.

2. Any Department initiated permit modification, suspension or revocation will be conducted in accordance with 6 NYCRR Part 621, 6 NYCRR 750-1.18, and 6 NYCRR 750-1.20.

**Q. Penalties for Falsification of Forms and Reports**

In accordance with 6NYCRR Part 750-2.4 and 750-2.5, any person who knowingly makes any false material statement, representation, or certification in any application, record, report or other document filed or required to be maintained under this permit, including reports of compliance or noncompliance shall, upon conviction, be punished in accordance with ECL §71-1933 and or Articles 175 and 210 of the New York State Penal Law.





**R. Other Permits**

Nothing in this permit relieves the *owner or operator* from a requirement to obtain any other permits required by law.

## APPENDIX A – Acronyms and Definitions

**Acronyms**

APO – Agency Preservation Officer
BMP – Best Management Practice
CPESC – Certified Professional in Erosion and Sediment Control
Cpv – Channel Protection Volume
CWA – Clean Water Act (or the Federal Water Pollution Control Act, 33 U.S.C. §1251 et seq)
DOW – Division of Water
EAF – Environmental Assessment Form
ECL - Environmental Conservation Law
EPA – U. S. Environmental Protection Agency
HSG – Hydrologic Soil Group
MS4 – Municipal Separate Storm Sewer System
NOI – Notice of Intent
NOT – Notice of Termination
NPDES – National Pollutant Discharge Elimination System
OPRHP – Office of Parks, Recreation and Historic Places
Qf – Extreme Flood
Qp – Overbank Flood
RRv – Runoff Reduction Volume
RWE – Regional Water Engineer
SEQR – State Environmental Quality Review
SEQRA - State Environmental Quality Review Act
SHPA – State Historic Preservation Act
SPDES – State Pollutant Discharge Elimination System
SWPPP – Stormwater Pollution Prevention Plan
TMDL – Total Maximum Daily Load
UPA – Uniform Procedures Act
USDA – United States Department of Agriculture
WQv – Water Quality Volume





**Definitions**

<u>All definitions in this section are solely for the purposes of this permit.</u>

**Agricultural Building –** a structure designed and constructed to house farm implements, hay, grain, poultry, livestock or other horticultural products; excluding any structure designed, constructed or used, in whole or in part, for human habitation, as a place of employment where agricultural products are processed, treated or packaged, or as a place used by the public.

**Agricultural Property** –means the land for construction of a barn, *agricultural building*, silo, stockyard, pen or other structural practices identified in Table II in the “Agricultural Management Practices Catalog for Nonpoint Source Pollution in New York State” prepared by the Department in cooperation with agencies of New York Nonpoint Source Coordinating Committee (dated June 2007).

**Alter Hydrology from Pre to Post-Development Conditions -** means the post-development peak flow rate(s) has increased by more than 5% of the pre-developed condition for the design storm of interest (e.g. 10 yr and 100 yr).

**Combined Sewer -** means a sewer that is designed to collect and convey both “sewage” and “stormwater”.

**Commence (Commencement of) Construction Activities -** means the initial disturbance of soils associated with clearing, grading or excavation activities; or other construction related activities that disturb or expose soils such as demolition, stockpiling of fill material, and the initial installation of erosion and sediment control practices required in the SWPPP. See definition for “*Construction Activity(ies)*” also.

**Construction Activity(ies) -** means any clearing, grading, excavation, filling, demolition or stockpiling activities that result in soil disturbance. Clearing activities can include, but are not limited to, logging equipment operation, the cutting and skidding of trees, stump removal and/or brush root removal. Construction activity does not include routine maintenance that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of a facility.

**Construction Site** – means the land area where *construction activity(ies)* will occur. See definition for “*Commence (Commencement of) Construction Activities”* and “*Larger Common Plan of Development or Sale” also.*

**Dewatering** – means the act of draining rainwater and/or groundwater from building foundations, vaults or excavations/trenches.

**Direct Discharge (to a specific surface waterbody) -** means that runoff flows from a *construction site* by overland flow and the first point of discharge is the specific surface waterbody, or runoff flows from a *construction site* to a separate storm sewer system and the first point of discharge from the separate storm sewer system is the specific surface waterbody.

**Discharge(s)** - means any addition of any pollutant to waters of the State through an outlet or *point source*.

**Embankment** –means an earthen or rock slope that supports a road/highway.

**Endangered or Threatened Species** – see 6 NYCRR Part 182 of the Department's rules and regulations for definition of terms and requirements.

**Environmental Conservation Law (ECL)** - means chapter 43-B of the Consolidated Laws of the State of New York, entitled the Environmental Conservation Law.

**Equivalent (Equivalence)** – means that the practice or measure meets all the performance, longevity, maintenance, and safety objectives of the technical standard and will provide an equal or greater degree of water quality protection.

**Final Stabilization -** means that all soil disturbance activities have ceased and a uniform, perennial vegetative cover with a density of eighty (80) percent over the entire pervious surface has been established; or other equivalent stabilization measures, such as permanent landscape mulches, rock rip-rap or washed/crushed stone have been applied on all disturbed areas that are not covered by permanent structures, concrete or pavement.

**General SPDES permit** - means a SPDES permit issued pursuant to 6 NYCRR Part 750-1.21 and Section 70-0117 of the ECL authorizing a category of discharges.

**Groundwater(s)** - means waters in the saturated zone. The saturated zone is a subsurface zone in which all the interstices are filled with water under pressure greater than that of the atmosphere. Although the zone may contain gas-filled interstices or interstices filled with fluids other than water, it is still considered saturated.

**Historic Property** – means any building, structure, site, object or district that is listed on the State or National Registers of Historic Places or is determined to be eligible for listing on the State or National Registers of Historic Places.

**Impervious Area (Cover) -** means all impermeable surfaces that cannot effectively infiltrate rainfall. This includes paved, concrete and gravel surfaces (i.e. parking lots, driveways, roads, runways and sidewalks); building rooftops and miscellaneous impermeable structures such as patios, pools, and sheds.

**Infeasible** – means not technologically possible, or not economically practicable and achievable in light of best industry practices.





**Larger Common Plan of Development or Sale -** means a contiguous area where multiple separate and distinct *construction activities* are occurring, or will occur, under one plan. The term "plan" in "larger common plan of development or sale" is broadly defined as any announcement or piece of documentation (including a sign, public notice or hearing, marketing plan, advertisement, drawing, permit application, State Environmental Quality Review Act (SEQRA) environmental assessment form or other documents, zoning request, computer design, etc.) or physical demarcation (including boundary signs, lot stakes, surveyor markings, etc.) indicating that *construction activities* may occur on a specific plot.

For discrete construction projects that are located within a larger common plan of development or sale that are at least 1/4 mile apart, each project can be treated as a separate plan of development or sale provided any interconnecting road, pipeline or utility project that is part of the same "common plan" is not concurrently being disturbed.

**Minimize** – means reduce and/or eliminate to the extent achievable using control measures (including best management practices) that are technologically available and economically practicable and achievable in light of best industry practices.

**Municipal Separate Storm Sewer (MS4)** - a conveyance or system of conveyances (including roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, or storm drains):

- (i) Owned or operated by a State, city, town, borough, county, parish, district, association, or other public body (created by or pursuant to State law) having jurisdiction over disposal of sewage, industrial wastes, stormwater, or other wastes, including special districts under State law such as a sewer district, flood control district or drainage district, or similar entity, or an Indian tribe or an authorized Indian tribal organization, or a designated and approved management agency under section 208 of the CWA that discharges to surface waters of the State;
- (ii) Designed or used for collecting or conveying stormwater;
- (iii) Which is not a *combined sewer*; and
- (iv) Which is not part of a Publicly Owned Treatment Works (POTW) as defined at 40 CFR 122.2.

**National Pollutant Discharge Elimination System (NPDES)** - means the national system for the issuance of wastewater and stormwater permits under the Federal Water Pollution Control Act (Clean Water Act).

**Natural Buffer** –means an undisturbed area with natural cover running along a surface water (e.g. wetland, stream, river, lake, etc.).

**New Development** – means any land disturbance that does not meet the definition of Redevelopment Activity included in this appendix.

**New York State Erosion and Sediment Control Certificate Program** – a certificate program that establishes and maintains a process to identify and recognize individuals who are capable of developing, designing, inspecting and maintaining erosion and sediment control plans on projects that disturb soils in New York State. The certificate program is administered by the New York State Conservation District Employees Association.

**NOI Acknowledgment Letter** - means the letter that the Department sends to an owner or operator to acknowledge the Department's receipt and acceptance of a complete Notice of Intent. This letter documents the owner's or operator's authorization to discharge in accordance with the general permit for stormwater discharges from *construction activity*.

**Nonpoint Source** - means any source of water pollution or pollutants which is not a discrete conveyance or *point source* permitted pursuant to Title 7 or 8 of Article 17 of the Environmental Conservation Law (see ECL Section 17-1403).

**Overbank** –means flow events that exceed the capacity of the stream channel and spill out into the adjacent floodplain.

**Owner or Operator** - means the person, persons or legal entity which owns or leases the property on which the *construction activity* is occurring; an entity that has operational control over the construction plans and specifications, including the ability to make modifications to the plans and specifications; and/or an entity that has day-to-day operational control of those activities at a project that are necessary to ensure compliance with the permit conditions.

**Performance Criteria** – means the design criteria listed under the "Required Elements" sections in Chapters 5, 6 and 10 of the technical standard, New York State Stormwater Management Design Manual, dated January 2015. It does not include the Sizing Criteria (i.e. WQv, RRv, Cpv, Qp and Qf ) in Part I.C.2. of the permit.

**Point Source** - means any discernible, confined and discrete conveyance, including but not limited to any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, vessel or other floating craft, or landfill leachate collection system from which *pollutants* are or may be discharged.

**Pollutant** - means dredged spoil, filter backwash, solid waste, incinerator residue, sewage, garbage, sewage sludge, munitions, chemical wastes, biological materials, radioactive materials, heat, wrecked or discarded equipment, rock, sand and industrial, municipal, agricultural waste and ballast discharged into water; which may cause or might reasonably be expected to cause pollution of the waters of the state in contravention of the standards or guidance values adopted as provided in 6 NYCRR Parts 700 et seq .





**Qualified Inspector** - means a person that is knowledgeable in the principles and practices of erosion and sediment control, such as a licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, New York State Erosion and Sediment Control Certificate Program holder or other Department endorsed individual(s).

It can also mean someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided that person has training in the principles and practices of erosion and sediment control. Training in the principles and practices of erosion and sediment control means that the individual working under the direct supervision of the licensed Professional Engineer or Registered Landscape Architect has received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity. After receiving the initial training, the individual working under the direct supervision of the licensed Professional Engineer or Registered Landscape Architect shall receive four (4) hours of training every three (3) years.

It can also mean a person that meets the *Qualified Professional* qualifications in addition to the *Qualified Inspector* qualifications.

Note: Inspections of any post-construction stormwater management practices that include structural components, such as a dam for an impoundment, shall be performed by a licensed Professional Engineer.

**Qualified Professional -** means a person that is knowledgeable in the principles and practices of stormwater management and treatment, such as a licensed Professional Engineer, Registered Landscape Architect or other Department endorsed individual(s). Individuals preparing SWPPPs that require the post-construction stormwater management practice component must have an understanding of the principles of hydrology, water quality management practice design, water quantity control design, and, in many cases, the principles of hydraulics. All components of the SWPPP that involve the practice of engineering, as defined by the NYS Education Law (see Article 145), shall be prepared by, or under the direct supervision of, a professional engineer licensed to practice in the State of New York.

**Redevelopment Activity(ies)** – means the disturbance and reconstruction of existing impervious area, including impervious areas that were removed from a project site within five (5) years of preliminary project plan submission to the local government (i.e. site plan, subdivision, etc.).

**Regulated, Traditional Land Use Control MS4 -** means a city, town or village with land use control authority that is authorized to discharge under New York State DEC's

SPDES General Permit For Stormwater Discharges from Municipal Separate Stormwater Sewer Systems (MS4s) or the City of New York's Individual SPDES Permit for their Municipal Separate Storm Sewer Systems (NY-0287890).

**Routine Maintenance Activity -** means *construction activity* that is performed to maintain the original line and grade, hydraulic capacity, or original purpose of a facility, including, but not limited to:

- Re-grading of gravel roads or parking lots,
- Cleaning and shaping of existing roadside ditches and culverts that maintains the approximate original line and grade, and hydraulic capacity of the ditch,
- Cleaning and shaping of existing roadside ditches that does not maintain the approximate original grade, hydraulic capacity and purpose of the ditch if the changes to the line and grade, hydraulic capacity or purpose of the ditch are installed to improve water quality and quantity controls (e.g. installing grass lined ditch),
- Placement of aggregate shoulder backing that stabilizes the transition between the road shoulder and the ditch or *embankment*,
- Full depth milling and filling of existing asphalt pavements, replacement of concrete pavement slabs, and similar work that does not expose soil or disturb the bottom six (6) inches of subbase material,
- Long-term use of equipment storage areas at or near highway maintenance facilities,
- Removal of sediment from the edge of the highway to restore a previously existing sheet-flow drainage connection from the highway surface to the highway ditch or *embankment*,
- Existing use of Canal Corp owned upland disposal sites for the canal, and
- Replacement of curbs, gutters, sidewalks and guide rail posts.

**Site limitations** – means site conditions that prevent the use of an infiltration technique and or infiltration of the total WQv. Typical site limitations include: seasonal high groundwater, shallow depth to bedrock, and soils with an infiltration rate less than 0.5 inches/hour. The existence of site limitations shall be confirmed and documented using actual field testing (i.e. test pits, soil borings, and infiltration test) or using information from the most current United States Department of Agriculture (USDA) Soil Survey for the County where the project is located.

**Sizing Criteria** – means the criteria included in Part I.C.2 of the permit that are used to size post-construction stormwater management control practices. The criteria include; Water Quality Volume (WQv), Runoff Reduction Volume (RRv), Channel Protection Volume (Cpv), *Overbank* Flood (Qp), and Extreme Flood (Qf).

**State Pollutant Discharge Elimination System (SPDES)** - means the system established pursuant to Article 17 of the ECL and 6 NYCRR Part 750 for issuance of permits authorizing discharges to the waters of the state.





**Steep Slope** – means land area designated on the current United States Department of Agriculture ("USDA") Soil Survey as Soil Slope Phase "D", (provided the map unit name is inclusive of slopes greater than 25%) , or Soil Slope Phase E or F, (regardless of the map unit name), or a combination of the three designations.

**Streambank** – as used in this permit, means the terrain alongside the bed of a creek or stream. The bank consists of the sides of the channel, between which the flow is confined.

**Stormwater Pollution Prevention Plan (SWPPP)** – means a project specific report, including construction drawings, that among other things: describes the construction activity(ies), identifies the potential sources of pollution at the *construction site*; describes and shows the stormwater controls that will be used to control the pollutants (i.e. erosion and sediment controls; for many projects, includes post-construction stormwater management controls); and identifies procedures the *owner or operator* will implement to comply with the terms and conditions of the permit. See Part III of the permit for a complete description of the information that must be included in the SWPPP.

**Surface Waters of the State** - shall be construed to include lakes, bays, sounds, ponds, impounding reservoirs, springs, rivers, streams, creeks, estuaries, marshes, inlets, canals, the Atlantic ocean within the territorial seas of the state of New York and all other bodies of surface water, natural or artificial, inland or coastal, fresh or salt, public or private (except those private waters that do not combine or effect a junction with natural surface waters), which are wholly or partially within or bordering the state or within its jurisdiction. Waters of the state are further defined in 6 NYCRR Parts 800 to 941.

**Temporarily Ceased** – means that an existing disturbed area will not be disturbed again within 14 calendar days of the previous soil disturbance.

**Temporary Stabilization** - means that exposed soil has been covered with material(s) as set forth in the technical standard, New York Standards and Specifications for Erosion and Sediment Control, to prevent the exposed soil from eroding. The materials can include, but are not limited to, mulch, seed and mulch, and erosion control mats (e.g. jute twisted yarn, excelsior wood fiber mats).

**Total Maximum Daily Loads** (TMDLs) - A TMDL is the sum of the allowable loads of a single pollutant from all contributing point and *nonpoint source*s. It is a calculation of the maximum amount of a pollutant that a waterbody can receive on a daily basis and still meet *water quality standards*, and an allocation of that amount to the pollutant's sources. A TMDL stipulates wasteload allocations (WLAs) for *point source* discharges, load allocations (LAs) for *nonpoint source*s, and a margin of safety (MOS).

**Trained Contractor -** means an employee from the contracting (construction) company, identified in Part III.A.6., that has received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity. After receiving the initial training, the *trained contractor* shall receive four (4) hours of training every three (3) years.

It can also mean an employee from the contracting (construction) company, identified in Part III.A.6., that meets the *qualified inspector* qualifications (e.g. licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, New York State Erosion and Sediment Control Certificate Program holder, or someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided they have received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity).

The *trained contractor* is responsible for the day to day implementation of the SWPPP.

**Uniform Procedures Act (UPA) Permit** - means a permit required under 6 NYCRR Part 621 of the Environmental Conservation Law (ECL), Article 70.

**Water Quality Standard** - means such measures of purity or quality for any waters in relation to their reasonable and necessary use as promulgated in 6 NYCRR Part 700 et seq.



## APPENDIX B – Required SWPPP Components by Project Type

**Table 1**
**Construction Activities that Require the Preparation of a SWPPP That Only Includes Erosion and Sediment Controls**

**The following construction activities that involve soil disturbances of one (1) or more acres of land, but less than five (5) acres:**

- Single family home not located in one of the watersheds listed in Appendix C or not *directly discharging* to one of the 303(d) segments listed in Appendix E
- Single family residential subdivisions with 25% or less impervious cover at total site build-out and not located in one of the watersheds listed in Appendix C and not directly discharging to one of the 303(d) segments listed in Appendix E
- Construction of a barn or other *agricultural building*, silo, stock yard or pen.

**The following construction activities that involve soil disturbances between five thousand (5000) square feet and one (1) acre of land:**

All construction activities located in the watersheds identified in Appendix D that involve soil disturbances between five thousand (5,000) square feet and one (1) acre of land.

**The following construction activities that involve soil disturbances of one (1) or more acres of land:**

- Installation of underground, linear utilities; such as gas lines, fiber-optic cable, cable TV, electric, telephone, sewer mains, and water mains
- Environmental enhancement projects, such as wetland mitigation projects, stormwater retrofits and stream restoration projects
- Pond construction
- Linear bike paths running through areas with vegetative cover, including bike paths surfaced with an impervious cover
- Cross-country ski trails and walking/hiking trails
- Sidewalk, bike path or walking path projects, surfaced with an impervious cover, that are not part of residential, commercial or institutional development;
- Sidewalk, bike path or walking path projects, surfaced with an impervious cover, that include incidental shoulder or curb work along an existing highway to support construction of the sidewalk, bike path or walking path.
- Slope stabilization projects
- Slope flattening that changes the grade of the site, but does not significantly change the runoff characteristics

**Table 1 (Continued) CONSTRUCTION ACTIVITIES THAT REQUIRE THE PREPARATION OF A SWPPP THAT ONLY INCLUDES EROSION AND SEDIMENT CONTROLS**

**The following construction activities that involve soil disturbances of one (1) or more acres of land:**

- Spoil areas that will be covered with vegetation
- Vegetated open space projects (i.e. recreational parks, lawns, meadows, fields, downhill ski trails) excluding projects that *alter hydrology from pre to post development* conditions,
- Athletic fields (natural grass) that do not include the construction or reconstruction of *impervious area* and do not *alter hydrology from pre to post development* conditions
- Demolition project where vegetation will be established, and no redevelopment is planned
- Overhead electric transmission line project that does not include the construction of permanent access roads or parking areas surfaced with *impervious cover*
- Structural practices as identified in Table II in the "Agricultural Management Practices Catalog for Nonpoint Source Pollution in New York State", excluding projects that involve soil disturbances of greater than five acres and construction activities that include the construction or reconstruction of impervious area
- Temporary access roads, median crossovers, detour roads, lanes, or other temporary impervious areas that will be restored to pre-construction conditions once the construction activity is complete





**Table 2**
**CONSTRUCTION ACTIVITIES THAT REQUIRE THE PREPARATION OF A SWPPP THAT INCLUDES POST-CONSTRUCTION STORMWATER MANAGEMENT PRACTICES**

**The following construction activities that involve soil disturbances of one (1) or more acres of land:**

- Single family home located in one of the watersheds listed in Appendix C or *directly discharging* to one of the 303(d) segments listed in Appendix E
- Single family home that disturbs five (5) or more acres of land
- Single family residential subdivisions located in one of the watersheds listed in Appendix C or *directly discharging* to one of the 303(d) segments listed in Appendix E
- Single family residential subdivisions that involve soil disturbances of between one (1) and five (5) acres of land with greater than 25% impervious cover at total site build-out
- Single family residential subdivisions that involve soil disturbances of five (5) or more acres of land, and single family residential subdivisions that involve soil disturbances of less than five (5) acres that are part of a larger common plan of development or sale that will ultimately disturb five or more acres of land
- Multi-family residential developments; includes duplexes, townhomes, condominiums, senior housing complexes, apartment complexes, and mobile home parks
- Airports
- Amusement parks
- Breweries, cideries, and wineries, including establishments constructed on agricultural land
- Campgrounds
- Cemeteries that include the construction or reconstruction of impervious area (>5% of disturbed area) or *alter the hydrology from pre to post development* conditions
- Commercial developments
- Churches and other places of worship
- Construction of a barn or other *agricultural building* (e.g. silo) and structural practices as identified in Table II in the "Agricultural Management Practices Catalog for Nonpoint Source Pollution in New York State" that include the construction or reconstruction of *impervious area*, excluding projects that involve soil disturbances of less than five acres.
- Golf courses
- Institutional development; includes hospitals, prisons, schools and colleges
- Industrial facilities; includes industrial parks
- Landfills
- Municipal facilities; includes highway garages, transfer stations, office buildings, POTW's, water treatment plants, and water storage tanks
- Office complexes
- Playgrounds that include the construction or reconstruction of impervious area
- Sports complexes
- Racetracks; includes racetracks with earthen (dirt) surface
- Road construction or reconstruction, including roads constructed as part of the construction activities listed in Table 1

**Table 2 (Continued)**

**CONSTRUCTION ACTIVITIES THAT REQUIRE THE PREPARATION OF A SWPPP THAT INCLUDES POST-CONSTRUCTION STORMWATER MANAGEMENT PRACTICES**

**The following construction activities that involve soil disturbances of one (1) or more acres of land:**

- Parking lot construction or reconstruction, including parking lots constructed as part of the construction activities listed in Table 1
- Athletic fields (natural grass) that include the construction or reconstruction of impervious area (>5% of disturbed area) or *alter the hydrology from pre to post development* conditions
- Athletic fields with artificial turf
- Permanent access roads, parking areas, substations, compressor stations and well drilling pads, surfaced with *impervious cover,* and constructed as part of an over-head electric transmission line project, wind-power project, cell tower project, oil or gas well drilling project, sewer or water main project or other linear utility project
- Sidewalk, bike path or walking path projects, surfaced with an impervious cover, that are part of a residential, commercial or institutional development
- Sidewalk, bike path or walking path projects, surfaced with an impervious cover, that are part of a highway construction or reconstruction project
- All other construction activities that include the construction or reconstruction of *impervious area* or *alter the hydrology from pre to post development* conditions, and are not listed in Table 1



## APPENDIX C – Watersheds Requiring Enhanced Phosphorus Removal

**Watersheds where *owners or operators* of construction activities identified in Table 2 of Appendix B must prepare a SWPPP that includes post-construction stormwater management practices designed in conformance with the Enhanced Phosphorus Removal Standards included in the technical standard, New York State Stormwater Management Design Manual ("Design Manual").**

- Entire New York City Watershed located east of the Hudson River **-** Figure 1
- Onondaga Lake Watershed **-** Figure 2
- Greenwood Lake Watershed **-**Figure 3
- Oscawana Lake Watershed – Figure 4
- Kinderhook Lake Watershed – Figure 5

**Figure 1 - New York City Watershed East of the Hudson**

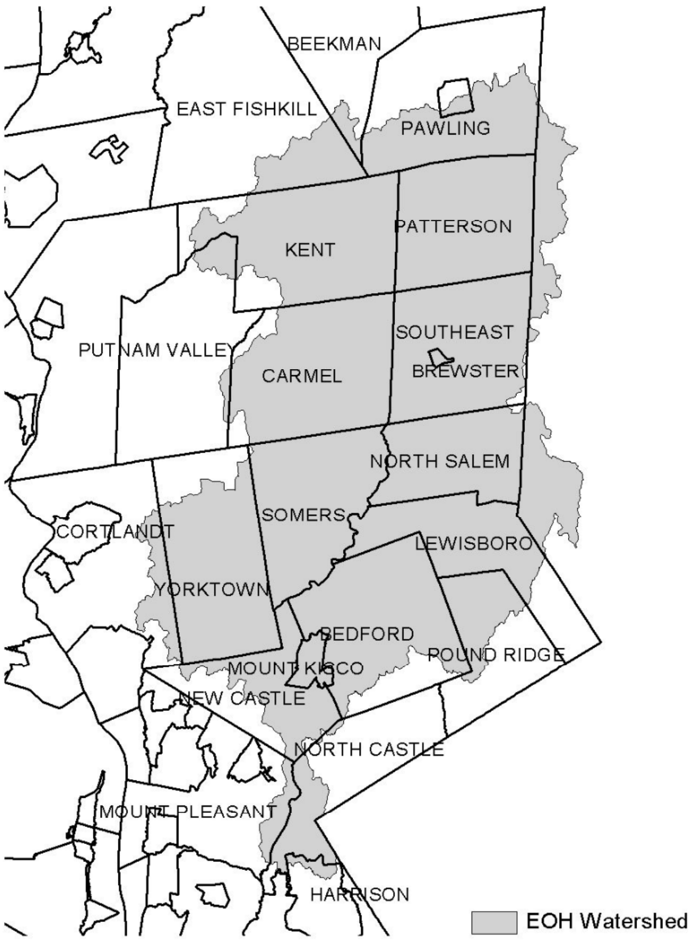







**Figure 2 - Onondaga Lake Watershed**

**Figure 3 - Greenwood Lake Watershed**

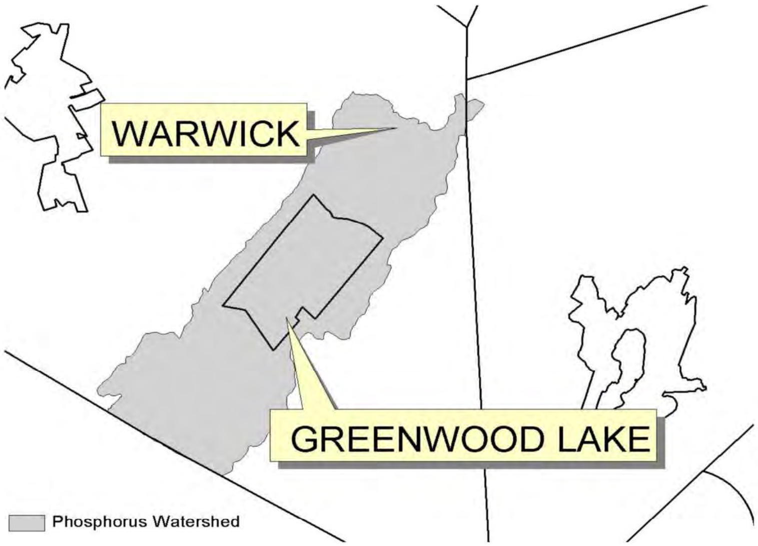







**Figure 4 - Oscawana Lake Watershed**

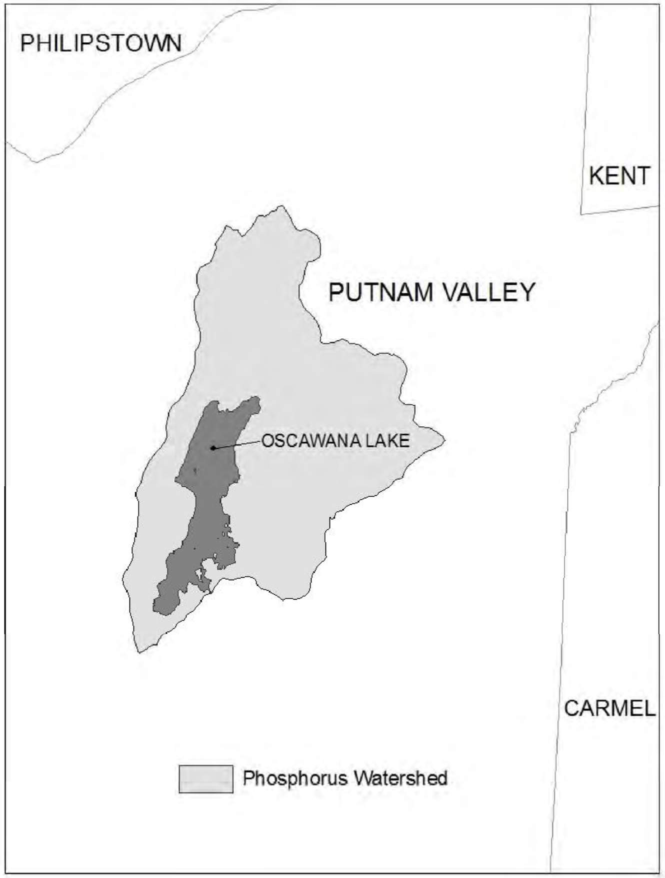
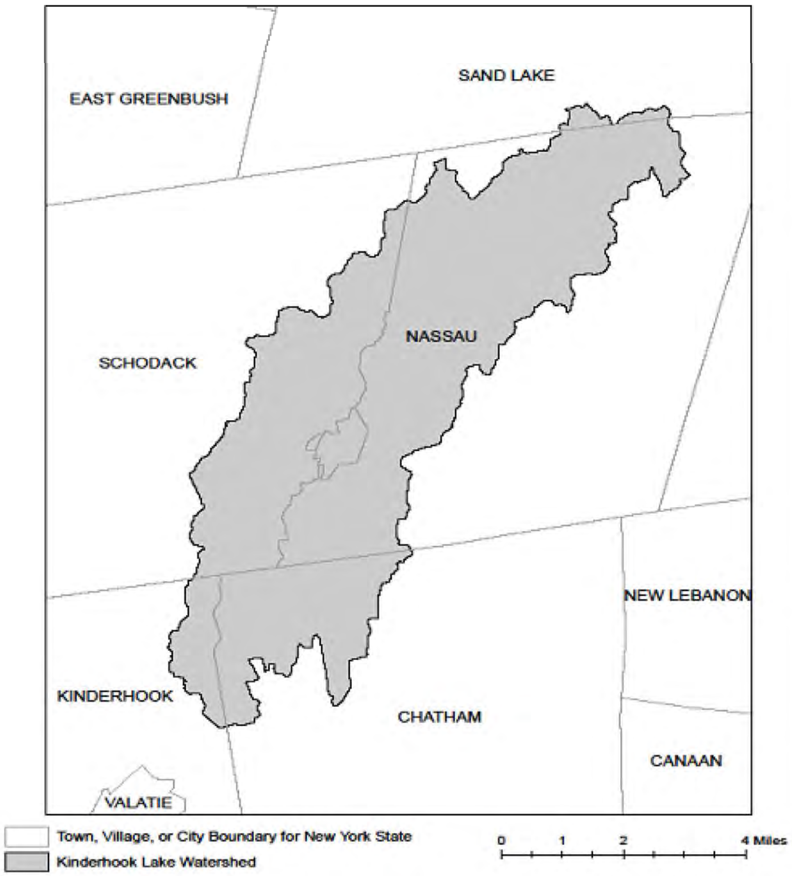


**Figure 5 - Kinderhook Lake Watershed**






## APPENDIX D – Watersheds with Lower Disturbance Threshold

**Watersheds where *owners or operators* of construction activities that involve soil disturbances between five thousand (5000) square feet and one (1) acre of land must obtain coverage under this permit.**

| |
|---|
| Entire New York City Watershed that is located east of the Hudson River **-** See Figure 1 in Appendix C |

## APPENDIX E – 303(d) Segments Impaired by Construction Related Pollutant(s)

List of 303(d) segments impaired by pollutants related to *construction activity* (e.g. silt, sediment or nutrients). The list was developed using "The Final New York State 2016 Section 303(d) List of Impaired Waters Requiring a TMDL/Other Strategy" dated November 2016. *Owners or operators* of single family home and single family residential subdivisions with 25% or less total impervious cover at total site build-out that involve soil disturbances of one or more acres of land, but less than 5 acres, and *directly discharge* to one of the listed segments below shall prepare a SWPPP that includes post-construction stormwater management practices designed in conformance with the New York State Stormwater Management Design Manual ("Design Manual"), dated January 2015.

| COUNTY | WATERBODY | POLLUTANT |
|---|---|---|
| Albany | Ann Lee (Shakers) Pond, Stump Pond | Nutrients |
| Albany | Basic Creek Reservoir | Nutrients |
| Allegany | Amity Lake, Saunders Pond | Nutrients |
| Bronx | Long Island Sound, Bronx | Nutrients |
| Bronx | Van Cortlandt Lake | Nutrients |
| Broome | Fly Pond, Deer Lake, Sky Lake | Nutrients |
| Broome | Minor Tribs to Lower Susquehanna (north) | Nutrients |
| Broome | Whitney Point Lake/Reservoir | Nutrients |
| Cattaraugus | Allegheny River/Reservoir | Nutrients |
| Cattaraugus | Beaver (Alma) Lake | Nutrients |
| Cattaraugus | Case Lake | Nutrients |
| Cattaraugus | Linlyco/Club Pond | Nutrients |
| Cayuga | Duck Lake | Nutrients |
| Cayuga | Little Sodus Bay | Nutrients |
| Chautauqua | Bear Lake | Nutrients |
| Chautauqua | Chadakoin River and tribs | Nutrients |
| Chautauqua | Chautauqua Lake, North | Nutrients |
| Chautauqua | Chautauqua Lake, South | Nutrients |
| Chautauqua | Findley Lake | Nutrients |
| Chautauqua | Hulburt/Clymer Pond | Nutrients |
| Clinton | Great Chazy River, Lower, Main Stem | Silt/Sediment |
| Clinton | Lake Champlain, Main Lake, Middle | Nutrients |
| Clinton | Lake Champlain, Main Lake, North | Nutrients |
| Columbia | Kinderhook Lake | Nutrients |
| Columbia | Robinson Pond | Nutrients |
| Cortland | Dean Pond | Nutrients |





| | | |
|---|---|---|
| Dutchess | Fall Kill and tribs | Nutrients |
| Dutchess | Hillside Lake | Nutrients |
| Dutchess | Wappingers Lake | Nutrients |
| Dutchess | Wappingers Lake | Silt/Sediment |
| Erie | Beeman Creek and tribs | Nutrients |
| Erie | Ellicott Creek, Lower, and tribs | Silt/Sediment |
| Erie | Ellicott Creek, Lower, and tribs | Nutrients |
| Erie | Green Lake | Nutrients |
| Erie | Little Sister Creek, Lower, and tribs | Nutrients |
| Erie | Murder Creek, Lower, and tribs | Nutrients |
| Erie | Rush Creek and tribs | Nutrients |
| Erie | Scajaquada Creek, Lower, and tribs | Nutrients |
| Erie | Scajaquada Creek, Middle, and tribs | Nutrients |
| Erie | Scajaquada Creek, Upper, and tribs | Nutrients |
| Erie | South Branch Smoke Cr, Lower, and tribs | Silt/Sediment |
| Erie | South Branch Smoke Cr, Lower, and tribs | Nutrients |
| Essex | Lake Champlain, Main Lake, South | Nutrients |
| Essex | Lake Champlain, South Lake | Nutrients |
| Essex | Willsboro Bay | Nutrients |
| Genesee | Bigelow Creek and tribs | Nutrients |
| Genesee | Black Creek, Middle, and minor tribs | Nutrients |
| Genesee | Black Creek, Upper, and minor tribs | Nutrients |
| Genesee | Bowen Brook and tribs | Nutrients |
| Genesee | LeRoy Reservoir | Nutrients |
| Genesee | Oak Orchard Cr, Upper, and tribs | Nutrients |
| Genesee | Tonawanda Creek, Middle, Main Stem | Nutrients |
| Greene | Schoharie Reservoir | Silt/Sediment |
| Greene | Sleepy Hollow Lake | Silt/Sediment |
| Herkimer | Steele Creek tribs | Silt/Sediment |
| Herkimer | Steele Creek tribs | Nutrients |
| Jefferson | Moon Lake | Nutrients |
| Kings | Hendrix Creek | Nutrients |
| Kings | Prospect Park Lake | Nutrients |
| Lewis | Mill Creek/South Branch, and tribs | Nutrients |
| Livingston | Christie Creek and tribs | Nutrients |
| Livingston | Conesus Lake | Nutrients |
| Livingston | Mill Creek and minor tribs | Silt/Sediment |
| Monroe | Black Creek, Lower, and minor tribs | Nutrients |
| Monroe | Buck Pond | Nutrients |
| Monroe | Cranberry Pond | Nutrients |

## 303(d) Segments Impaired by Construction Related Pollutant(s)

| | | |
|---|---|---|
| Monroe | Lake Ontario Shoreline, Western | Nutrients |
| Monroe | Long Pond | Nutrients |
| Monroe | Mill Creek and tribs | Nutrients |
| Monroe | Mill Creek/Blue Pond Outlet and tribs | Nutrients |
| Monroe | Minor Tribs to Irondequoit Bay | Nutrients |
| Monroe | Rochester Embayment - East | Nutrients |
| Monroe | Rochester Embayment - West | Nutrients |
| Monroe | Shipbuilders Creek and tribs | Nutrients |
| Monroe | Thomas Creek/White Brook and tribs | Nutrients |
| Nassau | Beaver Lake | Nutrients |
| Nassau | Camaans Pond | Nutrients |
| Nassau | East Meadow Brook, Upper, and tribs | Silt/Sediment |
| Nassau | East Rockaway Channel | Nutrients |
| Nassau | Grant Park Pond | Nutrients |
| Nassau | Hempstead Bay | Nutrients |
| Nassau | Hempstead Lake | Nutrients |
| Nassau | Hewlett Bay | Nutrients |
| Nassau | Hog Island Channel | Nutrients |
| Nassau | Long Island Sound, Nassau County Waters | Nutrients |
| Nassau | Massapequa Creek and tribs | Nutrients |
| Nassau | Milburn/Parsonage Creeks, Upp, and tribs | Nutrients |
| Nassau | Reynolds Channel, west | Nutrients |
| Nassau | Tidal Tribs to Hempstead Bay | Nutrients |
| Nassau | Tribs (fresh) to East Bay | Nutrients |
| Nassau | Tribs (fresh) to East Bay | Silt/Sediment |
| Nassau | Tribs to Smith/Halls Ponds | Nutrients |
| Nassau | Woodmere Channel | Nutrients |
| New York | Harlem Meer | Nutrients |
| New York | The Lake in Central Park | Nutrients |
| Niagara | Bergholtz Creek and tribs | Nutrients |
| Niagara | Hyde Park Lake | Nutrients |
| Niagara | Lake Ontario Shoreline, Western | Nutrients |
| Niagara | Lake Ontario Shoreline, Western | Nutrients |
| Oneida | Ballou, Nail Creeks and tribs | Nutrients |
| Onondaga | Harbor Brook, Lower, and tribs | Nutrients |
| Onondaga | Ley Creek and tribs | Nutrients |
| Onondaga | Minor Tribs to Onondaga Lake | Nutrients |
| Onondaga | Ninemile Creek, Lower, and tribs | Nutrients |
| Onondaga | Onondaga Creek, Lower, and tribs | Nutrients |
| Onondaga | Onondaga Creek, Middle, and tribs | Nutrients |



## 303(d) Segments Impaired by Construction Related Pollutant(s)

| | | |
|---|---|---|
| Onondaga | Onondaga Lake, northern end | Nutrients |
| Onondaga | Onondaga Lake, southern end | Nutrients |
| Ontario | Great Brook and minor tribs | Silt/Sediment |
| Ontario | Great Brook and minor tribs | Nutrients |
| Ontario | Hemlock Lake Outlet and minor tribs | Nutrients |
| Ontario | Honeoye Lake | Nutrients |
| Orange | Greenwood Lake | Nutrients |
| Orange | Monhagen Brook and tribs | Nutrients |
| Orange | Orange Lake | Nutrients |
| Orleans | Lake Ontario Shoreline, Western | Nutrients |
| Orleans | Lake Ontario Shoreline, Western | Nutrients |
| Oswego | Lake Neatahwanta | Nutrients |
| Oswego | Pleasant Lake | Nutrients |
| Putnam | Bog Brook Reservoir | Nutrients |
| Putnam | Boyd Corners Reservoir | Nutrients |
| Putnam | Croton Falls Reservoir | Nutrients |
| Putnam | Diverting Reservoir | Nutrients |
| Putnam | East Branch Reservoir | Nutrients |
| Putnam | Lake Carmel | Nutrients |
| Putnam | Middle Branch Reservoir | Nutrients |
| Putnam | Oscawana Lake | Nutrients |
| Putnam | Palmer Lake | Nutrients |
| Putnam | West Branch Reservoir | Nutrients |
| Queens | Bergen Basin | Nutrients |
| Queens | Flushing Creek/Bay | Nutrients |
| Queens | Jamaica Bay, Eastern, and tribs (Queens) | Nutrients |
| Queens | Kissena Lake | Nutrients |
| Queens | Meadow Lake | Nutrients |
| Queens | Willow Lake | Nutrients |
| Rensselaer | Nassau Lake | Nutrients |
| Rensselaer | Snyders Lake | Nutrients |
| Richmond | Grasmere Lake/Bradys Pond | Nutrients |
| Rockland | Congers Lake, Swartout Lake | Nutrients |
| Rockland | Rockland Lake | Nutrients |
| Saratoga | Ballston Lake | Nutrients |
| Saratoga | Dwaas Kill and tribs | Silt/Sediment |
| Saratoga | Dwaas Kill and tribs | Nutrients |
| Saratoga | Lake Lonely | Nutrients |
| Saratoga | Round Lake | Nutrients |
| Saratoga | Tribs to Lake Lonely | Nutrients |

## 303(d) Segments Impaired by Construction Related Pollutant(s)

| | | |
|---|---|---|
| Schenectady | Collins Lake | Nutrients |
| Schenectady | Duane Lake | Nutrients |
| Schenectady | Mariaville Lake | Nutrients |
| Schoharie | Engleville Pond | Nutrients |
| Schoharie | Summit Lake | Nutrients |
| Seneca | Reeder Creek and tribs | Nutrients |
| St.Lawrence | Black Lake Outlet/Black Lake | Nutrients |
| St.Lawrence | Fish Creek and minor tribs | Nutrients |
| Steuben | Smith Pond | Nutrients |
| Suffolk | Agawam Lake | Nutrients |
| Suffolk | Big/Little Fresh Ponds | Nutrients |
| Suffolk | Canaan Lake | Silt/Sediment |
| Suffolk | Canaan Lake | Nutrients |
| Suffolk | Flanders Bay, West/Lower Sawmill Creek | Nutrients |
| Suffolk | Fresh Pond | Nutrients |
| Suffolk | Great South Bay, East | Nutrients |
| Suffolk | Great South Bay, Middle | Nutrients |
| Suffolk | Great South Bay, West | Nutrients |
| Suffolk | Lake Ronkonkoma | Nutrients |
| Suffolk | Long Island Sound, Suffolk County, West | Nutrients |
| Suffolk | Mattituck (Marratooka) Pond | Nutrients |
| Suffolk | Meetinghouse/Terrys Creeks and tribs | Nutrients |
| Suffolk | Mill and Seven Ponds | Nutrients |
| Suffolk | Millers Pond | Nutrients |
| Suffolk | Moriches Bay, East | Nutrients |
| Suffolk | Moriches Bay, West | Nutrients |
| Suffolk | Peconic River, Lower, and tidal tribs | Nutrients |
| Suffolk | Quantuck Bay | Nutrients |
| Suffolk | Shinnecock Bay and Inlet | Nutrients |
| Suffolk | Tidal tribs to West Moriches Bay | Nutrients |
| Sullivan | Bodine, Montgomery Lakes | Nutrients |
| Sullivan | Davies Lake | Nutrients |
| Sullivan | Evens Lake | Nutrients |
| Sullivan | Pleasure Lake | Nutrients |
| Tompkins | Cayuga Lake, Southern End | Nutrients |
| Tompkins | Cayuga Lake, Southern End | Silt/Sediment |
| Tompkins | Owasco Inlet, Upper, and tribs | Nutrients |
| Ulster | Ashokan Reservoir | Silt/Sediment |
| Ulster | Esopus Creek, Upper, and minor tribs | Silt/Sediment |
| Warren | Hague Brook and tribs | Silt/Sediment |



## 303(d) Segments Impaired by Construction Related Pollutant(s)

| | | |
|---|---|---|
| Warren | Huddle/Finkle Brooks and tribs | Silt/Sediment |
| Warren | Indian Brook and tribs | Silt/Sediment |
| Warren | Lake George | Silt/Sediment |
| Warren | Tribs to L.George, Village of L George | Silt/Sediment |
| Washington | Cossayuna Lake | Nutrients |
| Washington | Lake Champlain, South Bay | Nutrients |
| Washington | Tribs to L.George, East Shore | Silt/Sediment |
| Washington | Wood Cr/Champlain Canal and minor tribs | Nutrients |
| Wayne | Port Bay | Nutrients |
| Westchester | Amawalk Reservoir | Nutrients |
| Westchester | Blind Brook, Upper, and tribs | Silt/Sediment |
| Westchester | Cross River Reservoir | Nutrients |
| Westchester | Lake Katonah | Nutrients |
| Westchester | Lake Lincolndale | Nutrients |
| Westchester | Lake Meahagh | Nutrients |
| Westchester | Lake Mohegan | Nutrients |
| Westchester | Lake Shenorock | Nutrients |
| Westchester | Long Island Sound, Westchester (East) | Nutrients |
| Westchester | Mamaroneck River, Lower | Silt/Sediment |
| Westchester | Mamaroneck River, Upper, and minor tribs | Silt/Sediment |
| Westchester | Muscoot/Upper New Croton Reservoir | Nutrients |
| Westchester | New Croton Reservoir | Nutrients |
| Westchester | Peach Lake | Nutrients |
| Westchester | Reservoir No.1 (Lake Isle) | Nutrients |
| Westchester | Saw Mill River, Lower, and tribs | Nutrients |
| Westchester | Saw Mill River, Middle, and tribs | Nutrients |
| Westchester | Sheldrake River and tribs | Silt/Sediment |
| Westchester | Sheldrake River and tribs | Nutrients |
| Westchester | Silver Lake | Nutrients |
| Westchester | Teatown Lake | Nutrients |
| Westchester | Titicus Reservoir | Nutrients |
| Westchester | Truesdale Lake | Nutrients |
| Westchester | Wallace Pond | Nutrients |
| Wyoming | Java Lake | Nutrients |
| Wyoming | Silver Lake | Nutrients |

## APPENDIX F – List of NYS DEC Regional Offices

| Region | Covering the following counties: | Division of Environmental Permits (DEP) Permit Administrators | Division of Water (DOW) Water (SPDES) Program |
|---|---|---|---|
| 1 | Nassau and Suffolk | 50 Circle Road<br>Stony Brook, Ny 11790<br>Tel. (631) 444-0365 | 50 Circle Road<br>Stony Brook, Ny 11790-3409<br>Tel. (631) 444-0405 |
| 2 | Bronx, Kings, New York, Queens and Richmond | 1 Hunters Point Plaza,<br>47-40 21st St.<br>Long Island City, Ny 11101-5407<br>Tel. (718) 482-4997 | 1 Hunters Point Plaza,<br>47-40 21st St.<br>Long Island City, Ny 11101-5407<br>Tel. (718) 482-4933 |
| 3 | Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster and Westchester | 21 South Putt Corners Road<br>New Paltz, Ny 12561-1696<br>Tel. (845) 256-3059 | 100 Hillside Avenue, Suite 1w<br>White Plains, Ny 10603<br>Tel. (914) 428 - 2505 |
| 4 | Albany, Columbia, Delaware, Greene, Montgomery, Otsego, Rensselaer, Schenectady and Schoharie | 1150 North Westcott Road<br>Schenectady, Ny 12306-2014<br>Tel. (518) 357-2069 | 1130 North Westcott Road<br>Schenectady, Ny 12306-2014<br>Tel. (518) 357-2045 |
| 5 | Clinton, Essex, Franklin, Fulton, Hamilton, Saratoga, Warren and Washington | 1115 State Route 86, Po Box 296<br>Ray Brook, Ny 12977-0296<br>Tel. (518) 897-1234 | 232 Golf Course Road<br>Warrensburg, Ny 12885-1172 Tel. (518) 623-1200 |
| 6 | HERKIMER, JEFFERSON, LEWIS, ONEIDA AND ST. LAWRENCE | STATE OFFICE BUILDING<br>317 WASHINGTON STREET<br>WATERTOWN, NY 13601-3787<br>TEL. (315) 785-2245 | STATE OFFICE BUILDING<br>207 GENESEE STREET<br>UTICA, NY 13501-2885 TEL. (315) 793-2554 |
| 7 | BROOME, CAYUGA, CHENANGO, CORTLAND, MADISON, ONONDAGA, OSWEGO, TIOGA AND TOMPKINS | 615 ERIE BLVD. WEST<br>SYRACUSE, NY 13204-2400<br>TEL. (315) 426-7438 | 615 ERIE BLVD. WEST<br>SYRACUSE, NY 13204-2400<br>TEL. (315) 426-7500 |
| 8 | CHEMUNG, GENESEE, LIVINGSTON, MONROE, ONTARIO, ORLEANS, SCHUYLER, SENECA, STEUBEN, WAYNE AND YATES | 6274 EAST AVON-LIMA ROADAVON, NY 14414-9519<br>TEL. (585) 226-2466 | 6274 EAST AVON-LIMA RD.<br>AVON, NY 14414-9519<br>TEL. (585) 226-2466 |
| 9 | ALLEGANY, CATTARAUGUS, CHAUTAUQUA, ERIE, NIAGARA AND WYOMING | 270 MICHIGAN AVENUE<br>BUFFALO, NY 14203-2999<br>TEL. (716) 851-7165 | 270 MICHIGAN AVENUE<br>BUFFALO, NY 14203-2999<br>TEL. (716) 851-7070 |

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# Appendix B:
# NYSDEC Forms

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# NOTICE OF INTENT

**New York State Department of Environmental Conservation**
**Division of Water**
**625 Broadway, 4th Floor**
**Albany, New York 12233-3505**

NYR ______ (for DEC use only)

**Stormwater Discharges Associated with Construction Activity Under State Pollutant Discharge Elimination System (SPDES) General Permit # GP-0-20-001**

**All sections must be completed unless otherwise noted.** Failure to complete all items may result in this form being returned to you, thereby delaying your coverage under this General Permit. Applicants must read and understand the conditions of the permit and prepare a Stormwater Pollution Prevention Plan prior to submitting this NOI. Applicants are responsible for identifying and obtaining other DEC permits that may be required.

## -IMPORTANT-
## RETURN THIS FORM TO THE ADDRESS ABOVE
**OWNER/OPERATOR MUST SIGN FORM**

**Owner/Operator Information**

Owner/Operator (Company Name/Private Owner Name/Municipality Name)
Gas Land Petroleum, Inc.

Owner/Operator Contact Person Last Name (NOT CONSULTANT)
Nesheiwat

Owner/Operator Contact Person First Name
Zeidan

Owner/Operator Mailing Address
3 South Ohioville Road

City
New Paltz

State
NY

Zip
12561 -

Phone (Owner/Operator)
845 - 331 - 7545

Fax (Owner/Operator)
- -

Email (Owner/Operator)

FED TAX ID
- (not required for individuals)

**Project Site Information**

Project/Site Name
Gas Land Petroleum - Route 9D

Street Address (NOT P.O. BOX)
2361 Route 9D

Side of Street
● **North** ○ **South** ○ **East** ○ **West**

City/Town/Village (THAT ISSUES BUILDING PERMIT)
Town of Wappinger

| State | Zip | County | DEC Region |
|---|---|---|---|
| NY | 12590 - | Dutchess | 3 |

Name of Nearest Cross Street
New Hamburg Road

Distance to Nearest Cross Street (Feet)
121

Project In Relation to Cross Street
○ **North** ○ **South** ● **East** ○ **West**

Tax Map Numbers
Section-Block-Parcel
6157-01-048643
/057654/057642/059643/040637

Tax Map Numbers

1. Provide the Geographic Coordinates for the project site in NYTM Units. To do this you **must** go to the NYSDEC Stormwater Interactive Map on the DEC website at:

**www.dec.ny.gov/imsmaps/stormwater/viewer.htm**

Zoom into your Project Location such that you can accurately click on the centroid of your site. Once you have located your project site, go to the tool boxes on the top and choose "i"(identify). Then click on the center of your site and a new window containing the X, Y coordinates in UTM will pop up. Transcribe these coordinates into the boxes below. For problems with the interactive map use the help function.

| X Coordinates (Easting) | Y Coordinates (Northing) |
|---|---|
| 589286 | 4603828 |

2. What is the nature of this construction project?

○ **New Construction**

● **Redevelopment with increase in impervious area**

○ **Redevelopment with no increase in impervious area**

3. Select the predominant land use for both pre and post development conditions.
**SELECT ONLY ONE CHOICE FOR EACH**

**Pre-Development Existing Land Use**

- ○ FOREST
- ○ PASTURE/OPEN LAND
- ○ CULTIVATED LAND
- ○ SINGLE FAMILY HOME
- ○ SINGLE FAMILY SUBDIVISION
- ○ TOWN HOME RESIDENTIAL
- ● MULTIFAMILY RESIDENTIAL
- ○ INSTITUTIONAL/SCHOOL
- ○ INDUSTRIAL
- ○ COMMERCIAL
- ○ ROAD/HIGHWAY
- ○ RECREATIONAL/SPORTS FIELD
- ○ BIKE PATH/TRAIL
- ○ LINEAR UTILITY
- ○ PARKING LOT
- ○ OTHER

**Post-Development Future Land Use**

- ○ SINGLE FAMILY HOME
- ○ SINGLE FAMILY SUBDIVISION — Number of Lots: 
- ○ TOWN HOME RESIDENTIAL
- ○ MULTIFAMILY RESIDENTIAL
- ○ INSTITUTIONAL/SCHOOL
- ○ INDUSTRIAL
- ○ COMMERCIAL
- ○ MUNICIPAL
- ○ ROAD/HIGHWAY
- ○ RECREATIONAL/SPORTS FIELD
- ○ BIKE PATH/TRAIL
- ○ LINEAR UTILITY (water, sewer, gas, etc.)
- ○ PARKING LOT
- ○ CLEARING/GRADING ONLY
- ○ DEMOLITION, NO REDEVELOPMENT
- ○ WELL DRILLING ACTIVITY *(Oil, Gas, etc.)
- ● OTHER: COMMERCIAL, RETAIL, RESIDENTIAL

***Note**: for gas well drilling, non-high volume hydraulic fractured wells only

4. In accordance with the larger common plan of development or sale, enter the total project site area; the total area to be disturbed; existing impervious area to be disturbed (for redevelopment activities); and the future impervious area constructed within the disturbed area. (Round to the nearest tenth of an acre.)

| Total Site Area | Total Area To Be Disturbed | Existing Impervious Area To Be Disturbed | Future Impervious Area Within Disturbed Area |
|---|---|---|---|
| 1.8 | 1.8 | 0.6 | 0. 0.9 |

5. Do you plan to disturb more than 5 acres of soil at any one time? ○ **Yes** ● **No**

6. Indicate the percentage of each Hydrologic Soil Group(HSG) at the site.

| A | B | C | D |
|---|---|---|---|
| 0 % | 100 % | 0 % | 0 % |

7. Is this a phased project? ○ **Yes** ● **No**

8. Enter the planned start and end dates of the disturbance activities.
**Start Date** 05/01/2022 - **End Date** 12/01/2022

9. Identify the nearest surface waterbody(ies) to which construction site runoff will discharge.

Name

Wappinger Creek

9a. Type of waterbody identified in Question 9?

- ○ Wetland / State Jurisdiction On Site (Answer 9b)
- ○ Wetland / State Jurisdiction Off Site
- ○ Wetland / Federal Jurisdiction On Site (Answer 9b)
- ○ Wetland / Federal Jurisdiction Off Site
- ○ Stream / Creek On Site
- ● Stream / Creek Off Site
- ○ River On Site
- ○ River Off Site
- ○ Lake On Site
- ○ Lake Off Site
- ○ Other Type On Site
- ○ Other Type Off Site

9b. How was the wetland identified?

- ● Regulatory Map
- ○ Delineated by Consultant
- ○ Delineated by Army Corps of Engineers
- ○ Other (identify)

10. Has the surface waterbody(ies) in question 9 been identified as a 303(d) segment in Appendix E of GP-0-20-001? ○ **Yes** ● **No**

11. Is this project located in one of the Watersheds identified in Appendix C of GP-0-20-001? ○ **Yes** ● **No**

12. Is the project located in one of the watershed areas associated with AA and AA-S classified waters?
**If no, skip question 13.** ○ **Yes** ● **No**

13. Does this construction activity disturb land with no existing impervious cover and where the Soil Slope Phase is identified as an E or F on the USDA Soil Survey? ○ **Yes** ○ **No**
**If Yes, what is the acreage to be disturbed?**

.

14. Will the project disturb soils within a State regulated wetland or the protected 100 foot adjacent area? ○ **Yes** ● **No**

15. Does the site runoff enter a separate storm sewer system (including roadside drains, swales, ditches, culverts, etc)? ● Yes ○ No ○ Unknown

16. What is the name of the municipality/entity that owns the separate storm sewer system?

Town of Wappinger

17. Does any runoff from the site enter a sewer classified as a Combined Sewer? ○ Yes ● No ○ Unknown

18. Will future use of this site be an agricultural property as defined by the NYS Agriculture and Markets Law? ○ Yes ● No

19. Is this property owned by a state authority, state agency, federal government or local government? ○ Yes ● No

20. Is this a remediation project being done under a Department approved work plan? (i.e. CERCLA, RCRA, Voluntary Cleanup Agreement, etc.) ○ Yes ● No

21. Has the required Erosion and Sediment Control component of the SWPPP been developed in conformance with the current NYS Standards and Specifications for Erosion and Sediment Control (aka Blue Book)? ● Yes ○ No

22. Does this construction activity require the development of a SWPPP that includes the post-construction stormwater management practice component (i.e. Runoff Reduction, Water Quality and Quantity Control practices/techniques)? ● Yes ○ No
**If No, skip questions 23 and 27-39.**

23. Has the post-construction stormwater management practice component of the SWPPP been developed in conformance with the current NYS Stormwater Management Design Manual? ● Yes ○ No

24. The Stormwater Pollution Prevention Plan (SWPPP) was prepared by:

- ● **Professional Engineer (P.E.)**
- ○ **Soil and Water Conservation District (SWCD)**
- ○ **Registered Landscape Architect (R.L.A)**
- ○ **Certified Professional in Erosion and Sediment Control (CPESC)**
- ○ **Owner/Operator**
- ○ **Other**

SWPPP Preparer
The Chazen Companies

Contact Name (Last, Space, First)
Lapine, Christopher

Mailing Address
21 Fox Street

City
Poughkeepsie

State
NY

Zip
12601 -

Phone
845 - 454 - 3980

Fax
- -

Email
clapine@chazencompanies.com

**SWPPP Preparer Certification**

I hereby certify that the Stormwater Pollution Prevention Plan (SWPPP) for this project has been prepared in accordance with the terms and conditions of the GP-0-20-001. Furthermore, I understand that certifying false, incorrect or inaccurate information is a violation of this permit and the laws of the State of New York and could subject me to criminal, civil and/or administrative proceedings.

**First Name**
Christopher

**MI**

**Last Name**
Lapine

**Signature**

**Date**
/ /

25. Has a construction sequence schedule for the planned management practices been prepared? ○ Yes ● No

26. Select **all** of the erosion and sediment control practices that will be employed on the project site:

## Temporary Structural

- ○ Check Dams
- ○ Construction Road Stabilization
- ○ Dust Control
- ○ Earth Dike
- ○ Level Spreader
- ○ Perimeter Dike/Swale
- ○ Pipe Slope Drain
- ○ Portable Sediment Tank
- ○ Rock Dam
- ○ Sediment Basin
- ○ Sediment Traps
- ● Silt Fence
- ● Stabilized Construction Entrance
- ● Storm Drain Inlet Protection
- ○ Straw/Hay Bale Dike
- ○ Temporary Access Waterway Crossing
- ○ Temporary Stormdrain Diversion
- ○ Temporary Swale
- ○ Turbidity Curtain
- ○ Water bars

## Biotechnical

- ○ Brush Matting
- ○ Wattling

## Vegetative Measures

- ○ Brush Matting
- ○ Dune Stabilization
- ○ Grassed Waterway
- ○ Mulching
- ○ Protecting Vegetation
- ○ Recreation Area Improvement
- ● Seeding
- ○ Sodding
- ○ Straw/Hay Bale Dike
- ○ Streambank Protection
- ○ Temporary Swale
- ● Topsoiling
- ○ Vegetating Waterways

## Permanent Structural

- ○ Debris Basin
- ○ Diversion
- ○ Grade Stabilization Structure
- ○ Land Grading
- ○ Lined Waterway (Rock)
- ○ Paved Channel (Concrete)
- ○ Paved Flume
- ● Retaining Wall
- ○ Riprap Slope Protection
- ● Rock Outlet Protection
- ○ Streambank Protection

**Other**

**Post-construction Stormwater Management Practice (SMP) Requirements**

**Important: Completion of Questions 27-39 is not required if response to Question 22 is No.**

27. Identify all site planning practices that were used to prepare the final site plan/layout for the project.

- ○ **Preservation of Undisturbed Areas**
- ○ **Preservation of Buffers**
- ○ **Reduction of Clearing and Grading**
- ○ **Locating Development in Less Sensitive Areas**
- ○ **Roadway Reduction**
- ● **Sidewalk Reduction**
- ● **Driveway Reduction**
- ○ **Cul-de-sac Reduction**
- ● **Building Footprint Reduction**
- ● **Parking Reduction**

27a. Indicate which of the following soil restoration criteria was used to address the requirements in Section 5.1.6("Soil Restoration") of the Design Manual (2010 version).

- ● All disturbed areas will be restored in accordance with the Soil Restoration requirements in Table 5.3 of the Design Manual (see page 5-22).
- ○ Compacted areas were considered as impervious cover when calculating the **WQv Required**, and the compacted areas were assigned a post-construction Hydrologic Soil Group (HSG) designation that is one level less permeable than existing conditions for the hydrology analysis.

28. Provide the total Water Quality Volume (WQv) required for this project (based on final site plan/layout).

**Total WQv Required**

0.049 **acre-feet**

29. Identify the RR techniques (Area Reduction), RR techniques(Volume Reduction) and Standard SMPs with RRv Capacity in Table 1 (See Page 9) that were used to reduce the Total WQv Required(#28).

Also, provide in Table 1 the total impervious area that contributes runoff to each technique/practice selected. For the Area Reduction Techniques, provide the total contributing area (includes pervious area) and, if applicable, the total impervious area that contributes runoff to the technique/practice.

**Note:** Redevelopment projects shall use Tables 1 and 2 to identify the SMPs used to treat and/or reduce the WQv required. If runoff reduction techniques will not be used to reduce the required WQv, skip to question 33a after identifying the SMPs.

## Table 1 - Runoff Reduction (RR) Techniques and Standard Stormwater Management Practices (SMPs)

| | Total Contributing Area (acres) | | Total Contributing Impervious Area(acres) |
|---|---|---|---|
| **RR Techniques (Area Reduction)** | | | |
| ○ Conservation of Natural Areas (RR-1) | . | and/or | . |
| ○ Sheetflow to Riparian Buffers/Filters Strips (RR-2) | . | and/or | . |
| ○ Tree Planting/Tree Pit (RR-3) | . | and/or | . |
| ○ Disconnection of Rooftop Runoff (RR-4) | . | and/or | . |
| **RR Techniques (Volume Reduction)** | | | |
| ○ Vegetated Swale (RR-5) | | | . |
| ○ Rain Garden (RR-6) | | | . |
| ○ Stormwater Planter (RR-7) | | | . |
| ○ Rain Barrel/Cistern (RR-8) | | | . |
| ○ Porous Pavement (RR-9) | | | . |
| ○ Green Roof (RR-10) | | | . |
| **Standard SMPs with RRv Capacity** | | | |
| ○ Infiltration Trench (I-1) | | | . |
| ○ Infiltration Basin (I-2) | | | . |
| ○ Dry Well (I-3) | | | . |
| ● Underground Infiltration System (I-4) | | | 0.37 |
| ● Bioretention (F-5) | | | 0.42 |
| ○ Dry Swale (O-1) | | | . |
| **Standard SMPs** | | | |
| ○ Micropool Extended Detention (P-1) | | | . |
| ○ Wet Pond (P-2) | | | . |
| ○ Wet Extended Detention (P-3) | | | . |
| ○ Multiple Pond System (P-4) | | | . |
| ○ Pocket Pond (P-5) | | | . |
| ○ Surface Sand Filter (F-1) | | | . |
| ○ Underground Sand Filter (F-2) | | | . |
| ○ Perimeter Sand Filter (F-3) | | | . |
| ○ Organic Filter (F-4) | | | . |
| ○ Shallow Wetland (W-1) | | | . |
| ○ Extended Detention Wetland (W-2) | | | . |
| ○ Pond/Wetland System (W-3) | | | . |
| ○ Pocket Wetland (W-4) | | | . |
| ○ Wet Swale (O-2) | | | . |

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**Table 2 - Alternative SMPs (DO NOT INCLUDE PRACTICES BEING USED FOR PRETREATMENT ONLY)**

| Alternative SMP | Total Contributing Impervious Area(acres) |
|---|---|
| ○ Hydrodynamic | . |
| ○ Wet Vault | . |
| ○ Media Filter | . |
| ○ Other | . |

Provide the name and manufacturer of the Alternative SMPs (i.e. proprietary practice(s)) being used for WQv treatment.

Name

Manufacturer

**Note**: Redevelopment projects which do not use RR techniques, shall use questions 28, 29, 33 and 33a to provide SMPs used, total WQv required and total WQv provided for the project.

30. Indicate the Total RRv provided by the RR techniques (Area/Volume Reduction) and Standard SMPs with RRv capacity identified in question 29.

**Total RRv provided**

0.060 **acre-feet**

31. Is the Total RRv provided (#30) greater than or equal to the total WQv required (#28).

**If Yes, go to question 36.**
**If No, go to question 32.**

● **Yes** ○ **No**

32. Provide the Minimum RRv required based on HSG.
[Minimum RRv Required = (P)(0.95)(Ai)/12, Ai=(S)(Aic)]

**Minimum RRv Required**

. **acre-feet**

32a. Is the Total RRv provided (#30) greater than or equal to the Minimum RRv Required (#32)?

○ **Yes** ○ **No**

**If Yes, go to question 33.**
**Note**: Use the space provided in question #39 to summarize the specific site limitations and justification for not reducing 100% of WQv required (#28). A detailed evaluation of the specific site limitations and justification for not reducing 100% of the WQv required (#28) must also be included in the SWPPP.
**If No, sizing criteria has not been met, so NOI can not be processed. SWPPP preparer must modify design to meet sizing criteria.**

33. Identify the Standard SMPs in Table 1 and, if applicable, the Alternative SMPs in Table 2 that were used to treat the remaining total WQv(=Total WQv Required in 28 - Total RRv Provided in 30).

Also, provide in Table 1 and 2 the total impervious area that contributes runoff to each practice selected.

**Note**: Use Tables 1 and 2 to identify the SMPs used on Redevelopment projects.

33a. Indicate the Total WQv provided (i.e. WQv treated) by the SMPs identified in question #33 and Standard SMPs with RRv Capacity identified in question 29.

**WQv Provided**

[ ][ ][ ] . [ ][ ][ ] **acre-feet**

**Note**: For the standard SMPs with RRv capacity, the WQv provided by each practice = the WQv calculated using the contributing drainage area to the practice - RRv provided by the practice. (See Table 3.5 in Design Manual)

34. Provide the sum of the Total RRv provided (#30) and the WQv provided (#33a). [ ][ ][ ] . [ ][ ][ ]

35. Is the sum of the RRv provided (#30) and the WQv provided (#33a) greater than or equal to the total WQv required (#28)? ○ **Yes** ○ **No**

**If Yes, go to question 36.**
**If No, sizing criteria has not been met, so NOI can not be processed. SWPPP preparer must modify design to meet sizing criteria.**

36. Provide the total Channel Protection Storage Volume (CPv) required and provided or select waiver (36a), if applicable.

| **CPv Required** | **CPv Provided** |
|---|---|
| 0.003 **acre-feet** | 0.003 **acre-feet** |

36a. The need to provide channel protection has been waived because:

○ Site discharges directly to tidal waters or a fifth order or larger stream.

○ Reduction of the total CPv is achieved on site through runoff reduction techniques or infiltration systems.

37. Provide the Overbank Flood (Qp) and Extreme Flood (Qf) control criteria or select waiver (37a), if applicable.

**Total Overbank Flood Control Criteria (Qp)**

| **Pre-Development** | **Post-development** |
|---|---|
| 0.77 **CFS** | 0.67 **CFS** |

**Total Extreme Flood Control Criteria (Qf)**

| **Pre-Development** | **Post-development** |
|---|---|
| 1.40 **CFS** | 1.38 **CFS** |

37a. The need to meet the Qp and Qf criteria has been waived because:

- ○ Site discharges directly to tidal waters or a fifth order or larger stream.
- ○ Downstream analysis reveals that the Qp and Qf controls are not required

38. Has a long term Operation and Maintenance Plan for the post-construction stormwater management practice(s) been developed? ○ Yes ○ No

If Yes, Identify the entity responsible for the long term Operation and Maintenance

Gasland Petroleum Inc

39. Use this space to summarize the specific site limitations and justification for not reducing 100% of WQv required(#28). (See question 32a)
This space can also be used for other pertinent project information.

40. Identify other DEC permits, existing and new, that are required for this project/facility.

- ○ Air Pollution Control
- ○ Coastal Erosion
- ○ Hazardous Waste
- ○ Long Island Wells
- ○ Mined Land Reclamation
- ○ Solid Waste
- ○ Navigable Waters Protection / Article 15
- ○ Water Quality Certificate
- ○ Dam Safety
- ○ Water Supply
- ○ Freshwater Wetlands/Article 24
- ○ Tidal Wetlands
- ○ Wild, Scenic and Recreational Rivers
- ○ Stream Bed or Bank Protection / Article 15
- ○ Endangered or Threatened Species(Incidental Take Permit)
- ○ Individual SPDES
- ○ SPDES Multi-Sector GP N Y R
- ○ Other
- ● None

41. Does this project require a US Army Corps of Engineers Wetland Permit? ○ Yes ● No
**If Yes, Indicate Size of Impact.** .

42. Is this project subject to the requirements of a regulated, traditional land use control MS4? ● Yes ○ No
**(If No, skip question 43)**

43. Has the "MS4 SWPPP Acceptance" form been signed by the principal executive officer or ranking elected official and submitted along with this NOI? ● Yes ○ No

44. If this NOI is being submitted for the purpose of continuing or transferring coverage under a general permit for stormwater runoff from construction activities, please indicate the former SPDES number assigned. N Y R

## Owner/Operator Certification

I have read or been advised of the permit conditions and believe that I understand them. I also understand that, under the terms of the permit, there may be reporting requirements. I hereby certify that this document and the corresponding documents were prepared under my direction or supervision. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations. I further understand that coverage under the general permit will be identified in the acknowledgment that I will receive as a result of submitting this NOI and can be as long as sixty (60) business days as provided for in the general permit. I also understand that, by submitting this NOI, I am acknowledging that the SWPPP has been developed and will be implemented as the first element of construction, and agreeing to comply with all the terms and conditions of the general permit for which this NOI is being submitted.

**Print First Name** Zeidan

**MI**

**Print Last Name** Nesheiwat

**Owner/Operator Signature**

**Date** / /

NYS Department of Environmental Conservation
Division of Water
625 Broadway, 4th Floor
Albany, New York 12233-3505

# MS4 Stormwater Pollution Prevention Plan (SWPPP) Acceptance Form

**for**

**Construction Activities Seeking Authorization Under SPDES General Permit**

*(NOTE: Attach Completed Form to Notice Of Intent and Submit to Address Above)

| | |
|---|---|
| **I. Project Owner/Operator Information** | |
| 1. Owner/Operator Name: | Gas Land Petroleum, Inc. |
| 2. Contact Person: | Zeidan Nesheiwat |
| 3. Street Address: | 785 Broadway |
| 4. City/State/Zip: | Kingston, NY 12401 |
| **II. Project Site Information** | |
| 5. Project/Site Name: | Gas Land Petroleum-Route 9D |
| 6. Street Address: | 3 Ohioville Rd |
| 7. City/State/Zip: | New Paltz, NY 12561 |
| **III. Stormwater Pollution Prevention Plan (SWPPP) Review and Acceptance Information** | |
| 8. SWPPP Reviewed by: | |
| 9. Title/Position: | |
| 10. Date Final SWPPP Reviewed and Accepted: | |
| **IV. Regulated MS4 Information** | |
| 11. Name of MS4: | Town of Wappinger |
| 12. MS4 SPDES Permit Identification Number: NYR20A | |
| 13. Contact Person: | Susan Dao |
| 14. Street Address: | 20 Middlebush Road |
| 15. City/State/Zip: | Wappingers Falls, NY |
| 16. Telephone Number: | 845-297-6256 |

## MS4 SWPPP Acceptance Form - continued

**V. Certification Statement - MS4 Official (principal executive officer or ranking elected official) or Duly Authorized Representative**

I hereby certify that the final Stormwater Pollution Prevention Plan (SWPPP) for the construction project identified in question 5 has been reviewed and meets the substantive requirements in the SPDES General Permit For Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s). Note: The MS4, through the acceptance of the SWPPP, assumes no responsibility for the accuracy and adequacy of the design included in the SWPPP. In addition, review and acceptance of the SWPPP by the MS4 does not relieve the owner/operator or their SWPPP preparer of responsibility or liability for errors or omissions in the plan.

Printed Name:

Title/Position:

Signature:

Date:

**VI. Additional Information**

(NYS DEC - MS4 SWPPP Acceptance Form - January 2015)

**New York State Department of Environmental Conservation**
**Division of Water**
**625 Broadway, 4th Floor**
**Albany, New York 12233-3505**
***(NOTE: Submit completed form to address above)***

# NOTICE OF TERMINATION for Storm Water Discharges Authorized under the SPDES General Permit for Construction Activity

**Please indicate your permit identification number:** NYR ___ ___ ___ ___ ___ ___

**I. Owner or Operator Information**

1. Owner/Operator Name: Gas Land Petroleum, Inc.

2. Street Address: 3 South Ohioville Rd

3. City/State/Zip: New Paltz, NY 12561

4. Contact Person: Zeidan Nesheiwat | 4a.Telephone:

4b. Contact Person E-Mail:

**II. Project Site Information**

5. Project/Site Name: Gas Land Rt 9D

6. Street Address: 2357, 2361, 2363, 2365 Route 9D

7. City/Zip: Wappinger, NY 12590

8. County: Dutchess

**III. Reason for Termination**

9a. □ All disturbed areas have achieved final stabilization in accordance with the general permit and SWPPP. ***Date final stabilization completed** (month/year): ______________________

9b. □ Permit coverage has been transferred to new owner/operator. Indicate new owner/operator's permit identification number: NYR ___ ___ ___ ___ ___ ___
(Note: Permit coverage can not be terminated by owner identified in I.1. above until new owner/operator obtains coverage under the general permit)

9c. □ Other (Explain on Page 2)

**IV. Final Site Information**:

10a. Did this construction activity require the development of a SWPPP that includes post-construction stormwater management practices? □ yes □ no ( If no, go to question 10f.)

10b. Have all post-construction stormwater management practices included in the final SWPPP been constructed? □ yes □ no (If no, explain on Page 2)

10c. Identify the entity responsible for long-term operation and maintenance of practice(s)?

______________________________________________

## NOTICE OF TERMINATION for Storm Water Discharges Authorized under the SPDES General Permit for Construction Activity - continued

10d. Has the entity responsible for long-term operation and maintenance been given a copy of the operation and maintenance plan required by the general permit? □ yes □ no

10e. Indicate the method used to ensure long-term operation and maintenance of the post-construction stormwater management practice(s):

□ Post-construction stormwater management practice(s) and any right-of-way(s) needed to maintain practice(s) have been deeded to the municipality.

□ Executed maintenance agreement is in place with the municipality that will maintain the post-construction stormwater management practice(s).

□ For post-construction stormwater management practices that are privately owned, a mechanism is in place that requires operation and maintenance of the practice(s) in accordance with the operation and maintenance plan, such as a deed covenant in the owner or operator's deed of record.

□ For post-construction stormwater management practices that are owned by a public or private institution (e.g. school, university or hospital), government agency or authority, or public utility; policy and procedures are in place that ensures operation and maintenance of the practice(s) in accordance with the operation and maintenance plan.

10f. Provide the total area of impervious surface (i.e. roof, pavement, concrete, gravel, etc.) constructed within the disturbance area? ______________________________ (acres)

11. Is this project subject to the requirements of a regulated, traditional land use control MS4? □ yes □ no

(If Yes, complete section VI - "MS4 Acceptance" statement

**V. Additional Information/Explanation:**

(Use this section to answer questions 9c. and 10b., if applicable)

**VI. MS4 Acceptance - MS4 Official (principal executive officer or ranking elected official) or Duly Authorized Representative** (Note: Not required when 9b. is checked -transfer of coverage)

I have determined that it is acceptable for the owner or operator of the construction project identified in question 5 to submit the Notice of Termination at this time.

Printed Name:

Title/Position:

| Signature: | Date: |
|---|---|

**NOTICE OF TERMINATION for Storm Water Discharges Authorized under the SPDES General Permit for Construction Activity - continued**

| | |
|---|---|
| **VII. Qualified Inspector Certification - Final Stabilization**: | |
| I hereby certify that all disturbed areas have achieved final stabilization as defined in the current version of the general permit, and that all temporary, structural erosion and sediment control measures have been removed. Furthermore, I understand that certifying false, incorrect or inaccurate information is a violation of the referenced permit and the laws of the State of New York and could subject me to criminal, civil and/or administrative proceedings. | |
| Printed Name: | |
| Title/Position: | |
| Signature: | Date: |
| **VIII. Qualified Inspector Certification - Post-construction Stormwater Management Practice(s):** | |
| I hereby certify that all post-construction stormwater management practices have been constructed in conformance with the SWPPP. Furthermore, I understand that certifying false, incorrect or inaccurate information is a violation of the referenced permit and the laws of the State of New York and could subject me to criminal, civil and/or administrative proceedings. | |
| Printed Name: | |
| Title/Position: | |
| Signature: | Date: |
| **IX. Owner or Operator Certification** | |
| I hereby certify that this document was prepared by me or under my direction or supervision. My determination, based upon my inquiry of the person(s) who managed the construction activity, or those persons directly responsible for gathering the information, is that the information provided in this document is true, accurate and complete. Furthermore, I understand that certifying false, incorrect or inaccurate information is a violation of the referenced permit and the laws of the State of New York and could subject me to criminal, civil and/or administrative proceedings. | |
| Printed Name: | |
| Title/Position: | |
| Signature: | Date: |

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# Appendix C:
# Contractor's Certification Form
# Subcontractor's Certification Form

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**Stormwater Pollution Prevention Plan**
**Contractor Certification Statement**
**(Responsible for overall SWPPP Compliance)**

Gas Land Petroleum-Route 9D
2361 Route 9D, Town of Wappingers, Dutchess County, New York

This is to certify that the following contracting firm will be responsible for installing, constructing, repairing, inspecting and/or maintaining the erosion and sediment control practices and post-construction stormwater management control practices required by the SWPPP.

**Contracting Firm Information**

Name: ______________________________

Address: ______________________________

Telephone & Fax: ______________________________

**Trained Contractor(s) [1] Responsible for SWPPP Implementation (**Provide name, title, and date of last training)

______________________________

______________________________

**Prior to commencement of construction activity, the following certification shall be issued:**

I hereby certify under penalty of law that I understand and agree to comply with the terms and conditions of the SWPPP and agree to implement any corrective actions identified by the *qualified inspector* during a site inspection. I also understand that the *owner or operator* must comply with the terms and conditions of the most current version of the New York State Pollutant Discharge Elimination System ("SPDES") general permit for stormwater *discharges* from *construction activities* and that it is unlawful for any person to cause or contribute to a violation of *water quality standards*. Furthermore, I am aware that there are significant penalties for submitting false information, that I do not believe to be true, including the possibility of fine and imprisonment for knowing violations.

Printed Name: ______________________________

Title/Position: ______________________________

Signature: ______________________ Date: ______________________

**Upon completion of construction activities, the following certification shall be issued, prior to issuance of the NOT:**

I hereby certify that that all permanent stormwater management practices required by the SWPPP have been installed in accordance with the contract documents. I further certify that all temporary erosion and sediment control measures have been removed from the site, and that the on-site soils disturbed by construction activity have been restored in accordance with the SWPPP and the NYSDEC Division of Water's publication "Deep-Ripping and Decompaction".

Printed Name: ______________________________

Title/Position: ______________________________

Signature: ______________________ Date: ______________________

[1] "Trained Contractor" means an employee from a contracting (construction) company that has received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity. After receiving the initial training, the "trained contractor" shall receive four (4) hours of training every three (3) years. It can also mean an employee from the contracting (construction) company that meets the "qualified inspector" qualifications (e.g. licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, or someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided they have received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity). The "Trained Contractor" will be responsible for the day to day implementation of the SWPPP.

[2] Signatory Requirements:

a. For a corporation, this form shall be signed by (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principle business function, or any other person who performs similar policy or decision-making functions for the corporation; or (ii) the manager of one or more manufacturing, production or operating facilities, provided the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
b. For a partnership or sole proprietorship, this form shall be signed by a general partner or the proprietor, respectively.
c. For a municipality, State, Federal, or other public agency, this form shall be signed by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g. Regional Administrators of EPA).

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**Stormwater Pollution Prevention Plan**
**Subcontractor Certification Statement**
**(whose work involves soil disturbance)**

Gas Land Petroleum-Route 9D
2361 Route 9D, Town of Wappingers, Dutchess County, New York

Each Subcontractor whose work will involve soil disturbance of any kind is required to complete and sign this Certification Statement before commencing any construction activity at the site. This completed Certification Statement(s) shall be maintained at the construction site in the Site Log Book.

**Subcontracting Firm Information**

Name: ______________________________

Address: ______________________________

______________________________

Telephone & Fax: ______________________________

**Trained Contractor(s) [2] Responsible for SWPPP Implementation (**Provide name, title, and date of last training)

______________________________

______________________________

**Prior to commencement of construction activities, the following certification shall be issued:**

I hereby certify under penalty of law that I understand and agree to comply with the terms and conditions of the SWPPP and agree to implement any corrective actions identified by the *qualified inspector* during a site inspection. I also understand that the *owner or operator* must comply with the terms and conditions of the most current version of the New York State Pollutant Discharge Elimination System ("SPDES") general permit for stormwater *discharges* from *construction activities* and that it is unlawful for any person to cause or contribute to a violation of *water quality standards*. Furthermore, I am aware that there are significant penalties for submitting false information, that I do not believe to be true, including the possibility of fine and imprisonment for knowing violations.

Printed Name: ______________________________

Title/Position: ______________________________

Signature: ____________________ Date: ____________________

[2] "Trained Contractor" means an employee from a contracting (construction) company that has received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity. After receiving the initial training, the "trained contractor" shall receive four (4) hours of training every three (3) years. It can also mean an employee from the contracting (construction) company that meets the "qualified inspector" qualifications (e.g. licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, or someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided they have received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity). The "Trained Contractor" will be responsible for the day to day implementation of the SWPPP.

[2] Signatory Requirements:

a. For a corporation, this form shall be signed by (i) a president, secretary, treasurer, or vice-president of the corporation in charge of a principle business function, or any other person who performs similar policy or decision-making functions for the corporation; or (ii) the manager of one or more manufacturing, production or operating facilities, provided the manager is authorized to make management decisions which govern the operation of the regulated facility including having the explicit or implicit duty of making major capital investment recommendations, and initiating and directing other comprehensive measures to assure long term environmental compliance with environmental laws and regulations; the manager can ensure that the necessary systems are established or actions taken to gather complete and accurate information for permit application requirements; and where authority to sign documents has been assigned or delegated to the manager in accordance with corporate procedures.
b. For a partnership or sole proprietorship, this form shall be signed by a general partner or the proprietor, respectively.
c. For a municipality, State, Federal, or other public agency, this form shall be signed by either a principal executive officer or ranking elected official. For purposes of this section, a principal executive officer of a Federal agency includes (i) the chief executive officer of the agency, or (ii) a senior executive officer having responsibility for the overall operations of a principal geographic unit of the agency (e.g. Regional Administrators of EPA).

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# Appendix D:
# SWPPP Inspection Report
# (Sample Form)

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**Stormwater Pollution Prevention Plan**
**Inspection Report**

Gas Land Petroleum-Route 9D
2361 Route 9D,
Town of Wappingers, Dutchess County, New York

A Qualified Inspector[1] shall prepare an inspection report subsequent to each and every inspection, as required in Part IV.C of the SPDES General Permit GP-0-20-001. All sections of this report are to be completed.

**1. Inspection Information**

Inspection number: ____________________

Date and Time of Inspection: ____________________

Weather Conditions: ____________________

Soil Conditions (e.g. dry, wet, saturated): ____________________

**2. Inspector Information**

Qualified Inspector[1]

Printed Name:____________________ Date: ____________________

Signature:____________________

Qualified Professional[1]

Printed Name ____________________ Date: ____________________

Signature:____________________

**3. On the included site plan, provide a sketch of areas that are disturbed at the time of the inspection and areas that have been stabilized (temporary and/or final) since the last inspection. Provide additional descriptions below if necessary.**

______________________________

______________________________

______________________________

______________________________

*[1] A Qualified Inspector means a person that is knowledgeable in the principles and practices of erosion and sediment control, such as licensed Professional Engineer, Certified Professional in Erosion and Sediment Control (CPESC), Registered Landscape Architect, or other Department endorsed individual(s). It can also mean someone working under the direct supervision of, and at the same company as, the licensed Professional Engineer or Registered Landscape Architect, provided that person has training in the principles and practices of erosion and sediment control. Training in the principles and practices of erosion and sediment control means that the individual working under the direct supervision of the licensed Professional Engineer or Registered Landscape Architect has received four (4) hours of Department endorsed training in proper erosion and sediment control principles from a Soil and Water Conservation District, or other Department endorsed entity. After receiving the initial training, the individual working under the direct supervision of the licensed Professional Engineer or Registered Landscape Architect shall receive four (4) hours of training every three (3) years. It can also mean a person that meets the Qualified Professional qualifications in addition to the Qualified Inspector qualifications. Note: Inspections of any post-construction stormwater management practices that include structural components, such as a dam for an impoundment, shall be performed by a licensed Professional Engineer.*

4. **In the following table, provide a description of the condition of the runoff at all points of discharge from the construction site, including conveyance systems (pipes, culverts, ditches, etc.) and overland flow. Provide a description of the condition of all natural surface waterbodies located within the property boundaries of the construction site which receive runoff from disturbed areas. Identify any discharges of sediment from the construction site. Use additional sheets if necessary.**

| Description of Discharge Point/Adjacent Natural Surface Waterbodies | Condition of Runoff | Sediment Discharge Noted |
|---|---|---|
| | | Yes / No |
| | | Yes / No |
| | | Yes / No |
| | | Yes / No |

5. **For all discharge points where sediment discharge has been noted in the above table, provide detailed corrective actions that are required. Use additional sheets if necessary.**

6. **In the following table, provide checkmarks in the appropriate columns to indicate the condition of all erosion and sediment control practices at the site.**

| Erosion & Sediment Control Practice | Not Applicable | Functioning as Designed | Needs Repair or Maintenance | Not Installed Properly | Date Deficiency First Reported (If Applicable) | Deficiency Corrected? Y/N (If Applicable) |
|---|---|---|---|---|---|---|
| **Temporary Erosion & Sediment Control Practices** | | | | | | |
| Stabilized construction entrance | | | | | | |
| Silt fence | | | | | | |
| Inlet protection measures | | | | | | |
| Soil stockpiles | | | | | | |
| Dust control measures | | | | | | |
| Pavement sweeping | | | | | | |
| Temporary stabilization | | | | | | |
| Dewatering operations | | | | | | |
| Slope protection measures | | | | | | |
| Temporary parking areas | | | | | | |
| Concrete washout | | | | | | |
| Temporary swales and berms | | | | | | |
| Stone check dams | | | | | | |
| Sediment traps | | | | | | |
| Fiber Roll | | | | | | |
| Other: | | | | | | |
| **Permanent Erosion & Sediment Control Practices** | | | | | | |
| Rock outlet protection | | | | | | |
| Permanent turf reinforcement | | | | | | |
| Permanent stabilization | | | | | | |
| Other: | | | | | | |

7. **For all erosion and sediment control practices identified in the above table as “needs repair or maintenance” or “not installed properly”, provide detailed corrective actions that are required. Use additional sheets if necessary.**

**8. In the following table, indicate the current phase of construction of all post-construction stormwater management practices and identify all construction that is not in conformance with the SWPPP and technical standards.**

| SWM Practice | Current Phase of Construction | Items not in conformance with the SWPPP |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

**9. For all post-construction stormwater management practices which are identified in the above table as including "items not in conformance with the SWPPP", provide detailed corrective action(s) that are required to correct the deficiencies. Use additional sheets if necessary.**

**Photo Log**

| | |
|---|---|
| *Date – Item in need of repair or maintenance:* | *Date – Corrected Action:* |
| *Date – Item in need of repair or maintenance:* | *Date – Corrected Action:* |
| *Date – Item in need of repair or maintenance:* | *Date – Corrected Action:* |

## Photo Log

| | |
|---|---|
| *Date – Item in need of repair or maintenance:* | *Date – Corrected Action:* |
| *Date – Item in need of repair or maintenance:* | *Date – Corrected Action:* |
| *Date – Item in need of repair or maintenance:* | *Date – Corrected Action:* |

# Appendix E:
# NYSDEC "Deep-Ripping and Decompaction," April 2008

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New York State
**DEPARTMENT OF ENVIRONMENTAL CONSERVATION**

Division of Water

# Deep-Ripping and Decompaction

**April 2008**

**New York State**
**Department of Environmental Conservation**

Document Prepared by:

John E. Lacey,
Land Resource Consultant and Environmental Compliance Monitor
(Formerly with the Division of Agricultural Protection and Development Services,
NYS Dept. of Agriculture & Markets)

## Description

The two-phase practice of 1) “Deep Ripping;” and 2) “Decompaction” (deep subsoiling), of the soil material as a step in the cleanup and restoration/landscaping of a construction site, helps mitigate the physically induced impacts of soil compression; i.e.: soil compaction or the substantial increase in the bulk density of the soil material.

Deep Ripping and Decompaction are key factors which help in restoring soil pore space and permeability for water infiltration. Conversely, the physical actions of cut-and-fill work, land grading, the ongoing movement of construction equipment and the transport of building materials throughout a site alter the architecture and structure of the soil, resulting in: the mixing of layers (horizons) of soil materials, compression of those materials and diminished soil porosity which, if left unchecked, severely impairs the soil’s water holding capacity and vertical drainage (rainfall infiltration), from the surface downward.

In a humid climate region, compaction damage on a site is virtually guaranteed over the duration of a project. Soil in very moist to wet condition when compacted, will have severely reduced permeability. Figure 1 displays the early stage of the deep-ripping phase (Note that all topsoil was stripped prior to construction access, and it remains stockpiled until the next phase – decompaction – is complete). A heavy-duty tractor is pulling a three-shank ripper on the first of several series of incrementally deepening passes through the construction access corridor's densely compressed subsoil material. Figure 2 illustrates the approximate volumetric composition of a loam surface soil when conditions are good for plant growth, with adequate natural pore space for fluctuating moisture conditions.

Fig. 1. A typical deep ripping phase of this practice, during the first in a series of progressively deeper “rips” through severely compressed subsoil.

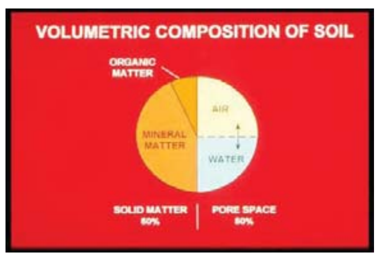


Fig. 2. About 50% of the volume of undisturbed loam surface soil is pore space, when soil is in good condition for plant growth. Brady, 2002.



## Recommended Application of Practice

The objective of Deep Ripping and Decompaction is to effectively fracture (vertically and laterallly) through the thickness of the physically compressed subsoil material (see Figure 3), restoring soil porosity and permeability and aiding infiltration to help reduce runoff. Together with topsoil stripping, the “two-phase” practice of Deep Ripping and Decompaction first became established as a “best management practice” through ongoing success on commercial farmlands affected by heavy utility construction right-of-way projects (transmission pipelines and large power lines).

Fig. 3. Construction site with significant compaction of the deep basal till subsoil extends 24 inches below this exposed cut-and-fill work surface.

Soil permeability, soil drainage and cropland productivity were restored. For broader construction application, the two-phase practice of Deep Ripping and Decompaction is best adapted to areas impacted with significant soil compaction, on contiguous open portions of large construction sites and inside long, open construction corridors used as temporary access over the duration of construction. Each mitigation area should have minimal above-and-below-ground obstructions for the easy avoidance and maneuvering of a large tractor and ripping/decompacting implements. Conversely, the complete two-phase practice is not recommended in congested or obstructed areas due to the limitations on tractor and implement movement.

## Benefits

Aggressive “deep ripping” through the compressed thickness of exposed subsoil before the replacement/respreading of the topsoil layer, followed by “decompaction,” i.e.: “sub-soiling,” through the restored topsoil layer down into the subsoil, offers the following benefits:

- Increases the project (larger size) area’s direct surface infiltration of rainfall by providing the open site’s mitigated soil condition and lowers the demand on concentrated runoff control structures
- Enhances direct groundwater recharge through greater dispersion across and through a broader surface than afforded by some runoff-control structural measures
- Decreases runoff volume generated and provides hydrologic source control
- May be planned for application in feasible open locations either alone or in

conjunction with plans for structural practices (e.g., subsurface drain line or infiltration basin) serving the same or contiguous areas

- Promotes successful long-term revegetation by restoring soil permeability, drainage and water holding capacity for healthy (rather than restricted) root-system development of trees, shrubs and deep rooted ground cover, minimizing plant drowning during wet periods and burnout during dry periods.

## Feasibility / Limitations

The effectiveness of Deep Ripping and Decompaction is governed mostly by site factors such as: the original (undisturbed) soil's hydrologic characteristics; the general slope; local weather/timing (soil moisture) for implementation; the space-related freedom of equipment/implement maneuverability (noted above in **Recommended Application of Practice**), and by the proper selection and operation of tractor and implements (explained below in **Design Guidance**). The more notable site-related factors include:

**Soil**

In the undisturbed condition, each identified soil type comprising a site is grouped into one of four categories of soil hydrology, Hydrologic Soil Group A, B, C or D, determined primarily by a range of characteristics including soil texture, drainage capability when thoroughly wet, and depth to water table. The natural rates of infiltration and transmission of soil-water through the undisturbed soil layers for Group A is "high" with a low runoff potential while soils in Group B are moderate in infiltration and the transmission of soil-water with a moderate runoff potential, depending somewhat on slope. Soils in Group C have slow rates of infiltration and transmission of soil-water and a moderately high runoff potential influenced by soil texture and slope; while soils in Group D have exceptionally slow rates of infiltration and transmission of soil-water, and high runoff potential.

In Figure 4, the profile displays the undisturbed horizons of a soil in Hydrologic Soil Group C and the naturally slow rate of infiltration through the subsoil. The slow rate of infiltration begins immediately below the topsoil horizon (30 cm), due to the limited amount of macro pores, e.g.: natural subsoil fractures, worm holes and root channels. Infiltration after the construction-induced mixing and compression of such subsoil material is virtually absent; but can be restored back to this natural level with the two-phase practice of deep ripping and decompaction, followed by the permanent establishment of an appropriate, deep taproot

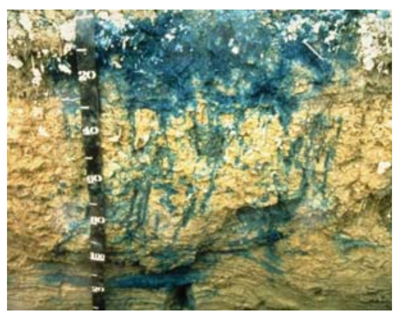

Fig. 4. Profile (in centimeters) displaying the infiltration test result of the natural undisturbed horizons of a soil in Hydrologic Soil Group C.



lawn/ground cover to help maintain the restored subsoil structure. Infiltration after construction-induced mixing and compression of such subsoil material can be notably rehabilitated with the Deep Ripping and Decompaction practice, which prepares the site for the appropriate long-term lawn/ground cover mix including deep taproot plants such as clover, fescue or trefoil, etc. needed for all rehabilitated soils.

Generally, soils in Hydrologic Soil Groups A and B, which respectively may include deep, well-drained, sandy-gravelly materials or deep, moderately well-drained basal till materials, are among the easier ones to restore permeability and infiltration, by deep ripping and decompaction. Among the many different soils in Hydrologic Soil Group C are those unique glacial tills having a natural fragipan zone, beginning about 12 to 18 inches (30 – 45cm), below surface. Although soils in Hydrologic Soil Group C do require a somewhat more carefully applied level of the Deep Ripping and Decompaction practice, it can greatly benefit such affected areas by reducing the runoff and fostering infiltration to a level equal to that of pre-disturbance.

Soils in Hydrologic Soil Group D typically have a permanent high water table close to the surface, influenced by a clay or other highly impervious layer of material. In many locations with clay subsoil material, the bulk density is so naturally high that heavy trafficking has little or no added impact on infiltration; and structural runoff control practices rather than Deep Ripping and Decompaction should be considered.

The information about Hydrologic Soil Groups is merely a general guideline. Site-specific data such as limited depths of cut-and-fill grading with minimal removal or translocation of the inherent subsoil materials (as analyzed in the county soil survey) or, conversely, the excavation and translocation of deeper, unconsolidated substratum or consolidated bedrock materials (unlike the analyzed subsoil horizons' materials referred to in the county soil survey) should always be taken into account.

Sites made up with significant quantities of large rocks, or having a very shallow depth to bedrock, are not conducive to deep ripping and decompation (subsoiling); and other measures may be more practical.

**Slope**

The two-phase application of 1) deep ripping and 2) decompaction (deep subsoiling), is most practical on flat, gentle and moderate slopes. In some situations, such as but not limited to temporary construction access corridors, inclusion areas that are moderately steep along a project's otherwise gentle or moderate slope may also be deep ripped and decompacted. For limited instances of moderate steepness on other projects, however, the post-construction land use and the relative alignment of the potential ripping and decompaction work in relation to the lay of the slope should be reviewed for safety and practicality. In broad construction areas predominated by moderately steep or steep slopes, the practice is generally not used.

**Local Weather/Timing/Soil Moisture**

Effective fracturing of compressed subsoil material from the exposed work surface, laterally and vertically down through the affected zone is achieved only when the soil material is moderately dry to moderately moist. Neither one of the two-phases, deep ripping nor decompaction (deep subsoiling), can be effectively conducted when the soil material (subsoil or replaced topsoil) is in either a "plastic" or "liquid" state of soil consistency. Pulling the respective implements legs through the soil when it is overly moist only results in the "slicing and smearing" of the material or added "squeezing and compression" instead of the necessary fracturing. Ample drying time is needed for a "rippable" soil condition not merely in the material close to the surface, but throughout the material located down to the bottom of the physically compressed zone of the subsoil.

The "poor man's Atterberg field test" for soil plasticity is a simple "hand-roll" method used for quick, on-site determination of whether or not the moisture level of the affected soil material is low enough for: effective deep ripping of subsoil; respreading of topsoil in a friable state; and final decompaction (deep subsoiling). Using a sample of soil material obtained from the planned bottom depth of ripping, e.g.: 20 - 24 inches below exposed subsoil surface, the sample is hand rolled between the palms down to a 1/8-inch diameter thread. (Use the same test for stored topsoil material before respreading on the site.) If the respective soil sample crumbles apart in segments no greater than 3/8 of an inch long, by the time it is rolled down to 1/8 inch diameter, it is low enough in moisture for deep ripping (or topsoil replacement), and decompaction. Conversely, as shown in Figure 5, if the rolled sample stretches out in increments greater than 3/8 of an inch long before crumbling, it is in a "plastic" state of soil consistency and is too wet for subsoil ripping (as well as topsoil replacement) and final decompaction.

Fig. 5. Augered from a depth of 19 inches below the surface of the replaced topsoil, this subsoil sample was hand rolled to a 1/8-inch diameter. The test shows the soil at this site stretches out too far without crumbling; it indicates the material is in a plastic state of consistence, too wet for final decompaction (deep subsoiling) at this time.

## Design Guidance

Beyond the above-noted site factors, a vital requirement for the effective Deep Ripping and Decompaction (deep subsoiling), is implementing the practice in its distinct, two-phase process:

1) Deep rip the affected thickness of exposed subsoil material (see Figure 10 and 11), aggressively fracturing it before the protected topsoil is reapplied on the site (see Figure 12); and

2) Decompact (deep subsoil), simultaneously through the restored topsoil layer and the upper half of the affected subsoil (Figure 13). The second phase, "decompaction," mitigates the partial recompaction which occurs during the heavy process of topsoil spreading/grading. Prior to deep ripping and decompacting the site, all construction activity, including construction equipment and material storage, site cleanup and trafficking (Figure 14), should be finished; and the site closed off to further disturbance. Likewise, once the practice is underway and the area's soil permeability and



rainfall infiltration are being restored, a policy limiting all further traffic to permanent travel lanes is maintained.

The other critical elements, outlined below, are: using the proper implements (deep, heavy-duty rippers and subsoilers), and ample pulling-power equipment (tractors); and conducting the practice at the appropriate speed, depth and pattern(s) of movement.

Note that an appropriate plan for the separate practice of establishing a healthy perennial ground cover, with deep rooting to help maintain the restored soil structure, should be developed in advance. This may require the assistance of an agronomist or landscape horticulturist.

**Implements**

Avoid the use of all undersize implements. The small-to-medium, light-duty tool will, at best, only "scarify" the uppermost surface portion of the mass of compacted subsoil material. The term "chisel plow" is commonly but incorrectly applied to a broad range of implements. While a few may be adapted for the moderate subsoiling of non-impacted soils, the majority are less durable and used for only lighter land-fitting (see Figure 6).

Fig. 6. A light duty chisel implement, not adequate for either the deep ripping or decompaction (deep subsoiling) phase.

Fig. 7. One of several variations of an agricultural ripper. This unit has long, rugged shanks mounted on a steel V-frame for deep, aggressive fracturing through Phase 1.

Use a "heavy duty" agricultural-grade, deep ripper (see Figures 7,9,10 and 11) for the first phase: the lateral and vertical fracturing of the mass of exposed and compressed subsoil, down and through, to the bottom of impact, prior to the replacement of the topsoil layer. (Any oversize rocks which are uplifted to the subsoil surface during the deep ripping phase are picked and removed.) Like the heavy-duty class of implement for the first phase, the decompaction (deep subsoiling) of Phase 2 is conducted with the heavy-duty version of the deep subsoiler. More preferable is the angled-leg variety of deep subsoiler (shown in Figures 8 and 13). It minimizes the inversion of the subsoil and topsoil layers while laterally and vertically fracturing the upper half of the previously ripped subsoil layer and all of the topsoil layer by delivering a momentary, wave-like "lifting and shattering" action up through the soil layers as it is pulled.

**Pulling-Power of Equipment**
Use the following rule of thumb for tractor horsepower (hp) whenever deep ripping and decompacting a significantly impacted site: For both types of implement, have at least 40 hp of tractor pull available for each mounted shank/ leg.

Using the examples of a 3-shank and a 5-shank implement, the respective tractors should have 120 and 200 hp available for fracturing down to the final depth of 20-to-24 inches per phase. Final depth for the deep ripping in Phase 1 is achieved incrementally by a progressive series of passes (see Depth and Patterns of Movement, below); while for Phase 2, the full operating depth of the deep subsoiler is applied from the beginning.

The operating speed for pulling both types of implement should not exceed 2 to 3 mph. At this slow and managed rate of operating speed, maximum functional performance is sustained by the tractor and the implement performing the soil fracturing. Referring to Figure 8, the implement is the 6-leg version of the deep angled-leg subsoiler. Its two outside legs are "chained up" so that only four legs will be engaged (at the maximum depth), requiring no less than 160 hp, (rather than 240 hp) of pull. The 4-wheel drive, articulated-frame tractor in Figure 8 is 174 hp. It will be decompacting this unobstructed, former construction access area simultaneously through 11 inches of replaced topsoil and the upper 12 inches of the previously deep-ripped subsoil. In constricted areas of Phase 1) Deep Ripping, a medium-size tractor with adequate hp, such as the one in Figure 9 pulling a 3-shank deep ripper, may be more maneuverable.


Fig. 8. A deep, angled-leg subsoiler, ideal for Phase 2 decompaction of after the topsoil layer is graded on top of the ripped subsoil.


Fig. 9. This medium tractor is pulling a 3-shank deep ripper. The severely compacted construction access corridor is narrow, and the 120 hp tractor is more maneuverable for Phase 1 deep ripping (subsoil fracturing), here.

Some industrial-grade variations of ripping implements are attached to power graders and bulldozers. Although highly durable, they are generally not recommended. Typically, the shanks or "teeth" of these rippers are too short and stout; and they are mounted too far apart to achieve the well-distributed type of lateral and vertical fracturing of the soil materials necessary to restore soil permeability and infiltration. In addition, the power graders and bulldozers, as pullers, are far less maneuverable for turns and patterns than the tractor.



**Depth and Patterns of Movement**
As previously noted both Phase 1 Deep Ripping through significantly compressed, exposed subsoil and Phase 2 Decompaction (deep subsoiling) through the replaced topsoil and upper subsoil need to be performed at maximum capable depth of each implement. With an implement's guide wheels attached, some have a "normal" maximum operating depth of 18 inches, while others may go deeper. In many situations, however, the tractor/implement operator must first remove the guide wheels and other non essential elements from the implement. This adapts the ripper or the deep subsoiler for skillful pulling with its frame only a few inches above surface, while the shanks or legs, fracture the soil material 20-to-24 inches deep.

There may be construction sites where the depth of the exposed subsoil's compression is moderate, e.g.: 12 inches, rather than deep. This can be verified by using a ¾ inch cone penetrometer and a shovel to test the subsoil for its level of compaction, incrementally, every three inches of increasing depth. Once the full thickness of the subsoil's compacted zone is finally "pieced" and there is a significant drop in the psi measurements of the soil penetrometer, the depth/thickness of compaction is determined. This is repeated at several representative locations of the construction site. If the thickness of the site's subsoil compaction is verified as, for example, ten inches, then the Phase 1 Deep Ripping can be correspondingly reduced to the implement's minimum operable depth of 12 inches. However, the Phase 2 simultaneous Decompation (subsoiling) of an 11 inch thick layer of replaced topsoil and the upper subsoil should run at the subsoiling implements full operating depth.


Fig. 10. An early pass with a 3-shank deep ripper penetrating only 8 inches into this worksite's severely compressed subsoil.


Fig. 11. A repeat run of the 3-shank ripper along the same patterned pass area as Fig. 9; here, incrementally reaching 18 of the needed 22 inches of subsoil fracture.

Typically, three separate series (patterns) are used for both the Phase 1 Deep Ripping and the Phase 2 Decompaction on significantly compacted sites. For Phase 1, each series begins with a moderate depth of rip and, by repeat-pass, continues until full depth is reached. Phase 2 applies the full depth of Decompation (subsoiling), from the beginning.

Every separate series (pattern) consists of parallel, forward-and-return runs, with each progressive pass of the implement's legs or shanks evenly staggered between those from the previous pass. This compensates for the shank or leg-spacing on the implement, e.g., with 24-to-30 inches between each shank or leg. The staggered return pass ensures lateral and vertical fracturing actuated every 12 to 15 inches across the densely compressed soil mass.

**Large, Unobstructed Areas**
For larger easy areas, use the standard patterns of movement:

- The first series (pattern) of passes is applied lengthwise, parallel with the longest spread of the site; gradually progressing across the site's width, with each successive pass.

- The second series runs obliquely, crossing the first series at an angle of about 45 degrees.

- The third series runs at right angle (or 90 degrees), to the first series to complete the fracturing and shattering on severely compacted sites, and avoid leaving large unbroken blocks of compressed soil material. (In certain instances, the third series may be optional, depending on how thoroughly the first two series loosen the material and eliminate large chunks/blocks of material as verified by tests with a ¾-inch cone penetrometer.)

Fig. 12. Moderately dry topsoil is being replaced on the affected site now that Phase 1 deep ripping of the compressed subsoil is complete.


Fig. 13. The same deep, angled-leg subsoiler shown in Fig. 7 is engaged at maximum depth for Phase 2, decompaction (deep soiling), of the replaced topsoil and the upper subsoil materials.

**Corridors**
In long corridors of limited width and less maneuverability than larger sites, e.g.: along compacted areas used as temporary construction access, a modified series of pattern passes are used.

- First, apply the same initial lengthwise, parallel series of passes described above.



- A second series of passes makes a broad "S" shaped pattern of rips, continually and gradually alternating the "S" curves between opposite edges inside the compacted corridor.

- The third and final series again uses the broad, alternating S pattern, but it is "flip-flopped" to continually cross the previous S pattern along the corridor's centerline. This final series of the S pattern curves back along the edge areas skipped by the second series.

## Maintenance and Cost

Once the two-phase practice of Deep Ripping and Decompation is completed, two items are essential for maintaining a site's soil porosity and permeability for infiltration. They are: planting and maintaining the appropriate ground cover with deep roots to maintain the soil structure (see Figure 15); and keeping the site free of traffic or other weight loads.

Note that site-specific choice of an appropriate vegetative ground-cover seed mix, including the proper seeding ratio of one or more perennial species with a deep taproot system and the proper amount of lime and soil nutrients (fertilizer mix) adapted to the soil-needs, are basic to the final practice of landscaping, i.e: surface tillage, seeding/planting/fertilizing and culti-packing or mulching is applied. The "maintenance" of an effectively deep-ripped and decompacted area is generally limited to the successful perennial (long-term) landscape ground cover; as long as no weight-bearing force of soil compaction is applied.


Fig. 14. The severely compacted soil of a temporary construction yard used daily by heavy equipment for four months; shown before deep ripping, topsoil replacement, and decompaction.


Fig. 15. The same site as Fig. 14 after deep ripping of the exposed subsoil, topsoil replacement, decompaction through the topsoil and upper subsoil and final surface tillage and revegetation to maintain soil permeability and infiltration.

The Deep Ripping and Decompaction practice is, by necessity, more extensive than periodic subsoiling of farmland.The cost of deep ripping and decompacting (deep subsoiling), will vary according to the depth and severity of soil-material compression and the relative amount of tractor and implement time that is required. In some instances, depending on open maneuverability, two-to-three acres of compacted project area may be deep-ripped in one day. In other situations of more severe compaction and - or less maneuverability, as little as one acre may be fully ripped in a day. Generally, if the Phase 1) Deep Ripping is fully effective, the Phase 2) Decompaction should be completed in 2/3 to 3/4 of the time required for Phase 1.

Using the example of two acres of Phase 1) Deep Ripping in one day, at $1800 per day, the net cost is $900 per acre. If the Phase 2) Decompacting or deep subsoiling takes 3/4 the time as Phase 1, it costs $675 per acre for a combined total of $1575 per acre to complete the practice (these figures do not include the cost of the separate practice of topsoil stripping and replacement). Due to the many variables, it must be recognized that cost will be determined by the specific conditions or constraints of the site and the availability of proper equipment.



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- Soil penetrometer information. Access by internet searches of: *Diagnosing Soil Compaction using a Penetrometer (soil compaction tester), PSU Extension;* as well as *Dickey-john Soil Compaction Tester*. http://www.dickey-johnproducts.com/pdf/SoilCompactionTest.pdf and http://cropsoil.psu.edu/Extension/Facts/uc178pdf Last visited Sept. 07

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# Appendix F:
# Post-Construction Inspections and Maintenance

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# POST CONSTRUCTION INSPECTIONS AND MAINTENANCE

## 1. SITE COVER

### a. Inspections

Site cover and associated structures and embankments should be inspected periodically for the first few months following construction and then on a biannual basis. Site inspections should also be performed following all major storm events. Items to check for include (but are not limited to):

i. Differential settlement of embankments, cracking or erosion.

ii. Lack of vigor and density of grass turf.

iii. Accumulation of sediments or litter on lawn areas, paved areas, or within catch basin sumps.

iv. Accumulation of pollutants, including oils or grease, in catch basin sumps.

v. Damage or fatigue of storm sewer structures or associated components.

### b. Mowing and Sweeping

Vegetated areas and landscaping should be maintained to promote vigorous and dense growth. Lawn areas should be mowed at least three times a year (more frequent mowing may be desired for aesthetic reasons). Resultant yard waste shall be collected and disposed of off-site.

Paved areas should be swept at least twice a year. Additional sweeping may be appropriate in the early spring for removal of deicing materials

### c. Debris and Litter Removal

Accumulation of litter and debris should be removed during each mowing or sweep operation.

### d. Structural Repair or Replacement

Components of the system which require repair or replacement should be addressed immediately following identification.

### e. Catch Basins

The frequency for cleanout of catch basin sumps will depend on the efficiency of mowing, sweeping, and debris and litter removal. Sumps should be cleaned when accumulation of sediments are within six inches of the catch basin outlet pipe.

Disposal of material from catch basins sumps, drainage manholes, and trench drains shall be in accordance with local, state, and federal guidelines.

**f. Rip-rap Dissipation structures**

Riprap used to dissipate energy from pipe outfalls shall be cleaned or replaced when it becomes overburdened with silt or sediment.

**g. Winter Maintenance**

To prevent impacts to storm water management facilities, the following winter maintenance limitations, restrictions, or requirements are recommended:

i. Remove snow and ice from inlet structures, basin inlet and outlet structures and away from culvert end sections.

ii. Snow removed from paved areas should not be piled at inlets/outlets of the storm water management basin.

iii. Use of deicing materials should be limited to sand and “environmentally friendly” chemical products. Use of salt mixtures should be kept to a minimum.

iv. Sand used for deicing should be clean, course material free of fines, silt, and clay.

v. Materials used for deicing should be removed during the early spring by sweeping and/ or vacuuming.

## 2. BIORETENTION FILTERS

**a. Inspection Schedule**

Bioretention filters should be inspected periodically for the first few months after construction and then on a monthly basis. Bioretention filters should be inspected after all major storm events.

**b. Inspection of Uphill Drainage Area**

Inspect areas that are uphill from the Bioretention filter.

i. Bare soil and/or erosion of the ground should be seeded and mulches to establish vegetation. Areas of erosion should be filled with soil, compacted, and seeded and strawed to establish vegetation.

ii. If a small channel(s) is forming, try to redirect water flowing to this area by creating a small berm or adding topsoil to areas that are heavily compacted.

iii. Piles of grass clippings, mulch, dirt, salt or other materials should be removed.

iv. Open containers of oil, grease, paint, or other substances should be covered and properly disposed of.

**c. Inspection of Inlets**

Stand in the Bioretention filter itself and inspect each location where water flows in.

i. Inlets should have a clear pathway for water to flow into the filter. Grit and debris or grass/weeds should be removed at curb inlets or openings.

ii. Clumps of growing grass or weeds and the associated soil or grit should be removed.

iii. Grass clippings, leaves, sticks, and other debris collecting at inlets should be removed.

iv. For pipes and ditches, sediment and debris partially blocking the pipe or ditch opening into the Bioretention filter should be removed.

v. All materials removed should be properly disposed in such a way that it may not re-enter the Bioretention filter.

vi. Small areas of erosion should be smoothed out and rock or stone applied to prevent further erosion. Reseeding and applying erosion-control matting can be used to prevent further erosion.

**d. Inspection of Ponding Area**

Examine the entire Bioretention surface and side slopes:

i. In areas where the mulch layer has decomposed or is less than 1-inch thick, new mulch should be added to a total depth of 2 to 3 inches. The mulch should be a shredded hardwood mulch that is less likely to float away during rainstorms. Avoid adding too much mulch so that inlets are obstructed, or certain areas become higher than the rest of the Bioretention surface.

ii. Excess sediment, grit, trash, or other debris that has accumulated on the bottom should be removed and disposed of in such a way that it cannot re-enter the Bioretention filter. If removing the material creates a hole or low area, fill in with a soil mix that matches the original mix and cover with mulch to create a flat surface.

iii. Eroded areas in the bottom or on the side slopes should be filled with clean topsoil or sand and covered with mulch. If the problem reoccurs, stone can be used to fill in the areas. If the erosion is on a side slope, fill in with clay that can be compacted and seed and mulch the area.

iv. The bottom of the Bioretention filter should be flat. The surface should be raked or mulch added to low spots to create a more level surface.

**e. Inspection of Vegetation**

Examine all Bioretention filter vegetation:

i. Weeds and dead and/or diseased plants should be removed and the mulch surrounding these replaced. Plants should be added to fill in areas that are not well vegetated.

ii. If bioretention filter utilized a vegetated seed mix, then grass areas shall be mowed to ensure that grass height does not exceed 6-inches.

iii. Undesirable trees and shrubs should be removed. Resultant yard wastes shall be collected and disposed of off-site

**f. Inspection of Outlets**

Examine the outlets that release water out of the Bioretention filter:

i. Stone should be added in areas of erosion at the outlet to reduce the impact from the water flowing out of the outlet pipe or weir during storms.

ii. Outlet obstructions should be removed and disposed of where it cannot re-enter the Bioretention filter.

**g. Debris, Trash and Litter Control**

Removal of debris and litter shall be accomplished during mowing operations. Inlet structures should be cleared of all debris and litter.

**h. Structural Repairs and Replacement**

Components of the bioretention filter, which require repair or replacement, should be addressed immediately following identification. This includes treating and or replacing diseased trees and shrub, fertilizing as necessary, replacing tree stakes and wires, replacing mulch where bare spots appear, replacing clogged underdrains, filter beds, and pea gravel diaphragm.

**i. Erosion and Sediment Control**

Sources of sedimentation, specifically eroded areas in upland drainage areas, should be stabilized immediately upon identification. Stabilization should be with vegetative practices or other erosion control practices when vegetative measures do not prove effective.

Soil slumpage, erosion of the embankments or around inlets/outlets, and cracking should be stabilized and repaired immediately upon identification.

**j. Sediment Removal**

Sediments that accumulate in the bioretention filter should be removed annually to prevent clogging of inlet or outlet structures. Disposal of material removed from bioretention filter shall be in accordance with local, state, and federal guidelines.

## 3. UNDERGROUND INFILTRATION SYSTEM

**a. Inspection Schedule**

Underground infiltration systems should be inspected periodically for the first few months after construction and then on an annual basis. Underground infiltration systems should be inspected after major storm events to ensure inlets and outlets remain clear.

**b. Inspection Items**

Items to check for include (but are not limited to):

i. Measure the sediment buildup at each riser.

ii. Inspect each header, all laterals, inlets, and outlet pipes for sediment build up, obstructions or other problems. Cracking, erosion or seepage through embankments.

Refer to the attached Stormtech "Isolator Row Operations and Maintenance Manual" for the manufacturer's inspection and maintenance requirements.

**c. Debris and Litter Control**

Inlet and outlet structures should be cleared of all debris and litter.

**d. Structural repairs and Replacement**

Components of the underground infiltration system, which require repair or replacement, should be addressed immediately following identification.

**e. Sedimentation Control**

Sources of sedimentation, specifically eroded areas in upland drainage areas, should be stabilized immediately upon identification. Stabilization should be with vegetative practices or other erosion control practices when vegetative measures do not prove effective.

**f. Sediment removal**

Sediments, which accumulate in the underground infiltration system, should be removed when it reaches 4% of the pipe diameter to prevent clogging of the outlet. A typical clean-out cycle should be between 5 to 10 years with more frequent cleanings near inlet and outlet structures. The unit may require cleaning in the event of a spill of a toxic or foreign substance. Disposal of material from the underground infiltration systems shall be in accordance with local, state, and federal guidelines.

Underground infiltration systems are confined space environment and only properly trained personnel possessing the necessary safety equipment should enter the systems to perform maintenance or inspection.

## 4. UNDERGROUND DETENTION SYSTEM

**a. Inspection Schedule**

Underground detention systems should be inspected periodically for the first few months after construction and then on an annual basis. Underground detention systems should be inspected after major storm events to ensure inlets and outlets remain clear.

**b. Inspection Items**

Items to check for include (but are not limited to):

i. Measure the sediment buildup at each riser.

ii. Inspect each header, all laterals, inlets, and outlet pipes for sediment build up, obstructions or other problems. Cracking, erosion or seepage through embankments.

**c. Debris and Litter Control**

Inlet and outlet structures should be cleared of all debris and litter.

**d. Structural repairs and Replacement**

Components of the detention basin, which require repair or replacement, should be addressed immediately following identification.

**e. Sedimentation Control**

Sources of sedimentation, specifically eroded areas in upland drainage areas, should be stabilized immediately upon identification. Stabilization should be with vegetative practices or other erosion control practices when vegetative measures do not prove effective.

**f. Sediment removal**

Sediments, which accumulate in the underground detention system basin, should be removed when it reaches 4% of the pipe diameter to prevent clogging of the outlet. A typical clean-out cycle should be between 5 to 10 years with more frequent cleanings near inlet and outlet structures. The unit may require cleaning in the event of a spill of a toxic or foreign substance. Disposal of material from the underground detention systems shall be in accordance with local, state, and federal guidelines.

Underground detention systems are confined space environment and only properly trained personnel possessing the necessary safety equipment should enter the systems to perform maintenance or inspection.

## 5. HYDRODYNAMIC DEVICE

The hydrodynamic device is a confined space environment and only properly trained personnel possessing the necessary safety equipment should enter the unit to perform maintenance or inspection.

**a. Inspection Schedule**

The hydrodynamic device shall be inspected every four months.

**b. Inspection Items**

The unit’s internal components should be inspected for any signs of damage or any loosening of the bolts used to fasten the various components to the manhole structure and to each other.

Refer to attached Operations and Maintenance Guidelines, for the CDS-4 (2015) Hydrodynamic Device, and Installation, Operation, Inspection, Maintenance, and Cleaning Manual for CrystalStream Technologies, for the manufacturer’s detailed inspection and maintenance requirements.

**c. Debris, Trash and Litter Control**

The screen shall be power washed for the inspection. The floatables shall be removed and the sump cleaned when it has reached 50% capacity. The unit may require cleaning in the event of a spill of a toxic or foreign substance. At a minimum, the hydrodynamic device shall be pumped out at least once a year if the sump does not reach its 50% capacity.

**d. Sediment removal**

Disposal of material from the hydrodynamic device shall be in accordance with local, state, and federal guidelines.

StormTech®
Detention • Retention • Water Quality
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**Save Valuable Land and Protect Water Resources**

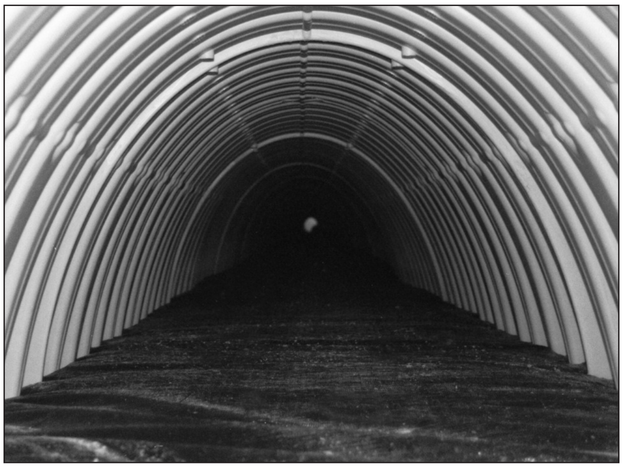
# Isolator® Row O&M Manual

StormTech® Chamber System for Stormwater Management

# 1.0 The Isolator® Row

## 1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.



*Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.*

## 1.2 THE ISOLATOR ROW

The Isolator Row is a row of StormTech chambers, either SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

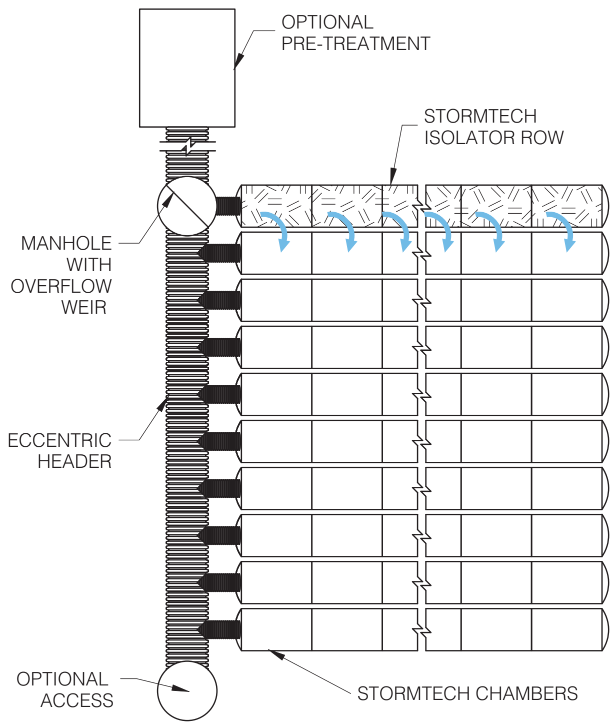
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

*Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.*

**StormTech Isolator Row with Overflow Spillway**
(not to scale)



# 2.0 Isolator Row Inspection/Maintenance

## 2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

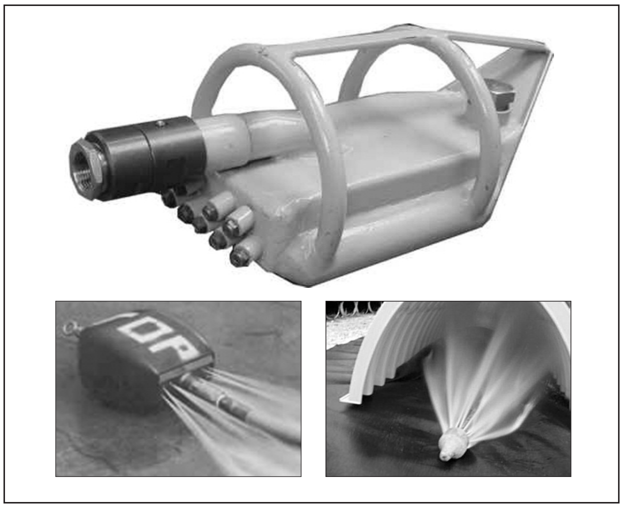
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

## 2.2 MAINTENANCE

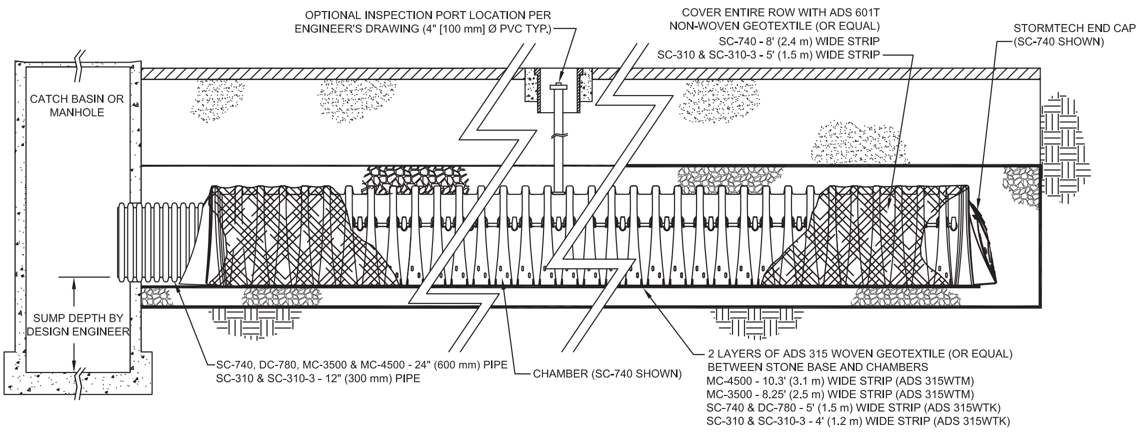
The Isolator Row was designed to reduce the cost of periodic maintenance. By “isolating” sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



*Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)*

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45” are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

**StormTech Isolator Row** (not to scale)

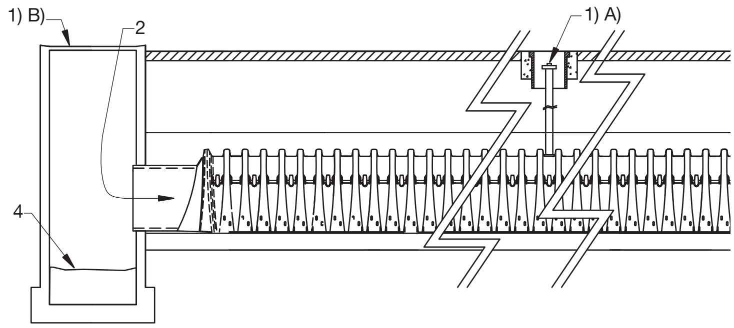



**NOTE:** NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 AND MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

# 3.0 Isolator Row Step By Step Maintenance Procedures

**Step 1)** Inspect Isolator Row for sediment
A) Inspection ports (if present)
  i. Remove lid from floor box frame
  ii. Remove cap from inspection riser
  iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.
  iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.
B) All Isolator Rows
  i. Remove cover from manhole at upstream end of Isolator Row
  ii. Using a flashlight, inspect down Isolator Row through outlet pipe
    1. Mirrors on poles or cameras may be used to avoid a confined space entry
    2. Follow OSHA regulations for confined space entry if entering manhole
  iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

**StormTech Isolator Row** (not to scale)




**Step 2)** Clean out Isolator Row using the JetVac process
A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable
B) Apply multiple passes of JetVac until backflush water is clean
C) Vacuum manhole sump as required

**Step 3)** Replace all caps, lids and covers, record observations and actions

**Step 4)** Inspect & clean catch basins and manholes upstream of the StormTech system

**Sample Maintenance Log**

| Date | Stadia Rod Readings | | Sediment Depth (1) - (2) | Observations/Actions | Inspector |
|---|---|---|---|---|---|
| | Fixed point to chamber bottom (1) | Fixed point to top of sediment (2) | | | |
| 3/15/01 | 6.3 ft. | none | | New installation. Fixed point is CI frame at grade | djm |
| 9/24/01 | | 6.2 | 0.1 ft. | Some grit felt | sm |
| 6/20/03 | | 5.8 | 0.5 ft. | Mucky feel, debris visible in manhole and in Isolator row, maintenance due | rv |
| 7/7/03 | 6.3 ft. | | 0 | System jetted and vacuumed | djm |

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# CDS Guide
## Operation, Design, Performance and Maintenance

## CDS®

Using patented continuous deflective separation technology, the CDS system screens, separates and traps debris, sediment, and oil and grease from stormwater runoff. The indirect screening capability of the system allows for 100% removal of floatables and neutrally buoyant material without blinding. Flow and screening controls physically separate captured solids, and minimize the re-suspension and release of previously trapped pollutants. Inline units can treat up to 6 cfs, and internally bypass flows in excess of 50 cfs (1416 L/s). Available precast or cast-in-place, offline units can treat flows from 1 to 300 cfs (28.3 to 8495 L/s). The pollutant removal capacity of the CDS system has been proven in lab and field testing.

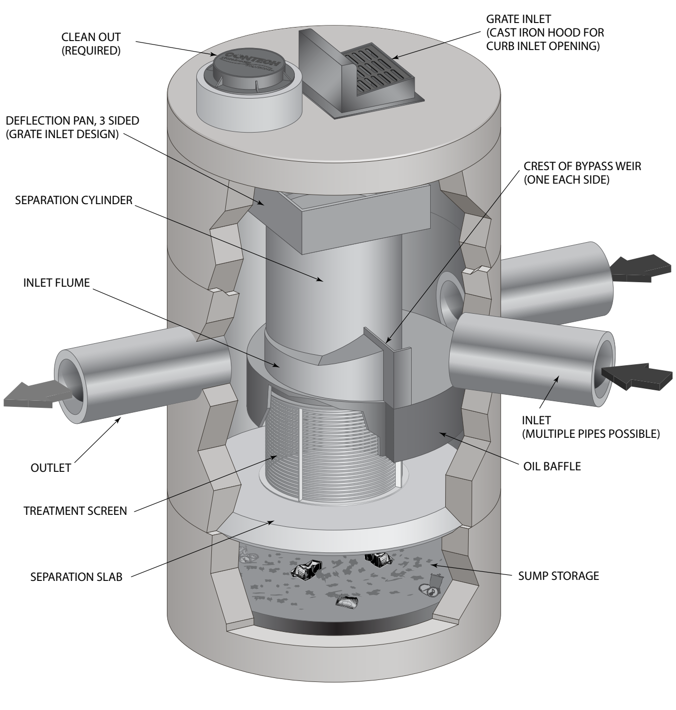
## Operation Overview

Stormwater enters the diversion chamber where the diversion weir guides the flow into the unit's separation chamber and pollutants are removed from the flow. All flows up to the system's treatment design capacity enter the separation chamber and are treated.

Swirl concentration and screen deflection force floatables and solids to the center of the separation chamber where 100% of floatables and neutrally buoyant debris larger than the screen apertures are trapped.

Stormwater then moves through the separation screen, under the oil baffle and exits the system. The separation screen remains clog free due to continuous deflection.

During the flow events exceeding the treatment design capacity, the diversion weir bypasses excessive flows around the separation chamber, so captured pollutants are retained in the separation cylinder.




## Design Basics

There are three primary methods of sizing a CDS system. The Water Quality Flow Rate Method determines which model size provides the desired removal efficiency at a given flow rate for a defined particle size. The Rational Rainfall Method™ or the and Probabilistic Method is used when a specific removal efficiency of the net annual sediment load is required.

Typically in the Unites States, CDS systems are designed to achieve an 80% annual solids load reduction based on lab generated performance curves for a gradation with an average particle size (d50) of 125 microns (μm). For some regulatory environments, CDS systems can also be designed to achieve an 80% annual solids load reduction based on an average particle size (d50) of 75 microns (μm) or 50 microns (μm).

### Water Quality Flow Rate Method

In some cases, regulations require that a specific treatment rate, often referred to as the water quality design flow (WQQ), be treated. This WQQ represents the peak flow rate from either an event with a specific recurrence interval, e.g. the six-month storm, or a water quality depth, e.g. 1/2-inch (13 mm) of rainfall.

The CDS is designed to treat all flows up to the WQQ. At influent rates higher than the WQQ, the diversion weir will direct most flow exceeding the WQQ around the separation chamber. This allows removal efficiency to remain relatively constant in the separation chamber and eliminates the risk of washout during bypass flows regardless of influent flow rates.

Treatment flow rates are defined as the rate at which the CDS will remove a specific gradation of sediment at a specific removal efficiency. Therefore the treatment flow rate is variable, based on the gradation and removal efficiency specified by the design engineer.

### Rational Rainfall Method™

Differences in local climate, topography and scale make every site hydraulically unique. It is important to take these factors into consideration when estimating the long-term performance of any stormwater treatment system. The Rational Rainfall Method combines site-specific information with laboratory generated performance data, and local historical precipitation records to estimate removal efficiencies as accurately as possible.

Short duration rain gauge records from across the United States and Canada were analyzed to determine the percent of the total annual rainfall that fell at a range of intensities. US stations' depths were totaled every 15 minutes, or hourly, and recorded in 0.01-inch increments. Depths were recorded hourly with 1-mm resolution at Canadian stations. One trend was consistent at all sites; the vast majority of precipitation fell at low intensities and high intensity storms contributed relatively little to the total annual depth.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Rainfall Method. Since most sites are relatively small and highly impervious, the Rational Rainfall Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS system are determined. Performance efficiency curve determined from full scale laboratory tests on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

### Probabilistic Rational Method

The Probabilistic Rational Method is a sizing program Contech developed to estimate a net annual sediment load reduction for a particular CDS model based on site size, site runoff coefficient, regional rainfall intensity distribution, and anticipated pollutant characteristics.

The Probabilistic Method is an extension of the Rational Method used to estimate peak discharge rates generated by storm events of varying statistical return frequencies (e.g. 2-year storm event). Under the Rational Method, an adjustment factor is used to adjust the runoff coefficient estimated for the 10-year event, correlating a known hydrologic parameter with the target storm event. The rainfall intensities vary depending on the return frequency of the storm event under consideration. In general, these two frequency dependent parameters (rainfall intensity and runoff coefficient) increase as the return frequency increases while the drainage area remains constant.

These intensities, along with the total drainage area and runoff coefficient for each specific site, are translated into flow rates using the Rational Method. Since most sites are relatively small and highly impervious, the Rational Method is appropriate. Based on the runoff flow rates calculated for each intensity, operating rates within a proposed CDS are determined. Performance efficiency curve on defined sediment PSDs is applied to calculate solids removal efficiency. The relative removal efficiency at each operating rate is added to produce a net annual pollutant removal efficiency estimate.

### Treatment Flow Rate

The inlet throat area is sized to ensure that the WQQ passes through the separation chamber at a water surface elevation equal to the crest of the diversion weir. The diversion weir bypasses excessive flows around the separation chamber, thus preventing re-suspension or re-entrainment of previously captured particles.

### Hydraulic Capacity

The hydraulic capacity of a CDS system is determined by the length and height of the diversion weir and by the maximum allowable head in the system. Typical configurations allow hydraulic capacities of up to ten times the treatment flow rate. The crest of the diversion weir may be lowered and the inlet throat may be widened to increase the capacity of the system at a given water surface elevation. The unit is designed to meet project specific hydraulic requirements.

## Performance

### Full-Scale Laboratory Test Results

A full-scale CDS system (Model CDS2020-5B) was tested at the facility of University of Florida, Gainesville, FL. This CDS unit was evaluated under controlled laboratory conditions of influent flow rate and addition of sediment.

Two different gradations of silica sand material (UF Sediment & OK-110) were used in the CDS performance evaluation. The particle size distributions (PSDs) of the test materials were analyzed using standard method "Gradation ASTM D-422 "Standard Test Method for Particle-Size Analysis of Soils" by a certified laboratory.

UF Sediment is a mixture of three different products produced by the U.S. Silica Company: "Sil-Co-Sil 106", "#1 DRY" and "20/40 Oil Frac". Particle size distribution analysis shows that the UF Sediment has a very fine gradation (d50 = 20 to 30 $\mu$m) covering a wide size range (Coefficient of Uniformity, C averaged at 10.6). In comparison with the hypothetical TSS gradation specified in the NJDEP (New Jersey Department of Environmental Protection) and NJCAT (New Jersey Corporation for Advanced Technology) protocol for lab testing, the UF Sediment covers a similar range of particle size but with a finer d50 (d50 for NJDEP is approximately 50 $\mu$m) (NJDEP, 2003).

The OK-110 silica sand is a commercial product of U.S. Silica Sand. The particle size distribution analysis of this material, also included in Figure 1, shows that 99.9% of the OK-110 sand is finer than 250 microns, with a mean particle size (d50) of 106 microns. The PSDs for the test material are shown in Figure 1.

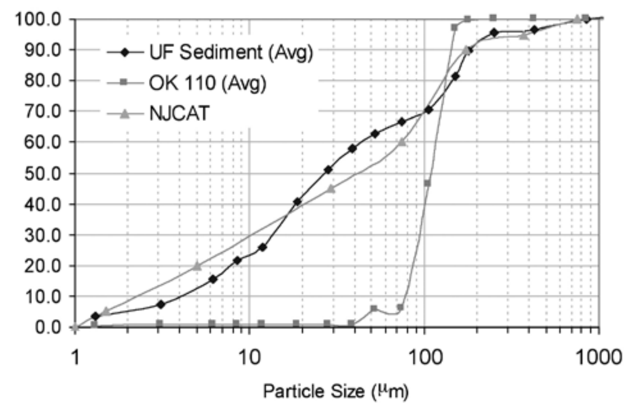



Figure 1. Particle size distributions

Tests were conducted to quantify the performance of a specific CDS unit (1.1 cfs (31.3-L/s) design capacity) at various flow rates, ranging from 1% up to 125% of the treatment design capacity of the unit, using the 2400 micron screen. All tests were conducted with controlled influent concentrations of approximately 200 mg/L. Effluent samples were taken at equal time intervals across the entire duration of each test run. These samples were then processed with a Dekaport Cone sample splitter to obtain representative sub-samples for Suspended Sediment Concentration (SSC) testing using ASTM D3977-97 "Standard Test Methods for Determining Sediment Concentration in Water Samples", and particle size distribution analysis.

## Results and Modeling

Based on the data from the University of Florida, a performance model was developed for the CDS system. A regression analysis was used to develop a fitting curve representative of the scattered data points at various design flow rates. This model, which demonstrated good agreement with the laboratory data, can then be used to predict CDS system performance with respect to SSC removal for any particle size gradation, assuming the particles are inorganic sandy-silt. Figure 2 shows CDS predictive performance for two typical particle size gradations (NJCAT gradation and OK-110 sand) as a function of operating rate.

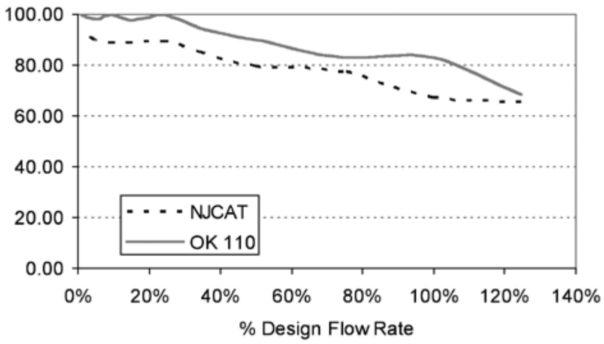



Figure 2. CDS stormwater treatment predictive performance for various particle gradations as a function of operating rate.

Many regulatory jurisdictions set a performance standard for hydrodynamic devices by stating that the devices shall be capable of achieving an 80% removal efficiency for particles having a mean particle size (d50) of 125 microns (e.g. Washington State Department of Ecology — WASDOE - 2008). The model can be used to calculate the expected performance of such a PSD (shown in Figure 3). The model indicates (Figure 4) that the CDS system with 2400 micron screen achieves approximately 80% removal at the design (100%) flow rate, for this particle size distribution (d50 = 125 $\mu$m).

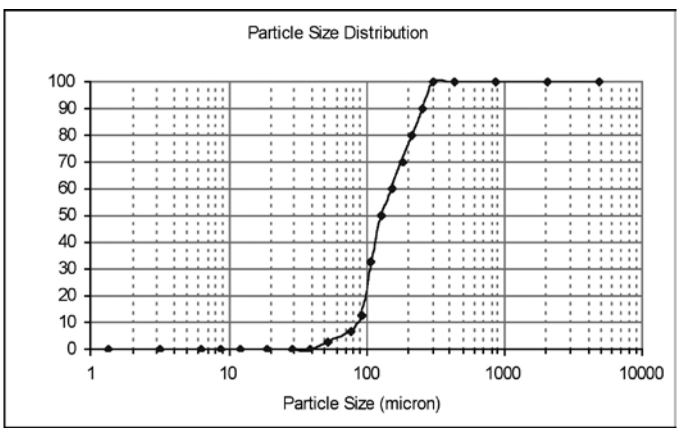



Figure 3. WASDOE PSD

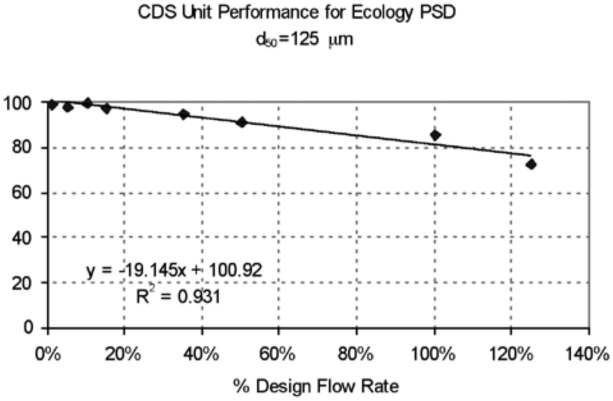



Figure 4. Modeled performance for WASDOE PSD.

## Maintenance

The CDS system should be inspected at regular intervals and maintained when necessary to ensure optimum performance. The rate at which the system collects pollutants will depend more heavily on site activities than the size of the unit. For example, unstable soils or heavy winter sanding will cause the grit chamber to fill more quickly but regular sweeping of paved surfaces will slow accumulation.

## Inspection

Inspection is the key to effective maintenance and is easily performed. Pollutant transport and deposition may vary from year to year and regular inspections will help ensure that the system is cleaned out at the appropriate time. At a minimum, inspections should be performed twice per year (e.g. spring and fall) however more frequent inspections may be necessary in climates where winter sanding operations may lead to rapid accumulations, or in equipment washdown areas. Installations should also be inspected more frequently where excessive amounts of trash are expected.

The visual inspection should ascertain that the system components are in working order and that there are no blockages or obstructions in the inlet and separation screen. The inspection should also quantify the accumulation of hydrocarbons, trash, and sediment in the system. Measuring pollutant accumulation can be done with a calibrated dipstick, tape measure or other measuring instrument. If absorbent material is used for enhanced removal of hydrocarbons, the level of discoloration of the sorbent material should also be identified

during inspection. It is useful and often required as part of an operating permit to keep a record of each inspection. A simple form for doing so is provided.

Access to the CDS unit is typically achieved through two manhole access covers. One opening allows for inspection and cleanout of the separation chamber (cylinder and screen) and isolated sump. The other allows for inspection and cleanout of sediment captured and retained outside the screen. For deep units, a single manhole access point would allows both sump cleanout and access outside the screen.

The CDS system should be cleaned when the level of sediment has reached 75% of capacity in the isolated sump or when an appreciable level of hydrocarbons and trash has accumulated. If absorbent material is used, it should be replaced when significant discoloration has occurred. Performance will not be impacted until 100% of the sump capacity is exceeded however it is recommended that the system be cleaned prior to that for easier removal of sediment. The level of sediment is easily determined by measuring from finished grade down to the top of the sediment pile. To avoid underestimating the level of sediment in the chamber, the measuring device must be lowered to the top of the sediment pile carefully. Particles at the top of the pile typically offer less resistance to the end of the rod than consolidated particles toward the bottom of the pile. Once this measurement is recorded, it should be compared to the as-built drawing for the unit to determine weather the height of the sediment pile off the bottom of the sump floor exceeds 75% of the total height of isolated sump.

## Cleaning

Cleaning of a CDS systems should be done during dry weather conditions when no flow is entering the system. The use of a vacuum truck is generally the most effective and convenient method of removing pollutants from the system. Simply remove the manhole covers and insert the vacuum hose into the sump. The system should be completely drained down and the sump fully evacuated of sediment. The area outside the screen should also be cleaned out if pollutant build-up exists in this area.

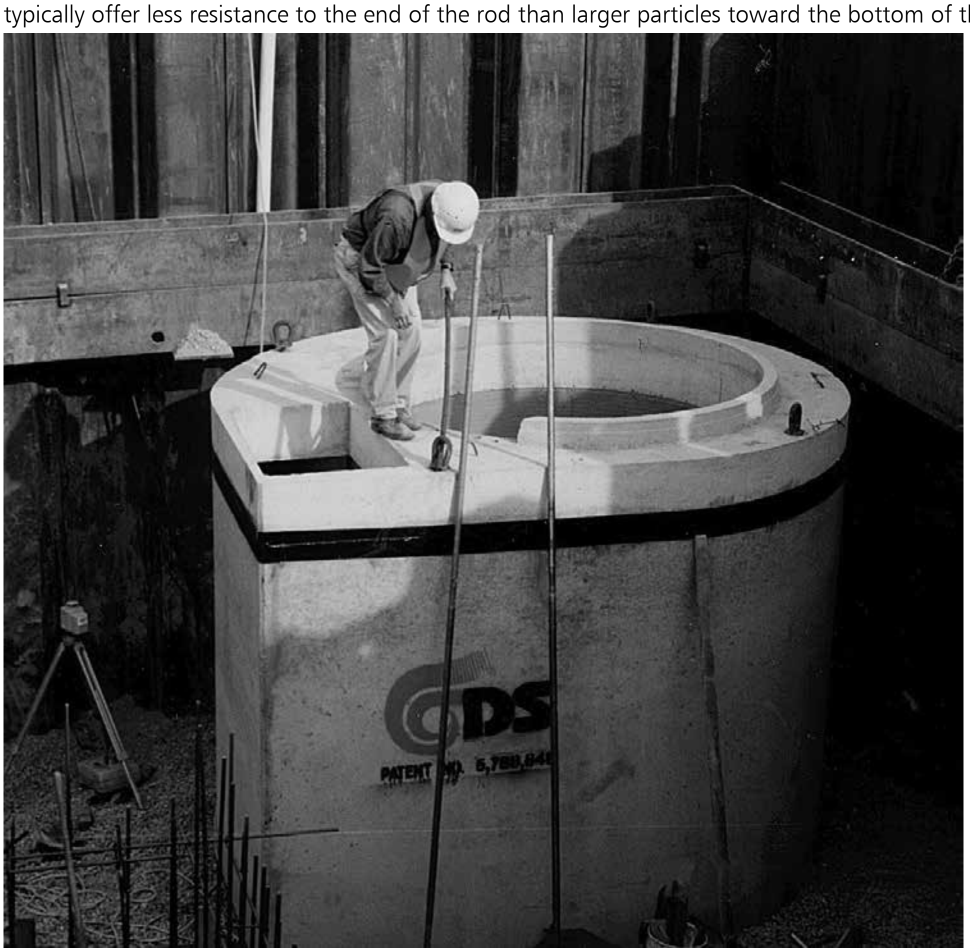
In installations where the risk of petroleum spills is small, liquid contaminants may not accumulate as quickly as sediment. However, the system should be cleaned out immediately in the event of an oil or gasoline spill. Motor oil and other hydrocarbons that accumulate on a more routine basis should be removed when an appreciable layer has been captured. To remove these pollutants, it may be preferable to use absorbent pads since they are usually less expensive to dispose than the oil/water emulsion that may be created by vacuuming the oily layer. Trash and debris can be netted out to separate it from the other pollutants. The screen should be cleaned to ensure it is free of trash and debris.

Manhole covers should be securely seated following cleaning activities to prevent leakage of runoff into the system from above and also to ensure that proper safety precautions have been followed. Confined space entry procedures need to be followed if physical access is required. Disposal of all material removed from the CDS system should be done in accordance with local regulations. In many jurisdictions, disposal of the sediments may be handled in the same manner as the disposal of sediments removed from catch basins or deep sump manholes. Check your local regulations for specific requirements on disposal.

| CDS Model | Diameter | | Distance from Water Surface to Top of Sediment Pile | | Sediment Storage Capacity | |
|---|---|---|---|---|---|---|
| | ft | m | ft | m | y³ | m³ |
| CDS1515 | 3 | 0.9 | 3.0 | 0.9 | 0.5 | 0.4 |
| CDS2015 | 4 | 1.2 | 3.0 | 0.9 | 0.9 | 0.7 |
| CDS2015 | 5 | 1.5 | 3.0 | 0.9 | 1.3 | 1.0 |
| CDS2020 | 5 | 1.5 | 3.5 | 1.1 | 1.3 | 1.0 |
| CDS2025 | 5 | 1.5 | 4.0 | 1.2 | 1.3 | 1.0 |
| CDS3020 | 6 | 1.8 | 4.0 | 1.2 | 2.1 | 1.6 |
| CDS3025 | 6 | 1.8 | 4.0 | 1.2 | 2.1 | 1.6 |
| CDS3030 | 6 | 1.8 | 4.6 | 1.4 | 2.1 | 1.6 |
| CDS3035 | 6 | 1.8 | 5.0 | 1.5 | 2.1 | 1.6 |
| CDS4030 | 8 | 2.4 | 4.6 | 1.4 | 5.6 | 4.3 |
| CDS4040 | 8 | 2.4 | 5.7 | 1.7 | 5.6 | 4.3 |
| CDS4045 | 8 | 2.4 | 6.2 | 1.9 | 5.6 | 4.3 |
| CDS5640 | 10 | 3.0 | 6.3 | 1.9 | 8.7 | 6.7 |
| CDS5653 | 10 | 3.0 | 7.7 | 2.3 | 8.7 | 6.7 |
| CDS5668 | 10 | 3.0 | 9.3 | 2.8 | 8.7 | 6.7 |
| CDS5678 | 10 | 3.0 | 10.3 | 3.1 | 8.7 | 6.7 |

Table 1: CDS Maintenance Indicators and Sediment Storage Capacities

Note: To avoid underestimating the volume of sediment in the chamber, carefully lower the measuring device to the top of the sediment pile. Finer silty particles at the top of the pile may be more difficult to feel with a measuring stick. These finer particles typically offer less resistance to the end of the rod than larger particles toward the bottom of the pile.



# CDS Inspection & Maintenance Log

CDS Model: ______________________ Location: ______________________

| Date | Water depth to sediment[1] | Floatable Layer Thickness[2] | Describe Maintenance Performed | Maintenance Personnel | Comments |
|---|---|---|---|---|---|
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1. The water depth to sediment is determined by taking two measurements with a stadia rod: one measurement from the manhole opening to the top of the sediment pile and the other from the manhole opening to the water surface. If the difference between these measurements is less than the values listed in table 1 the system should be cleaned out. **Note: to avoid underestimating the volume of sediment in the chamber, the measuring device must be carefully lowered to the top of the sediment pile**.

2. For optimum performance, the system should be cleaned out when the floating hydrocarbon layer accumulates to an appreciable thickness. In the event of an oil spill, the system should be cleaned immediately.

SUPPORT

- Drawings and specifications are available at www.ContechES.com.
- Site-specific design support is available from our engineers.

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The product(s) described may be protected by one or more of the following US patents: 5,322,629; 5,624,576; 5,707,527; 5,759,415; 5,788,848; 5,985,157; 6,027,639; 6,350,374; 6,406,218; 6,641,720; 6,511,595; 6,649,048; 6,991,114; 6,998,038; 7,186,058; 7,296,692; 7,297,266; related foreign patents or other patents pending.

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# Appendix G:
# Figures

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Phone: (518) 812-0513


***Route 9D - Gas Land Petroleum***

**Soils**

Route 9D, Town of Wappinger - Dutchess County NY

| | |
|---|---|
| Drawn: | SPL |
| Date: | 01/27/2021 |
| Scale: | 1 in = 166.7 feet |
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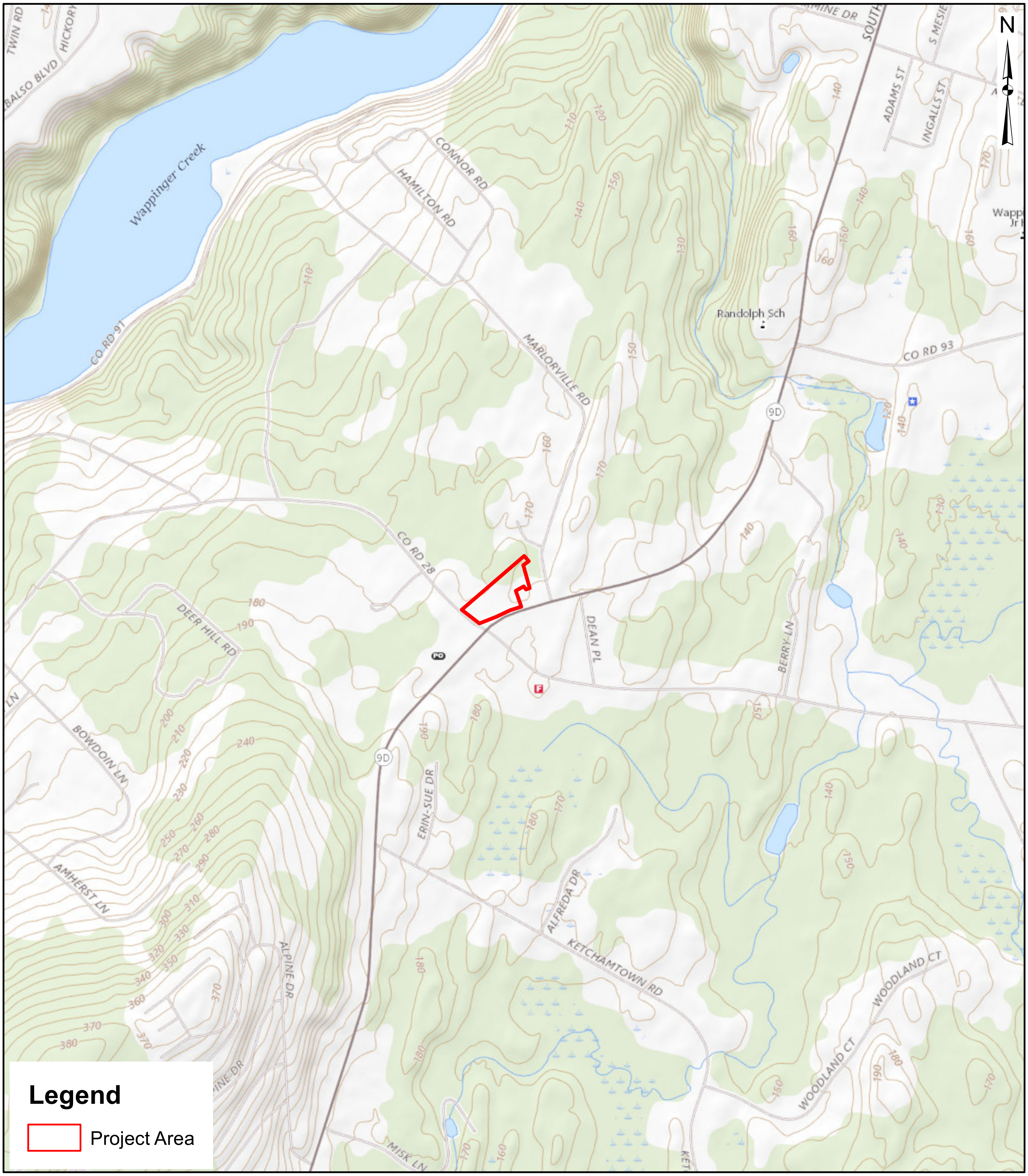
| Figure: | 2 |

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***Route 9D - Gas Land Petroleum***

**USGS Location Map**

Rpute 9D, Town of Wappinger - Dutchess County, NY

| | |
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| Drawn: | SPL |
| Date: | 01/27/2021 |
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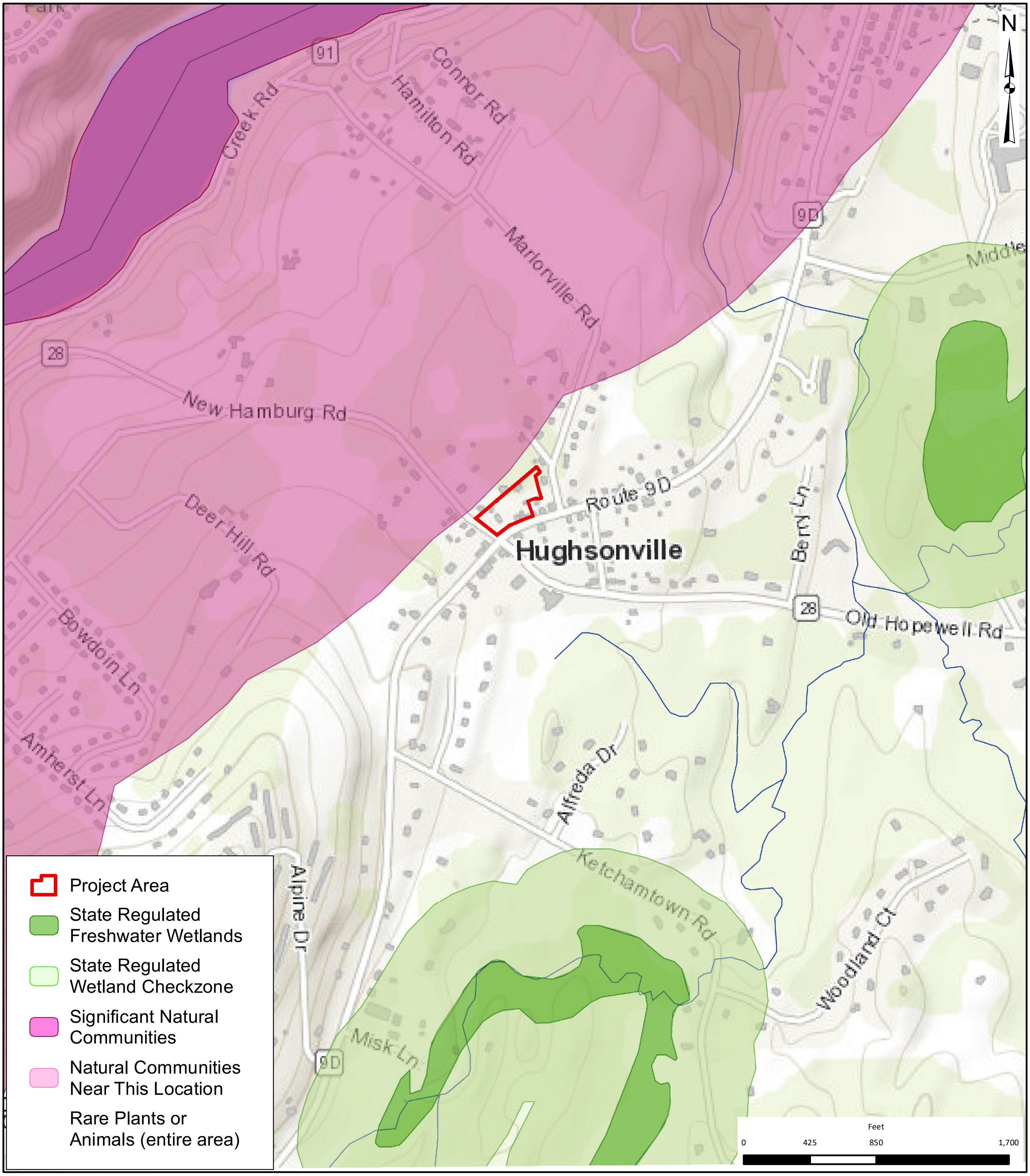
| Figure: | 1 |

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***Route 9D - Gas Land Petroleum***

**NYSDEC Environmental Resource Map**

Route 9D, Town of Wappinger - Dutchess County NY

| | |
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| Date: | 12/19/2019 |
| Scale: | 1 in = 850 feet |
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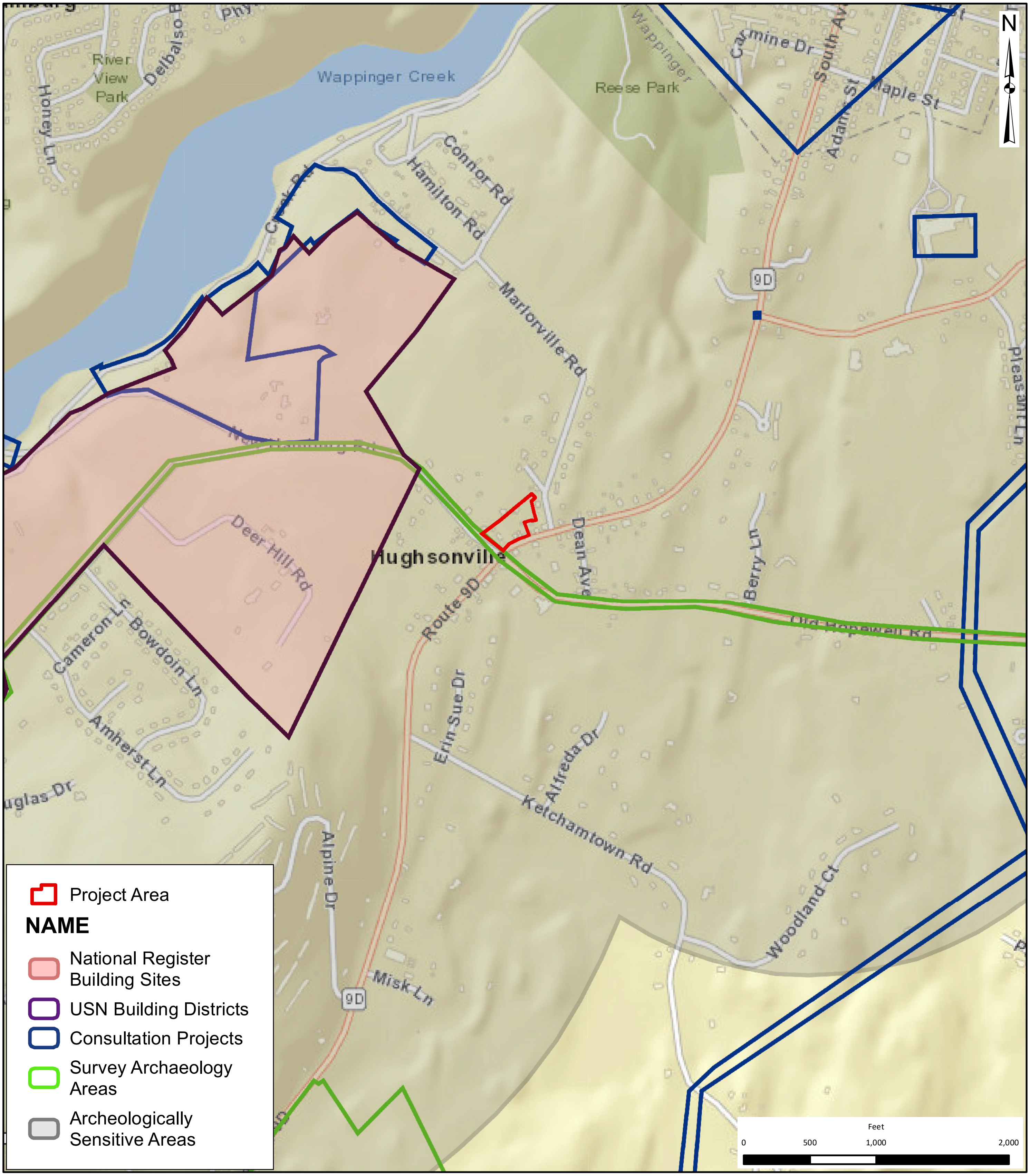
| Figure: | 3 |

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***Route 9D - Gas Land Petroleum***

**NYSOPRHP Cultural Resource Information System (CRIS) Map**

Route 9D, Town of Wappinger - Dutchess County NY

| | |
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| Drawn: | RL-B |
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| Figure: | 4 |


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| rev. | date | description |
|---|---|---|
| 1 | 02/16/21 | GENERAL REVISIONS. REVISED LAYOUT WITH AN ADDITIONAL TAXLOT ADDED |

GASLAND PETROLEUM, INC- NYS RTE 9D/CR 28 -TOWN OF WAPPINGER

# PRE-DEVELOPMENT WATERSHED MAP

TOWN OF WAPPINGER, DUTCHESS COUNTY, NEW YORK

| designed | checked |
|---|---|
| SPL | CPL |
| date 01/09/20 | scale 1"=20' |
| project no. 81941.00 | |
| sheet no. Fig 5 | |


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| rev. | date | description |
|---|---|---|
| 2 | 02/16/21 | GENERAL REVISIONS. REVISED LAYOUT WITH AN ADDITIONAL TAXLOT ADDED |
| 1 | 10/13/20 | REVISED PER PLANNING BOARD COMMENTS |

GASLAND PETROLEUM, INC- NYS RTE 9D/CR 28 -TOWN OF WAPPINGER

# POST-DEVELOPMENT WATERSHED MAP

TOWN OF WAPPINGER, DUTCHESS COUNTY, NEW YORK

| designed | checked |
|---|---|
| SPL | CPL |
| date 01/09/20 | scale 1"=20' |
| project no. 81941.00 | |
| sheet no. Fig 6 | |

Drawing Name: Z:\projects\81900-81999\81941.00 Gas Land Town of Wappinger Route 9D\DWG\FIG-5&6_81941-00_PRE_POST_WATERSHED_MAP.dwg
Xref's Attached: XSTORM_81941-00; XTB_81941-00; XGRADING_81941-00; XUTIL_81941-00; XLAYOUT_81941-00; XBASE-ENG_81941-00
Date Printed: Feb 15, 2021, 5:41pm

# Appendix H:
# Chazen Certifying Professionals Letter

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THE Chazen COMPANIES®
Proud to be Employee Owned

Civil Engineers
Land Surveyors
Planners
Environmental & Safety Professionals
Landscape Architects
Transportation Planners & Engineers

HUDSON VALLEY OFFICE
21 Fox Street
Poughkeepsie, NY 12601
P: 845.454.3980 or 888.539.9073
www.chazencompanies.com

January 29, 2020

To Whom it May Concern:

In accordance with the NYSDEC SPDES General Permit GP-0-20-001, part VII.H.2, the New York State licensed Professional Engineers employed by the Chazen Companies and listed on the attachment to this letter are duly authorized to sign and seal Stormwater Pollution Prevention Plan (SWPPPs), NOIs, and NOTs prepared under their direct supervision.

Sincerely,

Richard M. Loewenstein, Jr., P.E.
Chief Executive Officer

THE Chazen COMPANIES®
Proud to be Employee Owned

Civil Engineers
Land Surveyors
Planners
Environmental & Safety Professionals
Landscape Architects
Transportation Planners & Engineers

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Poughkeepsie, NY 12601
P: 845.454.3980 or 888.539.9073
www.chazencompanies.com

**Chazen Professional Engineers duly authorized to sign and seal SWPPPs, NOIs, and NOTs**

| **Name:** | **Position:** | **Signature:** | **Date:** |
|---|---|---|---|
| Joseph Lanaro, P.E. | Vice President of Engineering | | 1/30/2020 |
| James Connors, P.E. | Senior Director | | 1/30/2020 |
| Christopher Lapine, P.E. | Director | | 1/31/2020 |
| Roger Keating, P.E. | Director | | 1/30/2020 |
| Peter Romano, P.E. | Director | | 1/31/2020 |
| Walter Kubow, P.E. | Manager | | 1/29/2020 |
| Eric Johnson, P.E. | Director | | 1/30/2020 |
| George Cronk, P.E. | Director | | 1/31/2020 |
| Sean Doty, P.E. | Director | | 1/31/2020 |
| Michael Flanagan, P.E. | Sr. Project Engineer/Project Manager | | 1/31/2020 |
| Kyle Ahearn, P.E. | Project Manager | | 1/31/2020 |

# Appendix I:
# Pre-Development Stormwater Modeling

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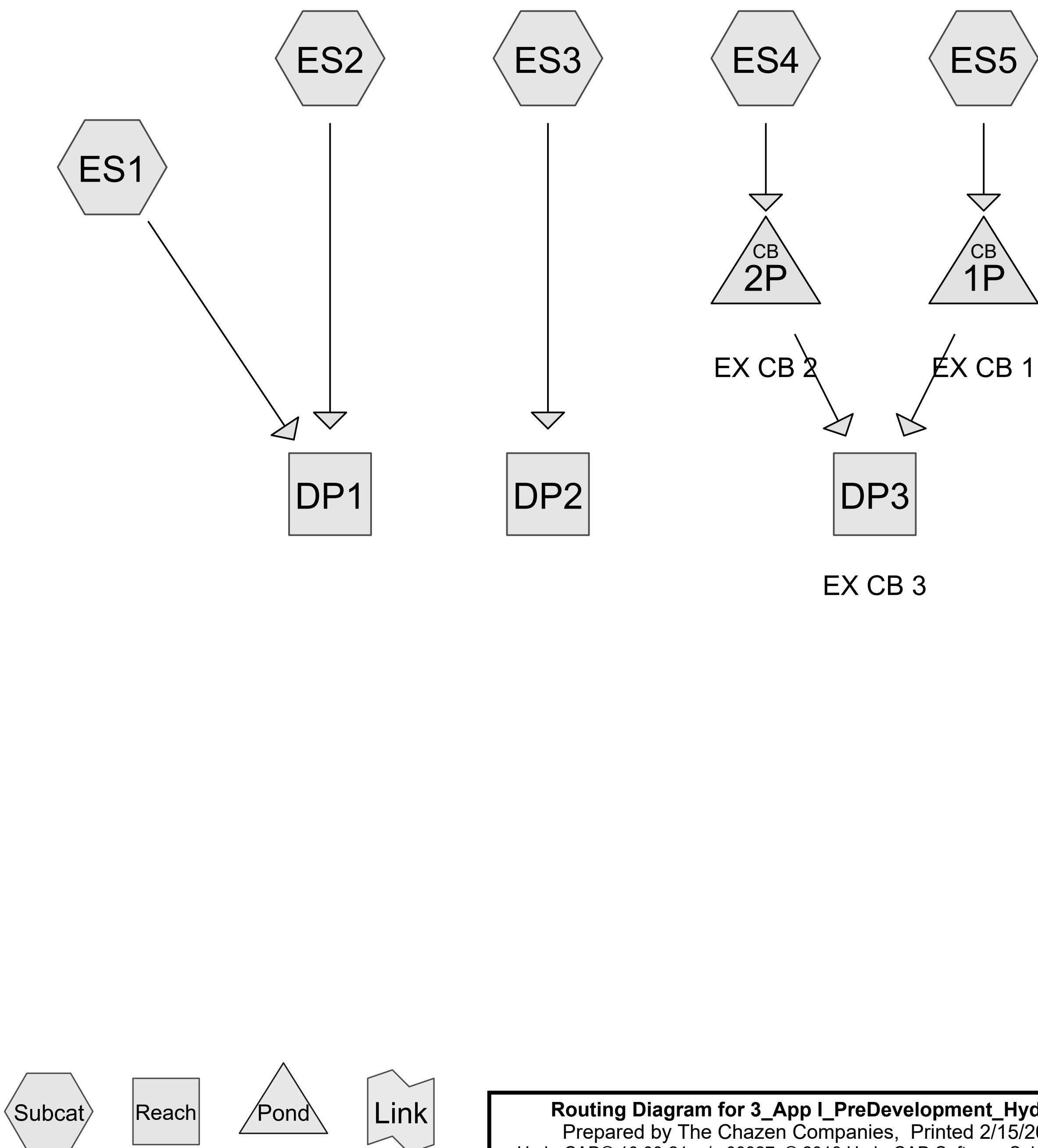



**Routing Diagram for 3_App I_PreDevelopment_Hydrocad**
Prepared by The Chazen Companies, Printed 2/15/2021
HydroCAD® 10.00-21 s/n 00927 © 2018 HydroCAD Software Solutions LLC

## Summary for Subcatchment ES1:

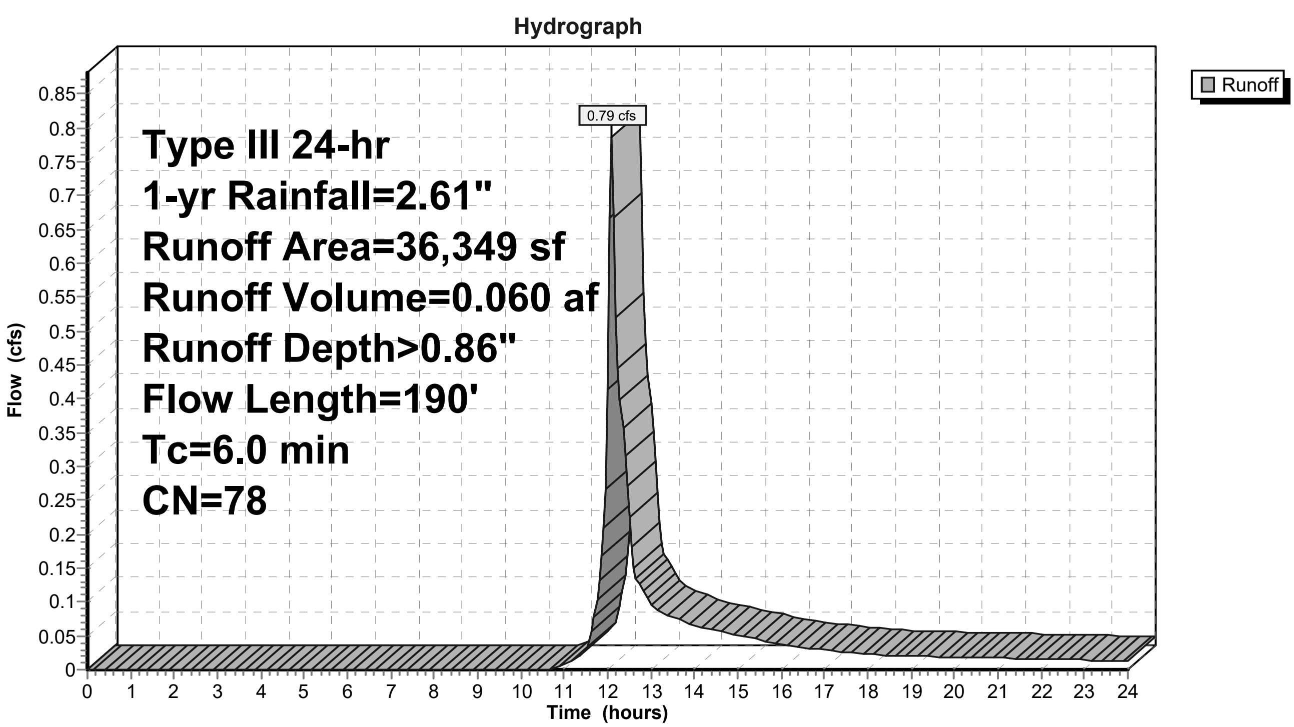
Runoff = 0.79 cfs @ 12.10 hrs, Volume= 0.060 af, Depth> 0.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 11,440 | 98 | Paved parking, HSG B |
| 24,909 | 69 | 50-75% Grass cover, Fair, HSG B |
| 36,349 | 78 | Weighted Average |
| 24,909 | | 68.53% Pervious Area |
| 11,440 | | 31.47% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.6 | 48 | 0.0312 | 1.41 | | **Sheet Flow, 48 ft paved** Smooth surfaces n= 0.011 P2= 3.15" |
| 3.0 | 142 | 0.0127 | 0.79 | | **Shallow Concentrated Flow, 142 ft grass** Short Grass Pasture Kv= 7.0 fps |
| 3.6 | 190 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES1:



## Summary for Subcatchment ES2:

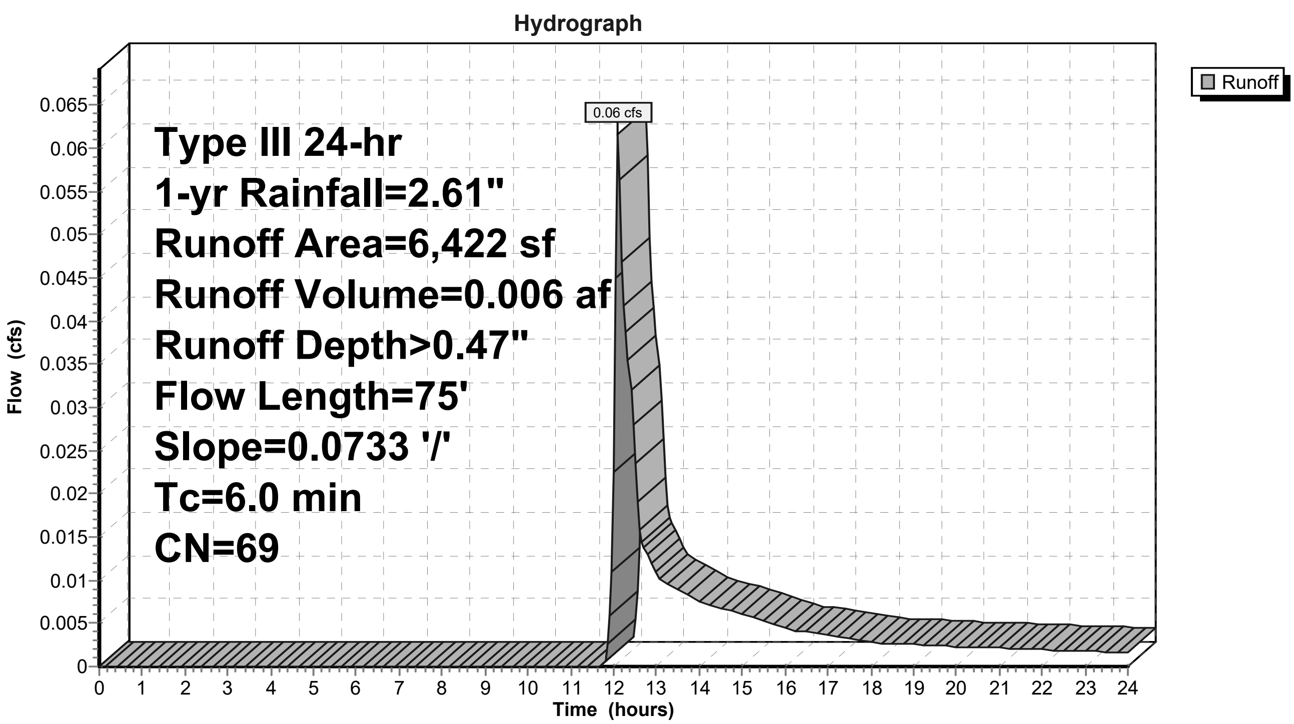
Runoff = 0.06 cfs @ 12.11 hrs, Volume= 0.006 af, Depth> 0.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 12 | 98 | Paved parking, HSG B |
| 6,410 | 69 | 50-75% Grass cover, Fair, HSG B |
| 6,422 | 69 | Weighted Average |
| 6,410 | | 99.81% Pervious Area |
| 12 | | 0.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.7 | 75 | 0.0733 | 0.27 | | **Sheet Flow, 75 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 4.7 | 75 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES2:



## Summary for Subcatchment ES3:

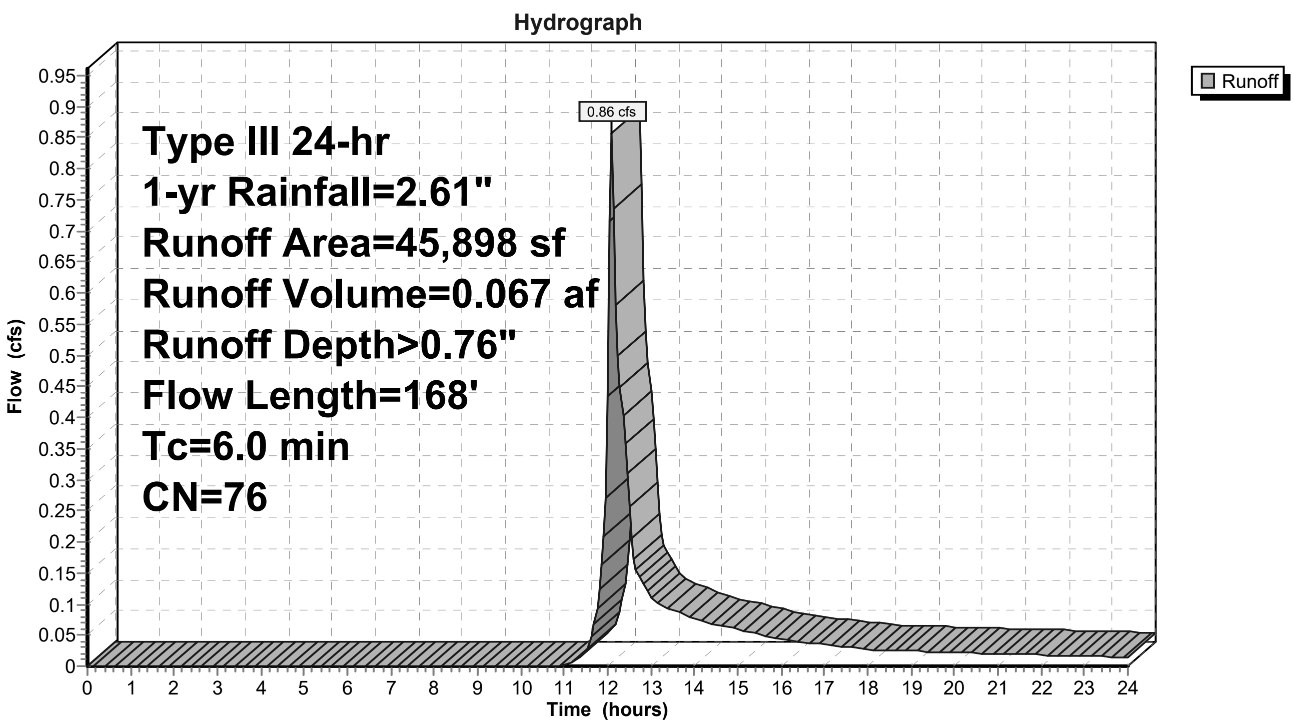
Runoff = 0.86 cfs @ 12.10 hrs, Volume= 0.067 af, Depth> 0.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 11,803 | 98 | Paved parking, HSG B |
| 34,095 | 69 | 50-75% Grass cover, Fair, HSG B |
| 45,898 | 76 | Weighted Average |
| 34,095 | | 74.28% Pervious Area |
| 11,803 | | 25.72% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.3 | 36 | 0.0972 | 0.26 | | **Sheet Flow, 36 ft grass** Grass: Short n= 0.150 P2= 3.15" |
| 0.2 | 54 | 0.0555 | 4.78 | | **Shallow Concentrated Flow, 54 ft paved** Paved Kv= 20.3 fps |
| 1.4 | 78 | 0.0167 | 0.90 | | **Shallow Concentrated Flow, 78 ft grass** Short Grass Pasture Kv= 7.0 fps |
| 3.9 | 168 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES3:



## Summary for Subcatchment ES4:

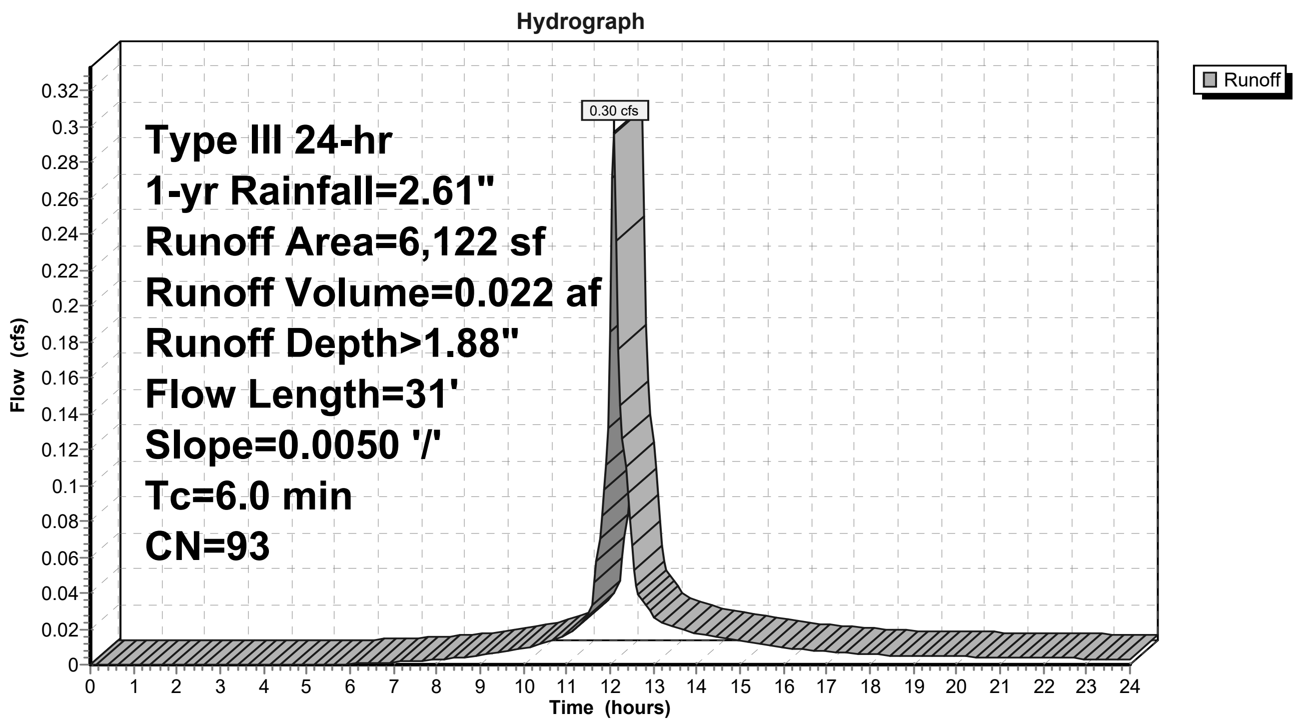
Runoff = 0.30 cfs @ 12.09 hrs, Volume= 0.022 af, Depth> 1.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 5,077 | 98 | Paved parking, HSG B |
| 1,045 | 69 | 50-75% Grass cover, Fair, HSG B |
| 6,122 | 93 | Weighted Average |
| 1,045 | | 17.07% Pervious Area |
| 5,077 | | 82.93% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 5.7 | 25 | 0.0050 | 0.07 | | **Sheet Flow, 25 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 0.1 | 6 | 0.0050 | 1.44 | | **Shallow Concentrated Flow, 6 ft paved**<br>Paved Kv= 20.3 fps |
| 5.8 | 31 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES4:



## Summary for Subcatchment ES5:

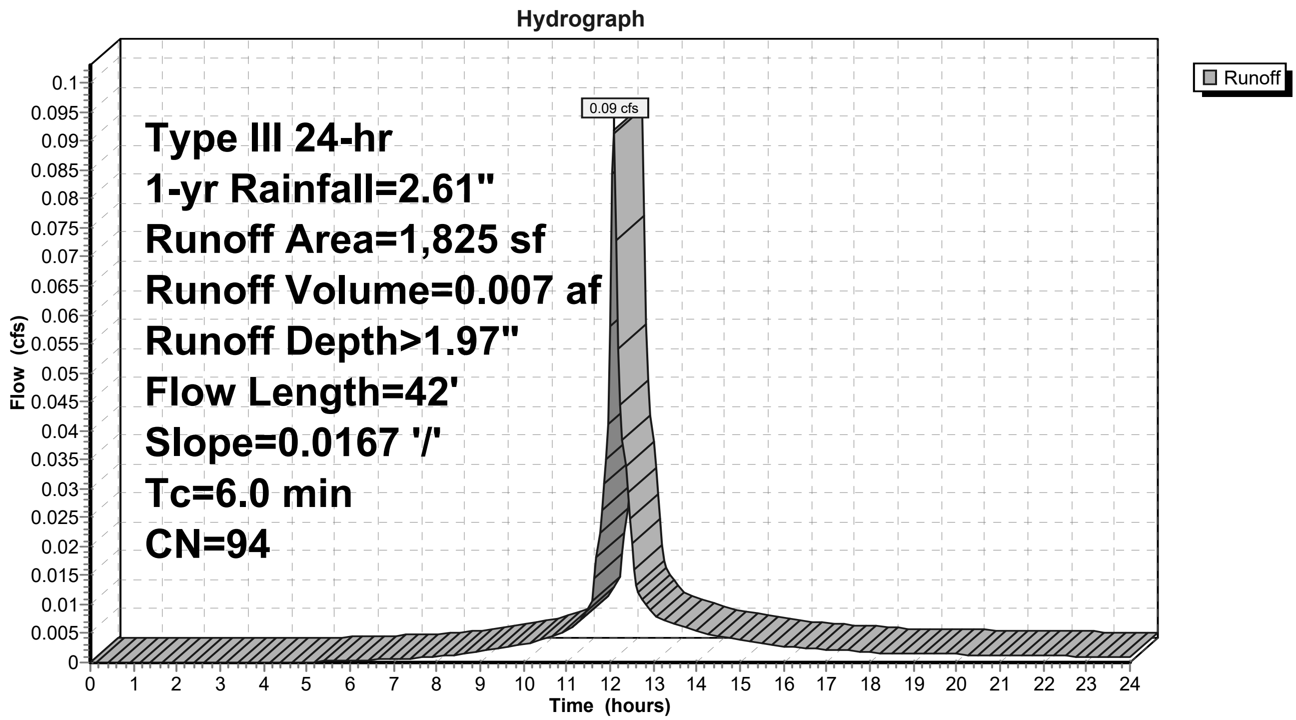
Runoff = 0.09 cfs @ 12.09 hrs, Volume= 0.007 af, Depth> 1.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 1,601 | 98 | Paved parking, HSG B |
| 224 | 69 | 50-75% Grass cover, Fair, HSG B |
| 1,825 | 94 | Weighted Average |
| 224 | | 12.27% Pervious Area |
| 1,601 | | 87.73% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.7 | 42 | 0.0167 | 1.07 | | **Sheet Flow, 42 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 0.7 | 42 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES5:

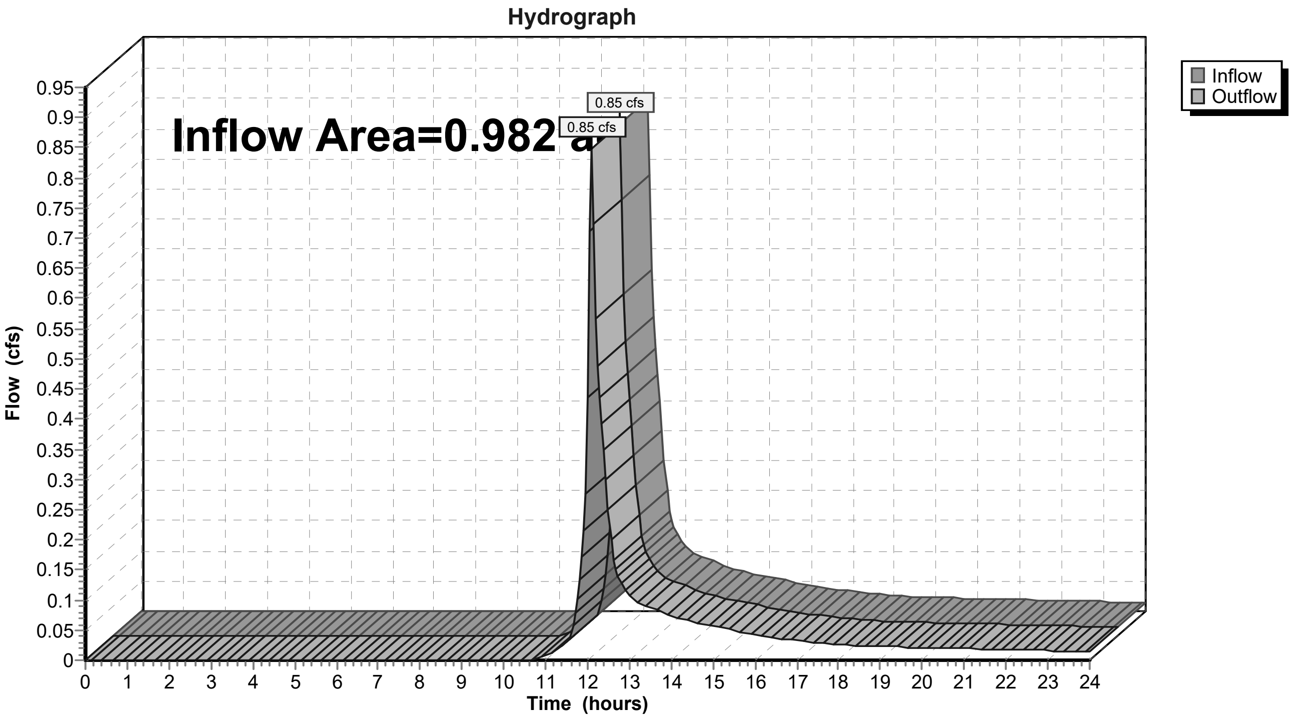


## Summary for Reach DP1:

Inflow Area = 0.982 ac, 26.78% Impervious, Inflow Depth > 0.80" for 1-yr event
Inflow = 0.85 cfs @ 12.10 hrs, Volume= 0.066 af
Outflow = 0.85 cfs @ 12.10 hrs, Volume= 0.066 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Reach DP1:

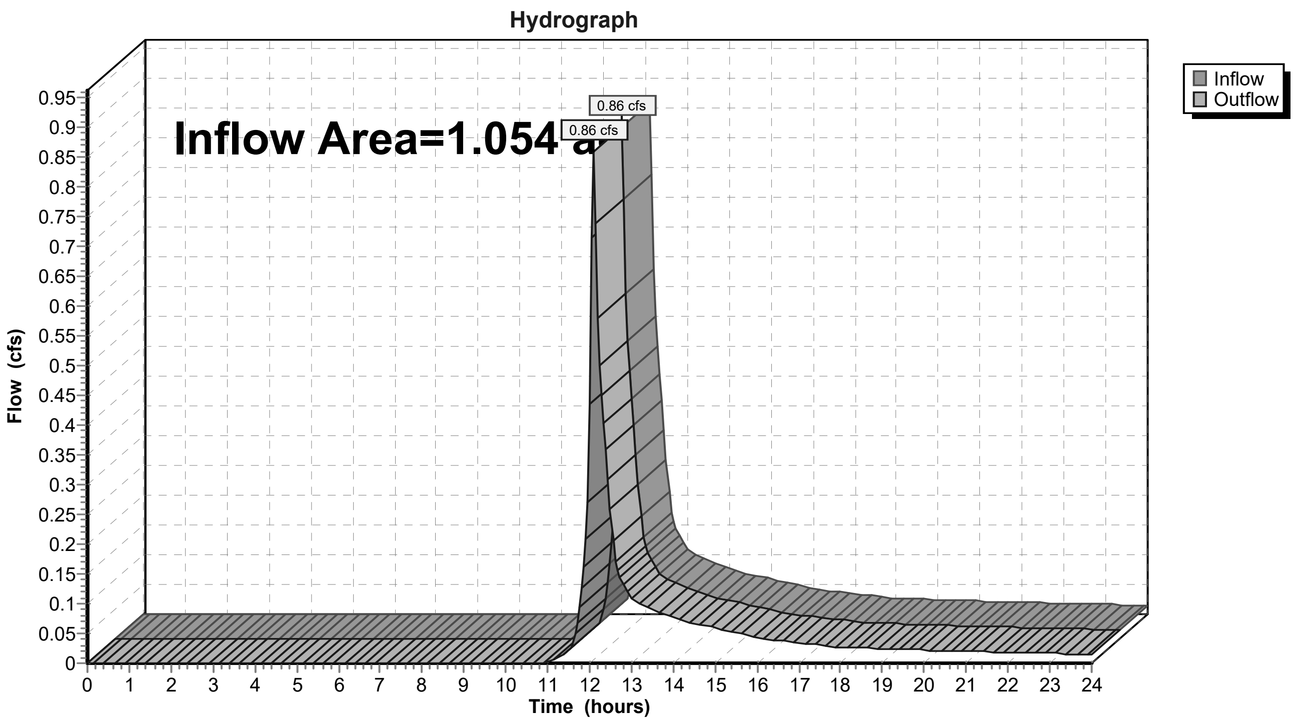


## Summary for Reach DP2:

Inflow Area = 1.054 ac, 25.72% Impervious, Inflow Depth > 0.76" for 1-yr event
Inflow = 0.86 cfs @ 12.10 hrs, Volume= 0.067 af
Outflow = 0.86 cfs @ 12.10 hrs, Volume= 0.067 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Reach DP2:

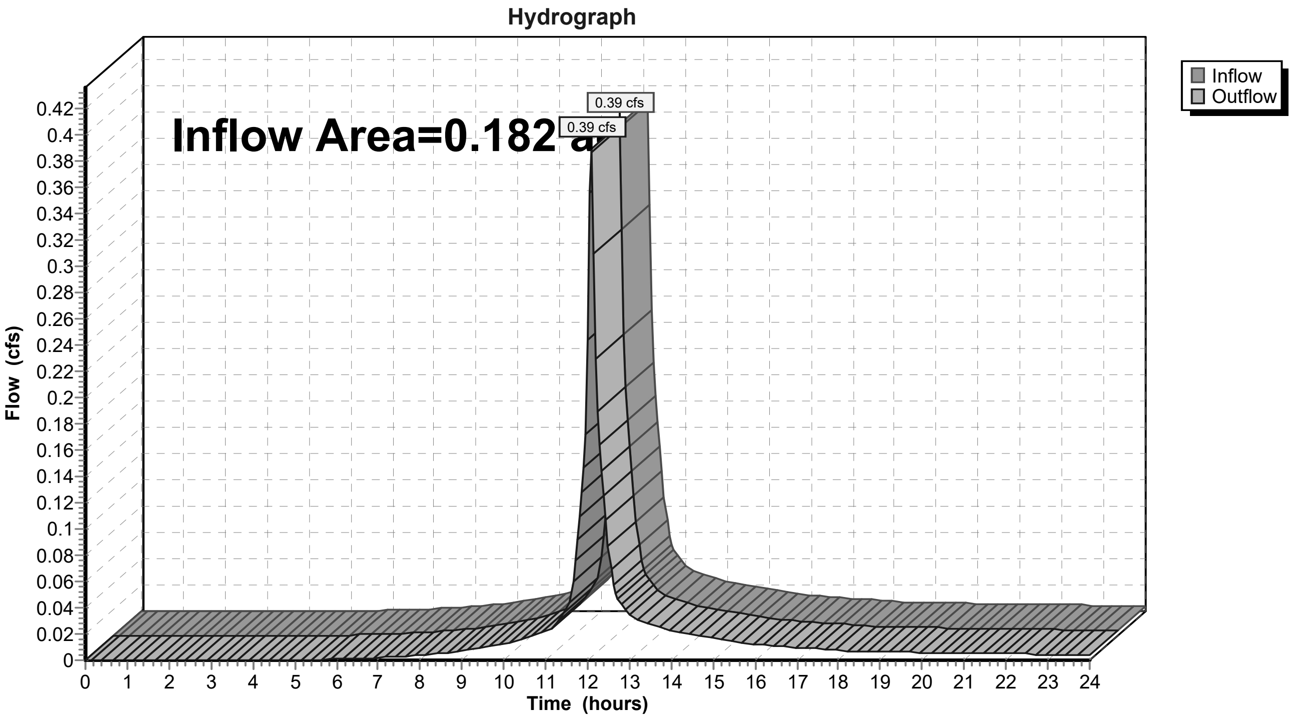


## Summary for Reach DP3: EX CB 3

Inflow Area = 0.182 ac, 84.03% Impervious, Inflow Depth > 1.90" for 1-yr event
Inflow = 0.39 cfs @ 12.09 hrs, Volume= 0.029 af
Outflow = 0.39 cfs @ 12.09 hrs, Volume= 0.029 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

### Reach DP3: EX CB 3



## Summary for Pond 1P: EX CB 1

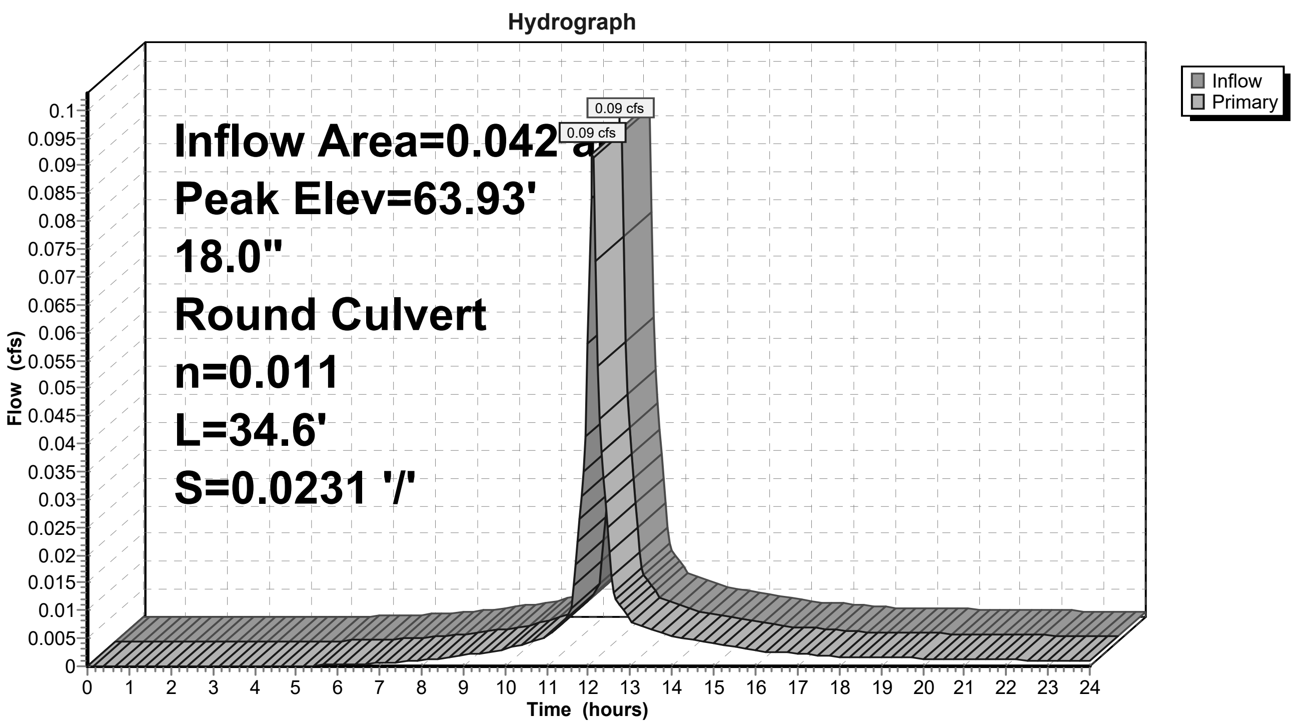
| | | | | |
|---|---|---|---|---|
| Inflow Area = | 0.042 ac, 87.73% Impervious, Inflow Depth > 1.97" for 1-yr event | | | |
| Inflow = | 0.09 cfs @ | 12.09 hrs, Volume= | 0.007 af | |
| Outflow = | 0.09 cfs @ | 12.09 hrs, Volume= | 0.007 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 0.09 cfs @ | 12.09 hrs, Volume= | 0.007 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 63.93' @ 12.09 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 63.80' | **18.0" Round Culvert**<br>L= 34.6' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 63.80' / 63.00' S= 0.0231 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.09 cfs @ 12.09 hrs HW=63.93' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 0.09 cfs @ 1.22 fps)

### Pond 1P: EX CB 1



## Summary for Pond 2P: EX CB 2

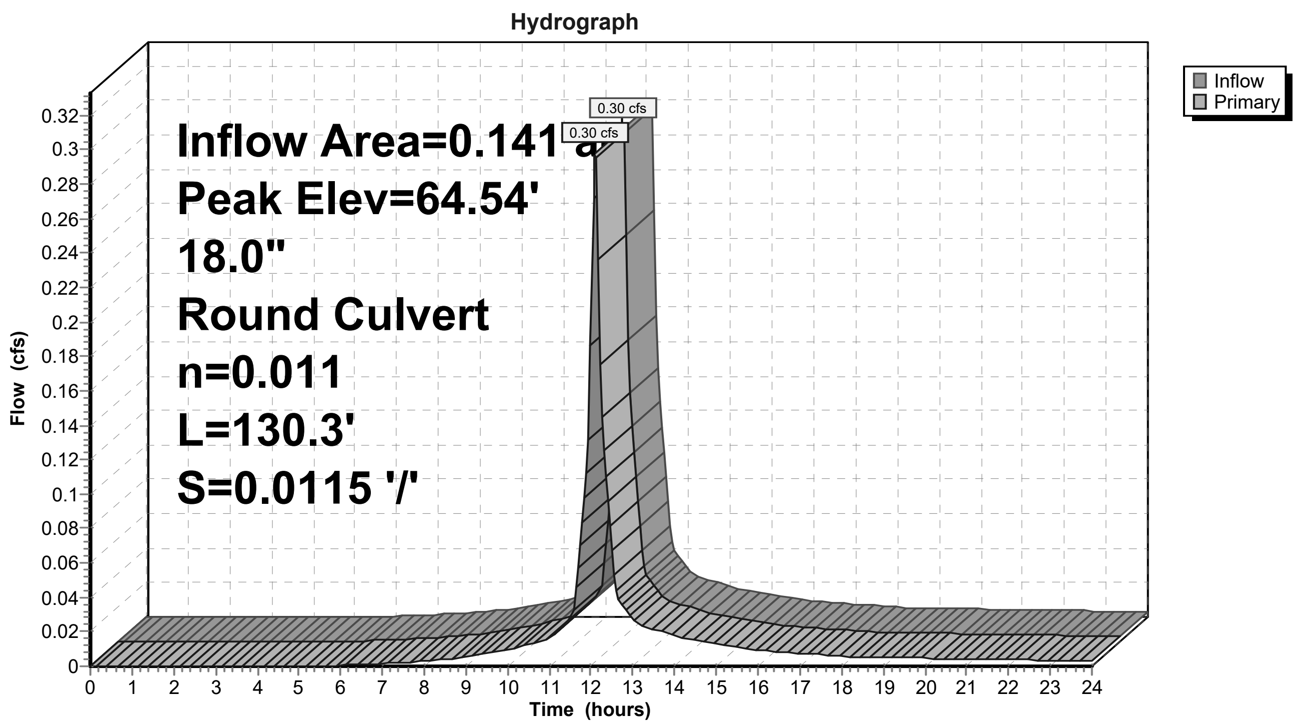
Inflow Area = 0.141 ac, 82.93% Impervious, Inflow Depth > 1.88" for 1-yr event
Inflow = 0.30 cfs @ 12.09 hrs, Volume= 0.022 af
Outflow = 0.30 cfs @ 12.09 hrs, Volume= 0.022 af, Atten= 0%, Lag= 0.0 min
Primary = 0.30 cfs @ 12.09 hrs, Volume= 0.022 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 64.54' @ 12.09 hrs
Flood Elev= 68.20'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.30' | **18.0" Round Culvert**<br>L= 130.3' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.30' / 62.80' S= 0.0115 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.29 cfs @ 12.09 hrs HW=64.53' TW=0.00' (Dynamic Tailwater)
**1=Culvert** (Inlet Controls 0.29 cfs @ 1.65 fps)

## Pond 2P: EX CB 2



## Summary for Subcatchment ES1:

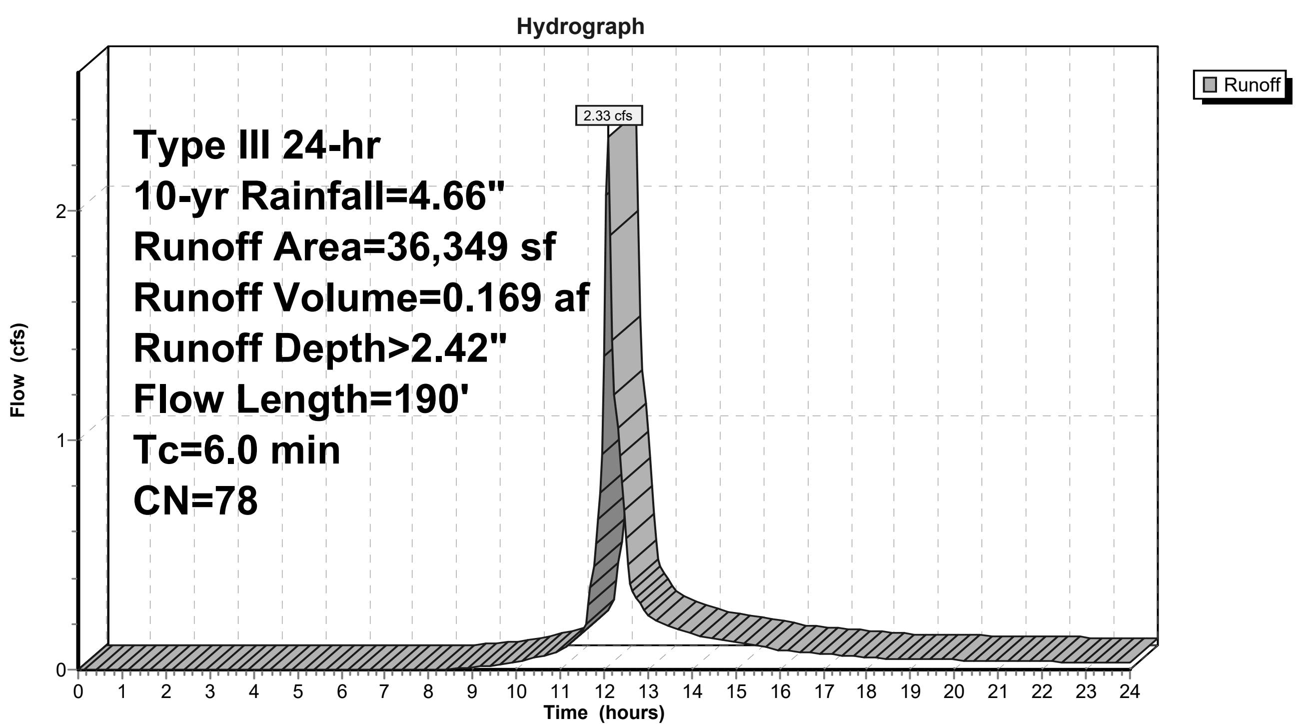
Runoff = 2.33 cfs @ 12.09 hrs, Volume= 0.169 af, Depth> 2.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 11,440 | 98 | Paved parking, HSG B |
| 24,909 | 69 | 50-75% Grass cover, Fair, HSG B |
| 36,349 | 78 | Weighted Average |
| 24,909 | | 68.53% Pervious Area |
| 11,440 | | 31.47% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.6 | 48 | 0.0312 | 1.41 | | **Sheet Flow, 48 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 3.0 | 142 | 0.0127 | 0.79 | | **Shallow Concentrated Flow, 142 ft grass**<br>Short Grass Pasture Kv= 7.0 fps |
| 3.6 | 190 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES1:



## Summary for Subcatchment ES2:

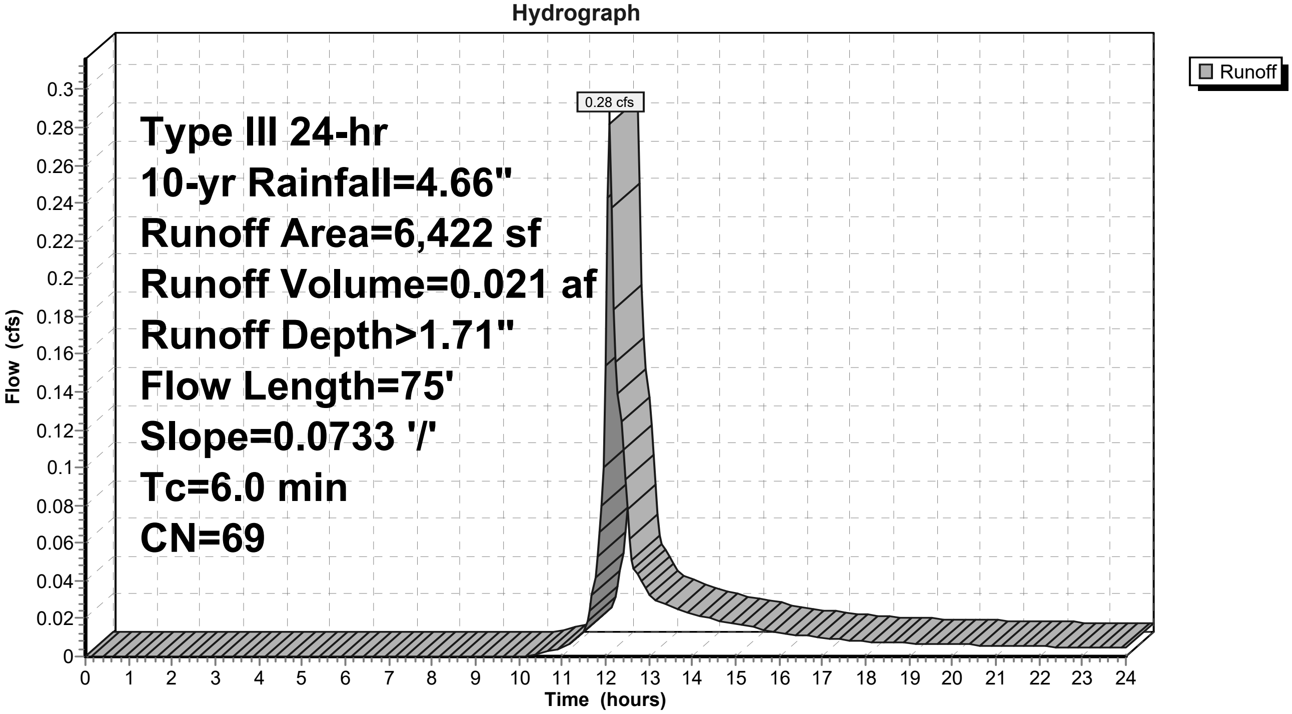
Runoff = 0.28 cfs @ 12.10 hrs, Volume= 0.021 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 12 | 98 | Paved parking, HSG B |
| 6,410 | 69 | 50-75% Grass cover, Fair, HSG B |
| 6,422 | 69 | Weighted Average |
| 6,410 | | 99.81% Pervious Area |
| 12 | | 0.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.7 | 75 | 0.0733 | 0.27 | | **Sheet Flow, 75 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 4.7 | 75 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES2:



## Summary for Subcatchment ES3:

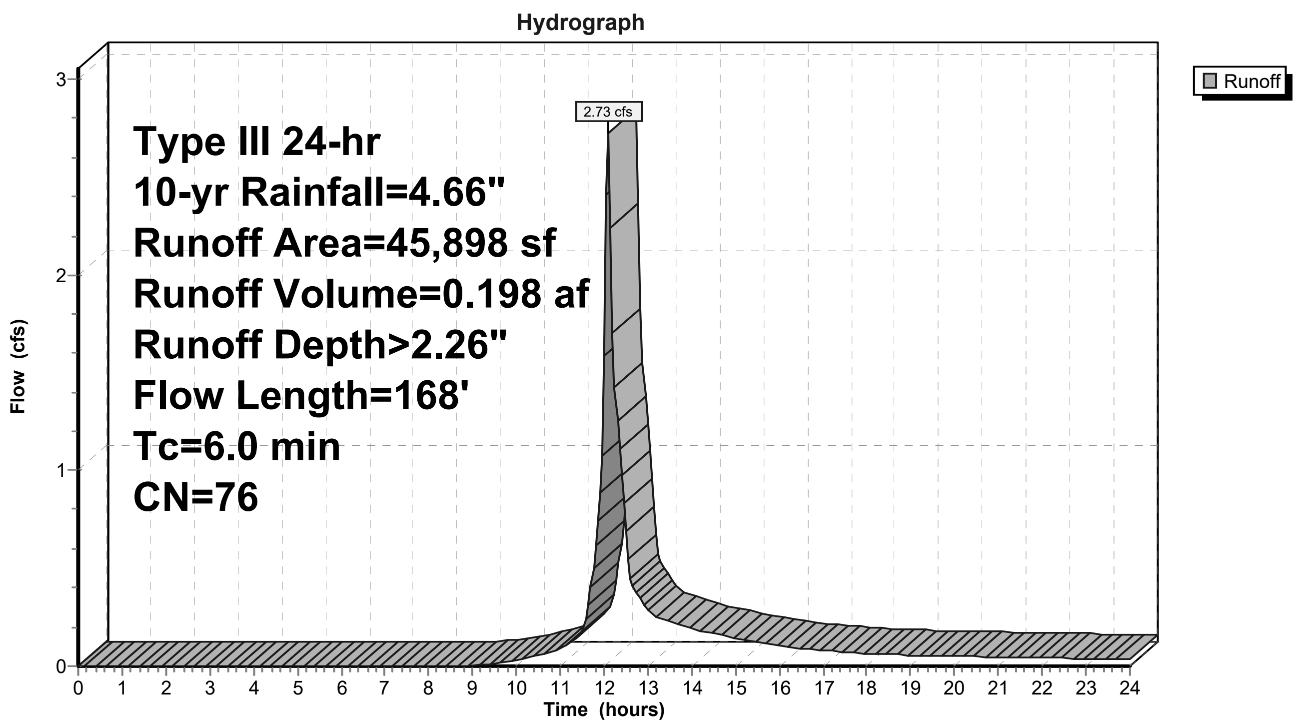
Runoff = 2.73 cfs @ 12.09 hrs, Volume= 0.198 af, Depth> 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 11,803 | 98 | Paved parking, HSG B |
| 34,095 | 69 | 50-75% Grass cover, Fair, HSG B |
| 45,898 | 76 | Weighted Average |
| 34,095 | | 74.28% Pervious Area |
| 11,803 | | 25.72% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.3 | 36 | 0.0972 | 0.26 | | **Sheet Flow, 36 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 0.2 | 54 | 0.0555 | 4.78 | | **Shallow Concentrated Flow, 54 ft paved**<br>Paved Kv= 20.3 fps |
| 1.4 | 78 | 0.0167 | 0.90 | | **Shallow Concentrated Flow, 78 ft grass**<br>Short Grass Pasture Kv= 7.0 fps |
| 3.9 | 168 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES3:



## Summary for Subcatchment ES4:

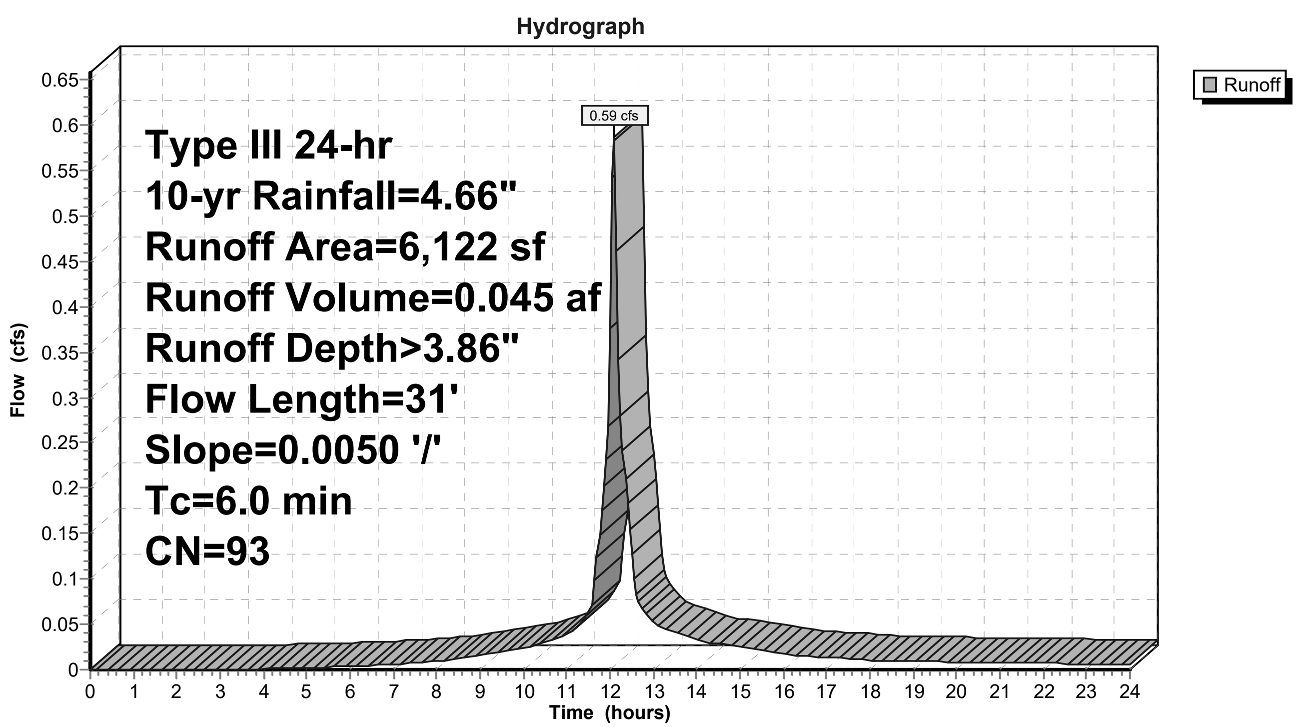
Runoff = 0.59 cfs @ 12.09 hrs, Volume= 0.045 af, Depth> 3.86"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 5,077 | 98 | Paved parking, HSG B |
| 1,045 | 69 | 50-75% Grass cover, Fair, HSG B |
| 6,122 | 93 | Weighted Average |
| 1,045 | | 17.07% Pervious Area |
| 5,077 | | 82.93% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 5.7 | 25 | 0.0050 | 0.07 | | **Sheet Flow, 25 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 0.1 | 6 | 0.0050 | 1.44 | | **Shallow Concentrated Flow, 6 ft paved**<br>Paved Kv= 20.3 fps |
| 5.8 | 31 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES4:



## Summary for Subcatchment ES5:

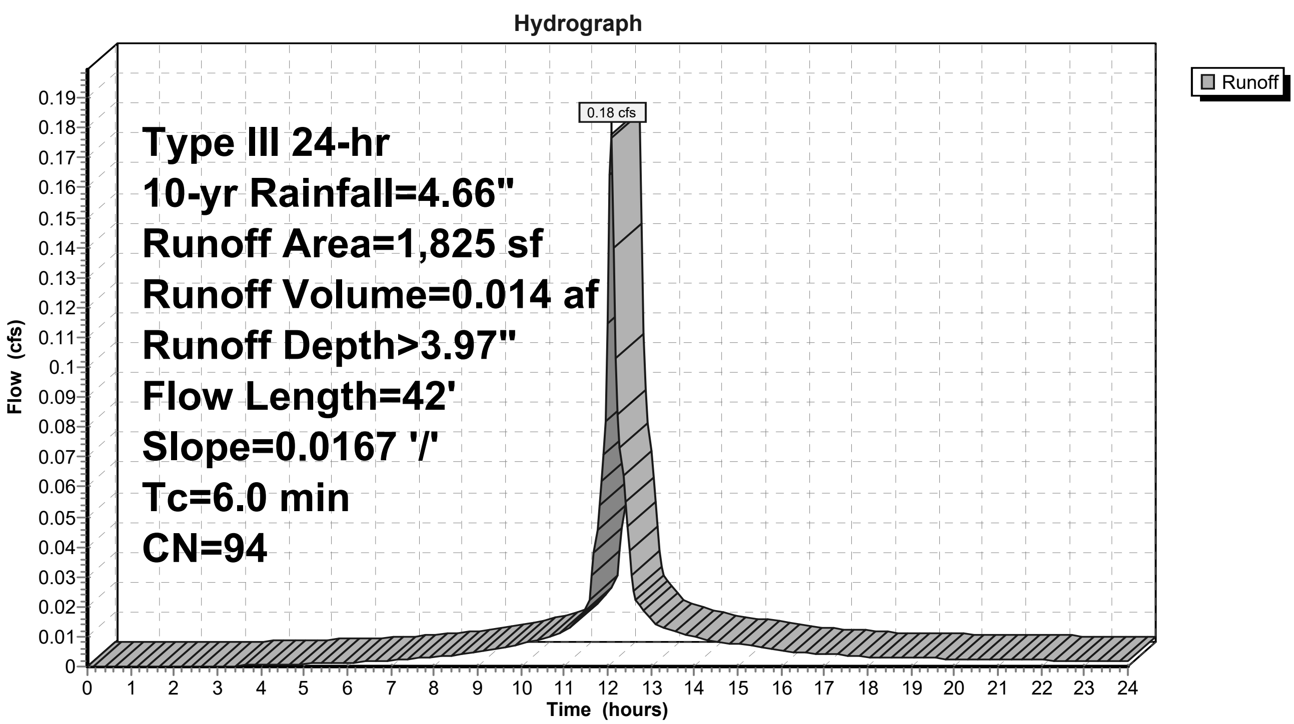
Runoff = 0.18 cfs @ 12.09 hrs, Volume= 0.014 af, Depth> 3.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 1,601 | 98 | Paved parking, HSG B |
| 224 | 69 | 50-75% Grass cover, Fair, HSG B |
| 1,825 | 94 | Weighted Average |
| 224 | | 12.27% Pervious Area |
| 1,601 | | 87.73% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.7 | 42 | 0.0167 | 1.07 | | **Sheet Flow, 42 ft paved** Smooth surfaces n= 0.011 P2= 3.15" |
| 0.7 | 42 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES5:

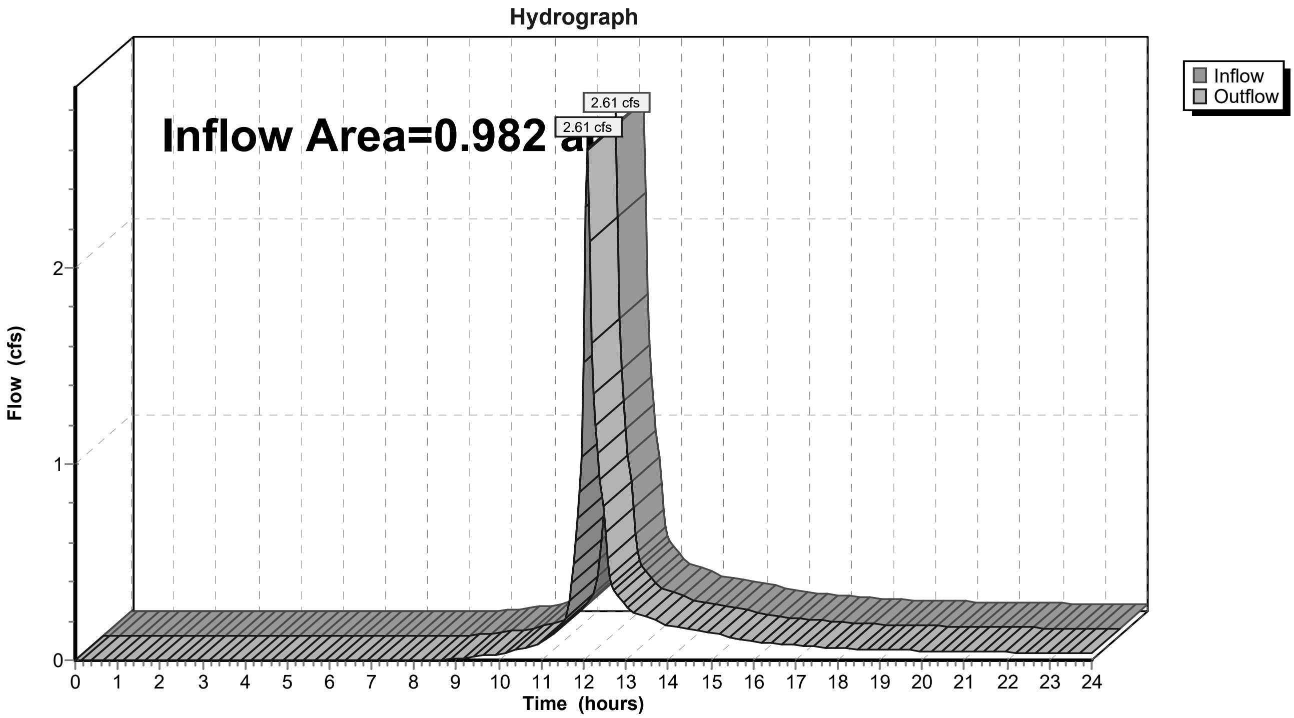


## Summary for Reach DP1:

Inflow Area = 0.982 ac, 26.78% Impervious, Inflow Depth > 2.32" for 10-yr event
Inflow = 2.61 cfs @ 12.09 hrs, Volume= 0.190 af
Outflow = 2.61 cfs @ 12.09 hrs, Volume= 0.190 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Reach DP1:

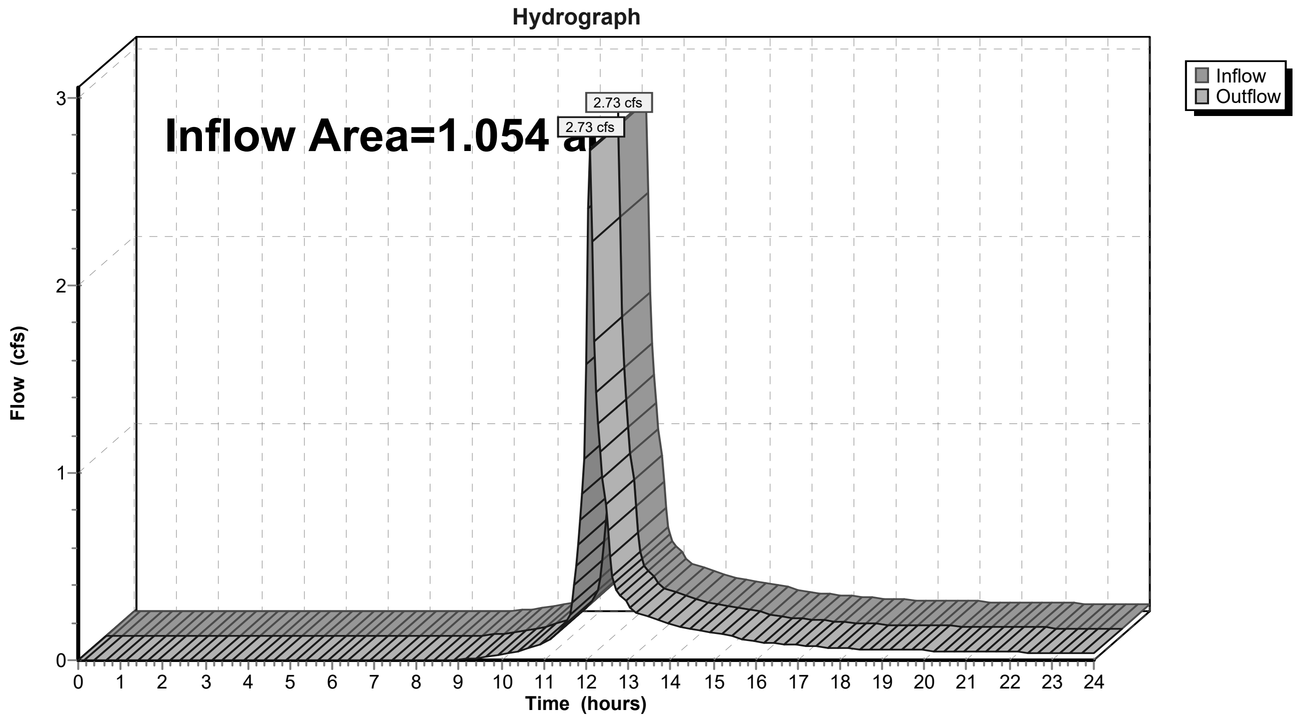


## Summary for Reach DP2:

Inflow Area = 1.054 ac, 25.72% Impervious, Inflow Depth > 2.26" for 10-yr event
Inflow = 2.73 cfs @ 12.09 hrs, Volume= 0.198 af
Outflow = 2.73 cfs @ 12.09 hrs, Volume= 0.198 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

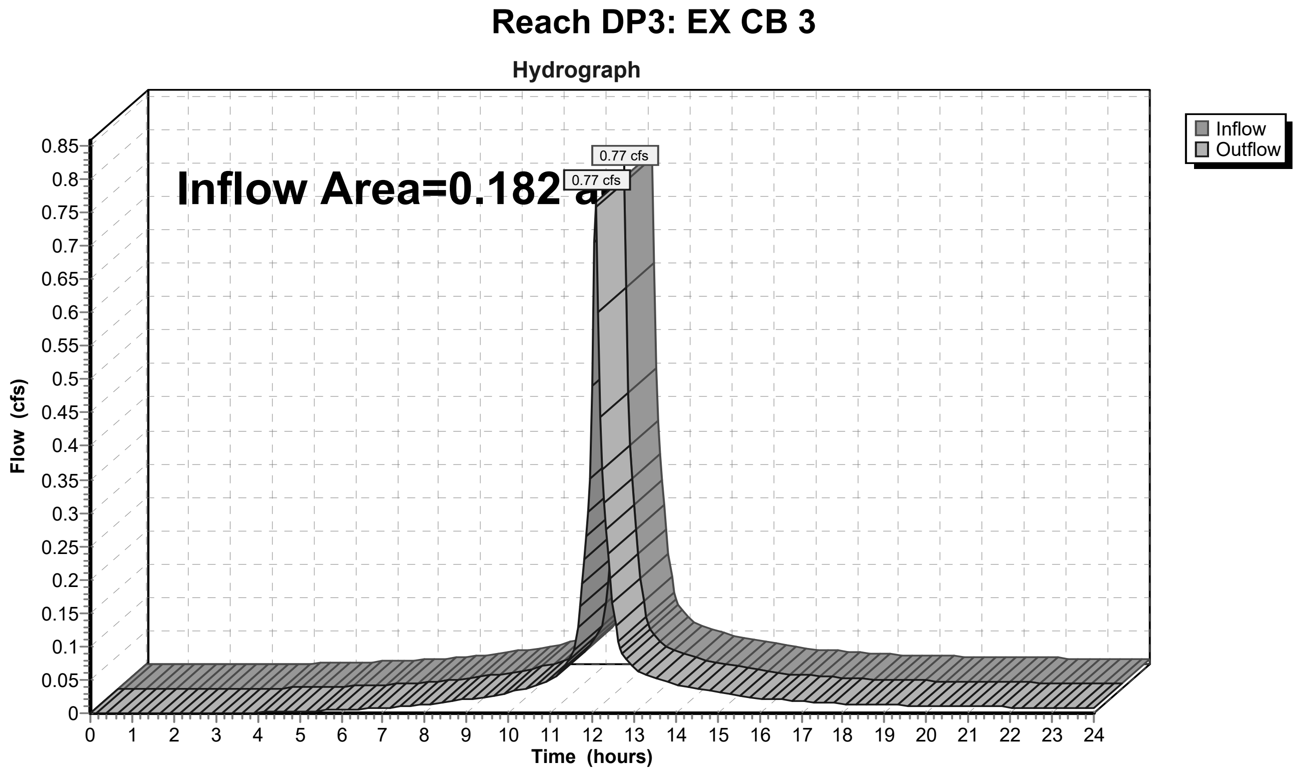
## Reach DP2:



## Summary for Reach DP3: EX CB 3

Inflow Area = 0.182 ac, 84.03% Impervious, Inflow Depth > 3.89" for 10-yr event
Inflow = 0.77 cfs @ 12.09 hrs, Volume= 0.059 af
Outflow = 0.77 cfs @ 12.09 hrs, Volume= 0.059 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



## Summary for Pond 1P: EX CB 1

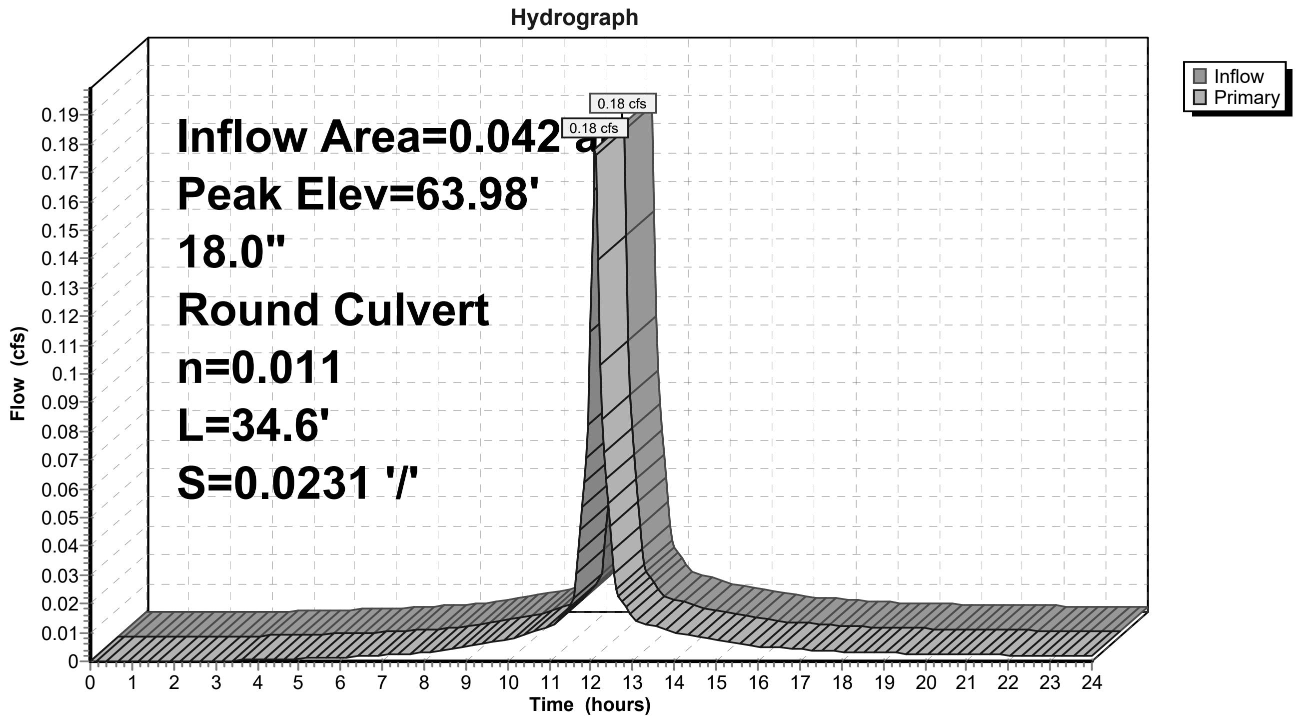
| | | | | |
|---|---|---|---|---|
| Inflow Area = | 0.042 ac, | 87.73% Impervious, | Inflow Depth > 3.97" | for 10-yr event |
| Inflow = | 0.18 cfs @ | 12.09 hrs, Volume= | 0.014 af | |
| Outflow = | 0.18 cfs @ | 12.09 hrs, Volume= | 0.014 af, Atten= 0%, Lag= 0.0 min | |
| Primary = | 0.18 cfs @ | 12.09 hrs, Volume= | 0.014 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 63.98' @ 12.09 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 63.80' | **18.0" Round Culvert**<br>L= 34.6' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 63.80' / 63.00' S= 0.0231 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.17 cfs @ 12.09 hrs HW=63.98' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 0.17 cfs @ 1.44 fps)

### Pond 1P: EX CB 1



## Summary for Pond 2P: EX CB 2

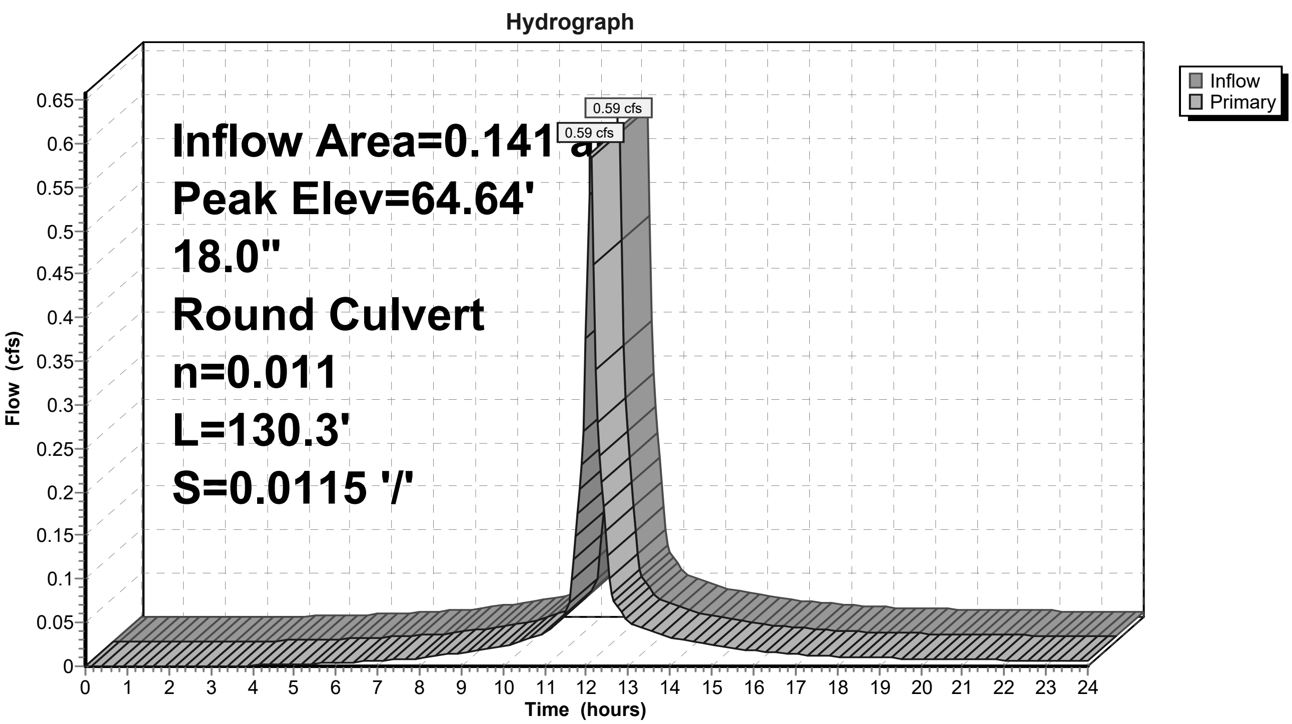
Inflow Area = 0.141 ac, 82.93% Impervious, Inflow Depth > 3.86" for 10-yr event
Inflow = 0.59 cfs @ 12.09 hrs, Volume= 0.045 af
Outflow = 0.59 cfs @ 12.09 hrs, Volume= 0.045 af, Atten= 0%, Lag= 0.0 min
Primary = 0.59 cfs @ 12.09 hrs, Volume= 0.045 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 64.64' @ 12.09 hrs
Flood Elev= 68.20'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.30' | **18.0" Round Culvert**<br>L= 130.3' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.30' / 62.80' S= 0.0115 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.57 cfs @ 12.09 hrs HW=64.63' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.57 cfs @ 1.96 fps)

### Pond 2P: EX CB 2



## Summary for Subcatchment ES1:

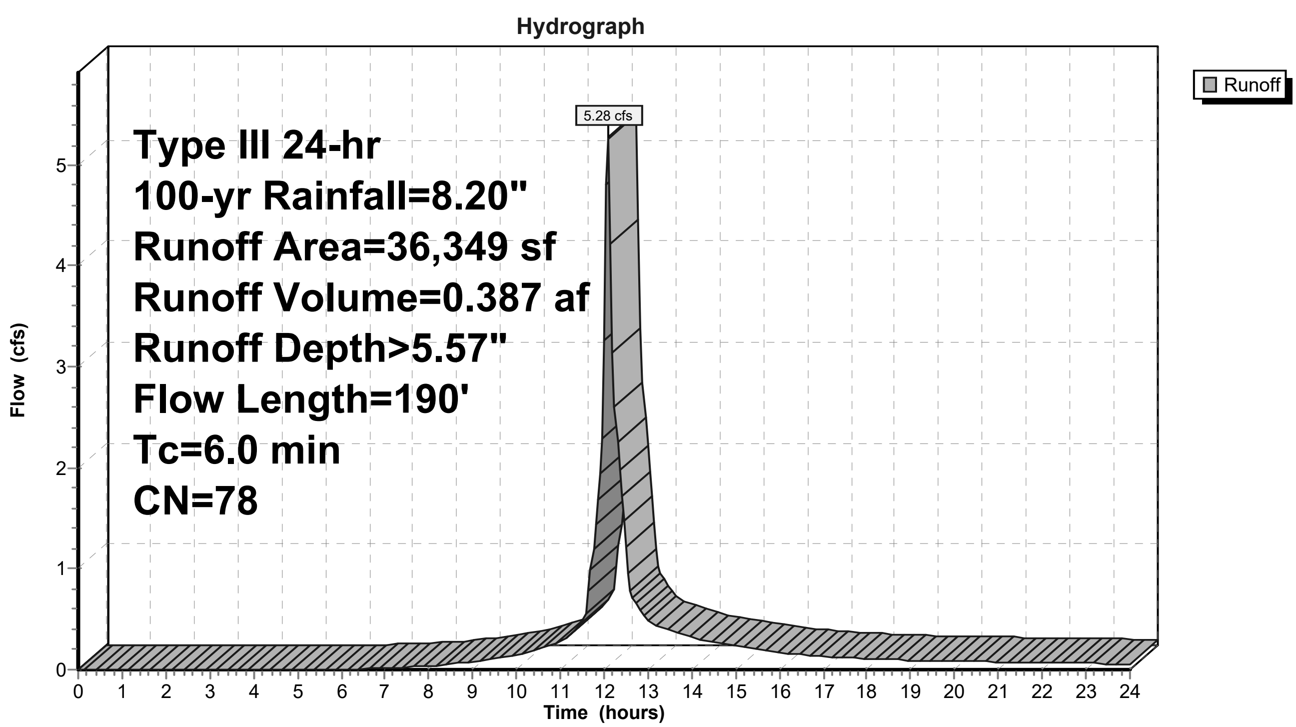
Runoff = 5.28 cfs @ 12.09 hrs, Volume= 0.387 af, Depth> 5.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 11,440 | 98 | Paved parking, HSG B |
| 24,909 | 69 | 50-75% Grass cover, Fair, HSG B |
| 36,349 | 78 | Weighted Average |
| 24,909 | | 68.53% Pervious Area |
| 11,440 | | 31.47% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.6 | 48 | 0.0312 | 1.41 | | **Sheet Flow, 48 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 3.0 | 142 | 0.0127 | 0.79 | | **Shallow Concentrated Flow, 142 ft grass**<br>Short Grass Pasture Kv= 7.0 fps |
| 3.6 | 190 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES1:



## Summary for Subcatchment ES2:

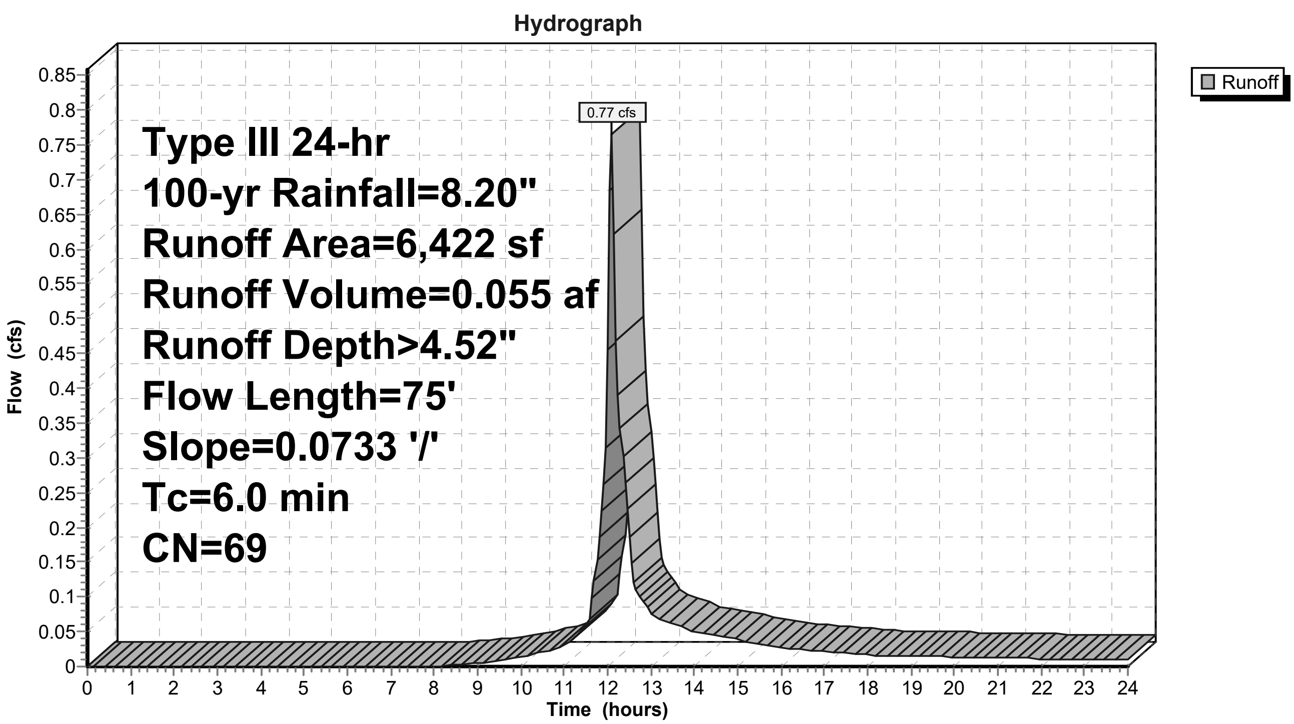
Runoff = 0.77 cfs @ 12.09 hrs, Volume= 0.055 af, Depth> 4.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 12 | 98 | Paved parking, HSG B |
| 6,410 | 69 | 50-75% Grass cover, Fair, HSG B |
| 6,422 | 69 | Weighted Average |
| 6,410 | | 99.81% Pervious Area |
| 12 | | 0.19% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 4.7 | 75 | 0.0733 | 0.27 | | **Sheet Flow, 75 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 4.7 | 75 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES2:



## Summary for Subcatchment ES3:

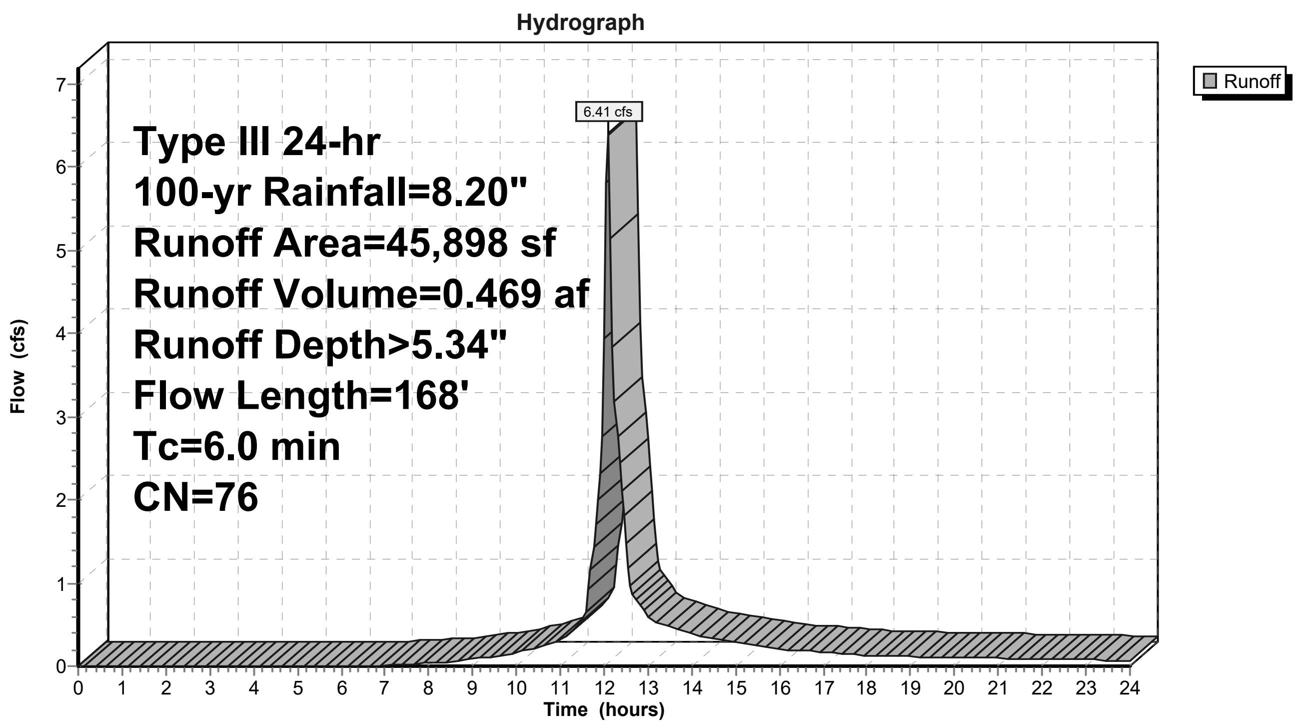
Runoff = 6.41 cfs @ 12.09 hrs, Volume= 0.469 af, Depth> 5.34"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 11,803 | 98 | Paved parking, HSG B |
| 34,095 | 69 | 50-75% Grass cover, Fair, HSG B |
| 45,898 | 76 | Weighted Average |
| 34,095 | | 74.28% Pervious Area |
| 11,803 | | 25.72% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 2.3 | 36 | 0.0972 | 0.26 | | **Sheet Flow, 36 ft grass** Grass: Short n= 0.150 P2= 3.15" |
| 0.2 | 54 | 0.0555 | 4.78 | | **Shallow Concentrated Flow, 54 ft paved** Paved Kv= 20.3 fps |
| 1.4 | 78 | 0.0167 | 0.90 | | **Shallow Concentrated Flow, 78 ft grass** Short Grass Pasture Kv= 7.0 fps |
| 3.9 | 168 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES3:



## Summary for Subcatchment ES4:

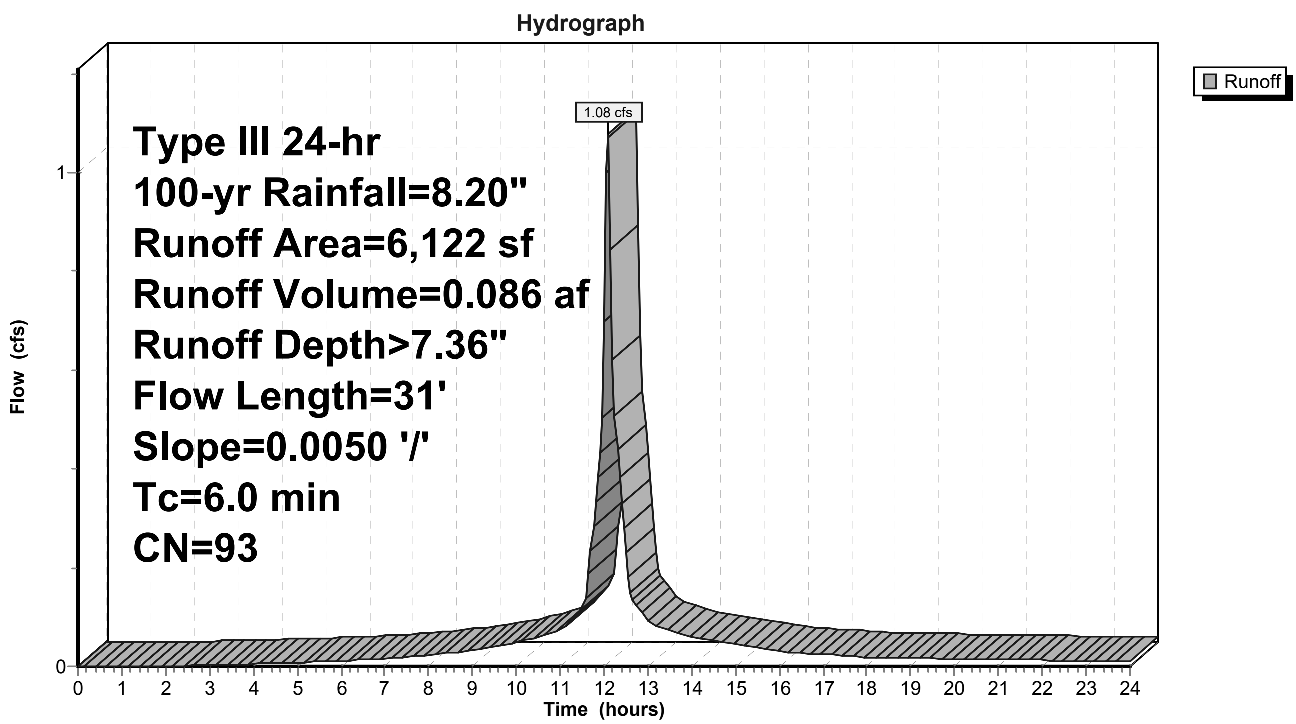
Runoff = 1.08 cfs @ 12.09 hrs, Volume= 0.086 af, Depth> 7.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 5,077 | 98 | Paved parking, HSG B |
| 1,045 | 69 | 50-75% Grass cover, Fair, HSG B |
| 6,122 | 93 | Weighted Average |
| 1,045 | | 17.07% Pervious Area |
| 5,077 | | 82.93% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 5.7 | 25 | 0.0050 | 0.07 | | **Sheet Flow, 25 ft grass** Grass: Short n= 0.150 P2= 3.15" |
| 0.1 | 6 | 0.0050 | 1.44 | | **Shallow Concentrated Flow, 6 ft paved** Paved Kv= 20.3 fps |
| 5.8 | 31 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES4:



## Summary for Subcatchment ES5:

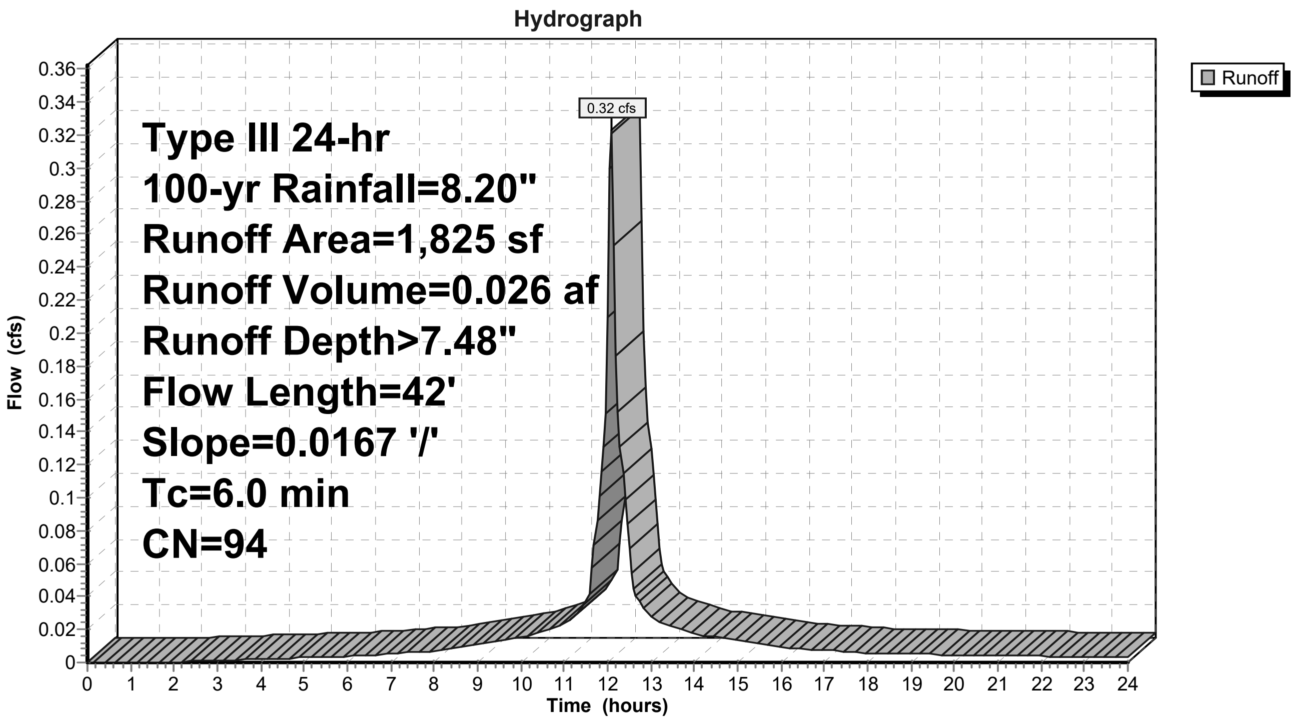
Runoff = 0.32 cfs @ 12.09 hrs, Volume= 0.026 af, Depth> 7.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 1,601 | 98 | Paved parking, HSG B |
| 224 | 69 | 50-75% Grass cover, Fair, HSG B |
| 1,825 | 94 | Weighted Average |
| 224 | | 12.27% Pervious Area |
| 1,601 | | 87.73% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.7 | 42 | 0.0167 | 1.07 | | **Sheet Flow, 42 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 0.7 | 42 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment ES5:

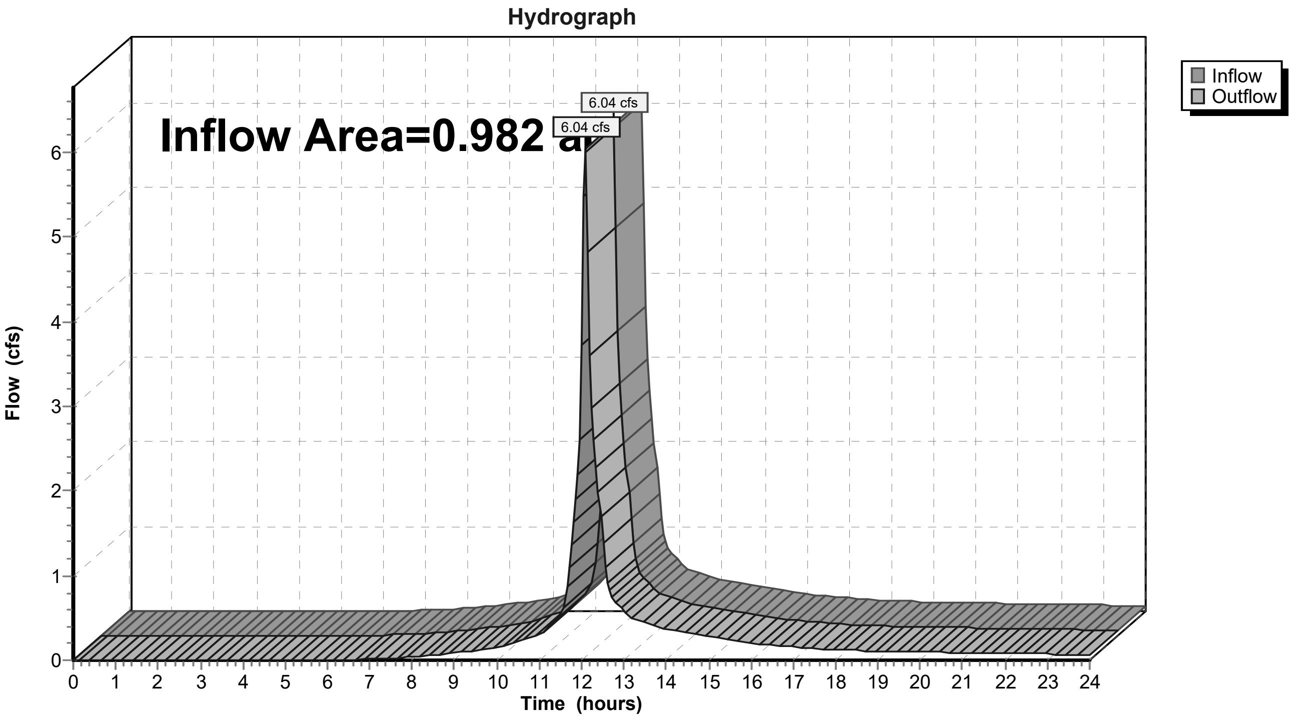


## Summary for Reach DP1:

Inflow Area = 0.982 ac, 26.78% Impervious, Inflow Depth > 5.41" for 100-yr event
Inflow = 6.04 cfs @ 12.09 hrs, Volume= 0.443 af
Outflow = 6.04 cfs @ 12.09 hrs, Volume= 0.443 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Reach DP1:

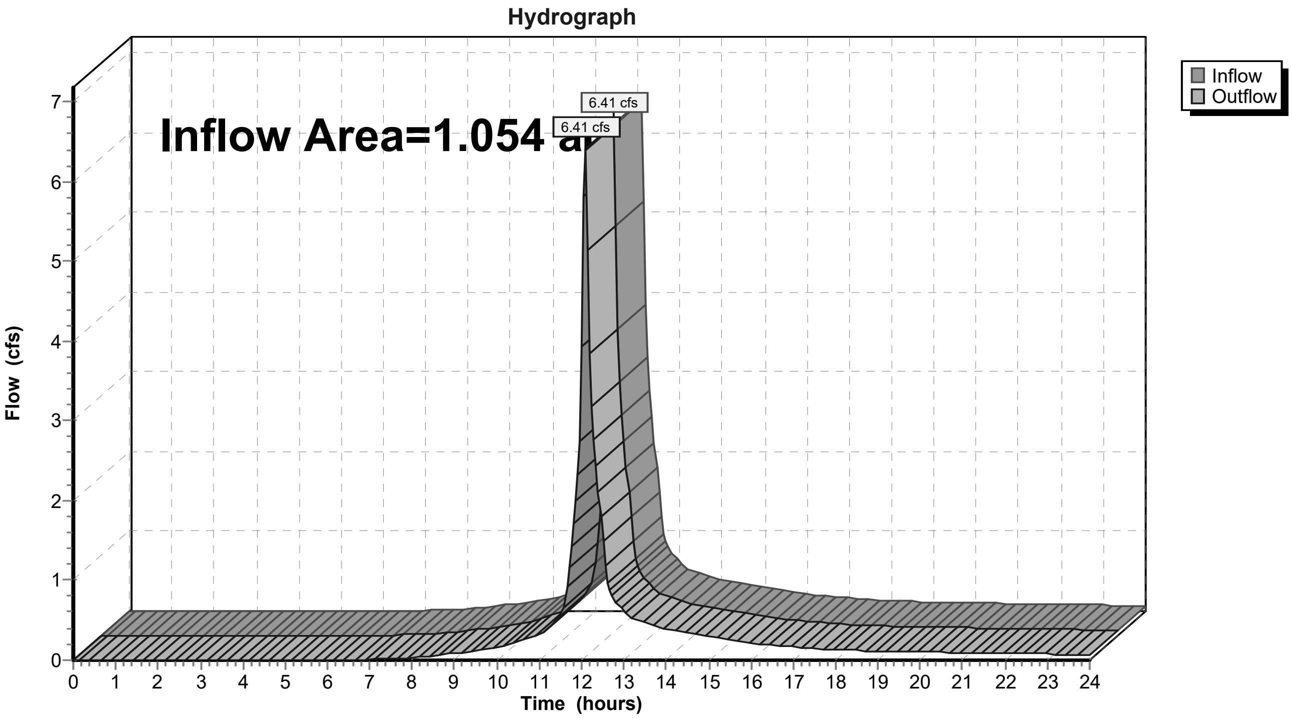


## Summary for Reach DP2:

Inflow Area = 1.054 ac, 25.72% Impervious, Inflow Depth > 5.34" for 100-yr event
Inflow = 6.41 cfs @ 12.09 hrs, Volume= 0.469 af
Outflow = 6.41 cfs @ 12.09 hrs, Volume= 0.469 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

## Reach DP2:

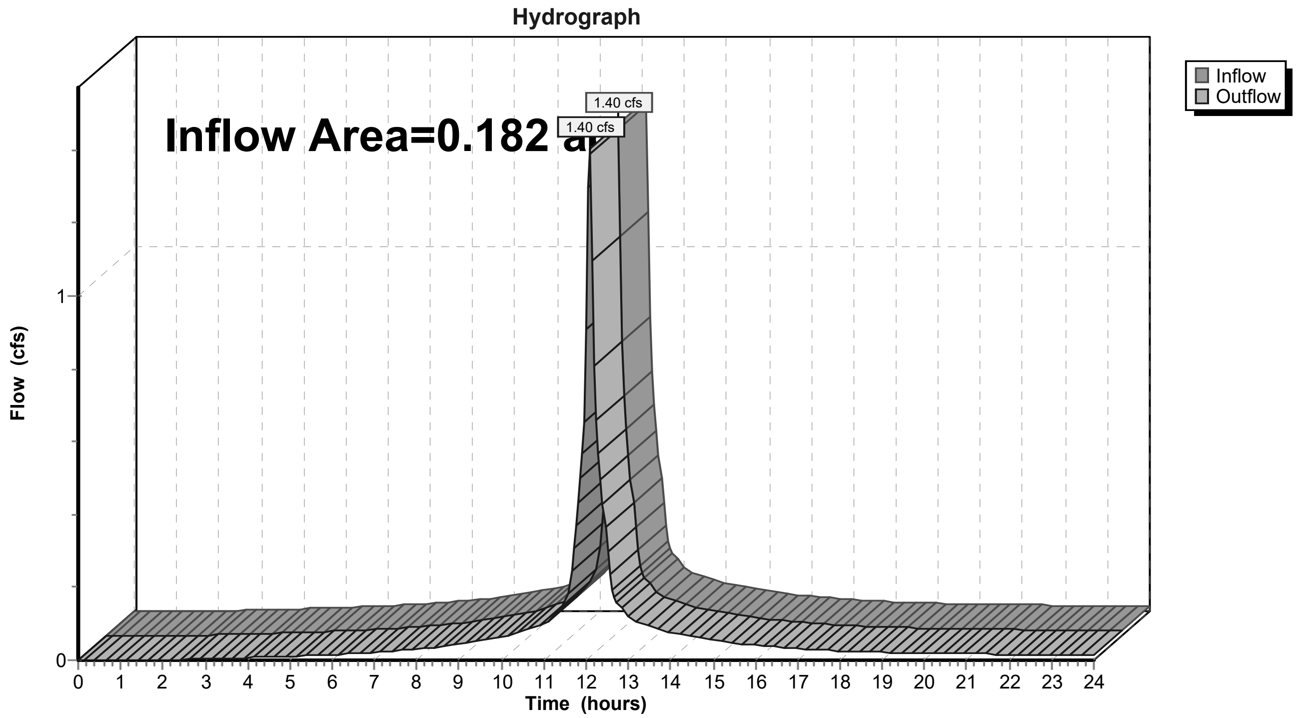


## Summary for Reach DP3: EX CB 3

| | | | | |
|---|---|---|---|---|
| Inflow Area = | 0.182 ac, | 84.03% Impervious, | Inflow Depth > 7.38" | for 100-yr event |
| Inflow = | 1.40 cfs @ | 12.09 hrs, Volume= | 0.112 af | |
| Outflow = | 1.40 cfs @ | 12.09 hrs, Volume= | 0.112 af, | Atten= 0%, Lag= 0.0 min |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

### Reach DP3: EX CB 3



## Summary for Pond 1P: EX CB 1

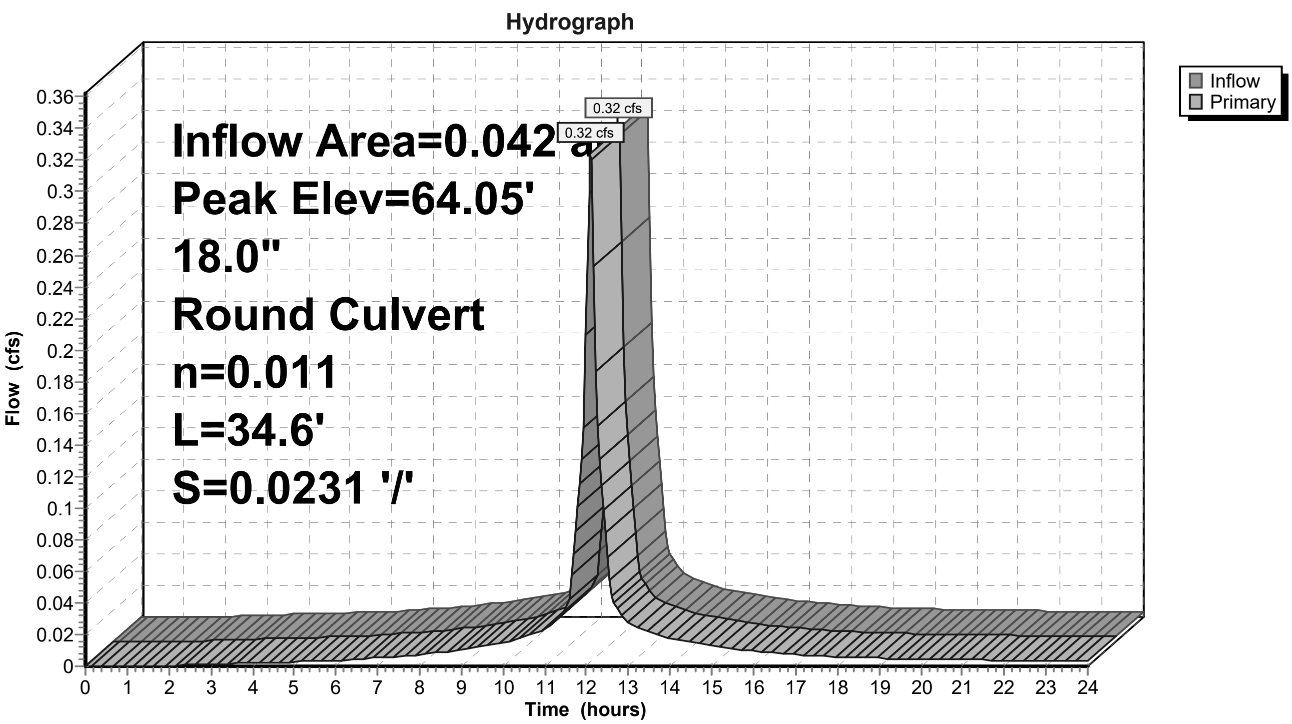
Inflow Area = 0.042 ac, 87.73% Impervious, Inflow Depth > 7.48" for 100-yr event
Inflow = 0.32 cfs @ 12.09 hrs, Volume= 0.026 af
Outflow = 0.32 cfs @ 12.09 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min
Primary = 0.32 cfs @ 12.09 hrs, Volume= 0.026 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 64.05' @ 12.09 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 63.80' | **18.0" Round Culvert**<br>L= 34.6' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 63.80' / 63.00' S= 0.0231 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.32 cfs @ 12.09 hrs HW=64.04' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.32 cfs @ 1.68 fps)

### Pond 1P: EX CB 1



## Summary for Pond 2P: EX CB 2

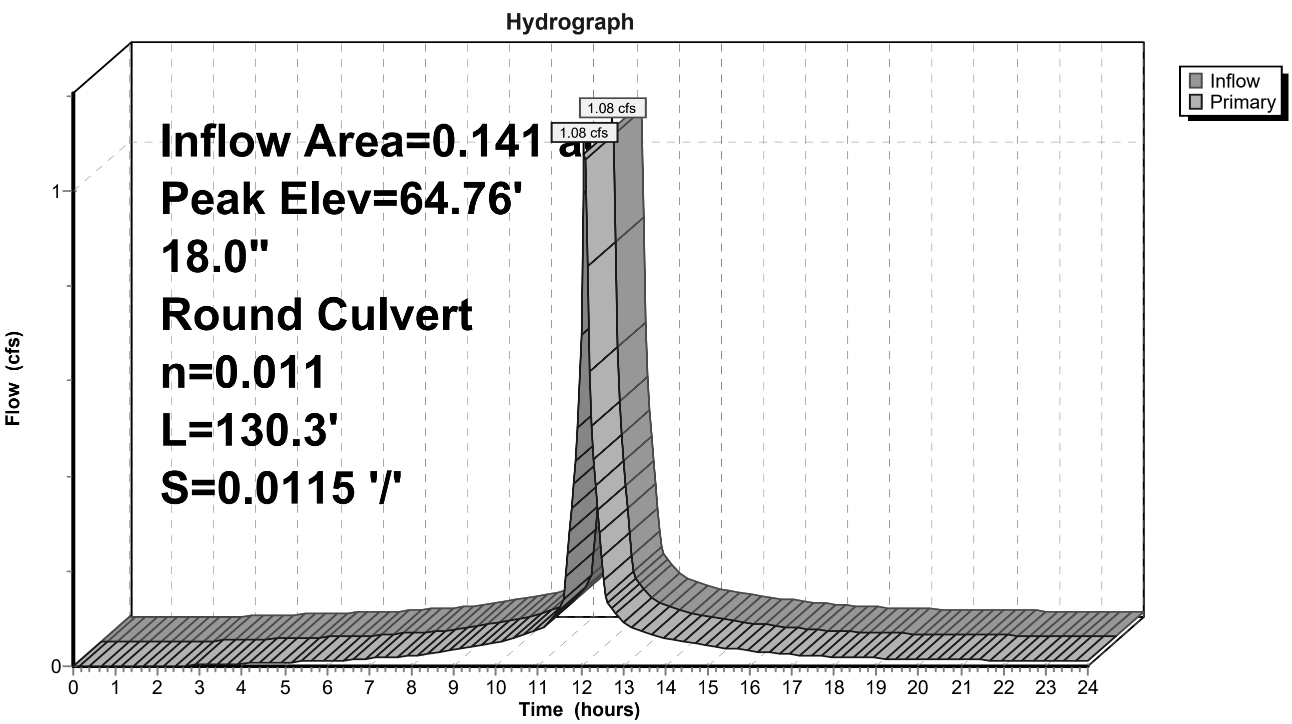
Inflow Area = 0.141 ac, 82.93% Impervious, Inflow Depth > 7.36" for 100-yr event
Inflow = 1.08 cfs @ 12.09 hrs, Volume= 0.086 af
Outflow = 1.08 cfs @ 12.09 hrs, Volume= 0.086 af, Atten= 0%, Lag= 0.0 min
Primary = 1.08 cfs @ 12.09 hrs, Volume= 0.086 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Peak Elev= 64.76' @ 12.09 hrs
Flood Elev= 68.20'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.30' | **18.0" Round Culvert**<br>L= 130.3' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.30' / 62.80' S= 0.0115 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=1.05 cfs @ 12.09 hrs HW=64.76' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.05 cfs @ 2.30 fps)

### Pond 2P: EX CB 2



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# Appendix J:
# Post-Development Stormwater Modeling

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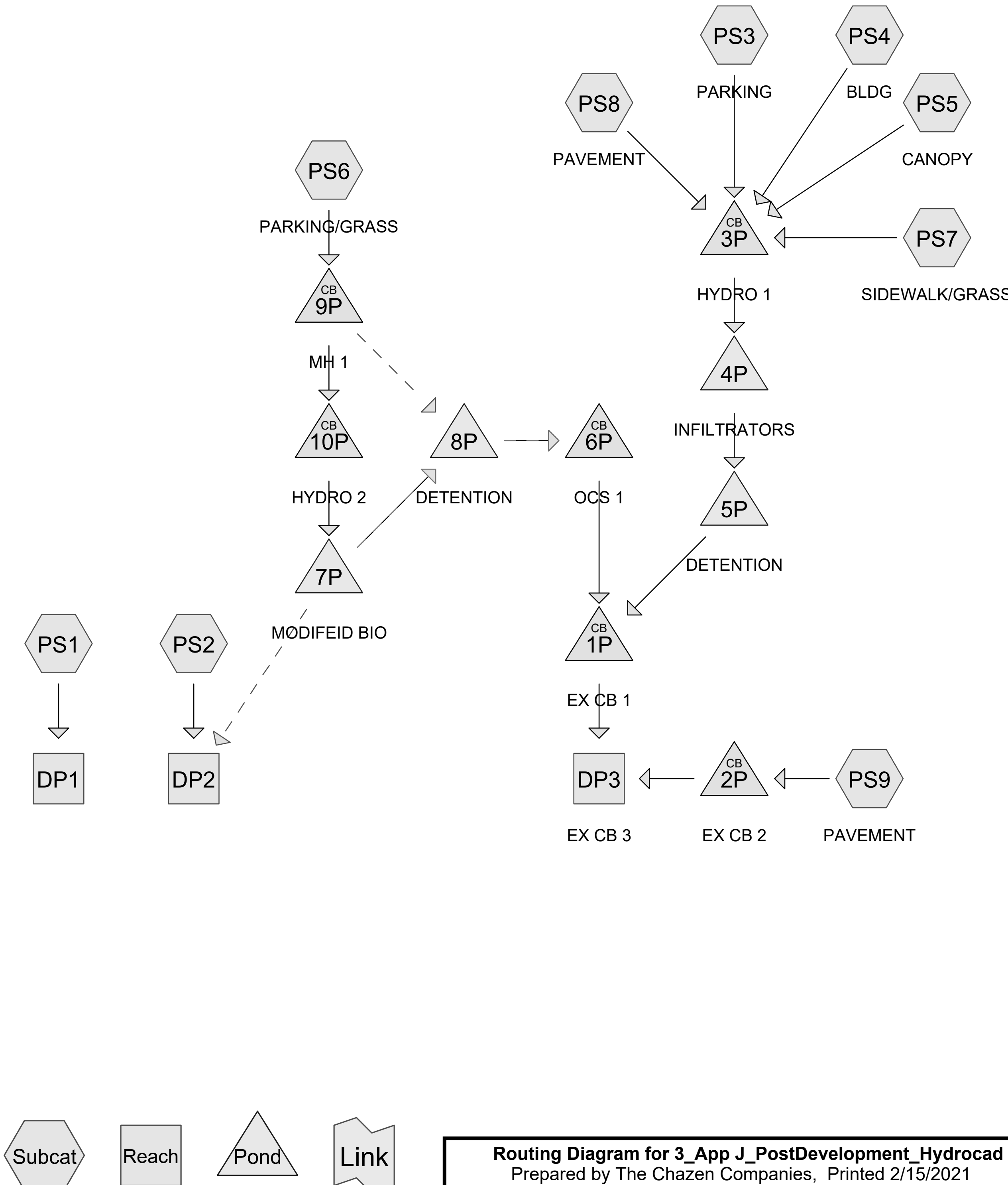



**Routing Diagram for 3_App J_PostDevelopment_Hydrocad**
Prepared by The Chazen Companies, Printed 2/15/2021
HydroCAD® 10.00-21 s/n 00927 © 2018 HydroCAD Software Solutions LLC

## Summary for Subcatchment PS1:

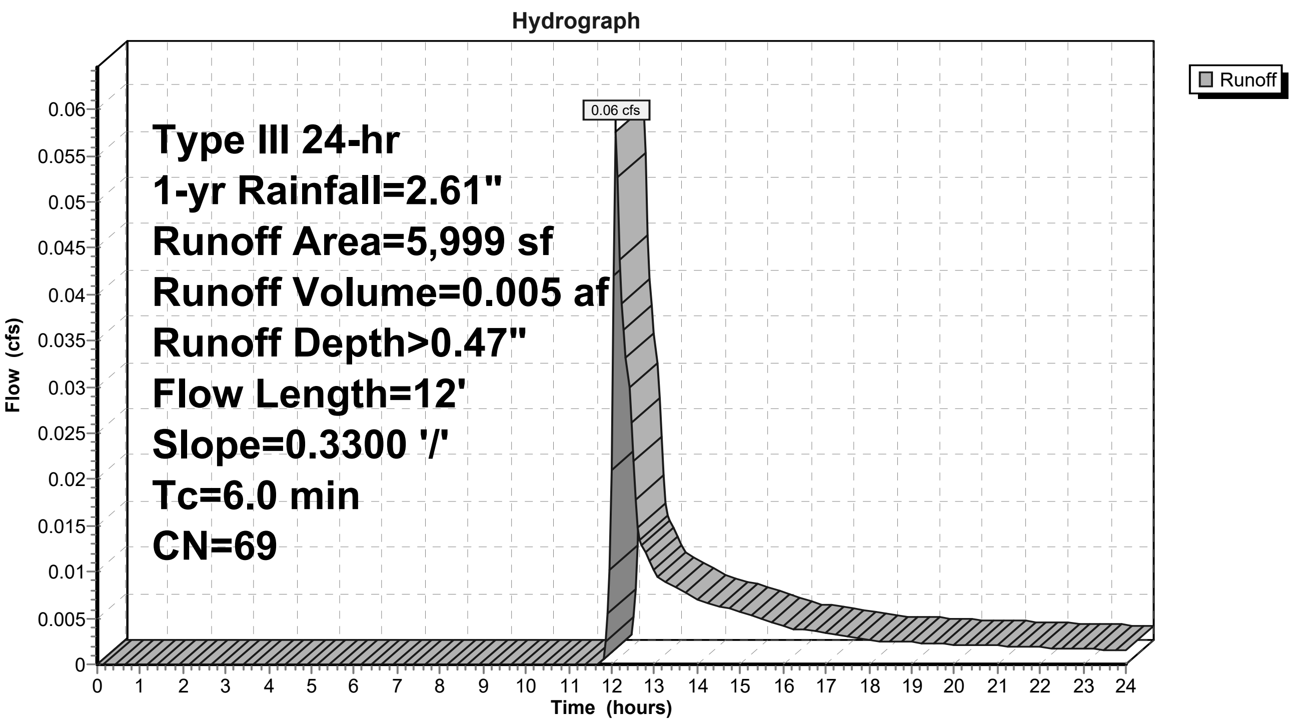
Runoff = 0.06 cfs @ 12.11 hrs, Volume= 0.005 af, Depth> 0.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 0 | 98 | Paved parking, HSG B |
| 5,999 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,999 | 69 | Weighted Average |
| 5,999 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.6 | 12 | 0.3300 | 0.34 | | **Sheet Flow, 12 ft grass** Grass: Short n= 0.150 P2= 3.15" |
| 0.6 | 12 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS1:



## Summary for Subcatchment PS2:

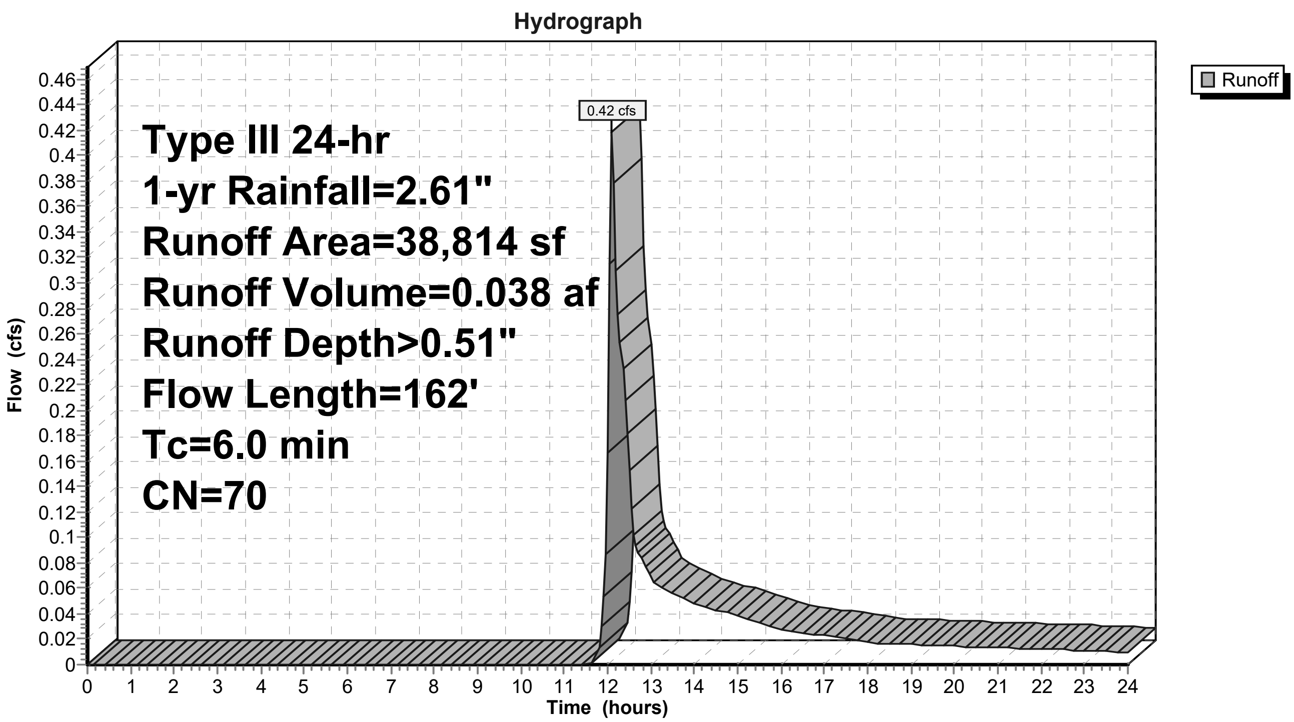
Runoff = 0.42 cfs @ 12.11 hrs, Volume= 0.038 af, Depth> 0.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 1,714 | 98 | Paved parking, HSG B |
| 37,100 | 69 | 50-75% Grass cover, Fair, HSG B |
| 38,814 | 70 | Weighted Average |
| 37,100 | | 95.58% Pervious Area |
| 1,714 | | 4.42% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 27 | 0.1850 | 0.32 | | **Sheet Flow, 27 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 1.9 | 135 | 0.0296 | 1.20 | | **Shallow Concentrated Flow, 78 ft grass**<br>Short Grass Pasture Kv= 7.0 fps |
| 3.3 | 162 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS2:



## Summary for Subcatchment PS3: PARKING

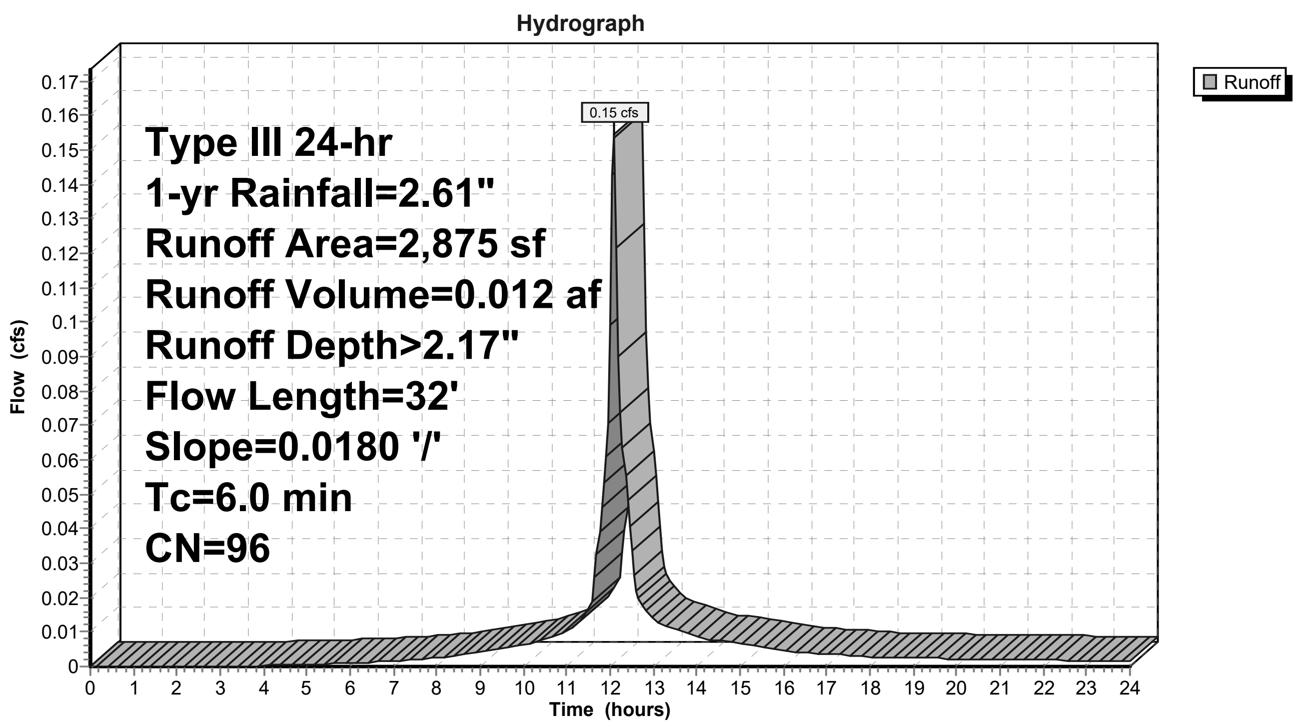
Runoff = 0.15 cfs @ 12.09 hrs, Volume= 0.012 af, Depth> 2.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 2,710 | 98 | Paved parking, HSG B |
| 165 | 69 | 50-75% Grass cover, Fair, HSG B |
| 2,875 | 96 | Weighted Average |
| 165 | | 5.74% Pervious Area |
| 2,710 | | 94.26% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.5 | 32 | 0.0180 | 1.04 | | **Sheet Flow, 32 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 0.5 | 32 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS3: PARKING



## Summary for Subcatchment PS4: BLDG

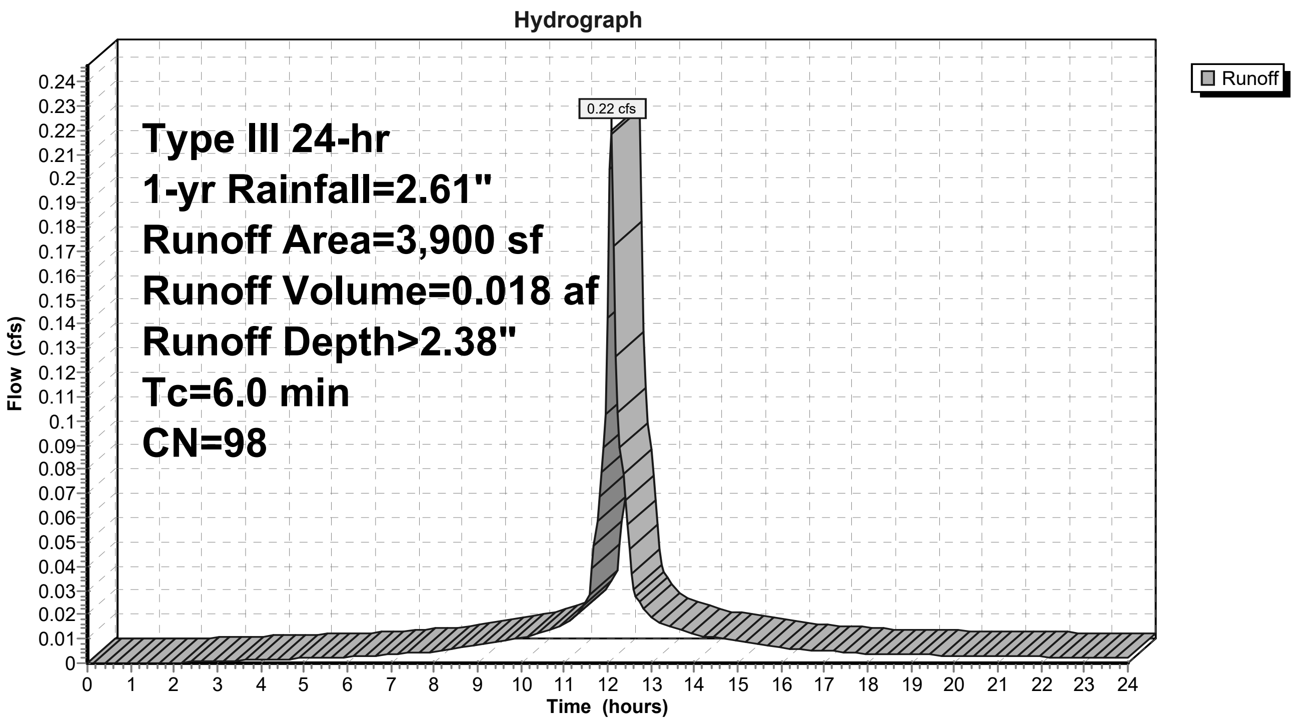
Runoff = 0.22 cfs @ 12.09 hrs, Volume= 0.018 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 3,900 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 3,900 | 98 | Weighted Average |
| 3,900 | | 100.00% Impervious Area |

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

## Subcatchment PS4: BLDG



## Summary for Subcatchment PS5: CANOPY

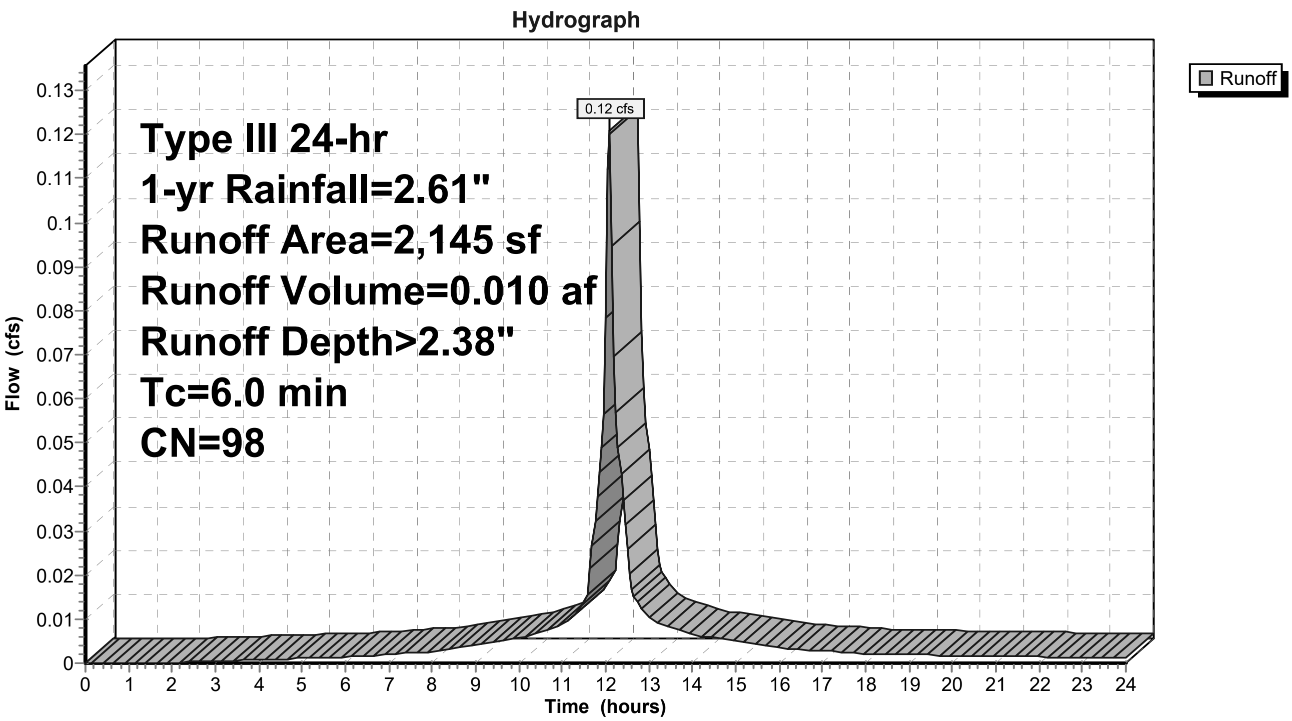
Runoff = 0.12 cfs @ 12.09 hrs, Volume= 0.010 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 2,145 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 2,145 | 98 | Weighted Average |
| 2,145 | | 100.00% Impervious Area |

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

## Subcatchment PS5: CANOPY



## Summary for Subcatchment PS6: PARKING/GRASS

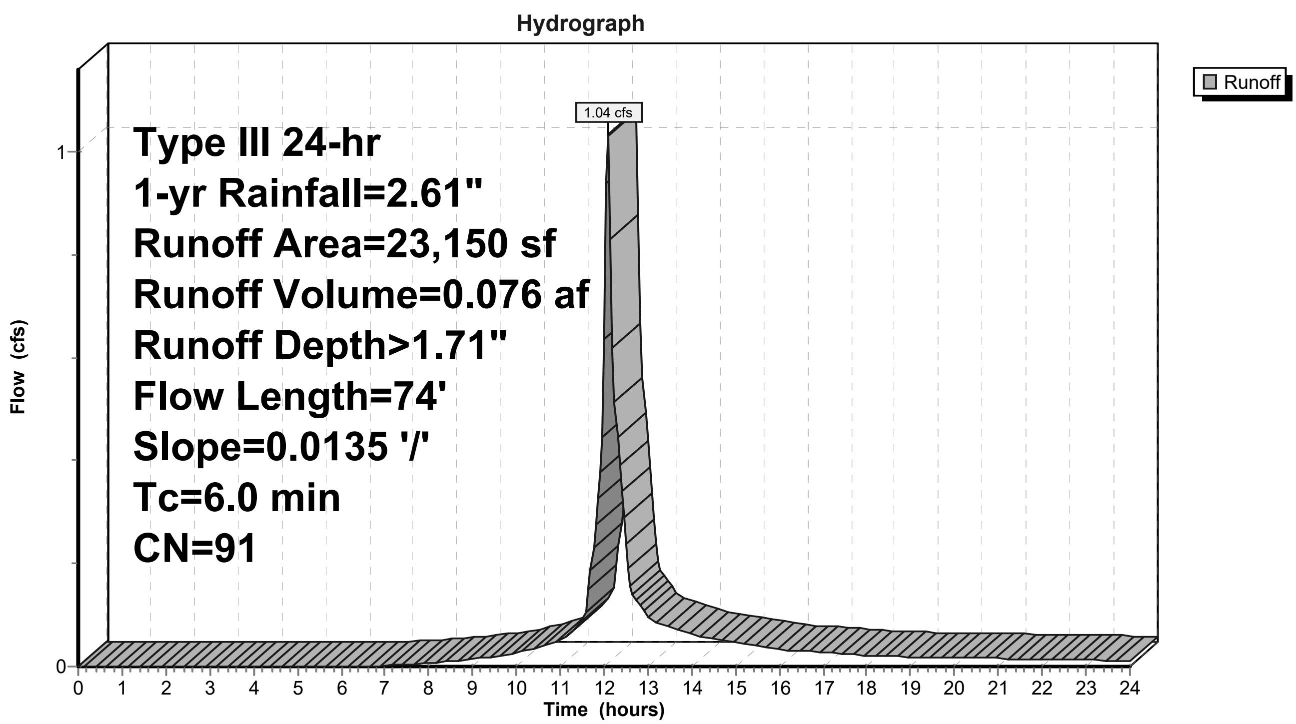
Runoff = 1.04 cfs @ 12.09 hrs, Volume= 0.076 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 17,420 | 98 | Paved parking, HSG B |
| 5,730 | 69 | 50-75% Grass cover, Fair, HSG B |
| 23,150 | 91 | Weighted Average |
| 5,730 | | 24.75% Pervious Area |
| 17,420 | | 75.25% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.1 | 74 | 0.0135 | 1.10 | | **Sheet Flow, 74 ft paved** Smooth surfaces n= 0.011 P2= 3.15" |
| 1.1 | 74 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS6: PARKING/GRASS



## Summary for Subcatchment PS7: SIDEWALK/GRASS

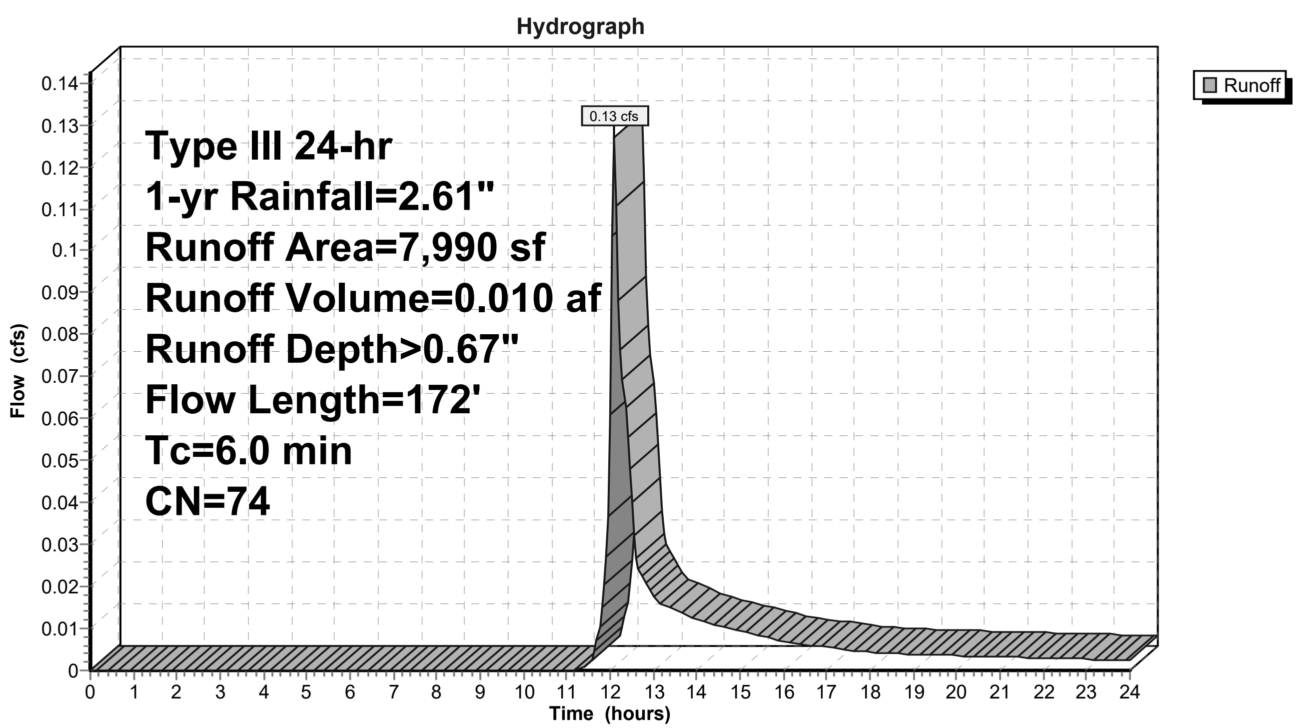
Runoff = 0.13 cfs @ 12.10 hrs, Volume= 0.010 af, Depth> 0.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 1,255 | 98 | Paved parking, HSG B |
| 6,735 | 69 | 50-75% Grass cover, Fair, HSG B |
| 7,990 | 74 | Weighted Average |
| 6,735 | | 84.29% Pervious Area |
| 1,255 | | 15.71% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.8 | 18 | 0.3300 | 0.37 | | **Sheet Flow, 18 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 0.8 | 33 | 0.0100 | 0.70 | | **Shallow Concentrated Flow, 33 ft grass**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.2 | 121 | 0.0500 | 10.14 | 7.97 | **Pipe Channel, yd 2 - hydro 1**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.013 Corrugated PE, smooth interior |
| 1.8 | 172 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS7: SIDEWALK/GRASS



## Summary for Subcatchment PS8: PAVEMENT

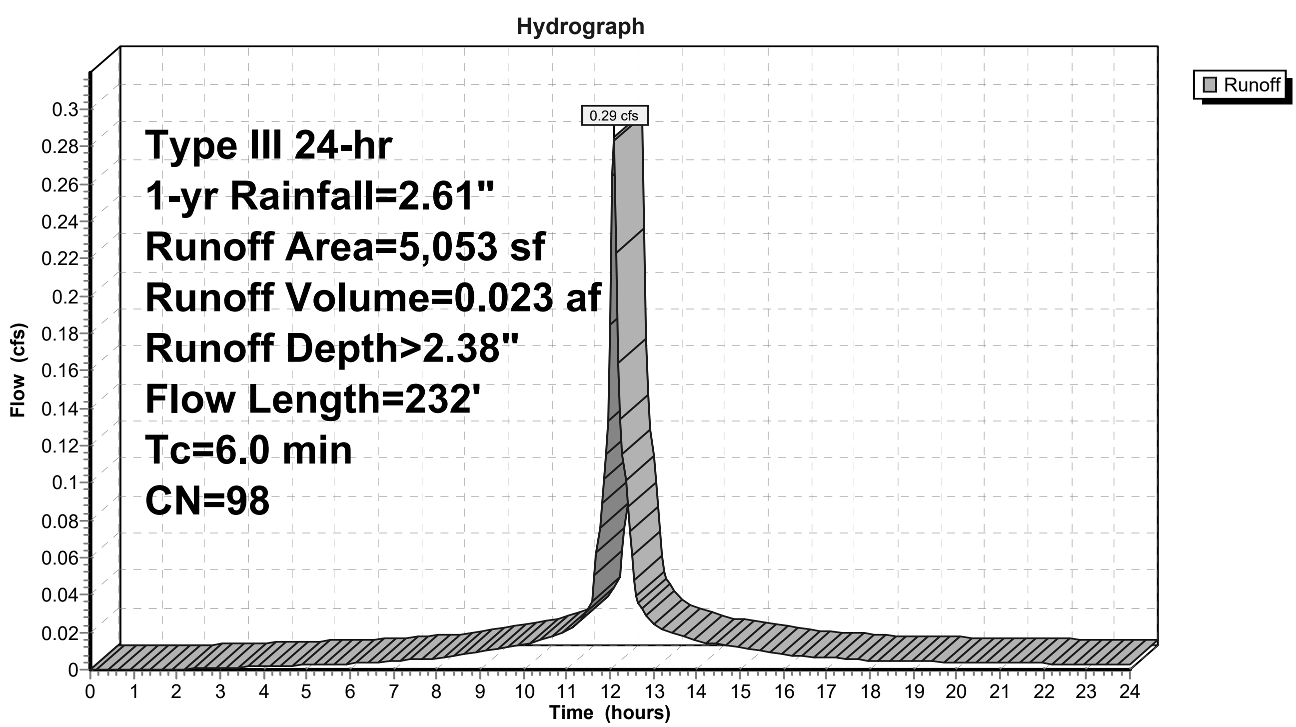
Runoff = 0.29 cfs @ 12.09 hrs, Volume= 0.023 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 5,053 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,053 | 98 | Weighted Average |
| 5,053 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.7 | 76 | 0.0405 | 1.71 | | **Sheet Flow, 76 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 0.3 | 156 | 0.0500 | 10.14 | 7.97 | **Pipe Channel, cb 1 - hydro 1**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.013 Corrugated PE, smooth interior |
| 1.0 | 232 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS8: PAVEMENT



## Summary for Subcatchment PS9: PAVEMENT

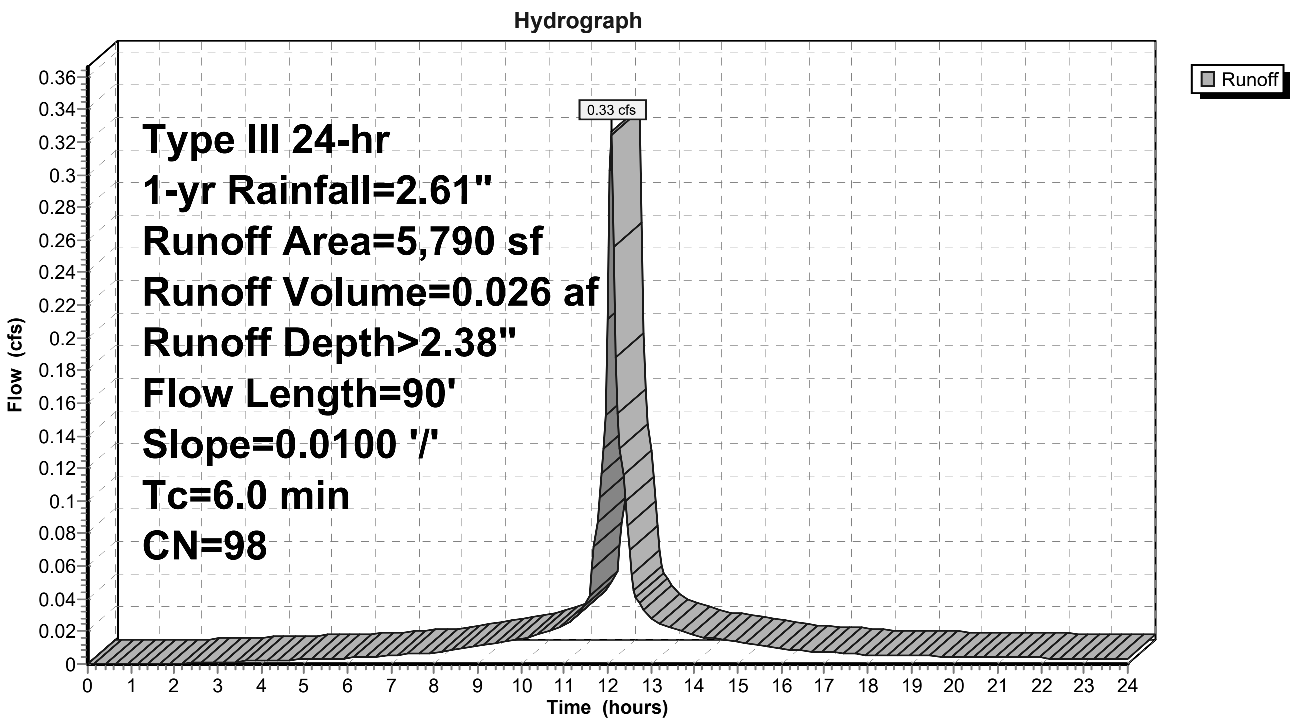
Runoff = 0.33 cfs @ 12.09 hrs, Volume= 0.026 af, Depth> 2.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 1-yr Rainfall=2.61"

| Area (sf) | CN | Description |
|---|---|---|
| 5,790 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,790 | 98 | Weighted Average |
| 5,790 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.5 | 90 | 0.0100 | 1.01 | | **Sheet Flow, 90 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 1.5 | 90 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS9: PAVEMENT

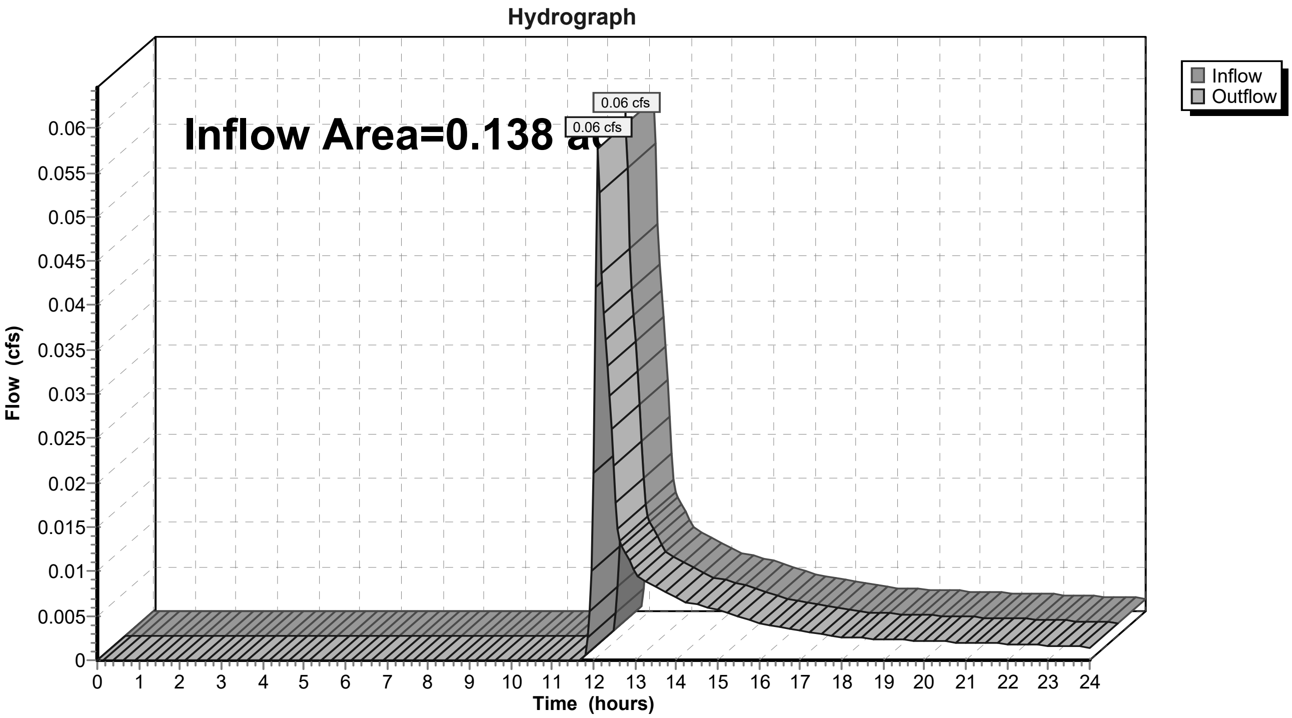


## Summary for Reach DP1:

Inflow Area = 0.138 ac, 0.00% Impervious, Inflow Depth > 0.47" for 1-yr event
Inflow = 0.06 cfs @ 12.11 hrs, Volume= 0.005 af
Outflow = 0.06 cfs @ 12.11 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

## Reach DP1:

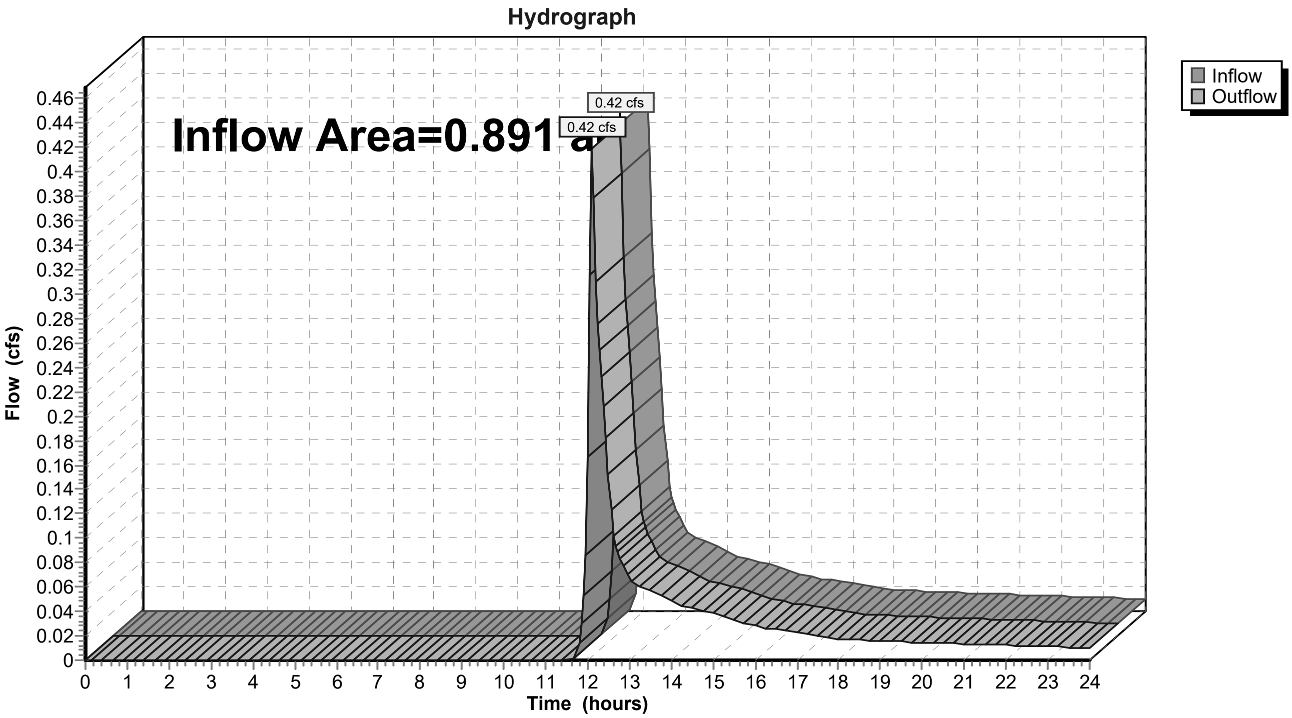


## Summary for Reach DP2:

Inflow Area = 0.891 ac, 4.42% Impervious, Inflow Depth > 0.51" for 1-yr event
Inflow = 0.42 cfs @ 12.11 hrs, Volume= 0.038 af
Outflow = 0.42 cfs @ 12.11 hrs, Volume= 0.038 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

## Reach DP2:

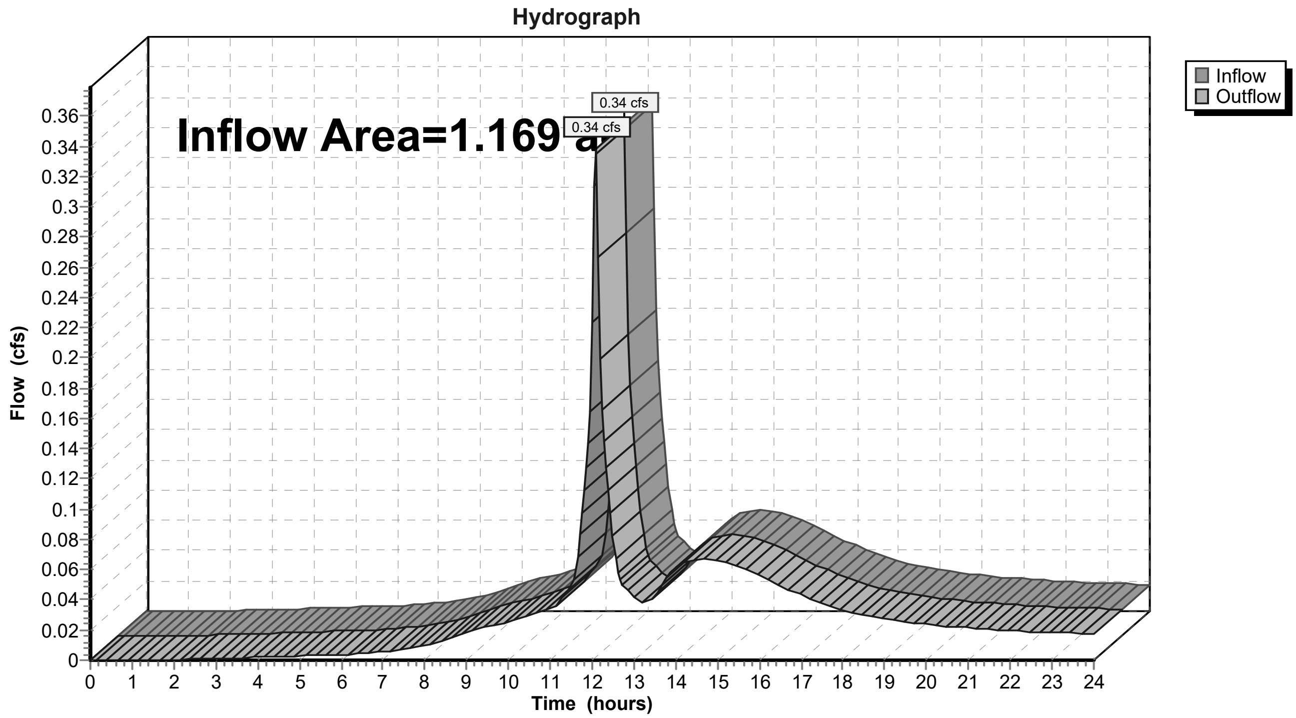


## Summary for Reach DP3: EX CB 3

Inflow Area = 1.169 ac, 75.19% Impervious, Inflow Depth > 0.57" for 1-yr event
Inflow = 0.34 cfs @ 12.09 hrs, Volume= 0.056 af
Outflow = 0.34 cfs @ 12.09 hrs, Volume= 0.056 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

### Reach DP3: EX CB 3



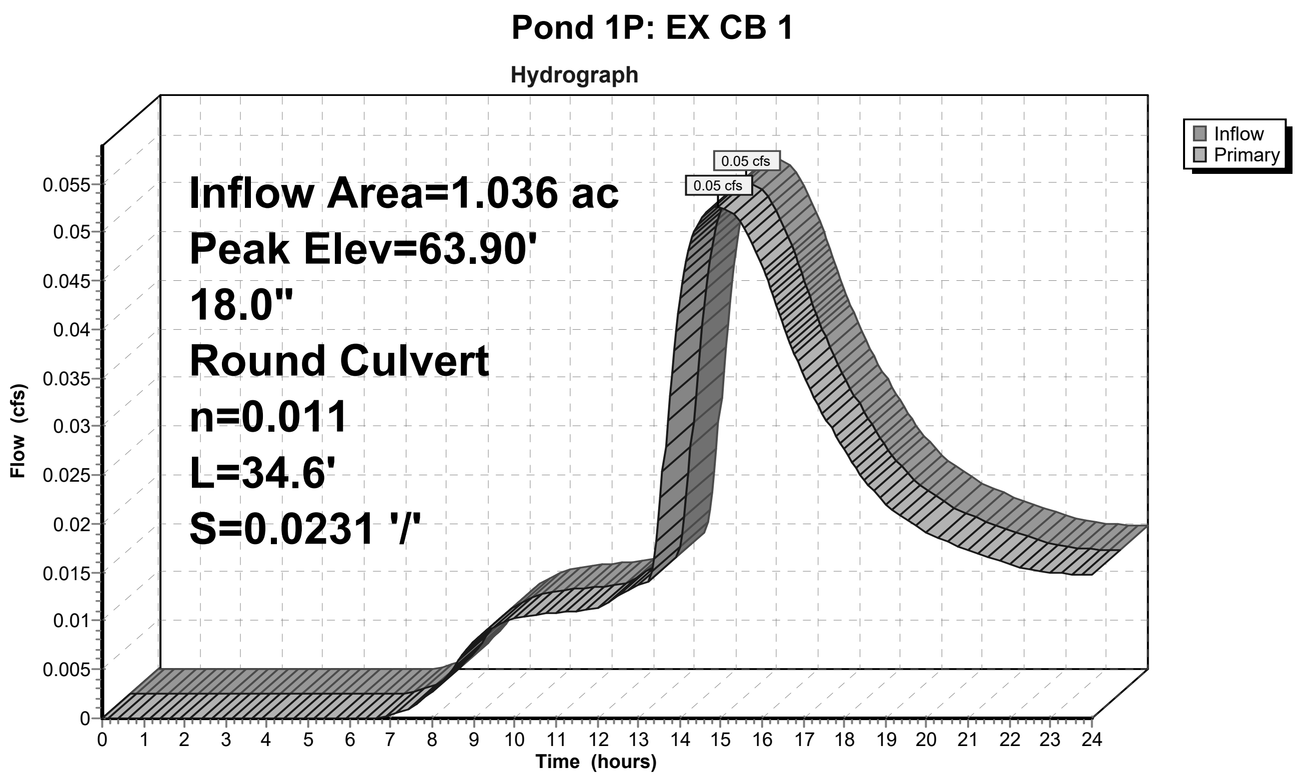
## Summary for Pond 1P: EX CB 1

Inflow Area = 1.036 ac, 72.00% Impervious, Inflow Depth > 0.34" for 1-yr event
Inflow = 0.05 cfs @ 14.93 hrs, Volume= 0.030 af
Outflow = 0.05 cfs @ 14.93 hrs, Volume= 0.030 af, Atten= 0%, Lag= 0.0 min
Primary = 0.05 cfs @ 14.93 hrs, Volume= 0.030 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 63.90' @ 14.93 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 63.80' | **18.0" Round Culvert**<br>L= 34.6' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 63.80' / 63.00' S= 0.0231 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.05 cfs @ 14.93 hrs HW=63.90' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.05 cfs @ 1.07 fps)



## Summary for Pond 2P: EX CB 2

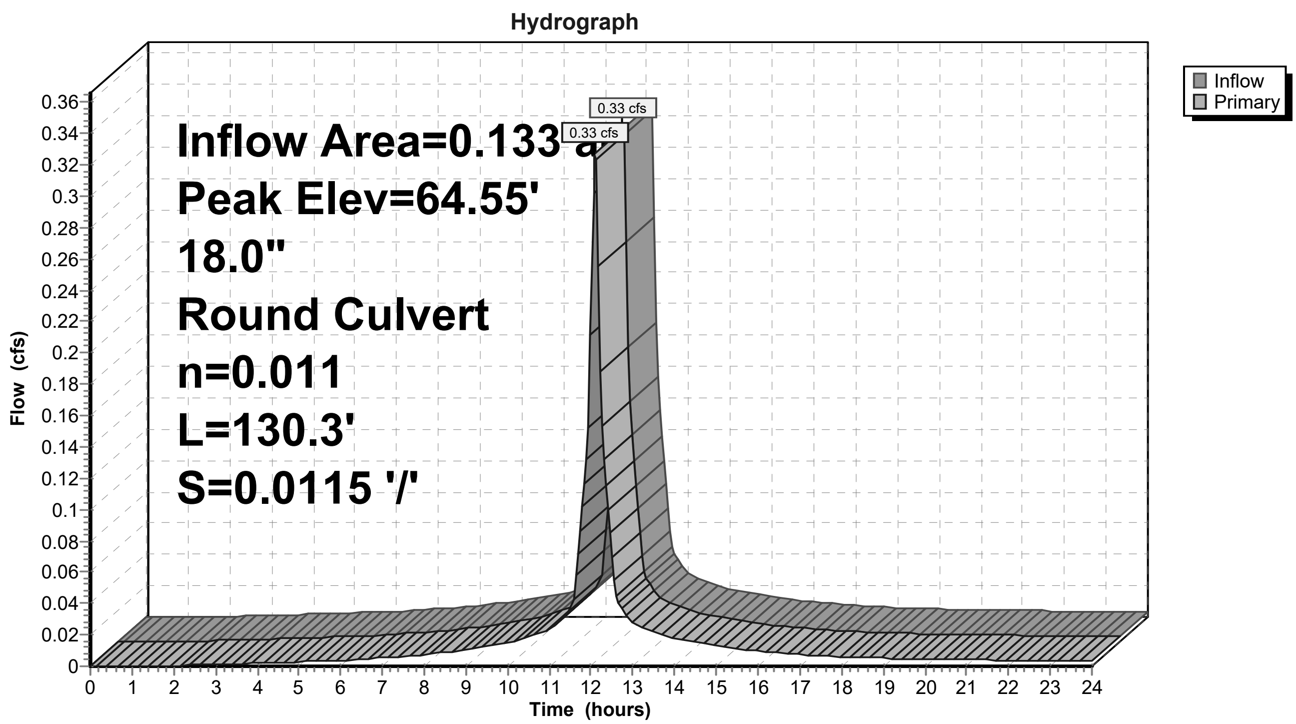
Inflow Area = 0.133 ac,100.00% Impervious, Inflow Depth > 2.38" for 1-yr event
Inflow = 0.33 cfs @ 12.09 hrs, Volume= 0.026 af
Outflow = 0.33 cfs @ 12.09 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min
Primary = 0.33 cfs @ 12.09 hrs, Volume= 0.026 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.55' @ 12.09 hrs
Flood Elev= 68.20'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.30' | **18.0" Round Culvert**<br>L= 130.3' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.30' / 62.80' S= 0.0115 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.32 cfs @ 12.09 hrs HW=64.55' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.32 cfs @ 1.69 fps)

### Pond 2P: EX CB 2



## Summary for Pond 3P: HYDRO 1

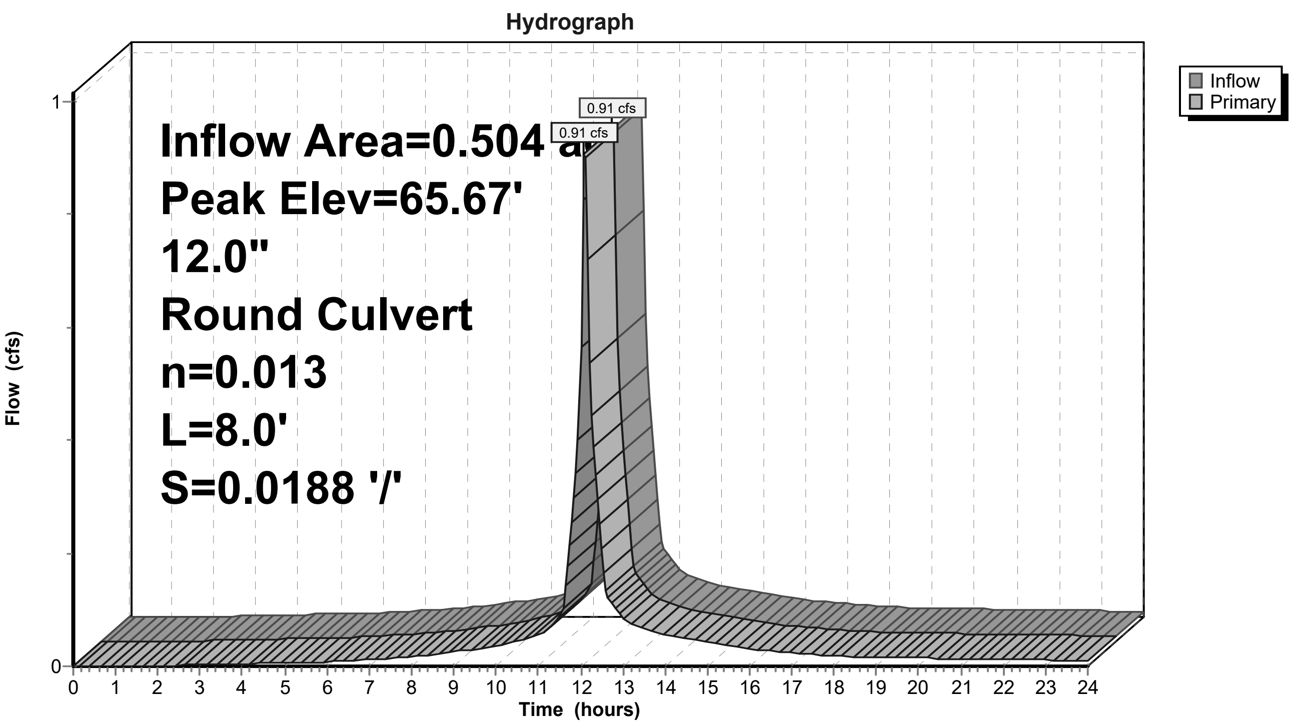
| | | | | |
|---|---|---|---|---|
| Inflow Area = | 0.504 ac, | 68.58% Impervious, | Inflow Depth > 1.73" | for 1-yr event |
| Inflow = | 0.91 cfs @ | 12.09 hrs, Volume= | 0.073 af | |
| Outflow = | 0.91 cfs @ | 12.09 hrs, Volume= | 0.073 af, Atten= 0%, Lag= 0.0 min | |
| Primary = | 0.91 cfs @ | 12.09 hrs, Volume= | 0.073 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 65.67' @ 12.09 hrs
Flood Elev= 68.50'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 65.15' | **12.0" Round Culvert**<br>L= 8.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.15' / 65.00' S= 0.0188 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=0.89 cfs @ 12.09 hrs HW=65.67' TW=63.08' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.89 cfs @ 3.15 fps)

### Pond 3P: HYDRO 1



## Summary for Pond 4P: INFILTRATORS

Inflow Area = 0.504 ac, 68.58% Impervious, Inflow Depth > 1.73" for 1-yr event
Inflow = 0.91 cfs @ 12.09 hrs, Volume= 0.073 af
Outflow = 0.63 cfs @ 12.10 hrs, Volume= 0.073 af, Atten= 30%, Lag= 0.6 min
Discarded = 0.63 cfs @ 12.10 hrs, Volume= 0.073 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 63.15' @ 12.17 hrs Surf.Area= 1,610 sf Storage= 95 cf
Flood Elev= 66.00' Surf.Area= 1,610 sf Storage= 3,090 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.3 min ( 780.2 - 779.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 63.00' | 1,482 cf | **34.75'W x 46.34'L x 3.50'H Field A**<br>5,636 cf Overall - 1,929 cf Embedded = 3,706 cf x 40.0% Voids |
| #2A | 63.50' | 1,929 cf | **ADS_StormTech SC-740 +Cap** x 42 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap<br>7 Rows of 6 Chambers |
| | | 3,412 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 63.00' | **17.000 in/hr Exfiltration over Surface area** |
| #2 | Primary | 65.50' | **6.0" Round Culvert**<br>L= 22.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.50' / 65.00' S= 0.0227 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf |

**Discarded OutFlow** Max=0.63 cfs @ 12.10 hrs HW=63.09' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.63 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=63.00' TW=64.00' (Dynamic Tailwater)
└─**2=Culvert** ( Controls 0.00 cfs)

## Pond 4P: INFILTRATORS - Chamber Wizard Field A

**Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

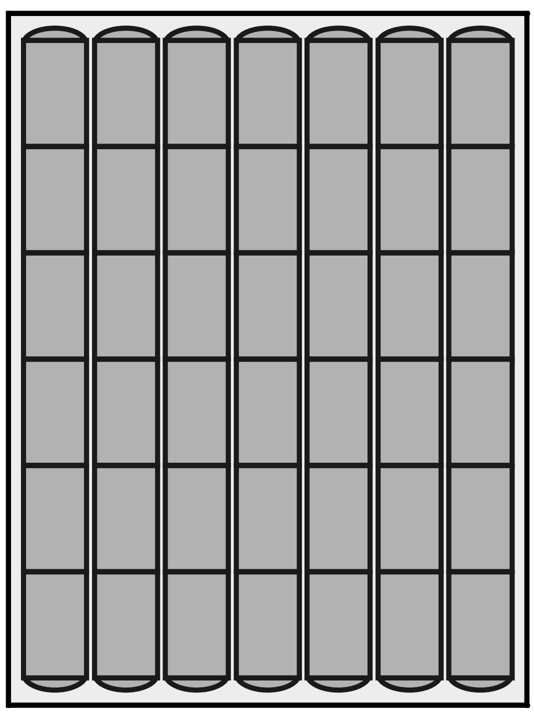
6 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 44.34' Row Length +12.0" End Stone x 2 = 46.34' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

42 Chambers x 45.9 cf = 1,929.5 cf Chamber Storage

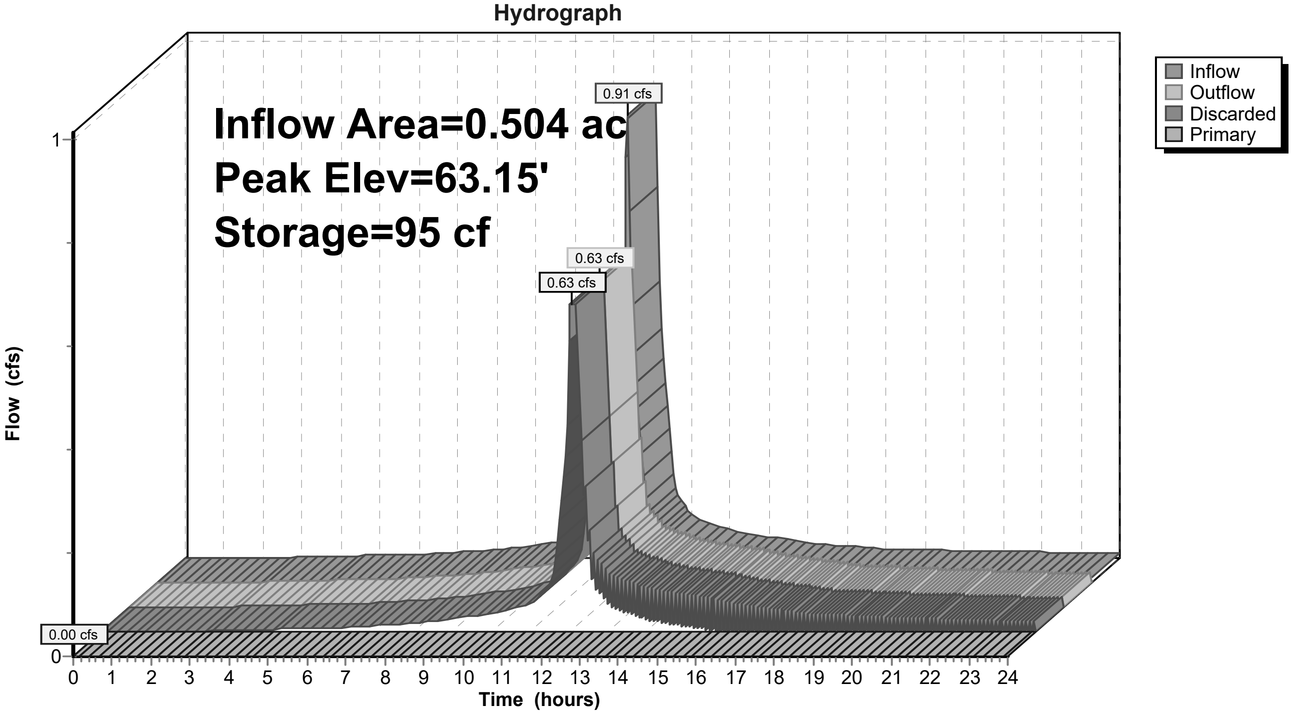
5,635.7 cf Field - 1,929.5 cf Chambers = 3,706.2 cf Stone x 40.0% Voids = 1,482.5 cf Stone Storage

Chamber Storage + Stone Storage = 3,412.0 cf = 0.078 af
Overall Storage Efficiency = 60.5%
Overall System Size = 46.34' x 34.75' x 3.50'

42 Chambers
208.7 cy Field
137.3 cy Stone



## Pond 4P: INFILTRATORS



## Summary for Pond 5P: DETENTION

Inflow Area = 0.504 ac, 68.58% Impervious, Inflow Depth = 0.00" for 1-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.00' @ 0.00 hrs Surf.Area= 0 sf Storage= 0 cf
Flood Elev= 65.50' Surf.Area= 0 sf Storage= 136 cf

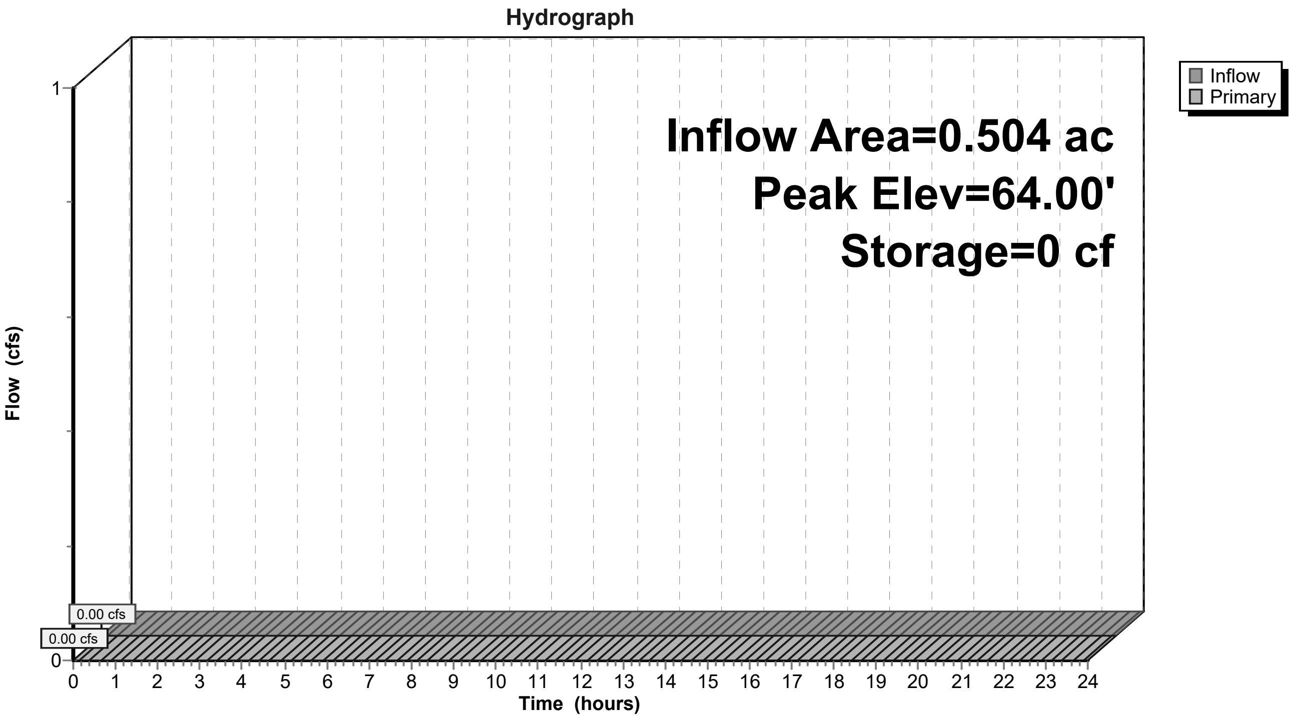
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 64.00' | 136 cf | **18.0" Round Pipe Storage**<br>L= 77.0' |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.00' | **8.0" Round Culvert**<br>L= 29.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.00' / 63.80' S= 0.0069 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |
| #2 | Device 1 | 64.00' | **3.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=64.00' TW=63.80' (Dynamic Tailwater)
└─**1=Culvert** ( Controls 0.00 cfs)
  └─**2=Orifice/Grate** ( Controls 0.00 cfs)

## Pond 5P: DETENTION



## Summary for Pond 6P: OCS 1

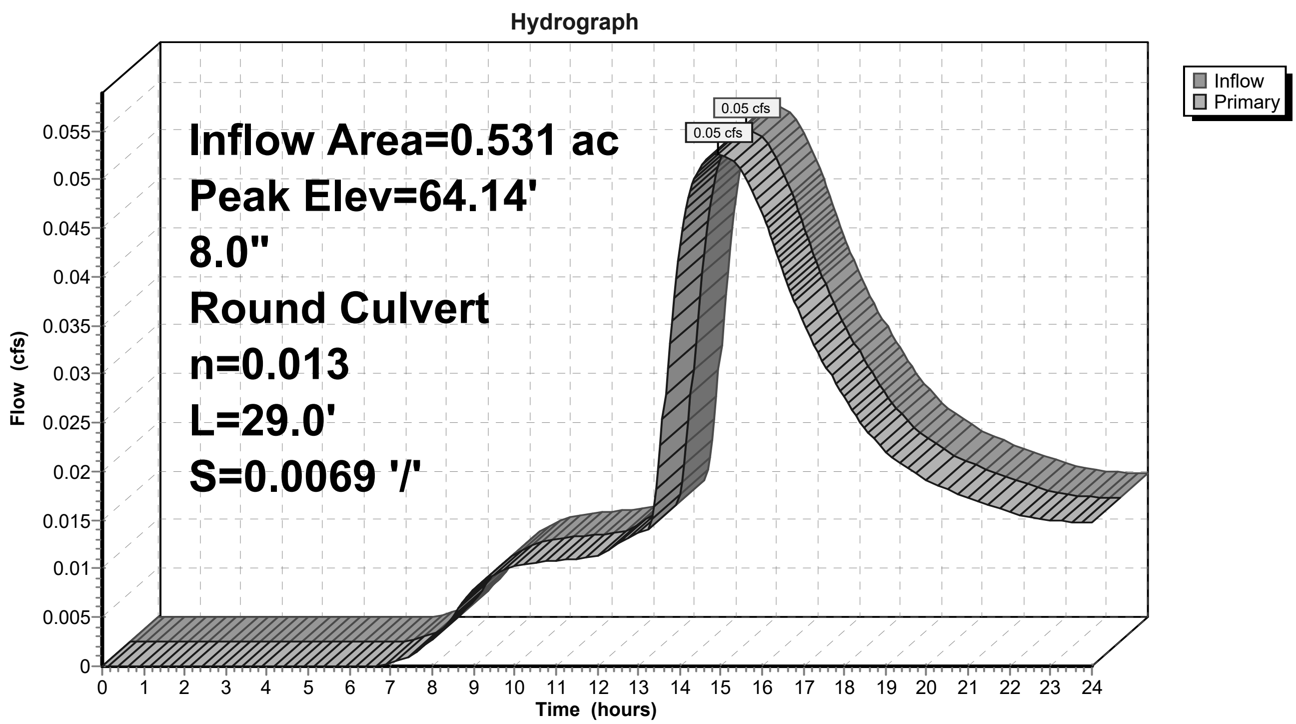
Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 0.67" for 1-yr event
Inflow = 0.05 cfs @ 14.93 hrs, Volume= 0.030 af
Outflow = 0.05 cfs @ 14.93 hrs, Volume= 0.030 af, Atten= 0%, Lag= 0.0 min
Primary = 0.05 cfs @ 14.93 hrs, Volume= 0.030 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.14' @ 14.93 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.00' | **8.0" Round Culvert**<br>L= 29.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.00' / 63.80' S= 0.0069 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |

**Primary OutFlow** Max=0.05 cfs @ 14.93 hrs HW=64.14' TW=63.90' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.05 cfs @ 1.48 fps)

### Pond 6P: OCS 1



## Summary for Pond 7P: MODIFEID BIO

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 1.71" for 1-yr event
Inflow = 1.04 cfs @ 12.09 hrs, Volume= 0.076 af
Outflow = 0.07 cfs @ 13.90 hrs, Volume= 0.030 af, Atten= 94%, Lag= 108.6 min
Primary = 0.07 cfs @ 13.90 hrs, Volume= 0.030 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 69.02' @ 13.90 hrs Surf.Area= 2,559 sf Storage= 2,051 cf
Flood Elev= 69.50' Surf.Area= 2,746 sf Storage= 3,311 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 149.5 min ( 959.3 - 809.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 68.10' | 3,311 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

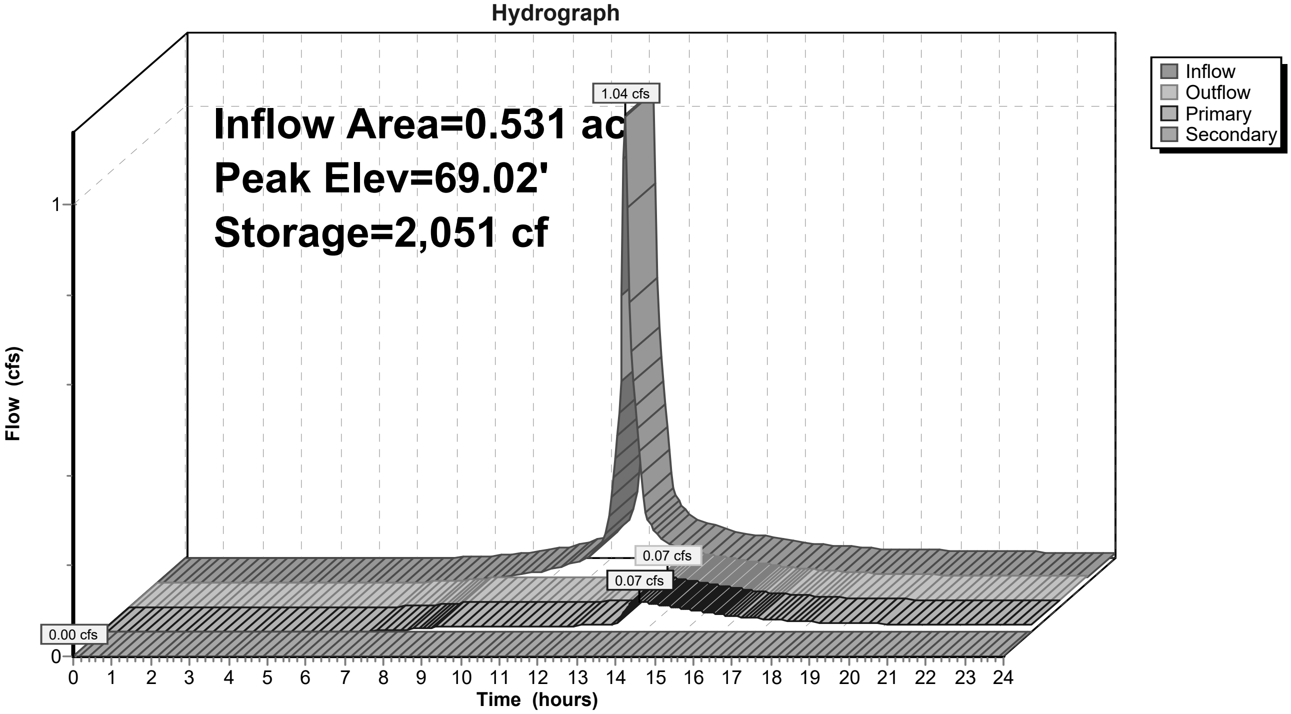
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 68.10 | 1,867 | 0 | 0 |
| 69.00 | 2,549 | 1,987 | 1,987 |
| 69.50 | 2,746 | 1,324 | 3,311 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 65.58' | **12.0" Round Culvert**<br>L= 5.2' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.58' / 65.55' S= 0.0058 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Secondary | 69.15' | **12.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 68.10' | **0.250 in/hr Exfiltration over Surface area** |
| #4 | Device 1 | 69.00' | **12.0" x 12.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=0.07 cfs @ 13.90 hrs HW=69.02' TW=64.21' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.07 cfs of 6.49 cfs potential flow)
  ├─**3=Exfiltration** (Exfiltration Controls 0.01 cfs)
  └─**4=Orifice/Grate** (Weir Controls 0.05 cfs @ 0.52 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=68.10' TW=0.00' (Dynamic Tailwater)
└─**2=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)

## Pond 7P: MODIFEID BIO



## Summary for Pond 8P: DETENTION

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 0.69" for 1-yr event
Inflow = 0.07 cfs @ 13.90 hrs, Volume= 0.030 af
Outflow = 0.05 cfs @ 14.93 hrs, Volume= 0.030 af, Atten= 21%, Lag= 61.7 min
Primary = 0.05 cfs @ 14.93 hrs, Volume= 0.030 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.26' @ 14.93 hrs Surf.Area= 971 sf Storage= 135 cf
Flood Elev= 67.05' Surf.Area= 0 sf Storage= 4,524 cf

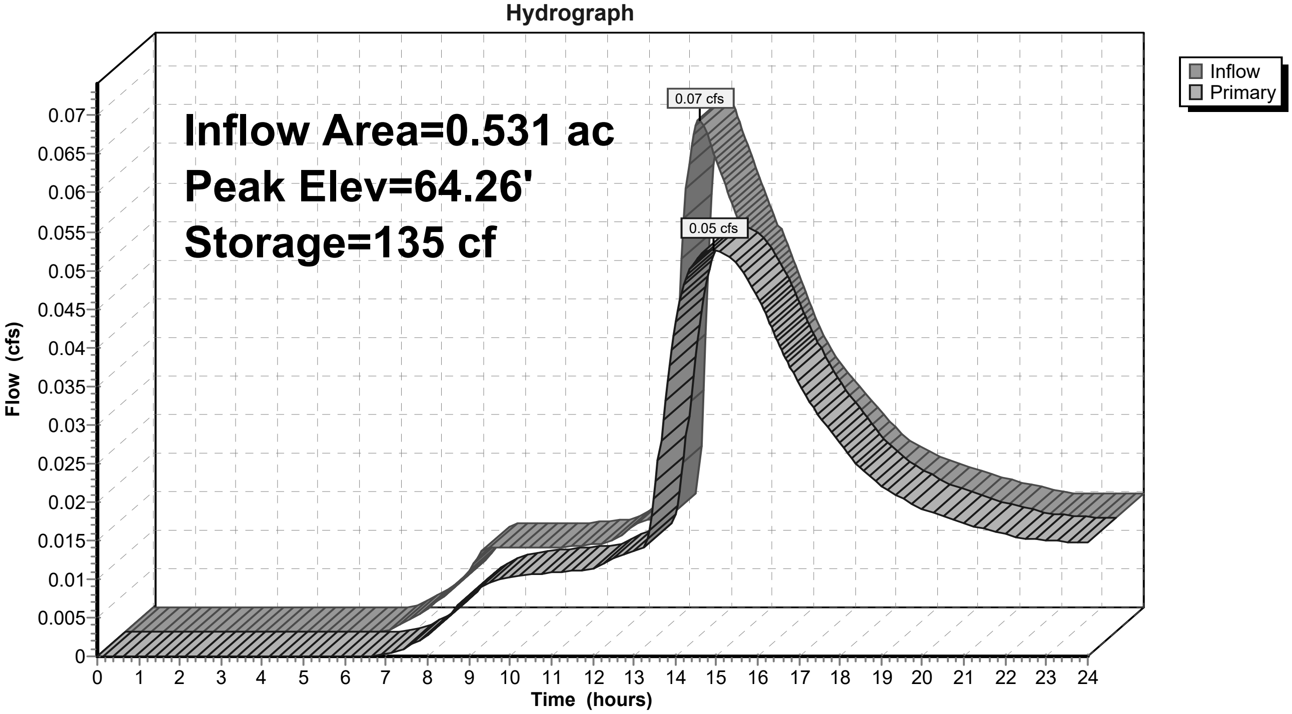
Plug-Flow detention time= 42.7 min calculated for 0.030 af (97% of inflow)
Center-of-Mass det. time= 28.3 min ( 987.7 - 959.3 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 64.05' | 4,524 cf | **36.0" Round Pipe Storage** x 4<br>L= 160.0' |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.05' | **2.5" Vert. Orifice/Grate** C= 0.600 |
| #2 | Primary | 65.45' | **2.0" Vert. Orifice/Grate** C= 0.600 |
| #3 | Primary | 66.35' | **6.5" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.05 cfs @ 14.93 hrs HW=64.26' TW=64.14' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.05 cfs @ 1.55 fps)
├─**2=Orifice/Grate** ( Controls 0.00 cfs)
└─**3=Orifice/Grate** ( Controls 0.00 cfs)

## Pond 8P: DETENTION



## Summary for Pond 9P: MH 1

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 1.71" for 1-yr event
Inflow = 1.04 cfs @ 12.09 hrs, Volume= 0.076 af
Outflow = 1.04 cfs @ 12.09 hrs, Volume= 0.076 af, Atten= 0%, Lag= 0.0 min
Primary = 1.04 cfs @ 12.09 hrs, Volume= 0.076 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

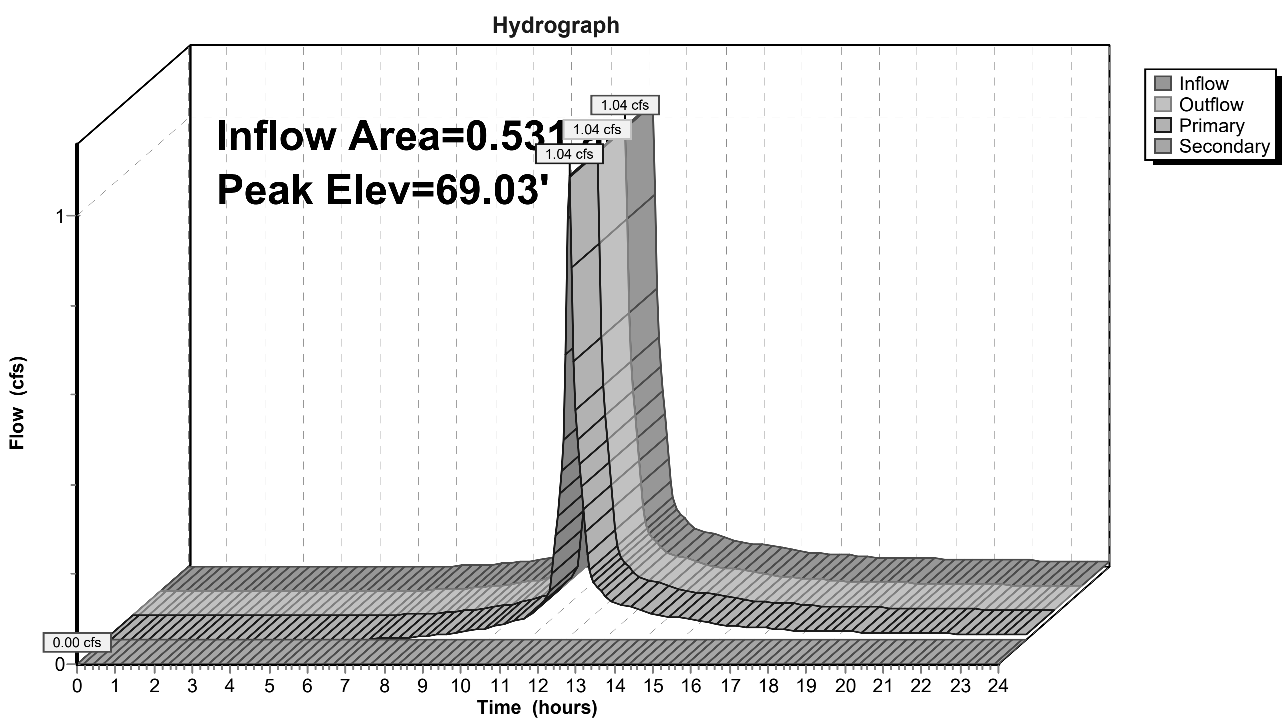
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 69.03' @ 13.87 hrs
Flood Elev= 71.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 68.17' | **10.0" Round Culvert**<br>L= 6.4' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 68.17' / 68.14' S= 0.0047 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf |
| #2 | Secondary | 69.17' | **12.0" Round Culvert**<br>L= 78.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 69.17' / 66.05' S= 0.0400 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=1.02 cfs @ 12.09 hrs HW=68.99' TW=68.84' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.02 cfs @ 1.87 fps)

**Secondary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=68.17' TW=64.05' (Dynamic Tailwater)
└─**2=Culvert** ( Controls 0.00 cfs)

### Pond 9P: MH 1



## Summary for Pond 10P: HYDRO 2

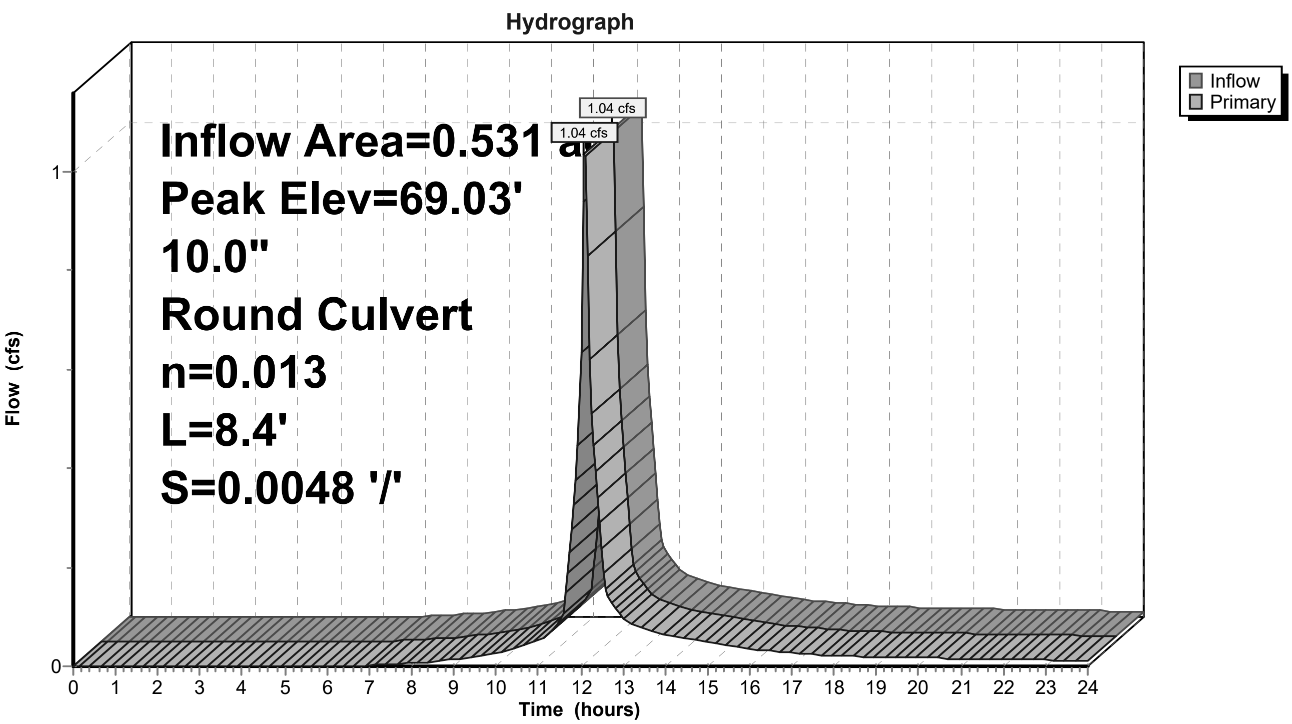
| | | | |
|---|---|---|---|
| Inflow Area = | 0.531 ac, 75.25% Impervious, Inflow Depth > 1.71" for 1-yr event | | |
| Inflow = | 1.04 cfs @ 12.09 hrs, Volume= | 0.076 af | |
| Outflow = | 1.04 cfs @ 12.09 hrs, Volume= | 0.076 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 1.04 cfs @ 12.09 hrs, Volume= | 0.076 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 69.03' @ 13.89 hrs
Flood Elev= 70.75'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 68.14' | **10.0" Round Culvert**<br>L= 8.4' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 68.14' / 68.10' S= 0.0048 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf |

**Primary OutFlow** Max=1.01 cfs @ 12.09 hrs HW=68.84' TW=68.57' (Dynamic Tailwater)
└1=**Culvert** (Barrel Controls 1.01 cfs @ 2.79 fps)

### Pond 10P: HYDRO 2



## Summary for Subcatchment PS1:

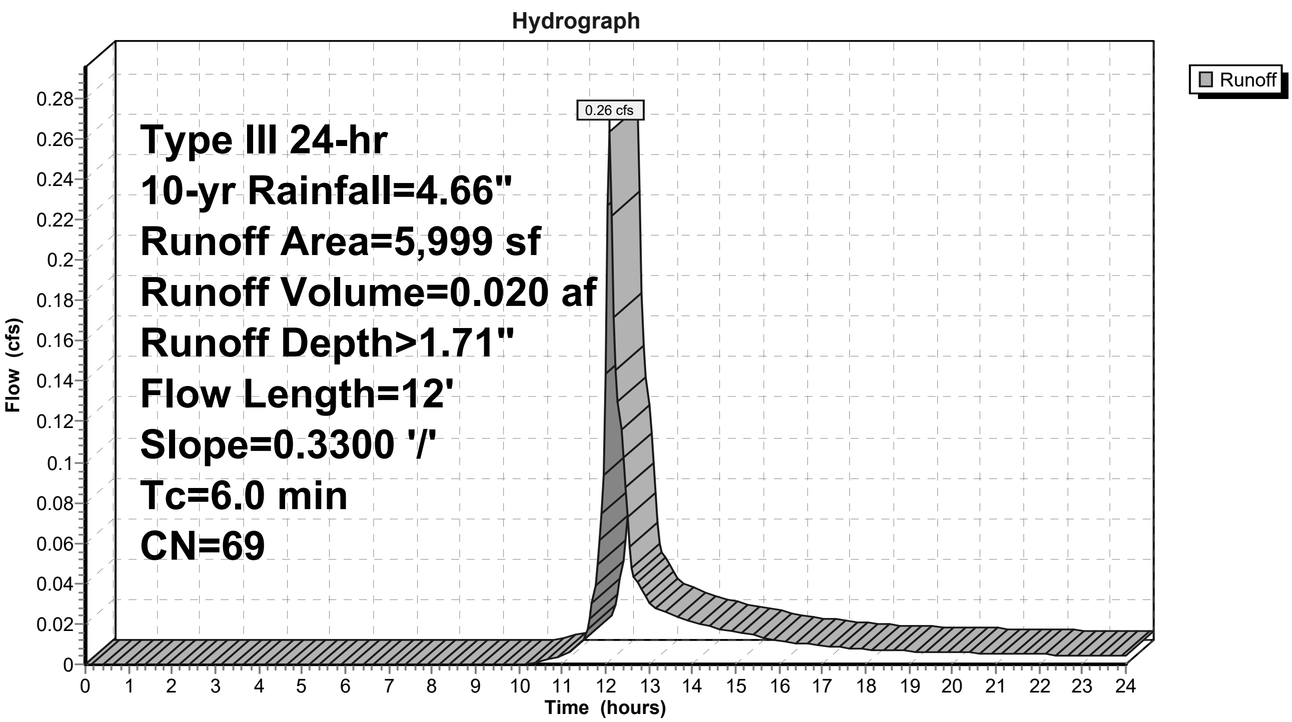
Runoff = 0.26 cfs @ 12.10 hrs, Volume= 0.020 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 0 | 98 | Paved parking, HSG B |
| 5,999 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,999 | 69 | Weighted Average |
| 5,999 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.6 | 12 | 0.3300 | 0.34 | | **Sheet Flow, 12 ft grass** Grass: Short n= 0.150 P2= 3.15" |
| 0.6 | 12 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS1:



## Summary for Subcatchment PS2:

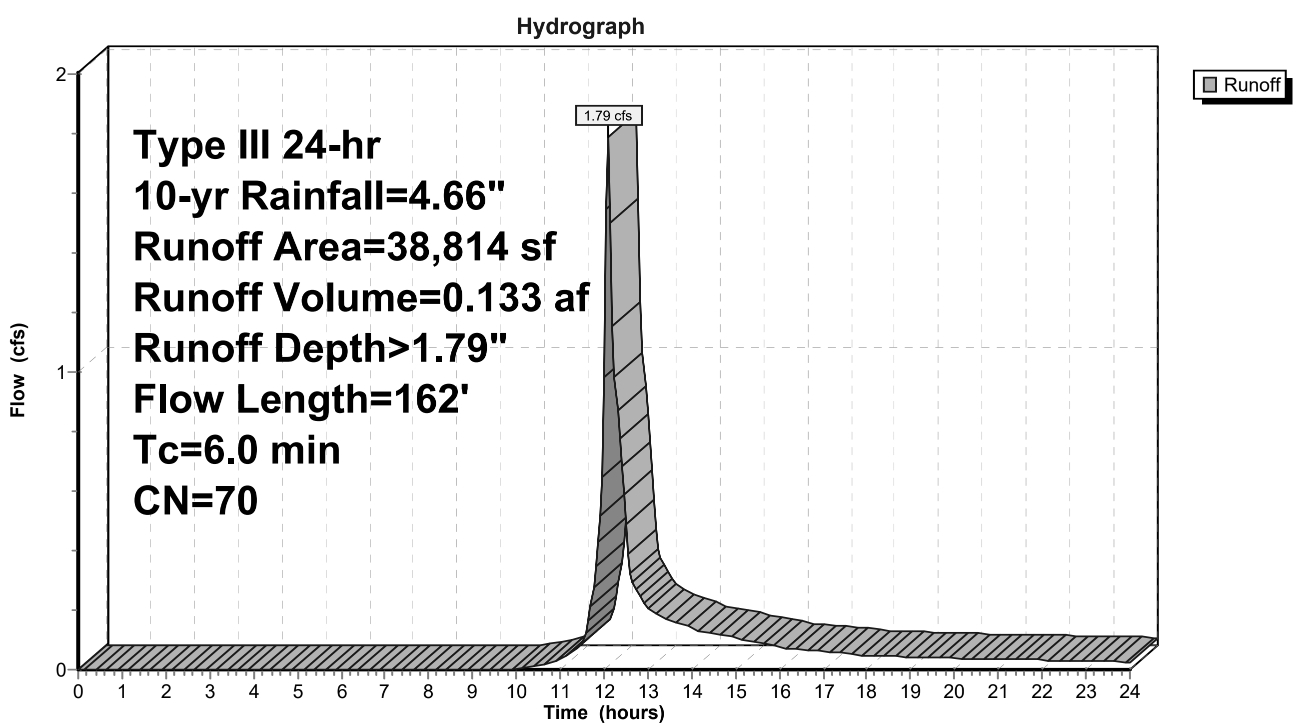
Runoff = 1.79 cfs @ 12.10 hrs, Volume= 0.133 af, Depth> 1.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 1,714 | 98 | Paved parking, HSG B |
| 37,100 | 69 | 50-75% Grass cover, Fair, HSG B |
| 38,814 | 70 | Weighted Average |
| 37,100 | | 95.58% Pervious Area |
| 1,714 | | 4.42% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 27 | 0.1850 | 0.32 | | **Sheet Flow, 27 ft grass** Grass: Short n= 0.150 P2= 3.15" |
| 1.9 | 135 | 0.0296 | 1.20 | | **Shallow Concentrated Flow, 78 ft grass** Short Grass Pasture Kv= 7.0 fps |
| 3.3 | 162 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS2:



## Summary for Subcatchment PS3: PARKING

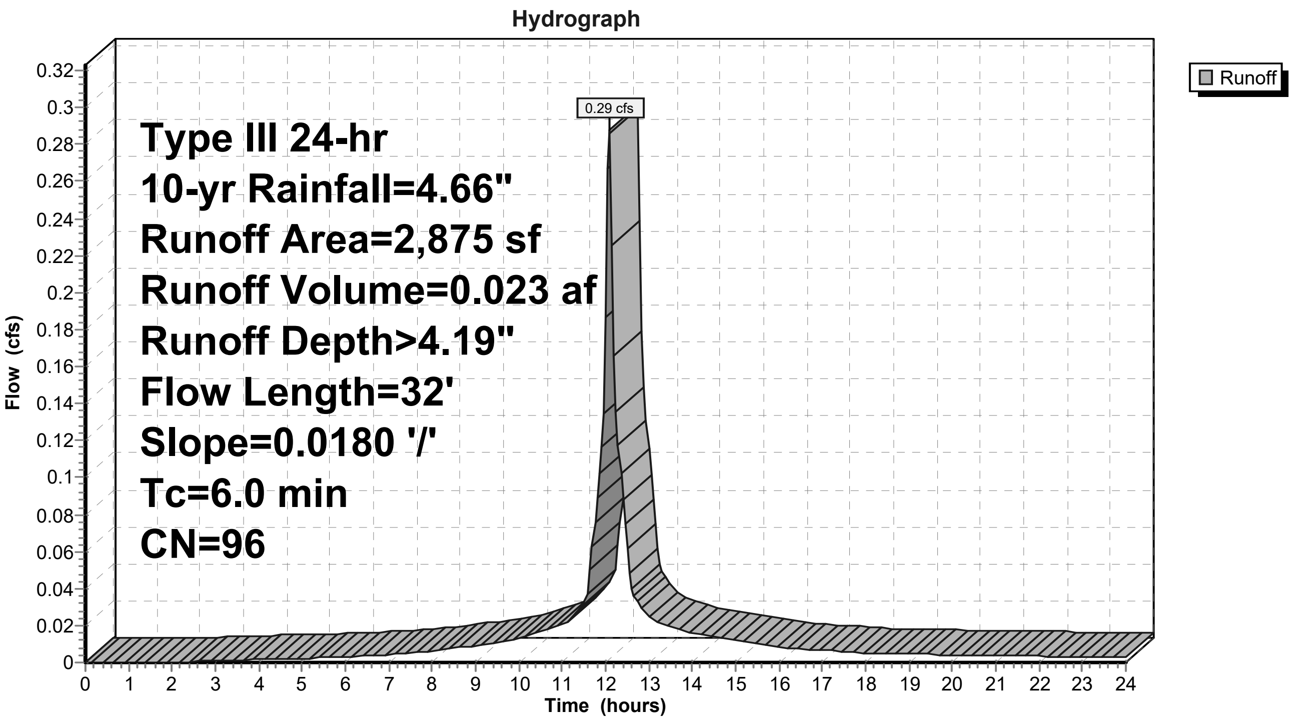
Runoff = 0.29 cfs @ 12.09 hrs, Volume= 0.023 af, Depth> 4.19"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 2,710 | 98 | Paved parking, HSG B |
| 165 | 69 | 50-75% Grass cover, Fair, HSG B |
| 2,875 | 96 | Weighted Average |
| 165 | | 5.74% Pervious Area |
| 2,710 | | 94.26% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.5 | 32 | 0.0180 | 1.04 | | **Sheet Flow, 32 ft paved** Smooth surfaces n= 0.011 P2= 3.15" |
| 0.5 | 32 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS3: PARKING



## Summary for Subcatchment PS4: BLDG

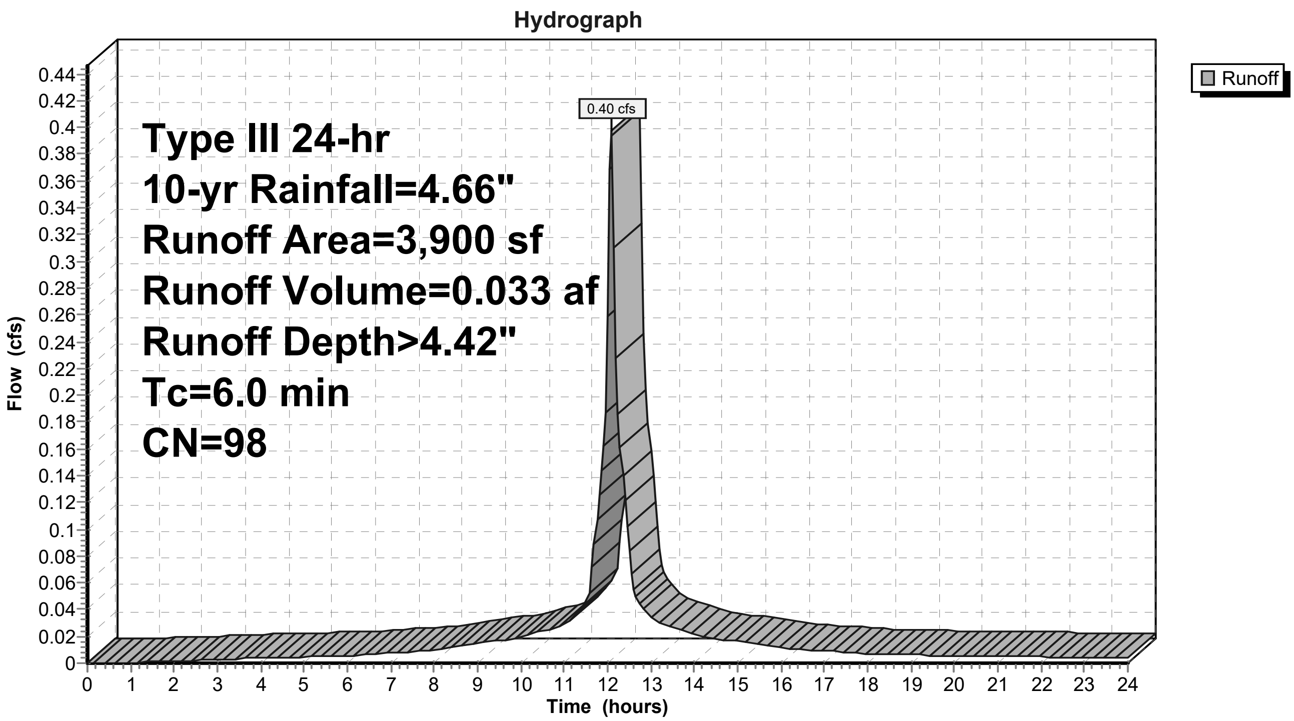
Runoff = 0.40 cfs @ 12.09 hrs, Volume= 0.033 af, Depth> 4.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 3,900 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 3,900 | 98 | Weighted Average |
| 3,900 | | 100.00% Impervious Area |

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

## Subcatchment PS4: BLDG



## Summary for Subcatchment PS5: CANOPY

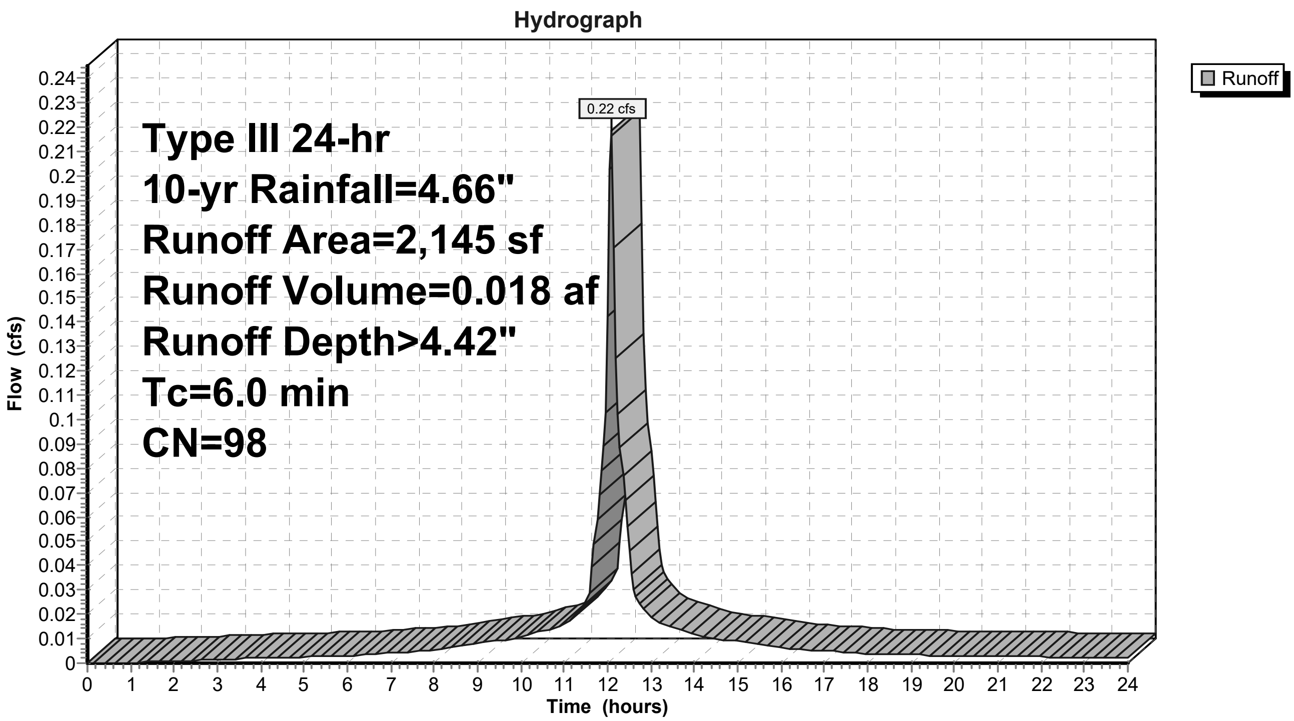
Runoff = 0.22 cfs @ 12.09 hrs, Volume= 0.018 af, Depth> 4.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 2,145 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 2,145 | 98 | Weighted Average |
| 2,145 | | 100.00% Impervious Area |

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

## Subcatchment PS5: CANOPY



## Summary for Subcatchment PS6: PARKING/GRASS

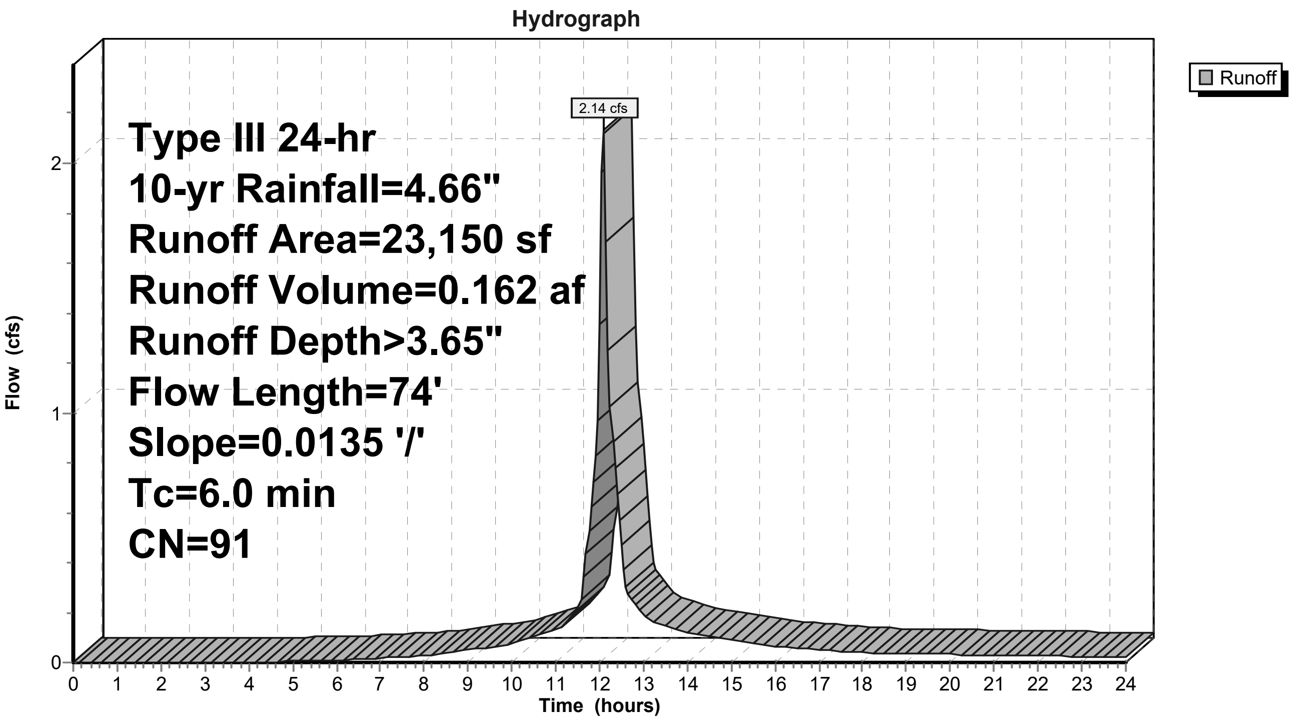
Runoff = 2.14 cfs @ 12.09 hrs, Volume= 0.162 af, Depth> 3.65"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 17,420 | 98 | Paved parking, HSG B |
| 5,730 | 69 | 50-75% Grass cover, Fair, HSG B |
| 23,150 | 91 | Weighted Average |
| 5,730 | | 24.75% Pervious Area |
| 17,420 | | 75.25% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.1 | 74 | 0.0135 | 1.10 | | **Sheet Flow, 74 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 1.1 | 74 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS6: PARKING/GRASS



## Summary for Subcatchment PS7: SIDEWALK/GRASS

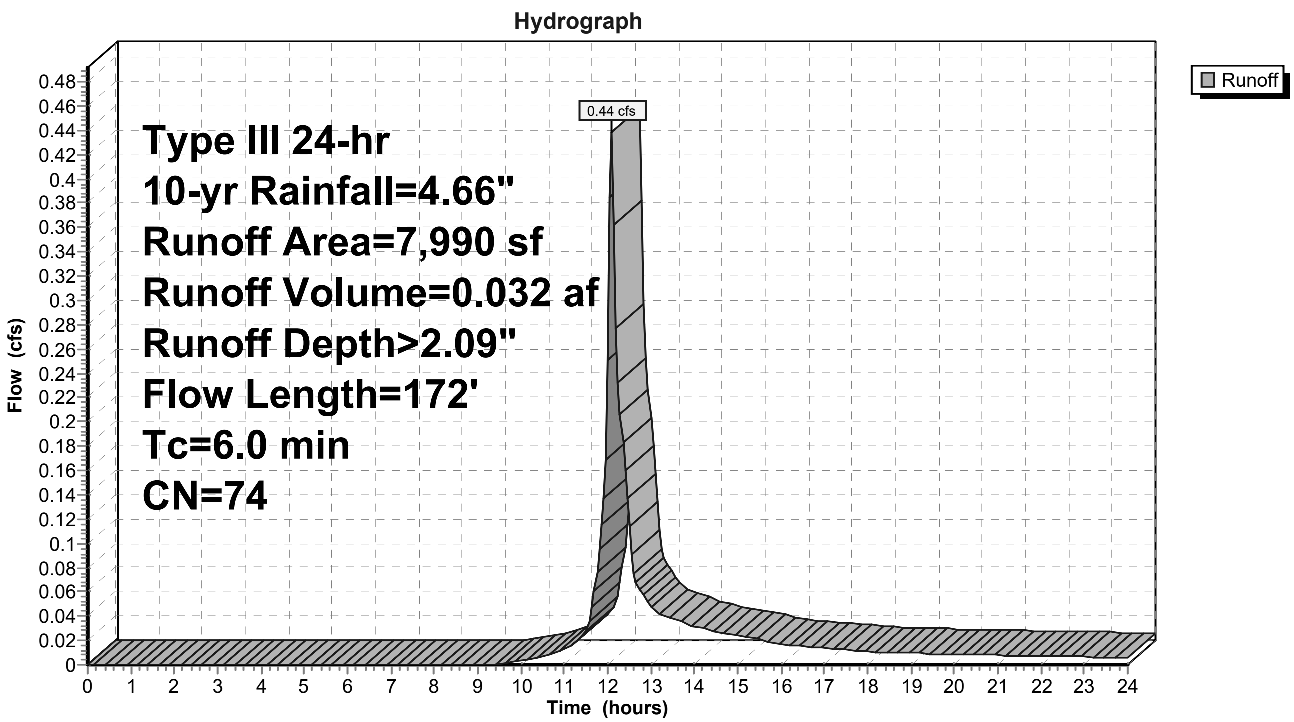
Runoff = 0.44 cfs @ 12.10 hrs, Volume= 0.032 af, Depth> 2.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 1,255 | 98 | Paved parking, HSG B |
| 6,735 | 69 | 50-75% Grass cover, Fair, HSG B |
| 7,990 | 74 | Weighted Average |
| 6,735 | | 84.29% Pervious Area |
| 1,255 | | 15.71% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.8 | 18 | 0.3300 | 0.37 | | **Sheet Flow, 18 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 0.8 | 33 | 0.0100 | 0.70 | | **Shallow Concentrated Flow, 33 ft grass**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.2 | 121 | 0.0500 | 10.14 | 7.97 | **Pipe Channel, yd 2 - hydro 1**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.013 Corrugated PE, smooth interior |
| 1.8 | 172 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS7: SIDEWALK/GRASS



## Summary for Subcatchment PS8: PAVEMENT

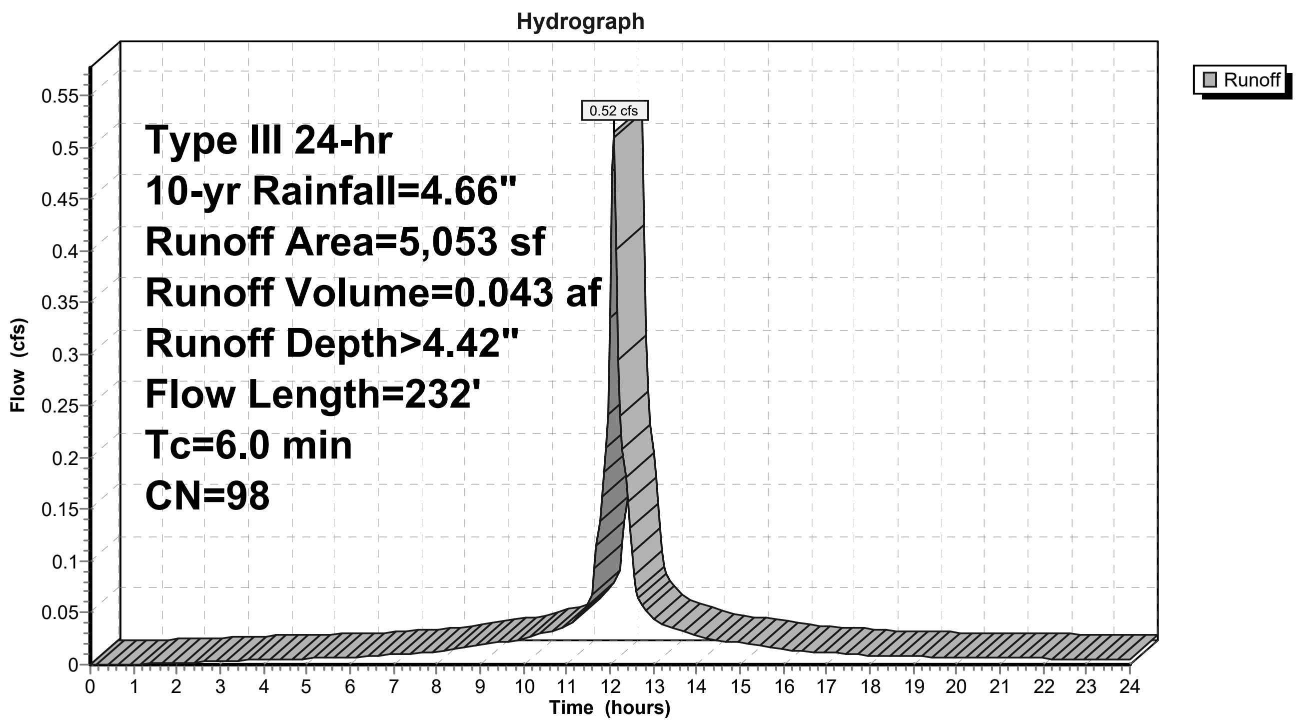
Runoff = 0.52 cfs @ 12.09 hrs, Volume= 0.043 af, Depth> 4.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 5,053 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,053 | 98 | Weighted Average |
| 5,053 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.7 | 76 | 0.0405 | 1.71 | | **Sheet Flow, 76 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 0.3 | 156 | 0.0500 | 10.14 | 7.97 | **Pipe Channel, cb 1 - hydro 1**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.013 Corrugated PE, smooth interior |
| 1.0 | 232 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS8: PAVEMENT



## Summary for Subcatchment PS9: PAVEMENT

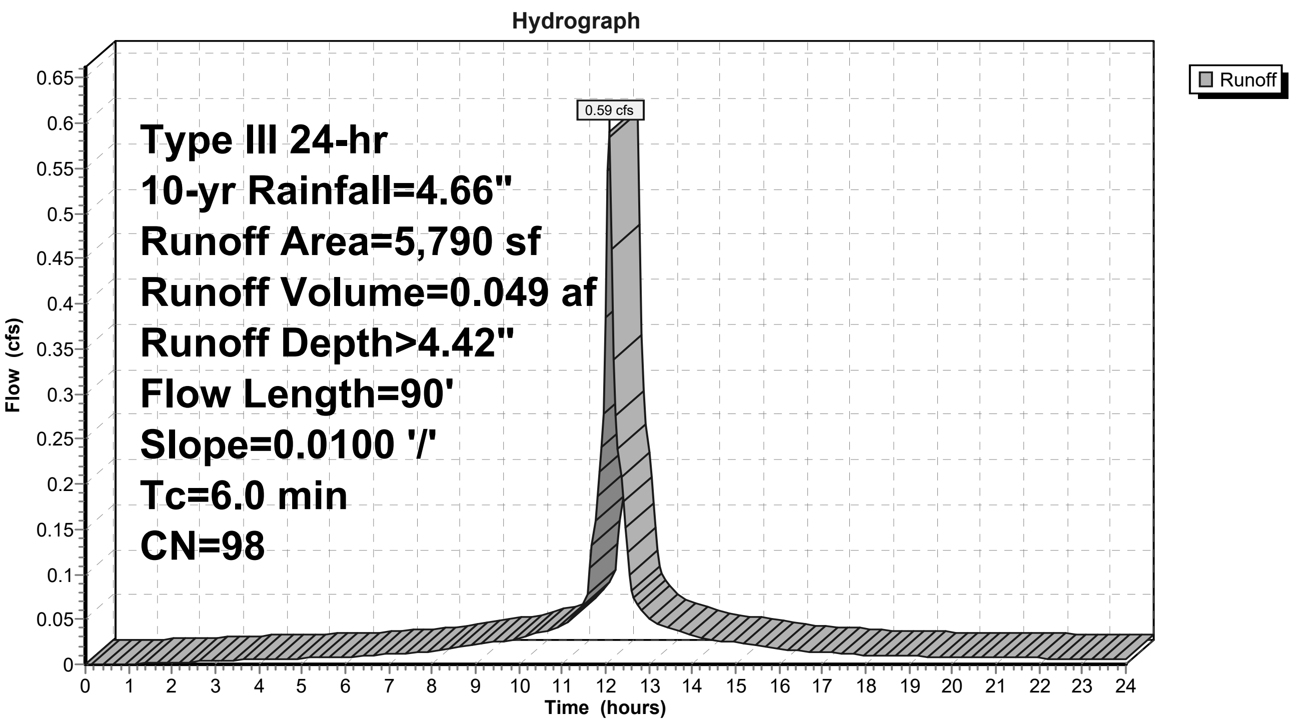
Runoff = 0.59 cfs @ 12.09 hrs, Volume= 0.049 af, Depth> 4.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-yr Rainfall=4.66"

| Area (sf) | CN | Description |
|---|---|---|
| 5,790 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,790 | 98 | Weighted Average |
| 5,790 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.5 | 90 | 0.0100 | 1.01 | | **Sheet Flow, 90 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 1.5 | 90 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS9: PAVEMENT

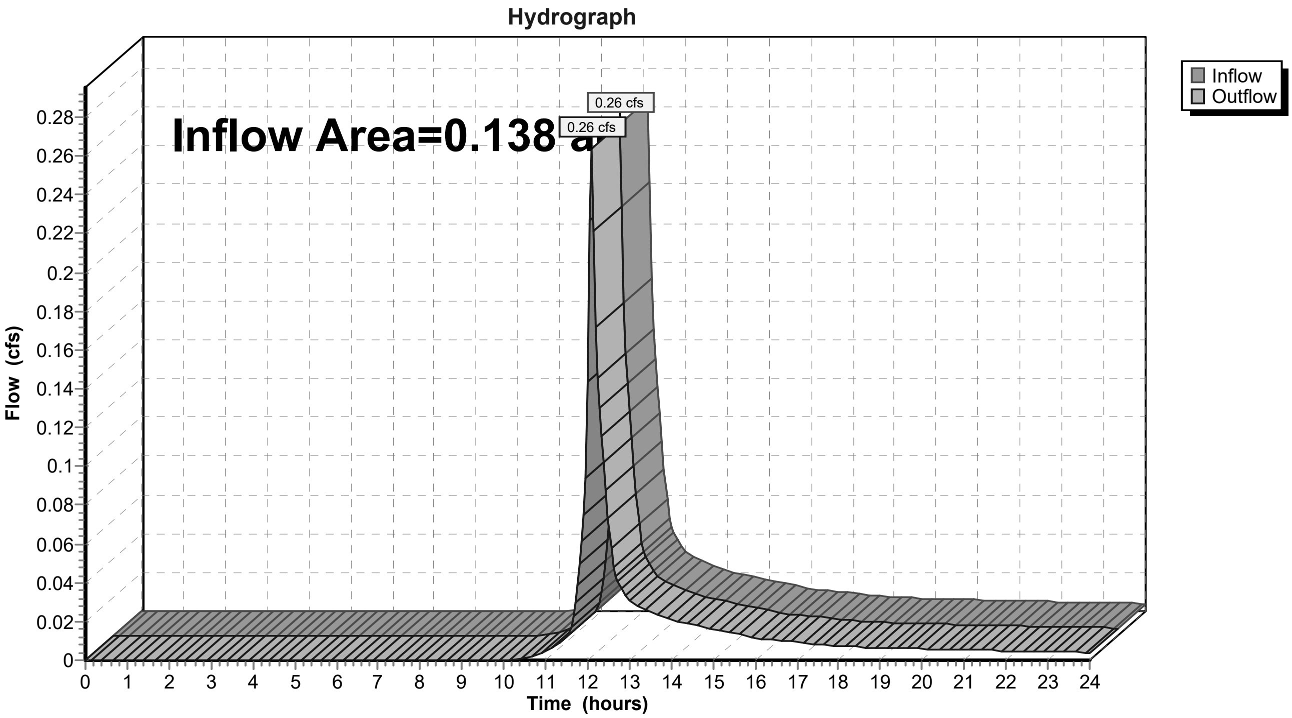


## Summary for Reach DP1:

Inflow Area = 0.138 ac, 0.00% Impervious, Inflow Depth > 1.71" for 10-yr event
Inflow = 0.26 cfs @ 12.10 hrs, Volume= 0.020 af
Outflow = 0.26 cfs @ 12.10 hrs, Volume= 0.020 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

## Reach DP1:

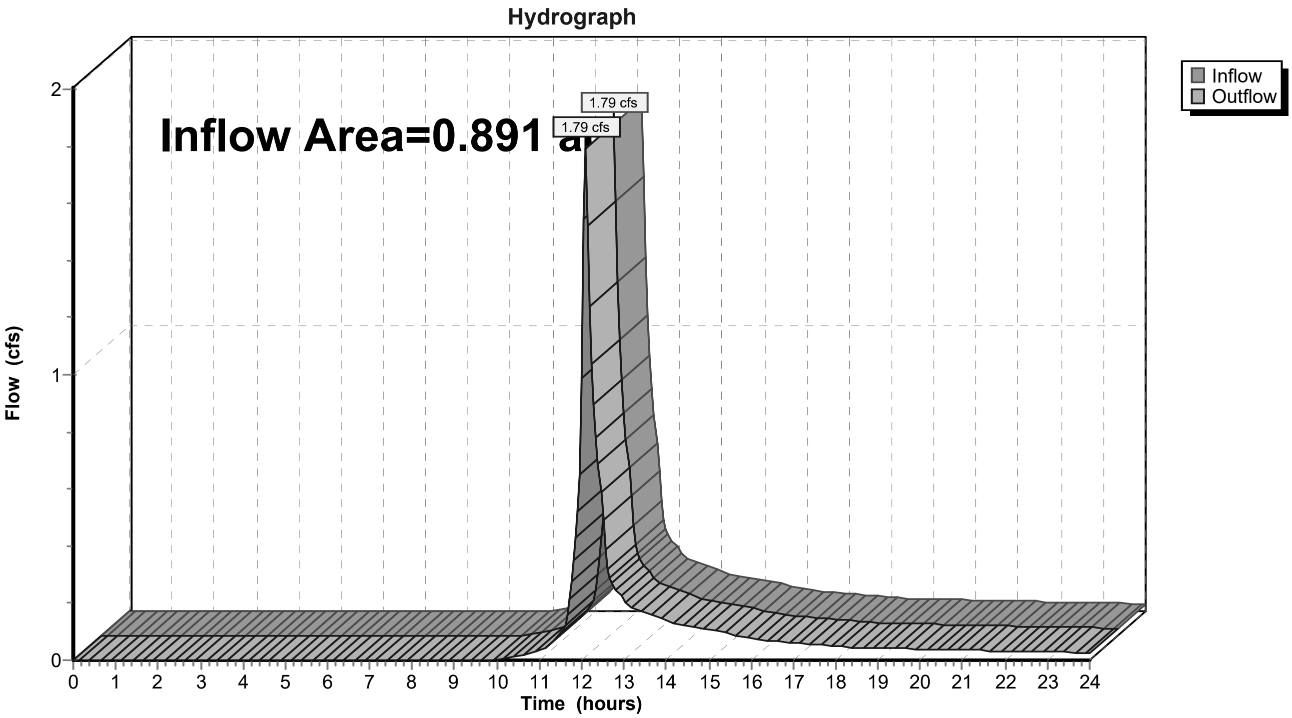


## Summary for Reach DP2:

Inflow Area = 0.891 ac, 4.42% Impervious, Inflow Depth > 1.80" for 10-yr event
Inflow = 1.79 cfs @ 12.10 hrs, Volume= 0.133 af
Outflow = 1.79 cfs @ 12.10 hrs, Volume= 0.133 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

## Reach DP2:

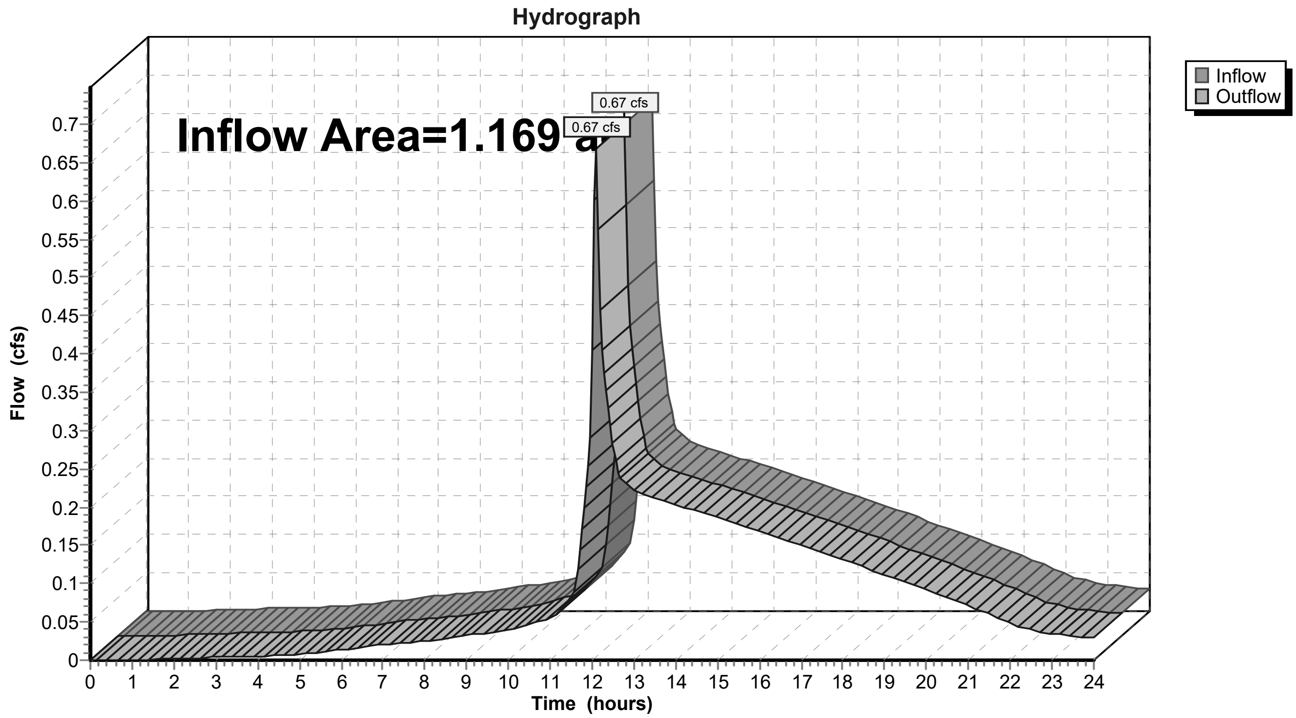


## Summary for Reach DP3: EX CB 3

Inflow Area = 1.169 ac, 75.19% Impervious, Inflow Depth > 1.67" for 10-yr event
Inflow = 0.67 cfs @ 12.09 hrs, Volume= 0.162 af
Outflow = 0.67 cfs @ 12.09 hrs, Volume= 0.162 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

### Reach DP3: EX CB 3



## Summary for Pond 1P: EX CB 1

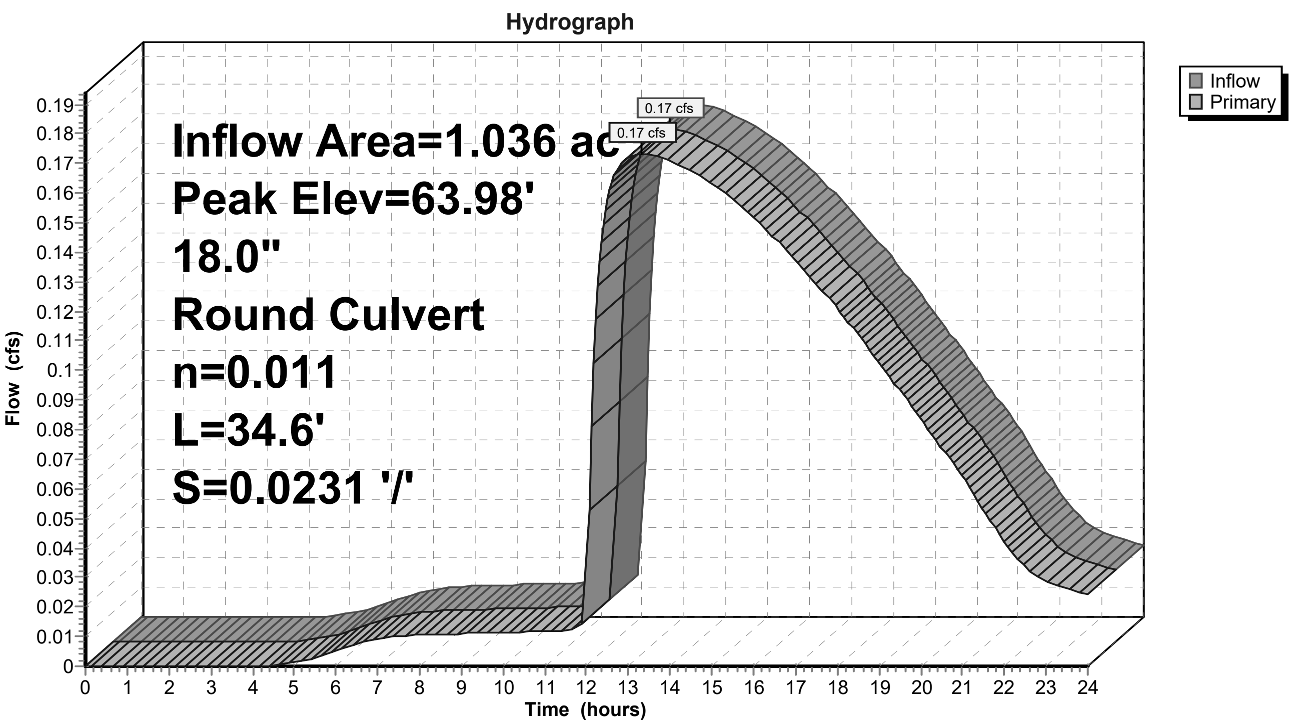
Inflow Area = 1.036 ac, 72.00% Impervious, Inflow Depth > 1.31" for 10-yr event
Inflow = 0.17 cfs @ 13.34 hrs, Volume= 0.113 af
Outflow = 0.17 cfs @ 13.34 hrs, Volume= 0.113 af, Atten= 0%, Lag= 0.0 min
Primary = 0.17 cfs @ 13.34 hrs, Volume= 0.113 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 63.98' @ 13.34 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 63.80' | **18.0" Round Culvert**<br>L= 34.6' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 63.80' / 63.00' S= 0.0231 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.17 cfs @ 13.34 hrs HW=63.98' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.17 cfs @ 1.44 fps)

## Pond 1P: EX CB 1



## Summary for Pond 2P: EX CB 2

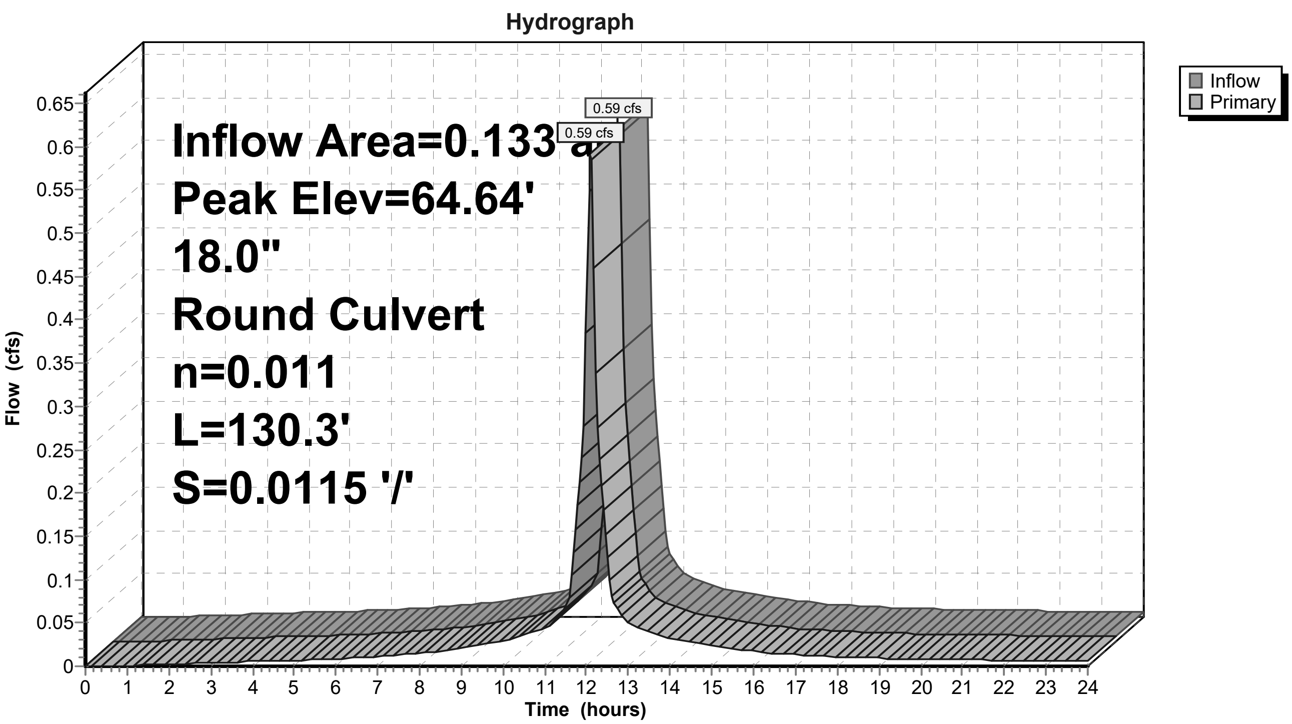
Inflow Area = 0.133 ac,100.00% Impervious, Inflow Depth > 4.42" for 10-yr event
Inflow = 0.59 cfs @ 12.09 hrs, Volume= 0.049 af
Outflow = 0.59 cfs @ 12.09 hrs, Volume= 0.049 af, Atten= 0%, Lag= 0.0 min
Primary = 0.59 cfs @ 12.09 hrs, Volume= 0.049 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.64' @ 12.09 hrs
Flood Elev= 68.20'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.30' | **18.0" Round Culvert**<br>L= 130.3' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.30' / 62.80' S= 0.0115 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=0.58 cfs @ 12.09 hrs HW=64.63' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 0.58 cfs @ 1.97 fps)

### Pond 2P: EX CB 2



## Summary for Pond 3P: HYDRO 1

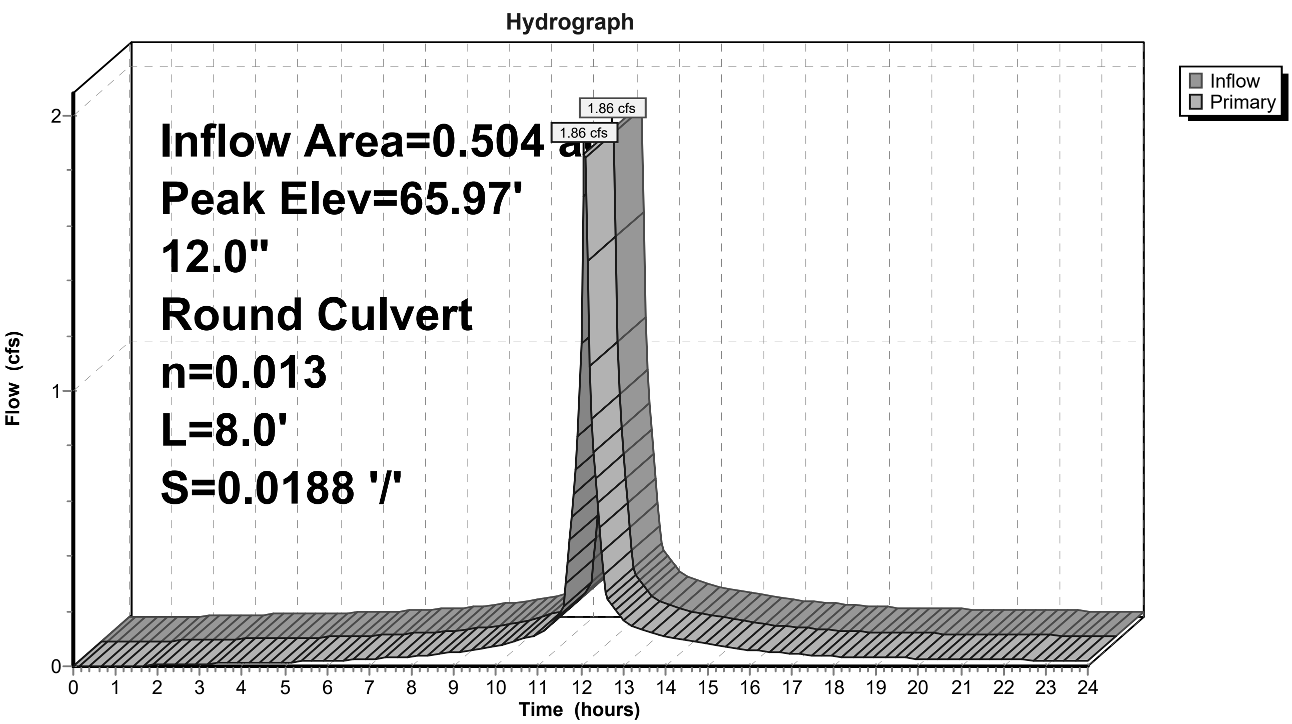
Inflow Area = 0.504 ac, 68.58% Impervious, Inflow Depth > 3.54" for 10-yr event
Inflow = 1.86 cfs @ 12.09 hrs, Volume= 0.149 af
Outflow = 1.86 cfs @ 12.09 hrs, Volume= 0.149 af, Atten= 0%, Lag= 0.0 min
Primary = 1.86 cfs @ 12.09 hrs, Volume= 0.149 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 65.97' @ 12.09 hrs
Flood Elev= 68.50'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 65.15' | **12.0" Round Culvert**<br>L= 8.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.15' / 65.00' S= 0.0188 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=1.81 cfs @ 12.09 hrs HW=65.96' TW=63.55' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 1.81 cfs @ 3.64 fps)

### Pond 3P: HYDRO 1



## Summary for Pond 4P: INFILTRATORS

Inflow Area = 0.504 ac, 68.58% Impervious, Inflow Depth > 3.54" for 10-yr event
Inflow = 1.86 cfs @ 12.09 hrs, Volume= 0.149 af
Outflow = 0.63 cfs @ 11.95 hrs, Volume= 0.149 af, Atten= 66%, Lag= 0.0 min
Discarded = 0.63 cfs @ 11.95 hrs, Volume= 0.149 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 63.93' @ 12.38 hrs Surf.Area= 1,610 sf Storage= 875 cf
Flood Elev= 66.00' Surf.Area= 1,610 sf Storage= 3,090 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 5.7 min ( 776.4 - 770.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 63.00' | 1,482 cf | **34.75'W x 46.34'L x 3.50'H Field A**<br>5,636 cf Overall - 1,929 cf Embedded = 3,706 cf x 40.0% Voids |
| #2A | 63.50' | 1,929 cf | **ADS_StormTech SC-740 +Cap** x 42 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap<br>7 Rows of 6 Chambers |
| | | 3,412 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 63.00' | **17.000 in/hr Exfiltration over Surface area** |
| #2 | Primary | 65.50' | **6.0" Round Culvert**<br>L= 22.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.50' / 65.00' S= 0.0227 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf |

**Discarded OutFlow** Max=0.63 cfs @ 11.95 hrs HW=63.05' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.63 cfs)

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=63.00' TW=64.00' (Dynamic Tailwater)
↑—**2=Culvert** ( Controls 0.00 cfs)

## Pond 4P: INFILTRATORS - Chamber Wizard Field A

**Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

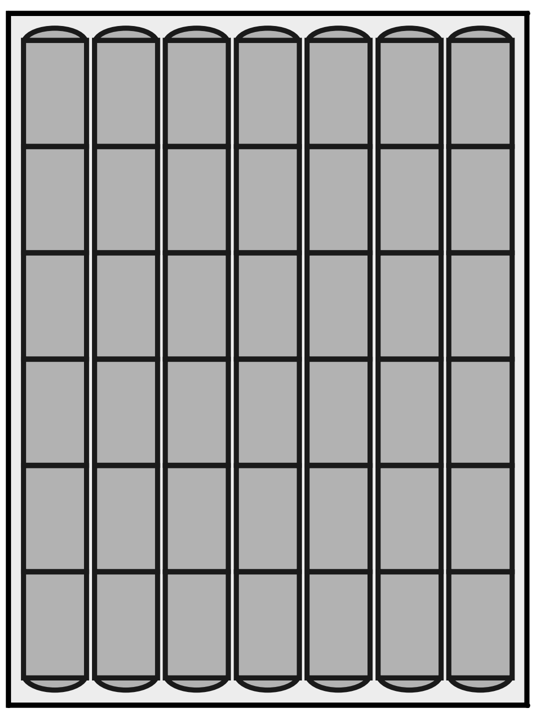
6 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 44.34' Row Length +12.0" End Stone x 2 = 46.34' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

42 Chambers x 45.9 cf = 1,929.5 cf Chamber Storage

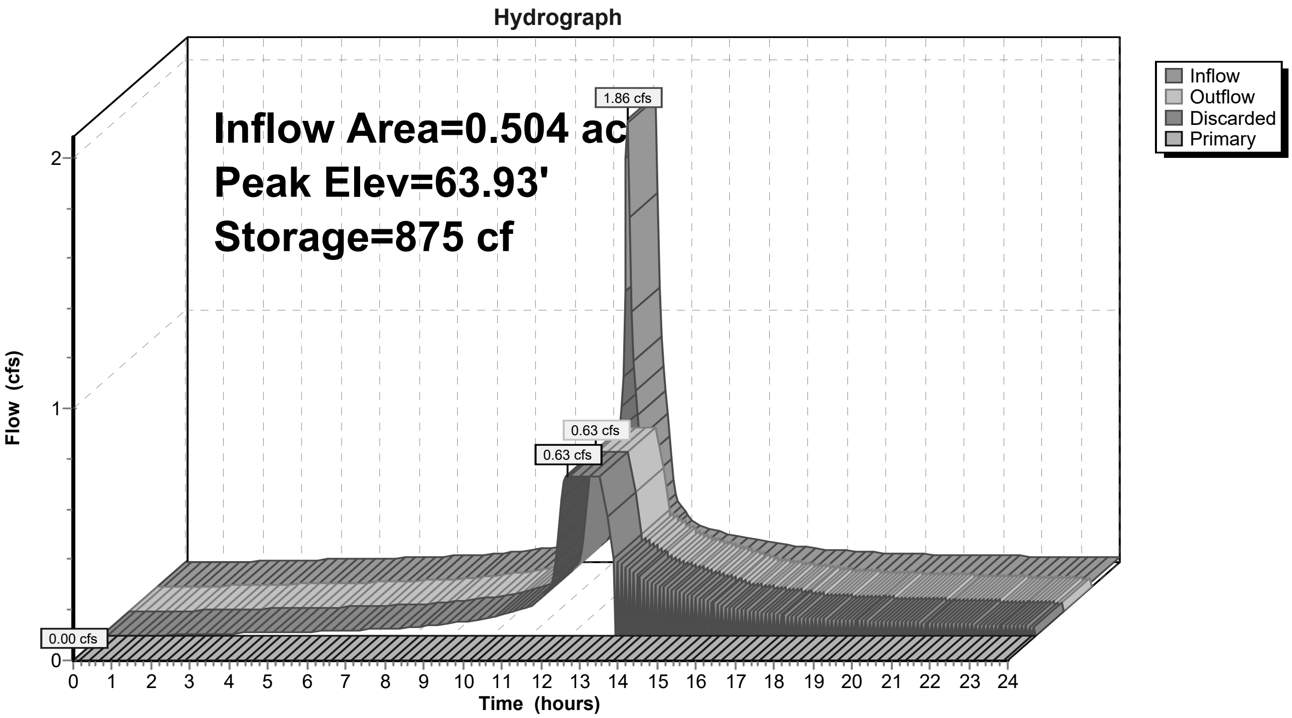
5,635.7 cf Field - 1,929.5 cf Chambers = 3,706.2 cf Stone x 40.0% Voids = 1,482.5 cf Stone Storage

Chamber Storage + Stone Storage = 3,412.0 cf = 0.078 af
Overall Storage Efficiency = 60.5%
Overall System Size = 46.34' x 34.75' x 3.50'

42 Chambers
208.7 cy Field
137.3 cy Stone



## Pond 4P: INFILTRATORS



## Summary for Pond 5P: DETENTION

Inflow Area = 0.504 ac, 68.58% Impervious, Inflow Depth = 0.00" for 10-yr event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.00' @ 0.00 hrs Surf.Area= 0 sf Storage= 0 cf
Flood Elev= 65.50' Surf.Area= 0 sf Storage= 136 cf

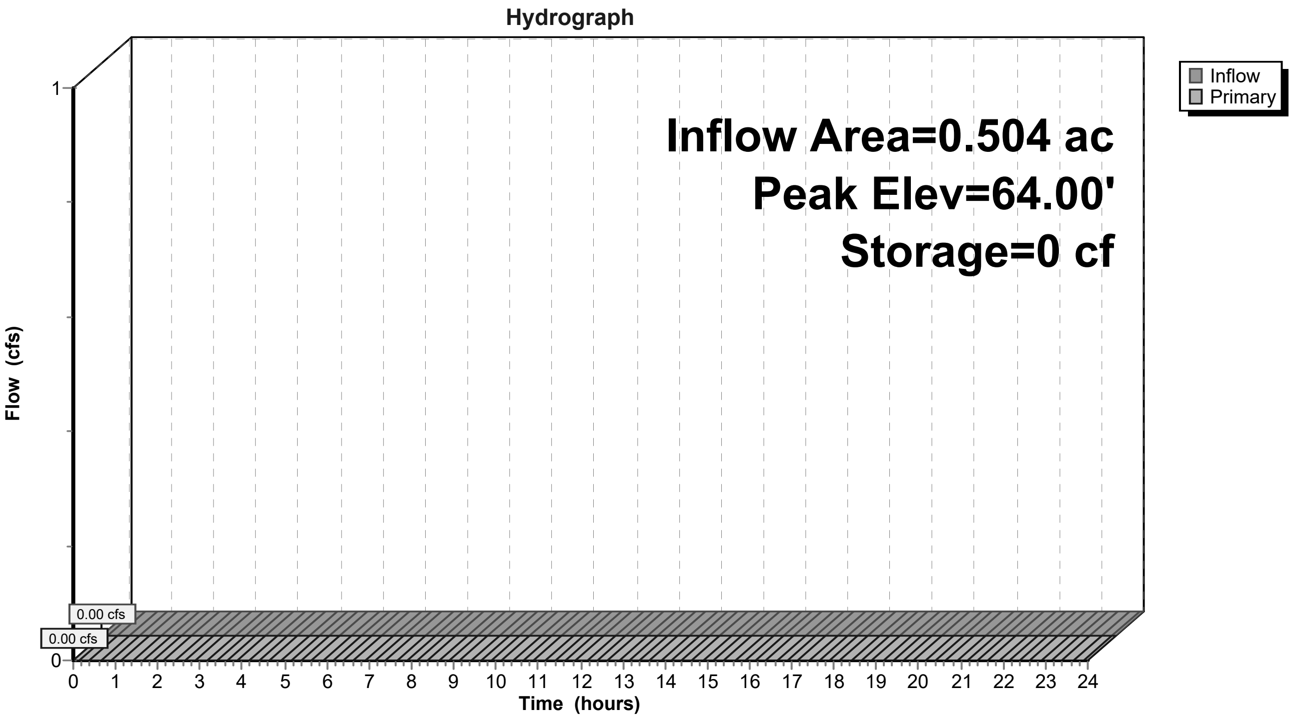
Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 64.00' | 136 cf | **18.0" Round Pipe Storage**<br>L= 77.0' |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.00' | **8.0" Round Culvert**<br>L= 29.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.00' / 63.80' S= 0.0069 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |
| #2 | Device 1 | 64.00' | **3.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.00 cfs @ 0.00 hrs HW=64.00' TW=63.80' (Dynamic Tailwater)
└─**1=Culvert** ( Controls 0.00 cfs)
  └─**2=Orifice/Grate** ( Controls 0.00 cfs)

## Pond 5P: DETENTION



## Summary for Pond 6P: OCS 1

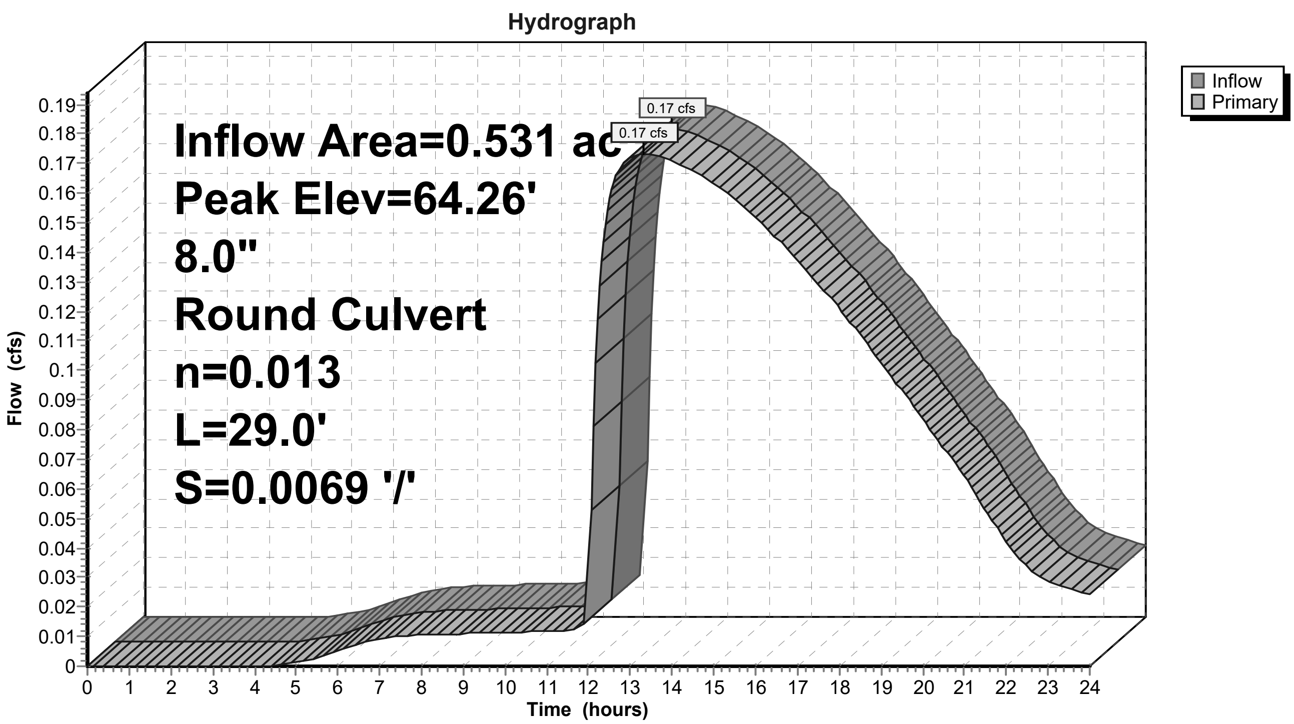
Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 2.56" for 10-yr event
Inflow = 0.17 cfs @ 13.34 hrs, Volume= 0.113 af
Outflow = 0.17 cfs @ 13.34 hrs, Volume= 0.113 af, Atten= 0%, Lag= 0.0 min
Primary = 0.17 cfs @ 13.34 hrs, Volume= 0.113 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.26' @ 13.34 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.00' | **8.0" Round Culvert**<br>L= 29.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.00' / 63.80' S= 0.0069 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |

**Primary OutFlow** Max=0.17 cfs @ 13.34 hrs HW=64.26' TW=63.98' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 0.17 cfs @ 2.03 fps)

### Pond 6P: OCS 1



## Summary for Pond 7P: MODIFEID BIO

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 3.38" for 10-yr event
Inflow = 1.34 cfs @ 12.07 hrs, Volume= 0.150 af
Outflow = 0.99 cfs @ 12.21 hrs, Volume= 0.104 af, Atten= 27%, Lag= 8.4 min
Primary = 0.90 cfs @ 12.21 hrs, Volume= 0.103 af
Secondary = 0.08 cfs @ 12.21 hrs, Volume= 0.001 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 69.17' @ 12.21 hrs Surf.Area= 2,615 sf Storage= 2,417 cf
Flood Elev= 69.50' Surf.Area= 2,746 sf Storage= 3,311 cf

Plug-Flow detention time= 162.5 min calculated for 0.104 af (69% of inflow)
Center-of-Mass det. time= 65.8 min ( 859.3 - 793.5 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 68.10' | 3,311 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

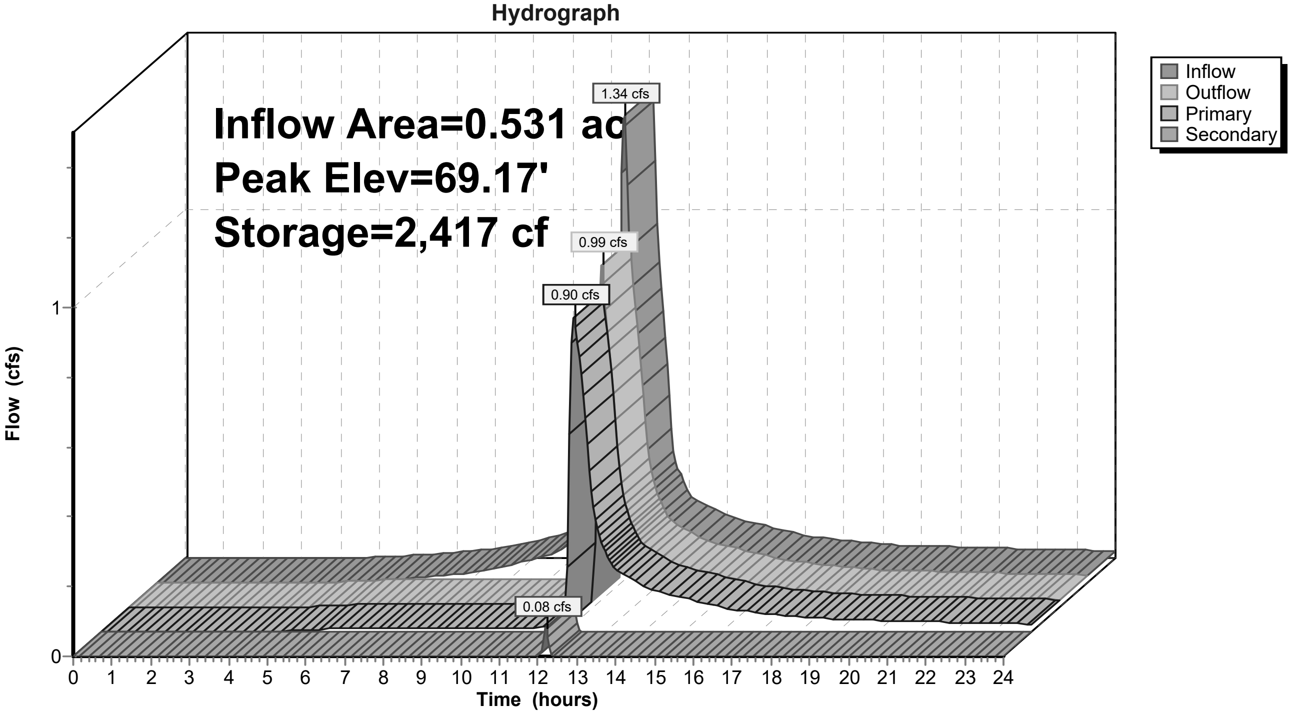
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 68.10 | 1,867 | 0 | 0 |
| 69.00 | 2,549 | 1,987 | 1,987 |
| 69.50 | 2,746 | 1,324 | 3,311 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 65.58' | **12.0" Round Culvert**<br>L= 5.2' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.58' / 65.55' S= 0.0058 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Secondary | 69.15' | **12.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 68.10' | **0.250 in/hr Exfiltration over Surface area** |
| #4 | Device 1 | 69.00' | **12.0" x 12.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=0.89 cfs @ 12.21 hrs HW=69.17' TW=64.75' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.89 cfs of 6.64 cfs potential flow)
  ├─**3=Exfiltration** (Exfiltration Controls 0.02 cfs)
  └─**4=Orifice/Grate** (Weir Controls 0.88 cfs @ 1.33 fps)

**Secondary OutFlow** Max=0.08 cfs @ 12.21 hrs HW=69.17' TW=0.00' (Dynamic Tailwater)
└─**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.08 cfs @ 0.41 fps)

## Pond 7P: MODIFEID BIO



## Summary for Pond 8P: DETENTION

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 2.59" for 10-yr event
Inflow = 1.45 cfs @ 12.12 hrs, Volume= 0.115 af
Outflow = 0.17 cfs @ 13.34 hrs, Volume= 0.113 af, Atten= 88%, Lag= 72.8 min
Primary = 0.17 cfs @ 13.34 hrs, Volume= 0.113 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 65.37' @ 13.34 hrs Surf.Area= 1,907 sf Storage= 1,924 cf
Flood Elev= 67.05' Surf.Area= 0 sf Storage= 4,524 cf

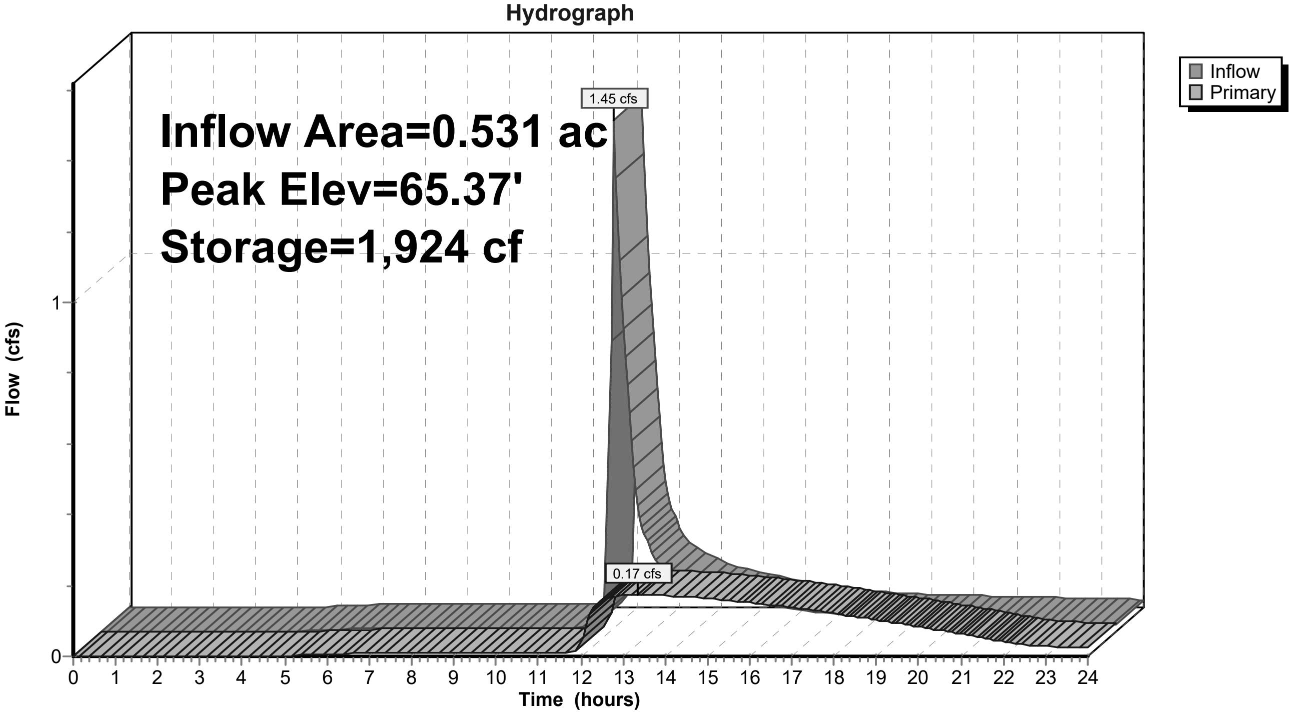
Plug-Flow detention time= 129.1 min calculated for 0.113 af (99% of inflow)
Center-of-Mass det. time= 122.0 min ( 968.6 - 846.6 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 64.05' | 4,524 cf | **36.0" Round Pipe Storage** x 4<br>L= 160.0' |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.05' | **2.5" Vert. Orifice/Grate** C= 0.600 |
| #2 | Primary | 65.45' | **2.0" Vert. Orifice/Grate** C= 0.600 |
| #3 | Primary | 66.35' | **6.5" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.17 cfs @ 13.34 hrs HW=65.37' TW=64.26' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.17 cfs @ 5.08 fps)
├─**2=Orifice/Grate** ( Controls 0.00 cfs)
└─**3=Orifice/Grate** ( Controls 0.00 cfs)

## Pond 8P: DETENTION



## Summary for Pond 9P: MH 1

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 3.65" for 10-yr event
Inflow = 2.14 cfs @ 12.09 hrs, Volume= 0.162 af
Outflow = 2.14 cfs @ 12.09 hrs, Volume= 0.162 af, Atten= 0%, Lag= 0.0 min
Primary = 1.34 cfs @ 12.07 hrs, Volume= 0.150 af
Secondary = 0.81 cfs @ 12.09 hrs, Volume= 0.012 af

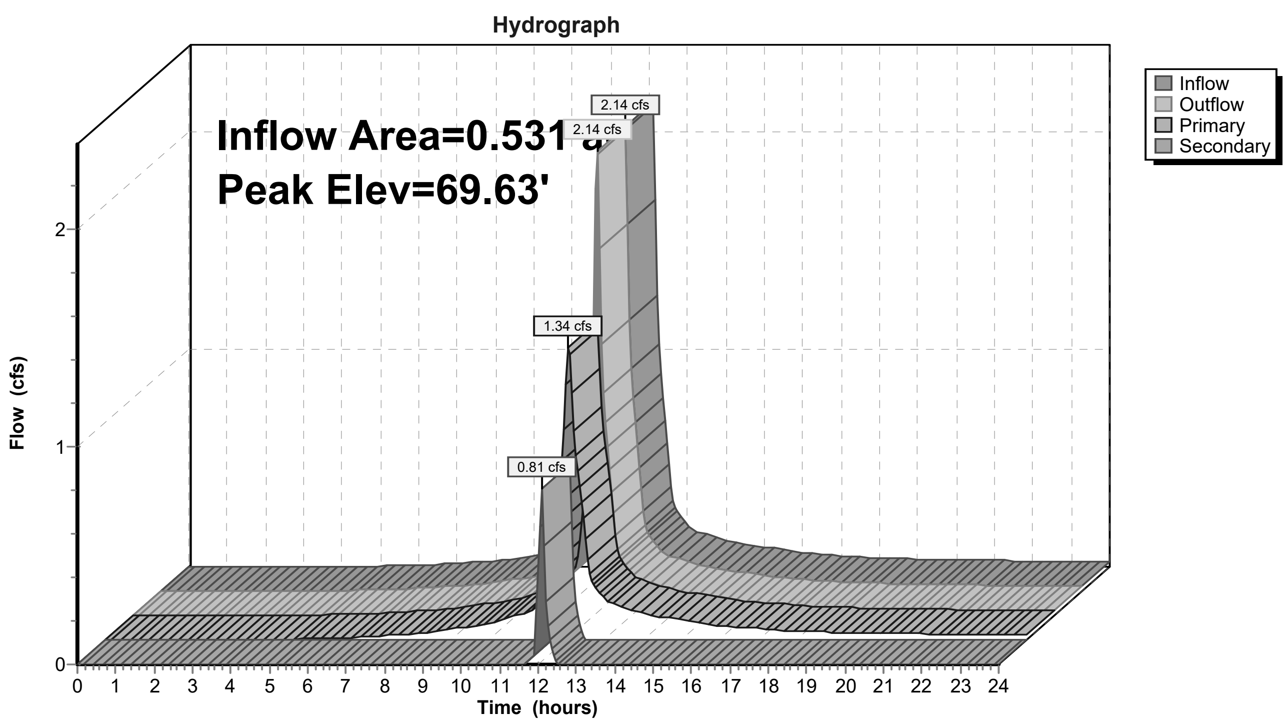
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 69.63' @ 12.09 hrs
Flood Elev= 71.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 68.17' | **10.0" Round Culvert**<br>L= 6.4' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 68.17' / 68.14' S= 0.0047 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf |
| #2 | Secondary | 69.17' | **12.0" Round Culvert**<br>L= 78.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 69.17' / 66.05' S= 0.0400 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=1.33 cfs @ 12.07 hrs HW=69.59' TW=69.34' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.33 cfs @ 2.45 fps)

**Secondary OutFlow** Max=0.79 cfs @ 12.09 hrs HW=69.62' TW=64.41' (Dynamic Tailwater)
└─**2=Culvert** (Inlet Controls 0.79 cfs @ 2.29 fps)

### Pond 9P: MH 1



## Summary for Pond 10P: HYDRO 2

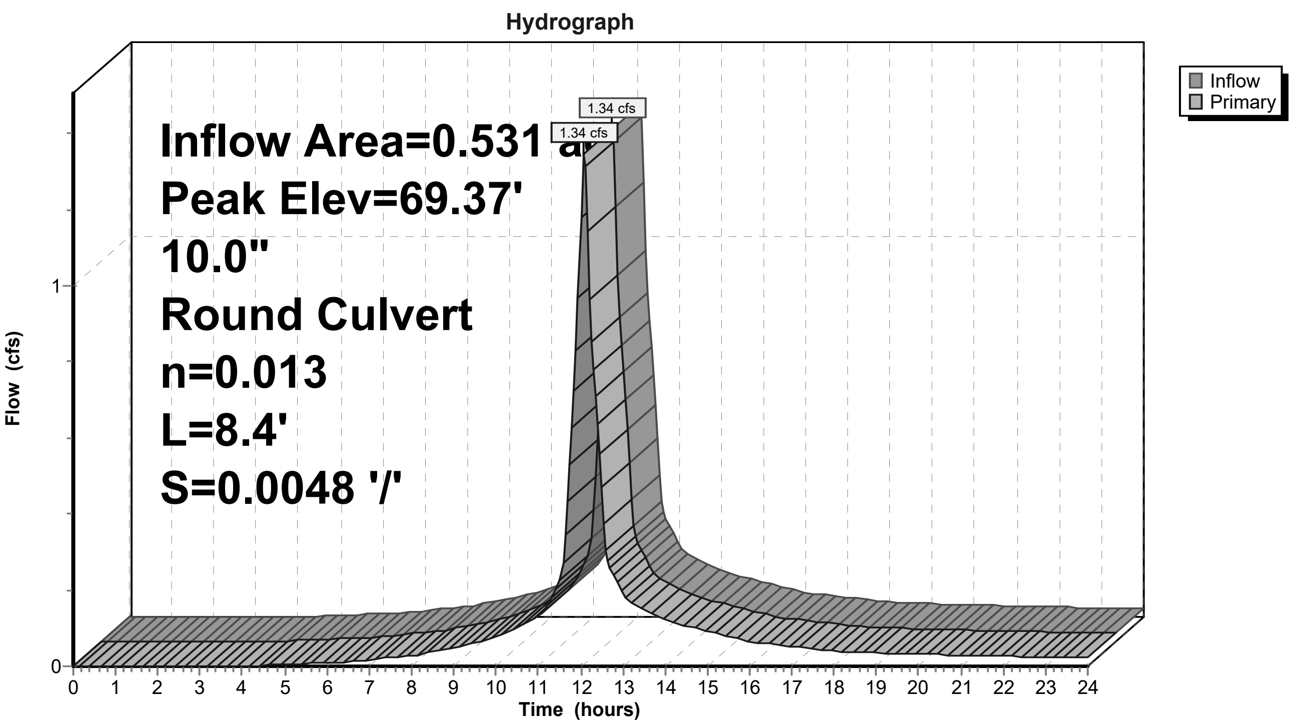
Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 3.38" for 10-yr event
Inflow = 1.34 cfs @ 12.07 hrs, Volume= 0.150 af
Outflow = 1.34 cfs @ 12.07 hrs, Volume= 0.150 af, Atten= 0%, Lag= 0.0 min
Primary = 1.34 cfs @ 12.07 hrs, Volume= 0.150 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 69.37' @ 12.11 hrs
Flood Elev= 70.75'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 68.14' | **10.0" Round Culvert**<br>L= 8.4' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 68.14' / 68.10' S= 0.0048 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf |

**Primary OutFlow** Max=1.32 cfs @ 12.07 hrs HW=69.34' TW=69.08' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.32 cfs @ 2.43 fps)

### Pond 10P: HYDRO 2



## Summary for Subcatchment PS1:

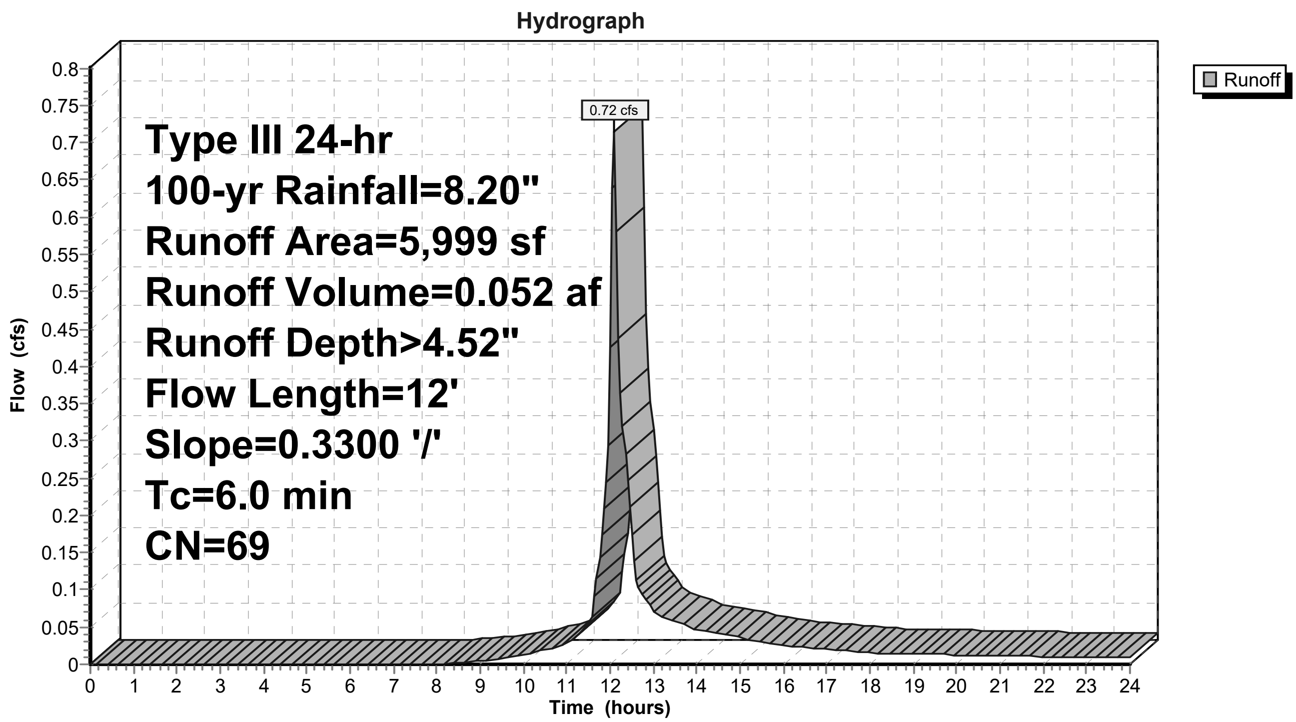
Runoff = 0.72 cfs @ 12.09 hrs, Volume= 0.052 af, Depth> 4.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 0 | 98 | Paved parking, HSG B |
| 5,999 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,999 | 69 | Weighted Average |
| 5,999 | | 100.00% Pervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.6 | 12 | 0.3300 | 0.34 | | **Sheet Flow, 12 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 0.6 | 12 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS1:



## Summary for Subcatchment PS2:

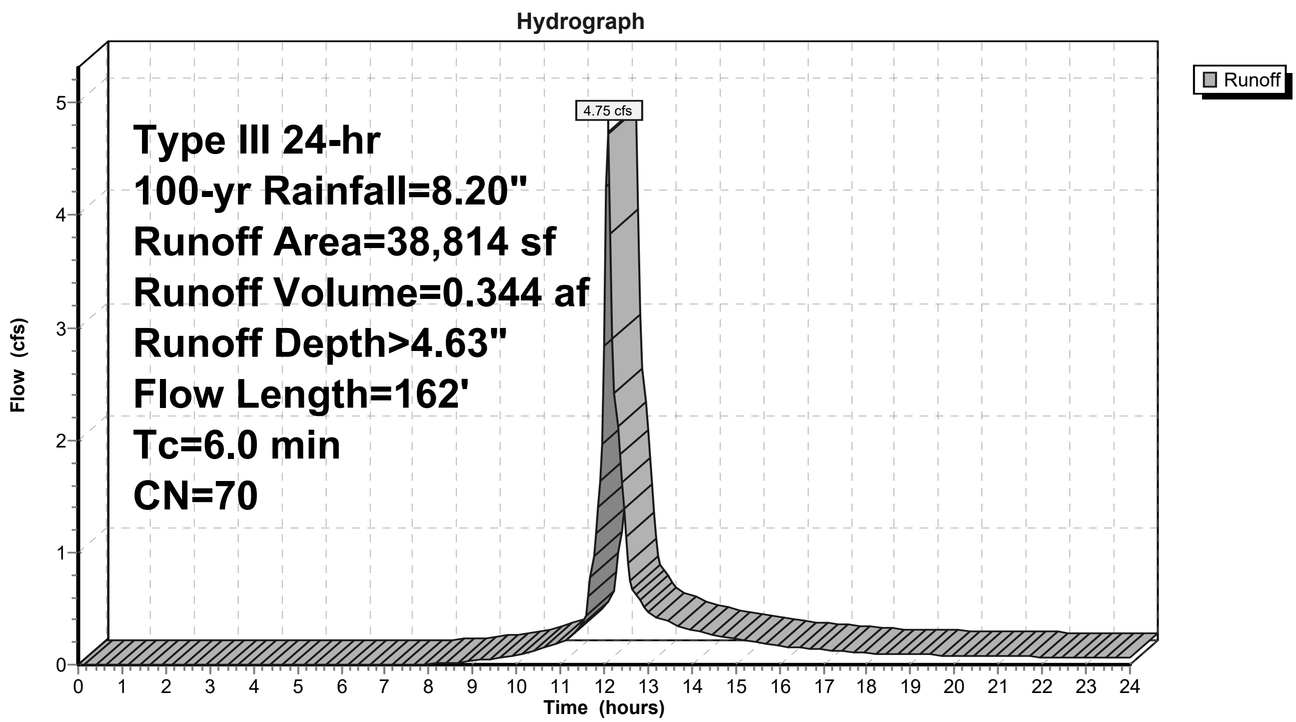
Runoff = 4.75 cfs @ 12.09 hrs, Volume= 0.344 af, Depth> 4.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 1,714 | 98 | Paved parking, HSG B |
| 37,100 | 69 | 50-75% Grass cover, Fair, HSG B |
| 38,814 | 70 | Weighted Average |
| 37,100 | | 95.58% Pervious Area |
| 1,714 | | 4.42% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.4 | 27 | 0.1850 | 0.32 | | **Sheet Flow, 27 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 1.9 | 135 | 0.0296 | 1.20 | | **Shallow Concentrated Flow, 78 ft grass**<br>Short Grass Pasture Kv= 7.0 fps |
| 3.3 | 162 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS2:



## Summary for Subcatchment PS3: PARKING

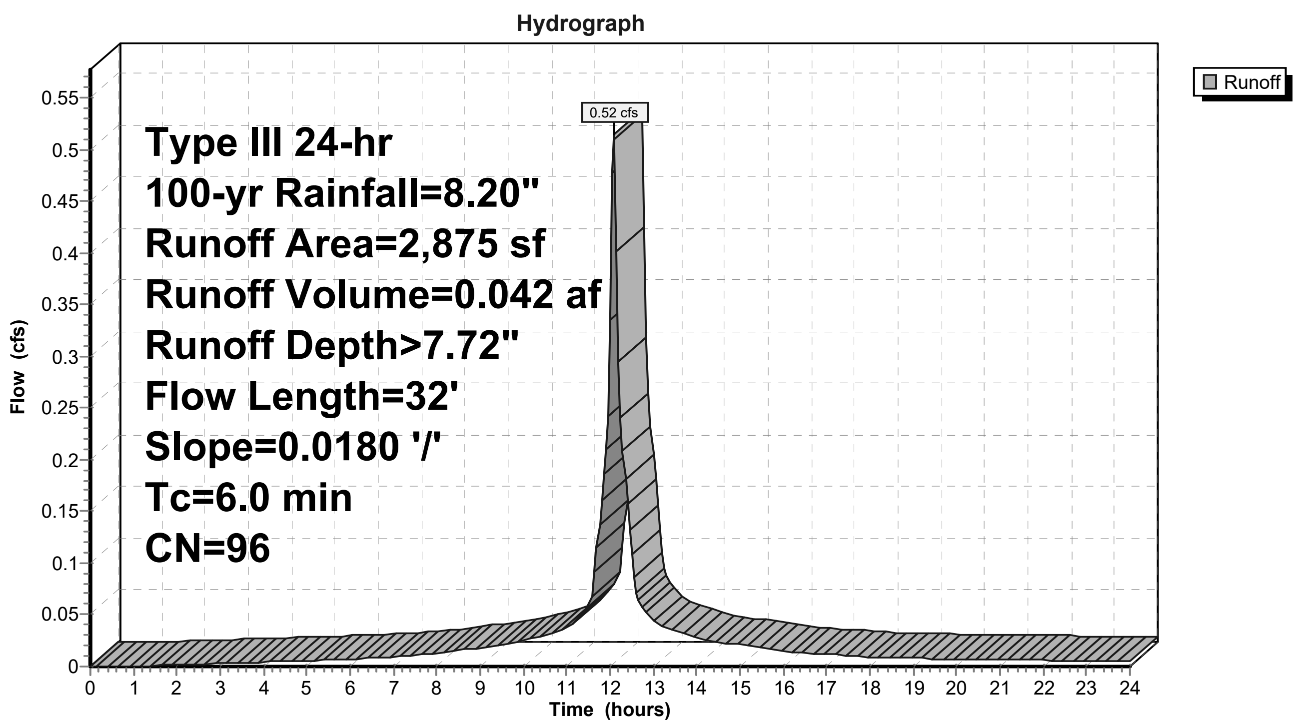
Runoff = 0.52 cfs @ 12.09 hrs, Volume= 0.042 af, Depth> 7.72"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 2,710 | 98 | Paved parking, HSG B |
| 165 | 69 | 50-75% Grass cover, Fair, HSG B |
| 2,875 | 96 | Weighted Average |
| 165 | | 5.74% Pervious Area |
| 2,710 | | 94.26% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.5 | 32 | 0.0180 | 1.04 | | **Sheet Flow, 32 ft paved** Smooth surfaces n= 0.011 P2= 3.15" |
| 0.5 | 32 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS3: PARKING



## Summary for Subcatchment PS4: BLDG

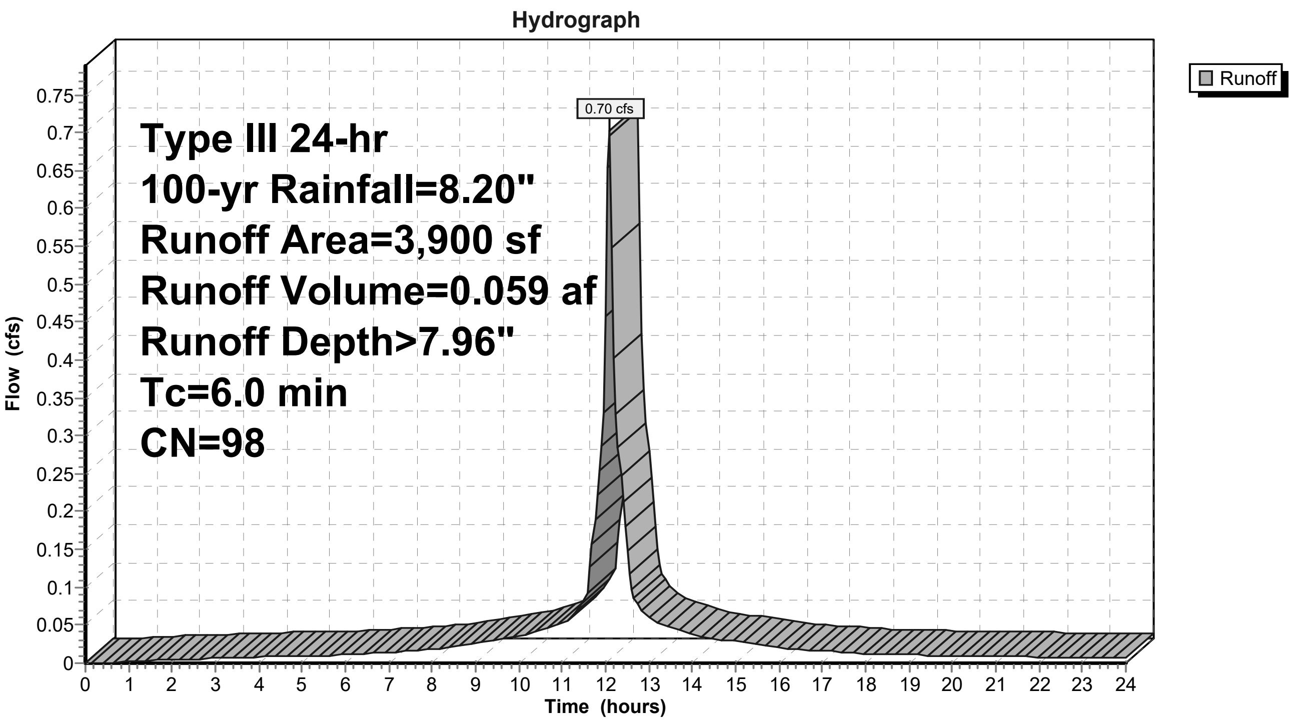
Runoff = 0.70 cfs @ 12.09 hrs, Volume= 0.059 af, Depth> 7.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 3,900 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 3,900 | 98 | Weighted Average |
| 3,900 | | 100.00% Impervious Area |

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

## Subcatchment PS4: BLDG



## Summary for Subcatchment PS5: CANOPY

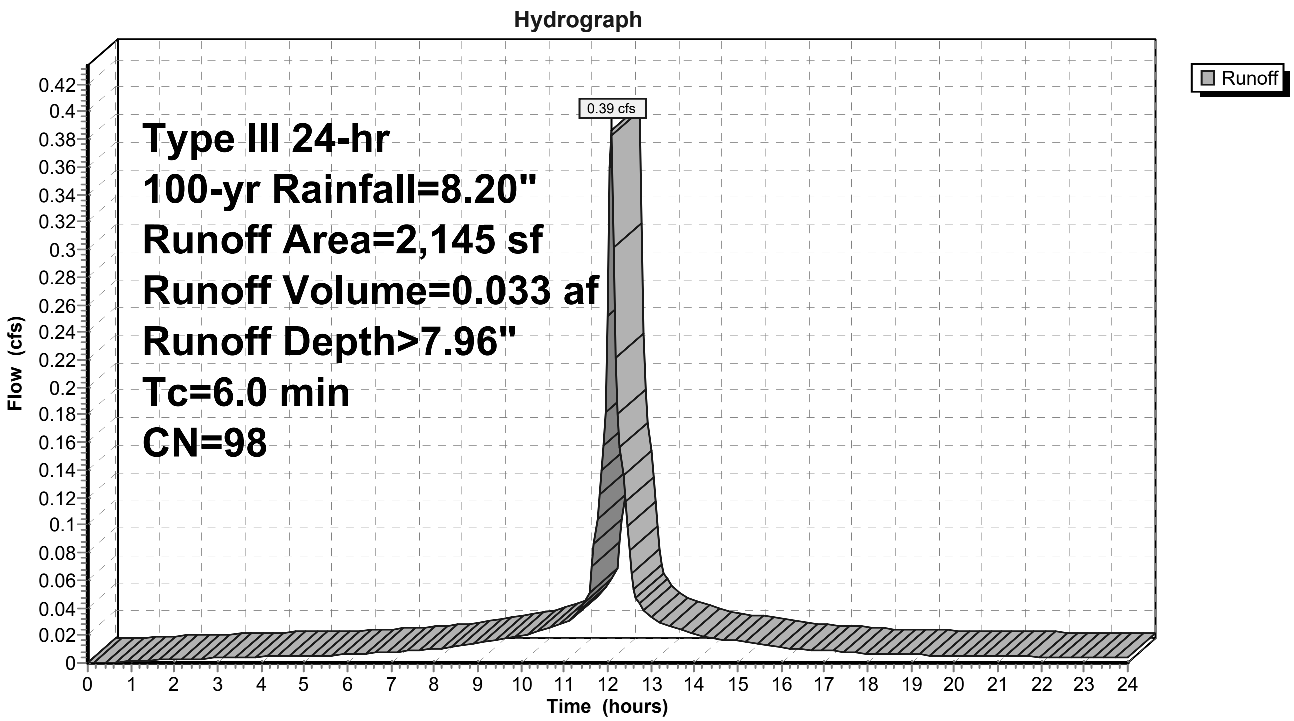
Runoff = 0.39 cfs @ 12.09 hrs, Volume= 0.033 af, Depth> 7.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 2,145 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 2,145 | 98 | Weighted Average |
| 2,145 | | 100.00% Impervious Area |

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

## Subcatchment PS5: CANOPY



## Summary for Subcatchment PS6: PARKING/GRASS

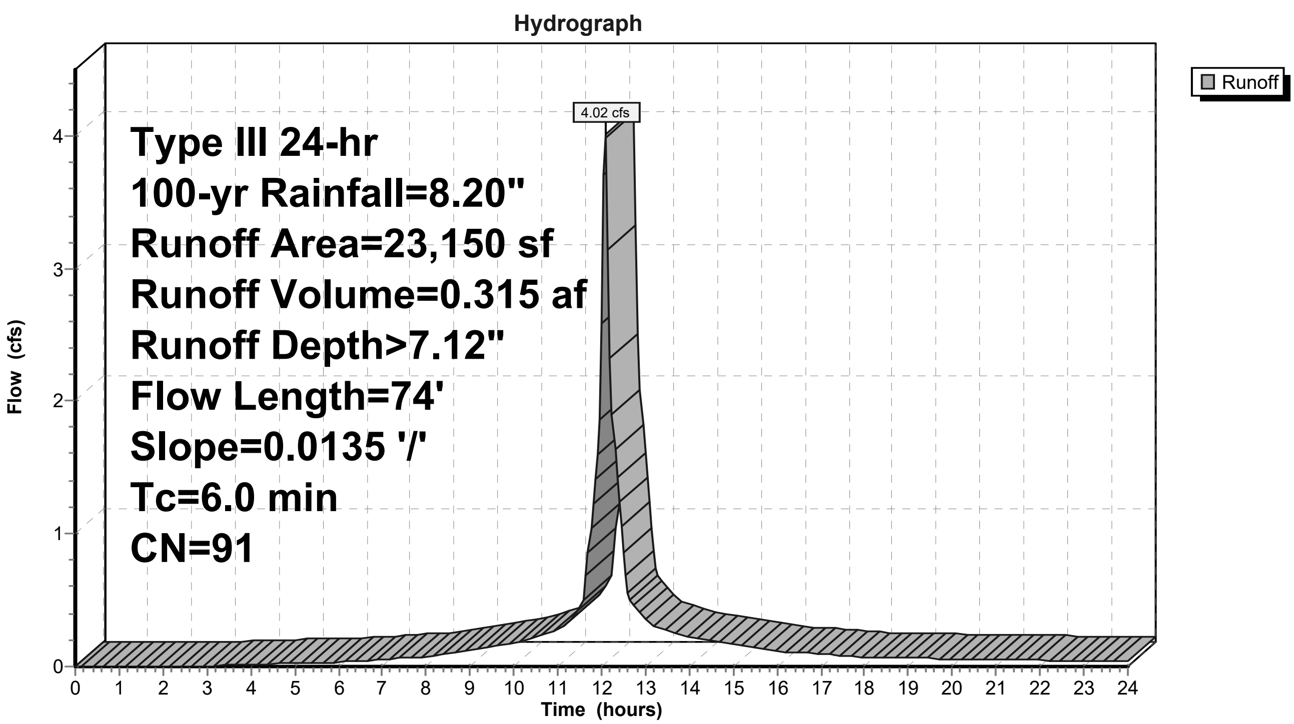
Runoff = 4.02 cfs @ 12.09 hrs, Volume= 0.315 af, Depth> 7.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 17,420 | 98 | Paved parking, HSG B |
| 5,730 | 69 | 50-75% Grass cover, Fair, HSG B |
| 23,150 | 91 | Weighted Average |
| 5,730 | | 24.75% Pervious Area |
| 17,420 | | 75.25% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.1 | 74 | 0.0135 | 1.10 | | **Sheet Flow, 74 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 1.1 | 74 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS6: PARKING/GRASS



## Summary for Subcatchment PS7: SIDEWALK/GRASS

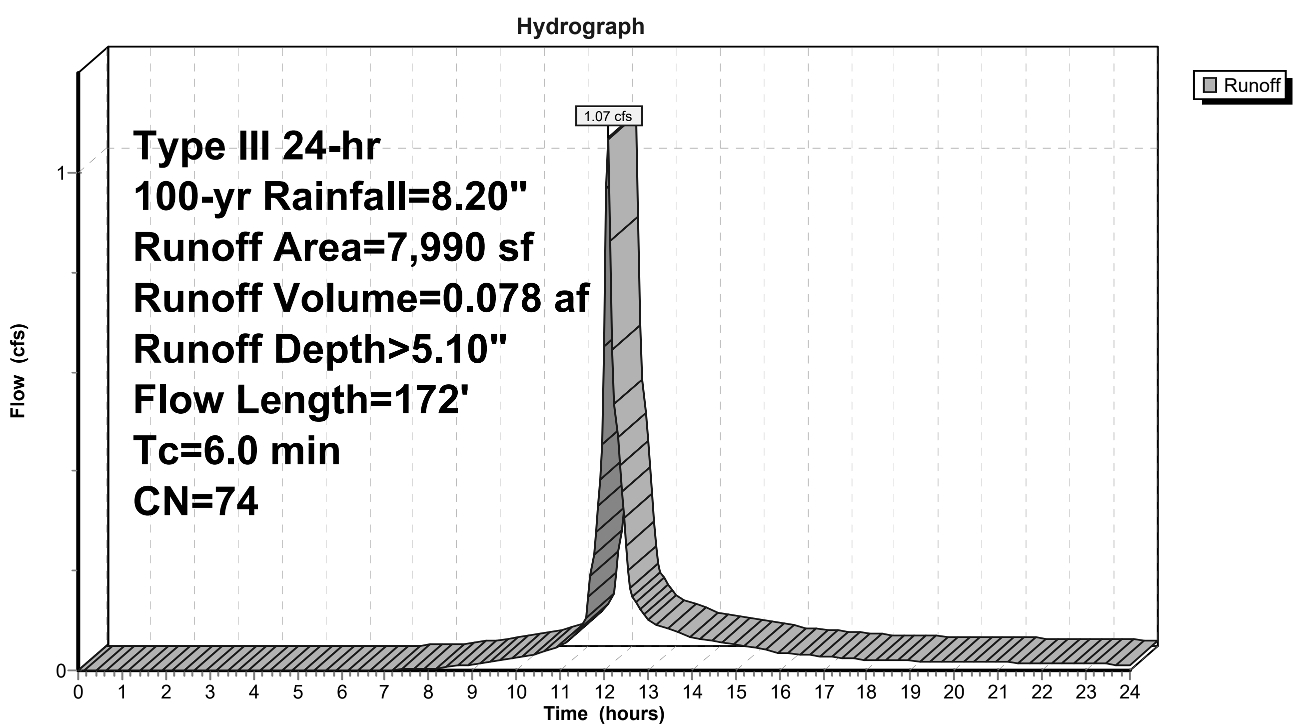
Runoff = 1.07 cfs @ 12.09 hrs, Volume= 0.078 af, Depth> 5.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 1,255 | 98 | Paved parking, HSG B |
| 6,735 | 69 | 50-75% Grass cover, Fair, HSG B |
| 7,990 | 74 | Weighted Average |
| 6,735 | | 84.29% Pervious Area |
| 1,255 | | 15.71% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.8 | 18 | 0.3300 | 0.37 | | **Sheet Flow, 18 ft grass**<br>Grass: Short n= 0.150 P2= 3.15" |
| 0.8 | 33 | 0.0100 | 0.70 | | **Shallow Concentrated Flow, 33 ft grass**<br>Short Grass Pasture Kv= 7.0 fps |
| 0.2 | 121 | 0.0500 | 10.14 | 7.97 | **Pipe Channel, yd 2 - hydro 1**<br>12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25'<br>n= 0.013 Corrugated PE, smooth interior |
| 1.8 | 172 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS7: SIDEWALK/GRASS



## Summary for Subcatchment PS8: PAVEMENT

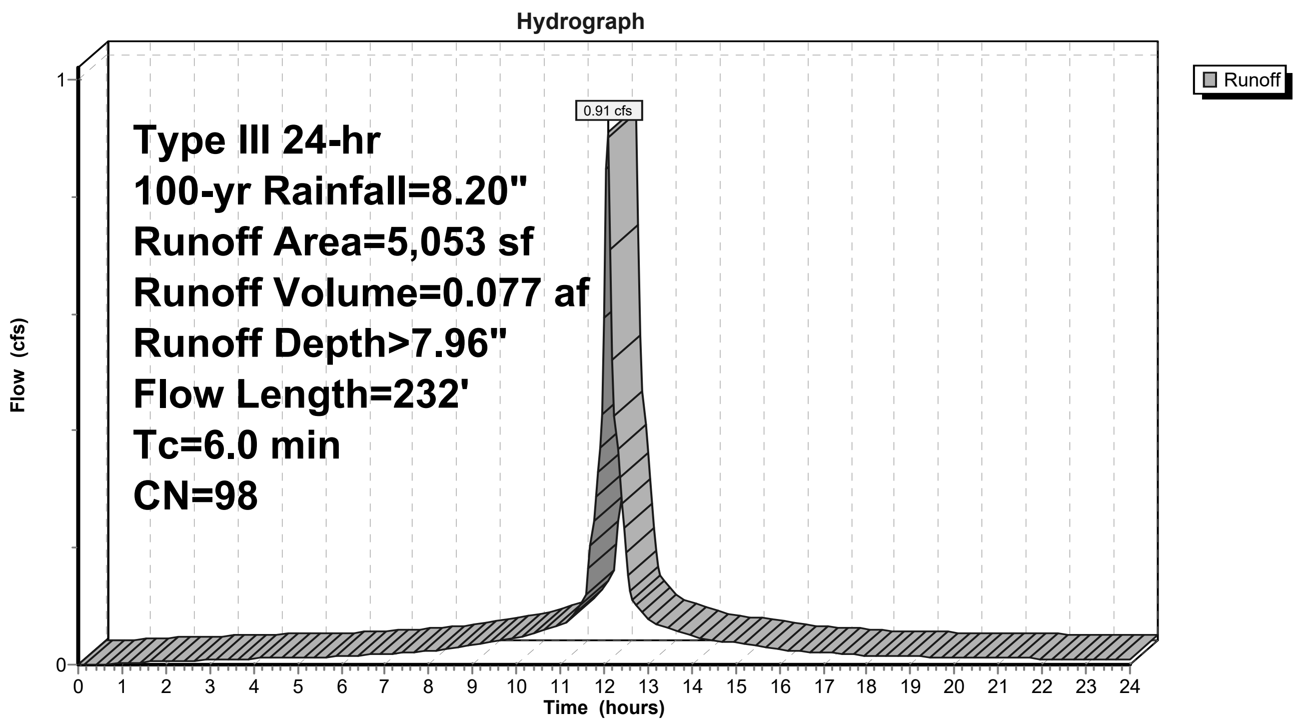
Runoff = 0.91 cfs @ 12.09 hrs, Volume= 0.077 af, Depth> 7.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 5,053 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,053 | 98 | Weighted Average |
| 5,053 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 0.7 | 76 | 0.0405 | 1.71 | | **Sheet Flow, 76 ft paved** Smooth surfaces n= 0.011 P2= 3.15" |
| 0.3 | 156 | 0.0500 | 10.14 | 7.97 | **Pipe Channel, cb 1 - hydro 1** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior |
| 1.0 | 232 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS8: PAVEMENT



## Summary for Subcatchment PS9: PAVEMENT

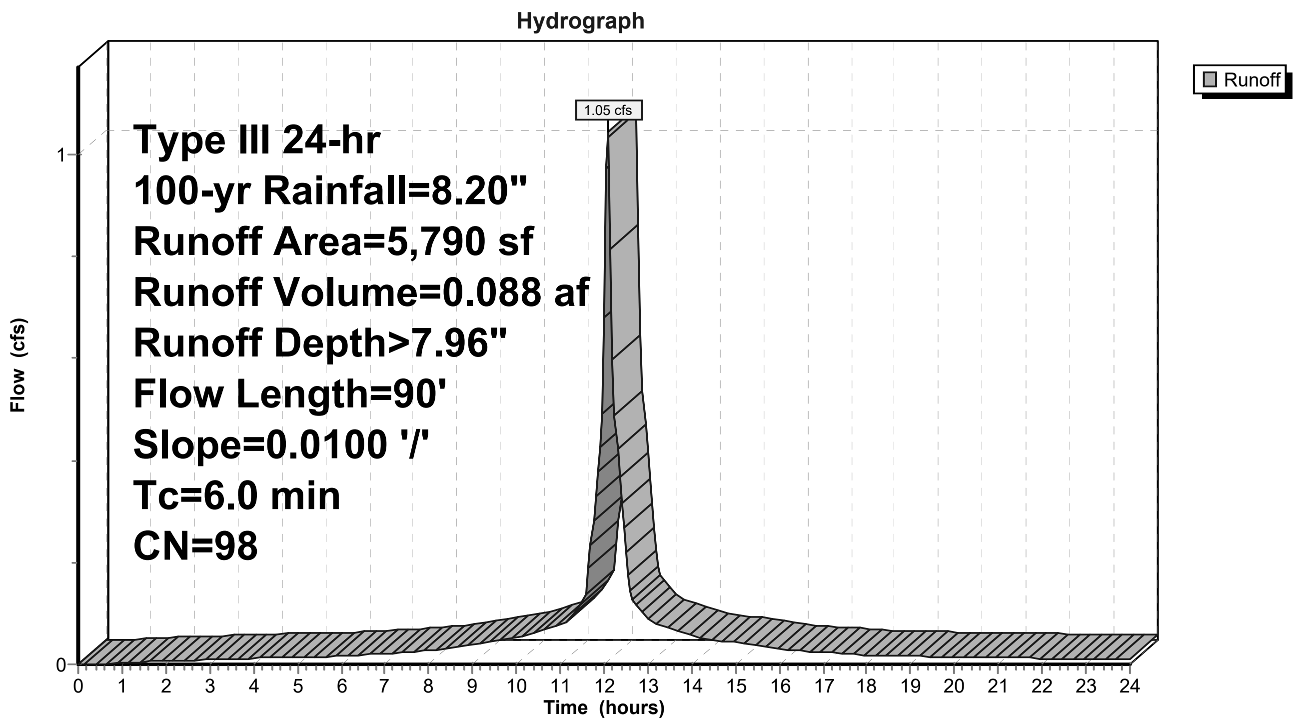
Runoff = 1.05 cfs @ 12.09 hrs, Volume= 0.088 af, Depth> 7.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-yr Rainfall=8.20"

| Area (sf) | CN | Description |
|---|---|---|
| 5,790 | 98 | Paved parking, HSG B |
| 0 | 69 | 50-75% Grass cover, Fair, HSG B |
| 5,790 | 98 | Weighted Average |
| 5,790 | | 100.00% Impervious Area |

| Tc (min) | Length (feet) | Slope (ft/ft) | Velocity (ft/sec) | Capacity (cfs) | Description |
|---|---|---|---|---|---|
| 1.5 | 90 | 0.0100 | 1.01 | | **Sheet Flow, 90 ft paved**<br>Smooth surfaces n= 0.011 P2= 3.15" |
| 1.5 | 90 | Total, Increased to minimum Tc = 6.0 min | | | |

## Subcatchment PS9: PAVEMENT

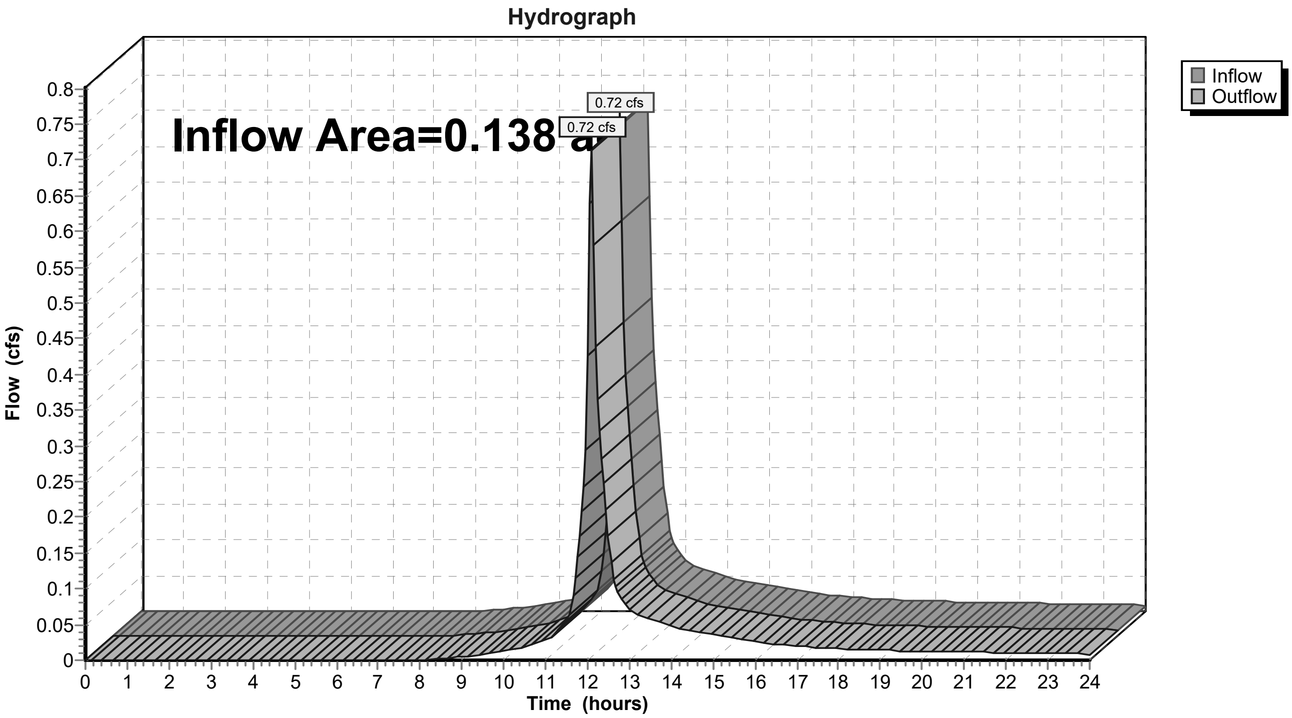


## Summary for Reach DP1:

Inflow Area = 0.138 ac, 0.00% Impervious, Inflow Depth > 4.52" for 100-yr event
Inflow = 0.72 cfs @ 12.09 hrs, Volume= 0.052 af
Outflow = 0.72 cfs @ 12.09 hrs, Volume= 0.052 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

## Reach DP1:

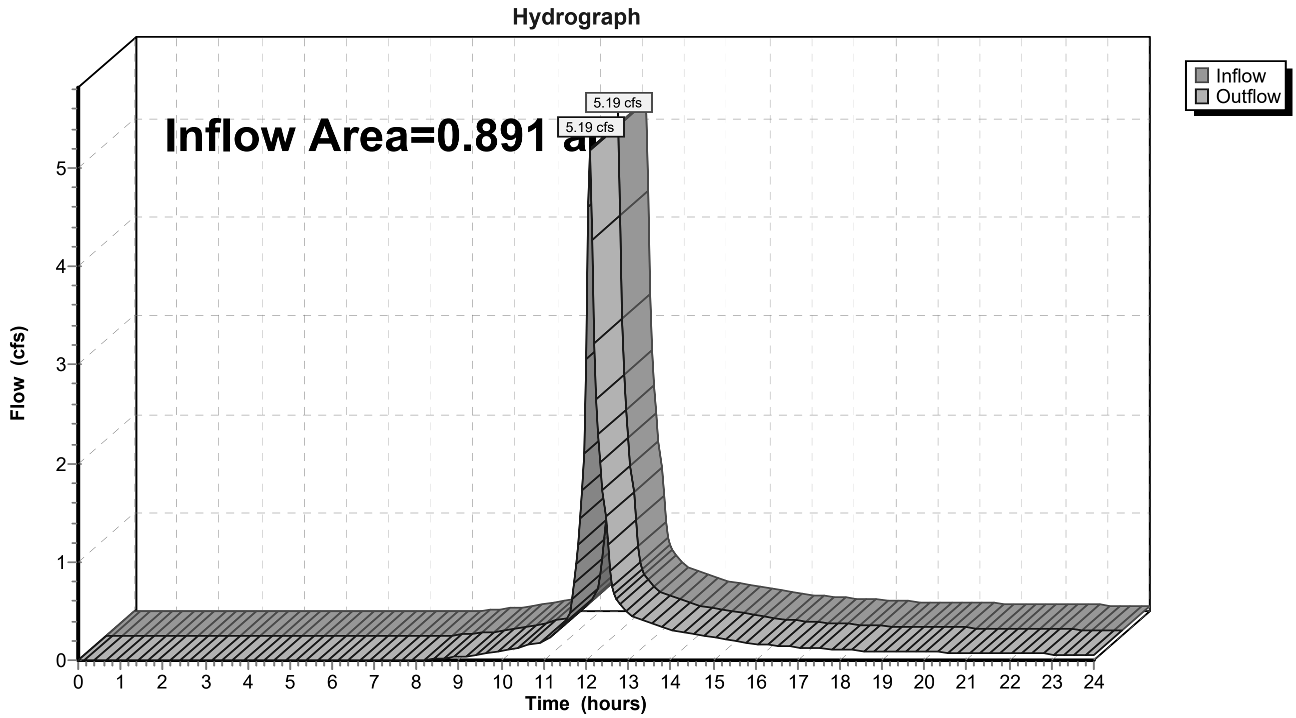


## Summary for Reach DP2:

Inflow Area = 0.891 ac, 4.42% Impervious, Inflow Depth > 4.79" for 100-yr event
Inflow = 5.19 cfs @ 12.09 hrs, Volume= 0.356 af
Outflow = 5.19 cfs @ 12.09 hrs, Volume= 0.356 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

## Reach DP2:

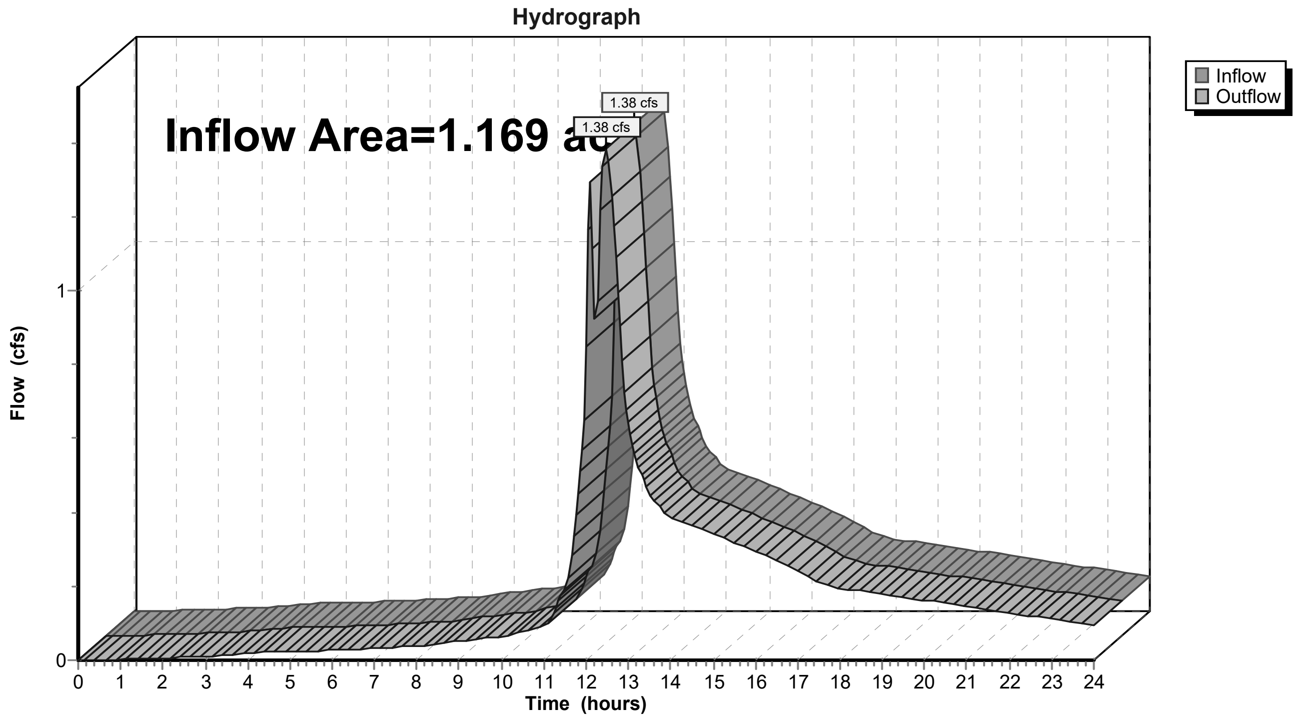


## Summary for Reach DP3: EX CB 3

Inflow Area = 1.169 ac, 75.19% Impervious, Inflow Depth > 3.54" for 100-yr event
Inflow = 1.38 cfs @ 12.47 hrs, Volume= 0.344 af
Outflow = 1.38 cfs @ 12.47 hrs, Volume= 0.344 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5

### Reach DP3: EX CB 3



## Summary for Pond 1P: EX CB 1

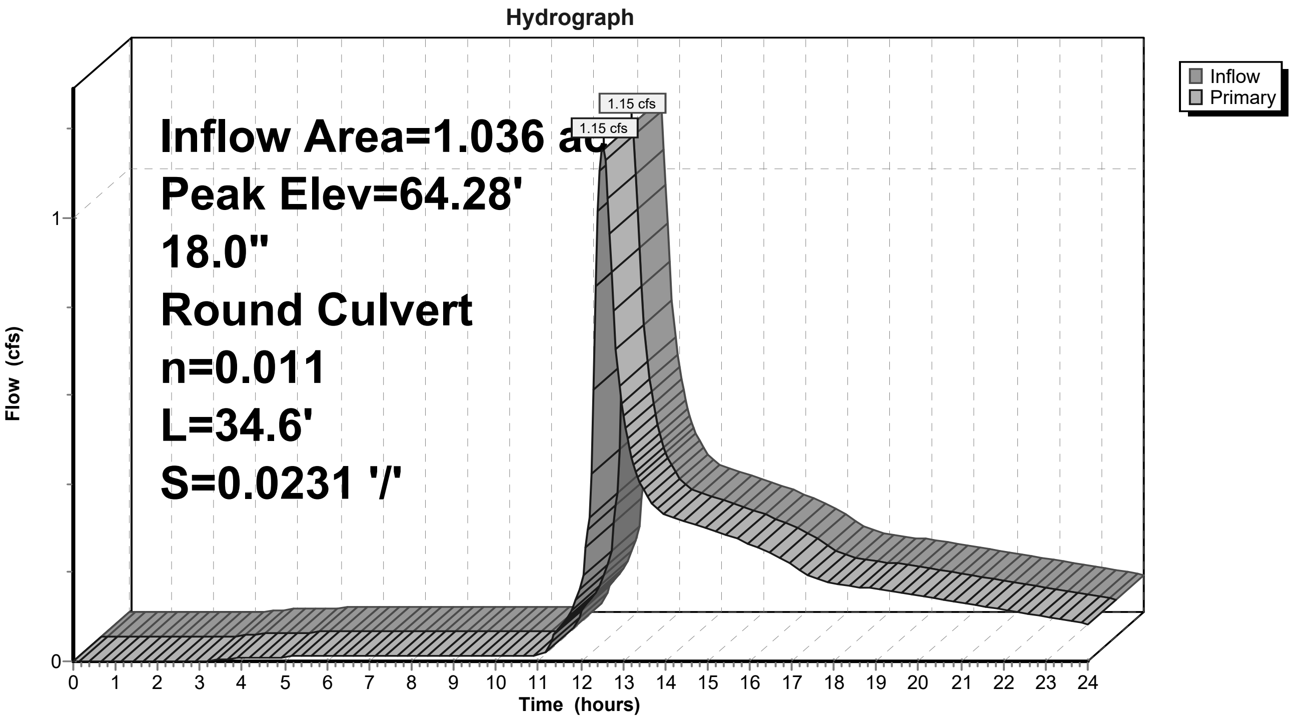
Inflow Area = 1.036 ac, 72.00% Impervious, Inflow Depth > 2.97" for 100-yr event
Inflow = 1.15 cfs @ 12.52 hrs, Volume= 0.256 af
Outflow = 1.15 cfs @ 12.52 hrs, Volume= 0.256 af, Atten= 0%, Lag= 0.0 min
Primary = 1.15 cfs @ 12.52 hrs, Volume= 0.256 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.28' @ 12.52 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 63.80' | **18.0" Round Culvert**<br>L= 34.6' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 63.80' / 63.00' S= 0.0231 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=1.15 cfs @ 12.52 hrs HW=64.28' TW=0.00' (Dynamic Tailwater)
↑—**1=Culvert** (Inlet Controls 1.15 cfs @ 2.36 fps)

### Pond 1P: EX CB 1



## Summary for Pond 2P: EX CB 2

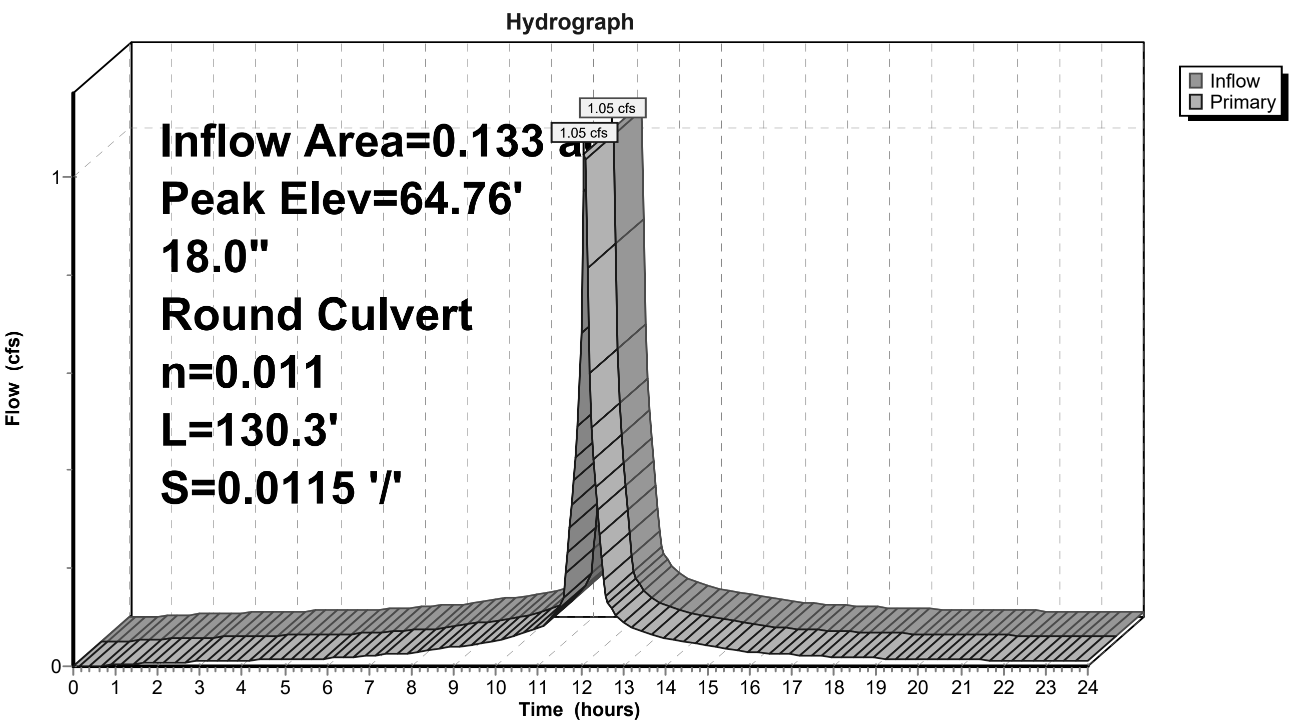
Inflow Area = 0.133 ac,100.00% Impervious, Inflow Depth > 7.96" for 100-yr event
Inflow = 1.05 cfs @ 12.09 hrs, Volume= 0.088 af
Outflow = 1.05 cfs @ 12.09 hrs, Volume= 0.088 af, Atten= 0%, Lag= 0.0 min
Primary = 1.05 cfs @ 12.09 hrs, Volume= 0.088 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.76' @ 12.09 hrs
Flood Elev= 68.20'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.30' | **18.0" Round Culvert**<br>L= 130.3' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.30' / 62.80' S= 0.0115 '/' Cc= 0.900<br>n= 0.011 Concrete pipe, straight & clean, Flow Area= 1.77 sf |

**Primary OutFlow** Max=1.02 cfs @ 12.09 hrs HW=64.75' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.02 cfs @ 2.28 fps)

### Pond 2P: EX CB 2



## Summary for Pond 3P: HYDRO 1

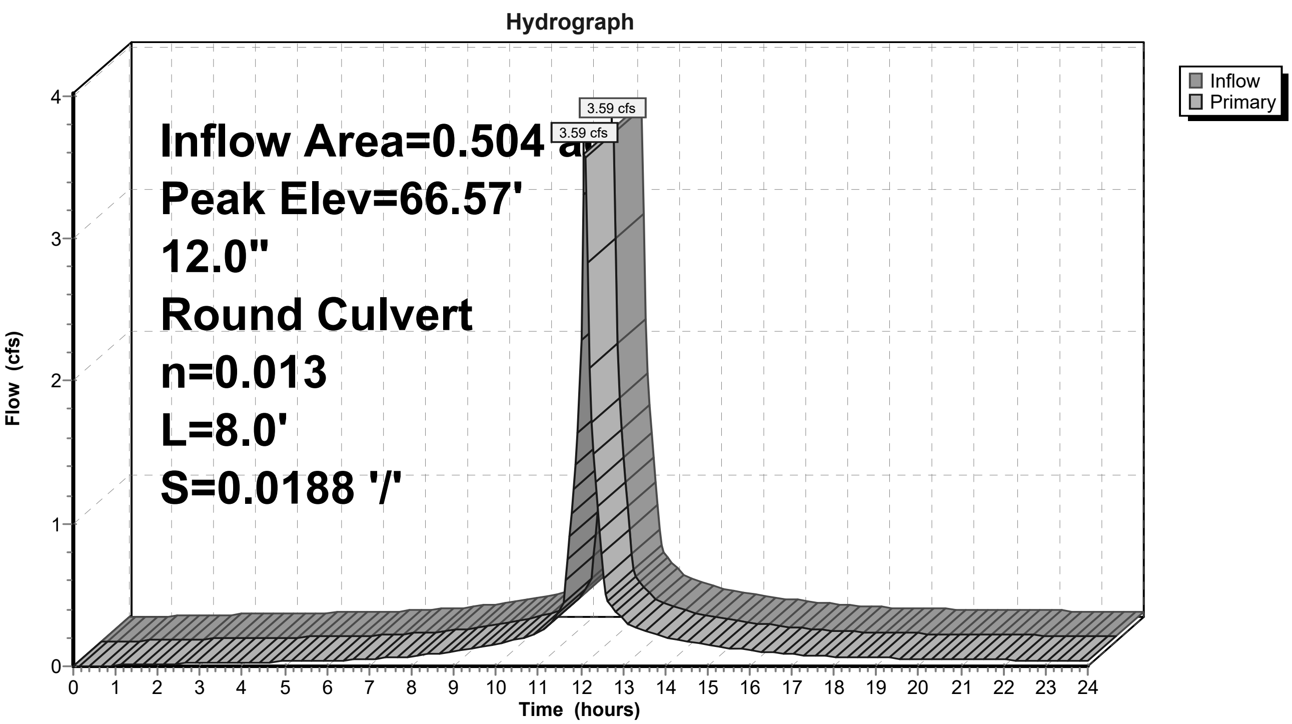
| | | | | |
|---|---|---|---|---|
| Inflow Area = | 0.504 ac, 68.58% Impervious, Inflow Depth > 6.89" for 100-yr event | | | |
| Inflow = | 3.59 cfs @ | 12.09 hrs, Volume= | 0.289 af | |
| Outflow = | 3.59 cfs @ | 12.09 hrs, Volume= | 0.289 af, | Atten= 0%, Lag= 0.0 min |
| Primary = | 3.59 cfs @ | 12.09 hrs, Volume= | 0.289 af | |

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 66.57' @ 12.09 hrs
Flood Elev= 68.50'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 65.15' | **12.0" Round Culvert**<br>L= 8.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.15' / 65.00' S= 0.0188 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=3.48 cfs @ 12.09 hrs HW=66.53' TW=64.43' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 3.48 cfs @ 4.43 fps)

### Pond 3P: HYDRO 1



## Summary for Pond 4P: INFILTRATORS

Inflow Area = 0.504 ac, 68.58% Impervious, Inflow Depth > 6.89" for 100-yr event
Inflow = 3.59 cfs @ 12.09 hrs, Volume= 0.289 af
Outflow = 0.96 cfs @ 12.45 hrs, Volume= 0.290 af, Atten= 73%, Lag= 21.9 min
Discarded = 0.63 cfs @ 11.75 hrs, Volume= 0.283 af
Primary = 0.32 cfs @ 12.45 hrs, Volume= 0.007 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 65.87' @ 12.45 hrs Surf.Area= 1,610 sf Storage= 3,003 cf
Flood Elev= 66.00' Surf.Area= 1,610 sf Storage= 3,090 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 23.9 min ( 786.0 - 762.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1A | 63.00' | 1,482 cf | **34.75'W x 46.34'L x 3.50'H Field A**<br>5,636 cf Overall - 1,929 cf Embedded = 3,706 cf x 40.0% Voids |
| #2A | 63.50' | 1,929 cf | **ADS_StormTech SC-740 +Cap** x 42 Inside #1<br>Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf<br>Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap<br>7 Rows of 6 Chambers |
| | | 3,412 cf | Total Available Storage |

Storage Group A created with Chamber Wizard

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Discarded | 63.00' | **17.000 in/hr Exfiltration over Surface area** |
| #2 | Primary | 65.50' | **6.0" Round Culvert**<br>L= 22.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.50' / 65.00' S= 0.0227 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.20 sf |

**Discarded OutFlow** Max=0.63 cfs @ 11.75 hrs HW=63.07' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.63 cfs)

**Primary OutFlow** Max=0.32 cfs @ 12.45 hrs HW=65.87' TW=64.80' (Dynamic Tailwater)
└─**2=Culvert** (Inlet Controls 0.32 cfs @ 2.07 fps)

## Pond 4P: INFILTRATORS - Chamber Wizard Field A

**Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)**
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

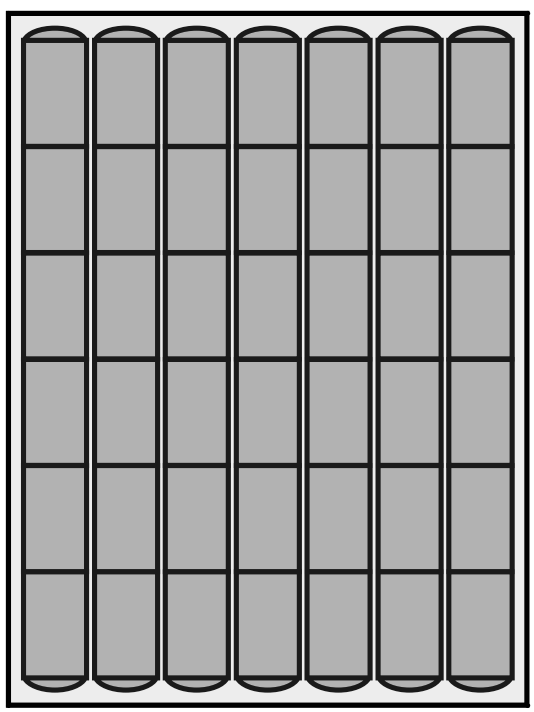
6 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 44.34' Row Length +12.0" End Stone x 2 = 46.34' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

42 Chambers x 45.9 cf = 1,929.5 cf Chamber Storage

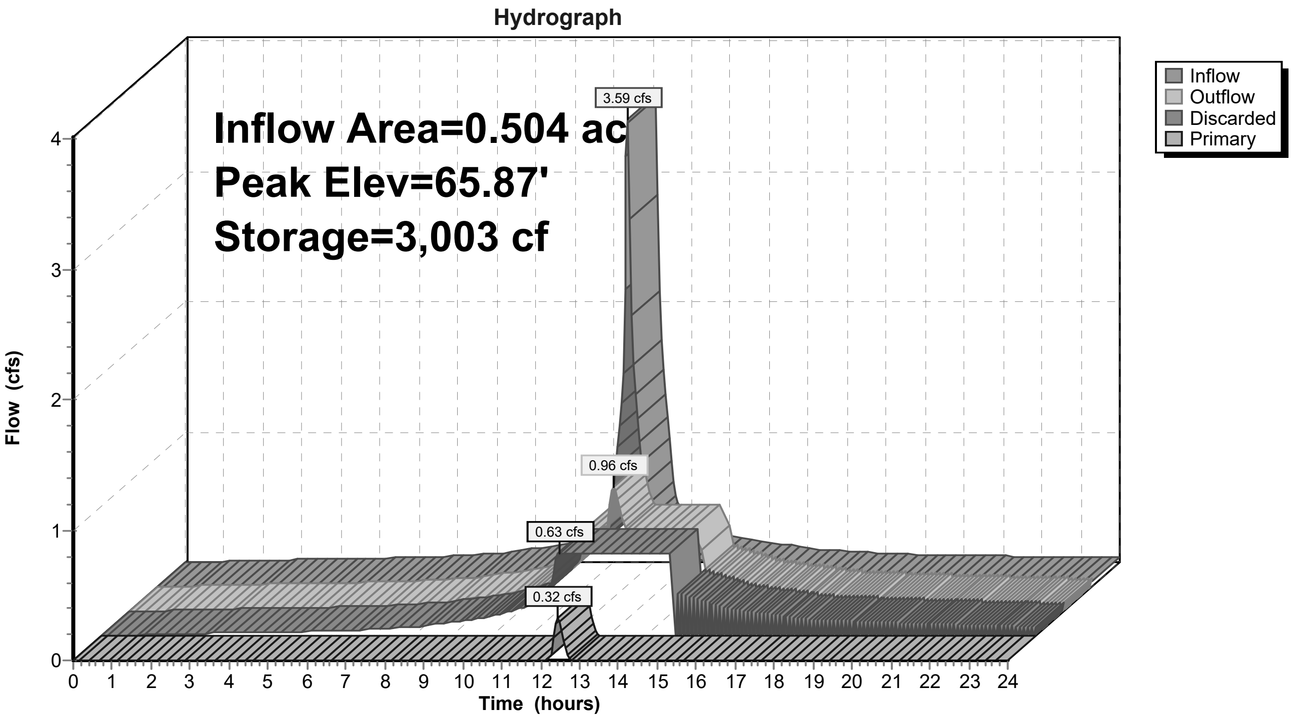
5,635.7 cf Field - 1,929.5 cf Chambers = 3,706.2 cf Stone x 40.0% Voids = 1,482.5 cf Stone Storage

Chamber Storage + Stone Storage = 3,412.0 cf = 0.078 af
Overall Storage Efficiency = 60.5%
Overall System Size = 46.34' x 34.75' x 3.50'

42 Chambers
208.7 cy Field
137.3 cy Stone



## Pond 4P: INFILTRATORS



## Summary for Pond 5P: DETENTION

Inflow Area = 0.504 ac, 68.58% Impervious, Inflow Depth = 0.16" for 100-yr event
Inflow = 0.32 cfs @ 12.45 hrs, Volume= 0.007 af
Outflow = 0.21 cfs @ 12.57 hrs, Volume= 0.007 af, Atten= 34%, Lag= 6.8 min
Primary = 0.21 cfs @ 12.57 hrs, Volume= 0.007 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 65.09' @ 12.56 hrs Surf.Area= 103 sf Storage= 106 cf
Flood Elev= 65.50' Surf.Area= 0 sf Storage= 136 cf

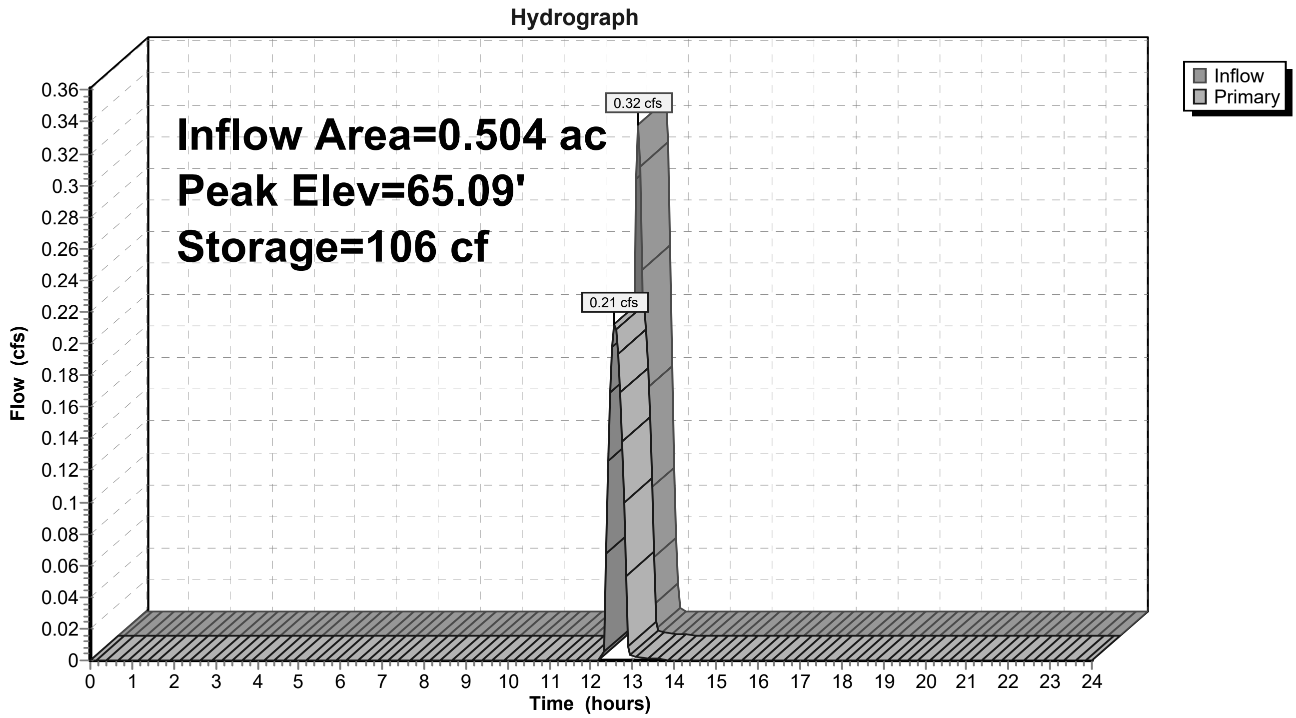
Plug-Flow detention time= 8.3 min calculated for 0.007 af (100% of inflow)
Center-of-Mass det. time= 7.9 min ( 757.0 - 749.1 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 64.00' | 136 cf | **18.0" Round Pipe Storage**<br>L= 77.0' |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.00' | **8.0" Round Culvert**<br>L= 29.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.00' / 63.80' S= 0.0069 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |
| #2 | Device 1 | 64.00' | **3.0" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.21 cfs @ 12.57 hrs HW=65.07' TW=64.28' (Dynamic Tailwater)
↑—**1=Culvert** (Passes 0.21 cfs of 1.25 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 0.21 cfs @ 4.29 fps)

## Pond 5P: DETENTION



## Summary for Pond 6P: OCS 1

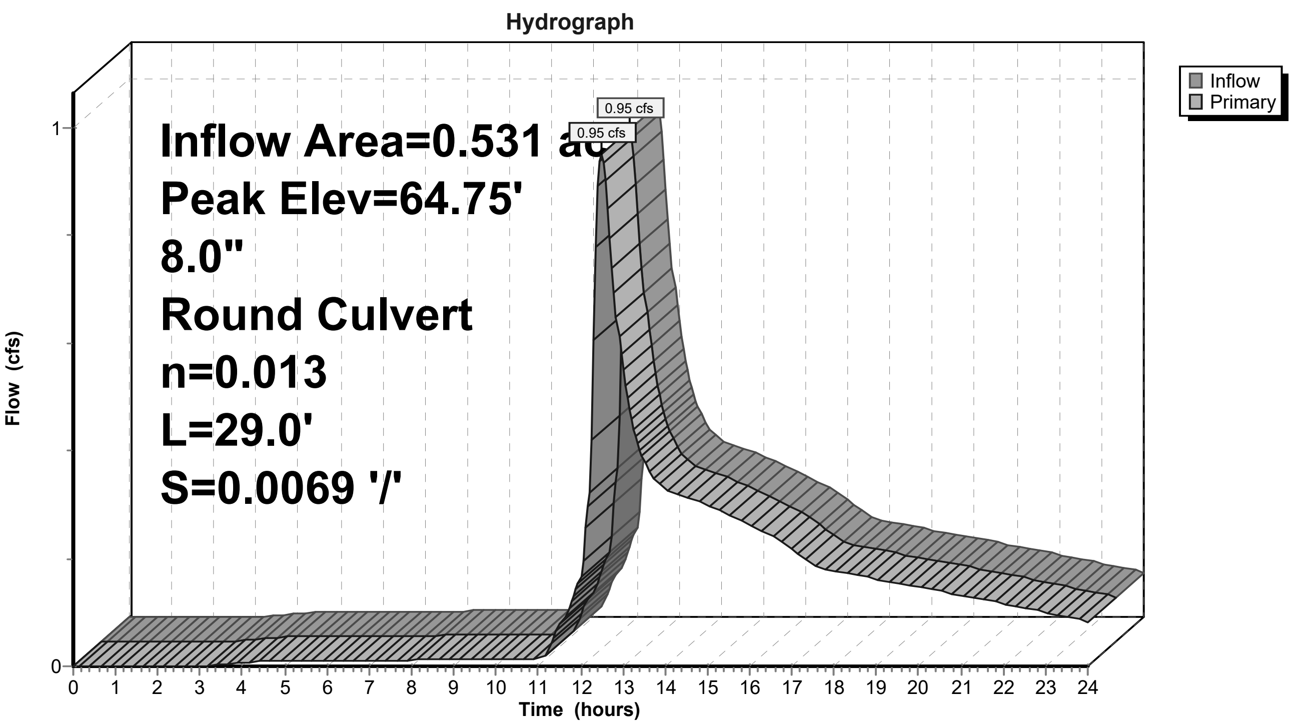
Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 5.63" for 100-yr event
Inflow = 0.95 cfs @ 12.50 hrs, Volume= 0.249 af
Outflow = 0.95 cfs @ 12.50 hrs, Volume= 0.249 af, Atten= 0%, Lag= 0.0 min
Primary = 0.95 cfs @ 12.50 hrs, Volume= 0.249 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 64.75' @ 12.50 hrs
Flood Elev= 68.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.00' | **8.0" Round Culvert**<br>L= 29.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 64.00' / 63.80' S= 0.0069 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.35 sf |

**Primary OutFlow** Max=0.95 cfs @ 12.50 hrs HW=64.75' TW=64.28' (Dynamic Tailwater)
└─**1=Culvert** (Barrel Controls 0.95 cfs @ 3.03 fps)

## Pond 6P: OCS 1



## Summary for Pond 7P: MODIFEID BIO

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 5.95" for 100-yr event
Inflow = 1.71 cfs @ 12.08 hrs, Volume= 0.264 af
Outflow = 1.66 cfs @ 12.11 hrs, Volume= 0.217 af, Atten= 3%, Lag= 1.9 min
Primary = 1.20 cfs @ 12.11 hrs, Volume= 0.205 af
Secondary = 0.46 cfs @ 12.11 hrs, Volume= 0.012 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 69.20' @ 12.11 hrs Surf.Area= 2,628 sf Storage= 2,509 cf
Flood Elev= 69.50' Surf.Area= 2,746 sf Storage= 3,311 cf

Plug-Flow detention time= 130.6 min calculated for 0.217 af (82% of inflow)
Center-of-Mass det. time= 54.5 min ( 834.9 - 780.4 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 68.10' | 3,311 cf | **Custom Stage Data (Prismatic)** Listed below (Recalc) |

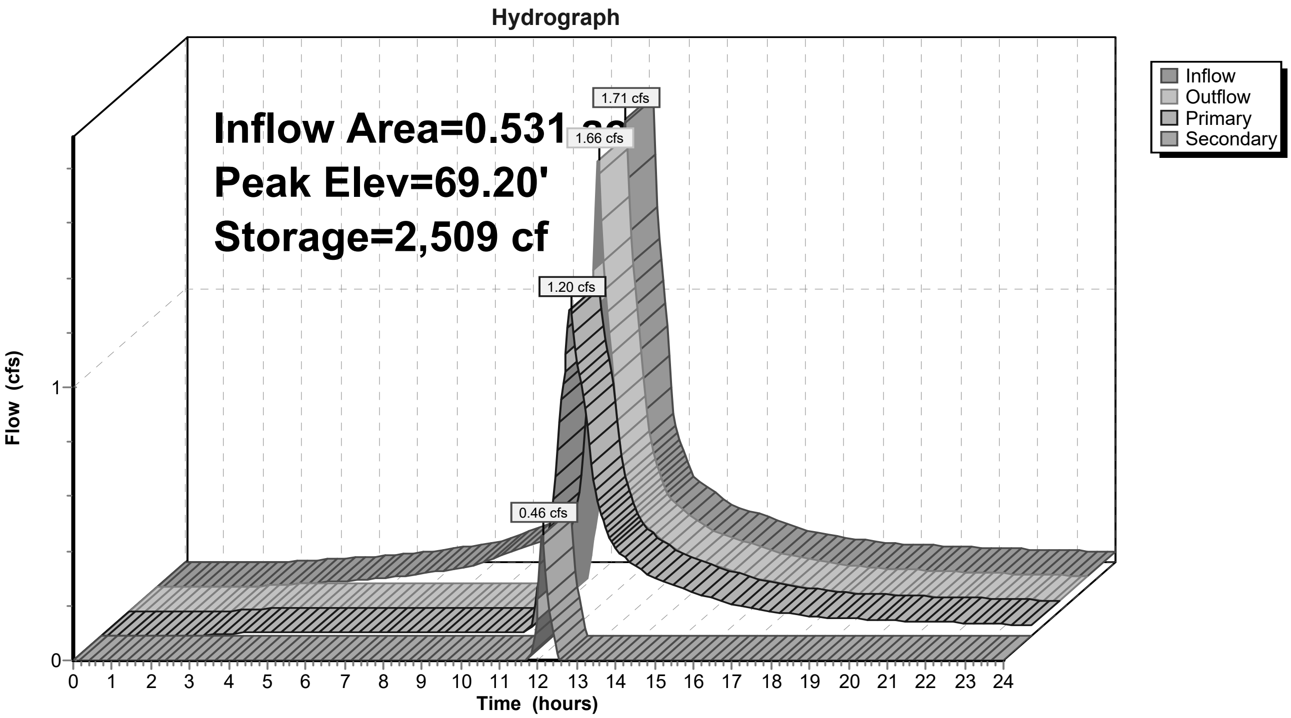
| Elevation (feet) | Surf.Area (sq-ft) | Inc.Store (cubic-feet) | Cum.Store (cubic-feet) |
|---|---|---|---|
| 68.10 | 1,867 | 0 | 0 |
| 69.00 | 2,549 | 1,987 | 1,987 |
| 69.50 | 2,746 | 1,324 | 3,311 |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 65.58' | **12.0" Round Culvert**<br>L= 5.2' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 65.58' / 65.55' S= 0.0058 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |
| #2 | Secondary | 69.15' | **12.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s) |
| #3 | Device 1 | 68.10' | **0.250 in/hr Exfiltration over Surface area** |
| #4 | Device 1 | 69.00' | **12.0" x 12.0" Horiz. Orifice/Grate** C= 0.600<br>Limited to weir flow at low heads |

**Primary OutFlow** Max=1.19 cfs @ 12.11 hrs HW=69.20' TW=65.91' (Dynamic Tailwater)
└─**1=Culvert** (Passes 1.19 cfs of 6.68 cfs potential flow)
  ├─**3=Exfiltration** (Exfiltration Controls 0.02 cfs)
  └─**4=Orifice/Grate** (Weir Controls 1.17 cfs @ 1.46 fps)

**Secondary OutFlow** Max=0.45 cfs @ 12.11 hrs HW=69.20' TW=0.00' (Dynamic Tailwater)
└─**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.45 cfs @ 0.73 fps)

## Pond 7P: MODIFEID BIO



## Summary for Pond 8P: DETENTION

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 5.80" for 100-yr event
Inflow = 3.49 cfs @ 12.09 hrs, Volume= 0.257 af
Outflow = 0.95 cfs @ 12.50 hrs, Volume= 0.249 af, Atten= 73%, Lag= 24.4 min
Primary = 0.95 cfs @ 12.50 hrs, Volume= 0.249 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 66.90' @ 12.50 hrs Surf.Area= 832 sf Storage= 4,441 cf
Flood Elev= 67.05' Surf.Area= 0 sf Storage= 4,524 cf

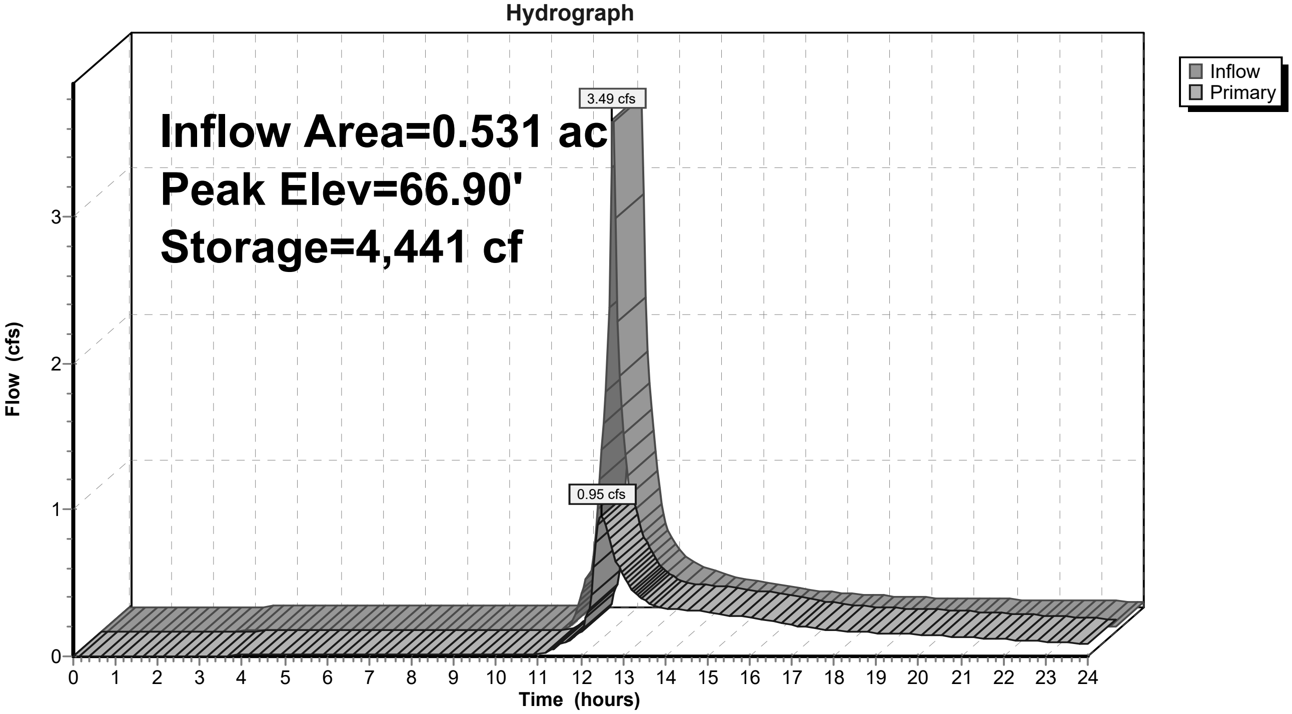
Plug-Flow detention time= 143.9 min calculated for 0.249 af (97% of inflow)
Center-of-Mass det. time= 126.8 min ( 944.6 - 817.8 )

| Volume | Invert | Avail.Storage | Storage Description |
|---|---|---|---|
| #1 | 64.05' | 4,524 cf | **36.0" Round Pipe Storage** x 4<br>L= 160.0' |

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 64.05' | **2.5" Vert. Orifice/Grate** C= 0.600 |
| #2 | Primary | 65.45' | **2.0" Vert. Orifice/Grate** C= 0.600 |
| #3 | Primary | 66.35' | **6.5" Vert. Orifice/Grate** C= 0.600 |

**Primary OutFlow** Max=0.95 cfs @ 12.50 hrs HW=66.90' TW=64.75' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 0.24 cfs @ 7.07 fps)
├─**2=Orifice/Grate** (Orifice Controls 0.12 cfs @ 5.63 fps)
└─**3=Orifice/Grate** (Orifice Controls 0.59 cfs @ 2.55 fps)

## Pond 8P: DETENTION



## Summary for Pond 9P: MH 1

Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 7.12" for 100-yr event
Inflow = 4.02 cfs @ 12.09 hrs, Volume= 0.315 af
Outflow = 4.02 cfs @ 12.09 hrs, Volume= 0.315 af, Atten= 0%, Lag= 0.0 min
Primary = 1.71 cfs @ 12.08 hrs, Volume= 0.264 af
Secondary = 2.30 cfs @ 12.09 hrs, Volume= 0.052 af

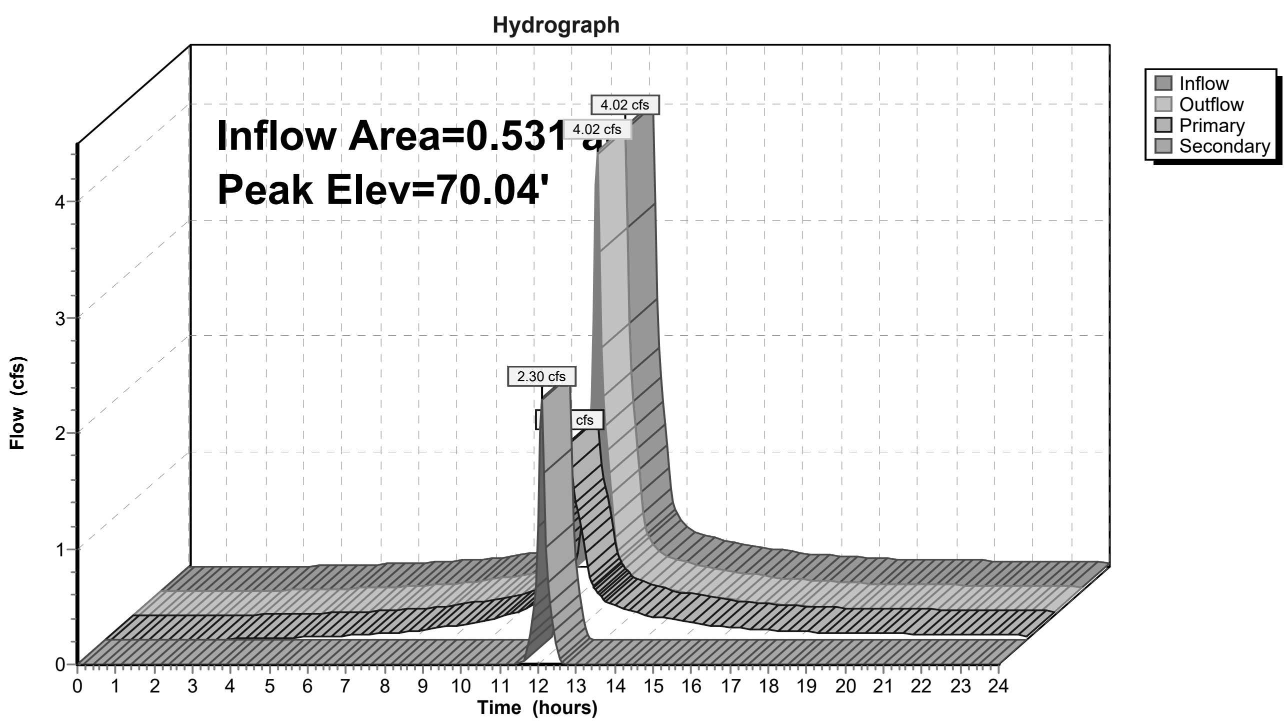
Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 70.04' @ 12.09 hrs
Flood Elev= 71.00'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 68.17' | **10.0" Round Culvert**<br>L= 6.4' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 68.17' / 68.14' S= 0.0047 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf |
| #2 | Secondary | 69.17' | **12.0" Round Culvert**<br>L= 78.0' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 69.17' / 66.05' S= 0.0400 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf |

**Primary OutFlow** Max=1.67 cfs @ 12.08 hrs HW=70.01' TW=69.61' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.67 cfs @ 3.05 fps)

**Secondary OutFlow** Max=2.23 cfs @ 12.09 hrs HW=70.02' TW=65.76' (Dynamic Tailwater)
└─**2=Culvert** (Inlet Controls 2.23 cfs @ 3.14 fps)

### Pond 9P: MH 1



## Summary for Pond 10P: HYDRO 2

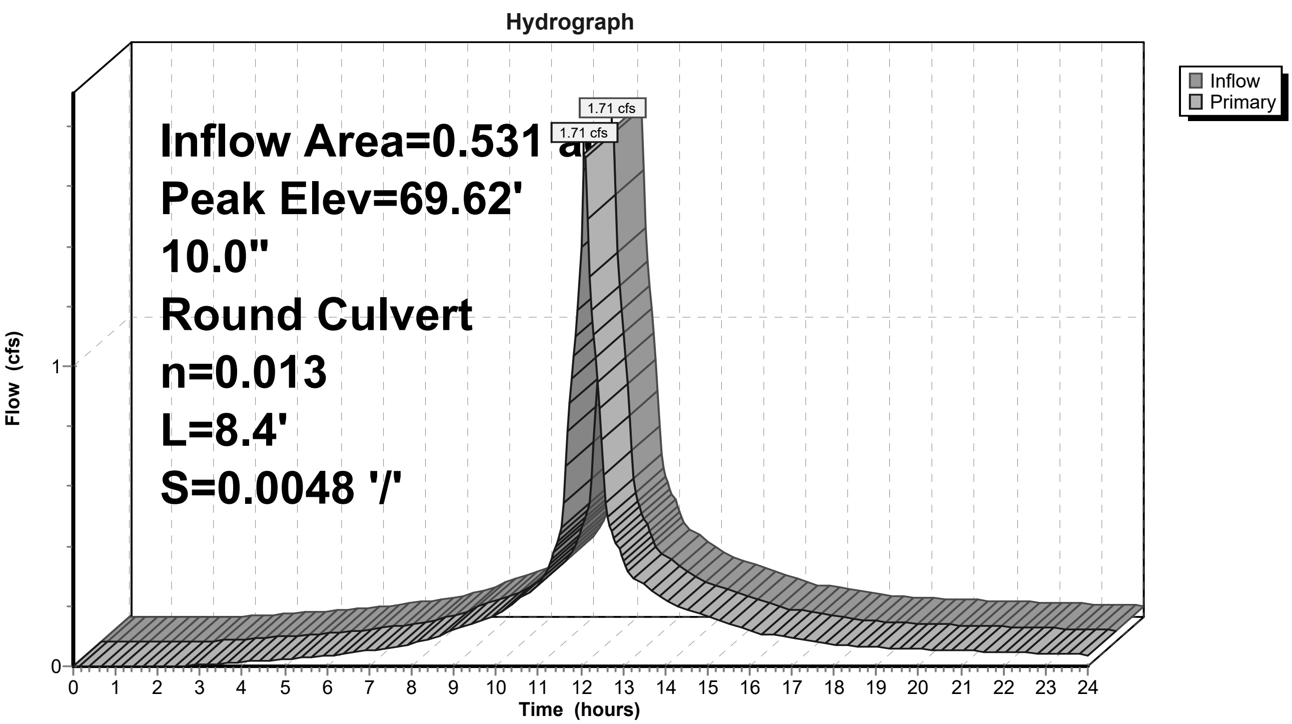
Inflow Area = 0.531 ac, 75.25% Impervious, Inflow Depth > 5.95" for 100-yr event
Inflow = 1.71 cfs @ 12.08 hrs, Volume= 0.264 af
Outflow = 1.71 cfs @ 12.08 hrs, Volume= 0.264 af, Atten= 0%, Lag= 0.0 min
Primary = 1.71 cfs @ 12.08 hrs, Volume= 0.264 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 5
Peak Elev= 69.62' @ 12.09 hrs
Flood Elev= 70.75'

| Device | Routing | Invert | Outlet Devices |
|---|---|---|---|
| #1 | Primary | 68.14' | **10.0" Round Culvert**<br>L= 8.4' CPP, square edge headwall, Ke= 0.500<br>Inlet / Outlet Invert= 68.14' / 68.10' S= 0.0048 '/' Cc= 0.900<br>n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.55 sf |

**Primary OutFlow** Max=1.68 cfs @ 12.08 hrs HW=69.61' TW=69.20' (Dynamic Tailwater)
└─**1=Culvert** (Inlet Controls 1.68 cfs @ 3.09 fps)

### Pond 10P: HYDRO 2



# Appendix K:
# Project Evaluation and Design Calculations

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## Appendix K - Table A
## Step 1 - Evaluation of Green Infrastructure Planning Measures

| Group | Practice | Description | Applicable | Project Specific Evaluation |
|---|---|---|---|---|
| Preservation of Natural Resources | **Preservation of Undisturbed Areas** | Delineate and place into permanent conservation undisturbed forests, native vegetated areas, riparian corridors, wetlands, and natural terrain. | **No** | The proposed site layout has been designed to limit land disturbance to the greatest extent practical. The project does not propose permanent conservation of this area at this time. |
| | **Preservation of Buffers** | Define, delineate and preserve naturally vegetated buffers along perennial streams, rivers, shorelines and wetlands. | **No** | There are no streams, rivers, shorelines, or wetlands on site. |
| | **Reduction of Clearing and Grading** | Limit clearing and grading to the minimum amount needed for roads, driveways, foundations, utilities and stormwater management facilities. | **N/A** | As a redevelopment, most of the site has already been cleared. |
| | **Locating Development in Less Sensitive Areas** | Avoid sensitive resource areas such as floodplains, steep slopes, erodible soils, wetlands, mature forests and critical habitats by locating development to fit the terrain in areas that will create the least impact. | **N/A** | There are no floodplains, steep slopes, erodible soils, wetlands, mature forests and critical habitats located on the project site. As such, this green planning measure does not apply. |
| | **Open Space Design** | Use clustering, conservation design or open space design to reduce impervious cover, preserve more open space and protect water resources. | **Yes** | The minimum drive aisle and parking space dimensions have been used to reduce the amount of impervious area. |
| | **Soil Restoration** | Restore the original properties and porosity of the soil by deep till and amendment with compost to reduce the generation of runoff and enhance the runoff reduction performance of practices such as downspout disconnections, grass channels, filter strips, and tree clusters. | **Yes** | Full soil restoration is proposed for all areas of disturbance that will not become hardscape. All areas will be stabilized with seed & mulch, and landscaped areas will be provided. |
| | **Roadway Reduction** | Minimize roadway widths and lengths to reduce site impervious area | **N/A** | There are no proposed roadways in this project. |

| | | | | |
|---|---|---|---|---|
| Reduction of Impervious Cover | **Sidewalk Reduction** | Minimize sidewalk lengths and widths to reduce site impervious area | **Yes** | Sidewalk widths and lengths have been minimized to the greatest extent practical. |
| | **Driveway Reduction** | Minimize driveway lengths and widths to reduce site impervious area | **Yes** | Driveway widths and lengths have been minimized to the greatest extent practical. |
| | **Cul-de-sac Reduction** | Minimize the number of cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. | **N/A** | No cul-de-sacs are proposed as part of this project. |
| | **Building Footprint Reduction** | Reduce the impervious footprint of residences and commercial buildings by using alternate or taller buildings while maintaining the same floor to area ratio. | **Yes** | This project removes multiple existing buildingsand proposes one building with a smaller footprint than the combined footprint of the various existing buildings. |
| | **Parking Reduction** | Reduce imperviousness on parking lots by eliminating unneeded spaces, providing compact car spaces and efficient parking lanes, minimizing stall dimensions, using porous pavement surfaces in overflow parking areas, and using multi-storied parking decks where appropriate. | **Yes** | On-site parking has been allocated to provide a sufficient number of spaces for the intended use. |

**Appendix K - Table B**
**Step 2 - Determine Water Quality Treatment Volume (WQv)**

| Determine Pre- and Post-Development Impervious Cover Areas | | | | |
|---|---|---|---|---|
| Watershed Pre-Development Impervious Area: | 30,536 | sf = | 0.70 | ac |
| Watershed Post-Development Impervious Area: | 40,890 | sf = | 0.94 | ac |
| Total Area Within Work Limits: | 79,622 | sf = | 1.83 | ac |
| Existing Disturbed Impervious Area: | 24,390 | sf = | 0.56 | ac |
| New Development Impervious Area: | 10,354 | sf = | 0.24 | **ac** |
| Redevelopment Impervious % (based on proposed treatment practice) | 25 | % | | |
| Redevelopment Impervious Area: | 6,098 | sf = | **0.14** | **ac** |

| Determine the Initial Water Quality Volume (WQv) | | | | |
|---|---|---|---|---|
| WQv(acre-feet) = [(P)(Rv)(A)] /12 | | | | |
| Rv = 0.05+0.009(I) | | | | |
| I = Impervious Cover (%) | | | | |
| P= | 1.35 | *inch* | | |
| I= | 21% | | | |
| Rv= | 0.236 | | | |
| **Initial WQv=** | **2,114** | cf = | **0.049** | **ac-ft** |

## Appendix K - Table C
## Step 3 - Determine Minimum Required Runoff Reduction Volume (RRv)

Section 4.3 of the NYSDEC Stormwater Management Design Manual describes the Runoff Reduction Volume equation as:

**RRv = (P x Rv* x Ai) / 12**

where: RRv = Runoff Reduction Volume (acre-feet)
P = 90% Rainfall Event Number (inches) (interpolated from Design Manual Fig 4.1)
Rv = 0.05 + 0.009 (I), where I is 100% impervious = 0.95 constant
Ai = (S x Aic) = Impervious cover targeted for runoff reduction
Aic = Total area of new impervious cover (acres)
S = Hydrologic Soil Group (HSG) Specific Reduction Factor
where:

| | | | |
|---|---|---|---|
| HSG A= | 0.55 | HSG C= | 0.30 |
| HSG B= | 0.40 | HSG D= | 0.20 |

The following table presents the RRv calculations for each of the proposed stormwater management

**Enter the Soils Data for the site**

| Soil Group | Acres | S |
|---|---|---|
| A | 0.00 | 0.55 |
| B | 1.80 | 0.40 |
| C | 0.00 | 0.30 |
| D | 0.00 | 0.20 |
| Total Area | 1.80 | acres |

**Calculate the Minimum RRv**

| | | |
|---|---|---|
| S = | **0.40** | |
| Impervious = | 0.24 | *acre* |
| Precipitation | 1.35 | *in* |
| Rv | 0.95 | |
| **Minimum RRv** | **443** | ***ft*** $^3$ |
| | 0.010 | af |

## Appendix K - Table D
## Step 3 - Evaluation of Runoff Reduction Techniques and Standard SMPs with RRv Capacity

| Design Variant | Practice | Description | Applicable | Project Specific Evaluation/Justification |
|---|---|---|---|---|
| *RR-1* | **Conservation of Natural Areas** | Retain the pre-development hydrologic and water quality characteristics of undisturbed natural areas, stream and wetland buffers by restoring and/or permanently conserving these areas on a site. | **No** | As a Redevelopment Project, the proposed site layout has been designed to limit land disturbance to the greatest extent practical. |
| *RR-2* | **Sheet flow to Riparian Buffers or Filter Strips** | Undisturbed natural areas such as forested conservation areas and stream buffers or vegetated filter strips and riparian buffers can be used to treat and control stormwater runoff from portions of development. | **No** | No untreated sheet flow is proposed to flow to the riparian areas from the proposed layout. |
| *RR-3* | **Tree Planting/ Tree Pit** | Plant or conserve trees to reduce stormwater runoff, increase nutrient uptake, and provide bank stabilization. Trees can be used for applications such as landscaping, stormwater management practice areas, and conservation areas. | **No** | The project proposes the preservation of existing mature trees, as well as the planting of numerous trees throughout the site, in order to reduce stormwater runoff, increase nutrient uptake, and provide bank stabilization. However, credit for these trees will not be taken toward an area reduction in the RRv calculations. |
| *RR-4* | **Disconnection of Rooftop Runoff** | Direct runoff from residential rooftop areas and upland overland runoff flow to designated pervious areas to reduce runoff volumes and rates. | **No** | No areas contain small enough roof areas or a long enough flow path before reconnecting with impervious areas to qualify for the rooftop disconnection credit. |
| *RR-5* | **Vegetated Swale** | The natural drainage paths, or properly designed vegetated channels, can be used instead of constructing underground storm sewers or concrete open channels to increase time of concentration, reduce the peak discharge, and provide infiltration. | **No** | There is no adequate space in the disturbaed area for a vegetated swale. |
| *RR-6* | **Rain Garden** | Manage and treat small volumes of stormwater runoff using a conditioned planting soil bed and planting materials to filter runoff stored within a shallow depression. | **No** | Due to the limited tributary area to rain gardens (less than or equal to 1,000SF), a rain garden is not practical at this site. |

| | | | | |
|---|---|---|---|---|
| *RR-7* | **Stormwater Planter** | Small landscaped stormwater treatment devices that can be designed as infiltration or filtering practices. Stormwater planters use soil infiltration and biogeochemical processes to decrease stormwater quantity and improve water quality. | **No** | The stormwater management approach for this project is intended to provide a more natural aesthetic that is consistent with the wooded surrounding. Since, stormwater planters have significant maintenance considerations and a more structured aesthetic, they have not been proposed for this project. |
| *RR-8* | **Rain Barrels/ Cisterns** | Capture and store stormwater runoff to be used for irrigation systems or filtered and reused for non-contact activities. | **No** | Rain Barrels/Cisterns are not proposed on-site due to the need for active management/maintenance and initial capital cost. In addition, the cold climate of the project area would require additional protection measures from freezing. |
| *RR-9* | **Porous Pavement** | Pervious types of pavements that provide an alternative to conventional paved surfaces, designed to infiltrate rainfall through the surface, thereby reducing stormwater runoff from a site and providing some pollutant uptake in the underlying soils. | **No** | Porous pavement is not proposed as part of this project due to majority of the site is considered a hot spot. |
| *RR-10* | **Green Roof** | Capture runoff by a layer of vegetation and soil installed on top of a conventional flat or sloped roof. The rooftop vegetation allows evaporation and evapotranspiration processes to reduce volume and discharge rate of runoff entering conveyance system. | **No** | A green roof is not proposed on-site due to significant structural, insurance, and maintenance considerations. |
| | **Stream Daylighting** | Stream Daylight previously-culverted/piped streams to restore natural habitats, better attenuate runoff by increasing the storage size, promoting infiltration, and help reduce pollutant loads. | **No** | Stream daylighting is not proposed on this site. |
| *I-1* | **Infiltration Trench** | Excavated, stone-filled trenches designed to capture and temporarily store runoff in the stone reservoir to promote infiltration. Can be constructed as sheet flow to a ground surface depression or piped flow discharged directly into the trench. | **No** | An infiltration trench is not applied to this project. However, an underground infiltration system is proposed. |

| | | | | |
|---|---|---|---|---|
| *I-2* | **Infiltration Basin** | Vegetated excavations designed to capture and infiltrate the WQv. Can be designed off-line to bypass larger flows to downstream flood control facilities or as combined infiltration/flood control facilities by providing temporary detention ponding. | **No** | An infiltration basin is not applied to this project. However, an underground infiltration system is proposed. |
| *I-3* | **Dry Wells** | Underground structures designed to capture, treat, and infiltrate runoff from small drainage areas (rooftop only) that have low sediment or pollutant loadings. Larger stormwater volumes can be bypassed directly to a flood control facility. | **No** | Dry wells have not been applied to this project. |
| *I-4* | **Underground Infiltration Systems** | Underground, proprietary systems designed to capture and infiltrate the WQv, reduce runoff, remove fine sediment and associated pollutants, recharge groundwater, and attenuate peak flows. | **Yes** | An underground infiltration system has been applied to this project. |
| *F-5* | **Bioretention** | Shallow landscaped depressions where stormwater flows into the practice, ponds at the surface, and gradually filters through the media to remove pollutants. Filtered runoff can either infiltrate into the surrounding soil, or be collected by an underdrain system and discharged to the storm sewer system or directly to receiving waters. | **Yes** | Bioretention has been applied to this project. |
| *O-1* | **Dry Swale** | Designed to temporarily hold the WQv in a pool or series of pools created by permanent check dams. The soil bed consists of native soils or highly permeable fill material, underlain by an underdrain system. Pollutants are removed through sedimentation, nutrient uptake, and infiltration. | **No** | Dry swales are not proposed. |

| Appendix K - Table E | | | | | | |
|---|---|---|---|---|---|---|
| **Summary Table: Runoff Reduction Volume and Treated volumes** | | | | | | |
| | **Runoff Reduction Techiques/Standard SMPs** | | **Total Contributing Area** | **Total Contributing Impervious Area** | **WQv Reduced (RRv)** | **WQv Treated** |
| | | | **(acres)** | **(acres)** | **cf** | **cf** |
| Area/Volume Reduction | Conservation of Natural Areas | RR-1 | 0.00 | 0.00 | | |
| | Sheetflow to Riparian Buffers/Filter Strips | RR-2 | 0.00 | 0.00 | | |
| | Tree Planting/Tree Pit | RR-3 | 0.07 | 0.00 | | |
| | Disconnection of Rooftop Runoff | RR-4 | 0.00 | 0.00 | | |
| | Vegetated Swale | RR-5 | 0.00 | 0.00 | 0 | |
| | Rain Garden | RR-6 | 0.00 | 0.00 | 0 | |
| | Stormwater Planter | RR-7 | 0.00 | 0.00 | 0 | |
| | Rain Barrel/Cistern | RR-8 | 0.00 | 0.00 | 0 | |
| | Porous Pavement | RR-9 | 0.00 | 0.00 | 0 | |
| | Green Roof (Intensive & Extensive) | RR-10 | 0.00 | 0.00 | 0 | |
| Standard SMPs w/RRv Capacity | Infiltration Trench | I-1 | 0.00 | 0.00 | 0 | 0 |
| | Infiltration Basins | I-2 | 0.00 | 0.00 | 0 | 0 |
| | Dry Well | I-3 | 0.00 | 0.00 | 0 | 0 |
| | Underground Infiltration System | I-4 | 0.38 | 0.37 | 1,741 | 1,741 |
| | Bioretention | F-5 | 0.55 | 0.42 | 858 | 1,287 |
| | Dry Swale | O-1 | 0.00 | 0.00 | 0 | 0 |
| Standard SMPs | Micropool Extended Detention (P-1) | P-1 | 0.00 | 0.00 | | 0 |
| | Wet Pond (P-2) | P-2 | 0.00 | 0.00 | | 0 |
| | Wet Extended Detention (P-3) | P-3 | 0.00 | 0.00 | | 0 |
| | Multiple Pond System (P-4) | P-4 | 0.00 | 0.00 | | 0 |
| | Pocket Pond (P-5) | P-5 | 0.00 | 0.00 | | 0 |
| | Surface Sand Filter (F-1) | F-1 | 0.00 | 0.00 | | 0 |
| | Underground Sand Filter (F-2) | F-2 | 0.00 | 0.00 | | 0 |
| | Perimeter Sand Filter (F-3) | F-3 | 0.00 | 0.00 | | 0 |
| | Organic Filter (F-4) | F-4 | 0.00 | 0.00 | | 0 |
| | Shallow Wetland (W-1) | W-1 | 0.00 | 0.00 | | 0 |
| | Extended Detention Wetland (W-2) | W-2 | 0.00 | 0.00 | | 0 |
| | Pond/Wetland System (W-3) | W-3 | 0.00 | 0.00 | | 0 |
| | Pocket Wetland (W-4) | W-4 | 0.00 | 0.00 | | 0 |
| | Wet Swale (O-2) | O-2 | 0.00 | 0.00 | | 0 |
| Alternative Practices | Hydrodynamic Separator | | 0.00 | 0.00 | | 0 |
| | Filterra Bioretention System | | 0.00 | 0.00 | | 0 |
| | Wet Vault | | 0.00 | 0.00 | | 0 |
| | Media Filter | | 0.00 | 0.00 | | 0 |
| | Totals by Area Reduction | → | 0.07 | 0.00 | 0 | |
| | Totals by Volume Reduction | → | 0.00 | 0.00 | 0 | |
| | Totals by Standard SMP w/RRV | → | 0.93 | 0.79 | 2,599 | 3,029 |
| | Totals by Standard SMP | → | 0.00 | 0.00 | | 0 |
| | Totals by Alternative Practices | → | 0.00 | 0.00 | | 0 |
| | Totals ( Area + Volume + all SMPs) | → | 1.00 | 0.79 | **2,599** | **3,029** |

**Practice Specific Sizing Calculation Worksheet**

## BIORETENTION NO. 1 (BIO-1)

| Practice Proposed? | Yes |
|---|---|

**Enter Site Data For Drainage Area to be Treated by Practice**

| Catchment Number | Total Area *(Acres)* | Impervious Area *(Acres)* | Percent Impervious *%* | Rv | WQv *($ft^3$)* | Precipitation *(in)* | Description |
|---|---|---|---|---|---|---|---|
| PS6 | 0.55 | 0.42 | 76% | 0.73 | 1,983 | 1.35 | Bioretention |
| Enter Impervious Area Reduced by Disconnection of Rooftops Within this Catchment: | | 0.00 | 76% | 0.73 | 1,983 | <<WQv after adjusting for Disconnected Rooftops | |
| Reduced by Tree Planting: | 0.00 | 0.00 | 76% | 0.73 | 1,983 | <<WQv after adjusting for Tree Planting | |
| Enter the portion of the WQv that is not reduced for all practices routed to this practice: | | | | | 0 | $ft^3$ | |

**Determine Required Water Quality Volume**

**WQv = (P/12) * Rv * A**

where: WQv = Water Quality Volume (acre-feet)
P = 1-year 24-hour design storm (inches)
Rv = 0.05 + 0.009 (I); min Rv = 0.2
I = Impervious Cover (%) within the drainage area contributing to the SWM practice
A = Drainage area (square feet) contributing to the SWM practice

| **WQv =** | **1,983** | **CF** |
|---|---|---|

**Value taken from Appendix K - Table B*

**Calculate Required Filter Bed Area**

**Af=(WQv)*(df)/[(k)*(hf+df)*(tf)]**

where: Af = Surface area of filter bed (SF)
WQv = Required Water Quality Volume (CF)
df = Filter bed depth (ft)
k = Coefficient of permeability of filter media (ft/day)
hf = Average height of water above filter bed (ft)
tf = Design filter bed drain time (days)

| SMP ID | WQv (cubic feet) | df (feet) | k (ft/day) | hf (feet) | tf (days) | Minimum Af (sq-ft) | Provided Af (sq-ft) |
|---|---|---|---|---|---|---|---|
| BIO-1 | 1,983 | 2.5 | 0.5 | 0.25 | 2.0 | 1,802 | 1,867 |

**Calculate Provided Water Quality Volume**

**WQv Provided Within Practice = Total volumes of soil media, mulch, and ponding**

WQv = $V_{SM} + V_M$ + Vpond

| | | | |
|---|---|---|---|
| $V_{SM}$ = | Af * df * $P_{SM}$ = | 934 | cf. |
| $V_M$ = | Af * dm * $P_M$ = | 187 | cf. |
| $V_{POND}$ = | (Af * hf * 2) + (2 * S * $hf^2$ * Pf) = | 1,025 | cf. |

where:

| | | | |
|---|---|---|---|
| $P_{SM}$ = | Porosity of soil media - 0.20 | 0.20 | |
| $P_M$ = | Porosity of mulch - 0.40 | 0.40 | |
| S = | Bioretention Side Slopes | 3.00 | :1 |
| Pf = | Bioretention Perimeter | 244 | LF |

| **WQv =** | **2,145** | **CF** |
|---|---|---|

**Calculate Provided Runoff Reduction Volume**

| | | |
|---|---|---|
| Using Underdrains? | Yes | |
| RRv = | 858 | CF |
| **RRv Applied =** | **858** | **CF** |

*This is 40% of the storage provided or WQv, whichever is less.*

**Appendix K - Table G**
**Practice Specific Sizing Calculation Worksheet**

| Enter Site Data For Drainage Area to be Treated by Practice | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Catchment Number** | **Total Area** *(Acres)* | **Impervious Area** *(Acres)* | **Percent Impervious** *%* | **Rv** | **WQv** *($ft^3$)* | **Precipitation** *(in)* | **Description** |
| PS3,4,5,7,8 | 0.38 | 0.37 | 99% | 0.94 | 1,741 | 1.35 | |

**Appendix K - Table F**
**Practice Specific Sizing Calculation Worksheet**

## SUBSURFACE INFILTRATION CHAMBERS

**Infiltrators 1:**

| WQv Required (cu ft) | Provided WQv (cu ft) | WQv Reduced (cu ft) | WQv Treated | Required Pretreatment | Provided Pretreatment | Description |
|---|---|---|---|---|---|---|
| 1,741 | 2,231 | 1,741 | 1,741 | 1,741 | 1,741 | Available storage above lowest overflow pipe |

**Appendix K - Table H**
**Practice Specific Sizing Calculation Worksheet**

# HYDRODYNAMIC SEPARATOR NO. 1 (HYDRO 1)

| | |
|---|---|
| Practice Proposed? | Yes |
| Treatment (Redevelopmen | No |

**Enter Site Data For Drainage Area to be Treated by Practice**

| Catchment Number | Total Area *(Acres)* | Impervious Area *(Acres)* | Percent Impervious *%* | Rv | WQv *($ft^3$)* | Precipitation *(in)* | Description |
|---|---|---|---|---|---|---|---|
| PS6 | 0.55 | 0.42 | 76% | 0.73 | 1,983 | 1.35 | Hydrodynamic Separator |

**Compute Peak Water Quality Discharge**

**Qp = qu * A * WQv** `

where: qu = the unit peak discharge, in cfs/$mi^2$/inch
A = Drainage area (square miles) contributing to the SMP
WQv = Water Quality Volume (inches)

The unit peak discharge qu is obtained from TR-55 Exhibits 4-I through 4-III, depending on the NRCS rainfall distribution type. It is based on the time of concentration (Tc) in hours, the initial abstraction (Ia) in inches, and the precipitation (P) in inches. The initial abstraction (Ia) is obtained from TR-55 Table 4-1, and is based on the equivalent Curve Number for the water quality volume.

The equivalent Curve Number is calculated using the following equation:

**CN = 1000 / [10 + 5P + 10Q - 10 * (Q^2 + 1.25QP)^0.5]**

where: CN = Equivalent Curve Number
P = 90% Rainfall Event Number (inches) = 1.35 in
Q = Water Quality Volume (inches)

The following table presents the Water Quality Peak Flow calculations for each of the proposed stormwater management practices (SMPs):

| SMP ID | A (ac) | WQv (cf) | Q (inches) | Tc (hours) | CN | Ia (inches) | Ia/P | qu (cfs/sq.mi.-inch) | Qp (cfs) |
|---|---|---|---|---|---|---|---|---|---|
| PS6 | 0.55 | 1,983 | 0.99 | 0.10 | 96.5 | 0.073 | 0.054 | 680 | **0.60** |

**Size Flow Diversion Structure**

**Orifice Equation: $Qp = CA(2gh)^{0.5}$**

where: C = Orifice coefficient
A = Area of WQv orifice (sf)
g = acceleration due to gravity (feet/$second^2$)
h = depth of water to center of orifice (ft)
d = minimum diameter of WQv orifice
y = distance of overflow bipass above invert of water quality pipe (ft)

The following table presents the minimum diameter of the WQv orifice and distance of the overflow bipass above the invert of

| SMP ID | C | A ($ft^2$) | g ($ft/sec^2$) | h (ft) | d (ft) | d (in) | y (ft) |
|---|---|---|---|---|---|---|---|

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| PS6 | 0.60 | 0.3 | 32.2 | 0.15 | 0.64 | 8 | 0.48 |

## HYDRODYNAMIC SEPARATOR NO. 2 (HYDRO 2)

| | |
|---|---|
| Practice Proposed? | Yes |
| Treatment (Redevelopmen | No |

**Enter Site Data For Drainage Area to be Treated by Practice**

| **Catchment Number** | **Total Area** *(Acres)* | **Impervious Area** *(Acres)* | **Percent Impervious** *%* | **Rv** | **WQv** *($ft^3$)* | **Precipitation** *(in)* | **Description** |
|---|---|---|---|---|---|---|---|
| PS3,4,5,7,8 | 0.38 | 0.37 | 99% | 0.94 | 1,741 | 1.35 | Hydrodynamic Separator |

**Compute Peak Water Quality Discharge**

**Qp = qu * A * WQv** `

where: qu = the unit peak discharge, in cfs/mi$^2$/inch
A = Drainage area (square miles) contributing to the SMP
WQv = Water Quality Volume (inches)

The unit peak discharge qu is obtained from TR-55 Exhibits 4-I through 4-III, depending on the NRCS rainfall distribution type.
The equivalent Curve Number is calculated using the following equation:
**CN = 1000 / [10 + 5P + 10Q - 10 * (Q^2 + 1.25QP)^0.5]**

where: CN = Equivalent Curve Number
P = 90% Rainfall Event Number (inches) = 0.00 in
Q = Water Quality Volume (inches)

The following table presents the Water Quality Peak Flow calculations for each of the proposed stormwater management

| **SMP ID** | **A** | **WQv** | **Q** | **Tc** | **CN** | **Ia** | **Ia/P** | **qu** | **Qp** |
|---|---|---|---|---|---|---|---|---|---|
| | **(ac)** | **(cf)** | **(inches)** | **(hours)** | | **(inches)** | | **(cfs/sq.mi.-inch)** | **(cfs)** |
| PS3,4,5,7,8 | 0.38 | 1,741 | 1.27 | 0.10 | 99.3 | 0.014 | 0.010 | 650 | **0.50** |

**Size Flow Diversion Structure**

**Orifice Equation: Qp = CA(2gh)$^{0.5}$**
where: C = Orifice coefficient
A = Area of WQv orifice (sf)
g = acceleration due to gravity (feet/second$^2$)
h = depth of water to center of orifice (ft)

d = minimum diameter of WQv orifice

y = distance of overflow bipass above invert of water quality pipe (ft)

The following table presents the minimum diameter of the WQv orifice and distance of the overflow bipass above the invert of

| SMP ID | C | A | g | h | d | d | y |
|---|---|---|---|---|---|---|---|
| | | ($ft^2$) | ($ft/sec^2$) | (ft) | (ft) | (in) | (ft) |
| PS3,4,5,7,8 | 0.60 | | 32.2 | | | | |

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# Appendix L:
# Soil Testing

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# DEEP TEST RESULTS

Date: 12/6/19

Name of property: Gasland Route 9D (T) Poughkeepsie

TAX GRID #

| | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | 6 | 1 | 5 | 7 | 0 | 1 | 0 | 5 | 7 | 6 | 5 | 4 |

Owner of property: Conklin, Charles L

Engineer: The Chazen Companies

Person directing test: Alec Barnes DCHD Rep: N/A

| HOLE # | LOT # | TOTAL DEPTH | ROCK DEPTH | WATER DEPTH | MOTTLING DEPTH | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|
| 1 | N/A | 8'0" | N/A | N/A | N/A | 6" Topsoil<br>6" to 30" Silty Loam<br>30" to 96" Rocky Shale w/ silty loam |
| | | | | | | |
| 2 | N/A | 8'0" | N/A | N/A | N/A | 6" Topsoil<br>6" to 36" Silty Loam<br>36" to 96" Small rock pebbles/shale w/ silty loam |
| | | | | | | |
| 3 | N/A | 8"0" | N/A | N/A | N/A | 6" Topsoil<br>6" to 36" Silty/Clay Loam<br>36" to 96" Pebbles/ Shale w/ Silty clay |
| | | | | | | |
| 4 | N/A | 8'0" | N/A | N/A | N/A | 6" White/ Ashy Topsoil<br>6" to 24" Silty/Sandy Loam<br>24" to 42" Silty/Clay Loam<br>42" to 96" Clay w/ silty loam; Some small shale/ pebbles |
| | | | | | | |
| 5 | N/A | 8'6" | N/A | N/A | N/A | 12" Topsoil<br>12" to 24" Silty Loam<br>24" to 66" Silty/Sandy Loam<br>66" to 102" Small pebbles w/ silt & shale rock |
| | | | | | | |
| 6 | N/A | 9'0" | N/A | N/A | N/A | 6" Topsoil<br>6" to 24" Silty Loam<br>24" to 42" Silty/ Sandy Loam<br>42" to 60" Silty/Clay Loam<br>60" to 108" Silty Loam w/ Shale |

General remarks (terrain; weather; springs, streams, etc.)

Cold, cloudy, and wet. Snow covered the ground. Last rain/snow event on 12/2/19 with 6 inches of snow.

**Gas Land Route 9D - Town of Wappinger**

Job Number: 81941
Date: 12/11/2019

**Falling Head No. 1** (Test Depth: 3.0')

| | Test 1 | Test 2 | Test 3 | Test 4 |
|---|---|---|---|---|
| Start Time | 9:13 | 10:32 | 4:58 | 5:07 |
| End Time | 10:13 | 11:32 | 5:07 | 5:14 |
| Run Time (min) | 60 | 60 | 60 | 60 |
| Run Time (hours) | 1 | 1 | 1 | 1 |
| Total Fall (in.) | 18 | 17 | 16 | 17 |
| | | | | |
| Rate (in/hr) | 18 | 17 | 16 | 17 |
| Design Rate (in/hr) | 17 | | | |

**Falling Head No. 2** (Test Depth: 3.0')

| | Test 1 | Test 2 | Test 3 | Test 4 | Test 5 |
|---|---|---|---|---|---|
| Start Time | 9:15 | 9:27 | 10:00 | 10:28 | 11:05 |
| End Time | 9:20 | 9:55 | 10:26 | 11:03 | 11:37 |
| Run Time (min) | 5 | 28 | 26 | 35 | 32 |
| Run Time (hours) | 0.08 | 0.47 | 0.43 | 0.58 | 0.53 |
| Total Fall (in.) | 24 | 24 | 24 | 24 | 24 |
| | | | | | |
| Rate (in/hr) | 288 | 51 | 55 | 41 | 45 |
| Design Rate (in/hr) | 48 | | | | |


0 1 2 3
ORIGINAL SCALE IN INCHES



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Chattanooga Tennessee Office:
1426 Williams Street (Suite 12)
Chattanooga, Tennessee 37408
Phone: (423) 241-6575

| rev. | date | description |
|---|---|---|

GAS LAND WAPPINGER

# SOIL TESTING MAP LOCATIONS

TOWN OF WAPPINGER, DUTCHESS COUNTY, NEW YORK

| designed | checked |
|---|---|
| APB | CPL |
| date 12/06/19 | scale 1"=20' |
| project no. 81941.00 | |
| sheet no. FIG7 | |

Drawing Name: Z:\projects\81900-81999\81941.00 Gas Land Town of Wappinger Route 9D\DWG\FIG7_81941-00_SOIL_TESTING_LOCATIONS_MAP_12_06_19.dwg
Xref's Attached: XBASE-ENG_81941-00; XUTIL_81941-00
Date Printed: Jul 23, 2020, 8:23am


ORIGINAL SCALE IN INCHES



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1426 Williams Street (Suite 12)
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| rev. | date | description |
|---|---|---|

GAS LAND WAPPINGER

# SOIL TESTING MAP LOCATIONS

TOWN OF WAPPINGER, DUTCHESS COUNTY, NEW YORK

| designed | checked |
|---|---|
| APB | CPL |
| date 12/06/19 | scale 1"=20' |
| project no. 81941.00 | |
| sheet no. FIG7 | |

Drawing Name: Z:\projects\81900-81999\81941.00 Gas Land Town of Wappinger Route 9D\DWG\FIG7_81941-00_SOIL_TESTING_LOCATIONS_MAP_12_06_19.dwg
Xref's Attached: XBASE-ENG_81941-00; XUTIL_81941-00
Date Printed: Jul 23, 2020, 8:23am

# Appendix M:
# Supporting Information

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**From:** Adewole, Adedayo J (DEC) <adedayo.adewole@dec.ny.gov>
**Sent:** Tuesday, September 11, 2018 1:41 PM
**To:** Kyle Bardwell
**Subject:** RE: Gas Land Rte 376 (81700.00) Stormwater Meeting
**Attachments:** VA_BMP_Spec_No_9_BIORETENTION_FINAL_Draft_v2-0_06Nov2013.pdf

As a follow up to our discussion. please find attached.

---

**From:** Kyle Bardwell [mailto:kbardwell@chazencompanies.com]
**Sent:** Monday, August 20, 2018 11:01 AM
**To:** Adewole, Adedayo J (DEC) <adedayo.adewole@dec.ny.gov>
**Cc:** Chris Lapine <clapine@chazencompanies.com>; Kyle Ahearn <kahearn@chazencompanies.com>
**Subject:** Gas Land Rte 376 (81700.00) Stormwater Meeting

*ATTENTION: This email came from an external source. Do not open attachments or click on links from unknown senders or unexpected emails.*

Adedayo,

Last week we sent over a conceptual stormwater design for a gas station in the Town of Wappinger, Dutchess County. We were hoping after you reviewed the plan we could sit down for a meeting to go over the design and your feedback. Do you have any availability this week to conduct this meeting? Feel free to give me a call at (845) 486-1573 if you would like to discuss possible times to meet.

Thank you,

**Kyle T. Bardwell, E.I.T.**
*Assistant Project Engineer*
*The Chazen Companies*
21 Fox Street
Poughkeepsie, New York 12601
845-454-3980 (Main)
845-486-1573 (Direct)
845-926-0735 (Mobile)
kbardwell@chazencompanies.com
www.chazencompanies.com

# VIRGINIA DCR STORMWATER DESIGN SPECIFICATION No. 9

# BIORETENTION

**VERSION 2.0**
**January 1, 2013**

## SECTION 1: DESCRIPTION

Individual bioretention areas can serve highly impervious drainage areas less than two (2) acres in size. Surface runoff is directed into a shallow landscaped depression that incorporates many of the pollutant removal mechanisms that operate in forested ecosystems. The primary component of a bioretention practice is the filter bed, which has a mixture of sand, soil, and organic material as the filtering media with a surface mulch layer. During storms, runoff temporarily ponds 6 to 12 inches above the mulch layer and then rapidly filters through the bed. Normally, the filtered runoff is collected in an underdrain and returned to the storm drain system. The underdrain consists of a perforated pipe in a gravel layer installed along the bottom of the filter bed. A bioretention facility with an underdrain system is commonly referred to as a *Bioretention Filter*.

Bioretention can also be designed to infiltrate runoff into native soils. This can be done at sites with permeable soils, a low groundwater table, and a low risk of groundwater contamination. This design features the use of a “partial exfiltration” system that promotes greater groundwater recharge. Underdrains are only installed beneath a portion of the filter bed, above a stone “sump” layer, or eliminated altogether, thereby increasing stormwater infiltration. A bioretention facility without an underdrain system, or with a storage sump in the bottom is commonly referred to as a *Bioretention Basin*.

Small-scale or Micro-Bioretention used on an individual residential lot is commonly referred to as a *Rain Garden*.

## SECTION 2: PERFORMANCE

Bioretention creates a good environment for runoff reduction, filtration, biological uptake, and microbial activity, and provides high pollutant removal. Bioretention can become an attractive landscaping feature with high amenity value and community acceptance. The overall stormwater functions of the bioretention are summarized in **Table 9.1**.

***Table 9.1. Summary of Stormwater Functions Provided by Bioretention Basins***

| Stormwater Function | Level 1 Design | Level 2 Design |
|---|---|---|
| **Annual Runoff Volume Reduction (RR)** | 40% | 80% |
| **Total Phosphorus (TP) EMC Reduction[1] by BMP Treatment Process** | 25% | 50% |
| **Total Phosphorus (TP) Mass Load Removal** | 55% | 90% |
| **Total Nitrogen (TN) EMC Reduction[1] by BMP Treatment Process** | 40% | 60% |
| **Total Nitrogen (TN) Mass Load Removal** | 64% | 90% |
| **Channel and Flood Protection** | • Use the Virginia Runoff Reduction Method (VRRM) Compliance Spreadsheet to calculate the Curve Number (CN) Adjustment<br>***OR***<br>• Design extra storage (optional; as needed) on the surface, in the engineered soil matrix, and in the stone/underdrain layer to accommodate a larger storm, and use NRCS TR-55 Runoff Equations[2] to compute the CN Adjustment. | |

[1] Change in event mean concentration (EMC) through the practice. Actual nutrient mass load removed is the product of the removal rate and the runoff reduction rate(see Table 1 in the *Introduction to the New Virginia Stormwater Design Specifications*).
[2] NRCS TR-55 Runoff Equations 2-1 thru 2-5 and Figure 2-1 can be used to compute a curve number adjustment for larger storm events based on the retention storage provided by the practice(s).

Sources: CWP and CSN (2008) and CWP (2007)

***Leadership in Energy and Environmental Design (LEED®).*** The LEED® point credit system designed by the U.S. Green Building Council (USGBC) and implemented by the Green Building Certification Institute (GBCI) awards points related to site design and stormwater management. Several categories of points are potentially available for new and redevelopment projects. **Chapter 6** and the 2013 *Virginia Stormwater Management Handbook* (2nd Edition) provides a more thorough discussion of the site planning process and design considerations as related to the environmental site design and potential LEED credits. However, the Virginia Department of Environmental Quality is not affiliated with the USGBC or GBCI and any information on applicable points provided here is based only on basic compatibility. **Designers should research and verify scoring criteria and applicability of points as related to the specific project being considered through USGBC LEED resources.**

***Table 9.2. Potential LEED® Credits for Bioretention*[1]**

| Credit Category | Credit No. | Credit Description |
|---|---|---|
| Sustainable Sites | SS5.1 | Site Development: Protect or Restore Habitat |
| Sustainable Sites | SS5.2 | Site Development: Maximize Open Space |
| Sustainable Sites | SS6.1 | Stormwater Design: Quantity Control |
| Sustainable Sites | SS6.2 | Stormwater Design: Quality Control |
| Water Efficiency | WE1.1 | Water Efficient Landscaping: Reduce by 50% |
| Water Efficiency | WE1.2 | Water Efficient Landscaping: No Potable Water Use or No Irrigation |

[1] Actual site design and/or BMP configuration may not qualify for the credits listed. Alternatively, the project may actually qualify for credits not listed here. Designers should consult with a qualified individual (LEED AP) to verify credit applicability.

## SECTION 3: DESIGN TABLES

The most important design factor to consider when applying bioretention to development sites is the ***scale*** at which it will be applied, as follows:

***Micro-Bioretention or Rain Gardens.*** These are small, distributed practices designed to treat runoff from small areas, such as individual rooftops, driveways and other on-lot features in single-family detached residential developments. Inflow is typically sheet flow, or can be concentrated flow with energy dissipation, when located at downspouts.

***Bioretention Basins.*** These are structures treating parking lots and/or commercial rooftops, usually in commercial or institutional areas. Inflow can be either sheet flow or concentrated flow. Bioretention basins may also be distributed throughout a residential subdivision, but ideally they should be located in common area or within drainage easements, to treat a combination of roadway and lot runoff.

***Urban Bioretention.*** These are structures such as expanded tree pits, curb extensions, and foundation planters located in ultra-urban developed areas such as city streetscapes. Please refer to **Appendix 9-A** of this specification for design criteria for Urban Bioretention.

The major design goal for bioretention is to maximize runoff volume reduction and nutrient removal. To this end, designers may choose to go with the baseline design (Level 1) or choose an enhanced design (Level 2) that maximizes nutrient and runoff reduction. If soil conditions require an underdrain, bioretention areas can still qualify for the Level 2 design if they contain a stone storage layer beneath the invert of the underdrain.

Both stormwater quality and quantity credits are accounted for in the Virginia Runoff Reduction Method (VRRM) compliance spreadsheet. The water quality credit represents an annual load reduction as a combination of the annual reduction of runoff volume (40% and 80% from Level 1 and Level 2 designs, respectively) and the reduction in the pollutant event mean concentration (EMC) (25% and 50% from Level 1 & 2 designs, respectively).

***Figure 9.1. Typical Bioretention Filters***

To compute the water quantity reduction for larger storm events, the designer can similarly use the VRRM Compliance spreadsheet or, as an option, the designer may choose to compute the adjusted curve number associated with the retention storage using the TR-55 Runoff Equations, as noted in **Table 9.1**. The adjusted curve number is then used to compute the peak discharge for the required design storms.

**Tables 9.3 and 9.4** below outline the Level 1 and 2 design guidelines for the two scales of bioretention design.

***Table 9.3. Micro-Bioretention (Rain Garden) Design Criteria***[1]

| Level 1 Design (RR 40 TP: 25) | Level 2 Design (RR: 80 TP: 50) |
|---|---|
| Sizing: $Tv_{BMP}$ = [(1)(Rv)(A) / 12] | Sizing: $Tv_{BMP}$ = [(1.25)(Rv)(A) / 12] (can be divided into different cells at downspouts). |
| Maximum contributing drainage area = 0.5 acres; 25% Impervious Cover (IC) [2] | |
| One cell design (can be divided into smaller cells at downspout locations) [2] | |
| Maximum Ponding Depth = 6 inches | |
| Filter Media Depth minimum = 18 inches; Recommended maximum = 36 inches | Filter Media Depth minimum = 24 inches; Recommended maximum = 36 inches |
| Media: mixed on-site or supplied by vendor | Media: supplied by vendor |
| All Designs: Media mix tested for an acceptable hydraulic conductivity (or permeability) and phosphorus content (**Section 6.6**) | |
| Sub-soil testing: not needed if an underdrain is used; | Sub-soil testing: one per practice; Min infiltration rate > 1/2 inch/hour and > 1 inch/hour in order to remove the underdrain requirement. |
| Underdrain: corrugated HDPE or equivalent. | Underdrain: corrugated HDPE or equivalent, with a minimum 6-inch stone sump below the invert; ***OR*** none, if soil infiltration requirements are met |
| Clean-outs: not needed | |
| Inflow: sheet flow or roof leader | |
| Pretreatment: external (leaf screens, grass filter strip, energy dissipater, etc.). | Pretreatment: external *plus* a grass filter strip |
| Vegetation: turf, herbaceous, or shrubs (min = 1 out of those 3 choices). | Vegetation: turf, herbaceous, shrubs, or trees (min = 2 out of those 4 choices). |
| Building setbacks[3]: 10 feet | |

[1] Consult **Appendix 9-A** for design criteria for Urban Bioretention Practices.

[2] Micro-Bioretention (Rain Gardens) can be located at individual downspout locations to treat up to 2,500 sq. ft. of impervious cover (100% IC).

[3] These are recommendations for simple building foundations. If an in-ground basement or other special conditions exist, the design should be reviewed by a licensed engineer. Also, a special footing or drainage design may be used to justify a reduction of the setbacks noted above.

***Table 9.4. Bioretention Filter and Basin Design Criteria***

| Level 1 Design (RR 40 TP: 25 ) | Level 2 Design (RR: 80 TP: 50) |
|---|---|
| Sizing (**Section 6.1**):<br>$Tv_{BMP}$ = [(1)(Rv)(A) / 12] + any remaining volume from upstream BMP<br>Surface Area (sq. ft.) = $Tv_{BMP}$ / Storage Depth [1] | Sizing (**Section 6.1**):<br>$Tv_{BMP}$ = [(1.25)(Rv)(A) / 12] + any remaining volume from upstream BMP<br>Surface Area (sq. ft.) = $Tv_{BMP}$ /Storage Depth [1] |
| Recommended maximum contributing drainage area = 2.5 acres, or with local approval up to 5 acres and a maximum of 50% impervious | |
| Maximum Ponding Depth = 6 to 12 inches [2] | Maximum Ponding Depth = 6 to 12 inches [2] |
| Filter Media Depth minimum = 24 inches; recommended maximum = 48 inches | Filter Media Depth minimum = 36 inches; recommended maximum = 48 inches |
| Media & Surface Cover (**Section 6.6**) = supplied by vendor; tested for acceptable hydraulic conductivity (or permeability) and phosphorus content | |
| Sub-soil Testing (**Section 6.2**): not needed if an underdrain used; Min infiltration rate > 1/2 inch/hour in order to remove the underdrain requirement. | Sub-soil Testing (**Section 6.2**): one soil profile and two infiltration tests per facility (up to 2,500 $ft^2$ of filter surface); Min infiltration rate > 1/2 inch/hour in order to remove the underdrain requirement. |
| Underdrain (**Section 6.7**) = Schedule 40 PVC with clean-outs | Underdrain & Underground Storage Layer (**Section 6.7**) = Schedule 40 PVC with clean outs, and a minimum 12-inch stone sump below the invert; ***OR***, none, if soil infiltration requirements are met (**Section 6.2**) |
| Inflow: sheet flow, curb cuts, trench drains, concentrated flow, or the equivalent | |
| Geometry (**Section 6.3**):<br>Length of shortest flow path/Overall length = 0.3; ***OR***, other design methods used to prevent short-circuiting; a one-cell design (not including the pre-treatment cell). | Geometry (**Section 6.3**):<br>Length of shortest flow path/Overall length = 0.8; ***OR***, other design methods used to prevent short-circuiting; a two-cell design (not including the pretreatment cell). |
| Pre-treatment (**Section 6.4**): a pretreatment cell, grass filter strip, gravel diaphragm, gravel flow spreader, or another approved (manufactured) pre-treatment structure. | Pre-treatment (**Section 6.4**): a pretreatment cell *plus* one of the following: a grass filter strip, gravel diaphragm, gravel flow spreader, or another approved (manufactured) pre-treatment structure. |
| Conveyance & Overflow (**Section 6.5**) | Conveyance & Overflow (**Section 6.5**) |
| Planting Plan (**Section 6.8**): a planting template to include turf, herbaceous vegetation, shrubs, and/or trees to achieve surface area coverage of at least 75% within 2 years. | Planting Plan (**Section 6.8**): a planting template to include turf, herbaceous vegetation, shrubs, and/or trees to achieve surface area coverage of at least 90% within 2 years. If using turf, must combine with other types of vegetation. |
| Building Setbacks [3] (**Section 5**):<br>10 feet if down-gradient from building or level (coastal plain); 50 feet if up-gradient.<br>(Refer to additional setback criteria in **Section 5**) | |
| Deeded Maintenance O&M Plan (**Section 8**) | |

[1] Storage depth is the sum of the porosity ($\eta$) of the soil media and gravel layers multiplied by their respective depths, plus the surface ponding depth. (**Section 6.1**).

[2] A ponding depth of 6 inches is preferred. Ponding depths greater than 6 inches will require a specific planting plan to ensure appropriate plant selection (**Section 6.8**).

[3] These are recommendations for simple building foundations. If an in-ground basement or other special conditions exist, the design should be reviewed by a licensed engineer. Also, a special footing or drainage design may be used to justify a reduction of the setbacks noted above.

## SECTION 3: TYPICAL DETAILS

**Figures 9.2 through 9.5** provide some typical details for several bioretention configurations. Also see additional details in **Appendix 9-B** of this design specification.

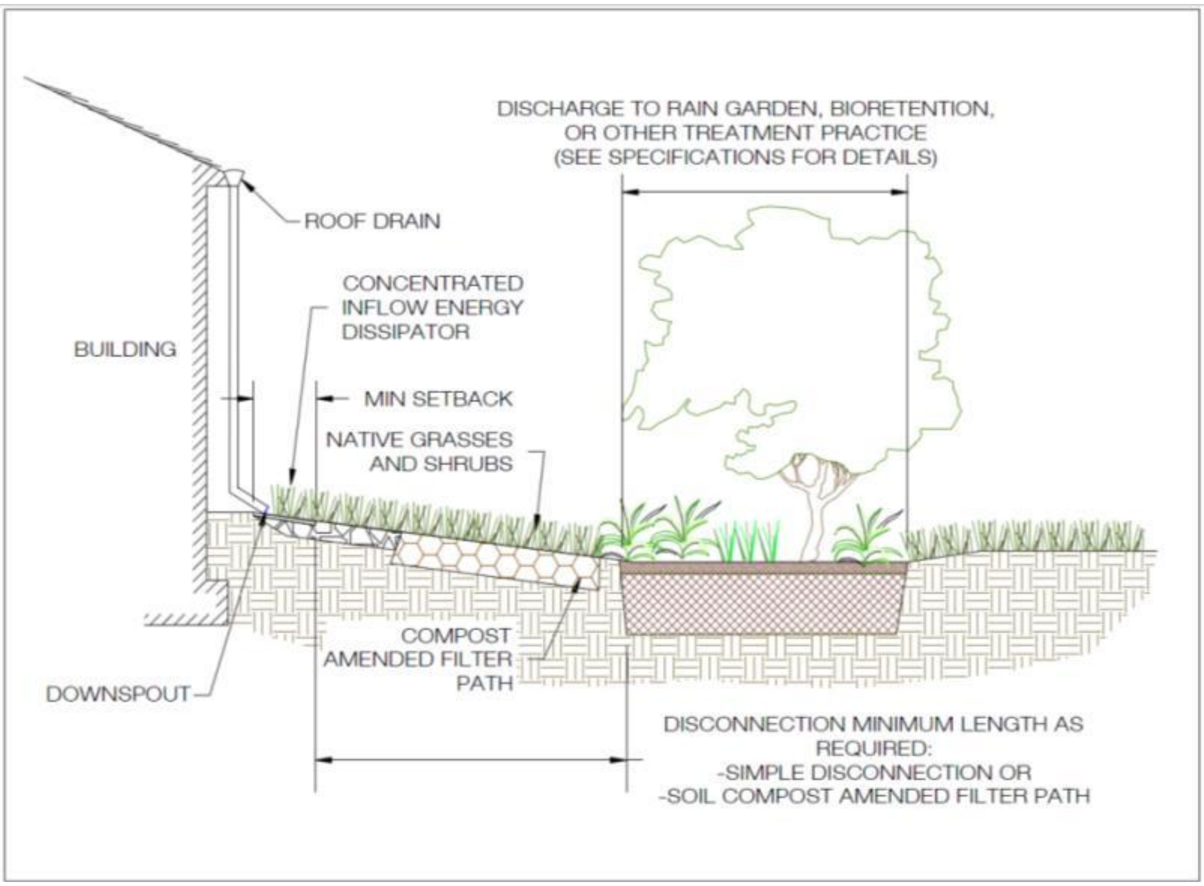


***Figure 9.2. Rain Garden (Micro Bioretention):***
***(a) Simple Disconnection to downstream Rain Garden; (b) Disconnection Alternate Practice: Compost Amended Filter Path to downstream Rain Garden***

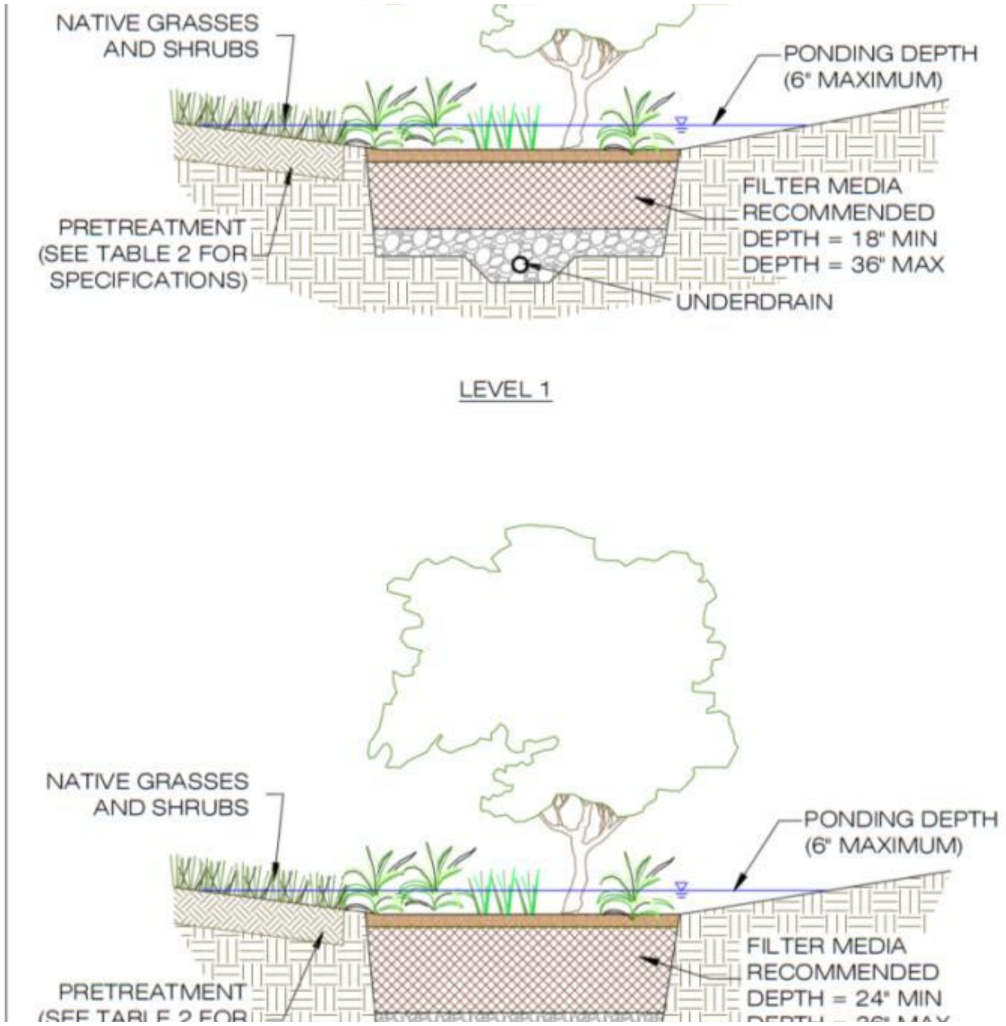


***Figure 9.3. Typical Micro-Bioretention Basin (Rain Garden) Level 1 and Level 2***

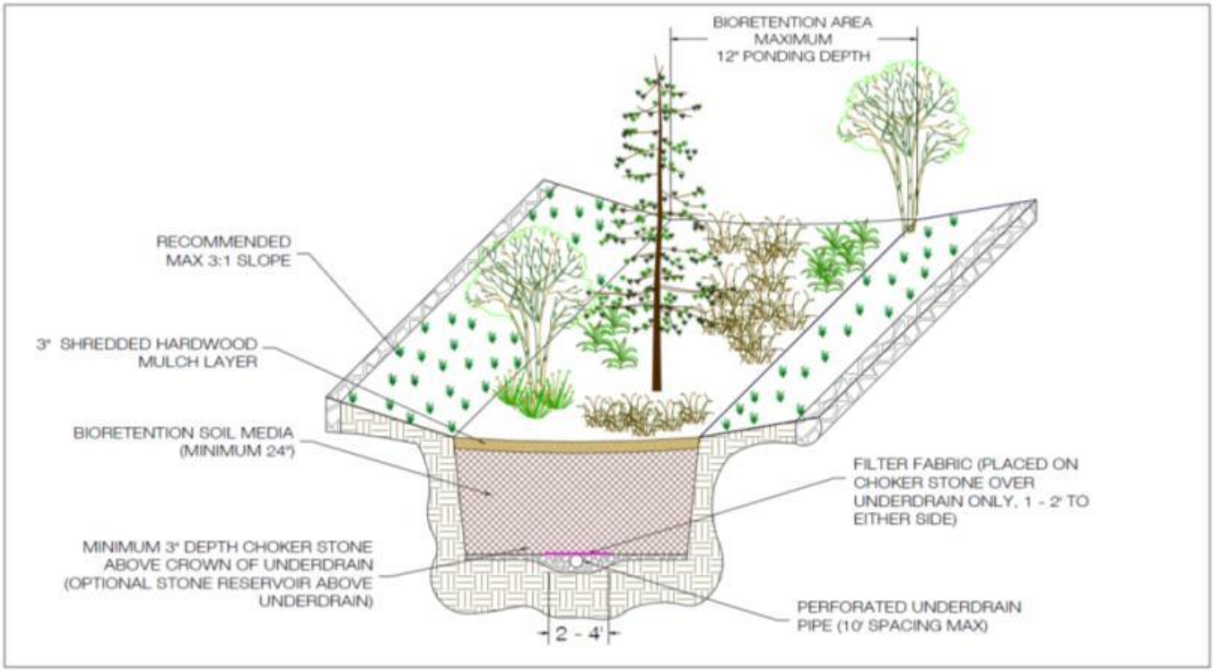


*Figure 9.4a: Typical Bioretention Basin Level 1*

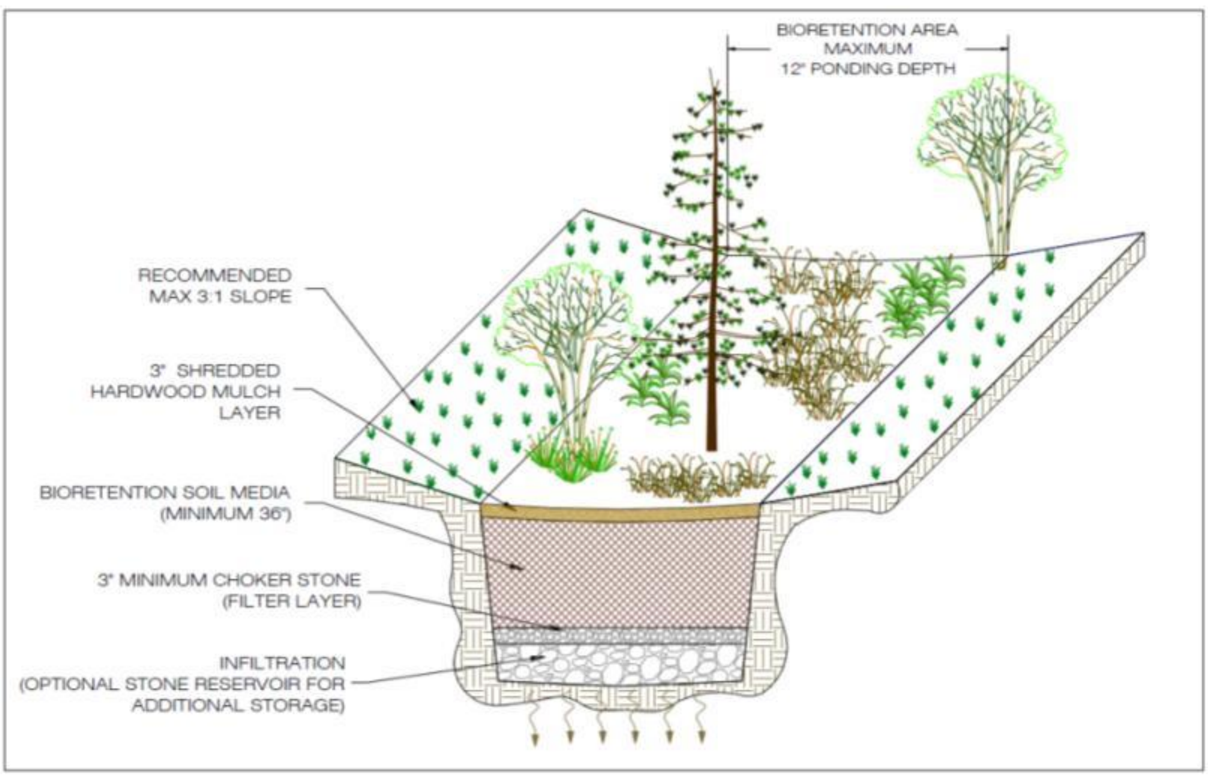


*Figure 9.4b: Typical Bioretention Basin Level 2: Infiltration*

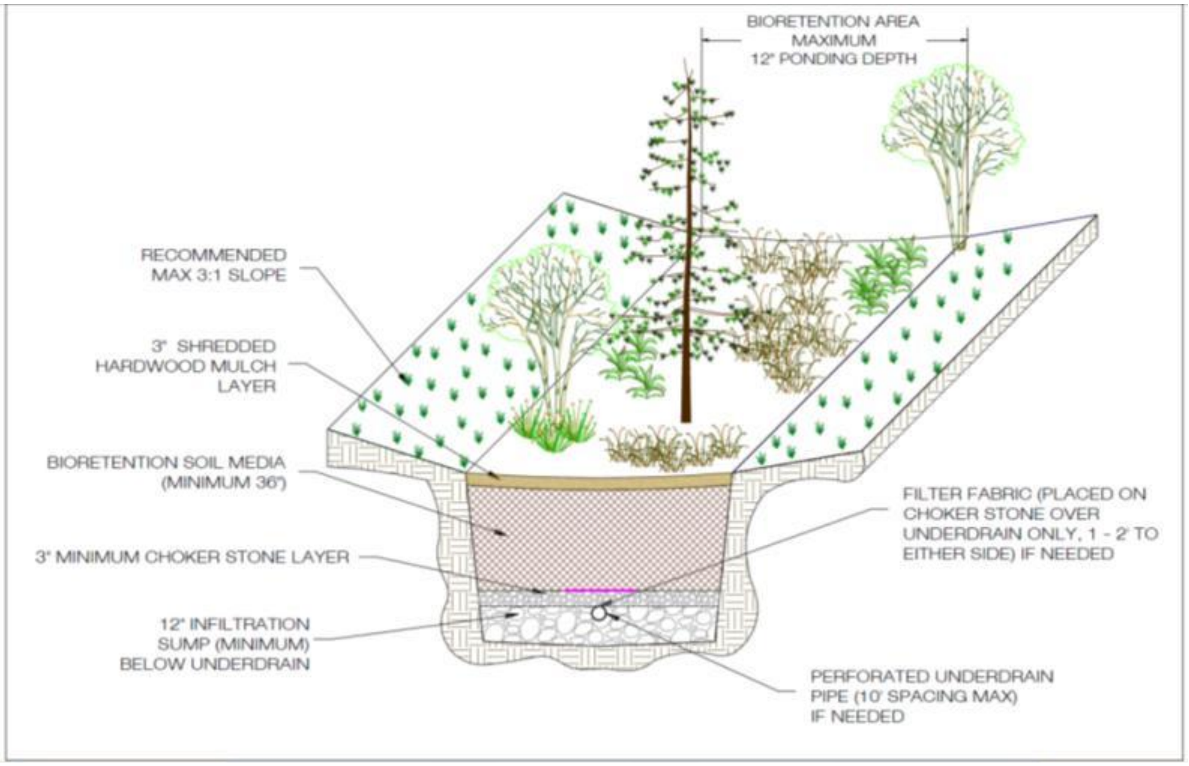


***Figure 9.4c: Typical Bioretention Basin Level 2: Infiltration Sump***

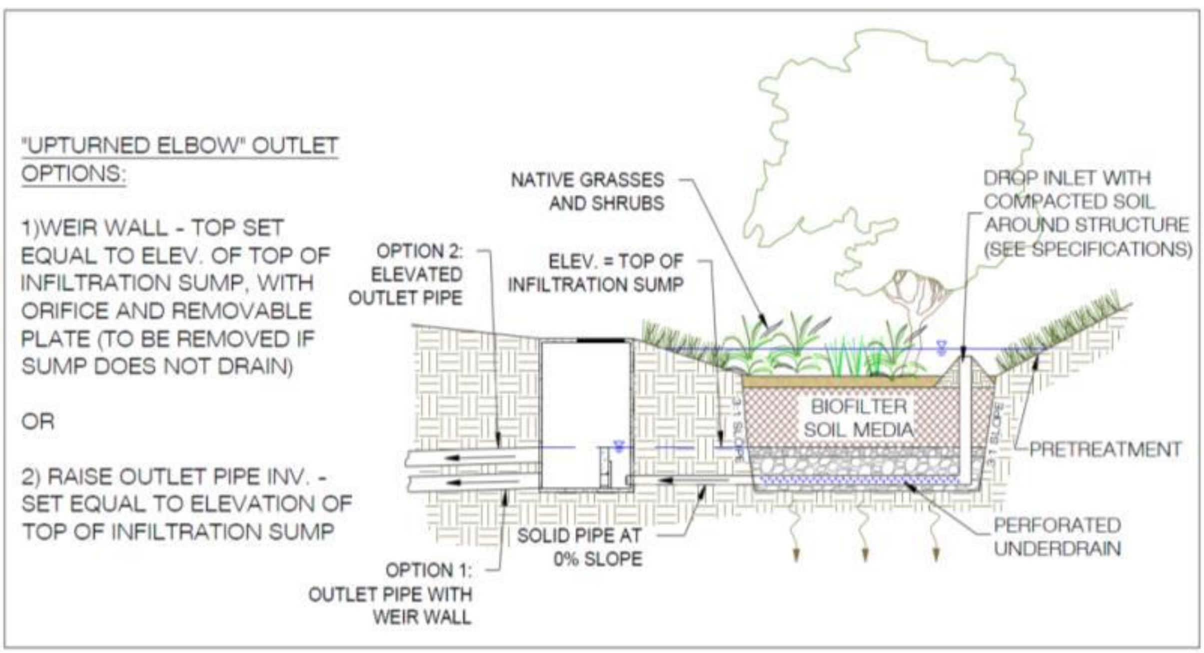


***Figure 9.4d: Typical Bioretention Level 2: Infiltration Sump with "Upturned Elbow" or Weir***

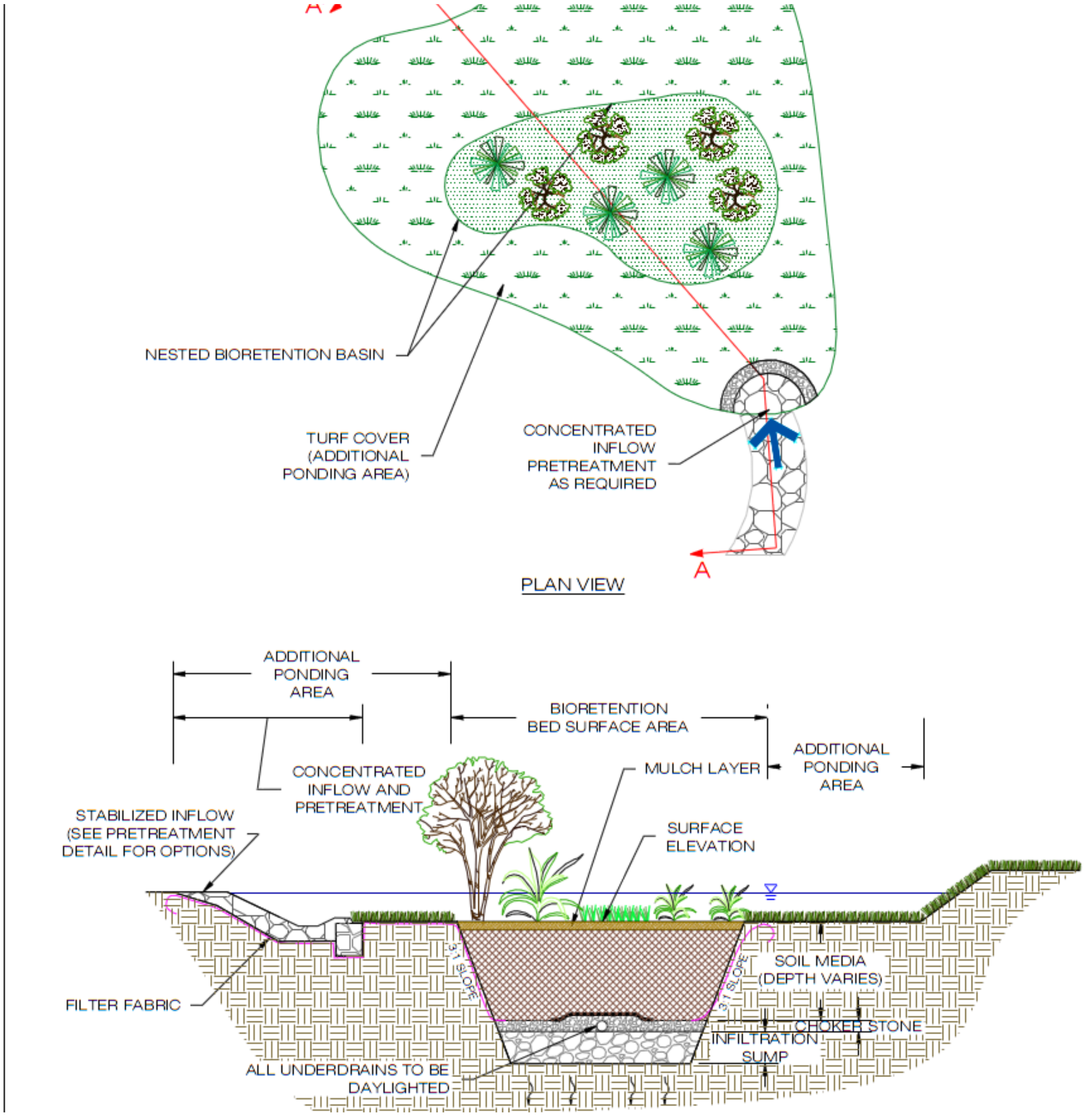


***Figure 9.5. Typical Detail of Bioretention with Additional Surface Ponding***

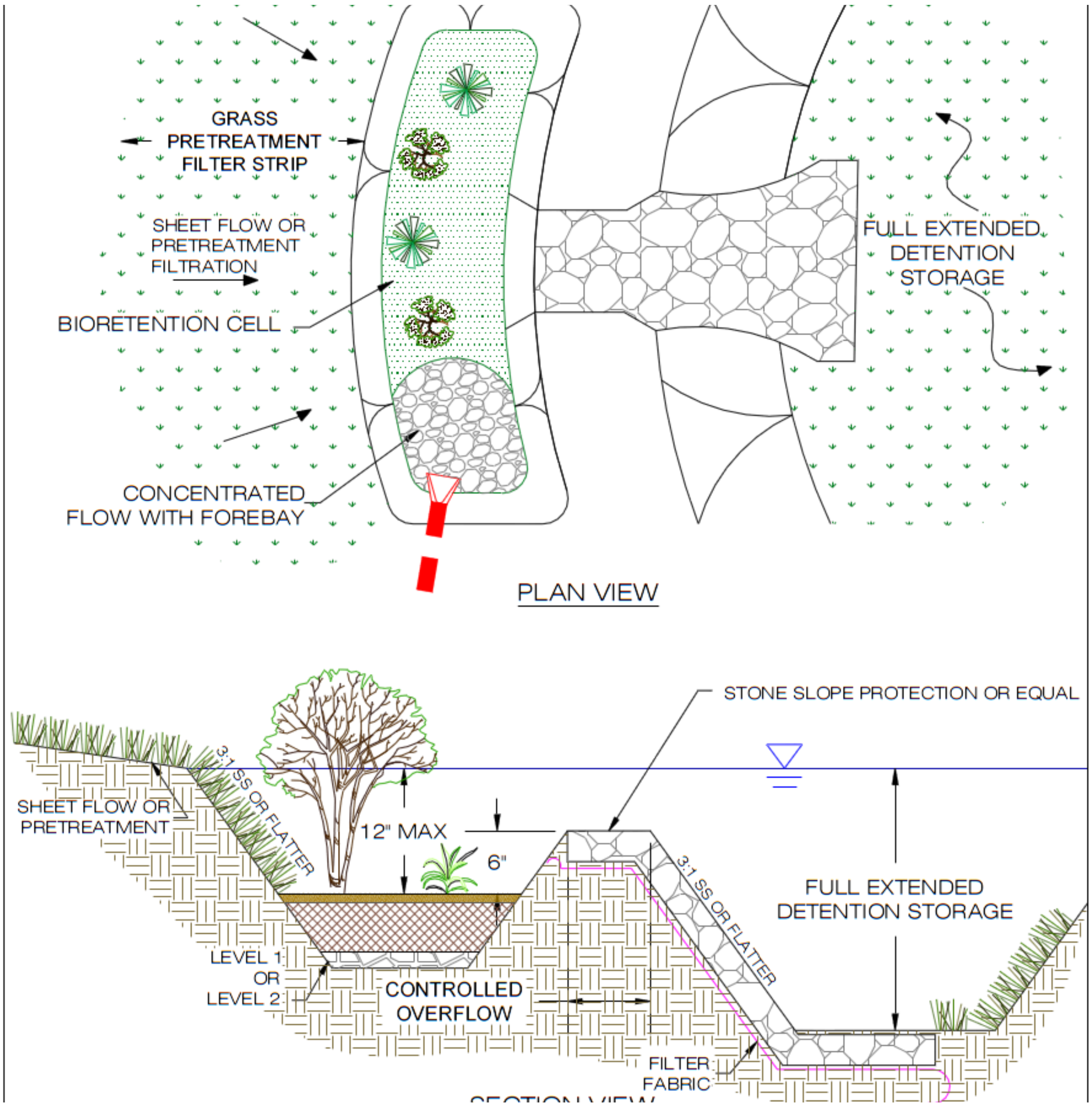


***Figure 9.6. Typical Detail of a Bioretention Basin within the Upper Shelf of an ED Pond***

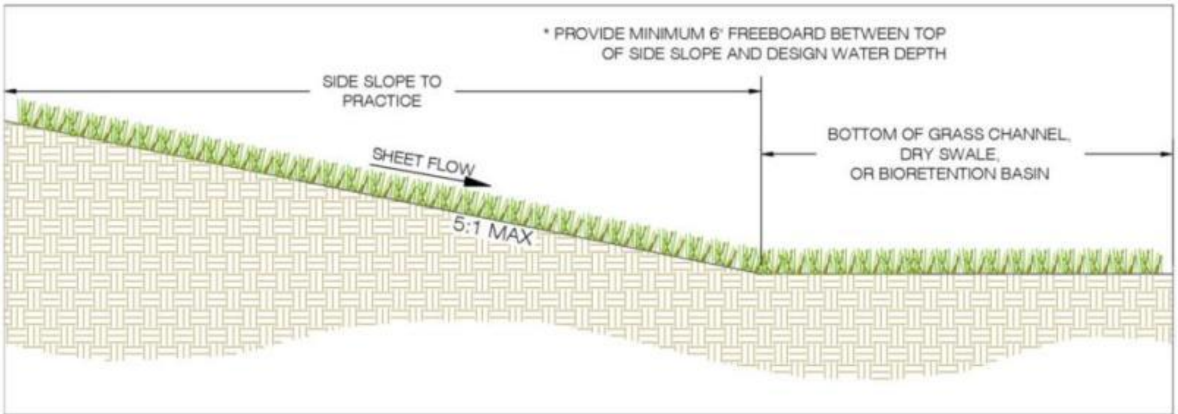


*Figure 9.7a. Pretreatment I – Grass Filter for Sheet Flow*

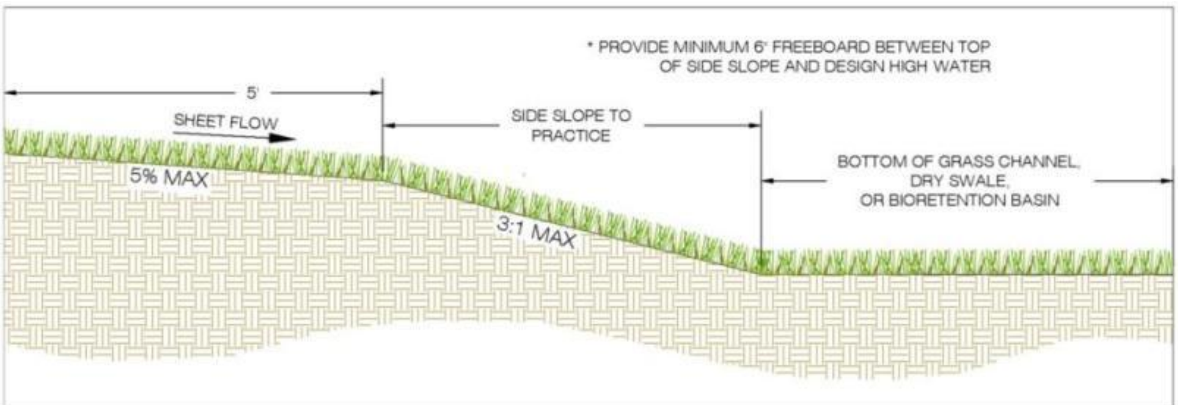


*Figure 9.7b. Pretreatment II – Grass Filter for Sheet Flow*

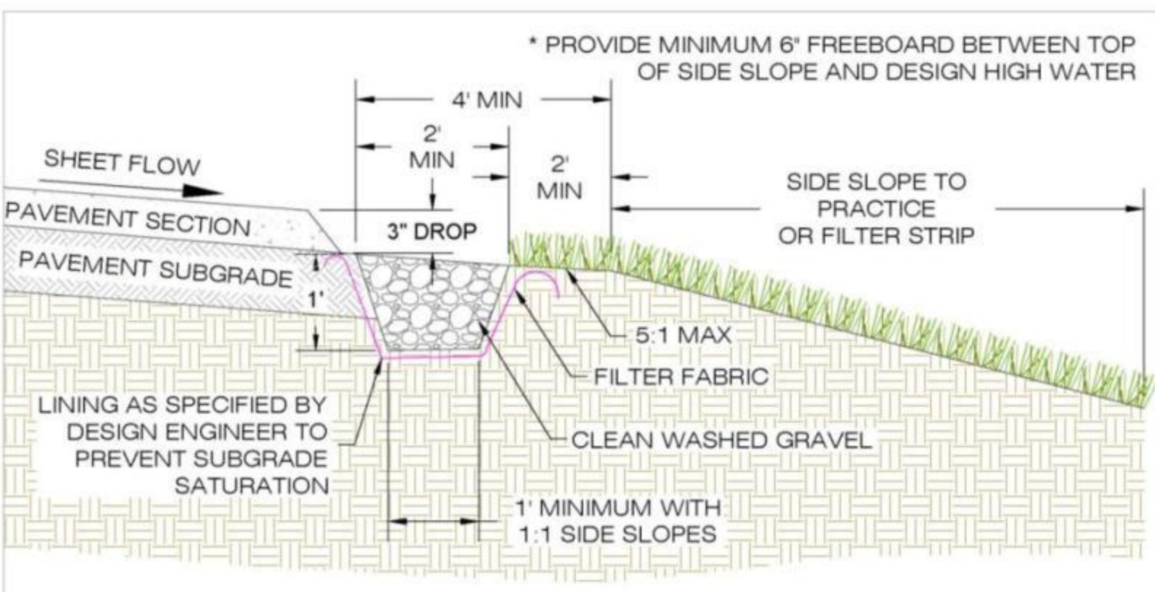


*Figure 9.8. Pretreatment – Gravel Diaphragm for Sheet Flow from Impervious or Pervious*

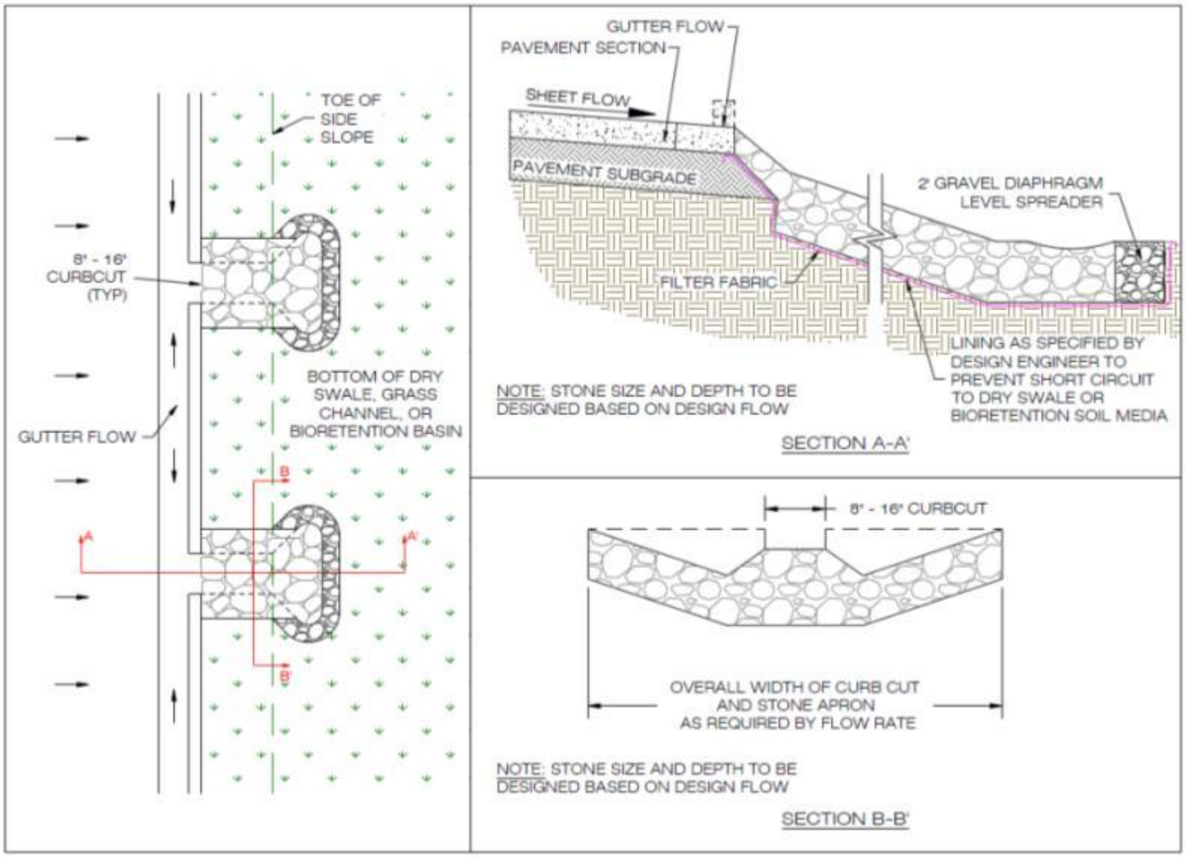


***Figure 9.9. Pre-Treatment – Gravel Flow Spreader for Concentrated Flow***

## SECTION 5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

### 5.1 Physical Feasibility

Bioretention can be applied in most soils or topography, since runoff simply percolates through an engineered soil bed and is returned to the stormwater system. Key constraints with bioretention include the following:

***Available Space.*** Planners and designers can assess the feasibility of using bioretention facilities based on a simple relationship between the contributing drainage area and the corresponding required surface area. The bioretention surface area will be approximately 3% to 6% of the contributing drainage area, depending on the imperviousness of the CDA and the desired bioretention design level.

***Site Topography.*** Bioretention is best applied when the grade of contributing slopes is greater than 1% and less than 5%.

***Contributing Drainage Area.*** Bioretention cells work best with smaller contributing drainage areas, where it is easier to achieve flow distribution over the filter bed. Typical drainage area size can range from 0.1 to 2.5 acres and consist of up to 100% impervious cover. Three scales of bioretention are defined in this specification: (1) micro-bioretention or *Rain Gardens* (up to 0.5 acre contributing drainage area); (2) bioretention basins (up to 2.5 acres of contributing drainage area); and (3) Urban Bioretention (**Appendix 9-A**). Each of these has different design requirements (refer to **Tables 9.3 and 9.4** above). The maximum recommended drainage area to a single bioretention basin or single cell of a bioretention basin is 2.5 acres. There are successful examples of bioretention basins treating up to 5 acres; however, the drainage areas are not entirely impervious. Therefore, if approved by the plan approving authority, the drainage area to a single bioretention basin can be increased to a maximum of 5 acres provided that the contributing impervious cover is limited to 2.5 acres (50% impervious cover), and the design elements intended to address the peak rate and energy of the inflow, such as forebay, energy dissipaters, high flow diversions, etc., are designed for the expected flows. In such cases, the bioretention facility should be located within the drainage area so as to capture the Treatment Volume ($T_v$) equally from the entire contributing area, and not fill the entire volume from the immediately adjacent area, thereby bypassing the runoff from the more remote portions of the site.

***Available Hydraulic Head.*** Bioretention is fundamentally constrained by the invert elevation of the downstream conveyance system to which the practice discharges (i.e., the bottom elevation needed to tie the underdrain from the bioretention area into the storm drain system). In general, 4 to 5 feet of elevation above this invert is needed to create the hydraulic head needed to drive stormwater through a proposed bioretention filter bed. Less hydraulic head is needed if the underlying soils are permeable enough to dispense with the underdrain.

***Water Table.*** Bioretention should always be separated from the water table to ensure that groundwater does not intersect the filter bed. Mixing can lead to possible groundwater contamination or failure of the bioretention facility. A separation distance of 2 feet is recommended between the bottom of the excavated bioretention area and the seasonally high ground water table. The separation distance may be reduced to 12 inches in coastal plain residential settings (Refer to **Section 7.2 –** Regional Adaptations).

***Utilities.*** Designers should ensure that future tree canopy growth in the bioretention area will not interfere with existing overhead utility lines. Interference with underground utilities should also be avoided, particularly water and sewer lines. Local utility design guidance should be consulted in order to determine the horizontal and vertical clearance required between stormwater infrastructure and other dry and wet utility lines.

***Soils.*** Soil conditions do not constrain the use of bioretention, although they determine whether an underdrain is needed. Impermeable soils such as those in Hydrologic Soil Group (HSG) C or D usually require an underdrain, whereas HSG A and some B soils generally do not. When designing a bioretention practice, designers must verify soil permeability by using the on-site soil investigation methods provided in **Appendix 8-A** of **Stormwater Design Specification No. 8 (Infiltration)**.

***Hotspot Land Uses.*** Runoff from hotspot land uses should not be treated with infiltrating bioretention (i.e., constructed *without* an underdrain). For a list of potential stormwater hotspots, please consult **Section 10.1** of **Stormwater Design Specification No. 8 (Infiltration)**. An impermeable bottom liner and an underdrain system must be employed when bioretention is used to receive and treat hotspot runoff.

***Floodplains.*** Bioretention areas should be constructed outside the limits of the ultimate 100-year floodplain.

***Avoidance of Irrigation or Baseflow.*** The planned bioretention area should not receive baseflow, irrigation water, chlorinated wash-water or other such non-stormwater flows that are not stormwater runoff.

***Setbacks.*** To avoid seepage and frost heave concerns, bioretention areas should not be hydraulically connected to structure foundations or pavement. Setbacks to structures and roads vary based on the scale of the bioretention design (see **Tables 9.2** and **9.3** above). Expected effluent concentrations of typical urban runoff (TP, TN, metals) from bioretention basins are reported by the International BMP Database and are considered to be acceptable in terms of groundwater impacts, provided that the feasibility factors of water table, hotspot land uses, and karst (**Section 7**) are met. However, if ground-water contamination is a concern, it is recommended that ground-water mapping be conducted to determine possible connections to adjacent ground-water wells. Otherwise, it is recommended that, at a minimum, bioretention basins be located a horizontal distance of 50 feet from any water supply well, 35 feet from septic system drainfields (20 feet if the bioretention filter is lined), and at least 5 feet from down-gradient wet utility lines. Dry utility lines such as gas, electric, cable and telephone may cross under bioretention areas if they are protected in accordance with the particular utility requirements and can be routinely accessed without disturbing the bioretention basin.

## 5.2 Potential Bioretention Applications

Bioretention can be used wherever water can be conveyed to a surface area. Bioretention has been used at commercial, institutional, and residential sites in spaces that are traditionally pervious and landscaped. It should be noted that special care must be taken to provide adequate pre-treatment for bioretention cells in space-constrained high traffic areas. Typical locations for bioretention include the following:

***Parking lot islands.*** The parking lot grading is designed for sheet flow towards linear landscaping areas and parking islands between rows of spaces. Curb-less pavement edges can be used to convey water into a depressed island landscaping area. Curb cuts can also be used for this purpose, but they are more prone to blockage, clogging and erosion.

***Parking lot edge.*** Small parking lots can be graded so that flows reach a curb-less pavement edge or curb cut before reaching catch basins or storm drain inlets. The turf at the edge of the parking lot functions as a filter strip to provide pre-treatment for the bioretention practice. The depression for bioretention is located in the pervious area adjacent to the parking lot.

***Road medians, roundabouts, interchanges and cul-de-sacs.*** The road cross-section is designed to slope towards the center median or center island rather than the outer edge, using a curb-less edge.

***Right-of-way or commercial setback.*** A linear configuration can be used to convey runoff in sheet flow from the roadway, or a grass channel or pipe may convey flows to the bioretention practice.

***Courtyards.*** Runoff collected in a storm drain system or roof leaders can be directed to courtyards or other pervious areas on site where bioretention can be installed.

***Individual residential lots.*** Roof leaders can be directed to small bioretention areas, often called "rain gardens," located at the front, side, or rear of a home in a drainage easement. For smaller lots, the front yard bioretention corridor design may be preferable (See Stormwater Design Specification No. 1: Rooftop Disconnection).

***Unused pervious areas on a site.*** Storm flows can be redirected from a storm drain pipe to discharge into a bioretention area.

***Dry Extended Detention (ED) basin.*** A bioretention cell can be located on an upper shelf of an extended detention basin, after the pre-treatment forebay, in order to boost treatment. Depending on the ED basin design, the designer may choose to locate the bioretention cell in the bottom of the basin. However, the design must carefully account for the potentially deeper ponding depths (greater than 6 or 12 inches) associated with extended detention.

***Retrofitting.*** Numerous options are available to retrofit bioretention in the urban landscape, as described in Profile Sheet ST-4 of Schueler et al (2007).

## SECTION 6: DESIGN CRITERIA

### 6.1. Sizing of Bioretention Practices

#### 6.1.1 Stormwater Quality

Sizing of the surface area (SA) for bioretention practices is based on the computed BMP design Treatment Volume, $Tv_{BMP}$. The $Tv_{BMP}$ is the treatment volume based on the contributing drainage area to the BMP, $Tv_{DA}$, plus any remaining runoff volume discharged from upstream BMPs in the treatment train. The required surface area (in square feet) is computed as the $Tv_{BMP}$ (in cubic feet) divided by the equivalent storage depth (in feet). The equivalent storage depth is computed as the depth of media, gravel, or surface ponding (in feet) multiplied by the accepted porosity. Therefore, the designer can influence the required surface area by adjusting the depth of each material layer (within the required minimums and maximums of **Table 9.3**).

The accepted porosity ($\eta$) for each of the materials is as follows (see **Figure 9.10** below):

Bioretention Soil Media $\eta$ = 0.25
Gravel $\eta$ = 0.40
Surface Storage = 1.0

The equivalent storage depth for Level 1 with a 6-inch surface ponding depth, a 24-inch soil media depth, and a 12-inch gravel layer is therefore computed as:

***Equation 9.1. Bioretention Level 1 Design Storage Depth***

*(2 ft. x 0.25) + (1 ft. x 0.40) + (0.5 x 1.0) = 1.40 ft.*

And the equivalent storage depth for Level 2 with a 6-inch surface ponding depth, a 36-inch soil media depth, and a 12-inch gravel layer is computed as:

***Equation 9.2. Bioretention Level 2 Design Storage Depth***

*(3 ft. x 0.25) + (1 ft. x 0.40) + (0.5 x 1.0) = 1.65 ft*

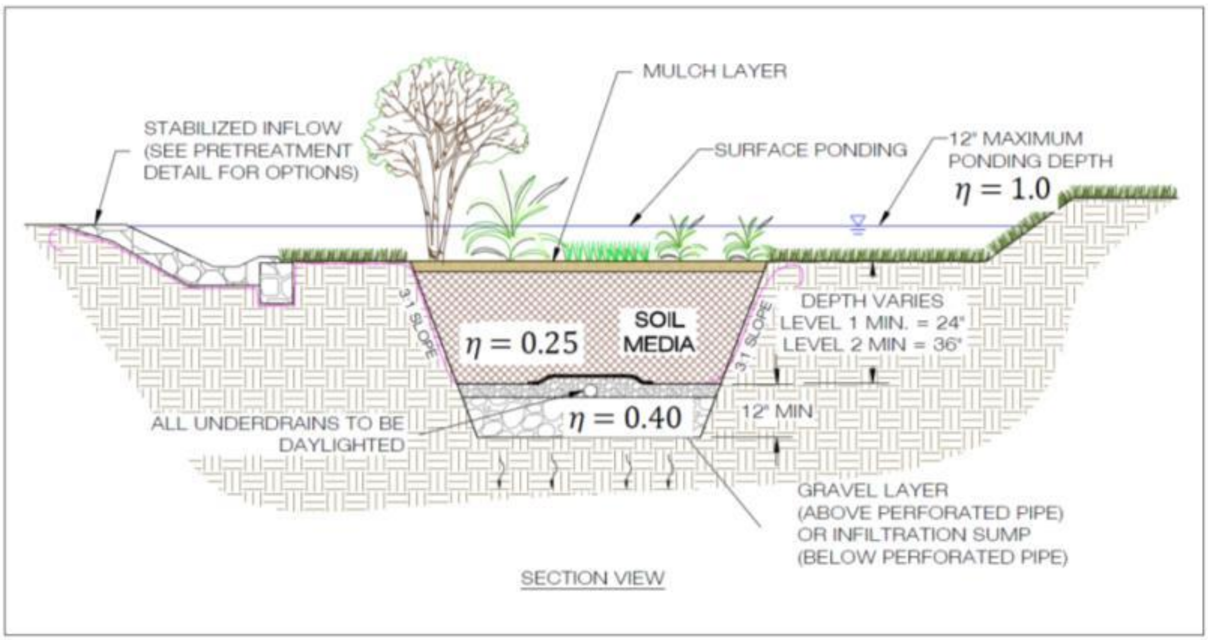


***Figure 9.10. Typical Bioretention Section with Porosity for Volume Computations***

Therefore, the Level 1 bioretention surface area (SA) is computed as:

***Equation 9.3. Bioretention Level 1 Design Surface Area***

$$SA\ (sq.\ ft.) = Tv_{BMP} / 1.40\ ft.$$

And the Level 2 bioretention surface area is computed as:

***Equation 9.4. Bioretention Level 2 Design Surface Area***

$$SA\ (sq.\ ft.) = (Tv_{BMP}) / 1.65\ ft.$$

Where:

$SA$ = Minimum surface area of bioretention filter (sq. ft.)

$Tv_{BMP}$ = Level 1 BMP design treatment volume (cu. ft.) = [(1.0 in.)($R_v$)(A) / 12]; or
= Level 2 BMP design treatment volume (cu. ft.) = 1.25[(1.0 in.)($R_v$)(A) / 12]

(**NOTE:** $R_v$ = the composite volumetric runoff coefficient from the VRRM Compliance Spreadsheet, or **Chapter 11** of the *Virginia Stormwater Management Handbook, 2nd Edition*.)

***Equations 9.1 through 9.4 should be modified if the storage depths of the soil media, gravel layer, or ponded water vary in the actual design or with the addition of any surface or subsurface storage components (e.g., additional area of surface ponding, subsurface storage chambers, etc.).***

**NOTE:** The infiltration rate of the soils must be verified at a minimum of 0.5 inches per hour in order for the volume infiltration sump to be counted towards the storage volume. Refer to **Section 6.7** below or **Figure 9.4c** above for information on implementing an "upturned elbow" configuration to create the infiltration sump. If the field-verified infiltration rate is less than 0.5 inches per hour, the sump will still qualify as a Level 2 design. However, any additional storage needed must be added above the sump through additional stone, media, or surface ponding.

### 6.1.2 Stormwater Quantity

The water quality $T_v$ can be counted as part of the Channel Protection Volume or Overbank Flood Protection Volume to satisfy stormwater quantity control requirements. In addition, designers may be able to create additional surface storage by expanding the surface ponding footprint in order to accommodate a greater quantity credit for channel and/or flood protection, without necessarily increasing the soil media footprint. In other words, the engineered soil media would only underlay part of the surface area of the bioretention (see **Figure 9.10** above).

In this regard, the ponding footprint can be increased as follows to allow for additional storage:

- 50% surface area increase if the ponding depth is 6 inches or less.
- 25% surface area increase if the ponding depth is between 6 and 12 inches.

These values may be modified as additional data on the long term permeability of bioretention filters becomes available.

## 6.2. Soil Infiltration Rate Testing

In order to determine if an underdrain will be needed, one must measure the infiltration rate of subsoils at the invert elevation of the bioretention area, as noted in the soil testing requirements for each scale of bioretention, in Design **Tables 9.3 and 9.4** above. The infiltration rate of subsoils must exceed 1 inch per hour in order to dispense with the underdrain requirement for Rain Gardens (micro-bioretention), and 1/2 inch per hour for bioretention basins. On-site soil infiltration rate testing requirements and procedures are outlined in **Appendix 8-A** of **Stormwater Design Specification No. 8** (Infiltration). Soil testing is not needed for Level 1 bioretention areas, where an underdrain is used.

### 6.3. BMP Geometry

Bioretention basins must be designed with an internal flow path geometry such that the treatment mechanisms provided by the bioretention are not bypassed or short-circuited. Examples of short-circuiting include inlets or curb cuts that are very close to outlet structures (see **Figure 9.11** below), or incoming flow that is diverted immediately to the underdrain through stone layers. Short-circuiting can be particularly problematic when there are multiple curb cuts or inlets.


***Figure 9.11. Examples of Short-Circuiting at Bioretention Facilities***

In order for these bioretention areas to have an acceptable internal geometry, the "travel time" from each inlet to the outlet should be maximized, and incoming flow must be distributed as evenly as possible across the filter surface area.

One important characteristic is the length of the shortest flow path compared to the overall length, as shown in **Figure 9.12** below. In this figure, the ratio of the shortest flow path to the overall length is represented as:

***Equation 9.5. Ratio of Shortest Flow Path to Overall Length***

$$SFP / L$$

Where:

*SFP* = length of the shortest flow path
*L* = length from the most distant inlet to the outlet

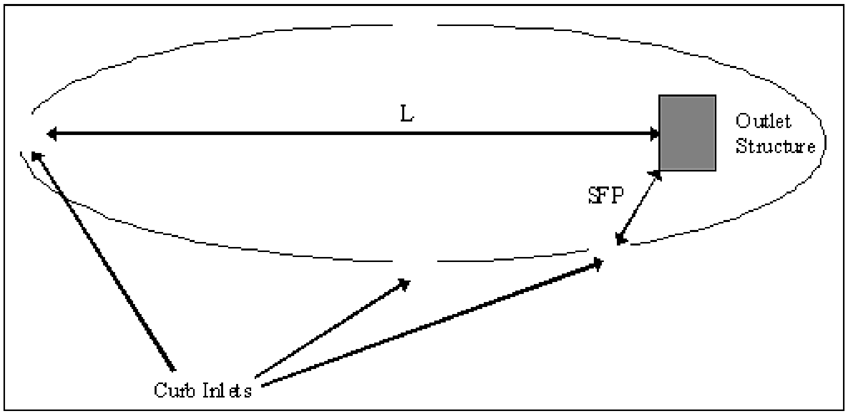


***Figure 9.12. Diagram showing shortest flow path as part of BMP geometry***

For Level 1 designs, the SFP/L ratio must be 0.3 or greater; the ratio must be 0.8 or greater for Level 2 designs. In some cases, due to site geometry, some inlets may not be able to meet these ratios. However, the drainage area served by such inlets should constitute no more than 20% of the contributing drainage area. Alternately, the designer may incorporate other design features that prevent short-circuiting, including features that help spread and distribute runoff as evenly as possible across the filter surface.

> ***Note: Local reviewers may waive or modify the guideline for the shortest flow path ratio in cases where (1) the outlet structure within the bioretention area is raised above the filter surface to the ponding depth elevation; and (2) the filter surface is flat.***

With regard to the first condition stated in the note above, field experience has shown that soil media immediately around a raised outlet structure is prone to scouring, erosion and, thus, short-circuiting of the treatment mechanism. For example, water can flow straight down through scour holes or sinkholes to the underdrain system (Hirschman et al., 2009). Design options should be used to prevent this type of scouring. One example is shown in **Figure 9.13**.

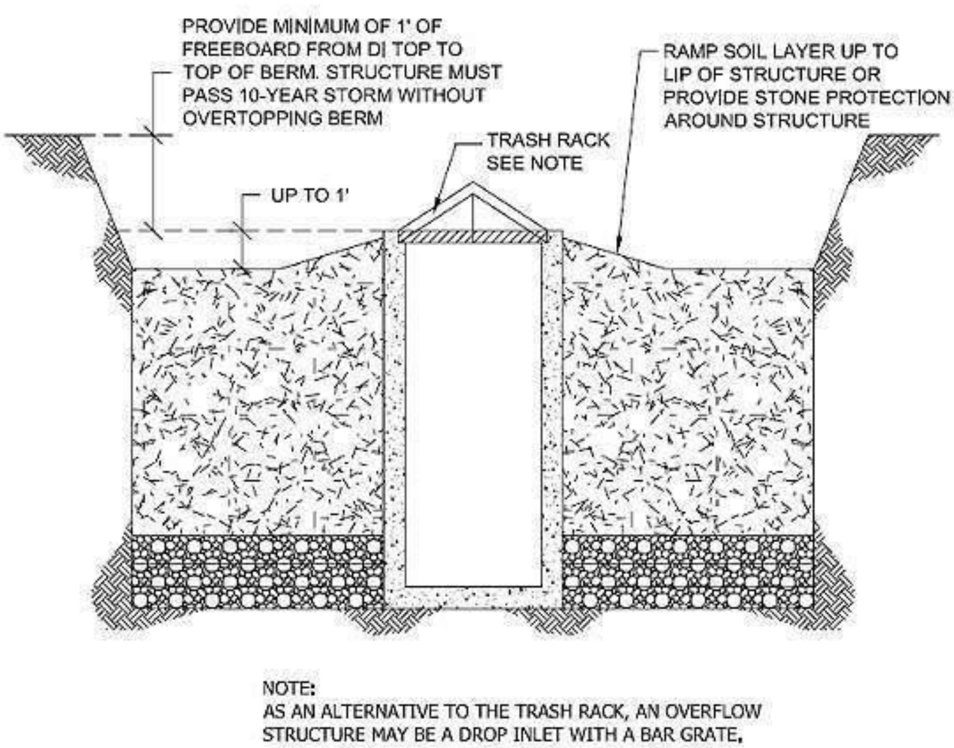


***Figure 9.13. Typical Detail of how to prevent bypass or short-circuiting around the overflow structure***

The designer should ensure that incoming flow is spread as evenly as possible across the filter surface to maximize the treatment potential.

## 6.4. Pre-treatment

Pre-treatment of runoff entering bioretention areas is necessary to trap coarse sediment particles before they reach and prematurely clog the filter bed. Pre-treatment measures must be designed to evenly spread runoff across the entire width of the bioretention area. Several pre-treatment measures are feasible, depending on the scale of the bioretention practice and whether it receives sheet flow, shallow concentrated flow or deeper concentrated flows. The following are appropriate pretreatment options:

***For Micro Bioretention (Rain Gardens):***

- **Leaf Screens** as part of the gutter system serve to keep the heavy loading of organic debris from accumulating in the bioretention cell.
- ***Grass Filter Strips*** (for sheet flow), applied on residential lots, where the lawn area can serve as a grass filter strip adjacent to a rain garden.
- ***Gravel or Stone Diaphragm*** (for either sheet flow or concentrated flow); this is a gravel diaphragm at the end of a downspout or other concentrated inflow point that should run perpendicular to the flow path to promote settling.

***For Bioretention Basins:***

- ***Pre-treatment Cells*** (channel flow): Similar to a forebay, this cell is located at piped inlets or curb cuts leading to the bioretention area and consists of an energy dissipater sized for the expected rates of discharge. It has a storage volume equivalent to at least 15% of the total $T_v$ (inclusive) with a 2:1 length-to-width ratio. The cell may be formed by a wooden or stone check dam or an earthen or rock berm. Pretreatment cells do not need underlying engineered soil media, in contrast to the main bioretention cell.
- ***Grass Filter Strips*** (for sheet flow): Grass filter strips extend from the edge of pavement to the bottom of the bioretention basin at a 5:1 slope or flatter. Alternatively, provide a combined 5 feet of grass filter strip at a maximum 5% (20:1) slope and 3:1 or flatter side slopes on the bioretention basin. (**See Figure 9.7**)
- ***Gravel or Stone Diaphragms*** (sheet flow). A gravel diaphragm located at the edge of the pavement should be oriented perpendicular to the flow path to pre-treat lateral runoff, with a 2 to 4 inch drop. The stone must be sized according to the expected rate of discharge. (**See Figure 9.8**)
- ***Gravel or Stone Flow Spreaders*** (concentrated flow). The gravel flow spreader is located at curb cuts, downspouts, or other concentrated inflow points, and should have a 2 to 4 inch elevation drop from a hard-edged surface into a gravel or stone diaphragm. The gravel should extend the entire width of the opening and create a level stone weir at the bottom or treatment elevation of the basin. (**See Figure 9.9**)
- ***Innovative or Proprietary Structure*:** An approved proprietary structure with demonstrated capability of reducing sediment and hydrocarbons may be used to provide pre-treatment. Refer to the Virginia BMP Clearinghouse web site (http://www.vwrrc.vt.edu/swc/) for information on approved proprietary structures.

## 6.5. Conveyance and Overflow

***For on-line bioretention:*** An overflow structure should always be incorporated into on-line designs to safely convey larger storms through the bioretention area. The following criteria apply to overflow structures:

- The overflow associated with the 2 and 10 year design storms should be controlled so that velocities are non-erosive at the outlet point (i.e., to prevent downstream erosion).
- Common overflow systems within bioretention practices consist of an inlet structure, where the top of the structure is placed at the maximum water surface elevation of the bioretention area, which is typically 6 to 12 inches above the surface of the filter bed (6 inches is the preferred ponding depth).
- The overflow capture device (typically a yard inlet) should be scaled to the application – this may be a landscape grate inlet or a commercial-type structure.
- The filter bed surface should generally be flat so the bioretention area fills up like a bathtub.

***For off-line bioretention:*** Off-line designs are preferred (see **Figure 9.14** below for an example). One common approach is to create an alternate flow path at the inflow point into the structure such that when the maximum ponding depth is reached, the incoming flow is diverted past the facility. In this case, the higher flows do not pass over the filter bed and through the facility, and additional flow is able to enter as the ponding water filtrates through the soil media.

Another option is to use a low-flow diversion or flow splitter at the inlet to allow only the $T_v$ to enter the facility. This may be achieved with a weir or curb opening sized for the target flow, in combination with a bypass channel. Using a weir or curb opening helps minimize clogging and reduces the maintenance frequency. (Further guidance on determining the $T_v$ design peak flow rate will be necessary in order to ensure proper design of the diversion structure.)

### 6.6. Filter Media and Surface Cover

***The filter media and surface cover are the two most important elements of a bioretention facility in terms of long-term performance***. The ultimate performance goals of the combination of engineered soil mix and surface cover (plants) is to maintain a design infiltration rate and soil permeability so as to treat the stormwater runoff to remove phosphorus (P) and other nutrients and contaminants during a wide range of storm intensities and volumes.

Some important definitions to help designers, contractors, and material suppliers achieve these goals include the following:

**Soil infiltration:** the rate at which stormwater enters the surface of the soil. Infiltration is influenced by soil structure, compaction/bulk density, organic matter, moisture content, and other physical characteristics at the soil surface. The design infiltration rate is usually expressed as a constant value, but the actual infiltration rate can vary due to differences in depth of ponding (hydraulic head) or other surface and subsurface soil conditions during the receiving event. Initial rates of infiltration into dry surface soils can be quite rapid and then will decrease as the soil wets and/or swells. Assuming constant head conditions, the infiltration rate will equilibrate after some period of time to approach and reflect the internal permeability (see below) of the underlying soil mix as described below.

**Soil media permeability:** the rate at which percolating stormwater flows *through* the soil after it has infiltrated.

> **NOTE:** ***Infiltration and Permeability are used interchangeably in many reference materials but refer to two different physical processes.***

The infiltration and permeability of a given soil are related to the hydraulic conductivity of the soil (K). The rate at which water enters the soil (*infiltration*), under optimal conditions, starts very fast and then declines and eventually approaches a constant rate of entry. This constant rate of infiltration is sometimes called the soil's permeability, but is technically defined as the *saturated hydraulic conductivity* (*Ksat*) when it equals or approaches the internal permeability of the underlying soil medium. In almost all cases, reference to an infiltration rate implies this long-term constant rate (permeability or Ksat; Jarrett, 2008). For the purpose of bioretention and other engineered media system design, it is reasonable to assume that the soil media should *infiltrate* the stormwater at a rate equal to the long-term Ksat of the underlying soil media mix.

Therefore, the design goal of the soil media is to provide a mixture that has a porosity that will maintain the desired permeability, while also providing limited soil fines and sufficient organic matter to support plant growth and adsorb P and other stormwater contaminants. It is expected that over time, the seasonal cycle of plant growth within the bioretention basin will lead to an adequate accumulation of organic matter to maintain plant growth. The challenge, therefore, is to provide enough organic matter within the *initial* soil media mix to support the initial seasons of plant establishment and growth, while not overloading the system with excessive nutrients or soil fines (from the organic matter or topsoil) which might cause leaching of nutrients or gradual clogging of the soil porosity. It is also expected that the organic matter will enhance aggregation/structure of the media mix over time to aid in maintenance of permeability.

**Soil porosity** is the fraction of a volume of soil material that is not solid (also referred to as the void space). As the volume of fines − defined as either clay particles (less than 2 microns, or 0.002 mm) or silt particles (between 2 and 50 microns, or 0.002 and 0.05 mm) − within a given soil mix is increased, there is a possibility that those fines may migrate or be flushed downward through the soil mix with each runoff event and eventually fill or otherwise clog the void space randomly throughout the mix, creating preferential flow paths. In the short term this can lead to short-circuiting and reduced volume reduction and pollutant removal, and in the long term it can result in clogging the soil layer. This tendency is offset by the addition and maintenance of appropriate amounts of soil organic matter, which binds the soil fines into larger non-mobile aggregates.

- ***General Filter Media Physical Composition.*** The mineral soil texture of the bioretention soil mix should be loamy coarse sand with no more than 10% clay and at least 10% but no more than 20% silt + clay; at least 75% of the sand fraction should be coarse or very coarse sand.

- To allow for appropriate Cation Exchange Capacity (CEC) and nutrient removal, ***the mix should contain at least 10% soil fines (silt + clay)*** while meeting the overall texture specification above. The particle size analysis must be conducted on the mineral fraction only or after following appropriate treatments to remove organic matter before the particle size analysis.

- The Filter Media should contain ***3% to 5% organic matter***, as determined by the conventional Walkley-Black soil organic matter determination method or a similar analysis. Soil organic matter is expressed on a dry weight basis and does not include coarse particulate (visible) components.

- The overall particle size distribution of the mix will vary since the sand fraction may contain some finer sizes, as will native topsoils, if used. As stated previously, the goal of the mixture is to achieve the desired constant head permeability. Therefore, the filter media composition noted above serves as the target recipe for the three ingredients, while the ultimate performance goal is to achieve a verified soil permeability or hydraulic conductivity (Ksat) of 1 to 2 inches per hour (or 30 to 60 cm/day).

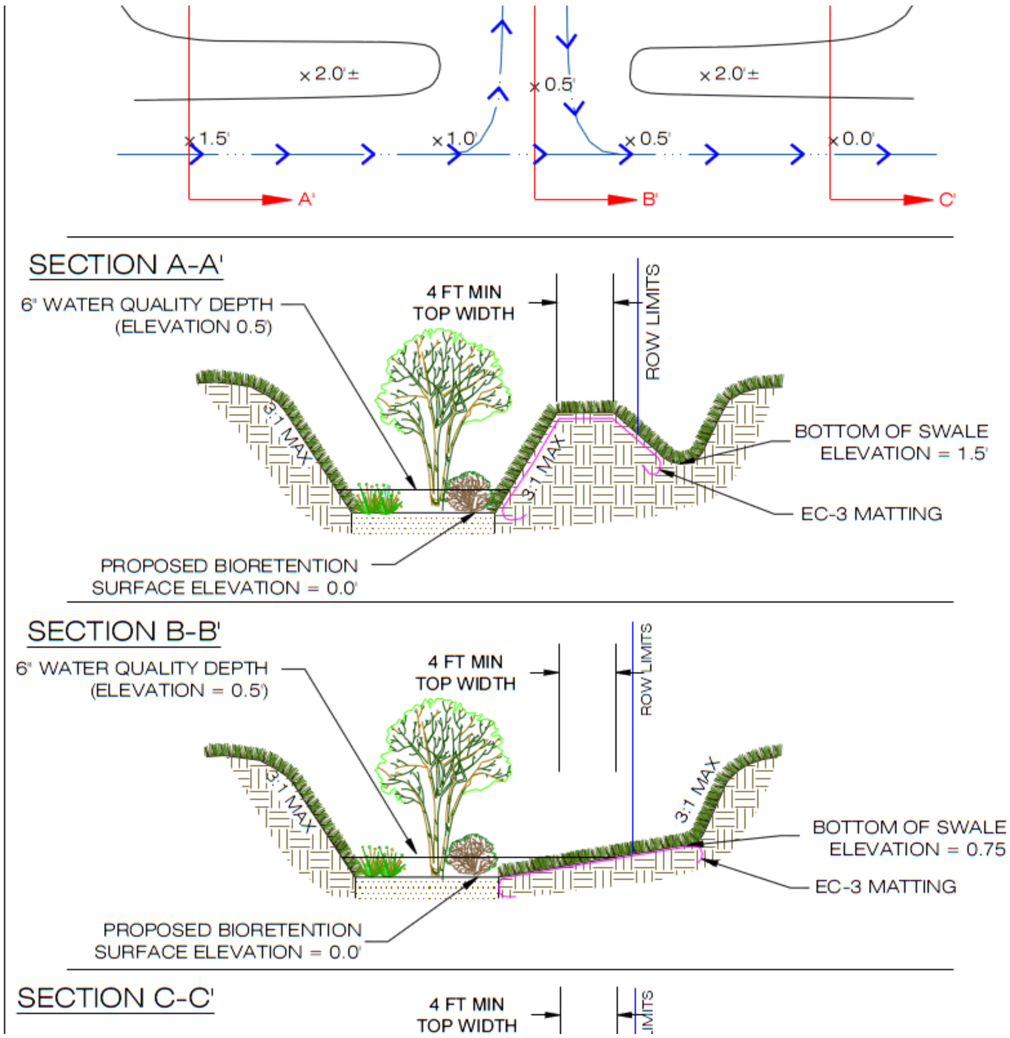


***Figure 9.14. Typical Details for Off-Line Bioretention Basin***

- The following is the recommended composition of the three media ingredients:
  - **Sand** shall consist of silica based coarse aggregate, angular or round in shape and meet the mixture grain size distribution below. No substitutions of alternate materials such as diabase, calcium carbonate, rock dust or dolomitic sands are accepted. In particular, mica can make up no more than 5% of the total sand fraction. The sand fraction may also contain a limited amount of particles > 2.0 mm and < 9.5 mm (see the table below), but the overall sand fraction must meet the specification of >75% being coarse or very coarse sand.

***Table 9.5. Sand Composition***

| Sieve | Size | % Passing |
|---|---|---|
| 3/8 in | 9.50 mm | 100 |
| No. 4 | 4.75 mm | 95 to 100 |
| No. 8 | 2.36 mm | 80 to 100 |
| No. 16 | 1.18 mm | 45 to 85 |
| No. 30 | 0.6 mm | 15 to 60 |
| No. 50 | 0.3 mm | 3 to 15 |
| No. 100 | 0.15 mm | 0 to 4 |
| Effective Particle size (D10) > 0.3mm | | |
| Uniformity Coefficient (D60/D10) < 4.0 | | |

- **Topsoil** is generally defined as the combination of the other ingredients referenced in the bioretention soil media: sand, fines (silt and clay), and any associated soil organic matter. Since the objective of the specification is to carefully establish the proper blend of these ingredients, the designer (or contractor or materials supplier) must carefully select the topsoil source material in order to not exceed the amount of any one ingredient.

  Generally, the use of a topsoil defined as a loamy sand, sandy loam, or loam (referring to the USDA Textural Triangle) will be an acceptable ingredient and, in combination with the other ingredients, meet the overall performance goal of the soil media.

- **Organic matter** used in the soil media mix should consist of well-decomposed natural C-containing organic materials such as peat moss, humus, compost (consistent with the material specifications found in **Design Specification #4** (**Soil Compost Amendments**), pine bark fines or other organic soil conditioning material. However, as stated above, the combined media mix should contain 3% to 5% soil organic matter on a dry weight basis (grams of organic matter per 100 grams of dry soil) as determined using the Walkley-Black method or another similar analytical technique.

It may be advisable to start with an open-graded coarse sand material and proportionately mix in the topsoil materials that may contain anywhere from 10% to 30% soil fines (sandy loam, loamy sand, loam) to achieve the desired ratio of sand and fines. Sufficient suitable organic amendments can then be added to achieve the 3% to 5% soil organic matter target. The exact composition of organic matter and topsoil material will vary, making the exact particle size distribution of the final total soil media mixture difficult to define in advance of evaluating available materials.

- ***Available Soil Phosphorus (P).*** Plant-available soil P should be within the range of Low$^{+}$ (L$^{+}$) to Medium (M) as defined in Table 2.2 of the Virginia DCR's *Virginia Nutrient Management Standards and Criteria* (DCR, 2005). ***For the Mehlich I extraction procedure, this equates to a range of 5 to 15 mg/kg P or 18 to 40 mg/kg P for the Mehlich III procedure.***

The filter media should contain sufficient plant available P to support initial plant establishment and plant growth, but not serve as a significant source of P that could result in long term leaching. The media must also be relatively loose and non-compacted to allow for adequate inter-connected porosity to meet the required permeability (Ksat) specification. Saxton et al. (1986) estimated generalized bulk densities and soil-water characteristics from soil texture assumptions. The expected bulk density of the loamy sand soil composition described above should be in the range of 1.6 to 1.7 g/cm$^3$.

- ***Cation Exchange Capacity (CEC).*** The relative ability of soils to hold and retain nutrient cations like Ca and K is referred to as *cation exchange capacity* or CEC, measured as the total amount of positively charged cations that a soil can hold per unit of dry mass. CEC is also used as an index of overall soil reactivity and is commonly expressed in milliequivalents per 100 grams (meq/100g) of soil or cmol$^+$/kg (equal values). A soil with a moderate to high CEC indicates a greater ability to capture and retain positively charged contaminants, which encourages conditions to remove phosphorus, assuming that soil fines (particularly fine silts and clays) are at least partially responsible for CEC. The minimum CEC of a bioretention soil media mix for pollutant removal is 5.0 (meq/100 g or cmol$^+$/kg) or greater. The filter media CEC should be determined by the Unbuffered Salt, Ammonium Acetate, Summation of Cations or Effective CEC techniques (Sumner and Miller, 1996) or similar methods that do not use strongly acidic extracting solutions.

  Coatings of Fe- and Al-oxides on mineral soil surfaces are also responsible for significant P retention and may be present in soils with low CEC. Thus, it is important for filter media P removal efficiency that some amount of mineral fines (10% - 20%) be present as long as the texture and permeability specifications cited herein are met. This is important due to the fact that soil organic matter per se is not active in adsorption of P.

  The CEC of the soil is determined in part by the amount of clay and/or humus or organic matter present. Since the bioretention media is a coarse mineral texture, and since the added organic matter may not have the relatively high CEC of native humus, it may be difficult to achieve the ideal CEC for the mixture as a whole in freshly blended materials. However, it is expected that over time, natural accumulation of organic matter will improve soil reactivity. Therefore, the initial media mixture may require additional suitable organic matter to increase the CEC to the extent possible without overly compromising the filter media composition or elevating the available P.

- ***Filter Media Permeability:*** The bioretention soil media should have a minimum infiltration rate of 1 to 2 inches per hour (or 30 to 60 cm/day). (Note: a proper soil mix will have an initial infiltration rate that is significantly higher.)

- ***Depth.*** The standard minimum filter bed depth ranges from 24 and 36 inches for Level 1 and Level 2 designs, respectively, (18 to 24 inches for rain gardens or micro-bioretention). If trees are included in the bioretention planting plan, tree planting holes in the filter bed must be at least 4 feet deep to provide enough soil volume for the root structure of mature trees. Use turf, perennials or shrubs instead of trees to landscape shallower filter beds.

- ***Filter Media for Tree Planting Areas.*** A more organic filter media is recommended within the planting holes for trees, with a ratio of 50% sand, 30% topsoil and 20% acceptable leaf compost.

- ***Mulch.*** A 2- to 3-inch layer of mulch on the surface of the filter bed enhances plant survival, suppresses weed growth, and pre-treats runoff before it reaches the filter media. Shredded, aged hardwood bark mulch makes a very good surface cover, as it retains a significant amount of nitrogen and typically will not float away.

- ***Alternative to Mulch Cover.*** In some situations, designers may consider alternative surface covers such as turf, native groundcover, erosion control matting (coir or jute matting), river stone, or pea gravel. The decision regarding the type of surface cover to use should be based on function, cost and maintenance. Stone or gravel are not recommended in parking lot applications, since they increase soil temperature and have low water holding capacity.

- ***Media for Turf Cover.*** One adaptation is to design the filter media primarily as a sand filter with organic content only at the top. Leaf compost tilled into the top layers will provide organic content for the vegetative cover. If grass is the only vegetation, the ratio of compost may be reduced.

### 6.7. Underdrain and Underground Storage Layer

Some Level 2 designs will not use an underdrain (where soil infiltration rates meet minimum standards; see **Section 6.2** and **Section 3** design tables). For Level 2 designs with an underdrain, an underground storage layer, referred to as an infiltration sump, of 12 inches should be incorporated below the invert of the underdrain.

The total depth of the storage layer, including the sump, will depend on the target treatment and storage volumes needed to meet water quality, channel protection, and/or flood protection criteria. However, the bottom of the storage layer must be at least 2 feet above the seasonally high water table. The storage layer should consist of clean, washed #57 stone and, when needed, an approved infiltration or storage module.

The infiltration sump can consist of a 12-inch stone layer underneath the perforated underdrain pipe, or as an alternative, the infiltration sump can be created with an "upturned elbow" configuration on the underdrain. This configuration places the perforated underdrain at the bottom of the stone reservoir layer, with the outlet elevated to the same elevation as the top of the sump. **Figure 9.4.c** illustrates this design variant. The sump will dewater by percolating into the native soils. A minimum field-verified infiltration rate of ½-inch per hour is required in order to count the stone reservoir as storage volume.

The underdrain transitions to a solid wall pipe prior to exiting the stone reservoir layer and is directed towards an outlet manhole or other structure. (This run of pipe should be straight, or include cleanouts at 45 degree (maximum) horizontal bends, and be set at a minimal grade.) In order to create the higher outlet elevation, the outlet manhole is configured with an internal weir wall with the top of the weir set at the same elevation as the top of the stone sump. This is preferred over installing a vertical bend on the outlet pipe that can be difficult to maintain. This design variant can also include a drain orifice in the bottom of the weir to allow the sump to be drained if, over time, the exfiltration into the soil becomes restricted. This orifice should be covered with a plate that is clearly marked to indicate that it remain blocked under normal operating conditions.

All bioretention basins should include observation wells (**Figure 9.b.4** above). The observation wells should be tied into any T's or Y's in the underdrain system, and should extend upwards to be flush with the surface, with a vented cap.

### 6.8. Bioretention Planting Plans

A landscaping plan must be provided for each bioretention area. Minimum plan elements shall include the proposed bioretention template to be used, delineation of planting areas, the planting plan, including the size, the list of planting stock, sources of plant species, and the planting sequence, including post-nursery care and initial maintenance requirements. The planting plan should be prepared by a qualified landscape architect in order to tailor the planting plan to the site-specific conditions.

Native plant species are preferred over non-native species, but some ornamental species may be used for landscaping effect if they are not aggressive or invasive. Some popular native species that work well in bioretention areas and are commercially available can be found in **Table 9.6**. Internet links to more detailed bioretention plant lists developed in piedmont and coastal plain communities of the Chesapeake Bay region are provided in **Table 9.7**.

The planting template refers to the form and combination of native trees, shrubs, and perennial ground covers that maintain the appearance and function of the bioretention area. There is a growing consensus among horticulturists that a diverse herbaceous cover will create a dynamic ground-plane of native perennials and grasses that, working in concert with the soil, will be more effective at filtering pollutants than a sparse collection of woody trees or shrubs will be. Where trees and shrubs are recommended (typically Level 2 designs), the designer should consider the long term growth of the plants – trees can dominate a facility and require extensive maintenance. In either case, a diverse mixture will allow plants best suited to the particular wet/dry regime of the practice's micro-environment to thrive. This will result in more rigorous growth, greater pollutant removal performance, and less (or easier) maintenance.

The six most common bioretention templates are as follows:

- ***Turf.*** This option is typically restricted to on-lot micro-bioretention applications, such as a front yard rain garden. Grass species should be selected that have dense cover, are relatively slow growing, and require the least mowing and chemical inputs (e.g., fine fescue, tall fescue).
- ***Perennial garden.*** This option uses herbaceous plants and native grasses to create a garden effect with seasonal cover. It may be employed in both micro-scale and small scale bioretention applications. This option is attractive, but it requires more maintenance in the form of weeding.

- ***Perennial garden with shrubs.*** This option provides greater vertical form by mixing native shrubs and perennials together in the bioretention area. This option is frequently used when the filter bed is too shallow to support tree roots. Shrubs should have a minimum height of 30 inches.
- ***Tree, shrub and herbaceous plants.*** This is the traditional landscaping option for bioretention. It produces the most natural effect, and it is highly recommended for bioretention basin applications. The landscape goal is to simulate the structure and function of a native forest plant community.
- ***Turf and tree.*** This option is a lower maintenance version of the tree-shrub-herbaceous option 4, where the mulch layer is replaced by turf cover. Trees are planted within larger mulched islands to prevent damage during mowing operations.
- ***Herbaceous meadow.*** This is another lower maintenance approach that focuses on the herbaceous layer and may resemble a wildflower meadow or roadside vegetated area (e.g., with Joe Pye Weed, New York Ironweed, sedges, grasses, etc.). The goal is to establish a more natural look that may be appropriate if the facility is located in a lower maintenance area (e.g., further from buildings and parking lots). Shrubs and trees may be incorporated around the perimeter. Erosion control matting can be used in lieu of the conventional mulch layer.

***Table 9.6. Popular Native Plant Materials for Bioretention***

| Perennials/Herbaceous | Shrubs | Trees |
|---|---|---|
| Virginia Wild Rye<br>*(Elymus virginicus)* | Common Winterberry<br>*(Ilex verticillatta)* | River Birch<br>*(Betula nigra)* |
| Redtop Grass<br>*(Agrostis alba)* | Inkberry<br>*(Ilex glabra)* | Red Maple<br>*(Acer rubrum)* |
| Swamp Milkweed<br>*(Asclepias incarnata)* | Sweet Pepperbush<br>*(Clethra ainifolia)* | Pin Oak<br>*(Quercus palustris)* |
| Switchgrass<br>*(Panicum virgatum)* | Wax Myrtle<br>*(Myrica cerifera)* | Willow Oak<br>*(Quercus phellos)* |
| Cardinal Flower<br>*(Lobelia cardinalis)* | Virginia Sweetspire<br>*(Itea virginica)* | Sweetgum<br>*(Liquidambar styraciflua)* |
| Common Three Square<br>*(Scirpus americanus)* | Swamp Azeala<br>*(Azeala viscosum)* | Black Willow<br>*(Salix nigra)* |
| Sensitive Fern<br>*(Onoclea sensibilis)* | Button Bush<br>*(Cephalanthus occidentalis)* | Grey Birch<br>*(Betula populifolia)* |
| Blue Flag<br>*(Iris versicolor)* | Black Haw<br>*(Virburnum prunifolium))* | Black Gum<br>*(Nyassa sylvatica)* |
| Woolgrass<br>*(Scirpus cyperninus)* | Indigo Bush<br>*(Amorpha fruticosa)* | Sycamore<br>*(Platanus occidentalis)* |
| Indian Grass<br>*(Sorghastrum nutans)* | Arrowwood<br>*(Virburum dentatum)* | Green Ash<br>*(Fraxinus pennsylvanica* |
| Marsh Marigold<br>*(Caltha palustris)* | | Sweetbay Magnolia*<br>*(Magnolia virginiana)* |
| Joe Pye Weed<br>*(Eupatorium purpureum)* | | Atlantic White Cedar*<br>*(Charnaecyparis thyoides)* |
| Turk's cap lily<br>(*Lilium superbum*) | | Bald Cypress*<br>*(Taxodium distichum)* |
| Bee Balm<br>*(Mornarda didyma)* | | Grey Dogwood<br>*(Cornus racernosa)* |
| Northern Sea Oats<br>*(Chasmanthium latifolium)* | | Smooth Alder<br>*(Alnus serrulata))* |
| | | Serviceberry<br>*(Amelanchier canadensis)* |
| | | Redbud<br>(*Cercis candensis*) |
| | | Box Elder<br>*(Acer negundo)* |
| | | Fringe Tree<br>(*Chionanthus virginicus*) |

**Note**: Prior to selection, please consult bioretention plant lists for more detailed information regarding inundation, drought and salt tolerance for each species.
* most applicable to the coastal plain

***Table 9.7. Sources of Bioretention Plant Lists***

| |
|---|
| **Fairfax County, VA**<br>https://166.94.9.135/dpwes/publications/lti/07-03attach3.pdf<br><br>**Prince Georges County, MD**<br>http://www.co.pg.md.us/Government/AgencyIndex/DER/ESD/Bioretention/pdf/Plant_list.pdf<br><br>**City of Suffolk, VA**<br>http://www.suffolk.va.us/citygovt/udo/apdx_c/appendix_c9-2_plant_list.pdf<br><br>**Virginia**<br>http://www.ext.vt.edu/pubs/waterquality/426-043/426-043.html<br><br>**Bay Directory of Native Plant Nurseries**<br>http://www.montgomerycountymd.gov/Content/DEP/Rainscapes/nurseries.htm<br><br>**Delaware Green Technology Standards and Specifications**<br>http://www.dnrec.state.de.us/DNREC2000/Divisions/Soil/Stormwater/New/GT_Stds%20&%20Specs_06-05.pdf |

The choice of which planting template to use depends on the scale of bioretention, the context of the site in the urban environment, the filter depth, the desired landscape amenities, and the future owner's capability to maintain the landscape. In general, the vegetative goal is to cover up the filter surface with vegetation in a short amount of time. This means that the herbaceous layer is equally or more important than widely-spaced trees and shrubs. In the past, many bioretention areas in Virginia did not include enough herbaceous plants.

The following additional guidance is provided regarding developing an effective bioretention landscaping plan:

- Plants should be selected based on a specified zone of hydric tolerance and must be capable of surviving both wet and dry conditions.
- "Wet footed" species should be planted near the center, whereas upland species do better planted near the edge.
- Woody vegetation should not be located at points of inflow; trees should not be planted directly above underdrains, but should be located closer to the perimeter.
- If trees are part of the planting plan, a tree density of approximately one tree per 250 square feet (i.e., 15 feet on-center) is recommended.
- Shrubs and herbaceous vegetation should generally be planted in clusters and at higher densities (10 feet on-center and 1 to 1.5 feet on-center, respectively).
- Temporary or supplemental irrigation may be needed for the bioretention plantings in order for plant installers to provide a warranty regarding plant material survival.
- Supplemental irrigation by a rain tank system is also recommended (See Stormwater Design Specification No. 6: Rainwater Harvesting).
- Designers should also remember that planting holes for trees need must be at least 4 feet deep to provide enough soil volume for the root structure of mature trees. This applies even if the remaining soil media layer is shallower than 4 feet.

- If trees are used, plant shade-tolerant ground covers within the drip line.
- Maintenance is an important consideration in selecting plant species. Plant selection differs if the area will be frequently mowed, pruned, and weeded, in contrast to a site which will receive minimum annual maintenance.
- If the bioretention area is to be used for snow storage or is to accept snowmelt runoff, it should be planted with salt-tolerant, herbaceous perennials.

## 6.9. Bioretention Material Specifications

**Table 9.8** outlines the standard material specifications used to construct bioretention areas.

***Table 9.8. Bioretention Material Specifications***

| Material | Specification | Notes |
|---|---|---|
| Filter Media Composition | Filter Media to contain:<br>• 80% - 90% sand<br>• 10%-20% soil fines<br>• 3%-5% organic matter | The volume of filter media based on 110% of the plan volume, to account for settling or compaction. |
| Filter Media Testing | Available P between L+ and M per DCR 2005 Nutrient Management Criteria. | The media should be certified by the supplier. |
| Mulch Layer | Use aged, shredded hardwood bark mulch or stable coarse compost. | Lay a 2 to 3 inch layer on the surface of the filter bed. |
| Alternative Surface Cover | Use river stone or pea gravel, coir and jute matting, or turf cover. | Lay a 2 to 3 inch layer of to suppress weed growth. |
| Top Soil For Turf Cover | Loamy sand or sandy loam texture, with less than 5% clay content, pH corrected to between 6 and 7, and an organic matter content of at least 2%. | 3 inch surface depth. |
| Geotextile/Liner | Use a non-woven geotextile fabric with a flow rate of > 110 gal./min./sq. ft. (e.g., Geotex 351 or equivalent) | Apply only to the sides and directly above the underdrain. For hotspots and certain karst sites only, use an appropriate liner on bottom. |
| Choking Layer | Lay a 2 to 4 inch layer of sand over a 2 inch layer of choker stone (typically #8 or #89 washed gravel), which is laid over the underdrain stone. | |
| Stone Jacket for Underdrain and/or Storage Layer | 1 inch stone should be double-washed and clean and free of all fines (e.g., VDOT #57 stone). | 12 inches for the underdrain;<br>12 to 18 inches for the stone storage layer, if needed |
| Underdrains, Cleanouts, and Observation Wells | Use 6 inch rigid schedule 40 PVC pipe (or equivalent corrugated HDPE for micro-bioretention), with 3/8-inch perforations at 6 inches on center; position each underdrain on a 1% or 2% slope located nor more than 20 feet from the next pipe. | Lay the perforated pipe under the length of the bioretention cell, and install non-perforated pipe as needed to connect with the storm drain system. Install T's and Y's as needed, depending on the underdrain configuration. Extend cleanout pipes to the surface with vented caps at the Ts and Ys. |
| Plant Materials | Plant one tree per 250 square feet (15 feet on-center, minimum 1 inch caliper).<br>Shrubs a minimum of 30 inches high planted a minimum of 10 feet on-center.<br>Plant ground cover plugs at 12 to 18 inches on-center; Plant container-grown plants at 18 to 24 inches on-center, depending on the initial plant size and how large it will grow. | Establish plant materials as specified in the landscaping plan and the recommended plant list.<br>In general, plant spacing must be sufficient to ensure the plant material achieves 80% cover in the proposed planting areas within a 3-year period.<br>If seed mixes are used, they should be from a qualified supplier, should be appropriate for stormwater basin applications, and should consist of native species (unless the seeding is to establish maintained turf). |

# SECTION 7: REGIONAL & SPECIAL CASE DESIGN ADAPTATIONS

## 7.1 Karst Terrain

Karst regions are found in much of the Ridge and Valley province of Virginia, which complicates both land development and stormwater design. While bioretention areas produce less deep ponding than conventional stormwater practices (e.g., ponds and wetlands), Level 2 bioretention designs (i.e., infiltration) are not recommended in any area with a moderate or high risk of sinkhole formation (Hyland, 2005). On the other hand, Level 1 designs that meet separation distance requirements (3 feet) and possess an impermeable bottom liner and an underdrain should work well. In general, micro-bioretention and bioretention basins with contributing drainage areas not exceeding 20,000 square feet are preferred (compared to bioretention with larger drainage areas), in order to prevent possible sinkhole formation. However, it may be advisable to increase standard setbacks to buildings.

## 7.2 Coastal Plain

The flat terrain, low hydraulic head, and high water table of many coastal plain sites can constrain the application of deeper bioretention areas (particularly Level 2 designs). In such settings, the following design adaptations may be helpful:

- A linear approach to bioretention, using multiple cells leading to the ditch system, helps conserve hydraulic head.
- The minimum depth of the filter bed may be 18 to 24 inches. It is useful to limit surface ponding to 6 to 9 inches and avoid the need for additional depth by establishing a turf cover rather than using mulch. The shallower media depth and the turf cover generally comply with the Dry Swale specification, and therefore will be credited with a slightly lower pollutant removal (See Stormwater Design Specification No. 10: Dry Swales).
- The minimum depth to the seasonally high water table from the invert of the system can be 1 foot, as long as the bioretention area is equipped with a large-diameter underdrain (e.g., 6 inches).
- Maintain at least 0.5% slope in the underdrain to ensure positive drainage.
- The underdrain should be tied into the ditch or conveyance system.
- The mix of plant species selected should reflect coastal plain plant communities and should be more wet-footed and salt-tolerant than those used in typical Piedmont applications.

While these design criteria permit bioretention to be used on a wider range of coastal plain sites, it is important to evaluate the specific constraints represented by the particular site and avoid using bioretention on marginal sites that directly impact the pollutant removal and volume reduction pathways. Other stormwater practices, such as wet swales, ditch wetland restoration, and smaller linear wetlands, are often preferred alternatives for coastal plain sites.

### 7.3 Steep Terrain

In steep terrain, land with a slope of up to 15% may drain to a bioretention area, as long as a two cell design is used to dissipate erosive energy prior to filtering. The first cell, between the slope and the filter media, functions as a forebay to dissipate energy and settle any sediment that migrates down the slope. Designers may also want to terrace a series of bioretention cells to manage runoff across or down a slope. The drop in slope between cells should be limited to 1 foot and should be armored with river stone or a suitable equivalent.

### 7.4 Cold Climate and Winter Performance

Bioretention areas can be used for snow storage as long as an overflow is provided and they are planted with salt-tolerant, non-woody plant species. [NOTE: Designers may want to evaluate Chesapeake Bay wetland plant species that tolerate slightly brackish water, or consult the Minnesota Stormwater Manual for a list of salt-tolerant grass species (MSSC, 2005).] Tree and shrub locations should not conflict with plowing and piling of snow into storage areas.

While several studies have shown that bioretention facilities operate effectively in Pennsylvania and West Virginia winters, it is a good idea to extend the filter bed and underdrain pipe below the frost line and/or oversize the underdrain by one pipe size to reduce the freezing potential.

### 7.5 Linear Highway Sites

Bioretention is a preferred practice for constrained highway right of ways when designed as a series of individual on-line or off-line cells. In these situations, the final design closely resembles that of dry swales. Salt tolerant species should be selected if salt compounds will be used to de-ice the contributing roadway in the winter.

## SECTION 8: CONSTRUCTION

### 8.1. Construction Sequence

***Construction Stage E&S Controls.*** Micro-bioretention and small-scale bioretention areas should be fully protected by silt fence or construction fencing, particularly if they will rely on infiltration (i.e., have no underdrains). Ideally, bioretention should remain outside the limit of disturbance during construction to prevent soil compaction by heavy equipment. Bioretention basin locations may be used as small sediment traps or basins during construction. However, these must be accompanied by notes and graphic details on the ESC plan specifying that (1) the maximum excavation depth at the construction stage must be at least 1 foot above the post-construction maximum excavation, (2) the facility must contain an underdrain, and (3) the plan must also show the proper procedures for converting the temporary sediment control practice to a permanent bioretention facility, including dewatering, cleanout and stabilization.

## 8.2 Bioretention Installation

The following is a typical construction sequence to properly install a bioretention basin. The installation of a bioretention basin will include intermediate inspections at critical stages of construction with inspector sign-off that the particular elements of the bioretention are constructed according the approved plans and specifications. As an alternative, if allowed by the VSMP Authority, the contractor may rely on the engineer of record or other qualified individual to conduct the intermediate inspections and certifications of compliance. The construction sequence for micro-bioretention is more simplified. These steps may be modified to reflect different bioretention applications or expected site conditions:

***Step 1.*** Construction of the bioretention area may only begin after the entire contributing drainage area has been stabilized with vegetation. It may be necessary to block certain curb or other inlets while the bioretention area is being constructed. The proposed site should be checked for existing utilities prior to any excavation.

***Step 2.*** The designer and the installer should have a preconstruction meeting, checking the boundaries of the contributing drainage area and the actual inlet elevations to ensure they conform to original design. Since other contractors may be responsible for constructing portions of the site, it is quite common to find subtle differences in site grading, drainage and paving elevations that can produce hydraulically important differences for the proposed bioretention area. The designer should clearly communicate, in writing, any project changes determined during the preconstruction meeting to the installer and the plan review/inspection authority.

***Step 3.*** Temporary E&S controls are needed during construction of the bioretention area to divert stormwater away from the bioretention area until it is completed. Special protection measures such as erosion control fabrics may be needed to protect vulnerable side slopes from erosion during the construction process.

***Step 4.*** Any pre-treatment cells should be excavated first and then sealed to trap sediments.

***Step 5.*** Excavators or backhoes should work from the sides to excavate the bioretention area to its appropriate design depth and dimensions. Excavating equipment should have scoops with adequate reach so they do not have to sit inside the footprint of the bioretention area. Contractors should use a cell construction approach in larger bioretention basins, whereby the basin is split into 500 to 1,000 sq. ft. temporary cells with a 10-15 foot earth bridge in between, so that cells can be excavated from the side.

***Step 6.*** It may be necessary to rip the bottom soils to a depth of 6 to 12 inches to promote greater infiltration.

***Step 7.*** Place geotextile fabric on the sides of the bioretention area with a 6-inch overlap on the sides. If a stone storage layer will be used, place the appropriate depth of #57 stone on the bottom, install the perforated underdrain pipe, pack #57 stone to 3 inches above the underdrain pipe, and add approximately 3 inches of choker stone/pea gravel as a filter between the underdrain and the soil media layer. If no stone storage layer is used, start with 6 inches of #57 stone on the bottom, and proceed with the layering as described above.

***Step 8.*** Obtain soil media from a qualified vendor, and store it on an adjacent impervious area or plastic sheeting. After verifying that the media meets the specifications, apply the media in 12-inch lifts until the desired top elevation of the bioretention area is achieved. Wait a few days to check for settlement, and add additional media, as needed, to achieve the design elevation.

***Step 9.*** Prepare planting holes for any trees and shrubs, install the vegetation, and water accordingly. Install any temporary irrigation.

***Step 10.*** Place the surface cover in both cells (mulch, river stone or turf), depending on the design. If coir or jute matting will be used in lieu of mulch, the matting will need to be installed prior to planting (**Step 9**), and holes or slits will have to be cut in the matting to install the plants.

***Step 11.*** Install the plant materials as shown in the landscaping plan, and water them during weeks of no rain for the first two months.

## 8.3 Construction Inspection

Inspections during and immediately after construction are needed to ensure that all the elements of bioretention basins are built in accordance with these specifications. Use a detailed inspection checklist that requires sign-offs by qualified individuals at critical stages of construction to ensure that the contractor's interpretation of the plan is consistent with the designer's intent. The following identifies the critical stages of construction where an intermediate inspection and sign-off by a qualified individual is recommended, since the items can't be verified after construction is completed. A construction inspection checklist that includes certifications of inspection at critical stages is provided at the end of this specification.

The following represents items that are frequently overlooked during construction inspection but represent important elements for ensuring the success of the bioretention facility during the initial break-in period.

- Verify the proper coverage and depth of mulch, vegetation, or soil matting has been achieved following construction, both on the filter bed and the side-slopes.
- Inspect the pre-treatment forbays and filter strips to verify that they are properly installed, stabilized, and working effectively before opening the facility to runoff.
- Check that outfall protection/energy dissipation measures at concentrated inflow and outflow points are stable.

Upon final acceptance of the facility, log the practice's GPS coordinates and submit them for entry into the VSMP Authority's BMP maintenance tracking database.

# SECTION 9: MAINTENANCE

## 9.1. Maintenance Agreements

The Virginia Stormwater Management regulations (4 VAC 50-60) specify the circumstances under which a maintenance agreement must be executed between the owner and the VSMP authority, and sets forth inspection requirements, compliance procedures if maintenance is neglected, notification of the local program upon transfer of ownership, and right-of-entry for local program personnel.

- All bioretention practices must include a long term maintenance agreements consistent with the provisions of the VSMP regulations, and must include the recommended maintenance tasks and a copy of an annual inspection checklist.

- When micro-scale bioretention practices are applied on private residential lots, homeowners should be educated (ideally, provide handout materials) regarding their routine maintenance needs by being provided a simple document that explains their purpose and routine maintenance needs.

- A deed restriction, drainage easement or other mechanism enforceable by the VSMP authority must be in place to help ensure that rain gardens and bioretention filters are maintained and not converted or disturbed, as well as to pass the knowledge along to any subsequent owners.

- The mechanism should, if possible, grant authority for the VSMP authority to access the property for inspection or corrective action.

## 9.2. First Year Maintenance Operations

Successful establishment of bioretention areas requires that the following tasks be undertaken in the first year following installation:

- ***Initial inspections.*** For the first 6 months following construction, the site should be inspected at least twice after storm events that exceed 1/2 inch of rainfall.
- ***Spot Reseeding.*** Inspectors should look for bare or eroding areas in the contributing drainage area or around the bioretention area, and make sure they are immediately stabilized with grass cover.
- ***Fertilization.*** One-time, spot fertilization may be needed for initial plantings.
- ***Watering.*** Watering is needed once a week during the first 2 months, and then as needed during first growing season (April-October), depending on rainfall.
- ***Remove and replace dead plants.*** Since up to 10% of the plant stock may die off in the first year, construction contracts should include a care and replacement warranty to ensure that vegetation is properly established and survives during the first growing season following construction. The typical thresholds below which replacement is required are 85% survival of plant material and 100% survival of trees.

### 9.3. Maintenance Inspections

It is highly recommended that a spring maintenance inspection and cleanup be conducted at each bioretention area. The following is a list of some of the key maintenance problems to look for:

- Check to see if 75% to 90% cover (mulch plus vegetative cover) has been achieved in the bed, and measure the depth of the remaining mulch.
- Check for sediment buildup at curb cuts, gravel diaphragms or pavement edges that prevents flow from getting into the bed, and check for other signs of bypassing.
- Check for any winter- or salt-killed vegetation, and replace it with hardier species.
- Note presence of accumulated sand, sediment and trash in the pre-treatment cell or filter beds, and remove it.
- Inspect bioretention side slopes and grass filter strips for evidence of any rill or gully erosion, and repair it.
- Check the bioretention bed for evidence of mulch flotation, excessive ponding, dead plants or concentrated flows, and take appropriate remedial action.
- Check inflow points for clogging, and remove any sediment.
- Look for any bare soil or sediment sources in the contributing drainage area, and stabilize them immediately.
- Check for clogged or slow-draining soil media, a crust formed on the top layer, inappropriate soil media, or other causes of insufficient filtering time, and restore proper filtration characteristics.

Example maintenance inspection checklists for Bioretention areas can be accessed in Appendix C of Chapter 9 of the *Virginia Stormwater Management Handbook* (2nd Edition).

### 9.4. Routine and Non-Routine Maintenance Tasks

Maintenance of bioretention areas should be integrated into routine landscape maintenance tasks. If landscaping contractors will be expected to perform maintenance, their contracts should contain specifics on unique bioretention landscaping needs, such as maintaining elevation differences needed for ponding, proper mulching, sediment and trash removal, and limited use of fertilizers and pesticides. A customized maintenance schedule must be prepared for each bioretention facility, since the maintenance tasks will differ depending on the scale of bioretention, the landscaping template chosen, and the type of surface cover. A generalized summary of common maintenance tasks and their frequency is provided in **Table 9.9**.

The most common non-routine maintenance problem involves standing water. If water remains on the surface for more than 48 hours after a storm, adjustments to the grading may be needed or underdrain repairs may be needed. The surface of the filter bed should also be checked for accumulated sediment or a fine crust that builds up after the first several storm events. There are several methods that can be used to rehabilitate the filter (try the easiest things first, as listed below):

- Open the underdrain observation well or cleanout and pour in water to verify that the underdrains are functioning and not clogged or otherwise in need of repair. The purpose of this check is to see if there is standing water all the way down through the soil. If there is standing water on top, but not in the underdrain, then there is a clogged soil layer. If the underdrain and stand pipe indicates standing water, then the underdrain must be clogged and will need to be snaked.

- Remove accumulated sediment and till 2 to 3 inches of sand into the upper 8 to 12 inches of soil.
- Install sand wicks from 3 inches below the surface to the underdrain layer. Sand wicks can be installed by excavating or augering (using a tree auger or similar tool) down to the gravel storage zone to create vertical columns which are then filled with a clean open-graded coarse sand material (coarse sand mix similar to the gradation used for the soil media). A sufficient number of wick drains of sufficient dimension should be installed to meet the design dewatering time for the facility.
- Last resort - remove and replace some or all of the soil media.

***Table 9.9. Suggested Annual Maintenance Activities for Bioretention***

| Maintenance Tasks | Frequency |
|---|---|
| • Mowing of grass filter strips and bioretention turf cover | At least 4 times a year |
| • Spot weeding, erosion repair, trash removal, and mulch raking | Twice during growing season |
| • Add reinforcement planting to maintain desired the vegetation density<br>• Remove invasive plants using recommended control methods<br>• Stabilize the contributing drainage area to prevent erosion | As needed |
| • Spring inspection and cleanup<br>• Supplement mulch to maintain a 3 inch layer<br>• Prune trees and shrubs | Annually |
| • Remove sediment in pre-treatment cells and inflow points | Once every 2 to 3 years |
| • Replace the mulch layer | Every 3 years |

***Sample Construction Inspection Checklist for Bioretention Practices***: The following checklist provides a basic outline of the anticipated items for the construction inspection of Bioretention Practices. This checklist does not necessarily distinguish between all the design variations and differences in construction between the family of practices: bioretention basins, micro-bioretention (or rain gardens), and urban bioretention. Similarly, the use of an infiltration sump below an underdrain, or an infiltration sump with an "upturned elbow", and other variations between Level 1 and Level 2 bioretention may not be clearly identified in this checklist. Inspectors should review the plans carefully, and adjust these items and the timing of inspection verification as needed to ensure the intent of the design is met. Finally, users of this information may wish to incorporate these items into a VSMP Authority Construction Checklist format consistent with the format used for erosion and sediment control and BMP construction inspections.

**Pre-Construction Meeting**

☐ Pre-construction meeting with the contractor designated to install the bioretention practice has been conducted.

☐ Identify the tentative schedule for construction and verify the requirements and schedule for interim inspections and sign-off.

☐ Subsurface investigation and soils report supports the placement of an bioretention practice in the proposed location.

☐ Impervious cover has been constructed/installed and area is free of construction equipment, vehicles, material storage, etc.

☐ All pervious areas of the contributing drainage areas have been adequately stabilized with a thick layer of vegetation and erosion control measures have been removed.

☐ Area of bioretention practice has not been impacted during construction.

☐ Stormwater has been diverted around the area of the bioretention practice and perimeter erosion control measures to protect the facility during construction have been installed.

**Excavation**

☐ Compare the bioretention surface and invert design elevations with the actual constructed elevations of the inflow and outlet inverts and adjust design elevations as needed.

☐ Area of bioretention excavation is marked and the size and location conforms to plan.

☐ If the excavation area has been used as a sediment trap: verify that the bottom elevation of the proposed stone reservoir is lower than the bottom elevation of the existing trap.

☐ For Level 2 bioretention, ensure the bottom of the excavation is scarified prior to placement of stone.

☐ Subgrade surface is free of rocks and roots, and large voids. Any voids should be refilled with the base aggregate to create a level surface for the placement of aggregates and underdrain (if required).

☐ No groundwater seepage or standing water is present. Any standing water is dewatered to an acceptable dewatering device.

☐ Excavation of the bioretention practice has achieved proper grades and the required geometry and elevations without compacting the bottom of the excavation.

☐ **Certification of Excavation Inspection**: Inspector certifies the successful completion of the excavation steps listed above.

**Filter Layer, Underdrain, and Stone Reservoir Placement**

☐ All aggregates, including, as required, the filter layer (choker stone & sand), the stone reservoir layer or infiltration sump conform to specifications as certified by quarry.
☐ Underdrain size and perforations meet the specifications.
☐ For Level 2 installations: placement of filter layer and initial lift of stone reservoir layer aggregates with underdrain or infiltration sump, spread (not dumped) to avoid aggregate segregation; or
☐ Impermeable liner, when required, meets project specifications and is placed in accordance with manufacturers specifications.
☐ Sides of excavation covered with geotextile, when required, prior to placing stone reservoir aggregate; no tears or holes, or excessive wrinkles are present.
☐ Placement of underdrain, observation wells, and underdrain fittings (45 degree wyes, cap at the upstream end, etc.) are in accordance with the approved plans.
☐ Elevations of underdrain and outlet structure are in accordance with approved plans, or as adjusted to meet field conditions.
☐ Placement of remaining lift of stone reservoir layer as needed to achieve the required reservoir depth.
☐ **Certification of Filter Layer and Underdrain Placement Inspection:** Inspector certifies the successful completion of the filter layer and underdrain placement steps listed above.

**Bioretention Soil Media Placement**
☐ Soil media is certified by supplier or contractor as meeting the project specifications.
☐ Soil media is placed in 12-inch lifts to the design top elevation of the bioretention area. Elevation has been verified after settlement (2 to 4 days after initial placement).
☐ Side slopes of ponding area are feathered back at the required slope (no steeper than 3H:1V).
☐ **Certification of Soil Media Placement Inspection:** Inspector certifies the successful completion of the soil media steps listed above.

**Pretreatment and Plant Installation**
☐ Placement of energy dissipaters and pretreatment practices (forebays, gravel diaphragms, etc.) are installed in accordance with the approved plans.
☐ Riser, overflow weir, or other outflow structure is set to the proper elevation and functional; or.
☐ External bypass structure is built in accordance with the approved plans.
☐ Appropriate number and spacing of plants are installed in accordance with the approved plans.
☐ All erosion and sediment control practices have been removed.
☐ Follow-up inspection and as-built survey/certification has been scheduled.
☐ GPS coordinates have been documented for all bioretention practice installations on the parcel.

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# APPENDIX 9-A

# URBAN BIORETENTION

### Stormwater Planters
### Expanded Tree Pits
### Stormwater Curb Extensions

**VERSION 1.7**
**January 1, 2013**



## SECTION 9-A-1: DESCRIPTION

Urban bioretention practices are similar in function to regular bioretention practices except they are adapted to fit into "containers" within urban landscapes. Typically, urban bioretention is installed within an urban streetscape or city street right-of-way, urban landscaping beds, tree pits and plazas, or other features within an ultra-urban area. Urban bioretention is not intended for large commercial areas, nor should it be used to treat small sub-areas of a large drainage area such as a parking lot. Rather, urban bioretention is intended to be a containerized practice incorporated into small fragmented drainage areas such as shopping or pedestrian plazas within a larger urban development.

Urban bioretention features hard edges, often with vertical concrete sides, as contrasted with the more gentle earthen slopes of regular bioretention. These practices may be open-bottomed, to allow some infiltration of runoff into the sub-grade, but they generally are served by an underdrain.

**Stormwater planters** (also known as vegetative box filters or foundation planters) take advantage of limited space available for stormwater treatment by placing a soil filter in a container located above ground or at grade in landscaping areas between buildings and roadways (**Figure 9-A.1**). The small footprint of foundation planters is typically contained in a precast or cast-in-place concrete vault. Other materials may include molded polypropylene cells and precast modular block systems.


***Figure 9-A.1. Stormwater Planters***

**Extended tree pits** are installed in the sidewalk zone near the street where urban street trees are normally installed. The soil volume for the tree pit is increased and used as a stormwater (**Figure 9-A.2**). Treatment is increased by using a series of connected tree planting areas together in a row. The surface of the enlarged planting area may be mulch, grates, permeable pavers, or conventional pavement. The large and shared rooting space and a reliable water supply increase the growth and survival rates in this otherwise harsh planting environment.

***Figure 9-A.2. Expanded Tree Pits***

**Stormwater curb extensions** (also known as parallel bioretention) are installed in the road right-of way either in the sidewalk area or in the road itself. In many cases, curb extensions serve as a traffic calming or street parking control device. The basic design adaptation is to move the raised concrete curb closer to the street or in the street, and then create inlets or curb cuts that divert street runoff into depressed vegetated areas within the expanded right of way (**Figure 9-A.3**).

*Figure 9-A.3. Stormwater Curb Extensions*

Each urban bioretention variant is planted with a mix of trees, shrubs, and grasses as appropriate for its size and landscaping context.

## SECTION 9-A-2: PERFORMANCE

The typical stormwater functions of an urban bioretention area are described in **Table 9-A.1**. The three major design variants of urban bioretention are described below:

*Table 9-A.1. Summary of Stormwater Functions Provided by Urban Bioretention Areas*

| Stormwater Function | Level 1 Design | Level 2 Design |
|---|---|---|
| **Annual Runoff Volume Reduction (RR)** | 40% (for Water Quality credit in the VRRM Compliance spreadsheet only)<br><br>0% credit for Channel Protection | NA |
| **Total Phosphorus (TP) EMC Reduction[1] by BMP Treatment Process** | 25% | NA |
| **Total Phosphorus (TP) Mass Load Removal** | 55% | |
| **Total Nitrogen (TN) EMC Reduction[1] by BMP Treatment Process** | 40% | NA |
| | 64% | |
| **Channel and Flood Protection** | • Use the Virginia Runoff Reduction Method (VRRM) Compliance Spreadsheet to calculate the Curve Number (CN) Adjustment<br>***OR***<br>Design extra storage (optional; as needed) on the surface, in the engineered soil matrix, and in the stone/underdrain layer to accommodate a larger storm, and use NRCS TR-55 Runoff Equations[2] to compute the CN Adjustment. | |

[1] Change in the event mean concentration (EMC) through the practice. The actual nutrient mass load removed is the product of the removal rate and the runoff reduction rate (see Table 1 in the *Introduction to the New Virginia Stormwater Design Specifications*).
[2] NRCS TR-55 Runoff Equations 2-1 thru 2-5 and Figure 2-1 can be used to compute a curve number adjustment for larger storm events based on the retention storage provided by the practice(s).

**Sources:** CWP and CSN (2008) and CWP (2007)

***Leadership in Energy and Environmental Design (LEED®).*** The LEED® point credit system designed by the U.S. Green Building Council (USGBC) and implemented by the Green Building Certification Institute (GBCI) awards points related to site design and stormwater management. Several categories of points are potentially available for new and redevelopment projects. **Chapter 6** and the 2013 *Virginia Stormwater Management Handbook* (2nd Edition) provides a more thorough discussion of the site planning process and design considerations as related to the environmental site design and potential LEED credits. However, the Virginia Department of Environmental Quality is not affiliated with the USGBC or GBCI and any information on applicable points provided here is based only on basic compatibility. **Designers should research and verify scoring criteria and applicability of points as related to the specific project being considered through USGBC LEED resources.**

***Table 9-A.2. Potential LEED® Credits for Urban Bioretention[1]***

| Credit Category | Credit No. | Credit Description |
|---|---|---|
| Sustainable Sites | SS5.1 | Site Development: Protect or Restore Habitat[2] |
| Sustainable Sites | SS5.2 | Site Development: Maximize Open Space |
| Sustainable Sites | SS6.1 | Stormwater Design: Quantity Control |
| Sustainable Sites | SS6.2 | Stormwater Design: Quality Control |
| Water Efficiency | WE1.1 | Water Efficient Landscaping: Reduce by 50% [4] |
| Water Efficiency | WE1.2 | Water Efficient Landscaping: No Potable Water Use or No Irrigation [4] |

[1] Actual site design and/or BMP configuration may not qualify for the credits listed. Alternatively, the project may actually qualify for credits not listed here. Designers should consult with a qualified individual (LEED AP) to verify credit applicability.

## SECTION 9-A-3: DESIGN TABLE

***Table 9-A.3. Urban Bioretention Design Criteria***

| **Level 1 Design Only (RR: 40; TP: 25 )** |
|---|
| Sizing (**Section 9-A-6.1**):<br>$Tv_{BMP}$ = [(1)(Rv)(A) / 12] |
| Underdrain = Schedule 40 PVC with clean-outs<br>(Refer to the Main Bioretention Design Specification, **Section 6.7**) |
| Recommended Maximum Drainage Area = 2,500 sq. ft.[1] (100% impervious) |
| Maximum Ponding Depth = 6 to 12 inches [2] |
| Filter media depth minimum = 18 inches; recommended maximum = 36 inches |
| Media and Surface Cover (Refer to the Bioretention Design Specification, **Table 9-4 and Section 6.6**) |
| Sub-soil testing (Refer to the Bioretention Design Specification, **Section 6.2**) |
| Inflow = sheet flow, curb cuts, trench drains, roof drains, concentrated flow, or equivalent |
| Building setbacks (Refer to **Section A-4 9-A-5**) |
| Deeded maintenance O&M plan (Refer to the Main Bioretention Design Specification, **Section 9.1**) |
| [1]Larger drainage areas may be allowed with sufficient flow controls and other mechanisms to ensure proper function, safety, and community acceptance; however, the urban bioretention filter must then be designed in accordance with the Level 1 bioretention filter criteria (**Table 9-4**).<br>[2]Ponding depth above 6 inches will require a specific planting plan to ensure appropriate plants (Refer to the Main Bioretention Design Specification, **Section 6.1**). |

## SECTION 9-A-4: TYPICAL DETAILS

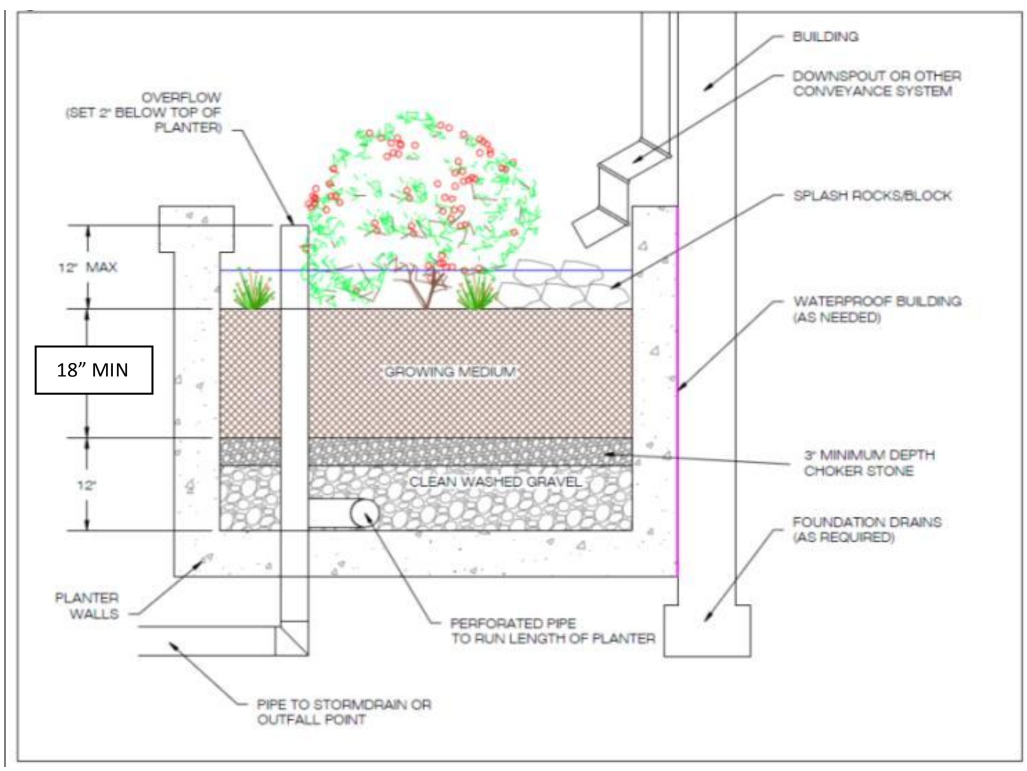


***Figure 9-A.4. Stormwater Planter Cross-Section***

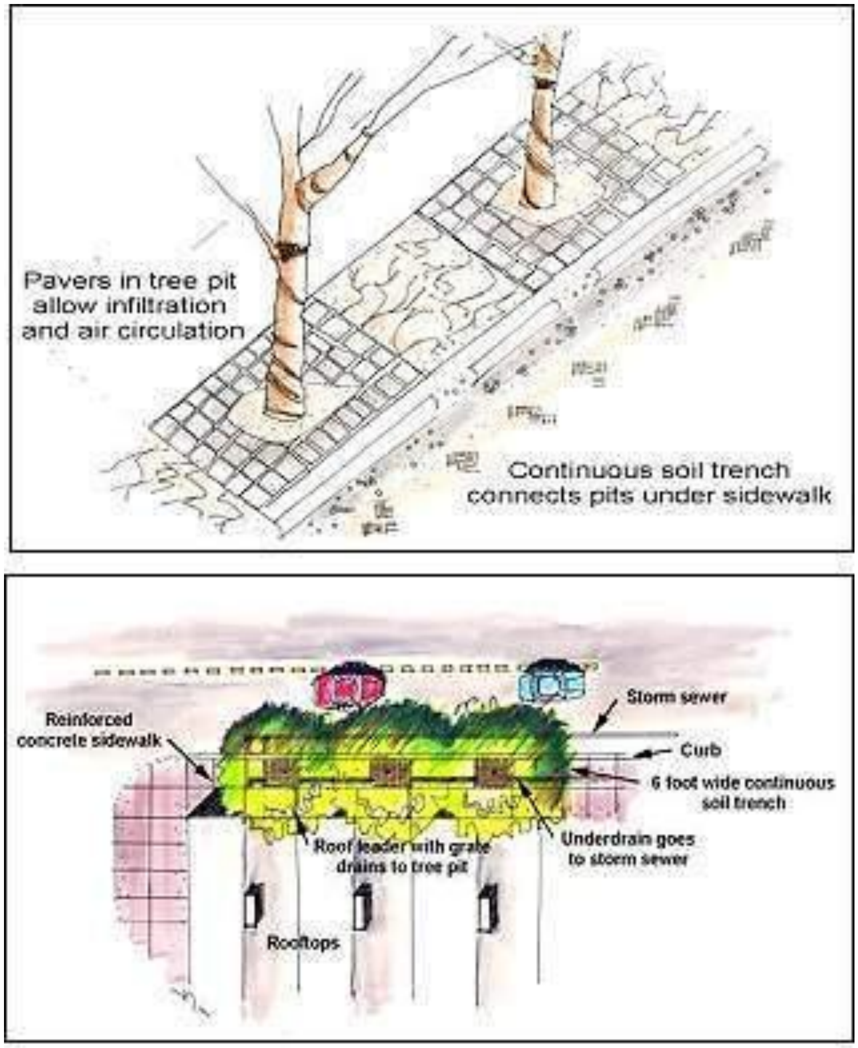


***Figure 9-A.5. Expanded Tree Pit Details***

Portland, Oregon (Portland BES, 2004) has thorough construction details for stormwater curb extensions, expanded tree pits, and utility house connections, available online at http://www.portlandonline.com/bes/index.cfm?c=44213& .

## SECTION 9-A-5: PHYSICAL FEASIBILITY & DESIGN APPLICATIONS

In general, urban bioretention has the same constraints as regular bioretention, along with a few additional constraints as noted below:

***Contributing Drainage Area.*** The drainage areas in these urban settings are typically 100% impervious. Urban bioretention can be considered a micro-bioretention practice (**Table 9-3**) and is therefore limited to 2,500 sq. ft. of drainage area (100% impervious) to each unit when using the minimum soil depth of 18 inches. Larger drainage areas may be allowed with sufficient flow controls and other mechanisms to ensure proper function, safety, and community acceptance; however, the urban bioretention filter must then be designed in accordance with the Level 1 bioretention filter criteria (**Table 9-4**). While multiple units can be installed adjacent to large buildings, parking decks, etc., to maximize the treatment area in ultra-urban watersheds, urban bioretention is not intended to be used as treatment for large impervious areas (such as parking lots) as noted in **Section 9-A-1**.

***Adequate Drainage.*** Urban bioretention practice elevations must allow the untreated stormwater runoff to be discharged at the surface of the filter bed and ultimately connect to the local storm drain system.

***Available Hydraulic Head.*** In general, 3 to 5 feet of elevation difference is needed between the downstream storm drain invert and the inflow point of the urban bioretention practice. This is generally not a constraint, due to the standard depth of most storm drains systems.

***Setbacks from Buildings or Roads.*** If an impermeable liner and an underdrain are used, no setback is needed from the building. Otherwise, the standard 10 foot down-gradient setback applies.

***Proximity to Underground Utilities.*** Urban bioretention practices frequently compete for space with a variety of utilities. Since they are often located parallel to the road right-of-way, care should be taken to provide utility-specific horizontal and vertical setbacks. However, conflicts with water and sewer laterals (e.g., house connections) may be unavoidable, and the construction sequence must be altered, as necessary, to avoid impacts to existing service.

***Overhead Wires.*** Designers should also check whether future tree canopy heights achieved in conjunction with urban bioretention practices will interfere with existing overhead telephone, cable communications and power lines.

***Minimizing External Impacts.*** Because urban bioretention practices are installed in highly urban settings, individual units may be subject to higher public visibility, greater trash loads, pedestrian use traffic, vandalism, and even vehicular loads. Designers should design these practices in ways that prevent, or at least minimize, such impacts. In addition, designers should clearly recognize the need to perform frequent landscaping maintenance to remove trash, check for clogging, and maintain vigorous vegetation. The urban landscape context may feature naturalized landscaping or a more formal deign. When urban bioretention is used in sidewalk areas of high foot traffic, designers should not impede pedestrian movement or create a safety hazard. Designers may also install low fences, grates or other measures to prevent damage from pedestrian short-cutting across the practices.

## SECTION 9-A-6: DESIGN CRITERIA

Urban bioretention practices are similar in function to regular bioretention practices except they are adapted to fit into “containers” within urban landscapes. Therefore, special sizing accommodations are made to allow these practices to fit in very constrained areas where other surface practices may not be feasible.

## 6.1. Sizing of Urban Bioretention

The requirements for sizing an urban bioretention filter are the same as that of bioretention and micro-bioretention described in **Section 6** of the conventional **Bioretention** design specification.

## 6.2 General Design Criteria for Urban Bioretention

Design of urban bioretention should follow the general guidance presented in the main part of this Bioretention design specification. The actual geometric design of urban bioretention is usually dictated by other landscape elements such as buildings, sidewalk widths, utility corridors, retaining walls, etc. Designers can divert fractions of the runoff volume from small impervious surfaces into micro-bioretention units that are integrated with the overall landscape design. Inlets and outlets should be located as far apart as possible. The following is additional design guidance that applies to all variations of urban bioretention:

- Each individual urban bioretention unit should be stenciled or otherwise permanently marked to designate it as a stormwater management facility. The stencil or plaque should indicate (1) its water quality purpose, (2) that it may pond briefly after a storm, and (3) that it is not to be disturbed except for required maintenance.
- The ground surface of the micro-bioretention cell should slope 1% towards the outlet, unless a stormwater planter is used.
- The soil media depth should be a minimum of 18 inches.
- If large trees and shrubs are to be installed, soil media depths should be a minimum of 4 feet.
- All urban bioretention practices should be designed to fully drain within 24 hours.
- Any grates used above urban bioretention areas must be removable to allow maintenance access.
- The inlet(s) to urban bioretention should be stabilized using VDOT #3 stone, splash block, river stone or other acceptable energy dissipation measures. The following forms of inlet stabilization are recommended:
  - Downspouts to stone energy dissipaters.
  - Sheet flow over a depressed curb with a 3-inch drop.
  - Curb cuts allowing runoff into the bioretention area.
  - Covered drains that convey flows across sidewalks from the curb or downspouts.
  - Grates or trench drains that capture runoff from the sidewalk or plaza area.
- Pre-treatment options overlap with those of regular bioretention practices. However, the materials used may be chosen based on their aesthetic qualities in addition to their functional properties. For example, river rock may be used in lieu of rip rap. Other pretreatment options may include one of the following:
  - A trash rack between the pre-treatment cell and the main filter bed. This will allow trash to be collected from one location.
  - A trash rack across curb cuts. While this trash rack may clog occasionally, it keeps trash in the gutter, where it can be picked up by street sweeping equipment.
  - A pre-treatment area above ground or a manhole or grate directly over the pre-treatment area.
- Overflows can either be diverted from entering the bioretention cell or dealt with via an overflow inlet. Optional methods include the following:

- Size curb openings to capture only the $T_v$ and bypass higher flows through the existing gutter.
- Use landscaping type inlets or standpipes with trash guards as overflow devices.
- Use a pre-treatment chamber with a weir design that limits flow to the filter bed area.

## 6.3 Specific Design Issues for Stormwater Planters

Since stormwater planters are often located near building foundations, waterproofing by using a watertight concrete shell or an impermeable liner is required to prevent seepage.

## 6.4 Specific Design Issues for Expanded Tree Pits

- The bottom of the soil layer must be a minimum of 4 inches below the root ball of plants to be installed.
- Extended tree pits designs sometimes cover portions of the filter media with pervious pavers or cantilevered sidewalks. In these situations, it is important that the filter media is connected beneath the surface so that stormwater and tree roots can share this space.
- Installing a tree pit grate over filter bed media is one possible solution to prevent pedestrian traffic and trash accumulation.
- Low, wrought iron fences can help restrict pedestrian traffic across the tree pit bed and serve as a protective barrier if there is a drop-off from the pavement to the micro-bioretention cell.
- A removable grate capable of supporting typical H-20 axel loads may be used to allow the tree to grow through it.
- Each tree needs a minimum of 400 cubic feet of shared root space.

## 6.5 Specific Design Issues for Stormwater Curb Extensions

Roadway stability can be a design issue where stormwater curb extensions are installed. Consult design standards pertaining to roadway drainage. It may be necessary to provide a barrier to keep water from saturating the road’s sub-base and demonstrate it is capable of supporting H-20 axel loads.

## 6.6 Planting and Landscaping Considerations

Plant selection for urban bioretention areas should take into account the extreme conditions of the urban landscape: reduced sunlight due to building shade, heat island effects, safety concerns related to volume of pedestrian traffic and visibility, etc. Also, the degree of landscape maintenance that can be provided will determine some of the planting choices for urban bioretention areas. The planting cells can be formal gardens or naturalized landscapes.

In areas where less maintenance will be provided and where trash accumulation in shrubbery or herbaceous plants is a concern, consider a “turf and trees” landscaping model. Spaces for herbaceous flowering plants can be included. This may be attractive at a community entrance location.

Native trees or shrubs are preferred for urban bioretention areas, although some ornamental species may be used. As with regular bioretention, the selected perennials, shrubs, and trees must be tolerant of salt, drought, and inundation. Additionally, tree species should be those that are known to survive well in the compacted soils and polluted air and water of an urban landscape.

## SECTION 9-A-7: URBAN BIORETENTION MATERIAL SPECIFICATIONS

Please consult the **main part of this design specification** (**Table 9.7**) for the typical materials needed for filter media, stone, mulch and other bioretention features. The unique components for urban bioretention may include the inlet control device, a concrete box or other containing shell, protective grates, and an underdrain that daylights to another stormwater practice or connects to the storm drain system. The underdrain should:

- Consist of slotted pipe greater than or equal to 4 inches in diameter, placed in a layer of washed (less than 1% passing a #200 sieve) VDOT #57 stone.
- Have a minimum of 2 inches of gravel laid above and below the pipe.
- Be laid at a minimum slope of 0.5 %.
- Extend the length of the box filter from one wall to within 6 inches of the opposite wall, and may be either centered in the box or offset to one side.
- Be separated from the soil media by an appropriate filter fabric for the particular application, based on AASHTO M288-06, or a 2 to 3 inch layer of either washed VDOT #8 stone or 1/8- to 3/8-inch pea gravel.

## SECTION 9-A.8: CONSTRUCTION

The construction sequence and inspection requirements for urban bioretention are generally the same as micro-bioretention practices. Consult the construction sequence and inspection guidance provided in **the main part of this design specification**. In cases where urban bioretention is constructed in the road or right-of-way, the construction sequence may need to be adjusted to account for traffic control, pedestrian access and utility notification.

Urban bioretention areas should only be constructed after the drainage area to the facility is completely stabilized. The specified growth media should be placed and spread by hand with minimal compaction, in order to avoid compaction and maintain the porosity of the media. The media should be placed in 8 to 12 inch lifts with no machinery allowed directly on the media during or after construction. The media should be overfilled above the proposed surface elevation, as needed, to allow for natural settling. Lifts may be lightly watered to encourage settling. After the final lift is placed, the media should be raked (to level it), saturated, and allowed to settle for at least one week prior to installation of plant materials.

## SECTION 9-A-9: MAINTENANCE

Routine operation and maintenance are essential to gain public acceptance of highly visible urban bioretention areas. Weeding, pruning, and trash removal should be done as needed to maintain the aesthetics necessary for community acceptance. During drought conditions, it may be necessary to water the plants, as would be necessary for any landscaped area.

To ensure proper performance, inspectors should check that stormwater infiltrates properly into the soil within 24 hours after a storm. If excessive surface ponding is observed, corrective measures include inspection for soil compaction and underdrain clogging. Consult the maintenance guidance outlined in **the main part of this design specification**.

## SECTION 9-A-10: DESIGN REFERENCES

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# APPENDIX 9-B

# ADDITIONAL DETAILS AND SCHEMATICS FOR REGULAR BIORETENTION PRACTICES

**VERSION 2.0**
**January 1, 2013**

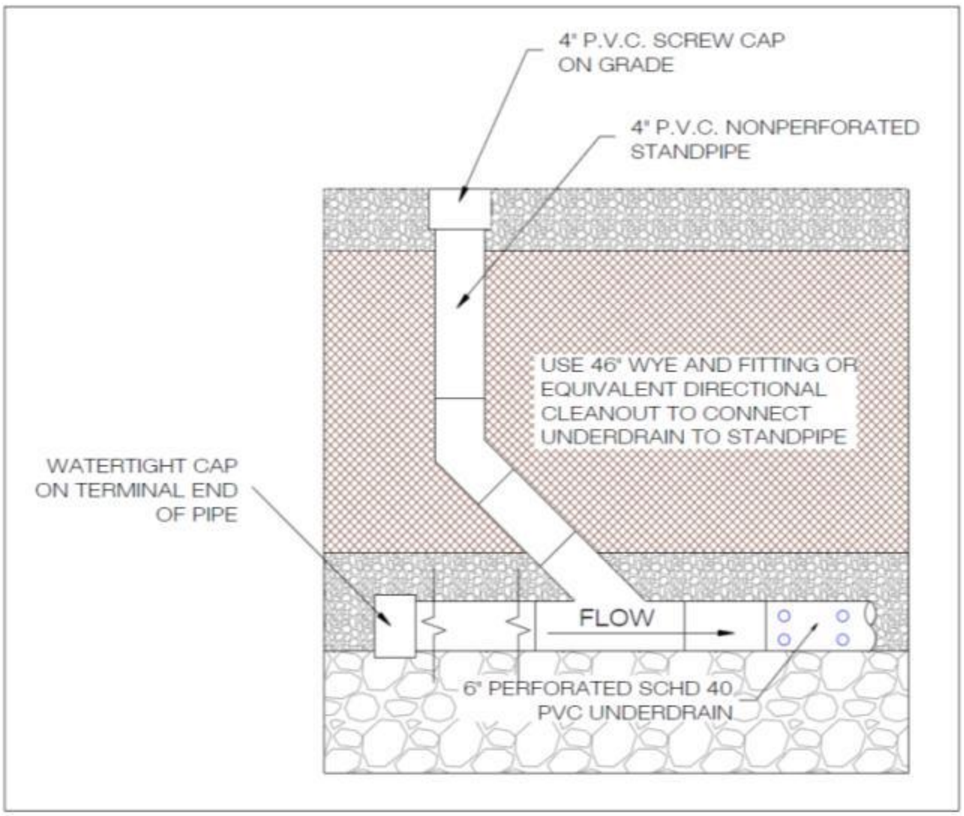
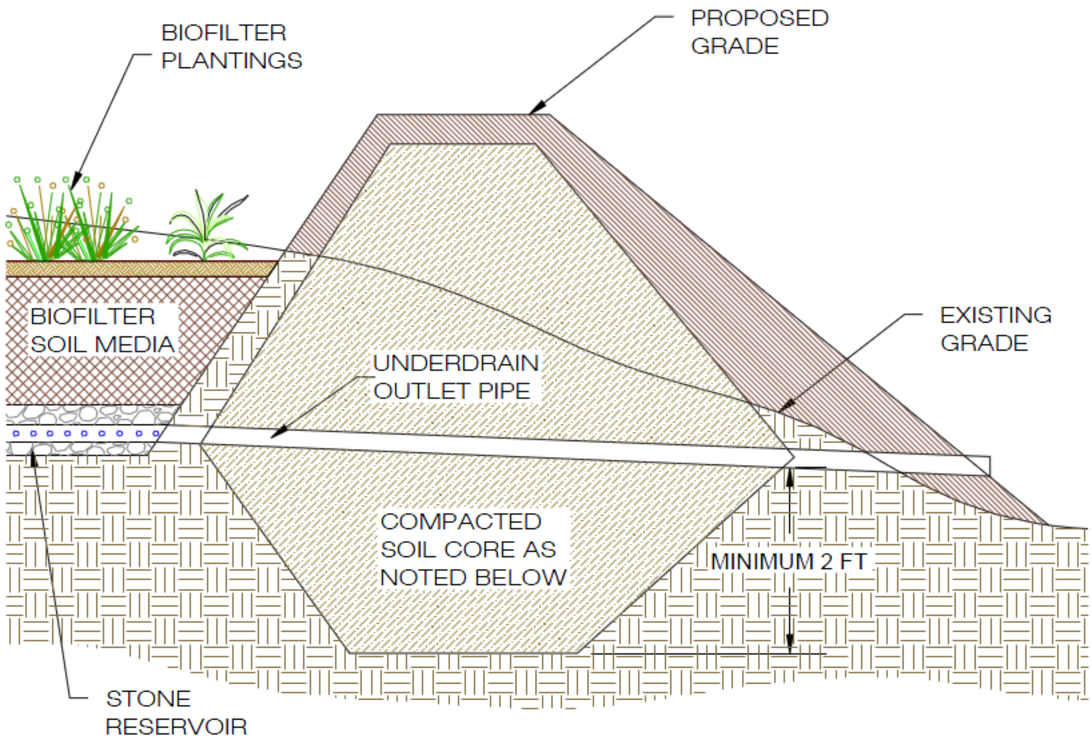



***Figure 9-B.1. 4" P.V.C. Cleanout Detail***




NOTES:

1) STABILIZE BERM AND SPILLWAY WITH EC-3 MATTING.

2) REMAINING DISTURBED SLOPES SHALL BE STABILIZED WITH EC-3 MATTING.

3) ALL BERM FILL MATERIAL SHALL CONSIST OF ML, CL, SC, OR GC SOILS (USCS) OR AS APPROVED BY GEOTECHNICAL ENGINEER TO CREATE AN ACCEPTABLE EMBANKMENT AS APPLICATBLE FOR THE CONDISTIONS. COMPACTED FILL SHALL BE FREE OF WOOD, ROOTS, ROCKS, OR ANY OTHER NON-COMPACTIBLE SOIL. COMPACTED FILL SHALL BE INSTALLED IN MAXIMUM 6-INCH LIFTS TO A DRY DENSITY OF 95% OF THE STANDARD PROCTOR MAXIMUM DRY DENSTIY ASTM D698.

***Figure 9-B.2. Typical Bioretention Basin Berm***