November 1, 2023

Electronic Delivery and FedEx

Wayland Conservation Commission
Wayland Town Hall
41 Cochituate Road
Wayland, MA 01778

Re: Response to Peer Review Comments 3 [LEC File #: CDALLC\22-051.02]
DEP File #: 322-1000 Notice of Intent Application
113-115 Boston Post Road
Assessor's Map 30, Lots 70 and 71
Wayland, Massachusetts

Dear Members of the Conservation Commission:

LEC has prepared this *Response to Peer Review Comments 3* to address the remaining peer review comments included in the September 6, 2023 Peer Review Letter provided by BETA (*BETA Letter 3*). Appendices to this *Response to Peer Review Comments 3* letter include:

- Revised site plans entitled, *Cascade Residential Housing Development* dated November 14, 2022 and revised October 31, 2023, and prepared by C1.0 Engineering, LLC (*Revised Plans 3,* **Appendix A**);
- Revised stormwater report entitled *Post Construction Stormwater Management Report* dated October 31, 2023 and prepared by C1.0 Engineering, LLC (*Revised Stormwater Report,* **Appendix B**);
- *Response to BETA Letter dated September 6, 2023* dated October 31, 2023 and prepared by Geosphere Environmental Management, Inc. (**Appendix C**); and
- *Response to Scott Horsley Letter to Wayland Conservation Commission* dated September 15, 2023 and prepared by Geosphere Environmental Management, Inc. (**Appendix D**).

BETA Group Comments (responses provided by C1.0 Engineering, LLC)

BETA Comment G12. *In accordance with Volume 2, Chapter 2 of the Stormwater Handbook, flow into the proposed infiltration basin will require 44% pretreatment for the infiltration basin to achieve 80% TSS Removal. The exception to this is the roof runoff which can be piped directly into the basin. As proposed, the pretreatment provided for the runoff from Route 20 and the west parking lot is not documented. Provide a description of the measures to be implemented and the design calculations which document that they are adequately sized in accordance with the Handbook.*

C1.0 5/3 Response: Separate Stormceptor units have been added to each of the parking lots and the Route 20 drain has been disconnected. Contech specified a Stormceptor 450i Catch Basin inlet for the west parking lot and a Stormceptor 1515-3-C inline unit for the east parking lot.

BETA 6/5 Comment: *Based upon a report from the EPA, the proprietary separators are approximately 40% effective. (See Attached) BETA has normally allowed these units to be used as pretreatment units which will provide the 44% TSS Removal required prior to the infiltration SCM. This is consistent with the requirements for discharges to Cold Water Fisheries as outlined in Volume 1 Chapter 1, page 20 of the Handbook, which states "For discharges near or to cold-water fisheries, proprietary BMPs may be used for pretreatment only, unless verified for such other uses by STEP or TARP. "Since the STEP and TARP program has been discontinued, It is our opinion that using them exclusively for treatment should be reserved when they are needed to meet the MEP requirement for redevelopment (Standard 7). In this instance also, the design provides no treatment for the roof runoff.*

C1.0 7/11 Response: Sediment forebays have been added to the two parking lot treatment trains. There are now two separate pretreatment systems from the parking lots that include deep sump catch basins to sediment forebays, which provide 44% TSS removal from the respective parking lots prior to draining to the infiltration basin. Both parking lot pretreatment systems drain to the infiltration basin for the total TSS removal efficiency of 89%. The roof drains tie in to the drainage system after the pretreatment systems and drain to the infiltration basin without going through the pretreatment systems. TSS and WQV calculations are provided in Appendix D.

BETA 9/6 Comment: *The design as modified will provide the pretreatment needed for the infiltration basin to achieve the 80% TSS Removal rate. In addition, the design no longer depends upon proprietary separators for pretreatment. However, the total TSS removal rate provided is only 80%. The pretreatment cannot be included in the total removal rate determination.*

C1.0 10/31 Response: The TSS calculation sheets have been adjusted.

BETA Comment G17 (this comment was noted as G18 on previous BETA Peer Review Letters).
There are not enough grades shown on the Grading Sheet (C-1.0) to show that the runoff from the pavement on the east side of the building will be collected by the basins.

C1.0 5/3 Response: Grades have been adjusted and a note has been added that walk and parking lot drain to CB #302.

BETA 6/5 Comment: *The grades as shown are incorrect. The rim elevation for CB 302 is 175.3, which is higher than the grade as shown at elevation 174.5+. Comment remains.*

C1.0 7/11 Response: The elevation has been corrected.

BETA 9/6 Comment: *The proposed rim elevation has been corrected to Elevation 174.30; however, the outlet pipe is a 12" HDPE culvert at invert elevation 173.0. Based upon the elevations, this structure*

cannot be built as shown. Based upon the inverts at DMH 351, it appears that the invert could be dropped to Elevation 172.27 which would provide the cover depth needed for the piping. This should be corrected.

C1.0 10/31 Response: The elevation has been changed to 172.27.

BETA Comment G19 (this comment was noted as G20 on previous BETA Peer Review Letters). *There are no details provided for the proposed infiltration basin embankments. Provide a detail for this structure including crest width, material, gradient of side slopes, surface treatment, spillway design, and general material requirements.*

C1.0 5/3 Response: A detail has been added that illustrates the cross section of the basin embankment and the spillway.

BETA 6/5 Comment: *More dimensional detail is required to define this embankment including crest elevation, crest width, depth and limits of fill removal, replacement material specifications, and bottom material type and depth.*

C1.0 7/11 Response: Additional detail has been added to the plan.

BETA 96/ Response: *The detail does not match the plan view. In addition, the crest width of the embankment is not identified. Ideally, a width of 8' should be provided. Comment Remains.*

C1.0 10/31 Response: The stormwater basin is located immediately adjacent to a parking lot where it can be easily accessed for maintenance. The stormwater basin is relatively shallow, measuring up to two feet deep, which will allows for adequate access by foot or machine for maintenance.

BETA Comment G22. *Based upon the plans, the proposed infiltration basin is located 34.3+ feet from the adjacent wetlands. In accordance with Volume 1, Chapter 2 of the standards, infiltration structures should be a minimum of 50' from waters of the commonwealth. In addition, Item 6 of the Standards espoused in Volume 1, Chapter 1 of the Handbook, states: "Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment" The discussion relative to compliance with this standard should be included in the narrative.*

C1.0 5/3 Response: The retention basin is now located 107 feet from the stream. There are two outlets, one that drains west and one that drains to a newly created swale where the Route 20 drain pipe has been cut back about 110 feet to "daylight" the stream.

BETA 6/5 Comment: *By scale, the toe of the proposed embankment is 57+ feet from the last wetland flag on the abutting lot which is the nearest point to the abutting resource. See comment G12 above relative to the treatment level provided. It should also be noted that the connection of the outlet with the Route 20 Swale would be considered a direct discharge to an ORW. The applicant should expand their explanation of this issue to justify the connection.*

C1.0 7/11 Response: Additional explanation has been added to the Drainage Report narrative. Discharging the now treated Route 20 stormwater run-off directly to Pine Brook is required due to existing site topography. Instead of the existing condition, where untreated Route 20 stormwater discharges directly to Route 20 via a broken drainage pipe, stormwater from Route 20 will be directed to a treatment swale prior to discharge, thereby improving conditions for Pine Brook. The only viable alternative would be to retain the existing condition. The proposed drainage swale connection to Pine Brook will be achieved by excavating the land immediately behind the large stones and boulders that currently comprise the Pine Brook Bank, such that treated stormwater will flow through the spaces between the stones and boulders as it enters Pine Brook and the existing Bank will be preserved. This work will be conducted under the supervision of a qualified Wetland Scientist during construction. A note to this effect has been added to Sheet C1.0 of the Revised Plan Set.

BETA 9/6 Comment: *In accordance with the Volume 1, Chapter 1, page 17, of the handbook, "The long-term pollution prevention strategies for sites near critical areas must also incorporate designs that allow for shutdown and containment where appropriate to isolate the system in the event of an emergency spill or other unexpected event." The outlet configuration should be designed accordingly. As previously noted, this remains a direct discharge to a critical area and a waiver from the standards will be required and should be requested. NEC comments regarding this outfall should also be considered in this request.*

C1.0 10/31 Response: Gate valves have been added to the outlet catch basins CB#304 and new CB# 305 so the basin can be isolated from the discharge points. The outlet pipes are proposed to be constructed of cement lined ductile iron to accommodate a typical mechanically connected gate valve. Regarding a waiver to the regulations, the outlet is an existing discharge point comprised of a degraded reinforced concrete pipe. The new discharge point is to replace the existing discharge point at the same location, by removing the last 75-feet of pipe and converting it to an open, naturalized channel. No new discharge point is being created.

BETA Comment G32. *The assumption that the Tc for EDA 2 is 6.0 minutes is not appropriate. The Tc should be the longest duration travel time not the longest distance.*

C1.0 7/11 Response: The Tc has been calculated in the model.

BETA 9/6 Response: *The initial sheet flow assumption is incorrect. The slope is exaggerated, and the surface conditions are a grassed surface. Comment remains.*

C1.0 10/31 Response: The Tc surface designation is changed from "smooth surface" to "short grass pasture". The differing slopes for the reaches along the Tc line have been verified and adjusted as needed.

BETA Comment G38. *The HYDRO-CAD calculations cannot be used to determine that the infiltration basin has been designed in compliance with Standards 3 & 4. Storage documentation in accordance with Volume 3, Chapter 1 should be provided in the report.*

C1.0 7/11 Response: The calculations for infiltration volume and water quality volume based on the Volume #3 of the Handbook, are provided in Appendix D, these calculations have been revised with the adjustments to the drainage system and associated calculations.

BETA 9/6 Response: *The Water Quality Volume is 1" of runoff from the impervious surfaces, which includes all roof area. The calculation is as follows.*

Total Impervious Area = 43,788 sq. ft.
WQV = 1" = 43,788 (1/12") = 3,649 cu. ft.
Static Volume Provided = 2,688 cu. ft.

The basin does not provide the WQV capacity required by the standards. The following issues with the basin design should also be addressed, which include:

1) *In accordance with Volume 3, Chapter 1, page 28 of the handbook: Mounding analysis is required when the vertical separation from the bottom of an exfiltration system to seasonal high groundwater is less than four (4) feet and the recharge system is proposed to attenuate the peak discharge from a 10-year or higher 24-hour storm (e.g., 10-year, 25-year, 50-year, or 100-year 24-hour storm).*

   C1.0 10/31 Response: The basin shape and outlet controls have been adjusted to provide 3,896 cubic feet of static volume below the outlet.

2) *A mounding analysis was not included in the report.*

   C1.0 10/31 Response: Attachment C contains a Groundwater Mounding Analysis prepared by Geosphere Environmental Management, Inc.

3) *The emergency spillway has been incorporated into the normal discharge from the basin in events as low as a 2-year storm. BETA recommends that the design of the outlet control structure be modified to provide the combined discharge capacity and a true emergency spillway be provided above the 100-year water surface elevation.*

   C1.0 10/31 Response: 3.The intent of the design is to have water flow to two different discharges to balance the water flow. A second outlet control catch basin has been added at the location of the spillway and the spillway has been raised.

4) *The infiltration rate used in the analysis is 1.02 inches/hour. In accordance with the handbook, the design rate based on the C horizon soils would be 2.41 in/hr. BETA recommends that the design analysis be revised to reflect this rate since it may help with the design modification needed to address the above comment.*

   C1.0 10/31 Response: 4.The infiltration rate has been adjusted.

5) *As discussed at the last hearing, the Commission is concerned about temperature issues associated with the discharge from the basin. BETA recommends that the design be modified to*

provide a temperature sink to cool the water prior to discharge. The State of Maine stormwater standards have recommendations for designs which could be implemented to achieve this goal.

C1.0 10/31 Response: Attachment D contains a *Response to Scott Horsley Letter to Wayland Conservation Commission* prepared by Geosphere Environmental Management, Inc., dated September 15, 2023.

6) *The TSS removal calculations are incorrect. The pretreatment is required for the infiltration basin to achieve the 80% Removal Rate quoted. Therefore, the pretreatment rate cannot be used in determining the total TSS removal provided by the train. The actual Removal rate provide is only 80%, not the 89% reported. The sheets should be corrected.*

   C1.0 10/31 Response: The TSS calculation sheets have been revised to only include the infiltration basins which as designed includes the Deep Sump Catch basins and the Sediment Forebays as pretreatment.

7) *Provide the sizing requirements for the sediment forebay and document that they provide the volume required in accordance with the handbook.*

   C1.0 10/31 Response: 7.The sediment forebay size requirements are provided in Appendix D of the *Revised Stormwater Report.*

Thank you for considering this *Response to Peer Review Comments 3* to address the remaining BETA peer review comments. We look forward to meeting with the Commission and discussing these comments at the November 8, 2023 Public Hearing. Should you have any questions, please do not hesitate to contact me in our Wakefield office at 781-245-2500 or at rkirby@lecenvironmental.com.

Sincerely,

LEC Environmental Consultants, Inc.

Richard A. Kirby
Senior Wetland Scientist

cc: DEP, Northeast Region
Cascade Development Associates, LLC
Paul Haverty, Attorney
C1.0 Engineering & Development

rak: projects\22-051.02\Peer Review\Response to Peer Review Comments 7-11-2023.doc

Appendix A

Cascade Residential Housing Development,
dated November 14, 2022 and revised October 31, 2023,
prepared by C1.0 Engineering, LLC

CASCADE RESIDENTIAL HOUSING DEVELOPMENT

BOSTON POST ROAD
WAYLAND, MASSACHUSETTS

MIDDLESEX COUNTY

Owner:

Cascade Development Associates, LLC

831 Beacon Street, Suite #268
Newton Center, MA 02459
T: 617-213-0432

Contact: Zachary Deese-Laurent

Legal Counsel:

Blatman, Bobrowski, Haverty & Silverstein, LLC

9 Damonmill Square, Suite 4A4
Concord, MA 01742
T: 978-371-2226
F: 978-371-2296

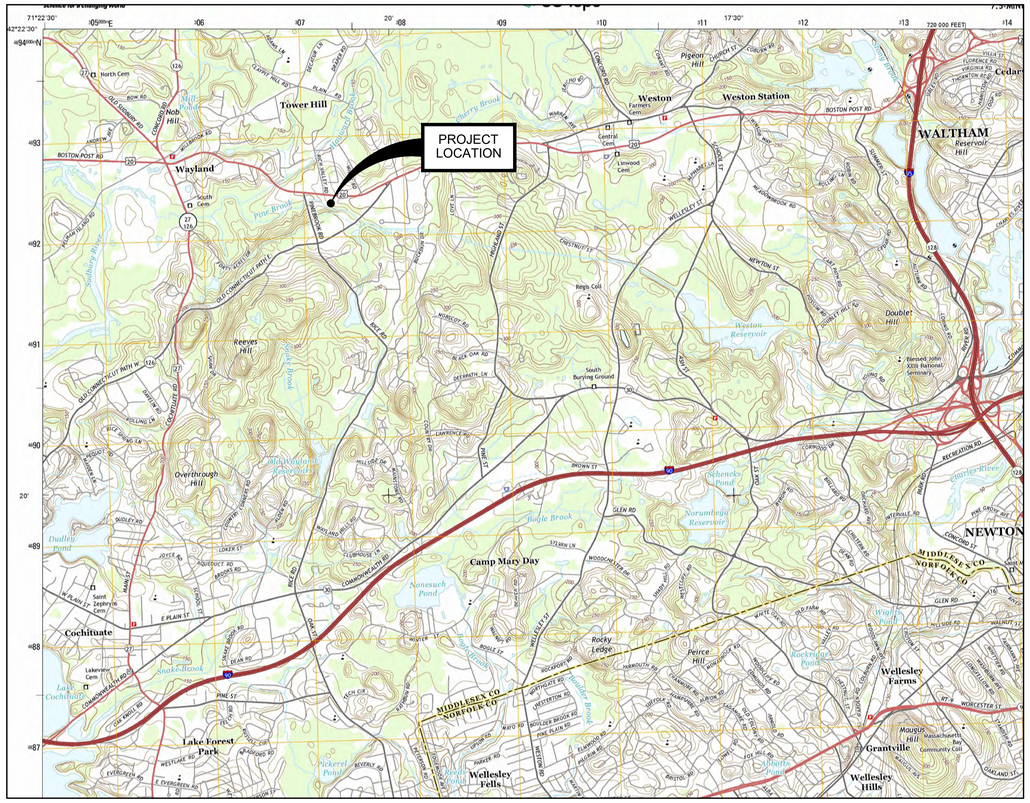
Contact: Paul J. Haverty

Environmental Consultant:

LEC Environmental Consultants, Inc.

100 Grove Street, Suite 302
Worcester, MA 01605
T: 508-753-3077
F: 508-753-3177
www.lecenvironmental.com

Contact: Richard A. Kirby



LOCUS MAP

NOVEMBER 14, 2022
REVISED OCTOBER 31, 2023

PRELIMINARY

NOT FOR CONSTRUCTION

THESE PLANS WERE PREPARED FOR THE PURPOSE OF OBTAINING STATE AND LOCAL APPROVALS AND ARE NOT INTENDED TO BE USED AS CONSTRUCTION DOCUMENTS.

Land Surveyors:

Beals and Thomas, Inc.

144 Turnpike Road, Suite 210
Southborough, Massachusetts 01772
T: 508-366-0560
F: 508-366-4391

Contact:

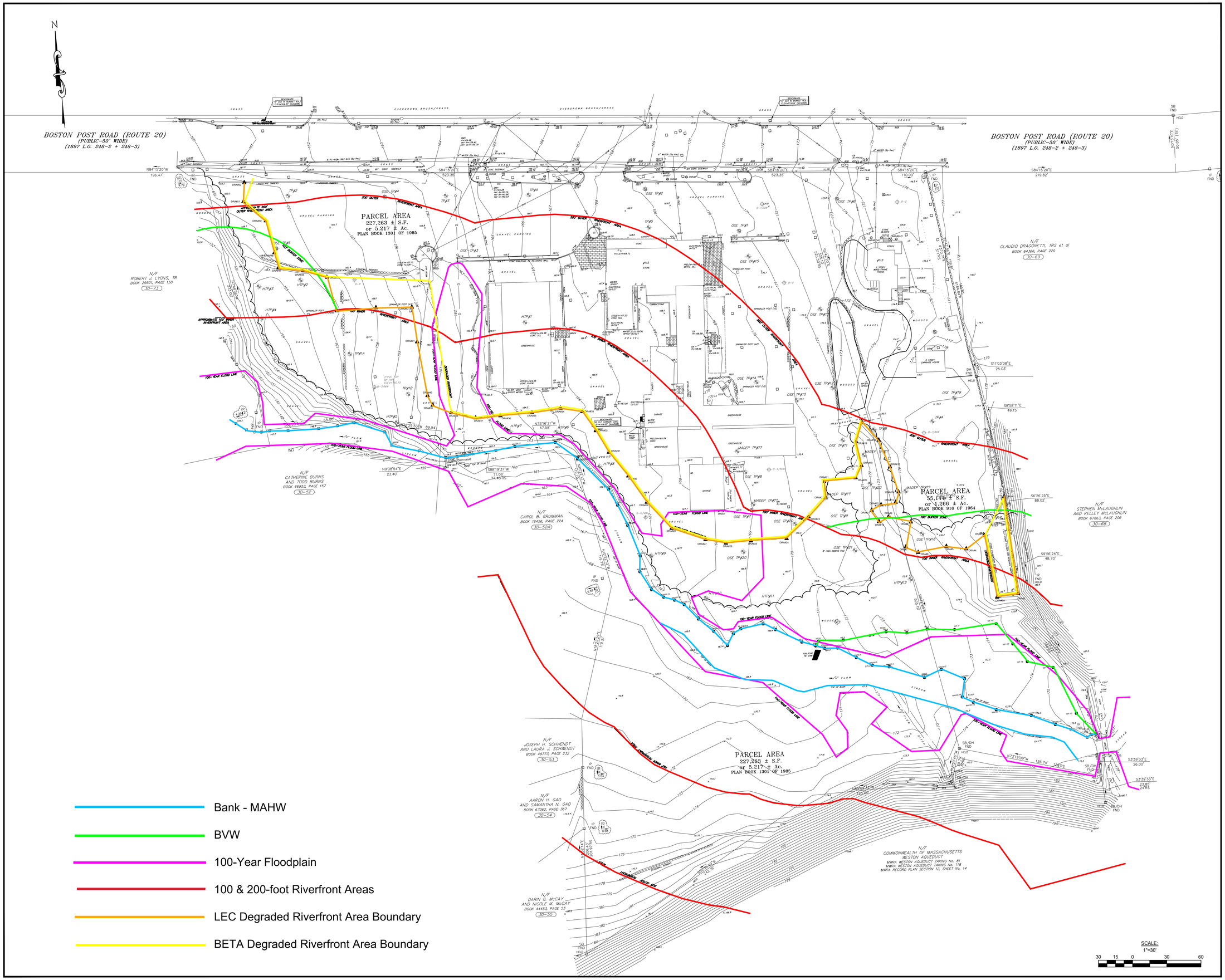
Civil Engineers:

C1.0 Egineering, LLC

14 Spring Street
Waltham, Massachusetts 02453
T: (781) 850-2731

Contact: William Doyle, PE

Drawing List:



Bank - MAHW

BVW

100-Year Floodplain

100 & 200-foot Riverfront Areas

LEC Degraded Riverfront Area Boundary

BETA Degraded Riverfront Area Boundary

C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-18
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

COMMONWEALTH OF MASSACHUSETTS
WILLIAM A. DOYLE
CIVIL
NO. 41810
REGISTERED PROFESSIONAL ENGINEER

Key Plan

Project Title:

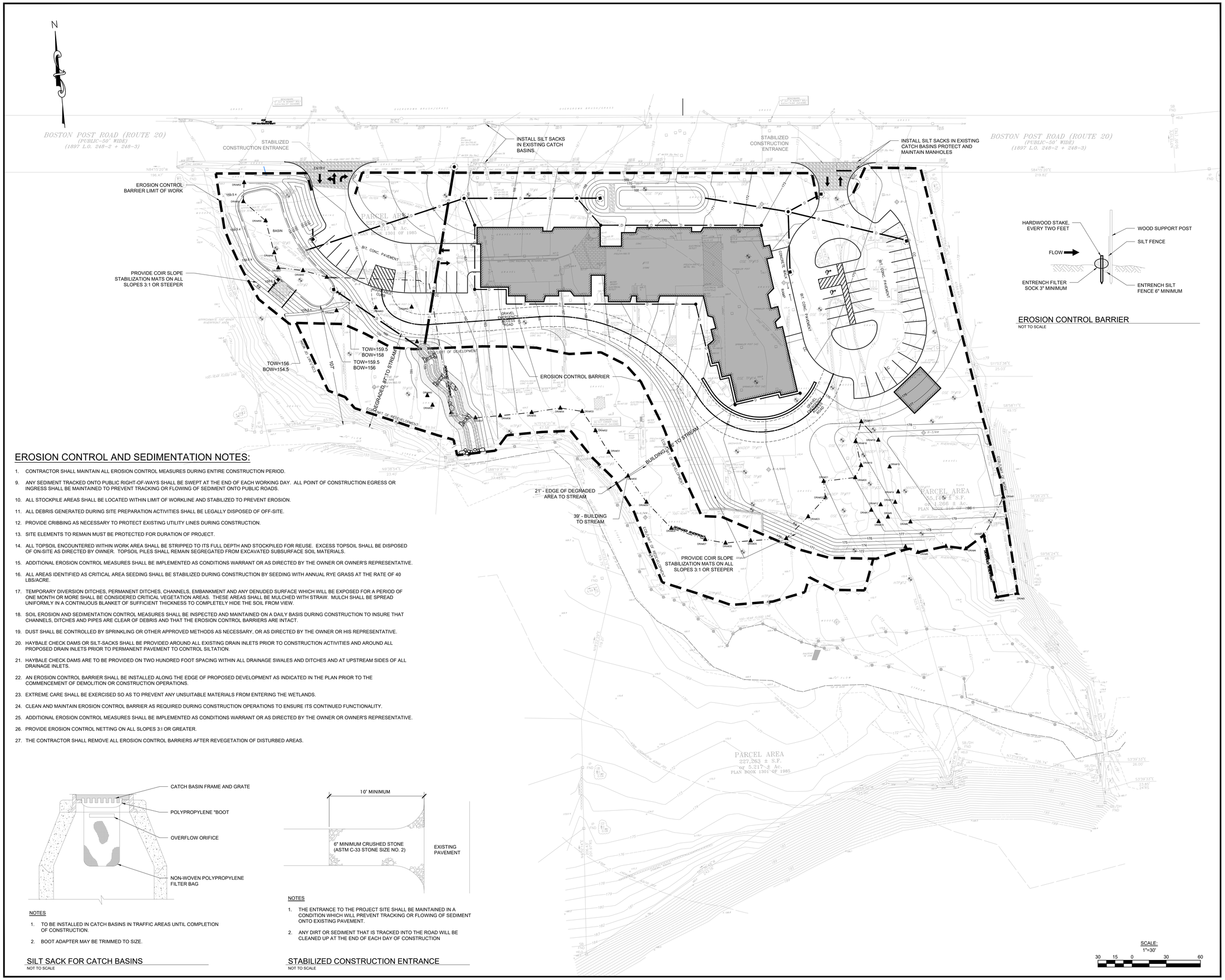
CASCADE WAYLAND
NOTICE OF INTENT

Drawing Title:

EXISTING CONDITIONS
PLAN

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No. EX1.0



EROSION CONTROL BARRIER
NOT TO SCALE

EROSION CONTROL AND SEDIMENTATION NOTES:

1. CONTRACTOR SHALL MAINTAIN ALL EROSION CONTROL MEASURES DURING ENTIRE CONSTRUCTION PERIOD.
9. ANY SEDIMENT TRACKED ONTO PUBLIC RIGHT-OF-WAYS SHALL BE SWEPT AT THE END OF EACH WORKING DAY. ALL POINT OF CONSTRUCTION EGRESS OR INGRESS SHALL BE MAINTAINED TO PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO PUBLIC ROADS.
10. ALL STOCKPILE AREAS SHALL BE LOCATED WITHIN LIMIT OF WORKLINE AND STABILIZED TO PREVENT EROSION.
11. ALL DEBRIS GENERATED DURING SITE PREPARATION ACTIVITIES SHALL BE LEGALLY DISPOSED OF OFF-SITE.
12. PROVIDE CRIBBING AS NECESSARY TO PROTECT EXISTING UTILITY LINES DURING CONSTRUCTION.
13. SITE ELEMENTS TO REMAIN MUST BE PROTECTED FOR DURATION OF PROJECT.
14. ALL TOPSOIL ENCOUNTERED WITHIN WORK AREA SHALL BE STRIPPED TO ITS FULL DEPTH AND STOCKPILED FOR REUSE. EXCESS TOPSOIL SHALL BE DISPOSED OF ON-SITE AS DIRECTED BY OWNER. TOPSOIL PILES SHALL REMAIN SEGREGATED FROM EXCAVATED SUBSURFACE SOIL MATERIALS.
15. ADDITIONAL EROSION CONTROL MEASURES SHALL BE IMPLEMENTED AS CONDITIONS WARRANT OR AS DIRECTED BY THE OWNER OR OWNER'S REPRESENTATIVE.
16. ALL AREAS IDENTIFIED AS CRITICAL AREA SEEDING SHALL BE STABILIZED DURING CONSTRUCTION BY SEEDING WITH ANNUAL RYE GRASS AT THE RATE OF 40 LBS/ACRE.
17. TEMPORARY DIVERSION DITCHES, PERMANENT DITCHES, CHANNELS, EMBANKMENT AND ANY DENUDED SURFACE WHICH WILL BE EXPOSED FOR A PERIOD OF ONE MONTH OR MORE SHALL BE CONSIDERED CRITICAL VEGETATION AREAS. THESE AREAS SHALL BE MULCHED WITH STRAW. MULCH SHALL BE SPREAD UNIFORMLY IN A CONTINUOUS BLANKET OF SUFFICIENT THICKNESS TO COMPLETELY HIDE THE SOIL FROM VIEW.
18. SOIL EROSION AND SEDIMENTATION CONTROL MEASURES SHALL BE INSPECTED AND MAINTAINED ON A DAILY BASIS DURING CONSTRUCTION TO INSURE THAT CHANNELS, DITCHES AND PIPES ARE CLEAR OF DEBRIS AND THAT THE EROSION CONTROL BARRIERS ARE INTACT.
19. DUST SHALL BE CONTROLLED BY SPRINKLING OR OTHER APPROVED METHODS AS NECESSARY, OR AS DIRECTED BY THE OWNER OR HIS REPRESENTATIVE.
20. HAYBALE CHECK DAMS OR SILT-SACKS SHALL BE PROVIDED AROUND ALL EXISTING DRAIN INLETS PRIOR TO CONSTRUCTION ACTIVITIES AND AROUND ALL PROPOSED DRAIN INLETS PRIOR TO PERMANENT PAVEMENT TO CONTROL SILTATION.
21. HAYBALE CHECK DAMS ARE TO BE PROVIDED ON TWO HUNDRED FOOT SPACING WITHIN ALL DRAINAGE SWALES AND DITCHES AND AT UPSTREAM SIDES OF ALL DRAINAGE INLETS.
22. AN EROSION CONTROL BARRIER SHALL BE INSTALLED ALONG THE EDGE OF PROPOSED DEVELOPMENT AS INDICATED IN THE PLAN PRIOR TO THE COMMENCEMENT OF DEMOLITION OR CONSTRUCTION OPERATIONS.
23. EXTREME CARE SHALL BE EXERCISED SO AS TO PREVENT ANY UNSUITABLE MATERIALS FROM ENTERING THE WETLANDS.
24. CLEAN AND MAINTAIN EROSION CONTROL BARRIER AS REQUIRED DURING CONSTRUCTION OPERATIONS TO ENSURE ITS CONTINUED FUNCTIONALITY.
25. ADDITIONAL EROSION CONTROL MEASURES SHALL BE IMPLEMENTED AS CONDITIONS WARRANT OR AS DIRECTED BY THE OWNER OR OWNER'S REPRESENTATIVE.
26. PROVIDE EROSION CONTROL NETTING ON ALL SLOPES 3:1 OR GREATER.
27. THE CONTRACTOR SHALL REMOVE ALL EROSION CONTROL BARRIERS AFTER REVEGETATION OF DISTURBED AREAS.

NOTES

1. TO BE INSTALLED IN CATCH BASINS IN TRAFFIC AREAS UNTIL COMPLETION OF CONSTRUCTION.
2. BOOT ADAPTER MAY BE TRIMMED TO SIZE.

SILT SACK FOR CATCH BASINS
NOT TO SCALE

NOTES

1. THE ENTRANCE TO THE PROJECT SITE SHALL BE MAINTAINED IN A CONDITION WHICH WILL PREVENT TRACKING OR FLOWING OF SEDIMENT ONTO EXISTING PAVEMENT.
2. ANY DIRT OR SEDIMENT THAT IS TRACKED INTO THE ROAD WILL BE CLEANED UP AT THE END OF EACH DAY OF CONSTRUCTION

STABILIZED CONSTRUCTION ENTRANCE
NOT TO SCALE

C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

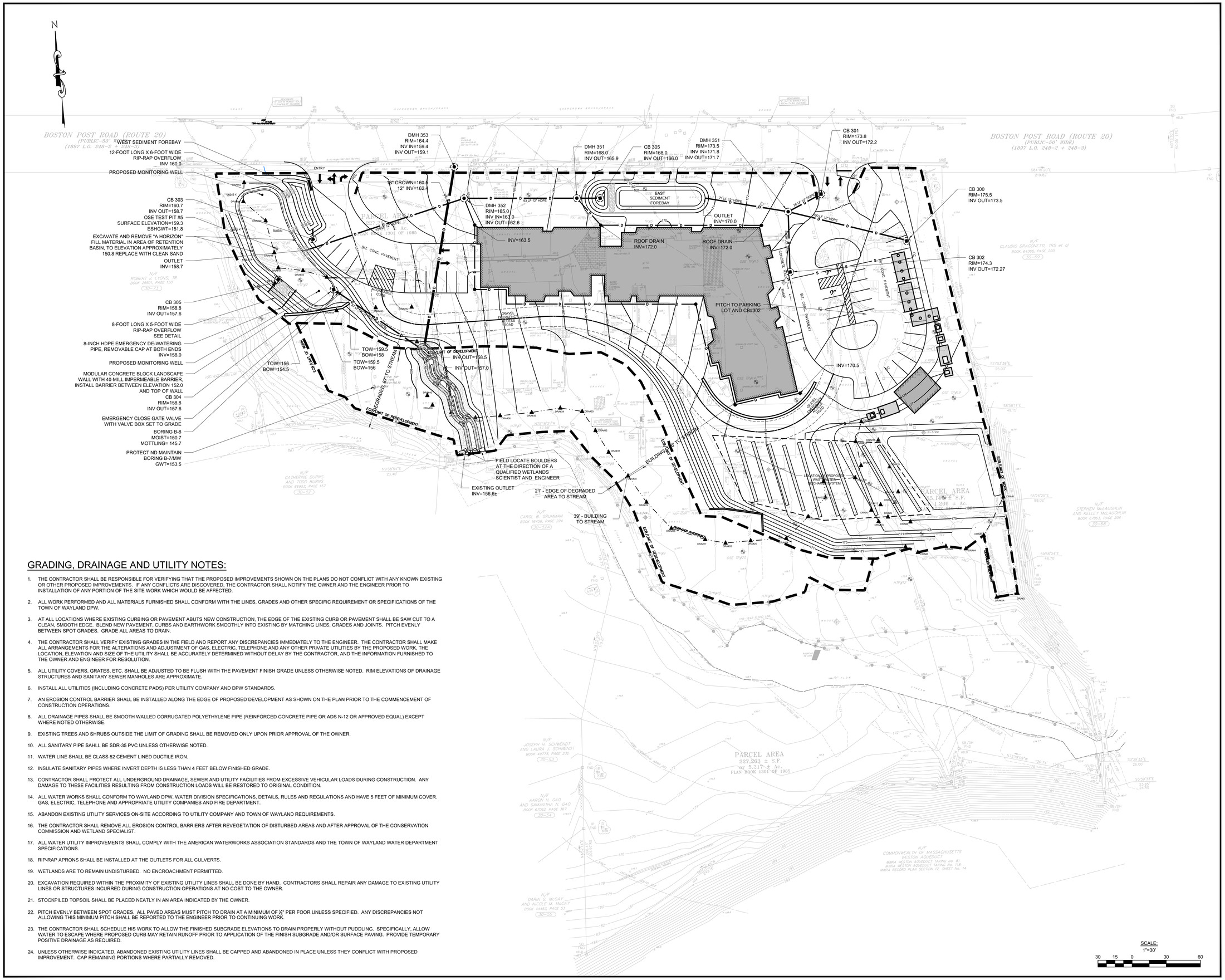
CASCADE WAYLAND
NOTICE OF INTENT

Drawing Title:

EROSION CONTROL PLAN

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No. C0.0



GRADING, DRAINAGE AND UTILITY NOTES:

1. THE CONTRACTOR SHALL BE RESPONSIBLE FOR VERIFYING THAT THE PROPOSED IMPROVEMENTS SHOWN ON THE PLANS DO NOT CONFLICT WITH ANY KNOWN EXISTING OR OTHER PROPOSED IMPROVEMENTS. IF ANY CONFLICTS ARE DISCOVERED, THE CONTRACTOR SHALL NOTIFY THE OWNER AND THE ENGINEER PRIOR TO INSTALLATION OF ANY PORTION OF THE SITE WORK WHICH WOULD BE AFFECTED.
2. ALL WORK PERFORMED AND ALL MATERIALS FURNISHED SHALL CONFORM WITH THE LINES, GRADES AND OTHER SPECIFIC REQUIREMENT OR SPECIFICATIONS OF THE TOWN OF WAYLAND DPW.
3. AT ALL LOCATIONS WHERE EXISTING CURBING OR PAVEMENT ABUTS NEW CONSTRUCTION, THE EDGE OF THE EXISTING CURB OR PAVEMENT SHALL BE SAW CUT TO A CLEAN, SMOOTH EDGE. BLEND NEW PAVEMENT, CURBS AND EARTHWORK SMOOTHLY INTO EXISTING BY MATCHING LINES, GRADES AND JOINTS. PITCH EVENLY BETWEEN SPOT GRADES. GRADE ALL AREAS TO DRAIN.
4. THE CONTRACTOR SHALL VERIFY EXISTING GRADES IN THE FIELD AND REPORT ANY DISCREPANCIES IMMEDIATELY TO THE ENGINEER. THE CONTRACTOR SHALL MAKE ALL ARRANGEMENTS FOR THE ALTERATIONS AND ADJUSTMENT OF GAS, ELECTRIC, TELEPHONE AND ANY OTHER PRIVATE UTILITIES BY THE PROPOSED WORK. THE LOCATION, ELEVATION AND SIZE OF THE UTILITY SHALL BE ACCURATELY DETERMINED WITHOUT DELAY BY THE CONTRACTOR, AND THE INFORMATION FURNISHED TO THE OWNER AND ENGINEER FOR RESOLUTION.
5. ALL UTILITY COVERS, GRATES, ETC. SHALL BE ADJUSTED TO BE FLUSH WITH THE PAVEMENT FINISH GRADE UNLESS OTHERWISE NOTED. RIM ELEVATIONS OF DRAINAGE STRUCTURES AND SANITARY SEWER MANHOLES ARE APPROXIMATE.
6. INSTALL ALL UTILITIES (INCLUDING CONCRETE PADS) PER UTILITY COMPANY AND DPW STANDARDS.
7. AN EROSION CONTROL BARRIER SHALL BE INSTALLED ALONG THE EDGE OF PROPOSED DEVELOPMENT AS SHOWN ON THE PLAN PRIOR TO THE COMMENCEMENT OF CONSTRUCTION OPERATIONS.
8. ALL DRAINAGE PIPES SHALL BE SMOOTH WALLED CORRUGATED POLYETHYLENE PIPE (REINFORCED CONCRETE PIPE OR ADS N-12 OR APPROVED EQUAL) EXCEPT WHERE NOTED OTHERWISE.
9. EXISTING TREES AND SHRUBS OUTSIDE THE LIMIT OF GRADING SHALL BE REMOVED ONLY UPON PRIOR APPROVAL OF THE OWNER.
10. ALL SANITARY PIPE SAHLL BE SDR-35 PVC UNLESS OTHERWISE NOTED.
11. WATER LINE SHALL BE CLASS 52 CEMENT LINED DUCTILE IRON.
12. INSULATE SANITARY PIPES WHERE INVERT DEPTH IS LESS THAN 4 FEET BELOW FINISHED GRADE.
13. CONTRACTOR SHALL PROTECT ALL UNDERGROUND DRAINAGE, SEWER AND UTILITY FACILITIES FROM EXCESSIVE VEHICULAR LOADS DURING CONSTRUCTION. ANY DAMAGE TO THESE FACILITIES RESULTING FROM CONSTRUCTION LOADS WILL BE RESTORED TO ORIGINAL CONDITION.
14. ALL WATER WORKS SHALL CONFORM TO WAYLAND DPW, WATER DIVISION SPECIFICATIONS, DETAILS, RULES AND REGULATIONS AND HAVE 5 FEET OF MINIMUM COVER. GAS, ELECTRIC, TELEPHONE AND APPROPRIATE UTILITY COMPANIES AND FIRE DEPARTMENT.
15. ABANDON EXISTING UTILITY SERVICES ON-SITE ACCORDING TO UTILITY COMPANY AND TOWN OF WAYLAND REQUIREMENTS.
16. THE CONTRACTOR SHALL REMOVE ALL EROSION CONTROL BARRIERS AFTER REVEGETATION OF DISTURBED AREAS AND AFTER APPROVAL OF THE CONSERVATION COMMISSION AND WETLAND SPECIALIST.
17. ALL WATER UTILITY IMPROVEMENTS SHALL COMPLY WITH THE AMERICAN WATERWORKS ASSOCIATION STANDARDS AND THE TOWN OF WAYLAND WATER DEPARTMENT SPECIFICATIONS.
18. RIP-RAP APRONS SHALL BE INSTALLED AT THE OUTLETS FOR ALL CULVERTS.
19. WETLANDS ARE TO REMAIN UNDISTURBED. NO ENCROACHMENT PERMITTED.
20. EXCAVATION REQUIRED WITHIN THE PROXIMITY OF EXISTING UTILITY LINES SHALL BE DONE BY HAND. CONTRACTORS SHALL REPAIR ANY DAMAGE TO EXISTING UTILITY LINES OR STRUCTURES INCURRED DURING CONSTRUCTION OPERATIONS AT NO COST TO THE OWNER.
21. STOCKPILED TOPSOIL SHALL BE PLACED NEATLY IN AN AREA INDICATED BY THE OWNER.
22. PITCH EVENLY BETWEEN SPOT GRADES. ALL PAVED AREAS MUST PITCH TO DRAIN AT A MINIMUM OF ¼" PER FOOR UNLESS SPECIFIED. ANY DISCREPANCIES NOT ALLOWING THIS MINIMUM PITCH SHALL BE REPORTED TO THE ENGINEER PRIOR TO CONTINUING WORK.
23. THE CONTRACTOR SHALL SCHEDULE HIS WORK TO ALLOW THE FINISHED SUBGRADE ELEVATIONS TO DRAIN PROPERLY WITHOUT PUDDLING. SPECIFICALLY, ALLOW WATER TO ESCAPE WHERE PROPOSED CURB MAY RETAIN RUNOFF PRIOR TO APPLICATION OF THE FINISH SUBGRADE AND/OR SURFACE PAVING. PROVIDE TEMPORARY POSITIVE DRAINAGE AS REQUIRED.
24. UNLESS OTHERWISE INDICATED, ABANDONED EXISTING UTILITY LINES SHALL BE CAPPED AND ABANDONED IN PLACE UNLESS THEY CONFLICT WITH PROPOSED IMPROVEMENT. CAP REMAINING PORTIONS WHERE PARTIALLY REMOVED.

C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

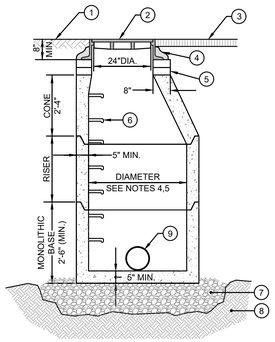
CASCADE WAYLAND NOTICE OF INTENT

Drawing Title:

GRADING DRAINAGE AND UTILITY PLAN

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

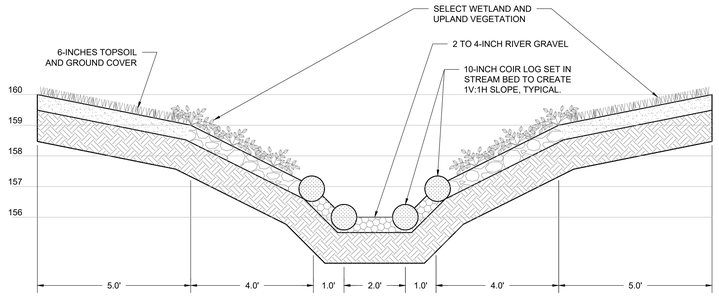
Drawing No. C1.0



1. UNPAVED SURFACE
2. HEAVY DUTY CAST IRON MANHOLE FRAME & COVER, TYPE 'B', TO BE SET IN FULL BED OF MORTAR WITH 24" DIA. CLEAR OPENING
3. PAVED SURFACE
4. FRAME TO BE SET IN FULL BED OF MORTAR
5. ADJUST TO GRADE WITH BRICK OR PRECAST CONCRETE RINGS: MAX. 8" ADJUSTMENT
6. MANHOLE STEP @ 12" O.C. (TYP)
7. 12" COMPACTED GRAVEL BORROW
8. UNDISTURBED SUBGRADE
9. MORTAR PIPE JOINTS

NOTES:
1. PRECAST CONCRETE STRUCTURES AND CASTINGS SHALL BE SUITABLE FOR HS20 LOADINGS.
2. PRECAST CONCRETE STRUCTURES SHALL BE MANUFACTURED IN ACCORDANCE WITH ASTM-C-478.
3. ALTERNATE SLAB TOP MAY BE USED AS DICTATED BY DESIGN AND/OR FIELD CONDITIONS.
4. UNLESS OTHERWISE NOTED, MANHOLES SHALL BE 48" I.D.
5. SPECIAL MANHOLES SHALL BE 72" I.D.

PRECAST CONCRETE DRAIN MANHOLE
NOT TO SCALE

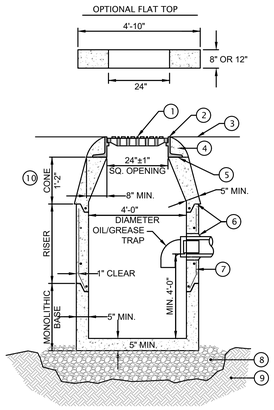


$$D_{50} = \frac{V^2}{2(G)\,C\,(S-1)} = \frac{(4.17\ F/S)^2}{2(32.2)\ 1.2\ (2.75-1)} = 0.129' = 1.6"$$

D_{50} = MEDIAN STONE DIAMETER
G = GRAVITY 32.2 FT/S^2
C = 0.86 TURBULENT OR 1.20 LAMINAR
S = 2.50 TO 3.00 SPECIFIC GRAVITY OF STONE
V = VELOCITY 4.17 F/S FROM HYDROCAD 100YR STORM

STONE SIZE SHALL BE MINIMUM 3-INCHES, PROVIDE 3 TO 6-INCH RIP-RAP AT INVERT OF CHANNEL

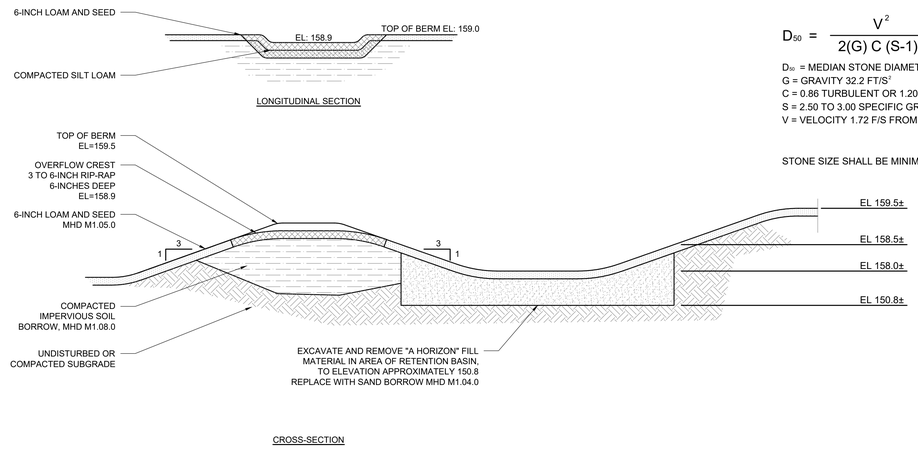
SWALE SECTION
NOT TO SCALE



1. FRAME AND GRATE, DOUBLE OR SINGLE
2. FRAME TO BE SET IN FULL BED OF MORTAR
3. PAVED SURFACE
4. STIFF MORTAR
5. ADJUST TO GRADE WITH BRICK OR PRECAST CONCRETE RINGS: MAX. 8" ADJUSTMENT
6. MORTAR PIPE JOINTS
7. MIN. 0.12 SQ. IN. STEEL PER VERTICAL FOOT, PLACED ACCORDING TO ASTM C-478
8. 12" COMPACTED GRAVEL BORROW
9. UNDISTURBED SUBGRADE OR SUITABLE COMPACTED BACKFILL IN ACCORDANCE WITH THE SPECIFICATIONS
10. FLAT TOP MAY BE REQUIRED WHERE SHALLOW PIPE COVER IS ENCOUNTERED.

NOTES:
1. PRECAST CONCRETE STRUCTURES AND CASTINGS SHALL BE SUITABLE FOR HS20LOADINGS.
2. PRECAST CONCRETE STRUCTURES SHALL BE MANUFACTURED IN ACCORDANCE WITH ASTM-C-478.
3. ALTERNATE SLAB TOP MAY BE USED AS DICTATED BY DESIGN AND/OR FIELD CONDITIONS.
4. UNLESS OTHERWISE NOTED, CATCH BASINS SHALL BE 48" I.D.
5. CATCH BASIN GRATES SHALL BE LEBARON LF248-2 OR EQUIVALENT CAST IRON, WITH A MAXIMUM OPENING SIZE OF 2-1/4".

PRECAST CONCRETE CATCH BASIN WITH TRAP
NOT TO SCALE

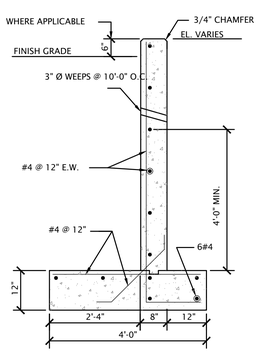


$$D_{50} = \frac{V^2}{2(G)\,C\,(S-1)} = \frac{(1.72\ F/S)^2}{2(32.2)\ 1.2\ (2.75-1)} = 0.022' = 0.25"$$

D_{50} = MEDIAN STONE DIAMETER
G = GRAVITY 32.2 FT/S^2
C = 0.86 TURBULENT OR 1.20 LAMINAR
S = 2.50 TO 3.00 SPECIFIC GRAVITY OF STONE
V = VELOCITY 1.72 F/S FROM HYDROCAD 100YR STORM

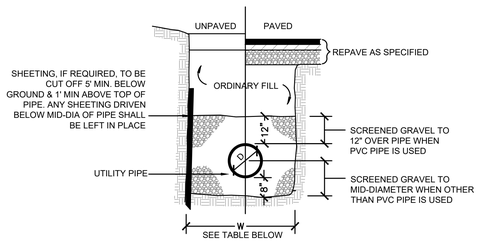
STONE SIZE SHALL BE MINIMUM 2-INCHES, PROVIDE 2 TO 4-INCH RIP-RAP AT CREST OF SPILLWAY

OVERFLOW BERM AND BASIN CROSS SECTION
NOT TO SCALE



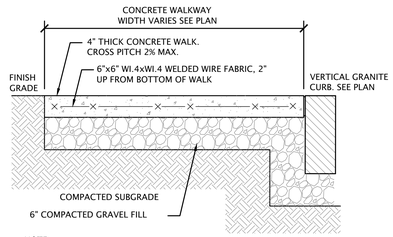
STAMPED PLANS OF THE FINAL WALL DESIGN SHALL BE SUBMITTED BY THE CONTRACTOR

TYPICAL RETAINING WALL DETAIL
NOT TO SCALE



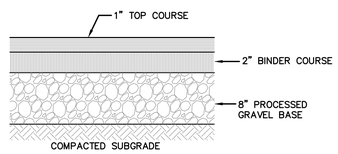
TRENCH WIDTH (W)		
D DIAMETER OF PIPE	W UNSHEETED	W SHEETED
TO 12"	3'	4'
14" TO 24"	4'	5'
30" TO 36"	5'	6'

TYPICAL PIPE TRENCH SECTION
NOT TO SCALE



NOTE:
1. SIDEWALK SURFACE SHALL BE BROOM FINISHED.
2. MUNICIPAL SIDEWALKS SHALL BE CONSTRUCTED WITH FIBERMESH CONCRETE WITH NO WELDED WIRE FABRIC.

CONCRETE WALK
NOT TO SCALE



BITUMINOUS CONCRETE PAVEMENT
NOT TO SCALE

C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

CASCADE WAYLAND
NOTICE OF INTENT

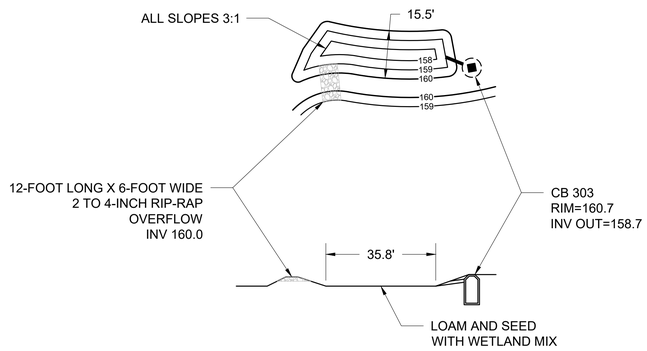
Drawing Title:

DETAILS

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

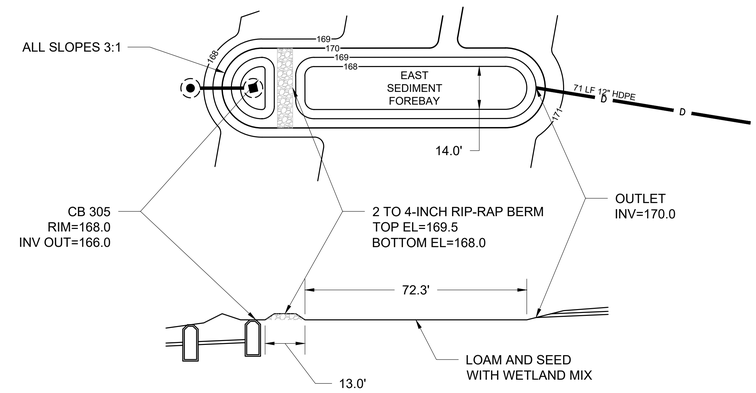
Drawing No.

C1.1



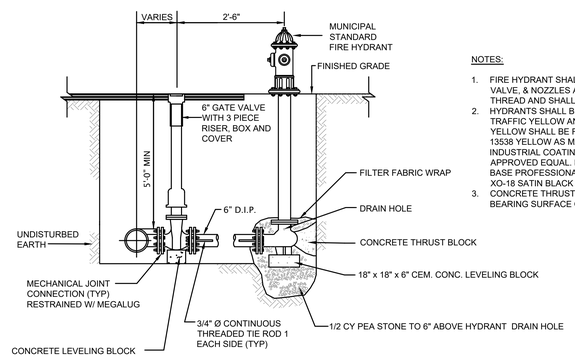
WEST SEDIMENT FOREBAY

NOT TO SCALE



EAST SEDIMENT FOREBAY

NOT TO SCALE

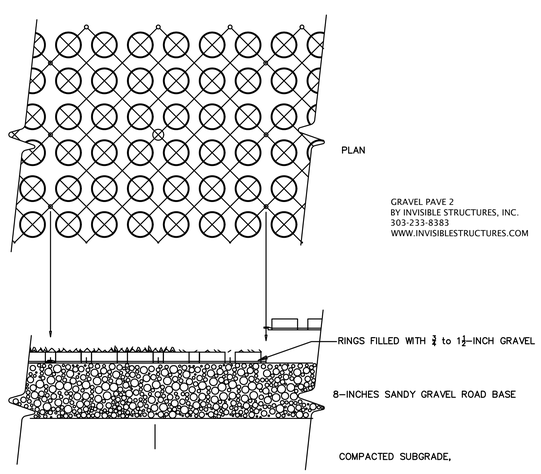


NOTES:

1. FIRE HYDRANT SHALL HAVE M.J. SHOE, 5-1/4" MAIN VALVE, & NOZZLES AND (1) 4-1/2" NATIONAL STANDARD THREAD AND SHALL OPEN LEFT.
2. HYDRANTS SHALL BE PAINTED WITH TWO COATS OF TRAFFIC YELLOW AND BLACK PER CITY STANDARD. YELLOW SHALL BE F-173 FAST DRY ACRYLIC ENAMEL # 13538 YELLOW AS MANUFACTURED BY COASTLINE INDUSTRIAL COATINGS, STAFFORD TEXAS, OR APPROVED EQUAL. BLACK SHALL BE RUSTOLEUM OIL BASE PROFESSIONAL STRENGTH EXTERIOR ENAMEL XO-18 SATIN BLACK OR APPROVED EQUAL.
3. CONCRETE THRUST BLOCKING SHALL HAVE A MINIMUM BEARING SURFACE OF 4 SQUARE FEET.

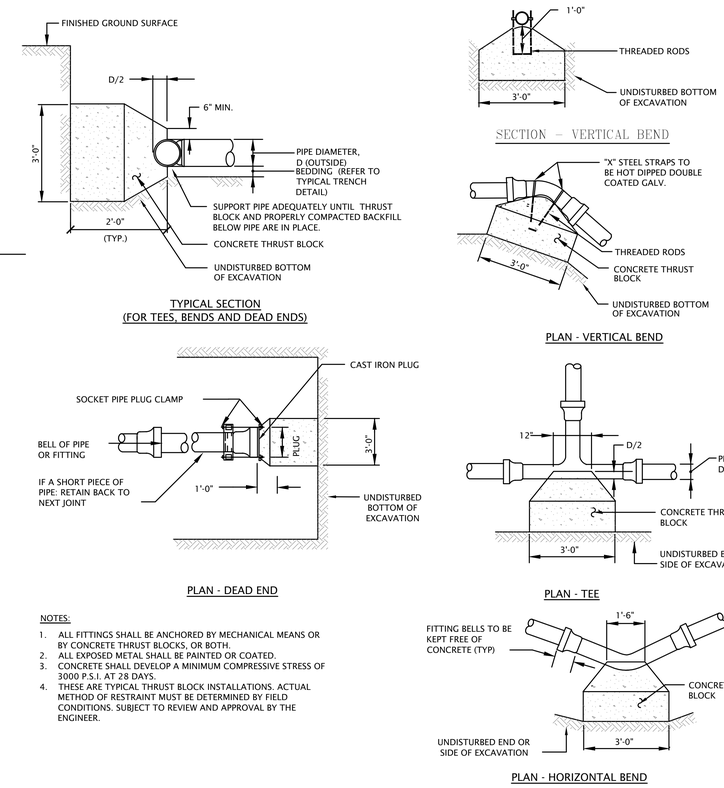
FIRE HYDRANT CONNECTION

NOT TO SCALE



EMERGENCY ACCESS DRIVE GRAVEL PAVEMENT REINFORCING

NOT TO SCALE



NOTES:

1. ALL FITTINGS SHALL BE ANCHORED BY MECHANICAL MEANS OR BY CONCRETE THRUST BLOCKS, OR BOTH.
2. ALL EXPOSED METAL SHALL BE PAINTED OR COATED.
3. CONCRETE SHALL DEVELOP A MINIMUM COMPRESSIVE STRESS OF 3000 P.S.I. AT 28 DAYS.
4. THESE ARE TYPICAL THRUST BLOCK INSTALLATIONS. ACTUAL METHOD OF RESTRAINT MUST BE DETERMINED BY FIELD CONDITIONS. SUBJECT TO REVIEW AND APPROVAL BY THE ENGINEER.

TYPICAL THRUST BLOCK

NOT TO SCALE

C1.0

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14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

CASCADE WAYLAND
NOTICE OF INTENT

Drawing Title:

DETAILS

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No.

C1.2

CASCADE PLANT LIST

SYMBOL	BOTANICAL NAME	COMMON NAME
DECIDUOUS TREES		
AF	ACER X FREEMANII JEFFERSRED	FREEMAN MAPLE
AC	AMELANCHIER CANADENSIS	SHADBLOW SERVICEBERRY
BN	BETULA NIGRA L.	RIVER BIRCH
EVERGREEN TREES		
AB	ABIES BALSAMEA	BALSAM FIR
LARGE SHRUBS		
AP	AESCULUS PARVIFLORA	BOTTLEBRUSH BUCKEYE
RM	RHODODENDRON MAXIMUM	ROSEBAY RHODODENDRON
VD	VIBURNUM DENTATUM	ARROWWOOD VIBURNUM
SHRUBS		
CA	CLETHRA ALNIFOLIA 'HUMMINGBIRD'	HUMMINGBIRD SUMMERSWEET
CS	CORNUS SERICEA 'FARROW'	ARCTIC FIRE RED TWIG DOGWOOD
FG	FOTHERGILLA GARDENII	DWARF FOTHERGILLA
FM	FOTHERGILLA MAJOR	FOTHERGILLA
HA	HYDRANGEA ARBORESCENS	SMOOTH HYDRANGEA
HQ	HYDRANGEA QUERCIFOLIA	OAK LEAF HYDRANGEA
IV	ILEX VERTICILLATA	WINTERBERRY
IH	ITEA VIRGINICA 'HENRY'S GARNET'	VIRGINIA SWEETSPIRE
GROUNDCOVER / PERENNIALS / ORNAMENTAL GRASSES		
AP	ADIANTUM PEDATUM	NORTHERN MAIDENHAIR FERN
BA	BAPTISIA AUSTRALIS	BLUE WILD INDIGO
CA	CHASMANTHIUM L ATI	FOLIUM WOOD OATS
NF	NEPETA X FAASSENII	CATMINT
OC	OSMUNDA CINNAMOMEA	CINNAMON FERN
PV	PANICUM VIRGATUM	SWITCHGRASS
RH	RUDBECKIA HIRTA	BLACK-EYED SUSAN
SS	SCHIZACHYRIUM SCOPARIUM	LITTLE BLUESTEM
SH	SPOROBOLUS HETEROLEPIS	PRAIRIE DROPSEED
DETENTION BASIN VEGETATION		
	APPROPRIATE WETLAND MIX	

PLANTING LEGEND

- GROUNDCOVER/ PERENNIAL PLANTINGS
- WETLAND PLANT MIX
- SHRUB PLANTING
- ORNAMENTAL TREE
- EVERGREEN TREE
- DECIDUOUS TREE

C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

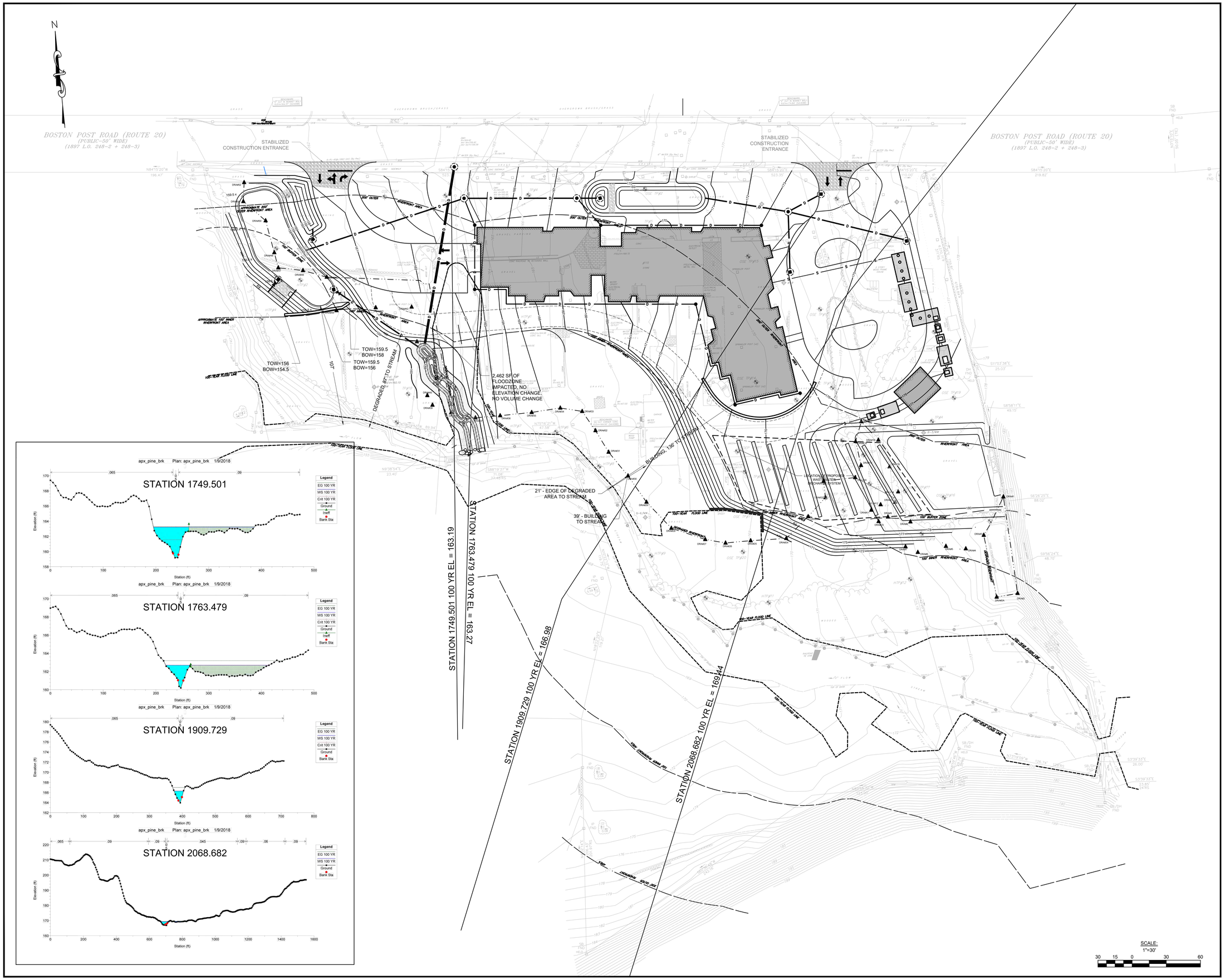
CASCADE WAYLAND NOTICE OF PROJECT CHANGE

Drawing Title:

LANDSCAPE PLAN

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No. L1.0



C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

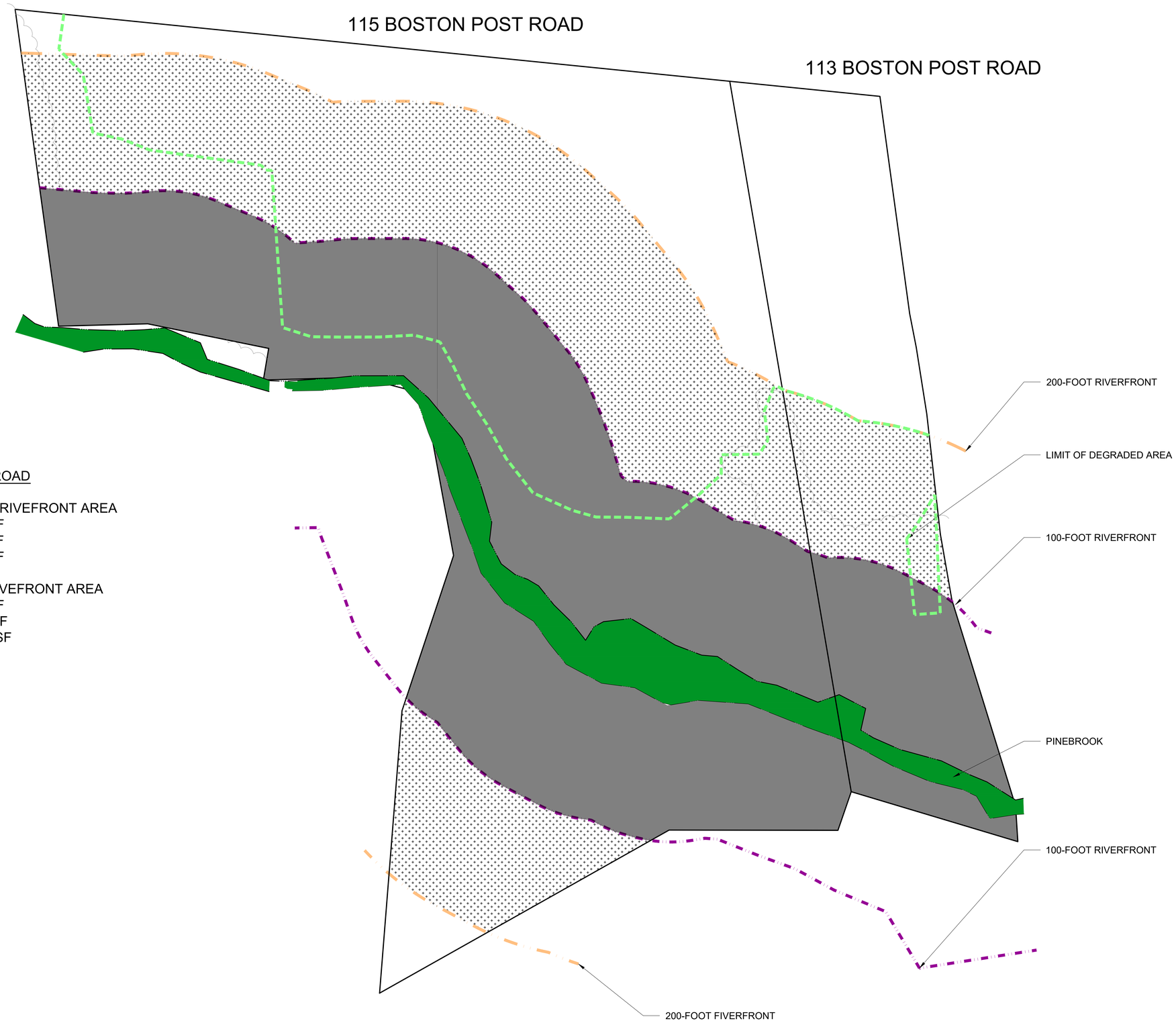
CASCADE WAYLAND
NOTICE OF INTENT

Drawing Title:

FLOOD ZONE
ELEVATION PLAN

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No. FL1.0



BOSTON POST ROAD

100 to 200-FOOT RIVEFRONT AREA
NORTH 77,178 SF
SOUTH 14,837 SF
TOTAL 92,015 SF

0 to 100-FOOT RIVEFRONT AREA
NORTH 81,497 SF
SOUTH 35,934 SF
TOTAL 117,431 SF

C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

CASCADE WAYLAND
NOTICE OF INTENT

Drawing Title:

TOTAL RIVERFRONT AREA

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No.

AREA 1

BOSTON POST ROAD

NON-DEGRADED RIVERFRONT AREA BEING ALTERED - 11,948 SF

WOODED NON-DEGRADED RIVERFRONT AREA BEING ALTERED - 5,668 SF

C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

CASCADE WAYLAND
NOTICE OF INTENT

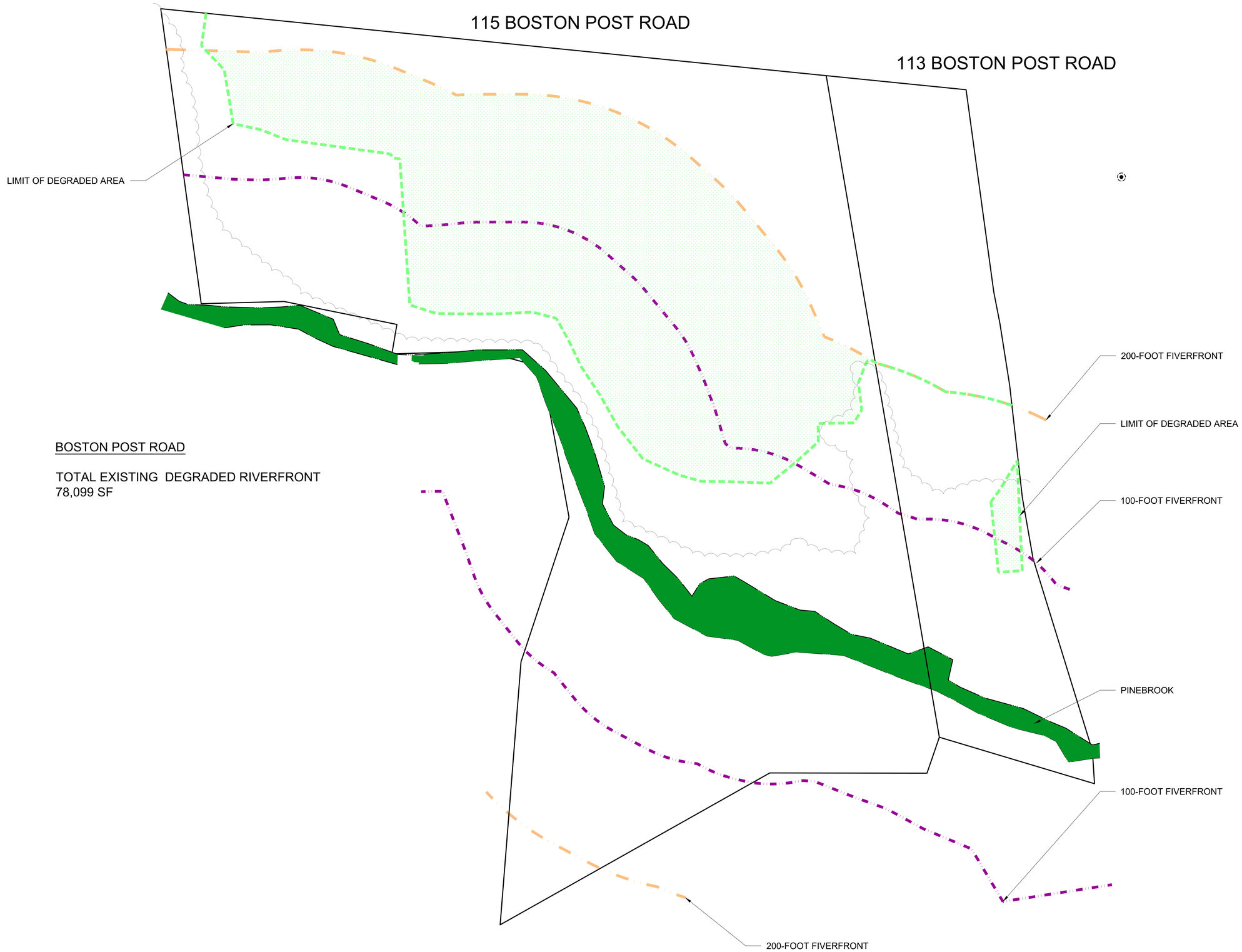
Drawing Title:

NON-DEGRADED RIVERFRONT BEING ALTERED

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No.

AREA 2



BOSTON POST ROAD

TOTAL EXISTING DEGRADED RIVERFRONT
78,099 SF

C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

CASCADE WAYLAND
NOTICE OF INTENT

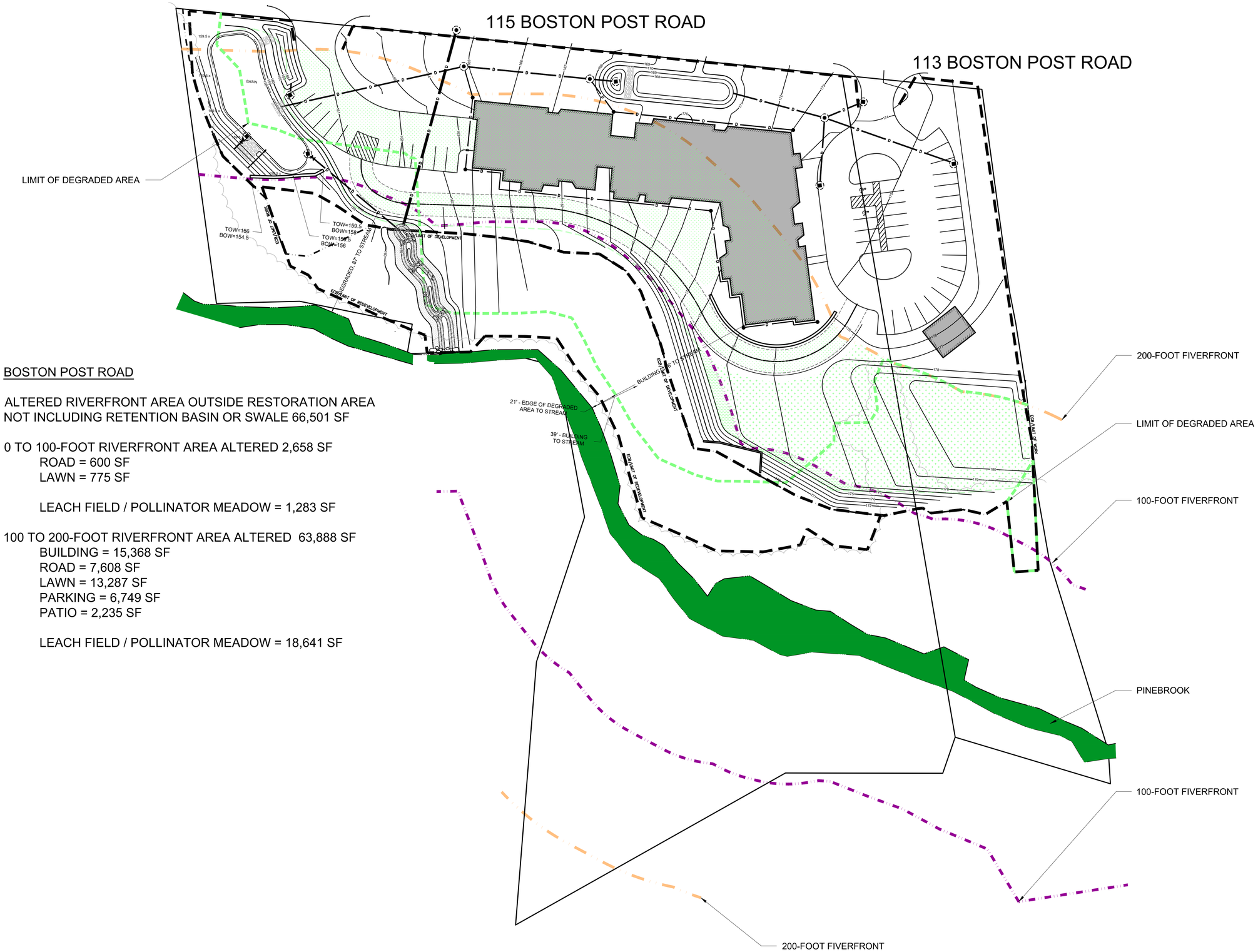
Drawing Title:

EXISTING DEGRADED RIVERFRONT AREA ON THE PROPERTY

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No.

AREA 3



BOSTON POST ROAD

ALTERED RIVERFRONT AREA OUTSIDE RESTORATION AREA
NOT INCLUDING RETENTION BASIN OR SWALE 66,501 SF

0 TO 100-FOOT RIVERFRONT AREA ALTERED 2,658 SF
ROAD = 600 SF
LAWN = 775 SF

LEACH FIELD / POLLINATOR MEADOW = 1,283 SF

100 TO 200-FOOT RIVERFRONT AREA ALTERED 63,888 SF
BUILDING = 15,368 SF
ROAD = 7,608 SF
LAWN = 13,287 SF
PARKING = 6,749 SF
PATIO = 2,235 SF

LEACH FIELD / POLLINATOR MEADOW = 18,641 SF

C1.0

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14 Spring St, 2nd Floor
Waltham, MA 02451

No.	Description	Date
3	PEER REVIEW COMMENTS	2023-10-31
2	PEER REVIEW COMMENTS	2023-06-30
1	PEER REVIEW COMMENTS	2023-05-01

DWG ISSUE & REVISION HISTORY

Stamp

Key Plan

Project Title:

CASCADE WAYLAND
NOTICE OF INTENT

Drawing Title:

RIVERFRONT AREA
ALTERATION FOR
DEVELOPMENT

Project No.: 160012 Scale: 1"=30'
Drawn By: SJ
Checked By: WAD
Approved By: WAD
Date: NOVEMBER 14, 2022

Drawing No.

AREA 4

Appendix B

Post Construction Stormwater Management Report,
dated October 31, 2023,
prepared by C1.0 Engineering, LLC

113 – 115 Boston Post Road

Wayland, Massachusetts

October 31, 2023

POST CONSTRUCTION STORMWATER MANAGEMENT REPORT

Prepared For:

Cascade Development Associates, LLC
831 Beacon Street, Suite #268
Newton Center, MA 02459

Prepared By:

C1.0

ENGINEERING & DEVELOPMENT

14 Spring Street
2nd Floor
Waltham, MA 02451

C1.0 #160012

TABLE OF CONTENTS **PAGE NO.**

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

1. INTRODUCTION

The proposed project includes a stormwater management system designed to mitigate potential impacts the proposed project could have on the existing watershed. Stormwater controls have been proposed to mitigate peak runoff rates, provide water quality, promote groundwater recharge and provide sediment removal. The proposed system has been designed to comply with:

- The 2008 Massachusetts Department of Environmental Protection (DEP) Stormwater Management Handbook, and
- The Massachusetts Wetland Protection Act (310 CMR 10.00)

The pre- and post-development hydrologic conditions were modeled using HydroCAD version 10.00 to demonstrate that post-development stormwater runoff rates will be less than or equal to the pre-development rates. Watershed maps with soil types as well as detailed analyses of the model results are also included. The following tables summarize the peak runoff rates and volumes for the pre- and post-development conditions.

Table 1: Pre- & Post-development Peak Runoff Rate Comparison, units are in cubic feet per second (cfs).

Storm Event	2 Year		10 Year		100 Year	
	Pre	Post	Pre	Post	Pre	Post
DP-1	0.58	0.00	2.01	0.45	7.04	2.72
DP-2	0.00	0.00	0.10	0.00	6.03	0.20

Table 2: Pre- & Post-development Runoff Volumes Comparison, units are in acre feet (af).

Storm Event	2 Year		10 Year		100 Year	
	Pre	Post	Pre	Post	Pre	Post
DP-1	0.102	0.000	0.290	0.050	0.839	0.368
DP-2	0.000	0.000	0.000	0.000	0.291	0.005

2. PRE-DEVELOPMENT CONDITIONS

2.1 Site Conditions

The Property consists of a ±6.5-acre site, comprised of two separate parcels which can be further identified as Assessors Map 30, Lots 70 and 71. The parcel at 115 Boston Post Road is currently occupied by a garden center and contains buildings, parking lots, greenhouses, and appurtenances associated with the business. The parcel at 113 Boston Post Road contains a single-family dwelling and carriage house. The Site is surrounded by a combination of residential dwellings and retail and commercial development.

Runoff from the site currently drains, unmitigated and untreated, to a stream (Pine Brook) on the southern side of the property. This stream, which flows from east to west, is classified as a cold-water fishery and therefore the site discharges to a critical area. The stream and associated wetland to the south have been identified as Design Point 1 (DP-1) accordingly in the hydrologic analyses. A portion of the onsite runoff flows to the western abutter prior to ultimately discharging to the stream. Accordingly, the property line shared with the western abutter has been identified as Design Point 2 (DP-2).

There exists a stormwater pipe that extends from Boston Post Road through the project site and to the Pine Brook. This pipe conveys runoff from approximately 7.9 acres of land easterly along Boston Post Road. The catchment area for this pipe, as well as the pipe, was modeled to determine flow velocities and volumes that pass through and discharge into the brook.

2.2 Soil Description

According to the United States Department of Agricultural (USDA) soil survey for Middlesex County and the Natural Resources Conservation Service (NRCS) Web Soil Survey, dominant soils within upland portions of the site are mapped as Haven-Urban land complex, with slopes ranging from 0 to 8 percent. These are generally classified as well drained soils of excavated or filled land. Dominant soils within the wetland areas are classified as Scarboro Mucky fine sandy loam with 0 to 3 percent slopes. These are classified as very poorly drained depressions, outwash terraces, or drainage ways. These map designations are generally consistent with field observations. Topographically, the Site is relatively flat and slopes gently towards the wetland systems to the south and west of the existing development and towards Pine Brook. NRCS classifies these types of soils as hydrologic class A/D and A soils. While the USDA classifies these types of soils as hydrologic class B and D soils.

Competent Soils Individuals conducted site visits on 12/13/2016 & 1/12/17 and subsequently on 11/14/17, & 12/22/17 to verify the NRCS classification. Test pits logs indicated that the on-site soils are generally sandy loam, loamy sand, sand and gravel. Based on the data present in the test pit logs, the soils were modeled as a Class B soils for the hydrology analysis. Wetland soils were modeled as a Class D soils for the hydrology analysis.

The estimated seasonal high groundwater elevation varied throughout the site. Mottling and redox features were found as shallow as 2.6-feet and as deep as 9.3-feet below surface grade.

2.3 Hydrologic Analysis

Sub-catchment areas were delineated based on existing runoff patterns and topographic information. This information is shown on the *Pre-Development Conditions Hydrologic Areas Map* included in Appendix B. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results also in Appendix B.

3. POST-DEVELOPMENT CONDITIONS

3.1 Design Strategy

During the design phase of the site layout, consideration was given to conserving environmentally sensitive features and improving impact on the existing hydrology. Through careful site planning the proposed impervious surfaces have been minimized, reducing the impact the project may have on the existing watershed. Specifically, many of the parking areas have been located in a subsurface parking garage to reduce paved parking impervious surfaces.

A stormwater management system has been designed to provide treatment for stormwater runoff associated with the proposed impervious surfaces on site. All

stormwater BMPs were designed to treat a minimum of the first 1.0 inch of runoff generated by the on-site impervious areas. Deep Sump Catch Basins, Sediment Forebays and the Infiltration Basin are proposed to treat the runoff associated with the water quality volume in accordance with the requirements of the DEP Stormwater Handbook. Stormwater BMP sizing worksheets and water quality sizing calculations are included in Appendix E of this report. The resulting stormwater runoff water quality will be significantly improved from existing conditions.

To mitigate increased stormwater flow rates associated with the proposed impervious area, an infiltration basin is proposed. Based on the data presented in the soil borings, and the natural topography of the site, the infiltration basin is located at the western edge of the site, downgradient from the major development activities. The infiltration basin will not only hold and infiltrate stormwater, it will also discharge stormwater to the wetlands to the west of the property and the newly daylit stream where the existing Route #20 drain outfall is located.

In addition to the collection, conveyance and treatment of stormwater generated from the project site, the drainage system has been designed to treat the stormwater from the Boston Post Road municipal drainage system that is located within Boston Post Road and that discharges though the project property directly to the Pine Brook with no treatment or other mitigation measures. The existing culvert where it discharges into the Pine Brook is collapsed and submerge under the base water flow of the Brook. The new system has been designed to continue to collect stormwater from the Boston Post Road system via the existing culvert, however the culvert will be opened and turned into a grass and stone lined daylit stream from the edge of the proposed emergency access road to the Brook, approximately 100-feet. The proposed retention basin will also discharge into the newly created daylit stream at the emergency access road. The retention basin could simply overflow from the basin onto the land and eventually reach the Pine Brook, however allowing the outlet to tie into the daylit stream will provide a greater and more consistent baseflow into the Brook. A healthy baseflow will create a healthy stream channel that will allow for greater biodiversity and overall health of the stream through filtration and nutrient uptake. The new daylit stream will also enhance the existing bank by stabilizing currently unnaturally placed bank walls and unstable slopes and creating additional bank length, riverfront area and habitat along the daylit stream.

Instead of the existing condition, where untreated Route 20 stormwater discharges directly to Route 20 via a broken drainage pipe, stormwater from Route 20 will be directed to a treatment swale prior to discharge, thereby improving conditions for Pine Brook. The only viable alternative would be to retain the existing pipe in its existing location and condition. The proposed daylit stream connection to Pine Brook will be achieved by excavating the land immediately behind the large stones and boulders that currently comprise the Pine Brook Bank, such that treated stormwater will flow through the spaces between the stones and boulders as it enters Pine Brook and the existing Bank will be preserved. This work will be conducted under the supervision of a qualified Wetland Scientist during construction.

3.2 Hydrologic Analysis

The established design point used in the pre-development conditions analysis was used in the post-development analysis for direct comparison. The tributary areas and flow

paths were modified to reflect post-development conditions. See Appendix C for the *Post-Development Conditions Hydrologic Areas Map*. Summaries of each area with respect to Curve Number and Time of Concentration calculations can be found in the model results in Appendix C.

3.3 Stormwater Management Controls Sizing

Infiltration Basin

The proposed infiltration basin has been designed to provide groundwater recharge and reduce post-development runoff for the 2, 10 and 100-year storm events. The infiltration basin has been designed with a catch basin type and gravel overflow type outlets that will together provide control for the storm events which would otherwise send stormwater towards the Bordering Vegetated Wetlands (BVW). In the event of overtopping the gravel overflow outlet will allow excess water to flow to the existing wetlands. Under the storm events modeled, there are no conditions where the developed runoff rates and volumes excess the exiting runoff rates and volumes.

The infiltration system was sized using the Static Method, as described in Chapter 3 of the Massachusetts Stormwater Handbook. A volume of water equivalent to the Recharge volume is retained within the infiltration basin, below the outlet inverts, and is forced to infiltrate into the soils. A permeability rate of 1.07 was initially used for the infiltration rate from the retention basin, this value was then adjusted to 2.41 based on recommendations from Beta Group. The system has been designed to meet the required recharge volume, and will fully dewater within 72 hours. These calculations can be found in Appendix D of this report.

Daylit Stream

A daylit stream is being proposed to replace the last 100-feet of the 18-inch pipe that extends from Boston Post Road to the Pine Brook. The existing pipe will be replaced from Boston Post Road and will discharge into the stream. The stream is designed to match the invert elevation of the existing pipe and add sinuosity, vegetation, riffles and pools and energy dissipation. The swale will be lined with stone rip-rap sized to resist erosion; coir logs placed longitudinally at the edge of the low flow channel. Wetland and upland plantings will be placed at appropriate elevations along the channel.

4. Compliance with DEP Stormwater Management Standards

The proposed stormwater management system was designed in compliance with the ten (10) DEP Stormwater Management Standards. The following summary provides key information related to the proposed stormwater management system, its design elements, and mitigation measures for potential impacts.

STANDARD 1: No new stormwater conveyance (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.
There will be no direct discharge of untreated stormwater to nearby wetlands or waters of the Commonwealth. Runoff from all impervious areas of the site will be conveyed to stormwater management controls for infiltration, water quality treatment, and runoff rate attenuation prior to discharge to adjacent wetlands.

STANDARD 2: Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

The stormwater management design will control post-development peak discharge rates for the 2-, 10-, and 100-year, 24-hour storms to maintain or reduce pre-development peak discharge rates. Refer to Section 1.0 Introduction for a summary of the peak runoff rates.

STANDARD 3: Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater management practices and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil types. This Standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.

The stormwater management system includes an infiltration basin which will effectively recharge groundwater on-site. The Infiltration BMP was sized using the simple dynamic method based on the required recharge volume for the post-development site. As a result, annual recharge from the post-development site will approximate the annual recharge from the site under pre-development conditions. See Appendix E for stormwater BMP design worksheets and Groundwater Recharge Calculation.

The existing site includes various buildings, a large heavily compacted gravel lot, and a wooded area. The existing buildings and the gravel lot are functioning as impervious surfaces. Currently there is no stormwater recharge infrastructure at the site. The existing impervious area is 0.525 acres with an increase of 0.597 from the development to a total proposed impervious area being 1.122 acres, this includes 0.098 acres for the surface area of the proposed retention basin. For the purposes of calculating required recharge volume, we have not included the existing gravel areas in the total impervious area. Under post-development conditions, the required recharge volume is approximately 0.057 acre-feet. The infiltration basin will provide 0.060 acre-feet of recharge volume, see Appendix D.

STANDARD 4: Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).

The proposed project will meet the water quality requirements of Standard 4 using two separate on site treatment trains that achieve 89% TSS removal. Refer to Appendix D for the TSS removal worksheets. Structural BMPs designed for water quality treatment, include Deep Sump Catch Basins, Sediment Forebays and the Infiltration Basin that are sized to capture and treat the volume associated with the first 1.0-inch of runoff from proposed sediment generating impervious surfaces. All proposed stormwater management BMPs will be operated and maintained to ensure continued water quality treatment of runoff. The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

STANDARD 5: For land uses with higher potential pollutant loads (LUHPPLs), source control and pollution prevention shall be implemented in accordance with the

Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.

The proposed project is not associated with stormwater discharges from land uses with higher potential pollutant loads.

STANDARD 6: Stormwater discharges to critical areas must utilize certain stormwater management BMPs approved for critical areas. Critical areas are Outstanding Resource Waters, shellfish beds, swimming beaches, cold-water fisheries and recharge areas for public water supplies.

The proposed BMPs are consistent with the Stormwater Management Handbook for use within critical areas. The stormwater management system has been designed to capture and treat the first 1.0-inch of runoff as stipulated in the Stormwater Management Handbook. The infiltration basin, and treatment train will remove pollutants from the first 1.0-inch of runoff from impervious areas that generate sediments. In addition the daylit stream section of the Route 20 drainage system will provide additional treatment and habitat.

STANDARD 7: Redevelopment of previously developed sites must meet the Stormwater Management Standards to the maximum extent practicable. However, if it is not practicable to meet all the Standards, new (retrofitted or expanded) stormwater management systems must be designed to improve existing conditions.

The proposed project qualifies as a redevelopment and complies with standards of the Stormwater Management Handbook.

STANDARD 8: A plan to control construction-related impacts during erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

A Stormwater Pollution Prevention Plan (SWPPP) has been developed to comply with Section 3 of the NPDES Construction General Permit for Stormwater Discharges, and a draft version of the SWPPP has been included in the Appendices of this report; therefore, the requirements of Standard 8 are fulfilled.

STANDARD 9: A Long-Term Operation and Maintenance (O&M) Plan shall be developed and implemented to ensure that stormwater management systems function as designed.

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards. The Manual outlines source control and pollution prevention measures and maintenance requirements of the stormwater best management practices (BMPs) associated with the proposed development.

STANDARD 10: All illicit discharges to the stormwater management system are prohibited.

There will be no illicit discharges to the proposed stormwater management system associated with the proposed project. An Illicit Discharge Compliance Statement is provided below.

4.1 Illicit Discharge Compliance Statement

An illicit discharge is any discharge to a municipal separate storm sewer that is not comprised entirely of stormwater, discharges from fire-fighting activities, and certain non-designated non-stormwater discharges.

To the best of my knowledge, no detectable illicit discharge exists on site. The site plans included with this report detail the storm sewers that convey stormwater on the site and demonstrate that these systems do not include the entry of an illicit discharge. A Site Owner's Manual is also included, which contains the Long-Term Pollution Plan that outlines measures to prevent future illicit discharges. As the Site Owner, I will ultimately be responsible for implementing the Long-Term Pollution Prevention Plan.

Signature: _____
Cascade Development Associates, LLC

APPENDIX A

Soil Information

Map Unit Name—Middlesex County, Massachusetts
(2841.01)

Map Scale: 1:2,850 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 40 80 160 240

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

Haven-Urban land complex, 0 to 8 percent slopes

Scarboro mucky fine sandy loam, 0 to 3 percent slopes

Not rated or not available

Soil Rating Lines

Haven-Urban land complex, 0 to 8 percent slopes

Scarboro mucky fine sandy loam, 0 to 3 percent slopes

Not rated or not available

Soil Rating Points

Haven-Urban land complex, 0 to 8 percent slopes

Scarboro mucky fine sandy loam, 0 to 3 percent slopes

Not rated or not available

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:25,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 17, Oct 6, 2017

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Name

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	4.2	26.9%
624B	Haven-Urban land complex, 0 to 8 percent slopes	Haven-Urban land complex, 0 to 8 percent slopes	11.3	73.1%
Totals for Area of Interest			**15.5**	**100.0%**

Description

A soil map unit is a collection of soil areas or nonsoil areas (miscellaneous areas) delineated in a soil survey. Each map unit is given a name that uniquely identifies the unit in a particular soil survey area.

Rating Options

Aggregation Method: No Aggregation Necessary

Tie-break Rule: Lower

Map Unit Description

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

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

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

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

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

Soils that have profiles that are almost alike make up a *soil series*. All the soils of a series have major horizons that are similar in composition, thickness, and arrangement. Soils of a given series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

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

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

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

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

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

Additional information about the map units described in this report is available in other soil reports, which give properties of the soils and the limitations, capabilities, and potentials for many uses. Also, the narratives that accompany the soil reports define some of the properties included in the map unit descriptions.

Report—Map Unit Description

Middlesex County, Massachusetts

6A—Scarboro mucky fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svky
Elevation: 0 to 1,320 feet

Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 250 days
Farmland classification: Not prime farmland

Map Unit Composition

Scarboro and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Scarboro

Setting

Landform: Depressions, outwash terraces, drainageways, outwash deltas
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Sandy glaciofluvial deposits derived from schist and/or sandy glaciofluvial deposits derived from gneiss and/or sandy glaciofluvial deposits derived from granite

Typical profile

Oe - 0 to 3 inches: mucky peat
A - 3 to 11 inches: mucky fine sandy loam
Cg1 - 11 to 21 inches: sand
Cg2 - 21 to 65 inches: gravelly coarse sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: About 0 to 2 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Salinity, maximum in profile: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water storage in profile: Low (about 4.7 inches)

Interpretive groups

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

Minor Components

Swansea

Percent of map unit: 10 percent
Landform: Bogs, swamps

Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Walpole

Percent of map unit: 5 percent
Landform: Deltas, depressions, depressions, outwash plains, outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, talf, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Wareham

Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

624B—Haven-Urban land complex, 0 to 8 percent slopes

Map Unit Setting

National map unit symbol: 9956
Elevation: 0 to 1,000 feet
Mean annual precipitation: 45 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Haven and similar soils: 40 percent
Urban land: 40 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Haven

Setting

Landform: Terraces, plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Friable loamy eolian deposits over loose sandy glaciofluvial deposits

Typical profile

H1 - 0 to 2 inches: silt loam
H2 - 2 to 20 inches: silt loam

H3 - 20 to 32 inches: very fine sandy loam
H4 - 32 to 65 inches: stratified coarse sand to sand to fine sand

Properties and qualities

Slope: 0 to 8 percent
Depth to restrictive feature: 18 to 36 inches to strongly contrasting textural stratification
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

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

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Tisbury

Percent of map unit: 10 percent
Landform: Terraces, plains
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

Hinckley

Percent of map unit: 5 percent
Landform: Eskers, ridges, terraces
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landform: Terraces, plains
Landform position (two-dimensional): Shoulder

Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Data Source Information

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 17, Oct 6, 2017

Legend

- Borehole
- Monitoring Well
- Test Pit
- Leachfields
- Pine Brook
- Site Parcel
- Tax Parcels

0 25 50 100 150 200 Feet

1 inch = 100 feet

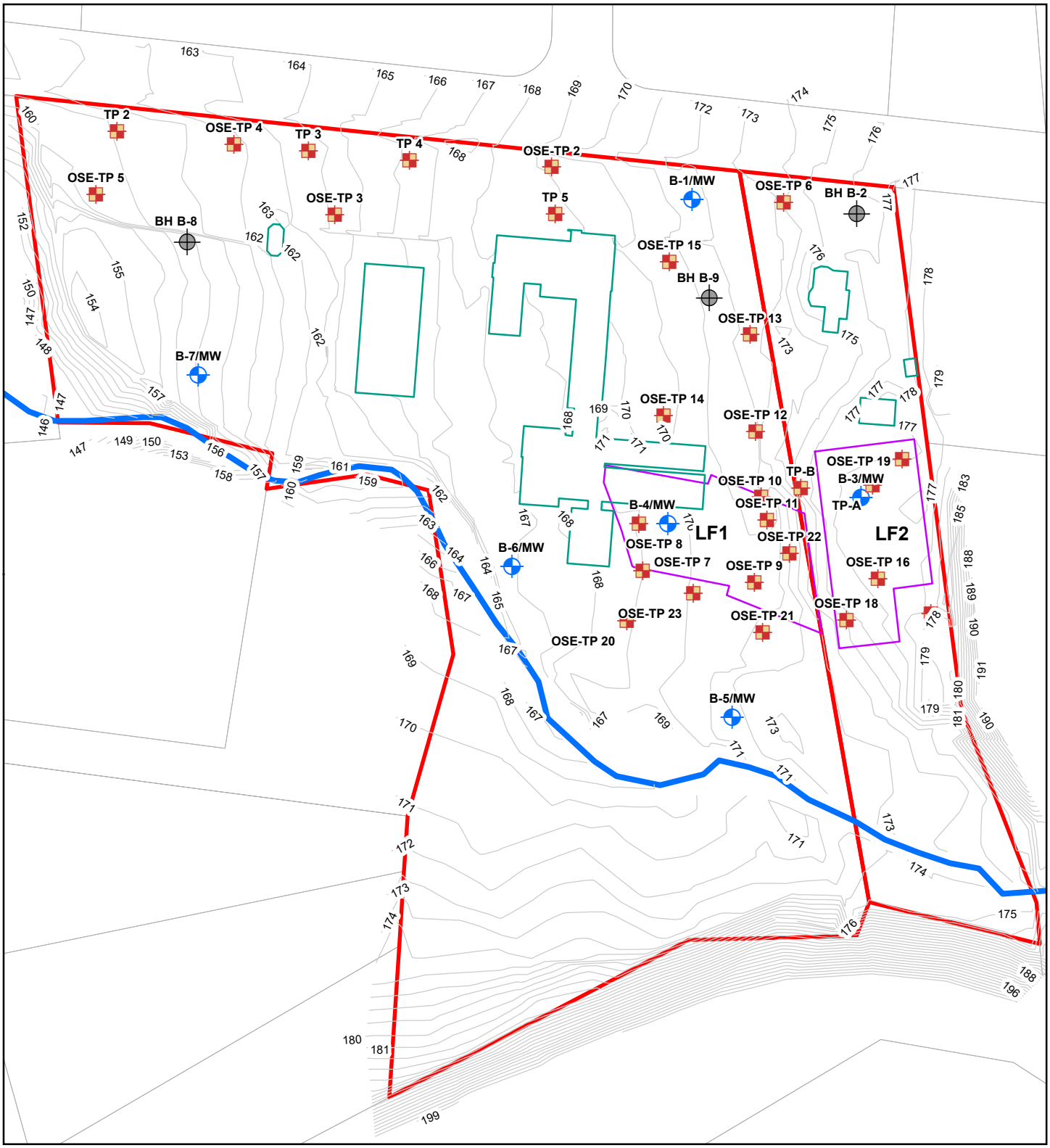
N W E S

GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 2
Aerial Site Plan

Cascade Wayland
115 Boston Post Road
Wayland, MA

CREATED BY: LB	CHECKED BY: DN	PROJ. NO: 17205
DATE: 06/08/2018	DATE: 06/08/2018	17205\Figures



Legend

- Borehole
- Monitoring Well
- Test Pit
- Building Outlines
- Leachfields
- Surface Topography feet AVD
- Pine Brook
- Site Parcel
- Tax Parcels

0 25 50 100 150 200 Feet

1 inch = 100 feet

N W E S

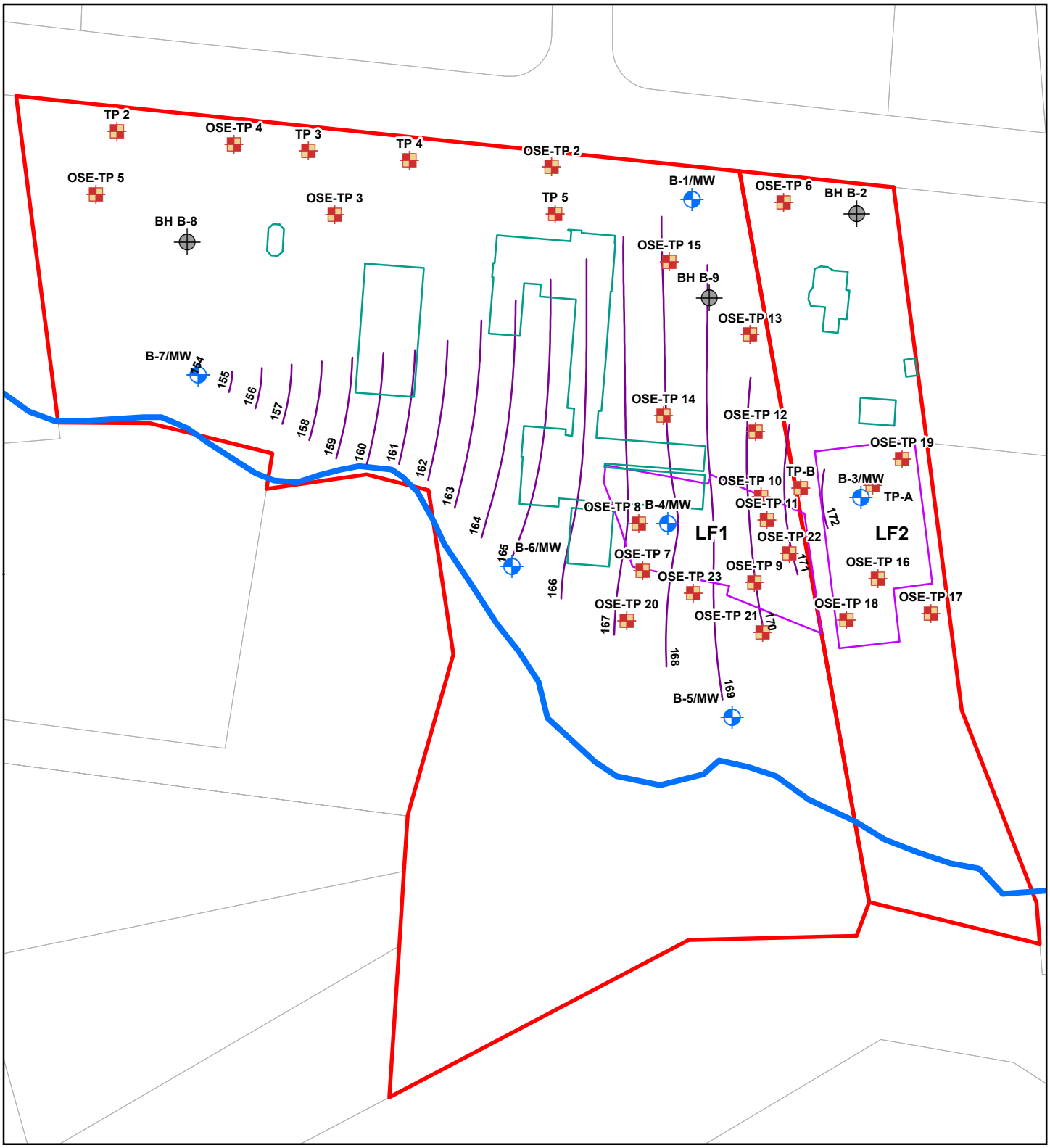
GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 3
Site Plan

Cascade Wayland
115 Boston Post Road
Wayland, MA

CREATED BY: LB	CHECKED BY: RT	PROJ. NO: 17205
DATE: 06/08/2018	DATE: 06/08/2018	17205\Figures

Ground elevation surveyed by Beals & Thomas, Southborough, Massachusetts
AVD = Above vertical datum
All elevations relative to North American Vertical Datum of 1988



Legend

- Borehole
- Monitoring Well
- Test Pit
- Building Outlines
- Leachfields
- Groundwater Contours 4/6/2018 feet AVD
- Pine Brook
- Site Parcel
- Tax Parcels

0 25 50 100 150 200 Feet

1 inch = 100 feet

N W E S

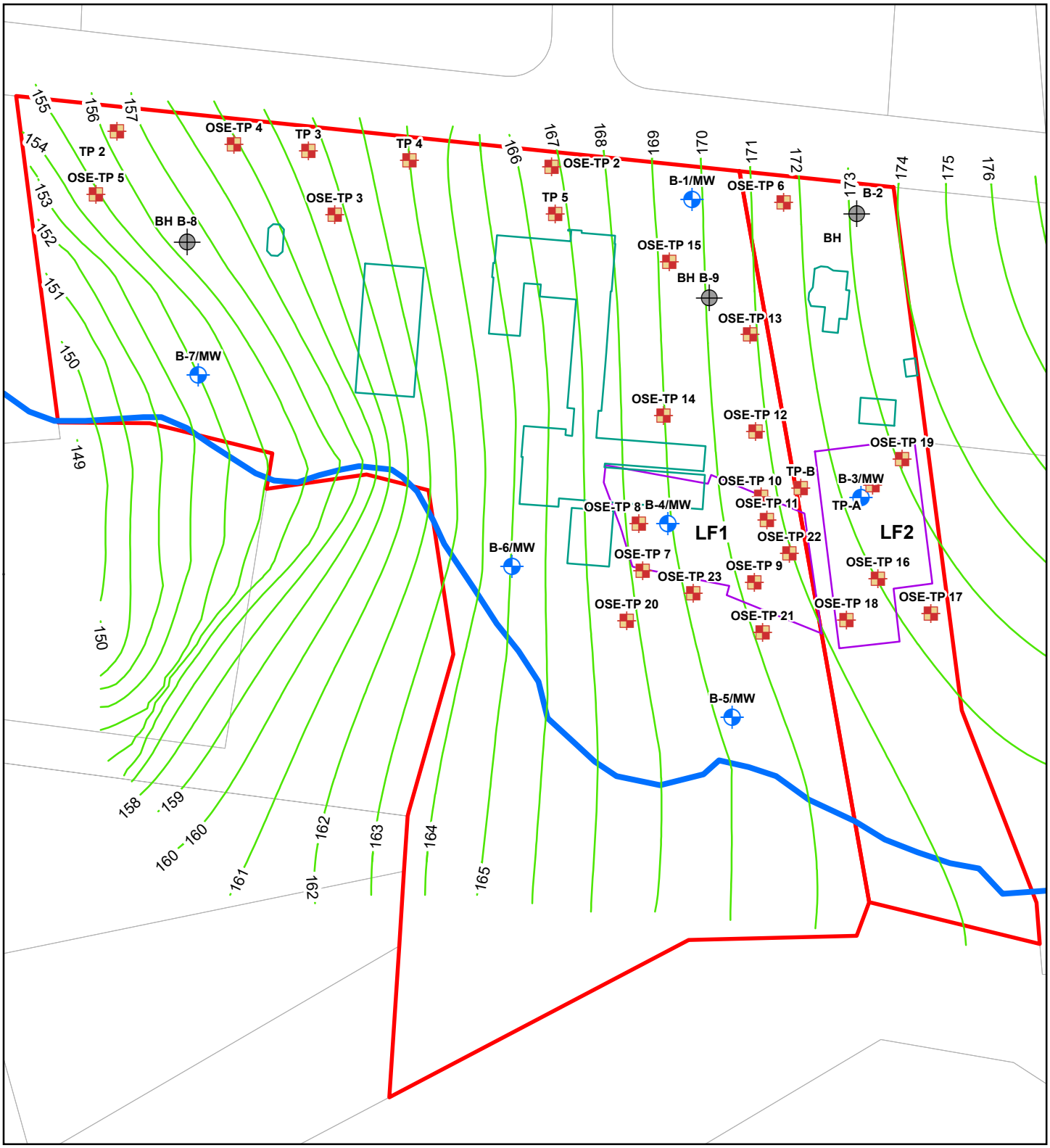
GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 4
Observed Groundwater Contours - April 6, 2018

Cascade Wayland
115 Boston Post Road
Wayland, MA

CREATED BY: LB	CHECKED BY: DN	PROJ. NO: 17205
DATE: 06/08/2018	DATE: 06/08/2018	17205\Figures

Water level data collected by GEOSPHERE on 4/8/2018
Ground elevation surveyed by Beals & Thomas, Southborough, Massachusetts
AVD = Above vertical datum
All elevations relative to North American Vertical Datum of 1988



Legend

- Borehole
- Monitoring Well
- Test Pit
- Building Outlines
- Leachfields
- ESHGW Contours feet AVD
- Pine Brook
- Site Parcel
- Tax Parcels

0 25 50 100 150 200 Feet

1 inch = 100 feet

N W E S

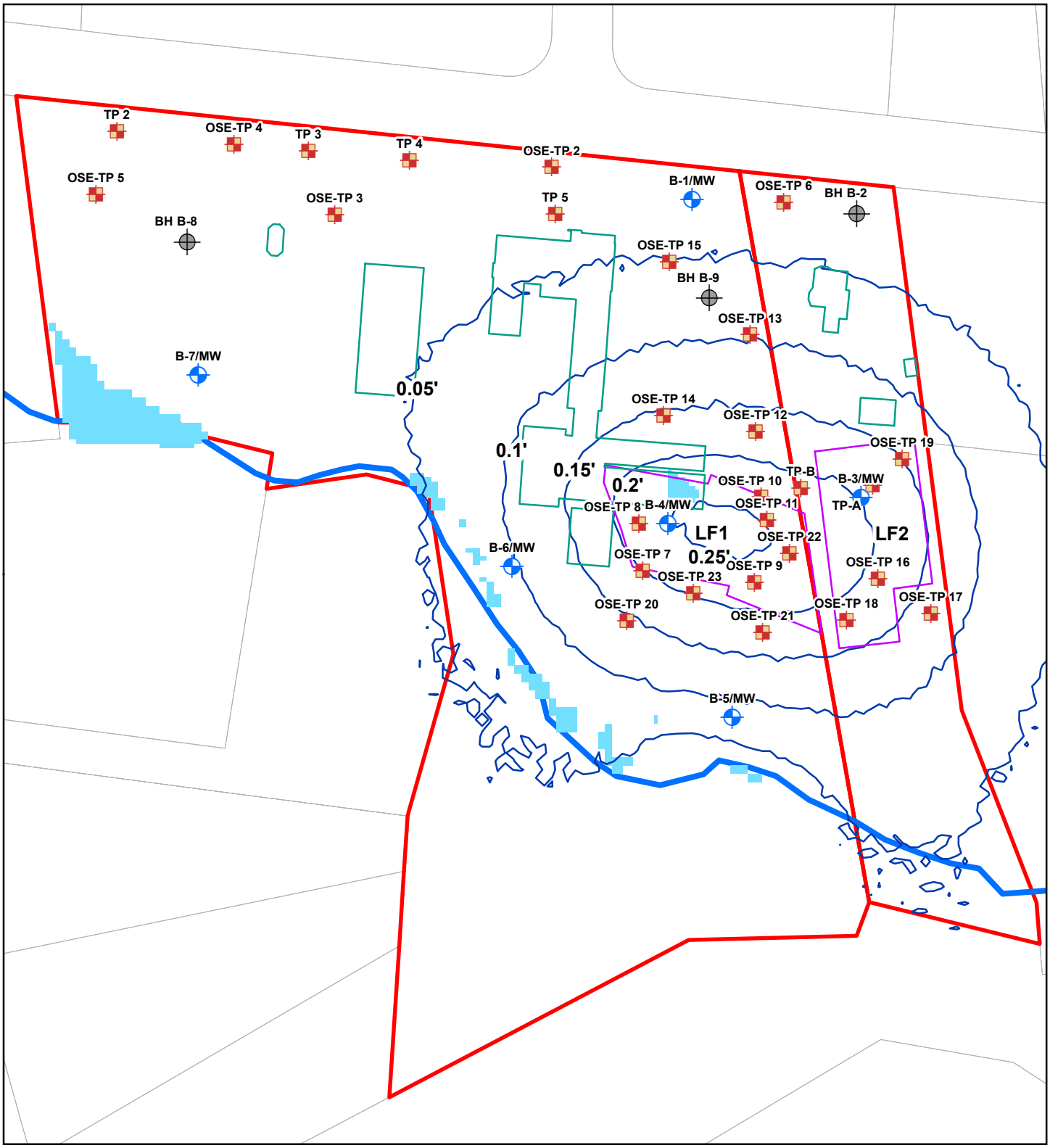
GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 5
Simulated ESHGW Contours

Cascade Wayland
115 Boston Post Road
Wayland, MA

CREATED BY: LB	CHECKED BY: DN	PROJ. NO: 17205
DATE: 06/26/2018	DATE: 06/26/2018	17205\Figures

AVD = Above vertical datum
Ground elevation surveyed by Beals & Thomas, Southborough, Massachusetts
All elevations relative to North American Vertical Datum of 1988



Legend

- Borehole
- Monitoring Well
- Test Pit
- Building Outlines
- Leachfields
- 90-Day Mound Height feet
- Flooded Cells
- Pine Brook
- Site Parcel
- Tax Parcels

0 25 50 100 150 200 Feet

1 inch = 100 feet

N W E S

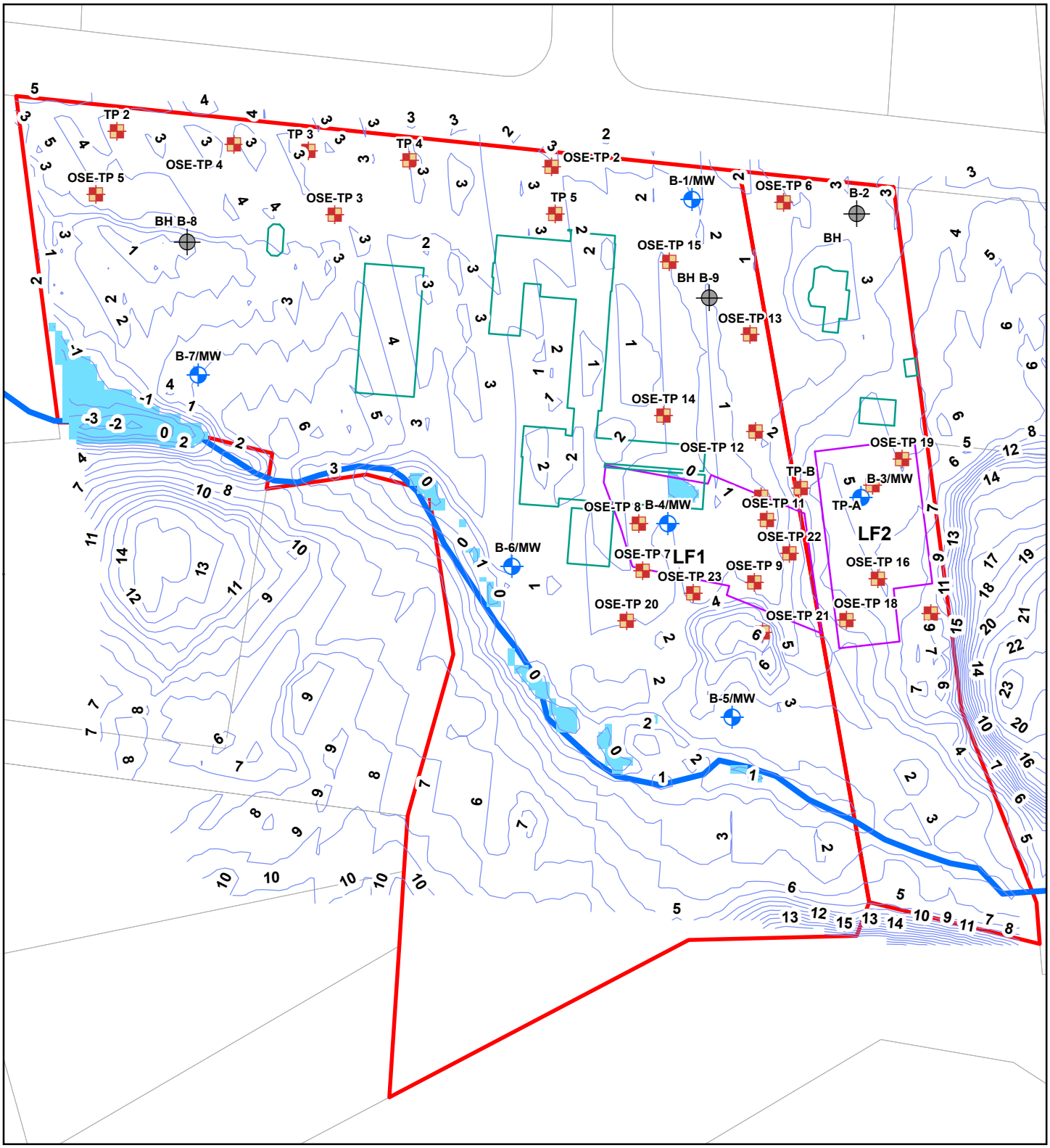
GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 6
Simulated Est. Mound Height & Breakout

Cascade Wayland
115 Boston Post Road
Wayland, MA

CREATED BY: LB	CHECKED BY: DN	PROJ. NO: 17205
DATE: 06/26/2018	DATE: 06/26/2018	17205\Figures

AVD = Above vertical datum
Ground elevation surveyed by Beals & Thomas, Southborough, Massachusetts
All elevations relative to North American Vertical Datum of 1988



Legend

- Borehole
- Flooded cells Monitoring Well
- Test Pit
- Building Outlines
- Leachfields
- Depth to Mound Contours feet BGS
- Flooded Cells
- Pine Brook
- Site Parcel
- Tax Parcels

0 25 50 100 150 200 Feet

1 inch = 100 feet

N W E S

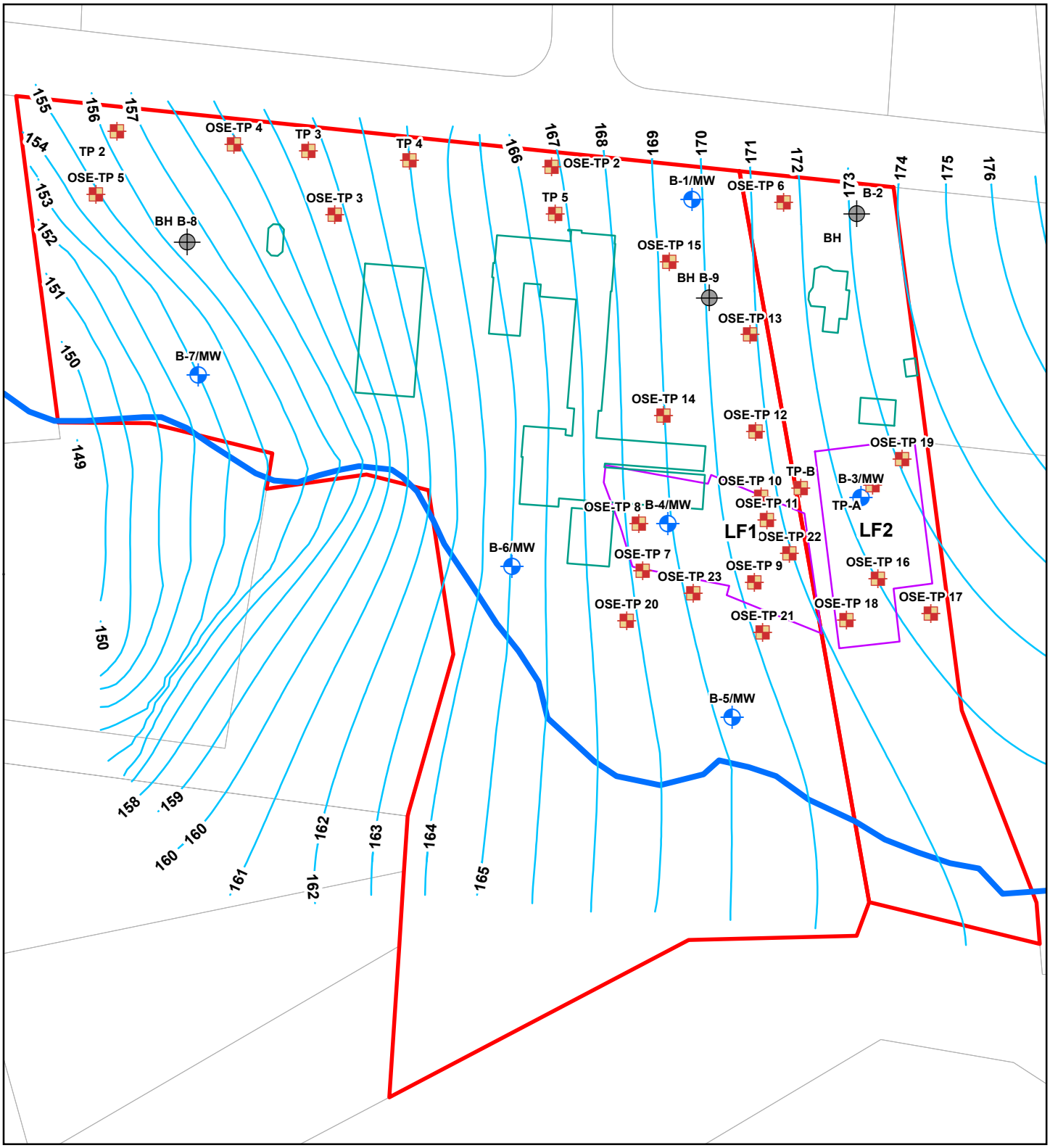
GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 7
Depth to Mound Below Ground Surface

Cascade Wayland
115 Boston Post Road
Wayland, MA

CREATED BY: LB	CHECKED BY: DN	PROJ. NO: 17205
DATE: 06/26/2018	DATE: 06/26/2018	17205\Figures

BGS = Below ground surface
Ground elevation surveyed by Beals & Thomas, Southborough, Massachusetts
All elevations relative to North American Vertical Datum of 1988



Legend

- Borehole
- Monitoring Well
- Test Pit
- Building Outlines
- Leachfields
- 90-Day Simulated Head feet AVD
- Pine Brook
- Site Parcel
- Tax Parcels

0 25 50 100 150 200 Feet

1 inch = 100 feet

N W E S

GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 8
90-Day Simulated Head

Cascade Wayland
115 Boston Post Road
Wayland, MA

CREATED BY: LB	CHECKED BY: DN	PROJ. NO: 17205
DATE: 06/26/2018	DATE: 06/26/2018	17205\Figures

AVD = Above vertical datum
Ground elevation surveyed by Beals & Thomas, Southborough, Massachusetts
All elevations relative to North American Vertical Datum of 1988

Appendix A

Test Pit and Percolation Test Logs
Massachusetts DEP Forms 11 and 12

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

DEP has provided this form for use by on-site professionals and local Boards of Health. Other forms may be used, but the information must be substantially the same as provided here. Before using this form, check with your local Board of Health to determine the form they use.

A. Facility Information

1. Facility Information

Mahoney's Garden Center, LLC
Owner Name

115 Boston Post Road Map/Lot: Map 30, Lot 071
Street Address

Wayland MA 01778
City/Town State Zip Code

B. Site Information

1. (Check one) New Construction ☒ Upgrade ☐ Repair ☐

2. Published Soil Survey available? Yes ☒ No ☐ If yes: _____ _____ __
Year Published Publication Scale Soil Map Unit

Haven Urban Land Complex (MassGIS) _____
Soil Name Soil limitations

3. Surficial Geological Report available? Yes ☐ No ☒ If yes: _____ _____ _____
Year Published Publication Scale Map Unit

_____ _____
Geologic Material Landform

4. Flood Rate Insurance Map:

Above the 500 year flood boundary? Yes ☒ No ☐ Within the 100 year flood boundary? Yes ☐ No ☒

Within the 500 year flood boundary? Yes ☐ No ☒ Within a Velocity Zone? Yes ☐ No ☒

5. Wetland Area: National Wetland Inventory Map _____ _____
Map Unit Name

Wetlands Conservancy Program Map _____ _____
Map Unit Name

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

6. Current Water Resource Conditions (USGS) December 2016 (Month/Year) Range: Above Normal ☐ Normal ☐ Below Normal ☒

7. Other references reviewed: _____

C. On-Site Review

(*minimum of two holes required at every proposed primary and reserved disposal area)*

Deep Observation Hole Number: December 13, 2016 (Date) AM (Time) Sunny 30s F (Weather)

1. Location

   Ground Elevation at Surface of Hole Varies

   Location (Identify on Plan) See Plan

2. Land Use: Nursery (e.g. woodland, agricultural field, vacant lot, etc.) None (Surface Stones) 3-8% (Slope (%))

   Disturbed (Vegetation) Moraine (Landform) _____ (Position on landscape (attach sheet))

3. Distances from: Open Water Body > 100 feet Drainage Way > 100 feet Possible Wet Area > 100 feet

   Property Line >10 feet Drinking Water Well > 100 feet Other _____

4. Parent Material: Ice Contact Outwash Unsuitable Materials Present: Yes ☒ No ☐

   If Yes: Disturbed Soil ☐ Fill Material ☒ Impervious Layer(s) ☐ Weathered/Fractured Rock ☐ Bedrock ☒

5. Groundwater Observed: Yes ☒ No ☐

   If Yes: Depth Weeping from Pit Varies Depth Standing Water in Hole Varies

   Estimated Depth to High Groundwater: Varies (see Testpits) (inches) _____ (elevation)

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-5

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-90	Fill										
90-101	A	10 YR 3/2	90”			Sandy Loam			Massive	Friable	
101-132	C	2.5 Y 5/6				Very Fine Loamy Sand			Single Grain	Loose	

Additional Notes Water Standing @ 112”, ESHGW=90”

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method used:
   - ☒ Depth observed standing water in observation hole A. Varies (inches) B. _ (inches)
   - ☒ Depth weeping from side of observation hole A. Varies (inches) B. _ (inches)
   - ☒ Depth to soil redoximorphic features (mottles) A. Varies (inches) B. _ (inches)
   - ☐ Groundwater adjustment (USGS methodology) A. _____ (inches) B. _____ (inches)

2. Index Well Number _____ Reading Date _____ Index Well Level _____

   Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes ☐ No ☐

   b. If yes, at what depth was it observed? Upper boundary: Varies (inches) Lower boundary: Varies (inches)

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

_____ Signature of Soil Evaluator

_____ Date

Raymond Willis, P.E., SE2612 — Typed or Printed Name of Soil Evaluator/License Number

May 1996 — *Date of Soil Evaluator Exam

Darren MacCaughey — Name of Board of Health Witness

Town of Wayland — Board of Health

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Use this sheet for field diagrams:

See Attached Plans

Appendix B

Soil Boring/Monitoring Well Construction Logs
TJ Ogden Well Driller's Log – Irrigation Well (2003)

GEOSPHERE
ENVIRONMENTAL MANAGEMENT INC.
51 Portsmouth Ave.
Exeter, NH 03833
(603)773-0075

Log of Borehole/MW: B-7/MW

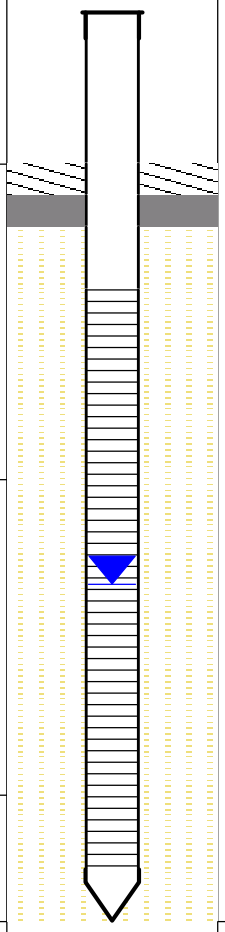
Project No.: 17205

Site: Mahoney Garden Center Borehole Location: B-7/MW

Address: 115 Boston Post Road

Client: Eden Management Geologist: MK/LB

SUBSURFACE PROFILE			SAMPLE					
Depth (ft / m)	Symbol	Description	Core ID	Sample ID	Pen (ft)	Rec (ft)	Well Data	Comments
-3 / -1		Ground Surface						4" diameter riser stick up 2.4'
1 / 3		***Fill*** (no sample collected) (0'-5')	B7-1		60"	6"		-Concrete seal 0'-0.5' -Bentonite seal 0.5'-1' -Silica sand filter pack 1'-12'
5 / 7 / 9 / 11 (2)		***Silty Gravel with Sand*** Light brown Fines (20%), medium to coarse Sand (40%) and Gravel (50%). Very compact, dry. (5'-12')	B7-2	S15	60"	27"		Screen 2'-12'
			B7-3		24"	No Rec.		Well set at 12'
13 / 15 / 17 (4)		***End of Boring/Refusal at 12'***						End of boring/Refusal at 12'



Drill Date: 11/29/2017 Borehole Diameter: 7" Ground Elevation: 0

Drill Method: Geoprobe/Auger Sampler Diameter: 2" Depth to GW: 6.66

Driller: Crawford Drilling Services Well Casing Diameter: N/A Date of Static GW Level: 12/12/2017

GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.
51 Portsmouth Ave.
Exeter, NH 03833
(603)773-0075

Log of Borehole/MW: B-8

Project No.: 17205

Site: Mahoney Garden Center Borehole Location: B-8

Address: 115 Boston Post Road

Client: Eden Management Geologist: MK/LB

SUBSURFACE PROFILE			SAMPLE					
Depth (ft / m)	Symbol	Description	Core ID	Sample ID	Pen (ft)	Rec (ft)	Well Data	Comments
0 / 0		Ground Surface						
		Fill (no sample collected) Moist at 4'. (0'-4')	B8-1		60"	22"		No well set.
		Well graded Sand with Gravel Light brown medium to coarse Sand (50-60%), and Gravel (40-50%). Moist at 7', wet at 13', mottling at 12'. Very compact 5-15'. (4'-15')	B8-2	S16 5'-13'	60"	32"		
			B8-3		60"	24"		
		Silty Sand with Gravel Dark brown fines (50-60%), Sand (25-30%), and Gravel (25%). Very compact, wet. (15'-18')	B8-4	S17 13'-18'	36"	24"		
		End of Boring/Refusal at 18'						

Drill Date: 11/29/2017 Borehole Diameter: 2.5" Ground Elevation: 0

Drill Method: Hollow Stem Auger Sampler Diameter: 2" Depth to GW: N/A

Driller: Crawford Drilling Services Well Casing Diameter: N/A Date of Static GW Level: N/A

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

DEP has provided this form for use by on-site professionals and local Boards of Health. Other forms may be used, but the information must be substantially the same as provided here. Before using this form, check with your local Board of Health to determine the form they use.

A. Facility Information

1. Facility Information

Mahoney's Garden Center, LLC
Owner Name

115 Boston Post Road Map/Lot: Map 30, Lot 071
Street Address

Wayland MA 01778
City/Town State Zip Code

B. Site Information

1. (Check one) New Construction ☒ Upgrade ☐ Repair ☐

2. Published Soil Survey available? Yes ☒ No ☐ If yes: _____ _____ __
Year Published Publication Scale Soil Map Unit

Haven Urban Land Complex (MassGIS) _____
Soil Name Soil limitations

3. Surficial Geological Report available? Yes ☐ No ☒ If yes: _____ _____ _____
Year Published Publication Scale Map Unit

_____ _____
Geologic Material Landform

4. Flood Rate Insurance Map:

Above the 500 year flood boundary? Yes ☒ No ☐ Within the 100 year flood boundary? Yes ☐ No ☒

Within the 500 year flood boundary? Yes ☐ No ☒ Within a Velocity Zone? Yes ☐ No ☒

5. Wetland Area: National Wetland Inventory Map _____ _____
Map Unit Name

Wetlands Conservancy Program Map _____ _____
Map Unit Name

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

6. Current Water Resource Conditions (USGS) December 2016 (Month/Year) Range: Above Normal ☐ Normal ☐ Below Normal ☒

7. Other references reviewed: _____

C. On-Site Review

(*minimum of two holes required at every proposed primary and reserved disposal area)*

Deep Observation Hole Number: December 13, 2016 (Date) AM (Time) Sunny 30s F (Weather)

1. Location

   Ground Elevation at Surface of Hole Varies

   Location (Identify on Plan) See Plan

2. Land Use: Nursery (e.g. woodland, agricultural field, vacant lot, etc.) None (Surface Stones) 3-8% (Slope (%))

   Disturbed (Vegetation) Moraine (Landform) _____ (Position on landscape (attach sheet))

3. Distances from: Open Water Body > 100 feet Drainage Way > 100 feet Possible Wet Area > 100 feet

   Property Line >10 feet Drinking Water Well > 100 feet Other _____

4. Parent Material: Ice Contact Outwash Unsuitable Materials Present: Yes ☒ No ☐

   If Yes: Disturbed Soil☐ Fill Material☒ Impervious Layer(s) ☐ Weathered/Fractured Rock☐ Bedrock ☒

5. Groundwater Observed: Yes ☒ No ☐

   If Yes: Depth Weeping from Pit Varies Depth Standing Water in Hole Varies

   Estimated Depth to High Groundwater: Varies (see Testpits) (inches) _____ (elevation)

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-1

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			

Additional Notes Excavation within buried foundation

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-2

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-42	Fill		38”								
42-60	C_1	2.5 Y 7/6				Very Fine Sand			Single Grain	Loose	
60-108	C_2	2.5 Y 6/6				Sandy Loam			Massive	Friable	

Additional Notes Water Weeping @ 78”, ESHGW = 38”

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-3

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-22	Fill										
22-33	A	10 YR 3/2				Sandy Loam			Massive	Friable	
33-105	C_1	2.5 Y 6/6	58”			Loamy Sand			Single Grain	Loose	

Additional Notes Water Weeping @ 74”, ESHGW=58”

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-4

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-50	Fill										
50-57	A	10 YR 3/2	55”			Sandy Loam			Massive	Friable	
57-72	C_1	2.5 Y 6/3				Coarse Sand			Single Grain	Loose	
72-106	C_2	2.5 Y 6/3				Very Fine Loamy Sand			Single Grain	Loose	

Additional Notes Water Weeping @ 72”, ESHGW=55”

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-5

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-90	Fill										
90-101	A	10 YR 3/2	90”			Sandy Loam			Massive	Friable	
101-132	C	2.5 Y 5/6				Very Fine Loamy Sand			Single Grain	Loose	

Additional Notes Water Standing @ 112”, ESHGW=90”

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: OSE-TP-6

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-13	Fill										
13-24	A	10 YR 3/2				Sandy Loam			Massive	Friable	
24-48	Bw	10 YR 5/6	39”			Sandy Loam			Massive	Friable	
48-108	C_1	2.5 Y 6/6				Sandy Loam			Massive	Friable	

Additional Notes ESHGW=39”

Commonwealth of Massachusetts
City/Town of Brookfield, Massachusetts

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method used:
   - ☒ Depth observed standing water in observation hole A. Varies (inches) B. _ (inches)
   - ☒ Depth weeping from side of observation hole A. Varies (inches) B. _ (inches)
   - ☒ Depth to soil redoximorphic features (mottles) A. Varies (inches) B. _ (inches)
   - ☐ Groundwater adjustment (USGS methodology) A. _____ (inches) B. _____ (inches)

2. Index Well Number _____ Reading Date _____ Index Well Level _____

   Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

   a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes ☒ No ☐

   b. If yes, at what depth was it observed? Upper boundary: Varies (inches) Lower boundary: Varies (inches)

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

_____ Signature of Soil Evaluator

_____ Date

Raymond Willis, P.E. for Onsite Engineering, Inc. Typed or Printed Name of Soil Evaluator/License Number

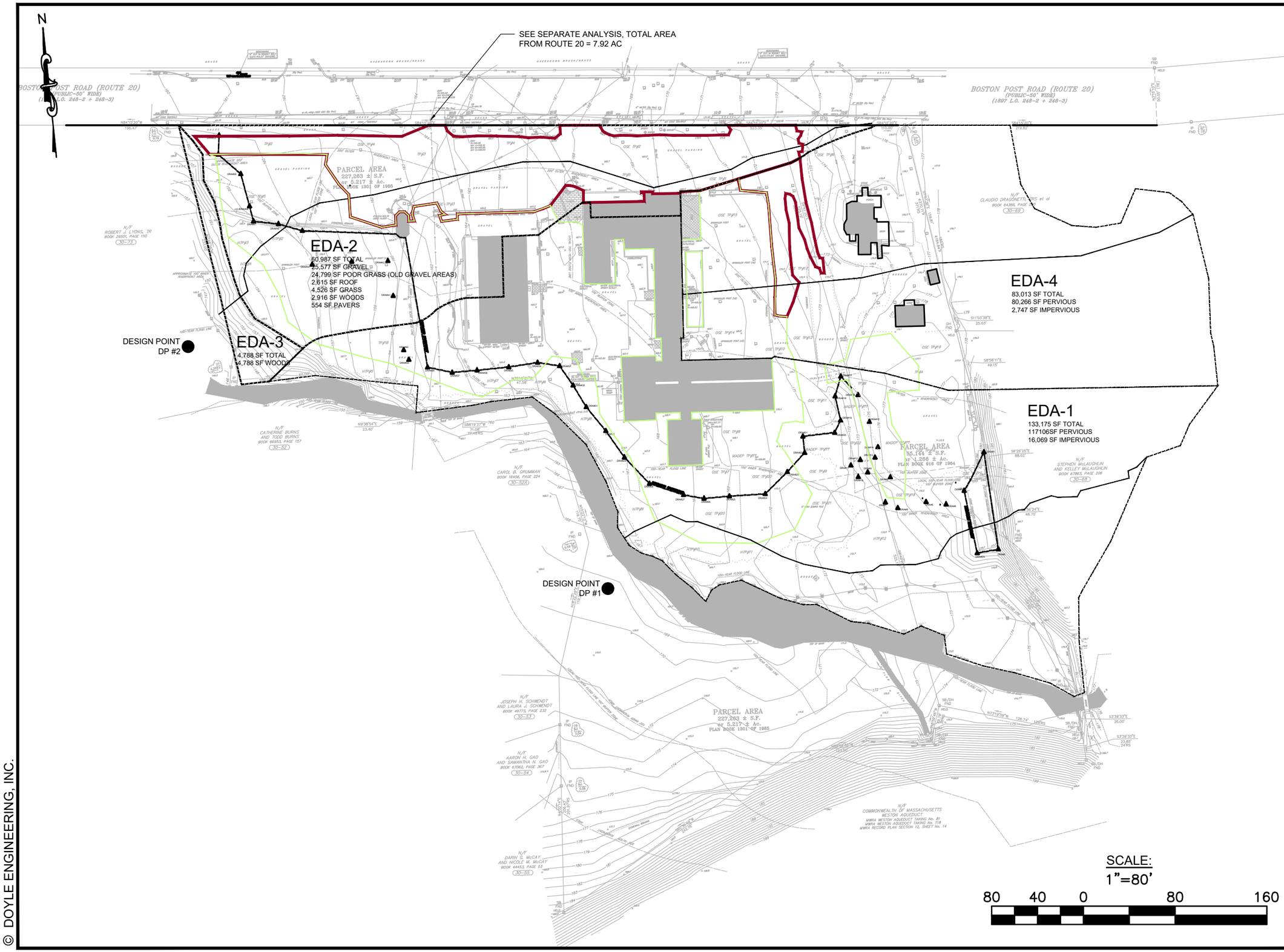
May 1996 *Date of Soil Evaluator Exam

Darren MacCaughey Name of Board of Health Witness

Town of Wayland Board of Health

APPENDIX B

Pre-Development Hydrologic Analysis



C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

113-115 BOSTON POST ROAD
WAYLAND, MA

Watershed Plan

SUB AREA LABEL EX-1

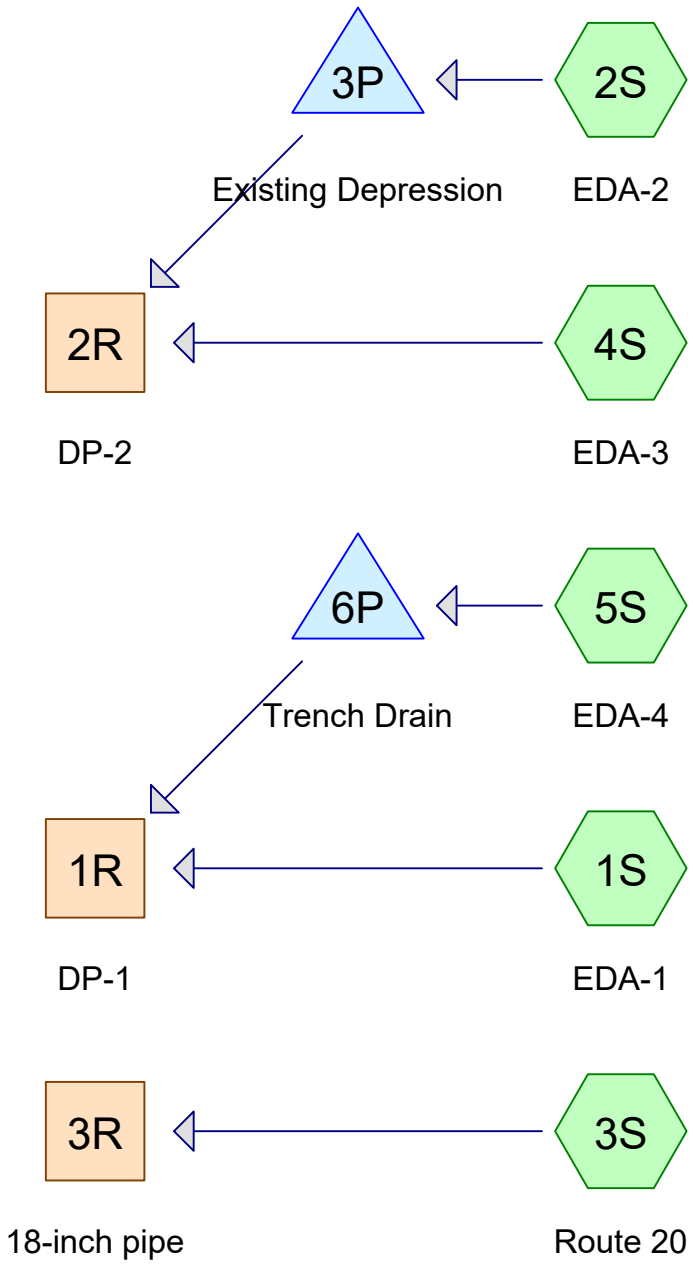
DRAINAGE AREA BOUNDARY - - - - - -

TIME OF CONCENTRATION FLOW TYPES:
SHEET - SHEET FLOW
SC - SHALLOW CONCENTRATED FLOW
CHANNEL - CHANNEL FLOW

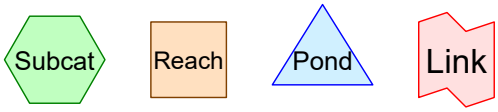
NOTE: IF Tc IS LESS THAN 5 MINUTES, USE 5 MINUTES (MIN. Tc=5 MINUTES)

EXISTING

SCALE: 1"=80' **FIG. 2**



Pre-Development Conditions



Routing Diagram for Existing
Prepared by Doyle Engineering, Printed 10/17/2023
HydroCAD® 10.20-2g s/n 07330 © 2022 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	Middlesex-002yr	Type III 24-hr		Default	24.00	1	3.10	2
2	Middlesex-010yr	Type III 24-hr		Default	24.00	1	4.50	2
3	Middlesex-100yr	Type III 24-hr		Default	24.00	1	7.00	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
7.020	51	1 acre lots, 20% imp, HSG A (3S)
1.739	49	50-75% Grass cover, Fair, HSG A (1S, 2S, 5S)
1.367	68	<50% Grass cover, Poor, HSG A (1S, 5S)
0.104	39	>75% Grass cover, Good, HSG A (2S)
0.587	92	Gravel roads, HSG A (2S)
0.080	76	Gravel roads, HSG A (5S)
0.013	98	Paved parking, HSG A (2S)
0.900	98	Paved roads w/curbs & sewers, HSG A (3S)
0.512	98	Roofs, HSG A (1S, 2S, 5S)
1.868	30	Woods, Good, HSG A (1S, 2S, 4S, 5S)
0.203	77	Woods, Good, HSG D (1S)
14.393	**56**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
14.190	HSG A	1S, 2S, 3S, 4S, 5S
0.000	HSG B	
0.000	HSG C	
0.203	HSG D	1S
0.000	Other	
14.393		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
7.020	0.000	0.000	0.000	0.000	7.020	1 acre lots, 20% imp	3S
1.739	0.000	0.000	0.000	0.000	1.739	50-75% Grass cover, Fair	1S, 2S, 5S
1.367	0.000	0.000	0.000	0.000	1.367	<50% Grass cover, Poor	1S, 5S
0.104	0.000	0.000	0.000	0.000	0.104	>75% Grass cover, Good	2S
0.667	0.000	0.000	0.000	0.000	0.667	Gravel roads	2S, 5S
0.013	0.000	0.000	0.000	0.000	0.013	Paved parking	2S
0.900	0.000	0.000	0.000	0.000	0.900	Paved roads w/curbs & sewers	3S
0.512	0.000	0.000	0.000	0.000	0.512	Roofs	1S, 2S, 5S
1.868	0.000	0.000	0.203	0.000	2.071	Woods, Good	1S, 2S, 4S, 5S
14.190	**0.000**	**0.000**	**0.203**	**0.000**	**14.393**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	3R	159.09	156.60	254.0	0.0098	0.011	0.0	18.0	0.0

Time span=8.00-28.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=133,175 sf 12.07% Impervious Runoff Depth=0.07"
Flow Length=504' Tc=23.7 min CN=48 Runoff=0.03 cfs 0.019 af

Subcatchment 2S: EDA-2 Runoff Area=60,987 sf 5.20% Impervious Runoff Depth=0.68"
Flow Length=632' Tc=11.3 min CN=68 Runoff=0.77 cfs 0.079 af

Subcatchment 3S: Route 20 Runoff Area=344,995 sf 29.09% Impervious Runoff Depth=0.25"
Flow Length=1,440' Slope=0.0320 '/' Tc=7.0 min CN=56 Runoff=0.82 cfs 0.164 af

Subcatchment 4S: EDA-3 Runoff Area=4,788 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment 5S: EDA-4 Runoff Area=83,011 sf 4.36% Impervious Runoff Depth=0.51"
Flow Length=168' Tc=18.4 min CN=64 Runoff=0.58 cfs 0.082 af

Reach 1R: DP-1 Inflow=0.58 cfs 0.102 af
Outflow=0.58 cfs 0.102 af

Reach 2R: DP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach 3R: 18-inch pipe Avg. Flow Depth=0.26' Max Vel=3.95 fps Inflow=0.82 cfs 0.164 af
18.0" Round Pipe n=0.011 L=254.0' S=0.0098 '/' Capacity=12.29 cfs Outflow=0.82 cfs 0.164 af

Pond 3P: Existing Depression Peak Elev=154.65' Storage=960 cf Inflow=0.77 cfs 0.079 af
Discarded=0.18 cfs 0.079 af Primary=0.00 cfs 0.000 af Outflow=0.18 cfs 0.079 af

Pond 6P: Trench Drain Peak Elev=168.42' Storage=11 cf Inflow=0.58 cfs 0.082 af
Discarded=0.00 cfs 0.000 af Primary=0.58 cfs 0.083 af Outflow=0.58 cfs 0.083 af

Total Runoff Area = 14.393 ac Runoff Volume = 0.344 af Average Runoff Depth = 0.29"
80.35% Pervious = 11.564 ac 19.65% Impervious = 2.829 ac

Summary for Subcatchment 1S: EDA-1

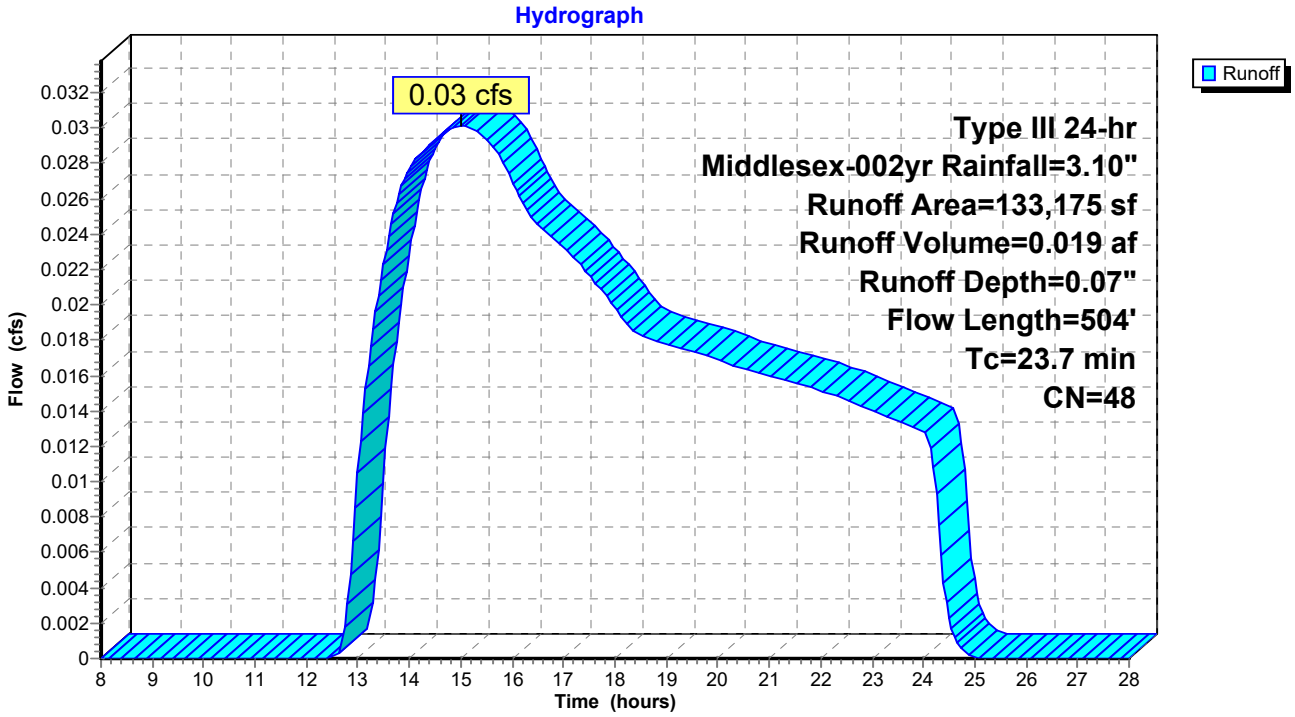
Runoff = 0.03 cfs @ 15.01 hrs, Volume= 0.019 af, Depth= 0.07"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
16,069	98	Roofs, HSG A
2,495	68	<50% Grass cover, Poor, HSG A
67,286	30	Woods, Good, HSG A
8,822	77	Woods, Good, HSG D
38,503	49	50-75% Grass cover, Fair, HSG A
133,175	48	Weighted Average
117,106		87.93% Pervious Area
16,069		12.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, sf1** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		**Shallow Concentrated Flow, SCF4** Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		**Shallow Concentrated Flow, SCF5** Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		**Shallow Concentrated Flow, SCF6** Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		**Shallow Concentrated Flow, SCF7** Woodland Kv= 5.0 fps
23.7	504	Total			

Subcatchment 1S: EDA-1



Summary for Subcatchment 2S: EDA-2

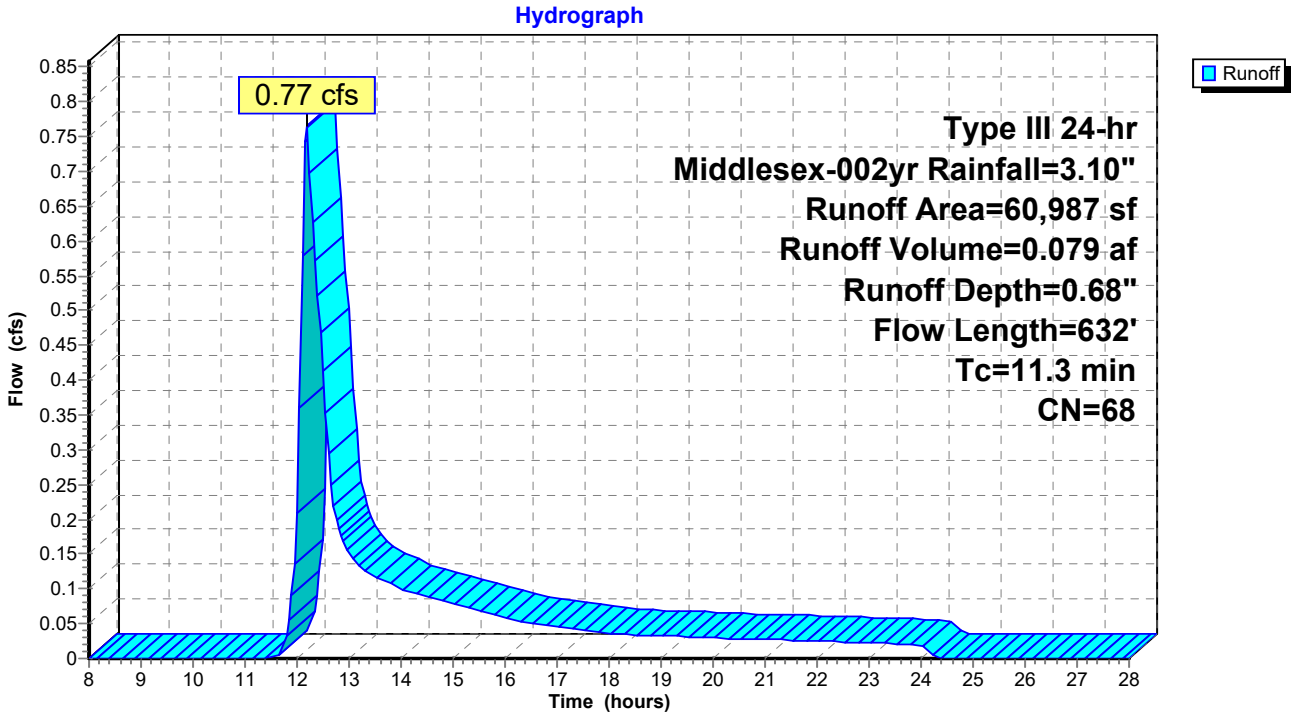
Runoff = 0.77 cfs @ 12.19 hrs, Volume= 0.079 af, Depth= 0.68"
Routed to Pond 3P : Existing Depression

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

	Area (sf)	CN	Description
	24,799	49	50-75% Grass cover, Fair, HSG A
	4,526	39	>75% Grass cover, Good, HSG A
	554	98	Paved parking, HSG A
	2,615	98	Roofs, HSG A
*	25,577	92	Gravel roads, HSG A
	2,916	30	Woods, Good, HSG A
	60,987	68	Weighted Average
	57,818		94.80% Pervious Area
	3,169		5.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
6.3	510	0.0370	1.35		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	72	0.0694	1.84		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
11.3	632	Total			

Subcatchment 2S: EDA-2



Summary for Subcatchment 3S: Route 20

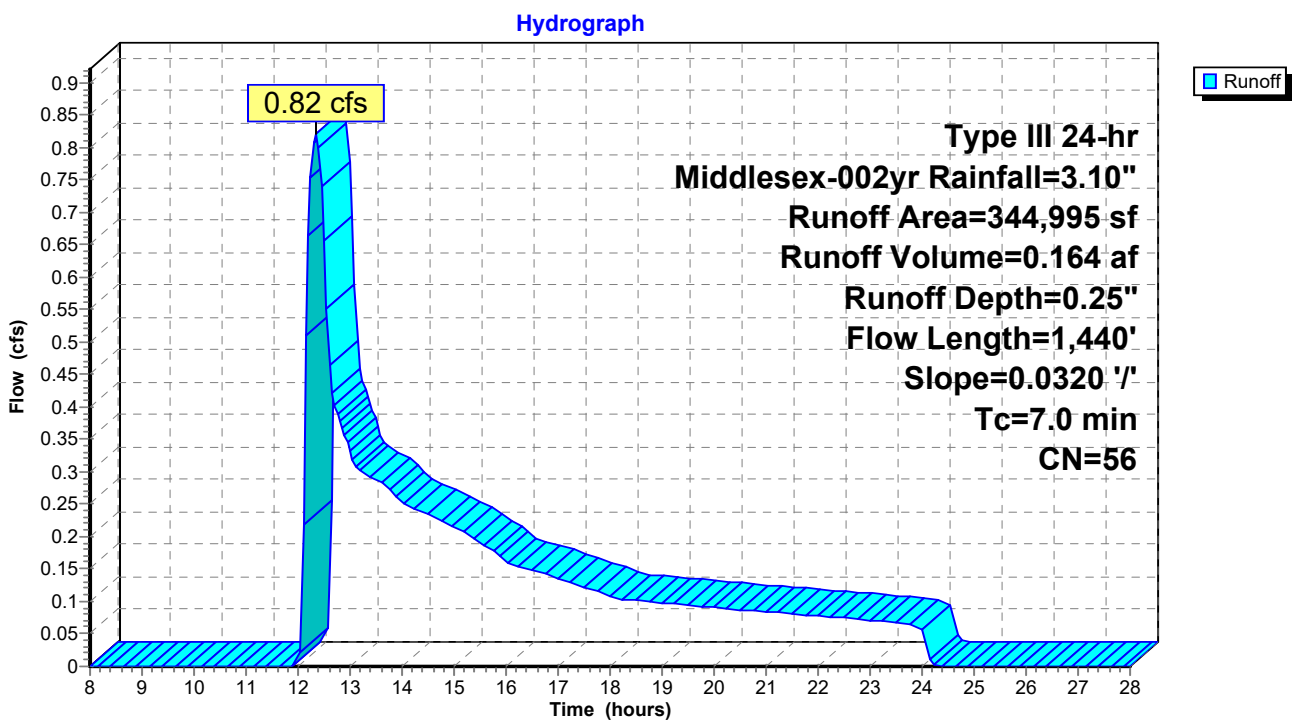
Runoff = 0.82 cfs @ 12.34 hrs, Volume= 0.164 af, Depth= 0.25"
Routed to Reach 3R : 18-inch pipe

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
305,791	51	1 acre lots, 20% imp, HSG A
39,204	98	Paved roads w/curbs & sewers, HSG A
344,995	56	Weighted Average
244,633		70.91% Pervious Area
100,362		29.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0320	1.42		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
6.4	1,390	0.0320	3.63		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
7.0	1,440	Total			

Subcatchment 3S: Route 20



Summary for Subcatchment 4S: EDA-3

[49] Hint: Tc<2dt may require smaller dt
[45] Hint: Runoff=Zero

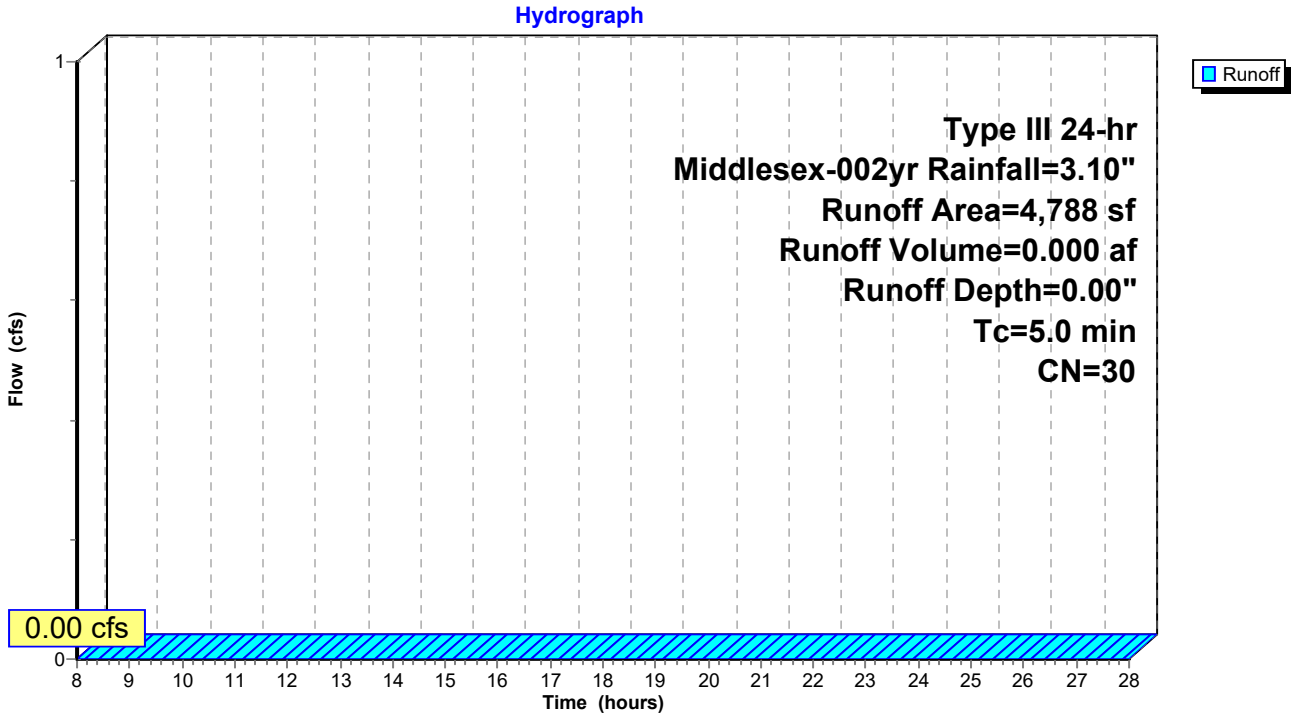
Runoff = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
4,788	30	Woods, Good, HSG A
4,788		100.00% Pervious Area

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

Subcatchment 4S: EDA-3



Summary for Subcatchment 5S: EDA-4

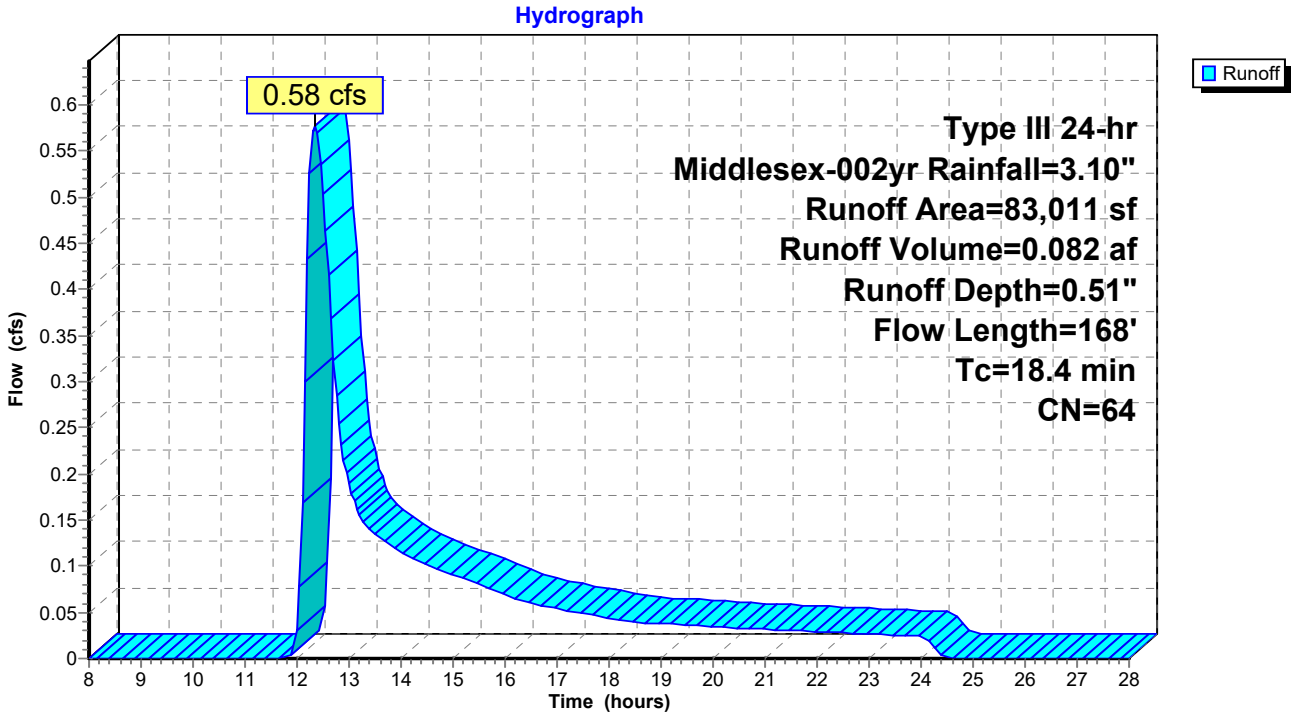
Runoff = 0.58 cfs @ 12.34 hrs, Volume= 0.082 af, Depth= 0.51"
Routed to Pond 6P : Trench Drain

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
3,494	76	Gravel roads, HSG A
3,618	98	Roofs, HSG A
6,385	30	Woods, Good, HSG A
57,050	68	<50% Grass cover, Poor, HSG A
12,464	49	50-75% Grass cover, Fair, HSG A
83,011	64	Weighted Average
79,393		95.64% Pervious Area
3,618		4.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, sf1** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
18.4	168	Total			

Subcatchment 5S: EDA-4



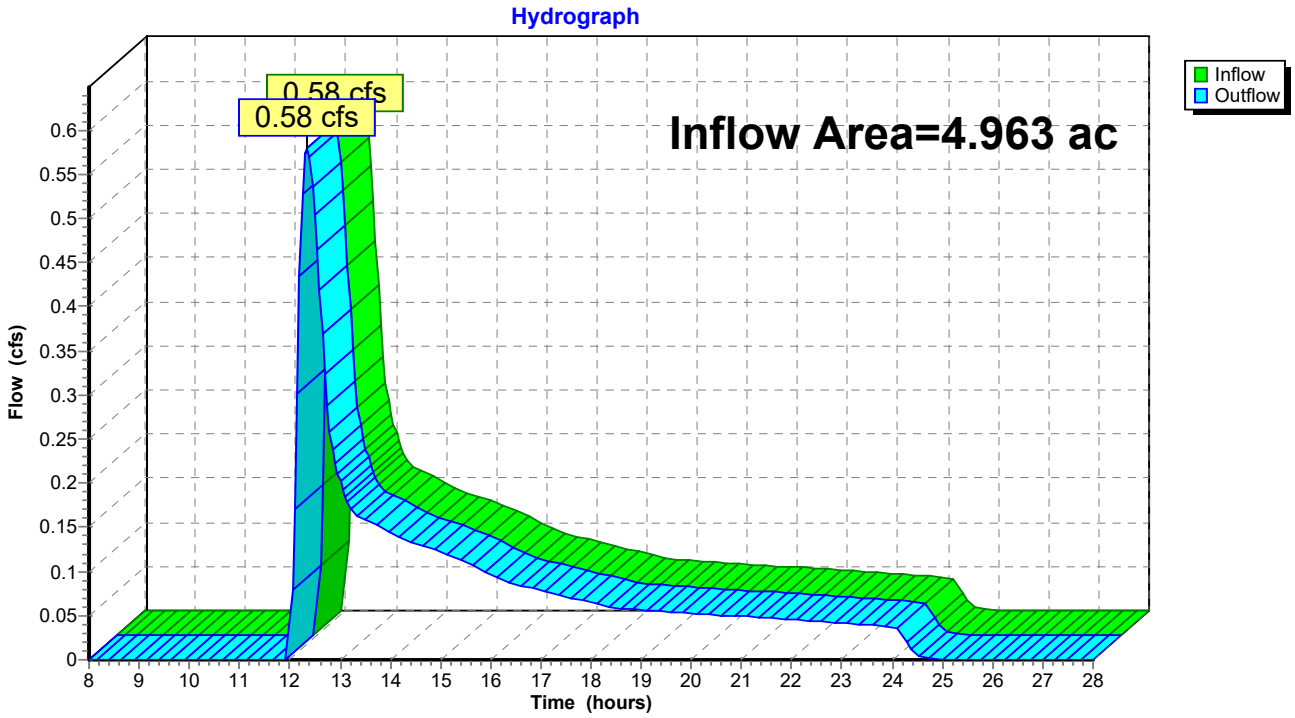
Summary for Reach 1R: DP-1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.963 ac, 9.11% Impervious, Inflow Depth = 0.25" for Middlesex-002yr event
Inflow = 0.58 cfs @ 12.34 hrs, Volume= 0.102 af
Outflow = 0.58 cfs @ 12.34 hrs, Volume= 0.102 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs

Reach 1R: DP-1



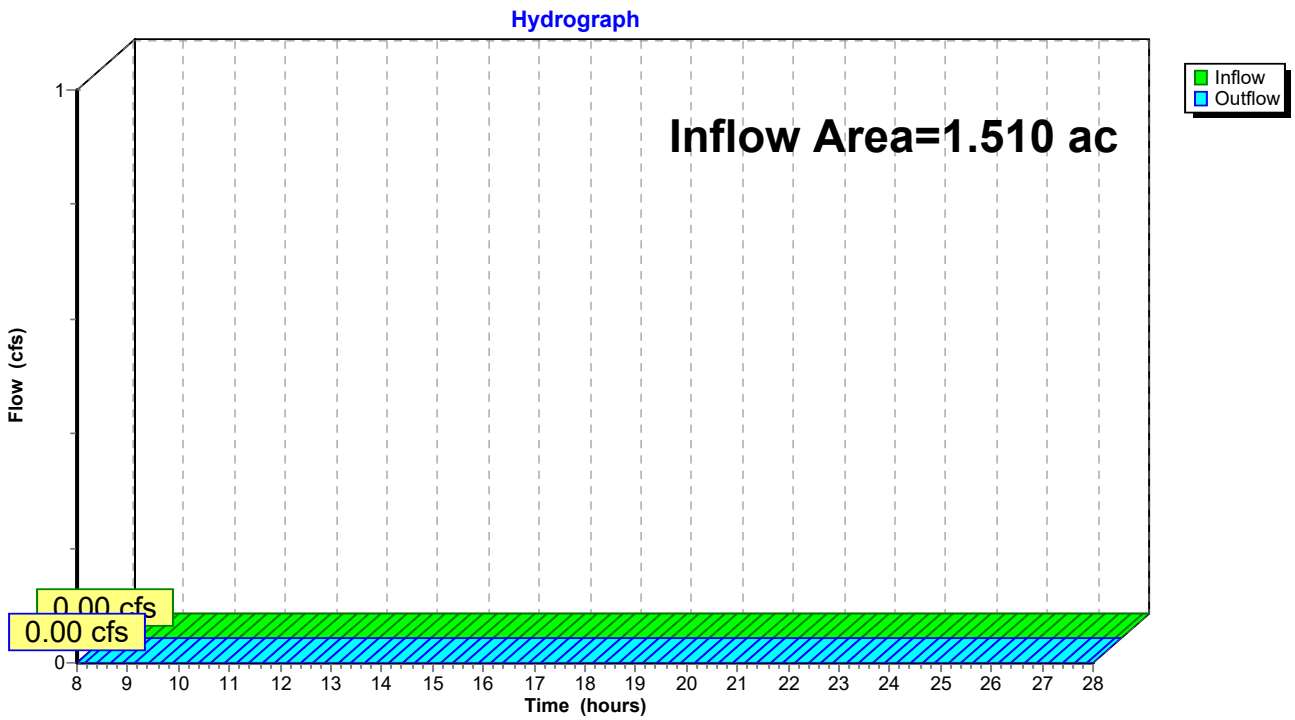
Summary for Reach 2R: DP-2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.510 ac, 4.82% Impervious, Inflow Depth = 0.00" for Middlesex-002yr event
Inflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs

Reach 2R: DP-2



Summary for Reach 3R: 18-inch pipe

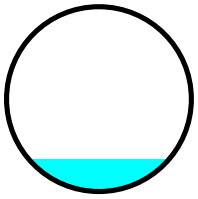
[52] Hint: Inlet/Outlet conditions not evaluated

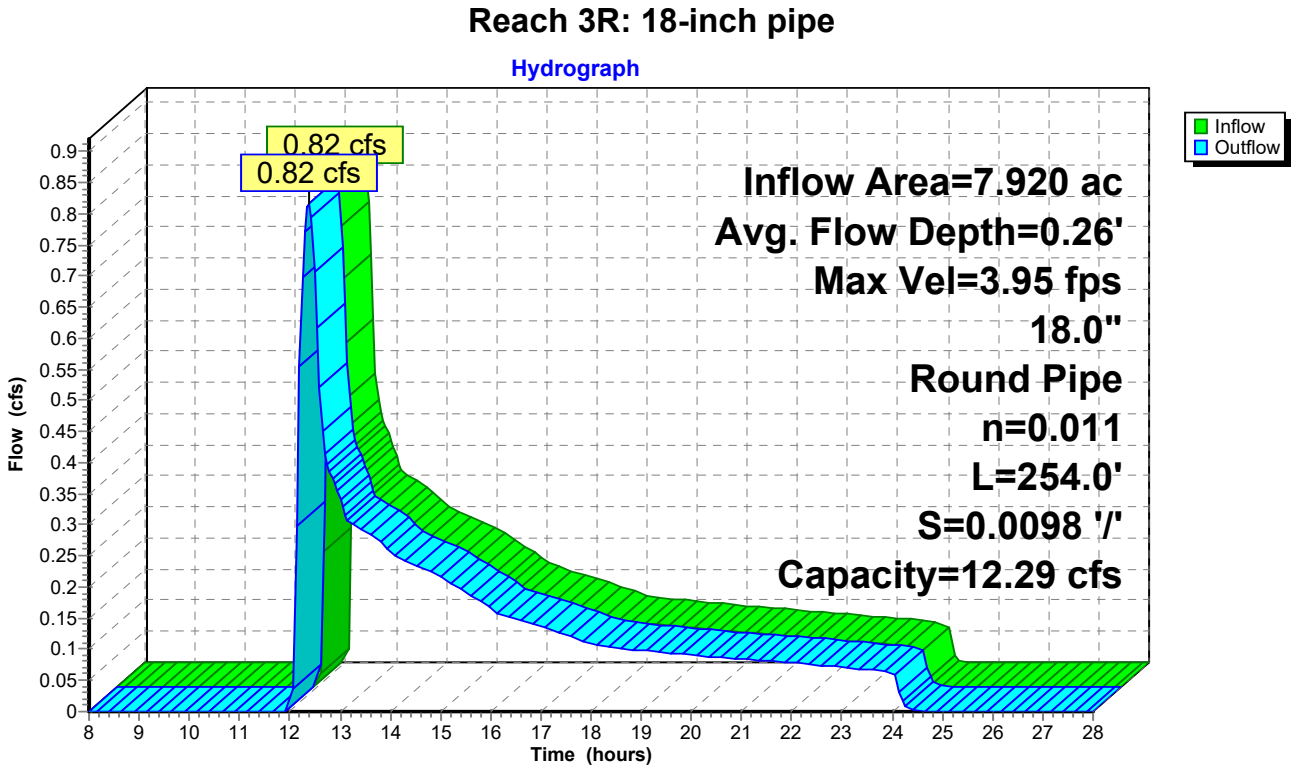
Inflow Area = 7.920 ac, 29.09% Impervious, Inflow Depth = 0.25" for Middlesex-002yr event
Inflow = 0.82 cfs @ 12.34 hrs, Volume= 0.164 af
Outflow = 0.82 cfs @ 12.37 hrs, Volume= 0.164 af, Atten= 1%, Lag= 1.8 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.95 fps, Min. Travel Time= 1.1 min
Avg. Velocity = 2.25 fps, Avg. Travel Time= 1.9 min

Peak Storage= 53 cf @ 12.36 hrs
Average Depth at Peak Storage= 0.26' , Surface Width= 1.14'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 12.29 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 254.0' Slope= 0.0098 '/'
Inlet Invert= 159.09', Outlet Invert= 156.60'





Summary for Pond 3P: Existing Depression

[92] Warning: Device #1 is above defined storage

Inflow Area = 1.400 ac, 5.20% Impervious, Inflow Depth = 0.68" for Middlesex-002yr event
Inflow = 0.77 cfs @ 12.19 hrs, Volume= 0.079 af
Outflow = 0.18 cfs @ 12.84 hrs, Volume= 0.079 af, Atten= 77%, Lag= 39.2 min
Discarded = 0.18 cfs @ 12.84 hrs, Volume= 0.079 af
Primary = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Routed to Reach 2R : DP-2

Routing by Stor-Ind method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 154.65' @ 12.84 hrs Surf.Area= 2,351 sf Storage= 960 cf

Plug-Flow detention time= 58.3 min calculated for 0.079 af (100% of inflow)
Center-of-Mass det. time= 58.2 min (949.0 - 890.7)

Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	1,934 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

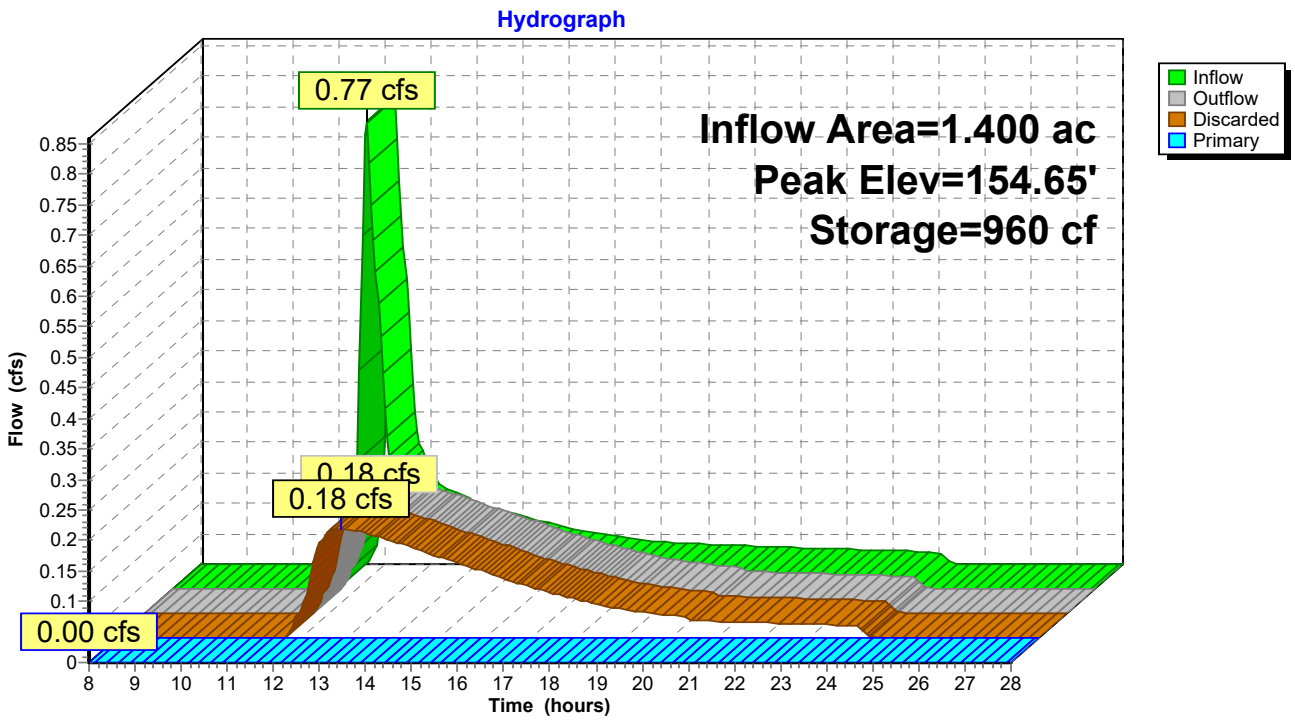
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
154.00	583	0	0
155.00	3,285	1,934	1,934

Device	Routing	Invert	Outlet Devices
#1	Primary	155.00'	**55.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	154.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 153.00'

Discarded OutFlow Max=0.18 cfs @ 12.84 hrs HW=154.65' (Free Discharge)
└**2=Exfiltration** (Controls 0.18 cfs)

Primary OutFlow Max=0.00 cfs @ 8.00 hrs HW=154.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Existing Depression



Summary for Pond 6P: Trench Drain

[92] Warning: Device #2 is above defined storage

Inflow Area = 1.906 ac, 4.36% Impervious, Inflow Depth = 0.51" for Middlesex-002yr event
Inflow = 0.58 cfs @ 12.34 hrs, Volume= 0.082 af
Outflow = 0.58 cfs @ 12.34 hrs, Volume= 0.083 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Primary = 0.58 cfs @ 12.34 hrs, Volume= 0.083 af
Routed to Reach 1R : DP-1

Routing by Stor-Ind method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 168.42' @ 12.34 hrs Surf.Area= 8 sf Storage= 11 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 3.6 min (918.4 - 914.8)

Volume	Invert	Avail.Storage	Storage Description
#1	167.00'	11 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

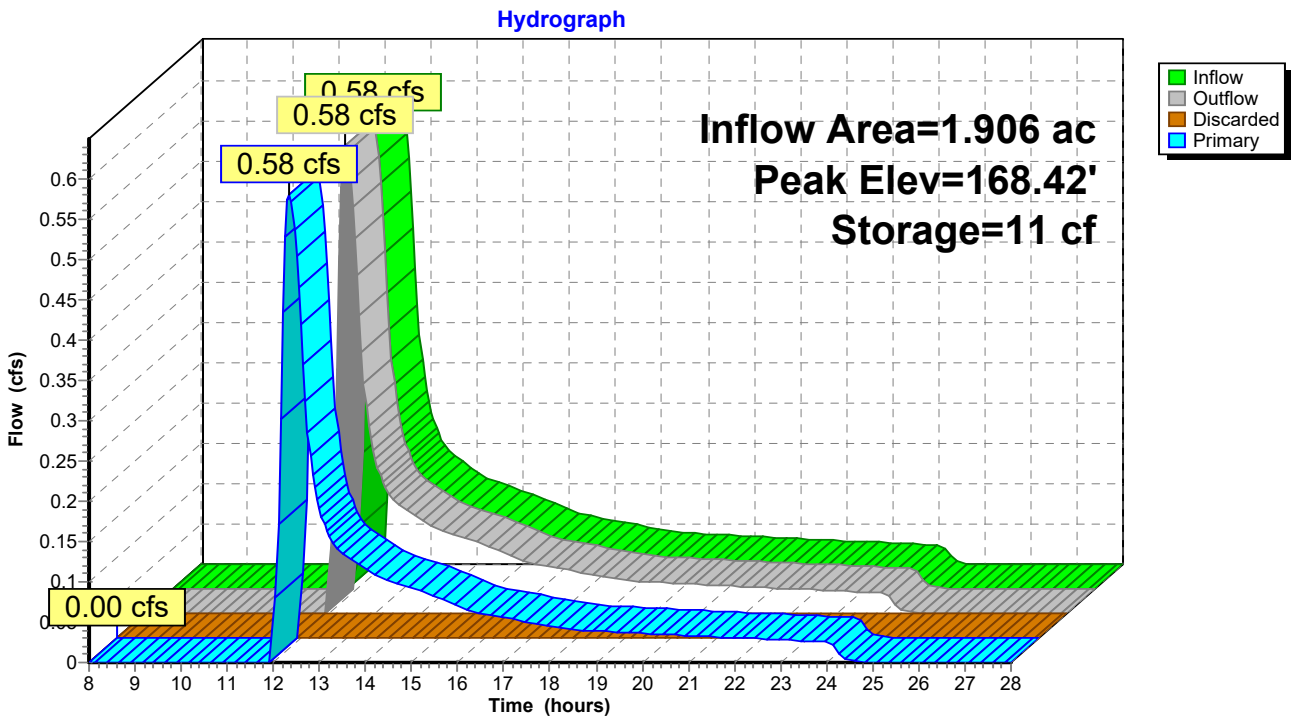
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
167.00	8	0	0
168.42	8	11	11

Device	Routing	Invert	Outlet Devices
#1	Discarded	167.00'	**1.000 in/hr Exfiltration over Surface area above 167.00'** Conductivity to Groundwater Elevation = 150.00' Excluded Surface area = 8 sf
#2	Primary	168.42'	**2.5" x 2.5" Horiz. Orifice/Grate X 6.00 columns** X 12 rows C= 0.600 in 24.0" x 48.0" Grate (39% open area)

Discarded OutFlow Max=0.00 cfs @ 8.00 hrs HW=167.00' (Free Discharge)
└─**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=1.02 cfs @ 12.34 hrs HW=168.42' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 1.02 cfs @ 0.33 fps)

Pond 6P: Trench Drain



Time span=8.00-28.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=133,175 sf 12.07% Impervious Runoff Depth=0.41"
Flow Length=504' Tc=23.7 min CN=48 Runoff=0.47 cfs 0.105 af

Subcatchment 2S: EDA-2 Runoff Area=60,987 sf 5.20% Impervious Runoff Depth=1.53"
Flow Length=632' Tc=11.3 min CN=68 Runoff=1.99 cfs 0.179 af

Subcatchment 3S: Route 20 Runoff Area=344,995 sf 29.09% Impervious Runoff Depth=0.80"
Flow Length=1,440' Slope=0.0320 '/' Tc=7.0 min CN=56 Runoff=5.19 cfs 0.525 af

Subcatchment 4S: EDA-3 Runoff Area=4,788 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment 5S: EDA-4 Runoff Area=83,011 sf 4.36% Impervious Runoff Depth=1.27"
Flow Length=168' Tc=18.4 min CN=64 Runoff=1.78 cfs 0.201 af

Reach 1R: DP-1 Inflow=2.01 cfs 0.290 af
Outflow=2.01 cfs 0.290 af

Reach 2R: DP-2 Inflow=0.10 cfs 0.000 af
Outflow=0.10 cfs 0.000 af

Reach 3R: 18-inch pipe Avg. Flow Depth=0.68' Max Vel=6.67 fps Inflow=5.19 cfs 0.525 af
18.0" Round Pipe n=0.011 L=254.0' S=0.0098 '/' Capacity=12.29 cfs Outflow=5.14 cfs 0.525 af

Pond 3P: Existing Depression Peak Elev=155.01' Storage=1,934 cf Inflow=1.99 cfs 0.179 af
Discarded=0.27 cfs 0.155 af Primary=0.10 cfs 0.000 af Outflow=0.37 cfs 0.156 af

Pond 6P: Trench Drain Peak Elev=168.43' Storage=11 cf Inflow=1.78 cfs 0.201 af
Discarded=0.00 cfs 0.000 af Primary=1.77 cfs 0.185 af Outflow=1.77 cfs 0.185 af

Total Runoff Area = 14.393 ac Runoff Volume = 1.010 af Average Runoff Depth = 0.84"
80.35% Pervious = 11.564 ac 19.65% Impervious = 2.829 ac

Summary for Subcatchment 1S: EDA-1

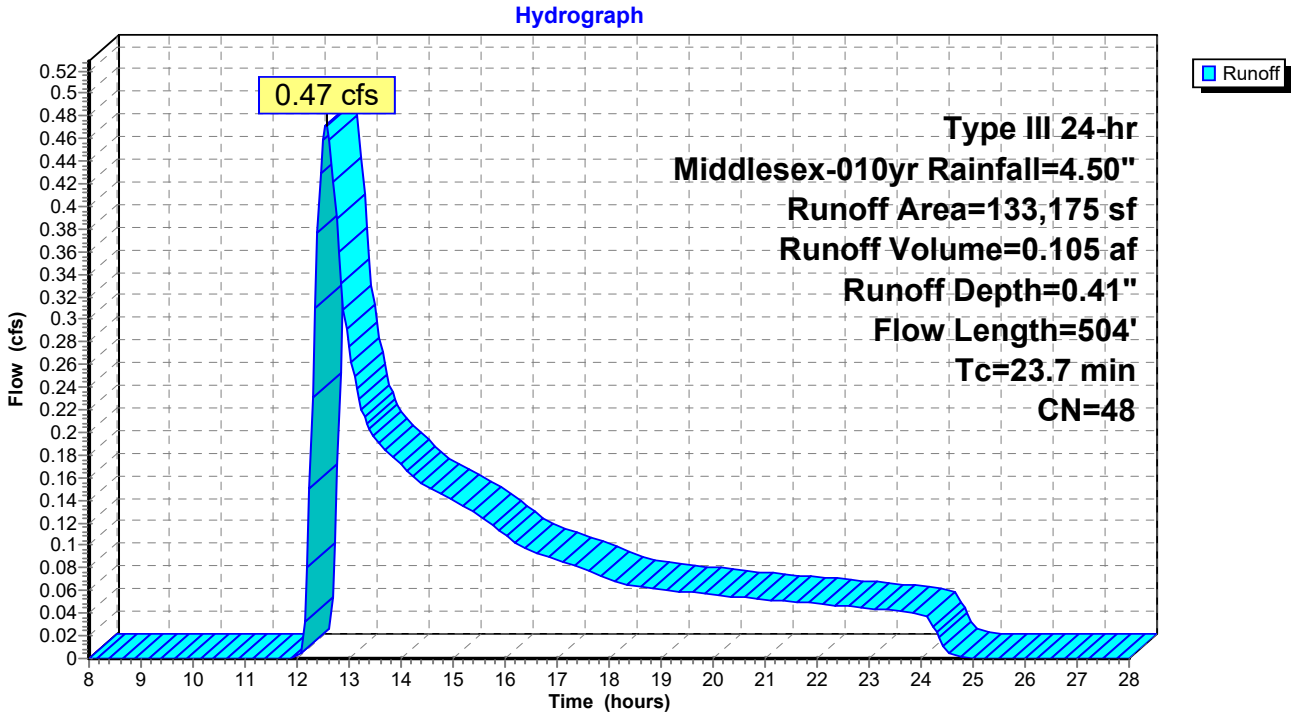
Runoff = 0.47 cfs @ 12.56 hrs, Volume= 0.105 af, Depth= 0.41"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
16,069	98	Roofs, HSG A
2,495	68	<50% Grass cover, Poor, HSG A
67,286	30	Woods, Good, HSG A
8,822	77	Woods, Good, HSG D
38,503	49	50-75% Grass cover, Fair, HSG A
133,175	48	Weighted Average
117,106		87.93% Pervious Area
16,069		12.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, sf1** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		**Shallow Concentrated Flow, SCF4** Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		**Shallow Concentrated Flow, SCF5** Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		**Shallow Concentrated Flow, SCF6** Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		**Shallow Concentrated Flow, SCF7** Woodland Kv= 5.0 fps
23.7	504	Total			

Subcatchment 1S: EDA-1



Summary for Subcatchment 2S: EDA-2

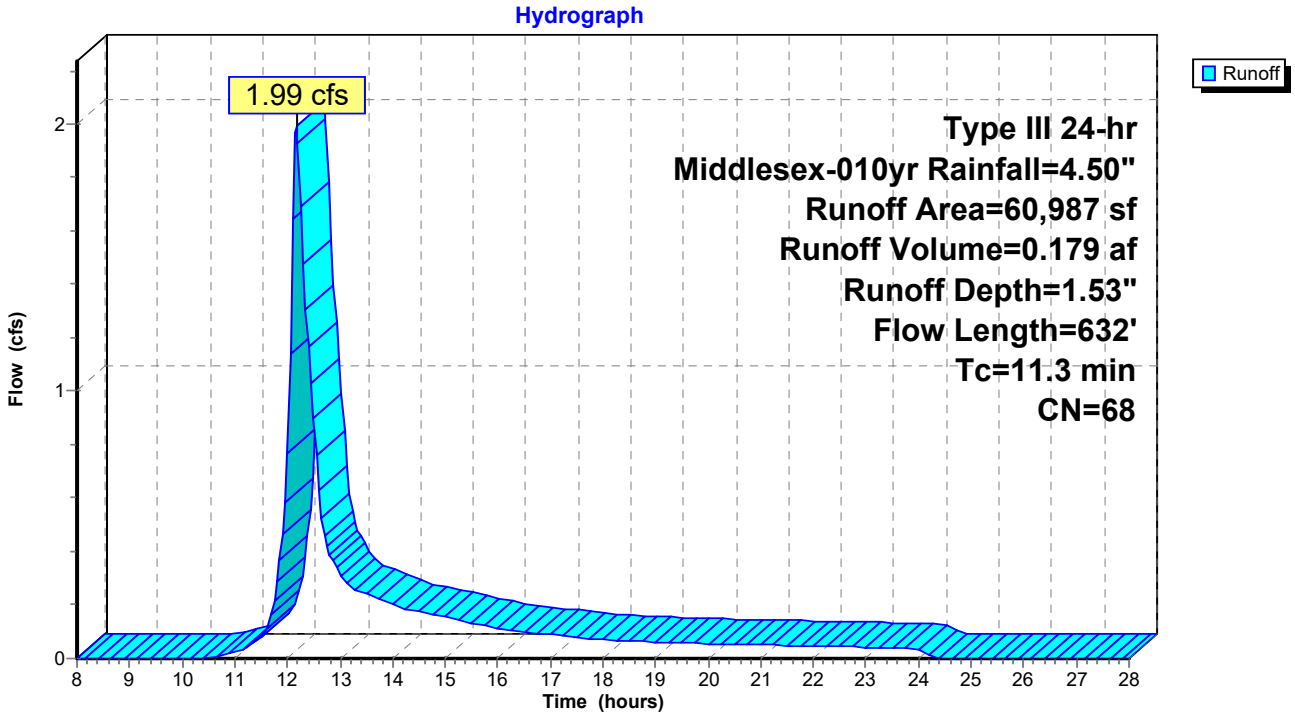
Runoff = 1.99 cfs @ 12.17 hrs, Volume= 0.179 af, Depth= 1.53"
Routed to Pond 3P : Existing Depression

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

	Area (sf)	CN	Description
	24,799	49	50-75% Grass cover, Fair, HSG A
	4,526	39	>75% Grass cover, Good, HSG A
	554	98	Paved parking, HSG A
	2,615	98	Roofs, HSG A
*	25,577	92	Gravel roads, HSG A
	2,916	30	Woods, Good, HSG A
	60,987	68	Weighted Average
	57,818		94.80% Pervious Area
	3,169		5.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
6.3	510	0.0370	1.35		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	72	0.0694	1.84		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
11.3	632	Total			

Subcatchment 2S: EDA-2



Summary for Subcatchment 3S: Route 20

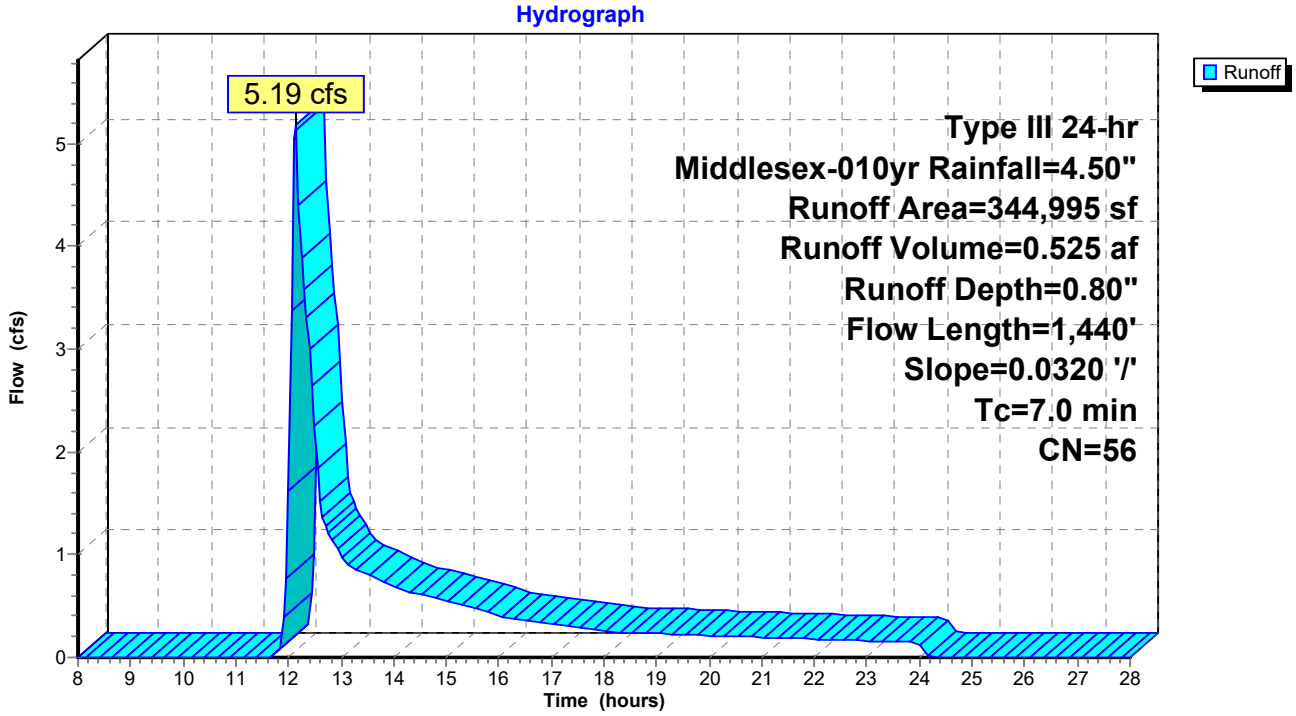
Runoff = 5.19 cfs @ 12.13 hrs, Volume= 0.525 af, Depth= 0.80"
Routed to Reach 3R : 18-inch pipe

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
305,791	51	1 acre lots, 20% imp, HSG A
39,204	98	Paved roads w/curbs & sewers, HSG A
344,995	56	Weighted Average
244,633		70.91% Pervious Area
100,362		29.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0320	1.42		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
6.4	1,390	0.0320	3.63		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
7.0	1,440	Total			

Subcatchment 3S: Route 20



Summary for Subcatchment 4S: EDA-3

[49] Hint: Tc<2dt may require smaller dt
[45] Hint: Runoff=Zero

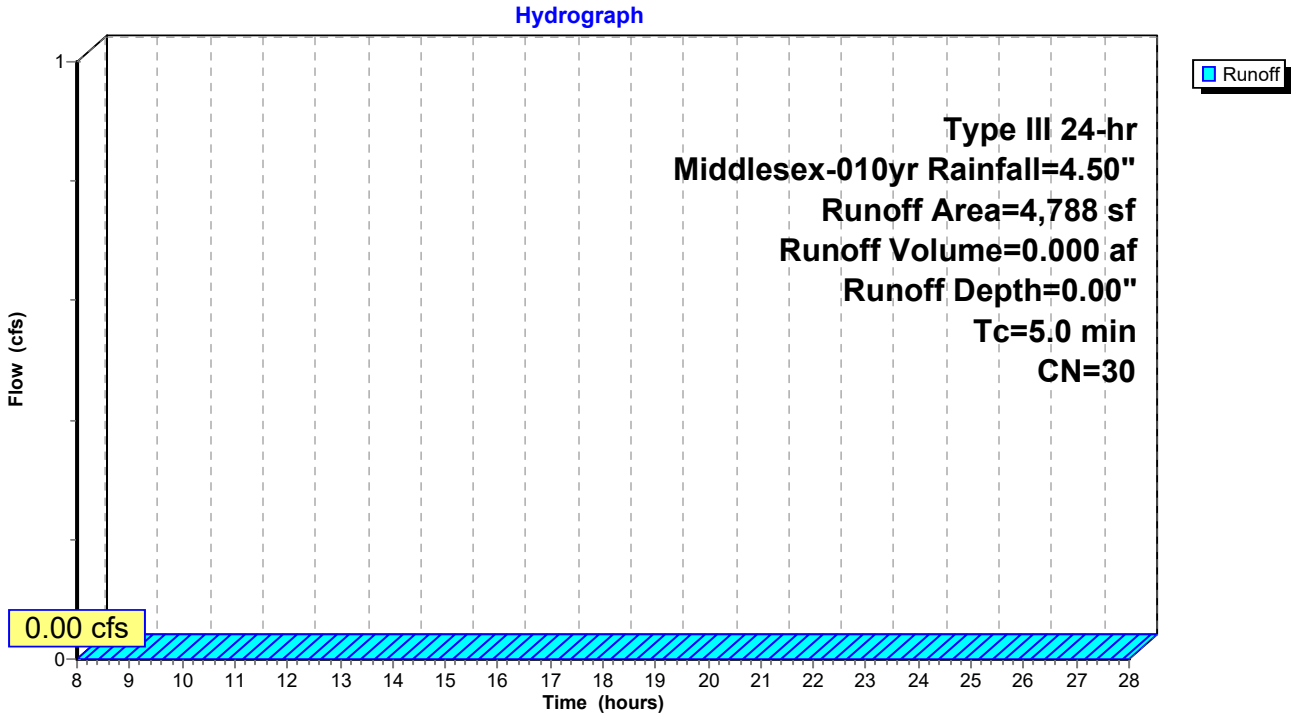
Runoff = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
4,788	30	Woods, Good, HSG A
4,788		100.00% Pervious Area

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

Subcatchment 4S: EDA-3



Summary for Subcatchment 5S: EDA-4

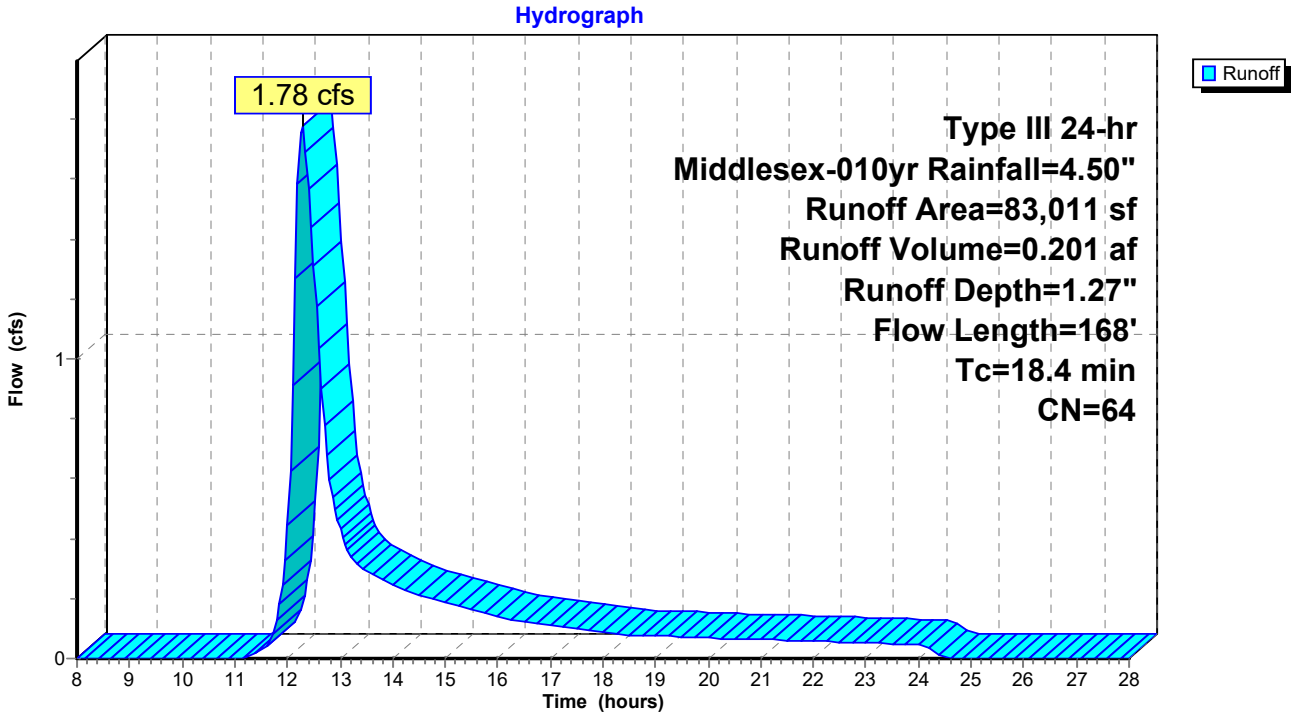
Runoff = 1.78 cfs @ 12.28 hrs, Volume= 0.201 af, Depth= 1.27"
Routed to Pond 6P : Trench Drain

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
3,494	76	Gravel roads, HSG A
3,618	98	Roofs, HSG A
6,385	30	Woods, Good, HSG A
57,050	68	<50% Grass cover, Poor, HSG A
12,464	49	50-75% Grass cover, Fair, HSG A
83,011	64	Weighted Average
79,393		95.64% Pervious Area
3,618		4.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, sf1** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
18.4	168	Total			

Subcatchment 5S: EDA-4



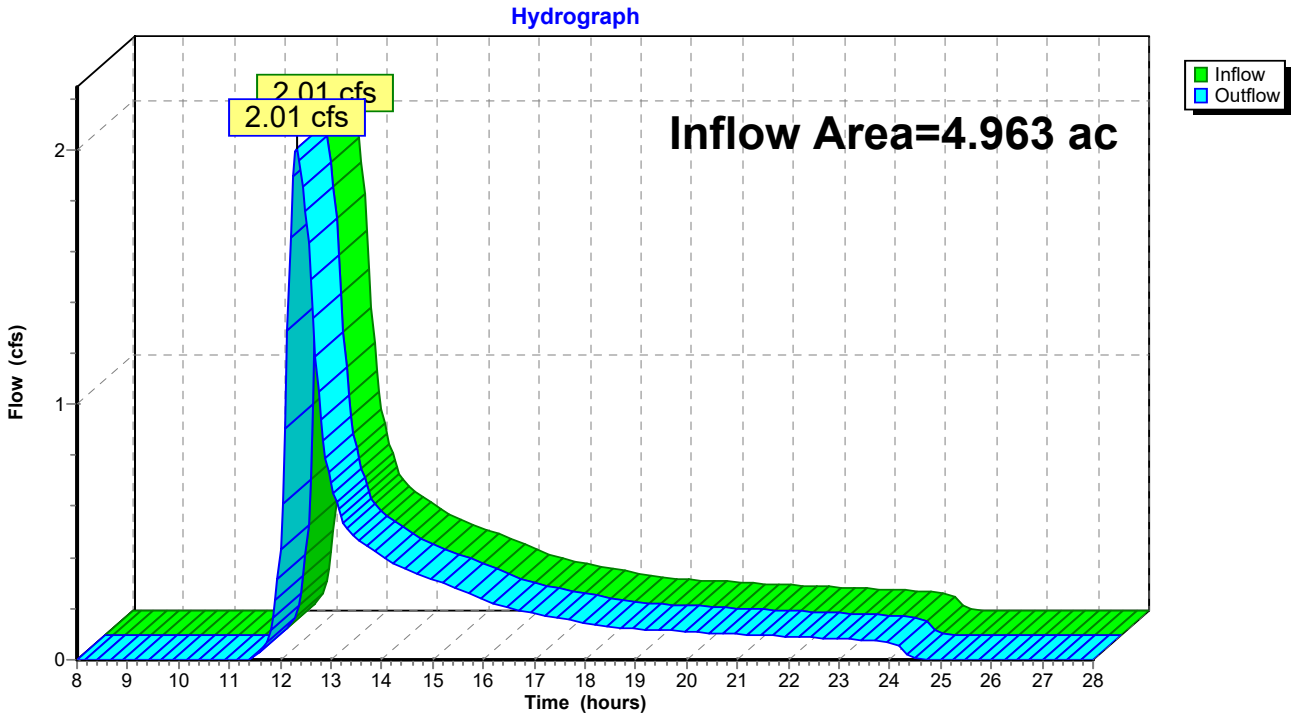
Summary for Reach 1R: DP-1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	4.963 ac,	9.11% Impervious,	Inflow Depth =	0.70"	for Middlesex-010yr event
Inflow =	2.01 cfs @	12.32 hrs,	Volume=	0.290 af	
Outflow =	2.01 cfs @	12.32 hrs,	Volume=	0.290 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs

Reach 1R: DP-1



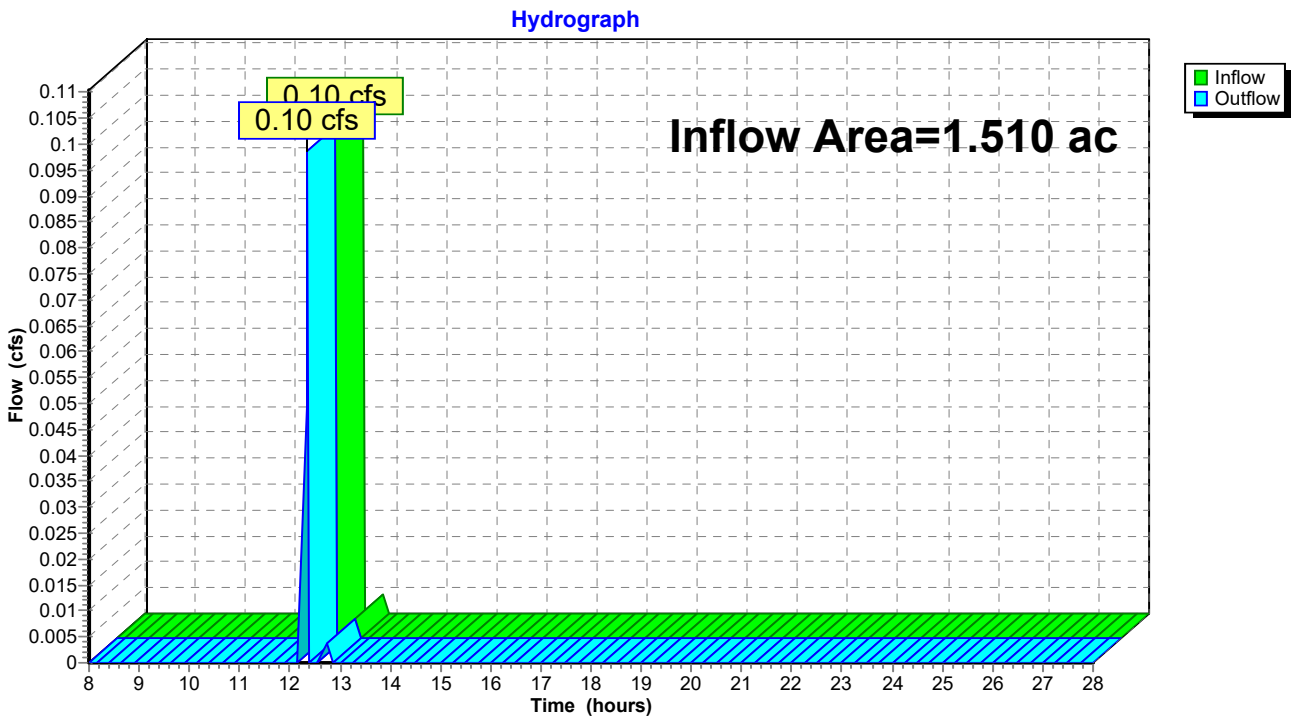
Summary for Reach 2R: DP-2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.510 ac, 4.82% Impervious, Inflow Depth = 0.00" for Middlesex-010yr event
Inflow = 0.10 cfs @ 12.35 hrs, Volume= 0.000 af
Outflow = 0.10 cfs @ 12.35 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs

Reach 2R: DP-2



Summary for Reach 3R: 18-inch pipe

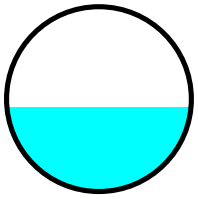
[52] Hint: Inlet/Outlet conditions not evaluated

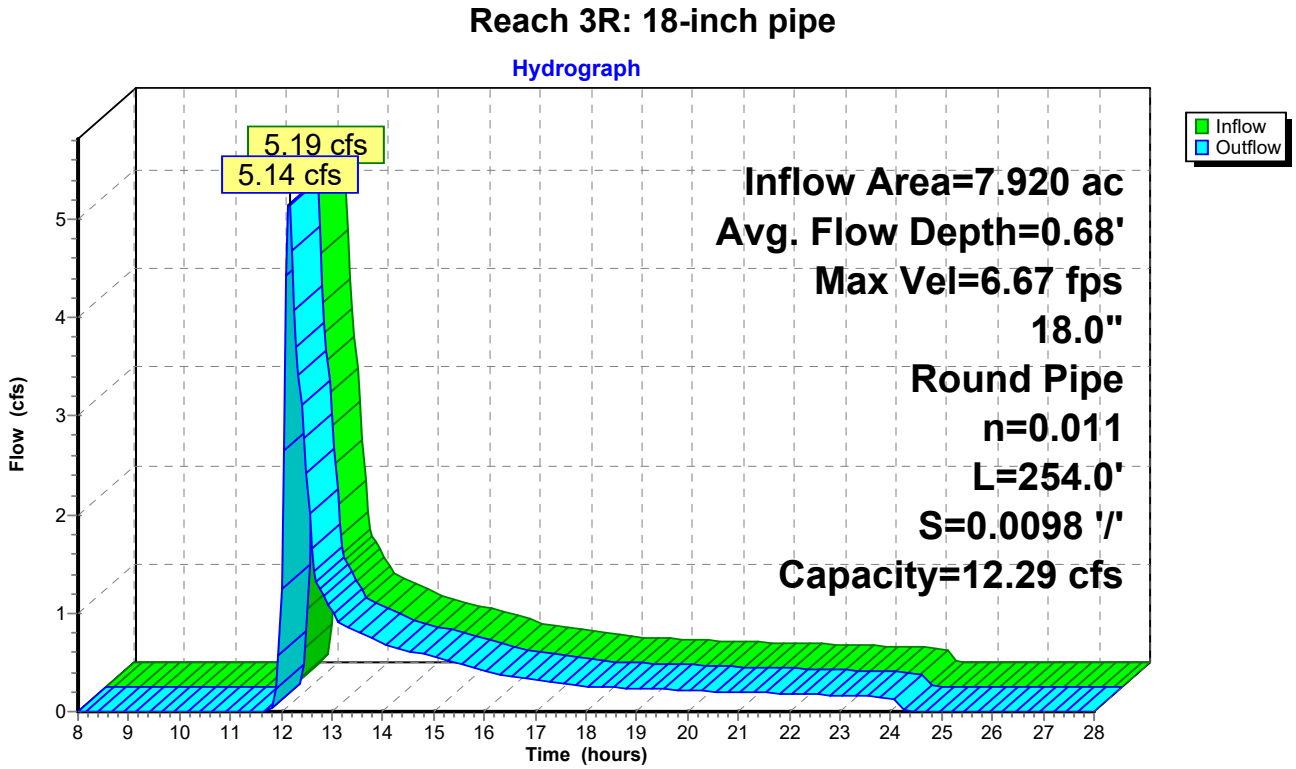
Inflow Area = 7.920 ac, 29.09% Impervious, Inflow Depth = 0.80" for Middlesex-010yr event
Inflow = 5.19 cfs @ 12.13 hrs, Volume= 0.525 af
Outflow = 5.14 cfs @ 12.16 hrs, Volume= 0.525 af, Atten= 1%, Lag= 1.5 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Max. Velocity= 6.67 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 3.00 fps, Avg. Travel Time= 1.4 min

Peak Storage= 199 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.68' , Surface Width= 1.49'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 12.29 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 254.0' Slope= 0.0098 '/'
Inlet Invert= 159.09', Outlet Invert= 156.60'





Summary for Pond 3P: Existing Depression

[92] Warning: Device #1 is above defined storage
[93] Warning: Storage range exceeded by 0.01'

Inflow Area = 1.400 ac, 5.20% Impervious, Inflow Depth = 1.53" for Middlesex-010yr event
Inflow = 1.99 cfs @ 12.17 hrs, Volume= 0.179 af
Outflow = 0.37 cfs @ 12.35 hrs, Volume= 0.156 af, Atten= 81%, Lag= 10.9 min
Discarded = 0.27 cfs @ 12.36 hrs, Volume= 0.155 af
Primary = 0.10 cfs @ 12.35 hrs, Volume= 0.000 af
Routed to Reach 2R : DP-2

Routing by Stor-Ind method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 155.01' @ 12.35 hrs Surf.Area= 3,285 sf Storage= 1,934 cf

Plug-Flow detention time= 163.6 min calculated for 0.155 af (87% of inflow)
Center-of-Mass det. time= 104.5 min (968.5 - 864.0)

Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	1,934 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

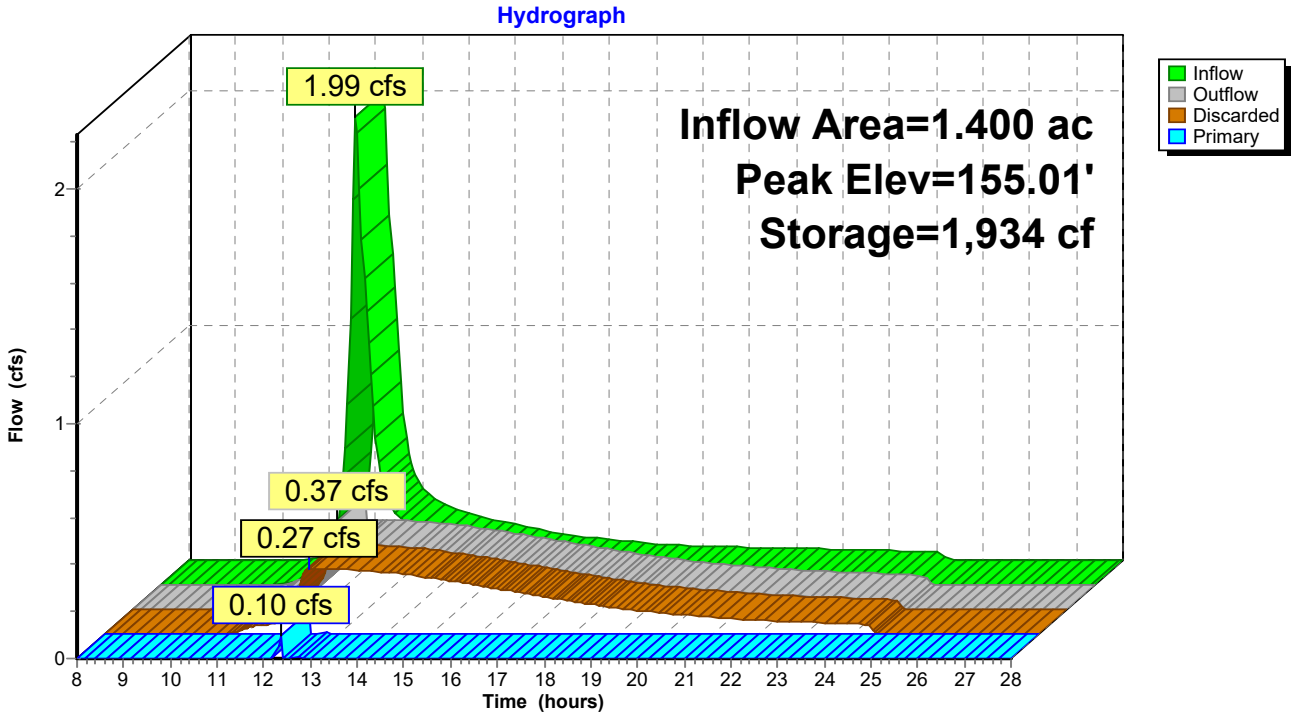
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
154.00	583	0	0
155.00	3,285	1,934	1,934

Device	Routing	Invert	Outlet Devices
#1	Primary	155.00'	**55.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	154.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 153.00'

Discarded OutFlow Max=0.27 cfs @ 12.36 hrs HW=155.01' (Free Discharge)
└─**2=Exfiltration** (Controls 0.27 cfs)

Primary OutFlow Max=0.09 cfs @ 12.35 hrs HW=155.01' (Free Discharge)
└─**1=Broad-Crested Rectangular Weir** (Weir Controls 0.09 cfs @ 0.20 fps)

Pond 3P: Existing Depression



Summary for Pond 6P: Trench Drain

[92] Warning: Device #2 is above defined storage
[93] Warning: Storage range exceeded by 0.01'

Inflow Area = 1.906 ac, 4.36% Impervious, Inflow Depth = 1.27" for Middlesex-010yr event
Inflow = 1.78 cfs @ 12.28 hrs, Volume= 0.201 af
Outflow = 1.77 cfs @ 12.28 hrs, Volume= 0.185 af, Atten= 1%, Lag= 0.0 min
Discarded = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Primary = 1.77 cfs @ 12.28 hrs, Volume= 0.185 af
Routed to Reach 1R : DP-1

Routing by Stor-Ind method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 168.43' @ 12.28 hrs Surf.Area= 8 sf Storage= 11 cf

Plug-Flow detention time= 23.0 min calculated for 0.185 af (92% of inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	167.00'	11 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

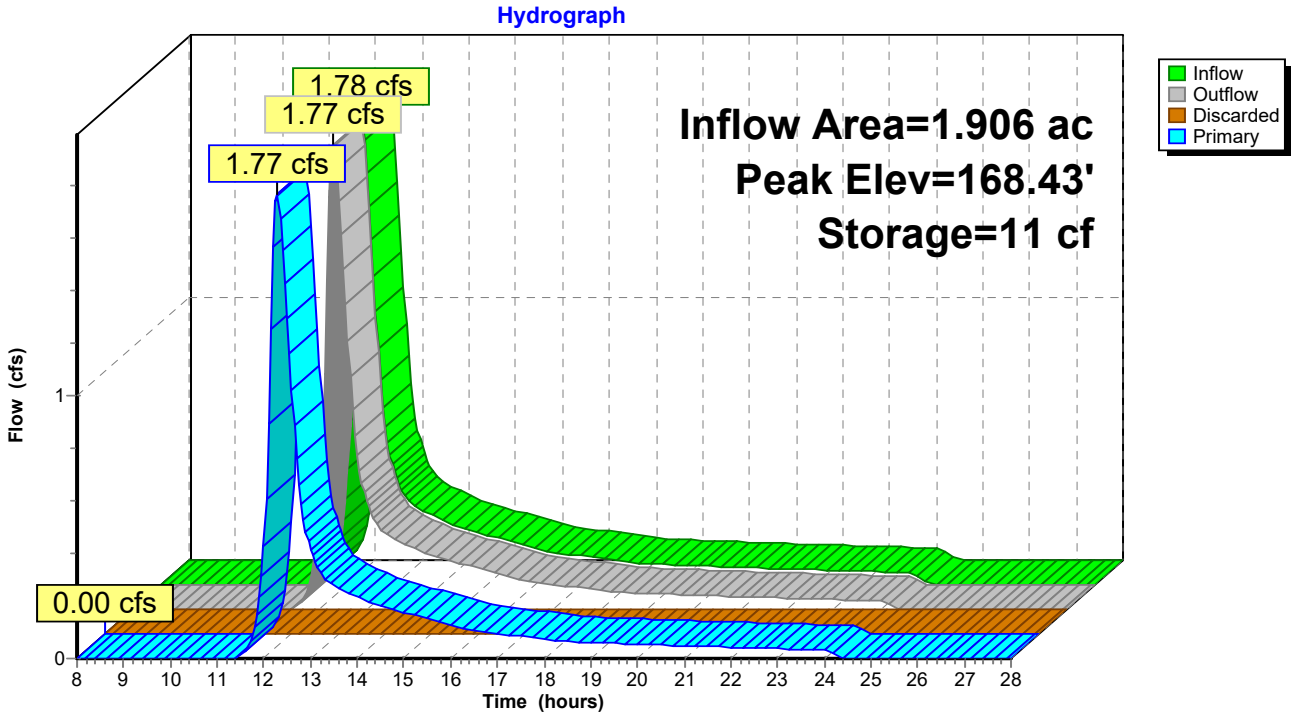
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
167.00	8	0	0
168.42	8	11	11

Device	Routing	Invert	Outlet Devices
#1	Discarded	167.00'	**1.000 in/hr Exfiltration over Surface area above 167.00'** Conductivity to Groundwater Elevation = 150.00' Excluded Surface area = 8 sf
#2	Primary	168.42'	**2.5" x 2.5" Horiz. Orifice/Grate X 6.00 columns** X 12 rows C= 0.600 in 24.0" x 48.0" Grate (39% open area)

Discarded OutFlow Max=0.00 cfs @ 8.00 hrs HW=167.00' (Free Discharge)
└**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=1.78 cfs @ 12.28 hrs HW=168.43' (Free Discharge)
└**2=Orifice/Grate** (Orifice Controls 1.78 cfs @ 0.57 fps)

Pond 6P: Trench Drain



Time span=8.00-28.00 hrs, dt=0.05 hrs, 401 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: EDA-1 Runoff Area=133,175 sf 12.07% Impervious Runoff Depth=1.49"
Flow Length=504' Tc=23.7 min CN=48 Runoff=2.79 cfs 0.380 af

Subcatchment 2S: EDA-2 Runoff Area=60,987 sf 5.20% Impervious Runoff Depth=3.41"
Flow Length=632' Tc=11.3 min CN=68 Runoff=4.64 cfs 0.398 af

Subcatchment 3S: Route 20 Runoff Area=344,995 sf 29.09% Impervious Runoff Depth=2.22"
Flow Length=1,440' Slope=0.0320 '/' Tc=7.0 min CN=56 Runoff=18.51 cfs 1.464 af

Subcatchment 4S: EDA-3 Runoff Area=4,788 sf 0.00% Impervious Runoff Depth=0.21"
Tc=5.0 min CN=30 Runoff=0.00 cfs 0.002 af

Subcatchment 5S: EDA-4 Runoff Area=83,011 sf 4.36% Impervious Runoff Depth=3.00"
Flow Length=168' Tc=18.4 min CN=64 Runoff=4.59 cfs 0.477 af

Reach 1R: DP-1 Inflow=7.04 cfs 0.839 af
Outflow=7.04 cfs 0.839 af

Reach 2R: DP-2 Inflow=6.03 cfs 0.291 af
Outflow=6.03 cfs 0.291 af

Reach 3R: 18-inch pipe Avg. Flow Depth=1.50' Max Vel=7.76 fps Inflow=18.51 cfs 1.464 af
18.0" Round Pipe n=0.011 L=254.0' S=0.0098 '/' Capacity=12.29 cfs Outflow=12.46 cfs 1.464 af

Pond 3P: Existing Depression Peak Elev=155.13' Storage=1,934 cf Inflow=4.64 cfs 0.398 af
Discarded=0.29 cfs 0.228 af Primary=6.03 cfs 0.289 af Outflow=6.32 cfs 0.517 af

Pond 6P: Trench Drain Peak Elev=168.51' Storage=11 cf Inflow=4.59 cfs 0.477 af
Discarded=0.00 cfs 0.000 af Primary=4.58 cfs 0.459 af Outflow=4.58 cfs 0.459 af

Total Runoff Area = 14.393 ac Runoff Volume = 2.720 af Average Runoff Depth = 2.27"
80.35% Pervious = 11.564 ac 19.65% Impervious = 2.829 ac

Summary for Subcatchment 1S: EDA-1

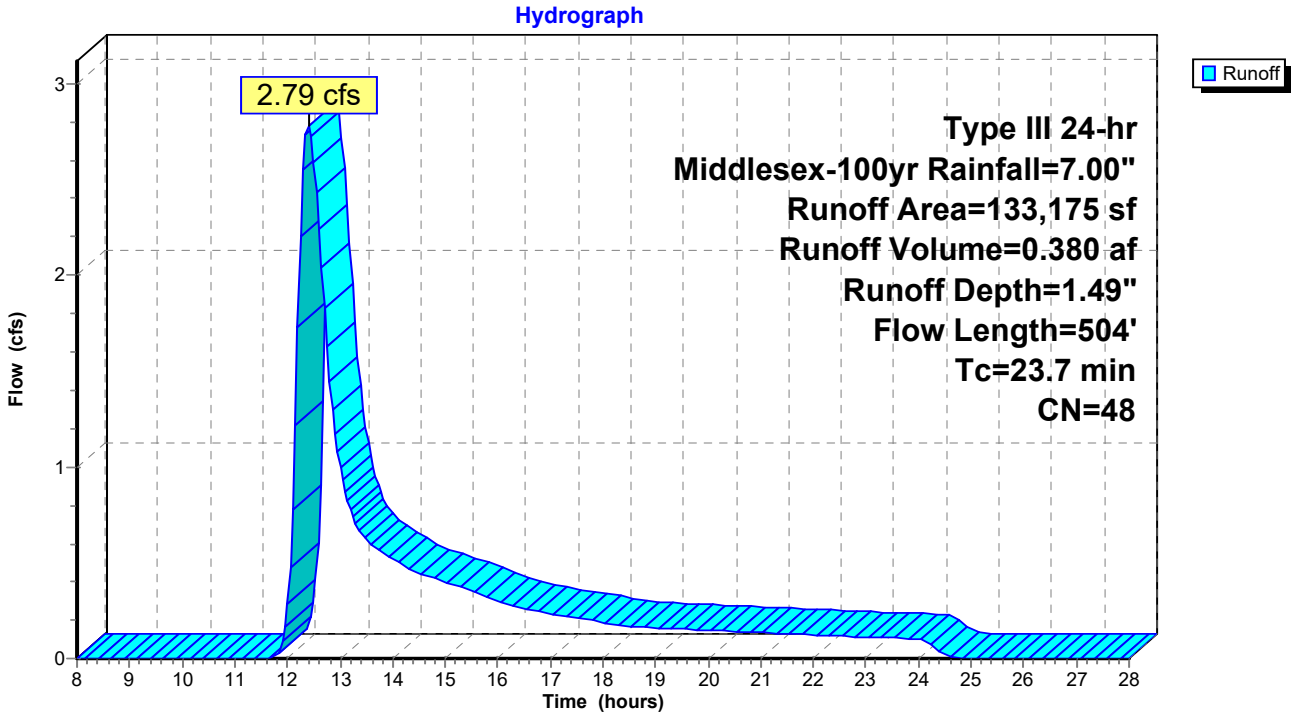
Runoff = 2.79 cfs @ 12.40 hrs, Volume= 0.380 af, Depth= 1.49"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
16,069	98	Roofs, HSG A
2,495	68	<50% Grass cover, Poor, HSG A
67,286	30	Woods, Good, HSG A
8,822	77	Woods, Good, HSG D
38,503	49	50-75% Grass cover, Fair, HSG A
133,175	48	Weighted Average
117,106		87.93% Pervious Area
16,069		12.07% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, sf1** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		**Shallow Concentrated Flow, SCF4** Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		**Shallow Concentrated Flow, SCF5** Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		**Shallow Concentrated Flow, SCF6** Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		**Shallow Concentrated Flow, SCF7** Woodland Kv= 5.0 fps
23.7	504	Total			

Subcatchment 1S: EDA-1



Summary for Subcatchment 2S: EDA-2

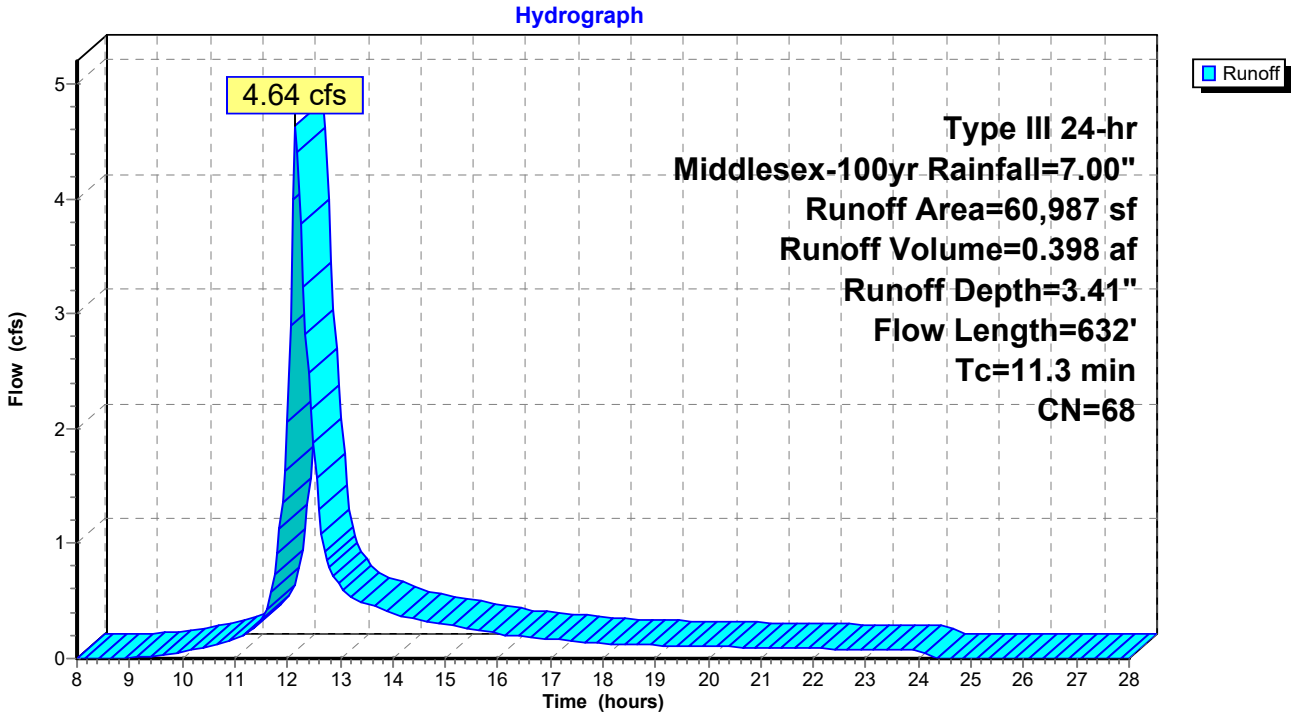
Runoff = 4.64 cfs @ 12.16 hrs, Volume= 0.398 af, Depth= 3.41"
Routed to Pond 3P : Existing Depression

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

	Area (sf)	CN	Description
	24,799	49	50-75% Grass cover, Fair, HSG A
	4,526	39	>75% Grass cover, Good, HSG A
	554	98	Paved parking, HSG A
	2,615	98	Roofs, HSG A
*	25,577	92	Gravel roads, HSG A
	2,916	30	Woods, Good, HSG A
	60,987	68	Weighted Average
	57,818		94.80% Pervious Area
	3,169		5.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.10"
6.3	510	0.0370	1.35		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
0.7	72	0.0694	1.84		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
11.3	632	Total			

Subcatchment 2S: EDA-2



Summary for Subcatchment 3S: Route 20

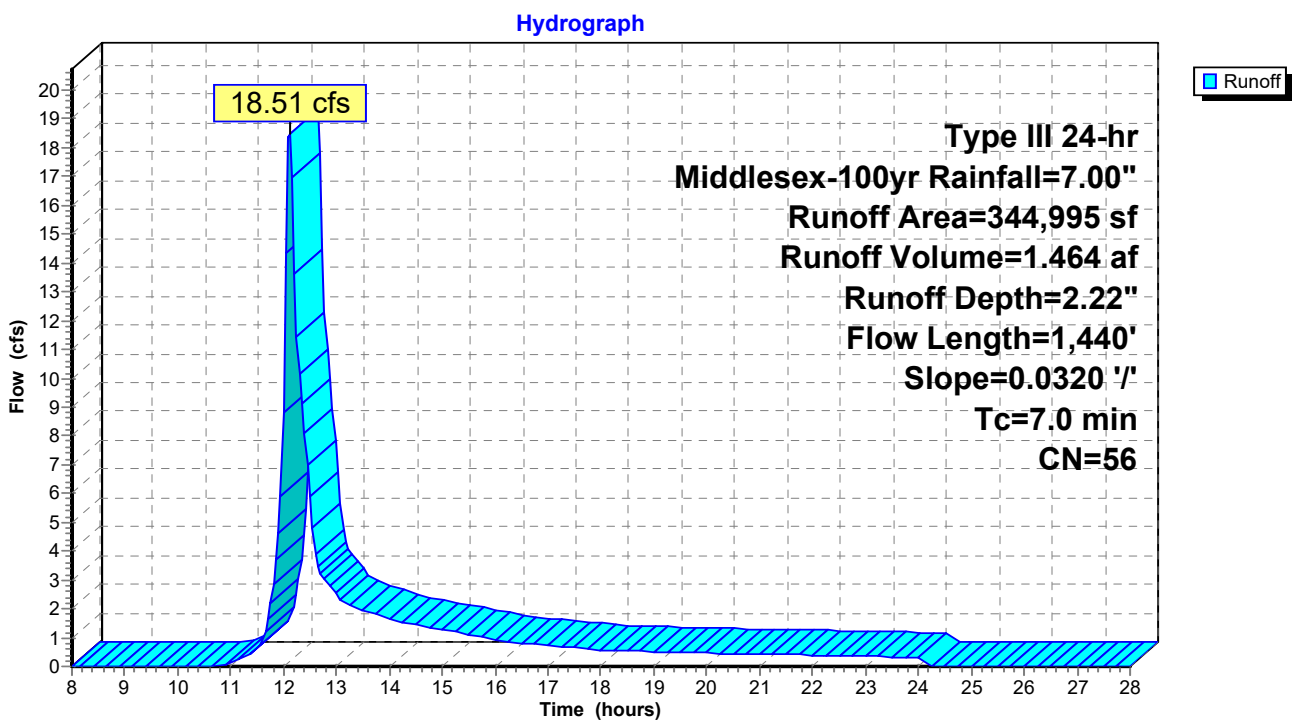
Runoff = 18.51 cfs @ 12.11 hrs, Volume= 1.464 af, Depth= 2.22"
Routed to Reach 3R : 18-inch pipe

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
305,791	51	1 acre lots, 20% imp, HSG A
39,204	98	Paved roads w/curbs & sewers, HSG A
344,995	56	Weighted Average
244,633		70.91% Pervious Area
100,362		29.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0320	1.42		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
6.4	1,390	0.0320	3.63		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
7.0	1,440	Total			

Subcatchment 3S: Route 20



Summary for Subcatchment 4S: EDA-3

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

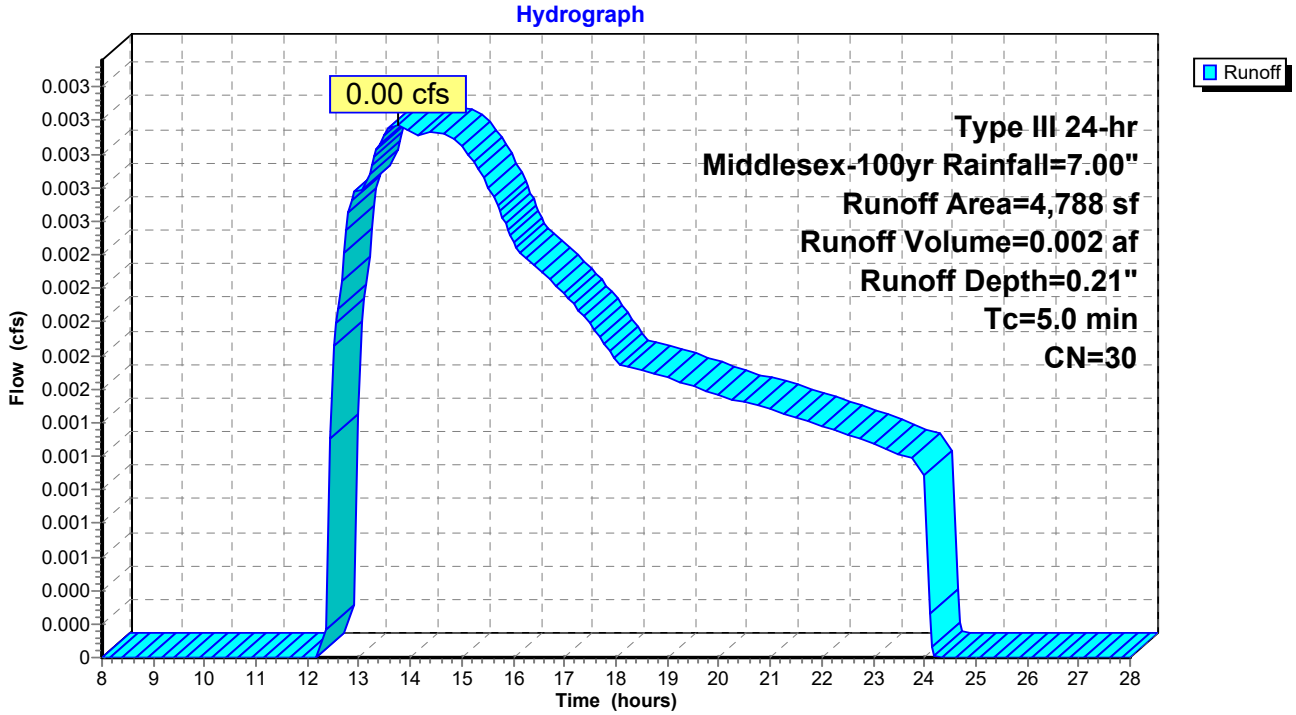
Runoff = 0.00 cfs @ 13.75 hrs, Volume= 0.002 af, Depth= 0.21"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
4,788	30	Woods, Good, HSG A
4,788		100.00% Pervious Area

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

Subcatchment 4S: EDA-3



Summary for Subcatchment 5S: EDA-4

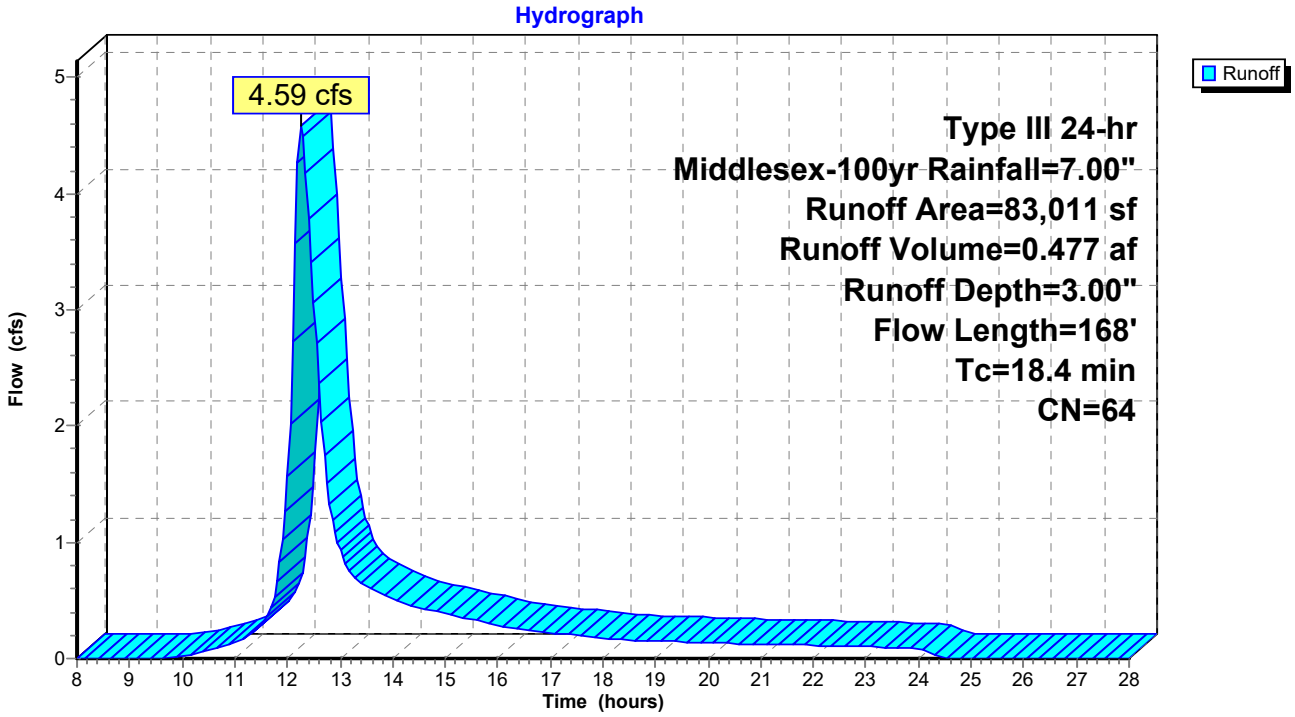
Runoff = 4.59 cfs @ 12.26 hrs, Volume= 0.477 af, Depth= 3.00"
Routed to Pond 6P : Trench Drain

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
3,494	76	Gravel roads, HSG A
3,618	98	Roofs, HSG A
6,385	30	Woods, Good, HSG A
57,050	68	<50% Grass cover, Poor, HSG A
12,464	49	50-75% Grass cover, Fair, HSG A
83,011	64	Weighted Average
79,393		95.64% Pervious Area
3,618		4.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, sf1** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
18.4	168	Total			

Subcatchment 5S: EDA-4



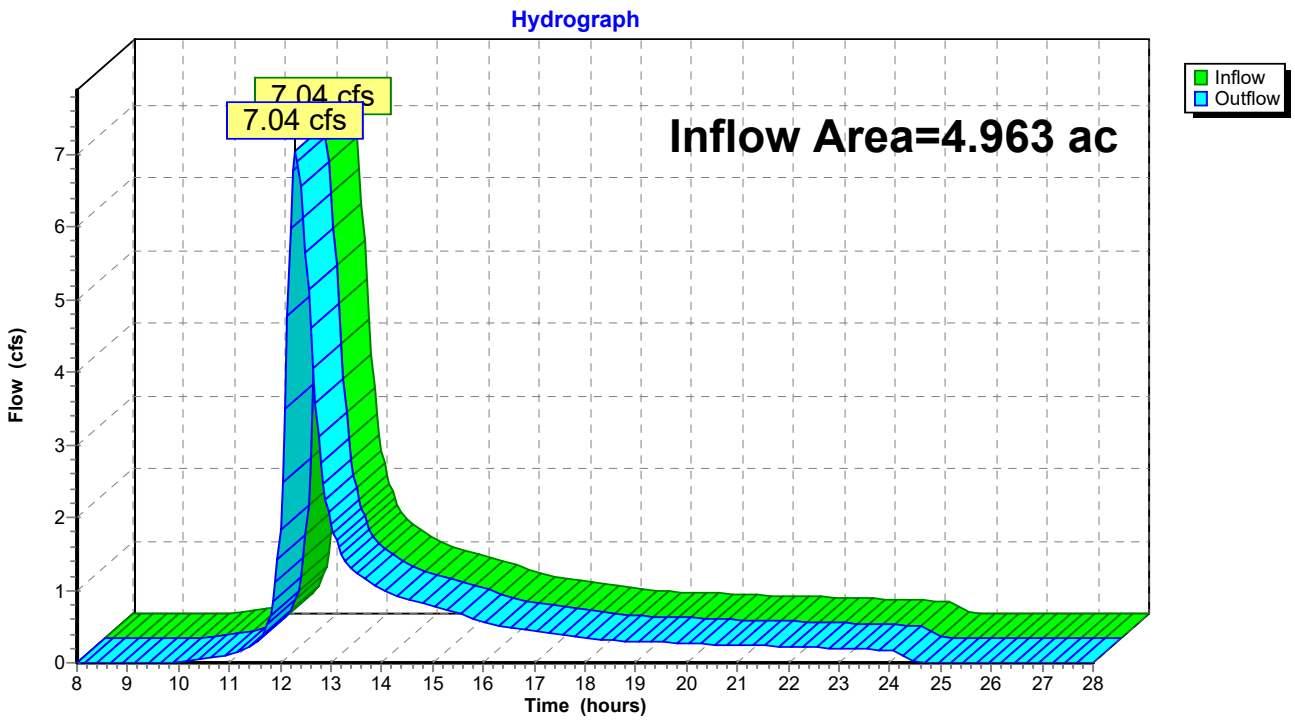
Summary for Reach 1R: DP-1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	4.963 ac,	9.11% Impervious,	Inflow Depth =	2.03"	for Middlesex-100yr event
Inflow =	7.04 cfs @	12.31 hrs,	Volume=	0.839 af	
Outflow =	7.04 cfs @	12.31 hrs,	Volume=	0.839 af,	Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs

Reach 1R: DP-1



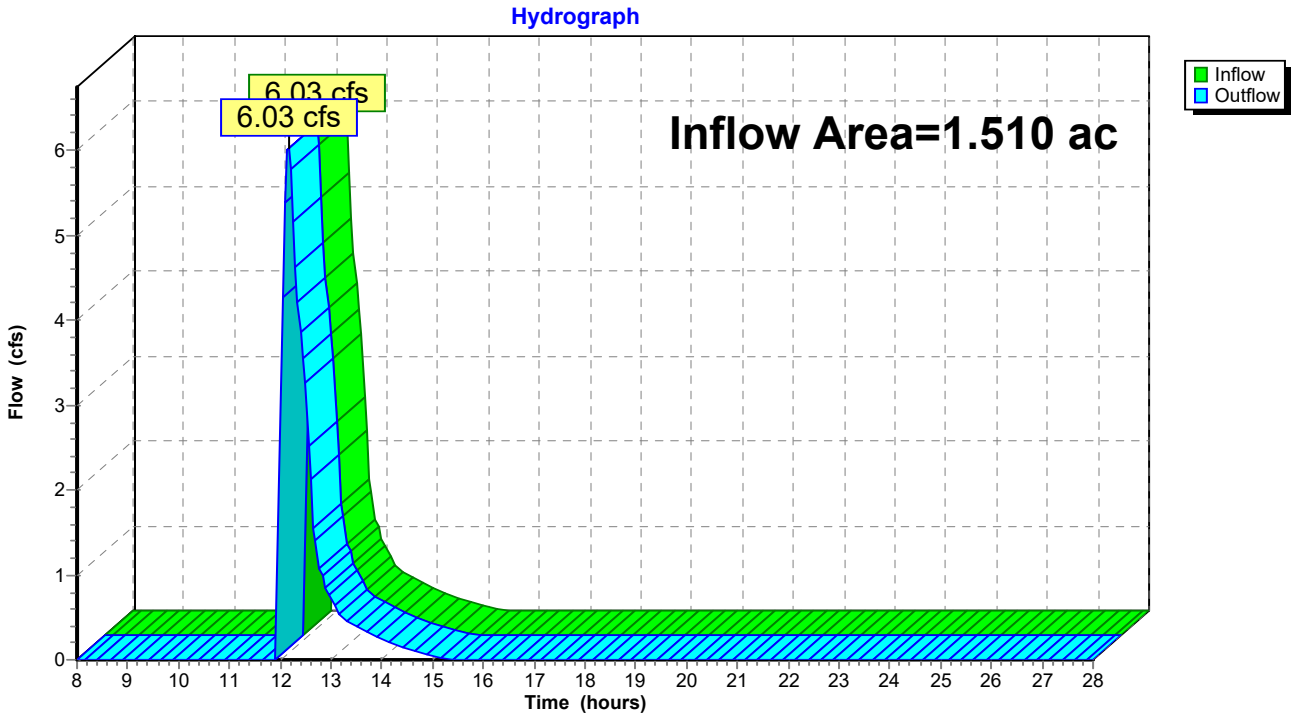
Summary for Reach 2R: DP-2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 1.510 ac, 4.82% Impervious, Inflow Depth = 2.31" for Middlesex-100yr event
Inflow = 6.03 cfs @ 12.16 hrs, Volume= 0.291 af
Outflow = 6.03 cfs @ 12.16 hrs, Volume= 0.291 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs

Reach 2R: DP-2



Summary for Reach 3R: 18-inch pipe

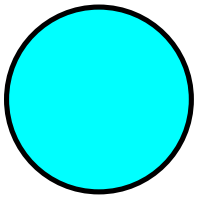
[52] Hint: Inlet/Outlet conditions not evaluated
[55] Hint: Peak inflow is 151% of Manning's capacity
[76] Warning: Detained 0.054 af (Pond w/culvert advised)

Inflow Area = 7.920 ac, 29.09% Impervious, Inflow Depth = 2.22" for Middlesex-100yr event
Inflow = 18.51 cfs @ 12.11 hrs, Volume= 1.464 af
Outflow = 12.46 cfs @ 12.10 hrs, Volume= 1.464 af, Atten= 33%, Lag= 0.0 min

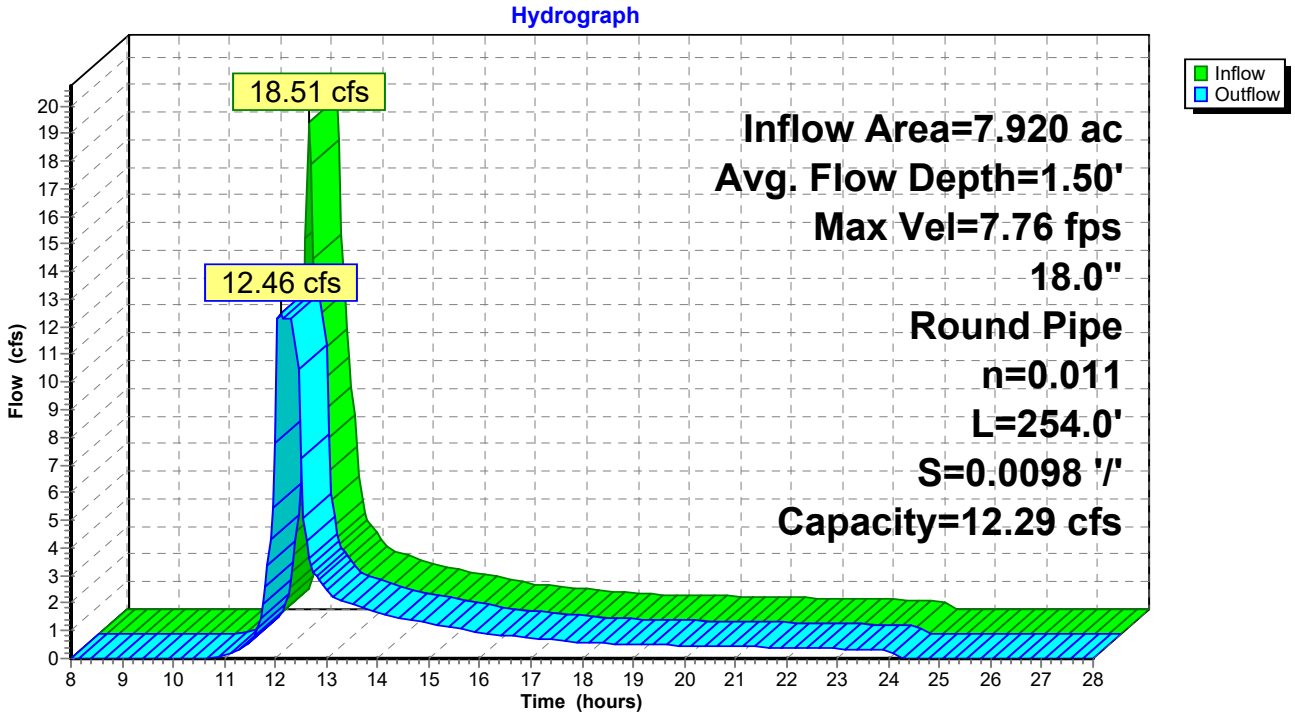
Routing by Stor-Ind+Trans method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs
Max. Velocity= 7.76 fps, Min. Travel Time= 0.5 min
Avg. Velocity = 3.77 fps, Avg. Travel Time= 1.1 min

Peak Storage= 449 cf @ 12.10 hrs
Average Depth at Peak Storage= 1.50'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 12.29 cfs

18.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 254.0' Slope= 0.0098 '/'
Inlet Invert= 159.09', Outlet Invert= 156.60'



Reach 3R: 18-inch pipe



Summary for Pond 3P: Existing Depression

[92] Warning: Device #1 is above defined storage
[93] Warning: Storage range exceeded by 0.13'
[88] Warning: Qout>Qin may require smaller dt or Finer Routing

Inflow Area = 1.400 ac, 5.20% Impervious, Inflow Depth = 3.41" for Middlesex-100yr event
Inflow = 4.64 cfs @ 12.16 hrs, Volume= 0.398 af
Outflow = 6.32 cfs @ 12.16 hrs, Volume= 0.517 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.29 cfs @ 12.16 hrs, Volume= 0.228 af
Primary = 6.03 cfs @ 12.16 hrs, Volume= 0.289 af
Routed to Reach 2R : DP-2

Routing by Stor-Ind method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 155.13' @ 12.16 hrs Surf.Area= 3,285 sf Storage= 1,934 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 23.6 min (863.8 - 840.2)

Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	1,934 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

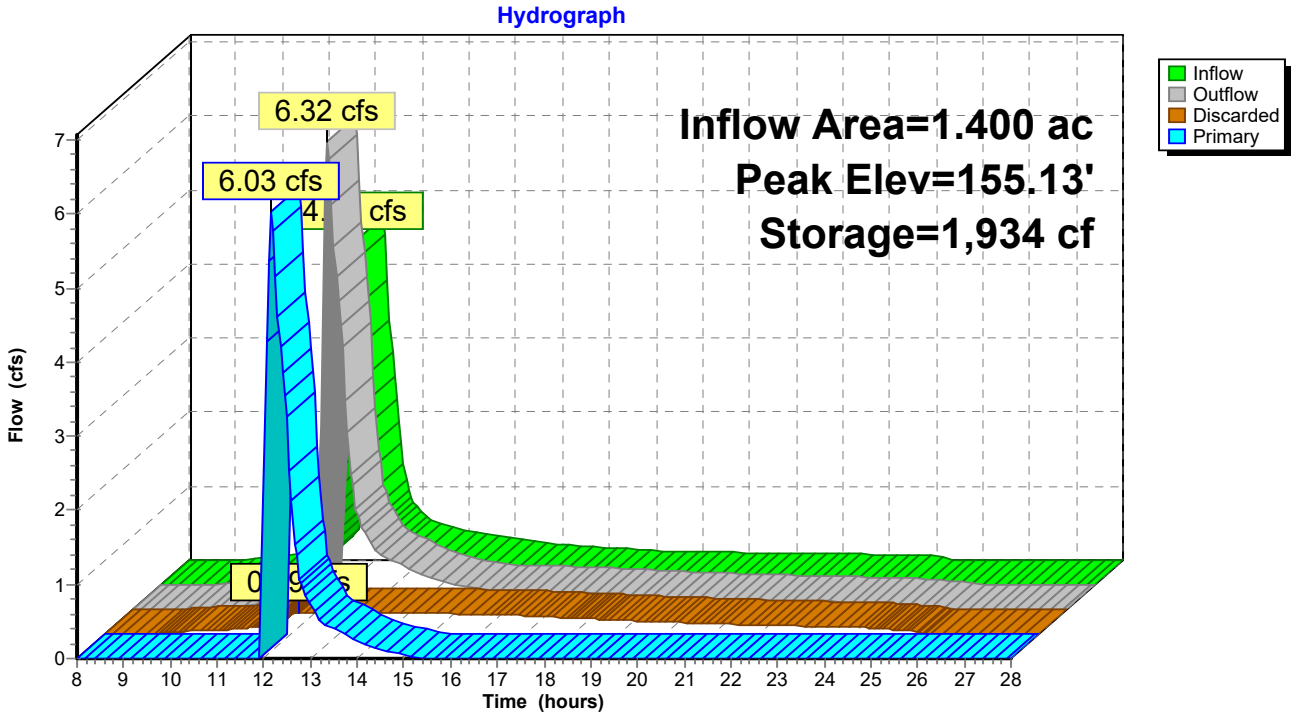
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
154.00	583	0	0
155.00	3,285	1,934	1,934

Device	Routing	Invert	Outlet Devices
#1	Primary	155.00'	**55.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	154.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 153.00'

Discarded OutFlow Max=0.29 cfs @ 12.16 hrs HW=155.13' (Free Discharge)
└**2=Exfiltration** (Controls 0.29 cfs)

Primary OutFlow Max=5.95 cfs @ 12.16 hrs HW=155.13' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 5.95 cfs @ 0.84 fps)

Pond 3P: Existing Depression



Summary for Pond 6P: Trench Drain

[92] Warning: Device #2 is above defined storage
[93] Warning: Storage range exceeded by 0.09'

Inflow Area = 1.906 ac, 4.36% Impervious, Inflow Depth = 3.00" for Middlesex-100yr event
Inflow = 4.59 cfs @ 12.26 hrs, Volume= 0.477 af
Outflow = 4.58 cfs @ 12.26 hrs, Volume= 0.459 af, Atten= 0%, Lag= 0.0 min
Discarded = 0.00 cfs @ 8.00 hrs, Volume= 0.000 af
Primary = 4.58 cfs @ 12.26 hrs, Volume= 0.459 af
Routed to Reach 1R : DP-1

Routing by Stor-Ind method, Time Span= 8.00-28.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 168.51' @ 12.26 hrs Surf.Area= 8 sf Storage= 11 cf

Plug-Flow detention time= 13.7 min calculated for 0.459 af (96% of inflow)
Center-of-Mass det. time= (not calculated: outflow precedes inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	167.00'	11 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

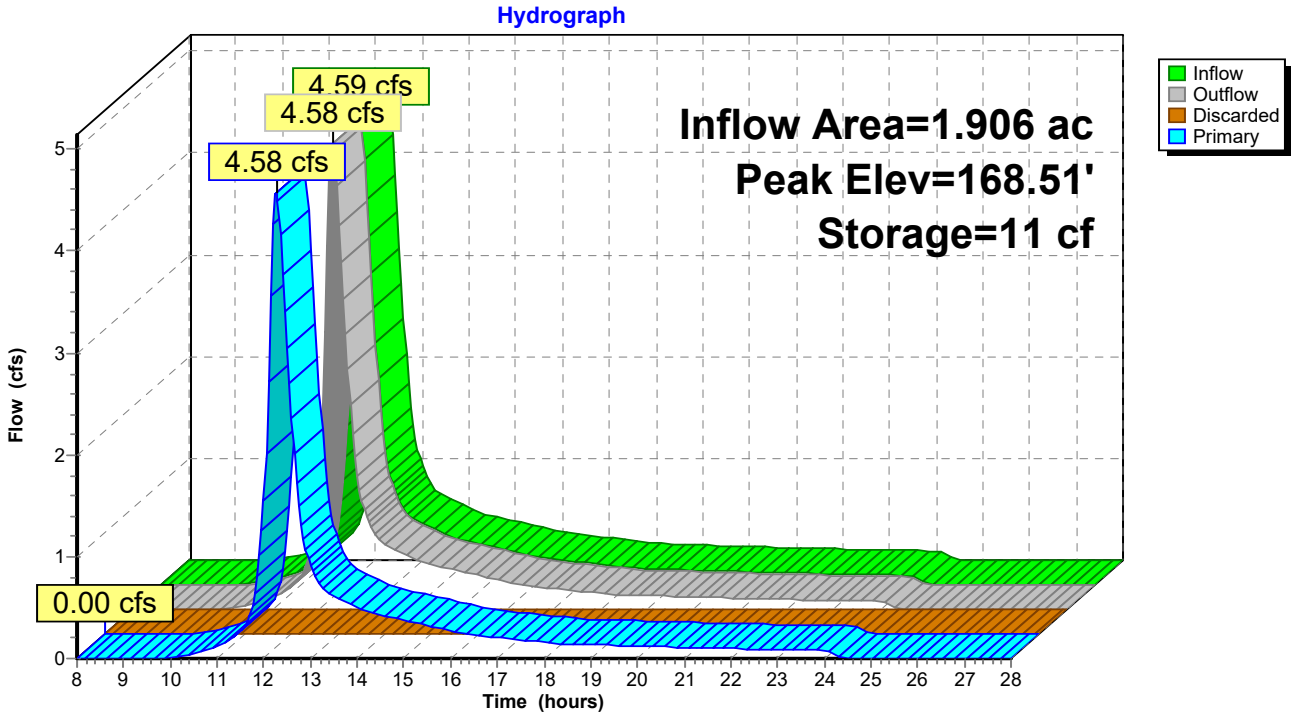
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
167.00	8	0	0
168.42	8	11	11

Device	Routing	Invert	Outlet Devices
#1	Discarded	167.00'	**1.000 in/hr Exfiltration over Surface area above 167.00'** Conductivity to Groundwater Elevation = 150.00' Excluded Surface area = 8 sf
#2	Primary	168.42'	**2.5" x 2.5" Horiz. Orifice/Grate X 6.00 columns** X 12 rows C= 0.600 in 24.0" x 48.0" Grate (39% open area)

Discarded OutFlow Max=0.00 cfs @ 8.00 hrs HW=167.00' (Free Discharge)
└**1=Exfiltration** (Controls 0.00 cfs)

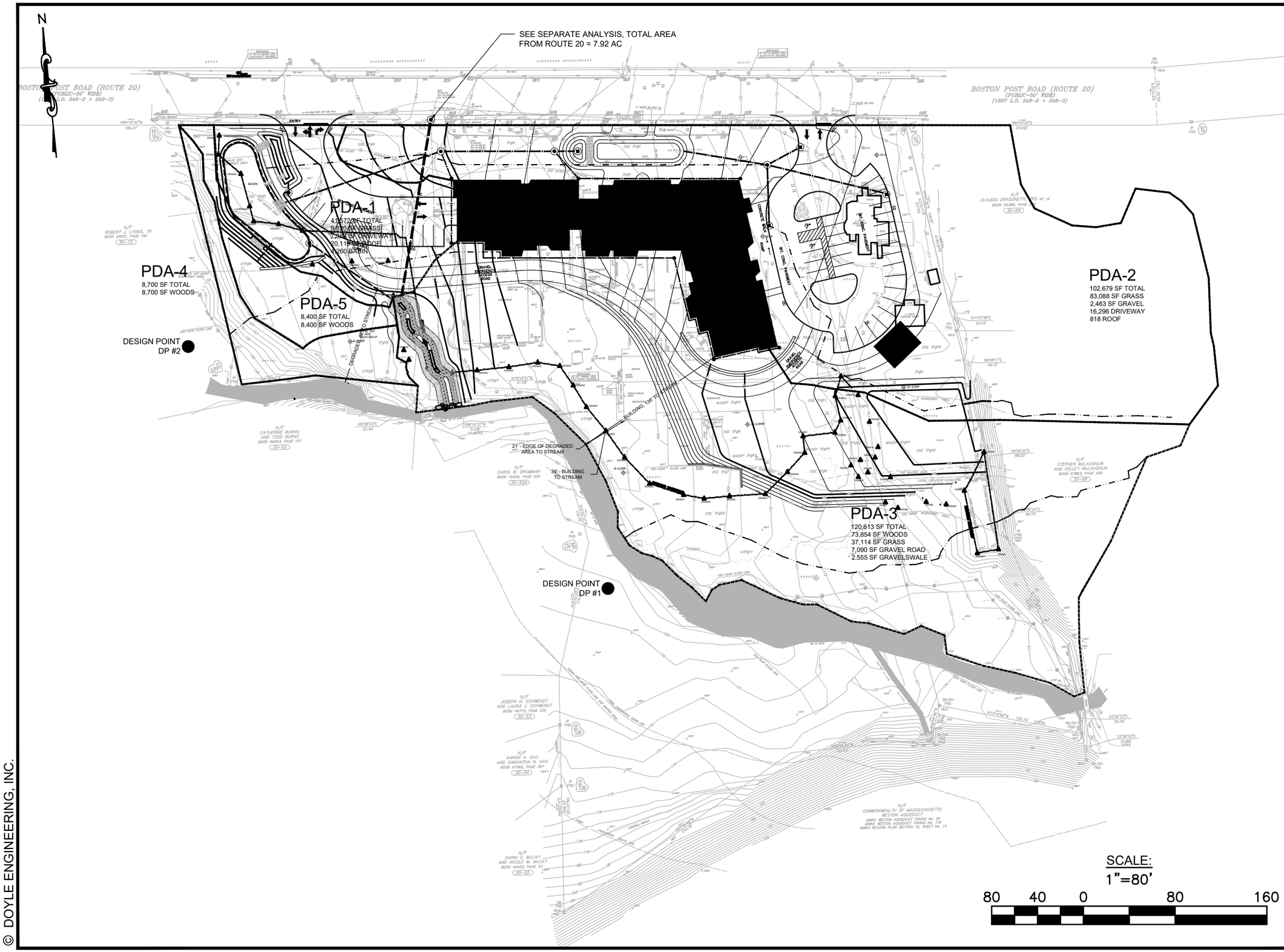
Primary OutFlow Max=4.54 cfs @ 12.26 hrs HW=168.51' (Free Discharge)
└**2=Orifice/Grate** (Orifice Controls 4.54 cfs @ 1.45 fps)

Pond 6P: Trench Drain



APPENDIX C

Post-Development Hydrologic Analysis



C1.0

ENGINEERING & DEVELOPMENT
14 Spring St, 2nd Floor
Waltham, MA 02451

113-115 BOSTON POST ROAD
WAYLAND, MA

Watershed Plan

SUB AREA LABEL PR-1

DRAINAGE AREA BOUNDARY - - - - - -

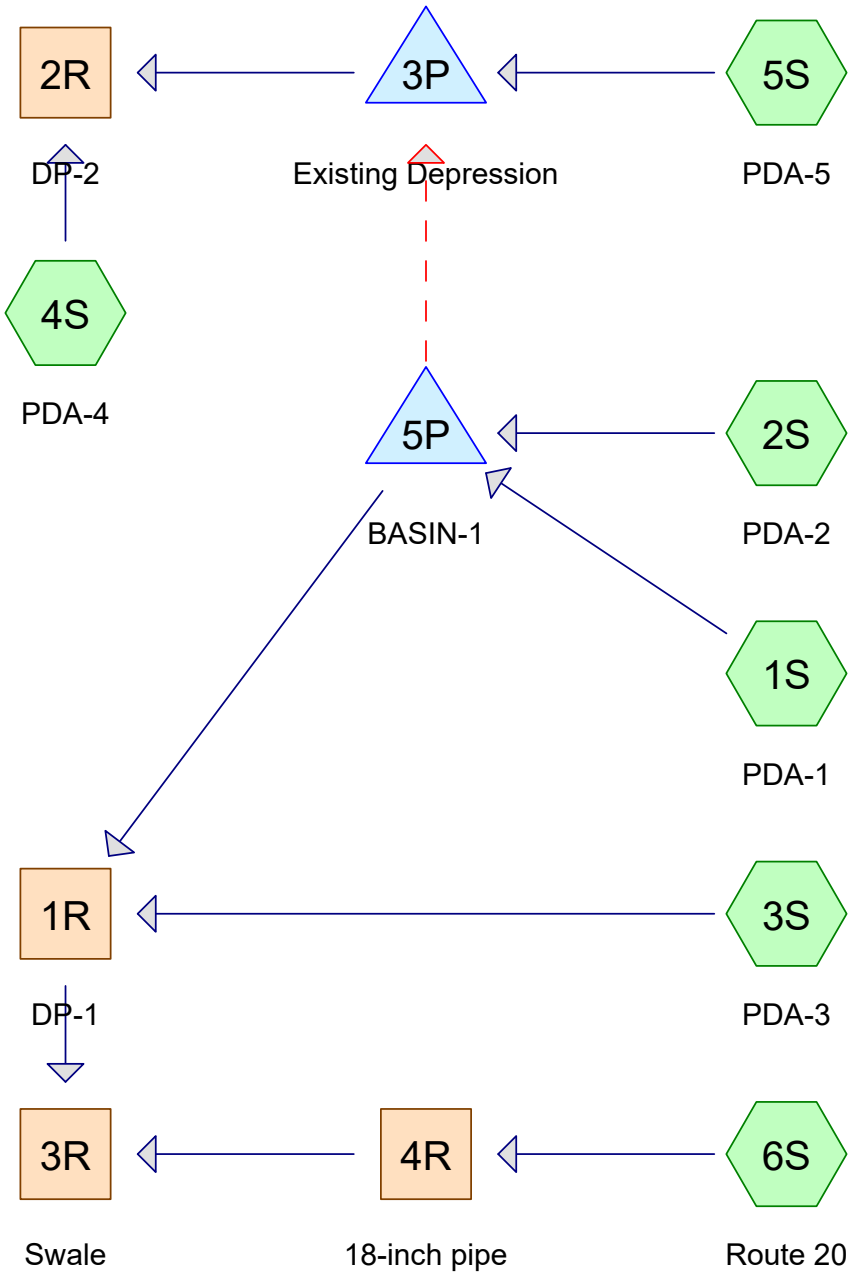
TIME OF CONCENTRATION FLOW TYPES:
SHEET - SHEET FLOW
SC - SHALLOW CONCENTRATED FLOW
CHANNEL - CHANNEL FLOW

NOTE: IF Tc IS LESS THAN 5 MINUTES, USE 5 MINUTES (MIN. Tc=5 MINUTES)

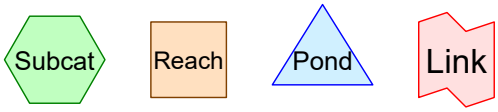
PROPOSED

SCALE: 1"=30'

FIG. 3



Post-Development Conditions



Routing Diagram for Proposed
Prepared by Doyle Engineering, Printed 10/17/2023
HydroCAD® 10.20-2g s/n 07330 © 2022 HydroCAD Software Solutions LLC

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	Middlesex-002yr	Type III 24-hr		Default	24.00	1	3.10	2
2	Middlesex-010yr	Type III 24-hr		Default	24.00	1	4.50	2
3	Middlesex-100yr	Type III 24-hr		Default	24.00	1	7.00	2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
7.020	51	1 acre lots, 20% imp, HSG A (6S)
2.985	39	>75% Grass cover, Good, HSG A (1S, 2S, 3S)
0.278	76	Gravel roads, HSG A (2S, 3S)
0.544	98	Paved parking, HSG A (1S, 2S)
0.900	98	Paved roads w/curbs & sewers, HSG A (6S)
0.480	98	Roofs, HSG A (1S, 2S)
0.098	98	Water Surface, 0% imp, HSG A (1S)
1.885	30	Woods, Good, HSG A (3S, 4S, 5S)
0.203	77	Woods, Good, HSG D (3S)
14.393	**53**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
14.190	HSG A	1S, 2S, 3S, 4S, 5S, 6S
0.000	HSG B	
0.000	HSG C	
0.203	HSG D	3S
0.000	Other	
14.393		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
7.020	0.000	0.000	0.000	0.000	7.020	1 acre lots, 20% imp	6S
2.985	0.000	0.000	0.000	0.000	2.985	>75% Grass cover, Good	1S, 2S, 3S
0.278	0.000	0.000	0.000	0.000	0.278	Gravel roads	2S, 3S
0.544	0.000	0.000	0.000	0.000	0.544	Paved parking	1S, 2S
0.900	0.000	0.000	0.000	0.000	0.900	Paved roads w/curbs & sewers	6S
0.480	0.000	0.000	0.000	0.000	0.480	Roofs	1S, 2S
0.098	0.000	0.000	0.000	0.000	0.098	Water Surface, 0% imp	1S
1.885	0.000	0.000	0.203	0.000	2.088	Woods, Good	3S, 4S, 5S
14.190	**0.000**	**0.000**	**0.203**	**0.000**	**14.393**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Width (inches)	Diam/Height (inches)	Inside-Fill (inches)
1	1S	0.00	0.00	440.0	0.0100	0.013	0.0	8.0	0.0
2	2S	0.00	0.00	497.0	0.0322	0.013	0.0	12.0	0.0
3	4R	159.10	158.50	155.0	0.0039	0.011	0.0	25.0	0.0

Time span=0.00-28.00 hrs, dt=0.04 hrs, 701 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA-1 Runoff Area=41,572 sf 66.13% Impervious Runoff Depth=1.60"
Flow Length=490' Slope=0.0100 '/' Tc=3.0 min CN=84 Runoff=1.96 cfs 0.127 af

Subcatchment 2S: PDA-2 Runoff Area=102,679 sf 16.67% Impervious Runoff Depth=0.11"
Flow Length=1,260' Tc=30.2 min CN=50 Runoff=0.04 cfs 0.021 af

Subcatchment 3S: PDA-3 Runoff Area=120,613 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=504' Tc=23.7 min CN=40 Runoff=0.00 cfs 0.000 af

Subcatchment 4S: PDA-4 Runoff Area=8,700 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment 5S: PDA-5 Runoff Area=8,400 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment 6S: Route 20 Runoff Area=344,995 sf 29.09% Impervious Runoff Depth=0.25"
Flow Length=1,440' Slope=0.0320 '/' Tc=7.0 min CN=56 Runoff=0.82 cfs 0.164 af

Reach 1R: DP-1 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach 2R: DP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach 3R: Swale Avg. Flow Depth=0.22' Max Vel=1.66 fps Inflow=0.82 cfs 0.164 af
n=0.040 L=102.0' S=0.0186 '/' Capacity=239.38 cfs Outflow=0.82 cfs 0.164 af

Reach 4R: 18-inch pipe Avg. Flow Depth=0.30' Max Vel=2.74 fps Inflow=0.82 cfs 0.164 af
25.0" Round Pipe n=0.011 L=155.0' S=0.0039 '/' Capacity=18.55 cfs Outflow=0.82 cfs 0.164 af

Pond 3P: Existing Depression Peak Elev=154.00' Storage=0 cf Inflow=0.00 cfs 0.000 af
Discarded=0.00 cfs 0.000 af Primary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.000 af

Pond 5P: BASIN-1 Peak Elev=158.48' Storage=1,851 cf Inflow=1.96 cfs 0.149 af
Discarded=0.25 cfs 0.149 af Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.25 cfs 0.149 af

Total Runoff Area = 14.393 ac Runoff Volume = 0.313 af Average Runoff Depth = 0.26"
76.88% Pervious = 11.065 ac 23.12% Impervious = 3.328 ac

Summary for Subcatchment 1S: PDA-1

[49] Hint: Tc<2dt may require smaller dt
[47] Hint: Peak is 162% of capacity of segment #2

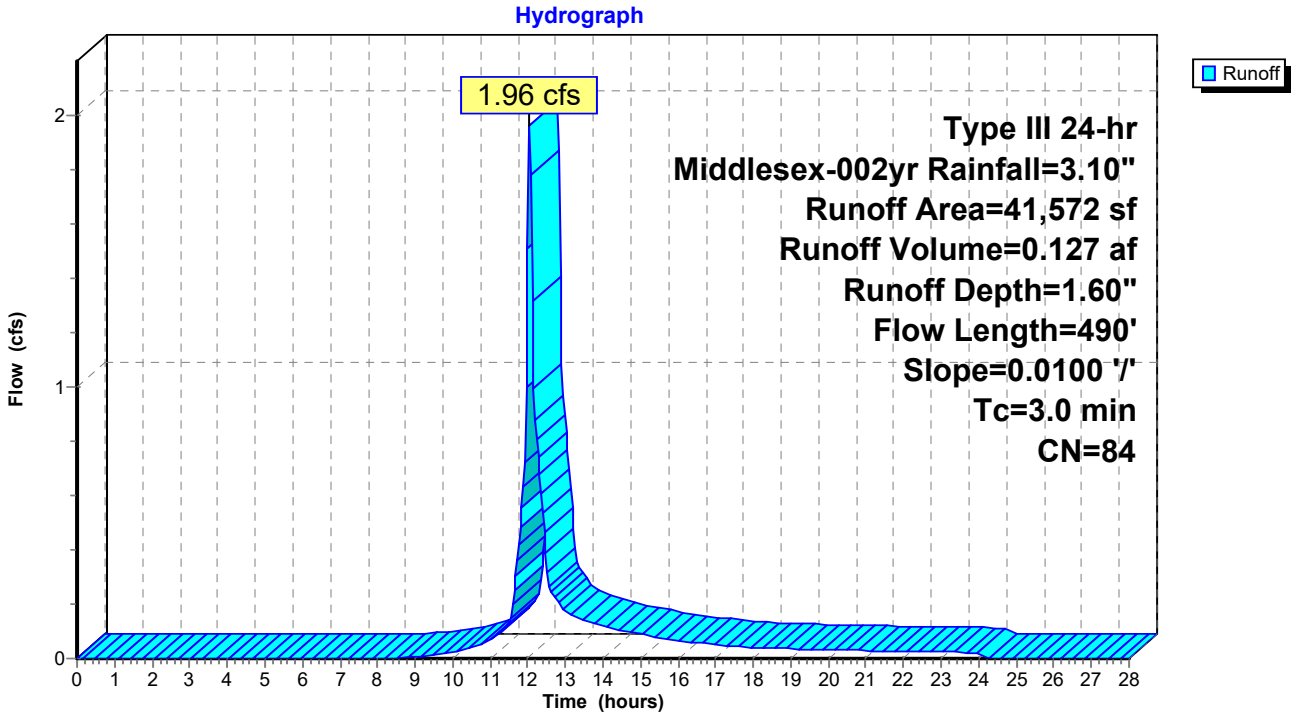
Runoff = 1.96 cfs @ 12.05 hrs, Volume= 0.127 af, Depth= 1.60"
Routed to Pond 5P : BASIN-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
20,110	98	Roofs, HSG A
9,820	39	>75% Grass cover, Good, HSG A
7,382	98	Paved parking, HSG A
4,260	98	Water Surface, 0% imp, HSG A
41,572	84	Weighted Average
14,080		33.87% Pervious Area
27,492		66.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.89		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
2.1	440	0.0100	3.46	1.21	**Pipe Channel, B-C** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.013 Corrugated PE, smooth interior
3.0	490	Total			

Subcatchment 1S: PDA-1



Summary for Subcatchment 2S: PDA-2

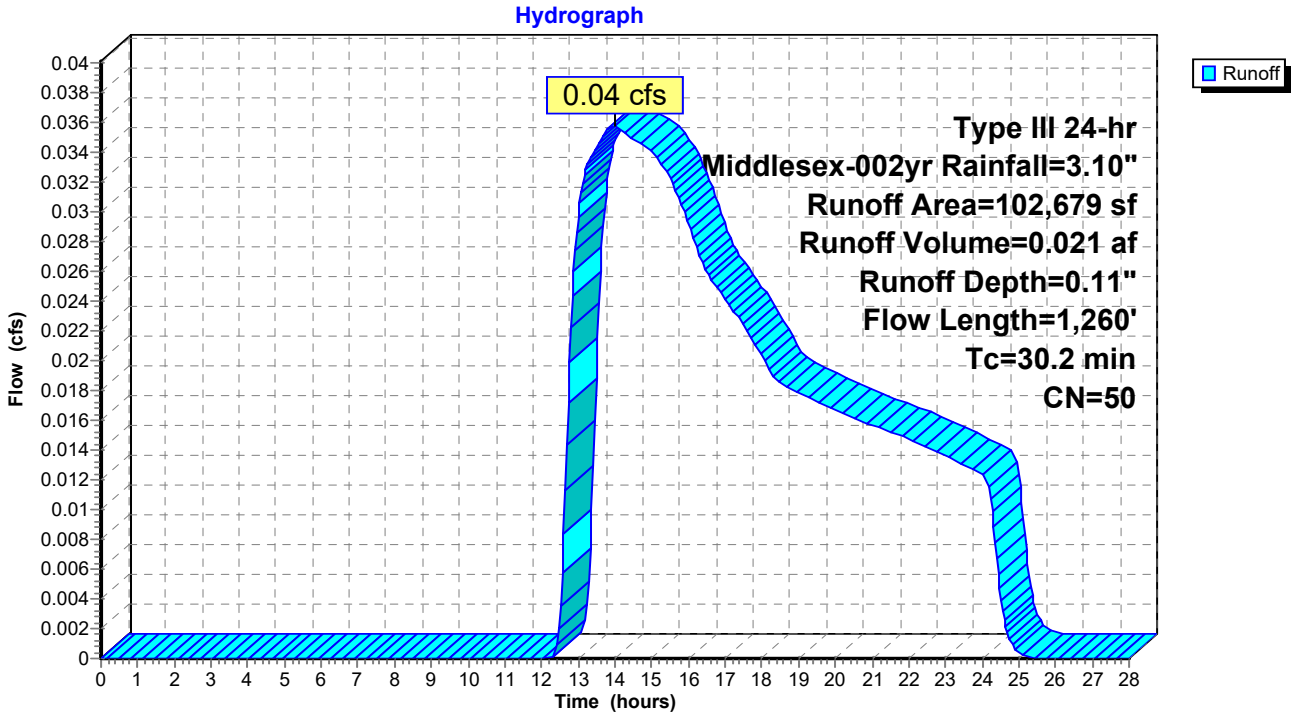
Runoff = 0.04 cfs @ 14.00 hrs, Volume= 0.021 af, Depth= 0.11"
Routed to Pond 5P : BASIN-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
83,102	39	>75% Grass cover, Good, HSG A
16,296	98	Paved parking, HSG A
2,463	76	Gravel roads, HSG A
818	98	Roofs, HSG A
102,679	50	Weighted Average
85,565		83.33% Pervious Area
17,114		16.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.1	50	0.0320	0.05		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.10"
7.8	418	0.0320	0.89		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
0.1	16	0.5625	3.75		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
2.2	166	0.0321	1.25		**Shallow Concentrated Flow, D-E** Short Grass Pasture Kv= 7.0 fps
1.0	113	0.0090	1.93		**Shallow Concentrated Flow, E-F** Paved Kv= 20.3 fps
1.0	497	0.0322	8.14	6.39	**Pipe Channel, F-G** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
30.2	1,260	Total			

Subcatchment 2S: PDA-2



Summary for Subcatchment 3S: PDA-3

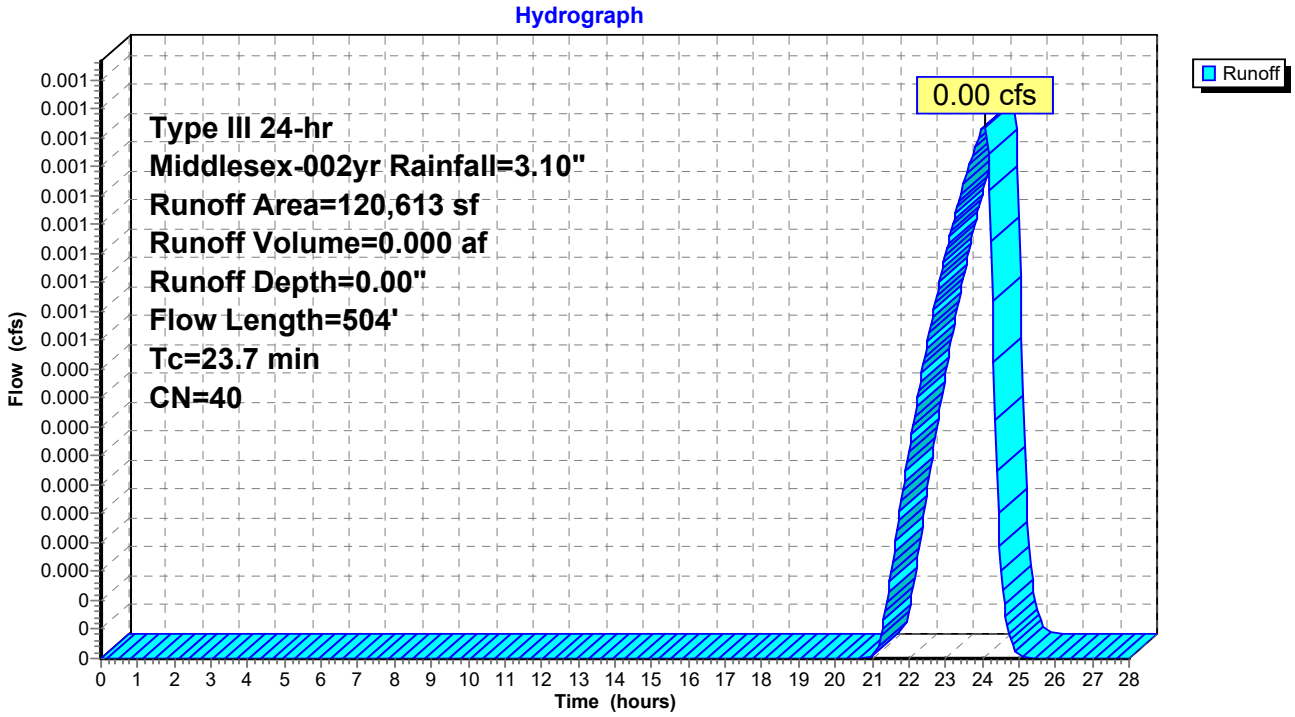
Runoff = 0.00 cfs @ 24.05 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
37,114	39	>75% Grass cover, Good, HSG A
7,090	76	Gravel roads, HSG A
65,032	30	Woods, Good, HSG A
8,822	77	Woods, Good, HSG D
2,555	76	Gravel roads, HSG A
120,613	40	Weighted Average
120,613		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, SF** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		**Shallow Concentrated Flow, SCF4** Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		**Shallow Concentrated Flow, SCF5** Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		**Shallow Concentrated Flow, SCF6** Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		**Shallow Concentrated Flow, SCF7** Woodland Kv= 5.0 fps
23.7	504	Total			

Subcatchment 3S: PDA-3



Summary for Subcatchment 4S: PDA-4

[45] Hint: Runoff=Zero

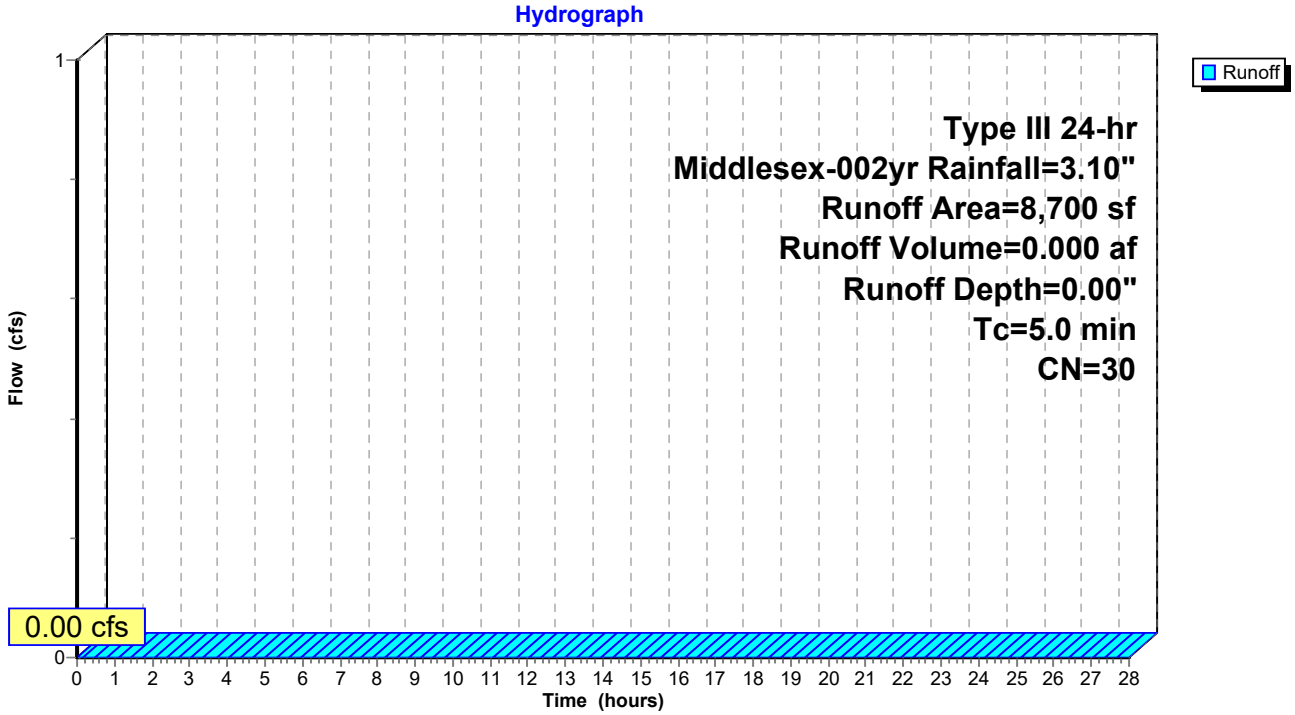
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
8,700	30	Woods, Good, HSG A
8,700		100.00% Pervious Area

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

Subcatchment 4S: PDA-4



Summary for Subcatchment 5S: PDA-5

[45] Hint: Runoff=Zero

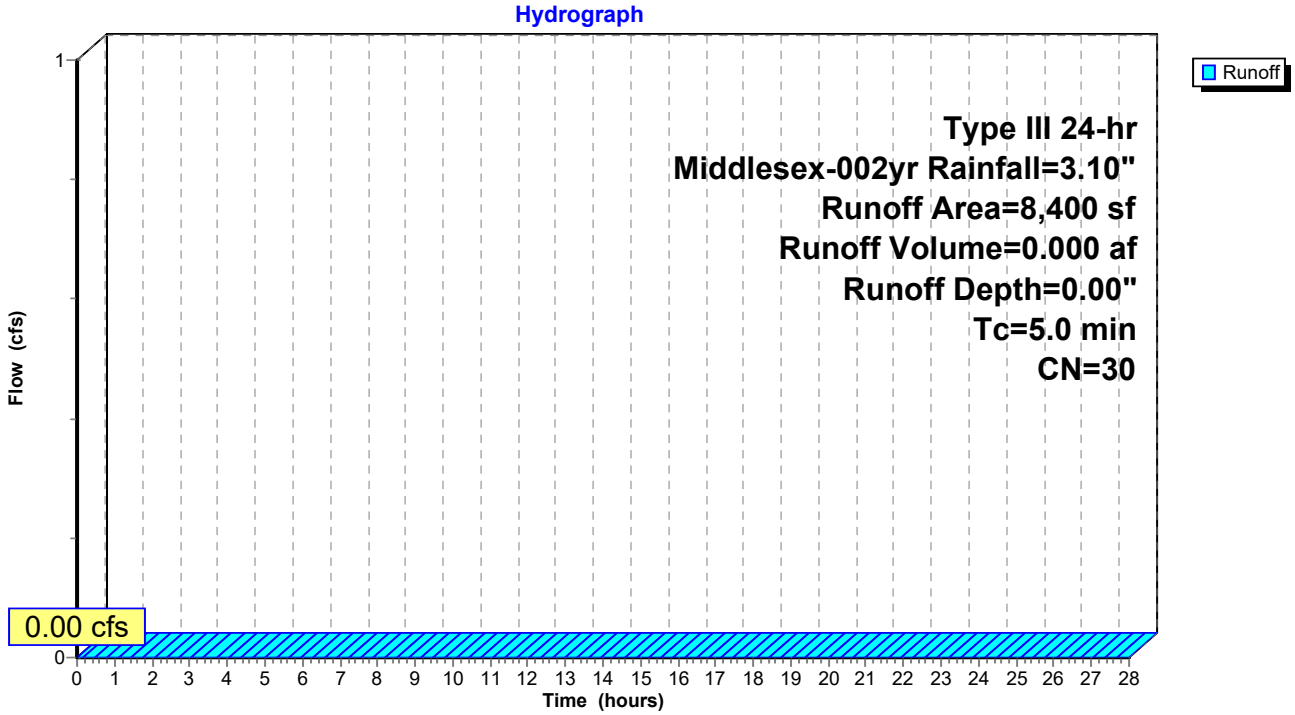
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Pond 3P : Existing Depression

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
8,400	30	Woods, Good, HSG A
8,400		100.00% Pervious Area

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

Subcatchment 5S: PDA-5



Summary for Subcatchment 6S: Route 20

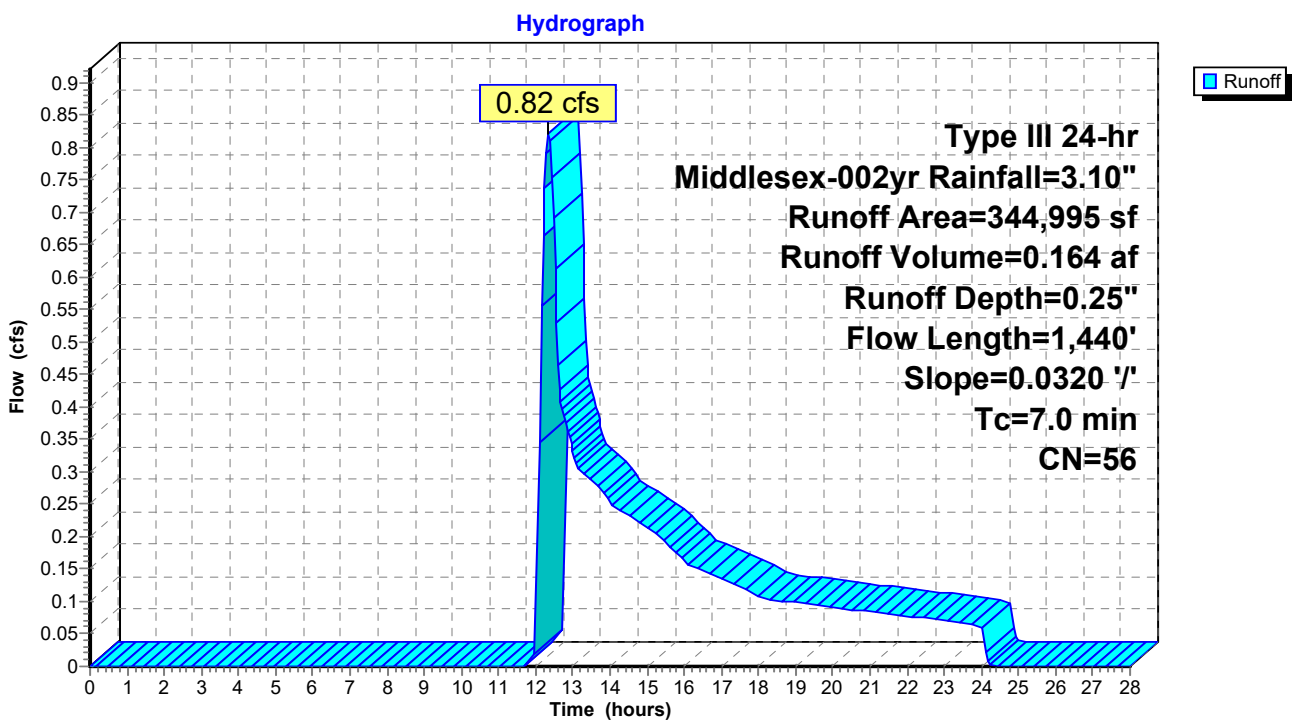
Runoff = 0.82 cfs @ 12.34 hrs, Volume= 0.164 af, Depth= 0.25"
Routed to Reach 4R : 18-inch pipe

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-002yr Rainfall=3.10"

Area (sf)	CN	Description
305,791	51	1 acre lots, 20% imp, HSG A
39,204	98	Paved roads w/curbs & sewers, HSG A
344,995	56	Weighted Average
244,633		70.91% Pervious Area
100,362		29.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0320	1.42		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
6.4	1,390	0.0320	3.63		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
7.0	1,440	Total			

Subcatchment 6S: Route 20



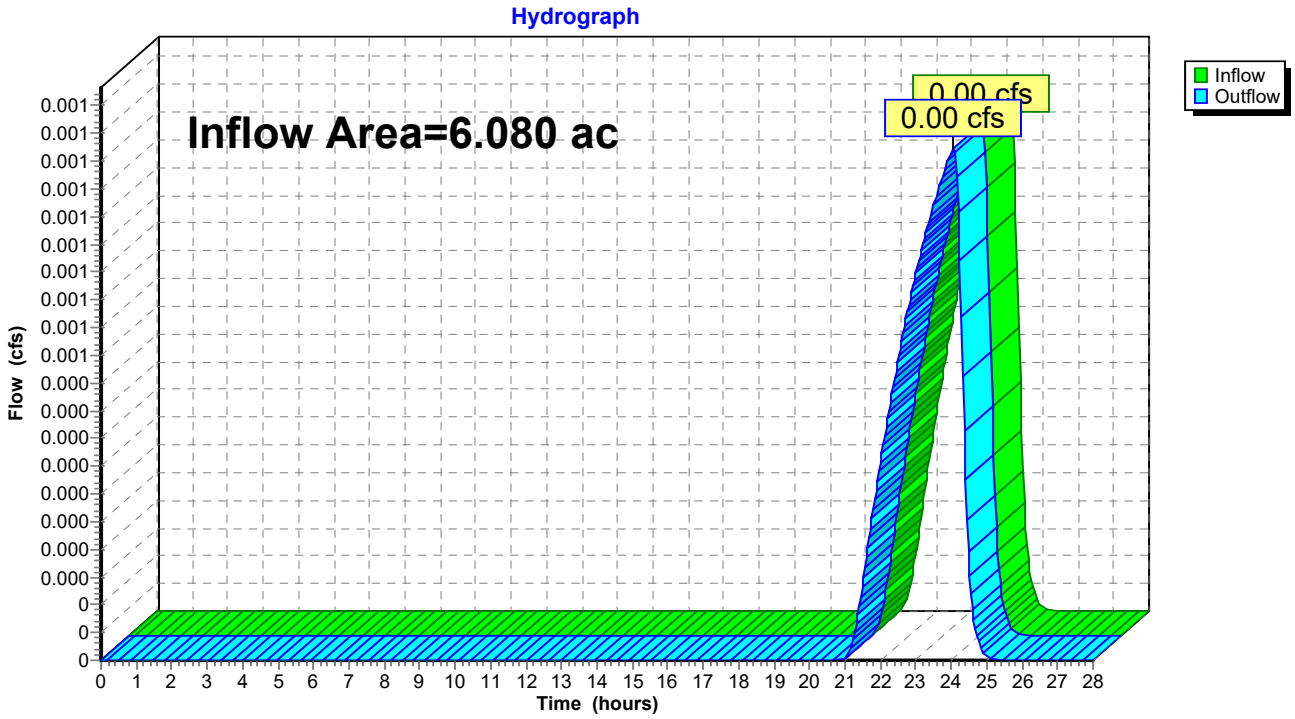
Summary for Reach 1R: DP-1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.080 ac, 16.84% Impervious, Inflow Depth = 0.00" for Middlesex-002yr event
Inflow = 0.00 cfs @ 24.05 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 24.05 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Routed to Reach 3R : Swale

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 1R: DP-1



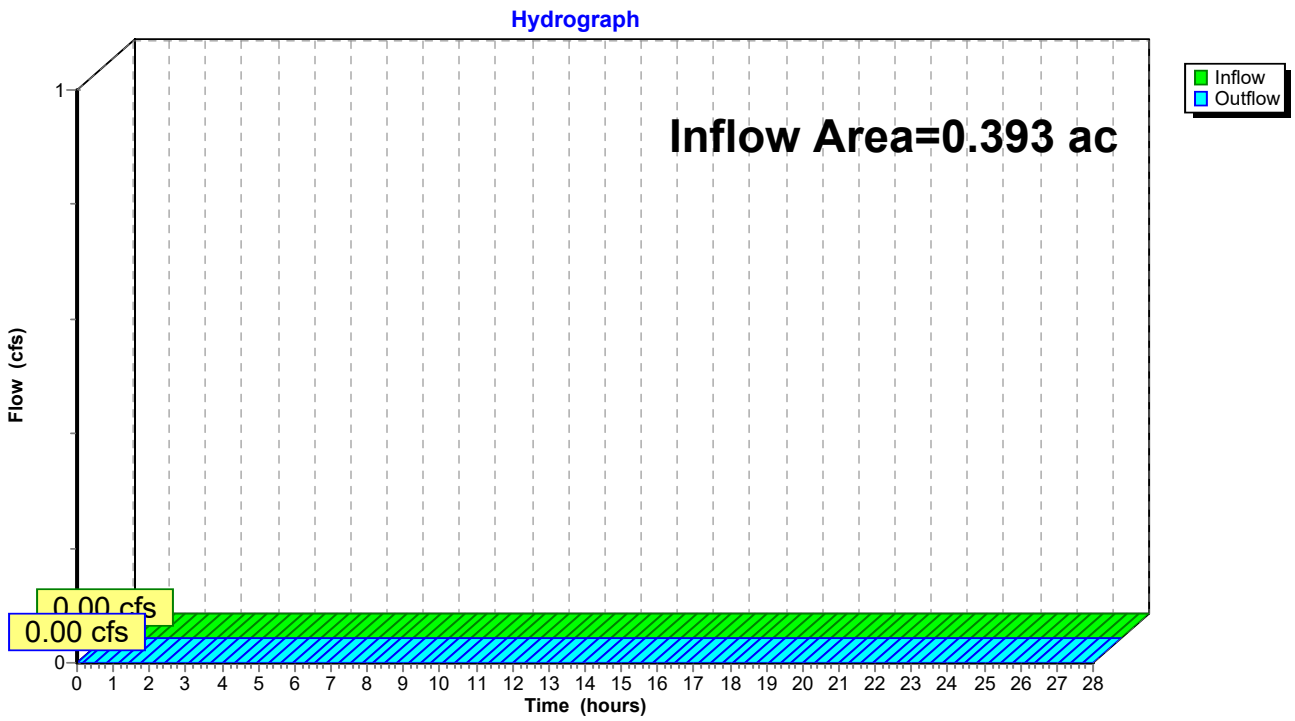
Summary for Reach 2R: DP-2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area =	0.393 ac,	0.00% Impervious,	Inflow Depth =	0.00"	for Middlesex-002yr 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

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 2R: DP-2



Summary for Reach 3R: Swale

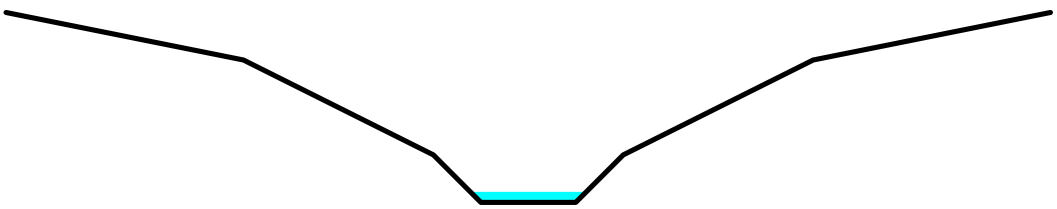
[61] Hint: Exceeded Reach 4R outlet invert by 0.22' @ 12.40 hrs

Inflow Area = 14.000 ac, 23.77% Impervious, Inflow Depth = 0.14" for Middlesex-002yr event
Inflow = 0.82 cfs @ 12.37 hrs, Volume= 0.164 af
Outflow = 0.82 cfs @ 12.40 hrs, Volume= 0.164 af, Atten= 0%, Lag= 1.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Max. Velocity= 1.66 fps, Min. Travel Time= 1.0 min
Avg. Velocity = 0.88 fps, Avg. Travel Time= 1.9 min

Peak Storage= 50 cf @ 12.38 hrs
Average Depth at Peak Storage= 0.22' , Surface Width= 2.44'
Bank-Full Depth= 4.00' Flow Area= 36.0 sf, Capacity= 239.38 cfs

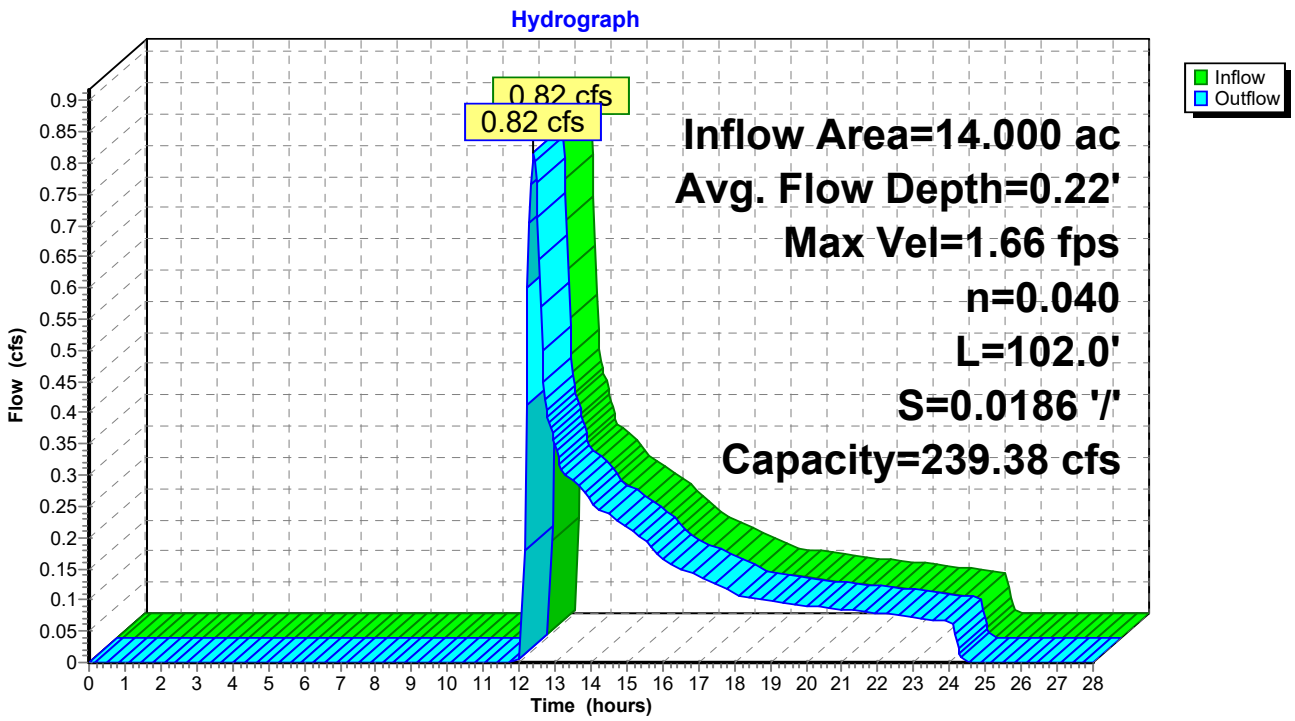
Custom cross-section, Length= 102.0' Slope= 0.0186 '/'
Constant n= 0.040 Winding stream, pools & shoals
Inlet Invert= 158.50', Outlet Invert= 156.60'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)
0.00	160.00	0.00
5.00	159.00	1.00
9.00	157.00	3.00
10.00	156.00	4.00
12.00	156.00	4.00
13.00	157.00	3.00
17.00	159.00	1.00
22.00	160.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	2.0	0.0	0	0.00
1.00	3.0	4.8	4.0	306	11.08
3.00	19.0	13.8	12.0	1,938	119.38
4.00	36.0	24.0	22.0	3,672	239.38

Reach 3R: Swale



Summary for Reach 4R: 18-inch pipe

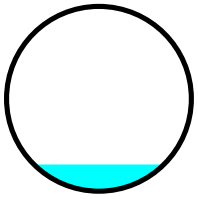
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 7.920 ac, 29.09% Impervious, Inflow Depth = 0.25" for Middlesex-002yr event
Inflow = 0.82 cfs @ 12.34 hrs, Volume= 0.164 af
Outflow = 0.82 cfs @ 12.37 hrs, Volume= 0.164 af, Atten= 0%, Lag= 1.6 min
Routed to Reach 3R : Swale

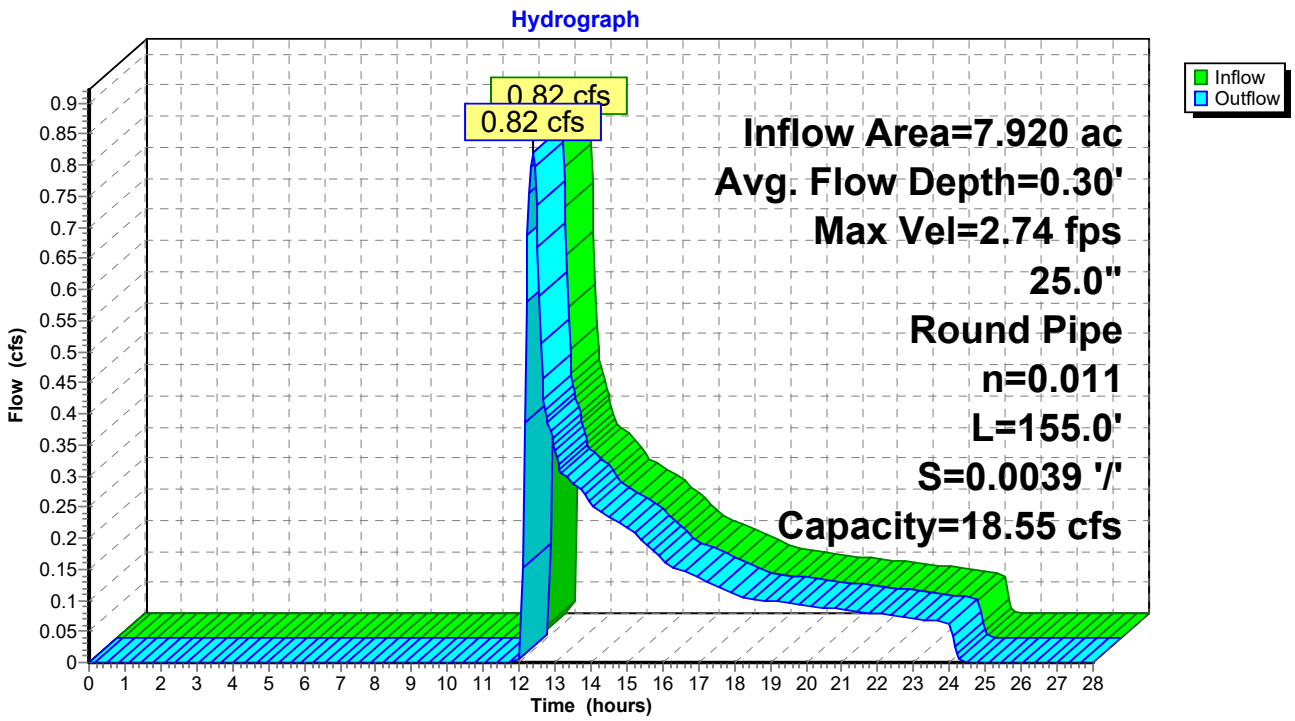
Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Max. Velocity= 2.74 fps, Min. Travel Time= 0.9 min
Avg. Velocity = 1.56 fps, Avg. Travel Time= 1.7 min

Peak Storage= 47 cf @ 12.35 hrs
Average Depth at Peak Storage= 0.30' , Surface Width= 1.46'
Bank-Full Depth= 2.08' Flow Area= 3.4 sf, Capacity= 18.55 cfs

25.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 155.0' Slope= 0.0039 '/'
Inlet Invert= 159.10', Outlet Invert= 158.50'



Reach 4R: 18-inch pipe



Summary for Pond 3P: Existing Depression

[92] Warning: Device #1 is above defined storage

Inflow Area = 0.193 ac, 0.00% Impervious, Inflow Depth = 0.00" for Middlesex-002yr 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
Discarded = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach 2R : DP-2

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs / 2
Peak Elev= 154.00' @ 0.00 hrs Surf.Area= 583 sf Storage= 0 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	154.00'	1,934 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

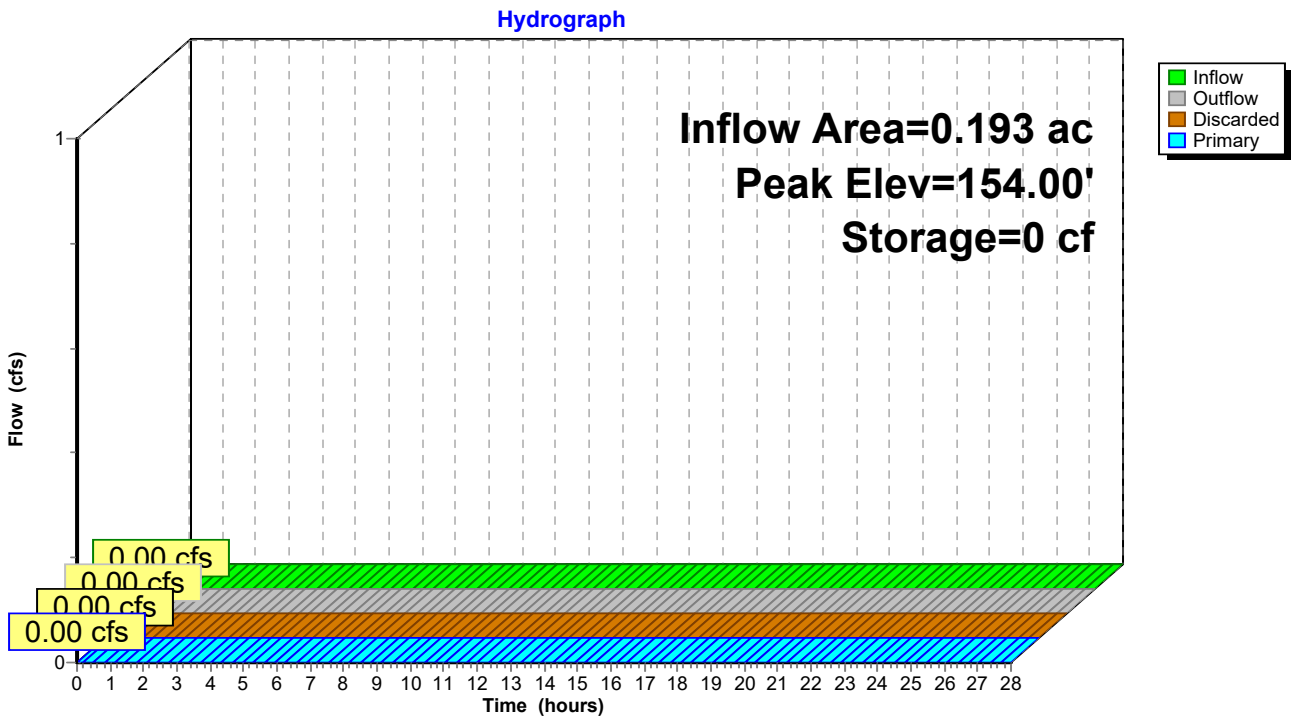
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
154.00	583	0	0
155.00	3,285	1,934	1,934

Device	Routing	Invert	Outlet Devices
#1	Primary	155.00'	**55.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	154.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 153.00'

Discarded OutFlow Max=0.00 cfs @ 0.00 hrs HW=154.00' (Free Discharge)
└**2=Exfiltration** (Passes 0.00 cfs of 0.03 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=154.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Existing Depression



Summary for Pond 5P: BASIN-1

Inflow Area = 3.312 ac, 30.92% Impervious, Inflow Depth = 0.54" for Middlesex-002yr event
Inflow = 1.96 cfs @ 12.05 hrs, Volume= 0.149 af
Outflow = 0.25 cfs @ 12.72 hrs, Volume= 0.149 af, Atten= 87%, Lag= 40.1 min
Discarded = 0.25 cfs @ 12.72 hrs, Volume= 0.149 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach 1R : DP-1
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Pond 3P : Existing Depression

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Peak Elev= 158.48' @ 12.72 hrs Surf.Area= 4,101 sf Storage= 1,851 cf

Plug-Flow detention time= 61.7 min calculated for 0.149 af (100% of inflow)
Center-of-Mass det. time= 61.6 min (921.0 - 859.3)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	6,515 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
158.00	3,690	0	0
159.00	4,556	4,123	4,123
159.50	5,011	2,392	6,515

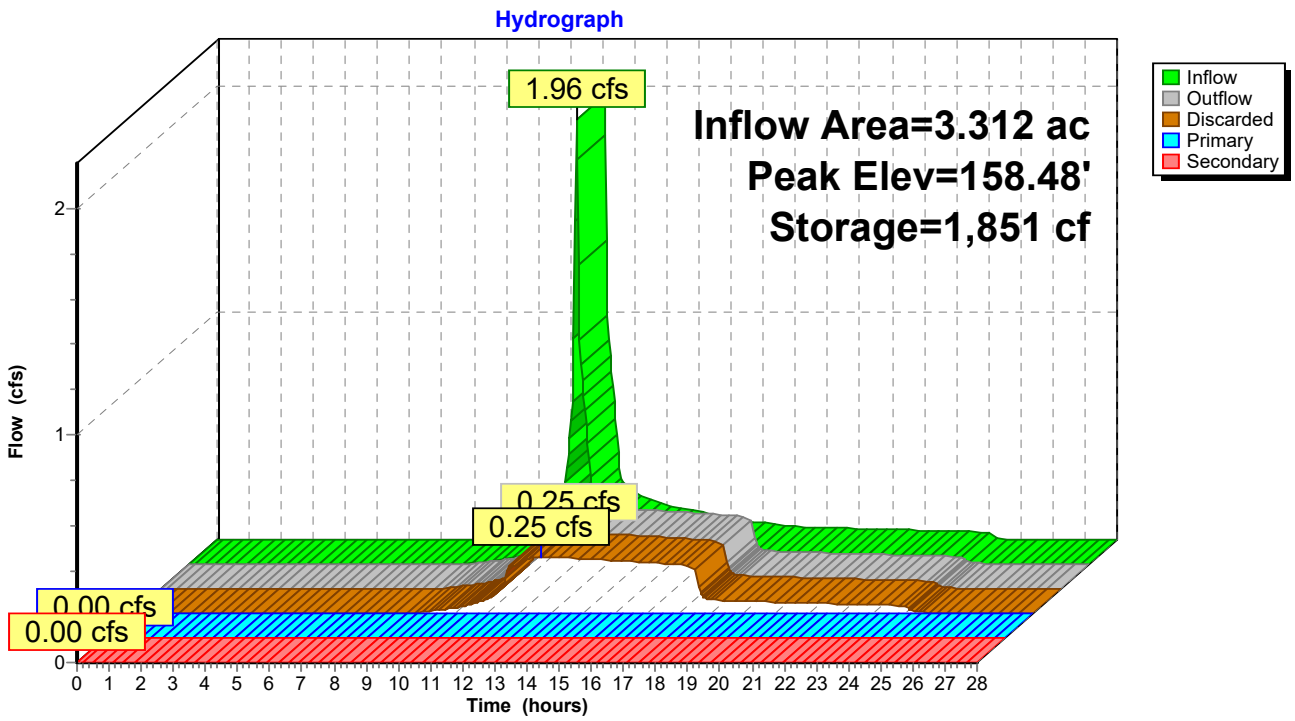
Device	Routing	Invert	Outlet Devices
#1	Discarded	158.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 152.00'
#2	Primary	158.95'	**2.5" x 2.5" Horiz. Orifice/Grate X 5.00 columns** X 5 rows C= 0.600 in 24.0" x 24.0" Grate (27% open area)
#3	Secondary	158.95'	**2.5" x 2.5" Horiz. Orifice/Grate X 5.00 columns** X 5 rows C= 0.600 in 24.0" x 24.0" Grate (27% open area)
#4	Secondary	159.40'	**14.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.25 cfs @ 12.72 hrs HW=158.48' (Free Discharge)
└**1=Exfiltration** (Controls 0.25 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=158.00' (Free Discharge)
└**2=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=158.00' (Free Discharge)
├**3=Orifice/Grate** (Controls 0.00 cfs)
└**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 5P: BASIN-1



Time span=0.00-28.00 hrs, dt=0.04 hrs, 701 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA-1 Runoff Area=41,572 sf 66.13% Impervious Runoff Depth=2.82"
Flow Length=490' Slope=0.0100 '/' Tc=3.0 min CN=84 Runoff=3.44 cfs 0.224 af

Subcatchment 2S: PDA-2 Runoff Area=102,679 sf 16.67% Impervious Runoff Depth=0.50"
Flow Length=1,260' Tc=30.2 min CN=50 Runoff=0.46 cfs 0.098 af

Subcatchment 3S: PDA-3 Runoff Area=120,613 sf 0.00% Impervious Runoff Depth=0.14"
Flow Length=504' Tc=23.7 min CN=40 Runoff=0.05 cfs 0.031 af

Subcatchment 4S: PDA-4 Runoff Area=8,700 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment 5S: PDA-5 Runoff Area=8,400 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=30 Runoff=0.00 cfs 0.000 af

Subcatchment 6S: Route 20 Runoff Area=344,995 sf 29.09% Impervious Runoff Depth=0.80"
Flow Length=1,440' Slope=0.0320 '/' Tc=7.0 min CN=56 Runoff=5.32 cfs 0.525 af

Reach 1R: DP-1 Inflow=0.45 cfs 0.050 af
Outflow=0.45 cfs 0.050 af

Reach 2R: DP-2 Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Reach 3R: Swale Avg. Flow Depth=0.65' Max Vel=2.98 fps Inflow=5.17 cfs 0.575 af
n=0.040 L=102.0' S=0.0186 '/' Capacity=239.38 cfs Outflow=5.12 cfs 0.575 af

Reach 4R: 18-inch pipe Avg. Flow Depth=0.76' Max Vel=4.68 fps Inflow=5.32 cfs 0.525 af
25.0" Round Pipe n=0.011 L=155.0' S=0.0039 '/' Capacity=18.55 cfs Outflow=5.17 cfs 0.525 af

Pond 3P: Existing Depression Peak Elev=154.35' Storage=366 cf Inflow=0.44 cfs 0.019 af
Discarded=0.10 cfs 0.019 af Primary=0.00 cfs 0.000 af Outflow=0.10 cfs 0.019 af

Pond 5P: BASIN-1 Peak Elev=158.96' Storage=3,932 cf Inflow=3.45 cfs 0.322 af
Discarded=0.29 cfs 0.285 af Primary=0.44 cfs 0.019 af Secondary=0.44 cfs 0.019 af Outflow=1.18 cfs 0.322 af

Total Runoff Area = 14.393 ac Runoff Volume = 0.878 af Average Runoff Depth = 0.73"
76.88% Pervious = 11.065 ac 23.12% Impervious = 3.328 ac

Summary for Subcatchment 1S: PDA-1

[49] Hint: Tc<2dt may require smaller dt
[47] Hint: Peak is 285% of capacity of segment #2

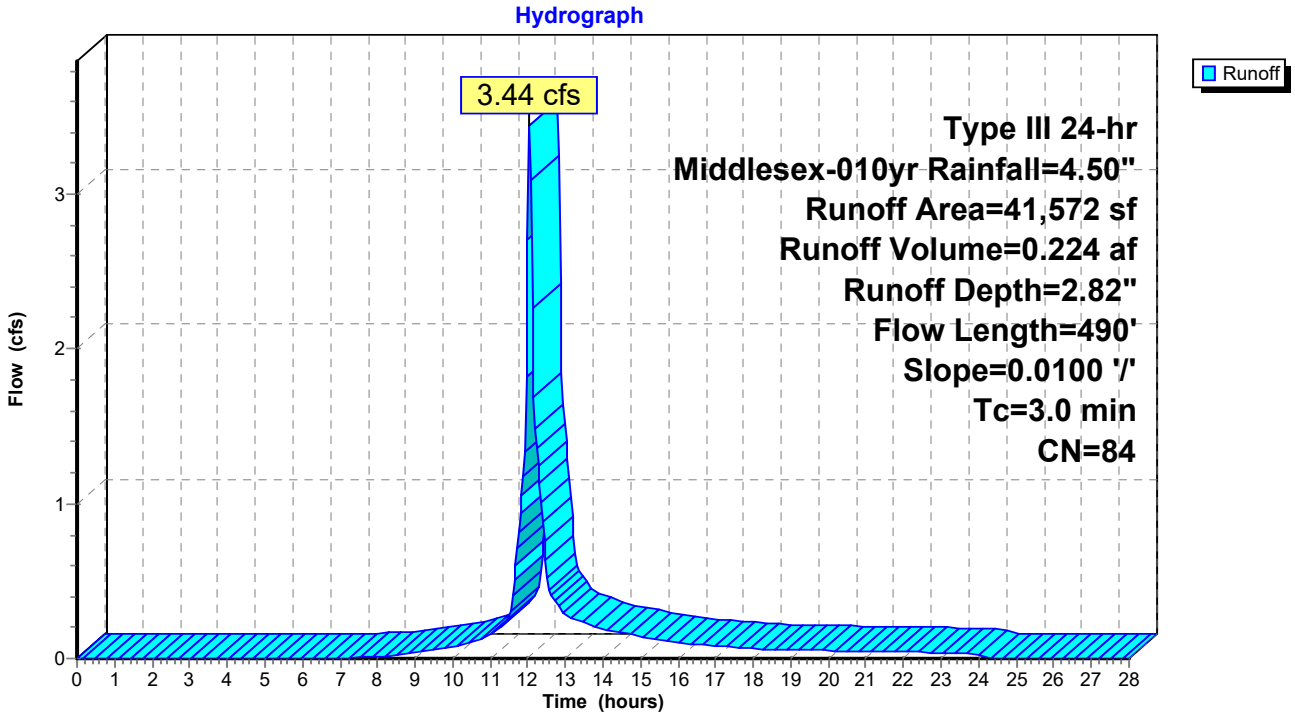
Runoff = 3.44 cfs @ 12.05 hrs, Volume= 0.224 af, Depth= 2.82"
Routed to Pond 5P : BASIN-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
20,110	98	Roofs, HSG A
9,820	39	>75% Grass cover, Good, HSG A
7,382	98	Paved parking, HSG A
4,260	98	Water Surface, 0% imp, HSG A
41,572	84	Weighted Average
14,080		33.87% Pervious Area
27,492		66.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.89		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
2.1	440	0.0100	3.46	1.21	**Pipe Channel, B-C** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.013 Corrugated PE, smooth interior
3.0	490	Total			

Subcatchment 1S: PDA-1



Summary for Subcatchment 2S: PDA-2

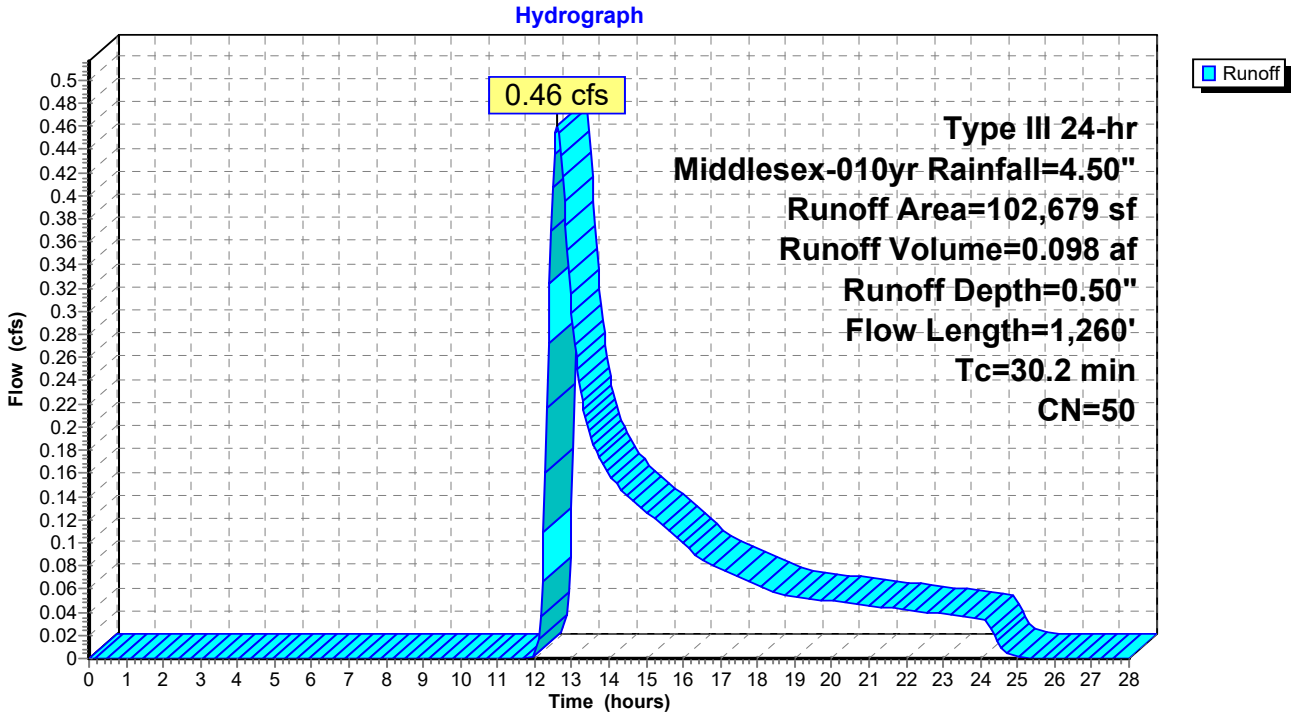
Runoff = 0.46 cfs @ 12.61 hrs, Volume= 0.098 af, Depth= 0.50"
Routed to Pond 5P : BASIN-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
83,102	39	>75% Grass cover, Good, HSG A
16,296	98	Paved parking, HSG A
2,463	76	Gravel roads, HSG A
818	98	Roofs, HSG A
102,679	50	Weighted Average
85,565		83.33% Pervious Area
17,114		16.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.1	50	0.0320	0.05		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.10"
7.8	418	0.0320	0.89		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
0.1	16	0.5625	3.75		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
2.2	166	0.0321	1.25		**Shallow Concentrated Flow, D-E** Short Grass Pasture Kv= 7.0 fps
1.0	113	0.0090	1.93		**Shallow Concentrated Flow, E-F** Paved Kv= 20.3 fps
1.0	497	0.0322	8.14	6.39	**Pipe Channel, F-G** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
30.2	1,260	Total			

Subcatchment 2S: PDA-2



Summary for Subcatchment 3S: PDA-3

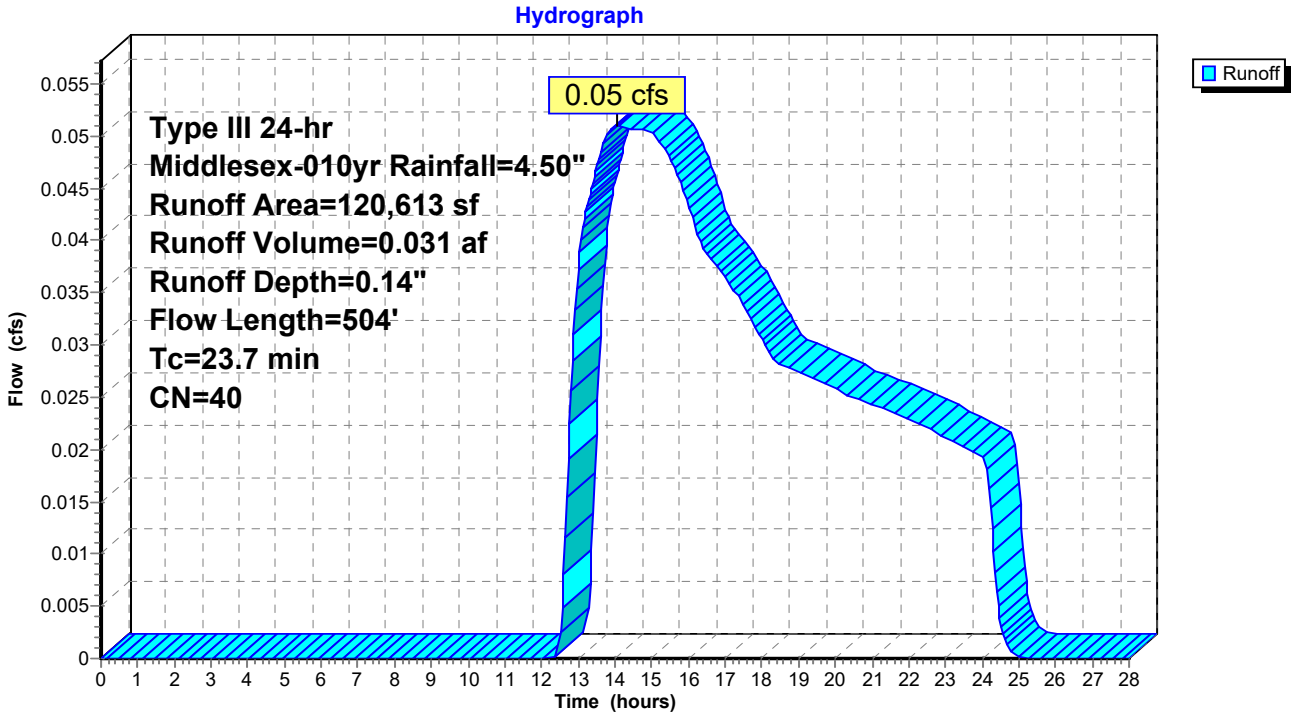
Runoff = 0.05 cfs @ 14.05 hrs, Volume= 0.031 af, Depth= 0.14"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
37,114	39	>75% Grass cover, Good, HSG A
7,090	76	Gravel roads, HSG A
65,032	30	Woods, Good, HSG A
8,822	77	Woods, Good, HSG D
2,555	76	Gravel roads, HSG A
120,613	40	Weighted Average
120,613		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, SF** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		**Shallow Concentrated Flow, SCF4** Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		**Shallow Concentrated Flow, SCF5** Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		**Shallow Concentrated Flow, SCF6** Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		**Shallow Concentrated Flow, SCF7** Woodland Kv= 5.0 fps
23.7	504	Total			

Subcatchment 3S: PDA-3



Summary for Subcatchment 4S: PDA-4

[45] Hint: Runoff=Zero

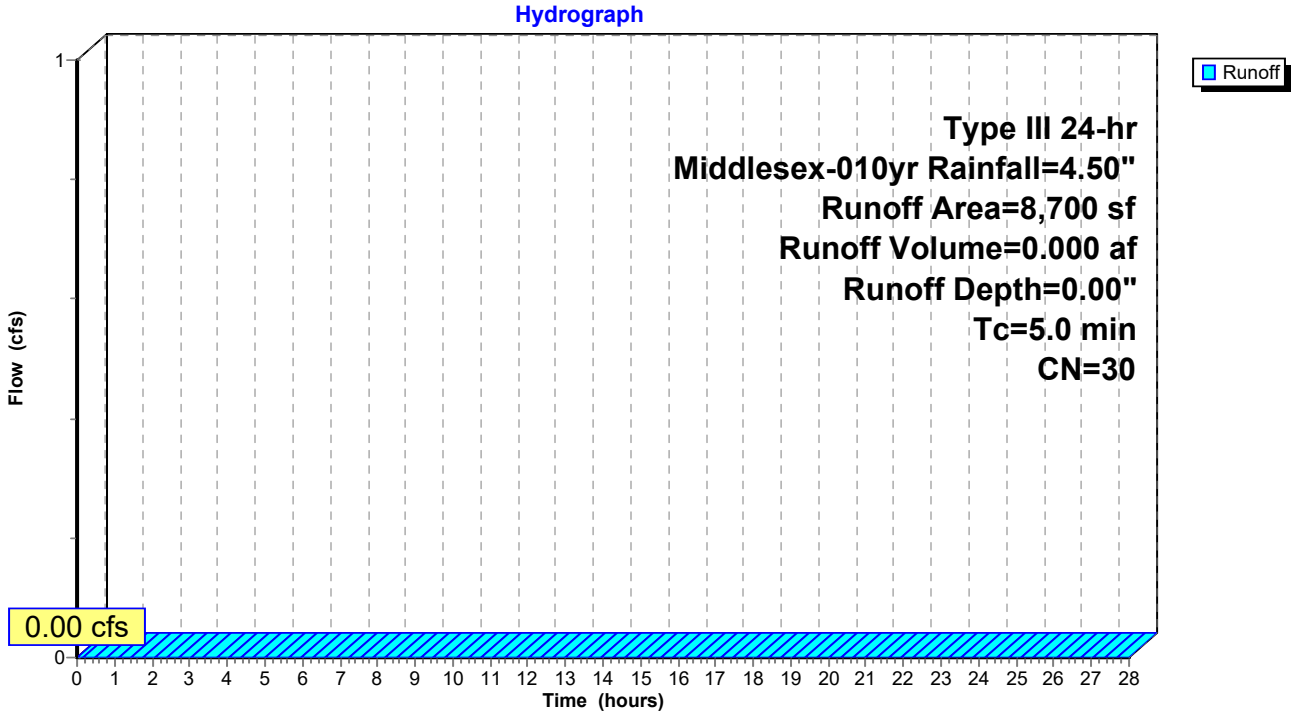
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
8,700	30	Woods, Good, HSG A
8,700		100.00% Pervious Area

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

Subcatchment 4S: PDA-4



Summary for Subcatchment 5S: PDA-5

[45] Hint: Runoff=Zero

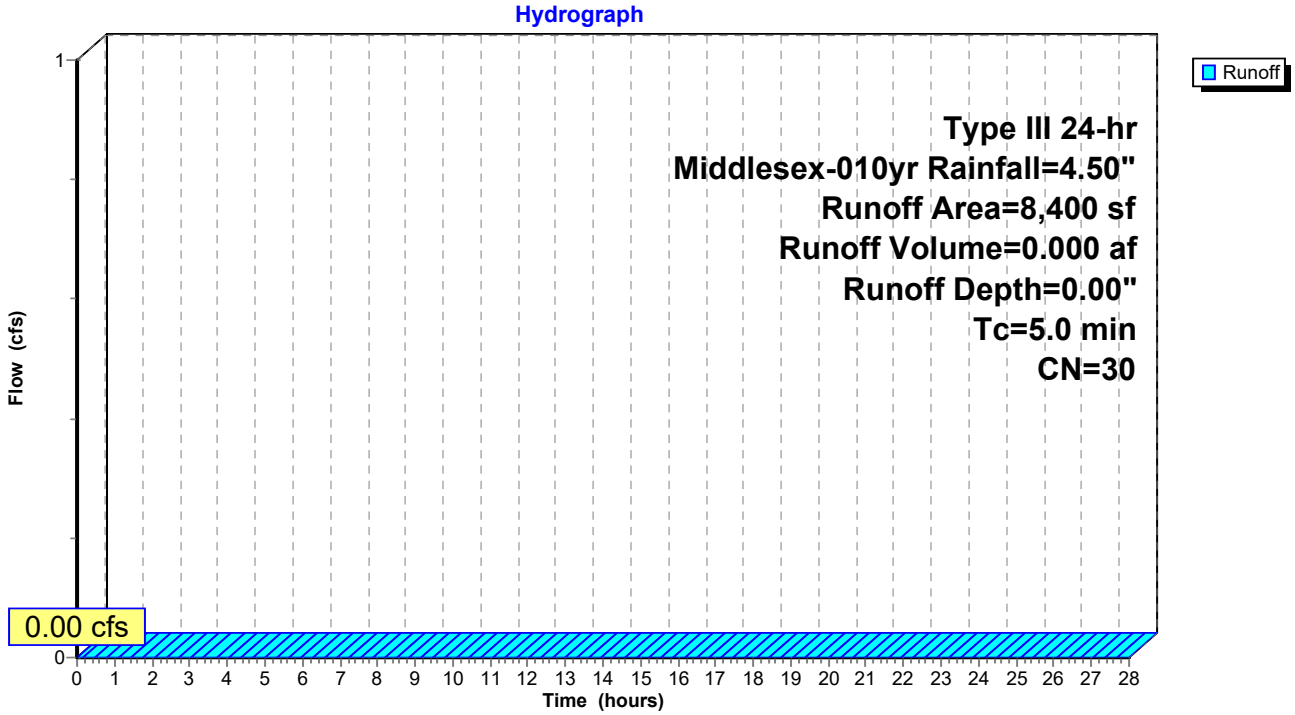
Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"
Routed to Pond 3P : Existing Depression

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
8,400	30	Woods, Good, HSG A
8,400		100.00% Pervious Area

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

Subcatchment 5S: PDA-5



Summary for Subcatchment 6S: Route 20

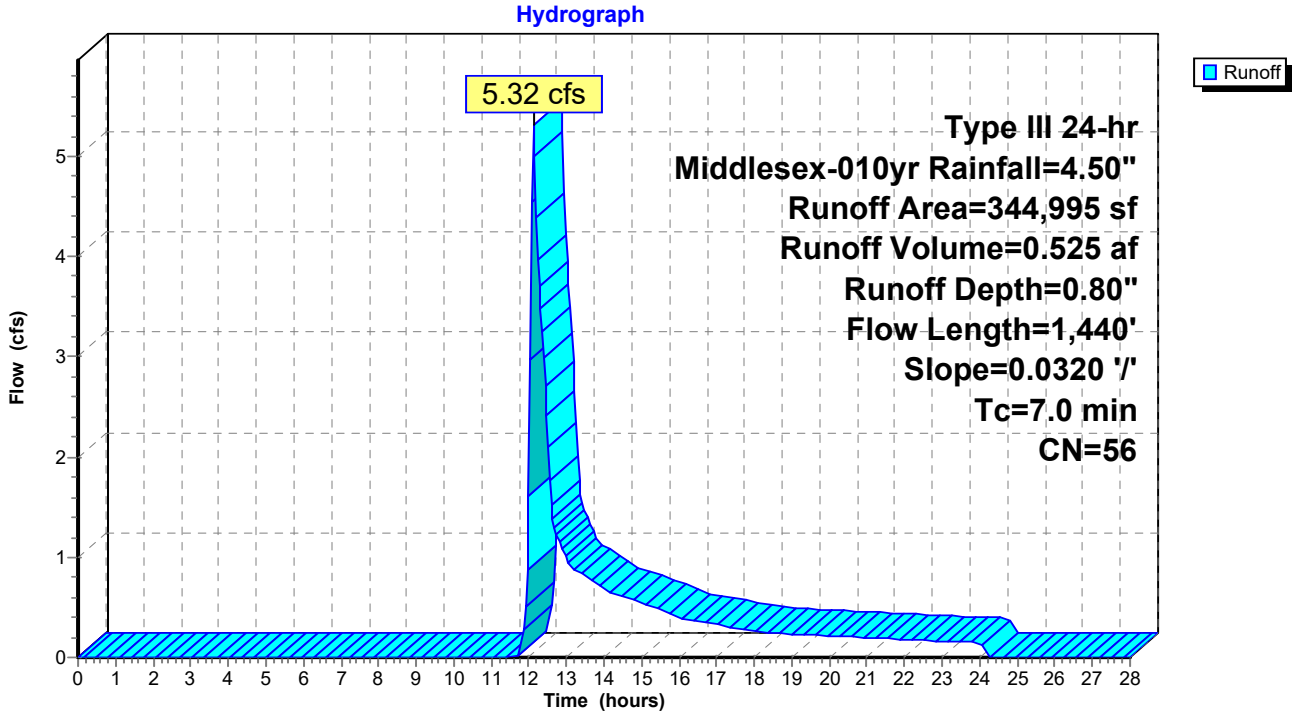
Runoff = 5.32 cfs @ 12.13 hrs, Volume= 0.525 af, Depth= 0.80"
Routed to Reach 4R : 18-inch pipe

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-010yr Rainfall=4.50"

Area (sf)	CN	Description
305,791	51	1 acre lots, 20% imp, HSG A
39,204	98	Paved roads w/curbs & sewers, HSG A
344,995	56	Weighted Average
244,633		70.91% Pervious Area
100,362		29.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0320	1.42		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
6.4	1,390	0.0320	3.63		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
7.0	1,440	Total			

Subcatchment 6S: Route 20



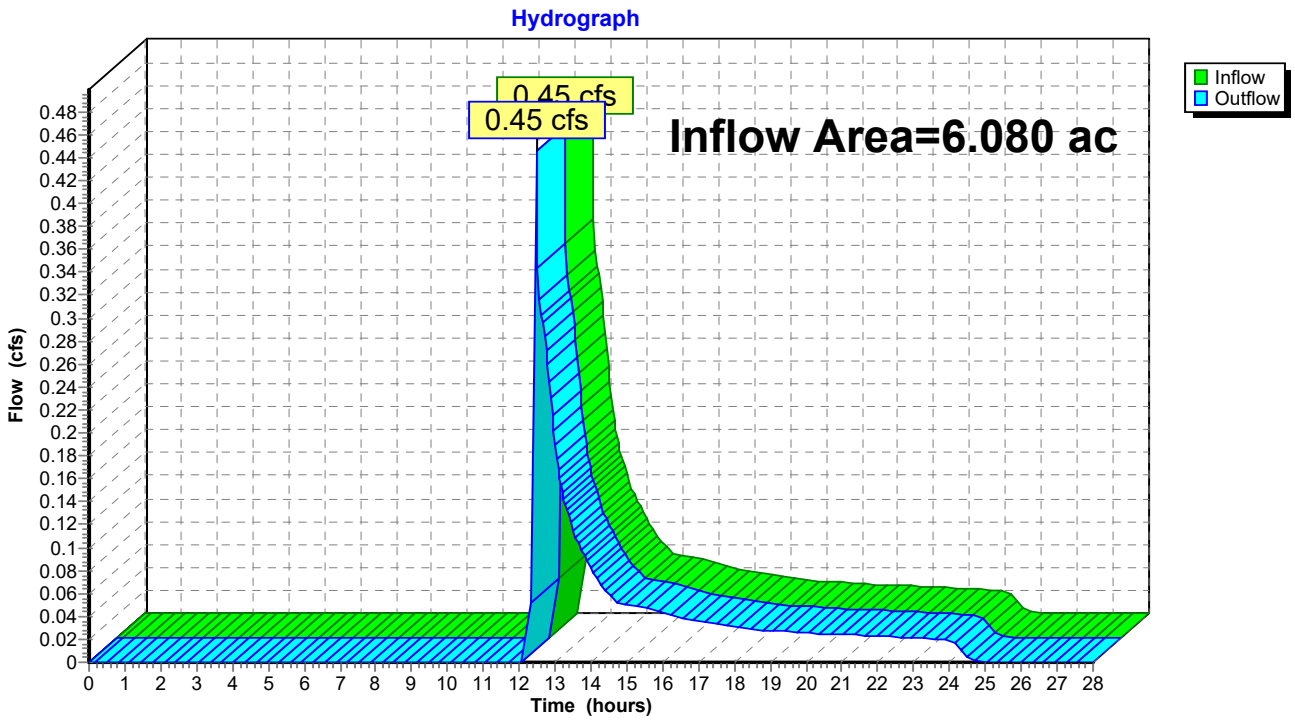
Summary for Reach 1R: DP-1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.080 ac, 16.84% Impervious, Inflow Depth = 0.10" for Middlesex-010yr event
Inflow = 0.45 cfs @ 12.49 hrs, Volume= 0.050 af
Outflow = 0.45 cfs @ 12.49 hrs, Volume= 0.050 af, Atten= 0%, Lag= 0.0 min
Routed to Reach 3R : Swale

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 1R: DP-1



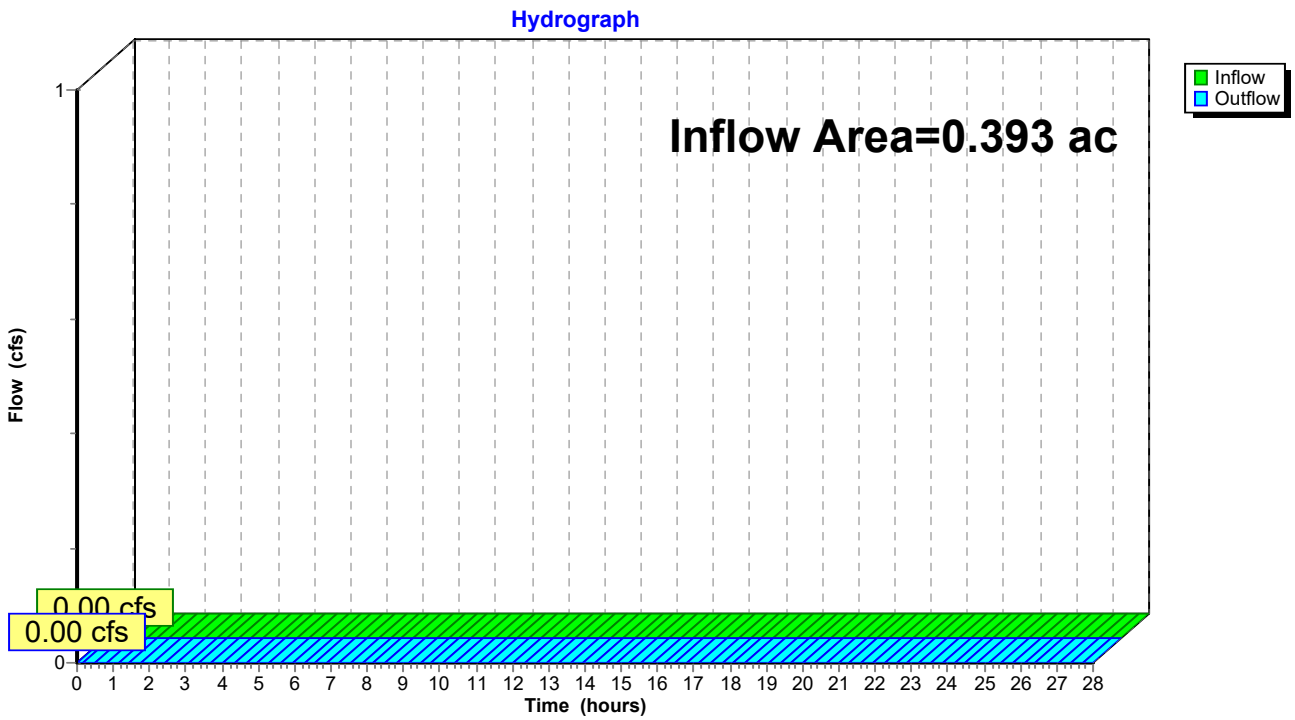
Summary for Reach 2R: DP-2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.393 ac, 0.00% Impervious, Inflow Depth = 0.00" for Middlesex-010yr 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

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 2R: DP-2



Summary for Reach 3R: Swale

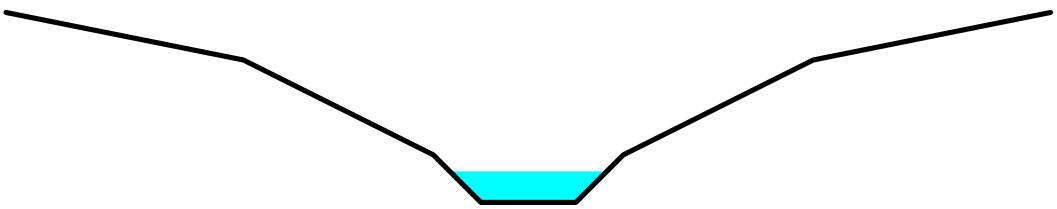
[61] Hint: Exceeded Reach 4R outlet invert by 0.65' @ 12.16 hrs

Inflow Area = 14.000 ac, 23.77% Impervious, Inflow Depth = 0.49" for Middlesex-010yr event
Inflow = 5.17 cfs @ 12.15 hrs, Volume= 0.575 af
Outflow = 5.12 cfs @ 12.17 hrs, Volume= 0.575 af, Atten= 1%, Lag= 1.2 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Max. Velocity= 2.98 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 1.26 fps, Avg. Travel Time= 1.3 min

Peak Storage= 177 cf @ 12.16 hrs
Average Depth at Peak Storage= 0.65' , Surface Width= 3.31'
Bank-Full Depth= 4.00' Flow Area= 36.0 sf, Capacity= 239.38 cfs

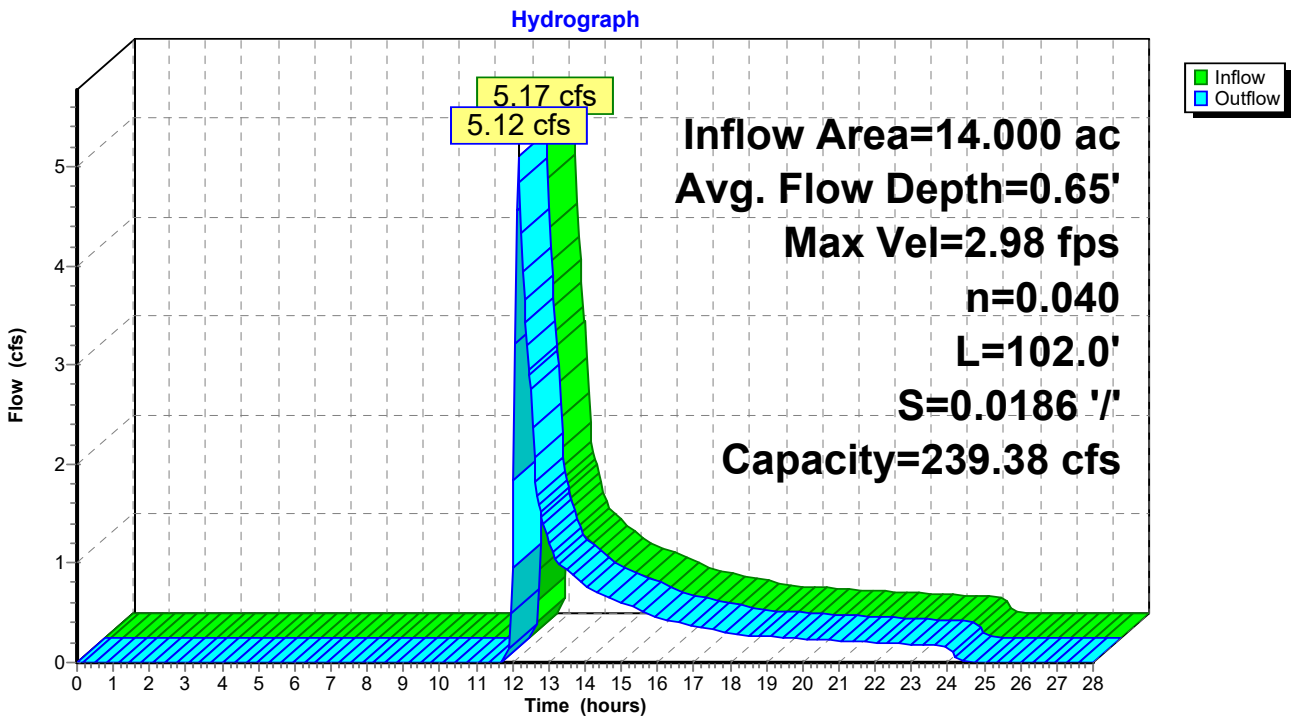
Custom cross-section, Length= 102.0' Slope= 0.0186 '/'
Constant n= 0.040 Winding stream, pools & shoals
Inlet Invert= 158.50', Outlet Invert= 156.60'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)
0.00	160.00	0.00
5.00	159.00	1.00
9.00	157.00	3.00
10.00	156.00	4.00
12.00	156.00	4.00
13.00	157.00	3.00
17.00	159.00	1.00
22.00	160.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	2.0	0.0	0	0.00
1.00	3.0	4.8	4.0	306	11.08
3.00	19.0	13.8	12.0	1,938	119.38
4.00	36.0	24.0	22.0	3,672	239.38

Reach 3R: Swale



Summary for Reach 4R: 18-inch pipe

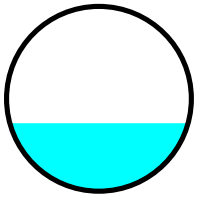
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 7.920 ac, 29.09% Impervious, Inflow Depth = 0.80" for Middlesex-010yr event
Inflow = 5.32 cfs @ 12.13 hrs, Volume= 0.525 af
Outflow = 5.17 cfs @ 12.15 hrs, Volume= 0.525 af, Atten= 3%, Lag= 1.1 min
Routed to Reach 3R : Swale

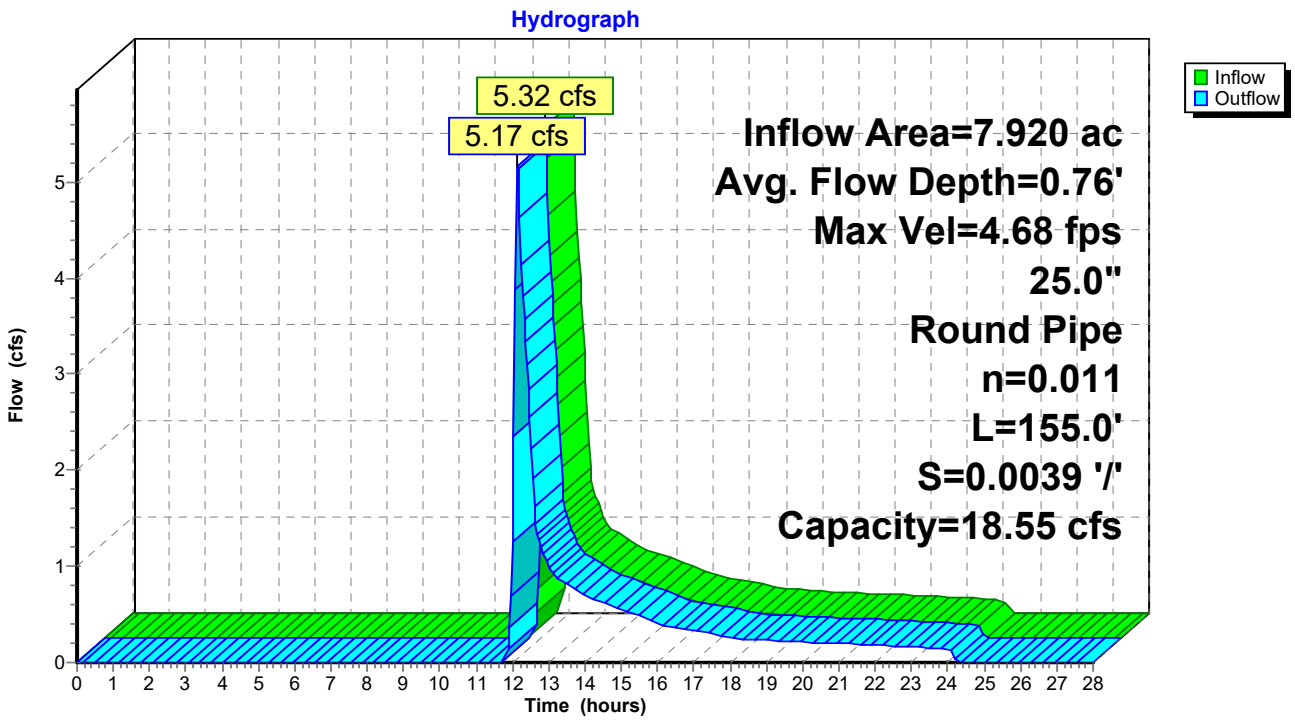
Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Max. Velocity= 4.68 fps, Min. Travel Time= 0.6 min
Avg. Velocity = 2.09 fps, Avg. Travel Time= 1.2 min

Peak Storage= 176 cf @ 12.14 hrs
Average Depth at Peak Storage= 0.76' , Surface Width= 2.01'
Bank-Full Depth= 2.08' Flow Area= 3.4 sf, Capacity= 18.55 cfs

25.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 155.0' Slope= 0.0039 '/'
Inlet Invert= 159.10', Outlet Invert= 158.50'



Reach 4R: 18-inch pipe



Summary for Pond 3P: Existing Depression

[92] Warning: Device #1 is above defined storage

Inflow Area = 0.193 ac, 0.00% Impervious, Inflow Depth = 1.16" for Middlesex-010yr event
Inflow = 0.44 cfs @ 12.49 hrs, Volume= 0.019 af
Outflow = 0.10 cfs @ 13.21 hrs, Volume= 0.019 af, Atten= 77%, Lag= 42.9 min
Discarded = 0.10 cfs @ 13.21 hrs, Volume= 0.019 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Routed to Reach 2R : DP-2

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs / 2
Peak Elev= 154.35' @ 13.21 hrs Surf.Area= 1,522 sf Storage= 366 cf

Plug-Flow detention time= 45.9 min calculated for 0.019 af (100% of inflow)
Center-of-Mass det. time= 45.8 min (825.2 - 779.4)

Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	1,934 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

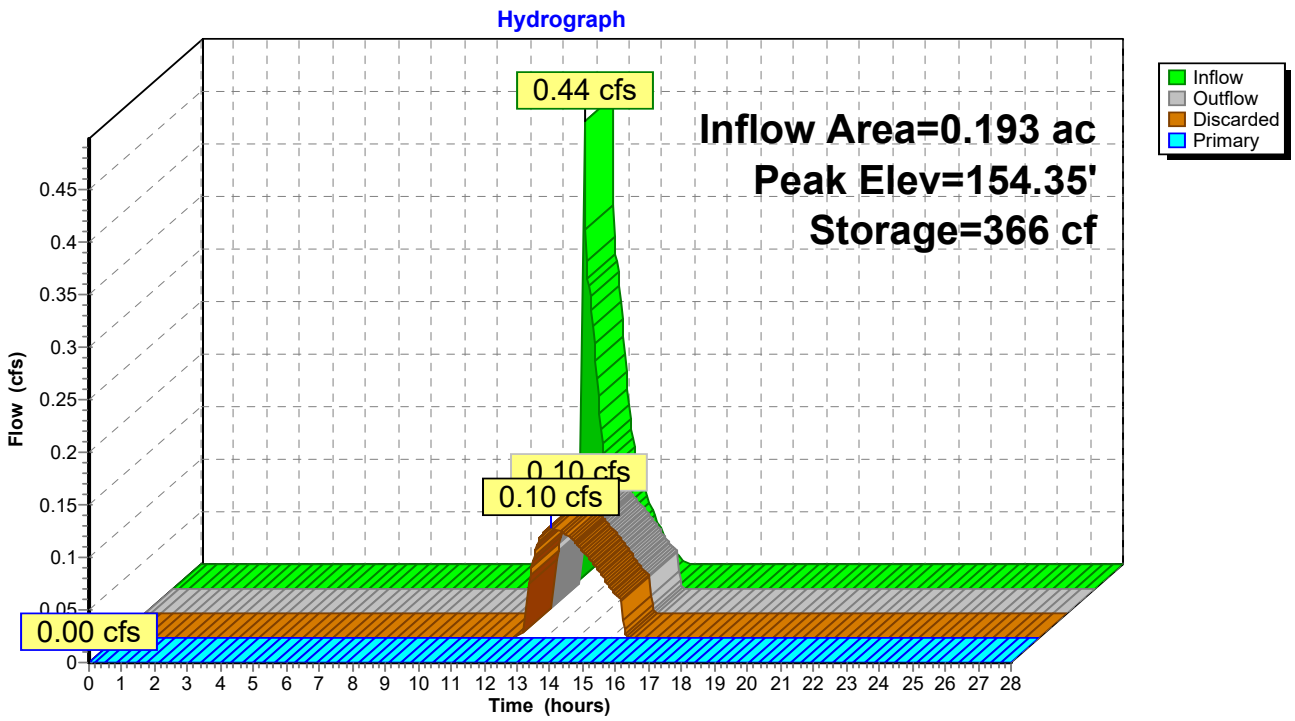
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
154.00	583	0	0
155.00	3,285	1,934	1,934

Device	Routing	Invert	Outlet Devices
#1	Primary	155.00'	**55.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	154.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 153.00'

Discarded OutFlow Max=0.10 cfs @ 13.21 hrs HW=154.35' (Free Discharge)
└**2=Exfiltration** (Controls 0.10 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=154.00' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 3P: Existing Depression



Summary for Pond 5P: BASIN-1

Inflow Area = 3.312 ac, 30.92% Impervious, Inflow Depth = 1.17" for Middlesex-010yr event
Inflow = 3.45 cfs @ 12.05 hrs, Volume= 0.322 af
Outflow = 1.18 cfs @ 12.49 hrs, Volume= 0.322 af, Atten= 66%, Lag= 26.8 min
Discarded = 0.29 cfs @ 12.48 hrs, Volume= 0.285 af
Primary = 0.44 cfs @ 12.49 hrs, Volume= 0.019 af
Routed to Reach 1R : DP-1
Secondary = 0.44 cfs @ 12.49 hrs, Volume= 0.019 af
Routed to Pond 3P : Existing Depression

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Peak Elev= 158.96' @ 12.48 hrs Surf.Area= 4,520 sf Storage= 3,932 cf

Plug-Flow detention time= 128.2 min calculated for 0.322 af (100% of inflow)
Center-of-Mass det. time= 128.2 min (983.0 - 854.8)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	6,515 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
158.00	3,690	0	0
159.00	4,556	4,123	4,123
159.50	5,011	2,392	6,515

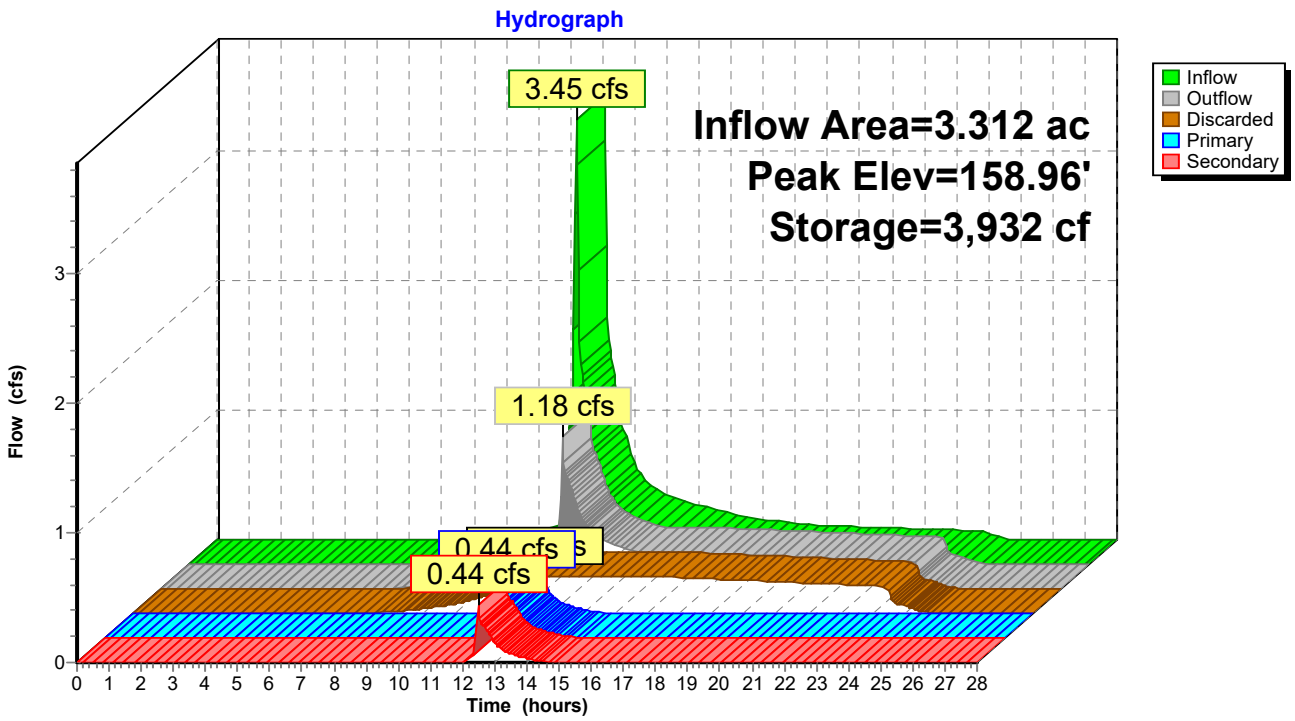
Device	Routing	Invert	Outlet Devices
#1	Discarded	158.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 152.00'
#2	Primary	158.95'	**2.5" x 2.5" Horiz. Orifice/Grate X 5.00 columns** X 5 rows C= 0.600 in 24.0" x 24.0" Grate (27% open area)
#3	Secondary	158.95'	**2.5" x 2.5" Horiz. Orifice/Grate X 5.00 columns** X 5 rows C= 0.600 in 24.0" x 24.0" Grate (27% open area)
#4	Secondary	159.40'	**14.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.29 cfs @ 12.48 hrs HW=158.96' (Free Discharge)
└─**1=Exfiltration** (Controls 0.29 cfs)

Primary OutFlow Max=0.45 cfs @ 12.49 hrs HW=158.96' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 0.45 cfs @ 0.42 fps)

Secondary OutFlow Max=0.45 cfs @ 12.49 hrs HW=158.96' (Free Discharge)
├─**3=Orifice/Grate** (Orifice Controls 0.45 cfs @ 0.42 fps)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 5P: BASIN-1



Time span=0.00-28.00 hrs, dt=0.04 hrs, 701 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: PDA-1 Runoff Area=41,572 sf 66.13% Impervious Runoff Depth=5.14"
Flow Length=490' Slope=0.0100 '/' Tc=3.0 min CN=84 Runoff=6.16 cfs 0.409 af

Subcatchment 2S: PDA-2 Runoff Area=102,679 sf 16.67% Impervious Runoff Depth=1.67"
Flow Length=1,260' Tc=30.2 min CN=50 Runoff=2.26 cfs 0.327 af

Subcatchment 3S: PDA-3 Runoff Area=120,613 sf 0.00% Impervious Runoff Depth=0.84"
Flow Length=504' Tc=23.7 min CN=40 Runoff=1.05 cfs 0.194 af

Subcatchment 4S: PDA-4 Runoff Area=8,700 sf 0.00% Impervious Runoff Depth=0.21"
Tc=5.0 min CN=30 Runoff=0.01 cfs 0.004 af

Subcatchment 5S: PDA-5 Runoff Area=8,400 sf 0.00% Impervious Runoff Depth=0.21"
Tc=5.0 min CN=30 Runoff=0.01 cfs 0.003 af

Subcatchment 6S: Route 20 Runoff Area=344,995 sf 29.09% Impervious Runoff Depth=2.22"
Flow Length=1,440' Slope=0.0320 '/' Tc=7.0 min CN=56 Runoff=18.51 cfs 1.464 af

Reach 1R: DP-1 Inflow=2.72 cfs 0.368 af
Outflow=2.72 cfs 0.368 af

Reach 2R: DP-2 Inflow=0.20 cfs 0.005 af
Outflow=0.20 cfs 0.005 af

Reach 3R: Swale Avg. Flow Depth=1.40' Max Vel=4.15 fps Inflow=20.44 cfs 1.832 af
n=0.040 L=102.0' S=0.0186 '/' Capacity=239.38 cfs Outflow=20.19 cfs 1.832 af

Reach 4R: 18-inch pipe Avg. Flow Depth=1.70' Max Vel=6.20 fps Inflow=18.51 cfs 1.464 af
25.0" Round Pipe n=0.011 L=155.0' S=0.0039 '/' Capacity=18.55 cfs Outflow=18.26 cfs 1.464 af

Pond 3P: Existing Depression Peak Elev=155.01' Storage=1,934 cf Inflow=2.08 cfs 0.177 af
Discarded=0.27 cfs 0.118 af Primary=0.20 cfs 0.002 af Outflow=0.47 cfs 0.119 af

Pond 5P: BASIN-1 Peak Elev=159.11' Storage=4,620 cf Inflow=6.48 cfs 0.736 af
Discarded=0.30 cfs 0.388 af Primary=2.08 cfs 0.174 af Secondary=2.08 cfs 0.174 af Outflow=4.46 cfs 0.736 af

Total Runoff Area = 14.393 ac Runoff Volume = 2.401 af Average Runoff Depth = 2.00"
76.88% Pervious = 11.065 ac 23.12% Impervious = 3.328 ac

Summary for Subcatchment 1S: PDA-1

[49] Hint: Tc<2dt may require smaller dt
[47] Hint: Peak is 509% of capacity of segment #2

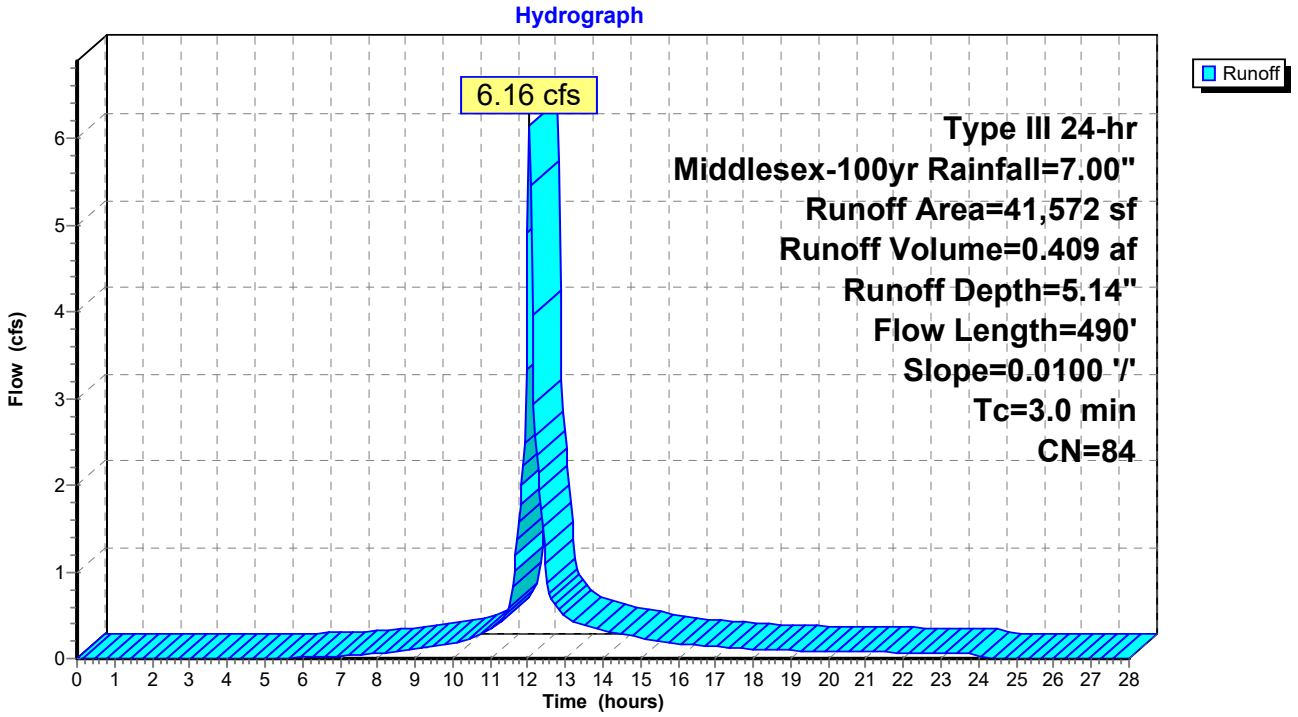
Runoff = 6.16 cfs @ 12.05 hrs, Volume= 0.409 af, Depth= 5.14"
Routed to Pond 5P : BASIN-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
20,110	98	Roofs, HSG A
9,820	39	>75% Grass cover, Good, HSG A
7,382	98	Paved parking, HSG A
4,260	98	Water Surface, 0% imp, HSG A
41,572	84	Weighted Average
14,080		33.87% Pervious Area
27,492		66.13% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.9	50	0.0100	0.89		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
2.1	440	0.0100	3.46	1.21	**Pipe Channel, B-C** 8.0" Round Area= 0.3 sf Perim= 2.1' r= 0.17' n= 0.013 Corrugated PE, smooth interior
3.0	490	Total			

Subcatchment 1S: PDA-1



Summary for Subcatchment 2S: PDA-2

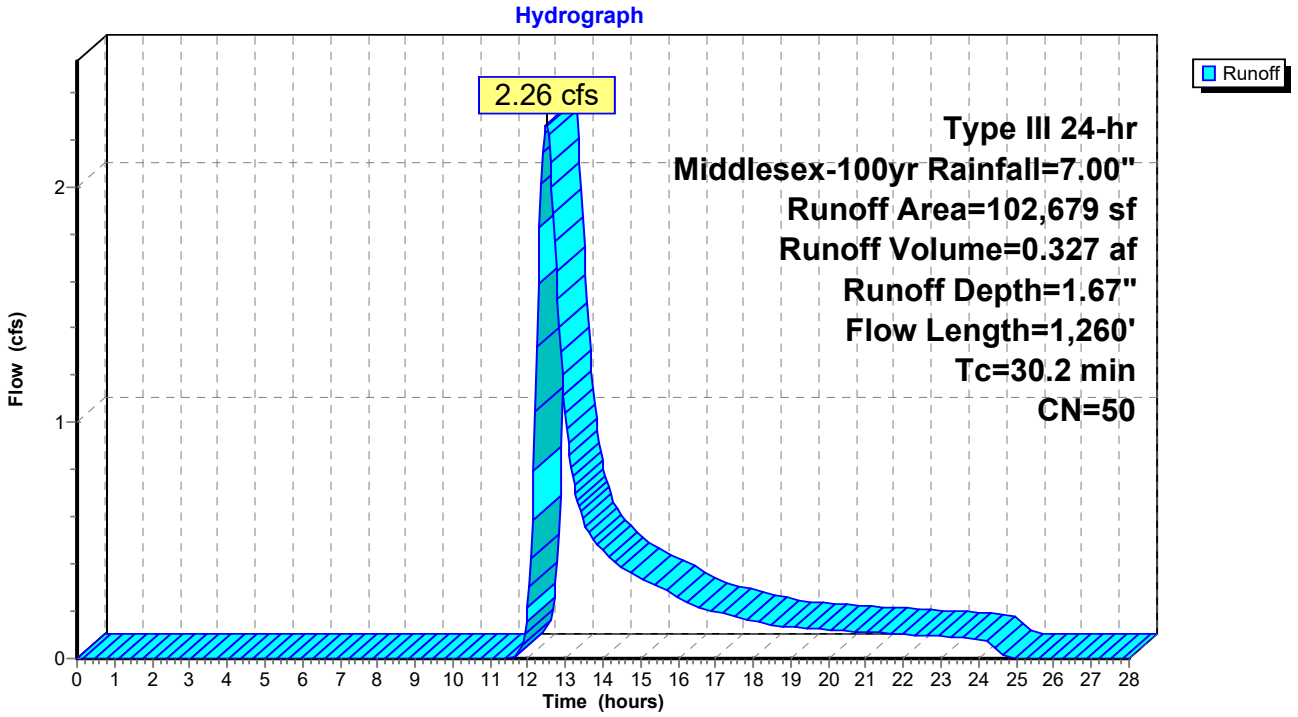
Runoff = 2.26 cfs @ 12.49 hrs, Volume= 0.327 af, Depth= 1.67"
Routed to Pond 5P : BASIN-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
83,102	39	>75% Grass cover, Good, HSG A
16,296	98	Paved parking, HSG A
2,463	76	Gravel roads, HSG A
818	98	Roofs, HSG A
102,679	50	Weighted Average
85,565		83.33% Pervious Area
17,114		16.67% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
18.1	50	0.0320	0.05		**Sheet Flow, A-B** Woods: Dense underbrush n= 0.800 P2= 3.10"
7.8	418	0.0320	0.89		**Shallow Concentrated Flow, B-C** Woodland Kv= 5.0 fps
0.1	16	0.5625	3.75		**Shallow Concentrated Flow, C-D** Woodland Kv= 5.0 fps
2.2	166	0.0321	1.25		**Shallow Concentrated Flow, D-E** Short Grass Pasture Kv= 7.0 fps
1.0	113	0.0090	1.93		**Shallow Concentrated Flow, E-F** Paved Kv= 20.3 fps
1.0	497	0.0322	8.14	6.39	**Pipe Channel, F-G** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
30.2	1,260	Total			

Subcatchment 2S: PDA-2



Summary for Subcatchment 3S: PDA-3

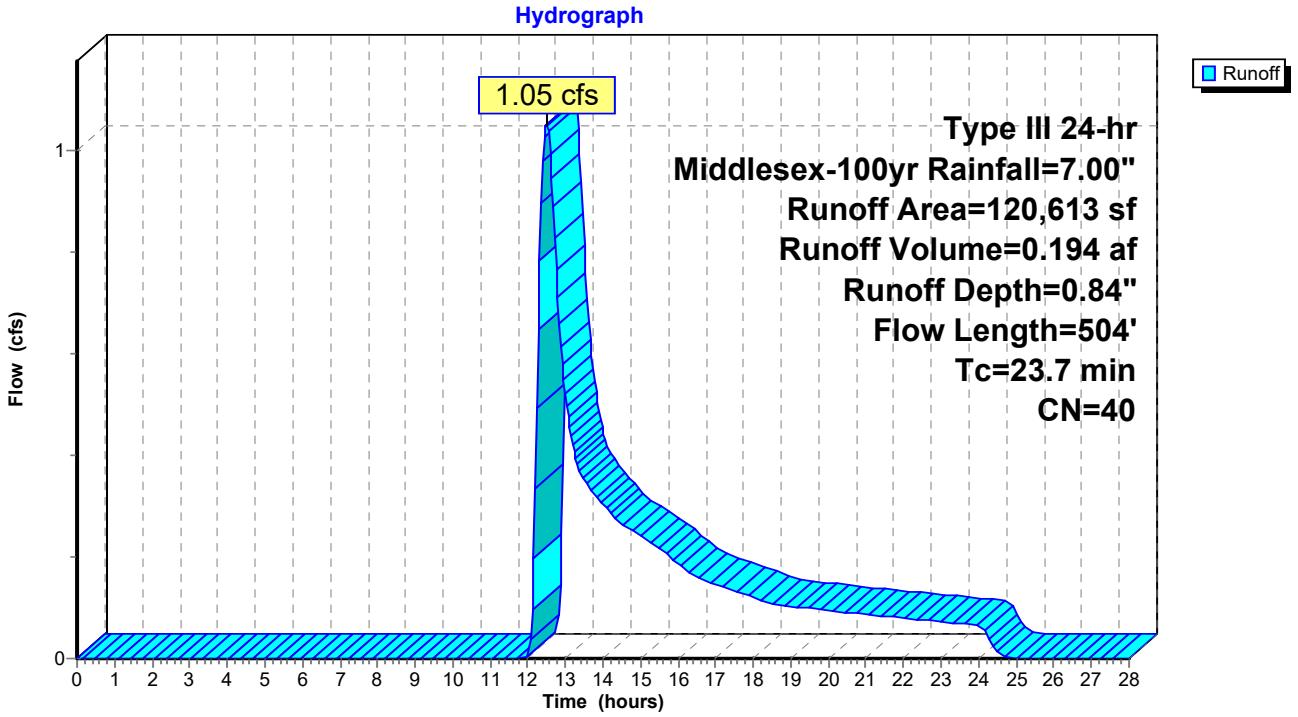
Runoff = 1.05 cfs @ 12.50 hrs, Volume= 0.194 af, Depth= 0.84"
Routed to Reach 1R : DP-1

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
37,114	39	>75% Grass cover, Good, HSG A
7,090	76	Gravel roads, HSG A
65,032	30	Woods, Good, HSG A
8,822	77	Woods, Good, HSG D
2,555	76	Gravel roads, HSG A
120,613	40	Weighted Average
120,613		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
17.4	50	0.0350	0.05		**Sheet Flow, SF** Woods: Dense underbrush n= 0.800 P2= 3.10"
0.9	97	0.1440	1.90		**Shallow Concentrated Flow, SCF1** Woodland Kv= 5.0 fps
0.0	6	0.6670	5.72		**Shallow Concentrated Flow, SCF2** Short Grass Pasture Kv= 7.0 fps
0.1	15	0.0130	2.31		**Shallow Concentrated Flow, SCF3** Paved Kv= 20.3 fps
0.1	6	0.0330	1.27		**Shallow Concentrated Flow, SCF4** Short Grass Pasture Kv= 7.0 fps
3.0	184	0.0430	1.04		**Shallow Concentrated Flow, SCF5** Woodland Kv= 5.0 fps
2.1	137	0.0240	1.08		**Shallow Concentrated Flow, SCF6** Short Grass Pasture Kv= 7.0 fps
0.1	9	0.2000	2.24		**Shallow Concentrated Flow, SCF7** Woodland Kv= 5.0 fps
23.7	504	Total			

Subcatchment 3S: PDA-3



Summary for Subcatchment 4S: PDA-4

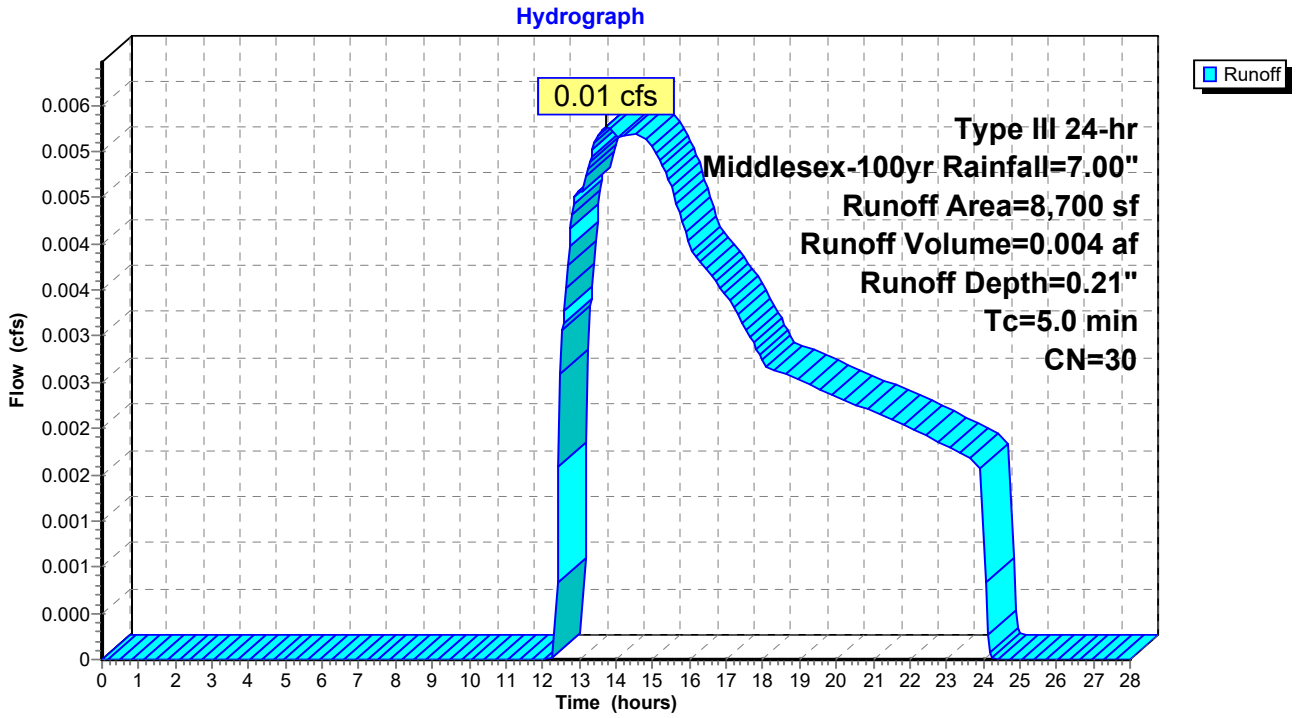
Runoff = 0.01 cfs @ 13.75 hrs, Volume= 0.004 af, Depth= 0.21"
Routed to Reach 2R : DP-2

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
8,700	30	Woods, Good, HSG A
8,700		100.00% Pervious Area

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

Subcatchment 4S: PDA-4



Summary for Subcatchment 5S: PDA-5

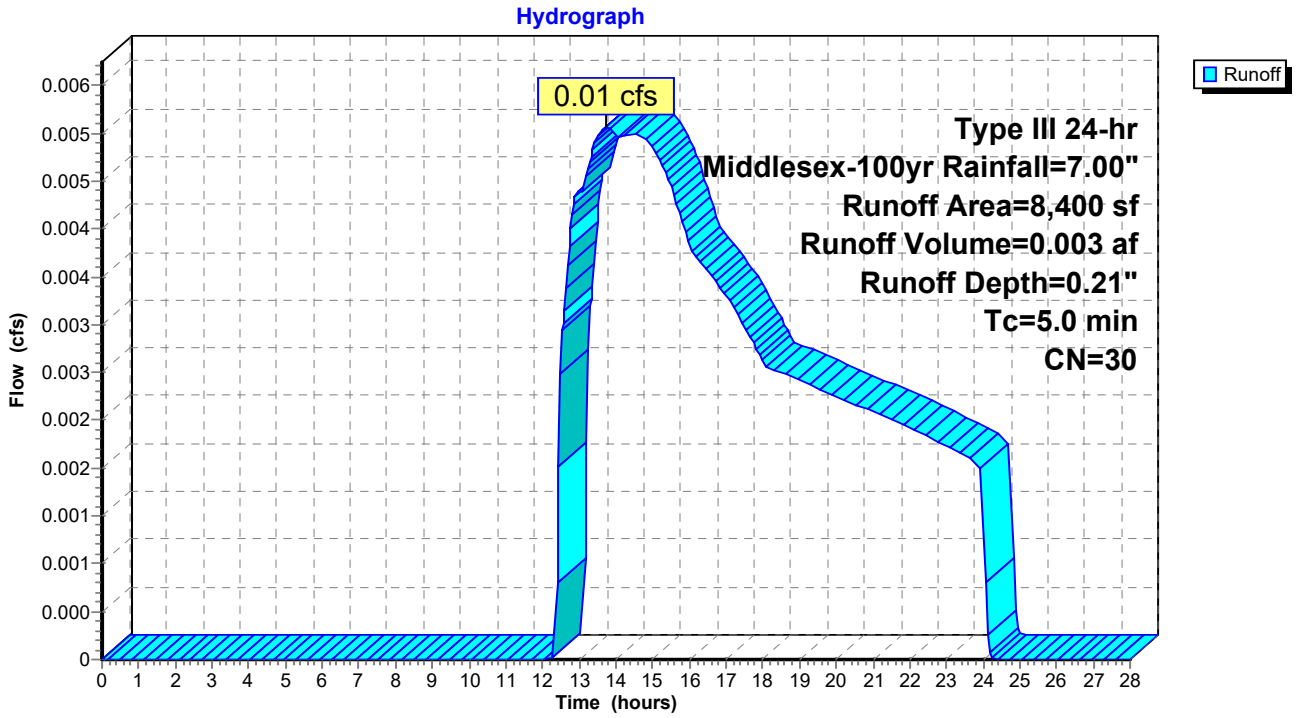
Runoff = 0.01 cfs @ 13.75 hrs, Volume= 0.003 af, Depth= 0.21"
Routed to Pond 3P : Existing Depression

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
8,400	30	Woods, Good, HSG A
8,400		100.00% Pervious Area

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

Subcatchment 5S: PDA-5



Summary for Subcatchment 6S: Route 20

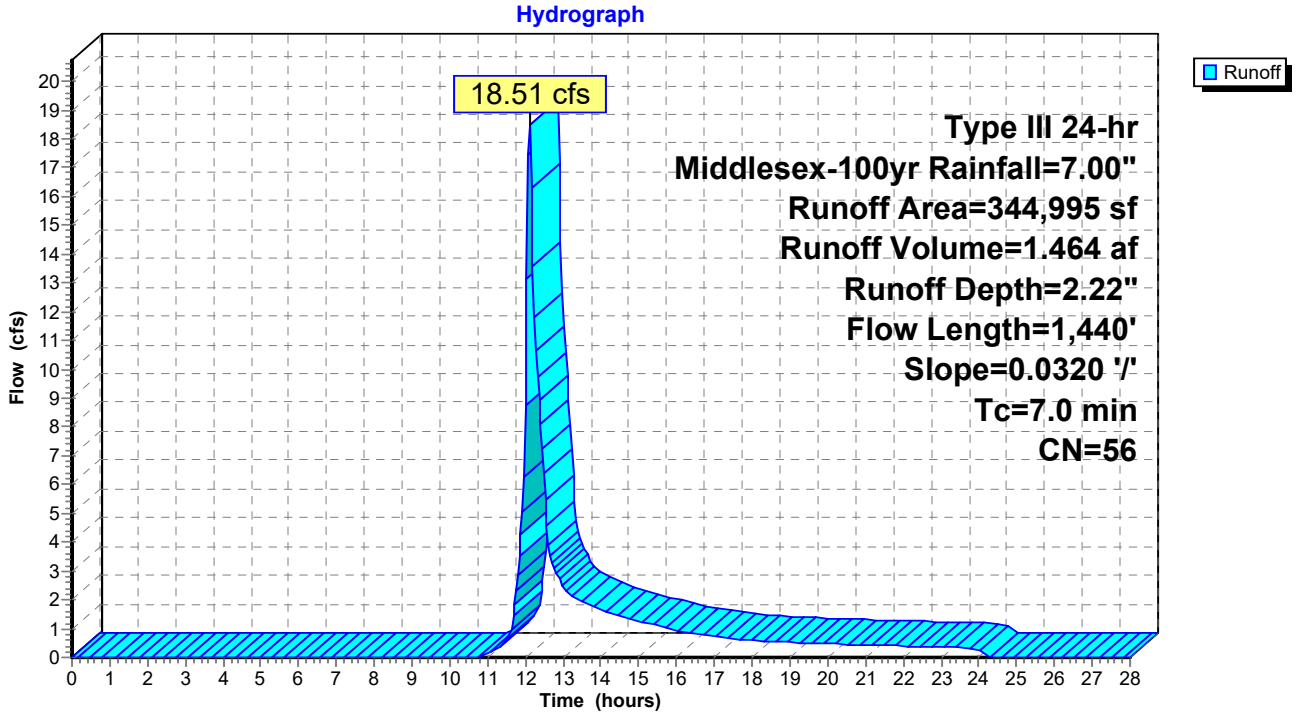
Runoff = 18.51 cfs @ 12.11 hrs, Volume= 1.464 af, Depth= 2.22"
Routed to Reach 4R : 18-inch pipe

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Type III 24-hr Middlesex-100yr Rainfall=7.00"

Area (sf)	CN	Description
305,791	51	1 acre lots, 20% imp, HSG A
39,204	98	Paved roads w/curbs & sewers, HSG A
344,995	56	Weighted Average
244,633		70.91% Pervious Area
100,362		29.09% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.6	50	0.0320	1.42		**Sheet Flow, A-B** Smooth surfaces n= 0.011 P2= 3.10"
6.4	1,390	0.0320	3.63		**Shallow Concentrated Flow, B-C** Paved Kv= 20.3 fps
7.0	1,440	Total			

Subcatchment 6S: Route 20



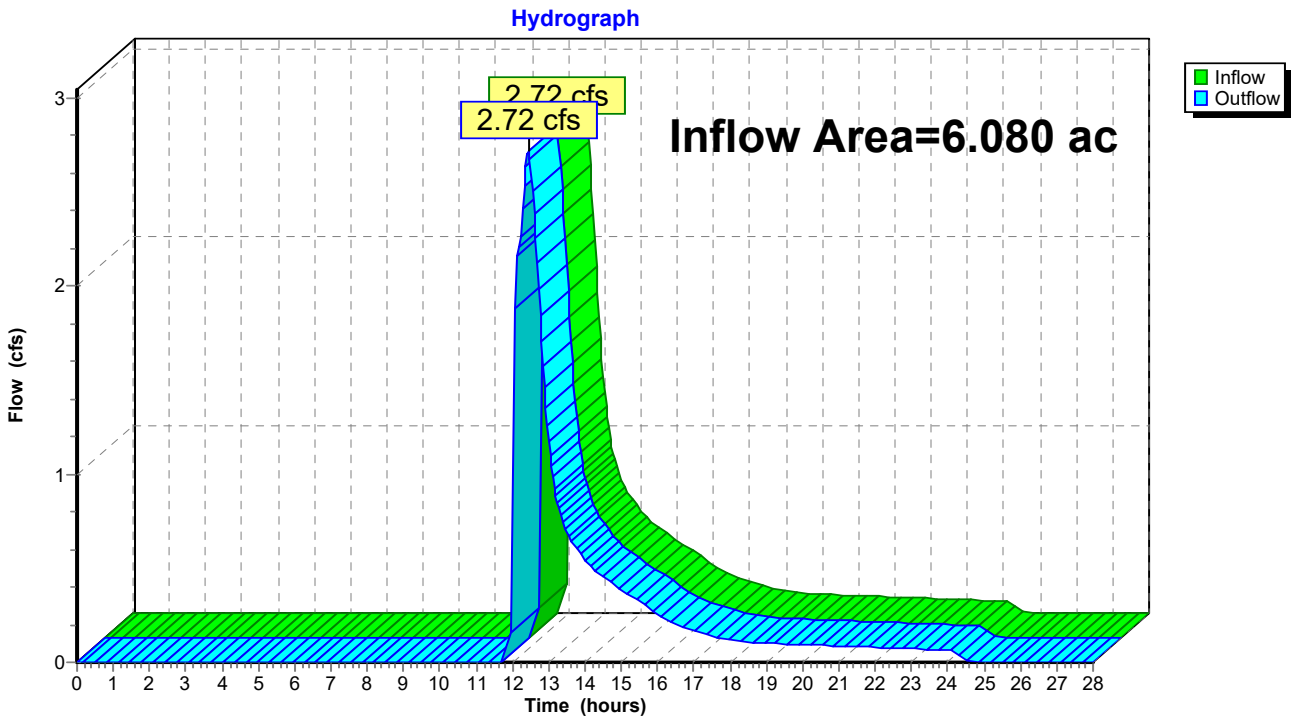
Summary for Reach 1R: DP-1

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 6.080 ac, 16.84% Impervious, Inflow Depth = 0.73" for Middlesex-100yr event
Inflow = 2.72 cfs @ 12.44 hrs, Volume= 0.368 af
Outflow = 2.72 cfs @ 12.44 hrs, Volume= 0.368 af, Atten= 0%, Lag= 0.0 min
Routed to Reach 3R : Swale

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 1R: DP-1



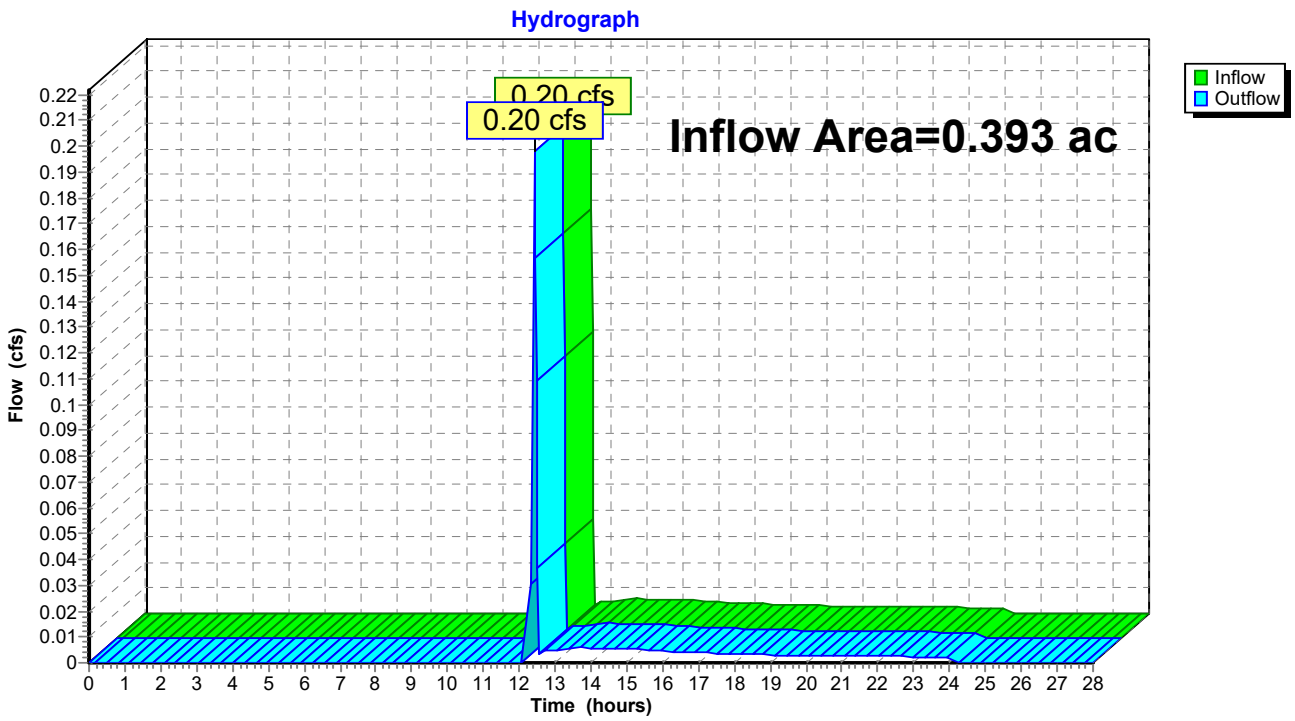
Summary for Reach 2R: DP-2

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 0.393 ac, 0.00% Impervious, Inflow Depth = 0.16" for Middlesex-100yr event
Inflow = 0.20 cfs @ 12.41 hrs, Volume= 0.005 af
Outflow = 0.20 cfs @ 12.41 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs

Reach 2R: DP-2



Summary for Reach 3R: Swale

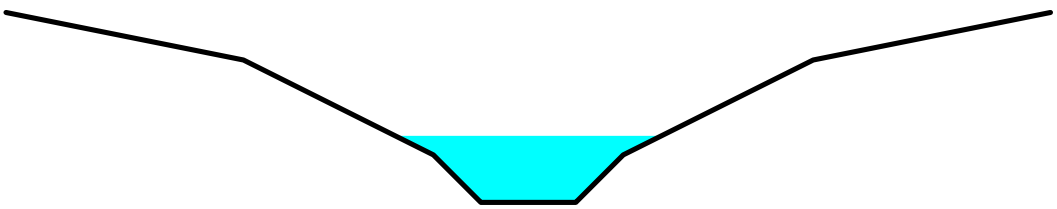
[62] Hint: Exceeded Reach 4R OUTLET depth by 0.10' @ 12.60 hrs

Inflow Area = 14.000 ac, 23.77% Impervious, Inflow Depth = 1.57" for Middlesex-100yr event
Inflow = 20.44 cfs @ 12.13 hrs, Volume= 1.832 af
Outflow = 20.19 cfs @ 12.14 hrs, Volume= 1.832 af, Atten= 1%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Max. Velocity= 4.15 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.70 fps, Avg. Travel Time= 1.0 min

Peak Storage= 502 cf @ 12.13 hrs
Average Depth at Peak Storage= 1.40' , Surface Width= 5.61'
Bank-Full Depth= 4.00' Flow Area= 36.0 sf, Capacity= 239.38 cfs

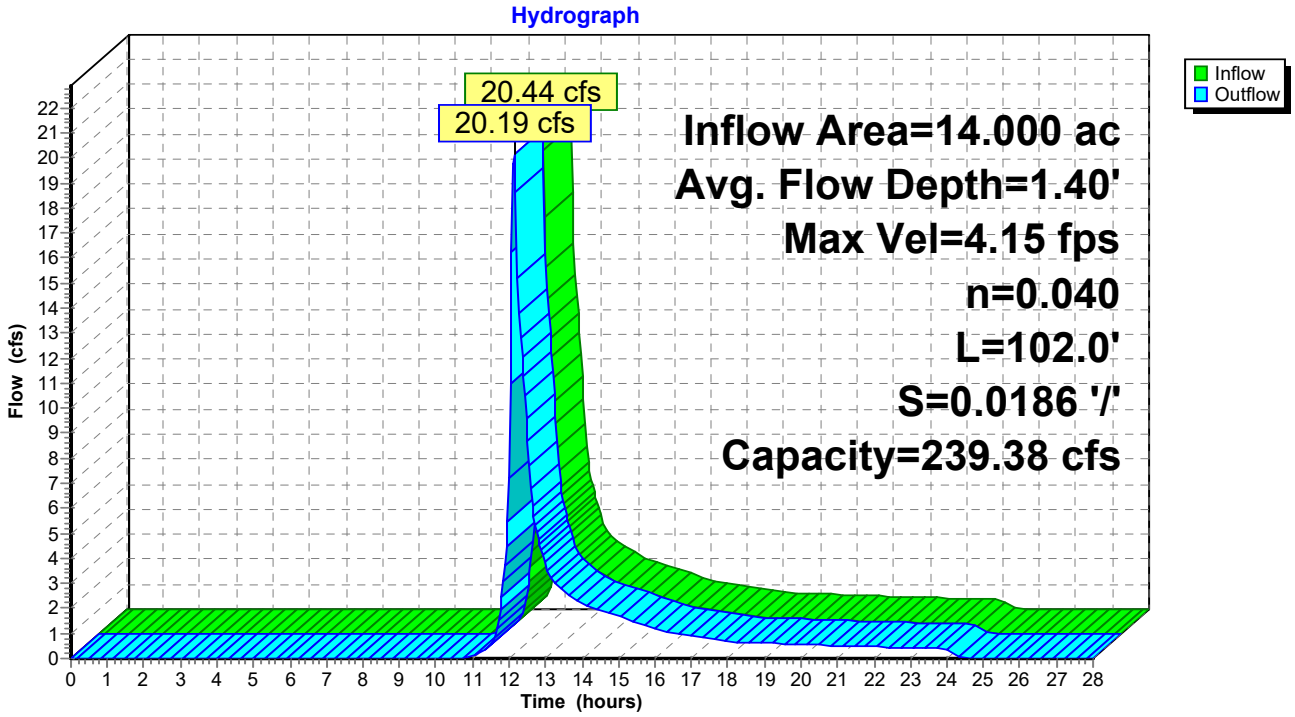
Custom cross-section, Length= 102.0' Slope= 0.0186 '/'
Constant n= 0.040 Winding stream, pools & shoals
Inlet Invert= 158.50', Outlet Invert= 156.60'



Offset (feet)	Elevation (feet)	Chan.Depth (feet)
0.00	160.00	0.00
5.00	159.00	1.00
9.00	157.00	3.00
10.00	156.00	4.00
12.00	156.00	4.00
13.00	157.00	3.00
17.00	159.00	1.00
22.00	160.00	0.00

Depth (feet)	End Area (sq-ft)	Perim. (feet)	Width (feet)	Storage (cubic-feet)	Discharge (cfs)
0.00	0.0	2.0	0.0	0	0.00
1.00	3.0	4.8	4.0	306	11.08
3.00	19.0	13.8	12.0	1,938	119.38
4.00	36.0	24.0	22.0	3,672	239.38

Reach 3R: Swale



Summary for Reach 4R: 18-inch pipe

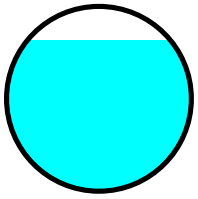
[52] Hint: Inlet/Outlet conditions not evaluated

Inflow Area = 7.920 ac, 29.09% Impervious, Inflow Depth = 2.22" for Middlesex-100yr event
Inflow = 18.51 cfs @ 12.11 hrs, Volume= 1.464 af
Outflow = 18.26 cfs @ 12.13 hrs, Volume= 1.464 af, Atten= 1%, Lag= 0.8 min
Routed to Reach 3R : Swale

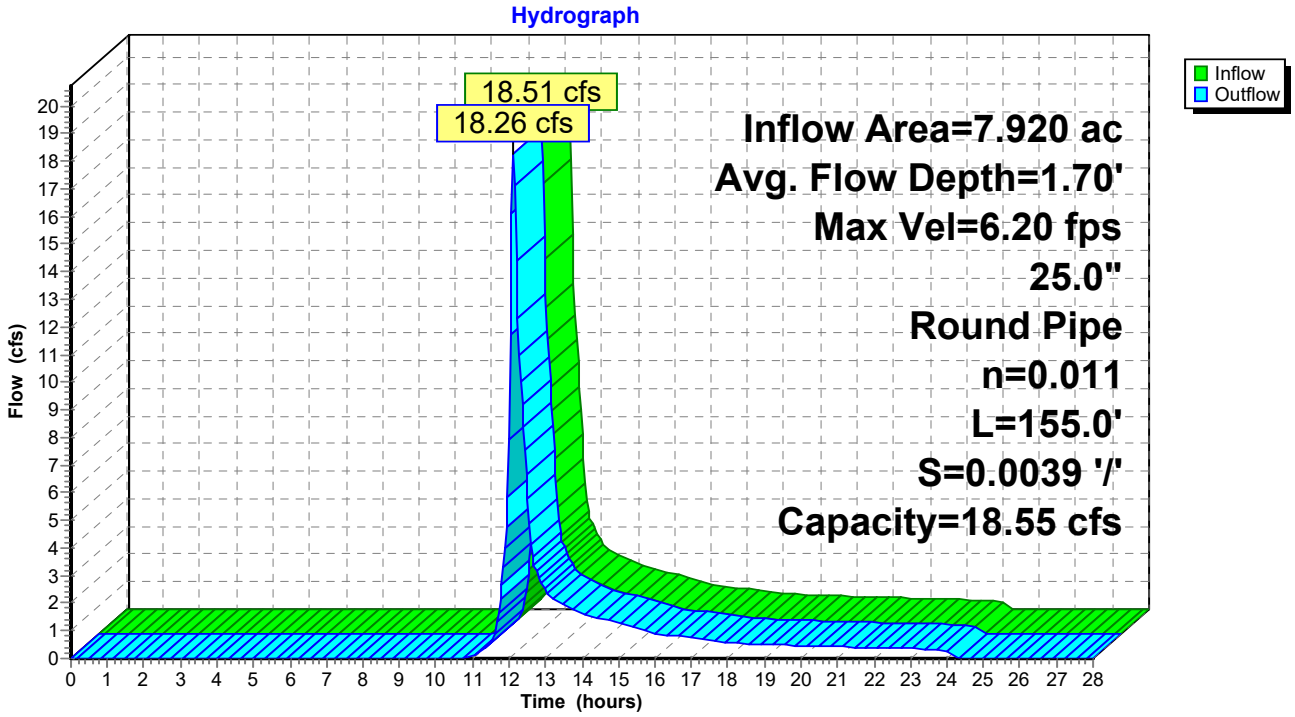
Routing by Stor-Ind+Trans method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Max. Velocity= 6.20 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 2.65 fps, Avg. Travel Time= 1.0 min

Peak Storage= 462 cf @ 12.12 hrs
Average Depth at Peak Storage= 1.70' , Surface Width= 1.61'
Bank-Full Depth= 2.08' Flow Area= 3.4 sf, Capacity= 18.55 cfs

25.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 155.0' Slope= 0.0039 '/'
Inlet Invert= 159.10', Outlet Invert= 158.50'



Reach 4R: 18-inch pipe



Summary for Pond 3P: Existing Depression

[92] Warning: Device #1 is above defined storage
[93] Warning: Storage range exceeded by 0.01'

Inflow Area = 0.193 ac, 0.00% Impervious, Inflow Depth = 11.03" for Middlesex-100yr event
Inflow = 2.08 cfs @ 12.13 hrs, Volume= 0.177 af
Outflow = 0.47 cfs @ 12.41 hrs, Volume= 0.119 af, Atten= 77%, Lag= 16.9 min
Discarded = 0.27 cfs @ 12.40 hrs, Volume= 0.118 af
Primary = 0.20 cfs @ 12.41 hrs, Volume= 0.002 af
Routed to Reach 2R : DP-2

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs / 2
Peak Elev= 155.01' @ 12.40 hrs Surf.Area= 3,285 sf Storage= 1,934 cf

Plug-Flow detention time= 150.5 min calculated for 0.119 af (67% of inflow)
Center-of-Mass det. time= 111.3 min (899.2 - 788.0)

Volume	Invert	Avail.Storage	Storage Description
#1	154.00'	1,934 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

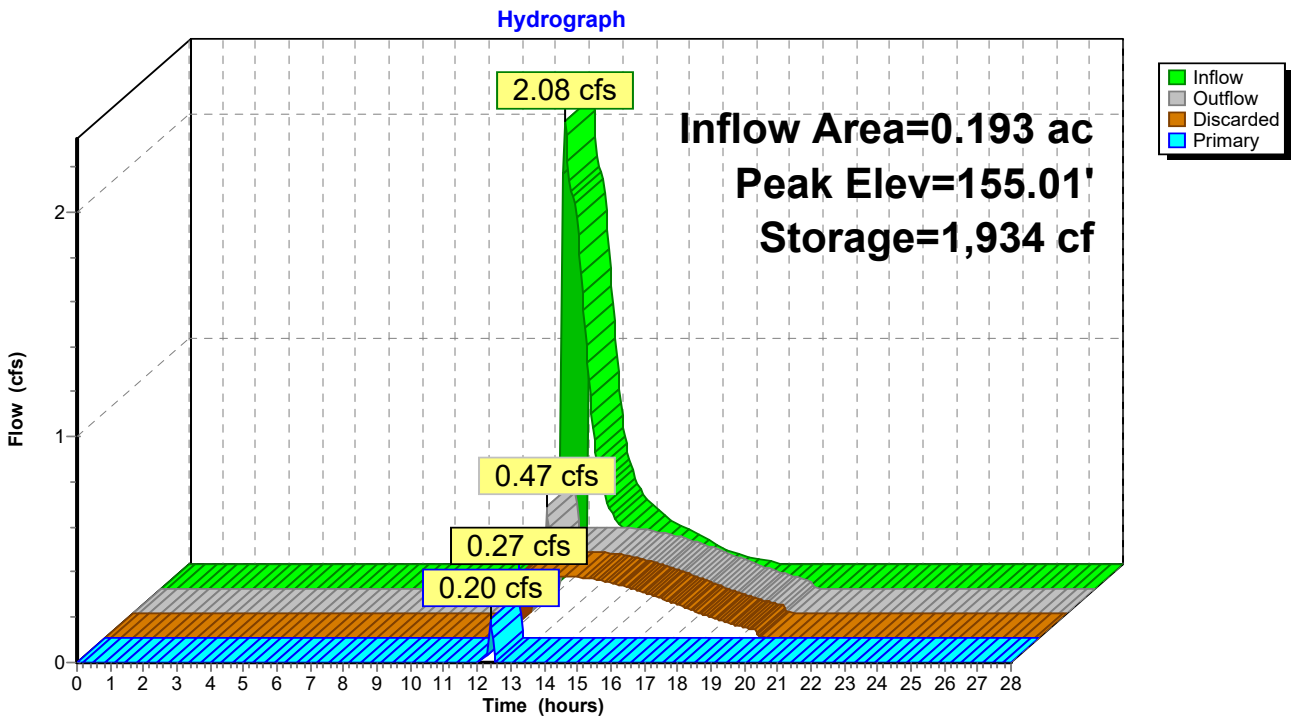
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
154.00	583	0	0
155.00	3,285	1,934	1,934

Device	Routing	Invert	Outlet Devices
#1	Primary	155.00'	**55.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	154.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 153.00'

Discarded OutFlow Max=0.27 cfs @ 12.40 hrs HW=155.01' (Free Discharge)
└**2=Exfiltration** (Controls 0.27 cfs)

Primary OutFlow Max=0.17 cfs @ 12.41 hrs HW=155.01' (Free Discharge)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 0.17 cfs @ 0.25 fps)

Pond 3P: Existing Depression



Summary for Pond 5P: BASIN-1

Inflow Area = 3.312 ac, 30.92% Impervious, Inflow Depth = 2.67" for Middlesex-100yr event
Inflow = 6.48 cfs @ 12.05 hrs, Volume= 0.736 af
Outflow = 4.46 cfs @ 12.13 hrs, Volume= 0.736 af, Atten= 31%, Lag= 5.1 min
Discarded = 0.30 cfs @ 12.13 hrs, Volume= 0.388 af
Primary = 2.08 cfs @ 12.13 hrs, Volume= 0.174 af
Routed to Reach 1R : DP-1
Secondary = 2.08 cfs @ 12.13 hrs, Volume= 0.174 af
Routed to Pond 3P : Existing Depression

Routing by Stor-Ind method, Time Span= 0.00-28.00 hrs, dt= 0.04 hrs
Peak Elev= 159.11' @ 12.13 hrs Surf.Area= 4,654 sf Storage= 4,620 cf

Plug-Flow detention time= 87.1 min calculated for 0.736 af (100% of inflow)
Center-of-Mass det. time= 87.1 min (930.2 - 843.1)

Volume	Invert	Avail.Storage	Storage Description
#1	158.00'	6,515 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
158.00	3,690	0	0
159.00	4,556	4,123	4,123
159.50	5,011	2,392	6,515

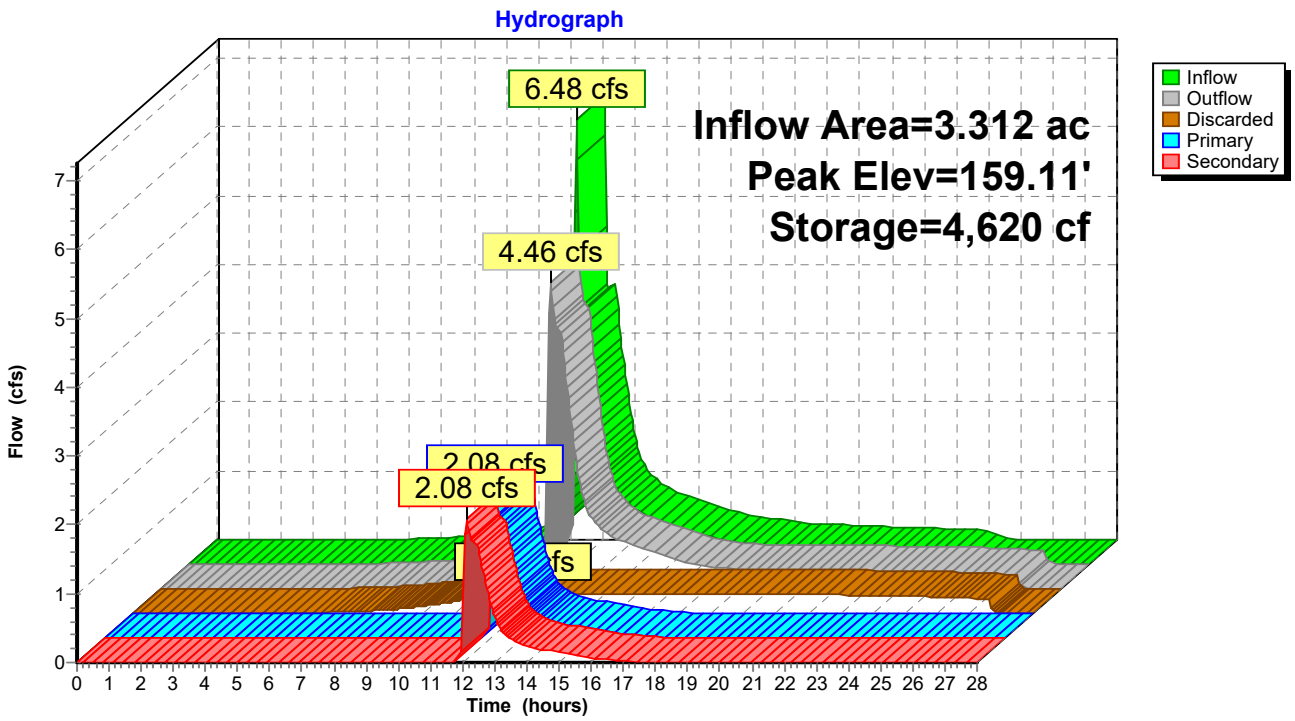
Device	Routing	Invert	Outlet Devices
#1	Discarded	158.00'	**2.410 in/hr Exfiltration over Surface area** Conductivity to Groundwater Elevation = 152.00'
#2	Primary	158.95'	**2.5" x 2.5" Horiz. Orifice/Grate X 5.00 columns** X 5 rows C= 0.600 in 24.0" x 24.0" Grate (27% open area)
#3	Secondary	158.95'	**2.5" x 2.5" Horiz. Orifice/Grate X 5.00 columns** X 5 rows C= 0.600 in 24.0" x 24.0" Grate (27% open area)
#4	Secondary	159.40'	**14.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=0.30 cfs @ 12.13 hrs HW=159.10' (Free Discharge)
└─**1=Exfiltration** (Controls 0.30 cfs)

Primary OutFlow Max=2.05 cfs @ 12.13 hrs HW=159.10' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 2.05 cfs @ 1.89 fps)

Secondary OutFlow Max=2.05 cfs @ 12.13 hrs HW=159.10' (Free Discharge)
├─**3=Orifice/Grate** (Orifice Controls 2.05 cfs @ 1.89 fps)
└─**4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 5P: BASIN-1



APPENDIX D

TSS Removal, Water Quality Volume and Recharge Calculations

Groundwater Recharge Volume Required:

Rv = F x Impervious Area, where:
Rv = Required Recharge Volume [Ac-ft]
F = Target Depth Factor associated with each Hydrologic Soil Group (HSG) [in]

Impervious Area = Total Increase in Pavement and Rooftop Area under Post development Conditions [Ac], (includes water surface of basin)

		Impervious Area [Acres]	Required Recharge Volume [Ac-Ft]
HSG "A", use F	= 0.60 in = 0.050 ft	1.122	0.056
HSG "B", use F	= 0.35 in = 0.029 ft	0.000	0.000
HSG "C", use F	= 0.25 in = 0.210 ft	0.000	0.000
HSG "D", use F	= 0.10 in = 0.008 ft	0.000	0.000
Total Required Recharge Volume (Rv) =			**0.056 Ac-ft**

Capture Area Adjustment: (Ref: DEP Handbook Volume 3, chapter 1, page 27-28)

Total Site Impervious Area (Total) =	1.122 Acres
Impervious Area Draining to Infiltrative BMPs (infill) =	1.122 Acres
Percent of Increase in Impervious Area Draining to Infiltrative BMPs =	100%
Capture Area Adjustment Factor = (Total)/(Infill) = Ca =	1.00
Adjusted Required Recharge Volume = Ca x Rv	**0.056 Ac-ft**

Groundwater Recharge Volume Provided (Static Method):

Using the conservative "Static" method, the infiltration basin is designed so that the volume in the basin below the outlet invert will be large enough to hold the entire Recharge Volume so that the entire recharge volume infiltrates. Below is the volume provided in the infiltration basin that can only leave through infiltration and below that is the Drawdown calculation showing that the basin will completely infiltrate the recharge volume within 72 hours.

Infiltration Basin BMP	**Provided Recharge Volume [Ac-ft]**
Infiltration Basin (volume in basin below outlet invert 158.95)	0.089
Total Provided Recharge Volume =	**0.089 Ac-ft**

Provided groundwater recharge volume is greater than or equal to the required recharge volume, therefore proposed stormwater management design follows Standard 3.

Drawdown Time Required

$$\textbf{Drawdown Time} = \frac{\textbf{Rv}}{\textbf{(K) (Bottom Area)}}$$

where:
Rv = Storage Volume Below Outlet [Ac-ft]
K= Infiltration Rate [in/hr]
Bottom Area= Area of Recharge [Ac]

Infiltration Basin

Rv =	0.089 Ac-ft (3,896 cf)
K =	2.41 in/hr
Bottom Area =	0.085 Acres (3,690 sf)

$$\textbf{Drawdown Time} = \frac{\textbf{0.060 Ac-ft}}{\textbf{(2.41 in/hr)(1/12in/ft)(0.085 ac)}} = \textbf{5.21 Hours}$$

Drawdown Time = 5.21 Hours

5.21 < 72 Hours, therefore design follows Standard #3

Note:

1. The infiltration BMPs have been designed to fully drain within 72 hours, therefore the proposed stormwater management design is following Standard 3.

2. Infiltration Rate based on Volume 3, Chapter 1, Table 2.3.3 Rawls Rates from the 2008 MADEP Stormwater Management Handbook.

Water Quality Volume Required

$V_{WQ} = (D_{WQ} / 12 \text{ in/ft}) \times (A_{IMP} \times 43{,}560 \text{ SF/Ac})$

Where:

V_{WQ} = Required Water Quality Volume [CF]

D_{WQ} = Water Quality Depth: 1-inch for discharges within a Zone II or Interim Wellhead Protection Area, to or near critical areas, runoff from LUHPPL, or exfiltration to soil with infiltration rate 2.4 in/hr or greater; ½-inch for discharges to other areas.

A_{IMP} = Post-development Impervious Area; may exclude roof top areas [Ac]

Water Quality Volume Provided

Required Water Quality Volume:

Drainage Area/ Treatment Train	A_{IMP} (sf)	A_{IMP} (ac)	DWQ (in)	WQV Required (cf)	WQV Provided (cf)
West Lot	7,382	0.169	1.0	615	
East Lot	16,296	0.374	1.0	1,358	
Roof	20,928	0.480	1.0	1,744	
TOTAL	**44,606**	**1.024**	**1.0**	**3,717**	**3,896**

Provided Water Quality Treatment Efficiency:

Drainage Area	BMP Treatment Train	Total Removal Efficiency
West Lot	Catch Basin to Sediment Forebay to infiltration basin	80%
East Lot	Catch Basin to Sediment Forebay to infiltration basin	80%

Sediment Forebay Volumes:

Drainage Area	Area (sf)	Area (ac)	Inch / impervious acre	Required Volume (cf)	Provided Volume (cf)
West Lot	7,382	0.169	0.1	736	869
East Lot	16,296	0.374	0.1	1,629	2,073

The water quality volume calculated is treated through a treatment train that achieves the required TSS removal efficiencies. See the MADEP TSS Removal worksheets below, both treatment trains achieve pretreatment removal efficiency of 44% prior to discharge to the Infiltration basin, where 80% efficiency is achieved. The proposed stormwater management design complies with Standard #4.

Stage-Area-Storage for Pond 5P: BASIN-1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
158.00	3,690	0
158.02	3,707	74
158.04	3,725	148
158.06	3,742	223
158.08	3,759	298
158.10	3,777	373
158.12	3,794	449
158.14	3,811	525
158.16	3,829	601
158.18	3,846	678
158.20	3,863	755
158.22	3,881	833
158.24	3,898	911
158.26	3,915	989
158.28	3,932	1,067
158.30	3,950	1,146
158.32	3,967	1,225
158.34	3,984	1,305
158.36	4,002	1,385
158.38	4,019	1,465
158.40	4,036	1,545
158.42	4,054	1,626
158.44	4,071	1,707
158.46	4,088	1,789
158.48	4,106	1,871
158.50	4,123	1,953
158.52	4,140	2,036
158.54	4,158	2,119
158.56	4,175	2,202
158.58	4,192	2,286
158.60	4,210	2,370
158.62	4,227	2,454
158.64	4,244	2,539
158.66	4,262	2,624
158.68	4,279	2,709
158.70	4,296	2,795
158.72	4,314	2,881
158.74	4,331	2,968
158.76	4,348	3,055
158.78	4,365	3,142
158.80	4,383	3,229
158.82	4,400	3,317
158.84	4,417	3,405
158.86	4,435	3,494
158.88	4,452	3,583
158.90	4,469	3,672
158.92	4,487	3,761
158.94	4,504	3,851
158.96	4,521	3,941
158.98	4,539	4,032
159.00	4,556	4,123
159.02	4,574	4,214
159.04	4,592	4,306
159.06	4,611	4,398
159.08	4,629	4,490
159.10	4,647	4,583
159.12	4,665	4,676
159.14	4,683	4,770
159.16	4,702	4,864
159.18	4,720	4,958
159.20	4,738	5,052
159.22	4,756	5,147
159.24	4,774	5,243
159.26	4,793	5,338
159.28	4,811	5,434
159.30	4,829	5,531
159.32	4,847	5,628
159.34	4,865	5,725
159.36	4,884	5,822
159.38	4,902	5,920
159.40	4,920	6,018
159.42	4,938	6,117
159.44	4,956	6,216
159.46	4,975	6,315
159.48	4,993	6,415
159.50	**5,011**	**6,515**

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: East Parking Lot

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Infiltration Basin	**0.80**	**1.00**	**0.80**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**

Total TSS Removal = 80%

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **Cascade, Wayland**
Prepared By: **William Doyle, PE**
Date: **18-Oct-23**

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

INSTRUCTIONS:
1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Version 1, Automated: Mar. 4, 2008

Location: West Parking Lot

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Infiltration Basin	**0.80**	**1.00**	**0.80**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**
	0.00	**0.20**	**0.00**	**0.20**

Total TSS Removal = **80%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **Cascade, Wayland**
Prepared By: **William Doyle, PE**
Date: **18-Oct-23**

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed
1. From MassDEP Stormwater Handbook Vol. 1

Mass. Dept. of Environmental Protection

APPENDIX E

Site Owner's Manual

113 – 115 Boston Post Road

Wayland, Massachusetts

October 31, 2023

PROJECT SITE OWNER'S MANUAL

Prepared For:

Cascade Development Associates, LLC
831 Beacon Street, Suite #268
Newton Center, MA 02459

Prepared By:

C1.0

ENGINEERING & DEVELOPMENT

14 Spring Street
2nd Floor
Waltham, MA 02451

C1.0 #160012

1.0 INTRODUCTION

The Site Owner's Manual complies with the Long-Term Pollution Prevention Plan (Standard 4) and the Long-Term Operation and Maintenance Plan (Standard 9) requirements of the 2008 Massachusetts Department of Environmental Protection (DEP) Stormwater Handbook. The Manual outlines source control and pollution prevention measures and maintenance requirements of stormwater best management practices (BMPs) associated with the proposed development.

2.0 SITE OWNER'S AGREEMENT

2.1 Operation and Maintenance Compliance Statement

Site Owner: Cascade Development Associates, LLC
831 Beacon Street, Suite #268
Newton Center, MA 02459

Responsible Party: Cascade Development Associates, LLC

Eden Management, Inc. or their successors shall maintain ownership of the on-site stormwater management system as well as the responsibility for operation and maintenance during the post-development stages of the project. The site has been inspected for erosion and appropriate measures have been taken to permanently stabilize any eroded areas. All aspects of stormwater best management practices (BMPs) have been inspected for damage, wear and malfunction, and appropriate steps have been taken to repair or replace the system or portions of the system so that the stormwater at the site may be managed in accordance with the Stormwater Management Standards. Future responsible parties shall be notified of their continuing legal responsibility to operate and maintain the BMPs. The operation and maintenance plan for the stormwater BMPs is being implemented.

_____ _____
Responsible Party Signature Date

2.2 Stormwater Maintenance Easements

There are no off-site areas utilized for stormwater control, therefore no stormwater management easements are required. The Site Owner will have access to all stormwater practices for inspection and maintenance, including direct maintenance access by heavy equipment to structures requiring regular maintenance.

2.3 Record Keeping

The Site Owner shall maintain a rolling log in which all inspections and maintenance activities for the past three years shall be recorded. The Operation and Maintenance Log includes information pertaining to inspections, repairs, and disposal relevant to the project's stormwater management system. The Operation and Maintenance Log shall be made available to the Conservation Commission and the DEP upon request. The Conservation Commission and the DEP shall be allowed to enter and inspect the premises to evaluate and ensure that the responsible party complies with the maintenance requirements for each BMP.

2.4 Training

Employees involved in grounds maintenance and emergency response will be educated on the general concepts of stormwater management and groundwater protection. The Site Owner's Manual will be reviewed with the maintenance staff. The staff will be trained on the proper course of action for specific events expected to be incurred during routine maintenance or emergency situations.

3.0 LONG-TERM POLLUTION PREVENTION PLAN

In compliance with Standard 4 of the 2008 DEP Stormwater Management Handbook, this section outlines source control and pollution prevention measures to be employed on-site after construction.

3.1 Storage of Materials and Waste

The site shall be always kept clear of trash and debris. Certain materials and waste products shall be stored inside or outside upon an impervious surface and covered, as required by local and state regulations.

3.2 Vehicle Washing

No commercial vehicle washing shall take place on site.

3.3 Routine Inspections and Maintenance of Stormwater BMPs

See Section 4.0 Long-Term Operation and Maintenance Plan, for routine inspection and maintenance requirements for all proposed stormwater BMPs.

3.4 Spill Prevention and Response

A contingency plan shall be implemented to address the spill or release of petroleum products and hazardous materials and will include the following measures:

3.4.1 Equipment necessary to quickly attend to inadvertent spills or leaks shall be stored on-site in a secure but accessible location. Such equipment shall include but not be limited to the following: safety goggles, chemically resistant gloves and overshoe boots, water and chemical fire extinguishers, sand and shovels, suitable absorbent materials, storage containers and first aid equipment (i.e. Indian Valley Industries, Inc. 55-gallon Spill Containment kit or approved equivalent).

3.4.2 Spills or leaks shall be treated properly according to material type, volume of spillage and location of spill. Mitigation shall include preventing further spillage, containing the spilled material in the smallest practical area, removing spilled material in a safe and environmentally-friendly manner, and remediation of any damage to the environment.

3.4.3 For large spills, Massachusetts DEP Hazardous Waste Incident Response Group shall be notified immediately at (617) 792-7653 and an emergency response contractor shall be consulted.

3.5 Maintenance of Lawns, Gardens, and other Landscaped Areas

Lawns, gardens, and other landscaped areas shall be maintained regularly by the site owner. Vegetated and landscaped BMPs will be maintained as outlined in Section 4.0.

3.6 Storage and Use of Fertilizers, Herbicides, and Pesticides

All fertilizers, herbicides, and pesticides shall be stored in accordance with local, state, and federal regulations. The application rate and use of fertilizers, herbicides, and pesticides on the site shall at no time exceed local, state, or federal specifications.

3.7 Pet Waste Management

Pet owners shall be required to pick up after their animals and dispose of waste in the trash.

3.8 Operation and Management of Septic Systems

The proposed development includes a septic system to treat wastewater. The septic system shall be operated and maintained in accordance with local and state regulations.

3.9 Snow and Deicing Chemical Management

Snow removal and use of deicing chemicals at the proposed development shall comply with the following requirements:

- Plowed snow shall be placed in the areas designated on the site plans and/or outside of wetland boundaries and stormwater best management practices. The following maintenance measures shall be undertaken at all snow disposal sites:
    - Debris shall be cleared from an area prior to using it for snow disposal.
    - Debris and accumulated sediments shall be cleared from the site and properly disposed of at the end of the snow season and no later than May 15.
- In accordance with the Massachusetts General Laws, Chapter 85, Section 7A, salt and other de-icing chemicals will be stored at an indoor location. Salt and other deicing chemicals shall be stored in accordance with Massachusetts General Law.
- Sand piles shall be contained and stabilized to prevent the discharge of sand to wetlands or water bodies, and, where feasible, covered.
- Salt storage piles shall be located outside of the 100-year floodplain.
- The application of salt on the proposed parking areas and driveway shall at no time exceed state or local requirements.

3.10 Nutrient Management Plan

There are no TMDLs issued for the waterbodies downstream of the proposed project.

4.0 LONG-TERM OPERATION AND MAINTENANCE PLAN

This section outlines the stormwater best management practices (BMPs) associated with the proposed stormwater management system and identifies the long-term inspection and maintenance requirements for each BMP.

4.1 Stormwater Management System Components

The following table outlines the type and quantity of the BMPs and their general location. Please reference the site plan(s) provided in the Figures section for exact location. All basins are accessible for maintenance from either the development driveway or parking areas.

BMP	Quantity	Location
Catch Basins	3	Throughout paved parking area.
Sediment Forebay	2	Between the building and Route 20 and west of the west site entrance.
Infiltration Basin	1	Along the western edge of the property

4.2 Inspection and Maintenance Schedules

4.2.1 General Maintenance for Mosquito Control

If necessary to minimize mosquito breeding, a licensed pesticide applicator shall apply larvicides, such as Bacillus sphaericus (Bs) to all catch basins sumps, and water quality inlets. Larvicides shall be applied in compliance with all pesticide label requirements, and will be applied during or immediately after wet weather, unless the product used can withstand extended dry periods. Ensure all manhole covers, and inspection ports are secure to reduce the likelihood of mosquitoes laying eggs in standing water.

4.2.2 Area Drains and Drop Inlets

Area drains and drop inlets shall be inspected and/or cleaned at least once per year.

4.2.3 Catch Basins

Maintenance of catch basis shall be performed according the recommendations set forth by the MADEP. Inspection and maintenance procedures for catch basins are provided below:

- Catch basins shall be inspected post-construction, prior to being put into service.
- Catch basins shall be inspected not less than four times per year following installation and no less than four times per year thereafter.
- Catch basins shall be inspected immediately after any oil, fuel or chemical spill.
- All inspections shall include checking the floatable level and sediment depth.
- A licensed waste management company shall remove captured petroleum waste products from any oil, chemical or fuel spills and dispose.
- Clean four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin

4.2.4 Sediment Forebays

Sediments and associated pollutants are removed only when sediment forebays are cleaned out, so regular maintenance is essential. Inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational. When mowing

grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of riling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or resodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

- Forebays shall be inspected post-construction, prior to being put into service.
- Forebays shall be inspected not less than four time per year following installation and no less than four times per year thereafter.
- Units shall be inspected immediately after any oil, fuel, or chemical spill.
- All inspections shall include checking the sediment depth in the forebay.
- Mow twice a year
- Examine the outlet structure for evidence of clogging or outflow release velocities that are greater than the design velocity.
- Identify areas of sediment accumulation, differential settlement, cracking,
- and erosion within the basin.
- Inspect embankments for leakage and tree growth.
- Examine the health of the vegetation within the basin and on the embankments.

4.2.5 Infiltration Basin

Infiltration basin shall be inspected and maintained after major storm events (rainfall totals greater than 2.5 inches in 24 hours) during the first three months of operation and twice a year and when there are discharges through the outlet control structure thereafter. Additionally, all pretreatment BMPs shall be inspected in accordance with the minimal requirements specified for those practices and after all major storm events. Inspections shall include the following measures:

- During and after major storm events, the length of time standing water remains in the basin shall be recorded.
    - Inspect after every major storm during first 3 months of operation and four times per year thereafter and when there are discharges through the high outlet orifice.
    - If the time is greater than 72 hours, thoroughly inspect the basin for signs of clogging. A corrective action plan should then be developed by a qualified professional to restore infiltrative function. The Site Owner shall take immediate action to implement these corrective measures.
- Mow twice a year
- Examine the outlet structure for evidence of clogging or outflow release velocities that are greater than the design velocity.
- Identify areas of sediment accumulation, differential settlement, cracking,
- and erosion within the basin.
- Inspect embankments for leakage and tree growth.
- Examine the health of the vegetation within the basin and on the embankments.

Corrective measures shall be taken immediately as warranted by the inspections. If any evidence of hydrocarbons is found during inspection, the material shall be immediately removed using absorbent pads or other suitable measures and legally disposed.

Preventative maintenance shall include the following activities:

- Mow the buffer area and basin bottom and side slopes, if vegetated.
- Remove trash, debris, and accumulated organic matter.
- Remove clippings after mowing.

4.2.6 Stormwater Outfalls

Flared end sections and associated riprap spillways shall be inspected at least once per year and after major storm events (rainfall totals greater than 2.5 inches in 24 hours) to ensure that the stability of the outlet area is maintained. The outfall area shall be kept clear of debris such as trash, branches, and sediment. Repairs shall be made immediately if riprap displacement or downstream channel scour is observed.

4.3 Estimated Operation and Maintenance Budget

An operations and maintenance budget was prepared to approximate the annual cost of the inspections required in compliance with the DEP Stormwater Management Policy. The table below estimates the annual cost to inspect and maintain each proposed BMP, based on the requirements in Section 4.2.

BMP Type	# of BMPS	Annual O&M Cost (per BMP)	Total Cost
Catch Basin	4	$200-$400	$800-$1,600
Area Drain	1	$50-$100	$50-$100
Sediment Forebay	2	$100-$300	$200-$600
Infiltration Basin	1	$200 - $400	$200-$400
Riprap Spillway	3	$50-$100	$150-$300
Swale	1	$300	$300
		Total	**$1,500-$2,900**

4.4 Public Safety Features

Multiple safety measures are proposed to protect the public and prevent pollutant contamination of the stormwater management system and other water resources. Curbing and vegetation along the driveway will prevent cars from inadvertently detouring down steep side slopes and into adjacent wetlands or stormwater basins. The site was designed to ensure protection to the public and prevent pollutant contamination of the stormwater management system and the municipal drainage system.

APPENDIX F

Stormwater Checklist

Appendix C

Response to BETA Letter dated September 6, 2023,
dated October 31, 2023,
prepared by Geosphere Environmental Management, Inc.

October 31, 2023

Sean Fair, Chairperson
Wayland Conservation Commission
Wayland town Hall
41 Cochituate Road
Wayland, MA 01778

RE: Response to Beta Letter Dated September 6, 2023
Cascade Wayland 40B
113 – 119 Boston Post Road
Wayland, MA

Dear Chairperson Fair,

Geosphere Environmental Management, Inc. (GEOSPHERE) has prepared the following response to Comment G38 of the Gary James of BETA letter dated September 6, 2023 regarding the need for a mounding analysis for the proposed stormwater basin.

GEOSPHERE has completed a groundwater mounding analysis for the proposed stormwater retention basin (stormwater basin) associated with the redevelopment of the former Mahoney Garden Center located at 113 – 119 Boston Post Road, Wayland, Massachusetts (the site). The stormwater basin is proposed in the western portion of the site. The groundwater mounding analysis for the stormwater basin was conducted using a spreadsheet published by the U.S. Geological Survey that simulates groundwater mounds beneath hypothetical stormwater infiltration basins using the Hantush equation (Carleton, G. B., 2010). All parameters used in the analysis are listed below in **Table 1**.

Table 1: Input Parameters		
Parameter	**Units**	**Value**
Infiltration Rate	(feet/day)	4.81
Specific Yield	Dimensionless	0.3
Horizontal Hydraulic Conductivity	(feet/day)	90
1/2 Length of Basin	(feet)	17.5
1/2 Width of Basin	(feet)	60
Duration of Infiltration Period	(days)	0.50375
Initial Thickness of Saturated Zone	(feet)	7.5

The values for the infiltration rate and the duration of the infiltration period were set to correspond to rates used by C1.0 Engineering and Development, LCC in their drainage report for the site (C1.0, 2023). Horizonal hydraulic conductivity was set equal to the value used in the 2018 groundwater model of the site (GEOSPHERE, 2018). Specific yield was set using a table of specific yield values for various geologic materials (Morris and Johnson, 1967). The initial

thickness of the saturated zone was set equal to the thickness of the aquifer during estimated seasonal high groundwater levels and was calculated using data from test pit OSE-TP-5 and borehole B-8 (GEOSPHERE, 2018). Test pit OSE-TP-5 is located near the middle of the stormwater basin and borehole B-8 is located just west of the stormwater basin. The Hantush equation considers only square or rectangular drainage basins while the stormwater basin at the site is slightly L-shaped. The length and width of the basin were set so that the resulting square footage (4,200 square feet) approximately equals the square footage of the stormwater basin at its overflow elevation of 159.0 feet (4,261 square feet) (C1.0, 2023). A printout of the spreadsheet used in the analysis is included in **Attachment A**.

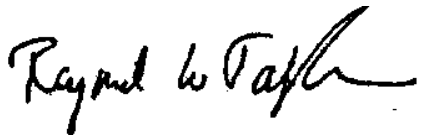
Applying the parameters described above to the Hantush equation results in a groundwater mound that is 3.20 feet above the estimated seasonal high-water table at the center of the stormwater basin. As shown in **Figure 1**, the groundwater mound is projected to be less than 0.5 feet above the estimated seasonal high-water table within 100 feet to the east or west of the center of the stormwater basin. The elevation of the estimated seasonal high-water table at test pit OSE-TP-5 (located near the center of the stormwater basin) is 151.5 feet (GEOSPHERE, 2018) and the elevation of the bottom of the stormwater basin is 158.0 feet. This indicates that the groundwater mound resulting from infiltration at the stormwater basin is likely to remain 3 +/- feet below the bottom of the stormwater basin during heavy precipitation events. The groundwater mound resulting from infiltration at the stormwater basin is not expected to reach the stormwater basin bottom elevation or be within 2 feet of the stormwater basin bottom elevation at any location. This is shown on **Figure 2** which displays the projected elevation of the groundwater mound during estimated seasonal high groundwater levels.

The ambient direction of groundwater flow in the vicinity of the stormwater basin is from east to west (GEOSPHERE, 2018). Mounding beneath the stormwater basin is not expected to significantly alter the direction of groundwater flow. **Figure 2** shows that groundwater continues to generally flow from east to west during peak mounding conditions at the time of estimated seasonal high groundwater levels. **Figure 1** and **Figure 2** show that the groundwater mound from the stormwater basin is not expected to reach the stream to the south of the stormwater basin.

Thank You

If you have any questions or require further information, please do not hesitate to contact our office.

Sincerely,
GEOSPHERE ENVIRONMENTAL MANAGEMENT, INC.



Raymond W. Talkington, Ph.D., P.G.,
President/Principal Hydrogeologist

References

Carleton, G. B. (2010). *Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins*. U. S. Geological Survey, 2010.

C1.0 (2023*). Drainage Report, Proposed Cascade Development, 115 Boston Post Road, Wayland, MA* Prepared for Eden Management, Inc., 2023.

GEOSPHERE (2018*). Hydrogeologic Report: Groundwater Mounding Analysis for Proposed Subsurface Disposal System, Proposed Cascade Development, 115 Boston Post Road, Wayland, MA* Prepared for Eden Management, Inc., June 26, 2018. Submitted to the Conservation Commission on or around June 30, 2023.

Morris, D. A., & Johnson, A. I. (1967). *Summary of hydrologic and physical properties of rock and soil materials, as analyzed by the hydrologic laboratory of the US Geological Survey*, 1948-60 (No. 1839-D), 1967.

Attachment A

Spreadsheet for Simulation of Groundwater Mounding Beneath Hypothetical Stormwater Infiltration Basin

This spreadsheet will calculate the height of a groundwater mound beneath a stormwater infiltration basin. More information can be found in the U.S. Geological Survey Scientific Investigations Report 2010-5102 "Simulation of groundwater mounding beneath hypothetical stormwater infiltration basins".

The user must specify infiltration rate (R), specific yield (Sy), horizontal hydraulic conductivity (Kh), basin dimensions (x, y), duration of infiltration period (t), and the initial thickness of the saturated zone (hi(0), height of the water table if the bottom of the aquifer is the datum). For a square basin the half width equals the half length (x = y). For a rectangular basin, if the user wants the water-table changes perpendicular to the long side, specify x as the short dimension and y as the long dimension. Conversely, if the user wants the values perpendicular to the short side, specify y as the short dimension, x as the long dimension. All distances are from the center of the basin. Users can change the distances from the center of the basin at which water-table aquifer thickness are calculated.
Cells highlighted in yellow are values that can be changed by the user. Cells highlighted in red are output values based on user-specified inputs. The user MUST click the blue "Re-Calculate Now" button each time ANY of the user-specified inputs are changed otherwise necessary iterations to converge on the correct solution will not be done and values shown will be incorrect. Use consistent units for all input values (for example, feet and days)

use consistent units (e.g. feet & days **or** inches & hours)

Input Values

4.8100	*R*	**Recharge (infiltration) rate (feet/day)**
0.300	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
90.00	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
60.000	x	**1/2 length of basin (x direction, in feet)**
17.500	y	**1/2 width of basin (y direction, in feet)**
0.504	t	**duration of infiltration period (days)**
7.500	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	**feet/day**
0.67	1.33
2.00	4.00

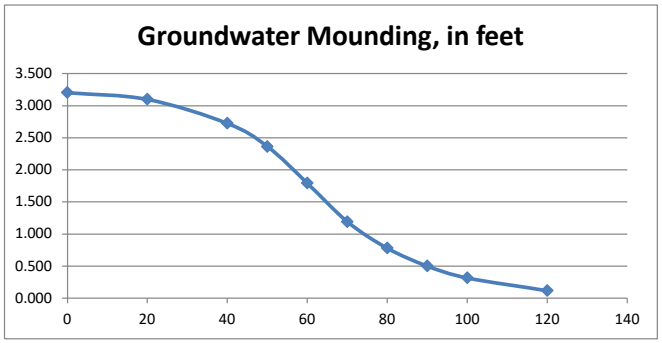
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

10.703	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
3.203	Δh(max)	**maximum groundwater mounding (beneath center of basin at end of infiltration period)**

Ground-water Mounding, in feet	**Distance from center of basin in x direction, in feet**
3.203	**0**
3.099	**20**
2.724	**40**
2.364	**50**
1.793	**60**
1.192	**70**
0.780	**80**
0.501	**90**
0.316	**100**
0.117	**120**

Re-Calculate Now

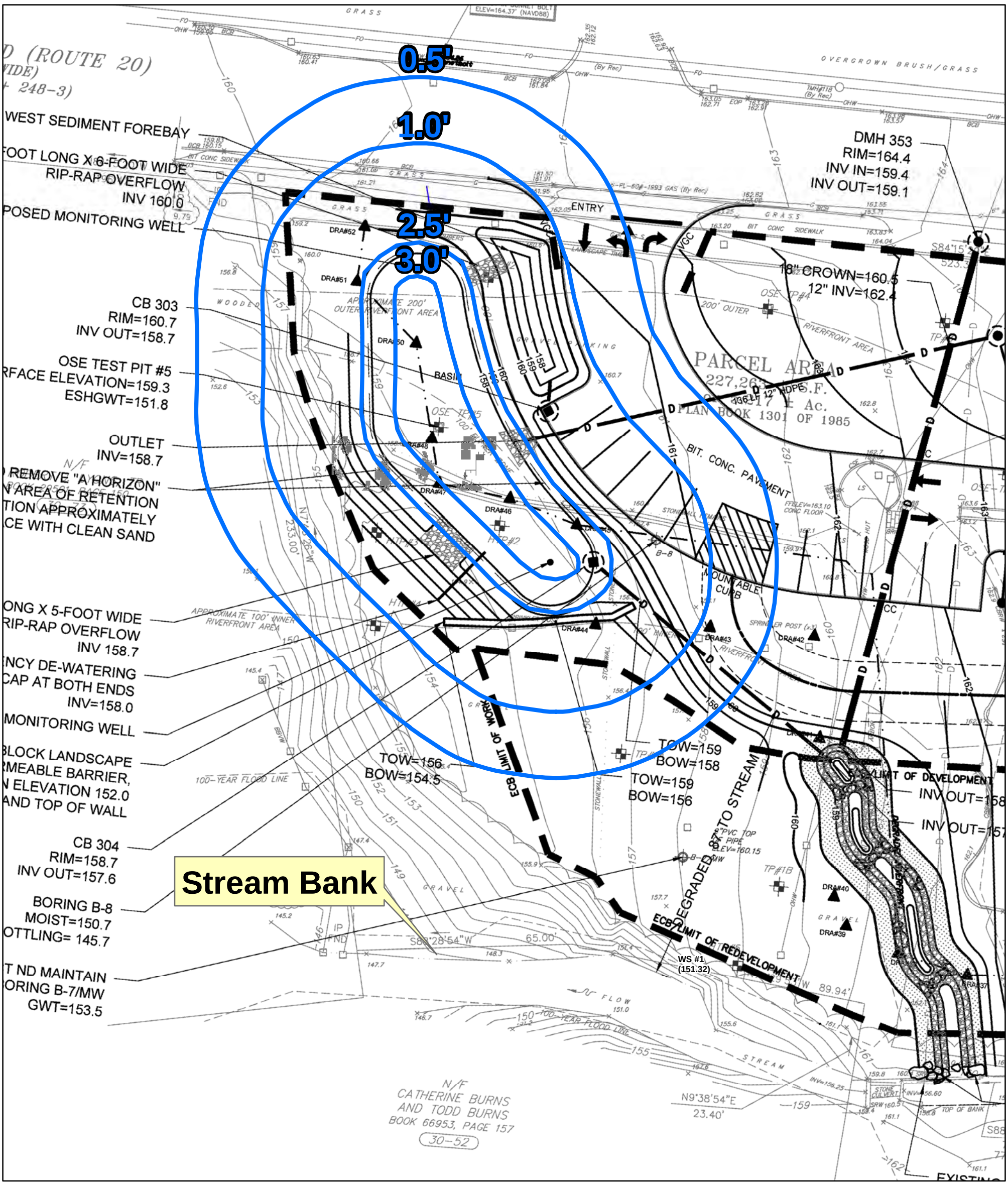


Disclaimer

This spreadsheet solving the Hantush (1967) equation for ground-water mounding beneath an infiltration basin is made available to the general public as a convenience for those wishing to replicate values documented in the USGS Scientific Investigations Report 2010-5102 "Groundwater mounding beneath hypothetical stormwater infiltration basins" or to calculate values based on user-specified site conditions. Any changes made to the spreadsheet (other than values identified as user-specified) after transmission from the USGS could have unintended, undesirable consequences. These consequences could include, but may not be limited to: erroneous output, numerical instabilities, and violations of underlying assumptions that are inherent in results presented in the accompanying USGS published report. The USGS assumes no responsibility for the consequences of any changes made to the spreadsheet. If changes are made to the spreadsheet, the user is responsible for documenting the changes and justifying the results and conclusions.

Attachment B

Figures



Legend

Groundwater Mounding Contours

N
W E
S

0 40 80 160 Feet

GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

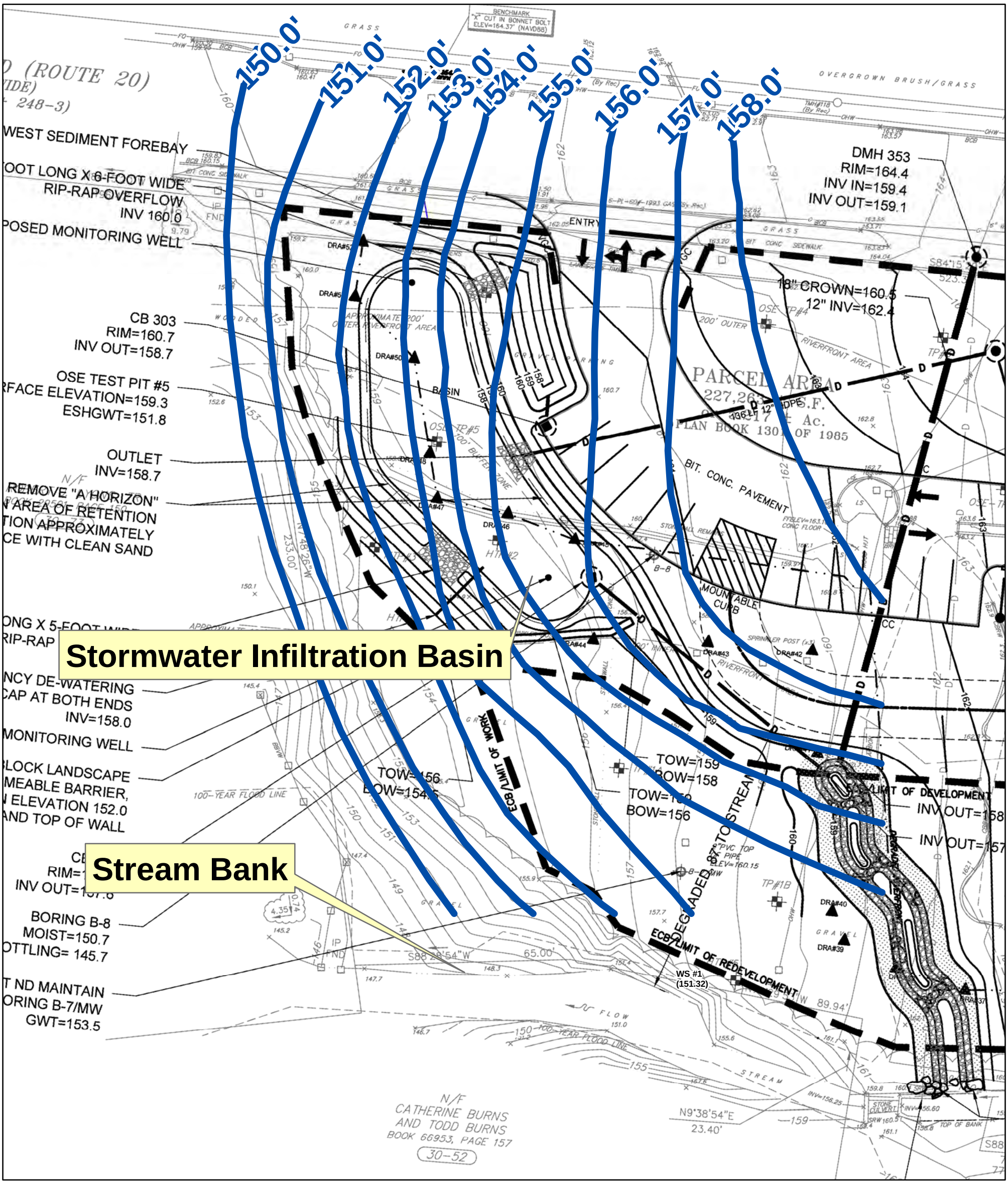
FIGURE 1

PROJECTED MAXIMUM GROUNDWATER MOUNDING at STORMWATER BASIN

Cascade Wayland
115 Boston Post Road

CREATED BY:	CHECKED BY:	PROJECT:
Ryan Chase 10/20/2023	Ray Talkington 10/20/2023	17205.1\FIGURES\ 2020_Report

Data Source: MassGIS (Bureau of Geogrpahic Information).
Imagery Date: 2019.



Legend

Groundwater Elevation

N
W
E
S

0 40 80 160 Feet

GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 2

PROJECTED ELEVATION OF GROUNDWATER MOUNDING at ESTIMATED SEASONAL HIGH GROUNDWATER LEVELS

Cascade Wayland

CREATED BY:	CHECKED BY:	PROJECT:
Ryan Chase 10/20/2023	Ray Talkington 10/20/2023	17205.1\FIGURES\ 2020_Report

Data Source: MassGIS (Bureau of Geogrpahic Information).
Imagery Date: 2019.

Appendix D

Response to Scott Horsley Letter to Wayland Conservation Commission,
dated September 15, 2023,
prepared by Geosphere Environmental Management, Inc.

GEOSPHERE
ENVIRONMENTAL MANAGEMENT INC.

September 15, 2023

Sean Fair, Chairperson
Wayland Conservation Commission
Wayland town Hall
41 Cochituate Road
Wayland, MA 01778

RE: Response to Scott Horsley Letter to Wayland Conservation Commission dated August 2, 2023
Cascade Wayland 40B
113 – 119 Boston Post Road
Wayland, MA

Dear Chairperson Fair,

Geosphere Environmental Management, Inc. (GEOSPHERE) is in receipt of the letter prepared by Scott Horsley (Horsley) dated August 2, 2023 on the potential water quality impacts associated with the proposed project, specifically the proposed subsurface disposal system.

Horsley has indicated that the direction of groundwater flow at the proposed project site is in a westerly direction from the proposed subsurface disposal system. This is correct. The direction of groundwater flow has been established at the proposed project site based on measurements of static groundwater on multiple occasions between 2018 and 2022 (14 measurements total) and 11 measurements conducted over the course of 24 weeks in the spring of 2020.

Horsley indicates that "…the applicant has not provided any analysis of water quality impacts associated with the proposed wastewater facility." This comment has already been addressed by GEOSPHERE in both the MADEP-approved Revised Hydrogeological Report and the comments provided to the Town of Wayland to the *Revised Scope of Work – Hydrogeological Assessment for Groundwater Discharge Permit, Cascade Wayland, 115 Boston Post Road* (GEOSPHERE, April 29, 2020) on June 30, 2020. As GEOSPHERE responded to the Town – "Information on the wastewater treatment system will be submitted to Mass. DEP for approval as part of the groundwater discharge permit application process. We envision providing a tertiary level treatment system with disinfection capabilities. The design and specification of the treatment system is not typically submitted during the hydrogeological site assessment and permitting process." As indicated on page 5 of the Horsley letter, he also indicates that water quality analysis is not commonly included in the MADEP permitting process. As such, his comments associated with a "wastewater plume" associated with elevated concentrations of nutrients (nitrogen and phosphorus) are premature and have no basis for this proposed subsurface disposal system and all associated calculations are as best speculative and without foundation.

Pine Brook is designated as a coldwater fishery. GEOSPHERE has stated this in the MADEP-approved Revised Hydrogeological Report and acknowledged this in our comments to the Town of Wayland on June 20, 2020.

51 PORTSMOUTH AVENUE, EXETER, NEW HAMPSHIRE 03833
Telephone: 603-773-0075 Fax: 603-773-0077
www.geospherenh.com

In the Revised Hydrogeological Report dated January 19, 2021, GEOSPHERE indicates that "the modeled volume of water discharged into Pine Brook is predicted to increase by 5% from 10,101 cubic feet per day (cfd) predicted under low flow estimated conditions, to 10,592 cfd with the addition of the proposed groundwater discharge." After discussions with MADEP personnel regarding the temperature effects from proposed sanitary discharges, they have indicated that temperature effects from domestic sanitary discharges into subsurface leach fields are not expected to raise ambient groundwater conditions outside the leach field footprint. Although this may be accurate, In the Revised Hydrogeological Report, GEOSPHERE proposed a groundwater monitoring plan that includes monitoring locations (see attached Figure 3), frequency of monitoring, and water quality testing designed to monitor the effects of the subsurface sanitary wastewater discharge on groundwater quality and surface water quality both upgradient and downgradient of the discharge. This groundwater and surface water quality plan has been approved by MADEP. The elements of this monitoring plan are listed below.

Monitoring ID	**Location**
MW-3	Existing Upgradient Monitoring Well
MW-5, MW-6	Existing Downgradient Monitoring Wells
SW-U	Proposed Upgradient Stream Sampling Location
SW-M	Proposed Mid-Stream Sampling Location

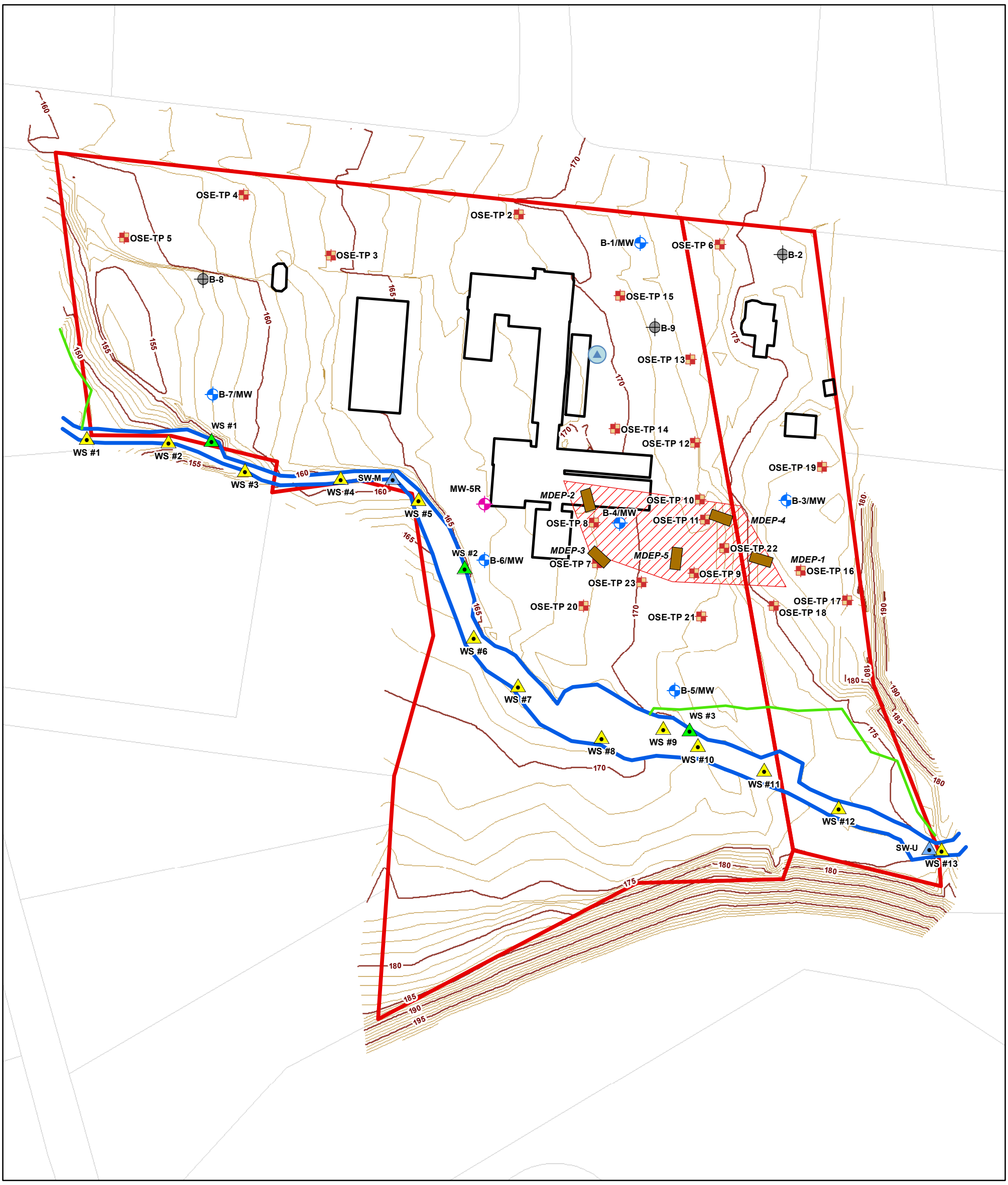
Water Quality Parameter	Frequency
Temperature	Monthly
pH	Monthly
Specific Conductance	Monthly
Water Levels	Monthly (Monitoring Wells)
Nitrate-Nitrogen	Quarterly
Total Nitrogen	Quarterly
Total Phosphurus	Quarterly
Orthophosphate	Quarterly

If you require additional explanation or information, please let me know.

Thank you,

Raymond Talkington, Ph.D, P.G.
Principal Hydrogeologist

Atttachment – Figure 3



Legend

- Proposed Replacement Monitoring Well (MW-5R)
- Borehole
- Monitoring Well
- OnSite Test Pits
- Stream Survey Location - Jan. 2018
- Proposed Surface Water Quality Monitoring Location
- Stream Surface Survey - Nov. 2019
- Irrigation Well (Approx.)
- Suface Topography (1-ft interval)
- River_Bank
- Wetland Boundary
- Revised 2020 Leachfield
- OnSite/MDEP Test Pits - June 2020
- Existing Buildings
- Property Boundary

0 40 80 160 240 320 400 Feet

N W E S

GEOSPHERE ENVIRONMENTAL MANAGEMENT INC.

FIGURE 3

REVISED SITE PLAN

Cascade Wayland
115 Boston Post Road
Wayland, MA

CREATED BY:	CHECKED BY:	PROJECT:
Matt Krapf 5/19/2021	Ray Talkington 5/19/2021	17205.1\FIGURES\ 2020_Report

Data Source: MassGIS (Bureau of Geogrpahic Information). Imagery Date: 2019. Ground elevation survey: Beals & Thomas, Southborough, MA. Elevations relative to North American Vertical Datum, 1988.