Proposed Mixed Use Development – Phase 2

950 Phenix Avenue
Cranston, Rhode Island

PREPARED FOR

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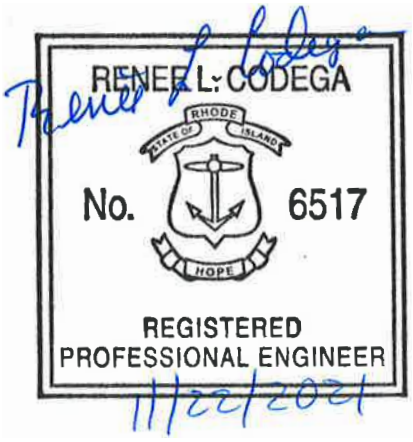
November 22, 2021



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1

Summary

This stormwater management report is being prepared in support of a proposed mixed-use development at 950 Phenix Avenue in Cranston, Rhode Island (see Figure 1). The entire site was originally designed by VHB and permitted by RIDEM on December 1, 2016 under Wetland Application No. 16-0222 and RIPDES No. RIR101465 which expired on December 1, 2020. The southern and western portion of the permitted design was constructed in 2018 which includes three buildings (a childcare facility and two storage facilities) along with associated parking lots, access drives, utilities, and stormwater management practices. The constructed area is being referred to as "Phase 1" on plans and documents. The remaining project area that was not completed is being depicted as "Phase 2" on the Site Plans and is the subject of this stormwater report. Phase 2 has been redesigned and will be permitted as a new development. Overall, the altered design results in a decrease from previously approved plans. The drainage design intent also remains the same with the proposed BMPs being slightly modified to accommodate the new building program. Furthermore, the proposed design is fully within the prior approved limit of work. The Phase 2 development does not include any impacts to wetlands and therefore, the project does not require wetland permitting. The following stormwater report summarizes "Phase 2" of the project and the measures proposed to ensure that this phase complies fully with the Rhode Island Stormwater Design and Installation Standards Manual dated March 2015 (RISDISM). See Appendix A for the completed RISDISM Stormwater Management Checklist.

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Existing Conditions

The project is located at 950 Phenix Avenue in Cranston, Rhode Island. This approximately 14.9-acre property is Lot 3 as shown on Assessor's Plat 19-1 and is bounded by vacant land to the south; Phenix Avenue and Natick Avenue to the west; a municipal skating rink and animal shelter to the north; and I-295 to the east. According to the Federal Emergency Management Agency, portions of the Site are subject to flooding, as shown on the following Flood Insurance Rate Map Community Panel No. 44007C0313H, revised October 2, 2015. A copy of the FEMA map is included in Appendix C.

Although a portion of the site to the north has been cleared and graded in preparation of Phase 2, for analysis purposes the existing condition of the project site will be treated as the original existing condition of primarily woodlands with pockets of grass and brush. The south western and southern portions of the site have been developed as part of Phase 1 and include three existing buildings with associated parking and landscaping. Key natural resources within and adjacent to the Site include a small, (0.8± acre) wetland complex (hereinafter "Wetland 1") at the southern terminus of the parcel, and a small (0.03± acre), isolated, forested wetland (hereinafter "Wetland 2") near the western property line. Stormwater from the project site discharges to the northeast, away from the onsite wetland areas and riverfront area, ultimately discharging to Meshanticut Brook (RI0006017R-02). Refer to Figure 2 for existing drainage patterns. The Meshanticut Brook has an associated TMDL listed as Enterococcus. Infiltration Basins have been proposed which are effective in treating pathogens.

Geotechnical explorations revealed a soil profile in which fill material from the former mining operations is prevalent in the upper horizon. According to the Soil Survey of the State of Rhode Island, published by the Natural Resources Conservation Service, the following (underlying) soils are found on-site: Udorthents-Urban Land complex (HSG A), and Pits, Gravel (Not Rated).

NRCS soils information for the Site is provided in further detail in Appendix B. Soil tests were also conducted throughout the Site to determine characteristics such as design soil permeability rates and seasonal high ground water elevations, and are also provided in Appendix B.

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Proposed Conditions

The project proposes to construct a 37,000± square foot self-storage building. The project includes parking, landscaping, and utilities associated with the proposed building.

Best management practices (BMPs) have been proposed to mitigate the impact of this activity. Existing drainage patterns were maintained to the maximum extent practicable in the proposed design.

The proposed design includes two surface infiltration basins. Pretreatment is achieved through the use of two stone diaphragms and a sediment forebay. All applicable stormwater features have been sized to adequately convey the discharge from the drainage areas.

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Hydrology

A HydroCAD hydrologic model of the Site and areas connected hydrologically thereto, using TR-20 methodology, was developed to evaluate the existing and proposed drainage conditions. Peak runoff rates were evaluated at a common design point described as the aforementioned northeast discharge point. See Figure 3 for more details. The summary below presents the results of the analysis provided in Appendix D. The table also includes peak runoff rates to design point 2 from the permitted design approved under Wetland Application No. 16-0222 and RIPDES No. RIR101465 to allow for a better understanding of the impacts of the proposed revisions.

Design Point 2: Northeast Design Point

Peak Runoff Rate					
Existing Conditions		**2016 Permitted Conditions**		**Proposed Conditions**	
1-year storm:	0.00 CFS	1-year storm:	0.00 CFS	1-year storm:	0.00 CFS
2-year storm:	0.00 CFS	2-year storm:	0.00 CFS	2-year storm:	0.00 CFS
10-year storm:	0.01 CFS	10-year storm:	0.00 CFS	10-year storm:	0.01 CFS
25-year storm:	0.09 CFS	25-year storm:	0.00 CFS	25-year storm:	0.04 CFS
100-year storm:	1.43 CFS	100-year storm:	0.40 CFS	100-year storm:	0.68 CFS

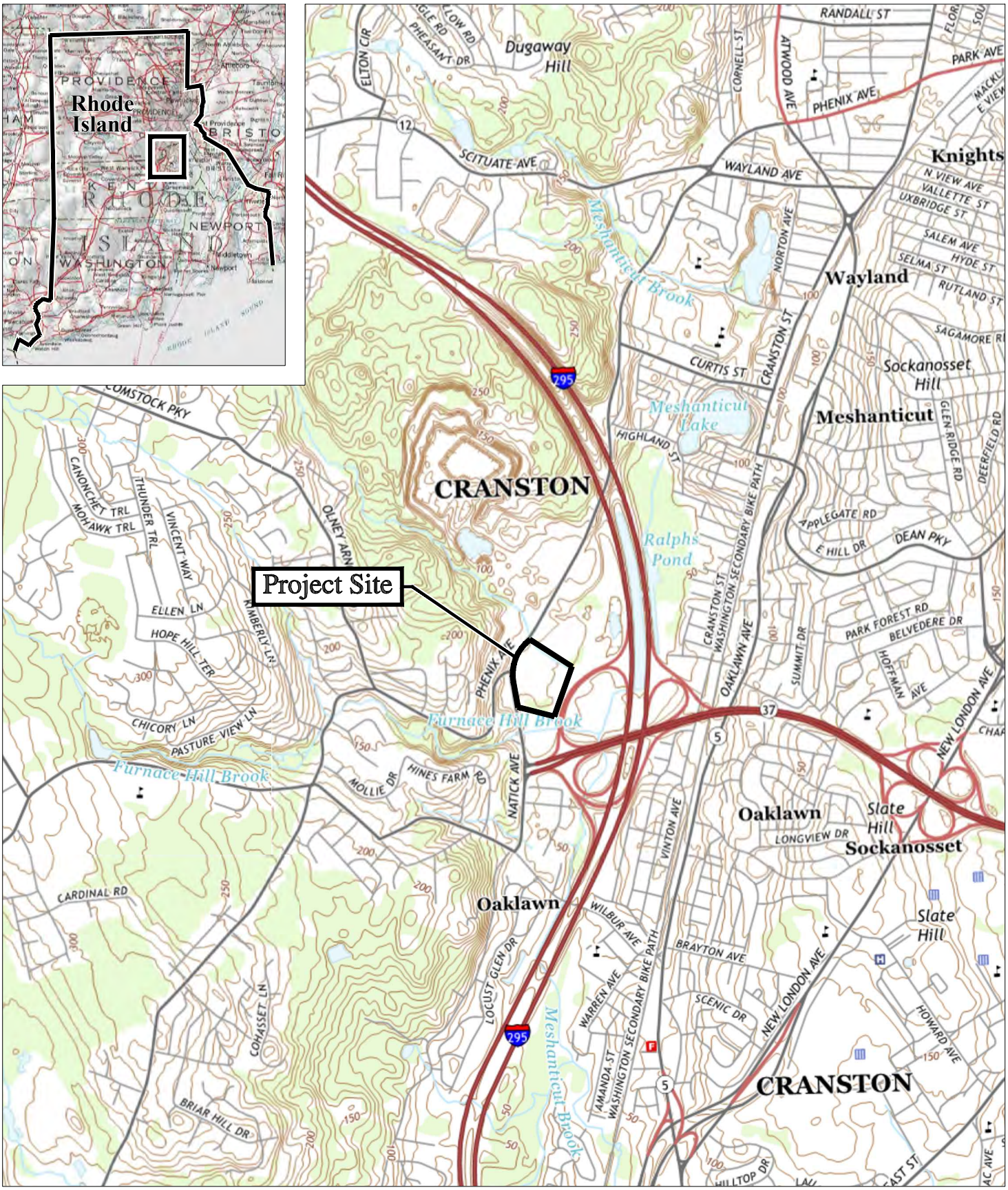
Site Surface Coverage Tabulation (Overall Drainage Area)

Existing Conditions		Permitted Conditions		Proposed Conditions	
Impervious Surface	0.00 AC	Impervious Surface	2.15 AC	Impervious Surface	1.80 AC
Pervious Surface	5.23 AC	Pervious Surface	3.10 AC	Pervious Surface	3.45 AC

The results of the analysis show that there is a decrease in peak rates to Design Point 2 from existing conditions.

Figures

- Figure 1 – Site Locus Map
- Figure 2-1 – Existing Drainage Area Map
- Figure 3-1 – Proposed Drainage Area Map

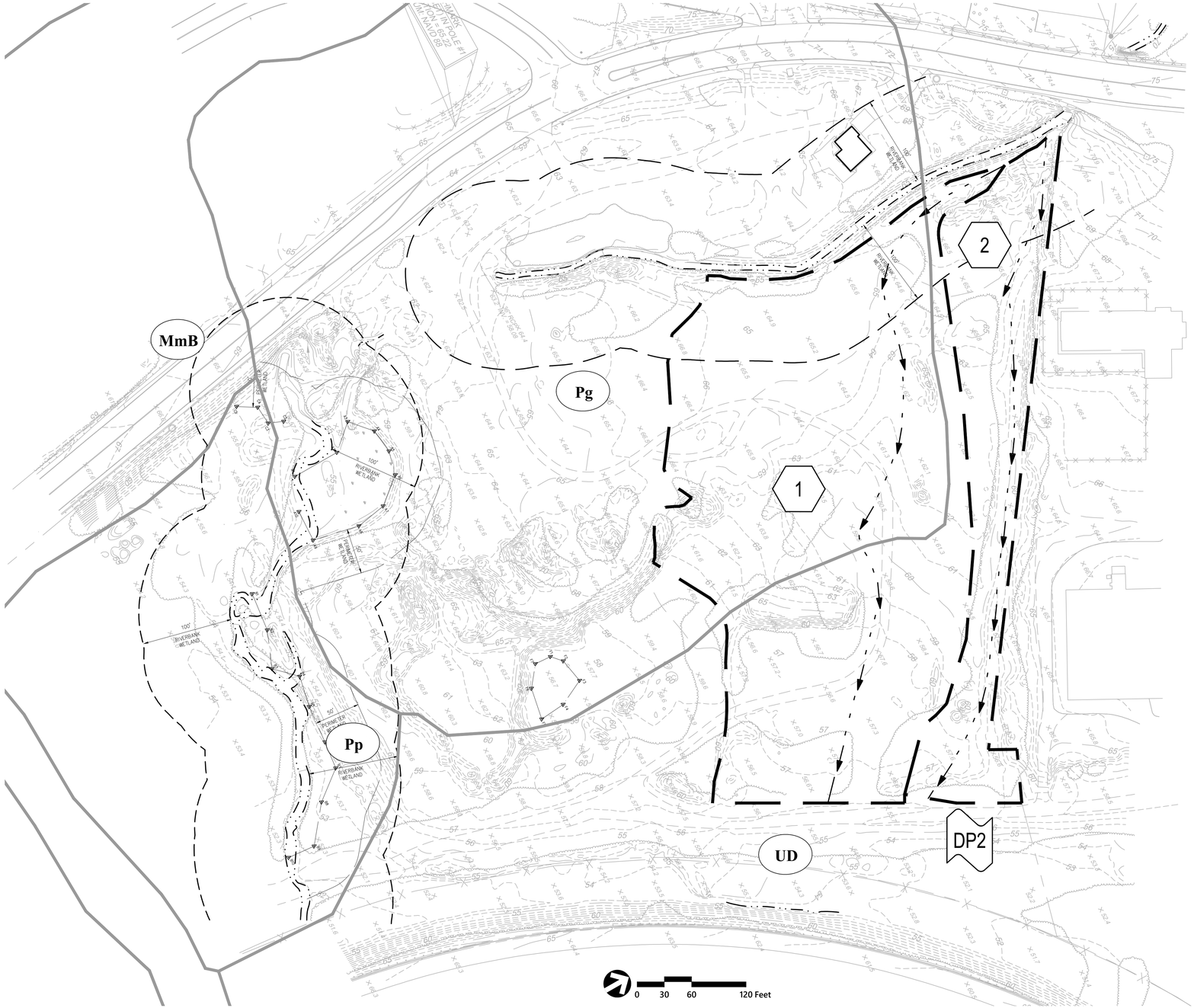


Project Location Map
Mixed Use Development
Phenix/Natick Avenue
Cranston, RI

FIGURE 1

06/2016

\\vhb\gbl\proj\Providence\72627.00\cad\ld\Eng\72627 Existing Drainage_Phase 2.dwg



Legend

SYMBOLS

- DESIGN POINT
- DRAINAGE AREA DESIGNATION
- POND
- REACH

LINETYPES

- DRAINAGE AREA BOUNDARY
- TIME OF CONCENTRATION FLOW LINE
- SOIL TYPE BOUNDARY
- 100' BUFFER ZONE
- WETLAND BOUNDARY

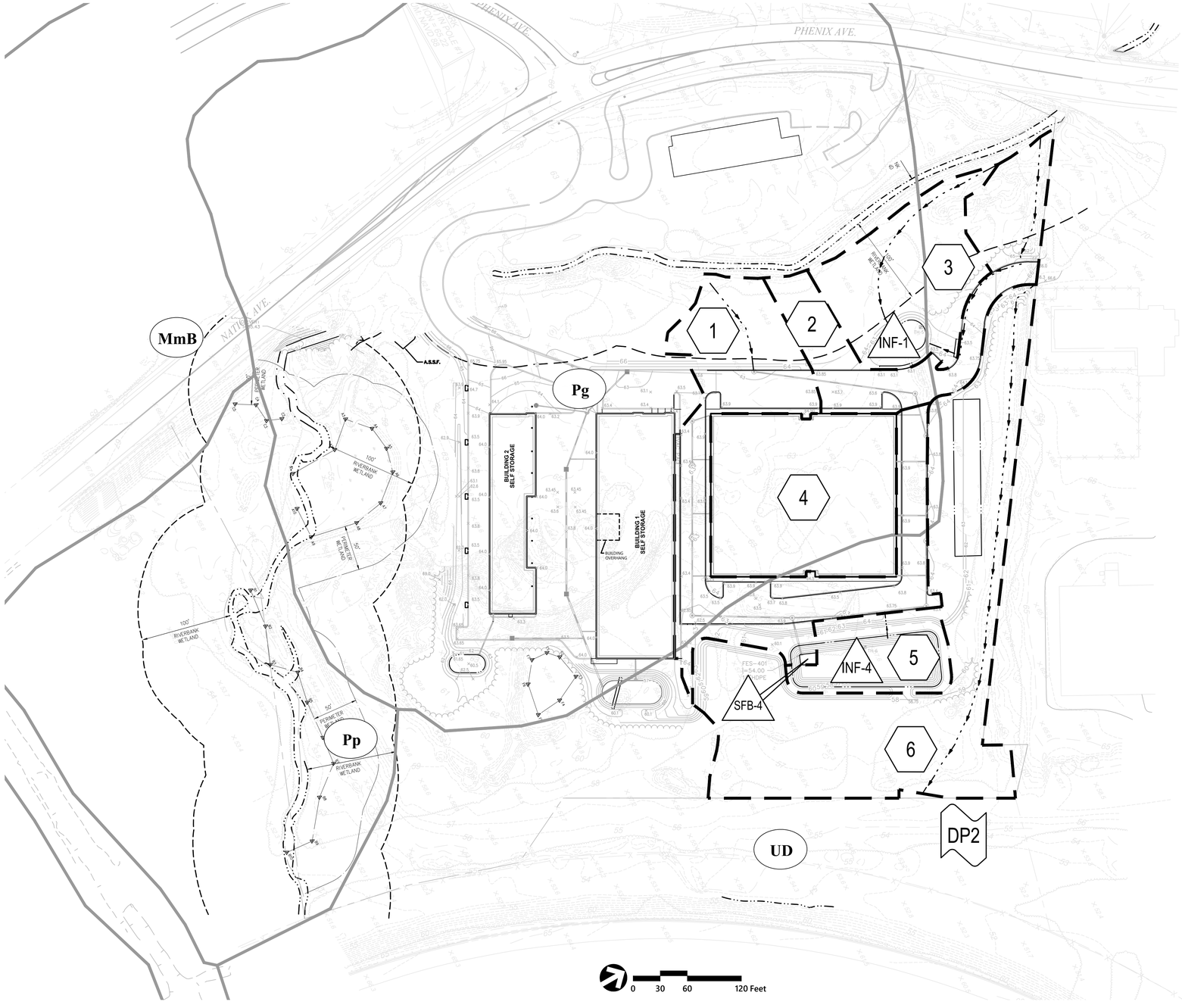
SCS SOIL CLASSIFICATIONS

- MmB — MERRIMAC FINE SANDY LOAM, 3 TO 8 PERCENT SLOPES, HSG A
- Pg — PITS, QUARRIES
- Pp — POOTATUCK FINE SANDY LOAM, HSG B
- UD — UDORTHENTS URBAN LAND COMPLEX, HSG A

Existing Drainage Conditions
Proposed Mixed Use Development-Phase 2
Cranston, Rhode Island

Figure 2-1

November 2021



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NOTE:

THERE IS A NET INCREASE IN AREA DIRECTED TO DP 2 IN PROPOSED CONDITIONS. THIS IS DUE TO A SMALL AREA DIRECTED TO DP 1 IN EXISTING CONDITIONS THAT IS NOW DIRECTED TO DP 2 AS A RESULT OF THE PHASE 1 CONSTRUCTION.

Proposed Drainage Conditions
Proposed Mixed Use Development-Phase 2
Cranston, Rhode Island

Figure 3-1

November 2021

Appendix A – Minimum Standard 1 – RISDISM Stormwater Management Checklist A (Bound Separately)

APPENDIX A: STORMWATER MANAGEMENT PLAN CHECKLIST AND LID PLANNING REPORT – STORMWATER DESIGN SUMMARY

PROJECT NAME **Proposed Mixed Use Development – Phase 2**	**(RIDEM USE ONLY)** **STW/WQC File #:** **Date Received:**
TOWN **Cranston, Rhode Island**	
BRIEF PROJECT DESCRIPTION: Phase 2 of the project includes construction of a self-storage building with associated drives, stormwater treatment areas, and utilities. The project was previously permitted in 2016, but this portion of the site was not constructed before the permits expired.	

Stormwater Management Plan (SMP) Elements – Minimum Standards

When submitting a SMP,[1] submit four separately bound documents: Appendix A Checklist; Stormwater Site Planning, Analysis and Design Report with Plan Set/Drawings; Soil Erosion and Sediment Control (SESC) Plan, and Post Construction Operations and Maintenance (O&M) Plan. Please refer to Suggestions to Promote Brevity.

Note: **All stormwater construction projects must create a Stormwater Management Plan (SMP). However, not every element listed below is required per the RIDEM Stormwater Rules and the RIPDES Construction General Permit (CGP). This checklist will help identify the required elements to be submitted with an Application for Stormwater Construction Permit & Water Quality Certification.**

PART 1. PROJECT AND SITE INFORMATION

PROJECT TYPE (Check all that apply)

☐ Residential	☒ Commercial	☐ Federal	☐ Retrofit	☐ Restoration
☐ Road	☐ Utility	☐ Fill	☐ Dredge	☐ Mine
☐ Other (specify):				

SITE INFORMATION

☒ Vicinity Map

INITIAL DISCHARGE LOCATION(S): The WQv discharges to: (You may choose more than one answer if several discharge points are associated with the project.)

☒ **Groundwater**	☒ **Surface Water**	☐ **MS4**
☐ GAA	☐ Isolated Wetland	☐ RIDOT
☒ GA	☒ Named Waterbody	☐ RIDOT Alteration Permit is Approved
☐ GB	☐ Unnamed Waterbody Connected to Named Waterbody	☐ Town
		☐ Other (specify):

ULTIMATE RECEIVING WATERBODY LOCATION(S): Include pertinent information that applies to both WQ_v and flow from larger storm events including overflows. Choose all that apply, and repeat table for each waterbody.

☒ Groundwater or Disconnected Wetland	☐ SRWP		
☒ Waterbody Name: Meshanticut Brook	☐ Coldwater	☒ Warmwater	☐ Unassessed
☒ Waterbody ID: RI0006017R-02	☐ 4th order stream of pond 50 acres or more		
☒ TMDL for: Enterococcus	☐ Watershed of flood prone river (e.g., Pocasset River)		
☐ Contributes to a priority outfall listed in the TMDL	☐ Contributes stormwater to a public beach		
☒ 303(d) list – Impairment(s) for: Enterococcus	☐ Contributes to shellfishing grounds		

[1] Applications for a Construction General Permit that do not require any other permits from RIDEM and will disturb less than 5 acres over the entire course of the project do not need to submit a SMP. The Appendix A checklist must still be submitted.

PROJECT HISTORY		
☒ RIDEM Pre-Application Meeting	Meeting Date: 9/15/2021	☐ Minutes Attached
☐ Municipal Master Plan Approval	Approval Date: 2014	☐ Minutes Attached
☐ Subdivision Suitability Required	Approval #:	
☐ Previous Enforcement Action has been taken on the property	Enforcement #:	

FLOODPLAIN & FLOODWAY See Guidance Pertaining to Floodplain and Floodways	
☒ Riverine 100-year floodplain: **FEMA FLOODPLAIN FIRMETTE** has been reviewed and the 100-year floodplain is on site	
☒ Delineated from FEMA Maps	
NOTE: Per Rule 250-RICR-150-10-8-1.1(B)(5)(d)(3), provide volumetric floodplain compensation calculations for cut and fill/displacement calculated by qualified professional	
☐ Calculated by Professional Engineer	
☐ Calculations are provided for cut vs. fill/displacement volumes proposed within the 100-year floodplain	Amount of Fill (CY):
	Amount of Cut (CY):
☐ Restrictions or modifications are proposed to the flow path or velocities in a floodway	
☐ Floodplain storage capacity is impacted	
☒ Project area is not within 100-year floodplain as defined by RIDEM	

CRMC JURISDICTION
☐ CRMC Assent required
☐ Property subject to a Special Area Management Plan (SAMP). If so, specify which SAMP:
☐ Sea level rise mitigation has been designed into this project

LUHPPL IDENTIFICATION - MINIMUM STANDARD 8:			
1. OFFICE OF Land Revitalization and Sustainable Materials Management (OLRSMM)			
	☐ Known or suspected releases of HAZARDOUS MATERIAL are present at the site (Hazardous Material is defined in Rule 1.4(A)(33) of 250-140-30-1 of the RIDEM Rules and Regulations for Investigation and Remediation of Hazardous Materials (the Remediation Regulations))		**RIDEM CONTACT:**
	☐ Known or suspected releases of PETROLEUM PRODUCT are present at the site (Petroleum Product as defined in Rule 1.5(A)(84) of 250-140-25-1 of the RIDEM Rules and Regulations for Underground Storage Facilities Used for Regulated Substances and Hazardous Materials)		
	☐ This site is identified on the RIDEM Environmental Resources Map as one of the following regulated facilities		**SITE ID#:**
		☐ CERCLIS/Superfund (NPL)	
		☐ State Hazardous Waste Site (SHWS)	
		☐ Environmental Land Usage Restriction (ELUR)	
		☐ Leaking Underground Storage Tank (LUST)	
		☐ Closed Landfill	
Note: If any boxes in 1 above are checked, the applicant must contact the RIDEM OLRSMM Project Manager associated with the Site to determine if subsurface infiltration of stormwater is allowable for the project. Indicate if the infiltration corresponds to "Red," "Yellow" or "Green" as described in Section 3.2.8 of the RISDISM Guidance (Subsurface Contamination Guidance). Also, note and reference approval in PART 3, Minimum Standard 2: Groundwater Recharge/Infiltration.			
2. PER MINIMUM STANDARD 8 of RICR 8.14.C.1-6 "LUHPPLS," THE SITE IS/HAS:			
	☐ Industrial Site with RIPDES MSGP, except where No Exposure Certification exists. http://www.dem.ri.gov/programs/water/permits/ripdes/stormwater/status.php		
	☐ Auto Fueling Facility (e.g., gas station)		
	☐ Exterior Vehicles Service, Maintenance, or Equipment Cleaning Area		

	☐ Road Salt Storage and Loading Areas (exposed to rainwater)	
	☐ Outdoor Storage and Loading/Unloading of Hazardous Substances	
3.	**STORMWATER INDUSTRIAL PERMITTING**	
	☐ The site is associated with existing or proposed activities that are considered Land Uses with Higher Potential Pollutant Loads (LUHPPLS) (see RICR 8.14.C)	Activities: Sector:
	☐ Construction is proposed on a site that is subject to THE MULTI-SECTOR GENERAL PERMIT (MSGP) UNDER RULE 31(B)15 OF THE RIPDES REGULATIONS.	MSGP permit #
	☐ Additional stormwater treatment is required by the MSGP Explain:	

REDEVELOPMENT STANDARD – MINIMUM STANDARD 6		
☒ Pre Construction Impervious Area		
	☐ Total Pre-Construction Impervious Area (**TIA**) 2.58 ac	
	☐ Total Site Area (**TSA**) 14.86 ac	
	☐ Jurisdictional Wetlands (**JW**) 1.79 ac	
	☐ Conservation Land (**CL**) N/A	
☒ Calculate the Site Size (defined as contiguous properties under same ownership)		
	☐ Site Size (**SS**) = (**TSA**) – (**JW**) – (**CL**) = 14.86 – 1.79 – 0.00 = 13.07 ac	
	☐ (**TIA**) / (**SS**) = 2.58 / 13.07 = 0.20 ac	☐ (**TIA**) / (**SS**) >**0.4**? No
☐ YES, Redevelopment		

PART 2. LOW IMPACT DEVELOPMENT ASSESSMENT – MINIMUM STANDARD 1

(NOT REQUIRED FOR REDEVELOPMENT OR RETROFITS)
This section may be deleted if not required.

Note: A written description must be provided specifying why each method is not being used or is not applicable at the Site. Appropriate answers may include:

- Town requires … (state the specific local requirement)
- Meets Town's dimensional requirement of …
- Not practical for site because …
- Applying for waiver/variance to achieve this (pending/approved/denied)
- Applying for wavier/variance to seek relief from this (pending/approved/denied)

A) PRESERVATION OF UNDISTURBED AREAS, BUFFERS, AND FLOODPLAINS	**IF NOT IMPLEMENTED, EXPLAIN HERE**
☒ Sensitive resource areas and site constraints are identified (required) ☒ Local development regulations have been reviewed (required) ☒ All vegetated buffers and coastal and freshwater wetlands will be protected during and after construction ☐ Conservation Development or another site design technique has been incorporated to protect open space and pre-development hydrology. **Note:** If Conservation Development has been used, check box and skip to Subpart C ☒ As much natural vegetation and pre-development hydrology as possible has been maintained	

B) LOCATE DEVELOPMENT IN LESS SENSITIVE AREAS AND WORK WITH THE NATURAL LANDSCAPE CONDITIONS, HYDROLOGY, AND SOILS ☒ Development sites and building envelopes have been appropriately distanced from wetlands and waterbodies ☒ Development and stormwater systems have been located in areas with greatest infiltration capacity (e.g., soil groups A and B) ☐ Plans show measures to prevent soil compaction in areas designated as Qualified Pervious Areas (QPA's) ☒ Development sites and building envelopes have been positioned outside of floodplains ☒ Site design positions buildings, roadways and parking areas in a manner that avoids impacts to surface water features ☒ Development sites and building envelopes have been located to minimize impacts to steep slopes (≥15%) ☐ Other (describe):	
C) MINIMIZE CLEARING AND GRADING ☒ Site clearing has been restricted to <u>minimum area needed</u> for building footprints, development activities, construction access, and safety. ☒ Site has been designed to position buildings, roadways, and parking areas in a manner that minimizes grading (cut and fill quantities) ☐ Protection for stands of trees and individual trees and their root zones to be preserved has been specified, and such protection extends at least to the tree canopy drip line(s) ☐ Plan notes specify that public trees removed or damaged during construction shall be replaced with equivalent	
D) REDUCE IMPERVIOUS COVER ☐ Reduced roadway widths (≤22 feet for ADT ≤400; ≤26 feet for ADT 400 - 2,000) ☐ Reduced driveway areas (length minimized via reduced ROW width (≤45 ft.) and/or reduced (or absolute minimum) front yard setback; width minimized to ≤9 ft. wide one lane; ≤18 ft. wide two lanes; shared driveways; pervious surface) ☐ Reduced building footprint: Explain approach: ☐ Reduced sidewalk area (≤4 ft. wide; one side of the street; unpaved path; pervious surface) ☐ Reduced cul-de-sacs (radius <45 ft; vegetated island; alternative turn-around) ☐ Reduced parking lot area: Explain approach ☐ Use of pervious surfaces for driveways, sidewalks, parking areas/overflow parking areas, etc. ☐ Minimized impervious surfaces (project meets or is less than maximum specified by Zoning Ordinance) ☐ Other (describe):	Original permit included multiple buildings, parking, and drives. This permit consists of only one large building, allowing a reduction in impervious cover.
E) DISCONNECT IMPERVIOUS AREA ☐ Impervious surfaces have been disconnected, and runoff has been diverted to QPAs to the maximum extent possible ☐ Residential street edges allow side-of-the-road drainage into vegetated open swales ☐ Parking lot landscaping breaks up impervious expanse AND accepts runoff ☐ Other (describe):	QPAs and parking lot treatment areas are not feasible for this site. Infiltration basins were utilized as alternatives.
F) MITIGATE RUNOFF AT THE POINT OF GENERATION ☒ Small-scale BMPs have been designated to treat runoff as close as possible to the source	

G) PROVIDE LOW-MAINTENANCE NATIVE VEGETATION ☒ Low-maintenance landscaping has been proposed using native species and cultivars ☐ Plantings of native trees and shrubs in areas previously cleared of native vegetation are shown on site plan ☒ Lawn areas have been limited/minimized, and yards have been kept undisturbed to the maximum extent practicable on residential lots	
H) RESTORE STREAMS/WETLANDS ☐ Historic drainage patterns have been restored by removing closed drainage systems, daylighting buried streams, and/or restoring degraded stream channels and/or wetlands ☐ Removal of invasive species ☐ Other	There are no streams in this phase of the project. Stream/wetland restoration was part of Phase 1.

PART 3. SUMMARY OF REMAINING STANDARDS

GROUNDWATER RECHARGE – MINIMUM STANDARD 2		
YES	**NO**	
☒	☐	The project has been designed to meet the groundwater recharge standard.
☐	☐	If "No," the justification for groundwater recharge criterion waiver has been explained in the Narrative (e.g., threat of groundwater contamination or physical limitation), if applicable (see RICR 8.8.D);
☐	☐	Your waiver request has been explained in the Narrative, if applicable.
☐	☒	Is this site identified as a Regulated Facility in Part 1, Minimum Standard 8: LUHPPL Identification?
☐	☐	If "Yes," has approval for infiltration by the OLRSMM Site Project Manager, per Part 1, Minimum Standard 8, been requested?

TABLE 2-1: Summary of Recharge (see RISDISM Section 3.3.2)
(Add or Subtract Rows as Necessary)

Design Point	Impervious Area Treated (sq ft)	Total Re_v Required (cu ft)	LID Stormwater Credits (see RISDISM Section 4.6.1)	Recharge Required by Remaining BMPs (cu ft)	Recharge Provided by BMPs (cu ft)
			Portion of Re_v directed to a QPA (cu ft)		
DP-2: Northeast Design Point	78,726	3,936	0	3,936	14,771
TOTALS:	78,726	3,936	0	3,936	14,771

Notes:
1. Only BMPs listed in RISDISM Table 3-5 "List of BMPs Acceptable for Recharge" may be used to meet the recharge requirement.
2. Recharge requirement must be satisfied for each waterbody ID.

☒ Indicate where the pertinent calculations and/or information for the above items are provided (i.e., name of report/document, page numbers, appendices, etc.):
Appendix D of Stormwater Management Report: Minimum Standard 2: Groundwater Recharge (Re_v) Calculations

WATER QUALITY – MINIMUM STANDARD 3		
YES	**NO**	
☒	☐	Does this project meet or exceed the required water quality volume WQv (see RICR 8.9.E-I)?
☒	☐	Is the proposed final impervious cover greater than 20% of the disturbed area (see RICR 8.9.E-I)?
☒	☐	If "Yes," either the Modified Curve Number Method or the Split Pervious/Impervious method in Hydro-CAD was used to calculate WQv; or,
☐	☐	If "Yes," either TR-55 or TR-20 was used to calculate WQv; and,
☐	☐	If "No," the project meets the minimum WQv of 0.2 watershed inches over the entire disturbed area.
☐	☐	Not Applicable
☒	☐	Does this project meet or exceed the ability to treat required water quality flow WQf (see RICR 8.9.I.1-3)?
☐	☒	Does this project propose an increase of impervious cover to a receiving water body with impairments? If "Yes," please indicate below the method that was used to address the water quality requirements of no further degradation to a low-quality water.
☐	☒	RICR 8.36. A Pollutant Loading Analysis is needed and has been completed.
☒	☐	The Water Quality Guidance Document (Water Quality Goals and Pollutant Loading Analysis Guidance for Discharges to Impaired Waters) has been followed as applicable.
☐	☒	BMPs are proposed that are on the approved technology list. If "Yes," please provide all required worksheets from the manufacturer.
☐	☒	Additional pollutant-specific requirements and/or pollutant removal efficiencies are applicable to the site as the result of a TMDL, SAMP, or other watershed-specific requirements. If "Yes," please describe:

TABLE 3-1: Summary of Water Quality (see RICR 8.9)

Design Point and WB ID	Impervious area treated (sq ft)	Total WQ_v Required (cu ft)	LID Stormwater Credits (see RICR 8.18) WQv directed to a QPA (cu ft)	Water Quality Treatment Remaining (cu ft)	Water Quality Provided by BMPs (cu ft)
DP-2: Northeast Design Point	78,726	6,561	0	6,561	6,561
TOTALS:	78,726	6,561	0	6,561	6,561

Notes:
1. Only BMPs listed in RICR 8.20 and 8.25 or the Approved Technologies List of BMPs is Acceptable for Water Quality treatment.
2. For each Design Point, the Water Quality Volume Standard must be met for each Waterbody ID.

☒ YES ☐ NO	This project has met the setback requirements for each BMP. If "No," please explain:

☒ Indicate where the pertinent calculations and/or information for the above items are provided (i.e., name of report/document, page numbers, appendices, etc.):
Appendix D of Stormwater Management Report: Minimum Standard 3: Water Quality Calculations

CONVEYANCE AND NATURAL CHANNEL PROTECTION (RICR 8.10) – MINIMUM STANDARD 4		
YES	**NO**	
☐	☒	Is this standard waived? If "Yes," please indicate one or more of the reasons below:
		☐ The project directs discharge to a large river (i.e., 4th-order stream or larger. See RISDISM Appendix I for State-wide list and map of stream orders), bodies of water >50.0 acres in surface area (i.e., lakes, ponds, reservoirs), or tidal waters. ☐ The project is a small facility with impervious cover of less than or equal to 1 acre. ☐ The project has a post-development peak discharge rate from the facility that is less than 2 cfs for the 1-year, 24-hour Type III design storm event (prior to any attenuation). (Note: LID design strategies can greatly reduce the peak discharge rate).
☒	☐	Conveyance and natural channel protection for the site have been met. The entire 1-year storm is infiltrated.

TABLE 4-1: Summary of Channel Protection Volumes (see RICR 8.10)					
Design Point	**Receiving Water Body Name**	**Coldwater Fishery? (Y/N)**	**Total CPv Required (cu ft)**	**Total CPv Provided (cu ft)**	**Average Release Rate Modeled in the 1-yr storm (cfs)**
DP-2: Northeast Design Point	Meshanticut Brook	N	NA*	NA*	NA*
TOTALS:					
*The entire 1-year storm is infiltrated; therefore, channel protection volume requirement is met.					

Note: The Channel Protection Volume Standard must be met in each waterbody ID.

☐ YES ☒ NO	The CPv is released at roughly a uniform rate over a 24-hour duration (see examples of sizing calculations in Appendix D of the RISDISM).
☐ YES ☒ NO	Do additional design restrictions apply resulting from any discharge to cold-water fisheries; If "Yes," please indicate restrictions and solutions below.

☒ Indicate below where the pertinent calculations and/or information for the above items are provided (i.e., name of report/document, page numbers, appendices, etc.).

Stormwater Report Appendix D

OVERBANK FLOOD PROTECTION (RICR 8.11) AND OTHER POTENTIAL HIGH FLOWS – MINIMUM STANDARD 5			
YES	**NO**		
☐	☒	Is this standard waived? If yes, please indicate one or more of the reasons below:	
		☐	The project directs discharge to a large river (i.e., 4th-order stream or larger. See Appendix I for state-wide list and map of stream orders), bodies of water >50.0 acres in surface area (i.e., lakes, ponds, reservoirs), or tidal waters.
		☐	A Downstream Analysis (see RICR 8.11.D and E) indicates that peak discharge control would not be beneficial or would exacerbate peak flows in a downstream tributary of a particular site (e.g., through coincident peaks).
☐	☒	Does the project flow to an MS4 system or subject to other stormwater requirements? If "Yes," indicate as follows:	
		☐	RIDOT
		☐	Other (specify):
Note: The project could be approved by RIDEM but not meet RIDOT or Town standards. RIDOT's regulations indicate that post-volumes must be **less** than pre-volumes for the 10-yr storm at the design point entering the RIDOT system. If you have not already received approval for the discharge to an MS4, please explain below your strategy to comply with RIDEM and the MS4.			
		Indicate below which model was used for your analysis. ☐ TR-55 ☐ TR-20 ☒ HydroCAD ☐ Bentley/Haestad ☐ Intellisolve ☐ Other (Specify):	
YES	**NO**		
☒	☐	Does the drainage design demonstrate that flows from the 100-year storm event through a BMP will safely manage and convey the 100-year storm? If "No," please explain briefly below and reference where in the application further documentation can be found (i.e., name of report/document, page numbers, appendices, etc.):	
☐	☒	Do off-site areas contribute to the sub-watersheds and design points? If "Yes,"	
☐	☐	Are the areas modeled as "present condition" for both pre- and post-development analysis?	
☐	☐	Are the off-site areas shown on the subwatershed maps?	
☒	☐	Does the drainage design confirm safe passage of the 100-year flow through the site for off-site runoff?	
☐	☒	Is a Downstream Analysis required (see RICR 8.11.E.1)?	
☒	☐	Calculate the following:	
		☒	Area of disturbance within the sub-watershed (areas) 3.09 ac
		☒	Impervious cover (%) 51.6%
☐	☒	Is a dam breach analysis required (earthen embankments over six (6) feet in height, or a capacity of 15 acre-feet or more, and contributes to a significant or high hazard dam)?	
☒	☐	Does this project meet the overbank flood protection standard?	

Table 5-1 Hydraulic Analysis Summary								
Subwatershed (Design Point)	**1.2" Peak Flow (cfs)****		**1-yr Peak Flow (cfs)**		**10-yr Peak Flow (cfs)**		**100-yr Peak Flow (cfs)**	
	Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)	Pre (cfs)	Post (cfs)
DP-2: Northeast Design Point	0.00	0.00	0.00	0.00	0.01	0.01	1.43	0.68
TOTALS:	0.00	0.00	0.00	0.00	0.01	0.01	1.43	0.68

** Utilize modified curve number method or split pervious /impervious method in HydroCAD.

Note: The hydraulic analysis must demonstrate no impact to each individual subwatershed DP unless each DP discharges to the same wetland or water resource.

Indicate as follows where the pertinent calculations and/or information for the items above are provided	**Name of report/document, page numbers, appendices, etc.**
Existing conditions analysis for each subwatershed, including curve numbers, times of concentration, runoff rates, volumes, and water surface elevations showing methodologies used and supporting calculations.	Figure 2-1, "Existing Drainage Conditions"; Existing Conditions HydroCAD model; Appendix D calculations
Proposed conditions analysis for each subwatershed, including curve numbers, times of concentration, runoff rates, volumes, water surface elevations, and routing showing the methodologies used and supporting calculations.	Figure 3-1, "Proposed Drainage Conditions"; Proposed Conditions HydroCAD model; Appendix D calculations
Final sizing calculations for structural stormwater BMPs, including contributing drainage area, storage, and outlet configuration.	Stormwater Report Appendix D
Stage-storage, inflow and outflow hydrographs for storage facilities (e.g., detention, retention, or infiltration facilities).	Stormwater Report Appendix D

Table 5-2 Summary of Best Management Practices											
BMP ID	**DP #**	**BMP Type** (e.g., bioretention, tree filter)	**BMP Functions**					**Bypass Type**	**Horizontal Setback Criteria are met per RICR 8.21.B.10, 8.22.D.11, and 8.35.B.4**		
			Pre-Treatment (Y/N/NA)	Re_v (cf)	WQ_v (cf)	CP_v (Y/N/NA)	Overbank Flood Reduction (Y/N/NA)	External (E) Internal (I) or NA	Yes /No	Technical Justification (Design Report page number)	Distance Provided
SFB-4	DP-2	Sediment Forebay	Y	NA	NA	NA	NA	NA	Y	25 ft. (RICR 8.21.B.10)	74 ft.
SD-1	DP-2	Stone Diaphragm	Y	NA	NA	NA	NA	NA	Y	25 ft. (RICR 8.21.B.10)	89 ft.
SD-2	DP-2	Stone Diaphragm	Y	NA	NA	NA	NA	NA	Y	25 ft. (RICR 8.21.B.10)	49 ft.
INF-1	DP-2	Infiltration Basin	N	2,301	928	NA	Y	NA	Y	25 ft. (RICR 8.21.B.10)	70 ft.
INF-4	DP-2	Infiltration Basin	N	12,470	5,633	NA	Y	I	Y	25 ft. (RICR 8.21.B.10)	64 ft.
		TOTALS:		14,771	6,561						

Table 5.3 Summary of Soils to Evaluate Each BMP									
DP #	**BMP ID**	**BMP Type** (e.g., bioretention, tree filter)	**Soils Analysis for Each BMP**						
			Test Pit ID# and Ground Elevation		SHWT Elevation (ft)	Bottom of Practice Elevation* (ft)	Separation Distance Provided (ft)	Hydrologic Soil Group (A, B, C, D)	Exfiltration Rate Applied (in/hr)
			Primary	Secondary					
DP-2: Northeast Design Point	INF-1	Infiltration Basin	TH-5	N/A	54.42	61	5.6	A	6.0
DP-2: Northeast Design Point	INF-4	Infiltration Basin	TH-6	N/A	50.90	54	3.1	A	6.0
		TOTALS:							

* For underground infiltration systems (UICs) bottom equals bottom of stone, for surface infiltration basins bottom equals bottom of basin, for filters bottom equals interface of storage and top of filter layer

LAND USES WITH HIGHER POTENTIAL POLLUTANTS LOADS (LUHPPLs) – MINIMUM STANDARD 8			
YES	**NO**	**N/A**	
☐	☐	☒	Describe any LUHPPLs identified in Part 1, Minimum Standard 8, Section 2. If not applicable, continue to Minimum Standard 9.
☐	☐	☒	Are these activities already covered under an MSGP? If "No," please explain if you have applied for an MSGP or intend to do so?
☐	☐	☒	List the specific BMPs that are proposed for this project that receive stormwater from LUHPPL drainage areas. These BMP types must be listed in RISDISM Table 3-3, "Acceptable BMPs for Use at LUHPPLs." Please list BMPs:
☐	☐	☒	Additional BMPs, or additional pretreatment BMP's if any, that meet RIPDES MSGP requirements; Please list BMPs:
			Indicate below where the pertinent calculations and/or information for the above items are provided (i.e., name of report/document, page numbers, appendices, etc.).

ILLICIT DISCHARGES – MINIMUM STANDARD 9			
Illicit discharges are defined as unpermitted discharges to Waters of the State that do not consist entirely of stormwater or uncontaminated groundwater, except for certain discharges identified in the RIPDES Phase II Stormwater General Permit.			
YES	**NO**	**N/A**	
☒	☐	☐	Have you checked for illicit discharges?
☐	☒	☐	Have any been found and/or corrected? If "Yes," please identify.
☒	☐	☐	Does your report explain preventative measures that keep non-stormwater discharges out of the Waters of the State (during and after construction)?

SOIL EROSION AND SEDIMENT CONTROL (SESC) – MINIMUM STANDARD 10				
YES	**NO**	**N/A**		
☒	☐	☐	Have you included a Soil Erosion and Sediment Control Plan Set and/or Complete Construction Plan Set?	
☒	☐	☐	Have you provided a **separately-bound** document based upon the SESC Template? If yes, proceed to Minimum Standard 11 (the following items can be assumed to be addressed).	
			If "No," include a document with your submittal that addresses the following elements of an SESC Plan:	
			☐	Soil Erosion and Sediment Control Plan Project Narrative, including a description of how the fifteen (15) Performance Criteria have been met:
			☐	Provide Natural Buffers and Maintain Existing Vegetation
			☐	Minimize Area of Disturbance
			☐	Minimize the Disturbance of Steep Slopes
			☐	Preserve Topsoil
			☐	Stabilize Soils
			☐	Protect Storm Drain Inlets
			☐	Protect Storm Drain Outlets
			☐	Establish Temporary Controls for the Protection of Post-Construction Stormwater Control Measures
			☐	Establish Perimeter Controls and Sediment Barriers
			☐	Divert or Manage Run-On from Up-Gradient Areas
			☐	Properly Design Constructed Stormwater Conveyance Channels
			☐	Retain Sediment On-Site
			☐	Control Temporary Increases in Stormwater Velocity, Volume, and Peak Flows
			☐	Apply Construction Activity Pollution Prevention Control Measures
			☐	Install, Inspect, and Maintain Control Measures and Take Corrective Actions
			☐	Qualified SESC Plan Preparer's Information and Certification
			☐	Operator's Information and Certification; if not known at the time of application, the Operator must certify the SESC Plan upon selection and prior to initiating site activities
			☐	Description of Control Measures, such as Temporary Sediment Trapping and Conveyance Practices, including design calculations and supporting documentation, as required

STORMWATER MANAGEMENT SYSTEM OPERATION, MAINTENANCE, AND POLLUTION PREVENTION PLAN – MINIMUM STANDARDS 7 AND 9		
Operation and Maintenance Section		
YES	**NO**	
☒	☐	Have you minimized all sources of pollutant contact with stormwater runoff, to the maximum extent practicable?
☒	☐	Have you provided a **separately-bound** Operation and Maintenance Plan for the site and for all of the BMPs, and does it address each element of RICR 8.17 and RISDISM Appendix C and E?
☒	☐	Lawn, Garden, and Landscape Management meet the requirements of RISDISM Section G.7? If "No," why not?
☒	☐	Is the property owner or homeowner's association responsible for the stormwater maintenance of all BMP's? If "No," you must provide a legally binding and enforceable maintenance agreement (see RISDISM Appendix E, page 26) that identifies the entity that will be responsible for maintenance of the stormwater. See Long Term Stormwater Operation and Maintenance Plan and Pollution Prevention and Source Control, Chapter 1, Page 1.
☐	☒	Do you anticipate that you will need legal agreements related to the stormwater structures? (e.g. off-site easements, deed restrictions, covenants, or ELUR per the Remediation Regulations). If "Yes," have you obtained them? Or please explain your plan to obtain them:

☐	☒	Is stormwater being directed from public areas to private property? If "Yes," note the following: Note: This is not allowed unless a funding mechanism is in place to provide the finances for the long-term maintenance of the BMP and drainage, or a funding mechanism is demonstrated that can guarantee the long-term maintenance of a stormwater BMP by an individual homeowner.
Pollution Prevention Section		
☒	☐	Designated snow stockpile locations?
☐	☒	Trash racks to prevent floatables, trash, and debris from discharging to Waters of the State?
☒	☐	Asphalt-only based sealants?
☐	☒	Pet waste stations? (Note: If a receiving water has a bacterial impairment, and the project involves housing units, then this could be an important part of your pollution prevention plan).
☒	☐	Regular sweeping? Please describe: Parking lots will be maintained
☒	☐	De-icing specifications, in accordance with RISDISM Appendix G. (NOTE: If the groundwater is GAA, or this area contributes to a drinking water supply, then this could be an important part of your pollution prevention plan).
☒	☐	A prohibition of phosphate-based fertilizers? (Note: If the site discharges to a phosphorus impaired waterbody, then this could be an important part of your pollution prevention plan).

PART 4. SUBWATERSHED MAPPING AND SITE-PLAN DETAILS

Existing and Proposed Subwatershed Mapping (REQUIRED)			
YES	**NO**		
☒	☐		Existing and proposed drainage area delineations
☒	☐		Locations of all streams and drainage swales
☒	☐		Drainage flow paths, mapped according to the DEM *Guidance for Preparation of Drainage Area Maps* (included in RISDISM Appendix K)
☒	☐		Complete drainage area boundaries; include off-site areas in both mapping and analyses, as applicable
☒	☐		Logs of borings and/or test pit investigations along with supporting soils/geotechnical report
☒	☐		Mapped seasonal high-water-table test pit locations
☒	☐		Mapped locations of the site-specific borings and/or test pits and soils information from the test pits at the locations of the BMPs
☒	☐		Mapped locations of the BMPs, with the BMPs consistently identified on the Site Construction Plans
☐	☒		Mapped bedrock outcrops adjacent to any infiltration BMP
☒	☐		Soils were logged by a:
		☒	DEM-licensed Class IV soil evaluator Name: Edward J. Avizinis, License #: D4083
		☐	RI-registered P.E. Name:

Subwatershed and Impervious Area Summary				
Subwatershed (area to each design point)	**First Receiving Water ID or MS4**	**Area Disturbed (sf)**	**Existing Impervious (sf)**	**Proposed Impervious (sf)**
DP-2: Northeast Design Point	RI0006017R-02	134,705	112,527	78,726
TOTALS:		134,705	112,527	78,726

Site Construction Plans (Indicate that the following applicable specifications are provided)		
YES	**NO**	
☒	☐	Existing and proposed plans (scale not greater than 1" = 40') with North arrow
☒	☐	Existing and proposed site topography (with 1 or 2-foot contours); 10-foot contours accepted for off-site areas
☒	☐	Boundaries of existing predominant vegetation and proposed limits of clearing
☒	☐	Site Location clarification
☒	☐	Location and field-verified boundaries of resource protection areas such as: ► freshwater and coastal wetlands, including lakes and ponds ► coastal shoreline features Perennial and intermittent streams, in addition to Areas Subject to Storm Flowage (ASSFs)
☒	☐	All required setbacks (e.g., buffers, water-supply wells, septic systems)
☒	☐	Representative cross-section and profile drawings, and notes and details of structural stormwater management practices and conveyances (i.e., storm drains, open channels, swales, etc.), which include: ► Location and size of the stormwater treatment practices (type of practice, depth, area). Stormwater treatment practices (BMPs) must have labels that correspond to RISDISM Table 5-2; ► Design water surface elevations (applicable storms); ► Structural details of outlet structures, embankments, spillways, stilling basins, grade-control structures, conveyance channels, etc.; ► Existing and proposed structural elevations (e.g., inverts of pipes, manholes, etc.); ► Location of floodplain and, if applicable, floodway limits and relationship of site to upstream and downstream properties or drainage that could be affected by work in the floodplain; ► Planting plans for structural stormwater BMPs, including species, size, planting methods, and maintenance requirements of proposed planting
☒	☐	Logs of borings and/or test pit investigations along with supporting soils/geotechnical report and corresponding water tables
☐	☒	Mapping of any OLRSMM-approved remedial actions/systems (including ELURs)
☒	☐	Location of existing and proposed roads, buildings, and other structures including limits of disturbance; ► Existing and proposed utilities (e.g., water, sewer, gas, electric) and easements; ► Location of existing and proposed conveyance systems, such as grass channels, swales, and storm drains, and location(s) of final discharge point(s) (wetland, waterbody, etc.); ► Cross sections of roadways, with edge details such as curbs and sidewalks; ► Location and dimensions of channel modifications, such as bridge or culvert crossings
☐	☒	Locations, cross sections, and profiles of all stream or wetland crossings and their method of stabilization

Appendix B – Test Pit Logs/NRCS Soils Data

Test Pit Logs

Site Sketch for Soil Evaluations
950 Phenix Ave
A.P. 19-1, Lot 3

Cranston, RI

Approximate Site Location
Monitoring Well Locations (Read 4/6 & 4/13/16
Test Hole Locations (DEM Witnessed 4/13/16)
Test Hole Locations (Not Witnessed 4/6/16)

Performed by Edward Avizinis D4083

N
W
E
S

2014 USGS Digital True Color Orthophotography

Natural Resource Services, Inc.
PO Box 311
180 Tikkham Lane
Hanseville RI 02830
p (401) 568-7390
f (401) 568 7393

STATE OF RHODE ISLAND AND PROVIDENCE PLANTATIONS

Department of Environmental Management
Office of Water Resources
Onsite Wastewater Treatment System Program

Site Evaluation Form
Part A – Soil Profile Description **Application Number** _____

Property Owner: _____
Property Location: 950 Phenix Ave - Cranston
Date of Test Hole: 4-6-16
Soil Evaluator: Edward J Avizinis License Number: D4083
Weather: Party Sunny - 40's Shaded: Yes ☐ No ☒ Time: 10 am

TH 5 Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox	Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab. S. Contr.				
HTM	60-0"	a	s	-	-	-	gSL	1fgr	fr	-
C	0-90"	-	-	10YR 7/2	10YR 5/6 10YR 5/1	f (2) p f (2) d	fS	1 thin PL	vfr	9

TH 6 Horizon	Depth	Horizon Boundaries		Soil Colors		Re-Dox	Texture	Structure	Consistence	Soil Category
		Dist	Topo	Matrix	Re-Dox Features	Ab. S. Contr.				
HTM	10-0"	a	s	-	-	-	gSL	1fgr	fr	-
C	0-134"	-	-	10YR 7/2	10YR 5/2 10YR 5/6	c (2) d c (2) p	fS	1 thin PL	vfr	9

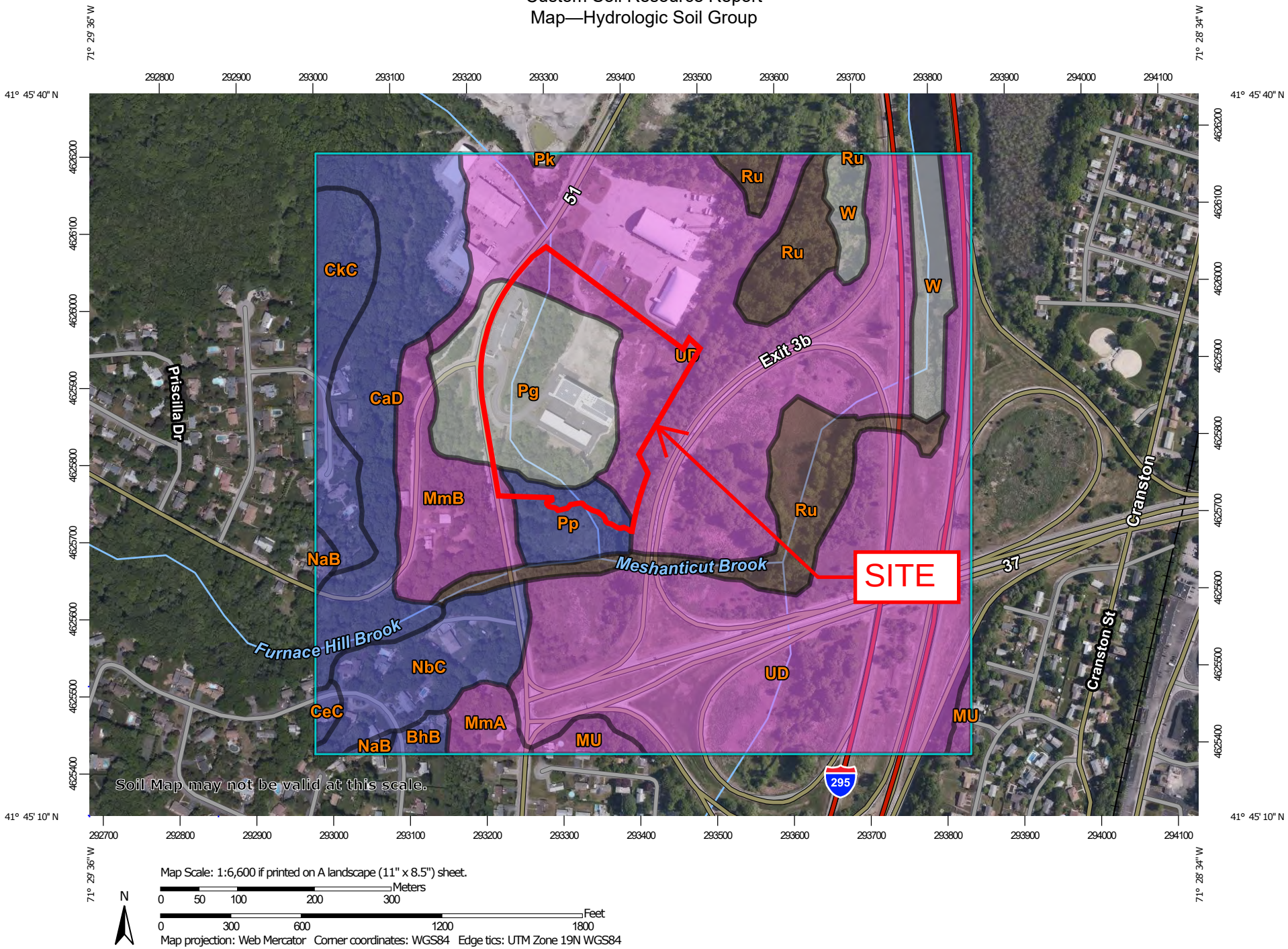
TH 5 Soil Class Lacustrine Total Depth 150" Impervious/Limiting Layer Depth >150" (og) GW Seepage Depth 120" SHWT 55" (og)

TH 6 Soil Class Lacustrine Total Depth 144" Impervious/Limiting Layer Depth >144" (og) GW Seepage Depth 100" SHWT 74" (og)

Comments: Storm water design only - not DEM witnessed

NRCS Soils Data

Map—Hydrologic Soil Group



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

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: State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties
Survey Area Data: Version 21, Sep 3, 2021

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

Date(s) aerial images were photographed: May 24, 2020—Jul 18, 2020

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

MAP LEGEND

MAP INFORMATION

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

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BhB	Bridgehampton silt loam, 3 to 8 percent slopes	B	0.8	0.5%
CaD	Canton-Charlton-Rock outcrop complex, 15 to 35 percent slopes, very stony	B	16.0	9.7%
CeC	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, very rocky	B	0.5	0.3%
CkC	Canton and Charlton fine sandy loams, 3 to 15 percent slopes, extremely stony	B	6.4	3.9%
MmA	Merrimac fine sandy loam, 0 to 3 percent slopes	A	2.0	1.2%
MmB	Merrimac fine sandy loam, 3 to 8 percent slopes	A	7.8	4.7%
MU	Merrimac-Urban land complex, 0 to 8 percent slopes	A	1.6	1.0%
NaB	Narragansett silt loam, 3 to 8 percent slopes	B	0.6	0.4%
NbC	Narragansett very stony silt loam, 8 to 15 percent slopes	B	7.7	4.6%
Pg	Pits, gravel		12.6	7.6%
Pk	Pits, quarries		0.1	0.1%
Pp	Pootatuck fine sandy loam	B	3.6	2.2%
Ru	Rippowam fine sandy loam	B/D	12.7	7.7%
UD	Udorthents-Urban land complex	A	87.0	52.7%
W	Water		5.6	3.4%
Totals for Area of Interest			**165.1**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Appendix C – FEMA Flood Map

National Flood Hazard Layer FIRMette

FEMA

71°29'31"W 41°45'45"N

71°28'54"W 41°45'18"N

Basemap: USGS National Map: Orthoimagery: Data refreshed October, 2020

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 Cross Sections with 1% Annual Chance
- 17.5 Water Surface Elevation
- Coastal Transect
- Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 10/8/2021 at 2:07 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.

Appendix D – Minimum Standards 2 through 5

Minimum Standard 2 – Groundwater Recharge Calculations

Computations

Project:	Proposed Self Storage Building	**Project #**	72627.20
Location:	Cranston, Rhode Island	**Sheet:**	1 **of** 1
Calculated By:	SAP	**Date:**	11/08/2021
Checked By:	AEC	**Date:**	11/19/2021
Title:	Groundwater Recharge		

Section 3.2.2 Minimum Standard 2: Groundwater Recharge (Re_v.)

- Re_v = X" * (F)*(I)/12

  Where:

  Re_v = required recharge volume (CF)

  F = Recharge Factors Based on Hydrologic Soil Group (HSG) from Table 3-4 of RISDISM (pg 3-11)

HSG	Recharge Factor (F)
A	0.60
B	0.35
C	0.25
D	0.10

  I = Total impervious area (SF)

  X = 1" new impervious area

  ½" existing impervious area to remain impervious

- Re_v = [(1") * (0.60) * (78,726 SF)] / 12 = **3,936 CF**

Recharge for the 1-Year Storm:

Infiltration Basin 1: 2,301 CF

Infiltration Basin 4: 12,470 CF

Total: 2,301 + 12,470 = **14,771 CF (>3,936 CF required)**

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Pond INF1: Infiltration Basin 1 Peak Elev=61.33' Storage=408 cf Inflow=0.60 cfs 2,292 cf
Outflow=0.18 cfs 2,301 cf

Pond INF4: Infiltration Basin 4 Peak Elev=55.04' Storage=4,036 cf Inflow=3.79 cfs 12,438 cf
Discarded=0.58 cfs 12,470 cf Primary=0.00 cfs 0 cf Outflow=0.58 cfs 12,470 cf

Minimum Standard 3 – Water Quality Calculations

Version: 4/2015

Project Name: Proposed Self Storage Facility

Date: 11/18/2021

Water Quality Volume Calculation WorkSheet

This worksheet is designed to assist the project engineer with a determination of the required water quality treatment area. The worksheet leads the designer through redevelopment applicability first and then receiving water requirements. This tool is intended to compliment to the Redevelopment Criteria Guidance and the Water Quality Guidance and assist both the designer and the permit application reviewer towards consistent results. Enter information into only the YELLOW Boxes.

Redevelopment Criteria Guidance

Water Quality Goals "Stormwater Compensation Method"

Step 1 - Determine which office in OWR you are applying to: Application Guidance

Step 2 - Site Information		value/calculation	units
Total Site Area (total area of project parcels)	TSA	14.86	acres
Total Jurisdictional Wetlands and/or floodplain within the above TSA	JW1=	1.79	acres
Existing impervious also within the Jurisdictonal Wetlands	-JW2=	0.00	acres
Conservation Land within the TSA	CL	0.00	acres
Site Size = (TSA)-(JW1-JW2)-CL	**SS=**	**13.07**	acres

Step 3 - Redevelopment Applicability			
Total Impervious Area (pre-construction)	TIA=	2.58	acres
% Impervious (if ≥40% - redevelopment standard 3.2.6 applies)		**0.20**	

REPEAT IF NECESSARY Steps 4, 5 and 6 for EACH Waterbody ID (RIVER-ID as found in the GIS Map Server)

Step 4 - Receiving waterbody information

Waterbody ID or RIVER ID from GIS Map Server	
Waterbody Name from GIS Map Server	
Name the sub-watersheds (design-points) contributing to this Waterbody ID	
Is this Waterbody Impaired/TMDL for any Phosphorus, Metals or Bacteria?	NO
Is this Waterbody Impaired for Nitrogen?	NO

Step 5 - Pre-Post Construction Conditions to the Waterbody

Total Pre-Construction Impervious Surface to this Waterbody ID	2.58	acres
Total Disturbed Existing Impervious (DI)	0.00	acres
Total Post-Construction Impervious to this Waterbody ID	4.39	acres
Net Increased Impervious (NII)	1.81	acres

Step 6 - Infiltration and BMP information - Note: Increasing infiltration will likely decrease stormwater treatment area for Metals, Bacteria and Phosporus

I am proposing to infiltrate this percentage WQv to this WBID	100%	%
I am proposing this number of BMP's	2	#

RESULTS - Select the Larger Number of the 2 numbers provided

Applicable Condition	**Min Water Quality Treatment Area**	**Min Treatment w/o WQ consideration**
No Impairement or TMDL - New Development	1.81	1.81
No Impairment or TMDL - Redevelopment		
Only Phosphorus, Metals or Bacteria Impairment - New Development		
Only Phosphorus, Metals or Bacteria Impairment - Redevelopment		
Nitrogen Impairment - New Development		
Nitrogen Impairment - Redevelopment		
REQUIRED STORMWATER TREATMENT AREA	**1.8** acres	

* Enter the name of the STP (both type and label) which has been designed to treat this particular Rev or Rea.

Project:	Proposed Self Storage Facility	**Project #**	72627.20
Location:	Cranston, Rhode Island	**Sheet:**	1 **of** 1
Calculated By:	SAP	**Date:**	11/04/2021
Checked By:	AEC	**Date:**	11/19/2021
Title:	Water Quality Volume (WQV)		

Computations

Section 3.2.3 Minimum Standard 3: Water Quality

- Required Water Quality Volume:
  - Existing Impervious = 2.58 acres
  - Proposed Impervious = 4.39 acres
  - Net increase in impervious = 1.81 acres

  WQV = (1")(1'/12")(1.81 ac) = 0.151 ac-ft = **6,561 cf**

- Provided Water Quality Volume:

Infiltration Basin 1:	928 cf
Infiltration Basin 4:	5,633 cf
Total:	**6,561 cf**

Project:	Mixed Use Development-Phase 2	Project #	72627.20
Location:	Cranston, RI	Sheet:	1 of 1
Calculated By:	SAP	Date:	11/19/2021
Checked By:	AEC	Date:	11/19/2021
Title:	Surface Infiltration Basin Design Criteria—INF 1 & INF 4.		

vhb Computations

Section 5.3 Required Elements (RISDISM)

Section 5.3.1 Feasibility

- Underlying soils shall have an in-situ infiltration rate of at least 0.5 inches per hour. **Infiltration rate = 6.0 in/hr.(see infiltration rate sheet)**
- The bottom of infiltration practices cannot be located in fill. **Basins are not located in fill.**
- The bottom of the infiltration facility shall be separated by at least 3 feet vertically from the seasonal high groundwater table (SHGT) and the bedrock layer (when treating WQv), as documented by on-site soil testing. **Basins are separated from groundwater by a minimum of 3 feet.**
- Infiltration basins shall meet all the setback requirements in Table 5-2. **Setback requirements are met.**
- The maximum contributing area to infiltration chambers and trenches should generally be less than 10 acres. **Contributing drainage area to each basin is less than 10 acres.**

Section 5.3.2 Conveyance

- Adequate stormwater outfalls shall be provided for the overflow associated with the 1-year design storm event. **Infiltration basins are sized to provide overbank flood control (Qp).**
- All infiltration systems shall be designed to fully de-water the entire WQv within 48 hours after the storm event. **Basins are fully drained within 48-hours. See Basin Drawdown hydrograph plots attached.**

Section 5.3.3 Pretreatment

- A minimum pretreatment volume of at least 25% of the WQv is provided by:

Infiltration Basin	Pretreatment Practice
INF 1	Stone Diaphragms – SD 1 & SD 2
INF 4	Sediment Forebay - SFB 4

- See calculations for Stone Diaphragm SD-1 and SD-2 and calculations for Sediment Forebay SFB-4.

Section 5.3.4 Treatment

- Infiltration practices shall be designed to exfiltrate the entire WQv through the floor of each practice. **Refer to table below:**

Infiltration Basin	Contributing Impervious	Water Quality Volume	Basin Volume
INF 1	11,137 sf	928 cf	7,233 cf
INF 4	67,589 sf	5,633 cf	23,263 cf

Static volume is provided to show required volume is provided. The entire water quality volume is collected and infiltrated, See hydrocad printouts provided for the water quality storm.

NSSH Exhibit 618-9

Infiltration Rates: for general soil texture groups

PREVIOUS RIDEM GUIDANCE FOR THIS PROJECT INDICATED TO FIND A MORE CONSERVATIVE INFILTRATION RATE THAN 8.27 IN/HR FOR FINE SAND

Soil Properties		Permeability			Ksat		
Texture	Classes	Rate In/Hr			Rate *um* s^{-1}		
		Low	Rv	High	Low	Rv	High
S, Gr	Very rapid	20.00	60.0000	100.00	>141.00141	>141.00	
LS, FS	Rapid	6.0000	13.0000	20.0000	42.0000	91.5000	141.0000
LFS, FSL, SL	Moderately rapid	2.0000	4.0000	6.0000	14.0000	28.0000	42.0000
SCL, L, SIL, VFSL	Moderate	0.6000	1.3000	2.0000	4.0000	9.0000	14.0000
CL, SICL, SI, SIC, SC	Moderately slow	0.2000	0.4000	0.6000	1.4000	2.7000	4.0000
C, SIC	Slow	0.0600	0.1300	0.2000	0.4200	0.9100	1.4000
C W/ > 60% CLAY	Very slow	0.0015	0.0308	0.0600	0.0100	0.2150	0.4200
	Impermeable	0.0000	0.0008	0.0015	0.0000	0.0005	0.0010

Project:	Storage Space Phase 2	Project #	72627.20
Location:	Cranston, RI	Sheet:	1 of 1
Calculated By:	SAP	Date:	11/04/2021
Checked By:	AEC	Date:	11/19/2021
Title:	Calculations for Stone Diaphragm SD 1 and 2.		

Computations

Stone Diaphragm – SD 1 (Pretreatment for Infiltration Basin 1)

- The stone diaphragm shall be sized to contain at least 25% of the WQv to INF 1:
  Impervious area contributing to SD 1 = 4,378 sf
  25% of WQv to SD 1= 25% x (4,378/12) cf = 91 cf

- Volume provided in SD 1 = (40% voids) x 20'L x 4'W x 3'D = **96 cf (>91 cf required)**

Stone Diaphragm – SD 2 (Pretreatment for Infiltration Basin 1)

- The stone diaphragm shall be sized to contain at least 25% of the WQv to INF 1:
  Impervious area contributing to SD 2 = 6,599 sf
  25% of WQv to SD 2= 25% x (6,599/12) cf = 138 cf

- Volume provided in SD 2 = (40% voids) x 37'L x 4'W x 3'D = **178 cf (>138 cf required)**

Computations

Project:	Mixed Use Dev.- Phase 2	Project #	72627.20
Location:	Cranston, RI	Sheet	1 of 1
Calculated by:	SAP	Date:	11/18/2021
Checked by:	AEC	Date:	11/19/2021
Title	Sediment Forebay		SFB-4

Section 6.4 Sediment Forebay

- As = 5,750 x Q

Where:

Q = Discharge from drainage area (CFS) = % WQV / 86,400 sec = 1 cfs

As = Sedimentation surface area (SF) = 94 sf

Area provided = 230 sf (> required 94 sf)

- The forebay shall be sized to contain a percent of the WQv as well as the required sediment volume.

Percent Required = 25%

Sediment Volume SV= {(76.6 x RA x TE) + (5.3 x DA x TE)} x T

RA = area of roadway or parking lots = 0.7 acres

TE = basin trap efficiency (80% standard)= 80%

DA = contributing land use area = 2.01 acres

T = time in years = 1 year(s)

SV = 52 cf

For % WQV refer to Chapter 5, for pretreatment requirements for each BMP used.

WQV % Required = 25%

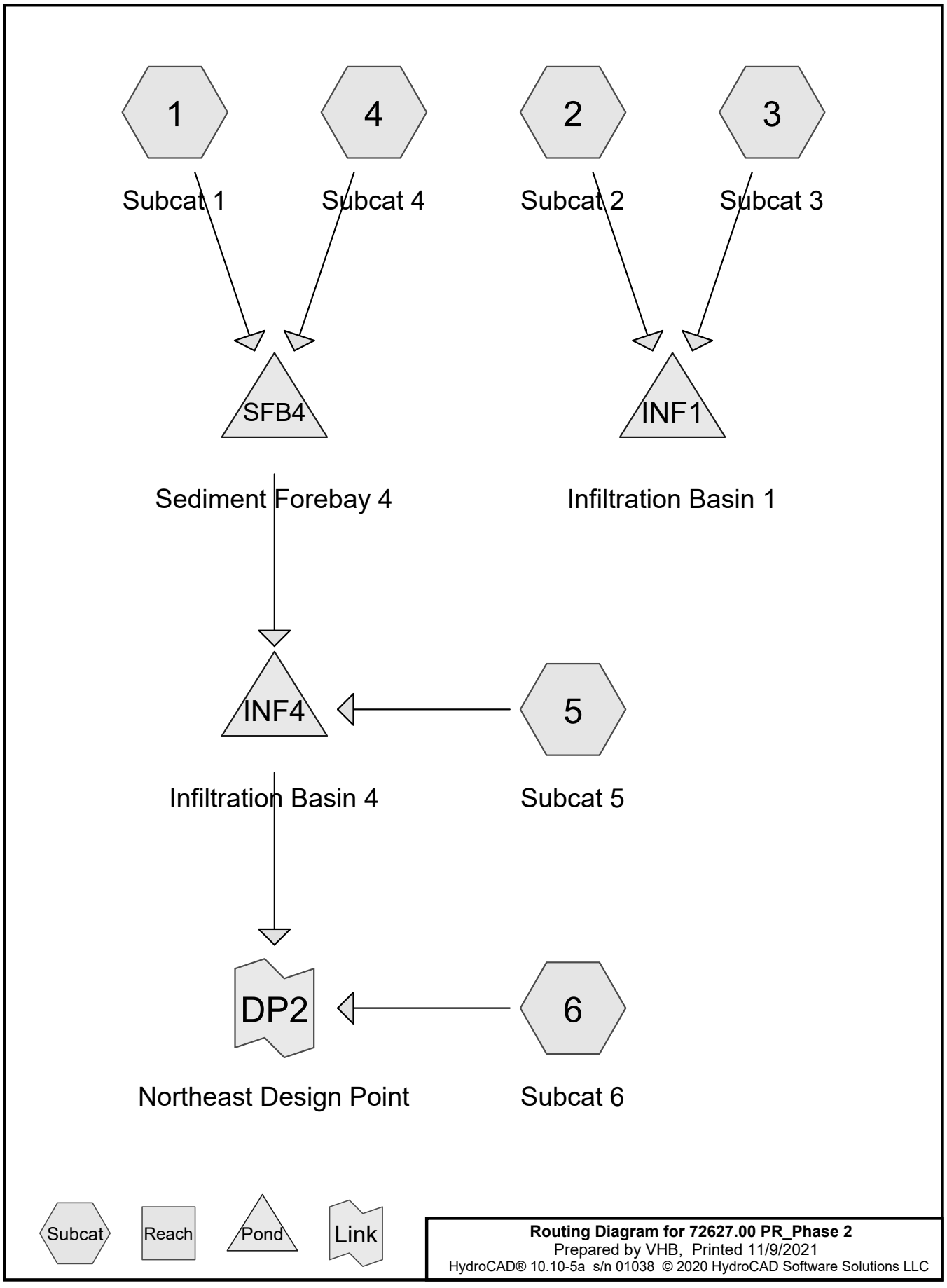
WQV = 5633 cf

WQV Required = 1409 cf

SV Required = 52 cf

Total volume required = 1409 cf + 52 cf = 1461 cf

Volume provided = 1472 cf (> required 1461 cf)



Routing Diagram for 72627.00 PR_Phase 2
Prepared by VHB, Printed 11/9/2021

Summary for Pond INF1: Infiltration Basin 1

Inflow Area = 53,004 sf, 21.01% Impervious, Inflow Depth = 0.21" for WQv event
Inflow = 0.25 cfs @ 12.12 hrs, Volume= 915 cf
Outflow = 0.17 cfs @ 12.24 hrs, Volume= 921 cf, Atten= 34%, Lag= 7.2 min
Discarded = 0.17 cfs @ 12.24 hrs, Volume= 921 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 61.03' @ 12.24 hrs Surf.Area= 1,202 sf Storage= 39 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 1.0 min (785.4 - 784.4)

Volume	Invert	Avail.Storage	Storage Description
#1	61.00'	7,233 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
61.00	1,190	128.0	0	0	1,190
62.00	1,602	147.0	1,391	1,391	1,628
63.00	2,894	198.0	2,216	3,607	3,039
64.00	4,410	326.0	3,625	7,233	8,383

Device	Routing	Invert	Outlet Devices
#1	Discarded	61.00'	**6.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.17 cfs @ 12.24 hrs HW=61.03' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Stage-Area-Storage for Pond INF1: Infiltration Basin 1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
61.00	1,190	0
61.05	1,209	60
61.10	1,228	121
61.15	1,248	183
61.20	1,268	246
61.25	1,287	310
61.30	1,307	374
61.35	1,327	440
61.40	1,347	507
61.45	1,368	575
61.50	1,388	644
61.55	1,409	714
61.60	1,430	785
61.65	1,451	857
61.70	1,472	930
61.75	1,493	1,004
61.80	1,515	1,079
61.85	1,536	1,156
61.90	1,558	1,233
61.95	1,580	1,311
62.00	1,602	1,391
62.05	1,658	1,472
62.10	1,714	1,557
62.15	1,772	1,644
62.20	1,830	1,734
62.25	1,889	1,827
62.30	1,950	1,923
62.35	2,011	2,022
62.40	2,073	2,124
62.45	2,136	2,229
62.50	2,201	2,338
62.55	2,266	2,449
62.60	2,332	2,564
62.65	2,399	2,682
62.70	2,467	2,804
62.75	2,535	2,929
62.80	2,605	3,058
62.85	2,676	3,190
62.90	2,748	3,325
62.95	2,820	3,464
63.00	2,894	3,607
63.05	2,962	3,754
63.10	3,031	3,904
63.15	3,101	4,057
63.20	3,172	4,214
63.25	3,243	4,374
63.30	3,315	4,538
63.35	3,388	4,706
63.40	3,462	4,877
63.45	3,537	5,052
63.50	3,612	5,231
63.55	3,688	5,413
63.60	3,765	5,599
63.65	3,843	5,790
63.70	3,922	5,984
63.75	4,001	6,182
63.80	4,081	6,384
63.85	4,162	6,590
63.90	4,244	6,800
63.95	4,327	7,014
64.00	**4,410**	**7,233**

Summary for Pond INF4: Infiltration Basin 4

Inflow Area = 101,255 sf, 66.75% Impervious, Inflow Depth = 0.48" for WQv event
Inflow = 1.58 cfs @ 12.11 hrs, Volume= 4,080 cf
Outflow = 0.52 cfs @ 12.44 hrs, Volume= 4,108 cf, Atten= 67%, Lag= 19.4 min
Discarded = 0.52 cfs @ 12.44 hrs, Volume= 4,108 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 54.23' @ 12.44 hrs Surf.Area= 3,750 sf Storage= 861 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 9.9 min (855.0 - 845.1)

Volume	Invert	Avail.Storage	Storage Description
#1	54.00'	24,837 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) x 0.8

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
54.00	4,541	355.6	0	0	4,541
55.00	5,187	369.0	4,860	4,860	5,394
56.00	5,852	382.5	5,516	10,377	6,285
57.00	6,535	396.0	6,190	16,567	7,207
58.00	7,238	409.4	6,884	23,450	8,156
59.00	7,959	422.9	7,596	31,046	9,142

Device	Routing	Invert	Outlet Devices
#1	Discarded	54.00'	**6.000 in/hr Exfiltration over Surface area**
#2	Primary	58.75'	**20.0' long x 3.0' 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 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Discarded OutFlow Max=0.52 cfs @ 12.44 hrs HW=54.23' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.52 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=54.00' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Stage-Area-Storage for Pond INF4: Infiltration Basin 4

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
54.00	3,633	0
54.05	3,658	182
54.10	3,683	366
54.15	3,708	551
54.20	3,733	737
54.25	3,759	924
54.30	3,784	1,112
54.35	3,810	1,302
54.40	3,835	1,493
54.45	3,861	1,686
54.50	3,887	1,880
54.55	3,913	2,075
54.60	3,939	2,271
54.65	3,965	2,468
54.70	3,991	2,667
54.75	4,017	2,868
54.80	4,043	3,069
54.85	4,070	3,272
54.90	4,096	3,476
54.95	4,123	3,682
55.00	4,150	3,888
55.05	4,175	4,096
55.10	4,201	4,306
55.15	4,227	4,517
55.20	4,253	4,729
55.25	4,280	4,942
55.30	4,306	5,157
55.35	4,332	5,373
55.40	4,359	5,590
55.45	4,385	5,808
55.50	4,412	6,028
55.55	4,438	6,250
55.60	4,465	6,472
55.65	4,492	6,696
55.70	4,519	6,921
55.75	4,546	7,148
55.80	4,573	7,376
55.85	4,600	7,605
55.90	4,627	7,836
55.95	4,654	8,068
56.00	4,682	8,301
56.05	4,708	8,536
56.10	4,735	8,772
56.15	4,762	9,009
56.20	4,788	9,248
56.25	4,815	9,488
56.30	4,842	9,730
56.35	4,869	9,973
56.40	4,897	10,217
56.45	4,924	10,462
56.50	4,951	10,709
56.55	4,978	10,957
56.60	5,006	11,207
56.65	5,033	11,458
56.70	5,061	11,710
56.75	5,089	11,964
56.80	5,116	12,219
56.85	5,144	12,476
56.90	5,172	12,734
56.95	5,200	12,993
57.00	5,228	13,254
57.05	5,255	13,516
57.10	5,283	13,779
57.15	5,311	14,044
57.20	5,338	14,310
57.25	5,366	14,578
57.30	5,394	14,847
57.35	5,422	15,117
57.40	5,450	15,389
57.45	5,478	15,662
57.50	5,506	15,937
57.55	5,534	16,213
57.60	5,562	16,490
57.65	5,590	16,769
57.70	5,619	17,049
57.75	5,647	17,331
57.80	5,676	17,614
57.85	5,704	17,898
57.90	5,733	18,184
57.95	5,762	18,472
58.00	5,790	18,760
58.05	5,819	19,051
58.10	5,847	19,342
58.15	5,875	19,635
58.20	5,904	19,930
58.25	5,932	20,226
58.30	5,961	20,523
58.35	5,989	20,822
58.40	6,018	21,122
58.45	6,047	21,423
58.50	6,075	21,727
58.55	6,104	22,031
58.60	6,133	22,337
58.65	6,162	22,644
58.70	6,191	22,953
58.75	6,220	23,263
58.80	6,250	23,575
58.85	6,279	23,888
58.90	6,308	24,203
58.95	6,338	24,519
59.00	**6,367**	**24,837**

Summary for Pond SFB4: Sediment Forebay 4

Inflow Area = 87,508 sf, 77.24% Impervious, Inflow Depth = 0.76" for WQv event
Inflow = 1.60 cfs @ 12.10 hrs, Volume= 5,552 cf
Outflow = 1.58 cfs @ 12.11 hrs, Volume= 4,080 cf, Atten= 1%, Lag= 0.9 min
Primary = 1.58 cfs @ 12.11 hrs, Volume= 4,080 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 58.23' @ 12.11 hrs Surf.Area= 542 sf Storage= 1,592 cf

Plug-Flow detention time= 149.0 min calculated for 4,080 cf (73% of inflow)
Center-of-Mass det. time= 62.1 min (845.1 - 783.0)

Volume	Invert	Avail.Storage	Storage Description
#1	54.00'	2,038 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
54.00	230	61.6	0	0	230
55.00	294	68.8	261	261	329
56.00	364	76.0	328	590	439
57.00	440	83.1	401	991	559
58.00	523	90.3	481	1,472	691
59.00	611	97.5	566	2,038	834

Device	Routing	Invert	Outlet Devices
#1	Primary	58.00'	**6.0' long x 3.0' 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 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#2	Primary	59.00'	**48.0' long x 3.0' 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 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=1.54 cfs @ 12.11 hrs HW=58.22' TW=54.10' (Dynamic Tailwater)
1=Broad-Crested Rectangular Weir (Weir Controls 1.54 cfs @ 1.16 fps)
2=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Stage-Area-Storage for Pond SFB4: Sediment Forebay 4

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
54.00	230	0
54.05	233	12
54.10	236	23
54.15	239	35
54.20	242	47
54.25	245	59
54.30	248	72
54.35	252	84
54.40	255	97
54.45	258	110
54.50	261	123
54.55	264	136
54.60	267	149
54.65	271	163
54.70	274	176
54.75	277	190
54.80	281	204
54.85	284	218
54.90	287	232
54.95	291	247
55.00	294	261
55.05	297	276
55.10	301	291
55.15	304	306
55.20	307	321
55.25	311	337
55.30	314	353
55.35	318	368
55.40	321	384
55.45	325	400
55.50	328	417
55.55	332	433
55.60	335	450
55.65	339	467
55.70	342	484
55.75	346	501
55.80	349	518
55.85	353	536
55.90	357	554
55.95	360	572
56.00	364	590
56.05	368	608
56.10	371	626
56.15	375	645
56.20	379	664
56.25	382	683
56.30	386	702
56.35	390	722
56.40	394	741
56.45	397	761
56.50	401	781
56.55	405	801
56.60	409	821
56.65	413	842
56.70	416	863
56.75	420	884
56.80	424	905
56.85	428	926
56.90	432	948
56.95	436	969
57.00	440	991
57.05	444	1,013
57.10	448	1,036
57.15	452	1,058
57.20	456	1,081
57.25	460	1,104
57.30	464	1,127
57.35	468	1,150
57.40	472	1,174
57.45	476	1,197
57.50	481	1,221
57.55	485	1,245
57.60	489	1,270
57.65	493	1,294
57.70	497	1,319
57.75	502	1,344
57.80	506	1,369
57.85	510	1,395
57.90	514	1,420
57.95	519	1,446
58.00	523	1,472
58.05	527	1,498
58.10	531	1,525
58.15	536	1,551
58.20	540	1,578
58.25	544	1,605
58.30	549	1,633
58.35	553	1,660
58.40	557	1,688
58.45	562	1,716
58.50	566	1,744
58.55	571	1,773
58.60	575	1,801
58.65	579	1,830
58.70	584	1,859
58.75	588	1,889
58.80	593	1,918
58.85	597	1,948
58.90	602	1,978
58.95	606	2,008
59.00	**611**	**2,038**

Basin Drawdown

Hydrograph for Pond INF1: Infiltration Basin 1

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Discarded (cfs)
0.00	0.00	0	61.00	0.00
1.00	0.01	0	61.00	0.01
2.00	0.01	0	61.00	0.01
3.00	0.02	0	61.00	0.02
4.00	0.02	0	61.00	0.02
5.00	0.03	0	61.00	0.03
6.00	0.03	0	61.00	0.03
7.00	0.04	0	61.00	0.04
8.00	0.05	0	61.00	0.05
9.00	0.08	0	61.00	0.08
10.00	0.11	0	61.00	0.11
11.00	0.16	0	61.00	0.15
12.00	**1.13**	**708**	**61.55**	**0.20**
13.00	**0.33**	**2,952**	**62.76**	**0.35**
14.00	0.21	2,639	62.63	0.33
15.00	0.17	2,195	62.43	0.29
16.00	0.12	1,733	62.20	0.25
17.00	0.10	1,285	61.93	0.22
18.00	0.08	848	61.64	0.20
19.00	0.07	416	61.33	0.18
20.00	0.06	24	61.02	0.17
21.00	0.06	0	61.00	0.01
22.00	0.05	0	61.00	0.01
23.00	0.05	0	61.00	0.00
24.00	0.04	0	61.00	0.00
25.00	0.00	0	61.00	0.00
26.00	0.00	0	61.00	0.00
27.00	0.00	0	61.00	0.00
28.00	0.00	0	61.00	0.00
29.00	0.00	0	61.00	0.00
30.00	0.00	0	61.00	0.00
31.00	0.00	0	61.00	0.00
32.00	0.00	0	61.00	0.00
33.00	0.00	0	61.00	0.00
34.00	0.00	0	61.00	0.00
35.00	0.00	0	61.00	0.00
36.00	0.00	0	61.00	0.00
37.00	0.00	0	61.00	0.00
38.00	0.00	0	61.00	0.00
39.00	0.00	0	61.00	0.00
40.00	0.00	0	61.00	0.00
41.00	0.00	0	61.00	0.00
42.00	0.00	0	61.00	0.00
43.00	0.00	0	61.00	0.00
44.00	0.00	0	61.00	0.00
45.00	0.00	0	61.00	0.00
46.00	0.00	0	61.00	0.00
47.00	0.00	0	61.00	0.00
48.00	0.00	0	61.00	0.00

Drains in < 48 hours

Hydrograph for Pond INF4: Infiltration Basin 4

Time (hours)	Inflow (cfs)	Storage (cubic-feet)	Elevation (feet)	Outflow (cfs)	Discarded (cfs)	Primary (cfs)
0.00	0.00	0	54.00	0.00	0.00	**0.00**
1.00	0.00	0	54.00	0.00	0.00	0.00
2.00	0.00	0	54.00	0.00	0.00	0.00
3.00	0.00	0	54.00	0.00	0.00	0.00
4.00	0.00	0	54.00	0.00	0.00	0.00
5.00	0.17	0	54.00	0.17	0.17	0.00
6.00	0.20	0	54.00	0.20	0.20	0.00
7.00	0.26	0	54.00	0.26	0.26	0.00
8.00	0.33	0	54.00	0.33	0.33	0.00
9.00	0.48	1	54.00	0.48	0.48	0.00
10.00	0.64	202	54.06	0.51	0.51	0.00
11.00	0.94	1,162	54.31	0.53	0.53	0.00
12.00	**7.50**	7,458	55.82	0.64	0.64	0.00
13.00	**1.24**	**21,749**	**58.50**	**0.84**	**0.84**	0.00
14.00	0.81	**22,240**	**58.58**	**0.85**	**0.85**	0.00
15.00	0.63	21,765	58.51	0.84	0.84	0.00
16.00	0.47	20,735	58.34	0.83	0.83	0.00
17.00	0.38	19,291	58.09	0.81	0.81	0.00
18.00	0.27	17,547	57.79	0.79	0.79	0.00
19.00	0.24	15,662	57.45	0.76	0.76	0.00
20.00	0.21	13,787	57.10	0.73	0.73	0.00
21.00	0.20	11,932	56.74	0.71	0.71	0.00
22.00	0.18	10,112	56.38	0.68	0.68	0.00
23.00	0.16	8,328	56.01	0.65	0.65	0.00
24.00	0.14	6,580	55.62	0.62	0.62	0.00
25.00	0.00	4,481	55.14	0.59	0.59	0.00
26.00	0.00	2,436	54.64	0.55	0.55	0.00
27.00	0.00	520	54.14	0.51	0.51	0.00
28.00	0.00	0	54.00	0.00	0.00	0.00
29.00	0.00	0	54.00	0.00	0.00	0.00
30.00	0.00	0	54.00	0.00	0.00	0.00
31.00	0.00	0	54.00	0.00	0.00	0.00
32.00	0.00	0	54.00	0.00	0.00	0.00
33.00	0.00	0	54.00	0.00	0.00	0.00
34.00	0.00	0	54.00	0.00	0.00	0.00
35.00	0.00	0	54.00	0.00	0.00	0.00
36.00	0.00	0	54.00	0.00	0.00	0.00
37.00	0.00	0	54.00	0.00	0.00	0.00
38.00	0.00	0	54.00	0.00	0.00	0.00
39.00	0.00	0	54.00	0.00	0.00	0.00
40.00	0.00	0	54.00	0.00	0.00	0.00
41.00	0.00	0	54.00	0.00	0.00	0.00
42.00	0.00	0	54.00	0.00	0.00	0.00
43.00	0.00	0	54.00	0.00	0.00	0.00
44.00	0.00	0	54.00	0.00	0.00	0.00
45.00	0.00	0	54.00	0.00	0.00	0.00
46.00	0.00	0	54.00	0.00	0.00	0.00
47.00	0.00	0	54.00	0.00	0.00	0.00
48.00	0.00	0	54.00	0.00	0.00	0.00

Drains in < 48 hours

Minimum Standard 4 – Conveyance and Natural Channel Protection Calculations

- Channel Protection Volume (CPv) – Entire 1-Year storm infiltrated; therefore, requirement met.
- Hydraulic Calculations
- FES Calc

CPv – Requirement met

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=50,470 sf 60.53% Impervious Runoff Depth=1.49"
Flow Length=110' Tc=8.3 min CN=35/98 Runoff=1.67 cfs 6,287 cf

Subcatchment2: Subcat 2 Runoff Area=26,837 sf 41.50% Impervious Runoff Depth=1.02"
Flow Length=315' Tc=8.6 min CN=32/98 Runoff=0.60 cfs 2,292 cf

Subcatchment3: Subcat 3 Runoff Area=26,167 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=243' Tc=17.1 min CN=32/0 Runoff=0.00 cfs 0 cf

Subcatchment4: Subcat 4 Runoff Area=37,038 sf 100.00% Impervious Runoff Depth=2.47"
Tc=6.0 min CN=0/98 Runoff=2.17 cfs 7,623 cf

Subcatchment5: Subcat 5 Runoff Area=13,747 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=39/0 Runoff=0.00 cfs 0 cf

Subcatchment6: Subcat 6 Runoff Area=75,001 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=590' Tc=11.8 min CN=33/0 Runoff=0.00 cfs 0 cf

Pond INF1: Infiltration Basin 1 Peak Elev=61.33' Storage=408 cf Inflow=0.60 cfs 2,292 cf
Outflow=0.18 cfs 2,301 cf

Pond INF4: Infiltration Basin 4 Peak Elev=55.04' Storage=4,036 cf Inflow=3.79 cfs 12,438 cf
Discarded=0.58 cfs 12,470 cf Primary=0.00 cfs 0 cf Outflow=0.58 cfs 12,470 cf

Pond SFB4: Sediment Forebay 4 Peak Elev=58.39' Storage=1,683 cf Inflow=3.80 cfs 13,910 cf
Outflow=3.79 cfs 12,438 cf

Link DP2: Northeast Design Point Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 229,260 sf Runoff Volume = 16,202 cf Average Runoff Depth = 0.85"
65.66% Pervious = 150,534 sf 34.34% Impervious = 78,726 sf

Hydraulic Calculations

1 Cedar Street, Suite 400
Providence, RI 02903
P 401.272.8100

Storm Drainage Computations

Design Parameters:

Design Storm: 25 Year

k_e= 0.2

Project	PROPOSED MIXED USE DEVELOPMENT - PHASE 2	**Project #**	72627.20
Calculated by	SAP	**Date**	11/4/2021
Checked by	AEC	**Date**	11/19/2021

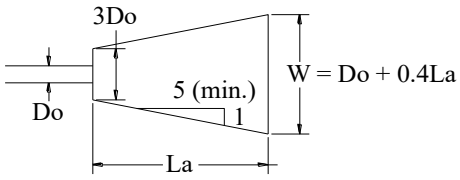
DESCRIPTION	LOCATION		AREA	C	C x A	SUM	FLOW TIME (MIN)		i*	DESIGN					CAPACITY		PROFILE							INLET CONTROL		OUTLET CONTROL			JUNCTION LOSSES		
	FROM	TO	(AC.)			C x A	PIPE	CONC TIME		Q	V	n	PIPE	SLOPE	Q full	V full	LENGTH	FALL	RIM	INV	INV	W.S.E.	Freeboard	HW/D	HW	H	TW or h_o	HW	K_m	K_d	H loss
										cfs	fps		SIZE		ft^3/s	ft/s	ft	ft		UPPER	LOWER	ft	ft	ft	ft	ft	ft	junction	junction	junction
	CB 401	CB 402	0.15	0.90	0.13	0.13	0.20	5.0	8.8	1.2	4.1	0.011	12	0.0120	4.6	5.9	50	0.60	63.25	59.60	59.00	59.6	3.7	0.00	0.00	0.0	0.0	0.00	0.20	0.80	0.26
	CB 402	CB 403	0.16	0.90	0.15	0.15	0.37	5.0	8.8	1.3	3.6	0.011	12	0.0076	3.7	4.7	80	0.61	63.10	58.90	58.30	58.7	4.4	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.04
	CB 403	CB 404	0.17	0.90	0.16	0.16	0.47	5.0	8.8	1.4	3.4	0.011	12	0.0063	3.3	4.3	95	0.60	63.10	58.20	57.60	58.1	5.0	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.04
	CB 404	DMH 404	0.24	0.88	0.21	0.43	0.37	5.0	8.8	3.8	5.0	0.011	15	0.0090	7.2	5.9	110	0.99	62.60	56.00	55.00	55.7	6.9	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.08
	CB 407	DMH 403	0.18	0.73	0.13	0.13	1.36	5.0	8.8	1.2	2.2	0.011	12	0.0022	2.0	2.5	180	0.40	62.80	57.80	57.40	57.7	5.1	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.02
	DMH 403	CB 408	0.00	0.00	0.00	0.13	0.27	6.4	8.1	1.1	3.0	0.011	12	0.0052	3.0	3.9	48	0.25	63.70	57.30	57.05	57.2	6.5	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.03
	CB 408	CB 409	0.19	0.78	0.15	0.15	0.28	5.0	8.8	1.3	3.4	0.011	12	0.0068	3.5	4.4	58	0.39	63.40	56.95	56.55	56.8	6.6	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.04
	CB 409	CB 410	0.18	0.79	0.14	0.14	0.28	5.0	8.8	1.3	3.4	0.011	12	0.0069	3.5	4.5	58	0.40	63.40	56.45	56.05	56.3	7.1	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.04
	CB 410	CB 413	0.18	0.79	0.14	0.14	0.35	5.0	8.8	1.3	3.4	0.011	12	0.0069	3.5	4.5	72	0.50	63.40	55.95	55.45	55.8	7.6	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.04
	CB 413	CB 411	0.17	0.82	0.14	0.14	0.36	5.0	8.8	1.2	4.3	0.011	12	0.0138	4.9	6.3	95	1.31	63.30	59.80	58.50	59.6	3.7	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.06
	CB 411	DMH 404	0.14	0.73	0.10	0.10	0.27	5.0	8.8	0.9	3.4	0.011	12	0.0091	4.0	5.1	55	0.50	63.00	58.00	57.50	57.9	5.1	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.04
	DMH 404	FES 401	0.00	0.00	0.00	1.24	0.14	9.3	6.6	8.2	6.2	0.011	18	0.0089	11.7	6.6	52	0.46	63.75	54.45	54.00	54.0	9.8	0.00	0.00	0.0	0.0	0.00	0.20	0.00	0.12

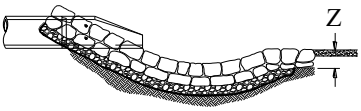
FES Calcs

Outfall Riprap Sizing and Velocity Calculations

Project	Proposed Storage Facility	**Project #**	72627.00
	Cranston, RI		
Calculated by	AEC	**Date**	11/19/2021
Checked by	GB	**Date**	11/21/2021

Tw ≥ 0.5Do





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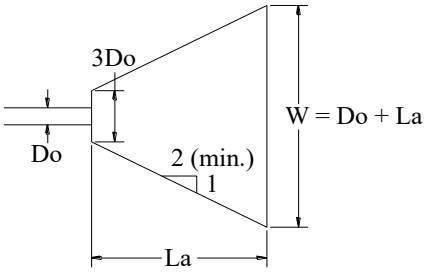


OUTLET DESCRIPTION:		**FES-401**
Design Storm	(yr)	25
Flow / Discharge (Q)	(cfs)	8.7
Defined Channel ?	-	NO
Defined Channel Width	(ft)	0
Outlet Pipe Diameter (D_O)	(in)	18
Tailwater Condition (T_W)	(ft)	TW ≥ 0.5D
Apron Length (L_A)	(ft)	8
Apron Width at Outlet ($3D_O$)	(ft)	4.5
Apron Width at End (W)	(ft)	4.7
Median Stone Diameter	(in)	6
Largest Stone Diameter	(in)	9
Apron Depth	(in)	13.5

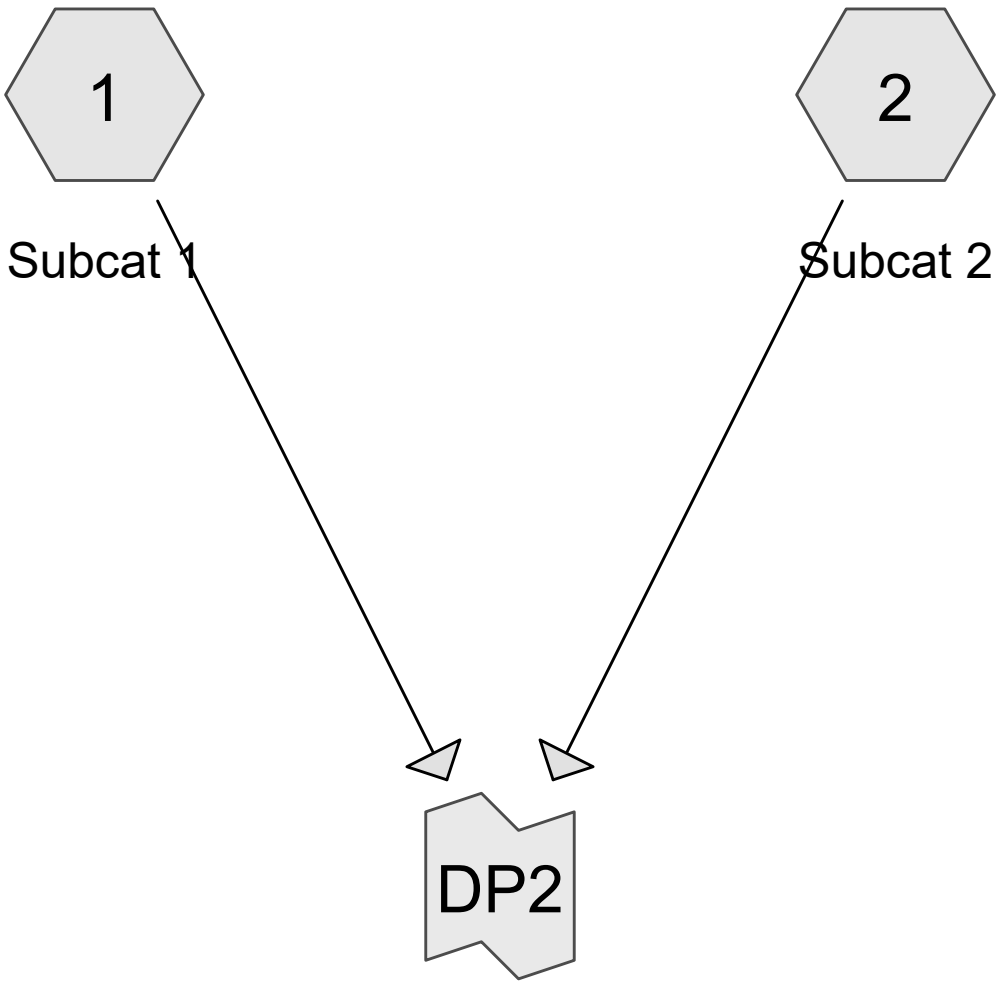
Note: The stone riprap covers the entire sediment forebay bottom; which is approximately 18' x 12.5'.

Apron Length (L_A):	*Length = From Virginia DCR Handbook - Plate 3.18-3*	*if T_W < 0.5D*
	Length = From Virginia DCR Handbook - Plate 3.18-4	*if T_W ≥ 0.5D*
Apron Width at Outlet ($3D_O$):	*Width = 3 x pipe dia. (or width of channel)*	
Apron Width at End (W):	*Width = dia. + apron length*	*if T_W < 0.5D*
	Width = dia. + 0.4 x apron length	*if T_W ≥ 0.5D*
	or apron width = channel width if a well defined channel exists	
Rock Riprap:	*Median Diameter (d_{50}) = From Virginia DCR Handbook - Plate 3.18-3 or 4*	
	Largest stone dia = 1.5 x d_{50}	
Apron Depth:	*6" or 1.5 x largest stone dia*	

Minimum Standard 5 – Overbank Flood Protection –

- Existing Conditions – HydroCAD Model
- Proposed Conditions – HydroCAD Model
- Mounding Analysis

Existing Conditions – HydroCAD Model



Northeast Design Point

Subcat Reach Pond Link

Routing Diagram for 72627.00 EX_Phase 2
Prepared by VHB, Printed 11/19/2021

WQv-Year Storm Event

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=174,937 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=790' Slope=0.0150 '/' Tc=19.7 min CN=32/0 Runoff=0.00 cfs 0 cf

Subcatchment2: Subcat 2 Runoff Area=53,063 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=758' Tc=13.9 min CN=30/0 Runoff=0.00 cfs 0 cf

Link DP2: Northeast Design Point Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 228,000 sf Runoff Volume = 0 cf Average Runoff Depth = 0.00"
100.00% Pervious = 228,000 sf 0.00% Impervious = 0 sf

Summary for Subcatchment 1: Subcat 1

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.20"

Area (sf)	CN	Description
115,978	30	Brush, Good, HSG A
7,728	76	Gravel roads, HSG A
51,231	30	Woods, Good, HSG A
174,937	32	Weighted Average
174,937	32	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.4	50	0.0150	0.06		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
6.3	740	0.0150	1.97		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
19.7	790	Total			

Summary for Subcatchment 2: Subcat 2

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr WQV Rainfall=1.20"

Area (sf)	CN	Description
11,849	30	Brush, Good, HSG A
41,214	30	Woods, Good, HSG A
53,063	30	Weighted Average
53,063	30	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	50	0.0800	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
7.0	708	0.0110	1.69		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
13.9	758	Total			

Summary for Link DP2: Northeast Design Point

Inflow Area = 228,000 sf, 0.00% Impervious, Inflow Depth = 0.00" for WQV event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

1-Year Storm Event

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=174,937 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=790' Slope=0.0150 '/' Tc=19.7 min CN=32/0 Runoff=0.00 cfs 0 cf

Subcatchment2: Subcat 2 Runoff Area=53,063 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=758' Tc=13.9 min CN=30/0 Runoff=0.00 cfs 0 cf

Link DP2: Northeast Design Point Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 228,000 sf Runoff Volume = 0 cf Average Runoff Depth = 0.00"
100.00% Pervious = 228,000 sf 0.00% Impervious = 0 sf

10-Year Storm Event

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=174,937 sf 0.00% Impervious Runoff Depth=0.02"
Flow Length=790' Slope=0.0150 '/' Tc=19.7 min CN=32/0 Runoff=0.01 cfs 281 cf

Subcatchment2: Subcat 2 Runoff Area=53,063 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=758' Tc=13.9 min CN=30/0 Runoff=0.00 cfs 10 cf

Link DP2: Northeast Design Point Inflow=0.01 cfs 291 cf
Primary=0.01 cfs 291 cf

Total Runoff Area = 228,000 sf Runoff Volume = 291 cf Average Runoff Depth = 0.02"
100.00% Pervious = 228,000 sf 0.00% Impervious = 0 sf

100-Year Storm Event

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

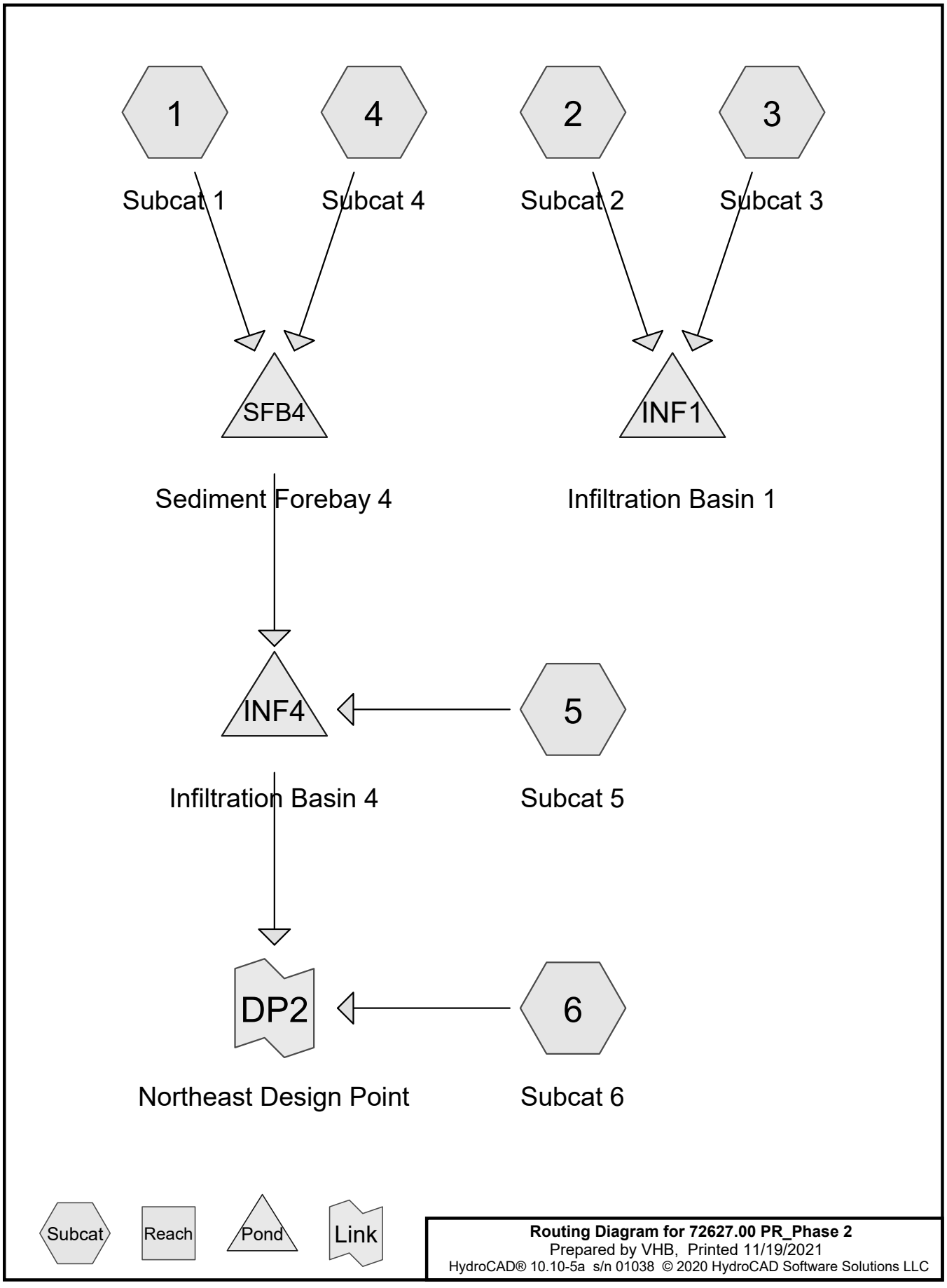
Subcatchment1: Subcat 1 Runoff Area=174,937 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=790' Slope=0.0150 '/' Tc=19.7 min CN=32/0 Runoff=1.19 cfs 11,233 cf

Subcatchment2: Subcat 2 Runoff Area=53,063 sf 0.00% Impervious Runoff Depth=0.59"
Flow Length=758' Tc=13.9 min CN=30/0 Runoff=0.24 cfs 2,629 cf

Link DP2: Northeast Design Point Inflow=1.43 cfs 13,861 cf
Primary=1.43 cfs 13,861 cf

Total Runoff Area = 228,000 sf Runoff Volume = 13,861 cf Average Runoff Depth = 0.73"
100.00% Pervious = 228,000 sf 0.00% Impervious = 0 sf

Proposed Conditions – HydroCAD Model



Routing Diagram for 72627.00 PR_Phase 2
Prepared by VHB, Printed 11/19/2021

WQv-Year Storm Event

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=50,470 sf 60.53% Impervious Runoff Depth=0.60"
Flow Length=110' Tc=8.3 min CN=35/98 Runoff=0.70 cfs 2,509 cf

Subcatchment2: Subcat 2 Runoff Area=26,837 sf 41.50% Impervious Runoff Depth=0.41"
Flow Length=315' Tc=8.6 min CN=32/98 Runoff=0.25 cfs 915 cf

Subcatchment3: Subcat 3 Runoff Area=26,167 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=243' Tc=17.1 min CN=32/0 Runoff=0.00 cfs 0 cf

Subcatchment4: Subcat 4 Runoff Area=37,038 sf 100.00% Impervious Runoff Depth=0.99"
Tc=6.0 min CN=0/98 Runoff=0.91 cfs 3,042 cf

Subcatchment5: Subcat 5 Runoff Area=13,747 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=39/0 Runoff=0.00 cfs 0 cf

Subcatchment6: Subcat 6 Runoff Area=75,001 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=590' Tc=11.8 min CN=33/0 Runoff=0.00 cfs 0 cf

Pond INF1: Infiltration Basin 1 Peak Elev=61.03' Storage=39 cf Inflow=0.25 cfs 915 cf
Outflow=0.17 cfs 921 cf

Pond INF4: Infiltration Basin 4 Peak Elev=54.23' Storage=861 cf Inflow=1.58 cfs 4,080 cf
Discarded=0.52 cfs 4,108 cf Primary=0.00 cfs 0 cf Outflow=0.52 cfs 4,108 cf

Pond SFB4: Sediment Forebay 4 Peak Elev=58.23' Storage=1,592 cf Inflow=1.60 cfs 5,552 cf
Outflow=1.58 cfs 4,080 cf

Link DP2: Northeast Design Point Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 229,260 sf Runoff Volume = 6,466 cf Average Runoff Depth = 0.34"
65.66% Pervious = 150,534 sf 34.34% Impervious = 78,726 sf

Summary for Subcatchment 1: Subcat 1

Runoff = 0.70 cfs @ 12.11 hrs, Volume= 2,509 cf, Depth= 0.60"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.20"

Area (sf)	CN	Description
10,111	39	>75% Grass cover, Good, HSG A
8,608	30	Brush, Good, HSG A
30,550	98	Paved parking, HSG A
0	98	Roofs, HSG A
1,200	30	Woods, Good, HSG A
50,470	73	Weighted Average
19,919	35	39.47% Pervious Area
30,551	98	60.53% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.3	10	0.0200	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
4.6	40	0.0200	0.15		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
0.4	52	0.0200	2.28		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.0	8	0.2000	7.20		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.3	110	Total			

Summary for Subcatchment 2: Subcat 2

Runoff = 0.25 cfs @ 12.12 hrs, Volume= 915 cf, Depth= 0.41"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.20"

Area (sf)	CN	Description
2,741	39	>75% Grass cover, Good, HSG A
3,790	30	Brush, Good, HSG A
11,137	98	Paved parking, HSG A
9,168	30	Woods, Good, HSG A
26,837	59	Weighted Average
15,699	32	58.50% Pervious Area
11,137	98	41.50% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
7.0	50	0.0760	0.12		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
0.4	77	0.0500	3.60		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.0	18	0.2200	7.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.9	134	0.0160	2.57		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
0.3	36	0.0140	1.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
8.6	315	Total			

Summary for Subcatchment 3: Subcat 3

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.20"

Area (sf)	CN	Description
7,054	39	>75% Grass cover, Good, HSG A
5,038	30	Brush, Good, HSG A
14,075	30	Woods, Good, HSG A
26,167	32	Weighted Average
26,167	32	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.8	50	0.0100	0.05		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.40"
1.3	193	0.0250	2.55		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
17.1	243	Total			

Summary for Subcatchment 4: Subcat 4

Runoff = 0.91 cfs @ 12.09 hrs, Volume= 3,042 cf, Depth= 0.99"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.20"

Area (sf)	CN	Description
37,038	98	Roofs, HSG A
37,038	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. 6 mins**

Summary for Subcatchment 5: Subcat 5

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.20"

Area (sf)	CN	Description
13,747	39	>75% Grass cover, Good, HSG A
13,747	39	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Min. 6 mins**

Summary for Subcatchment 6: Subcat 6

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv., Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr WQv Rainfall=1.20"

Area (sf)	CN	Description
21,045	39	>75% Grass cover, Good, HSG A
19,155	30	Brush, Good, HSG A
34,802	30	Woods, Good, HSG A
75,001	33	Weighted Average
75,001	33	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.1	28	0.3330	0.42		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
1.6	22	0.0810	0.23		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.40"
0.5	48	0.0100	1.61		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.8	66	0.0015	0.62		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
1.0	98	0.0110	1.69		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.8	93	0.0140	1.90		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.4	46	0.0170	2.10		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
0.7	69	0.0120	1.76		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
3.9	120	0.0010	0.51		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
11.8	590	Total			

Summary for Pond INF1: Infiltration Basin 1

Inflow Area = 53,004 sf, 21.01% Impervious, Inflow Depth = 0.21" for WQv event
Inflow = 0.25 cfs @ 12.12 hrs, Volume= 915 cf
Outflow = 0.17 cfs @ 12.24 hrs, Volume= 921 cf, Atten= 34%, Lag= 7.2 min
Discarded = 0.17 cfs @ 12.24 hrs, Volume= 921 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 61.03' @ 12.24 hrs Surf.Area= 1,202 sf Storage= 39 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 1.0 min (785.4 - 784.4)

Volume	Invert	Avail.Storage	Storage Description
#1	61.00'	7,233 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
61.00	1,190	128.0	0	0	1,190
62.00	1,602	147.0	1,391	1,391	1,628
63.00	2,894	198.0	2,216	3,607	3,039
64.00	4,410	326.0	3,625	7,233	8,383

Device	Routing	Invert	Outlet Devices
#1	Discarded	61.00'	**6.000 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.17 cfs @ 12.24 hrs HW=61.03' (Free Discharge)
↑**1=Exfiltration** (Exfiltration Controls 0.17 cfs)

Summary for Pond INF4: Infiltration Basin 4

Inflow Area = 101,255 sf, 66.75% Impervious, Inflow Depth = 0.48" for WQv event
Inflow = 1.58 cfs @ 12.11 hrs, Volume= 4,080 cf
Outflow = 0.52 cfs @ 12.44 hrs, Volume= 4,108 cf, Atten= 67%, Lag= 19.4 min
Discarded = 0.52 cfs @ 12.44 hrs, Volume= 4,108 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 54.23' @ 12.44 hrs Surf.Area= 3,750 sf Storage= 861 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 9.9 min (855.0 - 845.1)

Volume	Invert	Avail.Storage	Storage Description
#1	54.00'	24,837 cf	**Custom Stage Data (Irregular)** Listed below (Recalc) x 0.8

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
54.00	4,541	355.6	0	0	4,541
55.00	5,187	369.0	4,860	4,860	5,394
56.00	5,852	382.5	5,516	10,377	6,285
57.00	6,535	396.0	6,190	16,567	7,207
58.00	7,238	409.4	6,884	23,450	8,156
59.00	7,959	422.9	7,596	31,046	9,142

Device	Routing	Invert	Outlet Devices
#1	Discarded	54.00'	**6.000 in/hr Exfiltration over Surface area**
#2	Primary	58.75'	**20.0' long x 3.0' 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 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Discarded OutFlow Max=0.52 cfs @ 12.44 hrs HW=54.23' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.52 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=54.00' TW=0.00' (Dynamic Tailwater)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond SFB4: Sediment Forebay 4

Inflow Area = 87,508 sf, 77.24% Impervious, Inflow Depth = 0.76" for WQv event
Inflow = 1.60 cfs @ 12.10 hrs, Volume= 5,552 cf
Outflow = 1.58 cfs @ 12.11 hrs, Volume= 4,080 cf, Atten= 1%, Lag= 0.9 min
Primary = 1.58 cfs @ 12.11 hrs, Volume= 4,080 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Peak Elev= 58.23' @ 12.11 hrs Surf.Area= 542 sf Storage= 1,592 cf

Plug-Flow detention time= 149.0 min calculated for 4,080 cf (73% of inflow)
Center-of-Mass det. time= 62.1 min (845.1 - 783.0)

Volume	Invert	Avail.Storage	Storage Description
#1	54.00'	2,038 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
54.00	230	61.6	0	0	230
55.00	294	68.8	261	261	329
56.00	364	76.0	328	590	439
57.00	440	83.1	401	991	559
58.00	523	90.3	481	1,472	691
59.00	611	97.5	566	2,038	834

Device	Routing	Invert	Outlet Devices
#1	Primary	58.00'	**6.0' long x 3.0' 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 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32
#2	Primary	59.00'	**48.0' long x 3.0' 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 Coef. (English) 2.44 2.58 2.68 2.67 2.65 2.64 2.64 2.68 2.68 2.72 2.81 2.92 2.97 3.07 3.32

Primary OutFlow Max=1.54 cfs @ 12.11 hrs HW=58.22' TW=54.10' (Dynamic Tailwater)
↑ **1=Broad-Crested Rectangular Weir** (Weir Controls 1.54 cfs @ 1.16 fps)
└ **2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link DP2: Northeast Design Point

Inflow Area = 176,257 sf, 38.35% Impervious, Inflow Depth = 0.00" for WQv event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0 cf
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

1-Year Storm Event

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=50,470 sf 60.53% Impervious Runoff Depth=1.49"
Flow Length=110' Tc=8.3 min CN=35/98 Runoff=1.67 cfs 6,287 cf

Subcatchment2: Subcat 2 Runoff Area=26,837 sf 41.50% Impervious Runoff Depth=1.02"
Flow Length=315' Tc=8.6 min CN=32/98 Runoff=0.60 cfs 2,292 cf

Subcatchment3: Subcat 3 Runoff Area=26,167 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=243' Tc=17.1 min CN=32/0 Runoff=0.00 cfs 0 cf

Subcatchment4: Subcat 4 Runoff Area=37,038 sf 100.00% Impervious Runoff Depth=2.47"
Tc=6.0 min CN=0/98 Runoff=2.17 cfs 7,623 cf

Subcatchment5: Subcat 5 Runoff Area=13,747 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=39/0 Runoff=0.00 cfs 0 cf

Subcatchment6: Subcat 6 Runoff Area=75,001 sf 0.00% Impervious Runoff Depth=0.00"
Flow Length=590' Tc=11.8 min CN=33/0 Runoff=0.00 cfs 0 cf

Pond INF1: Infiltration Basin 1 Peak Elev=61.33' Storage=408 cf Inflow=0.60 cfs 2,292 cf
Outflow=0.18 cfs 2,301 cf

Pond INF4: Infiltration Basin 4 Peak Elev=55.04' Storage=4,036 cf Inflow=3.79 cfs 12,438 cf
Discarded=0.58 cfs 12,470 cf Primary=0.00 cfs 0 cf Outflow=0.58 cfs 12,470 cf

Pond SFB4: Sediment Forebay 4 Peak Elev=58.39' Storage=1,683 cf Inflow=3.80 cfs 13,910 cf
Outflow=3.79 cfs 12,438 cf

Link DP2: Northeast Design Point Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 229,260 sf Runoff Volume = 16,202 cf Average Runoff Depth = 0.85"
65.66% Pervious = 150,534 sf 34.34% Impervious = 78,726 sf

10-Year Storm Event

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=50,470 sf 60.53% Impervious Runoff Depth=2.85"
Flow Length=110' Tc=8.3 min CN=35/98 Runoff=3.07 cfs 11,990 cf

Subcatchment2: Subcat 2 Runoff Area=26,837 sf 41.50% Impervious Runoff Depth=1.95"
Flow Length=315' Tc=8.6 min CN=32/98 Runoff=1.11 cfs 4,353 cf

Subcatchment3: Subcat 3 Runoff Area=26,167 sf 0.00% Impervious Runoff Depth=0.02"
Flow Length=243' Tc=17.1 min CN=32/0 Runoff=0.00 cfs 42 cf

Subcatchment4: Subcat 4 Runoff Area=37,038 sf 100.00% Impervious Runoff Depth=4.66"
Tc=6.0 min CN=0/98 Runoff=3.98 cfs 14,394 cf

Subcatchment5: Subcat 5 Runoff Area=13,747 sf 0.00% Impervious Runoff Depth=0.18"
Tc=6.0 min CN=39/0 Runoff=0.01 cfs 207 cf

Subcatchment6: Subcat 6 Runoff Area=75,001 sf 0.00% Impervious Runoff Depth=0.03"
Flow Length=590' Tc=11.8 min CN=33/0 Runoff=0.01 cfs 208 cf

Pond INF1: Infiltration Basin 1 Peak Elev=61.84' Storage=1,135 cf Inflow=1.11 cfs 4,395 cf
Outflow=0.21 cfs 4,405 cf

Pond INF4: Infiltration Basin 4 Peak Elev=56.25' Storage=9,504 cf Inflow=6.98 cfs 25,118 cf
Discarded=0.67 cfs 25,125 cf Primary=0.00 cfs 0 cf Outflow=0.67 cfs 25,125 cf

Pond SFB4: Sediment Forebay 4 Peak Elev=58.58' Storage=1,787 cf Inflow=6.99 cfs 26,384 cf
Outflow=6.98 cfs 24,912 cf

Link DP2: Northeast Design Point Inflow=0.01 cfs 208 cf
Primary=0.01 cfs 208 cf

Total Runoff Area = 229,260 sf Runoff Volume = 31,194 cf Average Runoff Depth = 1.63"
65.66% Pervious = 150,534 sf 34.34% Impervious = 78,726 sf

100-Year Storm Event

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1: Subcat 1 Runoff Area=50,470 sf 60.53% Impervious Runoff Depth=5.54"
Flow Length=110' Tc=8.3 min CN=35/98 Runoff=5.70 cfs 23,289 cf

Subcatchment2: Subcat 2 Runoff Area=26,837 sf 41.50% Impervious Runoff Depth=3.96"
Flow Length=315' Tc=8.6 min CN=32/98 Runoff=2.03 cfs 8,860 cf

Subcatchment3: Subcat 3 Runoff Area=26,167 sf 0.00% Impervious Runoff Depth=0.77"
Flow Length=243' Tc=17.1 min CN=32/0 Runoff=0.18 cfs 1,680 cf

Subcatchment4: Subcat 4 Runoff Area=37,038 sf 100.00% Impervious Runoff Depth=8.46"
Tc=6.0 min CN=0/98 Runoff=7.09 cfs 26,111 cf

Subcatchment5: Subcat 5 Runoff Area=13,747 sf 0.00% Impervious Runoff Depth=1.46"
Tc=6.0 min CN=39/0 Runoff=0.39 cfs 1,677 cf

Subcatchment6: Subcat 6 Runoff Area=75,001 sf 0.00% Impervious Runoff Depth=0.86"
Flow Length=590' Tc=11.8 min CN=33/0 Runoff=0.68 cfs 5,394 cf

Pond INF1: Infiltration Basin 1 Peak Elev=62.76' Storage=2,955 cf Inflow=2.04 cfs 10,540 cf
Outflow=0.35 cfs 10,544 cf

Pond INF4: Infiltration Basin 4 Peak Elev=58.59' Storage=22,248 cf Inflow=13.02 cfs 49,605 cf
Discarded=0.85 cfs 49,620 cf Primary=0.00 cfs 0 cf Outflow=0.85 cfs 49,620 cf

Pond SFB4: Sediment Forebay 4 Peak Elev=58.85' Storage=1,951 cf Inflow=12.66 cfs 49,401 cf
Outflow=12.63 cfs 47,929 cf

Link DP2: Northeast Design Point Inflow=0.68 cfs 5,394 cf
Primary=0.68 cfs 5,394 cf

Total Runoff Area = 229,260 sf Runoff Volume = 67,011 cf Average Runoff Depth = 3.51"
65.66% Pervious = 150,534 sf 34.34% Impervious = 78,726 sf

Mounding Analysis

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		
5.1500	***R***	**Recharge (infiltration) rate (feet/day)**
0.260	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
120.00	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
17.000	**x**	**1/2 length of basin (x direction, in feet)**
72.000	**y**	**1/2 width of basin (y direction, in feet)**
1.000	**t**	**duration of infiltration period (days)**
18.200	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

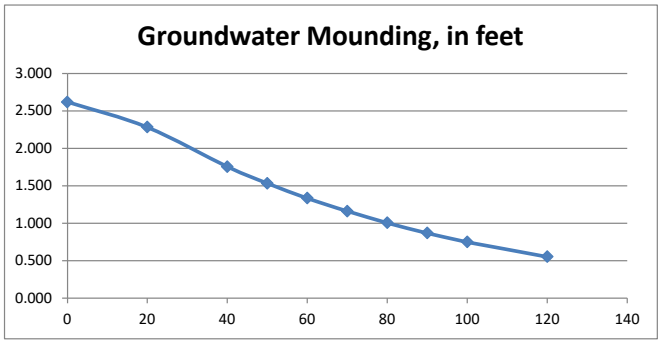
hours	days
36	1.50

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).

20.821	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
2.621	**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
2.621	**0**
2.284	**20**
1.756	**40**
1.534	**50**
1.336	**60**
1.161	**70**
1.007	**80**
0.870	**90**
0.751	**100**
0.554	**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.

The input parameters for the model were determined as follows:

Data Sources

The following materials were used to accurately model the stormwater infiltration system at the site.

- Geotechnical reports completed by Natural Resource Services, Inc. were used to determine soil types and groundwater elevations. Test pit TH-6 was selected as representative of conditions in Infiltration Basin 4.
- Initial saturated thickness was determined using borings performed by Lahlaf Geotechnical Consulting, Inc. attached
- Saturated hydraulic conductivity was assumed based on Rawls[1] rates.
- Specific yield was assumed to be 0.26, a typical value for medium sands[2].

Test pit logs are provided in Appendix B of this Stormwater Management Report.

Assumptions

The following assumptions were used in the preparation of the groundwater model. These were established based on site investigations:

- Soils are generally classified as fine sand.
- Seasonal High Groundwater is based on observed redoximorphic features.
- There was no indication of bedrock in any of the borings performed onsite. Therefore, the depth to restrictive layer was assumed to be the total depth of the deepest boring (B-1) which corresponds to an elevation of approximately 32.7 feet).
- Specific yield of the soil is 0.26, based on the literature range for medium sands.
- Mounding analysis is insensitive to changes in specific yield acceptable ranges therefore the use of literature values is warranted.

1 Rawls, Brakensiek and Saxton, 1982, Estimation of Soil Water Properties, Transactions American Society of Agricultural Engineers 25(5): 1316-1320, 1328.
2 Fetter, C. W. *Applied Hydrogeology* 4ed. Prentice Hall, 2000.

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LGCI
Lahlaf Geotechnical Consulting, Inc.

BORING LOG **Boring B-1** **Page 1 of 2**

Project:	**Proposed Multifamily Buildings, Cranston, Rhode Island**		
Client:	**Edward A. Fish Associates, LLC**		LGCI Project No.: 0801
Drilling Subcontractor:	Subsurface Drilling	Date Started:	01/21/08
Drilling Foreman:	Phil Thornsbury	Date Completed:	01/21/08
LGCI Engineer:	A. M. Lahlaf	Location:	Western side of Southern Building
Ground Surface El:	NA	Total Depth:	32 feet
Groundwater Depth:	~ 13.5 feet	Drill Rig Type:	Mobile Drill B-61 Truck Rig
		Drilling Method:	4" HSA
Hammer Weight:	140 lbs	Split Spoon Diameter:	ID - 1.375", OD - 2"
Hammer Type:	Safety	Rock Core Barrel Size:	NA
Drop:	30 in		

Depth Scale	Sample Depth (ft)	Sample No	Blows per 6 inches 0-6	6-12	12-18	18-24	Pen (in)	Rec (in)	Strata	Sample Description
	0 - 2	S1	15	17	16	20	24	16	Topsoil	S1 - Top 4": Topsoil
									1) Fill 4.8'	Bot. 12": Silty SAND (SM), fine to medium, ~ 15% fines, concrete pieces, traces of organics, brown (fill)
	2 - 4	S2	16	11	12	9	24	8		S2 - Similar to bot. 12: of S1
										S3 - Top 10": Poorly Graded SAND with Silt (SP-SM), fine to medium, ~ 10% fines, traces of concrete, tan to brown, (fill)
	4 - 6	S3	5	6	9	10	24	16		Bot. 6": Well Graded SAND (SW), medium to coarse, tan to brown, moist
										S4 - Well Graded SAND (SW), medium to coarse, tan to brown, moist
	6 - 8	S4	9	16	27	28	24	6		
									Sand & Gravel	
10ft										S5 - Well Graded SAND with Gravel (SW), medium to coarse, ~ 20% fine gravel, tan to brown, moist
	10-12	S5	4	7	10	10	24	12	12'	
										S6 - Silty SAND (SM), fine, ~ 20% fines, tan, wet
	15-17	S6	WOR	3	4	4	24	18		
									Sand	
20ft										S7 - Poorly Graded SAND with Silt (SP-SM), fine, ~ 10% fines, tan, wet
	20-22	S7	WOR	WOR	2	4	24	16		
										S8 - Similar to S7
	25-27	S8	WOR	4	5	3	24	20	2)	

Remarks:

Appendix E – Minimum Standard 7 and 11 – Stormwater Management System Operation and Maintenance Plan and Source Control and Pollution Prevention Plan (Bound Separately)

Appendix F – Minimum Standard 10 – Soil Erosion and Sediment Control Plan (Bound Separately)