DRAINAGE NARRATIVE AND ASSESSMENT
FOR
WEST END

130 West Street and 25 Spring Street
Walpole, Massachusetts 02081
Assessor's Map: 33, Parcels: 398 and 399
Zoning District: Central Business District (CBD)
November 2023

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Section 1: Introduction

This assessment has been prepared for the proposed development to be constructed at 130 West Street and 25 Spring Street in the Town of Walpole, Massachusetts. The site is bordered to the north by West Street, to the east by Spring Street, to the south by Clear Pond Drive, and to the west by various residential properties. The site is comprised of two (2) lots, Assessor's Map 33, Lots 398 and 399, and currently contains the Drycrete Waterproofing and the Innovative Engineering Solutions, Inc. office facilities. Both properties are owned by the applicant and are treated as a single lot in accordance with the Walpole Zoning Bylaw. The applicant intends on demolishing the existing office buildings to create 95 residential units and 10 commercial retail spaces. The existing office facilities have two curb openings on West Street and one curb opening on Spring Street. Access from both streets will remain, with access to the underground parking garage from Spring Street, and access to the above grade parking area from West Street.

The site falls within the Town's Central Business District (CBD), and it is the intent of the applicant to create a unique and attractive development in conformance with the applicable zoning requirements of the CBD. The western edge of the site borders the Water Resource Protection Overlay District (WRPOD) Area 2 and based upon the topographic survey of the property and surrounding areas, it is evident that the site is not within and drains away from the WRPOD Area 2. Also, the project area does not contain any wetlands, jurisdictional wetland buffer zones, or any other environmentally sensitive area of concern.

Although the site is considered a redevelopment, the proposed stormwater management systems have been designed in a manner to demonstrate full compliance with the stormwater requirements for a new development. The proposed development will include a series of underground infiltration systems to treat, recharge and attenuate stormwater runoff from the site in conformance with local (Walpole) and State (Massachusetts) stormwater requirements. Surface runoff will first pass through a proprietary treatment device (Stormceptor) for pretreatment prior to entering the proposed underground infiltration system for the below grade parking area, and sediment forebays for pretreatment prior to entering the systems for the above grade parking area.

All stormwater runoff leaving the site under existing conditions ultimately drains in a northeasterly direction into the closed drainage system of West Street. Under pre-development conditions, stormwater runoff generated onsite and upstream of the site, discharges overland directly to Spring and West Streets. The Spring Street drainage system connects into the West Street drains. There is no existing stormwater management system for the existing office facility. A pre- and post-development analysis of the site using HydroCAD v10 software has been provided to demonstrate that the proposed development and stormwater mitigation systems will yield a decrease in peak runoff flow rates and volumes discharging towards the Town's existing drainage systems and a significant improvement in water quality mitigation.

Figure 1 – Site Locus

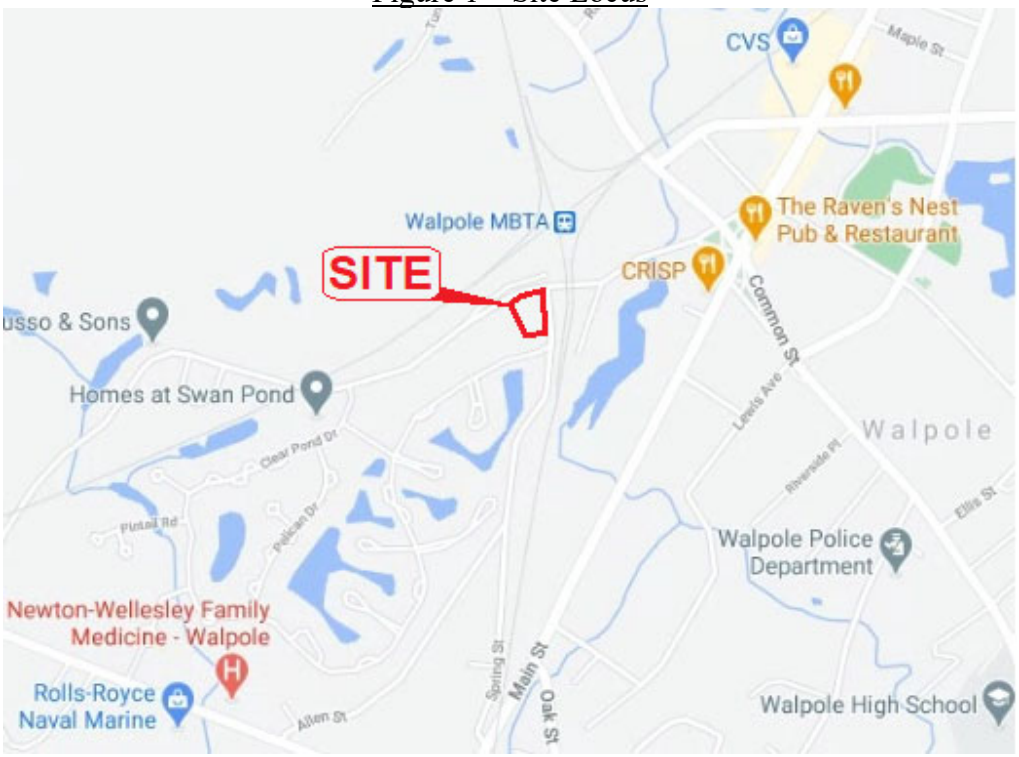


Figure 2 – Site Aerial

Section 2: The Stormwater Management Standards

The project is a combination of redevelopment and new development, and shall conform to all of the Stormwater Standards to the maximum extent practicable. A summary of how each of the Standards has been addressed is provided below:

Standard 1. No new stormwater conveyances (e.g. outfalls) may discharge untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

Response: The project has been designed so that no new stormwater conveyances will discharge untreated stormwater directly to our cause erosion in wetlands or waters of the Commonwealth. The proposed stormwater "Best Management Practices" or BMPs have been designed to demonstrate compliance with this standard by treating stormwater runoff from all new impervious areas prior to leaving the site and decreasing peak flow rates in all directions during the required design storm events. The stormwater runoff calculations are provided in the Appendix for the 1" storm and the, 1, 2, 10, 25, and 100-year storm events.

Standard 2. Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates. This Standard may be waived for discharges to land subject to coastal storm flowage as defined in 310 CMR 10.04.

Response: The project has been designed so that the post-development (proposed) peak flow rates will not exceed the pre-development (existing) rates for the design storm events. Calculations for the 1" storm and the 1, 2, 10, 25, and 100-year storm events are provided in Section 4 and Appendix C of this report.

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

Response: The groundwater recharge requirements shall be satisfied with several proposed underground infiltration systems throughout the development. System specific calculations are provided in Section 4 and Appendix C of this report.

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

a. *Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;*
b. *Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and*
c. *Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.*

Response: The project is designed to meet an 80% TSS removal rate using the following BMPs: Deep sump catchbasins, Stormceptors, and underground infiltration systems. Refer to Section 5 and Appendix E of the report for additional details and calculations.

Standard 5. For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§26-53 and the regulations promulgated there under at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00

Response: The proposed land use does not represent a higher potential pollutant load (LUHPPL) site, therefore this standard is not applicable.

Standard 6. Stormwater discharges within the Zone II or Interim Wellhead Protection Area of a public water supply, and stormwater discharges near or to any other critical area require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook. A discharge is near a critical area if there is a strong likelihood of a significant impact occurring to said area, taking into account site-specific factors. Stormwater discharges to Outstanding Resource Waters and Special Resource Waters shall be removed and set back from the receiving water or wetland and receive the highest and best practical method of treatment. A "stormwater discharge" as defined in 314 CMR 3.04(2)(a)1 or (b) to an Outstanding Resource Water or Special Resource Water shall comply with 314 CMR 3.00 and 314 CMR 4.00. Stormwater discharges to a Zone I or Zone A are prohibited unless essential to the operation of a public water supply.

Response: The development is not located within a Zone II, Wellhead Protection Zone or Surface Water Protection Zone.

Standard 7. A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

Response: Although this project is a combination if new development and redevelopment, the proposed stormwater management systems have been designed to meet all standards applicable to that of a new development.

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

Response: The project includes measures to control construction related impacts during construction.

Standard 9. A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

Response: The long-term maintenance plan is provided in the separately bound document.

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

Response: There are no known or suspected illicit discharges from the site.

Section 3: Methodology

Existing and Proposed Hydrographs

Existing and post-development hydrographs have been analyzed to compare runoff for existing and post development conditions. Runoff from the existing and post development hydrographs has been computed utilizing "HydroCAD" Version 10.0 software. Generally, the methodology encompasses the Natural Resources Conservation Service (NRCS) (formerly the Soil Conservation Service) unit hydrograph method used in TR-20 which provided a basis for TR-55. The hydrologic data is the same information required for TR-55 and includes watershed areas, NRCS runoff curve numbers, and the travel length from the most remote watershed point. With this data, complete NRCS hydrographs can be developed for a 24-hour Type III storm. The watershed time of concentration is computed internally using the velocity method shown in NRCS Methodologies. The velocity method assumes that time of concentration is the sum of travel times for segments along the hydraulically most distant flow path.

The hydraulically most distant point is the point with the longest time to the watershed outlet and not necessarily the point with the longest flow distance to the outlet.

The site is analyzed by modeling stage/storage/discharge relationships within the "HydroCAD" program. The input data required is:

Discharge

Orifice: Outlet Diameter
Pipe: Outlet Diameter
Manning's N-Value
Invert
Length
Slope

Weir: Crest Length
Crest Elevation
Weir Coefficient

Stage/Storage

Surface area at various stage elevations.

The "HydroCAD" program automatically routes hydrographs through BMPs to determine the resulting outflow over time. The program also can combine hydrographs to determine cumulative subwatershed flows.

Exfiltration volumes from infiltration BMPs can be determined by using a constant exfiltration rate or by using Darcy's Law. Input parameters include basin stage/storage data, infiltration rate, and groundwater elevation. Rainfall data used in the analysis were obtained from the HydroCAD rainfall event tables for the Norfolk County NRCC data.

Section 4: Watershed Analysis (Peak Flow Attenuation)

This section compares stormwater runoff conditions for the existing (pre-development) and proposed (post-development) condition watershed area for the 1" storm and the 1, 2, 10, 25, and 100-year storm events. The existing and proposed stormwater peak flow rates are provided below in Table 1, and the stormwater volumes provided in Table 2. The results of the hydrology analyses indicate that the proposed development and stormwater improvements will yield a decrease in peak flow rates and volumes during all of the design storm events. The HydroCAD stormwater runoff calculations for each watershed area and infiltration system are available in Appendix C.

Table 1 – Stormwater Runoff Peak Rate Flow Summary (cfs)

Flow to West Street Drainage System	Storm Event					
	1-inch	1-Year	2-Year	10-Year	25-Year	100-Year
EX-A *Existing Conditions*	0.00	0.17	0.64	2.55	4.45	8.99
PR-A *Proposed Conditions*	0.00	0.08*	0.20*	0.55*	0.87*	4.91
Change (cfs)	0.00	-0.09	-0.44	-2.00	-3.58	-4.08
Change (%)	-	-53%	-69%	-78%	-80%	-45%

**Direct runoff from landscaped and perimeter areas in front of building*

Table 2– Stormwater Runoff Volume Summary (acre-feet)

Flow to West Street Drainage System	Storm Event					
	1-inch	1-Year	2-Year	10-Year	25-Year	100-Year
EX-A *Existing Conditions*	0.000	0.037	0.087	0.249	0.408	0.792
PR-A *Proposed Conditions*	0.000	0.008	0.016	0.039	0.060	0.190
Change (acre-feet)	0.000	-0.029	-0.071	-0.210	-0.348	-0.602
Change (%)	-	-78%	-82%	-84%	-85%	-76%

Note: The infiltration rate utilized for the HydroCAD analysis was based upon on-site falling head permeability tests. The field measured rate of 33.36 in/hr was divided by a factor of 2 to justify a design value of 16.68 in/hr.

Section 5: Stormwater Treatment (Water Quality) and Groundwater Recharge

The water quality improvements for the project have been designed to satisfy the treatment and recharge requirements with a series of underground infiltration systems, sediment forebays, and a proprietary treatment device proposed on site. The required groundwater recharge and water quality volume equations utilized in sizing the proposed stormwater recharge and treatment facilities are provided below.

Required Recharge Volume (RRv)

RRv = F x I x (1.0”/12 in/ft) x (43,560 sf/acre)

Where: RRv = Required Recharge Volume
F = Target Depth Factor (Massachusetts Department of Environmental Protection, Stormwater Handbook) Note: The majority of existing soils within the site are identified as Urban Land, 0-15% slopes in the NRCS Soil Survey of MA. The Urban Land soil designation does not carry a specific Hydrologic Soil Group; therefore, the nearest offsite abutting soil series have been identified for this site’s HSG surface determinations. The neighboring soil series are Hinckley loamy sands and Merrimac-Urban land complex which carry the most conservative Hydrologic Soil Group designation of HSG A for stormwater design considerations. HSG A will be used for sizing the total post development recharge requirements (F= 0.60, Page 6 of V1 Ch1)
I = Impervious Area (square-feet) to each Infiltration BMP

Required Water Quality Volume (RWQv)

RWQv = I x (1.0”/12 in/ft) x (43,560 sf/acre)

Where: RWQv = Required Water Quality Volume
I = Impervious Area (square-feet) to each Infiltration BMP

The provided recharge and water quality volumes are defined as the proposed stormwater storage volume within each underground infiltration system (UIS) below the lowest outlet elevation. The required and provided recharge and water quality volumes are provided on the following pages in Table 3.

UIS 1 Outlet: CB9 Grate, RIM Elevation = 148.60
Provided Storage Volume = 1,505 CF

UIS 2 Outlet: DMH11 Weir Wall, Weir Elevation = 156.25
Provided Storage Volume = 9,170 CF

Table 3 – Required and Provided Recharge and Water Quality Volumes

Watershed	Impervious Area (sf)			Required (cf)		Proposed BMP	Provided (cf) Rv & WQv
	Pavement	Roof	Total	Rv	WQv		
PR-A1	15,314	0	15,314	765.7	1,276.2	UIS2	9,170
PR-A2	0	0	0	0	0	UIS2	
PR-A3	6,528	0	6,528	326.4	544.0	UIS2	
PR-A4	0	25,515	25,515	1,275.8	2,126.3	UIS2	
PR-A5	9,584	0	9,584	479.2	798.7	UIS1	1,505
PR-A6	5,420	0	5,420	271.0	451.7	--	--
Total	36,846	25,515	62,361	3,118.1	5,196.9	--	10,675

Drawdown Time

Stormwater runoff within the basin will infiltrate (drawdown) into the soils below. The on-site soil evaluations or test pits identified the existing restrictive subsoil to be sand project wide. A Rawls Rate of 8.27 in/hr will be utilized for vertical conductivity in the dewatering calculations for the underground infiltration system. Stormwater infiltration facilities are required to dewater within 72 hours. The drawdown time equation and the provided drawdown time calculations for each infiltration BMP are provided below to demonstrate the stormwater management systems dewater within a 72-hour period:

Provided Drawdown Time (PDt)

PDt = PWQv / (K x A)

Where: PDt = Provided Drawdown Time
PWQv = Provided Water Quality Volume
K = Infiltration Rate (8.27 in/hr)
A = Infiltration System Area

Table 4 – Provided Drawdown Times

Infiltration System	Provided (cf) Rv & WQv	Infiltration Area (sf)	Infiltration Rate (in/hr)	Drawdown Time (hours)
UIS1	1,505	1,134	8.27	1.93
UIS2	9,170	2,820	8.27	4.72

Pretreatment

All stormwater runoff from impervious areas (i.e., driveways and sidewalks) will undergo pretreatment prior to entering underground infiltration systems. The methods of pretreatment for this project are a combination of sediment forebays along the upper parking area and a Stormceptor proprietary treatment unit on the lower level. Roof runoff directed towards the proposed infiltration facilities do not require pretreatment. Additional pretreatment is provided

with the project wide use of deep-sump catchbasins. Runoff collected beneath the parking garage roof on the lower level is to be directed to an oil-sand separator before discharging into the municipal sewer system.

The Stormwater Handbook requires 10% of the required water quality volume to be stored within sediment forebays. For the following calculations, the top of the sediment forebay was considered to be the catchbasin rim elevation.

Pretreatment Volume Required (PV_R)

The required pretreatment volumes for the sediment forebays are determined below.

PV = 10% x I x 1" x (1 ft / 12 in)

Where: PV_R = Required Pretreatment Volume
PV_P = Proposed Pretreatment Volume
I = Design Impervious Area

Forebay 1:

PV_R = 10% x 15,314 sf impervious x (1.0"/12 in/ft) = 127.6 cubic-feet
Forebay 1 Outlet: CB10&11 Grates, RIM Elevation = 159.50
Provided Storage Volume at Elev. 159.50 = 276 CF
(see Appendix C, Stage-Area-Storage for Pond F1: FOREBAY1)

Forebay 2:

PV_R = 10% x 0 sf impervious x (1.0"/12 in/ft) = 0 cubic-feet

Forebay 3:

PV_R = 10% x 6,528 sf impervious x (1.0"/12 in/ft) = 54.4 cubic-feet
Forebay 3 Outlet: CB13 Grate, RIM Elevation = 156.55
Provided Storage Volume at Elev. 156.55 = 60 CF
(see Appendix C, Stage-Area-Storage for Pond F3: FOREBAY3)

When using a proprietary separator (Stormceptor), the pretreatment requirement is satisfied by specifying a proprietary separator or pretreatment chamber that can provide a maximum treatment flow rate greater than the "first flush" or 1-inch rainfall event discharging to the proposed pretreatment chamber. Roof runoff generated at the site will drain directly to Underground Infiltration System No. 2 (UIS-2) without pretreatment because no impervious ground surface drains directly to this system.

The 1-inch storm event summary to each of the Stormceptors using the HydroCAD split pervious-impervious calculation method is tabulated below in Table 5. The Stormceptor System Standard Sizing Chart is provided in Table 6. HydroCAD calculations for each Stormceptor are provided in Appendix C.

Table 5 – Site Specific Stormceptor Water Quality Flow Rates

Infiltration System	Water Quality Flow Rate (cfs)	Proprietary Treatment Device		Water Quality Flow Capacity (cfs)
		Stormceptor Model	Structure	
UIS1	0.06	STC-450	DMH8	0.283

Table 6 – Stormceptor System Sizing Chart

STC Model	Water Quality Flow Capacity (cfs)	Sediment Capacity (cf)	Oil Capacity (gal)	Total Holding Capacity (gal)
450	0.283	9	86	470

TSS Removal Rates

Minimum Standard 4 requires stormwater management systems to be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS). This stormwater standard is satisfied with the use of deep-sump catchbasins, Stormceptors, sediment forebays, and underground infiltration systems included with the development. The TSS Removal Rate calculations are for each treatment train type are provided below in Table 7, and the net TSS Removal Rate for the site computed in Table 8 on the following page. The TSS Removal Rate for the sediment forebays and proprietary treatment devices (Stormceptors) are assumed to be 0% because the Stormwater Handbook credits underground infiltration systems with 80% with pretreatment.

Table 7 – TSS Removal Rates per Treatment Train Type

Treatment Train: To Underground Infiltration System 1

BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C x D)	F Remaining Load (D - E)
Deep Sump and Hooded Catchbasin	0.25	1.00	0.25	0.75
Proprietary Treatment Practice (Stormceptor)	0.00	0.75	0.00	0.75
Underground Infiltration System (with pretreatment)	0.80	0.75	0.60	0.15
			Total TSS Removal =	85.0%

Treatment Train: To Underground Infiltration System 2

BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C x D)	F Remaining Load (D - E)
Deep Sump and Hooded Catchbasin	0.25	1.00	0.25	0.75
Sediment Forebay	0.00	0.75	0.00	0.75
Underground Infiltration System (with pretreatment)	0.80	0.75	0.60	0.15
			Total TSS Removal =	**85.0%**

Table 8 – Total TSS Removal Rates

Watershed	Treatment BMP	Impervious Area (sf)	Deep Sump Catchbasins	Sediment Forebay	Stormceptor	Underground Infiltration System	TSS Removal Rate (%)
PA1	UIS2	15,314	x	x		x	85.0
PA2	UIS2	0	x	x		x	85.0
PA3	UIS2	6,528	x	x		x	85.0
PA4 (roof)	UIS2	25,515				x	80.0
PA5	UIS1	9,584	x		x	x	85.0
PA6 (perimeter)	--	5,420*					0.00
Total		62,361					75.6

*Perimeter impervious area comprised of sidewalks and driveway transitions

Segments of the Neponset River are noted to have a TMDL for bacteria. The proposed design infiltrates 100% of the runoff, excluding minor perimeter areas, for the water quality storm event (and up to 25-year storm), therefore meets the recommended TMDL treatment goals.

Because the site proposes infiltration practices with subsoils that have a rapid infiltration rate (>2.41 in/hr), 44% pretreatment is required. The pretreatment TSS Removal Rate calculations for each pretreatment train type are provided in Table 9.

Table 9 – TSS Removal Rates per Pretreatment Train Type

Treatment Train: To Underground Infiltration System 1

BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C x D)	F Remaining Load (D - E)
Deep Sump and Hooded Catchbasin	0.25	1.00	0.25	0.75
Proprietary Treatment Practice (Stormceptor)	0.77	0.75	0.58	0.17
			Pretreatment TSS Removal =	**83.0%**

Treatment Train: To Underground Infiltration System 2

BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C x D)	F Remaining Load (D - E)
Sediment Forebay	0.25	1.00	0.25	0.75
Deep Sump and Hooded Catchbasin	0.25	0.75	0.19	0.56
			Pretreatment TSS Removal =	**44.0%**

Groundwater Mounding Analysis

In addition to providing groundwater recharge and treatment, the underground infiltration systems provide attenuation for the mitigation of peak flows and runoff volumes from the design storms up to 100-year frequency storm events. The minimum setback from the bottom of the systems to the seasonal high groundwater table is 2 feet, and this mounding analysis was performed to verify the system will not create impacts and will drain between storm events. The response of the water table was predicted by using the "USGS SIR 2010-5102 Simulation of Groundwater Mounding Beneath Hypothetical Infiltration Basins Spread Sheet" which is based upon the Hantush Method (1967). The program modeled the mound created by the 100-year storm event infiltration volume determined with HydroCAD and groundwater levels at the seasonal high elevation. The results of the mounding analyses are provided in Table 10, and the mounding spreadsheets for each system are available in Appendix E.

Table 10 – Groundwater Mounding Summary

Infiltration System	HydroCAD 100-Year Storm Exfiltrated Volume (acre-feet)	HydroCAD 100-Year Storm Exfiltrated Volume (cubic-feet)	x, (1/2) Inf. Length (ft)	y, (1/2) Inf. Width (ft)	t, time to drain (days)	R, Recharge Rate (ft per day)	Min. Cover over ESHWT (ft)	Δhmax GW Mound Height (ft)
UIS1	0.162	7,057	27.00	10.50	3	2.074	2.00	0.352
UIS2	0.765	33,323	165.885	4.25	3	3.939	3.50	0.857

Section 6: Appendix

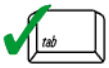
Appendix A. MADEP Stormwater Report Checklist

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

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[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- [X] No disturbance to any Wetland Resource Areas
- [X] Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- [ ] Reduced Impervious Area (Redevelopment Only)
- [X] Minimizing disturbance to existing trees and shrubs
- [ ] LID Site Design Credit Requested:
  - [ ] Credit 1
  - [ ] Credit 2
  - [ ] Credit 3
- [ ] Use of “country drainage” versus curb and gutter conveyance and pipe
- [ ] Bioretention Cells (includes Rain Gardens)
- [ ] Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- [ ] Treebox Filter
- [ ] Water Quality Swale
- [ ] Grass Channel
- [ ] Green Roof
- [ ] Other (describe): _____

Standard 1: No New Untreated Discharges

- [X] No new untreated discharges
- [X] Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- [X] Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☐ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☒ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

☒ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☐ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☒ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☒ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☐ is near or to other critical areas
- ☒ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☐ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☒ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☒ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☐ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☐ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

☐ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☐ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☒ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☐ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

Appendix B. Pre- and Post-Development Watershed Maps

- Civil
- Transportation
- Environmental
- Site Planning
- Surveying
- Permitting
- Landscape Architecture

CROSSMAN ENGINEERING

Rhode Island	Massachusetts
151 Centerville Road	103 Commonwealth Avenue
Warwick, RI 02886	North Attleboro, MA 02763
Phone: (401) 738-5660	Phone: (508) 695-1700

Email: cei@crossmaneng.com

PROJECT TITLE:

WEST END

130 WEST STREET and 25 SPRING STREET
WALPOLE, MASSACHUSETTS 02081

ASSESSOR'S MAP 33, PARCELS 398 and 399
ZONING DISTRICT:
CENTRAL BUSINESS DISTRICT (CBD)

APPLICANT:

PARAGON INVESTMENTS LLC
8 HANCOCK COURT
WALPOLE, MA 02081

DRAWING TITLE:

EXISTING CONDITIONS WATERSHED MAP

DATE:	SCALE:
NOVEMBER 2023	1"=20'

DWG. NAME: M22-127-EXWSD.dwg

REVISIONS

NUMBER	REMARKS	DATE
--	--	--

DRAWING NUMBER

EX-WSD

SHEET: — *OF:* —

• Civil
• Transportation
• Environmental
• Site Planning
• Surveying
• Permitting
• Landscape Architecture

CROSSMAN ENGINEERING

Rhode Island
151 Centerville Road
Warwick, RI 02886
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Massachusetts
103 Commonwealth Avenue
North Attleboro, MA 02763
Phone: (508) 695-1700

Email: cei@crossmaneng.com

PROJECT TITLE:

WEST END

130 WEST STREET and 25 SPRING STREET
WALPOLE, MASSACHUSETTS 02081

ASSESSOR'S MAP 33, PARCELS 398 and 399
ZONING DISTRICT:
CENTRAL BUSINESS DISTRICT (CBD)

APPLICANT:

PARAGON INVESTMENTS LLC
8 HANCOCK COURT
WALPOLE, MA 02081

DRAWING TITLE:

PROPOSED WATERSHED MAP

DATE:	SCALE:
NOVEMBER 2023	1"=20'

DWG. NAME: M22-PRWSD.dwg

REVISIONS

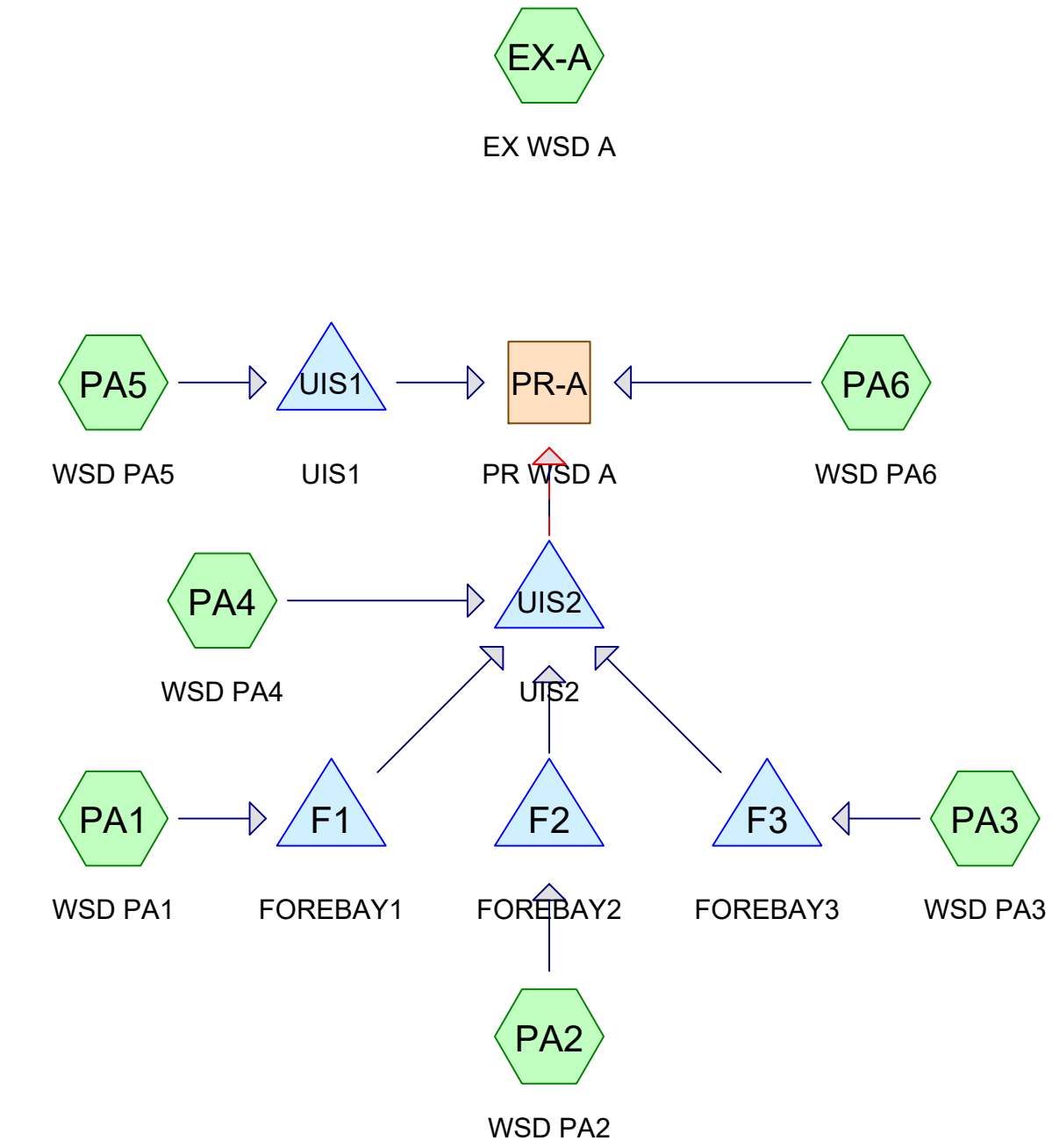
NUMBER	REMARKS	DATE
--	--	--

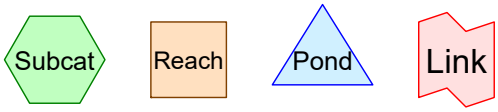
DRAWING NUMBER

PR-WSD

SHEET: — *OF:* —

Appendix C. Stormwater Runoff Peak Flow Calculations





Routing Diagram for M227-HydroCAD-November 2023
Prepared by Crossman Engineering, Printed 11/29/2023
HydroCAD® 10.00-26 s/n 08202 © 2020 HydroCAD Software Solutions LLC

Summary for Subcatchment EX-A: EX WSD A

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Rainfall=1.00"

	Area (sf)	CN	Description
	17,570	30	Woods, Good, HSG A
	40,265	39	>75% Grass cover, Good, HSG A
*	28,803	98	Pavement
*	10,862	98	Roof
	97,500	61	Weighted Average
	57,835	36	59.32% Pervious Area
	39,665	98	40.68% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.0	80	0.1500	0.17		**Sheet Flow, AB** Woods: Light underbrush n= 0.400 P2= 3.20"
1.1	20	0.1750	0.29		**Sheet Flow, BC** Grass: Short n= 0.150 P2= 3.20"
0.1	16	0.0940	2.15		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
0.8	100	0.0100	2.03		**Shallow Concentrated Flow, DE** Paved Kv= 20.3 fps
2.4	157	0.0240	1.08		**Shallow Concentrated Flow, EF** Short Grass Pasture Kv= 7.0 fps
12.4	373	Total			

Summary for Subcatchment PA1: WSD PA1

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Rainfall=1.00"

	Area (sf)	CN	Description
	12,392	30	Woods, Good, HSG A
	8,125	39	>75% Grass cover, Good, HSG A
*	15,314	98	Pavement
	35,831	61	Weighted Average
	20,517	34	57.26% Pervious Area
	15,314	98	42.74% Impervious Area

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

Summary for Subcatchment PA2: WSD PA2

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Rainfall=1.00"

	Area (sf)	CN	Description
	1,318	30	Woods, Good, HSG A
	2,497	39	>75% Grass cover, Good, HSG A
*	0	98	Pavement
*	0	98	Roof
	3,815	36	Weighted Average
	3,815	36	100.00% Pervious Area

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

Summary for Subcatchment PA3: WSD PA3

Runoff = 0.00 cfs @ 12.38 hrs, Volume= 0.001 af, Depth= 0.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Rainfall=1.00"

	Area (sf)	CN	Description
	100	30	Woods, Good, HSG A
	3,184	39	>75% Grass cover, Good, HSG A
*	6,528	98	Pavement
	9,812	78	Weighted Average
	3,284	39	33.47% Pervious Area
	6,528	98	66.53% Impervious Area

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

Summary for Subcatchment PA4: WSD PA4

Runoff = 0.54 cfs @ 12.07 hrs, Volume= 0.039 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Rainfall=1.00"

	Area (sf)	CN	Description
*	25,515	98	Roof
	25,515	98	100.00% Impervious Area

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

Summary for Subcatchment PA5: WSD PA5

Runoff = 0.06 cfs @ 12.09 hrs, Volume= 0.005 af, Depth= 0.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Rainfall=1.00"

	Area (sf)	CN	Description
*	9,584	98	Pavement
	2,227	39	>75% Grass cover, Good, HSG A
	11,811	87	Weighted Average
	2,227	39	18.86% Pervious Area
	9,584	98	81.14% Impervious Area

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

Summary for Subcatchment PA6: WSD PA6

Runoff = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Rainfall=1.00"

	Area (sf)	CN	Description
	5,655	39	>75% Grass cover, Good, HSG A
*	5,420	98	Pavement
	11,075	68	Weighted Average
	5,655	39	51.06% Pervious Area
	5,420	98	48.94% Impervious Area

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

Summary for Reach PR-A: PR WSD A

Inflow Area = 2.247 ac, 63.73% Impervious, Inflow Depth = 0.00" for 1-Inch event
Inflow = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 24.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Pond F1: FOREBAY1

Inflow Area = 0.823 ac, 42.74% Impervious, Inflow Depth = 0.00" for 1-Inch event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 159.00' @ 0.00 hrs Surf.Area= 330 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	159.00'	4,563 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
159.00	330	0	0
160.00	1,220	775	775
161.00	3,070	2,145	2,920
161.50	3,500	1,643	4,563

Device	Routing	Invert	Outlet Devices
#1	Primary	159.50'	**2.5" x 2.5" Horiz. CB10 Double Grate X 72.00** C= 0.600 Limited to weir flow at low heads
#2	Primary	159.50'	**2.5" x 2.5" Horiz. CB11 Double Grate X 72.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=159.00' TW=150.50' (Dynamic Tailwater)
└─**1=CB10 Double Grate** (Controls 0.00 cfs)
└─**2=CB11 Double Grate** (Controls 0.00 cfs)

Summary for Pond F2: FOREBAY2

Inflow Area = 0.088 ac, 0.00% Impervious, Inflow Depth = 0.00" for 1-Inch event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 157.50' @ 0.00 hrs Surf.Area= 280 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no inflow)

Volume	Invert	Avail.Storage	Storage Description
#1	157.50'	508 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
157.50	280	0	0
158.00	500	195	195
158.50	750	313	508

Device	Routing	Invert	Outlet Devices
#1	Primary	157.65'	**2.5" x 2.5" Horiz. CB12 Grate X 36.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=157.50' TW=150.50' (Dynamic Tailwater)
└**1=CB12 Grate** (Controls 0.00 cfs)

Summary for Pond F3: FOREBAY3

Inflow Area = 0.225 ac, 66.53% Impervious, Inflow Depth = 0.06" for 1-Inch event
Inflow = 0.00 cfs @ 12.38 hrs, Volume= 0.001 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 156.47' @ 24.29 hrs Surf.Area= 152 sf Storage= 48 cf

Plug-Flow detention time= (not calculated: initial storage exceeds outflow)
Center-of-Mass det. time= (not calculated: no outflow)

Volume	Invert	Avail.Storage	Storage Description
#1	156.00'	334 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
156.00	50	0	0
157.00	265	158	158
157.50	440	176	334

Device	Routing	Invert	Outlet Devices
#1	Primary	156.55'	**2.5" x 2.5" Horiz. CB13 Double Grate X 72.00** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=156.00' TW=150.50' (Dynamic Tailwater)
└─**1=CB13 Double Grate** (Controls 0.00 cfs)

Summary for Pond UIS1: UIS1

Inflow Area =	0.271 ac, 81.14% Impervious, Inflow Depth = 0.22" for 1-Inch event				
Inflow =	0.06 cfs @	12.09 hrs,	Volume=	0.005 af	
Outflow =	0.06 cfs @	12.09 hrs,	Volume=	0.005 af,	Atten= 0%, Lag= 0.0 min
Discarded =	0.06 cfs @	12.09 hrs,	Volume=	0.005 af	
Primary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 145.80' @ 0.00 hrs Surf.Area= 1,134 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (883.6 - 883.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	145.80'	678 cf	**21.00'W x 54.00'L x 2.54'H Field A** 2,882 cf Overall - 826 cf Embedded = 2,056 cf x 33.0% Voids
#2A	146.30'	826 cf	**Cultec R-150XLHD** x 30 Inside #1 Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap Row Length Adjustment= +0.75' x 2.65 sf x 6 rows
		1,505 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	145.80'	**16.680 in/hr Exfiltration over Surface area**
#2	Primary	148.60'	**2.5" x 2.5" Horiz. CB9 Grate X 36.00** C= 0.600 Limited to weir flow at low heads

Discarded OutFlow Max=0.00 cfs @ 12.09 hrs HW=145.80' (Free Discharge)
└**1=Exfiltration** (Passes 0.00 cfs of 0.44 cfs potential flow)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=145.80' TW=0.00' (Dynamic Tailwater)
└**2=CB9 Grate** (Controls 0.00 cfs)

Summary for Pond UIS2: UIS2

Inflow Area =	1.721 ac, 63.17% Impervious, Inflow Depth = 0.27" for 1-Inch event				
Inflow =	0.54 cfs @	12.07 hrs,	Volume=	0.039 af	
Outflow =	0.54 cfs @	12.07 hrs,	Volume=	0.039 af,	Atten= 0%, Lag= 0.0 min
Discarded =	0.54 cfs @	12.07 hrs,	Volume=	0.039 af	
Primary =	0.00 cfs @	0.00 hrs,	Volume=	0.000 af	

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 150.50' @ 12.07 hrs Surf.Area= 2,820 sf Storage= 0 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 0.0 min (786.9 - 786.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	150.50'	1,554 cf	**8.50'W x 131.37'L x 6.25'H Field A** 6,979 cf Overall - 2,271 cf Embedded = 4,708 cf x 33.0% Voids
#2A	151.25'	2,271 cf	**Cultec R-902HD** x 35 Inside #1 Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap Cap Storage= +2.8 cf x 2 x 1 rows = 5.5 cf
#3B	150.50'	1,038 cf	**8.50'W x 87.37'L x 6.25'H Field B** 4,641 cf Overall - 1,494 cf Embedded = 3,147 cf x 33.0% Voids
#4B	151.25'	1,494 cf	**Cultec R-902HD** x 23 Inside #3 Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap Cap Storage= +2.8 cf x 2 x 1 rows = 5.5 cf
#5C	150.50'	1,339 cf	**8.50'W x 113.03'L x 6.25'H Field C** 6,005 cf Overall - 1,948 cf Embedded = 4,057 cf x 33.0% Voids
#6C	151.25'	1,948 cf	**Cultec R-902HD** x 30 Inside #5 Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap Cap Storage= +2.8 cf x 2 x 1 rows = 5.5 cf
		9,644 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard
Storage Group C created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	150.50'	**16.680 in/hr Exfiltration over Surface area**
#2	Primary	154.00'	**2.5" x 2.5" Horiz. CB14 Grate X 36.00** C= 0.600 Limited to weir flow at low heads
#3	Device 2	152.00'	**18.0" Round Culvert** L= 42.0' Ke= 0.500 Inlet / Outlet Invert= 152.00' / 150.00' S= 0.0476 '/' Cc= 0.900 n= 0.013, Flow Area= 1.77 sf
#4	Device 3	156.25'	**4.0' long DMH11 Weir Wall** 2 End Contraction(s)

Discarded OutFlow Max=1.09 cfs @ 12.07 hrs HW=150.50' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 1.09 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=150.50' TW=0.00' (Dynamic Tailwater)
└─**2=CB14 Grate** (Controls 0.00 cfs)
  └─**3=Culvert** (Controls 0.00 cfs)
    └─**4=DMH11 Weir Wall** (Controls 0.00 cfs)

Pond UIS1: UIS1 - Chamber Wizard Field A

Chamber Model = Cultec R-150XLHD (Cultec Recharger® 150XLHD)
Effective Size= 29.8"W x 18.0"H => 2.65 sf x 10.25'L = 27.2 cf
Overall Size= 33.0"W x 18.5"H x 11.00'L with 0.75' Overlap
Row Length Adjustment= +0.75' x 2.65 sf x 6 rows

33.0" Wide + 6.0" Spacing = 39.0" C-C Row Spacing

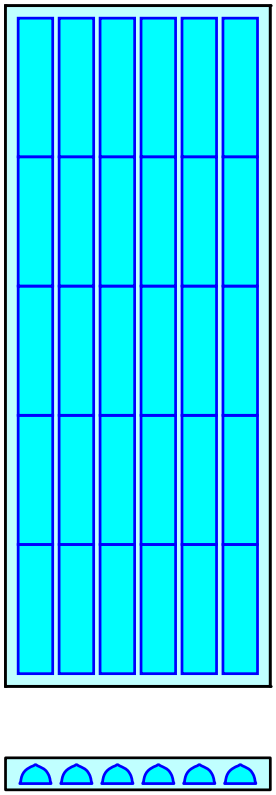
5 Chambers/Row x 10.25' Long +0.75' Row Adjustment = 52.00' Row Length +12.0" End Stone x 2 = 54.00' Base Length
6 Rows x 33.0" Wide + 6.0" Spacing x 5 + 12.0" Side Stone x 2 = 21.00' Base Width
6.0" Base + 18.5" Chamber Height + 6.0" Cover = 2.54' Field Height

30 Chambers x 27.2 cf +0.75' Row Adjustment x 2.65 sf x 6 Rows = 826.5 cf Chamber Storage

2,882.3 cf Field - 826.5 cf Chambers = 2,055.8 cf Stone x 33.0% Voids = 678.4 cf Stone Storage

Chamber Storage + Stone Storage = 1,504.9 cf = 0.035 af
Overall Storage Efficiency = 52.2%
Overall System Size = 54.00' x 21.00' x 2.54'

30 Chambers
106.8 cy Field
76.1 cy Stone



Pond UIS2: UIS2 - Chamber Wizard Field A

Chamber Model = Cultec R-902HD (Cultec Recharger® 902HD)
Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf
Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap
Cap Storage= +2.8 cf x 2 x 1 rows = 5.5 cf

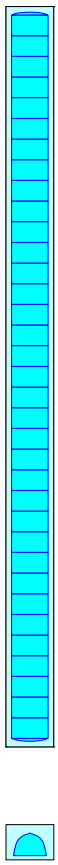
35 Chambers/Row x 3.67' Long +0.52' Cap Length x 2 = 129.37' Row Length +12.0" End Stone x 2 = 131.37' Base Length
1 Rows x 78.0" Wide + 12.0" Side Stone x 2 = 8.50' Base Width
9.0" Base + 48.0" Chamber Height + 18.0" Cover = 6.25' Field Height

35 Chambers x 64.7 cf + 2.8 cf Cap Volume x 2 x 1 Rows = 2,271.2 cf Chamber Storage

6,978.9 cf Field - 2,271.2 cf Chambers = 4,707.6 cf Stone x 33.0% Voids = 1,553.5 cf Stone Storage

Chamber Storage + Stone Storage = 3,824.8 cf = 0.088 af
Overall Storage Efficiency = 54.8%
Overall System Size = 131.37' x 8.50' x 6.25'

35 Chambers
258.5 cy Field
174.4 cy Stone



Pond UIS2: UIS2 - Chamber Wizard Field B

Chamber Model = Cultec R-902HD (Cultec Recharger® 902HD)
Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf
Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap
Cap Storage= +2.8 cf x 2 x 1 rows = 5.5 cf

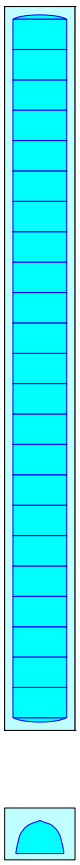
23 Chambers/Row x 3.67' Long +0.52' Cap Length x 2 = 85.37' Row Length +12.0" End Stone x 2 = 87.37' Base Length
1 Rows x 78.0" Wide + 12.0" Side Stone x 2 = 8.50' Base Width
9.0" Base + 48.0" Chamber Height + 18.0" Cover = 6.25' Field Height

23 Chambers x 64.7 cf + 2.8 cf Cap Volume x 2 x 1 Rows = 1,494.4 cf Chamber Storage

4,641.4 cf Field - 1,494.4 cf Chambers = 3,146.9 cf Stone x 33.0% Voids = 1,038.5 cf Stone Storage

Chamber Storage + Stone Storage = 2,532.9 cf = 0.058 af
Overall Storage Efficiency = 54.6%
Overall System Size = 87.37' x 8.50' x 6.25'

23 Chambers
171.9 cy Field
116.6 cy Stone



Pond UIS2: UIS2 - Chamber Wizard Field C

Chamber Model = Cultec R-902HD (Cultec Recharger® 902HD)
Effective Size= 69.8"W x 48.0"H => 17.65 sf x 3.67'L = 64.7 cf
Overall Size= 78.0"W x 48.0"H x 4.10'L with 0.44' Overlap
Cap Storage= +2.8 cf x 2 x 1 rows = 5.5 cf

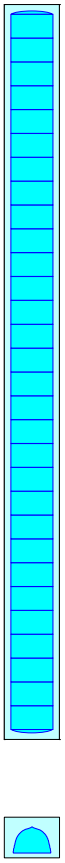
30 Chambers/Row x 3.67' Long +0.52' Cap Length x 2 = 111.03' Row Length +12.0" End Stone x 2 = 113.03' Base Length
1 Rows x 78.0" Wide + 12.0" Side Stone x 2 = 8.50' Base Width
9.0" Base + 48.0" Chamber Height + 18.0" Cover = 6.25' Field Height

30 Chambers x 64.7 cf + 2.8 cf Cap Volume x 2 x 1 Rows = 1,947.6 cf Chamber Storage

6,004.9 cf Field - 1,947.6 cf Chambers = 4,057.3 cf Stone x 33.0% Voids = 1,338.9 cf Stone Storage

Chamber Storage + Stone Storage = 3,286.5 cf = 0.075 af
Overall Storage Efficiency = 54.7%
Overall System Size = 113.03' x 8.50' x 6.25'

30 Chambers
222.4 cy Field
150.3 cy Stone



Stage-Area-Storage for Pond F1: FOREBAY1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
159.00	330	0
159.05	375	18
159.10	419	37
159.15	464	60
159.20	508	84
159.25	553	110
159.30	597	139
159.35	641	170
159.40	686	203
159.45	730	239
159.50	775	276
159.55	820	316
159.60	864	358
159.65	909	403
159.70	953	449
159.75	998	498
159.80	1,042	549
159.85	1,086	602
159.90	1,131	657
159.95	1,175	715
160.00	1,220	775
160.05	1,313	838
160.10	1,405	906
160.15	1,498	979
160.20	1,590	1,056
160.25	1,683	1,138
160.30	1,775	1,224
160.35	1,867	1,315
160.40	1,960	1,411
160.45	2,052	1,511
160.50	2,145	1,616
160.55	2,238	1,726
160.60	2,330	1,840
160.65	2,423	1,959
160.70	2,515	2,082
160.75	2,608	2,210
160.80	2,700	2,343
160.85	2,792	2,480
160.90	2,885	2,622
160.95	2,977	2,769
161.00	3,070	2,920
161.05	3,113	3,075
161.10	3,156	3,231
161.15	3,199	3,390
161.20	3,242	3,551
161.25	3,285	3,714
161.30	3,328	3,880
161.35	3,371	4,047
161.40	3,414	4,217
161.45	3,457	4,389
161.50	**3,500**	**4,563**

Stage-Area-Storage for Pond F2: FOREBAY2

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
157.50	280	0
157.51	284	3
157.52	289	6
157.53	293	9
157.54	298	12
157.55	302	15
157.56	306	18
157.57	311	21
157.58	315	24
157.59	320	27
157.60	324	30
157.61	328	33
157.62	333	37
157.63	337	40
157.64	342	44
157.65	346	47
157.66	350	50
157.67	355	54
157.68	359	58
157.69	364	61
157.70	368	65
157.71	372	69
157.72	377	72
157.73	381	76
157.74	386	80
157.75	390	84
157.76	394	88
157.77	399	92
157.78	403	96
157.79	408	100
157.80	412	104
157.81	416	108
157.82	421	112
157.83	425	116
157.84	430	121
157.85	434	125
157.86	438	129
157.87	443	134
157.88	447	138
157.89	452	143
157.90	456	147
157.91	460	152
157.92	465	156
157.93	469	161
157.94	474	166
157.95	478	171
157.96	482	175
157.97	487	180
157.98	491	185
157.99	496	190
158.00	500	195
158.01	505	200
158.02	510	205
158.03	515	210
158.04	520	215
158.05	525	221
158.06	530	226
158.07	535	231
158.08	540	237
158.09	545	242
158.10	550	247
158.11	555	253
158.12	560	259
158.13	565	264
158.14	570	270
158.15	575	276
158.16	580	281
158.17	585	287
158.18	590	293
158.19	595	299
158.20	600	305
158.21	605	311
158.22	610	317
158.23	615	323
158.24	620	329
158.25	625	336
158.26	630	342
158.27	635	348
158.28	640	355
158.29	645	361
158.30	650	368
158.31	655	374
158.32	660	381
158.33	665	387
158.34	670	394
158.35	675	401
158.36	680	407
158.37	685	414
158.38	690	421
158.39	695	428
158.40	700	435
158.41	705	442
158.42	710	449
158.43	715	456
158.44	720	463
158.45	725	471
158.46	730	478
158.47	735	485
158.48	740	493
158.49	745	500
158.50	**750**	**508**

Stage-Area-Storage for Pond F3: FOREBAY3

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
156.00	50	0
156.02	54	1
156.04	59	2
156.06	63	3
156.08	67	5
156.10	71	6
156.12	76	8
156.14	80	9
156.16	84	11
156.18	89	12
156.20	93	14
156.22	97	16
156.24	102	18
156.26	106	20
156.28	110	22
156.30	115	25
156.32	119	27
156.34	123	29
156.36	127	32
156.38	132	35
156.40	136	37
156.42	140	40
156.44	145	43
156.46	149	46
156.48	153	49
156.50	158	52
156.52	162	55
156.54	166	58
156.56	170	62
156.58	175	65
156.60	179	69
156.62	183	72
156.64	188	76
156.66	192	80
156.68	196	84
156.70	200	88
156.72	205	92
156.74	209	96
156.76	213	100
156.78	218	104
156.80	222	109
156.82	226	113
156.84	231	118
156.86	235	123
156.88	239	127
156.90	244	132
156.92	248	137
156.94	252	142
156.96	256	147
156.98	261	152
157.00	265	158
157.02	272	163
157.04	279	168
157.06	286	174
157.08	293	180
157.10	300	186
157.12	307	192
157.14	314	198
157.16	321	204
157.18	328	211
157.20	335	217
157.22	342	224
157.24	349	231
157.26	356	238
157.28	363	245
157.30	370	253
157.32	377	260
157.34	384	268
157.36	391	276
157.38	398	283
157.40	405	292
157.42	412	300
157.44	419	308
157.46	426	316
157.48	433	325
157.50	**440**	**334**

Stage-Area-Storage for Pond UIS1: UIS1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
145.80	**1,134**	0
145.85	1,134	19
145.90	1,134	37
145.95	1,134	56
146.00	1,134	75
146.05	1,134	94
146.10	1,134	112
146.15	1,134	131
146.20	1,134	150
146.25	1,134	168
146.30	1,134	187
146.35	1,134	232
146.40	1,134	276
146.45	1,134	319
146.50	1,134	363
146.55	1,134	406
146.60	1,134	449
146.65	1,134	492
146.70	1,134	534
146.75	1,134	577
146.80	1,134	619
146.85	1,134	661
146.90	1,134	702
146.95	1,134	743
147.00	1,134	784
147.05	1,134	824
147.10	1,134	864
147.15	1,134	903
147.20	1,134	941
147.25	1,134	978
147.30	1,134	1,015
147.35	1,134	1,051
147.40	1,134	1,085
147.45	1,134	1,119
147.50	1,134	1,151
147.55	1,134	1,182
147.60	1,134	1,211
147.65	1,134	1,237
147.70	1,134	1,260
147.75	1,134	1,282
147.80	1,134	1,302
147.85	1,134	1,321
147.90	1,134	1,340
147.95	1,134	1,358
148.00	1,134	1,377
148.05	1,134	1,396
148.10	1,134	1,414
148.15	1,134	1,433
148.20	1,134	1,452
148.25	1,134	1,471
148.30	1,134	1,489
148.35	1,134	**1,505**
148.40	1,134	1,505
148.45	1,134	1,505
148.50	1,134	1,505
148.55	1,134	1,505
148.60	1,134	1,505

Stage-Area-Storage for Pond UIS2: UIS2

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
150.50	**2,820**	0
150.60	2,820	93
150.70	2,820	186
150.80	2,820	279
150.90	2,820	372
151.00	2,820	465
151.10	2,820	558
151.20	2,820	651
151.30	2,820	807
151.40	2,820	1,025
151.50	2,820	1,244
151.60	2,820	1,461
151.70	2,820	1,678
151.80	2,820	1,893
151.90	2,820	2,109
152.00	2,820	2,323
152.10	2,820	2,537
152.20	2,820	2,748
152.30	2,820	2,960
152.40	2,820	3,171
152.50	2,820	3,381
152.60	2,820	3,589
152.70	2,820	3,796
152.80	2,820	4,002
152.90	2,820	4,207
153.00	2,820	4,412
153.10	2,820	4,615
153.20	2,820	4,817
153.30	2,820	5,018
153.40	2,820	5,216
153.50	2,820	5,414
153.60	2,820	5,610
153.70	2,820	5,803
153.80	2,820	5,995
153.90	2,820	6,184
154.00	2,820	6,370
154.10	2,820	6,553
154.20	2,820	6,733
154.30	2,820	6,909
154.40	2,820	7,080
154.50	2,820	7,247
154.60	2,820	7,410
154.70	2,820	7,566
154.80	2,820	7,716
154.90	2,820	7,856
155.00	2,820	7,984
155.10	2,820	8,097
155.20	2,820	8,200
155.30	2,820	8,295
155.40	2,820	8,388
155.50	2,820	8,481
155.60	2,820	8,574
155.70	2,820	8,667
155.80	2,820	8,760
155.90	2,820	8,853
156.00	2,820	8,946
156.10	2,820	9,039
156.20	2,820	9,132
156.30	2,820	9,225
156.40	2,820	9,318
156.50	2,820	9,412
156.60	2,820	9,505
156.70	2,820	**9,598**

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EX-A: EX WSD A Runoff Area=97,500 sf 40.68% Impervious Runoff Depth=0.00"
Flow Length=373' Tc=12.4 min CN=61 Runoff=0.00 cfs 0.000 af

Subcatchment PA1: WSD PA1 Runoff Area=35,831 sf 42.74% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=61 Runoff=0.00 cfs 0.000 af

Subcatchment PA2: WSD PA2 Runoff Area=3,815 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=36 Runoff=0.00 cfs 0.000 af

Subcatchment PA3: WSD PA3 Runoff Area=9,812 sf 66.53% Impervious Runoff Depth=0.06"
Tc=5.0 min CN=78 Runoff=0.00 cfs 0.001 af

Subcatchment PA4: WSD PA4 Runoff Area=25,515 sf 100.00% Impervious Runoff Depth=0.79"
Tc=5.0 min CN=98 Runoff=0.54 cfs 0.039 af

Subcatchment PA5: WSD PA5 Runoff Area=11,811 sf 81.14% Impervious Runoff Depth=0.22"
Tc=5.0 min CN=87 Runoff=0.06 cfs 0.005 af

Subcatchment PA6: WSD PA6 Runoff Area=11,075 sf 48.94% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=68 Runoff=0.00 cfs 0.000 af

Reach PR-A: PR WSD A Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond F1: FOREBAY1 Peak Elev=159.00' Storage=0 cf Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond F2: FOREBAY2 Peak Elev=157.50' Storage=0 cf Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond F3: FOREBAY3 Peak Elev=156.47' Storage=48 cf Inflow=0.00 cfs 0.001 af
Outflow=0.00 cfs 0.000 af

Pond UIS1: UIS1 Peak Elev=145.80' Storage=0 cf Inflow=0.06 cfs 0.005 af
Discarded=0.06 cfs 0.005 af Primary=0.00 cfs 0.000 af Outflow=0.06 cfs 0.005 af

Pond UIS2: UIS2 Peak Elev=150.50' Storage=0 cf Inflow=0.54 cfs 0.039 af
Discarded=0.54 cfs 0.039 af Primary=0.00 cfs 0.000 af Outflow=0.54 cfs 0.039 af

Total Runoff Area = 4.485 ac Runoff Volume = 0.045 af Average Runoff Depth = 0.12"
47.78% Pervious = 2.143 ac 52.22% Impervious = 2.342 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EX-A: EX WSD A Runoff Area=97,500 sf 40.68% Impervious Runoff Depth=0.20"
Flow Length=373' Tc=12.4 min CN=61 Runoff=0.17 cfs 0.037 af

Subcatchment PA1: WSD PA1 Runoff Area=35,831 sf 42.74% Impervious Runoff Depth=0.20"
Tc=5.0 min CN=61 Runoff=0.07 cfs 0.013 af

Subcatchment PA2: WSD PA2 Runoff Area=3,815 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=36 Runoff=0.00 cfs 0.000 af

Subcatchment PA3: WSD PA3 Runoff Area=9,812 sf 66.53% Impervious Runoff Depth=0.79"
Tc=5.0 min CN=78 Runoff=0.20 cfs 0.015 af

Subcatchment PA4: WSD PA4 Runoff Area=25,515 sf 100.00% Impervious Runoff Depth=2.27"
Tc=5.0 min CN=98 Runoff=1.46 cfs 0.111 af

Subcatchment PA5: WSD PA5 Runoff Area=11,811 sf 81.14% Impervious Runoff Depth=1.31"
Tc=5.0 min CN=87 Runoff=0.43 cfs 0.030 af

Subcatchment PA6: WSD PA6 Runoff Area=11,075 sf 48.94% Impervious Runoff Depth=0.39"
Tc=5.0 min CN=68 Runoff=0.08 cfs 0.008 af

Reach PR-A: PR WSD A Inflow=0.08 cfs 0.008 af
Outflow=0.08 cfs 0.008 af

Pond F1: FOREBAY1 Peak Elev=159.50' Storage=277 cf Inflow=0.07 cfs 0.013 af
Outflow=0.02 cfs 0.007 af

Pond F2: FOREBAY2 Peak Elev=157.50' Storage=0 cf Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond F3: FOREBAY3 Peak Elev=156.56' Storage=62 cf Inflow=0.20 cfs 0.015 af
Outflow=0.20 cfs 0.013 af

Pond UIS1: UIS1 Peak Elev=145.80' Storage=0 cf Inflow=0.43 cfs 0.030 af
Discarded=0.43 cfs 0.030 af Primary=0.00 cfs 0.000 af Outflow=0.43 cfs 0.030 af

Pond UIS2: UIS2 Peak Elev=150.71' Storage=193 cf Inflow=1.66 cfs 0.131 af
Discarded=1.09 cfs 0.131 af Primary=0.00 cfs 0.000 af Outflow=1.09 cfs 0.131 af

Total Runoff Area = 4.485 ac Runoff Volume = 0.213 af Average Runoff Depth = 0.57"
47.78% Pervious = 2.143 ac 52.22% Impervious = 2.342 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EX-A: EX WSD A Runoff Area=97,500 sf 40.68% Impervious Runoff Depth=0.47"
Flow Length=373' Tc=12.4 min CN=61 Runoff=0.64 cfs 0.087 af

Subcatchment PA1: WSD PA1 Runoff Area=35,831 sf 42.74% Impervious Runoff Depth=0.47"
Tc=5.0 min CN=61 Runoff=0.30 cfs 0.032 af

Subcatchment PA2: WSD PA2 Runoff Area=3,815 sf 0.00% Impervious Runoff Depth=0.00"
Tc=5.0 min CN=36 Runoff=0.00 cfs 0.000 af

Subcatchment PA3: WSD PA3 Runoff Area=9,812 sf 66.53% Impervious Runoff Depth=1.32"
Tc=5.0 min CN=78 Runoff=0.35 cfs 0.025 af

Subcatchment PA4: WSD PA4 Runoff Area=25,515 sf 100.00% Impervious Runoff Depth=3.03"
Tc=5.0 min CN=98 Runoff=1.92 cfs 0.148 af

Subcatchment PA5: WSD PA5 Runoff Area=11,811 sf 81.14% Impervious Runoff Depth=1.97"
Tc=5.0 min CN=87 Runoff=0.65 cfs 0.044 af

Subcatchment PA6: WSD PA6 Runoff Area=11,075 sf 48.94% Impervious Runoff Depth=0.77"
Tc=5.0 min CN=68 Runoff=0.20 cfs 0.016 af

Reach PR-A: PR WSD A Inflow=0.20 cfs 0.016 af
Outflow=0.20 cfs 0.016 af

Pond F1: FOREBAY1 Peak Elev=159.51' Storage=281 cf Inflow=0.30 cfs 0.032 af
Outflow=0.19 cfs 0.026 af

Pond F2: FOREBAY2 Peak Elev=157.50' Storage=0 cf Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond F3: FOREBAY3 Peak Elev=156.56' Storage=63 cf Inflow=0.35 cfs 0.025 af
Outflow=0.35 cfs 0.023 af

Pond UIS1: UIS1 Peak Elev=145.98' Storage=68 cf Inflow=0.65 cfs 0.044 af
Discarded=0.44 cfs 0.045 af Primary=0.00 cfs 0.000 af Outflow=0.44 cfs 0.045 af

Pond UIS2: UIS2 Peak Elev=151.09' Storage=546 cf Inflow=2.27 cfs 0.197 af
Discarded=1.09 cfs 0.197 af Primary=0.00 cfs 0.000 af Outflow=1.09 cfs 0.197 af

Total Runoff Area = 4.485 ac Runoff Volume = 0.353 af Average Runoff Depth = 0.94"
47.78% Pervious = 2.143 ac 52.22% Impervious = 2.342 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EX-A: EX WSD A Runoff Area=97,500 sf 40.68% Impervious Runoff Depth=1.33"
Flow Length=373' Tc=12.4 min CN=61 Runoff=2.55 cfs 0.249 af

Subcatchment PA1: WSD PA1 Runoff Area=35,831 sf 42.74% Impervious Runoff Depth=1.33"
Tc=5.0 min CN=61 Runoff=1.21 cfs 0.091 af

Subcatchment PA2: WSD PA2 Runoff Area=3,815 sf 0.00% Impervious Runoff Depth=0.10"
Tc=5.0 min CN=36 Runoff=0.00 cfs 0.001 af

Subcatchment PA3: WSD PA3 Runoff Area=9,812 sf 66.53% Impervious Runoff Depth=2.66"
Tc=5.0 min CN=78 Runoff=0.73 cfs 0.050 af

Subcatchment PA4: WSD PA4 Runoff Area=25,515 sf 100.00% Impervious Runoff Depth=4.70"
Tc=5.0 min CN=98 Runoff=2.93 cfs 0.230 af

Subcatchment PA5: WSD PA5 Runoff Area=11,811 sf 81.14% Impervious Runoff Depth=3.51"
Tc=5.0 min CN=87 Runoff=1.14 cfs 0.079 af

Subcatchment PA6: WSD PA6 Runoff Area=11,075 sf 48.94% Impervious Runoff Depth=1.84"
Tc=5.0 min CN=68 Runoff=0.55 cfs 0.039 af

Reach PR-A: PR WSD A Inflow=0.55 cfs 0.039 af
Outflow=0.55 cfs 0.039 af

Pond F1: FOREBAY1 Peak Elev=159.52' Storage=293 cf Inflow=1.21 cfs 0.091 af
Outflow=1.21 cfs 0.085 af

Pond F2: FOREBAY2 Peak Elev=157.60' Storage=32 cf Inflow=0.00 cfs 0.001 af
Outflow=0.00 cfs 0.000 af

Pond F3: FOREBAY3 Peak Elev=156.57' Storage=64 cf Inflow=0.73 cfs 0.050 af
Outflow=0.73 cfs 0.049 af

Pond UIS1: UIS1 Peak Elev=146.53' Storage=390 cf Inflow=1.14 cfs 0.079 af
Discarded=0.44 cfs 0.079 af Primary=0.00 cfs 0.000 af Outflow=0.44 cfs 0.079 af

Pond UIS2: UIS2 Peak Elev=152.33' Storage=3,032 cf Inflow=4.85 cfs 0.363 af
Discarded=1.09 cfs 0.363 af Primary=0.00 cfs 0.000 af Outflow=1.09 cfs 0.363 af

Total Runoff Area = 4.485 ac Runoff Volume = 0.739 af Average Runoff Depth = 1.98"
47.78% Pervious = 2.143 ac 52.22% Impervious = 2.342 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EX-A: EX WSD A Runoff Area=97,500 sf 40.68% Impervious Runoff Depth=2.19"
Flow Length=373' Tc=12.4 min CN=61 Runoff=4.45 cfs 0.408 af

Subcatchment PA1: WSD PA1 Runoff Area=35,831 sf 42.74% Impervious Runoff Depth=2.19"
Tc=5.0 min CN=61 Runoff=2.10 cfs 0.150 af

Subcatchment PA2: WSD PA2 Runoff Area=3,815 sf 0.00% Impervious Runoff Depth=0.36"
Tc=5.0 min CN=36 Runoff=0.01 cfs 0.003 af

Subcatchment PA3: WSD PA3 Runoff Area=9,812 sf 66.53% Impervious Runoff Depth=3.82"
Tc=5.0 min CN=78 Runoff=1.04 cfs 0.072 af

Subcatchment PA4: WSD PA4 Runoff Area=25,515 sf 100.00% Impervious Runoff Depth=6.03"
Tc=5.0 min CN=98 Runoff=3.73 cfs 0.294 af

Subcatchment PA5: WSD PA5 Runoff Area=11,811 sf 81.14% Impervious Runoff Depth=4.78"
Tc=5.0 min CN=87 Runoff=1.52 cfs 0.108 af

Subcatchment PA6: WSD PA6 Runoff Area=11,075 sf 48.94% Impervious Runoff Depth=2.83"
Tc=5.0 min CN=68 Runoff=0.87 cfs 0.060 af

Reach PR-A: PR WSD A Inflow=0.87 cfs 0.060 af
Outflow=0.87 cfs 0.060 af

Pond F1: FOREBAY1 Peak Elev=159.53' Storage=300 cf Inflow=2.10 cfs 0.150 af
Outflow=2.10 cfs 0.144 af

Pond F2: FOREBAY2 Peak Elev=157.65' Storage=47 cf Inflow=0.01 cfs 0.003 af
Outflow=0.00 cfs 0.002 af

Pond F3: FOREBAY3 Peak Elev=156.58' Storage=65 cf Inflow=1.04 cfs 0.072 af
Outflow=1.04 cfs 0.070 af

Pond UIS1: UIS1 Peak Elev=147.00' Storage=783 cf Inflow=1.52 cfs 0.108 af
Discarded=0.44 cfs 0.108 af Primary=0.00 cfs 0.000 af Outflow=0.44 cfs 0.108 af

Pond UIS2: UIS2 Peak Elev=153.71' Storage=5,816 cf Inflow=6.86 cfs 0.510 af
Discarded=1.09 cfs 0.510 af Primary=0.00 cfs 0.000 af Outflow=1.09 cfs 0.510 af

Total Runoff Area = 4.485 ac Runoff Volume = 1.095 af Average Runoff Depth = 2.93"
47.78% Pervious = 2.143 ac 52.22% Impervious = 2.342 ac

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment EX-A: EX WSD A Runoff Area=97,500 sf 40.68% Impervious Runoff Depth=4.25"
Flow Length=373' Tc=12.4 min CN=61 Runoff=8.99 cfs 0.792 af

Subcatchment PA1: WSD PA1 Runoff Area=35,831 sf 42.74% Impervious Runoff Depth=4.25"
Tc=5.0 min CN=61 Runoff=4.23 cfs 0.291 af

Subcatchment PA2: WSD PA2 Runoff Area=3,815 sf 0.00% Impervious Runoff Depth=1.29"
Tc=5.0 min CN=36 Runoff=0.09 cfs 0.009 af

Subcatchment PA3: WSD PA3 Runoff Area=9,812 sf 66.53% Impervious Runoff Depth=6.35"
Tc=5.0 min CN=78 Runoff=1.71 cfs 0.119 af

Subcatchment PA4: WSD PA4 Runoff Area=25,515 sf 100.00% Impervious Runoff Depth=8.79"
Tc=5.0 min CN=98 Runoff=5.38 cfs 0.429 af

Subcatchment PA5: WSD PA5 Runoff Area=11,811 sf 81.14% Impervious Runoff Depth=7.46"
Tc=5.0 min CN=87 Runoff=2.32 cfs 0.168 af

Subcatchment PA6: WSD PA6 Runoff Area=11,075 sf 48.94% Impervious Runoff Depth=5.11"
Tc=5.0 min CN=68 Runoff=1.58 cfs 0.108 af

Reach PR-A: PR WSD A Inflow=4.91 cfs 0.190 af
Outflow=4.91 cfs 0.190 af

Pond F1: FOREBAY1 Peak Elev=159.55' Storage=315 cf Inflow=4.23 cfs 0.291 af
Outflow=4.23 cfs 0.285 af

Pond F2: FOREBAY2 Peak Elev=157.66' Storage=50 cf Inflow=0.09 cfs 0.009 af
Outflow=0.07 cfs 0.008 af

Pond F3: FOREBAY3 Peak Elev=156.66' Storage=81 cf Inflow=1.71 cfs 0.119 af
Outflow=1.71 cfs 0.118 af

Pond UIS1: UIS1 Peak Elev=148.65' Storage=1,505 cf Inflow=2.32 cfs 0.168 af
Discarded=0.44 cfs 0.162 af Primary=1.10 cfs 0.006 af Outflow=1.54 cfs 0.169 af

Pond UIS2: UIS2 Peak Elev=156.66' Storage=9,563 cf Inflow=11.30 cfs 0.840 af
Discarded=1.09 cfs 0.765 af Primary=3.39 cfs 0.075 af Outflow=4.48 cfs 0.840 af

Total Runoff Area = 4.485 ac Runoff Volume = 1.918 af Average Runoff Depth = 5.13"
47.78% Pervious = 2.143 ac 52.22% Impervious = 2.342 ac

Appendix D. Falling Head Permeability Test

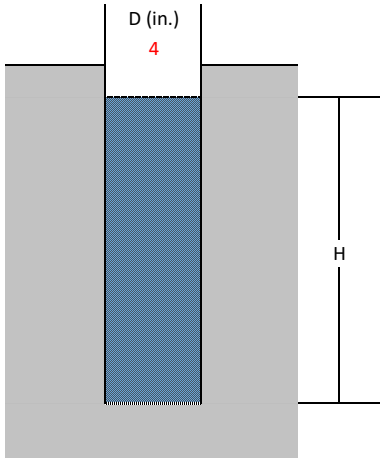
PERMEABILITY TESTING RESULTS

Falling Head Permeability Test

Project: West End
Location: 130 West Street
Test Date: November 12, 2021
Soil Evaluator: Brian King, Crossman Engineering
Witnessed By: Carl Balduf, Walpole Town Engineer

Test apparatus

36" long x 4" diameter pvc pipe
Bottom of pipe set 27" below existing grade



$$k = \frac{\pi D}{11(t_2 - t_1)} \ln(H_1/H_2)$$

Ref: Fig. 19.3
Lambe and Whitman,
Soil Mechanics,1969
Falling Head

4" Sch. 40 PVC Test Pipe

H (inches)	T (seconds)	H_1/H_2 (inches)	t_2-t_1 (seconds)	$\ln(H_1/H_2)$	Interm	k (in/sec)	k (in/hr)
36	0	n/a	n/a				
35	3	1.03	3	0.028	0.002681	0.010722	38.6
34	5	1.03	2	0.029	0.004137	0.016549	59.6
33	9	1.03	4	0.030	0.00213	0.008522	30.7
32	14	1.03	5	0.031	0.001757	0.007027	25.3
31	18	1.03	4	0.032	0.002266	0.009063	32.6
30	24	1.03	6	0.033	0.00156	0.00624	22.5
29	28	1.03	4	0.034	0.002419	0.009677	34.8
28	34	1.04	6	0.035	0.001669	0.006678	24.0
27	39	1.04	5	0.036	0.002076	0.008305	29.9
26	42	1.04	3	0.038	0.003591	0.014364	51.7
25	48	1.04	6	0.039	0.001866	0.007464	26.9
24	54	1.04	6	0.041	0.001942	0.007769	28.0
23	60	1.04	6	0.043	0.002025	0.008099	29.2
20	80	1.15	20	0.140	0.001995	0.007979	28.7
19	90	1.05	10	0.051	0.001464	0.005857	21.1
18	107	1.06	17	0.054	0.000908	0.003631	13.1
16	112	1.13	5	0.118	0.006724	0.026897	96.8

Average	33.36 in/hr
Safety Factor	2
Design K	***16.68 in/hr***

Appendix E. Groundwater Mounding Analyses

West End-Groundwater Mounding

Infiltration System	HydroCAD 100-Year Storm Exfiltrated Volume (acre-feet)	HydroCAD 100-Year Storm Exfiltrated Volume (cubic-feet)	x, (1/2) Infiltration Length (ft)	y, (1/2) Infiltration Width (ft)	t, time allowed to drain (days)	R, Recharge Rate (ft per day)	Min. Separation to ESHWT (ft)	Δhmax GW Mound Height (ft)
UIS1	0.162	7,057	27.00	10.50	3	2.074	2.00	0.352
UIS2(ABC)	0.765	33,323	165.885	4.25	3	3.939	3.50	0.857

Infiltration Rate (falling head permeability test)	16.68	in/hr
	33.36	ft/day
Horizontal Hydraulic Conductivity (inf. rate x 10)	333.6	ft/day

100 YEAR STORM
GROUNDWATER MOUND ESTIMATE
UIS 1

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

2.0740	*R*	**Recharge (infiltration) rate (feet/day)**
0.220	Sy	**Specific yield, Sy (dimensionless, between 0 and 1)**
333.60	K	**Horizontal hydraulic conductivity, Kh (feet/day)***
27.000	x	**1/2 length of basin (x direction, in feet)**
10.500	y	**1/2 width of basin (y direction, in feet)**
3.000	t	**duration of infiltration period (days)**
10.000	hi(0)	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	feet/day
0.67	1.33
2.00	4.00

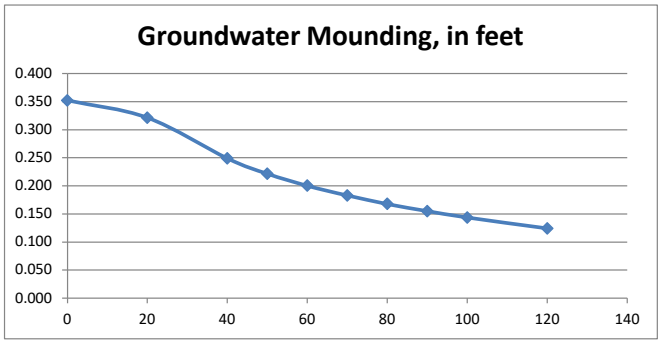
hours	days
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

10.352	h(max)	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.352	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
0.352	0
0.322	20
0.249	40
0.222	50
0.200	60
0.183	70
0.168	80
0.155	90
0.144	100
0.124	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.

100 YEAR STORM
GROUNDWATER MOUND ESTIMATE
UIS 2 (FIELDS A, B, C)

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

3.9390	***R***	**Recharge (infiltration) rate (feet/day)**
0.220	**Sy**	**Specific yield, Sy (dimensionless, between 0 and 1)**
333.60	**K**	**Horizontal hydraulic conductivity, Kh (feet/day)***
165.885	**x**	**1/2 length of basin (x direction, in feet)**
4.250	**y**	**1/2 width of basin (y direction, in feet)**
3.000	**t**	**duration of infiltration period (days)**
10.000	**hi(0)**	**initial thickness of saturated zone (feet)**

Conversion Table

inch/hour	**feet/day**
0.67	1.33
2.00	4.00

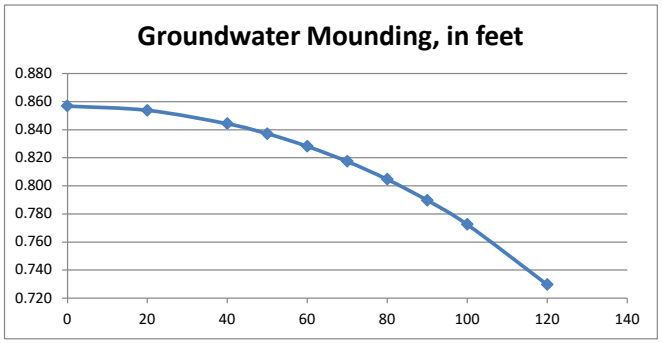
hours	**days**
36	1.50

In the report accompanying this spreadsheet (USGS SIR 2010-5102), vertical soil permeability (ft/d) is assumed to be one-tenth horizontal hydraulic conductivity (ft/d).

10.857	**h(max)**	**maximum thickness of saturated zone (beneath center of basin at end of infiltration period)**
0.857	**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**
0.857	**0**
0.854	**20**
0.844	**40**
0.837	**50**
0.828	**60**
0.817	**70**
0.805	**80**
0.790	**90**
0.772	**100**
0.730	**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.

Appendix F. Soil Evaluations

Commonwealth of Massachusetts
City/Town of Walpole: 130 West St. & 25 Spring St.

M227.00

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 23-1 (Hole #) | 9-1-23 (Date) | 7:15 am (Time) | 55 degrees-sunny (Weather) | ____ (Latitude) | ____ (Longitude)

1. Land Use: Developed (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | NA (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | ____ (Slope (%))

Description of Location: South side of site, just off pavement area

2. Soil Parent Material: Outwash | ____ (Landform) | ____ (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body ____ feet | Drainage Way ____ feet | Wetlands NA feet
   Property Line 30' feet | Drinking Water Well ____ feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 115" Depth to ~~Water in~~ Hole damp soil ~~Weep in~~ 120" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-9	Ap	sl	10YR 3/4	NA	Cnc : ____ Dpl: ____	____	____	____	gr	fr	
9-144	C1	s stratified w/fs & cs	2.5Y 5/4	NA	Cnc : ____ Dpl: ____	____	<5%	<5%	Osg	l	ESHWT=115" (elev. = 148.5)
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:
Estimated ground elevation at TP 23-1 = 158

Commonwealth of Massachusetts
City/Town of Walpole: 130 West St. & 25 Spring St.

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 23-2 (Hole #) | 9-1-23 (Date) | 8:00 am (Time) | 55 degrees-sunny (Weather) | ____ (Latitude) | ____ (Longitude)

1. Land Use: Developed (e.g., woodland, agricultural field, vacant lot, etc.) | Gravel (Vegetation) | NA (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | ____ (Slope (%))

Description of Location: Central part of site

2. Soil Parent Material: Outwash | ____ (Landform) | ____ (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body ____ feet | Drainage Way ____ feet | Wetlands ____ feet | Property Line ____ feet | Drinking Water Well ____ feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 160" Depth to ~~Weep~~ damp soil in Hole 164" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-1	gravel		___		Cnc : Dpl:						
1-12	Ap/HTM	gsl	10YR 3/4	NA	Cnc : ___ Dpl: ___	___	15%	___	gr	fr	
12-108	C1	s stratified	2.5Y 5/4	NA	Cnc : ___ Dpl: ___	___	<5%	<5%	Osg	l	
108-168	C2	cs	2.5Y 5/4	NA	Cnc : ___ Dpl: ___	___	<5%	<5%	Osg	l	ESHWT=160" (elev.=145.2)
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes: Estimated Ground Elevation at TP 23-2 =158.5

Commonwealth of Massachusetts
City/Town of Walpole: 130 West St. & 25 Spring St.

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 23-3 (Hole #) | 9-1-23 (Date) | 8:30 am (Time) | 55 degrees-sunny (Weather) | ____ (Latitude) | ____ (Longitude)

1. Land Use: Developed (e.g., woodland, agricultural field, vacant lot, etc.) | Gravel (Vegetation) | ____ (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | ____ (Slope (%))

Description of Location: West part of site

2. Soil Parent Material: Outwash | ____ (Landform) | ____ (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body ____ feet | Drainage Way ____ feet | Wetlands ____ feet
   Property Line 25' feet | Drinking Water Well ____ feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 144" Depth to ~~Weeping in~~ Hole damp soil ~~xxxxxx~~ | 147" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-8	HTM Mix	sl, pavement and gravel	10YR 3/3	NA	Cnc : ____ Dpl: ____	___	___		gr	fr	
8-45	C1	cs	2.5Y 5/4	NA	Cnc : ____ Dpl: ____	___	5%	___	Osg	l	
45-159	C2	gcs	2.5Y 5/4	NA	Cnc : ____ Dpl: ____	___	20%	___	Osg	1	ESHWT=144" (elev.= 147.0)
					Cnc : ____ Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes: Estimated ground elevation at TP 23-3 =159

Commonwealth of Massachusetts
City/Town of Walpole: 130 West St. & 25 Spring St.

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 23-4 (Hole #) | 9-1-23 (Date) | ____ (Time) | 55 degrees-sunny (Weather) | ____ (Latitude) | ____ (Longitude)

1. Land Use: Developed (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | NA (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | ____ (Slope (%))

Description of Location: Southerly part of site, 30' east of TP 23-1

2. Soil Parent Material: Outwash | ____ (Landform) | ____ (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body ____ feet | Drainage Way ____ feet | Wetlands ____ feet | Property Line ____ feet | Drinking Water Well ____ feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☐ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 120" Depth to ~~Water in Hole~~ damp ~~Weeping in Hole~~ 128" Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-8	Ap	sl	10YR 3/4	NA	Cnc : ___ Dpl: ___	___	___	___	gr	fr	
8-144	C1	s	2.5Y 5/4	NA	Cnc : ___ Dpl: ___	___	<5%	<5%	Osg	l	ESHWT+120" (elev. = 147.25)
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:
Estimated ground elevation at TP 23-4 =157.25

Commonwealth of Massachusetts
City/Town of Walpole: 130 West St. & 25 Spring St.

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 23-5 (Hole #) | 9-1-23 (Date) | 9:00 am (Time) | 60 degrees-sunny (Weather) | ____ (Latitude) | ____ (Longitude)

1. Land Use: Developed (e.g., woodland, agricultural field, vacant lot, etc.) | Vegetation: Overgrown | Surface Stones (e.g., cobbles, stones, boulders, etc.): ____ | Slope (%): ____

Description of Location: West side of site

2. Soil Parent Material: Outwash | Landform: ____ | Position on Landscape (SU, SH, BS, FS, TS, Plain): ____

3. Distances from: Open Water Body ____ feet | Drainage Way ____ feet | Wetlands ____ feet
   Property Line 30 feet | Drinking Water Well ____ feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: 163" Depth to ~~Weeping~~ damp soil in Hole | No Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	Ap	sl	10YR 3/4	___	Cnc : ___ Dpl: ___	___	___	___	gr	fr	
12-166	C1	s	2.5Y 5/4		Cnc : ___ Dpl: ___	___	<5%	<5%	Osg	l	ESHWT = 163 (elev.= 146.0)
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:
Estimated ground elevation at TP 23-5 =159.5

Commonwealth of Massachusetts
City/Town of Walpole: 130 West St. & 25 Spring St.

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

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 23-6 (Hole #) | 9-1-23 (Date) | 9:30 (Time) | 60 degrees-sunny (Weather) | _____ (Latitude) | _____ (Longitude)

1. Land Use: developed (e.g., woodland, agricultural field, vacant lot, etc.) | _____ (Vegetation) | _____ (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | _____ (Slope (%))

Description of Location: Front grass area, north side near West St.

2. Soil Parent Material: Outwash | _____ (Landform) | _____ (Position on Landscape (SU, SH, BS, FS, TS, Plain))

3. Distances from: Open Water Body _____ feet | Drainage Way _____ feet | Wetlands _____ feet | Property Line _____ feet | Drinking Water Well _____ feet | Other _____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: Dry Depth to Weeping in Hole _____ Depth to Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	Ap	sl	10YR 3/3	__	Cnc : ___ Dpl: ___	___	___	___	gr	fr	
12-120	C1	s	2.5Y 5/4	___	Cnc : ___ Dpl: ___	___	<5%	<5%	Osg	l	
120-168	C2	fs	2.5Y 5/4	___	Cnc : ___ Dpl: ___	___	<5%	<5%	Osg	l	ESHWT = 168" (elev = 143.5)
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:
Estimated ground elevation at TP 23-6 = 157.5

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 5 (Hole #) | 2-15-21 (Date) | 8:00-11:00 (Time) | Cloudy (Weather) | ____ (Latitude) | ____ (Longitude:)

1. Land Use: Developed (e.g., woodland, agricultural field, vacant lot, etc.) | ____ (Vegetation) | NA (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 6%-3% (Slope (%))

   Description of Location: 130 West Street, Walpole, MA

2. Soil Parent Material: Outwash | ____ (Landform) | Footslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body NA feet | Drainage Way NA feet | Wetlands NA feet | Property Line ____ feet | Drinking Water Well ____ feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 102" Depth Weeping from Pit 106" Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-7	Ap	ls	10YR 3/4	___	___	___	5	___	gr	fr	
7-68	C1	fs/vfs	2.5Y 5/4	___	___	___	5	___	Osg	l	
68-78	C2	vfs	2.5Y 5/4	___	___	___	5	___	Osg	l	
78-120	C3	s	2.5Y 5/4	___	___	___	5	___	Osg	l	soil damp at 86"

Additional Notes:
Recommended design GWT = 86"

Commonwealth of Massachusetts
City/Town of

Form 11 - Soil Suitability Assessment

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: 6 (Hole #) | 2-15-21 (Date) | 8:00-11:00 (Time) | Cloudy (Weather) | ____ (Latitude) | ____ (Longitude:)

1. Land Use: Developed (e.g., woodland, agricultural field, vacant lot, etc.) | ____ (Vegetation) | NA (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | ____ (Slope (%))

Description of Location: 130 West Street, Walpole, MA

2. Soil Parent Material: Outwash | ____ (Landform) | Footslope (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body NA feet | Drainage Way NA feet | Wetlands NA feet | Property Line ____ feet | Drinking Water Well ____ feet | Other ____ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☐ No If yes: 102" Depth Weeping from Pit 96" Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-7	Ap	ls	10YR 3/4	___	___	___	5	___	gr	fr	
7-23	C1	gs	2.5Y 5/4	___	___	___	35	10	Osg	l	North side of pit was HTM - stones
23-100	C2	fs	2.5Y 5/4	___	___	___	___	___	Osg	l	Soil damp @ 80"

Additional Notes:
Recommended design GWT = 80"

Appendix G. NRCS Web Soil Survey – Soil Map

Map Scale: 1:2,660 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 35 70 140 210

Feet: 0 100 200 400 600

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Norfolk and Suffolk Counties, Massachusetts
Survey Area Data: Version 16, Jun 11, 2020

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

Date(s) aerial images were photographed: Jul 28, 2019—Sep 24, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	1.8	6.2%
51	Swansea muck, 0 to 1 percent slopes	1.8	6.2%
245B	Hinckley loamy sand, 3 to 8 percent slopes	4.2	14.4%
245C	Hinckley loamy sand, 8 to 15 percent slopes	0.6	2.2%
600	Pits, sand and gravel	4.1	14.1%
602	Urban land, 0 to 15 percent slopes	16.3	56.6%
626B	Merrimac-Urban land complex, 0 to 8 percent slopes	0.1	0.2%
Totals for Area of Interest		**28.8**	**100.0%**

Appendix H. FEMA Flood Maps

National Flood Hazard Layer FIRMette

FEMA

71°15'51"W 42°8'51"N

71°15'14"W 42°8'24"N

Feet

0 250 500 1,000 1,500 2,000

1:6,000

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

- B 20.2 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 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 2/12/2021 at 3:04 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 I. Illicit Discharge Statement

MASSACHUSETTS STORMWATER STANDARD NO.10
ILLICIT DISCHARGE STATEMENT
130 WEST STREET
AP 33: LOTS 398-399
WALPOLE, MASSACHUSETTS

Per the requirements of Standard 10 of the Massachusetts Stormwater Management Standards it shall be stated there will be ***No Illicit Discharges*** constructed under the scope of the proposed development. Any existing illicit discharges discovered during construction shall be removed.

Zan C 5/27/21

Owner Contact **Date**