

Stormwater Analysis

**Monarch Drive
Littleton, Massachusetts**

Permit Set – April 2022



PREPARED FOR:

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The proposed site development will be the construction of a 98,000 s.f. industrial building. As the exact usage of the building is not yet determined, the perimeter of the parking/driveway area has been designed so that the southerly end of the building can accommodate either parking or loading bays. Loading bays will be provided at the northerly end of the building under all scenarios.

As this site is in an environmentally sensitive area as it is in the Aquifer Protection district as well as in a priority habitat area. As a result, the water quality volume is based on a 1" first flush and Low Impact Development techniques are preferable.

There are three general design methodologies being used to treat, infiltrate and attenuate runoff from the site. Tree Box Filters will be utilized along the perimeter of the parking areas, two different styles are utilized to provide a curb inlet in the front of the building and a drop inlet along the perimeter. These Tree Box Filters will be interconnected with a subsurface recharge trench that ultimately discharges into recharge basins or infiltration bed.

At the loading dock areas, the pavement pitches to a localized low area where a trench drain will capture the runoff and direct it to a hydrodynamic separator. In the event of a hazardous materials spill, a gate valve is provided prior to the hydrodynamic separator so that the contamination can be contained within the paved area immediately adjacent to the loading docks. Treated runoff from the loading docks as well as overflow from the Tree Filter Boxes is discharged into infiltration basins.

The point of analysis for the site is the northwesterly end of the drainage ditch (now BVW) as it enters the existing pond on Lot 1. A summary table of the flows is below:

HydroCAD Analysis Results				
	Storm Event Discharge Rates (cfs)			
Design Storm Event	2-Year	10-Year	25-Year	100-Year
Existing Conditions	0.03	0.31	0.93	3.64
Proposed Conditions	0.03	0.18	0.43	1.41

As Littleton is a MS4 community with a Stormwater By-law, calculations for Phosphorus removal have been included in these calculations. The total Phosphorus reduction from the developed portions of the site is 89.3 % (60% required)

This design is in full compliance with the MADEP stormwater management standards and incorporates best management practices (BMP's) consistent with low impact development (LID) and incorporates many of the concepts emphasized in LID design.

BMP's utilized:

- Tree Filter Box
- Hydrodynamic Separator
- Infiltration Basin
- Infiltration Trench

Introduction

Excerpt from MADEP Stormwater Management Standards Chapter 1:

In 1996, the Massachusetts Department of Environmental Protection (the “Department” or “MassDEP”) issued the Stormwater Policy that established Stormwater Management Standards aimed at encouraging recharge and preventing stormwater discharges from causing or contributing to the pollution of the surface waters and groundwaters of the Commonwealth. In 1997, MassDEP published the Massachusetts Stormwater Handbook as guidance on the Stormwater Policy. MassDEP has revised the Stormwater Management Standards and Massachusetts Stormwater Handbook to promote increased stormwater recharge, the treatment of more runoff from polluting land uses, low impact development (LID) techniques, pollution prevention, the removal of illicit discharges to stormwater management systems, and improved operation and maintenance of stormwater best management practices (BMPs). MassDEP applies the Stormwater Management Standards pursuant to its authority under the Wetlands Protection Act, M.G.L. c. 131, § 40, and the Massachusetts Clean Waters Act, M.G.L.c. 21, §§ 26-53. The revised Stormwater Management Standards have been incorporated in the Wetlands Protection Act Regulations, 310 CMR 10.05(6)(k) and the Water Quality Certification Regulations, 314 CMR 9.06(6)(a).

Stormwater runoff results from rainfall and snow melt and represents the single largest source responsible for water quality impairments in the Commonwealth’s rivers, lakes, ponds, and marine waters. New and existing development typically adds impervious surfaces and, if not properly managed, may alter natural drainage features, increase peak discharge rates and volumes, reduce recharge to wetlands and streams, and increase the discharge of pollutants to wetlands and water bodies.

The Stormwater Management Standards address water quality (pollutants) and water quantity (flooding, low base flow and recharge) by establishing standards that require the implementation of a wide variety of stormwater management strategies. These strategies include environmentally sensitive site design and LID techniques to minimize impervious surface and land disturbance, source control and pollution prevention, structural BMPs, construction period erosion and sedimentation control, and the long-term operation and maintenance of stormwater management systems.

Narrative – Existing Conditions

The existing site is located at the end of Monarch Drive in Littleton, MA. The proposed site is comprised of Lots 2A and 2B containing ??? acres is currently vacant land. The site was formerly mined for gravel and the remaining land has been left with little or no topsoil resulting in sparse vegetation. The soils are A manmade ditch, now qualifying as wetlands, encircles the buildable portion of the site directly adjacent to the shared access driveway, opposite of the existing office building at 1 Monarch Drive. This drainage system flows from the southwest, around the buildable area, through a 24" culvert to the east and loops back to a manmade pond on Lot 1 to the northwest of the site. The end of this drainage ditch, prior to the discharge into the pond is the Point of Analysis for this site.

The surface cover on the front portion of the site is a combination of brush/weeds interspersed with some trees as well as barren soil. This area is being categorized as brush/grass/weeds in poor condition due to the sparse vegetation and exposed soils. Generally, the more established vegetation is located within the 50' buffer to the wetlands and has been classified as wood in poor condition reflective of the thin layer of topsoil and leaf litter. There is some planted and maintained lawn areas, directly adjacent to the access driveway which is considered grass in good condition.

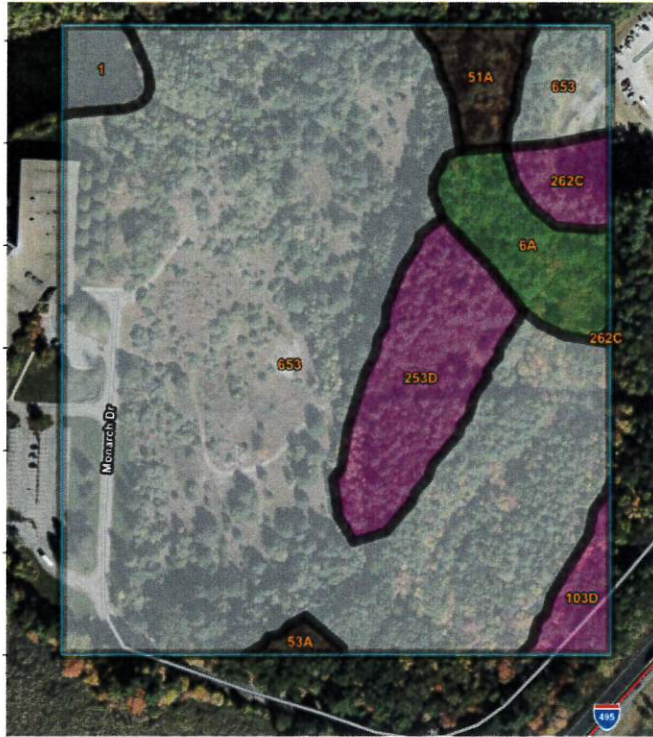
Access to the easterly side of the site is via a gravel road over the culvert. This area is wooded with tall pines and soil testing indicated 3-4" of topsoil, evidence of previous gravel mining operations. There is no shrub or herbaceous layer beneath the trees with thin forest litter, so these woods are considered fair condition.

In general, the site appears to have been graded for a pad development with a large portion of the buildable area at elevations 230 to 234. Elevations of the wetlands are approximately 224. Soil testing performed both for the current project and previous project are consistent with the groundwater table being at elevation 224 or lower.

Soils on this site are Hydrologic Group A containing udorthents and Hinckley loamy sand as indicated on the soils map below:

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
1	Water		0.8	2.0%
6A	Scarboro mucky fine sandy loam, 0 to 3 percent slopes	A/D	1.6	5.3%
51A	Swansea muck, 0 to 1 percent slopes	B/D	0.8	2.7%
53A	Freetown muck, ponded, 0 to 1 percent slopes	B/D	0.2	0.6%
103D	Charlton-Hollis-Rock outcrop complex, 15 to 25 percent slopes	A	0.6	2.2%
253D	Hinckley loamy sand, 15 to 25 percent slopes	A	2.6	8.8%
262C	Quonset sandy loam, 8 to 15 percent slopes	A	0.7	2.2%
653	Udorthents, sandy		22.8	76.3%
Totals for Area of Interest			29.9	100.0%



This site is contained in a mapped habitat area. Under a previous development proposal for a hotel, a large portion of the site was placed in a Conservation Restriction and areas designated for specific uses such as drainage or septic areas. Utilities were installed to serve the building on Lot 1.

Narrative – Proposed Conditions

The proposed site development will be the construction of a 98,000 s.f. industrial building. As the exact usage of the building is not yet determined, the perimeter of the parking/driveway area has been designed so that the southerly end of the building can accommodate either parking or loading bays. Loading bays will be provided at the northerly end of the building under all scenarios.

As this site is in an environmentally sensitive area as it is in the Aquifer Protection district as well as in a priority habitat area. As a result, the water quality volume is based on a 1" first flush and Low Impact Development techniques are preferable.

There are three general design methodologies being used to treat, infiltrate and attenuate runoff from the site. The first is with the use of Tree Filter Boxes. These will be used to capture and pre-treat the runoff from the parking areas and site driveway. There are two basic types of Tree Filter Boxes (TFB) proposed. The first is the traditional TFB where runoff enters the TFB from a curb inlet and the area around the base of the tree is covered in a tree grate. These TFB will be used adjacent to the parking areas at the front (west side) of the building. These areas are more removed from the perimeter of the site and are less likely to intercept young animals.

At the outer perimeter of the parking and loading dock areas, the second type of TFB will be utilized. These TFB will be comprised of an open bottom structure, set just below the elevation of the edge of pavement, dropping 6" to a bark mulch surface surrounding the tree. Parking lot runoff will enter the TFB via a break in the berm. This design will allow the surface surrounding the tree to be visible and if any animals are within the TFB, they can easily be viewed and freed. Both types of TFB will be interconnected with a 12" perforated pipe, set level, to allow recharge.

The catchbasin in the middle of the parking area at the front (west side) of the building must be pre-treated prior to discharge into subsurface chambers. A hydrodynamic separator, with a catchbasin grate will provide the pretreatment and direct the runoff into the chambers for recharge and attenuation.

At each loading dock area, at the north and south ends of the building, the intent is to provide emergency storage should there be any type of spill at the loading docks. The parking slopes from the loading dock to a trench drain at a localized low area. Runoff from the trench drain is routed into a catchbasin then via pipe to a hydrodynamic separator. Between the manhole and separator there will be a shut off valve. The area around the trench drain will contain a spill until it can be cleaned. From the hydrodynamic separator, the pretreated runoff will be directed into the infiltration basins on the easterly side of the building.

As Littleton is a MS4 community with a Stormwater By-law, calculations for Phosphorus removal have been included in these calculations.

This design is in full compliance with the MADEP stormwater management standards and incorporates best management practices (BMP's) consistent with low impact development (LID) and incorporates many of the concepts emphasized in LID design.

BMP's utilized:

- Tree Filter Box
- Hydrodynamic Separator
- Infiltration Basin
- Infiltration Trench

LID/Environmentally Sensitive Design Techniques utilized (Volume 1- Chapter 1):

- *Maintain as much of the pre-development vegetation as possible*
- *Maintain natural buffers and drainage ways*
- *Utilize country style drainage*

Narrative – Hydrologic Analysis

The point of analysis for the hydrologic analysis is the outlet from the existing drainage ditch, shown as Reach 3 in both the Pre and Post Development calculations.

In order to achieve both the attenuation of flow rates and a reduction in the total Phosphorus from the site recharge is required. This design has maximized the recharge to the extent practicable in order to achieve no increase in the rate of runoff for the 2 year storm event. The infiltration and stormwater basin system has been designed for overflow at the surface in order to meet the 50' no disturbance buffer zone to the wetlands. As a result, the surface stormwater basins do not overflow in the 2, 10 or 25 year storm events.

The soils on the site are a well sorted sand, with a percolation rate in excess of 2 minutes per inch. It is anticipated that runoff infiltrating into the groundwater will migrate to the same wetlands, helping to sustain the hydrology of those wetlands, despite the decrease in the rate of runoff.

The wooded area, to the east of the culvert crossing will be cleared for the septic system installation. The existing woods are considered to be Woods, fair condition due to the 3-4" of topsoil, absence of understory vegetation, both herbaceous and shrubs, and a very minimal surface litter. The Curve Number for these conditions, with A soils is 43. Under post development, the areas for the leaching field will be stabilized with 6" of loam and a conservation grass seed mix. As this area is not directly adjacent to the building, it is anticipated that it will be mowed several times a year, not weekly as the grass areas adjacent to the building. Once this area is fully vegetated, will likely have a combination of grasses, weeds and some brush given the presence of weed seed in the adjacent natural areas, in fair condition due to the excessively drained soils. Brush/weed/grass mix in fair condition has a curve number of 35. As a result, no changes are anticipated in the runoff from this portion of the property.

Documenting Compliance

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.

No untreated outfalls are proposed.

Standard 2 - Stormwater management systems shall be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates...To prevent storm damage and downstream and off-site flooding, Standard 2 requires that the post-development peak discharge rate is equal to or less than the pre-development rate from the 2-year and the 10-year 24-hour storms...Proponents must also evaluate the impact of peak discharges from the 100-year 24-hour storm. If this evaluation shows that increased off-site flooding will result from peak discharges from the 100-year 24-hour storms, BMPs must also be provided to attenuate these discharges.

The post development runoff calculations demonstrate no increase in the rate of runoff for any of the storms.

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.

Tributary Impervious area = 203,545 sq.ft. (buildings and pavement)

Class A soils = 0.6 inches x impervious area

Required recharge (Rv)= 203,545 sq.ft. x 0.6 inches x 1ft/12in = **10,177 cubic feet required**

Capture Area Adjustment:

Impervious surfaces tributary to Basins and Chambers = 132,540 + 27160+22,330=182,030

Ratio of total impervious to impervious to recharge=203,545/182,030=1.12

Adjusted minimum required recharge= 10,177x 1.12= **11,398 cubic feet required**

Static Recharge Provided (see HydroCAD output for details)

Infiltration Basin 1 (below overflow elevation 229.80) = **29,380 c.f.**

Infiltration Basin 2 & 3 (below overflow elevation 228.50) = **4,254 c.f.**

Infiltration Chambers (below outlet elevation of 228.0) = **2,215 c.f.**

Total provided= 25,600 c.f. < 11,398

Drawdown times:

To simplify, only consider infiltration in basins, excluding recharge occurring between tree filter boxes

Infiltration Basin 1

Rv= 132,540 x 0.6 x 1 ft/12in= 6627 c.f.

Time= 6627 c.f./ (8.27 in/hr)(1ft/12in)(4545 s.f.)= 2.1 hours

Infiltration Basins 2 and 3

Rv=27160x 0.6x 1/12=1358 c.f.

Time= 1358 c.f./ (8.27 in/hr)x 0.6 x1/12 x 1195)=2.75 hours

Infiltration Chambers

Rv=22,330x 0.6x 1/12=1117 c.f.

Time= 1117 c.f./ (8.27 in/hr)x 0.6 x1/12 x 1544 s.f.)=1.74 hours

Groundwater Mounding:

Use USGS Groundwater Mounding Spreadsheet with the following parameters

Rv= Recharge Volume

Recharge Rate = Rv applied over bottom for 72 hours = Rv/(bot area s.f.)(3 days)

Sy for sand= 0.26

K Horizontal Hydraulic Conductivity for coarse sand = 55

X= ½ length basin

Y=1/2 width basin

T= duration of flow = 3 days

Hi= initial thickness of saturated zone (assume 20' min. since area is an Aquifer District)

Infiltration Basin 1

R= 6627 c.f./ (4545 s.f.) x (3 days)= 0.49

Resulting Groundwater mound using Rv is 0.733'

Input Values		use consistent units (e.g. feet & days or inches & hours)		Conversion Table		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).
				inch/hour	feet/day	
0.4900	R	Recharge (infiltration) rate (feet/day)		0.67	1.33	
0.260	Sy	Specific yield, Sy (dimensionless, between 0 and 1)				
55.00	K	Horizontal hydraulic conductivity, Kh (feet/day)*		2.00	4.00	
51.000	x	1/2 length of basin (x direction, in feet)				
22.000	y	1/2 width of basin (y direction, in feet)				
3.000	t	duration of infiltration period (days)		hours	days	
15.000	hi(0)	initial thickness of saturated zone (feet)			36	
15.733	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)				
0.733	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)				

Infiltration Basins 2 and 3

$$R = 1358 \text{ c.f./3 days (1195 s.f.)} = 0.37$$

Resulting Groundwater mound using Rv is 0.187

Input Values		use consistent units (e.g. feet & days or inches & hours)		Conversion Table		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).
				inch/hour	feet/day	
0.3700	R	Recharge (infiltration) rate (feet/day)		0.67	1.33	
0.260	Sy	Specific yield, Sy (dimensionless, between 0 and 1)				
55.00	K	Horizontal hydraulic conductivity, Kh (feet/day)*		2.00	4.00	
41.000	x	1/2 length of basin (x direction, in feet)				
7.500	y	1/2 width of basin (y direction, in feet)				
3.000	t	duration of infiltration period (days)		hours	days	
15.000	hi(0)	initial thickness of saturated zone (feet)			36	
15.187	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)				
0.187	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)				

Infiltration Chambers

$$R = 1117 \text{ c.f./3 days (1544 s.f.)} = 0.03$$

Resulting Groundwater mound using Rv is 0.02'

Input Values		use consistent units (e.g. feet & days or inches & hours)		Conversion Table		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).
				inch/hour	feet/day	
0.0300	R	Recharge (infiltration) rate (feet/day)		0.67	1.33	
0.260	Sy	Specific yield, Sy (dimensionless, between 0 and 1)				
55.00	K	Horizontal hydraulic conductivity, Kh (feet/day)*		2.00	4.00	
33.000	x	1/2 length of basin (x direction, in feet)				
12.000	y	1/2 width of basin (y direction, in feet)				
3.000	t	duration of infiltration period (days)		hours	days	
15.000	hi(0)	initial thickness of saturated zone (feet)			36	
15.020	h(max)	maximum thickness of saturated zone (beneath center of basin at end of infiltration period)				
0.020	Δh(max)	maximum groundwater mounding (beneath center of basin at end of infiltration period)				

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

For purposes of Standards 3 and 4, impervious surfaces include roads, rooftops, parking lots, and sidewalks, when they are paved with concrete, asphalt, or brick pavers. (Volume 3, Chapter 1, Page 15)

Parking lot areas		Removal Rate	Remains	
Pretreatment	Tree Filter Box	85%	15%	
Treatment	Infiltration	80%	3%	

Final Rate			97%	removal
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* Tree Filter Box provided at a rate of 1/0.1 Ac. Impervious or less in compliance with UNH Stormwater Center Guidelines

Loading Dock Areas		Removal Rate	Remains	
Pretreatment	Hydrodynamic separator	80%	20%	
Treatment	Infiltration	80%	4%	
Final Rate			96%	removal

CTB front of building		Removal Rate	Remains	
Pretreatment	Hydrodynamic separator	80%	20%	
Treatment	Infiltration	80%	4%	
Final Rate			96%	removal

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 thereunder at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.

The project does not qualify as a LUHPPL.

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 "storm water 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.

This site is within a mapped Priority Habitat area. All discharge points are outside of the existing Conservation Restriction Area. The drainage design has incorporated multiple infiltration basins where the outlet utilizes natural low points or overflow weirs located outside the limits of the CR. The exception is the discharges near the cul-de-sac of Monarch Drive where existing grades in Monarch Drive are low, eliminating the ability to daylight the drainage system outside of the 50' vegetative buffer to the wetlands.

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.

The project is not proposed as redevelopment.

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.

See site plans included with this application.

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

See the Operation and Maintenance Plan included in this document.

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

Illicit Discharge Compliance Statement

To the best of my knowledge no illicit discharges currently exist on the site and no future illicit discharge will be allowed, including wastewater discharges and discharges of stormwater contaminated by contact with process wastes, raw materials, toxic pollutants, hazardous substances, oil, or grease.

Signature of Owner

Date

To be completed and submitted prior to the start of construction.

PHOSPHORUS REMOVAL:

MS4 requirements for 60% Total Phosphorous Removal.

IA= Impervious Area

PA= Pervious Area

Calculations:

BMP Design Volume = storage volume in basin which is available for recharge

IA Rainfall depth= depth of rainfall that would generate the BMP volume in the Basin.

PA BMP Volume= volume generated by the pervious areas using the IA rainfall depth and Chart 3-3 using soil type and surface cover to generate the volume (Excel chart for each BMP)

P Load= Phosphorus load based on surface cover (Appendix F, Attachment 3, Pg. 10)

BMP Reduction (%) = BMP Performance curve using infiltration rate and depth of runoff from the IA

Basin 1 (Pond 165):

Basin 1 has

Design Vol=29,380 c.f.

Infiltration Rate=8.27

Tributary Impervious= 132,540; Pervious (landscaped)= 27,585 s.f.

IA Rainfall Depth= (29,380 c.f.)/132,540 s.f. imp= 0.22 feet=2.66 inches

Note: Table 3-15 provides runoff depths for pervious surfaces with initial rainfall depths up to 2". The 100% P removal occurs with rainfall depth of 1.5" which is less than the IA rainfall depth. Therefore, these calculations will determine the minimum volume needed to achieve 100% Phosphorus removal.

From BMP Performance Curve: Infiltration Basin (Infiltration Rate = 8.27 in/hr), 100% Pollutant level is achieved with a 1.5" Depth of Runoff from the IA.

IA Rainfall Depth = 1.5"

IA Volume= IA depth (in)x 1'/12"x IA = 1.5"x1'/12"x 132,540 s.f.= 16,568 c.f

PA use Rainfall Depth 1.5" and excel spreadsheet to calculate volume of pervious areas= 322

Basin Volume for 100% P Reduction (1.5" Rainfall Depth) = IA Volume + PA Volume = 16,890 c.f. < 29,380c.f., therefore 100% reduction is achieved.

Basin 2 and 3 (Ponds 300 and 301):

Basins 2 and 3 have:

Design Vol=4254 c.f.

Infiltration Rate=8.27

Tributary Impervious= 27,160; Pervious (landscaped)= 33,305 s.f.

IA Rainfall Depth= (4115 c.f.)/27,160 s.f. imp= 0.151 feet=1.81 inches

Note: Table 3-15 provides runoff depths for pervious surfaces with initial rainfall depths up to 2". The 100% P removal occurs with rainfall depth of 1.5" which is less than the IA rainfall depth. Therefore, these calculations will determine the minimum volume needed to achieve 100% Phosphorus removal.

From BMP Performance Curve: Infiltration Basin (Infiltration Rate = 8.27 in/hr), 100% Pollutant level is achieved with a 1.5" Depth of Runoff from the IA.

IA Rainfall Depth = 1.5"

IA Volume= IA depth (in)x 1'/12"x IA = 1.5"x1'/12"x 27,160 s.f.= 3,395 c.f

PA use Rainfall Depth 1.5" and excel spreadsheet to calculated volume of pervious areas= 389

Basin Volume for 100% P Reduction (1.5" Rainfall Depth) = IA Volume + PA Volume = 3,784 c.f. < 4,115 c.f., therefore 100% reduction is achieved.

Infiltration Trenches and Infiltration Chamber (Ponds 220 and 222):

Design Vol=3,777 c.f.

Infiltration Rate=8.27

Tributary Impervious= 22,330; Pervious (landscaped)= 3845 s.f.

IA Rainfall Depth= (3,777 c.f.)/22,330 s.f. imp= 0.169 feet =2.03 inches

Note: Table 3-9 provides runoff depths for pervious surfaces with initial rainfall depths up to 2". The 100% P removal occurs with rainfall depth of 1.5" which is less than the IA rainfall depth. Therefore, these calculations will determine the minimum volume needed to achieve 100% Phosphorus removal.

From BMP Performance Curve: Infiltration Basin (Infiltration Rate = 8.27 in/hr), 100% Pollutant level is achieved with a 1.5" Depth of Runoff from the IA.

IA Rainfall Depth = 1.5"

IA Volume= IA depth (in)x 1'/12"x IA = 1.5"x1'/12"x 22,330 s.f.= 2,791 c.f

PA use Rainfall Depth 1.5" and excel spreadsheet to calculated volume of pervious areas= 45

Basin Volume for 100% P Reduction (1.5" Rainfall Depth) = IA Volume + PA Volume = 2,836 c.f. < 3,777 c.f., therefore 100% reduction is achieved.

TOTAL REDUCTION OF PHOSPHORUS LOAD SITEWIDE = 89.38 % >60%

Supporting Data – Phosphorus Removal

5554 VMD Post- Development

NRCC 24-hr D 25-Year Rainfall=5.87"

Prepared by Places Associates, Inc.

Printed 4/8/2022

HydroCAD® 10.10-7b s/n 02908 © 2022 HydroCAD Software Solutions LLC

Stage-Area-Storage for Pond 165: infiltration basin

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
226.00	4,515	0	228.60	9,015	17,289
226.05	4,592	228	228.65	9,112	17,743
226.10	4,668	459	228.70	9,209	18,201
226.15	4,745	694	228.75	9,306	18,664
226.20	4,821	934	228.80	9,403	19,131
226.25	4,898	1,177	228.85	9,499	19,604
226.30	4,974	1,423	228.90	9,596	20,081
226.35	5,050	1,674	228.95	9,693	20,563
226.40	5,127	1,928	229.00	9,790	21,051
226.45	5,203	2,187	229.05	9,868	21,542
226.50	5,280	2,449	229.10	9,945	22,037
226.55	5,357	2,715	229.15	10,023	22,536
226.60	5,433	2,984	229.20	10,101	23,040
226.65	5,510	3,258	229.25	10,179	23,547
226.70	5,586	3,535	229.30	10,257	24,057
226.75	5,663	3,817	229.35	10,334	24,572
226.80	5,739	4,102	229.40	10,412	25,091
226.85	5,815	4,390	229.45	10,490	25,613
226.90	5,892	4,683	229.50	10,568	26,140
226.95	5,968	4,980	229.55	10,645	26,670
227.00	6,045	5,280	229.60	10,723	27,204
227.05	6,135	5,585	229.65	10,801	27,742
227.10	6,226	5,894	229.70	10,878	28,284
227.15	6,316	6,207	229.75	10,956	28,830
227.20	6,407	6,525	229.80	11,034	29,380
227.25	6,497	6,848	229.85	11,112	29,934
227.30	6,587	7,175	229.90	11,190	30,491
227.35	6,678	7,506	229.95	11,267	31,053
227.40	6,768	7,843	230.00	11,345	31,618
227.45	6,859	8,183			
227.50	6,949	8,529			
227.55	7,039	8,878			
227.60	7,130	9,232			
227.65	7,220	9,591			
227.70	7,311	9,954			
227.75	7,401	10,322			
227.80	7,491	10,695			
227.85	7,582	11,071			
227.90	7,672	11,453			
227.95	7,763	11,839			
228.00	7,853	12,229			
228.05	7,950	12,624			
228.10	8,047	13,024			
228.15	8,144	13,429			
228.20	8,240	13,838			
228.25	8,337	14,253			
228.30	8,434	14,672			
228.35	8,531	15,096			
228.40	8,628	15,525			
228.45	8,725	15,959			
228.50	8,822	16,398			
228.55	8,918	16,841			

5554 VMD Post- Development

NRCC 24-hr D 25-Year Rainfall=5.87"

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Stage-Area-Storage for Pond 220: Infiltration Chambers

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
226.00	1,556	0	228.60	1,556	2,782
226.05	1,556	31	228.65	1,556	2,815
226.10	1,556	62	228.70	1,556	2,847
226.15	1,556	93	228.75	1,556	2,878
226.20	1,556	125	228.80	1,556	2,909
226.25	1,556	156	228.85	1,556	2,940
226.30	1,556	187	228.90	1,556	2,971
226.35	1,556	218	228.95	1,556	3,002
226.40	1,556	249	229.00	1,556	3,034
226.45	1,556	280	229.05	1,556	3,065
226.50	1,556	311	229.10	1,556	3,096
226.55	1,556	380	229.15	1,556	3,127
226.60	1,556	448	229.20	1,556	3,158
226.65	1,556	515			
226.70	1,556	582			
226.75	1,556	649			
226.80	1,556	716			
226.85	1,556	782			
226.90	1,556	848			
226.95	1,556	915			
227.00	1,556	981			
227.05	1,556	1,046			
227.10	1,556	1,111			
227.15	1,556	1,176			
227.20	1,556	1,240			
227.25	1,556	1,304			
227.30	1,556	1,367			
227.35	1,556	1,431			
227.40	1,556	1,493			
227.45	1,556	1,556			
227.50	1,556	1,618			
227.55	1,556	1,680			
227.60	1,556	1,742			
227.65	1,556	1,803			
227.70	1,556	1,863			
227.75	1,556	1,923			
227.80	1,556	1,982			
227.85	1,556	2,041			
227.90	1,556	2,099			
227.95	1,556	2,156			
228.00	1,556	2,212			
228.05	1,556	2,267			
228.10	1,556	2,322			
228.15	1,556	2,375			
228.20	1,556	2,428			
228.25	1,556	2,479			
228.30	1,556	2,529			
228.35	1,556	2,577			
228.40	1,556	2,623			
228.45	1,556	2,668			
228.50	1,556	2,709			
228.55	1,556	2,747			

5554 VMD Post- Development

NRCC 24-hr D 25-Year Rainfall=5.87"

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Stage-Area-Storage for Pond 222: Recharge Trench

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
228.00	690	0	229.04	690	718
228.02	690	14	229.06	690	731
228.04	690	28	229.08	690	745
228.06	690	41	229.10	690	759
228.08	690	55	229.12	690	773
228.10	690	69	229.14	690	787
228.12	690	83	229.16	690	800
228.14	690	97	229.18	690	814
228.16	690	110	229.20	690	828
228.18	690	124	229.22	690	842
228.20	690	138	229.24	690	856
228.22	690	152	229.26	690	869
228.24	690	166	229.28	690	883
228.26	690	179	229.30	690	897
228.28	690	193	229.32	690	911
228.30	690	207	229.34	690	925
228.32	690	221	229.36	690	938
228.34	690	235	229.38	690	952
228.36	690	248	229.40	690	966
228.38	690	262	229.42	690	980
228.40	690	276	229.44	690	994
228.42	690	290	229.46	690	1,007
228.44	690	304	229.48	690	1,021
228.46	690	317	229.50	690	1,035
228.48	690	331	229.52	690	1,049
228.50	690	345	229.54	690	1,063
228.52	690	359	229.56	690	1,076
228.54	690	373	229.58	690	1,090
228.56	690	386	229.60	690	1,104
228.58	690	400	229.62	690	1,118
228.60	690	414	229.64	690	1,132
228.62	690	428	229.66	690	1,145
228.64	690	442	229.68	690	1,159
228.66	690	455	229.70	690	1,173
228.68	690	469	229.72	690	1,187
228.70	690	483	229.74	690	1,201
228.72	690	497	229.76	690	1,214
228.74	690	511	229.78	690	1,228
228.76	690	524	229.80	690	1,242
228.78	690	538	229.82	690	1,256
228.80	690	552	229.84	690	1,270
228.82	690	566	229.86	690	1,283
228.84	690	580	229.88	690	1,297
228.86	690	593	229.90	690	1,311
228.88	690	607	229.92	690	1,325
228.90	690	621	229.94	690	1,339
228.92	690	635	229.96	690	1,352
228.94	690	649	229.98	690	1,366
228.96	690	662	230.00	690	1,380
228.98	690	676			
229.00	690	690			
229.02	690	704			

5554 VMD Post- Development

NRCC 24-hr D 25-Year Rainfall=5.87"

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Stage-Area-Storage for Pond 300: Infiltration 1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
227.00	900	0	228.04	2,756	1,862
227.02	934	18	228.06	2,830	1,918
227.04	968	37	228.08	2,903	1,976
227.06	1,003	57	228.10	2,976	2,034
227.08	1,037	77	228.12	3,049	2,095
227.10	1,071	99	228.14	3,122	2,156
227.12	1,105	120	228.16	3,196	2,219
227.14	1,139	143	228.18	3,269	2,284
227.16	1,174	166	228.20	3,342	2,350
227.18	1,208	190	228.22	3,415	2,418
227.20	1,242	214	228.24	3,488	2,487
227.22	1,276	239	228.26	3,562	2,557
227.24	1,310	265	228.28	3,635	2,629
227.26	1,345	292	228.30	3,708	2,703
227.28	1,379	319	228.32	3,781	2,778
227.30	1,413	347	228.34	3,854	2,854
227.32	1,447	376	228.36	3,928	2,932
227.34	1,481	405	228.38	4,001	3,011
227.36	1,516	435	228.40	4,074	3,092
227.38	1,550	465	228.42	4,147	3,174
227.40	1,584	497	228.44	4,220	3,258
227.42	1,618	529	228.46	4,294	3,343
227.44	1,652	562	228.48	4,367	3,429
227.46	1,687	595	228.50	4,440	3,518
227.48	1,721	629	228.52	4,694	3,609
227.50	1,755	664	228.54	4,948	3,705
227.52	1,789	699	228.56	5,202	3,807
227.54	1,823	735	228.58	5,456	3,913
227.56	1,858	772	228.60	5,710	4,025
227.58	1,892	810	228.62	5,964	4,142
227.60	1,926	848	228.64	6,218	4,264
227.62	1,960	887	228.66	6,472	4,390
227.64	1,994	926	228.68	6,726	4,522
227.66	2,029	966	228.70	6,980	4,659
227.68	2,063	1,007	228.72	7,234	4,802
227.70	2,097	1,049	228.74	7,488	4,949
227.72	2,131	1,091	228.76	7,742	5,101
227.74	2,165	1,134	228.78	7,996	5,259
227.76	2,200	1,178	228.80	8,250	5,421
227.78	2,234	1,222	228.82	8,504	5,589
227.80	2,268	1,267	228.84	8,758	5,761
227.82	2,302	1,313	228.86	9,012	5,939
227.84	2,336	1,359	228.88	9,266	6,122
227.86	2,371	1,406	228.90	9,520	6,310
227.88	2,405	1,454	228.92	9,774	6,502
227.90	2,439	1,503	228.94	10,028	6,700
227.92	2,473	1,552	228.96	10,282	6,904
227.94	2,507	1,601	228.98	10,536	7,112
227.96	2,542	1,652	229.00	10,790	7,325
227.98	2,576	1,703			
228.00	2,610	1,755			
228.02	2,683	1,808			

5554 VMD Post- Development

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Stage-Area-Storage for Pond 301: Infiltration 1

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
227.00	295	0	228.04	559	442
227.02	300	6	228.06	566	453
227.04	305	12	228.08	573	465
227.06	310	18	228.10	579	476
227.08	315	24	228.12	586	488
227.10	320	31	228.14	593	500
227.12	325	37	228.16	600	512
227.14	330	44	228.18	607	524
227.16	335	50	228.20	614	536
227.18	340	57	228.22	621	548
227.20	345	64	228.24	628	561
227.22	350	71	228.26	635	573
227.24	355	78	228.28	642	586
227.26	360	85	228.30	649	599
227.28	365	92	228.32	655	612
227.30	370	100	228.34	662	625
227.32	375	107	228.36	669	639
227.34	380	115	228.38	676	652
227.36	385	122	228.40	683	666
227.38	390	130	228.42	690	679
227.40	395	138	228.44	697	693
227.42	400	146	228.46	704	707
227.44	405	154	228.48	711	721
227.46	410	162	228.50	718	736
227.48	415	170	228.52	724	750
227.50	420	179	228.54	731	765
227.52	425	187	228.56	738	779
227.54	430	196	228.58	745	794
227.56	435	204	228.60	752	809
227.58	440	213	228.62	759	824
227.60	445	222	228.64	766	839
227.62	450	231	228.66	773	855
227.64	455	240	228.68	780	870
227.66	460	249	228.70	786	886
227.68	465	258	228.72	793	902
227.70	470	268	228.74	800	918
227.72	475	277	228.76	807	934
227.74	480	287	228.78	814	950
227.76	485	296	228.80	821	966
227.78	490	306	228.82	828	983
227.80	495	316	228.84	835	1,000
227.82	500	326	228.86	842	1,016
227.84	505	336	228.88	849	1,033
227.86	510	346	228.90	856	1,050
227.88	515	356	228.92	862	1,067
227.90	520	367	228.94	869	1,085
227.92	525	377	228.96	876	1,102
227.94	530	388	228.98	883	1,120
227.96	535	398	229.00	890	1,138
227.98	540	409			
228.00	545	420			
228.02	552	431			

Table 3-1: Average annual distinct phosphorus load (P Load) export rates for use in estimating phosphorus load reduction credits the MA MS4 Permit

Phosphorus Source Category by Land Use	Land Surface Cover	P Load Export Rate, lbs/acre/year	P Load Export Rate, kg/ha/yr
Commercial (Com) and Industrial (Ind)	Directly connected impervious	1.78	2.0
	Pervious	See* DevPERV	See* DevPERV
Multi-Family (MFR) and High-Density Residential (HDR)	Directly connected impervious	2.32	2.6
	Pervious	See* DevPERV	See* DevPERV
Medium -Density Residential (MDR)	Directly connected impervious	1.96	2.2
	Pervious	See* DevPERV	See* DevPERV
Low Density Residential (LDR) - "Rural"	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Highway (HWY)	Directly connected impervious	1.34	1.5
	Pervious	See* DevPERV	See* DevPERV
Forest (For)	Directly connected impervious	1.52	1.7
	Pervious	0.13	0.13
Open Land (Open)	Directly connected impervious	1.52	1.7
	Pervious	See* DevPERV	See* DevPERV
Agriculture (Ag)	Directly connected impervious	1.52	1.7
	Pervious	0.45	0.5
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group A	Pervious	0.03	0.03
*Developed Land Pervious (DevPERV)- Hydrologic Soil Group B	Pervious	0.12	0.13
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C	Pervious	0.21	0.24
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group C/D	Pervious	0.29	0.33
*Developed Land Pervious (DevPERV) - Hydrologic Soil Group D	Pervious	0.37	0.41

VMD MONARCH DRIVE INDUSTRIAL DEVELOPMENT

PHOSPHORUS REMOVAL CALCULATIONS

Basin Number	IMPERVIOUS				Soil Type	Forest/ woods					Lawn/Landscaped Areas					Total P	100% Reduction of Total P
	S.F	Ac.	P load Chart 3-1	Rainfall Depth for 100%		S.F	Ac.	P load Chart 3-1	Runoff depth Chart 3-3	Runoff Volume	S.F	Ac.	P load Chart 3-1	Runoff depth Chart 3-3	Runoff Volume		
Basin 1	132,540	3.043	5.96	1.50	A	0	0.000	0.00	0.14	0	27,585	0.633	0.02	0.14	322		
					B	0	0.000	0.00	0.22	0	0	0.000	0.00	0.22	0		
					C	0	0.000	0.00	0.69	0	0	0.000	0.00	0.69	0		
					D		0.000	0.00	0.89	0	0	0.000	0.00	0.89	0		
Totals		3.043	5.96			0	0.000	0.00		0	27585	0.633	0.02		322	5.98	5.98

PA Total Runoff Volume 322

Basin Number	IMPERVIOUS				Soil Type	Forest/ woods					Lawn/Landscaped Areas					Total P	100% Reduction of Total P
	S.F	Ac.	P load Chart 3-1	Rainfall Depth for 100%		S.F	Ac.	P load Chart 3-1	Runoff depth Chart 3-3	Runoff Volume	S.F	Ac.	P load Chart 3-1	Runoff depth Chart 3-3	Runoff Volume		
Basin 2 and 3	27,160	0.624	1.22	1.50	A	0	0.000	0.00	0.14	0	33,305	0.765	0.02	0.14	389		
					B	0	0.000	0.00	0.22	0	0	0.000	0.00	0.22	0		
					C	0	0.000	0.00	0.69	0	0	0.000	0.00	0.69	0		
					D		0.000	0.00	0.89	0	0	0.000	0.00	0.89	0		
Totals		0.624	1.22			0	0.000	0.00		0	33305	0.765	0.02		389	1.25	1.25

PA Total Runoff Volume 389

Basin Number	IMPERVIOUS				Soil Type	Forest/ woods					Lawn/Landscaped Areas					Total P	100% Reduction of Total P
	S.F	Ac.	P load Chart 3-1	Rainfall Depth for 100%		S.F	Ac.	P load Chart 3-1	Runoff depth Chart 3-3	Runoff Volume	S.F	Ac.	P load Chart 3-1	Runoff depth Chart 3-3	Runoff Volume		
Infiltration Trench and Chambers	22,330	0.513	1.00	1.50	A	0	0.000	0.00	0.14	0	3,845	0.088	0.00	0.14	45		
					B	0	0.000	0.00	0.22	0	0	0.000	0.00	0.22	0		
					C	0	0.000	0.00	0.69	0	0	0.000	0.00	0.69	0		
					D		0.000	0.00	0.89	0	0	0.000	0.00	0.89	0		
Totals		0.513	1.00			0	0.000	0.00		0	3845	0.088	0.00		45	1.01	1.01

PA Total Runoff Volume 45

8.24

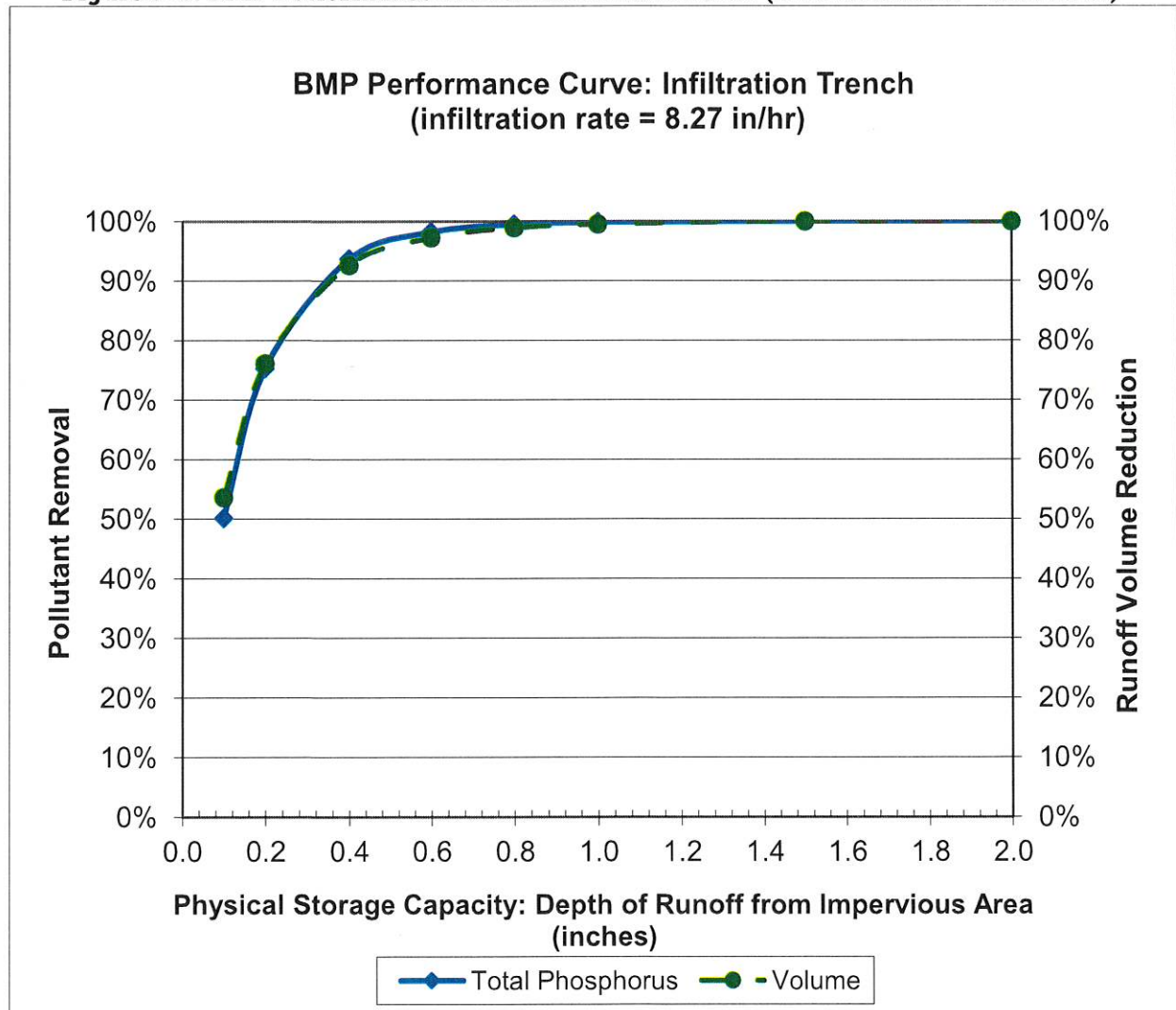
PHOSPHORUS LOAD FOR ALL DISTURBED AREAS OF SITE

Basin Number	IMPERVIOUS			Soil Type	Forest			Lawn/Landscaped Areas			Total P	Total P Reduction	Percent of Reduction
	S.F	Ac.	P load		S.F	Ac.	P load	S.F	Ac.	P load			
Entire Site	203545	4.673	9.16	A	0	0.000	0.00	87400	2.006	0.06			
				B	0	0.00	0.00	0	0.000	0.00			
				C	0	0.00	0.00	0	0.000	0.00			
				D	0	0.00	0.00	0	0.000	0.00			
Totals		4.673	9.16		0		0.00	87400	2.006	0.06	9.22	8.24	89.38

* Lawn/landscaped areas includes all areas included in the HydroCAD calculations (75,400 s.f.) plus an estimated 12,000 s.f. representing the wooded area where the septic system leaching areas will be installed. It should be noted that this Percentage of Reduction is a reduction of the post developed site without BMPs versus with the BMPs.

Table 3- 9: Infiltration Trench (8.27 in/hr) BMP Performance Table

Infiltration Trench (8.27 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	53.6%	76.1%	92.6%	97.2%	98.9%	99.5%	100.0%	100.0%
Cumulative Phosphorus Load Reduction	50%	75%	94%	98%	99%	100%	100%	100%

Figure 3- 6: BMP Performance Curve: Infiltration Trench (infiltration rate = 8.27 in/hr)

Flow Chart 3: Method to determine the design storage volume of a BMP to reach a known P load reduction when both impervious and pervious drainage areas are present.

- 1) Determine the desired cumulative phosphorus load reduction target (P_{target}) in percentage for the structural BMP;
- 2) Characterize the contributing drainage area to the structural BMP by identifying the following information for the impervious and pervious surfaces:

Impervious area (IA) - Area (acre) and land use (e.g., commercial)

Pervious area (PA) – Area (acre) and runoff depths based on hydrologic soil group (HSG) and rainfall depth. Table 3-3 provides values of runoff depth from pervious areas for various rainfall depths and HSGs. Soils are assigned to an HSG on the basis of their permeability. HSG A is the most permeable, and HSG D is the least permeable. HSG categories for pervious areas in the drainage area shall be estimated by consulting local soil surveys prepared by the National Resource Conservation Service (NRCS) or by a storm water professional evaluating soil testing results from the drainage area. If the HSG condition is not known, a HSG D soil condition should be assumed.

Table 3- 3: Developed Land Pervious Area Runoff Depths based on Precipitation depth and Hydrological Soil Groups (HSGs)

Developed Land Pervious Area Runoff Depths based on Precipitation depth and Hydrological Soil Groups					
Rainfall Depth, Inches	Runoff Depth, inches				
	Pervious HSG A	Pervious HSG B	Pervious HSG C	Pervious HSG C/D	Pervious HSG D
0.10	0.00	0.00	0.00	0.00	0.00
0.20	0.00	0.00	0.01	0.02	0.02
0.40	0.00	0.00	0.03	0.05	0.06
0.50	0.00	0.01	0.05	0.07	0.09
0.60	0.01	0.02	0.06	0.09	0.11
0.80	0.02	0.03	0.09	0.13	0.16
1.00	0.03	0.04	0.12	0.17	0.21
1.20	0.04	0.05	0.14	0.27	0.39
1.50	0.08	0.11	0.39	0.55	0.72
2.00	0.14	0.22	0.69	0.89	1.08

Notes: Runoff depths derived from combination of volumetric runoff coefficients from Table 5 of *Small Storm Hydrology and Why it is Important for the Design of Stormwater Control Practices*, (Pitt, 1999), and using the Stormwater Management Model (SWMM) in continuous model mode for hourly precipitation data for Boston, MA, 1998-2002.

- 3) Determine the structural BMP type (e.g., infiltration trench, gravel wetland). For infiltration systems, determine the appropriate infiltration rate for the location of the BMP in the Watershed;
- 4) Using the cumulative phosphorus removal performance curve for the selected structural BMP, determine the storage volume capacity of the BMP in inches needed to treat runoff from the contributing impervious area (BMP-Volume_{IA-in});

Table 3- 15: Infiltration Basin (8.27 in/hr) BMP Performance Table

Infiltration Basin (8.27 in/hr) BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Runoff Volume Reduction	54.6%	77.2%	93.4%	97.5%	99.0%	99.6%	100.0%	100.0%
Cumulative Phosphorus Load Reduction	59%	81%	96%	99%	100%	100%	100%	100%

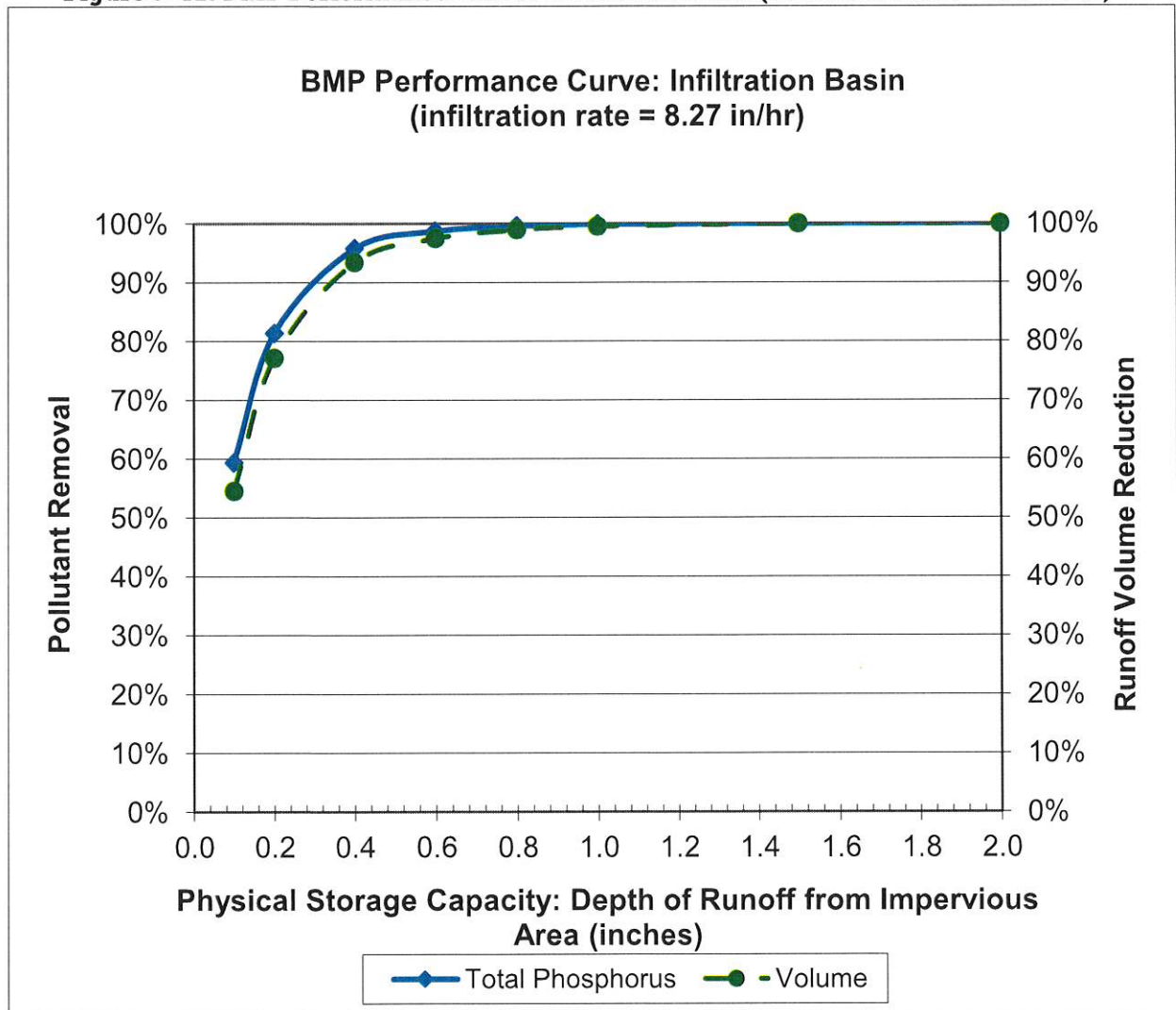
Figure 3- 12: BMP Performance Curve: Infiltration Basin (infiltration rate = 8.27 in/hr)

Table 3- 16: Biofiltration BMP Performance Table

Biofiltration BMP Performance Table: Long-Term Phosphorus Load Reduction								
BMP Capacity: Depth of Runoff Treated from Impervious Area (inches)	0.1	0.2	0.4	0.6	0.8	1.0	1.5	2.0
Cumulative Phosphorus Load Reduction	19%	34%	53%	64%	71%	76%	84%	89%

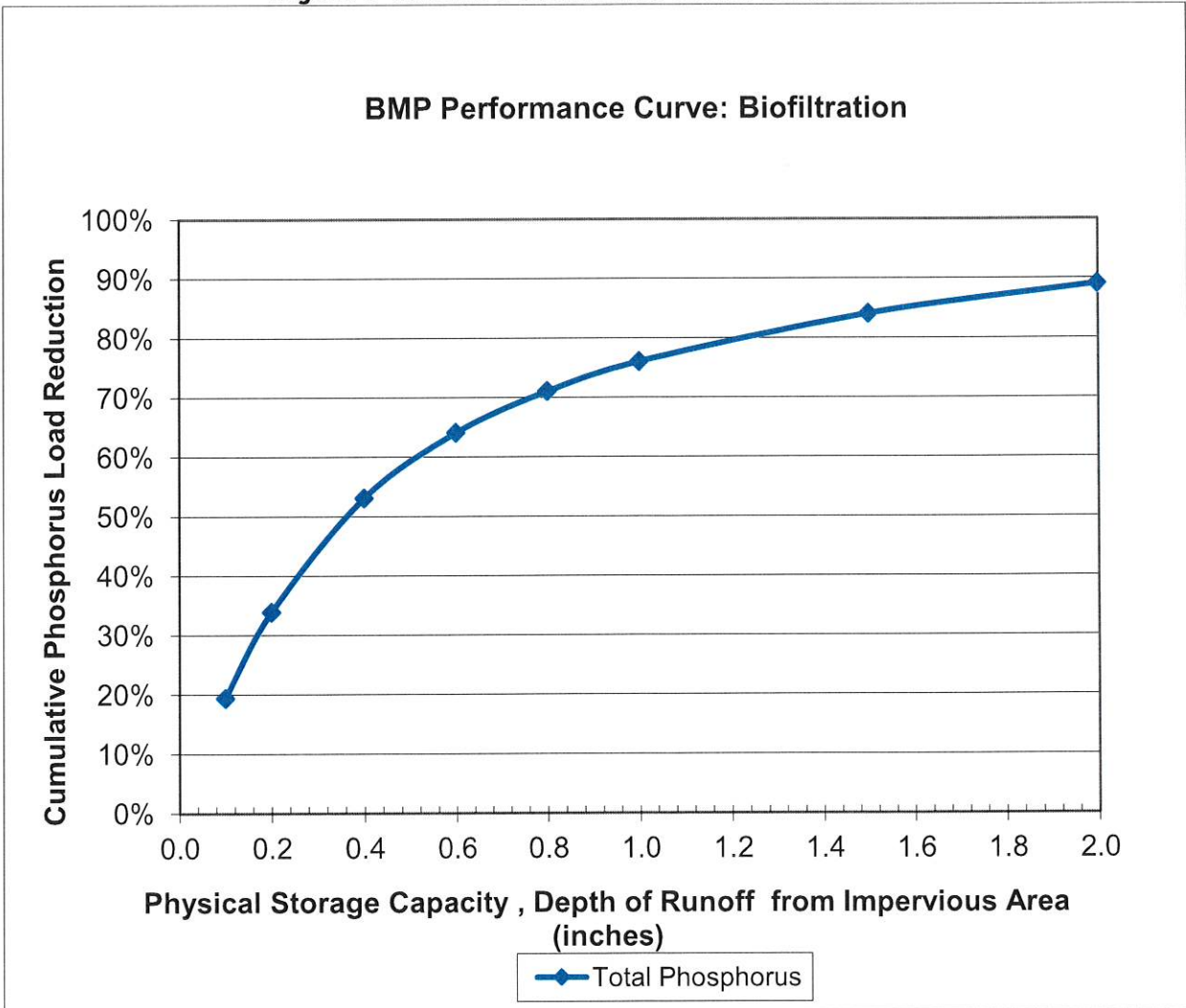
Figure 3- 13: BMP Performance Curve: Biofiltration

Table 3-30 Method for determining stormwater control design volume (DSV) (i.e., capacity) using Long-term cumulative performance curves

Stormwater Control Type	Description	Applicable Structural Stormwater Control Performance Curve	Equation for calculating Design Storage Capacity for Estimating Cumulative Reductions using Performance Curves
Infiltration Trench	Provides temporary storage of runoff using the void spaces within the soil/sand/gravel mixture that is used to backfill the trench for subsequent infiltration into the surrounding sub-soils.	Infiltration Trench (6 infiltration rates: 0.17, 0.27, 0.52, 1.02, 2.41 and 8.27 inches per hour)	DSV = void space volumes of gravel and sand layers $DSV = (L \times W \times D_{\text{stone}} \times n_{\text{stone}}) + (L \times W \times D_{\text{sand}} \times n_{\text{sand}})$
Subsurface Infiltration	Provides temporary storage of runoff using the combination of storage structures (e.g., galleries, chambers, pipes, etc.) and void spaces within the soil/sand/gravel mixture that is used to backfill the system for subsequent infiltration into the surrounding sub-soils.	Infiltration Trench (6 infiltration rates: 0.17, 0.27, 0.52, 1.02, 2.41 and 8.27 inches per hour)	DSV = Water storage volume of storage units and void space volumes of backfill materials. Example for subsurface galleries backfilled with washed stone: $DSV = (L \times W \times D_{\text{gallery}} + (L \times W \times D_{\text{stone}} \times n_{\text{stone}}))$
Surface Infiltration	Provides temporary storage of runoff through surface ponding storage structures (e.g., basin or swale) for subsequent infiltration into the underlying soils.	Infiltration Basin (6 infiltration rates: 0.17, 0.27, 0.52, 1.02, 2.41 and 8.27 inches per hour)	DSV = Water volume of storage structure before bypass. Example for linear trapezoidal vegetated swale $DSV = (L \times ((W_{\text{bottom}} + W_{\text{top}}) \times D) / 2) \times D$
Rain Garden/Bio-retention (no underdrains)	Provides temporary storage of runoff through surface ponding and possibly void spaces within the soil/sand/gravel mixture that is used to filter runoff prior to infiltration into underlying soils.	Infiltration Basin (6 infiltration rates: 0.17, 0.27, 0.52, 1.02, 2.41 and 8.27 inches per hour)	DSV = Ponding water storage volume and void space volumes of soil filter media. Example for rain garden: $DSV = (A_{\text{pond}} \times D_{\text{pond}}) + (A_{\text{soil}} \times D_{\text{soil}} \times n_{\text{soil}})$
Tree Filter (no underdrain)	Provides temporary storage of runoff through surface ponding and void spaces within the soil/sand/gravel mixture that is used to filter runoff prior to infiltration into underlying soils.	Infiltration Trench (6 infiltration rates: 0.17, 0.27, 0.52, 1.02, 2.41 and 8.27 inches per hour)	DSV = Ponding water storage volume and void space volumes of soil filter media. $DSV = (L \times W \times D_{\text{ponding}}) + (L \times W \times D_{\text{soil}} \times n_{\text{soil}})$
Bio-Filtration (w/underdrain)	Provides temporary storage of runoff for filtering through an engineered soil media. The storage capacity includes void spaces in the filter media and temporary ponding at the surface. After runoff has passed through the filter media it is collected by an under-drain pipe for discharge. Manufactured or packaged bio-filter systems such as tree box filters may be suitable for using the bio-filtration performance results.	Bio-filtration	DSV = Ponding water storage volume and void space volume of soil filter media. Example of a linear biofilter: $DSV = (L \times W \times D_{\text{ponding}}) + (L \times W \times D_{\text{soil}} \times n_{\text{soil}})$
Gravel Wetland	Based on design by the UNH Stormwater Center (UNHSC). Provides temporary surface ponding storage of runoff in a vegetated wetland cell that is eventually routed to an underlying saturated gravel internal storage reservoir (ISR) for nitrogen treatment. Outflow is controlled by an elevated orifice that has its invert elevation equal to the top of the ISR layer and provides a retention time of at least 24 hours.	Gravel Wetland	DSV = pretreatment volume + ponding volume + void space volume of gravel ISR. $DSV = (A_{\text{pretreatment}} \times D_{\text{pretreatment}}) + (A_{\text{wetland}} \times D_{\text{ponding}}) + (A_{\text{ISR}} \times D_{\text{gravel}} \times n_{\text{gravel}})$
Porous Pavement with subsurface infiltration	Provides filtering of runoff through a filter course and temporary storage of runoff within the void spaces of a subsurface gravel reservoir prior to infiltration into subsoils.	Infiltration Trench (6 infiltration rates: 0.17, 0.27, 0.52, 1.02, 2.41 and 8.27 inches per hour)	DSV = void space volumes of gravel layer $DSV = (L \times W \times D_{\text{stone}} \times n_{\text{stone}})$
Porous pavement w/ impermeable underliner w/underdrain	Provides filtering of runoff through a filter course and temporary storage of runoff within the void spaces prior to discharge by way of an underdrain.	Porous Pavement	Depth of Filter Course = D_{fc}
Wet Pond	Provides treatment of runoff through routing through permanent pool.	Wet Pond	DSV = Permanent pool volume prior to high flow bypass $DSV = A_{\text{pond}} \times D_{\text{pond}}$ (does not include pretreatment volume)
Extended Dry Detention Basin	Provides temporary detention storage for the design storage volume to drain in 24 hours through multiple out let controls.	Dry Pond	DSV = Ponding volume prior to high flow bypass $DSV = A_{\text{pond}} \times D_{\text{pond}}$ (does not include pretreatment volume)
Dry Water Quality Swale/Grass Swale	Based on MA design standards. Provides temporary surface ponding storage of runoff in an open vegetated channel through permeable check dams. Treatment is provided by filtering of runoff by vegetation and check dams and infiltration into subsurface soils.	Grass swale	DSV = Volume of swale at full design depth $DSV = L \times \text{swale} \times A_{\text{swale}}$
Definitions: DSV = Design Storage Volume = physical storage capacity to hold water; VSV = Void Space Volume; L = length, W = width, D = depth at design capacity before bypass, n = porosity fill material, A = average surface area for calculating volume; Infiltration rate = saturated soil hydraulic conductivity			

MADEP Stormwater Checklist



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:

- ☒ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☒ 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

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ 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 Field¹
- ☒ 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.

Stormwater Operation and Maintenance Plan

Stormwater Operation and Maintenance Plan - Long Term Pollution Prevention

Ongoing maintenance is required for the proper function of the stormwater management system allowing the system prevent pollution for the long term. This document provides a guideline for this work and allows for record keeping.

Stormwater Management System Owner: To be determined

Signature/date

Party Responsible for Maintenance: To be determined

Signature/date

Snow Removal

Snow removal from parking areas will be the responsibility of the property owner.

Public Safety Features

The site has been designed with sidewalks and lighting to allow for safe movement throughout the site.

Preliminary Stormwater O&M Maintenance Budget

Inspection and maintenance = \$1,000 x 4 times per year = \$4,000±

Site Specific BMP Maintenance Plans

(Reference MADEP Volume 2, Chapter – Structural BMP Specifications for the Massachusetts Stormwater Handbook)

Drainage Channels, Grassed Channels and Water Quality Swales

Inspect drainage channels the first few months after construction to make sure that there is no rilling or gullyng, and that vegetation in the channels is adequate. Thereafter, inspect the channel twice a year for slope integrity, soil moisture, vegetative health, soil stability, soil compaction, soil erosion, ponding, and sediment accumulation. Regular maintenance tasks include mowing, fertilizing, liming, watering, pruning, weeding, and pest control. Mow channels at least once per year. Do not cut the grass shorter than three to four inches. Keep grass height under 6 inches to maintain the design depth necessary to serve as a conveyance. Do not mow excessively, because it may increase the design flow velocity. Remove sediment and debris manually at least once per year. Re-seed periodically to maintain the dense growth of grass vegetation.

Sediment Forebay

Sediments and associated pollutants are contained within the sediment forebay and removed only when sediment forebays are cleaned out, so regular maintenance is essential. Frequently removing accumulated sediments will make it less likely that sediments will be resuspended. At a minimum, inspect sediment forebays monthly and clean them out at least four times per year. Stabilize the floor and sidewalls of the sediment forebay before making it operational, otherwise the practice will discharge excess amounts of suspended sediments. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullyng and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or resodding. When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Infiltration Basin

Inspect and complete preventive maintenance at least twice a year, and after every time drainage discharges through the emergency spillway. Inspect the pretreatment as required. Once the basin is in use, inspect it after every major storm for the first few months to ensure it is stabilized and functioning properly and if necessary, take corrective action. Note how long water remains standing in the basin after a storm; standing water within the basin 48 to 72 hours after a storm indicates the infiltration capacity may have been overestimated. If the ponding is due to clogging, immediately address the reasons for the clogging (such as upland sediment erosion, excessive compaction of soils, or low spots). Thereafter, inspect the infiltration basin at least twice per year. Important items to check during the inspection include:

- Signs of differential settlement
- Cracking, Erosion
- Leakage in the embankments
- Tree growth on the embankments
- Condition of riprap
- Sediment accumulation
- The health of the turf.

At least twice a year, mow the buffer area, side slopes, and basin bottom if grassed. Remove grass clippings and accumulated organic matter to prevent an impervious organic mat from forming. Remove trash and debris at the same time. Use deep tilling to break up clogged surfaces and revegetate immediately. Remove sediment from the basin as necessary but wait until the floor of the basin is thoroughly dry. Use light equipment to remove the top layer to not compact the underlying soil. Deeply till the remaining soil and revegetate as soon as possible. Inspect and clean pretreatment devices per O&M.

(print a log for each BMP and maintain a log book for the project)

BMP: _____

[illegible]

Soils Data



Commonwealth of Massachusetts
City/Town of

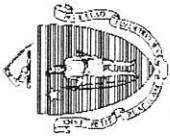
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Owner Name CDK-MEL, LLC Map/Lot # R10 16 B
Street Address MONARZIT DRIVE City LITTLETON State MA
Zip Code 01460

B. Site Information

1. (Check one) ☒ New Construction ☒ Upgrade
2. Soil Survey NRCS Soil Map Unit 253D Soil Series HINCKLEY, LOAMY SAND
OUTWASH Landform RAPID INFILTRATION Soil Limitations
SANDY AND GRAVELLY GLACIOFLUVIAL DEPOSITS DERIVED FROM GNEISS, GRANITE, SCHIST Soil Parent material GLACIAL STRATIFIED DEPOSITS
Glacial stratified Deposits of well sorted gravel, sand, silt and clay Description of Geologic Map Unit: in layers Map Unit
3. Surficial Geological Report 2022 / Mass mapper Year Published/Source
MassGIS; Littleton GIS Month/Day/Year
4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No
5. Within a velocity zone? ☐ Yes ☒ No
6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: Wetland Type
Range: ☐ Above Normal ☒ Normal ☐ Below Normal
7. Current Water Resource Conditions (USGS): 3/4/22 Month/Day/Year
8. Other references reviewed: MassGIS; Littleton GIS
(Zone II, IWPA, Zone A, EEA Data Portal, etc.)



Commonwealth of Massachusetts
City/Town of

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: D11-1 3/4/22 8:00 am 40° P44 cldy 42°31'01" 71°30'57"
Hole # Date Time Weather Latitude Longitude

1. Land Use Woodland trees, scrub brush Few large boulders
(e.g., woodland, agricultural field, vacant lot, etc.) Vegetation Surface Stones (e.g., cobbles, stones, boulders, etc.) Slope (%)

Description of Location: wooded undeveloped area

2. Soil Parent Material: Glaciofluvial Deposits Actwash Plain TS
Landform Position on Landscape (SU, SH, BS, FS, TS, Plain)

3. Distances from: Open Water Body 7750± feet Drainage Way 100± feet Wetlands 90± feet
Property Line 150± feet Drinking Water Well 720± feet Other _____ feet

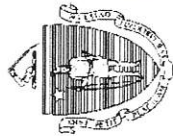
4. Unsuitable Materials Present: ☐ Yes ☒ No ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: N/A Depth to Weeping in Hole 84" 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			
0-4	A _p	FSL	10YR 3/2	Cnc : Dpl:						FRABLE	
4-20	B _w	FSL	10YR 6/6	Cnc : Dpl:						FRABLE	
20-120	C	FINE SAND	2.5Y 4/2	Cnc : Dpl:	60"				SINGLE GRAIN	LOOSE	
				Cnc : Dpl:							
				Cnc : Dpl:							
				Cnc : Dpl:							
				Cnc : Dpl:							
				Cnc : Dpl:							

Additional Notes: -



Commonwealth of Massachusetts
City/Town of

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: DH-2 3/4/22 8:15am 40° Pkly Clay 42°31'01" 71°30'57"
Hole # Date Time Weather Latitude Longitude

1. Land Use: Wetland trees scrub brush Few large boulders
(e.g., woodland, agricultural field, vacant lot, etc.) Surface Stones (e.g., cobbles, stones, boulders, etc.) Slope (%)

Description of Location: wooded undeveloped area

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

3. Distances from: Open Water Body 7750 feet Drainage Way 1500 feet Wetlands 1350 feet
Property Line 2000 feet Drinking Water Well 7200 feet Other feet

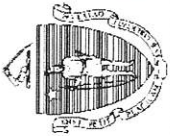
4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 105" Depth to Weeping in Hole 84" 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 Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones		
0-8	Ap	FSL	10YR 3/2	Cnc : Dpl:					FR, ABLE	
8-26	Bw	FSL	10YR 5/6	Cnc : Dpl:					FR, ABLE	
26-96	C	SAND	2.5Y 5/2 43'	Cnc : Dpl:			2%		SINGLY GRANULAR LOOSE	
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						

Additional Notes:



Commonwealth of Massachusetts
City/Town of

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: DH-3 3/4/22 8:30 400 P44 clay 42° 31' 01" 71° 30' 57"
Hole # Date Time Weather Latitude Longitude
1. Land Use Woodland trees scrub brush Few large boulders 2%
(e.g., woodland, agricultural field, vacant lot, etc.)
Description of Location: wooded undeveloped area Surface Stones (e.g., cobbles, stones, boulders, etc.) Slope (%)

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

3. Distances from: Open Water Body > 200' feet Drainage Way 190± feet Wetlands 180± feet
Property Line 240± feet Drinking Water Well 7200 feet Other _____ feet

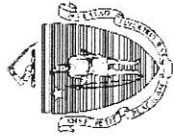
4. Unsuitable Materials Present: ☐ Yes ☒ No ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 96" Depth to Weeping in Hole 82" 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			
0-22	Ap	FSL	10YR 3/2	Cnc : Dpl:							
22-35	Bw	FSL	10YR 5/6	Cnc : Dpl:							
35-99	C	SAND	2.5Y 6/2	Cnc : Dpl:			2%		SINGLE GRAIN	LOOSE	
				Cnc : Dpl:							
				Cnc : Dpl:							
				Cnc : Dpl:							
				Cnc : Dpl:							

Additional Notes:



Commonwealth of Massachusetts
City/Town of

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: DH-4 3/4/22 9:00am 40° 44' N 40° 31' 01" W 71° 30' 57" Longitude
22% Slope (%)

1. Land Use: Woodland traces scrub brush Few large boulders
(e.g., woodland, agricultural field, vacant lot, etc.) Surface Stones (e.g., cobbles, stones, boulders, etc.)

Description of Location: wooded undeveloped land

2. Soil Parent Material: Glacial Fluvial Deposits Outwash Plain TS
Position on Landscape (SU, SH, BS, FS, TS, Plain)

3. Distances from: Open Water Body 7750 feet Drainage Way 240 feet Wetlands 140 feet
Property Line 220 feet Drinking Water Well 720 feet Other feet

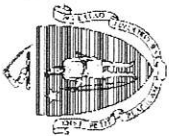
4. Unsuitable Materials Present: ☐ Yes ☒ No ☐ If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No 79" Depth to Weeping in Hole 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			
0-3	O	FSL	10YR2/2		Cnc : Dpl:						
3-100	C	SAND	2.5Y5/2	52"	Cnc : Dpl:			2%	Subs. gran.	Loose	
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:



Commonwealth of Massachusetts
City/Town of

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: D11-5

Date: 3/4/22

Time: 9:15

Weather: 40° 71y clay

Latitude: 42°31'01"

Longitude: 71°30'57"

Vegetation: woodland

Land Use: woodland

Description of Location: undeveloped wooded area

Surface Stones (e.g., cobbles, stones, boulders, etc.): Few large boulders

Soil Parent Material: Glaciofluvial Deposits Outwash Plain

Position on Landscape (SU, SH, BS, FS, TS, Plain): TS

Distances from: Open Water Body 7800 feet

Drainage Way: 1650 feet

Property Line 2150 feet

Drinking Water Well: 7200 feet

Unsuitable Materials Present: ☐ Yes ☒ No

Weathered/Fractured Rock: ☐ Weathered/Fractured Rock ☐ Bedrock

Groundwater Observed: ☒ Yes ☐ No

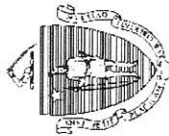
Depth to Weeping in Hole: 81"

Depth to Standing Water in Hole: 81"

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			
0-6	Ap	FSL	10YR 3/2	Cnc : Dpl:						
6-18	Bw	FSL	10YR 5/6	Cnc : Dpl:						
18-90	C	SAND	2.5Y 6/2	42" Cnc : Dpl:				SINGLE GRANULAR	LOOSE	
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						

Additional Notes:



Commonwealth of Massachusetts
City/Town of

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: DH-6

Date: 3/4/22

Time: 9:30

Weather: 40° Pky Cldy

Latitude: 42° 31' 01"

Longitude: 71° 30' 57"

1. Land Use:

Woodland

(e.g., woodland, agricultural field, vacant lot, etc.)

Vegetation: trees, scrub brush

Surface Stones (e.g., cobbles, stones, boulders, etc.): Few large boulders

Slope (%): 2%

Description of Location: wooded, undeveloped area

2. Soil Parent Material: Glacial fluvial deposits

Landform: outwash plain

Position on Landscape (SU, SH, BS, FS, TS, Plain): B

3. Distances from:

Open Water Body: >800 feet

Drainage Way: 140± feet

Wetlands: 115± feet

Property Line: 175± feet

Drinking Water Well: >200 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: 82"

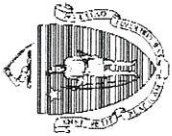
Depth to Weeping in Hole

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			
0-8	Ap	FSL	10YR 2/2		Cnc : Dpl:						
8-36	Bw	FSL	10YR 3/6		Cnc : Dpl:						
36-122	C	SAND	2.5Y 4/2	84"	Cnc : Dpl:				SINGLE GRAN	LOOSE	
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:



Commonwealth of Massachusetts
City/Town of

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: DH-7 3/4/22 9:45 40° 34' N 42° 31' 01" W 71° 30' 57" N

1. Land Use Woodland Date 3/4/22 Time 9:45 Weather 40° 34' N Latitude 42° 31' 01" Longitude 71° 30' 57"

Description of Location: wooded undeveloped area Vegetation tree scrub brush Surface Stones (e.g., cobbles, stones, boulders, etc.) Few large boulders Slope (%) 2

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

3. Distances from: Open Water Body > 800 feet Drainage Way 130± feet Wetlands 90 feet
Property Line 200± feet Drinking Water Well > 200 feet Other feet

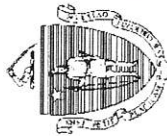
4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil/Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 96" Depth to Weeping in Hole 76" 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			
0-3	D		10YR 7/2		Cnc : Dpl:						
3-98	C		2.5Y 4/2	10"	Cnc : Dpl:				SINGLE GRAN	LOOSE	
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						
					Cnc : Dpl:						

Additional Notes:



Commonwealth of Massachusetts
City/Town of

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: DA-8

Date: 3/4/22

Time: 10:15

Weather: 45° Pkly

Latitude: 42°31'01"

Longitude: 71°30'57"

1. Land Use: Woodland

(e.g., woodland, agricultural field, vacant lot, etc.)

Vegetation: trees, scrub brush

Surface Stones (e.g., cobbles, stones, boulders, etc.): Few large boulders

Slope (%): 2%

Description of Location: wooded undeveloped area

2. Soil Parent Material: Glaciofluvial Deposits

Landform: Outwash Plain

Position on Landscape (SU, SH, BS, FS, TS, Plain): TS

3. Distances from: Open Water Body 2850± feet

Drainage Way 120± feet

Wetlands 103± feet

Property Line 205± feet

Drinking Water Well 7200 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: 52"

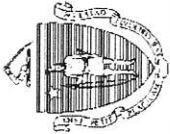
68"

Depth to Weeping in Hole _____ 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		
0-4	D		10YR 2/2	Cnc : Dpl:						
4-90	C	FINE SAND	2.5Y 4/1	28" Cnc : Dpl:					SINGLE GRAIN	LOOSE
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						
				Cnc : Dpl:						

Additional Notes:



Commonwealth of Massachusetts
City/Town of

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

D. Determination of High Groundwater Elevation

1. Method Used (Choose one):

☒ Depth to soil redoximorphic features

☐ Depth to observed standing water in observation hole

☐ Depth to adjusted seasonal high groundwater (S_h)
(USGS methodology)

Obs. Hole # DH-1 Obs. Hole # DH-2 DH-4
60 inches 43 inches 52"
_____ inches _____ inches _____ inches

Index Well Number

Reading Date

$$S_h = S_c - [S_r \times (OW_c - OW_{max}) / OW_r]$$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

E. Certification

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

Signature of Soil Evaluator

Patrick J. Burke II / SE 278

Typed or Printed Name of Soil Evaluator / License #

James Garreff

Name of Approving Authority Witness

Approving Authority

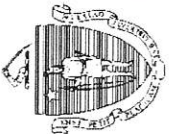
Date

4/8/22

Expiration Date of License

6/30/22
NABOH

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



Commonwealth of Massachusetts
City/Town of

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

D. Determination of High Groundwater Elevation

1. Method Used (Choose one):

☒ Depth to soil redoximorphic features

☐ Depth to observed standing water in observation hole

☐ Depth to adjusted seasonal high groundwater (S_h)
(USGS methodology)

Obs. Hole # DH-5
42" inches

Obs. Hole # DH-6
84" inches

DH-7
10" inches

DH-8
28" inches

Index Well Number

Reading Date

$$S_h = S_c - [S_r \times (OW_c - OW_{max}) / OW_r]$$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

E. Certification

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

Patrick J. Burke II

Signature of Soil Evaluator

Patrick J. Burke II / SE 278

Typed or Printed Name of Soil Evaluator / License #

Expiration Date of License

4/8/22
Date

NABert

Approving Authority

Name of Approving Authority Witness

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



Commonwealth of Massachusetts
City/Town of
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

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



A. Site Information

CDK-MEL, LLC
Owner Name
MONARCH DRIVE

Street Address or Lot #
LITTLETON
City/Town

MA
State

01460
Zip Code

Contact Person (if different from Owner)

Telephone Number

B. Test Results

	Date	Time	Date	Time
Observation Hole #	3/4/22	12:56	3/4/22	11:29
Depth of Perc	PT-1		PT-2	
Start Pre-Soak	33" shelf		34" shelf	
End Pre-Soak	12:56 pm		1:21 pm	
Time at 12"	1:14 pm		1:36 pm	
Time at 9"	1:14 pm		1:36 pm	
Time at 6"	1:15 pm		1:42 pm	
Time (9"-6")	1:17 pm		1:47 pm	
Rate (Min./Inch)	2 min		5 min	
	< 2 min/inch		< 2 min/inch	

Test Passed: ☒
Test Failed: ☐

Test Passed: ☒
Test Failed: ☐

Patrick J. Burke size 278
Test Performed By:
James Garreffa NABOH
Board of Health Witness

Comments:

PT-1 tested next to DH-1

PT-2 tested next to DH-3



Commonwealth of Massachusetts
City/Town of
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

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



A. Site Information

CDK-MEL, LLC

Owner Name

MONARCH DRIVE

Street Address or Lot #

LITTLETON

City/Town

MA

State

01460

Zip Code

Contact Person (if different from Owner)

Telephone Number

B. Test Results

Observation Hole #

3/4/22

Date

Time

PT-3

24" shelf

Depth of Perc

12:29 pm

Start Pre-Soak

12:44 pm

End Pre-Soak

12:44 pm

Time at 12"

1:30 pm

Time at 9"

2:19 pm

Time at 6"

49 min

Time (9"-6")

17 min/inch

Rate (Min./Inch)

Test Passed:



Test Failed:



3/4/22

Date

Time

PT-4

30" shelf

12:42

12:57

24 gallons

poured

Test Passed:



Test Failed:



Patrick J. Burke Sr 288

Test Performed By:

James Gerreffi

Board of Health Witness

Comments:

PT-3 tested next to DH-7

PT-4 tested next to DH-6



SOILS OBSERVATION AND TESTING REPORT

Site Location: Monarch Drive, Littleton, MA
Project No.: 5554
Date: 03/04/2022
Time of Testing: 2:00 PM

Weather No precipitation
Temp: 45° F
Sky Condition: Partly Cloudy

Notes:

SW #1: 0"-1" Organic
1"-96" Sand, single grain loose
No groundwater observed
No Redox observed

SW #2: 0"-2" Organic
1"-78" Sand, single grain loose
No groundwater observed
Redox @72"

SW #3: 0"-2" Organic
1"-96" Sand, single grain loose
No groundwater observed
Redox @58"

SW #4: 0"-3" Organic
3"-140" Sand, single grain loose
Groundwater observed weeping@140"
No Redox observed

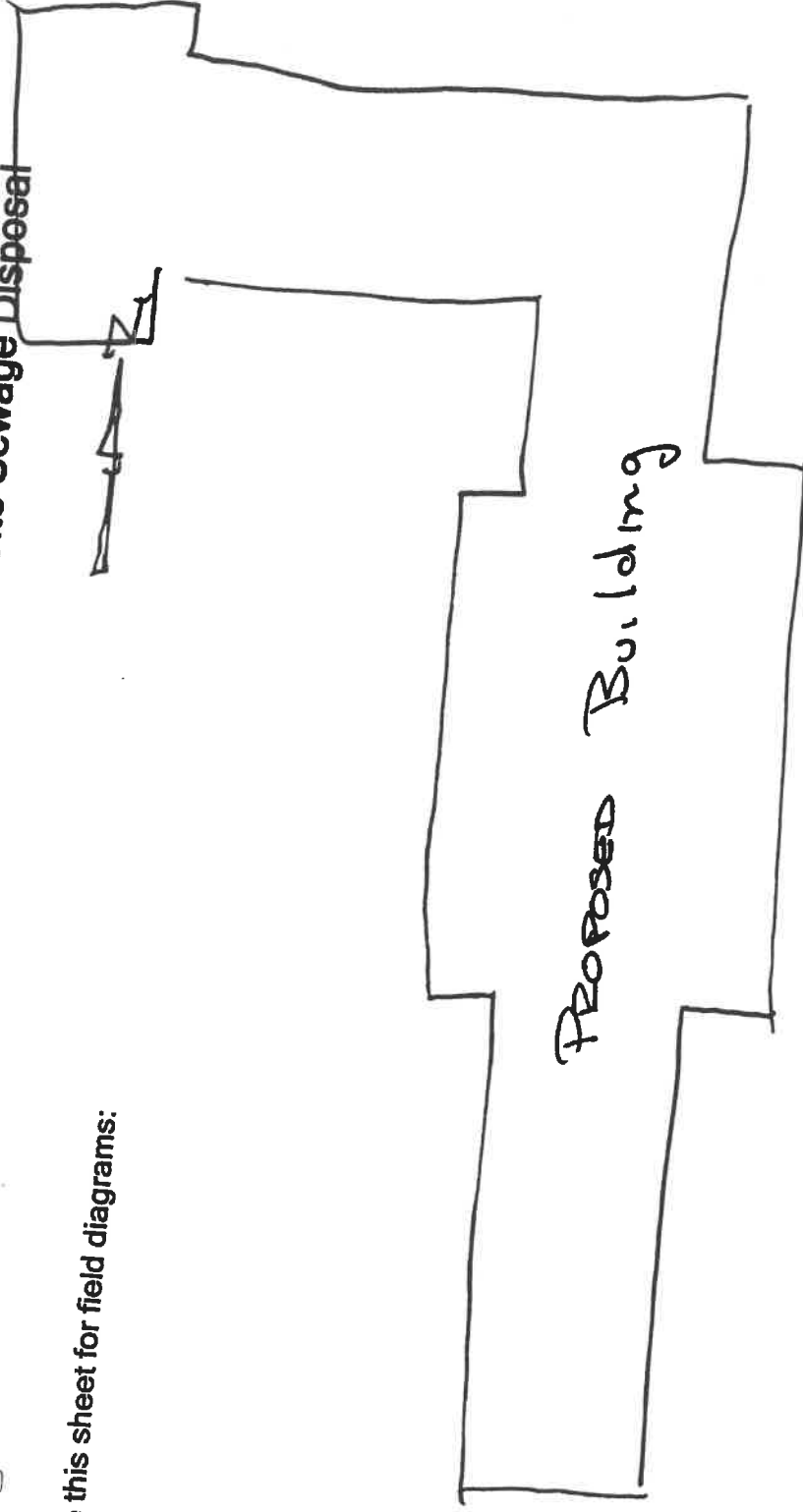
Plot



Commonwealth of Massachusetts
City/Town of

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

Use this sheet for field diagrams:



465

460

467



Town of 417725701

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

MONARCH DRIVE

COPY

JOB FILE

417-0007

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

A. Facility Information

1. Facility Information

Owner Name WATERFORD DEVELOPMENT
Street Address 175 HIGHLAND AVE Map/Lot _____
City/Town NEEDHAM State MA Zip Code 02494

B. Site Information

1. (Check one) New Construction ☒ Upgrade ☐ Repair ☐
2. Published Soil Survey available? Yes ☐ No ☐ If yes:

Soil Name _____ Year Published _____ Publication Scale _____ Soil Map Unit _____

3. Surficial Geological Report available? Yes ☐ No ☐ If yes:

Geologic Material _____ Year Published _____ Publication Scale _____ Map Unit _____

4. Flood Rate Insurance Map:

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

Within the 100 year flood boundary? Yes ☐ No ☐
Within a Velocity Zone? Yes ☐ No ☐

5. Wetland Area: National Wetland Inventory Map

Map Unit _____ Name _____

Map Unit _____ Name _____

Wetlands Conservancy Program Map

6. Current Water Resource Conditions (USGS)

Month/Year _____

Range: Above Normal ☐ Normal ☐ Below Normal ☐

7. Other references reviewed:

HAYES ENGINEERING, INC.
603 SALEM STREET
WAKEFIELD, MA 01880
TEL: 781-938-2800
FAX: 781-938-7596

T-1 + T-2



Commonwealth of Massachusetts
City/Town of LITTLETON

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

D. Determination of High Groundwater Elevation

1. Method used:
- | | | |
|--|----------------------|----------------------|
| ☐ Depth observed standing water in observation hole | A. <u>126</u> inches | B. <u>132</u> inches |
| ☐ Depth weeping from side of observation hole | A. <u>126</u> inches | B. <u>132</u> inches |
| ☐ Depth to soil redoximorphic features (mottles) | A. <u>126</u> inches | B. <u>132</u> inches |
| ☐ Groundwater adjustment (USGS methodology) | A. _____ inches | B. _____ inches |

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

Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

- a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes ☐ No ☐
- b. If yes, at what depth was it observed? Upper boundary: _____ inches
Lower boundary: _____ inches

F. Certification

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

Signature of Soil Evaluator
Gordon Rogerson

SE 2074

Typed or Printed Name of Soil Evaluator/License Number

Jim GARCETTI DAVE BOYER (RED)

Name of Board of Health Witness

Date

April 8, 2008

*Date of Soil Evaluator Exam

Nov. 1994

Board of Health

LITTLETON

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



Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review (Cont.)

Deep Observation Hole Number: T-1

Date 4-8-08

1. Location

Time

Sunny
Weather

Ground Elevation at Surface of Hole

Location (Identify on Plan)

2. Land Use:

FIELD

(e.g. woodland, agricultural field, vacant lot, etc.)

grasses
Vegetation

No

Surface Stones

A
Slope (%)

Landform

3. Distances from: Open Water Body

feet

Drainage Way

feet

Property Line

feet

Drinking Water Well

feet

Other

feet

Possible Wet Area

Position on landscape (attach sheet)

4. Parent Material:

Glacial Outwash

If Yes: Disturbed Soil ☐

Fill Material ☐

Impervious Layer(s) ☐

Unsuitable Materials Present: Yes ☐ No ☒

Weathered/Fractured Rock ☐

Bedrock ☐

5. Groundwater Observed: Yes ☐ No ☒

If Yes:

Depth Weeping from Pit 126

Estimated Depth to High Groundwater:

126

inches

Depth Standing Water in Hole 126

elevation



Commonwealth of Massachusetts
City/Town of LITTLETON

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

0

Deep Observation Hole Number: T-1

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0 - 12	Bw	10YR 5/6				ls	0	%	m	muf	
12 - 132	c	2.5Y 6/3	126			cs	30	%	sg	muf	

Additional Notes _____



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

C. On-Site Review (Cont.)

Deep Observation Hole Number: T-2 Date: 4-8-08 Time: Sunny Weather: 50°

1. Location

Ground Elevation at Surface of Hole _____
Location (Identify on Plan) _____

2. Land Use: FIELD

(e.g. woodland, agricultural field, vacant lot, etc.)
Grasses

Surface Stones No

Slope (%) A

Landform _____

Position on landscape (attach sheet) _____

Possible Wet Area _____ feet
Other _____ feet

Drinking Water Well _____ feet

Drainage Way _____ feet

4. Parent Material: Glacial Outwash

If Yes: Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Unsuitable Materials Present: Yes ☐ No ☒

Weathered/Fractured Rock ☐ Bedrock ☐

5. Groundwater Observed: Yes ☒ No ☐

If Yes: Depth Weeping from Pit 132

Estimated Depth to High Groundwater: 132 inches
Depth Standing Water in Hole 132 elevation



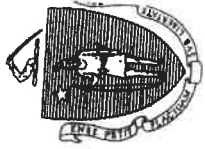
Commonwealth of Massachusetts
City/Town of

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

Deep Observation Hole Number: T-2

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0 - 10	Bw	10YR 5/6				1s	0	0%	m	muf	
10 - 96	C ₁	2.5Y 6/4				m/c 5	0	0%	sg	muf	
96 - 144	C ₂	2.5Y 6/3	132			cs	30	0%	sg	muf	

Additional Notes



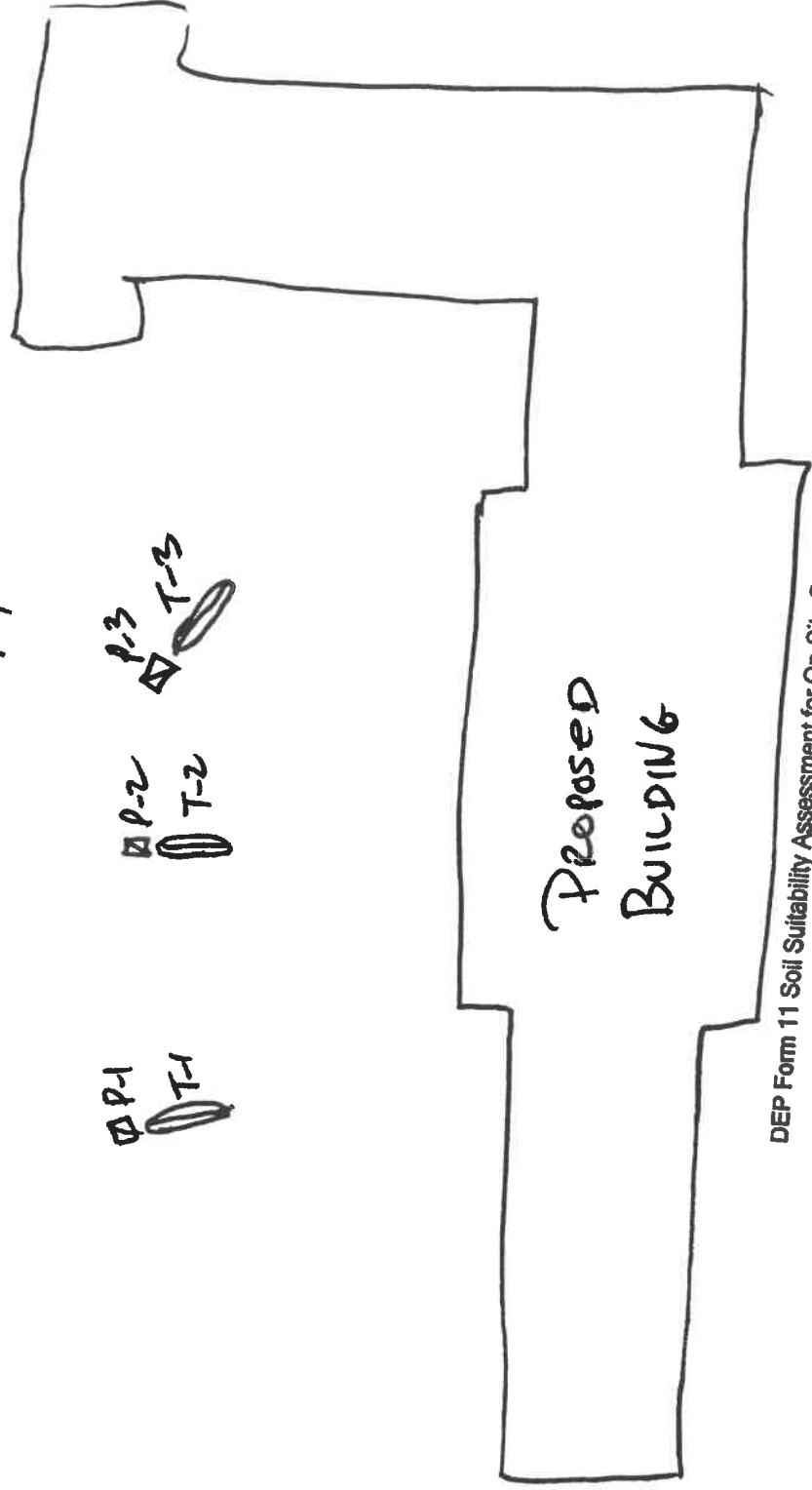
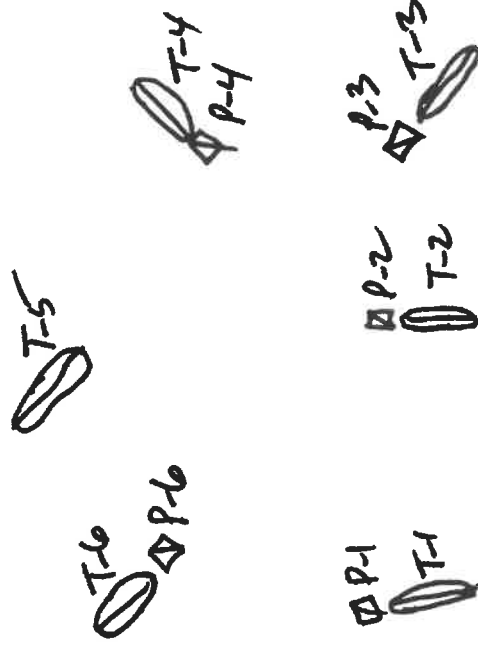
Commonwealth of Massachusetts
City/Town of

BIT. DRIVE

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



Use this sheet for field diagrams:





Commonwealth of Massachusetts
City/Town of **LITTLETON**
Percolation Test
Form 12

HAYES ENGINEERING, INC.
603 SALEM STREET
WAKEFIELD, MA 01880
(617) 246-2800
(617) 246-7596

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



Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

A. Site Information

Owner Name **Waterford Development**
Street Address or Lot # **175 HIGHLAND AVE**
City/Town **NEEDHAM** State **MA** Zip Code _____
Contact Person (if different from Owner) _____ Telephone Number _____

B. Test Results

Observation Hole #	Date	Time	Date	Time
Depth of Perc	4-8-08	P-1	4-8-08	P-2
Start Pre-Soak	18" + 18" = 36"	9:14	21" + 18" = 39"	9:18
End Pre-Soak	25 gals		25 gals	
Time at 12"	9:16		9:29	
Time at 9"			9:32	
Time at 6"	9:17		9:35	
Time (9"-6")	1		3	
Rate (Min./Inch)	< 2 m/i		< 2 m/i	

Gordon Rogerson

Test Performed By:

Witnessed By: **Dave Boyer (DEP)**

Comments:

Test Passed: ☒
Test Failed: ☐

Test Passed: ☒
Test Failed: ☐



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

MONARCH DRIVE

JOB FILE

LIT-0007

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

A. Facility Information

1. Facility Information

Owner Name

WATERFORD DEVELOPMENT

Street Address

175 HIGHLAND AVE

City/Town

NEEDHAM

Map/Lot

02494

State

MA

Zip Code

B. Site Information

1. (Check one)

New Construction ☐

Upgrade ☐

Repair ☐

2. Published Soil Survey available? Yes ☐ No ☐ If yes:

Soil Name

Year Published

Publication Scale

Soil Map Unit

Soil limitations

3. Surficial Geological Report available? Yes ☐ No ☐ If yes:

Geologic Material

Year Published

Publication Scale

Map Unit

4. Flood Rate Insurance Map:

Landform

Above the 500 year flood boundary? Yes ☐ No ☐

Within the 500 year flood boundary? Yes ☐ No ☐

Within the 100 year flood boundary? Yes ☐ No ☐

Within a Velocity Zone? Yes ☐ No ☐

5. Wetland Area: National Wetland Inventory Map

Wetlands Conservancy Program Map

6. Current Water Resource Conditions (USGS)

7. Other references reviewed:

Month/Year

Range: Above Normal ☐ Normal ☐ Below Normal ☐

HAYES ENGINEERING, INC.
603 SALEM STREET
WAKEFIELD, MA 01880
TEL: (617) 662-2800
FAX: (617) 662-7596

7-3 + 7-4



Commonwealth of Massachusetts
City/Town of

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

D. Determination of High Groundwater Elevation

T-3 T-4

1. Method used:
- | | | |
|--|----------------------|----------------------|
| ☐ Depth observed standing water in observation hole | A. <u>132</u> inches | B. <u>120</u> inches |
| ☐ Depth weeping from side of observation hole | A. <u>132</u> inches | B. <u>120</u> inches |
| ☐ Depth to soil redoximorphic features (mottles) | A. <u>132</u> inches | B. <u>120</u> inches |
| ☐ Groundwater adjustment (USGS methodology) | A. _____ inches | B. _____ inches |

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

Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

- a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes ☐ No ☐
- b. If yes, at what depth was it observed? Upper boundary: _____ inches Lower boundary: _____ inches

F. Certification

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

Signature of Soil Evaluator
Gordon Rogers SE 2074

Typed or Printed Name of Soil Evaluator/License Number

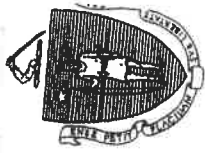
JIM GARROFFI DAVE BOYER (DEP)

Name of Board of Health Witness

Date April 8 2008
Date of Soil Evaluator Exam

Board of Health

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



Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review (Cont.)

Deep Observation Hole Number: 1-3

Date: 4-8-08

1. Location

Ground Elevation at Surface of Hole _____

Time _____

Weather: Sunny 53°

Location (Identify on Plan) _____

2. Land Use:

Field

(e.g. woodland, agricultural field, vacant lot, etc.)

Vegetation: grasses

No

Surface Stones

Slope (%): A

Landform _____

Position on landscape (attach sheet)

Distances from: Open Water Body _____ feet

Drainage Way _____ feet

Possible Wet Area _____ feet

Property Line _____ feet

Drinking Water Well _____ feet

Other _____

4. Parent Material:

Glacial Outwash

If Yes: Disturbed Soil ☐ Fill Material ☐

Impervious Layer(s) ☐

Weathered/Fractured Rock ☐

Bedrock ☐

Unsuitable Materials Present: Yes ☐ No ☒

5. Groundwater Observed: Yes ☒ No ☐

If Yes: Depth Weeping from Pit 132

Estimated Depth to High Groundwater: _____

Depth Standing Water in Hole 132

132 inches

elevation _____



Commonwealth of Massachusetts
City/Town of

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

Deep Observation Hole Number: T-3

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)		Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color		Gravel	Cobbles & Stones			
0- 12	Bw	10YR 5/6			fs	0	0%	m	mvfr	
12- 104	C ₁	2.5Y 6/4			f/m s	0	0%	m	mvfr	
104- 140	C ₂	2.5Y 6/3	132		cs	20	0%	sg	mvfr	

Additional Notes



Commonwealth of Massachusetts
City/Town of

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

C. On-Site Review (Cont.)

Deep Observation Hole Number: 7-4

1. Location

Date

Time

Sunny 50°
Weather

Ground Elevation at Surface of Hole

Location (Identify on Plan)

2. Land Use:

Field

(e.g. woodland, agricultural field, vacant lot, etc.)

grasses
Vegetation

Nd
Surface Stones

Landform

A
Slope (%)

3. Distances from:

Open Water Body

Drainage Way

feet

Property Line

feet

Drinking Water Well

feet

Possible Wet Area

feet

Other

Position on landscape (attach sheet)

4. Parent Material:

Glacial Outwash

If Yes: Disturbed Soil ☐

Fill Material ☐

Impervious Layer(s) ☐

Unsuitable Materials Present: Yes ☐ No ☒

Weathered/Fractured Rock ☐

Bedrock ☐

5. Groundwater Observed: Yes ☒ No ☐

If Yes: Depth Weeping from Pit 120

Estimated Depth to High Groundwater:

120
inches

Depth Standing Water in Hole 120

elevation



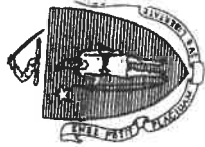
Commonwealth of Massachusetts
City/Town of LITTLETON

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

Deep Observation Hole Number: T-4

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0 - 13	Bw	10YR 5/6				1/s	0	0%	m	muf	
13 - 126	C	2.5Y 6/4	120			m/c s	0	0%	sg	muf	

Additional Notes

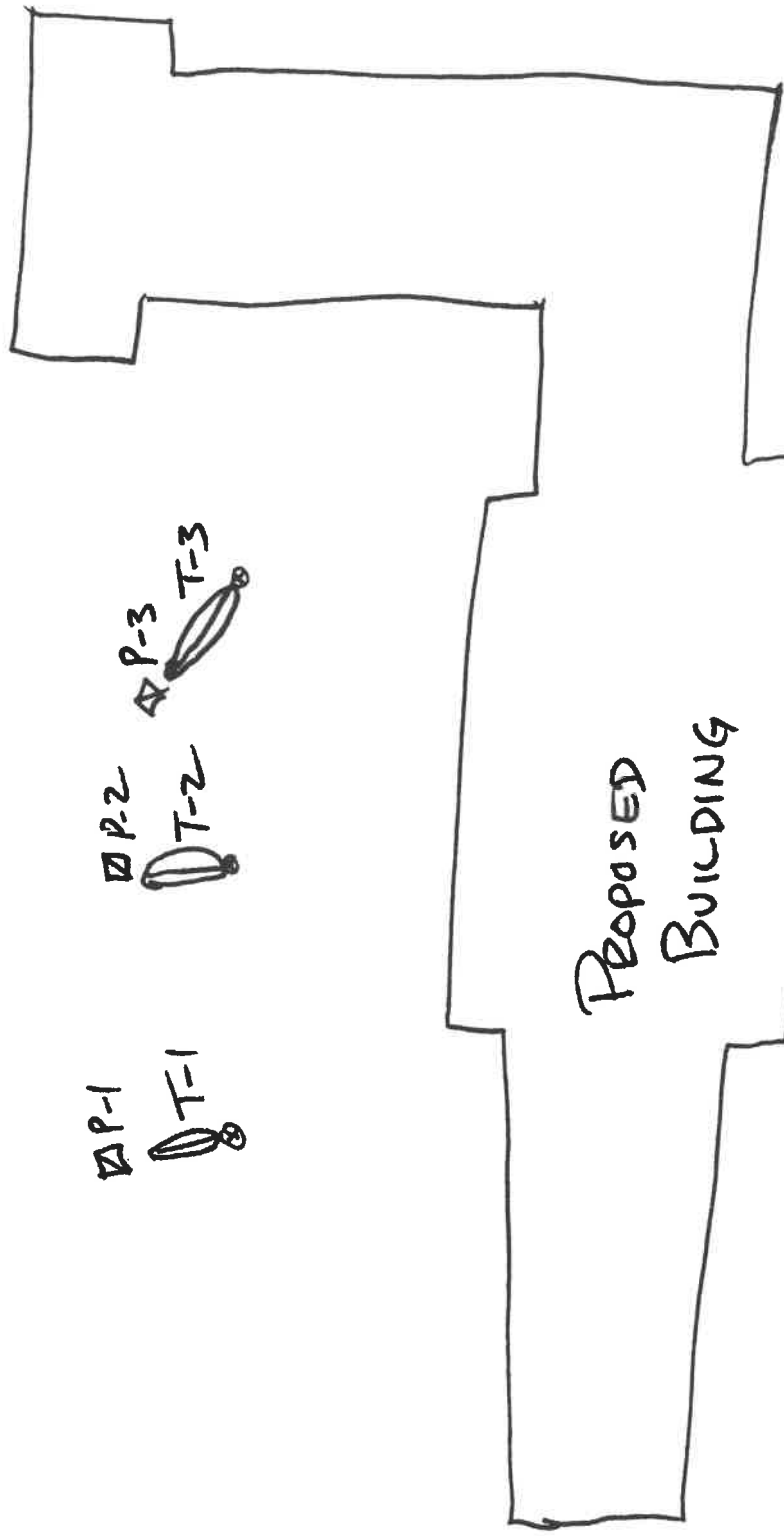
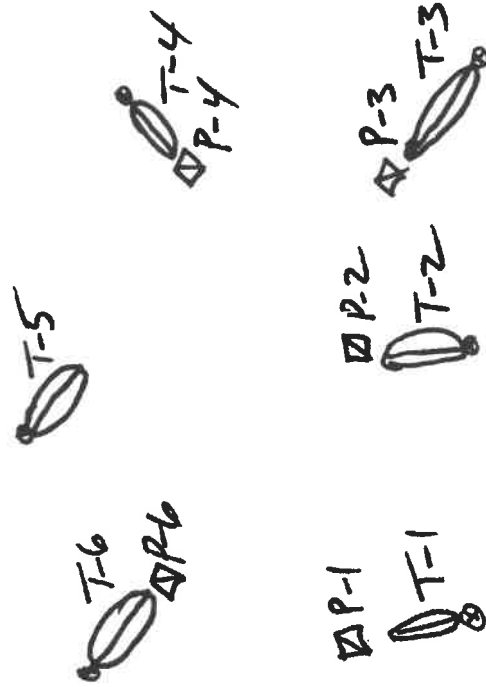


Commonwealth of Massachusetts
City/Town of LITTLETON

BIR DRIVE

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

Use this sheet for field diagrams:

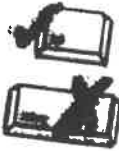




Commonwealth of Massachusetts
City/Town of **LITTLETON**
Percolation Test
Form 12

HAYES ENGINEERING, INC.
603 SALEM STREET
WAKEFIELD, MA 01880
(781) 246-2800
(781) 246-7596

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



Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

A. Site Information

Owner Name **Waterford Development**

Street Address or Lot # **179 HIGHLAND**

City/Town **NEEDHAM**

State **MA**

Contact Person (if different from Owner)

Telephone Number

Zip Code

B. Test Results

Observation Hole #	Date	Time
	4-8-08	
Depth of Perc	P-3	
Start Pre-Soak	30" ± 18" = 48"	
End Pre-Soak	9:37	
Time at 12"	25 gals	
Time at 9"	9:49	
Time at 6"	9:51	
Time (9"-6")	9:56	
Rate (Min./Inch)	5	
	< 2 m/i	

Observation Hole #	Date	Time
	4-8-08	
Depth of Perc	P-4	
Start Pre-Soak	28" ± 18" = 46"	
End Pre-Soak	9:57	
Time at 12"	25 gals	
Time at 9"	10:08	
Time at 6"	10:09	
Time (9"-6")	10:11	
Rate (Min./Inch)	2	
	< 2 m/i	

Gordon Rogerson

Test Performed By

DAVE BOYER (DEP)

Witnessed By:

Comments:

MONARCH DRIVE

Test Passed: ☒
Test Failed: ☐

Test Passed: ☒
Test Failed: ☐



City/Town of LITTLETON

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

Monarch Drive

JOB FILE

LIT-0007

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

A. Facility Information

1. Facility Information

Owner Name WATERFORD DEVELOPMENT
Street Address 175 HIGHLAND AVE
City/Town NEEDHAM State MA. Map/Lot 02494 Zip Code 02494

HAYES ENGINEERING, INC.
603 SALEM STREET
WAKEFIELD, MA 01880
TEL: 617-280-2800
FAX: 617-280-7596
7-5 + 7-6

B. Site Information

1. (Check one) New Construction ☒ Upgrade ☐ Repair ☐
2. Published Soil Survey available? Yes ☐ No ☐ If yes:

Soil Name _____ Year Published _____ Publication Scale _____ Soil Map Unit _____
Soil limitations _____

3. Surficial Geological Report available? Yes ☐ No ☐ If yes:

Geologic Material _____ Year Published _____ Publication Scale _____ Map Unit _____
Landform _____

4. Flood Rate Insurance Map:

Above the 500 year flood boundary? Yes ☐ No ☐
Within the 500 year flood boundary? Yes ☐ No ☐
Within the 100 year flood boundary? Yes ☐ No ☐
Within a Velocity Zone? Yes ☐ No ☐

5. Wetland Area: National Wetland Inventory Map

Map Unit _____ Name _____
Map Unit _____ Name _____

Wetlands Conservancy Program Map

6. Current Water Resource Conditions (USGS)

Month/Year _____

7. Other references reviewed: _____

Range: Above Normal ☐ Normal ☐ Below Normal ☐



Commonwealth of Massachusetts
City/Town of LITTLETON

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

D. Determination of High Groundwater Elevation

1. Method used:

- ☐ Depth observed standing water in observation hole
☐ Depth weeping from side of observation hole
☐ Depth to soil redoximorphic features (mottles)
☐ Groundwater adjustment (USGS methodology)

T-5 T-6
A. 132 inches B. 132 inches
A. 132 inches B. 132 inches
A. 132 inches B. 132 inches
A. _____ inches B. _____ inches

2. Index Well Number _____

Reading Date _____

Index Well Level _____

Adjustment Factor _____

Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

- a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes ☐ No ☐
- b. If yes, at what depth was it observed? Upper boundary: _____ inches
Lower boundary: _____ inches

F. Certification

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

Signature of Soil Evaluator
Gordon Rogers

SE 2074

Typed or Printed Name of Soil Evaluator/License Number

Jim GARREFFI DAVE BOYER (DED)

Name of Board of Health Witness

Date

April 8, 2008

Date of Soil Evaluator Exam

LITTLETON

Board of Health

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



C. On-Site Review (Cont.)

Deep Observation Hole Number: T-5 4-8-08 Date

1. Location
Ground Elevation at Surface of Hole _____ Time _____
Location (Identify on Plan) _____ Weather Sunny SD

2. Land Use: FIELD
(e.g. woodland, agricultural field, vacant lot, etc.)
grasses Surface Stones NO Slope (%) A

3. Distances from: Open Water Body _____ Landform _____
Property Line _____ feet Drainage Way _____ feet
Drinking Water Well _____ feet Possible Wet Area _____ feet
Other _____ feet

4. Parent Material: Glacial Outwash
If Yes: Disturbed Soil ☐ Fill Material ☐ Impervious Layer(s) ☐ Unsuitable Materials Present: Yes ☐ No ☒
Weathered/Fractured Rock ☐ Bedrock ☐

5. Groundwater Observed: Yes ☒ No ☐
If Yes: Depth Weeping from Pit 132
Estimated Depth to High Groundwater: 132 inches
Depth Standing Water in Hole 132 elevation _____



City/Town of *LITTLETON*
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: 1-5

Additional Notes



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

C. On-Site Review (Cont.)

Deep Observation Hole Number: 7-6

Date 4-8-08

1. Location

Time

Weather Sunny 50°

Ground Elevation at Surface of Hole

Location (Identify on Plan)

2. Land Use:

Field

(e.g. woodland, agricultural field, vacant lot, etc.)

grasses

Vegetation

No

Surface Stones

A

Slope (%)

Landform

3. Distances from: Open Water Body

Property Line

feet

Drainage Way

feet

Possible Wet Area

feet

Drinking Water Well

feet

Other

feet

Position on landscape (attach sheet)

4. Parent Material:

Glacial Outwash

If Yes: Disturbed Soil ☐

Fill Material ☐

Impervious Layer(s) ☐

Unsuitable Materials Present: Yes ☐ No ☒

Weathered/Fractured Rock ☐

Bedrock ☐

5. Groundwater Observed: Yes ☒ No ☐

If Yes: Depth Weeping from Pit 132

Estimated Depth to High Groundwater:

132

inches

Depth Standing Water in Hole 132

elevation



City/Town of *LITTLETON*
Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

Deep Observation Hole Number: T-6

[illegible]

Additional Notes:



Commonwealth of Massachusetts

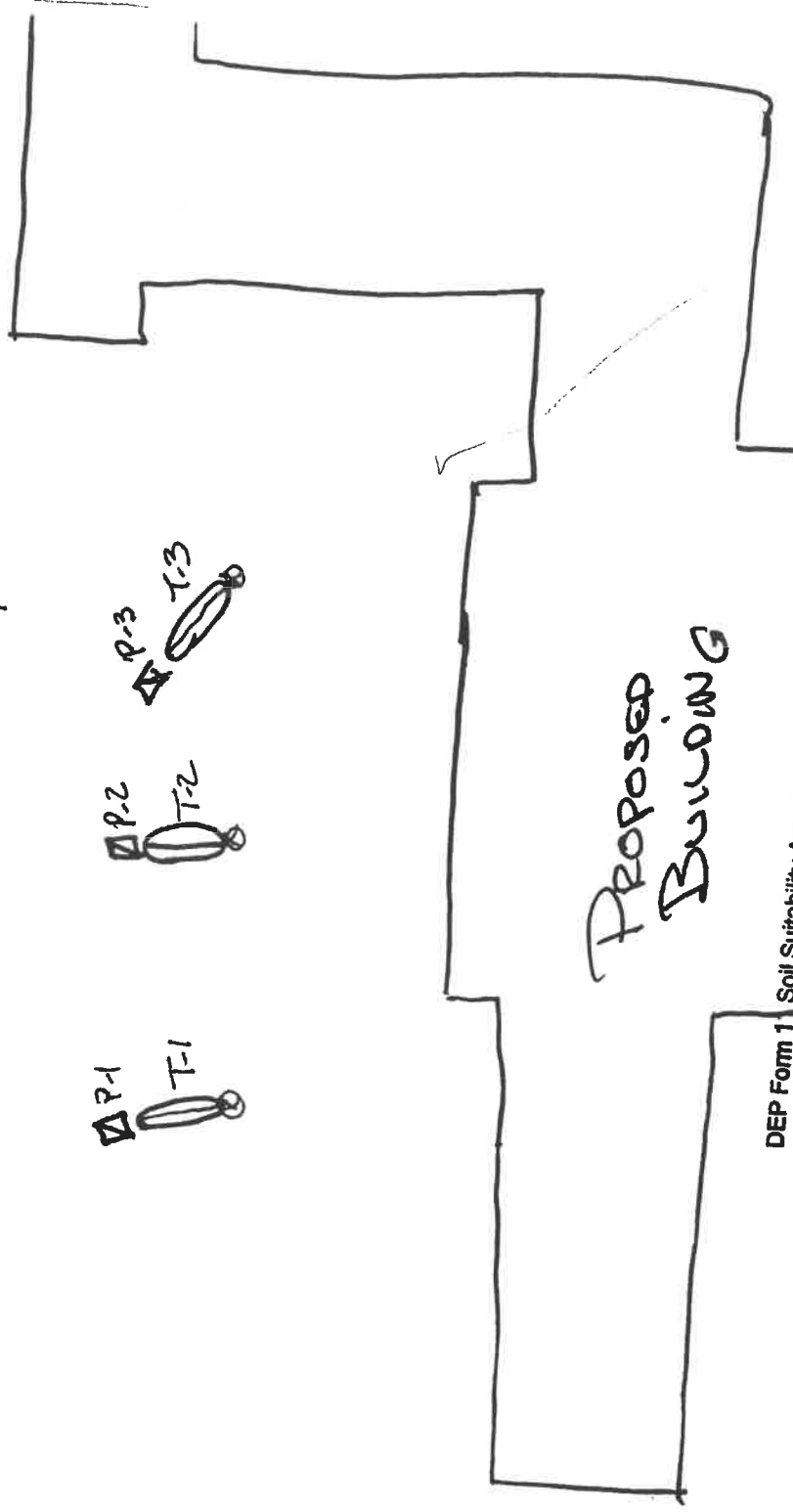
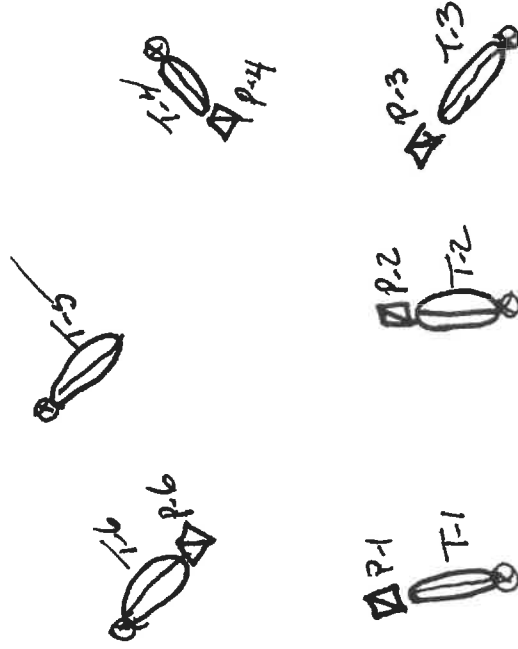
City/Town of **LITTLETON**

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

BIT. DRIVE



Use this sheet for field diagrams:





Commonwealth of Massachusetts
City/Town of **LITTLETON**
Percolation Test
Form 12

HAYES ENGINEERING, INC.
603 SALEM STREET
WAKEFIELD, MA 01880
(781) 246-2800
(781) 246-7596

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key.



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A. Site Information

Owner Name **WATERFORD DEVELOPMENT**
Street Address or Lot # **179 HIGHLAND AVE**
City/Town **NEEDHAM** State **MA**
Contact Person (if different from Owner) _____ Zip Code _____
Telephone Number _____

B. Test Results

Observation Hole #	Date	Time
Depth of Perc	4-8-08	P-6
Start Pre-Soak	22" + 18" = 40"	
End Pre-Soak	10:06	
Time at 12"	25 gals	
Time at 9"	10:08	
Time at 6"	10:09	
Time (9"-6")	10:10	
Rate (Min./Inch)	1	

< 2m / 1

Gordon Rogerson
Test Performed By: **Dave Boyer (DEP)**
Witnessed By: _____

Test Passed: ☐
Test Failed: ☐

Test Passed: ☒
Test Failed: ☐

Comments:
MONARCH DRIVE



JOB FILE

LIT-0007

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

A. Facility Information

1. Facility Information
- Owner Name WATERFORD DEVELOPMENT
- Street Address MONARCH DRIVE Map/Lot _____
- City/Town LITTLETON State MA Zip Code _____

HAYES ENGINEERING, INC.
603 SALEM STREET
WAKEFIELD, MA 01880
TEL: (617) 280-1880
FAX: (617) 280-67596

B. Site Information

1. (Check one) New Construction ☒ Upgrade ☐ Repair ☐
2. Published Soil Survey available? Yes ☐ No ☐ If yes: _____
- Soil Name _____ Year Published _____ Publication Scale _____ Soil Map Unit _____
3. Surficial Geological Report available? Yes ☐ No ☐ If yes: _____
- Soil limitations _____ Year Published _____ Publication Scale _____ Map Unit _____
4. Flood Rate Insurance Map: _____
- Landform _____
- Above the 500 year flood boundary? Yes ☐ No ☐
- Within the 500 year flood boundary? Yes ☐ No ☐
- Within the 100 year flood boundary? Yes ☐ No ☐
- Within a Velocity Zone? Yes ☐ No ☐
5. Wetland Area: National Wetland Inventory Map
- Wetlands Conservancy Program Map
- Map Unit _____ Name _____
- Map Unit _____ Name _____
6. Current Water Resource Conditions (USGS)
- Month/Year _____ Range: Above Normal ☐ Normal ☐ Below Normal ☐
7. Other references reviewed: _____



Commonwealth of Massachusetts
City/Town of _____

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

D. Determination of High Groundwater Elevation

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

2. Index Well Number _____ Reading Date _____ Index Well Level _____
- Adjustment Factor _____ Adjusted Groundwater Level _____

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

- a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system? Yes ☐ No ☐
- b. If yes, at what depth was it observed? Upper boundary: _____ inches Lower boundary: _____ inches

F. Certification

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

Signature of Soil Evaluator
Gordon Rogerson

SE 2074

Date

Nov. 1994

Typed or Printed Name of Soil Evaluator/License Number

*Date of Soil Evaluator Exam

Name of Board of Health Witness

Board of Health

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



Commonwealth of Massachusetts
City/Town of LITTLETON

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

C. On-Site Review (Cont.)

Deep Observation Hole Number: 465

Date 4-8-08

1. Location

Time

Weather Sunny 50°

Ground Elevation at Surface of Hole

Location (Identify on Plan)

2. Land Use:

Field

(e.g. woodland, agricultural field, vacant lot, etc.)

grasses

Vegetation

No

Surface Stones

A

Slope (%)

Landform

3. Distances from: Open Water Body

feet

Drainage Way

feet

Property Line

feet

Drinking Water Well

feet

Other

Possible Wet Area

feet

Position on landscape (attach sheet)

40±

4. Parent Material:

Glacial Outwash

If Yes: Disturbed Soil ☐

Fill Material ☐

Impervious Layer(s) ☐

Weathered/Fractured Rock ☐

Bedrock ☐

Unsuitable Materials Present: Yes ☐ No ☒

5. Groundwater Observed: Yes ☒ No ☐

If Yes: Depth Weeping from Pit

84

Estimated Depth to High Groundwater:

Depth Standing Water in Hole

84

Inches

elevation



Commonwealth of Massachusetts
City/Town of **LITTLETON**

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

Deep Observation Hole Number: 465

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0- 32	C ₁	10YR 5/6				grcs	45	%	sg	mvt	
32- 108	C ₂	2.5Y 6/3	84			cs	20	%	sg	mvt	

Additional Notes



Commonwealth of Massachusetts
City/Town of **LITTLETON**

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

C. On-Site Review (Cont.)

Deep Observation Hole Number: 466 Date 4-8-08

1. Location

Ground Elevation at Surface of Hole _____

Location (Identify on Plan) _____

Time

Weather Sunny SD

2. Land Use:

Field

(e.g. woodland, agricultural field, vacant lot, etc.)

Vegetation grasses

NO

Surface Stones

A

Slope (%)

Landform

3. Distances from: Open Water Body _____

Property Line _____

Drainage Way _____

Drinking Water Well _____

Possible Wet Area _____

Other _____

Position on landscape (attach sheet)

4. Parent Material:

Glacial Outwash

If Yes: Disturbed Soil ☐ Fill Material ☐

Impervious Layer(s) ☐

Unsuitable Materials Present: Yes ☐ No ☒

Weathered/Fractured Rock ☐ Bedrock ☐

5. Groundwater Observed: Yes ☒ No ☐

If Yes: Depth Weeping from Pit 72

Estimated Depth to High Groundwater: _____

Depth Standing Water in Hole 72

inches

elevation



Commonwealth of Massachusetts
City/Town of **LITTLETON**

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

Deep Observation Hole Number: 466

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0-30	C ₁	10YR 5/6				grcs	45	0%	sg	muf	
30-96	C ₂	2.5Y 6/3	72			CS	35	0%	sg	muf	

Additional Notes _____



Commonwealth of Massachusetts
City/Town of LITTLETON

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

C. On-Site Review (Cont.)

Deep Observation Hole Number: 467 Date: 4-8-08 Time: _____ Weather: Sunny 50°

1. Location

Ground Elevation at Surface of Hole _____

Location (Identify on Plan) _____

2. Land Use: Field

(e.g. woodland, agricultural field, vacant lot, etc.)

grasses
Vegetation

No
Surface Stones

Landform _____

A
Slope (%)

3. Distances from:

Open Water Body _____

Drainage Way _____

feet

Possible Wet Area _____

feet

Drinking Water Well _____

feet

Other _____

Position on landscape (attach sheet)

4. Parent Material: Glacial Outwash

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

Unsuitable Materials Present: Yes ☐ No ☒

5. Groundwater Observed: Yes ☒ No ☐

If Yes: Depth Weeping from Pit 68

Estimated Depth to High Groundwater: 68 inches

Depth Standing Water in Hole 68

elevation



Commonwealth of Massachusetts
City/Town of **LITTLETON**

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

Deep Observation Hole Number: 467

Depth (In.)	Soil Horizon/ Layer	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features (mottles)			Soil Texture (USDA)	Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
			Depth	Color	Percent		Gravel	Cobbles & Stones			
0- 10	C ₁	10YR 5/6				grCS	25	0%	sg	muf	
10- 72	C ₂	2.5Y 6/3	68			CS	35	0%	sg	muf	
72- 90	C ₃	10YR 4/4				vy grCY	50	0%	sg	muf	

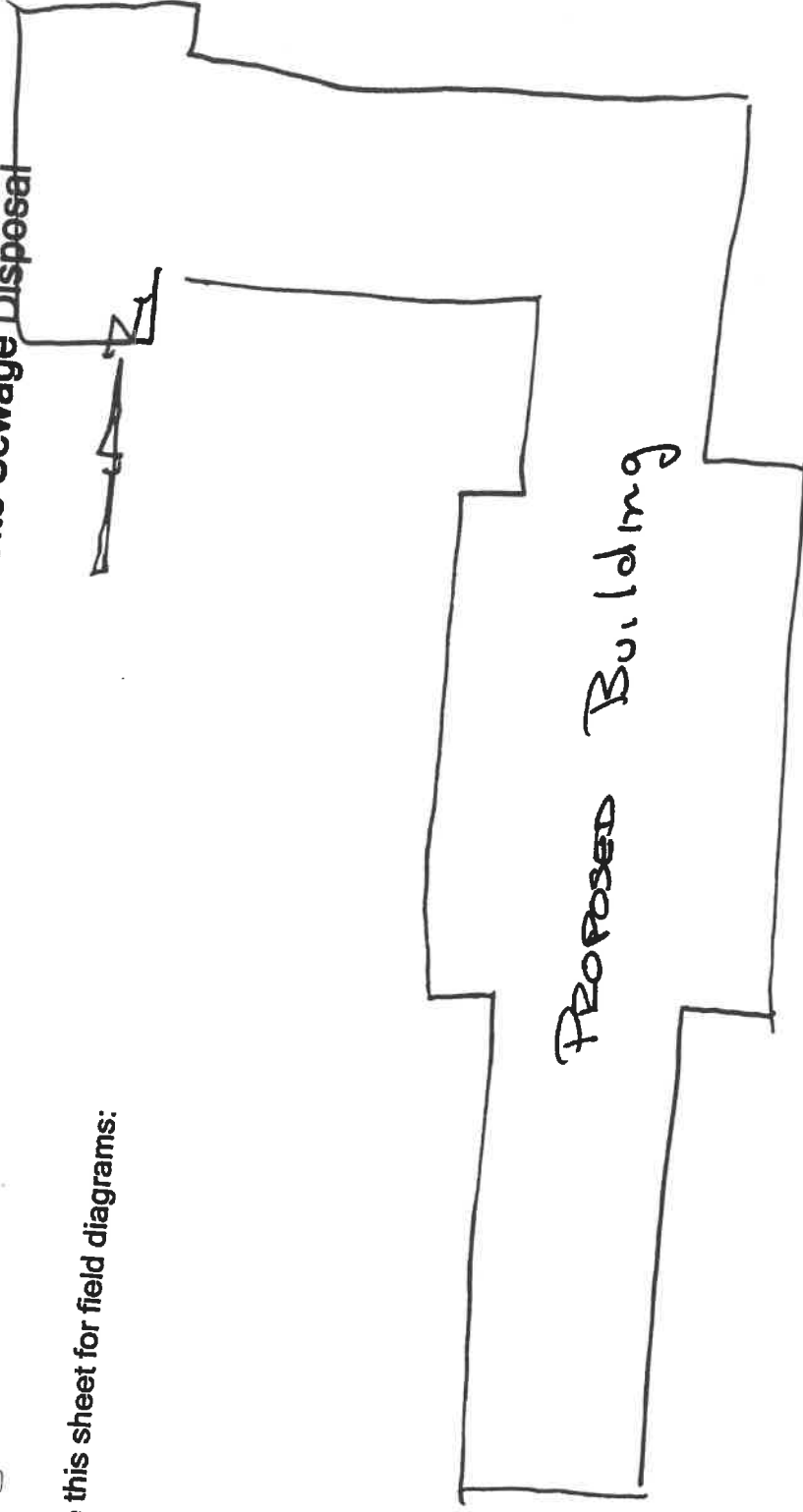
Additional Notes



Commonwealth of Massachusetts
City/Town of

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

Use this sheet for field diagrams:



465

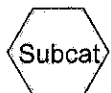
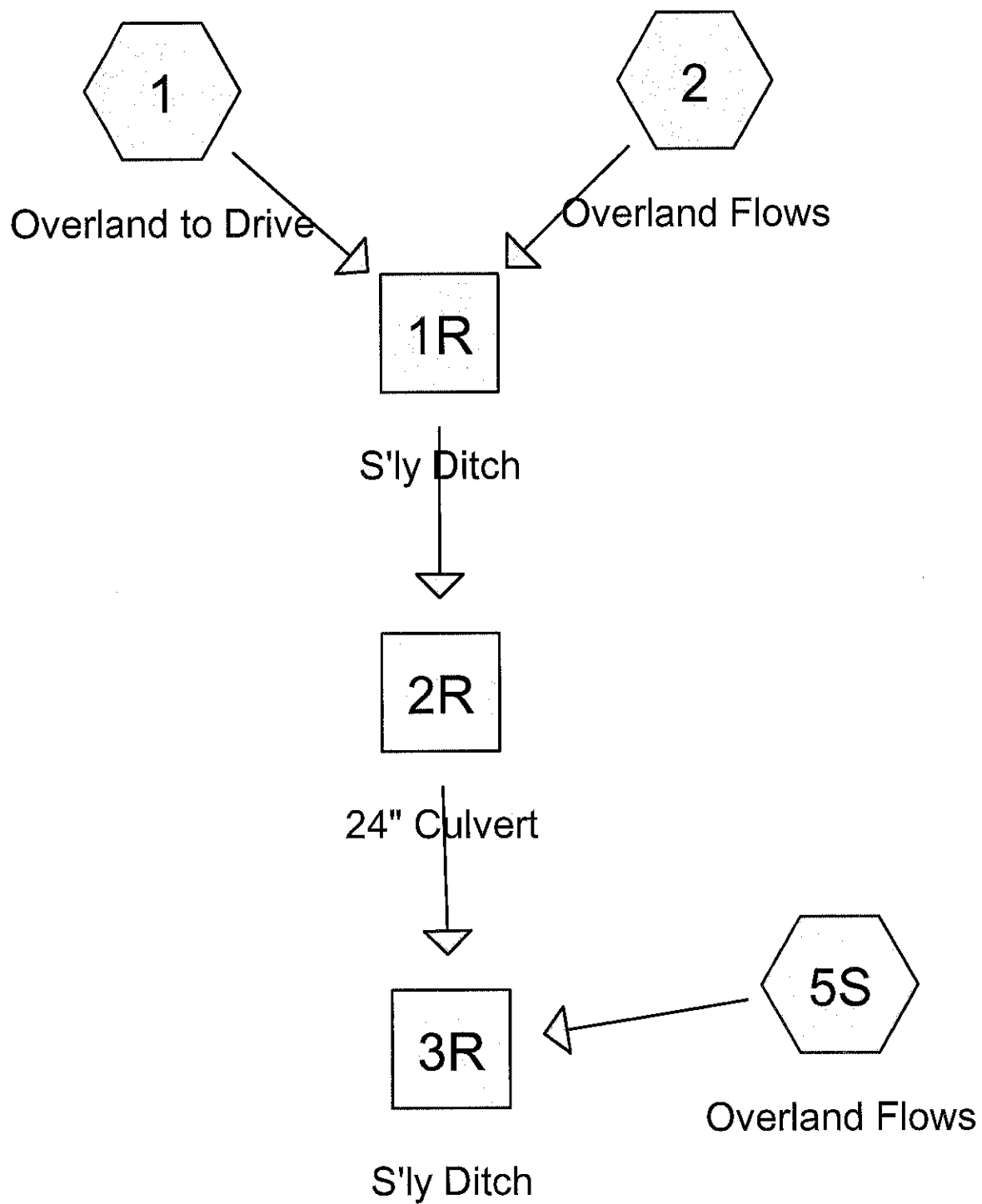
460

467

HydroCAD Data



PRE-DEVELOPMENT DRAINAGE CALCULATIONS



5554 VMD Pre- Development

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Page 2

Rainfall Events Listing (selected events)

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-Year	NRCC 24-hr	D	Default	24.00	1	3.09	2
2	10-Year	NRCC 24-hr	D	Default	24.00	1	4.65	2
3	25-Year	NRCC 24-hr	D	Default	24.00	1	5.87	2
4	100-Year	NRCC 24-hr	D	Default	24.00	1	8.36	2

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Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
9,500	39	>75% Grass cover, Good, HSG A (1, 2)
279,675	48	Brush, Poor, HSG A (1, 2, 5S)
5,325	72	Dirt roads, HSG A (1, 2, 5S)
71,115	36	Woods, Fair, HSG A (1, 2, 5S)
365,615	46	TOTAL AREA

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Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
365,615	HSG A	1, 2, 5S
0	HSG B	
0	HSG C	
0	HSG D	
0	Other	
365,615		TOTAL AREA

5554 VMD Pre- Development

NRCC 24-hr D 2-Year Rainfall=3.09"

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Time span=1.00-30.00 hrs, dt=0.01 hrs, 2901 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: Overland to Drive	Runoff Area=39,730 sf 0.00% Impervious Runoff Depth=0.06" Flow Length=195' Tc=6.0 min CN=47 Runoff=0.01 cfs 190 cf
Subcatchment 2: Overland Flows	Runoff Area=190,495 sf 0.00% Impervious Runoff Depth=0.04" Flow Length=230' Tc=6.1 min CN=46 Runoff=0.02 cfs 701 cf
Subcatchment 5S: Overland Flows	Runoff Area=135,390 sf 0.00% Impervious Runoff Depth=0.03" Flow Length=390' Tc=10.1 min CN=45 Runoff=0.01 cfs 365 cf
Reach 1R: S'ly Ditch	Avg. Flow Depth=0.10' Max Vel=0.09 fps Inflow=0.03 cfs 891 cf n=0.100 L=750.0' S=0.0007 ' Capacity=58.69 cfs Outflow=0.03 cfs 811 cf
Reach 2R: 24" Culvert	Avg. Flow Depth=0.07' Max Vel=0.78 fps Inflow=0.03 cfs 811 cf 24.0" Round Pipe n=0.012 L=105.0' S=0.0023 ' Capacity=11.72 cfs Outflow=0.03 cfs 809 cf
Reach 3R: S'ly Ditch	Avg. Flow Depth=0.15' Max Vel=0.07 fps Inflow=0.04 cfs 1,175 cf n=0.100 L=700.0' S=0.0003 ' Capacity=38.78 cfs Outflow=0.03 cfs 783 cf
Total Runoff Area = 365,615 sf Runoff Volume = 1,256 cf Average Runoff Depth = 0.04" 100.00% Pervious = 365,615 sf 0.00% Impervious = 0 sf	

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NRCC 24-hr D 2-Year Rainfall=3.09"

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Summary for Subcatchment 1: Overland to Drive

Runoff = 0.01 cfs @ 21.62 hrs, Volume= 190 cf, Depth= 0.06"
 Routed to Reach 1R : S'ly Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.01 hrs
 NRCC 24-hr D 2-Year Rainfall=3.09"

Area (sf)	CN	Description
2,875	36	Woods, Fair, HSG A
30,260	48	Brush, Poor, HSG A
5,075	39	>75% Grass cover, Good, HSG A
1,520	72	Dirt roads, HSG A
39,730	47	Weighted Average
39,730		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.0060	0.21		Sheet Flow, Fallow n= 0.050 P2= 3.00"
1.1	95	0.0200	1.41		Shallow Concentrated Flow, Nearly Bare & Untilled Kv= 10.0 fps
0.3	50	0.0200	2.87		Shallow Concentrated Flow, Paved Kv= 20.3 fps
5.3	195	Total, Increased to minimum Tc = 6.0 min			

Summary for Subcatchment 2: Overland Flows

Runoff = 0.02 cfs @ 24.01 hrs, Volume= 701 cf, Depth= 0.04"
 Routed to Reach 1R : S'ly Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.01 hrs
 NRCC 24-hr D 2-Year Rainfall=3.09"

Area (sf)	CN	Description
38,225	36	Woods, Fair, HSG A
144,680	48	Brush, Poor, HSG A
4,425	39	>75% Grass cover, Good, HSG A
3,165	72	Dirt roads, HSG A
190,495	46	Weighted Average
190,495		100.00% Pervious Area

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NRCC 24-hr D 2-Year Rainfall=3.09"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.2	50	0.0240	0.37		Sheet Flow, Fallow n= 0.050 P2= 3.00"
1.7	115	0.0120	1.10		Shallow Concentrated Flow, Nearly Bare & Untilled Kv= 10.0 fps
2.1	45	0.0013	0.36		Shallow Concentrated Flow, Nearly Bare & Untilled Kv= 10.0 fps
0.1	20	0.2700	5.20		Shallow Concentrated Flow, Nearly Bare & Untilled Kv= 10.0 fps
6.1	230	Total			

Summary for Subcatchment 5S: Overland Flows

Runoff = 0.01 cfs @ 24.02 hrs, Volume= 365 cf, Depth= 0.03"
 Routed to Reach 3R : S'ly Ditch

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-30.00 hrs, dt= 0.01 hrs
 NRCC 24-hr D 2-Year Rainfall=3.09"

Area (sf)	CN	Description
30,015	36	Woods, Fair, HSG A
104,735	48	Brush, Poor, HSG A
640	72	Dirt roads, HSG A
135,390	45	Weighted Average
135,390		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
2.4	50	0.0200	0.35		Sheet Flow, Fallow n= 0.050 P2= 3.00"
0.2	30	0.1100	3.32		Shallow Concentrated Flow, Nearly Bare & Untilled Kv= 10.0 fps
7.4	280	0.0040	0.63		Shallow Concentrated Flow, Nearly Bare & Untilled Kv= 10.0 fps
0.1	30	0.1600	4.00		Shallow Concentrated Flow, Nearly Bare & Untilled Kv= 10.0 fps
10.1	390	Total			

Summary for Reach 1R: S'ly Ditch

Inflow Area = 230,225 sf, 0.00% Impervious, Inflow Depth = 0.05" for 2-Year event
 Inflow = 0.03 cfs @ 24.01 hrs, Volume= 891 cf
 Outflow = 0.03 cfs @ 26.46 hrs, Volume= 811 cf, Atten= 3%, Lag= 146.8 min
 Routed to Reach 2R : 24" Culvert

Routing by Stor-Ind+Trans method, Time Span= 1.00-30.00 hrs, dt= 0.01 hrs
 Max. Velocity= 0.09 fps, Min. Travel Time= 145.5 min
 Avg. Velocity= 0.07 fps, Avg. Travel Time= 179.0 min