

# McLean Child and Adolescent Campus

115 Mill Street  
Belmont, MA

PREPARED FOR

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McLean Hospital  
115 Mill Street  
Belmont, MA 02478

PREPARED BY

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260 Arsenal Place #2  
Watertown, MA 02472  
617.924.1770

ISSUE DATE

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December 16, 2024

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*Justin W. Mosca*  
12/16/2024

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# Stormwater Report Narrative

This Stormwater Report has been prepared to demonstrate compliance with Section 6A.5 Stormwater Management Facilities of the Town of Belmont Zoning By-Law, approved January 7, 2021 (Zoning Bylaw), the Massachusetts Stormwater Handbook, and the MS4 Permit per the requirements of the Town of Belmont Stormwater Management and Erosion Control Bylaw, adopted September 18, 2023 (Stormwater Bylaw) for stormwater design and management. Although the project is not subject to the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00) this Stormwater Report documents compliance with the MA Stormwater Management Standards per the requirements of the Town of Belmont.

## Project Description

The Applicant, McLean Hospital Corporation, is proposing to construct a new academic and residential campus with related site improvements (The Project) situated in the Research and Development Subdistrict (Zone 4) of the McLean Zoning District at 115 Mill Street in Belmont, MA. The Project consists of two multi-story buildings, each with approximate footprints of 15,000-square feet (SF), and a parking structure with an approximate footprint of 24,600 SF. Associated site improvements include a circulation drive for building and garage access, an at-grade exterior parking lot sited adjacent to the parking structure, designated loading dock area, driveway connections to various existing drives at the perimeter of the Project, utility improvements to support the proposed use, and landscape/amenity improvements to exterior spaces adjacent to the buildings, courtyards, and playground areas.

The Project is not considered a Land Use with Higher Potential Pollutant Loads (LUHPPL).

For planning purposes, the Zoning Bylaw allows for a maximum gross floor area of 150,000 SF in the Zone 4 subdistrict. The Project is targeting construction of just under 89,500 SF of gross floor area. To allow for flexibility of siting a future project in Zone 4, the northeast portion of the Zone 4 subdistrict is not proposed to be improved as part of the Project. As a result, only topographic areas contributing runoff to the Project or areas proposed for disturbance as part of the Project were considered in the stormwater design. A separate stormwater design and analysis will be developed to manage stormwater, treat water quality, and implement erosion and sediment controls for any future project within Zone 4, as required by the Town of Belmont regulations.

## Site Description

The Project Site is proposed to encompass approximately 8.6 acres (the Site) of the overall 11.6 acres of land located in Zone 4 of the McLean Zoning District located at 115 Mill Street in Belmont, Massachusetts (see Figure 1). The Site lies within the surface watershed of the Mystic River and is bounded by the McLean Hospital campus to the north and west and Town of Belmont open space to the south and east. See Figure 1, Site Locus Map.

Zone 4 lies entirely within Zone X, as shown on the FEMA Flood Insurance Rate Map for the Town of Belmont, Massachusetts, Map Number 25017C0414E, Effective Date December June 4, 2010 (See Figure 2). Zone X are designated as areas of minimal flood hazard and are considered outside of the 100-year floodplain.

According to the Natural Resources Conservation Service (NRCS), surface soils on the Site are primarily classified as Hydrologic Soil Group 'A' (HSG A) soils and a small portion of area not proposed for disturbance is classified as Hydrologic Soil Group 'D' (HSG D) soils in the northeast portion of Zone 4. HSG A classified soils include Narragansett-Hollis-Rock outcrop complex (3% to 15% slopes) and Narragansett-Hollis-Rock outcrop complex (15% to 25% slopes). HSG D classified soil includes Hollis-Rock outcrop-Charlton complex (0% to 15% slopes).

Haley & Aldrich, Inc. performed soil explorations for several test pits throughout Zone 4 that are described in a report titled "Results of Subsurface Investigations and Concept Level Geotechnical Design Considerations," dated February 8, 2022 (Geotechnical Report). In general, subsurface conditions consist of shallow bedrock overlain by glacial till, organic deposits, loess deposits, and fill. Bedrock was encountered in each of the test pits between approximately 5 to 8.5-feet. In addition, groundwater was observed in four test pits measuring 3.5 to 7.2-feet below ground surface. Infiltration testing was conducted in one test pit and was not performed in two other locations due to limitations in soils encountered and safety concerns for one location and soils and groundwater encountered at the second location. Ultimately, a concept level estimated design infiltration value of 0.19 in/hr was established based on one permeameter testing location in sandy loam. Considering the shallow depths to groundwater and bedrock, the poorly draining soils encountered, and infiltration rate being challenging to establish in the field and approaching the minimum value of 0.17 in/hour allowed by the MA Stormwater Handbook, the design approach does not propose infiltration in the stormwater analysis.

A HSG A designation was utilized for the existing and proposed hydrologic conditions analysis to reflect the consistency between the NRCS classifications and surface soil conditions encountered and documented in the Geotechnical Report.

## Existing Drainage Conditions

Under existing conditions, the Site is developed and predominantly pervious with hilly topography. Existing impervious conditions at the Site consist of a centrally located paved parking area and paved driveways traversing the west portion of Zone 4 that historically provided access to two buildings that are now demolished. Existing pervious conditions at the Site consist of varying levels of established grassed areas around the paved parking lot and in areas surrounding the demolished buildings and wooded areas at the east and south perimeter

of the Site. There is also a wooded area surrounding an archaeological preservation restriction located between the existing parking area and driveways, generally located at the southeast end of the Site.

Topography at the Site varies significantly and generally slopes from north to the south end of the Site. The highest topography on the Site is located at the northeast corner as elevation 216-feet (NAVD 1988). The lowest topography on the Site is located at the southwest corner as elevation 176-feet (NAVD 1988). A majority of the central developed portion of the Site generally flatter and ranges from approximately El. 194-feet to El. 191-feet (NAVD 1988).

Overland stormwater runoff from Zone 4 discharges to an existing drainage channel located at the southwest corner of Zone 4 and to various topographic low points along the south zoning district line of Zone 4. The existing drainage channel was determined to not be subject to jurisdiction under the Massachusetts Wetland Protection Act according to a Determination of Applicability established by the Belmont Conservation Commission on November 13, 2024. There is also a conventional closed-drainage system that collects runoff from the paved parking area and upstream Zone 5 and discharges stormwater runoff south to the existing drainage channel. The end of the closed-drainage system is located within a stone-reinforced slope and was not readily visible or accessible during the survey conducted for the Site (see Civil Plans under separate cover).

Under existing conditions, the Site is divided into two drainage subcatchment areas that discharge to two existing design points, DP-1 and DP-2. Descriptions of the Design Points and upstream contributing subcatchment are provided below. Figure 3 illustrates the existing drainage patterns on the Site.

### Design Points

**DP-1, Existing Drainage Channel:** Design Point 1 represents the surface discharge point to the existing drainage channel. The upstream subcatchment generally consists of the parking area, areas surrounding and including the two demolished buildings, and wooded areas at the northeast corner of the Site and north of the archaeological preservation restricted area.

**DP-2, Localized Low Point:** Design Point 2 represents the surface discharge point at a localized topographic low point located central to Zone 4 at the south zoning district line. The upstream subcatchment generally consists of the archaeological preservation restricted area and surrounding wooded area and driveways, and wooded areas at the southeast corner of the Site.

Table 1 below provides a summary of the existing conditions hydrologic data.

**Table 1 Existing Conditions Hydrologic Data**

Drainage Area	Discharge Location	Design Point	Area (Acres)	Curve Number	Time of Concentration (min)
EX-1	DP-1	DP-1	6.17	57	9.9
EX-2	DP-2	DP-2	2.62	51	6.4

## Proposed Drainage Conditions

Under the proposed conditions, the existing drainage patterns will generally be maintained to route runoff from north to the south end of the Site. The highest and lowest topography on the Site will be maintained at the same elevations, the exterior parking lot will be graded to generally range from El. 202-feet to El. 196-feet (NAVD 1988), and a majority of the proposed campus will be graded to generally range from El. 195-feet to El. 191-feet (NAVD 1988).

In general, stormwater runoff from the Site will be routed overland to new deep-sump, hooded catch basins in paved areas and area drains in vegetated areas. Stormwater will then collect in a closed-drainage system designed to convey the 10-year storm event and be routed to one of four subsurface sand filter/detention systems located throughout the Site. The roofs of the occupied buildings and the parking structure will also be routed to a subsurface sand filter/detention system. There are some areas that will direct discharge runoff off the site without being managed in the subsurface sand filter/detention systems; these include overland flow areas along the south zoning district line, an area east of the garage where the project terminates at an existing driveway, and a landscaped courtyard between the school and the wooded area surrounding the archeological preservation restriction. The direct discharge subcatchments are largely pervious and will have some hardscape walks that have been accounted for in the hydrologic design analysis.

Runoff within the subsurface sand filter/detention systems will be managed through the construction of an outlet control structure to control peak runoff rates prior to stormwater discharging from the Site. The sand filter portion of the systems will allow stormwater to filter through the sand to treat the required water quality volume for TSS and phosphorous before discharging from the Site.

Figure 4 illustrates the proposed "post construction" drainage conditions for the project. As shown, the Site will be divided into fourteen drainage areas that discharge treated stormwater to the two existing Design Points. Table 2 below provides a summary of the proposed conditions hydrologic data.

**Table 2 Proposed Conditions Hydrologic Data**

Drainage Area	Discharge Location	Design Point	Area (Acres)	Curve Number	Time of Concentration (min)
PR-10.1	Drainage Channel	DP-1	0.10	37	5
PR-10.2	Drainage Channel	DP-1	0.22	46	5
PR-11.1	P-11	DP-1	1.67	62	5
PR-11.2	P-11	DP-1	0.34	98	5
PR-11.3	P-11	DP-1	0.15	98	5
PR-12.1	P-12	DP-1	1.36	60	5
PR-12.2	P-12	DP-1	0.22	98	5
PR-13.1	P-13	DP-1	1.19	57	5
PR-13.2	P-13	DP-1	0.56	98	5
PR-20.1	Offsite to South	DP-2	0.49	44	5
PR-20.2	Offsite to South	DP-2	0.23	36	5
PR-20.3	Offsite to South	DP-2	0.74	37	5
PR-21.1	P-21	DP-2	1.02	66	5
PR-21.2	P-21	DP-2	0.48	83	5

The site design integrates a comprehensive stormwater management system that has been developed in accordance with the Massachusetts Stormwater Handbook and meets the requirements established by the MS4, applicable TMDLs, and the Town of Belmont regulations. To meet the MA Stormwater Handbook requirements, the TSS percentage computations spreadsheet reflect the proposed stormwater management system is designed to provide 85% Total Suspended Solids (TSS) from proposed pavement and hardscape areas and 80% Total Suspended Solids (TSS) from roof areas. Calculations can be found in Appendix D.

The system was designed to remove 62% of the average annual load of Total Phosphorus (TP) from the Site. The phosphorus calculations were developed based on US EPA Region 1's BMP Accounting and Tracking Tool and also reflect a 99% TSS removal for the proposed stormwater management system. This exceeds the current MS4, applicable TMDLs, and the Town of Belmont regulations for New Development Sites that require a new development to meet an average annual pollutant removal equivalent to 90% TSS and 60% TP. Calculations can be found in Appendix F.



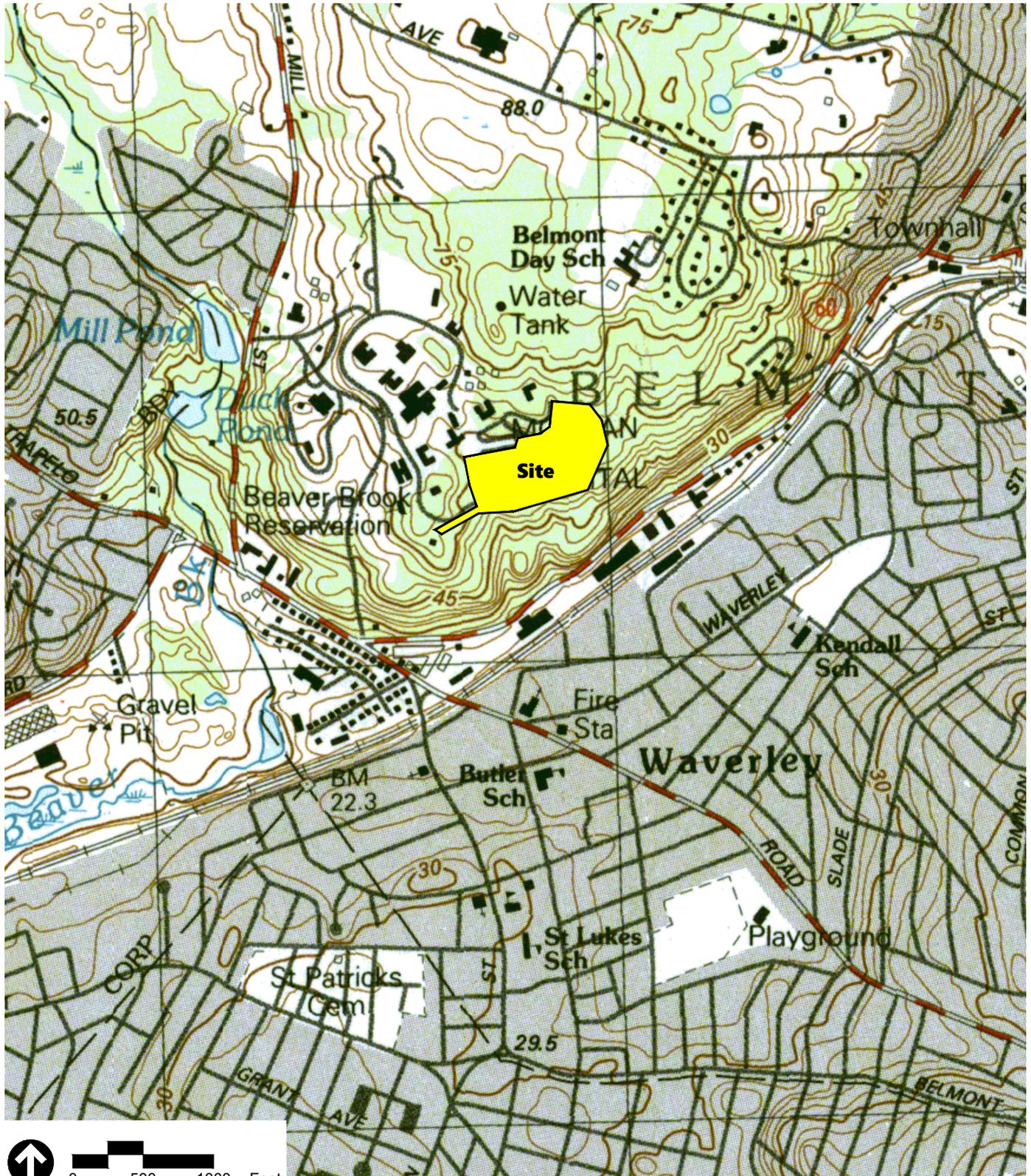


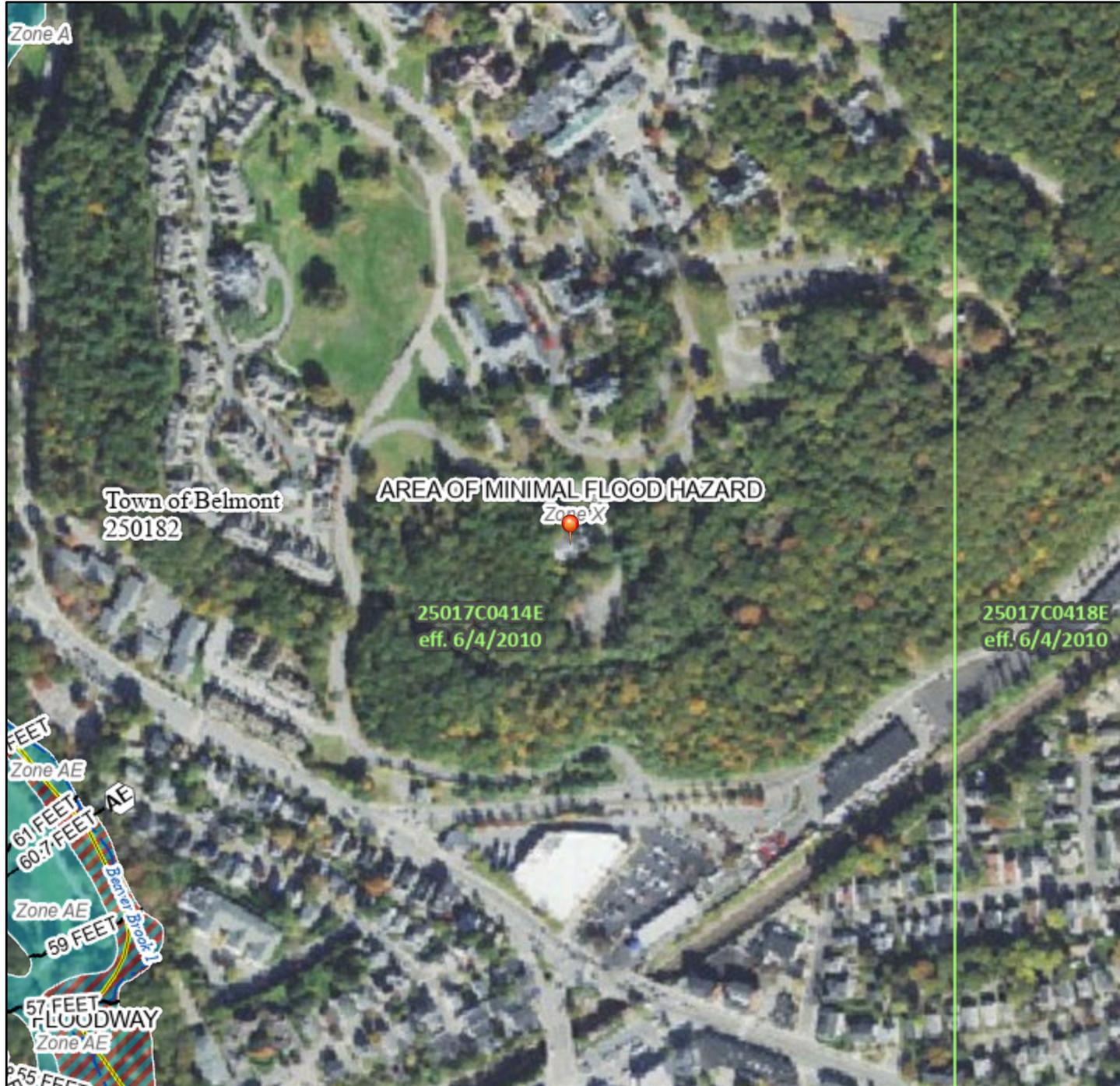
Figure 1  
Site Locus Map

**McLean Child and Adolescent Campus  
Belmont, MA**

# National Flood Hazard Layer FIRMMette



71°11'46"W 42°23'40"N



## Legend

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

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

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

OTHER AREAS	NO SCREEN Area of Minimal Flood Hazard <i>Zone X</i>
	Effective LOMRs
	Area of Undetermined Flood Hazard <i>Zone D</i>

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

OTHER FEATURES	Cross Sections with 1% Annual Chance Water Surface Elevation
	20.2
	17.5
	Coastal Transect
	Base Flood Elevation Line (BFE)

OTHER FEATURES	Limit of Study
	Jurisdiction Boundary
	Coastal Transect Baseline
	Profile Baseline
	Hydrographic Feature

MAP PANELS	Digital Data Available
	No Digital Data Available
	Unmapped

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on **11/14/2024 at 10:27 PM** and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

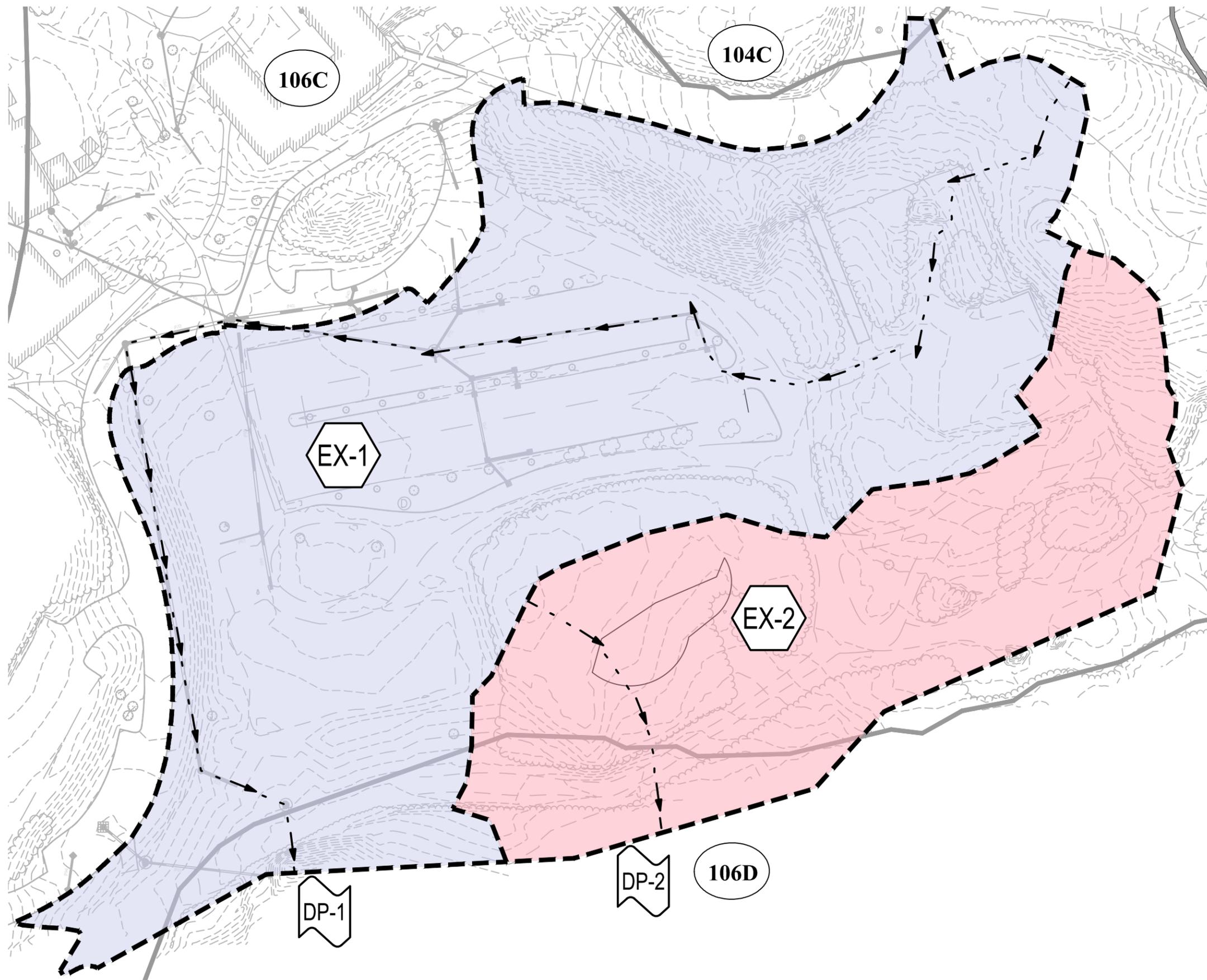
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory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



1:6,000

71°11'9"W 42°23'13"N

Basemap Imagery Source: USGS National Map 2023



## Legend

### SYMBOLS

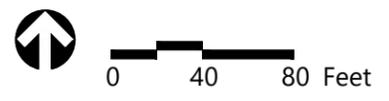
-  DESIGN POINT
-  DRAINAGE AREA DESIGNATION

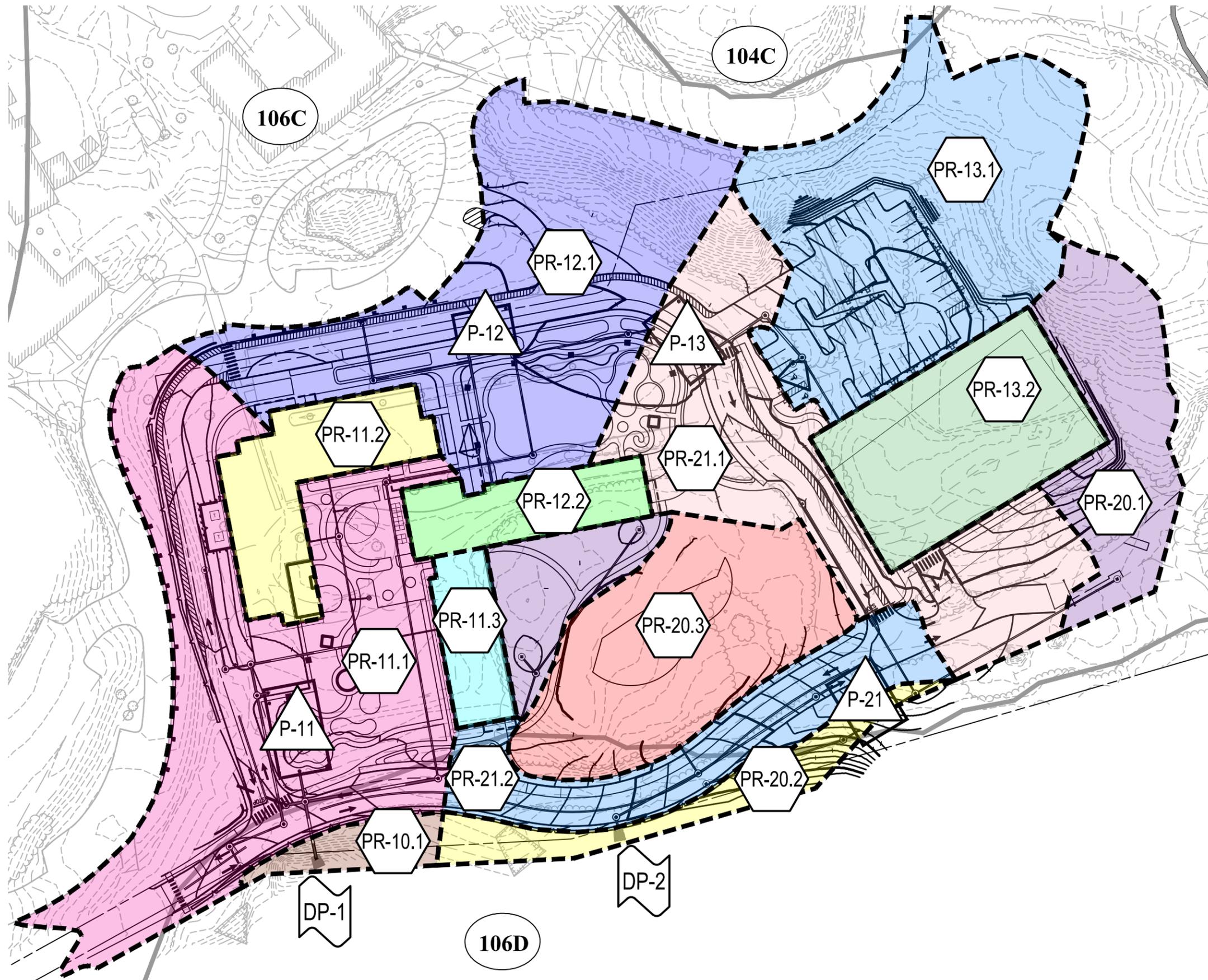
### LINETYPES

-  DRAINAGE AREA BOUNDARY
-  TIME OF CONCENTRATION FLOW LINE
-  SOIL TYPE BOUNDARY

### SCS SOIL CLASSIFICATIONS

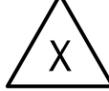
-  HOLLIS-ROCK OUTCROP CHARLTON COMPLEX, 0 TO 15 PERCENT SLOPES
-  NARRAGANSETT-HOLLIS ROCK OUTCROP COMPLEX, 3 TO 15 PERCENT SLOPES
-  NARRAGANSETT-HOLLIS ROCK OUTCROP COMPLEX, 15 TO 25 PERCENT SLOPES





## Legend

### SYMBOLS

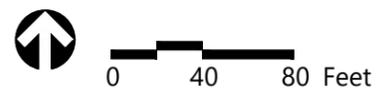
-  DESIGN POINT
-  DRAINAGE AREA DESIGNATION
-  POND

### LINETYPES

-  DRAINAGE AREA BOUNDARY
-  TIME OF CONCENTRATION FLOW LINE
-  SOIL TYPE BOUNDARY

### SCS SOIL CLASSIFICATIONS

-  HOLLIS-ROCK OUTCROP CHARLTON COMPLEX, 0 TO 15 PERCENT SLOPES
-  NARRAGANSETT-HOLLIS ROCK OUTCROP COMPLEX, 3 TO 15 PERCENT SLOPES
-  NARRAGANSETT-HOLLIS ROCK OUTCROP COMPLEX, 15 TO 25 PERCENT SLOPES





# Regulatory Compliance

## Massachusetts Department of Environmental Protection (DEP) – Stormwater Management Standards

As demonstrated below, the proposed Project fully complies with the DEP Stormwater Management Standards.

### Standard 1: No New Untreated Discharges or Erosion to Wetlands

The Project has been designed to comply with Standard 1.

The Best Management Practices (BMPs) included in the proposed stormwater management system have been designed in accordance with the Massachusetts Stormwater Handbook. Supporting information and computations demonstrating that no new untreated discharges will result from the Project are presented through compliance with Standards 4 through 6.

All proposed Project stormwater outlets and conveyances have been designed to not cause erosion or scour to wetlands or receiving waters. Outlets from closed-drainage systems have been designed with stone protection to dissipate discharge velocities.

Computations and supporting information for the sizing and selection of materials used to protect from scour and erosion are included in Appendix A.

### Standard 2: Peak Rate Attenuation

The Project has been designed to comply with Standard 2.

The rainfall-runoff response of the Site under existing and proposed conditions was analyzed for storm events with recurrence intervals of 2, 10, 25 and 100 years. The results of the analysis, as summarized in Table 3 below, indicate that there is no increase in peak discharge rates between the existing and proposed conditions 2-, 10-, 25- and 100-year storm events.

Computations and supporting information regarding the hydrologic modeling are included in Appendix B.

**Table 3 Peak Discharge Rates (cfs\*)**

Design Point	2-year	10-year	25-year	100-year
<b>DP-1: Drainage Channel</b>				
Existing	0.9	5.4	10.3	22.4
Proposed	0.2	1.3	6.8	21.5
<b>DP-2: Localized Low Point</b>				
Existing	0.1	1.3	3.3	8.3
Proposed	0.1	0.2	1.2	7.2

### Standard 3: Stormwater Recharge

Haley & Aldrich, Inc. performed soil explorations for several test pits throughout Zone 4 that are described in a report titled "Results of Subsurface Investigations and Concept Level Geotechnical Design Considerations," dated February 8, 2022 (Geotechnical Report). Considering the shallow depths to groundwater and bedrock, soils encountered, and infiltration rate being challenging to establish in the field and approaching the minimum value of 0.17 in/hour allowed by the MA Stormwater Handbook, the infiltration of stormwater is not feasible and as such, the design approach does not propose infiltration in the stormwater analysis.

A HSG A designation was utilized for the existing and proposed hydrologic conditions analysis to reflect the consistency between the NRCS classifications and surface conditions of the sandier fill soils encountered and documented in the Geotechnical Report. Soil evaluation (including Geotechnical Report) and supporting information are included in Appendix C.

### Standard 4: Water Quality

The Project has been designed to comply with Standard 4.

The proposed stormwater management system implements a treatment train of BMPs designed to provide 85% Total Suspended Solids (TSS) from proposed pavement and hardscape areas and 80% Total Suspended Solids (TSS) from roof areas.

Computations and supporting information, including the Long-Term Pollution Prevention Plan, are included in Appendix D.

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

The Project is not considered a LUHPPL.

### Standard 6: Critical Areas

The Project will not discharge stormwater near or to a critical area.

## **Standard 7: Redevelopments and Other Projects Subject to the Standards only to the Maximum Extent Practicable**

The Project has been designed to comply with all Stormwater Management Standards, with the exception of Standard 3. The project is seeking relief from Standard 3 due to shallow depths to groundwater and bedrock, and poorly infiltrating soils encountered on the Site. All other Standards have been met fully. Refer directly to each Standard for applicable computations and supporting information demonstrating compliance with each.

## **Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Controls**

The Project will disturb approximately 8.8 acres of land and is therefore required to obtain coverage under the Environmental Protection Agency (EPA) National Pollutant Discharge Elimination System (NPDES) Construction General Permit. As required under this permit, a Stormwater Pollution Prevention Plan (SWPPP) will be developed and submitted before land disturbance begins. Recommended construction period pollution prevention and erosion and sedimentation controls to be finalized in the SWPPP are included in Appendix E.

## **Standard 9: Operation and Maintenance Plan**

In compliance with Standard 9, a Post Construction Stormwater Operation and Maintenance (O&M) Plan has been developed for the Project. The O&M Plan is included in Appendix D as part of the Long-Term Pollution Prevention Plan.

## **Standard 10: Prohibition of Illicit Discharges**

### Illicit Discharge Compliance Statement:

Sanitary sewer and storm drainage structures remaining from previous development which are part of the proposed Site area will be removed or will be incorporated into updated sanitary sewer and separate stormwater sewer systems. The design plans submitted with this report have been designed so that the components included therein are in full compliance with current standards. No statement is made regarding the drainage system in portions of the property not included in the proposed Project Site area.

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

## Local Municipal Rules and Regulations

The proposed stormwater management system is designed in accordance with Section 6A.5 Stormwater Management Facilities of the Town of Belmont Zoning By-Law, approved January 7, 2021 (Zoning Bylaw) and the requirements of the Town of Belmont Stormwater Management and Erosion Control Bylaw, adopted September 18, 2023 (Stormwater Bylaw). The system achieves the water quality treatment requirements as stated in the Massachusetts MS4, applicable TMDLs, and the Massachusetts Stormwater Standards, as required by the local bylaw.

The completed Checklist for Stormwater Management and Erosion Control Report is provided in Appendix F.

### Belmont Zoning By-Law: Stormwater Management Facilities Requirements

The requirements found in Section 6A.5 Stormwater Management Facilities of the Town of Belmont Zoning By-Law are summarized below:

The Site stormwater management facilities have been designed to comply with the requirements of the Zoning By-Law. The proposed stormwater management systems utilized subsurface detention facilities rather than open detention basins to mitigate post-development peak runoff to pre-development levels. Discharge from the Site to the storm drainage system(s) downstream of the Site is reduced for the analyzed peak storm events and does not negatively impact the existing Town off-site storm drainage system. The stormwater facilities are proposed to be sited entirely in Zone 4, will be structurally capable of withstanding H-20 loading, will incorporate the use of an overflow control structure to mitigate flows to the downstream stormwater system, and will treat both paved and roofs areas within the subsurface detention facility to address MS4 requirements. Reference the appendices and narrative herein for additional information.

### Belmont Stormwater By-Law: Design Criteria

The design criteria as stated in Section 60-325.F. (4) of the Belmont Stormwater Management and Erosion Control Bylaw are listed below:

*(a) Compliance with all applicable provisions of the Stormwater Management Standards, regardless of the proximity of the development to resource areas or their buffer zones, as defined by the Wetlands Protection Act, M.G.L. c. 131, § 40 and its implementing regulations.*

The Site stormwater management system meets all Stormwater Management Standards, see appendices and narrative herein for details and calculations.

*(b) Erosion and sediment controls must be implemented to prevent adverse impacts during disturbance and construction activities.*

The Project will employ erosion and sedimentation controls throughout the course of construction. A SWPPP will be filed with the EPA prior to construction which will govern the erosion and sedimentation controls implemented by the site Operators. A recommended construction-period BMP checklist is included in the appendices of this report, and the site plans

show the minimum required erosion and sedimentation controls as well as notes stating minimum required measures to control the site during construction.

*(c) There shall be no change to the existing conditions of abutting properties from any increase in peak flows or volumes of stormwater runoff or from erosion, silting, flooding, sedimentation or impacts to wetlands, ground water levels or wells.*

The stormwater management system has been designed to reduce post-development discharge peak rates of runoff for the 2, 10, 25- and 100-year storms to below pre-development discharge peak rates of runoff at each design point in the stormwater analysis.

*(d) When any proposed discharge may have an impact upon streams, wetlands or storm sewers, the OCD may require minimization or elimination of this impact based on site conditions and existing stormwater system capacity.*

All stormwater outfall locations have been designed with stone protection to avoid erosion and sedimentation.

*(e) Compliance with all applicable provisions of the MS4 Permit, including performance standards for New Development and Redevelopment.*

The stormwater management systems are designed to exceed the requirements to meet an average annual pollutant removal equivalent to 90% TSS and 60% TP based on the calculations developed consistent with US EPA Region 1's BMP Accounting and Tracking Tool<sup>1</sup>. See appendices and narrative herein for details and calculations.

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<sup>1</sup> The system has been designed to achieve a 62% reduction in the average annual load of Total Phosphorus (TP) from the Site, aligning with the phosphorus reduction target requirements outlined for sites within the Mystic River Watershed. These requirements are specified in the draft Commercial, Industrial, and Institutional (CII) Stormwater General Permit proposed by the United States Environmental Protection Agency (US EPA), which is expected to be adopted in 2025.



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## Appendix A: Standard 1 Computations and Supporting Information

- › Pipe Sizing Calculations
- › Stone outlet protection for pipe ends

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## Pipe Sizing Calculations

The closed drainage system was designed for the 10-year storm event.

Drainage pipes were sized using Manning's Equation and the Rational Method. Additionally, the performance of the system was analyzed using StormCAD, a HEC-22 based program.

StormCAD Pipe Sizing Calculations  
 McLean - Zone 4  
 Belmont, MA  
 10-year Storm

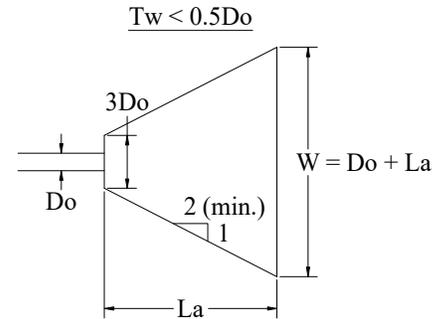
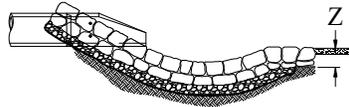
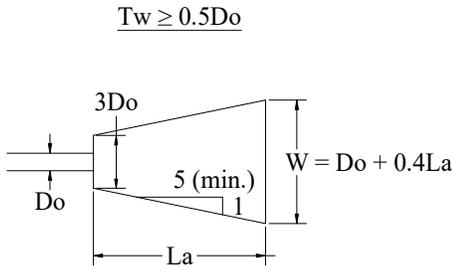
Start Node	Stop Node	Upstream Inlet Area (acres)	Upstream Inlet C	System CA (acres)	Conc Time (min)	Intensity (in/h)	Pipe Size (in)	Manning's n	Slope (%)	Length (ft)	Capacity (Full Flow) (ft <sup>3</sup> /s)	Flow (Design) (ft <sup>3</sup> /s)	Velocity (Average) (ft/s)	Rim (Upper) (ft)	Hydraulic Grade Line In (ft)	Rim (Lower) (ft)	Hydraulic Grade Line Out (ft)	Invert (Upper) (ft)	Invert (Lower) (ft)
RD-1	DMH-104	0.56	0.90	0.51	5.00	5.8	12	0.011	1.1%	57.0	4.3	2.9	5.9	195.5	193.7	195.1	193.4	193.0	192.4
CB-100	DMH-104	1.19	0.42	0.50	5.00	5.8	18	0.011	0.6%	8.7	9.4	2.9	4.7	195.0	193.4	195.1	193.4	192.5	192.4
DMH-104	DMH-105			1.01	5.16	5.7	18	0.011	1.1%	43.7	13.3	5.8	7.3	195.1	193.2	196.2	192.8	192.3	191.8
DMH-105	SFD-13			1.01	5.26	5.7	18	0.011	1.1%	48.7	13.2	5.8	7.2	196.2	192.6	194.7	191.9	191.7	191.2
SFD-13	DMH-141			0.00	0.00	5.8	12	0.011	1.2%	20.1	4.7	1.0	4.8	192.0	186.7	192.1	186.3	186.3	186.0
DMH-141	DMH-108			0.00	0.07	5.8	12	0.011	1.2%	90.6	4.6	1.0	4.7	192.1	186.3	189.8	185.1	185.9	184.8
CB-115	DMH-114	1.37	0.45	0.62	5.00	5.8	12	0.011	1.1%	47.3	4.3	3.6	6.2	193.1	191.3	194.3	190.9	190.5	190.0
DMH-114	DMH-113			0.62	5.13	5.7	18	0.011	1.2%	77.0	13.4	3.6	6.4	194.3	190.6	193.0	190.2	189.9	189.0
RD-2	DMH-113	0.22	0.90	0.20	5.00	5.8	18	0.011	1.0%	96.5	12.6	1.1	4.4	194.5	190.4	193.0	190.2	190.0	189.0
DMH-113	SFD-12			0.81	5.36	5.7	18	0.011	0.9%	11.4	11.6	4.6	6.2	193.0	190.1	194.6	190.1	188.9	188.8
SFD-12	DMH-108			0.00	0.00	5.8	12	0.011	1.7%	12.0	5.4	0.3	3.7	189.1	185.1	189.8	185.1	184.5	184.3
DMH-108	DMH-107			0.00	0.39	5.8	12	0.011	1.1%	79.1	4.5	1.3	4.9	189.8	184.7	194.6	183.8	184.2	183.3
DMH-107	DMH-118			0.00	0.66	5.8	12	0.011	1.0%	117.1	4.3	1.3	4.8	194.6	183.7	190.7	182.5	183.2	182.0
DMH-118	DMH-119			0.00	1.07	5.8	12	0.011	1.0%	234.7	4.3	1.3	4.8	190.7	182.4	193.4	179.9	181.9	179.5
CB-50	DMH-52	0.10	0.20	0.02	5.00	5.8	12	0.011	1.2%	138.2	4.7	0.1	2.5	194.4	191.0	194.3	189.3	190.9	189.2
CB-51	DMH-52	0.13	0.20	0.03	5.00	5.8	12	0.011	1.8%	17.0	5.6	0.2	3.1	194.4	191.1	194.3	190.7	190.9	190.6
DMH-52	CO-53			0.05	5.92	5.5	12	0.011	1.3%	31.6	4.7	0.3	3.2	194.3	189.3	194.5	188.9	189.1	188.7
CO-53	CO-54			0.05	6.09	5.5	12	0.011	1.5%	20.2	5.1	0.3	3.4	194.5	188.9	194.2	188.6	188.7	188.4
CO-54	DMH-119			0.05	6.19	5.4	12	0.011	1.4%	65.8	4.9	0.3	3.3	194.2	188.6	193.4	187.7	188.4	187.5
DMH-119	DMH-122			0.05	6.52	5.4	24	0.011	1.3%	105.6	30.8	1.5	5.1	193.4	179.8	186.3	179.6	179.4	178.0
RD-4	DMH-129	0.18	0.90	0.16	5.00	5.8	8	0.011	1.3%	24.0	1.6	0.9	4.7	194.5	189.7	194.0	189.5	189.2	188.9
RD-5	DMH-129	0.17	0.90	0.15	5.00	5.8	8	0.011	1.1%	47.3	1.5	0.9	4.4	194.5	189.8	194.0	189.5	189.4	188.9
DMH-129	DMH-128			0.31	5.18	5.7	12	0.011	1.3%	85.6	4.8	1.8	5.6	194.0	189.4	194.5	188.3	188.8	187.7
RD-3	DMH-128	0.15	0.90	0.13	5.00	5.8	12	0.011	1.3%	63.7	4.7	0.8	4.4	194.5	188.9	194.5	188.3	188.5	187.7
DMH-128	DMH-125			0.44	5.43	5.6	18	0.011	1.2%	85.8	13.4	2.5	5.8	194.5	188.2	191.0	187.6	187.6	186.6
CB-131	DMH-130	0.81	0.47	0.38	5.00	5.8	12	0.011	1.3%	79.1	4.7	2.2	5.9	191.0	189.1	193.1	188.2	188.5	187.5
DMH-130	DMH-125			0.38	5.22	5.7	12	0.011	1.5%	20.1	5.1	2.2	6.3	193.1	188.0	191.0	187.6	187.4	187.1
DMH-125	DMH-136			0.82	5.68	5.6	18	0.011	1.2%	24.6	13.7	4.6	7.0	191.0	187.3	192.9	187.3	186.5	186.2
CB-133	DMH-134	0.86	0.41	0.41	5.00	5.8	12	0.011	1.1%	17.5	4.4	2.4	5.7	190.6	188.8	191.8	188.6	188.1	187.9
DMH-134	DMH-135			0.41	5.05	5.7	12	0.011	1.1%	45.7	4.4	2.4	5.7	191.8	188.5	191.5	187.8	187.8	187.3
DMH-135	DMH-136			0.41	5.19	5.7	18	0.011	1.0%	102.5	12.3	2.4	5.4	191.5	187.8	192.9	187.3	187.2	186.2
DMH-136	SFD-11			1.23	5.74	5.6	18	0.011	1.2%	8.6	13.4	6.9	7.6	192.9	187.1	193.0	186.9	186.1	186.0
SFD-11	DMH-122			0.00	0.00	5.8	18	0.011	1.2%	24.4	13.8	0.5	3.7	191.8	181.3	186.3	180.9	181.0	180.7
DMH-123	DMH-122			0.00	0.00	5.8	24	0.011	1.3%	15.2	30.7	17.0	10.0	192.0	183.2	186.3	182.8	181.7	181.5
DMH-122	FES-1			0.05	6.87	5.3	24	0.011	1.4%	45.1	32.1	19.0	10.7	186.3	179.5	187.0	178.5	177.9	177.3
CB-211	DMH-214	0.49	0.27	0.13	5.00	5.8	12	0.011	1.2%	181.4	4.6	0.8	4.4	193.7	190.5	194.0	188.3	190.1	187.9
CB-212	DMH-214	1.02	0.52	0.53	5.00	5.8	12	0.011	1.0%	172.4	4.3	3.1	6.0	194.0	192.3	194.0	190.3	191.5	189.7
DMH-214	SFD-21			0.66	5.70	5.6	12	0.011	1.5%	19.9	5.2	3.7	7.2	194.0	188.2	189.8	187.8	187.4	187.1
CB-203	DMH-207	0.48	0.72	0.34	5.00	5.8	12	0.011	1.2%	112.6	4.5	2.0	5.6	189.5	186.8	191.5	186.4	186.2	184.9
DMH-207	SFD-21			0.34	5.34	5.7	12	0.011	1.4%	14.1	5.0	2.0	2.5	191.5	186.4	189.2	186.3	184.8	184.6
SFD-21	DMH-205			0.00	0.00	5.8	15	0.011	1.4%	14.8	8.9	0.2	3.0	185.6	181.2	191.0	180.9	181.0	180.8
DMH-205	DMH-202			0.00	0.08	5.8	15	0.011	1.1%	109.8	8.0	0.2	2.8	191.0	180.9	188.4	179.8	180.7	179.5
CB-204	DMH-202	0.74	0.20	0.15	5.00	5.8	12	0.011	1.1%	26.2	4.5	0.9	4.4	187.8	183.9	188.4	183.5	183.5	183.2
DMH-202	DMH-201			0.15	5.10	5.7	15	0.011	1.0%	72.7	7.5	1.1	4.3	188.4	179.8	190.4	179.0	179.4	178.7
DMH-201	FES-2			0.15	5.38	5.7	15	0.011	1.1%	9.3	7.9	1.1	4.5	190.4	179.0	190.5	178.8	178.6	178.5

\*Provided from 10-year storm modeled in HydroCAD



# Outfall Riprap Sizing and Velocity Calculations

Project	McLean-Zone 4	Project #	13555.11
Calculated by	SRK	Date	12/12/2024
Checked by		Date	



## OUTLET DESCRIPTION:

<b>WALL PIPE</b>				
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Design Storm	(yr)	10			
Flow / Discharge (Q)	(cfs)	0.2			

Defined Channel ?	-	NO			
Defined Channel Width	(ft)	0			
Outlet Pipe Diameter ( $D_o$ )	(in)	15			
Tailwater Condition ( $T_w$ )	(ft)	$TW < 0.5D$			

Apron Length ( $L_A$ )	(ft)	8			
Apron Width at Outlet ( $3D_o$ )	(ft)	3.75			
Apron Width at End (W)	(ft)	9.25			

Median Stone Diameter ( $d_{50}$ )	(in)	6			
Largest Stone Diameter	(in)	9			
Apron Depth (Z)	(in)	13.5			

Apron Length ( $L_A$ ): Length = From Virginia DCR Handbook - Plate 3.18-3 if  $T_w < 0.5D$   
 Length = From Virginia DCR Handbook - Plate 3.18-4 if  $T_w \geq 0.5D$

Apron Width at Outlet ( $3D_o$ ): Width = 3 x pipe dia. (or width of channel)

Apron Width at End (W): Width = dia. + apron length if  $T_w < 0.5D$   
 Width = dia. + 0.4 x apron length if  $T_w \geq 0.5D$   
 or apron width = channel width if a well defined channel exists

Rock Riprap: Median Diameter ( $d_{50}$ ) = From Virginia DCR Handbook - Plate 3.18-3 or 4  
 Largest stone dia = 1.5 x  $d_{50}$

Apron Depth (Z): 6" or 1.5 x largest stone dia



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## Appendix B: Standard 2 Computations and Supporting Information

The rainfall-runoff response of the Site under existing and proposed conditions was evaluated for storm events with recurrence intervals of 2, 10, 25 and 100-years. Rainfall volumes used for this analysis were based on the most current rainfall data published by the Northeast Regional Climate Center, 24-hour design storm precipitation depths for the site: 3.21, 4.86, 6.16, and 8.84 inches, respectively. Runoff coefficients for the pre- and post-development conditions, as previously shown in Tables 1 and 2 respectively, were determined using NRCS Technical Release 55 (TR-55) methodology as provided in HydroCAD. Drainage areas used in the analyses were described in previous sections and shown on Figures 2 and 3. The HydroCAD model is based on the NRCS Technical Release 20 (TR-20) Model for Project Formulation Hydrology.

# Extreme Precipitation Tables

## Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Metadata for Point	
Smoothing	Yes
State	Massachusetts
Location	Massachusetts, United States
Latitude	42.392 degrees North
Longitude	71.189 degrees West
Elevation	50 feet
Date/Time	Mon Dec 09 2024 13:27:50 GMT-0500 (Eastern Standard Time)

### Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.28	0.43	0.53	0.70	0.87	1.10	1yr	0.75	1.04	1.28	1.63	2.08	2.67	2.91	1yr	2.36	2.80	3.27	3.95	4.63	1yr
2yr	0.35	0.54	0.67	0.88	1.11	1.40	2yr	0.96	1.28	1.62	2.04	2.56	3.21	3.56	2yr	2.84	3.42	3.92	4.67	5.32	2yr
5yr	0.42	0.65	0.81	1.09	1.39	1.77	5yr	1.20	1.61	2.06	2.59	3.25	4.06	4.53	5yr	3.60	4.36	4.98	5.93	6.65	5yr
10yr	0.47	0.74	0.94	1.27	1.65	2.12	10yr	1.43	1.91	2.47	3.11	3.90	4.86	5.44	10yr	4.30	5.23	5.96	7.12	7.87	10yr
25yr	0.56	0.89	1.13	1.56	2.07	2.68	25yr	1.79	2.40	3.14	3.96	4.96	6.16	6.92	25yr	5.45	6.66	7.57	9.06	9.85	25yr
50yr	0.63	1.02	1.30	1.83	2.47	3.22	50yr	2.13	2.85	3.78	4.78	5.97	7.38	8.32	50yr	6.53	8.00	9.08	10.87	11.69	50yr
100yr	0.73	1.19	1.53	2.16	2.94	3.86	100yr	2.53	3.39	4.53	5.74	7.15	8.84	10.00	100yr	7.82	9.62	10.88	13.06	13.86	100yr
200yr	0.84	1.37	1.77	2.54	3.50	4.62	200yr	3.02	4.04	5.45	6.90	8.60	10.59	12.03	200yr	9.37	11.57	13.05	15.69	16.44	200yr
500yr	1.02	1.67	2.18	3.16	4.41	5.88	500yr	3.81	5.08	6.94	8.80	10.95	13.46	15.37	500yr	11.91	14.78	16.61	20.01	20.62	500yr

### Lower Confidence Limits

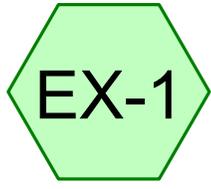
	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.24	0.37	0.46	0.62	0.76	0.84	1yr	0.65	0.82	1.14	1.45	1.78	2.44	2.51	1yr	2.16	2.41	2.90	3.51	4.13	1yr
2yr	0.33	0.51	0.63	0.85	1.05	1.26	2yr	0.91	1.23	1.44	1.91	2.47	3.10	3.44	2yr	2.74	3.31	3.79	4.50	5.15	2yr
5yr	0.39	0.60	0.75	1.02	1.30	1.50	5yr	1.13	1.47	1.73	2.24	2.89	3.74	4.16	5yr	3.31	4.00	4.56	5.44	6.12	5yr
10yr	0.44	0.67	0.83	1.16	1.50	1.72	10yr	1.30	1.68	1.94	2.53	3.24	4.32	4.79	10yr	3.82	4.61	5.24	6.25	6.96	10yr
25yr	0.50	0.77	0.96	1.36	1.79	2.04	25yr	1.55	1.99	2.28	2.97	3.78	5.19	5.76	25yr	4.60	5.53	6.30	7.48	8.22	25yr
50yr	0.56	0.85	1.06	1.53	2.05	2.33	50yr	1.77	2.28	2.58	3.35	4.25	5.97	6.61	50yr	5.28	6.35	7.22	8.55	9.32	50yr
100yr	0.63	0.95	1.19	1.71	2.35	2.65	100yr	2.03	2.59	2.91	3.55	4.79	6.87	7.56	100yr	6.08	7.27	8.29	9.74	10.57	100yr
200yr	0.70	1.06	1.34	1.94	2.71	3.03	200yr	2.34	2.96	3.30	3.96	5.40	7.91	8.65	200yr	7.00	8.32	9.51	11.07	11.97	200yr
500yr	0.82	1.23	1.58	2.29	3.26	3.60	500yr	2.81	3.52	3.88	4.57	6.34	9.53	10.29	500yr	8.43	9.90	11.41	13.08	14.08	500yr

### Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.31	0.48	0.59	0.79	0.97	1.14	1yr	0.84	1.11	1.33	1.78	2.26	2.85	3.12	1yr	2.52	3.00	3.49	4.25	5.00	1yr
2yr	0.36	0.56	0.69	0.94	1.16	1.36	2yr	1.00	1.33	1.57	2.08	2.68	3.33	3.71	2yr	2.94	3.56	4.09	4.85	5.52	2yr
5yr	0.45	0.70	0.86	1.19	1.51	1.79	5yr	1.30	1.75	2.05	2.65	3.38	4.40	4.96	5yr	3.90	4.77	5.39	6.45	7.18	5yr
10yr	0.55	0.84	1.04	1.46	1.88	2.21	10yr	1.62	2.16	2.56	3.21	4.05	5.46	6.20	10yr	4.84	5.97	6.68	8.03	8.77	10yr
25yr	0.71	1.08	1.34	1.92	2.52	2.91	25yr	2.18	2.85	3.41	4.15	5.16	7.25	8.38	25yr	6.41	8.05	8.87	10.74	11.47	25yr
50yr	0.86	1.31	1.63	2.34	3.15	3.61	50yr	2.72	3.52	4.23	5.03	6.20	8.98	10.51	50yr	7.95	10.11	10.98	13.42	14.06	50yr
100yr	1.05	1.58	1.99	2.87	3.93	4.45	100yr	3.39	4.35	5.26	6.47	7.44	11.14	13.21	100yr	9.86	12.70	13.59	16.79	17.26	100yr
200yr	1.28	1.92	2.43	3.52	4.91	5.50	200yr	4.24	5.37	6.54	7.91	8.93	13.85	16.63	200yr	12.25	15.99	16.86	21.02	21.21	200yr
500yr	1.66	2.47	3.18	4.62	6.56	7.25	500yr	5.66	7.09	8.73	10.36	11.37	18.45	22.57	500yr	16.33	21.70	22.40	28.34	27.89	500yr



## HydroCAD Analysis: Existing Conditions



Overland to Drainage Channel



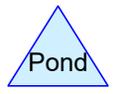
Drainage Channel



Overland to South PL



Offsite at South PL



**13555.11-Existing**

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Type III 24-hr 2-yr Rainfall=3.21"

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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**SubcatchmentEX-1: Overland to Drainage** Runoff Area=268,842 sf 30.0% Impervious Runoff Depth=0.31"  
Flow Length=1,380' Tc=9.9 min CN=57 Runoff=0.9 cfs 7,013 cf

**SubcatchmentEX-2: Overland to South PL** Runoff Area=114,167 sf 16.7% Impervious Runoff Depth=0.15"  
Flow Length=220' Tc=6.4 min CN=51 Runoff=0.1 cfs 1,449 cf

**Link DP-1: Drainage Channel**

Inflow=0.9 cfs 7,013 cf  
Primary=0.9 cfs 7,013 cf

**Link DP-2: Offsite at South PL**

Inflow=0.1 cfs 1,449 cf  
Primary=0.1 cfs 1,449 cf

**Total Runoff Area = 383,009 sf Runoff Volume = 8,463 cf Average Runoff Depth = 0.27"**  
**74.0% Pervious = 283,289 sf 26.0% Impervious = 99,720 sf**

**13555.11-Existing**

Prepared by VHB, Inc

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Type III 24-hr 2-yr Rainfall=3.21"

Printed 12/12/2024

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**Summary for Subcatchment EX-1: Overland to Drainage Channel**

Runoff = 0.9 cfs @ 12.33 hrs, Volume= 7,013 cf, Depth= 0.31"  
 Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
30,958	49	50-75% Grass cover, Fair, HSG A
87,162	39	>75% Grass cover, Good, HSG A
331	80	>75% Grass cover, Good, HSG D
1,616	96	Gravel surface, HSG A
80,645	98	Paved parking, HSG A
68,130	36	Woods, Fair, HSG A
268,842	57	Weighted Average
188,197		70.0% Pervious Area
80,645		30.0% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	25	0.0850	0.11		<b>Sheet Flow, Woods</b> Woods: Light underbrush n= 0.400 P2= 3.25"
3.1	230	0.0610	1.23		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
0.7	180	0.0420	4.16		<b>Shallow Concentrated Flow, Pavement</b> Paved Kv= 20.3 fps
2.2	945	0.0100	7.20	22.62	<b>Pipe Channel,</b> 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
9.9	1,380	Total			

**Summary for Subcatchment EX-2: Overland to South PL**

Runoff = 0.1 cfs @ 12.44 hrs, Volume= 1,449 cf, Depth= 0.15"  
 Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
28,610	49	50-75% Grass cover, Fair, HSG A
2,235	39	>75% Grass cover, Good, HSG A
2,711	96	Gravel surface, HSG A
19,075	98	Paved parking, HSG A
61,536	36	Woods, Fair, HSG A
114,167	51	Weighted Average
95,092		83.3% Pervious Area
19,075		16.7% Impervious Area

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Type III 24-hr 2-yr Rainfall=3.21"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	25	0.0800	0.10		<b>Sheet Flow, Woods</b> Woods: Light underbrush n= 0.400 P2= 3.25"
1.8	140	0.0650	1.27		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
0.1	15	0.0333	3.70		<b>Shallow Concentrated Flow, Paved Road</b> Paved Kv= 20.3 fps
0.5	40	0.0625	1.25		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
6.4	220	Total			

**Summary for Link DP-1: Drainage Channel**

Inflow Area = 268,842 sf, 30.0% Impervious, Inflow Depth = 0.31" for 2-yr event  
 Inflow = 0.9 cfs @ 12.33 hrs, Volume= 7,013 cf  
 Primary = 0.9 cfs @ 12.33 hrs, Volume= 7,013 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**Summary for Link DP-2: Offsite at South PL**

Inflow Area = 114,167 sf, 16.7% Impervious, Inflow Depth = 0.15" for 2-yr event  
 Inflow = 0.1 cfs @ 12.44 hrs, Volume= 1,449 cf  
 Primary = 0.1 cfs @ 12.44 hrs, Volume= 1,449 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**13555.11-Existing**

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Type III 24-hr 10-yr Rainfall=4.86"

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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**SubcatchmentEX-1: Overland to Drainage** Runoff Area=268,842 sf 30.0% Impervious Runoff Depth=1.03"  
Flow Length=1,380' Tc=9.9 min CN=57 Runoff=5.4 cfs 23,094 cf

**SubcatchmentEX-2: Overland to South PL** Runoff Area=114,167 sf 16.7% Impervious Runoff Depth=0.69"  
Flow Length=220' Tc=6.4 min CN=51 Runoff=1.3 cfs 6,548 cf

**Link DP-1: Drainage Channel**

Inflow=5.4 cfs 23,094 cf  
Primary=5.4 cfs 23,094 cf

**Link DP-2: Offsite at South PL**

Inflow=1.3 cfs 6,548 cf  
Primary=1.3 cfs 6,548 cf

**Total Runoff Area = 383,009 sf Runoff Volume = 29,641 cf Average Runoff Depth = 0.93"**  
**74.0% Pervious = 283,289 sf 26.0% Impervious = 99,720 sf**

**13555.11-Existing**

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Type III 24-hr 10-yr Rainfall=4.86"

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**Summary for Subcatchment EX-1: Overland to Drainage Channel**

Runoff = 5.4 cfs @ 12.16 hrs, Volume= 23,094 cf, Depth= 1.03"

Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
30,958	49	50-75% Grass cover, Fair, HSG A
87,162	39	>75% Grass cover, Good, HSG A
331	80	>75% Grass cover, Good, HSG D
1,616	96	Gravel surface, HSG A
80,645	98	Paved parking, HSG A
68,130	36	Woods, Fair, HSG A
268,842	57	Weighted Average
188,197		70.0% Pervious Area
80,645		30.0% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	25	0.0850	0.11		<b>Sheet Flow, Woods</b> Woods: Light underbrush n= 0.400 P2= 3.25"
3.1	230	0.0610	1.23		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
0.7	180	0.0420	4.16		<b>Shallow Concentrated Flow, Pavement</b> Paved Kv= 20.3 fps
2.2	945	0.0100	7.20	22.62	<b>Pipe Channel,</b> 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
9.9	1,380	Total			

**Summary for Subcatchment EX-2: Overland to South PL**

Runoff = 1.3 cfs @ 12.13 hrs, Volume= 6,548 cf, Depth= 0.69"

Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
28,610	49	50-75% Grass cover, Fair, HSG A
2,235	39	>75% Grass cover, Good, HSG A
2,711	96	Gravel surface, HSG A
19,075	98	Paved parking, HSG A
61,536	36	Woods, Fair, HSG A
114,167	51	Weighted Average
95,092		83.3% Pervious Area
19,075		16.7% Impervious Area

**13555.11-Existing**

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Type III 24-hr 10-yr Rainfall=4.86"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	25	0.0800	0.10		<b>Sheet Flow, Woods</b> Woods: Light underbrush n= 0.400 P2= 3.25"
1.8	140	0.0650	1.27		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
0.1	15	0.0333	3.70		<b>Shallow Concentrated Flow, Paved Road</b> Paved Kv= 20.3 fps
0.5	40	0.0625	1.25		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
6.4	220	Total			

**Summary for Link DP-1: Drainage Channel**

Inflow Area = 268,842 sf, 30.0% Impervious, Inflow Depth = 1.03" for 10-yr event  
 Inflow = 5.4 cfs @ 12.16 hrs, Volume= 23,094 cf  
 Primary = 5.4 cfs @ 12.16 hrs, Volume= 23,094 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**Summary for Link DP-2: Offsite at South PL**

Inflow Area = 114,167 sf, 16.7% Impervious, Inflow Depth = 0.69" for 10-yr event  
 Inflow = 1.3 cfs @ 12.13 hrs, Volume= 6,548 cf  
 Primary = 1.3 cfs @ 12.13 hrs, Volume= 6,548 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**13555.11-Existing**

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Type III 24-hr 25-yr Rainfall=6.16"

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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**SubcatchmentEX-1: Overland to Drainage** Runoff Area=268,842 sf 30.0% Impervious Runoff Depth=1.77"  
Flow Length=1,380' Tc=9.9 min CN=57 Runoff=10.3 cfs 39,744 cf

**SubcatchmentEX-2: Overland to South PL** Runoff Area=114,167 sf 16.7% Impervious Runoff Depth=1.30"  
Flow Length=220' Tc=6.4 min CN=51 Runoff=3.3 cfs 12,343 cf

**Link DP-1: Drainage Channel**

Inflow=10.3 cfs 39,744 cf  
Primary=10.3 cfs 39,744 cf

**Link DP-2: Offsite at South PL**

Inflow=3.3 cfs 12,343 cf  
Primary=3.3 cfs 12,343 cf

**Total Runoff Area = 383,009 sf Runoff Volume = 52,087 cf Average Runoff Depth = 1.63"**  
**74.0% Pervious = 283,289 sf 26.0% Impervious = 99,720 sf**

**13555.11-Existing**

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Type III 24-hr 25-yr Rainfall=6.16"

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**Summary for Subcatchment EX-1: Overland to Drainage Channel**

Runoff = 10.3 cfs @ 12.15 hrs, Volume= 39,744 cf, Depth= 1.77"

Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
30,958	49	50-75% Grass cover, Fair, HSG A
87,162	39	>75% Grass cover, Good, HSG A
331	80	>75% Grass cover, Good, HSG D
1,616	96	Gravel surface, HSG A
80,645	98	Paved parking, HSG A
68,130	36	Woods, Fair, HSG A
268,842	57	Weighted Average
188,197		70.0% Pervious Area
80,645		30.0% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	25	0.0850	0.11		<b>Sheet Flow, Woods</b> Woods: Light underbrush n= 0.400 P2= 3.25"
3.1	230	0.0610	1.23		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
0.7	180	0.0420	4.16		<b>Shallow Concentrated Flow, Pavement</b> Paved Kv= 20.3 fps
2.2	945	0.0100	7.20	22.62	<b>Pipe Channel,</b> 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
9.9	1,380	Total			

**Summary for Subcatchment EX-2: Overland to South PL**

Runoff = 3.3 cfs @ 12.11 hrs, Volume= 12,343 cf, Depth= 1.30"

Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
28,610	49	50-75% Grass cover, Fair, HSG A
2,235	39	>75% Grass cover, Good, HSG A
2,711	96	Gravel surface, HSG A
19,075	98	Paved parking, HSG A
61,536	36	Woods, Fair, HSG A
114,167	51	Weighted Average
95,092		83.3% Pervious Area
19,075		16.7% Impervious Area

**13555.11-Existing**

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Type III 24-hr 25-yr Rainfall=6.16"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	25	0.0800	0.10		<b>Sheet Flow, Woods</b> Woods: Light underbrush n= 0.400 P2= 3.25"
1.8	140	0.0650	1.27		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
0.1	15	0.0333	3.70		<b>Shallow Concentrated Flow, Paved Road</b> Paved Kv= 20.3 fps
0.5	40	0.0625	1.25		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
6.4	220	Total			

**Summary for Link DP-1: Drainage Channel**

Inflow Area = 268,842 sf, 30.0% Impervious, Inflow Depth = 1.77" for 25-yr event  
 Inflow = 10.3 cfs @ 12.15 hrs, Volume= 39,744 cf  
 Primary = 10.3 cfs @ 12.15 hrs, Volume= 39,744 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**Summary for Link DP-2: Offsite at South PL**

Inflow Area = 114,167 sf, 16.7% Impervious, Inflow Depth = 1.30" for 25-yr event  
 Inflow = 3.3 cfs @ 12.11 hrs, Volume= 12,343 cf  
 Primary = 3.3 cfs @ 12.11 hrs, Volume= 12,343 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**13555.11-Existing**

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Type III 24-hr 100-yr Rainfall=8.84"

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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN

Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**SubcatchmentEX-1: Overland to Drainage** Runoff Area=268,842 sf 30.0% Impervious Runoff Depth=3.61"  
Flow Length=1,380' Tc=9.9 min CN=57 Runoff=22.4 cfs 80,949 cf

**SubcatchmentEX-2: Overland to South PL** Runoff Area=114,167 sf 16.7% Impervious Runoff Depth=2.90"  
Flow Length=220' Tc=6.4 min CN=51 Runoff=8.3 cfs 27,555 cf

**Link DP-1: Drainage Channel**

Inflow=22.4 cfs 80,949 cf  
Primary=22.4 cfs 80,949 cf

**Link DP-2: Offsite at South PL**

Inflow=8.3 cfs 27,555 cf  
Primary=8.3 cfs 27,555 cf

**Total Runoff Area = 383,009 sf Runoff Volume = 108,504 cf Average Runoff Depth = 3.40"**  
**74.0% Pervious = 283,289 sf 26.0% Impervious = 99,720 sf**

**13555.11-Existing**

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Type III 24-hr 100-yr Rainfall=8.84"

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**Summary for Subcatchment EX-1: Overland to Drainage Channel**

Runoff = 22.4 cfs @ 12.14 hrs, Volume= 80,949 cf, Depth= 3.61"

Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
30,958	49	50-75% Grass cover, Fair, HSG A
87,162	39	>75% Grass cover, Good, HSG A
331	80	>75% Grass cover, Good, HSG D
1,616	96	Gravel surface, HSG A
80,645	98	Paved parking, HSG A
68,130	36	Woods, Fair, HSG A
268,842	57	Weighted Average
188,197		70.0% Pervious Area
80,645		30.0% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	25	0.0850	0.11		<b>Sheet Flow, Woods</b> Woods: Light underbrush n= 0.400 P2= 3.25"
3.1	230	0.0610	1.23		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
0.7	180	0.0420	4.16		<b>Shallow Concentrated Flow, Pavement</b> Paved Kv= 20.3 fps
2.2	945	0.0100	7.20	22.62	<b>Pipe Channel,</b> 24.0" Round Area= 3.1 sf Perim= 6.3' r= 0.50' n= 0.013
9.9	1,380	Total			

**Summary for Subcatchment EX-2: Overland to South PL**

Runoff = 8.3 cfs @ 12.10 hrs, Volume= 27,555 cf, Depth= 2.90"

Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
28,610	49	50-75% Grass cover, Fair, HSG A
2,235	39	>75% Grass cover, Good, HSG A
2,711	96	Gravel surface, HSG A
19,075	98	Paved parking, HSG A
61,536	36	Woods, Fair, HSG A
114,167	51	Weighted Average
95,092		83.3% Pervious Area
19,075		16.7% Impervious Area

**13555.11-Existing**

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Type III 24-hr 100-yr Rainfall=8.84"

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.0	25	0.0800	0.10		<b>Sheet Flow, Woods</b> Woods: Light underbrush n= 0.400 P2= 3.25"
1.8	140	0.0650	1.27		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
0.1	15	0.0333	3.70		<b>Shallow Concentrated Flow, Paved Road</b> Paved Kv= 20.3 fps
0.5	40	0.0625	1.25		<b>Shallow Concentrated Flow, Woods</b> Woodland Kv= 5.0 fps
6.4	220	Total			

**Summary for Link DP-1: Drainage Channel**

Inflow Area = 268,842 sf, 30.0% Impervious, Inflow Depth = 3.61" for 100-yr event  
 Inflow = 22.4 cfs @ 12.14 hrs, Volume= 80,949 cf  
 Primary = 22.4 cfs @ 12.14 hrs, Volume= 80,949 cf, Atten= 0%, Lag= 0.0 min

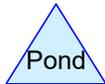
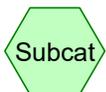
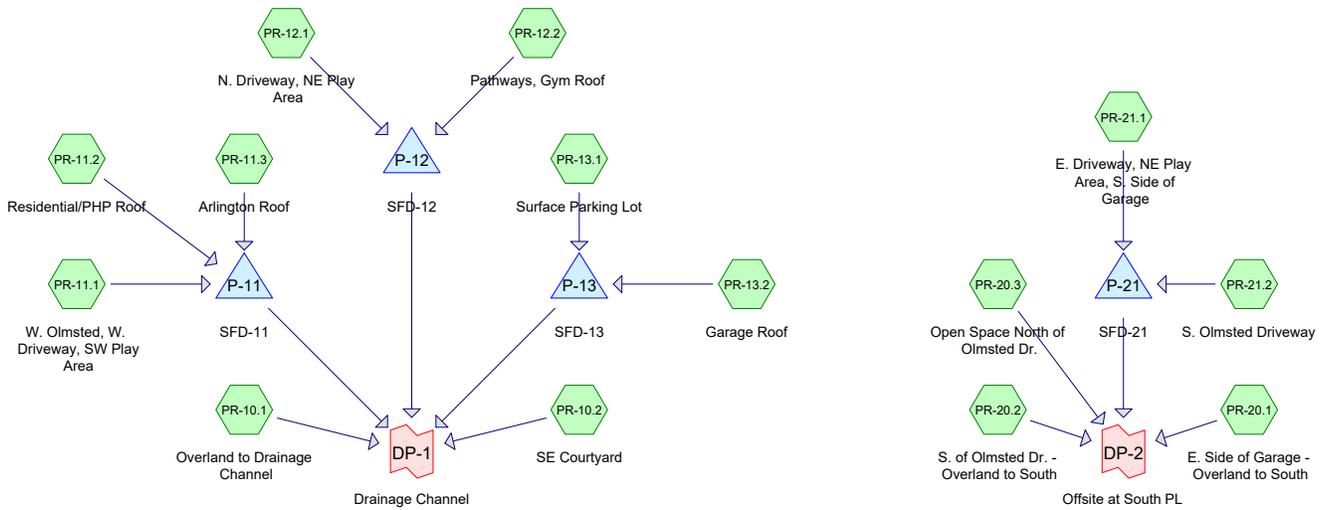
Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**Summary for Link DP-2: Offsite at South PL**

Inflow Area = 114,167 sf, 16.7% Impervious, Inflow Depth = 2.90" for 100-yr event  
 Inflow = 8.3 cfs @ 12.10 hrs, Volume= 27,555 cf  
 Primary = 8.3 cfs @ 12.10 hrs, Volume= 27,555 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

## HydroCAD Analysis: Proposed Conditions



**Routing Diagram for 13555.11-Proposed**  
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**13555.11-Proposed**

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Proposed Conditions  
Type III 24-hr 2-yr Rainfall=3.21"

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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>SubcatchmentPR-10.1: Overland to Drainage</b>	Runoff Area=4,536 sf 0.0% Impervious Runoff Depth=0.00" Tc=5.0 min CN=37 Runoff=0.00 cfs 0 cf
<b>SubcatchmentPR-10.2: SE Courtyard</b>	Runoff Area=9,750 sf 0.0% Impervious Runoff Depth=0.06" Tc=5.0 min CN=46 Runoff=0.00 cfs 48 cf
<b>SubcatchmentPR-11.1: W. Olmsted, W.</b>	Runoff Area=72,929 sf 38.8% Impervious Runoff Depth=0.49" Tc=5.0 min CN=62 Runoff=0.67 cfs 2,949 cf
<b>SubcatchmentPR-11.2: Residential/PHP</b>	Runoff Area=14,944 sf 100.0% Impervious Runoff Depth=2.98" Tc=5.0 min CN=98 Runoff=1.11 cfs 3,708 cf
<b>SubcatchmentPR-11.3: Arlington Roof</b>	Runoff Area=6,388 sf 100.0% Impervious Runoff Depth=2.98" Tc=5.0 min CN=98 Runoff=0.47 cfs 1,585 cf
<b>SubcatchmentPR-12.1: N. Driveway, NE</b>	Runoff Area=59,581 sf 35.9% Impervious Runoff Depth=0.41" Tc=5.0 min CN=60 Runoff=0.40 cfs 2,047 cf
<b>SubcatchmentPR-12.2: Pathways, Gym</b>	Runoff Area=9,417 sf 100.0% Impervious Runoff Depth=2.98" Tc=5.0 min CN=98 Runoff=0.70 cfs 2,337 cf
<b>SubcatchmentPR-13.1: Surface Parking Lot</b>	Runoff Area=51,984 sf 31.2% Impervious Runoff Depth=0.31" Tc=5.0 min CN=57 Runoff=0.18 cfs 1,356 cf
<b>SubcatchmentPR-13.2: Garage Roof</b>	Runoff Area=24,538 sf 100.0% Impervious Runoff Depth=2.98" Tc=5.0 min CN=98 Runoff=1.82 cfs 6,089 cf
<b>SubcatchmentPR-20.1: E. Side of Garage -</b>	Runoff Area=21,182 sf 9.8% Impervious Runoff Depth=0.03" Tc=5.0 min CN=44 Runoff=0.00 cfs 58 cf
<b>SubcatchmentPR-20.2: S. of Olmsted Dr. -</b>	Runoff Area=10,104 sf 0.0% Impervious Runoff Depth=0.00" Tc=5.0 min CN=36 Runoff=0.00 cfs 0 cf
<b>SubcatchmentPR-20.3: Open Space North of</b>	Runoff Area=32,268 sf 0.0% Impervious Runoff Depth=0.00" Tc=5.0 min CN=37 Runoff=0.00 cfs 0 cf
<b>SubcatchmentPR-21.1: E. Driveway, NE</b>	Runoff Area=44,601 sf 45.7% Impervious Runoff Depth=0.65" Tc=5.0 min CN=66 Runoff=0.66 cfs 2,409 cf
<b>SubcatchmentPR-21.2: S. Olmsted</b>	Runoff Area=20,786 sf 74.5% Impervious Runoff Depth=1.62" Tc=5.0 min CN=83 Runoff=0.94 cfs 2,802 cf
<b>Pond P-11: SFD-11</b>	Peak Elev=184.36' Storage=4,081 cf Inflow=2.21 cfs 8,242 cf Outflow=0.09 cfs 8,236 cf
<b>Pond P-12: SFD-12</b>	Peak Elev=188.37' Storage=2,397 cf Inflow=1.06 cfs 4,383 cf Outflow=0.04 cfs 3,829 cf

**13555.11-Proposed**

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*Type III 24-hr 2-yr Rainfall=3.21"*

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**Pond P-13: SFD-13**

Peak Elev=190.15' Storage=4,016 cf Inflow=1.93 cfs 7,445 cf  
Outflow=0.07 cfs 7,012 cf

**Pond P-21: SFD-21**

Peak Elev=184.14' Storage=2,784 cf Inflow=1.58 cfs 5,210 cf  
Outflow=0.07 cfs 5,207 cf

**Link DP-1: Drainage Channel**

Inflow=0.20 cfs 19,125 cf  
Primary=0.20 cfs 19,125 cf

**Link DP-2: Offsite at South PL**

Inflow=0.07 cfs 5,265 cf  
Primary=0.07 cfs 5,265 cf

**Total Runoff Area = 383,009 sf Runoff Volume = 25,387 cf Average Runoff Depth = 0.80"**  
**58.5% Pervious = 223,930 sf 41.5% Impervious = 159,079 sf**

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**Summary for Subcatchment PR-10.1: Overland to Drainage Channel**

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"  
Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
1,396	39	>75% Grass cover, Good, HSG A
3,140	36	Woods, Fair, HSG A
4,536	37	Weighted Average
4,536		100.0% Pervious Area

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

**Summary for Subcatchment PR-10.2: SE Courtyard**

Runoff = 0.00 cfs @ 15.03 hrs, Volume= 48 cf, Depth= 0.06"  
Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
8,583	39	>75% Grass cover, Good, HSG A
1,167	96	Gravel surface, HSG A
9,750	46	Weighted Average
9,750		100.0% Pervious Area

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

**Summary for Subcatchment PR-11.1: W. Olmsted, W. Driveway, SW Play Area**

Runoff = 0.67 cfs @ 12.10 hrs, Volume= 2,949 cf, Depth= 0.49"  
Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

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Area (sf)	CN	Description
43,800	39	>75% Grass cover, Good, HSG A
713	96	Gravel surface, HSG A
27,996	98	Paved parking, HSG A
265	98	Roofs, HSG A
154	36	Woods, Fair, HSG A
72,929	62	Weighted Average
44,667		61.2% Pervious Area
28,262		38.8% Impervious Area

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

**Summary for Subcatchment PR-11.2: Residential/PHP Roof**

Runoff = 1.11 cfs @ 12.07 hrs, Volume= 3,708 cf, Depth= 2.98"  
 Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
14,944	98	Roofs, HSG A
14,944	98	Weighted Average
0		0.0% Pervious Area
14,944		100.0% Impervious Area

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

**Summary for Subcatchment PR-11.3: Arlington Roof**

Runoff = 0.47 cfs @ 12.07 hrs, Volume= 1,585 cf, Depth= 2.98"  
 Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
0	96	Gravel surface, HSG A
6,388	98	Roofs, HSG A
6,388	98	Weighted Average
0		0.0% Pervious Area
6,388		100.0% Impervious Area

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

**Summary for Subcatchment PR-12.1: N. Driveway, NE Play Area**

Runoff = 0.40 cfs @ 12.11 hrs, Volume= 2,047 cf, Depth= 0.41"  
Routed to Pond P-12 : SFD-12

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
24,947	39	>75% Grass cover, Good, HSG A
52	96	Gravel surface, HSG A
21,366	98	Paved parking, HSG A
13,216	36	Woods, Fair, HSG A
59,581	60	Weighted Average
38,215		64.1% Pervious Area
21,366		35.9% Impervious Area

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

**Summary for Subcatchment PR-12.2: Pathways, Gym Roof**

Runoff = 0.70 cfs @ 12.07 hrs, Volume= 2,337 cf, Depth= 2.98"  
Routed to Pond P-12 : SFD-12

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
9,417	98	Roofs, HSG A
9,417	98	Weighted Average
0		0.0% Pervious Area
9,417		100.0% Impervious Area

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

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### Summary for Subcatchment PR-13.1: Surface Parking Lot

Runoff = 0.18 cfs @ 12.14 hrs, Volume= 1,356 cf, Depth= 0.31"  
Routed to Pond P-13 : SFD-13

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
15,813	39	>75% Grass cover, Good, HSG A
331	80	>75% Grass cover, Good, HSG D
16,239	98	Paved parking, HSG A
19,601	36	Woods, Fair, HSG A
51,984	57	Weighted Average
35,745		68.8% Pervious Area
16,239		31.2% Impervious Area

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

### Summary for Subcatchment PR-13.2: Garage Roof

Runoff = 1.82 cfs @ 12.07 hrs, Volume= 6,089 cf, Depth= 2.98"  
Routed to Pond P-13 : SFD-13

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
24,538	98	Roofs, HSG A
24,538		100.0% Impervious Area

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

### Summary for Subcatchment PR-20.1: E. Side of Garage - Overland to South

Runoff = 0.00 cfs @ 15.65 hrs, Volume= 58 cf, Depth= 0.03"  
Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

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Area (sf)	CN	Description
12,400	39	>75% Grass cover, Good, HSG A
2,066	98	Paved parking, HSG A
6,715	36	Woods, Fair, HSG A
21,182	44	Weighted Average
19,116		90.2% Pervious Area
2,066		9.8% Impervious Area

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

**Summary for Subcatchment PR-20.2: S. of Olmsted Dr. - Overland to South**

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"  
Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
1,368	39	>75% Grass cover, Good, HSG A
8,735	36	Woods, Fair, HSG A
10,104	36	Weighted Average
10,104		100.0% Pervious Area

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

**Summary for Subcatchment PR-20.3: Open Space North of Olmsted Dr.**

[45] Hint: Runoff=Zero

Runoff = 0.00 cfs @ 0.00 hrs, Volume= 0 cf, Depth= 0.00"  
Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
9,201	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
23,067	36	Woods, Fair, HSG A
32,268	37	Weighted Average
32,268		100.0% Pervious Area
0		0.0% Impervious Area

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

**Summary for Subcatchment PR-21.1: E. Driveway, NE Play Area, S. Side of Garage**

Runoff = 0.66 cfs @ 12.09 hrs, Volume= 2,409 cf, Depth= 0.65"  
Routed to Pond P-21 : SFD-21

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
21,277	39	>75% Grass cover, Good, HSG A
140	96	Gravel surface, HSG A
20,314	98	Paved parking, HSG A
64	98	Roofs, HSG A
2,806	36	Woods, Fair, HSG A
44,601	66	Weighted Average
24,223		54.3% Pervious Area
20,378		45.7% Impervious Area

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

**Summary for Subcatchment PR-21.2: S. Olmsted Driveway**

Runoff = 0.94 cfs @ 12.08 hrs, Volume= 2,802 cf, Depth= 1.62"  
Routed to Pond P-21 : SFD-21

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 2-yr Rainfall=3.21"

Area (sf)	CN	Description
3,706	39	>75% Grass cover, Good, HSG A
91	96	Gravel surface, HSG A
15,480	98	Paved parking, HSG A
1	98	Roofs, HSG A
1,509	36	Woods, Fair, HSG A
20,786	83	Weighted Average
5,306		25.5% Pervious Area
15,481		74.5% Impervious Area

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

**Summary for Pond P-11: SFD-11**

Inflow Area = 94,261 sf, 52.6% Impervious, Inflow Depth = 1.05" for 2-yr event  
 Inflow = 2.21 cfs @ 12.08 hrs, Volume= 8,242 cf  
 Outflow = 0.09 cfs @ 10.85 hrs, Volume= 8,236 cf, Atten= 96%, Lag= 0.0 min  
 Primary = 0.09 cfs @ 10.85 hrs, Volume= 8,236 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 184.36' @ 16.13 hrs Surf.Area= 4,598 sf Storage= 4,081 cf

Plug-Flow detention time= 417.3 min calculated for 8,233 cf (100% of inflow)  
 Center-of-Mass det. time= 416.9 min ( 1,227.0 - 810.1 )

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	2,014 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	183.50'	11,483 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		13,497 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
181.00	2,014	0.0	0	0
181.01	2,014	40.0	8	8
183.50	2,014	40.0	2,006	2,014

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
183.50	2,014	0	0
183.75	2,014	504	504
183.76	2,584	23	526
184.00	2,584	620	1,147
185.50	2,584	3,876	5,023
188.00	2,584	6,460	11,483

Device	Routing	Invert	Outlet Devices
#1	Primary	181.00'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 181.00' / 180.75' S= 0.0250 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	181.00'	<b>0.09 cfs Exfiltration at all elevations</b>
#3	Device 1	185.50'	<b>12.0" W x 10.0" H Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	187.25'	<b>1.0' long x 0.75' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

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**Primary OutFlow** Max=0.09 cfs @ 10.85 hrs HW=181.14' (Free Discharge)

- 1=Culvert (Passes 0.09 cfs of 0.10 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.09 cfs)
- 3=Orifice/Grate ( Controls 0.00 cfs)
- 4=Sharp-Crested Rectangular Weir( Controls 0.00 cfs)

**Summary for Pond P-12: SFD-12**

Inflow Area = 68,998 sf, 44.6% Impervious, Inflow Depth = 0.76" for 2-yr event  
 Inflow = 1.06 cfs @ 12.09 hrs, Volume= 4,383 cf  
 Outflow = 0.04 cfs @ 10.78 hrs, Volume= 3,829 cf, Atten= 96%, Lag= 0.0 min  
 Primary = 0.04 cfs @ 10.78 hrs, Volume= 3,829 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 188.37' @ 17.93 hrs Surf.Area= 2,044 sf Storage= 2,397 cf

Plug-Flow detention time= 544.8 min calculated for 3,829 cf (87% of inflow)  
 Center-of-Mass det. time= 482.3 min ( 1,314.1 - 831.8 )

Volume	Invert	Avail.Storage	Storage Description
#1	184.50'	840 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	187.00'	4,723 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		5,563 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
184.50	840	0.0	0	0
184.51	840	40.0	3	3
187.00	840	40.0	837	840

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
187.00	840	0	0
187.25	840	210	210
187.26	1,204	10	220
190.00	1,204	3,299	3,519
191.00	1,204	1,204	4,723

Device	Routing	Invert	Outlet Devices
#1	Primary	184.50'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 184.50' / 184.25' S= 0.0250 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	184.50'	<b>0.04 cfs Exfiltration at all elevations</b>
#3	Device 1	190.00'	<b>3.0' long x 1.00' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

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**Primary OutFlow** Max=0.04 cfs @ 10.78 hrs HW=184.63' (Free Discharge)

- 1=Culvert (Passes 0.04 cfs of 0.08 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.04 cfs)
- 3=Sharp-Crested Rectangular Weir ( Controls 0.00 cfs)

**Summary for Pond P-13: SFD-13**

Inflow Area = 76,522 sf, 53.3% Impervious, Inflow Depth = 1.17" for 2-yr event  
 Inflow = 1.93 cfs @ 12.08 hrs, Volume= 7,445 cf  
 Outflow = 0.07 cfs @ 9.56 hrs, Volume= 7,012 cf, Atten= 97%, Lag= 0.0 min  
 Primary = 0.07 cfs @ 9.56 hrs, Volume= 7,012 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 190.15' @ 16.69 hrs Surf.Area= 3,366 sf Storage= 4,016 cf

Plug-Flow detention time= 527.6 min calculated for 7,012 cf (94% of inflow)  
 Center-of-Mass det. time= 494.4 min ( 1,283.1 - 788.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	186.25'	1,452 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	188.75'	7,060 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		8,512 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
186.25	1,452	0.0	0	0
186.26	1,452	40.0	6	6
188.75	1,452	40.0	1,446	1,452

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
188.75	1,452	0	0
189.00	1,452	363	363
189.01	1,914	17	380
190.75	1,914	3,330	3,710
192.50	1,914	3,350	7,060

Device	Routing	Invert	Outlet Devices
#1	Primary	186.25'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 186.25' / 186.00' S= 0.0250 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	186.25'	<b>0.07 cfs Exfiltration at all elevations</b>
#3	Device 1	190.75'	<b>24.0" W x 6.0" H Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	191.75'	<b>2.0' long x 0.75' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

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**Primary OutFlow** Max=0.07 cfs @ 9.56 hrs HW=186.38' (Free Discharge)

- 1=Culvert (Passes 0.07 cfs of 0.08 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.07 cfs)
- 3=Orifice/Grate ( Controls 0.00 cfs)
- 4=Sharp-Crested Rectangular Weir( Controls 0.00 cfs)

**Summary for Pond P-21: SFD-21**

Inflow Area = 65,387 sf, 54.8% Impervious, Inflow Depth = 0.96" for 2-yr event  
 Inflow = 1.58 cfs @ 12.08 hrs, Volume= 5,210 cf  
 Outflow = 0.07 cfs @ 11.68 hrs, Volume= 5,207 cf, Atten= 96%, Lag= 0.0 min  
 Primary = 0.07 cfs @ 11.68 hrs, Volume= 5,207 cf  
 Routed to Link DP-2 : Offsite at South PL

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 184.14' @ 16.15 hrs Surf.Area= 3,610 sf Storage= 2,784 cf

Plug-Flow detention time= 425.6 min calculated for 5,205 cf (100% of inflow)  
 Center-of-Mass det. time= 425.3 min ( 1,283.9 - 858.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	1,596 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	183.50'	7,949 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		9,545 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
181.00	1,596	0.0	0	0
181.01	1,596	40.0	6	6
183.50	1,596	40.0	1,590	1,596

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
183.50	1,596	0	0
183.75	1,596	399	399
183.76	2,014	18	417
186.25	2,014	5,015	5,432
187.50	2,014	2,518	7,949

Device	Routing	Invert	Outlet Devices
#1	Primary	181.00'	<b>12.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 181.00' / 180.75' S= 0.0250 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	181.00'	<b>0.07 cfs Exfiltration at all elevations</b>
#3	Device 1	186.25'	<b>1.5' long x 1.25' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

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**Primary OutFlow** Max=0.07 cfs @ 11.68 hrs HW=181.13' (Free Discharge)

↑ **1=Culvert** (Passes 0.07 cfs of 0.08 cfs potential flow)

↑ **2=Exfiltration** (Exfiltration Controls 0.07 cfs)

↑ **3=Sharp-Crested Rectangular Weir** ( Controls 0.00 cfs)

**Summary for Link DP-1: Drainage Channel**

Inflow Area = 254,068 sf, 47.7% Impervious, Inflow Depth > 0.90" for 2-yr event  
Inflow = 0.20 cfs @ 15.03 hrs, Volume= 19,125 cf  
Primary = 0.20 cfs @ 15.03 hrs, Volume= 19,125 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**Summary for Link DP-2: Offsite at South PL**

Inflow Area = 128,941 sf, 29.4% Impervious, Inflow Depth > 0.49" for 2-yr event  
Inflow = 0.07 cfs @ 15.65 hrs, Volume= 5,265 cf  
Primary = 0.07 cfs @ 15.65 hrs, Volume= 5,265 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>SubcatchmentPR-10.1: Overland to Drainage</b>	Runoff Area=4,536 sf 0.0% Impervious Runoff Depth=0.11" Tc=5.0 min CN=37 Runoff=0.00 cfs 43 cf
<b>SubcatchmentPR-10.2: SE Courtyard</b>	Runoff Area=9,750 sf 0.0% Impervious Runoff Depth=0.44" Tc=5.0 min CN=46 Runoff=0.05 cfs 360 cf
<b>SubcatchmentPR-11.1: W. Olmsted, W.</b>	Runoff Area=72,929 sf 38.8% Impervious Runoff Depth=1.35" Tc=5.0 min CN=62 Runoff=2.52 cfs 8,221 cf
<b>SubcatchmentPR-11.2: Residential/PHP</b>	Runoff Area=14,944 sf 100.0% Impervious Runoff Depth=4.62" Tc=5.0 min CN=98 Runoff=1.69 cfs 5,758 cf
<b>SubcatchmentPR-11.3: Arlington Roof</b>	Runoff Area=6,388 sf 100.0% Impervious Runoff Depth=4.62" Tc=5.0 min CN=98 Runoff=0.72 cfs 2,461 cf
<b>SubcatchmentPR-12.1: N. Driveway, NE</b>	Runoff Area=59,581 sf 35.9% Impervious Runoff Depth=1.22" Tc=5.0 min CN=60 Runoff=1.80 cfs 6,058 cf
<b>SubcatchmentPR-12.2: Pathways, Gym</b>	Runoff Area=9,417 sf 100.0% Impervious Runoff Depth=4.62" Tc=5.0 min CN=98 Runoff=1.06 cfs 3,628 cf
<b>SubcatchmentPR-13.1: Surface Parking Lot</b>	Runoff Area=51,984 sf 31.2% Impervious Runoff Depth=1.03" Tc=5.0 min CN=57 Runoff=1.24 cfs 4,465 cf
<b>SubcatchmentPR-13.2: Garage Roof</b>	Runoff Area=24,538 sf 100.0% Impervious Runoff Depth=4.62" Tc=5.0 min CN=98 Runoff=2.77 cfs 9,454 cf
<b>SubcatchmentPR-20.1: E. Side of Garage -</b>	Runoff Area=21,182 sf 9.8% Impervious Runoff Depth=0.36" Tc=5.0 min CN=44 Runoff=0.07 cfs 629 cf
<b>SubcatchmentPR-20.2: S. of Olmsted Dr. -</b>	Runoff Area=10,104 sf 0.0% Impervious Runoff Depth=0.09" Tc=5.0 min CN=36 Runoff=0.00 cfs 75 cf
<b>SubcatchmentPR-20.3: Open Space North of</b>	Runoff Area=32,268 sf 0.0% Impervious Runoff Depth=0.11" Tc=5.0 min CN=37 Runoff=0.01 cfs 308 cf
<b>SubcatchmentPR-21.1: E. Driveway, NE</b>	Runoff Area=44,601 sf 45.7% Impervious Runoff Depth=1.63" Tc=5.0 min CN=66 Runoff=1.94 cfs 6,070 cf
<b>SubcatchmentPR-21.2: S. Olmsted</b>	Runoff Area=20,786 sf 74.5% Impervious Runoff Depth=3.05" Tc=5.0 min CN=83 Runoff=1.76 cfs 5,279 cf
<b>Pond P-11: SFD-11</b>	Peak Elev=185.73' Storage=7,639 cf Inflow=4.91 cfs 16,440 cf Outflow=0.46 cfs 13,589 cf
<b>Pond P-12: SFD-12</b>	Peak Elev=190.09' Storage=4,473 cf Inflow=2.85 cfs 9,686 cf Outflow=0.32 cfs 6,955 cf

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**Pond P-13: SFD-13**

Peak Elev=191.03' Storage=5,690 cf Inflow=3.99 cfs 13,920 cf  
Outflow=1.00 cfs 11,723 cf

**Pond P-21: SFD-21**

Peak Elev=186.33' Storage=7,180 cf Inflow=3.70 cfs 11,349 cf  
Outflow=0.17 cfs 7,486 cf

**Link DP-1: Drainage Channel**

Inflow=1.26 cfs 32,671 cf  
Primary=1.26 cfs 32,671 cf

**Link DP-2: Offsite at South PL**

Inflow=0.20 cfs 8,497 cf  
Primary=0.20 cfs 8,497 cf

**Total Runoff Area = 383,009 sf Runoff Volume = 52,810 cf Average Runoff Depth = 1.65"**  
**58.5% Pervious = 223,930 sf 41.5% Impervious = 159,079 sf**

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**Summary for Subcatchment PR-10.1: Overland to Drainage Channel**

Runoff = 0.00 cfs @ 14.75 hrs, Volume= 43 cf, Depth= 0.11"  
 Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
1,396	39	>75% Grass cover, Good, HSG A
3,140	36	Woods, Fair, HSG A
4,536	37	Weighted Average
4,536		100.0% Pervious Area

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

**Summary for Subcatchment PR-10.2: SE Courtyard**

Runoff = 0.05 cfs @ 12.28 hrs, Volume= 360 cf, Depth= 0.44"  
 Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
8,583	39	>75% Grass cover, Good, HSG A
1,167	96	Gravel surface, HSG A
9,750	46	Weighted Average
9,750		100.0% Pervious Area

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

**Summary for Subcatchment PR-11.1: W. Olmsted, W. Driveway, SW Play Area**

Runoff = 2.52 cfs @ 12.08 hrs, Volume= 8,221 cf, Depth= 1.35"  
 Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

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Area (sf)	CN	Description
43,800	39	>75% Grass cover, Good, HSG A
713	96	Gravel surface, HSG A
27,996	98	Paved parking, HSG A
265	98	Roofs, HSG A
154	36	Woods, Fair, HSG A
72,929	62	Weighted Average
44,667		61.2% Pervious Area
28,262		38.8% Impervious Area

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

**Summary for Subcatchment PR-11.2: Residential/PHP Roof**

Runoff = 1.69 cfs @ 12.07 hrs, Volume= 5,758 cf, Depth= 4.62"  
 Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
14,944	98	Roofs, HSG A
14,944	98	Weighted Average
0		0.0% Pervious Area
14,944		100.0% Impervious Area

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

**Summary for Subcatchment PR-11.3: Arlington Roof**

Runoff = 0.72 cfs @ 12.07 hrs, Volume= 2,461 cf, Depth= 4.62"  
 Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
0	96	Gravel surface, HSG A
6,388	98	Roofs, HSG A
6,388	98	Weighted Average
0		0.0% Pervious Area
6,388		100.0% Impervious Area

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

**Summary for Subcatchment PR-12.1: N. Driveway, NE Play Area**

Runoff = 1.80 cfs @ 12.09 hrs, Volume= 6,058 cf, Depth= 1.22"  
 Routed to Pond P-12 : SFD-12

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
24,947	39	>75% Grass cover, Good, HSG A
52	96	Gravel surface, HSG A
21,366	98	Paved parking, HSG A
13,216	36	Woods, Fair, HSG A
59,581	60	Weighted Average
38,215		64.1% Pervious Area
21,366		35.9% Impervious Area

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

**Summary for Subcatchment PR-12.2: Pathways, Gym Roof**

Runoff = 1.06 cfs @ 12.07 hrs, Volume= 3,628 cf, Depth= 4.62"  
 Routed to Pond P-12 : SFD-12

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
9,417	98	Roofs, HSG A
9,417	98	Weighted Average
0		0.0% Pervious Area
9,417		100.0% Impervious Area

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

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**Summary for Subcatchment PR-13.1: Surface Parking Lot**

Runoff = 1.24 cfs @ 12.09 hrs, Volume= 4,465 cf, Depth= 1.03"  
 Routed to Pond P-13 : SFD-13

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
15,813	39	>75% Grass cover, Good, HSG A
331	80	>75% Grass cover, Good, HSG D
16,239	98	Paved parking, HSG A
19,601	36	Woods, Fair, HSG A
51,984	57	Weighted Average
35,745		68.8% Pervious Area
16,239		31.2% Impervious Area

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

**Summary for Subcatchment PR-13.2: Garage Roof**

Runoff = 2.77 cfs @ 12.07 hrs, Volume= 9,454 cf, Depth= 4.62"  
 Routed to Pond P-13 : SFD-13

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
24,538	98	Roofs, HSG A
24,538		100.0% Impervious Area

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

**Summary for Subcatchment PR-20.1: E. Side of Garage - Overland to South**

Runoff = 0.07 cfs @ 12.33 hrs, Volume= 629 cf, Depth= 0.36"  
 Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

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Area (sf)	CN	Description
12,400	39	>75% Grass cover, Good, HSG A
2,066	98	Paved parking, HSG A
6,715	36	Woods, Fair, HSG A
21,182	44	Weighted Average
19,116		90.2% Pervious Area
2,066		9.8% Impervious Area

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

**Summary for Subcatchment PR-20.2: S. of Olmsted Dr. - Overland to South**

Runoff = 0.00 cfs @ 15.03 hrs, Volume= 75 cf, Depth= 0.09"  
 Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
1,368	39	>75% Grass cover, Good, HSG A
8,735	36	Woods, Fair, HSG A
10,104	36	Weighted Average
10,104		100.0% Pervious Area

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

**Summary for Subcatchment PR-20.3: Open Space North of Olmsted Dr.**

Runoff = 0.01 cfs @ 14.75 hrs, Volume= 308 cf, Depth= 0.11"  
 Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
9,201	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
23,067	36	Woods, Fair, HSG A
32,268	37	Weighted Average
32,268		100.0% Pervious Area
0		0.0% Impervious Area

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

**Summary for Subcatchment PR-21.1: E. Driveway, NE Play Area, S. Side of Garage**

Runoff = 1.94 cfs @ 12.08 hrs, Volume= 6,070 cf, Depth= 1.63"  
Routed to Pond P-21 : SFD-21

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
21,277	39	>75% Grass cover, Good, HSG A
140	96	Gravel surface, HSG A
20,314	98	Paved parking, HSG A
64	98	Roofs, HSG A
2,806	36	Woods, Fair, HSG A
44,601	66	Weighted Average
24,223		54.3% Pervious Area
20,378		45.7% Impervious Area

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

**Summary for Subcatchment PR-21.2: S. Olmsted Driveway**

Runoff = 1.76 cfs @ 12.07 hrs, Volume= 5,279 cf, Depth= 3.05"  
Routed to Pond P-21 : SFD-21

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 10-yr Rainfall=4.86"

Area (sf)	CN	Description
3,706	39	>75% Grass cover, Good, HSG A
91	96	Gravel surface, HSG A
15,480	98	Paved parking, HSG A
1	98	Roofs, HSG A
1,509	36	Woods, Fair, HSG A
20,786	83	Weighted Average
5,306		25.5% Pervious Area
15,481		74.5% Impervious Area

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

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Type III 24-hr 10-yr Rainfall=4.86"

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**Summary for Pond P-11: SFD-11**

Inflow Area = 94,261 sf, 52.6% Impervious, Inflow Depth = 2.09" for 10-yr event  
 Inflow = 4.91 cfs @ 12.08 hrs, Volume= 16,440 cf  
 Outflow = 0.46 cfs @ 13.15 hrs, Volume= 13,589 cf, Atten= 91%, Lag= 64.4 min  
 Primary = 0.46 cfs @ 13.15 hrs, Volume= 13,589 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 185.73' @ 13.15 hrs Surf.Area= 4,598 sf Storage= 7,639 cf

Plug-Flow detention time= 433.7 min calculated for 13,586 cf (83% of inflow)  
 Center-of-Mass det. time= 357.9 min ( 1,166.9 - 809.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	2,014 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	183.50'	11,483 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		13,497 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
181.00	2,014	0.0	0	0
181.01	2,014	40.0	8	8
183.50	2,014	40.0	2,006	2,014

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
183.50	2,014	0	0
183.75	2,014	504	504
183.76	2,584	23	526
184.00	2,584	620	1,147
185.50	2,584	3,876	5,023
188.00	2,584	6,460	11,483

Device	Routing	Invert	Outlet Devices
#1	Primary	181.00'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 181.00' / 180.75' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	181.00'	<b>0.09 cfs Exfiltration at all elevations</b>
#3	Device 1	185.50'	<b>12.0" W x 10.0" H Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	187.25'	<b>1.0' long x 0.75' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=0.45 cfs @ 13.15 hrs HW=185.73' (Free Discharge)

- 1=Culvert (Passes 0.45 cfs of 11.98 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.09 cfs)
- 3=Orifice/Grate (Orifice Controls 0.36 cfs @ 1.55 fps)
- 4=Sharp-Crested Rectangular Weir ( Controls 0.00 cfs)

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## Summary for Pond P-12: SFD-12

Inflow Area = 68,998 sf, 44.6% Impervious, Inflow Depth = 1.68" for 10-yr event  
 Inflow = 2.85 cfs @ 12.08 hrs, Volume= 9,686 cf  
 Outflow = 0.32 cfs @ 13.00 hrs, Volume= 6,955 cf, Atten= 89%, Lag= 55.0 min  
 Primary = 0.32 cfs @ 13.00 hrs, Volume= 6,955 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 190.09' @ 13.00 hrs Surf.Area= 2,044 sf Storage= 4,473 cf

Plug-Flow detention time= 402.0 min calculated for 6,953 cf (72% of inflow)  
 Center-of-Mass det. time= 297.9 min ( 1,126.2 - 828.3 )

Volume	Invert	Avail.Storage	Storage Description
#1	184.50'	840 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	187.00'	4,723 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		5,563 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
184.50	840	0.0	0	0
184.51	840	40.0	3	3
187.00	840	40.0	837	840

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
187.00	840	0	0
187.25	840	210	210
187.26	1,204	10	220
190.00	1,204	3,299	3,519
191.00	1,204	1,204	4,723

Device	Routing	Invert	Outlet Devices
#1	Primary	184.50'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 184.50' / 184.25' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	184.50'	<b>0.04 cfs Exfiltration at all elevations</b>
#3	Device 1	190.00'	<b>3.0' long x 1.00' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=0.32 cfs @ 13.00 hrs HW=190.09' (Free Discharge)

1=Culvert (Passes 0.32 cfs of 13.17 cfs potential flow)

2=Exfiltration (Exfiltration Controls 0.04 cfs)

3=Sharp-Crested Rectangular Weir (Weir Controls 0.28 cfs @ 1.01 fps)

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## Summary for Pond P-13: SFD-13

Inflow Area = 76,522 sf, 53.3% Impervious, Inflow Depth = 2.18" for 10-yr event  
 Inflow = 3.99 cfs @ 12.08 hrs, Volume= 13,920 cf  
 Outflow = 1.00 cfs @ 12.48 hrs, Volume= 11,723 cf, Atten= 75%, Lag= 23.9 min  
 Primary = 1.00 cfs @ 12.48 hrs, Volume= 11,723 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 191.03' @ 12.48 hrs Surf.Area= 3,366 sf Storage= 5,690 cf

Plug-Flow detention time= 369.8 min calculated for 11,720 cf (84% of inflow)  
 Center-of-Mass det. time= 298.2 min ( 1,090.5 - 792.3 )

Volume	Invert	Avail.Storage	Storage Description
#1	186.25'	1,452 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	188.75'	7,060 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		8,512 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
186.25	1,452	0.0	0	0
186.26	1,452	40.0	6	6
188.75	1,452	40.0	1,446	1,452

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
188.75	1,452	0	0
189.00	1,452	363	363
189.01	1,914	17	380
190.75	1,914	3,330	3,710
192.50	1,914	3,350	7,060

Device	Routing	Invert	Outlet Devices
#1	Primary	186.25'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 186.25' / 186.00' S= 0.0250 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	186.25'	<b>0.07 cfs Exfiltration at all elevations</b>
#3	Device 1	190.75'	<b>24.0" W x 6.0" H Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	191.75'	<b>2.0' long x 0.75' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=1.00 cfs @ 12.48 hrs HW=191.03' (Free Discharge)

- 1=Culvert (Passes 1.00 cfs of 12.04 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.07 cfs)
- 3=Orifice/Grate (Orifice Controls 0.93 cfs @ 1.69 fps)
- 4=Sharp-Crested Rectangular Weir ( Controls 0.00 cfs)

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## Summary for Pond P-21: SFD-21

Inflow Area = 65,387 sf, 54.8% Impervious, Inflow Depth = 2.08" for 10-yr event  
 Inflow = 3.70 cfs @ 12.08 hrs, Volume= 11,349 cf  
 Outflow = 0.17 cfs @ 15.43 hrs, Volume= 7,486 cf, Atten= 95%, Lag= 200.9 min  
 Primary = 0.17 cfs @ 15.43 hrs, Volume= 7,486 cf  
 Routed to Link DP-2 : Offsite at South PL

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 186.33' @ 15.43 hrs Surf.Area= 3,610 sf Storage= 7,180 cf

Plug-Flow detention time= 597.0 min calculated for 7,486 cf (66% of inflow)  
 Center-of-Mass det. time= 490.1 min ( 1,328.0 - 837.9 )

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	1,596 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	183.50'	7,949 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		9,545 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
181.00	1,596	0.0	0	0
181.01	1,596	40.0	6	6
183.50	1,596	40.0	1,590	1,596

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
183.50	1,596	0	0
183.75	1,596	399	399
183.76	2,014	18	417
186.25	2,014	5,015	5,432
187.50	2,014	2,518	7,949

Device	Routing	Invert	Outlet Devices
#1	Primary	181.00'	<b>12.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 181.00' / 180.75' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	181.00'	<b>0.07 cfs Exfiltration at all elevations</b>
#3	Device 1	186.25'	<b>1.5' long x 1.25' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=0.17 cfs @ 15.43 hrs HW=186.33' (Free Discharge)

1=Culvert (Passes 0.17 cfs of 8.31 cfs potential flow)

2=Exfiltration (Exfiltration Controls 0.07 cfs)

3=Sharp-Crested Rectangular Weir (Weir Controls 0.10 cfs @ 0.90 fps)

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**Summary for Link DP-1: Drainage Channel**

Inflow Area = 254,068 sf, 47.7% Impervious, Inflow Depth > 1.54" for 10-yr event  
Inflow = 1.26 cfs @ 12.96 hrs, Volume= 32,671 cf  
Primary = 1.26 cfs @ 12.96 hrs, Volume= 32,671 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**Summary for Link DP-2: Offsite at South PL**

Inflow Area = 128,941 sf, 29.4% Impervious, Inflow Depth > 0.79" for 10-yr event  
Inflow = 0.20 cfs @ 15.39 hrs, Volume= 8,497 cf  
Primary = 0.20 cfs @ 15.39 hrs, Volume= 8,497 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>SubcatchmentPR-10.1: Overland to Drainage</b>	Runoff Area=4,536 sf 0.0% Impervious Runoff Depth=0.38" Tc=5.0 min CN=37 Runoff=0.01 cfs 145 cf
<b>SubcatchmentPR-10.2: SE Courtyard</b>	Runoff Area=9,750 sf 0.0% Impervious Runoff Depth=0.93" Tc=5.0 min CN=46 Runoff=0.17 cfs 759 cf
<b>SubcatchmentPR-11.1: W. Olmsted, W.</b>	Runoff Area=72,929 sf 38.8% Impervious Runoff Depth=2.20" Tc=5.0 min CN=62 Runoff=4.32 cfs 13,374 cf
<b>SubcatchmentPR-11.2: Residential/PHP</b>	Runoff Area=14,944 sf 100.0% Impervious Runoff Depth=5.92" Tc=5.0 min CN=98 Runoff=2.15 cfs 7,375 cf
<b>SubcatchmentPR-11.3: Arlington Roof</b>	Runoff Area=6,388 sf 100.0% Impervious Runoff Depth=5.92" Tc=5.0 min CN=98 Runoff=0.92 cfs 3,152 cf
<b>SubcatchmentPR-12.1: N. Driveway, NE</b>	Runoff Area=59,581 sf 35.9% Impervious Runoff Depth=2.03" Tc=5.0 min CN=60 Runoff=3.20 cfs 10,064 cf
<b>SubcatchmentPR-12.2: Pathways, Gym</b>	Runoff Area=9,417 sf 100.0% Impervious Runoff Depth=5.92" Tc=5.0 min CN=98 Runoff=1.35 cfs 4,647 cf
<b>SubcatchmentPR-13.1: Surface Parking Lot</b>	Runoff Area=51,984 sf 31.2% Impervious Runoff Depth=1.77" Tc=5.0 min CN=57 Runoff=2.38 cfs 7,685 cf
<b>SubcatchmentPR-13.2: Garage Roof</b>	Runoff Area=24,538 sf 100.0% Impervious Runoff Depth=5.92" Tc=5.0 min CN=98 Runoff=3.52 cfs 12,109 cf
<b>SubcatchmentPR-20.1: E. Side of Garage -</b>	Runoff Area=21,182 sf 9.8% Impervious Runoff Depth=0.80" Tc=5.0 min CN=44 Runoff=0.28 cfs 1,411 cf
<b>SubcatchmentPR-20.2: S. of Olmsted Dr. -</b>	Runoff Area=10,104 sf 0.0% Impervious Runoff Depth=0.33" Tc=5.0 min CN=36 Runoff=0.02 cfs 280 cf
<b>SubcatchmentPR-20.3: Open Space North of</b>	Runoff Area=32,268 sf 0.0% Impervious Runoff Depth=0.38" Tc=5.0 min CN=37 Runoff=0.10 cfs 1,031 cf
<b>SubcatchmentPR-21.1: E. Driveway, NE</b>	Runoff Area=44,601 sf 45.7% Impervious Runoff Depth=2.56" Tc=5.0 min CN=66 Runoff=3.14 cfs 9,513 cf
<b>SubcatchmentPR-21.2: S. Olmsted</b>	Runoff Area=20,786 sf 74.5% Impervious Runoff Depth=4.24" Tc=5.0 min CN=83 Runoff=2.43 cfs 7,345 cf
<b>Pond P-11: SFD-11</b>	Peak Elev=186.26' Storage=8,999 cf Inflow=7.37 cfs 23,901 cf Outflow=2.22 cfs 20,840 cf
<b>Pond P-12: SFD-12</b>	Peak Elev=190.35' Storage=4,785 cf Inflow=4.55 cfs 14,711 cf Outflow=2.05 cfs 11,969 cf

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**Pond P-13: SFD-13**

Peak Elev=191.36' Storage=6,330 cf Inflow=5.87 cfs 19,794 cf  
Outflow=2.89 cfs 17,503 cf

**Pond P-21: SFD-21**

Peak Elev=186.60' Storage=7,725 cf Inflow=5.56 cfs 16,857 cf  
Outflow=1.02 cfs 12,833 cf

**Link DP-1: Drainage Channel**

Inflow=6.78 cfs 51,217 cf  
Primary=6.78 cfs 51,217 cf

**Link DP-2: Offsite at South PL**

Inflow=1.22 cfs 15,556 cf  
Primary=1.22 cfs 15,556 cf

**Total Runoff Area = 383,009 sf Runoff Volume = 78,891 cf Average Runoff Depth = 2.47"**  
**58.5% Pervious = 223,930 sf 41.5% Impervious = 159,079 sf**

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### Summary for Subcatchment PR-10.1: Overland to Drainage Channel

Runoff = 0.01 cfs @ 12.36 hrs, Volume= 145 cf, Depth= 0.38"  
Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
1,396	39	>75% Grass cover, Good, HSG A
3,140	36	Woods, Fair, HSG A
4,536	37	Weighted Average
4,536		100.0% Pervious Area

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

### Summary for Subcatchment PR-10.2: SE Courtyard

Runoff = 0.17 cfs @ 12.10 hrs, Volume= 759 cf, Depth= 0.93"  
Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
8,583	39	>75% Grass cover, Good, HSG A
1,167	96	Gravel surface, HSG A
9,750	46	Weighted Average
9,750		100.0% Pervious Area

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

### Summary for Subcatchment PR-11.1: W. Olmsted, W. Driveway, SW Play Area

Runoff = 4.32 cfs @ 12.08 hrs, Volume= 13,374 cf, Depth= 2.20"  
Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

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Area (sf)	CN	Description
43,800	39	>75% Grass cover, Good, HSG A
713	96	Gravel surface, HSG A
27,996	98	Paved parking, HSG A
265	98	Roofs, HSG A
154	36	Woods, Fair, HSG A
72,929	62	Weighted Average
44,667		61.2% Pervious Area
28,262		38.8% Impervious Area

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

**Summary for Subcatchment PR-11.2: Residential/PHP Roof**

Runoff = 2.15 cfs @ 12.07 hrs, Volume= 7,375 cf, Depth= 5.92"  
Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
14,944	98	Roofs, HSG A
14,944	98	Weighted Average
0		0.0% Pervious Area
14,944		100.0% Impervious Area

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

**Summary for Subcatchment PR-11.3: Arlington Roof**

Runoff = 0.92 cfs @ 12.07 hrs, Volume= 3,152 cf, Depth= 5.92"  
Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
0	96	Gravel surface, HSG A
6,388	98	Roofs, HSG A
6,388	98	Weighted Average
0		0.0% Pervious Area
6,388		100.0% Impervious Area

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

**Summary for Subcatchment PR-12.1: N. Driveway, NE Play Area**

Runoff = 3.20 cfs @ 12.08 hrs, Volume= 10,064 cf, Depth= 2.03"  
Routed to Pond P-12 : SFD-12

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
24,947	39	>75% Grass cover, Good, HSG A
52	96	Gravel surface, HSG A
21,366	98	Paved parking, HSG A
13,216	36	Woods, Fair, HSG A
59,581	60	Weighted Average
38,215		64.1% Pervious Area
21,366		35.9% Impervious Area

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

**Summary for Subcatchment PR-12.2: Pathways, Gym Roof**

Runoff = 1.35 cfs @ 12.07 hrs, Volume= 4,647 cf, Depth= 5.92"  
Routed to Pond P-12 : SFD-12

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
9,417	98	Roofs, HSG A
9,417	98	Weighted Average
0		0.0% Pervious Area
9,417		100.0% Impervious Area

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

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**Summary for Subcatchment PR-13.1: Surface Parking Lot**

Runoff = 2.38 cfs @ 12.08 hrs, Volume= 7,685 cf, Depth= 1.77"  
 Routed to Pond P-13 : SFD-13

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
15,813	39	>75% Grass cover, Good, HSG A
331	80	>75% Grass cover, Good, HSG D
16,239	98	Paved parking, HSG A
19,601	36	Woods, Fair, HSG A
51,984	57	Weighted Average
35,745		68.8% Pervious Area
16,239		31.2% Impervious Area

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

**Summary for Subcatchment PR-13.2: Garage Roof**

Runoff = 3.52 cfs @ 12.07 hrs, Volume= 12,109 cf, Depth= 5.92"  
 Routed to Pond P-13 : SFD-13

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
24,538	98	Roofs, HSG A
24,538		100.0% Impervious Area

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

**Summary for Subcatchment PR-20.1: E. Side of Garage - Overland to South**

Runoff = 0.28 cfs @ 12.11 hrs, Volume= 1,411 cf, Depth= 0.80"  
 Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 25-yr Rainfall=6.16"

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Area (sf)	CN	Description
12,400	39	>75% Grass cover, Good, HSG A
2,066	98	Paved parking, HSG A
6,715	36	Woods, Fair, HSG A
21,182	44	Weighted Average
19,116		90.2% Pervious Area
2,066		9.8% Impervious Area

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

**Summary for Subcatchment PR-20.2: S. of Olmsted Dr. - Overland to South**

Runoff = 0.02 cfs @ 12.39 hrs, Volume= 280 cf, Depth= 0.33"  
Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
1,368	39	>75% Grass cover, Good, HSG A
8,735	36	Woods, Fair, HSG A
10,104	36	Weighted Average
10,104		100.0% Pervious Area

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

**Summary for Subcatchment PR-20.3: Open Space North of Olmsted Dr.**

Runoff = 0.10 cfs @ 12.36 hrs, Volume= 1,031 cf, Depth= 0.38"  
Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
9,201	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
23,067	36	Woods, Fair, HSG A
32,268	37	Weighted Average
32,268		100.0% Pervious Area
0		0.0% Impervious Area

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

**Summary for Subcatchment PR-21.1: E. Driveway, NE Play Area, S. Side of Garage**

Runoff = 3.14 cfs @ 12.08 hrs, Volume= 9,513 cf, Depth= 2.56"  
 Routed to Pond P-21 : SFD-21

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
21,277	39	>75% Grass cover, Good, HSG A
140	96	Gravel surface, HSG A
20,314	98	Paved parking, HSG A
64	98	Roofs, HSG A
2,806	36	Woods, Fair, HSG A
44,601	66	Weighted Average
24,223		54.3% Pervious Area
20,378		45.7% Impervious Area

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

**Summary for Subcatchment PR-21.2: S. Olmsted Driveway**

Runoff = 2.43 cfs @ 12.07 hrs, Volume= 7,345 cf, Depth= 4.24"  
 Routed to Pond P-21 : SFD-21

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 25-yr Rainfall=6.16"

Area (sf)	CN	Description
3,706	39	>75% Grass cover, Good, HSG A
91	96	Gravel surface, HSG A
15,480	98	Paved parking, HSG A
1	98	Roofs, HSG A
1,509	36	Woods, Fair, HSG A
20,786	83	Weighted Average
5,306		25.5% Pervious Area
15,481		74.5% Impervious Area

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

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## Summary for Pond P-11: SFD-11

Inflow Area = 94,261 sf, 52.6% Impervious, Inflow Depth = 3.04" for 25-yr event  
 Inflow = 7.37 cfs @ 12.08 hrs, Volume= 23,901 cf  
 Outflow = 2.22 cfs @ 12.42 hrs, Volume= 20,840 cf, Atten= 70%, Lag= 20.7 min  
 Primary = 2.22 cfs @ 12.42 hrs, Volume= 20,840 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 186.26' @ 12.42 hrs Surf.Area= 4,598 sf Storage= 8,999 cf

Plug-Flow detention time= 300.0 min calculated for 20,840 cf (87% of inflow)  
 Center-of-Mass det. time= 239.1 min ( 1,045.3 - 806.1 )

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	2,014 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	183.50'	11,483 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		13,497 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
181.00	2,014	0.0	0	0
181.01	2,014	40.0	8	8
183.50	2,014	40.0	2,006	2,014

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
183.50	2,014	0	0
183.75	2,014	504	504
183.76	2,584	23	526
184.00	2,584	620	1,147
185.50	2,584	3,876	5,023
188.00	2,584	6,460	11,483

Device	Routing	Invert	Outlet Devices
#1	Primary	181.00'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 181.00' / 180.75' S= 0.0250 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	181.00'	<b>0.09 cfs Exfiltration at all elevations</b>
#3	Device 1	185.50'	<b>12.0" W x 10.0" H Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	187.25'	<b>1.0' long x 0.75' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=2.22 cfs @ 12.42 hrs HW=186.26' (Free Discharge)

- 1=Culvert (Passes 2.22 cfs of 12.72 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.09 cfs)
- 3=Orifice/Grate (Orifice Controls 2.12 cfs @ 2.80 fps)
- 4=Sharp-Crested Rectangular Weir ( Controls 0.00 cfs)

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**Summary for Pond P-12: SFD-12**

Inflow Area = 68,998 sf, 44.6% Impervious, Inflow Depth = 2.56" for 25-yr event  
 Inflow = 4.55 cfs @ 12.08 hrs, Volume= 14,711 cf  
 Outflow = 2.05 cfs @ 12.28 hrs, Volume= 11,969 cf, Atten= 55%, Lag= 12.2 min  
 Primary = 2.05 cfs @ 12.28 hrs, Volume= 11,969 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 190.35' @ 12.28 hrs Surf.Area= 2,044 sf Storage= 4,785 cf

Plug-Flow detention time= 258.3 min calculated for 11,969 cf (81% of inflow)  
 Center-of-Mass det. time= 179.3 min ( 1,002.8 - 823.5 )

Volume	Invert	Avail.Storage	Storage Description
#1	184.50'	840 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	187.00'	4,723 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		5,563 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
184.50	840	0.0	0	0
184.51	840	40.0	3	3
187.00	840	40.0	837	840

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
187.00	840	0	0
187.25	840	210	210
187.26	1,204	10	220
190.00	1,204	3,299	3,519
191.00	1,204	1,204	4,723

Device	Routing	Invert	Outlet Devices
#1	Primary	184.50'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 184.50' / 184.25' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	184.50'	<b>0.04 cfs Exfiltration at all elevations</b>
#3	Device 1	190.00'	<b>3.0' long x 1.00' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=2.05 cfs @ 12.28 hrs HW=190.35' (Free Discharge)

- 1=Culvert (Passes 2.05 cfs of 13.51 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.04 cfs)
- 3=Sharp-Crested Rectangular Weir (Weir Controls 2.01 cfs @ 1.94 fps)

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## Summary for Pond P-13: SFD-13

Inflow Area = 76,522 sf, 53.3% Impervious, Inflow Depth = 3.10" for 25-yr event  
 Inflow = 5.87 cfs @ 12.08 hrs, Volume= 19,794 cf  
 Outflow = 2.89 cfs @ 12.23 hrs, Volume= 17,503 cf, Atten= 51%, Lag= 9.0 min  
 Primary = 2.89 cfs @ 12.23 hrs, Volume= 17,503 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 191.36' @ 12.23 hrs Surf.Area= 3,366 sf Storage= 6,330 cf

Plug-Flow detention time= 261.9 min calculated for 17,503 cf (88% of inflow)  
 Center-of-Mass det. time= 204.7 min ( 996.9 - 792.2 )

Volume	Invert	Avail.Storage	Storage Description
#1	186.25'	1,452 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	188.75'	7,060 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		8,512 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
186.25	1,452	0.0	0	0
186.26	1,452	40.0	6	6
188.75	1,452	40.0	1,446	1,452

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
188.75	1,452	0	0
189.00	1,452	363	363
189.01	1,914	17	380
190.75	1,914	3,330	3,710
192.50	1,914	3,350	7,060

Device	Routing	Invert	Outlet Devices
#1	Primary	186.25'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 186.25' / 186.00' S= 0.0250' /' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	186.25'	<b>0.07 cfs Exfiltration at all elevations</b>
#3	Device 1	190.75'	<b>24.0" W x 6.0" H Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	191.75'	<b>2.0' long x 0.75' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=2.89 cfs @ 12.23 hrs HW=191.36' (Free Discharge)

- 1=Culvert (Passes 2.89 cfs of 12.51 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.07 cfs)
- 3=Orifice/Grate (Orifice Controls 2.82 cfs @ 2.82 fps)
- 4=Sharp-Crested Rectangular Weir ( Controls 0.00 cfs)

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## Summary for Pond P-21: SFD-21

Inflow Area = 65,387 sf, 54.8% Impervious, Inflow Depth = 3.09" for 25-yr event  
 Inflow = 5.56 cfs @ 12.08 hrs, Volume= 16,857 cf  
 Outflow = 1.02 cfs @ 12.54 hrs, Volume= 12,833 cf, Atten= 82%, Lag= 27.6 min  
 Primary = 1.02 cfs @ 12.54 hrs, Volume= 12,833 cf  
 Routed to Link DP-2 : Offsite at South PL

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 186.60' @ 12.54 hrs Surf.Area= 3,610 sf Storage= 7,725 cf

Plug-Flow detention time= 385.8 min calculated for 12,833 cf (76% of inflow)  
 Center-of-Mass det. time= 298.6 min ( 1,126.0 - 827.5 )

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	1,596 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	183.50'	7,949 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		9,545 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
181.00	1,596	0.0	0	0
181.01	1,596	40.0	6	6
183.50	1,596	40.0	1,590	1,596

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
183.50	1,596	0	0
183.75	1,596	399	399
183.76	2,014	18	417
186.25	2,014	5,015	5,432
187.50	2,014	2,518	7,949

Device	Routing	Invert	Outlet Devices
#1	Primary	181.00'	<b>12.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 181.00' / 180.75' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	181.00'	<b>0.07 cfs Exfiltration at all elevations</b>
#3	Device 1	186.25'	<b>1.5' long x 1.25' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=1.02 cfs @ 12.54 hrs HW=186.60' (Free Discharge)

1=Culvert (Passes 1.02 cfs of 8.54 cfs potential flow)

2=Exfiltration (Exfiltration Controls 0.07 cfs)

3=Sharp-Crested Rectangular Weir (Weir Controls 0.95 cfs @ 1.92 fps)

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**Summary for Link DP-1: Drainage Channel**

Inflow Area = 254,068 sf, 47.7% Impervious, Inflow Depth > 2.42" for 25-yr event  
Inflow = 6.78 cfs @ 12.32 hrs, Volume= 51,217 cf  
Primary = 6.78 cfs @ 12.32 hrs, Volume= 51,217 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**Summary for Link DP-2: Offsite at South PL**

Inflow Area = 128,941 sf, 29.4% Impervious, Inflow Depth > 1.45" for 25-yr event  
Inflow = 1.22 cfs @ 12.52 hrs, Volume= 15,556 cf  
Primary = 1.22 cfs @ 12.52 hrs, Volume= 15,556 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

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Time span=0.00-36.00 hrs, dt=0.01 hrs, 3601 points  
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
 Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

<b>SubcatchmentPR-10.1: Overland to Drainage</b>	Runoff Area=4,536 sf 0.0% Impervious Runoff Depth=1.31" Tc=5.0 min CN=37 Runoff=0.11 cfs 497 cf
<b>SubcatchmentPR-10.2: SE Courtyard</b>	Runoff Area=9,750 sf 0.0% Impervious Runoff Depth=2.31" Tc=5.0 min CN=46 Runoff=0.57 cfs 1,878 cf
<b>SubcatchmentPR-11.1: W. Olmsted, W.</b>	Runoff Area=72,929 sf 38.8% Impervious Runoff Depth=4.22" Tc=5.0 min CN=62 Runoff=8.55 cfs 25,638 cf
<b>SubcatchmentPR-11.2: Residential/PHP</b>	Runoff Area=14,944 sf 100.0% Impervious Runoff Depth=8.60" Tc=5.0 min CN=98 Runoff=3.09 cfs 10,710 cf
<b>SubcatchmentPR-11.3: Arlington Roof</b>	Runoff Area=6,388 sf 100.0% Impervious Runoff Depth=8.60" Tc=5.0 min CN=98 Runoff=1.32 cfs 4,578 cf
<b>SubcatchmentPR-12.1: N. Driveway, NE</b>	Runoff Area=59,581 sf 35.9% Impervious Runoff Depth=3.98" Tc=5.0 min CN=60 Runoff=6.56 cfs 19,740 cf
<b>SubcatchmentPR-12.2: Pathways, Gym</b>	Runoff Area=9,417 sf 100.0% Impervious Runoff Depth=8.60" Tc=5.0 min CN=98 Runoff=1.94 cfs 6,749 cf
<b>SubcatchmentPR-13.1: Surface Parking Lot</b>	Runoff Area=51,984 sf 31.2% Impervious Runoff Depth=3.61" Tc=5.0 min CN=57 Runoff=5.15 cfs 15,652 cf
<b>SubcatchmentPR-13.2: Garage Roof</b>	Runoff Area=24,538 sf 100.0% Impervious Runoff Depth=8.60" Tc=5.0 min CN=98 Runoff=5.07 cfs 17,585 cf
<b>SubcatchmentPR-20.1: E. Side of Garage -</b>	Runoff Area=21,182 sf 9.8% Impervious Runoff Depth=2.08" Tc=5.0 min CN=44 Runoff=1.07 cfs 3,677 cf
<b>SubcatchmentPR-20.2: S. of Olmsted Dr. -</b>	Runoff Area=10,104 sf 0.0% Impervious Runoff Depth=1.21" Tc=5.0 min CN=36 Runoff=0.21 cfs 1,020 cf
<b>SubcatchmentPR-20.3: Open Space North of</b>	Runoff Area=32,268 sf 0.0% Impervious Runoff Depth=1.31" Tc=5.0 min CN=37 Runoff=0.79 cfs 3,536 cf
<b>SubcatchmentPR-21.1: E. Driveway, NE</b>	Runoff Area=44,601 sf 45.7% Impervious Runoff Depth=4.71" Tc=5.0 min CN=66 Runoff=5.86 cfs 17,490 cf
<b>SubcatchmentPR-21.2: S. Olmsted</b>	Runoff Area=20,786 sf 74.5% Impervious Runoff Depth=6.78" Tc=5.0 min CN=83 Runoff=3.80 cfs 11,749 cf
<b>Pond P-11: SFD-11</b>	Peak Elev=187.69' Storage=12,696 cf Inflow=12.95 cfs 40,925 cf Outflow=6.30 cfs 37,748 cf
<b>Pond P-12: SFD-12</b>	Peak Elev=190.91' Storage=5,451 cf Inflow=8.49 cfs 26,489 cf Outflow=8.00 cfs 23,737 cf

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**Pond P-13: SFD-13**

Peak Elev=192.29' Storage=8,114 cf Inflow=10.20 cfs 33,238 cf  
Outflow=8.01 cfs 30,909 cf

**Pond P-21: SFD-21**

Peak Elev=187.47' Storage=9,490 cf Inflow=9.66 cfs 29,238 cf  
Outflow=5.62 cfs 25,162 cf

**Link DP-1: Drainage Channel**

Inflow=21.55 cfs 94,769 cf  
Primary=21.55 cfs 94,769 cf

**Link DP-2: Offsite at South PL**

Inflow=7.20 cfs 33,394 cf  
Primary=7.20 cfs 33,394 cf

**Total Runoff Area = 383,009 sf Runoff Volume = 140,498 cf Average Runoff Depth = 4.40"**  
**58.5% Pervious = 223,930 sf 41.5% Impervious = 159,079 sf**

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**Summary for Subcatchment PR-10.1: Overland to Drainage Channel**

Runoff = 0.11 cfs @ 12.10 hrs, Volume= 497 cf, Depth= 1.31"  
 Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
1,396	39	>75% Grass cover, Good, HSG A
3,140	36	Woods, Fair, HSG A
4,536	37	Weighted Average
4,536		100.0% Pervious Area

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

**Summary for Subcatchment PR-10.2: SE Courtyard**

Runoff = 0.57 cfs @ 12.09 hrs, Volume= 1,878 cf, Depth= 2.31"  
 Routed to Link DP-1 : Drainage Channel

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
8,583	39	>75% Grass cover, Good, HSG A
1,167	96	Gravel surface, HSG A
9,750	46	Weighted Average
9,750		100.0% Pervious Area

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

**Summary for Subcatchment PR-11.1: W. Olmsted, W. Driveway, SW Play Area**

Runoff = 8.55 cfs @ 12.08 hrs, Volume= 25,638 cf, Depth= 4.22"  
 Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-yr Rainfall=8.84"

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Area (sf)	CN	Description
43,800	39	>75% Grass cover, Good, HSG A
713	96	Gravel surface, HSG A
27,996	98	Paved parking, HSG A
265	98	Roofs, HSG A
154	36	Woods, Fair, HSG A
72,929	62	Weighted Average
44,667		61.2% Pervious Area
28,262		38.8% Impervious Area

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

**Summary for Subcatchment PR-11.2: Residential/PHP Roof**

Runoff = 3.09 cfs @ 12.07 hrs, Volume= 10,710 cf, Depth= 8.60"  
 Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
14,944	98	Roofs, HSG A
14,944	98	Weighted Average
0		0.0% Pervious Area
14,944		100.0% Impervious Area

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

**Summary for Subcatchment PR-11.3: Arlington Roof**

Runoff = 1.32 cfs @ 12.07 hrs, Volume= 4,578 cf, Depth= 8.60"  
 Routed to Pond P-11 : SFD-11

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
0	96	Gravel surface, HSG A
6,388	98	Roofs, HSG A
6,388	98	Weighted Average
0		0.0% Pervious Area
6,388		100.0% Impervious Area

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

**Summary for Subcatchment PR-12.1: N. Driveway, NE Play Area**

Runoff = 6.56 cfs @ 12.08 hrs, Volume= 19,740 cf, Depth= 3.98"  
Routed to Pond P-12 : SFD-12

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
24,947	39	>75% Grass cover, Good, HSG A
52	96	Gravel surface, HSG A
21,366	98	Paved parking, HSG A
13,216	36	Woods, Fair, HSG A
59,581	60	Weighted Average
38,215		64.1% Pervious Area
21,366		35.9% Impervious Area

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

**Summary for Subcatchment PR-12.2: Pathways, Gym Roof**

Runoff = 1.94 cfs @ 12.07 hrs, Volume= 6,749 cf, Depth= 8.60"  
Routed to Pond P-12 : SFD-12

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
0	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
9,417	98	Roofs, HSG A
9,417	98	Weighted Average
0		0.0% Pervious Area
9,417		100.0% Impervious Area

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

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Type III 24-hr 100-yr Rainfall=8.84"

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### Summary for Subcatchment PR-13.1: Surface Parking Lot

Runoff = 5.15 cfs @ 12.08 hrs, Volume= 15,652 cf, Depth= 3.61"  
Routed to Pond P-13 : SFD-13

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
15,813	39	>75% Grass cover, Good, HSG A
331	80	>75% Grass cover, Good, HSG D
16,239	98	Paved parking, HSG A
19,601	36	Woods, Fair, HSG A
51,984	57	Weighted Average
35,745		68.8% Pervious Area
16,239		31.2% Impervious Area

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

### Summary for Subcatchment PR-13.2: Garage Roof

Runoff = 5.07 cfs @ 12.07 hrs, Volume= 17,585 cf, Depth= 8.60"  
Routed to Pond P-13 : SFD-13

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
24,538	98	Roofs, HSG A
24,538		100.0% Impervious Area

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

### Summary for Subcatchment PR-20.1: E. Side of Garage - Overland to South

Runoff = 1.07 cfs @ 12.09 hrs, Volume= 3,677 cf, Depth= 2.08"  
Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

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Area (sf)	CN	Description
12,400	39	>75% Grass cover, Good, HSG A
2,066	98	Paved parking, HSG A
6,715	36	Woods, Fair, HSG A
21,182	44	Weighted Average
19,116		90.2% Pervious Area
2,066		9.8% Impervious Area

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

**Summary for Subcatchment PR-20.2: S. of Olmsted Dr. - Overland to South**

Runoff = 0.21 cfs @ 12.11 hrs, Volume= 1,020 cf, Depth= 1.21"  
 Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
1,368	39	>75% Grass cover, Good, HSG A
8,735	36	Woods, Fair, HSG A
10,104	36	Weighted Average
10,104		100.0% Pervious Area

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

**Summary for Subcatchment PR-20.3: Open Space North of Olmsted Dr.**

Runoff = 0.79 cfs @ 12.10 hrs, Volume= 3,536 cf, Depth= 1.31"  
 Routed to Link DP-2 : Offsite at South PL

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
9,201	39	>75% Grass cover, Good, HSG A
0	98	Paved parking, HSG A
23,067	36	Woods, Fair, HSG A
32,268	37	Weighted Average
32,268		100.0% Pervious Area
0		0.0% Impervious Area

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Type III 24-hr 100-yr Rainfall=8.84"

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

**Summary for Subcatchment PR-21.1: E. Driveway, NE Play Area, S. Side of Garage**

Runoff = 5.86 cfs @ 12.08 hrs, Volume= 17,490 cf, Depth= 4.71"  
Routed to Pond P-21 : SFD-21

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
21,277	39	>75% Grass cover, Good, HSG A
140	96	Gravel surface, HSG A
20,314	98	Paved parking, HSG A
64	98	Roofs, HSG A
2,806	36	Woods, Fair, HSG A
44,601	66	Weighted Average
24,223		54.3% Pervious Area
20,378		45.7% Impervious Area

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

**Summary for Subcatchment PR-21.2: S. Olmsted Driveway**

Runoff = 3.80 cfs @ 12.07 hrs, Volume= 11,749 cf, Depth= 6.78"  
Routed to Pond P-21 : SFD-21

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Type III 24-hr 100-yr Rainfall=8.84"

Area (sf)	CN	Description
3,706	39	>75% Grass cover, Good, HSG A
91	96	Gravel surface, HSG A
15,480	98	Paved parking, HSG A
1	98	Roofs, HSG A
1,509	36	Woods, Fair, HSG A
20,786	83	Weighted Average
5,306		25.5% Pervious Area
15,481		74.5% Impervious Area

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

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Type III 24-hr 100-yr Rainfall=8.84"

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## Summary for Pond P-11: SFD-11

Inflow Area = 94,261 sf, 52.6% Impervious, Inflow Depth = 5.21" for 100-yr event  
 Inflow = 12.95 cfs @ 12.07 hrs, Volume= 40,925 cf  
 Outflow = 6.30 cfs @ 12.22 hrs, Volume= 37,748 cf, Atten= 51%, Lag= 8.9 min  
 Primary = 6.30 cfs @ 12.22 hrs, Volume= 37,748 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 187.69' @ 12.22 hrs Surf.Area= 4,598 sf Storage= 12,696 cf

Plug-Flow detention time= 184.2 min calculated for 37,748 cf (92% of inflow)  
 Center-of-Mass det. time= 143.1 min ( 942.8 - 799.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	2,014 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	183.50'	11,483 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		13,497 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
181.00	2,014	0.0	0	0
181.01	2,014	40.0	8	8
183.50	2,014	40.0	2,006	2,014

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
183.50	2,014	0	0
183.75	2,014	504	504
183.76	2,584	23	526
184.00	2,584	620	1,147
185.50	2,584	3,876	5,023
188.00	2,584	6,460	11,483

Device	Routing	Invert	Outlet Devices
#1	Primary	181.00'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 181.00' / 180.75' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	181.00'	<b>0.09 cfs Exfiltration at all elevations</b>
#3	Device 1	185.50'	<b>12.0" W x 10.0" H Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	187.25'	<b>1.0' long x 0.75' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=6.29 cfs @ 12.22 hrs HW=187.69' (Free Discharge)

- 1=Culvert (Passes 6.29 cfs of 14.55 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.09 cfs)
- 3=Orifice/Grate (Orifice Controls 5.33 cfs @ 6.40 fps)
- 4=Sharp-Crested Rectangular Weir (Weir Controls 0.87 cfs @ 2.17 fps)

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## Summary for Pond P-12: SFD-12

Inflow Area = 68,998 sf, 44.6% Impervious, Inflow Depth = 4.61" for 100-yr event  
 Inflow = 8.49 cfs @ 12.08 hrs, Volume= 26,489 cf  
 Outflow = 8.00 cfs @ 12.10 hrs, Volume= 23,737 cf, Atten= 6%, Lag= 1.7 min  
 Primary = 8.00 cfs @ 12.10 hrs, Volume= 23,737 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 190.91' @ 12.10 hrs Surf.Area= 2,044 sf Storage= 5,451 cf

Plug-Flow detention time= 147.7 min calculated for 23,737 cf (90% of inflow)  
 Center-of-Mass det. time= 96.4 min ( 910.7 - 814.3 )

Volume	Invert	Avail.Storage	Storage Description
#1	184.50'	840 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	187.00'	4,723 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		5,563 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
184.50	840	0.0	0	0
184.51	840	40.0	3	3
187.00	840	40.0	837	840

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
187.00	840	0	0
187.25	840	210	210
187.26	1,204	10	220
190.00	1,204	3,299	3,519
191.00	1,204	1,204	4,723

Device	Routing	Invert	Outlet Devices
#1	Primary	184.50'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 184.50' / 184.25' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	184.50'	<b>0.04 cfs Exfiltration at all elevations</b>
#3	Device 1	190.00'	<b>3.0' long x 1.00' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=7.99 cfs @ 12.10 hrs HW=190.91' (Free Discharge)

1=Culvert (Passes 7.99 cfs of 14.21 cfs potential flow)

2=Exfiltration (Exfiltration Controls 0.04 cfs)

3=Sharp-Crested Rectangular Weir (Weir Controls 7.95 cfs @ 3.11 fps)

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Type III 24-hr 100-yr Rainfall=8.84"

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## Summary for Pond P-13: SFD-13

Inflow Area = 76,522 sf, 53.3% Impervious, Inflow Depth = 5.21" for 100-yr event  
 Inflow = 10.20 cfs @ 12.07 hrs, Volume= 33,238 cf  
 Outflow = 8.01 cfs @ 12.13 hrs, Volume= 30,909 cf, Atten= 22%, Lag= 3.6 min  
 Primary = 8.01 cfs @ 12.13 hrs, Volume= 30,909 cf  
 Routed to Link DP-1 : Drainage Channel

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
 Peak Elev= 192.29' @ 12.13 hrs Surf.Area= 3,366 sf Storage= 8,114 cf

Plug-Flow detention time= 163.8 min calculated for 30,901 cf (93% of inflow)  
 Center-of-Mass det. time= 125.8 min ( 915.4 - 789.7 )

Volume	Invert	Avail.Storage	Storage Description
#1	186.25'	1,452 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	188.75'	7,060 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		8,512 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
186.25	1,452	0.0	0	0
186.26	1,452	40.0	6	6
188.75	1,452	40.0	1,446	1,452

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
188.75	1,452	0	0
189.00	1,452	363	363
189.01	1,914	17	380
190.75	1,914	3,330	3,710
192.50	1,914	3,350	7,060

Device	Routing	Invert	Outlet Devices
#1	Primary	186.25'	<b>15.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 186.25' / 186.00' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf
#2	Device 1	186.25'	<b>0.07 cfs Exfiltration at all elevations</b>
#3	Device 1	190.75'	<b>24.0" W x 6.0" H Vert. Orifice/Grate</b> C= 0.600 Limited to weir flow at low heads
#4	Device 1	191.75'	<b>2.0' long x 0.75' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=7.99 cfs @ 12.13 hrs HW=192.29' (Free Discharge)

- 1=Culvert (Passes 7.99 cfs of 13.75 cfs potential flow)
- 2=Exfiltration (Exfiltration Controls 0.07 cfs)
- 3=Orifice/Grate (Orifice Controls 5.46 cfs @ 5.46 fps)
- 4=Sharp-Crested Rectangular Weir (Weir Controls 2.46 cfs @ 2.41 fps)

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Type III 24-hr 100-yr Rainfall=8.84"

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**Summary for Pond P-21: SFD-21**

Inflow Area = 65,387 sf, 54.8% Impervious, Inflow Depth = 5.37" for 100-yr event  
Inflow = 9.66 cfs @ 12.07 hrs, Volume= 29,238 cf  
Outflow = 5.62 cfs @ 12.18 hrs, Volume= 25,162 cf, Atten= 42%, Lag= 6.2 min  
Primary = 5.62 cfs @ 12.18 hrs, Volume= 25,162 cf  
Routed to Link DP-2 : Offsite at South PL

Routing by Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs  
Peak Elev= 187.47' @ 12.18 hrs Surf.Area= 3,610 sf Storage= 9,490 cf

Plug-Flow detention time= 222.7 min calculated for 25,155 cf (86% of inflow)  
Center-of-Mass det. time= 161.1 min ( 974.1 - 813.0 )

Volume	Invert	Avail.Storage	Storage Description
#1	181.00'	1,596 cf	<b>Below Sand Filter (Prismatic)</b> Listed below (Recalc)
#2	183.50'	7,949 cf	<b>Above Sand Filter (Prismatic)</b> Listed below (Recalc)
		9,545 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Voids (%)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
181.00	1,596	0.0	0	0
181.01	1,596	40.0	6	6
183.50	1,596	40.0	1,590	1,596

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
183.50	1,596	0	0
183.75	1,596	399	399
183.76	2,014	18	417
186.25	2,014	5,015	5,432
187.50	2,014	2,518	7,949

Device	Routing	Invert	Outlet Devices
#1	Primary	181.00'	<b>12.0" Round Culvert</b> L= 10.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 181.00' / 180.75' S= 0.0250'/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	181.00'	<b>0.07 cfs Exfiltration at all elevations</b>
#3	Device 1	186.25'	<b>1.5' long x 1.25' rise Sharp-Crested Rectangular Weir</b> 2 End Contraction(s)

**Primary OutFlow** Max=5.62 cfs @ 12.18 hrs HW=187.47' (Free Discharge)

1=Culvert (Passes 5.62 cfs of 9.24 cfs potential flow)

2=Exfiltration (Exfiltration Controls 0.07 cfs)

3=Sharp-Crested Rectangular Weir (Weir Controls 5.55 cfs @ 3.61 fps)

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**Summary for Link DP-1: Drainage Channel**

Inflow Area = 254,068 sf, 47.7% Impervious, Inflow Depth > 4.48" for 100-yr event  
Inflow = 21.55 cfs @ 12.13 hrs, Volume= 94,769 cf  
Primary = 21.55 cfs @ 12.13 hrs, Volume= 94,769 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

**Summary for Link DP-2: Offsite at South PL**

Inflow Area = 128,941 sf, 29.4% Impervious, Inflow Depth > 3.11" for 100-yr event  
Inflow = 7.20 cfs @ 12.16 hrs, Volume= 33,394 cf  
Primary = 7.20 cfs @ 12.16 hrs, Volume= 33,394 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

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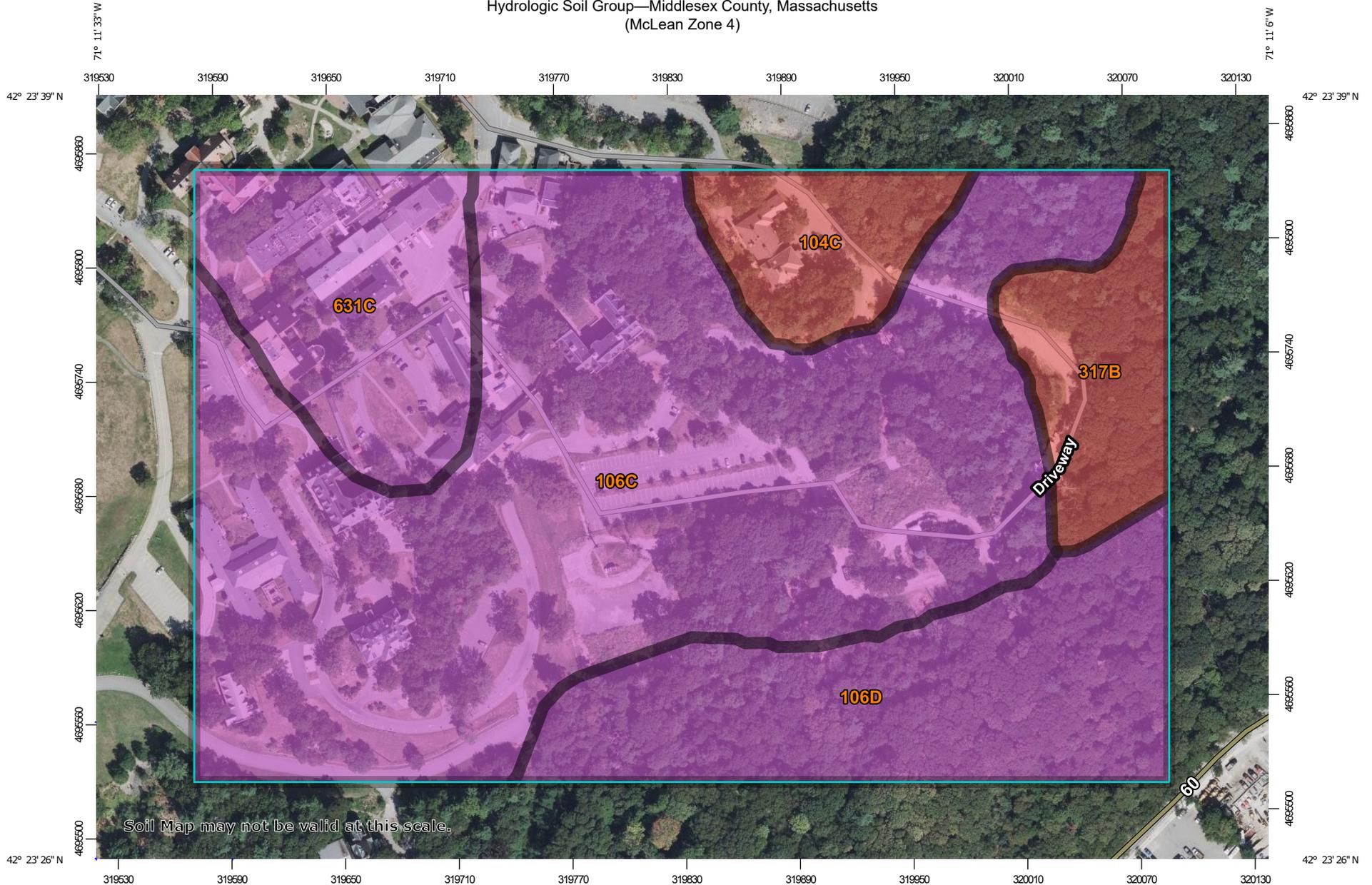
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## Appendix C: Standard 3 Computations and Supporting Documentation

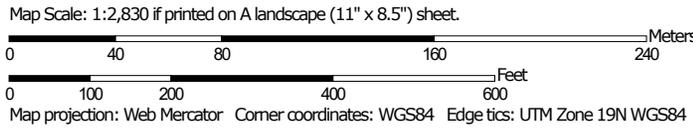
- › NRCS Web Soil Survey
- › Geotechnical Report

## NRCS Web Soil Survey

Hydrologic Soil Group—Middlesex County, Massachusetts  
(McLean Zone 4)



Soil Map may not be valid at this scale.



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

#### Soil Rating Polygons

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

#### Soil Rating Lines

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

#### Soil Rating Points

 A  
 A/D  
 B  
 B/D

 C  
 C/D  
 D  
 Not rated or not available

### Water Features

 Streams and Canals

### Transportation

 Rails  
 Interstate Highways  
 US Routes  
 Major Roads  
 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts  
 Survey Area Data: Version 21, Sep 2, 2021

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

Date(s) aerial images were photographed: Aug 13, 2020—Sep 15, 2020

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

## Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
104C	Hollis-Rock outcrop-Charlton complex, 0 to 15 percent slopes	D	2.4	5.8%
106C	Narragansett-Hollis-Rock outcrop complex, 3 to 15 percent slopes	A	23.8	57.9%
106D	Narragansett-Hollis-Rock outcrop complex, 15 to 25 percent slopes	A	7.2	17.6%
317B	Scituate fine sandy loam, 3 to 8 percent slopes, extremely stony	D	2.9	7.0%
631C	Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky	A	4.8	11.7%
<b>Totals for Area of Interest</b>			<b>41.1</b>	<b>100.0%</b>

## Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

## Rating Options

*Aggregation Method:* Dominant Condition

*Component Percent Cutoff:* None Specified

*Tie-break Rule:* Higher

# Geotechnical Report



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8 February 2022  
File No. 135214-001

McLean Hospital  
115 Mill Street  
Belmont, Massachusetts 02478

Attention: Andrew Healy  
Director of Hospital Facilities Department

Subject: Results of Subsurface Investigations and Concept Level Geotechnical Design Considerations  
New Child and Adolescent Campus, East House Addition, and Parking Structure  
McLean Hospital Campus  
Belmont, Massachusetts

Dear Mr. Healy:

The purpose of this letter is to transmit results from a recent subsurface exploration program conducted within the southeastern portion of the McLean Hospital campus located at 115 Mill Street in Belmont, Massachusetts (the "Site"), and to provide concept level geotechnical design considerations for the subject project. The approximate location of the Site is provided in Figure 1, Project Locus.

## **Proposed Development**

Our understanding of the proposed New Child and Adolescent Campus and East House Addition project is based on the proposed site layout overlay plan provided by HGA in October 2021. The proposed development will include construction of three connected main buildings, an addition to the East House, and a proposed parking structure. As of this letter, the architectural design is envisioned to include student activity/academic space, residential space, and office support/administration space within the proposed buildings. We understand the footprint and number of above-grade levels for the proposed parking structure is not defined at the time of this report but may include a multi-level parking structure located at the east portion of the site.

Site development will include construction of new surficial parking spaces and both pedestrian pathways and vehicular roadways. New site utilities (electric, water, sewer, etc.) are anticipated to be constructed to service the proposed buildings. Stormwater will be managed through a series of infiltration and/or detention basins per the Town of Belmont's stormwater management regulations.

## Subsurface Exploration Program

### PREVIOUS EXPLORATION PROGRAM

GEI Consultants, Inc. previously performed a subsurface investigation program at the project site in May 2000, which consisted of twenty-three test pit excavations to observe subsurface conditions in readily accessible areas. Designations and approximate locations of the test borings are shown on Figure 2.

### CONCEPT DESIGN EXPLORATION PROGRAM

Between 7 December and 8 December 2021, Haley & Aldrich, Inc. (Haley & Aldrich) oversaw the excavation of sixteen (16) test pits by James W. Flett Co., Inc using a CAT M813 backhoe. The test pits (designated TP21-1 through TP21-16) were advanced in readily-accessible topsoil and/or asphalt-covered areas of the site to maximum depths of approximately 10 feet below ground surface (ft bgs). Haley & Aldrich observed the subsurface conditions encountered while excavating the test pits. Locations of the test pits are provided on Figure 2, Site and Subsurface Exploration Location Plan, and test pit logs and photographs are provided in Appendix A.

### SOIL AND BEDROCK CONDITIONS

A general summary of the soil conditions encountered is provided below:

- **Fill** – A Fill layer was encountered just below the ground surface and was generally described as a brown to yellow-brown or gray silty SAND with gravel or poorly-graded SAND with gravel with varying amounts of gravel and silt. Where encountered, the thickness of the Fill ranged from 0.3 to 7.4 ft.
- **Loess Deposits** – Loess Deposits were encountered in TP21-9 and TP21-10, and TP21-12 through TP-16. The Loess Deposits were generally described as a light brown to red brown sandy SILT and was measured to be between 2 to 3 ft thick.
- **Organic Deposits** – An approximately 0.5-thick layer of light gray sandy ORGANIC SOIL was observed in TP21 and was not observed in the remaining test pits.
- **Glacial Till** – A layer of Glacial Till was typically encountered immediately above Bedrock, with the exception of test pits TP21-2, TP21-7, and TP21-16. The Glacial Till was generally described as a dark brown to light gray silty SAND with gravel with varying amounts of gravel and silt. The layer additionally contained varying amounts of cobbles and boulders.
- **Bedrock** – Bedrock was encountered in each of the test pits between approximately 5 to 8.5 ft bgs, except for test pits TP21-1 and TP21-5. The Bedrock surface was observed to be a hard, non-rippable (with the equipment excavating the test pit) GABBRO or DIORITE.

Based on depth and elevation of Bedrock encountered in test pit excavations conducted at the site, a contour plan of the top of Bedrock within the proposed development was prepared for planning and design purposes. Refer to Figure 3 for estimated Top of Bedrock Contour Plan.

## GROUNDWATER LEVELS

Groundwater levels were observed in four test pits during the explorations. Depths to groundwater, where encountered, were measured between 3.5 ft and 7.2 ft below ground surface, with respective groundwater elevations as shown in the following table.

Exploration Designation	Groundwater Elevation (NAVD88)
TP21-1	183.6
TP21-2	182.8
TP21-3	187.5
TP21-5	189.0

## SOIL HYDRAULIC CONDUCTIVITY TESTING

Following excavation of TP21-1, a field saturated hydraulic conductivity test was completed in natural soils using a Guelph permeameter test. The Guelph permeameter is an instrument used to conduct an in-situ constant head hydraulic conductivity test. The test simulates a wetting front moving through the soil and is therefore a field measurement of the field saturated hydraulic conductivity of the soil at the test interval. The Guelph permeameter is one of the acceptable test methods identified in the Massachusetts Stormwater Handbook. The tabulated field data and calculation of the saturated hydraulic conductivity are attached in Appendix B.

Grain size distribution testing was performed on two samples collected at two of the test pits where infiltration testing was conducted. The soil samples were submitted to Geotesting Express, Inc. (Geotesting) for grain size analysis. Based on the grain size analyses, the Glacial Till Soils for both TP21-1 and TP21-3 were characterized as Sandy Loam. The results of the grain size analyses and respective United States Department of Agriculture (USDA) Soil Texture Triangles for the soil samples are included in Appendix C.

Results of the permeameter testing are as follows:

Location	Ground Surface Elevation (ft)	Test Depth (ft)	Soil Stratum	Field Estimated Saturated Hydraulic Conductivity (cm/sec)	Field Estimated Saturated Hydraulic Conductivity (in/hr)
TP21-1	190	4 – 4.5	Glacial Till silty SAND (SM) with gravel	$2.6 \times 10^{-4}$	0.37

An infiltration test was proposed at TP21-3, however, the test was not performed due to Glacial Till encountered at a depth of 4.5 ft bgs and safety concerns for entering the test pit at depth without shoring (note, temporary earth support within the test pits was not anticipated for this scope of work). An infiltration test was also proposed at TP21-5, however, the test was not performed due to the top of Glacial Till encountered at a depth 4.5 ft bgs and groundwater entering the test pit at a depth of approximately 4 ft bgs.

Based on preliminary review of the infiltration and soil grain size distribution test results, Haley & Aldrich recommends using 50% of the lowest hydraulic conductivity value measured from the field saturated hydraulic conductivity testing rather than published Rawls Rates, as indicated in Table 2.3.3 of the Massachusetts Stormwater Handbook. Accordingly, a concept level estimated design infiltration value should be 0.19 in/hr and be utilized for evaluating stormwater infiltration system locations.

Given the shallow depth to groundwater and bedrock, supplemental infiltration tests will be required as the design progresses and to fulfill requirements of the Massachusetts Stormwater Handbook.

## **Concept Design Considerations and Recommendations**

The following sections of this letter report present geotechnical design recommendations pertaining to the permanent design of the proposed buildings. The recommendations and conclusions provided herein were developed during Concept Design and are based on review of available drawings and sketches received by Haley & Aldrich. As the design for the proposed site progresses, we will provide subsequent geotechnical design memoranda specific to the final design as well as geotechnical related construction considerations.

### **General**

Foundations and below-grade structures should be designed and constructed in accordance with the 9<sup>th</sup> Edition of the Massachusetts State Building Code.

Depending on the planned design of the lowest level building grades within the proposed structures and subsurface soil and bedrock conditions at the site, the proposed development could incur premium costs for foundation construction and site development. Controlled blasting and bedrock stabilization methods will be required in certain areas to reach design footing bearing elevations and site grades.

### **Site Development**

Earthwork for construction of the proposed structures as well as site development will require excavation of bituminous asphalt, pavement base course, existing and original topsoil layers, Fill, Glacial Till, and Bedrock to reach design elevations.

Depending on final design, Bedrock excavation using controlled blasting techniques will likely be required to achieve design bearing elevations. The Bedrock at the subject site is considered very hard and likely cannot be removed efficiently, if at all, using conventional excavation equipment. Where the depth of Bedrock removal is limited, the use of a hoe ram may be appropriate. However, where the quantity of Bedrock removal is anticipated to be significant, a combination of hoe ramming and controlled blasting methods will be needed. A blasting contractor should be consulted to obtain an estimate of controlled blasting costs.

Some filling to raise grades (generally within roadways and parking areas) could be required outside proposed building limits. Prior to placing fills, excavation to naturally-deposited Glacial Till soils or Bedrock will be required to achieve proper bearing conditions.

Existing utilities to be abandoned will require cut-and-capping beyond the plan limits of the work and complete removal from within the footprint of the proposed buildings. Existing, active utilities to remain and new utilities to be installed will require coordination with new work to avoid potential design conflicts. Construction activities will need to be coordinated to not impact the active utilities to remain or new utilities to be constructed.

### Foundation and Slab Design Recommendations

Excavations within Glacial Till or Bedrock will most likely be required to achieve foundation subgrades. Accordingly, construction of the proposed buildings may be supported on conventional footing foundations.

- Footings On Bedrock: Footing foundations to bear on Bedrock or blasted Bedrock should be designed at a maximum allowable bearing pressure of 20 kips per square foot assuming the Bedrock: a) has not been significantly disturbed during blasting and b) any loose Bedrock is removed and the footing subgrade is leveled (maximum 2H:1V slope) with lean concrete.
- Footing on Soil: Footings bearing on Glacial Till should be designed for a bearing pressure of 10 kips per square foot. Footings bearing on compacted structural fill or Processed Rock Fill should be design for a bearing pressure of 6 kips per square foot. Approved soil subgrades should be protected with a 3-in. minimum thickness lean concrete mudmat.
- Where Bedrock is not encountered at footing design bearing elevations, excavation down to Bedrock and backfill with lean concrete to footing design bearing elevation is an option where Glacial Till or Bedrock is locally shallow relative to footing design bearing elevation.
- Footings founded on soils should bear a minimum of 4-ft below the lowest adjacent ground surface exposed to freezing. Footings bearing directly on Bedrock should be designed to bear 18 inches below the adjacent ground or slab surface exposed to freezing.
- Footings shall bear below a line drawn upward and outward on a 2 horizontal to 1 vertical slope from the bottom outside edge of any utility trenches, or other localized excavation, located below-grade or below slab.
- It is recommended that the ground floor slabs be designed as a slab-on-grade, bearing directly on  $\frac{3}{4}$  in. crushed stone as described below, placed on undisturbed, naturally deposited, inorganic soil, or Bedrock subgrade.

### Seismic Design Criteria

In accordance with the Building Code, the site is classified as a Seismic Site Class B. For design, and in accordance with the 9th Edition of the Massachusetts Building Code Table 1604.11, the short period spectral response acceleration (SS) shall be 0.215g (21.5%g) and the 1-second spectral response acceleration (S1) shall be 0.070g (7.0%g).

Based on results from the subsurface explorations, the soils within the limits of the proposed buildings are considered to be non-susceptible to liquefaction for design level earthquake shaking.

### **Lowest level Floor Slab / Groundwater Control / Radon Control**

If the lowest level of the proposed buildings will be below planned adjacent exterior grades and below site groundwater levels. For these areas, we recommend permanent, below-slab and perimeter foundation drain systems be provided as follows.

- The lowest level floor slab may be designed as a soil supported slab-on-grade. An underslab drainage system will be required below the lowest level floor slab to provide permanent hydrostatic relief. The underslab drainage system should consist of a network of 4-in. diameter perforated PVC pipes in an 18-in. thick layer of ¾ in. crushed stone fully enveloped in geotextile fabric.
- A radon mitigation system consisting of 2-in. diameter perforated pipe centered within the upper 6 in. of the 18-in. underslab drainage crushed stone layer is recommended to mitigate radon below the slab. The radon mitigation system will sit directly below the slab-on-grade and above the underslab drainage system. A vapor barrier (minimum 15-mil) should be provided on the underside of the lowest level slab.
- A perimeter foundation drainage system should be provided along all below-grade walls where the adjacent floor slab is below the adjacent exterior finished grade. The perimeter foundation drain system should consist of a continuous perforated drain pipe (6-in. diameter) completely encapsulated in ¾-in. crushed stone enveloped in nonwoven geotextile fabric and be positioned at the exterior base of the foundation wall, with the invert of the perimeter drain set 12-in. below the level of the interior finished floor.
- To limit water infiltration into the perimeter foundation system, it is recommended that ground surface immediately adjacent to buildings should be sloped downward away from the structure to direct surface runoff.

### **Site Grading and Soil Slope Stabilization**

In connection with proposed site grading, earth slopes to be covered with grass, mulch or other types of vegetation should be no steeper than 2 horizontal to 1 vertical (2H:1V). Steeper slopes (up to 1H:1V) could be possible using rip-rap, earth reinforcement, or other earth retention systems, and should be analyzed on an individual basis.

### **Pavement Sections**

Preparation of pavement subgrade should consist of excavation and removal of all existing pavements, topsoil, and unsuitable/unstable soils, to allow for construction of a 2-ft layer of compacted granular backfill above subgrade elevation or excavation of bedrock. Base and/or subbase for parking lots and roadway areas should bear on a proofrolled subgrade consisting of existing stable fills, natural glacial

soils, or Bedrock following proof-compaction. A graded filter layer or geotextile fabric should be placed between blasted rock or fill and pavement subgrade material.

### **Bedrock Blasting and Vibrations**

The Contractor is responsible for preventing damage to any nearby existing or new structures, newly concreted foundation elements, utilities, and other facilities resulting from blasting operations, and for conforming to applicable codes and regulations. Controlled blasting techniques are recommended to minimize ground vibrations and airblast overpressures.

Contract documents should require blasting be conducted in such a manner that the resulting peak particle velocity of ground motion and the airblast overpressure at adjacent structures do not exceed levels recommended by the U.S. Bureau of Mines and State and local regulations to protect residential and commercial structures. The Contractor should design each blasting round for the project accordingly. Blasting mats or other suitable cover should be utilized to control flyrock during blasting operations.

A Blasting Impact Report will be required by the Town of Belmont prior to performing any blasting on the site. Such a report would usually provide estimates of anticipated blasting vibrations at the nearest building locations and describe the proposed precondition survey and monitoring programs.

### **Pre-construction Survey**

For the protection of the project team, including the Contractor, from damage claims due to blasting or other construction operations, a pre- and post-construction survey of existing structures within 250 ft (State Code requirement) of the proposed construction should be performed by a professional engineer registered in the Commonwealth of Massachusetts. Also, the construction should include monitoring and documenting vibration and airblast overpressure levels resulting from each blast round on the project.

### **Limitations**

This report was prepared in accordance with our proposal with McLean Hospital dated 3 November 2021 and your subsequent authorization. This report has been prepared for the specific application to the New Child and Adolescent Campus and East House Addition project is based on the proposed site layout overlay plan provided by HGA in October 2021.

The nature and extent in variations in the subsurface conditions between explorations may not become evident until construction. If the project design and configuration changes prior to the construction and/or significant variations in the subsurface conditions appear during construction, it will be necessary to re-evaluate the information included in this report.

Thank you for the opportunity to perform this assessment for you. Please do not hesitate to contact us if you have comments or wish to discuss this report.

Sincerely yours,  
HALEY & ALDRICH, INC.



Nolan T. Lescalleet, G.I.T.  
Senior Geologist



R. Scott Goldkamp, P.E.  
Principal



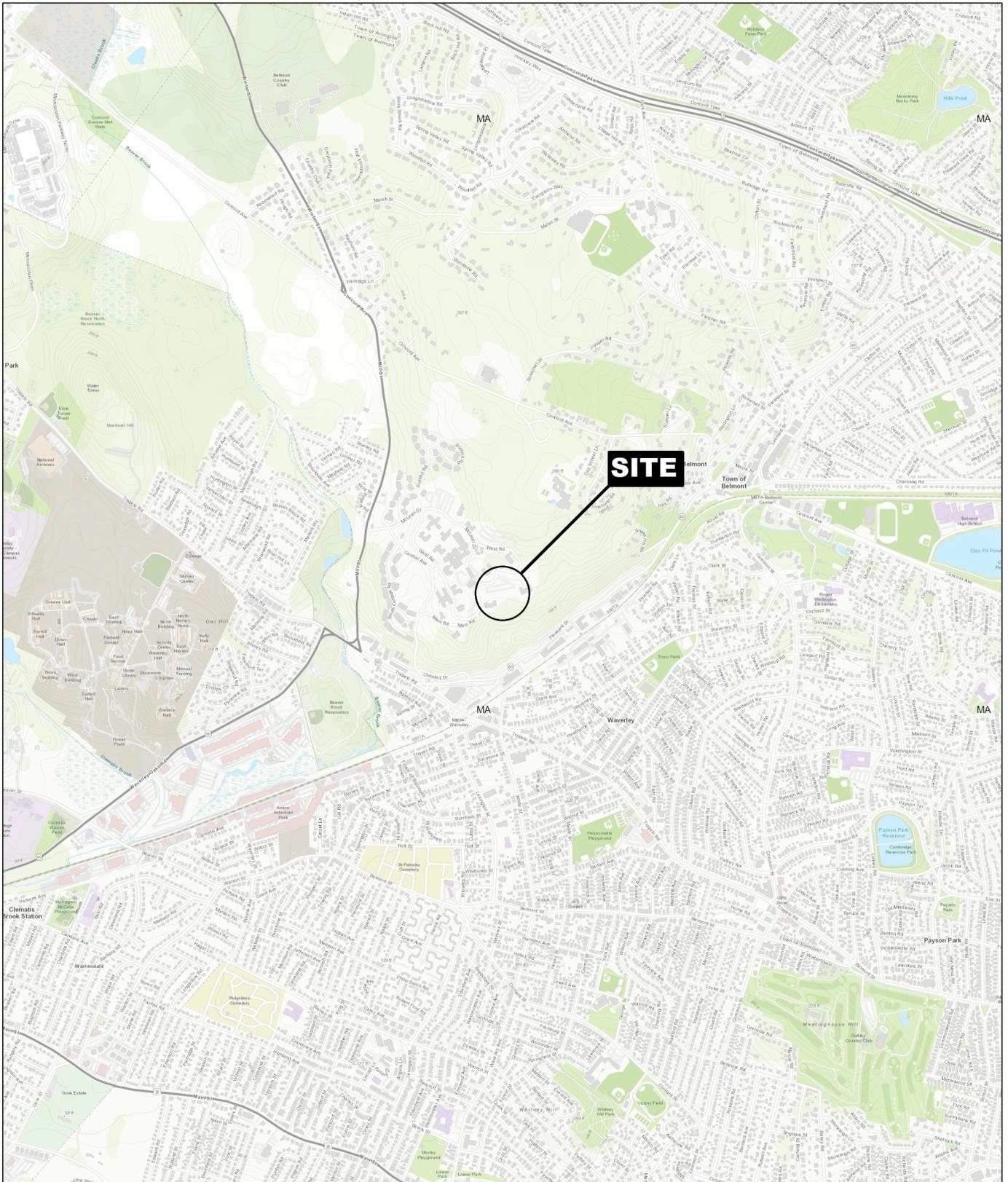
Joel S. Mooney, P.E., L.S.P.  
Principal | Senior Vice President

cc: HGA Architect; Candice Barter  
Simon Design Engineering; Alan Simon  
VHB; Justin Mosca

Attachments:

Figure 1	Project Locus
Figure 2	Site and Subsurface Exploration Location Plan
Figure 3	Top of Bedrock Contour Plan
Appendix A	Test Pit Logs and Photographs
Appendix B	Guelph Permeameter Field Data
Appendix C	Soil Grain Size Distribution and Soil Texture Triangle

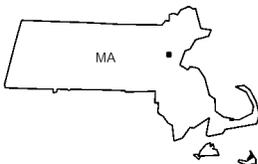
\\haleyaldrich.com\share\CF\Projects\135214\Reports\Concept Level Letter\Draft-Report\2022-0125\_HAI\_McLean-Hospital-Geotech-Schematic-Design-Letter\_F.docx



SITE COORDINATES: 42°23'32"N, 71°11'19"W

**HALEY  
ALDRICH**

MCLEAN HOSPITAL  
115 MILL STREET  
BELMONT, MASSACHUSETTS



**PROJECT LOCUS**

MAP SOURCE: USGS

APPROXIMATE SCALE: 1 INCH = 2,000 FEET  
FEBRUARY 2022

**FIGURE 1**

Saved by: KPOSTOLOWSKI Printed: 1/14/2022 10:48 AM Sheet: FIG 2  
\\HALEYALDRICH.COM\SHARE\PROJECTS\135214-001\2021-0113 DUE DILIGENCE LETTER\CAD\135214\_001\_0002 SITE PLAN.DWG



**LEGEND**

- TP21-2  DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT EXCAVATED BY JAMES W. FLETT CO., INC. OF BELMONT, MA AND OBSERVED BY HALEY & ALDRICH, INC. BETWEEN 7 DECEMBER AND 8 DECEMBER 2021.
- TP21-1  DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT EXCAVATED BY JAMES W. FLETT CO., INC. OF BELMONT, MA AND OBSERVED AND TESTED FOR GUELPH PERMEAMETER TESTING BY HALEY & ALDRICH, INC. ON 8 DECEMBER 2021
- TP-4  DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT EXCAVATED BY NORFOLK SERVICES OF STOUGHTON, MA AND OBSERVED BY GEI CONSULTANTS, INC. BETWEEN 24 AND 25 APRIL 2000.
-  APPROXIMATE LIMITS OF DEMOLISHED STRUCTURE

**NOTES**

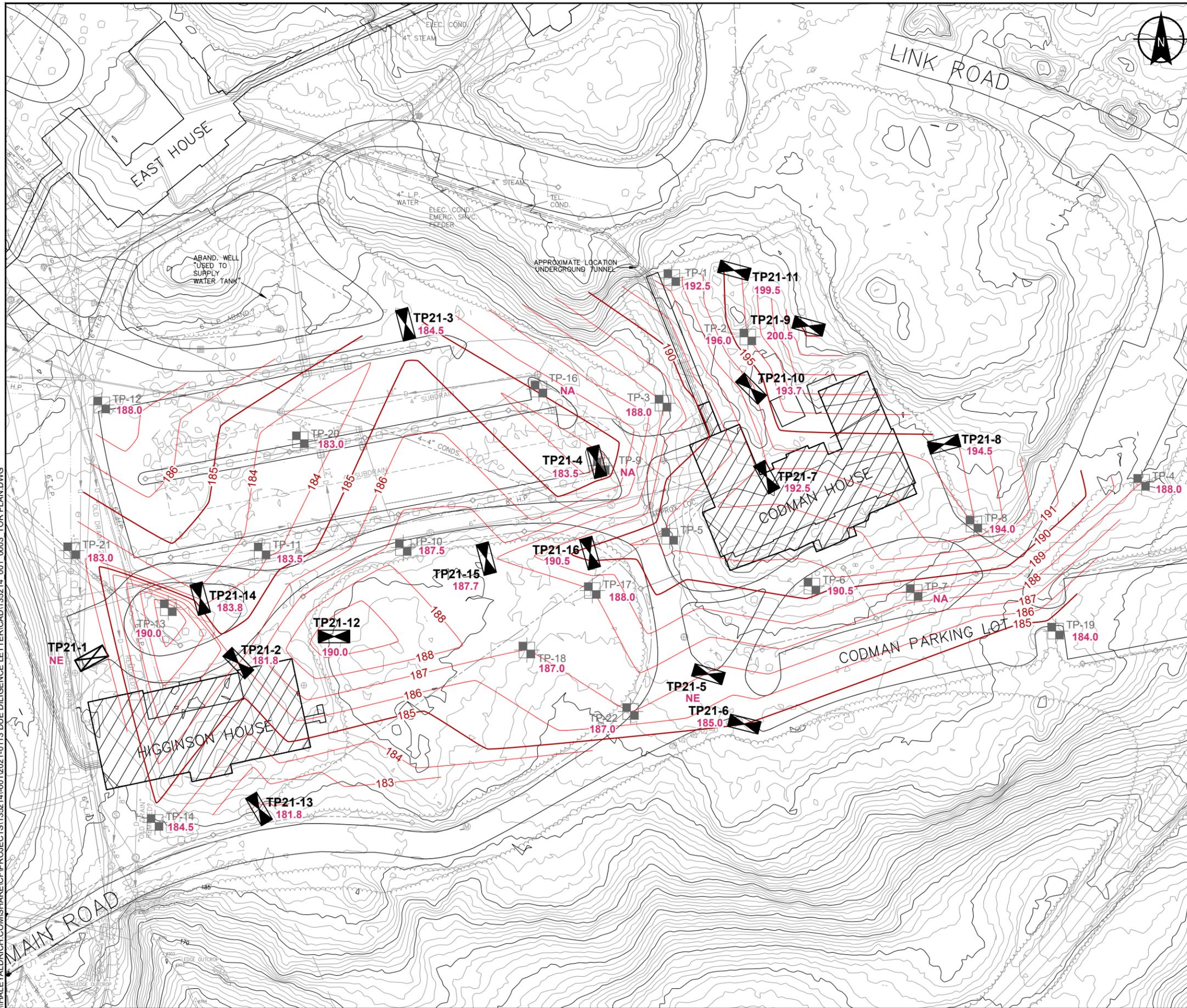
1. BASE PLAN TAKEN FROM AN ELECTRONIC FILE TITLED "13555.05\_EX-COMPILED.dwg", PROVIDED BY VANASSE HANGEN BRUSTLIN, INC. (VHB) ON 2 DECEMBER 2021.
2. 2020 TEST PIT LOCATIONS TAKEN FROM ELECTRONIC CAD IMAGE ENTITLED "SITE PLAN" DATED MAY 2000 FROM GEI CONSULTANTS OF CAMBRIDGE, MASSACHUSETTS.
3. LOCATIONS OF TEST PITS ARE APPROXIMATE.



**HALEY ALDRICH**  
MCLEAN HOSPITAL  
NEW CHILD AND ADOLESCENT CAMPUS AND  
EAST HOUSE ADDITION  
115 MILL STREET  
BELMONT, MASSACHUSETTS  
**SITE AND SUBSURFACE  
EXPLORATION LOCATION PLAN**

SCALE: AS SHOWN  
FEBRUARY 2022

**FIGURE 2**



**LEGEND**

- TP21-2** DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT EXCAVATED BY JAMES W. FLETT CO., INC. OF BELMONT, MA AND OBSERVED BY HALEY & ALDRICH, INC. BETWEEN 7 DECEMBER AND 8 DECEMBER 2021.
- TP21-1** DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT EXCAVATED BY JAMES W. FLETT CO., INC. OF BELMONT, MA AND OBSERVED AND TESTED FOR GUELPH PERMEAMETER TESTING BY HALEY & ALDRICH, INC. ON 8 DECEMBER 2021
- TP-4** DESIGNATION AND APPROXIMATE LOCATION OF TEST PIT EXCAVATED BY NORFOLK SERVICES OF STOUGHTON, MA AND OBSERVED BY GEI CONSULTANTS, INC. BETWEEN 24 AND 25 APRIL 2000.
- APPROXIMATE LIMITS OF DEMOLISHED STRUCTURE
- 188.0 TOP OF BEDROCK ELEVATION
- 190 — TOP OF ROCK CONTOUR MAJOR (5 FT. INTERVALS)
- — — TOP OF ROCK CONTOUR MINOR (1 FT. INTERVALS)
- NE NA NOT ENCOUNTERED; NOT AVAILABLE

**NOTES**

1. BASE PLAN TAKEN FROM AN ELECTRONIC FILE TITLED "13555.05\_EX-COMPILED.dwg", PROVIDED BY VANASSE HANGEN BRUSTLIN, INC. (VHB) ON 2 DECEMBER 2021.
2. 2020 TEST PIT LOCATIONS TAKEN FROM ELECTRONIC CAD IMAGE ENTITLED "SITE PLAN" DATED MAY 2000 FROM GEI CONSULTANTS OF CAMBRIDGE, MASSACHUSETTS.
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HALEY  
ALDRICH
 MCLEAN HOSPITAL  
 NEW CHILD AND ADOLESCENT CAMPUS AND  
 EAST HOUSE ADDITION  
 115 MILL STREET  
 BELMONT, MASSACHUSETTS

**TOP OF ROCK  
CONTOUR PLAN**

SCALE: AS SHOWN  
FEBRUARY 2022

**FIGURE 3**

## **APPENDIX A**

### **Test Pit Logs and Photographs**

# IDENTIFICATION AND DESCRIPTION OF SUBSURFACE MATERIALS

## SOIL

Soil description on logs of subsurface explorations are based on Standard Penetration Test results, visual-manual examination of exposed soil and soil samples, and the results of laboratory tests on selected samples. The criteria, descriptive terms and definitions are as follows:

### DENSITY OR CONSISTENCY

Density of Cohesionless Soils	Penetration Resistance (Blows per ft.)	Consistency of Cohesive Soils	Penetration Resistance (Blows per ft.)
Very Loose	0-4	Very Soft	0-2
Loose	5-10	Soft	3-4
Medium	11-30	Medium	5-8
Dense	31-50	Stiff	9-15
Very Dense	over 50	Very Stiff	16-30
		Hard	over 30

### PENETRATION RESISTANCE

Standard Penetration Test (ASTM D-1586) - Number of blows required to drive a standard 2 in. O.D. split spoon sampler 1 ft. with a 140 lb. weight falling freely through 30 in.

**COLOR:** Basic colors and combinations: black, brown, gray, yellow-brown, etc.

### SUPPLEMENTAL SOIL TERMINOLOGY:

Laminae	- 0 to 1/16 in. thick (cohesive)
Parting	- 0 to 1/16 in. thick (granular)
Seam	- 1/16 to 1/2 in. thick
Layer	- 1/2 to 12 in. thick
Stratum	- > 12 in. thick
Pocket	- Small, erratic deposit less than 12 in. size
Lens	- Lenticular deposit larger than a pocket
Occasional	- One or less per 12 in. of thickness
Frequent	- More than one per 12 in. of thickness
Interbedded	- Alternating soil layers of differing composition
Varved	- Alternating thin seams of silt and clay
Mottled	- Variation of color

### GEOLOGIC INTERPRETATION

Deposit type - GLACIAL TILL, ALLUVIUM, FILL.....

The natural soils are identified by criteria of Unified Soil Classification System (USCS), with appropriate group symbol in parenthesis for each soil description. Fill materials may not be classified by USCS criteria.

## ROCK

Rock descriptions noted on logs of subsurface explorations are based on visual-manual examination of exposed rock outcrops and core samples. The criteria, descriptive terms and definitions used are as follows:

**FIELD HARDNESS:** A measure of resistance to scratching.

Very Hard	Cannot be scratched with a knife point or sharp pick.
Hard	Can be scratched with a knife point or sharp pick, only with difficulty.
Moderately Hard	Can be readily scratched with a knife point or pick.
Medium Hard	Can be grooved or gouged 1/16 in. deep with firm pressure on a knife point or sharp pick.
Soft	Can be grooved or gouged easily with a knife point or pick.
Very Soft	Can be carved with a knife and excavated with a pick point.

### DISCONTINUITIES:

Type	Definition
Joint	A natural fracture along which no displacement has occurred. May occur in parallel groups called sets.
Shear	A natural fracture along which displacement has occurred. Surface may be slickensided or striated.
Fault	A natural fracture along which displacement has occurred. Usually lined with gouge and slickensides.
Shear or Fault Zone	Zone of fractured rock and gouge bordering the displacement plane.

### ORIENTATION/ATTITUDE:

Term	Angle (degrees)
Horizontal	0-5
Low Angle	6-35
Moderately Dipping	36-55
High Angle	56-85
Vertical	86-100

### SPACING:

Discontinuity Term	Bedding Term	Inches
Extremely Close	Extremely Thin	< 3/4
Very Close	Very Thin	3/4 - 2.5
Close	Thin	2.5 - 8
Moderate	Medium	8 - 24
Wide	Thick	24 - 80
Very Wide	Very Thick	80 - 240
Extremely Wide	Extremely Thick	> 240

### PERSISTENCE/CONTINUITY:

Term	Feet	Term	Distance
Very Low	0-3	Very Tight	< 0.1mm
Low	3-10	Tight	0.1mm-0.25mm
Medium	10-35	Partly Open	0.25mm-0.5mm
High	35-65	Open	0.5mm-2.5mm
Very High	> 65	Moderately Wide	2.5mm-1cm
		Wide	> 1cm
		Very Wide	1cm-10cm
		Extremely Wide	10cm-1m
		Cavernous	> 1m

### APERTURE/GAP:

### POROSITY:

**Type**  
Primary:  
Pre-depositional and depositional inter- and intra- granular, particle, or crystalline pores.

Secondary:  
Solution features including pits, vugs, caverns, molds, and channels.  
Fracture features including joints, shears, faults, shrinkage and breccia fabrics.

Term	Size
Micro	< 0.0625 mm
Meso	0.0625-4.0 mm
Mega	4.0-256 mm

U.S. Standard Series Sieve				Clear Square Sieve Openings			
12"	3"	3/4"		4	10	40	200
Boulders	Cobbles	Gravel		Sand			Silts and Clays
		Coarse	Fine	Coarse	Medium	Fine	
305 mm	76 mm	19 mm	4.75 mm	2.00 mm	0.43 mm	0.074 mm	

## UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		Group Symbol	Graphic Symbol	TYPICAL NAMES	
Coarse grained soils: more than half is larger than number 200 sieve	Gravels More than half of coarse fraction is larger than number 4 sieve	GW		Well graded gravels, gravel-sand mixtures	
		GP		Poorly graded gravels, gravel-sand mixtures	
		GM		Silty gravels, poorly graded gravel-sand-silt mixtures	
		GC		Clayey gravels, poorly graded gravel-sand-clay mixtures	
	Sands More than half of coarse fraction is smaller than number 4 sieve	Sands with little or no fines	SW		Well graded sands, gravelly sands
			SP		Poorly graded sands, gravelly sands
		Sands with over 12% fines	SM		Silty sands, poorly graded sand-silt mixtures
			SC		Clayey sands, poorly graded sand-clay mixtures
Fined-grained soils: more than half smaller than number 200 sieve	Silts and Clays Liquid limit 50% or less	ML		Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity	
		CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		OL		Organic clays and organic silty clays of low plasticity	
	Silts and Clays Liquid limit greater than 50%	MH		Inorganic silty, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		CH		Inorganic clays of high plasticity, fat clays	
		OH		Organic clays of medium to high plasticity, organic silts	
Highly organic soils		PT		Peat and other highly organic soils	

### GENERAL NOTES

- Logs of subsurface explorations depict soil, rock and groundwater conditions only at the locations specified on the dates indicated. Subsurface conditions may vary at other locations and at other times.
- Water levels noted on the logs were measured at the times and under the conditions indicated. During test borings, these water levels could have been affected by the introduction of water into the borehole, extraction of tools on other procedures and thus may not reflect actual groundwater level at the test boring location. Groundwater level fluctuations may also occur as a result of variations in precipitation, temperature, season, tides, adjacent construction activities and pumping of water supply wells and construction dewatering systems.

**WEATHERING:** The action of organic and inorganic and chemical and physical processes resulting in alteration of color, texture and composition.

Fresh-FR	No visible sign of alteration, except perhaps slight discoloration on major discontinuity surfaces.
Slight-SL	Discoloration of rock material and discontinuity surfaces. All rock may be discolored and/or somewhat weaker than in its fresh condition.
Moderate-MOD	Less than half the rock material is decomposed and/or disintegrated to a soil. Some fresh or discolored rock is present as either a continuous framework or as corestones.
High-HIGH	More than half the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present as either a discontinuous framework or as corestones.
Complete-COMP	All rock material is decomposed and/or disintegrated to soil. The original mass structure is largely intact.
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There has been a large change of volume, but the material has not been significantly transported.

**COLOR:** Basic colors and combinations: gray, light gray, brown, red-brown.

**TEXTURE:** Size, shape and arrangements of constituents.

Term	Size	
	Igneous	Sedimentary
Coarse-grained	> 5 mm	> 2 mm
Medium-grained	1 - 5 mm	0.625 - 2 mm
Fine-grained	< 1 mm	< 0.625 mm
Aphanitic	Individual grains invisible to the unaided eye.	

**LITHOLOGY:** Rock classification and modifiers; accepted formation names.

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SUBSURFACE EXPLORATION KEY

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 8 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 190.0 (est.)  
**El. Datum:** NAVD88

**Location:** See Plan

**Groundwater depths/entry rates (in./min.):** Groundwater encountered at approximately 6.4 ft bgs

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests				
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0		189.7 0.3	SP	-ASPHALT- Yellow-brown to brown poorly-graded SAND with gravel (SW), no structure, no odor, dry, 10% oversized  -FILL-	10	10	-	10	70	-				
2		187.0 3.0	SM	Red-brown to gray-brown silty SAND with gravel (SM), no structure, no odor, dry to wet, 5% oversized  -GLACIAL TILL-  Note: Infiltration permeability (Guelph) test performed at approximately 4 ft bgs.	-	10	-	15	55	20				
4														
6														
8														
10		180.0 10.0		Note: Bedrock was not encountered or observed during the excavation.  BOTTOM OF EXPLORATION AT 10.0 FT BGS										

**Obstructions:** -

**Remarks:** -

**Field Tests**

Dilatancy R - Rapid S - Slow N - None  
 Toughness L - Low M - Medium H - High  
 Plasticity N - Nonplastic L - Low M - Medium H - High  
 Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

at depth 6.4 ft  
 measured after - hours elapsed

**Boulders**

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 8.0 X 4.5  
 Pit Depth (ft) 10.0

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**



# TEST PIT LOG

Test Pit No. TP21-2

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 7 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 190.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Groundwater encountered at 7.2 ft bgs  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		189.5 0.5	SP-SM	Dark brown to light brown poorly-graded SAND with silt and gravel (SP-SM), dry	15	-	15	15	45	10								
				-FILL-														
2				Note: PVC pipe was observed at approximately 2 ft bgs.														
		187.0 3.0	ML	Light gray sandy SILT (ML), dry, 0% oversized	-	10	-	20	35	35								
4		186.0 4.0	SM	Brown silty SAND with gravel (SM), no odor, dry to wet, 10-20% oversized, 10% brick and concrete	5	10	5	20	25	35								
				-FILL-														
6				Note: Top of bedrock was observed at approximately 4 ft bgs. The top of an old concrete slab foundation was observed at the top of rock elevation. Test pit advanced down adjacent to concrete slab until refusal at approximately 7.4 ft bgs.														
		182.6 7.4		BOTTOM OF EXPLORATION AT 7.4 FT BGS														

**Obstructions:** PVC pipe

**Remarks:** -

**Field Tests**

Dilatancy      R - Rapid    S - Slow    N - None  
Toughness      L - Low    M - Medium    H - High  
Plasticity      N - Nonplastic    L - Low    M - Medium    H - High  
Dry Strength    N - None    L - Low    M - Medium    H - High    V - Very High

**Standing Water in Completed Pit**

at depth      7.2      ft  
measured after    0.25      hours elapsed

**Boulders**

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 25.0 X 4.0  
Pit Depth (ft) 7.4

**NOTE:** Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

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**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 8 Dec 2021  
**Weather** Cloudy, 40°

**Ground El.:** 191.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Groundwater encountered at 3.5 ft bgs  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		190.5 0.5	SM	Brown silty SAND with gravel (SM), no structure, no odor, dry to moist, 5% oversized	10	10	10	25	25	20								
1				-FILL-														
2																		
3		188.0 3.0	SP	Black poorly-graded SAND with gravel (SP), no structure, no odor, possible ash/cinder used as fill	10	20	-	60	10	-								
		187.5 3.5	OL/OH	Light gray sandy ORGANIC SOIL with gravel (OL/OH), no structure, slight organic odor, moist	10	10	-	20	60	-								
4		187.0 4.0	SM	-ORGANIC SOILS- Dark brown silty SAND with gravel (SM), no structure, no odor, wet, 50% oversized														
5				-GLACIAL TILL-														
6		184.5 6.5		Note: Excavator refusal on suspected bedrock at approximately 6.5 ft bgs. BOTTOM OF EXPLORATION AT 6.5 FT BGS														

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	3.5	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft)	11.0 X 4.5
measured after	0.25	hours elapsed	12 to 24	-	= -	Pit Depth (ft)	6.5
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. **TP21-4**

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 7 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 192.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		191.5 0.5	SP	Brown to yellow-brown poorly-graded SAND with gravel (SP), no structure, no odor, dry, 0% oversized  -FILL-	-	15	-	20	60	5								
2		190.0 2.0	GP-GM	Black poorly-graded GRAVEL with silt and sand (GP-GM), no structure, no odor, dry, asphalt used as fill  -FILL-	30	30	-	-	40	-								
4																		
6		187.0 5.0	ML	Light gray sandy SILT with gravel (ML), no structure, no odor, dry, 5% oversized  -GLACIAL TILL-	10	-	-	10	30	50								
8		183.5 8.5		BOTTOM OF EXPLORATION AT 8.5 FT BGS														

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft)	8.0 X 4.5
measured after	-	hours elapsed	12 to 24	-	=	Pit Depth (ft)	8.5
			over 24	-	=		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. TP21-5

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 8 Dec 2021  
**Weather** Cloudy, 40°

**Ground El.:** 193.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Groundwater encountered at 4.0 ft bgs  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		192.5 0.5	SM	Dark brown silty SAND with gravel (SM), no structure, no odor, dry	-	20	-	15	50	15								
1				-FILL-														
		190.5 2.5	ML	Red-brown sandy SILT (ML), no structure, no odor, dry to moist	-	-	-	10	20	70								
3				-FILL-														
		188.5 4.5	ML	Light gray sandy SILT with gravel (ML), no structure, no odor, dry to moist	10	-	-	10	35	45								
5				-GLACIAL TILL-														
6		186.8 6.2		Note: Excavator refusal on suspected bedrock at approximately 6.2 ft bgs. BOTTOM OF EXPLORATION AT 6.2 FT BGS														

Obstructions: -

Remarks: -

**Field Tests**

Dilatancy      R - Rapid    S - Slow    N - None  
Toughness      L - Low    M - Medium    H - High  
Plasticity      N - Nonplastic    L - Low    M - Medium    H - High  
Dry Strength    N - None    L - Low    M - Medium    H - High    V - Very High

**Standing Water in Completed Pit**

at depth      4.0      ft  
measured after    0.25      hours elapsed

**Boulders**

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 8.0 X 4.5  
Pit Depth (ft) 6.2

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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**TEST PIT LOG**

**Test Pit No. TP21-6**

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 8 Dec 2021  
**Weather** Cloudy, 40°

**Ground El.:** 193.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Groundwater encountered at 7.8 ft bgs  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0		192.7 0.3		-TOPSOIL-														
			SW-SM	Gray to dark brown well-graded SAND with silt and gravel (SW-SM), no structure, no odor, dry, 5% oversized	5	10	20	30	20	15								
				-FILL-														
2																		
4		189.0 4.0	ML	Red-brown to light gray gravelly SILT with sand (ML), no structure, no odor, moist to wet, 10% oversized	5	10	20	30	20	15								
				-GLACIAL TILL-														
6																		
8		185.0 8.0 184.5 8.5		-WEATHERED BEDROCK- Note: Excavation refusal on suspected bedrock at approximately 8.5 ft bgs.														
				BOTTOM OF EXPLORATION AT 8.5 FT BGS														

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft)	11.0 X 4.5
measured after	-	hours elapsed	12 to 24	-	= -	Pit Depth (ft)	8.5
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. TP21-7

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 7 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 200.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-ASPHALT/TOPSOIL-														
		199.5 0.5	SW	Brown well-graded SAND with gravel (SW), no structure, no odor, dry, 25% oversized	20	10	20	20	30	-								
2				-FILL-														
4				Note: A segment of a former concrete foundation was encountered at approximately 3 ft bgs.														
6		192.5 7.5		Note: Excavation refusal on suspected bedrock at approximately 7.5 ft bgs.														
				BOTTOM OF EXPLORATION AT 7.5 FT BGS														

**Obstructions:** Former concrete building foundation

**Remarks:** -

**Field Tests**

Dilatancy      R - Rapid    S - Slow    N - None  
Toughness      L - Low    M - Medium    H - High  
Plasticity      N - Nonplastic    L - Low    M - Medium    H - High  
Dry Strength    N - None    L - Low    M - Medium    H - High    V - Very High

**Standing Water in Completed Pit**

at depth      NE      ft  
measured after      -      hours elapsed

**Boulders**

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 15.0 X 10.0  
Pit Depth (ft) 7.5

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. TP21-8

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 7 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 200.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
199.5 0.5			SP	Yellow-brown poorly-graded SAND with gravel (SP), no structure, no odor, dry, 5% oversized	5	10	-	15	65	5								
1				-FILL-														
197.0 3.0			ML	Light gray sandy SILT with gravel (ML), no structure, no odor, dry, 10% oversized	10	5	-	5	20	60								
3				-GLACIAL TILL-														
194.5 5.5				Note: Approximately 2.5-ft diameter boulder was observed at approximately 5 ft bgs. Note: Excavation refusal on suspected bedrock at 5.5 ft bgs.														
5				BOTTOM OF EXPLORATION AT 5.5 FT BGS														

<b>Obstructions:</b> 2.5-ft diameter boulder	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft)	11.0 X 4.5
measured after	-	hours elapsed	12 to 24	-	= -	Pit Depth (ft)	5.5
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. TP21-9

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 7 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 205.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		204.5 0.5	ML	Brown to light brown sandy SILT (ML), no structure, no odor, dry  -LOESS DEPOSITS-	5	5	5	10	20	55								
1																		
2																		
3																		
		201.5 3.5	ML	Light gray sandy SILT with gravel (ML), no structure, no odor, dry  -GLACIAL TILL-	15	5	-	10	20	50								
4				Note: Excavation refusal on suspected bedrock at approximately 4.5 ft bgs.														
		200.5 4.5		BOTTOM OF EXPLORATION AT 4.5 FT BGS														

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft) 11.0 X 4.5	
measured after	-	hours elapsed	12 to 24	-	= -	Pit Depth (ft) 4.5	
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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HA-TP07-1.GDT

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HA TESTPIT-09.R1



# TEST PIT LOG

Test Pit No. TP21-10

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 8 Dec 2021  
**Weather** Cloudy, 40°

**Ground El.:** 200.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests				
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength
0		199.7 0.3		-TOPSOIL- Dark brown poorly-graded SAND with silt and gravel (SP-SM), no structure, no odor, 20% oversized	20	-	20	30	20	10				
1				-FILL-										
2		197.7 2.3	ML	Red-brown to light brown sandy SILT with gravel (ML) no structure, no odor, dry, 0% oversized	10	10	5	15	20	40				
3				-LOESS DEPOSITS-										
4														
5		195.3 4.7	ML	Light gray sandy SILT with gravel (ML), no structure, no odor, dry to moist	10	10	5	15	20	40				
6		193.7 6.3		-GLACIAL TILL-  Note: Excavation refusal on suspected bedrock at approximately 6.3 ft bgs.										
				BOTTOM OF EXPLORATION AT 6.3 FT BGS										

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft)	11.0 X 4.5
measured after	-	hours elapsed	12 to 24	-	= -	Pit Depth (ft)	6.3
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. TP21-11

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 8 Dec 2021  
**Weather** Cloudy, 40°

**Ground El.:** 203.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		202.5 0.5	SM	Dark brown silty SAND (SM), no structure, no odor, dry  -FILL-	-	10	-	-	60	30								
2		201.0 2.0	SM	Brown to light brown silty SAND with gravel (SM), no structure, no odor, dry  -GLACIAL TILL-	15	-	10	5	40	30								
4																		
6																		
		195.5 7.5		Note: Excavation refusal on suspected bedrock at approximately 7.5 ft bgs.  BOTTOM OF EXPLORATION AT 7.5 FT BGS														

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft)	11.0 X 4.5
measured after	-	hours elapsed	12 to 24	-	= -	Pit Depth (ft)	7.5
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

25-Jan-22

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PLOG-HA-LIB09-BGS STANDARD ONLY.GLB

HA TESTPIT-09.R1



# TEST PIT LOG

Test Pit No. TP21-12

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 7 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 195.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		194.7 0.3	ML	Yellow-brown to red-brown sandy SILT with gravel (ML), no structure, no odor, dry	10	10	-	10	20	50								
1				-LOESS DEPOSITS-														
2																		
3		192.0 3.0	ML	Light gray sandy SILT with gravel (ML), no structure, no odor, dry, 10% oversized	15	-	-	20	25	40								
4				-GLACIAL TILL-														
5		190.0 5.0		Note: Excavation refusal on suspected bedrock at approximately 5 ft bgs. BOTTOM OF EXPLORATION AT 5.0 FT BGS														

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>			
		Dilatancy	R - Rapid	S - Slow	N - None
		Toughness	L - Low	M - Medium	H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High		
		Dry Strength	N - None L - Low M - Medium H - High V - Very High		

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft)	9.0 X 4.5
measured after	-	hours elapsed	12 to 24	-	= -	Pit Depth (ft)	5.0
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. **TP21-13**

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 8 Dec 2021  
**Weather** Cloudy, 40°

**Ground El.:** 190.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests						
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength		
0		189.7 0.3		-TOPSOIL- Dark brown to light brown poorly-graded SAND with gravel (SP), no structure, no odor, dry, 0% oversized	15	-	-	25	55	5						
				-FILL-												
2		187.0 3.0	ML	Red-brown SILT with sand and gravel (ML), no structure, no odor, dry -LOESS DEPOSITS-	15	-	-	25	55	5						
4		185.0 5.0	ML	Light gray sandy SILT with gravel (ML), no structure, no odor, dry, 5% oversized -GLACIAL TILL-	15	-	15	-	30	40						
6																
8		181.8 8.2		Note: Excavation refusal on suspected bedrock at approximately 8.2 ft bgs. BOTTOM OF EXPLORATION AT 8.2 FT BGS												

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft) 12.0 X 4.5	
measured after	-	hours elapsed	12 to 24	-	= -	Pit Depth (ft) 8.2	
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. TP21-14

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 9 Dec 2021  
**Weather**

**Ground El.:** 191.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Groundwater encountered at 7.2 ft bgs  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		190.3 0.7	SP	Light gray to dark brown poorly-graded SAND with gravel (SP), no structure, no odor, dry, 0% oversized	10	10	-	25	50	5								
				-FILL-														
2		189.0 2.0	SM	Red-brown to yellow-brown silty SAND with gravel (SM), no structure, no odor, dry, 5% oversized	5	10	5	5	45	30								
				-LOESS DEPOSITS-														
4																		
		186.0 5.0	ML	Light gray sandy SILT with gravel (ML), no structure, no odor, dry, 10% oversized	10	-	-	10	30	50								
				-GLACIAL TILL-														
6				Note: Excavation refusal on suspected bedrock at approximately 7.2 ft bgs.														
		183.8 7.2		BOTTOM OF EXPLORATION AT 7.2 FT BGS														

<b>Obstructions:</b> -	<b>Remarks:</b> -	<b>Field Tests</b>	
		Dilatancy	R - Rapid S - Slow N - None
		Toughness	L - Low M - Medium H - High
		Plasticity	N - Nonplastic L - Low M - Medium H - High
		Dry Strength	N - None L - Low M - Medium H - High V - Very High

<b>Standing Water in Completed Pit</b>			<b>Boulders</b>			<b>Test Pit Dimensions (ft)</b>	
at depth	NE	ft	Diameter (in.)	Number	Approx. Vol. (cu.ft)	Pit Length x Width (ft)	14.0 X 4.5
measured after	-	hours elapsed	12 to 24	-	= -	Pit Depth (ft)	7.2
			over 24	-	= -		

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

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# TEST PIT LOG

Test Pit No. **TP21-15**

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 7 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 194.0 (est.)  
**El. Datum:** NAVD88

**Location:** See Plan

**Groundwater depths/entry rates (in./min.):** Groundwater encountered at 6.3 ft bgs

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
193.5 0.5			SP	Light brown silty SAND (SM), no structure, no odor, dry  -LOESS DEPOSITS-	10	10	-	20	60	-								
191.0 3.0			GM	Light gray sandy GRAVEL with silt (GM), no structure, no odor, dry to wet, 20% oversized  -GLACIAL TILL-	20	50	-	-	20	10								
187.8 6.3				Note: Excavation refusal on suspected bedrock at approximately 6.3 ft bgs.  BOTTOM OF EXPLORATION AT 6.3 FT BGS														

**Obstructions:** -

**Remarks:** -

**Field Tests**

Dilatancy R - Rapid S - Slow N - None  
Toughness L - Low M - Medium H - High  
Plasticity N - Nonplastic L - Low M - Medium H - High  
Dry Strength N - None L - Low M - Medium H - High V - Very High

**Standing Water in Completed Pit**

at depth NE ft  
measured after - hours elapsed

**Boulders**

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) ?? x ??  
Pit Depth (ft) 6.3

**NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.**

25-Jan-22

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# TEST PIT LOG

Test Pit No. TP21-16

**Project** McLean Hospital - New Child and Adolescent Campus and East House Addition  
**Location** 115 Mill Street, Bedmont, Massachusetts  
**Client** McLean Hospital  
**Contractor** James W. Flett Co., Inc.  
**Equipment Used** CAT M813

**File No.** 135214-001  
**H&A Rep** A. Briner  
**Date** 7 Dec 2021  
**Weather** Cloudy, 30°

**Ground El.:** 194.0 (est.)      **Location:** See Plan      **Groundwater depths/entry rates (in./min.):** Not Encountered  
**El. Datum:** NAVD88

Depth (ft)	Sample ID	Stratum Change Elev./Depth (ft)	USCS Symbol	VISUAL-MANUAL IDENTIFICATION AND DESCRIPTION (Color GROUP NAME & SYMBOL, % oversized, maximum particle size, structure, odor, moisture, optional descriptions GEOLOGIC INTERPRETATION)	Gravel		Sand			Field Tests								
					% Coarse	% Fine	% Coarse	% Medium	% Fine	% Fines	Dilatancy	Toughness	Plasticity	Strength				
0				-TOPSOIL-														
		193.5 0.5	SP-SM	Dark brown poorly-graded SAND with silt and gravel (SP-SM), no structure, no odor, dry	5	10	-	10	65	10								
1				-FILL-														
		192.5 1.5	SM	Yellow-brown silty SAND with gravel (SM), no structure, no odor, dry	20	-	-	20	60	-								
2				-LOESS DEPOSITS-														
3				Note: Excavation refusal on suspected bedrock at approximately 3.5 ft bgs.														
		190.5 3.5		BOTTOM OF EXPLORATION AT 3.5 FT BGS														

Obstructions: -

Remarks: -

**Field Tests**

Dilatancy      R - Rapid    S - Slow    N - None  
Toughness      L - Low    M - Medium    H - High  
Plasticity      N - Nonplastic    L - Low    M - Medium    H - High  
Dry Strength    N - None    L - Low    M - Medium    H - High    V - Very High

**Standing Water in Completed Pit**

at depth      NE      ft  
measured after    -      hours elapsed

**Boulders**

Diameter (in.)	Number	Approx. Vol. (cu.ft)
12 to 24	-	= -
over 24	-	= -

**Test Pit Dimensions (ft)**

Pit Length x Width (ft) 10.0 X 4.5  
Pit Depth (ft) 3.5

NOTE: Soil identification based on visual-manual methods of the USCS system as practiced by Haley & Aldrich, Inc.

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McLean Hospital Campus  
Belmont, Massachusetts  
File No. 135214-001  
Date Photographs Taken: 7 and 8 December 2021

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*Photo 1: Image of TP21-2, looking west.*



*Photo 2: Image of urban fill in TP21-2, looking south*



*Photo 3: Image of TP21-2, looking east*



*Photo 4: Former concrete foundation observed in TP21-2, looking south.*



*Photo 5: Image of TP21-3, looking east.*



*Photo 6: Image of TP21-3, looking east.*

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*Photo 7: Image of TP21-3, looking southeast.*



*Photo 8: Image of TP21-4, looking north.*



*Photo 9: Image of TP21-4, looking east.*



*Photo 10: Image of TP21-5, looking east.*



*Photo 11: Image of TP21-5, looking north.*



*Photo 12: Image of TP21-5, looking northwest.*

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*Photo 13: Image of TP21-6, looking west.*



*Photo 14: TP21-6, looking south.*



*Photo 15: Image of TP21-6, looking south.*



*Photo 16: Image of TP21-6, looking east.*



*Photo 17: Image of former concrete foundation element observed in TP21-7, looking west.*



*Photo 18: Image of former concrete foundation element observed in TP21-7, looking south.*

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*Photo 19: Image of TP21-8, looking east.*



*Photo 20: Image of TP21-8, looking west*



*Photo 21: Image of TP21-9, looking south.*



*Photo 22: Image of TP21-9, looking east.*



*Photo 23: Image of TP21-10, looking north.*



*Photo 24: Image of TP21-10, looking southeast.*

McLean Hospital Campus  
Belmont, Massachusetts  
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*Photo 25: Image of TP21-12, looking east.*



*Photo 26: Image of TP21-12, looking southwest.*



*Photo 27: Image of TP21-14, looking east.*



*Photo 28: Image of TP21-14, looking south.*



*Photo 29: Image of TP21-15, looking north.*



*Photo 30: Image of TP21-15, looking west.*

McLean Hospital Campus

Belmont, Massachusetts

File No. 135214-001

Date Photographs Taken: 7 and 8 December 2021

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*Photo 31: Image of TP21-16, looking west.*



*Photo 32: Image of TP21-16, looking south.*

**Notes**

- Photos were taken by a Haley & Aldrich representative during the December 2021 test pit exploration program.
- Photos were generally taken at completion of the excavated test pit.
- Photos for TP21-1, TP21-11, and TP21-13 were omitted as photos were not taken.

**APPENDIX B**

**Guelph Permeameter Field Data**



## **APPENDIX C**

### **Soil Grain Size Distribution and Soil Texture Triangle**

Client:	Haley & Aldrich, Inc.		
Project:	McLeanHosp. - New Child/Adolescent & East House		
Location:	Belmont, MA	Project No:	GTX-314800
Boring ID:	TP21-1	Sample Type:	bag
Sample ID:	TP21-1_4.0-4.5	Test Date:	01/06/22
Depth:	4.0-4.5	Test Id:	647493
Test Comment:	---		
Visual Description:	Moist, olive gray silty sand		
Sample Comment:	Removed one unrepresentative 1" rock		

## USDA Textural Classification

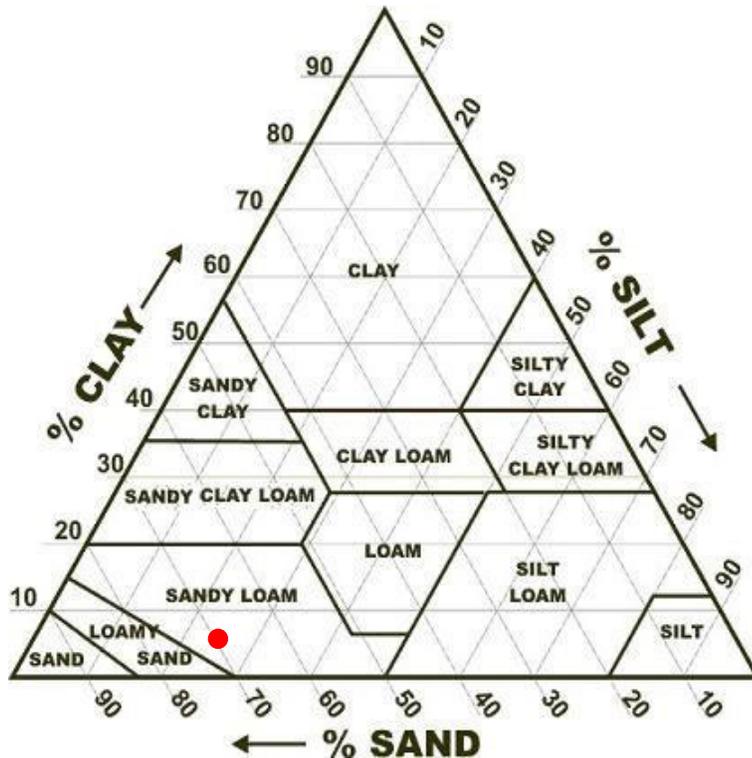
Boring ID	Sample ID	Depth	Sand, %	Silt, %	Clay, %	Classification
TP21-1	TP21-1_4.0-4.5	4.0-4.5	70	27	3	Sandy Loam

Classifications based only on material passing the #10 sieve

Sand: material passing 2.0 mm and retained on 0.05 mm diameter

Silt: material passing 0.05 mm and retained on 0.002 mm diameter

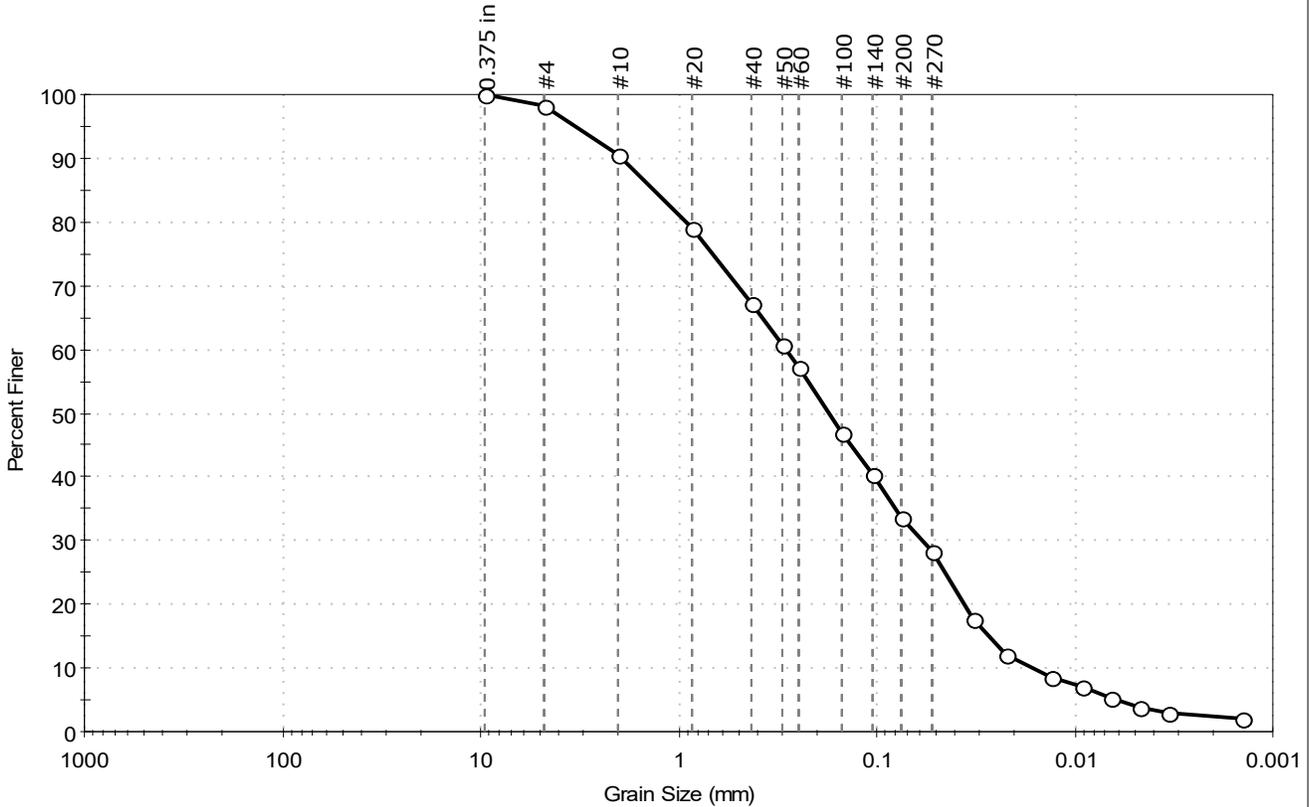
Clay: material passing 0.002 mm diameter





Client: Haley & Aldrich, Inc.  
 Project: McLeanHosp. - New Child/Adolescent & East House  
 Location: Belmont, MA Project No: GTX-314800  
 Boring ID: TP21-1 Sample Type: bag Tested By: ckg  
 Sample ID: TP21-1\_4.0-4.5 Test Date: 01/06/22 Checked By: bfs  
 Depth: 4.0-4.5 Test Id: 647491  
 Test Comment: ---  
 Visual Description: Moist, olive gray silty sand  
 Sample Comment: Removed one unrepresentative 1" rock

## Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	1.7	64.6	33.7

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.375 in	9.50	100		
#4	4.75	98		
#10	2.00	90		
#20	0.85	79		
#40	0.42	67		
#50	0.30	61		
#60	0.25	57		
#100	0.15	47		
#140	0.11	41		
#200	0.075	34		
#270	0.053	28		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0329	18		
---	0.0221	12		
---	0.0132	9		
---	0.0093	7		
---	0.0066	5		
---	0.0048	4		
---	0.0034	3		
---	0.0014	2		

**Coefficients**

D <sub>85</sub> = 1.3235 mm	D <sub>30</sub> = 0.0589 mm
D <sub>60</sub> = 0.2901 mm	D <sub>15</sub> = 0.0272 mm
D <sub>50</sub> = 0.1758 mm	D <sub>10</sub> = 0.0162 mm
C <sub>u</sub> = 17.907	C <sub>c</sub> = 0.738

**Classification**

ASTM N/A

AASHTO Silty Gravel and Sand (A-2-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

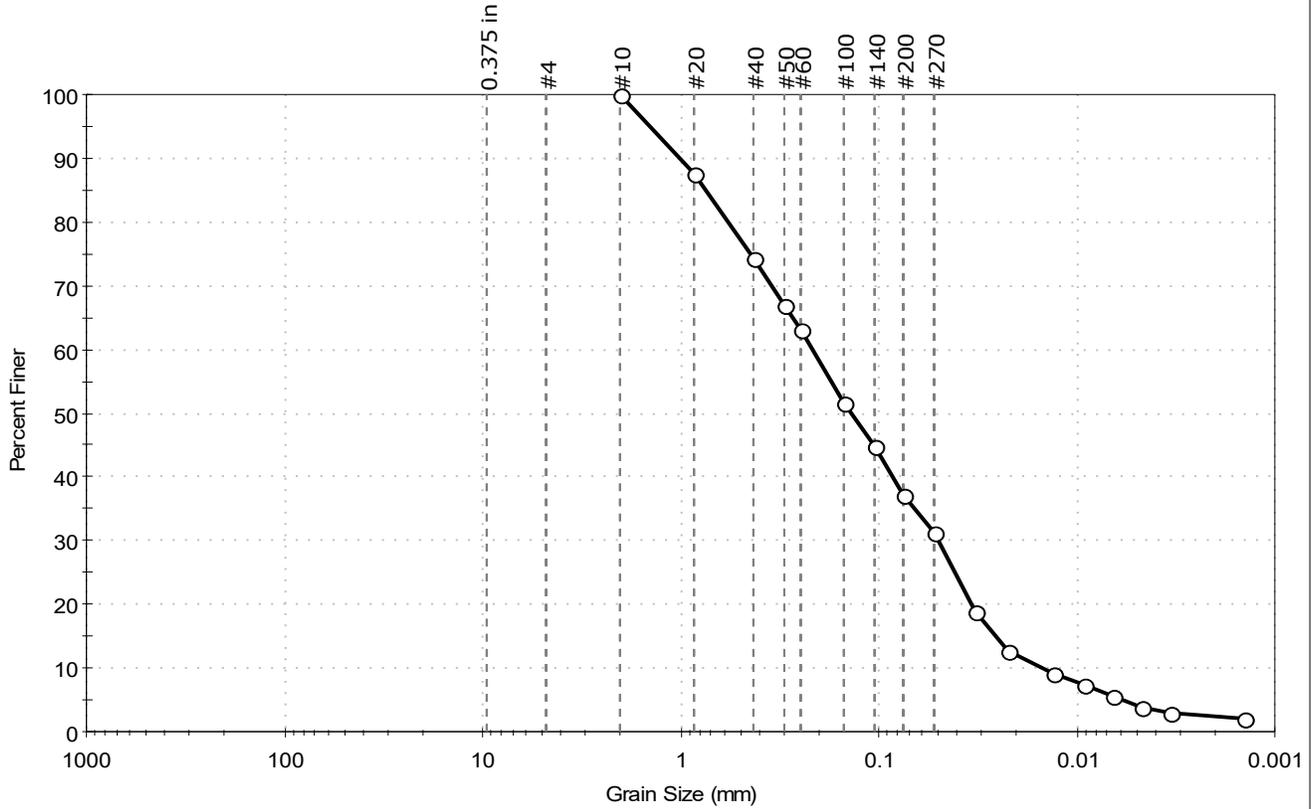
Est. Specific Gravity : 2.65

Separation of Sample: #270 Sieve



Client: Haley & Aldrich, Inc.  
 Project: McLeanHosp. - New Child/Adolescent & East House  
 Location: Belmont, MA Project No: GTX-314800  
 Boring ID: TP21-1 Sample Type: bag Tested By: ckg  
 Sample ID: TP21-1\_4.0-4.5 Test Date: 01/06/22 Checked By: bfs  
 Depth: 4.0-4.5 Test Id: 647491  
 Test Comment: Only minus No. 10 sieve for USDA classification  
 Visual Description: Moist, olive gray silty sand  
 Sample Comment: Removed one unrepresentative 1" rock

## Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	0.0	62.7	37.3

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
#10	2.00	100		
#20	0.85	88		
#40	0.42	74		
#50	0.30	67		
#60	0.25	63		
#100	0.15	52		
#140	0.11	45		
#200	0.075	37		
#270	0.053	31		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0329	19		
---	0.0221	13		
---	0.0132	9		
---	0.0093	8		
---	0.0066	6		
---	0.0048	4		
---	0.0034	3		
---	0.0014	2		

**Coefficients**

D <sub>85</sub> = 0.7429 mm	D <sub>30</sub> = 0.0503 mm
D <sub>60</sub> = 0.2169 mm	D <sub>15</sub> = 0.0254 mm
D <sub>50</sub> = 0.1375 mm	D <sub>10</sub> = 0.0146 mm
C <sub>u</sub> = 14.856	C <sub>c</sub> = 0.799

**Classification**

ASTM    N/A

AASHTO    Silty Soils (A-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR

Sand/Gravel Hardness : HARD

Dispersion Device : Apparatus A - Mech Mixer

Dispersion Period : 1 minute

Est. Specific Gravity : 2.65

Separation of Sample: #270 Sieve

Client:	Haley & Aldrich, Inc.		
Project:	McLeanHosp. - New Child/Adolescent & East House		
Location:	Belmont, MA	Project No:	GTX-314800
Boring ID:	TP21-3	Sample Type:	bag
Sample ID:	TP21-3_4.0-4.5	Test Date:	01/06/22
Depth:	4.0-4.5	Test Id:	647494
Test Comment:	---		
Visual Description:	Moist, olive silty sand with gravel		
Sample Comment:	---		

## USDA Textural Classification

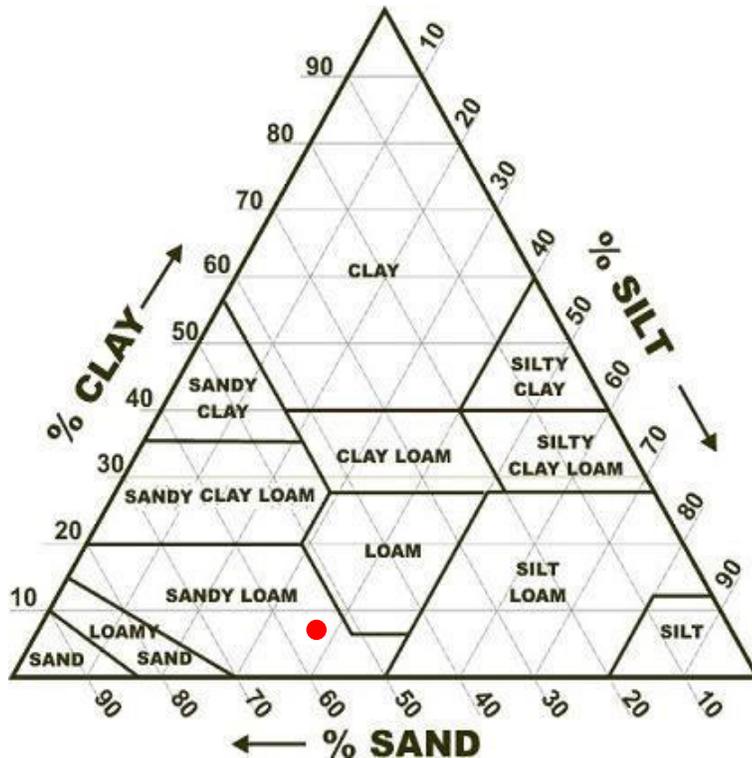
Boring ID	Sample ID	Depth	Sand, %	Silt, %	Clay, %	Classification
TP21-3	TP21-3_4.0-4.5	4.0-4.5	56	37	7	Sandy Loam

Classifications based only on material passing the #10 sieve

Sand: material passing 2.0 mm and retained on 0.05 mm diameter

Silt: material passing 0.05 mm and retained on 0.002 mm diameter

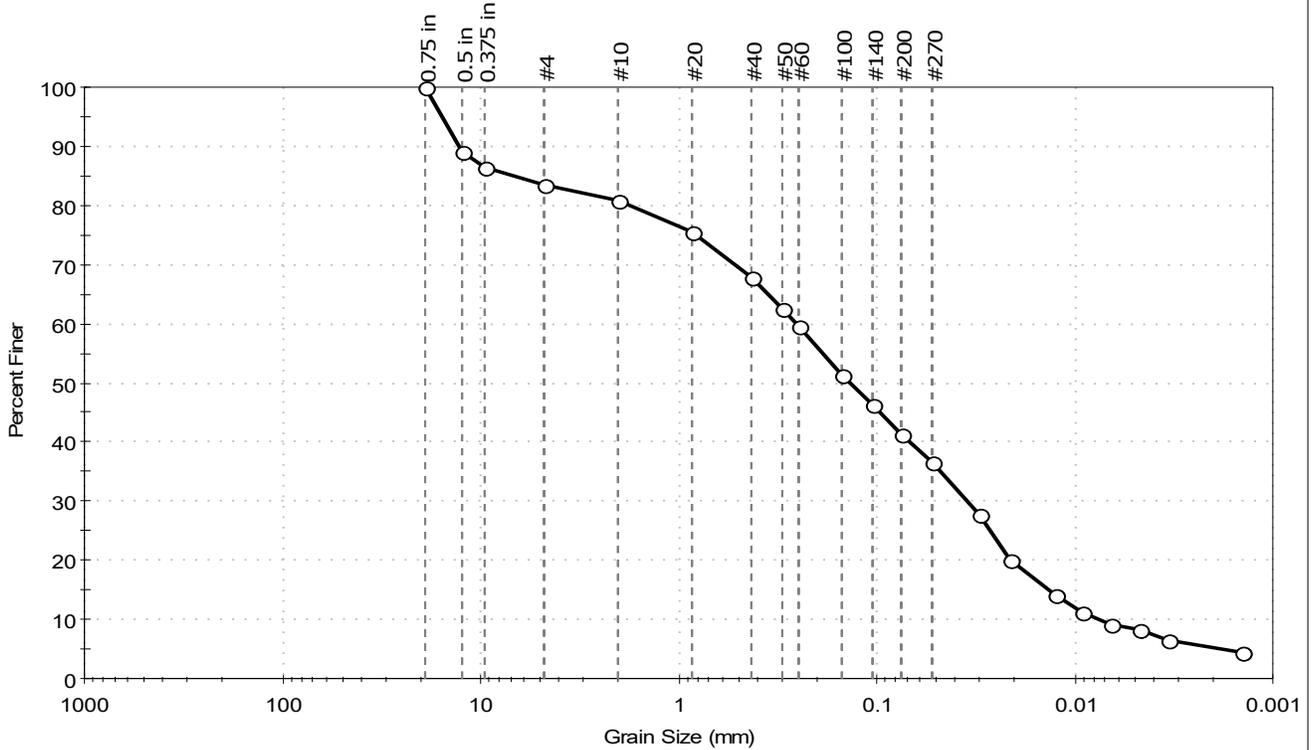
Clay: material passing 0.002 mm diameter





Client: Haley & Aldrich, Inc.  
 Project: McLeanHosp. - New Child/Adolescent & East House  
 Location: Belmont, MA  
 Project No: GTX-314800  
 Boring ID: TP21-3  
 Sample Type: bag  
 Tested By: ckg  
 Sample ID: TP21-3\_4.0-4.5  
 Test Date: 01/06/22  
 Checked By: bfs  
 Depth: 4.0-4.5  
 Test Id: 647492  
 Test Comment: ---  
 Visual Description: Moist, olive silty sand with gravel  
 Sample Comment: ---

## Particle Size Analysis - ASTM D6913/D7928



% Cobble	% Gravel	% Sand	% Silt & Clay Size
—	16.4	42.2	41.4

Sieve Name	Sieve Size, mm	Percent Finer	Spec. Percent	Complies
0.75 in	19.00	100		
0.5 in	12.50	89		
0.375 in	9.50	86		
#4	4.75	84		
#10	2.00	81		
#20	0.85	75		
#40	0.42	68		
#50	0.30	63		
#60	0.25	60		
#100	0.15	51		
#140	0.11	46		
#200	0.075	41		
#270	0.053	36		
Hydrometer	Particle Size (mm)	Percent Finer	Spec. Percent	Complies
---	0.0306	28		
---	0.0211	20		
---	0.0125	14		
---	0.0092	11		
---	0.0066	9		
---	0.0047	8		
---	0.0033	6		
---	0.0014	4		

**Coefficients**

D <sub>85</sub> = 6.6969 mm	D <sub>30</sub> = 0.0351 mm
D <sub>60</sub> = 0.2547 mm	D <sub>15</sub> = 0.0134 mm
D <sub>50</sub> = 0.1368 mm	D <sub>10</sub> = 0.0074 mm
C <sub>u</sub> = 34.419	C <sub>c</sub> = 0.654

**Classification**

<u>ASTM</u>	N/A
<u>AASHTO</u>	Silty Soils (A-4 (0))

**Sample/Test Description**

Sand/Gravel Particle Shape : ANGULAR  
 Sand/Gravel Hardness : HARD  
 Dispersion Device : Apparatus A - Mech Mixer  
 Dispersion Period : 1 minute  
 Est. Specific Gravity : 2.65  
 Separation of Sample: #270 Sieve



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## Appendix D: Standard 4 Computations and Supporting Information

- › Operation and Maintenance Plan and Long Term Pollution Prevention Plan
- › Water Quality Volume Calculations
- › TSS Removal Worksheets

# Operations and Maintenance Plan

# McLean Child and Adolescent Campus

115 Mill Street  
Belmont, MA

PREPARED FOR

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McLean Hospital  
115 Mill Street  
Belmont, MA 02478  
800.333.0338

PREPARED BY

---



260 Arsenal Place #2  
Watertown, MA 02472  
617.924.1770

Issued: December 13, 2024



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## Project Information

### Site

McLean Child and Adolescent Campus  
115 Mill Street  
Belmont, MA

### Proponent

McLean Hospital  
115 Mill Street  
Belmont, MA

### Site Supervisor

*(TBD... to be hired)*

Name: \_\_\_\_\_  
115 Mill Street  
Belmont, MA 02478

### Site Contact

Name: Jessica Tsymbal  
Telephone: 617.855.2617  
Email: jtsymbal@mgb.org

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## Section A: Source Control

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## A Source Control

A comprehensive source control program will be implemented at McLean Child and Adolescent Campus, which includes the following components:

- › Regular pavement sweeping in the private driveway and parking areas
- › Catch basin cleaning
- › Clearing litter from the parking area, islands, and perimeter landscape areas
- › Enclosure and regular maintenance of all dumpsters and storage areas
- › Spill Prevention training

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## Section B: Spill Prevention

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## Emergency Notification Phone Numbers

### 1. FACILITY MANAGER

Name: Jessica Tsymbol

Phone: 617.855.2617

Beeper/Cell: \_\_\_\_\_

Home Phone: \_\_\_\_\_

Alternate Contact: Sarah Augood

Phone: 617.855.2633

Beeper/Cell: \_\_\_\_\_

Home Phone: \_\_\_\_\_

### 2. FIRE & POLICE DEPARTMENT

Emergency: 911

### 3. CLEANUP CONTRACTOR

Address: \_\_\_\_\_

Phone: \_\_\_\_\_

### 4. MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION (DEP)

Emergency: (978) 694-3200

(Northeast Region)

24 Hour Spill/ 888-304-1133

Emergency Line: \_\_\_\_\_

### 5. NATIONAL RESPONSE CENTER

Phone: (800) 424-8802

Alternate: U.S. Environmental Protection Agency

Emergency: \_\_\_\_\_

Business: \_\_\_\_\_

### 6. BELMONT HEALTH DEPARTMENT

Phone: (617) 993-2720

Belmont Conservation Commission:

Phone: (617) 993-2667

## Hazardous Waste & Oil Spill Report

Date: \_\_\_\_\_ Time: \_\_\_\_\_ AM / PM

Exact location  
(Transformer #): \_\_\_\_\_

Type of equipment: \_\_\_\_\_ Make: \_\_\_\_\_ Size: \_\_\_\_\_

S / N: \_\_\_\_\_ Weather Conditions: \_\_\_\_\_

On or near water?  Yes  No If yes, name of body of water: \_\_\_\_\_

Type of chemical / oil spilled: \_\_\_\_\_

Amount of chemical / oil spilled: \_\_\_\_\_

Cause of spill: \_\_\_\_\_

Measures taken to  
contain or clean up spill: \_\_\_\_\_

Amount of chemical / oil recovered: \_\_\_\_\_ Method: \_\_\_\_\_

Material collected as a result of cleanup:

\_\_\_\_\_ drums containing \_\_\_\_\_

\_\_\_\_\_ drums containing \_\_\_\_\_

\_\_\_\_\_ drums containing \_\_\_\_\_

Location and method of debris disposal: \_\_\_\_\_

Name and address of any person, firm,  
or corporation suffering charges: \_\_\_\_\_

Procedures, method, and precautions  
instituted to prevent a similar occurrence  
from recurring: \_\_\_\_\_

Spill reported by General Office by: \_\_\_\_\_ Time: \_\_\_\_\_ AM / PM

Spill reported to DEP / National Response Center by: \_\_\_\_\_

DEP Date: \_\_\_\_\_ Time: \_\_\_\_\_ AM / PM Inspector: \_\_\_\_\_

NRC Date: \_\_\_\_\_ Time: \_\_\_\_\_ AM / PM Inspector: \_\_\_\_\_

Additional comments: \_\_\_\_\_

### B.3 Assessment – Initial Containment

The supervisor or manager will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.

Fire / Police Department:	<u>911</u>
Belmont Health Department:	<u>(617) 993-2720</u>
Belmont Conservation Commission:	<u>(617) 993-2667</u>

#### Emergency Response Equipment

The following equipment and materials shall be maintained at all times and stored in a secure area for long-term emergency response need.

Supplies	Quantity	Recommended Suppliers
› Sorbent Pillows/"Pigs"	2	<a href="http://www.newpig.com">http://www.newpig.com</a> Item # KIT276 — mobile container with two pigs
› Sorbent Boom/Sock	25 feet	<a href="http://www.forestry-suppliers.com">http://www.forestry-suppliers.com</a>
› Sorbent Pads	50	
› Lite-Dri® Absorbent	5 pounds	
› Shovel	1	Item # 33934 — Shovel (or equivalent)
› Pry Bar	1	Item # 43210 — Manhole cover pick (or equivalent)
› Goggles	1 pair	Item # 23334 — Goggles (or equivalent)
› Gloves – Heavy	1 pair	Item # 90926 — Gloves (or equivalent)

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## Section C: Snow Management

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## C Snow Management

### C.1 Snow Removal

Snow removal is handled in two stages. Low-volume storms will be plowed to on-site locations within parking lots or adjacent to the vehicular or pedestrian surfaces being cleared. Stored snow will not affect sight lines of vehicles entering or exiting the site. In addition:

- › Snow storage areas will be managed to prevent blockage of storm drain catch basins and stormwater drainage swales. Snow combined with sand and debris may block a storm drainage system, diminishing the infiltration capacity of the system and causing localized flooding.
- › Sand and debris deposited on vegetated or paved areas shall be cleared from the site and properly disposed of at the end of the snow season, no later than May 15.
- › Snow shall not be dumped into any waterbody, pond, or wetland resource area.

### C.2 Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

- › Standard deicing chemicals in granular and/or liquid form are permissible throughout the site including but not limited to sodium chloride, calcium chloride, and potassium chloride.
- › Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.
- › Sand and salt shall not be stockpiled on the site.

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## **Section D: Maintenance of Stormwater Management Systems**

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## D Maintenance of Stormwater Management Systems

### D.1 Pavement Systems

#### D.1.1 Standard Asphalt Pavement

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

- › Sweep or vacuum standard asphalt pavement areas at least four times per year and properly dispose of removed material.
- › Recommended sweeping schedule:
  - Oct/Nov
  - Feb/Mar
  - Apr/May
  - Aug/Sep
- › More frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.
- › Check loading docks and dumpster areas frequently for spillage and/or pavement staining and clean as necessary.

### D.2 Structural Stormwater Management Devices

#### D.2.1 Catch Basins

The proper removal of sediments and associated pollutants and trash occurs only when catch basin inlets and sumps are cleaned out regularly. The more frequent the cleaning, the less likely sediments will be re-suspended and subsequently discharged. In addition, frequent cleaning also results in more volume available for future deposition and enhances the overall performance. As noted in the pavement Operation and Maintenance (O&M) section, more frequent sweeping of paved surfaces will result in less accumulation in catch basins, less cleaning of subsurface structures, and less disposal costs.

There are catch basins throughout the McLean Child and Adolescent Campus. These catch basins are constructed with sumps (minimum 4 feet) and hooded outlets to trap debris, sediments, and floating contaminants. Disposal of all sediments must be in accordance with applicable local, state, and federal guidelines. A map of the catch basin locations is included in Section E.5 Maintenance Checklists and Device Location Maps.

### **Inspections and Cleaning**

- › All catch basins shall be inspected at least four times per year and cleaned a minimum of at least once per year.
- › Sediment (if more than six inches deep) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.
- › Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary
- › During colder periods, the catch basin grates must be kept free of snow and ice.
- › During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

## **D.2.2 Subsurface Detention Tank/Sand Filter**

The subsurface detention basins are used to detain roadway and rooftop runoff. There are four (4) subsurface detention tanks/sand filters at McLean Child and Adolescent Campus. Each detention tank contains a sand filter to treat the water quality volume. The sand filter consists a perforated subdrain covered by a layer of compacted gravel, filter fabric, and a layer of sand. To maintain functionality, the sand filter requires regular inspection and cleaning. A map of the subsurface detention tank/sand filter locations is included in Section E.5 Maintenance Checklists and Device Location Maps.

### **Inspections and Cleaning**

- › The subsurface detention tank/sand filter will be inspected after every major storm event for the first year and at least four times per year thereafter by removing the manhole/access port covers to check for sediment and debris accumulation.
- › Remove sediment if more than 6-inches has accumulated.
- › Any structural damage or other indication of malfunction will be reported to the site manager and repaired as necessary.
- › Outlet control structure shall be inspected and verified that no blockage has occurred.
- › Inspect sand for clogging by raking first inch of sand. Check for clogging at the inflow and outflow structures.
- › Replace Sand filter media as needed if it becomes clogged or over-compacted. Typically the top 2-3 inches of media may experience clogging. Stabilize any eroded areas.
- › System will be observed after ½" rainfalls to see if it is properly draining.

### D.2.3 Stormwater Outfalls

The stormwater drainage system at McLean Child and Adolescent Campus has two (2) outfall locations where treated stormwater is discharged. A map of these locations is included in Section E.5 Maintenance Checklists and Device Location Maps.

- › Inspect outfall locations monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- › Inspect outfalls annually after initial three-month period.
- › Annual inspections should be supplemented after large storms, when washouts may occur.
- › Maintain vegetation around outfalls to prevent blockages at the outfall.
- › Maintain rip rap pad below each outfall and replace any washouts.
- › Remove and dispose of any trash or debris at the outfall.

### D.2.4 Roof Drain Leader

Roof runoff from buildings and parking structures at McLean Child Adolescent Campus are directed to the stormwater collection system.

- › Perform routine roof inspections quarterly.
- › Keep roofs clean and free of debris.
- › Keep roof drainage systems clear.
- › Keep roof access limited to authorized personnel.
- › Clean inlets as necessary.

## D.3 Vegetated Areas Maintenance

Although not a structural component of the drainage system, the maintenance of vegetated areas may affect the functioning of the stormwater management system. This includes the health/density of vegetative cover and activities such as the application and disposal of lawn and garden care products, disposal of leaves and yard trimmings and proper aeration of soils.

- › Inspect planted areas on a semi-annual basis and remove any litter.
- › Maintain planted areas adjacent to pavement to prevent soil washout.
- › Remove any soil deposited on pavement.
- › Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.
- › Plant alternative mixture of grass species in the event of unsuccessful establishment.
- › The grass vegetation should be cut to a height between three and four inches.
- › Pesticide/Herbicide Usage – Pesticides should be limited to spot treatments if required for a specific control applications.

- › Fertilizer usage should be avoided. If deemed necessary, slow release fertilizer should be used. Fertilizer may be used to begin the establishment of vegetation in bare or damaged areas, but should not be applied on a regular basis unless necessary.
- › Annual application of compost amendments and aeration are recommended.
- › Pet waste provision if applicable.

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## Section E: Operations and Maintenance Plan Summary

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## E Operations and Maintenance Plan Summary

This Operation and Maintenance Plan has been prepared in accordance with the Stormwater Management Policy developed by the MassDEP. It specifies operational practices and drainage system maintenance requirements for the proposed development. Requirements should be adjusted by the site manager as necessary to ensure successful functioning of system components.

### E.1 Routine Maintenance Checklists

Routine required maintenance is described in Sections A – D. The following checklists are to be used by the property manager to implement and document the required maintenance and inspection tasks.

### E.2 Reporting and Documentation

The site supervisor shall be responsible for ensuring that the scheduled tasks as described in this plan are appropriately completed and recorded in the Maintenance Log. Accurate records of all inspections, routine maintenance and repairs shall be documented and kept onsite for a minimum of five years.

The Maintenance Log shall:

- › Document the completion of required maintenance tasks.
- › Identify the person responsible for the completion of tasks.
- › Identify any outstanding problems, malfunctions or inconsistencies identified during the course of routine maintenance.
- › Document specific repairs or replacements.

## E.3 Construction Practices Maintenance/ Evaluation Checklist

### McLean Child and Adolescent Campus – Belmont, MA

Best Management Practice	Inspection Frequency	Date Inspected	Inspector Initials	Minimum Maintenance and Key Items to Check	Cleaning or Repair Needed <input type="checkbox"/> Yes/No (List Items)	Date of Cleaning or Repair	Performed by:
Straw Bales/ Silt Fencing	In accordance with SWPPP			Inspect for deterioration or failure. Remove sediment when buildup exceeds half the bale or sock height.			
Gravel Construction Entrance	In accordance with SWPPP			Inspect for breakdown of crushed stone. Reapply stone if necessary to depths specified in construction documents.			
Catch Basin Protection	In accordance with SWPPP			Inspect for proper operation of catch basin. If clogged, dispose of sediment.			
Diversion Channels	In accordance with SWPPP			Check for erosion or breakout and proper function. Correct if necessary.			
Temporary Sedimentation Basins	In accordance with SWPPP			Inspect for proper function. Correct for cracking, erosion, breakout, sediment buildup, contaminants, or as necessary.			
Vegetative Slope Stabilization	In accordance with SWPPP			Inspect for erosion. Correct if necessary.			

Stormwater Control Manager: \_\_\_\_\_

## E.4 Long-term Maintenance/Evaluation Checklist

### McLean Child and Adolescent Campus – Belmont, MA

Best Management Practice	Minimum Maintenance and Key Items to Check	Inspection Frequency	Date Inspected	Inspector Initials	Cleaning Frequency	Cleaning or Repair Needed <input type="checkbox"/> Yes/No	Date of Cleaning or Repair	Performed by:
Street Sweeping	Sweeper	4X per year			4X per year* minimum			
Outfall Structures	Remove debris and excess vegetation, replace any dislodged riprap	1X per year			1X per year			
Deep Sump and Hooded Catch basins	Remove sediment 1X per year or if >6 inches	4X per year			1X per year or as necessary			
Subsurface Detention Tanks/Sand Filters	Remove sediment if >6 inches, examine outlet control structure, inspect sand for clogging, replace sand as needed	4X per year			1X per year or as necessary			
Roof Drains	Remove debris, clean inlets draining to subsurface bed	4x per year			2x per year inlet cleaning, roof debris as necessary			

\* Recommend sweeping Oct/Nov, Feb/Mar, Apr/May Jul/Aug with late winter most important

Stormwater Control Manager: \_\_\_\_\_

## **E.5 Maintenance Checklists and Device Location Maps**

These checklists are provided for the maintenance crew to photocopy and use when conducting inspections and cleaning activities to the stormwater management systems.

## Maintenance Checklists

---

**Catchbasins – Inspect 4 times per year, clean when sediment depth >6 inches or at least once per year.**

Catch Basin #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damage)
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	
_____				/ /	

**Outfalls – Inspect 4 times per year, replace any dislodged rip-rap, remove excess vegetation, remove any debris.**

Outfall	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damage)
OF 1				/ /	
OF 2				/ /	

**Subsurface Sand Filter Detention Tank – Inspect once per year, remove sediment if more than 6 inches has accumulated in sediment forebay.**

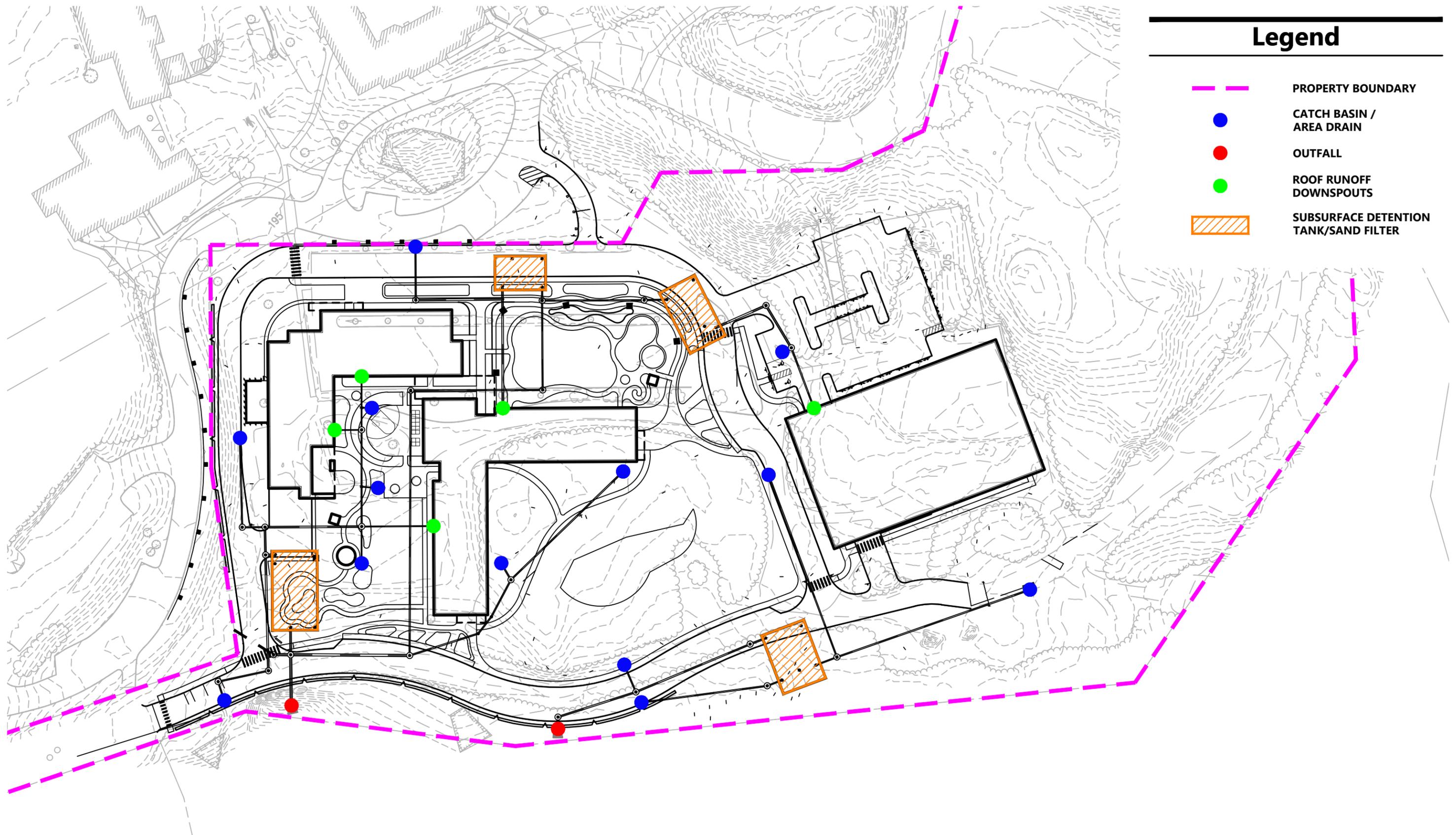
Basin	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damage)
SFD 1				/ /	
SFD 2				/ /	
SFD 3				/ /	
SFD 4				/ /	

**Roof Runoff Downspouts – Inspect roof drains monthly, clean inlets draining to the subsurface bed twice per year.**

Bldg #	Inspected (Y/N)	Sediment Depth (inches)	Cleaning needed (Y/N)	Date Cleaned	Comments (Trash, Oil, Pet waste, Lawn Debris, Damage)
Resi/PHP				/ /	
Pathways				/ /	
Arlington				/ /	
Garage				/ /	

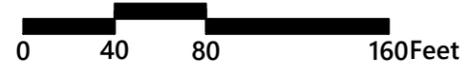
## Device Location Map

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### Legend

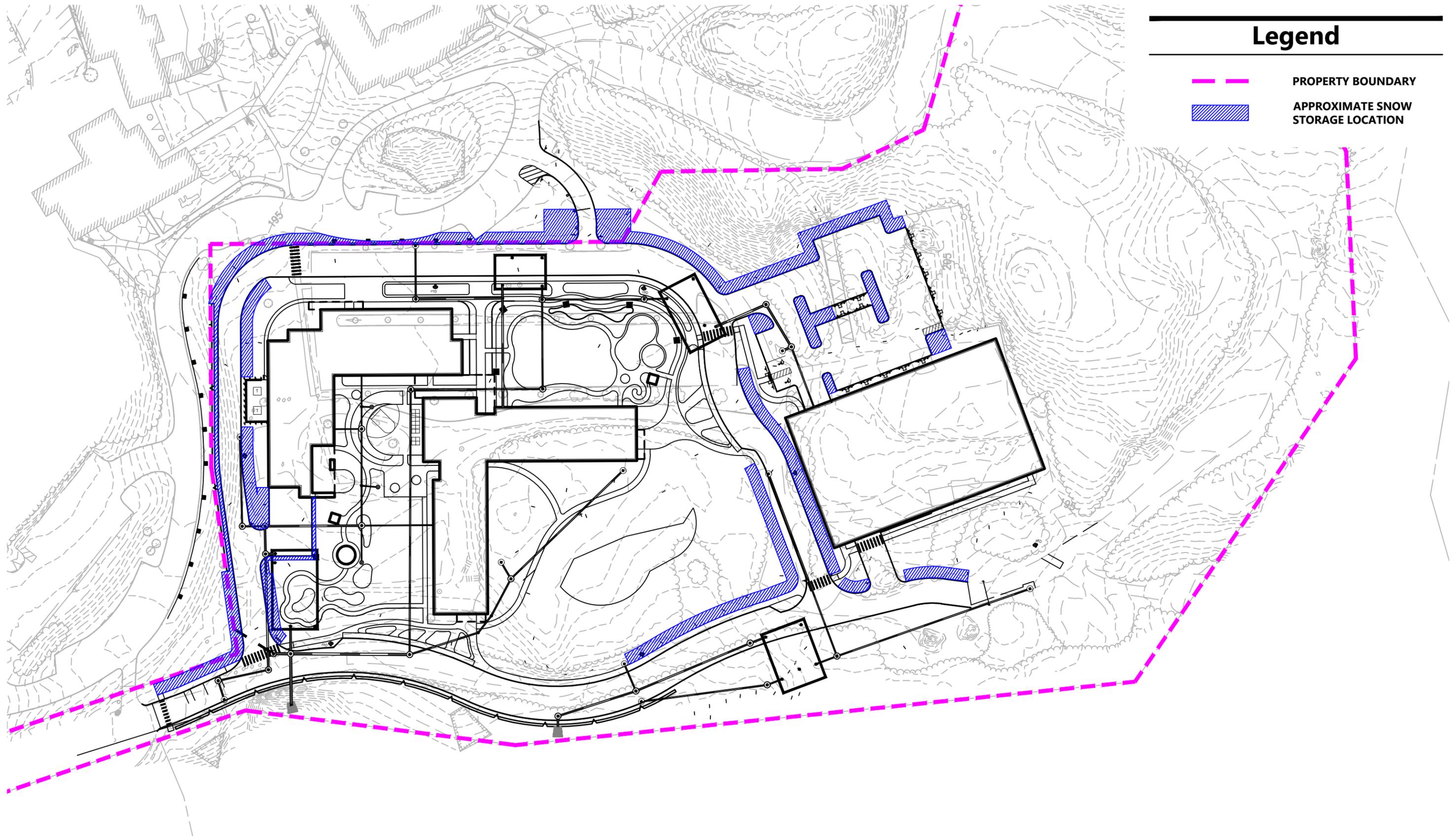
-  PROPERTY BOUNDARY
-  CATCH BASIN / AREA DRAIN
-  OUTFALL
-  ROOF RUNOFF DOWNSPOUTS
-  SUBSURFACE DETENTION TANK/SAND FILTER



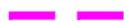
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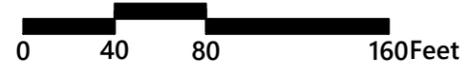
## Snow Storage Areas Map

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**Legend**

-  PROPERTY BOUNDARY
-  APPROXIMATE SNOW STORAGE LOCATION



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## F Product Literature

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## Water Quality Volume Calculations



# Computations

Project:	McLean - Zone 4	Project #	13555.11
Location:	SF-11	Sheet	1 of 2
Calculated by:	SRK	Date:	12-Dec-24
Checked by:		Date:	
Title	Sand Filter Sizing Calculations: SF-11		

## Sedimentation Chamber Sizing

$$A_s = -Q/W \ln(1-E)$$

$A_s$  = sedimentation surface area (ft<sup>2</sup>)

Q = discharge rate from drainage area (ft<sup>3</sup>/s) = WQV/24hr

W = particle settling velocity (0.0004 ft/s recommended for silt)

E = sediment removal efficiency (assume 0.9 or 90%)

WQV = 8270 ft<sup>3</sup>

Impervious Area = 49,594 sf

Q = 0.096 ft<sup>3</sup>/s

Water Quality Depth = 2 inches

W = 0.0004 ft/s

E = 0.9

**$A_s = 551.0 \text{ ft}^2$**

**$A_s \text{ Provided} = 570 \text{ ft}^2$**

L = 15 ft

W = 38 Ft

## Filter Bed Sizing (Sand Filter)

$$A_f = (WQV \times d) / kt(h+d)$$

$A_f$  = filter bed surface area (ft<sup>2</sup>)

WQV = water quality volume (ft<sup>3</sup>)

d = filter bed depth (ft)

k = hydraulic conductivity of filter media (ft/day) Typically 4 ft/day

t = time of water quality volume to drain from system (24 hours)

h = average height of water above filter bed during water quality design storm (half the maximum head on the filter)

From Sand Filter Detail: 18 -inches of sand

WQV = 8,270 ft<sup>3</sup>

12 -inches of gravel

d = 2.5 ft

d = 30 inches

k = 4 ft/day

t = 1 day

(Maximum filter bed head)  $h_{f(Actual)} = 2 \text{ ft}$

$(1/2 h_f) = h = 1.00 \text{ ft}$

**$A_f = 1476.8 \text{ ft}^2$**

**$A_f \text{ Provided} = 2014 \text{ ft}^2$**

L = 53 ft

W = 38 Ft

Overall Sand Filter Dimensions =

**$L_{\text{Sandfilter}} = 40 \text{ ft}$**

**$W_{\text{Sandfilter}} = 70 \text{ ft}$**

**$A_{\text{Sandfilter}} = 2584 \text{ ft}^2$**

$$Q_{\text{Exfiltration}} = k \times A_f$$

$$Q_{\text{Exfiltration}} = 0.093 \text{ cfs}$$

# Computations



Project:	McLean - Zone 4	Project #	13555.11
Location:	SF-11	Sheet	2 of 2
Calculated by:	SRK	Date:	12-Dec-24
Checked by:		Date:	
Title	Sand Filter Sizing Calculations: SF-11		

## Water Quality Volume Storage Check

*(Following Georgia Stormwater Management Manual)*

Per Massachusetts Stormwater Handbook Volume 2 Chapter 2, design of Sand Filter references Georgia Stormwater Management Manual

As described the Georgia Stormwater Management Manual, "the entire treatment system ... must temporarily hold at least 75% of the (water quality volume)". The total volume below the outfall weir must be equal to at least 75% of the required WQV.

$$\text{WQV} = 8,270 \text{ ft}^3$$

$$\mathbf{75\% \text{ WQV} = 6,203 \text{ ft}^3}$$

$V_s$  = volume within sedimentation chamber below the top of the sand media

$V_t$  = volume within the voids in the filter bed (assume 40% voids)

$V_{temp}$  = temporary volume stored above the filter bed and low flow weir

$A_f$  = provided filter bed surface area (ft<sup>2</sup>)

$A_s$  = provided sedimentation surface area (ft<sup>2</sup>)

$d$  = filter bed depth (ft)

$h_f$  = average height of water above filter bed during water quality design storm

$h_s$  = height of sedimentation chambers below top of sand media

$h_{s2}$  = height of sedimentation chambers above top of sand media and below sedimentation weir

$$V_t = A_f * d * 0.4$$

$$A_f = 2014 \text{ ft}^2$$

$$d = 2.5 \text{ ft}$$

$$\mathbf{V_t = 2014 \text{ ft}^3}$$

$$V_{temp} = (A_f + A_s) * h_f$$

$$A_f = 2014 \text{ ft}^2$$

$$A_s = 570 \text{ ft}^2$$

$$h_f = 2.00 \text{ ft}$$

$$h_{s2} = 3 \text{ -inches (per Sand Filter Detail)}$$

$$\mathbf{V_{temp} = 5,026 \text{ ft}^3}$$

$$V_s = A_s * h_s$$

$$A_s = 570 \text{ ft}^2$$

$$h_s = 2.75 \text{ ft} = d + 3 \text{ -inches (per Sand Filter Detail)}$$

$$\mathbf{V_s = 1,568 \text{ ft}^3}$$

$$\text{Total Provided WQV} = V_s + V_t + V_{temp}$$

$$\mathbf{\text{Total WQV} = 8,607 \text{ ft}^3 > 6,203 \text{ ft}^3 \text{ Required}}$$



# Computations

Project:	McLean - Zone 4	Project #	13555.11
Location:	SF-12	Sheet	1 of 2
Calculated by:	SRK	Date:	12-Dec-24
Checked by:		Date:	
Title	Sand Filter Sizing Calculations: SF-12		

## Sedimentation Chamber Sizing

$$A_s = -Q/W \ln(1-E)$$

$A_s$  = sedimentation surface area (ft<sup>2</sup>)

Q = discharge rate from drainage area (ft<sup>3</sup>/s) = WQV/24hr

W = particle settling velocity (0.0004 ft/s recommended for silt)

E = sediment removal efficiency (assume 0.9 or 90%)

WQV =	5140 ft <sup>3</sup>	Impervious Area =	30,783 sf
Q =	0.059 ft <sup>3</sup> /s	Water Quality Depth =	2 inches
W =	0.0004 ft/s		
E =	0.9		

$$A_s = 342.5 \text{ ft}^2$$

$$A_s \text{ Provided} = 364 \text{ ft}^2 \quad L = 13 \text{ ft} \quad W = 28 \text{ Ft}$$

## Filter Bed Sizing (Sand Filter)

$$A_f = (WQV \times d) / kt(h+d)$$

$A_f$  = filter bed surface area (ft<sup>2</sup>)

WQV = water quality volume (ft<sup>3</sup>)

d = filter bed depth (ft)

k = hydraulic conductivity of filter media (ft/day) Typically 4 ft/day

t = time of water quality volume to drain from system (24 hours)

h = average height of water above filter bed during water quality design storm (half the maximum head on the filter)

From Sand Filter Detail: 18 -inches of sand

WQV =	5,140 ft <sup>3</sup>		12 -inches of gravel
d =	2.5 ft	d =	30 inches
k =	4 ft/day		
t =	1 day	(Maximum filter bed head) $h_{f(\text{actual})}$ =	3 ft
$(1/2 h_f) = h =$	1.50 ft		

$$A_f = 803.1 \text{ ft}^2$$

$$A_f \text{ Provided} = 840 \text{ ft}^2 \quad L = 30 \text{ ft} \quad W = 28 \text{ Ft}$$

Overall Sand Filter Dimensions =

$$L_{\text{Sandfilter}} = 30 \text{ ft}$$

$$W_{\text{Sandfilter}} = 45 \text{ ft}$$

$$A_{\text{Sandfilter}} = 1204 \text{ ft}^2$$

$$Q_{\text{Exfiltration}} = k \times A_f$$

$$Q_{\text{Exfiltration}} = 0.039 \text{ cfs}$$

# Computations



Project:	McLean - Zone 4	Project #	13555.11
Location:	SF-12	Sheet	2 of 2
Calculated by:	SRK	Date:	12-Dec-24
Checked by:		Date:	
Title	Sand Filter Sizing Calculations: SF-12		

## Water Quality Volume Storage Check

*(Following Georgia Stormwater Management Manual)*

Per Massachusetts Stormwater Handbook Volume 2 Chapter 2, design of Sand Filter references Georgia Stormwater Management Manual

As described the Georgia Stormwater Management Manual, "the entire treatment system ... must temporarily hold at least 75% of the (water quality volume)". The total volume below the outfall weir must be equal to at least 75% of the required WQV.

$$WQV = 5,140 \text{ ft}^3$$

$$75\% \text{ WQV} = 3,855 \text{ ft}^3$$

$V_s$  = volume within sedimentation chamber below the top of the sand media

$V_t$  = volume within the voids in the filter bed (assume 40% voids)

$V_{temp}$  = temporary volume stored above the filter bed and low flow weir

$A_f$  = provided filter bed surface area (ft<sup>2</sup>)

$A_s$  = provided sedimentation surface area (ft<sup>2</sup>)

$d$  = filter bed depth (ft)

$h_f$  = average height of water above filter bed during water quality design storm

$h_s$  = height of sedimentation chambers below top of sand media

$h_{s2}$  = height of sedimentation chambers above top of sand media and below sedimentation weir

$$V_t = A_f * d * 0.4$$

$$A_f = 840 \text{ ft}^2$$

$$d = 2.5 \text{ ft}$$

$$V_t = 840 \text{ ft}^3$$

$$V_{temp} = (A_f + A_s) * h_f$$

$$A_f = 840 \text{ ft}^2$$

$$A_s = 364 \text{ ft}^2$$

$$h_f = 3.00 \text{ ft}$$

$$h_{s2} = 3 \text{ -inches (per Sand Filter Detail)}$$

$$V_{temp} = 3,521 \text{ ft}^3$$

$$V_s = A_s * h_s$$

$$A_s = 364 \text{ ft}^2$$

$$h_s = 2.75 \text{ ft} = d + 3 \text{ -inches (per Sand Filter Detail)}$$

$$V_s = 1,001 \text{ ft}^3$$

$$\text{Total Provided WQV} = V_s + V_t + V_{temp}$$

$$\text{Total WQV} = 5,362 \text{ ft}^3 > 3,855 \text{ ft}^3 \text{ Required}$$



# Computations

Project:	McLean - Zone 4	Project #	13555.11
Location:	SF-13	Sheet	1 of 2
Calculated by:	SRK	Date:	12-Dec-24
Checked by:		Date:	
Title	Sand Filter Sizing Calculations: SF-13		

## Sedimentation Chamber Sizing

$$A_s = -Q/W \ln(1-E)$$

$A_s$  = sedimentation surface area (ft<sup>2</sup>)

Q = discharge rate from drainage area (ft<sup>3</sup>/s) = WQV/24hr

W = particle settling velocity (0.0004 ft/s recommended for silt)

E = sediment removal efficiency (assume 0.9 or 90%)

WQV = 6800 ft<sup>3</sup>

Q = 0.079 ft<sup>3</sup>/s

W = 0.0004 ft/s

E = 0.9

**$A_s = 453.1 \text{ ft}^2$**

Impervious Area = 40,777 sf

Water Quality Depth = 2 inches

**$A_s \text{ Provided} = 462 \text{ ft}^2$**       L = 14 ft      W = 33 Ft

## Filter Bed Sizing (Sand Filter)

$$A_f = (WQV \times d) / kt(h+d)$$

$A_f$  = filter bed surface area (ft<sup>2</sup>)

WQV = water quality volume (ft<sup>3</sup>)

d = filter bed depth (ft)

k = hydraulic conductivity of filter media (ft/day)      Typically 4 ft/day

t = time of water quality volume to drain from system (24 hours)

h = average height of water above filter bed during water quality design storm (half the maximum head on the filter)

From Sand Filter Detail: 18 -inches of sand

WQV = 6,800 ft<sup>3</sup>

d = 2.5 ft

k = 4 ft/day

t = 1 day

(1/2 h<sub>f</sub>) = h = 1.00 ft

(Maximum filter bed head) h<sub>f(actual)</sub> = 2 ft

12 -inches of gravel

d = 30 inches

**$A_f = 1214.3 \text{ ft}^2$**

**$A_f \text{ Provided} = 1452 \text{ ft}^2$**       L = 44 ft      W = 33 Ft

Overall Sand Filter Dimensions =

**$L_{\text{Sandfilter}} = 35 \text{ ft}$**

**$W_{\text{Sandfilter}} = 60 \text{ ft}$**

**$A_{\text{Sandfilter}} = 1914 \text{ ft}^2$**

$Q_{\text{Exfiltration}} = k \times A_f$

$Q_{\text{Exfiltration}} = 0.067 \text{ cfs}$

# Computations



Project:	McLean - Zone 4	Project #	13555.11
Location:	SF-13	Sheet	2 of 2
Calculated by:	SRK	Date:	12-Dec-24
Checked by:		Date:	
Title	Sand Filter Sizing Calculations: SF-13		

## Water Quality Volume Storage Check

*(Following Georgia Stormwater Management Manual)*

Per Massachusetts Stormwater Handbook Volume 2 Chapter 2, design of Sand Filter references Georgia Stormwater Management Manual

As described the Georgia Stormwater Management Manual, "the entire treatment system ... must temporarily hold at least 75% of the (water quality volume)". The total volume below the outfall weir must be equal to at least 75% of the required WQV.

$$\text{WQV} = 6,800 \text{ ft}^3$$

$$\text{75\% WQV} = 5,100 \text{ ft}^3$$

$V_s$  = volume within sedimentation chamber below the top of the sand media

$V_t$  = volume within the voids in the filter bed (assume 40% voids)

$V_{temp}$  = temporary volume stored above the filter bed and low flow weir

$A_f$  = provided filter bed surface area (ft<sup>2</sup>)

$A_s$  = provided sedimentation surface area (ft<sup>2</sup>)

$d$  = filter bed depth (ft)

$h_f$  = average height of water above filter bed during water quality design storm

$h_s$  = height of sedimentation chambers below top of sand media

$h_{s2}$  = height of sedimentation chambers above top of sand media and below sedimentation weir

$$V_t = A_f * d * 0.4$$

$$A_f = 1452 \text{ ft}^2$$

$$d = 2.5 \text{ ft}$$

$$V_t = 1452 \text{ ft}^3$$

$$V_{temp} = (A_f + A_s) * h_f$$

$$A_f = 1452 \text{ ft}^2$$

$$A_s = 462 \text{ ft}^2$$

$$h_f = 2.00 \text{ ft}$$

$$h_{s2} = 3 \text{ -inches (per Sand Filter Detail)}$$

$$V_{temp} = 3,713 \text{ ft}^3$$

$$V_s = A_s * h_s$$

$$A_s = 462 \text{ ft}^2$$

$$h_s = 2.75 \text{ ft} = d + 3 \text{ -inches (per Sand Filter Detail)}$$

$$V_s = 1,271 \text{ ft}^3$$

$$\text{Total Provided WQV} = V_s + V_t + V_{temp}$$

$$\text{Total WQV} = 6,435 \text{ ft}^3 > 5,100 \text{ ft}^3 \text{ Required}$$



# Computations

Project:	McLean - Zone 4	Project #	13555.11
Location:	SF-21	Sheet	1 of 2
Calculated by:	SRK	Date:	12-Dec-24
Checked by:		Date:	
Title	Sand Filter Sizing Calculations: SF-21		

## Sedimentation Chamber Sizing

$$A_s = -Q/W \ln(1-E)$$

$A_s$  = sedimentation surface area (ft<sup>2</sup>)

Q = discharge rate from drainage area (ft<sup>3</sup>/s) = WQV/24hr

W = particle settling velocity (0.0004 ft/s recommended for silt)

E = sediment removal efficiency (assume 0.9 or 90%)

WQV =	4290 ft <sup>3</sup>	Impervious Area =	25,684 sf
Q =	0.050 ft <sup>3</sup> /s	Water Quality Depth =	2 inches
W =	0.0004 ft/s		
E =	0.9		
<b>A<sub>s</sub> =</b>	<b>285.8 ft<sup>2</sup></b>		
<b>A<sub>s</sub> Provided =</b>	<b>418 ft<sup>2</sup></b>	L =	11 ft
		W =	38 Ft

## Filter Bed Sizing (Sand Filter)

$$A_f = (WQV \times d) / kt(h+d)$$

$A_f$  = filter bed surface area (ft<sup>2</sup>)

WQV = water quality volume (ft<sup>3</sup>)

d = filter bed depth (ft)

k = hydraulic conductivity of filter media (ft/day) Typically 4 ft/day

t = time of water quality volume to drain from system (24 hours)

h = average height of water above filter bed during water quality design storm (half the maximum head on the filter)

		From Sand Filter Detail:	18 -inches of sand
WQV =	4,290 ft <sup>3</sup>		12 -inches of gravel
d =	2.5 ft	d =	30 inches
k =	4 ft/day		
t =	1 day	(Maximum filter bed head) $h_{f(actual)}$ =	3 ft
(1/2 h <sub>f</sub> ) = h =	1.50 ft		
<b>A<sub>f</sub> =</b>	<b>670.3 ft<sup>2</sup></b>		
<b>A<sub>f</sub> Provided =</b>	<b>1520 ft<sup>2</sup></b>	L =	40 ft
		W =	38 Ft

Overall Sand Filter Dimensions =

<b>L<sub>Sandfilter</sub> =</b>	<b>40 ft</b>	$Q_{Exfiltration} = k \times A_f$
<b>W<sub>Sandfilter</sub> =</b>	<b>53 ft</b>	$Q_{Exfiltration} = 0.07 \text{ cfs}$
<b>A<sub>Sandfilter</sub> =</b>	<b>1938 ft<sup>2</sup></b>	

# Computations



Project:	McLean - Zone 4	Project #	13555.11
Location:	SF-21	Sheet	2 of 2
Calculated by:	SRK	Date:	12-Dec-24
Checked by:		Date:	
Title	Sand Filter Sizing Calculations: SF-21		

## Water Quality Volume Storage Check

*(Following Georgia Stormwater Management Manual)*

Per Massachusetts Stormwater Handbook Volume 2 Chapter 2, design of Sand Filter references Georgia Stormwater Management Manual

As described the Georgia Stormwater Management Manual, "the entire treatment system ... must temporarily hold at least 75% of the (water quality volume)". The total volume below the outfall weir must be equal to at least 75% of the required WQV.

$$\begin{aligned} \text{WQV} &= 4,290 \text{ ft}^3 \\ \mathbf{75\% \text{ WQV}} &= \mathbf{3,218 \text{ ft}^3} \end{aligned}$$

$V_s$  = volume within sedimentation chamber below the top of the sand media

$V_t$  = volume within the voids in the filter bed (assume 40% voids)

$V_{temp}$  = temporary volume stored above the filter bed and low flow weir

$A_f$  = provided filter bed surface area (ft<sup>2</sup>)

$A_s$  = provided sedimentation surface area (ft<sup>2</sup>)

$d$  = filter bed depth (ft)

$h_f$  = average height of water above filter bed during water quality design storm

$h_s$  = height of sedimentation chambers below top of sand media

$h_{s2}$  = height of sedimentation chambers above top of sand media and below sedimentation weir

$$V_t = A_f * d * 0.4$$

$$\begin{aligned} A_f &= 1520 \text{ ft}^2 \\ d &= 2.5 \text{ ft} \\ \mathbf{V_t} &= \mathbf{1520 \text{ ft}^3} \end{aligned}$$

$$V_{temp} = (A_f + A_s) * h_f$$

$$\begin{aligned} A_f &= 1520 \text{ ft}^2 \\ A_s &= 418 \text{ ft}^2 \\ h_f &= 3.00 \text{ ft} \\ h_{s2} &= 3 \text{ -inches (per Sand Filter Detail)} \\ \mathbf{V_{temp}} &= \mathbf{5,710 \text{ ft}^3} \end{aligned}$$

$$V_s = A_s * h_s$$

$$\begin{aligned} A_s &= 418 \text{ ft}^2 \\ h_s &= 2.75 \text{ ft} = d + 3 \text{ -inches (per Sand Filter Detail)} \\ \mathbf{V_s} &= \mathbf{1,150 \text{ ft}^3} \end{aligned}$$

$$\text{Total Provided WQV} = V_s + V_t + V_{temp}$$

$$\mathbf{\text{Total WQV} = 8,379 \text{ ft}^3} > \mathbf{3,218 \text{ ft}^3 \text{ Required}}$$

## TSS Removal Worksheets



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# TSS Removal Calculation Worksheet

Project Name: **McLean - Zone 4**  
 Project Number: **13555.11**  
 Location: **Belmont, MA**  
 Discharge Point: **DP-1**  
 Drainage Area(s): **PR-11.1, PR-12.1, PR-13.1**

Sheet: **3 of 3**  
 Date: **12-Dec-2024**  
 Computed by: **CJM**  
 Checked by: **SRK**

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	25%	1.00	0.25	0.75
Sand Filter	80%	0.75	0.60	0.15
	0%	0.15	0.00	0.15
	0%	0.15	0.00	0.15
	0%	0.15	0.00	0.15

\* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.  
 \*\* Equals remaining load from previous BMP (E)

**Treatment Train  
 TSS Removal =** **85%**



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## TSS Removal Calculation Worksheet

Project Name: **McLean - Zone 4**  
 Project Number: **13555.11**  
 Location: **Belmont, MA**  
 Discharge Point: **DP-1**  
 Drainage Area(s): **PR-11.2, PR-11.3, PR-12.2, PR-13.2**

Sheet: **3 of 3**  
 Date: **12-Dec-2024**  
 Computed by: **CJM**  
 Checked by: **SRK**

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D E)
Sand Filter	80%	1.00	0.80	0.20
	0%	0.20	0.00	0.20
	0%	0.20	0.00	0.20
	0%	0.20	0.00	0.20
	0%	0.20	0.00	0.20

\* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.

\*\* Equals remaining load from previous BMP (E)

**Treatment Train  
 TSS Removal =**

<b>80%</b>
------------



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# TSS Removal Calculation Worksheet

Project Name: **McLean - Zone 4**  
 Project Number: **13555.11**  
 Location: **Belmont, MA**  
 Discharge Point: **DP-2**  
 Drainage Area(s): **PR-21.1, PR-21.2**

Sheet: **2 of 3**  
 Date: **12-Dec-2024**  
 Computed by: **CJM**  
 Checked by: **SRK**

A	B	C	D	E
BMP*	TSS Removal Rate*	Starting TSS Load**	Amount Removed (C*D)	Remaining Load (D-E)
Deep Sump and Hooded Catch Basin	25%	1.00	0.25	0.75
Sand Filter	80%	0.75	0.60	0.15
	0%	0.15	0.00	0.15
	0%	0.15	0.00	0.15
	0%	0.15	0.00	0.15

\* BMP and TSS Removal Rate Values from the MassDEP Stormwater Handbook Vol. 1.  
 \*\* Equals remaining load from previous BMP (E)

**Treatment Train  
TSS Removal =**

<b>85%</b>
------------

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## Appendix E: Standard 8 Supporting Information

- › List of recommended Erosion and Sedimentation Control Measures
- › Recommended Construction BMPs-Maintenance/Evaluation Checklist

# Recommended Erosion and Sedimentation Control Measures

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## **Erosion and Sedimentation Control Measures**

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

### **Straw Bale Barriers and Compost Socks**

Straw bale barriers and/or compost socks will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site. Bales will be set at least four inches into the existing ground to minimize undercutting by runoff. Compost socks will be installed tight against the ground and overlapped horizontally at least two feet at joints.

### **Silt Fencing**

In areas where high runoff velocities or high sediment loads are expected, hay bale barriers will be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and straw bale barrier will be replaced as determined by periodic field inspections.

### **Catch Basin Protection**

Newly constructed and existing catch basins will be protected with straw bale barriers (where appropriate) or silt sacks throughout construction.

### **Gravel and Construction Entrance/Exit**

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

### **Diversion Channels**

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

### **Temporary Sediment Basins**

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based

on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

### **Vegetative Slope Stabilization**

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

### **Maintenance**

- The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.
- The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.
- Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.
- Damaged or deteriorated items will be repaired immediately after identification.
- The underside of hay bales should be kept in close contact with the earth and reset as necessary.
- Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.
- Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be regraded and stabilized as necessary.

**McLean Child And Adolescent Campus, Belmont Massachusetts  
Construction Best Management Practices – Maintenance/ Evaluation Checklist**

<b>Best Management Practice</b>	<b>Inspection Frequency</b>	<b>Date Inspected</b>	<b>Inspector</b>	<b>Minimum Maintenance and Key Items to Check</b>	<b>Cleaning/Repair Needed (List Items)</b>	<b>Date of Cleaning/Repair</b>	<b>Performed by:</b>
Erosion Control Barriers/Silt Fencing	Weekly and after 1/2" storm events or greater			Inspect for deterioration or failure. Remove sediment when buildup exceeds half the bale or sock height.	<input type="checkbox"/> yes <input type="checkbox"/> no		
Silt Sack Catch Basin Protection	Weekly and after 1/2" storm events or greater			Inspect for proper operation of catch basin. If clogged, dispose of sediment.	<input type="checkbox"/> yes <input type="checkbox"/> no		
Gravel and Construction Entrance/Exit	Weekly and after 1/2" storm events or greater			Inspect for breakdown of crushed stone. Reapply stone if necessary to depths specified in construction documents.	<input type="checkbox"/> yes <input type="checkbox"/> no		
Diversion Channels	Weekly and after 1/2" storm events or greater			Check for erosion or breakout and proper function. Correct if necessary.	<input type="checkbox"/> yes <input type="checkbox"/> no		
Temporary Sediment Basins	Weekly and after 1/2" storm events or greater			Inspect for proper function. Correct for cracking, erosion, breakout, sediment buildup, contaminants, or as necessary.	<input type="checkbox"/> yes <input type="checkbox"/> no		
Vegetative Slope Stabilization	Weekly and after 1/2" storm events or greater			Inspect for erosion. Correct if necessary.	<input type="checkbox"/> yes <input type="checkbox"/> no		

Stormwater Control Manager \_\_\_\_\_

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## Appendix F: Local Compliance

- › Phosphorous Removal Calculations
- › Town of Belmont Stormwater Checklist

## Phosphorous Removal Calculations



## Site Summary

Project	McLean - Zone 4	Project #	13555.11
Calculated by	CJM	Date	12/12/2024
Checked by	SRK	Date	12/12/2024

Treatment Category	Area to Treatment Category (ac)	Impervious Area to Treatment Category (ac)	P Load of Impervious Area (lb/yr)	P Load Removed (lb/yr)	Average Area Weighted P Reduction (%)	TSS Load of Impervious Area (lb/yr)	TSS Load Removed (lb/yr)	Average Area Weighted TSS Reduction (%)
Structural BMPs	7.1	3.4	6.0	3.8	63%	1,271	1,297	100%
Impervious Area Disconnection	-	-	-	-	-	-	-	-
Porous Pavement (w/ underdrain)	-	-	-	-	-	-	-	-
Untreated	1.8	0.0	0.1	0	0%	18	0	0%
<b>TOTAL</b>	<b>8.9</b>	<b>3.4</b>	<b>6.1</b>	<b>3.8</b>	<b>62%</b>	<b>1,289</b>	<b>1,297</b>	<b>99%</b>





## Town of Belmont Stormwater Checklist



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

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



**Project Location:** McLean Hospital - Child and Adolescent Campus (Zone 4)

### A. Introduction

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

The Report must include:

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

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

As noted in the Checklist, the Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Report shall also document compliance with the Stormwater Management and Erosion Control Bylaw and the Stormwater Management and Erosion Control Rules and Regulations, recognizing the bylaw contains provisions that could be more strict or broader in scope than the Stormwater Management Standards.

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

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

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



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

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### B. Report 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 Report. The checklist is also intended to provide the reviewing authority with a summary of the components necessary for a comprehensive Report that addresses the ten Stormwater Standards.

*Note:* Because stormwater requirements vary from project to project, it is possible that a complete 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.

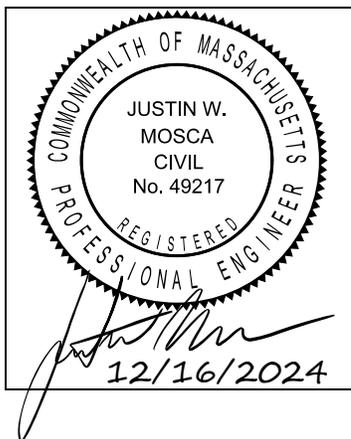
A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Report.

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### Registered Professional Engineer's Certification

I have reviewed the Stormwater Management and Erosion Control Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan, 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



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Signature and Date

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# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

### 60-325 - Stormwater Management and Erosion Control Bylaw (excerpt)

#### **F Stormwater Management and Erosion Control**

##### **F (1) Regulated Activities**

A Stormwater Management and Erosion Control Permit shall be required prior to undertaking any land disturbance that involves:

- (a) An alteration that will result in land disturbances of 2,500 square feet of total area or more, or that is part of a common plan of development that will disturb 2,500 square feet or more;
- (b) An alteration that will increase the amount of a lot's impervious surface area to more than 25% of the lot's total area; or
- (c) Storage or permanent placement of more than 100 cubic yards of excavated material, fill, snow or ice.

##### **F (3) General Requirements**

(a) An Operation and Maintenance Plan shall be submitted to the OCD for approval prior to the issuance of a Stormwater Management and Erosion Control Permit. The Operation and Maintenance Plan shall be designed to ensure compliance with the Stormwater Management and Erosion Control Permit, this Section, and the Massachusetts Surface Water Quality Standards, 314 CMR 4.00, in all seasons and throughout the life of the system.

(b) As-built drawings shall be submitted to the OCD at the completion of a project. The as-built drawings must depict all on-site controls, both structural and non-structural, designed to manage the stormwater associated with the completed site.

(c) The OCD may require the applicant to contribute to the cost of design, construction, and maintenance of a public or shared stormwater facility in lieu of an onsite stormwater facility where the OCD determines that there are not sufficient site conditions for onsite Best Management Practices that will satisfy the design criteria set forth in Section F. (4) of this Bylaw and the performance standards set forth in the regulations promulgated under this Bylaw. Funds so contributed may be used to design, construct, and maintain stormwater projects that will improve the quality and quantity of surface waters in Belmont by treating and recharging stormwater from existing impervious surfaces that is now discharged to said waters with inadequate treatment or recharge. The amount of any required contribution to the fund shall be determined by the OCD pursuant to standards established in the Regulations adopted pursuant to this Section.

##### **F (4) Design Criteria (The Report shall consider all of the design criteria below)**

Each New Development and each Redevelopment shall satisfy the following design criteria:

- (a) Compliance with all applicable provisions of the Stormwater Management Standards, regardless of the proximity of the development to resource areas or their buffer zones, as defined by the *Wetlands Protection Act, M.G.L. c. 131, § 40* and its implementing regulations.
- (b) Erosion and sediment controls must be implemented to prevent adverse impacts during disturbance and construction activities.
- (c) There shall be no change to the existing conditions of abutting properties from any increase in peak flows or volumes of stormwater runoff or from erosion, silting, flooding, sedimentation or impacts to wetlands, ground water levels or wells.
- (d) When any proposed discharge may have an impact upon streams, wetlands or storm sewers, the OCD may require minimization or elimination of this impact based on site conditions and existing stormwater system capacity.
- (e) Compliance with all applicable provisions of the MS4 Permit, including performance standards for New Development and Redevelopment.



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

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### 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

**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
- 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.



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

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### 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.
- Any potential change to the existing conditions of abutting properties from any increase in volume of stormwater runoff have been identified in the Report
- The Report provides calculations demonstrating that the post-development discharge volume is equal to or less than the pre-development discharge volume from the 2-year and the 10-year 24-hour storms. [N/A due to inability to infiltrate stormwater. Refer to Standard 3.]
- The Report provides a quantitative impact of discharge volumes from the 100-year 24-hour storm. If this evaluation shows that increased off-site flooding result from the discharge volumes from the 100-year 24-hour storms, BMPs also are described in the Report that the applicant will implement and maintained to attenuate these discharges.
- Any potential change to the existing conditions of abutting properties from erosion, silting, flooding, or sedimentation have been identified in the Report.
- The Report describes the practices and controls that the Applicant will implement and maintain to prevent adverse impacts from erosion, silting, flooding, or sedimentation.
- Any potential impacts to wetlands have been identified in the Report. [N/A]
- The Report describes the practices and controls that the Applicant will implement and maintain to prevent adverse impacts to wetlands. [N/A]

### Additional Requirements:

- Any potential impacts to ground water levels or wells have been identified in the Report, including quantitative projections of changes in the seasonal high water table and quantitative projections of storm-related short-term mounding calculations associated with infiltration BMPs for a 24-hour 10 year design storm. [N/A]
- The Report describes the practices and controls that the Applicant will implement and maintain (if required) to prevent adverse impacts to ground water levels or wells for a 24-hour 10 year design storm. [N/A]

### Requirements Specific to Section F (4)(d)

- Is stormwater from the pre-development site discharged directly to (check all that apply):



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

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- A surface water body (specify the water body)
- The Belmont MS4 (storm sewers ) [\[via an overland drainage channel\]](#)
- Another MS4 (specify the MS4)
- Other (specify)
- Will stormwater from the post-development site be discharges directly to (check all that apply):
  - A surface water body (specify the water body)
  - The Belmont MS4 (storm sewers)
  - Another MS4 (specify the MS4)
  - Other (specify) [\[discharges to an off-site drainage channel\]](#)
- Any potential impacts upon streams, wetlands and/or storm sewers have been identified in the Report. (Explain in Report narrative)
  - These will be prevented with mitigating measures that the Applicant will implement and maintain (explain in Report narrative)
  - These will be prevented without mitigating measures (explain in Report narrative)
- The Report describes the practices and controls that the Applicant will implement and maintain to prevent any adverse impacts to streams, wetlands and/or storm sewers.

### Additional Requirements:

- If the discharge is to an MS4, a certification that the discharge meets Massachusetts Surface Water Quality Standards and any applicable approved Total Maximum Daily Load (TMDL) waste load allocation is included in the Report.

### Standard 3: Recharge

- Soil Analysis provided. [\[Geotechnical investigations identified shallow bedrock overlain by glacial till and silty soils, precluding potential for infiltration. No recharge is proposed.\]](#)
- Required Recharge Volume calculation provided.
- Required Recharge volume reduced through use of the LID site Design Credits.
- Sizing the infiltration, BMPs is based on the following method: Check the method used.
  - Static
  - Simple Dynamic
  - Dynamic Field<sup>1</sup>
- 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.



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

- Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason: [No recharge is proposed.]
- 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.
- <sup>1</sup> 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.
- 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

### 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: [N/A]
- 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.



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

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- The Required Water Quality Volume is reduced through use of the LID site Design Credits.
- Calculations documenting that the treatment train meets the requirements of the MS4 Permit for TSS removal which are 80% TSS removal for redevelopment or 90% TSS removal for new development. If applicable, calculations documenting the 44% TSS removal pretreatment requirement.

Calculations documenting that the treatment train meets the requirements of the MS4 Permit for total phosphorus removal which are 50% total phosphorus removal for redevelopment or 60% total phosphorus removal for new development.

- 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 or total phosphorus and documentation showing that the BMPs selected are consistent with the TMDL is provided.

### Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs) [N/A; not a LUHPPL]

- 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.

### Standard 7: Not Applicable

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



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

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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.

Adverse impacts due to erosion, sedimentation, or both during disturbance and construction activities are prevented:

With erosion and sediment controls that the Applicant will implement and maintain (explain in Report narrative)

Without erosion and sediment controls (explain in Report narrative)

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

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;



# TOWN OF BELMONT

## Checklist for Stormwater Management and Erosion Control Report

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- 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.