Civil Engineering Land Surveying Environmental Consulting Landscape Architecture

HANCOCK
ASSOCIATES

Stormwater Report
In Support of

The Coolidge at Sudbury Phase 2
187-189 Boston Post Road
Sudbury, Ma

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BY: ....

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#15526

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B'nai B'rith Housing New England Inc.

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INTRODUCTION

Excerpt from MADEP Stormwater Management Standards Chapter 1:

> *Stormwater runoff results from rainfall and snow melt and represents the single largest source responsible for water quality impairments in the Commonwealth's rivers, lakes, ponds, and marine waters. New and existing development typically adds impervious surfaces and, if not properly managed, may alter natural drainage features, increase peak discharge rates and volumes, reduce recharge to wetlands and streams, and increase the discharge of pollutants to wetlands and water bodies.*
>
> *The Stormwater Management Standards address water quality (pollutants) and water quantity (flooding, low base flow and recharge) by establishing standards that require the implementation of a wide variety of stormwater management strategies. These strategies include environmentally sensitive site design and LID techniques to minimize impervious surface and land disturbance, source control and pollution prevention, structural BMPs, construction period erosion and sedimentation control, and the long-term operation and maintenance of stormwater management systems.*

EXISTING CONDITIONS

The approximate 6 acre site is located on the south side of Boston Post Road and East of Landham Road. The site currently has a 64 unit senior housing facility known as the Coolidge at Sudbury. Topography on site ranges from a high elevation of 160 adjacent to Landham Road to a low of elevation 136 at the wetland area to the southeast. Stormwater runoff generally flows toward the wetland area at the southwest corner of the site. Soils on site have been classified by the USDA Natural Resource Conservation Service as Udorthents-Urban land complex with adjacent areas of Class A and Class C soils. Hancock Associates performed soil testing on site and determined the site to contain areas of both these soil classes. See predevelopment watershed mapping for additional information. The Coolidge project was built in 2013. The stormwater management system includes a large detention basin, rain garden, grassed swale, and roof drain infiltration system.

PROPOSED CONDITIONS

The proposal calls for the construction of a second 56 unit senior housing building (Coolidge at Sudbury Phase 2) with parking beneath and an expansion of the existing parking lot utilizing the existing access from Boston Post Road. The proposed buildings will be served by town water, gas, underground electric, cable and telephone, and onsite sewage. The six acre site will be subdivided into two approximately three acre parcels.

Stormwater will be managed on site in compliance with the Massachusetts DEP Stormwater Regulations. The system will be modified with the elimination of the rain garden to the east of the existing parking lot and grassed swale, the treatment and small amount of attenuation will be replaced with a new system. The eastern parking area will also collected via a standard catch basin/manhole system with the addition of a trench drain collecting drainage from the parking garage entrance area. Runoff from the eastern lot will be routed through a Stormtech MC-3500 isolator row for treatment prior to discharging to the infiltration basin behind the building. Roof runoff from the new building will be infiltrated via same infiltration basin behind the building. The western parking area will be collected via a standard catchbasin/manhole system and discharged to an extended detention basin.

The original drainage model has been updated to reflect the phase 1 as-built conditions at the phase 2 project details. The predevelopment conditions reflect the site conditions prior to phase 1. The analysis demonstrating compliance with MASS DEP stormwater standards reflects both phase 1 and 2 together.

STORMWATER MANAGEMENT DESIGN – DOCUMENTING COMPLIANCE
In accordance with the Massachusetts Stormwater Handbook Volume 3

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

No untreated discharges are proposed and therefore the standard is met.

STANDARD 2. PEAK RATE ATTENUATION
To prevent storm damage and downstream and off-site flooding, Standard 2 requires that the post-development peak discharge rate is equal to or less than the pre-development rate from the 2-year and the 10-year 24-hour storms. Proponents must also evaluate the impact of peak discharges from the 100-year 24-hour storm. If this evaluation shows that increased off-site flooding will result from peak discharges from the 100-year 24-hour storms, BMPs must also be provided to attenuate these discharges.

Peak Flow Summary Table

	1-Inch Storm	2-year 24-hour Storm (3.2 inches)	10-year 24-hour Storm (4.8 inches)	100-year 24-hour Storm **(8.6 inches)**
Pre-development to Street (1s)	0.0 cfs 0.0 af	0.0 cfs 0.0 af	0.1 cfs 0.017 af	1.5 cfs 0.0113af
Post-development to Street (10s)	0.0 cfs 0.0 af	0.0 cfs 0.002 af	0.1 cfs 0.012 af	1.0 cfs 0.059 af
Pre-development into Wetland (4p)	0.4 cfs 0.031 af	1.4 cfs 0.171 af	3.4 cfs 0.422 af	13.7 cfs 1.334 af
Post-development to Wetland (4p)	0.5 cfs 0.056 af	1.5 cfs 0.253 af	2.5 cfs 0.520 af	10.8 cfs 1.342 af

In accordance with *Section 8.0 A.3i of the Sudbury Stormwater Management Bylaw Regulations* the runoff volume has also been evaluated. Increases of less than 0.1 cfs are considered within the tolerances of the analysis method, as shown in the table above runoff volumes to the street have been maintained or reduced in all storms. To ensure that runoff volumes to the wetlands do not increase off-site flooding the "pocket" wetland was modeled as a pond in the drainage calculations and the peak staging elevation compared for each storm event. The results are listed below and show no significant change in peak elevation in all storm events.

Peak Wetland Elevation

	1-Inch Storm	2-year 24-hour Storm (3.2 inches)	10-year 24-hour Storm (4.8 inches)	100-year 24-hour Storm **(8.6 inches)**
Pre-development	135.45	136.05	136.67	137.17
Post-development	135.60	136.28	136.86	137.16

We feel the stage increase of less than 3 inches are negligible and will not adversely impact the wetlands.
Thus, the requirements of the standard are met.

STANDARD 3. STORMWATER RECHARGE

Loss of annual recharge to groundwater shall be eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post- development site shall approximate the annual recharge from pre-development conditions based on soil type.

A Soils new Impervious Area = 75,294sq.ft x 0.60 inches x 1/12 = 3,765 cubic feet
C Soils new Impervious Area = 20,100sq.ft x 0.25 inches x 1/12 = 419 cubic feet
Total Recharge Volume = 4,181 cubic feet

Total new impervious area = 95,394sq.ft

Total new impervious area to recharge facilities = 83,461

Capture Area Adjustment
95,394sq.ft /83,461sq.ft = 1.14 x 4,181 cubic feet = ***4,770 cubic feet.***

Static Volume Provided
Front system
System Volume = 15' x 120' x 3' = 5,400 cubic feet
Pipe volume = 3.14 x 1^2 x 120 x 4 pipes = 1,500 cubic feet
Stone Volume = (5,400-1,500) x 0.4 = 1,560 cubic feet
Total Volume = 1,500 + 1,560 = 3,000 cubic feet

300' long Reservoir Below Porous Fire Road
4059 square feet x 0.5'deep x 0.4 = 811 cubic feet

Infiltration Basin Behind East Building
Volume below outlet = 8,533 cubic feet

Total Volume Provided = ***12,344 cubic feet***

Thus, the requirements of the standard are met.

Drawdown Analysis

The Massachusetts Stormwater Handbook states that the recharge volume must drain within 72 hours. Hydraulic Conductivity tests done on site discovered that the in-situ hydraulic conductivity of the southeastern area of the site where the detention basin is proposed to be 62 in/hr. The "Dynamic Field" method for recharge calculations allows a system to be designed using a drawdown rate of 50% of that found in the field, therefore the following drawdown calculation assumes a rate of 31 inches per hour.

East Infiltration Basin $= 8{,}533 \pm ft^3 / ((31 \text{ in/hour} / 12 \text{ in/ft}) * 4{,}593 \pm ft^2)$
$= 43 \pm$ ***minutes***

Because the infiltration system for the roof drain of the building on the western side of the property is located in HSG type "A" soil, the Rawl's Rate for saturated hydraulic conductivity (2.41 in/hour for HSG "A"-type soil) is used for the following calculation.

Infiltration System $= 3{,}065 \pm ft^3 / ((2.41 \text{ in/hour} / 12 \text{ in/ft}) * 1{,}800 \pm ft^2)$
$= 8 \pm$ ***hours***

Because the pervious pavement reservoir on the south western side of the property is located in HSG type "C" soil, the Rawl's Rate for saturated hydraulic conductivity (0.27 in/hour for HSG "C"-type soil) is used for the following calculation.

Reservoir $= 811 \pm ft^3 / ((0.27 \text{ in/hour} / 12 \text{ in/ft}) * 4{,}059 \pm ft^2)$
$= 9 \pm$ ***hours***

West Stormwater Basin $= 8{,}736 \pm ft^3 / ((2.41 \text{ in/hour} / 12 \text{ in/ft}) * 1{,}453 \pm ft^2)$
$= 30 \pm$ ***hours***

This Standard is met.

STANDARD 4. WATER QUALITY

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

Treatment Chain

1		Removal Rate	Remains	
1st Link	Deep sump hooded catch basins	25%	75.00%	
2nd Link	Extended Detention Basin	50%	37.50%	
3rd Link	Grass Channel	50%	18.75%	
Final Rate			81.25%	removal

2		Removal Rate	Remains	
1st Link	Deep sump hooded catch basins	25%	75.00%	
2nd Link	Isolator row	84%	12.00%	
Final Rate			88.00%	removal

Thus, the requirements of the standard are met.

In addition the "water quality volume for sizing of BMPs shall be based on 1-inch of runoff from the tributary area" per the Town of Sudbury Stormwater Management Bylaw.

Infiltration Chambers
Volume Required = 1" x 4,770±sq.ft. = 398 cubic feet.

Static Volume Provided
System Volume = 15' x 120' x 3' = 5,400 cubic feet
Pipe volume = 3.14 x 1^2 x 120 x 4 pipes = 1,500 cubic feet
Stone Volume = (5,400-1,500) x 0.4 = 1,560 cubic feet
Total Volume = 1,500 + 1,560 = 3,000 cubic feet

Isolator Row

The isolator row, consisting of Stormtech MC-3500 chambers wrapped in filter fabric has been sized to provide 84% TSS removal per the Stormtech Isolator Row Sizing Chart (Appendix V) and the DEP's Equivalent Water Quality Peak Flow Rate guidelines:

System "A"
Time of Concentration, Tc = 0.083 Hours
Unit Peak Discharge, qu = 773 csm/in
Impervious Surface Area, A = 0.0014625 mi^2
Water Quality Volume, WQV = 1 Inches
Water Quality Flow, WQF = 0.92 cfs

Isolator Row Chambers Required = 0.92 cfs / 0.24 cfs = ***4 Chambers***
Isolator Row Chambers Provided = 4 Chambers

STANDARD 5.) LAND USES WITH HIGHER POTENTIAL POLLUTANT LOADS

The proposed use is not considered a use with a higher potential pollutant load as defined by the Stormwater Management Standards.

STANDARD 6.) CRITICAL AREAS

"Standard 6 applies to discharges within a Zone II, Interim Wellhead Protection Areas or near or to other Critical Areas: Shellfish Growing Areas, Bathing Beaches, Outstanding Resource Waters Special Resource Waters, and Cold-Water Fisheries" per Volume 3: Documenting Compliance with the Massachusetts Stormwater Management Standards Chapter 1.

This site is not located within or adjacent to a Critical Area.

STANDARD 7.) REDEVELOPMENT

This project is not being proposed as redevelopment.

STANDARD 8.) CONSTRUCTION PERIOD CONTROLS

Construction Period controls will be included in the stormwater pollution prevention plan in the final submittal.

STANDARD 9.) OPERATION AND MAINTENANCE PLAN

A preliminary Operation and Maintenance Plan has been developed and included in Appendix.

STANDARD 10.) ILLICIT DISCHARGES TO DRAINAGE SYSTEM

This standard is not applicable to a site without a centralized collection system.

EROSION AND SEDIMENTATION PLAN

Best management practices (BMP) for erosion and sedimentation control are staked straw bales, filter fences, hydro seeding, and phased development. Many stormwater BMP technologies (e.g., infiltration technologies) are not designed to handle the high concentrations of sediments typically found in construction runoff and must be protected from construction-related sediment loadings. Construction BMP's **must** be maintained.

In developing the proposed project, certain measures will be implemented to minimize impacts which erosion and sedimentation could have on surrounding areas. This section addresses items that involve proper construction techniques, close surveillance of workmanship, and immediate response to emergency situations. The developer must be prepared to provide whatever reasonable measures are necessary to protect the environment during construction and to stabilize all disturbed areas as soon as construction ends.

Pre-Construction

1. The contractor shall have a stockpile of materials required to control erosion on-site to be used to supplement or repair erosion control devices. These materials shall include, but are not limited to straw bales, silt fence and crushed stone.
2. The contractor is responsible for erosion control on site and shall utilize erosion control measures where needed, regardless of whether the measures are specified on the plan or in the Order of Conditions.

Preliminary Site Work

1. Materials such as gravel to be removed should be stockpiled, separating the topsoil for future use on the site. Erosion control shall be utilized along the down slope side of the piles if the piles are to remain for more than three weeks.
2. If intense rainfall is anticipated, the installation of supplemental straw bale dikes, silt fences, or armored dikes shall be considered.

Landscaping

1. Landscaping shall occur as soon as practical to provide permanent stabilization of disturbed surfaces.
2. If the season or adverse weather conditions do not allow the establishment of vegetation, temporary mulching with straw, wood chips weighted with snow fence or branches, or other methods shall be provided.
3. A minimum of 4 inches of topsoil shall be placed and its surface smoothed to the specified grades.
4. The use of herbicides is strongly discouraged.
5. Hydro seeding is encouraged for steep slopes. Application rates on slopes greater than 3:1 shall have a minimum seeding rate of 5-lbs/1000 SF. A latex or fiber tackifier shall be used on these slopes at a minimum rate of 50 lbs. of tackifier per 500 gallons of water used.

STORMWATER OPERATION AND MAINTENANCE PLAN

Stormwater management system owner: Affiliate B'nai B'rith Housing of New England, Inc.

The party or parties responsible for operation and maintenance: Affiliate B'nai B'rith Housing of New England, Inc.

- **The town of Sudbury shall be allowed to enter the property at reasonable times and in a reasonable manner for the purpose of inspecting the stormwater system.**
- **The responsible parties shall maintain a log of all operation and maintenance activities, including without limitation, inspections, repairs, replacement and disposal.**
- **All drainage components shall be maintained to function as designed.**

Deep Sump Hooded Catch Basins
Inspect or clean deep sump catch basins four times per year at the end of the foliage and snow removal seasons. Sediments must also be removed four times per year or when the depth of deposits is greater than or equal to one half the depth from the bottom of the lowest pipe in the basin. Vacuum trucks are to be used to remove trapped sediment and supernatant.
Although catch basin debris often contains concentrations of oil and hazardous materials such as petroleum hydrocarbons and metals, MassDEP classifies them as solid waste. Any contaminated materials must be evaluated in accordance with the Hazardous Waste Regulations, 310 CMR 30.00, and handled as hazardous waste. MassDEP regulations prohibit landfills from accepting materials that contain free draining liquids.

Sediment Forebay
Inspect sediment forebay monthly and clean out at least four times per year. When mowing grasses, keep the grass height no greater than 6 inches. Set mower blades no lower than 3 to 4 inches. Check for signs of rilling and gullying and repair as needed. After removing the sediment, replace any vegetation damaged during the clean-out by either reseeding or resodding.
When reseeding, incorporate practices such as hydroseeding with a tackifier, blanket, or similar practice to ensure that no scour occurs in the forebay, while the seeds germinate and develop roots.

Detention Basin
Inspect to ensure proper functioning after every major storm during first 3 months of operation and twice a year thereafter and when there are discharges through the high outlet orifice. Mow the buffer area, side slopes, and basin bottom grassed floor, remove trash and debris; remove grass clippings and accumulated organic matter twice per year. Inspect and clean pretreatment devices, every other month recommended and at least twice a year and after every major storm event.

Swale
Inspect semi-annually the first year, and at least once a year thereafter. Inspect the grass for growth and the side slopes for signs of erosion and formation of rills and gullies. Plant an alternative grass species if the original grass cover is not successfully established. If grass growth is impaired by winter road salt or other deicer use, re-establish the grass in the spring. *Trash/Debris Removal:* Remove accumulated trash and debris prior to mowing. *Sediment removal:* Check on a yearly basis and clean as needed. Use hand methods (i.e., a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils. Mow on an as-needed basis during the growing season so that the grass height does not exceed 6 inches.

Infiltration BMP
The infiltration BMP (subsurface chamber system) shall be inspected after every major storm for the first few months to ensure it is stabilized and functioning properly. If necessary, corrective action shall be taken until the system functions properly. Inspectors should note how long water remains standing in the inspection port after a storm; standing water within the basin 48 to 72 hours after a storm indicates that the infiltration capacity may have been overestimated. If the ponding is due to clogging, immediately address the reasons for the clogging. Thereafter, inspect the infiltration BMP at least
twice per year.

Infiltration Basin Area
Inspect for sediment build-up, structural damage, and standing water in the spring and fall. Sediment shall be removed and any damage repaired. Inspect soil and repair eroded areas monthly. Re-mulch void areas with hardwood mulch (no dye) as needed. Remove litter and debris monthly. Treat diseased vegetation as needed. Remove and replace dead vegetation twice per year (spring and fall).Vegetation shall be trimmed biannually as appropriate. If a major incident/spill occurs that fouls the sandy soil at the bottom of the infiltration basin area to a degree requiring removal to the sand, perform the following. First, place straw wattles completely around the affected area at the top of embankment. Second, place an anchored filter fabric over the pipe overflow and inflow. Third, carefully excavate the affected area by hand with a flat tip shovel; place in transport vehicle for proper disposal offsite in manner compliant with all pertinent regulations. Fourth, replace all removed material with clean sand. All work should be performed in the dry anticipating no significant wet weather during the work period.

Permeable Asphalt Pavement - non-travelled areas
In most porous pavement designs, the pavement itself acts as pretreatment to the stone reservoir below. Consequently, frequent cleaning and maintenance of the pavement surface is critical to prevent clogging. To keep the surface clean, frequent vacuum sweeping along with jet washing of asphalt and concrete pavement is required. No winter sanding shall be conducted on the porous surface. For proper maintenance:

- Post signs identifying porous pavement areas.
- Minimize salt use during winter months.
- No winter sanding is allowed.
- Keep landscaped areas well maintained to prevent soil from being transported onto the pavement.
- Clean the surface using vacuum sweeping machines biannuannly.
- Regularly monitor the paving surface to make sure it drains properly after storms.
- Never reseal or repave with impermeable materials.
- Inspect the surface annually for deterioration or spalling.

Isolator Row
Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should inspected a minimum of one time. If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

Roof Drain Leaders
Routine roof inspections shall be performed two times per year. The roof shall be kept clean and free of debris, and the roof drainage systems shall be kept clear. Gutters and downspouts shall be cleaned at least twice per year, or more frequently as necessary.

- **<u>STORMWATER BEST MANAGEMENT PRACTICES (BMP) YEARLY MAINTENANCE LOG</u>**

See Operation and Maintenance Plan for required frequency.
Site Owner:____
Site Address: ____
Stormwater BMP's On-site:_______________________________

<u>Deep Sump Hooded Catch Basins</u>
Maintenance Schedule: 4 times per year

Date	Inspector	Depth of Sediment	Sediment Disposal Site	Notes

<u>Detention Basin</u>
Maintenance Schedule: 2 times per year

Date	Inspector	Problem Observed	Action taken	Notes

<u>Swale</u>
Maintenance Schedule: 1 times per year

Date	Inspector	Problem Observed	Action taken	Notes

Roof Drain leaders
Maintenance Schedule: 2 times per year

Date	Inspector	Problem Observed	Action taken	Notes

Infiltration Structures
Maintenance Schedule: 2 times per year

Date	Inspector	Problem Observed	Action taken	Notes

Permeable Asphalt Pavement - non-travelled areas
Maintenance Schedule: 2 times per year

Date	Inspector	Problem Observed	Action taken	Notes

Infiltration Basin
Maintenance Schedule: 2 times per year

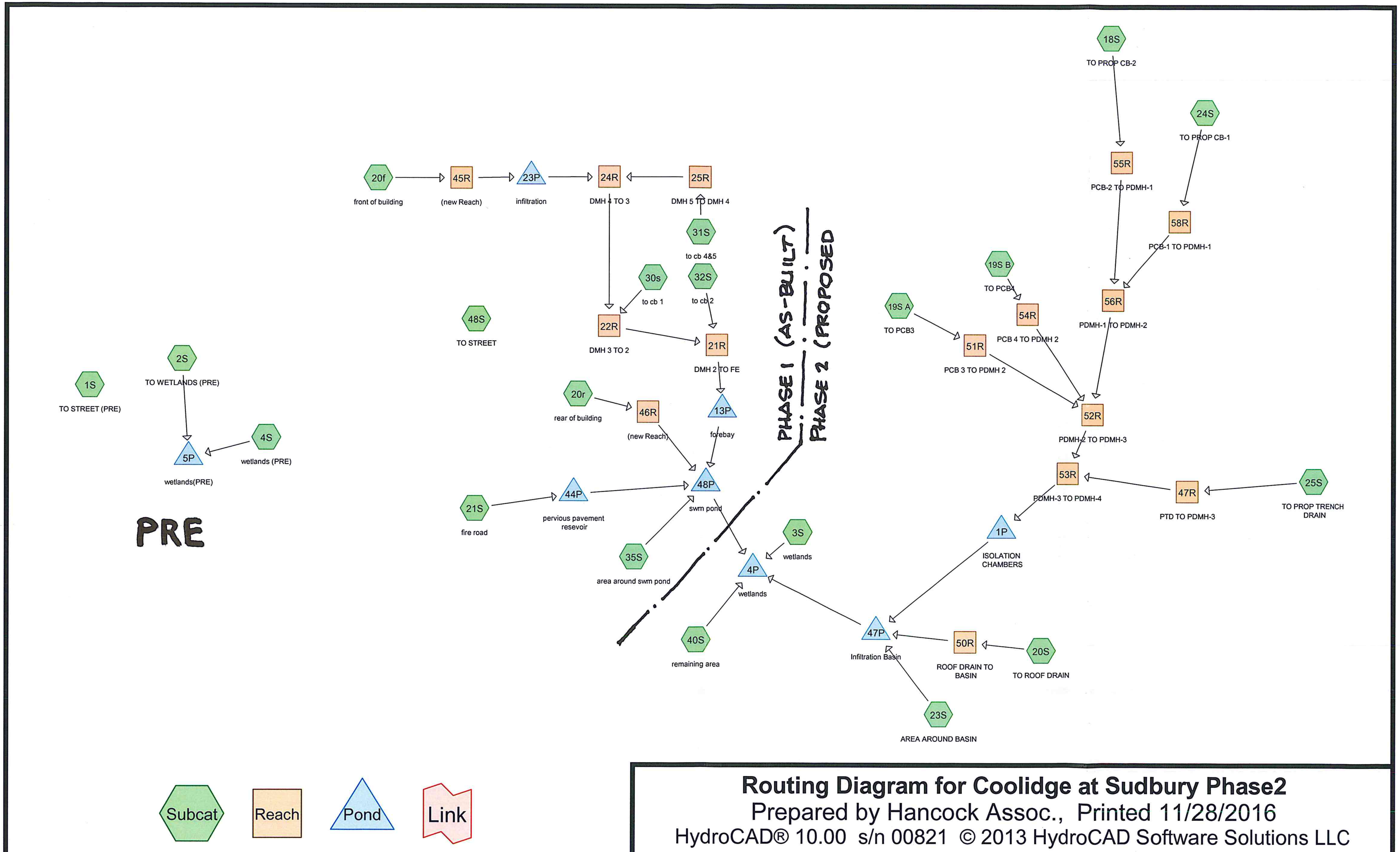
Date	Inspector	Problem Observed	Action taken	Notes

Isolator Row
Maintenance Schedule: 2 times per year

Date	Inspector	Problem Observed	Action taken	Notes

APPENDIX I HydroCAD Output

APPENDIX II NRCS Soils Mapping



Routing Diagram for Coolidge at Sudbury Phase2

Prepared by Hancock Assoc., Printed 11/28/2016

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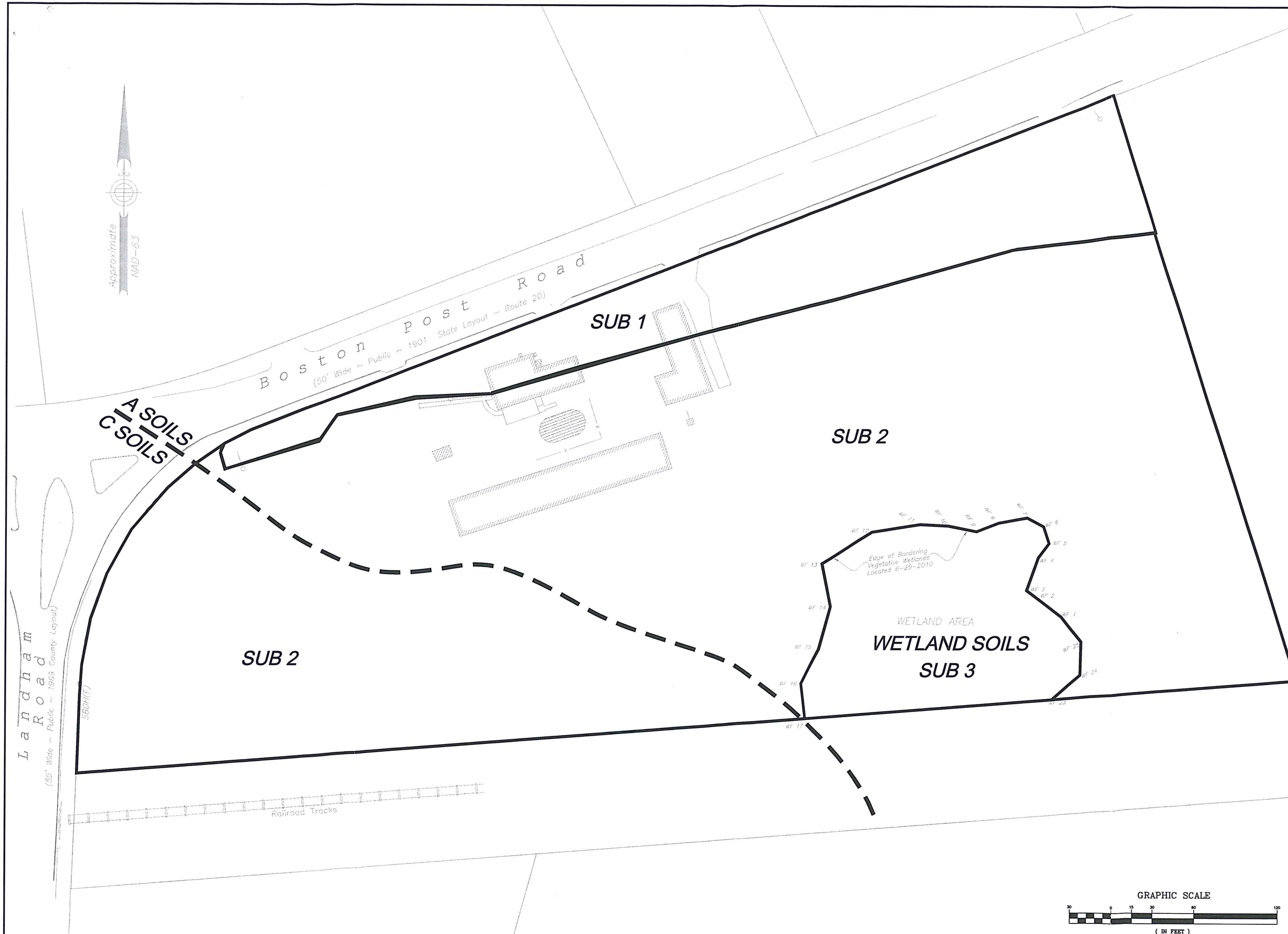

THE COOLIDGE AT SUDBURY

189 Boston Post Road
Sudbury, Massachusetts

PREPARED FOR:

B'nai B'rith Housing New England, Inc.

34 Washington Street
Brighton, Ma

HANCOCK ASSOCIATES

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NO.	BY	APP	DATE	ISSUE/REVISION DESCRIPTION

DATE:	10-10-16	DRAWN BY:	JTL
SCALE:	1"=30'	CHECK BY:	JDP

PRE

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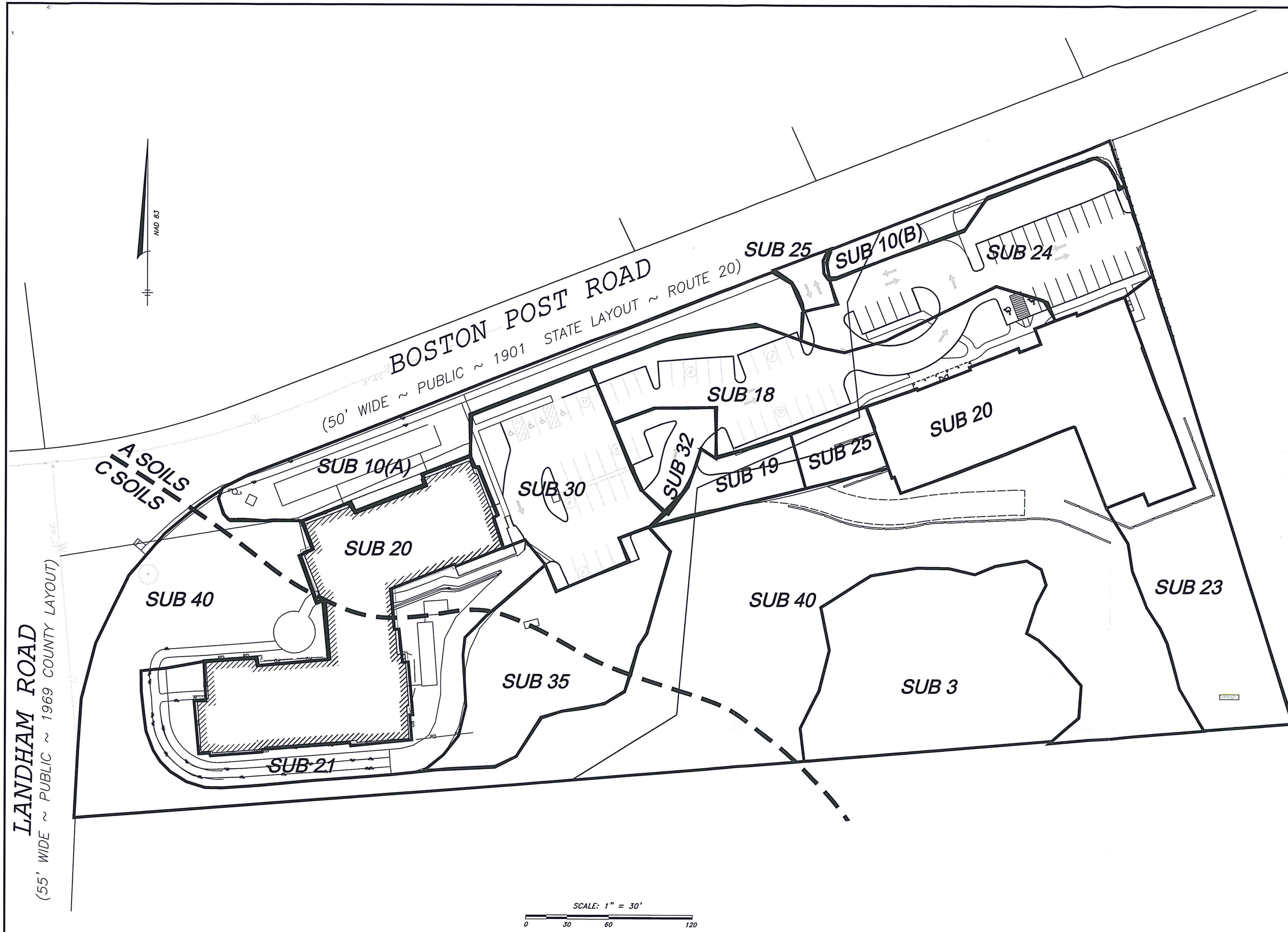
LAYOUT:

SHEET: OF

PROJECT NO.: 15526



187-189 BOSTON POST ROAD

Sudbury, Massachusetts 01776

PREPARED FOR:

B'NAI B'RITH HOUSING NEW ENGLAND

34 Washington Street
Brighton, Massachusetts 02135

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NO.	BY	APP	DATE	ISSUE/REVISION DESCRIPTION

DATE:	11/16/16	DRAWN BY:	JTL
SCALE:	1" = 30'	CHECK BY:	JP

POST SUBCATCHMENT PLAN

PLOT DATE: Nov 23, 2016 8:41 am
PATH: V:\Vol1\HSA\Civil 30 Projects\15526\Source Drawings\

DWG: 15526-11-22-16.dwg

LAYOUT: EX

SHEET: 1 OF 1

POST

PROJECT NO.: 15526

Summary for Subcatchment 1S: TO STREET (PRE)

Runoff = 0.00 cfs @ 17.15 hrs, Volume= 0.001 af, Depth> 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.090	98	Paved parking & roofs
0.060	49	50-75% Grass cover, Fair, HSG A
0.670	35	Brush, Fair, HSG A
0.820	43	Weighted Average
0.730		89.02% Pervious Area
0.090		10.98% Impervious Area

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

Summary for Subcatchment 2S: TO WETLANDS (PRE)

Runoff = 0.20 cfs @ 12.57 hrs, Volume= 0.054 af, Depth> 0.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (sf)	CN	Description
6,970	98	Paved parking & roofs
60,113	49	50-75% Grass cover, Fair, HSG A
73,834	35	Brush, Fair, HSG A
62,726	70	Brush, Fair, HSG C
203,643	52	Weighted Average
196,673		96.58% Pervious Area
6,970		3.42% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	50	0.0700	0.24		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
2.1	170	0.0700	1.32		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.7	320	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
16.2	540	Total			

Summary for Subcatchment 3S: wetlands

Runoff = 1.35 cfs @ 12.14 hrs, Volume= 0.119 af, Depth> 2.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
*	22,018	98	wetland
	22,018		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
5.4	280	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.2	330	Total			

Summary for Subcatchment 4S: wetlands (PRE)

Runoff = 1.35 cfs @ 12.14 hrs, Volume= 0.119 af, Depth> 2.82"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
*	22,018	98	wetland
	22,018		100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.8	50	0.0300	0.17		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.20"
5.4	280	0.0300	0.87		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
10.2	330	Total			

Summary for Subcatchment 18S: TO PROP CB-2

Runoff = 0.90 cfs @ 12.08 hrs, Volume= 0.060 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
*	14,524	98	Paved
	3,789	39	>75% Grass cover, Good, HSG A
	18,313	86	Weighted Average
	3,789		20.69% Pervious Area
	14,524		79.31% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.0					**Direct Entry, 5**

Summary for Subcatchment 19S A: TO PCB3

Runoff = 0.03 cfs @ 12.10 hrs, Volume= 0.003 af, Depth> 0.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
*	1,188	98	Paved
	1,516	39	>75% Grass cover, Good, HSG A
	2,704	65	Weighted Average
	1,516		56.07% Pervious Area
	1,188		43.93% Impervious Area

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

Summary for Subcatchment 19S B: TO PCB4

Runoff = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Depth= 0.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (sf)	CN	Description
1,516	39	>75% Grass cover, Good, HSG A
1,516		100.00% Pervious Area

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

Summary for Subcatchment 20f: front of building

Runoff = 0.49 cfs @ 12.00 hrs, Volume= 0.033 af, Depth> 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
*	6,000	98	
	6,000		100.00% Impervious Area

Summary for Subcatchment 20r: rear of building

Runoff = 1.00 cfs @ 12.07 hrs, Volume= 0.076 af, Depth> 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (sf)	CN	Description
14,000	98	Paved parking & roofs
14,000		100.00% Impervious Area

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

Summary for Subcatchment 20S: TO ROOF DRAIN

Runoff = 1.28 cfs @ 12.07 hrs, Volume= 0.096 af, Depth> 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (sf)	CN	Description
17,814	98	Roofs, HSG A
17,814		100.00% Impervious Area

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

Summary for Subcatchment 21S: fire road

Runoff = 0.58 cfs @ 12.08 hrs, Volume= 0.038 af, Depth> 1.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (ac)	CN	Description
*	0.170	98	pervious pavement
*	0.030	98	patio
	0.060	39	>75% Grass cover, Good, HSG A
	0.060	74	>75% Grass cover, Good, HSG C
	0.320	82	Weighted Average
	0.120		37.50% Pervious Area
	0.200		62.50% Impervious Area

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

Summary for Subcatchment 23S: AREA AROUND BASIN

Runoff = 0.07 cfs @ 12.15 hrs, Volume= 0.010 af, Depth> 0.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
*	5,518	98	POND
	11,914	39	>75% Grass cover, Good, HSG A
	17,432	58	Weighted Average
	11,914		68.35% Pervious Area
	5,518		31.65% Impervious Area

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

Summary for Subcatchment 24S: TO PROP CB-1

Runoff = 0.78 cfs @ 12.08 hrs, Volume= 0.052 af, Depth> 1.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
*	13,415	98	Paved
	4,691	39	>75% Grass cover, Good, HSG A
	18,106	83	Weighted Average
	4,691		25.91% Pervious Area
	13,415		74.09% Impervious Area

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

Summary for Subcatchment 25S: TO PROP TRENCH DRAIN

Runoff = 0.08 cfs @ 12.09 hrs, Volume= 0.005 af, Depth> 0.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
*	1,769	98	Paved
	1,181	39	>75% Grass cover, Good, HSG A
	2,950	74	Weighted Average
	1,181		40.03% Pervious Area
	1,769		59.97% Impervious Area

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

Summary for Subcatchment 30s: to cb 1

Runoff = 0.65 cfs @ 12.08 hrs, Volume= 0.043 af, Depth> 1.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.240	98	Paved parking & roofs
0.060	39	>75% Grass cover, Good, HSG A
0.300	86	Weighted Average
0.060		20.00% Pervious Area
0.240		80.00% Impervious Area

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

Summary for Subcatchment 31S: to cb 4&5

Runoff = 0.06 cfs @ 12.07 hrs, Volume= 0.005 af, Depth> 2.83"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.020	98	Paved parking & roofs
0.020		100.00% Impervious Area

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

Summary for Subcatchment 32S: to cb 2

Runoff = 0.21 cfs @ 12.07 hrs, Volume= 0.014 af, Depth> 2.13"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (ac)	CN	Description
0.070	98	Paved parking & roofs
0.010	39	>75% Grass cover, Good, HSG A
0.080	91	Weighted Average
0.010		12.50% Pervious Area
0.070		87.50% Impervious Area

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

Summary for Subcatchment 35S: area around swm pond

Runoff = 0.44 cfs @ 12.08 hrs, Volume= 0.030 af, Depth> 1.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (ac)	CN	Description
*	0.160	98	pond & forebay
	0.080	39	>75% Grass cover, Good, HSG A
	0.080	74	>75% Grass cover, Good, HSG C
	0.320	77	Weighted Average
	0.160		50.00% Pervious Area
	0.160		50.00% Impervious Area

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

Summary for Subcatchment 40S: remaining area

Runoff = 0.03 cfs @ 13.87 hrs, Volume= 0.015 af, Depth> 0.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

Area (sf)	CN	Description
2,178	98	Paved parking & roofs
10,019	74	>75% Grass cover, Good, HSG C
1,307	39	>75% Grass cover, Good, HSG A
17,424	70	Brush, Fair, HSG C
47,021	35	Brush, Fair, HSG A
77,949	50	Weighted Average
75,771		97.21% Pervious Area
2,178		2.79% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.8	50	0.0100	0.08		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.20"
23.3	700	0.0100	0.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
34.1	750	Total			

Summary for Subcatchment 48S: TO STREET

Runoff = 0.00 cfs @ 14.70 hrs, Volume= 0.002 af, Depth> 0.05"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 YEAR Rainfall=3.20"

	Area (sf)	CN	Description
	14,949	39	>75% Grass cover, Good, HSG A
*	2,283	98	Paved
	17,232	47	Weighted Average
	14,949		86.75% Pervious Area
	2,283		13.25% Impervious Area

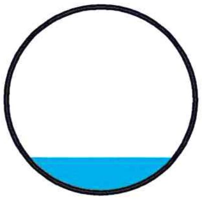
Summary for Reach 21R: DMH 2 TO FE

Inflow Area = 0.538 ac, 86.98% Impervious, Inflow Depth > 1.38" for 2 YEAR event
Inflow = 0.88 cfs @ 12.08 hrs, Volume= 0.062 af
Outflow = 0.88 cfs @ 12.09 hrs, Volume= 0.062 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.81 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.19 fps, Avg. Travel Time= 0.6 min

Peak Storage= 9 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.28'
Bank-Full Depth= 1.50' Flow Area= 1.8 sf, Capacity= 11.38 cfs

18.0" Round Pipe
n= 0.012 Concrete pipe, finished
Length= 40.0' Slope= 0.0100 '/'
Inlet Invert= 144.19', Outlet Invert= 143.79'



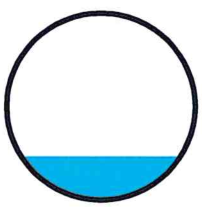
Summary for Reach 22R: DMH 3 TO 2

Inflow Area = 0.458 ac, 86.89% Impervious, Inflow Depth > 1.25" for 2 YEAR event
Inflow = 0.68 cfs @ 12.08 hrs, Volume= 0.048 af
Outflow = 0.67 cfs @ 12.09 hrs, Volume= 0.048 af, Atten= 1%, Lag= 0.5 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.92 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.51 fps, Avg. Travel Time= 0.7 min

Peak Storage= 9 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.23'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 5.78 cfs

12.0" Round Pipe
n= 0.012 Concrete pipe, finished
Length= 62.0' Slope= 0.0224 '/'
Inlet Invert= 145.68', Outlet Invert= 144.29'



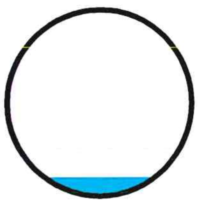
Summary for Reach 24R: DMH 4 TO 3

Inflow Area = 0.158 ac,100.00% Impervious, Inflow Depth > 0.36" for 2 YEAR event
Inflow = 0.06 cfs @ 12.15 hrs, Volume= 0.005 af
Outflow = 0.05 cfs @ 12.20 hrs, Volume= 0.005 af, Atten= 5%, Lag= 2.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.38 fps, Min. Travel Time= 1.6 min
Avg. Velocity = 0.50 fps, Avg. Travel Time= 4.4 min

Peak Storage= 5 cf @ 12.17 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.73 cfs

12.0" Round Pipe
n= 0.012 Concrete pipe, finished
Length= 132.0' Slope= 0.0050 '/'
Inlet Invert= 146.44', Outlet Invert= 145.78'



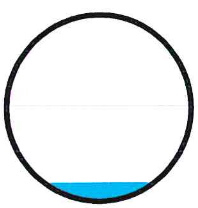
Summary for Reach 25R: DMH 5 TO DMH 4

Inflow Area = 0.020 ac,100.00% Impervious, Inflow Depth > 2.83" for 2 YEAR event
Inflow = 0.06 cfs @ 12.07 hrs, Volume= 0.005 af
Outflow = 0.06 cfs @ 12.15 hrs, Volume= 0.005 af, Atten= 7%, Lag= 4.9 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.44 fps, Min. Travel Time= 2.8 min
Avg. Velocity = 0.52 fps, Avg. Travel Time= 7.8 min

Peak Storage= 10 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.10'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.84 cfs

12.0" Round Pipe
n= 0.012 Concrete pipe, finished
Length= 242.0' Slope= 0.0054 '/'
Inlet Invert= 147.75', Outlet Invert= 146.44'



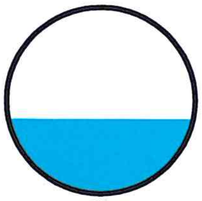
Summary for Reach 45R: (new Reach)

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth > 2.83" for 2 YEAR event
Inflow = 0.49 cfs @ 12.00 hrs, Volume= 0.033 af
Outflow = 0.49 cfs @ 12.00 hrs, Volume= 0.032 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.35 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 1.12 fps, Avg. Travel Time= 0.1 min

Peak Storage= 1 cf @ 12.00 hrs
Average Depth at Peak Storage= 0.20'
Bank-Full Depth= 0.50' Flow Area= 0.4 sf, Capacity= 1.46 cfs

A factor of 2.00 has been applied to the storage and discharge capacity
6.0" Round Pipe
n= 0.010 PVC, smooth interior
Length= 10.0' Slope= 0.0100 '/'
Inlet Invert= 153.10', Outlet Invert= 153.00'



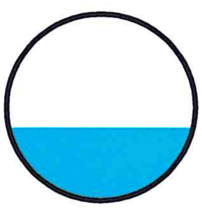
Summary for Reach 46R: (new Reach)

Inflow Area = 0.321 ac,100.00% Impervious, Inflow Depth > 2.83" for 2 YEAR event
Inflow = 1.00 cfs @ 12.07 hrs, Volume= 0.076 af
Outflow = 1.00 cfs @ 12.07 hrs, Volume= 0.076 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.97 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 1.39 fps, Avg. Travel Time= 0.1 min

Peak Storage= 3 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.26'
Bank-Full Depth= 0.67' Flow Area= 0.7 sf, Capacity= 3.14 cfs

A factor of 2.00 has been applied to the storage and discharge capacity
8.0" Round Pipe
n= 0.010 PVC, smooth interior
Length= 10.0' Slope= 0.0100 '/'
Inlet Invert= 145.10', Outlet Invert= 145.00'



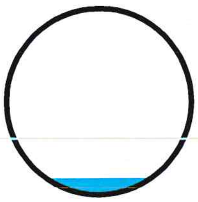
Summary for Reach 47R: PTD TO PDMH-3

Inflow Area = 0.068 ac, 59.97% Impervious, Inflow Depth > 0.95" for 2 YEAR event
Inflow = 0.08 cfs @ 12.09 hrs, Volume= 0.005 af
Outflow = 0.08 cfs @ 12.09 hrs, Volume= 0.005 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 2.36 fps, Min. Travel Time= 0.2 min
Avg. Velocity = 1.02 fps, Avg. Travel Time= 0.4 min

Peak Storage= 1 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.09'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 5.04 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 25.0' Slope= 0.0200 '/'
Inlet Invert= 143.20', Outlet Invert= 142.70'



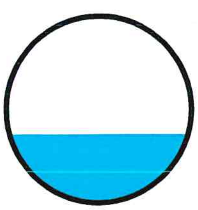
Summary for Reach 50R: ROOF DRAIN TO BASIN

Inflow Area = 0.409 ac,100.00% Impervious, Inflow Depth > 2.83" for 2 YEAR event
Inflow = 1.28 cfs @ 12.07 hrs, Volume= 0.096 af
Outflow = 1.27 cfs @ 12.07 hrs, Volume= 0.096 af, Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.91 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.71 fps, Avg. Travel Time= 0.3 min

Peak Storage= 7 cf @ 12.07 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 4.52 cfs

12.0" Round Pipe
n= 0.011 Concrete pipe, straight & clean
Length= 26.0' Slope= 0.0115 '/'
Inlet Invert= 139.30', Outlet Invert= 139.00'



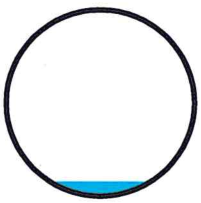
Summary for Reach 51R: PCB 3 TO PDMH 2

Inflow Area = 0.062 ac, 43.93% Impervious, Inflow Depth > 0.53" for 2 YEAR event
Inflow = 0.03 cfs @ 12.10 hrs, Volume= 0.003 af
Outflow = 0.03 cfs @ 12.11 hrs, Volume= 0.003 af, Atten= 2%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 1.24 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 0.60 fps, Avg. Travel Time= 0.9 min

Peak Storage= 1 cf @ 12.11 hrs
Average Depth at Peak Storage= 0.08'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 2.86 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 31.0' Slope= 0.0065 '/'
Inlet Invert= 144.60', Outlet Invert= 144.40'



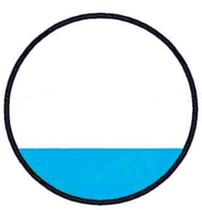
Summary for Reach 52R: PDMH-2 TO PDMH-3

Inflow Area =	0.933 ac, 71.67% Impervious, Inflow Depth > 1.47"	for 2 YEAR event		
Inflow =	1.69 cfs @	12.10 hrs, Volume=	0.115 af	
Outflow =	1.68 cfs @	12.10 hrs, Volume=	0.114 af,	Atten= 1%, Lag= 0.2 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.82 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.18 fps, Avg. Travel Time= 0.4 min

Peak Storage= 14 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.36'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 9.42 cfs

15.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 47.0' Slope= 0.0213 '/'
Inlet Invert= 143.70', Outlet Invert= 142.70'



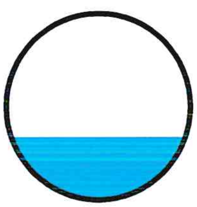
Summary for Reach 53R: PDMH-3 TO PDMH-4

Inflow Area = 1.001 ac, 70.88% Impervious, Inflow Depth > 1.44" for 2 YEAR event
Inflow = 1.76 cfs @ 12.10 hrs, Volume= 0.120 af
Outflow = 1.75 cfs @ 12.10 hrs, Volume= 0.120 af, Atten= 0%, Lag= 0.1 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.86 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 1.83 fps, Avg. Travel Time= 0.2 min

Peak Storage= 9 cf @ 12.10 hrs
Average Depth at Peak Storage= 0.42'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 7.22 cfs

15.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 24.0' Slope= 0.0125 '/'
Inlet Invert= 142.60', Outlet Invert= 142.30'



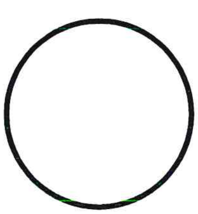
Summary for Reach 54R: PCB 4 TO PDMH 2

Inflow Area = 0.035 ac, 0.00% Impervious, Inflow Depth = 0.00" for 2 YEAR event
Inflow = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 0.00 fps, Min. Travel Time= 0.0 min
Avg. Velocity = 0.00 fps, Avg. Travel Time= 0.0 min

Peak Storage= 0 cf @ 1.00 hrs
Average Depth at Peak Storage= 0.00'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.69 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 17.0' Slope= 0.0353 '/'
Inlet Invert= 145.00', Outlet Invert= 144.40'



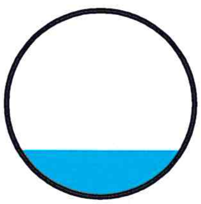
Summary for Reach 55R: PCB-2 TO PDMH-1

Inflow Area = 0.420 ac, 79.31% Impervious, Inflow Depth > 1.71" for 2 YEAR event
Inflow = 0.90 cfs @ 12.08 hrs, Volume= 0.060 af
Outflow = 0.90 cfs @ 12.08 hrs, Volume= 0.060 af, Atten= 0%, Lag= 0.3 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 5.96 fps, Min. Travel Time= 0.1 min
Avg. Velocity = 2.24 fps, Avg. Travel Time= 0.4 min

Peak Storage= 8 cf @ 12.08 hrs
Average Depth at Peak Storage= 0.25'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 6.76 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 50.0' Slope= 0.0360 '/'
Inlet Invert= 148.90', Outlet Invert= 147.10'



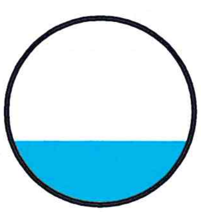
Summary for Reach 56R: PDMH-1 TO PDMH-2

Inflow Area = 0.836 ac, 76.72% Impervious, Inflow Depth > 1.60" for 2 YEAR event
Inflow = 1.67 cfs @ 12.09 hrs, Volume= 0.112 af
Outflow = 1.66 cfs @ 12.10 hrs, Volume= 0.112 af, Atten= 1%, Lag= 0.6 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 4.56 fps, Min. Travel Time= 0.3 min
Avg. Velocity = 1.71 fps, Avg. Travel Time= 0.9 min

Peak Storage= 34 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.43'
Bank-Full Depth= 1.25' Flow Area= 1.2 sf, Capacity= 6.73 cfs

15.0" Round Pipe
n= 0.013 Concrete pipe, bends & connections
Length= 92.0' Slope= 0.0109 '/'
Inlet Invert= 144.80', Outlet Invert= 143.80'



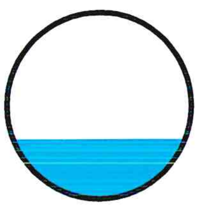
Summary for Reach 58R: PCB-1 TO PDMH-1

Inflow Area = 0.416 ac, 74.09% Impervious, Inflow Depth > 1.50" for 2 YEAR event
Inflow = 0.78 cfs @ 12.08 hrs, Volume= 0.052 af
Outflow = 0.78 cfs @ 12.09 hrs, Volume= 0.052 af, Atten= 1%, Lag= 0.7 min

Routing by Stor-Ind+Trans method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Max. Velocity= 3.65 fps, Min. Travel Time= 0.4 min
Avg. Velocity = 1.42 fps, Avg. Travel Time= 0.9 min

Peak Storage= 17 cf @ 12.09 hrs
Average Depth at Peak Storage= 0.32'
Bank-Full Depth= 1.00' Flow Area= 0.8 sf, Capacity= 3.59 cfs

12.0" Round Pipe
n= 0.013 Corrugated PE, smooth interior
Length= 79.0' Slope= 0.0101 '/'
Inlet Invert= 147.90', Outlet Invert= 147.10'



Summary for Pond 1P: ISOLATION CHAMBERS

Inflow Area = 1.001 ac, 70.88% Impervious, Inflow Depth > 1.44" for 2 YEAR event
Inflow = 1.75 cfs @ 12.10 hrs, Volume= 0.120 af
Outflow = 1.72 cfs @ 12.12 hrs, Volume= 0.118 af, Atten= 2%, Lag= 1.0 min
Primary = 1.72 cfs @ 12.12 hrs, Volume= 0.118 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 142.83' @ 12.12 hrs Surf.Area= 290 sf Storage= 216 cf

Plug-Flow detention time= 10.9 min calculated for 0.118 af (98% of inflow)
Center-of-Mass det. time= 5.1 min (799.9 - 794.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	141.50'	449 cf	**8.42'W x 34.45'L x 5.50'H Field A** 1,595 cf Overall - 471 cf Embedded = 1,124 cf x 40.0% Voids
#2A	142.25'	471 cf	**ADS_StormTech MC-3500 c +Cap** x 4 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap Cap Storage= +15.6 cf x 2 x 1 rows = 31.2 cf
		920 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	144.35'	**15.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	142.10'	**15.0" Round Culvert** L= 130.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 142.10' / 139.50' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=1.66 cfs @ 12.12 hrs HW=142.82' (Free Discharge)
↑—**1=Orifice/Grate** (Controls 0.00 cfs)
└—**2=Culvert** (Inlet Controls 1.66 cfs @ 2.28 fps)

Summary for Pond 4P: wetlands

Inflow Area = 5.604 ac, 52.63% Impervious, Inflow Depth > 0.54" for 2 YEAR event
Inflow = 1.47 cfs @ 12.14 hrs, Volume= 0.253 af
Outflow = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 136.28' @ 20.00 hrs Surf.Area= 16,675 sf Storage= 10,994 cf

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

Volume	Invert	Avail.Storage	Storage Description
#1	135.00'	53,300 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
135.00	0	0	0
136.00	13,600	6,800	6,800
137.00	24,700	19,150	25,950
138.00	30,000	27,350	53,300

Device	Routing	Invert	Outlet Devices
#1	Primary	137.00'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=135.00' (Free Discharge)
└—**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 5P: wetlands(PRE)

Inflow Area = 5.180 ac, 12.85% Impervious, Inflow Depth > 0.40" for 2 YEAR event
Inflow = 1.35 cfs @ 12.14 hrs, Volume= 0.173 af
Outflow = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af, Atten= 100%, Lag= 0.0 min
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 136.05' @ 20.00 hrs Surf.Area= 14,195 sf Storage= 7,544 cf

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

Volume	Invert	Avail.Storage	Storage Description
#1	135.00'	53,300 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
135.00	0	0	0
136.00	13,600	6,800	6,800
137.00	24,700	19,150	25,950
138.00	30,000	27,350	53,300

Device	Routing	Invert	Outlet Devices
#1	Primary	137.00'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=135.00' (Free Discharge)
↑**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 13P: forebay

Inflow Area = 0.538 ac, 86.98% Impervious, Inflow Depth > 1.38" for 2 YEAR event
Inflow = 0.88 cfs @ 12.09 hrs, Volume= 0.062 af
Outflow = 0.87 cfs @ 12.10 hrs, Volume= 0.057 af, Atten= 0%, Lag= 0.8 min
Primary = 0.87 cfs @ 12.10 hrs, Volume= 0.057 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 143.20' @ 12.10 hrs Surf.Area= 479 sf Storage= 250 cf

Plug-Flow detention time= 43.1 min calculated for 0.057 af (93% of inflow)
Center-of-Mass det. time= 17.5 min (797.6 - 780.1)

Volume	Invert	Avail.Storage	Storage Description
#1	142.00'	251 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
142.00	51	0	0
142.50	160	53	53
143.00	314	119	171
143.20	480	79	251

Device	Routing	Invert	Outlet Devices
#1	Primary	143.08'	**9.0' long x 4.0' breadth Broad-Crested Rectangular Weir**

Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00
2.50 3.00 3.50 4.00 4.50 5.00 5.50
Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66
2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=0.87 cfs @ 12.10 hrs HW=143.20' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 0.87 cfs @ 0.82 fps)

Summary for Pond 23P: infiltration

Inflow Area =	0.138 ac,100.00% Impervious,	Inflow Depth > 2.83"	for 2 YEAR event
Inflow =	0.49 cfs @ 12.00 hrs, Volume=	0.032 af	
Outflow =	0.00 cfs @ 1.00 hrs, Volume=	0.000 af, Atten= 100%, Lag= 0.0 min	
Discarded =	0.00 cfs @ 1.00 hrs, Volume=	0.000 af	
Primary =	0.00 cfs @ 1.00 hrs, Volume=	0.000 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 151.63' @ 20.00 hrs Surf.Area= 1,800 sf Storage= 1,415 cf

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

Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	1,597 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 5,501 cf Overall - 1,508 cf Embedded = 3,993 cf x 40.0% Voids
#2	151.00'	1,508 cf	**24.0" Round Pipe Storage** x 4 Inside #1 L= 120.0'
		3,105 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
150.00	1,800	0	0
153.00	1,800	5,400	5,400
153.10	12	91	5,491
154.00	12	11	5,501

Device	Routing	Invert	Outlet Devices
#1	Discarded	150.00'	**2.400 in/hr Exfiltration over Horizontal area above 150.00'** Excluded Horizontal area = 1,800 sf
#2	Primary	153.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.00 cfs @ 1.00 hrs HW=150.00' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=150.00' (Free Discharge)
↑—**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 44P: pervious pavement resevoir

Inflow Area = 0.320 ac, 62.50% Impervious, Inflow Depth > 1.43" for 2 YEAR event
Inflow = 0.58 cfs @ 12.08 hrs, Volume= 0.038 af
Outflow = 0.08 cfs @ 12.69 hrs, Volume= 0.019 af, Atten= 86%, Lag= 36.8 min
Discarded = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Primary = 0.08 cfs @ 12.69 hrs, Volume= 0.019 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 141.56' @ 12.69 hrs Surf.Area= 4,059 sf Storage= 911 cf

Plug-Flow detention time= 181.7 min calculated for 0.019 af (49% of inflow)
Center-of-Mass det. time= 98.4 min (896.2 - 797.8)

Volume	Invert	Avail.Storage	Storage Description
#1	141.00'	4,871 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 12,177 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
141.00	4,059	0	0
143.00	4,059	8,118	8,118
144.00	4,059	4,059	12,177

Device	Routing	Invert	Outlet Devices
#1	Primary	141.50'	**6.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	143.70'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#3	Discarded	141.00'	**0.270 in/hr Exfiltration over Horizontal area above 141.00'** Excluded Horizontal area = 4,059 sf

Discarded OutFlow Max=0.00 cfs @ 1.00 hrs HW=141.00' (Free Discharge)
└─**3=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.08 cfs @ 12.69 hrs HW=141.56' (Free Discharge)
├─**1=Orifice/Grate** (Weir Controls 0.08 cfs @ 0.81 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 47P: Infiltration Basin

Inflow Area = 1.810 ac, 68.79% Impervious, Inflow Depth > 1.49" for 2 YEAR event
Inflow = 2.98 cfs @ 12.10 hrs, Volume= 0.224 af
Outflow = 2.96 cfs @ 12.11 hrs, Volume= 0.224 af, Atten= 0%, Lag= 0.5 min
Discarded = 2.96 cfs @ 12.11 hrs, Volume= 0.224 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs

Peak Elev= 138.02' @ 12.11 hrs Surf.Area= 4,609 sf Storage= 82 cf

Plug-Flow detention time= 0.5 min calculated for 0.224 af (100% of inflow)
Center-of-Mass det. time= 0.4 min (772.5 - 772.1)

Volume	Invert	Avail.Storage	Storage Description
#1	138.00'	11,054 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
138.00	4,593	0	0	4,593
139.00	5,518	5,048	5,048	5,552
140.00	6,507	6,006	11,054	6,578

Device	Routing	Invert	Outlet Devices
#1	Discarded	138.00'	**31.000 in/hr Exfiltration over Wetted area**
#2	Primary	139.60'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=3.31 cfs @ 12.11 hrs HW=138.02' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 3.31 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=138.00' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 48P: swm pond

Inflow Area =	1.499 ac, 76.65% Impervious, Inflow Depth > 1.45" for 2 YEAR event		
Inflow =	2.29 cfs @ 12.09 hrs, Volume=	0.181 af	
Outflow =	0.20 cfs @ 13.88 hrs, Volume=	0.119 af,	Atten= 91%, Lag= 107.8 min
Primary =	0.20 cfs @ 13.88 hrs, Volume=	0.119 af	

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 141.83' @ 13.88 hrs Surf.Area= 4,023 sf Storage= 3,855 cf

Plug-Flow detention time= 180.3 min calculated for 0.119 af (66% of inflow)
Center-of-Mass det. time= 99.8 min (880.6 - 780.9)

Volume	Invert	Avail.Storage	Storage Description
#1	140.50'	11,889 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
140.50	1,453	0	0
141.50	3,690	2,572	2,572
142.00	4,190	1,970	4,542
142.50	4,703	2,223	6,765
143.00	5,265	2,492	9,257
143.50	5,265	2,633	11,889

Device	Routing	Invert	Outlet Devices
#1	Primary	140.11'	**2.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	141.70'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	142.88'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	142.93'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=0.20 cfs @ 13.88 hrs HW=141.83' (Free Discharge)
- **1=Orifice/Grate** (Orifice Controls 0.13 cfs @ 6.17 fps)
- **2=Orifice/Grate** (Orifice Controls 0.06 cfs @ 1.24 fps)
- **3=Orifice/Grate** (Controls 0.00 cfs)
- **4=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: TO STREET (PRE) Runoff Area=0.820 ac 10.98% Impervious Runoff Depth>0.25"
Tc=5.0 min CN=43 Runoff=0.09 cfs 0.017 af

Subcatchment 2S: TO WETLANDS (PRE) Runoff Area=203,643 sf 3.42% Impervious Runoff Depth>0.62"
Flow Length=540' Tc=16.2 min CN=52 Runoff=1.93 cfs 0.243 af

Subcatchment 3S: wetlands Runoff Area=22,018 sf 100.00% Impervious Runoff Depth>4.35"
Flow Length=330' Slope=0.0300 '/' Tc=10.2 min CN=98 Runoff=2.04 cfs 0.183 af

Subcatchment 4S: wetlands (PRE) Runoff Area=22,018 sf 100.00% Impervious Runoff Depth>4.35"
Flow Length=330' Slope=0.0300 '/' Tc=10.2 min CN=98 Runoff=2.04 cfs 0.183 af

Subcatchment 18S: TO PROP CB-2 Runoff Area=18,313 sf 79.31% Impervious Runoff Depth>3.09"
Tc=5.0 min CN=86 Runoff=1.61 cfs 0.108 af

Subcatchment 19S A: TO PCB3 Runoff Area=2,704 sf 43.93% Impervious Runoff Depth>1.39"
Tc=5.0 min CN=65 Runoff=0.11 cfs 0.007 af

Subcatchment 19S B: TO PCB4 Runoff Area=1,516 sf 0.00% Impervious Runoff Depth>0.12"
Tc=5.0 min CN=39 Runoff=0.00 cfs 0.000 af

Subcatchment 20f: front of building Runoff Area=6,000 sf 100.00% Impervious Runoff Depth>4.36"
Tc=0.0 min CN=98 Runoff=0.74 cfs 0.050 af

Subcatchment 20r: rear of building Runoff Area=14,000 sf 100.00% Impervious Runoff Depth>4.35"
Tc=5.0 min CN=98 Runoff=1.52 cfs 0.117 af

Subcatchment 20S: TO ROOF DRAIN Runoff Area=17,814 sf 100.00% Impervious Runoff Depth>4.35"
Tc=5.0 min CN=98 Runoff=1.93 cfs 0.148 af

Subcatchment 21S: fire road Runoff Area=0.320 ac 62.50% Impervious Runoff Depth>2.72"
Tc=5.0 min CN=82 Runoff=1.09 cfs 0.072 af

Subcatchment 23S: AREA AROUND BASIN Runoff Area=17,432 sf 31.65% Impervious Runoff Depth>0.95"
Tc=5.0 min CN=58 Runoff=0.43 cfs 0.032 af

Subcatchment 24S: TO PROP CB-1 Runoff Area=18,106 sf 74.09% Impervious Runoff Depth>2.81"
Tc=5.0 min CN=83 Runoff=1.45 cfs 0.097 af

Subcatchment 25S: TO PROP TRENCH Runoff Area=2,950 sf 59.97% Impervious Runoff Depth>2.04"
Tc=5.0 min CN=74 Runoff=0.17 cfs 0.012 af

Subcatchment 30s: to cb 1 Runoff Area=0.300 ac 80.00% Impervious Runoff Depth>3.09"
Tc=5.0 min CN=86 Runoff=1.15 cfs 0.077 af

Subcatchment 31S: to cb 4&5 Runoff Area=0.020 ac 100.00% Impervious Runoff Depth>4.35"
Tc=5.0 min CN=98 Runoff=0.09 cfs 0.007 af

Subcatchment 32S: to cb 2 Runoff Area=0.080 ac 87.50% Impervious Runoff Depth>3.59"
Tc=5.0 min CN=91 Runoff=0.34 cfs 0.024 af

Subcatchment 35S: area around swm pond Runoff Area=0.320 ac 50.00% Impervious Runoff Depth>2.28"
Tc=5.0 min CN=77 Runoff=0.92 cfs 0.061 af

Subcatchment 40S: remaining area Runoff Area=77,949 sf 2.79% Impervious Runoff Depth>0.52"
Flow Length=750' Slope=0.0100 '/' Tc=34.1 min CN=50 Runoff=0.44 cfs 0.078 af

Subcatchment 48S: TO STREET Runoff Area=17,232 sf 13.25% Impervious Runoff Depth>0.40"
Tc=0.0 min CN=47 Runoff=0.11 cfs 0.013 af

Reach 21R: DMH 2 TO FE Avg. Flow Depth=0.37' Max Vel=4.47 fps Inflow=1.53 cfs 0.108 af
18.0" Round Pipe n=0.012 L=40.0' S=0.0100 '/' Capacity=11.38 cfs Outflow=1.52 cfs 0.108 af

Reach 22R: DMH 3 TO 2 Avg. Flow Depth=0.31' Max Vel=5.77 fps Inflow=1.19 cfs 0.084 af
12.0" Round Pipe n=0.012 L=62.0' S=0.0224 '/' Capacity=5.78 cfs Outflow=1.19 cfs 0.084 af

Reach 24R: DMH 4 TO 3 Avg. Flow Depth=0.12' Max Vel=1.58 fps Inflow=0.09 cfs 0.007 af
12.0" Round Pipe n=0.012 L=132.0' S=0.0050 '/' Capacity=2.73 cfs Outflow=0.08 cfs 0.007 af

Reach 25R: DMH 5 TO DMH 4 Avg. Flow Depth=0.12' Max Vel=1.64 fps Inflow=0.09 cfs 0.007 af
12.0" Round Pipe n=0.012 L=242.0' S=0.0054 '/' Capacity=2.84 cfs Outflow=0.09 cfs 0.007 af

Reach 45R: (new Reach) Avg. Flow Depth=0.25' Max Vel=3.73 fps Inflow=0.74 cfs 0.050 af
6.0" Round Pipe x 2.00 n=0.010 L=10.0' S=0.0100 '/' Capacity=1.46 cfs Outflow=0.74 cfs 0.050 af

Reach 46R: (new Reach) Avg. Flow Depth=0.33' Max Vel=4.43 fps Inflow=1.52 cfs 0.117 af
8.0" Round Pipe x 2.00 n=0.010 L=10.0' S=0.0100 '/' Capacity=3.14 cfs Outflow=1.51 cfs 0.117 af

Reach 47R: PTD TO PDMH-3 Avg. Flow Depth=0.13' Max Vel=2.99 fps Inflow=0.17 cfs 0.012 af
12.0" Round Pipe n=0.013 L=25.0' S=0.0200 '/' Capacity=5.04 cfs Outflow=0.17 cfs 0.012 af

Reach 50R: ROOF DRAIN TO BASIN Avg. Flow Depth=0.46' Max Vel=5.49 fps Inflow=1.93 cfs 0.148 af
12.0" Round Pipe n=0.011 L=26.0' S=0.0115 '/' Capacity=4.52 cfs Outflow=1.92 cfs 0.148 af

Reach 51R: PCB 3 TO PDMH 2 Avg. Flow Depth=0.13' Max Vel=1.73 fps Inflow=0.11 cfs 0.007 af
12.0" Round Pipe n=0.013 L=31.0' S=0.0065 '/' Capacity=2.86 cfs Outflow=0.10 cfs 0.007 af

Reach 52R: PDMH-2 TO PDMH-3 Avg. Flow Depth=0.49' Max Vel=6.88 fps Inflow=3.11 cfs 0.213 af
15.0" Round Pipe n=0.013 L=47.0' S=0.0213 '/' Capacity=9.42 cfs Outflow=3.09 cfs 0.213 af

Reach 53R: PDMH-3 TO PDMH-4 Avg. Flow Depth=0.59' Max Vel=5.74 fps Inflow=3.27 cfs 0.224 af
15.0" Round Pipe n=0.013 L=24.0' S=0.0125 '/' Capacity=7.22 cfs Outflow=3.26 cfs 0.224 af

Reach 54R: PCB 4 TO PDMH 2 Avg. Flow Depth=0.01' Max Vel=0.76 fps Inflow=0.00 cfs 0.000 af
12.0" Round Pipe n=0.013 L=17.0' S=0.0353 '/' Capacity=6.69 cfs Outflow=0.00 cfs 0.000 af

Reach 55R: PCB-2 TO PDMH-1 Avg. Flow Depth=0.33' Max Vel=6.99 fps Inflow=1.61 cfs 0.108 af
12.0" Round Pipe n=0.013 L=50.0' S=0.0360 '/' Capacity=6.76 cfs Outflow=1.59 cfs 0.108 af

Reach 56R: PDMH-1 TO PDMH-2 Avg. Flow Depth=0.59' Max Vel=5.33 fps Inflow=3.03 cfs 0.205 af
15.0" Round Pipe n=0.013 L=92.0' S=0.0109 '/' Capacity=6.73 cfs Outflow=3.00 cfs 0.205 af

Reach 58R: PCB-1 TO PDMH-1 Avg. Flow Depth=0.44' Max Vel=4.31 fps Inflow=1.45 cfs 0.097 af
12.0" Round Pipe n=0.013 L=79.0' S=0.0101 '/' Capacity=3.59 cfs Outflow=1.44 cfs 0.097 af

Pond 1P: ISOLATION CHAMBERS Peak Elev=143.19' Storage=295 cf Inflow=3.26 cfs 0.224 af
Outflow=3.20 cfs 0.222 af

Pond 4P: wetlands Peak Elev=136.86' Storage=22,640 cf Inflow=2.49 cfs 0.520 af
Outflow=0.00 cfs 0.000 af

Pond 5P: wetlands(PRE) Peak Elev=136.68' Storage=18,562 cf Inflow=3.35 cfs 0.426 af
Outflow=0.00 cfs 0.000 af

Pond 13P: forebay Peak Elev=143.25' Storage=251 cf Inflow=1.52 cfs 0.108 af
Outflow=1.55 cfs 0.104 af

Pond 23P: infiltration Peak Elev=152.22' Storage=2,179 cf Inflow=0.74 cfs 0.050 af
Discarded=0.00 cfs 0.000 af Primary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.000 af

Pond 44P: pervious pavement resevoir Peak Elev=141.77' Storage=1,247 cf Inflow=1.09 cfs 0.072 af
Discarded=0.00 cfs 0.000 af Primary=0.49 cfs 0.053 af Outflow=0.49 cfs 0.053 af

Pond 47P: Infiltration Basin Peak Elev=138.21' Storage=965 cf Inflow=5.45 cfs 0.402 af
Discarded=3.43 cfs 0.402 af Primary=0.00 cfs 0.000 af Outflow=3.43 cfs 0.402 af

Pond 48P: swm pond Peak Elev=142.34' Storage=6,043 cf Inflow=4.19 cfs 0.334 af
Outflow=1.10 cfs 0.259 af

Time span=1.00-20.00 hrs, dt=0.05 hrs, 381 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1S: TO STREET (PRE) Runoff Area=0.820 ac 10.98% Impervious Runoff Depth>1.65"
Tc=5.0 min CN=43 Runoff=1.50 cfs 0.113 af

Subcatchment 2S: TO WETLANDS (PRE) Runoff Area=203,643 sf 3.42% Impervious Runoff Depth>2.59"
Flow Length=540' Tc=16.2 min CN=52 Runoff=10.79 cfs 1.010 af

Subcatchment 3S: wetlands Runoff Area=22,018 sf 100.00% Impervious Runoff Depth>7.97"
Flow Length=330' Slope=0.0300 '/' Tc=10.2 min CN=98 Runoff=3.68 cfs 0.336 af

Subcatchment 4S: wetlands (PRE) Runoff Area=22,018 sf 100.00% Impervious Runoff Depth>7.97"
Flow Length=330' Slope=0.0300 '/' Tc=10.2 min CN=98 Runoff=3.68 cfs 0.336 af

Subcatchment 18S: TO PROP CB-2 Runoff Area=18,313 sf 79.31% Impervious Runoff Depth>6.55"
Tc=5.0 min CN=86 Runoff=3.27 cfs 0.229 af

Subcatchment 19S A: TO PCB3 Runoff Area=2,704 sf 43.93% Impervious Runoff Depth>4.08"
Tc=5.0 min CN=65 Runoff=0.32 cfs 0.021 af

Subcatchment 19S B: TO PCB4 Runoff Area=1,516 sf 0.00% Impervious Runoff Depth>1.25"
Tc=5.0 min CN=39 Runoff=0.04 cfs 0.004 af

Subcatchment 20f: front of building Runoff Area=6,000 sf 100.00% Impervious Runoff Depth>7.99"
Tc=0.0 min CN=98 Runoff=1.33 cfs 0.092 af

Subcatchment 20r: rear of building Runoff Area=14,000 sf 100.00% Impervious Runoff Depth>7.98"
Tc=5.0 min CN=98 Runoff=2.73 cfs 0.214 af

Subcatchment 20S: TO ROOF DRAIN Runoff Area=17,814 sf 100.00% Impervious Runoff Depth>7.98"
Tc=5.0 min CN=98 Runoff=3.48 cfs 0.272 af

Subcatchment 21S: fire road Runoff Area=0.320 ac 62.50% Impervious Runoff Depth>6.07"
Tc=5.0 min CN=82 Runoff=2.36 cfs 0.162 af

Subcatchment 23S: AREA AROUND BASIN Runoff Area=17,432 sf 31.65% Impervious Runoff Depth>3.28"
Tc=5.0 min CN=58 Runoff=1.65 cfs 0.109 af

Subcatchment 24S: TO PROP CB-1 Runoff Area=18,106 sf 74.09% Impervious Runoff Depth>6.19"
Tc=5.0 min CN=83 Runoff=3.11 cfs 0.214 af

Subcatchment 25S: TO PROP TRENCH Runoff Area=2,950 sf 59.97% Impervious Runoff Depth>5.13"
Tc=5.0 min CN=74 Runoff=0.43 cfs 0.029 af

Subcatchment 30s: to cb 1 Runoff Area=0.300 ac 80.00% Impervious Runoff Depth>6.55"
Tc=5.0 min CN=86 Runoff=2.34 cfs 0.164 af

Subcatchment 31S: to cb 4&5 Runoff Area=0.020 ac 100.00% Impervious Runoff Depth>7.98"
Tc=5.0 min CN=98 Runoff=0.17 cfs 0.013 af

Subcatchment 32S: to cb 2 Runoff Area=0.080 ac 87.50% Impervious Runoff Depth>7.15"
Tc=5.0 min CN=91 Runoff=0.66 cfs 0.048 af

Subcatchment 35S: area around swm pond Runoff Area=0.320 ac 50.00% Impervious Runoff Depth>5.48"
Tc=5.0 min CN=77 Runoff=2.17 cfs 0.146 af

Subcatchment 40S: remaining area Runoff Area=77,949 sf 2.79% Impervious Runoff Depth>2.36"
Flow Length=750' Slope=0.0100 '/' Tc=34.1 min CN=50 Runoff=2.73 cfs 0.351 af

Subcatchment 48S: TO STREET Runoff Area=17,232 sf 13.25% Impervious Runoff Depth>2.07"
Tc=0.0 min CN=47 Runoff=1.10 cfs 0.068 af

Reach 21R: DMH 2 TO FE Avg. Flow Depth=0.53' Max Vel=5.43 fps Inflow=3.06 cfs 0.246 af
18.0" Round Pipe n=0.012 L=40.0' S=0.0100 '/' Capacity=11.38 cfs Outflow=3.05 cfs 0.246 af

Reach 22R: DMH 3 TO 2 Avg. Flow Depth=0.45' Max Vel=6.99 fps Inflow=2.44 cfs 0.198 af
12.0" Round Pipe n=0.012 L=62.0' S=0.0224 '/' Capacity=5.78 cfs Outflow=2.41 cfs 0.198 af

Reach 24R: DMH 4 TO 3 Avg. Flow Depth=0.16' Max Vel=1.89 fps Inflow=0.16 cfs 0.034 af
12.0" Round Pipe n=0.012 L=132.0' S=0.0050 '/' Capacity=2.73 cfs Outflow=0.15 cfs 0.034 af

Reach 25R: DMH 5 TO DMH 4 Avg. Flow Depth=0.16' Max Vel=1.97 fps Inflow=0.17 cfs 0.013 af
12.0" Round Pipe n=0.012 L=242.0' S=0.0054 '/' Capacity=2.84 cfs Outflow=0.16 cfs 0.013 af

Reach 45R: (new Reach) Avg. Flow Depth=0.38' Max Vel=4.21 fps Inflow=1.33 cfs 0.092 af
6.0" Round Pipe x 2.00 n=0.010 L=10.0' S=0.0100 '/' Capacity=1.46 cfs Outflow=1.33 cfs 0.092 af

Reach 46R: (new Reach) Avg. Flow Depth=0.48' Max Vel=5.05 fps Inflow=2.73 cfs 0.214 af
8.0" Round Pipe x 2.00 n=0.010 L=10.0' S=0.0100 '/' Capacity=3.14 cfs Outflow=2.73 cfs 0.214 af

Reach 47R: PTD TO PDMH-3 Avg. Flow Depth=0.20' Max Vel=3.89 fps Inflow=0.43 cfs 0.029 af
12.0" Round Pipe n=0.013 L=25.0' S=0.0200 '/' Capacity=5.04 cfs Outflow=0.43 cfs 0.029 af

Reach 50R: ROOF DRAIN TO BASIN Avg. Flow Depth=0.66' Max Vel=6.31 fps Inflow=3.48 cfs 0.272 af
12.0" Round Pipe n=0.011 L=26.0' S=0.0115 '/' Capacity=4.52 cfs Outflow=3.46 cfs 0.272 af

Reach 51R: PCB 3 TO PDMH 2 Avg. Flow Depth=0.23' Max Vel=2.40 fps Inflow=0.32 cfs 0.021 af
12.0" Round Pipe n=0.013 L=31.0' S=0.0065 '/' Capacity=2.86 cfs Outflow=0.32 cfs 0.021 af

Reach 52R: PDMH-2 TO PDMH-3 Avg. Flow Depth=0.77' Max Vel=8.30 fps Inflow=6.61 cfs 0.468 af
15.0" Round Pipe n=0.013 L=47.0' S=0.0213 '/' Capacity=9.42 cfs Outflow=6.59 cfs 0.468 af

Reach 53R: PDMH-3 TO PDMH-4 Avg. Flow Depth=0.99' Max Vel=6.70 fps Inflow=7.02 cfs 0.497 af
15.0" Round Pipe n=0.013 L=24.0' S=0.0125 '/' Capacity=7.22 cfs Outflow=7.00 cfs 0.497 af

Reach 54R: PCB 4 TO PDMH 2 Avg. Flow Depth=0.06' Max Vel=2.39 fps Inflow=0.04 cfs 0.004 af
12.0" Round Pipe n=0.013 L=17.0' S=0.0353 '/' Capacity=6.69 cfs Outflow=0.04 cfs 0.004 af

Reach 55R: PCB-2 TO PDMH-1 Avg. Flow Depth=0.49' Max Vel=8.46 fps Inflow=3.27 cfs 0.229 af
12.0" Round Pipe n=0.013 L=50.0' S=0.0360 '/' Capacity=6.76 cfs Outflow=3.23 cfs 0.229 af

Reach 56R: PDMH-1 TO PDMH-2 Avg. Flow Depth=0.96' Max Vel=6.23 fps Inflow=6.29 cfs 0.444 af
15.0" Round Pipe n=0.013 L=92.0' S=0.0109 '/' Capacity=6.73 cfs Outflow=6.25 cfs 0.444 af

Reach 58R: PCB-1 TO PDMH-1 Avg. Flow Depth=0.72' Max Vel=5.12 fps Inflow=3.11 cfs 0.214 af
12.0" Round Pipe n=0.013 L=79.0' S=0.0101 '/' Capacity=3.59 cfs Outflow=3.06 cfs 0.214 af

Pond 1P: ISOLATION CHAMBERS Peak Elev=144.63' Storage=590 cf Inflow=7.00 cfs 0.497 af
Outflow=6.75 cfs 0.495 af

Pond 4P: wetlands Peak Elev=137.16' Storage=29,909 cf Inflow=10.77 cfs 1.342 af
Outflow=2.98 cfs 0.722 af

Pond 5P: wetlands(PRE) Peak Elev=137.17' Storage=30,345 cf Inflow=13.69 cfs 1.346 af
Outflow=3.48 cfs 0.726 af

Pond 13P: forebay Peak Elev=143.35' Storage=251 cf Inflow=3.05 cfs 0.246 af
Outflow=3.03 cfs 0.241 af

Pond 23P: infiltration Peak Elev=153.03' Storage=3,084 cf Inflow=1.33 cfs 0.092 af
Discarded=0.00 cfs 0.000 af Primary=0.08 cfs 0.021 af Outflow=0.08 cfs 0.021 af

Pond 44P: pervious pavement resevoir Peak Elev=142.44' Storage=2,344 cf Inflow=2.36 cfs 0.162 af
Discarded=0.00 cfs 0.000 af Primary=0.92 cfs 0.142 af Outflow=0.92 cfs 0.142 af

Pond 47P: Infiltration Basin Peak Elev=139.23' Storage=6,340 cf Inflow=11.62 cfs 0.876 af
Discarded=4.15 cfs 0.876 af Primary=0.00 cfs 0.000 af Outflow=4.15 cfs 0.876 af

Pond 48P: swm pond Peak Elev=143.09' Storage=9,731 cf Inflow=8.65 cfs 0.743 af
Outflow=5.93 cfs 0.655 af

Summary for Pond 1P: ISOLATION CHAMBERS

Inflow Area = 1.001 ac, 70.88% Impervious, Inflow Depth > 5.96" for 100 YEAR event
Inflow = 7.00 cfs @ 12.09 hrs, Volume= 0.497 af
Outflow = 6.75 cfs @ 12.11 hrs, Volume= 0.495 af, Atten= 4%, Lag= 1.2 min
Primary = 6.75 cfs @ 12.11 hrs, Volume= 0.495 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 144.63' @ 12.12 hrs Surf.Area= 290 sf Storage= 590 cf

Plug-Flow detention time= 4.7 min calculated for 0.495 af (100% of inflow)
Center-of-Mass det. time= 3.0 min (765.9 - 762.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	141.50'	449 cf	**8.42'W x 34.45'L x 5.50'H Field A** 1,595 cf Overall - 471 cf Embedded = 1,124 cf x 40.0% Voids
#2A	142.25'	471 cf	**ADS_StormTech MC-3500 c +Cap** x 4 Inside #1 Effective Size= 70.4"W x 45.0"H => 15.33 sf x 7.17'L = 110.0 cf Overall Size= 77.0"W x 45.0"H x 7.50'L with 0.33' Overlap Cap Storage= +15.6 cf x 2 x 1 rows = 31.2 cf
		920 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	144.35'	**15.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	142.10'	**15.0" Round Culvert** L= 130.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 142.10' / 139.50' S= 0.0200 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=6.56 cfs @ 12.11 hrs HW=144.57' (Free Discharge)
├─**1=Orifice/Grate** (Orifice Controls 0.23 cfs @ 1.59 fps)
└─**2=Culvert** (Inlet Controls 6.33 cfs @ 5.16 fps)

Summary for Pond 4P: wetlands

Inflow Area = 5.604 ac, 52.63% Impervious, Inflow Depth > 2.87" for 100 YEAR event
Inflow = 10.77 cfs @ 12.17 hrs, Volume= 1.342 af
Outflow = 2.98 cfs @ 13.18 hrs, Volume= 0.722 af, Atten= 72%, Lag= 60.6 min
Primary = 2.98 cfs @ 13.18 hrs, Volume= 0.722 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 137.16' @ 13.18 hrs Surf.Area= 25,535 sf Storage= 29,909 cf

Plug-Flow detention time= 210.0 min calculated for 0.722 af (54% of inflow)
Center-of-Mass det. time= 110.1 min (905.2 - 795.1)

Volume	Invert	Avail.Storage	Storage Description
#1	135.00'	53,300 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
135.00	0	0	0
136.00	13,600	6,800	6,800
137.00	24,700	19,150	25,950
138.00	30,000	27,350	53,300

Device	Routing	Invert	Outlet Devices
#1	Primary	137.00'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=2.98 cfs @ 13.18 hrs HW=137.16' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 2.98 cfs @ 0.94 fps)

Summary for Pond 5P: wetlands(PRE)

Inflow Area = 5.180 ac, 12.85% Impervious, Inflow Depth > 3.12" for 100 YEAR event
Inflow = 13.69 cfs @ 12.21 hrs, Volume= 1.346 af
Outflow = 3.48 cfs @ 12.79 hrs, Volume= 0.726 af, Atten= 75%, Lag= 34.7 min
Primary = 3.48 cfs @ 12.79 hrs, Volume= 0.726 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 137.17' @ 12.79 hrs Surf.Area= 25,626 sf Storage= 30,345 cf

Plug-Flow detention time= 192.4 min calculated for 0.726 af (54% of inflow)
Center-of-Mass det. time= 99.7 min (897.8 - 798.1)

Volume	Invert	Avail.Storage	Storage Description
#1	135.00'	53,300 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
135.00	0	0	0
136.00	13,600	6,800	6,800
137.00	24,700	19,150	25,950
138.00	30,000	27,350	53,300

Device	Routing	Invert	Outlet Devices
#1	Primary	137.00'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=3.47 cfs @ 12.79 hrs HW=137.17' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 3.47 cfs @ 0.99 fps)

Summary for Pond 13P: forebay

Inflow Area = 0.538 ac, 86.98% Impervious, Inflow Depth > 5.48" for 100 YEAR event
Inflow = 3.05 cfs @ 12.08 hrs, Volume= 0.246 af
Outflow = 3.03 cfs @ 12.08 hrs, Volume= 0.241 af, Atten= 1%, Lag= 0.0 min
Primary = 3.03 cfs @ 12.08 hrs, Volume= 0.241 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 143.35' @ 12.08 hrs Surf.Area= 480 sf Storage= 251 cf

Plug-Flow detention time= 16.6 min calculated for 0.240 af (98% of inflow)
Center-of-Mass det. time= 9.0 min (774.7 - 765.8)

Volume	Invert	Avail.Storage	Storage Description
#1	142.00'	251 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
142.00	51	0	0
142.50	160	53	53
143.00	314	119	171
143.20	480	79	251

Device	Routing	Invert	Outlet Devices
#1	Primary	143.08'	**9.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Primary OutFlow Max=2.95 cfs @ 12.08 hrs HW=143.34' (Free Discharge)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 2.95 cfs @ 1.25 fps)

Summary for Pond 23P: infiltration

Inflow Area = 0.138 ac,100.00% Impervious, Inflow Depth > 7.98" for 100 YEAR event
Inflow = 1.33 cfs @ 12.00 hrs, Volume= 0.092 af
Outflow = 0.08 cfs @ 13.12 hrs, Volume= 0.021 af, Atten= 94%, Lag= 67.0 min
Discarded = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Primary = 0.08 cfs @ 13.12 hrs, Volume= 0.021 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 153.03' @ 13.12 hrs Surf.Area= 1,224 sf Storage= 3,084 cf

Plug-Flow detention time= 449.4 min calculated for 0.021 af (23% of inflow)
Center-of-Mass det. time= 215.5 min (924.6 - 709.0)

Volume	Invert	Avail.Storage	Storage Description
#1	150.00'	1,597 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 5,501 cf Overall - 1,508 cf Embedded = 3,993 cf x 40.0% Voids
#2	151.00'	1,508 cf	**24.0" Round Pipe Storage** x 4 Inside #1 L= 120.0'
		3,105 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
150.00	1,800	0	0
153.00	1,800	5,400	5,400
153.10	12	91	5,491
154.00	12	11	5,501

Device	Routing	Invert	Outlet Devices
#1	Discarded	150.00'	**2.400 in/hr Exfiltration over Horizontal area above 150.00'** Excluded Horizontal area = 1,800 sf
#2	Primary	153.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Discarded OutFlow Max=0.00 cfs @ 1.00 hrs HW=150.00' (Free Discharge)
↑—**1=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.08 cfs @ 13.12 hrs HW=153.03' (Free Discharge)
↑—**2=Sharp-Crested Rectangular Weir** (Weir Controls 0.08 cfs @ 0.59 fps)

Summary for Pond 44P: pervious pavement resevoir

Inflow Area = 0.320 ac, 62.50% Impervious, Inflow Depth > 6.07" for 100 YEAR event
Inflow = 2.36 cfs @ 12.07 hrs, Volume= 0.162 af
Outflow = 0.92 cfs @ 12.30 hrs, Volume= 0.142 af, Atten= 61%, Lag= 13.8 min
Discarded = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af
Primary = 0.92 cfs @ 12.30 hrs, Volume= 0.142 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 142.44' @ 12.30 hrs Surf.Area= 4,059 sf Storage= 2,344 cf

Plug-Flow detention time= 81.0 min calculated for 0.142 af (88% of inflow)
Center-of-Mass det. time= 42.8 min (806.7 - 763.9)

Volume	Invert	Avail.Storage	Storage Description
#1	141.00'	4,871 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 12,177 cf Overall x 40.0% Voids

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
141.00	4,059	0	0
143.00	4,059	8,118	8,118
144.00	4,059	4,059	12,177

Device	Routing	Invert	Outlet Devices
#1	Primary	141.50'	**6.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	143.70'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#3	Discarded	141.00'	**0.270 in/hr Exfiltration over Horizontal area above 141.00'** Excluded Horizontal area = 4,059 sf

Discarded OutFlow Max=0.00 cfs @ 1.00 hrs HW=141.00' (Free Discharge)
└─**3=Exfiltration** (Controls 0.00 cfs)

Primary OutFlow Max=0.92 cfs @ 12.30 hrs HW=142.44' (Free Discharge)
├─**1=Orifice/Grate** (Orifice Controls 0.92 cfs @ 4.68 fps)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 47P: Infiltration Basin

Inflow Area = 1.810 ac, 68.79% Impervious, Inflow Depth > 5.81" for 100 YEAR event
Inflow = 11.62 cfs @ 12.10 hrs, Volume= 0.876 af
Outflow = 4.15 cfs @ 12.38 hrs, Volume= 0.876 af, Atten= 64%, Lag= 16.9 min
Discarded = 4.15 cfs @ 12.38 hrs, Volume= 0.876 af
Primary = 0.00 cfs @ 1.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 139.23' @ 12.38 hrs Surf.Area= 5,738 sf Storage= 6,340 cf

Plug-Flow detention time= (not calculated: outflow precedes inflow)
Center-of-Mass det. time= 7.8 min (762.2 - 754.5)

Volume	Invert	Avail.Storage	Storage Description
#1	138.00'	11,054 cf	**Custom Stage Data (Conic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
138.00	4,593	0	0	4,593
139.00	5,518	5,048	5,048	5,552
140.00	6,507	6,006	11,054	6,578

Device	Routing	Invert	Outlet Devices
#1	Discarded	138.00'	**31.000 in/hr Exfiltration over Wetted area**
#2	Primary	139.60'	**20.0' long x 4.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.38 2.54 2.69 2.68 2.67 2.67 2.65 2.66 2.66 2.68 2.72 2.73 2.76 2.79 2.88 3.07 3.32

Discarded OutFlow Max=4.15 cfs @ 12.38 hrs HW=139.23' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 4.15 cfs)

Primary OutFlow Max=0.00 cfs @ 1.00 hrs HW=138.00' (Free Discharge)
↑—**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond 48P: swm pond

Inflow Area = 1.499 ac, 76.65% Impervious, Inflow Depth > 5.95" for 100 YEAR event
Inflow = 8.65 cfs @ 12.08 hrs, Volume= 0.743 af
Outflow = 5.93 cfs @ 12.18 hrs, Volume= 0.655 af, Atten= 31%, Lag= 6.3 min
Primary = 5.93 cfs @ 12.18 hrs, Volume= 0.655 af

Routing by Stor-Ind method, Time Span= 1.00-20.00 hrs, dt= 0.05 hrs
Peak Elev= 143.09' @ 12.18 hrs Surf.Area= 5,265 sf Storage= 9,731 cf

Plug-Flow detention time= 85.1 min calculated for 0.653 af (88% of inflow)
Center-of-Mass det. time= 47.0 min (809.9 - 762.9)

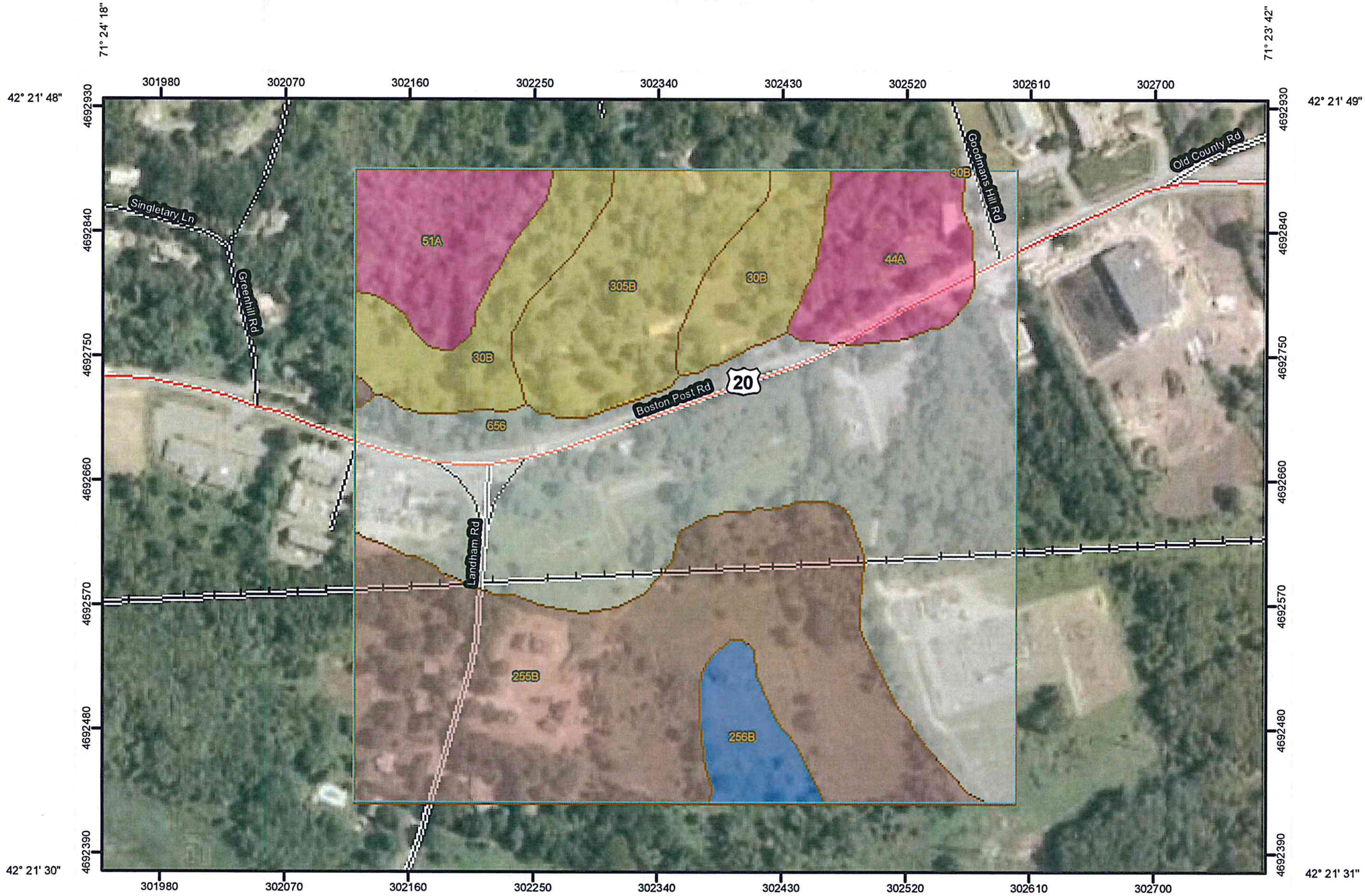
Volume	Invert	Avail.Storage	Storage Description
#1	140.50'	11,889 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
140.50	1,453	0	0
141.50	3,690	2,572	2,572
142.00	4,190	1,970	4,542
142.50	4,703	2,223	6,765
143.00	5,265	2,492	9,257
143.50	5,265	2,633	11,889

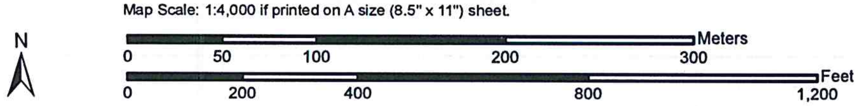
Device	Routing	Invert	Outlet Devices
#1	Primary	140.11'	**2.0" Vert. Orifice/Grate** C= 0.600
#2	Primary	141.70'	**8.0" Vert. Orifice/Grate** C= 0.600
#3	Primary	142.88'	**24.0" x 24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#4	Primary	142.93'	**10.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Primary OutFlow Max=5.83 cfs @ 12.18 hrs HW=143.09' (Free Discharge)
↑—**1=Orifice/Grate** (Orifice Controls 0.18 cfs @ 8.19 fps)
—**2=Orifice/Grate** (Orifice Controls 1.73 cfs @ 4.94 fps)
—**3=Orifice/Grate** (Weir Controls 2.47 cfs @ 1.49 fps)
—**4=Broad-Crested Rectangular Weir** (Weir Controls 1.46 cfs @ 0.93 fps)

APPENDIX II NRCS Soils Mapping



Map Scale: 1:4,000 if printed on A size (8.5" x 11") sheet.



MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

- Soil Map Units

Soil Ratings

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

Political Features

- Cities

Water Features

- Oceans
- Streams and Canals

Transportation

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

MAP INFORMATION

Map Scale: 1:4,000 if printed on A size (8.5" × 11") sheet.

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

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

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL: http://websoilsurvey.nrcs.usda.gov
Coordinate System: UTM Zone 19N NAD83

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 12, Feb 26, 2010

Date(s) aerial images were photographed: 7/10/2003

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.

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: Lower

Hydrologic Soil Group

Hydrologic Soil Group— Summary by Map Unit — Middlesex County, Massachusetts				
Map unit symbol	**Map unit name**	**Rating**	**Acres in AOI**	**Percent of AOI**
30B	Raynham silt loam, 0 to 5 percent slopes	C	5.1	9.4%
44A	Birdsall mucky silt loam, 0 to 1 percent slopes	D	3.3	6.1%
51A	Swansea muck, 0 to 1 percent slopes	D	3.2	5.8%
255B	Windsor loamy sand, 3 to 8 percent slopes	A	15.7	29.0%
256B	Deerfield loamy sand, 3 to 8 percent slopes	B	1.6	3.0%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	C	4.8	8.8%
656	Udorthents-Urban land complex		20.5	37.8%
Totals for Area of Interest			**54.3**	**100.0%**

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November 22, 2016
GZA File No. 01.170478.80

B'nai B'rith Housing New England
34 Washington Street
Brighton, Massachusetts 02135

Attention: Ms. Holly M. Grace

Re: Geotechnical Engineering Report
Proposed Senior Housing Facility
Coolidge at Sudbury II
189 Boston Post Road
Sudbury, Massachusetts

Dear Ms. Grace:

In accordance with our agreement dated September 23, 2016, GZA GeoEnvironmental, Inc. (GZA) is pleased to submit this geotechnical engineering report to B'nai B'rith Housing New England (Client) for the proposed Senior Housing Facility – Coolidge at Sudbury II in Sudbury, Massachusetts (Site). The objective of our work was to perform a subsurface exploration program to evaluate subsurface conditions and to develop geotechnical engineering design and construction recommendations for the proposed development. This report is subject to the Limitations set forth in **Appendix A** and the Terms and Conditions of our agreement.

GZA prepared a Phase I Environmental Site Assessment of the Site dated October 28, 2016 and submitted it under separate cover.

Elevations cited in this report are referenced to the National Geodetic Vertical Datum of 1929 (NGVD 1929).

BACKGROUND

Our understanding of the project is based on:

- discussions with you;
- our previous work at the site; and
- a set of plans titled "Comprehensive Permit Site Plan, The Coolidge at Sudbury II, 189 Boston Post Road, Sudbury, MA," prepared by The Architectural Team (TAT) dated June 29, 2016. The plans include an existing conditions plan and a grading and utility plan showing the proposed project layout.

GZA previously provided geotechnical and consulting services for construction of the existing "Coolidge at Sudbury" multi-unit residential building just to the west of the proposed Phase II development. Construction was completed in 2014.

EXISTING CONDITIONS

The Site consists of Lot 2 at 189 Boston Post Road in Sudbury, Massachusetts. Lot 2 is approximately 2.5 acres and is bound to the north by Boston Post Road, the east by Boston

Edison Company, the south by Massachusetts Bay Transit Authority train tracks and to the west by Lot 1. Lot 1 is presently occupied by a two-story, wood-framed senior living facility (Coolidge at Sudbury I.) An asphalt parking lot and detention basin are located at the northern portion of Lot 2 adjacent to Boston Post Road. Otherwise, the Site is generally wooded and undeveloped. Wetlands are located at the southern end of the lot. Grades generally slope from about elevation 153 feet at the northern side of the site to elevation 136 at the southern end.

PROPOSED DEVELOPMENT

The proposed building will be a 3-story, wood-frame, multi-unit residential building, with parking under the full footprint area of about 18,000 square feet. The proposed first floor grade will be 154 feet, with the adjacent parking area at about elevations 152 to 153 feet, and the parking garage will be at elevation 144 feet. The building will be cut into an existing sloped area where grades currently vary between about elevations 140 to 153 feet. Accordingly, there will be a foundation retaining wall along the north side of the building retaining about 10 feet of soil. The garage will be accessed from the western side of the proposed building. Retaining walls for the garage access drive will retain up to 4 feet of soil. A retaining wall will also be required to retain up to 4 feet of soil at the northeastern corner of the Site and along the southern side of the Site. We understand the retaining walls will consist of either mechanically stabilized earth (MSE) walls or gravity block walls.

A portion of the building footprint will be within the 100-foot wetland buffer zone. A storm water detention/infiltration area is planned just south of the building with a bottom grade of about elevation 137 feet. The existing parking area adjacent to Boston Post Road will be extended east almost to the eastern property line at approximately the same grade as existing grades; the existing retention pond will be filled.

A Site locus is shown on **Figure 1**. Existing conditions and the proposed development are shown on **Figure 2**.

SCOPE OF SERVICES

GZA performed the following scope of work:

1. Developed and executed a subsurface exploration program consisting of four test borings and seven test pits to evaluate subsurface soil and groundwater conditions. Performed one field permeability test in one of the test pits.

2. Performed gradation analyses on three selected soil samples from the test pits and test borings, to confirm field classifications and assist in evaluating potential on-site reuse of soils excavated during construction.

3. Performed engineering analyses, developed geotechnical design and construction recommendations for the proposed development, and prepared this report summarizing our findings.

SUBSURFACE EXPLORATIONS

Previous Explorations by GZA and Others

Several subsurface explorations were performed by GZA and others for the Coolidge at Sudbury I development. Four of these explorations are generally in the area of the proposed limit of work for Phase II.

On January 17, 2007, Subsurface Drilling, Inc. performed a test boring and installed a groundwater monitoring well at MW-1. This work was performed under the direction of Loitherstein Environmental, Inc. The boring was advanced using hollow-stem augers and carried to a depth of 12 feet.

On June 11, 2010, Ronald A. Marini Corp. of Newton, Massachusetts performed test pits TP-1 through TP-4 within areas of the proposed limit of work for the proposed Coolidge at Sudbury II development. Test pits TP-1 through TP-4 were extended to depths of 4.5 to 10 feet below existing grades. Upon completion, the test pits were backfilled with the excavated soil. A GZA representative observed the test pits, classified the soil samples, and prepared the test pit logs.

The logs for previously performed explorations are included as **Appendix B**.

Recent GZA Explorations

GZA subcontracted with Cryan Landscape Contractors of Attleboro, Massachusetts to perform seven test pits (TP-101 through TP-107) at the site on October 12, 2016. The test pits were performed using a Caterpillar 430F rubber-tired backhoe and carried to depths of up to 12 feet.

GZA subcontracted with New England Boring Contractors of Brockton, Massachusetts to perform four test borings (B-1 through B-4) at the site on October 19, 2016. The borings were performed with an all-terrain vehicle (ATV) mounted drill rig and advanced using rotary-wash drilling techniques to depths of up to about 21 feet below ground surface (bgs). Standard Penetration Tests (SPTs) were performed and split spoon samples were generally obtained continuously in the upper 6 feet and at about 5-foot intervals thereafter. The borings were backfilled with drill cuttings upon completion.

A GZA field representative observed the test pits and borings, classified the soil samples using a modified Burmister Classification System and prepared logs. Logs for the recent test pits and borings are included as **Appendix B** and **Appendix C**, respectively.

FIELD PERMEABILITY TESTING

GZA performed a falling head permeability test in test pit TP-107 at a depth of about 2 feet within the natural sandy loam stratum using a single-ring infiltrometer. The intent of the permeability test was to provide data for design of a stormwater infiltration system and to generally satisfy the criteria of the "falling head permeameter" test listed as an approved field test method in Chapter 3 of the 2008 MassDEP Storm Water Regulations. The test was performed above the water table observed at the time of the test.

The single-ring infiltrometer consisted of an approximately 10-inch-diameter by 3-foot long section of solid PVC pipe. The pipe was inserted into a hand-excavated hole (approximately 2 feet in diameter and 1.5 feet deep). The annulus between the pipe and the hand-excavated hole was backfilled with excavated soil (and manually tamped) to help stabilize the pipe.

The inside of the pipe was filled with water for approximately 15 minutes to presoak the underlying soils prior to recording the water level drop in the pipe during the test. Based on the field permeability test performed, the estimated hydraulic conductivity for the natural sandy loam is $4x10^{-2}$ centimeters per second. A log for the field permeability test is included in **Appendix C**. The hydraulic conductivity of the underlying glacial till and the silty loam encountered in the adjacent test pit, TP-106, is anticipated to be lower.

Previous and recently performed exploration locations are shown on **Figure 2**.

GEOTECHNICAL LABORATORY TESTING

Three soil samples obtained from the recent explorations were submitted to GZA's geotechnical laboratory subcontractor, Thielsch Engineering, for grain size distribution analyses. Laboratory test results are attached as **Appendix E**.

SUBSURFACE CONDITIONS

Based on the recent GZA test pits and borings, subsurface conditions at the Site consist of a layer of topsoil (or mulch) underlain by natural sand/silt underlain by Silt & Clay and/or glacial till. Up to 4.5 feet of fill was encountered in boring B-3 and test pits TP-101 and TP-103. About a foot of buried topsoil was encountered below the fill in test pits TP-101 and TP-103.

The soil strata encountered in the test pits and borings are described below in order of increasing depth. Refer to the recent test pit logs and test boring logs, attached as **Appendix C** and **D**, respectively, for detailed subsurface conditions at specific exploration locations.

- <u>Topsoil</u> – The topsoil encountered in test pits and borings was generally 3 to 6 inches in thickness, except in test pit TP-104 where the fill was 2 feet in thickness and test pits TP-105 through TP-107 the fill was about 1 foot in thickness. This layer generally consisted of dark brown, fine to coarse sand, up to about 50 percent silt, and up to about 20 percent gravel, roots and other organic matter.

- <u>Fill</u> – A 2- to 4-foot-thick layer of fill was encountered below the surficial layer of topsoil or mulch in boring B-3 and test pits TP-102 and TP-103. The fill generally consisted of brown, fine to coarse sand with up to 35 percent gravel and up to 20 percent silt with few cobbles and boulders. Boulders were generally less than 12 inches in diameter in the test pits. Buried topsoil/subsoil was encountered below the fill in boring B-3 and test pits TP-101 and TP-103.

- <u>Natural Sand/Silt</u> –Natural Sand/Silt were encountered below the topsoil/subsoil and/or fill in most of the explorations (glacial till was encountered directly below the fill in test pit TP-102). These soils varied from sandy silt, silty sand, sandy gravel and sand. In general, these strata contained 20 percent silt or greater. However, strata of fine sand with trace amounts of silt were also encountered. Most samples contained trace amounts of gravel. SPT N-values ranged from 9 to 39 indicating the stratum was loose to medium dense; however, most the samples were medium dense.

- <u>Silt & Clay</u> – Silt & Clay was encountered in borings B-1 through B-3 at depths of about 13 feet, corresponding to elevations ranging from about 133 to 139 feet. The Silt & Clay was not fully penetrated in these borings which were carried to depths of up to 21 feet. The Silt & Clay was brown and generally contained trace amounts of fine sand. SPT N-values ranged from 11 to 18 indicating the stratum was stiff to very stiff.

- <u>Glacial Till</u> – Glacial till was encountered in boring B-4 and test pits TP-102, TP-103, TP-104 and TP-107 at depths ranging from about 1 to 9.5 feet. These depths correspond to elevations ranging from about 132 to 149 feet. The till generally consisted of gray-brown, silt or clayey silt with up to 50 percent sand and up to 50 percent gravel. Few cobbles and boulders (diameter 12 inches or less) were encountered in the till. SPT N-values ranged from 27 to 69 indicating the stratum was medium dense to very dense.

GROUNDWATER

Groundwater was measured in the borings at the approximate depths and elevations shown below:

Boring	B-1	B-2	B-3 (well)	B-4
Depth to Groundwater (feet)	15.5	18	13.5	8
Groundwater Elevation (feet)	136	132	132	131

However, these groundwater depths may not represent stabilized conditions as the borings were drilled using water and the observations were made shortly after drilling. Redoximorphic features (soil mottles) were observed in test pits TP-106 and TP-107 at approximately elevations 135.4 and 135.9 feet, respectively. These soil mottles may be indicative of seasonal groundwater levels.

Groundwater levels were previously measured in on-site monitoring well MW-101 by GZA and Loitherstein at elevations ranging between about 132.5 and 138 feet as follows:

	January 2007*		6/11/2010		7/30/10		9/28/12	
	Depth (ft)	Elev (ft)	Depth (ft)	Elev (ft)	Depth (ft)	Elev (ft)	Depth (ft)	Elev (ft)
MW-101	5	138	7.2	135.8	8.0	135.0	10.5	132.5

* reported by Loitherstein (date estimated)

Groundwater observations were made at the time and under the conditions stated on GZA's exploration logs. Note that groundwater levels will fluctuate due to variations in season, rainfall, and other factors different than those existing at the time the observations were made. The recent explorations were performed after an extended drought and thus we would expect higher groundwater levels during periods of higher precipitation.

ENGINEERING IMPLICATIONS OF SUBSURFACE CONDITIONS

Based on the subsurface explorations and our understanding of the proposed development, subsurface conditions will have an impact on the following aspects of the proposed development:

- *Foundation Type* – The existing topsoil/subsoil and fill are not suitable for support of the proposed building foundation and slab loads and will need to be removed from the building footprint. In some area, this will result in overexcavation of materials below the proposed slab and bottom of footing elevations. In addition, the silty nature of the natural soils anticipated at subgrade level can be easily disturbed by moisture and construction equipment. Thus, the footing and slab subgrades will need to be protected as further described herein.

- *Reuse of On-Site Soils* – Most of the excavated soils will consist of fill and natural sand/silt. The silt & clay is not anticipated to be encountered during excavation. Most of the natural sand/silt and fill will not meet recommended gradation requirements for Sand-Gravel Fill and Granular Fill due to low gravel and high silt content. Some areas of sand with trace amounts of silt may be encountered in the excavations and may be suitable for reuse provided it can be adequately compacted. Excavated soils with high silt content may be reused as fill outside of the proposed building footprint provided moisture content can be controlled and the material can be compacted as described herein. Granular Fill and Sand-Gravel Fill will need to be imported to the Site. Topsoil and subsoil should be reserved for proposed landscaped areas. Excess soil will require off-site disposal at an appropriate facility.

GEOTECHNICAL RECOMMENDATIONS

The design and construction recommendations presented below are based on our evaluation of the available data and design concepts provided to GZA and are subject to the Limitations contained in **Appendix A**. References to the IBC refer to the International Building Code 2012 with Massachusetts State Building Code 8th Edition (MSBC) amendments.

DESIGN

1. Building Foundations

We recommend a shallow foundation system consisting of spread footings bearing on undisturbed natural Sand/Silt or on compacted Structural Fill placed over this stratum after removal of the existing topsoil/subsoil and fill. The recommended maximum net allowable bearing pressure is 2 tons per square foot (tsf).

Structural Fill consists of Granular Fill or Sand-Gravel Fill. Recommended gradation requirements for Granular Fill and Sand-Gravel fill are presented in **Table 1**. Subgrade preparation recommendations and reuse of site soils are presented in the Construction section of this report.

For foundations that are smaller than 3 feet wide, reduce the bearing value to one third of the above value multiplied by the least lateral footing dimension in feet. Isolated footings should be at least 24 inches wide.

For frost protection, footings in unheated areas should bear at least 4 feet below final exterior grades. Footings in the garage should bear at least four feet below the top of slab as this will be an unheated area.

2. Building Ground Floor Slabs

A slab-on-grade is recommended. Support the proposed garage slab-on-grade on a 9-inch-thick base course of compacted Sand-Gravel Fill over natural granular soils or Structural Fill placed over natural granular soils after the removal of existing topsoil/subsoil and fill throughout the proposed building footprint. Subgrade preparation recommendations are provided in the construction section of this report.

3. Settlement

Total and differential post-construction settlements are anticipated to be less than 1-inch and ½-inch, respectively, provided foundations are designed and constructed as recommended herein.

4. Seismic Design

Soils encountered in the building area are not considered susceptible to liquefaction based on criteria set forth in the Massachusetts State Building Code (MSBC) Section 1806.4.

The SPT N-values from the borings were used to evaluate seismic Site Class in accordance with Section 1613.5.5 of the MSBC, and the 2009 edition of the International Building Code. We recommend Site Class D be used for seismic design. The mapped seismic design factors for the Town of Sudbury, S_S and S_1, are 0.27 and 0.069, respectively, in accordance with Table 1604.11 of the MSBC.

5. Lateral Earth Pressures

Building Foundation Walls

Buried building foundation retaining walls subjected to unbalanced earth-loading conditions should be designed to resist lateral earth pressures. Design lateral earth pressures behind the wall should be calculated using an equivalent fluid unit weight of 65 pounds/cubic foot (pcf). Cast-in-place flexible cantilever walls (such as the garage entrance walls) should be designed with an equivalent fluid unit weight of 45 pcf.

These values are for horizontal backfill and assume that the walls are backfilled with free draining soils such as Granular Fill (provided that it has less than 8 percent passing sieve No. 200) or Sand Gravel Fill within at least 3 feet of the walls and provided with perimeter drains at footing grade so that no water pressure develops behind the wall. Where the calculated earth pressure behind the wall is less than 250 pounds per square foot (psf), it should be increased to 250 psf to account for stresses created by compaction within 5 feet of the wall. This pressure does not account for large equipment such as cranes and concrete trucks. Walls should also be designed for appropriate surcharge loads per Section 1807.2 of the MSBC. Walls should also be designed for seismic loads based on criteria set forth in the IBC Section 1807.2.

Site Retaining Walls

Site retaining walls consisting of either proprietary gravity block walls or mechanically stabilized earth (MSE) are planned in the northeast portion of the site and along the southern edge of the site. Proprietary walls should be designed by a Professional Engineer licensed in the Commonwealth of Massachusetts employed by the contractor, and reviewed by the owner's geotechnical engineer before construction.

Design for seismic and surcharge loadings in accordance with the IBC. Retaining walls should be designed using a factor of safety of 1.5 against overturning and a factor of safety of 2.0 against sliding. Design of retaining walls should include an evaluation of global stability and provide for erosion protection at the base of the wall. We recommend the global stability analyses use a unit weight of 115 pounds per cubic foot and an angle of internal friction of 28 degrees for the natural silt/sand. The wall designer should select appropriate unit weight and friction angles for the soils used to backfill the walls.

Gravity Site Retaining Walls

Gravity walls rely on the weight of large blocks to resist lateral loads, often without geogrid behind the wall. Design lateral earth pressures for soil on the gravity site retaining walls should be calculated using an equivalent fluid pressure of 45 pcf. The equivalent fluid pressure provided assumes "active" conditions for the site retaining walls with horizontal backfill. Where the pressure is less than 250 pounds per square foot (psf), it should be increased to 250 psf to account for compaction-induced stresses.

Mechanically Stabilized Earth Walls

MSE walls consist of a system of mortarless modular blocks connected to soil reinforcing grids (geogrid) embedded between compacted lifts of granular backfill behind the wall. Geogrid required for a site retaining walls should be outside the bearing area of the building footings, as described by the zone extending at a one-horizontal to one-vertical angle (1H:1V) sloping down and outward from 1 foot horizontally outside from the bottom edge of footing exterior. Provide a perforated pipe surrounded by at least 6 inches of ¾-inch crushed stone and wrapped in non-woven filter fabric at wall footing grade to drain the wall backfill. No large bushes, trees or utilities should be located in the grid zone. We recommend the fill used for backfill within the MSE wall geogrid reinforcing zones meet the gradation criteria for Sand-Gravel. The on-site soils will not meet this requirement.

6. Permanent Groundwater Control

We recommend a perimeter drain be provided along the perimeter of the foundation walls. The perimeter drain should consist of 4-inch-diameter perforated PVC pipe installed outside the building, above the bottom of adjacent perimeter footings and below top of the adjacent garage slab. The perimeter drain should be surrounded by at least 6 inches of ¾-inch Crushed Stone wrapped in a non-woven filter fabric. Free draining Sand-Gravel backfill (required gradation provided in **Table 1**) should be placed within 3 feet horizontally of the perimeter foundation walls and hydraulically connect to the perimeter drain. In lieu of the Sand-Gravel, drainage board or geosynthetic drainage material (geonet) could be used against the foundation wall provided it is hydraulically connected to the perimeter drain. Provide cleanouts for the perimeter drains.

The perimeter drains should drain by gravity to an on-site sump or manhole outside the building. The project civil engineer should select the final discharge location. Local, state and/or federal permits may be required depending on the drains' final discharge point.

7. Pavement for Roadways and Parking Areas

GZA recommends the following asphalt pavement sections for the proposed development.

	Light Duty Pavement (car parking)	Heavy Duty Pavement (truck traffic, entrance-ways)
Asphalt Surface (in.)	1.5	1.5
Asphalt Binder (in.)	1.5	2.5
Sand and Gravel Base (in.)	10*	12*

* Where silt, or silty sand is present at subgrade level, the base course should be increased to 12 and 16 inches for light and heavy duty pavement, respectively.

In rigid pavement (exterior concrete slab-on-grade) areas, such as dumpster pad and loading dock approach areas, provide at least 12 inches (16 inches for silt/silty sand subgrades) of Sand-Gravel fill or ¾-inch Crushed Stone (underlain by non-woven filter fabric) base course. Concrete thickness should be at least 6 inches and designed by the project structural or civil engineer. At least 18 inches of free-draining Sand-Gravel or Crushed Stone should be provided below concrete sidewalks to help reduce the potential for frost heave.

8. Earth Slopes

Permanent slopes with loamed-and-seeded surface should not be steeper than 2.5 horizontal to 1 vertical (2.5H:1V) without slope protection to limit erosion and sloughing of the slope. If steeper slopes are found to be required during design, special slope treatment may be required. GZA can provide this input and perform additional analyses if/when required.

CONSTRUCTION

1. Foundation Subgrade Preparation

The existing vegetation, topsoil, fill and buried topsoil/subsoil should be removed throughout the entire building footprint (and within the bearing zone of footings) to the top of the undisturbed natural Sand/Silt. This will require overexcavation below the proposed slab and footing subgrade elevations in some areas. The bearing zone is defined as the zone extending at a one-horizontal to one-vertical angle (1H:1V) sloping down and outward from 1 foot horizontally outside from the bottom edge of footing exterior to natural Sand/Silt. Prior to placing fill or concrete, the exposed subgrade soils should be proof-compacted prior to base course or Structural Fill placement with at least six passes of a large vibratory drum roller (with a minimum static drum weight of 10,000-pounds). Overexcavate any weak or soft spots identified during proof-compaction and replace with compacted Structural Fill. If water is present or for silty subgrades, the proof-compaction may need to be performed under static conditions.

Footing subgrades should be proof-compacted with at least six passes of a large vibratory plate compactor. Overexcavate any weak or soft spots identified during proof-compaction and replace with compacted Structural Fill. Protect silty or clayey subgrades with a 6-inch layer of compacted Sand-Gravel, or 3-inches of ¾-inch Crushed Stone or lean concrete. Crushed stone greater than 6 inches in thickness should be wrapped in non-woven filter fabric (Mirafi 140N or similar).

Particular care should be taken with foundation subgrade preparation in the vicinity of the test pits. These test pit areas should be re-excavated and backfilled in a controlled manner if any part of them is within the bearing zone of the building footings or site retaining walls.

2. Fill Material, Placement and Compaction

The minimum gradational requirements for various fill materials and their recommended uses are provided in **Table 1**. The recommended minimum compaction for structural fill, based on percentage of maximum dry density as defined by ASTM D-1557 Method C, is specified below for different areas. When placed, Crushed Stone should be compacted to an unyielding surface.

Fill Area	Percent of Maximum Dry Density
Within Building Area and 1H:1V Bearing Zone of Footings	95
Utility Trench Backfill	95
Beneath Pavement (upper 2 feet)	95
More than 2 feet below Pavement	92
Outside Building & Adjacent to Exterior Building Foundations	92
Beneath Landscape Areas	90

Compaction within 5 feet of foundation retaining walls should be performed using a walk behind vibratory plate compactor. Backfill and compact all fill at approximately similar elevations on each side of foundation walls to avoid unbalanced loading.

Frozen soil should not be placed as fill. In addition, fill should not be placed over frozen soil. Protect footings, slabs and footing and slab subgrades from frost at all times during construction.

3. Reuse of Existing On-site Material

The natural Sand/Silt and fill will not meet recommended gradation requirements for Sand-Gravel Fill and Granular Fill due to low gravel and high silt content. Existing fill and Sand/Silt may be reused outside of the proposed building footprint. Topsoil/subsoil should be reserved for proposed landscaped areas.

Imported Sand-Gravel Fill will be required for building slab and pavement base course, back filling foundation walls and within the geogrid zones of MSE walls. The silt & clay and glacial till are not anticipated to be encountered in the excavations.

Excess soil generated during construction that cannot be reused on site should be disposed off site in accordance with applicable local, state, and federal regulations.

4. Pavement Subgrade Preparation

Within pavement areas, remove topsoil and excavate to the minimum depth required to accommodate Finish, Binder and Sand-Gravel Base courses. Proof compact the exposed subgrade with a minimum of six passes of a vibratory drum roller (with a minimum static drum weight of 10,000-pounds capable of at least 20,000 pounds of dynamic force). Any weak or soft spots identified during proof-compacting should be excavated and replaced with compacted Structural Fill. Existing fill may remain in place below pavement provided it is dense and stable during proof compaction.

5. Construction Dewatering

Groundwater or perched groundwater may be encountered in excavations depending on groundwater conditions at the time of construction. As such, construction dewatering may be required to help control groundwater and to conduct work "in the dry". Based on a review of the existing soil conditions, we anticipate that this may be achieved with localized sump pumps with discharge on site into excavated pits located outside of the building area. Pumped groundwater should not be discharged directly into wetlands.

It is recommended that temporary control measures be implemented to reduce the amount of surface water (from rainfall runoff) from potentially entering and ponding in the excavations. Temporary measures should include, but not be limited to, construction of drainage ditches to divert and/or reduce the amount of surface water flowing over exposed subgrades during construction.

Discharge of pumped water off-site (if required) should be performed in accordance with all federal, state, and/or local regulations, which may require a discharge permit and possible filtration and chemical testing of the water prior to discharge.

6. Excavation Support

Where space is not available to safely lay back excavations, or will encroach beyond the property lines, a temporary earth support system will be required. Temporary earth support systems, if required, should be selected by the contractor and be designed by an experienced Professional Engineer registered in the Commonwealth of Massachusetts and retained by the Contractor.

The Owner and the Contractor should make themselves aware of and become familiar with applicable local, state, and federal safety regulations, including the current Occupational Safety and Health Administration (OSHA) Excavation and Trench Safety Standards. Construction site safety generally is the sole responsibility of the Contractor, who shall also be solely responsible for the means, methods, and sequencing of construction operations. We are providing this information solely as a service to our Client. Under no circumstances should the information provided below be interpreted to mean that GZA is assuming responsibility for construction site safety or the Contractor's activities; such responsibility is not being implied and should not be inferred.

The Contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations, e.g.; OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, or successor regulations. Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties.

As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance from the crest of the slope equal to no less than the slope height. Exposed slope faces should also be protected against the elements.

FINAL DESIGN AND CONSTRUCTION

We trust that the information presented herein addresses your needs related to the geotechnical aspects of the project at this time.

We recommend GZA be retained to prepare technical specifications for earthwork and contractor designed retaining walls and review the near-final foundation, grading, and utility plans to confirm that our recommendations are properly implemented in the design documents.

During construction, GZA should review contractor submittals and observe foundation and site earthwork construction for compliance with our recommendations, project foundation plans, and specifications. Our construction services would focus on:

- observing prepared footing subgrades;
- observing construction and backfilling of retaining walls; and
- confirming adequate compaction and maintaining gradation and moisture control during fill placement.

The IBC with Massachusetts amendments requires foundation subgrade preparation be observed/documented by a registered Professional Engineer or his/her representative.

We have enjoyed working with you on this project and would look forward to our continued involvement. Please call Derek Schipper at 781-278-5792 or Bruce Fairless at 617-963-1002 should you have any questions.

Very truly yours,

GZA GEOENVIRONMENTAL, INC.

Derek J. Schipper, P.E.
Senior Project Manager

Mary B. Hall, P.E.
Consultant/Reviewer

Bruce W. Fairless, P.E.
Associate Principal

Attachments: Table
Figures
Appendix A – Limitations
Appendix B – Previous Boring and Test Pit Logs
Appendix C – GZA Boring Logs
Appendix D – GZA Test Pit Logs
Appendix E – Geotechnical Laboratory Testing Results

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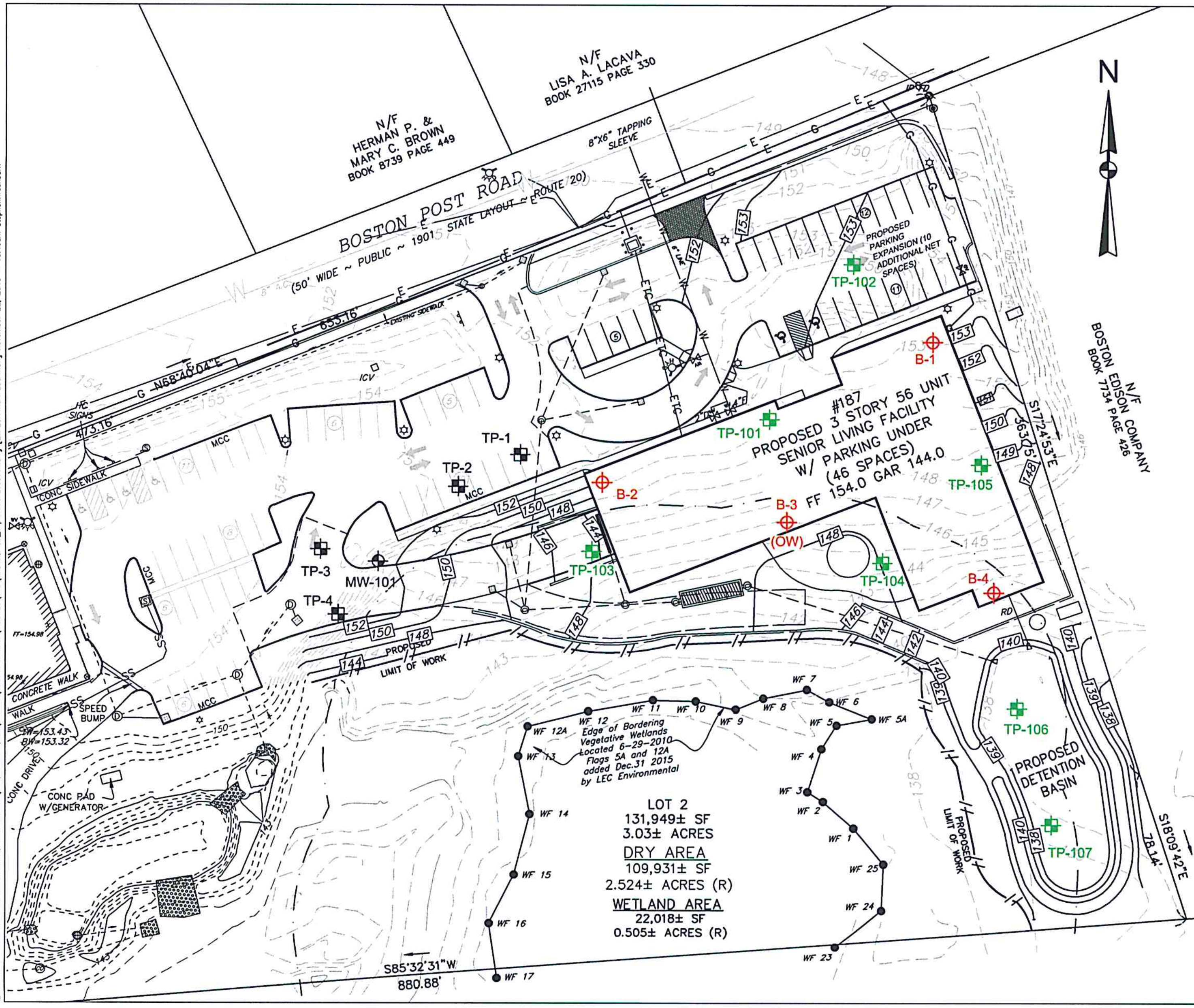

LEGEND

- B-3 — BORINGS PERFORMED BY NEW ENGLAND BORING CONTRACTORS OF BROCKTON MA ON OCTOBER 19, 2016. OBSERVED AND LOGGED BY GZA PERSONNEL.
- (OW) — INDICATES OBSERVATION WELL INSTALLED.
- TP-101 — TEST PITS PERFORMED BY CRYAN LANDSCAPE OF ATTLEBORO MA ON OCTOBER 12, 2016. OBSERVED AND LOGGED BY GZA PERSONNEL.
- TP-1 — TEST PITS PERFORMED BY RONALD A. MARINI CORP. ON JUNE 11, 2010. OBSERVED AND LOGGED BY GZA PERSONNEL.
- MW-101 — BORING PERFORMED AND MONITORING WELL INSTALLED BY SUBSURFACE DRILLING INC. UNDER THE DIRECTION OF LOITHERSTEIN ENVIRONMENTAL ENGINEERING INC. ON JANUARY 17, 2007.
- 100' WETLAND BUFFER

GENERAL NOTES:

1. THE BASE MAP WAS DEVELOPED FROM ELECTRONIC FILES PROVIDED BY HANCOCK ASSOCIATES ENTITLED "PRELIMINARY GRADING AND UTILITY PLAN" DATED: 06-29-2016, ORIGINAL SCALE: 1"=30', DRAWING NO. 15526, CAD FILE: 15526-C6.DWG.
2. THE LOCATION AND ELEVATIONS OF THE BORINGS AND TEST PITS WERE APPROXIMATELY DETERMINED BY GPS. THIS DATA SHOULD BE CONSIDERED ACCURATE ONLY TO THE DEGREE IMPLIED BY THE METHOD USED.
3. VERTICAL DATUM IS NGVD1929.

0 25 50 100
SCALE IN FEET

B'NAI B'RITH HOUSING NEW ENGLAND
189 BOSTON POST ROAD
SUDBURY, MASSACHUSETTS

EXPLORATION LOCATION PLAN

PREPARED BY	PREPARED FOR
GZA GeoEnvironmental, Inc. Engineers and Scientists www.gza.com	B'NAI B'RITH HOUSING NEW ENGLAND

PROJ MGR: DJS	REVIEWED BY: BWF	CHECKED BY: DJS	FIGURE
DESIGNED BY: DJS	DRAWN BY: SMW	SCALE: 1" = 50'	2
DATE: 11-22-2016	PROJECT NO. 01.0170478.80	REVISION NO.	

GZA GeoEnvironmental, Inc.
Engineers/Scientists

Proposed Senior Housing Facility
Geotechnical Services
189 Boston Post Road, Sudbury, MA

Test Pit No.	TP-101
Page No.	1 of 1
File No.	170478.80
Checked By:	DJS

Excavation Equipment

GZA Rep.	M. Ostrowski	Contractor	Cryan Landscape	Date	10/12/2016
		Operator	Dan Flynn	Ground Elev.	151
Weather	M. Sunny 50s to 60s	Make	CAT Model 430F	Time Started	0730
		Capacity	0.2 cu. Yd. Reach 14 ft.	Time Completed	0800

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0 – 0.5'	Dark brown SILT, some fine to coarse Sand, some Gravel, little Boulders. (TOPSOIL)	S-1		M/E	3A	1
0.5' – 4.5'	Dry, brown fine to coarse SAND, some fine to coarse Gravel, little Silt, trace Boulder. (FILL)	S-2		E/M	2A	
				E/M	1A	
				E/M	0	
4.5' – 5.2'	Dry, dark brown SILT, some fine to coarse Sand, trace fine Gravel, trace Roots. (BURIED TOPSOIL)	S-3		E/M	0	
5.2' – 10.5'	Dry, brown fine SAND, trace Silt. (SAND)	S-4		E	0	2
				E	0	
				E/M	0	
				E/M	0	
				E/M	0	
10.5'	Bottom of Test Pit at approximately 10.5 feet.			E/M	0	3

Notes:

1. Test pit location and ground surface elevation was determined using a Trimble GeoXH handheld GPS device. Vertical datum is NGVD29.
2. Sand stratum from approximately 5.2 to 6 feet appeared orange-colored (possible buried subsoil).
3. Backfilled test pit with lifts of spoils with each lift tamped by the excavator bucket upon completion.

Test Pit Plan: 11' × 2'; NORTH →

Volume = 4 cu. yd.

Boulder Class Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.

GZA GeoEnvironmental, Inc.
Engineers/Scientists

Proposed Senior Housing Facility
Geotechnical Services
189 Boston Post Road, Sudbury, MA

Test Pit No.	TP-102
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File No.	170478.80
Checked By:	DJS

Excavation Equipment

GZA Rep.	M. Ostrowski	Contractor	Cryan Landscape	Date	10/12/2016
		Operator	Dan Flynn	Ground Elev.	149.7
Weather	M. Sunny 50s to 60s	Make	CAT Model 430F	Time Started	0820
		Capacity	0.2 cu. Yd. Reach 14 ft.	Time Completed	0850

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0	0.3' Red MULCH			E	0	1, 2
1'	1' Wet, dark brown/gray fine to coarse SAND, little (+) Silt, trace fine Gravel (FILL)	S-1				
2'				E	0	
3'				M	0	
4'	Moist, brown SILT, some fine to coarse Sand, little fine to coarse Gravel. (Glacial TILL)	S-2		M	0	
5'				M	0	
6'	6'			D	0	3
7'	Bottom of Test Pit at approximately 6 feet.					
8'						
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:

1. Test pit location and ground surface elevation was determined using a Trimble GeoXH handheld GPS device. Vertical datum is NGVD29.
2. Water from adjacent rain garden pond seeped into the excavation during excavation.
3. Backfilled test pit with lifts of spoils with each lift tamped by the excavator bucket upon completion.

Test Pit Plan

2' × 6'

NORTH →

Volume = 1 cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(x) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
See Note #2	

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.

GZA GeoEnvironmental, Inc. *Engineers/Scientists*	Proposed Senior Housing Facility Geotechnical Services 189 Boston Post Road, Sudbury, MA	Test Pit No. Page No. File No. Checked By:	TP-103 1 of 1 170478.80 DJS

Excavation Equipment

GZA Rep.	M. Ostrowski	Contractor	Cryan Landscape	Date	10/12/2016
		Operator	Dan Flynn	Ground Elev.	146.7
Weather	M. Sunny 50s to 60s	Make	CAT Model 430F	Time Started	0855
		Capacity	0.2 cu. Yd. Reach 14 ft.	Time Completed	0930

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0 – 0.3'	Moist dark brown SILT, some fine to coarse Sand, trace fine Gravel, trace Roots. (TOPSOIL)	S-1		E	0	1
0.3' – 4.5'	Dry, brown fine to coarse SAND, some fine to coarse Gravel, little Silt. (FILL)	S-2		M	1A (12")	
				M	1A (12")	
				M	0	
				E	0	
4.5' – 5.5'	Dry, dark brown fine to coarse SAND, some Silt, some fine to coarse Gravel. (BURIED TOPSOIL)	S-3		E/M	0	
5.5' – 6'	Dry, orange SILT, and fine to medium SAND, trace (+) Silt. (BURIED SUBSOIL)	S-4		E/M	0	
6' – 9.5'	Dry, light brown fine SAND, trace (+) Silt. (SAND)	S-5		E/M	0	
				E/M	0	
				E/M	0	
9.5' – 10.5'	Damp, brown/gray SILT, some fine to coarse Gravel, little fine Sand. (TILL)	S-6		M/D	1A	2 3
10.5'	Bottom of Test Pit at approximately 10.5 feet.					

Notes:

1. Test pit location and ground surface elevation was determined using a Trimble GeoXH handheld GPS device. Vertical datum is NGVD29.
2. Mottling observed from approximately 9.5 to 10.5 feet.
3. Backfilled test pit with lifts of spoils with each lift tamped by the excavator bucket upon completion.

Test Pit Plan

8' × 2'

→ NORTH

Volume = 3 cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.

GZA GeoEnvironmental, Inc.
Engineers/Scientists

Proposed Senior Housing Facility
Geotechnical Services
189 Boston Post Road, Sudbury, MA

Test Pit No.	TP-104
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File No.	170478.80
Checked By:	DJS

Excavation Equipment

GZA Rep.	M. Ostrowski	Contractor	Cryan Landscape	Date	10/12/2016
		Operator	Dan Flynn	Ground Elev.	144.4
Weather	M. Sunny 50s to 60s	Make	CAT; Model 430F	Time Started	1000
		Capacity	0.2 cu. Yd.; Reach 14 ft.	Time Completed	1035

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0				E	0	1
1'	Damp, dark brown SILT, some fine to medium Sand, trace Roots. (TOPSOIL)	S-1		E	0	
2'	2'					
	2.5' Dry, orange/brown fine to medium SAND, some Silt, trace Roots. (SUBSOIL)	S-2		E	1A (12")	
3'				E/M	1A (12")	
4'	Dry, light brown fine SAND, trace Silt. (SAND)	S-3		E/M	0	
5'	5'			M	0	
6'				M	0	
7'				M	0	
8'	Dry to moist, gray/brown with mottling, Clayey SILT, little fine Sand, trace fine to coarse Gravel. (TILL)	S-4		M	0	
9'				M	0	
10'				M	0	2
11'				M/D	0	
12'	12'					3, 4
	Bottom of Test Pit at approximately 12 feet.					
13'						
14'						
15'						
16'						

Notes:

1. Test pit location and ground surface elevation was determined using a Trimble GeoXH handheld GPS device. Vertical datum is NGVD29.
2. Soil appeared damp below approximately 10 feet.
3. Ended due to approximate extent of the reach of the backhoe and excavation difficulty.
4. Backfilled test pit with lifts of spoils with each lift tamped by the excavator bucket upon completion.

Test Pit Plan

9' × 2'

NORTH

Volume = 4 cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used	
TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(x) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
See Note # 2	

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.

GZA GeoEnvironmental, Inc.
Engineers/Scientists

Proposed Senior Housing Facility
Geotechnical Services
189 Boston Post Road, Sudbury, MA

Test Pit No.	TP-105
Page No.	1 of 1
File No.	170478.80
Checked By:	DJS

Excavation Equipment

GZA Rep.	M. Ostrowski	Contractor	Cryan Landscape			Date	10/12/2016
		Operator	Dan Flynn			Ground Elev.	148.5
Weather	M. Sunny 50s to 60s	Make	CAT	Model	430F	Time Started	1045
		Capacity	0.2 cu. Yd.	Reach	14 ft.	Time Completed	1110

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0	Damp, dark brown SILT, some fine to medium Sand, trace fine Gravel, trace Roots.			E	0	1
1'	(TOPSOIL)	S-1				
1.3'				E/M	0	
2'				E/M	0	
3'	Dry, light brown fine to coarse SAND, some Gravel, little (+) Silt. (Gravelly SAND)	S-2		E/M	0	
4'				E/M	0	
5'	5'			E/M	0	
6'				E/M	0	
7'				E/M	0	
8'	Moist/Damp brown/gray with mottling bands SILT. (SILT)	S-3		E/M	0	
9'				M/E	0	
10'				M/E	0	
11'	11'					2
	Bottom of Test Pit at approximately 11 feet.					
12'						
13'						
14'						
15'						
16'						

Notes:

1. Test pit location and ground surface elevation was determined using a Trimble GeoXH handheld GPS device. Vertical datum is NGVD29.
2. Backfilled test pit with lifts of spoils with each lift tamped by the excavator bucket upon completion.

Test Pit Plan

2' × 10'

NORTH →

Volume = 4 cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.

GZA GeoEnvironmental, Inc.
Engineers/Scientists

Proposed Senior Housing Facility
Geotechnical Services
189 Boston Post Road, Sudbury, MA

Test Pit No.	TP-106
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File No.	170478.80
Checked By:	DJS

Excavation Equipment

GZA Rep.	M. Ostrowski	Contractor	Cryan Landscape	Date	10/12/2016
		Operator	Dan Flynn	Ground Elev.	137.6
Weather	M. Sunny 50s to 60s	Make	CAT Model 430F	Time Started	1130
		Capacity	0.2 cu. Yd. Reach 14 ft.	Time Completed	1155

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0–1'	Damp, dark brown SILT, little fine to medium Sand, trace fine Gravel, trace Roots. (TOPSOIL)	S-1		E	0	1
1'	1'					
1'–2'				M/E	0	2
2'–3'				M/E	0	
3'–4'				M/E	0	
4'–5'	Dry to damp, light brown with occasional mottling bands SILT, little fine Sand, trace Gravel. (SILTY LOAM - C) (SANDY SILT)	S-2		M/E	0	
5'–6'				M/E	0	
6'–7'				D	0	
7'	7'					
7'–8'	Bottom of Test Pit ranged from approximately 7 to 8.5 feet.			D	Note #4	2, 3
8'–9'	8.5'			D	Note #3	4, 5
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:

1. Test pit location and ground surface elevation was determined using a Trimble GeoXH handheld GPS device. Vertical datum is NGVD29.
2. Redoximorphic features observed from a depth of about 2.2 feet.
3. Large boulder or bedrock encountered at approximately 7 feet at the south end of the test pit. The excavation was ended at approximately 8.5 feet at the north end of the test pit.
4. Soil appeared damp below approximately 7 feet.
5. Backfilled test pit with lifts of spoils with each lift tamped by the excavator bucket upon completion.
6. USDA texture class and corresponding NRCS hydrologic soil group indicated in parenthesis beside soil description.

Test Pit Plan

10' x 2'

→ NORTH

Volume = 3 cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
E-----Easy
M-----Moderate
D-----Difficult

Proportions Used

TRACE (TR.)	0 - 10%
LITTLE (LI.)	10 - 20%
SOME (SO.)	20 - 35%
AND	35 - 50%

Abbreviations
F = Fine
M = Medium
C = Coarse
V = Very
F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(x) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water
See Note #4	

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings h ave been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.

GZA GeoEnvironmental, Inc.
Engineers/Scientists

Proposed Senior Housing Facility	Test Pit No. TP-107
Geotechnical Services	Page No. 1 of 1
189 Boston Post Road, Sudbury, MA	File No. 170478.80
	Checked By: DJS

Excavation Equipment

GZA Rep.	M. Ostrowski	Contractor	Cryan Landscape	Date	10/12/2016
		Operator	Dan Flynn	Ground Elev.	138.4
Weather	M. Sunny 50s to 60s	Make	CAT Model 430F	Time Started	1210
		Capacity	0.2 cu. Yd. Reach 14 ft.	Time Completed	1440

Depth	Soil Description	Sample No.	PID Reading (ppm)	Excav. Effort	Boulders: Count/ Class	Note No.
0						
	Moist, dark brown fine to coarse SAND and SILT, trace fine Gravel, trace Roots.	S-1		E	0	1
1'	0.9' (TOPSOIL)					2
	Moist, brown fine to coarse SAND and fine to coarse GRAVEL, little Silt.	S-2		M	0	
2'	2' (SANDY LOAM - C)					
3'				M/D	0	3
4'				D	1A (8")	
5'	Dry, brown fine to coarse SAND and fine to coarse GRAVEL, some Silt, little Cobbles. (SANDY LOAM - C)	S-3		D	0	
6'	(Glacial TILL)			D	1A (8")	
7'				D	0	
	7.5'				0	4, 5
8'	Bottom of Test Pit at approximately 7.5 feet.					
9'						
10'						
11'						
12'						
13'						
14'						
15'						
16'						

Notes:

1. Test pit location and ground surface elevation was determined using a Trimble GeoXH handheld GPS device. Vertical datum is NGVD29.
2. Infiltration test performed at a depth of approximately 1.9 feet. Refer to the calculation sheet for the results.
3. Redoximorphic features observed at a depth of about 2.5 feet.
4. Ended test pit due to excavation difficulty.
5. Backfilled test pit with lifts of spoils with each lift tamped by the excavator bucket upon completion.
6. USDA texture class and corresponding NRCS hydrologic soil group indicated in parenthesis beside soil description.

Test Pit Plan

10' × 2'

NORTH →

Volume = 3 cu. yd.

Boulder Class

Letter Designation	Size Range Classification
A	6" - 17"
B	18" - 36"
C	36" and Larger

Excavation Effort
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Abbreviations
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F/M = Fine to medium
F/C = Fine to coarse
GR = Gray
BN = Brown
YEL = Yellow

GROUNDWATER
( ) Encountered
(X) Not Encountered

Elapsed Time to Reading (Hours)	Depth to Ground-water

Stratification lines represent approximate boundaries between soil types, transitions may be gradual. Water level readings have been made at times and under conditions stated. Fluctuations of groundwater may occur due to factors other than those present at the time measurements were made.

PERMEABILITY TEST NO. 1
Location: TP-107

Test Data

Date of Test	10/12/2016	
Casing Inside Diameter (in)	11.8	
Depth to Bottom of Casing (feet)	1.9	(measured from ground surface)
Casing Stickup (feet)	1.4	(measured from bottom of test pit)
Ground Surface Elevation (feet)	138.4	
Approx. Groundwater Level Depth (feet)	Not Encountered	(measured from ground surface)

Time Elasped		Depth of Water from Top of Casing	
(minute)	(second)	(ft)	(in)
0.00	0	0.00	0.0
0.25	15	0.08	1.0
0.50	30	0.10	1.2
1.00	60	0.17	2.0
2.00	120	0.33	4.0
3.00	180	0.44	5.3
4.00	240	0.57	6.8
5.00	300	0.69	8.3
7.00	420	0.90	10.8
10.00	600	1.17	14.0
13.00	780	1.40	16.8
16.00	960	1.61	19.3
20.00	1200	1.84	22.1
21.00	1260	1.88	22.6
22.00	1320	1.93	23.2
23.00	1380	1.97	23.6

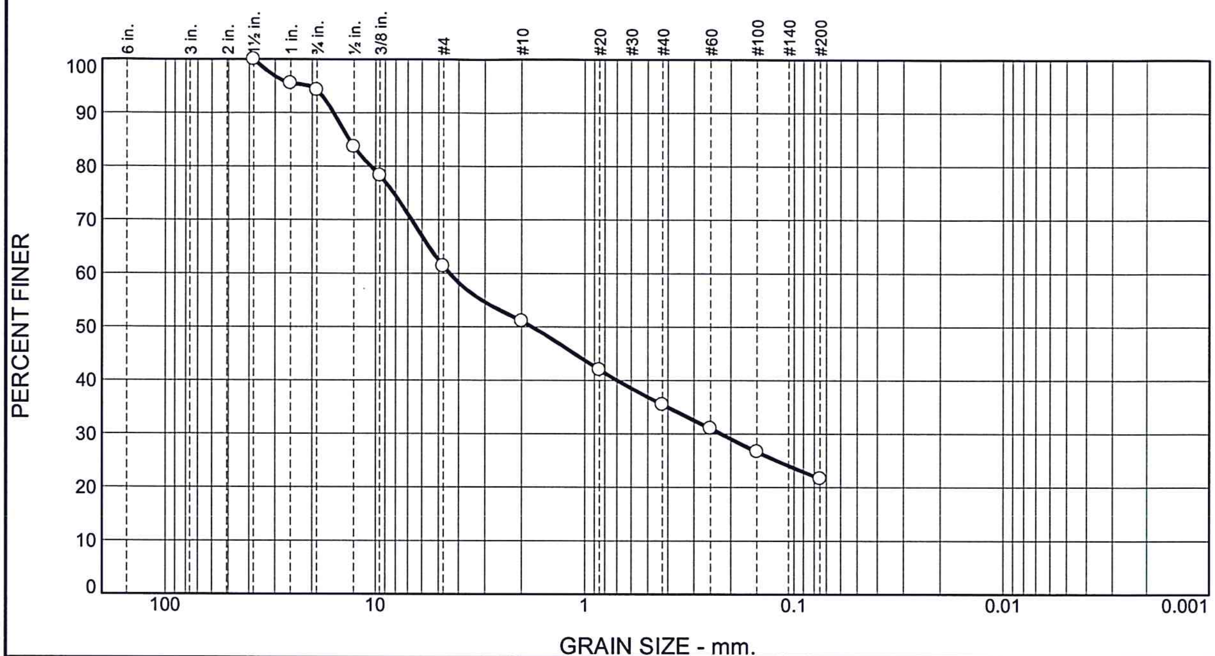
Calculations

Exposed Surface Area, A (in^2)	109.59
Drop in Water Level (in)	23.6
Time Interval (sec)	1380
Volume of Water (in^3)	2590.7
Flow Rate, Q (in^3/sec)	1.88
Estimated Hydraulic conductivity, k (in/sec)	1.7E-02
k (cm/sec)	**4.4E-02**

Notes

1. Data presented represents falling head permeameter testing conducted by GZA. Test hole pre-soaked for approx. 15 min. prior to recording water level drop
2. Permeability results were approximated using the formula Q=kiA where, Q is the flow rate, k is the permeability, i=1.0 (gravity drainage above the water table), and A is the area at the exposed surface area at the bottom of the casing.
3. Ground surface elevation determined using a Trimble GeoXH handheld GPS device.

Particle Size Distribution Report



% +3"	% Gravel		% Sand			% Fines	
	Coarse	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	5.8	32.9	10.2	15.6	13.8	21.7	

TEST RESULTS (D422)

Opening Size	Percent Finer	Spec.* (Percent)	Pass? (X=Fail)
1.5	100.0		
1	95.5		
0.75	94.2		
0.5	83.7		
.375	78.3		
#4	61.3		
#10	51.1		
#20	42.0		
#40	35.5		
#60	31.0		
#100	26.7		
#200	21.7		

* (no specification provided)

Material Description

Light Brown f-c SAND and f-c GRAVEL, some Silt

Atterberg Limits (ASTM D 4318)

PL= NP **LL=** NV **PI=** NP

Classification

USCS (D 2487)= SM **AASHTO (M 145)=** A-1-b

Coefficients

D_{90}= 15.8489 D_{85}= 13.3707 D_{60}= 4.4420
D_{50}= 1.7853 D_{30}= 0.2226 D_{15}=
D_{10}= C_u= C_c=

Remarks

Date Received: 10.21.16 **Date Tested:** 10.26.16

Tested By: IA

Checked By: Matthew Colman, P.E.

Title: Laboratory Manager

Source of Sample: Test Pits **Depth:** 3 to 5' **Date Sampled:**
Sample Number: TP-107 S-3

Thielsch Engineering Inc.

Cranston, RI

Client: GZA GeoEnvironmental
Project: Coolidge at Sudbury II
Sudbury, MA
Project No: 01.0170478.80 **Figure** S-1