Stormwater Report
Herb Chambers Jaguar/Land Rover
83 Boston Post Road
Sudbury, Massachusetts

CHA Project Number: 31554

Submitted To:
Sudbury Planning Board
278 Old Sudbury Road
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LIST OF ACRONYMS & ABBREVIATIONS

BFE	Base Flood Elevation
BMP	Best Management Practice
BVW	Bordering Vegetated Wetland
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HSG	Hydrologic Soil Group
IWPA	Interim Wellhead Protection Area
MAHW	Mean Annual High-Water
MassDEP	Massachusetts Department of Environmental Protection
NAVD	North American Vertical Datum
NRCS	Natural Resources Conservation Service
SHGW	Seasonal High Groundwater
SWMSH	Stormwater Management Standards Handbook
Tc	Time of Concentration
TSS	Total Suspended Solids
USGS	United States Geological Survey

1.0 NARRATIVE

1.1 EXECUTIVE SUMMARY

On behalf of Herb Chambers 83 Boston Post Road, LLC (Applicant), CHA has prepared this Stormwater Report for the proposed building addition and stormwater improvements for the site located at 83 Boston Post Road (Route-20) in Sudbury, Massachusetts. The developed portion of the project site measures approximately 2.7 acres in area and is divided by both the Town of Wayland and the Town of Sudbury. The site is owned and controlled by the Herb Chambers Companies and is currently used as a Jaguar/ Land Rover auto dealership. The property is bounded to the north by Boston Post Road and south by an existing Bordering Vegetated Wetland (BVW) under Conservation Restriction protection. The property is bounded to the west by MA DPW property and to the east by an existing car dealership.

The purpose of this stormwater analysis and report is to assess and compare existing and proposed hydrologic conditions at the property to demonstrate that the stormwater management system design effectively satisfies the requirements of the Massachusetts Stormwater Regulations and the Town of Sudbury Stormwater Management Bylaw Regulations.

The existing property is currently served a conventional drainage system with a minimal number of catch basins. The existing stormwater BMPs (Best Management Practices) include catch basins, leaching pits for roof drains, concrete infiltration galleys, and a water quality swale with an emergency overflow spillway that discharges to BVW.

The north portion of the site drains into an existing catch basin in Route-20 and is conveyed via an 18-inch drainage pipe under the existing parking lot before discharging to the BVW. Stormwater runoff from the existing parking lot utilized overland flow to direct runoff away from the building and to the southeast corner of the lot where it is collected in a multi-inlet concrete drainage structure. The structure discharges stormwater to a water quality swale that outlets to the BVW. Stormwater from the west portion of the existing roof is collected by roof drains and piped to a leaching dry well structure. The remaining roof area utilized downspouts to discharge stormwater at exiting grade for overland flow and collection by catch basins. In the adjacent parking area west of the building, a catch basin collects stormwater and conveys it to an existing concrete galley infiltration BMP. An existing septic system and leaching trenches are located onsite, between the existing building and the concrete galley BMP.

The proposed project is a mix of new development and redevelopment and will create a net new impervious area of approximately 4,225 square feet. To offset the impacts from the increase in impervious area and improve water quality for the redeveloped site, the proposed site design includes multiple stormwater BMPs including deep sump hooded catch basins, isolator rows, three (3) subsurface infiltration/detention chamber systems, and improvement to the existing water quality swale. These BMPs are further described in this report and as shown on the attached site development plans. The proposed stormwater management system will reduce the peak stormwater discharge rates and volume by utilizing outlet control structures to control outflows from the infiltration/detention systems as documented in the included HydroCAD model.

The proposed stormwater management system design complies with all applicable sections of Town of Sudbury Stormwater Management Bylaw Regulations and the 2008 Massachusetts Stormwater Regulations by utilizing multiple BMP's including the subsurface detention/infiltration systems to collect, treat, and control stormwater runoff generated on the site during storm events. The proposed improvements are shown on the attached site development plans prepared by CHA, 141 Longwater Park Drive, Norwell, Massachusetts.

1.2 OBJECTIVE OF CALCULATIONS

The purpose of this stormwater analysis is to assess and quantify the existing and proposed stormwater runoff conditions from the site based upon standard methodologies in accordance with the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards and the applicable provisions of the Town of Sudbury "Stormwater Management Bylaw", "Wetlands Administration Bylaw", and the "Wetlands Administration (Article XXII) regulations.

The goals of the stormwater management system design for this project are to provide for stormwater quality treatment, reduction in post-development peak runoff rates as compared to pre-development peak runoff rates, improve water quality, and to protect the surrounding area from any potential flooding impacts in accordance with the Stormwater Management Regulations. The following analysis includes stormwater routing calculations performed using the 2-year, 10-year, 25-year, and 100-year frequency, Type III, 24-hour SCS design storms. The analysis also includes calculations for the 0.5 inch and 1 inch rainfall events.

1.3 METHODOLOGY

The HydroCAD Stormwater Modeling computer program, version 10.00, by Applied Microcomputer Systems, Inc. is used to develop peak stormwater runoff rates and volumes for the existing and proposed conditions at the project site. The HydroCAD software is a hydrograph generation and routing program like TR-20. The software uses Soil Conservation Service (SCS) Unit Hydrograph Methodology. Information regarding the equations and calculation procedures utilized in HydroCAD will be made available upon request.

The following basic steps are employed in the routing procedure:

1. A rainfall distribution is selected which indicates how the storm rainfall depth will be distributed over time. This is the standardized Type III SCS distribution based upon the project's location.
2. The design storm rainfall amount is determined from rainfall frequency atlas based upon the return period being modeled. Combined with the distribution of rainfall, a cumulative rainfall depth at each period during the storm is determined.
3. Based upon the Time of Concentration (Tc), the storm is divided into bursts of equal duration. For each burst, the SCS runoff equation and the average Curve Number are used to determine the portion of that burst that will appear as runoff.
4. A unit hydrograph representing the runoff resulting from one inch of precipitation excess

generated uniformly over the watershed in conjunction with the Time of Concentration is used to determine how the runoff from a burst is distributed over time. The result is a runoff hydrograph for a single burst.

5. Individual hydrographs are added together for all bursts in the storm yielding the complete runoff hydrograph for each storm.

The SCS rainfall distributions are derived from observations that were used to develop the Intensity-Duration-Frequency relationship or IDF curve. By studying the Weather Bureau's Rainfall Frequency Atlases, the SCS developed four "mass curves" that could be used to represent the characteristics of the rainfall distribution throughout the continental United States. The mass curve is a dimensionless distribution of rainfall over time, which indicates the fraction of the rainfall event that occurs at a given time within a 24-hour precipitation event. This synthetic distribution develops peak rates for storms of varying durations and intensities. The SCS distribution provides a cumulative rainfall at any point in time and allows volume dependent routing runoff calculations to occur.

The HydroCAD software has the additional capability to describe shallow concentrated flow. The "NEH-4 Upland Method" included in the HydroCAD software is applicable for conditions which occur in the headwaters of a watershed up to 2000 acres. The NEH-4 Upland Method allows the Time of Concentration (Tc) to reflect ground conditions such as overland flow, grassed waterways, paved areas and upland gullies. This results in a model that more accurately reflects the ground surface for shallow concentrated flow conditions, than TR-20, which is limited to distinguishing only paved and unpaved surfaces. Tc is the time required for water to flow from the most distant point on a runoff area to the measurement or collection point. In instances where the watersheds are small and impervious, Tc has been directly entered as a 6-minute minimum, or 0.1 hours. This is consistent with standard engineering practice and Technical Release (TR-55) Urban Hydrology for Small Watersheds graphical method. A lower boundary of 6 minutes will yield a conservative, yet practical measure of stormwater runoff flow for small watersheds contained within the development.

The curve number or CN is a land sensitive coefficient that determines the relationship between total rainfall depth and direct stormwater runoff. Based upon the cover in each sub-watershed a weighted average CN value was determined. The area, CN value, and time of concentration are input into the HydroCAD modeling software to develop runoff hydrographs for the pre and post-developed conditions at the site.

As previously mentioned, two design points were chosen at the down gradient point in each of the drainage areas to compare runoff conditions for both the predevelopment and postdevelopement conditions for each of the following SCS Type III 24-hour design storm events. The design storm frequencies and corresponding rainfall depths were compiled from the Northeast Regional Climate Center "Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada". Rainfall data was examined from the Cornell NRCC website (http://precip.eas.cornell.edu/) and the Sudbury Stormwater Regulations. Rainfall from the NRCC was compared to the Sudbury documents due to the project being in partial jurisdiction with the Town of Sudbury. The more stringent rainfall amounts from Sudbury were utilized for the hydrology model to also meet the requirements for rainfall under the Wayland Wetlands and Water

Resources Bylaws. For the project location, the 24 hr rainfall amounts are as follows:

Storm Frequency (Years)	Rainfall Depth (Inches)
0.5- Inch Storm	0.5
1-Inch Storm	1.0
2	3.2
10	4.8
25	6.0
100	8.6

Drainage area maps for both pre- and post-development conditions have been included in this submission in Section 3.2 of this Stormwater Report.

1.4 SITE HYDROLOGY

Hydrologic soil groups (HSG) are used primarily to estimate runoff from precipitation in engineering calculations. HSG designations vary from "A" to "D" with "A" having the highest infiltration rate and "D" the slowest. The delineated soil boundaries from the Natural Resources Conservation Service (NRCS) soil survey show that the site consists predominantly of 656, Udorthents-Urban Land (excavated and filled land) and 52, Freetown muck at the BVW. Additional soil information can be found in the attached "Custom Soil Resource Report for Middlesex County, Massachusetts, 83 Boston Post Rd, Sudbury, MA" by the NRCS.

An array of soil borings that were also performed at the site to examine soils and groundwater levels. The "Geotechnical Study" by KMM Geotechnical Consultants, LLC (Appendix B) summarized the onsite testing information and confirms widespread fill (sand with some gravel, little silt) overtop Fluvial deposits of fine sand with silt. For surface runoff calculations, the project site has been classified as HSG B to approximate the amount of runoff generated by the fill soils with sandy loam to loam properties. The HSG B assumption will also be used in the post developed runoff conditions.

The onsite testing of the Fluvial sub-strata layers showed soils with varying consistencies in a range including sand, silty sand, sandy silt, and sandy gravel. For the infiltration calculations in the HydroCAD model, the rate has been consistently and very conservatively assumed at the low value of 0.27 in/hr (HSG C) from the Rawls Rates table.

1.4.1 PRE-DEVELOPED HYDROLOGY

The majority of the present site is covered by impervious surface and is served by existing stormwater conveyance and basic treatment systems. The site is analyzed and divided into sub-watershed areas that are tributary to those conveyance systems. The sub-watershed areas are depicted on the Existing Watershed Plan that is included in Section 3.2.1. of this report. The cover condition of the existing drainage areas consists mostly of pavement/roofs, and landscaped areas. The hydrologic soil group (HSG) is assumed to be

"B" for all sub catchments in this project except the wetlands which has been assigned a "D" soil designation.
The existing condition hydrology consists of four different sub-catchment areas, Ares 1S, 2S, 3S, 4S. There are two design points selected as analysis points. DP-1 is the existing BVW and DP-2 is the concrete galleys under the western parking area.

Existing Conditions Sub-catchment Area 1S

This sub-catchment encompasses the parking area west of the existing building. Stormwater runs from the parking lot and is collected via a catch basin structure and conveyed to the subsurface concrete galley drainage structures designated as DP-2. The major cover type in Sub-catchment Area 1S is pavement. The drainage galleys measure 4'x 4'x4' and are arranged in two (2) rows of eight (8). They are set in a stone bed, wrapped in filter fabric according to design plans on record.

Existing Conditions Sub-catchment Area 2S

This sub-catchment encompasses the area tributary to the existing catch basin vault structure upstream of DP-1 and consists mainly of pavement/roof areas. Roof runoff is discharged at grade and flows overland along with pavement runoff to the southeast corner of the site. The catch basin vault structure collects runoff and discharges to a water quality swale equipped with a broad crested weir overflow that leads to the BVW.

Existing Conditions Sub-catchment Area 3S

This sub-catchment area includes the north, street facing side of the existing building and the driveway entrance to Boston Post Road. Stormwater runoff from this area is collected by curb and gutter and directed to a catch basin in the side gutter line of Boston Post Road. The outlet of the catch basin is an 18" pipe that flows south, under the parking lot, and discharges to the BVW (DP-1).

Existing Conditions Sub-catchment Area 4S

This sub-catchment area includes a large portion of the existing roof. The roof runoff is collected by roof drains and directed to a leaching dry well structure located west of the building. In the event of an overflow, it appears the roof runoff will continue downslope to a catch basin structure whose outlet pipe discharges to a grass swale. The grass swale directs stormwater runoff to the BVW (DP-1). The leaching dry well has been conservatively excluded from the hydrology model.

1.4.2 POST DEVELOPED HYDROLOGY

The proposed project consists of a 2,600 square foot building addition, drainage infrastructure improvements, septic system repairs, and updates to the parking layout of the dealership. Changes to the overall layout include a one-way access drive that is located to the west of the existing building. Drainage infrastructure improvements will include new deep sump hooded catch basins, associated drainage piping, and the construction of three (3) new subsurface infiltration chamber systems.

Roof runoff from the proposed building addition will be directed to a proposed subsurface infiltration system. New catch basins will be situated throughout the parking area to collect and convey stormwater to the three subsurface infiltrations systems. The existing 4'x'4'x4' concrete stormwater galleries will remain and be inspected and cleaned. The existing catch basin vault structure in the southeast corner of the parking lot will also be inspected, cleaned, and kept in operation. The existing water quality swale will be regraded and improved with an outlet control device.

The proposed condition hydrologic model consists of ten different sub-catchment areas, Area 1S through Area 10S. Refer to the Proposed Watershed Plan, attached in Section 3.2.1 of this report. The analysis is performed utilizing the same two design points as in the existing conditions case to allow comparison. DP-1 is the existing BVW and DP-2 is the concrete galleys under the western parking area.

Proposed Conditions Sub-catchment Area 1S
This sub-catchment is the same area as the existing conditions and encompasses the parking area west of the existing building. Stormwater runs from the parking lot and is collected via a catch basin structure and conveyed to the subsurface concrete galley drainage structures designated as DP-2.

Proposed Conditions Sub-catchment Area 2S
This sub-catchment consists of the driveway leading to the western parking area. The mostly impervious area is tributary to a proposed catch basin. The catch basin's outlet pipe connects to a pipe network that discharges to the reconstructed water quality swale at DP-2.

Proposed Conditions Sub-catchment Area 3S
This sub-catchment area includes the driveway entrance and a portion of Boston Post Road. Stormwater runoff from this area is collected by curb and gutter and directed to a catch basin in the side gutter line of Boston Post Road. The outlet of the catch basin is an 18" pipe that flows south, under the parking lot, and discharges to the BVW (DP-1).

Proposed Conditions Sub-catchment Area 4S
This sub-catchment includes the north end of the parking lot tributary to underground system UG-1.

Proposed Conditions Sub-catchment Area 5S
This sub-catchment includes a middle portion of the parking lot tributary to underground system UG-2.

Proposed Conditions Sub-catchment Area 6S
This sub-catchment includes a middle portion of the parking lot also tributary to underground system UG-2.

Proposed Conditions Sub-catchment Area 7S
This sub-catchment includes the parking lot pavement runoff to the southeast corner of the

site. The catch basin vault structure collects runoff and discharges to a water quality swale equipped with a broad crested weir overflow that leads to the BVW.

Proposed Conditions Sub-catchment Area 8S

This sub-catchment is located on the south end of the site and contains the remaining area outside of the parking lot. It encompasses the reconstructed water quality swale.

Proposed Conditions Sub-catchment Area 9S

This sub-catchment includes the southwest portion of the parking lot tributary to underground system UG-3.

Proposed Conditions Sub-catchment Area 10S

This sub-catchment area includes a large portion of the existing roof. The roof runoff is collected by roof drains and directed to a leaching dry well structure located west of the building. In the event of an overflow, it appears the roof runoff will continue downslope to a catch basin structure whose outlet pipe discharges to a grass swale. The grass swale has been regraded and now directs stormwater runoff to the reconstructed water quality swale before discharge to the BVW (DP-1). The leaching dry well has been conservatively excluded from the hydrology model.

1.5 STORMWATER MANAGEMENT

The following section describes how the proposed project addresses and complies with the 2008 MassDEP Stormwater Management Regulation requirements.

Standard 1: No New Untreated Discharges – No new stormwater system conveyances will discharge untreated runoff or cause erosion in wetlands or waters of the Commonwealth.

The new stormwater system conveyances will not discharge untreated runoff or cause erosion in wetlands or waters of the Commonwealth. Energy dissipators are proposed at the flared end sections and riprap has been appropriately sized.

Standard 2: Peak Rate Attenuation – Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.

The peak discharge rates are calculated with the aid of a hydrograph routing program using TR-20 methodology called HydroCAD. The HydroCAD calculations estimating the expected Pre- and Post-Development runoff peak rates have been performed. The proposed HydroCAD analysis examines hydrologic conditions at two design points as shown on the Watershed Plans. The analysis demonstrates that the proposed stormwater management system reduces post-development peak rates of runoff below pre-development peak rates. Refer to Section 1.7 for a summary of pre-development and post-development peak runoff rates for comparison.

Standard 3: Recharge – Loss of annual recharge to groundwater shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and

good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook. MassDEP also recognizes that on some sites, there is a risk that infiltrating the required recharge volume may cause or contribute to groundwater contamination. MassDEP requires infiltration only to the maximum extent practicable on project sites where contamination has been capped in place.

The project's stormwater management system utilizes subsurface infiltration/detention chamber systems to provide recharge. Based on the recharge calculations contained in this Stormwater Report, the proposed project provides the required recharge volume to meet the requirements for Standard 3. Please refer to the recharge volume calculations located in ***Section 4*** *of this Stormwater Report.*

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).
This Standard is met when:

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

The project proposes to use deep sump hooded catch basins to remove 25% TSS followed by Isolator Rows (69%) to remove greater than 44% prior to infiltration (80%) from the SC-310 StormTech units for a total greater than 80% TSS removal for the project. The Long-Term Pollution Prevention Plan is included in conjunction with the Operation and Maintenance Plan required by Standard 9, which outlines routine inspections, cleaning & street sweeping procedures and frequencies. Refer to Section 4.1 of this report for the TSS removal calculation worksheet.

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

The project is not considered a LUHPL (Land Use with Higher Potential Pollutant Load); however, the stormwater design has used the 1.0-inch Water Quality Volume (WQV) converted to a flow in calculating the proposed BMP sizes.

Standard 6: Critical Areas – Critical areas are Outstanding Resource Waters as designated in 314 CMR 4.00, Special Resource Waters as designated in 314 CMR 4.00, recharge areas for public water supplies as defined in 310 CMR 22.02 (Zone Is, Zone IIs, and Interim Wellhead Protection Areas for groundwater sources and Zone (A)s for surface water sources.)

There are no critical areas associated with this project.

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

The project is considered a mix of new development and redevelopment per the Stormwater Handbook. The project has been designed to fully comply with the MA Stormwater regulations as a new development.

Standard 8: Construction Period Pollution Prevention Plan and Erosion and Sedimentation Control – A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

The project will require an EPA NPDES Construction General Permit and the prerequisite Stormwater Pollution Prevention Plan prior to commencement of construction activities.

Standard 9: Operation and Maintenance Plan – A long-term Operation and Maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

An Operation and Maintenance Plan has been prepared for this project. Refer to Section 2 attached. Provisions to maintain runoff control devices have been assured through non-structural, structural, and construction management approaches.

Standard 10: Prohibition of Illicit Discharges – All illicit discharges to the stormwater management system are prohibited.

The Operation and Maintenance plan required by Standard 9 includes measures to prevent illicit discharges. An Illicit Discharge Compliance Statement is included in Section 4.6.

1.6 BEST MANAGEMENT PRACTICES (BMP'S)

A system of deep sump hooded catch basins and StormTech Isolator Rows are proposed to treat site generated stormwater runoff. See Section 4.3 for the Total Suspended Solids (TSS) calculation spreadsheet. A description of the devices used to provide treatment is provide below.

1.6.1 PROPOSED STRUCTURAL AND TREATMENT BMPs

1. DEEP SUMP HOODED CATCH BASINS

Deep sump catch basins are modified versions of inlet structures installed to collect and convey stormwater on the site. The deep sumps, typically a 4-ft dimension below the outlet pipe invert, are most effective of placed "off-line"; that is they do not have inlet pipes. The catch basins contain traps or hoods on the outlet pipes and serve as pretreatment for other downstream BMPs. Deep sump catch basins will be installed throughout the site to remove trash, debris, sediment and a limited amount of oil and grease from stormwater runoff. Catch basins shall be cleaned, in dry weather, when half of the sump capacity is filled or at a minimum quarterly or as required through periodic inspection. Cleaning will take place at the completion of construction and in early spring after sanding of roadways has ceased or as needed depending on the frequency of major storm events (greater than 1-inch of rainfall).

2. ISOLATOR ROWS

The Isolator Row is a series of StormTech chambers surrounded with filter fabric and connected to one or more manholes for access. The chambers are wrapped in fabric and provide settling and filtration. Stormwater runoff is first directed to the Isolator Row where they capture sediments, thereby protecting the rest of the underground system consisting of standard chambers in a stone bed. This technology will be used as a part of a treatment train consisting of other structural and non-structural approaches such as street sweeping and reduced road salt alternatives. Isolator Rows will be inspected routinely and cleaned in accordance with manufacturer's recommendations.

3. SUBSURFACE DRAINAGE SYSTEM (UG-1, UG-2, UG-3)

A subsurface drainage system consisting of high-density polyethylene plastic chambers (StormTech) set in a stone bed are proposed to detain, recharge, and infiltrate storm runoff. The chamber system aims to provide peak flow reduction, stormwater runoff volume reduction, and TSS removal for various storm events. The proposed system drains down completely between storm events due to the orifice being placed at the bottom of the detention chambers. Manhole risers or manufacturer recommended inspection ports are proposed at the ground surface to allow inspection and maintenance access.

4. OUTLET CONTROL STRUCTURES

The outlet control structure (OCS) detains the stormwater utilizing orifices to control the outlet flow and are accessed through the top grate of the structure. Although the outlet control structures should not collect much debris, they should be inspected along with the water quality swale inspection to make sure they are clean of debris and functioning properly. Sand accumulation within the OCS is a sign there is an issue with the stability

of the swale. The OCS shall be inspected once per year. It may be necessary to clean the structure and the use of a vacuum truck may be necessary.

5. WATER QUALITY SWALE/PARTIAL EXFILTRATION BASIN

A stone lines swale conveys stormwater from the existing catch basin vault structure and proposed pipe headwall outlet to the vegetated water quality swale/partial exfiltration basin area. The swale design includes a surrounding berm to detain stormwater. Stormwater exiting the swale is controlled by a proposed outlet structure and a broad crested weir. Swales shall be inspected on a semi-annual basis in the early spring and fall. Additional inspections shall be performed during the first few months after construction to ensure that adequate vegetation has been established. Regular maintenance shall include mowing, fertilizing, pruning, debris removal, and weed/pest control. Swales shall be mowed at least once per year to a minimum of 4 inches so as not to reduce the effectiveness of pollutant removal and energy.

6. LEVEL SPREADER/PLUNGE POOL/ENERGY DISSIPATER AND DOWNSTREAM SLOPES:

The level spreader/plunge pool/energy dissipaters are utilized at the outlet pipes prior to discharge to the wetland to prevent erosion. The level spreader/plunge pool/energy dissipaters should be inspected at least once a year for sand accumulation and debris which may impact its effectiveness to slow water. Cleaning should take place during the early spring, although, additional inspections and cleaning may be needed.

In order to ensure that the level spreader systems are working, the outlets as well as slopes downstream for the first three (3) years of operation, should be inspected after every storm of 1" or greater to assure no erosion of the slope. After the first three years, we recommend inspections after any large storm (25+ year event) for erosion. If no erosion is evident, then the stone size and level spreader design is adequate. Should there be erosion of the level spreader, stone size should be increased or additional large stones added to enhance energy dissipation of water. If downstream slopes exhibit signs of erosion, repairs to soils and slope should be made and then a treatment such as an erosion control matting should be instituted to reinforce soils until vegetative cover can be restored. We recommend that the aprons and downstream slopes be inspected and cleaned annually as part of the outlet maintenance to ensure future adequacy.

1.7 SUMMARY OF HYDROLOGY & STORMWATER CALCULATIONS

The results of the pre and post-development hydrology calculations provided in Section 3 are summarized in the following tables. The table corresponds to the design points as indicated on the drainage area maps and hydrograph routing calculations.

Design Point 1 represents stormwater runoff reaching the BVW at the south end of the property.

TOTAL RUNOFF PEAK FLOW RATE (CFS)
DESIGN POINT 1 (DP-1)

STORM SCS 24-HR	EXISTING	PROPOSED REV1	DIFFERENCE
0.5-Inch	0.00	0.00	0.00
1-Inch	0.14	0.06	-0.08
2-YEAR	5.85	5.10	-0.75
10-YEAR	9.95	9.08	-0.87
25-YEAR	13.01	12.54	-0.47
100-YEAR	19.37	19.36	-0.01

TOTAL RUNOFF VOLUME (AF)
DESIGN POINT 1 (DP-1)

STORM SCS 24-HR	EXISTING	PROPOSED REV1	DIFFERENCE
0.5-Inch	0.001	0.000	-0.001
1-Inch	0.026	0.024	-0.002
2-YEAR	0.417	0.395	-0.022
10-YEAR	0.743	0.713	-0.030
25-YEAR	0.994	0.959	-0.035
100-YEAR	1.548	1.507	-0.041

Design Point 2 represents the existing, onsite concrete galley system that collects and infiltrates stormwater for the western parking lot. During the redevelopment the tributary area and total impervious area does not change.

TOTAL RUNOFF PEAK FLOW RATE (CFS)
DESIGN POINT 2 (DP-2)

STORM SCS 24-HR	EXISTING	PROPOSED	DIFFERENCE
0.5-Inch	0.01	0.01	0.0
1-Inch	0.11	0.11	0.0
2-YEAR	0.86	0.86	0.0
10-YEAR	1.45	1.45	0.0
25-YEAR	1.89	1.89	0.0
100-YEAR	2.84	2.84	0.0

TOTAL RUNOFF VOLUME (AF)
DESIGN POINT 2 (DP-2)

STORM SCS 24-HR	EXISTING	PROPOSED	DIFFERENCE
0.5-Inch	0.001	0.001	0.0
1-Inch	0.008	0.008	0.0
2-YEAR	0.062	0.062	0.0
10-YEAR	0.106	0.106	0.0
25-YEAR	0.140	0.140	0.0
100-YEAR	0.215	0.215	0.0

The proposed project design meets or reduces the flow in the post-developed condition at all Design Points, DP-1 through DP-2 for the listed design storm events.

1.8 CONCLUSION

In conclusion, the project provides a reduction in post-developed peak rates of runoff compared to pre-development rates, through the detailed design of stormwater Best Management Practices (BMPs). The overall drainage system has been designed to control peak discharge rates and volumes for up to and including the 100-yr design storm event. The design provides total suspended solids (TSS) removal and water quality treatment, as required by the Massachusetts Stormwater Management Regulations.

It is our professional opinion that the proposed development project will not adversely affect the surrounding drainage patterns. The following routing calculations, Best Management Practice design, and associated documentation within this report have been prepared to illustrate that runoff from the project has been mitigated.

1.9 REFERENCES

1. Commonwealth of Massachusetts, Department of Environmental Protection, Stormwater Management Standards Handbook. Volumes 1-3 February 2008 (DEP Stormwater Management Policy 2008).

2. Commonwealth of Massachusetts, Department of Environmental Protection. 310 CMR 10.00: Massachusetts Wetlands Protection Act Regulations. 2008.

3. Commonwealth of Massachusetts, Department of Environmental Protection. 314 CMR 4.00: Massachusetts Surface Water Quality Standards. 2007.

4. Commonwealth of Massachusetts, Department of Environmental Protection. 314 CMR 9.00: Massachusetts Water Quality Regulations. 2008.

5. United States Department of Agriculture, Natural Resources Conservation Services Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55). June 1986.

6. United States Department of Agriculture, Natural Resources Conservation Services Project Formulation Hydrology Program System, Technical Release 20 (TR-20). Oct. 2004.

1.10 GENERAL CONSTRUCTION SEQUENCING

The following section provides construction details and highlights the construction sequence and timing of earthmoving activities. The overall project will be broken down into the following phases:

A. Pre-construction Meeting

An on-site meeting will be conducted by the Owner's Representative prior to the start of construction activity. The appropriate State & Town Departments will be invited to participate. A copy of the Stormwater Pollution Prevention Plan (SWPPP) and NPDES Construction General Permit (CGP) will be provided to applicable parties, Authorities, and Town Departments.

B. Installation of Erosion Controls

Erosion and sedimentation controls (i.e. silt fence, filter socks, and inlet protection) will be installed at the limits of work and within the existing catch basins, as applicable. Tree protection will be installed around trees specified to remain within the limit of work. Structures to remain shall also be visibly flagged/protected.

C. Installation of Construction Entrance

A construction entrance will be installed in the location as shown on the Erosion Control Plan in accordance with the construction detail provided in the plan set. Existing pavement will be removed within the limits of the proposed construction entrance to accommodate the crushed stone entrance. In lieu of removing the pavement, the Contractor can install a layer of filter fabric and cover with crushed stone per Construction Document details.

D. Demolition

Any existing building, utilities services, and pavement within the project area will be demolished in accordance with the Construction Plans. Those utilities effected by construction activates shall be coordinated with the utility purveyors and Dig Safe procedures taken prior to implementation of agreed upon connections/disconnections/abandonment of services. Materials that are to be removed from the site will be transported to an appropriate facility or will be disposed of elsewhere according to Federal, State, and Local guidelines. Inactive stockpiles or areas of granular material or topsoil shall be temporarily secured in accordance with the SWPPP in order to control sediment laden runoff.

E. Site Clearing and Rough Grading

The site will be cleared and rough graded in accordance with the proposed grading as shown on the plans. If suitable topsoil is found, it will be removed and stockpiled within the project limits. Areas which have been cleared (outside of the right-of-way) will be stabilized.

F. Building Construction

This phase of construction will involve the installation of the buildings including the proposed foundations and vertical construction of the buildings. All building waste is to be properly disposed of in dumpsters. While this phase commences, other site construction activities will be taking place.

G. Installation of Drainage and Utilities

Utility relocations and modifications, including water, gas, and electric, are anticipated to occur in conjunction with the drainage work. Temporary sediment basins will be constructed at this time on an as-needed basis to collect stormwater runoff during construction. Stockpiles will be established in designated areas as shown on project plans. All temporary/inactive stockpile areas will be encompassed by straw bales or other approved erosion control devices to control sediment laden runoff as necessary and will be temporarily seeded, mulched or covered with plastic, as necessary. Material stabilization will be in accordance with the SWPPP.

H. Fine Grading, Paving, Etc.

The fine grading and shaping will commence along with the installation of curbing to prepare for paving operations. Areas outside of the parking lot will be shaped and prepped for loam, seed, or other treatments. Paving operations will begin with the installation of both binder and finish course layers.

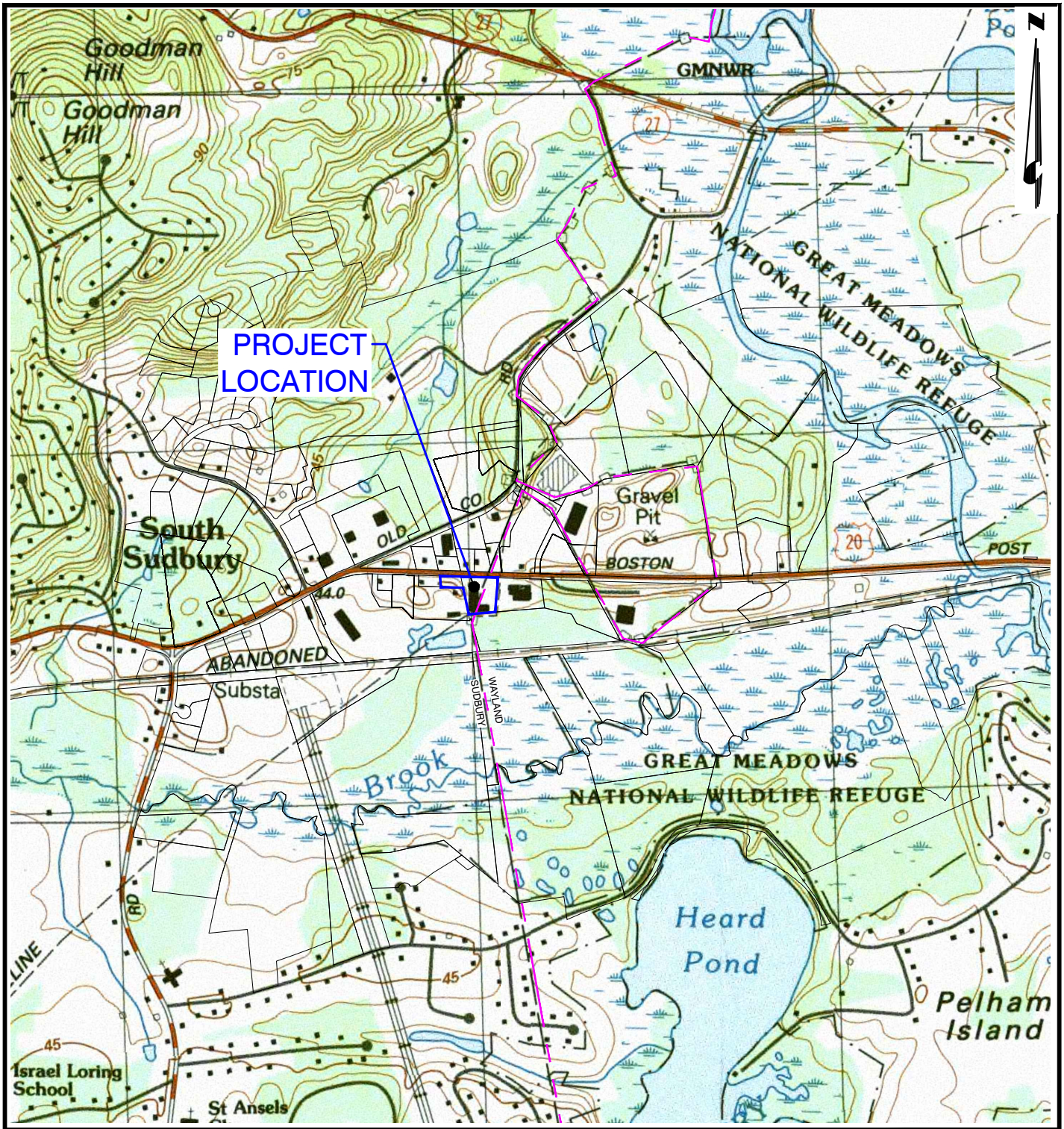
I. Permanent / Final Site Stabilization

The final phase of the project final parking lot paving, landscaping, and restoration and stabilization of all exposed surfaces. Curb installation, final parking lot paving, and final landscaping will be performed upon completion construction.

Disturbed areas will be landscaped, mulched or seeded in accordance with the landscape requirements. Permanent restoration and revegetation measures serve to control erosion and sedimentation by establishing a vegetative cover. In the event that weather conditions prevent final restoration, temporary erosion and sedimentation measures will be employed until the weather is suitable for final cleanup. A final inspection will ensure that the project site is cleared of all project debris and that erosion and sedimentation controls are functioning properly. Once the site has been stabilized, newly installed catch basins and the subsurface recharge/detention system will be inspected for sediment deposits and cleaned if necessary.

Section 1.11

Figures



LEGEND

PROJECT LOCATION

CHA
141 Longwater Drive
Norwell, MA 02061
Main: (781) 982-5400 www.chacompanies.com

TITLE:

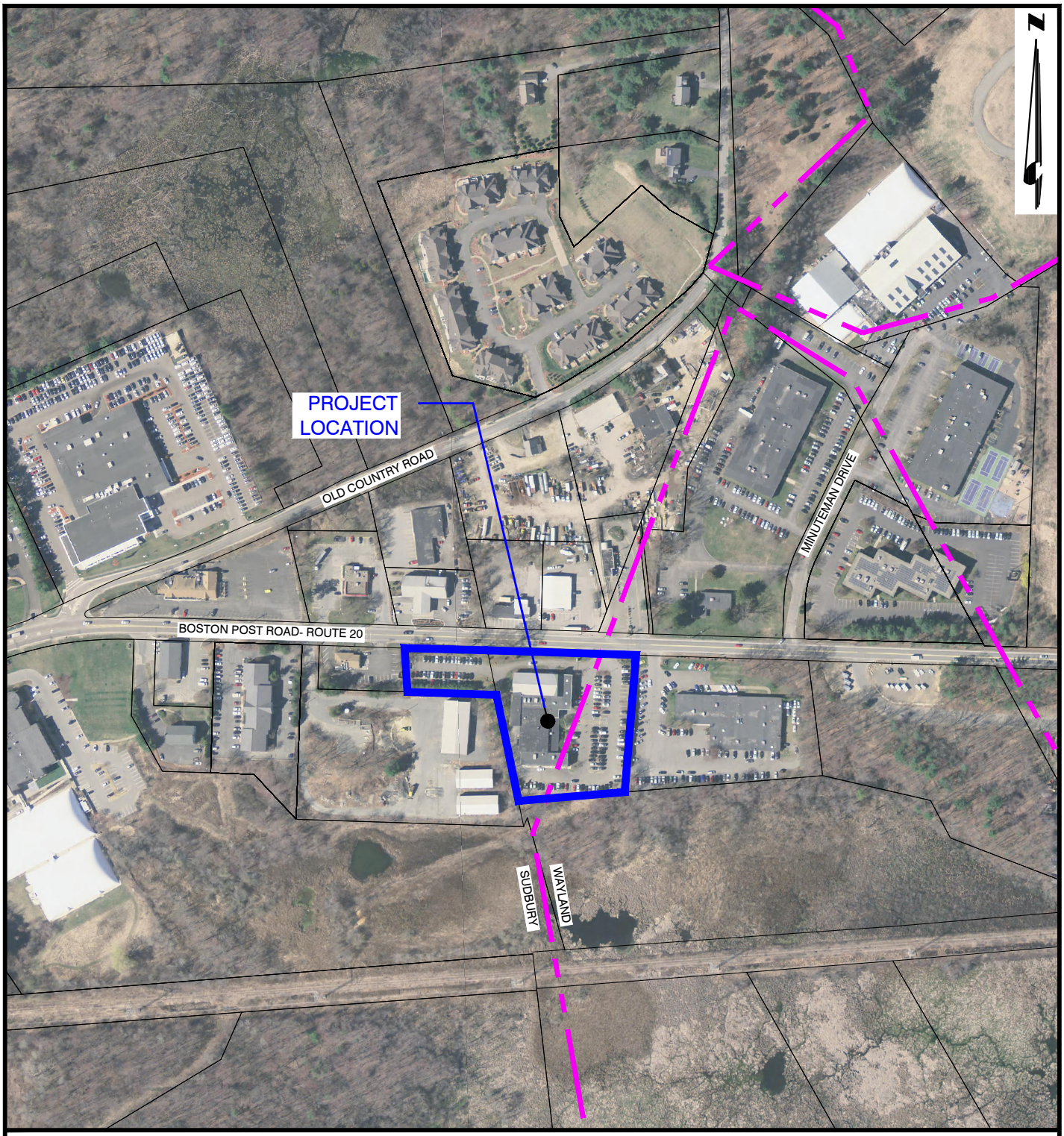
USGS PLAN

PROPOSED SITE DEVELOPMENT
83 BOSTON POST ROAD
SUDBURY, MA

DATE:	DEC 11, 2018
DRAWN:	AMV
CHECK:	KK
SCALE:	1" = 400'
JOB NO.:	31554

FIG. 1

200 100 0 200 400



LEGEND

PROJECT LOCATION

CHA
141 Longwater Drive
Norwell, MA 02061
Main: (781) 982-5400 www.chacompanies.com

TITLE:

LOCUS PLAN

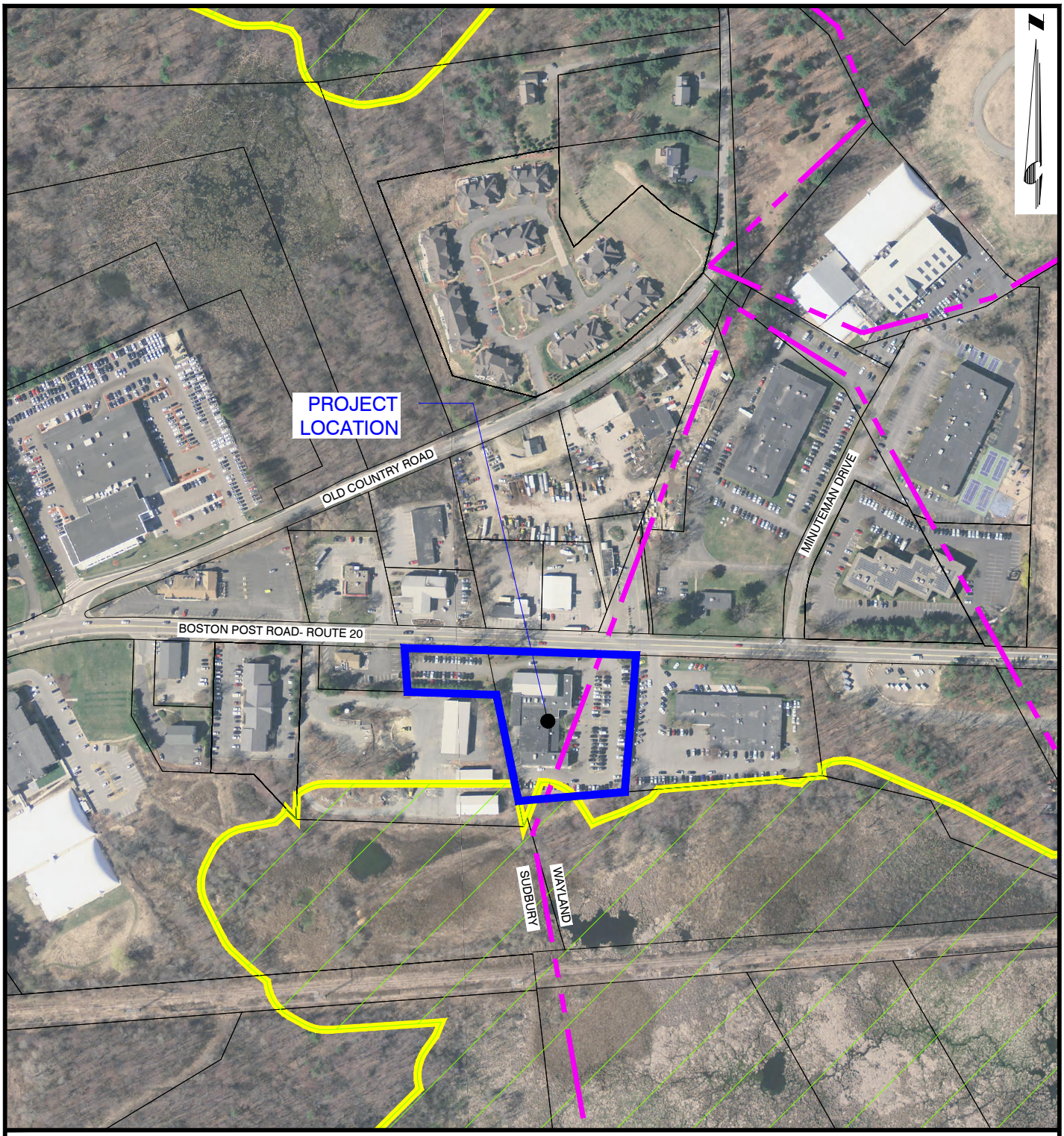
PROPOSED SITE DEVELOPMENT

83 BOSTON POST ROAD
SUDBURY, MA

DATE:	DEC 11, 2018
DRAWN:	AMV
CHECK:	KK
SCALE:	1" = 100'
JOB NO.:	31554

FIG. 2

50 25 0 50 100



LEGEND

PROJECT LOCATION

NHESP ESTIMATED HABITATS OF RARE WILDLIFE

NHESP PRIORITY HABITATS OF RARE SPECIES

CHA
141 Longwater Drive
Norwell, MA 02061
Main: (781) 982-5400 www.chacompanies.com

TITLE:

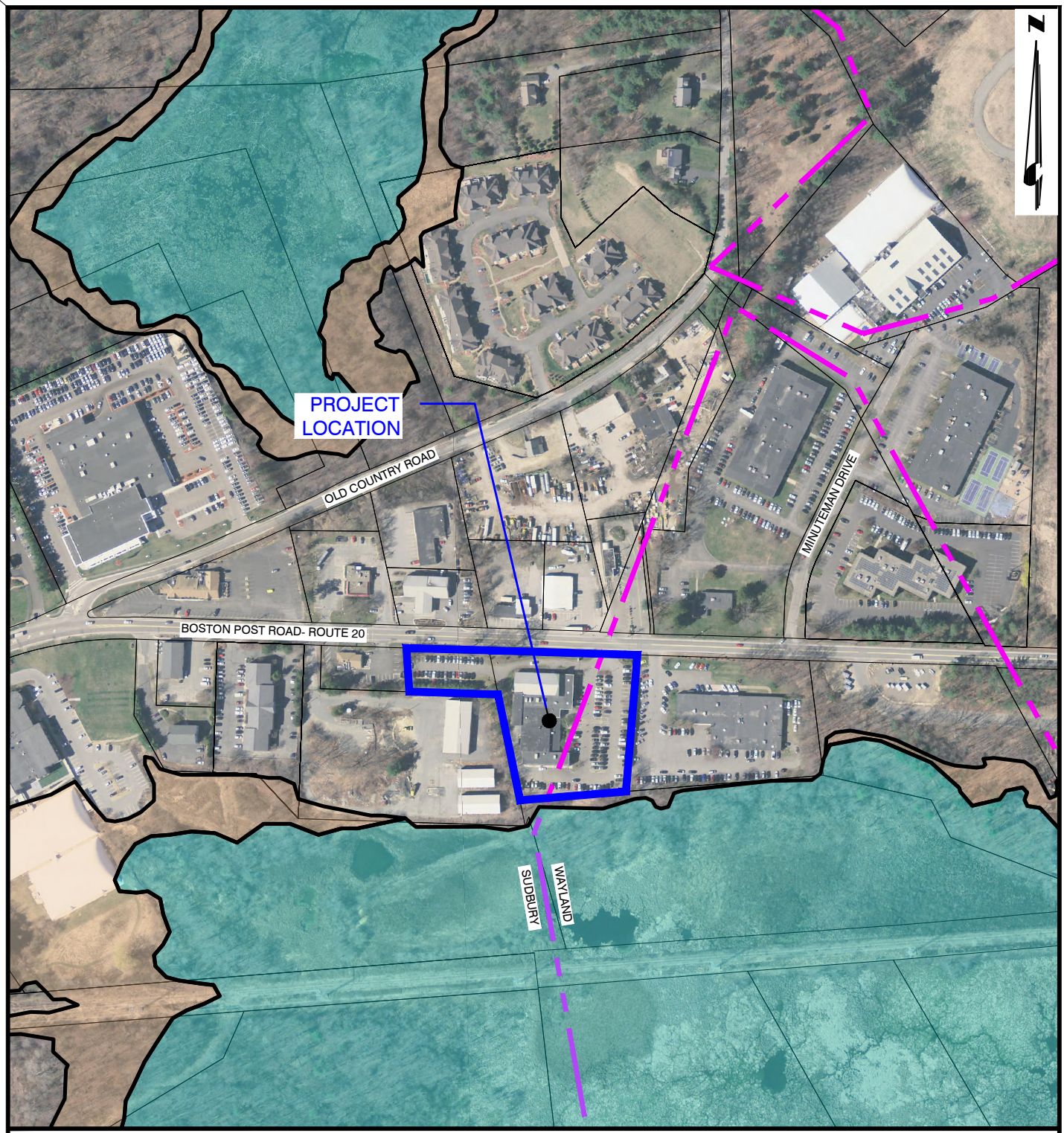
HABITAT MAP

PROPOSED SITE DEVELOPMENT
83 BOSTON POST ROAD
SUDBURY, MA

DATE:	DEC 11, 2018
DRAWN:	AMV
CHECK:	KK
SCALE:	1" = 100'
JOB NO.:	31554

FIG. 3

50 25 0 50 100



LEGEND

PROJECT LOCATION

FLOOD ZONES

FEMA ZONE AE: AREAS OF 100-YEAR FLOOD; WITH BFE

FEMA ZONE X: AREAS OF 0.2% ANNUAL CHANCE FLOOD HAZARD

FEMA FLOOD MAP: MIDDLESEX COUNTY, MA, NO. 25017C0507F, PANEL 507, JULY 7, 2014

CHA
141 Longwater Drive
Norwell, MA 02061
Main: (781) 982-5400 www.chacompanies.com

TITLE:

FEMA FLOOD MAP

PROPOSED SITE DEVELOPMENT

83 BOSTON POST ROAD

SUDBURY, MA

DATE: DEC 11, 2018
DRAWN: AMV
CHECK: KK
SCALE: 1" = 100'
JOB NO.: 31554

50 25 0 50 100

FIG. 4

Section 2.0

Long-Term Pollution Prevention and Operation and Maintenance Plan

LONG-TERM STORMWATER POLLUTION PREVENTION AND OPERATION & MAINTENANCE PLAN TO COMPLY WITH STORMWATER STANDARDS 4, 6, & 9

APPLICABILITY

This document identifies constituents of concern that have the potential to contaminate stormwater runoff from the proposed project site located at 83 Boston Post Road and provides a framework of Best Management Practices (BMPs) for handling stormwater runoff. It also outlines an inspection and maintenance program to ensure continued effectiveness of the proposed stormwater management system. The proposed BMPs are shown on the plans prepared by CHA, 141 Longwater Drive, Norwell, Massachusetts.

PROJECT OVERVIEW:

The proposed project includes the building addition, stormwater infastrucutre improvments, and repairs to the existing septic system. Additional deep sump hood catch basins will be added to convey stormwater flow to proposed underground infiltration/detention systems. The underground chamber systems will treat stormwater (TSS removal) through the use of Isolator Rows. The project proposes to treat stormwater runoff from impervious areas in accordance with the 2008 Massachusetts Stormwater Handbook. The project has been designed to improve management of stormwater by reducing proposed peak runoff rates below existing peak rates and removal of Total Suspended Solids (TSS) by use of non-structural and structural BMPs.

OWNER AND RESPONSIBLE PARTY:

Owner:

Herb Chambers 83 Boston Post Road, LLC

83 Boston Post Road

Sudbury, MA 01776

Day-to-day Operation and Maintenance:

Herb Chambers 83 Boston Post Road, LLC

83 Boston Post Road

Sudbury, MA 01776

CONSTRUCTION MANAGEMENT:

A construction manager with adequate knowledge and experience on projects of similar size and scope shall be employed to oversee all site work related construction. The contractor shall incorporate the appropriate techniques to control sediment and erosion pollution during construction in accordance with the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas and any conditions of approval from the local conservation commission.

The design incorporates measures to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities. The information contained herein and within the engineering drawings identifies construction period pollution prevention measures, responsible parties, erosion control measures (straw bales and silt fence, etc.), BMPs for collecting and treating runoff and groundwater during construction[1], site stabilization measures (i.e. gravel, seed, pavement, etc.), an operations and maintenance plan & long-term pollution prevention plan contained herein.

Care should be taken when constructing stormwater control structures. Light earth-moving equipment shall be used when operating over top of buried utilities or drain or chambers.

ON-GOING MAINTENANCE CONTRACT

The non-structural and structural approaches recommended below, as well as the required BMP maintenance, will be completed by an appropriate contractor. Adequate personnel with appropriate training and access to proper equipment will be available to complete the tasks. Future responsible parties must be notified of their responsibility to operate and maintain the system in perpetuity.

LIVING DOCUMENT PROVISIONS

This document shall be updated as necessary to reflect new procedures, technologies or requirements.

MAINTENANCE LOG

The Responsible Party shall develop and maintain a log of inspections, maintenance, repairs, and disposal (including location of disposal) during the life of the project. Records will be maintained for at least 3 years be made available for viewing to the Massachusetts Department of Environmental Protection in accordance with the provisions of the Massachusetts Stormwater Handbook. Copies of the maintenance log shall be submitted to the, annually, for their reference. A sample of such a maintenance log is provided.

GOOD HOUSEKEEPING PRACTICES DURING CONSTRUCTION

The Responsible Party shall maintain good housekeeping practices by maintaining a clean and orderly facility to prevent potential pollution sources, including debris, from coming into contact with stormwater and degrading water quality. It includes establishing protocols to reduce the possibility of mishandling materials or equipment and training employees in good housekeeping

[1] Should the need for de-watering arise during construction at the site, groundwater will be pumped directly from the work area into geotextile filter bags, temporary settling basins, or portable fractionation tanks (depending on the nature and volume of water encountered) which will act as sediment traps during construction. Discharge points will be setback outside of all resource areas and buffers monitored by qualified personnel (wetland scientist, licensed site professional, civil engineer, etc.) to ensure no impacts to resource areas and compliance with applicable Federal and state regulations. All discharges will be free from visible floating, suspended, and settleable solids that would impair the functions of the nearby drainage systems, wetlands, or downstream rivers. Refer to the details provided on the drawing set for additional information.

techniques. Common areas where good housekeeping practices should be followed shall include: material storage areas, vehicle and equipment maintenance areas, and loading areas. Good housekeeping practices must include a designated and secure location for garbage. A schedule for regular pickup and disposal of garbage and waste materials and routine inspections of containers for leaks and structural integrity shall be developed.

Specific good housekeeping practices that will be implemented include routine removal of trash. items including scrap, metal, wood, plastic, miscellaneous trash, paper, glass, insulation, misc. building materials, and packaging. Additional practices include securing and covering any containers, supplies, or equipment that could become sources of stormwater pollution.

MINIMIZING EXPOSURE DURING CONSTRUCTION

The Responsible Party will minimize exposure of potential pollutant sources, including debris, from coming into contact with precipitation and being picked up by stormwater and carried into drains and surface waters using the following steps:

- Storing all containerized materials in a protected, secure location away from drains and plainly labeled.
- Containing all activities that can generate sources of contaminants from reaching the receiving water or the stormwater management system.
- Securing any equipment or supplies so that they are not transported during storm events into receiving waters or stormwater management system.

BEST MANAGEMENT PRACTICES (BMP) MAINTENANCE POST CONSTRUCTION

The proposed stormwater management system has been designed with appropriate BMPs aimed at reducing the pollutants typically found in stormwater discharge based upon the intended subdivision development land use. All BMPs require regular maintenance to function as intended. Some management measures have simple maintenance requirements; others are more involved. The Responsible Party must have all BMPs regularly inspected to ensure they are operating properly on an as needed basis, including during storm events exceeding 0.5 inches of rainfall.

A description of the non-structural and structural approaches to be incorporated are indicated below. The following Best Management Practices are proposed to be incorporated into the stormwater management system treatment train design to reduce source runoff and improve stormwater runoff discharge quality. The Responsible Party will regularly inspect all BMPs to ensure they are operating properly. If any deficiencies are identified during these inspections, action to resolve it will be initiated and documented on the maintenance log.

NON-STRUCTURAL BEST MANAGEMENT PRACTICES (BMPs)

STREET SWEEPING

As street sweeping is a BMP under MassDEP guidelines, this non-structural BMP is an effective removal of Total Suspended Solids (TSS) in a comprehensive stormwater

management program. At the property owner's discretion, a maintenance program of street sweeping with a High Efficiency Vacuum Sweeper or a Regenerative Air Sweeper can reduce sediment accumulation in the deep sump catch basins and subsurface systems. Sweeping can be conducted on a semi-annual basis (primarily in the spring and fall) to keep downstream treatment train BMPs operating effectively.

GRADING

The impervious areas of the site shall be graded as gently as possible to reduce runoff velocities. Steep slopes will be permanently vegetated to dissipate energy and reduce potential erosion. No constructed vegetated slopes should exceed 2H: 1V without providing additional reinforcement. Steep slopes may require soil reinforcement and additional vegetation.

SNOW STORAGE AND DEICING

Snow storage is anticipated to occur around the perimeter of the parking areas. The landscaping has been designed accordingly.

In the interest of reducing the volume of dissolved salt that enters the watershed, the operator of the development will rely on sand alone where traction on snowy surfaces is the primary objective. However, when deicing is necessary due to safety reasons during winter months, paved surfaces will typically be treated with a mixture of 90% sand and 10% road salt (NaCl).

FERTILIZER:

Slow release organic fertilizers are recommended to be used in landscape areas to limit nutrient transport to groundwater and the wetland area. It is recommended that application be limited to 5 lbs. per 1000 square feet of lawn area.

WASTE MANAGEMENT:

Solid waste will be contained within standard residential trash and recycling containers.

STRUCTURAL BEST MANAGEMENT PRACTICES:

Prior to final completion and full occupancy of the development, it is recommended that a representative of the Contractor, Manufacturer, and/or Engineer either designing or building the facility for the Owner properly instruct the Responsible Party as to the maintenance practices required to responsibly maintain the effectiveness of the drainage system. These frequencies and requirements are recommendations to maintain minimum effectiveness in most typical environments. Ultimately, the Responsible Party will implement the procedures and frequencies as they see fit under their current plan and inspect the systems as needed to maintain minimum effectiveness as recommended by the manufacturer. The following maintenance of structural BMPs will be implemented:

DEEP SUMP CATCH BASINS AND MANHOLE STRUCTURES

Catch basins shall be inspected annually and cleaning to be dictated by the inspector following completion of each inspection. Cleaning will also take place once at the completion of construction. All manholes shall be inspected at least once annually. Any obstructions, sediment, and debris that could potentially cause clogs shall be removed within the conveyance system as necessary. Inverts, grates, and hoods shall be checked and replaced as necessary to maintain hydraulic effectiveness.

SUBSURFACE DRAINAGE SYSTEMS

The subsurface system has been designed with StormTech® chamber system from ADS and utilize Isolator Rows to remove sediment and debris within the stormwater. The subsurface system has riser structures/inspection ports at grade to inspect sediment accumulation and allow for removal of sediment and debris from the detention system. The subsurface drainage system connects to a multi-stage outlet structure to regulate discharge from storm events. Once the system goes online, inspections should occur after each major storm event for the first few months to ensure proper stabilization, function, and to ensure that the outlets remain free of obstructions. After that, the system should be inspected annually. Water levels should be checked and recorded against rainfall amounts to verify that the drainage system is working properly.

ISOLATOR ROW

The Isolator Rows in the subsurface systems shall be inspected once per year and cleaned as dictated by the results of each inspection and in accordance with the manufacturer's recommendations. Periodic inspections performed by the Responsible Party may dictate cleaning on a more frequent basis depending on the suspended solids loading. During construction accumulated sediment may need to be removed more frequently. Conduct JetVac process annually or when inspection shows that maintenance is necessary. See attached maintenance documentation from the manufacturer.

OUTLET CONTROL STRUCTURES

The outlet control structure (OCS) detains the stormwater utilizing orifices to control the outlet flow and are accessed through the top grate of the structure. Although the outlet control structures should not collect much debris, they should be inspected along with the underground system inspection to make sure they are clean of debris and functioning properly. Sand accumulation within the OCS is a sign there is an issue with the upstream stormwater treatment device. The OCS shall be inspected once per year. It may be necessary to clean the structure and the use of a vacuum truck may be necessary.

WATER QUALITY SWALE/PARTIAL EXFILTRATION BASIN

A stone lines swale conveys stormwater from the existing catch basin vault structure and proposed pipe headwall outlet to the vegetated water quality swale/partial exfiltration basin area. The swale design includes a surrounding berm to detain stormwater. Stormwater exiting the swale is controlled by a proposed outlet structure and a broad crested weir. Swales shall be inspected on a semi-annual basis in the early spring and fall. Additional

inspections shall be performed during the first few months after construction to ensure that adequate vegetation has been established. Regular maintenance shall include mowing, fertilizing, pruning, debris removal, and weed/pest control. Swales shall be mowed at least once per year to a minimum of 4 inches so as not to reduce the effectiveness of pollutant removal and energy

LEVEL SPREADER/PLUNGE POOL/ENERGY DISSIPATER AND DOWNSTREAM SLOPES:
The level spreader/plunge pool/energy dissipaters are utilized at the outlet pipes prior to discharge to the wetland to prevent erosion. The level spreader/plunge pool/energy dissipaters should be inspected at least once a year for sand accumulation and debris which may impact its effectiveness to slow water. Cleaning should take place during the early spring, although, additional inspections and cleaning may be needed.

In order to ensure that the level spreader systems are working, the outlets as well as slopes downstream for the first three years of operation, should be inspected after every storm of 1" or greater to assure no erosion of the slope. After the first three years, we recommend inspections after any large storm (25+ year event) for erosion. If no erosion is evident, then the stone size and level spreader design is adequate. Should there be erosion of the level spreader, stone size should be increased or additional large stones added to enhance energy dissipation of water. If downstream slopes exhibit signs of erosion, repairs to soils and slope should be made and then a treatment such as an erosion control matting should be instituted to reinforce soils until vegetative cover can be restored. We recommend that the aprons and downstream slopes be inspected and cleaned annually as part of the outlet maintenance to ensure future adequacy.

SPILL CONTROL:

Since the site is a residential development, it is unlikely there will be a spill other than possibly petroleum products from a resident's vehicle. Thus, it is only a recommendation that a contingency plan to address the spillage/release of petroleum products and any hazardous material be implemented for the facility. The recommendation includes that the property manager have all MassDEP emergency spill response information posted on-site at all times. It is also recommended an emergency spill response kit including absorbent pillows be stored on-site along with instructions for the kit, a copy of applicable regulations regarding spills, and a list of individuals to contact (local and state officials) in the event of a spill.

Spills or leaks will be treated properly according to material type, volume of spillage and location of spill. Mitigation will include preventing further spillage, containing the spilled material in the smallest practical area, removing spilled material in a safe and environmentally friendly manner, and remediating any damage to the environment.

LONG-TERM OPERATION AND MAINTENANCE BUDGET:

Consistent with Standard 9 of the Massachusetts Department of Environmental Protection Stormwater Handbook (February 2008) the approximate cost of inspections and maintenance based on the abovementioned post-construction activities and frequencies is as follows:

- Street Sweeping - $2,500 per year based on annual sweepings.
- Deep Sump Catch Basins - inspection/cleaning - $200 per year/per catch basin based on annual inspections and sediment removal of both single and double grate deep sump catch basins.
- Underground Detention Systems - inspection - $1,000 per year based on semi-annual inspections. Cleaning/debris removal - $1,000 per year for accumulated sediment and trash removal.

Additional costs may be incurred if it is determined during routine inspections of the BMP's that further corrective actions are necessary.

LONG TERM STRUCTURAL BEST MANAGEMENT PRACTICE INSPECTION & MAINTENANCE MATRIX AFTER CONSTRUCTION

Note: BMP's shall be visually inspected and repaired by a qualified party in accordance with the following chart. Note these are minimum inspection criteria/frequencies and should be adjusted throughout the project lifespan as required to maintain effectiveness. Refer to maintenance standards for drainage facilities and structural best management practices in the "Recommended Long-Term Stormwater Pollution Prevention Plan."

Conventional & LID Best Management Practices	Recommended Minimum Inspection & Maintenance Frequency	Erosion/Scouring	Tree Growth Hazards	Differential Settlement/Seepage	Structural Damage/Obstructions	Trash & Debris	Removal of Accumulated Sediment	Slope Integrity	*Mow Vegetation/Poor Vegetation Coverage	Remove/Reset Filter Fabric & Stone As Required	Remove & Replace Hardwood mulch/media	Vac Truck Sediment & Contaminants	Remove/Reset Riprap as Required
Catch Basin	Annually		☑	☑	☑	☑	☑					☑	
Energy Dissipaters	Annually	☑	☑	☑		☑	☑		☑	☑			
Drainage Swales	Semi-Annual	☑				☑		☑	☑				☑
Outlet Structure	Semi-Annual	☑		☑	☑	☑	☑			☑			☑
Detention/Infiltration	Semi-Annual	☑	☑	☑	☑	☑	☑					☑	
Emergency Overflow	Semi-Annual	☑	☑	☑	☑			☑	☑	☑			☑
Level Spreader	Annually	☑	☑			☑			☑	☑			☑
Plunge Pool	Annually	☑				☑	☑		☑	☑			☑

Stormwater BMP Inspection and Maintenance Log

Facility Name	
Address	
Begin Date	End Date

Date	BMP ID#	BMP Description	Inspected by:	Cause for Inspection	Exceptions Noted	Comments and Actions Taken

Instructions: Record all inspections and maintenance for all treatment BMPs on this form. Use additional log sheets and/or attach extended comments or documentation as necessary.

- BMP ID# — Always use ID# from the Operation and Maintenance Manual or Approved Plans.
- Inspected by — Note all inspections and maintenance on this form, including the required independent annual inspection.
- Cause for inspection — Note if the inspection is routine, pre-rainy-season, post-storm, annual, or in response to a noted problem or complaint.
- Exceptions noted — Note any condition that requires correction or indicates a need for maintenance.
- Comments and actions taken — Describe any maintenance done and need for follow-up.

StormTech®

Detention • Retention • Water Quality

A division of ADS®

Save Valuable Land and Protect Water Resources

Isolator® Row O&M Manual

StormTech® Chamber System for Stormwater Management

1.0 The Isolator® Row

1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

1.2 THE ISOLATOR ROW

The Isolator Row is a row of StormTech chambers, either SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

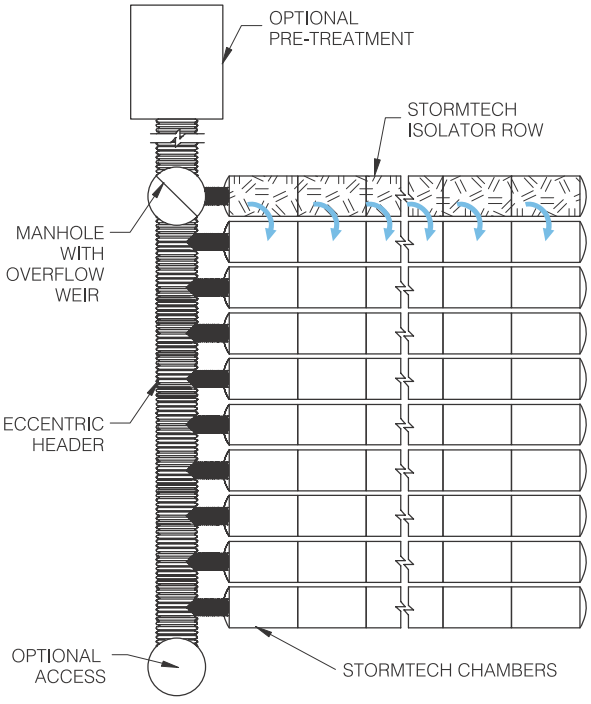
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



2.0 Isolator Row Inspection/Maintenance

2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

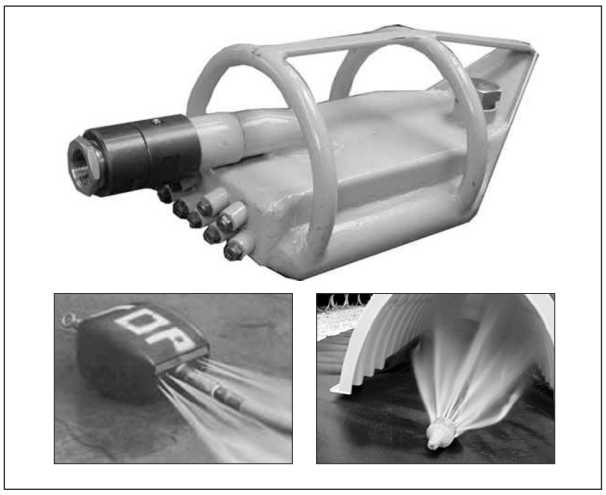
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

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.

2.2 MAINTENANCE

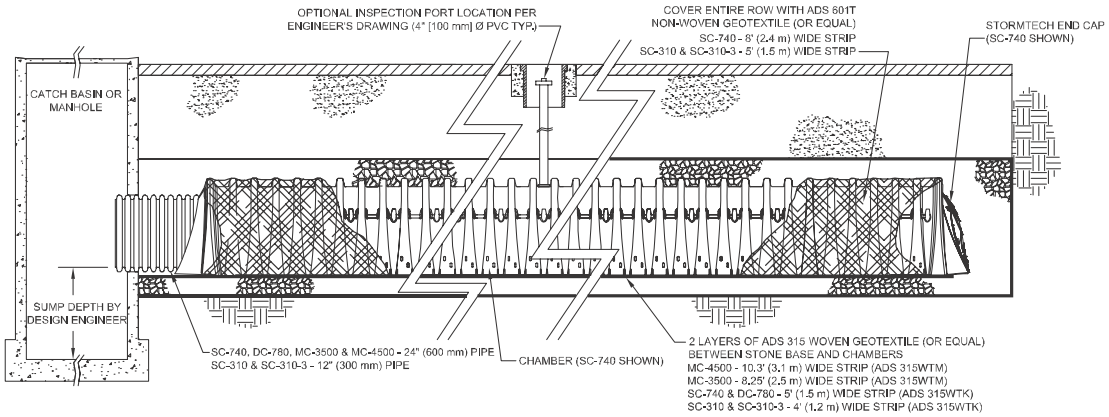
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 AND MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

3.0 Isolator Row Step By Step Maintenance Procedures

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.

iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.

B) All Isolator Rows

i. Remove cover from manhole at upstream end of Isolator Row

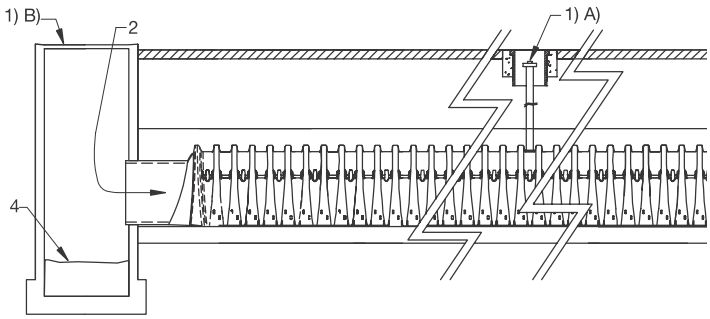
ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Mirrors on poles or cameras may be used to avoid a confined space entry

2. Follow OSHA regulations for confined space entry if entering manhole

iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

StormTech Isolator Row (not to scale)



Step 2) Clean out Isolator Row using the JetVac process

A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable

B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers, record observations and actions

Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

Sample Maintenance Log

Date	Stadia Rod Readings		Sediment Depth (1) - (2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/01	6.3 ft.	none		New installation. Fixed point is CI frame at grade	djm
9/24/01		6.2	0.1 ft.	Some grit felt	sm
6/20/03		5.8	0.5 ft.	Mucky feel, debris visible in manhole and in Isolator row, maintenance due	rv
7/7/03	6.3 ft.		0	System jetted and vacuumed	djm

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Section 3.0

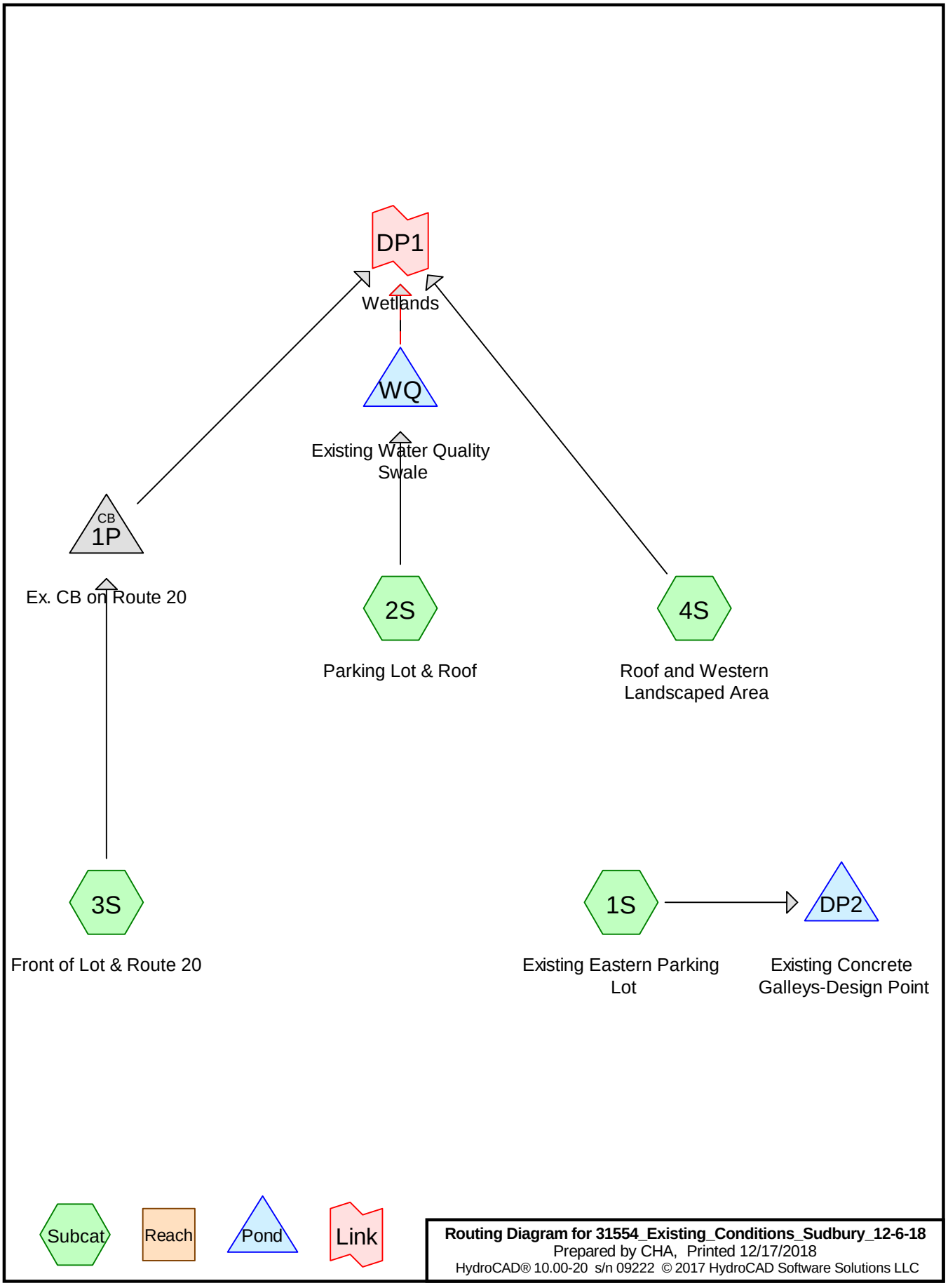
Hydrology and Hydraulic Modeling

Section 3.1

HydroCAD Site Hydrology Calculations

Section 3.1.1

Pre-Developed Stormwater Report Calculations



Routing Diagram for 31554_Existing_Conditions_Sudbury_12-6-18
Prepared by CHA, Printed 12/17/2018

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.705	61	>75% Grass cover, Good, HSG B (1S, 2S, 3S, 4S)
0.169	96	Gravel surface, HSG B (1S, 2S, 3S, 4S)
1.557	98	Paved parking, HSG B (1S, 2S, 3S, 4S)
0.551	98	Roofs, HSG B (2S, 3S, 4S)
2.982	**89**	**TOTAL AREA**

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=0.04"
Flow Length=152' Tc=6.0 min CN=89 Runoff=0.01 cfs 0.001 af

Subcatchment 2S: Parking Lot & Roof Runoff Area=66,929 sf 82.02% Impervious Runoff Depth=0.11"
Flow Length=102' Tc=6.0 min CN=93 Runoff=0.17 cfs 0.014 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=28,830 sf 52.06% Impervious Runoff Depth=0.01"
Flow Length=297' Tc=6.0 min CN=84 Runoff=0.00 cfs 0.000 af

Subcatchment 4S: Roof and Western Runoff Area=18,700 sf 56.10% Impervious Runoff Depth=0.01"
Flow Length=102' Tc=6.0 min CN=85 Runoff=0.00 cfs 0.000 af

Pond 1P: Ex. CB on Route 20 Peak Elev=122.81' Inflow=0.00 cfs 0.000 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=0.00 cfs 0.000 af

Pond DP2: Existing Concrete Galleys-Design Point Peak Elev=129.43' Storage=18 cf Inflow=0.01 cfs 0.001 af
Outflow=0.00 cfs 0.001 af

Pond WQ: Existing Water Quality Swale Peak Elev=123.04' Storage=348 cf Inflow=0.17 cfs 0.014 af
Discarded=0.01 cfs 0.014 af Primary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.014 af

Link DP1: Wetlands Inflow=0.00 cfs 0.001 af
Primary=0.00 cfs 0.001 af

Total Runoff Area = 2.982 ac Runoff Volume = 0.016 af Average Runoff Depth = 0.07"
29.30% Pervious = 0.874 ac 70.70% Impervious = 2.109 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 0.01 cfs @ 12.31 hrs, Volume= 0.001 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Parking Lot & Roof

Runoff = 0.17 cfs @ 12.10 hrs, Volume= 0.014 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
43,350	98	Paved parking, HSG B
2,726	96	Gravel surface, HSG B
9,310	61	>75% Grass cover, Good, HSG B
11,543	98	Roofs, HSG B
66,929	93	Weighted Average
12,036		17.98% Pervious Area
54,893		82.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 0.00 cfs @ 15.34 hrs, Volume= 0.000 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
12,720	98	Paved parking, HSG B
2,852	96	Gravel surface, HSG B
10,970	61	>75% Grass cover, Good, HSG B
2,288	98	Roofs, HSG B
28,830	84	Weighted Average
13,822		47.94% Pervious Area
15,008		52.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	297		0.82		**Direct Entry, A-B**

Summary for Subcatchment 4S: Roof and Western Landscaped Area

Runoff = 0.00 cfs @ 14.82 hrs, Volume= 0.000 af, Depth= 0.01"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
300	98	Paved parking, HSG B
1,531	96	Gravel surface, HSG B
6,679	61	>75% Grass cover, Good, HSG B
10,190	98	Roofs, HSG B
18,700	85	Weighted Average
8,210		43.90% Pervious Area
10,490		56.10% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Pond 1P: Ex. CB on Route 20

Inflow Area = 0.662 ac, 52.06% Impervious, Inflow Depth = 0.01" for 0.5-Inch Storm event
Inflow = 0.00 cfs @ 15.34 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 15.34 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 15.34 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 122.81' @ 15.34 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=0.00 cfs @ 15.34 hrs HW=122.81' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Barrel Controls 0.00 cfs @ 0.44 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 0.04" for 0.5-Inch Storm event
Inflow = 0.01 cfs @ 12.31 hrs, Volume= 0.001 af
Outflow = 0.00 cfs @ 13.41 hrs, Volume= 0.001 af, Atten= 50%, Lag= 66.0 min
Discarded = 0.00 cfs @ 13.41 hrs, Volume= 0.001 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 129.43' @ 13.41 hrs Surf.Area= 0 sf Storage= 18 cf

Plug-Flow detention time= 214.2 min calculated for 0.001 af (68% of inflow)
Center-of-Mass det. time= 94.1 min (1,042.6 - 948.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.00 cfs @ 13.41 hrs HW=129.43' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.00 cfs)

Summary for Pond WQ: Existing Water Quality Swale

Inflow Area = 1.536 ac, 82.02% Impervious, Inflow Depth = 0.11" for 0.5-Inch Storm event
Inflow = 0.17 cfs @ 12.10 hrs, Volume= 0.014 af
Outflow = 0.01 cfs @ 17.01 hrs, Volume= 0.014 af, Atten= 95%, Lag= 294.3 min
Discarded = 0.01 cfs @ 17.01 hrs, Volume= 0.014 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 123.04' @ 17.01 hrs Surf.Area= 1,306 sf Storage= 348 cf

Plug-Flow detention time= 559.3 min calculated for 0.014 af (100% of inflow)
Center-of-Mass det. time= 559.5 min (1,444.6 - 885.1)

Volume	Invert	Avail.Storage	Storage Description
#1	122.50'	3,646 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.50	112	90.0	0	0	112
123.00	1,260	245.0	291	291	4,245
124.00	2,500	460.0	1,845	2,136	16,312
124.50	3,570	475.0	1,510	3,646	17,452

Device	Routing	Invert	Outlet Devices
#1	Primary	123.70'	**6.0' 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
#2	Discarded	122.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 17.01 hrs HW=123.04' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.50' TW=0.00' (Dynamic Tailwater)
1=Broad-Crested Rectangular Weir (Controls 0.00 cfs)

Summary for Link DP1: Wetlands

Inflow Area = 2.628 ac, 70.24% Impervious, Inflow Depth = 0.00" for 0.5-Inch Storm event
Inflow = 0.00 cfs @ 15.10 hrs, Volume= 0.001 af
Primary = 0.00 cfs @ 15.10 hrs, Volume= 0.001 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=0.28"
Flow Length=152' Tc=6.0 min CN=89 Runoff=0.11 cfs 0.008 af

Subcatchment 2S: Parking Lot & Roof Runoff Area=66,929 sf 82.02% Impervious Runoff Depth=0.45"
Flow Length=102' Tc=6.0 min CN=93 Runoff=0.81 cfs 0.058 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=28,830 sf 52.06% Impervious Runoff Depth=0.15"
Flow Length=297' Tc=6.0 min CN=84 Runoff=0.08 cfs 0.008 af

Subcatchment 4S: Roof and Western Runoff Area=18,700 sf 56.10% Impervious Runoff Depth=0.17"
Flow Length=102' Tc=6.0 min CN=85 Runoff=0.07 cfs 0.006 af

Pond 1P: Ex. CB on Route 20 Peak Elev=122.94' Inflow=0.08 cfs 0.008 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=0.08 cfs 0.008 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=129.73' Storage=110 cf Inflow=0.11 cfs 0.008 af
Outflow=0.02 cfs 0.008 af

Pond WQ: Existing Water Quality Swale Peak Elev=123.72' Storage=1,497 cf Inflow=0.81 cfs 0.058 af
Discarded=0.01 cfs 0.043 af Primary=0.05 cfs 0.011 af Outflow=0.06 cfs 0.054 af

Link DP1: Wetlands Inflow=0.14 cfs 0.026 af
Primary=0.14 cfs 0.026 af

Total Runoff Area = 2.982 ac Runoff Volume = 0.081 af Average Runoff Depth = 0.32"
29.30% Pervious = 0.874 ac 70.70% Impervious = 2.109 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 0.11 cfs @ 12.10 hrs, Volume= 0.008 af, Depth= 0.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Parking Lot & Roof

Runoff = 0.81 cfs @ 12.09 hrs, Volume= 0.058 af, Depth= 0.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
43,350	98	Paved parking, HSG B
2,726	96	Gravel surface, HSG B
9,310	61	>75% Grass cover, Good, HSG B
11,543	98	Roofs, HSG B
66,929	93	Weighted Average
12,036		17.98% Pervious Area
54,893		82.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 0.08 cfs @ 12.12 hrs, Volume= 0.008 af, Depth= 0.15"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
12,720	98	Paved parking, HSG B
2,852	96	Gravel surface, HSG B
10,970	61	>75% Grass cover, Good, HSG B
2,288	98	Roofs, HSG B
28,830	84	Weighted Average
13,822		47.94% Pervious Area
15,008		52.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	297		0.82		**Direct Entry, A-B**

Summary for Subcatchment 4S: Roof and Western Landscaped Area

Runoff = 0.07 cfs @ 12.11 hrs, Volume= 0.006 af, Depth= 0.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
300	98	Paved parking, HSG B
1,531	96	Gravel surface, HSG B
6,679	61	>75% Grass cover, Good, HSG B
10,190	98	Roofs, HSG B
18,700	85	Weighted Average
8,210		43.90% Pervious Area
10,490		56.10% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Pond 1P: Ex. CB on Route 20

Inflow Area = 0.662 ac, 52.06% Impervious, Inflow Depth = 0.15" for 1-Inch Storm event
Inflow = 0.08 cfs @ 12.12 hrs, Volume= 0.008 af
Outflow = 0.08 cfs @ 12.12 hrs, Volume= 0.008 af, Atten= 0%, Lag= 0.0 min
Primary = 0.08 cfs @ 12.12 hrs, Volume= 0.008 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 122.94' @ 12.12 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=0.08 cfs @ 12.12 hrs HW=122.94' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 0.08 cfs @ 0.99 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 0.28" for 1-Inch Storm event
Inflow = 0.11 cfs @ 12.10 hrs, Volume= 0.008 af
Outflow = 0.02 cfs @ 11.93 hrs, Volume= 0.008 af, Atten= 82%, Lag= 0.0 min
Discarded = 0.02 cfs @ 11.93 hrs, Volume= 0.008 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 129.73' @ 12.65 hrs Surf.Area= 832 sf Storage= 110 cf

Plug-Flow detention time= 67.7 min calculated for 0.008 af (95% of inflow)
Center-of-Mass det. time= 42.0 min (911.9 - 869.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 11.93 hrs HW=129.43' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.02 cfs)

Summary for Pond WQ: Existing Water Quality Swale

Inflow Area = 1.536 ac, 82.02% Impervious, Inflow Depth = 0.45" for 1-Inch Storm event
Inflow = 0.81 cfs @ 12.09 hrs, Volume= 0.058 af
Outflow = 0.06 cfs @ 13.84 hrs, Volume= 0.054 af, Atten= 92%, Lag= 105.1 min
Discarded = 0.01 cfs @ 13.84 hrs, Volume= 0.043 af
Primary = 0.05 cfs @ 13.84 hrs, Volume= 0.011 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 123.72' @ 13.84 hrs Surf.Area= 2,114 sf Storage= 1,497 cf

Plug-Flow detention time= 960.1 min calculated for 0.054 af (93% of inflow)
Center-of-Mass det. time= 924.8 min (1,765.7 - 840.9)

Volume	Invert	Avail.Storage	Storage Description
#1	122.50'	3,646 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.50	112	90.0	0	0	112
123.00	1,260	245.0	291	291	4,245
124.00	2,500	460.0	1,845	2,136	16,312
124.50	3,570	475.0	1,510	3,646	17,452

Device	Routing	Invert	Outlet Devices
#1	Primary	123.70'	**6.0' 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
#2	Discarded	122.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.01 cfs @ 13.84 hrs HW=123.72' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.05 cfs @ 13.84 hrs HW=123.72' TW=0.00' (Dynamic Tailwater)
1=Broad-Crested Rectangular Weir (Weir Controls 0.05 cfs @ 0.35 fps)

Summary for Link DP1: Wetlands

Inflow Area = 2.628 ac, 70.24% Impervious, Inflow Depth = 0.12" for 1-Inch Storm event
Inflow = 0.14 cfs @ 12.11 hrs, Volume= 0.026 af
Primary = 0.14 cfs @ 12.11 hrs, Volume= 0.026 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=2.08"
Flow Length=152' Tc=6.0 min CN=89 Runoff=0.86 cfs 0.062 af

Subcatchment 2S: Parking Lot & Roof Runoff Area=66,929 sf 82.02% Impervious Runoff Depth=2.45"
Flow Length=102' Tc=6.0 min CN=93 Runoff=4.27 cfs 0.313 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=28,830 sf 52.06% Impervious Runoff Depth=1.68"
Flow Length=297' Tc=6.0 min CN=84 Runoff=1.31 cfs 0.093 af

Subcatchment 4S: Roof and Western Runoff Area=18,700 sf 56.10% Impervious Runoff Depth=1.76"
Flow Length=102' Tc=6.0 min CN=85 Runoff=0.89 cfs 0.063 af

Pond 1P: Ex. CB on Route 20 Peak Elev=123.38' Inflow=1.31 cfs 0.093 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=1.31 cfs 0.093 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=133.93' Storage=1,764 cf Inflow=0.86 cfs 0.062 af
Outflow=0.02 cfs 0.061 af

Pond WQ: Existing Water Quality Swale Peak Elev=124.10' Storage=2,394 cf Inflow=4.27 cfs 0.313 af
Discarded=0.02 cfs 0.047 af Primary=3.78 cfs 0.262 af Outflow=3.80 cfs 0.309 af

Link DP1: Wetlands Inflow=5.85 cfs 0.417 af
Primary=5.85 cfs 0.417 af

Total Runoff Area = 2.982 ac Runoff Volume = 0.530 af Average Runoff Depth = 2.13"
29.30% Pervious = 0.874 ac 70.70% Impervious = 2.109 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 0.86 cfs @ 12.09 hrs, Volume= 0.062 af, Depth= 2.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Parking Lot & Roof

Runoff = 4.27 cfs @ 12.09 hrs, Volume= 0.313 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
43,350	98	Paved parking, HSG B
2,726	96	Gravel surface, HSG B
9,310	61	>75% Grass cover, Good, HSG B
11,543	98	Roofs, HSG B
66,929	93	Weighted Average
12,036		17.98% Pervious Area
54,893		82.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 1.31 cfs @ 12.09 hrs, Volume= 0.093 af, Depth= 1.68"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
12,720	98	Paved parking, HSG B
2,852	96	Gravel surface, HSG B
10,970	61	>75% Grass cover, Good, HSG B
2,288	98	Roofs, HSG B
28,830	84	Weighted Average
13,822		47.94% Pervious Area
15,008		52.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	297		0.82		**Direct Entry, A-B**

Summary for Subcatchment 4S: Roof and Western Landscaped Area

Runoff = 0.89 cfs @ 12.09 hrs, Volume= 0.063 af, Depth= 1.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
300	98	Paved parking, HSG B
1,531	96	Gravel surface, HSG B
6,679	61	>75% Grass cover, Good, HSG B
10,190	98	Roofs, HSG B
18,700	85	Weighted Average
8,210		43.90% Pervious Area
10,490		56.10% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Pond 1P: Ex. CB on Route 20

Inflow Area = 0.662 ac, 52.06% Impervious, Inflow Depth = 1.68" for 2-Year 24-Hour event
Inflow = 1.31 cfs @ 12.09 hrs, Volume= 0.093 af
Outflow = 1.31 cfs @ 12.09 hrs, Volume= 0.093 af, Atten= 0%, Lag= 0.0 min
Primary = 1.31 cfs @ 12.09 hrs, Volume= 0.093 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 123.38' @ 12.09 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=1.31 cfs @ 12.09 hrs HW=123.38' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 1.31 cfs @ 2.05 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 2.08" for 2-Year 24-Hour event
Inflow = 0.86 cfs @ 12.09 hrs, Volume= 0.062 af
Outflow = 0.02 cfs @ 9.46 hrs, Volume= 0.061 af, Atten= 98%, Lag= 0.0 min
Discarded = 0.02 cfs @ 9.46 hrs, Volume= 0.061 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 133.93' @ 17.48 hrs Surf.Area= 832 sf Storage= 1,764 cf

Plug-Flow detention time= 856.1 min calculated for 0.061 af (99% of inflow)
Center-of-Mass det. time= 852.1 min (1,663.2 - 811.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 9.46 hrs HW=129.43' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.02 cfs)

Summary for Pond WQ: Existing Water Quality Swale

Inflow Area = 1.536 ac, 82.02% Impervious, Inflow Depth = 2.45" for 2-Year 24-Hour event
Inflow = 4.27 cfs @ 12.09 hrs, Volume= 0.313 af
Outflow = 3.80 cfs @ 12.13 hrs, Volume= 0.309 af, Atten= 11%, Lag= 2.5 min
Discarded = 0.02 cfs @ 12.13 hrs, Volume= 0.047 af
Primary = 3.78 cfs @ 12.13 hrs, Volume= 0.262 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 124.10' @ 12.13 hrs Surf.Area= 2,697 sf Storage= 2,394 cf

Plug-Flow detention time= 192.9 min calculated for 0.309 af (99% of inflow)
Center-of-Mass det. time= 184.5 min (977.2 - 792.7)

Volume	Invert	Avail.Storage	Storage Description
#1	122.50'	3,646 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.50	112	90.0	0	0	112
123.00	1,260	245.0	291	291	4,245
124.00	2,500	460.0	1,845	2,136	16,312
124.50	3,570	475.0	1,510	3,646	17,452

Device	Routing	Invert	Outlet Devices
#1	Primary	123.70'	**6.0' 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
#2	Discarded	122.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 12.13 hrs HW=124.10' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=3.78 cfs @ 12.13 hrs HW=124.10' TW=0.00' (Dynamic Tailwater)
1=Broad-Crested Rectangular Weir (Weir Controls 3.78 cfs @ 1.58 fps)

Summary for Link DP1: Wetlands

Inflow Area = 2.628 ac, 70.24% Impervious, Inflow Depth = 1.91" for 2-Year 24-Hour event
Inflow = 5.85 cfs @ 12.11 hrs, Volume= 0.417 af
Primary = 5.85 cfs @ 12.11 hrs, Volume= 0.417 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=3.58"
Flow Length=152' Tc=6.0 min CN=89 Runoff=1.45 cfs 0.106 af

Subcatchment 2S: Parking Lot & Roof Runoff Area=66,929 sf 82.02% Impervious Runoff Depth=4.00"
Flow Length=102' Tc=6.0 min CN=93 Runoff=6.79 cfs 0.512 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=28,830 sf 52.06% Impervious Runoff Depth=3.09"
Flow Length=297' Tc=6.0 min CN=84 Runoff=2.38 cfs 0.170 af

Subcatchment 4S: Roof and Western Runoff Area=18,700 sf 56.10% Impervious Runoff Depth=3.18"
Flow Length=102' Tc=6.0 min CN=85 Runoff=1.59 cfs 0.114 af

Pond 1P: Ex. CB on Route 20 Peak Elev=123.62' Inflow=2.38 cfs 0.170 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=2.38 cfs 0.170 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=136.29' Storage=2,739 cf Inflow=1.45 cfs 0.106 af
Outflow=0.07 cfs 0.105 af

Pond WQ: Existing Water Quality Swale Peak Elev=124.23' Storage=2,776 cf Inflow=6.79 cfs 0.512 af
Discarded=0.02 cfs 0.049 af Primary=6.17 cfs 0.459 af Outflow=6.19 cfs 0.508 af

Link DP1: Wetlands Inflow=9.95 cfs 0.743 af
Primary=9.95 cfs 0.743 af

Total Runoff Area = 2.982 ac Runoff Volume = 0.902 af Average Runoff Depth = 3.63"
29.30% Pervious = 0.874 ac 70.70% Impervious = 2.109 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 1.45 cfs @ 12.09 hrs, Volume= 0.106 af, Depth= 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Parking Lot & Roof

Runoff = 6.79 cfs @ 12.08 hrs, Volume= 0.512 af, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
43,350	98	Paved parking, HSG B
2,726	96	Gravel surface, HSG B
9,310	61	>75% Grass cover, Good, HSG B
11,543	98	Roofs, HSG B
66,929	93	Weighted Average
12,036		17.98% Pervious Area
54,893		82.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 2.38 cfs @ 12.09 hrs, Volume= 0.170 af, Depth= 3.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
12,720	98	Paved parking, HSG B
2,852	96	Gravel surface, HSG B
10,970	61	>75% Grass cover, Good, HSG B
2,288	98	Roofs, HSG B
28,830	84	Weighted Average
13,822		47.94% Pervious Area
15,008		52.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	297		0.82		**Direct Entry, A-B**

Summary for Subcatchment 4S: Roof and Western Landscaped Area

Runoff = 1.59 cfs @ 12.09 hrs, Volume= 0.114 af, Depth= 3.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
300	98	Paved parking, HSG B
1,531	96	Gravel surface, HSG B
6,679	61	>75% Grass cover, Good, HSG B
10,190	98	Roofs, HSG B
18,700	85	Weighted Average
8,210		43.90% Pervious Area
10,490		56.10% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Pond 1P: Ex. CB on Route 20

Inflow Area = 0.662 ac, 52.06% Impervious, Inflow Depth = 3.09" for 10-Year 24-Hour event
Inflow = 2.38 cfs @ 12.09 hrs, Volume= 0.170 af
Outflow = 2.38 cfs @ 12.09 hrs, Volume= 0.170 af, Atten= 0%, Lag= 0.0 min
Primary = 2.38 cfs @ 12.09 hrs, Volume= 0.170 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 123.62' @ 12.09 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=2.38 cfs @ 12.09 hrs HW=123.61' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 2.38 cfs @ 2.43 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 3.58" for 10-Year 24-Hour event
Inflow = 1.45 cfs @ 12.09 hrs, Volume= 0.106 af
Outflow = 0.07 cfs @ 14.57 hrs, Volume= 0.105 af, Atten= 95%, Lag= 149.1 min
Discarded = 0.07 cfs @ 14.57 hrs, Volume= 0.105 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 136.29' @ 14.57 hrs Surf.Area= 2,969 sf Storage= 2,739 cf

Plug-Flow detention time= 703.8 min calculated for 0.105 af (100% of inflow)
Center-of-Mass det. time= 701.3 min (1,497.1 - 795.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.07 cfs @ 14.57 hrs HW=136.29' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.07 cfs)

Summary for Pond WQ: Existing Water Quality Swale

Inflow Area = 1.536 ac, 82.02% Impervious, Inflow Depth = 4.00" for 10-Year 24-Hour event
Inflow = 6.79 cfs @ 12.08 hrs, Volume= 0.512 af
Outflow = 6.19 cfs @ 12.12 hrs, Volume= 0.508 af, Atten= 9%, Lag= 2.2 min
Discarded = 0.02 cfs @ 12.12 hrs, Volume= 0.049 af
Primary = 6.17 cfs @ 12.12 hrs, Volume= 0.459 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 124.23' @ 12.12 hrs Surf.Area= 2,977 sf Storage= 2,776 cf

Plug-Flow detention time= 126.1 min calculated for 0.508 af (99% of inflow)
Center-of-Mass det. time= 120.8 min (900.3 - 779.5)

Volume	Invert	Avail.Storage	Storage Description
#1	122.50'	3,646 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.50	112	90.0	0	0	112
123.00	1,260	245.0	291	291	4,245
124.00	2,500	460.0	1,845	2,136	16,312
124.50	3,570	475.0	1,510	3,646	17,452

Device	Routing	Invert	Outlet Devices
#1	Primary	123.70'	**6.0' 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
#2	Discarded	122.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 12.12 hrs HW=124.23' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=6.17 cfs @ 12.12 hrs HW=124.23' TW=0.00' (Dynamic Tailwater)
1=Broad-Crested Rectangular Weir (Weir Controls 6.17 cfs @ 1.92 fps)

Summary for Link DP1: Wetlands

Inflow Area = 2.628 ac, 70.24% Impervious, Inflow Depth = 3.39" for 10-Year 24-Hour event
Inflow = 9.95 cfs @ 12.11 hrs, Volume= 0.743 af
Primary = 9.95 cfs @ 12.11 hrs, Volume= 0.743 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=4.74"
Flow Length=152' Tc=6.0 min CN=89 Runoff=1.89 cfs 0.140 af

Subcatchment 2S: Parking Lot & Roof Runoff Area=66,929 sf 82.02% Impervious Runoff Depth=5.18"
Flow Length=102' Tc=6.0 min CN=93 Runoff=8.67 cfs 0.664 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=28,830 sf 52.06% Impervious Runoff Depth=4.20"
Flow Length=297' Tc=6.0 min CN=84 Runoff=3.21 cfs 0.231 af

Subcatchment 4S: Roof and Western Runoff Area=18,700 sf 56.10% Impervious Runoff Depth=4.30"
Flow Length=102' Tc=6.0 min CN=85 Runoff=2.12 cfs 0.154 af

Pond 1P: Ex. CB on Route 20 Peak Elev=123.77' Inflow=3.21 cfs 0.231 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=3.21 cfs 0.231 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=136.62' Storage=3,620 cf Inflow=1.89 cfs 0.140 af
Outflow=0.10 cfs 0.140 af

Pond WQ: Existing Water Quality Swale Peak Elev=124.32' Storage=3,040 cf Inflow=8.67 cfs 0.664 af
Discarded=0.02 cfs 0.051 af Primary=7.90 cfs 0.609 af Outflow=7.92 cfs 0.659 af

Link DP1: Wetlands Inflow=13.01 cfs 0.994 af
Primary=13.01 cfs 0.994 af

Total Runoff Area = 2.982 ac Runoff Volume = 1.189 af Average Runoff Depth = 4.78"
29.30% Pervious = 0.874 ac 70.70% Impervious = 2.109 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 1.89 cfs @ 12.08 hrs, Volume= 0.140 af, Depth= 4.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Parking Lot & Roof

Runoff = 8.67 cfs @ 12.08 hrs, Volume= 0.664 af, Depth= 5.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
43,350	98	Paved parking, HSG B
2,726	96	Gravel surface, HSG B
9,310	61	>75% Grass cover, Good, HSG B
11,543	98	Roofs, HSG B
66,929	93	Weighted Average
12,036		17.98% Pervious Area
54,893		82.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 3.21 cfs @ 12.09 hrs, Volume= 0.231 af, Depth= 4.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
12,720	98	Paved parking, HSG B
2,852	96	Gravel surface, HSG B
10,970	61	>75% Grass cover, Good, HSG B
2,288	98	Roofs, HSG B
28,830	84	Weighted Average
13,822		47.94% Pervious Area
15,008		52.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	297		0.82		**Direct Entry, A-B**

Summary for Subcatchment 4S: Roof and Western Landscaped Area

Runoff = 2.12 cfs @ 12.09 hrs, Volume= 0.154 af, Depth= 4.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
300	98	Paved parking, HSG B
1,531	96	Gravel surface, HSG B
6,679	61	>75% Grass cover, Good, HSG B
10,190	98	Roofs, HSG B
18,700	85	Weighted Average
8,210		43.90% Pervious Area
10,490		56.10% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Pond 1P: Ex. CB on Route 20

Inflow Area = 0.662 ac, 52.06% Impervious, Inflow Depth = 4.20" for 25-Year 24-Hour event
Inflow = 3.21 cfs @ 12.09 hrs, Volume= 0.231 af
Outflow = 3.21 cfs @ 12.09 hrs, Volume= 0.231 af, Atten= 0%, Lag= 0.0 min
Primary = 3.21 cfs @ 12.09 hrs, Volume= 0.231 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 123.77' @ 12.09 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=3.20 cfs @ 12.09 hrs HW=123.77' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 3.20 cfs @ 2.65 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 4.74" for 25-Year 24-Hour event
Inflow = 1.89 cfs @ 12.08 hrs, Volume= 0.140 af
Outflow = 0.10 cfs @ 14.12 hrs, Volume= 0.140 af, Atten= 95%, Lag= 122.3 min
Discarded = 0.10 cfs @ 14.12 hrs, Volume= 0.140 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 136.62' @ 14.12 hrs Surf.Area= 4,233 sf Storage= 3,620 cf

Plug-Flow detention time= 660.7 min calculated for 0.140 af (100% of inflow)
Center-of-Mass det. time= 659.0 min (1,447.2 - 788.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.10 cfs @ 14.12 hrs HW=136.62' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.10 cfs)

Summary for Pond WQ: Existing Water Quality Swale

Inflow Area = 1.536 ac, 82.02% Impervious, Inflow Depth = 5.18" for 25-Year 24-Hour event
Inflow = 8.67 cfs @ 12.08 hrs, Volume= 0.664 af
Outflow = 7.92 cfs @ 12.12 hrs, Volume= 0.659 af, Atten= 9%, Lag= 2.1 min
Discarded = 0.02 cfs @ 12.12 hrs, Volume= 0.051 af
Primary = 7.90 cfs @ 12.12 hrs, Volume= 0.609 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 124.32' @ 12.12 hrs Surf.Area= 3,163 sf Storage= 3,040 cf

Plug-Flow detention time= 101.0 min calculated for 0.659 af (99% of inflow)
Center-of-Mass det. time= 97.1 min (870.1 - 773.0)

Volume	Invert	Avail.Storage	Storage Description
#1	122.50'	3,646 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.50	112	90.0	0	0	112
123.00	1,260	245.0	291	291	4,245
124.00	2,500	460.0	1,845	2,136	16,312
124.50	3,570	475.0	1,510	3,646	17,452

Device	Routing	Invert	Outlet Devices
#1	Primary	123.70'	**6.0' 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
#2	Discarded	122.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 12.12 hrs HW=124.32' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=7.90 cfs @ 12.12 hrs HW=124.32' TW=0.00' (Dynamic Tailwater)
1=Broad-Crested Rectangular Weir (Weir Controls 7.90 cfs @ 2.12 fps)

Summary for Link DP1: Wetlands

Inflow Area = 2.628 ac, 70.24% Impervious, Inflow Depth = 4.54" for 25-Year 24-Hour event
Inflow = 13.01 cfs @ 12.10 hrs, Volume= 0.994 af
Primary = 13.01 cfs @ 12.10 hrs, Volume= 0.994 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=7.28"
Flow Length=152' Tc=6.0 min CN=89 Runoff=2.84 cfs 0.215 af

Subcatchment 2S: Parking Lot & Roof Runoff Area=66,929 sf 82.02% Impervious Runoff Depth=7.76"
Flow Length=102' Tc=6.0 min CN=93 Runoff=12.69 cfs 0.993 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=28,830 sf 52.06% Impervious Runoff Depth=6.67"
Flow Length=297' Tc=6.0 min CN=84 Runoff=4.99 cfs 0.368 af

Subcatchment 4S: Roof and Western Runoff Area=18,700 sf 56.10% Impervious Runoff Depth=6.79"
Flow Length=102' Tc=6.0 min CN=85 Runoff=3.28 cfs 0.243 af

Pond 1P: Ex. CB on Route 20 Peak Elev=124.10' Inflow=4.99 cfs 0.368 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=4.99 cfs 0.368 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=137.08' Storage=5,703 cf Inflow=2.84 cfs 0.215 af
Outflow=0.15 cfs 0.215 af

Pond WQ: Existing Water Quality Swale Peak Elev=124.50' Storage=3,643 cf Inflow=12.69 cfs 0.993 af
Discarded=0.02 cfs 0.052 af Primary=11.49 cfs 0.937 af Outflow=11.51 cfs 0.989 af

Link DP1: Wetlands Inflow=19.37 cfs 1.548 af
Primary=19.37 cfs 1.548 af

Total Runoff Area = 2.982 ac Runoff Volume = 1.819 af Average Runoff Depth = 7.32"
29.30% Pervious = 0.874 ac 70.70% Impervious = 2.109 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 2.84 cfs @ 12.08 hrs, Volume= 0.215 af, Depth= 7.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Parking Lot & Roof

Runoff = 12.69 cfs @ 12.08 hrs, Volume= 0.993 af, Depth= 7.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
43,350	98	Paved parking, HSG B
2,726	96	Gravel surface, HSG B
9,310	61	>75% Grass cover, Good, HSG B
11,543	98	Roofs, HSG B
66,929	93	Weighted Average
12,036		17.98% Pervious Area
54,893		82.02% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 4.99 cfs @ 12.09 hrs, Volume= 0.368 af, Depth= 6.67"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
12,720	98	Paved parking, HSG B
2,852	96	Gravel surface, HSG B
10,970	61	>75% Grass cover, Good, HSG B
2,288	98	Roofs, HSG B
28,830	84	Weighted Average
13,822		47.94% Pervious Area
15,008		52.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	297		0.82		**Direct Entry, A-B**

Summary for Subcatchment 4S: Roof and Western Landscaped Area

Runoff = 3.28 cfs @ 12.08 hrs, Volume= 0.243 af, Depth= 6.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
300	98	Paved parking, HSG B
1,531	96	Gravel surface, HSG B
6,679	61	>75% Grass cover, Good, HSG B
10,190	98	Roofs, HSG B
18,700	85	Weighted Average
8,210		43.90% Pervious Area
10,490		56.10% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	102		0.28		**Direct Entry, A-B**

Summary for Pond 1P: Ex. CB on Route 20

Inflow Area = 0.662 ac, 52.06% Impervious, Inflow Depth = 6.67" for 100-Year 24-Hour event
Inflow = 4.99 cfs @ 12.09 hrs, Volume= 0.368 af
Outflow = 4.99 cfs @ 12.09 hrs, Volume= 0.368 af, Atten= 0%, Lag= 0.0 min
Primary = 4.99 cfs @ 12.09 hrs, Volume= 0.368 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 124.10' @ 12.09 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=4.98 cfs @ 12.09 hrs HW=124.10' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 4.98 cfs @ 3.06 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 7.28" for 100-Year 24-Hour event
Inflow = 2.84 cfs @ 12.08 hrs, Volume= 0.215 af
Outflow = 0.15 cfs @ 13.99 hrs, Volume= 0.215 af, Atten= 95%, Lag= 114.6 min
Discarded = 0.15 cfs @ 13.99 hrs, Volume= 0.215 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 137.08' @ 13.99 hrs Surf.Area= 6,530 sf Storage= 5,703 cf

Plug-Flow detention time= 639.0 min calculated for 0.215 af (100% of inflow)
Center-of-Mass det. time= 638.0 min (1,414.9 - 776.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.15 cfs @ 13.99 hrs HW=137.08' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.15 cfs)

Summary for Pond WQ: Existing Water Quality Swale

Inflow Area = 1.536 ac, 82.02% Impervious, Inflow Depth = 7.76" for 100-Year 24-Hour event
Inflow = 12.69 cfs @ 12.08 hrs, Volume= 0.993 af
Outflow = 11.51 cfs @ 12.12 hrs, Volume= 0.989 af, Atten= 9%, Lag= 2.2 min
Discarded = 0.02 cfs @ 12.12 hrs, Volume= 0.052 af
Primary = 11.49 cfs @ 12.12 hrs, Volume= 0.937 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Peak Elev= 124.50' @ 12.12 hrs Surf.Area= 3,568 sf Storage= 3,643 cf

Plug-Flow detention time= 72.3 min calculated for 0.989 af (100% of inflow)
Center-of-Mass det. time= 69.4 min (832.9 - 763.6)

Volume	Invert	Avail.Storage	Storage Description
#1	122.50'	3,646 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.50	112	90.0	0	0	112
123.00	1,260	245.0	291	291	4,245
124.00	2,500	460.0	1,845	2,136	16,312
124.50	3,570	475.0	1,510	3,646	17,452

Device	Routing	Invert	Outlet Devices
#1	Primary	123.70'	**6.0' 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
#2	Discarded	122.50'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 12.12 hrs HW=124.50' (Free Discharge)
2=Exfiltration (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=11.48 cfs @ 12.12 hrs HW=124.50' TW=0.00' (Dynamic Tailwater)
1=Broad-Crested Rectangular Weir (Weir Controls 11.48 cfs @ 2.40 fps)

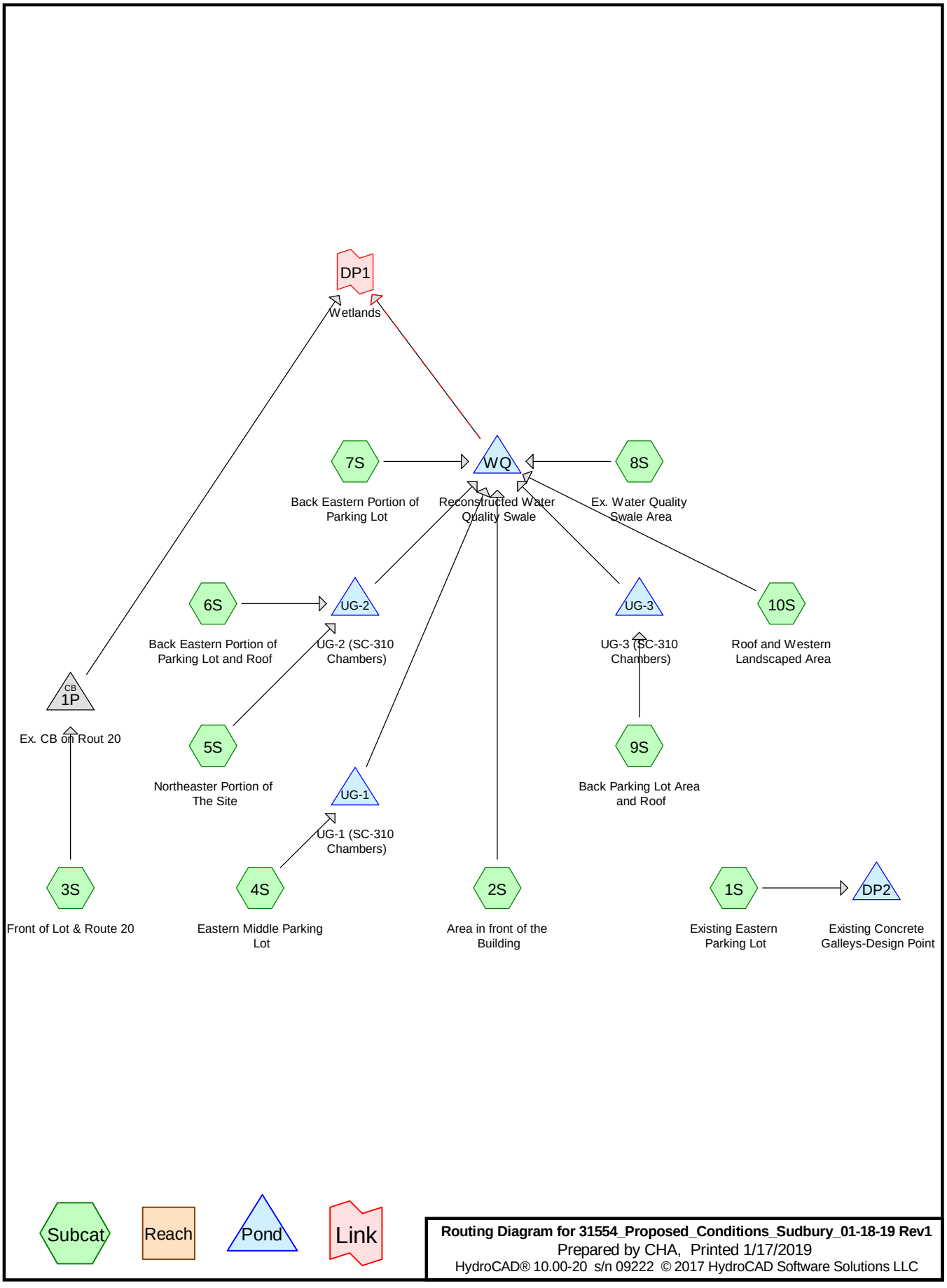
Summary for Link DP1: Wetlands

Inflow Area = 2.628 ac, 70.24% Impervious, Inflow Depth = 7.07" for 100-Year 24-Hour event
Inflow = 19.37 cfs @ 12.10 hrs, Volume= 1.548 af
Primary = 19.37 cfs @ 12.10 hrs, Volume= 1.548 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Section 3.1.2

Post-Developed Stormwater Report Calculations



Routing Diagram for 31554_Proposed_Conditions_Sudbury_01-18-19 Rev1
Prepared by CHA, Printed 1/17/2019

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.721	61	>75% Grass cover, Good, HSG B (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S, 10S)
0.054	96	Gravel surface, HSG B (1S, 8S)
1.630	98	Paved parking, HSG B (1S, 2S, 3S, 4S, 5S, 6S, 7S, 9S, 10S)
0.093	98	Roof (4S)
0.482	98	Roofs, HSG B (9S, 10S)
2.980	**89**	**TOTAL AREA**

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=0.04"
Flow Length=152' Tc=6.0 min CN=89 Runoff=0.01 cfs 0.001 af

Subcatchment 2S: Area in front of the Building Runoff Area=7,400 sf 68.51% Impervious Runoff Depth=0.02"
Tc=6.0 min CN=86 Runoff=0.00 cfs 0.000 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=18,885 sf 46.97% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=78 Runoff=0.00 cfs 0.000 af

Subcatchment 4S: Eastern Middle Parking Lot Runoff Area=12,040 sf 87.83% Impervious Runoff Depth=0.11"
Tc=6.0 min CN=93 Runoff=0.03 cfs 0.003 af

Subcatchment 5S: Northeaster Portion of The Runoff Area=10,265 sf 90.21% Impervious Runoff Depth=0.14"
Tc=6.0 min CN=94 Runoff=0.03 cfs 0.003 af

Subcatchment 6S: Back Eastern Portion of Runoff Area=12,250 sf 90.73% Impervious Runoff Depth=0.17"
Tc=6.0 min CN=95 Runoff=0.05 cfs 0.004 af

Subcatchment 7S: Back Eastern Portion of Runoff Area=10,035 sf 81.86% Impervious Runoff Depth=0.07"
Tc=6.0 min CN=91 Runoff=0.01 cfs 0.001 af

Subcatchment 8S: Ex. Water Quality Swale Area Runoff Area=5,205 sf 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=75 Runoff=0.00 cfs 0.000 af

Subcatchment 9S: Back Parking Lot Area and Runoff Area=17,300 sf 99.31% Impervious Runoff Depth=0.32"
Tc=6.0 min CN=98 Runoff=0.15 cfs 0.011 af

Subcatchment 10S: Roof and Western Runoff Area=20,985 sf 68.19% Impervious Runoff Depth=0.02"
Tc=6.0 min CN=86 Runoff=0.00 cfs 0.001 af

Pond 1P: Ex. CB on Rout 20 Peak Elev=122.80' Inflow=0.00 cfs 0.000 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=0.00 cfs 0.000 af

Pond DP2: Existing Concrete Galleys-Design Point Peak Elev=129.43' Storage=18 cf Inflow=0.01 cfs 0.001 af
Outflow=0.00 cfs 0.001 af

Pond UG-1: UG-1 (SC-310 Chambers) Peak Elev=123.06' Storage=38 cf Inflow=0.03 cfs 0.003 af
Discarded=0.00 cfs 0.003 af Primary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.003 af

Pond UG-2: UG-2 (SC-310 Chambers) Peak Elev=122.62' Storage=139 cf Inflow=0.09 cfs 0.007 af
Discarded=0.01 cfs 0.007 af Primary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.007 af

Pond UG-3: UG-3 (SC-310 Chambers) Peak Elev=122.45' Storage=215 cf Inflow=0.15 cfs 0.011 af
Discarded=0.01 cfs 0.011 af Primary=0.00 cfs 0.000 af Outflow=0.01 cfs 0.011 af

Pond WQ: Reconstructed Water Quality Swale Peak Elev=122.01' Storage=10 cf Inflow=0.01 cfs 0.002 af
Discarded=0.00 cfs 0.002 af Primary=0.00 cfs 0.000 af Secondary=0.00 cfs 0.000 af Outflow=0.00 cfs 0.002 af

Link DP1: Wetlands

Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Total Runoff Area = 2.980 ac Runoff Volume = 0.023 af Average Runoff Depth = 0.09"
26.01% Pervious = 0.775 ac 73.99% Impervious = 2.205 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 0.01 cfs @ 12.31 hrs, Volume= 0.001 af, Depth= 0.04"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Area in front of the Building

Runoff = 0.00 cfs @ 13.66 hrs, Volume= 0.000 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
2,330	61	>75% Grass cover, Good, HSG B
5,070	98	Paved parking, HSG B
7,400	86	Weighted Average
2,330		31.49% Pervious Area
5,070		68.51% Impervious Area

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

Summary for Subcatchment 3S: Front of Lot & Route 20

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

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
10,015	61	>75% Grass cover, Good, HSG B
8,870	98	Paved parking, HSG B
18,885	78	Weighted Average
10,015		53.03% Pervious Area
8,870		46.97% Impervious Area

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

Summary for Subcatchment 4S: Eastern Middle Parking Lot

Runoff = 0.03 cfs @ 12.10 hrs, Volume= 0.003 af, Depth= 0.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

	Area (sf)	CN	Description
	1,465	61	>75% Grass cover, Good, HSG B
	6,545	98	Paved parking, HSG B
*	4,030	98	Roof
	12,040	93	Weighted Average
	1,465		12.17% Pervious Area
	10,575		87.83% Impervious Area

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

Summary for Subcatchment 5S: Northeaster Portion of The Site

Runoff = 0.03 cfs @ 12.10 hrs, Volume= 0.003 af, Depth= 0.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
1,005	61	>75% Grass cover, Good, HSG B
9,260	98	Paved parking, HSG B
10,265	94	Weighted Average
1,005		9.79% Pervious Area
9,260		90.21% Impervious Area

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

Summary for Subcatchment 6S: Back Eastern Portion of Parking Lot and Roof

Runoff = 0.05 cfs @ 12.10 hrs, Volume= 0.004 af, Depth= 0.17"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
1,135	61	>75% Grass cover, Good, HSG B
11,115	98	Paved parking, HSG B
12,250	95	Weighted Average
1,135		9.27% Pervious Area
11,115		90.73% Impervious Area

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

Summary for Subcatchment 7S: Back Eastern Portion of Parking Lot

Runoff = 0.01 cfs @ 12.12 hrs, Volume= 0.001 af, Depth= 0.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
1,820	61	>75% Grass cover, Good, HSG B
8,215	98	Paved parking, HSG B
10,035	91	Weighted Average
1,820		18.14% Pervious Area
8,215		81.86% Impervious Area

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

Summary for Subcatchment 8S: Ex. Water Quality Swale Area

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

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
2,105	96	Gravel surface, HSG B
3,100	61	>75% Grass cover, Good, HSG B
5,205	75	Weighted Average
5,205		100.00% Pervious Area

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

Summary for Subcatchment 9S: Back Parking Lot Area and Roof

Runoff = 0.15 cfs @ 12.09 hrs, Volume= 0.011 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
9,560	98	Paved parking, HSG B
7,620	98	Roofs, HSG B
120	61	>75% Grass cover, Good, HSG B
17,300	98	Weighted Average
120		0.69% Pervious Area
17,180		99.31% Impervious Area

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

Summary for Subcatchment 10S: Roof and Western Landscaped Area

Runoff = 0.00 cfs @ 13.66 hrs, Volume= 0.001 af, Depth= 0.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 0.5-Inch Storm Rainfall=0.50"

Area (sf)	CN	Description
13,380	98	Roofs, HSG B
930	98	Paved parking, HSG B
6,675	61	>75% Grass cover, Good, HSG B
20,985	86	Weighted Average
6,675		31.81% Pervious Area
14,310		68.19% Impervious Area

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

Summary for Pond 1P: Ex. CB on Rout 20

Inflow Area = 0.434 ac, 46.97% Impervious, Inflow Depth = 0.00" for 0.5-Inch Storm event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Outflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 122.80' @ 0.00 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.80' TW=0.00' (Dynamic Tailwater)
↑—**1=18" Culvert** (Controls 0.00 cfs)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 0.04" for 0.5-Inch Storm event
Inflow = 0.01 cfs @ 12.31 hrs, Volume= 0.001 af
Outflow = 0.00 cfs @ 13.41 hrs, Volume= 0.001 af, Atten= 50%, Lag= 66.0 min
Discarded = 0.00 cfs @ 13.41 hrs, Volume= 0.001 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 129.43' @ 13.41 hrs Surf.Area= 0 sf Storage= 18 cf

Plug-Flow detention time= 214.2 min calculated for 0.001 af (68% of inflow)
Center-of-Mass det. time= 94.1 min (1,042.6 - 948.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.00 cfs @ 13.41 hrs HW=129.43' (Free Discharge)
↑—**1=Exfiltration** (Exfiltration Controls 0.00 cfs)

Summary for Pond UG-1: UG-1 (SC-310 Chambers)

Inflow Area = 0.276 ac, 87.83% Impervious, Inflow Depth = 0.11" for 0.5-Inch Storm event
Inflow = 0.03 cfs @ 12.10 hrs, Volume= 0.003 af
Outflow = 0.00 cfs @ 11.97 hrs, Volume= 0.003 af, Atten= 89%, Lag= 0.0 min
Discarded = 0.00 cfs @ 11.97 hrs, Volume= 0.003 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.06' @ 13.87 hrs Surf.Area= 528 sf Storage= 38 cf

Plug-Flow detention time= 115.2 min calculated for 0.003 af (100% of inflow)
Center-of-Mass det. time= 115.2 min (1,000.3 - 885.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.85'	338 cf	**11.50'W x 45.92'L x 2.33'H Field A** 1,232 cf Overall - 265 cf Embedded = 967 cf x 35.0% Voids
#2A	123.35'	265 cf	**ADS_StormTech SC-310 +Cap** x 18 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 3 Rows of 6 Chambers
		604 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	123.34'	**12.0" Round Culvert** L= 51.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.34' / 123.09' S= 0.0049 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	123.55'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	124.68'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.85'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.00 cfs @ 11.97 hrs HW=122.86' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.85' TW=122.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.00 cfs)
  ├**2=Orifice** (Controls 0.00 cfs)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond UG-2: UG-2 (SC-310 Chambers)

Inflow Area = 0.517 ac, 90.50% Impervious, Inflow Depth = 0.15" for 0.5-Inch Storm event
Inflow = 0.09 cfs @ 12.10 hrs, Volume= 0.007 af
Outflow = 0.01 cfs @ 11.82 hrs, Volume= 0.007 af, Atten= 94%, Lag= 0.0 min
Discarded = 0.01 cfs @ 11.82 hrs, Volume= 0.007 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 122.62' @ 15.37 hrs Surf.Area= 834 sf Storage= 139 cf

Plug-Flow detention time= 288.6 min calculated for 0.007 af (100% of inflow)
Center-of-Mass det. time= 288.6 min (1,153.2 - 864.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.14'	526 cf	**18.17'W x 45.92'L x 2.33'H Field A** 1,946 cf Overall - 442 cf Embedded = 1,504 cf x 35.0% Voids
#2A	122.64'	442 cf	**ADS_StormTech SC-310 +Cap** x 30 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 6 Chambers
#3	123.97'	19 cf	**4.00'D x 1.53'H Vertical Cone/Cylinder** -Impervious
		988 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.64'	**15.0" Round Culvert** L= 44.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 122.64' / 122.33' S= 0.0070 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	122.92'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.97'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.14'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 11.82 hrs HW=122.16' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.14' TW=122.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.00 cfs)
  ├**2=Orifice** (Controls 0.00 cfs)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond UG-3: UG-3 (SC-310 Chambers)

Inflow Area = 0.397 ac, 99.31% Impervious, Inflow Depth = 0.32" for 0.5-Inch Storm event
Inflow = 0.15 cfs @ 12.09 hrs, Volume= 0.011 af
Outflow = 0.01 cfs @ 11.42 hrs, Volume= 0.011 af, Atten= 94%, Lag= 0.0 min
Discarded = 0.01 cfs @ 11.42 hrs, Volume= 0.011 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 122.45' @ 14.15 hrs Surf.Area= 1,352 sf Storage= 215 cf

Plug-Flow detention time= 241.0 min calculated for 0.011 af (100% of inflow)
Center-of-Mass det. time= 240.9 min (1,054.2 - 813.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.00'	846 cf	**18.17'W x 74.40'L x 2.33'H Field A** 3,154 cf Overall - 737 cf Embedded = 2,417 cf x 35.0% Voids
#2A	122.50'	737 cf	**ADS_StormTech SC-310 +Cap** x 50 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 10 Chambers
#3	123.83'	35 cf	**4.00'D x 2.77'H Vertical Cone/Cylinder** -Impervious
		1,618 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.41'	**12.0" Round Culvert** L= 14.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 122.41' / 122.30' S= 0.0079 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	122.78'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.83'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 11.42 hrs HW=122.01' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.00' TW=122.00' (Dynamic Tailwater)
└**1=Culvert** (Controls 0.00 cfs)
  ├**2=Orifice** (Controls 0.00 cfs)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond WQ: Reconstructed Water Quality Swale

Inflow Area = 2.192 ac, 79.31% Impervious, Inflow Depth = 0.01" for 0.5-Inch Storm event
Inflow = 0.01 cfs @ 12.12 hrs, Volume= 0.002 af
Outflow = 0.00 cfs @ 12.67 hrs, Volume= 0.002 af, Atten= 61%, Lag= 32.9 min
Discarded = 0.00 cfs @ 12.67 hrs, Volume= 0.002 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 122.01' @ 12.67 hrs Surf.Area= 752 sf Storage= 10 cf

Plug-Flow detention time= 28.3 min calculated for 0.002 af (100% of inflow)
Center-of-Mass det. time= 28.2 min (986.8 - 958.5)

Volume	Invert	Avail.Storage	Storage Description
#1	122.00'	4,427 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.00	745	205.0	0	0	745
123.00	1,330	260.0	1,023	1,023	2,793
124.00	2,500	460.0	1,884	2,908	14,258
124.50	3,610	475.0	1,519	4,427	15,399

Device	Routing	Invert	Outlet Devices
#1	Primary	121.11'	**12.0" Round Culvert** L= 22.0' Ke= 0.200 Inlet / Outlet Invert= 121.11' / 121.00' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	122.17'	**0.5" Vert. Orifice/Grate X 2.00** C= 0.600
#3	Device 1	122.55'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	123.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	123.40'	**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
#6	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.00 cfs @ 12.67 hrs HW=122.01' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.00' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.00 cfs of 1.94 cfs potential flow)
  ├**2=Orifice/Grate** (Controls 0.00 cfs)
  ├**3=Orifice/Grate** (Controls 0.00 cfs)
  └**4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.00' TW=0.00' (Dynamic Tailwater)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link DP1: Wetlands

Inflow Area = 2.625 ac, 73.97% Impervious, Inflow Depth = 0.00" for 0.5-Inch Storm event
Inflow = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af
Primary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=0.28"
Flow Length=152' Tc=6.0 min CN=89 Runoff=0.11 cfs 0.008 af

Subcatchment 2S: Area in front of the Building Runoff Area=7,400 sf 68.51% Impervious Runoff Depth=0.20"
Tc=6.0 min CN=86 Runoff=0.03 cfs 0.003 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=18,885 sf 46.97% Impervious Runoff Depth=0.06"
Tc=6.0 min CN=78 Runoff=0.01 cfs 0.002 af

Subcatchment 4S: Eastern Middle Parking Lot Runoff Area=12,040 sf 87.83% Impervious Runoff Depth=0.45"
Tc=6.0 min CN=93 Runoff=0.14 cfs 0.010 af

Subcatchment 5S: Northeaster Portion of The Runoff Area=10,265 sf 90.21% Impervious Runoff Depth=0.50"
Tc=6.0 min CN=94 Runoff=0.14 cfs 0.010 af

Subcatchment 6S: Back Eastern Portion of Runoff Area=12,250 sf 90.73% Impervious Runoff Depth=0.56"
Tc=6.0 min CN=95 Runoff=0.19 cfs 0.013 af

Subcatchment 7S: Back Eastern Portion of Runoff Area=10,035 sf 81.86% Impervious Runoff Depth=0.36"
Tc=6.0 min CN=91 Runoff=0.09 cfs 0.007 af

Subcatchment 8S: Ex. Water Quality Swale Area Runoff Area=5,205 sf 0.00% Impervious Runoff Depth=0.03"
Tc=6.0 min CN=75 Runoff=0.00 cfs 0.000 af

Subcatchment 9S: Back Parking Lot Area and Runoff Area=17,300 sf 99.31% Impervious Runoff Depth=0.79"
Tc=6.0 min CN=98 Runoff=0.35 cfs 0.026 af

Subcatchment 10S: Roof and Western Runoff Area=20,985 sf 68.19% Impervious Runoff Depth=0.20"
Tc=6.0 min CN=86 Runoff=0.09 cfs 0.008 af

Pond 1P: Ex. CB on Rout 20 Peak Elev=122.84' Inflow=0.01 cfs 0.002 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=0.01 cfs 0.002 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=129.73' Storage=110 cf Inflow=0.11 cfs 0.008 af
Outflow=0.02 cfs 0.008 af

Pond UG-1: UG-1 (SC-310 Chambers) Peak Elev=123.62' Storage=196 cf Inflow=0.14 cfs 0.010 af
Discarded=0.00 cfs 0.007 af Primary=0.02 cfs 0.003 af Outflow=0.02 cfs 0.010 af

Pond UG-2: UG-2 (SC-310 Chambers) Peak Elev=123.08' Storage=412 cf Inflow=0.32 cfs 0.023 af
Discarded=0.01 cfs 0.014 af Primary=0.08 cfs 0.009 af Outflow=0.09 cfs 0.023 af

Pond UG-3: UG-3 (SC-310 Chambers) Peak Elev=122.85' Storage=593 cf Inflow=0.35 cfs 0.026 af
Discarded=0.01 cfs 0.022 af Primary=0.02 cfs 0.004 af Outflow=0.03 cfs 0.026 af

Pond WQ: Reconstructed Water Quality Swale Peak Elev=122.69' Storage=640 cf Inflow=0.21 cfs 0.035 af
Discarded=0.01 cfs 0.013 af Primary=0.06 cfs 0.021 af Secondary=0.00 cfs 0.000 af Outflow=0.06 cfs 0.035 af

Link DP1: Wetlands

Inflow=0.06 cfs 0.024 af
Primary=0.06 cfs 0.024 af

Total Runoff Area = 2.980 ac Runoff Volume = 0.088 af Average Runoff Depth = 0.35"
26.01% Pervious = 0.775 ac 73.99% Impervious = 2.205 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 0.11 cfs @ 12.10 hrs, Volume= 0.008 af, Depth= 0.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Area in front of the Building

Runoff = 0.03 cfs @ 12.11 hrs, Volume= 0.003 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
2,330	61	>75% Grass cover, Good, HSG B
5,070	98	Paved parking, HSG B
7,400	86	Weighted Average
2,330		31.49% Pervious Area
5,070		68.51% Impervious Area

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

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 0.01 cfs @ 12.39 hrs, Volume= 0.002 af, Depth= 0.06"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
10,015	61	>75% Grass cover, Good, HSG B
8,870	98	Paved parking, HSG B
18,885	78	Weighted Average
10,015		53.03% Pervious Area
8,870		46.97% Impervious Area

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

Summary for Subcatchment 4S: Eastern Middle Parking Lot

Runoff = 0.14 cfs @ 12.09 hrs, Volume= 0.010 af, Depth= 0.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

	Area (sf)	CN	Description
	1,465	61	>75% Grass cover, Good, HSG B
	6,545	98	Paved parking, HSG B
*	4,030	98	Roof
	12,040	93	Weighted Average
	1,465		12.17% Pervious Area
	10,575		87.83% Impervious Area

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

Summary for Subcatchment 5S: Northeaster Portion of The Site

Runoff = 0.14 cfs @ 12.09 hrs, Volume= 0.010 af, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
1,005	61	>75% Grass cover, Good, HSG B
9,260	98	Paved parking, HSG B
10,265	94	Weighted Average
1,005		9.79% Pervious Area
9,260		90.21% Impervious Area

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

Summary for Subcatchment 6S: Back Eastern Portion of Parking Lot and Roof

Runoff = 0.19 cfs @ 12.09 hrs, Volume= 0.013 af, Depth= 0.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
1,135	61	>75% Grass cover, Good, HSG B
11,115	98	Paved parking, HSG B
12,250	95	Weighted Average
1,135		9.27% Pervious Area
11,115		90.73% Impervious Area

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

Summary for Subcatchment 7S: Back Eastern Portion of Parking Lot

Runoff = 0.09 cfs @ 12.09 hrs, Volume= 0.007 af, Depth= 0.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
1,820	61	>75% Grass cover, Good, HSG B
8,215	98	Paved parking, HSG B
10,035	91	Weighted Average
1,820		18.14% Pervious Area
8,215		81.86% Impervious Area

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

Summary for Subcatchment 8S: Ex. Water Quality Swale Area

Runoff = 0.00 cfs @ 13.78 hrs, Volume= 0.000 af, Depth= 0.03"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
2,105	96	Gravel surface, HSG B
3,100	61	>75% Grass cover, Good, HSG B
5,205	75	Weighted Average
5,205		100.00% Pervious Area

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

Summary for Subcatchment 9S: Back Parking Lot Area and Roof

Runoff = 0.35 cfs @ 12.08 hrs, Volume= 0.026 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
9,560	98	Paved parking, HSG B
7,620	98	Roofs, HSG B
120	61	>75% Grass cover, Good, HSG B
17,300	98	Weighted Average
120		0.69% Pervious Area
17,180		99.31% Impervious Area

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

Summary for Subcatchment 10S: Roof and Western Landscaped Area

Runoff = 0.09 cfs @ 12.11 hrs, Volume= 0.008 af, Depth= 0.20"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 1-Inch Storm Rainfall=1.00"

Area (sf)	CN	Description
13,380	98	Roofs, HSG B
930	98	Paved parking, HSG B
6,675	61	>75% Grass cover, Good, HSG B
20,985	86	Weighted Average
6,675		31.81% Pervious Area
14,310		68.19% Impervious Area

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

Summary for Pond 1P: Ex. CB on Rout 20

Inflow Area = 0.434 ac, 46.97% Impervious, Inflow Depth = 0.06" for 1-Inch Storm event
Inflow = 0.01 cfs @ 12.39 hrs, Volume= 0.002 af
Outflow = 0.01 cfs @ 12.39 hrs, Volume= 0.002 af, Atten= 0%, Lag= 0.0 min
Primary = 0.01 cfs @ 12.39 hrs, Volume= 0.002 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 122.84' @ 12.39 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=0.01 cfs @ 12.39 hrs HW=122.84' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 0.01 cfs @ 0.56 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 0.28" for 1-Inch Storm event
Inflow = 0.11 cfs @ 12.10 hrs, Volume= 0.008 af
Outflow = 0.02 cfs @ 11.93 hrs, Volume= 0.008 af, Atten= 82%, Lag= 0.0 min
Discarded = 0.02 cfs @ 11.93 hrs, Volume= 0.008 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 129.73' @ 12.65 hrs Surf.Area= 832 sf Storage= 110 cf

Plug-Flow detention time= 67.7 min calculated for 0.008 af (95% of inflow)
Center-of-Mass det. time= 42.0 min (911.9 - 869.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 11.93 hrs HW=129.43' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.02 cfs)

Summary for Pond UG-1: UG-1 (SC-310 Chambers)

Inflow Area = 0.276 ac, 87.83% Impervious, Inflow Depth = 0.45" for 1-Inch Storm event
Inflow = 0.14 cfs @ 12.09 hrs, Volume= 0.010 af
Outflow = 0.02 cfs @ 12.63 hrs, Volume= 0.010 af, Atten= 84%, Lag= 32.1 min
Discarded = 0.00 cfs @ 11.05 hrs, Volume= 0.007 af
Primary = 0.02 cfs @ 12.63 hrs, Volume= 0.003 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.62' @ 12.63 hrs Surf.Area= 528 sf Storage= 196 cf

Plug-Flow detention time= 416.6 min calculated for 0.010 af (100% of inflow)
Center-of-Mass det. time= 416.6 min (1,257.5 - 840.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.85'	338 cf	**11.50'W x 45.92'L x 2.33'H Field A** 1,232 cf Overall - 265 cf Embedded = 967 cf x 35.0% Voids
#2A	123.35'	265 cf	**ADS_StormTech SC-310 +Cap** x 18 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 3 Rows of 6 Chambers
		604 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	123.34'	**12.0" Round Culvert** L= 51.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.34' / 123.09' S= 0.0049 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	123.55'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	124.68'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.85'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.00 cfs @ 11.05 hrs HW=122.86' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.02 cfs @ 12.63 hrs HW=123.62' TW=122.46' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.02 cfs of 0.24 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 0.02 cfs @ 0.92 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond UG-2: UG-2 (SC-310 Chambers)

Inflow Area = 0.517 ac, 90.50% Impervious, Inflow Depth = 0.54" for 1-Inch Storm event
Inflow = 0.32 cfs @ 12.09 hrs, Volume= 0.023 af
Outflow = 0.09 cfs @ 12.46 hrs, Volume= 0.023 af, Atten= 72%, Lag= 22.5 min
Discarded = 0.01 cfs @ 10.49 hrs, Volume= 0.014 af
Primary = 0.08 cfs @ 12.46 hrs, Volume= 0.009 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 123.08' @ 12.46 hrs Surf.Area= 834 sf Storage= 412 cf

Plug-Flow detention time= 407.8 min calculated for 0.023 af (100% of inflow)
Center-of-Mass det. time= 407.9 min (1,235.7 - 827.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.14'	526 cf	**18.17'W x 45.92'L x 2.33'H Field A** 1,946 cf Overall - 442 cf Embedded = 1,504 cf x 35.0% Voids
#2A	122.64'	442 cf	**ADS_StormTech SC-310 +Cap** x 30 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 6 Chambers
#3	123.97'	19 cf	**4.00'D x 1.53'H Vertical Cone/Cylinder** -Impervious
		988 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.64'	**15.0" Round Culvert** L= 44.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 122.64' / 122.33' S= 0.0070 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	122.92'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.97'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.14'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 10.49 hrs HW=122.16' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.08 cfs @ 12.46 hrs HW=123.08' TW=122.37' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.08 cfs of 0.72 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 0.08 cfs @ 1.35 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond UG-3: UG-3 (SC-310 Chambers)

Inflow Area = 0.397 ac, 99.31% Impervious, Inflow Depth = 0.79" for 1-Inch Storm event
Inflow = 0.35 cfs @ 12.08 hrs, Volume= 0.026 af
Outflow = 0.03 cfs @ 13.11 hrs, Volume= 0.026 af, Atten= 92%, Lag= 61.7 min
Discarded = 0.01 cfs @ 9.43 hrs, Volume= 0.022 af
Primary = 0.02 cfs @ 13.11 hrs, Volume= 0.004 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 122.85' @ 13.11 hrs Surf.Area= 1,352 sf Storage= 593 cf

Plug-Flow detention time= 519.7 min calculated for 0.026 af (100% of inflow)
Center-of-Mass det. time= 519.7 min (1,307.6 - 787.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.00'	846 cf	**18.17'W x 74.40'L x 2.33'H Field A** 3,154 cf Overall - 737 cf Embedded = 2,417 cf x 35.0% Voids
#2A	122.50'	737 cf	**ADS_StormTech SC-310 +Cap** x 50 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 10 Chambers
#3	123.83'	35 cf	**4.00'D x 2.77'H Vertical Cone/Cylinder** -Impervious
		1,618 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.41'	**12.0" Round Culvert** L= 14.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 122.41' / 122.30' S= 0.0079 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	122.78'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.83'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 9.43 hrs HW=122.01' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.02 cfs @ 13.11 hrs HW=122.85' TW=122.63' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.02 cfs of 0.63 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 0.02 cfs @ 0.92 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond WQ: Reconstructed Water Quality Swale

Inflow Area = 2.192 ac, 79.31% Impervious, Inflow Depth = 0.19" for 1-Inch Storm event
Inflow = 0.21 cfs @ 12.10 hrs, Volume= 0.035 af
Outflow = 0.06 cfs @ 13.97 hrs, Volume= 0.035 af, Atten= 70%, Lag= 112.0 min
Discarded = 0.01 cfs @ 13.97 hrs, Volume= 0.013 af
Primary = 0.06 cfs @ 13.97 hrs, Volume= 0.021 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 122.69' @ 13.97 hrs Surf.Area= 1,129 sf Storage= 640 cf

Plug-Flow detention time= 327.7 min calculated for 0.035 af (100% of inflow)
Center-of-Mass det. time= 327.8 min (1,193.0 - 865.2)

Volume	Invert	Avail.Storage	Storage Description
#1	122.00'	4,427 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.00	745	205.0	0	0	745
123.00	1,330	260.0	1,023	1,023	2,793
124.00	2,500	460.0	1,884	2,908	14,258
124.50	3,610	475.0	1,519	4,427	15,399

Device	Routing	Invert	Outlet Devices
#1	Primary	121.11'	**12.0" Round Culvert** L= 22.0' Ke= 0.200 Inlet / Outlet Invert= 121.11' / 121.00' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	122.17'	**0.5" Vert. Orifice/Grate X 2.00** C= 0.600
#3	Device 1	122.55'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	123.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	123.40'	**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
#6	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 13.97 hrs HW=122.69' (Free Discharge)
└─**6=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.06 cfs @ 13.97 hrs HW=122.69' TW=0.00' (Dynamic Tailwater)
└─**1=Culvert** (Passes 0.06 cfs of 3.80 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.01 cfs @ 3.39 fps)
  ├─**3=Orifice/Grate** (Orifice Controls 0.05 cfs @ 1.26 fps)
  └─**4=Orifice/Grate** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.00' TW=0.00' (Dynamic Tailwater)
└─**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link DP1: Wetlands

Inflow Area = 2.625 ac, 73.97% Impervious, Inflow Depth = 0.11" for 1-Inch Storm event
Inflow = 0.06 cfs @ 13.95 hrs, Volume= 0.024 af
Primary = 0.06 cfs @ 13.95 hrs, Volume= 0.024 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=2.08"
Flow Length=152' Tc=6.0 min CN=89 Runoff=0.86 cfs 0.062 af

Subcatchment 2S: Area in front of the Building Runoff Area=7,400 sf 68.51% Impervious Runoff Depth=1.84"
Tc=6.0 min CN=86 Runoff=0.37 cfs 0.026 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=18,885 sf 46.97% Impervious Runoff Depth=1.27"
Tc=6.0 min CN=78 Runoff=0.63 cfs 0.046 af

Subcatchment 4S: Eastern Middle Parking Lot Runoff Area=12,040 sf 87.83% Impervious Runoff Depth=2.45"
Tc=6.0 min CN=93 Runoff=0.77 cfs 0.056 af

Subcatchment 5S: Northeaster Portion of The Runoff Area=10,265 sf 90.21% Impervious Runoff Depth=2.54"
Tc=6.0 min CN=94 Runoff=0.67 cfs 0.050 af

Subcatchment 6S: Back Eastern Portion of Runoff Area=12,250 sf 90.73% Impervious Runoff Depth=2.64"
Tc=6.0 min CN=95 Runoff=0.82 cfs 0.062 af

Subcatchment 7S: Back Eastern Portion of Runoff Area=10,035 sf 81.86% Impervious Runoff Depth=2.26"
Tc=6.0 min CN=91 Runoff=0.60 cfs 0.043 af

Subcatchment 8S: Ex. Water Quality Swale Area Runoff Area=5,205 sf 0.00% Impervious Runoff Depth=1.09"
Tc=6.0 min CN=75 Runoff=0.15 cfs 0.011 af

Subcatchment 9S: Back Parking Lot Area and Runoff Area=17,300 sf 99.31% Impervious Runoff Depth=2.97"
Tc=6.0 min CN=98 Runoff=1.23 cfs 0.098 af

Subcatchment 10S: Roof and Western Runoff Area=20,985 sf 68.19% Impervious Runoff Depth=1.84"
Tc=6.0 min CN=86 Runoff=1.04 cfs 0.074 af

Pond 1P: Ex. CB on Rout 20 Peak Elev=123.20' Inflow=0.63 cfs 0.046 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=0.63 cfs 0.046 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=133.93' Storage=1,764 cf Inflow=0.86 cfs 0.062 af
Outflow=0.02 cfs 0.061 af

Pond UG-1: UG-1 (SC-310 Chambers) Peak Elev=124.06' Storage=349 cf Inflow=0.77 cfs 0.056 af
Discarded=0.00 cfs 0.009 af Primary=0.69 cfs 0.047 af Outflow=0.70 cfs 0.056 af

Pond UG-2: UG-2 (SC-310 Chambers) Peak Elev=123.86' Storage=786 cf Inflow=1.50 cfs 0.112 af
Discarded=0.01 cfs 0.016 af Primary=1.19 cfs 0.096 af Outflow=1.19 cfs 0.112 af

Pond UG-3: UG-3 (SC-310 Chambers) Peak Elev=123.62' Storage=1,232 cf Inflow=1.23 cfs 0.098 af
Discarded=0.01 cfs 0.027 af Primary=0.87 cfs 0.071 af Outflow=0.88 cfs 0.098 af

Pond WQ: Reconstructed Water Quality Swale Peak Elev=123.35' Storage=1,560 cf Inflow=4.68 cfs 0.368 af
Discarded=0.01 cfs 0.019 af Primary=4.54 cfs 0.349 af Secondary=0.00 cfs 0.000 af Outflow=4.55 cfs 0.368 af

Link DP1: Wetlands

Inflow=5.10 cfs 0.395 af
Primary=5.10 cfs 0.395 af

Total Runoff Area = 2.980 ac Runoff Volume = 0.528 af Average Runoff Depth = 2.13"
26.01% Pervious = 0.775 ac 73.99% Impervious = 2.205 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 0.86 cfs @ 12.09 hrs, Volume= 0.062 af, Depth= 2.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Area in front of the Building

Runoff = 0.37 cfs @ 12.09 hrs, Volume= 0.026 af, Depth= 1.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
2,330	61	>75% Grass cover, Good, HSG B
5,070	98	Paved parking, HSG B
7,400	86	Weighted Average
2,330		31.49% Pervious Area
5,070		68.51% Impervious Area

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

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 0.63 cfs @ 12.09 hrs, Volume= 0.046 af, Depth= 1.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
10,015	61	>75% Grass cover, Good, HSG B
8,870	98	Paved parking, HSG B
18,885	78	Weighted Average
10,015		53.03% Pervious Area
8,870		46.97% Impervious Area

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

Summary for Subcatchment 4S: Eastern Middle Parking Lot

Runoff = 0.77 cfs @ 12.09 hrs, Volume= 0.056 af, Depth= 2.45"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

	Area (sf)	CN	Description
	1,465	61	>75% Grass cover, Good, HSG B
	6,545	98	Paved parking, HSG B
*	4,030	98	Roof
	12,040	93	Weighted Average
	1,465		12.17% Pervious Area
	10,575		87.83% Impervious Area

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

Summary for Subcatchment 5S: Northeaster Portion of The Site

Runoff = 0.67 cfs @ 12.08 hrs, Volume= 0.050 af, Depth= 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
1,005	61	>75% Grass cover, Good, HSG B
9,260	98	Paved parking, HSG B
10,265	94	Weighted Average
1,005		9.79% Pervious Area
9,260		90.21% Impervious Area

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

Summary for Subcatchment 6S: Back Eastern Portion of Parking Lot and Roof

Runoff = 0.82 cfs @ 12.08 hrs, Volume= 0.062 af, Depth= 2.64"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
1,135	61	>75% Grass cover, Good, HSG B
11,115	98	Paved parking, HSG B
12,250	95	Weighted Average
1,135		9.27% Pervious Area
11,115		90.73% Impervious Area

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

Summary for Subcatchment 7S: Back Eastern Portion of Parking Lot

Runoff = 0.60 cfs @ 12.09 hrs, Volume= 0.043 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
1,820	61	>75% Grass cover, Good, HSG B
8,215	98	Paved parking, HSG B
10,035	91	Weighted Average
1,820		18.14% Pervious Area
8,215		81.86% Impervious Area

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

Summary for Subcatchment 8S: Ex. Water Quality Swale Area

Runoff = 0.15 cfs @ 12.09 hrs, Volume= 0.011 af, Depth= 1.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
2,105	96	Gravel surface, HSG B
3,100	61	>75% Grass cover, Good, HSG B
5,205	75	Weighted Average
5,205		100.00% Pervious Area

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

Summary for Subcatchment 9S: Back Parking Lot Area and Roof

Runoff = 1.23 cfs @ 12.08 hrs, Volume= 0.098 af, Depth= 2.97"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
9,560	98	Paved parking, HSG B
7,620	98	Roofs, HSG B
120	61	>75% Grass cover, Good, HSG B
17,300	98	Weighted Average
120		0.69% Pervious Area
17,180		99.31% Impervious Area

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

Summary for Subcatchment 10S: Roof and Western Landscaped Area

Runoff = 1.04 cfs @ 12.09 hrs, Volume= 0.074 af, Depth= 1.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year 24-Hour Rainfall=3.20"

Area (sf)	CN	Description
13,380	98	Roofs, HSG B
930	98	Paved parking, HSG B
6,675	61	>75% Grass cover, Good, HSG B
20,985	86	Weighted Average
6,675		31.81% Pervious Area
14,310		68.19% Impervious Area

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

Summary for Pond 1P: Ex. CB on Rout 20

Inflow Area = 0.434 ac, 46.97% Impervious, Inflow Depth = 1.27" for 2-Year 24-Hour event
Inflow = 0.63 cfs @ 12.09 hrs, Volume= 0.046 af
Outflow = 0.63 cfs @ 12.09 hrs, Volume= 0.046 af, Atten= 0%, Lag= 0.0 min
Primary = 0.63 cfs @ 12.09 hrs, Volume= 0.046 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.20' @ 12.09 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=0.63 cfs @ 12.09 hrs HW=123.20' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 0.63 cfs @ 1.69 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 2.08" for 2-Year 24-Hour event
Inflow = 0.86 cfs @ 12.09 hrs, Volume= 0.062 af
Outflow = 0.02 cfs @ 9.46 hrs, Volume= 0.061 af, Atten= 98%, Lag= 0.0 min
Discarded = 0.02 cfs @ 9.46 hrs, Volume= 0.061 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 133.93' @ 17.48 hrs Surf.Area= 832 sf Storage= 1,764 cf

Plug-Flow detention time= 856.1 min calculated for 0.061 af (99% of inflow)
Center-of-Mass det. time= 852.1 min (1,663.2 - 811.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.02 cfs @ 9.46 hrs HW=129.43' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.02 cfs)

Summary for Pond UG-1: UG-1 (SC-310 Chambers)

Inflow Area = 0.276 ac, 87.83% Impervious, Inflow Depth = 2.45" for 2-Year 24-Hour event
Inflow = 0.77 cfs @ 12.09 hrs, Volume= 0.056 af
Outflow = 0.70 cfs @ 12.12 hrs, Volume= 0.056 af, Atten= 9%, Lag= 2.3 min
Discarded = 0.00 cfs @ 6.68 hrs, Volume= 0.009 af
Primary = 0.69 cfs @ 12.12 hrs, Volume= 0.047 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 124.06' @ 12.12 hrs Surf.Area= 528 sf Storage= 349 cf

Plug-Flow detention time= 104.0 min calculated for 0.056 af (100% of inflow)
Center-of-Mass det. time= 104.1 min (896.8 - 792.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.85'	338 cf	**11.50'W x 45.92'L x 2.33'H Field A** 1,232 cf Overall - 265 cf Embedded = 967 cf x 35.0% Voids
#2A	123.35'	265 cf	**ADS_StormTech SC-310 +Cap** x 18 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 3 Rows of 6 Chambers
		604 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	123.34'	**12.0" Round Culvert** L= 51.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.34' / 123.09' S= 0.0049 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	123.55'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	124.68'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.85'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.00 cfs @ 6.68 hrs HW=122.86' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=0.69 cfs @ 12.12 hrs HW=124.06' TW=123.35' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.69 cfs of 1.31 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 0.69 cfs @ 2.42 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond UG-2: UG-2 (SC-310 Chambers)

Inflow Area = 0.517 ac, 90.50% Impervious, Inflow Depth = 2.60" for 2-Year 24-Hour event
Inflow = 1.50 cfs @ 12.08 hrs, Volume= 0.112 af
Outflow = 1.19 cfs @ 12.15 hrs, Volume= 0.112 af, Atten= 20%, Lag= 3.7 min
Discarded = 0.01 cfs @ 5.82 hrs, Volume= 0.016 af
Primary = 1.19 cfs @ 12.15 hrs, Volume= 0.096 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 123.86' @ 12.14 hrs Surf.Area= 834 sf Storage= 786 cf

Plug-Flow detention time= 111.7 min calculated for 0.112 af (100% of inflow)
Center-of-Mass det. time= 111.7 min (895.4 - 783.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.14'	526 cf	**18.17'W x 45.92'L x 2.33'H Field A** 1,946 cf Overall - 442 cf Embedded = 1,504 cf x 35.0% Voids
#2A	122.64'	442 cf	**ADS_StormTech SC-310 +Cap** x 30 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 6 Chambers
#3	123.97'	19 cf	**4.00'D x 1.53'H Vertical Cone/Cylinder** -Impervious
		988 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.64'	**15.0" Round Culvert** L= 44.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 122.64' / 122.33' S= 0.0070 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	122.92'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.97'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.14'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 5.82 hrs HW=122.16' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=1.19 cfs @ 12.15 hrs HW=123.85' TW=123.35' (Dynamic Tailwater)
└**1=Culvert** (Passes 1.19 cfs of 3.58 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 1.19 cfs @ 3.41 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond UG-3: UG-3 (SC-310 Chambers)

Inflow Area = 0.397 ac, 99.31% Impervious, Inflow Depth = 2.97" for 2-Year 24-Hour event
Inflow = 1.23 cfs @ 12.08 hrs, Volume= 0.098 af
Outflow = 0.88 cfs @ 12.17 hrs, Volume= 0.098 af, Atten= 29%, Lag= 5.5 min
Discarded = 0.01 cfs @ 4.31 hrs, Volume= 0.027 af
Primary = 0.87 cfs @ 12.17 hrs, Volume= 0.071 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.62' @ 12.16 hrs Surf.Area= 1,352 sf Storage= 1,232 cf

Plug-Flow detention time= 211.5 min calculated for 0.098 af (100% of inflow)
Center-of-Mass det. time= 211.7 min (968.1 - 756.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.00'	846 cf	**18.17'W x 74.40'L x 2.33'H Field A** 3,154 cf Overall - 737 cf Embedded = 2,417 cf x 35.0% Voids
#2A	122.50'	737 cf	**ADS_StormTech SC-310 +Cap** x 50 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 10 Chambers
#3	123.83'	35 cf	**4.00'D x 2.77'H Vertical Cone/Cylinder** -Impervious
		1,618 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.41'	**12.0" Round Culvert** L= 14.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 122.41' / 122.30' S= 0.0079 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	122.78'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.83'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 4.31 hrs HW=122.01' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=0.87 cfs @ 12.17 hrs HW=123.61' TW=123.34' (Dynamic Tailwater)
└**1=Culvert** (Passes 0.87 cfs of 2.45 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 0.87 cfs @ 2.50 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond WQ: Reconstructed Water Quality Swale

Inflow Area = 2.192 ac, 79.31% Impervious, Inflow Depth = 2.01" for 2-Year 24-Hour event
Inflow = 4.68 cfs @ 12.11 hrs, Volume= 0.368 af
Outflow = 4.55 cfs @ 12.14 hrs, Volume= 0.368 af, Atten= 3%, Lag= 1.6 min
Discarded = 0.01 cfs @ 12.14 hrs, Volume= 0.019 af
Primary = 4.54 cfs @ 12.14 hrs, Volume= 0.349 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.35' @ 12.14 hrs Surf.Area= 1,703 sf Storage= 1,560 cf

Plug-Flow detention time= 60.6 min calculated for 0.367 af (100% of inflow)
Center-of-Mass det. time= 60.8 min (876.7 - 816.0)

Volume	Invert	Avail.Storage	Storage Description
#1	122.00'	4,427 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.00	745	205.0	0	0	745
123.00	1,330	260.0	1,023	1,023	2,793
124.00	2,500	460.0	1,884	2,908	14,258
124.50	3,610	475.0	1,519	4,427	15,399

Device	Routing	Invert	Outlet Devices
#1	Primary	121.11'	**12.0" Round Culvert** L= 22.0' Ke= 0.200 Inlet / Outlet Invert= 121.11' / 121.00' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	122.17'	**0.5" Vert. Orifice/Grate X 2.00** C= 0.600
#3	Device 1	122.55'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	123.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	123.40'	**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
#6	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 12.14 hrs HW=123.35' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=4.53 cfs @ 12.14 hrs HW=123.35' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Passes 4.53 cfs of 5.34 cfs potential flow)
  ├**2=Orifice/Grate** (Orifice Controls 0.01 cfs @ 5.19 fps)
  ├**3=Orifice/Grate** (Orifice Controls 0.18 cfs @ 4.09 fps)
  └**4=Orifice/Grate** (Weir Controls 4.34 cfs @ 1.95 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=122.00' TW=0.00' (Dynamic Tailwater)
└**5=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Link DP1: Wetlands

Inflow Area = 2.625 ac, 73.97% Impervious, Inflow Depth = 1.80" for 2-Year 24-Hour event
Inflow = 5.10 cfs @ 12.13 hrs, Volume= 0.395 af
Primary = 5.10 cfs @ 12.13 hrs, Volume= 0.395 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=3.58"
Flow Length=152' Tc=6.0 min CN=89 Runoff=1.45 cfs 0.106 af

Subcatchment 2S: Area in front of the Building Runoff Area=7,400 sf 68.51% Impervious Runoff Depth=3.28"
Tc=6.0 min CN=86 Runoff=0.65 cfs 0.046 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=18,885 sf 46.97% Impervious Runoff Depth=2.54"
Tc=6.0 min CN=78 Runoff=1.29 cfs 0.092 af

Subcatchment 4S: Eastern Middle Parking Lot Runoff Area=12,040 sf 87.83% Impervious Runoff Depth=4.00"
Tc=6.0 min CN=93 Runoff=1.22 cfs 0.092 af

Subcatchment 5S: Northeaster Portion of The Runoff Area=10,265 sf 90.21% Impervious Runoff Depth=4.11"
Tc=6.0 min CN=94 Runoff=1.06 cfs 0.081 af

Subcatchment 6S: Back Eastern Portion of Runoff Area=12,250 sf 90.73% Impervious Runoff Depth=4.22"
Tc=6.0 min CN=95 Runoff=1.28 cfs 0.099 af

Subcatchment 7S: Back Eastern Portion of Runoff Area=10,035 sf 81.86% Impervious Runoff Depth=3.79"
Tc=6.0 min CN=91 Runoff=0.98 cfs 0.073 af

Subcatchment 8S: Ex. Water Quality Swale Area Runoff Area=5,205 sf 0.00% Impervious Runoff Depth=2.29"
Tc=6.0 min CN=75 Runoff=0.32 cfs 0.023 af

Subcatchment 9S: Back Parking Lot Area and Runoff Area=17,300 sf 99.31% Impervious Runoff Depth=4.56"
Tc=6.0 min CN=98 Runoff=1.86 cfs 0.151 af

Subcatchment 10S: Roof and Western Runoff Area=20,985 sf 68.19% Impervious Runoff Depth=3.28"
Tc=6.0 min CN=86 Runoff=1.83 cfs 0.132 af

Pond 1P: Ex. CB on Rout 20 Peak Elev=123.38' Inflow=1.29 cfs 0.092 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=1.29 cfs 0.092 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=136.29' Storage=2,739 cf Inflow=1.45 cfs 0.106 af
Outflow=0.07 cfs 0.105 af

Pond UG-1: UG-1 (SC-310 Chambers) Peak Elev=124.30' Storage=422 cf Inflow=1.22 cfs 0.092 af
Discarded=0.00 cfs 0.010 af Primary=1.08 cfs 0.083 af Outflow=1.08 cfs 0.092 af

Pond UG-2: UG-2 (SC-310 Chambers) Peak Elev=124.15' Storage=877 cf Inflow=2.34 cfs 0.180 af
Discarded=0.01 cfs 0.017 af Primary=2.28 cfs 0.163 af Outflow=2.29 cfs 0.180 af

Pond UG-3: UG-3 (SC-310 Chambers) Peak Elev=123.96' Storage=1,410 cf Inflow=1.86 cfs 0.151 af
Discarded=0.01 cfs 0.029 af Primary=1.65 cfs 0.123 af Outflow=1.66 cfs 0.151 af

Pond WQ: Reconstructed Water Quality Swale Peak Elev=123.60' Storage=2,018 cf Inflow=8.58 cfs 0.642 af
Discarded=0.01 cfs 0.021 af Primary=5.80 cfs 0.601 af Secondary=2.14 cfs 0.019 af Outflow=7.95 cfs 0.642 af

Link DP1: Wetlands

Inflow=9.08 cfs 0.713 af
Primary=9.08 cfs 0.713 af

Total Runoff Area = 2.980 ac Runoff Volume = 0.894 af Average Runoff Depth = 3.60"
26.01% Pervious = 0.775 ac 73.99% Impervious = 2.205 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 1.45 cfs @ 12.09 hrs, Volume= 0.106 af, Depth= 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Area in front of the Building

Runoff = 0.65 cfs @ 12.09 hrs, Volume= 0.046 af, Depth= 3.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
2,330	61	>75% Grass cover, Good, HSG B
5,070	98	Paved parking, HSG B
7,400	86	Weighted Average
2,330		31.49% Pervious Area
5,070		68.51% Impervious Area

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

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 1.29 cfs @ 12.09 hrs, Volume= 0.092 af, Depth= 2.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
10,015	61	>75% Grass cover, Good, HSG B
8,870	98	Paved parking, HSG B
18,885	78	Weighted Average
10,015		53.03% Pervious Area
8,870		46.97% Impervious Area

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

Summary for Subcatchment 4S: Eastern Middle Parking Lot

Runoff = 1.22 cfs @ 12.08 hrs, Volume= 0.092 af, Depth= 4.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

	Area (sf)	CN	Description
	1,465	61	>75% Grass cover, Good, HSG B
	6,545	98	Paved parking, HSG B
*	4,030	98	Roof
	12,040	93	Weighted Average
	1,465		12.17% Pervious Area
	10,575		87.83% Impervious Area

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

Summary for Subcatchment 5S: Northeaster Portion of The Site

Runoff = 1.06 cfs @ 12.08 hrs, Volume= 0.081 af, Depth= 4.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
1,005	61	>75% Grass cover, Good, HSG B
9,260	98	Paved parking, HSG B
10,265	94	Weighted Average
1,005		9.79% Pervious Area
9,260		90.21% Impervious Area

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

Summary for Subcatchment 6S: Back Eastern Portion of Parking Lot and Roof

Runoff = 1.28 cfs @ 12.08 hrs, Volume= 0.099 af, Depth= 4.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
1,135	61	>75% Grass cover, Good, HSG B
11,115	98	Paved parking, HSG B
12,250	95	Weighted Average
1,135		9.27% Pervious Area
11,115		90.73% Impervious Area

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

Summary for Subcatchment 7S: Back Eastern Portion of Parking Lot

Runoff = 0.98 cfs @ 12.08 hrs, Volume= 0.073 af, Depth= 3.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
1,820	61	>75% Grass cover, Good, HSG B
8,215	98	Paved parking, HSG B
10,035	91	Weighted Average
1,820		18.14% Pervious Area
8,215		81.86% Impervious Area

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

Summary for Subcatchment 8S: Ex. Water Quality Swale Area

Runoff = 0.32 cfs @ 12.09 hrs, Volume= 0.023 af, Depth= 2.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
2,105	96	Gravel surface, HSG B
3,100	61	>75% Grass cover, Good, HSG B
5,205	75	Weighted Average
5,205		100.00% Pervious Area

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

Summary for Subcatchment 9S: Back Parking Lot Area and Roof

Runoff = 1.86 cfs @ 12.08 hrs, Volume= 0.151 af, Depth= 4.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
9,560	98	Paved parking, HSG B
7,620	98	Roofs, HSG B
120	61	>75% Grass cover, Good, HSG B
17,300	98	Weighted Average
120		0.69% Pervious Area
17,180		99.31% Impervious Area

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

Summary for Subcatchment 10S: Roof and Western Landscaped Area

Runoff = 1.83 cfs @ 12.09 hrs, Volume= 0.132 af, Depth= 3.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year 24-Hour Rainfall=4.80"

Area (sf)	CN	Description
13,380	98	Roofs, HSG B
930	98	Paved parking, HSG B
6,675	61	>75% Grass cover, Good, HSG B
20,985	86	Weighted Average
6,675		31.81% Pervious Area
14,310		68.19% Impervious Area

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

Summary for Pond 1P: Ex. CB on Rout 20

Inflow Area = 0.434 ac, 46.97% Impervious, Inflow Depth = 2.54" for 10-Year 24-Hour event
Inflow = 1.29 cfs @ 12.09 hrs, Volume= 0.092 af
Outflow = 1.29 cfs @ 12.09 hrs, Volume= 0.092 af, Atten= 0%, Lag= 0.0 min
Primary = 1.29 cfs @ 12.09 hrs, Volume= 0.092 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.38' @ 12.09 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=1.29 cfs @ 12.09 hrs HW=123.38' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 1.29 cfs @ 2.05 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 3.58" for 10-Year 24-Hour event
Inflow = 1.45 cfs @ 12.09 hrs, Volume= 0.106 af
Outflow = 0.07 cfs @ 14.57 hrs, Volume= 0.105 af, Atten= 95%, Lag= 149.1 min
Discarded = 0.07 cfs @ 14.57 hrs, Volume= 0.105 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 136.29' @ 14.57 hrs Surf.Area= 2,969 sf Storage= 2,739 cf

Plug-Flow detention time= 703.8 min calculated for 0.105 af (100% of inflow)
Center-of-Mass det. time= 701.3 min (1,497.1 - 795.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.07 cfs @ 14.57 hrs HW=136.29' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.07 cfs)

Summary for Pond UG-1: UG-1 (SC-310 Chambers)

Inflow Area = 0.276 ac, 87.83% Impervious, Inflow Depth = 4.00" for 10-Year 24-Hour event
Inflow = 1.22 cfs @ 12.08 hrs, Volume= 0.092 af
Outflow = 1.08 cfs @ 12.13 hrs, Volume= 0.092 af, Atten= 11%, Lag= 2.5 min
Discarded = 0.00 cfs @ 4.76 hrs, Volume= 0.010 af
Primary = 1.08 cfs @ 12.13 hrs, Volume= 0.083 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 124.30' @ 12.13 hrs Surf.Area= 528 sf Storage= 422 cf

Plug-Flow detention time= 71.2 min calculated for 0.092 af (100% of inflow)
Center-of-Mass det. time= 71.1 min (850.7 - 779.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.85'	338 cf	**11.50'W x 45.92'L x 2.33'H Field A** 1,232 cf Overall - 265 cf Embedded = 967 cf x 35.0% Voids
#2A	123.35'	265 cf	**ADS_StormTech SC-310 +Cap** x 18 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 3 Rows of 6 Chambers
		604 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	123.34'	**12.0" Round Culvert** L= 51.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.34' / 123.09' S= 0.0049 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	123.55'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	124.68'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.85'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.00 cfs @ 4.76 hrs HW=122.86' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=1.08 cfs @ 12.13 hrs HW=124.30' TW=123.60' (Dynamic Tailwater)
└**1=Culvert** (Passes 1.08 cfs of 2.03 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 1.08 cfs @ 3.09 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond UG-2: UG-2 (SC-310 Chambers)

Inflow Area = 0.517 ac, 90.50% Impervious, Inflow Depth = 4.17" for 10-Year 24-Hour event
Inflow = 2.34 cfs @ 12.08 hrs, Volume= 0.180 af
Outflow = 2.29 cfs @ 12.10 hrs, Volume= 0.180 af, Atten= 2%, Lag= 0.7 min
Discarded = 0.01 cfs @ 4.00 hrs, Volume= 0.017 af
Primary = 2.28 cfs @ 12.10 hrs, Volume= 0.163 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 124.15' @ 12.10 hrs Surf.Area= 834 sf Storage= 877 cf

Plug-Flow detention time= 77.9 min calculated for 0.180 af (100% of inflow)
Center-of-Mass det. time= 78.1 min (849.8 - 771.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.14'	526 cf	**18.17'W x 45.92'L x 2.33'H Field A** 1,946 cf Overall - 442 cf Embedded = 1,504 cf x 35.0% Voids
#2A	122.64'	442 cf	**ADS_StormTech SC-310 +Cap** x 30 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 6 Chambers
#3	123.97'	19 cf	**4.00'D x 1.53'H Vertical Cone/Cylinder** -Impervious
		988 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.64'	**15.0" Round Culvert** L= 44.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 122.64' / 122.33' S= 0.0070 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	122.92'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.97'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.14'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 4.00 hrs HW=122.16' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=2.28 cfs @ 12.10 hrs HW=124.15' TW=123.55' (Dynamic Tailwater)
└**1=Culvert** (Passes 2.28 cfs of 4.58 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 1.30 cfs @ 3.73 fps)
  └**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.98 cfs @ 1.38 fps)

Summary for Pond UG-3: UG-3 (SC-310 Chambers)

Inflow Area = 0.397 ac, 99.31% Impervious, Inflow Depth = 4.56" for 10-Year 24-Hour event
Inflow = 1.86 cfs @ 12.08 hrs, Volume= 0.151 af
Outflow = 1.66 cfs @ 12.12 hrs, Volume= 0.151 af, Atten= 11%, Lag= 2.4 min
Discarded = 0.01 cfs @ 2.62 hrs, Volume= 0.029 af
Primary = 1.65 cfs @ 12.12 hrs, Volume= 0.123 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.96' @ 12.12 hrs Surf.Area= 1,352 sf Storage= 1,410 cf

Plug-Flow detention time= 159.2 min calculated for 0.151 af (100% of inflow)
Center-of-Mass det. time= 159.2 min (907.9 - 748.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.00'	846 cf	**18.17'W x 74.40'L x 2.33'H Field A** 3,154 cf Overall - 737 cf Embedded = 2,417 cf x 35.0% Voids
#2A	122.50'	737 cf	**ADS_StormTech SC-310 +Cap** x 50 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 10 Chambers
#3	123.83'	35 cf	**4.00'D x 2.77'H Vertical Cone/Cylinder** -Impervious
		1,618 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.41'	**12.0" Round Culvert** L= 14.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 122.41' / 122.30' S= 0.0079 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	122.78'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.83'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 2.62 hrs HW=122.01' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=1.65 cfs @ 12.12 hrs HW=123.96' TW=123.60' (Dynamic Tailwater)
└**1=Culvert** (Passes 1.65 cfs of 2.86 cfs potential flow)
├**2=Orifice** (Orifice Controls 1.02 cfs @ 2.92 fps)
└**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.63 cfs @ 1.19 fps)

Summary for Pond WQ: Reconstructed Water Quality Swale

Inflow Area = 2.192 ac, 79.31% Impervious, Inflow Depth = 3.51" for 10-Year 24-Hour event
Inflow = 8.58 cfs @ 12.10 hrs, Volume= 0.642 af
Outflow = 7.95 cfs @ 12.14 hrs, Volume= 0.642 af, Atten= 7%, Lag= 1.9 min
Discarded = 0.01 cfs @ 12.14 hrs, Volume= 0.021 af
Primary = 5.80 cfs @ 12.14 hrs, Volume= 0.601 af
Secondary = 2.14 cfs @ 12.14 hrs, Volume= 0.019 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.60' @ 12.14 hrs Surf.Area= 1,991 sf Storage= 2,018 cf

Plug-Flow detention time= 42.2 min calculated for 0.641 af (100% of inflow)
Center-of-Mass det. time= 42.4 min (844.9 - 802.5)

Volume	Invert	Avail.Storage	Storage Description
#1	122.00'	4,427 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.00	745	205.0	0	0	745
123.00	1,330	260.0	1,023	1,023	2,793
124.00	2,500	460.0	1,884	2,908	14,258
124.50	3,610	475.0	1,519	4,427	15,399

Device	Routing	Invert	Outlet Devices
#1	Primary	121.11'	**12.0" Round Culvert** L= 22.0' Ke= 0.200 Inlet / Outlet Invert= 121.11' / 121.00' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	122.17'	**0.5" Vert. Orifice/Grate X 2.00** C= 0.600
#3	Device 1	122.55'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	123.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	123.40'	**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
#6	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 12.14 hrs HW=123.60' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=5.80 cfs @ 12.14 hrs HW=123.60' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 5.80 cfs @ 7.39 fps)
  ├**2=Orifice/Grate** (Passes < 0.02 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 0.21 cfs potential flow)
  └**4=Orifice/Grate** (Passes < 9.60 cfs potential flow)

Secondary OutFlow Max=2.13 cfs @ 12.14 hrs HW=123.60' TW=0.00' (Dynamic Tailwater)
└**5=Broad-Crested Rectangular Weir** (Weir Controls 2.13 cfs @ 1.05 fps)

Summary for Link DP1: Wetlands

Inflow Area = 2.625 ac, 73.97% Impervious, Inflow Depth = 3.26" for 10-Year 24-Hour event
Inflow = 9.08 cfs @ 12.13 hrs, Volume= 0.713 af
Primary = 9.08 cfs @ 12.13 hrs, Volume= 0.713 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=4.74"
Flow Length=152' Tc=6.0 min CN=89 Runoff=1.89 cfs 0.140 af

Subcatchment 2S: Area in front of the Building Runoff Area=7,400 sf 68.51% Impervious Runoff Depth=4.41"
Tc=6.0 min CN=86 Runoff=0.86 cfs 0.062 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=18,885 sf 46.97% Impervious Runoff Depth=3.58"
Tc=6.0 min CN=78 Runoff=1.82 cfs 0.129 af

Subcatchment 4S: Eastern Middle Parking Lot Runoff Area=12,040 sf 87.83% Impervious Runoff Depth=5.18"
Tc=6.0 min CN=93 Runoff=1.56 cfs 0.119 af

Subcatchment 5S: Northeaster Portion of The Runoff Area=10,265 sf 90.21% Impervious Runoff Depth=5.30"
Tc=6.0 min CN=94 Runoff=1.34 cfs 0.104 af

Subcatchment 6S: Back Eastern Portion of Runoff Area=12,250 sf 90.73% Impervious Runoff Depth=5.41"
Tc=6.0 min CN=95 Runoff=1.62 cfs 0.127 af

Subcatchment 7S: Back Eastern Portion of Runoff Area=10,035 sf 81.86% Impervious Runoff Depth=4.96"
Tc=6.0 min CN=91 Runoff=1.27 cfs 0.095 af

Subcatchment 8S: Ex. Water Quality Swale Area Runoff Area=5,205 sf 0.00% Impervious Runoff Depth=3.28"
Tc=6.0 min CN=75 Runoff=0.46 cfs 0.033 af

Subcatchment 9S: Back Parking Lot Area and Runoff Area=17,300 sf 99.31% Impervious Runoff Depth=5.76"
Tc=6.0 min CN=98 Runoff=2.34 cfs 0.191 af

Subcatchment 10S: Roof and Western Runoff Area=20,985 sf 68.19% Impervious Runoff Depth=4.41"
Tc=6.0 min CN=86 Runoff=2.43 cfs 0.177 af

Pond 1P: Ex. CB on Rout 20 Peak Elev=123.50' Inflow=1.82 cfs 0.129 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=1.82 cfs 0.129 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=136.62' Storage=3,620 cf Inflow=1.89 cfs 0.140 af
Outflow=0.10 cfs 0.140 af

Pond UG-1: UG-1 (SC-310 Chambers) Peak Elev=124.54' Storage=484 cf Inflow=1.56 cfs 0.119 af
Discarded=0.00 cfs 0.010 af Primary=1.37 cfs 0.110 af Outflow=1.37 cfs 0.119 af

Pond UG-2: UG-2 (SC-310 Chambers) Peak Elev=124.23' Storage=901 cf Inflow=2.97 cfs 0.231 af
Discarded=0.01 cfs 0.017 af Primary=2.92 cfs 0.214 af Outflow=2.93 cfs 0.231 af

Pond UG-3: UG-3 (SC-310 Chambers) Peak Elev=124.04' Storage=1,449 cf Inflow=2.34 cfs 0.191 af
Discarded=0.01 cfs 0.029 af Primary=2.23 cfs 0.161 af Outflow=2.24 cfs 0.191 af

Pond WQ: Reconstructed Water Quality Swale Peak Elev=123.74' Storage=2,298 cf Inflow=11.42 cfs 0.852 af
Discarded=0.01 cfs 0.022 af Primary=6.04 cfs 0.772 af Secondary=4.81 cfs 0.058 af Outflow=10.87 cfs 0.852 af

Link DP1: Wetlands

Inflow=12.54 cfs 0.959 af
Primary=12.54 cfs 0.959 af

Total Runoff Area = 2.980 ac Runoff Volume = 1.177 af Average Runoff Depth = 4.74"
26.01% Pervious = 0.775 ac 73.99% Impervious = 2.205 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 1.89 cfs @ 12.08 hrs, Volume= 0.140 af, Depth= 4.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Area in front of the Building

Runoff = 0.86 cfs @ 12.09 hrs, Volume= 0.062 af, Depth= 4.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
2,330	61	>75% Grass cover, Good, HSG B
5,070	98	Paved parking, HSG B
7,400	86	Weighted Average
2,330		31.49% Pervious Area
5,070		68.51% Impervious Area

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

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 1.82 cfs @ 12.09 hrs, Volume= 0.129 af, Depth= 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
10,015	61	>75% Grass cover, Good, HSG B
8,870	98	Paved parking, HSG B
18,885	78	Weighted Average
10,015		53.03% Pervious Area
8,870		46.97% Impervious Area

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

Summary for Subcatchment 4S: Eastern Middle Parking Lot

Runoff = 1.56 cfs @ 12.08 hrs, Volume= 0.119 af, Depth= 5.18"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

	Area (sf)	CN	Description
	1,465	61	>75% Grass cover, Good, HSG B
	6,545	98	Paved parking, HSG B
*	4,030	98	Roof
	12,040	93	Weighted Average
	1,465		12.17% Pervious Area
	10,575		87.83% Impervious Area

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

Summary for Subcatchment 5S: Northeaster Portion of The Site

Runoff = 1.34 cfs @ 12.08 hrs, Volume= 0.104 af, Depth= 5.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
1,005	61	>75% Grass cover, Good, HSG B
9,260	98	Paved parking, HSG B
10,265	94	Weighted Average
1,005		9.79% Pervious Area
9,260		90.21% Impervious Area

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

Summary for Subcatchment 6S: Back Eastern Portion of Parking Lot and Roof

Runoff = 1.62 cfs @ 12.08 hrs, Volume= 0.127 af, Depth= 5.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
1,135	61	>75% Grass cover, Good, HSG B
11,115	98	Paved parking, HSG B
12,250	95	Weighted Average
1,135		9.27% Pervious Area
11,115		90.73% Impervious Area

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

Summary for Subcatchment 7S: Back Eastern Portion of Parking Lot

Runoff = 1.27 cfs @ 12.08 hrs, Volume= 0.095 af, Depth= 4.96"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
1,820	61	>75% Grass cover, Good, HSG B
8,215	98	Paved parking, HSG B
10,035	91	Weighted Average
1,820		18.14% Pervious Area
8,215		81.86% Impervious Area

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

Summary for Subcatchment 8S: Ex. Water Quality Swale Area

Runoff = 0.46 cfs @ 12.09 hrs, Volume= 0.033 af, Depth= 3.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
2,105	96	Gravel surface, HSG B
3,100	61	>75% Grass cover, Good, HSG B
5,205	75	Weighted Average
5,205		100.00% Pervious Area

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

Summary for Subcatchment 9S: Back Parking Lot Area and Roof

Runoff = 2.34 cfs @ 12.08 hrs, Volume= 0.191 af, Depth= 5.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
9,560	98	Paved parking, HSG B
7,620	98	Roofs, HSG B
120	61	>75% Grass cover, Good, HSG B
17,300	98	Weighted Average
120		0.69% Pervious Area
17,180		99.31% Impervious Area

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

Summary for Subcatchment 10S: Roof and Western Landscaped Area

Runoff = 2.43 cfs @ 12.09 hrs, Volume= 0.177 af, Depth= 4.41"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 25-Year 24-Hour Rainfall=6.00"

Area (sf)	CN	Description
13,380	98	Roofs, HSG B
930	98	Paved parking, HSG B
6,675	61	>75% Grass cover, Good, HSG B
20,985	86	Weighted Average
6,675		31.81% Pervious Area
14,310		68.19% Impervious Area

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

Summary for Pond 1P: Ex. CB on Rout 20

Inflow Area = 0.434 ac, 46.97% Impervious, Inflow Depth = 3.58" for 25-Year 24-Hour event
Inflow = 1.82 cfs @ 12.09 hrs, Volume= 0.129 af
Outflow = 1.82 cfs @ 12.09 hrs, Volume= 0.129 af, Atten= 0%, Lag= 0.0 min
Primary = 1.82 cfs @ 12.09 hrs, Volume= 0.129 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.50' @ 12.09 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=1.82 cfs @ 12.09 hrs HW=123.50' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 1.82 cfs @ 2.25 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 4.74" for 25-Year 24-Hour event
Inflow = 1.89 cfs @ 12.08 hrs, Volume= 0.140 af
Outflow = 0.10 cfs @ 14.12 hrs, Volume= 0.140 af, Atten= 95%, Lag= 122.3 min
Discarded = 0.10 cfs @ 14.12 hrs, Volume= 0.140 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 136.62' @ 14.12 hrs Surf.Area= 4,233 sf Storage= 3,620 cf

Plug-Flow detention time= 660.7 min calculated for 0.140 af (100% of inflow)
Center-of-Mass det. time= 659.0 min (1,447.2 - 788.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.10 cfs @ 14.12 hrs HW=136.62' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.10 cfs)

Summary for Pond UG-1: UG-1 (SC-310 Chambers)

Inflow Area = 0.276 ac, 87.83% Impervious, Inflow Depth = 5.18" for 25-Year 24-Hour event
Inflow = 1.56 cfs @ 12.08 hrs, Volume= 0.119 af
Outflow = 1.37 cfs @ 12.13 hrs, Volume= 0.119 af, Atten= 12%, Lag= 2.6 min
Discarded = 0.00 cfs @ 3.86 hrs, Volume= 0.010 af
Primary = 1.37 cfs @ 12.13 hrs, Volume= 0.110 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 124.54' @ 12.13 hrs Surf.Area= 528 sf Storage= 484 cf

Plug-Flow detention time= 58.4 min calculated for 0.119 af (100% of inflow)
Center-of-Mass det. time= 58.6 min (831.6 - 773.0)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.85'	338 cf	**11.50'W x 45.92'L x 2.33'H Field A** 1,232 cf Overall - 265 cf Embedded = 967 cf x 35.0% Voids
#2A	123.35'	265 cf	**ADS_StormTech SC-310 +Cap** x 18 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 3 Rows of 6 Chambers
		604 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	123.34'	**12.0" Round Culvert** L= 51.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.34' / 123.09' S= 0.0049 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	123.55'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	124.68'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.85'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.00 cfs @ 3.86 hrs HW=122.86' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=1.37 cfs @ 12.13 hrs HW=124.54' TW=123.74' (Dynamic Tailwater)
└**1=Culvert** (Passes 1.37 cfs of 2.67 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 1.37 cfs @ 3.91 fps)
  └**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Summary for Pond UG-2: UG-2 (SC-310 Chambers)

Inflow Area = 0.517 ac, 90.50% Impervious, Inflow Depth = 5.36" for 25-Year 24-Hour event
Inflow = 2.97 cfs @ 12.08 hrs, Volume= 0.231 af
Outflow = 2.93 cfs @ 12.09 hrs, Volume= 0.231 af, Atten= 1%, Lag= 0.6 min
Discarded = 0.01 cfs @ 3.22 hrs, Volume= 0.017 af
Primary = 2.92 cfs @ 12.09 hrs, Volume= 0.214 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 124.23' @ 12.10 hrs Surf.Area= 834 sf Storage= 901 cf

Plug-Flow detention time= 64.6 min calculated for 0.231 af (100% of inflow)
Center-of-Mass det. time= 64.8 min (830.6 - 765.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.14'	526 cf	**18.17'W x 45.92'L x 2.33'H Field A** 1,946 cf Overall - 442 cf Embedded = 1,504 cf x 35.0% Voids
#2A	122.64'	442 cf	**ADS_StormTech SC-310 +Cap** x 30 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 6 Chambers
#3	123.97'	19 cf	**4.00'D x 1.53'H Vertical Cone/Cylinder** -Impervious
		988 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.64'	**15.0" Round Culvert** L= 44.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 122.64' / 122.33' S= 0.0070 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	122.92'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.97'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.14'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 3.22 hrs HW=122.16' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=2.92 cfs @ 12.09 hrs HW=124.23' TW=123.71' (Dynamic Tailwater)
└**1=Culvert** (Passes 2.92 cfs of 4.27 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 1.21 cfs @ 3.48 fps)
  └**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.70 cfs @ 1.66 fps)

Summary for Pond UG-3: UG-3 (SC-310 Chambers)

Inflow Area = 0.397 ac, 99.31% Impervious, Inflow Depth = 5.76" for 25-Year 24-Hour event
Inflow = 2.34 cfs @ 12.08 hrs, Volume= 0.191 af
Outflow = 2.24 cfs @ 12.10 hrs, Volume= 0.191 af, Atten= 4%, Lag= 1.2 min
Discarded = 0.01 cfs @ 1.89 hrs, Volume= 0.029 af
Primary = 2.23 cfs @ 12.10 hrs, Volume= 0.161 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 124.04' @ 12.11 hrs Surf.Area= 1,352 sf Storage= 1,449 cf

Plug-Flow detention time= 138.3 min calculated for 0.191 af (100% of inflow)
Center-of-Mass det. time= 138.3 min (883.5 - 745.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.00'	846 cf	**18.17'W x 74.40'L x 2.33'H Field A** 3,154 cf Overall - 737 cf Embedded = 2,417 cf x 35.0% Voids
#2A	122.50'	737 cf	**ADS_StormTech SC-310 +Cap** x 50 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 10 Chambers
#3	123.83'	35 cf	**4.00'D x 2.77'H Vertical Cone/Cylinder** -Impervious
		1,618 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.41'	**12.0" Round Culvert** L= 14.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 122.41' / 122.30' S= 0.0079 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	122.78'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.83'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 1.89 hrs HW=122.01' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=2.23 cfs @ 12.10 hrs HW=124.04' TW=123.73' (Dynamic Tailwater)
└**1=Culvert** (Passes 2.23 cfs of 2.67 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 0.95 cfs @ 2.72 fps)
  └**3=Sharp-Crested Rectangular Weir** (Weir Controls 1.28 cfs @ 1.51 fps)

Summary for Pond WQ: Reconstructed Water Quality Swale

Inflow Area = 2.192 ac, 79.31% Impervious, Inflow Depth = 4.66" for 25-Year 24-Hour event
Inflow = 11.42 cfs @ 12.09 hrs, Volume= 0.852 af
Outflow = 10.87 cfs @ 12.12 hrs, Volume= 0.852 af, Atten= 5%, Lag= 1.6 min
Discarded = 0.01 cfs @ 12.12 hrs, Volume= 0.022 af
Primary = 6.04 cfs @ 12.12 hrs, Volume= 0.772 af
Secondary = 4.81 cfs @ 12.12 hrs, Volume= 0.058 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.74' @ 12.12 hrs Surf.Area= 2,158 sf Storage= 2,298 cf

Plug-Flow detention time= 35.3 min calculated for 0.852 af (100% of inflow)
Center-of-Mass det. time= 35.5 min (830.3 - 794.8)

Volume	Invert	Avail.Storage	Storage Description
#1	122.00'	4,427 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.00	745	205.0	0	0	745
123.00	1,330	260.0	1,023	1,023	2,793
124.00	2,500	460.0	1,884	2,908	14,258
124.50	3,610	475.0	1,519	4,427	15,399

Device	Routing	Invert	Outlet Devices
#1	Primary	121.11'	**12.0" Round Culvert** L= 22.0' Ke= 0.200 Inlet / Outlet Invert= 121.11' / 121.00' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	122.17'	**0.5" Vert. Orifice/Grate X 2.00** C= 0.600
#3	Device 1	122.55'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	123.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	123.40'	**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
#6	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 12.12 hrs HW=123.74' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=6.04 cfs @ 12.12 hrs HW=123.74' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 6.04 cfs @ 7.69 fps)
  ├**2=Orifice/Grate** (Passes < 0.02 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 0.22 cfs potential flow)
  └**4=Orifice/Grate** (Passes < 12.99 cfs potential flow)

Secondary OutFlow Max=4.80 cfs @ 12.12 hrs HW=123.74' TW=0.00' (Dynamic Tailwater)
└**5=Broad-Crested Rectangular Weir** (Weir Controls 4.80 cfs @ 1.42 fps)

Summary for Link DP1: Wetlands

Inflow Area = 2.625 ac, 73.97% Impervious, Inflow Depth = 4.39" for 25-Year 24-Hour event
Inflow = 12.54 cfs @ 12.12 hrs, Volume= 0.959 af
Primary = 12.54 cfs @ 12.12 hrs, Volume= 0.959 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Time span=0.00-60.00 hrs, dt=0.01 hrs, 6001 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 1S: Existing Eastern Parking Lot Runoff Area=15,450 sf 74.15% Impervious Runoff Depth=7.28"
Flow Length=152' Tc=6.0 min CN=89 Runoff=2.84 cfs 0.215 af

Subcatchment 2S: Area in front of the Building Runoff Area=7,400 sf 68.51% Impervious Runoff Depth=6.91"
Tc=6.0 min CN=86 Runoff=1.31 cfs 0.098 af

Subcatchment 3S: Front of Lot & Route 20 Runoff Area=18,885 sf 46.97% Impervious Runoff Depth=5.95"
Tc=6.0 min CN=78 Runoff=2.98 cfs 0.215 af

Subcatchment 4S: Eastern Middle Parking Lot Runoff Area=12,040 sf 87.83% Impervious Runoff Depth=7.76"
Tc=6.0 min CN=93 Runoff=2.28 cfs 0.179 af

Subcatchment 5S: Northeaster Portion of The Runoff Area=10,265 sf 90.21% Impervious Runoff Depth=7.88"
Tc=6.0 min CN=94 Runoff=1.96 cfs 0.155 af

Subcatchment 6S: Back Eastern Portion of Runoff Area=12,250 sf 90.73% Impervious Runoff Depth=8.00"
Tc=6.0 min CN=95 Runoff=2.35 cfs 0.187 af

Subcatchment 7S: Back Eastern Portion of Runoff Area=10,035 sf 81.86% Impervious Runoff Depth=7.52"
Tc=6.0 min CN=91 Runoff=1.87 cfs 0.144 af

Subcatchment 8S: Ex. Water Quality Swale Area Runoff Area=5,205 sf 0.00% Impervious Runoff Depth=5.59"
Tc=6.0 min CN=75 Runoff=0.78 cfs 0.056 af

Subcatchment 9S: Back Parking Lot Area and Runoff Area=17,300 sf 99.31% Impervious Runoff Depth=8.36"
Tc=6.0 min CN=98 Runoff=3.35 cfs 0.277 af

Subcatchment 10S: Roof and Western Runoff Area=20,985 sf 68.19% Impervious Runoff Depth=6.91"
Tc=6.0 min CN=86 Runoff=3.73 cfs 0.278 af

Pond 1P: Ex. CB on Rout 20 Peak Elev=123.73' Inflow=2.98 cfs 0.215 af
18.0" Round Culvert n=0.012 L=368.0' S=0.0117 '/' Outflow=2.98 cfs 0.215 af

Pond DP2: Existing Concrete Galleys-Design Peak Elev=137.08' Storage=5,703 cf Inflow=2.84 cfs 0.215 af
Outflow=0.15 cfs 0.215 af

Pond UG-1: UG-1 (SC-310 Chambers) Peak Elev=124.82' Storage=536 cf Inflow=2.28 cfs 0.179 af
Discarded=0.00 cfs 0.010 af Primary=2.26 cfs 0.169 af Outflow=2.27 cfs 0.179 af

Pond UG-2: UG-2 (SC-310 Chambers) Peak Elev=124.42' Storage=958 cf Inflow=4.31 cfs 0.342 af
Discarded=0.01 cfs 0.018 af Primary=4.13 cfs 0.325 af Outflow=4.13 cfs 0.342 af

Pond UG-3: UG-3 (SC-310 Chambers) Peak Elev=124.35' Storage=1,589 cf Inflow=3.35 cfs 0.277 af
Discarded=0.01 cfs 0.030 af Primary=3.07 cfs 0.247 af Outflow=3.08 cfs 0.277 af

Pond WQ: Reconstructed Water Quality Swale Peak Elev=123.93' Storage=2,736 cf Inflow=16.91 cfs 1.315 af
Discarded=0.02 cfs 0.023 af Primary=6.37 cfs 1.116 af Secondary=10.15 cfs 0.176 af Outflow=16.53 cfs 1.315 af

Link DP1: Wetlands

Inflow=19.36 cfs 1.507 af
Primary=19.36 cfs 1.507 af

Total Runoff Area = 2.980 ac Runoff Volume = 1.803 af Average Runoff Depth = 7.26"
26.01% Pervious = 0.775 ac 73.99% Impervious = 2.205 ac

Summary for Subcatchment 1S: Existing Eastern Parking Lot

Runoff = 2.84 cfs @ 12.08 hrs, Volume= 0.215 af, Depth= 7.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
11,456	98	Paved parking, HSG B
232	96	Gravel surface, HSG B
3,762	61	>75% Grass cover, Good, HSG B
15,450	89	Weighted Average
3,994		25.85% Pervious Area
11,456		74.15% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	152		0.42		**Direct Entry, A-B**

Summary for Subcatchment 2S: Area in front of the Building

Runoff = 1.31 cfs @ 12.08 hrs, Volume= 0.098 af, Depth= 6.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
2,330	61	>75% Grass cover, Good, HSG B
5,070	98	Paved parking, HSG B
7,400	86	Weighted Average
2,330		31.49% Pervious Area
5,070		68.51% Impervious Area

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

Summary for Subcatchment 3S: Front of Lot & Route 20

Runoff = 2.98 cfs @ 12.09 hrs, Volume= 0.215 af, Depth= 5.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
10,015	61	>75% Grass cover, Good, HSG B
8,870	98	Paved parking, HSG B
18,885	78	Weighted Average
10,015		53.03% Pervious Area
8,870		46.97% Impervious Area

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

Summary for Subcatchment 4S: Eastern Middle Parking Lot

Runoff = 2.28 cfs @ 12.08 hrs, Volume= 0.179 af, Depth= 7.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

	Area (sf)	CN	Description
	1,465	61	>75% Grass cover, Good, HSG B
	6,545	98	Paved parking, HSG B
*	4,030	98	Roof
	12,040	93	Weighted Average
	1,465		12.17% Pervious Area
	10,575		87.83% Impervious Area

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

Summary for Subcatchment 5S: Northeaster Portion of The Site

Runoff = 1.96 cfs @ 12.08 hrs, Volume= 0.155 af, Depth= 7.88"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
1,005	61	>75% Grass cover, Good, HSG B
9,260	98	Paved parking, HSG B
10,265	94	Weighted Average
1,005		9.79% Pervious Area
9,260		90.21% Impervious Area

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

Summary for Subcatchment 6S: Back Eastern Portion of Parking Lot and Roof

Runoff = 2.35 cfs @ 12.08 hrs, Volume= 0.187 af, Depth= 8.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
1,135	61	>75% Grass cover, Good, HSG B
11,115	98	Paved parking, HSG B
12,250	95	Weighted Average
1,135		9.27% Pervious Area
11,115		90.73% Impervious Area

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

Summary for Subcatchment 7S: Back Eastern Portion of Parking Lot

Runoff = 1.87 cfs @ 12.08 hrs, Volume= 0.144 af, Depth= 7.52"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
1,820	61	>75% Grass cover, Good, HSG B
8,215	98	Paved parking, HSG B
10,035	91	Weighted Average
1,820		18.14% Pervious Area
8,215		81.86% Impervious Area

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

Summary for Subcatchment 8S: Ex. Water Quality Swale Area

Runoff = 0.78 cfs @ 12.09 hrs, Volume= 0.056 af, Depth= 5.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
2,105	96	Gravel surface, HSG B
3,100	61	>75% Grass cover, Good, HSG B
5,205	75	Weighted Average
5,205		100.00% Pervious Area

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

Summary for Subcatchment 9S: Back Parking Lot Area and Roof

Runoff = 3.35 cfs @ 12.08 hrs, Volume= 0.277 af, Depth= 8.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
9,560	98	Paved parking, HSG B
7,620	98	Roofs, HSG B
120	61	>75% Grass cover, Good, HSG B
17,300	98	Weighted Average
120		0.69% Pervious Area
17,180		99.31% Impervious Area

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

Summary for Subcatchment 10S: Roof and Western Landscaped Area

Runoff = 3.73 cfs @ 12.08 hrs, Volume= 0.278 af, Depth= 6.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year 24-Hour Rainfall=8.60"

Area (sf)	CN	Description
13,380	98	Roofs, HSG B
930	98	Paved parking, HSG B
6,675	61	>75% Grass cover, Good, HSG B
20,985	86	Weighted Average
6,675		31.81% Pervious Area
14,310		68.19% Impervious Area

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

Summary for Pond 1P: Ex. CB on Rout 20

Inflow Area = 0.434 ac, 46.97% Impervious, Inflow Depth = 5.95" for 100-Year 24-Hour event
Inflow = 2.98 cfs @ 12.09 hrs, Volume= 0.215 af
Outflow = 2.98 cfs @ 12.09 hrs, Volume= 0.215 af, Atten= 0%, Lag= 0.0 min
Primary = 2.98 cfs @ 12.09 hrs, Volume= 0.215 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.73' @ 12.09 hrs
Flood Elev= 127.00'

Device	Routing	Invert	Outlet Devices
#1	Primary	122.80'	**18.0" Round 18" Culvert** L= 368.0' CMP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 122.80' / 118.50' S= 0.0117 '/' Cc= 0.900 n= 0.012 Steel, smooth, Flow Area= 1.77 sf

Primary OutFlow Max=2.98 cfs @ 12.09 hrs HW=123.73' TW=0.00' (Dynamic Tailwater)
1=18" Culvert (Inlet Controls 2.98 cfs @ 2.59 fps)

Summary for Pond DP2: Existing Concrete Galleys-Design Point

Inflow Area = 0.355 ac, 74.15% Impervious, Inflow Depth = 7.28" for 100-Year 24-Hour event
Inflow = 2.84 cfs @ 12.08 hrs, Volume= 0.215 af
Outflow = 0.15 cfs @ 13.99 hrs, Volume= 0.215 af, Atten= 95%, Lag= 114.6 min
Discarded = 0.15 cfs @ 13.99 hrs, Volume= 0.215 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 137.08' @ 13.99 hrs Surf.Area= 6,530 sf Storage= 5,703 cf

Plug-Flow detention time= 639.0 min calculated for 0.215 af (100% of inflow)
Center-of-Mass det. time= 638.0 min (1,414.9 - 776.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	129.43'	981 cf	**20.80'W x 40.00'L x 4.50'H Field A** 3,744 cf Overall - 942 cf Embedded = 2,802 cf x 35.0% Voids
#2A	129.93'	710 cf	**Concrete Galley 4x4x4** x 16 Inside #1 Inside= 42.0"W x 43.0"H => 12.67 sf x 3.50'L = 44.3 cf Outside= 52.8"W x 48.0"H => 14.72 sf x 4.00'L = 58.9 cf 2 Rows of 8 Chambers
#3	128.00'	88 cf	**4.00'D x 7.00'H Vertical Cone/Cylinder** -Impervious
#4	135.00'	6,838 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)
		8,616 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
135.00	20	20.0	0	0	20
136.00	1,235	200.0	471	471	3,173
137.00	5,300	375.0	3,031	3,502	11,186
137.50	8,145	445.0	3,336	6,838	15,758

Device	Routing	Invert	Outlet Devices
#1	Discarded	129.43'	**1.020 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.15 cfs @ 13.99 hrs HW=137.08' (Free Discharge)
1=Exfiltration (Exfiltration Controls 0.15 cfs)

Summary for Pond UG-1: UG-1 (SC-310 Chambers)

Inflow Area = 0.276 ac, 87.83% Impervious, Inflow Depth = 7.76" for 100-Year 24-Hour event
Inflow = 2.28 cfs @ 12.08 hrs, Volume= 0.179 af
Outflow = 2.27 cfs @ 12.09 hrs, Volume= 0.179 af, Atten= 1%, Lag= 0.4 min
Discarded = 0.00 cfs @ 2.71 hrs, Volume= 0.010 af
Primary = 2.26 cfs @ 12.09 hrs, Volume= 0.169 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 124.82' @ 12.09 hrs Surf.Area= 528 sf Storage= 536 cf

Plug-Flow detention time= 43.3 min calculated for 0.179 af (100% of inflow)
Center-of-Mass det. time= 43.3 min (806.8 - 763.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.85'	338 cf	**11.50'W x 45.92'L x 2.33'H Field A** 1,232 cf Overall - 265 cf Embedded = 967 cf x 35.0% Voids
#2A	123.35'	265 cf	**ADS_StormTech SC-310 +Cap** x 18 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 3 Rows of 6 Chambers
		604 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	123.34'	**12.0" Round Culvert** L= 51.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 123.34' / 123.09' S= 0.0049 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	123.55'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	124.68'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.85'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.00 cfs @ 2.71 hrs HW=122.86' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.00 cfs)

Primary OutFlow Max=2.26 cfs @ 12.09 hrs HW=124.82' TW=123.91' (Dynamic Tailwater)
└**1=Culvert** (Passes 2.26 cfs of 3.05 cfs potential flow)
  ├**2=Orifice** (Orifice Controls 1.60 cfs @ 4.58 fps)
  └**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.66 cfs @ 1.21 fps)

Summary for Pond UG-2: UG-2 (SC-310 Chambers)

Inflow Area = 0.517 ac, 90.50% Impervious, Inflow Depth = 7.94" for 100-Year 24-Hour event
Inflow = 4.31 cfs @ 12.08 hrs, Volume= 0.342 af
Outflow = 4.13 cfs @ 12.10 hrs, Volume= 0.342 af, Atten= 4%, Lag= 1.1 min
Discarded = 0.01 cfs @ 2.21 hrs, Volume= 0.018 af
Primary = 4.13 cfs @ 12.10 hrs, Volume= 0.325 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3

Peak Elev= 124.42' @ 12.11 hrs Surf.Area= 834 sf Storage= 958 cf

Plug-Flow detention time= 48.1 min calculated for 0.342 af (100% of inflow)
Center-of-Mass det. time= 48.3 min (805.7 - 757.4)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.14'	526 cf	**18.17'W x 45.92'L x 2.33'H Field A** 1,946 cf Overall - 442 cf Embedded = 1,504 cf x 35.0% Voids
#2A	122.64'	442 cf	**ADS_StormTech SC-310 +Cap** x 30 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 6 Chambers
#3	123.97'	19 cf	**4.00'D x 1.53'H Vertical Cone/Cylinder** -Impervious
		988 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.64'	**15.0" Round Culvert** L= 44.0' RCP, sq.cut end projecting, Ke= 0.500 Inlet / Outlet Invert= 122.64' / 122.33' S= 0.0070 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 1.23 sf
#2	Device 1	122.92'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.97'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.14'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 2.21 hrs HW=122.16' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=4.13 cfs @ 12.10 hrs HW=124.41' TW=123.93' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 4.13 cfs @ 3.36 fps)
  ├**2=Orifice** (Passes < 1.17 cfs potential flow)
  └**3=Sharp-Crested Rectangular Weir** (Passes < 3.78 cfs potential flow)

Summary for Pond UG-3: UG-3 (SC-310 Chambers)

Inflow Area = 0.397 ac, 99.31% Impervious, Inflow Depth = 8.36" for 100-Year 24-Hour event
Inflow = 3.35 cfs @ 12.08 hrs, Volume= 0.277 af
Outflow = 3.08 cfs @ 12.12 hrs, Volume= 0.277 af, Atten= 8%, Lag= 2.2 min
Discarded = 0.01 cfs @ 1.15 hrs, Volume= 0.030 af
Primary = 3.07 cfs @ 12.12 hrs, Volume= 0.247 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 124.35' @ 12.12 hrs Surf.Area= 1,352 sf Storage= 1,589 cf

Plug-Flow detention time= 106.7 min calculated for 0.277 af (100% of inflow)
Center-of-Mass det. time= 106.7 min (847.0 - 740.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	122.00'	846 cf	**18.17'W x 74.40'L x 2.33'H Field A** 3,154 cf Overall - 737 cf Embedded = 2,417 cf x 35.0% Voids
#2A	122.50'	737 cf	**ADS_StormTech SC-310 +Cap** x 50 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 5 Rows of 10 Chambers
#3	123.83'	35 cf	**4.00'D x 2.77'H Vertical Cone/Cylinder** -Impervious
		1,618 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	122.41'	**12.0" Round Culvert** L= 14.0' RCP, groove end projecting, Ke= 0.200 Inlet / Outlet Invert= 122.41' / 122.30' S= 0.0079 '/' Cc= 0.900 n= 0.013 Concrete pipe, bends & connections, Flow Area= 0.79 sf
#2	Device 1	122.78'	**8.0" Vert. Orifice** C= 0.600
#3	Device 1	123.83'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.01 cfs @ 1.15 hrs HW=122.01' (Free Discharge)
└**4=Exfiltration** (Exfiltration Controls 0.01 cfs)

Primary OutFlow Max=3.07 cfs @ 12.12 hrs HW=124.35' TW=123.93' (Dynamic Tailwater)
└**1=Culvert** (Inlet Controls 3.07 cfs @ 3.91 fps)
  ├**2=Orifice** (Passes < 1.09 cfs potential flow)
  └**3=Sharp-Crested Rectangular Weir** (Passes < 4.63 cfs potential flow)

Summary for Pond WQ: Reconstructed Water Quality Swale

Inflow Area = 2.192 ac, 79.31% Impervious, Inflow Depth = 7.20" for 100-Year 24-Hour event
Inflow = 16.91 cfs @ 12.09 hrs, Volume= 1.315 af
Outflow = 16.53 cfs @ 12.11 hrs, Volume= 1.315 af, Atten= 2%, Lag= 1.3 min
Discarded = 0.02 cfs @ 12.11 hrs, Volume= 0.023 af
Primary = 6.37 cfs @ 12.11 hrs, Volume= 1.116 af
Secondary = 10.15 cfs @ 12.11 hrs, Volume= 0.176 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs / 3
Peak Elev= 123.93' @ 12.11 hrs Surf.Area= 2,406 sf Storage= 2,736 cf

Plug-Flow detention time= 26.1 min calculated for 1.315 af (100% of inflow)
Center-of-Mass det. time= 26.2 min (808.8 - 782.6)

Volume	Invert	Avail.Storage	Storage Description
#1	122.00'	4,427 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
122.00	745	205.0	0	0	745
123.00	1,330	260.0	1,023	1,023	2,793
124.00	2,500	460.0	1,884	2,908	14,258
124.50	3,610	475.0	1,519	4,427	15,399

Device	Routing	Invert	Outlet Devices
#1	Primary	121.11'	**12.0" Round Culvert** L= 22.0' Ke= 0.200 Inlet / Outlet Invert= 121.11' / 121.00' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 0.79 sf
#2	Device 1	122.17'	**0.5" Vert. Orifice/Grate X 2.00** C= 0.600
#3	Device 1	122.55'	**2.0" Vert. Orifice/Grate X 2.00** C= 0.600
#4	Device 1	123.00'	**24.0" Horiz. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#5	Secondary	123.40'	**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
#6	Discarded	122.00'	**0.270 in/hr Exfiltration over Surface area** Phase-In= 0.01'

Discarded OutFlow Max=0.02 cfs @ 12.11 hrs HW=123.93' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.02 cfs)

Primary OutFlow Max=6.37 cfs @ 12.11 hrs HW=123.93' TW=0.00' (Dynamic Tailwater)
└**1=Culvert** (Barrel Controls 6.37 cfs @ 8.11 fps)
  ├**2=Orifice/Grate** (Passes < 0.02 cfs potential flow)
  ├**3=Orifice/Grate** (Passes < 0.24 cfs potential flow)
  └**4=Orifice/Grate** (Passes < 14.58 cfs potential flow)

Secondary OutFlow Max=10.13 cfs @ 12.11 hrs HW=123.93' TW=0.00' (Dynamic Tailwater)
└**5=Broad-Crested Rectangular Weir** (Weir Controls 10.13 cfs @ 1.91 fps)

Summary for Link DP1: Wetlands

Inflow Area = 2.625 ac, 73.97% Impervious, Inflow Depth = 6.89" for 100-Year 24-Hour event
Inflow = 19.36 cfs @ 12.11 hrs, Volume= 1.507 af
Primary = 19.36 cfs @ 12.11 hrs, Volume= 1.507 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-60.00 hrs, dt= 0.01 hrs

Section 3.3

Drainage Area Plans

DP1

DP2

2S
AREA= 66,928 SF
TC= 6 MIN.
CN= 93

4S
AREA= 18,700 SF
TC= 6 MIN.
CN= 85

3S
AREA= 28,830 SF
TC= 6 MIN.
CN= 84

1S
AREA= 15,450 SF
TC= 6 MIN.
CN= 89

LEGEND

SUBCATCHMENT BOUNDARY

1 SUBCATCHMENT

DP1 DESIGN POINT

0 30 60
SCALE IN FEET

CHA
1601 Accord Park Drive
Norwell, MA 02061
Main: (781) 982-5400 • www.chacompanies.com

No.	Submittal / Revision	Appr'd	By	Date
B	Wayland Site Plan Approval	KK	SFA	12/18/18
A	ZBA Submittal	KK	SFA	12/12/18

APPLICANT

HERB CHAMBERS
83 BOSTON POST RD, LLC

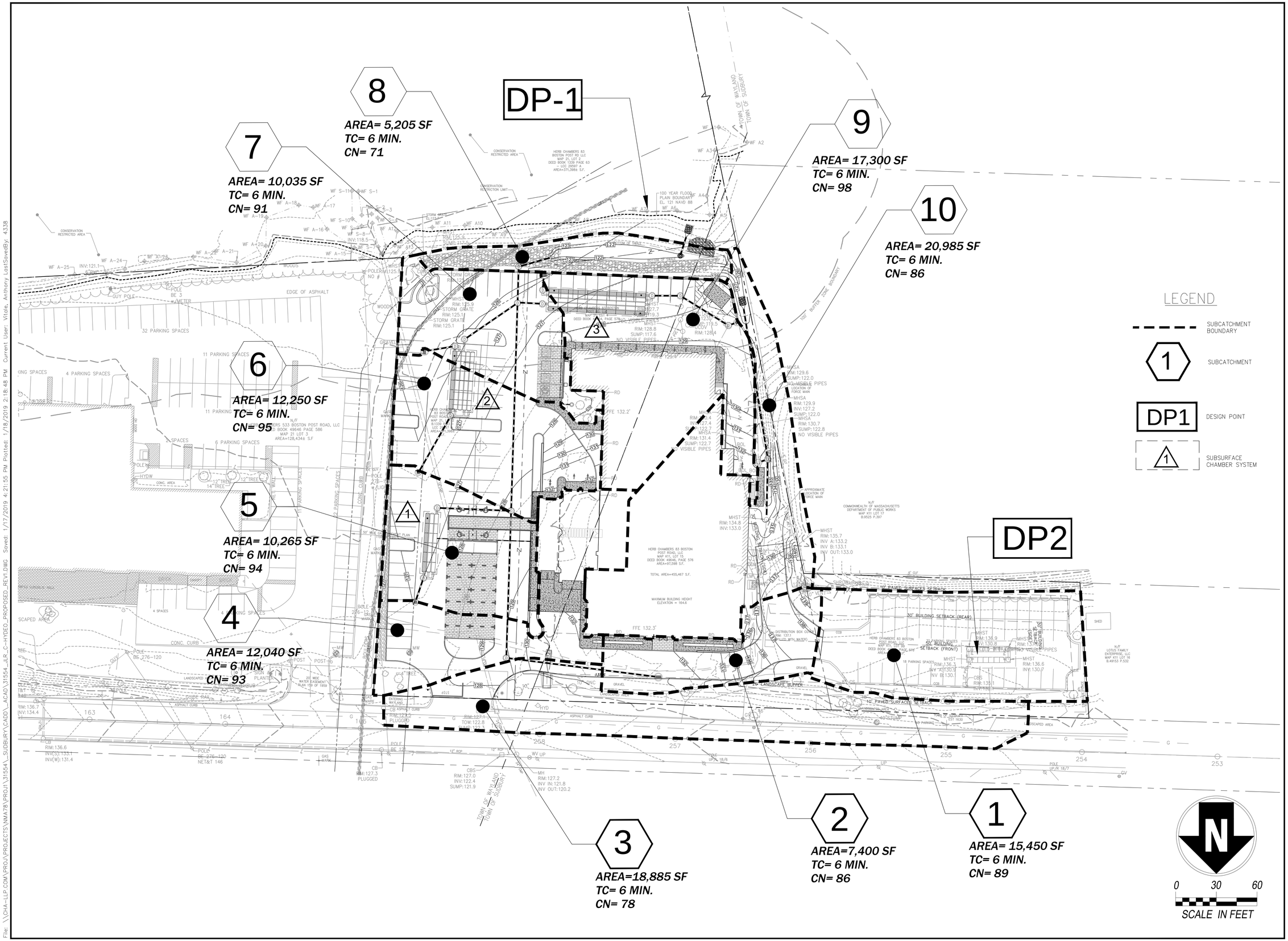
Proposed Site Development Plans
for
HERB CHAMBERS
JAGUAR / LAND ROVER of SUDBURY
83 BOSTON POST ROAD - ROUTE 20
SUDBURY, MA 01776

PRE-DEVELOPMENT DRAINAGE SUBCATCHMENT PLAN

Designed By:	Drawn By:	Checked By:
Issue Date: 12/12/18	Project No: 31554	Scale: AS SHOWN

Drawing No:
DR-1

File: \\CHA-LLP.COM\PROJ\PROJECTS\NMA7$\PROJ\31554_SUDBURY\CADD_ACAD\31554_JLR_C-HYDEO_EXISTNG_REVO.DWG Saved: 12/17/2018 3:02:07 PM Plotted: 12/26/2018 3:37:49 PM Current User: Vitale, Anthony LastSavedBy: 4338



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No.	Submittal / Revision	Appr'd.	By	Date
D	Sudbury Fire Dept. Comments	KK	SFA	01/18/19
C	Sudbury Site Plan Approval	KK	SFA	12/18/18
B	Wayland Site Plan Approval	KK	SFA	12/18/18
A	ZBA Submittal	KK	SFA	12/12/18

APPLICANT

HERB CHAMBERS
83 BOSTON POST RD, LLC

Proposed Site Development Plans
for
HERB CHAMBERS
JAGUAR / LAND ROVER of SUDBURY
83 BOSTON POST ROAD - ROUTE 20
SUDBURY, MA 01776

POST-DEVELOPMENT DRAINAGE SUBCATCHMENT PLAN

Designed By:	Drawn By:	Checked By:
Issue Date: 12/12/18	Project No: 31554	Scale: AS SHOWN

Drawing No:
DR-2

Section 4.0

Stormwater Management Calculations

Section 4.1

TSS Calculations

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: UG Chamber Systems 1 - 3

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump Catch basin	**0.25**	**1.00**	**0.25**	**0.75**
Proprietary - Isolator Row	**0.69**	**0.75**	**0.52**	**0.23**
Subsurface Infiltration Chamber	**0.80**	**0.23**	**0.18**	**0.05**

Total TSS Removal = **95%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **Land Rover Jaguar**

Prepared By: **AMV**

Date: **12/14/2018**

*Equals remaining load from previous BMP (E) which enters the BMP

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Water Quality Swale/ Partial Exfiltration Basin

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Deep Sump Catch basin - pretreatment	**0.00**	**1.00**	**0.00**	**1.00**
Partial Exfiltration Basin	**0.80**	**1.00**	**0.80**	**0.20**

Total TSS Removal = **80%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project: **Land Rover Jaguar**

Prepared By: **AMV**

Date: **12/14/2018**

*Equals remaining load from previous BMP (E) which enters the BMP

Performance Evaluation

Back to Profile

StormTech Isolator Row :: A product from STORMTECH LLC ::

Performance information: (This product was evaluated in at least one third-party study. See MASTEP Evaluation Summary.)

The StormTech Isolator Row was tested several times at a laboratory at Tennessee Tech University and also in the field by the UNH Stormwater Center (initially reported on in 2008, expanded and updated in a 2010 report). UNH analyzed runoff from a 9 acre parking lot for TSS, TPH, nitrogen as nitrate (DIN), TZn, and TP. Samples were collected during 23 events (13.2" rainfall) from 2007- 2009. The following pollutants were monitored, with results obtained: TSS (81% Efficiency Ratio (ER), 69% mean Removal Efficiency (RE), 83% median RE); SSC (only 5 storms monitored (94% ER, 93% mean RE, 91% median RE); Zinc (61% ER, 60% mean RE, 57% median RE); Total Phosphorus (53% ER, 29% mean RE, 33% median RE); Dissolved Inorganic Nitrogen(-74% ER, -97% mean RE, -80% median RE); Total Petroleum Hydrocarbons (79% ER, 81% mean RE, 91% median RE). A full scale StormTech SC-740 isolator Row was tested in the laboratory at Tennessee Tech University. Three different influent mixes were used in the testing including a SIL-CO-SIL 106, SIL-CO-SIL250 and US Silica OK-110. The SIL-CO-SIL106 had a median particle size of 22 microns and was tested at a hydraulic loading rate of 3.2gpm/ft2 of filter area. The SIL-CO-SIL 250 had a median particle size of 45 microns and was tested at 3.2 and 1.7 gpm/ft2 of filter area. The OK-110 influent slurry had a median particle size of 110 microns and was tested at rates up to 4.8 and 8.1 gpm/ft2 in the four and two chamber configurations. Five runs were done with the SIL-CO-SIL 106 influent at 3.2gpm/ft2 (125% of treatment operating rate). One run was done with the SIL-CO-SIL 250 slurry at each of the two hydraulic loading rates (3.2, 1.7gpm/ft2-62.5% of treatment operating rate). Each run lasted 15 detention times, allowing 3 detention times prior to collecting samples. OK-110 tests were run for 11 treatment flows from 44.9-539gpm (0.1-1.2cfs) or hydraulic loading rates of 0.4-4.8gpm/ft2 with a four chamber Isolator row. They also ran tests with a two chamber model at 0.4, 1.0, and 1.2 cfs, up to a hydraulic loading rate of 8.1gpm/ft2. Results of SIL-CO-SIL 106 runs show an average influent of 270 +/-59mg/l (range 139-361mg/l). This influent was higher than expected and due to recirculation of sediments that were not trapped in the filter sock at the outlet. Average removal efficiency was 60% across all samples but average removal by sample number (1-5) shows that removal efficiency decreased with increasing detention time from 66% at sample 1 to 58% at sample 5. Results for the SIL-CO-SIL 250 test at 3.2gpm/ft2 an average removal of 71%. Recirculation in these tests would have reduced the D50 below 45microns in the influent but a PSD was not done as it was with the SIL-CO-SIL 106 influent mix. Results for SIL-CO-SIL 250 at 1.7gpm/ft2 found an average removal of 88%. Compared to the demonstrated results for the SIL-CO-SIL106, these values appear reasonable since higher removal efficiencies are expected when the particle size distribution is greater. Results from OK-110 testing demonstrated an average removal of 99.14% from discrete samples and 98.06% from the grab samples across all flow rates tested.

Pollutants addressed	Manufacturer's Removal Efficiency claim	Minimum particle size	Tested removal efficiency (*)	Test Data Status (**)	Notes
Suspended sediment concentration	60-95%	-	60-95 %	2	average removal for all rates and influent types from Tenn Tech studies verified by NJCAT
Total suspended solids	66%	-	69-83 %	2	UNH Stormwater Center field studies, removal efficiency and efficiency ratio methods.
Zinc	50%	-	57-61 %	2	UNH Stormwater Center field studies, removal efficiency and efficiency ratio methods.
Hydrocarbons	78%	-	79-91 %	2	UNH Stormwater Center field studies, removal efficiency and efficiency ratio methods.
Total Phosphorus	37%	-	29-53 %	2	UNH Stormwater Center field studies, removal efficiency and efficiency ratio methods.

* - Pollution removal efficiency evaluated by MASTEP staff based on review of available performance evaluation reports.

** - **1** = sufficient credible data to be able to evaluate pollution removal efficiency claims. **2** = promising studies are underway. **3** = insufficient credible data be able to evaluate claims. **0** = data review not yet conducted.

Test reports: (click on link to view a summary of a test, click on disk icon to download the full report)

Title	Author / Agency	Date	TARP compliancy	Test protocol compliancy	Documents
Hydraulic Performance and Sediment Trap Efficiency for the StormTech SC-740 Isolator Row	Andrew Christensen and Vince Neary	02/23/2005	No	-	Hydraulic_Perf_Sed_Trap_Eff_StormTech_Isolator.pdf
PERFORMANCE EVALUATION OF SEDIMENT REMOVAL EFFICIENCY STORMTECH ISOLATOR ROW	Vincent Neary	10/20/2006	No	-	Tenn Tech Oct 2006 Report.pdf
NJCAT Technology Verification of the StormTech Isolotor Row	-	08/01/2007	No	-	NJCAT_Verification_StormTech_081507finalbdapprov-doc1.pdf
FINAL REPORT ON FIELD VERIFICATION TESTING OF THE STORMTECH ISOLATOR ROW TREATMENT UNIT	University of New Hampshire Stormwater Center	06/01/2008	No	The UNHSC QAPP was designed tobsubstantially comply with TARP and TAPE guidelines	UNHSC_StormTech Isolator Row_Final Report_6_08.pdf
Performance Evaluation Report of the StormTech Isolator Row Treatment Unit	Roseen et al	09/01/2010	No	TARP and TAPE	UNHSC_Stormtech PER_9_9_10-Final.pdf

Return to the Home Page

Section 4.2

Recharge Narrative & Calculations

RECHARGE NARRATIVE - REV1

The calculation for the *Required Recharge Volume* is done using the equation in the 2008 Massachusetts Stormwater Handbook. The *Required Recharge Volume* equals a depth of runoff corresponding to the soil type times the new impervious areas covering that soil type at the post-development site. The *Required Recharge Volume* is based on the *Static* method. The infiltration BMPs proposed are three subsurface infiltration chamber systems.

Rv = F x impervious area (Equation 1) Volume 3, Ch 1, page 15

Rv = Required Recharge Volume, expressed in cubic feet, cubic yards, or acre-feet
F = Target Depth Factor associated with each Hydrologic Soil Group (HSG)
Impervious Area = new pavement and new rooftop area

F for A soils = 0.60 inches (Table 2.3.2) Volume 3, Ch 1, page 16
***F* for B soils = 0.35 inches**
F for C soils = 0.25 inches
F for D soils = 0.10 inches

Using the formula above, the following table shows the site's proposed impervious surface area overlying particular Hydrologic Soil Groups and the calculated *Required Recharge Volume*. The soil exploration in the locations of the infiltration BMPs show fill with properties similar to sandy loam. For consistency in the stormwater runoff calculations, the Hydrologic Soil Group for this analysis has been assumed in aggregate as HSG B. The *Required Recharge Volume* will consider the net increase in impervious area in the calculation. The proposed design will, at a minimum, approximate the annual recharge from the pre-developed conditions. The totals below are from the tributary watershed areas which extend beyond the project's property lines. The increase in impervious area is located onsite.

Total Existing Impervious	= 91,824 sq. ft.	= 2.108 ac.
Total Proposed Impervious	= 96,050 sq. ft.	= 2.205 ac.
Net New increase	= 4,225 sq. ft.	= 0.097 ac.

Required Recharge Volume
Rv = F x Imp
Rv = 0.35 in x (0.097 ac) x 1 ft/12 in
Rv = 0.0028 ac-ft or 123 cu. ft.

Storage volume for Recharge (below lowest orifice invert) calculated in HydroCAD:
UG-1 = 169 cu. ft.
UG-2 = 319 cu. ft.
UG-3 = 521 cu. ft.
Total Storage = 1,009 cu. ft.
The storage available in UG-1 through 3 is more than the Required Recharge Volume

1,009 cu. ft. > 123 cu. ft.
Conclusion:

The recharge provided by the proposed underground systems exceeds the required recharge for the total proposed impervious on the site. The proposed design exceeds the requirements in Standard 3 of the MassDEP Stormwater regulations.

Section 4.3

Water Quality Narrative & Calculations

Sizing using the equivalent water quality flow from 1.0" rainfall depth

Discharge Point	Structure	Tributary Area	Tributary Area	% Impervious	CN Value	WQV	Tc	qu	WQF = qu A Q	Unit	Unit's Max Capacity
		(acres)	(sq miles)		(Estimated)	(Watershed Inches)	(min)	(csm/in)	(cfs)		(cfs)
Isolator Row	UG-1	0.24	0.0004	100%	98	1.00	5	795	0.30	ISO SC-310	See Sizing Below
Isolator Row	UG-2	0.49	0.0008	100%	98	1.00	5	795	0.61	ISO SC-310	See Sizing Below
Isolator Row	UG-3	0.38	0.0006	100%	98	1.00	5	795	0.47	ISO SC-310	See Sizing Below

* Abbreviations
ISO Isolator Row

StormTech Isolator Row Sizing	Unit Type	Chamber Area (SF)	Treated flow per unit** (CFS)	Flow Required WQF	Number of Units Req.	Number of Units Provided	Treated Flow
UG-1-ISO	SC-310	20	0.11	0.30	3	6	0.66
UG-2-ISO	SC-310	20	0.11	0.61	6	6	0.66
UG-3-ISO	SC-310	20	0.11	0.47	5	10	1.10

**Treatment Flow Capacity
2.5 GPM/SF NJCAT verified treated flow rate
(2.5 GPM=0.0055 CFS)

StormTech®

Detention • Retention • Water Quality

Division of ADS

STORMTECH ISOLATOR ROW SIZING CHART					
	SC-310	SC-740	DC-780	MC-3500	MC-4500
Chamber Area (Sq.Ft.)	20	27.8	27.8	43.2	30.1
Treated Flow Rate per chamber (CFS)	0.11	0.15	0.15	0.24	0.17

NOTE: *Testing of the Isolator Row completed by Tennesse Tech has been verified by NJCAT and it has shown to have a TSS removal efficiency of 84% for SIL-CO-SIL 250*

NJCAT verified Treated Flow Rate (GPM / Sq.Ft.) 2.5

Section 4.5

Drawdown Narrative & Calculations

DRAWDOWN TIME

Below are the drawdown time calculations for the recharge systems proposed on the site. The calculation uses a conservative estimated hydraulic conductivity value "*K*" of 0.27 inches per hour, corresponding to Silt Loam, HSG C in the Rawls Rate table. The soil classifications found on the site found from the NRCS soil data is Udorthents. The presence of soils with Sandy Loam to Loam properties were confirmed based on the test boring logs from KMM's Geotechnical Report.

The formula below is the recommended method of calculating drawdown times from the Massachusetts Stormwater Management Handbook

DRAWDOWN TIME CALCULATION

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:
Rv = Required Recharge Storage Volume
K = Saturated Hydraulic Conductivity, Rawls Rate
Bottom Area = Bottom Area of Recharge BMP

The drawdown time is the time it takes to drain the BMP down from the lowest outlet invert. The infiltration rate has been assumed at 0.27 in/hr (the Rawls Rate for HSG C, Silt Loam)

See the following Drawdown Calculation table for volume, infiltration rate, bottom area, and drawdown time.

Recharge BMP	*Storage in System below lowest orifice (cf)*	*Infiltration Rate (in/hr)*	*Square Footage of Basin (sf)*	*Drawdown Time (hrs)*
UG-1	169	0.27	528	**14.2**
UG-2	319	0.27	834	**17.0**
UG-3	521	0.27	1352	**17.1**

Conclusion:

The calculations show that the infiltration BMP draws down in less than 72 hours, as required.

Section 4.6

Illicit Discharge Statement

ILLICIT DISCHARGE COMPLIANCE STATEMENT

Standard 10: Massachusetts Stormwater Standards Handbook

Illicit discharges are defined as discharges into waters of the State or municipal separate stormwater system (MS4) that are not entirely comprised of stormwater. Exclusions for non-stormwater discharges into drainage systems include activities or facilities for firefighting, water line flushing, landscape irrigation, uncontaminated groundwater discharge, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, water used to clean residential buildings without detergents, water used for street washing, and flows from riparian habitats/wetlands. These exclusions are subject to change and are under the discretion of the local governing authority.

To the best of our knowledge and professional belief no illicit discharges to the stormwater system, surface waters, or wetland resource areas will remain on the site after construction. We will agree to implement a pollution prevention plan to prevent illicit discharges into the stormwater management system. The design of the site based on the plans prepared by CHA, 141 Longwater Drive, Norwell, Massachusetts show a separation and no direct connection between the stormwater management systems and the wastewater and/ or groundwater on the site. To the maximum extent practicable, the design prevents entry of illicit discharges into the stormwater management system.

Engineer's Name: KELLY KILLEEN
(please print) CHA CONSULTING, INC.

Engineer's Signature: _____ Date: 12-18-18

Company: CHA

Section 5.0

Stormwater Checklist

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

Kelly Killeen, P.E.
CHA
141 Longwater Drive
Norwell, MA 02061
(781) 982-5400

12-18-18

Signature and Date

Checklist

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

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

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

☒ No disturbance to any Wetland Resource Areas

☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)

☐ Reduced Impervious Area (Redevelopment Only)

☒ Minimizing disturbance to existing trees and shrubs

☐ LID Site Design Credit Requested:

- ☐ Credit 1
- ☐ Credit 2
- ☐ Credit 3

☐ Use of "country drainage" versus curb and gutter conveyance and pipe

☐ Bioretention Cells (includes Rain Gardens)

☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)

☐ Treebox Filter

☐ Water Quality Swale

☐ Grass Channel

☐ Green Roof

☒ Other (describe): Subsurface Drainage System (ADS Chambers)

Standard 1: No New Untreated Discharges

☒ No new untreated discharges

☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth

☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

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

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

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

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

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

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

☒ Static ☐ Simple Dynamic ☐ Dynamic Field[1]

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

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

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

Standard 4: Water Quality

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

Standard 4: Water Quality (continued)

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

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

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

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

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

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

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

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

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

☐ All exposure has been eliminated.

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

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

Standard 6: Critical Areas

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

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

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

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

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

Checklist for Stormwater Report

Checklist (continued)

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

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

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

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

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

Standard 9: Operation and Maintenance Plan

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

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

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

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

Standard 10: Prohibition of Illicit Discharges

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

☒ An Illicit Discharge Compliance Statement is attached;

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

Appendix A

Soils

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Middlesex County, Massachusetts

83 Boston Post Road, Sudbury, MA

December 11, 2018

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Custom Soil Resource Report
Soil Map

Map Scale: 1:1,070 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

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

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 18, Sep 7, 2018

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
52A	Freetown muck, 0 to 1 percent slopes	1.3	21.9%
656	Udorthents-Urban land complex	4.6	78.1%
Totals for Area of Interest		**5.9**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however,

onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Middlesex County, Massachusetts

52A—Freetown muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2t2q9
Elevation: 0 to 1,110 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Farmland of unique importance

Map Unit Composition

Freetown and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Freetown

Setting

Landform: Swamps, depressions, depressions, bogs, marshes, kettles
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Highly decomposed organic material

Typical profile

Oe - 0 to 2 inches: mucky peat
Oa - 2 to 79 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Percent of area covered with surface fragments: 0.0 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 14.17 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Rare
Frequency of ponding: Frequent
Available water storage in profile: Very high (about 19.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: B/D
Hydric soil rating: Yes

Minor Components

Scarboro

Percent of map unit: 5 percent
Landform: Drainageways, depressions
Landform position (two-dimensional): Toeslope

Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Swansea

Percent of map unit: 5 percent
Landform: Bogs, kettles, depressions, depressions, marshes, swamps
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Tread, dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Whitman

Percent of map unit: 5 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

656—Udorthents-Urban land complex

Map Unit Setting

National map unit symbol: 995k
Elevation: 0 to 3,000 feet
Mean annual precipitation: 32 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 110 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Udorthents and similar soils: 40 percent
Urban land: 40 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Udorthents

Setting

Parent material: Loamy alluvium and/or sandy glaciofluvial deposits and/or loamy glaciolacustrine deposits and/or loamy marine deposits and/or loamy basal till and/or loamy lodgment till

Properties and qualities

Slope: 0 to 15 percent
Depth to restrictive feature: More than 80 inches
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None

Description of Urban Land

Setting

Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Excavated and filled land

Minor Components

Canton

Percent of map unit: 10 percent
Landform: Hills
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Side slope, base slope
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Paxton

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (two-dimensional): Backslope, summit
Landform position (three-dimensional): Head slope, side slope
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Merrimac

Percent of map unit: 5 percent
Landform: Terraces, plains
Landform position (two-dimensional): Shoulder
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Soil Information for All Uses

Soil Properties and Qualities

The Soil Properties and Qualities section includes various soil properties and qualities displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each property or quality.

Soil Qualities and Features

Soil qualities are behavior and performance attributes that are not directly measured, but are inferred from observations of dynamic conditions and from soil properties. Example soil qualities include natural drainage, and frost action. Soil features are attributes that are not directly part of the soil. Example soil features include slope and depth to restrictive layer. These features can greatly impact the use and management of the soil.

Hydrologic Soil Group

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.

Custom Soil Resource Report
Map—Hydrologic Soil Group

Map Scale: 1:1,070 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 15 30 60 90

Feet: 0 50 100 200 300

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

MAP LEGEND

Area of Interest (AOI)

- Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

- Streams and Canals

Transportation

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

Background

- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Middlesex County, Massachusetts
Survey Area Data: Version 18, Sep 7, 2018

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

Date(s) aerial images were photographed: Sep 12, 2014—Sep 28, 2014

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.

Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
52A	Freetown muck, 0 to 1 percent slopes	B/D	1.3	21.9%
656	Udorthents-Urban land complex		4.6	78.1%
Totals for Area of Interest			**5.9**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

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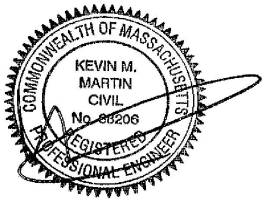
KMM GEOTECHNICAL CONSULTANTS, LLC
7 Marshall Road
Hampstead, NH 03841
603-489-5556 (p)/ 603-489-5558 (f)/781-718-4084(m)
kevinmartinpe@aol.com

MEMORANDUM

TO: The Herb Chambers Companies
259 McGrath Highway
Somerville MA. 02143



FROM: Kevin M. Martin, P.E.
Geotechnical Engineer

DATE: June 7, 2018

RE: **GEOTECHNICAL STUDY**
PROPOSED BUILDING EXPANSION & RENOVATIONS
HERB CHAMBERS JAGUAR-LAND ROVER OF SUDBURY
83 BOSTON POST ROAD (ROUTE 20)
SUDBURY, MASSACHUSETTS

This memorandum report serves as a geotechnical summary report for the referenced project. The contents of this memorandum are subject to the attached ***Limitations***.

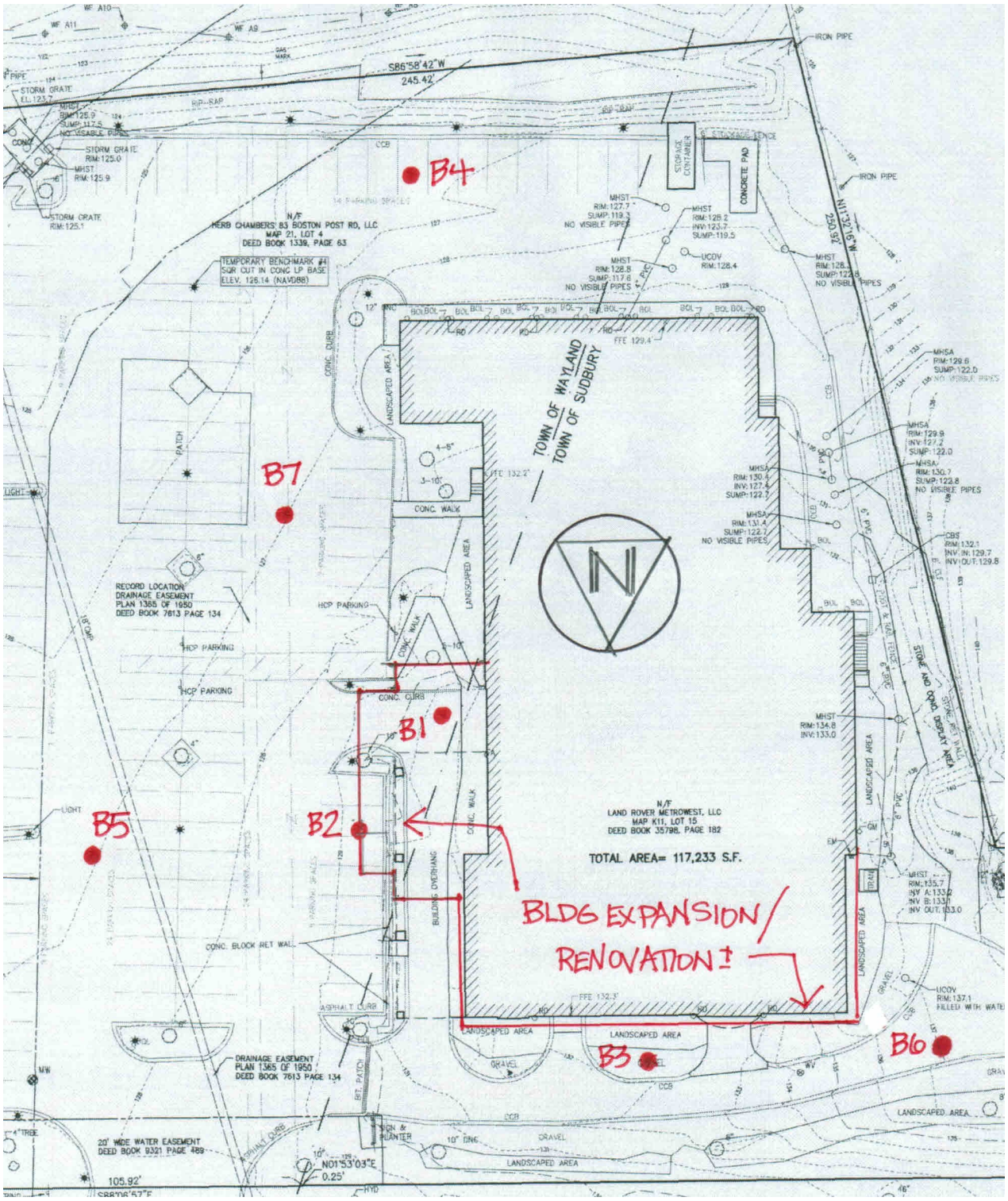
SITE & PROJECT DESCRIPTION

Present development includes an existing car dealership with associated pavement and landscape areas. The project intersects the Towns of Sudbury & Wayland. KMM has no knowledge of past construction, development and/or use of the property except what is visible or shown on the *Site Plans*. Based on review of the *Site Plan*, grades vary from elevation ≈140-125 ft possessing a gradual downward slope to the east. Low lying wetlands are delineated towards the rear (south) of the site near elevation ≈120-122 ft.

The project includes a small building expansion to the front of the building. The proposed expansion is understood to include a single-story, steel and concrete masonry framed structure. It is intended to support the building on a conventional spread footing foundation (no basement). Minor grading is expected for the project. *Grading Plans* were not available at this time.

The purpose of this study is to review the subgrade conditions and provide a geotechnical evaluation related to foundation design and construction per the *Massachusetts State Building Code*. This report does not include an environmental assessment relative to oil, gasoline, solid waste and/or other

hazardous materials. The environmental conditions of the property should be addressed by others as necessary. This study also does not include review of site design or construction issues such as infiltration systems, dry wells, retaining walls, excavation support systems, steepened slopes, underground utilities, crane pads, shoring, protection of surrounding buildings/utilities or other site and/or temporary design unless specifically addressed herein.



TEST BORE LOCATIONS

SUBSURFACE EXPLORATIONS

Test Borings

The exploration program for the project included seven (7) test borings at the prescribed locations. The test borings (B1 to B7) were advanced to depths of ≈22-27 ft utilizing 4 inch hollow stem augers. Soil samples were typically retrieved at no greater than 5 ft intervals with a 2 inch diameter split-spoon sampler. Standard Penetration Tests (SPTs) were performed at the sampling intervals in general accordance with ASTM-D1586 (*Standard Method for Penetration Test and Split-Barrel Sampling of Soils*). Field descriptions and penetration resistance of the soils encountered, observed depth to groundwater and other pertinent data are contained on the attached *Test Boring Logs*. The attached *Sketch* shows the test bore locations.

SUBSURFACE CONDITIONS

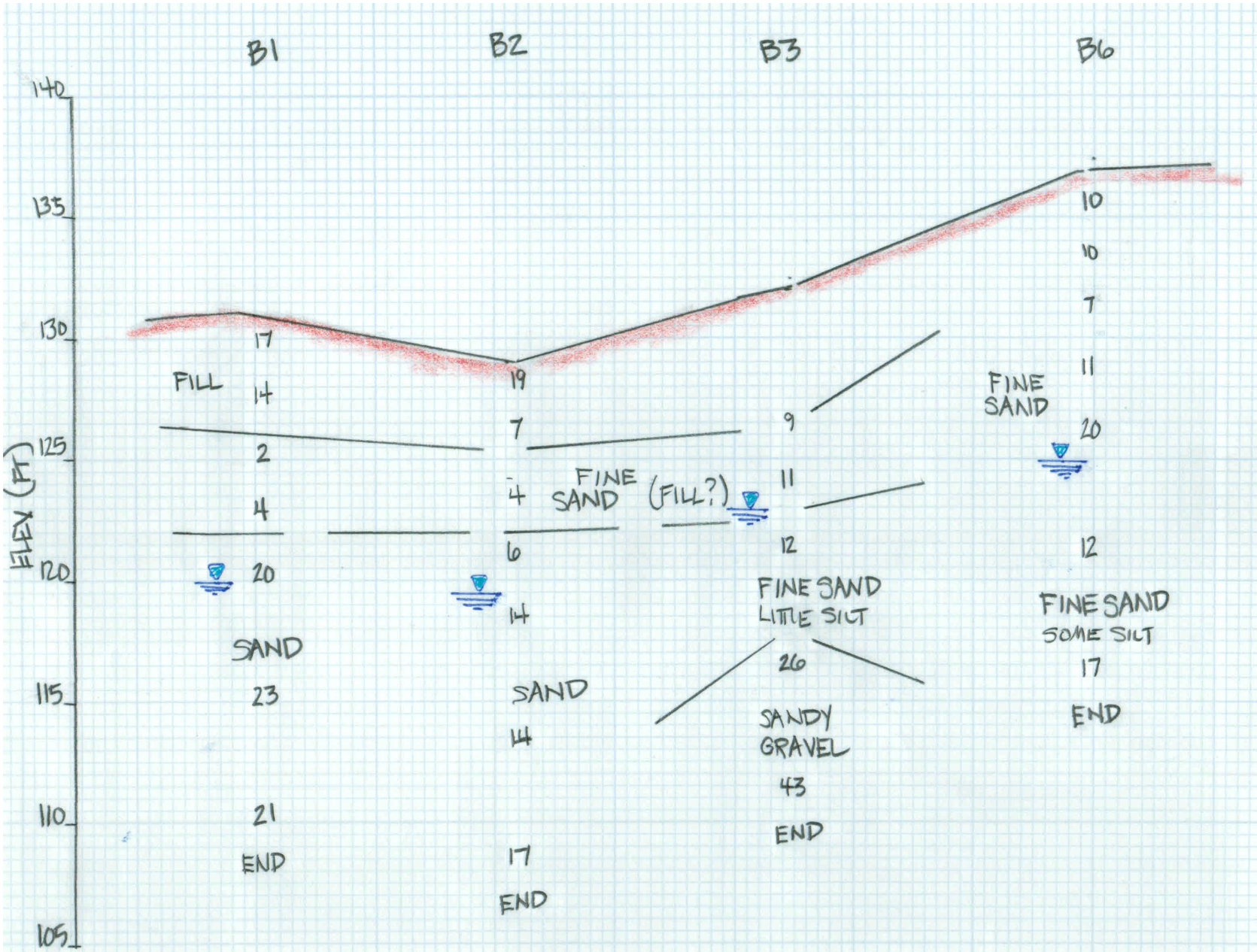
The subsurface conditions generally include (1) Fill underlain by (2) Fluvial soils of varying composition. Two (2) *Subsurface Profiles* depicting soil and groundwater conditions are attached for review.

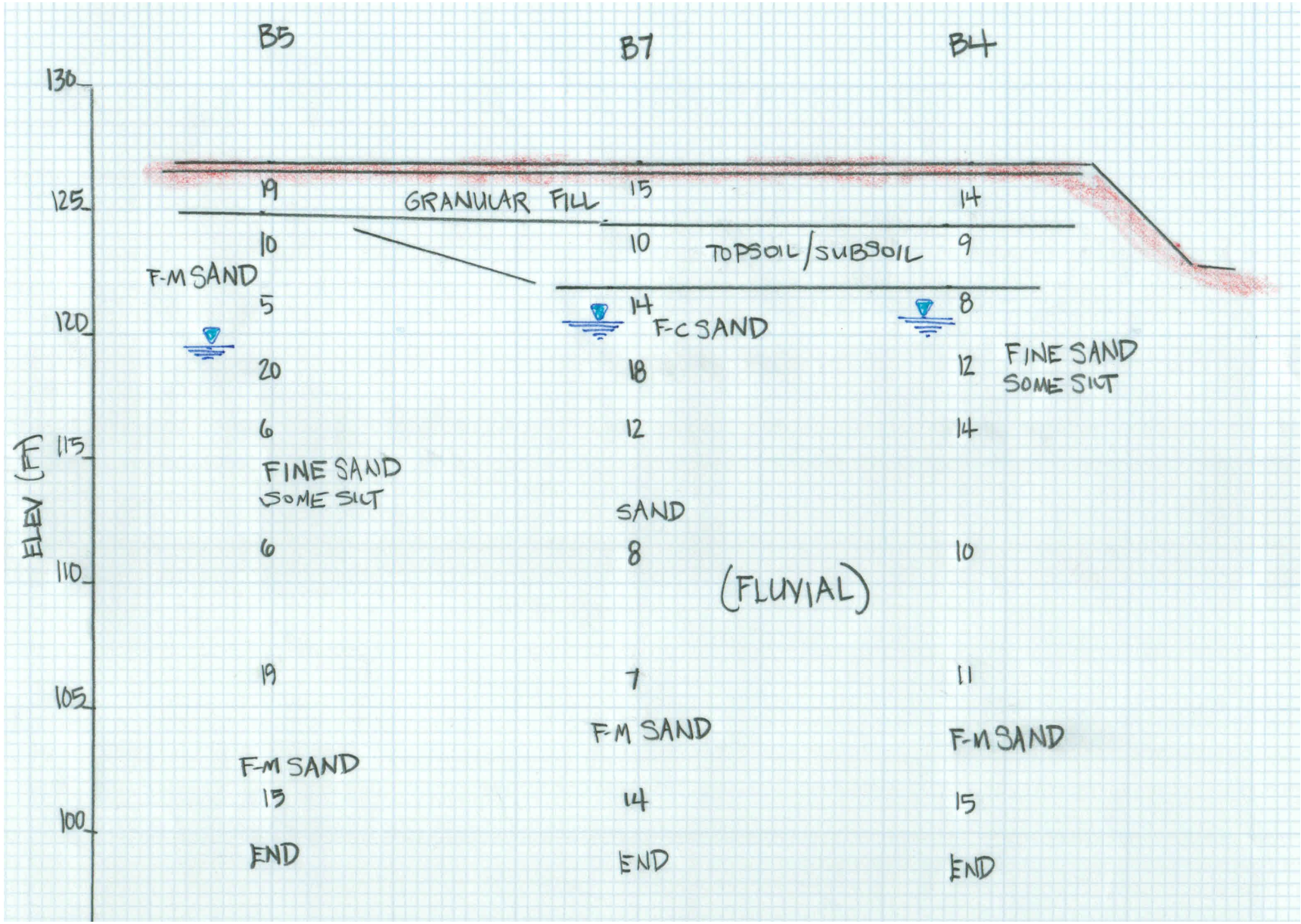
Fill / Organic

Fill and shallow Organic soils were identified at most test locations. The Fill appears deeper around the building. The Fill is generally Sandy in composition and likely represents re-worked site soils. The Fill includes brown, fine to medium Sand, little gravel, little silt to a Fine Sand, little silt. Minor amounts of loam, rubble and brick are embedded in the Fill. It was difficult to distinguish the deeper Fill from the parent soils given similar composition. The Fill, especially the deeper Fill, was very loose. The presence of deep Fill around the building (B1 to B3) to depths of ≈9-10 ft is uncertain. There is no basement or deep utility for which the fill may be associated. Nonetheless, very loose soils were identified in these areas. Test pits should be considered to better review the presence and extent of the fill. Other Fill should be expected given present development, utilities and site grading. Some buried Topsoil and Subsoil was identified in the pavement areas (B4 & B7) to shallow depths of ≈4-5 ft. Test pits would be a better means to evaluate the Fill and Organic soils given limited exposure with small diameter test bores.

Fluvial Deposits

Stratified or layered Fluvial soils were encountered through the site. These soils are associated Hop Brook and Great Meadows to the rear of the property. These are tributaries of the Sudbury River to the east. These soils vary considerably in composition and include Clean Sand, silty Sand, sandy Silt and/or sandy Gravel. For the most part, these soils include Sand, Fine Sand and/or Fine Sand w/ Silt. These soils are generally stable and compact with some loose pockets. A Glacial Till Hardpan nor Bedrock were encountered to ≈25 ft.


B1
B2
B3
B6
ELEV (FT)
140
135
130
125
120
115
110
105
17
FILL
14
2
4
20
SAND
23
21
END
19
7
4
FINE SAND (FILL?)
6
14
SAND
14
17
END
9
11
12
FINE SAND
LITTLE SILT
26
SANDY GRAVEL
43
END
10
10
7
11
FINE SAND
20
12
FINE SAND
SOME SILT
17
END


B5
B7
B4
130
125
120
115
110
105
100
ELEV (FT)
19
10
5
20
6
6
19
15
GRANULAR FILL
F-M SAND
FINE SAND
SOME SILT
F-M SAND
END
15
10
14
18
12
8
7
14
TOPSOIL/SUBSOIL
F-C SAND
SAND
(FLUVIAL)
F-M SAND
END
14
9
8
12
14
10
11
15
FINE SAND
SOME SILT
F-M SAND
END

Groundwater

Groundwater was encountered in the test holes at depths of ≈6-12 ft below grade upon completion. Wet soils were encountered below these depths. These depths correspond to elevation ≈120-125 ft. Low lying wetlands are delineated towards the rear (south) of the site near elevation ≈120-122 ft. It should be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, utilities and other factors differing from the time of the measurements. This study was completed at a time of seasonally normal groundwater.

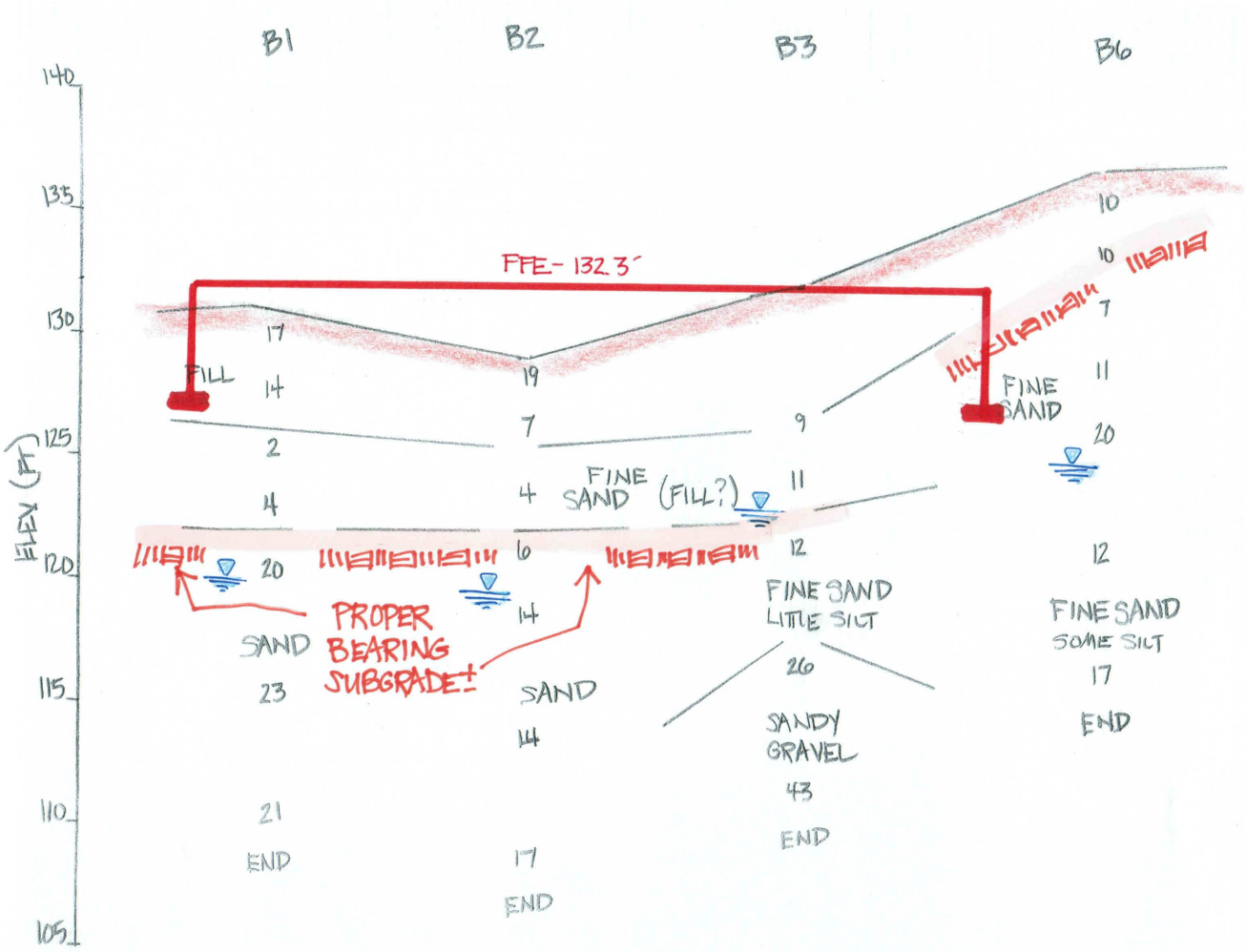
FOUNDATION SUBGRADE RECOMMENDATIONS

The subgrade conditions warrant some concern for supporting the proposed building expansion on a conventional spread footing foundation with a concrete floor slab. The undocumented fill, organic laden soils and other questionable materials are not considered suitable for foundation bearing support. These soils shall be removed from the building pad including the *Footing Zone of Influence* (*FZOI*). The *FZOI* is defined as that area extending laterally one foot from the edge of footing then outward and downward at a 1H:1V splay. There is deep suspect Fill around the building (B1 to B3) that extends to depths of ≈9-10 ft. It is uncertain if the existing foundation extends such depth. Otherwise, the existing foundation may become undermined and require shoring or underpinning. Review of the existing foundation via test pits was beyond the scope of this study. Structural Fill necessary to achieve foundation grade should conform to the *Specifications* (Table 1).

Helical piles may be another option top support the building. It is expected that the ground floor can be supported at grade. Helical piles should be able to achieve capacity of ≈25 kips given the subgrade conditions. KMM can provide additional assistance if piles are to be considered for foundation support. Helical piles are likely the least disruptive to the dealership operations.

The parent subgrade soils should be exposed in the foundation areas prior to casting the footings or placing structural fill. The parent subgrade shall be proof-rolled with vibratory densification and exhibit stable and compact conditions. The purpose of the proof-rolling is to densify the site soils and identify potential loose or unstable areas which should be removed as necessary. Recommended proof-rolling should involve at least 4-5 passes with a vibratory compactor (minimum 850 pound static weight) operating at peak energy. During the proof rolling process, the subgrade should be observed by an Engineer to identify areas exhibiting weaving or instability. It will be necessary to remove weakened or unstable soils and replace with a Structural Fill. Proper groundwater control and storm water management are also necessary to maintain site stability.

The subgrade should ultimately be stable, dewatered, compact and protected from frost throughout construction. Bearing subgrades that become weakened or disturbed due to wet conditions will be rendered unsuitable for structural support. The Contractor shall ultimately be responsible for the means and methods of temporary groundwater control, subgrade protection and site stability during construction. An Engineer from KMM should be scheduled to review the foundation subgrade conditions and preparation during construction.



FOUNDATION DESIGN RECOMMENDATIONS

The footings are expected to gain bearing support atop the parent site soils (Fluvial) and/or compacted Structural Fill (Table 1). Footings may be designed using an allowable bearing capacity of 3 ksf (FS=3). The allowable bearing capacity may be increased a third (⅓) when considering transient loads such as wind or seismic. The bearing capacity is contingent upon the perimeter strip footings and isolated column footings being no less than 2 ft and 3 ft in width respectively. For footings less than 3 ft in lateral dimension, the allowable bearing capacity should be reduced to one-third and multiplied by the least lateral footing dimension in feet. Foundation settlement should be less than 1 inch with differential settlement less than ½ inch. The settlement should be elastic and occur during construction. Exterior footings shall be provided with at least 4 ft of frost protection.

The subsurface conditions were reviewed with respect to seismic criteria set forth in the ***Massachusetts State Building Code***. Based on the relative density of the soils and the depth to groundwater, the site does not appear susceptible to liquefaction (complete loss of shear resistance) in the event of an earthquake. Based on interpretation of the *Building Code*, the *Site Classification* is "D" (Stable Soil Profile).

It is recommended that a minimum 8-inch base of *Gravel Base Fill* (Table 1) be placed below the concrete floor slab for moisture and frost control. The gravel base shall be increased to no less than 12 inches for exterior concrete slabs exposed to frost (18 inches at ramps, entrances, aprons, etc). A subgrade modulus of 150 pci may be used for design of the floor slab. The subgrade modulus may be increased 25 pci for every 2 inch in additional gravel base thickness (200 pci @ 12 inch gravel base) as necessary. A vapor retarder should be used below the floor slab dependent upon the floor treatment. A vapor barrier should be specified by others per ACI Standards.

Structural fill necessary within and below the foundation should conform to the attached *Specifications* (Table 1). The clean Sand should be suitable for general backfill or Common Fill. These soils will need to be screened of large stones and segregated from organic laden soils. The silty soils and organic laden soils should not be re-used with or around the foundation.

PROTECTION OF EXISTING FOUNDATION

It is recommended that where the addition adjoins the existing building that the footings be constructed at similar grade to mitigate the overlapping of stresses. The *Existing Footing Zone of Influence* of the existing foundation should not be encroached or disturbed without review by a Professional Engineer. The *Existing Footing Zone of Influence* is defined as that area extending laterally one foot from the edge of footing then outward and downward at a 1.5H:1V splay. Per the *Building Code (Section 1805.5)*, an imaginary line drawn between the lower edges of adjoining footings shall not have a steeper slope than 25° (2H:1V) with the horizontal unless the material supporting the higher footing is braced or otherwise retained. There is no present information regarding the adjacent building. This study did not include verification of the existing foundation via test pits. It is expected that standard footings extend ≈4-5 ft below grade (except that loose soils extend ≈9-10 ft below grade). KMM can provide additional technical assistance if the existing foundation needs to be shored or underpinned. It is expected that conventional concrete pit underpinning will be the most practical. It is recommended that an experienced Contractor be retained for the underpinning. A *Technical Submittal* prepared by a qualified Engineer should be provided to outline the proposed means and methods to protect the existing building and construct the new underpinning pits.

CONSTRUCTION CONCERNS

The contractor should be required to maintain a stable-dewatered subgrade for the building foundation and other concerned areas during construction. Subgrade disturbance may be influenced by excavation methods, moisture, precipitation, groundwater control and construction activities. The Fluvial soils, especially the silty soils, are considered potentially vulnerable to disturbance when

exposed to wet conditions and construction activities. The contractor should take precautions to reduce subgrade disturbance. Such precautions may include diverting storm run-off away from construction areas, reducing traffic in sensitive areas, minimizing the extent of exposed subgrade if inclement weather is forecast, backfilling footings as soon as practicable and maintaining an effective dewatering program. Soils exhibiting weaving or instability should be over-excavated to a competent bearing subgrade then replaced with a free draining structural fill or crushed stone. The moisture concerns are typically more problematic if construction takes place during the winter to spring season or other periods of inclement weather. A protective base of ¾-inch minus crushed stone may be placed ≈6 inches below and laterally beyond the footing limits for protection during construction. The stone base is to protect the site soils, facilitate any necessary dewatering and provide a dry/stable base upon which to progress foundation construction. The protective base should be considered elective and dependent upon the site conditions. The stone base should be considered necessary if wet conditions are encountered at footing grade. The protective stone base shall be tamped with a plate compactor and exhibit stable conditions.

The groundwater table, if encountered, will need to be temporarily controlled during construction to complete work in dry conditions and protect the competency of the subgrade. The groundwater table and puddled groundwater should be continuously maintained at least one foot below construction grade until backfilling is complete. The groundwater is expected to be controlled with conventional sumps and pumps. The temporary sumps should be filtered with stone and fabric and extend at least 24 inches below construction grade. A ≈6 inch lift of ¾-inch minus crushed stone (or larger graded stone) should be placed atop the wet subgrade to protect its competency and facilitate dewatering. The stone base should have positive slope to the sump. Adequate dewatering and storm water management are necessary for maintaining the competency of the site soils.

The subgrade should ultimately be stable, dewatered, compact and protected from frost throughout construction. Bearing subgrades that become weakened or disturbed due to wet conditions will be rendered unsuitable for structural support. The Contractor shall ultimately be responsible for the means and methods of temporary groundwater control, subgrade protection and site stability during construction. An Engineer from KMM should be scheduled to review the foundation subgrade conditions and preparation during construction.

CONSTRUCTION MONITORING

It is recommended that a qualified engineer or representative be retained to review earthwork activities such as the preparation of the foundation bearing subgrade and the placement/compaction of Structural Fill. It is recommended that KMM be retained to provide construction monitoring services. This is to observe compliance with the design concepts presented herein.

We trust the contents of this memorandum report are responsive to your needs at this time. Should you have any questions or require additional assistance, please do not hesitate to contact our office.

LIMITATIONS

Explorations

1. The analyses, recommendations and designs submitted in this report are based in part upon the data obtained from preliminary subsurface explorations. The nature and extent of variations between these explorations may not become evident until construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report.

2. The generalized soil profile described in the text is intended to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and have been developed by interpretation of widely spaced explorations and samples; actual soil transitions are probably more gradual. For specific information, refer to the individual test pit and/or boring logs.

3. Water level readings have been made in the test pits and/or test borings under conditions stated on the logs. These data have been reviewed and interpretations have been made in the text of this report. However, it must be noted that fluctuations in the level of the groundwater may occur due to variations in rainfall, temperature, and other factors differing from the time the measurements were made.

Review

4. It is recommended that this firm be given the opportunity to review final design drawings and specifications to evaluate the appropriate implementation of the recommendations provided herein.

5. In the event that any changes in the nature, design, or location of the proposed areas are planned, the conclusions and recommendations contained in this report shall not be considered valid unless the changes are reviewed and conclusions of the report modified or verified in writing by KMM Geotechnical Consultants, LLC.

Construction

6. It is recommended that this firm be retained to provide geotechnical engineering services during the earthwork phases of the work. This is to observe compliance with the design concepts, specifications, and recommendations and to allow design changes in the event that subsurface conditions differ from those anticipated prior to the start of construction.

Use of Report

7. This report has been prepared for the exclusive use of The Herb Chambers Company in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made.

8. This report has been prepared for this project by KMM Geotechnical Consultants, LLC. This report was completed for preliminary design purposes and may be limited in its scope to complete an accurate bid. Contractors wishing a copy of the report may secure it with the understanding that its scope is limited to preliminary geotechnical design considerations only.

TABLE 1

Herb Chambers
83 Boston Post Road
Sudbury, Massachusetts

Recommended Soil Gradation & Compaction Specifications

Gravel Base Fill
(Select Gravel Fill)

SIEVE SIZE	PERCENT PASSING BY WEIGHT
3 inch	100
3/4 inch	60-90
No. 4	20-70
No. 200	2-8

NOTE: For minimum 8-inch base below Concrete Floor Slabs (in heated areas)
For minimum 12-inch base for concrete slabs exposed to frost
For minimum 18-inch base below ramps, entrances and aprons
Shall have less than 12% fines (No. 200 sieve) based on the Sand fraction

Structural Fill
(Gravelly SAND, little Silt)

SIEVE SIZE	PERCENT PASSING BY WEIGHT
5 inch	100
3/4 inch	60-100
No. 4	20-80
No. 200	0-10

NOTE: For use as structural load support below the foundations
For use as backfill behind unbalanced foundation/retaining walls
A ¾-inch crushed stone may be used in wet conditions
Shall have less than 20% fines (No. 200 sieve) based on the Sand fraction

Structural Fill placed beneath the foundation should include the *Footing Zone of Influence* which is defined as that area extending laterally one foot from the edge of the footing then outward and downward at a 1H:1V splay. Structural Fill should be placed in loose lifts not exceeding 12 inches for heavy vibratory rollers and 8 inches for vibratory plate compactors. All Structural Fill should be compacted to at least 95 percent of maximum dry density as determined by the Modified Proctor Test (ASTM-D1557). Structural Fill should be compacted within ±3% of optimum moisture content. The adequacy of the compaction efforts should be verified by field density testing which is also a requirement of the *Massachusetts State Building Code*.

TEST BORING LOG SHEET 1

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Herb Chambers
Site 83 Boston Post Road
Sudbury, MA.

BORING B-1

PROJECT NO. 18-0524

DATE: May 18, 2018

Ground Elevation:
Date Started: May 17, 2018
Date Finished: May 17, 2018
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
5/17/18	10 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	12"	0'0" – 2'0"	6-8-11-12		Dark Brown, f-c Sand, little gravel, little silt
		2	12"	2'0" – 4'0"	11-8-6-5		Same, trace asphalt (FILL)
5		3	3"	5'0"- 7'0"	2-1-1-1		Brown, fine to medium Sand, little gravel, little silt, dry (FILL)
		4	9"	7'0" – 9'0"	1-2-2-6	9'	Brown, f-m Sand, little silt, dry
10		5	18"	10'0" - 12'0"	8-11-9-11		Brown, fine to coarse Sand, wet
15		6	18"	15'0" - 17'0"	10-12-11-14		Rust Brown, f-m Sand, little gravel, little silt
20		7	18"	20'0" – 22'0"	10-10-11-13		Brown, f-m Sand, little silt End of boring at 22 ft Water encountered at 10 ft upon completion
25							
30							
35							

Notes: Hollow Stem Auger Size 4-1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V Dense.
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 2

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Herb Chambers
Site 83 Boston Post Road
Sudbury, MA.

BORING B-2

PROJECT NO. 18-0524

DATE: May 18, 2018

Ground Elevation:
Date Started: May 17, 2018
Date Finished: May 17, 2018
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
5/17/18	8 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	15"	0'0" – 2'0"	9-11-8-9		
		2	12"	2'0" – 4'0"	4-4-3-3		Brown, fine to medium Sand, little gravel, little silt, dry (FILL)
						5'	
5		3	21"	5'0"- 7'0"	2-2-2-3		
		4	15"	7'0" – 9'0"	2-3-3-5		Brown, Fine Sand, little silt, wet
						10'	
10		5	21"	10'0" - 12'0"	6-7-7-6		Brown, f-c Sand, wet
15		6	18"	15'0" - 17'0"	6-7-7-8		Brown, fine to medium Sand, wet (SAND)
20		7	21"	20'0" – 22'0"	7-8-9-4		Brown, f-m Sand
							End of boring at 22 ft Water encountered at 8 ft upon completion
25							
30							
35							

Notes: Hollow Stem Auger Size 4-1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 3

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Herb Chambers
Site 83 Boston Post Road
Sudbury, MA.

BORING B-3

PROJECT NO. 18-0524

DATE: May 18, 2018

Ground Elevation:
Date Started: May 17, 2018
Date Finished: May 17, 2018
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
5/17/18	9 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
		1		0'0" – 5'0"	Grab		Vacuum Extract
1							Brown, fine to medium Sand, some gravel, trace silt (FILL)
						5'	
5		2	15"	5'0"- 7'0"	4-4-5-5		Brown, Fine Sand, little silt, trace loam, dry
		3	18"	7'0" – 9'0"	5-5-6-7		Fine Sand, little silt, trace brick?? (FILL)
						9'	
10		4	21"	10'0" - 12'0"	5-5-7-8		Brown, Fine Sand, little/some silt, wet
						15'	
15		5	6"	15'0" - 17'0"	10-11-15-16		Brown, fine to coarse Sand & Gravel
							(G LACIAL)
20		6	18"	20'0" – 22'0"	13-18-25-28		Brown, f-c Sand & Gravel, little silt, cobbles
							End of boring at 22 ft
							Water encountered at 9 ft upon completion
25							
30							
35							

Notes: Hollow Stem Auger Size 4-1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 4

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Site: Herb Chambers
83 Boston Post Road
Sudbury, MA.

BORING B-4

PROJECT NO. 18-0524

DATE: May 24, 2018

Ground Elevation:
Date Started: May 23, 2018
Date Finished: May 23, 2018
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
5/23/18	6 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						3"	Asphalt
1		1	12"	1'0" – 3'0"	5-6-8-7	3'	Dark Brown, fine to medium Sand, little gravel, little silt (FILL)
		2	6"	3'0" – 4'0"	5-5		Topsoil/ Subsoil (ORGANIC)
		2A	6"	4'0" – 5'0"	4-4	5'	
5		3	16"	5'0"- 7'0"	4-4-4-5		Brown, Fine Sand w/ silt, wet
		4	21"	7'0" – 9'0"	4-5-7-10		Brown, Fine Sand, some silt, wet (FLUVIAL)
10		5	16"	10'0" - 12'0"	6-7-7-8		Brown, Fine Sand, little/some silt
15		6	12"	15'0" - 17'0"	4-5-5-5		Same
						19'	
20		7	18"	20'0" – 22'0"	5-5-6-6		Brown, fine to medium Sand, trace silt (SAND)
25		8	16"	25'0" – 27'0"	6-7-8-8		End of boring at 27 ft Water encountered at 6 ft upon completion
30							
35							

Notes: Hollow Stem Auger Size 4-1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V Dense.
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 5

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Site: Herb Chambers
83 Boston Post Road
Sudbury, MA.

BORING B-5

PROJECT NO. 18-0524

DATE: May 24, 2018

Ground Elevation:
Date Started: May 23, 2018
Date Finished: May 23, 2018
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
5/23/18	7 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						3"	Asphalt
1		1	12"	1'0" – 3'0"	6-12-7-9		
		2	12"	3'0" – 5'0"	7-5-5-4	3'	Brown, fine to medium Sand & Gravel, trace silt (FILL)
5		3	6"	5'0"- 7'0"	3-2-3-5		Brown, f-m Sand, trace gravel, trace silt (FILL??)
		4	6"	7'0" – 9'0"	5-9-11-12	7'	Brown, fine to medium Sand, little gravel, little silt, wet
10		5	18"	10'0" - 12'0"	3-3-3-4		Brown, Fine Sand, little/some silt, wet
15		6	18"	15'0" - 17'0"	3-3-3-3		Brown, Fine Sand, little/some silt (FLUVIAL)
20		7	14"	20'0" – 22'0"	7-8-11-11		Same Occasional Sand lenses
25		8	24"	25'0" – 27'0"	7-7-8-12		Brown, f-m Sand, trace silt (SAND)
							End of boring at 27 ft Water encountered at 7 ft upon completion
30							
35							

Notes: Hollow Stem Auger Size 4-1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 6

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Herb Chambers
Site 83 Boston Post Road
Sudbury, MA.

BORING B-6

PROJECT NO. 18-0524

DATE: May 18, 2018

Ground Elevation:
Date Started: May 17, 2018
Date Finished: May 17, 2018
Driller: PG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
5/17/18	12 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	12"	0'0" – 2'0"	4-5-5-6		Tan, Fine Sand, little silt
		2	12"	2'0" – 4'0"	6-5-5-4		Brown, Fine Sand, little silt, trace gravel
5		3	18"	5'0"- 7'0"	4-3-4-5		Tan, Fine Sand, dry
		4	21"	7'0" – 9'0"	4-5-6-7		Tan, mottled, f-m Sand, little silt, dry
10		5	18"	10'0" - 12'0"	8-9-11-13		Brown, mottled, Fine Sand, some silt, damp
15		6	21"	15'0" - 17'0"	5-6-6-7		Brown, Fine Sand, some silt,, wet
20		7	21"	20'0" – 22'0"	8-8-9-11		Brown, Fine Sand, little silt, wet
							End of boring at 22 ft Water encountered at 12 ft upon completion
25							
30							
35							

Notes: Hollow Stem Auger Size 4-1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SHEET 7

Soil Exploration Corp.
Geotechnical Drilling
Groundwater Monitor Well
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Site: Herb Chambers
83 Boston Post Road
Sudbury, MA.

BORING B-7

PROJECT NO. 18-0524

DATE: May 24, 2018

Ground Elevation:
Date Started: May 23, 2018
Date Finished: May 23, 2018
Driller: TF
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION
5/23/18	6 ft	n/a	

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
						3"	Asphalt
1		1	12"	1'0" – 3'0"	8-7-8-6	3'	Brown, fine to medium Sand, little gravel, little silt (FILL)
		2	16"	3'0" – 5'0"	5-6-4-5	5'	Topsoil/ Subsoil (ORGANIC)
5		3	16"	5'0"- 7'0"	7-7-7-11		Brown, f-c Sand, trace gravel, wet
		4	18"	7'0" – 9'0"	8-9-9-11		Brown, f-m Sand, little silt, wet
10		5	16"	10'0" - 12'0"	8-8-4-7		Brown, f-m Sand, wet Fine Sand, some silt, wet
15		6	16"	15'0" - 17'0"	3-4-4-5		Brown, f-m Sand, trace silt, wet (SAND)
20		7	20"	20'0" – 22'0"	3-3-4-7		Brown, f-m Sand, trace silt, wet
25		8	12"	25'0" – 27'0"	5-7-7-10		Brown, f-m Sand, trace silt, wet
							End of boring at 27 ft Water encountered at 6 ft upon completion
30							
35							

Notes: Hollow Stem Auger Size 4-1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"