TECHNICAL REPORT IN SUPPORT OF A SPECIAL PERMIT

11 LEWIS STREET

ANDOVER, MASSACHUSETTS

NOVEMBER 15, 2023

SUBMITTED TO:

TOWN OF ANDOVER
PLANNING BOARD
36 BARTLETT STREET
ANDOVER, MA 01810

APPLICANT:

ANDOVER TOWN YARD, LLC
231 SUTTON STREET, SUITE 1B
NORTH ANDOVER, MA 01845

TECHNICAL REPORT

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DRAINAGE REPORT
Town Yard Development

I. Executive Summary

Andover Town Yard, LLC, the applicant, proposes to construct a multi-family residential building at 11 Lewis Street in Andover, Massachusetts ("site"). The project will include 164 residential units, commercial lease space, indoor amenity space including a public amenity building, public park space including an fenced in dog park, public parking spaces, private garage parking, landscaping improvements, stormwater management system and new utility infrastructure. The subject parcels consist of an aggregate land area of 4.125± acres and are shown on the Town of Andover Assessor's Map 38 as Lots 4, 15, 16, 32A and 35 which are situated in the Single Residence A, Mixed Use and General Business Zoning District. All the parcels are located within the Historic Mill Overlay District (HMD).

The project will require Site Plan Approval, HMD Special Permit and Stormwater Permit through the Andover Planning Board. As part of the project permitting, the proponent must demonstrate compliance with applicable stormwater best management practices and regulations. The following drainage report contains a description of existing and proposed site conditions, stormwater management design methodology and results summaries and other supplemental information in support of the stormwater best management system design.

II. Existing Site Description

The site consists of a total land area of 179,690 square feet (4.125± acres) and is a combination of five lots. The primary development parcel known as the "Town Yard" is the former Andover Department of Public Works site that consists of four (4) commercial buildings, material stockpile areas, gas filup station and accessory buildings. The Town Yard site is mostly paved. Areas that are not paved consist of compacted gravel and open land. It is mostly devoid of vegetation. The Town Yard parcel is under a land disposition agreement between the applicant and the Town of Andover. 122 North Main Street and and 35 Pearson Street consist of single family dwellings and are owned by the applicant. 2-4 Buxton Court and 7 Lewis Street consist of two-family dwellings and are owned by the applicant. The residential lots are fully developed with the dwelling, driveways and open yard areas, typical for the use. The five (5) lots shall collectively be referred to as the "site" herein.

The site contains 5 curb cuts, one on North Main Street, two on Pearson Street, one at the end of Buxton Ct and one at the end of Lewis Street. The site is bordered to the south by residentces, a preschool and home businesses along Pearson Street, the Andover Public Safety Center to the southeast, to the east by residential uses along Buxton Court and to the west by the MBTA Railroad. Refer to Figure 1: Ortho Map and Figure 2: USGS Locus Map for illustrations of the site and surrounding features.

Existing infrastructure on the site consists of an 8" water main which loops from Pearson Street to Lewis Street, drainage infrastructure which extends under the railroad to the west, an 8" sewer which extends down Buxton Court and under the railroad to the west, electric, communications and natural gas. These utilities were identified through a combination of public and private utiltiy records research, on the ground survey of the site and CCTV inspections of the gravity sewer systems. There are no stormwater management mitigation and treatment systems present on the site other than shallow catch basin sumps.

Grades on the site vary from 1.5% on the property south by Pearson Street curb cut, to 10.5% near curb cut on end of Lewis Street, to 20% on north portion, on lot with frontage to North Main Street. The site has a high elevation of approximately 118 (southeast corner of the site at Buxton Ct.) and low elevation of approximately 92 (northwest area near MBTA property line).

Soils on site is mapped as Urban land, Hydrologic Soil Group (HSG) B (602) according to the National Resource Conservation Service (NRCS) soil maps; Soil testing and soil boring information confirms the presence of approximately 4 feet of fill throughout the site. Beneath the fill, the native soil consists of a loamy sand "till" with bedrock verying in depth from 8 feet or greater below the ground surface. See Figure 3: SCS Soils Map for an illustration of the soil types.

The entire site is shown to be within a Zone X, area inundated by 500-year flooding according to the FEMA Federal Insurance Rate Map (FIRM) #25009C0217F, dated July 3, 2012 (See Figure 4: FEMA Flood Map). There are not restrictions to development within a zone x.

III. Proposed Site Description

The applicant proposes to construct a 165-unit multifamily residential building with associated parking, landscaping, stormwater management system and new utility connections and maintain the existing single-family dwelling on North Main Street. The project will also include an accessory public amenity building with a small commercial space, public parking, public and private park areas including a fenced in public dog park. All site improvements will comply with the Massachusetts Architectural Access Board (MAAB) for handicap access.

The multifamily residential building will be constructed of a combination of steel and wood up to 5 stories on the west side and 4 stories on the east side along Buxton Court. Parking will be provided beneath the entire building, including landscaped plazas on portions of the garage roof around the building. The footprint area of the building is 69,300± square feet. The accessory commercial and amenity building has a footprint area of 2,710± square feet will be constructed just south of the residential building. Drive aisles and surface parking are also proposed with a curb cut located on Pearson Street and another from Buxton Court. Additional public parking is proposed along frontage on Pearson Street.

Infrastructure associated with the development of the site will include the removal and replacement of the existing water, drainage, overhead-electrical and sewer services and construction of stormwater management infrastructure with other associated utilities including domestic water and fire protection services, natural gas, electrical, communications and fiber optic services. New utility connections will extend from Buxton Court and Pearson Street, with fire hydrants provided. The water main will be looped between Pearson and Buxton Court along the site driveway.

The proposed stormwater management system for the project will consist of various Best Management Practices ("BMP's") in both mitigating and renovating stormwater runoff. The entire stormwater system was designed in accordance with the Town of Andover's Stormwater Management and Erosion Control Regulations and the Massachusetts Stormwater Management Handbook ("Handbook"), which the Town of Andover references in its regulations. The measures to be implemented at the site includes a subsurface infiltration system utilizing Cultec Recharger 360HD, CDS water quality units and a Jellyfish Filter for phosphorous mitigation. Refer to the Grading & Drainage Plan and associated construction details for more information. The existing watershed characteristics, flow paths and drainage patterns were matched to the extent practicable in the proposed condition to demonstrate that there are no adverse impacts to adjacent properties at the design points.

IV. Stormwater Management

A. Existing Watershed Characteristics

Stormwater runoff exits the site in the existing condition at two (2) distinct locations. The location where stormwater runoff leaves the site boundary is called the design point ("DP"). DP1 is the existing double catch basin carrying water offsite under Pearson Street. DP2 is the western corner of the site where water flows onto Route 1. The design points and the tributary watersheds (or subcatchments) are illustrated on Sheet C-2.2 Pre-Development Watershed Plan. The table below lists the total area associated with each subcatchment area.

Summary of Existing Subcatchments

Existing Drainage Area (E)	Total Area (SF)	% Impervious	Composite Curve Number
ES-1	300,300	78.05%	88
ES-2	13,496	62.41%	84
Total	**313,796 (7.20 acres)**	**77.38%**	**88**

Description of Existing Subcatchments

The subcatchments analyzed in the existing condition can be described as follows:

- **Subcatchment ES1:** This area consists of the majority of the site, including off-site, Lewis Street, Buxton Court, woods behind the existing dwelling off North Main Street, all parking area and building roofs. The stormwater runoff from these areas drain to the MBTA property and end up in the public drainage system on Railroad Street.
- **Subcatchment ES2:** This subcatchment includes only the frontage of the site along Pearson Street and part of Pearson Street. It contains paved parking areas, landscaped areas and building roof. Stormwater from this area sheet flow west to the existing catch basins into the public drainage system.

B. Proposed Watershed Characteristics

The proposed development of the site will maintain the design points identified in the existing watershed analysis. In order to understand and analyze the proposed development, smaller subcatchments were delineated to analyze stormwater impacts on more detailed scale. The table below provides the total drainage area and the percentage that will be impervious in the post-development condition. The design points and the tributary watersheds (or subcatchments) are illustrated on Sheet C-5.2 Post Development Watershed Plan. The table below lists the total area associated with each subcatchment area.

Summary of Proposed Subcatchments

Proposed Drainage Area	Total Area (SF)	% Impervious	Composite Curve Number
PS-1	245,672	76.55	91
PS-1.1	58,367	65.93	88
PS-2	9,957	87.30	96
TOTALS	**313,796 (7.20 acres)**	**75.02%**	**90**

Description of Proposed Subcatchments

- **Subcatchment PS-1:** This area consists of some off-site areas that include the residential properties between North Main Street and Buxton Court, Lewis Street and Buxton Court, and the all southern piece of the development, to include building roofs, new road, courtyard area and pathway connecting Buxton Court to the Courtyard area.
- **Subcatchment PS-1.1:** This area consists of the northern proposed parking lot, dog park and part of the off-site area to include residential properties between North Main Street and Buxton Ct.
- **Subcatchment PS-2:** This area includes the southern parking lot, off of Pearson Street, the proposed curb cut and Pearson Street.

C. Hydrologic Analysis:

The purpose of the stormwater analysis is to demonstrate that the proposed development will not adversely impact the land or surrounding land. The industry standard for stormwater management design in Massachusetts is governed by the Massachusetts Stormwater Management Handbook ("Handbook")

published by the Mass Department of Environmental Protection, January 2008. The Town of Andover Stormwater Management and Erosion Control Bylaw and associated Regulations provide additional requirements including analyzing the 2, 10, 25 and 100-year storm events.

The Handbook lists 10 standards covering both mitigation and renovation of stormwater runoff. A full discussion on compliance with the standards can be found at the end of this report. However, the following section will summarize the projects compliance with the mitigation standards 1 and 2 of the Handbook relating to reducing peak rates of runoff and creating no adverse down gradient impacts.

In order to demonstrate that there will be no downstream impacts as a result of the proposed project, a stormwater analysis was performed using the U.S. Soil Conservation Service (S.C.S) method of analysis contained in Technical Release #20 (TR-20) published by the U.S. Conservation Service, along with the extreme precipitation values published by the Northeast Regional Climate Center. The software application HydroCAD was used to analyze the existing and proposed development watershed conditions. This application is widely used in the civil engineering industry and is an accepted means of performing a TR-20 analysis. It is a computer aided design program for analyzing the hydrology and hydraulics of storm water runoff. It utilizes the latest techniques of both fields to accurately predict the consequences of any given storm event. This analysis allows the engineer to verify that a given drainage system is adequate for the area under consideration and further allows the engineer to predict where flooding or erosion are most likely to occur. This model was used to analyze the storm drainage system designed for the development to demonstrate that the drainage system is in compliance with the Town's Stormwater Management Standards.

The HydroCAD analysis was performed by examining the two design points that were previously referenced. The following is a listing of the total existing and proposed development rates of stormwater runoff for the proposed development for the 2, 10, and 100-year rainfall events:

DP1 Peak Discharge Rates (CFS)				
Storm Event		**Existing Conditions**	**Proposed Conditions**	**Change in Peak**
2-yr	Outflow	15.7	15.7	0
10-yr	Outflow	28.7	28.7	0
25-yr	Outflow	36.7	36.4	-0.2
100-yr	Outflow	49.0	48.9	-0.1

DP2 Peak Discharge Rates (CFS)				
Storm Event		**Existing Conditions**	**Proposed Conditions**	**Change in Peak**
2-yr	Outflow	0.6	0.6	0
10-yr	Outflow	1.2	1.1	-0.1
25-yr	Outflow	1.5	1.3	-0.2
100-yr	Outflow	2.1	1.7	-0.4

D. Review of Stormwater Management Standards

The proposed development project is comprised of a mix of new development and redevelopment. The drainage system has been designed to attenuate peak rates of stormwater for all storm events up to and including the 100-year event. Measures will also be implemented to provide the required total suspended solids (TSS) removal where practicable, to ensure the stormwater runoff is renovated prior to discharge. A waiver will be required in order to meet Standard 4. The following is an assessment of each Standard as it relates to the proposed multi-family residential development project:

1. No stormwater conveyance system discharges untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth.

   The proposed development meets this standard. All stormwater runoff from the site will be collected in a closed drainage system and discharged to the public storm sewer on Railroad Avenue or Pearson Street. All stormwater runoff will receive at least 80% Total Suspended Solids removal and 70% phosphorus treatment before discharge to the public storm sewer.

2. The stormwater management system has been designed such that proposed peak rates of runoff do not exceed existing rates for all storm events considered.

   The proposed development meets this standard. A small infiltration system will be implemented to promote groundwater recharge and mitigate the post development rate of runoff prior to discharging to the Railroad Ave drainage system. Stormwater runoff to Pearson Street will be reduced by reduing the area of land tributary to the street.

3. Loss of annual recharge to groundwater has been eliminated or minimized through the use of environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance.

   The proposed development meets this standard. The site will result in a slight increase in impervious area. Groundwater will be recharged with a subsurface Cultec system to comply with this standard.

4. The proposed stormwater management system has been designed to remove a minimum of 80% of the average annual post-construction load of Total Suspended Solids (TSS) and about 70% of Total Phosphorous (TP).

   The proposed development meets this standard. All stormwater runoff from paved areas of the site will pass through a treatment train consisting catch basins, proprietary pretreatment CDS units and a jellyfish phosphorous treatment unit. A portion of the site will also be recharged which provides further treatment of stormwater runoff.

5. Land Uses with Higher Potential Pollutant Load.

   This standard does not apply.

6. Discharges to critical areas.

   This standard does not apply.

7. Redevelopment Projects: the project consists of a mix of new development and redevelopment.

   The project includes a mix of new development and redevelopment. All standards are fully met as described above and no relief is sought under this standard.

8. A Construction Phase Operation and Maintenance Plan in included herewith. A Stormwater Pollution Prevention Plan following the EPA guidelines under the National Pollutant Discharge Elimination System will be prepared prior to construction.

   The proposed development meets this standard.

9. A long-term operation and maintenance plan: A long-term O&M has been prepared to provide guidance for current and future owners to inspect and maintain the stormwater management systems in perpetuity. A copy of this O&M plan is included herein.

   The proposed development meets this standard.

10. Illicit discharges: To the best of our knowledge and belief there are no illicit discharges to the stormwater management system on this site. A certification is included herein.

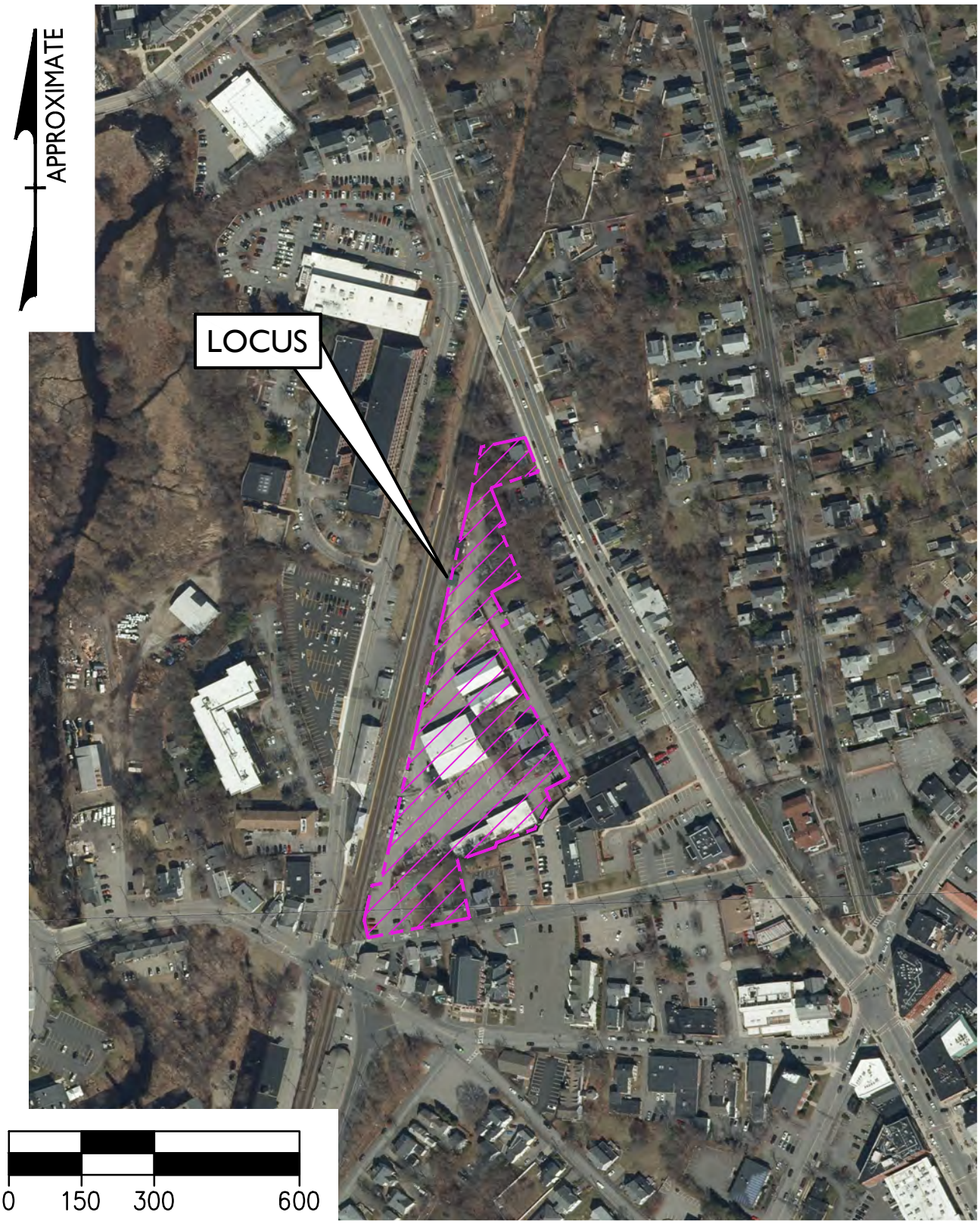
    The proposed development meets this standard.

V. Conclusion

The Town Yard development project fully complies with the Massachusetts Stormwater Management Handbook and Andover Stormwater & Erosion Control Bylaw.

For questions regarding this Drainage Report, please contact The Morin-Cameron Group, Inc. between the hours of 8:30am to 4:30pm at (978) 373-0310.

FIGURES



THE MORIN-CAMERON GROUP, INC.
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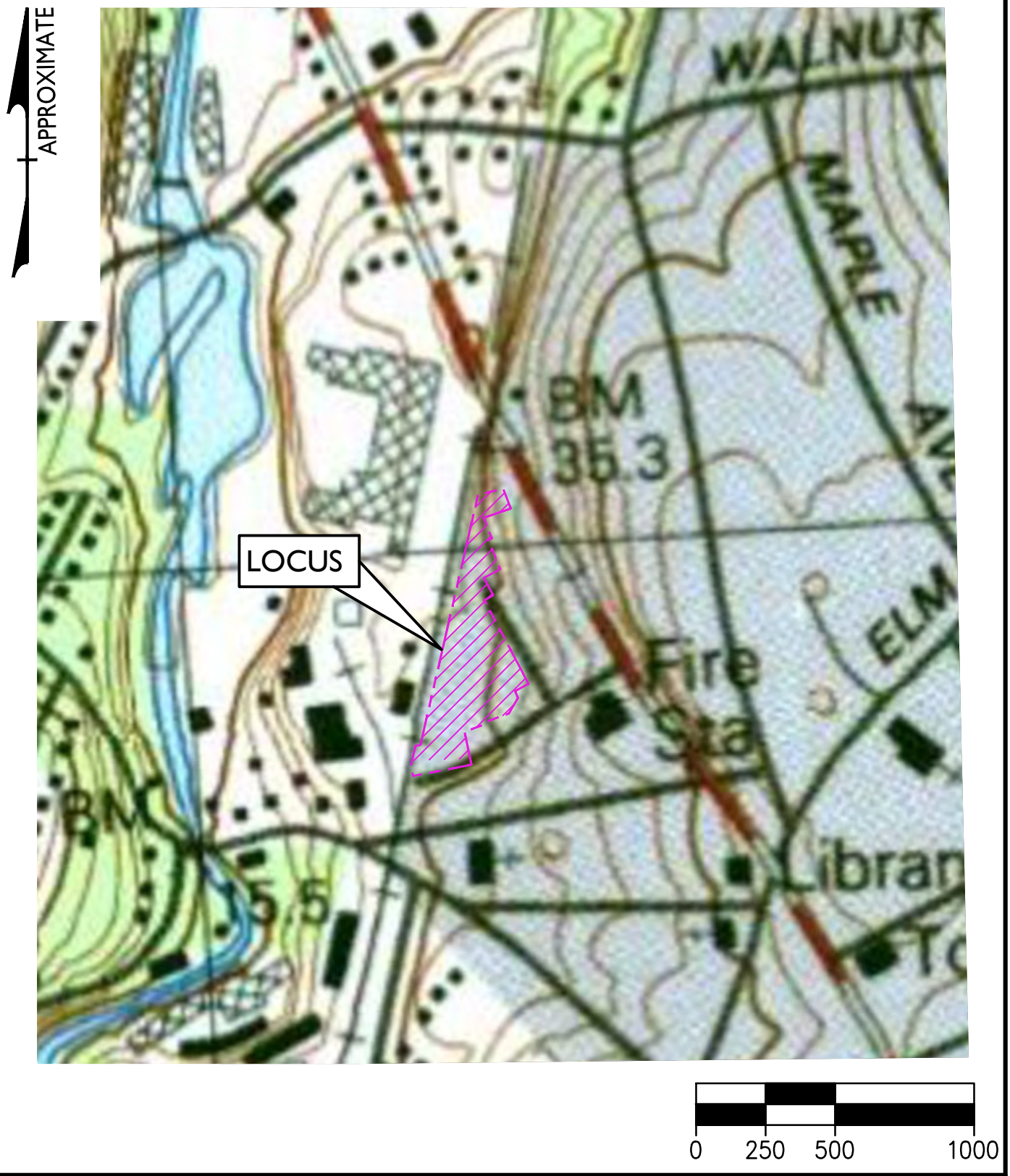
P: **978-777-8586**
WWW.MORINCAMERON.COM

ORTHO MAP
"ANDOVER TOWN YARD"
IN
ANDOVER, MA

DATE: NOVEMBER 15, 2023

Scale: 1" = 300'

FIGURE #1



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USGS MAP

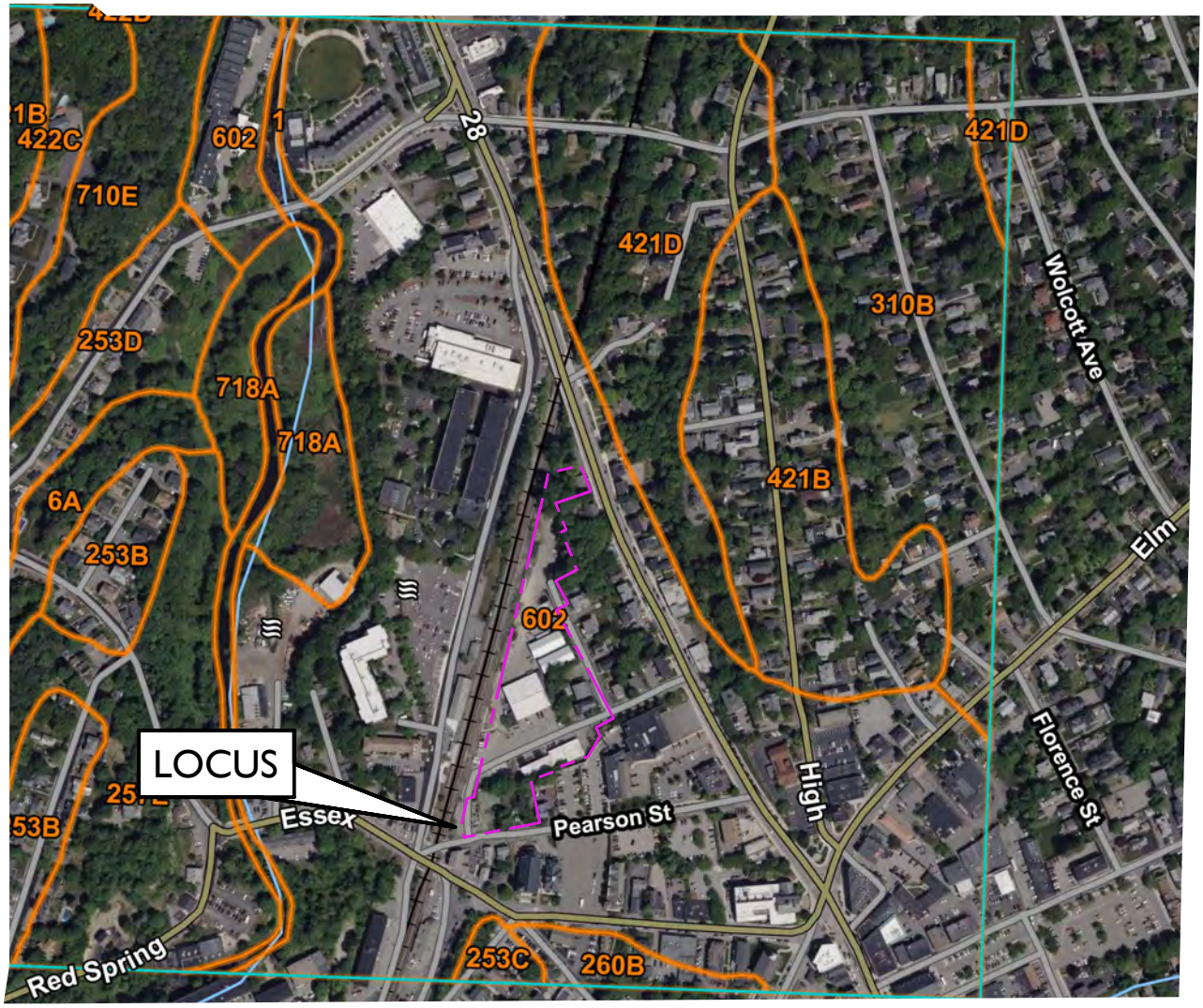
"ANDOVER TOWN YARD" IN ANDOVER, MA

DATE: NOVEMBER 15, 2023

SCALE: 1" = 500'

FIGURE #2

APPROXIMATE



LEGEND:

602 URBAN LAND

0 250 500 1000

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SCS SOILS MAP

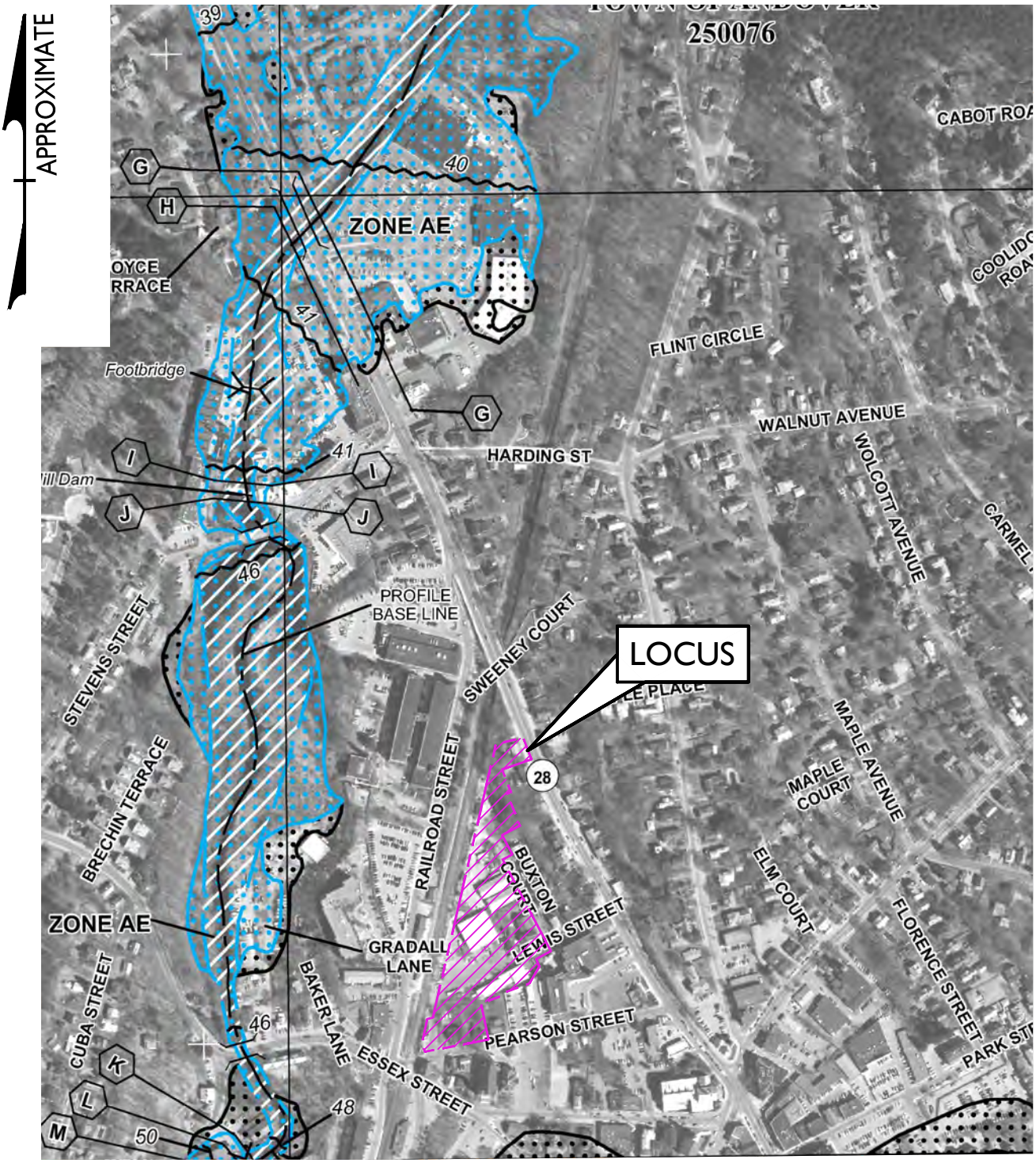
"ANDOVER TOWN YARD"

ANDOVER, MA

DATE: NOVEMBER 15, 2023

SCALE: 1" = 500'

FIGURE #3



FEMA MAP No: 25009C0217F

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FEMA MAP

"ANDOVER TOWN YARD" IN ANDOVER, MA

DATE: NOVEMBER 15, 2023

Scale: 1" = 500'

FIGURE #4

APPENDIX A:

MASSDEP STORMWATER

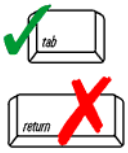
MANAGEMENT REPORT CHECKLIST

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

Checklist for Stormwater Report

A. Introduction

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



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

The Stormwater Report must include:

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

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

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

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

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

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

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

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

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

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

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

Registered Professional Engineer's Certification

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

Registered Professional Engineer Block and Signature

Signature and Date 11/05/23

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): Phosphorous Treatment

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;

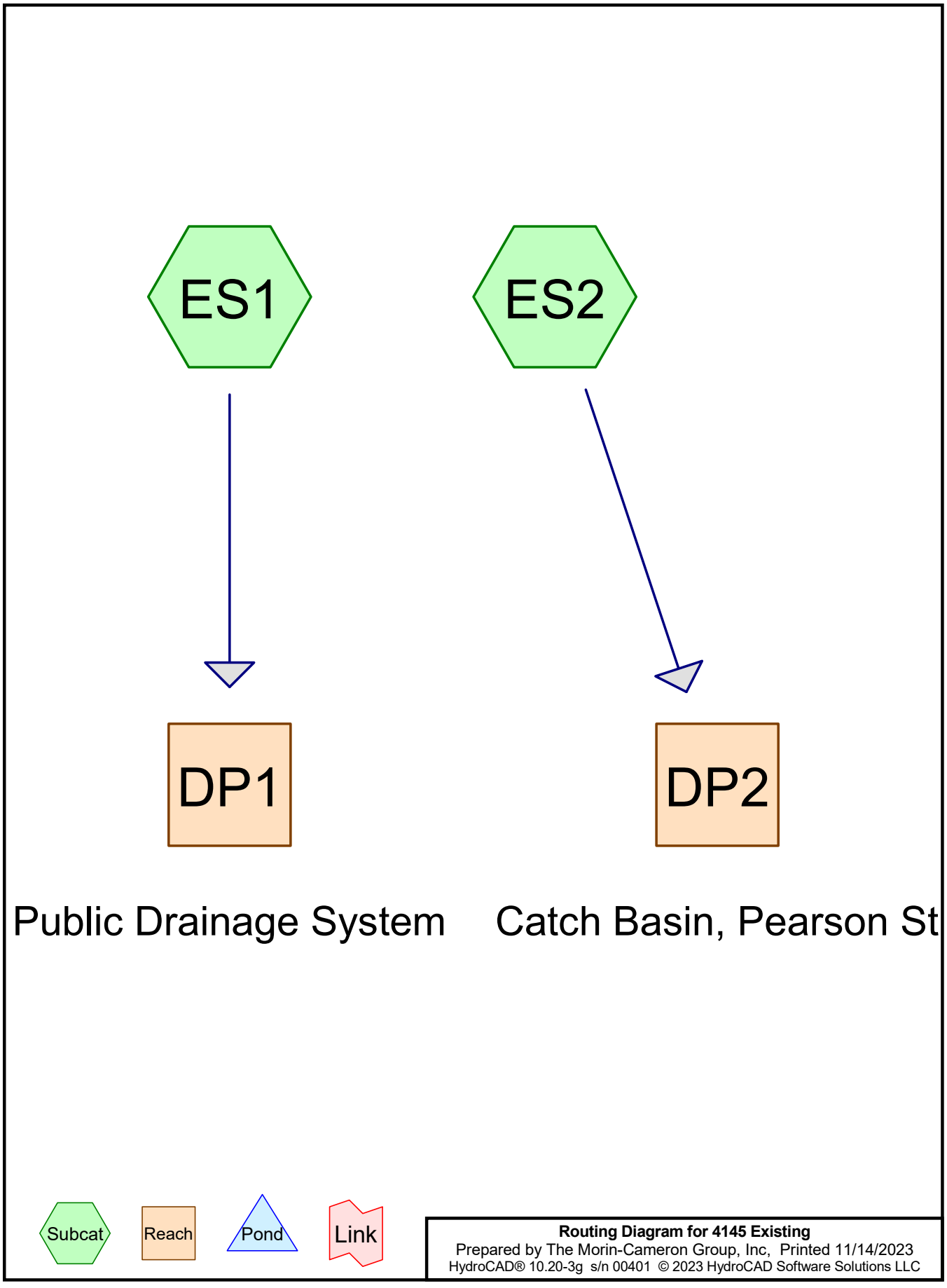
☒ An Illicit Discharge Compliance Statement is attached;

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

APPENDIX B:

EXISTING CONDITIONS

HYDROLOGIC ANALYSIS



Routing Diagram for 4145 Existing
Prepared by The Morin-Cameron Group, Inc, Printed 11/14/2023

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-yr	NOAA 24-hr	D	Default	24.00	1	3.16	2
2	10-yr	NOAA 24-hr	D	Default	24.00	1	5.01	2
3	25-yr	NOAA 24-hr	D	Default	24.00	1	6.16	2
4	100-yr	NOAA 24-hr	D	Default	24.00	1	7.94	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
91,247	85	1/8 acre lots, 65% imp, HSG B (ES1)
26,315	85	Gravel surface, HSG B "100% imp" (ES1)
26,935	61	Open space (50-75% Grass Cover), HSG B (ES1, ES2)
122,150	98	Paved parking, HSG B (ES1, ES2)
35,033	98	Roofs, HSG B (ES1, ES2)
12,116	55	Woods, HSG B (ES1)

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
313,796	HSG B	ES1, ES2
0	HSG C	
0	HSG D	
0	Other	

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

Subcatchment ES1: Runoff Area=300,300 sf 78.05% Impervious Runoff Depth=1.96"
Flow Length=592' Tc=6.0 min CN=88 Runoff=15.7 cfs 49,076 cf

Subcatchment ES2: Runoff Area=13,496 sf 62.41% Impervious Runoff Depth=1.65"
Flow Length=251' Tc=6.0 min CN=84 Runoff=0.6 cfs 1,854 cf

Reach DP1: Public Drainage System Inflow=15.7 cfs 49,076 cf
Outflow=15.7 cfs 49,076 cf

Reach DP2: Catch Basin, Pearson St Inflow=0.6 cfs 1,854 cf
Outflow=0.6 cfs 1,854 cf

Summary for Subcatchment ES1:

Runoff = 15.7 cfs @ 12.13 hrs, Volume= 49,076 cf, Depth= 1.96"
Routed to Reach DP1 : Public Drainage System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 2-yr Rainfall=3.16"

	Area (sf)	CN	Description
	114,973	98	Paved parking, HSG B
	33,787	98	Roofs, HSG B
*	12,116	55	Woods, HSG B
*	21,862	61	Open space (50-75% Grass Cover), HSG B
*	26,315	85	Gravel surface, HSG B "100% imp"
	91,247	85	1/8 acre lots, 65% imp, HSG B
	300,300	88	Weighted Average
	65,914		21.95% Pervious Area
	234,386		78.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	50	0.0900	2.17		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.15"
0.3	138	0.2029	9.14		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.4	128	0.0800	5.74		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.1	111	0.1050	15.92	12.51	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.1	87	0.1400	18.39	14.44	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	78	0.0100	4.91	3.86	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
4.4					**Direct Entry, Adjustment to 0.1hr**
6.0	592	Total			

Summary for Subcatchment ES2:

Runoff = 0.6 cfs @ 12.13 hrs, Volume= 1,854 cf, Depth= 1.65"
Routed to Reach DP2 : Catch Basin, Pearson St

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 2-yr Rainfall=3.16"

	Area (sf)	CN	Description
	7,177	98	Paved parking, HSG B
	1,246	98	Roofs, HSG B
*	5,073	61	Open space (50-75% Grass Cover), HSG B
	13,496	84	Weighted Average
	5,073		37.59% Pervious Area
	8,423		62.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0500	1.71		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.15"
0.4	121	0.0500	4.54		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.1	80	0.0400	9.83	7.72	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
5.0					**Direct Entry, Adjustment to 0.1hr**
6.0	251	Total			

Summary for Reach DP1: Public Drainage System

Inflow Area = 300,300 sf, 78.05% Impervious, Inflow Depth = 1.96" for 2-yr event
Inflow = 15.7 cfs @ 12.13 hrs, Volume= 49,076 cf
Outflow = 15.7 cfs @ 12.13 hrs, Volume= 49,076 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Catch Basin, Pearson St

Inflow Area = 13,496 sf, 62.41% Impervious, Inflow Depth = 1.65" for 2-yr event
Inflow = 0.6 cfs @ 12.13 hrs, Volume= 1,854 cf
Outflow = 0.6 cfs @ 12.13 hrs, Volume= 1,854 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

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

Subcatchment ES1: Runoff Area=300,300 sf 78.05% Impervious Runoff Depth=3.68"
Flow Length=592' Tc=6.0 min CN=88 Runoff=28.7 cfs 92,053 cf

Subcatchment ES2: Runoff Area=13,496 sf 62.41% Impervious Runoff Depth=3.28"
Flow Length=251' Tc=6.0 min CN=84 Runoff=1.2 cfs 3,688 cf

Reach DP1: Public Drainage System Inflow=28.7 cfs 92,053 cf
Outflow=28.7 cfs 92,053 cf

Reach DP2: Catch Basin, Pearson St Inflow=1.2 cfs 3,688 cf
Outflow=1.2 cfs 3,688 cf

Summary for Subcatchment ES1:

Runoff = 28.7 cfs @ 12.13 hrs, Volume= 92,053 cf, Depth= 3.68"
Routed to Reach DP1 : Public Drainage System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 10-yr Rainfall=5.01"

	Area (sf)	CN	Description
	114,973	98	Paved parking, HSG B
	33,787	98	Roofs, HSG B
*	12,116	55	Woods, HSG B
*	21,862	61	Open space (50-75% Grass Cover), HSG B
*	26,315	85	Gravel surface, HSG B "100% imp"
	91,247	85	1/8 acre lots, 65% imp, HSG B
	300,300	88	Weighted Average
	65,914		21.95% Pervious Area
	234,386		78.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	50	0.0900	2.17		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.15"
0.3	138	0.2029	9.14		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.4	128	0.0800	5.74		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.1	111	0.1050	15.92	12.51	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.1	87	0.1400	18.39	14.44	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	78	0.0100	4.91	3.86	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
4.4					**Direct Entry, Adjustment to 0.1hr**
6.0	592	Total			

Summary for Subcatchment ES2:

Runoff = 1.2 cfs @ 12.13 hrs, Volume= 3,688 cf, Depth= 3.28"
Routed to Reach DP2 : Catch Basin, Pearson St

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 10-yr Rainfall=5.01"

	Area (sf)	CN	Description
	7,177	98	Paved parking, HSG B
	1,246	98	Roofs, HSG B
*	5,073	61	Open space (50-75% Grass Cover), HSG B
	13,496	84	Weighted Average
	5,073		37.59% Pervious Area
	8,423		62.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0500	1.71		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.15"
0.4	121	0.0500	4.54		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.1	80	0.0400	9.83	7.72	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
5.0					**Direct Entry, Adjustment to 0.1hr**
6.0	251	Total			

Summary for Reach DP1: Public Drainage System

Inflow Area = 300,300 sf, 78.05% Impervious, Inflow Depth = 3.68" for 10-yr event
Inflow = 28.7 cfs @ 12.13 hrs, Volume= 92,053 cf
Outflow = 28.7 cfs @ 12.13 hrs, Volume= 92,053 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Catch Basin, Pearson St

Inflow Area = 13,496 sf, 62.41% Impervious, Inflow Depth = 3.28" for 10-yr event
Inflow = 1.2 cfs @ 12.13 hrs, Volume= 3,688 cf
Outflow = 1.2 cfs @ 12.13 hrs, Volume= 3,688 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

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

Subcatchment ES1: Runoff Area=300,300 sf 78.05% Impervious Runoff Depth=4.78"
Flow Length=592' Tc=6.0 min CN=88 Runoff=36.7 cfs 119,622 cf

Subcatchment ES2: Runoff Area=13,496 sf 62.41% Impervious Runoff Depth=4.35"
Flow Length=251' Tc=6.0 min CN=84 Runoff=1.5 cfs 4,888 cf

Reach DP1: Public Drainage System Inflow=36.7 cfs 119,622 cf
Outflow=36.7 cfs 119,622 cf

Reach DP2: Catch Basin, Pearson St Inflow=1.5 cfs 4,888 cf
Outflow=1.5 cfs 4,888 cf

Summary for Subcatchment ES1:

Runoff = 36.7 cfs @ 12.13 hrs, Volume= 119,622 cf, Depth= 4.78"
Routed to Reach DP1 : Public Drainage System

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

	Area (sf)	CN	Description
	114,973	98	Paved parking, HSG B
	33,787	98	Roofs, HSG B
*	12,116	55	Woods, HSG B
*	21,862	61	Open space (50-75% Grass Cover), HSG B
*	26,315	85	Gravel surface, HSG B "100% imp"
	91,247	85	1/8 acre lots, 65% imp, HSG B
	300,300	88	Weighted Average
	65,914		21.95% Pervious Area
	234,386		78.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	50	0.0900	2.17		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.15"
0.3	138	0.2029	9.14		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.4	128	0.0800	5.74		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.1	111	0.1050	15.92	12.51	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.1	87	0.1400	18.39	14.44	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	78	0.0100	4.91	3.86	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
4.4					**Direct Entry, Adjustment to 0.1hr**
6.0	592	Total			

Summary for Subcatchment ES2:

Runoff = 1.5 cfs @ 12.13 hrs, Volume= 4,888 cf, Depth= 4.35"
Routed to Reach DP2 : Catch Basin, Pearson St

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

	Area (sf)	CN	Description
	7,177	98	Paved parking, HSG B
	1,246	98	Roofs, HSG B
*	5,073	61	Open space (50-75% Grass Cover), HSG B
	13,496	84	Weighted Average
	5,073		37.59% Pervious Area
	8,423		62.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0500	1.71		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.15"
0.4	121	0.0500	4.54		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.1	80	0.0400	9.83	7.72	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
5.0					**Direct Entry, Adjustment to 0.1hr**
6.0	251	Total			

Summary for Reach DP1: Public Drainage System

Inflow Area = 300,300 sf, 78.05% Impervious, Inflow Depth = 4.78" for 25-yr event
Inflow = 36.7 cfs @ 12.13 hrs, Volume= 119,622 cf
Outflow = 36.7 cfs @ 12.13 hrs, Volume= 119,622 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Catch Basin, Pearson St

Inflow Area = 13,496 sf, 62.41% Impervious, Inflow Depth = 4.35" for 25-yr event
Inflow = 1.5 cfs @ 12.13 hrs, Volume= 4,888 cf
Outflow = 1.5 cfs @ 12.13 hrs, Volume= 4,888 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

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

Subcatchment ES1: Runoff Area=300,300 sf 78.05% Impervious Runoff Depth=6.51"
Flow Length=592' Tc=6.0 min CN=88 Runoff=49.0 cfs 162,901 cf

Subcatchment ES2: Runoff Area=13,496 sf 62.41% Impervious Runoff Depth=6.04"
Flow Length=251' Tc=6.0 min CN=84 Runoff=2.1 cfs 6,790 cf

Reach DP1: Public Drainage System Inflow=49.0 cfs 162,901 cf
Outflow=49.0 cfs 162,901 cf

Reach DP2: Catch Basin, Pearson St Inflow=2.1 cfs 6,790 cf
Outflow=2.1 cfs 6,790 cf

Summary for Subcatchment ES1:

Runoff = 49.0 cfs @ 12.13 hrs, Volume= 162,901 cf, Depth= 6.51"
Routed to Reach DP1 : Public Drainage System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 100-yr Rainfall=7.94"

	Area (sf)	CN	Description
	114,973	98	Paved parking, HSG B
	33,787	98	Roofs, HSG B
*	12,116	55	Woods, HSG B
*	21,862	61	Open space (50-75% Grass Cover), HSG B
*	26,315	85	Gravel surface, HSG B "100% imp"
	91,247	85	1/8 acre lots, 65% imp, HSG B
	300,300	88	Weighted Average
	65,914		21.95% Pervious Area
	234,386		78.05% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	50	0.0900	2.17		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.15"
0.3	138	0.2029	9.14		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.4	128	0.0800	5.74		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.1	111	0.1050	15.92	12.51	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.1	87	0.1400	18.39	14.44	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
0.3	78	0.0100	4.91	3.86	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
4.4					**Direct Entry, Adjustment to 0.1hr**
6.0	592	Total			

Summary for Subcatchment ES2:

Runoff = 2.1 cfs @ 12.13 hrs, Volume= 6,790 cf, Depth= 6.04"
Routed to Reach DP2 : Catch Basin, Pearson St

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 100-yr Rainfall=7.94"

	Area (sf)	CN	Description
	7,177	98	Paved parking, HSG B
	1,246	98	Roofs, HSG B
*	5,073	61	Open space (50-75% Grass Cover), HSG B
	13,496	84	Weighted Average
	5,073		37.59% Pervious Area
	8,423		62.41% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.5	50	0.0500	1.71		**Sheet Flow, Sheet Flow** Smooth surfaces n= 0.011 P2= 3.15"
0.4	121	0.0500	4.54		**Shallow Concentrated Flow, Shallow Concentrated** Paved Kv= 20.3 fps
0.1	80	0.0400	9.83	7.72	**Pipe Channel, RCP_Round 12"** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.012 Concrete pipe, finished
5.0					**Direct Entry, Adjustment to 0.1hr**
6.0	251	Total			

Summary for Reach DP1: Public Drainage System

Inflow Area = 300,300 sf, 78.05% Impervious, Inflow Depth = 6.51" for 100-yr event
Inflow = 49.0 cfs @ 12.13 hrs, Volume= 162,901 cf
Outflow = 49.0 cfs @ 12.13 hrs, Volume= 162,901 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Catch Basin, Pearson St

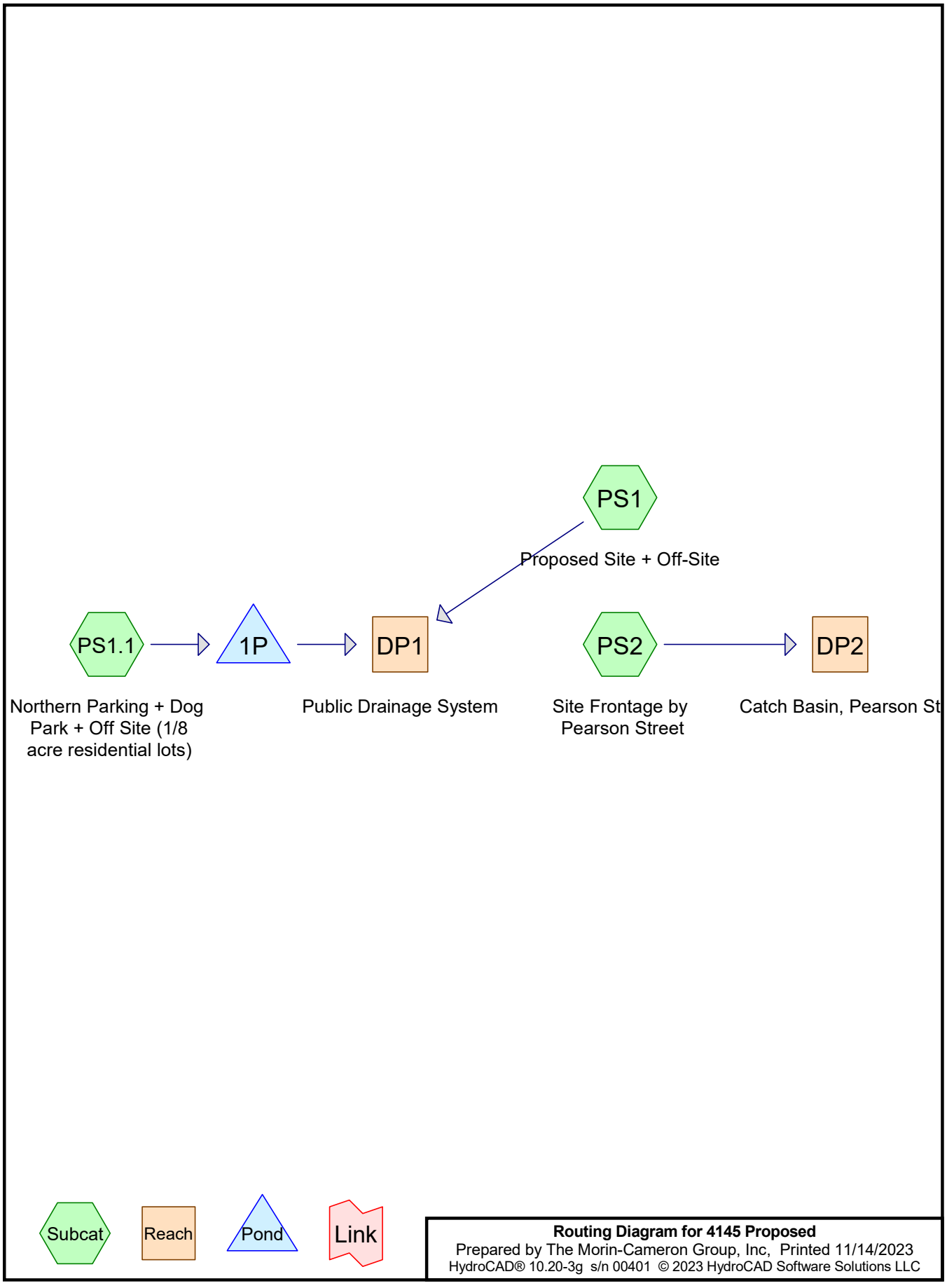
Inflow Area = 13,496 sf, 62.41% Impervious, Inflow Depth = 6.04" for 100-yr event
Inflow = 2.1 cfs @ 12.13 hrs, Volume= 6,790 cf
Outflow = 2.1 cfs @ 12.13 hrs, Volume= 6,790 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

APPENDIX C:

PROPOSED CONDITIONS

HYDROLOGIC ANALYSIS



Routing Diagram for 4145 Proposed
Prepared by The Morin-Cameron Group, Inc, Printed 11/14/2023

Rainfall Events Listing

Event#	Event Name	Storm Type	Curve	Mode	Duration (hours)	B/B	Depth (inches)	AMC
1	2-yr	NOAA 24-hr	D	Default	24.00	1	3.16	2
2	10-yr	NOAA 24-hr	D	Default	24.00	1	5.01	2
3	25-yr	NOAA 24-hr	D	Default	24.00	1	6.16	2
4	100-yr	NOAA 24-hr	D	Default	24.00	1	7.94	2

Area Listing (all nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
91,247	85	1/8 acre lots, 65% imp, HSG B (PS1, PS1.1)
14,391	85	Gravel surface, HSG B "100% imp" (PS1, PS2)
40,739	79	Open Space (75-100% grass cover), HSG B (PS1, PS1.1, PS2)
88,596	98	Paved parking, HSG B (PS1, PS1.1, PS2)
73,101	98	Roofs, HSG B (PS1)
5,722	55	Woods (PS1)

Soil Listing (all nodes)

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
308,074	HSG B	PS1, PS1.1, PS2
0	HSG C	
0	HSG D	
5,722	Other	PS1

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

Subcatchment PS1: Proposed Site + Runoff Area=245,672 sf 76.55% Impervious Runoff Depth=2.22"
Tc=6.0 min CN=91 Runoff=14.3 cfs 45,465 cf

Subcatchment PS1.1: Northern Parking + Runoff Area=58,367 sf 65.93% Impervious Runoff Depth=1.96"
Tc=6.0 min CN=88 Runoff=3.1 cfs 9,538 cf

Subcatchment PS2: Site Frontage by Runoff Area=9,757 sf 90.88% Impervious Runoff Depth=2.71"
Tc=6.0 min CN=96 Runoff=0.6 cfs 2,203 cf

Reach DP1: Public Drainage System Inflow=15.7 cfs 52,679 cf
Outflow=15.7 cfs 52,679 cf

Reach DP2: Catch Basin, Pearson St Inflow=0.6 cfs 2,203 cf
Outflow=0.6 cfs 2,203 cf

Pond 1P: Peak Elev=89.03' Storage=1,605 cf Inflow=3.1 cfs 9,538 cf
Discarded=0.0 cfs 2,324 cf Primary=1.7 cfs 7,215 cf Outflow=1.7 cfs 9,538 cf

Summary for Subcatchment PS1: Proposed Site + Off-Site

Runoff = 14.3 cfs @ 12.13 hrs, Volume= 45,465 cf, Depth= 2.22"
Routed to Reach DP1 : Public Drainage System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 2-yr Rainfall=3.16"

	Area (sf)	CN	Description
	62,700	98	Paved parking, HSG B
	73,101	98	Roofs, HSG B
*	31,313	79	Open Space (75-100% grass cover), HSG B
	58,820	85	1/8 acre lots, 65% imp, HSG B
*	14,016	85	Gravel surface, HSG B "100% imp"
*	5,722	55	Woods
	245,672	91	Weighted Average
	57,622		23.45% Pervious Area
	188,050		76.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Subcatchment PS1.1: Northern Parking + Dog Park + Off Site (1/8 acre residential lots)

Runoff = 3.1 cfs @ 12.13 hrs, Volume= 9,538 cf, Depth= 1.96"
Routed to Pond 1P :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 2-yr Rainfall=3.16"

	Area (sf)	CN	Description
*	17,404	98	Paved parking, HSG B
*	8,536	79	Open Space (75-100% grass cover), HSG B
	32,427	85	1/8 acre lots, 65% imp, HSG B
	58,367	88	Weighted Average
	19,885		34.07% Pervious Area
	38,482		65.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Subcatchment PS2: Site Frontage by Pearson Street

Runoff = 0.6 cfs @ 12.13 hrs, Volume= 2,203 cf, Depth= 2.71"
Routed to Reach DP2 : Catch Basin, Pearson St

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 2-yr Rainfall=3.16"

	Area (sf)	CN	Description
	8,492	98	Paved parking, HSG B
*	890	79	Open Space (75-100% grass cover), HSG B
*	375	85	Gravel surface, HSG B "100% imp"
	9,757	96	Weighted Average
	890		9.12% Pervious Area
	8,867		90.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Reach DP1: Public Drainage System

Inflow Area = 304,039 sf, 74.51% Impervious, Inflow Depth = 2.08" for 2-yr event
Inflow = 15.7 cfs @ 12.13 hrs, Volume= 52,679 cf
Outflow = 15.7 cfs @ 12.13 hrs, Volume= 52,679 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Catch Basin, Pearson St

Inflow Area = 9,757 sf, 90.88% Impervious, Inflow Depth = 2.71" for 2-yr event
Inflow = 0.6 cfs @ 12.13 hrs, Volume= 2,203 cf
Outflow = 0.6 cfs @ 12.13 hrs, Volume= 2,203 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 58,367 sf, 65.93% Impervious, Inflow Depth = 1.96" for 2-yr event
Inflow = 3.1 cfs @ 12.13 hrs, Volume= 9,538 cf
Outflow = 1.7 cfs @ 12.22 hrs, Volume= 9,538 cf, Atten= 45%, Lag= 5.2 min
Discarded = 0.0 cfs @ 12.22 hrs, Volume= 2,324 cf
Primary = 1.7 cfs @ 12.22 hrs, Volume= 7,215 cf
Routed to Reach DP1 : Public Drainage System

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 89.03' @ 12.22 hrs Surf.Area= 1,354 sf Storage= 1,605 cf

Plug-Flow detention time= 41.2 min calculated for 9,536 cf (100% of inflow)
Center-of-Mass det. time= 41.2 min (865.1 - 823.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	87.30'	1,325 cf	**24.25'W x 55.83'L x 4.00'H Field A** 5,416 cf Overall - 2,104 cf Embedded = 3,312 cf x 40.0% Voids
#2A	87.80'	2,104 cf	**Cultec R-360HD** x 56 Inside #1 Effective Size= 54.9"W x 36.0"H => 9.99 sf x 3.67'L = 36.6 cf Overall Size= 60.0"W x 36.0"H x 4.17'L with 0.50' Overlap

56 Chambers in 4 Rows
Cap Storage= 6.5 cf x 2 x 4 rows = 51.7 cf

3,429 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	87.80'	**18.0" Round 18" Outlet** L= 39.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 87.80' / 87.00' S= 0.0205 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	87.80'	**12.0" W x 4.0" H Vert. Orifice/Grate-2yr** C= 0.600 Limited to weir flow at low heads
#3	Device 1	89.00'	**6.0" Vert. Orifice/Grate-10yr X 3.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	89.90'	**5.0" Vert. Orifice/Grate-25yr X 3.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	90.70'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Discarded	87.30'	**1.020 in/hr Exfiltration over Wetted area** Phase-In= 0.01'

Discarded OutFlow Max=0.0 cfs @ 12.22 hrs HW=89.03' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=1.7 cfs @ 12.22 hrs HW=89.03' TW=0.00' (Dynamic Tailwater)
└**1=18" Outlet** (Passes 1.7 cfs of 4.6 cfs potential flow)
- **2=Orifice/Grate-2yr** (Orifice Controls 1.7 cfs @ 4.95 fps)
- **3=Orifice/Grate-10yr** (Orifice Controls 0.0 cfs @ 0.56 fps)
- **4=Orifice/Grate-25yr** (Controls 0.0 cfs)
- **5=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

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

Subcatchment PS1: Proposed Site + Runoff Area=245,672 sf 76.55% Impervious Runoff Depth=3.99"
Tc=6.0 min CN=91 Runoff=24.8 cfs 81,723 cf

Subcatchment PS1.1: Northern Parking + Runoff Area=58,367 sf 65.93% Impervious Runoff Depth=3.68"
Tc=6.0 min CN=88 Runoff=5.6 cfs 17,892 cf

Subcatchment PS2: Site Frontage by Runoff Area=9,757 sf 90.88% Impervious Runoff Depth=4.54"
Tc=6.0 min CN=96 Runoff=1.1 cfs 3,693 cf

Reach DP1: Public Drainage System Inflow=28.7 cfs 96,969 cf
Outflow=28.7 cfs 96,969 cf

Reach DP2: Catch Basin, Pearson St Inflow=1.1 cfs 3,693 cf
Outflow=1.1 cfs 3,693 cf

Pond 1P: Peak Elev=89.80' Storage=2,374 cf Inflow=5.6 cfs 17,892 cf
Discarded=0.0 cfs 2,646 cf Primary=4.3 cfs 15,246 cf Outflow=4.3 cfs 17,892 cf

Summary for Subcatchment PS1: Proposed Site + Off-Site

Runoff = 24.8 cfs @ 12.13 hrs, Volume= 81,723 cf, Depth= 3.99"
Routed to Reach DP1 : Public Drainage System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 10-yr Rainfall=5.01"

	Area (sf)	CN	Description
	62,700	98	Paved parking, HSG B
	73,101	98	Roofs, HSG B
*	31,313	79	Open Space (75-100% grass cover), HSG B
	58,820	85	1/8 acre lots, 65% imp, HSG B
*	14,016	85	Gravel surface, HSG B "100% imp"
*	5,722	55	Woods
	245,672	91	Weighted Average
	57,622		23.45% Pervious Area
	188,050		76.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Subcatchment PS1.1: Northern Parking + Dog Park + Off Site (1/8 acre residential lots)

Runoff = 5.6 cfs @ 12.13 hrs, Volume= 17,892 cf, Depth= 3.68"
Routed to Pond 1P :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 10-yr Rainfall=5.01"

	Area (sf)	CN	Description
*	17,404	98	Paved parking, HSG B
*	8,536	79	Open Space (75-100% grass cover), HSG B
	32,427	85	1/8 acre lots, 65% imp, HSG B
	58,367	88	Weighted Average
	19,885		34.07% Pervious Area
	38,482		65.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Subcatchment PS2: Site Frontage by Pearson Street

Runoff = 1.1 cfs @ 12.13 hrs, Volume= 3,693 cf, Depth= 4.54"
Routed to Reach DP2 : Catch Basin, Pearson St

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 10-yr Rainfall=5.01"

	Area (sf)	CN	Description
	8,492	98	Paved parking, HSG B
*	890	79	Open Space (75-100% grass cover), HSG B
*	375	85	Gravel surface, HSG B "100% imp"
	9,757	96	Weighted Average
	890		9.12% Pervious Area
	8,867		90.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Reach DP1: Public Drainage System

Inflow Area = 304,039 sf, 74.51% Impervious, Inflow Depth = 3.83" for 10-yr event
Inflow = 28.7 cfs @ 12.13 hrs, Volume= 96,969 cf
Outflow = 28.7 cfs @ 12.13 hrs, Volume= 96,969 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Catch Basin, Pearson St

Inflow Area = 9,757 sf, 90.88% Impervious, Inflow Depth = 4.54" for 10-yr event
Inflow = 1.1 cfs @ 12.13 hrs, Volume= 3,693 cf
Outflow = 1.1 cfs @ 12.13 hrs, Volume= 3,693 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 58,367 sf, 65.93% Impervious, Inflow Depth = 3.68" for 10-yr event
Inflow = 5.6 cfs @ 12.13 hrs, Volume= 17,892 cf
Outflow = 4.3 cfs @ 12.18 hrs, Volume= 17,892 cf, Atten= 22%, Lag= 2.9 min
Discarded = 0.0 cfs @ 12.18 hrs, Volume= 2,646 cf
Primary = 4.3 cfs @ 12.18 hrs, Volume= 15,246 cf
Routed to Reach DP1 : Public Drainage System

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 89.80' @ 12.18 hrs Surf.Area= 1,354 sf Storage= 2,374 cf

Plug-Flow detention time= 29.6 min calculated for 17,887 cf (100% of inflow)
Center-of-Mass det. time= 29.7 min (833.8 - 804.2)

Volume	Invert	Avail.Storage	Storage Description
#1A	87.30'	1,325 cf	**24.25'W x 55.83'L x 4.00'H Field A** 5,416 cf Overall - 2,104 cf Embedded = 3,312 cf x 40.0% Voids
#2A	87.80'	2,104 cf	**Cultec R-360HD** x 56 Inside #1 Effective Size= 54.9"W x 36.0"H => 9.99 sf x 3.67'L = 36.6 cf Overall Size= 60.0"W x 36.0"H x 4.17'L with 0.50' Overlap

56 Chambers in 4 Rows
Cap Storage= 6.5 cf x 2 x 4 rows = 51.7 cf

3,429 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	87.80'	**18.0" Round 18" Outlet** L= 39.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 87.80' / 87.00' S= 0.0205 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	87.80'	**12.0" W x 4.0" H Vert. Orifice/Grate-2yr** C= 0.600 Limited to weir flow at low heads
#3	Device 1	89.00'	**6.0" Vert. Orifice/Grate-10yr X 3.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	89.90'	**5.0" Vert. Orifice/Grate-25yr X 3.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	90.70'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Discarded	87.30'	**1.020 in/hr Exfiltration over Wetted area** Phase-In= 0.01'

Discarded OutFlow Max=0.0 cfs @ 12.18 hrs HW=89.80' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=4.3 cfs @ 12.18 hrs HW=89.80' TW=0.00' (Dynamic Tailwater)
└**1=18" Outlet** (Passes 4.3 cfs of 7.5 cfs potential flow)
  ├**2=Orifice/Grate-2yr** (Orifice Controls 2.2 cfs @ 6.52 fps)
  ├**3=Orifice/Grate-10yr** (Orifice Controls 2.1 cfs @ 3.57 fps)
  ├**4=Orifice/Grate-25yr** (Controls 0.0 cfs)
  └**5=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

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

Subcatchment PS1: Proposed Site + Runoff Area=245,672 sf 76.55% Impervious Runoff Depth=5.11"
Tc=6.0 min CN=91 Runoff=31.3 cfs 104,695 cf

Subcatchment PS1.1: Northern Parking + Runoff Area=58,367 sf 65.93% Impervious Runoff Depth=4.78"
Tc=6.0 min CN=88 Runoff=7.1 cfs 23,250 cf

Subcatchment PS2: Site Frontage by Runoff Area=9,757 sf 90.88% Impervious Runoff Depth=5.69"
Tc=6.0 min CN=96 Runoff=1.3 cfs 4,624 cf

Reach DP1: Public Drainage System Inflow=36.4 cfs 125,159 cf
Outflow=36.4 cfs 125,159 cf

Reach DP2: Catch Basin, Pearson St Inflow=1.3 cfs 4,624 cf
Outflow=1.3 cfs 4,624 cf

Pond 1P: Peak Elev=90.23' Storage=2,760 cf Inflow=7.1 cfs 23,250 cf
Discarded=0.0 cfs 2,786 cf Primary=5.9 cfs 20,464 cf Outflow=6.0 cfs 23,250 cf

Summary for Subcatchment PS1: Proposed Site + Off-Site

Runoff = 31.3 cfs @ 12.13 hrs, Volume= 104,695 cf, Depth= 5.11"
Routed to Reach DP1 : Public Drainage System

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

	Area (sf)	CN	Description
	62,700	98	Paved parking, HSG B
	73,101	98	Roofs, HSG B
*	31,313	79	Open Space (75-100% grass cover), HSG B
	58,820	85	1/8 acre lots, 65% imp, HSG B
*	14,016	85	Gravel surface, HSG B "100% imp"
*	5,722	55	Woods
	245,672	91	Weighted Average
	57,622		23.45% Pervious Area
	188,050		76.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Subcatchment PS1.1: Northern Parking + Dog Park + Off Site (1/8 acre residential lots)

Runoff = 7.1 cfs @ 12.13 hrs, Volume= 23,250 cf, Depth= 4.78"
Routed to Pond 1P :

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

	Area (sf)	CN	Description
*	17,404	98	Paved parking, HSG B
*	8,536	79	Open Space (75-100% grass cover), HSG B
	32,427	85	1/8 acre lots, 65% imp, HSG B
	58,367	88	Weighted Average
	19,885		34.07% Pervious Area
	38,482		65.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Subcatchment PS2: Site Frontage by Pearson Street

Runoff = 1.3 cfs @ 12.13 hrs, Volume= 4,624 cf, Depth= 5.69"
Routed to Reach DP2 : Catch Basin, Pearson St

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

	Area (sf)	CN	Description
	8,492	98	Paved parking, HSG B
*	890	79	Open Space (75-100% grass cover), HSG B
*	375	85	Gravel surface, HSG B "100% imp"
	9,757	96	Weighted Average
	890		9.12% Pervious Area
	8,867		90.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Reach DP1: Public Drainage System

Inflow Area = 304,039 sf, 74.51% Impervious, Inflow Depth = 4.94" for 25-yr event
Inflow = 36.4 cfs @ 12.13 hrs, Volume= 125,159 cf
Outflow = 36.4 cfs @ 12.13 hrs, Volume= 125,159 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Catch Basin, Pearson St

Inflow Area = 9,757 sf, 90.88% Impervious, Inflow Depth = 5.69" for 25-yr event
Inflow = 1.3 cfs @ 12.13 hrs, Volume= 4,624 cf
Outflow = 1.3 cfs @ 12.13 hrs, Volume= 4,624 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 58,367 sf, 65.93% Impervious, Inflow Depth = 4.78" for 25-yr event
Inflow = 7.1 cfs @ 12.13 hrs, Volume= 23,250 cf
Outflow = 6.0 cfs @ 12.17 hrs, Volume= 23,250 cf, Atten= 16%, Lag= 2.4 min
Discarded = 0.0 cfs @ 12.17 hrs, Volume= 2,786 cf
Primary = 5.9 cfs @ 12.17 hrs, Volume= 20,464 cf
Routed to Reach DP1 : Public Drainage System

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 90.23' @ 12.17 hrs Surf.Area= 1,354 sf Storage= 2,760 cf

Plug-Flow detention time= 26.0 min calculated for 23,243 cf (100% of inflow)
Center-of-Mass det. time= 26.0 min (822.1 - 796.1)

Volume	Invert	Avail.Storage	Storage Description
#1A	87.30'	1,325 cf	**24.25'W x 55.83'L x 4.00'H Field A** 5,416 cf Overall - 2,104 cf Embedded = 3,312 cf x 40.0% Voids
#2A	87.80'	2,104 cf	**Cultec R-360HD** x 56 Inside #1 Effective Size= 54.9"W x 36.0"H => 9.99 sf x 3.67'L = 36.6 cf Overall Size= 60.0"W x 36.0"H x 4.17'L with 0.50' Overlap

56 Chambers in 4 Rows
Cap Storage= 6.5 cf x 2 x 4 rows = 51.7 cf

3,429 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	87.80'	**18.0" Round 18" Outlet** L= 39.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 87.80' / 87.00' S= 0.0205 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	87.80'	**12.0" W x 4.0" H Vert. Orifice/Grate-2yr** C= 0.600 Limited to weir flow at low heads
#3	Device 1	89.00'	**6.0" Vert. Orifice/Grate-10yr X 3.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	89.90'	**5.0" Vert. Orifice/Grate-25yr X 3.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	90.70'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Discarded	87.30'	**1.020 in/hr Exfiltration over Wetted area** Phase-In= 0.01'

Discarded OutFlow Max=0.0 cfs @ 12.17 hrs HW=90.23' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=5.9 cfs @ 12.17 hrs HW=90.23' TW=0.00' (Dynamic Tailwater)
└**1=18" Outlet** (Passes 5.9 cfs of 8.7 cfs potential flow)
- **2=Orifice/Grate-2yr** (Orifice Controls 2.4 cfs @ 7.25 fps)
- **3=Orifice/Grate-10yr** (Orifice Controls 2.8 cfs @ 4.78 fps)
- **4=Orifice/Grate-25yr** (Orifice Controls 0.7 cfs @ 1.97 fps)
- **5=Broad-Crested Rectangular Weir** (Controls 0.0 cfs)

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

Subcatchment PS1: Proposed Site + Runoff Area=245,672 sf 76.55% Impervious Runoff Depth=6.87"
Tc=6.0 min CN=91 Runoff=41.2 cfs 140,549 cf

Subcatchment PS1.1: Northern Parking + Runoff Area=58,367 sf 65.93% Impervious Runoff Depth=6.51"
Tc=6.0 min CN=88 Runoff=9.5 cfs 31,662 cf

Subcatchment PS2: Site Frontage by Runoff Area=9,757 sf 90.88% Impervious Runoff Depth=7.46"
Tc=6.0 min CN=96 Runoff=1.7 cfs 6,066 cf

Reach DP1: Public Drainage System Inflow=48.9 cfs 169,274 cf
Outflow=48.9 cfs 169,274 cf

Reach DP2: Catch Basin, Pearson St Inflow=1.7 cfs 6,066 cf
Outflow=1.7 cfs 6,066 cf

Pond 1P: Peak Elev=90.85' Storage=3,186 cf Inflow=9.5 cfs 31,662 cf
Discarded=0.0 cfs 2,937 cf Primary=8.7 cfs 28,725 cf Outflow=8.7 cfs 31,662 cf

Summary for Subcatchment PS1: Proposed Site + Off-Site

Runoff = 41.2 cfs @ 12.13 hrs, Volume= 140,549 cf, Depth= 6.87"
Routed to Reach DP1 : Public Drainage System

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 100-yr Rainfall=7.94"

	Area (sf)	CN	Description
	62,700	98	Paved parking, HSG B
	73,101	98	Roofs, HSG B
*	31,313	79	Open Space (75-100% grass cover), HSG B
	58,820	85	1/8 acre lots, 65% imp, HSG B
*	14,016	85	Gravel surface, HSG B "100% imp"
*	5,722	55	Woods
	245,672	91	Weighted Average
	57,622		23.45% Pervious Area
	188,050		76.55% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Subcatchment PS1.1: Northern Parking + Dog Park + Off Site (1/8 acre residential lots)

Runoff = 9.5 cfs @ 12.13 hrs, Volume= 31,662 cf, Depth= 6.51"
Routed to Pond 1P :

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 100-yr Rainfall=7.94"

	Area (sf)	CN	Description
*	17,404	98	Paved parking, HSG B
*	8,536	79	Open Space (75-100% grass cover), HSG B
	32,427	85	1/8 acre lots, 65% imp, HSG B
	58,367	88	Weighted Average
	19,885		34.07% Pervious Area
	38,482		65.93% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Subcatchment PS2: Site Frontage by Pearson Street

Runoff = 1.7 cfs @ 12.13 hrs, Volume= 6,066 cf, Depth= 7.46"
Routed to Reach DP2 : Catch Basin, Pearson St

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
NOAA 24-hr D 100-yr Rainfall=7.94"

	Area (sf)	CN	Description
	8,492	98	Paved parking, HSG B
*	890	79	Open Space (75-100% grass cover), HSG B
*	375	85	Gravel surface, HSG B "100% imp"
	9,757	96	Weighted Average
	890		9.12% Pervious Area
	8,867		90.88% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry, Adjustment to 0.1hr**

Summary for Reach DP1: Public Drainage System

Inflow Area = 304,039 sf, 74.51% Impervious, Inflow Depth = 6.68" for 100-yr event
Inflow = 48.9 cfs @ 12.14 hrs, Volume= 169,274 cf
Outflow = 48.9 cfs @ 12.14 hrs, Volume= 169,274 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Reach DP2: Catch Basin, Pearson St

Inflow Area = 9,757 sf, 90.88% Impervious, Inflow Depth = 7.46" for 100-yr event
Inflow = 1.7 cfs @ 12.13 hrs, Volume= 6,066 cf
Outflow = 1.7 cfs @ 12.13 hrs, Volume= 6,066 cf, Atten= 0%, Lag= 0.0 min

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs

Summary for Pond 1P:

Inflow Area = 58,367 sf, 65.93% Impervious, Inflow Depth = 6.51" for 100-yr event
Inflow = 9.5 cfs @ 12.13 hrs, Volume= 31,662 cf
Outflow = 8.7 cfs @ 12.16 hrs, Volume= 31,662 cf, Atten= 8%, Lag= 1.7 min
Discarded = 0.0 cfs @ 12.16 hrs, Volume= 2,937 cf
Primary = 8.7 cfs @ 12.16 hrs, Volume= 28,725 cf
Routed to Reach DP1 : Public Drainage System

Routing by Dyn-Stor-Ind method, Time Span= 0.00-36.00 hrs, dt= 0.01 hrs
Peak Elev= 90.85' @ 12.16 hrs Surf.Area= 1,354 sf Storage= 3,186 cf

Plug-Flow detention time= 22.4 min calculated for 31,653 cf (100% of inflow)
Center-of-Mass det. time= 22.4 min (809.3 - 786.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	87.30'	1,325 cf	**24.25'W x 55.83'L x 4.00'H Field A** 5,416 cf Overall - 2,104 cf Embedded = 3,312 cf x 40.0% Voids
#2A	87.80'	2,104 cf	**Cultec R-360HD** x 56 Inside #1 Effective Size= 54.9"W x 36.0"H => 9.99 sf x 3.67'L = 36.6 cf Overall Size= 60.0"W x 36.0"H x 4.17'L with 0.50' Overlap

56 Chambers in 4 Rows
Cap Storage= 6.5 cf x 2 x 4 rows = 51.7 cf

3,429 cf Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	87.80'	**18.0" Round 18" Outlet** L= 39.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 87.80' / 87.00' S= 0.0205 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf
#2	Device 1	87.80'	**12.0" W x 4.0" H Vert. Orifice/Grate-2yr** C= 0.600 Limited to weir flow at low heads
#3	Device 1	89.00'	**6.0" Vert. Orifice/Grate-10yr X 3.00** C= 0.600 Limited to weir flow at low heads
#4	Device 1	89.90'	**5.0" Vert. Orifice/Grate-25yr X 3.00** C= 0.600 Limited to weir flow at low heads
#5	Device 1	90.70'	**4.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#6	Discarded	87.30'	**1.020 in/hr Exfiltration over Wetted area** Phase-In= 0.01'

Discarded OutFlow Max=0.0 cfs @ 12.16 hrs HW=90.85' (Free Discharge)
└**6=Exfiltration** (Exfiltration Controls 0.0 cfs)

Primary OutFlow Max=8.7 cfs @ 12.16 hrs HW=90.85' TW=0.00' (Dynamic Tailwater)
└**1=18" Outlet** (Passes 8.7 cfs of 10.2 cfs potential flow)
- **2=Orifice/Grate-2yr** (Orifice Controls 2.7 cfs @ 8.17 fps)
- **3=Orifice/Grate-10yr** (Orifice Controls 3.6 cfs @ 6.09 fps)
- **4=Orifice/Grate-25yr** (Orifice Controls 1.7 cfs @ 4.14 fps)
- **5=Broad-Crested Rectangular Weir** (Weir Controls 0.6 cfs @ 1.08 fps)

APPENDIX D:

SUPPLEMENTAL STORMWATER MANAGEMENT CALCULATIONS

November 15, 2023

Stormwater Management Calculations

STANDARD 3: Recharge To Groundwater: Static Method

- Calculate Impervious Area *(From HydroCAD Model)*

Description	Existing Impervious Area	Proposed Impervious Area
Gravel Surface	26,315	14,391
Paved Parking	122,150	88,596
Roof	35,033	73,101
Total:	**183,498**	**176,088**

This project development will be decreasing the impervious areas by 7,410 S.F, therefore no recharge volume is required. However, a subsurface recharging system has been proposed. See calculation below depicting the volume to be recharged.

- Calculate Provided Recharge
  Proposed Recharge System provided in infiltration basin

HCAD System ID	Bottom of System	Lowest System Outlet	Total Recharge Volume Provided
Bottom of System	87.3	89	**2,466**

Recharge volume provided measured to lowest system outlet.

Verify Drawdown, Maximum 72-Hours: Static Method

HCAD System ID	Recharge Volume (CF)	Bottom Surface Area (SF)	Infiltration Rate Inches/Hour	Drawdown Time Rv / (K x A) (Hours)	Description
1P	2,466	1,354	1.02	21.4	Subsurface Chambers

Design Complies with Recharge Volume Standard*

November 15, 2023

STANDARD 4: Water Quality Volume

The proposed development will be utilizing a CDS Water Quality Unit to treat the stormwater that will be directed to the stormwater subsurface system and will also utilize a Contech Jellyfish filter that will treat Total Phosphorous up to 70%. See TSS removal calculations attached.

Project: Andover Town Yard
Location: Andover, MA
Prepared For: The Morin Cameron Group

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

$$Q = (qu)\ (A)\ (WQV)$$

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
WQU-1	0.85	0.0013281	6.0	0.100	1.00	774.00	1.03

CONTECH ENGINEERED SOLUTIONS

CDS TECHNOLOGIES

CDS ESTIMATED NET ANNUAL SOLIDS LOAD REDUCTION
BASED ON THE RATIONAL RAINFALL METHOD

ANDOVER TOWN YARD
ANDOVER, MA

Area	**0.85 ac**	Unit Site Designation	**WQU-1**
Weighted C	**0.9**	Rainfall Station #	**69**
t_c	**6 min**		
CDS Model	**2015-4**	CDS Treatment Capacity	**1.4 cfs**

Rainfall Intensity[1] (in/hr)	Percent Rainfall Volume[1]	Cumulative Rainfall Volume	Total Flowrate (cfs)	Treated Flowrate (cfs)	Incremental Removal (%)
0.02	10.2%	10.2%	0.02	0.02	9.8
0.04	9.6%	19.8%	0.03	0.03	9.2
0.06	9.4%	29.3%	0.05	0.05	9.0
0.08	7.7%	37.0%	0.06	0.06	7.3
0.10	8.6%	45.6%	0.08	0.08	8.0
0.12	6.3%	51.9%	0.09	0.09	5.8
0.14	4.7%	56.5%	0.11	0.11	4.3
0.16	4.6%	61.2%	0.12	0.12	4.2
0.18	3.5%	64.7%	0.14	0.14	3.2
0.20	4.3%	69.1%	0.15	0.15	3.9
0.25	8.0%	77.1%	0.19	0.19	7.0
0.30	5.6%	82.7%	0.23	0.23	4.8
0.35	4.4%	87.0%	0.27	0.27	3.7
0.40	2.5%	89.5%	0.31	0.31	2.1
0.45	2.5%	92.1%	0.34	0.34	2.0
0.50	1.4%	93.5%	0.38	0.38	1.1
0.75	5.0%	98.5%	0.57	0.57	3.5
1.00	1.0%	99.5%	0.77	0.77	0.6
1.50	0.0%	99.5%	1.15	1.15	0.0
2.00	0.0%	99.5%	1.53	1.40	0.0
3.00	0.5%	100.0%	2.30	1.40	0.1
					89.7
				Removal Efficiency Adjustment[2] =	6.5%
				Predicted % Annual Rainfall Treated =	93.4%
				Predicted Net Annual Load Removal Efficiency =	**83.3%**

1 - Based on 10 years of hourly precipitation data from NCDC Station 770, Boston WSFO AP, Suffolk County, MA
2 - Reduction due to use of 60-minute data for a site that has a time of concentration less than 30-minutes.

CONTECH Stormwater Solutions Inc. Engineer: JBS
Date Prepared: **10/27/2023**

Site Information

Project Name	**Andover Town Yard**	
Project State	**MA**	
Project City	**Andover**	
Site Designation	**Jellyfish**	
Total Drainage Area, Ad	**3.44**	ac
Post Development Impervious Area, Ai	**3.44**	ac
Pervious Area, Ap	**0.00**	ac
% Impervious	**100%**	
Runoff Coefficient, Rc	**0.95**	

Mass Loading Calculations

Mean Annual Rainfall, P	**40.0**	in
Agency Required % Removal	**80%**	
Percent Runoff Capture	**90%**	
Mean Annual Runoff, Vt	**427,062**	ft^3
Event Mean Concentration of Pollutant, EMC	**75**	mg/l
Annual Mass Load, M total	**1998**	lbs

Filter System

Filtration Brand	**Jelly Fish**	
Cartridge Length	**54**	in

Jelly Fish Sizing

Mass to be Captured by System	**1599**	lbs
Water Quality Flow	**4.16**	cfs

Method to Use **FLOW BASED**

Summary			
Flow	Treatment Flow Rate	4.19	cfs
	Required Size	**JFPD0812-21-5**	

Project:	**Andover Town Yard**
Location:	**Andover, MA**
Prepared For:	**The Morin Cameron Group**

Purpose: To calculate the water quality flow rate (WQF) over a given site area. In this situation the WQF is derived from the first 1" of runoff from the contributing impervious surface.

Reference: Massachusetts Dept. of Environmental Protection Wetlands Program / United States Department of Agriculture Natural Resources Conservation Service TR-55 Manual

Procedure: Determine unit peak discharge using Figure 1 or 2. Figure 2 is in tabular form so is preferred. Using the tc, read the unit peak discharge (qu) from Figure 1 or Table in Figure 2. qu is expressed in the following units: cfs/mi^2/watershed inches (csm/in).

Compute Q Rate using the following equation:

$$Q = (qu)\ (A)\ (WQV)$$

where:

Q = flow rate associated with first 1" of runoff
qu = the unit peak discharge, in csm/in.
A = impervious surface drainage area (in square miles)
WQV = water quality volume in watershed inches (1" in this case)

Structure Name	Impv. (acres)	A (miles^2)	t_c (min)	t_c (hr)	WQV (in)	qu (csm/in.)	Q (cfs)
JF	3.44	0.0053750	6.0	0.100	1.00	774.00	4.16

APPENDIX E:

CONSTRUCTION PHASE

BEST MANAGEMENT PRACTICES

Construction Phase Best Management Practices (BMP's)

Erosion and Sedimentation will be controlled at the site by utilizing Structural Practices, Stabilization Practices, and Dust Control. These practices correspond with plans entitled "Site Development Plans - 2-4 Buxton Court, 7-9 & 11 Lewis Street, 35 Pearson Street & 122 North Main Street - Andover, Massachusetts" prepared by The Morin-Cameron Group, Inc. dated November 15, 2023.

Responsible Party Contact Information:

Stormwater Management System Owner:	Andover Town Yard, LLC 231 Sutton Street, Suite 1B North Andover, 01845 P: (978) 687-6200
Andover Department of Public Works:	5 Campanelli Drive Andover, MA 01810 P: (978) 623-8700
Andover Planning Board:	Town Hall 36 Bartlet Street Andover, MA 01810 P: (978) 623-8230
Site Design Engineer Information:	The Morin-Cameron Group, Inc. 66 Elm Street Danvers, MA 01923 Phone: (978) 777-8586

Structural Practices:

1) **Straw Wattle/Mulch Sock** – Straw Wattle and mulch sock fence shall be installed in accordance with the approved plans where high rates of stormwater runoff are anticipated.
   a) Installation Schedule: Prior to Start of land disturbance

   a) Maintenance and Inspection: The site supervisor shall inspect the barrier at least once per week or after a major storm (3.15 inches of rainfall within a twenty-four-hour period). event and shall repair any damaged or affected areas of the barrier at the time they are noted. Remove sediment deposits promptly after storm events to provide adequate storage volume for the next rain and to reduce pressure on the barrier. Sediment will be removed from in front of the barrier when it becomes about 4" deep at the barrier. Take care to avoid undermining the barrier during cleanout.

2) **Inlet Protection** – Inlet Protection will be utilized around the catch basin grates in the street layout along the frontage of the property. The inlet protection will allow the storm drain inlets to be used before final stabilization. This structural practice will allow early use of the drainage system. Siltsack or equivalent will be utilized for the inlet protection. Siltsack is manufactured by ACF Environmental. The telephone number is 800-448-3636. Regular flow siltsack will be utilized, and if it does not allow enough storm water flow, hi-flow siltsack will be utilized.

Silt Sack (or equivalent) Inlet Protection Inspection/Maintenance Requirements *

a) The silt sack trapping devices and the catch basins should be inspected after every rain storm and repairs made as necessary.

b) Sediment should be removed from the silt sack after the sediment has reached a maximum depth of one-half the depth of the trap.

c) Sediment should be disposed of in a suitable area and protected from erosion by either structural or vegetative means. Sediment material removed shall be disposed of in accordance with all applicable local, state, and federal regulations.

d) The silt sack must be replaced if it is ripped or torn in any way.

e) Temporary traps should be removed and the area repaired as soon as the contributing drainage area to the inlet has been completely stabilized.

3) **Sediment Track-Out:** Stabilized Construction Exit: Prior to the commencement of site work, crushed stone anti-tracking pads will be installed at the entrance to the site. This will prevent trucks from tracking material onto the road from the construction site. If, at any point during the project, the tracking pad becomes ineffective due to accumulation of soil, the crushed stone shall be replaced. Details for construction of the stabilized entrance can be found in the details sheet that is part of the comprehensive permit plan set associated with the project. The site supervisor will inspect the tracking pads weekly to ensure that they are properly limiting the tracking of soil onto the road. If tracking onto the roadway is noted, it shall be removed immediately via by hand or a mechanical street sweeper.

Stabilization Practices:

Stabilization measures shall be implemented as soon as practicable in portions of the site where construction activities have temporarily or permanently ceased, but in no case more than 14 days after the construction activity in that portion of the site has temporarily or permanently ceased, with the following exceptions.

- Where the initiation of stabilization measures by the 14th day after construction activity temporary or permanently cease is precluded by snow cover, stabilization measures shall be initiated as soon as practicable.

- Where construction activity will resume on a portion of the site within 21 days from when activities ceased, (e.g. the total time period that construction activity is temporarily ceased is less than 21 days) then stabilization measures do not have to be initiated on that portion of the site by the 14th day after construction activity temporarily ceased.

1) **Temporary Seeding** – Temporary seeding will allow a short-term vegetative cover on disturbed site areas that may be in danger of erosion. Temporary seeding will be done at stock piles and disturbed portions of the site where construction activity will temporarily cease for at least 21 days. The temporary seeding will stabilize cleared and unvegetated areas that will not be brought into final grade for several weeks or months.

   Temporary Seeding Planting Procedures *

   a) Planting should preferably be done between April 1st and June 30th, and September 1st through September 31st. If planting is done in the months of July and August, irrigation may be required. If planting is done between October 1st and March 31st, mulching should be applied immediately after planting.

   b) Before seeding, install structural practice controls. Utilize Amoco supergro or equivalent.

   c) Select the appropriate seed species for temporary cover from the following table.

Species	Seeding Rate (lbs./1,000 sq.)	Seeding Rate (lbs./acre)	Recommended Seeding Dates	Seed Cover required
Annual Ryegrass	1	40	April 1st to June 1st August 15th to Sept. 15th	¼ inch
Foxtail Millet	0.7	30	May 1st to June 30th	½ to ¾ inch
Oats	2	80	April 1st to July 1st August 15th to Sept. 15th	1 to 1-½ inch
Winter Rye	3	120	August 15th to Oct. 15th	1 to 1-½ inch

Apply the seed uniformly by hydroseeding, broadcasting, or by hand.

d) Use effective mulch, such as clean grain straw; tacked and/or tied with netting to protect seedbed and encourage plant growth.

Temporary Seeding Inspection/Maintenance *

a) Inspect within 6 weeks of planting to see if stands are adequate. Check for damage within 24 hours of the end to a heavy rainfall, defined as a 2-year storm event (i.e., 3.15 inches of rainfall within a twenty-four-hour period). Stands should be uniform and dense. Reseed and mulch damaged and sparse areas immediately. Tack or tie down mulch as necessary.

b) Seeds should be supplied with adequate moisture. Furnish water as needed, especially in abnormally hot or dry weather. Water application rates should be controlled to prevent runoff.

2) **Geotextiles** - Geotextiles such as jute netting will be used in combination with other practices such as mulching to stabilize slopes. The following geotextile materials or equivalent are to be utilized for structural and nonstructural controls as shown in the following table.

Practice	Manufacturer	Product	Remarks
Sediment Fence	Amoco	Woven polypropylene 1198 or equivalent	0.425 mm opening
Construction Entrance	Amoco	Woven polypropylene 2002 or equivalent	0.300 mm opening
Outlet Protection	Amoco	Nonwoven polypropylene 4551 or equivalent	0.150 mm opening
Erosion Control (slope stability)	Amoco	Supergro or equivalent	Erosion control revegetation mix, open polypropylene fiber on degradable polypropylene net scrim

Amoco may be reached at (800) 445-7732

Geotextile Installation

a) Netting and matting require firm, continuous contact between the materials and the soil. If there is no contact, the material will not hold the soil and erosion will occur underneath the material.

Geotextile Inspection/Maintenance *

a) In the field, regular inspections should be made to check for cracks, tears, or breaches in the fabric. The appropriate repairs should be made.

3) **Mulching and Netting** – Mulching will provide immediate protection to exposed soils during the period of short construction delays, or over winter months through the application of plant residues, or other suitable materials, to exposed soil areas. In areas, which have been seeded either for temporary or permanent cover, mulching should immediately follow seeding. On steep slopes, mulch must be supplemented with netting. The preferred mulching material is straw.

Mulch (Hay or Straw) Materials and Installation

a) Straw has been found to be one of the most effective organic mulch materials. The specifications for straw are described below, but other material may be appropriate. The straw should be air-dried; free of undesirable seeds & coarse materials. The application rate per 1,000 sq. is 90-100 lbs. (2-3 bales) and the application rate per acre is 2 tons (100-120 bales). The application should cover about 90% of the surface. The use of straw mulch is appropriate where mulch is maintained for more than three months. Straw mulch is subject to wind blowing unless anchored, is the most commonly used mulching material, and has the best microenvironment for germinating seeds.

Mulch Maintenance *

a) Inspect after rainstorms to check for movement of mulch or erosion. If washout, breakage, or erosion occurs, repair surface, reseed, remulch, and install new netting.

b) Straw or grass mulches that blow or wash away should be repaired promptly.

c) If plastic netting is used to anchor mulch, care should be taken during initial mowing to keep the mower height high. Otherwise, the netting can wrap up on the mower blade shafts. After a period of time, the netting degrades and becomes less of a problem.

d) Continue inspections until vegetation is well established.

4) **Land Grading** – Grading on fill slopes, cut slopes, and stockpile areas will be done with full siltation controls in place.

Land Grading Design/Installation Requirements

a) Areas to be graded should be cleared and grubbed of all timber, logs, brush, rubbish, and vegetated matter that will interfere with the grading operation. Topsoil should be stripped and stockpiled for use on critical disturbed areas for establishment of vegetation. Cut slopes to be topsoiled should be thoroughly scarified to a minimum depth of 3-inches prior to placement of topsoil.

b) Fill materials should be generally free of brush, rubbish, rocks, and stumps. Frozen materials or soft and easily compressible materials should not be used in fills intended to support buildings, parking lots, roads, conduits, or other structures.

c) Earth fill intended to support structural measures should be compacted to a minimum of 90 percent of Standard Proctor Test density with proper moisture control, or as otherwise specified by the engineer responsible for the design. Compaction of other fills should be to the density required to control sloughing, erosion or excessive moisture content. Maximum thickness of fill layers prior to compaction should not exceed 9 inches.

d) The uppermost one foot of fill slopes should be compacted to at least 85 percent of the maximum unit weight (based on the modified AASHTO compaction test). This is usually accomplished by running heavy equipment over the fill.

e) Fill should consist of material from borrow areas and excess cut will be stockpiled on site. All disturbed areas should be free draining, left with a neat and finished appearance, and should be protected from erosion.

Land Grading Stabilization Inspection/Maintenance *

a) All slopes should be checked periodically to see that vegetation is in good condition. Any rills or damage from erosion and animal burrowing should be repaired immediately to avoid further damage.

b) If seeps develop on the slopes, the area should be evaluated to determine if the seep will cause an unstable condition. Subsurface drains or a gravel mulch may be required to solve seep problems.

c) Areas requiring revegetation should be repaired immediately. Control undesirable vegetation such as weeds and woody growth to avoid bank stability problems in the future.

5) **Topsoiling *** – Topsoiling will help establish vegetation on all disturbed areas throughout the site during the seeding process. The soil texture of the topsoil to be used will be a sandy loam to a silt loam texture with 15% to 20% organic content.

Topsoiling Placement

a) Topsoil should not be placed while in a frozen or muddy condition, when the subgrade is excessively wet, or when conditions exist that may otherwise be detrimental to proper grading or proposed seeding.

b) Do not place topsoil on slopes steeper than 2.5:1, as it will tend to erode.

c) If topsoil and subsoil are not properly bonded, water will not infiltrate the soil profile evenly and it will be difficult to establish vegetation. The best method is to actually work the topsoil into the layer below for a depth of at least 6 inches.

6) **Permanent Seeding** – Permanent Seeding should be done immediately after the final design grades are achieved. Native species of plants should be used to establish perennial vegetative cover on disturbed areas. The revegetation should be done early enough in the fall so that a good cover is established before cold weather comes and growth stops until the spring. A good cover is defined as vegetation covering 75 percent or more of the ground surface.

Permanent Seeding Seedbed Preparation

a) In infertile or coarse-textured subsoil, it is best to stockpile topsoil and re-spread it over the finished slope at a minimum 2 to 6-inch depth and roll it to provide a firm seedbed. The topsoil must have a sandy loam to silt loam texture with 15% to 20% organic content. If construction fill operations have left soil exposed with a loose, rough, or irregular surface, smooth with blade and roll.

b) Loosen the soil to a depth of 3-5 inches with suitable agricultural or construction equipment.

c) Areas not to receive topsoil shall be treated to firm the seedbed after incorporation of the lime and fertilizer so that it is depressed no more than ½ - 1 inch when stepped on with a shoe. Areas to receive topsoil shall not be firmed until after topsoiling and lime and fertilizer is applied and incorporated, at which time it shall be treated to firm the seedbed as described above.

Permanent Seeding Grass Selection/Application

a) Select an appropriate cool or warm season grass based on site conditions and seeding date. Apply the seed uniformly by hydro-seeding, broadcasting, or by hand. Uniform seed distribution is essential. On steep slopes, hydroseeding may be the most effective seeding method. Surface roughening is particularly important when preparing slopes for hydroseeding.

b) Lime and fertilize. Organic fertilizer shall be utilized in areas within the 100-foot buffer zone to a wetland resource area.

c) Mulch the seedings with straw applied at the rate of ½ tons per acre. Anchor the mulch with erosion control netting or fabric on sloping areas. Amoco supergro or equivalent should be utilized.

Permanent Seeding Inspection/Maintenance *

a) Frequently inspect seeded areas for failure and make necessary repairs and reseed immediately. Conduct or follow-up survey after one year and replace failed plants where necessary.

b) If vegetative cover is inadequate to prevent rill erosion, overseed and fertilize in accordance with soil test results.

c) If a stand has less than 40% cover, reevaluate choice of plant materials and quantities of lime and fertilizer. Re-establish the stand following seedbed preparation and seeding recommendations, omitting lime and fertilizer in the absence of soil test results. If the season prevents resowing, mulch or jute netting is an effective temporary cover.

d) Seeded areas should be fertilized during the second growing season. Lime and fertilize thereafter at periodic intervals, as needed. Organic fertilizer shall be utilized in areas within the 100-foot buffer zone to a wetland resource area.

Dust Control:

Dust control will be utilized throughout the entire construction process of the site. For example, keeping disturbed surfaces moist during windy periods will be an effective control measure, especially for construction access roads. The use of dust control will prevent the movement of soil to offsite areas. However, care must be taken to not create runoff from excessive use of water to control dust. The following are methods of Dust Control that may be used on-site:

- Vegetative Cover – The most practical method for disturbed areas not subject to traffic.
- Calcium Chloride – Calcium chloride may be applied by mechanical spreader as loose, dry granules or flakes at a rate that keeps the surface moist but not so high as to cause water pollution or plant damage.
- Sprinkling – The site may be sprinkled until the surface is wet. Sprinkling will be effective for dust control on haul roads and other traffic routes.
- Stone – Stone will be used to stabilize construction roads and will provide dust control.

The general contractor shall employ an on-site water vehicle for the control of dust as necessary.

Non-Stormwater Discharges:

The construction de-watering and all non-stormwater discharges will be directed into a sediment dirt bag (or equivalent inlet protection) or a sediment basin. Sediment material removed shall be disposed of in accordance with all applicable local, state, and federal regulations.

The developer and site general contractor will comply with the E.P.A.'s Final General Permit for Construction De-watering Discharges, (N.P.D.E.S., Section 402 and 40 C.F.R. 122.26(b) (14) (x).

Inspection/Maintenance:

Operator personnel must inspect the construction site at least once every 14 calendar days and within 24 hours of a storm event of ½-inch or greater. The applicant shall be responsible to secure the services of a design professional or similar professional (inspector) on an on-going basis throughout all phases of the project. Refer to the Inspection/Maintenance Requirements presented earlier in the "Structural and Stabilization Practices." The inspector should review the erosion and sediment controls with respect to the following:

- Whether or not the measure was installed/performed correctly.
- Whether or not there has been damage to the measure since it was installed or performed.
- What should be done to correct any problems with the measure.

The inspector should complete a Stormwater Management Construction Phase BMP Inspection Schedule and Evaluation Checklist for documenting the findings and should request the required maintenance or repair for the pollution prevention measures when the inspector finds that it is necessary for the measure to be effective. The inspector should notify the appropriate person to make the required changes.

It is essential that the inspector document the inspection of the pollution prevention measures. These records will be used to request maintenance and repair and to prove that the inspection and maintenance were performed. The forms list each of the measures to be inspected on the site, the inspector's name, the date of the inspection, the condition of the measure/area inspected, maintenance or repair performed and any changes which should be made to the Operation and Maintenance Plan to control or eliminate unforeseen pollution of storm water.

APPENDIX F:

LONG TERM BEST MANAGEMENT PRACTICES O&M PLAN

Long Term Stormwater Best Management Practices
Operation and Maintenance Plan
for
Site Development Plans "Andover Town Yard"
Andover, Massachusetts
Issued November 15, 2023

The following operation and maintenance plan has been provided to satisfy the requirements of Standard 9 of the Mass DEP Stormwater Management Handbook associated with development of the site and associated infrastructure. The success of the Stormwater Management Plan depends on the proper implementation, operation and maintenance of several management components. The following procedures shall be implemented to ensure success of the Stormwater Management Plan:

1. The contractor shall comply with the details of construction of the site as shown on the approved plans.
2. The catch basins, subsurface detention and recharge galleys, pocket wetland and CDS water quality units shall be inspected and maintained as indicated below.
3. Effective erosion control measurers during and after construction shall be maintained until a stable turf is established on all altered areas.
4. A Stormwater Management Maintenance Log is included at the end of this Appendix.

Basic Information

Stormwater Management System Owner:	Andover Town Yard, LLC 231 Sutton Street, Suite 1B North Andover, 01845 P: (978) 687-6200
Andover Department of Public Works:	5 Campanelli Drive Andover, MA 01810 P: (978) 623-8700
Andover Planning Board:	Town Hall 36 Bartlet Street Andover, MA 01810 P: (978) 623-8695

Erosion and Sedimentation Controls during Construction:

The site and drainage construction contractor shall be responsible for maintaining the stormwater system during construction. Routine maintenance of all items shall be performed to ensure adequate runoff and pollution control during construction.

A proposed construction fence and mulch sock will be placed as shown on the Demolition and Erosion Control Plan prior to the commencement of any clearing, grubbing, and earth removal or construction activity. The integrity of the erosion control barrier will be maintained by periodic inspection and replacement as necessary. The erosion control barrier will remain in place until the first course of pavement has been placed and all side slopes have been loamed and seeded and vegetation has been established. Silt sacks will also be placed over the new catch basins once constructed.

Operations and maintenance plans for the Stormwater Management construction phase and long term operation of the system have been attached to this report.

General Conditions

1. The developer shall be responsible for scheduling regular inspections and maintenance of the stormwater BMP's until such time when the homeowner's association is established at which time the homeowner's association shall become the responsible party. The BMP maintenance shall be conducted as detailed in the following long-term pollution prevention plan and illustrated on the approved design plans:

   "Site Development Plans - 2-4 Buxton Court, 7-9 & 11 Lewis Street, 35 Pearson Street & 122 North Main Street - Andover, Massachusetts" prepared by The Morin-Cameron Group, Inc. dated November 15, 2023. All Stormwater BMP's shall be operated and maintained in accordance with the design plans and the following Long-Term Pollution Prevention Plan.
2. The owner shall:
   a. Maintain an Operation and Maintenance Log for the last three years. The Log shall include all BMP inspections, repairs, replacement activities and disposal activities (disposal material and disposal location shall be included in the Log);
   b. Make the log available to the Andover Department of Public Works, Planning Board and Conservation Commission upon request;
   c. Allow members and agents of the Andover Department of Public Works Planning Board and Conservation Commission to enter the premises and ensure that the Owner has complied with the Operation and Maintenance Plan requirements for each BMP.
3. A recommended inspection and maintenance schedule is outlined below based on statewide averages. This inspection and maintenance schedule shall be adhered to at
4. A minimum for the first year of service of all BMP's referenced in this document. At the commencement of the first year of service, a more accurate inspection/maintenance schedule shall be determined based on the level of service for this site.

Long-Term Pollution Prevention Plan (LTPPP)

Vegetated Areas:
Immediately after construction, monitoring of the erosion control systems shall occur until establishment of natural vegetation. Afterwards, vegetated areas shall be maintained as such. Vegetation shall be replaced as necessary to ensure proper stabilization of the site.

Cost: Included with annual landscaping budget. Consult with local landscape contractors.

Paved Areas:
Sweepers shall sweep paved areas periodically during dry weather to remove excess sediments and to reduce the amount of sediments that the drainage system shall have to remove from the runoff. The sweeping shall be conducted primarily between March 15th and November 15th. Special attention should be made to sweeping paved surfaces in March and April before spring rains wash residual sand into the drainage system. Sweeeping shall occur at a minimum of twice per year (Spring and Fall).

Cost: $100-$300 per sweeping

Salt used for de-icing on the roadway during winter months shall be limited as much as possible as this will reduce the need for removal and treatment. Sand containing the minimum amount of calcium chloride (or approved equivalent) needed for handling may be applied as part of the routine winter maintenance activities.

CDS Water Quality Unit:
The CDS Water Quality Unit shall be inspected after every major storm event for the first 3 months after construction; a major storm event is 3.15 inches of rainfall within a twenty-four-hour period. Thereafter, the system shall be inspected twice per year in April and October. The units shall be cleaned per manufacturer's instructions included herein.

Cost: The owner shall consult local landscaping contractor for details.

Public Safety Concerns: The manhole covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately.

Subsurface Infiltration and Detention Galleys:
The subsurface infiltration and detention galleys and outlet structures shall be checked for debris accumulation twice per year. Each system is equipped with an inspection manhole on the first tank in the series and on the last tank in the series in addition to the inspection manholes for the sediment trap tanks. Additional inspections should be scheduled during the first few months to make sure that the facility is functioning as intended. Trash, leaves, branches, etc. shall be removed from facility. Silt, sand and sediment, if significant accumulation occurs, shall be removed annually. Material removed from the galleys shall be disposed of in accordance with all applicable local, state, and federal regulations. In the case that water remains in the infiltration facilities for greater than three (3) days after a storm event, an inspection is warranted and necessary maintenance or repairs should be addressed as necessary.

The outlet structure shall be inspected annually for structural integrity. The inspections shall be conducted by qualified personnel.

Cost: $500-$2,500 per cleaning depending on the volume of material/liquids that need to be removed.

Public Safety Concerns: The manhole covers shall not be left open and unattended at any time during inspection, cleaning or otherwise. Broken covers or frames shall be replaced immediately. At no time shall any person enter the subsurface structure unless measures have been taken to ensure safe access in accordance with OSHA enclosed space regulations.

Overall Site Grading and Stormwater Management on Lots:
After construction, and during the initial vegetation establishment period, the site should be inspected after every rainfall. Mowing, litter removal, and spot vegetation repair should be performed on a regular basis.

Debris & Litter:
All debris and litter shall be removed from the driveway/parking area as necessary to prevent migration into the drainage system.

Pesticides, Herbicides, and Fertilizers:
Pesticides and herbicides shall be used sparingly. Fertilizers shall be restricted to the use of organic fertilizers only. All fertilizers, herbicides, pesticides, sand and salt for deicing and the like shall be stored in dry area that is protected from weather.

Cost: Included in the routine landscaping maintenance schedule. The Owner shall consult local landscaping contractors for details.

Public Safety Concerns: Chemicals shall be stored in a secure area to prevent children from obtaining access to them. Any major spills shall be reported to municipal officials.

Prevention of Illicit Discharges:
Illicit discharges to the stormwater management system are not allowed. Illicit discharges are discharges that are not comprised entirely of stormwater. Pursuant to Mass DEP Stormwater Standards the following activities or facilities are not considered illicit discharges: firefighting, water line flushing, landscape irrigation, uncontaminated groundwater, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, flows from riparian habitats and wetlands, Dechlorinated water from swimming pools, water used for street washing and water used to clean residential building without detergents.

To prevent illicit discharges to the stormwater management system the following policies should be implemented:

1. Provisions For Storing Materials And Waste Products Inside Or Under Cover
2. Vehicle Maintenance And Washing Controls
3. Requirements for Routine Inspections of the Stormwater Management System (i.e.: catch basins, hydrodynamic separator units, pocket wetland & subsurface recharge system.)
4. Spill Prevention and Response Plans.

APPENDIX G:

ILLICIT

DISCHARGE STATEMENT

Illicit Discharge Compliance Statement

I, Scott P. Cameron, P.E., hereby notify the Andover Zoning Board that I have not witnessed, nor am aware of any existing illicit discharges at the site known 11 Lewis Street, Andover, Massachusetts. I also hereby certify that the development of said property as illustrated on the final plans entitled "Site Development Plans, 11 Lewis Street, Andover, Massachusetts" prepared by The Morin-Cameron Group, Inc. dated November 15, 2023 and as revised and approved by the Andover Planning Board and maintenance thereof in accordance with the "Construction Phase Best Management Practices" and "Long Term Stormwater Best Management Practices" prepared by The Morin-Cameron Group, Inc dated November 15, 2023 will not create any new illicit discharges. There is no warranty implied regarding future illicit discharges that may occur as a result of improper construction or maintenance of the stormwater management system or unforeseen accidents.

Name: Scott P. Cameron, P.E.

Company: The Morin-Cameron Group, Inc.

Title: Owner's Representative

Signature:

Date: 11/15/2023

APPENDIX H:

SOIL BORING LOGS

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-1
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 95	**V. Datum:** NAVD88
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 27	
		Date Start - Finish: 8/1/2022 - 8/1/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30
Other: -	**Other:** Autohammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
Not	recorded			

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)	SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Elev. (ft.)
		S-1	0-2	24	9	7 6 3 2	9	S-1: Loose, dark brown/brown, fine to coarse SAND, some Gravel, little Silt, trace Organics, trace Asphalt, trace Glass.	1		0.5'	ASPHALT	94.5'
		S-2	2-4	24	9	2 3 10 12	13	S-2: (Top 7") Dark brown/brown, fine to coarse SAND and GRAVEL, little Silt.				FILL	
		S-3	4-6	24	12	13 18 23 22	41	S-2: (Bottom 2") Brown/tan, fine to coarse SAND and GRAVEL, trace Silt. S-3: Dense, brown/tan, fine to coarse SAND and GRAVEL, trace Silt.	2		4'		91.0'
5												SAND AND GRAVEL	
10		S-4	10-12	24	9	11 15 18 17	33	S-4: Dense, brown, fine to coarse SAND and GRAVEL, little Silt.	3		12'		83.0'
15		S-5	15-17	24	15	21 24 16 18	40	S-5: Dense, brown, fine to coarse SAND and GRAVEL, some Silt.				GLACIAL TILL	
20		S-6	20-22	24	16	8 23 22 33	45	S-6: Hard, gray/brown, CLAY & SILT, some fine to coarse Sand, some Gravel.	4				
25		S-7	25-27	24	24	17 17 16 33	33	S-7: Hard, gray/brown, CLAY & SILT, little fine to medium Sand, trace Gravel.			27'		68.0'
30								Bottom of boring at 27 feet.	5				

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Wet soils observed beginning at approximately 4 feet below ground surface (bgs).
3. Increase in drill effort observed at approximately 12 feet bgs.
4. Increase in drill effort observed at approximately 22 feet bgs.
5. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-1

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-2
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 98	
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 13	**V. Datum:** NAVD88
		Date Start - Finish: 8/2/2022 - 8/2/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon	
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2	
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140	
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30	
Other: -	**Other:** Autohammer	

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
8/2/22	0900	5.5	13	0 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	12	25 52 19 24	71	S-1: Very dense, brown/white, fine to coarse SAND and GRAVEL, little Silt, trace Asphalt.	1		0.5'	ASPHALT	97.5'
		S-2	2-4	24	12	9 5 6 4	11	S-2: (Top 6") Brown, fine to coarse SAND and GRAVEL, little Silt.				FILL	
5		S-3	4-6	24	12	5 29 29 42	58	S-2: (Bottom 6") Dark brown/brown, Clayey SILT, little fine to coarse Sand, trace Gravel, trace Brick. S-3: Very dense, dark brown/brown, fine to coarse SAND and GRAVEL, some Clayey Silt.			4'		94.0'
10		S-4	10-12	24	20	23 50 28 26	78	S-4: Very dense, brown, fine to coarse SAND, some Gravel, little Silt & Clay.				GLACIAL TILL	
								Bottom of boring at 13 feet.	2 3 4		13'		85.0'
15													
20													
25													
30													

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Increase in drill effort observed at approximately 13 feet below ground surface (bgs).
3. Auger refusal observed at approximately 13 feet bgs using up to 1200 psi of down pressure for 5 minutes with no advancement.
4. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-2

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-3
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 108	**V. Datum:** NAVD88
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 12	
		Date Start - Finish: 8/4/2022 - 8/4/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30
Other: -	**Other:** Autohammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
8/4/22	0930	dry	12	0 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	9	4 2 1 2	3	S-1: Very loose, dark brown/brown, fine to coarse SAND and GRAVEL, little Silt, trace Organics.	1				
		S-2	2-4	24	8	2 1 1 1	2	S-2: Very loose, dark brown/brown, fine to coarse SAND and GRAVEL, little Silt, trace Organics.					
5		S-3	4-6	24	15	2 2 2 2	4	S-3: Very loose, dark brown/brown, fine to coarse SAND and GRAVEL, little Silt, trace Brick, trace Organics.				FILL	
		S-4	6-8	24	6	2 2 1 1	3	S-4: Very loose, dark brown/brown, fine to coarse SAND and GRAVEL, little Silt, trace Brick.					
		S-5	8-9.5	18	11	1 1 6 30	7	S-5: Loose, dark brown/brown/light brown, fine to coarse SAND and GRAVEL, little Silt, trace Brick.	2				
10		S-6	10-11	12	7	15 50/6"	R	S-6: Very dense, dark brown/brown/light brown/gray, fine to coarse SAND and GRAVEL, some Silt.	3		10'		98.0'
									4			GLACIAL TILL	
											12'		96.0'
								Bottom of boring at 12 feet.	5 6				
15													
20													
25													
30													

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Wet soils observed beginning at approximately 8 feet below ground surface (bgs). Groundwater depth measured at 0930 hours may not represent stabilized conditions.
3. Increase in drill effort observed at approximately 9.5 feet bgs.
4. Weathered rock observed at tip of split spoon sample.
5. Auger refusal observed at approximately 12 feet bgs using up to 1200 psi of down pressure for 5 minutes with no advancement.
6. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-3

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-4
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 105	
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 28	**V. Datum:** NAVD88
		Date Start - Finish: 8/3/2022 - 8/3/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon	
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2	
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140	
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30	
Other: -	**Other:** Autohammer	

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
8/3/22	0945	25.2	28	0 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	10	5 2 5 2	7	S-1: Loose, dark brown/brown, fine to coarse SAND and GRAVEL, some Silt, trace Asphalt.	1		0.5'	ASPHALT	104.5'
		S-2	2-4	24	12	4 1 2 1	3	S-2: Very loose, brown, fine to coarse SAND, little Gravel, little Silt.					
5		S-3	4-6	24	7	1 1 1 1	2	S-3: Very loose, dark brown, fine to coarse SAND, some Gravel, little Silt, trace Asphalt.				FILL	
		S-4	6-8	24	5	2 1 2 1	3	S-4: Very loose, dark brown, fine to medium SAND and GRAVEL, little Silt & Clay.					
10		S-5	10-12	24	12	7 17 12 11	29	S-5: (Top 6") Dark brown, fine to coarse SAND, some Gravel, some Silt.			11'		94.0'
								S-5: (Bottom 6") Brown, fine to medium SAND, some Clayey Silt, little Gravel.	2			SAND AND GRAVEL	
15		S-6	15-17	24	19	7 10 11 10	21	S-6: Medium dense, brown, fine to medium SAND, little Gravel, little Silt.	3		17'		88.0'
20		S-7	20-22	24	17	15 24 45 27	69	S-7: Very dense, brown/gray, fine to medium SAND and Clayey SILT, little Gravel.				GLACIAL TILL	
25		S-8	25-27	24	21	31 40 50 50	90	S-8: Very dense, brown/gray, fine to medium SAND, some Silt, some Gravel.			28'		77.0'
								Bottom of boring at 28 feet.	4 5				
30													

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Increase in drill effort on likely cobbles observed between 11.5 and 13.5 feet below ground surface (bgs).
3. Wet soils observed beginning at approximately 15 feet bgs. Groundwater depth measured at 0945 hours may not represent stabilized conditions.
4. Auger refusal observed at approximately 28 feet bgs using up to 1200 psi of down pressure for 5 minutes with no advancement.
5. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-4

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-5
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 99	**V. Datum:** NAVD88
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 10.5	
		Date Start - Finish: 8/1/2022 - 8/1/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30
Other: -	**Other:** Autohammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
8/1/22	0920	dry		0 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	10	31 19 9 9	28	S-1: Medium dense, dark brown/brown, fine to coarse SAND and GRAVEL, some Silt, trace Asphalt, trace Organics.	1		0.5'	ASPHALT	98.5'
		S-2	2-4	24	15	27 17 20 11	37	S-2: Dense, brown, fine to coarse SAND and GRAVEL, little Silt.				FILL	
5		S-3	4-6	24	17	20 43 36 28	79	S-3: Very dense, olive-brown/gray, GRAVEL, some fine to coarse Sand, little Silt.			4'		95.0'
												GLACIAL TILL	
10		S-4	10-10.3	3	3	50/6"	R	S-4: Very dense, brown, fine to coarse SAND and GRAVEL, some Silt.	2 3 4		10.5'		88.5'
								Bottom of boring at 10.5 feet.					
15													
20													
25													
30													

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Weathered rock observed at tip of split spoon sample.
3. Auger refusal observed at approximately 10.5 feet below ground surface (bgs) using up to 1200 psi of down pressure for 5 minutes with no advancement.
4. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-5

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-6
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 93	
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 23	**V. Datum:** NAVD88
		Date Start - Finish: 8/1/2022 - 8/1/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon	
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2	
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140	
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30	
Other: -	**Other:** Autohammer	

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
Not	recorded			

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	8	5 2 2 4	4	S-1: Loose, dark brown/brown, fine to coarse SAND and GRAVEL, little Silt, trace Asphalt.	1		0.5'	ASPHALT	92.5'
		S-2	2-4	24	6	2 3 1 4	4	S-2: Loose, dark brown, GRAVEL and fine to coarse SAND, trace Silt.					
5		S-3	4-6	24	18	4 5 8 9	13	S-3: Medium dense, dark brown/gray, fine SAND, little Silt, trace Gravel.	2 3			FILL	
											8'		85.0'
10		S-4	10-12	24	15	2 4 6 7	10	S-4: Stiff, brown/gray, Clayey SILT, trace fine to coarse Sand.				CLAYEY SILT	
											14'		79.0'
15		S-5	15-17	24	20	16 37 24 18	61	S-5: Very dense, brown/white, fine to coarse SAND, little Gravel, little Clayey Silt.	4			GLACIAL TILL	
20		S-6	20-22	24	24	8 9 12 39	21	S-6: Medium dense, gray, fine to coarse SAND and GRAVEL, some Clayey Silt.					
											23'		70.0'
								Bottom of boring at 23 feet.	5 6				
25													
30													

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Strong hydrocarbon like odor noted in sample S-3.
3. Wet soils observed beginning at approximately 5 feet below ground surface (bgs).
4. Increase in drill effort at approximately 18 feet bgs.
5. Auger refusal observed at approximately 23 feet bgs using up to 1200 psi of down pressure for 5 minutes with no advancement.
6. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-6

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-7
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 94	
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 19.5	**V. Datum:** NAVD88
		Date Start - Finish: 8/2/2022 - 8/2/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon	
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2	
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140	
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30	
Other: -	**Other:** Autohammer	

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
8/2/22	1100	17.5	19.5	0 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)	SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	19	32 25 28 40	53	S-1: (Top 6") Dark brown, fine to coarse SAND, some Gravel, some Silt, trace Organics, trace Brick.	1		0.5'	ASPHALT	93.5'
		S-2	2-4	24	16	23 22 18 16	40	S-1: (Bottom 13") Brown/tan, fine to coarse SAND and GRAVEL, little Silt.				FILL	
		S-3	4-6	24	17	14 18 24 21	42	S-2: Dense, brown/tan, fine to coarse SAND and GRAVEL, little Silt.			4'		90.0'
5								S-3: Dense, brown, fine to coarse SAND, some Gravel, little Silt.				SAND AND GRAVEL	
10		S-4	10-12	24	12	10 13 15 19	28	S-4: Medium dense, brown, fine to coarse SAND and GRAVEL, some Silt.	2		12'		82.0'
15		S-5	15-17	24	24	21 25 29 33	54	S-5: Very dense, brown, fine to medium SAND, some Silt, little Gravel.				GLACIAL TILL	
20									3		19.5'		74.5'
								Bottom of boring at 19.5 feet.	4 5				
25													
30													

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Wet soils observed beginning at approximately 10 feet below ground surface (bgs). Groundwater depth measured at 1100 hours may not represent stabilized conditions.
3. Increase in drill effort at approximately 18.5 feet bgs.
4. Auger refusal observed at approximately 19.5 feet bgs using up to 1200 psi of down pressure for 5 minutes with no advancement.
5. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-7

18.0175728.00 11 LEWIS ST ANDOVER MA.GPJ; STRATUM ONLY NORWOOD; 8/26/2022

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-8
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 94	
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 28.5	**V. Datum:** NAVD88
		Date Start - Finish: 8/2/2022 - 8/2/2022	
Auger/Casing Type: HSA	**Sampler Type:** Split Spoon		
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2		
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140		
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30		
Other: -	**Other:** Autohammer		

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
8/2/22	1410	21	28.5	0 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	19	26 27 22 21	49	S-1: (Top 4") Dark brown, fine to coarse SAND and GRAVEL, trace Silt.	1				
		S-2	2-4	24	19	21 28 42 37	70	S-1: (Bottom 15") Brown/tan, fine to coarse SAND and GRAVEL, little Silt.				FILL	
								S-2: (Top 6") Dark brown, fine to coarse SAND and GRAVEL, trace Silt.			3'		91.0'
5		S-3	4-6	24	18	23 21 20 19	41	S-2: (Bottom 13") Brown/tan, fine to coarse SAND and GRAVEL, little Silt.					
								S-3: Dense, brown/tan, fine to coarse SAND and GRAVEL, little Silt.					
10		S-4	10-11.5	18	18	36 33 50/6"	R	S-4: Very dense, brown/gray, fine to coarse SAND, some Clayey Silt, little Gravel.	2				
									3				
15		S-5	15-17	24	18	33 35 50 50	85	S-5: Very dense, brown/gray, fine to medium SAND, some Clayey Silt, little Gravel.				GLACIAL TILL	
20		S-6	20-21.5	18	15	25 41 50/6"	R	S-6: Very dense, brown/gray, fine to medium SAND, some Gravel, some Clayey Silt.					
25		S-7	25-27	24	15	25 40 25 23	65	S-7: Very dense, dark gray, fine to medium SAND, some Clayey Silt, little Gravel.					
											28.5'		65.5'
30								Bottom of boring at 28.5 feet.	4 5				

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Wet soils observed beginning at approximately 10 feet below ground surface (bgs). Groundwater depth measured at 1410 may not represent stabilized conditions.
3. Increase in drill effort on likely cobbles between 11.5 and 22 feet bgs.
4. Auger refusal observed at approximately 28.5 feet bgs using up to 1200 psi of down pressure for 5 minutes with no advancement.
5. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-8

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-9
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 108	**V. Datum:** NAVD88
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 16	
		Date Start - Finish: 8/3/2022 - 8/3/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30
Other: -	**Other:** Autohammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
8/4/22	0715	dry	16	0 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Pen. (in)	Rec. (in)	Blows (per 6 in.)	SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	9	1 2 3 2	5	S-1: Loose, dark-light brown, fine to medium SAND, little Gravel, little Silt, trace Brick, trace Organics.	1			FILL	
		S-2	2-4	24	5	4 2 3 7	5	S-2: Loose, dark-light brown, fine to coarse SAND, little Gravel, little Silt, trace Organics.			4'		104.0'
5		S-3	4-6	24	22	21 30 18 11	48	S-3: Dense, brown, fine to medium SAND, some Silt, little Gravel.				SAND AND GRAVEL	
		S-4	6-8	24	22	36 17 17 15	34	S-4: Dense, brown, fine to medium SAND, some Silt, some Gravel.	2		8'		100.0'
10		S-5	10-12	24	19	10 24 21 18	45	S-5: Dense, brown, fine to medium SAND, some Gravel, some Clayey Silt.				GLACIAL TILL	
15		S-6	15-15.5	6	6	50/6"	R	S-6: Very dense, brown, fine to medium SAND, some Gravel, some Clayey Silt.	3 4		16'		92.0'
								Bottom of boring at 16 feet.					
20													
25													
30													

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Increase in drill effort at approximately 6.5 feet and 9.5 feet below ground surface (bgs).
3. Auger refusal observed at approximately 16 feet bgs using up to 1200 psi of down pressure for 5 minutes with no advancement.
4. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-9

18.0175728.00 11 LEWIS ST ANDOVER MA.GPJ; STRATUM ONLY NORWOOD; 8/26/2022

TEST BORING LOG

GZA GeoEnvironmental, Inc.
Engineers and Scientists

Buxton Redevelopment, LLC
Andover Town Yard Development
11 Lewis Street
Andover, Massachusetts

BORING NO.: GZ-10
SHEET: 1 of 1
PROJECT NO: 18.0175728.00
REVIEWED BY: LWP

Drilling Co.: Drilex Environmental, Inc.	**Type of Rig:** Truck	**Boring Location:** See Plan	**H. Datum:**
Foreman: Enzo Gravante	**Rig Model:** CME 75	**Ground Surface Elev. (ft.):** 103	
Logged By: Anthony Lupo	**Drilling Method:** HSA	**Final Boring Depth (ft.):** 23	**V. Datum:** NAVD88
		Date Start - Finish: 8/3/2022 - 8/3/2022	

Auger/Casing Type: HSA	**Sampler Type:** Split Spoon
I.D/O.D.(in): 4.25/7.625	**I.D./O.D. (in.):** 1.375/2
Hammer Weight (lb.): -	**Sampler Hmr Wt (lb):** 140
Hammer Fall (in.): -	**Sampler Hmr Fall (in):** 30
Other: -	**Other:** Autohammer

Groundwater Depth (ft.)

Date	Time	Water Depth	Casing	Stab. Time
8/3/22	1320	19.25	23	0 min.

Depth (ft)	Casing Blows/ Core Rate	Sample No.	Sample Depth (ft.)	Sample Pen. (in)	Sample Rec. (in)	Sample Blows (per 6 in.)	Sample SPT Value	Sample Description and Identification (Modified Burmister Procedure)	Remark	Field Test Data	Stratum Depth (ft.)	Stratum Description	Stratum Elev. (ft.)
		S-1	0-2	24	10	9 11 13 11	24	S-1: Medium dense, dark brown/brown, fine to coarse SAND and GRAVEL, little Silt, trace Organics.	1				
		S-2	2-4	24	8	17 7 5 2	12	S-2: Medium dense, dark brown/brown, fine to coarse SAND and GRAVEL, little Silt, little Brick, trace Organics.				FILL	
5		S-3	4-6	24	15	5 7 5 3	12	S-3: (Top 9") Brown, fine to coarse SAND, some Gravel, little Silt, little Brick.			5'		98.0'
		S-4	6-8	24	21	7 7 7 14	14	S-3: (Bottom 6") Brown/orange, fine to medium SAND, some Gravel, some Silt. S-4: Medium dense, brown, fine to medium SAND, some Silt, trace Gravel.				SAND	
10		S-5	10-12	24	14	5 8 9 10	17	S-5: Medium dense, brown/dark brown/light brown, fine to coarse SAND and GRAVEL, trace Silt.			9'		94.0'
												SAND AND GRAVEL	
15		S-6	15-17	24	17	12 18 15 19	33	S-6: Dense, brown/light brown, fine to coarse SAND and GRAVEL, some Clayey Silt.	2 3		13'		90.0'
												GLACIAL TILL	
20		S-7	20-22	18	12	28 20 50/6"	R	S-7: Very dense, brown/gray, fine to coarse SAND, some Clayey Silt, some Gravel.					
											23'		80.0'
25								Bottom of boring at 23 feet.	4 5				
30													

REMARKS

1. Ground surface elevation estimated from Town of Andover GIS webiste.
2. Wet soils observed beginning at approximately 17 feet below ground surface (bgs). Groundwater depth measured at 1320 hours may not represent stabilized conditions.
3. Increase in drill effort at approximately 18 feet bgs.
4. Auger refusal observed at approximately 23 feet bgs using up to 1200 psi of down pressure for 5 minutes with no advancement.
5. Upon completion borehole backfilled with soil cuttings to approximate ground surface.

See Log Key for explanation of sample description and identification procedures. Stratification lines represent approximate boundaries between soil and bedrock types. Actual transitions may be gradual. Water level readings have been made at the times and under the conditions stated. Fluctuations of groundwater may occur due to other factors than those present at the times the measurements were made.

Boring No.: GZ-10

APPENDIX I:

MANUFACTURER BROCHURES

CONTECH®
ENGINEERED SOLUTIONS

Jellyfish® Filter
Stormwater Treatment

The experts you need to solve your stormwater challenges

Contech is the leader in stormwater solutions, helping engineers, contractors and owners with infrastructure and land development projects throughout North America.

With our responsive team of stormwater experts, local regulatory expertise and flexible solutions, Contech is the trusted partner you can count on for stormwater management solutions.

Your Contech Team

STORMWATER CONSULTANT

It's my job to recommend the best solution to meet permitting requirements.

STORMWATER DESIGN ENGINEER

I work with consultants to design the best approved solution to meet your project's needs.

REGULATORY MANAGER

I understand the local stormwater regulations and what solutions will be approved.

SALES ENGINEER

I make sure our solutions meet the needs of the contractor during construction.

Contech is your partner in stormwater management solutions

Setting new standards in Stormwater Treatment – Jellyfish® Filter

The Jellyfish Filter has been tested in the field and laboratory, and has received approval from numerous stormwater regulatory agencies.

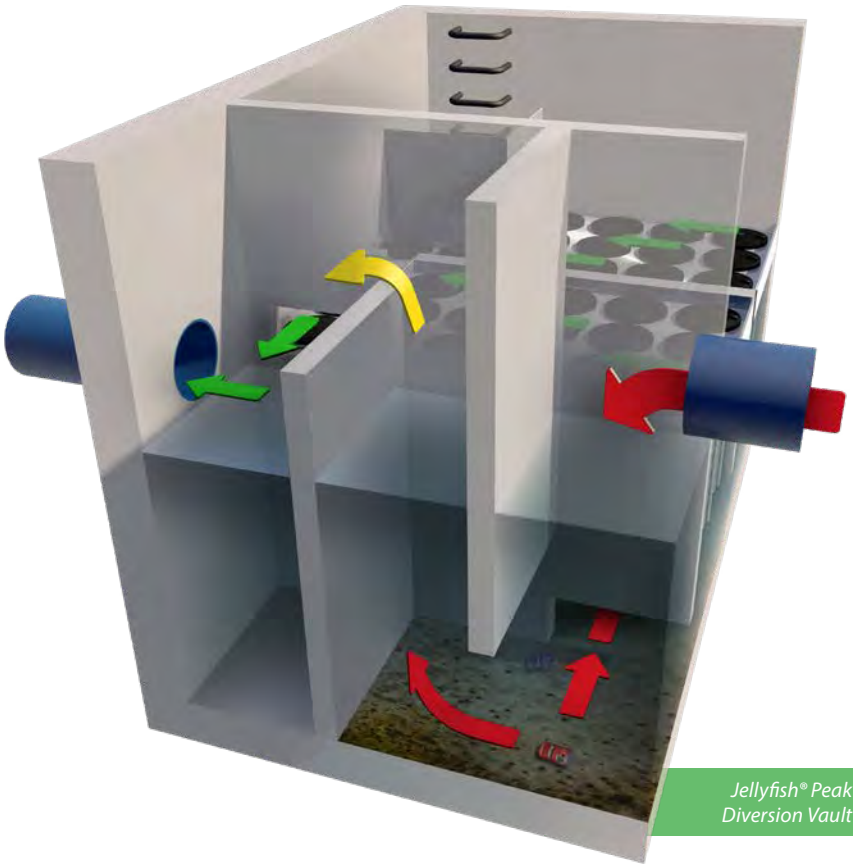
The Jellyfish Filter is a stormwater quality treatment technology featuring high flow pretreatment and membrane filtration in a compact stand-alone system. Jellyfish removes floatables, trash, oil, debris, TSS, fine silt-sized particles, and a high percentage of particulate-bound pollutants; including phosphorus, nitrogen, metals, and hydrocarbons. The high surface area membrane cartridges, combined with up-flow hydraulics, frequent, passive backwashing, and rinseable/ reusable cartridges ensure long-lasting performance.

Jellyfish® Filter

How the Jellyfish® Filter Treats Stormwater

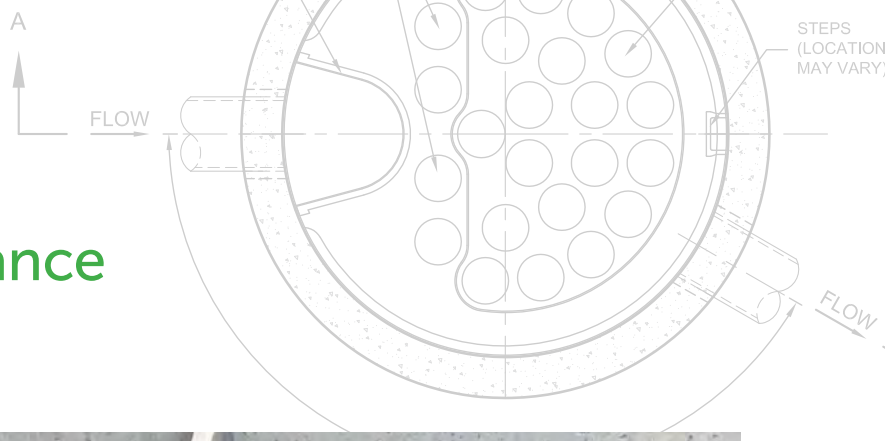
Tested in the field and laboratory ...

- Water enters the vault via an inlet bay where floating pollutants, oil, and grease are trapped behind a baffle wall.
- Water flows through the inlet bay transfer opening into the treatment chamber.
- Water is forced up from the treatment chamber, through the membrane filtration, and into the backwash pool.
- The water then fills and overflows the backwash pool and exits via the outlet bay transfer opening.
- As each storm subsides, the remaining water caught in the backwash pool flows back into the treatment chamber through the cartridges.
- This passive backwash extends cartridge life and prepares them for the next storm event. The draindown cartridges located outside the backwash pool enables water levels to balance.
- During peak flows, the internal weir allows high flows to bypass treatment, eliminating the need for an external bypass structure.



Jellyfish® Peak Diversion Vault

Learn More:
www.ContechES.com/jellyfish



Jellyfish® Filter Performance Testing Results

APPLICATION TIPS

- The Peak Diversion Jellyfish provides treatment and high-flow bypass in one structure, eliminating the need for a separate bypass structure.
- LID and GI are complemented by filtration solutions, as they help keep sites free from fine sediments that can impede performance, remove unsightly trash, and provide a single point of maintenance.
- Selecting a filter with a long maintenance cycle and low maintenance cost will result in healthy waterways and happy property owners.

The pleated tentacles of the Jellyfish® Filter provide a large surface area for pollutant removal.

POLLUTANT OF CONCERN	% REMOVAL
Total Suspended Solids (TSS)	85%
Total Phosphorus (TP)	75%
Total Copper (TCu)	67%
Total Zinc (TZn)	60%

Sources:
WA DOE TAPE Testing: https://fortress.wa.gov/ecy/ezshare/wq/tape/use_designations/JELLYFISHfilterIMBRIUMguld.pdf

Jellyfish® Filter Features and Benefits

FEATURE	BENEFITS
High surface area membrane filtration	Low flux rate promotes cake filtration and slows membrane occlusion
High design treatment flow rate per cartridge (up to 80 gpm (5 L/s))	Compact system with a small footprint, lower construction cost
Low driving head (typically 18-21 inches or less (457-533 mm))	Design flexibility, lower construction cost
Lightweight cartridges with passive backwash	Easy maintenance and low life-cycle cost

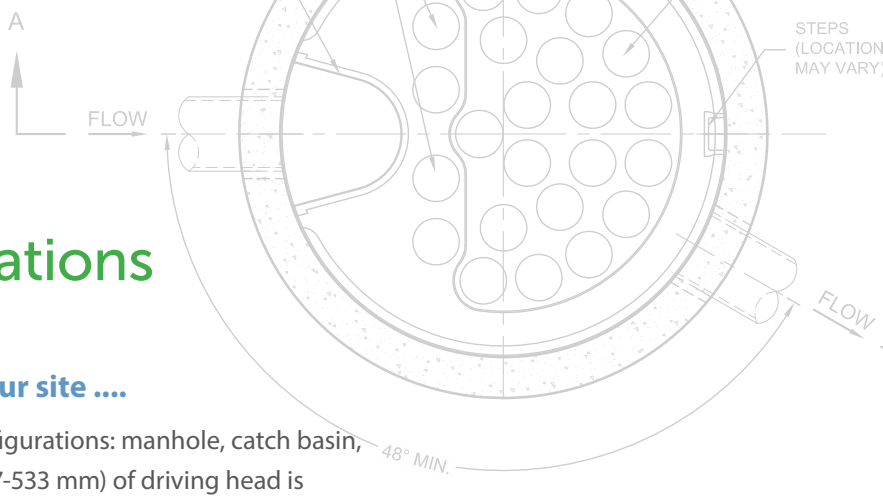
The Jellyfish Filter can be configured in a manhole, catch basin, or vault.

Select Jellyfish® Filter Certifications and Verifications

The Jellyfish Filter has been reviewed by numerous state and federal programs, including:

- New Jersey Corporation for Advanced Technology (NJCAT) – Field Performance per TARP Tier II Protocol
- Washington State Department of Ecology (TAPE – GULD)
- Maryland Department of the Environment (MD DOE)
- Canada ISO 14034 Environmental Management - Environmental Technology Verification (ETV)
- Texas Commission on Environmental Quality (TCEQ)
- Virginia Department of Environmental Quality (VA DEQ)

Field tested and performance verified

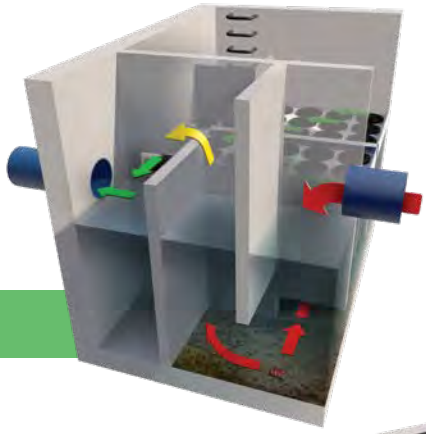


Jellyfish® Filter Configurations

Multiple system configurations to optimize your site ....

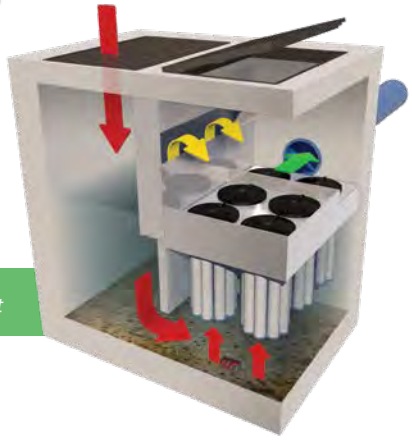
The Jellyfish Filter can be manufactured in a variety of configurations: manhole, catch basin, vault, or custom configurations. Typically, 18-21 inches (457-533 mm) of driving head is designed into the system.

Manhole



Vault

Curb Inlet



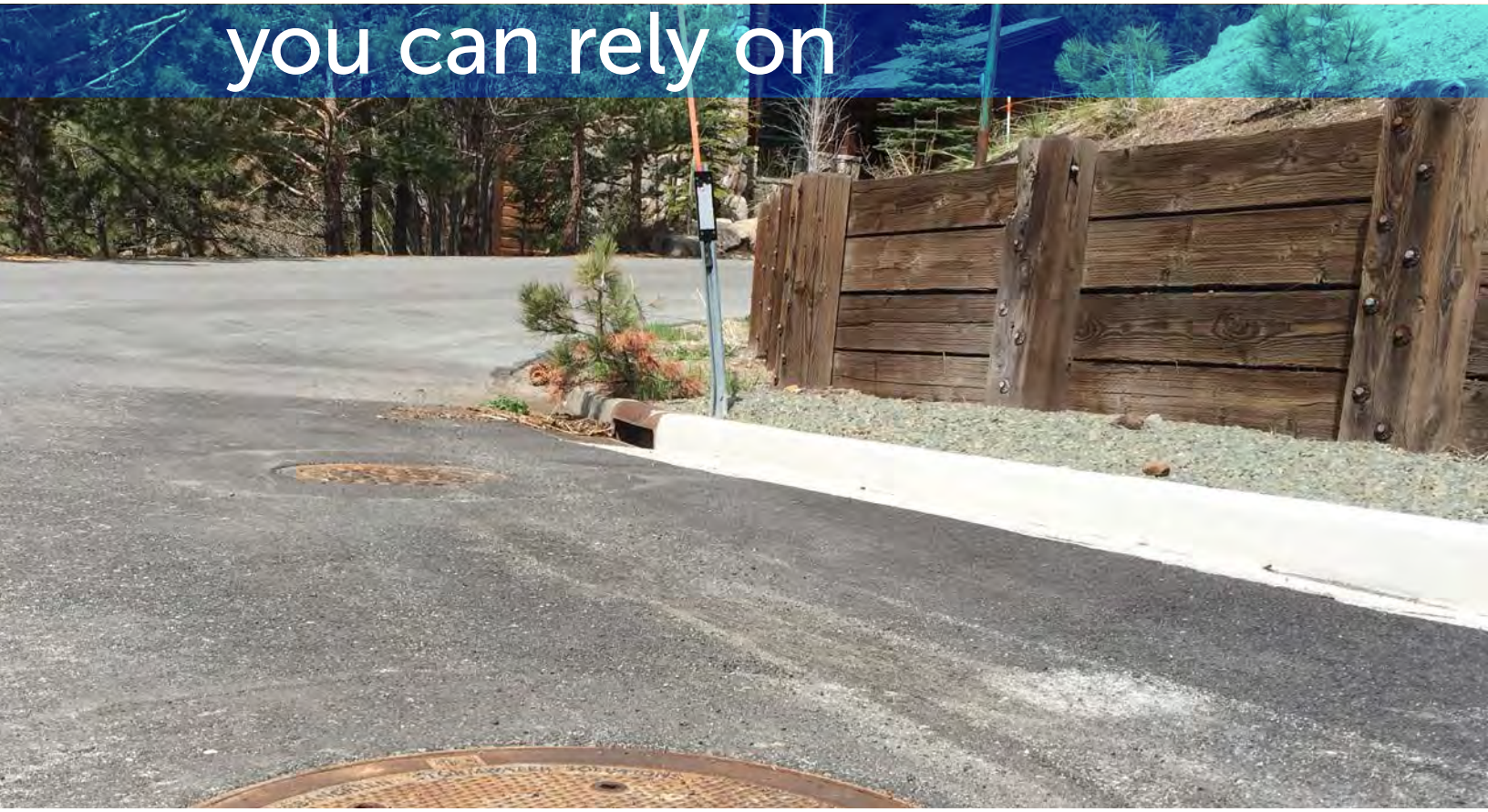
Grated Inlet

Jellyfish® Filter Maintenance

- Jellyfish Filter cartridges are light weight and reusable
- Maintenance of the filter cartridges is performed by removing, rinsing and reusing the cartridge tentacles.
- Vacuum extraction of captured pollutants in the sump is recommended at the same time.
- Full cartridge replacement intervals differ by site due to varying pollutant loading and type, and maintenance frequency. Replacement is anticipated every 2-5 years.
- Contech® has created a network of Certified Maintenance Providers to provide maintenance on stormwater BMPs.

The Jellyfish® Filter tentacle is light and easy to clean.

A partner you can rely on



STORMWATER SOLUTIONS

PIPE SOLUTIONS

STRUCTURES SOLUTIONS

Few companies offer the wide range of high-quality stormwater resources you can find with us — state-of-the-art products, decades of expertise, and all the maintenance support you need to operate your system cost-effectively.

THE CONTECH WAY

Contech® Engineered Solutions provides innovative, cost-effective site solutions to engineers, contractors, and developers on projects across North America. Our portfolio includes bridges, drainage, erosion control, retaining wall, sanitary sewer and stormwater management products.

TAKE THE NEXT STEP

For more information: www.ContechES.com

CONTECH® ENGINEERED SOLUTIONS

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CULTEC Recharger® 360HD Stormwater Chamber

The Recharger® 360HD is a 36" (914 mm) tall, high capacity chamber. Typically when using this model, fewer chambers are required resulting in less labor and a smaller installation area. The Recharger® 360HD has the side portal internal manifold feature. HVLV® FC-48 Feed Connectors are inserted into the side portals to create the internal manifold.

Recharger 360HD Chamber

Recharger 360HD End Cap

Recharger 360HD Chamber	
Size (L x W x H)	4.17' x 60" x 36"
	1.27 m x 1525 mm x 914 mm
Installed Length	3.67'
	1.12 m
Length Adjustment per Row - with two end caps installed	2.5'
	0.76 m
Length Adjustment per Row - when not using end caps	0.5'
	0.15 m
Chamber Storage	10.00 ft^3/ft
	0.929 m^3/m
	36.66 ft^3/unit
	1.038 m^3/unit
Min. Installed Storage	15.199 ft^3/ft
	1.412 m^3/m
	55.73 ft^3/unit
	1.58 m^3/unit
Min. Area Required	21.08 ft^2
	1.96 m^2
Chamber Weight	57.0 lbs
	25.85 kg
Shipping	20 chambers/skid
	1,265 lbs/skid
	11 skids/48' flatbed
Min. Center-to-Center Spacing	5.75'
	1.75 m
Max. Allowable Cover	12'
	3.66 m
Max. Allowable O.D. in Side Portal	10" HDPE, 12" PVC
	250 mm HDPE, 300 mm PVC
Compatible Feed Connector	HVLV FC-48 Feed Connector

Calculations are based on installed chamber length.
All above values are nominal.
Min. installed storage includes 6" (152 mm) stone base, 6" (152 mm) stone above crown of chamber and typical stone surround at 5.75 (1.75 m) center-to-center spacing.

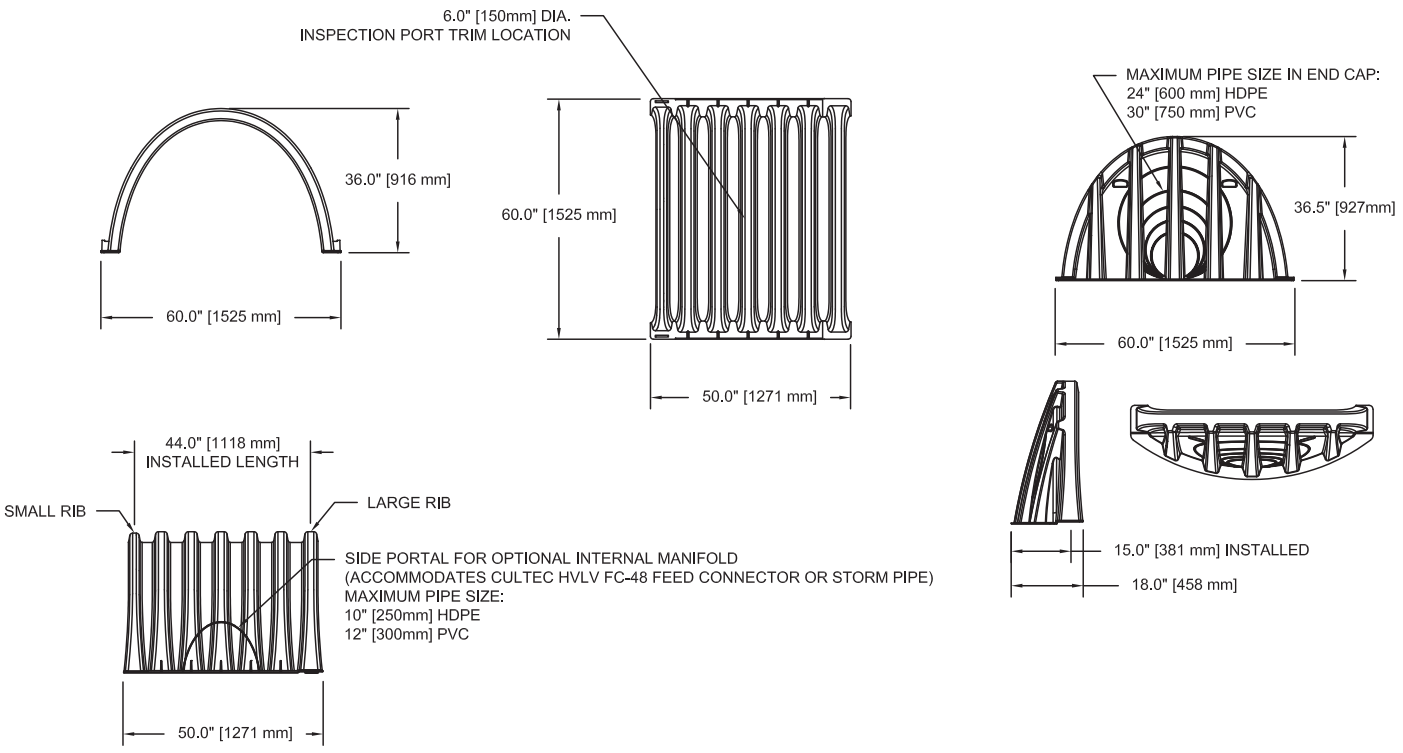
	Stone Foundation Depth		
	6"	12"	18"
	152 mm	305 mm	457 mm
Chamber and Stone Storage Per Chamber	55.73 ft^3	59.95 ft^3	64.17 ft^3
	1.58 m^3	1.70 m^3	1.82 m^3
Min. Effective Depth	4.00'	4.50'	5.0'
	1.22 m	1.37 m	1.52 m
Stone Required Per Chamber	1.77 yd^3	2.16 yd^3	2.55 yd^3
	1.35 m^3	1.65 m^3	1.95 m^3

Recharger 360HD End Cap	
Size (L x W x H)	18" x 60" x 36.5"
	458 mm x 1525 mm x 927 mm
Installed Length	15"
	381 mm
End Cap Storage	5.17 ft^3/ft
	0.48 m^3/m
	6.46 ft^3/unit (interlocked)
	0.183 m^3/unit (interlocked)
Min. Installed Storage	12.40 ft^3/ft
	1.15 m^3/m
	15.50 ft^3/unit
	0.44 m^3/unit
End Cap Weight	22.0 lbs
	9.98 kg
Shipping	20 end caps/skid
	565 lbs/skid
	11 skids/48' flatbed
Max. Inlet Opening in End Cap	24" HDPE, 30" PVC
	600 mm HDPE, 750 mm PVC

Calculations are based on installed chamber length.
Includes 6" (305 mm) stone above crown of chamber and typical stone surround at. 5.75' (1.75 m) center-to-center spacing and stone foundation as listed in table.
Stone void calculated at 40%.

For more information, contact CULTEC at (203) 775-4416 or visit www.cultec.com.

Three View Drawing



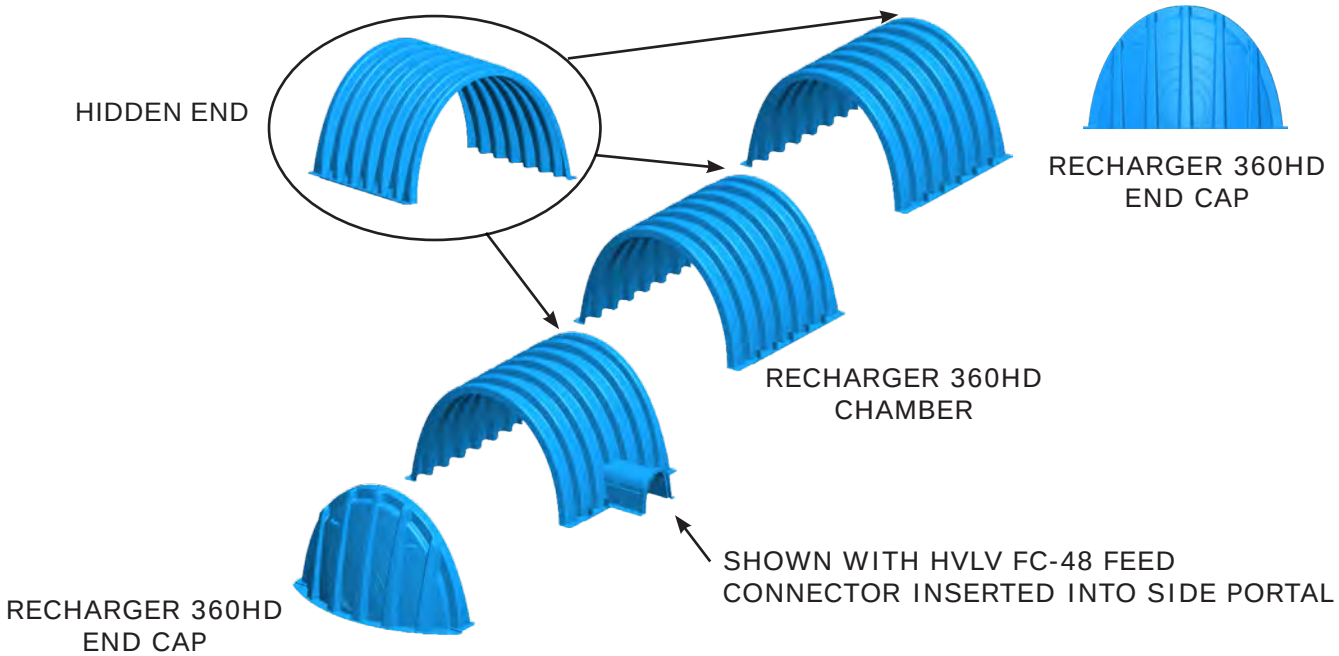
CULTEC RECHARGER 360HD CHAMBER STORAGE = 10.0 CF/FT [.928m³/m]
CHAMBER STORAGE VOLUME = 36.66 CF [1.038m³]
INSTALLED LENGTH ADJUSTMENT = 0.50' [0.15m]
SIDE PORTAL ACCEPTS CULTEC HVLV FC-48 FEED CONNECTOR

Recharger 360HD Chamber

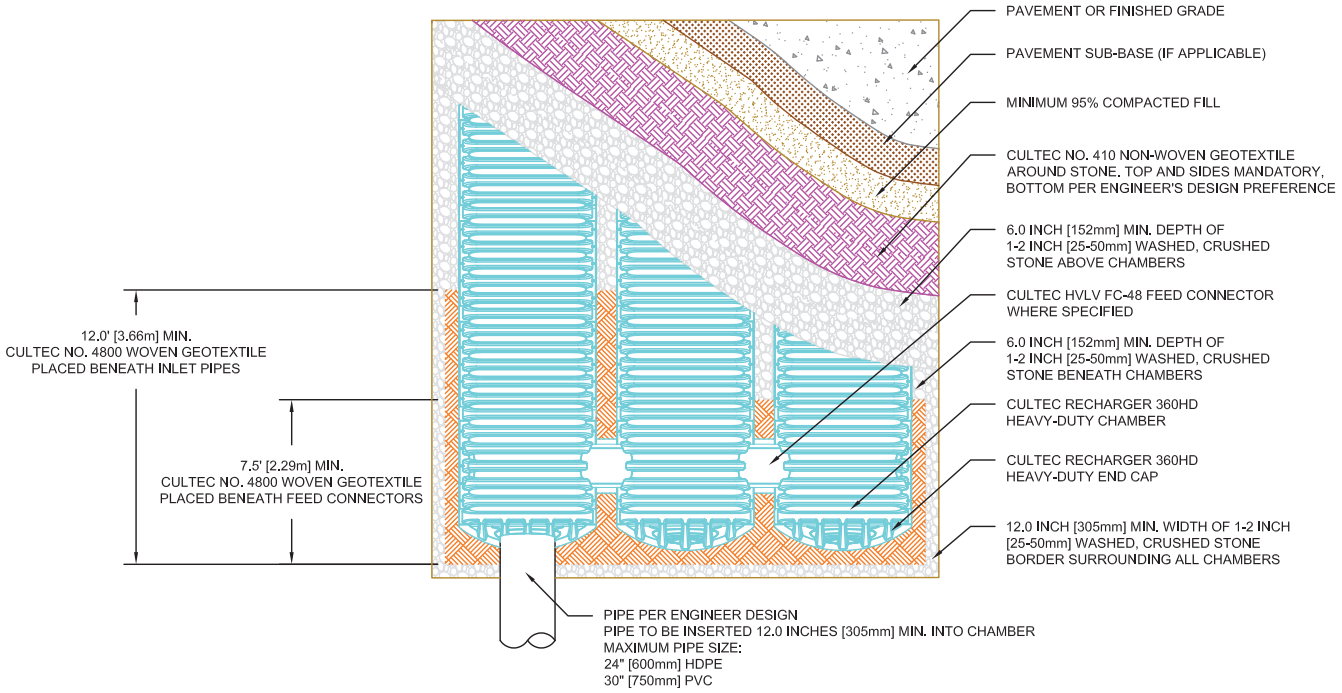
CULTEC RECHARGER 360HD END CAP
STORAGE = 5.17 CF/FT [0.48 m³/m]
END CAP STORAGE VOLUME = 6.46 CF [0.183 m3]
INSTALLED LENGTH ADJUSTMENT = 0.25' [0.08 m]

Recharger 360HD End Cap

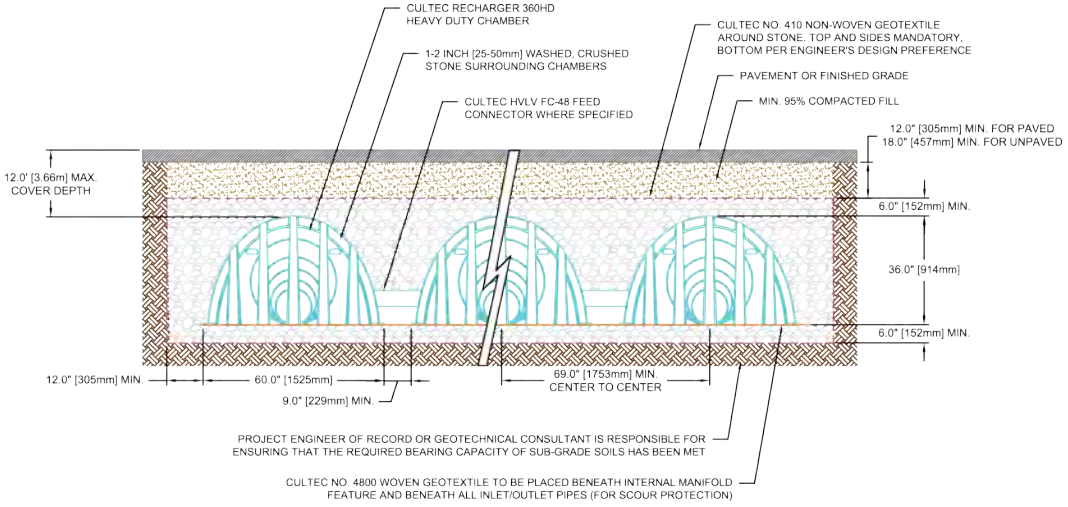
Typical Interlock Installation



Plan View Drawing



Typical Cross Section for Traffic Application



NOTES:
1. THE CHAMBERS SHALL BE DESIGNED AND TESTED IN ACCORDANCE WITH ASTM F2787 "STANDARD PRACTICE FOR STRUCTURAL DESIGN OF THERMOPLASTIC CORRUGATED WALL STORMWATER COLLECTION CHAMBERS." THE LOAD CONFIGURATION SHALL INCLUDE:
   1.a. INSTANTANEOUS AASHTO DESIGN TRUCK LIVE LOAD AT MINIMUM COVER
   1.b. MAXIMUM PERMANENT (50-YEAR) COVER LOAD
   1.c. 1-WEEK PARKED AASHTO DESIGN TRUCK LOAD
2. THE CHAMBERS SHALL MEET THE REQUIREMENTS OF ASTM F3430-20 "STANDARD SPECIFICATION FOR CELLULAR POLYPROPYLENE (PP) CORRUGATED WALL STORMWATER COLLECTION CHAMBERS"
3. THE INSTALLED CHAMBER SYSTEM SHALL PROVIDE RESISTANCE TO THE LOADS AND LOAD FACTORS AS DEFINED IN THE AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS SECTION 12.12, WHEN INSTALLED ACCORDING TO CULTEC'S RECOMMENDED INSTALLATION INSTRUCTIONS. THE STRUCTURAL DESIGN OF THE CHAMBERS SHALL INCLUDE THE FOLLOWING:
   3.a. THE CREEP MODULUS SHALL BE 50-YEAR AS SPECIFIED IN ASTM F3430
   3.b. THE MINIMUM SAFETY FACTOR FOR LIVE LOADS SHALL BE 1.75
   3.c. THE MINIMUM SAFETY FACTOR FOR DEAD LOADS SHALL BE 1.95

Recharger® 360HD Bare Chamber Storage Volumes

Elevation		Incremental Storage Volume				Cumulative Storage	
in.	mm	ft³/ft	m³/m	ft³	m³	ft³	m³
36	914	0.022	0.002	0.08	0.002	3.3658	1.038
35	889	0.046	0.004	0.17	0.005	36.577	1.036
34	864	0.069	0.006	0.25	0.007	36.407	1.031
33	838	0.117	0.011	0.43	0.012	36.154	1.024
32	813	0.148	0.014	0.54	0.015	35.726	1.012
31	787	0.171	0.016	0.63	0.018	35.185	0.996
30	762	0.190	0.018	0.70	0.020	34.560	0.979
29	737	0.206	0.019	0.76	0.021	33.864	0.959
28	711	0.221	0.021	0.81	0.023	33.108	0.938
27	686	0.234	0.022	0.86	0.024	32.298	0.915
26	660	0.246	0.023	0.90	0.026	31.441	0.890
25	635	0.257	0.024	0.94	0.027	30.539	0.865
24	609	0.267	0.025	0.98	0.028	29.598	0.838
23	584	0.276	0.026	1.01	0.029	28.620	0.811
22	559	0.284	0.026	1.04	0.030	27.608	0.782
21	533	0.292	0.027	1.07	0.031	26.565	0.752
20	508	0.300	0.028	1.10	0.032	25.493	0.722
19	483	0.307	0.028	1.12	0.033	24.394	0.691
18	457	0.313	0.029	1.15	0.033	23.239	0.659
17	432	0.319	0.030	1.17	0.033	22.121	0.626
16	406	0.325	0.030	1.19	0.034	20.950	0.593
15	381	0.331	0.031	1.21	0.034	19.757	0.560
14	356	0.336	0.031	1.23	0.035	18.545	0.525
13	330	0.341	0.032	1.25	0.035	17.313	0.490
12	305	0.345	0.032	1.27	0.036	16.064	0.455
11	279	0.350	0.032	1.28	0.036	14.798	0.419
10	254	0.354	0.033	1.30	0.037	13.516	0.383
9	229	0.358	0.033	1.31	0.037	12.219	0.346
8	203	0.361	0.034	1.32	0.038	10.908	0.309
7	178	0.365	0.034	1.34	0.038	9.584	0.271
6	152	0.368	0.034	1.35	0.038	8.247	0.234
5	127	0.371	0.034	1.36	0.039	6.898	0.195
4	102	0.374	0.035	1.37	0.039	5.538	0.157
3	76	0.376	0.035	1.38	0.039	4.168	0.118
2	51	0.379	0.035	1.39	0.039	2.787	0.079
1	25	0.381	0.035	1.40	0.040	1.398	0.040
Total		9.998	0.929	36.66	1.038	36.658	1.038

Calculations are based on installed chamber length of 3.67' (1.12 m).

Recharger® 360HD Bare End Cap Storage Volumes

Elevation		Incremental Storage Volume				Cumulative Storage	
in.	mm	ft³/ft	m³/m	ft³	m³	ft³	m³
36	914	0.008	0.0007	0.01	0.000	6.460	0.183
35	889	0.016	0.0015	0.02	0.001	6.450	0.183
34	864	0.024	0.0022	0.03	0.001	6.430	0.182
33	838	0.032	0.0030	0.04	0.001	6.400	0.181
32	813	0.040	0.0037	0.05	0.001	6.360	0.180
31	787	0.048	0.0045	0.06	0.002	6.310	0.179
30	762	0.056	0.0052	0.07	0.002	6.250	0.177
29	737	0.064	0.0059	0.08	0.002	6.180	0.175
28	711	0.072	0.0067	0.09	0.003	6.100	0.173
27	686	0.080	0.0074	0.10	0.003	6.010	0.170
26	660	0.088	0.0082	0.11	0.003	5.910	0.167
25	635	0.096	0.0089	0.12	0.003	5.800	0.164
24	609	0.112	0.0104	0.14	0.004	5.680	0.161
23	584	0.120	0.0111	0.15	0.004	5.540	0.157
22	559	0.128	0.0119	0.16	0.005	5.390	0.153
21	533	0.136	0.0126	0.17	0.005	5.230	0.148
20	508	0.144	0.0134	0.18	0.005	5.060	0.143
19	483	0.152	0.0141	0.19	0.005	4.880	0.138
18	457	0.160	0.0149	0.20	0.006	4.690	0.133
17	432	0.160	0.0149	0.20	0.006	4.490	0.127
16	406	0.168	0.0156	0.21	0.006	4.290	0.121
15	381	0.176	0.0164	0.22	0.006	4.080	0.116
14	356	0.184	0.0171	0.23	0.007	3.860	0.109
13	330	0.192	0.0178	0.24	0.007	3.630	0.103
12	305	0.192	0.0178	0.24	0.007	3.390	0.096
11	279	0.200	0.0186	0.25	0.007	3.150	0.089
10	254	0.208	0.0193	0.26	0.007	2.900	0.082
9	229	0.208	0.0193	0.26	0.007	2.640	0.075
8	203	0.216	0.0201	0.27	0.008	2.380	0.067
7	178	0.224	0.0208	0.28	0.008	2.110	0.060
6	152	0.232	0.0216	0.29	0.008	1.830	0.052
5	127	0.232	0.0216	0.29	0.008	1.540	0.044
4	102	0.240	0.0223	0.30	0.008	1.250	0.035
3	76	0.240	0.0223	0.30	0.008	0.950	0.027
2	51	0.248	0.0230	0.31	0.009	0.650	0.018
1	25	0.272	0.0253	0.34	0.010	0.340	0.010
Total		5.168	0.480	6.46	0.183	6.460	0.183

Calculations are based on installed end cap length of 15" (381 mm).

CULTEC Recharger® 360HD Specifications

GENERAL

CULTEC Recharger® 360HD chambers are designed for underground stormwater management. The chambers may be used for retention, recharging, detention or controlling the flow of on-site stormwater runoff.

CHAMBER PARAMETERS

1. The chambers shall be manufactured in the U.S.A. or Canada by CULTEC, Inc. of Brookfield, CT (cultec.com, 203-775-4416).
2. The chambers shall be designed and tested in accordance with ASTM F2787 "Standard Practice for Structural Design of Thermoplastic Corrugated Wall Stormwater Collection Chambers". The load configuration shall include:
    a. Instantaneous AASHTO Design Truck live load at minimum cover
    b. Maximum permanent (50-year) cover load
    c. 1-week parked AASHTO design truck load
3. The chambers shall meet the requirements of ASTM F3430-20 "Standard Specification for Cellular Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers".
4. The installed chamber system shall provide resistance to the loads and load factors as defined in the AASHTO LRFD Bridge Design Specifications Section 12.12, when installed according to CULTEC's recommended installation instructions. The structural design of the chambers shall include the following:
    a. The Creep Modulus shall be 50-year as specified in ASTM F3430
    b. The minimum safety factor for live loads shall be 1.75
    c. The minimum safety factor for dead loads shall be 1.95
5. The chamber shall be structural foam injection molded of blue virgin high molecular weight impact-modified polypropylene.
6. The chamber shall be arched in shape.
7. The chamber shall be open-bottomed.
8. The chamber shall be joined using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings.
9. The nominal chamber dimensions of the CULTEC Recharger® 360HD shall be 36 inches (915 mm) tall, 60 inches (1525 mm) wide and 50 inches (1275 m) long. The installed length of a joined Recharger 360HD shall be 3.67 feet (1.12 m).
10. Multiple chambers may be connected to form different length rows. Each row shall begin and end with a separately formed CULTEC Recharger® 360HD End Cap. Maximum inlet opening on the end cap is 24 inches (600 mm) HDPE or 30 inches (750 mm) PVC.
11. The chamber shall have two side portals to accept CULTEC HVLV™ FC-48 Feed Connectors to create an internal manifold. Maximum allowable pipe size in the side portal is 10 inches (250 mm) HDPE or 12 inches (300 mm) PVC.
12. The nominal chamber dimensions of the CULTEC HVLV™ FC-48 Feed Connector shall be 12 inches (305 mm) tall, 16 inches (406 mm) wide and 49 inches (1245 mm) long.
13. The nominal storage volume of the Recharger 360HD chamber shall be 10.0 ft^3 / ft (0.928 m^3 / m) - without stone.
    The nominal storage volume of a joined Recharger 360HD shall be 36.66 ft^3 / unit (1.038 m^3 / unit) - without stone.
14. The nominal storage volume of the HVLV™ FC-48 Feed Connector shall be 0.913 ft^3 / ft (0.085 m^3 / m) - without stone.
15. The Recharger 360HD chamber shall have 7 corrugations.
16. The chamber shall be manufactured in a facility employing CULTEC's Quality Control and Assurance Procedures.
17. Maximum allowable cover over the top of the chamber shall be 12 feet (3.66 m).

END CAP PARAMETERS

1. The CULTEC Recharger® 360HD End Cap (referred to as 'end cap') shall be manufactured in the U.S.A. or Canada by CULTEC, Inc. of Brookfield, CT (cultec.com, 203-775-4416).
2. The end cap shall be structural foam injection molded of blue virgin high molecular weight impact-modified polypropylene.
3. The end cap shall be arched in shape.
4. The end cap shall be open-bottomed.
5. The end cap shall be joined at the beginning and end of each row of chambers using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings.
6. The end cap shall have 5 corrugations.
7. The nominal dimensions of the end cap shall be 36.5 inches (927 mm) tall, 60 inches (1525 mm) wide and 18 inches (458 mm) long. When joined with a Recharger 360HD Chamber, the installed length of the end cap shall be 15 inches (381 mm).
8. The nominal storage volume of the end cap shall be 5.17 ft^3 / ft (0.48 m^3 / m) - without stone. The nominal storage volume of an interlocked end cap shall be 6.46 ft^3 / unit (0.183 m^3 / unit) - without stone.
9. Maximum inlet opening on the end cap is 24 inches (600 mm) HDPE or 30 inches (750 mm) PVC.
10. The end cap shall be manufactured in a facility employing CULTEC's Quality Control and Assurance Procedures.
11. The end cap shall provide resistance to the loads and load factors as defined in the AASHTO LRFD Bridge Design Specifications Section 12.12.

APPENDIX I:

REFERENCES AND SOURCES

References and Sources:

- Massachusetts Stormwater Handbook and Stormwater Standards, February 2008

- Federal Highway Administration, Hydraulic Engineering Circular No. 14, Third Edition (HEC-14), Hydraulic Design for Culverts and Channels, Publication No. FHWA-NHI-06-086, July 2006

- Town of Andover Zoning Bylaw, Recodified March 21, 2023

- Town of Andover GIS database, https://mimap.mvpc.org/map/index.html?viewer=andover

- United States Department of Agriculture, Natural Resources Conservation Service, Web Soil Survey