April 20, 2021

Town of Fairhaven Conservation Commission
ATTN: Ms. Whitney McClees, Conservation Agent
40 Center Street
Fairhaven, MA 02719

Re: **Response to Comments from Conservation Commission Meeting**
for a Request for Determination of Applicability (RDA) Application
Fairhaven High School Synthetic Turf Athletic Field
12 Huttleston Avenue
Fairhaven, Massachusetts
(Pare Project No. 20211.00)

Dear Ms. McClees:

On behalf of Fairhaven Public Schools and the Town of Fairhaven, Pare Corporation and Traverse Landscape Architects presented the proposed Fairhaven High School Synthetic Turf Project at the Fairhaven Conservation Commission (the Commission) public meeting that was held on April 12, 2021 for a Request for Determination of Applicability (RDA) application due to a portion of the project being located within 100-ft of Floodplain Zone AE. The project was continued at the meeting until April 26, 2021.

During the April 12, 2021 public meeting, one Commission Member referenced potential changes on the plans. We are unsure of what plans the Commission member was speaking of. The plans that have been presented to the Commission are the current plans.

Pare followed up after the meeting for clarification on the information being requested by the Commission and provided a preliminary response to questions via e-mail on April 15, 2021. A meeting was held with the Conservation Agent, Pare, and Traverse on April 16, 2021 to discuss the information being requested, data used for the flood and drainage analysis, known issues with the existing drainage infrastructure in the area of the project, and the specific flood concerns expressed by the Commission.

A meeting was also held with the Director of Planning and Economic Development, Fairhaven Public Schools, Pare, and Traverse on April 15, 2021 to clarify the Planning Board's jurisdiction on the project. The Director stated they will be providing the Commission with a letter summarizing the Planning Board's role.

This cover letter is being provided as a formal response to stormwater and flood questions raised by the Commission. Please find enclosed the following:

- Project Narrative with Stormwater Management information included within this Cover Letter;
- Attachment A: FEMA Flood Mapping (FIRMette)
- Attachment B: NOAA Atlas-14 Rainfall Data
- Attachment C: XBT1 Existing Hydrology Plan and XBT2 Proposed Hydrology Plan;
- Attachment D: Hydrologic Calculations - Existing and Proposed Conditions;
- Attachment E: Hydraulic Pipe-Sizing Calculations;
- Attachment F: Groundwater Recharge Calculations;
- Attachment G: Fairhaven MVP Program's Summary of Findings for Reference.

Existing Conditions

The proposed synthetic turf athletic field project is located within the footprint of the existing natural turf athletic field in the eastern portion of the Fairhaven High School property. The project area is bordered by Huttleston Ave to the south, Green Street to the East, a school parking lot and Larch Ave to the north, and an access drive and the school building to the west. The existing project area is comprised of a grassed field that is surrounded by fencing, 3-ft high decorative brick walls, bleachers, and a concession stand.

There are no existing wetlands or natural water features onsite. The Acushnet River is located approximately 950± feet west of the project area. Based on FEMA mapping, Floodplain Zone AE with Elevation 6 feet is associated with the river. The floodplain is located southeast of the school property at the corner of Huttleston Avenue and Green Street; this floodplain is located outside of the proposed project limits. The floodplain according to the FEMA Mapping and Elevation 6.0 per the existing conditions survey are shown on the project plans along with the 100-ft floodplain buffer.

The existing field has poor drainage that often makes it unplayable for days after rain events. Years of playing and overuse on the athletic field have compacted the existing soils and it is expected that the existing field surface has very little infiltration. The current natural turf field was designed in 1994 with drywells to help promote infiltration for stormwater management, but observations in the field indicate that those drywells have exceeded their life expectancy and are no longer infiltrating. The drywells are equipped with drain pipes that convey stormwater runoff that cannot be infiltrated to the existing 60" culvert that runs parallel to Huttleston Avenue.

The soils within the athletic field are mapped by the USDA Natural Resources Conservation Service (NRCS) as Urban Land with no associated hydrologic soil group (HSG). Four test pits were conducted within the limit of disturbance on January 20, 2021 by a Massachusetts Certified Soil Evaluated at Pare Corporation. In summary, a fill layer of approximately 4 - 5 feet deep comprised of silty material and debris was encountered in all four test pits. Native soil material was observed underneath the fill layer and is comprised of well-draining sands and loamy sands. Therefore, the existing soils were modeled conservatively for the project as "HSG B." Estimated seasonal high groundwater (ESHGW) is approximated to be near the top of the native soil layer.

Proposed Improvements

The proposed project includes replacement of the existing natural turf althetic field with synthetic turf, a new field drainage system, ADA accessible pedestrian walkways around the field, a 1,100 S.F.± restroom/storage building, replacement of existing field lighting, and other associated improvements. The limit of disturbance for the project is approximately 2.3 acres. Many of the existing site features are intended to remain, including the bleachers, concession stand, press box, and the decorative brick wall surrounding the field. The project will upgrade the existing athletic field and associated features but will not change the use. Grading revisions within the limit of disturbance are minor and designed to meet current athletic and accessibility slope requirements.

Drainage features will utilize existing drainage lines located within public rights-of-way. The drainage system for the proposed field has been designed to improve water quality and reduce peak flows and runoff volumes with no adverse impacts to regulated flood zones. A notable benefit of a synthetic turf athletic field for the surrounding resource areas is that they do not require the fertilizers or herbicides that are used to treat a natural turf field. The Acushnet River is the receiving water for discharges from the athletic field, and the TMDL report indicates that the river is impaired for nutrients, so elimination of fertilizers and herbicides in the contributing watershed will help improve water quality.

Resource Area Impacts

The project is not subject to the Wetlands Protection Act. The Town of Fairhaven Conservation Commission bylaw requires review of projects within 100-feet of FEMA delineated floodplains. While the entire property and limit of disturbance for the project are outside of the FEMA floodplain, the southeastern portion of the athletic field is located within 100-ft of Floodplain Zone AE (elevation 6.0). The project area within 100-ft of the floodplain is approximately 17,600± S.F. (0.4 acres) and is surrounded by an existing 3-ft± high decorative brick wall that will remain. The project is expected to have no impact on the floodplain.

Stormwater Management Design

Overview and Methodology

The stormwater management system is designed in accordance with the 2008 Massachusetts Department of Environmental Protection (MADEP) Stormwater Handbook and the local Town of Fairhaven bylaws, Chapter 194 Stormwater Management. Subsequent mention of “Standards” included herein are referencing the minimum standards included in the MADEP Stormwater Handbook.

The drainage system for the athletic field was modelled in HydroCAD-10.10-3a which was publicly released on February 10, 2020. The precipitation data used to analyze the drainage system is from the latest NOAA Atlas 14 Precipitation Frequency Atlas of the United States: Northeast States, and the specific data used is for Bristol County, Massachusetts. The rainfall depths used for the various storms analyzed can be viewed in the tables below and in the attachments.

HydroCAD uses the TR-55 methodology to calculate runoff and TR-20 methodology for storm routing through pipes and detention facilities. Modeling for the routing of hydrograph outfalls to determine the peak flows at each storm event utilizes TR-20, SCS Type III 24-hour storm methodology. Site hydrology was evaluated for the 2-, 10-, 25-, and 100-year storms in accordance with the MA DEP Stormwater Handbook. Existing and Proposed Watershed Maps indicating the subwatersheds and associated stormwater flow paths are included in the attachments.

The hydraulic design calculations were completed using the Rational Method to calculate the accumulated flows to each structure. The stormwater conveyance system was designed using Manning's Equation. The stormwater conveyance system was designed to handle the runoff generated by a 25-year design storm. Pipe sizing calculations are included in the attachments.

Synthetic turf fields function very similarly to porous pavement in terms of stormwater management and treatment. Stormwater runoff directed to the synthetic turf field is filtered by the synthetic turf backing and the stone base layers beneath the synthetic turf prior to discharging to the perimeter manifold system. The synthetic turf system is expected to provide a decrease in pollutant loading compared to the existing natural turf field. The Fairhaven Bylaws Chapter 198 defines the water quality depth as the "first flush" or the first 1.25 inches of flow. Because the synthetic turf and stone base layers filter out any sediments the first flush will be fully treated as it seeps through the turf. The existing natural turf field was modelled as grass with a curve number (CN) value of 74 while the synthetic turf for the hydrologic model was designated a conservative CN value of 98. This conservative approach is a similar approach to the modeling procedures of porous pavement published by the UNH Stormwater Center.

Flood Data

The historic flooding data analyzed for the project is the information presented by FEMA and their flood mapping. The area of the field is denoted on the FEMA flood maps as being in an area that is protected from storm events larger than the 100-year storm by a levee system. The information utilizes FEMA Panel 0394G, dated June 2014. The FEMA FIRMette displaying the information is included in the attachments. Additionally, the Fairhaven MVP Program was reviewed and the Summary of Findings (Section 4) is included in the attachments for reference. The photos in the findings are from 2019 and are indicative of a significant flood event on Huttleston Avenue which is at approximately elevation 6.0' in this location (which matches the available FEMA flood information). The lowest elevation on the proposed synthetic turf field is elevation 8.5', which is 2.5' higher than elevation 6.0' for FEMA flood elevation.

Proposed Drainage Design

The proposed synthetic turf field is a pervious surface equipped with flat drains laid in a herringbone pattern across the field. The flat drains connect to a perforated perimeter manifold drain pipe set in crushed stone which is routed to two outlet control structures. The outlet control structures will tie-into existing drainage lines located within public rights-of-way.

The primary outlet control structure (OCS-1) connects to the existing drainage system on the school property which discharges to the existing 60” drain culvert that runs parallel through the southern portion of the athletic field. All storms modeled up to the 100-year storm event will discharge through OCS-1 and into the existing 60” culvert. The secondary outlet control structure (OCS-2) is a “back-up” outlet control structure with a weir set at the 100-year storm event elevation and connects to the drainage system in Green Street. No flows are expected to discharge to the Green Street drain system under normal circumstances. In a catastrophic event or if there is a clog in the primary drainage outlet from the field, the secondary outlet will allow the field to drain. Both outlet pipes from OCS-1 and OCS-2 are equipped with backflow preventers to block water from the drain mains from entering the field drainage system if there is a backup.

Per Minimum Standard 2: Peak Rate Attenuation, the post-development peak discharge rates for the project do not exceed the pre-development discharge rates. The pre- and post- development discharge rates can be viewed in Table 1 below.

Table 1: Peak Stormwater Runoff Flow Rate (CFS)

Design Point	**2-Year Event 3.30”**	**10-Year Event 4.88”**	**25-Year Event 6.10”**	**100-year Event 8.56”**
DP-1 Existing	1.89	4.08	5.92	9.82
DP-1 Proposed	1.89	3.95	4.83	6.31
Change	-0.00	-0.13	-1.09	-3.51

Per local bylaw Chapter 194 Stormwater Management, the runoff volumes were also calculated. It shall be noted that the bylaws state that no increase in peak volumes are allowed for up to the 10-year design storm, but with the improved drainage system within the athletic field footprint which will control flows and a provide infiltration, the project actually achieves a reduction in stormwater volume discharges from all storm events analyzed. The results are in Table 2 below.

Table 2: Volume of Runoff (cubic feet, c.f.)

Design Point	**2-Year Event 3.30”**	**10-Year Event 4.88”**	**25-Year Event 6.10”**	**100-year Event 8.56”**
DP-1 Existing	9,058	18,616	26,823	44,547
DP-1 Proposed	8,332	15,894	22,531	37,313
Change	-726	-2,722	-4,292	-7,234

The new restroom/storage building and walkways will increase impervious area within the limit of disturbance by 11,158 S.F. Per Minimum Standard 3: Recharge, with a target depth factor of 0.35" for HSG B soils, the required recharge volume was calculated to be 325 cubic feet. The crushed stone surrounding the perforated perimeter manifold acts as an infiltration system at elevations below the lowest outlet from the field, which is Elevation 4.0'. Using 40% voids for crushed stone, the perimeter manifold stone trench has a void volume of approximately 473 cubic feet below the lowest outlet and thus will infiltrate the required recharge volume. Recharge volume calculations are included in the attachments.

The proposed synthetic turf field has been designed to accommodate storage for the 100-year storm event. In a catastrophic rain event, the backflow preventers on the drainage pipes are not likely to engage until 3"-4" of rain has fallen. There is ample stormwater storage capacity underneath the field with the combination of stone voids, new drainage pipes, and the 1" air drain in the synthetic turf and the field will continue to infiltrate during storm events. Therefore, the field is never expected to flood above the surface elevation even with the backflow preventers engaged.

In conclusion, the proposed synthetic turf athletic field project is an important project for Fairhaven Public Schools and the Town of Fairhaven and will improve the playing field surface, amenities, and drainage system. The project will reduce peak discharge flow rates and volumes during storm events which will alleviate the burden on the existing drainage infrastructure in the surrounding roadways. Prior to construction, the Contractor will be required to prepare a Stormwater Pollution Prevention Plan (SWPPP) and file a Notice of Intent with the EPA for a National Pollutant Discharge Elimination System (NPDES) Permit. Erosion and sediment controls will be installed by the Contractor and maintained throughout construction until the site is fully stabilized.

Should you have any questions or require additional information, please feel free to contact our office at (401) 334-4100. We look forward to clarifying the questions asked by the Commission in the upcoming public meeting on April 26, 2021.

Sincerely,

Lance Hill, P.E.
Managing Engineer

LH/JRR

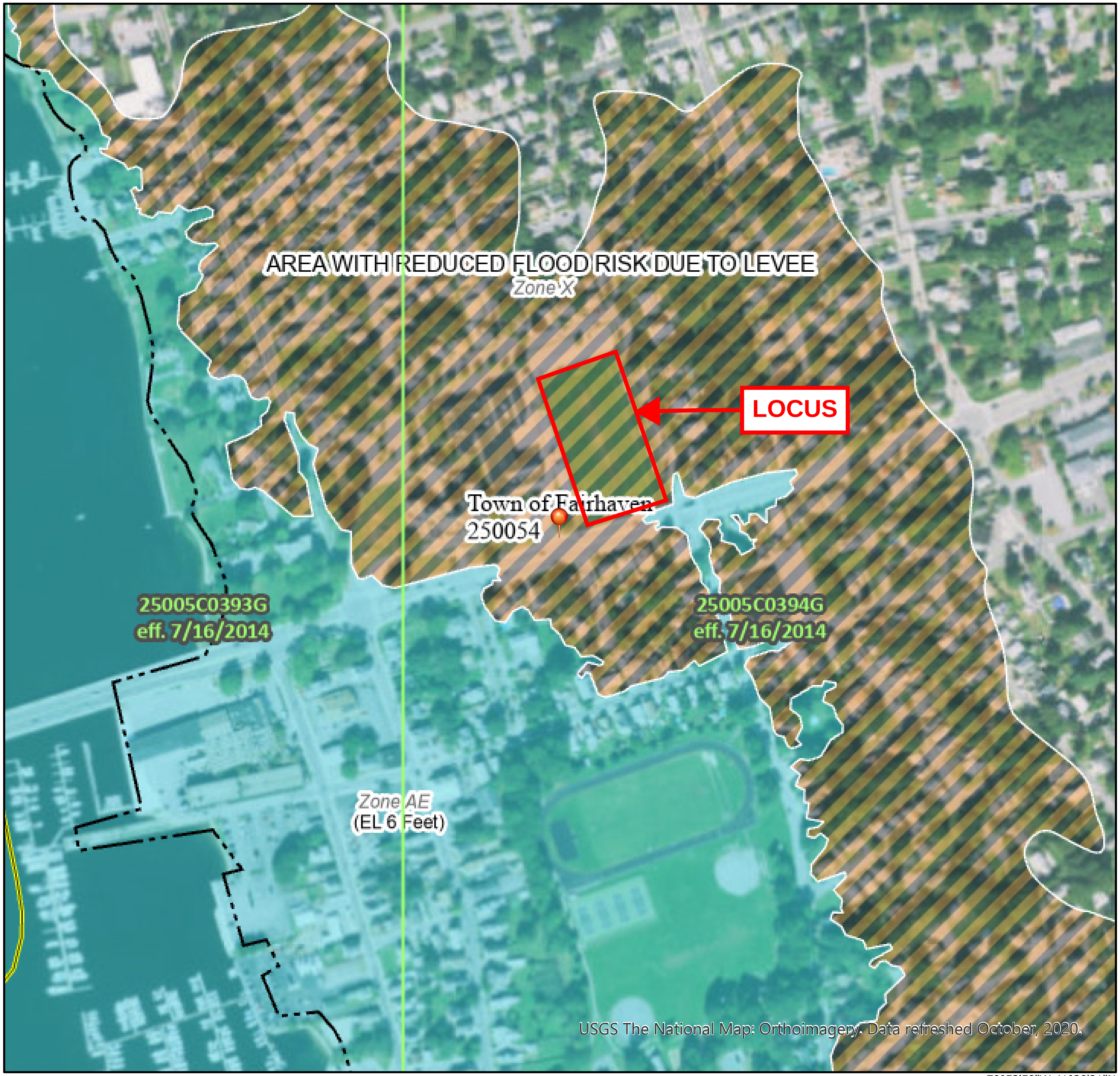
ATTACHMENT A

FEMA Flood Mapping (FIRMette)

National Flood Hazard Layer FIRMette

FEMA

70°54'36"W 41°38'48"N



70°53'58"W 41°38'21"N

Feet 0 250 500 1,000 1,500 2,000

1:6,000

Legend

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

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

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

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

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

OTHER FEATURES
- B 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 8 Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 12/29/2020 at 4:49 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

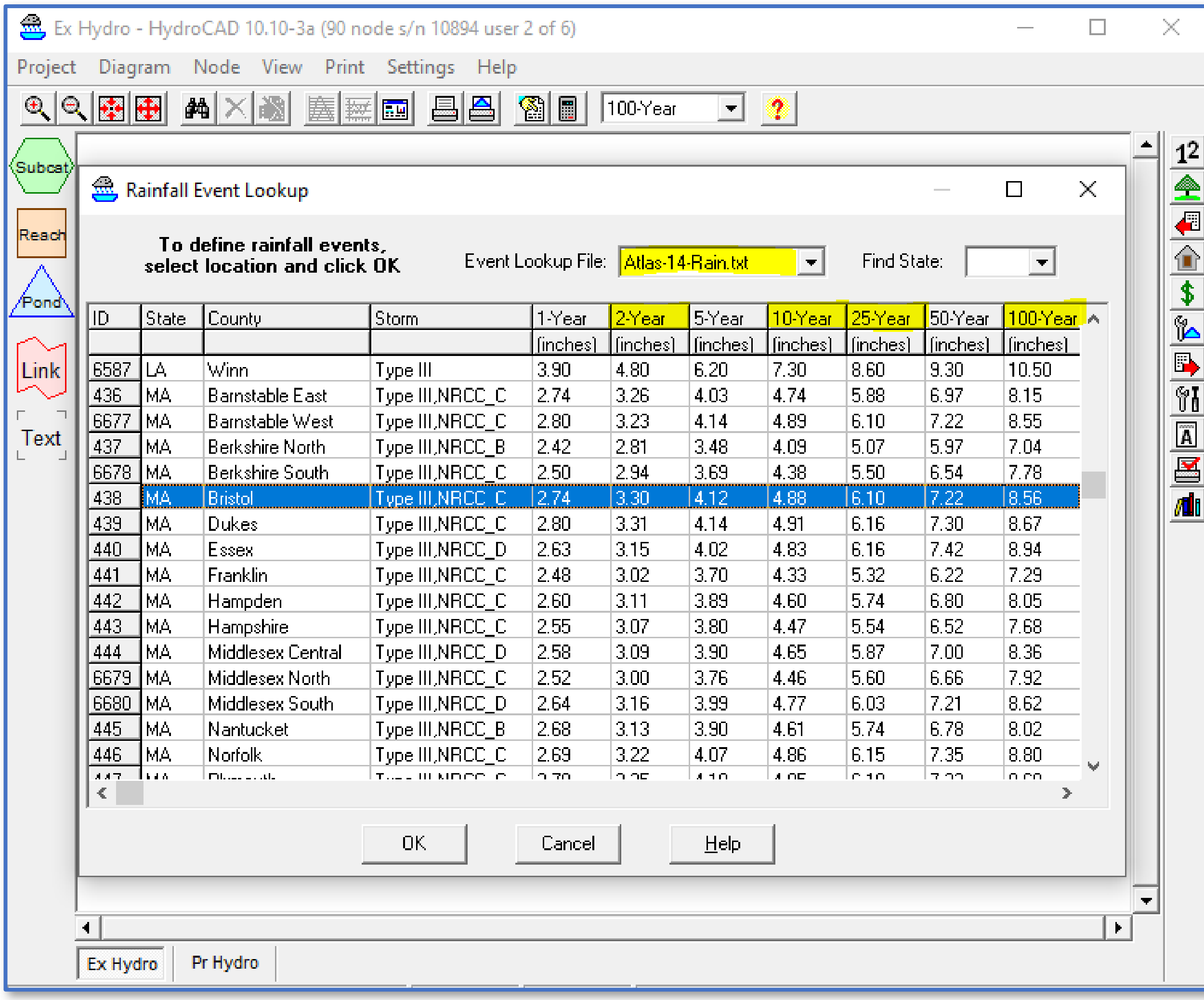
This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory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

ATTACHMENT B

NOAA Atlas-14 Rainfall Data

NOAA Atlas-14 Rainfall Data

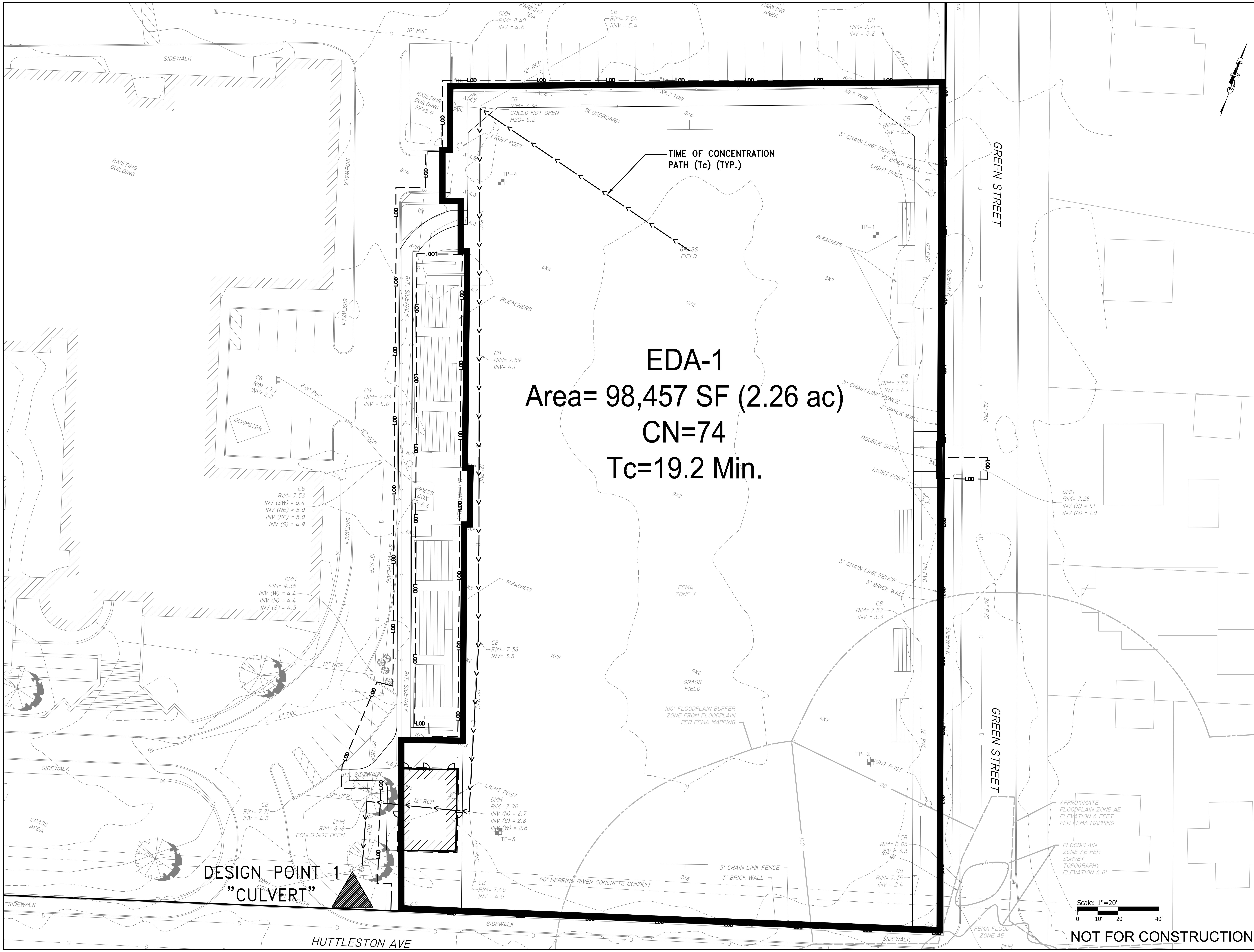
The drainage system for the athletic field was modelled in HydroCAD-10.10-3a which was publicly released on February 10, 2020. The precipitation data used to analyze the drainage system is from the latest NOAA Atlas 14 Precipitation Frequency Atlas of the United States: Northeast States, and the specific data used is for Bristol County, Massachusetts.



ID	State	County	Storm	1-Year (inches)	2-Year (inches)	5-Year (inches)	10-Year (inches)	25-Year (inches)	50-Year (inches)	100-Year (inches)
6587	LA	Winn	Type III	3.90	4.80	6.20	7.30	8.60	9.30	10.50
436	MA	Barnstable East	Type III,NRCC_C	2.74	3.26	4.03	4.74	5.88	6.97	8.15
6677	MA	Barnstable West	Type III,NRCC_C	2.80	3.23	4.14	4.89	6.10	7.22	8.55
437	MA	Berkshire North	Type III,NRCC_B	2.42	2.81	3.48	4.09	5.07	5.97	7.04
6678	MA	Berkshire South	Type III,NRCC_C	2.50	2.94	3.69	4.38	5.50	6.54	7.78
438	MA	Bristol	Type III,NRCC_C	2.74	3.30	4.12	4.88	6.10	7.22	8.56
439	MA	Dukes	Type III,NRCC_C	2.80	3.31	4.14	4.91	6.16	7.30	8.67
440	MA	Essex	Type III,NRCC_D	2.63	3.15	4.02	4.83	6.16	7.42	8.94
441	MA	Franklin	Type III,NRCC_C	2.48	3.02	3.70	4.33	5.32	6.22	7.29
442	MA	Hampden	Type III,NRCC_C	2.60	3.11	3.89	4.60	5.74	6.80	8.05
443	MA	Hampshire	Type III,NRCC_C	2.55	3.07	3.80	4.47	5.54	6.52	7.68
444	MA	Middlesex Central	Type III,NRCC_D	2.58	3.09	3.90	4.65	5.87	7.00	8.36
6679	MA	Middlesex North	Type III,NRCC_C	2.52	3.00	3.76	4.46	5.60	6.66	7.92
6680	MA	Middlesex South	Type III,NRCC_D	2.64	3.16	3.99	4.77	6.03	7.21	8.62
445	MA	Nantucket	Type III,NRCC_B	2.68	3.13	3.90	4.61	5.74	6.78	8.02
446	MA	Norfolk	Type III,NRCC_C	2.69	3.22	4.07	4.86	6.15	7.35	8.80

ATTACHMENT C

XBT1 Existing Hydrology Plan
XBT2 Proposed Hydrology Plan



TRAVERSE landscape architects
150 Chestnut Street, 4th Floor Providence, RI 02903
68 Harrison Avenue, 6th Floor Boston, MA 02111

STAMP

CONSULTANT

PARE CORPORATION
ENGINEERS - SCIENTISTS - PLANNERS
10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
508-543-1755

SHEET TITLE

EXISTING HYDROLOGY PLAN

PROJECT NAME

FAIRHAVEN HIGH SCHOOL

ATHLETIC FIELD-SYNTHETIC TURF

PROJECT ADDRESS

12 HUTTLESTONE AVE
FAIRHAVEN , MA 02719

SUBMITTAL	DATE
SCHEMATIC DESIGN	2021/01/29
DESIGN DEVELOPMENT	2021/03/05
ISSUED FOR PERMITTING	2021/03/22
PLANNING BOARD REVIEW	2021/03/29

NO.	REVISIONS	DATE

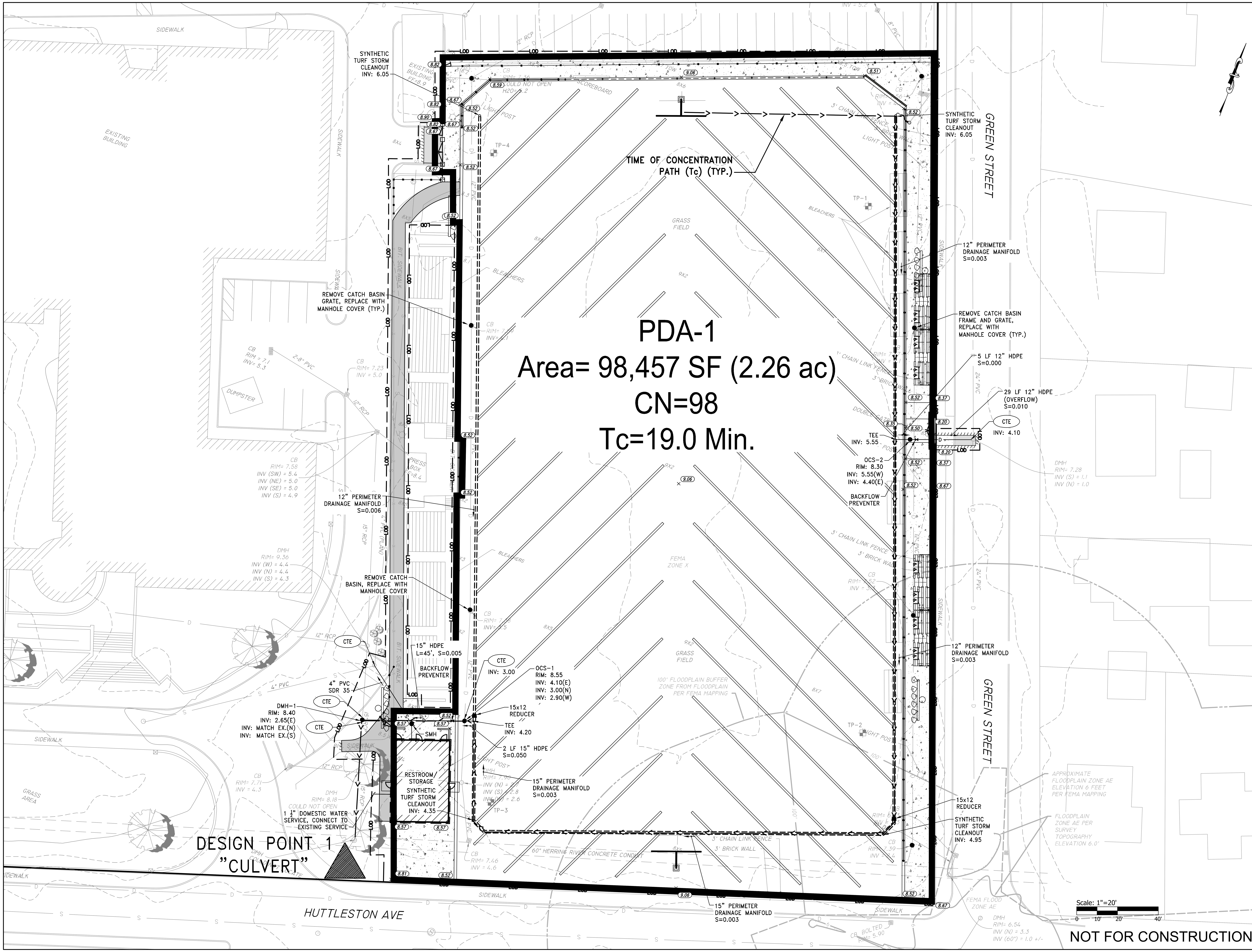
DRAWN BY:	CHECKED BY:
AWB	JRR
DATE ISSUED: 03/29/2021	SCALE: 1"=20'

PROJ. NO. A1037

SHEET NO. XBT1

FAIRHAVEN HS ATHLETIC FIELD -SYNTHETIC TURF

DESIGN DEVELOPMENT- 03/05/2021



NOT FOR CONSTRUCTION

TRAVERSE landscape architects
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FOXBORO, MA 02035
508-543-1755

SHEET TITLE

PROPOSED HYDROLOGY PLAN

PROJECT NAME

FAIRHAVEN HIGH SCHOOL

ATHLETIC FIELD-SYNTHETIC TURF

PROJECT ADDRESS

12 HUTTLESTONE AVE
FAIRHAVEN , MA 02719

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NO.	REVISIONS	DATE

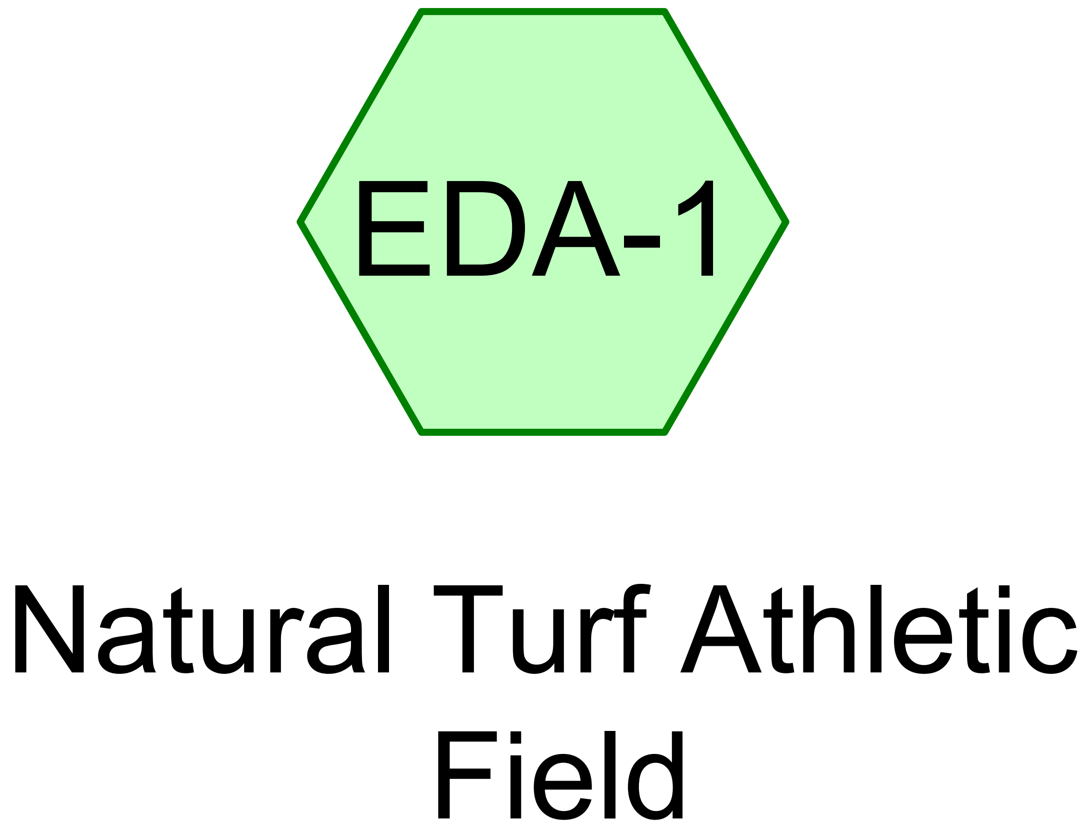
DRAWN BY: AWB	CHECKED BY: JRR
DATE ISSUED: 03/29/2021	SCALE: 1"=20'
PROJ. NO. A1037	
SHEET NO. XBT2	

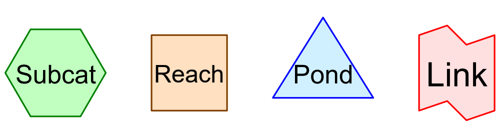
FAIRHAVEN HS ATHLETIC FIELD -SYNTHETIC TURF

DESIGN DEVELOPMENT- 03/05/2021

ATTACHMENT D

Existing Hydrologic Calculations (HydroCAD Printouts)
Proposed Hydrologic Calculations (HydroCAD Printouts)





Routing Diagram for Ex Hydro
Prepared by Pare Corporation, Printed 4/20/2021
HydroCAD® 10.10-3a s/n 10894 © 2020 HydroCAD Software Solutions LLC

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEDA-1: Natural Turf Athletic Runoff Area=98,457 sf 1.50% Impervious Runoff Depth=1.10"
Flow Length=545' Slope=0.0050 '/' Tc=19.2 min CN=74 Runoff=1.89 cfs 9,058 cf

Total Runoff Area = 98,457 sf Runoff Volume = 9,058 cf Average Runoff Depth = 1.10"
98.50% Pervious = 96,979 sf 1.50% Impervious = 1,478 sf

Summary for Subcatchment EDA-1: Natural Turf Athletic Field

Runoff = 1.89 cfs @ 12.29 hrs, Volume= 9,058 cf, Depth= 1.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
1,478	98	Unconnected pavement, HSG C
96,979	74	>75% Grass cover, Good, HSG C
98,457	74	Weighted Average
96,979	74	98.50% Pervious Area
1,478	98	1.50% Impervious Area
1,478		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
16.8	100	0.0050	0.10		**Sheet Flow, Natural Grass Turf** Grass: Short n= 0.150 P2= 3.30"
0.7	20	0.0050	0.49		**Shallow Concentrated Flow, Natural Grass Turf** Short Grass Pasture Kv= 7.0 fps
1.6	395	0.0050	4.17	3.28	**Pipe Channel, 12" PVC Pipe** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.010 PVC, smooth interior
0.1	30	0.0050	4.40	5.40	**Pipe Channel, 15" RCP** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.011 Concrete pipe, straight & clean
19.2	545	Total			

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEDA-1: Natural Turf Athletic Runoff Area=98,457 sf 1.50% Impervious Runoff Depth=2.27"
Flow Length=545' Slope=0.0050 '/' Tc=19.2 min CN=74 Runoff=4.08 cfs 18,616 cf

Total Runoff Area = 98,457 sf Runoff Volume = 18,616 cf Average Runoff Depth = 2.27"
98.50% Pervious = 96,979 sf 1.50% Impervious = 1,478 sf

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

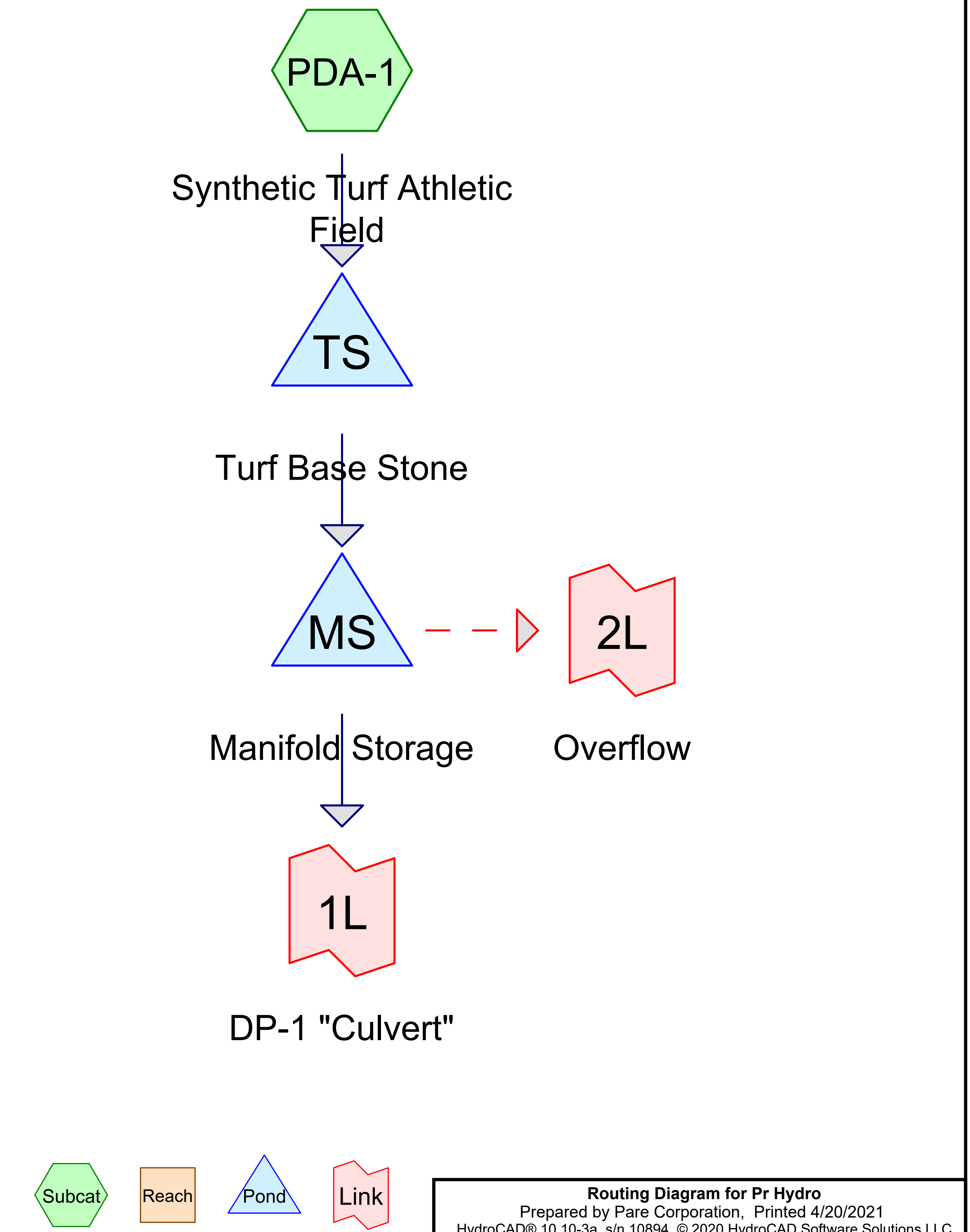
SubcatchmentEDA-1: Natural Turf Athletic Runoff Area=98,457 sf 1.50% Impervious Runoff Depth=3.27"
Flow Length=545' Slope=0.0050 '/' Tc=19.2 min CN=74 Runoff=5.92 cfs 26,823 cf

Total Runoff Area = 98,457 sf Runoff Volume = 26,823 cf Average Runoff Depth = 3.27"
98.50% Pervious = 96,979 sf 1.50% Impervious = 1,478 sf

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentEDA-1: Natural Turf Athletic Runoff Area=98,457 sf 1.50% Impervious Runoff Depth=5.43"
Flow Length=545' Slope=0.0050 '/' Tc=19.2 min CN=74 Runoff=9.82 cfs 44,547 cf

Total Runoff Area = 98,457 sf Runoff Volume = 44,547 cf Average Runoff Depth = 5.43"
98.50% Pervious = 96,979 sf 1.50% Impervious = 1,478 sf



Routing Diagram for Pr Hydro
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HydroCAD® 10.10-3a s/n 10894 © 2020 HydroCAD Software Solutions LLC

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PDA-1: Synthetic Turf Runoff Area=98,457 sf 99.83% Impervious Runoff Depth=3.07"
Flow Length=800' Tc=19.0 min CN=98 Runoff=5.03 cfs 25,165 cf

Pond MS: Manifold Storage Peak Elev=5.60' Storage=2,711 cf Inflow=2.78 cfs 8,806 cf
Primary=1.89 cfs 8,332 cf Secondary=0.00 cfs 0 cf Outflow=1.89 cfs 8,332 cf

Pond TS: Turf Base Stone Peak Elev=7.36' Storage=4,043 cf Inflow=5.03 cfs 25,165 cf
Discarded=0.55 cfs 16,359 cf Primary=2.78 cfs 8,806 cf Outflow=3.33 cfs 25,165 cf

Link 1L: DP-1 "Culvert" Inflow=1.89 cfs 8,332 cf
Primary=1.89 cfs 8,332 cf

Link 2L: Overflow Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 98,457 sf Runoff Volume = 25,165 cf Average Runoff Depth = 3.07"
0.17% Pervious = 172 sf 99.83% Impervious = 98,286 sf

Summary for Subcatchment PDA-1: Synthetic Turf Athletic Field

Runoff = 5.03 cfs @ 12.25 hrs, Volume= 25,165 cf, Depth= 3.07"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.30"

Area (sf)	CN	Description
172	74	>75% Grass cover, Good, HSG C
12,636	98	Unconnected pavement, HSG C
85,650	98	Paved parking, HSG C
98,457	98	Weighted Average
172	74	0.17% Pervious Area
98,286	98	99.83% Impervious Area
12,636		12.86% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
15.4	90	0.0050	0.10		**Sheet Flow, Synthetic Grass Turf** Grass: Short n= 0.150 P2= 3.30"
1.8	340	0.0050	3.21	2.52	**Pipe Channel, 12" Perimeter Manifold** 12.0" Round Area= 0.8 sf Perim= 3.1' r= 0.25' n= 0.013 Corrugated PE, smooth interior
1.5	260	0.0030	2.88	3.54	**Pipe Channel, 15" Perimeter Manifold** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
0.3	110	0.0100	5.26	6.46	**Pipe Channel, 15" HDPE** 15.0" Round Area= 1.2 sf Perim= 3.9' r= 0.31' n= 0.013 Corrugated PE, smooth interior
19.0	800	Total			

Summary for Pond MS: Manifold Storage

Inflow Area = 98,457 sf, 99.83% Impervious, Inflow Depth = 1.07" for 2-Year event
Inflow = 2.78 cfs @ 12.46 hrs, Volume= 8,806 cf
Outflow = 1.89 cfs @ 12.79 hrs, Volume= 8,332 cf, Atten= 32%, Lag= 19.8 min
Primary = 1.89 cfs @ 12.79 hrs, Volume= 8,332 cf
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 5.60' @ 12.79 hrs Surf.Area= 5,482 sf Storage= 2,711 cf

Plug-Flow detention time= 21.4 min calculated for 8,326 cf (95% of inflow)
Center-of-Mass det. time= 18.2 min (778.5 - 760.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	4.75'	3,869 cf	**3.21'W x 642.00'L x 2.71'H Field A Z=1.0**
			10,342 cf Overall - 670 cf Embedded = 9,672 cf x 40.0% Voids
#2A	5.75'	518 cf	**ADS N-12 12"** x 32 Inside #1
			Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
			Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf
#3B	3.00'	1,904 cf	**3.50'W x 262.00'L x 3.00'H Field B Z=1.0**
			5,175 cf Overall - 415 cf Embedded = 4,760 cf x 40.0% Voids
#4B	4.00'	312 cf	**ADS N-12 15"** x 13 Inside #3
			Inside= 14.8"W x 14.8"H => 1.20 sf x 20.00'L = 24.0 cf
			Outside= 18.0"W x 18.0"H => 1.60 sf x 20.00'L = 31.9 cf
		6,603 cf	Total Available Storage

Storage Group A created with Chamber Wizard
Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	4.00'	**8.0" Vert. Orifice/Grate** C= 0.600 Limited to weir flow at low heads
#2	Primary	5.60'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Secondary	6.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=1.89 cfs @ 12.79 hrs HW=5.60' TW=0.00' (Dynamic Tailwater)
├─**1=Orifice/Grate** (Orifice Controls 1.89 cfs @ 5.41 fps)
└─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=3.00' TW=0.00' (Dynamic Tailwater)
└─**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond MS: Manifold Storage - Chamber Wizard Field A

Chamber Model = ADS N-12 12" (ADS N-12® Pipe)
Inside= 12.2"W x 12.2"H => 0.81 sf x 20.00'L = 16.2 cf
Outside= 14.5"W x 14.5"H => 1.05 sf x 20.00'L = 20.9 cf

32 Chambers/Row x 20.00' Long = 640.00' Row Length +12.0" End Stone x 2 = 642.00' Base Length
1 Rows x 14.5" Wide + 12.0" Side Stone x 2 = 3.21' Base Width
12.0" Stone Base + 14.5" Chamber Height + 6.0" Stone Cover = 2.71' Field Height

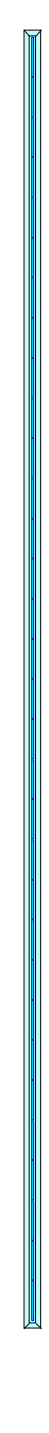
1.0 '/' Side-Z x Height = 32.5" Flare/Side
Base Length + Flare x 2 = 647.42' Top Length
Base Width + Flare x 2 = 8.63' Top Width

32 Chambers x 16.2 cf = 518.4 cf Chamber Storage
32 Chambers x 20.9 cf = 669.6 cf Displacement

10,341.6 cf Field - 669.6 cf Chambers = 9,672.0 cf Stone x 40.0% Voids = 3,868.8 cf Stone Storage

Chamber Storage + Stone Storage = 4,387.2 cf = 0.101 af
Overall Storage Efficiency = 42.4%
Overall System Size = 642.00' x 3.21' x 2.71'

32 Chambers
383.0 cy Field
358.2 cy Stone



Pond MS: Manifold Storage - Chamber Wizard Field B

Chamber Model = ADS N-12 15" (ADS N-12® Pipe)
Inside= 14.8"W x 14.8"H => 1.20 sf x 20.00'L = 24.0 cf
Outside= 18.0"W x 18.0"H => 1.60 sf x 20.00'L = 31.9 cf

13 Chambers/Row x 20.00' Long = 260.00' Row Length +12.0" End Stone x 2 = 262.00' Base Length
1 Rows x 18.0" Wide + 12.0" Side Stone x 2 = 3.50' Base Width
12.0" Stone Base + 18.0" Chamber Height + 6.0" Stone Cover = 3.00' Field Height

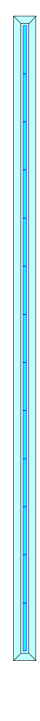
1.0 '/' Side-Z x Height = 36.0" Flare/Side
Base Length + Flare x 2 = 268.00' Top Length
Base Width + Flare x 2 = 9.50' Top Width

13 Chambers x 24.0 cf = 312.0 cf Chamber Storage
13 Chambers x 31.9 cf = 414.8 cf Displacement

5,174.5 cf Field - 414.8 cf Chambers = 4,759.7 cf Stone x 40.0% Voids = 1,903.9 cf Stone Storage

Chamber Storage + Stone Storage = 2,215.9 cf = 0.051 af
Overall Storage Efficiency = 42.8%
Overall System Size = 262.00' x 3.50' x 3.00'

13 Chambers
191.6 cy Field
176.3 cy Stone



Stage-Discharge for Pond MS: Manifold Storage

Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)	Elevation (feet)	Discharge (cfs)	Primary (cfs)	Secondary (cfs)
3.00	0.00	0.00	0.00	5.55	1.85	1.85	0.00
3.05	0.00	0.00	0.00	5.60	1.89	1.89	0.00
3.10	0.00	0.00	0.00	5.65	2.11	2.11	0.00
3.15	0.00	0.00	0.00	5.70	2.48	2.48	0.00
3.20	0.00	0.00	0.00	5.75	2.94	2.94	0.00
3.25	0.00	0.00	0.00	5.80	3.49	3.49	0.00
3.30	0.00	0.00	0.00	5.85	4.09	4.09	0.00
3.35	0.00	0.00	0.00	5.90	4.76	4.76	0.00
3.40	0.00	0.00	0.00	5.95	5.48	5.48	0.00
3.45	0.00	0.00	0.00	6.00	6.24	6.24	0.00
3.50	0.00	0.00	0.00	6.05	7.23	7.05	0.18
3.55	0.00	0.00	0.00	6.10	8.41	7.90	0.51
3.60	0.00	0.00	0.00	6.15	9.73	8.79	0.94
3.65	0.00	0.00	0.00	6.20	11.16	9.71	1.45
3.70	0.00	0.00	0.00	6.25	12.70	10.67	2.02
3.75	0.00	0.00	0.00	6.30	14.32	11.66	2.65
3.80	0.00	0.00	0.00	6.35	16.03	12.69	3.34
3.85	0.00	0.00	0.00	6.40	17.81	13.74	4.07
3.90	0.00	0.00	0.00	6.45	19.67	14.82	4.85
3.95	0.00	0.00	0.00	6.50	21.60	15.93	5.66
4.00	0.00	0.00	0.00	6.55	23.59	17.07	6.52
4.05	0.01	0.01	0.00	6.60	25.64	18.23	7.42
4.10	0.04	0.04	0.00	6.65	27.76	19.41	8.35
4.15	0.08	0.08	0.00	6.70	29.93	20.62	9.31
4.20	0.13	0.13	0.00	6.75	32.15	21.85	10.30
4.25	0.20	0.20	0.00	6.80	34.43	23.10	11.32
4.30	0.28	0.28	0.00	6.85	36.75	24.37	12.38
4.35	0.37	0.37	0.00	6.90	39.12	25.67	13.46
4.40	0.47	0.47	0.00	6.95	41.54	26.98	14.56
4.45	0.57	0.57	0.00	7.00	44.01	28.31	15.70
4.50	0.68	0.68	0.00	7.05	46.51	29.66	16.85
4.55	0.78	0.78	0.00	7.10	49.06	31.03	18.03
4.60	0.87	0.87	0.00	7.15	51.65	32.42	19.24
4.65	0.95	0.95	0.00	7.20	54.28	33.82	20.46
4.70	1.02	1.02	0.00	7.25	56.94	35.24	21.71
4.75	1.08	1.08	0.00	7.30	59.65	36.67	22.97
4.80	1.15	1.15	0.00	7.35	62.38	38.12	24.26
4.85	1.21	1.21	0.00	7.40	65.15	39.58	25.57
4.90	1.27	1.27	0.00	7.45	**67.96**	**41.06**	**26.89**
4.95	1.32	1.32	0.00				
5.00	1.37	1.37	0.00				
5.05	1.42	1.42	0.00				
5.10	1.47	1.47	0.00				
5.15	1.52	1.52	0.00				
5.20	1.56	1.56	0.00				
5.25	1.61	1.61	0.00				
5.30	1.65	1.65	0.00				
5.35	1.69	1.69	0.00				
5.40	1.74	1.74	0.00				
5.45	1.78	1.78	0.00				
5.50	1.82	1.82	0.00				

Stage-Area-Storage for Pond MS: Manifold Storage

Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)
3.00	0	5.55	2,605
3.05	19	5.60	2,714
3.10	38	5.65	2,825
3.15	57	5.70	2,937
3.20	78	5.75	3,051
3.25	98	5.80	3,164
3.30	120	5.85	3,275
3.35	141	5.90	3,397
3.40	164	5.95	3,526
3.45	187	6.00	3,659
3.50	210	6.05	3,746
3.55	234	6.10	3,837
3.60	258	6.15	3,929
3.65	283	6.20	4,024
3.70	309	6.25	4,121
3.75	335	6.30	4,220
3.80	362	6.35	4,321
3.85	389	6.40	4,422
3.90	416	6.45	4,525
3.95	445	6.50	4,629
4.00	473	6.55	4,733
4.05	501	6.60	4,838
4.10	528	6.65	4,943
4.15	555	6.70	5,047
4.20	588	6.75	5,151
4.25	622	6.80	5,252
4.30	659	6.85	5,351
4.35	698	6.90	5,441
4.40	737	6.95	5,534
4.45	778	7.00	5,633
4.50	820	7.05	5,733
4.55	863	7.10	5,835
4.60	907	7.15	5,938
4.65	952	7.20	6,042
4.70	997	7.25	6,148
4.75	1,043	7.30	6,255
4.80	1,131	7.35	6,363
4.85	1,221	7.40	6,472
4.90	1,313	7.45	**6,583**
4.95	1,406		
5.00	1,501		
5.05	1,598		
5.10	1,695		
5.15	1,794		
5.20	1,894		
5.25	1,994		
5.30	2,096		
5.35	2,196		
5.40	2,295		
5.45	2,395		
5.50	2,498		

Summary for Pond TS: Turf Base Stone

Inflow Area = 98,457 sf, 99.83% Impervious, Inflow Depth = 3.07" for 2-Year event
Inflow = 5.03 cfs @ 12.25 hrs, Volume= 25,165 cf
Outflow = 3.33 cfs @ 12.46 hrs, Volume= 25,165 cf, Atten= 34%, Lag= 12.8 min
Discarded = 0.55 cfs @ 11.45 hrs, Volume= 16,359 cf
Primary = 2.78 cfs @ 12.46 hrs, Volume= 8,806 cf

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs / 3
Peak Elev= 7.36' @ 12.46 hrs Surf.Area= 88,450 sf Storage= 4,043 cf

Plug-Flow detention time= 12.1 min calculated for 25,148 cf (100% of inflow)
Center-of-Mass det. time= 12.1 min (779.9 - 767.8)

Volume	Invert	Avail.Storage	Storage Description
#1	7.25'	233 cf	**12.0" W x 1.0" H Ellipse Flat Drain Pipe Storage** x 27 Inside #2 L= 132.0'
#2	7.24'	35,464 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc) 88,892 cf Overall - 233 cf Embedded = 88,659 cf x 40.0% Voids
		35,697 cf	Total Available Storage

Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
7.24	0	0	0
7.25	88,450	442	442
8.25	88,450	88,450	88,892

Device	Routing	Invert	Outlet Devices
#1	Primary	7.25'	**12.0" W x 1.0" H Vert. Orifice/Grate X 28.00** C= 0.600 Limited to weir flow at low heads
#2	Discarded	7.24'	**0.270 in/hr Exfiltration over Surface area**

Discarded OutFlow Max=0.55 cfs @ 11.45 hrs HW=7.25' (Free Discharge)
↑—**2=Exfiltration** (Exfiltration Controls 0.55 cfs)

Primary OutFlow Max=2.77 cfs @ 12.46 hrs HW=7.36' TW=5.20' (Dynamic Tailwater)
↑—**1=Orifice/Grate** (Orifice Controls 2.77 cfs @ 1.19 fps)

Stage-Discharge for Pond TS: Turf Base Stone

Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)	Elevation (feet)	Discharge (cfs)	Discarded (cfs)	Primary (cfs)
7.24	0.00	0.00	0.00	7.75	8.16	0.55	7.60
7.25	0.55	**0.55**	0.00	7.76	8.24	0.55	7.69
7.26	0.64	0.55	0.09	7.77	8.32	0.55	7.77
7.27	0.81	0.55	0.25	7.78	8.40	0.55	7.85
7.28	1.02	0.55	0.47	7.79	8.48	0.55	7.93
7.29	1.27	0.55	0.72	7.80	8.56	0.55	8.01
7.30	1.56	0.55	1.00	7.81	8.64	0.55	8.09
7.31	1.87	0.55	1.32	7.82	8.72	0.55	8.16
7.32	2.22	0.55	1.66	7.83	8.79	0.55	8.24
7.33	2.59	0.55	2.03	7.84	8.87	0.55	8.32
7.34	2.93	0.55	2.38	7.85	8.95	0.55	8.39
7.35	3.20	0.55	2.65	7.86	9.02	0.55	8.47
7.36	3.44	0.55	2.89	7.87	9.09	0.55	8.54
7.37	3.66	0.55	3.11	7.88	9.17	0.55	8.62
7.38	3.86	0.55	3.31	7.89	9.24	0.55	8.69
7.39	4.05	0.55	3.50	7.90	9.31	0.55	8.76
7.40	4.23	0.55	3.67	7.91	9.39	0.55	8.83
7.41	4.40	0.55	3.84	7.92	9.46	0.55	8.90
7.42	4.56	0.55	4.01	7.93	9.53	0.55	8.97
7.43	4.72	0.55	4.16	7.94	9.60	0.55	9.04
7.44	4.87	0.55	4.31	7.95	9.67	0.55	9.11
7.45	5.01	0.55	4.46	7.96	9.74	0.55	9.18
7.46	5.15	0.55	4.60	7.97	9.80	0.55	9.25
7.47	5.29	0.55	4.73	7.98	9.87	0.55	9.32
7.48	5.42	0.55	4.87	7.99	9.94	0.55	9.39
7.49	5.55	0.55	4.99	8.00	10.01	0.55	9.45
7.50	5.67	0.55	5.12	8.01	10.07	0.55	9.52
7.51	5.79	0.55	5.24	8.02	10.14	0.55	9.59
7.52	5.91	0.55	5.36	8.03	10.21	0.55	9.65
7.53	6.03	0.55	5.48	8.04	10.27	0.55	9.72
7.54	6.14	0.55	5.59	8.05	10.34	0.55	9.78
7.55	6.26	0.55	5.70	8.06	10.40	0.55	9.85
7.56	6.37	0.55	5.81	8.07	10.46	0.55	9.91
7.57	6.47	0.55	5.92	8.08	10.53	0.55	9.97
7.58	6.58	0.55	6.03	8.09	10.59	0.55	10.04
7.59	6.68	0.55	6.13	8.10	10.65	0.55	10.10
7.60	6.79	0.55	6.23	8.11	10.72	0.55	10.16
7.61	6.89	0.55	6.33	8.12	10.78	0.55	10.22
7.62	6.99	0.55	6.43	8.13	10.84	0.55	10.29
7.63	7.08	0.55	6.53	8.14	10.90	0.55	10.35
7.64	7.18	0.55	6.63	8.15	10.96	0.55	10.41
7.65	7.27	0.55	6.72	8.16	11.02	0.55	10.47
7.66	7.37	0.55	6.81	8.17	11.08	0.55	10.53
7.67	7.46	0.55	6.91	8.18	11.14	0.55	10.59
7.68	7.55	0.55	7.00	8.19	11.20	0.55	10.65
7.69	7.64	0.55	7.09	8.20	11.26	0.55	10.71
7.70	7.73	0.55	7.18	8.21	11.32	0.55	10.77
7.71	7.82	0.55	7.26	8.22	11.38	0.55	10.82
7.72	7.90	0.55	7.35	8.23	11.43	0.55	10.88
7.73	7.99	0.55	7.44	8.24	11.49	0.55	10.94
7.74	8.07	0.55	7.52	8.25	**11.55**	0.55	**11.00**

Stage-Area-Storage for Pond TS: Turf Base Stone

Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)	Elevation (feet)	Surface (sq-ft)	Storage (cubic-feet)
7.24	0	0	7.75	88,450	18,007
7.25	**88,450**	177	7.76	88,450	18,361
7.26	88,450	540	7.77	88,450	18,714
7.27	88,450	910	7.78	88,450	19,068
7.28	88,450	1,284	7.79	88,450	19,422
7.29	88,450	1,659	7.80	88,450	19,776
7.30	88,450	2,034	7.81	88,450	20,130
7.31	88,450	2,408	7.82	88,450	20,483
7.32	88,450	2,779	7.83	88,450	20,837
7.33	88,450	3,145	7.84	88,450	21,191
7.34	88,450	3,501	7.85	88,450	21,545
7.35	88,450	3,855	7.86	88,450	21,899
7.36	88,450	4,209	7.87	88,450	22,252
7.37	88,450	4,562	7.88	88,450	22,606
7.38	88,450	4,916	7.89	88,450	22,960
7.39	88,450	5,270	7.90	88,450	23,314
7.40	88,450	5,624	7.91	88,450	23,668
7.41	88,450	5,978	7.92	88,450	24,021
7.42	88,450	6,331	7.93	88,450	24,375
7.43	88,450	6,685	7.94	88,450	24,729
7.44	88,450	7,039	7.95	88,450	25,083
7.45	88,450	7,393	7.96	88,450	25,437
7.46	88,450	7,747	7.97	88,450	25,790
7.47	88,450	8,100	7.98	88,450	26,144
7.48	88,450	8,454	7.99	88,450	26,498
7.49	88,450	8,808	8.00	88,450	26,852
7.50	88,450	9,162	8.01	88,450	27,206
7.51	88,450	9,516	8.02	88,450	27,559
7.52	88,450	9,869	8.03	88,450	27,913
7.53	88,450	10,223	8.04	88,450	28,267
7.54	88,450	10,577	8.05	88,450	28,621
7.55	88,450	10,931	8.06	88,450	28,975
7.56	88,450	11,285	8.07	88,450	29,328
7.57	88,450	11,638	8.08	88,450	29,682
7.58	88,450	11,992	8.09	88,450	30,036
7.59	88,450	12,346	8.10	88,450	30,390
7.60	88,450	12,700	8.11	88,450	30,744
7.61	88,450	13,054	8.12	88,450	31,097
7.62	88,450	13,407	8.13	88,450	31,451
7.63	88,450	13,761	8.14	88,450	31,805
7.64	88,450	14,115	8.15	88,450	32,159
7.65	88,450	14,469	8.16	88,450	32,513
7.66	88,450	14,823	8.17	88,450	32,866
7.67	88,450	15,176	8.18	88,450	33,220
7.68	88,450	15,530	8.19	88,450	33,574
7.69	88,450	15,884	8.20	88,450	33,928
7.70	88,450	16,238	8.21	88,450	34,282
7.71	88,450	16,592	8.22	88,450	34,635
7.72	88,450	16,945	8.23	88,450	34,989
7.73	88,450	17,299	8.24	88,450	35,343
7.74	88,450	17,653	8.25	88,450	**35,697**

Summary for Link 1L: DP-1 "Culvert"

Inflow Area =	98,457 sf,	99.83% Impervious,	Inflow Depth = 1.02"	for 2-Year event
Inflow =	1.89 cfs @	12.79 hrs, Volume=	8,332 cf	
Primary =	1.89 cfs @	12.79 hrs, Volume=	8,332 cf,	Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Summary for Link 2L: Overflow

Inflow	=	0.00 cfs @	0.00 hrs, Volume=	0 cf
Primary	=	0.00 cfs @	0.00 hrs, Volume=	0 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PDA-1: Synthetic Turf Runoff Area=98,457 sf 99.83% Impervious Runoff Depth=4.64"
Flow Length=800' Tc=19.0 min CN=98 Runoff=7.49 cfs 38,098 cf

Pond MS: Manifold Storage Peak Elev=5.84' Storage=3,249 cf Inflow=4.04 cfs 16,367 cf
Primary=3.95 cfs 15,894 cf Secondary=0.00 cfs 0 cf Outflow=3.95 cfs 15,894 cf

Pond TS: Turf Base Stone Peak Elev=7.42' Storage=6,416 cf Inflow=7.49 cfs 38,098 cf
Discarded=0.55 cfs 21,730 cf Primary=4.04 cfs 16,367 cf Outflow=4.60 cfs 38,098 cf

Link 1L: DP-1 "Culvert" Inflow=3.95 cfs 15,894 cf
Primary=3.95 cfs 15,894 cf

Link 2L: Overflow Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 98,457 sf Runoff Volume = 38,098 cf Average Runoff Depth = 4.64"
0.17% Pervious = 172 sf 99.83% Impervious = 98,286 sf

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

SubcatchmentPDA-1: Synthetic Turf Runoff Area=98,457 sf 99.83% Impervious Runoff Depth=5.86"
Flow Length=800' Tc=19.0 min CN=98 Runoff=9.39 cfs 48,094 cf

Pond MS: Manifold Storage Peak Elev=5.91' Storage=3,410 cf Inflow=4.87 cfs 23,005 cf
Primary=4.83 cfs 22,531 cf Secondary=0.00 cfs 0 cf Outflow=4.83 cfs 22,531 cf

Pond TS: Turf Base Stone Peak Elev=7.48' Storage=8,471 cf Inflow=9.39 cfs 48,094 cf
Discarded=0.55 cfs 25,090 cf Primary=4.87 cfs 23,005 cf Outflow=5.42 cfs 48,094 cf

Link 1L: DP-1 "Culvert" Inflow=4.83 cfs 22,531 cf
Primary=4.83 cfs 22,531 cf

Link 2L: Overflow Inflow=0.00 cfs 0 cf
Primary=0.00 cfs 0 cf

Total Runoff Area = 98,457 sf Runoff Volume = 48,094 cf Average Runoff Depth = 5.86"
0.17% Pervious = 172 sf 99.83% Impervious = 98,286 sf

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points x 3
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment PDA-1: Synthetic Turf Runoff Area=98,457 sf 99.83% Impervious Runoff Depth=8.32"
Flow Length=800' Tc=19.0 min CN=98 Runoff=13.20 cfs 68,263 cf

Pond MS: Manifold Storage Peak Elev=6.00' Storage=3,667 cf Inflow=6.33 cfs 37,789 cf
Primary=6.31 cfs 37,313 cf Secondary=0.00 cfs 1 cf Outflow=6.31 cfs 37,315 cf

Pond TS: Turf Base Stone Peak Elev=7.61' Storage=13,024 cf Inflow=13.20 cfs 68,263 cf
Discarded=0.55 cfs 30,474 cf Primary=6.33 cfs 37,789 cf Outflow=6.88 cfs 68,263 cf

Link 1L: DP-1 "Culvert" Inflow=6.31 cfs 37,313 cf
Primary=6.31 cfs 37,313 cf

Link 2L: Overflow Inflow=0.00 cfs 1 cf
Primary=0.00 cfs 1 cf

Total Runoff Area = 98,457 sf Runoff Volume = 68,263 cf Average Runoff Depth = 8.32"
0.17% Pervious = 172 sf 99.83% Impervious = 98,286 sf

ATTACHMENT E

Hydraulic Pipe-Sizing Calculations

PROJECT: Fairhaven High School Synthetic Turf PROJECT NUMBER: 20211.00
SUBJECT: Pipe Sizing - Hydraulic Calcs
COMPUTATIONS BY: JRR DATE: 3/25/21
CHECK BY: LH DATE: 4/20/21

Hydraulic Design Calculations- 25-YEAR DESIGN STORM

Basin	Ground Cover Area (ft^2)			Total Area		Weighted		Tc	Intensity	Q_P	FROM	TO	Upstream	Downstream	Length	Slope	Material	Manning's	Pipe Diameter	Pipe Capacity (Full Flow)		Check
Name	Grass	Pavement	Woods	(ft^2)	(acre)	C	C*A	(min)	(inch/hour)	(cfs)	Upstream Manhole	Downstream Manhole	Invert	Invert	(ft)	(ft/ft)		n	(inch)	V (fps)	Q_{CAP} (cfs)	$Q_{CAP} \geq Q_P$
Field East (Subcatment 1)	33,277	6,487	0	39,764	0.91	0.40	0.36	5.0	6.10	2.22	Cleanout (East)	Reducer (East)	6.05	4.95	330	0.003	HDPE	0.012	12	2.84	2.23	OK
Field West (Subcatment 2)	28,679	2,084	0	30,763	0.71	0.34	0.24	5.0	6.10	1.47	Cleanout (West)	OCS-1	6.05	4.10	305	0.006	HDPE	0.012	12	3.94	3.09	OK
Field South (Subcatment 3)	23,870	4,061	0	27,931	0.64	0.39	0.25	5.0	6.10	3.73	Reducer (East)	OCS-1	4.95	4.10	250	0.003	HDPE	0.012	15	3.33	4.09	OK
OCS-1 --> Ex Drain							-	5.0	6.10	5.95	OCS-1	DMH-1	2.90	2.60	36	0.008	HDPE	0.012	15	5.22	6.41	OK

* Flow rate generated by hydrologic model
** Minimum pipe size and slope to handle max flow

Ground Cover	C
Grass	0.30
Woods	0.20
Pavement	0.90

Rational Method Equation

$Q_P = C * I * A$

where,
Q_P = Peak Discharge, cfs
C = Runoff Coefficient, based on ground cover
I = Rainfall intensity, inch/hour
A = Drainage Area

Manning's Equation

$Q_{CAP} = (1.486/n)\ A\ (R^{2/3})\ S^{1/2}$

where,
Q_{CAP} = Flow rate, cfs
V = Velocity, fps
n = Manning coefficient of roughness
R = A/P = D/4 (full flow pipe), ft
A_x = Cross-sectional Flow Area, ft^2
P = Wetted Perimeter, ft
S = Slope, ft/ft

ATTACHMENT F

Groundwater Recharge Calculations

PROJECT	Fairhaven High School Synthetic Turf	PROJECT NUMBER	20211.00
SUBJECT	Required Recharge Volume		
COMPUTATIONS BY	JRR	DATE	3/25/2021
CHECK BY	LH	DATE	4/20/2021

PARE CORPORATION

Groundwater Recharge Calculation

A. Resources:

MassDEP Stormwater Handbook, 2008 Volume 3

B. Data:

Existing Impervious Area =	1,478	SF
Proposed Impervious Area =	12,636	SF
Net Increase =	11,158	SF

C. Equation

$$R_v = F \times \textit{Impervious Area}$$

Rv = (0.35'/12") x 11,158 SF

R_v = Require Recharge Volume, Ft^3 (soil group B = 0.35 in)

F = Target Depth Factor

Impervious Area = net impervious area

C. Calculations:

Required Recharge Volume:

Soil Group	Impervious Area (SF)	Required Volume (CF)	Volume Provided* (CF)
B	11,158	325	473

*Volume provided by the 40% Stone Voids in the crushed stone under the Perimeter Manifold below the invert out at el. *4.00'*

Stage-Area-Storage for Pond MS: Manifold Storage

Elevation (feet)	Storage (cubic-feet)	Elevation (feet)	Storage (cubic-feet)
3.00	0	5.55	2,605
3.05	19	5.60	2,714
3.10	38	5.65	2,825
3.15	57	5.70	2,937
3.20	78	5.75	3,051
3.25	98	5.80	3,164
3.30	120	5.85	3,275
3.35	141	5.90	3,397
3.40	164	5.95	3,526
3.45	187	6.00	3,659
3.50	210	6.05	3,746
3.55	234	6.10	3,837
3.60	258	6.15	3,929
3.65	283	6.20	4,024
3.70	309	6.25	4,121
3.75	335	6.30	4,220
3.80	362	6.35	4,321
3.85	389	6.40	4,422
3.90	416	6.45	4,525
3.95	445	6.50	4,629
4.00	473	6.55	4,733
4.05	501	6.60	4,838
4.10	528	6.65	4,943
4.15	555	6.70	5,047
4.20	588	6.75	5,151
4.25	622	6.80	5,252
4.30	659	6.85	5,351
4.35	698	6.90	5,441
4.40	737	6.95	5,534
4.45	778	7.00	5,633
4.50	820	7.05	5,733
4.55	863	7.10	5,835
4.60	907	7.15	5,938
4.65	952	7.20	6,042
4.70	997	7.25	6,148
4.75	1,043	7.30	6,255
4.80	1,131	7.35	6,363
4.85	1,221	7.40	6,472
4.90	1,313	7.45	**6,583**
4.95	1,406		
5.00	1,501		
5.05	1,598		
5.10	1,695		
5.15	1,794		
5.20	1,894		
5.25	1,994		
5.30	2,096		
5.35	2,196		
5.40	2,295		
5.45	2,395		
5.50	2,498		

ATTACHMENT G

Fairhaven MVP Program's Summary of Findings for Reference

Excerpt from the Fairhaven MVP program Summary of Findings (Section 4):

Another significant risk for Fairhaven is the threat of more **interior flooding due to heavy rainfall events.** The principal sources of riverine flooding in Fairhaven are the Acushnet River and its tributaries which help drain the Taunton and Buzzards Bay watersheds. Of perhaps greater concern is the likely increase in the frequency of urban/stormwater flood events caused by heavy precipitation that can overwhelm local drainage systems and cause major impacts to low-lying areas across town. These events often strike rapidly and have occurred in areas generally not considered at risk to major flooding, including areas outside of the Town's mapped floodplains. This is particularly true for more urbanized areas along Route 6 and isolated areas with outdated or undersized stormwater infrastructure near the historic Town Center. The compounding effects from high tides and coastal storm events can make these interior flooding situations worse by impeding drainage flows at stormwater outfalls. These incidents, which are anticipated to become more frequent due to sea level rise and more heavy downpours, can create significant threats to public safety due to the lack of warning and flooded roadways, and as experienced in recent years, significant damage and loss to property owners can result from flooded basements and other impacts.

Flooding on Huttleston Avenue (between Francis and Green Streets) following a heavy rainfall event in November 2019. Image credit: Karen Vilandry.