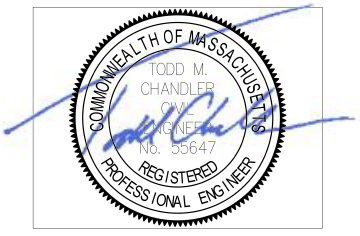
Development Impact Statement

FOR

Singletary Arms

Millbury, Massachusetts

DATE PREPARED
August 24, 2020



PREPARED BY
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Table of Contents

Appendices

Development Impact Statement

The Traffic Assessment Report prepared by Nitsch Engineering concluded that the increase of traffic caused by the development on the roadway network would be minimal, suggesting low impact on traffic operations and safety at the intersection. Therefore, they did not recommend any changes to the intersection geometry, traffic control, or roadway network.

In addition, they also stated that the total number of parking spaces provided is 56 spaces less than the number of spaces required by the TRC. Therefore, a variance will be required from the Town. However, the parking spaces provided exceeds the ITE parking requirements showing that it is anticipated that the amount parking provided is sufficient to meet the demand.

Environmental Impact Assessment:

The site, an operating +/- 50,000 square feet manufacturing facility, will be redeveloped into a mixed-use development consisting of a converted warehouse and two proposed three-story apartment buildings. The manufacturing facility, located at the southwest corner of West Main Street and Burbank Avenue in Millbury, sits on 1.5 acres of a 12.5-acre parcel. The undeveloped parcel consists of 4.5 acres of wooded upland and approximately 6.5-acres of pond, stream, and wetland.

The proposed apartment buildings will be situated on a 4.5-acre wooded upland. The balance of the parcel will remain undisturbed. Given the existing ground drops approximately fifty feet in elevation across the width of the 4.5-acre site, it has been graded in a tiered fashion to accommodate stormwater management, vehicle access, pedestrian access, along with aesthetics. To reduce disturbed area, each building will be constructed over a parking lot with the balance of the disturbed area being surface parking, and landscaping. The disturbed area should be seventy percent stabilized once the parking area base rock has been installed.

Both construction period and permanent best management practices will be used to control sediment. Examples of some of these measures include silt fence, silt sock, rip-rap, inlet protection, seed and mulch, and sod. The best management practices will be properly maintained from commencement of site construction through to site stabilization with permanent measures. See Appendices B and C for Construction Period and Permanent measures.

The impervious cover of the proposed re-development is 25%, with lot coverage well under the required 50% maximum requirement at 12.32%. The total disturbed area is approximately 32% of total parcel area. In addition to the recommended best management practices, there will remain an undisturbed wooded and grass buffer approximately one hundred feet wide running

the length of Singletary Brook. This in conjunction with properly maintained BMP's will result in no degradation of water quality during project construction.

Once operational, the two subsurface chamber style detention basins in conjunction with pervious pavers, and the 40% void of clean rock will increase TSS removal. The volume created by the extended detention will result in 80% removal of total suspended solids. In addition, precast concrete sump type inlets will be used upstream of the detention basins to provide additional pre-treatment. The basins will release at the pre-developed volume allowing for the outlet structure rip-rap to effectively reduce the discharge to a non-erosive velocity.

System Capacity

Potable Water

There is an existing 8" water main that runs along the west side of Burbank Street adjacent to the site. At a predevelopment meeting at the City of Millbury, the utility provider stated that the hydrant has a static pressure of 90 psi. Based on this static pressure, a simulation was run using EPA Net. The existing distribution system can deliver 1,500 gallons per minute via a proposed eight inch fire main to a fire hydrant serving the first floor Building 2, the upper building, at 39.8 psi while also delivering 50 gpm to the roof at 27.1 psi. It may be necessary to install a booster within Building 2 to provide adequate pressure for the fire suppression system.

For the potable distribution system, a four inch main will be installed, this system will be able to deliver 50 gpm to the roof of Building 2 at 54.8 psi, and 50 gpm to the roof of the lower building, Building 1, at 64 psi. It may be necessary to install a pressure reducing valve within each building to ensure the operating pressure does not exceed 80 psi on the lower floor of the building.

Sanitary Sewer

There is an existing 8" gravity sewer main that runs along Burbank Street adjacent to the site. At minimum pipe slope for an 8" PVC pipe, the capacity at full flow is 412 gpm or 593,000 gallons per day. At 300 gallons per day per home, the main has the capacity to serve approximately 1,900 homes. The proposed average flow from the development is estimated to be 15.9 gpm, with an estimated peak flow of 58.43 gpm. At worst case, these flows represent 3.8% and 14.1% of the available capacity, respectively. Based on the site location and the use of the potential service area, the existing 8" main has adequate capacity to serve the project.

Solid Waste

Each of the proposed buildings will have a trash shoot that empties into a trash room located in the parking area below the building. In addition, there will dumpsters located at several locations within the parking lot.

Electricity

The electricity for the site will be provided by NextEra Energy Services, the current utility provider for the area.

Mitigation Measures

Both a construction period and a permanent pollution prevention plan have been developed to ensure that the site contractor has effective measures to accommodate various site conditions.

Given the proposed grading plan and the building design, the surface parking areas will need to be stabilized with aggregate to provide parking and staging areas for both construction workers and building materials. This should bring approximately 3.12 acres of disturbed area to a stabilized condition once site grading and the utilities are installed.

The total area of wooded upland to be disturbed is approximately 32% of the total parcel area. In addition to best management practices, there will remain an undisturbed wooded and grass buffer that is one hundred and fifty feet wide along the entire length of the disturbed area. This buffer, in conjunction with properly maintained BMP's, should result in no degradation of water quality.

Fiscal Impact:

The proposed mixed-use redevelopment will cost approximately fifty million dollars to construct. This investment within the community will include the employment of design and construction professionals, the employment of craftsman and laborers, the purchase of building materials from local suppliers, and the payment of sales and other taxes.

Once complete, the project will become a vibrant center of both residential and commercial activity. This in turn will create an incentive for others to redevelop the West Main Street corridor resulting in additional economic benefit for both the community and City.

At five thousand dollars per unit, the sewer connection fee for the 198 apartment units will be $990,000, and the water tap fee at eleven hundred dollars per unit will be $217,800. Given the utility improvements necessary to serve the project will be installed and paid for by the developer, the utility providers will have adequate funding to make any minor improvements necessary to serve the project.

In addition, the project will also increase property values of adjoining parcels as well as the commercial corridor of Wets Main Street adding to the beneficial impact of the proposed project.

Historic Impact:

The project includes the redevelopment of one of the most iconic buildings in the region, the Steelcraft Building. The buildings history dates to the Revolutionary War where it operated as a paper mill. Then it was transformed into the Mayo Woolen Factory employing townspeople who resided in tenements located in the same wooded upland as the proposed buildings. In its current state, the building houses an operating medical equipment manufacturing facility. Throughout its history, the improvements have enriched the community with housing, employment, and manufactured goods.

In addition, the ancient hose house, which is adjacent to the former mill pond, will also be revitalized as part of the redevelopment project.

Development Goals:

The building is located in the Bramanville Village District which was created to spur redevelopment of the central part of the Bramanville District. The intent of the district is to create a vibrant, pedestrian friendly village center. As stated in the ordinance, this is to be accomplished by allowing high-density residential and small-scale commercial uses to serve the residents of the area. As intended by the special zoning district, this development will create property with a unique identity on a village scale.

The proposed redevelopment project includes 198 apartment units, twenty-four hundred square feet of restaurant space, and ten thousand square feet of office/workshare space. The existing mill building will be redeveloped in a manner which maintains its architectural character. The proposed buildings have been placed in a manner that best suits the site topography. To create a village atmosphere, the architectural elements of the proposed buildings mimic those of the existing mill building. This redevelopment will offer the tenants and residents of the community a village center within the Bramanville District.

Appendix A
Traffic Study

Nitsch Engineering

Traffic Assessment Report

115 West Main Street

Millbury, MA

April 30, 2020

Prepared for:

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Nitsch Engineering Project #14139

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 Introduction

Nitsch Engineering (Nitsch) has prepared this Traffic Assessment Report (TAR) for the proposed development at 115 West Main Street, Millbury, MA. This TAR will discuss the existing roadway conditions, access/egress, crash data, and traffic volumes; and assess the existing and future conditions at the intersections at the study location to establish the impact of the proposed development on traffic operations.

Figure 1 shows the Locus Map and Figure 2 shows the study area.

1.1 Existing Site

The proposed development site is bounded by West Main Street to the west, Burbank Street to the north, a landscaped lot to the east, and Singletary Brook to the south.

The site is occupied by 3-story and 2-story buildings annexed together, comprising approximately 35,000 square feet of gross floor area and is used by Steelcraft Inc., a manufacturer of medical equipment. Vehicular access is not provided to the site however pedestrian access to the buildings is provided via the Burbank Street and the West Main Street entrances. Parking spaces are provided on the northwest side of the buildings along Burbank Street.

1.2 Proposed Development

Based on the site improvement plan, the project will construct two (2) new 3-story buildings and renovate the existing Steelcraft buildings to create 197 residential units. The current plan for the apartment mix is shown in Table 1.

Table 1 – Apartment Mix

Type	Percent Mix	Number of Units	Number of Bedrooms
Efficiency	51%	100	100
1-Bedroom	36%	70	70
2-Bedroom	13%	27	54
Total	**100%**	**197**	**224**

In addition, 2,400 square feet will be allocated for restaurants and 7,500 square feet will be allocated for office space. A small, approximately 1,400-square-foot, 2-story parking garagse will be constructed on the western side of the site. A total of 330 parking spaces will be provided on site; 295 parking spaces in the apartment complex underground parking garages, 27 surface parking spaces on Burbank Street, and 8 surface parking spaces on West Main Street. 74 spaces will be allocated to restaurant and office space users. Access to the parking garages will be provided via two separate entrances on Burbank Street.

1.3 Study Area

The study area includes the 115 West Main Street Development driveways, the adjacent three (3) roadways and one (1) intersection.

Roadways

- West Main Street
- Burbank Street
- High Street

Intersection

- West Main Street at Burbank Street/High Street

1.4 Methodology

The traffic analysis herein is summarized in the following sections:

1. An inventory of existing transportation conditions, including roadway, parking, transit, pedestrian, and bicycle circulation.
2. An evaluation of future transportation conditions and an assessment of potential traffic impacts associated with the Project and other neighboring projects. Long-term impacts are evaluated for the year 2025, based on a five-year horizon from the 2020 base year. Expected roadway, parking, transit, pedestrian, and loading conditions and deficiencies are identified. This section includes the following scenarios:
    a. The No-Build Scenario (2025) includes general background growth and additional vehicular traffic associated with specific proposed or planned developments and roadway changes in the vicinity of the Project site; and
    b. The Build Scenario (2025) includes specific travel demand forecasts for the Project.
3. An identification of appropriate measures to mitigate Project-related impacts identified in the previous phase.
4. An evaluation of short-term traffic impacts associated with construction activities is also included.

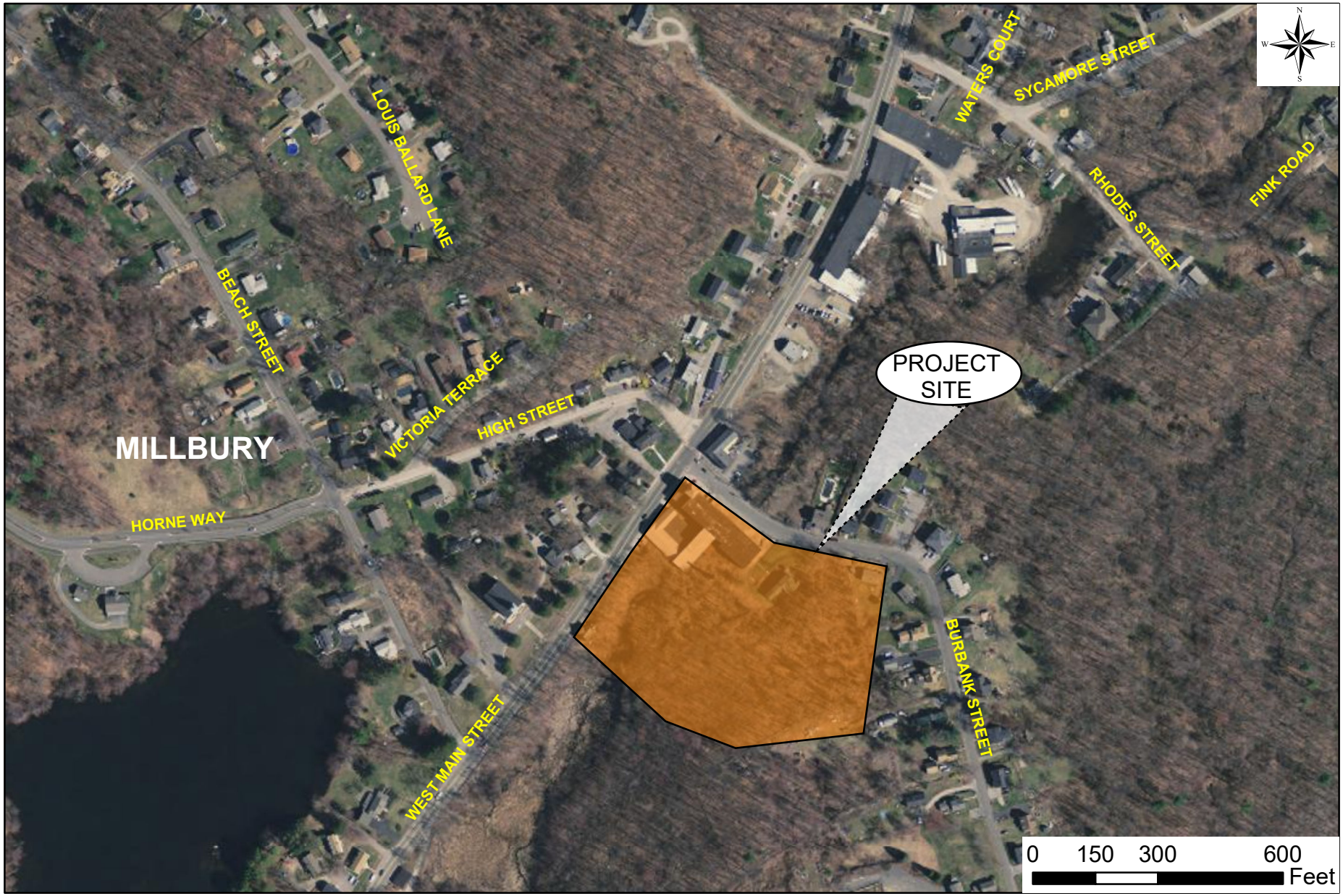


Figure 1: Locus Map

115 West Main Street
Millbury, MA

Data Source: MassGIS
Nitsch Project #14139

Nitsch Engineering

Figure 2: Study Area

115 West Main Street
Millbury, MA

Data Source: MassGIS
Nitsch Project #14139

Nitsch Engineering

2 Existing Conditions

2.1 Study Roadways

West Main Street

West Main Street is a two-way urban minor arterial under the Town of Millbury jurisdiction, that runs in the north-south direction from its northern terminus at the Worcester-Providence Turnpike (Rte. 146) to Singletary Road and then continues in the east-west direction from Singletary Road to its western terminus at the Town of Auburn boundary. In the immediate vicinity of the site, West Main Street is separated by a double yellow center line (DYCL), providing one 15-foot-wide lane in the northbound direction and one 18-foot-wide lane in the southbound direction. Sidewalks are present continuously on the northbound side of the roadway. Speed limit or on-street parking restriction signs are not posted in the immediate vicinity of the site.

Burbank Street

Burbank Street is a two-way local roadway under the Town of Millbury jurisdiction that runs in the general north-south direction from its northern terminus at West Main Street to its southern terminus at Boston Road. In the immediate vicinity of the site, Burbank Street is 24 feet wide although no lane markings are provided. Asphalt sidewalks are present on both sides of the roadway. Speed limit or on-street parking restriction signs are not posted in the immediate vicinity of the site.

High Street

High Street is a two-way local roadway under the Town of Millbury jurisdiction that runs in the general east-west direction from its eastern terminus at West Main Street to its western terminus at Beach Street where it transitions to Horne Way. In the immediate vicinity of the site, High Street is 20 feet wide although no lane markings are provided. Sidewalk is present on the south side of the roadway. Speed limit or on-street parking restriction signs are not posted in the immediate vicinity of the site.

2.2 Study Intersection

West Main Street at Burbank Street/High Street

West Main Street intersects with Burbank Street and High Street to form an offset four-legged unsignalized intersection, with West Main Street operating freely and approaching from the north and the south, Burbank Street operating under stop control and approaching from the east, and High Street operating under stop control and approaching from the west.

The West Main Street northbound approach to the intersection consists of one 16-foot wide through/left turn/right turn lane and the West Main Street southbound approach consists of one 18-foot wide through/left turn/right lane. The High Street eastbound approach consists of one 10-foot wide through/left turn/right turn lane and the Burbank Street westbound approach consists of one 14-foot wide through/left turn/right turn lane.

At the intersection, four (4) angled parking spaces are provided on the north side of Burbank Street for the Village Knoll market and unmarked parking spaces are located on the south side of Burbank Street for the existing Steelcraft building. Crosswalks are present at the southbound and westbound approaches however the wheelchair ramps appear to be not ADA-compliant as they are missing detectable warning panels.

2.3 Public Transportation

Public transportation services are not available in the vicinity of the site. However, Worcester Regional Transit Authority (WRTA) provides bus services at Millbury Town Center which is about 1.0 miles northeast of the site. WRTA provides direct connections to Worcester Union Station, Northbridge, and Grafton from the Town Center. WRTA also provides paratransit service for the elderly and disabled from 8:00 AM to 4:30 PM. In addition, the Town of Millbury provides curb-to-curb van services for the elderly and disabled.

2.4 Bicycle Facilities

Shared or dedicated bike lanes are not present on the subject roadways. Shoulders are also not provided on these roadways. There is a proposed 48-mile-long bikeway, the Blackstone River Bikeway, consisting of on and off-road segments along the Blackstone River, connecting Worcester, MA and Providence, RI. A 2.5-mile segment of the bikeway between the Blackstone Heritage Corridor Visitor Center in Worcester and the parking lot at 1265 Millbury Street in Millbury, approximately 1.75 miles north of the site, has been completed.

2.5 Pedestrian Facilities

Near the project site, sidewalks are present on both sides of West Main Street and Burbank Street, and the southbound side of High Street, providing a good opportunity for pedestrian mobility. Crosswalks are present on Burbank Street and the north of West Main Street. However, ADA compliant ramps and detectable panels are not present.

3 Existing Traffic Conditions

3.1 Traffic Count Data

We reached out to the Town of Millbury and the Central Massachusetts Regional Planning Commission (CMRPC) as well as reviewed the MassDOT Transportation Data Management System (TDMS) to determine if traffic count data is available for our study intersections and roadways. We had also coordinated with the Project Manager for MassDOT's recently completed project at the intersection of Route 146 over West Main Street and obtained the Functional Design Report and traffic data for this project. Turning Movement Count (TMC) data at the study intersection was not available in any of the reports, however, we obtained hourly traffic data at the following two locations:

- West Main Street, west of Sutter Road, data collected on 6/20/2017 (from CMRPC)
- On Sutton Road, east of West Main Street, data collected on 6/20/2017 (from MassDOT TDMS)

We used the hourly traffic data from these two locations to estimate West Main Street northbound and southbound morning and evening peak hour traffic. The data from these two locations are included in Appendix A.

We applied a seasonal adjustment factor (0.89) and a background growth factor (0.6%) to the estimated data to obtain 2020 peak hour data at the study intersection. Discussions on seasonal adjustment factor and background growth rate are described in sections 3.2 and section 4.1, respectively. We were not able to obtain data for Burbank Street or High Street. As the traffic from the existing land uses on Burbank Street would be potentially

low relative to West Main Street, we assumed that there would be no traffic impact on the study intersection by Burbank Street or High Street traffic. Figure 3 presents the 2020 Existing Peak Hour Volumes.

3.2 Seasonal Adjustment

Nitsch Engineering researched MassDOT traffic data for counts nearby that would establish a seasonal adjustment for the volumes we obtained from 2017. Due to the lack of data on comparable roadways in the vicinity of the project location, we used MassDOT's 2017 Weekday Seasonal Adjustment Factors. West Main Street falls withing Group U4 – "Urban Minor Arterial" for which the seasonality factor for the month of June is 0.89. We multiplied this factor to the to adjust the existing data. MassDOT's 2017 Weekday Seasonal Factors is included in Appendix B.

3.3 Safety Review

We obtained crash data within the study intersection for three (3) most recent years (2017- 2019) available from Millbury Police Department. Table 2 summarizes the crash statistics for the study intersection.

Table 2 – Crash Statistics

Location	Number of Crashes			Severity					Manner of Collision				Percent During	
	Year	Total Crashes	Annual Average	PD[a]	PI[b]	NR[c]	F[d]	A[e]	RE[f]	HO[g]	Other[h]	Incl. Ped-Bike[j]	Peak Hours[k]	Wet/Icy Conditions
West Main Street at Burbank Street/High Street	2017	2	3.0			2		1			1			
	2018	3		2	1			2	1				67%	
	2019	4		4				1	1		2		25%	
	Total	**9**		**6**	**1**	**2**	**0**	**4**	**2**	**0**	**3**	**0**	**33%**	**0**

[a]Property Damage Only; [b]Personal Injury Only (non-Fatal Injury); [c]Not Reported; [d]Fatality; [e]Angle; [f]Rear-end; [g]Head-on; [h]Sideswipe, opposite direction; sideswipe, same direction, single vehicle crash, rear-to-rear, not reported, unknown, etc.; [j]Includes pedestrian or cyclist; [k]Occurred between 7-9am or 4-6pm

A total of 9 crashes were reported within the study intersection from 2017 to 2019. In terms of severity, one (1) crash reported personal injury, and there were no crashes with reported fatalities. Angle crashes were the most frequent type of crash with a total of four (4) crashes, and of the remaining crashes, two (2) were rear-end, one (1) was single vehicle, one (1) crash was rear-to-rear, and one (1) crash was sideswipe (same direction). No pedestrian crashes were reported. 33% of all crashes in the study area occurred during peak hours.

Crash rates for intersections are expressed by the number of crashes per million entering vehicles (MEV), and crash rates for roadway segments are expressed by the number of crashes per million vehicle miles traveled (MVMT). Table 3 compares the crash rates for the study.

Table 3 – Crash Rate Summary

Location	Facility Type	Number of Crashes[a]	Crash Rate[b]	Average Rates[b,c]		Comparison to Average Rates	
				District 3	Statewide	District 3	Statewide
West Main Street at Burbank Street/ High Street	Unsignalized	9	1.05	0.61	0.57	Above	Above

[a] Based on 3-year crash history from MassDOT, 2017-2019
[b] Intersections: Crashes per million entering vehicles (MEV),
Roadway Segments: Crashes per million vehicle miles traveled (MVMT)
[c] Based on latest MassDOT crash data queried June 2018.

As shown in Table 3, the Crash Rate at the study intersection is above the District 3 and statewide averages.

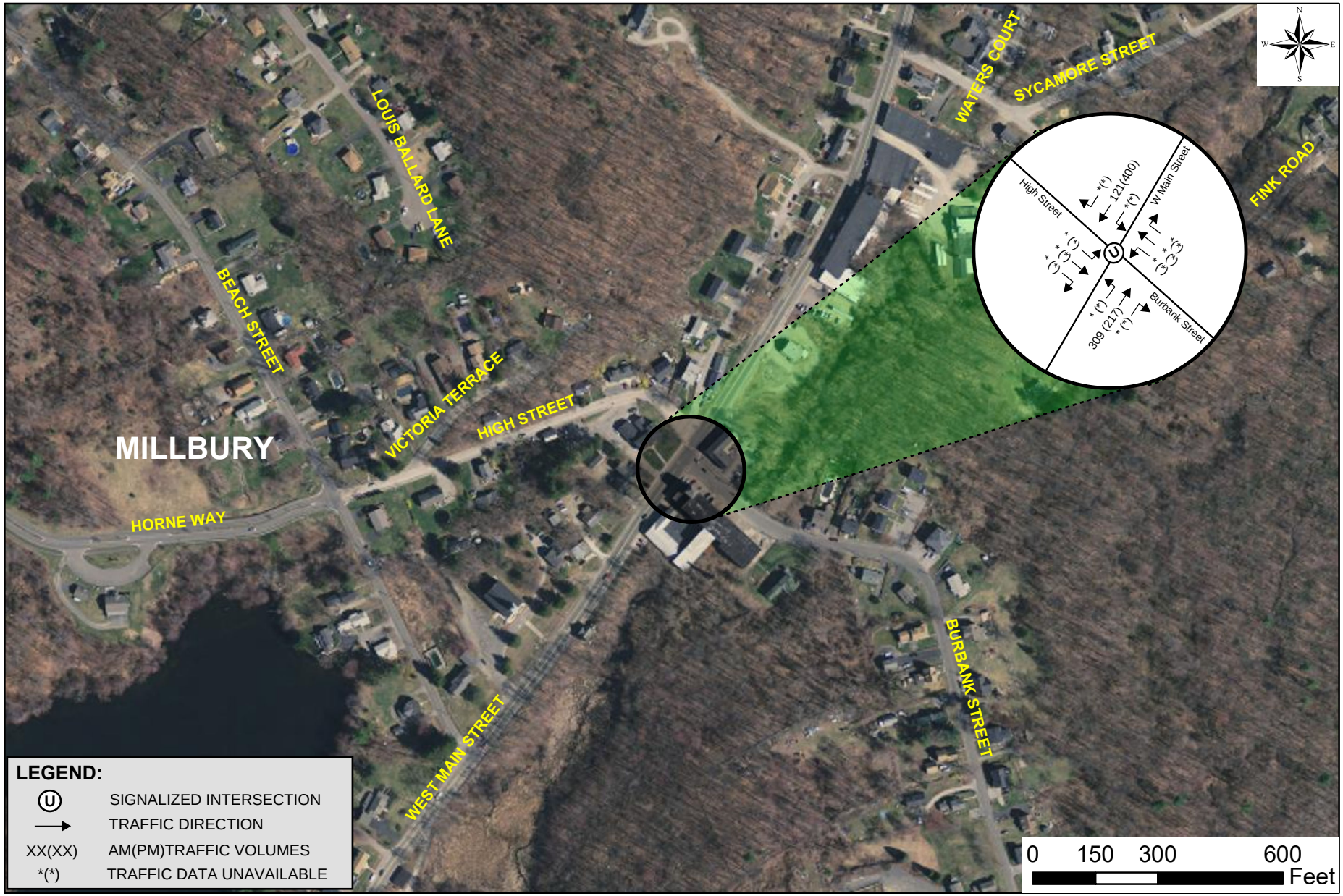


Figure 3: 2020 Existing Traffic Volumes

115 West Main Street
Millbury, MA

Data Source: MassGIS
Nitsch Project #14139

Nitsch Engineering

4 Future No-Build Traffic Conditions

We used the seasonally adjusted and projected 2020 existing peak hour traffic volumes as the baseline for projecting traffic volumes to the future 2025 no-build condition. To determine the future 2025 no-build condition volumes, we performed the following steps:

- Project the 2020 traffic volumes five years into the future to the horizon year, 2025, using an annual background traffic growth factor;
- Include any planned roadway improvements that may affect traffic volumes; and
- Add traffic volumes associated with any planned developments that may impact the study area.

4.1 Background Growth

MassDOT records traffic volumes at various stations throughout the Commonwealth over multiple years to identify regional shifts in traffic. Nitsch Engineering researched MassDOT count stations near the study area to determine a traffic volume trend throughout the years of volume data available. Due to the lack of continuous count stations in Millbury or nearby towns, we used MassDOT count station #240697, located on Singletary Road at the boundary of the Town of Millbury and the Town of Sutton, about 0.6 mile southwest of the study intersection. Table 4 depicts the traffic volumes and the calculated growth rate for a 2- year period.

Table 4 – Background Annual Traffic Growth Rate

Count Location	AADT[1], Year		Annual Growth Rate
	2017	2019	
Singletary Road at Sutton Town Boundary	2,397	2,394	2017 - 2019
			-0.06%

[1]Annual Average Daily Traffic (AADT) is the average traffic volume for the entire given calendar year (Source: Massachusetts Department of Transportation (MassDOT))

Table 4 shows a background traffic growth rate about -0.06% per year between 2017 and 2019. However, using a negative growth rate is not an accurate means for projecting future traffic. Therefore, we reviewed the FDR received for MassDOT's Route 146 over West Main Street Project and used a 0.6% growth rate to represent regional background growth of traffic in this area. Per the FDR, this rate was calculated by taking the average of the employment and population growth values from the transportation analysis zones in the CMRPC's regional model for current and future analysis years. We applied this growth rate over a 3-year period to project 2020 Existing peak hour counts (Figure 3) and over the 5-year design period from 2020 to estimate 2025 for future no build traffic data.

4.2 Planned Roadway Improvements

We researched the MassDOT Project Information website[1] to establish if there are any planned roadway improvements in the towns near the study area that could potentially affect traffic operations. We have not identified any project that is under construction or in design that could potentially impact the study intersection.

4.3 Additional Development

We contacted the Town of Millbury to establish if any planned developments will potentially add traffic to the study area. We obtained information on one housing development project, Stratford Village, that is under construction near the site. The development involves the construction of 49 duplex and triplex townhouses at 42 Burbank Street. The development was originally approved as a 55 and older development but now the requirement has been lifted. Access to the development will be provided via an entrance on Burbank Street.

We obtained the vehicular trip generation at Stratford Village by using the Institute of Transportation Engineers' (ITE) *Trip Generation, 10th Edition*[2] ("the ITE method"). As most units are duplexes, we used Land Use Code (LUC) 220 – "Multifamily Housing (Low-Rise)", which includes apartments, townhouses, and condominiums located within the same building with at least three (3) other dwelling units and between one (1) or two (2) levels (floors) of residence. Table 5 shows the trips generated from Stratford Village.

Table 5 – Stratford Village Peak Hour Trip Generation

Period	Direction	Stratford Village (vehicle)
Weekday morning	Enter	7
	Exit	20
	Total	**27**
Weekday evening	Enter	19
	Exit	14
	Total	**33**

To assess the impact at our study intersection, we assumed that all trips generated from Stratford Village will be distributed at our study intersection. We applied the trip distribution discussed in section 5.3 to get the trip assignment at our study intersection.

4.4 2025 No-Build Traffic Volumes

The 2025 future year traffic volumes were calculated by projecting the 2020 traffic volumes and applying the 0.6% annual traffic increase over the five-year assessment period and then adding the trips generated by the Stratford Village. The results are presented in Figure 4.

[1] https://hwy.massdot.state.ma.us/projectinfo/projectinfo.asp
[2] *Trip Generation*, Institute of Transportation Engineers, 10th Edition, 2016, Washington, D.C

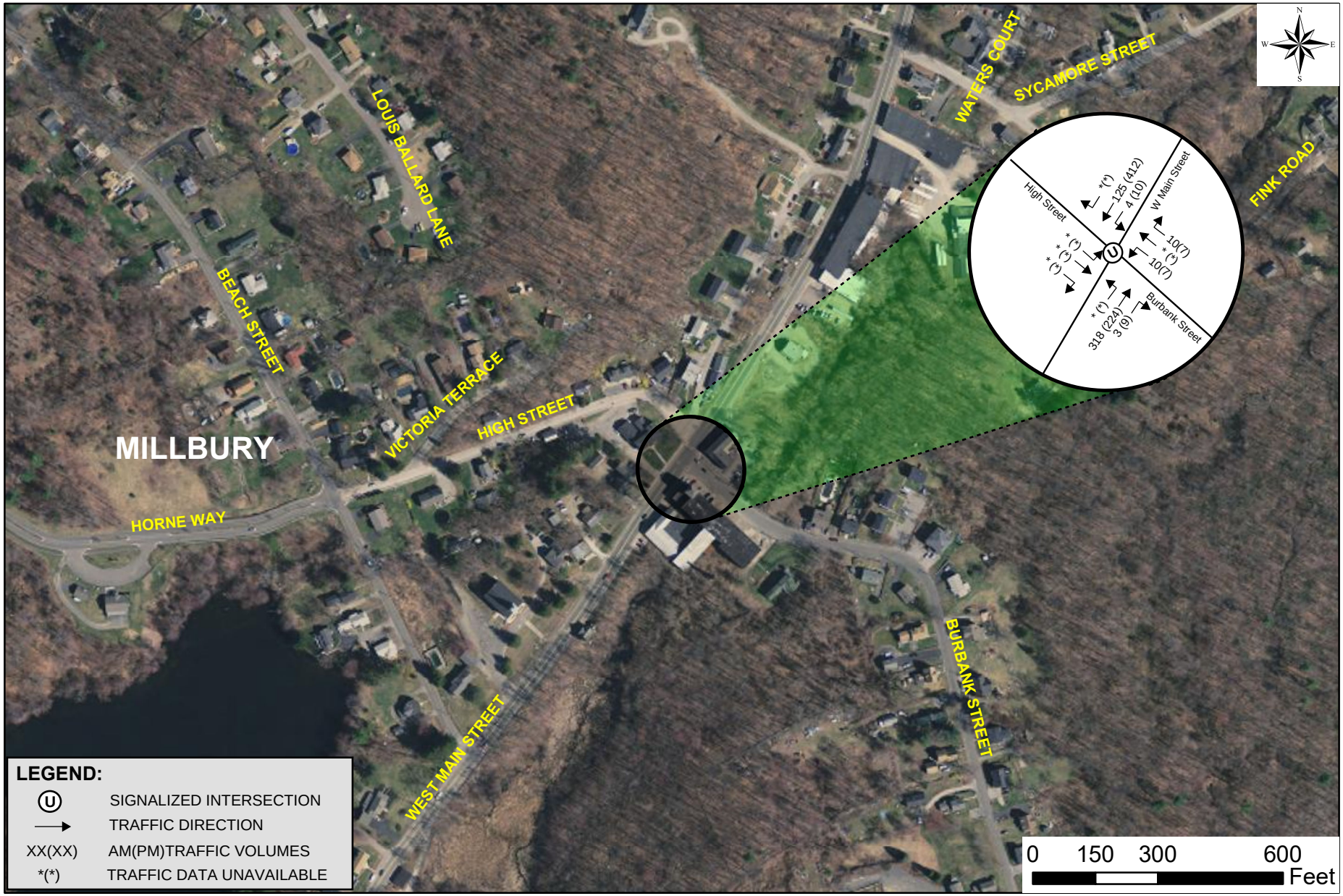


Figure 4: 2025 Future No-Build Traffic Volumes

115 West Main Street
Millbury, MA

Data Source: MassGIS
Nitsch Project #14139

Nitsch Engineering

5 Proposed Future Conditions

5.1 Proposed Site Changes

The proposed project will renovate the existing Steelcraft buildings and construct two (2) new 3-story buildings to create 197 studio, one-bedroom, and two-bedroom apartments, 2,400 square feet restaurant space, and 7,500 square feet office space, and construct a small, approximately 1,400-square-foot, 2-story parking garage. A total of 330 parking spaces will be provided on site: 295 parking spaces in the apartment complex underground parking garages, 27 surface parking spaces on Burbank Street, and 8 surface parking spaces on West Main Street. 74 spaces will be allocated to restaurant and office space users. Access to the parking garages will be provided via two separate entrances on Burbank Street.

5.2 Trip Generation

We estimated the trip generation for the existing use and the proposed use to obtain the net trip generation by using the Institute of Transportation Engineers' (ITE) *Trip Generation, 10th Edition*[3] ("the ITE method"). For the existing Steelcraft buildings we used Land Use Code (LUC) 140 – "Manufacturing". For the new apartment complex, we used Land Use Code (LUC) 221 – "Multifamily Housing (Mid-Rise)", which includes apartments, townhouses, and condominiums located within the same building with at least three (3) other dwelling units and between three (3) and 10 levels (floors) of residence. For the offices, we used Land Use Code (LUC) 710- "General Office Buildings". For the restaurants, we used Land Use Code (LUC) 932- "High-Turnover (Sit-Down) Restaurant". We obtained person-trips for apartment complex and office spaces and vehicle-trips for manufacturing buildings and restaurants as ITE does not provide person-trips for these categories.

Based on the Town of Millbury 2019 Master Plan[4], less than 15% of Millbury's employed labor force works in Millbury and most residents prefer to use personal vehicles over other modes of travel. About 84% of travelers use single occupancy vehicles and 11% carpool, suggesting that 95% of people prefer cars. Therefore, the average vehicle occupancy factor is approximately 1.1 persons per vehicle which we applied to the vehicle trip generation for the existing Steelcraft buildings and future restaurants to estimate person-trips for these uses. We obtained the net future trips generated from the site by subtracting Future trips from the existing trips as shown in Table 6.

Table 6 – Peak Hour Trip Generation

Period	Direction	Future Peak Hour Trips			Existing Peak Hour Trips	Net Peak Hour Trips (persons)
		Apartment Trips (persons)	Office Trips (persons)	Restaurant Trips (persons)	Steelcraft Trips (persons)	
Weekday morning	Enter	17	10	21	22	26
	Exit	46	1	17	9	55
	Total	**63**	**11**	**38**	**31**	**81**
Weekday evening	Enter	60	2	24	13	73
	Exit	39	10	22	18	53
	Total	**99**	**12**	**46**	**31**	**126**

[3] *Trip Generation*, Institute of Transportation Engineers, 10th Edition, 2016, Washington, D.C.
[4] *Comprehensive Master Plan 2019,* Town of Millbury

Mode Share

The Town of Millbury 2019 Master Plan[5] published the transportation mode share which states that 95% of people use cars, only 1% of people use public transportation, and 3% of people work from home. We applied this data to the net peak hour trips (Table 6) to determine the mode share for the proposed development, which is shown in Table 7.

Table 7 – Mode Share for the Proposed Development (Net Trip Generation)

Mode	Mode Shae	Weekday Morning			Weekday Evening		
		Enter	Exit	Total	Enter	Exit	Total
Vehicle (car and carpool)	95%	25	52	77	69	51	120
Public Transportation	1%	0	1	1	1	0	1
Walk/ Bicycle	0%	0	0	0	0	0	0
Work from Home	3%	1	1	2	2	2	4
Other	1%	0	1	1	1	0	1
Total	**100%**	**26**	**55**	**81**	**73**	**53**	**126**

Detailed trip generation calculations are provided in Appendix D.

5.3 Trip Distribution

We based the additional peak-hour trips to/from the site using the existing distribution. The results are shown in Table 8.

Table 8 – Trip Distribution

Direction and Roadway	Percentage
To/From North of W Main Street	50%
To/From South of W Main Street	50%
Total	**100%**
Source: Figure 3 – 2020 Existing Peak Hour Traffic Volumes	

5.4 Trip Assignment

Between the two parking garage entrances and 27 on-street parking spaces on Burbank Street, 98% of project generated trips will be coming to/from Burbank Street. For the purposes of this assessment, we assumed that all peak hour trips will be distributed through Burbank Street. Therefore, we assigned the net peak-hour vehicle trips shown in Table 7 by the Trip Distribution percentages shown in Table 8. The resultant new trip assignment volumes are shown in Figure 5.

[5] *Comprehensive Master Plan 2019,* Town of Millbury

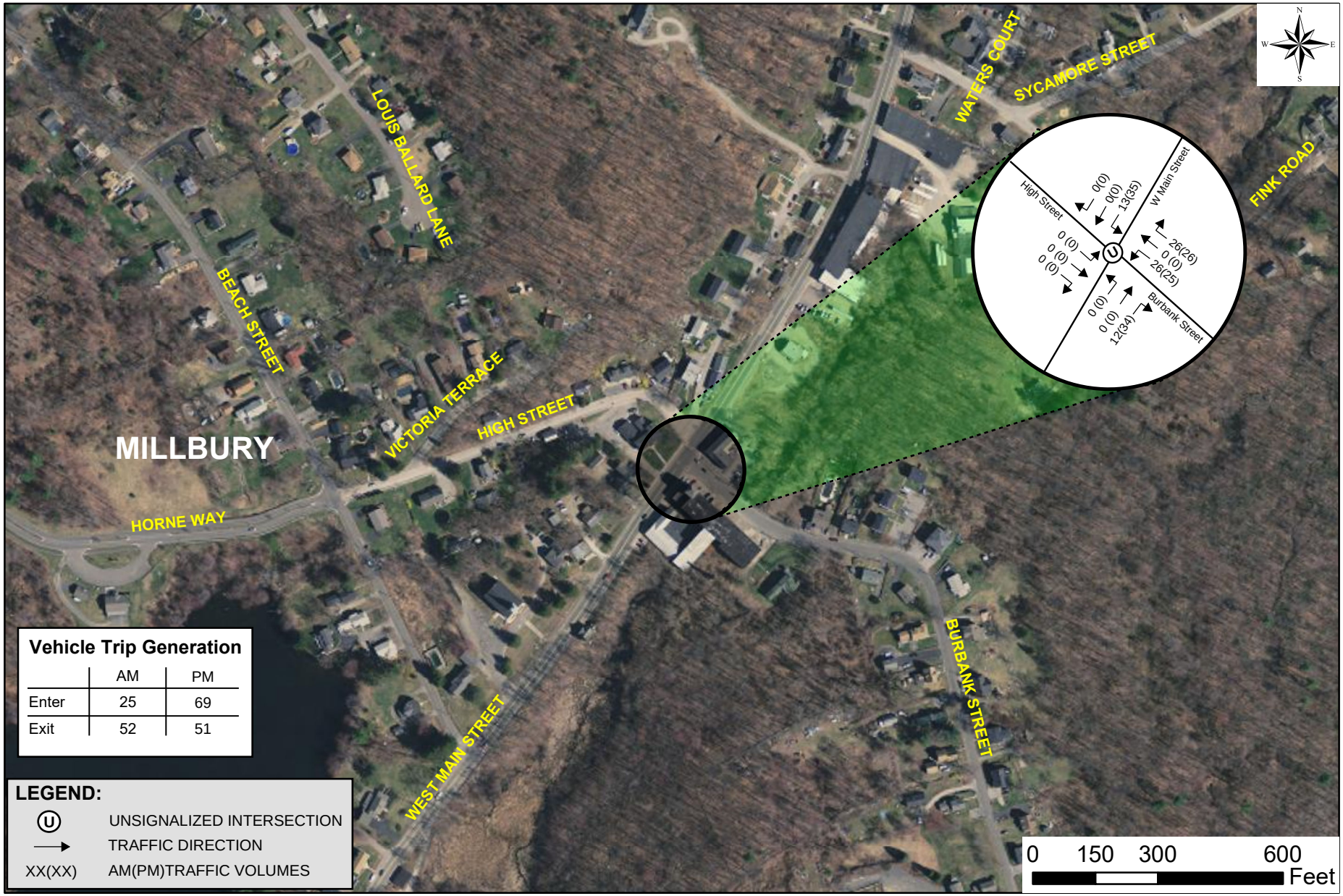


Figure 5: Net Trip Assignment

115 West Main Street
Millbury, MA

Data Source: MassGIS
Nitsch Project #14139

Nitsch Engineering

5.5 2025 Build Traffic Volumes and Operations Assessment

We added the Trip Assignment volumes from Figure 5 to 2025 No-Build conditions traffic volumes from Figure 4 to yield the 2025 Build conditions peak-hour traffic volumes, which are shown Figure 6. Table 9 shows the net increase in traffic to the intersection of West Main Street and Burbank Street/High Street from the 2025 No-Build condition to the 2025 Build Condition.

Table 9 – Increase in Traffic at Study Intersection

Roadway and Approach	Time Period					
	Weekday Morning Peak			Weekday Evening Peak		
	2025 No-Build Traffic	2025 Build Traffic	Percent Increase	2025 No-Build Traffic	2025 Build Traffic	Percent Increase
Burbank Street Westbound	20	72	260%	14	65	364%
West Main Street Northbound	321	333	4%	233	267	15%
West Main Street Southbound	129	142	10%	435	457	5%
Total	**470**	**547**	16%	**682**	**789**	16%

As seen in Table 9, the proposed development will increase intersection volumes by 16% in the morning peak hour and in the evening peak hour period to this intersection. As the increase in traffic in all approaches is considered low, it is unlikely that there would be any deficiency in traffic operations at this intersection.

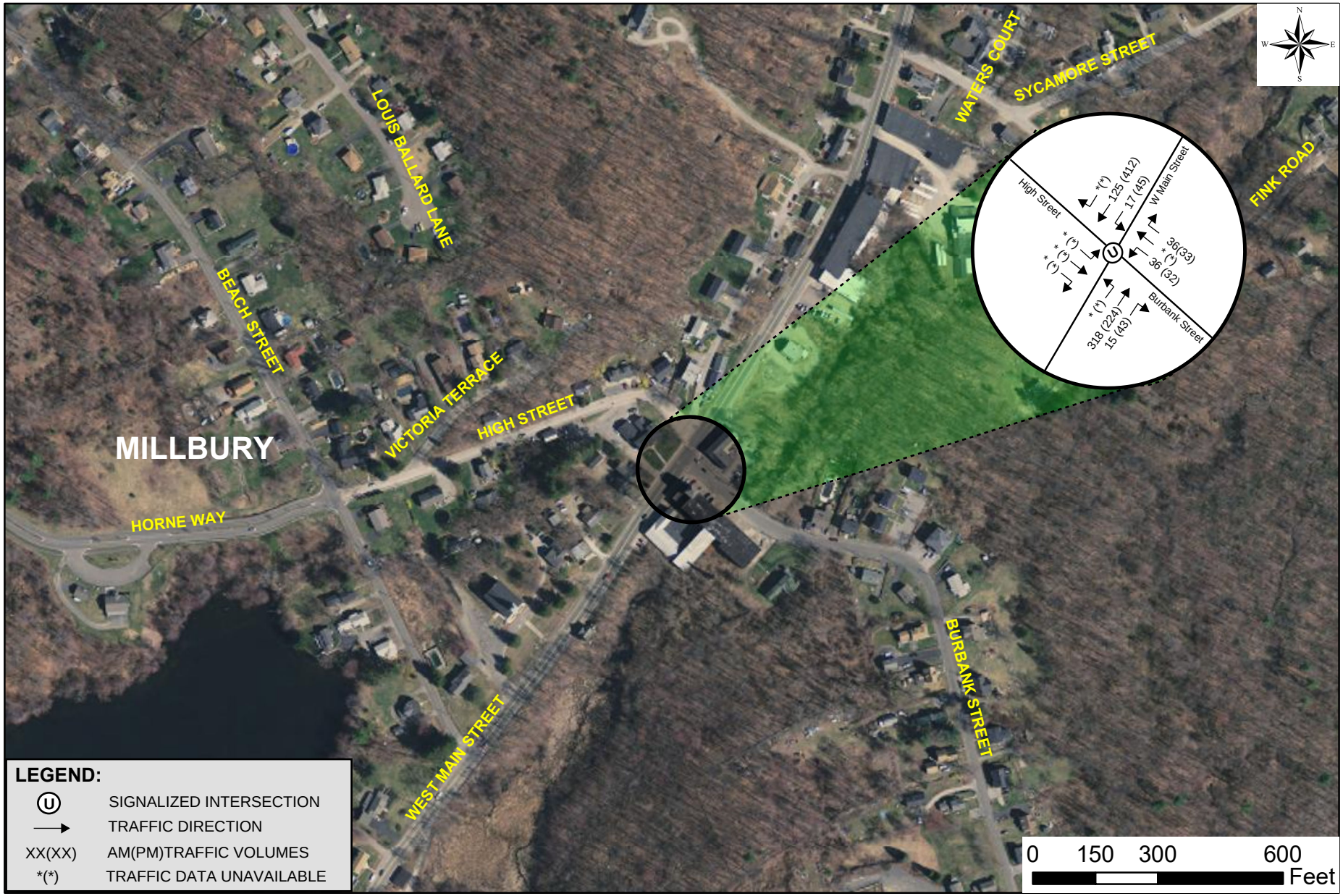


Figure 6: 2025 Build Condition Peak Hour Traffic Volumes

115 West Main Street
Millbury, MA

Data Source: MassGIS
Nitsch Project #14139

Nitsch Engineering

5.6 Parking Generation

To estimate the required amount of parking needed for the proposed development, we used the ITE *Parking General Manual*, 5th Edition. For the apartment complex, we used the Land Use Code 221 "Multifamily Housing (Mid-Rise)" with dwelling units as the independent variables. For the office space, we used the Land Use Code 710 "General Office Building" and for the restaurant, we used the Land Use Code 932 "High-Turnover (Sit Down) Restaurant". Table 10 shows the parking generated from each type of land use for weekday and Saturday.

Table 10 – ITE Parking Generation

Period	Type			Total
	Apartments	Office	Restaurants	
Weekday	258	18	23	299
Saturday	240	2	29	271

As reported by the developer, the project team met with the Town of Millbury's Technical Review Committee on March 16, 2020 and had negotiated parking requirements. Using the parking ratios, we calculated the amount of parking spaces required by the Town for each type of use. We provided the required parking along with the parking spaces provided and compared them to the ITE Parking Generation in Table 11.

Table 11 – Parking Comparison

Type		Number of Units/ Area	TRC Parking Requirements[a]	TRC Parking Required[a]	Parking Provided[b]	ITE Parking Generation[c]
Residential	**Efficiency**	100	1 per dwelling unit	100	-	-
	1-Bedroom	70	2 per dwelling unit	140	-	-
	2-Bedroom	27	3 per 2-bedroom dwelling unit	81	-	-
			Residential Total	**321**	**295**	**258**
Office Space		7,500 sq. ft.	1 per 200 sq. ft. gross leasable area	38	--	18
Restaurants		2,400 sq. ft. (108 seats)	1 per 4 seats	27	--	23
			Commercial Total	**65**	**--**	**41**
Additional Parking (Burbank Street and West Main Street)					**35**	**-**
			Grand Total	**386**	**330**	**299**

Sources: [a]TRC agreed parking, [b]Site Improvement Plan, [c]Table 10 (represents weekday requirements due to higher total required parking)

As shown in Table 11, the total number of spaces provided is 56 spaces less than the number of spaces required by the TRC therefore a variance will be required from the Town. However, the parking spaces provided exceeds the ITE parking requirements showing that it is anticipated the amount parking provided is sufficient to meet the demand.

5.7 Construction Management Outline

During construction of the development, no detours or lane closures at any of the study intersections or study roadways is anticipated.

During construction, pedestrian accessibility should be maintained. If necessary, temporary crosswalks and ramps should be provided. All pedestrian accommodations should adhere to Massachusetts Architectural Access Board (MAAB) and Americans with Disabilities Act (ADA) guidelines.

6 Conclusions

Nitsch Engineering has prepared this Traffic Assessment Report (TAR) for the proposed development at 115 West Main Street, Millbury, Ma. We studied one (1) unsignalized intersection to assess the impact the renovation of the existing Steelcraft buildings and the construction of two (2) new 3-story buildings would have on the intersection traffic operations.

The crash data over the last three (3) years available from the Millbury Police Department indicate that the study intersections have crash rates above District 3 and statewide averages.

For future conditions, we projected the existing traffic volumes within the study area over a 5-year period to the horizon year 2025 using an annual growth rate of up to 0.6%, based on expected regional growth. We estimated the quantity of vehicle trips the proposed development would generate based on Institute of Transportation Engineers (ITE) *Trip Generation, 10th Edition* criteria. We applied an appropriate travel mode share based on the Town of Millbury Master Plan (2019) and distributed the additional vehicle trips to the roadway network using existing travel patterns and site access modification.

Our assessment shows that the increase of traffic caused by the development on the roadway network would be small, suggesting low impact on traffic operations and safety at the intersection. Therefore, we do not recommend any changes to the intersection geometry, traffic control, or roadway network.

APPENDIX CONTENTS

Appendix A: Traffic Count Data

Town : Millbury
Street : West Main Street
Location : West of Sutton Road

Site: 2017108

Weekly Volume

Interval Start	Mon 6/19/2017		Tue 6/20/2017		Wed 6/21/2017		Thu 6/22/2017		Fri 6/23/2017		Sat 6/24/2017		Sun 6/25/2017		Mon - Fri Average		Weekly Average	
	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB	SB	NB
12:00 AM	-	-	14	3	10	6	-	-	-	-	-	-	-	-	12.0	4.5	12.0	4.5
1:00 AM	-	-	5	3	12	6	-	-	-	-	-	-	-	-	8.5	4.5	8.5	4.5
2:00 AM	-	-	2	4	1	2	-	-	-	-	-	-	-	-	1.5	3.0	1.5	3.0
3:00 AM	-	-	6	5	5	5	-	-	-	-	-	-	-	-	5.5	5.0	5.5	5.0
4:00 AM	-	-	8	20	11	22	-	-	-	-	-	-	-	-	9.5	21.0	9.5	21.0
5:00 AM	-	-	26	78	22	77	-	-	-	-	-	-	-	-	24.0	77.5	24.0	77.5
6:00 AM	-	-	56	151	65	163	-	-	-	-	-	-	-	-	60.5	157.0	60.5	157.0
7:00 AM	-	-	76	237	92	237	-	-	-	-	-	-	-	-	84.0	237.0	84.0	237.0
8:00 AM	-	-	97	191	81	186	-	-	-	-	-	-	-	-	89.0	188.5	89.0	188.5
9:00 AM	-	-	96	150	87	161	-	-	-	-	-	-	-	-	91.5	155.5	91.5	155.5
10:00 AM	-	-	105	116	133	140	-	-	-	-	-	-	-	-	119.0	128.0	119.0	128.0
11:00 AM	-	-	121	113	-	-	-	-	-	-	-	-	-	-	121.0	113.0	121.0	113.0
12:00 PM	147	114	152	128	-	-	-	-	-	-	-	-	-	-	149.5	121.0	149.5	121.0
1:00 PM	142	125	145	121	-	-	-	-	-	-	-	-	-	-	143.5	123.0	143.5	123.0
2:00 PM	183	158	161	142	-	-	-	-	-	-	-	-	-	-	172.0	150.0	172.0	150.0
3:00 PM	205	158	198	133	-	-	-	-	-	-	-	-	-	-	201.5	145.5	201.5	145.5
4:00 PM	273	140	265	144	-	-	-	-	-	-	-	-	-	-	269.0	142.0	269.0	142.0
5:00 PM	266	198	283	147	-	-	-	-	-	-	-	-	-	-	274.5	172.5	274.5	172.5
6:00 PM	184	120	189	117	-	-	-	-	-	-	-	-	-	-	186.5	118.5	186.5	118.5
7:00 PM	140	90	143	99	-	-	-	-	-	-	-	-	-	-	141.5	94.5	141.5	94.5
8:00 PM	85	63	109	83	-	-	-	-	-	-	-	-	-	-	97.0	73.0	97.0	73.0
9:00 PM	68	47	91	54	-	-	-	-	-	-	-	-	-	-	79.5	50.5	79.5	50.5
10:00 PM	48	28	63	28	-	-	-	-	-	-	-	-	-	-	55.5	28.0	55.5	28.0
11:00 PM	23	16	35	22	-	-	-	-	-	-	-	-	-	-	29.0	19.0	29.0	19.0
Totals	1764	1257	2446	2289	519	1005	0	0	0	0	0	0	0	0	2425.0	2332.0	2425.0	2332.0
Combined	3021		4735		1524		0		0		0		0		4757.0		4757.0	
Split (%)	58.4	41.6	51.7	48.3	34.1	65.9	-	-	-	-	-	-	-	-	51.0	49.0	51.0	49.0

Peak Hours

12:00 AM - 12:00 PM	-	-	11:00 AM	7:00 AM	10:00 AM	7:00 AM	-	-	-	-	-	-	-	-	11:00 AM	7:00 AM	11:00 AM	7:00 AM
Volume	-	-	121	237	133	237	-	-	-	-	-	-	-	-	121.0	237.0	121.0	237.0
12:00 PM - 12:00 AM	4:00 PM	5:00 PM	5:00 PM	5:00 PM	-	-	-	-	-	-	-	-	-	-	5:00 PM	5:00 PM	5:00 PM	5:00 PM
Volume	273	198	283	147	-	-	-	-	-	-	-	-	-	-	274.5	172.5	274.5	172.5

Location Info	
Location ID	240697
Type	I-SECTION
Functional Class	4
Located On	SINGLETARY AVENUE
Between	AND
Direction	2-WAY
Community	Sutton
MPO_ID	
HPMS ID	
Agency	Massachusetts Highway Department

Count Data Info	
Start Date	6/20/2017
End Date	6/21/2017
Start Time	10:45 AM
End Time	10:45 AM
Direction	
Notes	
Count Source	240697
File Name	
Weather	
Study	
Owner	rpa05

Interval: 15 mins

Time	15 Min				Hourly Count
	1st	2nd	3rd	4th	
00:00 - 01:00	2	4	2	5	13
01:00 - 02:00	2	2	0	3	7
02:00 - 03:00	1	1	0	1	3
03:00 - 04:00	0	1	1	1	3
04:00 - 05:00	2	1	3	5	11
05:00 - 06:00	6	14	15	13	48
06:00 - 07:00	16	26	31	35	108
07:00 - 08:00	44	27	42	49	162
08:00 - 09:00	35	46	39	41	161
09:00 - 10:00	27	37	31	43	138
10:00 - 11:00	27	37	34	33	131
11:00 - 12:00	51	42	47	40	180
12:00 - 13:00	41	52	40	49	182
13:00 - 14:00	37	37	30	43	147
14:00 - 15:00	45	41	49	41	176
15:00 - 16:00	50	44	42	59	195
16:00 - 17:00	52	63	67	43	225
17:00 - 18:00	63	48	78	62	251
18:00 - 19:00	47	49	39	39	174
19:00 - 20:00	39	47	33	27	146
20:00 - 21:00	33	29	24	18	104
21:00 - 22:00	14	22	12	17	65

22:00 - 23:00	20	14	10	9	53
23:00 - 24:00	6	9	3	3	21
TOTAL					2704

Appendix B: MassDOT's 2017 Weekday Seasonal Adjustment Factors

Massachusetts Highway Department
Statewide Traffic Data Collection
2017 Weekday Seasonal Factors

Factor Group	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Axle Factor
R1	1.30	1.23	1.21	1.04	0.98	0.92	0.86	0.81	0.95	0.99	1.03	1.10	0.80
R2	0.95	0.96	0.98	0.97	0.97	0.93	0.97	0.94	0.96	0.90	0.92	0.93	0.96
R3	1.05	1.01	1.04	0.99	0.94	0.93	0.91	0.92	0.96	0.94	1.01	1.03	0.97
R4-R7	1.10	1.07	1.09	1.00	0.95	0.89	0.88	0.87	0.92	0.95	1.04	1.09	0.93
U1-Boston	1.01	1.04	0.99	0.94	0.93	0.92	0.96	0.93	0.94	0.93	0.95	0.98	0.95
U1-Essex	1.04	1.05	1.00	0.96	0.93	0.89	0.90	0.90	0.93	0.93	0.98	1.03	0.90
U1-Southeast	1.07	1.05	1.02	0.97	0.95	0.90	0.89	0.88	0.92	0.94	0.98	1.01	0.97
U1-West	1.00	0.96	0.94	0.92	0.93	0.92	0.95	0.93	0.92	0.92	0.97	0.97	0.89
U1-Worcester	1.10	1.10	1.04	0.97	0.95	0.94	0.93	0.91	0.95	0.96	0.98	1.04	0.89
U2	1.01	1.03	0.98	0.95	0.93	0.91	0.94	0.92	0.95	0.95	0.95	0.97	0.98
U3	1.03	1.05	1.01	0.95	0.92	0.90	0.94	0.93	0.93	0.92	0.96	0.99	0.96
U4-U7	1.06	1.05	1.02	0.96	0.92	0.89	0.95	0.95	0.92	0.92	0.98	1.03	0.98
Rec - East	1.18	1.17	1.08	1.03	0.95	0.87	0.83	0.83	0.97	0.98	1.19	1.19	0.98
Rec - West	1.30	1.23	1.32	1.18	0.95	0.82	0.70	0.69	0.97	0.96	1.16	1.15	0.95

Round off:
0-999 = 10
>1000 = 100

U = Urban
R = Rural

1 - Interstate
2 - Freeway and Expressway
3 - Other Principal Arterial
4 - Minor Arterial
5 - Major Collector
6 - Minor Collector
7 - Local Road and Street

Recreational - East Group - Cape Cod (all towns) including the town of Plymouth south of Route 3A (stations 7014,7079,7080,7090,7091,7092,7093,7094,7095,7096,7097,7108 and 7178), Martha's Vineyard and Nantucket.

Recreational - West Group - Continuous Stations 2 and 189 including stations 1066,1067,1083,1084,1085,1086,1087,1088,1089,1090,1091,1092,1093,1094,1095,1096,1097,1098,1099,1100,1101,1102,1103,1104,1105,1106,1107,1108,1113,1114, 1116,2196,2197 and 2198.

2/24/2020

Appendix C: Crash Rate Worksheets

INTERSECTION CRASH RATE WORKSHEET, 2017-2019

CITY/TOWN : Millbury COUNT DATE :

DISTRICT : 3 UNSIGNALIZED : X SIGNALIZED :

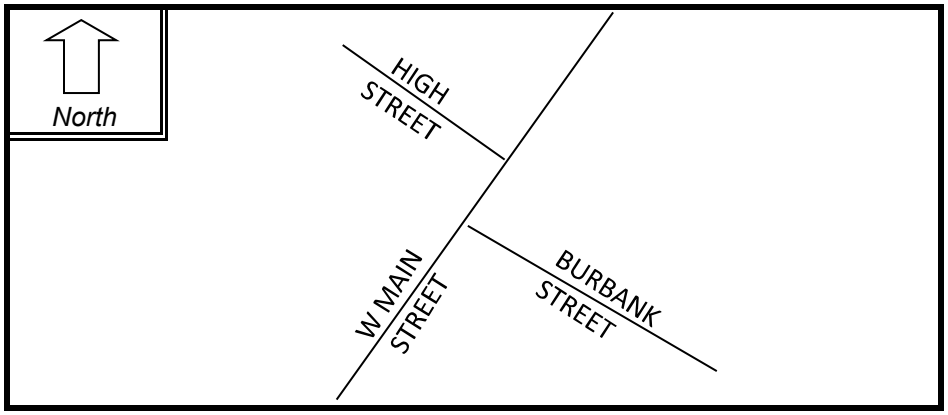
~ INTERSECTION DATA ~

MAJOR STREET : West Main Street

MINOR STREET(S) : Burbank Street

High Street

INTERSECTION DIAGRAM



PEAK HOUR VOLUMES

APPROACH :	1	2	3	4	5	Total Peak Hourly Approach Volume
DIRECTION :	EB	WB	NB	SB		
PEAK HOURLY VOLUMES (AM/PM) :			220	404		624

" K " FACTOR : 0.08

INTERSECTION ADT (**V**) = TOTAL DAILY APPROACH VOLUME : 7,800

TOTAL # OF CRASHES : 9

OF YEARS : 3

AVERAGE # OF CRASHES PER YEAR (**A**) : 3.00

CRASH RATE CALCULATION : 1.05

RATE = $\frac{(A * 1{,}000{,}000)}{(V * 365)}$

Comments : PM Peak used

Project Title & Date: 14139 115 West Main Street 04/22/2020

Appendix D: Detailed Trip Generation

Trip Generation from ITE Method by LUC

Period	Direction	Existing Trips			Future Trips								
		LUC 140 Manufacturing (35,000 sq ft) (vehicle trips)			LUC 221 Multifamily Housing (Mid-Rise) (202 Units) (person trips)			LUC 710 General Office Bldg. (7,500 Sq. ft.) (person trips)			LUC 932 High-Turnover (Sit-Down) Restaurant (2,400 sq ft) (vehicle trips)		
		Total Trips	Split	Trips	Total Trips	Split	Trips	Total Trips	Split	Trips	Total Trips	Split	Trips
AM	Enter	28	26%	20	63	27%	17	11	85%	10	34	56%	19
	Exit		74%	8		73%	46		115%	1		44%	15
PM	Enter	28	37%	12	99	61%	60	12	20%	2	42	52%	22
	Exit		63%	16		39%	39		80%	10		48%	20

Notes:
LUC = Land Use Code
Average rates were used to estimate trip generation.
Peak-hour trip generation based on peak hours of the generator due to limited data availability for peak hours of adjacent street traffic.

Appendix B
Construction Pollution Prevention Plan

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Straw Wattles

Straw wattles will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site.

Silt Fencing

In areas where high runoff velocities or high sediment loads are expected, straw wattles may be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and straw wattle barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing catch basins will be protected with straw bale barriers (where appropriate) or silt sacks throughout construction.

Gravel and Construction Entrance/Exit

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Temporary Sediment Basins

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

Maintenance

 The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.

 The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.

 Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.

 Damaged or deteriorated items will be repaired immediately after identification.

 The underside of straw wattles should be kept in close contact with the earth and reset as necessary.

 Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.

 Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be re- graded and stabilized as necessary.

Construction Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐ yes ☐ no (List Items)	Date of Cleaning/Repair	Performed by:
Straw Wattles/Silt Fencing	In accordance with NPDES CGP			• Inspect for accumulated sediment behind straw wattles/silt fencing and remove as needed. • Separation of straw wattles with the earth and each other. Make adjustments to eliminate separations. • Damaged or broken straw wattles/ silt fence. Replace as necessary.	☐ **yes** ☐ **no**		
Gravel Construction Entrance	In accordance with NPDES CGP			• Accumulated sediment • Remove sediment that is spilled, dropped, washed or tracked onto pavements outside limit of work.	☐ **yes** ☐ **no**		
Catch Basin Protection	In accordance with NPDES CGP			• Accumulated sediment within silt sacks. Remove sediment as necessary. • Rips or torn silt sacks. Replace damaged silt sacks.	☐ **yes** ☐ **no**		
Diversion Channels	In accordance with NPDES CGP			• Cracking, • Erosion, • Leakage in the embankments • Repair diversion channels as necessary to prevent downstream erosion and sedimentation.	☐ **yes** ☐ **no**		
Temporary Sedimentation Basins	In accordance with NPDES CGP			• Cracking, • Erosion, • Leakage in the embankments • Accumulation of sediment. • Remove sediment and make repairs as necessary to ensure proper function of sediment basin.	☐ **yes** ☐ **no**		
Vegetated Slope Stabilization	In accordance with NPDES CGP			• Cracking, • Erosion • Repair/reaplace as necessary to ensure proper function of slope stabilization and to prevent downstream erosion and sedimentation.	☐ **yes** ☐ **no**		

Stormwater Control Manager _____

Appendix C
Permanent Pollution Prevention Plan

Appendix D
Potable Water Engineering Report

Appendix E
Sanitary Sewer Engineering Report

Appendix F
Stormwater Report

Stormwater Report

FOR

Singletary Arms

Millbury, Massachusetts

DATE PREPARED
July 22, 2020

PREPARED BY
Todd Chandler, P.E.
301 W. Pacific
Suite B
Branson, MO 65616

TABLE OF CONTENTS

I. INTRODUCTION

The following report provides an analysis of the stormwater drainage conditions that will result from the re-development of Steelcraft Building located at 115 West Main Street in the City of Millbury, Massachusetts. The subject property ("the Site") contains approximately 12.5 acres of land, is situated on the southwest side of the intersection of West Main Street and Burbank Street. The Steelcraft Building is an existing three-story warehouse/manufacturing facility and associated infrastructure. The four acres of wooded upland immediately adjacent and south of the Steelcraft Building will be developed into two apartment buildings and associated infrastructure and surface parking. Up through the 1960's, the wooded upland was occupied by tenement housing, which were part of the Steelcraft complex. Later, this parcel was home to a large single-family residence which was destroyed by fire around 2003.

The proposed project will consist of redeveloping the Steelcraft building into a mixed-use property including 10,000 square feet of commercial space, 53 apartment units, and resident amenities. The two apartment buildings to be constructed on the former tenement site of the wooded upland will include paved parking, pervious paver parking, pedestrian access, stormwater management system and utilities.

This report includes an analysis of the pre- and post-development drainage characteristics including off site contribution, building, parking, and landscaped areas. The report provides a detailed analysis of the proposed stormwater facilities and best management practices (BMPs) that will control both stormwater outflows leaving the site.

This report addresses a comparative analysis of the pre- and post-development site stormwater runoff conditions with the following primary design constraints being:

1. The Massachusetts Department of Environmental Protection Agency's Stormwater Management Standards; and
2. The City of Millbury Stormwaater Ordinance.

II. DRAINAGE – EXISTING SITE CONDITIONS

The Steelcraft Building is situated on approximately 1.5 acres of ground which includes off-street parking, sidewalk, and utilities. In addition to the Steelcraft Building, the site contributory drainage area contains 7.42 acres of wooded upland and 3,000 square feet of rooftop which drains to the north toward Singletary Brook. The drainage areas are further defined in the "Pre-Development Drainage Area Map" which is included in Appendix 3 of this report.

The contributory drainage area is divided into three sub-areas:

DA - Pond 1- Offsite	3.01 Acres
DA - Pond 1 - Onsite	2.09 Acres
DA – Pond 2 – Onsite	2.32 Acres

Of this drainage area, 2.67 acres drains toward Burbank Street, and 4.74 acres drains toward Singletary Brook upstream of the Steelcraft Building. The Steelcraft building is located in close proximity to both West Main Street and Burbank Street and graded in manner that stormwater discharges directly into existing storm inlets located along Burbank Street.

Based on our review of the Natural Resources Conservation Service (NRCS) WSS online soil databases, the soils at the subject site are classified into five soil types:

420 B – Canton Fine Sandy Loam 3 – 8% slope

307 E – Paxton Fine Sandy Loam 15 – 35% slope

307 C – Paxton Fine Sandy Loam 8 – 15% slope

305 C – Paxton Fine Sandy Loam 8 – 15% slope

305 B – Paxton Fine Sandy Loam 3 – 8% slope

Subsurface soils information is provided in Boring Logs prepared by Soil X Corp, dated February 21, 2020, and included in Appendix 11 of this report.

III. DRAINAGE- PROPOSED SITE CONDITIONS

The proposed project will consist of renovating the existing Steelcraft Building into apartment units, 10,000± square foot (SF) commercial/retail and 2,400± SF restaurant space. The wooded upland will be developed into two apartment buildings, parking, utilities, landscape improvements, and stormwater management improvements. Refer to the Site Development Plans prepared by Chandler Engineering, dated April 20, 2020.

The goal of the stormwater management system design is to maintain existing site drainage patterns, mitigate peak post development rates, and protect water quality of receiving waters and groundwater in accordance with MassDEP's Stormwater Management Standards and the City of Millbury's Requirements.

Stormwater quality improvements proposed for the site include precast concrete catch basins, pervious pavers with extended detention area, and a subsurface detention system which will achieve the desired total suspended solids (TSS) removal required by both the DEP's and the City of Millbury's Stormwater Management Standards. Given the existing site topography, site geometry, and grading constraints, there is very little land area available to utilize low impact design practices. However, approximately six acres of property will remain undisturbed. By using an extended subsurface detention system with a volume 2.5 times greater than the one-inch rainfall volume, infiltration and pollutant removal have been achieved to the maximum extent possible.

The post-development condition consists of three (3) drainage areas DA – Pond 1 – Offsite, DA – Pond 1 – Onsite, and DA Pond 2 – Onsite. Drainage areas DA – Pond 1 – Offsite and DA – Pond 1 – Onsite discharges into Singletary Brook upstream of the Steelcraft Building. Drainage area DA Pond 2 – Onsite discharges into an existing inlet located along Burbank Street at the southeast corner of the Steelcraft Building. Refer to the "Post-Development Drainage Area Map" which is included in Appendix 3 of this report.

The onsite drainage areas for both Pond 1 and Pond 2 are further divided into inlet drainage areas. Refer to the "Post-Development Drainage Area Map (Inlets)" in Appendix 3 of this report. For TSS pretreatment, surface runoff captured by the pervious pavement, at each subsurface basin, flows via extended detention and perforated pipe to a precast concrete catch basin inlet immediately upstream of each subsurface detention basin. This basin then discharges into a subsurface chamber system for attenuation of peak runoff rates. Roof drainage and surface runoff collected by concrete catch basins immediately upstream of each detention basin for additional pretreatment prior to discharge.

Under proposed conditions, the stormwater runoff rates and volumes from the proposed development are attenuated to the pre-development condition for all storms including the 100-year storm event at both

Pond 1 and Pond 2.

Both subsurface basins have been sized to provide adequate storage to meet the City of Millbury requirements. Calculations have been provided in Appendix 5 of this report.

Pipe sizing calculations have also been included in Appendix 5. The calculations demonstrate that the drainage system has sufficient capacity for the 25-year storm event.

IV. DRAINAGE ANALYSIS METHODOLGY

The methodology utilized to design the proposed stormwater management system to comply with the City of Millbury and State requirements/guidelines is based on the Rational method. In addition, times of concentration were generated from the SCS TR 55 Urban Hydrology for small watersheds method. Runoff coefficients for the existing and proposed development conditions were developed using widely accepted runoff coefficients. The rainfall rates used were based on the TP-40 rainfall amounts for Essex County.

V. DRAINAGE ANALYSIS RESULTS

The tables below include the pre-development runoff rate and the post-development discharge rates and associated chamber system volume for the 2-, 10-, 25, 50 - and 100-year storm events. For both chamber systems, the post-development discharge rate for each storm event is less than the pre-developed discharge rate.

Project Area in Asphalt Pavement – 52,708 sf
Project Area in Concrete Sidewalk – 12,367 sf
Project Area in Proposed Roof – 41,902 sf

Project Area in Pervious Pavers – 24,158 sf
Project Area in Chamber System – 3196 sf, 15,191 cf
Volume in Extended Detention – (24158 – 3196) x 1’ x 0.35 = 7,336 cf

Table 1 – Pond-1 (Drainage Areas DA – Pond 1 – Offsite, DA – Pond 1 – Onsite**)**

PRE–DEVELOPMENT ALLOWABLE RELEASE RATES
& ACTUAL ROUTED RELEASE RATES

* = FROM PRE–DEV. HYDROGRAPH
** = FROM RATING TABLE

STORM EVENT	*PRE–DEVELOPMENT RELEASE RATE (CFS)	**ROUTED RELEASE RATE (CFS)	ELEVATION IN FEET	VOLUME PROVIDED
2	2.75	2.03	514.16	6260 CUFT
10	3.33	2.68	514.46	7058 CUFT
25	4.44	3.46	515.15	8903 CUFT
50	5.16	3.91	515.64	10190 CUFT
100	5.56	4.14	515.90	10903 CUFT

Table 2 –Pond-2 (DA Pond 2 – Onsite**)**

PRE–DEVELOPMENT ALLOWABLE RELEASE RATES
& ACTUAL ROUTED RELEASE RATES

* = FROM PRE–DEV. HYDROGRAPH
** = FROM RATING TABLE

STORM EVENT	*PRE–DEVELOPMENT RELEASE RATE (CFS)	**ROUTED RELEASE RATE (CFS)	ELEVATION IN FEET	VOLUME PROVIDED
2	1.79	1.55	485.69	2473 CUFT
10	2.13	1.78	485.96	2752 CUFT
25	2.78	2.29	486.69	3508 CUFT
50	3.20	2.49	487.04	3867 CUFT
100	3.44	2.72	487.44	4288 CUFT

VI. CONCLUSIONS

The proposed stormwater management system illustrated on the enclosed drawings prepared by Chandler Engineering, dated April 20, 2020, results in a decrease in post-development peak stormwater runoff rates for all storm events associated with the proposed development. In addition, best management practices being implemented as part of the proposed stormwater management system design will result in the required 80% TSS removal for the increase in impervious area from the pre-

developed condition. The project has been designed to manage stormwater onsite to the maximum extent practicable, and it also complies with the requirements of the Massachusetts Department of Environmental Protection Stormwater Standards and the City of Millbury Requirements.

VII. STORMWATER MANAGEMENT STANDARDS

As outlined below, the proposed drainage system was designed in accordance with the Massachusetts Stormwater Management Policy to the maximum extent practicable.

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

The proposed development has been designed so that all pavement areas from the proposed development are collected by the stormwater management system for treatment prior to being discharged to wetlands.

Standard #2: **Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.**

Runoff rates for the post-development condition were calculated for the 2-, 10-, 25-, 50- and 100-year 24- hour storm events. These calculations are provided in Appendix 4 of this report. As summarized in this report, there is no increase in peak stormwater runoff rates for the storm events analyzed for the proposed development due to the implementation of a stormwater management system.

Standard #3: **Loss of annual recharge to ground water shall be eliminated or minimized through the use of infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance.**

Given the existing ground slope only a limited portion of the site will be practicable for recharge BMPs. The project proposes an underground detention/infiltration system to mitigate peak runoff rates and volumes, and to promote groundwater recharge. The project has been designed to recharge stormwater runoff from the site to the maximum extent practicable. See Appendix 6 for calculations.

Standard #4: **Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).**

The proposed stormwater management system has been designed to provide at least 80% removal of TSS for the increase in impervious area compared to the pre-developed condition through the use of several BMPs, including deep sump catch basins, pervious pavement, and an extended detention basin. All water quality BMPs for this project have been sized to meet DEP standards. See Appendix 7 for calculations.

Standard #5: **For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable.**

Vehicle trips onsite may trigger the threshold considering the Site a Land Use with Higher Potential Pollutant Loads, therefore the project has been designed to treat stormwater discharges from the Site to the maximum extent practicable in accordance with the Massachusetts Stormwater Handbook.

Standard #6: **Stormwater discharges within the Zone II or Interim Wellhead Protection Area of**

a public water supply, and stormwater discharges near or to any other critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater best management practices determined by the Department to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook.

The site is not located within a Zone II, Interim Wellhead Protection Area, or near to any other critical area. The site is located adjacent to wetland resource areas and proposes to achieve a minimum of 80% TSS removal under post-development conditions for all stormwater leaving the site. In addition, all water quality BMPs for this project have been sized to meet DEP regulations.

Standard #7: **A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable.**

The proposed project is not a redevelopment and has been designed in accordance with the Massachusetts Stormwater Management regulations.

Standard #8: **A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.**

An Erosion and Sediment control plan has been prepared as part of the enclosed drawings prepared by Chandler Engineering. This includes implementation of a perimeter erosion control barrier along with a construction entrance, protection for catch basins inlets and protection around temporary material stock pile areas. The proposed area of disturbance is greater than one acre, therefore the project shall require filing of a Notice of Intent with EPA and shall implement a Stormwater Pollution Prevention Plan (SWPPP) during construction. The contractor will be required to maintain erosion control measures during construction and prevent erosion or sediment discharges to downstream areas.

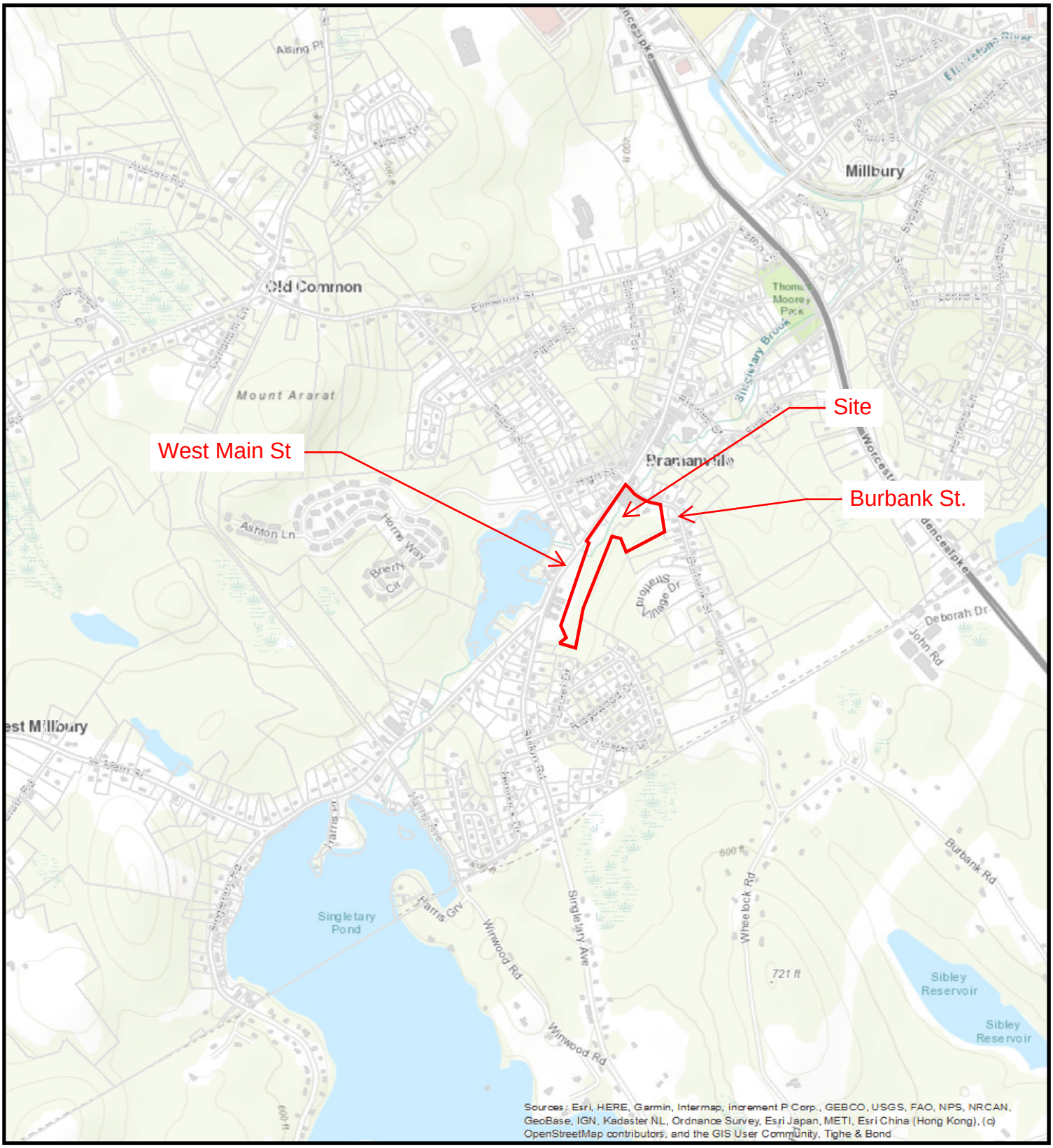
Standard #9: **A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.**

A Long Term Operation and Maintenance Plan for the proposed BMP's has been developed for this project and is included within Appendix 8 of this report. The O&M Plan outlines procedures and time tables for the long term operation and maintenance of the proposed stormwater management system, as well as includes a list of parties responsible and an estimated budget associated with inspections and maintenance.

Standard #10: **All illicit discharges to the stormwater management system are prohibited**

No illicit discharges will be created as part of the site construction for the proposed project.

APPENDIX 1
USGS Map



Location Map

4/12/2020 10:57:01 AM

Scale: 1"=1505'

Scale is approximate

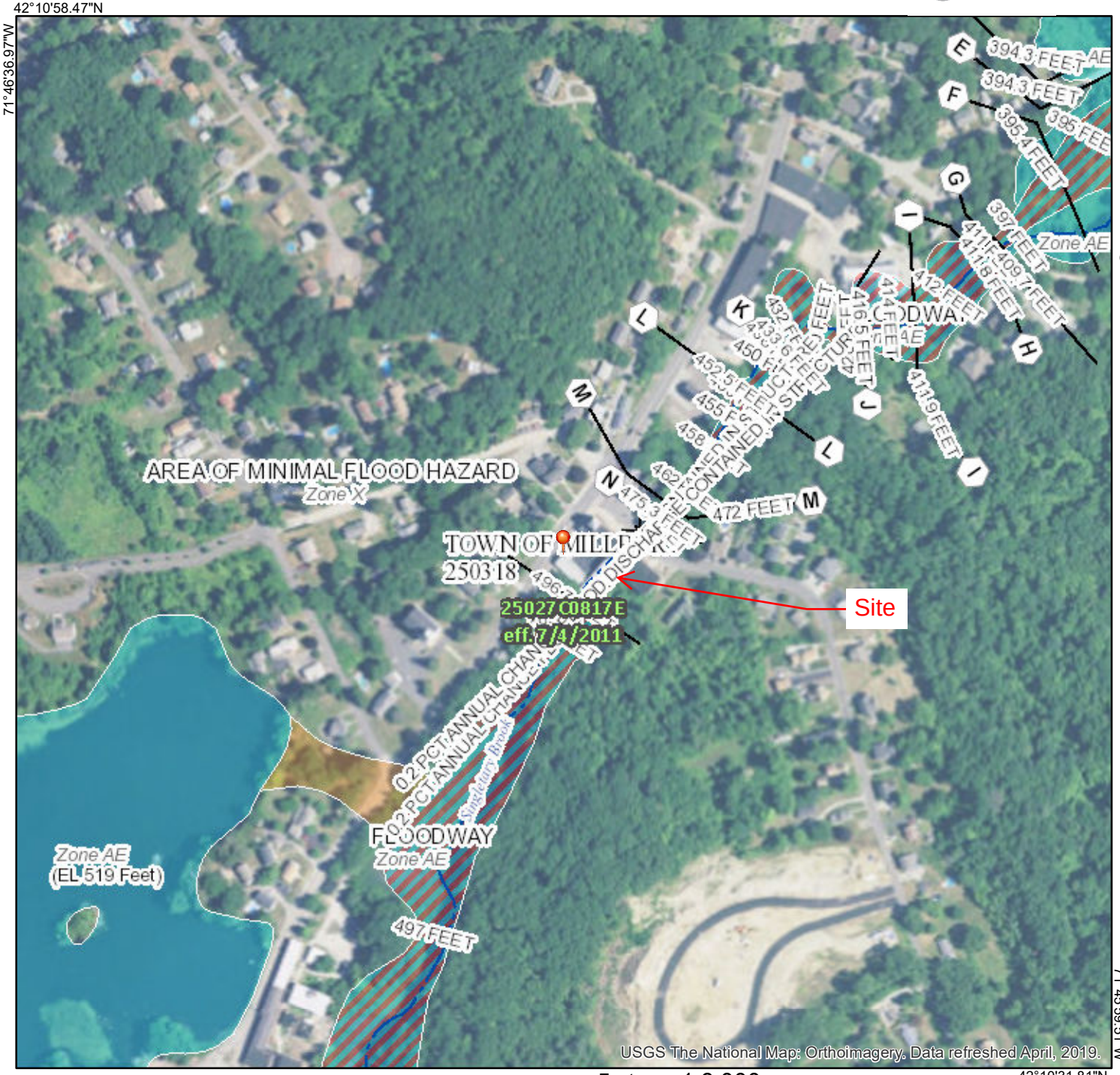
The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

APPENDIX 2

FIRM Map

National Flood Hazard Layer FIRMette

FEMA



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
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- 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.

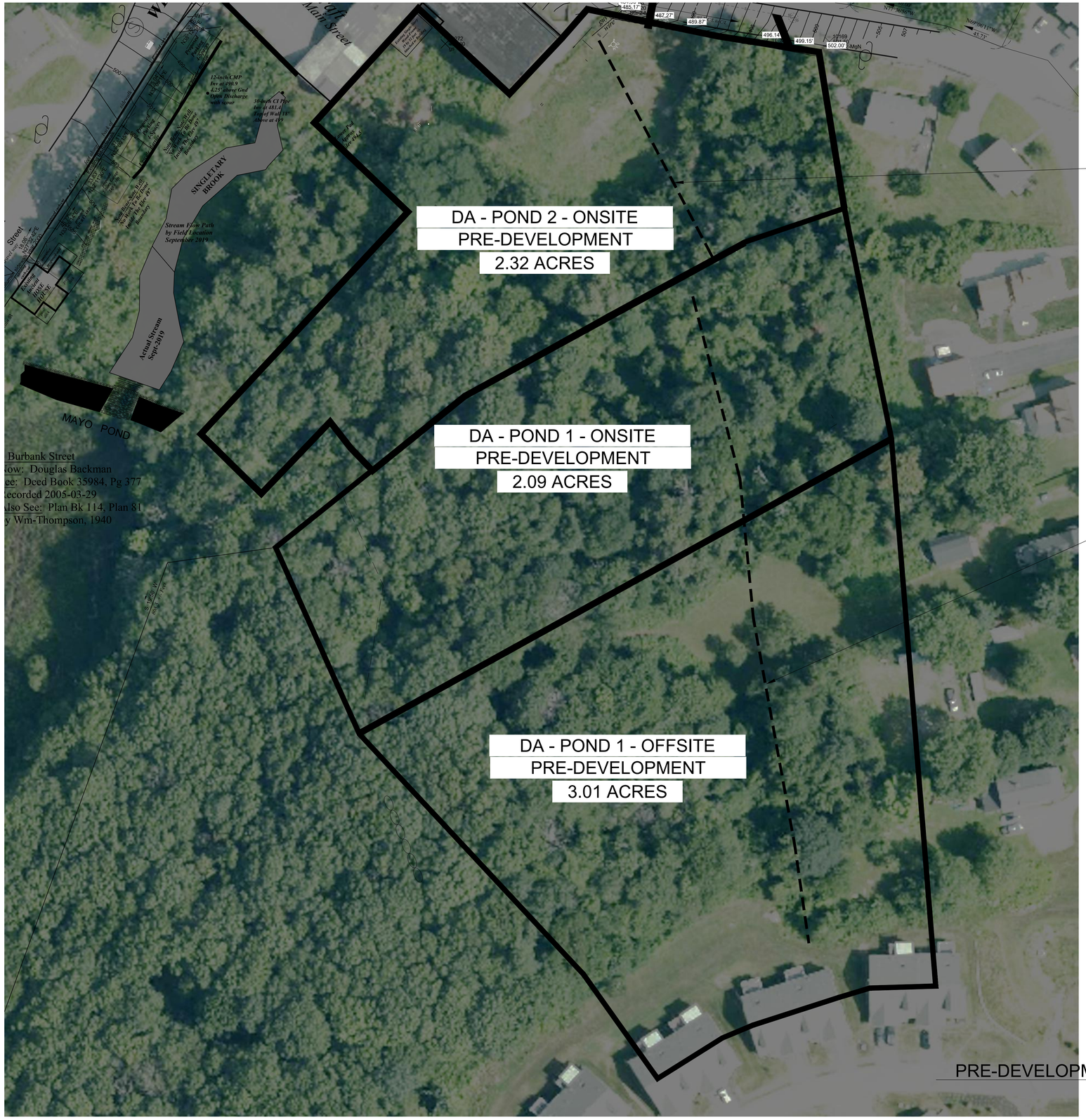
This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 5/10/2020 at 5:45:41 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.

APPENDIX 3

Pre- and Post-Development Watershed Maps



LEGEND

- RIGHT OF WAY LINE
- EXISTING WATER LINE
- EXISTING SANITARY SEWER LINE
- EXISTING STORM SEWER LINE
- WATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- EXISTING CONTOURS MAJOR
- EXISTING CONTOURS MINOR
- PROPOSED CONTOURS MAJOR
- PROPOSED CONTOURS MINOR
- SANITARY SEWER MANHOLE
- STORM SEWER MANHOLE
- WATER METER
- WATER VALVE
- FIRE HYDRANT
- THRUST BLOCK

PRE-DEVELOPMENT DRAINAGE AREA MAP

SCALE: 1"=50'

Project Name and Address
SINGLETARY ARMS
MILLBURY, MA

Sheet Title
PRE-DEVELOPMENT DRAINAGE AREA MAP

Date

No.	Revision/Issue	Date

Project No.	Sheet
***	C-17
Date: 04/20/20	
Scale: AS NOTED	

PLOTTED 4/18/2020 1:21:50 PM

LEGEND

- RIGHT OF WAY LINE
- EXISTING WATER LINE
- EXISTING SANITARY SEWER LINE
- EXISTING STORM SEWER LINE
- WATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- EXISTING CONTOURS MAJOR
- EXISTING CONTOURS MINOR
- PROPOSED CONTOURS MAJOR
- PROPOSED CONTOURS MINOR
- SANITARY SEWER MANHOLE
- STORM SEWER MANHOLE
- WATER METER
- WATER VALVE
- FIRE HYDRANT
- THRUST BLOCK

Project Name and Address
SINGLETARY ARMS
MILLBURY, MA

Sheet Title
POST-DEVELOPMENT DRAINAGE AREA MAP

Date

Date

Revision/Issue

Project No.
***

Date
04/20/20

Scale
AS NOTED

Sheet
C-18

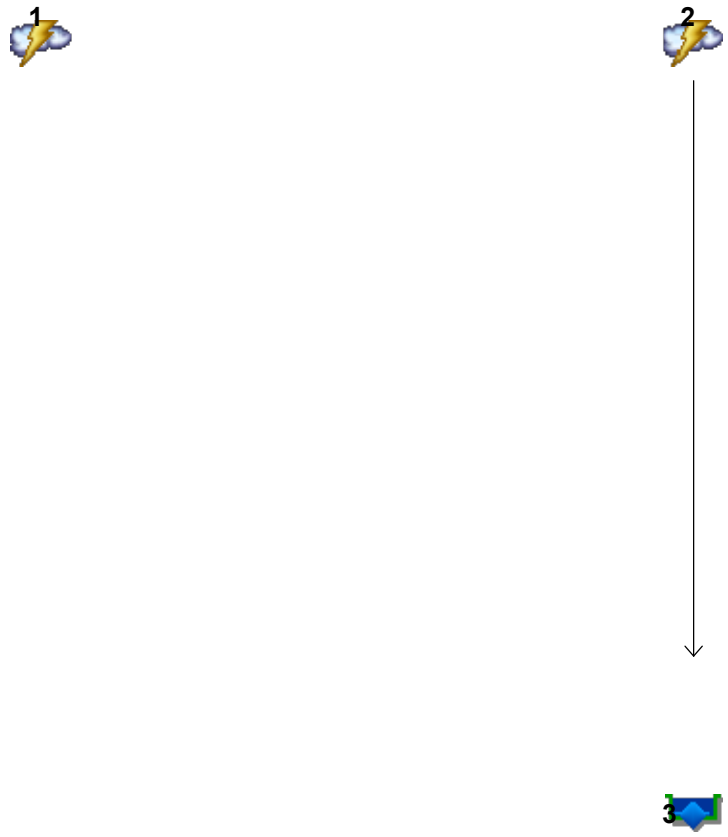
D:\Users\Owner\Documents\big box conversion\millbury mass\115 West Main St - Millbury Mass site - 18 millbury MS.dwg

APPENDIX 4

Stormwater Attenuation Calculations & Rainfall Data

POND 1

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	Rational	Pre-Development
2	Rational	Post-Development
3	Reservoir	Routed Detention Pond

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)							Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	Rational	------	-------	2.750	-------	-------	3.325	4.439	5.158	5.553	Pre-Development
2	Rational	------	-------	6.321	-------	-------	7.623	10.11	11.73	12.60	Post-Development
3	Reservoir	2	-------	2.034	-------	-------	2.678	3.458	3.912	4.142	Routed Detention Pond

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	2.750	1	24	3,960	------	------	------	Pre-Development
2	Rational	6.321	1	20	7,585	------	------	------	Post-Development
3	Reservoir	2.034	1	34	4,829	2	514.16	6,260	Routed Detention Pond

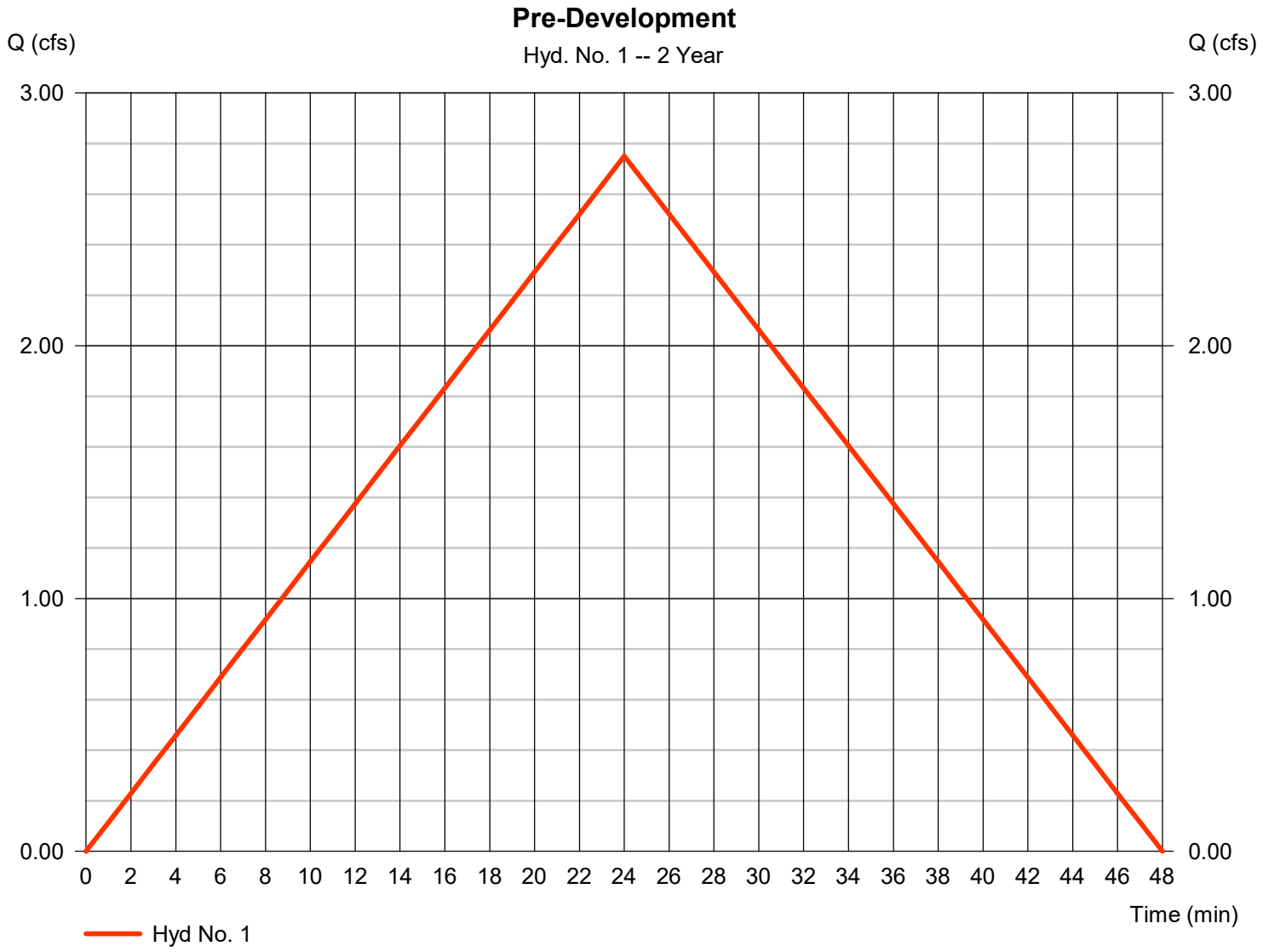
Hydrograph Report

Hyd. No. 1

Pre-Development

Hydrograph type	=	Rational	Peak discharge	=	2.750 cfs
Storm frequency	=	2 yrs	Time to peak	=	24 min
Time interval	=	1 min	Hyd. volume	=	3,960 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.25*
Intensity	=	2.157 in/hr	Tc by User	=	24.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.25)] / 5.100



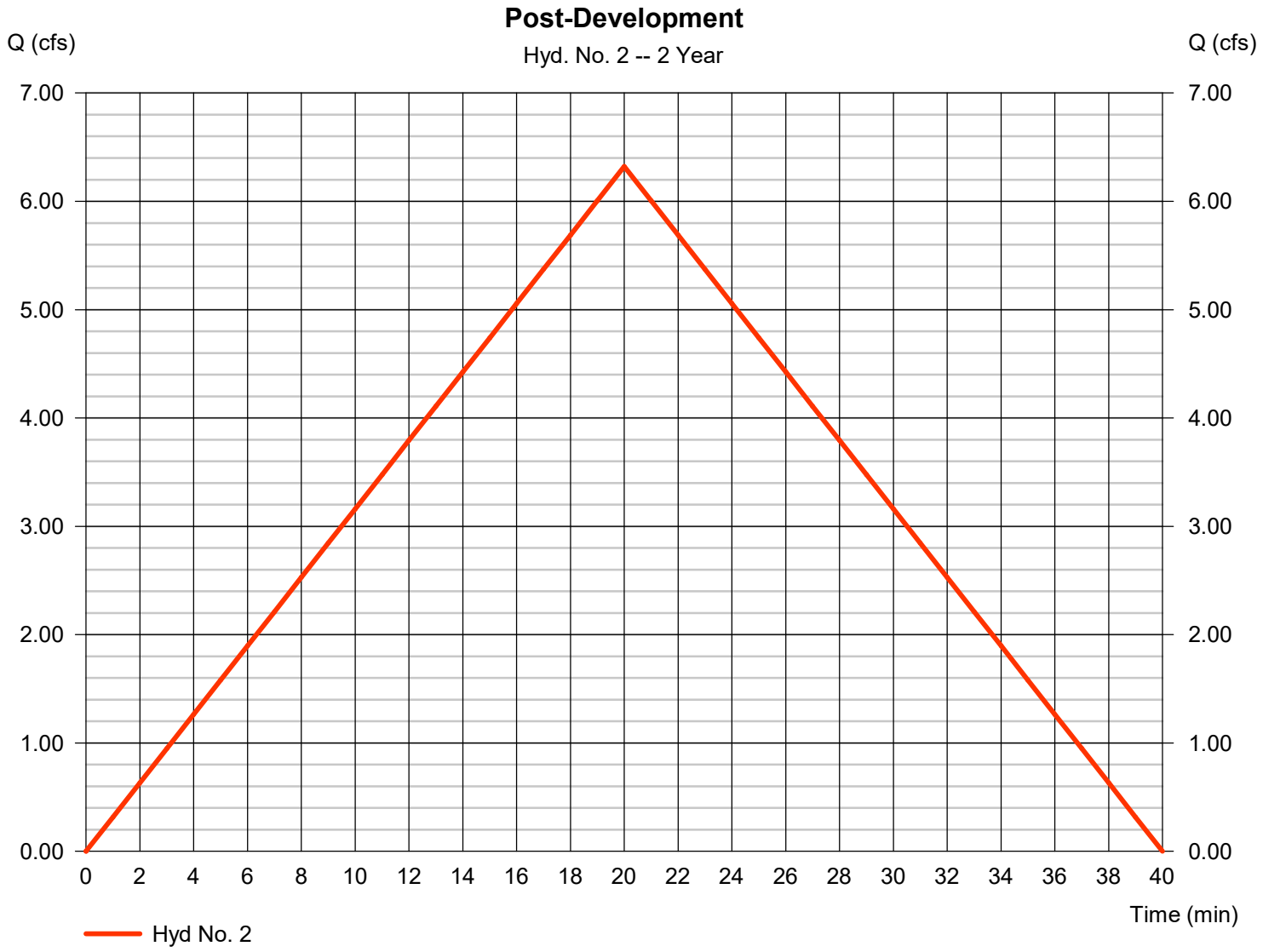
Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	6.321 cfs
Storm frequency	=	2 yrs	Time to peak	=	20 min
Time interval	=	1 min	Hyd. volume	=	7,585 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.52*
Intensity	=	2.384 in/hr	Tc by User	=	20.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.90)] / 5.100



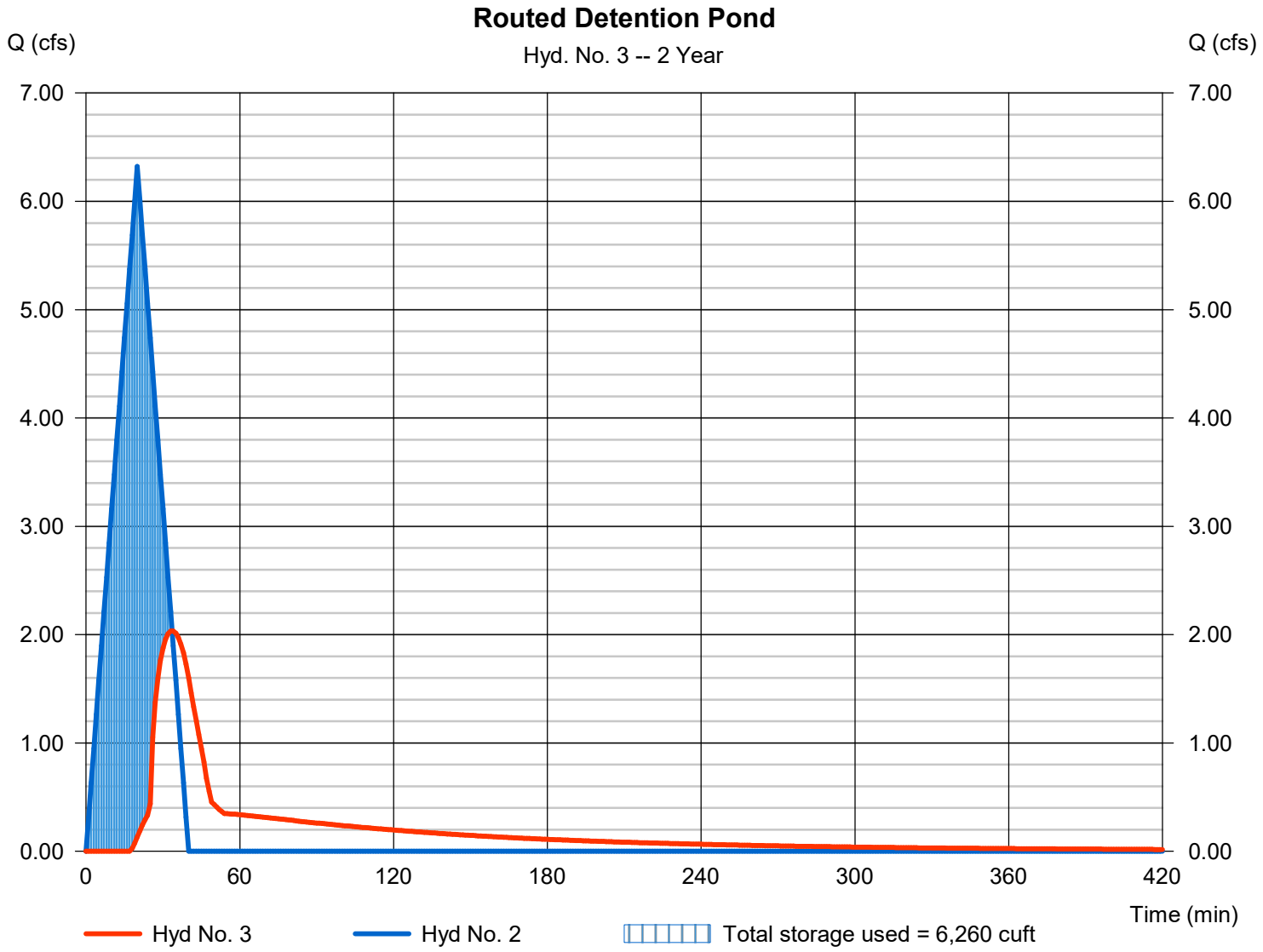
Hydrograph Report

Hyd. No. 3

Routed Detention Pond

Hydrograph type	=	Reservoir	Peak discharge	=	2.034 cfs
Storm frequency	=	2 yrs	Time to peak	=	34 min
Time interval	=	1 min	Hyd. volume	=	4,829 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	514.16 ft
Reservoir name	=	UnderGround Pond 1	Max. Storage	=	6,260 cuft

Storage Indication method used.



Pond No. 1 - UnderGround Pond 1

Pond Data

UG Chambers -Invert elev. = 513.00 ft, Rise x Span = 0.87 x 1.41 ft, Barrel Len = 7.12 ft, No. Barrels = 130, Slope = 0.00%, Headers = No
Encasement -Invert elev. = 512.00 ft, Width = 7.17 ft, Height = 4.00 ft, Voids = 40.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	512.00	n/a	0	0
0.40	512.40	n/a	1,062	1,062
0.80	512.80	n/a	1,062	2,124
1.20	513.20	n/a	1,217	3,341
1.60	513.60	n/a	1,336	4,678
2.00	514.00	n/a	1,168	5,845
2.40	514.40	n/a	1,062	6,908
2.80	514.80	n/a	1,062	7,970
3.20	515.20	n/a	1,062	9,032
3.60	515.60	n/a	1,062	10,094
4.00	516.00	n/a	1,062	11,156

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	10.00	0.00	0.00
Span (in)	= 0.00	10.00	0.00	0.00
No. Barrels	= 0	1	0	0
Invert El. (ft)	= 0.00	513.00	0.00	0.00
Length (ft)	= 0.00	1.00	0.00	0.00
Slope (%)	= 0.00	1.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	512.00	---	0.00	---	---	---	---	---	---	---	---	0.000
0.04	106	512.04	---	0.00	---	---	---	---	---	---	---	---	0.000
0.08	212	512.08	---	0.00	---	---	---	---	---	---	---	---	0.000
0.12	319	512.12	---	0.00	---	---	---	---	---	---	---	---	0.000
0.16	425	512.16	---	0.00	---	---	---	---	---	---	---	---	0.000
0.20	531	512.20	---	0.00	---	---	---	---	---	---	---	---	0.000
0.24	637	512.24	---	0.00	---	---	---	---	---	---	---	---	0.000
0.28	743	512.28	---	0.00	---	---	---	---	---	---	---	---	0.000
0.32	850	512.32	---	0.00	---	---	---	---	---	---	---	---	0.000
0.36	956	512.36	---	0.00	---	---	---	---	---	---	---	---	0.000
0.40	1,062	512.40	---	0.00	---	---	---	---	---	---	---	---	0.000
0.44	1,168	512.44	---	0.00	---	---	---	---	---	---	---	---	0.000
0.48	1,274	512.48	---	0.00	---	---	---	---	---	---	---	---	0.000
0.52	1,381	512.52	---	0.00	---	---	---	---	---	---	---	---	0.000
0.56	1,487	512.56	---	0.00	---	---	---	---	---	---	---	---	0.000
0.60	1,593	512.60	---	0.00	---	---	---	---	---	---	---	---	0.000
0.64	1,699	512.64	---	0.00	---	---	---	---	---	---	---	---	0.000
0.68	1,806	512.68	---	0.00	---	---	---	---	---	---	---	---	0.000
0.72	1,912	512.72	---	0.00	---	---	---	---	---	---	---	---	0.000
0.76	2,018	512.76	---	0.00	---	---	---	---	---	---	---	---	0.000
0.80	2,124	512.80	---	0.00	---	---	---	---	---	---	---	---	0.000
0.84	2,246	512.84	---	0.00	---	---	---	---	---	---	---	---	0.000
0.88	2,368	512.88	---	0.00	---	---	---	---	---	---	---	---	0.000
0.92	2,489	512.92	---	0.00	---	---	---	---	---	---	---	---	0.000
0.96	2,611	512.96	---	0.00	---	---	---	---	---	---	---	---	0.000
1.00	2,733	513.00	---	0.00	---	---	---	---	---	---	---	---	0.000
1.04	2,855	513.04	---	0.01 oc	---	---	---	---	---	---	---	---	0.005
1.08	2,976	513.08	---	0.02 oc	---	---	---	---	---	---	---	---	0.016
1.12	3,098	513.12	---	0.03 oc	---	---	---	---	---	---	---	---	0.030
1.16	3,220	513.16	---	0.05 oc	---	---	---	---	---	---	---	---	0.046
1.20	3,341	513.20	---	0.06 oc	---	---	---	---	---	---	---	---	0.064
1.24	3,475	513.24	---	0.08 oc	---	---	---	---	---	---	---	---	0.084

Continues on next page...

UnderGround Pond 1

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.28	3,609	513.28	---	0.10 oc	---	---	---	---	---	---	---	---	0.104
1.32	3,742	513.32	---	0.12 oc	---	---	---	---	---	---	---	---	0.124
1.36	3,876	513.36	---	0.15 oc	---	---	---	---	---	---	---	---	0.146
1.40	4,010	513.40	---	0.17 oc	---	---	---	---	---	---	---	---	0.168
1.44	4,143	513.44	---	0.19 oc	---	---	---	---	---	---	---	---	0.189
1.48	4,277	513.48	---	0.21 oc	---	---	---	---	---	---	---	---	0.211
1.52	4,410	513.52	---	0.23 oc	---	---	---	---	---	---	---	---	0.232
1.56	4,544	513.56	---	0.25 oc	---	---	---	---	---	---	---	---	0.253
1.60	4,678	513.60	---	0.27 oc	---	---	---	---	---	---	---	---	0.273
1.64	4,794	513.64	---	0.29 oc	---	---	---	---	---	---	---	---	0.292
1.68	4,911	513.68	---	0.31 oc	---	---	---	---	---	---	---	---	0.309
1.72	5,028	513.72	---	0.33 oc	---	---	---	---	---	---	---	---	0.325
1.76	5,145	513.76	---	0.34 oc	---	---	---	---	---	---	---	---	0.339
1.80	5,262	513.80	---	0.35 oc	---	---	---	---	---	---	---	---	0.349
1.84	5,378	513.84	---	0.45 oc	---	---	---	---	---	---	---	---	0.453
1.88	5,495	513.88	---	0.84 oc	---	---	---	---	---	---	---	---	0.838
1.92	5,612	513.92	---	1.10 oc	---	---	---	---	---	---	---	---	1.096
1.96	5,729	513.96	---	1.30 oc	---	---	---	---	---	---	---	---	1.303
2.00	5,845	514.00	---	1.48 oc	---	---	---	---	---	---	---	---	1.483
2.04	5,952	514.04	---	1.64 oc	---	---	---	---	---	---	---	---	1.642
2.08	6,058	514.08	---	1.79 oc	---	---	---	---	---	---	---	---	1.787
2.12	6,164	514.12	---	1.92 oc	---	---	---	---	---	---	---	---	1.921
2.16	6,270	514.16	---	2.05 oc	---	---	---	---	---	---	---	---	2.046
2.20	6,377	514.20	---	2.16 oc	---	---	---	---	---	---	---	---	2.164
2.24	6,483	514.24	---	2.28 oc	---	---	---	---	---	---	---	---	2.276
2.28	6,589	514.28	---	2.38 oc	---	---	---	---	---	---	---	---	2.383
2.32	6,695	514.32	---	2.49 oc	---	---	---	---	---	---	---	---	2.485
2.36	6,801	514.36	---	2.55 ic	---	---	---	---	---	---	---	---	2.550
2.40	6,908	514.40	---	2.60 ic	---	---	---	---	---	---	---	---	2.604
2.44	7,014	514.44	---	2.66 ic	---	---	---	---	---	---	---	---	2.656
2.48	7,120	514.48	---	2.71 ic	---	---	---	---	---	---	---	---	2.708
2.52	7,226	514.52	---	2.76 ic	---	---	---	---	---	---	---	---	2.758
2.56	7,332	514.56	---	2.81 ic	---	---	---	---	---	---	---	---	2.808
2.60	7,439	514.60	---	2.86 ic	---	---	---	---	---	---	---	---	2.856
2.64	7,545	514.64	---	2.90 ic	---	---	---	---	---	---	---	---	2.904
2.68	7,651	514.68	---	2.95 ic	---	---	---	---	---	---	---	---	2.951
2.72	7,757	514.72	---	3.00 ic	---	---	---	---	---	---	---	---	2.998
2.76	7,863	514.76	---	3.04 ic	---	---	---	---	---	---	---	---	3.043
2.80	7,970	514.80	---	3.09 ic	---	---	---	---	---	---	---	---	3.088
2.84	8,076	514.84	---	3.13 ic	---	---	---	---	---	---	---	---	3.133
2.88	8,182	514.88	---	3.18 ic	---	---	---	---	---	---	---	---	3.176
2.92	8,288	514.92	---	3.22 ic	---	---	---	---	---	---	---	---	3.219
2.96	8,394	514.96	---	3.26 ic	---	---	---	---	---	---	---	---	3.262
3.00	8,501	515.00	---	3.30 ic	---	---	---	---	---	---	---	---	3.304
3.04	8,607	515.04	---	3.35 ic	---	---	---	---	---	---	---	---	3.345
3.08	8,713	515.08	---	3.39 ic	---	---	---	---	---	---	---	---	3.386
3.12	8,819	515.12	---	3.43 ic	---	---	---	---	---	---	---	---	3.427
3.16	8,925	515.16	---	3.47 ic	---	---	---	---	---	---	---	---	3.467
3.20	9,032	515.20	---	3.51 ic	---	---	---	---	---	---	---	---	3.507
3.24	9,138	515.24	---	3.55 ic	---	---	---	---	---	---	---	---	3.546
3.28	9,244	515.28	---	3.58 ic	---	---	---	---	---	---	---	---	3.584
3.32	9,350	515.32	---	3.62 ic	---	---	---	---	---	---	---	---	3.623
3.36	9,456	515.36	---	3.66 ic	---	---	---	---	---	---	---	---	3.660
3.40	9,563	515.40	---	3.70 ic	---	---	---	---	---	---	---	---	3.698
3.44	9,669	515.44	---	3.73 ic	---	---	---	---	---	---	---	---	3.735
3.48	9,775	515.48	---	3.77 ic	---	---	---	---	---	---	---	---	3.772
3.52	9,881	515.52	---	3.81 ic	---	---	---	---	---	---	---	---	3.808
3.56	9,988	515.56	---	3.84 ic	---	---	---	---	---	---	---	---	3.844
3.60	10,094	515.60	---	3.88 ic	---	---	---	---	---	---	---	---	3.880
3.64	10,200	515.64	---	3.92 ic	---	---	---	---	---	---	---	---	3.915
3.68	10,306	515.68	---	3.95 ic	---	---	---	---	---	---	---	---	3.950
3.72	10,412	515.72	---	3.99 ic	---	---	---	---	---	---	---	---	3.985
3.76	10,519	515.76	---	4.02 ic	---	---	---	---	---	---	---	---	4.020
3.80	10,625	515.80	---	4.05 ic	---	---	---	---	---	---	---	---	4.054
3.84	10,731	515.84	---	4.09 ic	---	---	---	---	---	---	---	---	4.088
3.88	10,837	515.88	---	4.12 ic	---	---	---	---	---	---	---	---	4.121
3.92	10,943	515.92	---	4.15 ic	---	---	---	---	---	---	---	---	4.154
3.96	11,050	515.96	---	4.19 ic	---	---	---	---	---	---	---	---	4.187
4.00	11,156	516.00	---	4.22 ic	---	---	---	---	---	---	---	---	4.220

...End

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	3.325	1	24	4,788	------	------	------	Pre-Development
2	Rational	7.623	1	20	9,147	------	------	------	Post-Development
3	Reservoir	2.678	1	33	6,391	2	514.46	7,058	Routed Detention Pond

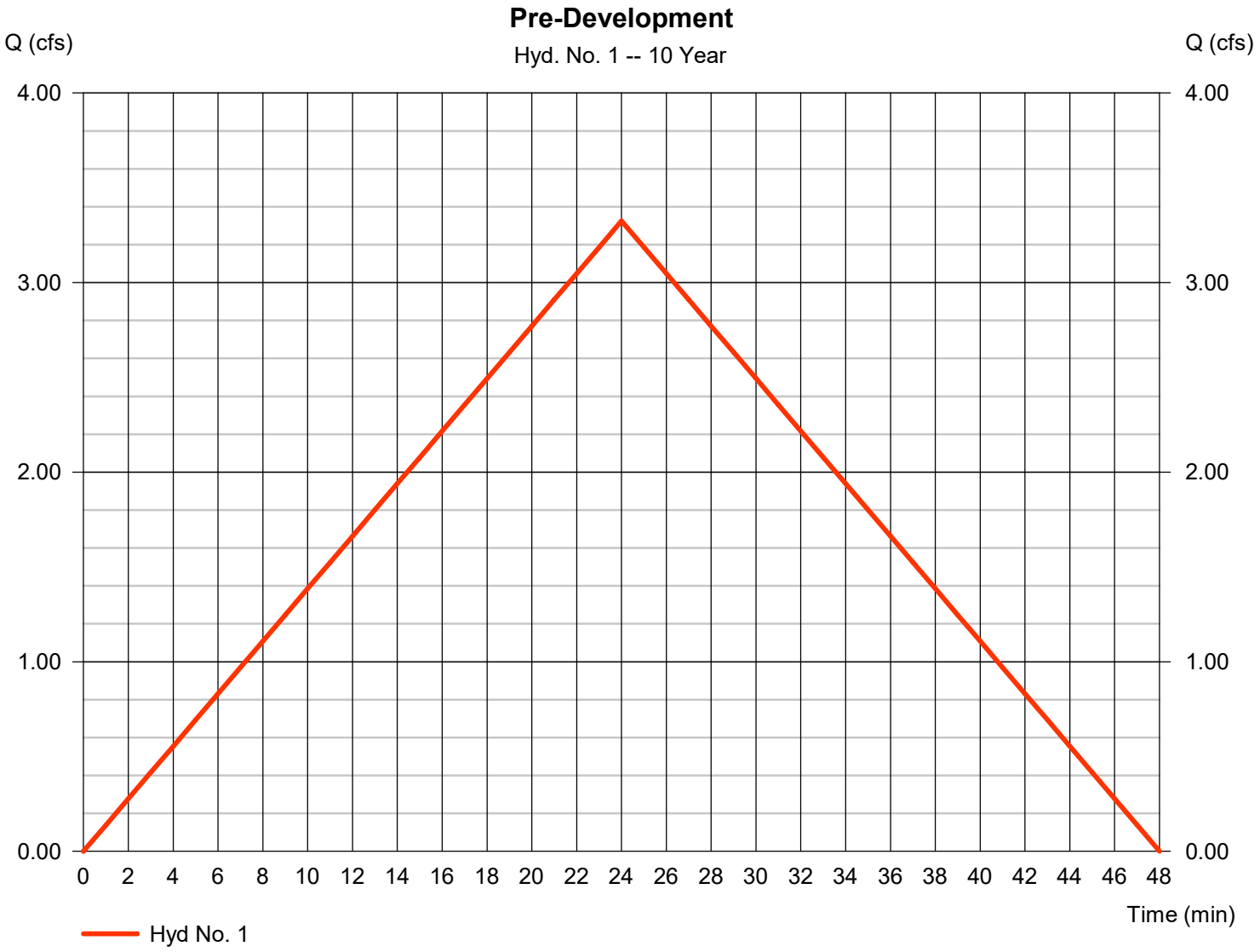
Hydrograph Report

Hyd. No. 1

Pre-Development

Hydrograph type	=	Rational	Peak discharge	=	3.325 cfs
Storm frequency	=	10 yrs	Time to peak	=	24 min
Time interval	=	1 min	Hyd. volume	=	4,788 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.25*
Intensity	=	2.608 in/hr	Tc by User	=	24.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.25)] / 5.100



Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	7.623 cfs
Storm frequency	=	10 yrs	Time to peak	=	20 min
Time interval	=	1 min	Hyd. volume	=	9,147 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.52*
Intensity	=	2.874 in/hr	Tc by User	=	20.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.90)] / 5.100

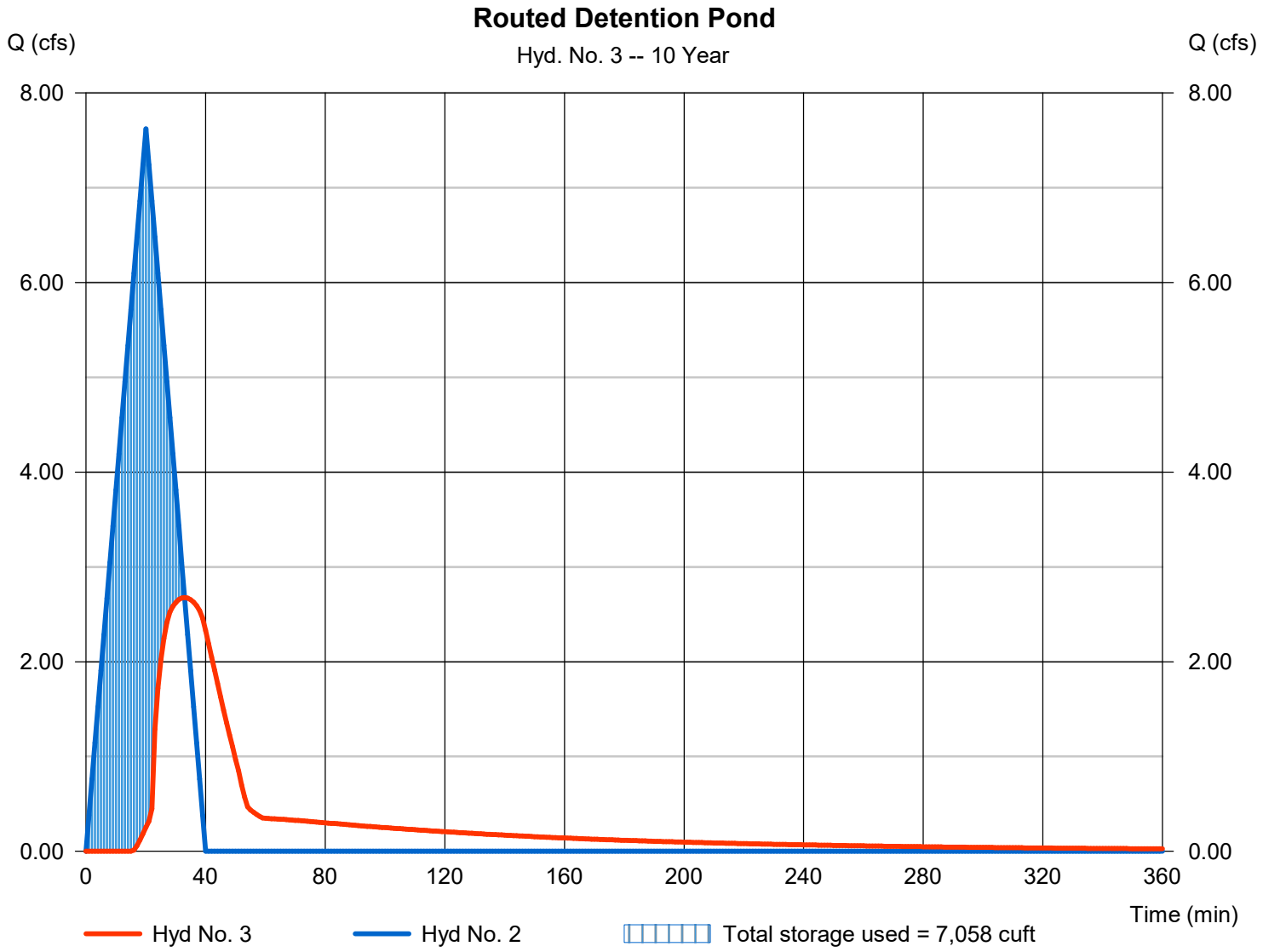
Hydrograph Report

Hyd. No. 3

Routed Detention Pond

Hydrograph type	=	Reservoir	Peak discharge	=	2.678 cfs
Storm frequency	=	10 yrs	Time to peak	=	33 min
Time interval	=	1 min	Hyd. volume	=	6,391 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	514.46 ft
Reservoir name	=	UnderGround Pond 1	Max. Storage	=	7,058 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	4.439	1	24	6,392	------	------	------	Pre-Development
2	Rational	10.11	1	20	12,130	------	------	------	Post-Development
3	Reservoir	3.458	1	33	9,374	2	515.15	8,903	Routed Detention Pond

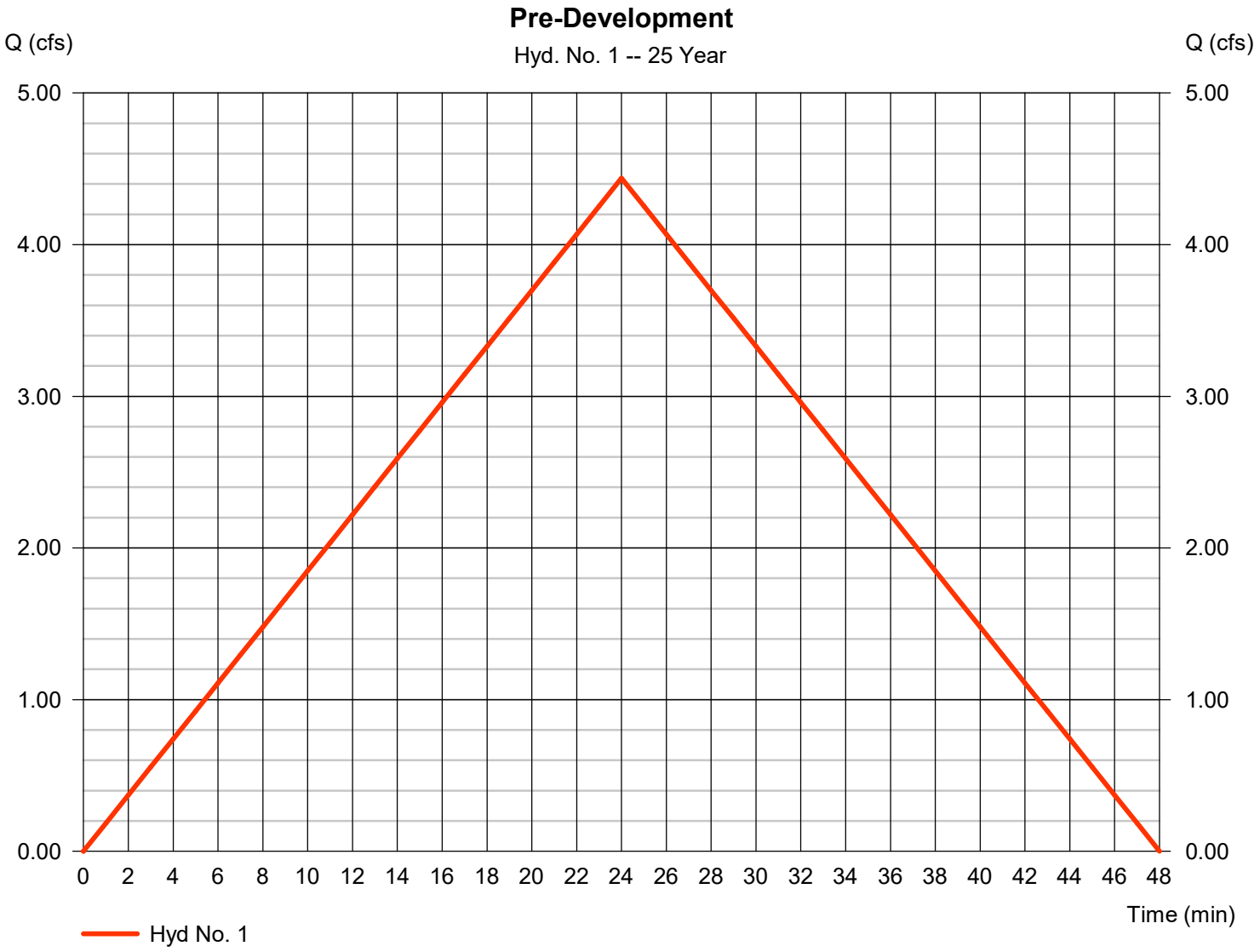
Hydrograph Report

Hyd. No. 1

Pre-Development

Hydrograph type	=	Rational	Peak discharge	=	4.439 cfs
Storm frequency	=	25 yrs	Time to peak	=	24 min
Time interval	=	1 min	Hyd. volume	=	6,392 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.25*
Intensity	=	3.481 in/hr	Tc by User	=	24.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.25)] / 5.100



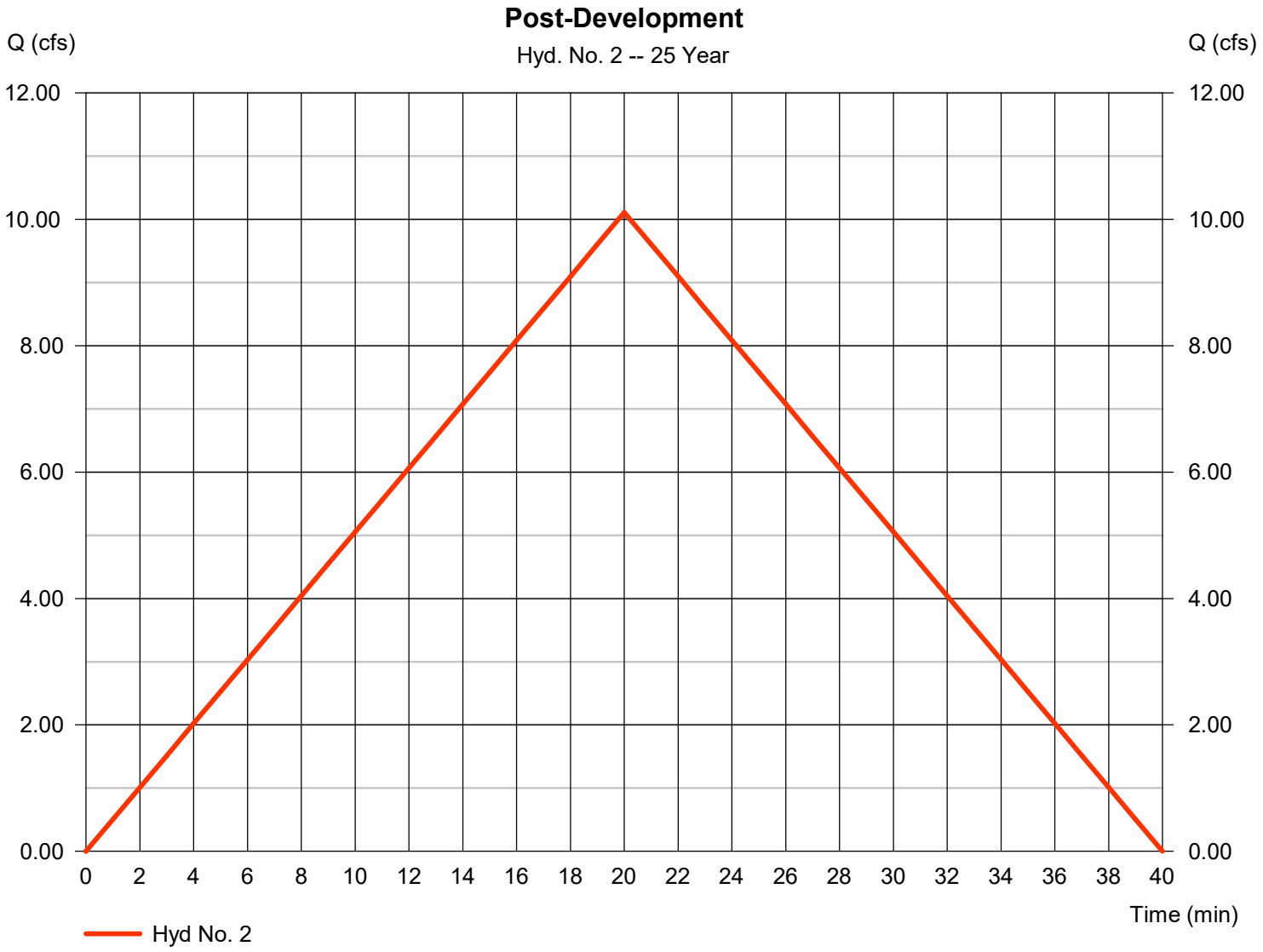
Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	10.11 cfs
Storm frequency	=	25 yrs	Time to peak	=	20 min
Time interval	=	1 min	Hyd. volume	=	12,130 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.52*
Intensity	=	3.812 in/hr	Tc by User	=	20.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.90)] / 5.100



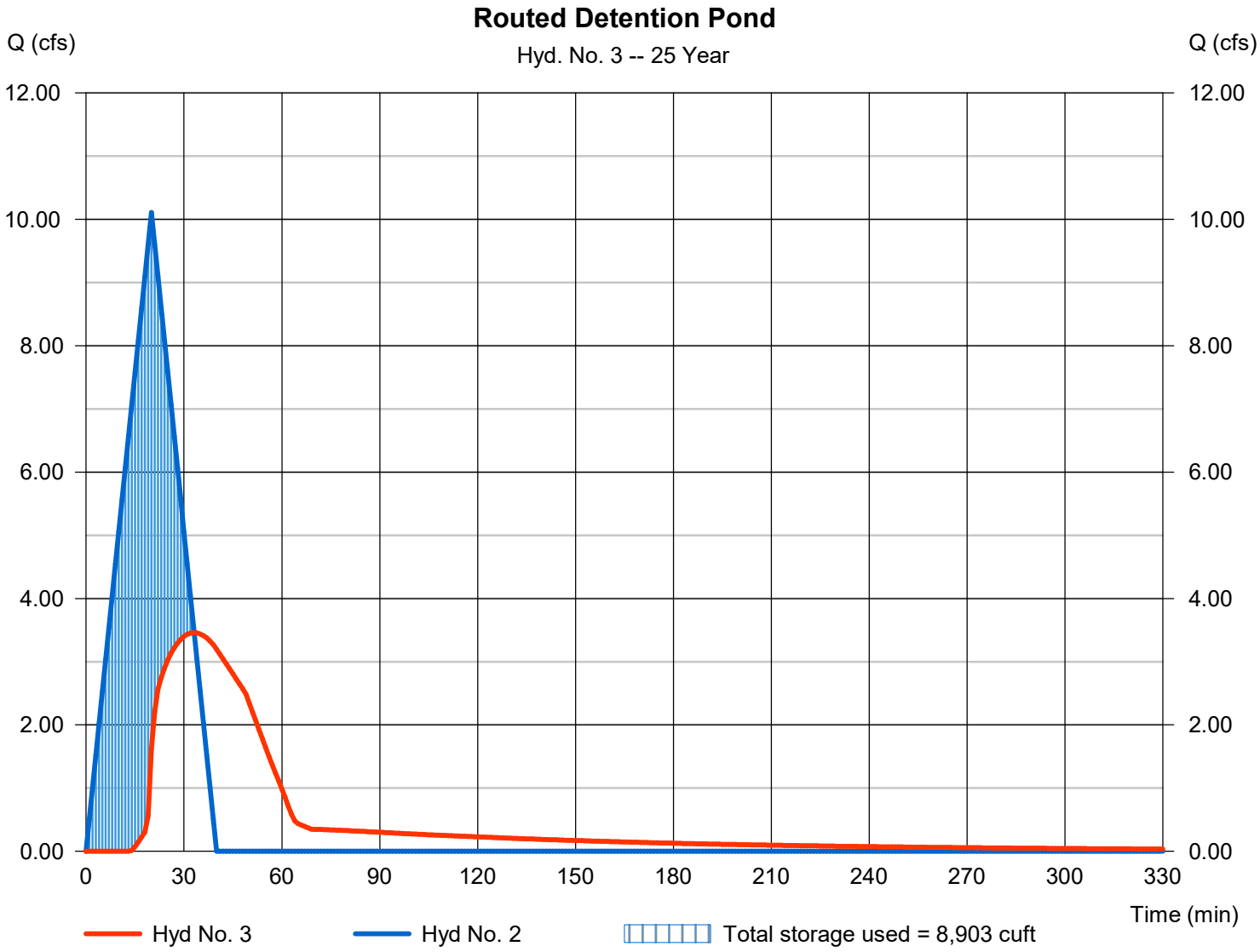
Hydrograph Report

Hyd. No. 3

Routed Detention Pond

Hydrograph type	=	Reservoir	Peak discharge	=	3.458 cfs
Storm frequency	=	25 yrs	Time to peak	=	33 min
Time interval	=	1 min	Hyd. volume	=	9,374 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	515.15 ft
Reservoir name	=	UnderGround Pond 1	Max. Storage	=	8,903 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	5.158	1	24	7,427	------	------	------	Pre-Development
2	Rational	11.73	1	20	14,078	------	------	------	Post-Development
3	Reservoir	3.912	1	33	11,322	2	515.64	10,190	Routed Detention Pond

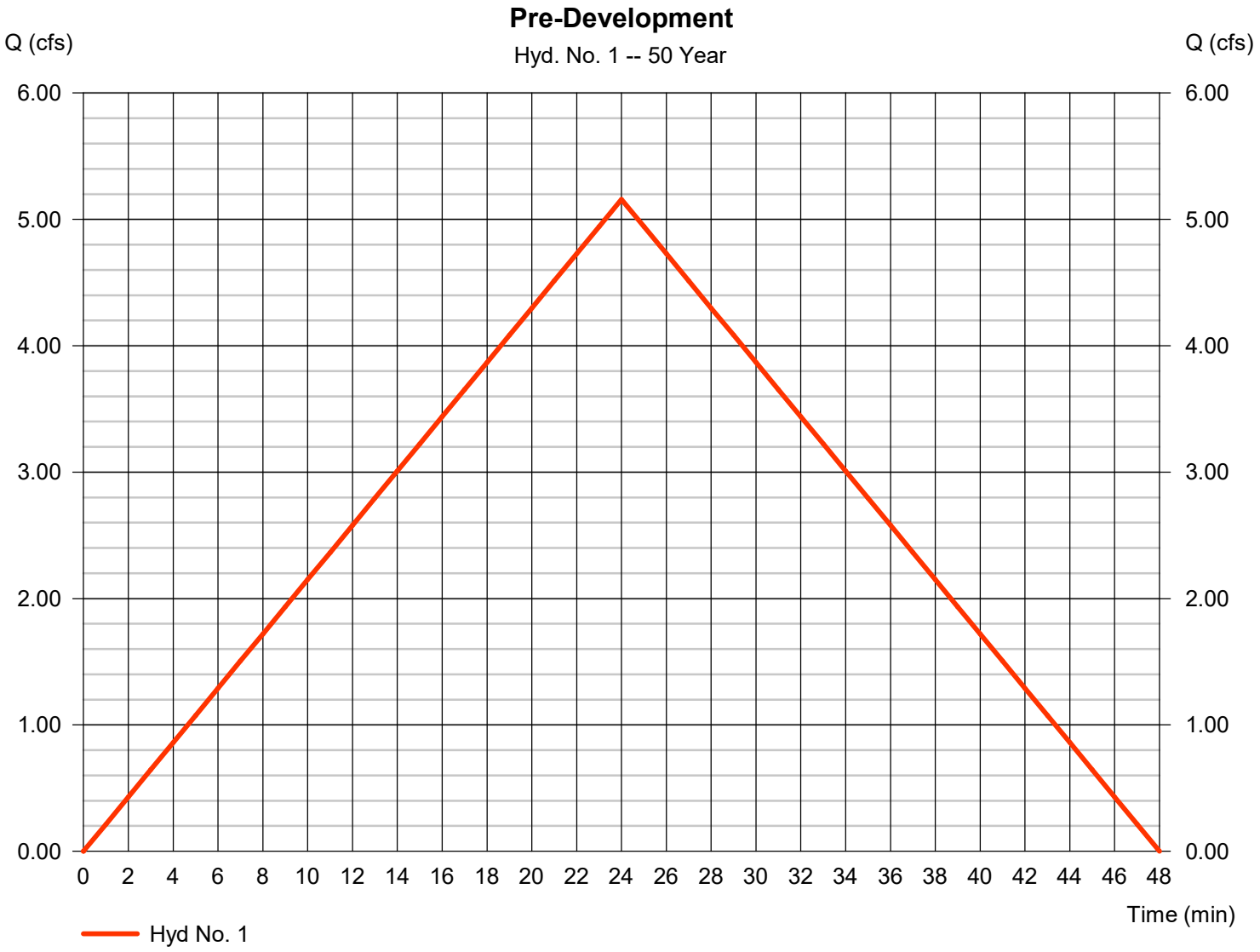
Hydrograph Report

Hyd. No. 1

Pre-Development

Hydrograph type	=	Rational	Peak discharge	=	5.158 cfs
Storm frequency	=	50 yrs	Time to peak	=	24 min
Time interval	=	1 min	Hyd. volume	=	7,427 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.25*
Intensity	=	4.045 in/hr	Tc by User	=	24.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.25)] / 5.100



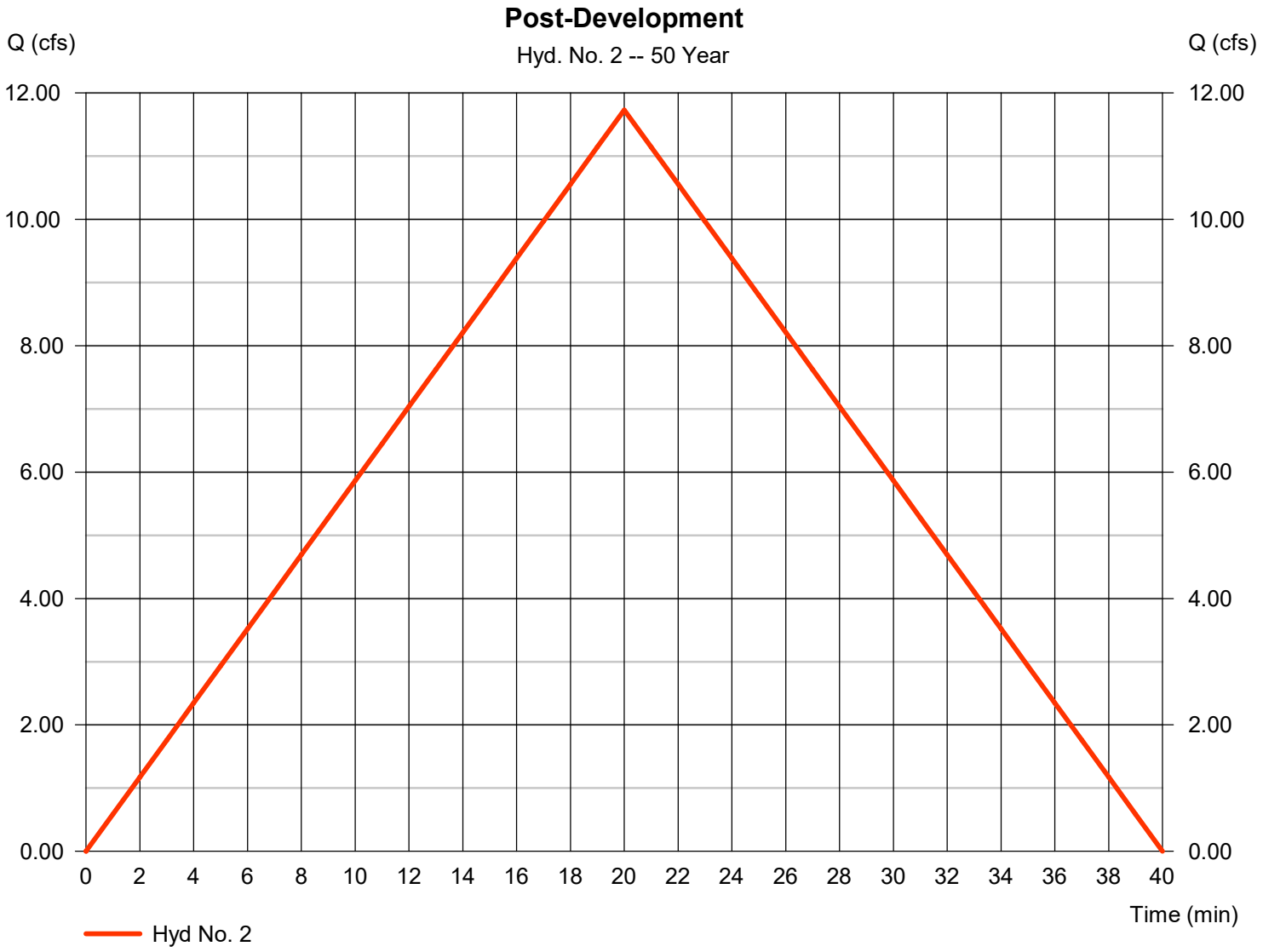
Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	11.73 cfs
Storm frequency	=	50 yrs	Time to peak	=	20 min
Time interval	=	1 min	Hyd. volume	=	14,078 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.52*
Intensity	=	4.424 in/hr	Tc by User	=	20.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.90)] / 5.100



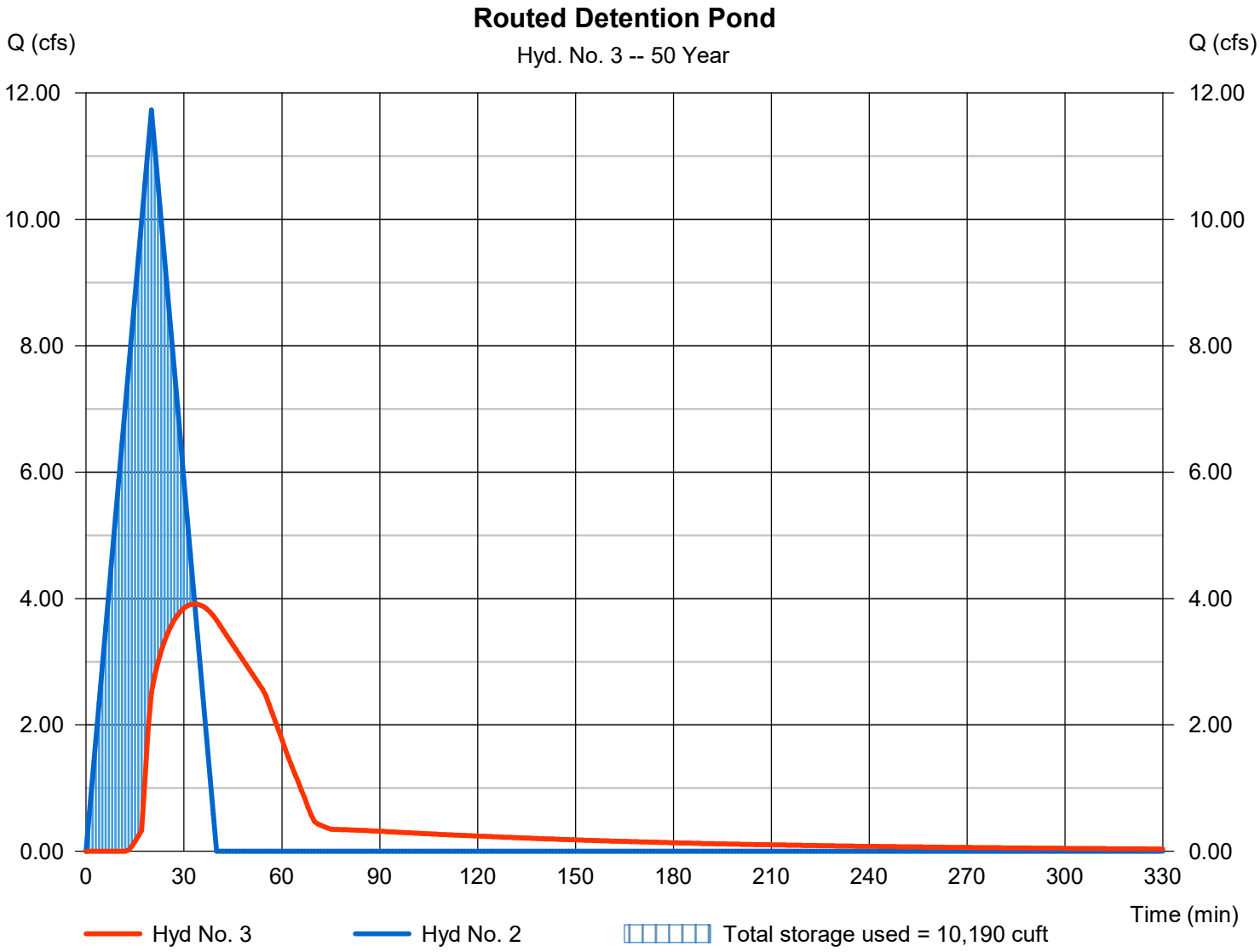
Hydrograph Report

Hyd. No. 3

Routed Detention Pond

Hydrograph type	=	Reservoir	Peak discharge	=	3.912 cfs
Storm frequency	=	50 yrs	Time to peak	=	33 min
Time interval	=	1 min	Hyd. volume	=	11,322 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	515.64 ft
Reservoir name	=	UnderGround Pond 1	Max. Storage	=	10,190 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	5.553	1	24	7,997	------	------	------	Pre-Development
2	Rational	12.60	1	20	15,117	------	------	------	Post-Development
3	Reservoir	4.142	1	33	12,361	2	515.90	10,903	Routed Detention Pond

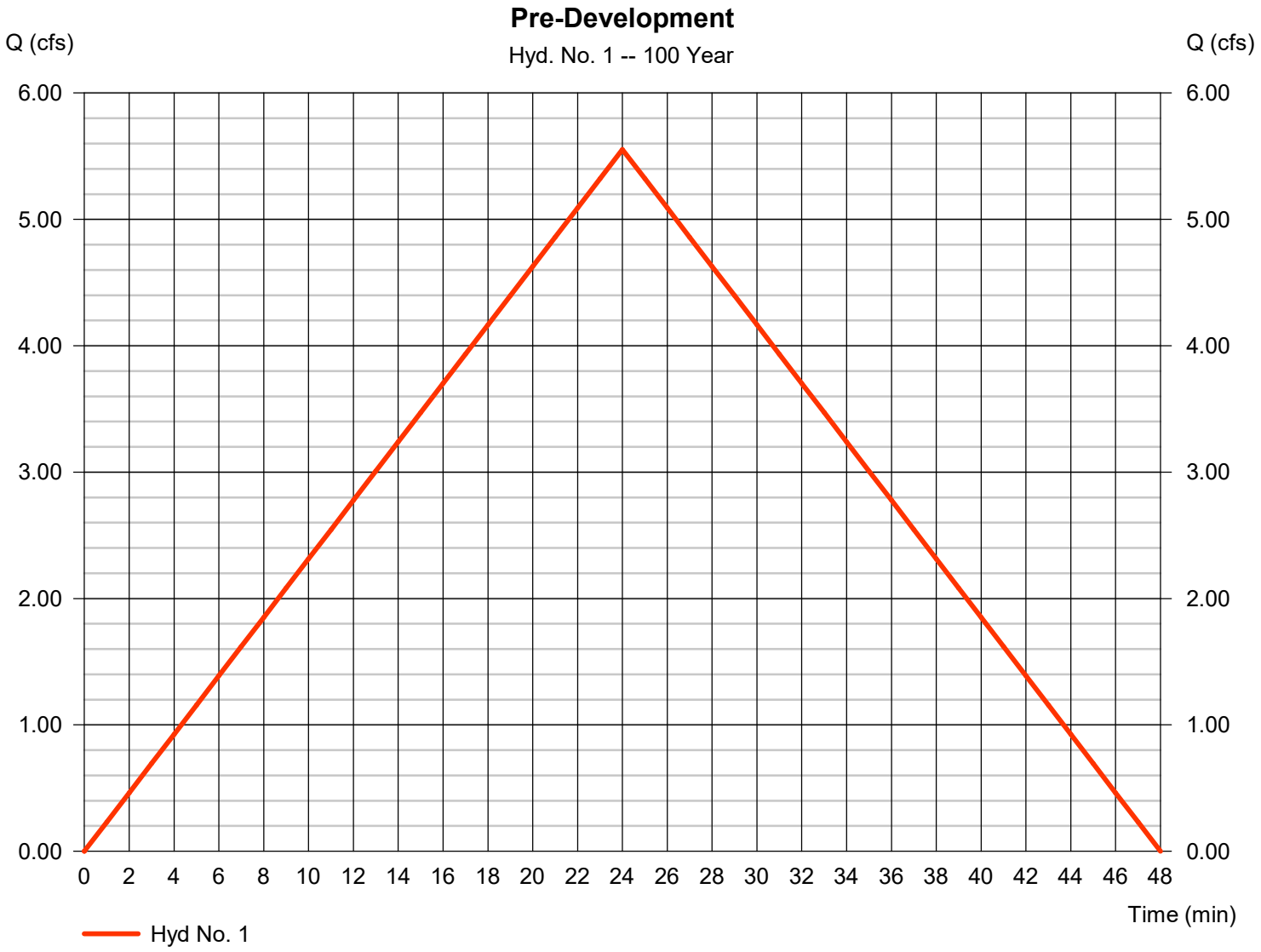
Hydrograph Report

Hyd. No. 1

Pre-Development

Hydrograph type	=	Rational	Peak discharge	=	5.553 cfs
Storm frequency	=	100 yrs	Time to peak	=	24 min
Time interval	=	1 min	Hyd. volume	=	7,997 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.25*
Intensity	=	4.356 in/hr	Tc by User	=	24.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.25)] / 5.100



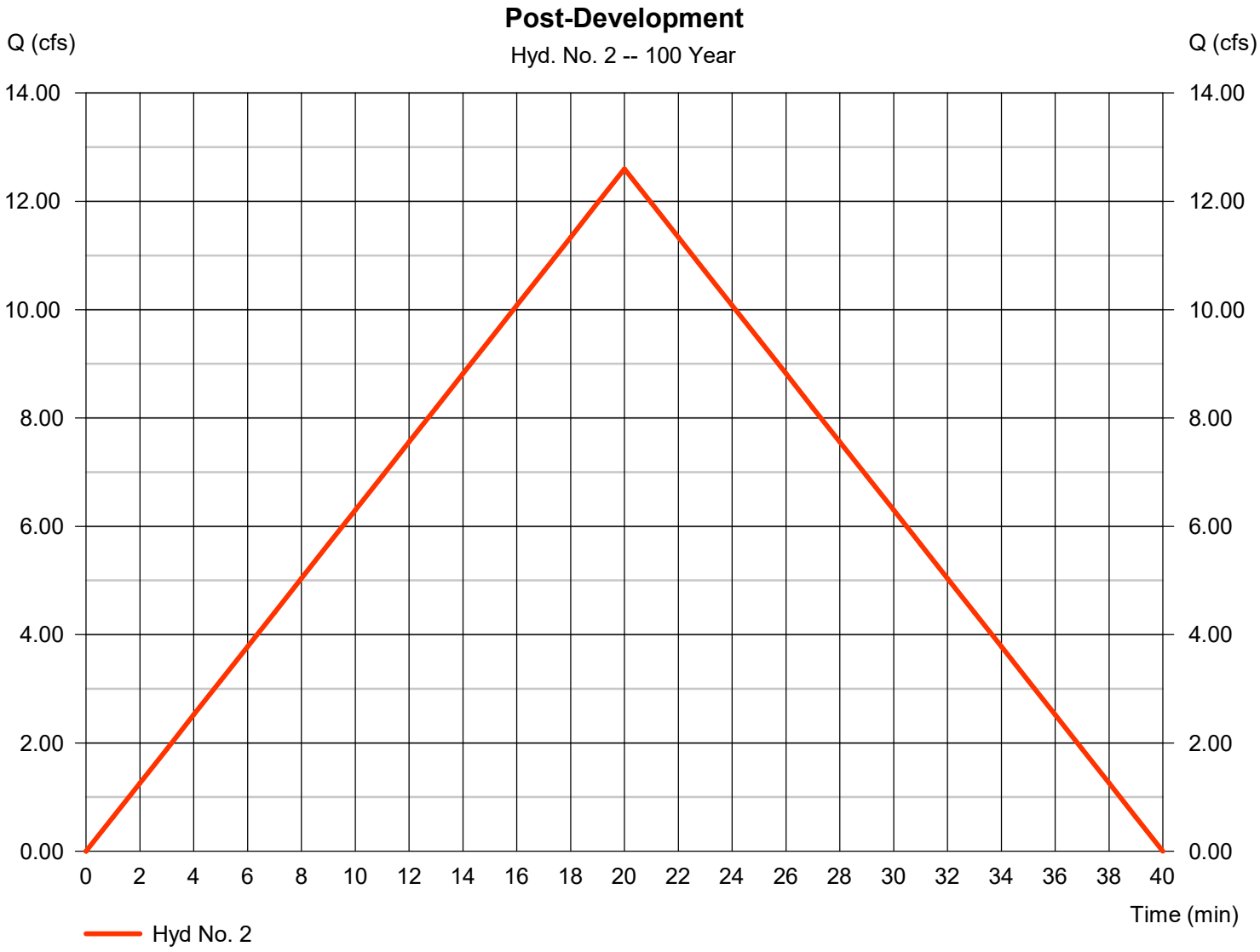
Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	12.60 cfs
Storm frequency	=	100 yrs	Time to peak	=	20 min
Time interval	=	1 min	Hyd. volume	=	15,117 cuft
Drainage area	=	5.100 ac	Runoff coeff.	=	0.52*
Intensity	=	4.750 in/hr	Tc by User	=	20.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

* Composite (Area/C) = [(3.010 x 0.25) + (2.090 x 0.90)] / 5.100



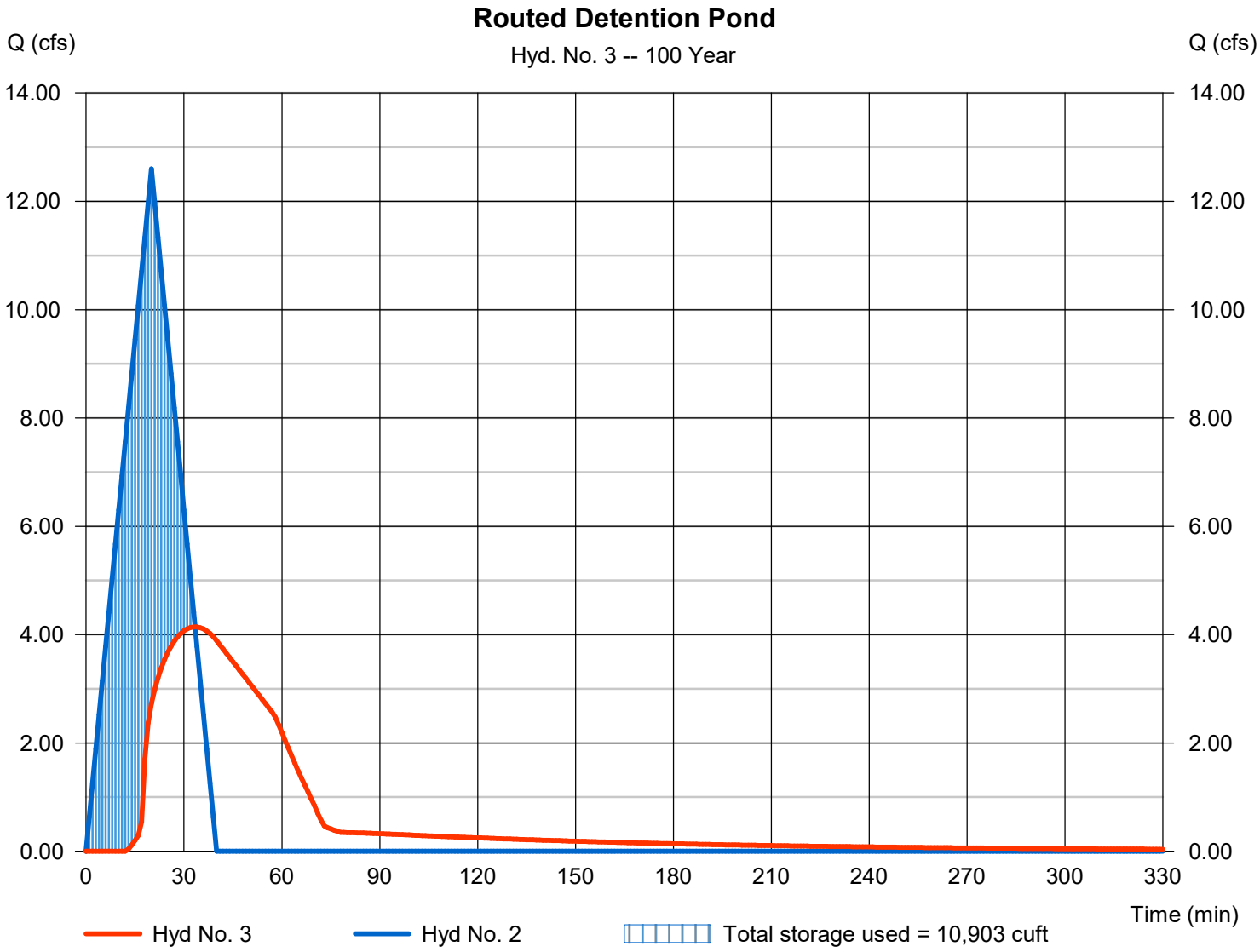
Hydrograph Report

Hyd. No. 3

Routed Detention Pond

Hydrograph type	=	Reservoir	Peak discharge	=	4.142 cfs
Storm frequency	=	100 yrs	Time to peak	=	33 min
Time interval	=	1 min	Hyd. volume	=	12,361 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	515.90 ft
Reservoir name	=	UnderGround Pond 1	Max. Storage	=	10,903 cuft

Storage Indication method used.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	56.1571	12.6000	0.8599	--------
2	21.4950	5.3000	0.6807	--------
3	0.0000	0.0000	0.0000	--------
5	64.6694	13.4000	0.7859	--------
10	34.7603	8.6000	0.7433	--------
25	33.1106	7.0000	0.6559	--------
50	56.6539	11.2000	0.7412	--------
100	34.5085	6.1000	0.6079	--------

File name: Millbury Storm.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.77	3.85	3.24	2.81	2.48	2.23	2.03	1.86	1.72	1.60	1.50	1.41
2	4.39	3.36	2.77	2.38	2.11	1.90	1.74	1.60	1.49	1.40	1.32	1.25
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.56	5.43	4.66	4.10	3.68	3.34	3.07	2.84	2.64	2.48	2.34	2.21
10	4.99	3.96	3.32	2.87	2.55	2.30	2.10	1.94	1.80	1.69	1.59	1.50
25	6.49	5.16	4.36	3.81	3.41	3.10	2.85	2.65	2.48	2.33	2.21	2.10
50	7.19	5.89	5.04	4.42	3.96	3.60	3.31	3.06	2.86	2.68	2.53	2.40
100	7.99	6.37	5.41	4.75	4.27	3.90	3.60	3.36	3.16	2.98	2.83	2.70

Tc = time in minutes. Values may exceed 60.

Precip. file name: D:\My stuff\Ozark Beach Vollyball\Storm Design\Ozark.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	3.90	0.00	0.00	5.65	6.78	9.60	8.00
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

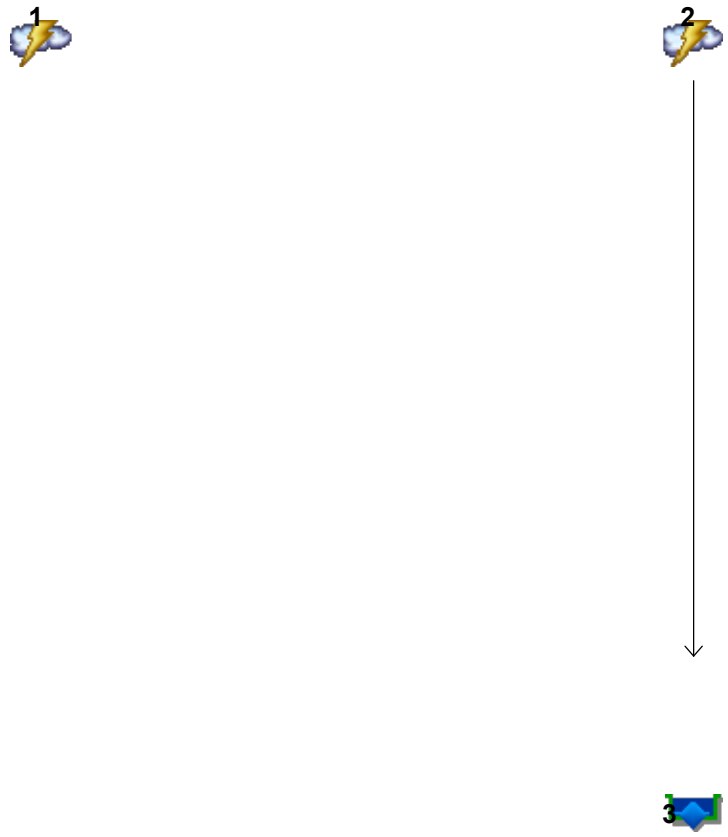
Hydraflow Table of Contents

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020 Monday, 04 / 13 / 2020

Stormwater Attenuation Calculations & Rainfall Data

POND 2

Watershed Model Schematic



Legend

Hyd.	Origin	Description
1	Rational	Pre-Development
2	Rational	Post-Development
3	Reservoir	Routed Pond

Hydrograph Return Period Recap

Hyd. No.	Hydrograph type (origin)	Inflow hyd(s)	Peak Outflow (cfs)							Hydrograph Description
			1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr	
1	Rational	------	-------	1.791	-------	-------	2.128	2.784	3.196	3.442	Pre-Development
2	Rational	------	-------	9.175	-------	-------	10.43	13.55	15.01	16.68	Post-Development
3	Reservoir	2	-------	1.553	-------	-------	1.782	2.289	2.494	2.715	Routed Pond

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	1.791	1	12	1,289	------	------	------	Pre-Development
2	Rational	9.175	1	5	2,753	------	------	------	Post-Development
3	Reservoir	1.553	1	9	1,678	2	485.69	2,473	Routed Pond

Hydrograph Report

Hyd. No. 1

Pre-Development

Hydrograph type	=	Rational	Peak discharge	=	1.791 cfs
Storm frequency	=	2 yrs	Time to peak	=	12 min
Time interval	=	1 min	Hyd. volume	=	1,289 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.25
Intensity	=	3.087 in/hr	Tc by TR55	=	12.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

TR55 Tc Worksheet

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No. 1

Pre-Development

Description	A		B		C		Totals
Sheet Flow							
Manning's n-value	= 0.400		0.011		0.011		
Flow length (ft)	= 194.0		0.0		0.0		
Two-year 24-hr precip. (in)	= 4.30		0.00		0.00		
Land slope (%)	= 20.62		0.00		0.00		
Travel Time (min)	**= 12.38**	**+**	**0.00**	**+**	**0.00**	**=**	**12.38**
Shallow Concentrated Flow							
Flow length (ft)	= 0.00		0.00		0.00		
Watercourse slope (%)	= 0.00		0.00		0.00		
Surface description	= Paved		Paved		Paved		
Average velocity (ft/s)	=0.00		0.00		0.00		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**
Channel Flow							
X sectional flow area (sqft)	= 0.00		0.00		0.00		
Wetted perimeter (ft)	= 0.00		0.00		0.00		
Channel slope (%)	= 0.00		0.00		0.00		
Manning's n-value	= 0.015		0.015		0.015		
Velocity (ft/s)	=0.00						
			0.00				
					0.00		
Flow length (ft)	({0})0.0		0.0		0.0		
Travel Time (min)	**= 0.00**	**+**	**0.00**	**+**	**0.00**	**=**	**0.00**

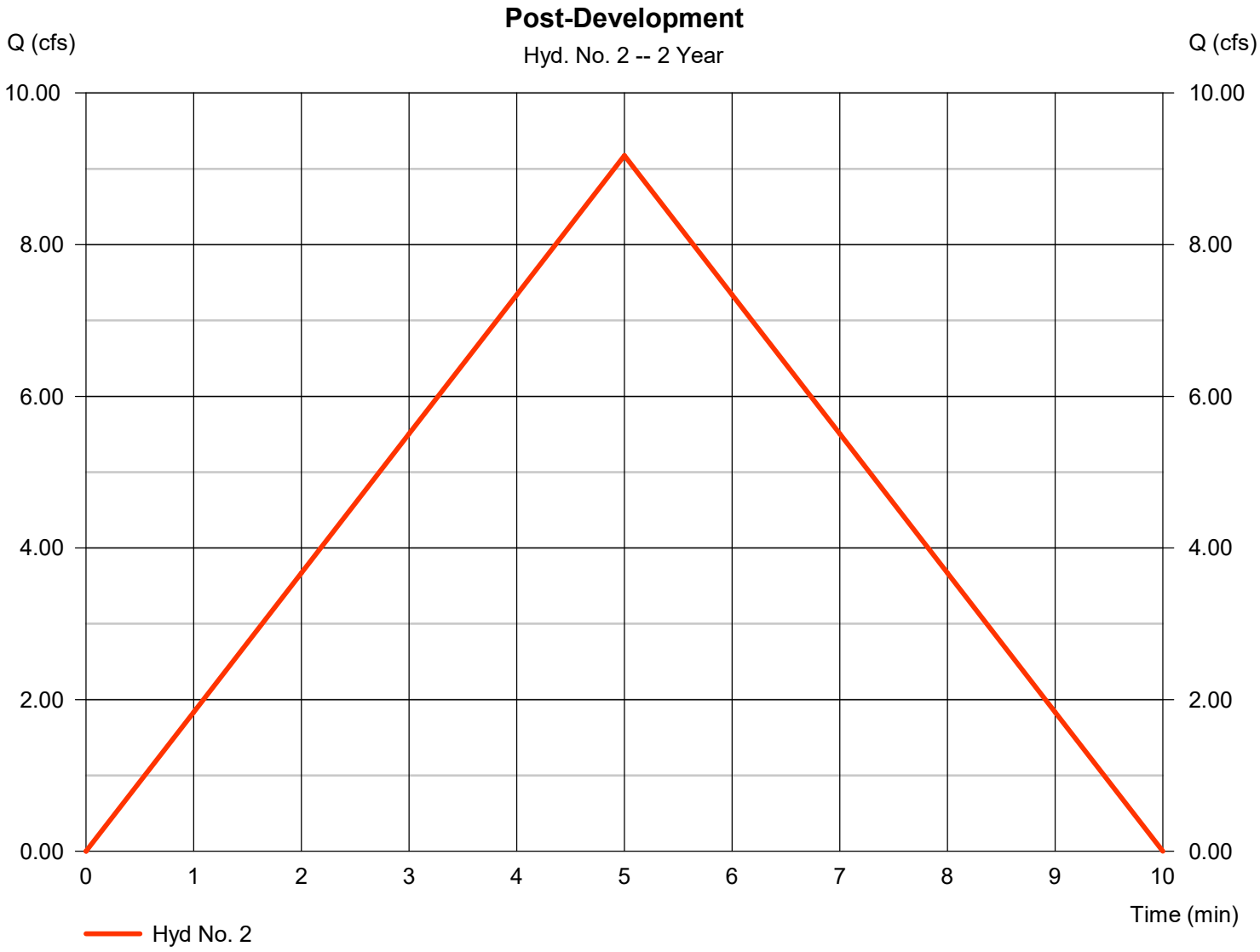
Total Travel Time, Tc ..... 12.00 min

Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	= Rational	Peak discharge	= 9.175 cfs
Storm frequency	= 2 yrs	Time to peak	= 5 min
Time interval	= 1 min	Hyd. volume	= 2,753 cuft
Drainage area	= 2.320 ac	Runoff coeff.	= 0.9
Intensity	= 4.394 in/hr	Tc by User	= 5.00 min
IDF Curve	= Millbury Storm.IDF	Asc/Rec limb fact	= 1/1



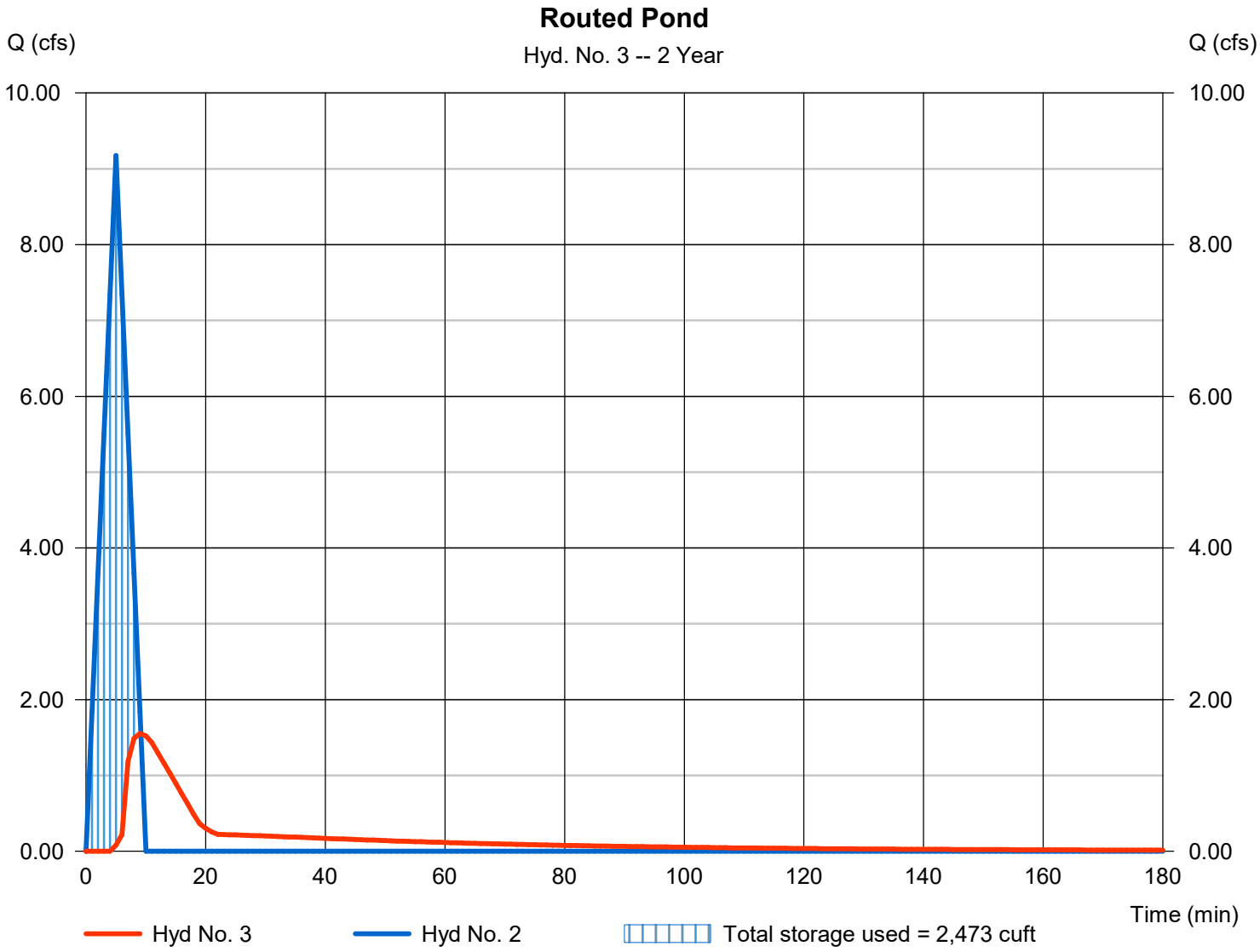
Hydrograph Report

Hyd. No. 3

Routed Pond

Hydrograph type	=	Reservoir	Peak discharge	=	1.553 cfs
Storm frequency	=	2 yrs	Time to peak	=	9 min
Time interval	=	1 min	Hyd. volume	=	1,678 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	485.69 ft
Reservoir name	=	Underground Pond 2	Max. Storage	=	2,473 cuft

Storage Indication method used.



Pond No. 1 - Underground Pond 2

Pond Data

UG Chambers -Invert elev. = 484.50 ft, Rise x Span = 0.87 x 1.41 ft, Barrel Len = 7.12 ft, No. Barrels = 51, Slope = 0.00%, Headers = No
Encasement -Invert elev. = 483.50 ft, Width = 7.12 ft, Height = 4.00 ft, Voids = 40.00%

Stage / Storage Table

Stage (ft)	Elevation (ft)	Contour area (sqft)	Incr. Storage (cuft)	Total storage (cuft)
0.00	483.50	n/a	0	0
0.40	483.90	n/a	414	414
0.80	484.30	n/a	414	827
1.20	484.70	n/a	475	1,302
1.60	485.10	n/a	521	1,823
2.00	485.50	n/a	455	2,279
2.40	485.90	n/a	414	2,692
2.80	486.30	n/a	414	3,106
3.20	486.70	n/a	414	3,520
3.60	487.10	n/a	414	3,934
4.00	487.50	n/a	414	4,347

Culvert / Orifice Structures

	[A]	[B]	[C]	[PrfRsr]
Rise (in)	= 0.00	8.00	0.00	0.00
Span (in)	= 0.00	8.00	0.00	0.00
No. Barrels	= 0	1	0	0
Invert El. (ft)	= 0.00	484.50	0.00	0.00
Length (ft)	= 0.00	1.00	0.00	0.00
Slope (%)	= 0.00	1.00	0.00	n/a
N-Value	= .013	.013	.013	n/a
Orifice Coeff.	= 0.60	0.60	0.60	0.60
Multi-Stage	= n/a	No	No	No

Weir Structures

	[A]	[B]	[C]	[D]
Crest Len (ft)	= 0.00	0.00	0.00	0.00
Crest El. (ft)	= 0.00	0.00	0.00	0.00
Weir Coeff.	= 3.33	3.33	3.33	3.33
Weir Type	= ---	---	---	---
Multi-Stage	= No	No	No	No

Exfil.(in/hr) = 0.000 (by Wet area)
TW Elev. (ft) = 0.00

Note: Culvert/Orifice outflows are analyzed under inlet (ic) and outlet (oc) control. Weir risers checked for orifice conditions (ic) and submergence (s).

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
0.00	0	483.50	---	0.00	---	---	---	---	---	---	---	---	0.000
0.04	41	483.54	---	0.00	---	---	---	---	---	---	---	---	0.000
0.08	83	483.58	---	0.00	---	---	---	---	---	---	---	---	0.000
0.12	124	483.62	---	0.00	---	---	---	---	---	---	---	---	0.000
0.16	165	483.66	---	0.00	---	---	---	---	---	---	---	---	0.000
0.20	207	483.70	---	0.00	---	---	---	---	---	---	---	---	0.000
0.24	248	483.74	---	0.00	---	---	---	---	---	---	---	---	0.000
0.28	290	483.78	---	0.00	---	---	---	---	---	---	---	---	0.000
0.32	331	483.82	---	0.00	---	---	---	---	---	---	---	---	0.000
0.36	372	483.86	---	0.00	---	---	---	---	---	---	---	---	0.000
0.40	414	483.90	---	0.00	---	---	---	---	---	---	---	---	0.000
0.44	455	483.94	---	0.00	---	---	---	---	---	---	---	---	0.000
0.48	496	483.98	---	0.00	---	---	---	---	---	---	---	---	0.000
0.52	538	484.02	---	0.00	---	---	---	---	---	---	---	---	0.000
0.56	579	484.06	---	0.00	---	---	---	---	---	---	---	---	0.000
0.60	621	484.10	---	0.00	---	---	---	---	---	---	---	---	0.000
0.64	662	484.14	---	0.00	---	---	---	---	---	---	---	---	0.000
0.68	703	484.18	---	0.00	---	---	---	---	---	---	---	---	0.000
0.72	745	484.22	---	0.00	---	---	---	---	---	---	---	---	0.000
0.76	786	484.26	---	0.00	---	---	---	---	---	---	---	---	0.000
0.80	827	484.30	---	0.00	---	---	---	---	---	---	---	---	0.000
0.84	875	484.34	---	0.00	---	---	---	---	---	---	---	---	0.000
0.88	922	484.38	---	0.00	---	---	---	---	---	---	---	---	0.000
0.92	970	484.42	---	0.00	---	---	---	---	---	---	---	---	0.000
0.96	1,017	484.46	---	0.00	---	---	---	---	---	---	---	---	0.000
1.00	1,065	484.50	---	0.00 oc	---	---	---	---	---	---	---	---	0.000
1.04	1,112	484.54	---	0.00 oc	---	---	---	---	---	---	---	---	0.005
1.08	1,160	484.58	---	0.01 oc	---	---	---	---	---	---	---	---	0.014
1.12	1,207	484.62	---	0.03 oc	---	---	---	---	---	---	---	---	0.027
1.16	1,255	484.66	---	0.04 oc	---	---	---	---	---	---	---	---	0.041
1.20	1,302	484.70	---	0.06 oc	---	---	---	---	---	---	---	---	0.056
1.24	1,354	484.74	---	0.07 oc	---	---	---	---	---	---	---	---	0.073

Continues on next page...

Underground Pond 2

Stage / Storage / Discharge Table

Stage ft	Storage cuft	Elevation ft	Clv A cfs	Clv B cfs	Clv C cfs	PrfRsr cfs	Wr A cfs	Wr B cfs	Wr C cfs	Wr D cfs	Exfil cfs	User cfs	Total cfs
1.28	1,406	484.78	---	0.09 oc	---	---	---	---	---	---	---	---	0.089
1.32	1,459	484.82	---	0.11 oc	---	---	---	---	---	---	---	---	0.107
1.36	1,511	484.86	---	0.12 oc	---	---	---	---	---	---	---	---	0.124
1.40	1,563	484.90	---	0.14 oc	---	---	---	---	---	---	---	---	0.141
1.44	1,615	484.94	---	0.16 oc	---	---	---	---	---	---	---	---	0.158
1.48	1,667	484.98	---	0.17 oc	---	---	---	---	---	---	---	---	0.174
1.52	1,719	485.02	---	0.19 oc	---	---	---	---	---	---	---	---	0.189
1.56	1,771	485.06	---	0.20 oc	---	---	---	---	---	---	---	---	0.203
1.60	1,823	485.10	---	0.21 oc	---	---	---	---	---	---	---	---	0.214
1.64	1,869	485.14	---	0.22 oc	---	---	---	---	---	---	---	---	0.222
1.68	1,915	485.18	---	0.34 oc	---	---	---	---	---	---	---	---	0.344
1.72	1,960	485.22	---	0.57 oc	---	---	---	---	---	---	---	---	0.566
1.76	2,006	485.26	---	0.72 oc	---	---	---	---	---	---	---	---	0.723
1.80	2,051	485.30	---	0.85 oc	---	---	---	---	---	---	---	---	0.851
1.84	2,097	485.34	---	0.96 oc	---	---	---	---	---	---	---	---	0.962
1.88	2,142	485.38	---	1.06 oc	---	---	---	---	---	---	---	---	1.062
1.92	2,188	485.42	---	1.15 oc	---	---	---	---	---	---	---	---	1.153
1.96	2,233	485.46	---	1.24 oc	---	---	---	---	---	---	---	---	1.238
2.00	2,279	485.50	---	1.32 oc	---	---	---	---	---	---	---	---	1.317
2.04	2,320	485.54	---	1.39 oc	---	---	---	---	---	---	---	---	1.392
2.08	2,361	485.58	---	1.45 ic	---	---	---	---	---	---	---	---	1.452
2.12	2,403	485.62	---	1.49 ic	---	---	---	---	---	---	---	---	1.491
2.16	2,444	485.66	---	1.53 ic	---	---	---	---	---	---	---	---	1.528
2.20	2,486	485.70	---	1.56 ic	---	---	---	---	---	---	---	---	1.565
2.24	2,527	485.74	---	1.60 ic	---	---	---	---	---	---	---	---	1.600
2.28	2,568	485.78	---	1.64 ic	---	---	---	---	---	---	---	---	1.635
2.32	2,610	485.82	---	1.67 ic	---	---	---	---	---	---	---	---	1.669
2.36	2,651	485.86	---	1.70 ic	---	---	---	---	---	---	---	---	1.703
2.40	2,692	485.90	---	1.74 ic	---	---	---	---	---	---	---	---	1.736
2.44	2,734	485.94	---	1.77 ic	---	---	---	---	---	---	---	---	1.768
2.48	2,775	485.98	---	1.80 ic	---	---	---	---	---	---	---	---	1.800
2.52	2,817	486.02	---	1.83 ic	---	---	---	---	---	---	---	---	1.831
2.56	2,858	486.06	---	1.86 ic	---	---	---	---	---	---	---	---	1.861
2.60	2,899	486.10	---	1.89 ic	---	---	---	---	---	---	---	---	1.891
2.64	2,941	486.14	---	1.92 ic	---	---	---	---	---	---	---	---	1.921
2.68	2,982	486.18	---	1.95 ic	---	---	---	---	---	---	---	---	1.950
2.72	3,023	486.22	---	1.98 ic	---	---	---	---	---	---	---	---	1.979
2.76	3,065	486.26	---	2.01 ic	---	---	---	---	---	---	---	---	2.007
2.80	3,106	486.30	---	2.04 ic	---	---	---	---	---	---	---	---	2.035
2.84	3,148	486.34	---	2.06 ic	---	---	---	---	---	---	---	---	2.063
2.88	3,189	486.38	---	2.09 ic	---	---	---	---	---	---	---	---	2.090
2.92	3,230	486.42	---	2.12 ic	---	---	---	---	---	---	---	---	2.117
2.96	3,272	486.46	---	2.14 ic	---	---	---	---	---	---	---	---	2.143
3.00	3,313	486.50	---	2.17 ic	---	---	---	---	---	---	---	---	2.170
3.04	3,354	486.54	---	2.20 ic	---	---	---	---	---	---	---	---	2.195
3.08	3,396	486.58	---	2.22 ic	---	---	---	---	---	---	---	---	2.221
3.12	3,437	486.62	---	2.25 ic	---	---	---	---	---	---	---	---	2.246
3.16	3,479	486.66	---	2.27 ic	---	---	---	---	---	---	---	---	2.271
3.20	3,520	486.70	---	2.30 ic	---	---	---	---	---	---	---	---	2.296
3.24	3,561	486.74	---	2.32 ic	---	---	---	---	---	---	---	---	2.321
3.28	3,603	486.78	---	2.34 ic	---	---	---	---	---	---	---	---	2.345
3.32	3,644	486.82	---	2.37 ic	---	---	---	---	---	---	---	---	2.369
3.36	3,685	486.86	---	2.39 ic	---	---	---	---	---	---	---	---	2.392
3.40	3,727	486.90	---	2.42 ic	---	---	---	---	---	---	---	---	2.416
3.44	3,768	486.94	---	2.44 ic	---	---	---	---	---	---	---	---	2.439
3.48	3,810	486.98	---	2.46 ic	---	---	---	---	---	---	---	---	2.462
3.52	3,851	487.02	---	2.49 ic	---	---	---	---	---	---	---	---	2.485
3.56	3,892	487.06	---	2.51 ic	---	---	---	---	---	---	---	---	2.508
3.60	3,934	487.10	---	2.53 ic	---	---	---	---	---	---	---	---	2.530
3.64	3,975	487.14	---	2.55 ic	---	---	---	---	---	---	---	---	2.552
3.68	4,016	487.18	---	2.57 ic	---	---	---	---	---	---	---	---	2.574
3.72	4,058	487.22	---	2.60 ic	---	---	---	---	---	---	---	---	2.596
3.76	4,099	487.26	---	2.62 ic	---	---	---	---	---	---	---	---	2.618
3.80	4,141	487.30	---	2.64 ic	---	---	---	---	---	---	---	---	2.639
3.84	4,182	487.34	---	2.66 ic	---	---	---	---	---	---	---	---	2.661
3.88	4,223	487.38	---	2.68 ic	---	---	---	---	---	---	---	---	2.682
3.92	4,265	487.42	---	2.70 ic	---	---	---	---	---	---	---	---	2.703
3.96	4,306	487.46	---	2.72 ic	---	---	---	---	---	---	---	---	2.724
4.00	4,347	487.50	---	2.74 ic	---	---	---	---	---	---	---	---	2.744

...End

Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

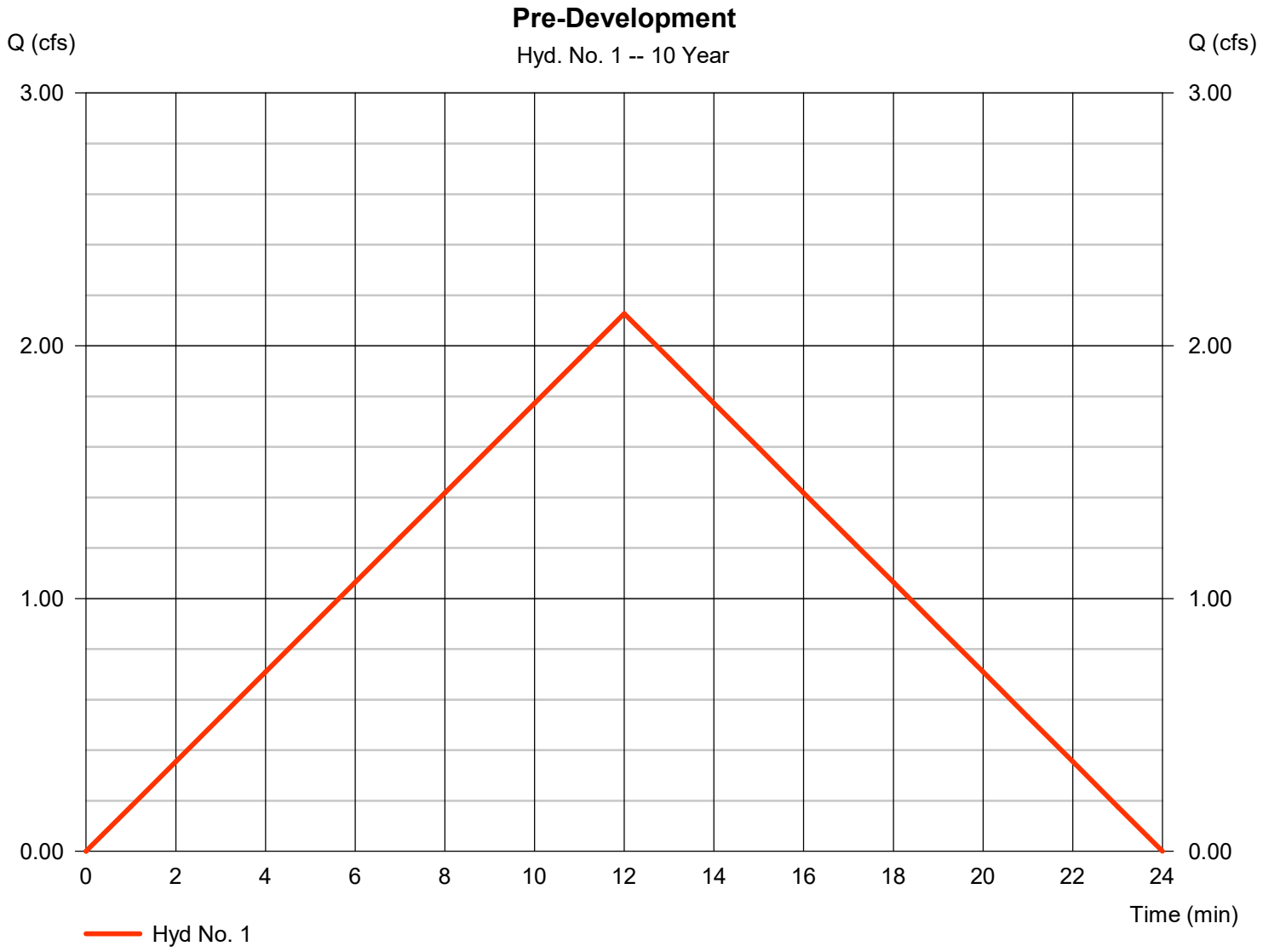
Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	2.128	1	12	1,532	------	------	------	Pre-Development
2	Rational	10.43	1	5	3,129	------	------	------	Post-Development
3	Reservoir	1.782	1	9	2,054	2	485.96	2,752	Routed Pond

Hydrograph Report

Hyd. No. 1

Pre-Development

Hydrograph type	=	Rational	Peak discharge	=	2.128 cfs
Storm frequency	=	10 yrs	Time to peak	=	12 min
Time interval	=	1 min	Hyd. volume	=	1,532 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.25
Intensity	=	3.668 in/hr	Tc by TR55	=	12.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

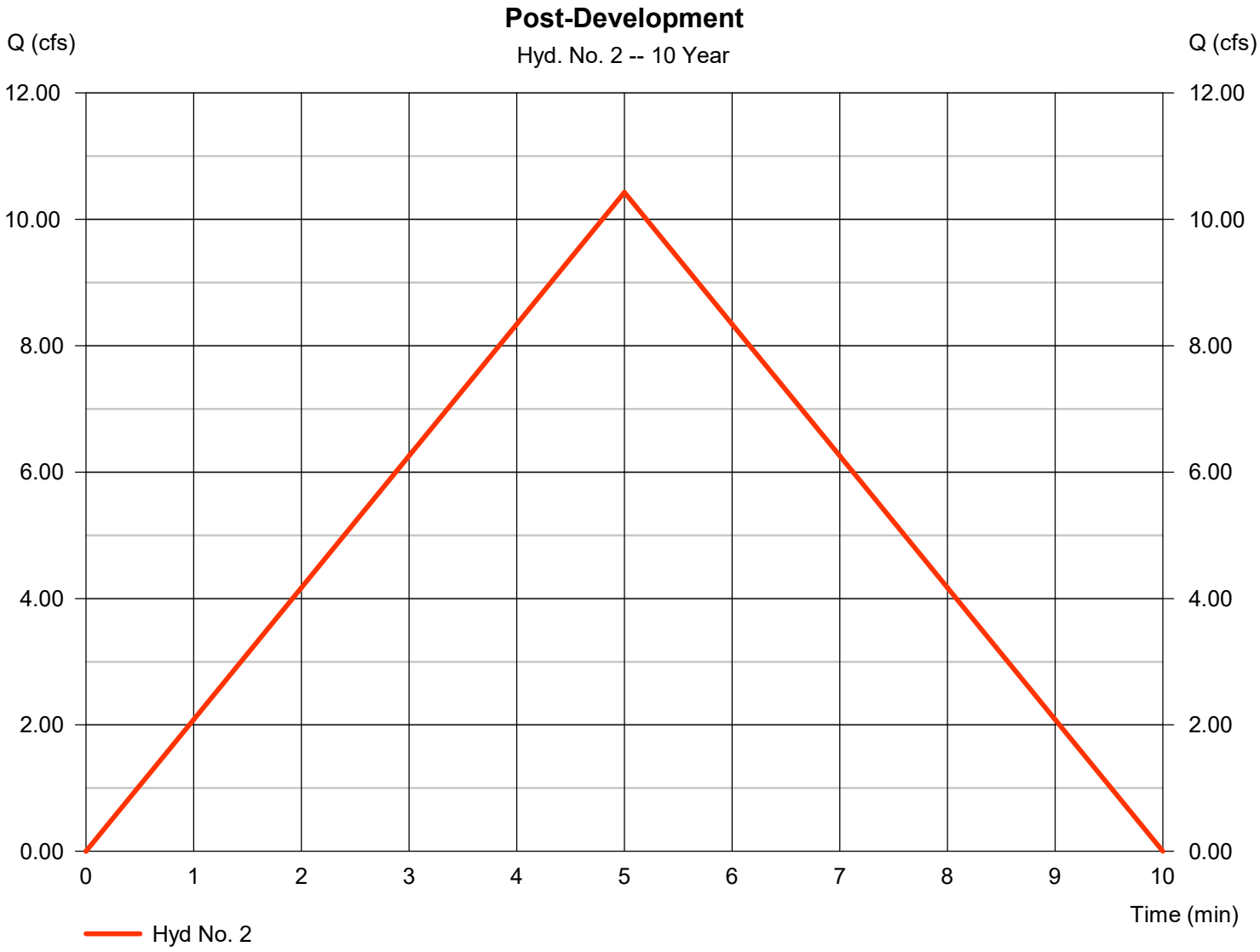


Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	10.43 cfs
Storm frequency	=	10 yrs	Time to peak	=	5 min
Time interval	=	1 min	Hyd. volume	=	3,129 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.9
Intensity	=	4.994 in/hr	Tc by User	=	5.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1



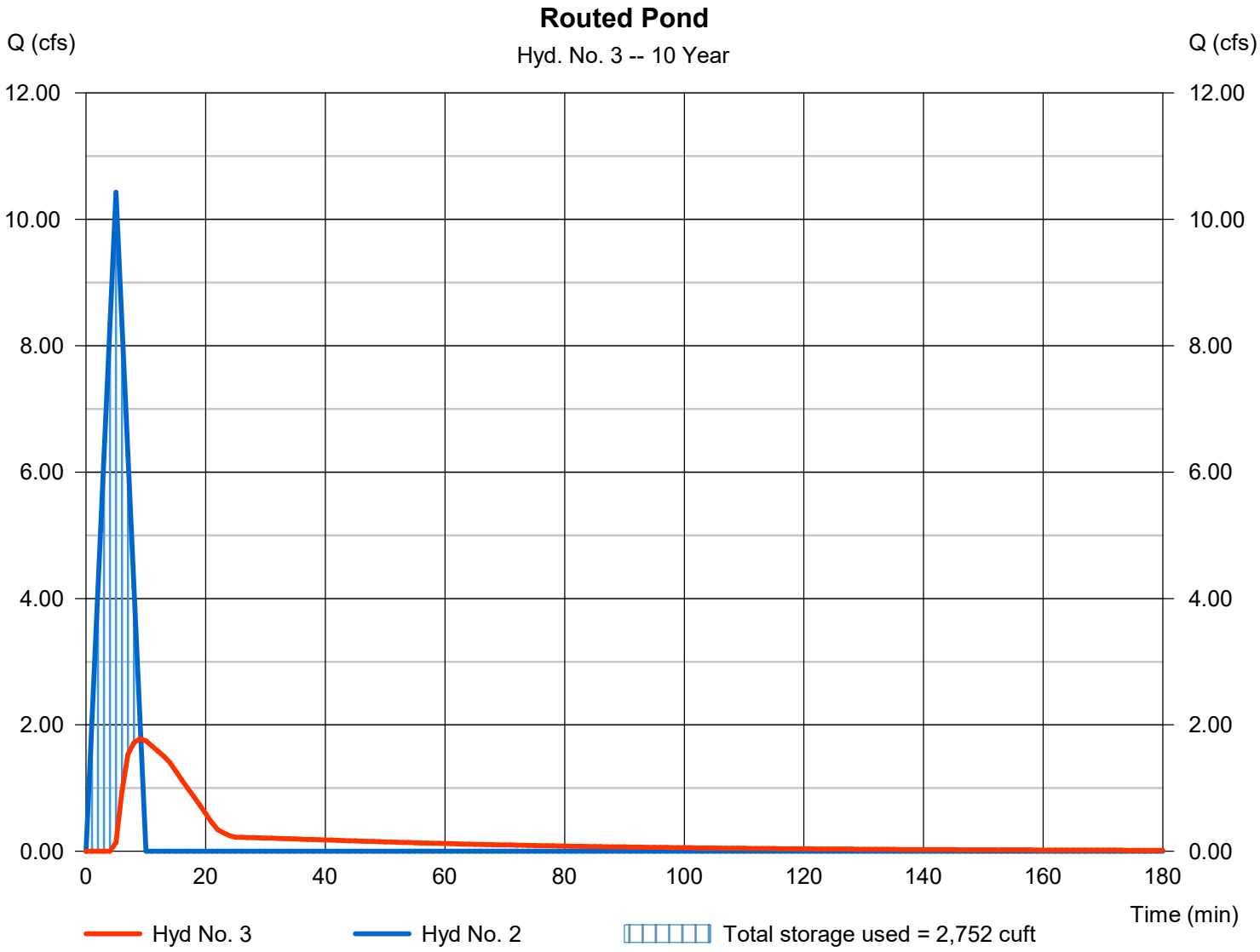
Hydrograph Report

Hyd. No. 3

Routed Pond

Hydrograph type	=	Reservoir	Peak discharge	=	1.782 cfs
Storm frequency	=	10 yrs	Time to peak	=	9 min
Time interval	=	1 min	Hyd. volume	=	2,054 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	485.96 ft
Reservoir name	=	Underground Pond 2	Max. Storage	=	2,752 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	2.784	1	12	2,004	------	------	------	Pre-Development
2	Rational	13.55	1	5	4,064	------	------	------	Post-Development
3	Reservoir	2.289	1	9	2,989	2	486.69	3,508	Routed Pond

Hydrograph Report

Hyd. No. 1

Pre-Development

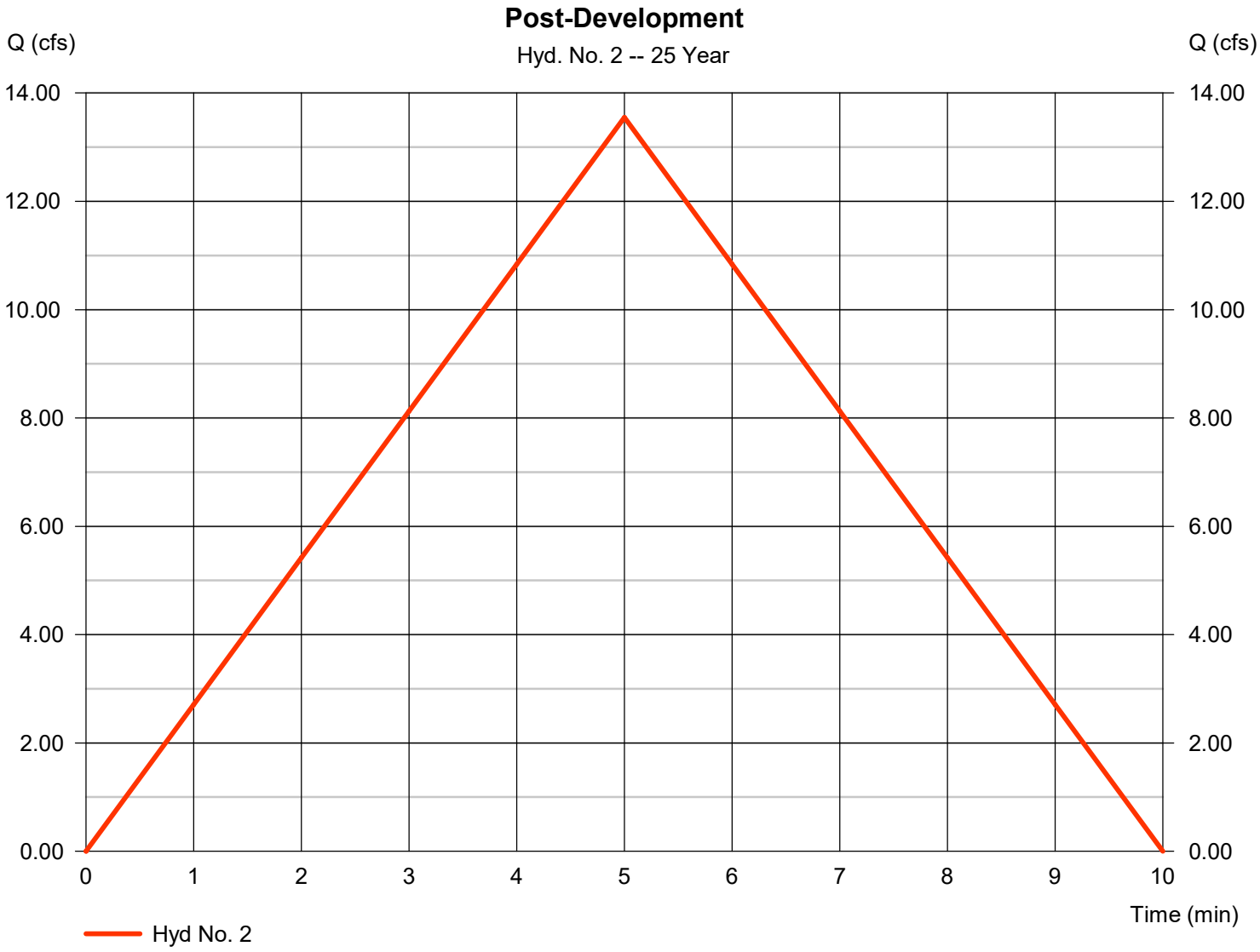
Hydrograph type	=	Rational	Peak discharge	=	2.784 cfs
Storm frequency	=	25 yrs	Time to peak	=	12 min
Time interval	=	1 min	Hyd. volume	=	2,004 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.25
Intensity	=	4.800 in/hr	Tc by TR55	=	12.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	13.55 cfs
Storm frequency	=	25 yrs	Time to peak	=	5 min
Time interval	=	1 min	Hyd. volume	=	4,064 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.9
Intensity	=	6.488 in/hr	Tc by User	=	5.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1



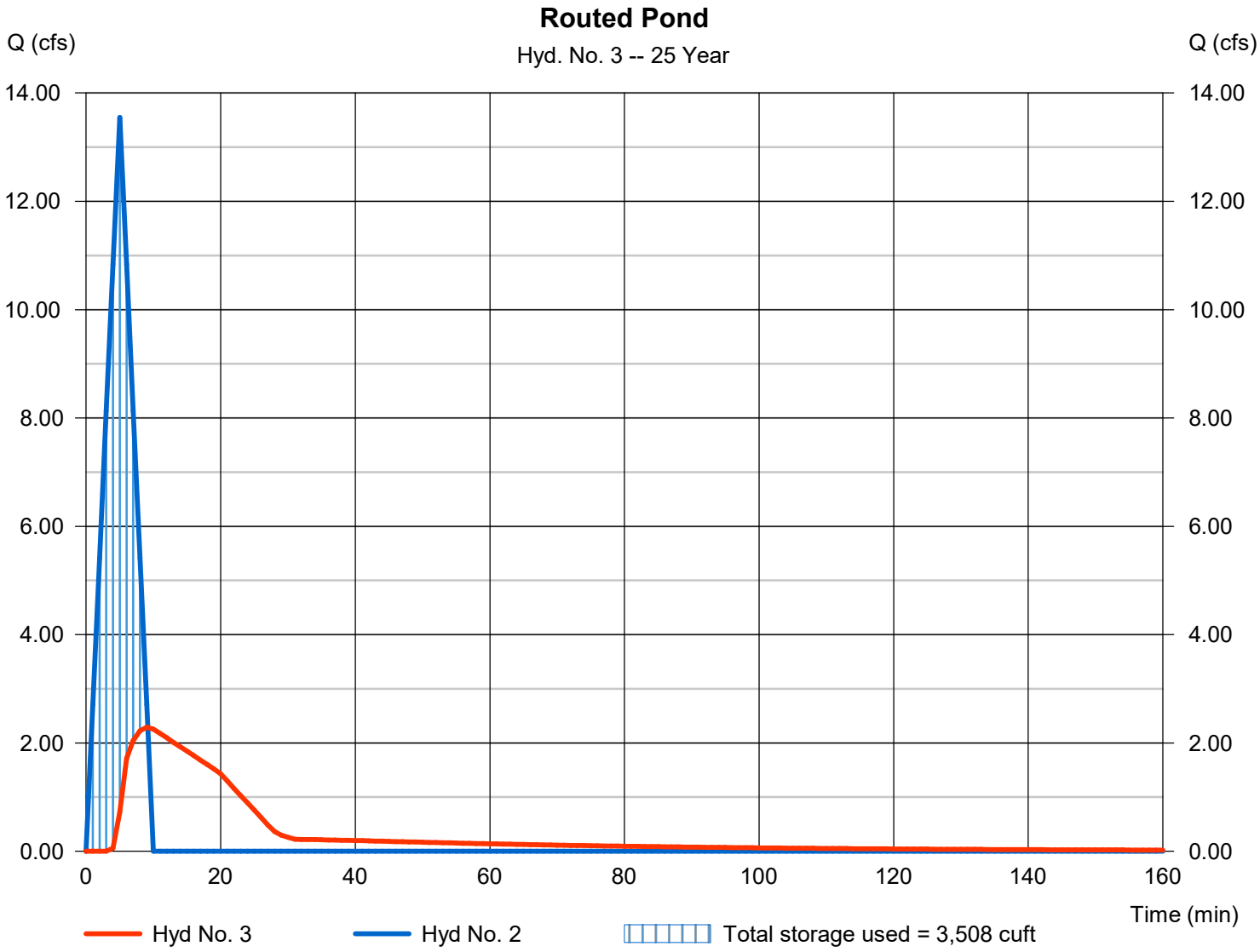
Hydrograph Report

Hyd. No. 3

Routed Pond

Hydrograph type	=	Reservoir	Peak discharge	=	2.289 cfs
Storm frequency	=	25 yrs	Time to peak	=	9 min
Time interval	=	1 min	Hyd. volume	=	2,989 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	486.69 ft
Reservoir name	=	Underground Pond 2	Max. Storage	=	3,508 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	3.196	1	12	2,301	------	------	------	Pre-Development
2	Rational	15.01	1	5	4,504	------	------	------	Post-Development
3	Reservoir	2.494	1	9	3,429	2	487.04	3,867	Routed Pond

Hydrograph Report

Hyd. No. 1

Pre-Development

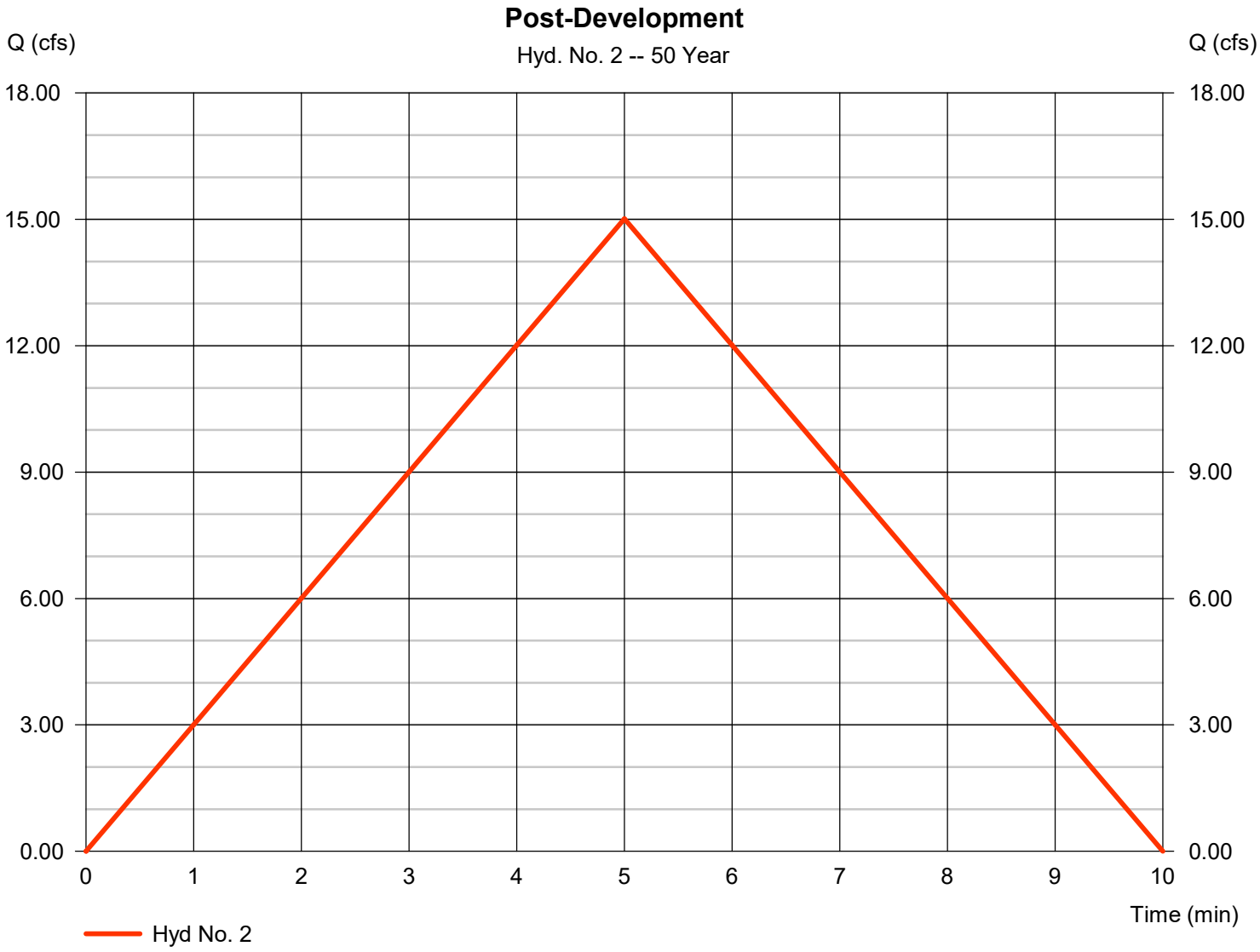
Hydrograph type	=	Rational	Peak discharge	=	3.196 cfs
Storm frequency	=	50 yrs	Time to peak	=	12 min
Time interval	=	1 min	Hyd. volume	=	2,301 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.25
Intensity	=	5.510 in/hr	Tc by TR55	=	12.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	15.01 cfs
Storm frequency	=	50 yrs	Time to peak	=	5 min
Time interval	=	1 min	Hyd. volume	=	4,504 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.9
Intensity	=	7.191 in/hr	Tc by User	=	5.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1



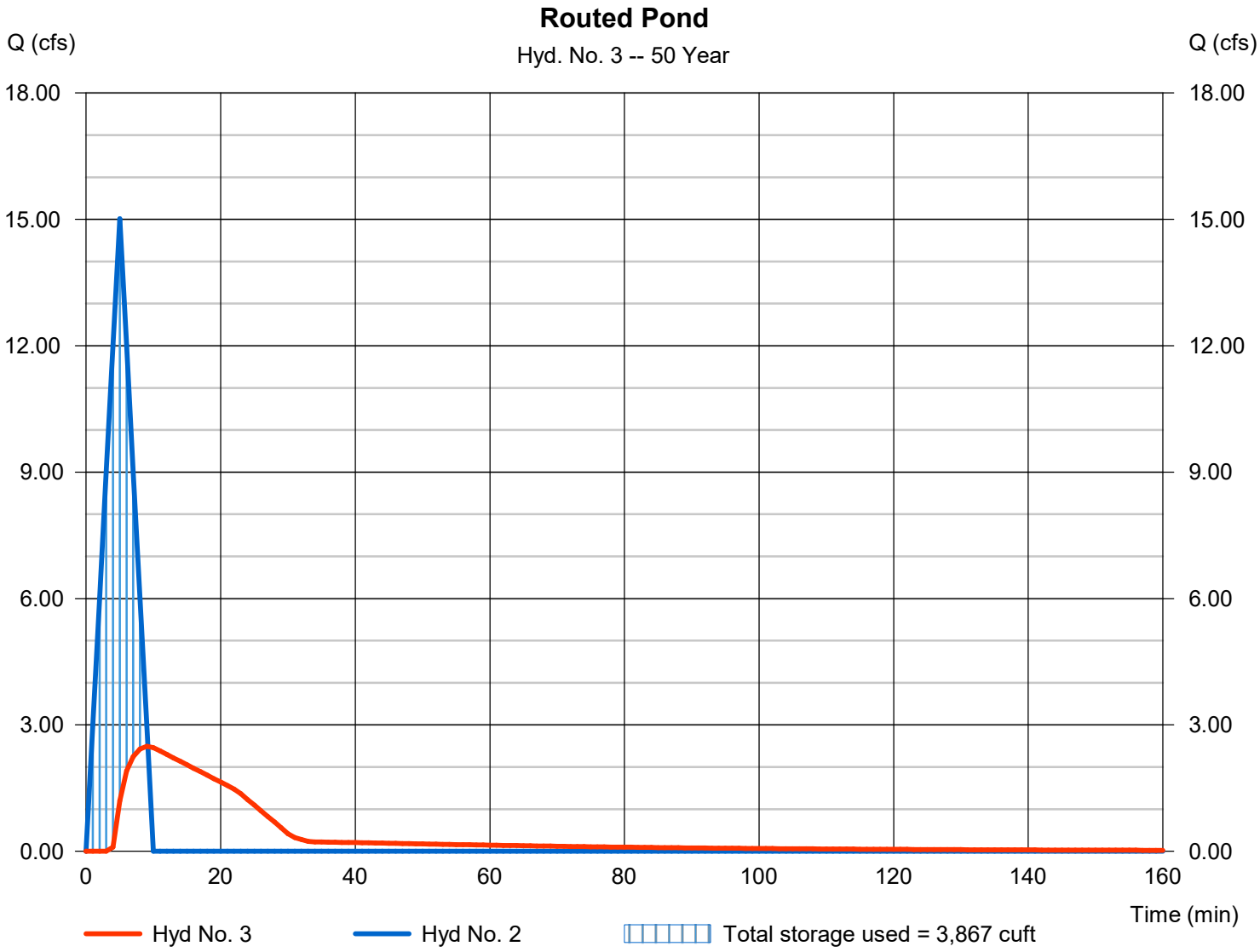
Hydrograph Report

Hyd. No. 3

Routed Pond

Hydrograph type	=	Reservoir	Peak discharge	=	2.494 cfs
Storm frequency	=	50 yrs	Time to peak	=	9 min
Time interval	=	1 min	Hyd. volume	=	3,429 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	487.04 ft
Reservoir name	=	Underground Pond 2	Max. Storage	=	3,867 cuft

Storage Indication method used.



Hydrograph Summary Report

Hydraflow Hydrographs Extension for Autodesk® Civil 3D® by Autodesk, Inc. v2020

Hyd. No.	Hydrograph type (origin)	Peak flow (cfs)	Time interval (min)	Time to Peak (min)	Hyd. volume (cuft)	Inflow hyd(s)	Maximum elevation (ft)	Total strge used (cuft)	Hydrograph Description
1	Rational	3.442	1	12	2,478	------	------	------	Pre-Development
2	Rational	16.68	1	5	5,004	------	------	------	Post-Development
3	Reservoir	2.715	1	9	3,929	2	487.44	4,288	Routed Pond

Hydrograph Report

Hyd. No. 1

Pre-Development

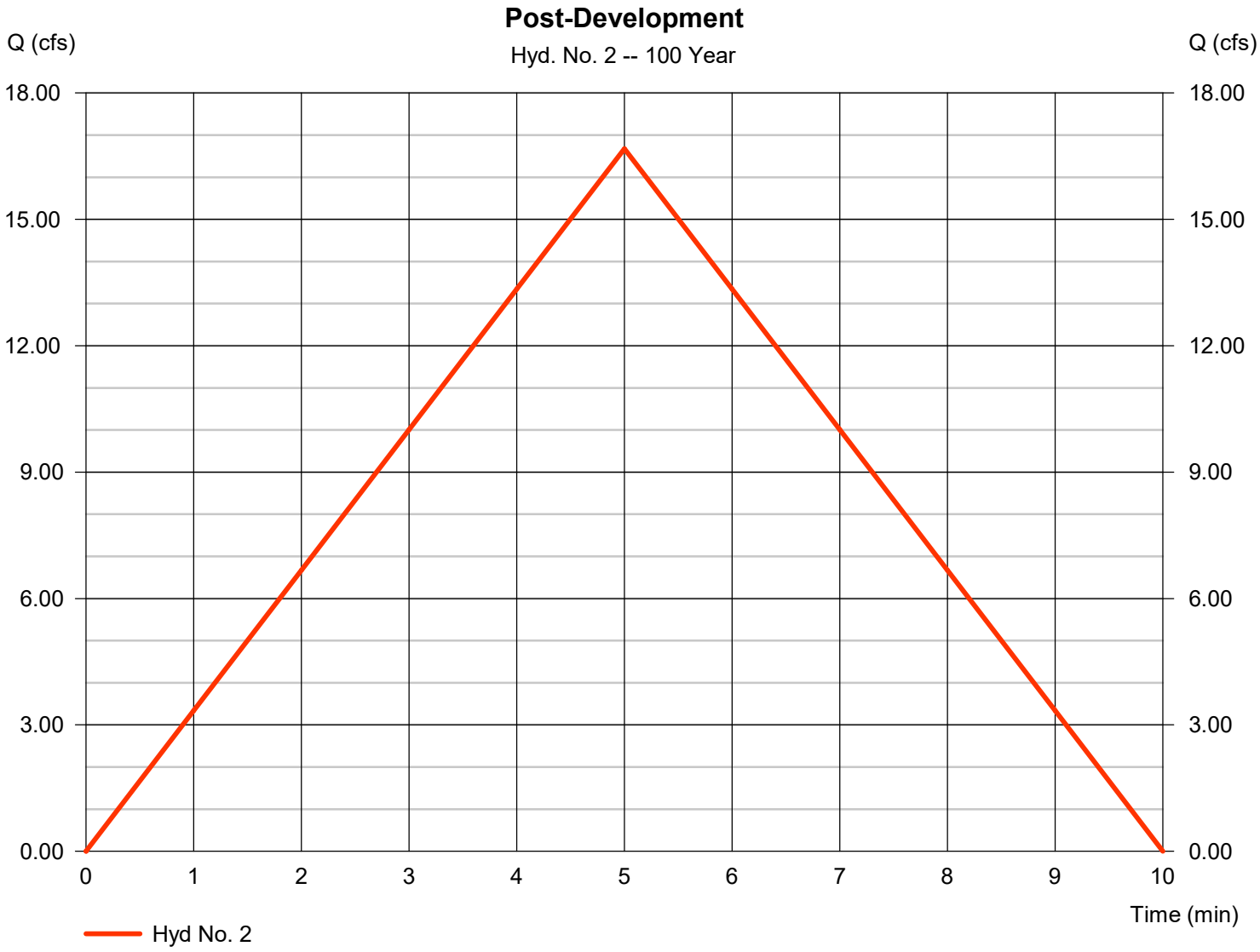
Hydrograph type	=	Rational	Peak discharge	=	3.442 cfs
Storm frequency	=	100 yrs	Time to peak	=	12 min
Time interval	=	1 min	Hyd. volume	=	2,478 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.25
Intensity	=	5.934 in/hr	Tc by TR55	=	12.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1

Hydrograph Report

Hyd. No. 2

Post-Development

Hydrograph type	=	Rational	Peak discharge	=	16.68 cfs
Storm frequency	=	100 yrs	Time to peak	=	5 min
Time interval	=	1 min	Hyd. volume	=	5,004 cuft
Drainage area	=	2.320 ac	Runoff coeff.	=	0.9
Intensity	=	7.988 in/hr	Tc by User	=	5.00 min
IDF Curve	=	Millbury Storm.IDF	Asc/Rec limb fact	=	1/1



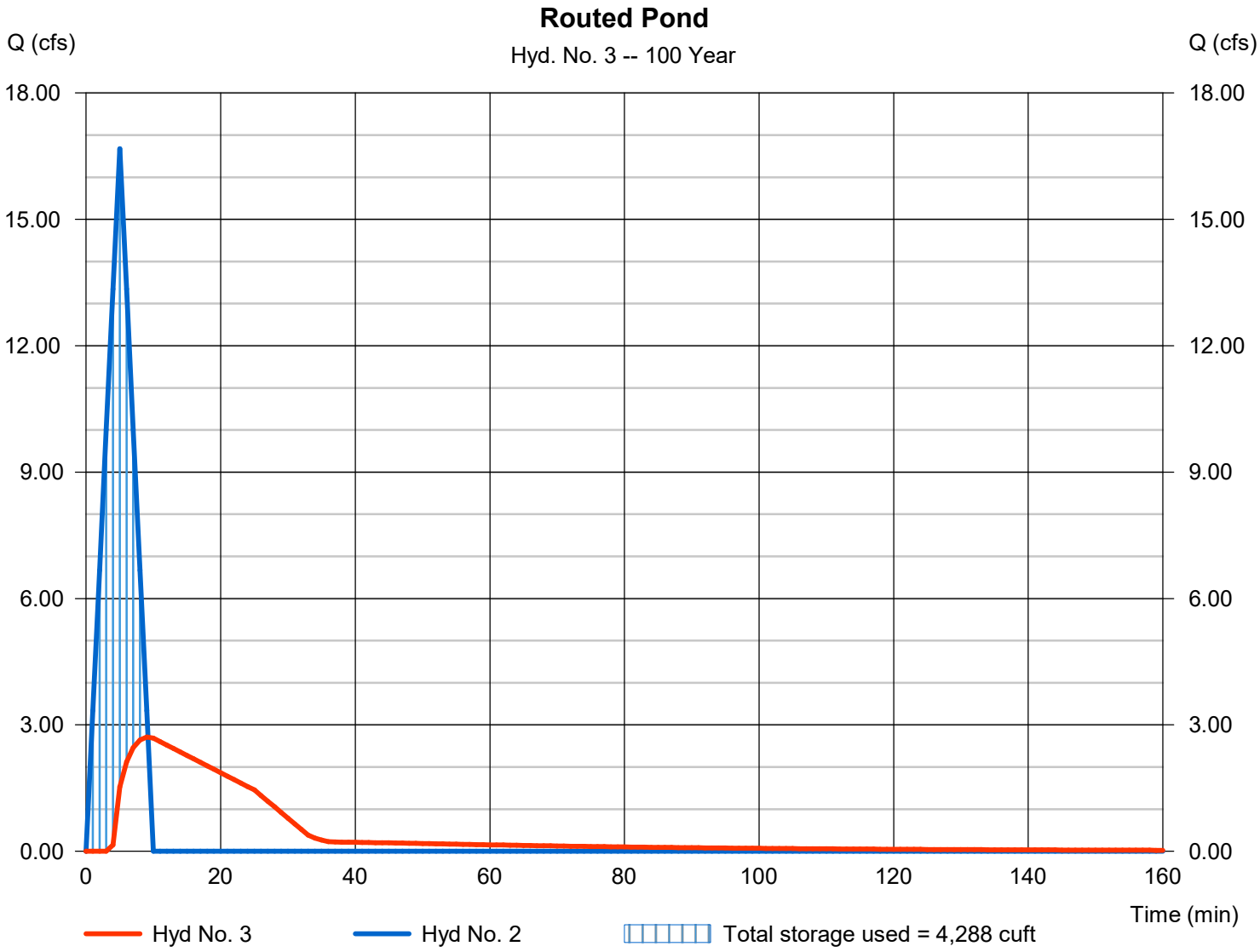
Hydrograph Report

Hyd. No. 3

Routed Pond

Hydrograph type	=	Reservoir	Peak discharge	=	2.715 cfs
Storm frequency	=	100 yrs	Time to peak	=	9 min
Time interval	=	1 min	Hyd. volume	=	3,929 cuft
Inflow hyd. No.	=	2 - Post-Development	Max. Elevation	=	487.44 ft
Reservoir name	=	Underground Pond 2	Max. Storage	=	4,288 cuft

Storage Indication method used.



Hydraflow Rainfall Report

Return Period (Yrs)	Intensity-Duration-Frequency Equation Coefficients (FHA)			
	B	D	E	(N/A)
1	56.1571	12.6000	0.8599	--------
2	21.4950	5.3000	0.6807	--------
3	0.0000	0.0000	0.0000	--------
5	64.6694	13.4000	0.7859	--------
10	34.7603	8.6000	0.7433	--------
25	33.1106	7.0000	0.6559	--------
50	56.6539	11.2000	0.7412	--------
100	34.5085	6.1000	0.6079	--------

File name: Millbury Storm.IDF

Intensity = B / (Tc + D)^E

Return Period (Yrs)	Intensity Values (in/hr)											
	5 min	10	15	20	25	30	35	40	45	50	55	60
1	4.77	3.85	3.24	2.81	2.48	2.23	2.03	1.86	1.72	1.60	1.50	1.41
2	4.39	3.36	2.77	2.38	2.11	1.90	1.74	1.60	1.49	1.40	1.32	1.25
3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	6.56	5.43	4.66	4.10	3.68	3.34	3.07	2.84	2.64	2.48	2.34	2.21
10	4.99	3.96	3.32	2.87	2.55	2.30	2.10	1.94	1.80	1.69	1.59	1.50
25	6.49	5.16	4.36	3.81	3.41	3.10	2.85	2.65	2.48	2.33	2.21	2.10
50	7.19	5.89	5.04	4.42	3.96	3.60	3.31	3.06	2.86	2.68	2.53	2.40
100	7.99	6.37	5.41	4.75	4.27	3.90	3.60	3.36	3.16	2.98	2.83	2.70

Tc = time in minutes. Values may exceed 60.

Precip. file name: D:\My stuff\Ozark Beach Vollyball\Storm Design\Ozark.pcp

Storm Distribution	Rainfall Precipitation Table (in)							
	1-yr	2-yr	3-yr	5-yr	10-yr	25-yr	50-yr	100-yr
SCS 24-hour	0.00	3.90	0.00	0.00	5.65	6.78	9.60	8.00
SCS 6-Hr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-1st	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-2nd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-3rd	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-4th	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Huff-Indy	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Custom	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hydraflow Table of Contents

APPENDIX 5

Pipe Sizing

Project Description

File Name	MILLBURY.SPF

Project Options

Flow Units	CFS
Elevation Type	Elevation
Hydrology Method	Rational
Time of Concentration (TOC) Method	User-Defined
Link Routing Method	Kinematic Wave
Enable Overflow Ponding at Nodes	YES
Skip Steady State Analysis Time Periods	NO

Analysis Options

Start Analysis On	Apr 11, 2020	00:00:00
End Analysis On	Apr 12, 2020	00:00:00
Start Reporting On	Apr 11, 2020	00:00:00
Antecedent Dry Days	0	days
Runoff (Dry Weather) Time Step	0 01:00:00	days hh:mm:ss
Runoff (Wet Weather) Time Step	0 00:05:00	days hh:mm:ss
Reporting Time Step	0 00:05:00	days hh:mm:ss
Routing Time Step	30	seconds

Number of Elements

	Qty
Rain Gages	0
Subbasins	11
Nodes	25
Junctions	8
Outfalls	6
Flow Diversions	0
Inlets	11
Storage Nodes	0
Links	27
Channels	8
Pipes	19
Pumps	0
Orifices	0
Weirs	0
Outlets	0
Pollutants	0
Land Uses	0

Rainfall Details

Return Period	10 year(s)

Subbasin Summary

SN	Subbasin ID	Area (ac)	Weighted Runoff Coefficient	Total Rainfall (in)	Total Runoff (in)	Total Runoff Volume (ac-in)	Peak Runoff (cfs)	Time of Concentration (days hh:mm:ss)
1	BASINA1	1.93	0.3300	1.52	0.50	0.97	2.89	0 00:20:00
2	BASINA3	0.61	0.9000	0.42	0.38	0.23	2.75	0 00:05:00
3	BASINB1	2.03	0.3800	1.52	0.58	1.17	3.51	0 00:20:00
4	BASINB2	0.36	0.9000	0.42	0.38	0.14	1.62	0 00:05:00
5	BASIND1	0.06	0.9000	0.42	0.38	0.02	0.27	0 00:05:00
6	BASIND2	0.16	0.9000	0.42	0.38	0.06	0.72	0 00:05:00
7	BASINE1	0.19	0.9000	0.42	0.38	0.07	0.86	0 00:05:00
8	BASINE2	0.34	0.9000	0.42	0.38	0.13	1.53	0 00:05:00
9	BASINF1	0.39	0.9000	0.42	0.38	0.15	1.76	0 00:05:00
10	BASINF2	0.17	0.9000	0.42	0.38	0.06	0.77	0 00:05:00
11	BASING1	0.42	0.9000	0.42	0.38	0.16	1.89	0 00:05:00

Node Summary

SN	Element ID	Element Type	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Initial Water Elevation (ft)	Surcharge Elevation (ft)	Ponded Area (ft²)	Peak Inflow (cfs)	Max HGL Elevation Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	A2	Junction	513.60	515.93	513.24	515.93	10.00	4.44	514.20	0.00	1.73	0 00:00	0.00	0.00
2	C1	Junction	513.00	519.00	513.00	519.00	10.00	4.14	513.40	0.00	5.60	0 00:00	0.00	0.00
3	C2	Junction	498.00	516.18	498.00	516.18	10.00	4.14	512.40	0.00	3.78	0 00:00	0.00	0.00
4	C3	Junction	490.00	500.19	490.00	500.19	10.00	4.14	495.47	0.00	4.72	0 00:00	0.00	0.00
5	C4	Junction	488.62	493.81	488.62	493.81	10.00	4.14	489.28	0.00	4.54	0 00:00	0.00	0.00
6	D3	Junction	485.94	493.50	485.94	493.50	10.00	3.20	486.40	0.00	7.09	0 00:00	0.00	0.00
7	D4	Junction	484.50	488.64	484.50	488.64	0.00	7.46	485.35	0.00	3.29	0 00:00	0.00	0.00
8	H1	Junction	483.59	487.95	483.59	0.00	10.00	2.72	483.87	0.00	4.08	0 00:00	0.00	0.00
9	EXISTINGINLET	Outfall	480.77					2.72	481.04					
10	INTODET1	Outfall	513.00					5.18	513.61					
11	INTODET2	Outfall	484.50					7.46	485.25					
12	Out-02	Outfall	495.00					0.00	495.00					
13	Out-03	Outfall	0.00					0.00	0.00					
14	Out-1Pipe - (51)	Outfall	488.00					4.14	488.65					

Link Summary

SN	Element ID	Element Type	From (Inlet) Node	To (Outlet) Node	Length	Inlet Invert Elevation	Outlet Invert Elevation	Average Slope	Diameter or Height	Manning's Roughness	Peak Flow	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Reported Condition
					(ft)	(ft)	(ft)	(%)	(in)		(cfs)	(cfs)		(ft/sec)	(ft)		(min)	
1	PIPEA1-A2	Pipe	A1	A2	42.00	516.00	513.60	5.7100	15.000	0.0120	1.12	16.73	0.07	7.70	0.22	0.18	0.00	Calculated
2	PIPEA2-A3	Pipe	A2	A3	19.00	513.60	513.24	1.8900	15.000	0.0120	4.44	9.63	0.46	7.69	0.60	0.48	0.00	Calculated
3	PIPEA3-DETENTION1	Pipe	A3	INTODET1	10.00	513.24	513.00	2.4000	15.000	0.0120	5.18	10.84	0.48	8.73	0.61	0.49	0.00	Calculated
4	PIPEB1-B2	Pipe	B1	B2	102.00	518.73	516.62	2.0600	15.000	0.0120	2.35	10.05	0.23	7.26	0.41	0.33	0.00	Calculated
5	PIPEB2-A2	Pipe	B2	A2	264.00	516.42	513.60	1.0700	15.000	0.0120	3.33	7.23	0.46	5.80	0.60	0.48	0.00	Calculated
6	PIPEC1-C2	Pipe	C1	C2	14.00	513.00	512.00	7.1400	15.000	0.0120	4.14	18.70	0.22	12.24	0.40	0.32	0.00	Calculated
7	PIPEC2-C3	Pipe	C2	C3	80.00	498.00	495.00	3.7500	15.000	0.0120	4.14	13.55	0.31	9.70	0.47	0.38	0.00	Calculated
8	PIPEC3-C4	Pipe	C3	C4	116.00	490.00	488.62	1.1900	15.000	0.0120	4.14	7.63	0.54	6.34	0.66	0.52	0.00	Calculated
9	PIPEC4-OUTLET	Pipe	C4	Out-1Pipe - (51)	50.00	488.62	488.00	1.2400	15.000	0.0120	4.14	7.79	0.53	6.44	0.65	0.52	0.00	Calculated
10	PIPED1-D2	Pipe	D1	D2	16.00	495.73	495.54	1.1900	15.000	0.0120	0.27	7.63	0.04	3.03	0.16	0.13	0.00	Calculated
11	PIPED2-D3	Pipe	D2	D3	72.00	486.68	485.94	1.0400	15.000	0.0120	1.73	7.11	0.24	4.78	0.42	0.34	0.00	Calculated
12	PIPED3-D4	Pipe	D3	D4	55.00	485.94	484.60	2.4400	15.000	0.0120	3.20	10.92	0.29	7.74	0.46	0.37	0.00	Calculated
13	PIPED4-DET2	Pipe	D4	INTODET2	2.50	484.60	484.50	4.0000	15.000	0.0150	7.46	11.20	0.67	9.76	0.75	0.60	0.00	Calculated
14	PIPEE1-E2	Pipe	E1	E2	120.00	496.80	489.30	6.2500	15.000	0.0120	0.83	17.50	0.05	10.13	0.18	0.15	0.00	Calculated
15	PIPEE2-D3	Pipe	E2	D3	76.00	487.51	485.94	2.0700	15.000	0.0120	2.17	10.06	0.22	6.56	0.39	0.31	0.00	Calculated
16	PIPEF1-F2	Pipe	F1	F2	46.00	490.00	487.50	5.4300	15.000	0.0120	1.45	16.31	0.09	9.23	0.25	0.20	0.00	Calculated
17	PIPEF2-D4	Pipe	F2	D4	96.00	487.30	484.60	2.8100	15.000	0.0120	2.38	11.74	0.20	7.51	0.38	0.31	0.00	Calculated
18	PIPEG1-D4	Pipe	G1	D4	28.00	485.00	484.60	1.4300	15.000	0.0120	1.93	8.36	0.23	5.55	0.41	0.33	0.00	Calculated
19	PIPEH1-EXINLET	Pipe	H1	EXISTINGINLET	21.00	483.59	480.77	13.4300	15.000	0.0120	2.72	25.65	0.11	13.60	0.27	0.22	0.00	Calculated
20	BYPASSA1-D2	Channel	A1	D2	203.07	516.00	486.68	14.4400	6.000	0.0320	1.73	22.25	0.08	3.99	0.18	0.36	0.00	
21	BYPASSB1-B2	Channel	B1	B2	115.48	518.73	516.42	2.0000	6.000	0.0320	1.11	7.52	0.15	1.38	0.22	0.45	0.00	
22	BYPASSB2-A3	Channel	B2	A3	288.00	516.42	513.00	1.1900	6.000	0.0320	0.14	8.78	0.02	1.89	0.09	0.18	0.00	
23	BYPASSD1-ROAD	Channel	D1	Out-02	13.48	497.00	495.00	14.8400	6.000	0.0320	0.00	32.15	0.00	0.00	0.00	0.00	0.00	
24	BYPASSE1-E2	Channel	E1	E2	132.58	496.80	487.51	7.0100	6.000	0.0320	0.01	16.81	0.00	2.19	0.03	0.06	0.00	
25	BYPASSE2-G1	Channel	E2	G1	97.68	487.51	485.00	2.5700	6.000	0.0320	0.13	15.40	0.01	2.67	0.07	0.15	0.00	
26	BYPASSF1-F2	Channel	F1	F2	59.26	490.00	487.30	4.5600	6.000	0.0320	0.26	14.07	0.02	2.40	0.10	0.21	0.00	
27	BYPASSF2-G1	Channel	F2	G1	137.86	487.30	485.00	1.6700	6.000	0.0320	0.02	10.20	0.00	1.38	0.04	0.07	0.00	

Inlet Summary

SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Initial Water Elevation (ft)	Ponded Area (ft^2)	Peak Flow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Allowable Spread (ft)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)
1	A1	FHWA HEC-22 GENERIC	N/A	On Grade	1	516.00	519.44	516.00	N/A	2.89	1.12	1.78	38.61	7.00	2.25	519.61
2	A3	FHWA HEC-22 GENERIC	N/A	On Sag	1	513.24	516.72	0.00	0.00	2.74	N/A	N/A	N/A	7.00	13.12	517.23
3	B1	FHWA HEC-22 GENERIC	N/A	On Grade	1	518.73	522.35	518.73	N/A	3.51	2.36	1.15	67.27	7.00	7.44	522.60
4	B2	FHWA HEC-22 GENERIC	N/A	On Grade	1	516.42	521.07	516.42	N/A	1.62	1.38	0.24	85.18	7.00	4.81	521.27
5	D1	FHWA HEC-22 GENERIC	N/A	On Grade	1	495.73	497.73	495.73	N/A	0.27	0.27	0.00	100.00	7.00	1.00	497.79
6	D2	FHWA HEC-22 GENERIC	N/A	On Sag	1	486.68	499.73	486.68	10.00	1.73	N/A	N/A	N/A	7.00	4.91	500.08
7	E1	FHWA HEC-22 GENERIC	N/A	On Grade	1	496.80	499.88	496.80	N/A	0.85	0.84	0.02	97.89	7.00	2.18	500.02
8	E2	FHWA HEC-22 GENERIC	N/A	On Grade	1	487.51	492.54	487.51	N/A	1.53	1.36	0.17	89.01	7.00	2.43	492.71
9	F1	FHWA HEC-22 GENERIC	N/A	On Grade	1	490.00	493.11	490.00	N/A	1.75	1.45	0.30	82.79	7.00	6.94	493.28
10	F2	FHWA HEC-22 GENERIC	N/A	On Grade	1	487.30	490.81	487.30	N/A	0.97	0.95	0.02	97.96	7.00	2.66	490.97
11	G1	FHWA HEC-22 GENERIC	N/A	On Sag	1	485.00	488.00	485.00	10.00	1.94	N/A	N/A	N/A	7.00	9.80	488.37

Subbasin Hydrology

Subbasin : BASINA1

Input Data

Area (ac) 1.93
Weighted Runoff Coefficient 0.3300

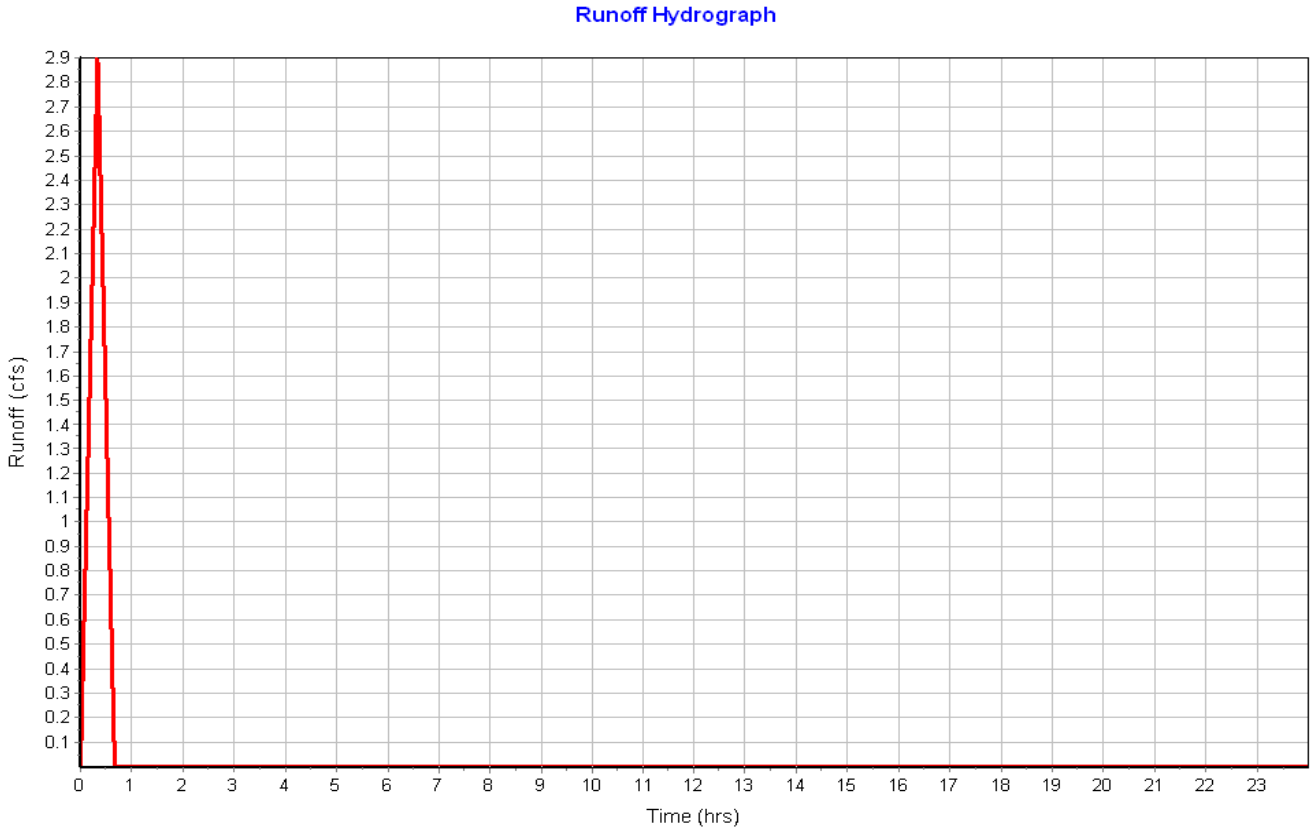
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.36	-	0.90
-	1.57	-	0.20
Composite Area & Weighted Runoff Coeff.	1.93		0.33

Subbasin Runoff Results

Total Rainfall (in) 1.52
Total Runoff (in) 0.50
Peak Runoff (cfs) 2.89
Rainfall Intensity 4.544
Weighted Runoff Coefficient 0.3300
Time of Concentration (days hh:mm:ss) 0 00:20:00

Subbasin : BASINA1



Subbasin : BASINA3

Input Data

Area (ac) 0.61
Weighted Runoff Coefficient 0.9000

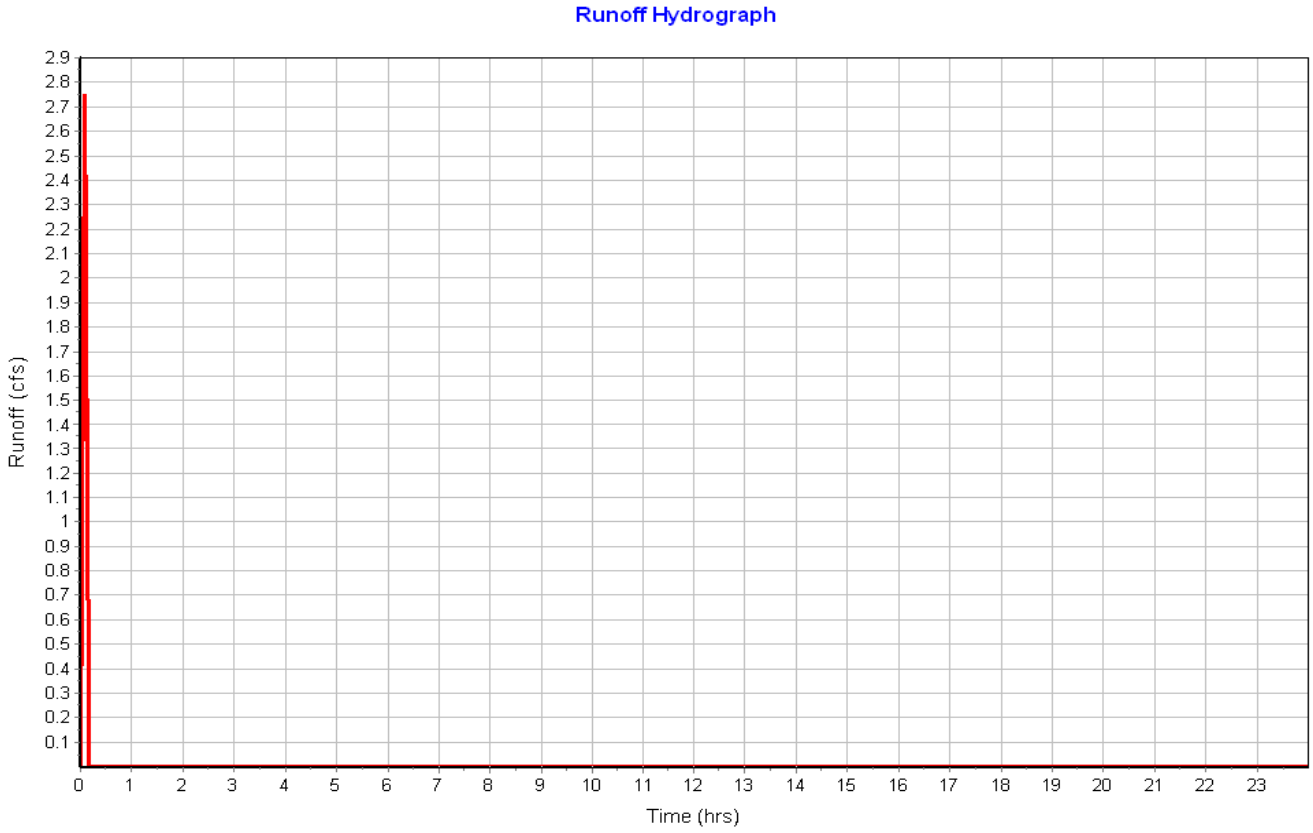
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.61	-	0.90
Composite Area & Weighted Runoff Coeff.	0.61		0.90

Subbasin Runoff Results

Total Rainfall (in) 0.42
Total Runoff (in) 0.38
Peak Runoff (cfs) 2.75
Rainfall Intensity 5.000
Weighted Runoff Coefficient 0.9000
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASINA3



Subbasin : BASINB1

Input Data

Area (ac) 2.03
Weighted Runoff Coefficient 0.3800

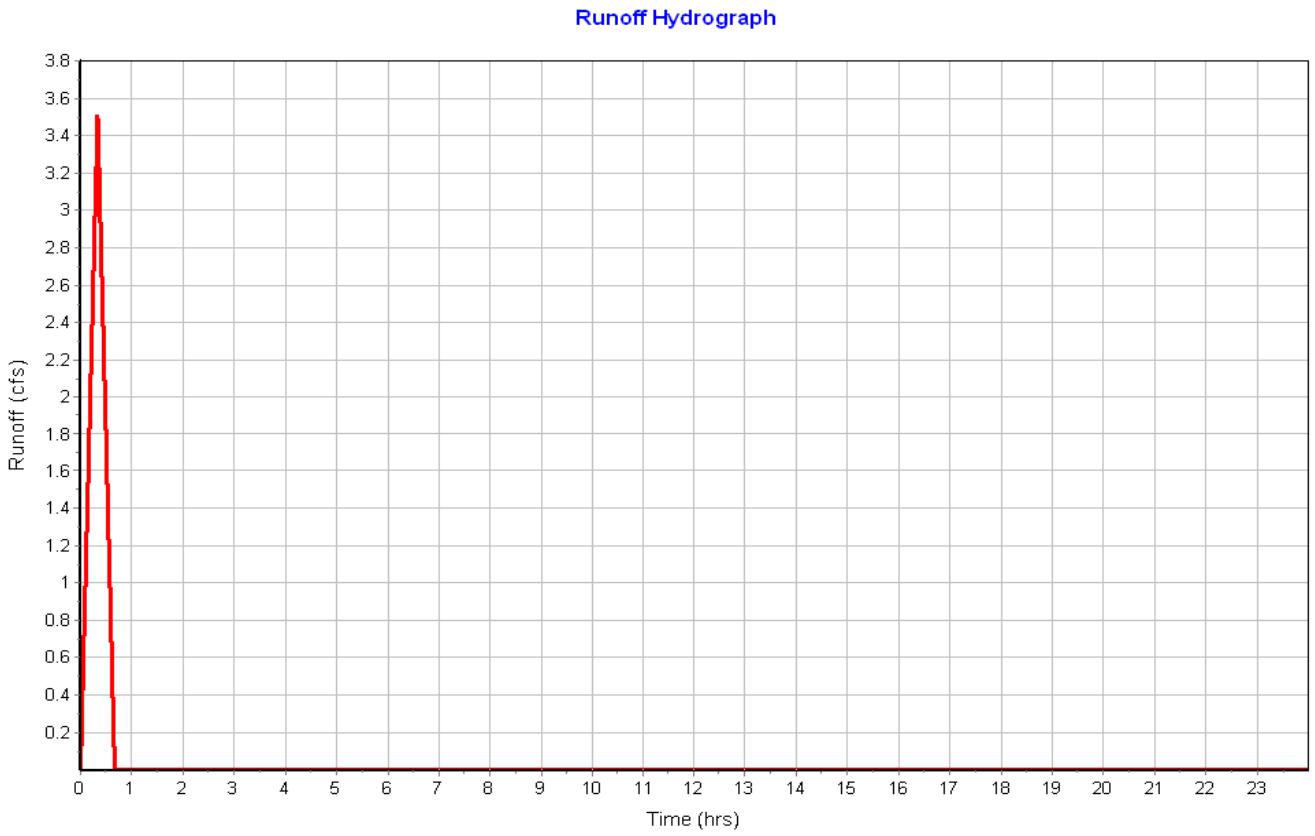
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.51	-	0.90
-	1.52	-	0.20
Composite Area & Weighted Runoff Coeff.	2.03		0.38

Subbasin Runoff Results

Total Rainfall (in) 1.52
Total Runoff (in) 0.58
Peak Runoff (cfs) 3.51
Rainfall Intensity 4.544
Weighted Runoff Coefficient 0.3800
Time of Concentration (days hh:mm:ss) 0 00:20:00

Subbasin : BASINB1



Subbasin : BASINB2

Input Data

Area (ac) 0.36
Weighted Runoff Coefficient 0.9000

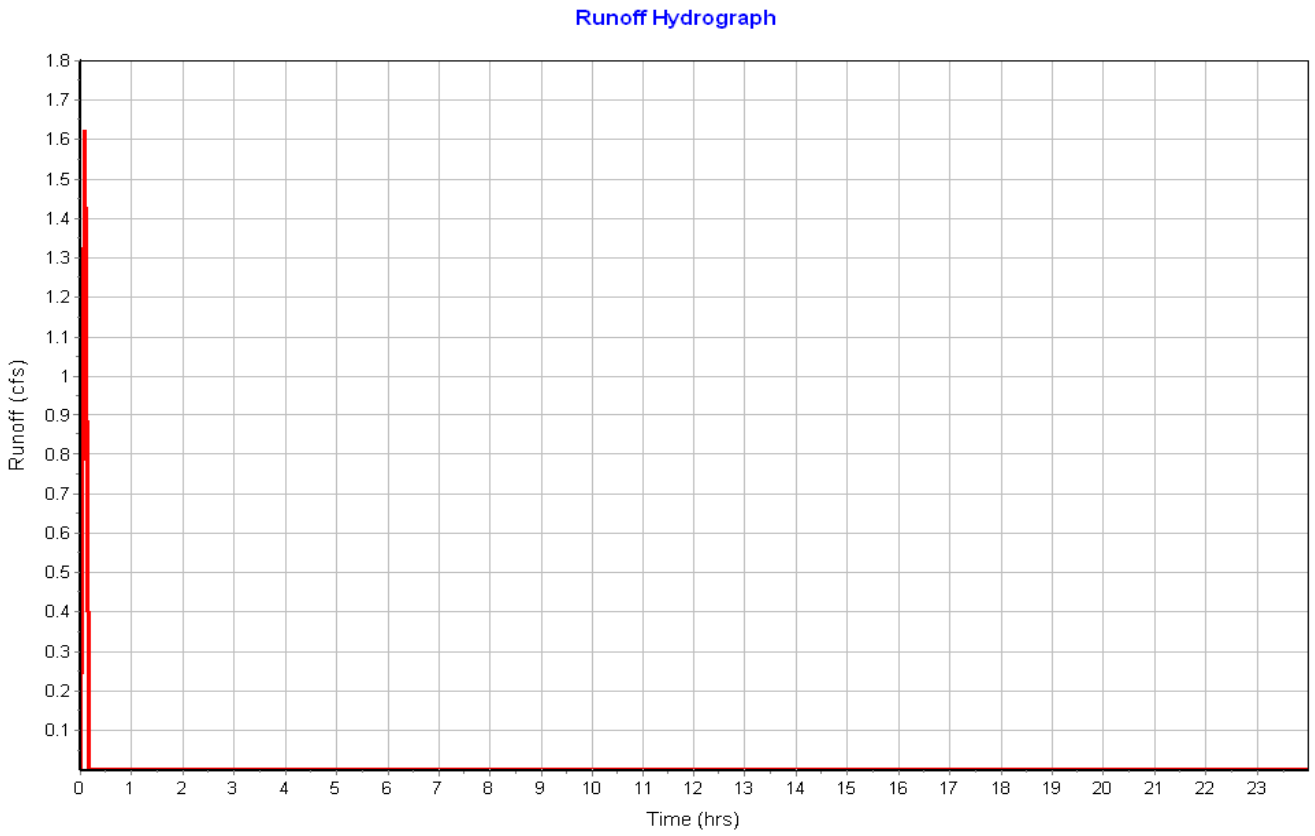
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.36	-	0.90
Composite Area & Weighted Runoff Coeff.	0.36		0.90

Subbasin Runoff Results

Total Rainfall (in) 0.42
Total Runoff (in) 0.38
Peak Runoff (cfs) 1.62
Rainfall Intensity 5.000
Weighted Runoff Coefficient 0.9000
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASINB2



Subbasin : BASIND1

Input Data

Area (ac)	0.06
Weighted Runoff Coefficient	0.9000

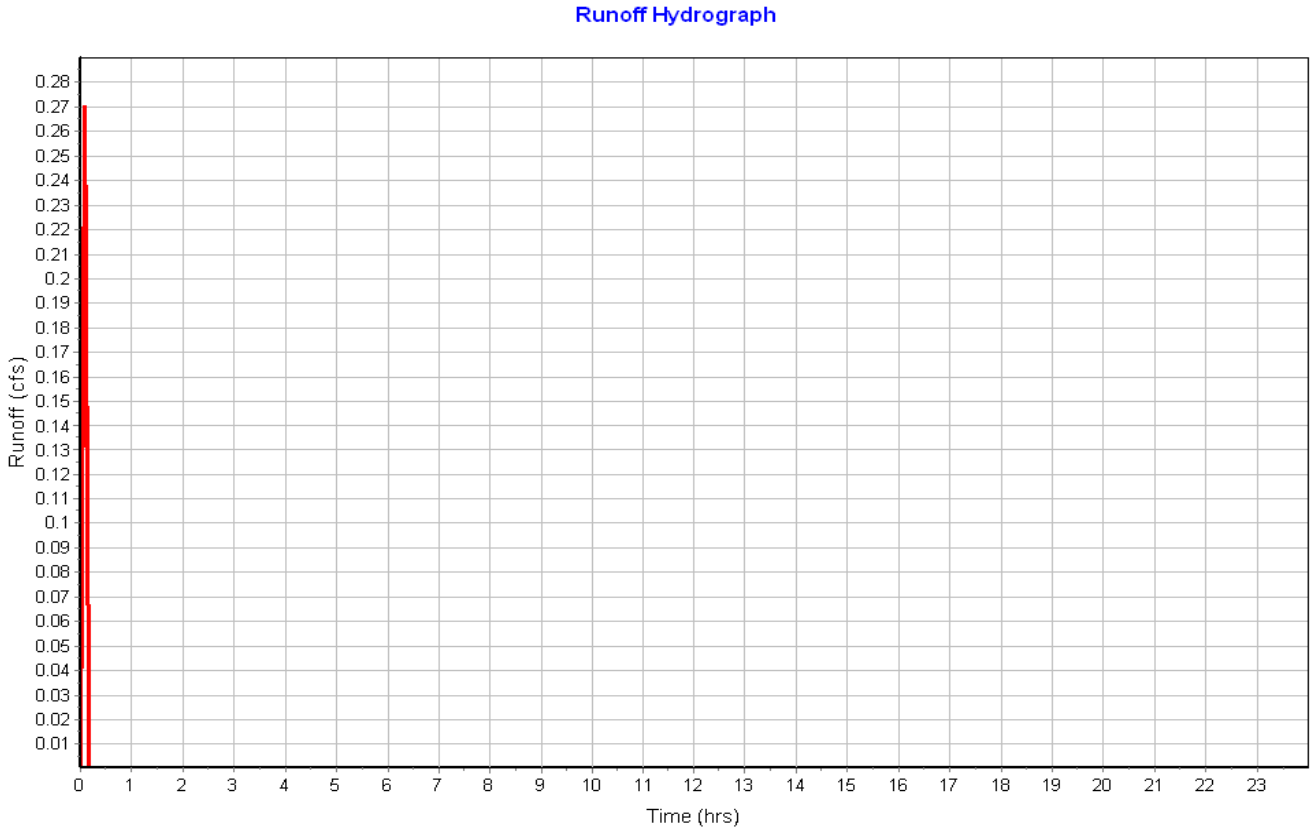
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.06	-	0.90
Composite Area & Weighted Runoff Coeff.	0.06		0.90

Subbasin Runoff Results

Total Rainfall (in)	0.42
Total Runoff (in)	0.38
Peak Runoff (cfs)	0.27
Rainfall Intensity	5.000
Weighted Runoff Coefficient	0.9000
Time of Concentration (days hh:mm:ss)	0 00:05:00

Subbasin : BASIND1



Subbasin : BASIND2

Input Data

Area (ac) 0.16
Weighted Runoff Coefficient 0.9000

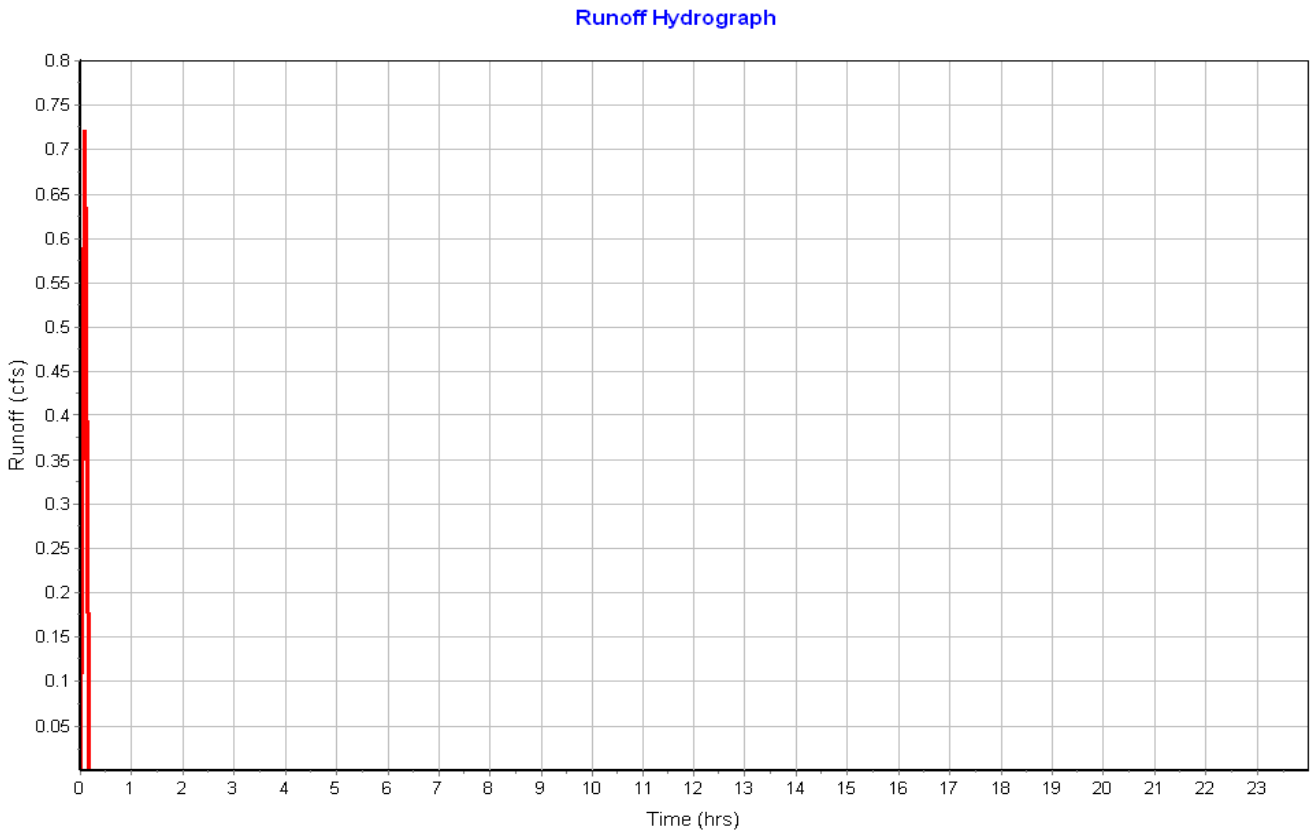
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.16	-	0.90
Composite Area & Weighted Runoff Coeff.	0.16		0.90

Subbasin Runoff Results

Total Rainfall (in) 0.42
Total Runoff (in) 0.38
Peak Runoff (cfs) 0.72
Rainfall Intensity 5.000
Weighted Runoff Coefficient 0.9000
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASIND2



Subbasin : BASINE1

Input Data

Area (ac) 0.19
Weighted Runoff Coefficient 0.9000

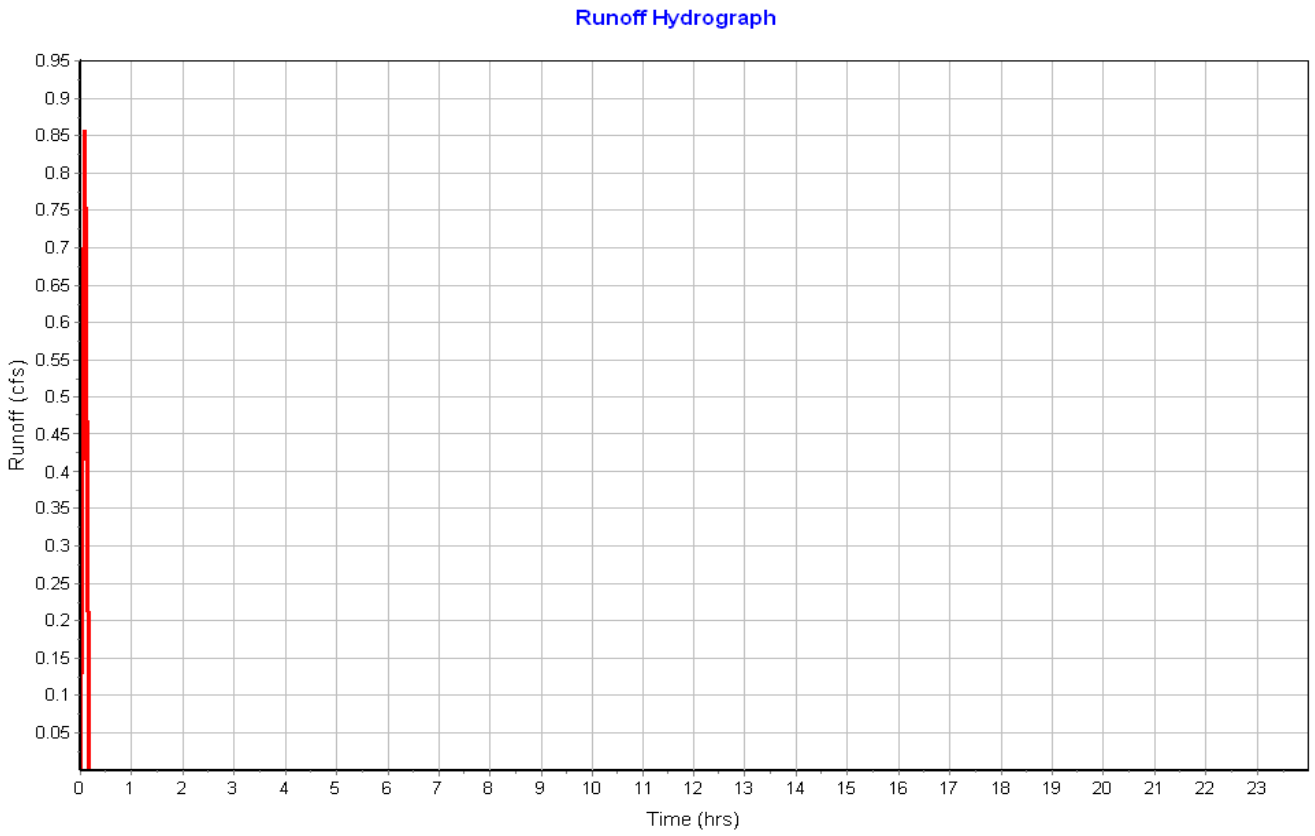
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.19	-	0.90
Composite Area & Weighted Runoff Coeff.	0.19		0.90

Subbasin Runoff Results

Total Rainfall (in) 0.42
Total Runoff (in) 0.38
Peak Runoff (cfs) 0.86
Rainfall Intensity 5.000
Weighted Runoff Coefficient 0.9000
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASINE1



Subbasin : BASINE2

Input Data

Area (ac) 0.34
Weighted Runoff Coefficient 0.9000

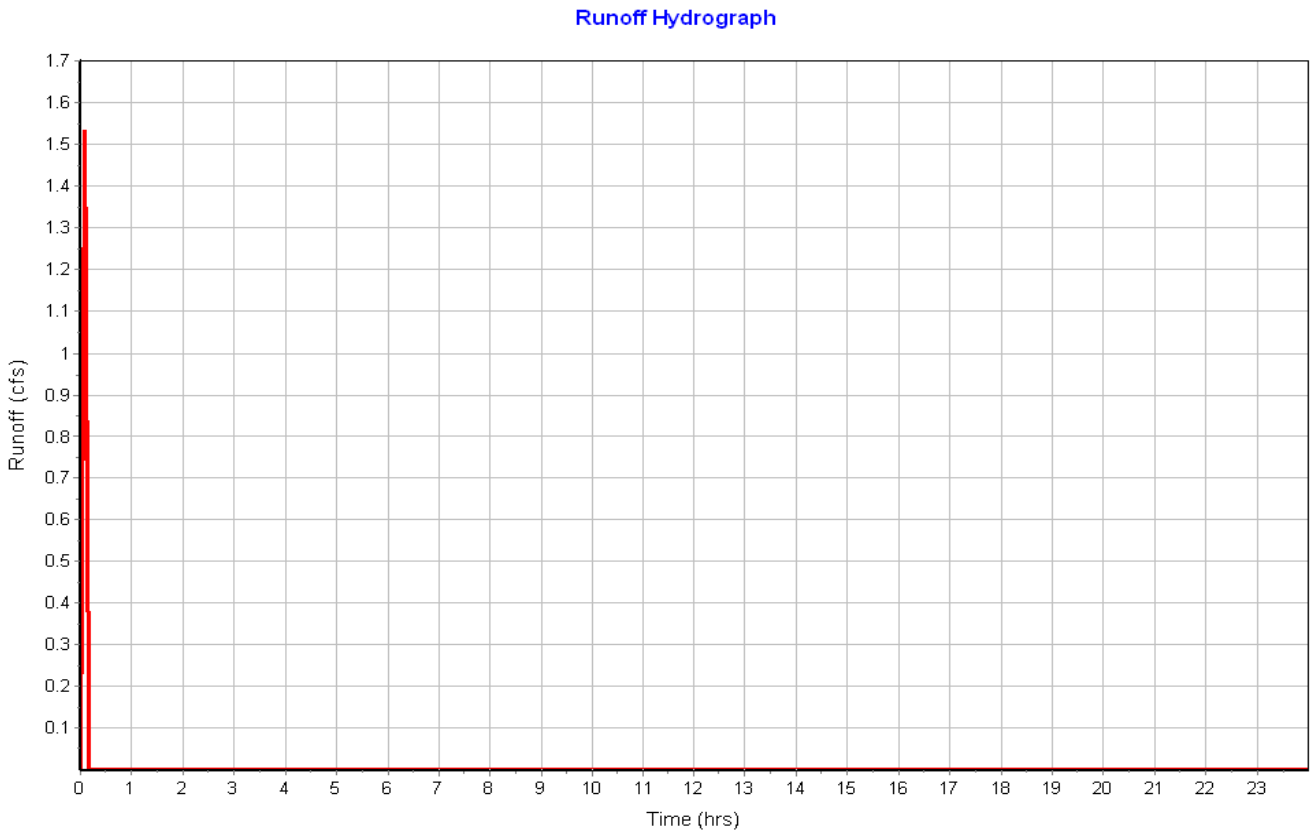
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.34	-	0.90
Composite Area & Weighted Runoff Coeff.	0.34		0.90

Subbasin Runoff Results

Total Rainfall (in) 0.42
Total Runoff (in) 0.38
Peak Runoff (cfs) 1.53
Rainfall Intensity 5.000
Weighted Runoff Coefficient 0.9000
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASINE2



Subbasin : BASINF1

Input Data

Area (ac) 0.39
Weighted Runoff Coefficient 0.9000

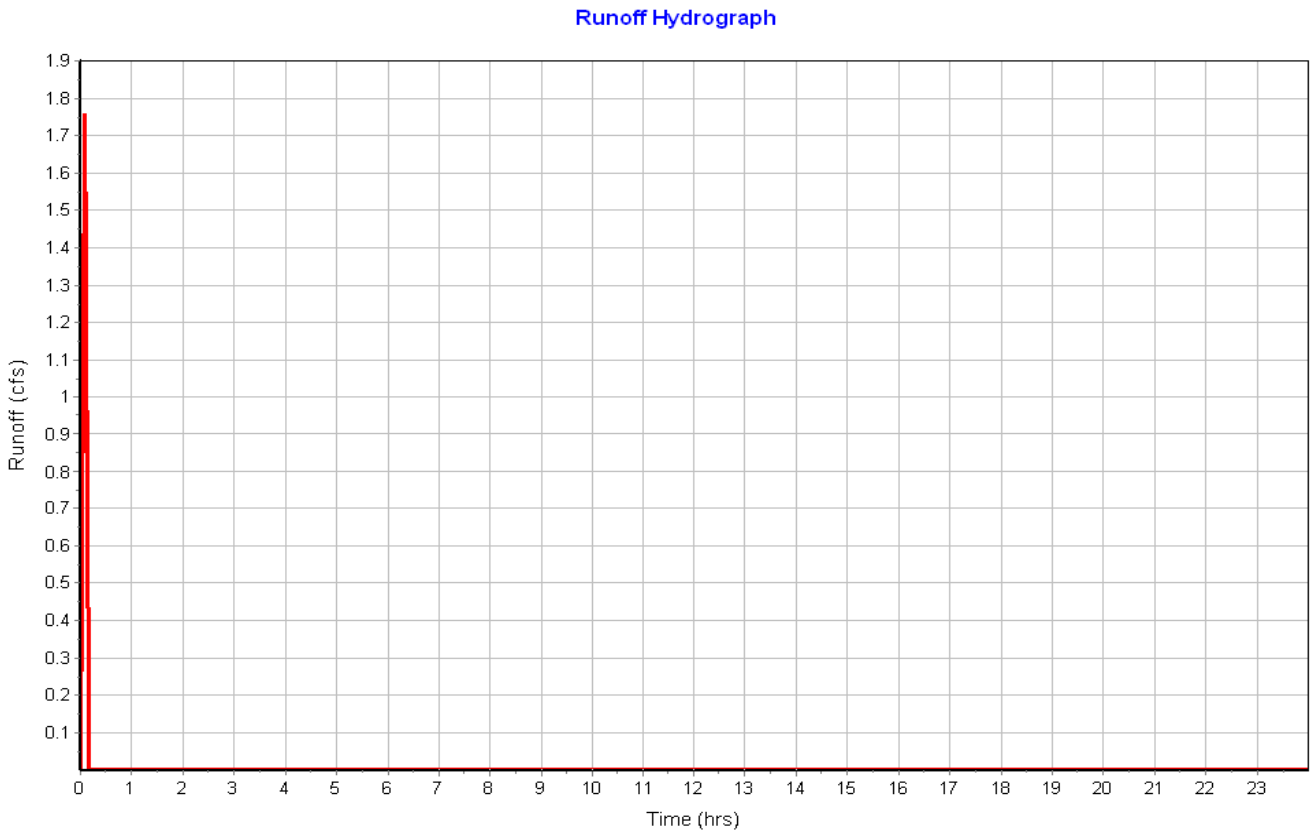
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.39	-	0.90
Composite Area & Weighted Runoff Coeff.	0.39		0.90

Subbasin Runoff Results

Total Rainfall (in) 0.42
Total Runoff (in) 0.38
Peak Runoff (cfs) 1.76
Rainfall Intensity 5.000
Weighted Runoff Coefficient 0.9000
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASINF1



Subbasin : BASINF2

Input Data

Area (ac) 0.17
Weighted Runoff Coefficient 0.9000

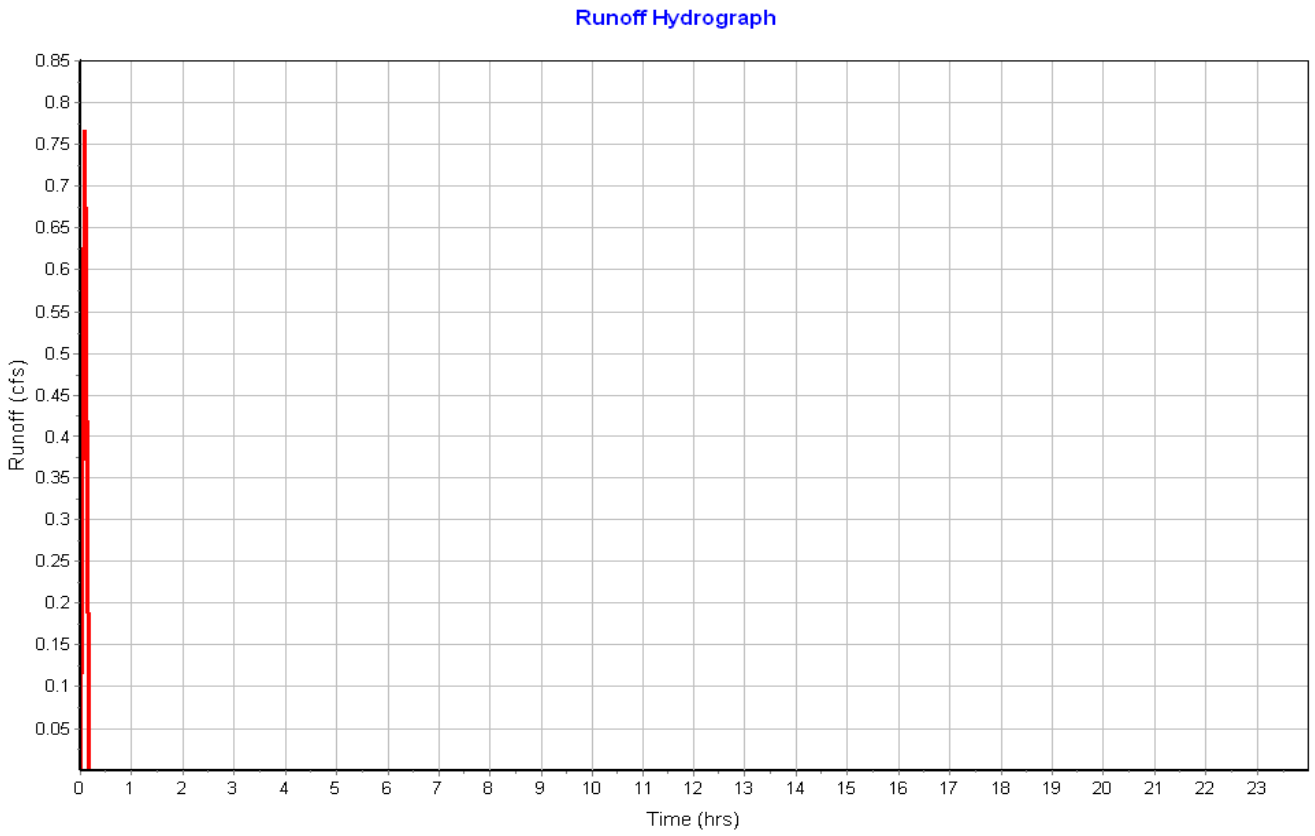
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.17	-	0.90
Composite Area & Weighted Runoff Coeff.	0.17		0.90

Subbasin Runoff Results

Total Rainfall (in) 0.42
Total Runoff (in) 0.38
Peak Runoff (cfs) 0.77
Rainfall Intensity 5.000
Weighted Runoff Coefficient 0.9000
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASINF2



Subbasin : BASING1

Input Data

Area (ac) 0.42
Weighted Runoff Coefficient 0.9000

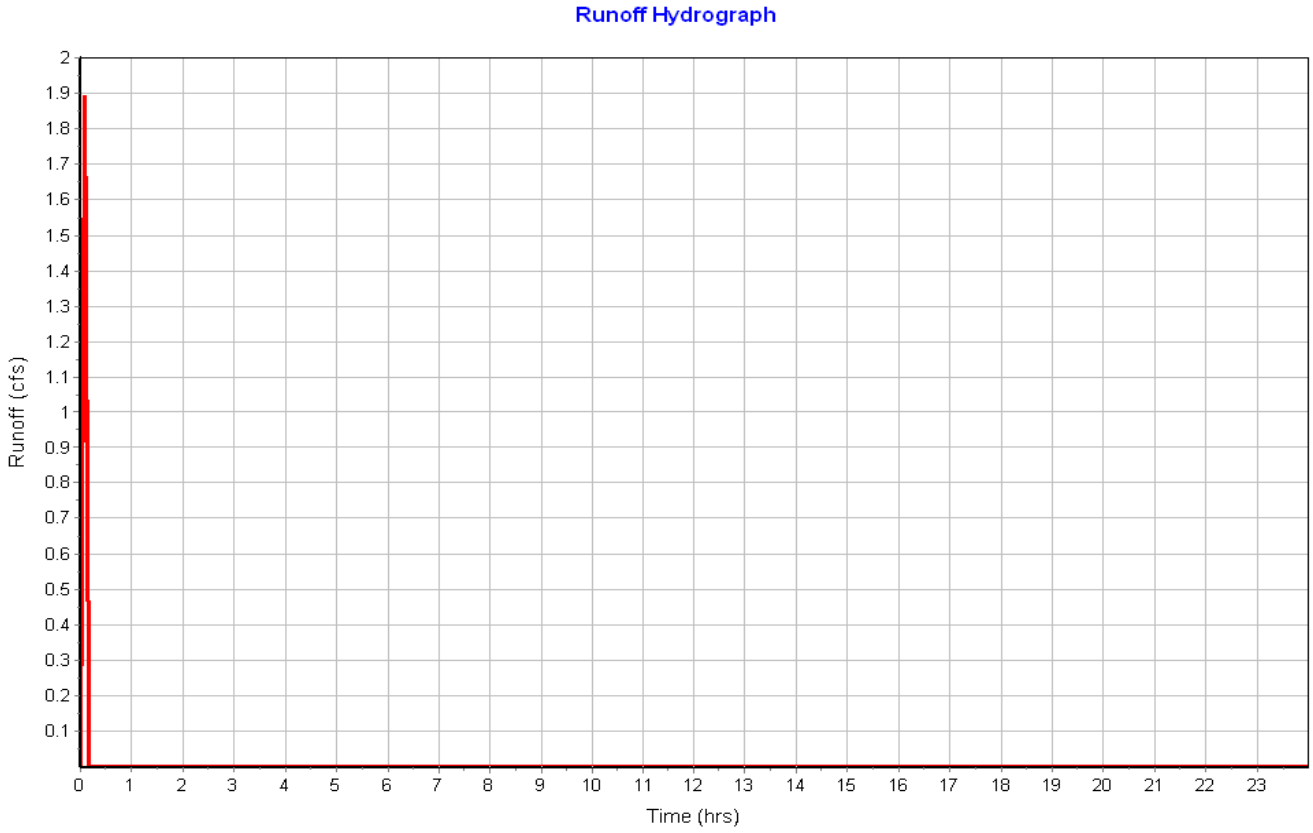
Runoff Coefficient

Soil/Surface Description	Area (acres)	Soil Group	Runoff Coeff.
-	0.42	-	0.90
Composite Area & Weighted Runoff Coeff.	0.42		0.90

Subbasin Runoff Results

Total Rainfall (in) 0.42
Total Runoff (in) 0.38
Peak Runoff (cfs) 1.89
Rainfall Intensity 5.000
Weighted Runoff Coefficient 0.9000
Time of Concentration (days hh:mm:ss) 0 00:05:00

Subbasin : BASING1



Junction Input

SN	Element ID	Invert Elevation (ft)	Ground/Rim (Max) Elevation (ft)	Ground/Rim (Max) Offset (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Surcharge Elevation (ft)	Surcharge Depth (ft)	Ponded Area (ft^2)	Minimum Pipe Cover (in)
1	A2	513.60	515.93	2.33	513.24	-0.36	515.93	0.00	10.00	0.00
2	C1	513.00	519.00	6.00	513.00	0.00	519.00	0.00	10.00	0.00
3	C2	498.00	516.18	18.18	498.00	0.00	516.18	0.00	10.00	0.00
4	C3	490.00	500.19	10.19	490.00	0.00	500.19	0.00	10.00	0.00
5	C4	488.62	493.81	5.19	488.62	0.00	493.81	0.00	10.00	0.00
6	D3	485.94	493.50	7.56	485.94	0.00	493.50	0.00	10.00	0.00
7	D4	484.50	488.64	4.14	484.50	0.00	488.64	0.00	0.00	0.00
8	H1	483.59	487.95	4.36	483.59	0.00	0.00	-487.95	10.00	0.00

Junction Results

SN	Element ID	Peak Inflow (cfs)	Peak Lateral Inflow (cfs)	Max HGL Elevation Attained (ft)	Max HGL Depth Attained (ft)	Max Surcharge Depth Attained (ft)	Min Freeboard Attained (ft)	Average HGL Elevation Attained (ft)	Average HGL Depth Attained (ft)	Time of Max HGL Occurrence (days hh:mm)	Time of Peak Flooding Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	A2	4.44	0.00	514.20	0.60	0.00	1.73	513.61	0.01	0 00:21	0 00:00	0.00	0.00
2	C1	4.14	4.14	513.40	0.40	0.00	5.60	513.40	0.40	0 00:00	0 00:00	0.00	0.00
3	C2	4.14	0.00	512.40	14.40	0.00	3.78	512.40	14.40	0 00:00	0 00:00	0.00	0.00
4	C3	4.14	0.00	495.47	5.47	0.00	4.72	495.47	5.47	0 00:02	0 00:00	0.00	0.00
5	C4	4.14	0.00	489.28	0.66	0.00	4.54	489.28	0.66	0 00:05	0 00:00	0.00	0.00
6	D3	3.20	0.00	486.40	0.46	0.00	7.09	485.95	0.01	0 00:05	0 00:00	0.00	0.00
7	D4	7.46	0.00	485.35	0.85	0.00	3.29	484.61	0.11	0 00:05	0 00:00	0.00	0.00
8	H1	2.72	2.72	483.87	0.28	0.00	4.08	483.87	0.28	0 00:00	0 00:00	0.00	0.00

Channel Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Shape	Height (ft)	Width (ft)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	BYPASSA1-D2	203.07	516.00	0.00	486.68	0.00	29.32	14.4400	User-Defined	0.500	10.000	0.0320	0.5000	0.5000	0.0000	0.00	No
2	BYPASSB1-B2	115.48	518.73	0.00	516.42	0.00	2.31	2.0000	User-Defined	0.500	10.000	0.0320	0.5000	0.5000	0.0000	0.00	No
3	BYPASSB2-A3	288.00	516.42	0.00	513.00	-0.24	3.42	1.1900	User-Defined	0.500	10.000	0.0320	0.5000	0.5000	0.0000	0.00	No
4	BYPASSD1-ROAD	13.48	497.00	1.27	495.00	0.00	2.00	14.8400	User-Defined	0.500	10.000	0.0320	0.5000	0.5000	0.0000	0.00	No
5	BYPASSE1-E2	132.58	496.80	0.00	487.51	0.00	9.29	7.0100	User-Defined	0.500	10.000	0.0320	0.5000	0.5000	0.0000	0.00	No
6	BYPASSE2-G1	97.68	487.51	0.00	485.00	0.00	2.51	2.5700	User-Defined	0.500	10.000	0.0320	0.5000	0.5000	0.0000	0.00	No
7	BYPASSF1-F2	59.26	490.00	0.00	487.30	0.00	2.70	4.5600	User-Defined	0.500	10.000	0.0320	0.5000	0.5000	0.0000	0.00	No
8	BYPASSF2-G1	137.86	487.30	0.00	485.00	0.00	2.30	1.6700	User-Defined	0.500	10.000	0.0320	0.5000	0.5000	0.0000	0.00	No

Channel Results

SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1	BYPASSA1-D2	1.73	0 00:20	22.25	0.08	3.99	0.85	0.18	0.36	0.00		
2	BYPASSB1-B2	1.11	0 00:21	7.52	0.15	1.38	1.39	0.22	0.45	0.00		
3	BYPASSB2-A3	0.14	0 00:08	8.78	0.02	1.89	2.54	0.09	0.18	0.00		
4	BYPASSD1-ROAD	0.00	0 00:00	32.15	0.00	0.00		0.00	0.00	0.00		
5	BYPASSE1-E2	0.01	0 00:07	16.81	0.00	2.19	1.01	0.03	0.06	0.00		
6	BYPASSE2-G1	0.13	0 00:06	15.40	0.01	2.67	0.61	0.07	0.15	0.00		
7	BYPASSF1-F2	0.26	0 00:05	14.07	0.02	2.40	0.41	0.10	0.21	0.00		
8	BYPASSF2-G1	0.02	0 00:07	10.20	0.00	1.38	1.66	0.04	0.07	0.00		

Pipe Input

SN	Element ID	Length (ft)	Inlet Invert Elevation (ft)	Inlet Invert Offset (ft)	Outlet Invert Elevation (ft)	Outlet Invert Offset (ft)	Total Drop (ft)	Average Slope (%)	Pipe Shape	Pipe Diameter or Height (in)	Pipe Width (in)	Manning's Roughness	Entrance Losses	Exit/Bend Losses	Additional Losses	Initial Flow (cfs)	Flap Gate
1	PIPEA1-A2	42.00	516.00	0.00	513.60	0.00	2.40	5.7100	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
2	PIPEA2-A3	19.00	513.60	0.00	513.24	0.00	0.36	1.8900	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
3	PIPEA3-DETENTION1	10.00	513.24	0.00	513.00	0.00	0.24	2.4000	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
4	PIPEB1-B2	102.00	518.73	0.00	516.62	0.20	2.11	2.0600	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
5	PIPEB2-A2	264.00	516.42	0.00	513.60	0.00	2.82	1.0700	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
6	PIPEC1-C2	14.00	513.00	0.00	512.00	14.00	1.00	7.1400	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
7	PIPEC2-C3	80.00	498.00	0.00	495.00	5.00	3.00	3.7500	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
8	PIPEC3-C4	116.00	490.00	0.00	488.62	0.00	1.38	1.1900	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
9	PIPEC4-OUTLET	50.00	488.62	0.00	488.00	0.00	0.62	1.2400	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
10	PIPED1-D2	16.00	495.73	0.00	495.54	8.86	0.19	1.1900	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
11	PIPED2-D3	72.00	486.68	0.00	485.94	0.00	0.75	1.0400	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
12	PIPED3-D4	55.00	485.94	0.00	484.60	0.10	1.34	2.4400	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
13	PIPED4-DET2	2.50	484.60	0.10	484.50	0.00	0.10	4.0000	CIRCULAR	15.000	15.000	0.0150	0.5000	0.5000	0.0000	0.00	No
14	PIPEE1-E2	120.00	496.80	0.00	489.30	1.79	7.50	6.2500	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
15	PIPEE2-D3	76.00	487.51	0.00	485.94	-0.01	1.57	2.0700	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
16	PIPEF1-F2	46.00	490.00	0.00	487.50	0.20	2.50	5.4300	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
17	PIPEF2-D4	96.00	487.30	0.00	484.60	0.10	2.70	2.8100	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
18	PIPEG1-D4	28.00	485.00	0.00	484.60	0.10	0.40	1.4300	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No
19	PIPEH1-EXINLET	21.00	483.59	0.00	480.77	0.00	2.82	13.4300	CIRCULAR	15.000	15.000	0.0120	0.5000	0.5000	0.0000	0.00	No

No. of Barrels
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1
1

Pipe Results

SN	Element ID	Peak Flow	Time of Peak Flow Occurrence	Design Flow Capacity	Peak Flow/ Design Flow Ratio	Peak Flow Velocity	Travel Time	Peak Flow Depth	Peak Flow Depth/ Total Depth Ratio	Total Time Surcharged	Froude Number	Reported Condition
		(cfs)	(days hh:mm)	(cfs)		(ft/sec)	(min)	(ft)		(min)		
1	PIPEA1-A2	1.12	0 00:20	16.73	0.07	7.70	0.09	0.22	0.18	0.00		Calculated
2	PIPEA2-A3	4.44	0 00:21	9.63	0.46	7.69	0.04	0.60	0.48	0.00		Calculated
3	PIPEA3-DETENTION1	5.18	0 00:05	10.84	0.48	8.73	0.02	0.61	0.49	0.00		Calculated
4	PIPEB1-B2	2.35	0 00:20	10.05	0.23	7.26	0.23	0.41	0.33	0.00		Calculated
5	PIPEB2-A2	3.33	0 00:21	7.23	0.46	5.80	0.76	0.60	0.48	0.00		Calculated
6	PIPEC1-C2	4.14	0 00:00	18.70	0.22	12.24	0.02	0.40	0.32	0.00		Calculated
7	PIPEC2-C3	4.14	0 00:02	13.55	0.31	9.70	0.14	0.47	0.38	0.00		Calculated
8	PIPEC3-C4	4.14	0 00:05	7.63	0.54	6.34	0.30	0.66	0.52	0.00		Calculated
9	PIPEC4-OUTLET	4.14	0 00:05	7.79	0.53	6.44	0.13	0.65	0.52	0.00		Calculated
10	PIPED1-D2	0.27	0 00:05	7.63	0.04	3.03	0.09	0.16	0.13	0.00		Calculated
11	PIPED2-D3	1.73	0 00:21	7.11	0.24	4.78	0.25	0.42	0.34	0.00		Calculated
12	PIPED3-D4	3.20	0 00:05	10.92	0.29	7.74	0.12	0.46	0.37	0.00		Calculated
13	PIPED4-DET2	7.46	0 00:05	11.20	0.67	9.76	0.00	0.75	0.60	0.00		Calculated
14	PIPEE1-E2	0.83	0 00:05	17.50	0.05	10.13	0.20	0.18	0.15	0.00		Calculated
15	PIPEE2-D3	2.17	0 00:05	10.06	0.22	6.56	0.19	0.39	0.31	0.00		Calculated
16	PIPEF1-F2	1.45	0 00:05	16.31	0.09	9.23	0.08	0.25	0.20	0.00		Calculated
17	PIPEF2-D4	2.38	0 00:05	11.74	0.20	7.51	0.21	0.38	0.31	0.00		Calculated
18	PIPEG1-D4	1.93	0 00:05	8.36	0.23	5.55	0.08	0.41	0.33	0.00		Calculated
19	PIPEH1-EXINLET	2.72	0 00:00	25.65	0.11	13.60	0.03	0.27	0.22	0.00		Calculated

Inlet Input

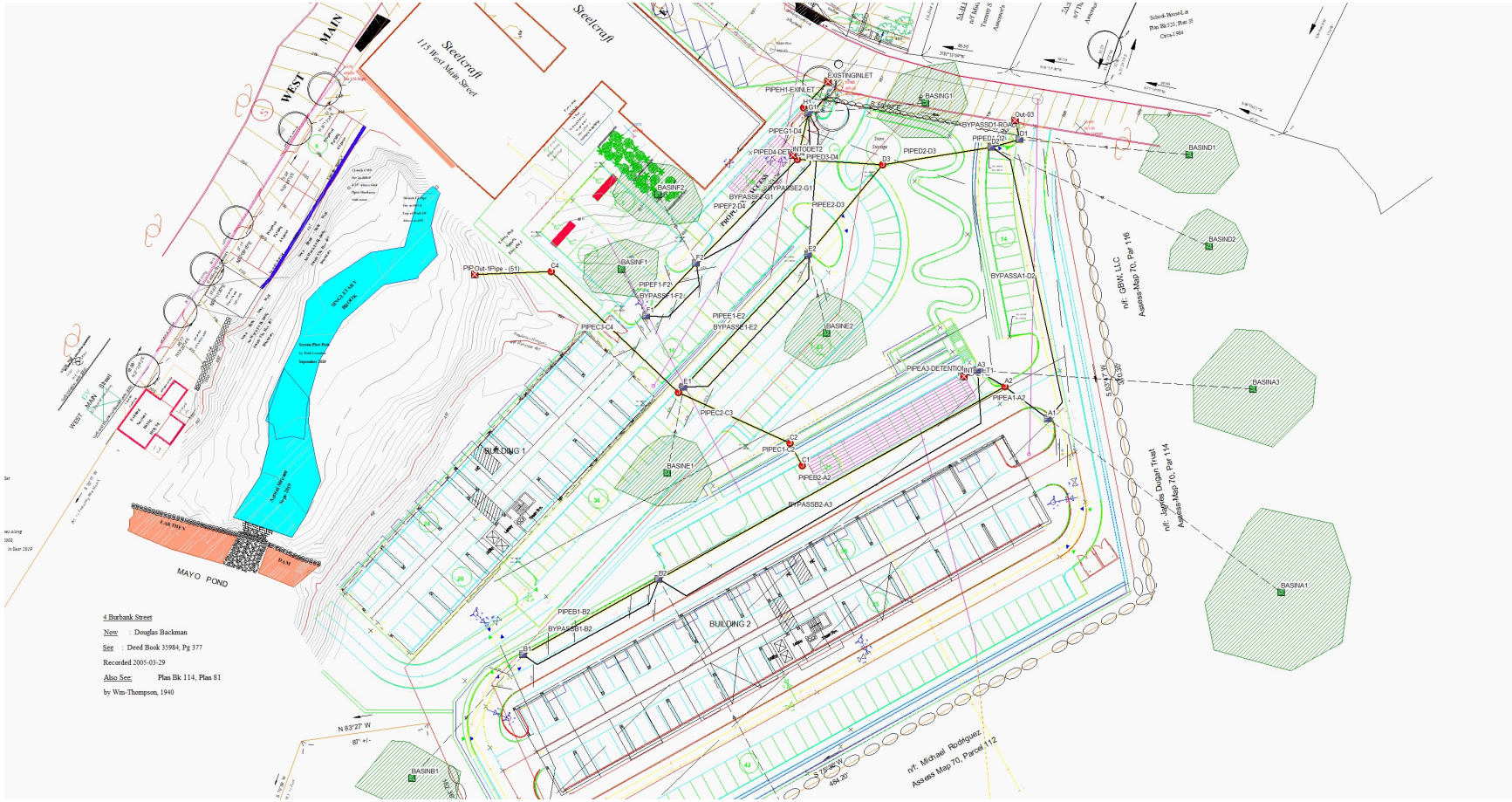
SN	Element ID	Inlet Manufacturer	Manufacturer Part Number	Inlet Location	Number of Inlets	Catchbasin Invert Elevation (ft)	Max (Rim) Elevation (ft)	Inlet Depth (ft)	Initial Water Elevation (ft)	Initial Water Depth (ft)	Ponded Area (ft^2)	Grate Clogging Factor (%)
1	A1	FHWA HEC-22 GENERIC	N/A	On Grade	1	516.00	519.44	3.44	516.00	0.00	N/A	0.00
2	A3	FHWA HEC-22 GENERIC	N/A	On Sag	1	513.24	516.72	3.48	0.00	0.00	0.00	0.00
3	B1	FHWA HEC-22 GENERIC	N/A	On Grade	1	518.73	522.35	3.63	518.73	0.00	N/A	0.00
4	B2	FHWA HEC-22 GENERIC	N/A	On Grade	1	516.42	521.07	4.65	516.42	0.00	N/A	0.00
5	D1	FHWA HEC-22 GENERIC	N/A	On Grade	1	495.73	497.73	2.00	495.73	0.00	N/A	0.00
6	D2	FHWA HEC-22 GENERIC	N/A	On Sag	1	486.68	499.73	13.05	486.68	0.00	10.00	0.00
7	E1	FHWA HEC-22 GENERIC	N/A	On Grade	1	496.80	499.88	3.08	496.80	0.00	N/A	0.00
8	E2	FHWA HEC-22 GENERIC	N/A	On Grade	1	487.51	492.54	5.03	487.51	0.00	N/A	0.00
9	F1	FHWA HEC-22 GENERIC	N/A	On Grade	1	490.00	493.11	3.11	490.00	0.00	N/A	0.00
10	F2	FHWA HEC-22 GENERIC	N/A	On Grade	1	487.30	490.81	3.51	487.30	0.00	N/A	0.00
11	G1	FHWA HEC-22 GENERIC	N/A	On Sag	1	485.00	488.00	3.00	485.00	0.00	10.00	0.00

Roadway & Gutter Input

SN	Element ID	Roadway Longitudinal Slope (ft/ft)	Roadway Cross Slope (ft/ft)	Roadway Manning's Roughness	Gutter Cross Slope (ft/ft)	Gutter Width (ft)	Gutter Depression (in)	Allowable Spread (ft)
1	A1	0.2000	0.2000	0.0130	0.0620	2.00	0.0000	7.00
2	A3	N/A	0.0200	0.0160	0.0620	2.00	0.0656	7.00
3	B1	0.0240	0.0240	0.0130	0.0620	2.00	0.0000	7.00
4	B2	0.0260	0.0260	0.0130	0.0620	2.00	0.0000	7.00
5	D1	0.0560	0.0560	0.0130	0.0620	2.00	0.0328	7.00
6	D2	N/A	0.0500	0.0130	0.0620	2.00	0.0328	7.00
7	E1	0.0630	0.0630	0.0130	0.0620	2.00	0.0000	7.00
8	E2	0.0630	0.1070	0.0130	0.0620	2.00	0.0328	7.00
9	F1	0.0620	0.0090	0.0130	0.0620	2.00	0.0328	7.00
10	F2	0.0350	0.0530	0.0130	0.0620	2.00	0.0328	7.00
11	G1	N/A	0.0210	0.0130	0.0620	2.00	0.0328	7.00

Inlet Results

SN	Element ID	Peak Flow (cfs)	Peak Lateral Inflow (cfs)	Peak Flow Intercepted by Inlet (cfs)	Peak Flow Bypassing Inlet (cfs)	Inlet Efficiency during Peak Flow (%)	Max Gutter Spread during Peak Flow (ft)	Max Gutter Water Elev. during Peak Flow (ft)	Max Gutter Water Depth during Peak Flow (ft)	Time of Max Depth Occurrence (days hh:mm)	Total Flooded Volume (ac-in)	Total Time Flooded (min)
1	A1	2.89	2.89	1.12	1.78	38.61	2.25	519.61	0.17	0 00:20	0.00	0.00
2	A3	2.74	2.74	N/A	N/A	N/A	13.12	517.23	0.51	0 00:05	0.00	0.00
3	B1	3.51	3.51	2.36	1.15	67.27	7.44	522.60	0.25	0 00:20	0.00	0.00
4	B2	1.62	1.62	1.38	0.24	85.18	4.81	521.27	0.20	0 00:20	0.00	0.00
5	D1	0.27	0.27	0.27	0.00	100.00	1.00	497.79	0.06	0 00:05	0.00	0.00
6	D2	1.73	0.72	N/A	N/A	N/A	4.91	500.08	0.35	0 00:05	0.00	0.00
7	E1	0.85	0.85	0.84	0.02	97.89	2.18	500.02	0.14	0 00:05	0.00	0.00
8	E2	1.53	1.53	1.36	0.17	89.01	2.43	492.71	0.17	0 00:05	0.00	0.00
9	F1	1.75	1.75	1.45	0.30	82.79	6.94	493.28	0.17	0 00:05	0.00	0.00
10	F2	0.97	0.76	0.95	0.02	97.96	2.66	490.97	0.16	0 00:05	0.00	0.00
11	G1	1.94	1.89	N/A	N/A	N/A	9.80	488.37	0.37	0 00:05	0.00	0.00



Autodesk Storm and Sanitary Analysis

APPENDIX 6

Groundwater Recharge Volume

Standard 3

Groundwater Recharge Volume Required:

Rv = F x Impervious Area, where:

Rv = Required Recharge Volume [Ac-ft]

F = Target Depth Factor associated with each Hydrologic Soil Group (HSG) [in] Impervious Area = Total Pavement and Rooftop Area under Post-development Conditions [Ac]

			Impervious Area [Acres]	Required Recharge Volume [Ac-ft]
HSG"A", F=	0.6	in	0.000	0.000
HSG"B", F=	0.35	in	0.000	0.000
HSG"C", F=	0.25	in	2.45	0.051
HSG"D", F=	0.1	in	0.000	0.000

Total Required Recharge Volume (Rv) = 0.051 Ac-ft

Capture Area Adjustment:
(PER DEP Handbook V.3 Ch.1 P.27-28)

Area in Pavement = 52,708 sf (1.21 AC)
Area in Sidewalk = 12,367 sf (0.28 AC)
Area in Roof = 41,902 sf (0.96 AC)

Total = 2.45 AC

Total Site Impervious Area (Total)= 2.45 Acres
Impervious Area Draining to lnfiltrative BMPs (infil) = 1.23 Acres
Percent Imp. Area Draining to lnfiltrative BMPs = 50%

Capture Area Adjustment Factor (Total)/(lnfil) = Ca = 2.0
Adjusted Required Recharge Volume = Ca x Rv = **0.102 Ac-Ft**

Total area in pervious pavers = 24,158 sf
Lower parking area = 14,064 sf
Area in Chambers = 770 sf
AR = Recharge surface area in square feet = Area in extended Detention = 13,295 sf

VRS = Volume of recharge system in cubic feet = Volume of 3/4 " clean Rock fill = 13,295 sf x 1 ft thick blanket = 13,295 cf
VRS = Volume in void = 13,295 cf x 0.35 = 4,653 cf = 0.106 Ac-Ft

Groundwater Recharge Volume Provided :

BMP	Provided Recharge_Volume (Ac-Ft)
Lower Extended Infiltartion/Detention Basin	0.106

PROVIDED GROUNDWATER RECHARGE VOLUME IS GREATER THAN OR EQUAL TO THE REQUIRED RECHARGE VOLUME, THEREFORE PROPOSED STORMWATER MANAGEMENT DESIGN IS IN COMPLIANCE WITH STANDARD 3.

The time required to dewater the recharge system may be estimated by the following equation:

$T_D = V_{RS} / (f/12 * AR)$

Where:

T_D = Dewatering time in hours
V_{RS} = Volume of recharge system in cubic feet
A_R = Recharge surface area in square feet
f = Design infiltration rater in inches/hour
12 = conversion from inches to feet

$T_D = V_{RS} / (f/12 * AR)$

= 4653 / (0.25/12 * 13,295)
= 16.04 hrs

Note:

1. The infiltration BMPs have been designed to fully drain within 72 hours, therefore the proposed stormwater management design is in compliance with Standard 3.

2. Per Volume 3 of the Massachusetts Stormwater management Standard, the "Static" method has been proposed. Therefore, the Rawls Rate at the location and soil depth has been used.

APPENDIX 7

Water Quality Calculations

Standard 4

Water Quality:

$V_{WQ} = (D_{WQ}/12 \text{ inches/foot}) * A_{IMP} * 43560 \text{ sf/acre})$:

V_{WQ} = *Required Water Quality Volume* (in cubic feet)

D_{WQ} = Water Quality Depth: one-inch for discharges within a Zone II or Interim Wellhead Protection Area, to or near another critical area, runoff from a LUHPPL, or exfiltration to soils with infiltration rate greater than 2.4 inches/hour or greater; ½-inch for discharges near or to other areas.

A_{IMP} = Impervious Area (in acres) Area in roof has been excluded.

Area in Pavement = 52,708 sf (1.21 AC)
Area in Sidewalk = 12,367 sf (0.28 AC)

Total = 1.49 AC

V_{WQ} = (D_{WQ}/12 inches/foot) * (A_{IMP} * 43,560 square feet/acre)
V_{WQ} = (½-inch/12 inches/foot) * (1.49 * 43,560 square feet/acre)
V_{WQ} = 2,704.3 cubic feet

Total water Quality Provided:

Pond 1 Chamber System Volume = 10,903 cf
Pond 2 Chamber System Volume = 4,788 cf

Total Provided = 15,691 cf

WATER QUALITY VOLUME IS GREATER THAN OR EAUQL TO THE REQUIRED WATER QUALITY VOLUME. THEREFORE, THE PROPOSED STORMWATER MANAGEMENTY DESIGN IS IN COMPLIANCE WITH STANDARD 4.

INSTRUCTIONS:

Version 1, Automated: Mar. 4, 2008

1. In BMP Column, click on Blue Cell to Activate Drop Down Menu
2. Select BMP from Drop Down Menu
3. After BMP is selected, TSS Removal and other Columns are automatically completed.

Location: Millbury, MA

TSS Removal Calculation Worksheet

B BMP[1]	C TSS Removal Rate[1]	D Starting TSS Load*	E Amount Removed (C*D)	F Remaining Load (D-E)
Porous Pavement	**0.80**	**1.00**	**0.80**	**0.20**
Deep Sump and Hooded Catch Basin	**0.25**	**0.20**	**0.05**	**0.15**
Street Sweeping - 10%	**0.10**	**0.15**	**0.02**	**0.14**
Subsurface Infiltration Structure	**0.80**	**0.14**	**0.11**	**0.03**
	0.00	**0.03**	**0.00**	**0.03**

Total TSS Removal = **97%**

Separate Form Needs to be Completed for Each Outlet or BMP Train

Project:

Prepared By:

Date:

*Equals remaining load from previous BMP (E) which enters the BMP

Non-automated TSS Calculation Sheet must be used if Proprietary BMP Proposed

1. From MassDEP Stormwater Handbook Vol. 1

APPENDIX 8

Long Term Stormwater Operation & Maintenance Plan

Long-Term Pollution Prevention Plan

This Long-Term Pollution Prevention Plan has been developed to establish site management practices that improve the quality of stormwater discharges from the Project.

Maintenance of Pavement Systems

Paved Surfaces

Regular maintenance of pavement surfaces will prevent pollutants such as oil and grease, trash, and sediments from entering the stormwater management system. The following practices should be performed:

Sweep or vacuum asphalt pavement areas with a commercial cleaning unit and dispose of removed material.

Routinely pick up and remove litter from the parking areas, islands, and perimeter landscaping.

Maintenance of Vegetated Areas

Proper maintenance of vegetated areas can prevent the pollution of stormwater runoff by controlling the source of pollutants such as suspended sediments, excess nutrients, and chemicals from landscape care products. Practices that should be followed under the regular maintenance of the vegetated landscape include:

Inspect planted areas on a semi-annual basis and remove any litter.

Maintain planted areas adjacent to pavement to prevent soil washout.

Immediately clean any soil deposited on pavement.

Re-seed bare areas; install appropriate erosion control measures when native soil is exposed or erosion channels are forming.

Plant alternative mixture of grass species in the event of unsuccessful establishment.

Management of Snow and Ice

Storage and Disposal

Snow shall be stockpiled on standard pavement surfaces so sand and salt may be swept in the spring or removed as snow melts and drains through the stormwater management system. Key practices for the safe storage and disposal of snow include:

Under no circumstances shall snow be disposed or stored in wetland resource areas.

Under no circumstances shall snow be disposed or stored in stormwater basins, ponds, rain gardens, swales, channels, or trenches.

Salt and Deicing Chemicals

The amount of salt and deicing chemicals to be used on the site shall be reduced to the minimum amount needed to provide safe pedestrian and vehicle travel. The following practices should be followed to control the amount of salt and deicing materials that come into contact with stormwater runoff:

Devices used for spreading salt and deicing chemicals should be capable of varying the rate of application based on the site specific conditions.

Sand and salt should be stockpiled under covered storage facilities that prevent precipitation and adjacent runoff from coming in contact with the deicing materials.

Spill Prevention and Response Plan

Spill prevention equipment and training will be provided by the property management company.

Initial Notification

In the event of a spill the facility and/or construction manager or supervisor will be notified immediately.

FACILITY MANAGER
Name: _____ Home Phone: _____
Phone: _____ E-mail: _____

CONSTRUCTION MANAGER
Name: _____ Home Phone: _____
Phone: _____ E-mail: _____

The supervisor will first contact the Fire Department and then notify the Police Department,

the Public Health Commission and the Conservation Commission. The Fire Department is ultimately responsible for matters of public health and safety and should be notified immediately.

Further Notification

Based on the assessment from the Fire Chief, additional notification to a cleanup contractor may be made. The Massachusetts Department of Environmental Protection (DEP) and the EPA may be notified depending upon the nature and severity of the spill. The Fire Chief will be responsible for determining the level of cleanup and notification required. The attached list of emergency phone numbers shall be posted in the main construction/facility office and readily accessible to all employees. A hazardous waste spill report shall be completed as necessary using the attached form.

Emergency Notification Phone Numbers

1. **FACILITY MANAGER**
   Name:_____ Home Phone: _____
   Phone:_____ E-mail:_____
   ALTERENATE
   Name: _____ Home Phone: _____
   Phone: _____ E-mail: _____

2. **FIRE DEPARTMENT**
   Emergency: **911**
   Business: _____
   POLICE DEPARTMENT
   Emergency: **911**
   Business: _____

3. **CLEANUP CONTRACTOR:**
   Address: _____
   Phone: _____

4. **MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL PROTECTION**
   Emergency: _____

5. **NATIONAL RESPONSE CENTER**
   Phone: _____

ALTERNATE: U.S. ENVIRONMENTAL PROTECTION AGENCY

Emergency: _____

Business: _____

6. CONSERVATION COMMISSION

Contact: _____

Phone: _____

7. HEALTH DEPARTMENT

Contact: _____

Phone: _____

Hazardous Waste / Oil Spill Report

Date_____ Time_____ AM / PM

Exact location (Transformer #) _____

_____ Type of equipment__Make

_____Size_____ S / N

_____Weather Conditions _____

_____

On or near Water ☐ Yes
If Yes, name of body of Water _____

☐ No

Type of chemical/oil spilled _____

Amount of chemical/oil spilled _____

Cause of Spill _____

Measures taken to contain or clean up spill _____

Amount of chemical/oil recovered_____Method_____

Material collected as a result of cleanup:

_____ Drums containing _____

_____ Drums containing _____

_____ Drums containing _____

Location and method of debris disposal

_____

Name and address of any person, firm, or corporation suffering damages:

_____

Procedures, method, and precautions instituted to prevent a similar occurrence from recurring:

_____

Spill reported to General Office by_____Time_____AM / PM

Spill reported to DEP / National Response Center by _____

DEP Date_____Time_____AM / PM Inspector _____

NRC Date_____Time_____AM / PM Inspector _____

Additional comments: _____

_____

Assessment - Initial Containment

The supervisor or manager will assess the incident and initiate containment control measures with the appropriate spill containment equipment included in the spill kit kept on-site. A list of recommended spill equipment to be kept on site is included on the following page.

Fire / Police Department 911

Millbury Health Department _____

Millbury Conservation Commission: _____

Emergency Response Equipment

The following equipment and materials shall be available and stored in a secure area for long-term emergency response needs.

Stormwater Operation and Maintenance Plan

Project Information

Site
115 West Main Street
Millbury, MA

Owner
Douglas Backman
115 West Main Street
Millbury, MA

Developer
Douglas Backman
115 West Main Street
Millbury, MA

Description of Stormwater Maintenance Measures

The following Operation and Maintenance (O&M) program is proposed to ensure the continued effectiveness of the stormwater management system. Attached to this plan are a Stormwater Best Management Practices Checklist and Maintenance Figure for use during the long term operation and maintenance of the stormwater management system.

Catch Basins

All catch basins shall be inspected and cleaned a minimum of at least four times per year.

Sediment (if more than two feet deep from the bottom of the structure) and/or floatable pollutants shall be pumped from the basin and disposed of at an approved offsite facility in accordance with all applicable regulations.

Any structural damage or other indication of malfunction will be reported to the site manager and repaired as required.

During colder periods, the catch basin grates must be kept free of snow and ice.

During warmer periods, the catch basin grates must be kept free of leaves, litter, sand, and debris.

Subsurface Infiltration/Detention System

- The subsurface infiltration/detention systems shall be inspected at least once each year by removing the manhole/access port covers and determining the thickness of sediment that has accumulated.
- If sediment is more than five inches deep from the bottom of the structure, it must be suspended via flushing with clean water and removed using a vactor truck.
- Manufacturer's specifications and instructions for cleaning the sediment removal row is provided as an attachment to this section.
- Emergency overflow pipes shall be examined at least once each year and verified that no blockage has occurred.
- System shall be observed after rainfalls to see if it is properly draining.

Stormwater Outfalls

- Inspect outfall locations monthly for the first three months after construction to ensure proper functioning and correct any areas that have settled or experienced washouts.
- Inspect outfalls annually after initial three-month period.
- Annual inspections should be supplemented after large storms when washouts may occur.
- Maintain vegetation around outfalls to prevent blockages at the outfall.
- Maintain riprap pad below each outfall and replace any washouts.
- Remove and dispose of any trash or debris at the outfall.

Long-Term Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐ yes ☐ no (List Items)	Date of Cleaning/Repair	Performed by
Catch basins	Four times per year			• Clean accumulated sand and sediment whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin; • Floatables	☐ yes ☐ no		
Subsurface Infiltration/Detention System	In accordance with manufacturer's recommendations but no less than twice a year following installation and no less than once a year thereafter.			• Remove any debris that might clog the system • Stadia rod may be inserted through inspection ports to determine the depth of sediment. Cleanout is required if the sediment has accumulated to an average depth exceeding 5" from the bottom of the structure, per the manufacturer's recommendations.	yes ☐ no ☐		
Stormwater Outfalls	Monthly for the first three months after construction and no less than once a year thereafter.			• Maintain vegetation around outfalls to prevent blockages • Maintain riprap pad below each outfall and replace any washouts • Remove and dispose of any trash or debris at the outfall	☐ yes ☐ no		

Stormwater Control Manager _____

Maintenance Guide

BaySaver Barracuda™

July 2017

One of the advantages of the BaySaver Barracuda is the ease of maintenance. Like any system that collects pollutants, the BaySaver Barracuda must be maintained for continued effectiveness. Maintenance is a simple procedure performed using a vacuum truck or similar equipment. The systems were designed to minimize the volume of water removed during routine maintenance, reducing disposal costs.

Contractors can access the pollutants stored in the manhole through the manhole cover. This allows them to gain vacuum hose access to the bottom of the manhole to remove sediment and trash. There is no confined space entry necessary for inspection or maintenance.

The entire maintenance procedure typically takes from 2 to 4 hours, depending on the size of the system, the captured material, and the capacity of the vacuum truck.

Local regulations may apply to the maintenance procedure. Safe and legal disposal of pollutants is the responsibility of the maintenance contractor. Maintenance should be performed only by a qualified contractor.

Inspection and Cleaning Cycle

Periodic inspection is needed to determine the need for and frequency of maintenance. You should begin inspecting as soon as construction is complete and thereafter on an annual basis. Typically, the system needs to be cleaned every 1-3 years.

Excessive oils, fuels or sediments may reduce the maintenance cycle. Periodic inspection is important.

Determining When to Clean

To determine the sediment depth, the maintenance contractor should lower a stadia rod into the manhole until it contacts the top of the captured sediment and mark that spot on the rod. Then push the probe through to the bottom of the sump and mark that spot to determine sediment depth.

Maintenance should occur when the sediment has reached the levels indicated in the Storage Capacity Chart.

BaySaver Barracuda Storage Capacities

Model	Manhole Diameter	Treatment Chamber Capacity	Standard Sediment Capacity (20” depth)	NJDEP Sediment Capacity (50% of standard depth)
S3	36”	212 gallons	0.44 cubic yards	0.22 cubic yards
S4	48”	564 gallons	0.78 cubic yards	0.39 cubic yards
S5	60”	881 gallons	1.21 cubic yards	0.61 cubic yards
S6	72”	1269 gallons	1.75 cubic yards	0.88 cubic yards
S8	96”	3835 gallons	3.10 cubic yards	1.55 cubic yards
S10	120”	7496 gallons	4.85 cubic yards	2.43 cubic yards

Maintenance Instructions

1. Remove the manhole cover to provide access to the pollutant storage. Pollutants are stored in the sump, below the bowl assembly visible from the surface. You’ll access this area through the 10” diameter access cylinder.

2. Use a vacuum truck or other similar equipment to remove all water, debris, oils and sediment. See figure 1.
3. Use a high pressure hose to clean the manhole of all the remaining sediment and debris. Then, use the vacuum truck to remove the water.
4. Fill the cleaned manhole with water until the level reaches the invert of the outlet pipe.
5. Replace the manhole cover.
6. Dispose of the polluted water, oils, sediment and trash at an approved facility.
   - Local regulations prohibit the discharge of solid material into the sanitary system. Check with the local sewer authority for authority to discharge the liquid.
   - Some localities treat the pollutants as leachate. Check with local regulators about disposal requirements.
   - Additional local regulations may apply to the maintenance procedure.

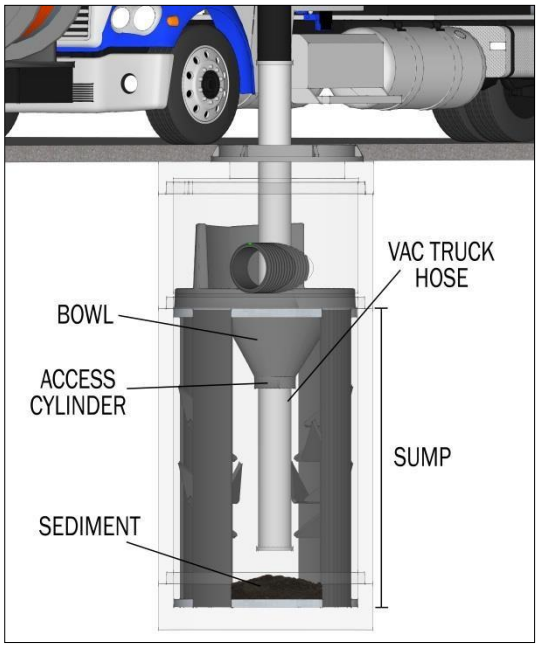


Figure 1

LONG-TERM CARE & MAINTENANCE

Even though Belgard® pavers are extremely durable and come with a lifetime structural warranty, seasonal maintenance is encouraged to preserve the beauty and integrity of your hardscape installation. To keep pavers looking their best, plan to clean and reseal them every three to five years.

GENERAL MAINTENANCE

Clean your pavers each Spring with a coarse-bristle "stable" broom and a paver cleaner to keep them looking like new.

Some weeds, if left unaddressed, can shift pavers apart over time. Be sure to periodically apply a granular weed preventative between joints as a part of your paver maintenance routine.

Be careful when cleaning your Belgard pavers with power washers as the force of the spray can expose the aggregate under the paver's surface.

Wait at least 90 days to seal your pavers so you can remove any efflorescence that might appear after installation.

CLEANING

Before applying any paver cleaning solution to your hardscape, test a small inconspicuous area first to be sure you get the desired results.

Be sure to read and follow the directions printed on container labels for cleaning solution use, application, precautions and first aid. Always rinse the solution off thoroughly after use.

In the event of an oil spill, act to remove it promptly with granular oil absorbent. Spills should be soaked up, not rubbed. Rubbing will drive the stain deeper into the concrete.

PROTECTING

De-icing substances, when used in proper amounts, should not damage pavers; however, they may accelerate surface wear on some paver styles. Use them in moderation.

Sealers should not be applied more than once in three years, to a maximum of two applications. Too many applications will create a film on the surface, which may discolor in sunlight.

The joints between paving stones are the most vulnerable areas of any installation. Keep these joints topped off with jointing sand to prevent the sand-bedding layer below from deteriorating, causing the pavers to shift.

Part of the Oldcastle® family of architectural products, Techniseal has been a world leader in the field of jointing sand and paver maintenance products for over 30 years. Inventors of the polymeric sand category, Techniseal has long been the preferred jointing material used with installations of Belgard pavers. In addition, Techniseal offers a number of cleaning and sealing products to ensure the lasting beauty of your Belgard installation for years to come.

LEARN MORE ABOUT TECHNISEAL PRODUCTS

APPENDIX 9

Construction Period Pollution Prevention Plan

Erosion and Sedimentation Control Measures

The following erosion and sedimentation controls are for use during the earthwork and construction phases of the project. The following controls are provided as recommendations for the site contractor and do not constitute or replace the final Stormwater Pollution Prevention Plan that must be fully implemented by the Contractor and owner in Compliance with EPA NPDES regulations.

Straw Wattles

Straw wattles will be placed to trap sediment transported by runoff before it reaches the drainage system or leaves the construction site.

Silt Fencing

In areas where high runoff velocities or high sediment loads are expected, straw wattles may be backed up with silt fencing. This semi-permeable barrier made of a synthetic porous fabric will provide additional protection. The silt fences and straw wattle barrier will be replaced as determined by periodic field inspections.

Catch Basin Protection

Newly constructed and existing catch basins will be protected with straw bale barriers (where appropriate) or silt sacks throughout construction.

Gravel and Construction Entrance/Exit

A temporary crushed-stone construction entrance/exit will be constructed. A cross slope will be placed in the entrance to direct runoff to a protected catch basin inlet or settling area. If deemed necessary after construction begins, a wash pad may be included to wash off vehicle wheels before leaving the project site.

Diversion Channels

Diversion channels will be used to collect runoff from construction areas and discharge to either sedimentation basins or protected catch basin inlets.

Temporary Sediment Basins

Temporary sediment basins will be designed either as excavations or bermed stormwater detention structures (depending on grading) that will retain runoff for a sufficient period of time to allow suspended soil particles to settle out prior to discharge. These temporary basins will be located based on construction needs as determined by the contractor and outlet devices will be designed to control velocity and sediment. Points of discharge from sediment basins will be stabilized to minimize erosion.

Vegetative Slope Stabilization

Stabilization of open soil surfaces will be implemented within 14 days after grading or construction activities have temporarily or permanently ceased, unless there is sufficient snow cover to prohibit implementation. Vegetative slope stabilization will be used to minimize erosion on slopes of 3:1 or flatter. Annual grasses, such as annual rye, will be used to ensure rapid germination and production of root mass. Permanent stabilization will be completed with the planting of perennial grasses or legumes. Establishment of temporary and permanent vegetative cover may be established by hydro-seeding or sodding. A suitable topsoil, good seedbed preparation, and adequate lime, fertilizer and water will be provided for effective establishment of these vegetative stabilization methods. Mulch will also be used after permanent seeding to protect soil from the impact of falling rain and to increase the capacity of the soil to absorb water.

Maintenance

 The contractor or subcontractor will be responsible for implementing each control shown on the Sedimentation and Erosion Control Plan. In accordance with EPA regulations, the contractor must sign a copy of a certification to verify that a plan has been prepared and that permit regulations are understood.

 The on-site contractor will inspect all sediment and erosion control structures periodically and after each rainfall event. Records of the inspections will be prepared and maintained on-site by the contractor.

 Silt shall be removed from behind barriers if greater than 6-inches deep or as needed.

 Damaged or deteriorated items will be repaired immediately after identification.

 The underside of straw wattles should be kept in close contact with the earth and reset as necessary.

 Sediment that is collected in structures shall be disposed of properly and covered if stored on-site.

 Erosion control structures shall remain in place until all disturbed earth has been securely stabilized. After removal of structures, disturbed areas shall be re- graded and stabilized as necessary.

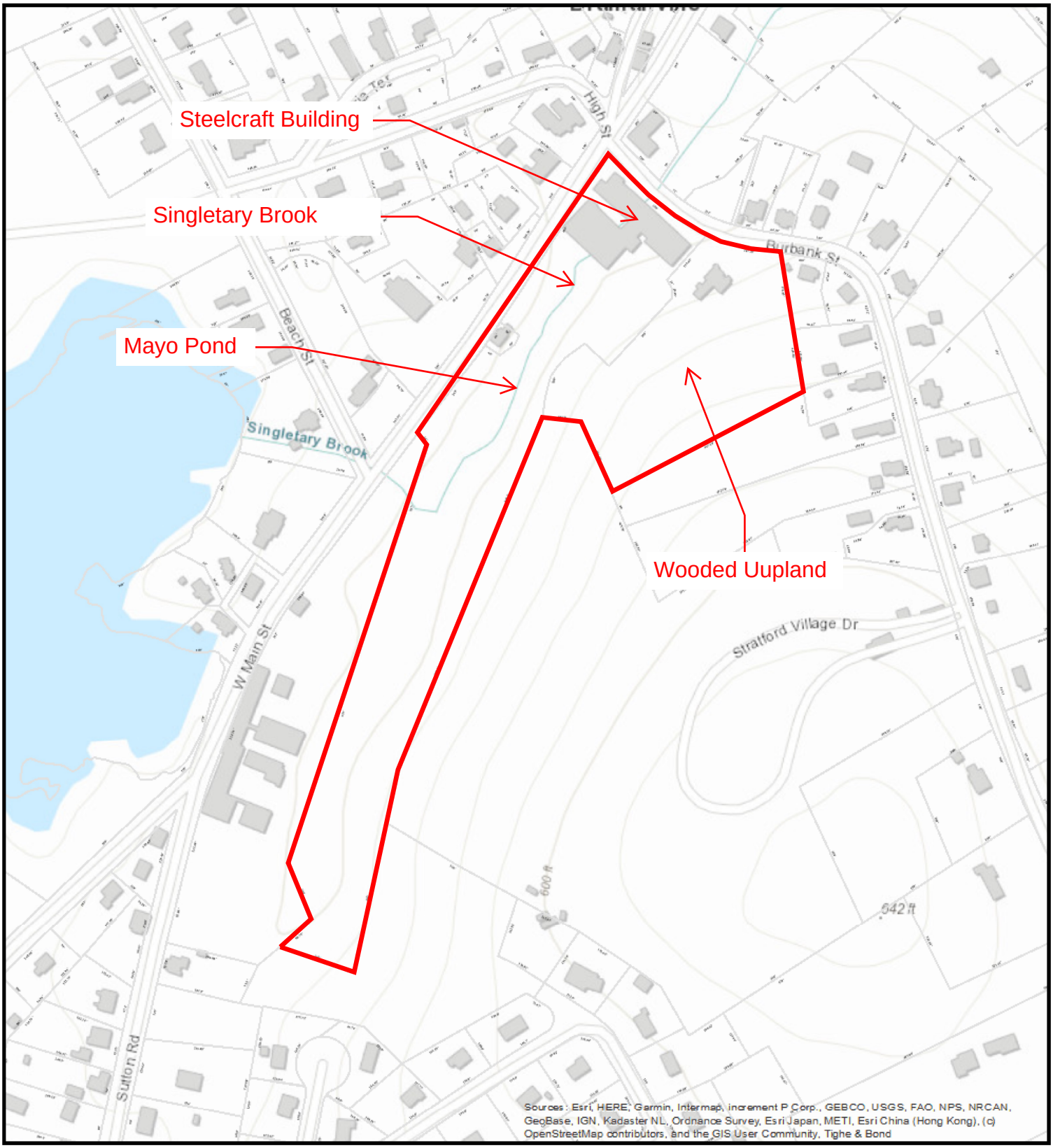
Construction Best Management Practices – Maintenance/ Evaluation Checklist

Best Management Practice	Inspection Frequency	Date Inspected	Inspector	Minimum Maintenance and Key Items to Check	Cleaning/Repair Needed ☐ yes ☐ no (List Items)	Date of Cleaning/Repair	Performed by:
Straw Wattles/Silt Fencing	In accordance with NPDES CGP			• Inspect for accumulated sediment behind straw wattles/silt fencing and remove as needed. • Separation of straw wattles with the earth and each other. Make adjustments to eliminate separations. • Damaged or broken straw wattles/ silt fence. Replace as necessary.	☐ **yes** ☐ **no**		
Gravel Construction Entrance	In accordance with NPDES CGP			• Accumulated sediment • Remove sediment that is spilled, dropped, washed or tracked onto pavements outside limit of work.	☐ **yes** ☐ **no**		
Catch Basin Protection	In accordance with NPDES CGP			• Accumulated sediment within silt sacks. Remove sediment as necessary. • Rips or torn silt sacks. Replace damaged silt sacks.	☐ **yes** ☐ **no**		
Diversion Channels	In accordance with NPDES CGP			• Cracking, • Erosion, • Leakage in the embankments • Repair diversion channels as necessary to prevent downstream erosion and sedimentation.	☐ **yes** ☐ **no**		
Temporary Sedimentation Basins	In accordance with NPDES CGP			• Cracking, • Erosion, • Leakage in the embankments • Accumulation of sediment. • Remove sediment and make repairs as necessary to ensure proper function of sediment basin.	☐ **yes** ☐ **no**		
Vegetated Slope Stabilization	In accordance with NPDES CGP			• Cracking, • Erosion • Repair/reaplace as necessary to ensure proper function of slope stabilization and to prevent downstream erosion and sedimentation.	☐ **yes** ☐ **no**		

Stormwater Control Manager _____

APPENDIX 10

NRCS Soil Map
Geotechnical Report
Test-Pit Data



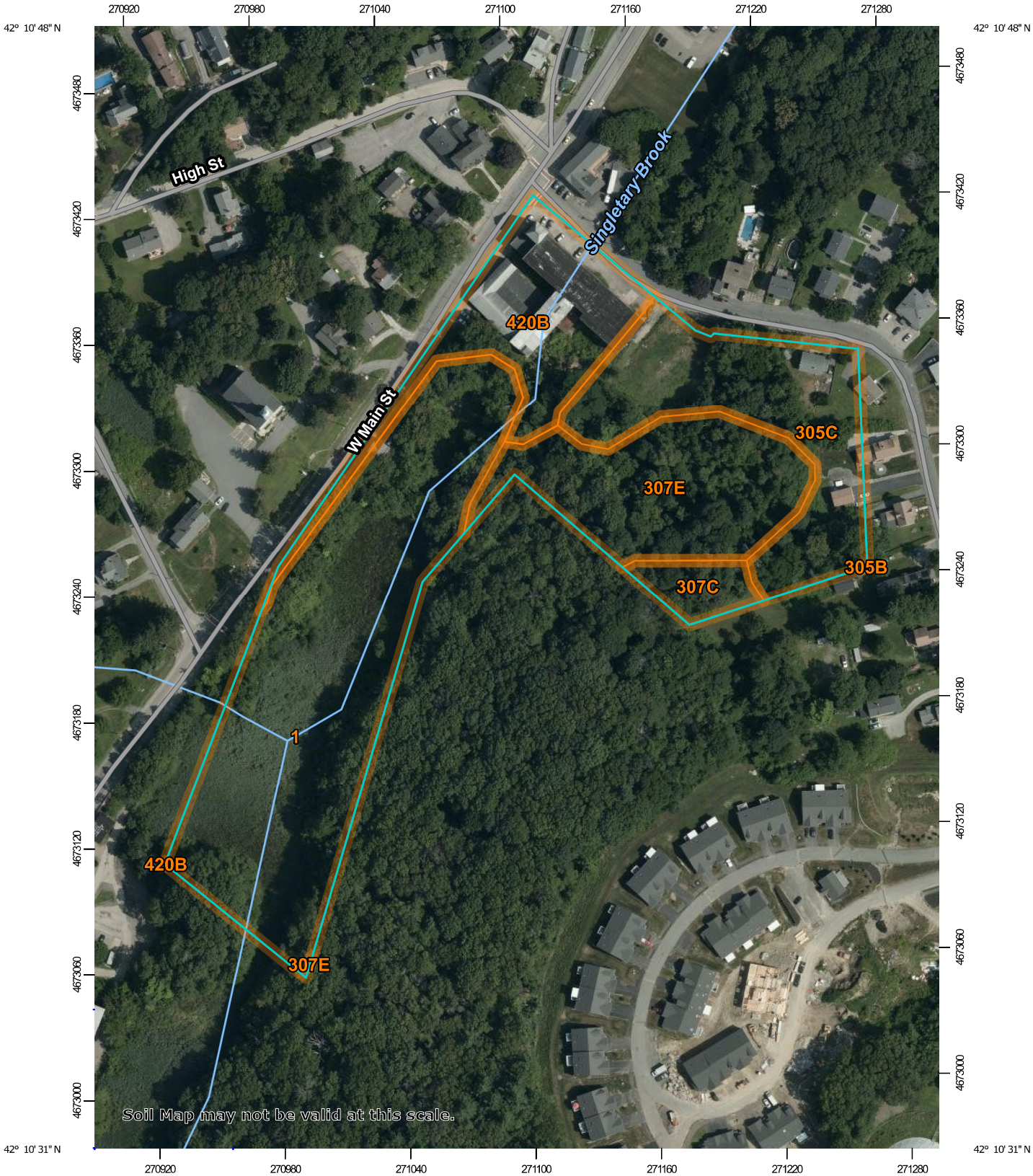
Topographic Map

4/12/2020 11:03:16 AM

Scale: 1"=300'

Scale is approximate

The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.



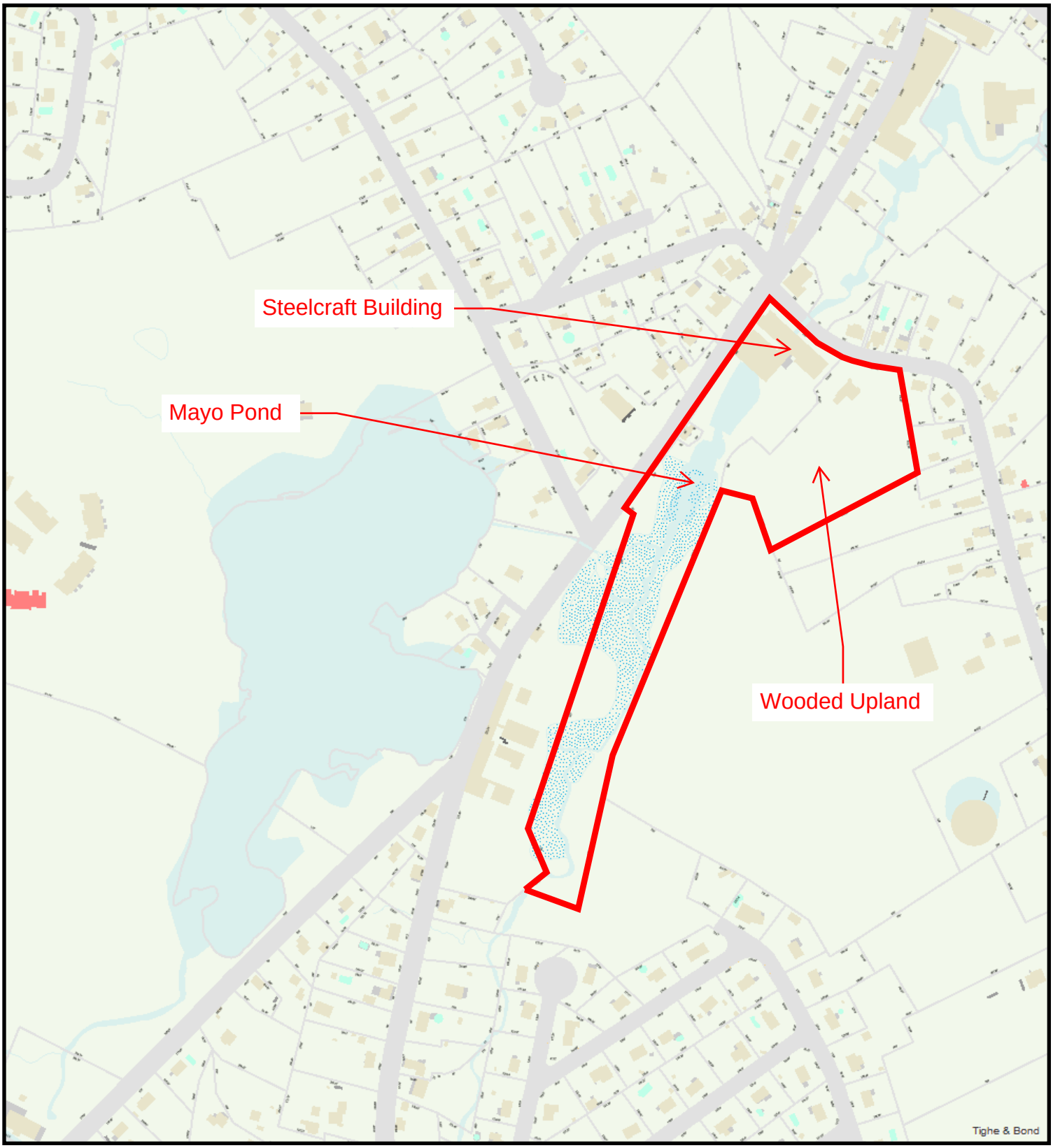
Map Scale: 1:2,600 if printed on A portrait (8.5" x 11") sheet.

N

Meters: 0 35 70 140 210

Feet: 0 100 200 400 600

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84



wetland

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Scale: 1"=400'

Scale is approximate

The information depicted on this map is for planning purposes only. It is not adequate for legal boundary definition, regulatory interpretation, or parcel-level analyses.

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

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

Background
- Aerial Photography

MAP INFORMATION

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

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

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

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

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

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

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

Soil Survey Area: Worcester County, Massachusetts, Southern Part
Survey Area Data: Version 12, Sep 12, 2019

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

Date(s) aerial images were photographed: Jul 26, 2019—Oct 5, 2019

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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
1	Water	4.8	44.2%
305B	Paxton fine sandy loam, 3 to 8 percent slopes	0.0	0.0%
305C	Paxton fine sandy loam, 8 to 15 percent slopes	2.2	20.0%
307C	Paxton fine sandy loam, 8 to 15 percent slopes, extremely stony	0.3	3.0%
307E	Paxton fine sandy loam, 15 to 35 percent slopes, extremely stony	1.9	17.8%
420B	Canton fine sandy loam, 3 to 8 percent slopes	1.6	15.0%
Totals for Area of Interest		**10.8**	**100.0%**

2/,9(5¸ 0DVV*,6 V 2QOLQH 2/,9(5 0DSSLQJ 7RROV

PLOOEXU\

=RRP WR D WRZQ

$YDLODEOH 'DWD /D\HUV

$FWLYH 'DWD /D\HUV

&KHFN DOO &KHFN QRQH 5HPRYH

- &RQWRXUV IW /DEHOV
- &RQWRXUV IW /LQHV
- 0DMRU 0DVV'27 5RXWHV
- 1+(63 (VWLPDWHG +DELWDW

/HJHQG

&RQWRXUV IW /DEHOV

&RQWRXUV IW /LQHV

150-FT INTERVAL

0DMRU 0DVV'27 5RXWHV

Interstate Highways

US Roads

State

0DVVDFKXVHWWV 7RZQV

1+(63 (VWLPDWHG +DELWDWV F

1+(63 3ULRULW\ +DELWDWV RI

6FDOH

P

%DVHPD

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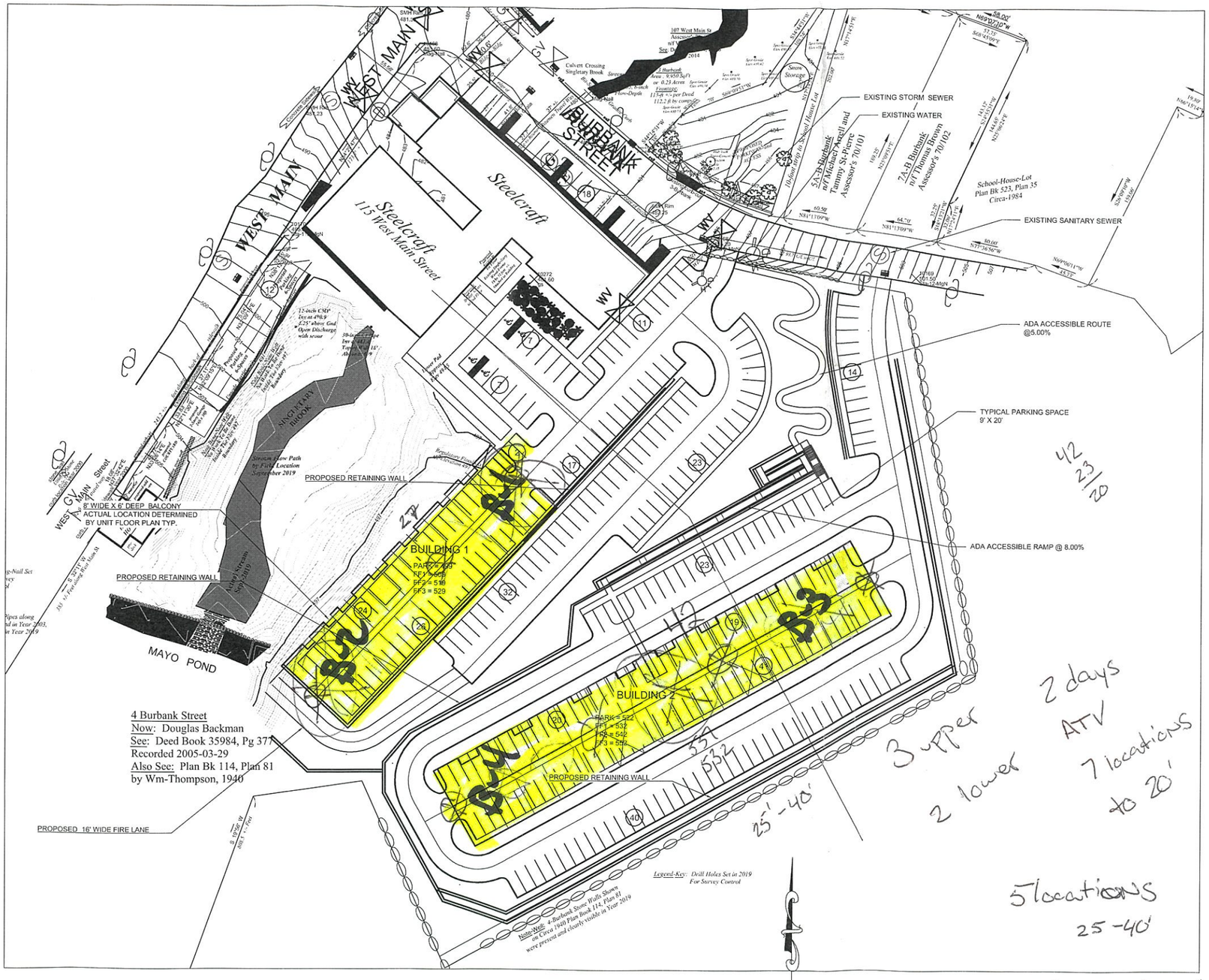
D:\Users\Owner\Documents\big box conversion\millbury mass\115 West Main St – Millbury Mass\site – 12 millbury.dwg



RESIDENTIAL DEVELOPMENT

BUILDING 1 AND 2 – THREE STORY

60 – EFFICIENCY
54 – 1 BEDROOM
36 – 2 BEDROOM

TOTAL NUMBER OF UNITS – 156

STEELCRAFT BUILDING

10 – EFFICIENCY
36 – 1 BEDROOM
6 – 2 BEDROOM

TOTAL NUMBER OF UNITS – 52

TOTAL NUMBER OF UNITS BOTH BUILDINGS = 202

REQUIRED PARKING –

70 – EFFICIENCY UNITS X 1 SPACES/UNIT = 70 SPACES
90 – 1 BEDROOM UNITS X 1.5 SPACES/UNIT = 135 SPACES
42 – 2 BEDROOM UNITS X 2 SPACES/UNIT = 84 SPACES

TOTAL REQUIRED = 289 SPACES

APARTMENT COMPLEX PARKING = 306 SPACES
BURBANK PARKING = 18 SPACES
WEST MAIN PARKING = 12 SPACES

TOTAL PARKING PROVIDED = 336

PARKING ALLOCATED TO COMMERCIAL – 47 SPACES

RESTAURANT – 2400 SF (1 SPACE PER 4 SEATS)
27 SPACES X 4 SEATS = 108 SEATS

OFFICE – 5400 SF (1 SPACE PER 200 SF)
20 SPACES X 200 SF = 4000 SF

GYM & LOUNGE & TENANT WORKSHARE – 8000 SF (TENANT AMENITY NO ADDITIONAL PARKING REQUIRED)

5X5 STORAGE UNITS – 102
5X8 STORAGE UNITS – 22 (TENANT SERVICE NO ADDITIONAL PARKING REQUIRED)

12/23/20

3 upper 2 lower 2 days ATV 7 locations to 20'

5 locations 25-40'

125' - 200' 60' per 80' day 2-3 days

Mike Stalker

LEGEND

- RIGHT OF WAY LINE
- EXISTING WATER LINE
- EXISTING SANITARY SEWER LINE
- EXISTING STORM SEWER LINE
- WATER LINE
- SANITARY SEWER LINE
- STORM SEWER LINE
- EXISTING CONTOURS MAJOR
- EXISTING CONTOURS MINOR
- PROPOSED CONTOURS MAJOR
- PROPOSED CONTOURS MINOR
- SANITARY SEWER MANHOLE
- STORM SEWER MANHOLE
- WATER METER
- WATER VALVE
- FIRE HYDRANT
- THRUST BLOCK

Project Name and Address: MILLBURY, CITY,ST

Sheet Title: PRELIMINARY SITE PLAN

Date

Revision/Issue — No. — Date

Project No. ***
Date 01/27/20
Scale AS NOTED
Sheet C-1

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Steelcraft
Site: 115 W Main Street
Millbury, MA.

BORING B-1

PROJECT NO. 20-02017

Ground Elevation:
Date Started: February 21, 2020
Date Finished: February 21, 2020
Driller: GG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	8"	0'0" – 2'0"	3-5-4-5	3'0"	Dry, brown, loose, coarse to fine SAND. (Fill)
5		2		5'0" – 7'0"	18-18-21-24	9'0"	Dry, brown, dense, coarse to fine SAND, some coarse to fine gravel, some silt.
10							End of Boring at 9'0" No water encountered upon completion.
15							
20							
25							
30							
35							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V Dense.
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M Stiff 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Steelcraft
Site: 115 W Main Street
Millbury, MA.

BORING B-2

PROJECT NO. 20-02017

Ground Elevation:
Date Started: February 21, 2020
Date Finished: February 21, 2020
Driller: GG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	8"	0'0" – 2'0"	5-4-5-5	4'0"	Dry, brown, loose. (Fill)
5		2	16"	5'0" – 7'0"	7-12-15-16		Dry, brown, medium dense to very dense, coarse to fine SAND, some coarse to fine gravel, some silt.
10		3	3"	10'0" – 11'4"	18-21-100/4"	12'0"	End of Boring at 12'0" - Refusal
15							No water encountered upon completion.
20							
25							
30							
35							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V Dense.
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M Stiff 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Steelcraft
Site: 115 W Main Street
Millbury, MA.

BORING B-3

PROJECT NO. 20-02017

Ground Elevation:
Date Started: February 21, 2020
Date Finished: February 21, 2020
Driller: GG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6"	Strata	Visual Identification of Soil and / or Rock Sample
1		1	8"	0'0" – 2'0"	1-1-3-4	2'6"	Dry, brown, loose, some medium to fine sand. (Fill)
5		2	17"	5'0" – 7'0"	17-18-18-18		Dry, brown, dense to very dense, coarse to fine SAND, trace coarse to fine gravel, some silt.
10		3	5"	10'0" – 10'10"	12-70/4"	12'0"	End of Boring at 12'0" - Refusal
15							No water encountered upon completion.
20							
25							
30							
35							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V Dense.
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M Stiff 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

TEST BORING LOG

SOIL X, Corp.
148 Pioneer Drive
Leominster, MA 01453
978 840-0391

Steelcraft
Site: 115 W Main Street
Millbury, MA.

BORING B-4

PROJECT NO. 20-02017

Ground Elevation:
Date Started: February 21, 2020
Date Finished: February 21, 2020
Driller: GG
Soil Engineer/Geologist:

GROUNDWATER OBSERVATIONS

DATE	DEPTH	CASING	STABILIZATION

Depth Ft.	Casing bl/ft	Sample No.	Pen/Rec	Sample Depth	Blows/6”	Strata	Visual Identification of Soil and / or Rock Sample
1		1	8”	0’0” – 2’0”	3-2-2-5	2’6”	Dry, brown, loose, some medium to fine sand. (Fill)
5		2	17”	5’0” – 7’0”	8-9-10-11	8’0”	Dry, brown, medium dense, medium to fine SAND, some silt.
10							End of Boring at 8’0” No water encountered upon completion.
15							
20							
25							
30							
35							

Notes: Hollow Stem Auger Size - 4 1/4"

Cohesionless: 0 - 4 V. Loose, 4 - 10 Loose, 10 -30 M Dense, 30 -50 Dense, 50+ V Dense.
Cohesive: 0 -2 V Soft, 2 -4 Soft, 4 -8 M Stiff 8 -15 Stiff, 15 -30 V. Stiff, 30 + Hard.

Trace	0 to 10%
Little	10 to 20%
Some	20 to 35%
And	35% to 50%

	CASING	SAMPLE	CORE TYPE
ID SIZE (IN)		SS	
HAMMER WGT (LB)		140 lb.	
HAMMER FALL (IN)		30"	

APPENDIX 11

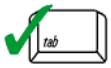
MADEP Stormwater Checklist

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

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): _____

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.