

Proposed Residential Development
507_509 High Street, South Kingstown
Stormwater Report (Revised 12/20)

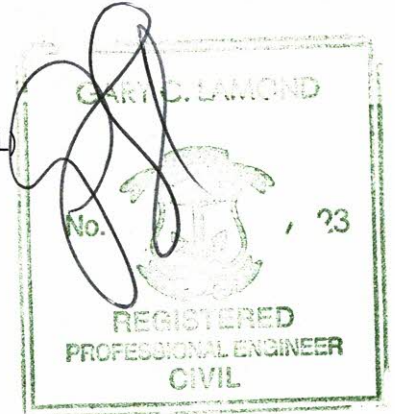
Project: Existing Multi Family Dwelling, Proposed 5-Unit Residential Condominium, Parking and Stormwater Improvements

Land use/Zoning: Commercial Downtown (CD Zone)

Proposed Land use: Multi Family Residential
Not a land use with high potential pollutant loads (LUHPPL)

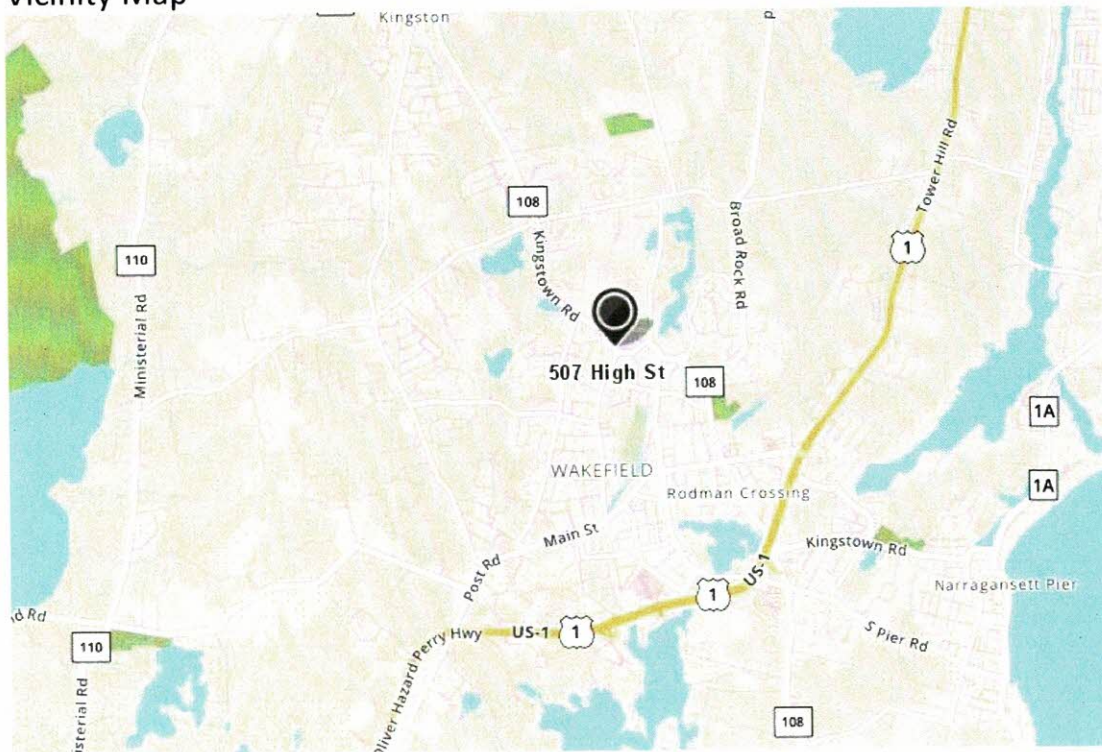
Applicant/Owner: Glenn & Gretel A. McCrory
570 Glen Hill Drive
Saunderstown, RI 02874

Engineer/Surveyor: Gary C. Lamond, PE, LLC
194 Hatchery Road
North Kingstown, RI 02852



The subject parcel is located at 507-509 High Street in the Town of South Kingstown. The site has approximately 99' of frontage along High Street.

Vicinity Map



Source: www.mapquest.com

The property is identified by the South Kingstown Assessor's Map as Plat 48-3, Lot 150 and contains approximately 0.36 acres. The parcel is currently occupied by an existing multi-family dwelling and associated gravel parking and driveway. The site slopes in a general south easterly direction at a slope of approximately two percent towards a freshwater wetland/stream complex (Rocky Brook).

Proposed Residential Development
 507_509 High Street, South Kingstown
 Stormwater Report (Revised 12/20)

A nearly identical project was previously approved for this parcel under Freshwater Wetlands Application 03-0013. Minor revisions have been made to this application to address updates to RIDEM stormwater requirements.

Based on the USDA Soil Conservation Service Soil Survey of Rhode Island, the northerly portion of the property is designated as Ur, Urban Land. The southerly portion of the property is designated as CB, Canton-Urban Land Complex.

As shown below, the CB and Ur designations are rated as hydrologic soil group B.

Hydrologic Soil Group



Summary by Map Unit — State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties (RI600)
 Summary by Map Unit — State of Rhode Island: Bristol, Kent, Newport, Providence, and Washington Counties (RI600)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
BnC	Bridgehampton-Charlton complex, very stony, 8 to 15 percent slopes	B	0.5	2.9%
CB	Canton-Urban land complex	B	9.4	50.6%
MU	Merrimac-Urban land complex, 0 to 8 percent slopes	A	1.6	8.5%
Ru	Rippowam fine sandy loam	B/D	2.6	13.9%
UD	Udorthents-Urban land complex	A	0.3	1.9%
Ur	Urban land		4.1	22.2%
Totals for Area of Interest			18.5	100.0%

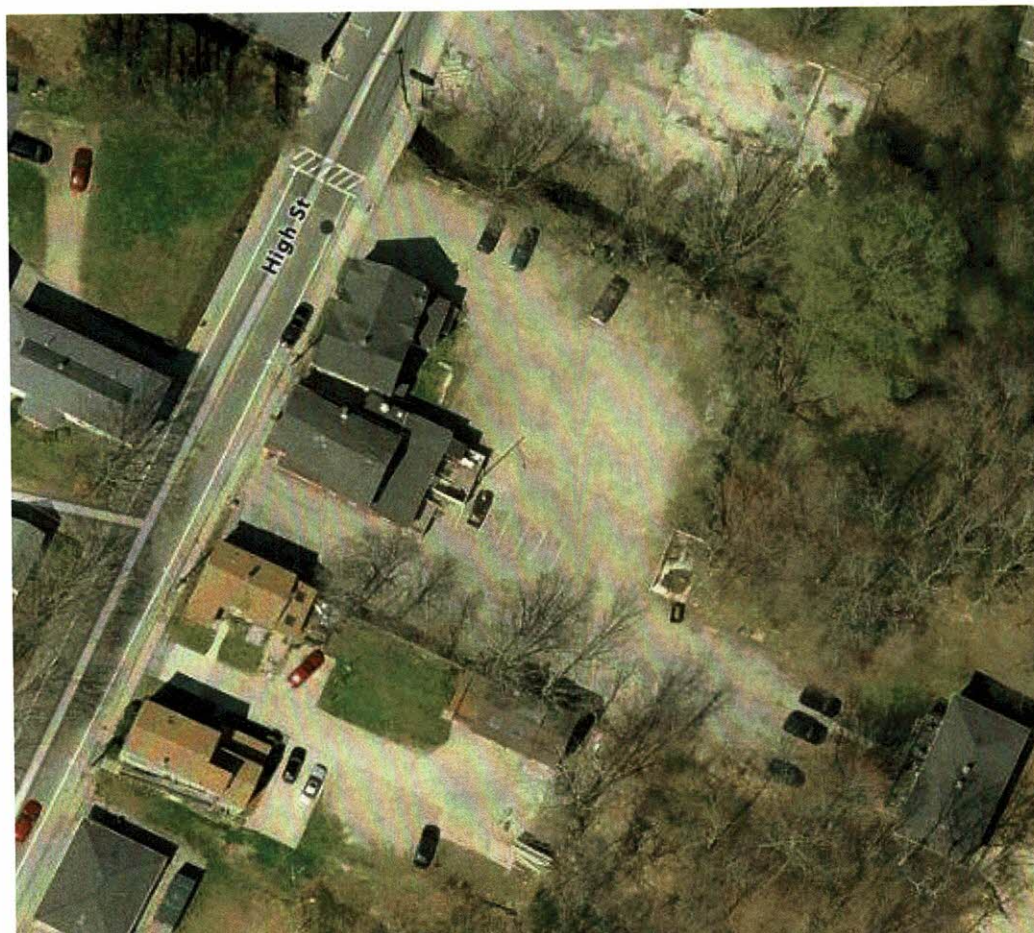
Source: www.websoilsurvey.sc.egov.usda.gov

Proposed Residential Development
507_509 High Street, South Kingstown
Stormwater Report (Revised 12/20)

The estimated seasonal high ground water table is estimated based on the elevation of the adjacent stream and wetland to be at elevation 18.5±.

The property is bordered on the northeast by a parcel owned by the Town of South Kingstown and to the southeast and southwest by residential properties. High Street borders the site to the northwest. The parcel is presently zoned Commercial Downtown (CD zone).

Aerial Photo



Source: <http://ridemgis.maps.arcgis.com/apps/webappviewer/index.html?id=87e104c8adb449eb9f905e5f18020de5>

The applicant is proposing to further develop an existing multi-family residential site. The proposed work includes the construction of a 5 unit attached condominium, a dumpster enclosure, associated utility connections, rain garden and landscaping. The proposed building is designed to for exclusively garage space on the lowest floor. The upper floors will be living area. The proposed building footprint is 2,240 SF. The proposed building will be constructed over the existing gravel parking area in the southerly portion of the property behind the existing multi-family dwelling. The majority of the existing gravel parking area will remain, however a portion of the gravel are will be removed to accommodate the proposed building and rain garden. The proposed rain garden is located in the southeast corner of the site. All of the proposed

Proposed Residential Development
507_509 High Street, South Kingstown
Stormwater Report (Revised 12/20)

improvements are located within the existing gravel parking area. The small area of existing woods immediately adjacent to the wetland edge will remain intact and undisturbed.

The project includes stormwater improvements to accommodate the proposed improvements. Runoff will be directed overland to a proposed rain garden. During larger storms the rain garden will fill and runoff will discharge through a rip rap spillway that will meter discharge at a rate equal to predevelopment levels. The proposed rain garden has been designed to mitigate potential impacts to water quality and downstream flooding from the proposed development.

The subject lot is located adjacent to Rocky Brook in the Saugatucket River watershed. We are mitigating the impacts from the additional impervious surface so no additional discharge is directed to the watershed.

RIDEM & CRMC STORMWATER MANAGEMENT STANDARDS

In December 2010, the Department of Environmental Management (DEM) and the Coastal Resources Management Council (CRMC) issued the Rhode Island Stormwater Design and Installation Standards Manual. The manual is intended to provide guidance in planning, designing and implementing effective stormwater best management practices during development projects. This is accomplished through the implementation of eleven minimum standards and performance criteria for stormwater management. The following subsections of the report describe how each of these standards will be achieved on this project by incorporating Best Management Practices (BMPs) into the design.

Minimum Standard 1: LID Site Planning and Design Strategies

Minimum Standard 1 calls for Low Impact Development (LID) planning and design strategies to be used to the maximum extent practicable for reduction in the generation of water runoff volume for new and redevelopment projects. LID should be considered in the early stages of planning in order to avoid stormwater impacts rather than mitigate its impacts. A Stormwater Management Plan is required to show compliance with this standard.

Some LID site planning and design strategies are being proposed in the development of the proposed 5-unit condominium at 507-509 High Street. To the extent possible, we will utilize existing drainage patterns. This will limit disturbance across the site. The drainage system is designed in a manner consistent with the goals of the most recent update of Rhode Island Stormwater Management Guidelines. Particular focus will be placed on water quality while emphasizing groundwater recharge.

As mentioned, stormwater will be directed overland and routed through a proposed rain garden system. The system is designed to handle the additional runoff generated from the increase in impervious surface area and is designed to mitigate impacts of a 100 year storm. The rain garden system will satisfy stormwater standards for water quality, recharge, channel protection and overbank flood control (RI Stormwater Standards 2 -5).

The following paragraphs further detail how the 11 stormwater standards are achieved for the proposed project.

Minimum Standard 2: Groundwater Recharge

In order to protect water table levels, stream baseflow, wetlands, and soil moisture levels at the proposed development site, Minimum Standard 2 requires that stormwater must be recharged

within the same subwatershed to maintain baseflow at the pre-development recharge levels. This recharge must be done while protecting groundwater quality.

The recharge volume Re_v is calculated using the following equation:

$$Re_v = (I')(F)(I)/12$$

Where:

Re_v = groundwater recharge volume (in acre-feet)

F = recharge factor

I = impervious area (acres)

The recharge factor is based on hydrologic soil group (HSG) and is determined from Table 3-4 of the Rhode Island Stormwater Design and Installation Standards Manual. The site is designated as CB, Canton-Urban Land Complex and Ur, Urban Land Complex by the NRCS web soil survey. These soil types are designated as hydrologic soil group "B" with a recharge factor of 0.35.

Recharge volumes for the proposed project are as follows:

Total Impervious Surface Area – 0.24 ac.

Recharge volume required for HSG "b"

Roads, Roofs and Gravel Driveways Driveways = 0.24 ac

$$Re_v = (1')(0.35)(0.24 \text{ ac.})/12 = 0.007 \text{ ac-ft} = 304.92 \text{ cf}$$

The total required recharge volume is 304.92 cf. The storage volume below elevation 22.6 of the rain garden is equal to 657 cf, therefore Standard 2 is satisfied.

Minimum Standard 3: Water Quality

Minimum Standard 3 requires the treatment of stormwater runoff before it is discharged to preserve the pre-developed water quality at and nearby the site. The portion of runoff containing the majority of the pollutants is known as the required water quality volume (WQ_v) and is the amount of water that must be treated from each rainfall event. Each location where a discharge of stormwater occurs requires a structural BMP to treat the WQ_v , with each structural BMP achieving the minimum average pollutant removal efficiencies of: 85% removal of total suspended solids (TSS), 60% removal of pathogens, 30% removal of total phosphorus (TP) for discharges to freshwater systems, and 30% removal of total nitrogen (TN) for discharges to saltwater or tidal systems. For impaired receiving waters, drinking water reservoirs, bathing beaches, shellfishing grounds, Outstanding National Resource Waters, Special Resource Protection Waters, tributaries thereto, and for those areas where watershed plans, including Special Area Management Plans (SAMPs) or Total Maximum Daily Load (TMDLs), have been completed, additional pollutant and pollutant removal efficiencies may be required.

The WQ_v is calculated using the following equation:

$$WQ_v = (I')(I)/12$$

Where:

WQ_v = water quality volume (in acre-feet)

I = impervious area (acres)

Water quality volume

Total Impervious Surface Area

Roads, Roofs and Gravel Driveways = 0.24 ac

$$WQ_v = (1'')(0.24 \text{ ac}) / 12 = .02 \text{ ac-ft} = 871.2 \text{ cf}$$

The total required water quality volume is therefore 871.2 cf. The storage volume below the discharge elevation of 22.6 is equal to 657 cf. The volume in the media is equal to 350 SF (bottom area) x (2' depth) x 0.33 = 231 cf. Therefore, the total storage is equal to 888 CF. Since 888 CF is greater than the required 871.2 cf the standard is satisfied.

Minimum Standard 4: Conveyance and Natural Channel Protection

To prevent erosive flow within natural channels and drainageways, Minimum Standard 4 calls for adequate design for open drainage and pipe conveyance systems to accommodate flows leading to, from, and through stormwater management facilities at least equal to the flow from the 10-year, 24-hour Type III design storm. In addition, protection for natural channels downstream must be able to provide detention of the one-year, 24-hour Type III storm runoff volume.

Given that the peak flow from the entire proposed subcatchment area discharges only 0.486 CFS during a the 1-year, 24 hour Type III design storm before it enters the rain garden, there will be no additional impacts to the existing system of conveyance.

Minimum Standard 5: Overbank Flood Protection

In order to prevent an increase in the frequency and magnitude of overbank flooding and to protect nearby structures, Minimum Standard 5 requires that downstream overbank flood protection be provided by reducing the post-development peak discharge rate to the pre-development peak discharge rate for the 10-year and 100-year, 24-hour Type III design storm events. In addition, the runoff from storms up to the 100-year, 24-hour Type III design storm must be shown to actually reach the proposed structural practices designed to meet this criterion.

Given all of the proposed improvements are located within existing gravel parking areas and a portion of the gravel parking will be removed in favor of proposed landscaping and a rain garden, there will be no net increase in runoff generated from the proposed improvements.

A summary of peak discharge rates for the 10 and 100 year storms is as follows:

	10-year	100-year
Existing Conditions	1.265	2.689
Proposed Conditions	1.265	2.689

As demonstrated in the above table, the proposed development will not result in downstream overbank flooding. Therefore Standard 5 is satisfied.

Minimum Standard 6: Redevelopment and Infill Projects

Proposed Residential Development
507_509 High Street, South Kingstown
Stormwater Report (Revised 12/20)

Minimum Standard 6 states that the requirements of the Rhode Island Stormwater Design and Installation Standards Manual apply to construction of new impervious areas on undeveloped land, whether or not other portions of the site have already been developed, unless it is an infill project. The manual defines redevelopment as "any construction, alteration, or improvement that disturbs a total of 10,000 square feet or more of existing impervious area where the existing land use is commercial, industrial, institutional, governmental, recreational, or multifamily residential". An infill project will meet the following criteria: the site is predominately pervious (less than 10,000 sf of existing impervious cover); is surrounded on at least three sides by existing development (excluding roadways); is served by existing infrastructure and doesn't require extension of utility lines or new public road construction to serve the property; and is no more than (1) acre where the existing land use is commercial, industrial, institutional, governmental, recreational, or multifamily residential. Infill projects are subject to the same requirements as new development, except the existing impervious area is not included in the stormwater management plan.

The proposed project does not meet the definition of redevelopment or infill as defined above and therefore this standard does not apply.

Minimum Standard 7: Pollution Prevention

Minimum Standard 7 requires the formation of a stormwater pollution prevention plan which uses source control and pollution prevention measures to prevent, to the maximum extent practicable, pollutants from coming into contact with stormwater runoff.

The pollutants generated from stormwater runoff in commercial developments come from paved surfaces and roof runoff. The runoff from the proposed 5-unit condominium will receive adequate treatment as it passes through the treatment train. Furthermore, the vast majority of the runoff will be captured and recharged in the above rain garden. Physical, biological and chemical processes will work to ensure that runoff entering the ground through recharge and/or discharged offsite undergoes the maximum treatment practical.

Minimum Standard 8: Land Uses with Higher Potential Pollutant Loads

In order to prevent, to the maximum extent practicable, pollution from entering water resources, Minimum Standard 8 requires the use of specific source control and pollution prevention measures as well as specific stormwater BMPs for use for stormwater discharges from land uses with higher potential pollutant loads (LUHPPLs). Recharge of stormwater runoff from a LUHPPL to groundwater is prohibited without adequate treatment for the pollutant of concern. If subsurface contamination is present from prior land use, infiltration practices should not be used without removal of the contamination prior to remediation of the site. Other LID practices may be used in these areas, provided they are lined to prevent pollutant migration.

The stormwater runoff generated from the proposed site redevelopment/rehabilitation does not fall under the category of a LUHPPL, therefore this standard does not apply.

Minimum Standard 9: Illicit Discharges

Minimum Standard 9 prohibits all illicit discharges, including those from OWTS, sub-drains and French drains near OWTS that do not meet the State's OWTS Rules, in order to prevent pollutants from being discharged into municipal separate storm sewer systems and Waters of the State and safeguard the environment and public health, safety and welfare. The stormwater

management system is only to be used for conveyance, treatment and infiltration of stormwater on site.

The proposed project prohibits all illicit discharges.

Minimum Standard 10: Construction Erosion and Sedimentation Control

Minimum Standard 10 requires that erosion and sedimentation control (ESC) practices are implemented during construction and any other land disturbing activities to prevent erosion and sedimentation from construction site runoff. These ESC practices must meet the following criteria: temporary sediment trapping must be sized to store the greater of 1 inch of runoff from the contributing area or per the sediment volume method; and temporary conveyance practices must be sized sufficiently to handle peak flow from the 10-year, 24-hour Type III design storm.

An Erosion and Sediment Control Plan will be developed for this project and will include the installation of silt fence or haybales. Any extra excavated soil which is not used to bury the bottom of the silt fence/hay bales will be cast upgradient.

- Silt fence/haybales shall be inspected after every major rainfall runoff event (over 1/2" depth of precipitation). All damaged or misaligned erosion control measures shall be immediately repaired. Silt shall be immediately removed from all areas of the silt fence/hay bales when depth of accumulation exceeds 6 inches.
- Sumps and outfalls shall be inspected after every major rainfall runoff event (over 1/2" depth of precipitation). Silt shall be immediately removed from all sumps where the depth of accumulation is excessive
- The proposed water quality structures and appurtenances shall be constructed prior to any other earthwork construction starting in order to utilize it as a construction sedimentation basin. The outlet shall be protected by double layers of silt fence/hay bales.
- All exposed construction areas will be stabilized immediately upon completion in order to minimize the time that these areas are unstabilized.

With the full implementation of the measures presented on the Erosion Control Plan, along with the provisions stipulated above, Minimum Standard 10 will be satisfied. A formal erosion and sediment control plan will be submitted following feedback from the Town of South Kingstown.

Minimum Standard 11: Stormwater Management System Operation and Maintenance

Minimum Standard 11 requires that the stormwater management system, including all structural stormwater controls and conveyances, have an operation and maintenance plan to ensure the continued function of the system as it was designed. This plan shall include, at a minimum, the following:

1. Stormwater management system(s) owners;
2. The party or parties responsible for operation and maintenance, including how future property owners will be notified of the presence of the stormwater management system and the requirement for proper operation and maintenance;
3. The routine and non-routine maintenance tasks for each BMP to be undertaken after construction is complete and a schedule for implementing those tasks;

Proposed Residential Development
507_509 High Street, South Kingstown
Stormwater Report (Revised 12/20)

4. A plan that is drawn to scale and shows the location of all stormwater BMPs in each treatment train along the with the discharge point;
5. A description and delineation of public safety features;
6. An estimated operation and maintenance budget; and
7. Funding source for operation and maintenance activities and equipment.

Watershed Model Schematic

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066



Legend

<u>Hyd. Origin</u>	<u>Description</u>
1	SCS Runoff Existing
10	SCS Runoff Proposed

Hydrograph Return Period Recap

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

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	SCS Runoff	-----	0.486	0.662	-----	-----	1.265	1.736	-----	2.689	Existing
10	SCS Runoff	-----	0.486	0.662	-----	-----	1.265	1.736	-----	2.689	Proposed

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

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	SCS Runoff	0.486	1	722	1,350	-----	-----	-----	Existing
10	SCS Runoff	0.486	1	722	1,350	-----	-----	-----	Proposed
High Street.gpw					Return Period: 1 Year			Monday, Dec 9, 2019	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Monday, Dec 9, 2019

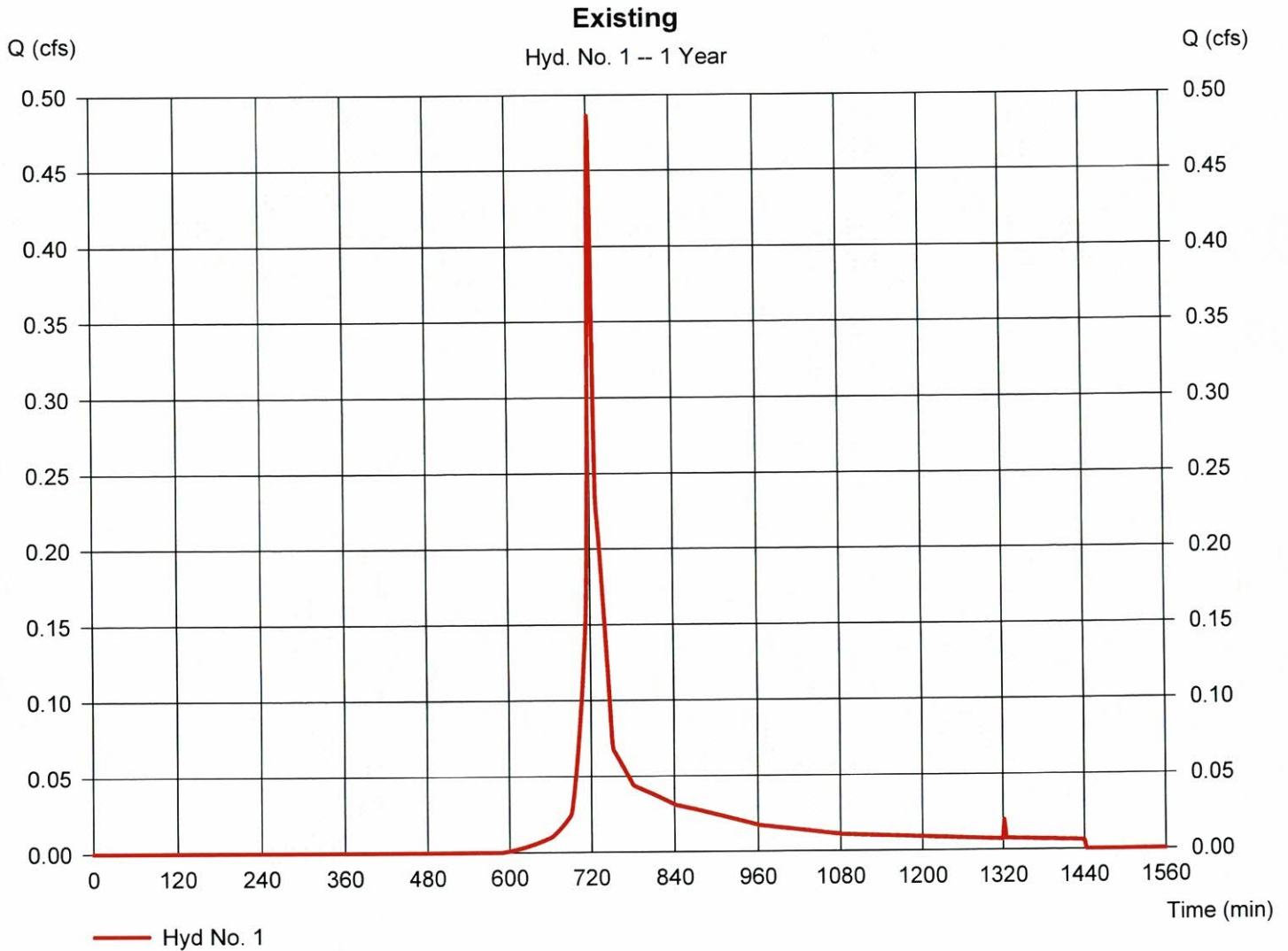
Hyd. No. 1

Existing

Hydrograph type = SCS Runoff
 Storm frequency = 1 yrs
 Time interval = 1 min
 Drainage area = 0.360 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 2.80 in
 Storm duration = 24 hrs

Peak discharge = 0.486 cfs
 Time to peak = 722 min
 Hyd. volume = 1,350 cuft
 Curve number = 80*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.80 min
 Distribution = Type III
 Shape factor = 484

* Composite (Area/CN) = [(0.033 x 98) + (0.039 x 61) + (0.250 x 85) + (0.042 x 55)] / 0.360



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Hyd. No. 1

Existing

<u>Description</u>	<u>A</u>		<u>B</u>		<u>C</u>		<u>Totals</u>	
Sheet Flow								
Manning's n-value	= 0.030		0.011		0.011			
Flow length (ft)	= 50.0		0.0		0.0			
Two-year 24-hr precip. (in)	= 3.30		0.00		0.00			
Land slope (%)	= 3.50		0.00		0.00			
Travel Time (min)	= 1.22	+	0.00	+	0.00	=	1.22	
Shallow Concentrated Flow								
Flow length (ft)	= 107.00		0.00		0.00			
Watercourse slope (%)	= 3.50		0.00		0.00			
Surface description	= Unpaved		Paved		Paved			
Average velocity (ft/s)	= 3.02		0.00		0.00			
Travel Time (min)	= 0.59	+	0.00	+	0.00	=	0.59	
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			
Travel Time (min)	= 0.00	+	0.00	+	0.00	=	0.00	
Total Travel Time, Tc							=	1.80 min

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Monday, Dec 9, 2019

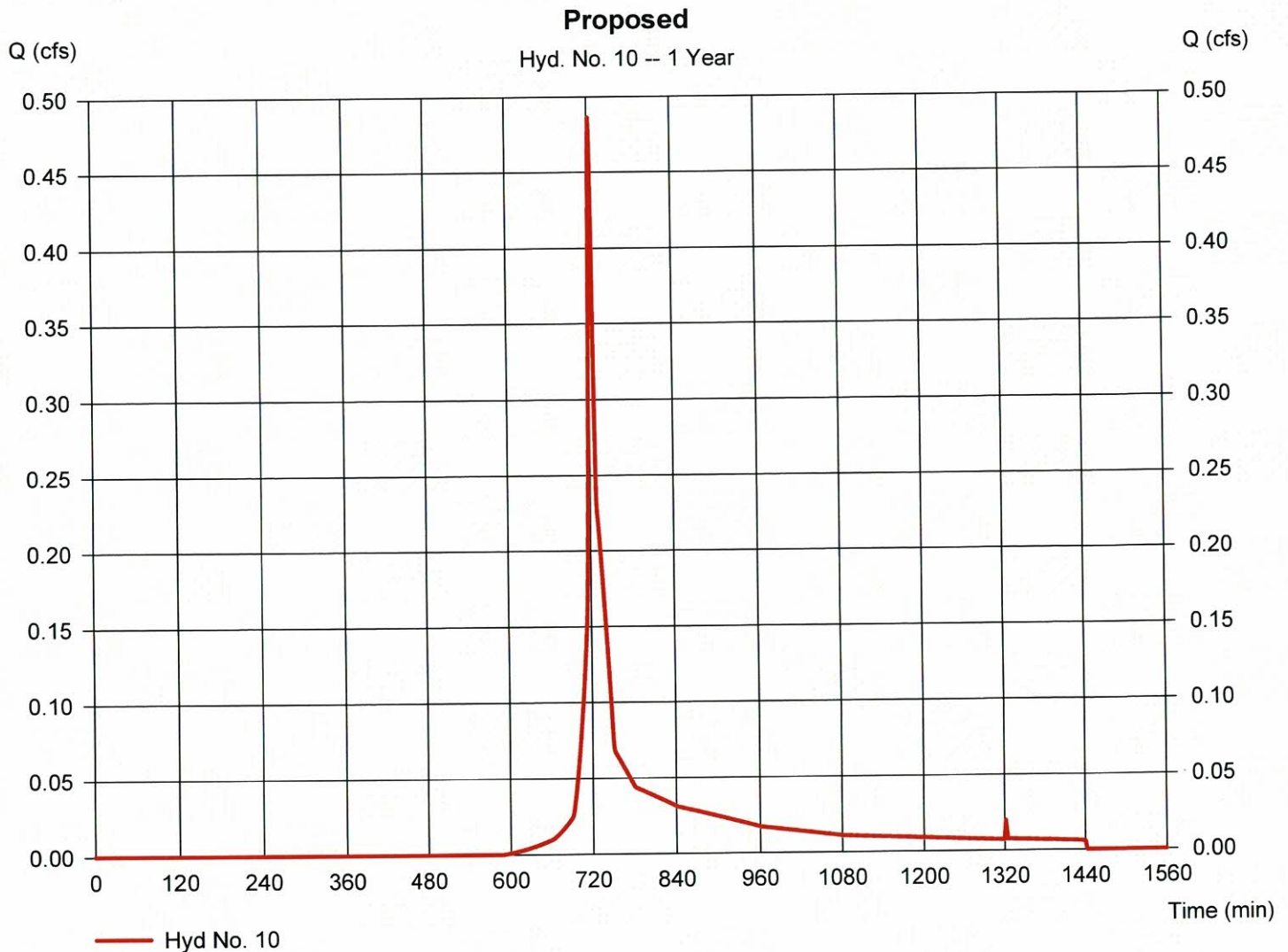
Hyd. No. 10

Proposed

Hydrograph type = SCS Runoff
 Storm frequency = 1 yrs
 Time interval = 1 min
 Drainage area = 0.360 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 2.80 in
 Storm duration = 24 hrs

Peak discharge = 0.486 cfs
 Time to peak = 722 min
 Hyd. volume = 1,350 cuft
 Curve number = 80*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.84 min
 Distribution = Type III
 Shape factor = 484

* Composite (Area/CN) = $[(0.100 \times 98) + (0.140 \times 85) + (0.080 \times 61) + (0.040 \times 55)] / 0.360$



TR55 Tc Worksheet

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Hyd. No. 10

Proposed

<u>Description</u>	<u>A</u>	<u>B</u>	<u>C</u>	<u>Totals</u>
Sheet Flow				
Manning's n-value	= 0.030	0.011	0.011	
Flow length (ft)	= 50.0	0.0	0.0	
Two-year 24-hr precip. (in)	= 3.30	0.00	0.00	
Land slope (%)	= 3.50	0.00	0.00	
Travel Time (min)	= 1.22	+ 0.00	+ 0.00	= 1.22
Shallow Concentrated Flow				
Flow length (ft)	= 112.00	0.00	0.00	
Watercourse slope (%)	= 3.50	0.00	0.00	
Surface description	= Unpaved	Paved	Paved	
Average velocity (ft/s)	= 3.02	0.00	0.00	
Travel Time (min)	= 0.62	+ 0.00	+ 0.00	= 0.62
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	
Travel Time (min)	= 0.00	+ 0.00	+ 0.00	= 0.00
Total Travel Time, Tc				1.84 min

Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

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	SCS Runoff	0.662	1	722	1,812	-----	-----	-----	Existing
10	SCS Runoff	0.662	1	722	1,812	-----	-----	-----	Proposed
High Street.gpw					Return Period: 2 Year			Monday, Dec 9, 2019	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Monday, Dec 9, 2019

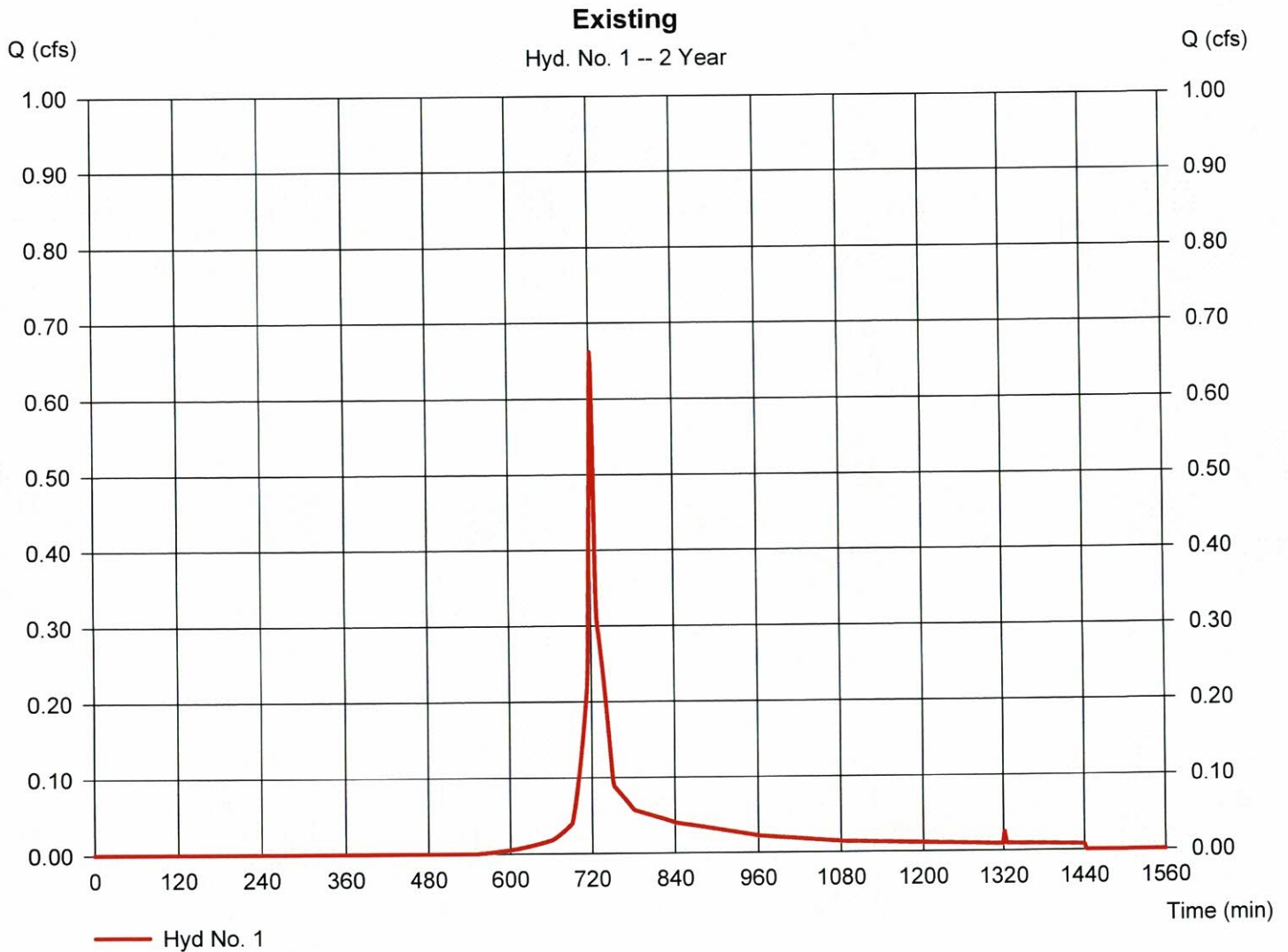
Hyd. No. 1

Existing

Hydrograph type = SCS Runoff
 Storm frequency = 2 yrs
 Time interval = 1 min
 Drainage area = 0.360 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 3.30 in
 Storm duration = 24 hrs

Peak discharge = 0.662 cfs
 Time to peak = 722 min
 Hyd. volume = 1,812 cuft
 Curve number = 80*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.80 min
 Distribution = Type III
 Shape factor = 484

* Composite (Area/CN) = [(0.033 x 98) + (0.039 x 61) + (0.250 x 85) + (0.042 x 55)] / 0.360



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Monday, Dec 9, 2019

Hyd. No. 10

Proposed

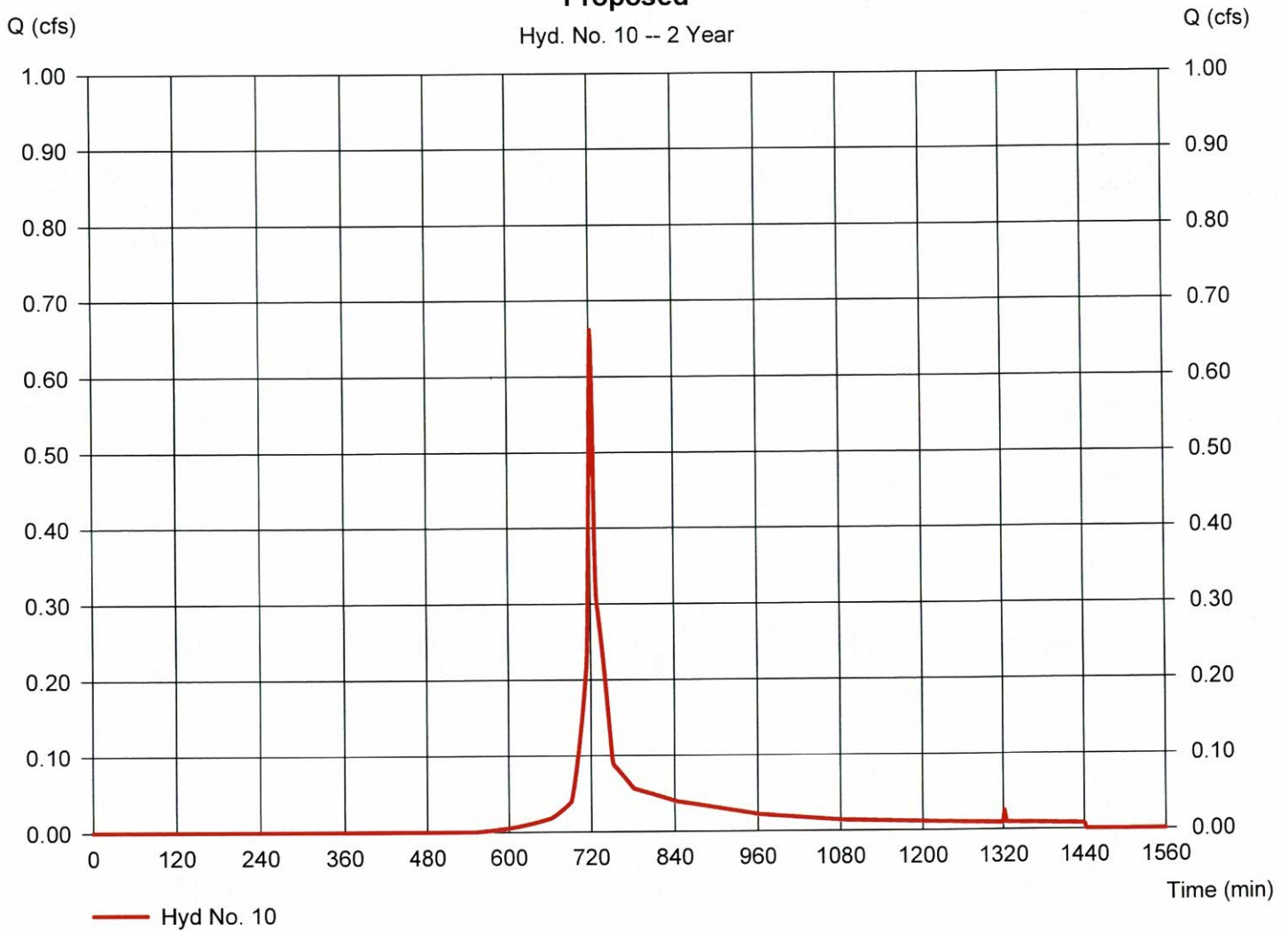
Hydrograph type = SCS Runoff
 Storm frequency = 2 yrs
 Time interval = 1 min
 Drainage area = 0.360 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 3.30 in
 Storm duration = 24 hrs

Peak discharge = 0.662 cfs
 Time to peak = 722 min
 Hyd. volume = 1,812 cuft
 Curve number = 80*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.84 min
 Distribution = Type III
 Shape factor = 484

* Composite (Area/CN) = [(0.100 x 98) + (0.140 x 85) + (0.080 x 61) + (0.040 x 55)] / 0.360

Proposed

Hyd. No. 10 -- 2 Year



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

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	SCS Runoff	1.265	1	722	3,437	-----	-----	-----	Existing
10	SCS Runoff	1.265	1	722	3,437	-----	-----	-----	Proposed
High Street.gpw					Return Period: 10 Year			Monday, Dec 9, 2019	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Monday, Dec 9, 2019

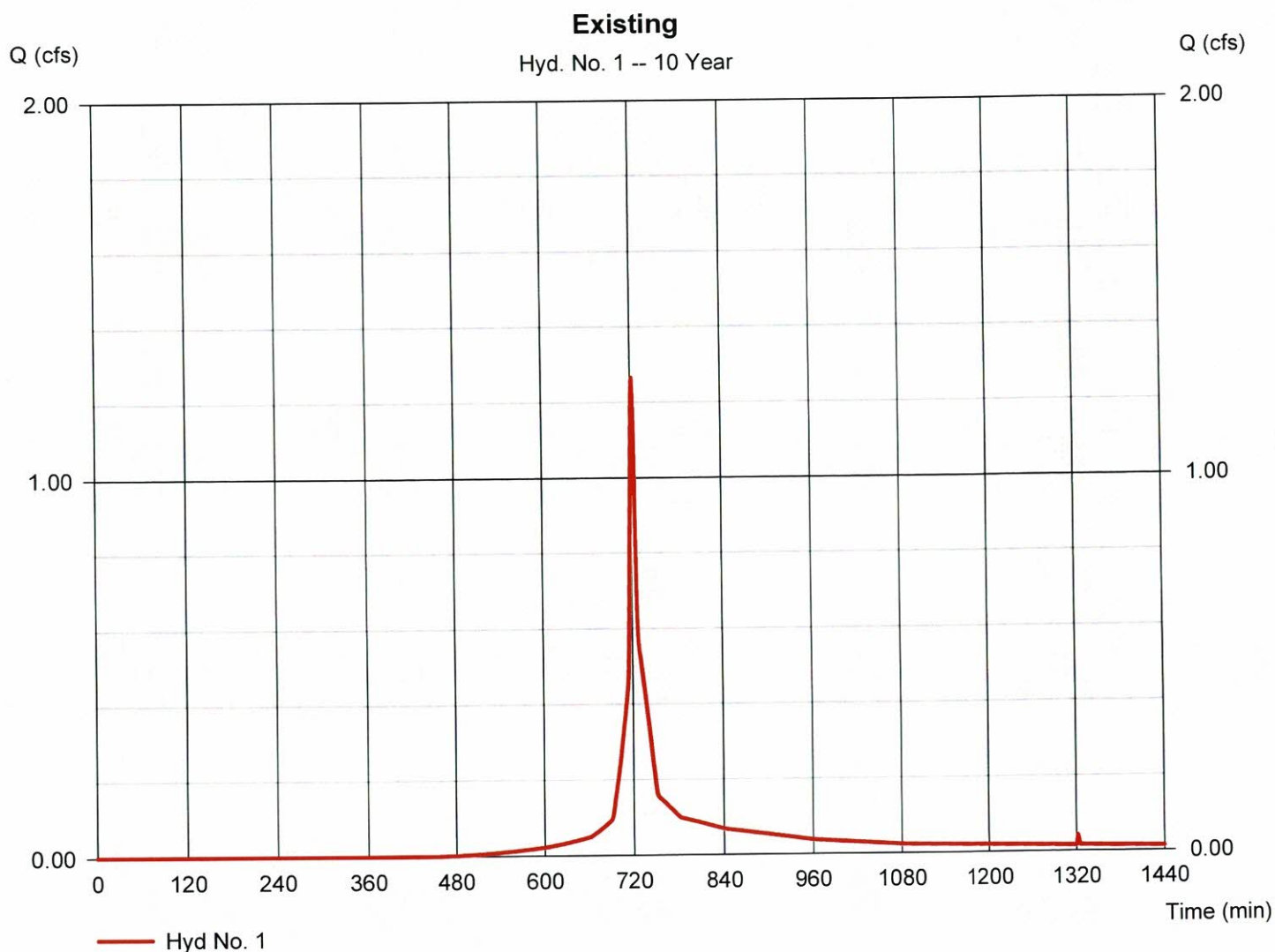
Hyd. No. 1

Existing

Hydrograph type = SCS Runoff
 Storm frequency = 10 yrs
 Time interval = 1 min
 Drainage area = 0.360 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 4.90 in
 Storm duration = 24 hrs

Peak discharge = 1.265 cfs
 Time to peak = 722 min
 Hyd. volume = 3,437 cuft
 Curve number = 80*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.80 min
 Distribution = Type III
 Shape factor = 484

* Composite (Area/CN) = [(0.033 x 98) + (0.039 x 61) + (0.250 x 85) + (0.042 x 55)] / 0.360



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

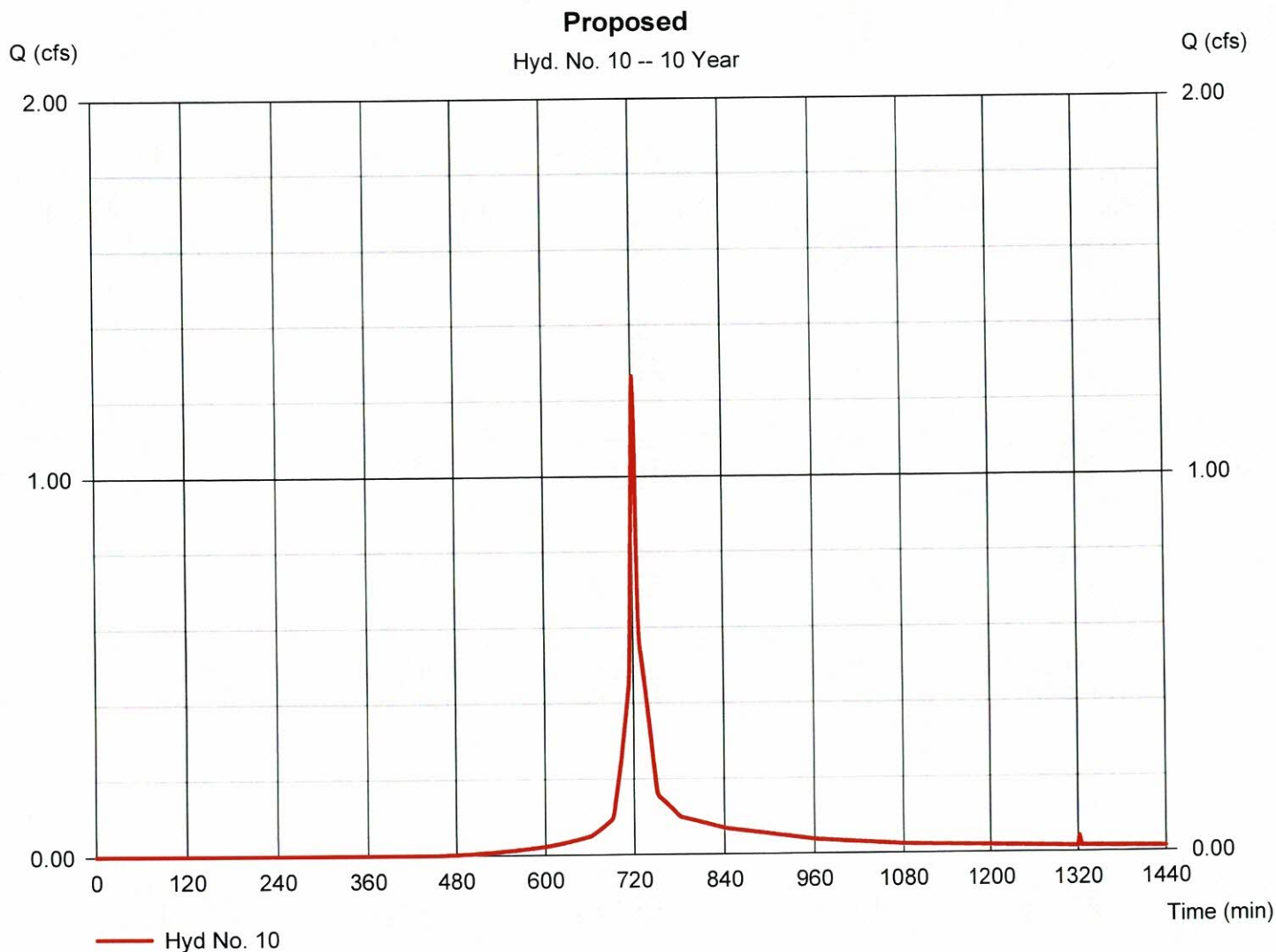
Monday, Dec 9, 2019

Hyd. No. 10

Proposed

Hydrograph type	= SCS Runoff	Peak discharge	= 1.265 cfs
Storm frequency	= 10 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 3,437 cuft
Drainage area	= 0.360 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 1.84 min
Total precip.	= 4.90 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.100 x 98) + (0.140 x 85) + (0.080 x 61) + (0.040 x 55)] / 0.360



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

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	SCS Runoff	1.736	1	722	4,743	-----	-----	-----	Existing
10	SCS Runoff	1.736	1	722	4,743	-----	-----	-----	Proposed
High Street.gpw					Return Period: 25 Year			Monday, Dec 9, 2019	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

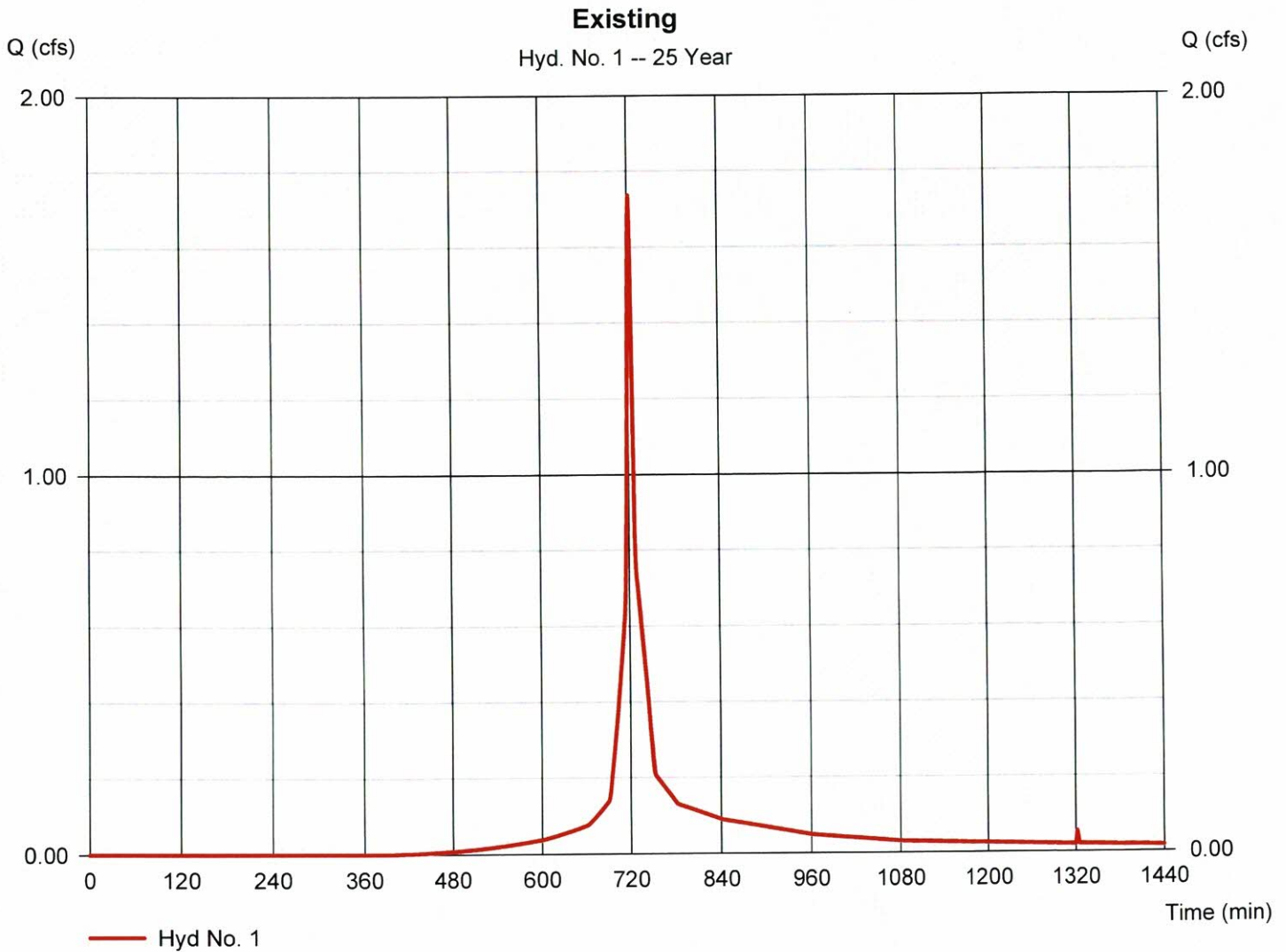
Monday, Dec 9, 2019

Hyd. No. 1

Existing

Hydrograph type	= SCS Runoff	Peak discharge	= 1.736 cfs
Storm frequency	= 25 yrs	Time to peak	= 722 min
Time interval	= 1 min	Hyd. volume	= 4,743 cuft
Drainage area	= 0.360 ac	Curve number	= 80*
Basin Slope	= 0.0 %	Hydraulic length	= 0 ft
Tc method	= TR55	Time of conc. (Tc)	= 1.80 min
Total precip.	= 6.10 in	Distribution	= Type III
Storm duration	= 24 hrs	Shape factor	= 484

* Composite (Area/CN) = [(0.033 x 98) + (0.039 x 61) + (0.250 x 85) + (0.042 x 55)] / 0.360



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Monday, Dec 9, 2019

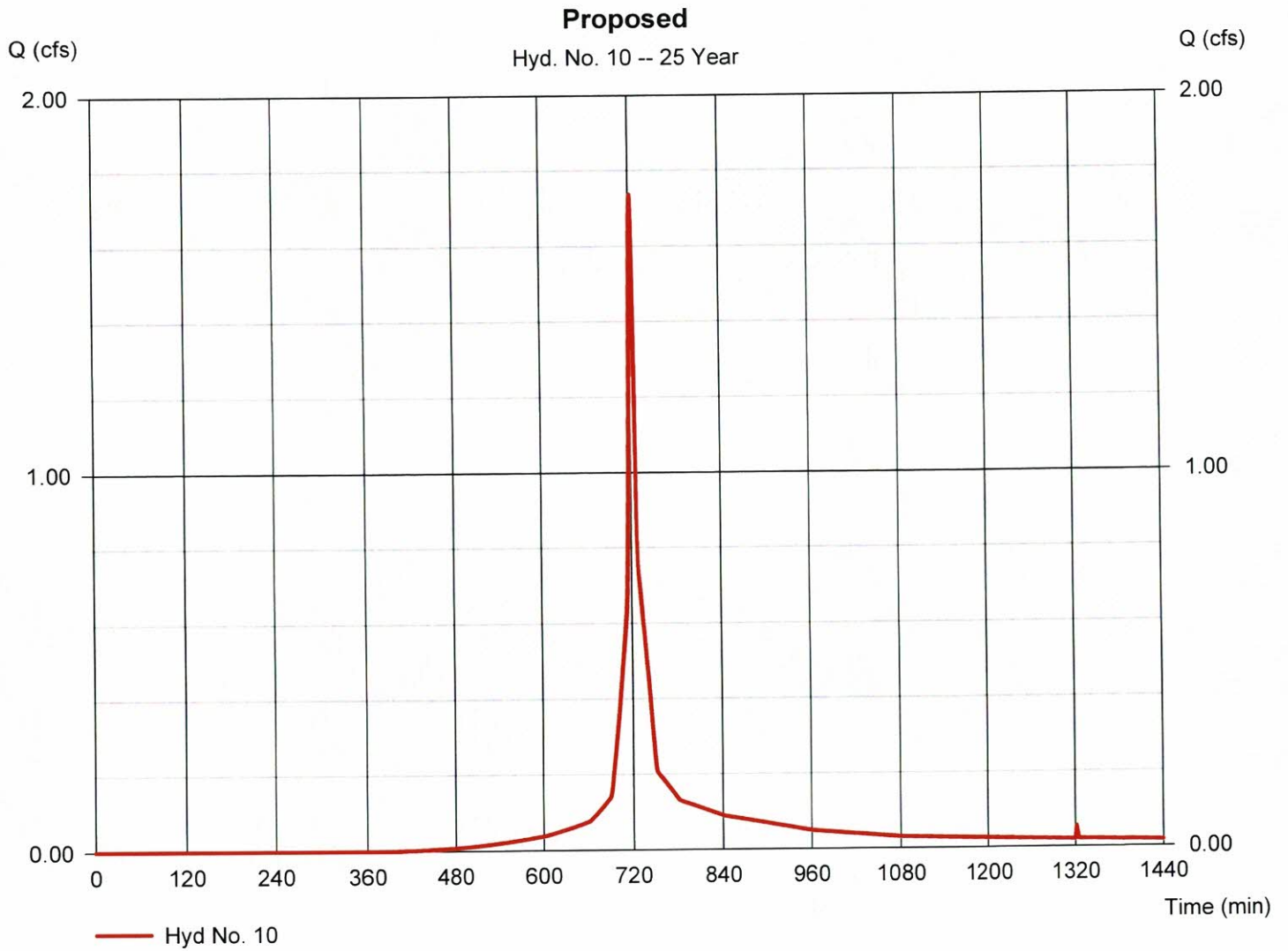
Hyd. No. 10

Proposed

Hydrograph type = SCS Runoff
 Storm frequency = 25 yrs
 Time interval = 1 min
 Drainage area = 0.360 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 6.10 in
 Storm duration = 24 hrs

Peak discharge = 1.736 cfs
 Time to peak = 722 min
 Hyd. volume = 4,743 cuft
 Curve number = 80*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.84 min
 Distribution = Type III
 Shape factor = 484

* Composite (Area/CN) = [(0.100 x 98) + (0.140 x 85) + (0.080 x 61) + (0.040 x 55)] / 0.360



Hydrograph Summary Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

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	SCS Runoff	2.689	1	722	7,467	-----	-----	-----	Existing
10	SCS Runoff	2.689	1	722	7,467	-----	-----	-----	Proposed
High Street.gpw					Return Period: 100 Year			Monday, Dec 9, 2019	

Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Monday, Dec 9, 2019

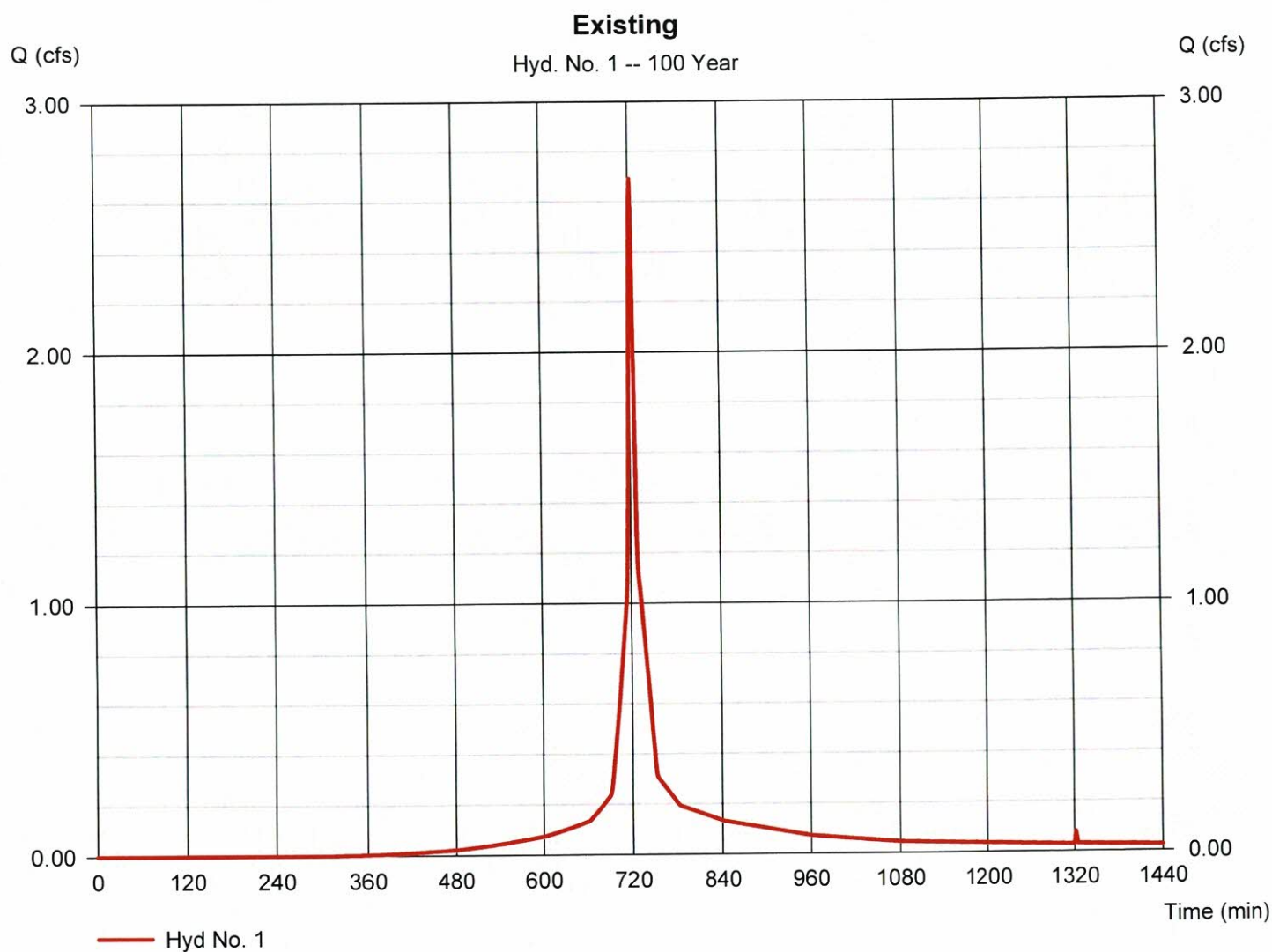
Hyd. No. 1

Existing

Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 1 min
 Drainage area = 0.360 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 8.50 in
 Storm duration = 24 hrs

Peak discharge = 2.689 cfs
 Time to peak = 722 min
 Hyd. volume = 7,467 cuft
 Curve number = 80*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.80 min
 Distribution = Type III
 Shape factor = 484

* Composite (Area/CN) = [(0.033 x 98) + (0.039 x 61) + (0.250 x 85) + (0.042 x 55)] / 0.360



Hydrograph Report

Hydraflow Hydrographs Extension for AutoCAD® Civil 3D® 2009 by Autodesk, Inc. v6.066

Monday, Dec 9, 2019

Hyd. No. 10

Proposed

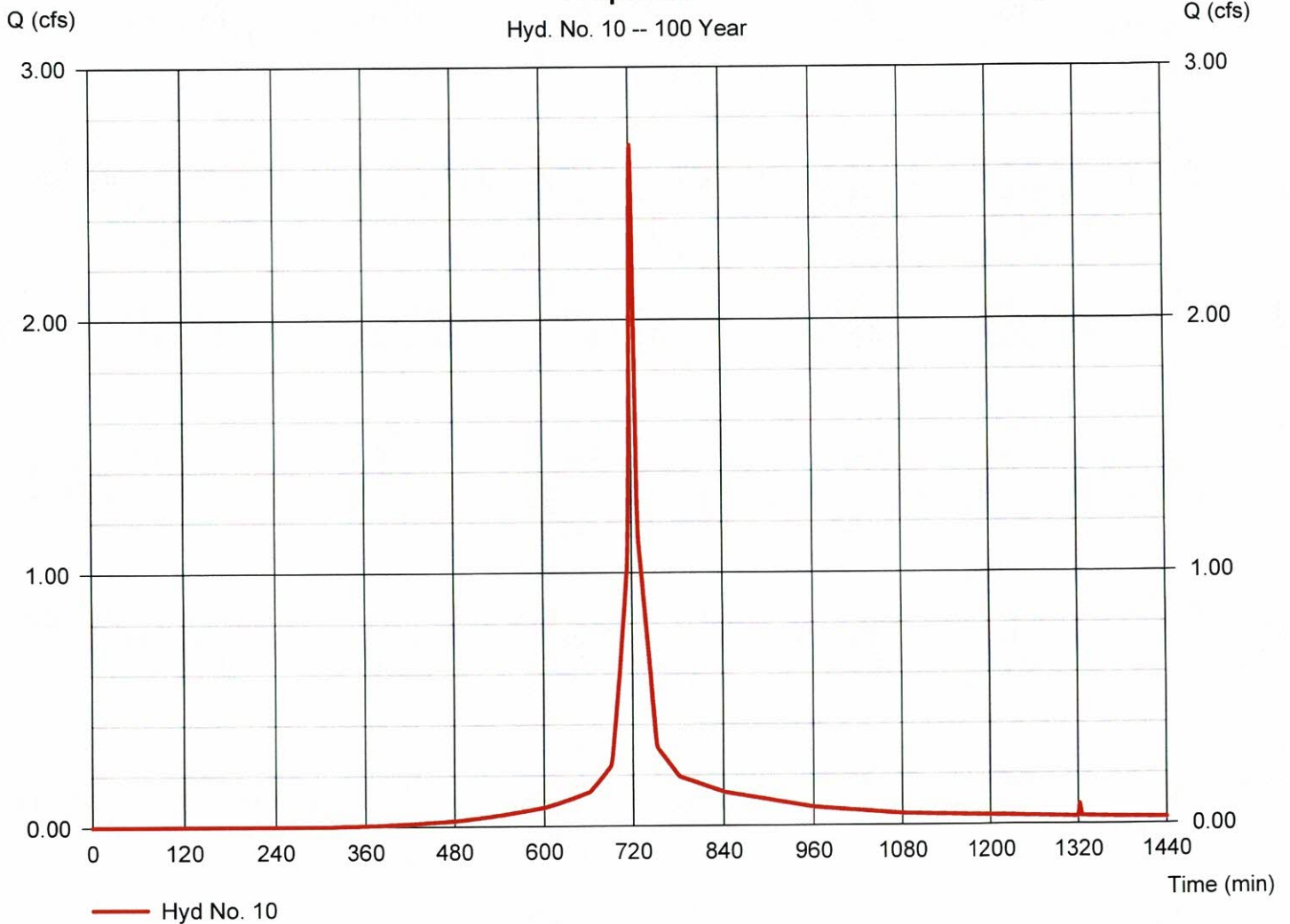
Hydrograph type = SCS Runoff
 Storm frequency = 100 yrs
 Time interval = 1 min
 Drainage area = 0.360 ac
 Basin Slope = 0.0 %
 Tc method = TR55
 Total precip. = 8.50 in
 Storm duration = 24 hrs

Peak discharge = 2.689 cfs
 Time to peak = 722 min
 Hyd. volume = 7,467 cuft
 Curve number = 80*
 Hydraulic length = 0 ft
 Time of conc. (Tc) = 1.84 min
 Distribution = Type III
 Shape factor = 484

* Composite (Area/CN) = [(0.100 x 98) + (0.140 x 85) + (0.080 x 61) + (0.040 x 55)] / 0.360

Proposed

Hyd. No. 10 -- 100 Year



Hydraflow Table of Contents

Watershed Model Schematic	1
Hydrograph Return Period Recap	2
1 - Year	
Summary Report	3
Hydrograph Reports	4
Hydrograph No. 1, SCS Runoff, Existing	4
TR-55 Tc Worksheet	5
Hydrograph No. 10, SCS Runoff, Proposed	6
TR-55 Tc Worksheet	7
2 - Year	
Summary Report	8
Hydrograph Reports	9
Hydrograph No. 1, SCS Runoff, Existing	9
Hydrograph No. 10, SCS Runoff, Proposed	10
10 - Year	
Summary Report	11
Hydrograph Reports	12
Hydrograph No. 1, SCS Runoff, Existing	12
Hydrograph No. 10, SCS Runoff, Proposed	13
25 - Year	
Summary Report	14
Hydrograph Reports	15
Hydrograph No. 1, SCS Runoff, Existing	15
Hydrograph No. 10, SCS Runoff, Proposed	16
100 - Year	
Summary Report	17
Hydrograph Reports	18
Hydrograph No. 1, SCS Runoff, Existing	18
Hydrograph No. 10, SCS Runoff, Proposed	19
IDF Report	20

Existing Conditions

E-SUB1

Total Area = 0.36 acres

<u>Woods B</u>	<u>Gravel B</u>	<u>Grass B</u>	<u>Impervious B</u>	
0.04 ac CN = 55	0.25 ac CN = 85	0.04 ac CN = 61	0.03 ac CN = 98	Composite CN = 80

Tc = 50 feet sheet flow @ 3.5% gravel
107 feet unpaved shallow concentrated flow @ 3.5%

Tc = 1.8 Minutes

Proposed Conditions

P-SUB 1

Total Area = 0.36 acres

<u>Woods B</u>	<u>Gravel B</u>	<u>Grass B</u>	<u>Impervious B</u>	
0.04 ac CN = 55	0.14 ac CN = 85	0.08 ac CN = 61	0.10 ac CN = 98	Composite CN = 80

Tc = 50 feet sheet flow @ 3.5% gravel
112 feet unpaved shallow concentrated flow @ 3.5%

Tc = 1.8 Minutes

Table 2-2a Runoff curve numbers for urban areas ^{1/}

Cover description Cover type and hydrologic condition	Average percent impervious area ^{2/}	Curve numbers for hydrologic soil group			
		A	B	C	D
Fully developed urban areas (vegetation established)					
Open space (lawns, parks, golf courses, cemeteries, etc.) ^{3/} :					
Poor condition (grass cover < 50%)		68	79	86	89
Fair condition (grass cover 50% to 75%)		49	69	79	84
Good condition (grass cover > 75%)		39	61	74	80
Impervious areas:					
Paved parking lots, roofs, driveways, etc. (excluding right-of-way)		98	98	98	98
Streets and roads:					
Paved; curbs and storm sewers (excluding right-of-way)		98	98	98	98
Paved; open ditches (including right-of-way)		83	89	92	93
Gravel (including right-of-way)		76	85	89	91
Dirt (including right-of-way)		72	82	87	89
Western desert urban areas:					
Natural desert landscaping (pervious areas only) ^{4/}		63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1- to 2-inch sand or gravel mulch and basin borders)		96	96	96	96
Urban districts:					
Commercial and business	85	89	92	94	95
Industrial	72	81	88	91	93
Residential districts by average lot size:					
1/8 acre or less (town houses)	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	12	46	65	77	82
Developing urban areas					
Newly graded areas					
(pervious areas only, no vegetation) ^{5/}		77	86	91	94
Idle lands (CN's are determined using cover types similar to those in table 2-2c).					

¹ Average runoff condition, and $I_a = 0.2S$.² The average percent impervious area shown was used to develop the composite CN's. Other assumptions are as follows: impervious areas are directly connected to the drainage system, impervious areas have a CN of 98, and pervious areas are considered equivalent to open space in good hydrologic condition. CN's for other combinations of conditions may be computed using figure 2-3 or 2-4.³ CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.⁴ Composite CN's for natural desert landscaping should be computed using figures 2-3 or 2-4 based on the impervious area percentage (CN = 98) and the pervious area CN. The pervious area CN's are assumed equivalent to desert shrub in poor hydrologic condition.⁵ Composite CN's to use for the design of temporary measures during grading and construction should be computed using figure 2-3 or 2-4 based on the degree of development (impervious area percentage) and the CN's for the newly graded pervious areas.

Table 2-2c Runoff curve numbers for other agricultural lands ^{1/}

Cover type	Cover description	Hydrologic condition	Curve numbers for hydrologic soil group			
			A	B	C	D
Pasture, grassland, or range—continuous forage for grazing. ^{2/}		Poor	68	79	86	89
		Fair	49	69	79	84
		Good	39	61	74	80
Meadow—continuous grass, protected from grazing and generally mowed for hay.		—	30	58	71	78
Brush—brush-weed-grass mixture with brush the major element. ^{3/}		Poor	48	67	77	83
		Fair	35	56	70	77
		Good	30 ^{4/}	48	65	73
Woods—grass combination (orchard or tree farm). ^{5/}		Poor	57	73	82	86
		Fair	43	65	76	82
		Good	32	58	72	79
Woods. ^{6/}		Poor	45	66	77	83
		Fair	36	60	73	79
		Good	30 ^{4/}	55	70	77
Farmsteads—buildings, lanes, driveways, and surrounding lots.		—	59	74	82	86

¹ Average runoff condition, and $I_a = 0.2S$.

² *Poor*: <50% ground cover or heavily grazed with no mulch.

Fair: 50 to 75% ground cover and not heavily grazed.

Good: > 75% ground cover and lightly or only occasionally grazed.

³ *Poor*: <50% ground cover.

Fair: 50 to 75% ground cover.

Good: >75% ground cover.

⁴ Actual curve number is less than 30; use CN = 30 for runoff computations.

⁵ CN's shown were computed for areas with 50% woods and 50% grass (pasture) cover. Other combinations of conditions may be computed from the CN's for woods and pasture.

⁶ *Poor*: Forest litter, small trees, and brush are destroyed by heavy grazing or regular burning.

Fair: Woods are grazed but not burned, and some forest litter covers the soil.

Good: Woods are protected from grazing, and litter and brush adequately cover the soil.