

06/09/2020

**Hingham Planning Board  
210 Central St # 10  
Hingham, MA 02043**

**RE: Site Plan Review Application  
31 Harborview Drive  
Hingham MA 02043**

### Letter of Transmittal

We would like to submit the attached site plan review form and related design reports and plans regarding proposed raze of single-story existing single-family dwelling and proposed two-story single-family dwelling with basement and proposed changes in grade in the backyard.

This submittal is nearly identical to the submittal sent to you via email by the applicant and property owner Paul Yingling on June 4<sup>th</sup> 2020. It was noticed by our office that the application form we submitted was for zoning permits and was supposed to be the site plan review for the building permit. Correct and filled site plan application form along with minor changes made to the plan (minor and/or cosmetic changes such as line scales) and stormwater report (including additional test in report and additional results to aid in the review of the planning boards consulting engineers). Plan and stormwater report dates were updated as June 9<sup>th</sup> 2020 instead of producing revision of the June 4<sup>th</sup> 2020 dated documents to avoid confusions

Please consider the application package submitted on 06/04/2020 via email withdrawn, and consider the application and materials attached to this letter of submittal for the proposed project at 31 Harborview Drive Hingham MA.

Munden Engineering represents the property owners for this project and welcomes any questions or concerns. Please contact Gamze Munden, P.E. directly at 603-660-0241 or [info@mundenengineering.com](mailto:info@mundenengineering.com).



Regards

Gamze Munden, P.E.  
Munden Engineering  
83 Morse Street Norwood Ma 02021  
781-302-6099  
[info@mundenengineering.com](mailto:info@mundenengineering.com)



**Hingham Planning Board**  
**APPLICATION FOR SITE PLAN APPROVAL**  
**IN ASSOCIATION WITH APPLICATION FOR BUILDING PERMIT**

**Application Date:** 06/09/2020

**Applicant:** Paul Yingling & Stacy Marcotte

**Contact Information** for Applicant or Authorized Agent (Attorney, Contractor, etc.)

Name/Title: Gigi Munden, P.E.

Phone: 781-302-6099

Address: P.O. Box 286 Canton MA 02021

Project Location: 31 Harborview Drive Hingham MA

**Site Plan Review Submittal Requirements**

*Please provide to the Planning Board office seven (7) hard copies and an electronic file of the Site Plan and submittal materials, except that only two copies of the drainage report are required. Submittal Requirements:*

- a. locus plan; diagram and statement of the ownership, area, dimensions, boundaries and principal elevations of the subject property; location of structures within 100 feet of property line;
- b. scaled and dimensioned plan of the location and footprint of existing and proposed buildings and structures; if applicable, building elevations and floor layouts;
- c. if applicable, plan showing proposed circulation of traffic within the development and in all adjacent public ways; dimensioned plan of loading and parking areas, aisles and driveways; plan with detail sheets if appropriate, profile and representative cross sections of proposed driveways and parking areas;
- d. analysis of compliance with all relevant dimensional provisions of this By-Law;
- e. detailed information on utilities, landscaping, refuse storage and removal;
- f. grading plan, estimated net import/export of material, drainage analysis, and traffic analysis, as applicable;
- g. analysis of the capacity of Town soils, water supply, ways and services to absorb the impact of the proposed development;
- h. analysis of compliance of the construction activities and the proposed project, including the extent the project incorporates low impact design and green infrastructure solutions, with the most current versions of the Massachusetts Department of Environmental Protection Stormwater Management Policy

and Standards including (i) the Massachusetts Stormwater Handbook, (ii) Massachusetts Erosion Sediment and Control Guidelines, and (iii) if applicable, additional requirements under the Town of Hingham MS4 Permit for projects that disturb more than one acre and discharge to the Town's municipal stormwater system;

- i. Site Lighting Plan showing the location, height, photometric, orientation, and specifications for all outdoor site lighting, including information on the intensity and range of illumination for each source of light proposed.
- j. an erosion control plan and an Operations and Management Plan for both the construction activities and ongoing post-construction maintenance and reporting requirements; and
- k. such other materials necessary to enable Town boards to make a positive determination on the proposed development.

**Brief Description of Work:**

The applicant proposed a raze the existing single story single family dwelling and build two story single family dwelling with basement. Proposed dwelling increases the impervious surface (roofs and driveways) on lot by approximately 926 sq. ft. from existing impervious surface (2054 sq. ft.). The applicant also proposed a change in grading in the back of the property in an area of approximately 7200 sq. ft. by proposing construction of an embankment slope and raise the grade 2 ft. to 12 ft. and creating an approximately 22 degree slope extending to approximately 20 ft from the back property line. Estimated amount of fill to be imported for the proposed embankment is approximately 32,000 cubic feet and/or 1200 cubic yards.

**Request for Waiver from Site Plan Review Requirements**

Upon written request of the applicant, the Planning Board may waive any of the submittal requirements set forth in Section I-I.6 deemed by the Planning Board to be not necessary for its review of the application. In addition, the Planning Board may waive other such requirements of Section I-I, including the requirement for a public hearing, where the Planning Board determines that the project constitutes a minor site plan. In order to constitute a minor site plan, the proposed work must be limited to (i) interior renovations to a building or structure that do not include a change of use or parking demand for which a Special Permit A2 or A3 is required and/or (ii) modifications to the site which, in the Planning Board's determination, do not materially or adversely affect conditions governed by the site plan review standards set forth in Section I-I.6

**Please indicate requested relief** (for example, "I request a waiver from the requirement for a public hearing" or "I request a waiver from the requirement to submit a utilities plan and lighting plan"):

We request a a waiver from the following requirements:

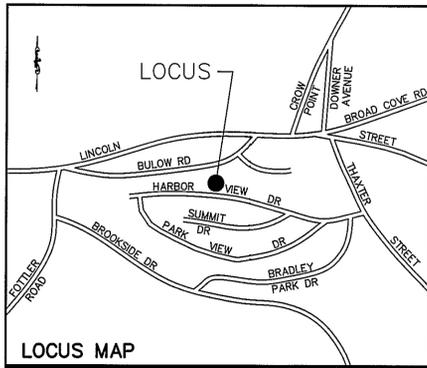
- to traffic analysis, as applicable
- to submit analysis of the capacity of Town soils, water supply, ways and services to absorb the impact of the proposed development
- Site Lighting Plan showing the location, height, photometric, orientation, and specifications for all outdoor site lighting, including information on the intensity and range of illumination for each source of light proposed

Waiver Granted

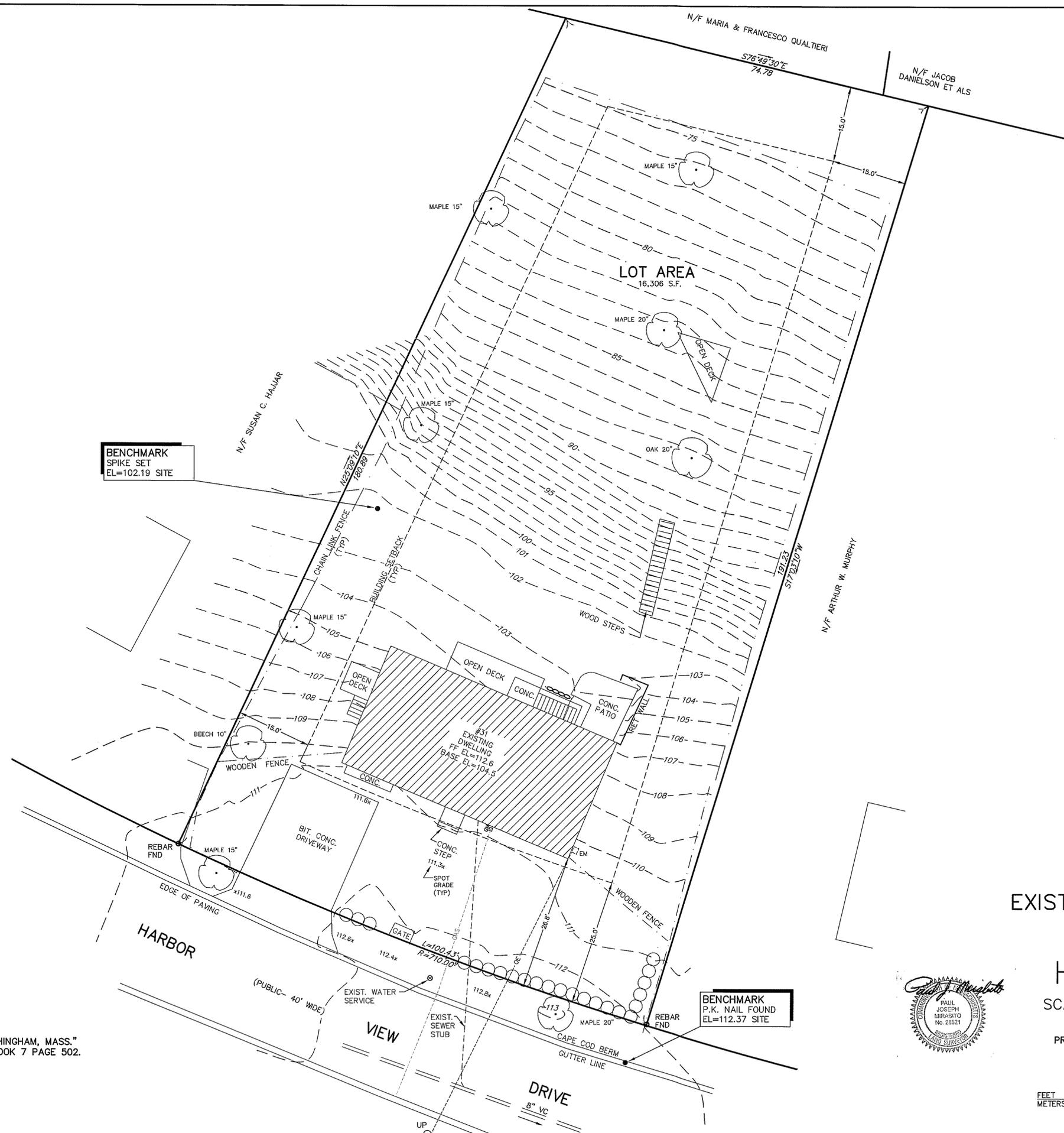
Waiver NOT Granted

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Signature of Authorized Agent (Chairman of the Planning Board or Town Planner)      Date



LOCUS MAP

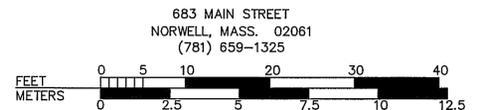


BENCHMARK  
SPIKE SET  
EL=102.19 SITE

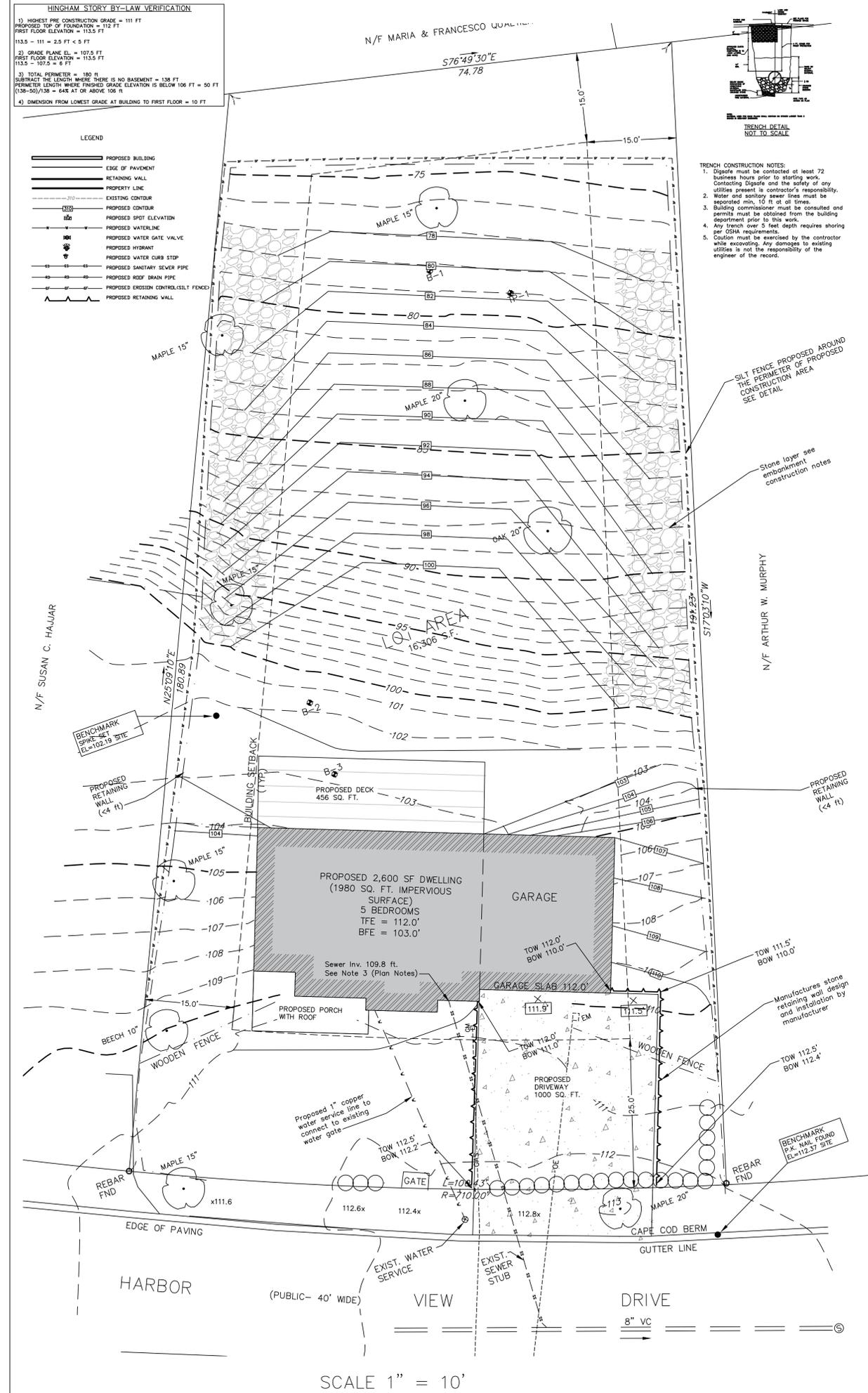
BENCHMARK  
P.K. NAIL FOUND  
EL=112.37 SITE

- NOTES:
- ZONING CLASSIFICATION - RESIDENCE A  
FRONT YARD SETBACK - 25'  
SIDE YARD SETBACK - 15'  
REAR YARD SETBACK - 15'
  - THE LOCUS IS NOT IN THE TOWN OF HINGHAM  
AQUIFER PROTECTION DISTRICT.
  - LOCUS LIES IN ZONE X AS SHOWN ON FIRM MAP  
COMMUNITY PANEL #250268 082 J, DATED NOV. 4, 2016.
  - PLAN REFERENCES:  
A) "SECTION III OF THE BRADLEY PARK DEVELOPMENT IN HINGHAM, MASS."  
BY R.N. LINKE, C.E. DATED AUGUST 26, 1947. PLAN BOOK 7 PAGE 502.
  - LOCUS DEED:  
BOOK 28777 PAGE 141 RECORDED JULY 30, 2004.  
ASSESSORS REFER: 48/0/60.

EXISTING CONDITIONS PLAN  
FOR  
31 HARBOR VIEW DRIVE  
IN  
HINGHAM, MA  
SCALE: 1"=10' MARCH 2, 2020  
ROSS ENGINEERING COMPANY INC.  
PROFESSIONAL ENGINEERS - LAND SURVEYORS



Q:\JDBS\4001-4250\4124\4124\_C3D\Production Drawings\4124.dwg, 3/10/2020 9:16:15 AM, DWG To PDF.pc3



**HIGHAM STORY BY-LAW VERIFICATION**

1) HIGHEST PRE CONSTRUCTION GRADE = 111 FT  
 PROPOSED TOP OF FOUNDATION = 112 FT  
 FIRST FLOOR ELEVATION = 113.5 FT  
 113.5 - 111 = 2.5 FT < 5 FT

2) GRADE PLANE EL. = 107.5 FT  
 FIRST FLOOR ELEVATION = 113.5 FT  
 113.5 - 107.5 = 6 FT

3) TOTAL PERIMETER = 180 FT  
 SUBTRACT THE LENGTH WHERE THERE IS NO BASEMENT = 138 FT  
 PERIMETER LENGTH WHERE FINISHED GRADE ELEVATION IS BELOW 106 FT = 50 FT  
 (138-50)/138 = 64% AT OR ABOVE 106 FT

4) DIMENSION FROM LOWEST GRADE AT BUILDING TO FIRST FLOOR = 10 FT

- LEGEND**
- PROPOSED BUILDING
  - EDGE OF PAVEMENT
  - RETAINING WALL
  - PROPERTY LINE
  - EXISTING CONTOUR
  - PROPOSED CONTOUR
  - PROPOSED SPOT ELEVATION
  - PROPOSED WATERLINE
  - PROPOSED WATER GATE VALVE
  - PROPOSED HYDRANT
  - PROPOSED WATER CURB STOP
  - PROPOSED SANITARY SEWER PIPE
  - PROPOSED ROOF DRAIN PIPE
  - PROPOSED EROSION CONTROL/SILT FENCE
  - PROPOSED RETAINING WALL

**PLAN NOTES**

- Existing lot lines, existing conditions and elevations (including utilities and accessory structures) and the location of the proposed addition is based on the existing conditions plan prepared by Ross Engineering Company Inc. and dated 03/02/2020.
- Contractor is responsible for digsafe and any and all safety measures and any necessary means and contracting to build the proposed structures to the specifications depicted on this plan.
- Existing sewer elevation and location to be replaced and a portion between lot line and the new foundation to be replaced. Invert elevation based on field measurements and must be considered approximate. Water and sewer services must be placed minimum 10 feet apart where possible.
- Driveway grading based on the owner's request. The owner of the property was informed driveway grading with a slope towards the garage was not advised and have been made aware of the possible flooding and water damage problems and assumes full responsibility for any problems that may arise regarding drainage and drainage caused problems from the driveway.
- Test pit and test boring locations depicted are based on field measurements and must be considered approximate.

**TRENCH CONSTRUCTION NOTES:**

- Digsafe must be contacted at least 72 business hours prior to starting work. Contacting Digsafe and the safety of any utilities present is contractor's responsibility.
- Water and sanitary sewer lines must be separated min. 10 ft at all times.
- Building commissioner must be consulted and permits must be obtained from the building department prior to this work.
- Any trench over 5 feet depth requires shoring per OSHA requirements.
- Caution must be exercised by the contractor while excavating. Any damages to existing utilities is not the responsibility of the engineer of the record.

**SOIL ANALYSIS**

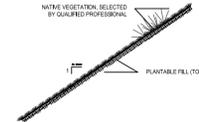
SOIL DESCRIPTION	DEPTH	WATER CONTENT (%)	LIQUID LIMIT (%)	PLASTICITY INDEX	GROUP SYMBOL
GRAVELLY SAND	0-12"	10.5	24.0	13.5	SW-6
SANDY SILT	12-18"	22.0	38.0	16.0	ML
SANDY SILT	18-24"	25.0	40.0	15.0	ML
SANDY SILT	24-30"	28.0	42.0	14.0	ML
SANDY SILT	30-36"	30.0	44.0	14.0	ML
SANDY SILT	36-42"	32.0	46.0	14.0	ML
SANDY SILT	42-48"	34.0	48.0	14.0	ML
SANDY SILT	48-54"	36.0	50.0	14.0	ML
SANDY SILT	54-60"	38.0	52.0	14.0	ML
SANDY SILT	60-66"	40.0	54.0	14.0	ML
SANDY SILT	66-72"	42.0	56.0	14.0	ML

**GENERAL EROSION AND SEDIMENT CONTROL NOTES:**

- All erosion and sediment control measures are to be placed prior to commencement of land disturbance activities.
- The contractor is responsible for installation of any additional erosion control measures necessary to prevent erosion and sedimentation.
- All disturbances to drain to approved sediment control measures at all times during land disturbing activities and during site development until final stabilization is achieved.
- The contractor shall inspect all erosion control measures weekly and after each rainfall event. Any necessary repairs or cleanup to maintain the effectiveness of the erosion control devices shall be made immediately.
- The contractor shall maintain a surplus supply of necessary erosion control devices on-site for emergency use (straw bales, wattles, filter berm, silt fence, stakes, crushed stone).

**POST CONSTRUCTION SEDIMENT AND EROSION CONTROL NOTES:**

- Sloped areas must be inspected after every major storm for the first 6 months after construction for signs of erosion, gulleying, and intactness of the plants and vegetation and riprap areas. If gulleying or localized, differential erosion is observed the engineer of the record must be contacted. After the slopes, the inspection frequency can reduce to a monthly schedule.
- Maintenance of the vegetation, planting and the rip rap areas are the responsibility of the owner.



**NOTE:**  
 TOPSOIL SHALL BE LOAMY SAND OR FINE GRADATION WITH 10%-15% ORGANIC CONTENT OR MATERIAL APPROVED BY A QUALIFIED LANDSCAPE ARCHITECT. VEGETATION TYPE SHALL BE SPECIFIED BY A QUALIFIED LANDSCAPE ARCHITECT.

**EMBANKMENT CONSTRUCTION NOTES**

- All material used for the construction of the fill slope (embankment) must have size distribution in compliance with AASHTO A-1-b, MassDOT M1.03.0-1and/or MassDOT M2.01.7-1.
- Where required, crushed stone/riprap must be Modified rockfill as described in MassDOT specifications (2020) and shall consist of hard, durable angular shaped stones which are the product of the primary crushing of a stone crusher. Rounded stone, boulders, sandstone and similar soft stone or relatively thin slabs will not be acceptable. Stone shall be free from overburden, spoil, shale, organic material and meet the following gradation:  

Size of Stone (in.)	Passing Percentages
8	95-100
4	0-25
2 1/2	0-5
- All subgrade must be flattened to the extent possible, existing slopes benched accordingly with OSHA guidelines and all fill material to be removed from the bottom prior to construction. Crushed stone must be placed after granular fill is placed and compacted for the entire embankment.
- The foundation areas shall be cleared, grubbed and stripped as required, and all soft, spongy or other material unsuitable for embankment foundation shall be removed. When, in the Engineer's judgment, there is reasonable doubt as to the suitability of the existing material for embankment foundation, no further work shall be performed in the area in question until the material is tested and approved for use or remedial methods are ordered by the Engineer.
- Where embankment is to be placed against existing earth slopes, steeper than 3 to 1, the slope shall be broken up into steps of random width as the fill is placed in order to provide a suitable bond between the existing ground and the new embankment.
- If subsurface conditions different than what is shown on this plan and accompanying reports are encountered during construction, the engineer of the record must be contacted immediately.
- Fill material shall be placed and compacted in uniform layers not exceeding 12 in. in depth, loose measurement; each layer of material shall be spread on the entire width of the embankment and leveled off by approved equipment.
- The embankment materials shall be compacted to not less than 95% of the maximum dry density of the embankment material as determined by AASHTO Standard

**STORMWATER MANAGEMENT NOTES**

**Existing Impervious Area:**  
 Roof : 1234 sq. ft.  
 Driveway : 614 sq. ft.  
 Patio Pavers: 206 sq. ft.

Existing Total : 2054 sq. ft.

**Proposed Impervious Area:**  
 Roof : 1980 sq. ft.  
 Driveway : 1000 sq. ft.

Proposed Total : 2980 sq. ft.

Increase in Impervious Area: 926 sq. ft.

Peak Runoff rates for existing and proposed conditions are presented below:

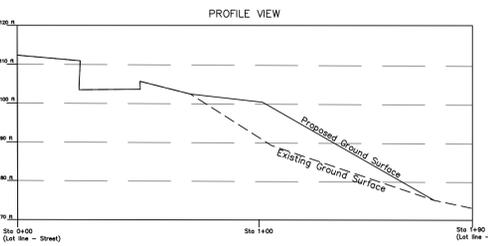
Storm Intensity	Rainfall (in.)	Existing Conditions Runoff (cfs)	Proposed Conditions Runoff (cfs)
2-yr	3.30	0.46	0.49
10-yr	4.89	0.99	1.03
25-yr	6.12	1.44	1.48
100-yr	8.60	2.38	2.42

Please also refer to the stormwater management report for additional information.

**CONSTRUCTION SEQUENCE**

Items must occur in the order listed; items cannot occur concurrently unless specifically noted.

- No construction can begin until any and all permits are obtained from Town of Hingham
- Pre-construction meeting on-site
- Clearing & grubbing only as necessary for installation of perimeter controls
- Installation of perimeter controls (silt fence)
- Demolition of existing house dwelling (sediment & erosion control measures for these areas must already be installed)
- Clearing & grubbing for the remainder of the lot where grade changes are proposed
- Construction of concrete foundation
- Clearing & grubbing of site or demolition (sediment & erosion control measures for these areas must already be installed)
- Rough grading (also see embankment construction notes)
- Installation of utilities
- Fine grading, paving, etc. (also see embankment construction notes)
- Construction of framing and exteriors including roofs, windows, doors, siding, decking etc.)
- Permanent/final stabilization
- Removal of temporary sediment & erosion control measures
- Perform as-built surveys and submit to Town of Hingham for acceptance



**Revisions**

Rev. No.	Rev. Date	Description

**PROPOSED CONDITIONS SITE PLAN**

31 Harborview Dr  
 Hingham MA

June 9th 2020

Prepared For:

PAUL YINGLING  
 &  
 STACY MARCOTTE  
 31 Harborview Dr  
 HINGHAM MA

Prepared By:

**Munden Engineering**  
 83 Morse Street  
 Norwood MA 02062  
 781-302-6099  
 mundenengineering.com



06/09/2020



Munden Engineering

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[info@mundenengineering.com](mailto:info@mundenengineering.com)  
781-302-6099

## **STORMWATER REPORT & DRAINAGE CALCULATIONS**

**31 HARBORVIEW DR  
HINGHAM MA**

**June 9<sup>th</sup> 2020**

**Prepared By: Gamze Munden, P.E**



**Munden Engineering**



## Table of Contents

Design & Calculation Standards  
Locus Analysis & Project Summary  
Pre-Development Condition  
Post-Development Condition  
Erosion Control

## Appendices

- A. GIS and FEMA MAPS
- B. NRCS SOIL DATA
- C. Precipitation Data
- D. Pre-Development Drainage Calculations
- E. Post-Development Drainage Calculations
- F. Stormwater Management and Erosion Control Plan



06/09/2020

## **Design Calculations & Standards**

Pre- and Post-Development drainage calculations were prepared utilizing the U.S. Soil Conservation Service Technical Release 20 – Urban Hydrology for Small Watersheds, Technical Release 55 - Urban Hydrology for Small Watersheds, the U.S. Soil Conservation Service National Engineering Hydrology Handbook, design rainfall data obtained from Extreme Precipitation Tables presented by Northeast Regional Climate Center, and accepted engineering design practice. These standards were applied in the use of HydroCAD stormwater modeling software to generate a representative model of existing hydrology and proposed stormwater management features. Details of this model can be found in the appendices of this report.

Where applicable, MA Department of Environmental Protection (DEP) Stormwater Handbook performance standards, along with accepted engineering practices, are utilized in preparing a stormwater management system design.

## **Locus Analysis & Project Summary**

The project proponent and current property owners, Paul Yingling and Stacy Marcotte, are proposing to raze the existing 2054 sq. ft. impervious area consisting of single family dwelling, driveway and concrete patios, and propose to rebuild a single family dwelling and driveway resulting in total of 2980 sq. ft. impervious surface and embankment slope in the back of the property extending the existing slope. The difference between existing and proposed impervious areas is approximately 926 sq. ft.

The existing parcel is located on the North side of Harborview Dr and abuts residential properties to the North, East and West and has a 100 feet frontage on Harborview Dr on the South side.

The NRCS Soil Survey classifies the native soils on site as a "Charlton-Urban land-Hollis complex, 3 to 15 percent slopes, rocky (631 C)". This soil profile has a rating "C", which indicates that a low infiltration rate can be expected for purposes of designing subsurface

stormwater best management practices. Three (3) test borings and one (1) test pit were through out the site in the back of the existing dwelling to ranging approximately 5 to 12 feet in depth, and all test explorations were terminated in refusal. Please also refer to the test exploration logs as depicted on the Stormwater Management and Erosion Control Plan in Appendix F.

### **Pre-Development Condition**

Existing conditions of the lot included a single-family home, bituminous concrete driveway, and a concrete areas (patio and walkway), landscaping and associated utilities. The total existing impervious footprint on the site is 2054 square feet, which includes the existing house roof, driveway, and patio. The existing topography slopes downhill from the foundation with slopes ranging from 10 to 45 percent.

For the purposes of producing a hydrologic model, one design point was analyzed for the predevelopment conditions, which includes runoff to neighboring properties and to the public road.

Drainage calculations for the pre-development conditions are shown with the post-development conditions below.

### **Post-Development Condition**

The applicant proposes to raze existing dwelling, driveway and other appurtenances and rebuild a single family dwelling and driveway resulting in total of 2980 sq. ft. impervious surface and embankment slope in the back of the property extending the existing slope. The difference in impervious areas is 926 sq. ft. between existing and proposed conditions.

Proposed embankment slopes are flatter or equal to the existing slopes currently present on site. The overall flattening of the steep slopes existing in pre-development conditions and other

surface and landscaping improvements provide minimal increase for a proposed 926 sq. ft. increase of impervious surfaces.

For the purposes of producing a hydrologic model, one design point was analyzed for the post-development conditions, which includes runoff to neighboring properties.

TR-55 requires a minimum time of concentration (Tc) value of 6 minutes. Both existing and proposed conditions add up to a time of concentration values of 2.5 and 2.8 minutes, respectively which are both under 6 minutes. Analyses performed for both existing and proposed conditions for minimum Tc of 6 minutes and calculated Tc values, as summarized below and also as attached in Appendices D and E.

Peak Runoff rates for existing and proposed conditions are presented below:

**Table 1. Summary of Analyses Results for Tc = 6 min**

Storm Frequency	Rainfall 24 -hr (in)	Existing Conditions Peak Rate of Runoff (cfs)	Proposed Conditions Peak Rate of Runoff (cfs)
2 - yr	3.30	0.46	0.49
10 - yr	4.89	0.99	1.03
25 - yr	6.12	1.44	1.48
100 - yr	8.60	2.38	2.42

**Table 2. Summary of Analyses Results for calculated Tc values**

Storm Frequency	Rainfall 24 -hr (in)	Existing Conditions Peak Rate of Runoff (cfs, Tc 2.5 min)	Proposed Conditions Peak Rate of Runoff (cfs, Tc 2.8 min)
2 - yr	3.30	0.51	0.54
10 - yr	4.89	1.12	1.14
25 - yr	6.12	1.62	1.65
100 - yr	8.60	2.68	2.70

## **Stormwater Management**

As summarized above, the increase in peak rate of runoff in all design storms and both with minimum Tc and calculated Tc calculations is **no more than 0.05 cfs (and approximately 5% average for all storms)** for proposed conditions compared to the existing conditions. Given the minimal amount of increase in peak rate of runoff, a stormwater system to attenuate peak rates of runoff is not recommended for this project. It is our professional opinion that the design of a system that can attenuate the peak rates of runoff would require a system larger than required due to the low infiltrations rates to conform to 72-hour drawdown, might affect slope stability of existing and proposed slopes and require increased land disturbance and overall, the cons might outweigh the pros for both in the interests of the town and the property owners.

## **Erosion Control**

### Construction Erosion Control

During construction, erosion control will be installed around the limit of work as indicated on the site plans and maintained until the entire site is stabilized with vegetation. The erosion control barrier will consist of a staked-in silt fence placed north, east and west sides of the proposed construction area as depicted on the proposed conditions plan.

### Post-Construction Erosion Control

Post construction erosion control will be accomplished with vegetation on the face and sides of the slopes and with 8" Rip-Rap at the corners where proposed embankment meets existing slope.



## **Compliance with Stormwater Management Standards:**

The proposed project complies with the Stormwater Management Standards to the maximum extent practicable as follows:

### Standard 1: No New Stormwater Conveyances of Untreated Stormwater or Erosion Offsite

There will be no new stormwater conveyances of untreated stormwater since peak runoff will be reduced with the proposed infiltration system.

Potential for erosion will be greatly reduced by both the reduced peak runoff rates and also the flattening of the existing steep slopes.

### Standard 2: Peak Rate Attenuation

Increase in peak rate of runoff, expressed in cubic feet per second (CFS) will be minimal, **no more than 0.05 cfs (and approximately 5% average for all storms)** for proposed conditions compared to the existing conditions. Given the minimal amount of increase in peak rate of runoff, a stormwater system to attenuate peak rates of runoff is not recommended for this project.

### Standard 3: Recharge and Discharge Volume

Runoff attenuation was obtained through changes in grading for this project. Due to low infiltration rates for the soil and the presence of slopes over 20 degrees, an infiltration system in a size is not feasible option for this project.

### Standard 4: Water Quality

Not applicable.

### Standard 5: Land Uses with Higher Pollutant Loads (LUHPPLs)

Not applicable.

### Standard 6: Critical Areas

The residential site is not located within a critical area, see attached MassGIS and Town of Hingham map (Appendix A).

### Standard 7: Redevelopment

This project is considered redevelopment.

### Standard 8: Construction Period Pollution Prevention and Erosion and



### Sedimentation Control

See post-construction erosion control plan on the proposed conditions plan.

### Standard 9: Long Term Operation and Maintenance Plan

See post-construction erosion control plan on the proposed conditions plan.

### Standard 10: Prohibition of Illicit Discharges

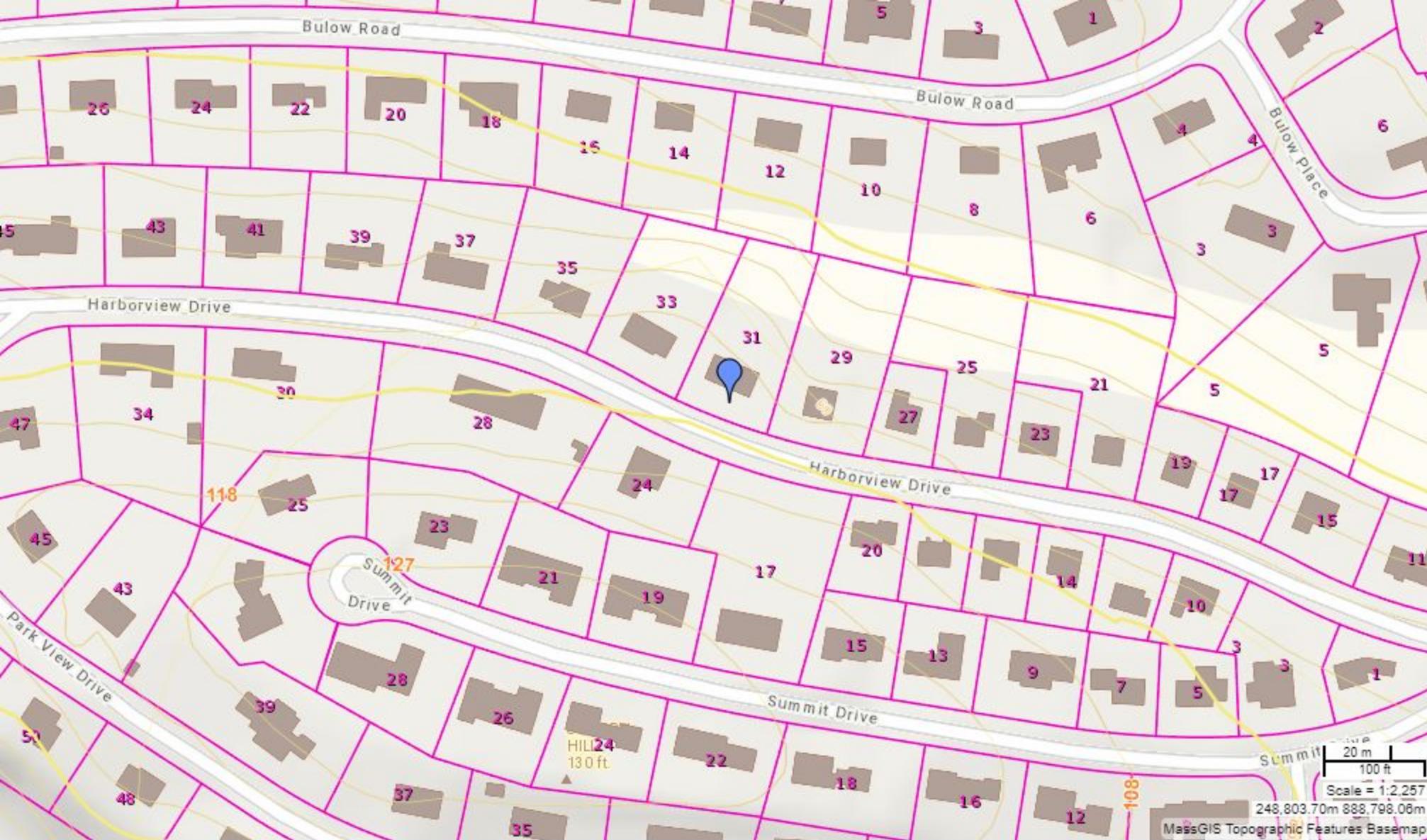
Routine visual inspections, good housekeeping and compliance with MassDEP Stormwater Management and Erosion and Sediment Control Policies are required to prevent illicit discharges into the stormwater system.



Munden Engineering

mundenengineering.com  
[info@mundenengineering.com](mailto:info@mundenengineering.com)  
781-302-6099

## Appendix A GIS and FEMA Maps



Status / Availability (maps showing where data is a...)

Theme Maps

Layers for Query

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**Active Data Layers**

Check all | Uncheck all | Remove all

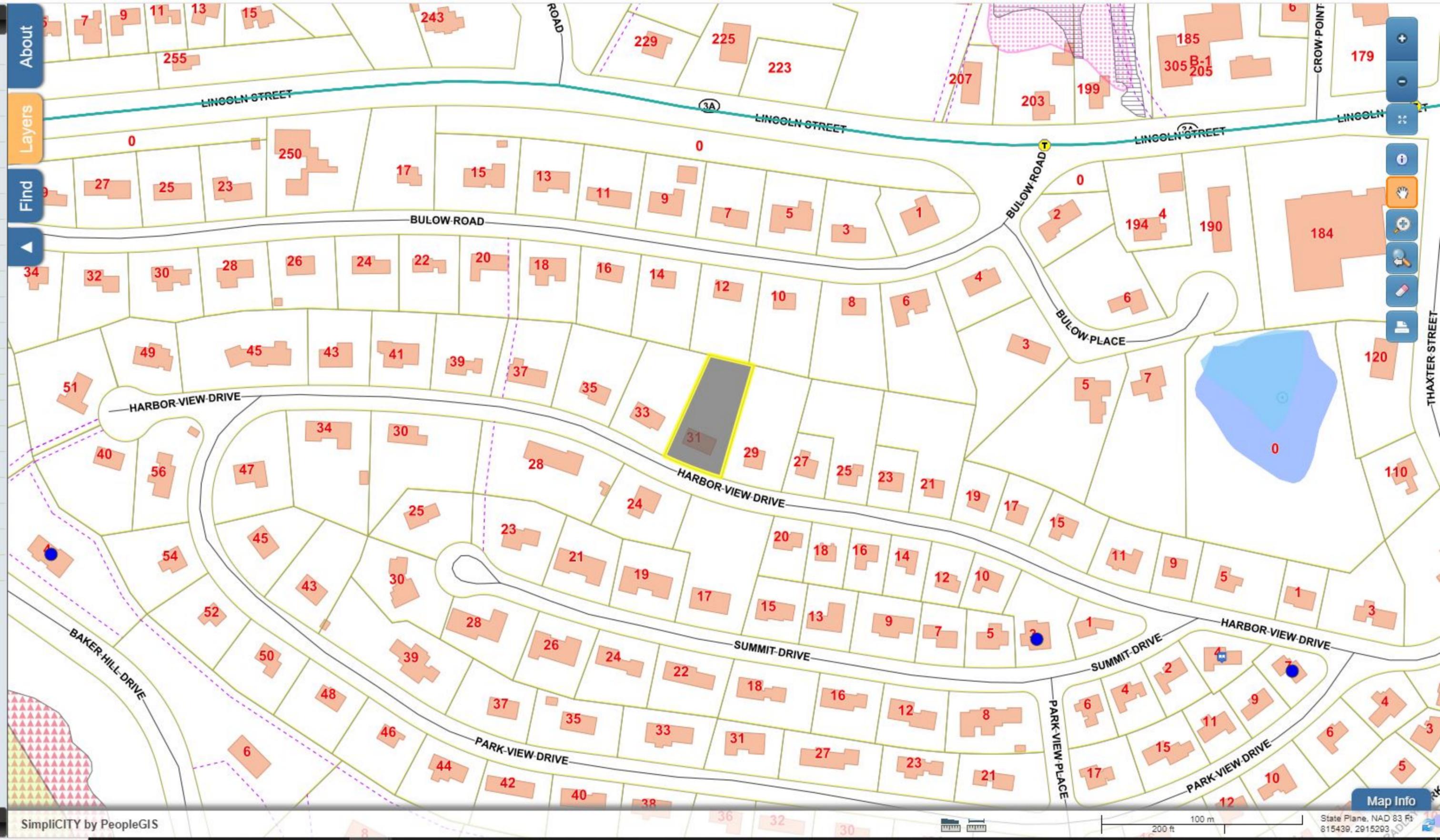
- Contours 3m Lines
- Contours 3m Labels Feet
- Contours 30ft Lines
- Contours 30ft Labels
- Zone Is
- Zone Is Dissolved
- Zone IIs
- Zone IIs Dissolved
- Zone A
- Outstanding Resource Waters
- NHESP Priority Habitats of Rare Species
- Potential Vernal Pools
- NHESP Estimated Habitats of Rare Wildlife
- NHESP Certified Vernal Pools
- IWPA's
- IWPA's Dissolved
- DEP Wetlands Detailed
- Areas of Critical Environmental Concern ACECs
- Tax Parcels for Query
- Detailed Features
- Tax Parcels for Display
- Structures

Layers

- Places
- Private Wells
- MBTA
- Historical Inventory
- Town Road Moratorium
- Watershed
- Zoning Overlay Districts
- Zoning
- Historic Districts
- LIMWA Effective 9-8-17
- Current FEMA Flood Zones
- MA DEP Wetlands
- Hydrography
- Areas of Critical Environmental Concern
- NHESP
- Open Space 2018
- Easements
- Labels
- Parcels
- Parcels w/ Orthos
- Buildings

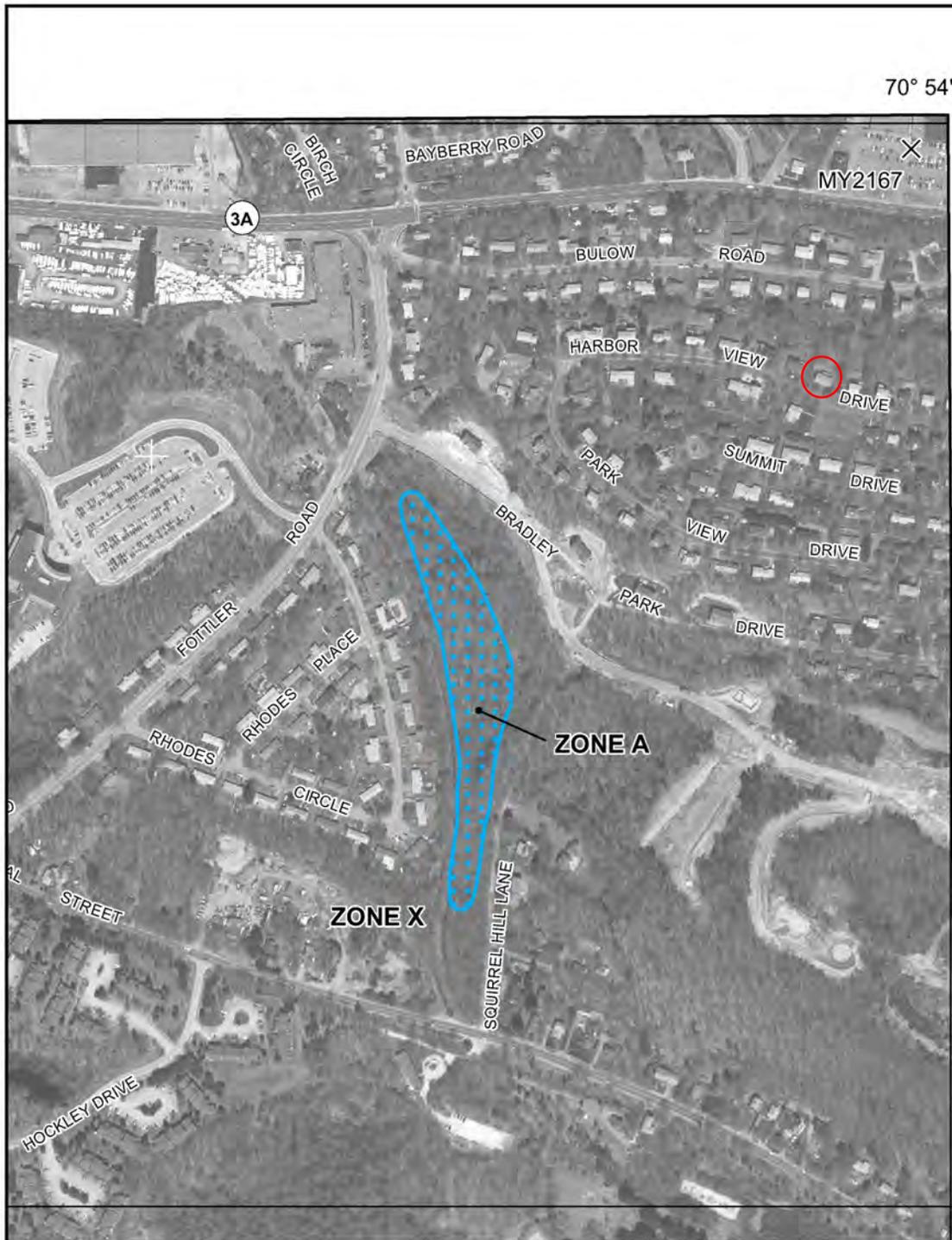
- Basemap - Town Base Map
-  Town Boundary
  -  Interstate
  -  US Highway
  -  Numbered Routes
  - 

Base Maps



Map Info

State Plane, NAD 83 Ft  
815439, 2915293



70° 54' 22.5"

42° 15' 00"



MAP SCALE 1" = 500'



NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0081J

# FIRM

FLOOD INSURANCE RATE MAP  
PLYMOUTH COUNTY,  
MASSACHUSETTS  
(ALL JURISDICTIONS)

PANEL 81 OF 650  
(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
HINGHAM, TOWN OF	250268	0081	J

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.



**MAP NUMBER**  
25023C0081J  
**EFFECTIVE DATE**  
JULY 17, 2012

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at [www.msc.fema.gov](http://www.msc.fema.gov)



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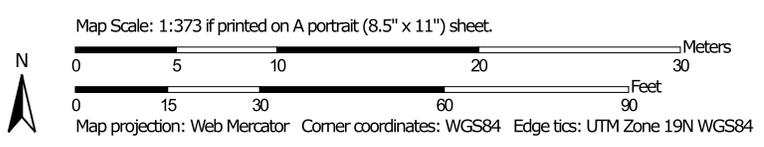
mundenengineering.com  
[info@mundenengineering.com](mailto:info@mundenengineering.com)  
781-302-6099

## Appendix B NRCS Soil Data

Soil Map—Plymouth County, Massachusetts  
(31 Harborview Drive, Hingham, MA)



Soil Map may not be valid at this scale.



## 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
- 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 1:12,000.

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: Plymouth County, Massachusetts  
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: Aug 10, 2014—Aug 25, 2014

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

## Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
305E	Paxton fine sandy loam, 25 to 35 percent slopes	0.2	49.0%
340C	Broadbrook very fine sandy loam, 8 to 15 percent slopes	0.2	51.0%
<b>Totals for Area of Interest</b>		<b>0.4</b>	<b>100.0%</b>

## Plymouth County, Massachusetts

### 305E—Paxton fine sandy loam, 25 to 35 percent slopes

#### Map Unit Setting

*National map unit symbol:* 2w682  
*Elevation:* 0 to 1,200 feet  
*Mean annual precipitation:* 36 to 71 inches  
*Mean annual air temperature:* 39 to 55 degrees F  
*Frost-free period:* 145 to 240 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Paxton and similar soils:* 90 percent  
*Minor components:* 10 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Paxton

##### Setting

*Landform:* Drumlins, ground moraines, hills  
*Landform position (two-dimensional):* Backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Linear, convex  
*Across-slope shape:* Convex  
*Parent material:* Coarse-loamy lodgment till derived from gneiss, granite, and/or schist

##### Typical profile

*Ap - 0 to 8 inches:* fine sandy loam  
*Bw1 - 8 to 15 inches:* fine sandy loam  
*Bw2 - 15 to 26 inches:* fine sandy loam  
*Cd - 26 to 65 inches:* gravelly fine sandy loam

##### Properties and qualities

*Slope:* 25 to 35 percent  
*Depth to restrictive feature:* 20 to 39 inches to densic material  
*Natural drainage class:* Well drained  
*Runoff class:* High  
*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately low (0.00 to 0.14 in/hr)  
*Depth to water table:* About 18 to 37 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Salinity, maximum in profile:* Nonsaline (0.0 to 1.9 mmhos/cm)  
*Available water storage in profile:* Low (about 4.1 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* C

*Hydric soil rating:* No

### **Minor Components**

#### **Charlton**

*Percent of map unit:* 8 percent

*Landform:* Hills

*Landform position (two-dimensional):* Backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Hydric soil rating:* No

#### **Woodbridge**

*Percent of map unit:* 2 percent

*Landform:* Hills, drumlins, ground moraines

*Landform position (two-dimensional):* Backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Concave

*Across-slope shape:* Linear

*Hydric soil rating:* No

## **Data Source Information**

Soil Survey Area: Plymouth County, Massachusetts

Survey Area Data: Version 12, Sep 12, 2019

## Plymouth County, Massachusetts

### 340C—Broadbrook very fine sandy loam, 8 to 15 percent slopes

#### Map Unit Setting

*National map unit symbol:* 9y4b

*Elevation:* 50 to 400 feet

*Mean annual precipitation:* 41 to 54 inches

*Mean annual air temperature:* 43 to 54 degrees F

*Frost-free period:* 145 to 240 days

*Farmland classification:* Farmland of statewide importance

#### Map Unit Composition

*Broadbrook and similar soils:* 80 percent

*Minor components:* 20 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Broadbrook

##### Setting

*Landform:* Hills, drumlins, till plains

*Landform position (two-dimensional):* Shoulder, backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Convex

*Parent material:* Coarse-loamy eolian deposits over coarse-loamy lodgment till

##### Typical profile

*Oi - 0 to 2 inches:* slightly decomposed plant material

*Oe - 2 to 4 inches:* moderately decomposed plant material

*A - 4 to 6 inches:* very fine sandy loam

*Bw1 - 6 to 18 inches:* very fine sandy loam

*Bw2 - 18 to 30 inches:* very fine sandy loam

*2Cd1 - 30 to 44 inches:* gravelly fine sandy loam

*2Cd2 - 44 to 63 inches:* gravelly sandy loam

##### Properties and qualities

*Slope:* 8 to 15 percent

*Depth to restrictive feature:* 20 to 39 inches to densic material

*Natural drainage class:* Well drained

*Runoff class:* Low

*Capacity of the most limiting layer to transmit water (Ksat):* Very low to moderately high (0.00 to 0.20 in/hr)

*Depth to water table:* About 18 to 30 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* Low (about 4.6 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3e

*Hydrologic Soil Group:* C

*Hydric soil rating:* No

### Minor Components

#### Woodbridge

*Percent of map unit:* 5 percent

*Landform:* Drumlins, till plains, hills

*Landform position (two-dimensional):* Backslope, shoulder

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Concave

*Hydric soil rating:* No

#### Montauk

*Percent of map unit:* 5 percent

*Landform:* Till plains, drumlins, ground moraines

*Landform position (two-dimensional):* Shoulder, backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Convex

*Hydric soil rating:* No

#### Canton

*Percent of map unit:* 5 percent

*Landform:* Hills, till plains, ridges

*Landform position (two-dimensional):* Shoulder, backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Convex

*Hydric soil rating:* No

#### Paxton

*Percent of map unit:* 5 percent

*Landform:* Drumlins, ground moraines, hills, till plains

*Landform position (two-dimensional):* Backslope, shoulder

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Linear

*Across-slope shape:* Convex

*Hydric soil rating:* No

## Data Source Information

Soil Survey Area: Plymouth County, Massachusetts

Survey Area Data: Version 12, Sep 12, 2019



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781-302-6099

## Appendix C Precipitation Data

# Extreme Precipitation Tables

## Northeast Regional Climate Center

Data represents point estimates calculated from partial duration series. All precipitation amounts are displayed in inches.

Smoothing	Yes
State	Massachusetts
Location	
Longitude	70.908 degrees West
Latitude	42.248 degrees North
Elevation	0 feet
Date/Time	Tue, 31 Mar 2020 20:02:44 -0400

### Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.28	0.43	0.54	0.70	0.88	1.11	1yr	0.76	1.05	1.29	1.65	2.12	2.73	3.06	1yr	2.42	2.94	3.40	4.02	4.77	1yr
2yr	0.35	0.55	0.68	0.90	1.13	1.42	2yr	0.97	1.30	1.65	2.07	2.62	3.30	3.67	2yr	2.92	3.53	4.06	4.81	5.45	2yr
5yr	0.42	0.66	0.83	1.11	1.42	1.80	5yr	1.22	1.64	2.09	2.63	3.30	4.13	4.68	5yr	3.65	4.50	5.14	6.07	6.78	5yr
10yr	0.48	0.75	0.95	1.29	1.68	2.15	10yr	1.45	1.95	2.51	3.15	3.94	4.89	5.62	10yr	4.33	5.40	6.15	7.24	8.02	10yr
25yr	0.57	0.91	1.16	1.59	2.11	2.73	25yr	1.82	2.45	3.18	3.99	4.96	6.12	7.16	25yr	5.41	6.89	7.81	9.15	10.00	25yr
50yr	0.65	1.04	1.33	1.87	2.52	3.28	50yr	2.17	2.92	3.83	4.80	5.93	7.25	8.61	50yr	6.42	8.28	9.35	10.92	11.83	50yr
100yr	0.74	1.20	1.55	2.20	3.00	3.93	100yr	2.59	3.47	4.60	5.75	7.08	8.60	10.36	100yr	7.61	9.96	11.21	13.04	14.00	100yr
200yr	0.86	1.40	1.82	2.60	3.58	4.70	200yr	3.09	4.13	5.51	6.88	8.43	10.21	12.47	200yr	9.03	11.99	13.44	15.58	16.57	200yr
500yr	1.04	1.71	2.22	3.23	4.53	5.98	500yr	3.91	5.21	7.01	8.74	10.66	12.81	15.94	500yr	11.34	15.33	17.09	19.72	20.72	500yr

### Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.25	0.39	0.48	0.64	0.79	0.88	1yr	0.68	0.86	1.16	1.44	1.82	2.54	2.78	1yr	2.25	2.67	2.93	3.51	4.41	1yr
2yr	0.34	0.52	0.64	0.87	1.07	1.28	2yr	0.93	1.25	1.47	1.96	2.53	3.15	3.56	2yr	2.79	3.42	3.92	4.64	5.25	2yr
5yr	0.40	0.61	0.76	1.04	1.32	1.54	5yr	1.14	1.50	1.75	2.29	2.94	3.84	4.30	5yr	3.40	4.13	4.70	5.51	6.22	5yr
10yr	0.44	0.68	0.84	1.18	1.52	1.76	10yr	1.31	1.72	2.00	2.57	3.29	4.42	4.94	10yr	3.91	4.75	5.38	6.26	7.09	10yr
25yr	0.51	0.78	0.97	1.38	1.82	2.10	25yr	1.57	2.05	2.34	3.00	3.82	5.30	5.95	25yr	4.69	5.73	6.43	7.42	8.41	25yr
50yr	0.57	0.87	1.08	1.55	2.09	2.40	50yr	1.80	2.35	2.63	3.38	4.27	6.12	6.86	50yr	5.42	6.59	7.36	8.40	9.61	50yr
100yr	0.64	0.97	1.22	1.76	2.41	2.73	100yr	2.08	2.67	2.96	3.81	4.78	7.06	7.91	100yr	6.25	7.60	8.45	9.50	10.99	100yr
200yr	0.72	1.09	1.38	2.00	2.79	3.13	200yr	2.41	3.06	3.32	4.28	5.35	8.17	9.15	200yr	7.23	8.80	9.75	10.76	12.58	200yr
500yr	0.85	1.27	1.63	2.37	3.37	3.72	500yr	2.91	3.64	3.86	5.00	6.22	9.99	11.14	500yr	8.84	10.71	11.70	12.73	15.09	500yr

### Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.31	0.48	0.58	0.79	0.97	1.14	1yr	0.83	1.11	1.35	1.80	2.31	2.93	3.40	1yr	2.59	3.27	3.70	4.40	5.15	1yr
2yr	0.37	0.57	0.70	0.94	1.16	1.38	2yr	1.00	1.35	1.60	2.11	2.72	3.44	3.87	2yr	3.05	3.72	4.28	5.05	5.67	2yr
5yr	0.46	0.71	0.88	1.21	1.54	1.81	5yr	1.33	1.77	2.10	2.72	3.46	4.46	5.08	5yr	3.95	4.88	5.59	6.60	7.35	5yr
10yr	0.56	0.87	1.07	1.50	1.94	2.24	10yr	1.67	2.19	2.58	3.31	4.16	5.52	6.29	10yr	4.89	6.05	6.90	8.11	8.95	10yr
25yr	0.74	1.12	1.40	1.99	2.62	2.95	25yr	2.26	2.88	3.45	4.30	5.32	7.30	8.33	25yr	6.46	8.01	9.15	10.67	11.59	25yr
50yr	0.90	1.37	1.70	2.45	3.30	3.65	50yr	2.85	3.57	4.28	5.23	6.42	8.99	10.32	50yr	7.95	9.92	11.35	13.10	14.03	50yr
100yr	1.11	1.67	2.10	3.03	4.16	4.50	100yr	3.59	4.40	5.33	6.39	7.74	11.04	12.77	100yr	9.77	12.28	14.05	16.12	17.06	100yr
200yr	1.36	2.04	2.59	3.75	5.23	5.57	200yr	4.51	5.45	6.64	7.78	9.32	13.55	15.81	200yr	11.99	15.20	17.35	19.84	20.72	200yr
500yr	1.79	2.66	3.42	4.97	7.07	7.37	500yr	6.10	7.20	8.91	10.12	11.96	17.74	20.94	500yr	15.70	20.14	22.89	26.05	26.82	500yr

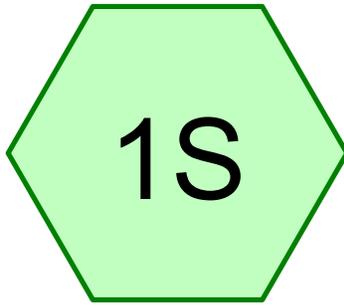




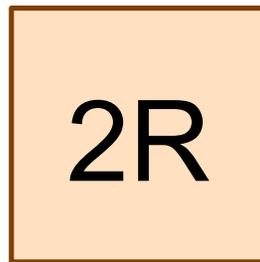
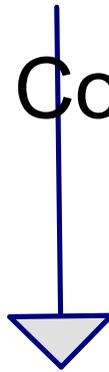
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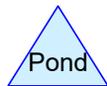
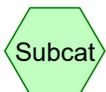
## Appendix D Pre-Development Drainage Calculations



Existing Conditions



Site Runoff



**31 Harborview - Existing**

Prepared by Munden Engineering LLC

HydroCAD® 10.00-25 s/n 11058 © 2019 HydroCAD Software Solutions LLC

**Area Listing (all nodes)**

Area (sq-ft)	CN	Description (subcatchment-numbers)
206	98	Concrete patios and pads, HSG C (1S)
614	98	Driveway, HSG C (1S)
14,252	70	Grass Cover > 75%; HSG C (1S)
1,234	98	Roofs, HSG C (1S)
<b>16,306</b>	<b>74</b>	<b>TOTAL AREA</b>

**31 Harborview - Existing**

Prepared by Munden Engineering LLC

HydroCAD® 10.00-25 s/n 11058 © 2019 HydroCAD Software Solutions LLC

**Soil Listing (all nodes)**

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
16,306	HSG C	1S
0	HSG D	
0	Other	
<b>16,306</b>		<b>TOTAL AREA</b>

**31 Harborview - Existing**

Prepared by Munden Engineering LLC

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**Ground Covers (all nodes)**

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
0	0	206	0	0	206	Concrete patios and pads
0	0	614	0	0	614	Driveway
0	0	14,252	0	0	14,252	Grass Cover > 75%;
0	0	1,234	0	0	1,234	Roofs
<b>0</b>	<b>0</b>	<b>16,306</b>	<b>0</b>	<b>0</b>	<b>16,306</b>	<b>TOTAL AREA</b>

## 31 Harborview - Existing

Prepared by Munden Engineering LLC

HydroCAD® 10.00-25 s/n 11058 © 2019 HydroCAD Software Solutions LLC

31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

Page 5

Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

### Subcatchment 1S: Existing Conditions

Runoff Area=16,306 sf 12.60% Impervious Runoff Depth=1.10"  
Flow Length=149' Tc=6.0 min CN=74 Runoff=0.46 cfs 1,500 cf

### Reach 2R: Site Runoff

Inflow=0.46 cfs 1,500 cf  
Outflow=0.46 cfs 1,500 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 1,500 cf Average Runoff Depth = 1.10"**  
**87.40% Pervious = 14,252 sf 12.60% Impervious = 2,054 sf**

### 31 Harborview - Existing

Prepared by Munden Engineering LLC

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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

Page 6

### Summary for Subcatchment 1S: Existing Conditions

Runoff = 0.46 cfs @ 12.10 hrs, Volume= 1,500 cf, Depth= 1.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
Type III 24-hr 2yr 24hr Rainfall=3.30"

Area (sf)	CN	Description
1,234	98	Roofs, HSG C
* 614	98	Driveway, HSG C
* 206	98	Concrete patios and pads, HSG C
* 14,252	70	Grass Cover > 75%; HSG C
16,306	74	Weighted Average
14,252		87.40% Pervious Area
2,054		12.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0312	1.33		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.5	27	0.1480	0.30		<b>Sheet Flow, Backyard</b> Grass: Short n= 0.150 P2= 3.30"
0.1	26	0.4600	3.39		<b>Shallow Concentrated Flow, Slope 1</b> Woodland Kv= 5.0 fps
0.5	64	0.2100	2.29		<b>Shallow Concentrated Flow, Slope 2</b> Woodland Kv= 5.0 fps
2.5	149	Total, Increased to minimum Tc = 6.0 min			

# 31 Harborview - Existing

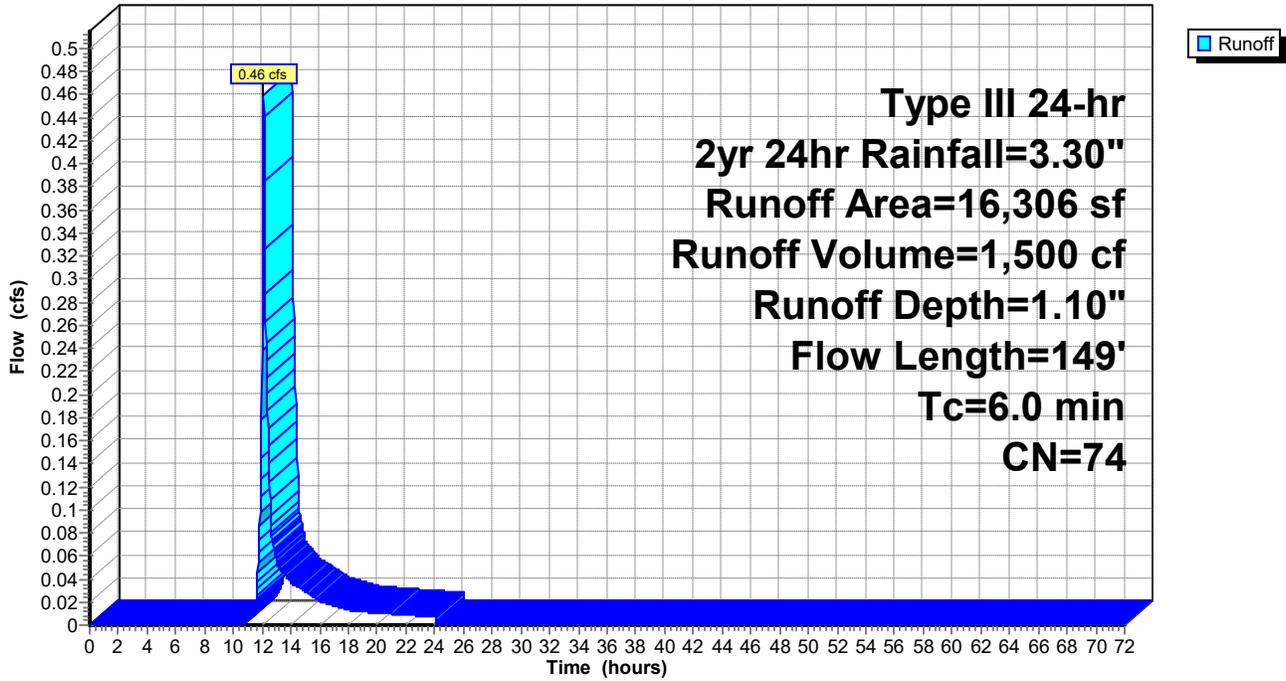
Prepared by Munden Engineering LLC

HydroCAD® 10.00-25 s/n 11058 © 2019 HydroCAD Software Solutions LLC

31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

## Subcatchment 1S: Existing Conditions

Hydrograph



# 31 Harborview - Existing

Prepared by Munden Engineering LLC

HydroCAD® 10.00-25 s/n 11058 © 2019 HydroCAD Software Solutions LLC

31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

## Summary for Reach 2R: Site Runoff

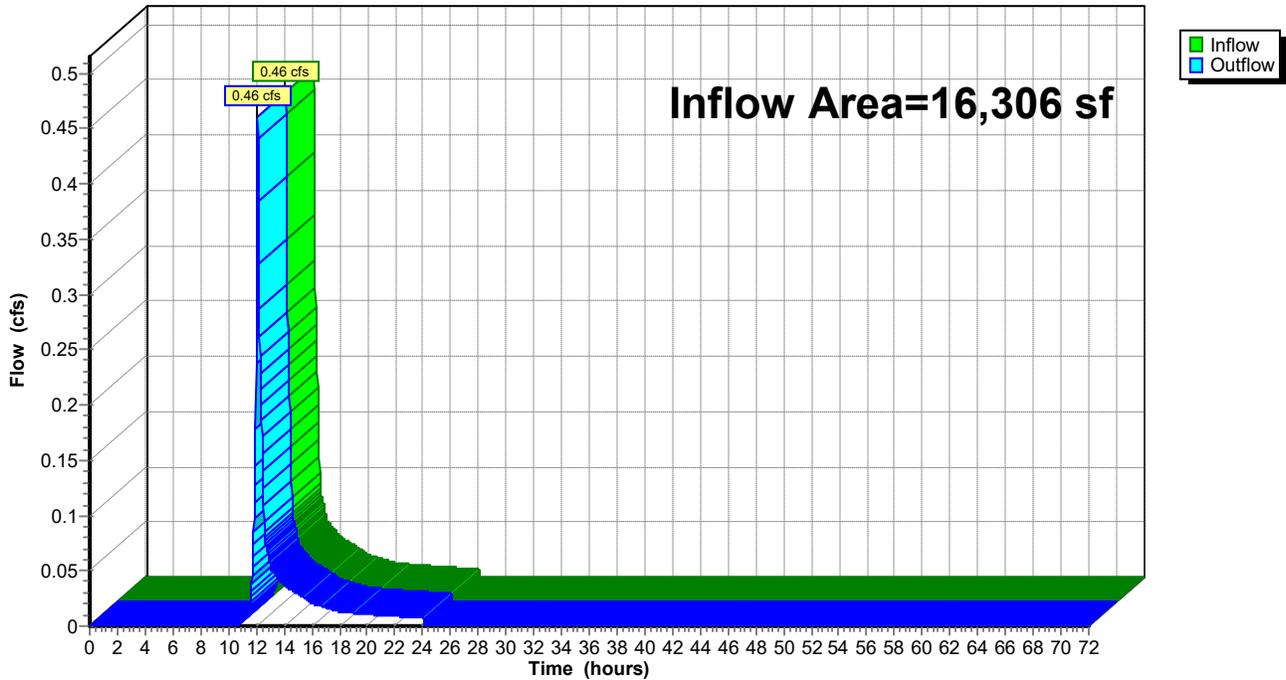
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 12.60% Impervious, Inflow Depth = 1.10" for 2yr 24hr event  
Inflow = 0.46 cfs @ 12.10 hrs, Volume= 1,500 cf  
Outflow = 0.46 cfs @ 12.10 hrs, Volume= 1,500 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 2R: Site Runoff

Hydrograph



### 31 Harborview - Existing

Prepared by Munden Engineering LLC

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Page 9

Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

#### Subcatchment 1S: Existing Conditions

Runoff Area=16,306 sf 12.60% Impervious Runoff Depth=2.28"  
Flow Length=149' Tc=6.0 min CN=74 Runoff=0.99 cfs 3,094 cf

#### Reach 2R: Site Runoff

Inflow=0.99 cfs 3,094 cf  
Outflow=0.99 cfs 3,094 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 3,094 cf Average Runoff Depth = 2.28"**  
**87.40% Pervious = 14,252 sf 12.60% Impervious = 2,054 sf**

**31 Harborview - Existing**

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**Summary for Subcatchment 1S: Existing Conditions**

Runoff = 0.99 cfs @ 12.09 hrs, Volume= 3,094 cf, Depth= 2.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 10yr 24hr Rainfall=4.89"

Area (sf)	CN	Description
1,234	98	Roofs, HSG C
* 614	98	Driveway, HSG C
* 206	98	Concrete patios and pads, HSG C
* 14,252	70	Grass Cover > 75%; HSG C
16,306	74	Weighted Average
14,252		87.40% Pervious Area
2,054		12.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0312	1.33		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.5	27	0.1480	0.30		<b>Sheet Flow, Backyard</b> Grass: Short n= 0.150 P2= 3.30"
0.1	26	0.4600	3.39		<b>Shallow Concentrated Flow, Slope 1</b> Woodland Kv= 5.0 fps
0.5	64	0.2100	2.29		<b>Shallow Concentrated Flow, Slope 2</b> Woodland Kv= 5.0 fps
2.5	149	Total, Increased to minimum Tc = 6.0 min			

# 31 Harborview - Existing

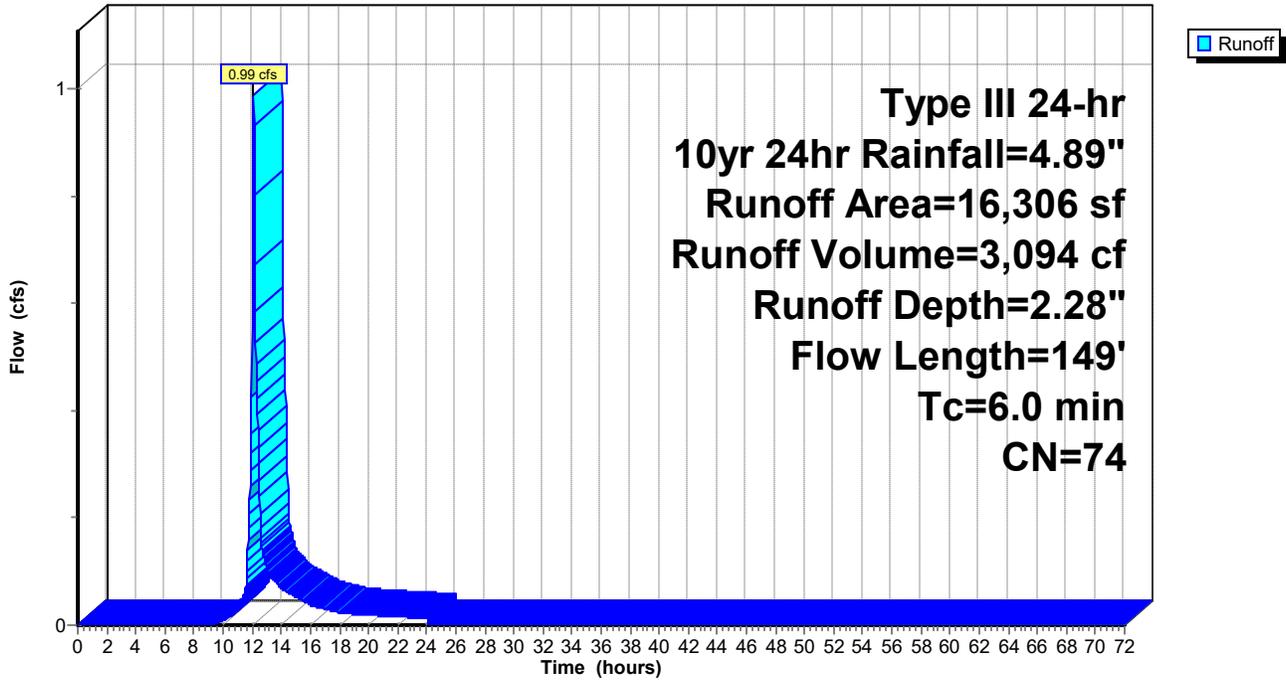
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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

## Subcatchment 1S: Existing Conditions

Hydrograph



# 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

## Summary for Reach 2R: Site Runoff

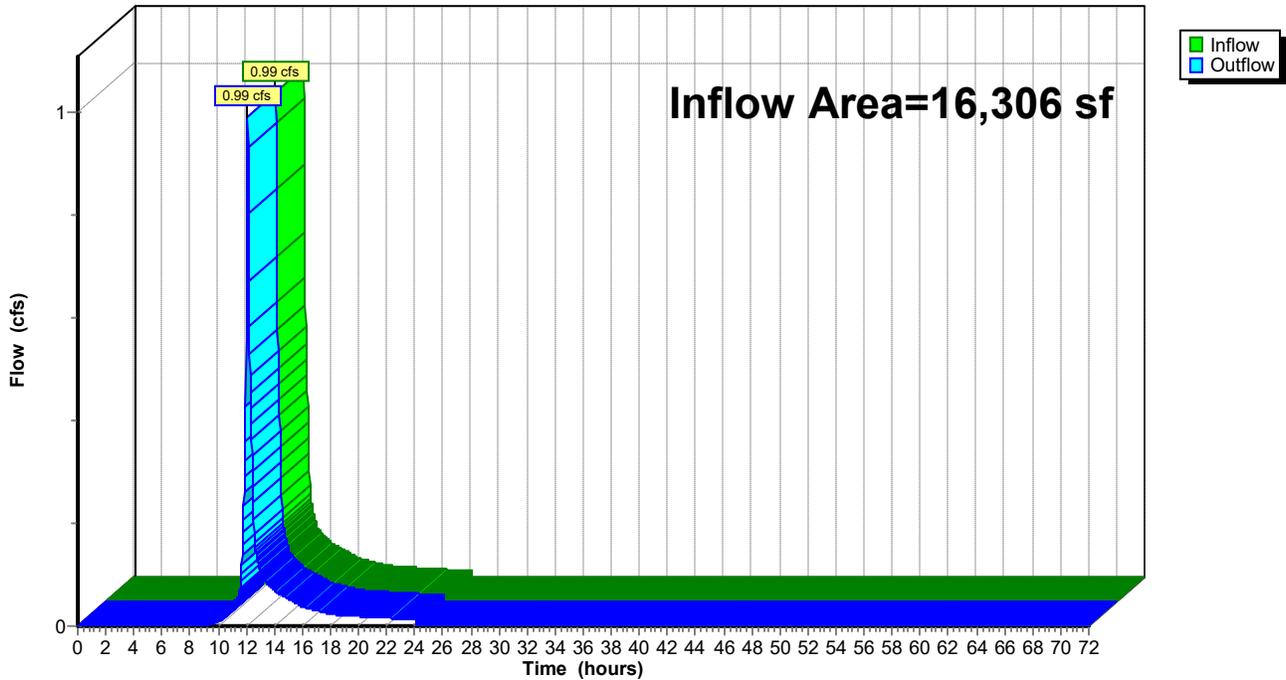
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 12.60% Impervious, Inflow Depth = 2.28" for 10yr 24hr event  
Inflow = 0.99 cfs @ 12.09 hrs, Volume= 3,094 cf  
Outflow = 0.99 cfs @ 12.09 hrs, Volume= 3,094 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 2R: Site Runoff

Hydrograph



### 31 Harborview - Existing

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

#### Subcatchment 1S: Existing Conditions

Runoff Area=16,306 sf 12.60% Impervious Runoff Depth=3.29"  
Flow Length=149' Tc=6.0 min CN=74 Runoff=1.44 cfs 4,465 cf

#### Reach 2R: Site Runoff

Inflow=1.44 cfs 4,465 cf  
Outflow=1.44 cfs 4,465 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 4,465 cf Average Runoff Depth = 3.29"**  
**87.40% Pervious = 14,252 sf 12.60% Impervious = 2,054 sf**

**31 Harborview - Existing**

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**Summary for Subcatchment 1S: Existing Conditions**

Runoff = 1.44 cfs @ 12.09 hrs, Volume= 4,465 cf, Depth= 3.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 25yr 24hr Rainfall=6.12"

Area (sf)	CN	Description
1,234	98	Roofs, HSG C
* 614	98	Driveway, HSG C
* 206	98	Concrete patios and pads, HSG C
* 14,252	70	Grass Cover > 75%; HSG C
16,306	74	Weighted Average
14,252		87.40% Pervious Area
2,054		12.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0312	1.33		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.5	27	0.1480	0.30		<b>Sheet Flow, Backyard</b> Grass: Short n= 0.150 P2= 3.30"
0.1	26	0.4600	3.39		<b>Shallow Concentrated Flow, Slope 1</b> Woodland Kv= 5.0 fps
0.5	64	0.2100	2.29		<b>Shallow Concentrated Flow, Slope 2</b> Woodland Kv= 5.0 fps
2.5	149	Total, Increased to minimum Tc = 6.0 min			

# 31 Harborview - Existing

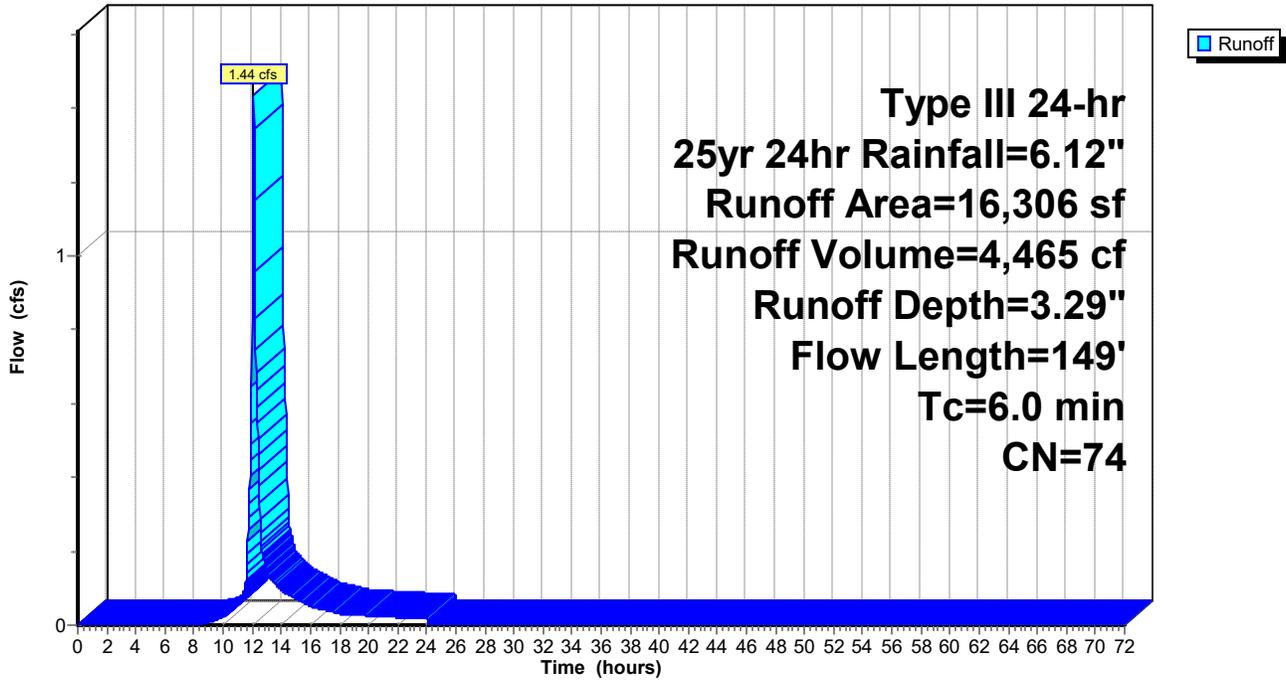
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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

## Subcatchment 1S: Existing Conditions

Hydrograph



# 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

## Summary for Reach 2R: Site Runoff

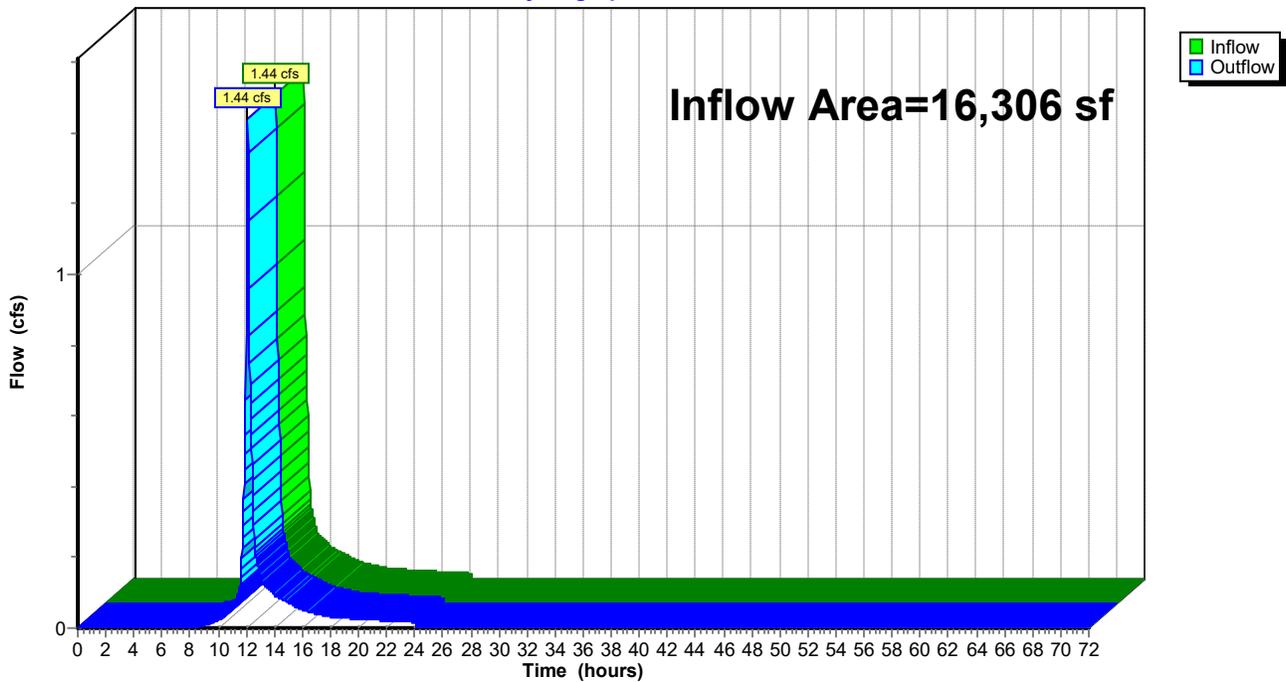
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 12.60% Impervious, Inflow Depth = 3.29" for 25yr 24hr event  
Inflow = 1.44 cfs @ 12.09 hrs, Volume= 4,465 cf  
Outflow = 1.44 cfs @ 12.09 hrs, Volume= 4,465 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

### Reach 2R: Site Runoff

Hydrograph



## 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

### Subcatchment 1S: Existing Conditions

Runoff Area=16,306 sf 12.60% Impervious Runoff Depth=5.47"  
Flow Length=149' Tc=6.0 min CN=74 Runoff=2.38 cfs 7,427 cf

### Reach 2R: Site Runoff

Inflow=2.38 cfs 7,427 cf  
Outflow=2.38 cfs 7,427 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 7,427 cf Average Runoff Depth = 5.47"**  
**87.40% Pervious = 14,252 sf 12.60% Impervious = 2,054 sf**

### 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

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### Summary for Subcatchment 1S: Existing Conditions

Runoff = 2.38 cfs @ 12.09 hrs, Volume= 7,427 cf, Depth= 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
Type III 24-hr 100yr 24hr Rainfall=8.60"

Area (sf)	CN	Description
1,234	98	Roofs, HSG C
* 614	98	Driveway, HSG C
* 206	98	Concrete patios and pads, HSG C
* 14,252	70	Grass Cover > 75%; HSG C
16,306	74	Weighted Average
14,252		87.40% Pervious Area
2,054		12.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0312	1.33		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.5	27	0.1480	0.30		<b>Sheet Flow, Backyard</b> Grass: Short n= 0.150 P2= 3.30"
0.1	26	0.4600	3.39		<b>Shallow Concentrated Flow, Slope 1</b> Woodland Kv= 5.0 fps
0.5	64	0.2100	2.29		<b>Shallow Concentrated Flow, Slope 2</b> Woodland Kv= 5.0 fps
2.5	149	Total, Increased to minimum Tc = 6.0 min			

# 31 Harborview - Existing

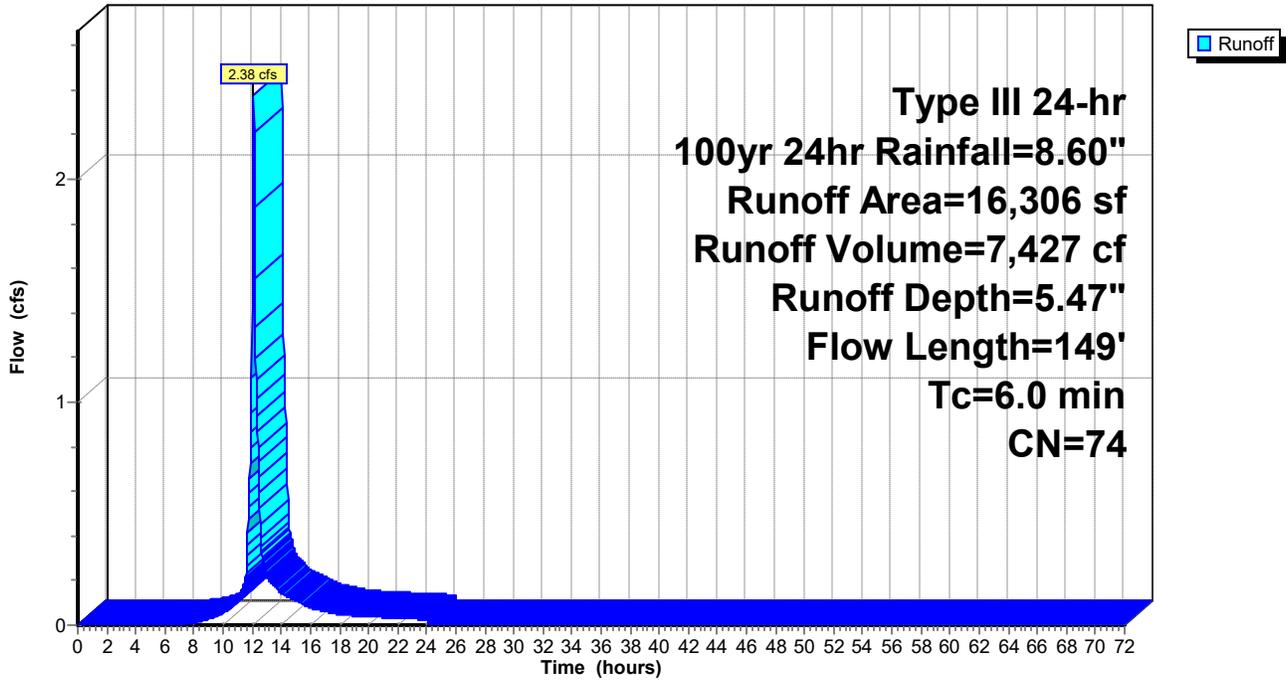
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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

## Subcatchment 1S: Existing Conditions

Hydrograph



# 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 6 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

## Summary for Reach 2R: Site Runoff

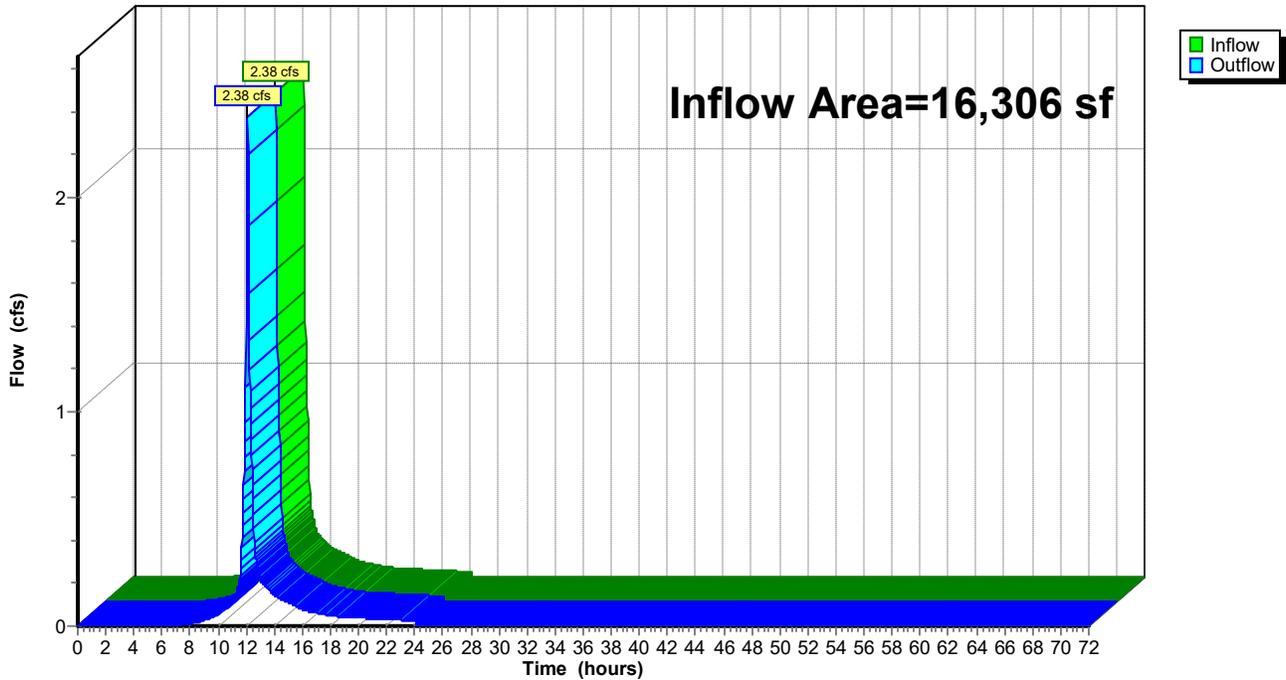
[40] Hint: Not Described (Outflow=Inflow)

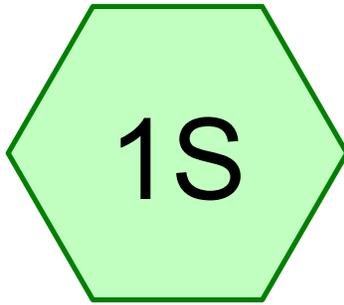
Inflow Area = 16,306 sf, 12.60% Impervious, Inflow Depth = 5.47" for 100yr 24hr event  
Inflow = 2.38 cfs @ 12.09 hrs, Volume= 7,427 cf  
Outflow = 2.38 cfs @ 12.09 hrs, Volume= 7,427 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

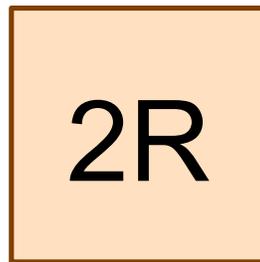
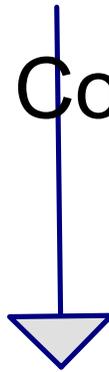
### Reach 2R: Site Runoff

Hydrograph

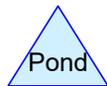
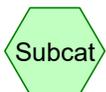




Existing Conditions



Site Runoff



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**Area Listing (all nodes)**

Area (sq-ft)	CN	Description (subcatchment-numbers)
206	98	Concrete patios and pads, HSG C (1S)
614	98	Driveway, HSG C (1S)
14,252	70	Grass Cover > 75%; HSG C (1S)
1,234	98	Roofs, HSG C (1S)
<b>16,306</b>	<b>74</b>	<b>TOTAL AREA</b>

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**Soil Listing (all nodes)**

Area (sq-ft)	Soil Group	Subcatchment Numbers
0	HSG A	
0	HSG B	
16,306	HSG C	1S
0	HSG D	
0	Other	
<b>16,306</b>		<b>TOTAL AREA</b>

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**Ground Covers (all nodes)**

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover
0	0	206	0	0	206	Concrete patios and pads
0	0	614	0	0	614	Driveway
0	0	14,252	0	0	14,252	Grass Cover > 75%;
0	0	1,234	0	0	1,234	Roofs
<b>0</b>	<b>0</b>	<b>16,306</b>	<b>0</b>	<b>0</b>	<b>16,306</b>	<b>TOTAL AREA</b>

## 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

### Subcatchment 1S: Existing Conditions

Runoff Area=16,306 sf 12.60% Impervious Runoff Depth=1.10"  
Flow Length=149' Tc=2.5 min CN=74 Runoff=0.51 cfs 1,500 cf

### Reach 2R: Site Runoff

Inflow=0.51 cfs 1,500 cf  
Outflow=0.51 cfs 1,500 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 1,500 cf Average Runoff Depth = 1.10"**  
**87.40% Pervious = 14,252 sf 12.60% Impervious = 2,054 sf**

### 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

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### Summary for Subcatchment 1S: Existing Conditions

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.51 cfs @ 12.05 hrs, Volume= 1,500 cf, Depth= 1.10"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
Type III 24-hr 2yr 24hr Rainfall=3.30"

Area (sf)	CN	Description
1,234	98	Roofs, HSG C
* 614	98	Driveway, HSG C
* 206	98	Concrete patios and pads, HSG C
* 14,252	70	Grass Cover > 75%; HSG C
16,306	74	Weighted Average
14,252		87.40% Pervious Area
2,054		12.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0312	1.33		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.5	27	0.1480	0.30		<b>Sheet Flow, Backyard</b> Grass: Short n= 0.150 P2= 3.30"
0.1	26	0.4600	3.39		<b>Shallow Concentrated Flow, Slope 1</b> Woodland Kv= 5.0 fps
0.5	64	0.2100	2.29		<b>Shallow Concentrated Flow, Slope 2</b> Woodland Kv= 5.0 fps
2.5	149	Total			

# 31 Harborview - Existing

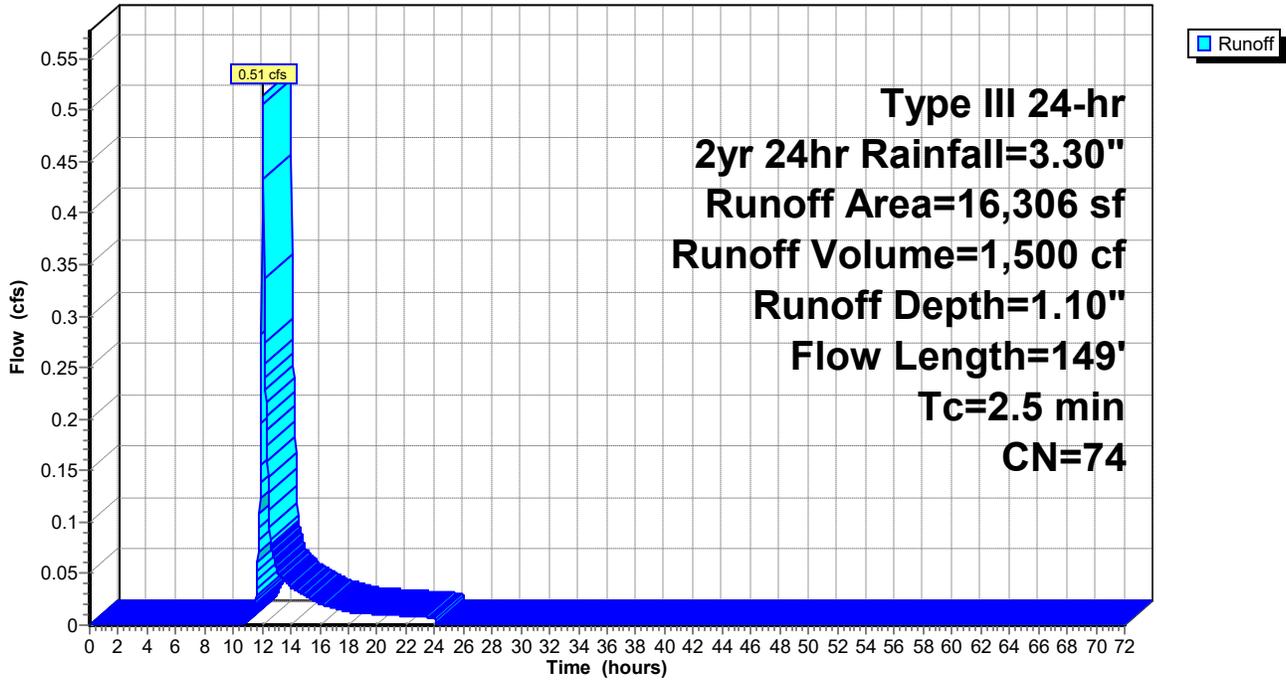
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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

## Subcatchment 1S: Existing Conditions

Hydrograph



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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

## Summary for Reach 2R: Site Runoff

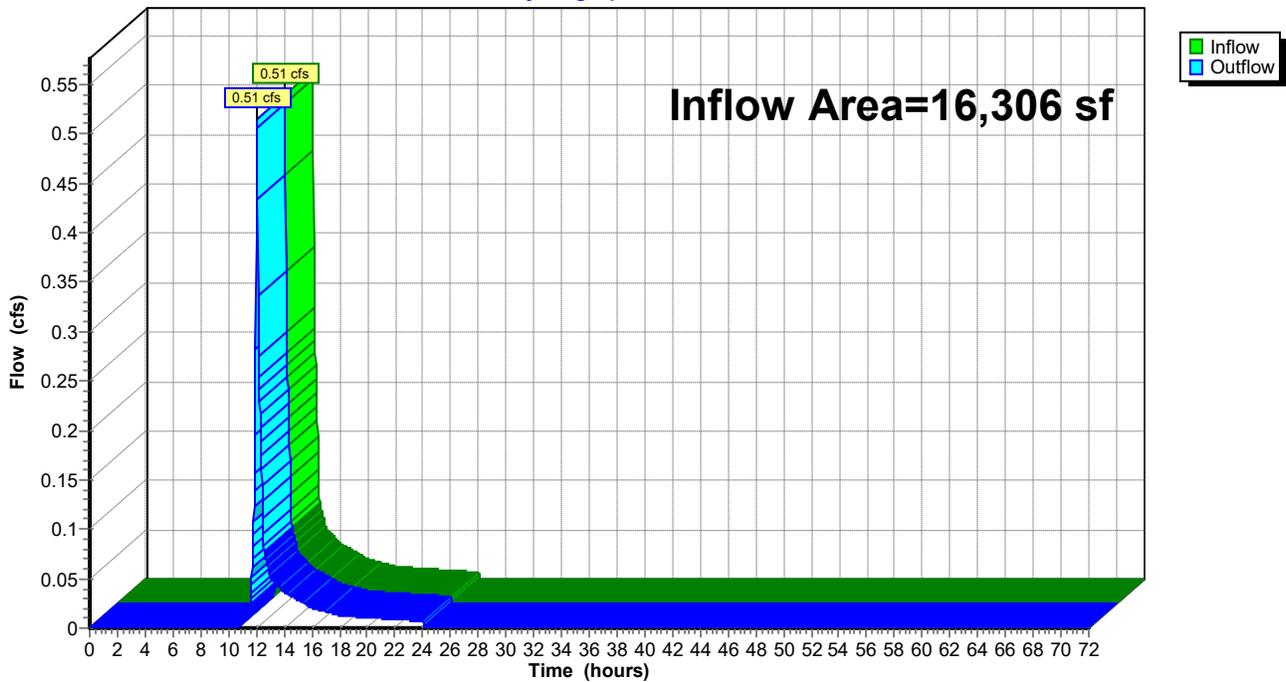
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 12.60% Impervious, Inflow Depth = 1.10" for 2yr 24hr event  
Inflow = 0.51 cfs @ 12.05 hrs, Volume= 1,500 cf  
Outflow = 0.51 cfs @ 12.05 hrs, Volume= 1,500 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 2R: Site Runoff

Hydrograph



### 31 Harborview - Existing

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

#### Subcatchment 1S: Existing Conditions

Runoff Area=16,306 sf 12.60% Impervious Runoff Depth=2.28"  
Flow Length=149' Tc=2.5 min CN=74 Runoff=1.12 cfs 3,094 cf

#### Reach 2R: Site Runoff

Inflow=1.12 cfs 3,094 cf  
Outflow=1.12 cfs 3,094 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 3,094 cf Average Runoff Depth = 2.28"**  
**87.40% Pervious = 14,252 sf 12.60% Impervious = 2,054 sf**

**31 Harborview - Existing**

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**Summary for Subcatchment 1S: Existing Conditions**

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.12 cfs @ 12.04 hrs, Volume= 3,094 cf, Depth= 2.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 10yr 24hr Rainfall=4.89"

Area (sf)	CN	Description
1,234	98	Roofs, HSG C
* 614	98	Driveway, HSG C
* 206	98	Concrete patios and pads, HSG C
* 14,252	70	Grass Cover > 75%; HSG C
16,306	74	Weighted Average
14,252		87.40% Pervious Area
2,054		12.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0312	1.33		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.5	27	0.1480	0.30		<b>Sheet Flow, Backyard</b> Grass: Short n= 0.150 P2= 3.30"
0.1	26	0.4600	3.39		<b>Shallow Concentrated Flow, Slope 1</b> Woodland Kv= 5.0 fps
0.5	64	0.2100	2.29		<b>Shallow Concentrated Flow, Slope 2</b> Woodland Kv= 5.0 fps
2.5	149	Total			

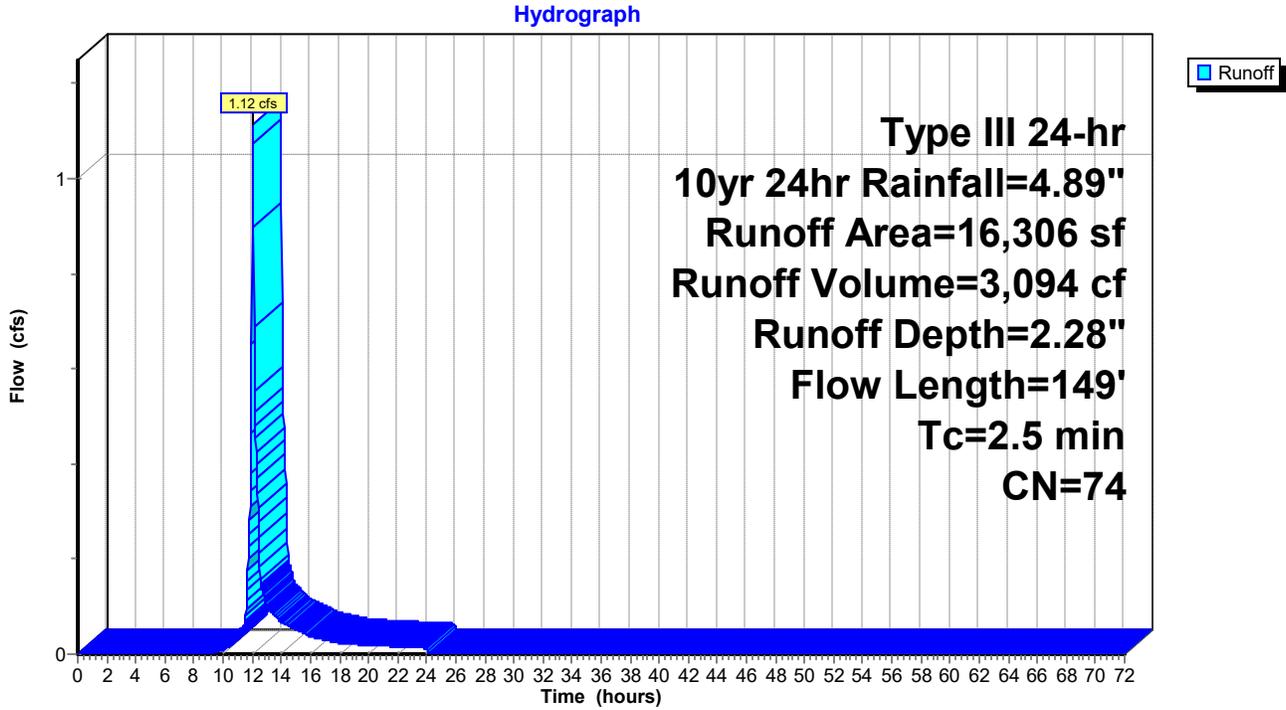
# 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

## Subcatchment 1S: Existing Conditions



# 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

## Summary for Reach 2R: Site Runoff

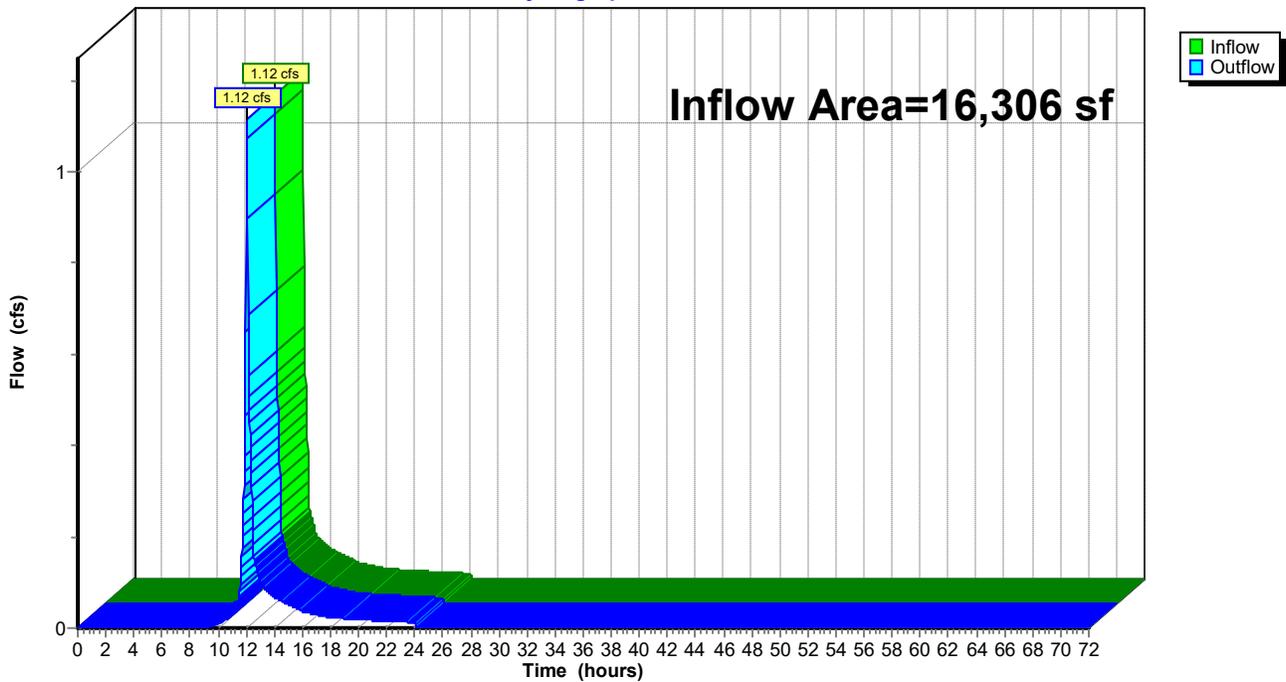
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 12.60% Impervious, Inflow Depth = 2.28" for 10yr 24hr event  
Inflow = 1.12 cfs @ 12.04 hrs, Volume= 3,094 cf  
Outflow = 1.12 cfs @ 12.04 hrs, Volume= 3,094 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 2R: Site Runoff

Hydrograph



**31 Harborview - Existing**

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: Existing Conditions**

Runoff Area=16,306 sf 12.60% Impervious Runoff Depth=3.29"  
Flow Length=149' Tc=2.5 min CN=74 Runoff=1.62 cfs 4,465 cf

**Reach 2R: Site Runoff**

Inflow=1.62 cfs 4,465 cf  
Outflow=1.62 cfs 4,465 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 4,465 cf Average Runoff Depth = 3.29"**  
**87.40% Pervious = 14,252 sf 12.60% Impervious = 2,054 sf**

**31 Harborview - Existing**

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**Summary for Subcatchment 1S: Existing Conditions**

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.62 cfs @ 12.04 hrs, Volume= 4,465 cf, Depth= 3.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 25yr 24hr Rainfall=6.12"

Area (sf)	CN	Description
1,234	98	Roofs, HSG C
* 614	98	Driveway, HSG C
* 206	98	Concrete patios and pads, HSG C
* 14,252	70	Grass Cover > 75%; HSG C
16,306	74	Weighted Average
14,252		87.40% Pervious Area
2,054		12.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0312	1.33		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.5	27	0.1480	0.30		<b>Sheet Flow, Backyard</b> Grass: Short n= 0.150 P2= 3.30"
0.1	26	0.4600	3.39		<b>Shallow Concentrated Flow, Slope 1</b> Woodland Kv= 5.0 fps
0.5	64	0.2100	2.29		<b>Shallow Concentrated Flow, Slope 2</b> Woodland Kv= 5.0 fps
2.5	149	Total			

# 31 Harborview - Existing

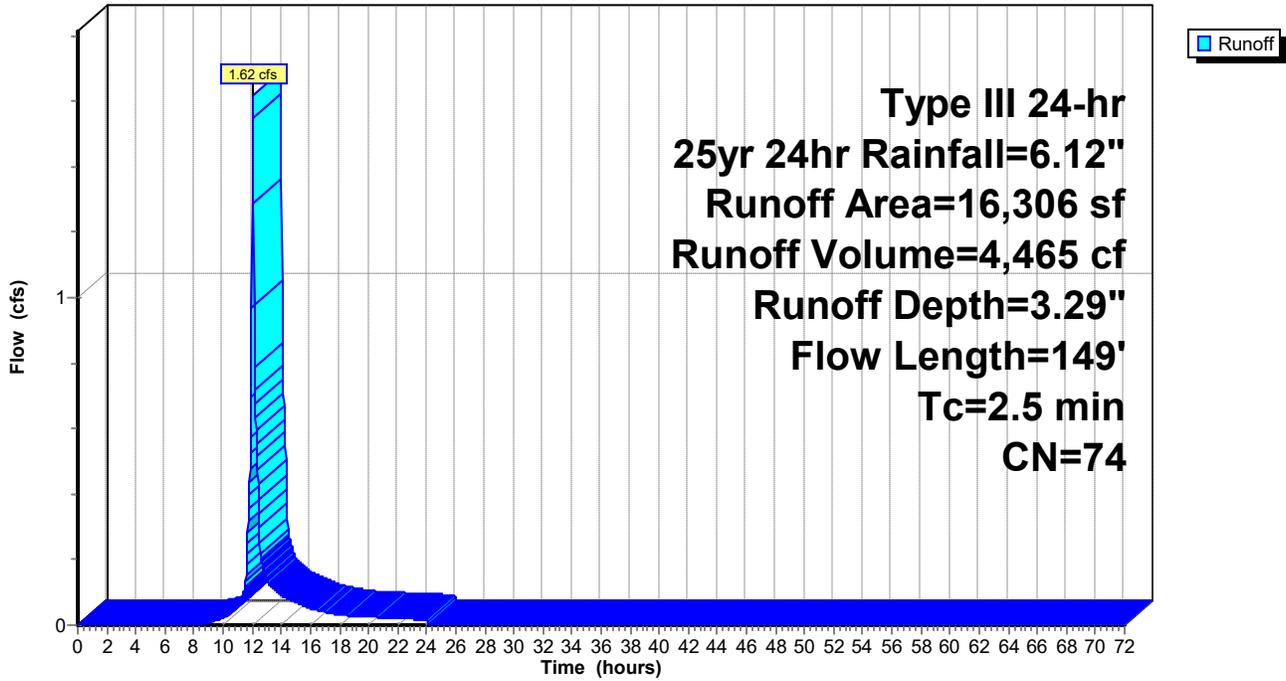
Prepared by Munden Engineering LLC

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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

## Subcatchment 1S: Existing Conditions

Hydrograph



# 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

## Summary for Reach 2R: Site Runoff

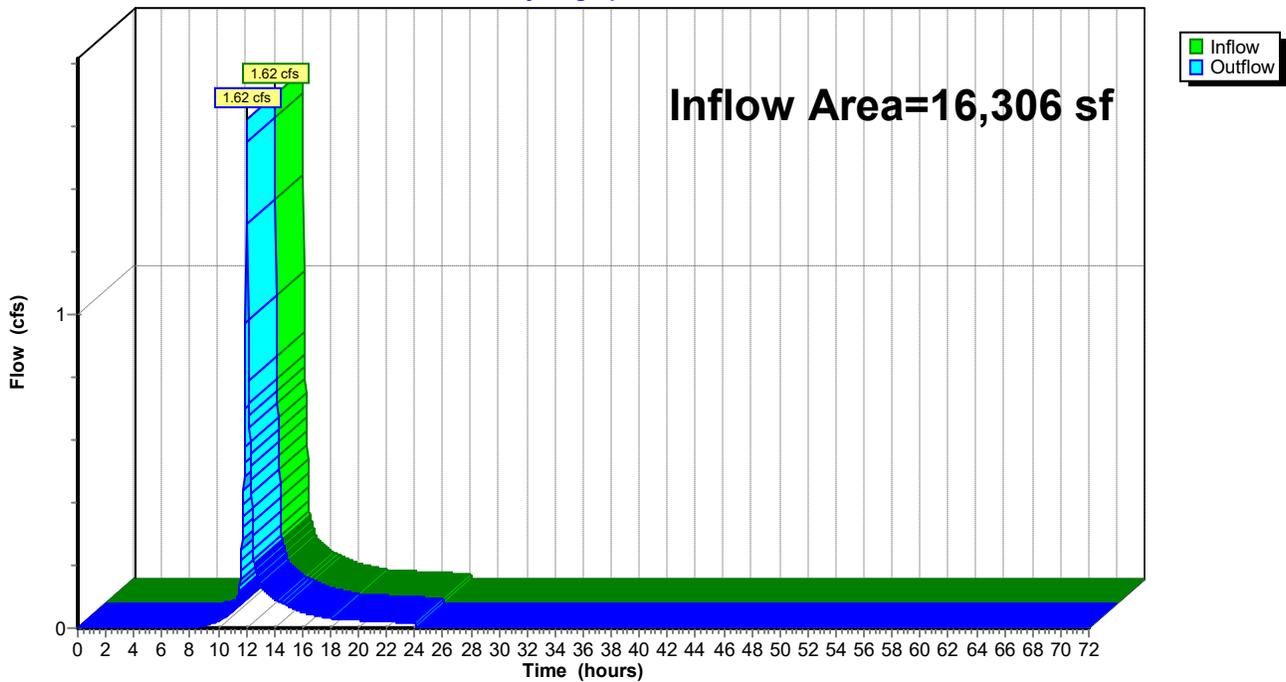
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 12.60% Impervious, Inflow Depth = 3.29" for 25yr 24hr event  
Inflow = 1.62 cfs @ 12.04 hrs, Volume= 4,465 cf  
Outflow = 1.62 cfs @ 12.04 hrs, Volume= 4,465 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 2R: Site Runoff

Hydrograph



**31 Harborview - Existing**

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 1S: Existing Conditions**

Runoff Area=16,306 sf 12.60% Impervious Runoff Depth=5.47"  
Flow Length=149' Tc=2.5 min CN=74 Runoff=2.68 cfs 7,427 cf

**Reach 2R: Site Runoff**

Inflow=2.68 cfs 7,427 cf  
Outflow=2.68 cfs 7,427 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 7,427 cf Average Runoff Depth = 5.47"**  
**87.40% Pervious = 14,252 sf 12.60% Impervious = 2,054 sf**

**31 Harborview - Existing**

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**Summary for Subcatchment 1S: Existing Conditions**

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.68 cfs @ 12.04 hrs, Volume= 7,427 cf, Depth= 5.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 100yr 24hr Rainfall=8.60"

Area (sf)	CN	Description
1,234	98	Roofs, HSG C
* 614	98	Driveway, HSG C
* 206	98	Concrete patios and pads, HSG C
* 14,252	70	Grass Cover > 75%; HSG C
16,306	74	Weighted Average
14,252		87.40% Pervious Area
2,054		12.60% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.4	32	0.0312	1.33		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.5	27	0.1480	0.30		<b>Sheet Flow, Backyard</b> Grass: Short n= 0.150 P2= 3.30"
0.1	26	0.4600	3.39		<b>Shallow Concentrated Flow, Slope 1</b> Woodland Kv= 5.0 fps
0.5	64	0.2100	2.29		<b>Shallow Concentrated Flow, Slope 2</b> Woodland Kv= 5.0 fps
2.5	149	Total			

# 31 Harborview - Existing

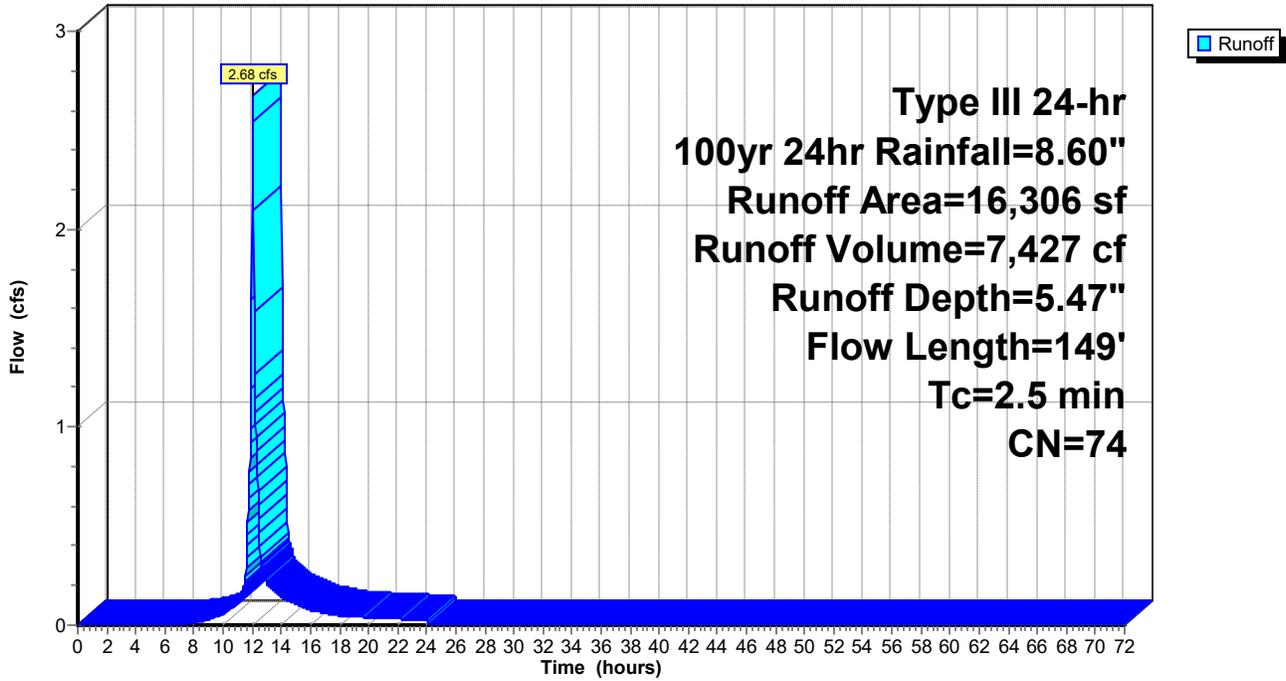
Prepared by Munden Engineering LLC

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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

## Subcatchment 1S: Existing Conditions

Hydrograph



# 31 Harborview - Existing

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31 Harborview Dr - Existing Tc 2.5 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

## Summary for Reach 2R: Site Runoff

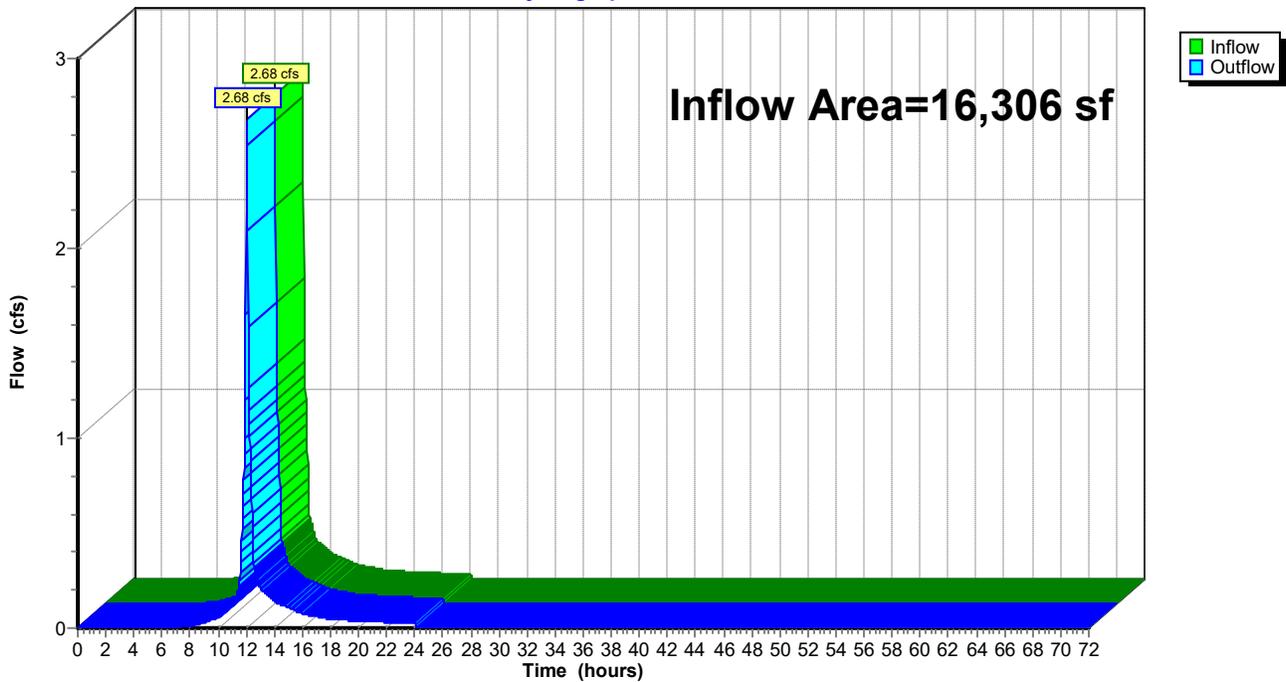
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 12.60% Impervious, Inflow Depth = 5.47" for 100yr 24hr event  
Inflow = 2.68 cfs @ 12.04 hrs, Volume= 7,427 cf  
Outflow = 2.68 cfs @ 12.04 hrs, Volume= 7,427 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

### Reach 2R: Site Runoff

Hydrograph

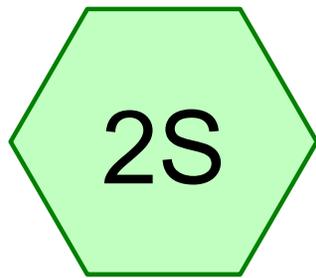




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781-302-6099

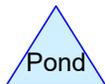
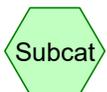
## Appendix E Post-Development Drainage Calculations



Proposed Conditions  
Unconnected



Site Runoff



**31 Harborview - Proposed**

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Page 2

**Area Listing (all nodes)**

Area (sq-ft)	CN	Description (subcatchment-numbers)
1,000	98	Driveway, HSG C (2S)
13,326	70	Grass Cover > 75%; HSG C (2S)
1,980	98	Roofs, HSG A (2S)
<b>16,306</b>	<b>75</b>	<b>TOTAL AREA</b>

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**Soil Listing (all nodes)**

Area (sq-ft)	Soil Group	Subcatchment Numbers
1,980	HSG A	2S
0	HSG B	
14,326	HSG C	2S
0	HSG D	
0	Other	
<b>16,306</b>		<b>TOTAL AREA</b>

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**Ground Covers (all nodes)**

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Subcat Number
0	0	1,000	0	0	1,000	Driveway	
0	0	13,326	0	0	13,326	Grass Cover > 75%;	
1,980	0	0	0	0	1,980	Roofs	
<b>1,980</b>	<b>0</b>	<b>14,326</b>	<b>0</b>	<b>0</b>	<b>16,306</b>	<b>TOTAL AREA</b>	

## 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 2S: Proposed Conditions** Runoff Area=16,306 sf 18.28% Impervious Runoff Depth=1.16"  
Flow Length=149' Tc=6.0 min CN=75 Runoff=0.49 cfs 1,579 cf

**Reach 10R: Site Runoff**

Inflow=0.49 cfs 1,579 cf  
Outflow=0.49 cfs 1,579 cf

**Total Runoff Area = 16,306 sf Runoff Volume = 1,579 cf Average Runoff Depth = 1.16"**  
**81.72% Pervious = 13,326 sf 18.28% Impervious = 2,980 sf**

### 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

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### Summary for Subcatchment 2S: Proposed Conditions Unconnected

Runoff = 0.49 cfs @ 12.10 hrs, Volume= 1,579 cf, Depth= 1.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
Type III 24-hr 2yr 24hr Rainfall=3.30"

Area (sf)	CN	Description
1,980	98	Roofs, HSG A
* 1,000	98	Driveway, HSG C
* 13,326	70	Grass Cover > 75%; HSG C
16,306	75	Weighted Average
13,326		81.72% Pervious Area
2,980		18.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	32	0.0625	1.75		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.9	30	0.1000	0.26		<b>Sheet Flow, Back yard</b> Grass: Short n= 0.150 P2= 3.30"
0.2	20	0.0500	1.57		<b>Shallow Concentrated Flow, Back yard 2</b> Short Grass Pasture Kv= 7.0 fps
0.3	55	0.2200	3.28		<b>Shallow Concentrated Flow, Slope</b> Short Grass Pasture Kv= 7.0 fps
0.1	12	0.2500	3.50		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
2.8	149	Total, Increased to minimum Tc = 6.0 min			

# 31 Harborview - Proposed

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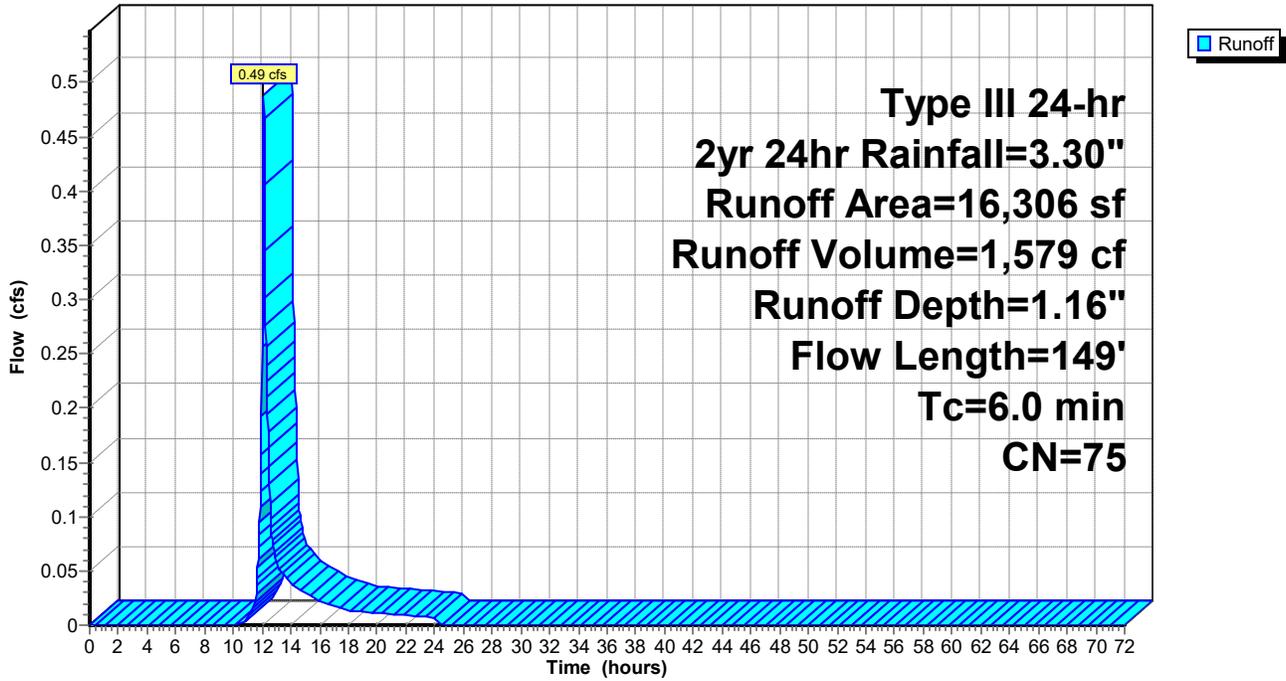
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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

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## Subcatchment 2S: Proposed Conditions Unconnected

Hydrograph



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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

## Summary for Reach 10R: Site Runoff

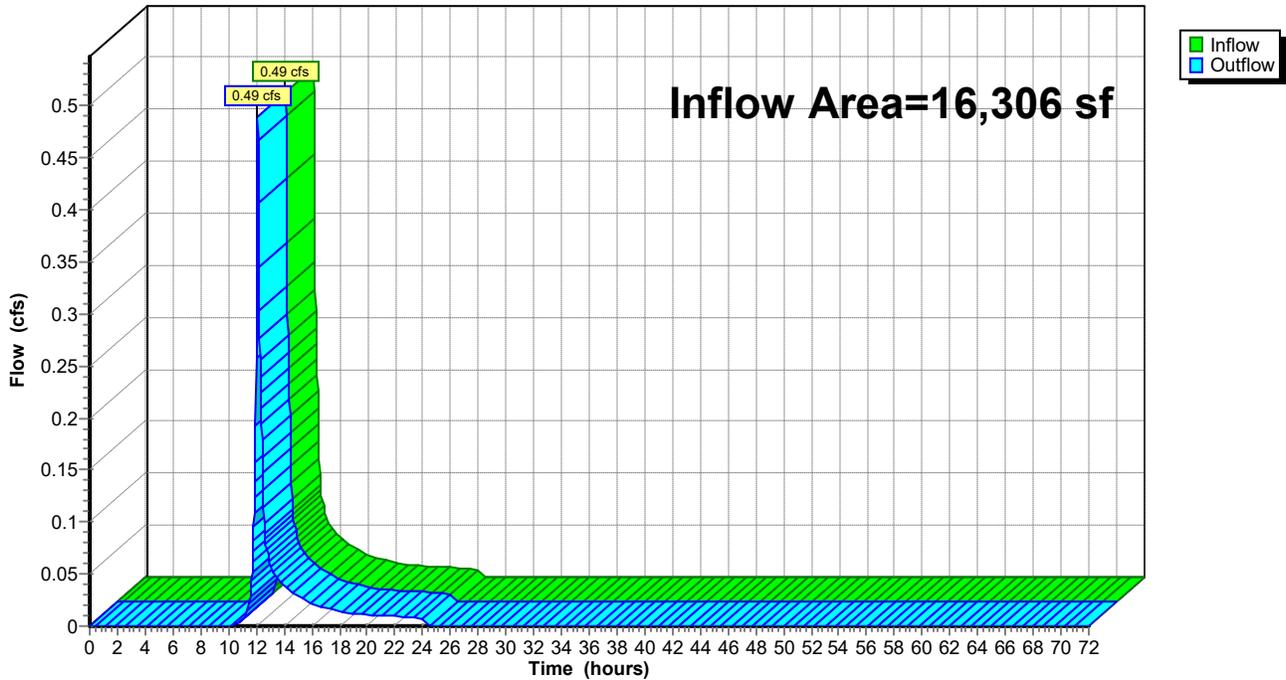
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 18.28% Impervious, Inflow Depth = 1.16" for 2yr 24hr event  
Inflow = 0.49 cfs @ 12.10 hrs, Volume= 1,579 cf  
Outflow = 0.49 cfs @ 12.10 hrs, Volume= 1,579 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 10R: Site Runoff

Hydrograph



### 31 Harborview - Proposed

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 2S: Proposed Conditions**    Runoff Area=16,306 sf    18.28% Impervious    Runoff Depth=2.36"  
Flow Length=149'    Tc=6.0 min    CN=75    Runoff=1.03 cfs    3,207 cf

**Reach 10R: Site Runoff**

Inflow=1.03 cfs    3,207 cf  
Outflow=1.03 cfs    3,207 cf

**Total Runoff Area = 16,306 sf    Runoff Volume = 3,207 cf    Average Runoff Depth = 2.36"**  
**81.72% Pervious = 13,326 sf    18.28% Impervious = 2,980 sf**

**31 Harborview - Proposed**

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**Summary for Subcatchment 2S: Proposed Conditions Unconnected**

Runoff = 1.03 cfs @ 12.09 hrs, Volume= 3,207 cf, Depth= 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 10yr 24hr Rainfall=4.89"

Area (sf)	CN	Description
1,980	98	Roofs, HSG A
* 1,000	98	Driveway, HSG C
* 13,326	70	Grass Cover > 75%; HSG C
16,306	75	Weighted Average
13,326		81.72% Pervious Area
2,980		18.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	32	0.0625	1.75		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.9	30	0.1000	0.26		<b>Sheet Flow, Back yard</b> Grass: Short n= 0.150 P2= 3.30"
0.2	20	0.0500	1.57		<b>Shallow Concentrated Flow, Back yard 2</b> Short Grass Pasture Kv= 7.0 fps
0.3	55	0.2200	3.28		<b>Shallow Concentrated Flow, Slope</b> Short Grass Pasture Kv= 7.0 fps
0.1	12	0.2500	3.50		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
2.8	149	Total, Increased to minimum Tc = 6.0 min			

**31 Harborview - Proposed**

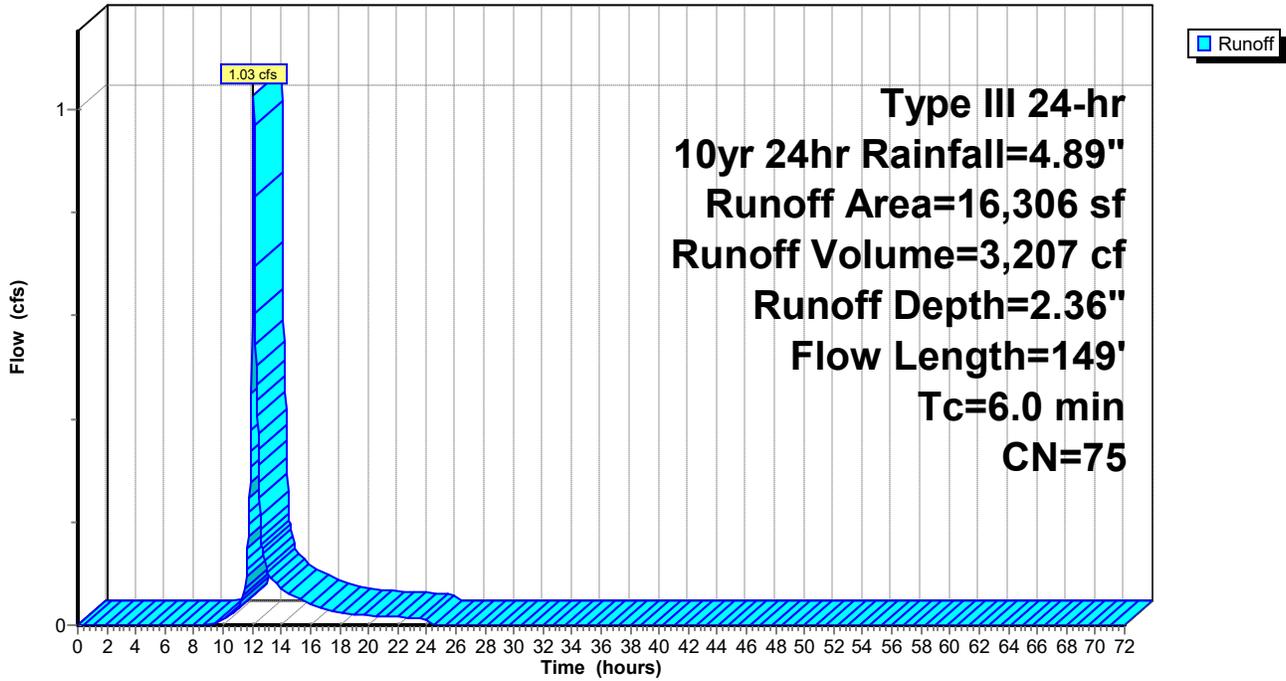
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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

**Subcatchment 2S: Proposed Conditions Unconnected**

Hydrograph



# 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

## Summary for Reach 10R: Site Runoff

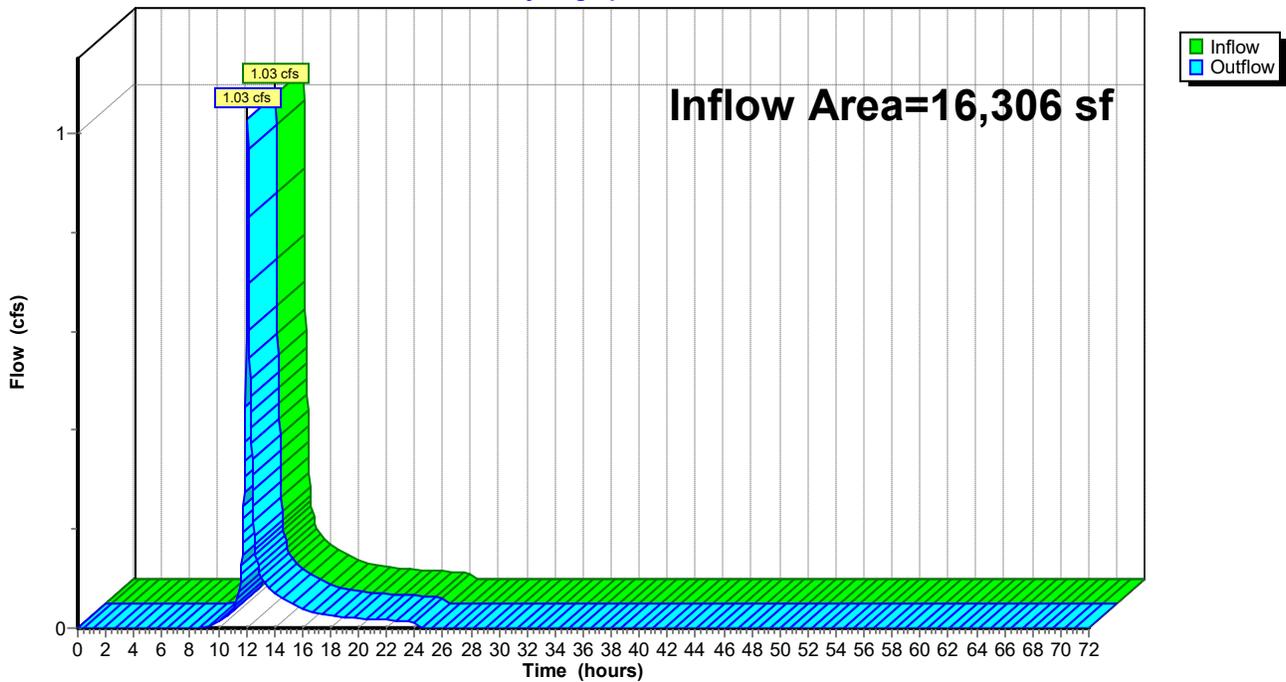
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 18.28% Impervious, Inflow Depth = 2.36" for 10yr 24hr event  
Inflow = 1.03 cfs @ 12.09 hrs, Volume= 3,207 cf  
Outflow = 1.03 cfs @ 12.09 hrs, Volume= 3,207 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 10R: Site Runoff

Hydrograph



**31 Harborview - Proposed**

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 2S: Proposed Conditions**    Runoff Area=16,306 sf    18.28% Impervious    Runoff Depth=3.38"  
Flow Length=149'    Tc=6.0 min    CN=75    Runoff=1.48 cfs    4,599 cf

**Reach 10R: Site Runoff**

Inflow=1.48 cfs    4,599 cf  
Outflow=1.48 cfs    4,599 cf

**Total Runoff Area = 16,306 sf    Runoff Volume = 4,599 cf    Average Runoff Depth = 3.38"**  
**81.72% Pervious = 13,326 sf    18.28% Impervious = 2,980 sf**

**31 Harborview - Proposed**

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**Summary for Subcatchment 2S: Proposed Conditions Unconnected**

Runoff = 1.48 cfs @ 12.09 hrs, Volume= 4,599 cf, Depth= 3.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 25yr 24hr Rainfall=6.12"

Area (sf)	CN	Description
1,980	98	Roofs, HSG A
* 1,000	98	Driveway, HSG C
* 13,326	70	Grass Cover > 75%; HSG C
16,306	75	Weighted Average
13,326		81.72% Pervious Area
2,980		18.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	32	0.0625	1.75		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.9	30	0.1000	0.26		<b>Sheet Flow, Back yard</b> Grass: Short n= 0.150 P2= 3.30"
0.2	20	0.0500	1.57		<b>Shallow Concentrated Flow, Back yard 2</b> Short Grass Pasture Kv= 7.0 fps
0.3	55	0.2200	3.28		<b>Shallow Concentrated Flow, Slope</b> Short Grass Pasture Kv= 7.0 fps
0.1	12	0.2500	3.50		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
2.8	149	Total, Increased to minimum Tc = 6.0 min			

**31 Harborview - Proposed**

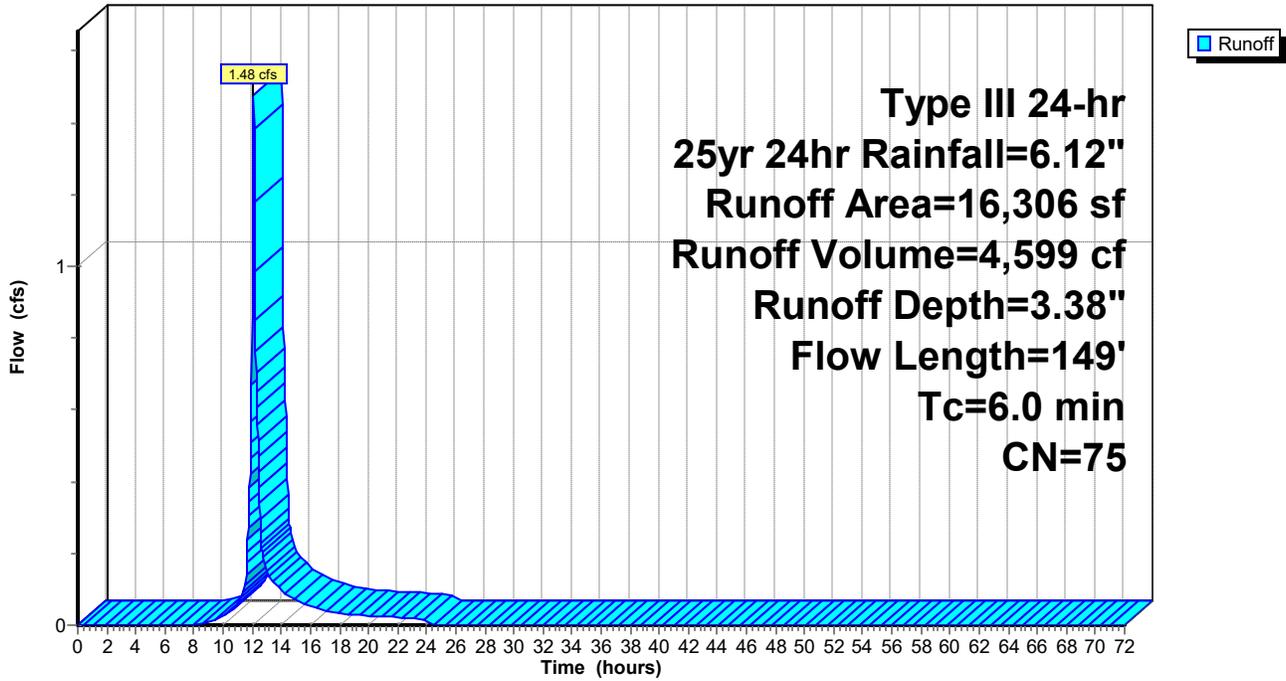
Prepared by Munden Engineering LLC

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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

**Subcatchment 2S: Proposed Conditions Unconnected**

Hydrograph



# 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

## Summary for Reach 10R: Site Runoff

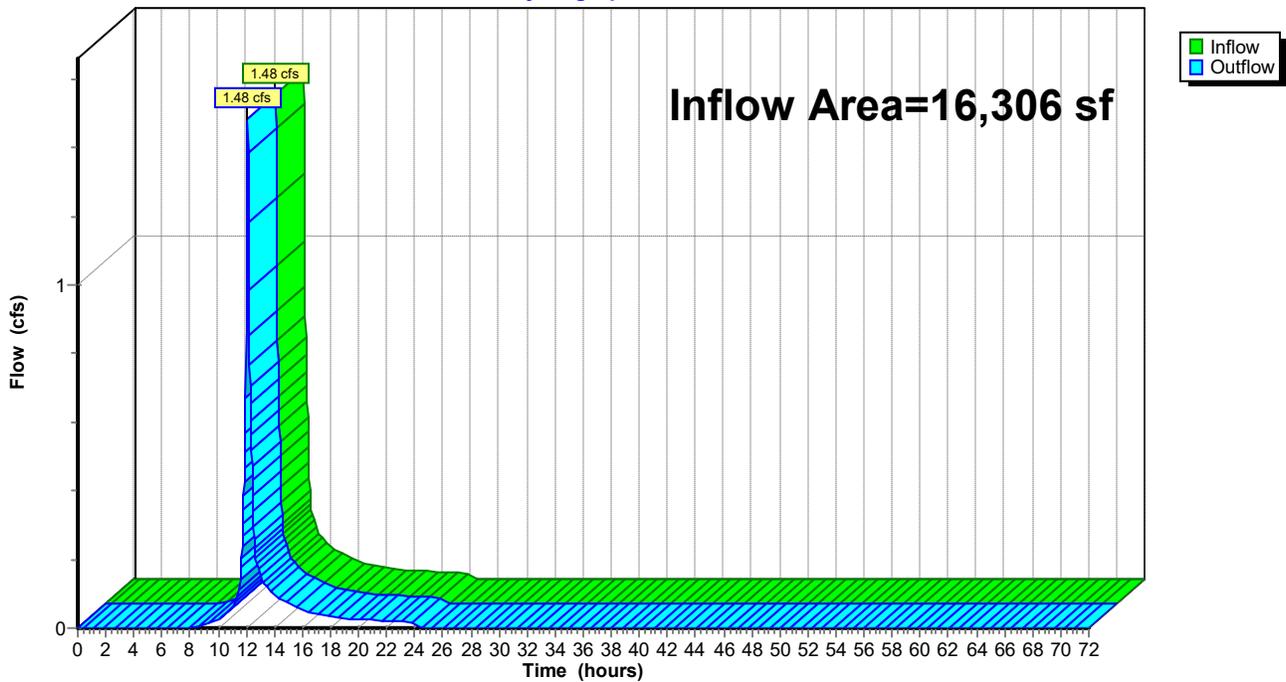
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 18.28% Impervious, Inflow Depth = 3.38" for 25yr 24hr event  
Inflow = 1.48 cfs @ 12.09 hrs, Volume= 4,599 cf  
Outflow = 1.48 cfs @ 12.09 hrs, Volume= 4,599 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

### Reach 10R: Site Runoff

Hydrograph



**31 Harborview - Proposed**

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 2S: Proposed Conditions**    Runoff Area=16,306 sf    18.28% Impervious    Runoff Depth=5.59"  
Flow Length=149'    Tc=6.0 min    CN=75    Runoff=2.42 cfs    7,591 cf

**Reach 10R: Site Runoff**

Inflow=2.42 cfs    7,591 cf  
Outflow=2.42 cfs    7,591 cf

**Total Runoff Area = 16,306 sf    Runoff Volume = 7,591 cf    Average Runoff Depth = 5.59"**  
**81.72% Pervious = 13,326 sf    18.28% Impervious = 2,980 sf**

**31 Harborview - Proposed**

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**Summary for Subcatchment 2S: Proposed Conditions Unconnected**

Runoff = 2.42 cfs @ 12.09 hrs, Volume= 7,591 cf, Depth= 5.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 100yr 24hr Rainfall=8.60"

Area (sf)	CN	Description
1,980	98	Roofs, HSG A
* 1,000	98	Driveway, HSG C
* 13,326	70	Grass Cover > 75%; HSG C
16,306	75	Weighted Average
13,326		81.72% Pervious Area
2,980		18.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	32	0.0625	1.75		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.9	30	0.1000	0.26		<b>Sheet Flow, Back yard</b> Grass: Short n= 0.150 P2= 3.30"
0.2	20	0.0500	1.57		<b>Shallow Concentrated Flow, Back yard 2</b> Short Grass Pasture Kv= 7.0 fps
0.3	55	0.2200	3.28		<b>Shallow Concentrated Flow, Slope</b> Short Grass Pasture Kv= 7.0 fps
0.1	12	0.2500	3.50		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
2.8	149	Total, Increased to minimum Tc = 6.0 min			

**31 Harborview - Proposed**

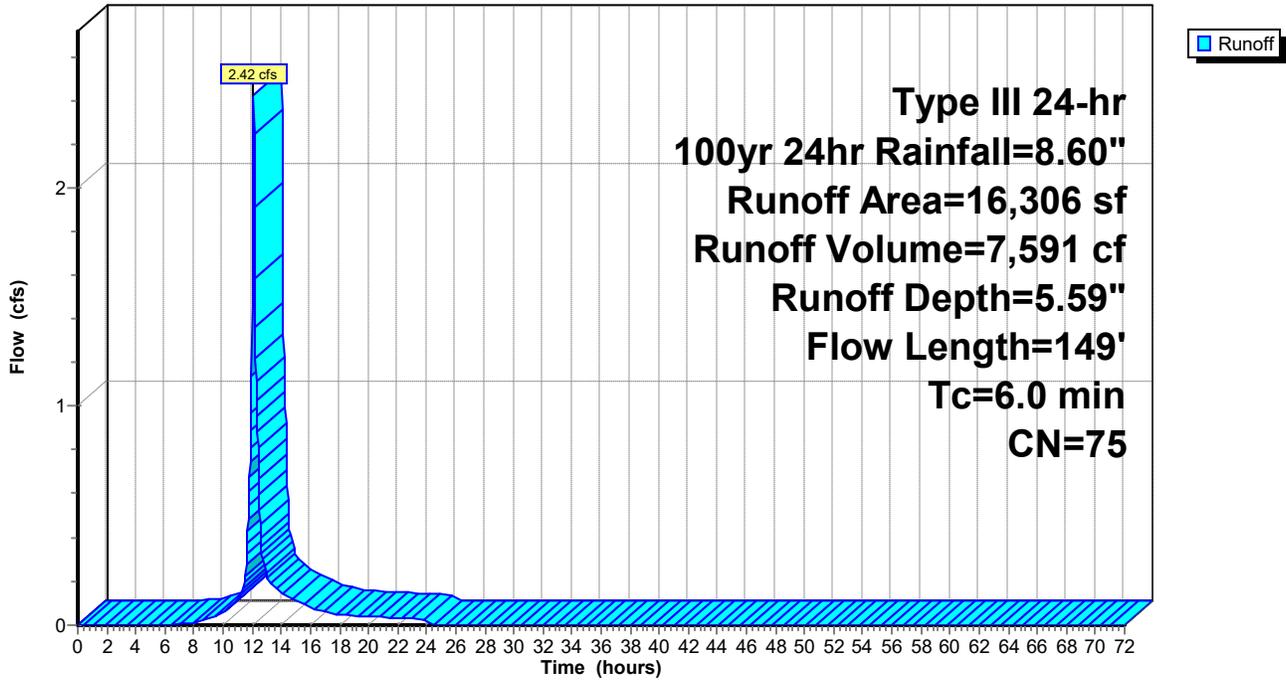
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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

**Subcatchment 2S: Proposed Conditions Unconnected**

Hydrograph



# 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 6 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

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## Summary for Reach 10R: Site Runoff

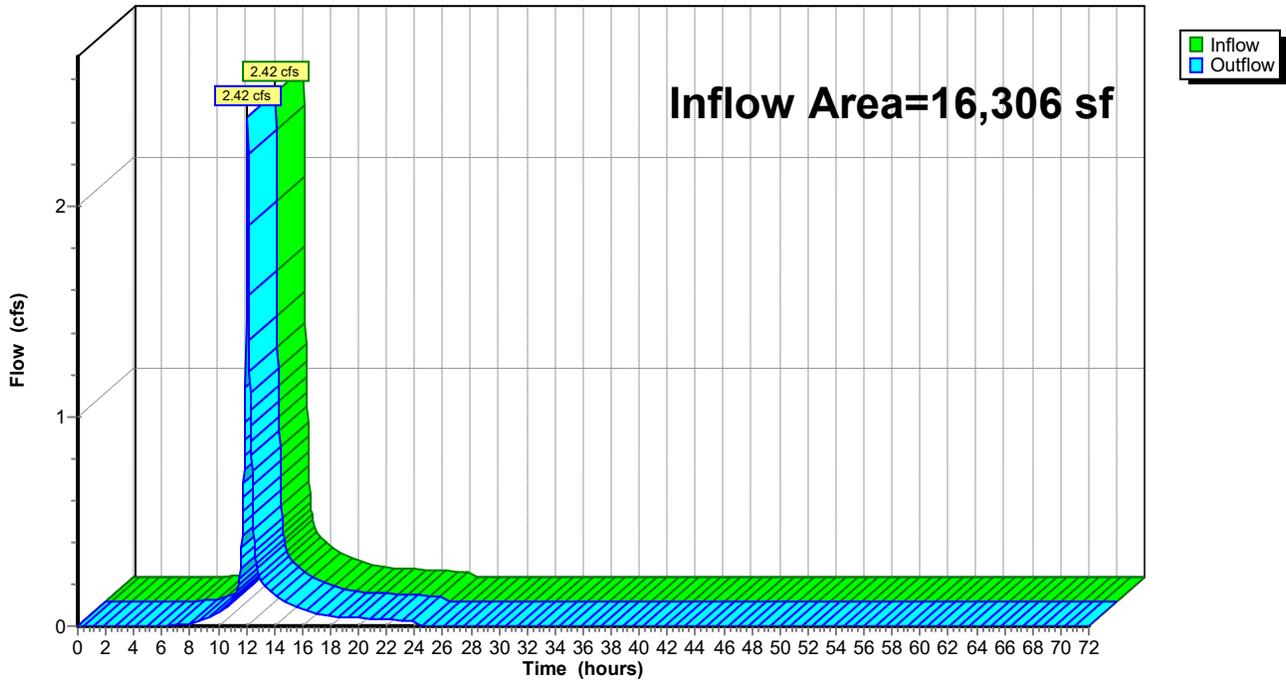
[40] Hint: Not Described (Outflow=Inflow)

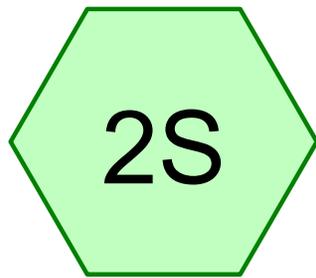
Inflow Area = 16,306 sf, 18.28% Impervious, Inflow Depth = 5.59" for 100yr 24hr event  
Inflow = 2.42 cfs @ 12.09 hrs, Volume= 7,591 cf  
Outflow = 2.42 cfs @ 12.09 hrs, Volume= 7,591 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

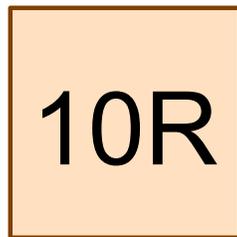
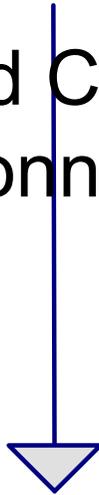
## Reach 10R: Site Runoff

Hydrograph

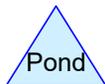
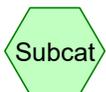




Proposed Conditions  
Unconnected



Site Runoff



**31 Harborview - Proposed**

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Page 2

**Area Listing (all nodes)**

Area (sq-ft)	CN	Description (subcatchment-numbers)
1,000	98	Driveway, HSG C (2S)
13,326	70	Grass Cover > 75%; HSG C (2S)
1,980	98	Roofs, HSG A (2S)
<b>16,306</b>	<b>75</b>	<b>TOTAL AREA</b>

**31 Harborview - Proposed**

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Page 3

**Soil Listing (all nodes)**

Area (sq-ft)	Soil Group	Subcatchment Numbers
1,980	HSG A	2S
0	HSG B	
14,326	HSG C	2S
0	HSG D	
0	Other	
<b>16,306</b>		<b>TOTAL AREA</b>

**31 Harborview - Proposed**

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**Ground Covers (all nodes)**

HSG-A (sq-ft)	HSG-B (sq-ft)	HSG-C (sq-ft)	HSG-D (sq-ft)	Other (sq-ft)	Total (sq-ft)	Ground Cover	Subcat Number
0	0	1,000	0	0	1,000	Driveway	
0	0	13,326	0	0	13,326	Grass Cover > 75%;	
1,980	0	0	0	0	1,980	Roofs	
<b>1,980</b>	<b>0</b>	<b>14,326</b>	<b>0</b>	<b>0</b>	<b>16,306</b>	<b>TOTAL AREA</b>	

## 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 2.8 min

Type III 24-hr 2yr 24hr Rainfall=3.30"

Page 5

Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 2S: Proposed Conditions**    Runoff Area=16,306 sf    18.28% Impervious    Runoff Depth=1.16"  
Flow Length=149'    Tc=2.8 min    CN=75    Runoff=0.54 cfs    1,579 cf

**Reach 10R: Site Runoff**

Inflow=0.54 cfs    1,579 cf  
Outflow=0.54 cfs    1,579 cf

**Total Runoff Area = 16,306 sf    Runoff Volume = 1,579 cf    Average Runoff Depth = 1.16"**  
**81.72% Pervious = 13,326 sf    18.28% Impervious = 2,980 sf**

### 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 2.8 min

Type III 24-hr 2yr 24hr Rainfall=3.30"

Page 6

### Summary for Subcatchment 2S: Proposed Conditions Unconnected

[49] Hint: Tc<2dt may require smaller dt

Runoff = 0.54 cfs @ 12.05 hrs, Volume= 1,579 cf, Depth= 1.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
Type III 24-hr 2yr 24hr Rainfall=3.30"

Area (sf)	CN	Description
1,980	98	Roofs, HSG A
* 1,000	98	Driveway, HSG C
* 13,326	70	Grass Cover > 75%; HSG C
16,306	75	Weighted Average
13,326		81.72% Pervious Area
2,980		18.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	32	0.0625	1.75		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.9	30	0.1000	0.26		<b>Sheet Flow, Back yard</b> Grass: Short n= 0.150 P2= 3.30"
0.2	20	0.0500	1.57		<b>Shallow Concentrated Flow, Back yard 2</b> Short Grass Pasture Kv= 7.0 fps
0.3	55	0.2200	3.28		<b>Shallow Concentrated Flow, Slope</b> Short Grass Pasture Kv= 7.0 fps
0.1	12	0.2500	3.50		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
2.8	149	Total			

# 31 Harborview - Proposed

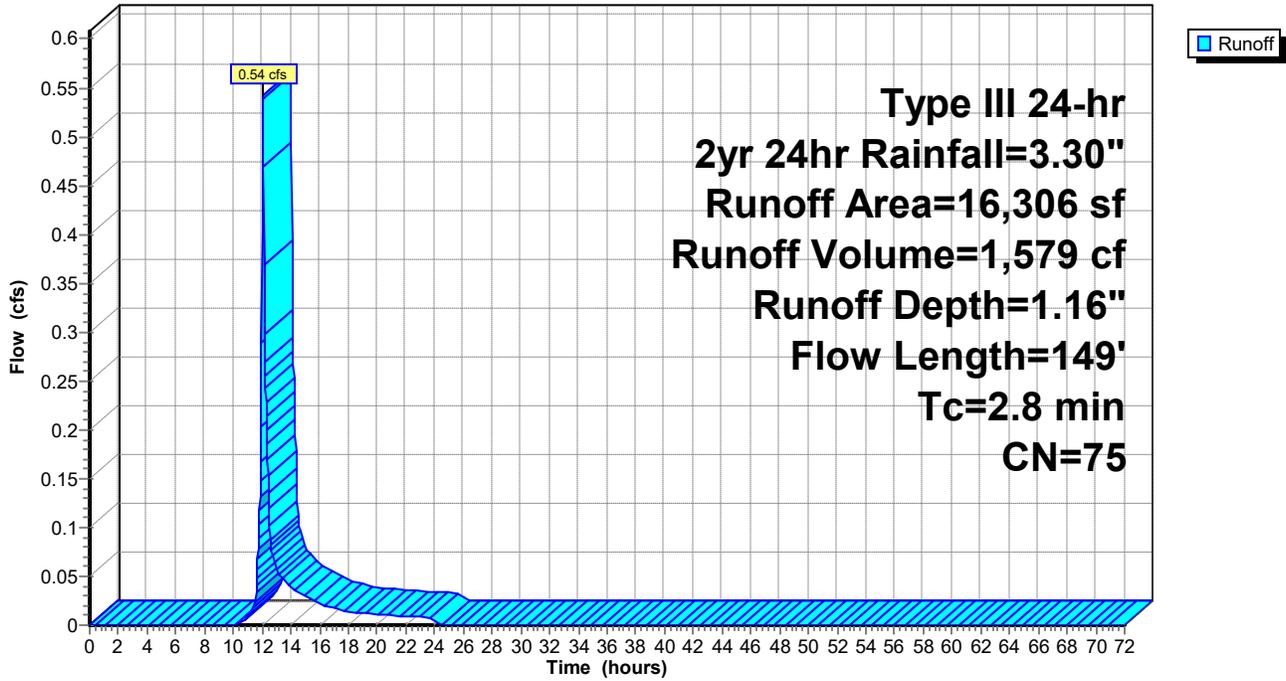
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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

## Subcatchment 2S: Proposed Conditions Unconnected

Hydrograph



# 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 2yr 24hr Rainfall=3.30"

## Summary for Reach 10R: Site Runoff

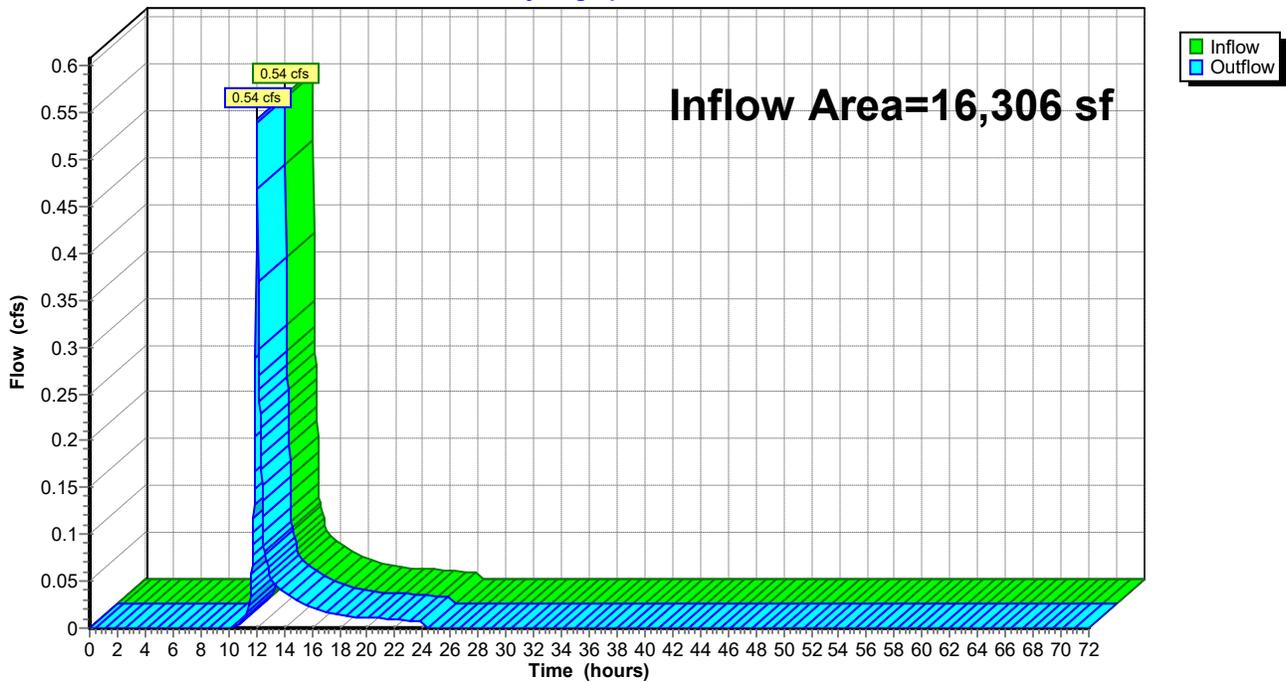
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 18.28% Impervious, Inflow Depth = 1.16" for 2yr 24hr event  
Inflow = 0.54 cfs @ 12.05 hrs, Volume= 1,579 cf  
Outflow = 0.54 cfs @ 12.05 hrs, Volume= 1,579 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 10R: Site Runoff

Hydrograph



## 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 2S: Proposed Conditions**    Runoff Area=16,306 sf    18.28% Impervious    Runoff Depth=2.36"  
Flow Length=149'    Tc=2.8 min    CN=75    Runoff=1.14 cfs    3,207 cf

**Reach 10R: Site Runoff**

Inflow=1.14 cfs    3,207 cf  
Outflow=1.14 cfs    3,207 cf

**Total Runoff Area = 16,306 sf    Runoff Volume = 3,207 cf    Average Runoff Depth = 2.36"**  
**81.72% Pervious = 13,326 sf    18.28% Impervious = 2,980 sf**

### 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

Page 10

### Summary for Subcatchment 2S: Proposed Conditions Unconnected

[49] Hint:  $T_c < 2dt$  may require smaller dt

Runoff = 1.14 cfs @ 12.05 hrs, Volume= 3,207 cf, Depth= 2.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
Type III 24-hr 10yr 24hr Rainfall=4.89"

Area (sf)	CN	Description
1,980	98	Roofs, HSG A
* 1,000	98	Driveway, HSG C
* 13,326	70	Grass Cover > 75%; HSG C
16,306	75	Weighted Average
13,326		81.72% Pervious Area
2,980		18.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	32	0.0625	1.75		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.9	30	0.1000	0.26		<b>Sheet Flow, Back yard</b> Grass: Short n= 0.150 P2= 3.30"
0.2	20	0.0500	1.57		<b>Shallow Concentrated Flow, Back yard 2</b> Short Grass Pasture Kv= 7.0 fps
0.3	55	0.2200	3.28		<b>Shallow Concentrated Flow, Slope</b> Short Grass Pasture Kv= 7.0 fps
0.1	12	0.2500	3.50		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
2.8	149	Total			

# 31 Harborview - Proposed

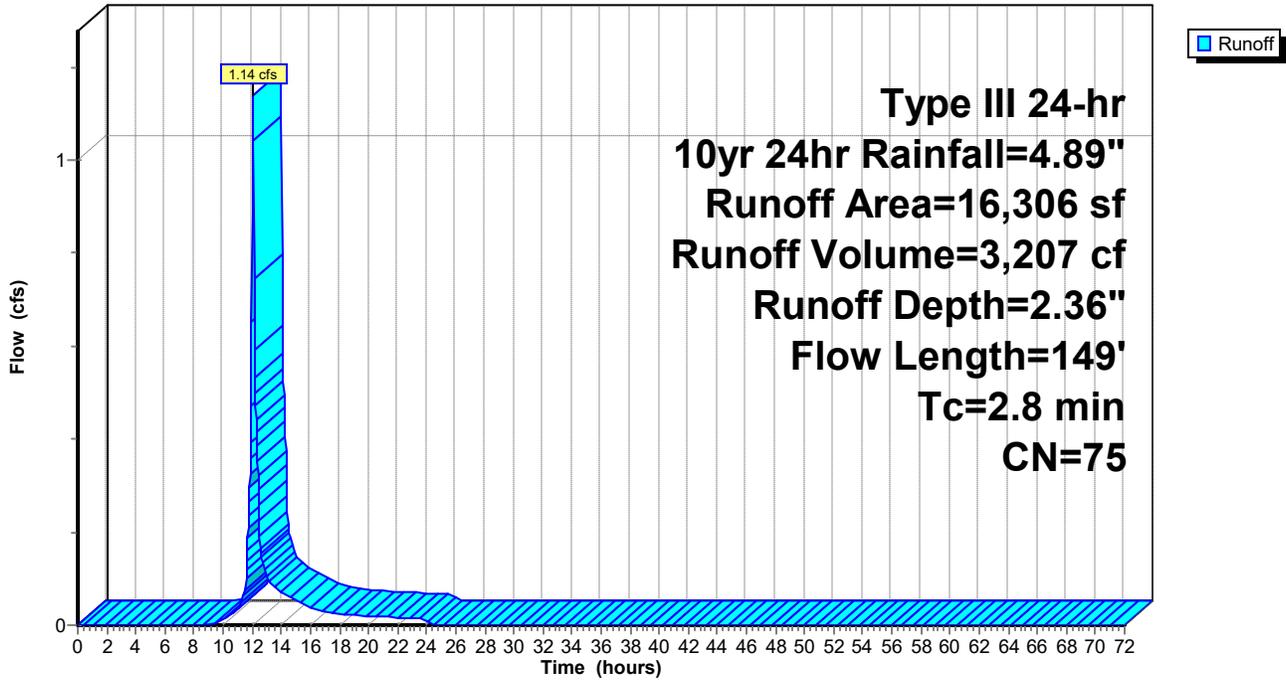
Prepared by Munden Engineering LLC

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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

## Subcatchment 2S: Proposed Conditions Unconnected

Hydrograph



# 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 10yr 24hr Rainfall=4.89"

## Summary for Reach 10R: Site Runoff

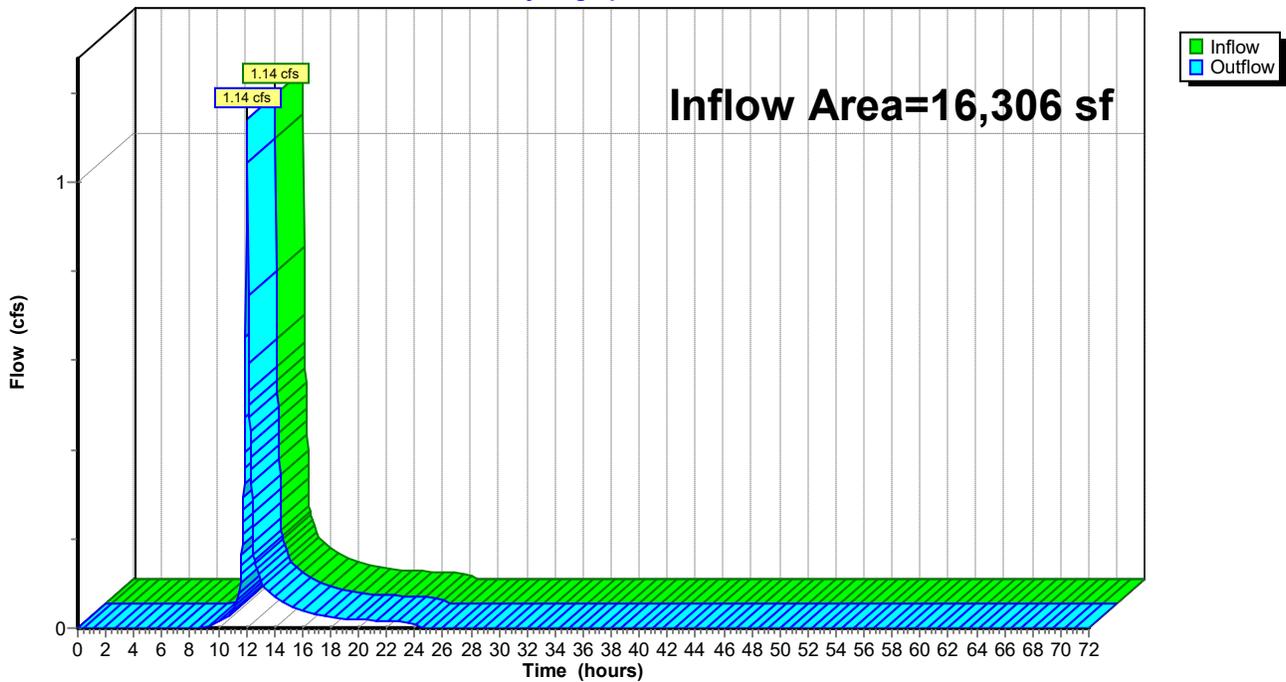
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 18.28% Impervious, Inflow Depth = 2.36" for 10yr 24hr event  
Inflow = 1.14 cfs @ 12.05 hrs, Volume= 3,207 cf  
Outflow = 1.14 cfs @ 12.05 hrs, Volume= 3,207 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 10R: Site Runoff

Hydrograph



## 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

Page 13

Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 2S: Proposed Conditions**    Runoff Area=16,306 sf    18.28% Impervious    Runoff Depth=3.38"  
Flow Length=149'    Tc=2.8 min    CN=75    Runoff=1.65 cfs    4,599 cf

**Reach 10R: Site Runoff**

Inflow=1.65 cfs    4,599 cf  
Outflow=1.65 cfs    4,599 cf

**Total Runoff Area = 16,306 sf    Runoff Volume = 4,599 cf    Average Runoff Depth = 3.38"**  
**81.72% Pervious = 13,326 sf    18.28% Impervious = 2,980 sf**

**31 Harborview - Proposed**

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**Summary for Subcatchment 2S: Proposed Conditions Unconnected**

[49] Hint: Tc<2dt may require smaller dt

Runoff = 1.65 cfs @ 12.04 hrs, Volume= 4,599 cf, Depth= 3.38"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 25yr 24hr Rainfall=6.12"

Area (sf)	CN	Description
1,980	98	Roofs, HSG A
* 1,000	98	Driveway, HSG C
* 13,326	70	Grass Cover > 75%; HSG C
16,306	75	Weighted Average
13,326		81.72% Pervious Area
2,980		18.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.3	32	0.0625	1.75		<b>Sheet Flow, Driveway</b> Smooth surfaces n= 0.011 P2= 3.30"
1.9	30	0.1000	0.26		<b>Sheet Flow, Back yard</b> Grass: Short n= 0.150 P2= 3.30"
0.2	20	0.0500	1.57		<b>Shallow Concentrated Flow, Back yard 2</b> Short Grass Pasture Kv= 7.0 fps
0.3	55	0.2200	3.28		<b>Shallow Concentrated Flow, Slope</b> Short Grass Pasture Kv= 7.0 fps
0.1	12	0.2500	3.50		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
2.8	149	Total			

**31 Harborview - Proposed**

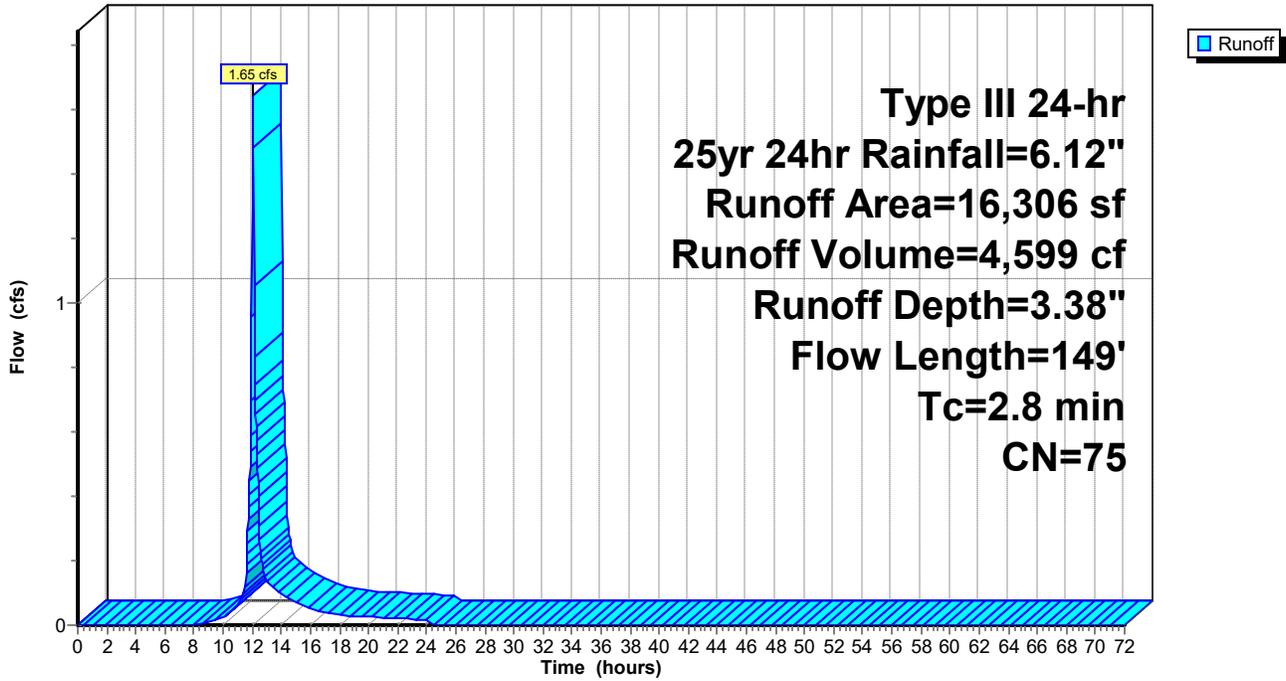
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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

**Subcatchment 2S: Proposed Conditions Unconnected**

Hydrograph



# 31 Harborview - Proposed

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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 25yr 24hr Rainfall=6.12"

## Summary for Reach 10R: Site Runoff

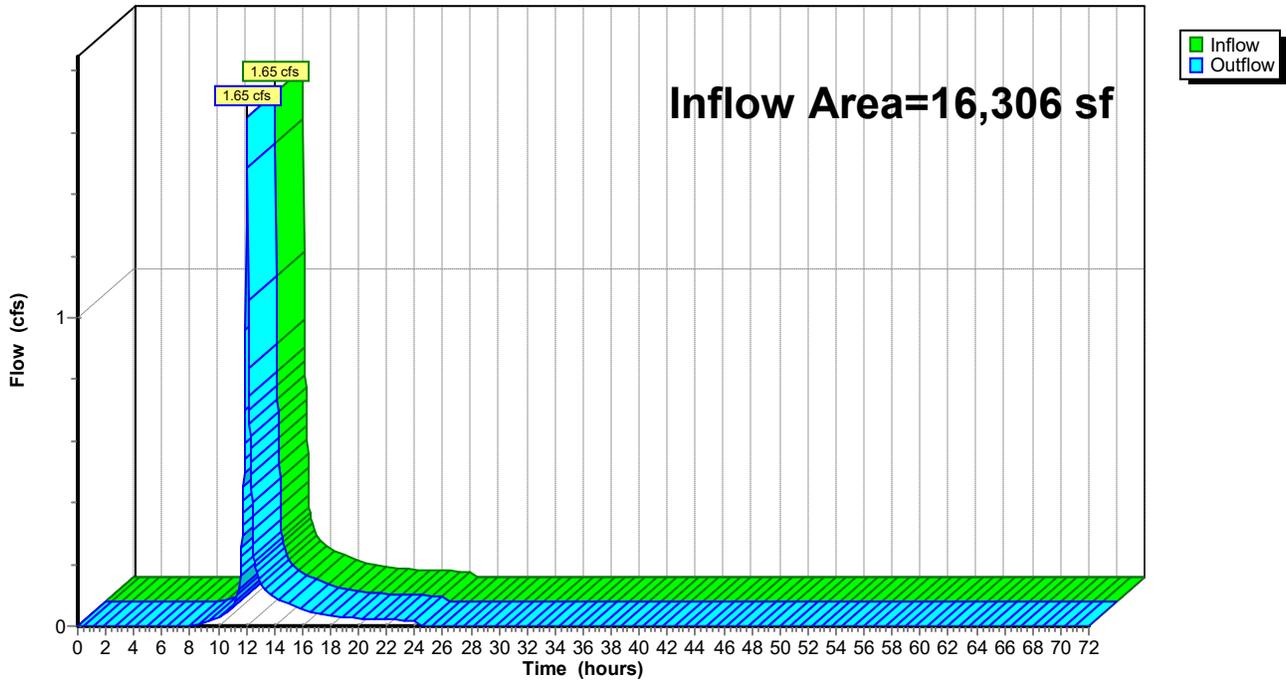
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 18.28% Impervious, Inflow Depth = 3.38" for 25yr 24hr event  
Inflow = 1.65 cfs @ 12.04 hrs, Volume= 4,599 cf  
Outflow = 1.65 cfs @ 12.04 hrs, Volume= 4,599 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 10R: Site Runoff

Hydrograph



**31 Harborview - Proposed**

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Time span=0.00-72.00 hrs, dt=0.03 hrs, 2401 points  
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN  
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

**Subcatchment 2S: Proposed Conditions**    Runoff Area=16,306 sf    18.28% Impervious    Runoff Depth=5.59"  
Flow Length=149'    Tc=2.8 min    CN=75    Runoff=2.70 cfs    7,591 cf

**Reach 10R: Site Runoff**

Inflow=2.70 cfs    7,591 cf  
Outflow=2.70 cfs    7,591 cf

**Total Runoff Area = 16,306 sf    Runoff Volume = 7,591 cf    Average Runoff Depth = 5.59"**  
**81.72% Pervious = 13,326 sf    18.28% Impervious = 2,980 sf**

**31 Harborview - Proposed**

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**Summary for Subcatchment 2S: Proposed Conditions Unconnected**

[49] Hint: Tc<2dt may require smaller dt

Runoff = 2.70 cfs @ 12.04 hrs, Volume= 7,591 cf, Depth= 5.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs  
 Type III 24-hr 100yr 24hr Rainfall=8.60"

Area (sf)	CN	Description
1,980	98	Roofs, HSG A
* 1,000	98	Driveway, HSG C
* 13,326	70	Grass Cover > 75%; HSG C
16,306	75	Weighted Average
13,326		81.72% Pervious Area
2,980		18.28% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
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1.9	30	0.1000	0.26		<b>Sheet Flow, Back yard</b> Grass: Short n= 0.150 P2= 3.30"
0.2	20	0.0500	1.57		<b>Shallow Concentrated Flow, Back yard 2</b> Short Grass Pasture Kv= 7.0 fps
0.3	55	0.2200	3.28		<b>Shallow Concentrated Flow, Slope</b> Short Grass Pasture Kv= 7.0 fps
0.1	12	0.2500	3.50		<b>Shallow Concentrated Flow,</b> Short Grass Pasture Kv= 7.0 fps
2.8	149	Total			

# 31 Harborview - Proposed

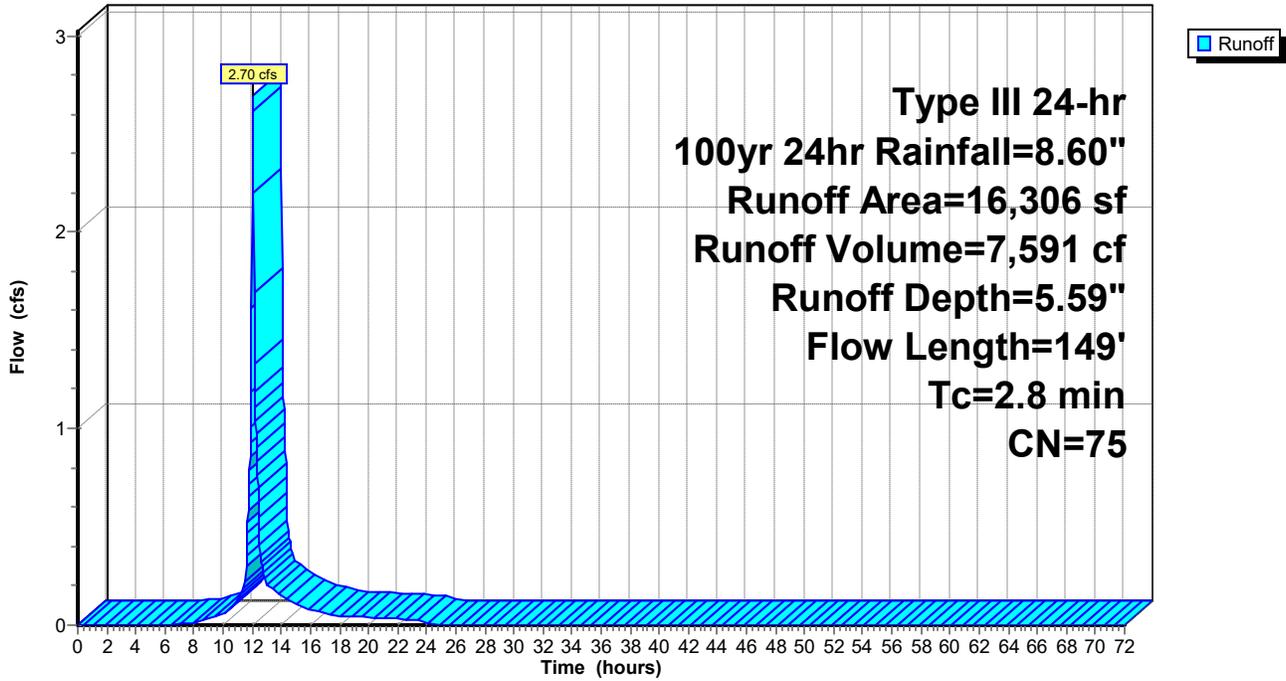
Prepared by Munden Engineering LLC

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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

## Subcatchment 2S: Proposed Conditions Unconnected

Hydrograph



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31 Harborview Dr - Proposed Tc 2.8 min  
Type III 24-hr 100yr 24hr Rainfall=8.60"

## Summary for Reach 10R: Site Runoff

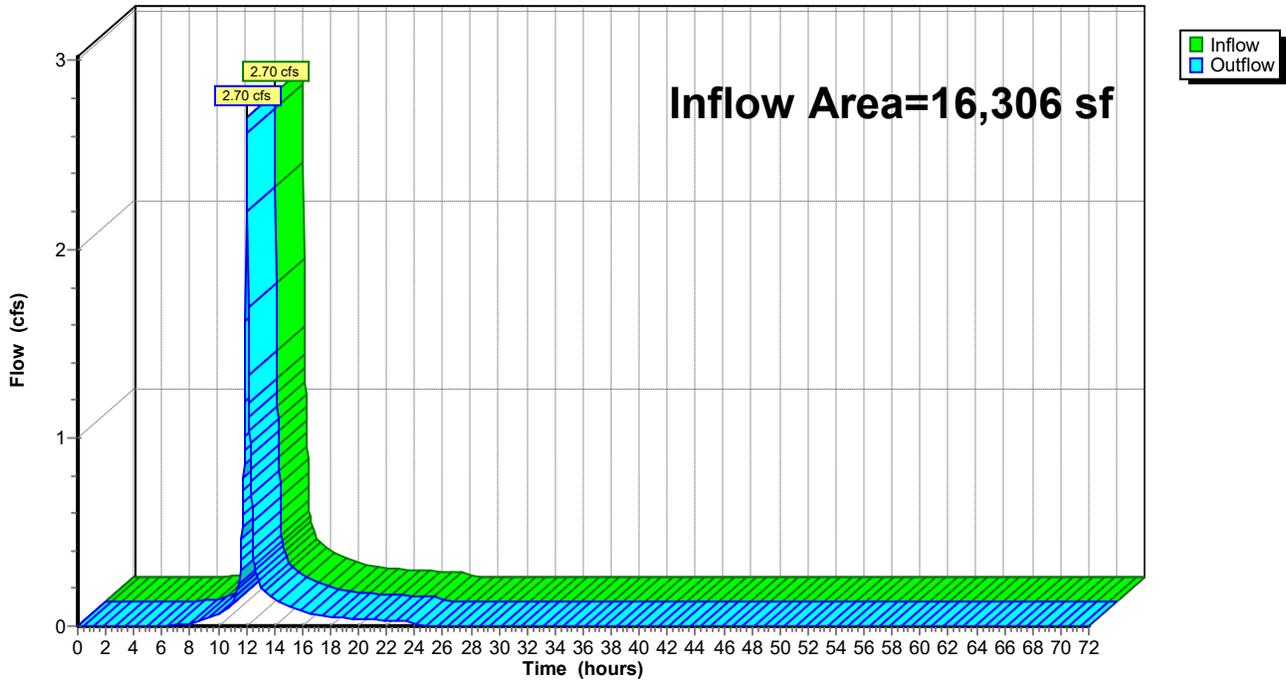
[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 16,306 sf, 18.28% Impervious, Inflow Depth = 5.59" for 100yr 24hr event  
Inflow = 2.70 cfs @ 12.04 hrs, Volume= 7,591 cf  
Outflow = 2.70 cfs @ 12.04 hrs, Volume= 7,591 cf, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.03 hrs

## Reach 10R: Site Runoff

Hydrograph

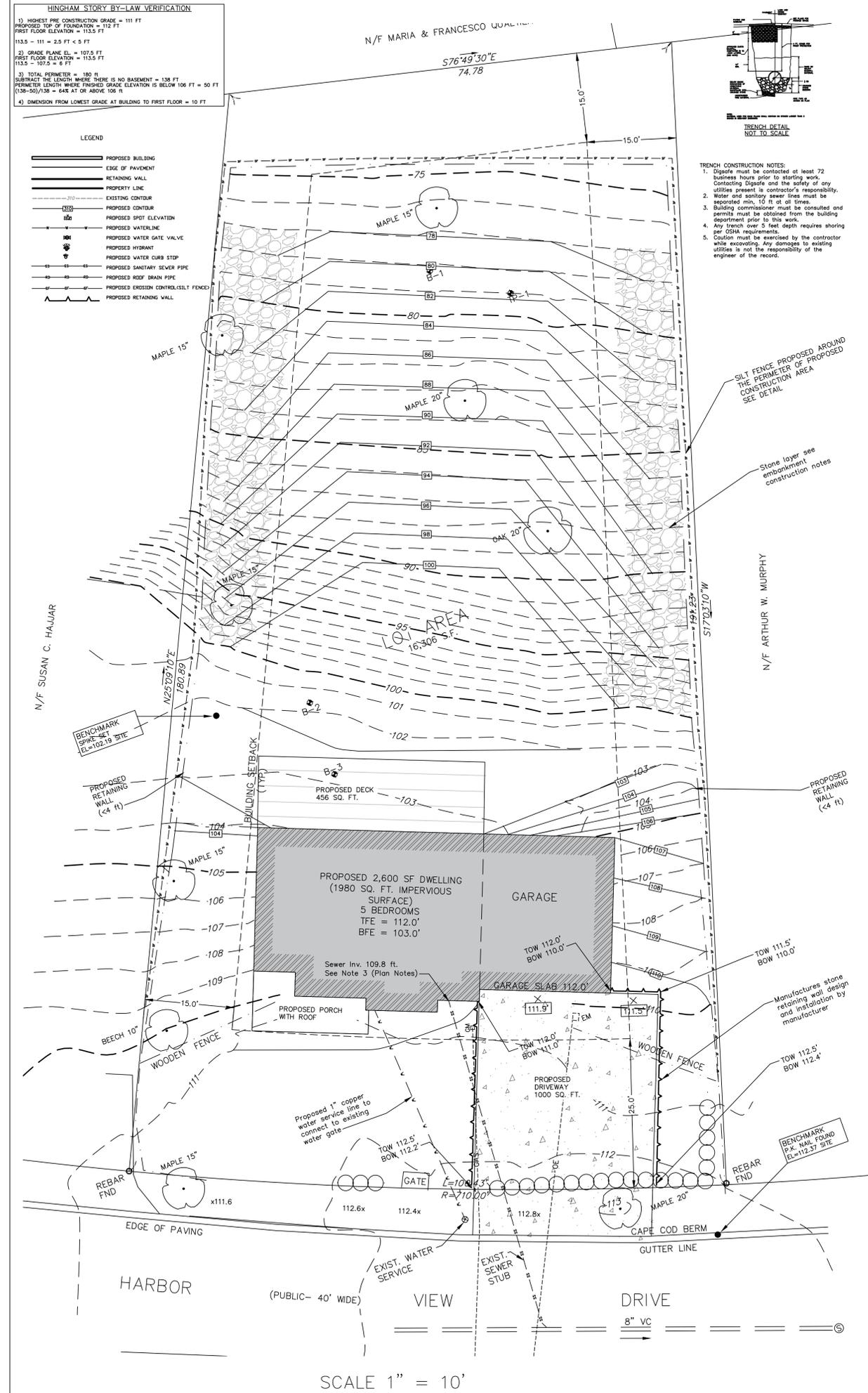




Munden Engineering

mundenengineering.com  
[info@mundenengineering.com](mailto:info@mundenengineering.com)  
781-302-6099

## Appendix F Stormwater Management and Erosion Control Plan



**HIGHAM STORY BY-LAW VERIFICATION**

1) HIGHEST PRE CONSTRUCTION GRADE = 111 FT  
 PROPOSED TOP OF FOUNDATION = 112 FT  
 FIRST FLOOR ELEVATION = 113.5 FT  
 113.5 - 111 = 2.5 FT < 5 FT

2) GRADE PLANE EL. = 107.5 FT  
 FIRST FLOOR ELEVATION = 113.5 FT  
 113.5 - 107.5 = 6 FT

3) TOTAL PERIMETER = 180 FT  
 SUBTRACT THE LENGTH WHERE THERE IS NO BASEMENT = 138 FT  
 PERIMETER LENGTH WHERE FINISHED GRADE ELEVATION IS BELOW 106 FT = 50 FT  
 (138-50)/18 = 4.66 AT OR ABOVE 105 FT

4) DIMENSION FROM LOWEST GRADE AT BUILDING TO FIRST FLOOR = 10 FT

- LEGEND**
- PROPOSED BUILDING
  - EDGE OF PAVEMENT
  - RETAINING WALL
  - PROPERTY LINE
  - EXISTING CONTOUR
  - PROPOSED CONTOUR
  - PROPOSED SPOT ELEVATION
  - PROPOSED WATERLINE
  - PROPOSED WATER GATE VALVE
  - PROPOSED HYDRANT
  - PROPOSED WATER CURB STOP
  - PROPOSED SANITARY SEWER PIPE
  - PROPOSED ROOF DRAIN PIPE
  - PROPOSED EROSION CONTROL/SILT FENCE
  - PROPOSED RETAINING WALL

**PLAN NOTES**

- Existing lot lines, existing conditions and elevations (including utilities and accessory structures) and the location of the proposed addition is based on the existing conditions plan prepared by Ross Engineering Company Inc. and dated 03/02/2020.
- Contractor is responsible for digsafe and any and all safety measures and any necessary means and contracting to build the proposed structures to the specifications depicted on this plan.
- Existing sewer elevation and location to be replaced and a portion between lot line and the new foundation to be replaced. Invert elevation based on field measurements and must be considered approximate. Water and sewer services must be placed minimum 10 feet apart where possible.
- Driveway grading based on the owner's request. The owner of the property was informed driveway grading with a slope towards the garage was not advised and have been made aware of the possible flooding and water damage problems and assumes full responsibility for any problems that may arise regarding drainage and drainage caused problems from the driveway.
- Test pit and test boring locations depicted are based on field measurements and must be considered approximate.

**STORMWATER MANAGEMENT NOTES**

**Existing Impervious Area:**  
 Roof : 1234 sq. ft.  
 Driveway : 614 sq. ft.  
 Patio Pavers: 206 sq. ft.

Existing Total : 2054 sq. ft.

**Proposed Impervious Area:**  
 Roof : 1980 sq. ft.  
 Driveway : 1000 sq. ft.

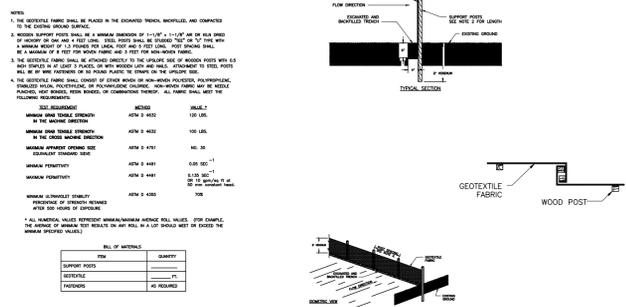
Proposed Total : 2980 sq. ft.

Increase in Impervious Area: 926 sq. ft.

Peak Runoff rates for existing and proposed conditions are presented below:

Storm Intensity	Rainfall (in.)	Existing Conditions Runoff (cfs)	Proposed Conditions Runoff (cfs)
2-yr	3.30	0.46	0.49
10-yr	4.89	0.99	1.03
25-yr	6.12	1.44	1.48
100-yr	8.60	2.38	2.42

Please also refer to the stormwater management report for additional information.



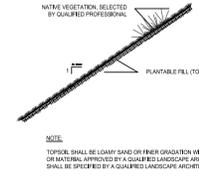
- TRENCH CONSTRUCTION NOTES:**
- Digsafe must be contacted at least 72 business hours prior to starting work. Contacting Digsafe and the safety of any utilities present is contractor's responsibility.
  - Water and sanitary sewer lines must be separated min. 10 ft at all times.
  - Building commissioner must be consulted and permits must be obtained from the building department prior to this work.
  - Any trench over 5 feet depth requires shoring per OSHA requirements.
  - Caution must be exercised by the contractor while excavating. Any damages to existing utilities is not the responsibility of the engineer of the record.

**GENERAL EROSION AND SEDIMENT CONTROL NOTES:**

- All erosion and sediment control measures are to be placed prior to commencement of land disturbance activities.
- The contractor is responsible for installation of any additional erosion control measures necessary to prevent erosion and sedimentation.
- All disturbances to drain to approved sediment control measures at all times during land disturbing activities and during site development until final stabilization is achieved.
- The contractor shall inspect all erosion control measures weekly and after each rainfall event. Any necessary repairs or cleanup to maintain the effectiveness of the erosion control devices shall be made immediately.
- The contractor shall maintain a surplus supply of necessary erosion control devices on-site for emergency use (straw bales, wattles, filter berm, silt fence, stakes, crushed stone).

**POST CONSTRUCTION SEDIMENT AND EROSION CONTROL NOTES:**

- Sloped areas must be inspected after every major storm for the first 6 months after construction for signs of erosion, gulleying, and intactness of the plants and vegetation and riprap areas. If gulleying or localized, differential erosion is observed the engineer of the record must be contacted. After the slopes, the inspection frequency can reduce to a monthly schedule.
- Maintenance of the vegetation, planting and the rip rap areas are the responsibility of the owner.



**EMBANKMENT CONSTRUCTION NOTES**

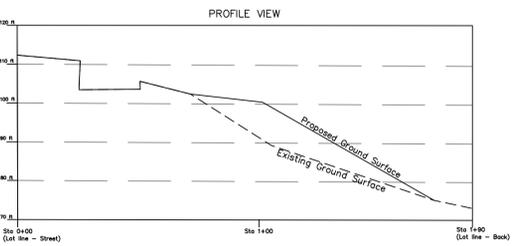
- All material used for the construction of the fill slope (embankment) must have size distribution in compliance with AASHTO A-1-b, MassDOT M1.03.0-1and/or MassDOT M2.01.7-1.
- Where required, crushed stone/riprap must be Modified rockfill as described in MassDOT specifications (2020) and shall consist of hard, durable angular shaped stones which are the product of the primary crushing of a stone crusher. Rounded stone, boulders, sandstone and similar soft stone or relatively thin slabs will not be acceptable. Stone shall be free from overburden, spoil, shale, organic material and meet the following gradation:  

Size of Stone (in.)	Passing Percentages
8	95-100
4	0-25
2 1/2	0-5
- All subgrade must be flattened to the extent possible, existing slopes benched accordingly with OSHA guidelines and all fill material to be removed from the bottom prior to construction. Crushed stone must be placed after granular fill is placed and compacted for the entire embankment.
- The foundation areas shall be cleared, grubbed and stripped as required, and all soft, spongy or other material unsuitable for embankment foundation shall be removed. When, in the Engineer's judgment, there is reasonable doubt as to the suitability of the existing material for embankment foundation, no further work shall be performed in the area in question until the material is tested and approved for use or remedial methods are ordered by the Engineer.
- Where embankment is to be placed against existing earth slopes, steeper than 3 to 1, the slope shall be broken up into steps of random width as the fill is placed in order to provide a suitable bond between the existing ground and the new embankment.
- If subsurface conditions different than what is shown on this plan and accompanying reports are encountered during construction, the engineer of the record must be contacted immediately.
- Fill material shall be placed and compacted in uniform layers not exceeding 12 in. in depth, loose measurement; each layer of material shall be spread on the entire width of the embankment and leveled off by approved equipment.
- The embankment materials shall be compacted to not less than 95% of the maximum dry density of the embankment material as determined by AASHTO Standard

**CONSTRUCTION SEQUENCE**

Items must occur in the order listed; items cannot occur concurrently unless specifically noted.

- No construction can begin until any and all permits are obtained from Town of Hingham
- Pre-construction meeting on-site
- Clearing & grubbing only as necessary for installation of perimeter controls
- Installation of perimeter controls (silt fence)
- Demolition of existing house dwelling (sediment & erosion control measures for these areas must already be installed)
- Clearing & grubbing for the remainder of the lot where grade changes are proposed
- Construction of concrete foundation
- Clearing & grubbing of site or demolition (sediment & erosion control measures for these areas must already be installed)
- Rough grading (also see embankment construction notes)
- Installation of utilities
- Fine grading, paving, etc. (also see embankment construction notes)
- Construction of framing and exteriors including roofs, windows, doors, siding, decking etc.)
- Permanent/final stabilization
- Removal of temporary sediment & erosion control measures
- Perform as-built surveys and submit to Town of Hingham for acceptance



- Method of Test T 99, Method C. If the material retained on the 1/2-in. sieve is 30% or more of the total sample, this test shall not apply and the material shall be compacted to the target density. The target density shall be established by determining the number of passes of a roller required to produce a constant and uniform density, after conducting a series of tests using either AASHTO T 310, In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth), or AASHTO T 191, Density of Soil in-Place by the Sand-Cone Method. The Contractor shall, without additional compensation, employ whatever measures may be necessary to adjust the natural water content of the suitable embankment material to permit the placement and compaction as hereinbefore specified.
- Each lift of compacted materials shall be visibly crowned to allow drainage of surface and rain waters off the surface of the embankment.
- Embankment construction with materials other than rock shall not be placed from December 1 to April 1, except with written permission of and under such special conditions and restrictions as may be imposed by the Engineer. The work may be ordered suspended if the weather and climatic conditions are such that the embankment and excavation cannot be performed in accordance with the specifications. No additional compensation will be allowed to the Contractor for such suspension of work. If the work is ordered suspended due to weather or other climatic conditions not under the control of the Contractor, an extension of time may be granted to the Contractor by the Engineer.
- The Contractor is responsible for all safety measures, equipment and mobilization, and means and methods for the proposed work.
- Topsoil and the planting plan and/or recommendations must be obtained by a registered landscape architect or other landscape professional.
- Engineer of the record shall not be liable for claims, liabilities or losses arising out of or connected with modification or misuse of the design and information on this plan and related reports and documents.
- It is the contractors responsibility to obtain all documents regarding design and construction.
- No changes in grade, construction of permanent or temporary structures, construction of drainage open r subsurface drainage systems and structures, or excavation shall be performed within a 100-ft of top of proposed embankment without consulting a registered professional engineer.



06/09/2020

**Revisions**

Rev. No.	Rev. Date	Description

**PROPOSED CONDITIONS SITE PLAN**

31 Harborview Dr  
 Hingham MA

June 9th 2020

Prepared For:

PAUL YINGLING  
 &  
 STACY MARCOTTE  
 31 Harborview Dr  
 HINGHAM MA

Prepared By:

**Munden Engineering**

83 Morse Street  
 Norwood MA 02062  
 781-302-6099  
 mundenengineering.com



**June 9th 2020**

Paul Yingling & Stacy Marcotte  
31 Harborview Drive  
Hingham MA

**Re: Geotechnical Design Report**

Proposed Raze and Rebuild Single Family Dwelling and Embankment Slope  
31 Harborview Drive, Hingham MA

**INTRODUCTION**

In accordance with our agreement dated March 13<sup>th</sup> 2020, Munden Engineering LLC (“Munden Engineering”) is pleased to present this geotechnical design report for raze and rebuild of a single-family dwelling and design of the embankment slope at 31 Harborview Drive Hingham Massachusetts, to Paul Yingling and Stacy Marcotte (“The Client”). The objectives of our work were to perform review subsurface investigation and geotechnical borings performed by others and design a new embankment extending the existing slope. This report is subject to the Limitations attached in Appendix A and the terms and conditions of our agreement. Elevations referenced as part of this report is based on the existing conditions site plan prepared by Ross Engineering Company Inc. and dated 03/02/2020.

**PROPOSED WORK**

Our understanding of the project is based on:

- Our conversations with you on site and through phone and email,
- Architects plans provided by the Client dated 4/3/2020 and revised 5/11/2020,

The subject site (the “Site”) is currently accessible through a paved driveway on Harborview Drive. The site is bordered by Harborview Drive in the front and abuts residential properties on both sides and back. The proposed embankment is designed to extend flat, useable land in the back yard by extending the top of existing slope in the back approximately 25 ft at 100 ft elevation to sloping down to 78 ft over 55 ft horizontal length, creating an approximately 22 degree slope.



## **SCOPE OF WORK**

Munden Engineering completed the following scope of work for this study:

Geotechnical Engineering Analyses & Design: Munden Engineering evaluated the subsurface conditions based on exploration data provided by others and conducted embankment design and stability analysis.

## **SUBSURFACE EXPLORATIONS**

Sviokla Drillers performed two (3) test borings (B-1, B-2 and B-3) on March 31<sup>st</sup> 2020 using cased drilling techniques. The borings were advanced with a tripod setting rigging system. Standard Penetration Tests (SPTs) were performed and split spoon samples obtained continuously in all borings to termination depth. Both B-1 was terminated at 7.3 feet below existing ground surface (El. 70.7 ft), B-2 was terminated at 12 ft below existing ground surface (El. 89.5 ft) and B-3 was terminated at 10.8 feet below existing ground surface (El. 92 ft).

The approximate boring locations are shown in Appendix B and the boring logs are included in Appendix C.

Based on the boring logs provided by others, subsurface consisted of the fill, sand and till layers and explained in detail below:

### **Fill**

Fill was encountered in all test borings extending to the depths of approximately 2 to 6.5 feet below existing ground surface. Fill layer generally consisted of fine to coarse Sand with up to 35 percent inorganic Silt, up to 35 percent gravel and trace amounts of debris and roots. The blows per foot (bpf) values ranged between 3 to 18 bpf in the fill layer.

### **Sand**

Sand layer was encountered below fill layer in boring B-3 with the top of the strata at approximately 6.5 feet below existing ground surface. Sand layer was approximately 1 foot in thickness and bottom of the layer extended to approximately 7.5 feet below the existing ground surface. Sand layer generally consisted of fine to coarse Sand with up to 50 percent Silt and varying amounts of gravel, roots and fibers. The blows per foot (bpf) value was 16 bpf for the sand layer.

### **Till**

Till was encountered in all test borings with the top of the strata at approximately 4.3 to 9 feet below existing ground surface. All borings were terminated in till layer. Till layer generally consisted of fine to coarse Sand with up to 50 percent inorganic Gravel, up to 35 percent inorganic Silt. The blows per foot (bpf) values ranged between 59 to over 100 bpf in the fill layer.



## **Groundwater**

Groundwater was not encountered in any of the borings performed. Redoximorphic features was observed in boring B-1 at approximately 4.3 feet below existing ground surface indicating high seasonal groundwater elevation.

It should be noted that fluctuations in groundwater levels may occur due to variations in season, rainfall, site features and other factors different from those existing at the time of explorations and measurements.

## **GEOTECHNICAL ANALYSES & DESIGN**

Geotechnical engineering analyses based on the soil samples and boring data collected through 3 test borings were used to determine additional properties to be used in embankment design. Table 1 below presents the soil properties for each layer that was used for analyses. Detailed calculations performed for soil properties are included in Appendix D.

**Table 1. Summary of Geotechnical Properties of Subsurface Layers**

Soil Strata	Unit Weight, $\gamma$ (pcf)	Internal Friction Angle, $\phi$ (deg)	Elastic Modulus E ( $10^6$ psf)	Poisson's Ratio
Fill	120	30	3	0.25
Sand	125	32	4	0.15
Till	130	36	4.5	0.3

## **Embankment Design**

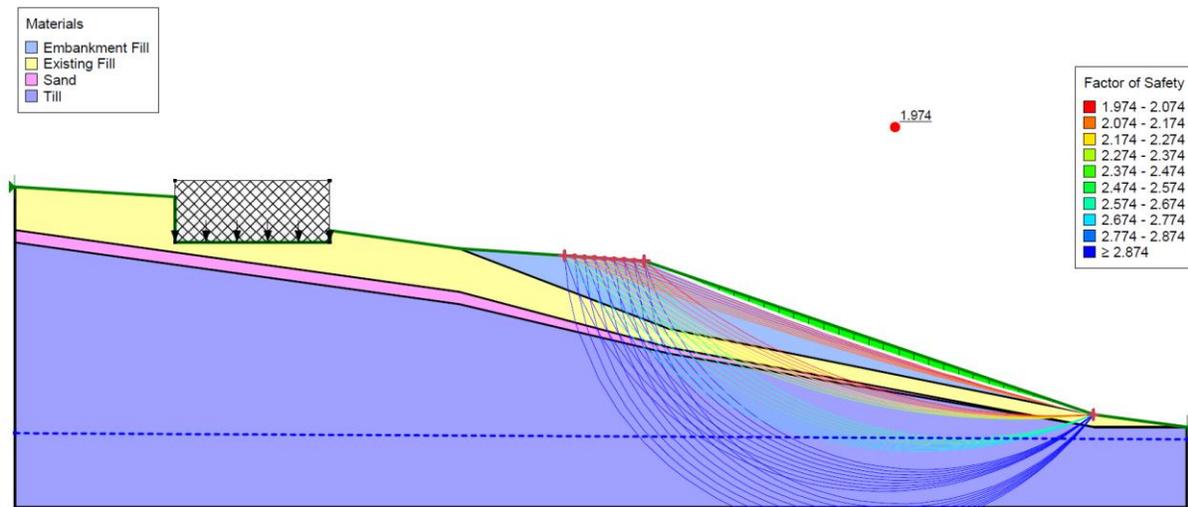
Embankment Design and analysis were performed using GeoStudio Slope/w and Sigma/w. Geotechnical properties of existing layers were used in the software as shown on Table 1. The properties for the imported embankment fill were estimated based on common granular fill and is depicted below:

**Table 2. Summary of Geotechnical Properties of Embankment Fill**

Soil Strata	Unit Weight, $\gamma$ (pcf)	Internal Friction Angle, $\phi$ (deg)	Elastic Modulus E ( $10^6$ psf)	Poisson's Ratio
Embankment Fill	125	34	4	0.2



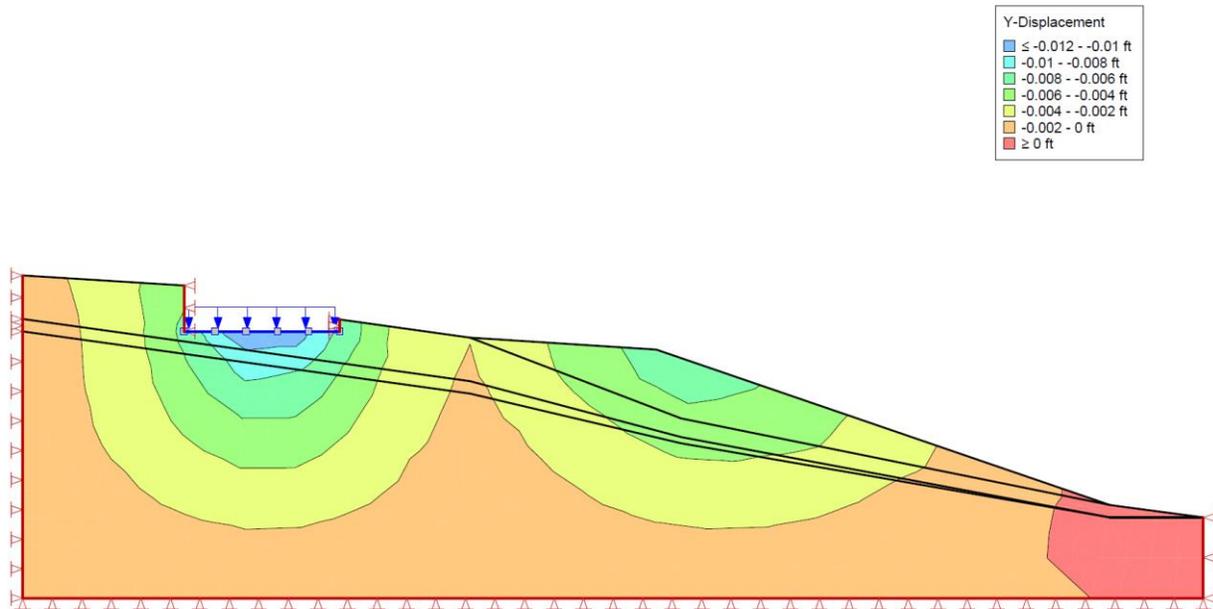
Slope Stability of the existing and slope and proposed embankment was designed to obtain a factor of safety of 2 (or 1.974 to be precise as shown below), based on Morgenstern-Price method. A snapshot of software output for designed slope stability is below:



**Figure 1. Slope/W Analysis Graphic**

Critical slip surface was established based on the fact that proposed is a homogeneous slope composed of dry cohesionless soil with a constant friction angle, of which critical slip surface is a plane coincident with the face of the slope. Existing and proposed single family dwellings were also modeled with both Slope/W and Sigma/W analysis considering common foundation stress of 1750 psf and 2000 psf, for existing and proposed conditions, respectively.

The existing subsurface was also further evaluated for stability with Sigma/w. The analysis depicts that the calculated settlement is less than  $\frac{1}{4}$  inches for immediate settlement. Long term consolidation settlements are not estimated since compressible clay soils were not encountered during subsurface exploration.



**Figure 2. Sigma/W Analysis Graphic**

Please refer to Appendix E for Slope/w and Sigma/w outputs. For information and details regarding construction refer to Appendix B for proposed conditions plan prepared by this office depicting construction notes and details, and to Appendix F for construction specifications.

#### **Additional Notes About Slope Design and Construction**

Analysis results and any calculations presented are based on embankment fill properties assumed based on the discussion with the Client. As of the day of this report, it is our understanding that the Client did not purchase or agree on a provider and product regarding embankment fill. When decided the gradation results must be submitted to the Engineer of the Record for review and approval. Density and optimum moisture tests must be performed to determine compaction density and moisture of the chosen fill for construction. Any fill must be granular soils and must be free of debris, organics, and/or recycled materials.



Munden Engineering  
mundenengineering.com  
[info@mundenengineering.com](mailto:info@mundenengineering.com)  
781-302-6099

## **CONSTRUCTION**

We would welcome the opportunity to observe site earthwork construction for compliance with the above recommendations, project plans and earthwork specifications.

We appreciate the opportunity to assist you on this phase of the project and look forward to assisting you as it moves toward construction. Please contact Munden Engineering LLC at 781-302-6099 or [info@mundenengineering.com](mailto:info@mundenengineering.com) with any questions.

Gamze Munden, P.E.

83 Morse Street

Norwood MA 02062

[mundenengineering.com](http://mundenengineering.com)

## **APPENDICES:**

**APPENDIX A – LIMITATIONS**

**APPENDIX B – PROPOSED CONDITIONS SITE PLAN**

**APPENDIX C – BORING LOGS**

**APPENDIX D – CALCULATIONS**

**APPENDIX E – GEOSTUDIO OUTPUT**

**APPENDIX F – CONSTRUCTION SPECS**

**APPENDIX A**  
**LIMITATIONS**

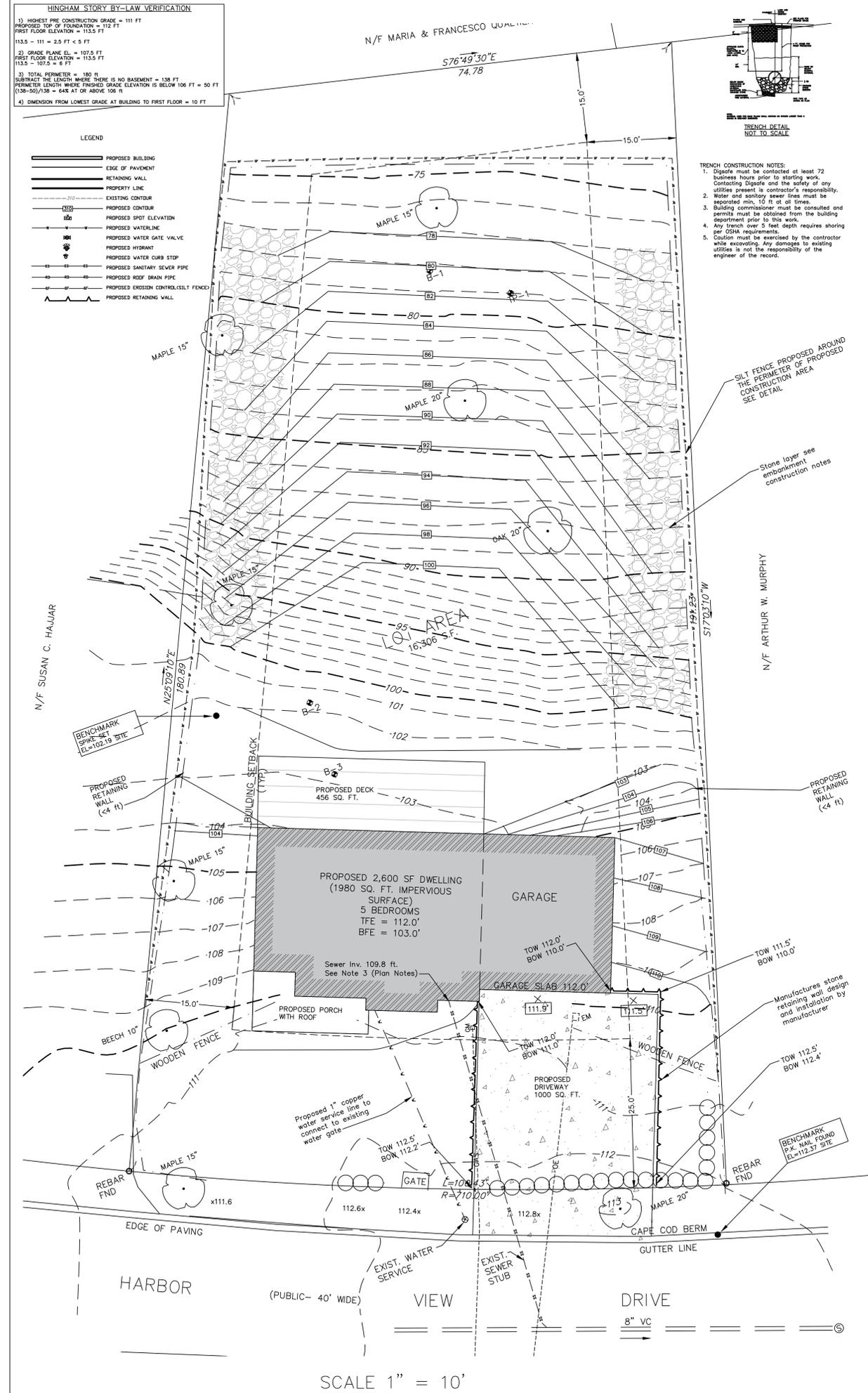


## LIMITATIONS

1. Munden Engineering LLC (Munden Engineering) prepared this report on behalf of, and for the exclusive use of the Client for the stated purposes and locations identified in the report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions and no responsibility is accepted by Munden Engineering for such uses. Further, reliance by any party not expressly identified in the contract documents, for any use, without our permission, shall be that party's sole risk, and without any liability to Munden Engineering.
2. The generalized soil profile provided in our report are based on widely spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated.
3. Our findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the report and reflect our professional judgement. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject locations, or the design has been altered in any way, Munden Engineering shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions.
4. Our services were performed using degree of skill and care ordinarily exercised by qualified professionals performing the similar type of services. No warranty, expressed or implied, is made.
5. In conducting our work, we relied upon certain information made available by public agencies, Client and/or others. Munden Engineering did not attempt to independently verify the accuracy or completeness of that information. If there are any inconsistencies noted by us, they are stated in the report.
6. Our services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.
7. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and sometimes contradictory, interpretations. Compliance with codes and regulations by other parties is not the responsibility of Munden Engineering.

**APPENDIX B**

PROPOSED CONDITIONS SITE PLAN



**PLAN NOTES**

- Existing lot lines, existing conditions and elevations (including utilities and accessory structures) and the location of the proposed addition is based on the existing conditions plan prepared by Ross Engineering Company Inc. and dated 03/02/2020.
- Contractor is responsible for digsafe and any and all safety measures and any necessary means and contracting to build the proposed structures to the specifications depicted on this plan.
- Existing sewer elevation and location to be replaced and a portion between lot line and the new foundation to be replaced. Invert elevation based on field measurements and must be considered approximate. Water and sewer services must be placed minimum 10 feet apart where possible.
- Driveway grading based on the owner's request. The owner of the property was informed driveway grading with a slope towards the garage was not advised and have been made aware of the possible flooding and water damage problems and assumes full responsibility for any problems that may arise regarding drainage and drainage caused problems from the driveway.
- Test pit and test boring locations depicted are based on field measurements and must be considered approximate.

**STORMWATER MANAGEMENT NOTES**

**Existing Impervious Area:**  
 Roof : 1234 sq. ft.  
 Driveway : 614 sq. ft.  
 Patio Pavers: 206 sq. ft.

Existing Total : 2054 sq. ft.

**Proposed Impervious Area:**  
 Roof : 1980 sq. ft.  
 Driveway : 1000 sq. ft.

Proposed Total : 2980 sq. ft.

Increase in Impervious Area: 926 sq. ft.

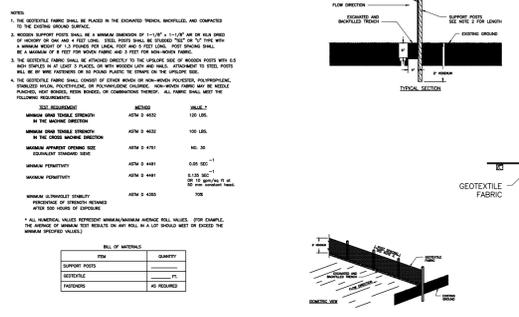
Peak Runoff rates for existing and proposed conditions are presented below:

Storm Intensity	Rainfall (in.)	Existing Conditions Runoff (cfs)	Proposed Conditions Runoff (cfs)
2-yr	3.30	0.46	0.49
10-yr	4.89	0.99	1.03
25-yr	6.12	1.44	1.48
100-yr	8.60	2.38	2.42

Please also refer to the stormwater management report for additional information.

**CONSTRUCTION SEQUENCE**

- Items must occur in the order listed; items cannot occur concurrently unless specifically noted.
- No construction can begin until all and all permits are obtained from Town of Hingham
  - Pre-construction meeting on-site
  - Clearing & grubbing only as necessary for installation of perimeter controls
  - Installation of perimeter controls (silt fence)
  - Demolition of existing house dwelling (sediment & erosion control measures for these areas must already be installed)
  - Clearing & grubbing for the remainder of the lot where grade changes are proposed
  - Construction of concrete foundation
  - Clearing & grubbing of site or demolition (sediment & erosion control measures for these areas must already be installed)
  - Rough grading (also see embankment construction notes)
  - Installation of utilities
  - Fine grading, paving, etc. (also see embankment construction notes)
  - Construction of framing and exteriors including roofs, windows, doors, siding, decking etc.)
  - Permanent/final stabilization
  - Removal of temporary sediment & erosion control measures
  - Perform as-built surveys and submit to Town of Hingham for acceptance

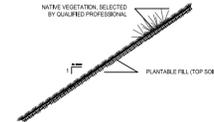


**GENERAL EROSION AND SEDIMENT CONTROL NOTES:**

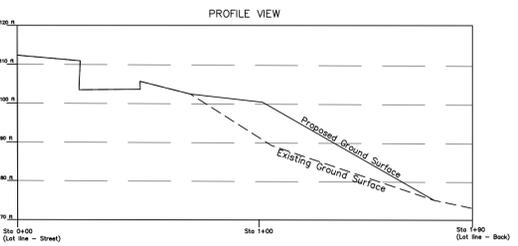
- All erosion and sediment control measures are to be placed prior to commencement of land disturbance activities.
- The contractor is responsible for installation of any additional erosion control measures necessary to prevent erosion and sedimentation.
- All disturbances to drain to approved sediment control measures at all times during land disturbing activities and during site development until final stabilization is achieved.
- The contractor shall inspect all erosion control measures weekly and after each rainfall event. Any necessary repairs or cleanup to maintain the effectiveness of the erosion control devices shall be made immediately.
- The contractor shall maintain a surplus supply of necessary erosion control devices on-site for emergency use (straw bales, wattles, filter berm, silt fence, stakes, crushed stone).

**POST CONSTRUCTION SEDIMENT AND EROSION CONTROL NOTES:**

- Sloped areas must be inspected after every major storm for the first 6 months after construction for signs of erosion, gulleying, and intactness of the plants and vegetation and riprap areas, if gulleying or localized, differential erosion is observed the engineer of the record must be connected. After the slopes, the inspection frequency can reduce to a monthly schedule.
- Maintenance of the vegetation, planting and the rip rap areas are the responsibility of the owner.



**NOTE:**  
 TOPSOIL SHALL BE LOAMY SAND OR FINE GRADATION WITH 10%-15% ORGANIC CONTENT OR MATERIAL APPROVED BY A QUALIFIED LANDSCAPE ARCHITECT. VEGETATION TYPE SHALL BE SPECIFIED BY A QUALIFIED LANDSCAPE ARCHITECT.



Method of Test T 99, Method C. If the material retained on the 1/2-in. sieve is 30% or more of the total sample, this test shall not apply and the material shall be compacted to the target density. The target density shall be established by determining the number of passes of a roller required to produce a constant and uniform density, after conducting a series of tests using either AASHTO T 310, In-Place Density and Moisture Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth), or AASHTO T 191, Density of Soil in-Place by the Sand-Cone Method. The Contractor shall, without additional compensation, employ whatever measures may be necessary to adjust the natural water content of the suitable embankment material to permit the placement and compaction as hereinbefore specified.

6. Each lift of compacted materials shall be visibly crowned to allow drainage of surface and rain waters off the surface of the embankment.

7. Embankment construction with materials other than rock shall not be placed from December 1 to April 1, except with written permission of and under such special conditions and restrictions as may be imposed by the Engineer. The work may be ordered suspended if the weather and climatic conditions are such that the embankment and excavation cannot be performed in accordance with the specifications. No additional compensation will be allowed to the Contractor for such suspension of work. If the work is ordered suspended due to weather or other climatic conditions not under the control of the Contractor, an extension of time may be granted to the Contractor by the Engineer.

7. The Contractor is responsible for all safety measures, equipment and mobilization, and means and methods for the proposed work.

8. Topsoil and the planting plan and/or recommendations must be obtained by a registered landscape architect or other landscape professional.

9. Engineer of the record shall not be liable for claims, liabilities or losses arising out of or connected with modification or misuse of the design and information on this plan and related reports and documents.

10. It is the contractors responsibility to obtain all documents regarding design and construction.

11. No changes in grade, construction of permanent or temporary structures, construction of drainage open r subsurface drainage systems and structures, or excavation shall be performed within a 100-ft of top of proposed embankment without consulting a registered professional engineer.



*G. Munden*  
 06/09/2020

**Revisions**

Rev. No.	Rev. Date	Description

**PROPOSED CONDITIONS SITE PLAN**

31 Harborview Dr  
 Hingham MA

June 9th 2020

Prepared For:

PAUL YINGLING & STACY MARCOTTE  
 31 Harborview Dr  
 HINGHAM MA

Prepared By:

**Munden Engineering**  
 83 Morse Street  
 Norwood MA 02062  
 781-302-6099  
 mundenengineering.com

**APPENDIX C**  
EXPLORATION LOGS

# SVIOKLA

Client: PAUL YINGLING  
 Project: 31 HARBORVIEW DR  
 Location: HINGHAM MA

Boring #: 1  
 Page 1 of 1

File# \_\_\_\_\_  
 Date Started: 3-21-20 Type: BW Casing: 5PT Core Barrel: \_\_\_\_\_ Surface Elevation: \_\_\_\_\_  
 Date Completed: 3-21-20 Size: 2.5 Sampler: 2.0" Station: \_\_\_\_\_  
 Driller: SVIOKLA Hammer: 300# 140# \_\_\_\_\_ Groundwater level readings: \_\_\_\_\_  
 Site Rep.: \_\_\_\_\_ Fall: 24" 30" \_\_\_\_\_ Date: \_\_\_\_\_ Depth: \_\_\_\_\_  
 Date: \_\_\_\_\_ Depth: \_\_\_\_\_

Depth (ft)	Cas bl/ft	Sample					Strata Change (ft)	Sample Description
		No.	Depth (ft)	Pen. (in)	Rec. (in)	Blows/6"		
			0-2	24	12	2-1-2.5		FILL RANDOM SAND + GRAVEL
							2'	
			2-4	24	18	9-30-40 36		3' MOIST SUBSOIL, SOME GRAVEL + ROOTS
							4.3	SANDY SILTY TILL w MOTTLING TO 4.3' ±
5			4-6	24	14	27-40- 41-45		V. DENSE GLACIAL TILL, SAND AND GRAVEL, SOME SILT. (CEMENTED)
			6-7.3	15	14	47-70- 30/3"		
10								EDB @ 7.3' REFUSAL NO WATER 0 HRS.
								B-1 PERFORMED AT TOE OF SLOPE
15								

Proportions Used	Cohesive Consistency (Blows/Ft)	Cohesionless Density Blows/Ft)	Sample Type
Trace 0 to 10%	0-2 Very soft	9-15 Stiff	UP = Fixed Piston
Little 10% to 20%	3-4 Soft	16-30 V-stiff	UT = Shelby Tube
Some 20% to 35%	5-8 M-stiff	31+ Hard	OE = Open End Rod
And 35% to 50%			* = 300# hammer
		0-10 Loose	
		10-30 M-Dense	
		30-50 Dense	
		50+ V-Dense	

Notes: 1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.  
 2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

Remarks:

# SVIOKLA

Client: PAUL YINGLING  
 Project: 31 HARBOR VIEW DR.  
 Location: HINGHAM, MA

Boring #: 2  
 Page 1 of 1

File# \_\_\_\_\_  
 Date Started: 3-21-20  
 Date Completed: 3-21-20  
 Driller: SVIOKLA  
 Site Rep.: \_\_\_\_\_

Casing: BW Sampler: SPT Core Barrel: \_\_\_\_\_  
 Type: \_\_\_\_\_ Size: 2.5 2.0  
 Hammer: 300# 140#  
 Fall: 24" 30"

Surface Elevation: \_\_\_\_\_  
 Station: \_\_\_\_\_  
 Groundwater level readings:  
 Date \_\_\_\_\_ Depth \_\_\_\_\_  
 Date \_\_\_\_\_ Depth \_\_\_\_\_

Depth (ft)	Cas bl/ft	Sample				Strata Change (ft)	Sample Description
		No.	Depth (ft)	Pen. (in)	Rec. (in)		
			0-2	24	10	5-4-5-6	TOPOSOIL MIXED WITH REMOLDED TILL - <u>FILL</u>
			2-4	24	9	2-1-3-4	FINE SAND, TR GRAVEL TRACE ROOTS - <u>FILL</u>
5			4-6	24	8	13-10-8	SILTY SAND, SOME GRAVEL TR. COBBLES <u>FILL</u>
						7	
			6-8	24	15	6-8-10	
			8-10	24	13	5-5-6-36	FINE SAND, SOME SILT, TRACE GRAVEL <u>FILL</u>
10						9±	FILL TO 9'
			10-12	24	18	39-47-51	GLACIAL TILL - FINE SAND + GRAVEL, SOME SILT, SOME GRAVEL (CEMENTED)
15							EDB @ 12' REFUSAL
							NO WATER - OHRS.
							B-2 PERFORMED AT TOP OF SLOPE

Proportions Used	Cohesive Consistency (Blows/Ft)	Cohesionless Density Blows/Ft)	Sample Type
Trace 0 to 10%	0-2 Very soft	9-15 Stiff	0-10 Loose
Little 10% to 20%	3-4 Soft	16-30 V-stiff	10-30 M-Dense
Some 20% to 35%	5-8 M-stiff	31+ Hard	30-50 Dense
And 35% to 50%			50+ V-Dense
			UP = Fixed Piston
			UT = Shelby Tube
			OE = Open End Rod
			* = 300# hammer

Notes: 1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.  
 2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

Remarks:

SVIOKLA

Client: PAUL YINGLING  
 Project: 31 HARBORVIEW DR  
 Location: HINGHAM, MA

Boring #: B-3  
 Page 1 of 1

File# \_\_\_\_\_  
 Date Started: 3-21-20  
 Date Completed: 3-21-20  
 Driller: SVIOKLA  
 Site Rep.: \_\_\_\_\_

Type \_\_\_\_\_  
 Size \_\_\_\_\_  
 Hammer \_\_\_\_\_  
 Fall \_\_\_\_\_

Casing: BW  
 Sampler: SPT  
 Core Barrel: \_\_\_\_\_  
 Surface Elevation: \_\_\_\_\_  
 Station: \_\_\_\_\_  
 Groundwater level readings:  
 Date \_\_\_\_\_ Depth \_\_\_\_\_  
 Date \_\_\_\_\_ Depth \_\_\_\_\_

Depth (ft)	Cas bl/ft	Sample				Blows/6"	Strata Change (ft)	Sample Description
		No.	Depth (ft)	Pen. (in)	Rec. (in)			
			0-2		8	3-5-7-8		4" TO SOIL OVER SAND + GRAVEL FILL
			2-4	24	13	5-3-4-4		SILTY FINE SAND, TRACE F. GRAVEL AND ROOTS - FILL
5			4-6	24	13	3-3-10-6		AS ABOVE SOME GRAVEL
			6-8	24	16	7-6-10-27	6.5 ±	FILL
							7.5 ±	NATIVE SANDY SILT W ROOT FIBER AND GRAVEL
			8-10	24	15	30-29-30-32		GLACIAL TILL - FINE SAND AND GRAVEL SOME SILT. (CEMENTED)
10			10-10.8	9	8	30-120/3"		EBC @ 10.8'
								REFUSAL NO WATER OHS.
15								B-3 PERFORMED AT LEFT REAR CORNER OF HOUSE

Proportions Used	Cohesive Consistency (Blows/Ft)	Cohesionless Density Blows/Ft)	Sample Type
Trace 0 to 10%	0-2 Very soft	0-10 Loose	UP = Fixed Piston
Little 10% to 20%	3-4 Soft	10-30 M-Dense	UT = Shelby Tube
Some 20% to 35%	5-8 M-stiff	30-50 Dense	OE = Open End Rod
And 35% to 50%	9-15 Stiff	50+ V-Dense	* = 300# hammer
	16-30 V-stiff		
	31+ Hard		

Notes: 1. The stratification lines represent the approximate boundary between soil types. The transition may be gradual.  
 2. Water level readings were made in the drill hole during or at the completion of drilling. The water level may fluctuate over time.

Remarks:

**APPENDIX D**  
CALCULATIONS

## SUBSURFACE EXPLORATION SUMMARY AND DETERMINATION OF GEOTECHNICAL PROPERTIES

**Objective:** To determine geotechnical properties required to perform geotechnical engineering analyses.

**References:** 1. Principles of Foundation Engineering, Das, 8th Edition

**Subsurface**

**Explorations:** Test Boring B-1, B-2 and B-3 performed on March 21st 2020 by Sviokla Drilling and boring logs provided by the Client.

**Assumptions:** Following unit weight values were used in analysis. These values were based on typical values for the described strata in the table below:

Strata	Unit Weight (pcf)
Fill	120
Sand	125
Till	130

**Calculations:** Split spoon blow numbers (SPTs) are converted to N1(60) values using the equations below:

These equations and correlations are as presented in Principles of Foundation Engineering 8th Edition by B. M. Das where

$$N_{60} = \frac{N \eta_H \eta_B \eta_S \eta_R}{60}$$

- $N_{60}$  = standard penetration number, corrected for field conditions
- $N$  = measured penetration number
- $\eta_H$  = hammer efficiency (%)
- $\eta_B$  = correction for borehole diameter
- $\eta_S$  = sampler correction
- $\eta_R$  = correction for rod length

1. Variation of $\eta_H$			
Country	Hammer type	Hammer release	$\eta_H$ (%)
Japan	Donut	Free fall	78
	Donut	Rope and pulley	67
United States	Safety	Rope and pulley	60
	Donut	Rope and pulley	45
Argentina	Donut	Rope and pulley	45
China	Donut	Free fall	60
	Donut	Rope and pulley	50

3. Variation of $\eta_S$	
Variable	$\eta_S$
Standard sampler	1.0
With liner for dense sand and clay	0.8
With liner for loose sand	0.9

2. Variation of $\eta_B$	
Diameter mm	$\eta_B$
60-120	1
150	1.05
200	1.15

2.5-inch (63.5 mm) diameter

4. Variation of $\eta_R$	
Rod length m	$\eta_R$
>10	1.0
6-10	0.95
4-6	0.85
0-4	0.75

Varies by sample depth

$$(N_1)_{60} = C_N \times N_{60}$$

where

- $(N_1)_{60}$  = value of  $N_{60}$  corrected to a standard value of  $\sigma'_v = p_a$  ( $\approx 100 \text{ kN/m}^2$ )
- $C_N$  = correction factor
- $N_{60}$  = value of  $N$  obtained from field exploration [Eq. (3.6)]

Seed et al.'s relationship (1975):

$$C_N = 1 - 1.25 \log \left( \frac{\sigma'_v}{p_a} \right)$$

where

- $\sigma'_v$  = overburden soil pressure (unit weight x layer height)
- $p_a$  = atmospheric pressure ( $\approx 2100 \text{ psf}$ )

Boring	Sample ID	Strata	Depth (ft)	N	nh	nr	N60	Unit Weight (pcf)	$\sigma'$	Cn	N1(60)	$\phi^2$
B-1	S-1	FILL	1	3	45	0.75	1.69	120	120	2.6	4.3	28.4
	S-2		3	70	45	0.75	39.4	120	360	2.0	77.1	47.0
	S-3	TILL	5	81	45	0.85	51.6	130	576.3	1.7	87.9	49.3
	S-4		7	100	45	0.95	71.3	130	667.8	1.6	115.6	54.6
B-2	S-1	FILL	1	9	45	0.75	5.06	120	120	2.6	12.9	30.9
	S-2		3	4	45	0.75	2.25	120	360	2.0	4.4	28.4
	S-3		5	18	45	0.85	11.5	120	600	1.7	19.3	32.7
	S-4		7	18	45	0.95	12.8	120	840	1.5	19.2	32.7
	S-5		9	13	45	0.95	9.26	120	1080	1.4	12.6	30.8
	S-6	TILL	11	98	45	1.00	73.5	130	1430	1.2	88.8	49.5
B-3	S-1	FILL	1	12	45	0.75	6.75	120	120	2.6	17.2	32.1
	S-2		3	7	45	0.75	3.94	120	360	2.0	7.7	29.4
	S-3		5	13	45	0.85	8.29	120	600	1.7	13.9	31.2
	S-4	SAND	7	16	45	0.95	11.4	125	875	1.5	16.8	32.0
	S-5	TILL	9	59	45	0.95	42	130	1170	1.3	55.4	42.1
	S-6		11	100	45	1.00	75	130	1430	1.2	90.6	49.9

Notes:

- Variation value for sampler (ns) and variation for boring diameter (nb) is omitted from the table due to their constant value of 1.
- Friction Angle ( $\phi$ ) value is based on the correlation developed by Peck et. al. (1979) and approximated as an equation by Wolff (1989).

$$\phi'(\text{deg}) = 27.1 + 0.3(N_1)_{60} - 0.00054[(N_1)_{60}]^2$$

- Unit weight of water when used for calculating overburden stress is considered as 62.4 pcf.

**Conclusion:** Geotechnical properties of the soils encountered during subsurface exploration are defined as follows:

Strata	Unit Weight (pcf)	Friction Angle (Deg)	Elastic Modulus, E (10 <sup>6</sup> psf)	Poisson's ratio
Fill	120	30	3	0.25
Sand	125	32	4	0.15
Till	130	36	4.5	0.3

- Modulus of Elasticity and Poisson's ratio chosen from ranging values presented in Publication No. FHWA NHI-05-037 dated May 2006 and published by U.S. Department of Transportation Federal Highway Administration

**APPENDIX E**  
GEOSTUDIO OUTPUT

# Embankment Slope

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## File Information

File Version: 10.02  
Created By: Gamze Munden  
Last Edited By: Gamze Munden  
Revision Number: 175  
Date: 06/04/2020  
Time: 12:34:54 AM  
Tool Version: 10.2.1.19666  
File Name: Yingling Residence.gsz  
Directory: C:\Users\gigim\Desktop\Projects\31 HarborView Drive Hingham\Slope stability\SLOPE-W\  
Last Solved Date: 06/04/2020  
Last Solved Time: 12:34:56 AM

## Project Settings

Unit System: U.S. Customary Units

## Analysis Settings

### Embankment Slope

Kind: SLOPE/W  
Parent: SLOPE/W Analysis  
Method: Morgenstern-Price  
Settings  
Side Function  
Interslice force function option: Half-Sine  
PWP Conditions from: Piezometric Line  
Apply Phreatic Correction: No  
Use Staged Rapid Drawdown: No  
Unit Weight of Water: 62.430189 pcf  
Slip Surface  
Direction of movement: Left to Right  
Use Passive Mode: No  
Slip Surface Option: Entry and Exit  
Critical slip surfaces saved: 1  
Optimize Critical Slip Surface Location: No  
Tension Crack Option: (none)  
Distribution  
F of S Calculation Option: Constant  
Advanced  
Geometry Settings  
Minimum Slip Surface Depth: 0.1 ft  
Number of Slices: 30  
Factor of Safety Convergence Settings  
Maximum Number of Iterations: 100  
Tolerable difference in F of S: 0.001  
Solution Settings  
Search Method: Root Finder  
Tolerable difference between starting and converged F of S: 3  
Maximum iterations to calculate converged lambda: 20  
Max Absolute Lambda: 2

## Materials

### Existing Fill

Model: Mohr-Coulomb  
Unit Weight: 120 pcf  
Cohesion: 0 psf  
Phi': 30 °  
Phi-B: 0 °  
Pore Water Pressure  
Piezometric Line: 1

### Sand

Model: Mohr-Coulomb  
Unit Weight: 125 pcf  
Cohesion: 0 psf  
Phi': 32 °  
Phi-B: 0 °  
Pore Water Pressure  
Piezometric Line: 1

### Till

Model: Mohr-Coulomb  
Unit Weight: 130 pcf  
Cohesion: 0 psf  
Phi': 36 °  
Phi-B: 0 °  
Pore Water Pressure  
Piezometric Line: 1

### Embankment Fill

Model: Mohr-Coulomb  
Unit Weight: 125 pcf  
Cohesion: 0 psf  
Phi': 34 °  
Phi-B: 0 °  
Pore Water Pressure  
Piezometric Line: 1

## Slip Surface Entry and Exit

Left Type: Range  
Left-Zone Left Coordinate: (89.11107, 100.85926) ft  
Left-Zone Right Coordinate: (102, 100) ft  
Left-Zone Increment: 8  
Right Type: Point  
Right Coordinate: (174.87527, 75.04272) ft

Right-Zone Increment: 8  
 Radius Increments: 4

### Slip Surface Limits

Left Coordinate: (0, 112) ft  
 Right Coordinate: (190, 73) ft

### Piezometric Lines

#### Piezometric Line 1

##### Coordinates

	X	Y
Coordinate 1	0 ft	72 ft
Coordinate 2	190 ft	71 ft

### Surcharge Loads

#### Surcharge Load 1

Surcharge (Unit Weight): 200 pcf  
 Direction: Vertical

##### Coordinates

	X	Y
	26 ft	103 ft
	26 ft	113 ft
	51 ft	113 ft
	51 ft	103 ft

### Geometry

Name: 2D Geometry

#### Settings

View: 2D  
 Element Thickness: 1 ft

#### Points

	X	Y
Point 1	0 ft	112 ft
Point 2	72 ft	102 ft
Point 3	106 ft	89 ft
Point 4	175 ft	75 ft
Point 5	190 ft	60 ft
Point 6	0 ft	60 ft
Point 7	0 ft	105 ft
Point 8	72 ft	95 ft
Point 9	106 ft	86 ft
Point 10	175 ft	73 ft
Point 11	190 ft	73 ft
Point 12	0 ft	103 ft
Point 13	72 ft	93 ft
Point 14	106 ft	85 ft
Point 15	26 ft	103 ft
Point 16	51 ft	103 ft
Point 17	51 ft	104.91667 ft
Point 18	26 ft	110.38889 ft
Point 19	182.5 ft	74 ft
Point 20	102 ft	100 ft
Point 21	186 ft	73.533333 ft

#### Regions

	Material	Points	Area
Region 1	Till	6,5,11,10,14,13,12	5,228 ft <sup>2</sup>
Region 2	Existing Fill	7,8,9,10,11,21,19,4,3,2,17,16,15,18,1	796.18 ft <sup>2</sup>
Region 3	Sand	7,12,13,14,10,9,8	229.5 ft <sup>2</sup>
Region 4		15,16,17,18	116.32 ft <sup>2</sup>
Region 5	Embankment Fill	2,3,4,20	512.5 ft <sup>2</sup>

### Slip Results

Slip Surfaces Analysed: 45 of 45 converged

### Current Slip Surface

Slip Surface: 41  
 Factor of Safety: 1.974  
 Volume: 70.60447 ft<sup>3</sup>  
 Weight: 8,825.5588 lbf  
 Resisting Moment: 3,041,810.4 lbf-ft  
 Activating Moment: 1,540,862.7 lbf-ft  
 Resisting Force: 5,330.5771 lbf  
 Activating Force: 2,700.3518 lbf  
 Slip Rank: 1 of 45 slip surfaces  
 Exit: (174.87527, 75.042716) ft  
 Entry: (102, 100) ft  
 Radius: 539.70068 ft  
 Center: (312.85103, 596.80848) ft

#### Slip Slices

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength	Suction Strength	Base Material
Slice 1	103.21459 ft	99.488012 ft	-1,749.996 psf	10.462224 psf	7.056859 psf	0 psf	0 psf	Embankment Fill
Slice 2	105.64376 ft	98.471003 ft	-1,687.3021 psf	30.573806 psf	20.622292 psf	0 psf	0 psf	Embankment Fill
Slice 3	108.07294 ft	97.467882 ft	-1,625.4753 psf	49.116574 psf	33.129547 psf	0 psf	0 psf	Embankment Fill
Slice 4	110.50211 ft	96.478566 ft	-1,564.5103 psf	66.144622 psf	44.615111 psf	0 psf	0 psf	Embankment Fill
Slice 5	112.93129 ft	95.502974 ft	-1,504.402 psf	81.707394 psf	55.112333 psf	0 psf	0 psf	Embankment Fill
Slice 6	115.36047 ft	94.541025 ft	-1,445.1456 psf	95.848078 psf	64.650345 psf	0 psf	0 psf	Embankment Fill
Slice 7	117.78964 ft	93.592641 ft	-1,386.736 psf	108.60239 psf	73.253235 psf	0 psf	0 psf	Embankment Fill
Slice 8	120.21882 ft	92.657746 ft	-1,329.1685 psf	119.9977 psf	80.939472 psf	0 psf	0 psf	Embankment Fill

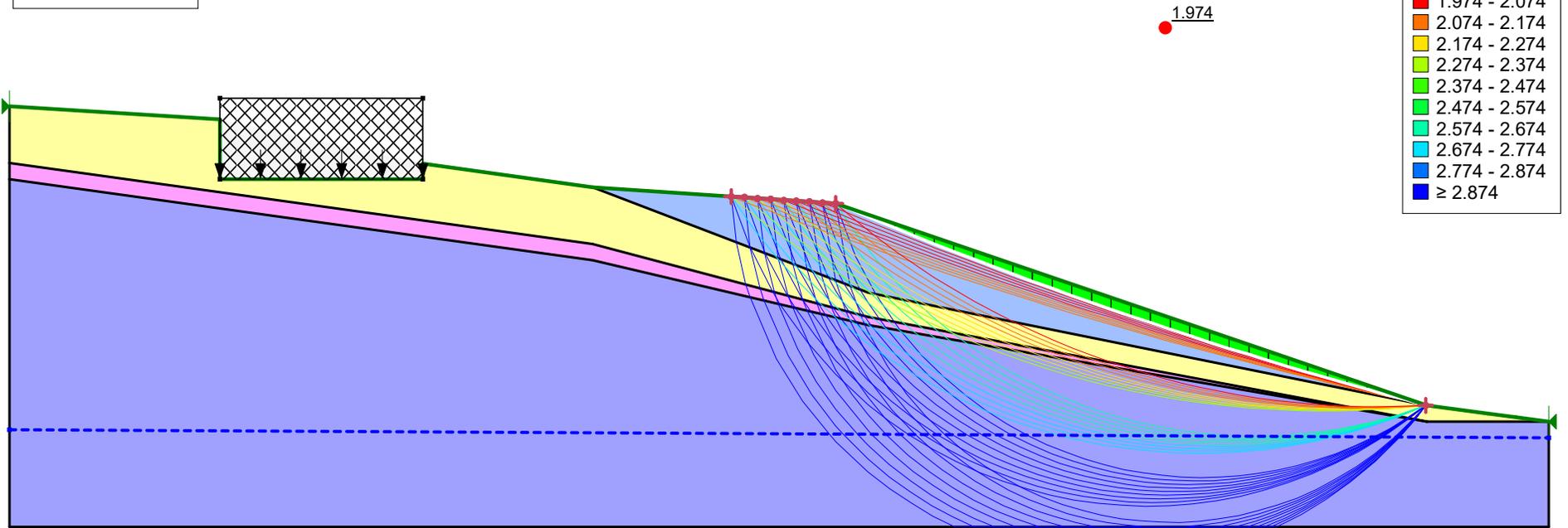
Slice 9	122.64799 ft	91.736264 ft	-1,272.4384 psf	130.05257 psf	87.721569 psf	0 psf	0 psf	Embankment Fill
Slice 10	125.07717 ft	90.828123 ft	-1,216.5411 psf	138.77658 psf	93.605984 psf	0 psf	0 psf	Embankment Fill
Slice 11	127.50634 ft	89.933251 ft	-1,161.4723 psf	146.17052 psf	98.593257 psf	0 psf	0 psf	Embankment Fill
Slice 12	129.93552 ft	89.051577 ft	-1,107.2274 psf	152.22693 psf	102.67836 psf	0 psf	0 psf	Embankment Fill
Slice 13	132.3647 ft	88.183034 ft	-1,053.8022 psf	156.93098 psf	105.85128 psf	0 psf	0 psf	Embankment Fill
Slice 14	134.79387 ft	87.327553 ft	-1,001.1926 psf	160.26154 psf	108.09777 psf	0 psf	0 psf	Embankment Fill
Slice 15	137.22305 ft	86.485069 ft	-949.3943 psf	162.19264 psf	109.40032 psf	0 psf	0 psf	Embankment Fill
Slice 16	139.65222 ft	85.655517 ft	-898.40344 psf	162.6951 psf	109.73923 psf	0 psf	0 psf	Embankment Fill
Slice 17	142.0814 ft	84.838836 ft	-848.21606 psf	161.73834 psf	109.09389 psf	0 psf	0 psf	Embankment Fill
Slice 18	144.51057 ft	84.034963 ft	-798.82831 psf	159.29227 psf	107.44399 psf	0 psf	0 psf	Embankment Fill
Slice 19	146.93975 ft	83.243839 ft	-750.23644 psf	155.32929 psf	104.77093 psf	0 psf	0 psf	Embankment Fill
Slice 20	149.36892 ft	82.465404 ft	-702.43678 psf	149.82614 psf	101.05901 psf	0 psf	0 psf	Embankment Fill
Slice 21	151.7981 ft	81.699601 ft	-655.42573 psf	142.76571 psf	96.296684 psf	0 psf	0 psf	Embankment Fill
Slice 22	154.22728 ft	80.946374 ft	-609.19978 psf	134.13843 psf	90.477516 psf	0 psf	0 psf	Embankment Fill
Slice 23	156.65645 ft	80.205667 ft	-563.7555 psf	123.94353 psf	83.600968 psf	0 psf	0 psf	Embankment Fill
Slice 24	159.08563 ft	79.477427 ft	-519.08953 psf	112.18966 psf	75.672881 psf	0 psf	0 psf	Embankment Fill
Slice 25	161.5148 ft	78.761602 ft	-475.19859 psf	98.895126 psf	66.705605 psf	0 psf	0 psf	Embankment Fill
Slice 26	163.94398 ft	78.058139 ft	-432.07947 psf	84.087554 psf	56.717771 psf	0 psf	0 psf	Embankment Fill
Slice 27	166.37315 ft	77.366989 ft	-389.72904 psf	67.80297 psf	45.733681 psf	0 psf	0 psf	Embankment Fill
Slice 28	168.80233 ft	76.688103 ft	-348.14422 psf	50.084354 psf	33.782324 psf	0 psf	0 psf	Embankment Fill
Slice 29	171.23151 ft	76.021432 ft	-307.32203 psf	30.979694 psf	20.896068 psf	0 psf	0 psf	Embankment Fill
Slice 30	173.66068 ft	75.366931 ft	-267.25953 psf	10.539634 psf	7.1090727 psf	0 psf	0 psf	Embankment Fill

**Materials**

- Embankment Fill
- Existing Fill
- Sand
- Till

**Factor of Safety**

- 1.974 - 2.074
- 2.074 - 2.174
- 2.174 - 2.274
- 2.274 - 2.374
- 2.374 - 2.474
- 2.474 - 2.574
- 2.574 - 2.674
- 2.674 - 2.774
- 2.774 - 2.874
- $\geq 2.874$

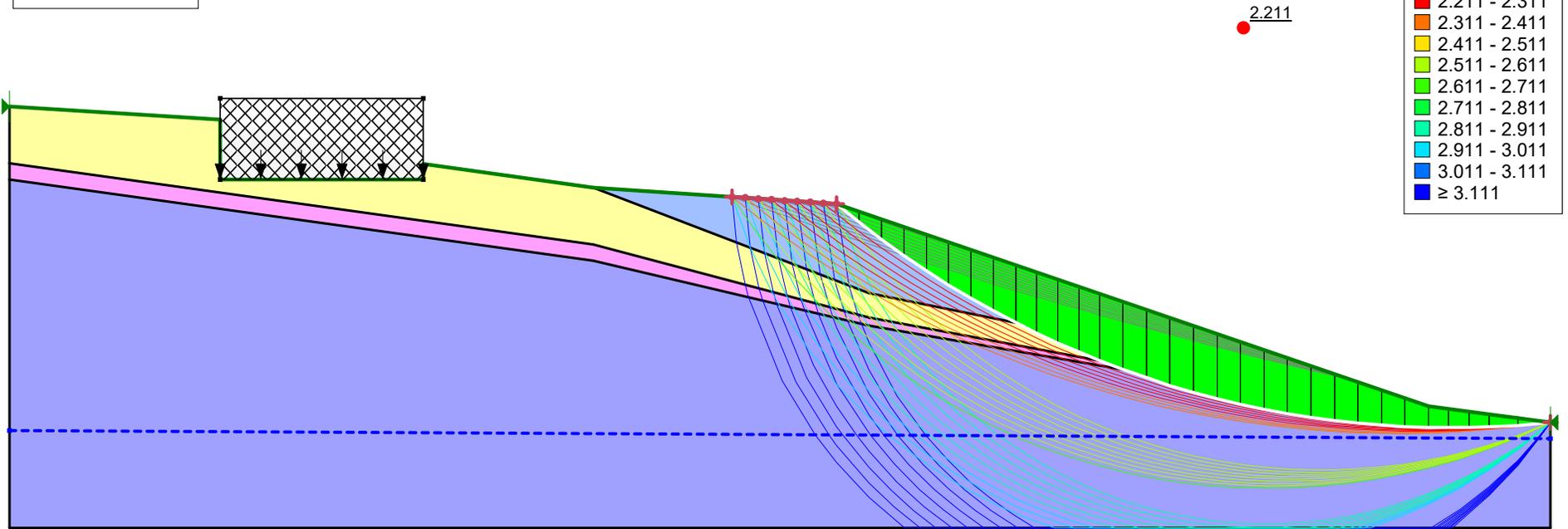


**Materials**

Embankment Fill
Existing Fill
Sand
Till

**Factor of Safety**

2.211 - 2.311
2.311 - 2.411
2.411 - 2.511
2.511 - 2.611
2.611 - 2.711
2.711 - 2.811
2.811 - 2.911
2.911 - 3.011
3.011 - 3.111
≥ 3.111



# Load/Deformation

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## File Information

File Version: 10.02  
Created By: Gamze Munden  
Last Edited By: Gamze Munden  
Revision Number: 150  
Date: 06/03/2020  
Time: 09:57:46 AM  
Tool Version: 10.2.1.19666  
File Name: Yingling Residence - Sigma.gsz  
Directory: C:\Users\gigim\Desktop\Projects\31 HarborView Drive Hingham\Slope stability\SLOPE-W\  
Last Solved Date: 06/03/2020  
Last Solved Time: 10:19:07 PM

## Project Settings

Unit System: U.S. Customary Units

## Analysis Settings

### Load/Deformation

Kind: SIGMA/W  
Parent: Insitu  
Method: Load/Deformation  
Settings  
Exclude cumulative values: No  
Initial stress: Parent Analysis  
Initial PWP: Parent Analysis  
Unit Weight of Water: 62.430189 pcf  
Convergence  
Maximum Number of Iterations: 50  
Maximum Difference: 0.001  
Significant Digits: 3  
Time  
Starting Time: 0 d  
Duration: 360 d  
# of Steps: 1  
Time Increment: 360 d  
Save Steps Every: 1  
Advanced  
Apply Body Force in All Steps: No  
Adjust Fill: No

## Materials

### Existing Fill

Stress  
Model: Linear Elastic (Total)  
Young's Modulus (E): 3,000,000 psf  
Unit Weight: 120 pcf  
Poisson's Ratio: 0.25

### Sand

Stress  
Model: Linear Elastic (Total)  
Young's Modulus (E): 4,000,000 psf  
Unit Weight: 125 pcf  
Poisson's Ratio: 0.15

### Till

Stress  
Model: Linear Elastic (Total)  
Young's Modulus (E): 4,500,000 psf  
Unit Weight: 130 pcf  
Poisson's Ratio: 0.3

### Embankment Fill

Stress  
Model: Linear Elastic (Total)  
Young's Modulus (E): 4,000,000 psf  
Unit Weight: 125 pcf  
Poisson's Ratio: 0.2

## Boundary Conditions

### Fixed X

Category: Stress/Strain  
X-Type: X-Displacement 0 ft

### Fixed Y

Category: Stress/Strain  
Y-Type: Y-Displacement 0 ft

### Proposed Foundation

Category: Stress/Strain  
X-Type: X-Stress 0 psf  
Y-Type: Y-Stress -2,000 psf

## Geometry

Name: 2D Geometry

### Settings

View: 2D  
Element Thickness: 1 ft

### Points

	X	Y

Point 1	0 ft	112 ft
Point 2	72 ft	102 ft
Point 3	106 ft	89 ft
Point 4	175 ft	75 ft
Point 5	190 ft	60 ft
Point 6	0 ft	60 ft
Point 7	102 ft	100.08824 ft
Point 8	0 ft	105 ft
Point 9	72 ft	95 ft
Point 10	106 ft	86 ft
Point 11	175 ft	73 ft
Point 12	190 ft	73 ft
Point 13	0 ft	103 ft
Point 14	72 ft	93 ft
Point 15	106 ft	85 ft
Point 16	26 ft	103 ft
Point 17	51 ft	103 ft
Point 18	51 ft	104.91667 ft
Point 19	26 ft	110.38889 ft

**Lines**

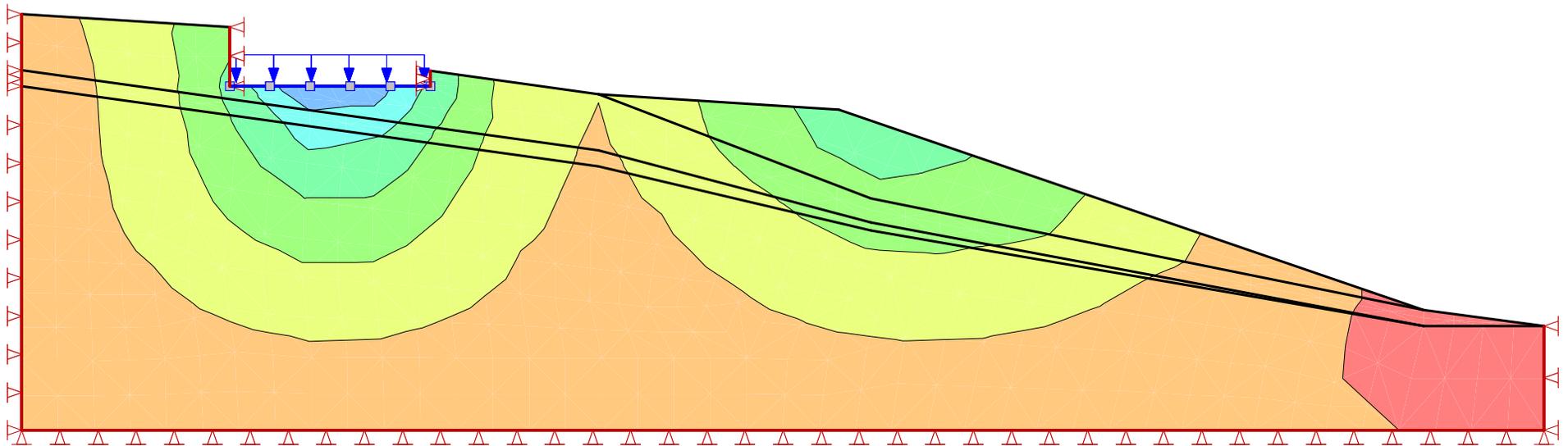
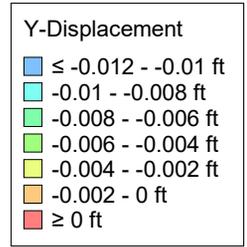
	Start Point	End Point	Length	Angle	Stress/Strain Boundary
Line 1	3	4	70.406 ft	-11.5 °	
Line 2	5	6	190 ft	0 °	Fixed Y
Line 3	2	3	36.401 ft	-20.9 °	
Line 4	2	7	30.061 ft	-3.65 °	
Line 5	8	1	7 ft	90 °	Fixed X
Line 6	4	12	15.133 ft	-7.59 °	
Line 7	12	5	13 ft	90 °	Fixed X
Line 8	8	9	72.691 ft	-7.91 °	
Line 9	9	10	35.171 ft	-14.8 °	
Line 10	10	11	70.214 ft	-10.7 °	
Line 11	11	12	15 ft	0 °	
Line 12	6	13	43 ft	90 °	Fixed X
Line 13	13	8	2 ft	90 °	Fixed X
Line 14	13	14	72.691 ft	-7.91 °	
Line 15	14	15	34.928 ft	-13.2 °	
Line 16	15	11	70.036 ft	-9.87 °	
Line 17	18	2	21.202 ft	-7.91 °	
Line 18	1	19	26.05 ft	-3.55 °	
Line 19	19	18	25.592 ft	-12.3 °	
Line 20	16	17	25 ft	0 °	Proposed Foundation
Line 21	17	18	1.9167 ft	90 °	Fixed X
Line 22	19	16	7.3889 ft	90 °	Fixed X
Line 23	7	4	77.191 ft	-19 °	

**Regions**

	Material	Points	Area
Region 1	Till	6,5,12,11,15,14,13	5,228 ft <sup>2</sup>
Region 2	Embankment Fill	2,7,4,3	517.04 ft <sup>2</sup>
Region 3	Existing Fill	8,9,10,11,12,4,3,2,18,17,16,19,1	796.18 ft <sup>2</sup>
Region 4	Sand	8,13,14,15,11,10,9	229.5 ft <sup>2</sup>
Region 5		16,17,18,19	116.32 ft <sup>2</sup>

**Mesh Properties**

Global Element Size: 9 ft



## **APPENDIX F**

SPECS

## SECTION 02300

### EARTHWORK

#### PART 1 - GENERAL

##### 1.01 WORK INCLUDED

- A. Under this Section, the Contractor shall furnish all labor, materials, equipment and transportation required to complete Earthwork as indicated on the drawings, as designated by the Owner's Representative, or as specified herein, to complete all proposed work.
- B. The Contractor or Sub-contractor must have a minimum of five (5) years of experience working on a similar size of this project.
- C. Without limiting the generality thereof, Earthwork shall include excavating, furnishing borrow materials as necessary, and backfilling for the construction of all proposed work from existing grades to finished grades. Work shall include the removal of unclassified material, such as bituminous pavements, curbs, ledge and boulders under one (1) cubic yard in size, concrete, reinforced and plain, structures, and metal or wood posts; and unsuitable materials of every nature throughout the site within twelve (12) inches below finished subgrade elevations for proposed work or as indicated or required for new construction; transportation of the excavated materials; backfilling to proposed base course subgrades with approved excavated and/or furnished materials; and the legal disposal of unsuitable, and/or surplus excavated materials.
- D. Work under this Section shall include the furnishing of all borrow materials required to complete the proposed work as designed. Where "processed gravel", "gravel borrow", or "gravel" is indicated in the specifications or on the drawings, only gravel conforming to this section of the specifications may be utilized.
- E. The Contractor shall make excavations of normal depth in earth for trenches and structures, shall backfill and compact such excavations to the extent necessary, shall furnish the necessary material and construct embankments and fills, and shall make miscellaneous earth excavations and do miscellaneous grading.

##### 1.02 RELATED WORK

- A. Special Conditions, PERMITS
- B. Section 01570, ENVIRONMENTAL PROTECTION

### 1.03 REFERENCES

AASHTO - American Association of State Highway and Transportation Officials (tests or specifications). AASHTO or AASHO

AWWA - American Waterworks Association

American Society for Testing and Materials (ASTM)

ASTM	C 131	Test Method for Resistance to Degradation of Small Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine.
ASTM	C136	Method for Sieve Analysis of Fine and Coarse Aggregates.
ASTM	C330	Specification for Lightweight Aggregate for Structural Concrete.
ASTM	D1 556	Test Method for Density of Soil in Place by the Sand Cone Method.
ASTM	D1557	Test Methods for Moisture-density Relations of Soils and Soil Aggregate Mixtures Using Ten-pound (10 Lb.) Hammer and Eighteen-inch (18") Drop.
ASTM	D2922	Test Methods for Density of Soil and Soil-aggregate in Place by Nuclear Methods (Shallow Depth).

Commonwealth of Massachusetts Highway Department Standard Specification for Highways and Bridges.

Code of Massachusetts Regulations (CMR) 310.40.0032 Contaminated Media and Contaminated Debris

Code of Massachusetts Regulations (CMR) 520 CMR 1400 Excavation & Trench Safety Regulations.

### 1.04 SUBMITTALS: IN ACCORDANCE WITH REQUIREMENTS OF GENERAL SPECIFICATIONS, SUBMIT THE FOLLOWING

Samples of all materials proposed for the project shall be submitted to the Owner's Representative for review. Size of the samples shall be as approved by the Owner's Representative.

### 1.05 PROTECTION OF EXISTING PROPERTY

- A. The work shall be executed in such manner as to prevent any damage to facilities at the site and adjacent property and existing improvements, such as but not limited to parking areas, curbs, paving, service utility lines, structures, monuments, bench marks, observation wells, and other public or private property. Protect existing improvements from damage caused by settlement, lateral movements, undermining, washout and other hazards created by earthwork operations.

- B. In case of any damage or injury caused in the performance of the work, the Contractor shall, at its own expense, make good such damage or injury to the satisfaction of, and without cost to, the Owner. Existing roads, sidewalks, and curbs damaged during the project work shall be repaired or replaced to at least the condition that existed at the start of operations. The Contractor shall replace, at his own cost, existing benchmarks, observation wells, monuments, and other reference points, which are disturbed or destroyed.
- C. Buried drainage structures and pipes, observation wells and piezometers, including those which project less than eighteen inches (18") above grade, which are subject to damage from construction equipment shall be clearly marked to indicate the hazard. Markers shall indicate limits of danger areas, by means which will be clearly visible to operators of trucks and other construction equipment, and shall be maintained at all times until completion of project.

#### 1.06 DRAINAGE

- A. The Contractor shall provide, at its own expense, adequate drainage facilities to complete all work items in an acceptable manner. Drainage shall be done in a manner so that runoff will not adversely affect construction procedures or cause excessive disturbance of underlying natural ground or abutting properties. All work shall be done in the dry.

#### 1.07 FROST PROTECTION AND SNOW REMOVAL

- A. The Contractor shall, at its own expense, keep earthwork operations clear and free of accumulations of snow as required to carry out the work.
- B. The Contractor shall protect the subgrade beneath new structures and pipes from frost penetration when freezing temperatures are expected.

#### 1.08 SPECIAL REQUIREMENTS

- A. The sequence of all excavation operations shall be such as to insure the most efficient re-use of suitable excavated materials and the use of a minimum amount of specified borrow.
- B. The Contractor shall inform and satisfy himself as to the character, quantity, and distribution of all material to be excavated. No payment will be made for the placement of any excavated material which is used for purposes other than those designated and as specified herein. Further, these shall be removed at no cost to the Owner if so approved by the Owner's Representative.
- C. The Owner's Representative shall have final determination over the excavation, moving, placing and disposition of all materials, and shall determine the suitability of materials to be placed in excavated areas.

- D. All backfill to subgrade, shall be compacted to not less than ninety-five percent (95%) of the maximum dry density of the material as determined by the Standard AASHTO Test Designation T-180-86, Modified Proctor Test.
- E. Unsuitable and/or excess excavated materials shall be removed and properly disposed of in legal disposal areas off the site at no additional cost to the Owner.
- F. Exploratory excavation to locate existing utilities or obstructions, shall be at the Contractor's discretion to assist him in the work of this project and no extra payment shall be made for such verification. Although extra payment is not considered, lack of such payment does not constitute a waiver of the Contractor's responsibility to verify all utilities. The contractor must ensure verification of existing services and ensure the safety of the Contractor's work forces.

PART 2 – PRODUCTS:

201 BORROW MATERIALS

- A. Excavated topsoil and furnished topsoil to cannot be utilized for sodding, seeding and landscaping.
- B. Gravel Borrow shall be as specified under paragraph 2.03 of these Specifications and shall be utilized whenever gravel is noted, including beneath pavements and structural elements unless otherwise noted.
- C. Although suitable excavated backfill materials may be reused to fill to subgrade as specified herein, if there are insufficient quantities of materials available the Contractor shall furnish Suitable Backfill as specified in paragraph 2.02A below.
- D. Where Sand Borrow is required, materials shall conform to Section M1.04.1 of the Massachusetts Standard Specifications. Utilize Sand Borrow as necessary for regarding subgrade.

202 SUITABLE ON SITE BACKFILL

- A. All other materials to be placed where Specifications or Drawings call for "fill," "backfilling," or "filling" to subgrade, shall be natural soil, well-graded and free from all organic weak, compressible, and frozen materials, and shall contain no stone larger than four (4) inches in maximum dimension. It shall be of such nature and character that it can be dried and compacted and shall be free of all expansive materials (such as high plastic clays) and of materials subject to decay, decomposition, or dissolution, and shall conform to the following gradations:

U.S. Sieve No. Total Percent Passing by Weight

3 inch	100
#40	0-50
#200	0-25

- B. If, sufficient suitable fill material is not available from excavations under this Contract, to complete filling to subgrades as specified above, additional fill, as specified under paragraph 2.02A above, shall be furnished by the Contractor from other sources at no additional cost. Excavated material from the site, and furnished material for use as Suitable Backfill, shall be deemed suitable only if they meet the requirements of paragraph 2.02A above, can be properly compacted, and are satisfactory to the Engineer.
- C. Use Suitable Backfill compacted as specified for general grading as backfill except as specified herein; fill to sub-grades of proposed work where shown.

203 MATERIALS:

A. GRAVEL BORROW:

Gravel Borrow shall satisfy the requirements listed in MASSDOT Specification Section M1.03.0, Type b.

B. MODIFIED ROCKFILL

Where required, crushed stone/riprap must be Modified rockfill as described in MassDOT specifications (2020) and shall consist of hard, durable angular shaped stones which are the product of the primary crushing of a stone crusher. Rounded stone, boulders, sandstone and similar soft stone or relatively thin slabs will not be acceptable. Stone shall be free from overburden, spoil, shale, organic material and meet the following gradation:

Size of Stone (in.)	Passing Percentages
8	95-100
4	0-25
2½	0-5

C. SAND BORROW:

Sand borrow for pipe bedding sand. This is not the sand indicated for soil amendments.  
Sand Borrow shall satisfy the requirements listed in MASSDOT Specification Section M1.04.0.

D. BACKFILL MATERIALS:

1. Class B Backfill:

Class B backfill shall be granular, well graded friable soil; free of rubbish, ice, snow, tree stumps, roots, clay and organic matter; with 30 percent or less passing the No. 200 sieve; no stone greater than two-third (2/3) loose lift thickness, or six inches, whichever is smaller.

2. Select Backfill:

Select backfill shall be granular, well graded friable soil, free of rubbish, ice, snow, tree stumps, roots, clay and organic matter, and other deleterious or organic material; graded within the following limits:

<u>Sieve Size</u>	<u>Percent Finer by Weight</u>
3"	100
No. 10	30-95
No. 40	10-70
No. 200	0-10

E. PROCESSED GRAVEL:

1. Processed gravel shall consist of inert material that is hard, durable stone and coarse sand, free from loam and clay, surface coatings and deleterious materials. The coarse aggregate shall have a percentage of wear, by the Los Angeles Abrasion Test, of not more than 50.
2. The gradation shall meet the following requirements:

<u>Sieve Designation</u>	<u>Percentage Passing</u>
3 in.	100
1 1/2 in.	70-100
1/4 in.	50-85
No. 4	30-60

3. The approved source of bank-run gravel material shall be processed by mechanical means. The equipment for producing crushed gravel shall be of adequate size with sufficient adjustments to produce the desired materials. The processed material shall be stockpiled in such a manner to minimize segregation of particle sizes. All processed gravel shall come from approved stockpiles.

## PART 3 - EXECUTION

### 3.01 DISTURBANCE OF EXCAVATED AND FILLED AREAS DURING CONSTRUCTION:

- A. Contractor shall take the necessary steps to avoid disturbance of subgrade during excavation and filling operations, including restricting the use of certain types of construction equipment and their movement over sensitive or unstable materials, dewatering and other acceptable control measures.

### 3.02 EXCAVATION:

#### A. GENERAL:

1. The Contractor shall perform all work of any nature and description required to accomplish the work as shown on the Drawings and as specified.
2. Excavations, unless otherwise required by the Owner's Representative, shall be carried only to the depths and limits shown on the Drawings. Contractor is responsible to utilize only low ground pressure equipment throughout the process of construction.
3. Prior to construction contractor shall submit a list of all earth moving equipment they intend to use on the site for approval. At no point during construction shall the contractor use unapproved equipment that may lead to unnecessary soil compaction. If so the contractor shall at their cost relieve all the compacted areas at the Owner's Representatives discretion.
4. In all excavation areas, the Contractor shall strip the surficial topsoil layer and underlying subsoil layer separate from underlying soils.
5. The Contractor shall follow a construction procedure, which permits visual identification of stable natural ground. Where groundwater is encountered, the size of the open excavation shall be limited to that which can be handled by the Contractor's chosen method of dewatering and which will allow visual observation of the bottom and backfill in the dry.
6. The Contractor shall excavate unsuitable materials to stable natural ground where encountered at proposed excavation subgrade, as approved by the Owner's Representative. Unsuitable material includes topsoil, loam, peat, other organic

materials, snow, ice, and trash. Unless specified elsewhere or otherwise approved by the Owner's Representative, areas where unsuitable materials have been excavated to stable ground shall be backfilled with compacted special bedding materials or crushed stone wrapped all around in non-woven filter fabric.

7. When the plans require excavation in areas in proximity to existing sidewalks, structures and utilities, it shall be the responsibility of the Contractor, at his own expense, to provide adequate and suitable drainage away from proposed work and existing features or use other satisfactory means and methods to protect and maintain the stability of such construction within or adjacent to the limits of work.
8. Protect all existing trees, shrubs or other plan referenced features to remain. Hand excavate around all items to remain including tree roots or where utilities must be verified. Exposed tree roots shall be immediately covered with Loam Borrow in accordance with these specifications.
9. No roots greater than two (2) inches in diameter shall be cut from trees to remain without approval of the Owner's Representative. Roots greater than one (1) inch in diameter that are cut or broken shall be promptly pruned to a smooth clean cut and painted with an approved compound.
10. Any removal of existing facilities required in order to achieve the excavation to proceed, such as fences, walls, walkways, etc., shall be accomplished by the Contractor at no additional cost to the owner. Restoration of these facilities shall be to a condition equal to that before removal, and safe and operational to the satisfaction of the Owner's Representative.
11. Excavation shall be performed to the lines, grades, and elevations shown on the plans or as approved by the Owner's Representative, and shall be made in such a manner that the requirements for formation of the subgrade can be followed.
12. No excavation shall be started until the Owner's Representative has reviewed and acknowledged the area of proposed construction. All material encountered, of whatever nature within the limits indicated, shall be removed and disposed of as approved. During the process of excavation, the grade shall be maintained in such condition that it will be well drained at all times.
13. The planes at the bottom of the excavation (in cut), or the top of the fill, when completed, shall be known as the subgrade, and shall be true to the lines, grades and cross section shown on the plans, to allow proposed work (base courses and finished courses) to be completed.
14. All unsuitable excavated material shall be legally disposed of outside of, and away from, the project limits. All suitable excavated material deemed surplus by the Owner's Representative shall become the property of the Contractor and shall be properly removed from the site.

15. Fills to subgrade level shall be formed of successive layers not exceeding six (6) inches in depth and each layer shall be compacted to not less than 95 percent of maximum dry density of the material as determined by the standard AASHTO Test Designation T-180-86, Modified Proctor Test.
16. No additional payment will be made for materials removed, manipulated or replaced by the Contractor in order to obtain the specified density. Any removal, manipulation, aerating, replacement and re-compaction of materials necessary to obtain the required density shall be considered as incidental to the excavation and compaction operations and shall be performed by the Contractor at no additional cost.
17. After the areas to receive topsoil have been brought to subgrade, and immediately prior to placing and spreading such material, the subgrade shall be loosened by disking to a depth of at least three inches to permit bonding of the finished material to the subgrade material. Then place and spread the loam borrow to the depths required by the Drawings to establish finish grades.
18. Protect all existing areas against damage due to the work under this Contract, and perform all repair and replacement work to any such areas which are damaged hereunder.
19. No extra work shall be initiated without notification of the Owner's Representative in writing, and the written approval of the Owner's Representative in response.
20. The Contractor shall be responsible for any and all pumping or bailing necessary to complete his operations, and to keep all areas sufficiently dry to guarantee compaction in accordance with the specifications.
21. Where insufficient suitable materials of any kind exist on site for incorporation into the proposed work within proposed work lines, the Contractor shall furnish materials from off site, as necessary and in accordance with these specifications, at no additional cost to the Owner.

#### C. EXCAVATION NEAR EXISTING STRUCTURES:

1. Attention is directed to the fact that there are pipes, manholes, drains, and other utilities in certain locations. An attempt has been made to locate all utilities on the drawings, but the completeness or accuracy of the given information is not guaranteed. The contractor is responsible for contacting dig safe and appropriate municipal departments prior to construction operations begin to indicate general location of all utilities.
2. As the excavation approaches pipes, conduits, or other underground structures, digging by machinery shall be discontinued and excavation shall be done by means of hand tools, as required. Such manual excavation, when incidental to normal

excavation, shall be included in the work to be done under items involving normal excavation.

3. Where determination of the exact location of a pipe or other underground structure is necessary for properly performing the work, the Contractor shall excavate test pits to determine the locations.

#### D. TRENCH HAND EXCAVATION

- a. When approaching the vicinity of significant tree roots, underground pipes, conduits, or other structures, or any suspected functioning underground features, digging by machinery shall be discontinued and the excavation shall be done by hand. Hand excavation shall also be undertaken when so approved by the Owner's Representative. Such hand excavation shall be considered incidental to the trench excavation and no additional compensation will be allowed.
- b. Protection of Existing Structures - All existing pipes, conduits, poles, wires, fences, curbing, property line markers, and other structures which, in the opinion of the Owner's Representative, are not required to be changed in location, shall be carefully supported and protected from injury by the Contractor, and in case of damage, they shall be restored by the Contractor without additional compensation, to as good a condition as that in which they were found.

### 3.03 BACKFILL PLACEMENT AND COMPACTION:

#### A. GENERAL:

- A. Prior to backfilling, the Contractor shall compact the exposed natural subgrade to the densities as specified herein.
- B. All subgrade must be flattened to the extent possible, existing slopes benched accordingly with OSHA guidelines and all fill material to be removed from the bottom prior to construction.
- C. Where embankment is to be placed against existing earth slopes, steeper than 3 to 1, the slope shall be broken up into steps of random width as the fill is placed in order to provide a suitable bond between the existing ground and the new embankment.
- D. If subsurface conditions different than what is shown on this plan and accompanying reports are encountered during construction, the engineer of the record must be connected immediately.
- E. Fill material shall be placed and compacted in uniform layers not exceeding 12 in. in depth, loose measurement; each layer of material shall be spread on the entire width of the embankment and leveled off by approved equipment.
- F. After approval of subgrade by the Owner's Representative, the Contractor shall backfill areas to required contours and elevations with specified materials.

- G. The Contractor shall place and compact materials to the specified density in continuous horizontal layers. The degree of compaction shall be based on maximum dry density as determined by ASTM Test D1557, Method C. The minimum degree of compaction for fill placed shall be as follows:

<u>Location</u>	<u>Percent of Maximum Density</u>
Below pipe centerline	95
Above pipe centerline	92
Below pavement (upper 3 ft.)	95
Embankments	95
Below pipe in embankments	95

Adjacent to structures	92
Below structures	95

- H. The Owner’s Representative reserves the right to test backfill for conformance to the specifications and Contractor shall assist as required to obtain the information. Compaction testing will be performed by the Owner’s Representative or by an inspection laboratory designated by the Owner’s Representative, engaged and paid for by the Owner. If test results indicate work does not conform to specification requirements, the Contractor shall remove or correct the defective Work by recompacting where appropriate or replacing as necessary and approved by the Owner’s Representative, to bring the work into compliance, at no additional cost to the Owner. All backfilled materials under structures and buildings shall be field tested for compliance with the requirements of this specification.
- I. The Contractor shall remove loam and topsoil, loose vegetation, stumps, large roots, etc., from areas upon which embankments will be built or areas where material will be placed for grading. The subgrade shall be shaped as indicated on the Drawings and shall be prepared by forking, furrowing, or plowing so that the first layer of the fill material placed on the subgrade will be well bonded to the subgrade.

**3.04 DISPOSAL OF SURPLUS MATERIALS:**

- A. Surplus excavated materials, which are acceptable to the Owner’s Representative, shall be used to backfill normal excavations in rock or to replace other materials unacceptable for use as backfill. Upon written approval of the Owner’s Representative, surplus excavated materials shall be neatly deposited and graded so as to make or widen fills, flatten side slopes, or fill depressions; or shall be neatly deposited for other purposes as indicated by the Owner, within its jurisdictional limits; all at no additional cost to the Owner.
- B. Surplus excavated material not needed as specified above shall be hauled away and disposed of by the Contractor at no additional cost to the Owner, at appropriate locations, and in accordance with arrangements made by him. Disposal of all rubble shall be in accordance with all applicable local, state and federal regulations.
- C. No excavated material shall be removed from the site of the work or disposed of by the Contractor unless approved by the Owner’s Representative.
- D. The Contractor shall comply with Massachusetts regulations (310 CMR 40.0032) that govern the removal and disposal of surplus excavated materials. Materials, including contaminated soils, having concentrations of oil or hazardous materials less than an otherwise Reportable Concentration and that are not a hazardous waste, may not be disposed of at locations where concentrations of oil and/or hazardous material at the receiving site are significantly lower than the levels of those oil and /or hazardous materials present in the soil being disposed or reused.

- E. Soil testing, if required, for all materials to be reused on-site or removed and disposed of offsite, shall be the responsibility of the contractor. The town reserves the right to obtain its own test results from the same sample as the contractor without penalties to the owner. The contractor is required to obtain a large enough sample to divide with the owner for this proposes.

- - - END OF SECTION - - -

01570  
ENVIRONMENTAL PROTECTION

PART 1 GENERAL

1.1 SUMMARY

A. Review exposure to possible environmental problems with Owner. Establish procedures and discipline among tradesmen and provide needed facilities, which will protect against environmental problems (pollution of air, water and soil, excessive noise, and similar problems).

1.2 WATER AND AIR POLLUTION

A. The Contractor shall exercise every reasonable precaution throughout the life of the project to prevent pollution of rivers, streams, and bodies of water. Pollutants such as chemicals, fuels, lubricants, bitumens, raw sewage, and other harmful waste shall not be discharged into or alongside of rivers, streams, and bodies of water or into natural or manmade channels leading thereto.

B. Contractor shall provide for the drainage of stormwater and such water as may be applied or discharged on the site in performance of the Work. Drainage facilities shall be adequate to prevent damage to the Work, the site, and adjacent property.

C. The Contractor shall comply with all State or local air pollution regulations throughout the life of the project.

1.3 WASTEWATER FLOW

A. The Contractor shall conduct his operations in manner and sequence, which will provide for the continued transportation of wastewater flows during construction. Contractor shall take all actions required to prevent discharge of sewer flow from the system to the ground or any stream. Any construction actions that impede or interrupt flow shall be carefully executed and monitored to prevent surcharging and overflow.

PART 2 PRODUCTS

Not Used

PART 3 EXECUTION

Not Used

END OF SECTION 01570