

STORMWATER MANAGEMENT REPORT



GRANITE ENGINEERING

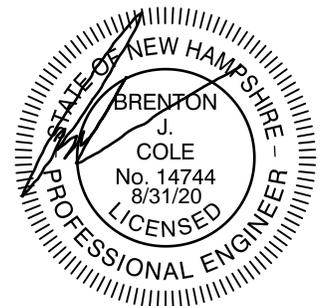
civil engineering • land planning • municipal services

STARK RESIDENCES AT OLD WELLINGTON

Map 645 Lots 4 & 5
534 & 550 Old Wellington Road
Manchester, New Hampshire
September 1, 2020

PREPARED FOR:
B&T DEVELOPMENT, LLC
39 TICKLEFANCY LANE
SALEM, NH 03079

PREPARED BY:
GRANITE ENGINEERING, LLC
250 COMMERCIAL ST, STE 3008
MANCHESTER, NH 03101
603.518.8030



GE Project No. 20-0420-1

TABLE OF CONTENTS

1. PROJECT NARRATIVE
 - I. INTRODUCTION
 - II. STORM DRAINAGE ANALYSIS & DESIGN
2. USGS MAP
3. WEB SOIL SURVEY
4. AERIAL PHOTOGRAPH
5. EXTREME PRECIPITATION TABLES
6. BMP WORKSHEETS
7. RIP-RAP APRON CALCULATIONS
8. HYDROCAD DRAINAGE ANALYSIS
9. PLANS
 - I. PRE-DEVELOPMENT DRAINAGE AREAS PLAN (11"x17")
 - II. POST-DEVELOPMENT DRAINAGE AREAS PLAN (11"x17")

1. PROJECT NARRATIVE

I. INTRODUCTION

A. Project Description

Stark Residences at Old Wellington is a proposed 20-unit townhouse-style rental facility. The project is located on two existing lots of record referenced on Tax map 645 as Lots 4 & 5, and is located at 534 & 550 Old Wellington Road.

The subject properties are currently developed with two single-family homes and associated outbuildings. Each parcel currently has a driveway that connects to Old Wellington Road. This project will raze all existing structures and remove the two existing driveways.

The new development will consist of three (3) separate buildings; two 6-unit buildings and one 8-unit building. Access to the development will be from a single 24' wide driveway located on Old Wellington Road. Onsite parking for the project includes the construction of a sixty (60) space parking lot.

B. Existing Site Conditions

Tax Map 645 Lots 4 is 0.953 acres in area and is developed with a 1-1/2 story wooden house and a paved driveway. The ground cover on the property consists of grass, woods, and impervious cover.

Tax Map 645 Lot 5 is 0.808 acres in area and is also developed with a 1-1/2 story wooden house and two (2) concrete block garages. The ground cover on the property consists of grass, woods, and impervious cover.

According to the USDA Natural Resources Conservation Service, the predominant onsite soil types are Chatfield-Hollis-Canton complex and Leicester-Walpole complex. The Chatfield-Hollis-Canton soils belong to a Hydrological Soil Group of 'A' soils and the Leicester-Walpole soils on the site belong to a Hydrological Soil Group of 'A/D' soils.

II. STORM DRAINAGE ANALYSIS & DESIGN

A. Methodology

In accordance with the City of Manchester Site Plan Regulations, the 25-year frequency storm has been used in the stormwater analysis for the subject site.

In appreciation of the benefits and limitations related to each of the various methods available to design professionals for estimating peak stormwater discharge rates for use in analysis and design, the TR-20 computer model

was used. Values for Time of Concentration used in the analysis were estimated using the methodology contained within USDA-S.C.S. publication Urban Hydrology for Small Watersheds Technical Release No. 55 (TR 55). All design and analysis calculations performed using the referenced methodologies are attached to this report. The minimum time of concentrations used for the analysis is 6 minutes. These calculations document each catchment area, a breakdown of surface type, time of concentration, rainfall intensity, peak discharge volume, Manning's "n" value, peak velocity, and other descriptive design data for each watershed evaluated. In addition, the "Pre/Post Development Drainage Area Plans" graphically define and illustrate the extent of each watershed or catchment area investigated.

B. Pre-Development Drainage Conditions

In order to evaluate the impact of the proposed development, two (2) Points of Analysis (POA) were analyzed to demonstrate that the peak rates of runoff would not increase from the proposed project.

The POA, Link A, is the city drainage that runs along Old Wellington Road. Stormwater runoff from a small portion of the subject properties drains towards and into the closed drainage system within old Wellington Road

The POA, Link B, is the existing wetlands to the northeast of the site. Stormwater runoff from the majority of the site is discharged off of the north property line and into an adjacent wetland complex.

Pre-development peak rates of discharge are identified in Table 1. For a more visual description of the information presented in this section, please refer to the attached "Pre-Development Drainage Areas Plan" attached in the appendix of this report.

C. Post-Development Drainage Conditions:

The same POAs from the Pre-Development scenario was used in the Post-Development analysis.

The project proposes the construction of a stormwater management system. This system includes a closed drainage system within the parking lot and the construction of an infiltration pond in the west corner of the property. The majority of the runoff from this development will be discharged into the proposed infiltration basin prior to discharging to POA B; the adjacent wetland complex. A very small portion of the property will continue to discharge to POA A; the closed drainage system within Old Wellington Road.

Stormwater treatment proposed includes, catch basins with sumps, oil/water separator hoods within the catch basins, sediment forebay, and infiltration of the water quality volume.

The detailed hydrologic and hydraulic relationship of each sub-catchment is described within the HydroCAD stormwater modeling, also contained in the appendix of this report.

The peak stormwater runoff rate for the specific storm frequency is presented and analyzed in the subsequent summary section of this report, for the points of analysis (Table 1).

D. Summary:

The subject project complies with the City of Manchester Subdivision and Site Plan Regulations as well as the Standard Specifications regarding peak stormwater discharge. The results are reported below in Table 1.

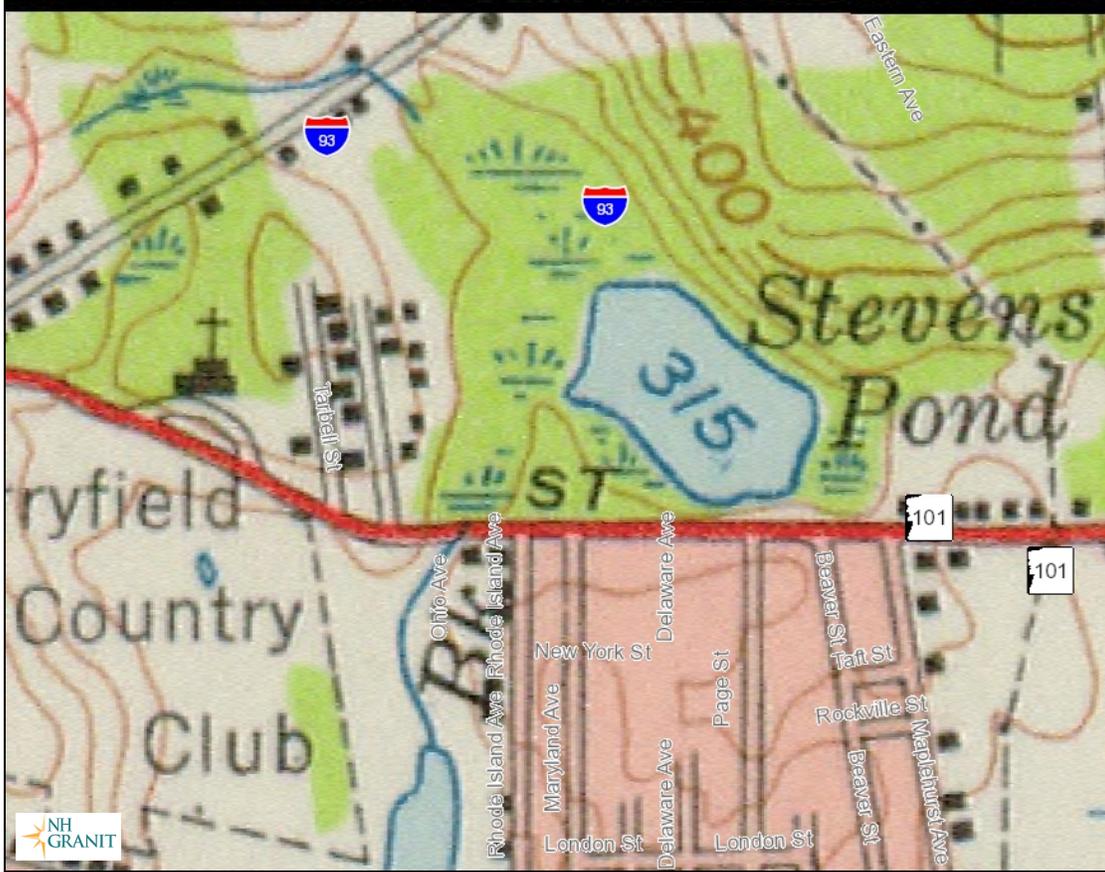
The results of the model conclude that the development of these properties will not generate post-development peak rates of stormwater discharge exceeding pre-development rates.

TABLE 1: PRE VS. POST PEAK RUNOFF

Site Pre-Development vs. Post Development (Peak Discharge Rate in cfs)		
Description	25-Year	
24-hr Rainfall	5.43 in	
	Pre (cfs)	Post (cfs)
A	1.13	1.10
B	3.96	3.69

2. USGS MAP

Stark Residences at Old Wellington USGS Map



Legend

- State
- County
- City/Town
- 1957 with vegetation
- 1953 with vegetation

Map Scale

1: 10,000

© NH GRANIT, www.granit.unh.edu

Map Generated: 8/26/2020

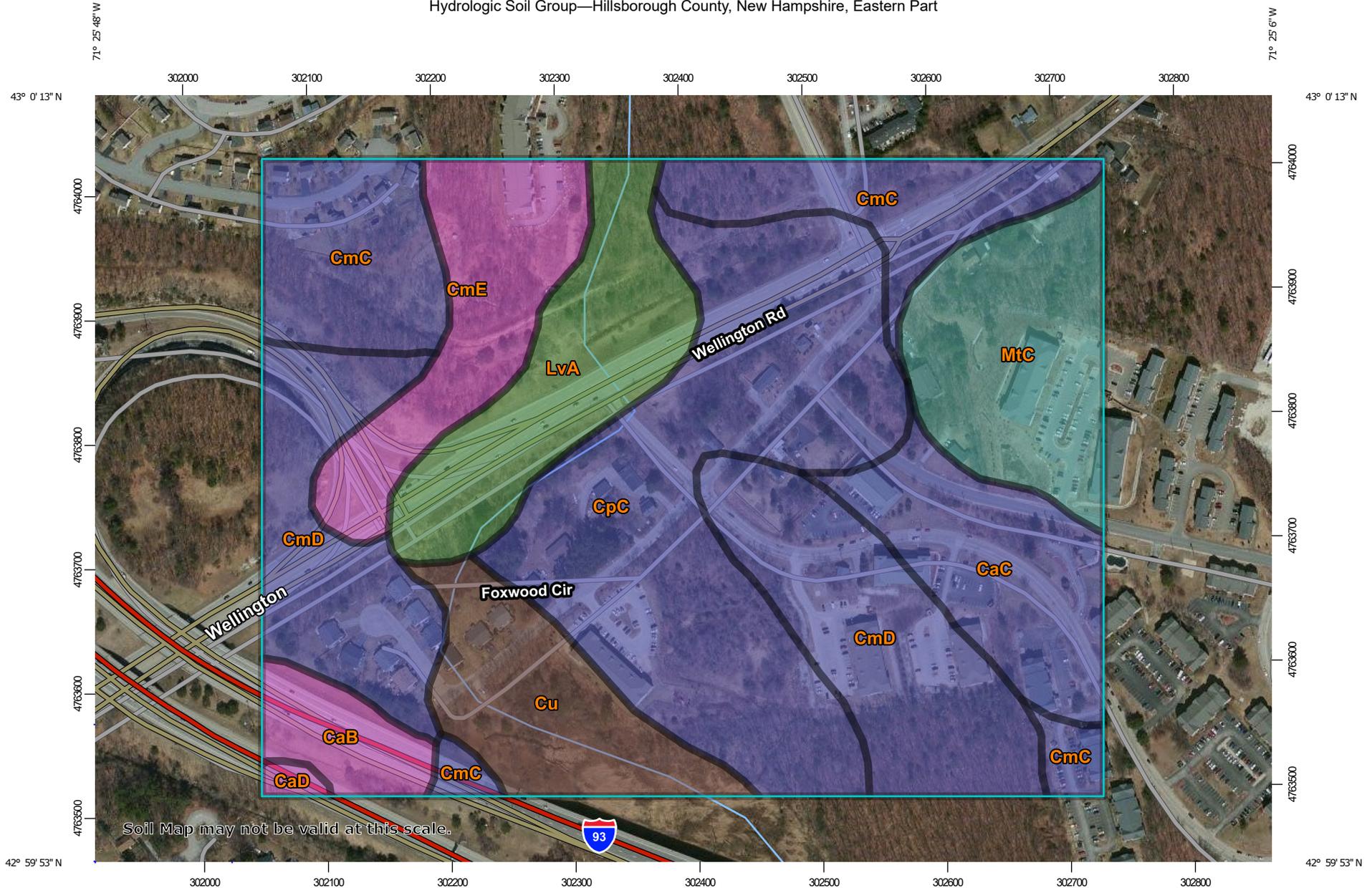


Notes

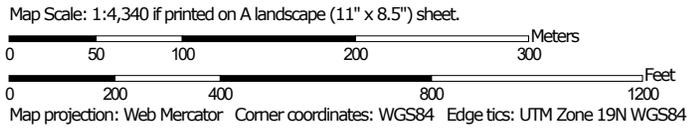


3. WEB SOIL SURVEY

Hydrologic Soil Group—Hillsborough County, New Hampshire, Eastern Part



Soil Map may not be valid at this scale.



MAP LEGEND

Area of Interest (AOI)

 Area of Interest (AOI)

Soils

Soil Rating Polygons

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Lines

 A
 A/D
 B
 B/D
 C
 C/D
 D
 Not rated or not available

Soil Rating Points

 A
 A/D
 B
 B/D

 C
 C/D
 D
 Not rated or not available

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 1:20,000.

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: Hillsborough County, New Hampshire, Eastern Part
 Survey Area Data: Version 22, May 29, 2020

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

Date(s) aerial images were photographed: Apr 8, 2011—Apr 9, 2011

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.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
CaB	Canton fine sandy loam, 0 to 8 percent slopes	A	2.5	2.9%
CaC	Canton fine sandy loam, 8 to 15 percent slopes	B	6.8	7.8%
CaD	Canton fine sandy loam, 15 to 25 percent slopes	A	0.3	0.4%
CmC	Canton fine sandy loam, 8 to 15 percent slopes, very stony	B	11.7	13.5%
CmD	Canton fine sandy loam, 15 to 25 percent slopes, very stony	B	16.0	18.5%
CmE	Canton stony fine sandy loam, 25 to 35 percent slopes	A	6.8	7.8%
CpC	Chatfield-Hollis-Canton complex, 8 to 15 percent slopes	B	20.2	23.4%
Cu	Swansea mucky peat, 0 to 2 percent slopes	B/D	6.3	7.3%
LvA	Leicester-Walpole complex stony, 0 to 3 percent slopes	A/D	7.8	9.1%
MtC	Montauk fine sandy loam, 8 to 15 percent slopes, very stony	C	8.1	9.3%
Totals for Area of Interest			86.5	100.0%

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

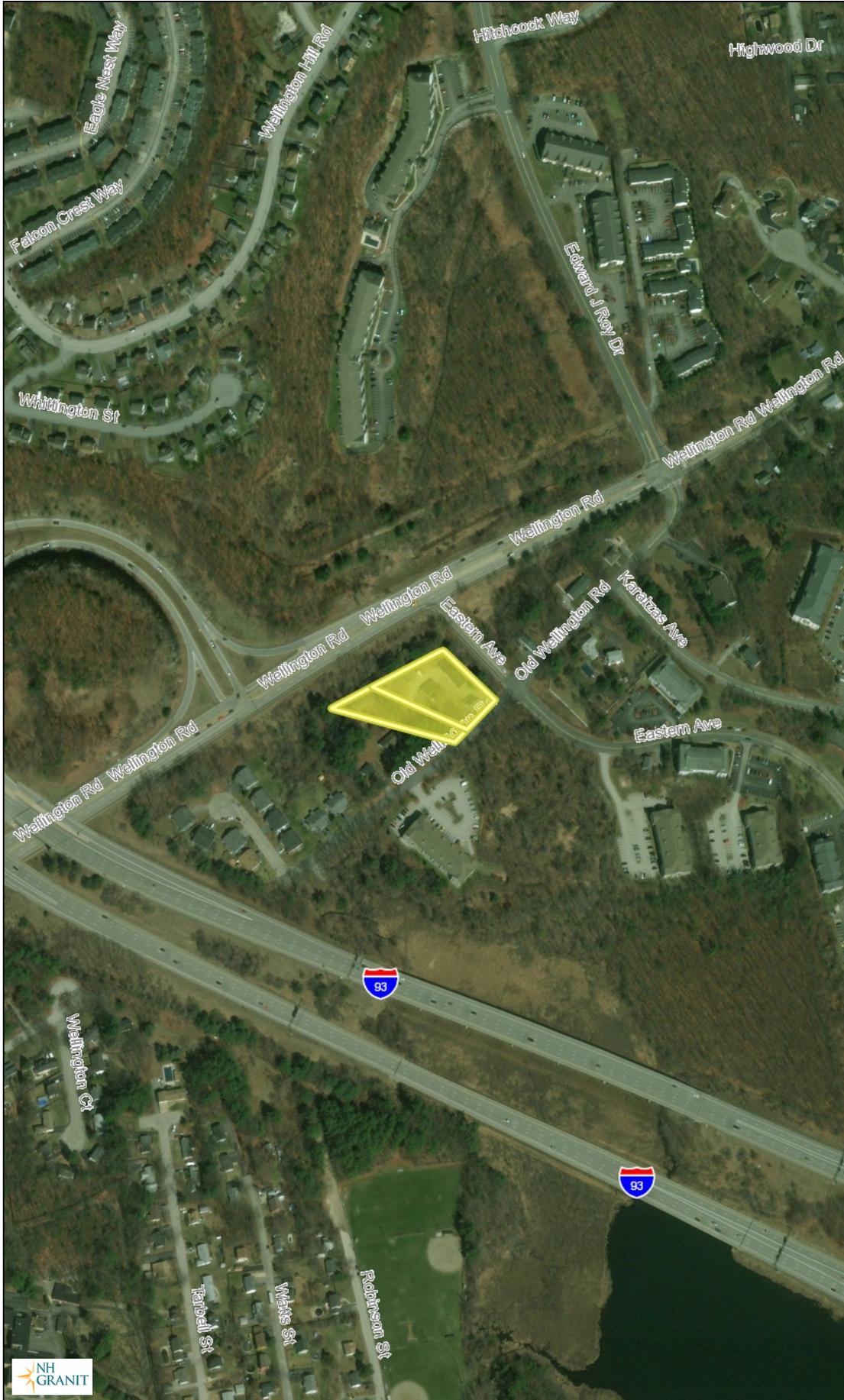
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

4. AERIAL PHOTOGRAPH

Stark Residences at Old Wellington



Legend

- State
- City/Town

Map Scale

1: 5,000

© NH GRANIT, www.granit.unh.edu

Map Generated: 8/26/2020



Notes



5. EXTREME PRECIPITATION TABLES

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	New Hampshire
Location	
Longitude	71.425 degrees West
Latitude	43.001 degrees North
Elevation	0 feet
Date/Time	Thu, 06 Aug 2020 10:42:51 -0400

Extreme Precipitation Estimates

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.26	0.40	0.50	0.66	0.82	1.03	1yr	0.71	0.99	1.19	1.50	1.90	2.40	2.63	1yr	2.13	2.53	2.93	3.60	4.18	1yr
2yr	0.32	0.49	0.61	0.81	1.02	1.28	2yr	0.88	1.17	1.48	1.84	2.30	2.86	3.19	2yr	2.54	3.07	3.55	4.24	4.83	2yr
5yr	0.38	0.59	0.74	0.99	1.27	1.61	5yr	1.09	1.47	1.86	2.33	2.90	3.61	4.06	5yr	3.19	3.91	4.51	5.31	5.99	5yr
10yr	0.43	0.67	0.85	1.15	1.50	1.92	10yr	1.29	1.73	2.23	2.80	3.48	4.30	4.88	10yr	3.81	4.69	5.41	6.30	7.06	10yr
25yr	0.51	0.80	1.02	1.41	1.87	2.41	25yr	1.61	2.17	2.82	3.54	4.40	5.43	6.23	25yr	4.80	5.99	6.89	7.90	8.77	25yr
50yr	0.57	0.92	1.18	1.65	2.22	2.88	50yr	1.91	2.57	3.37	4.24	5.27	6.47	7.50	50yr	5.73	7.21	8.28	9.38	10.34	50yr
100yr	0.65	1.05	1.36	1.93	2.63	3.44	100yr	2.27	3.04	4.04	5.09	6.30	7.72	9.03	100yr	6.84	8.68	9.95	11.14	12.19	100yr
200yr	0.75	1.22	1.58	2.26	3.11	4.10	200yr	2.69	3.60	4.82	6.08	7.53	9.22	10.87	200yr	8.16	10.45	11.96	13.24	14.39	200yr
500yr	0.90	1.47	1.92	2.79	3.90	5.18	500yr	3.36	4.52	6.11	7.70	9.54	11.66	13.91	500yr	10.32	13.38	15.25	16.64	17.92	500yr

Lower Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.22	0.33	0.41	0.55	0.67	0.86	1yr	0.58	0.84	1.06	1.35	1.62	2.22	2.50	1yr	1.97	2.40	2.70	3.25	3.63	1yr
2yr	0.31	0.47	0.58	0.79	0.97	1.16	2yr	0.84	1.14	1.33	1.75	2.23	2.77	3.07	2yr	2.45	2.95	3.42	4.11	4.69	2yr
5yr	0.35	0.54	0.67	0.92	1.17	1.39	5yr	1.01	1.36	1.56	2.03	2.59	3.31	3.71	5yr	2.93	3.57	4.12	4.91	5.56	5yr
10yr	0.39	0.59	0.74	1.03	1.33	1.57	10yr	1.15	1.53	1.77	2.28	2.90	3.78	4.28	10yr	3.34	4.12	4.72	5.62	6.31	10yr
25yr	0.44	0.67	0.84	1.20	1.58	1.83	25yr	1.36	1.79	2.09	2.66	3.37	4.48	5.14	25yr	3.97	4.94	5.62	6.70	7.44	25yr
50yr	0.49	0.74	0.92	1.33	1.78	2.06	50yr	1.54	2.01	2.37	2.99	3.78	5.09	5.92	50yr	4.51	5.69	6.39	7.65	8.40	50yr
100yr	0.54	0.82	1.03	1.48	2.04	2.32	100yr	1.76	2.27	2.69	3.37	4.25	5.77	6.79	100yr	5.10	6.53	7.24	8.73	9.47	100yr
200yr	0.60	0.90	1.15	1.66	2.31	2.61	200yr	2.00	2.55	3.04	3.80	4.78	6.53	7.80	200yr	5.78	7.50	8.19	9.97	10.65	200yr
500yr	0.69	1.03	1.33	1.93	2.75	3.05	500yr	2.37	2.98	3.60	4.46	5.61	7.66	9.33	500yr	6.78	8.97	9.57	11.87	12.44	500yr

Upper Confidence Limits

	5min	10min	15min	30min	60min	120min		1hr	2hr	3hr	6hr	12hr	24hr	48hr		1day	2day	4day	7day	10day	
1yr	0.30	0.46	0.56	0.75	0.92	1.09	1yr	0.80	1.06	1.21	1.61	2.04	2.58	2.79	1yr	2.28	2.68	3.28	4.13	4.58	1yr
2yr	0.33	0.51	0.63	0.86	1.06	1.26	2yr	0.91	1.23	1.42	1.86	2.37	2.99	3.33	2yr	2.64	3.20	3.71	4.39	5.01	2yr
5yr	0.41	0.64	0.79	1.09	1.38	1.60	5yr	1.19	1.56	1.82	2.34	2.96	3.95	4.45	5yr	3.50	4.28	4.91	5.75	6.50	5yr
10yr	0.50	0.77	0.95	1.32	1.71	1.94	10yr	1.48	1.90	2.20	2.79	3.53	4.90	5.57	10yr	4.34	5.36	6.12	7.08	7.91	10yr
25yr	0.64	0.97	1.21	1.72	2.27	2.52	25yr	1.96	2.46	2.84	3.52	4.43	6.56	7.52	25yr	5.81	7.23	8.20	9.30	10.33	25yr
50yr	0.76	1.16	1.45	2.08	2.80	3.07	50yr	2.42	3.00	3.42	4.21	5.26	8.17	9.45	50yr	7.23	9.09	10.25	11.46	12.63	50yr
100yr	0.93	1.40	1.76	2.54	3.49	3.74	100yr	3.01	3.66	4.15	5.03	6.26	10.20	11.87	100yr	9.02	11.41	12.80	14.13	15.49	100yr
200yr	1.12	1.69	2.14	3.09	4.31	4.56	200yr	3.72	4.46	5.03	6.01	7.46	12.73	14.97	200yr	11.27	14.39	16.06	17.45	19.01	200yr
500yr	1.45	2.16	2.77	4.03	5.73	5.95	500yr	4.94	5.81	6.50	7.63	9.41	17.10	20.32	500yr	15.13	19.54	21.67	23.06	25.00	500yr



6. BMP WORKSHEETS



INFILTRATION PRACTICE CRITERIA (Env-Wq 1508.06)

Type/Node Name: **Infiltration Pond (IP)**

Enter the type of infiltration practice (e.g., basin, trench) and the node name in the drainage analysis, if applicable.

Yes	Have you reviewed Env-Wq 1508.06(a) to ensure that infiltration is allowed?			← yes
1.48	ac	A = Area draining to the practice		
0.89	ac	A _i = Impervious area draining to the practice		
0.60	decimal	I = Percent impervious area draining to the practice, in decimal form		
0.59	unitless	R _v = Runoff coefficient = 0.05 + (0.9 x I)		
0.88	ac-in	WQV = 1" x R _v x A		
3,189	cf	WQV conversion (ac-in x 43,560 sf/ac x 1ft/12")		
797	cf	25% x WQV (check calc for sediment forebay volume)		
Sediment Forebay		Method of pretreatment? (not required for clean or roof runoff)		
865	cf	V _{SED} = Sediment forebay volume, if used for pretreatment		≥ 25%WQV
7,034	cf	V = Volume ¹ (attach a stage-storage table)		≥ WQV
2,924	sf	A _{SA} = Surface area of the bottom of the pond		
1.00	iph	K _{sat} _{DESIGN} = Design infiltration rate ²		
13.1	hours	I _{DRAIN} = Drain time = V / (A _{SA} * I _{DESIGN})		≤ 72-hrs
340.00	feet	E _{BTM} = Elevation of the bottom of the basin		
336.55	feet	E _{SHWT} = Elevation of SHWT (if none found, enter the lowest elevation of the test pit)		
336.55	feet	E _{ROCK} = Elevation of bedrock (if none found, enter the lowest elevation of the test pit)		
3.45	feet	D _{SHWT} = Separation from SHWT		≥ *³
3.4	feet	D _{ROCK} = Separation from bedrock		≥ *³
N/A	ft	D _{amend} = Depth of amended soil, if applicable due high infiltration rate		≥ 24"
N/A	ft	D _T = Depth of trench, if trench proposed		4 - 10 ft
N/A	Yes/No	If a trench or underground system is proposed, has observation well been provided?		← yes
N/A		If a trench is proposed, does material meet Env-Wq 1508.06(k)(2) requirements. ⁴		← yes
YES	Yes/No	If a basin is proposed, Is the perimeter curvilinear, and basin floor flat?		← yes
2.0	:1	If a basin is proposed, pond side slopes.		≥ 3:1
345.37	ft	Peak elevation of the 10-year storm event (infiltration can be used in analysis)		
345.76	ft	Peak elevation of the 50-year storm event (infiltration can be used in analysis)		
346.00	ft	Elevation of the top of the practice (if a basin, this is the elevation of the berm)		
YES		10 peak elevation ≤ Elevation of the top of the trench? ⁵		← yes
YES		If a basin is proposed, 50-year peak elevation ≤ Elevation of berm?		← yes

1. Volume below the lowest invert of the outlet structure and excludes forebay volume
2. K_{sat}_{DESIGN} includes a factor of safety. See Env-Wq 1504.14 for requirements for determining the infiltr. rate
3. 1' separation if treatment not required; 4' for treatment in GPAs & WSIPAs; & 3' in all other areas.
4. Clean, washed well graded diameter of 1.5 to 3 inches above the in-situ soil.
5. If 50-year peak elevation exceeds top of trench, the overflow must be routed in HydroCAD as secondary discharge.

Designer's Notes: _____

POST-DEVELOPMENT

Type III 24-hr 50YR Rainfall=6.47"

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Stage-Area-Storage for Pond IP: INFILTRATION POND (continued)

Elevation (feet)	Surface (sq-ft)	Wetted (sq-ft)	Storage (cubic-feet)
345.20	2,896	6,265	6,888
345.22	2,907	6,278	6,946
345.24	2,919	6,290	7,005
345.26	2,930	6,303	7,063
345.28	2,942	6,316	7,122
345.30	2,954	6,328	7,181
345.32	2,965	6,341	7,240
345.34	2,977	6,354	7,299
345.36	2,989	6,367	7,359
345.38	3,000	6,380	7,419
345.40	3,012	6,392	7,479
345.42	3,024	6,405	7,539
345.44	3,035	6,418	7,600
345.46	3,047	6,431	7,661
345.48	3,059	6,444	7,722
345.50	3,071	6,457	7,783
345.52	3,083	6,469	7,845
345.54	3,095	6,482	7,907
345.56	3,106	6,495	7,969
345.58	3,118	6,508	8,031
345.60	3,130	6,521	8,093
345.62	3,142	6,534	8,156
345.64	3,154	6,547	8,219
345.66	3,166	6,560	8,282
345.68	3,178	6,573	8,346
345.70	3,190	6,586	8,409
345.72	3,202	6,599	8,473
345.74	3,215	6,612	8,537
345.76	3,227	6,625	8,602
345.78	3,239	6,638	8,666
345.80	3,251	6,651	8,731
345.82	3,263	6,664	8,796
345.84	3,275	6,677	8,862
345.86	3,288	6,690	8,928
345.88	3,300	6,703	8,993
345.90	3,312	6,716	9,060
345.92	3,325	6,729	9,126
345.94	3,337	6,743	9,192
345.96	3,349	6,756	9,259
345.98	3,362	6,769	9,326
346.00	3,374	6,782	9,394

7034 cf storage at elev=345.25, with surface area of 2924-sf

7. RIP-RAP APRON CALCULATIONS



RIP RAP OUTLET PROTECTION APRON CALCULATIONS

Project: <u>Stark Residences at Old Wellington</u>	Date: <u>8/25/2020</u>
Location: <u>534 & 550 Old Wellington Road</u>	Job No.: <u>2004201</u>

INPUTS

Q	5.6	cfs	peak flow in the 25-year 24-hr storm event
Tw	0.89	ft	tailwater at the end of apron
d _o	1.5	ft	diameter in feet of outlet

OUTPUTS

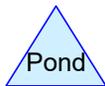
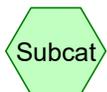
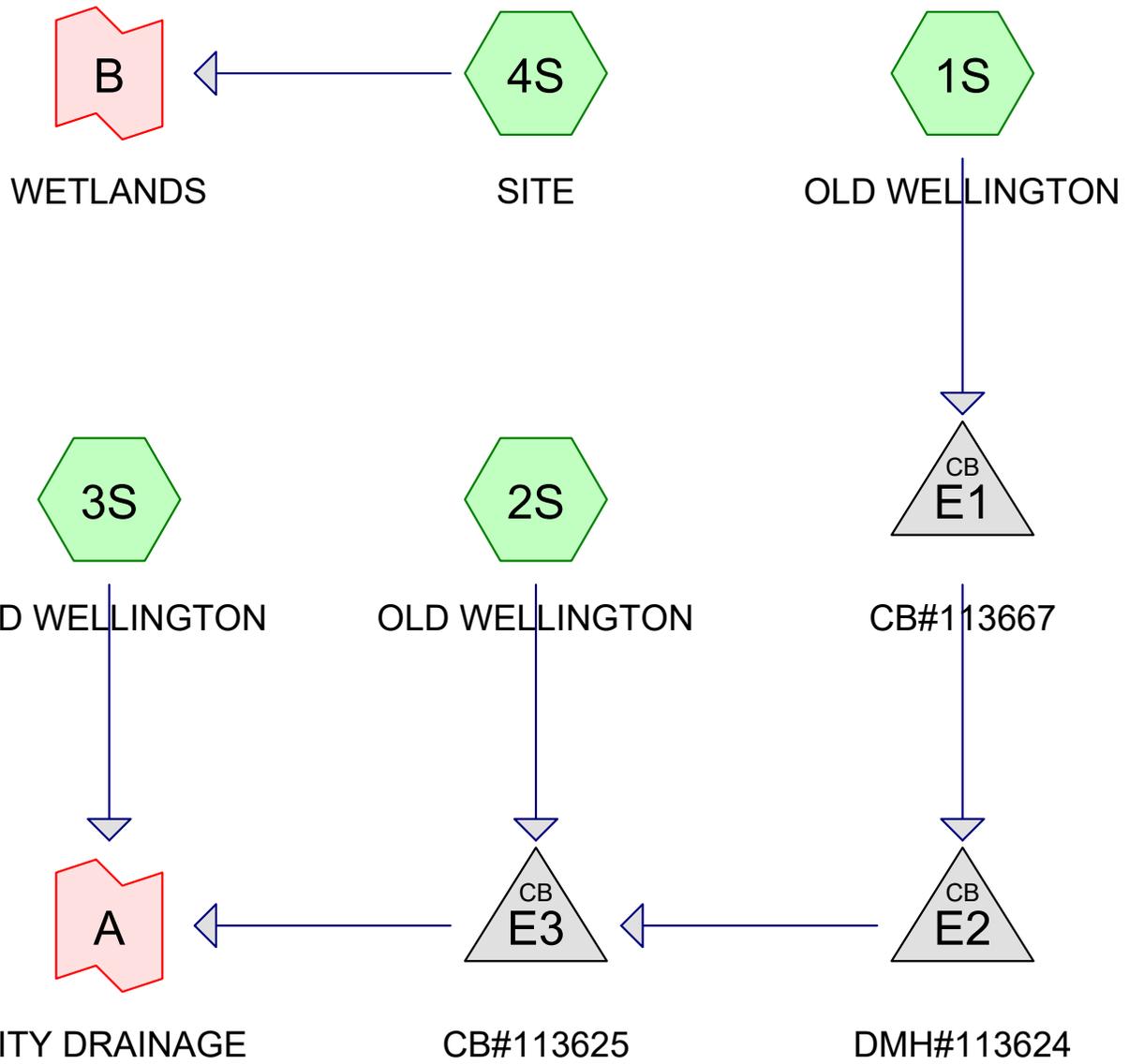
	D ₅₀	0.15	in	median stone size (ft)
Common	D ₅₀	4.00	in	median stone size (ft)
Riprap Depth		10	in	(min. 10 inches)
	L1 OR 2	18	ft	L1 and L2 differ depending if TW is > or < D0/2
	W1	12	ft	
	W2	5	ft	

Equations

$$D_{50} = \frac{C}{Tw} \left[\frac{Q}{d_o} \right]^{4/3}$$

D ₅₀	median stone size (ft)
Q	design discharge (cfs)
Tw	tailwater depth above the invert of the culvert (ft)
d _o	pipe diameter (ft)

8. HYDROCAD DRAINAGE ANALYSIS



Routing Diagram for PRE-DEVELOPMENT
 Prepared by Granite Engineering, LLC, Printed 8/31/2020
 HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

PRE-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Printed 8/31/2020

Page 2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.802	61.0	>75% Grass cover, Good, HSG B (1S, 2S, 3S, 4S)
0.662	98.0	Paved parking, HSG B (1S, 2S, 3S, 4S)
0.771	55.0	Woods, Good, HSG B (2S, 3S, 4S)
0.052	77.0	Woods, Good, HSG D (4S)
2.288	70.0	TOTAL AREA

PRE-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Printed 8/31/2020

Page 3

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
2.235	HSG B	1S, 2S, 3S, 4S
0.000	HSG C	
0.052	HSG D	4S
0.000	Other	
2.288		TOTAL AREA

PRE-DEVELOPMENT

Type III 24-hr 25YR Rainfall=5.43"

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 4

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points x 2
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: OLD WELLINGTON Runoff Area=4,406 sf 94.10% Impervious Runoff Depth>4.94"
Tc=6.0 min CN=95.8 Runoff=0.52 cfs 0.042 af

Subcatchment2S: OLD WELLINGTON Runoff Area=1,922 sf 89.75% Impervious Runoff Depth>4.70"
Tc=6.0 min CN=93.8 Runoff=0.22 cfs 0.017 af

Subcatchment3S: OLD WELLINGTON Runoff Area=4,212 sf 62.46% Impervious Runoff Depth>3.58"
Tc=6.0 min CN=83.1 Runoff=0.39 cfs 0.029 af

Subcatchment4S: SITE Runoff Area=89,109 sf 22.81% Impervious Runoff Depth>2.16"
Flow Length=284' Tc=13.4 min CN=67.6 Runoff=3.96 cfs 0.367 af

Pond E1: CB#113667 Peak Elev=353.02' Inflow=0.52 cfs 0.042 af
12.0" Round Culvert n=0.012 L=20.5' S=0.1317 '/ Outflow=0.52 cfs 0.042 af

Pond E2: DMH#113624 Peak Elev=350.26' Inflow=0.52 cfs 0.042 af
21.0" Round Culvert n=0.012 L=102.7' S=0.0500 '/ Outflow=0.52 cfs 0.042 af

Pond E3: CB#113625 Peak Elev=345.55' Inflow=0.74 cfs 0.059 af
12.0" Round Culvert n=0.012 L=35.9' S=0.0276 '/ Outflow=0.74 cfs 0.059 af

Link A: CITY DRAINAGE Inflow=1.13 cfs 0.088 af
Primary=1.13 cfs 0.088 af

Link B: WETLANDS Inflow=3.96 cfs 0.367 af
Primary=3.96 cfs 0.367 af

Total Runoff Area = 2.288 ac Runoff Volume = 0.455 af Average Runoff Depth = 2.39"
71.07% Pervious = 1.626 ac 28.93% Impervious = 0.662 ac

PRE-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=5.43"

Printed 8/31/2020

Page 5

Summary for Subcatchment 1S: OLD WELLINGTON

Runoff = 0.52 cfs @ 12.09 hrs, Volume= 0.042 af, Depth> 4.94"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
260	61.0	>75% Grass cover, Good, HSG B
0	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
4,146	98.0	Paved parking, HSG B
4,406	95.8	Weighted Average
260		5.90% Pervious Area
4,146		94.10% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 2S: OLD WELLINGTON

Runoff = 0.22 cfs @ 12.09 hrs, Volume= 0.017 af, Depth> 4.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
60	61.0	>75% Grass cover, Good, HSG B
137	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
1,725	98.0	Paved parking, HSG B
1,922	93.8	Weighted Average
197		10.25% Pervious Area
1,725		89.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 3S: OLD WELLINGTON

Runoff = 0.39 cfs @ 12.09 hrs, Volume= 0.029 af, Depth> 3.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

PRE-DEVELOPMENT

Type III 24-hr 25YR Rainfall=5.43"

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 6

Area (sf)	CN	Description
905	61.0	>75% Grass cover, Good, HSG B
676	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
2,631	98.0	Paved parking, HSG B
4,212	83.1	Weighted Average
1,581		37.54% Pervious Area
2,631		62.46% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 4S: SITE

Runoff = 3.96 cfs @ 12.20 hrs, Volume= 0.367 af, Depth> 2.16"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
33,724	61.0	>75% Grass cover, Good, HSG B
32,779	55.0	Woods, Good, HSG B
2,282	77.0	Woods, Good, HSG D
20,324	98.0	Paved parking, HSG B
89,109	67.6	Weighted Average
68,785		77.19% Pervious Area
20,324		22.81% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.7	50	0.0330	0.08		Sheet Flow, Woods: Light underbrush n= 0.400 P2= 2.86"
0.6	31	0.0270	0.82		Shallow Concentrated Flow, Woodland Kv= 5.0 fps
0.7	42	0.0210	1.01		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.5	92	0.0200	2.87		Shallow Concentrated Flow, Paved Kv= 20.3 fps
0.8	69	0.0380	1.36		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
13.4	284	Total			

Summary for Pond E1: CB#113667

Inflow Area = 0.101 ac, 94.10% Impervious, Inflow Depth > 4.94" for 25YR event
 Inflow = 0.52 cfs @ 12.09 hrs, Volume= 0.042 af
 Outflow = 0.52 cfs @ 12.09 hrs, Volume= 0.042 af, Atten= 0%, Lag= 0.0 min
 Primary = 0.52 cfs @ 12.09 hrs, Volume= 0.042 af

PRE-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=5.43"

Printed 8/31/2020

Page 7

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 353.02' @ 12.09 hrs

Flood Elev= 356.83'

Device	Routing	Invert	Outlet Devices
#1	Primary	352.66'	12.0" Round Culvert L= 20.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 352.66' / 349.96' S= 0.1317 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Primary OutFlow Max=0.50 cfs @ 12.09 hrs HW=353.01' TW=350.26' (Dynamic Tailwater)

↑**1=Culvert** (Inlet Controls 0.50 cfs @ 2.02 fps)

Summary for Pond E2: DMH#113624

Inflow Area = 0.101 ac, 94.10% Impervious, Inflow Depth > 4.94" for 25YR event
Inflow = 0.52 cfs @ 12.09 hrs, Volume= 0.042 af
Outflow = 0.52 cfs @ 12.09 hrs, Volume= 0.042 af, Atten= 0%, Lag= 0.0 min
Primary = 0.52 cfs @ 12.09 hrs, Volume= 0.042 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 350.26' @ 12.09 hrs

Flood Elev= 355.79'

Device	Routing	Invert	Outlet Devices
#1	Primary	349.96'	21.0" Round Culvert L= 102.7' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 349.96' / 344.83' S= 0.0500 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 2.41 sf

Primary OutFlow Max=0.50 cfs @ 12.09 hrs HW=350.26' TW=345.54' (Dynamic Tailwater)

↑**1=Culvert** (Inlet Controls 0.50 cfs @ 1.86 fps)

Summary for Pond E3: CB#113625

Inflow Area = 0.145 ac, 92.78% Impervious, Inflow Depth > 4.87" for 25YR event
Inflow = 0.74 cfs @ 12.09 hrs, Volume= 0.059 af
Outflow = 0.74 cfs @ 12.09 hrs, Volume= 0.059 af, Atten= 0%, Lag= 0.0 min
Primary = 0.74 cfs @ 12.09 hrs, Volume= 0.059 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2

Peak Elev= 345.55' @ 12.09 hrs

Flood Elev= 350.08'

Device	Routing	Invert	Outlet Devices
#1	Primary	345.11'	12.0" Round Culvert L= 35.9' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 345.11' / 344.12' S= 0.0276 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

PRE-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=5.43"

Printed 8/31/2020

Page 8

Primary OutFlow Max=0.72 cfs @ 12.09 hrs HW=345.54' TW=0.00' (Dynamic Tailwater)

↑1=Culvert (Inlet Controls 0.72 cfs @ 2.23 fps)

Summary for Link A: CITY DRAINAGE

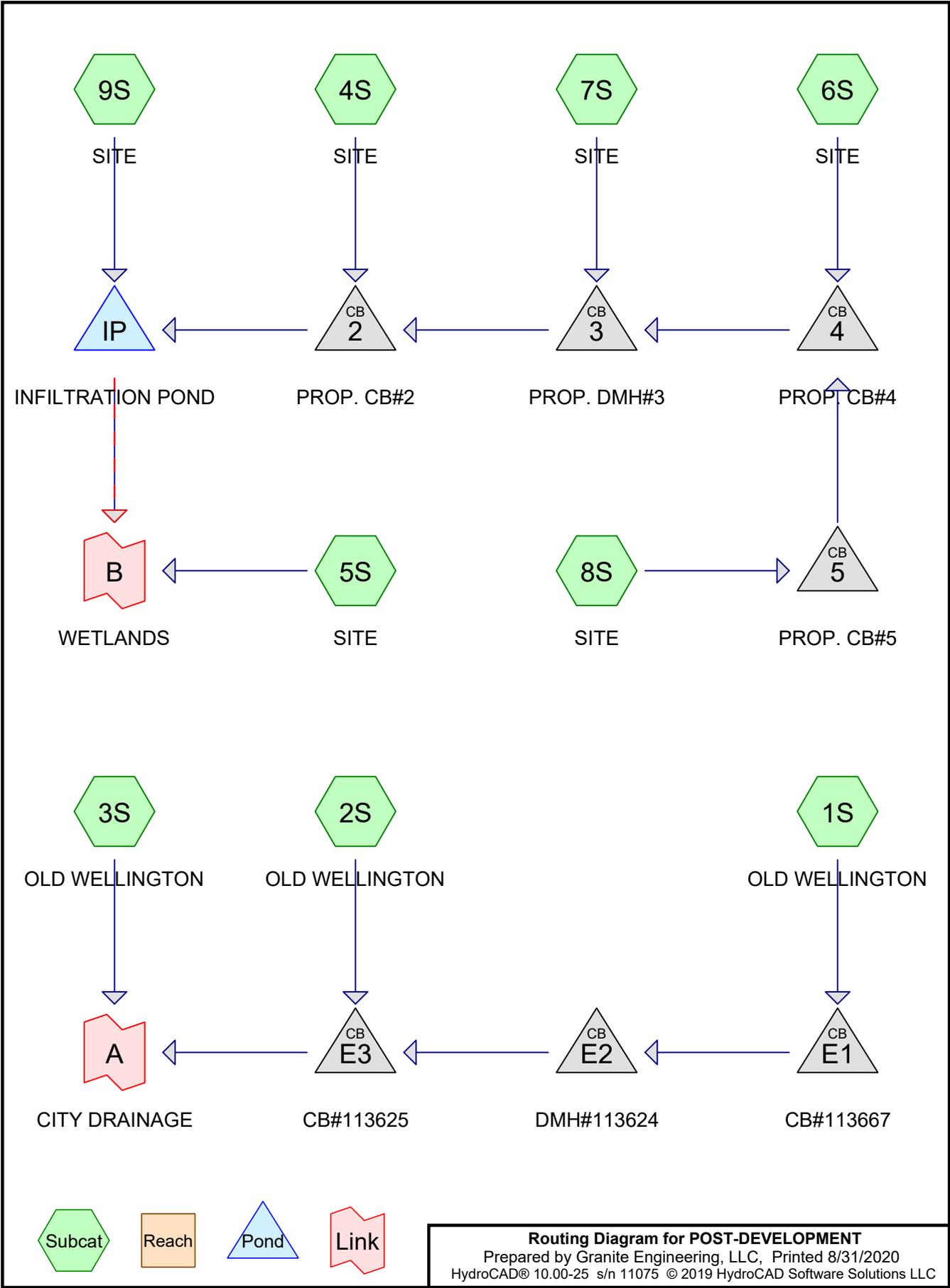
Inflow Area = 0.242 ac, 80.66% Impervious, Inflow Depth > 4.35" for 25YR event
Inflow = 1.13 cfs @ 12.09 hrs, Volume= 0.088 af
Primary = 1.13 cfs @ 12.09 hrs, Volume= 0.088 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link B: WETLANDS

Inflow Area = 2.046 ac, 22.81% Impervious, Inflow Depth > 2.16" for 25YR event
Inflow = 3.96 cfs @ 12.20 hrs, Volume= 0.367 af
Primary = 3.96 cfs @ 12.20 hrs, Volume= 0.367 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs



POST-DEVELOPMENT

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 2

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
0.828	61.0	>75% Grass cover, Good, HSG B (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S)
1.233	98.0	Paved parking, HSG B (1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S)
0.175	55.0	Woods, Good, HSG B (5S, 7S, 9S)
0.052	77.0	Woods, Good, HSG D (5S)
2.288	80.8	TOTAL AREA

POST-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Printed 8/31/2020

Page 3

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
2.235	HSG B	1S, 2S, 3S, 4S, 5S, 6S, 7S, 8S, 9S
0.000	HSG C	
0.052	HSG D	5S
0.000	Other	
2.288		TOTAL AREA

POST-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=5.43"

Printed 8/31/2020

Page 4

Time span=0.00-24.00 hrs, dt=0.05 hrs, 481 points x 2
 Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
 Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment1S: OLD WELLINGTON	Runoff Area=4,363 sf 95.03% Impervious Runoff Depth>4.98" Tc=6.0 min CN=96.2 Runoff=0.51 cfs 0.042 af
Subcatchment2S: OLD WELLINGTON	Runoff Area=2,559 sf 84.33% Impervious Runoff Depth>4.53" Tc=6.0 min CN=92.2 Runoff=0.29 cfs 0.022 af
Subcatchment3S: OLD WELLINGTON	Runoff Area=2,676 sf 82.25% Impervious Runoff Depth>4.44" Tc=6.0 min CN=91.4 Runoff=0.30 cfs 0.023 af
Subcatchment4S: SITE	Runoff Area=5,891 sf 84.45% Impervious Runoff Depth>4.53" Tc=6.0 min CN=92.2 Runoff=0.66 cfs 0.051 af
Subcatchment5S: SITE	Runoff Area=25,455 sf 24.62% Impervious Runoff Depth>2.40" Flow Length=247' Tc=6.8 min CN=70.5 Runoff=1.57 cfs 0.117 af
Subcatchment6S: SITE	Runoff Area=20,727 sf 86.16% Impervious Runoff Depth>4.60" Tc=6.0 min CN=92.9 Runoff=2.35 cfs 0.183 af
Subcatchment7S: SITE	Runoff Area=13,001 sf 34.63% Impervious Runoff Depth>2.58" Tc=6.0 min CN=72.5 Runoff=0.88 cfs 0.064 af
Subcatchment8S: SITE	Runoff Area=17,705 sf 63.06% Impervious Runoff Depth>3.70" Tc=6.0 min CN=84.3 Runoff=1.71 cfs 0.125 af
Subcatchment9S: SITE	Runoff Area=7,268 sf 5.83% Impervious Runoff Depth>1.77" Tc=6.0 min CN=62.8 Runoff=0.32 cfs 0.025 af
Pond 2: PROP. CB#2	Peak Elev=345.71' Inflow=5.60 cfs 0.423 af 18.0" Round Culvert n=0.013 L=7.0' S=0.0057 '/' Outflow=5.60 cfs 0.423 af
Pond 3: PROP. DMH#3	Peak Elev=345.75' Inflow=4.94 cfs 0.372 af 18.0" Round Culvert n=0.013 L=98.0' S=0.0050 '/' Outflow=4.94 cfs 0.372 af
Pond 4: PROP. CB#4	Peak Elev=346.20' Inflow=4.05 cfs 0.308 af 15.0" Round Culvert n=0.013 L=88.0' S=0.0050 '/' Outflow=4.05 cfs 0.308 af
Pond 5: PROP. CB#5	Peak Elev=346.03' Inflow=1.71 cfs 0.125 af 15.0" Round Culvert n=0.013 L=17.0' S=0.0053 '/' Outflow=1.71 cfs 0.125 af
Pond E1: CB#113667	Peak Elev=353.02' Inflow=0.51 cfs 0.042 af 12.0" Round Culvert n=0.012 L=20.5' S=0.1317 '/' Outflow=0.51 cfs 0.042 af
Pond E2: DMH#113624	Peak Elev=350.26' Inflow=0.51 cfs 0.042 af 21.0" Round Culvert n=0.012 L=102.7' S=0.0500 '/' Outflow=0.51 cfs 0.042 af
Pond E3: CB#113625	Peak Elev=345.57' Inflow=0.80 cfs 0.064 af 12.0" Round Culvert n=0.012 L=35.9' S=0.0276 '/' Outflow=0.80 cfs 0.064 af

POST-DEVELOPMENT

Type III 24-hr 25YR Rainfall=5.43"

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 5

Pond IP: INFILTRATIONPOND

Peak Elev=345.58' Storage=8,034 cf Inflow=5.92 cfs 0.448 af
Discarded=0.15 cfs 0.158 af Primary=2.81 cfs 0.156 af Outflow=2.96 cfs 0.314 af

Link A: CITY DRAINAGE

Inflow=1.10 cfs 0.086 af
Primary=1.10 cfs 0.086 af

Link B: WETLANDS

Inflow=3.69 cfs 0.273 af
Primary=3.69 cfs 0.273 af

Total Runoff Area = 2.288 ac Runoff Volume = 0.651 af Average Runoff Depth = 3.42"
46.11% Pervious = 1.055 ac 53.89% Impervious = 1.233 ac

POST-DEVELOPMENT

Type III 24-hr 25YR Rainfall=5.43"

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 6

Summary for Subcatchment 1S: OLD WELLINGTON

Runoff = 0.51 cfs @ 12.09 hrs, Volume= 0.042 af, Depth> 4.98"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
217	61.0	>75% Grass cover, Good, HSG B
0	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
4,146	98.0	Paved parking, HSG B
4,363	96.2	Weighted Average
217		4.97% Pervious Area
4,146		95.03% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 2S: OLD WELLINGTON

Runoff = 0.29 cfs @ 12.09 hrs, Volume= 0.022 af, Depth> 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
401	61.0	>75% Grass cover, Good, HSG B
0	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
2,158	98.0	Paved parking, HSG B
2,559	92.2	Weighted Average
401		15.67% Pervious Area
2,158		84.33% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 3S: OLD WELLINGTON

Runoff = 0.30 cfs @ 12.09 hrs, Volume= 0.023 af, Depth> 4.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

POST-DEVELOPMENT

Type III 24-hr 25YR Rainfall=5.43"

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 7

Area (sf)	CN	Description
475	61.0	>75% Grass cover, Good, HSG B
0	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
2,201	98.0	Paved parking, HSG B
2,676	91.4	Weighted Average
475		17.75% Pervious Area
2,201		82.25% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 4S: SITE

Runoff = 0.66 cfs @ 12.09 hrs, Volume= 0.051 af, Depth> 4.53"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
916	61.0	>75% Grass cover, Good, HSG B
0	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
4,975	98.0	Paved parking, HSG B
5,891	92.2	Weighted Average
916		15.55% Pervious Area
4,975		84.45% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 5S: SITE

Runoff = 1.57 cfs @ 12.11 hrs, Volume= 0.117 af, Depth> 2.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
12,484	61.0	>75% Grass cover, Good, HSG B
4,421	55.0	Woods, Good, HSG B
2,282	77.0	Woods, Good, HSG D
6,268	98.0	Paved parking, HSG B
25,455	70.5	Weighted Average
19,187		75.38% Pervious Area
6,268		24.62% Impervious Area

POST-DEVELOPMENT

Type III 24-hr 25YR Rainfall=5.43"

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 8

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.4	35	0.0290	0.17		Sheet Flow, Range n= 0.130 P2= 2.86"
1.0	15	0.1400	0.24		Sheet Flow, Grass: Short n= 0.150 P2= 2.86"
1.6	123	0.0320	1.25		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.2	29	0.1400	2.62		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
0.5	45	0.0440	1.47		Shallow Concentrated Flow, Short Grass Pasture Kv= 7.0 fps
6.8	247	Total			

Summary for Subcatchment 6S: SITE

Runoff = 2.35 cfs @ 12.09 hrs, Volume= 0.183 af, Depth> 4.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
2,869	61.0	>75% Grass cover, Good, HSG B
0	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
17,858	98.0	Paved parking, HSG B
20,727	92.9	Weighted Average
2,869		13.84% Pervious Area
17,858		86.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 7S: SITE

Runoff = 0.88 cfs @ 12.09 hrs, Volume= 0.064 af, Depth> 2.58"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
5,722	61.0	>75% Grass cover, Good, HSG B
2,777	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
4,502	98.0	Paved parking, HSG B
13,001	72.5	Weighted Average
8,499		65.37% Pervious Area
4,502		34.63% Impervious Area

POST-DEVELOPMENT

Type III 24-hr 25YR Rainfall=5.43"

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 9

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 8S: SITE

Runoff = 1.71 cfs @ 12.09 hrs, Volume= 0.125 af, Depth> 3.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
6,540	61.0	>75% Grass cover, Good, HSG B
0	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
11,165	98.0	Paved parking, HSG B
17,705	84.3	Weighted Average
6,540		36.94% Pervious Area
11,165		63.06% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

Summary for Subcatchment 9S: SITE

Runoff = 0.32 cfs @ 12.10 hrs, Volume= 0.025 af, Depth> 1.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs
Type III 24-hr 25YR Rainfall=5.43"

Area (sf)	CN	Description
6,437	61.0	>75% Grass cover, Good, HSG B
407	55.0	Woods, Good, HSG B
0	77.0	Woods, Good, HSG D
424	98.0	Paved parking, HSG B
7,268	62.8	Weighted Average
6,844		94.17% Pervious Area
424		5.83% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					Direct Entry,

POST-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=5.43"

Printed 8/31/2020

Page 10

Summary for Pond 2: PROP. CB#2

Inflow Area = 1.316 ac, 67.16% Impervious, Inflow Depth > 3.86" for 25YR event
Inflow = 5.60 cfs @ 12.09 hrs, Volume= 0.423 af
Outflow = 5.60 cfs @ 12.09 hrs, Volume= 0.423 af, Atten= 0%, Lag= 0.0 min
Primary = 5.60 cfs @ 12.09 hrs, Volume= 0.423 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 345.71' @ 12.19 hrs
Flood Elev= 346.90'

Device	Routing	Invert	Outlet Devices
#1	Primary	342.32'	18.0" Round Culvert L= 7.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 342.32' / 342.28' S= 0.0057 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=5.47 cfs @ 12.09 hrs HW=345.48' TW=345.07' (Dynamic Tailwater)
↑1=Culvert (Inlet Controls 5.47 cfs @ 3.10 fps)

Summary for Pond 3: PROP. DMH#3

Inflow Area = 1.181 ac, 65.18% Impervious, Inflow Depth > 3.78" for 25YR event
Inflow = 4.94 cfs @ 12.09 hrs, Volume= 0.372 af
Outflow = 4.94 cfs @ 12.09 hrs, Volume= 0.372 af, Atten= 0%, Lag= 0.0 min
Primary = 4.94 cfs @ 12.09 hrs, Volume= 0.372 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 345.75' @ 12.26 hrs
Flood Elev= 350.16'

Device	Routing	Invert	Outlet Devices
#1	Primary	342.91'	18.0" Round Culvert L= 98.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 342.91' / 342.42' S= 0.0050 '/' Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.77 sf

Primary OutFlow Max=1.43 cfs @ 12.09 hrs HW=345.51' TW=345.48' (Dynamic Tailwater)
↑1=Culvert (Outlet Controls 1.43 cfs @ 0.81 fps)

Summary for Pond 4: PROP. CB#4

Inflow Area = 0.882 ac, 75.52% Impervious, Inflow Depth > 4.19" for 25YR event
Inflow = 4.05 cfs @ 12.09 hrs, Volume= 0.308 af
Outflow = 4.05 cfs @ 12.09 hrs, Volume= 0.308 af, Atten= 0%, Lag= 0.0 min
Primary = 4.05 cfs @ 12.09 hrs, Volume= 0.308 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 346.20' @ 12.14 hrs
Flood Elev= 347.23'

POST-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=5.43"

Printed 8/31/2020

Page 11

Device	Routing	Invert	Outlet Devices
#1	Primary	343.60'	15.0" Round Culvert L= 88.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 343.60' / 343.16' S= 0.0050 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=3.61 cfs @ 12.09 hrs HW=345.98' TW=345.50' (Dynamic Tailwater)
↑**1=Culvert** (Outlet Controls 3.61 cfs @ 2.94 fps)

Summary for Pond 5: PROP. CB#5

Inflow Area = 0.406 ac, 63.06% Impervious, Inflow Depth > 3.70" for 25YR event
Inflow = 1.71 cfs @ 12.09 hrs, Volume= 0.125 af
Outflow = 1.71 cfs @ 12.09 hrs, Volume= 0.125 af, Atten= 0%, Lag= 0.0 min
Primary = 1.71 cfs @ 12.09 hrs, Volume= 0.125 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 346.03' @ 12.15 hrs
Flood Elev= 347.04'

Device	Routing	Invert	Outlet Devices
#1	Primary	343.79'	15.0" Round Culvert L= 17.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 343.79' / 343.70' S= 0.0053 '/ Cc= 0.900 n= 0.013 Corrugated PE, smooth interior, Flow Area= 1.23 sf

Primary OutFlow Max=0.00 cfs @ 12.09 hrs HW=345.71' TW=346.00' (Dynamic Tailwater)
↑**1=Culvert** (Controls 0.00 cfs)

Summary for Pond E1: CB#113667

Inflow Area = 0.100 ac, 95.03% Impervious, Inflow Depth > 4.98" for 25YR event
Inflow = 0.51 cfs @ 12.09 hrs, Volume= 0.042 af
Outflow = 0.51 cfs @ 12.09 hrs, Volume= 0.042 af, Atten= 0%, Lag= 0.0 min
Primary = 0.51 cfs @ 12.09 hrs, Volume= 0.042 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 353.02' @ 12.09 hrs
Flood Elev= 356.83'

Device	Routing	Invert	Outlet Devices
#1	Primary	352.66'	12.0" Round Culvert L= 20.5' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 352.66' / 349.96' S= 0.1317 '/ Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Primary OutFlow Max=0.50 cfs @ 12.09 hrs HW=353.01' TW=350.26' (Dynamic Tailwater)
↑**1=Culvert** (Inlet Controls 0.50 cfs @ 2.02 fps)

POST-DEVELOPMENT

Prepared by Granite Engineering, LLC

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Type III 24-hr 25YR Rainfall=5.43"

Printed 8/31/2020

Page 12

Summary for Pond E2: DMH#113624

Inflow Area = 0.100 ac, 95.03% Impervious, Inflow Depth > 4.98" for 25YR event
Inflow = 0.51 cfs @ 12.09 hrs, Volume= 0.042 af
Outflow = 0.51 cfs @ 12.09 hrs, Volume= 0.042 af, Atten= 0%, Lag= 0.0 min
Primary = 0.51 cfs @ 12.09 hrs, Volume= 0.042 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 350.26' @ 12.09 hrs
Flood Elev= 355.79'

Device	Routing	Invert	Outlet Devices
#1	Primary	349.96'	21.0" Round Culvert L= 102.7' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 349.96' / 344.83' S= 0.0500 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 2.41 sf

Primary OutFlow Max=0.50 cfs @ 12.09 hrs HW=350.26' TW=345.56' (Dynamic Tailwater)
↑1=Culvert (Inlet Controls 0.50 cfs @ 1.85 fps)

Summary for Pond E3: CB#113625

Inflow Area = 0.159 ac, 91.07% Impervious, Inflow Depth > 4.81" for 25YR event
Inflow = 0.80 cfs @ 12.09 hrs, Volume= 0.064 af
Outflow = 0.80 cfs @ 12.09 hrs, Volume= 0.064 af, Atten= 0%, Lag= 0.0 min
Primary = 0.80 cfs @ 12.09 hrs, Volume= 0.064 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 345.57' @ 12.09 hrs
Flood Elev= 350.08'

Device	Routing	Invert	Outlet Devices
#1	Primary	345.11'	12.0" Round Culvert L= 35.9' RCP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 345.11' / 344.12' S= 0.0276 '/' Cc= 0.900 n= 0.012 Concrete pipe, finished, Flow Area= 0.79 sf

Primary OutFlow Max=0.78 cfs @ 12.09 hrs HW=345.56' TW=0.00' (Dynamic Tailwater)
↑1=Culvert (Inlet Controls 0.78 cfs @ 2.28 fps)

Summary for Pond IP: INFILTRATION POND

Inflow Area = 1.483 ac, 60.26% Impervious, Inflow Depth > 3.62" for 25YR event
Inflow = 5.92 cfs @ 12.09 hrs, Volume= 0.448 af
Outflow = 2.96 cfs @ 12.26 hrs, Volume= 0.314 af, Atten= 50%, Lag= 10.3 min
Discarded = 0.15 cfs @ 12.26 hrs, Volume= 0.158 af
Primary = 2.81 cfs @ 12.26 hrs, Volume= 0.156 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs / 2

POST-DEVELOPMENT

Type III 24-hr 25YR Rainfall=5.43"

Prepared by Granite Engineering, LLC

Printed 8/31/2020

HydroCAD® 10.00-25 s/n 11075 © 2019 HydroCAD Software Solutions LLC

Page 13

Peak Elev= 345.58' @ 12.26 hrs Surf.Area= 3,119 sf Storage= 8,034 cf
 Flood Elev= 346.00' Surf.Area= 3,374 sf Storage= 9,394 cf

Plug-Flow detention time= 204.8 min calculated for 0.314 af (70% of inflow)
 Center-of-Mass det. time= 110.4 min (908.4 - 797.9)

Volume	Invert	Avail.Storage	Storage Description
#1	340.00'	9,394 cf	Infiltration Pond (Irregular) Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
340.00	419	96.3	0	0	419
342.00	906	143.0	1,294	1,294	1,340
343.99	1,640	196.5	2,497	3,792	2,824
344.00	2,247	269.3	19	3,811	5,523
346.00	3,374	294.4	5,583	9,394	6,782

Device	Routing	Invert	Outlet Devices
#1	Primary	345.25'	6.0' long x 6.0' breadth Broad-Crested Rectangular Weir Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.37 2.51 2.70 2.68 2.68 2.67 2.65 2.65 2.65 2.65 2.66 2.66 2.67 2.69 2.72 2.76 2.83
#2	Discarded	340.00'	1.000 in/hr Exfiltration over Wetted area Phase-In= 0.01'

Discarded OutFlow Max=0.15 cfs @ 12.26 hrs HW=345.58' (Free Discharge)

↳ **2=Exfiltration** (Exfiltration Controls 0.15 cfs)

Primary OutFlow Max=2.77 cfs @ 12.26 hrs HW=345.58' TW=0.00' (Dynamic Tailwater)

↳ **1=Broad-Crested Rectangular Weir**(Weir Controls 2.77 cfs @ 1.41 fps)

Summary for Link A: CITY DRAINAGE

Inflow Area = 0.220 ac, 88.61% Impervious, Inflow Depth > 4.71" for 25YR event
 Inflow = 1.10 cfs @ 12.09 hrs, Volume= 0.086 af
 Primary = 1.10 cfs @ 12.09 hrs, Volume= 0.086 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

Summary for Link B: WETLANDS

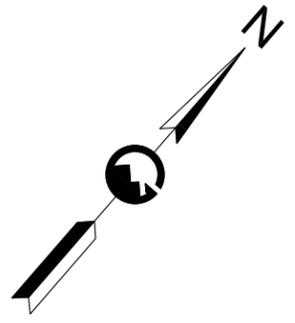
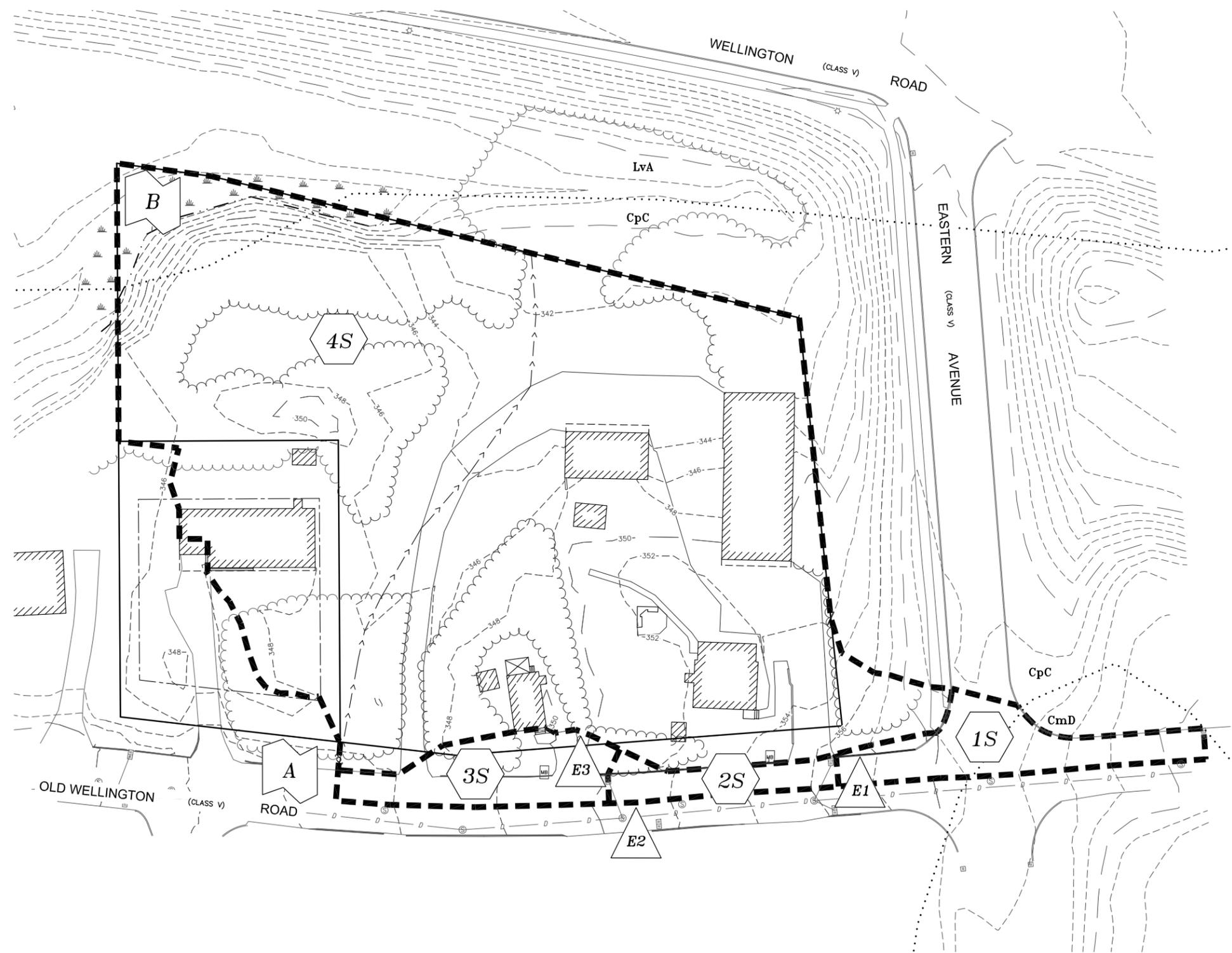
Inflow Area = 2.067 ac, 50.19% Impervious, Inflow Depth > 1.59" for 25YR event
 Inflow = 3.69 cfs @ 12.24 hrs, Volume= 0.273 af
 Primary = 3.69 cfs @ 12.24 hrs, Volume= 0.273 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-24.00 hrs, dt= 0.05 hrs

9. PLANS

- I. PRE-DEVELOPMENT DRAINAGE AREAS PLAN (11"X17")
 - II. POST-DEVELOPMENT DRAINAGE AREAS PLAN (11"X17")
-

NOTES:
 1. THE PURPOSE OF THIS PLAN IS TO DEPICT THE VARIOUS STORMWATER SUBCATCHMENT AREAS, CORRESPONDING TIMES OF CONCENTRATION, PONDS, AND REACHES ASSOCIATED WITH THE SUBJECT PARCEL PRIOR TO REDEVELOPMENT.
 2. EXISTING FEATURES DEPICTED ON THIS PLAN WERE TAKEN FROM EXISTING CONDITIONS & MERGER PLAN, TAX MAP 645 LOTS 4 & 5, 534 & 550 OLD WELLINGTON ROAD, MANCHESTER, NH, 03104* PREPARED BY JOSEPH M. WICHERT, LLS, INC., DATED AUGUST 10, 2020.



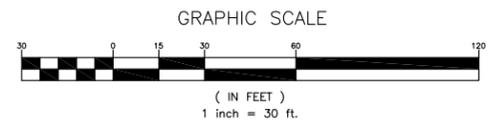
DRAINAGE LEGEND:

THE LEGEND BELOW REFLECTS THE HYDROCAD MODEL USED FOR DRAINAGE CALCULATIONS.

- SCS SOIL LINES
- 140B** DENOTES SOIL TYPE
- P** DENOTES POND
- S** DENOTES SUBCATCHMENT AREA
- R** DENOTES REACH
- L** DENOTES POINT OF INTEREST
- LIMIT OF SUBCATCHMENT AREA
- - - - - TIME OF CONCENTRATION
- - - - - REACH PATH

SCS LEGEND

- CmD** CANTON FINE SANDY LOAM, VERY STONY, 15-25% SLOPES
- CpC** CHATFIELD-HOLLIS-CANTON COMPLEX, 8-15% SLOPES
- LvA** LEICESTER-WALPOLE COMPLEX STONY 0-3% SLOPES



No.	DATE	REVISIONS	COMMENTS	BY
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

OWNER: KEVIN H. BOURGEOIS REVOCABLE TRUST
 KEVIN H. BOURGEOIS, TRUSTEE
 27 HOPKINS ROAD
 NEW BOSTON, NH 03070
 FORD BK: 8626 P.G. 700

APPLICANT: B&T DEVELOPMENT, LLC
 88 TOWNSEND AVENUE
 SALEM, NH 03079

GRANITE ENGINEERING
 civil engineering • land planning • municipal services

250 Commercial Street, Suite 3008
 Manchester, New Hampshire 03101
 603.518.8030

www.GraniteEng.com

STAMP: [Professional Engineer Seal for Jeffrey Merritt, No. 11778, State of New Hampshire, License No. 11778, dated 09/01/2020]

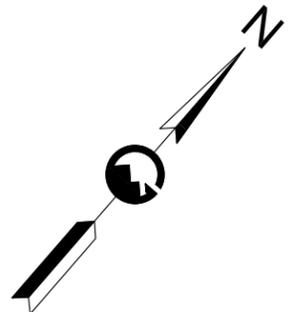
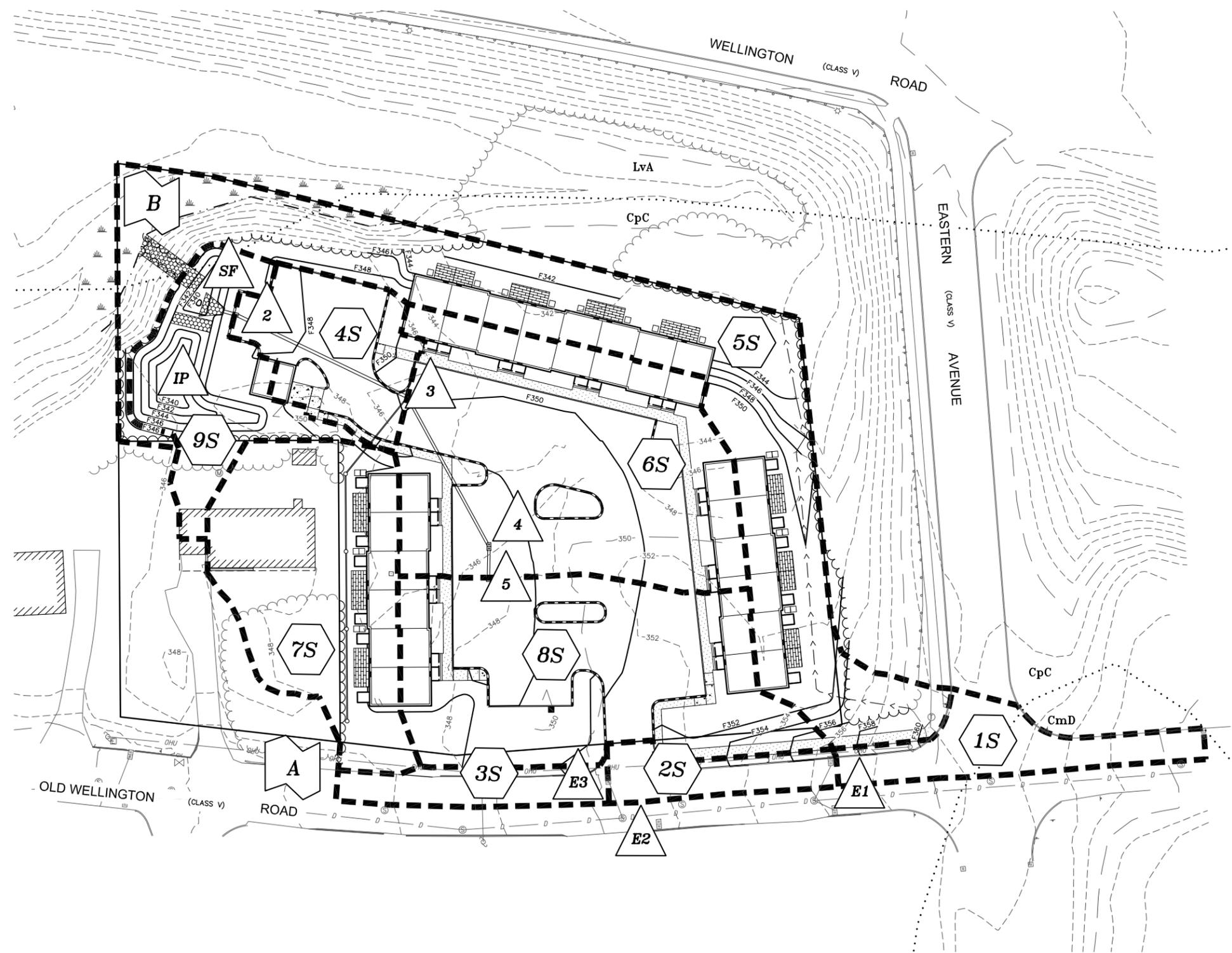
LOCATION:
 TAX MAP 645 LOTS 4 & 5
 534 & 550
 OLD WELLINGTON ROAD
 MANCHESTER, NEW HAMPSHIRE
 HILLSBOROUGH COUNTY

PROJECT:
**STARK RESIDENCES AT
 OLD WELLINGTON**

TITLE:
**PRE-DEVELOPMENT DRAIN
 AREAS PLAN**

PROJECT No. [20-0420-1] DATE: [SEPTEMBER 1, 2020] SCALE: [HORIZ. 1"=30']
 SHEET: [1 OF 2]

NOTES:
 1. THE PURPOSE OF THIS PLAN IS TO DEPICT THE VARIOUS STORMWATER SUBCATCHMENT AREAS, CORRESPONDING TIMES OF CONCENTRATION, PONDS, AND REACHES ASSOCIATED WITH THE SUBJECT PARCEL AFTER DEVELOPMENT.
 2. EXISTING FEATURES DEPICTED ON THIS PLAN WERE TAKEN FROM 'EXISTING CONDITIONS & MERGER PLAN FOR KEVIN H. BOURGEOIS REVOCABLE TRUST' PREPARED BY JOSEPH M. WICHERT LLS, INC. DATED AUGUST 10, 2020.



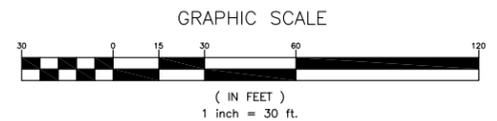
DRAINAGE LEGEND:

THE LEGEND BELOW REFLECTS THE HYDROCAD MODEL USED FOR DRAINAGE CALCULATIONS.

- SCS SOIL LINES
- 140B DENOTES SOIL TYPE
- P DENOTES POND
- S DENOTES SUBCATCHMENT AREA
- R DENOTES REACH
- L DENOTES POINT OF INTEREST
- LIMIT OF SUBCATCHMENT AREA
- - - - - TIME OF CONCENTRATION
- REACH PATH

SCS LEGEND

- CmD CANTON FINE SANDY LOAM, VERY STONY, 15-25% SLOPES
- CpC CHATFIELD-HOLLIS-CANTON COMPLEX, 8-15% SLOPES



No.	DATE	REVISIONS	COMMENTS	BY
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				

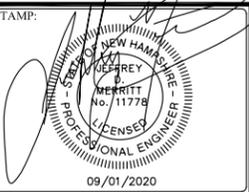
OWNER: KEVIN H. BOURGEOIS REVOCABLE TRUST
 KEVIN H. BOURGEOIS, TRUSTEE
 27 HOPKINS ROAD
 NEW BOSTON, NH 03070
 PH: 603.886.7670

APPLICANT: B&T DEVELOPMENT, LLC
 88 TOWNSEND AVENUE
 SALEM, NH 03079

GRANITE ENGINEERING
 civil engineering • land planning • municipal services

250 Commercial Street, Suite 3008
 Manchester, New Hampshire 03101
 603.518.8030

www.GraniteEng.com



LOCATION:
 TAX MAP 645 LOTS 4 & 5
 534 & 550
 OLD WELLINGTON ROAD
 MANCHESTER, NEW HAMPSHIRE
 HILLSBOROUGH COUNTY

PROJECT:
**STARK RESIDENCES AT
 OLD WELLINGTON**

TITLE:
**POST-DEVELOPMENT DRAIN
 AREAS PLAN**

PROJECT No. / DATE: 20-0420-1 / SEPTEMBER 1, 2020
 SHEET: 2 OF 2
 SCALE: HORIZ. 1"=30'