

Definitive Minor Subdivision Stormwater Report

Proposed Roadway Improvements

40 Ellingwood Court

Beverly, Massachusetts 01915

Prepared For

*Anthony P. Baltas, Trustee
Fresh Water Real Estate Trust
23 School Street
Beverly, MA 01915*

2, 10, & 100 Year Storm
24 Hour Duration



Date: June 6, 2019

George J. Zambouras, P.E.
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(978) 922-0217

INTRODUCTION:

This report describes the pre and post hydraulic analysis and stormwater management measures to be implemented to mitigate the impacts to the environment and surrounding properties in the construction of the Proposed Roadway Improvements project at 40 Ellingwood Court, Beverly, MA.

The design of the stormwater system's components is based on the hydraulic analysis performed utilizing "HydroCAD Storm water Modeling Software" for storm events of 2, 10, and 100-year.

As the project is:

- Exempt from Mass DEP Stormwater Standards
- Limited small scaled project having only 10,500 s.f. of disturbance
- Site containing ledge restrictions

the extend of analysis provided within this report is limited to a brief comparison of pre and post run-off conditions; erosion and sediment control measures to be implemented and TSS removal measures employed.

Additional calculations shall be provided as requested.

PROJECT SCOPE:

The scope of the project is to construct roadway improvements on Ellingwood Court and a single family dwelling at 40 Ellingwood Court an existing vacant lot.

The extent of the area analyzed is limited to the proposed disturbed area of approximately 10,500 s.f.

EXISTING CONDITIONS:

The existing site is a vacant parcel partially used for an extended lawn and use area for 23 School Street. The site consists of lawn and gravel area with shallow bedrock. Soils test (refer to sheet 2 of the drawings) indicate that the upper reaches of the bedrock is fractured and could support infiltration. However, in accordance with the DEP Stormwater Manual no infiltration calculations are provided.

DRAINAGE PATTERNS:

Stormwater runoff flows in a northeast to southwest direction for a majority of the vacant parcel and runoff from within the area of the layout of Ellingwood Court flows in the same northeast to southwest direction then southerly to School Street.

Following the construction of the roadway and development of the site the runoff patterns will remain consistent with existing conditions.

SITE CONDITIONS AND SOILS:

Existing soils within site are identified by the United States Department of Agriculture Natural Resources Conservation Services (NRCS) as Urban Land. This soil type is typically used by NRCS in built out urban areas and lacks any detailed classification by NRCS. A copy of the NRCS Soil Report is appended to this report.

Base on the site soil test were performed on July 19, 2018 and the shallow and exposed ledge within the site a soil classification of “C” is utilized for the comparison of pre and post runoff flows and volumes.

STORMWATER MANAGEMENT AND MITIGATION:

During construction a silt soc erosion barrier is proposed along the down stream extent of disturbance to control erosion and sedimentation.

The mitigate the effects of the added impervious to the extent possible due to shallow bedrock the following devises are proposed:

TSS Removal - Stone filter strip along the westerly edge of the roadway leading to a small grass lined water quality swale. Except for the driveway these components will capture runoff from the proposed roadway along the frontage of the vacant lot.

Recharge: Two rain gardens are proposed one at the northwest corner of the parcel and one at the southeast corners. Runoff from the dwellings roof and from the roadway will be directed to these areas via overland grading to the greatest extent possible.

SUMMARY:

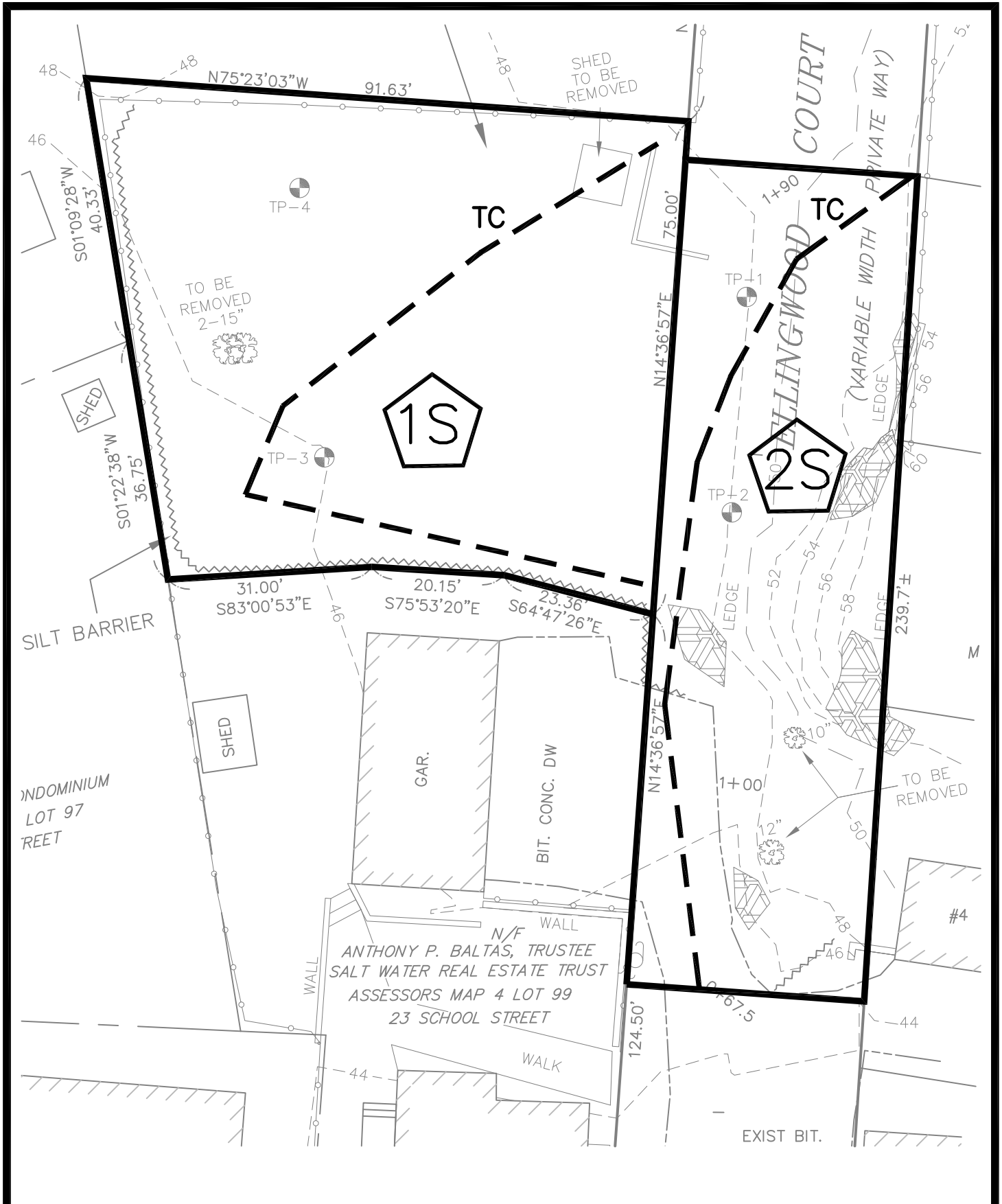
As indicated in the summary below the post development flow rates approximate the pre - development flows with slight increases in runoff volumes for the 2, 10 and 100-year storm.

This summary is without the benefit of any calculated infiltration which may occur within the rain gardens and roadside filter strip.

Summary of Total Site Discharge Flows and Volumes

<i>Design Storm</i>	<i>Pre-Development Max. Discharge (CFS.)</i>	<i>Post-Development Max. Discharge (CFS.)</i>	<i>Pre-Development Max. Volume (Cubic-FT.)</i>	<i>Post-Development Max. Volume (Cubic-FT.)</i>
<i>2 Yr.</i>	<i>0.39</i>	<i>0.43</i>	<i>1,142</i>	<i>1,407</i>
<i>10 Yr.</i>	<i>0.72</i>	<i>0.73</i>	<i>2,101</i>	<i>2,438</i>
<i>100 Yr.</i>	<i>1.20</i>	<i>1.17</i>	<i>3,592</i>	<i>3,990</i>

PRE-DEVELOPMENT CONDITIONS

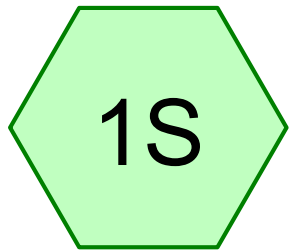


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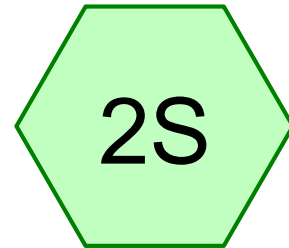
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POST-DEVELOPMENT SUBCATCHMENTS

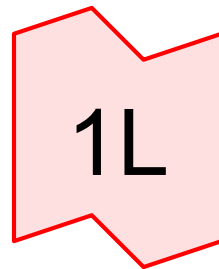
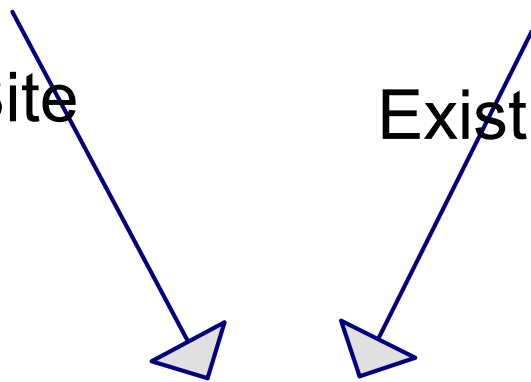
SCALE: 1" = 20' DATE: June 6, 2019



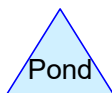
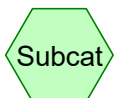
Exist Site



Exist Roadway



Exist Total



40 Ellingwood Court

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Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
8,357	79	50-75% Grass cover, Fair, HSG C (1S, 2S)
1,200	86	<50% Grass cover, Poor, HSG C (1S, 2S)
567	98	Paved parking, HSG C (2S)
301	98	Unconnected Ledge, HSG C (2S)
61	98	Unconnected roofs, HSG C (1S)
10,486	81	TOTAL AREA

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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: Exist Site

Runoff Area=6,005 sf 1.02% Impervious Runoff Depth>1.22"
Flow Length=90' Tc=6.0 min CN=80 Runoff=0.21 cfs 612 cf

Subcatchment 2S: Exist Roadway

Runoff Area=4,481 sf 19.37% Impervious Runoff Depth>1.42"
Flow Length=130' Tc=4.7 min CN=83 Runoff=0.19 cfs 530 cf

Link 1L: Exist Total

Inflow=0.39 cfs 1,142 cf
Primary=0.39 cfs 1,142 cf

Total Runoff Area = 10,486 sf Runoff Volume = 1,142 cf Average Runoff Depth = 1.31"
91.14% Pervious = 9,557 sf 8.86% Impervious = 929 sf

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Summary for Subcatchment 1S: Exist Site

Runoff = 0.21 cfs @ 12.10 hrs, Volume= 612 cf, Depth> 1.22"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
61	98	Unconnected roofs, HSG C
5,144	79	50-75% Grass cover, Fair, HSG C
800	86	<50% Grass cover, Poor, HSG C
6,005	80	Weighted Average
5,944		98.98% Pervious Area
61		1.02% Impervious Area
61		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.7	50	0.0200	0.15		Sheet Flow, Overland Grass: Short n= 0.150 P2= 3.10"
0.3	40	0.0150	1.97		Shallow Concentrated Flow, Overland Unpaved Kv= 16.1 fps
6.0	90	Total			

Summary for Subcatchment 2S: Exist Roadway

Runoff = 0.19 cfs @ 12.07 hrs, Volume= 530 cf, Depth> 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
567	98	Paved parking, HSG C
3,213	79	50-75% Grass cover, Fair, HSG C
400	86	<50% Grass cover, Poor, HSG C
* 301	98	Unconnected Ledge, HSG C
4,481	83	Weighted Average
3,613		80.63% Pervious Area
868		19.37% Impervious Area
301		34.68% Unconnected

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
1.9	32	0.1250	0.28		Sheet Flow, Overland Grass: Short n= 0.150 P2= 3.10"
2.5	18	0.0200	0.12		Sheet Flow, Overland Grass: Short n= 0.150 P2= 3.10"
0.2	40	0.0500	3.60		Shallow Concentrated Flow, Overland Unpaved Kv= 16.1 fps
0.1	40	0.0500	4.54		Shallow Concentrated Flow, Pavement Paved Kv= 20.3 fps
4.7	130	Total			

Summary for Link 1L: Exist Total

Inflow Area = 10,486 sf, 8.86% Impervious, Inflow Depth > 1.31" for 2-Year event
 Inflow = 0.39 cfs @ 12.09 hrs, Volume= 1,142 cf
 Primary = 0.39 cfs @ 12.09 hrs, Volume= 1,142 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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: Exist Site

Runoff Area=6,005 sf 1.02% Impervious Runoff Depth>2.29"
Flow Length=90' Tc=6.0 min CN=80 Runoff=0.39 cfs 1,148 cf

Subcatchment 2S: Exist Roadway

Runoff Area=4,481 sf 19.37% Impervious Runoff Depth>2.55"
Flow Length=130' Tc=4.7 min CN=83 Runoff=0.33 cfs 953 cf

Link 1L: Exist Total

Inflow=0.72 cfs 2,101 cf
Primary=0.72 cfs 2,101 cf

Total Runoff Area = 10,486 sf Runoff Volume = 2,101 cf Average Runoff Depth = 2.40"
91.14% Pervious = 9,557 sf 8.86% Impervious = 929 sf

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40 Ellingwood-Pre Development_060819
Type III 24-hr 100-Year Rainfall=6.50"

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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: Exist Site

Runoff Area=6,005 sf 1.02% Impervious Runoff Depth>3.98"
Flow Length=90' Tc=6.0 min CN=80 Runoff=0.67 cfs 1,989 cf

Subcatchment 2S: Exist Roadway

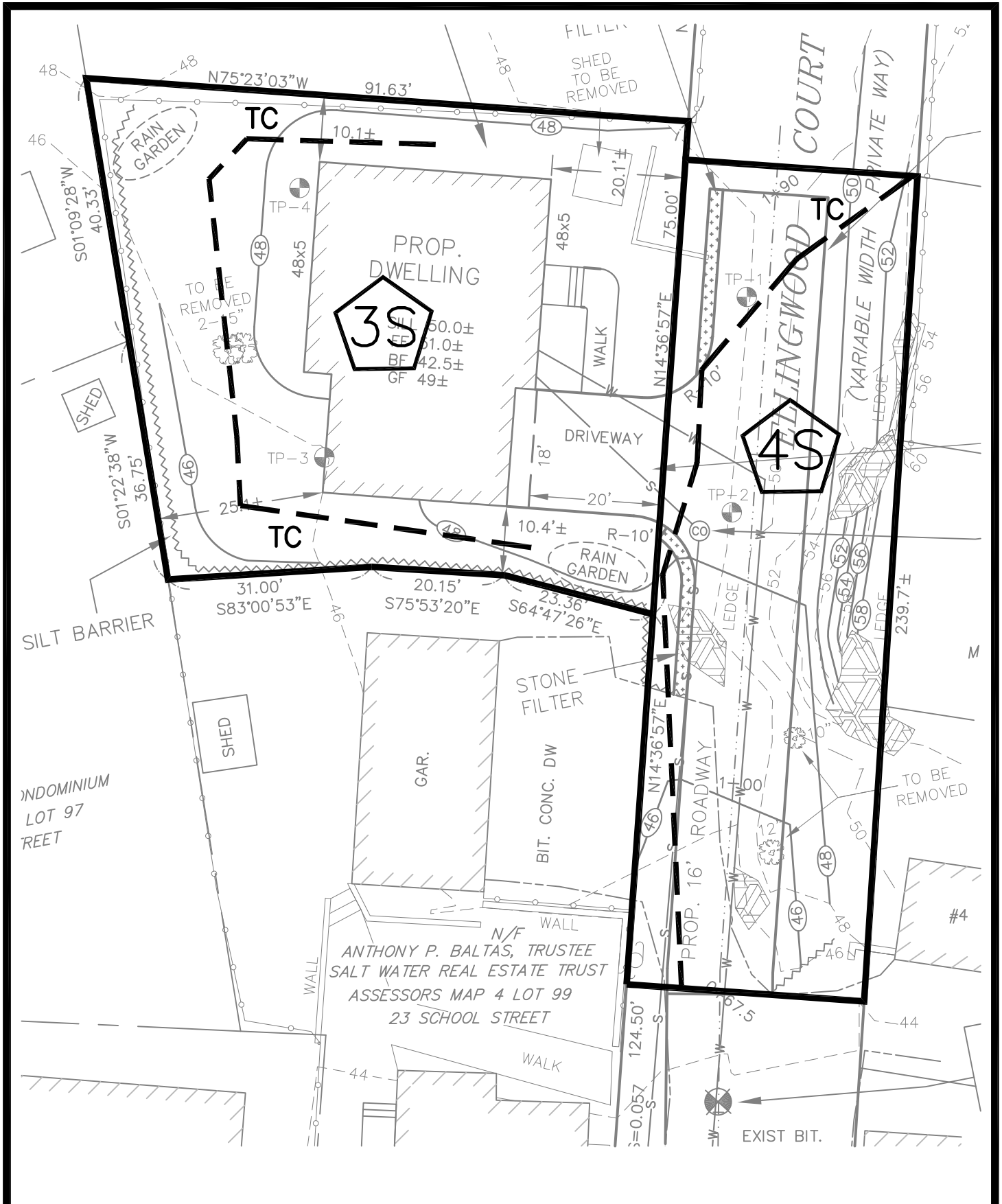
Runoff Area=4,481 sf 19.37% Impervious Runoff Depth>4.29"
Flow Length=130' Tc=4.7 min CN=83 Runoff=0.55 cfs 1,603 cf

Link 1L: Exist Total

Inflow=1.20 cfs 3,592 cf
Primary=1.20 cfs 3,592 cf

Total Runoff Area = 10,486 sf Runoff Volume = 3,592 cf Average Runoff Depth = 4.11"
91.14% Pervious = 9,557 sf 8.86% Impervious = 929 sf

POST-DEVELOPMENT CONDITIONS

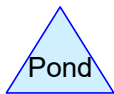
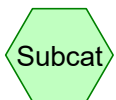
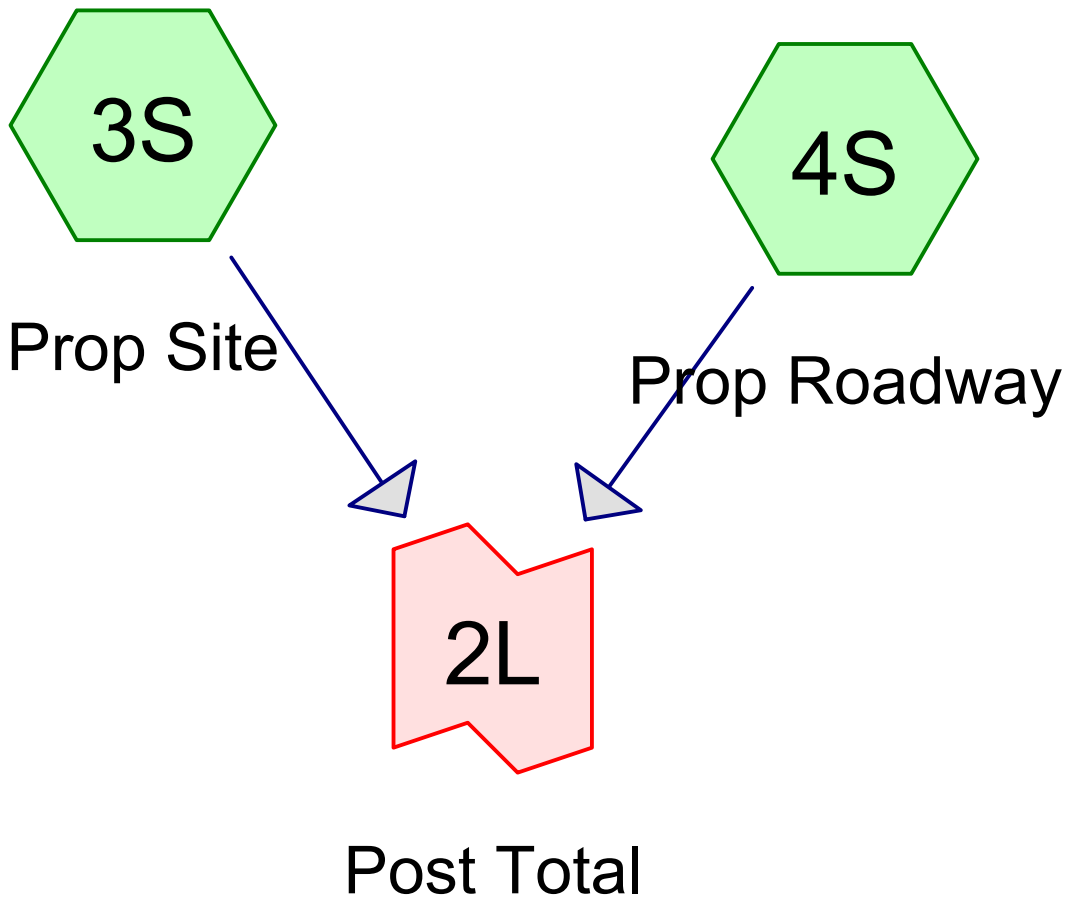


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POST-DEVELOPMENT SUBCATCHMENTS

SCALE: 1" = 20' DATE: June 6, 2019



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Area Listing (selected nodes)

Area (sq-ft)	CN	Description (subcatchment-numbers)
990	79	50-75% Grass cover, Fair, HSG C (4S)
4,678	74	>75% Grass cover, Good, HSG C (3S, 4S)
105	87	Dirt roads, HSG C (4S)
2,872	98	Paved parking, HSG C (3S, 4S)
210	98	Unconnected Ledge, HSG C (4S)
1,631	98	Unconnected roofs, HSG C (3S)
10,486	85	TOTAL AREA

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 3S: Prop Site

Runoff Area=6,005 sf 36.27% Impervious Runoff Depth>1.42"
Flow Length=127' Tc=8.0 min CN=83 Runoff=0.23 cfs 709 cf

Subcatchment 4S: Prop Roadway

Runoff Area=4,481 sf 56.57% Impervious Runoff Depth>1.87"
Flow Length=133' Tc=1.7 min CN=89 Runoff=0.26 cfs 698 cf

Link 2L: Post Total

Inflow=0.43 cfs 1,407 cf
Primary=0.43 cfs 1,407 cf

Total Runoff Area = 10,486 sf Runoff Volume = 1,407 cf Average Runoff Depth = 1.61"
55.05% Pervious = 5,773 sf 44.95% Impervious = 4,713 sf

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Summary for Subcatchment 3S: Prop Site

Runoff = 0.23 cfs @ 12.12 hrs, Volume= 709 cf, Depth> 1.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
1,631	98	Unconnected roofs, HSG C
547	98	Paved parking, HSG C
3,827	74	>75% Grass cover, Good, HSG C
6,005	83	Weighted Average
3,827		63.73% Pervious Area
2,178		36.27% Impervious Area
1,631		74.89% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.5	35	0.0180	0.13		Sheet Flow, Overland Grass: Short n= 0.150 P2= 3.10"
2.9	15	0.0100	0.09		Sheet Flow, Overland Grass: Short n= 0.150 P2= 3.10"
0.4	37	0.0100	1.50		Shallow Concentrated Flow, Overland Grassed Waterway Kv= 15.0 fps
0.2	40	0.0500	3.35		Shallow Concentrated Flow, Overland Grassed Waterway Kv= 15.0 fps
8.0	127	Total			

Summary for Subcatchment 4S: Prop Roadway

Runoff = 0.26 cfs @ 12.03 hrs, Volume= 698 cf, Depth> 1.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs
 Type III 24-hr 2-Year Rainfall=3.10"

Area (sf)	CN	Description
2,325	98	Paved parking, HSG C
990	79	50-75% Grass cover, Fair, HSG C
851	74	>75% Grass cover, Good, HSG C
105	87	Dirt roads, HSG C
* 210	98	Unconnected Ledge, HSG C
4,481	89	Weighted Average
1,946		43.43% Pervious Area
2,535		56.57% Impervious Area
210		8.28% Unconnected

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Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.8	13	0.2000	0.28		Sheet Flow, Overland Grass: Short n= 0.150 P2= 3.10"
0.6	37	0.0150	0.99		Sheet Flow, Overland Smooth surfaces n= 0.011 P2= 3.10"
0.3	83	0.0600	4.97		Shallow Concentrated Flow, Overland Paved Kv= 20.3 fps
1.7	133	Total			

Summary for Link 2L: Post Total

Inflow Area = 10,486 sf, 44.95% Impervious, Inflow Depth > 1.61" for 2-Year event
 Inflow = 0.43 cfs @ 12.06 hrs, Volume= 1,407 cf
 Primary = 0.43 cfs @ 12.06 hrs, Volume= 1,407 cf, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 5.00-20.00 hrs, dt= 0.05 hrs

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 3S: Prop Site

Runoff Area=6,005 sf 36.27% Impervious Runoff Depth>2.55"
Flow Length=127' Tc=8.0 min CN=83 Runoff=0.41 cfs 1,276 cf

Subcatchment 4S: Prop Roadway

Runoff Area=4,481 sf 56.57% Impervious Runoff Depth>3.11"
Flow Length=133' Tc=1.7 min CN=89 Runoff=0.42 cfs 1,162 cf

Link 2L: Post Total

Inflow=0.73 cfs 2,438 cf
Primary=0.73 cfs 2,438 cf

Total Runoff Area = 10,486 sf Runoff Volume = 2,438 cf Average Runoff Depth = 2.79"
55.05% Pervious = 5,773 sf 44.95% Impervious = 4,713 sf

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40 Ellingwood-Post Development_060819

Type III 24-hr 100-Year Rainfall=6.50"

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Time span=5.00-20.00 hrs, dt=0.05 hrs, 301 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 3S: Prop Site

Runoff Area=6,005 sf 36.27% Impervious Runoff Depth>4.29"
Flow Length=127' Tc=8.0 min CN=83 Runoff=0.67 cfs 2,146 cf

Subcatchment 4S: Prop Roadway

Runoff Area=4,481 sf 56.57% Impervious Runoff Depth>4.94"
Flow Length=133' Tc=1.7 min CN=89 Runoff=0.65 cfs 1,844 cf

Link 2L: Post Total

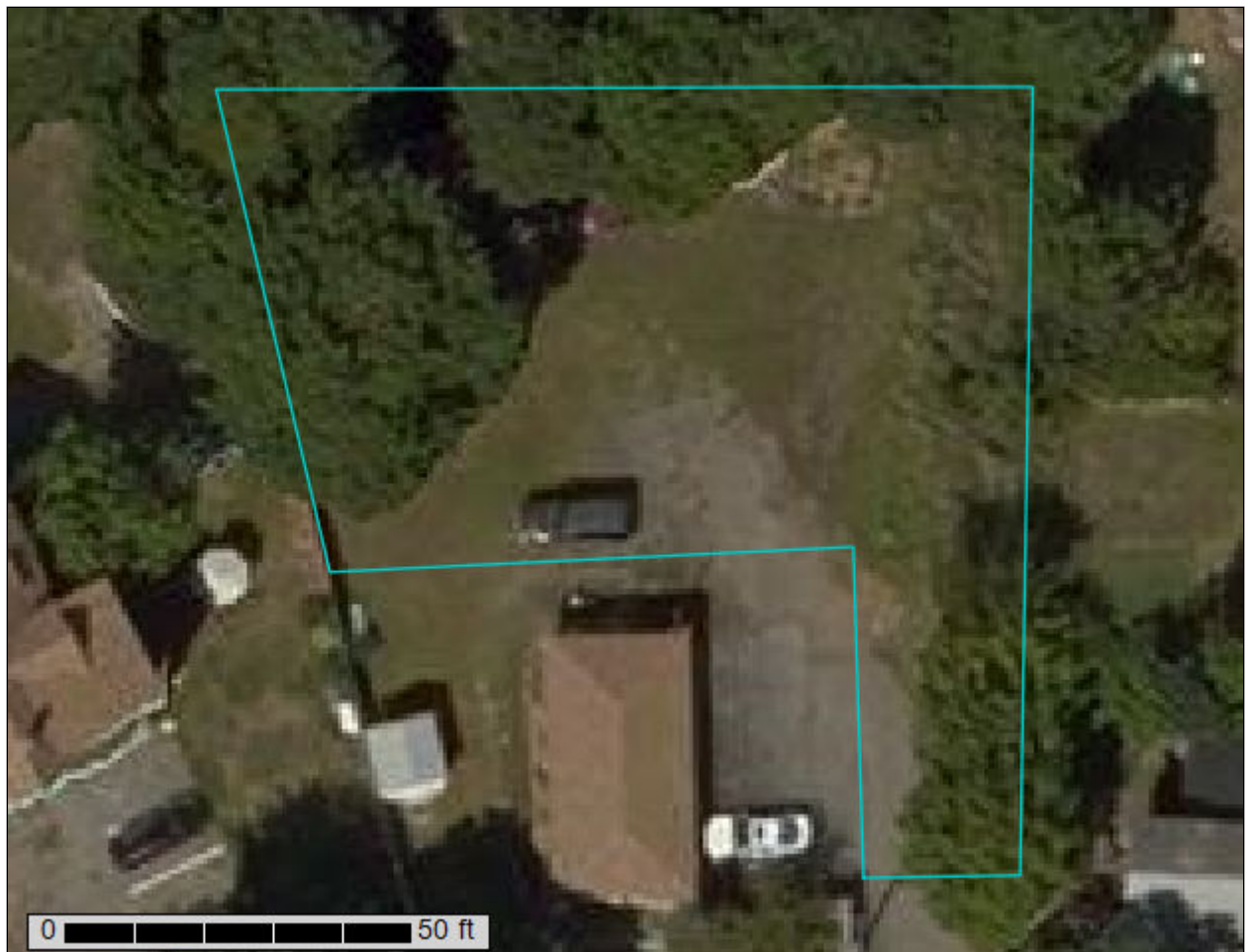
Inflow=1.17 cfs 3,990 cf
Primary=1.17 cfs 3,990 cf

Total Runoff Area = 10,486 sf Runoff Volume = 3,990 cf Average Runoff Depth = 4.57"
55.05% Pervious = 5,773 sf 44.95% Impervious = 4,713 sf

NRCS SOIL REPORT

Custom Soil Resource Report for Essex County, Massachusetts, Southern Part

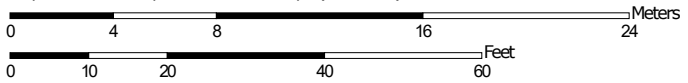
40 Ellingwood Court



Custom Soil Resource Report Soil Map



Map Scale: 1:293 if printed on A landscape (11" x 8.5") sheet.



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

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
602	Urban land	0.2	100.0%
Totals for Area of Interest		0.2	100.0%

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Custom Soil Resource Report

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Essex County, Massachusetts, Southern Part

602—Urban land

Map Unit Setting

National map unit symbol: vkjv

Frost-free period: 145 to 175 days

Farmland classification: Not prime farmland

Map Unit Composition

Urban land: 80 percent

Minor components: 20 percent

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

Description of Urban Land

Setting

Parent material: Excavated, filled, and made land

Minor Components

Udorthents

Percent of map unit: 7 percent

Hydric soil rating: No

Hollis

Percent of map unit: 5 percent

Whitman

Percent of map unit: 3 percent

Landform: Depressions

Hydric soil rating: Yes

Freetown

Percent of map unit: 1 percent

Landform: Bogs

Hydric soil rating: Yes

Maybid

Percent of map unit: 1 percent

Landform: Depressions

Hydric soil rating: Yes

Scarboro

Percent of map unit: 1 percent

Landform: Terraces

Hydric soil rating: Yes

Swansea

Percent of map unit: 1 percent

Landform: Bogs

Hydric soil rating: Yes

Whately variant

Percent of map unit: 1 percent

Landform: Glacial lakes (relict)

Hydric soil rating: Yes