Geotechnical
Environmental
Water Resources
Ecological

Crab Meadow Watershed Hydrology Study

Submitted to:
Town of Huntington
100 Main Street
Huntington, NY 11743

Submitted by:
GEI Consultants, Inc.
406 Science Drive, Suite 404
Madison, WI 53711

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Project No.: 132382-0

Paul D. Drew, P.E.
Project Engineer

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1.0 Introduction

1.1 Purpose

The Crab Meadow Wetlands are designated by the New York State Department of State (NYSDOS) as a Significant Coastal Fish and Wildlife Habitat, since they represent one of the largest tracts (approximately 300 acres) of undeveloped salt marsh on Long Island's north shore. The Crab Meadow Wetlands are recognized by the Long Island Sound Study initiative as a Stewardship Site which seeks to preserve native communities, protect critical habitats for endangered and threatened species, and promote multiple uses balanced with long-term scientific research and education.

The purpose of this study is to perform a preliminary hydrology analysis that characterizes the watershed, describes its flow patterns, and identify potential flooding impacts to help identify the drivers and stressors to this unique ecosystem with the intent of protecting its vitality through implementation of a community-based Stewardship Plan.

1.2 Scope of Work

A summary of the scope of work performed by GEI for this study is presented below:

1. Perform hydrologic analysis that identifies the watershed boundary and identify flow networks throughout the watershed.

2. Develop rainfall-runoff models to estimate the runoff volume for the 2-, 10- and 100-year return period rainfall amounts.

3. Provide the Town of Huntington with a conceptual model for future analyses. The model can be used for comparative analyses for land use changes, flow path modification, stormwater best management practices, and site specific hydrologic and hydraulic studies.

1.3 Project Personnel

The Crab Meadow Watershed Hydrology Study, and supporting analyses, was completed by the following personnel from GEI:

Nick Miller, P.E., P.H.	Technical Reviewer
Paul Drew, P.E.	Water Resources Engineer

The owner's representatives for this work were Margo Myles and Ed Carr.

2.0 FLO-2D Analysis

2.1 Hydrologic Model

The FLO-2D version 2009.06 model was used to perform the hydrologic analysis and to develop preliminary flood mapping for the Crab Meadow Watershed. FLO-2D, developed by FLO-2D Software, Inc., is a 2-dimensional computer model that routes rainfall events over a system of square grid elements (FLO-2D Software, Inc., 2009, 2010a and b). FLO-2D includes components to simulate 1-D channels (rivers and streets), levees, hydraulic structures, and obstructions. FLO-2D is a widely used and accepted hydrologic software package by state and federal regulatory agencies.

In general, these are the steps to develop a FLO-2D model:

1. Acquire necessary data including elevation data, land use data and flow control data.
2. Construct a computation grid and assign ground elevations to the grid cells.
3. Assign Manning's n values to the grid cells.
4. Assign rainfall and infiltration parameters to the grid cells.

The Crab Meadow Watershed is approximately 5.6 square miles in area and includes residential, commercial, nature preserves, parks, ponds, the Crab Meadow Golf Course and the Jerome A. Ambro Memorial Wetland Preserve. The FLO-2D model simulates this watershed with a grid domain consisting of 15, 312 grid cells covering approximately 5.6 square miles. Each grid cell is a 100 feet by 100 feet square. Figure 1 shows the model domain and watershed boundary area.

Ground elevations were interpolated to the grid cells using the FLO-2D Grid Developers System (GDS) algorithm. The topographic data points were read into the GDS as ASCII (x, y, z) files. Ground elevations were interpolated to the grid cells from 2 foot topographic contours provided by the Town of Huntington. The maximum and minimum grid cell elevations are 254.4 feet and 0 feet[1], respectively. Figure 2 shows the grid element elevation rendering. The ground elevations associated with the grid cells are contained in the FPLAIN.DAT file.

Manning's "n" values were assigned based on the California Department of Water Resources' (DWR) recommended default Manning's n values. Table 1 lists the DWR land use types and the associated low default Manning's n values. In urban areas, the initial

[1] The FLO-2D model was developed using the National Geodetic Survey Datum (NAD 83, State Plane New York Long Island (FIPS 3104) horizontal datum and the North American Vertical Datum of 1988 (NAVD88)

values were reviewed and adjusted, where appropriate, using ortho-photos. The Manning's n-values associated with the grid cells are contained in the FPLAIN.DAT file.

Table 1: DWR Land Use Types and Associated Low Default Manning's n values

Classification Description	Low Default n-value
Floodplain – Trees, heavy stand of timber, few down trees	0.12
Floodplain – Brush, medium to dense	0.10
Urban Development – Low Density	0.08
Urban Development – Medium Density	0.06
Main Channel	0.04
Water Surface	0.04

Streets and highways within the Crab Meadow Watershed were modeled as flood conveyance structures based on shapefiles provided by the Town of Huntington. An average roadway width of 40 feet with 6 inch barrier curbs was assumed for the watershed. GEI did not confirm the as-built condition of the roadways or include storm sewer networks for this analysis.

Land use shape files provided by the Town of Huntington and hydraulic soil types were provided by the Soil Survey Geographic (SSURGO) National Resources Conservation Service (NRCS) were used to estimate corresponding SCS Curve Numbers. The curve number is a dimensionless number defined such that $0 < CN < 100$. For impervious and water surfaces $CN = 100$; for natural surfaces $CN <100$. The SCS curve number method is used to estimate the volume of runoff when the precipitation volume and CN are known. Figures 3 and 4 illustrate the Crab Meadow Watershed land use and hydraulic soil types.

GEI modeled three precipitation scenarios: the 2-, 10- and 100-year return period storms. Surface runoff is a function of soil types, land use and cover including percent of impervious surfaces. The Suffolk County 24-hour rainfall amounts were taken from the TR-55 (ref. U.S. Department of Agriculture, Natural Resources Conservation Service, Conservation Engineering Division). 24-hour rainfall amounts are included in Table 2. SCS Type III rainfall distributions were used.

Table 2: Rainfall Depth-Duration Frequency Table

Duration	2-year	10-year	100-year
24 Hour	3.4	5.1	9.0

A total of 505 grid cells are defined as outflow nodes along the grid boundary. The outflow cells eliminate ponding at grid boundaries by removing water from the model that reaches the boundaries. The Rainfall information is contained in the RAIN.DAT input file, and the outflow cells are contained in the OUTFLOW.DAT file.

The FLO-2D model results are based on the parameter values and methods described above. The FLO-2D model uses a 100-ft grid cell size and includes various Manning's n-values and curve numbers to perform flood routing to estimate water surface elevations, flood depths, peak velocities, duration and the boundaries of flood areas.

2.2 Results

FLO-2D flood routing simulations were performed for the 2-, 10-, and 100-year storm events. The simulations are used to determine drainage patterns, sources and locations of expected surface water flooding, flow travel times, and flood durations. Tables 3 - 5 list important FLO-2D model output and results information for the Crab Meadow Watershed flood routing.

Table 3: 2-yr FLO-2D Model Results Summary

Parameter	Value
Total Rainfall Volume[1]	962.00 ac-ft
Total Outflow Volume[2]	8.05 ac-ft
Total Storage Volume[3]	276.46 ac-ft
Total Infiltration Volume[4]	677.49 ac-ft
Total Volume Conservation	100 (percent)
Maximum Area of Inundation	2.7 mi^2

Table 4: 10-yr FLO-2D Model Results Summary

Parameter	Value
Total Rainfall Volume[1]	1,443.00 ac-ft
Total Outflow Volume[2]	154.73 ac-ft
Total Storage Volume[3]	428.11 ac-ft
Total Infiltration Volume[4]	860.16 ac-ft
Total Volume Conservation	100 (percent)
Maximum Area of Inundation	4.6 mi^2

Table 5: 100-yr FLO-2D Model Results Summary

Parameter	Value
Total Rainfall Volume[1]	2,546.47 ac-ft
Total Outflow Volume[2]	880.62 ac-ft
Total Storage Volume[3]	541.54 ac-ft
Total Infiltration Volume[4]	1,124.31 ac-ft
Total Volume Conservation	100 percent
Maximum Area of Inundation	5.5 mi^2

1. Total rainfall is the volume of rainfall contributed by the 2-, 10- and 100-year storm events.
2. Total outflow volume is the volume of runoff leaving the model through the outflow cells during the simulation.
3. The total storage volume is the volume of runoff remaining on the grid at the end of the simulation.
4. The total infiltration volume is the amount of rainfall removed from the model by infiltration.

Floodplain cross sections were input within the Crab Meadow Wetland Preserve to calculate a discharge hydrograph and compile hydraulic results for the flow across the cross section. These cross sections provide an estimate of the peak discharges expected to flow into the Wetland Preserve during various flooding events. The floodplain cross sections location and results are summarized below in Table 6:

- Northwest Tributary of Crab Meadow Creek (Upstream of confluence)
- Southwest Tributary of Crab Meadow Creek (Upstream of Confluence
- East Tributary of Crab Meadow Creek (Downstream of Confluence)

Table 6: Crab Meadow Creek Peak Discharges

Cross Section	2-year	10-year	100-year
Northwest Tributary	3 cfs	12 cfs	82 cfs
Southwest Tributary	3 cfs	41 cfs	245 cfs
East Tributary	9 cfs	70 cfs	253 cfs

After executing the FLO-2D model for the 2-, 10- and 100-year return period storms, the following GIS shapefile results were developed:

- Plot of grid elements maximum (or peak) flow depths
- Plot of grid elements peak velocity
- Plot of grid elements peak velocity vectors
- Time (duration) of grid elements to reach two feet of flood depths

Information from these GIS shapefile results were used to construct the detailed maps presented below.

2.2.1 Plot of Peak flood depths

The peak flood depths at each grid element illustrate the difference between the peak water surface elevation and the ground elevation. The peak flood depths and locations are provided in Figures 5 -7 for the 2-, 10- and 100-year storm events.

2.2.2 Plot of Peak Velocity

The peak velocities at each grid element illustrate the peak velocity during the simulation. The final floodplain depths and locations are provided in Figure 8 for the 100-year storm events.

2.2.3 Plot of Grid Elements Peak Velocity Vectors

The peak velocity vectors at each grid element illustrate the peak velocity and direction during the simulation. The peak velocity vectors for the 100-year storm event in the Jerome A. Ambro Memorial Wetland Preserve are illustrated in Figure 9.

2.2.4 Time to Two Feet of Flood Depths

The time to two feet of flooding at each grid element is the amount of time it takes to increase the water surface elevation two feet above the ground elevation. The time to two feet of flood depths are illustrated in Figure 10 for the 100-year storm event.

2.3 Next Steps – Future Studies

The purpose of this hydrology study is to perform a preliminary hydrology study that characterizes the watershed, describes its flow patterns, potential flooding impacts to help identify the drivers and stressors to this unique ecosystem with the intent of protecting its vitality through implementation of a community-based Stewardship Plan.

2.3.1 Preliminary FLO-2D Analysis Limiting Assumptions

The accuracy of this study is limited to the following best available data sets at the time of the analysis:

- Two-foot topographic contours provide by the Town of Huntington. No independent topographic surveys were performed at key locations within the watershed.
- Soil and land-use information provided by NRCS and the Town of Huntington.
- 100 x 100 FLO-2D grid systems.
- Transportation shape files provided by the Town of Huntington. Average roadway width and barrier curbs were assumed and not independently field verified during this study.
- Limits of the watershed were provided by the Town of Huntington. An independent analysis of the assumed watershed boundary was not performed.
- Storm sewer networks, roadway culverts, dam, levees, and other flood control structures were not included in this study. Independent topographic survey information of each of these structures would need to be performed to include pertinent elevations relative to the ground surface provided by the Town of Huntington, sewer pipe lengths and slopes, etc. This complicated flood control network would need to be studied and field verified before inclusion into the FLO-2D model.
- Storm surges from the Long Island Sound are not included in this analysis. The current FLO-2D model assumes that the Long Island Sound is not experiencing a surge condition during the 2-, 10- or 100-year storm event. Additional modeling analyses would need to be performed to incorporate the results of the "Slosh" Model provided by the Town of Huntington.

2.3.2 Future FLO-2D Studies

The preliminary FLO-2D model prepared by GEI provides the Town of Huntington the framework to develop future analyses to complete a variety of objectives. As the funding and scope of this project expands over time, the model should be enhanced to improve the accuracy of results to include the following:

- Highway and roadway As-Builts from the Department of Transportation.
- Storm Sewer Network within the Watershed
- Dam Embankment, Spillways, Storage Reservoirs, Levees, and other flood control structures
- Site specific topographic survey data
- Updated LiDAR data
- Current and projected future land use
- Infiltration testing
- Storm Surge
- Climate Change

This hydrologic and hydraulic analysis is the foundation to an improved understanding of the dynamic Crab Meadow Watershed. The FLO-2D model will need to evolve with the availability of new information and the changing needs of the Town of Huntington. GEI appreciates the opportunity to begin this process with the residents of the Crab Meadow Watershed and looks forward to the next opportunity to progress this important study.

3.0 Limitation of Liability

This report presents the results of preliminary flood routing for the 2-, 10- and 100-year storm events in the Crab Meadow Watershed. The results are based on engineering judgment and best available data available at the time of the study. The results of this study should only be used to identify potential drainage patterns and hypothetical flooding impacts for various storm events. If any portion of the Crab Meadow Watershed were to experience flooding from a storm event, actual flooding limits, conditions, peak flows, peak velocities, duration and water surface elevations will vary from those presented in this study. Reuse of this study and FLO-2D model for any other purpose, in part or in whole, is at the sole risk of the user.

4.0 References

Chow, V. T. (1959). Open Channel Hydraulics, McGraw-Hill Book Company, Inc., New York.

FLO-2D Software, Inc. (2009). FLO-2D Grid Developers System GDS Users Manual: Version 2009.06, Nutrioso, AZ.

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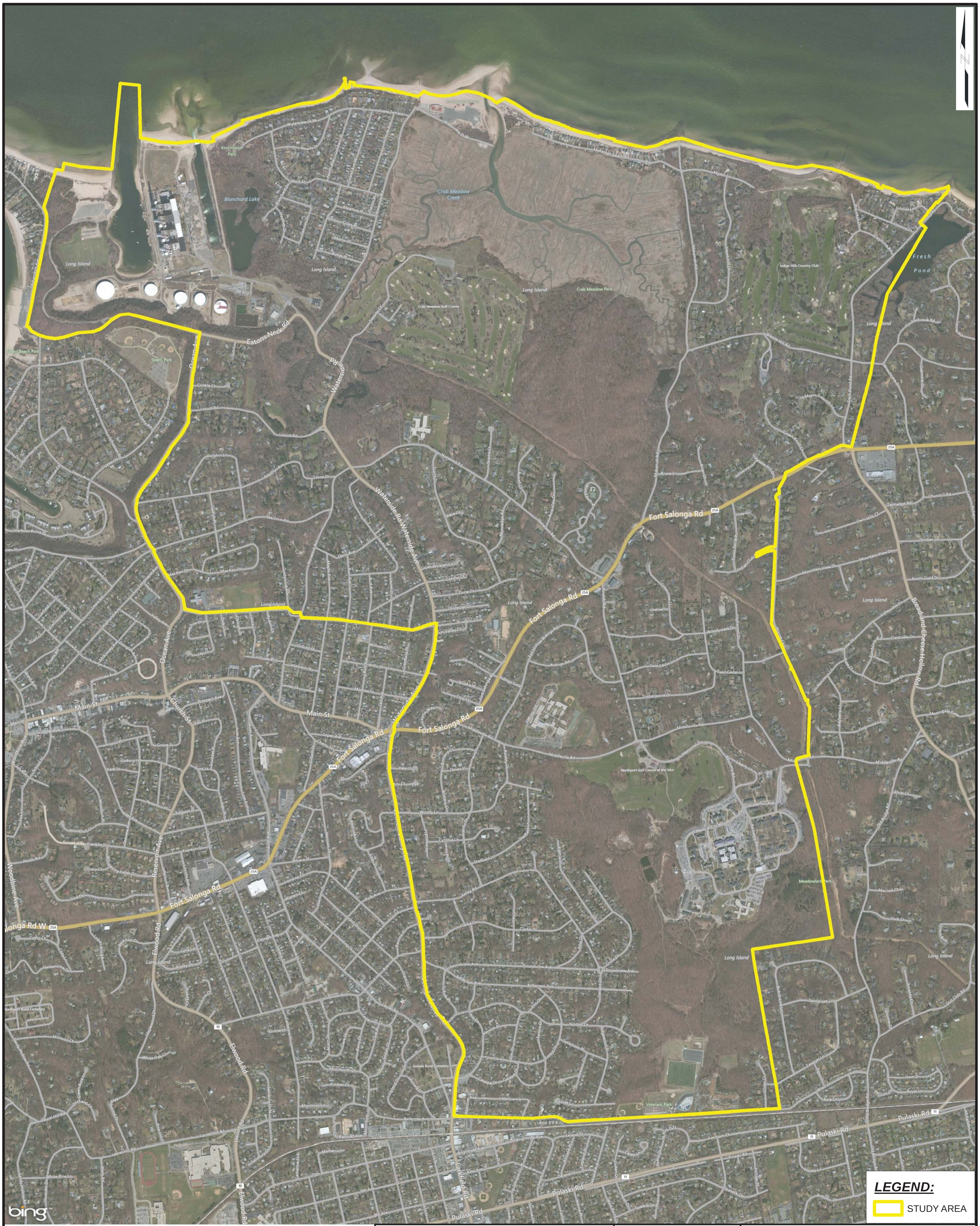
Environmental Sciences Research Institute, Inc. (ESRI), ArcGIS, Version 9.3.1, Redlands, California. 2009.

Figures



SOURCE:
1. BING MAPS, COPYRIGHT MICROSOFT CORPORATION AND ITS SUPPLIERS

0 1,000 2,000
SCALE, FEET

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CRAB MEADOW WATERSHED BOUNDARY AREA

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Figure 1

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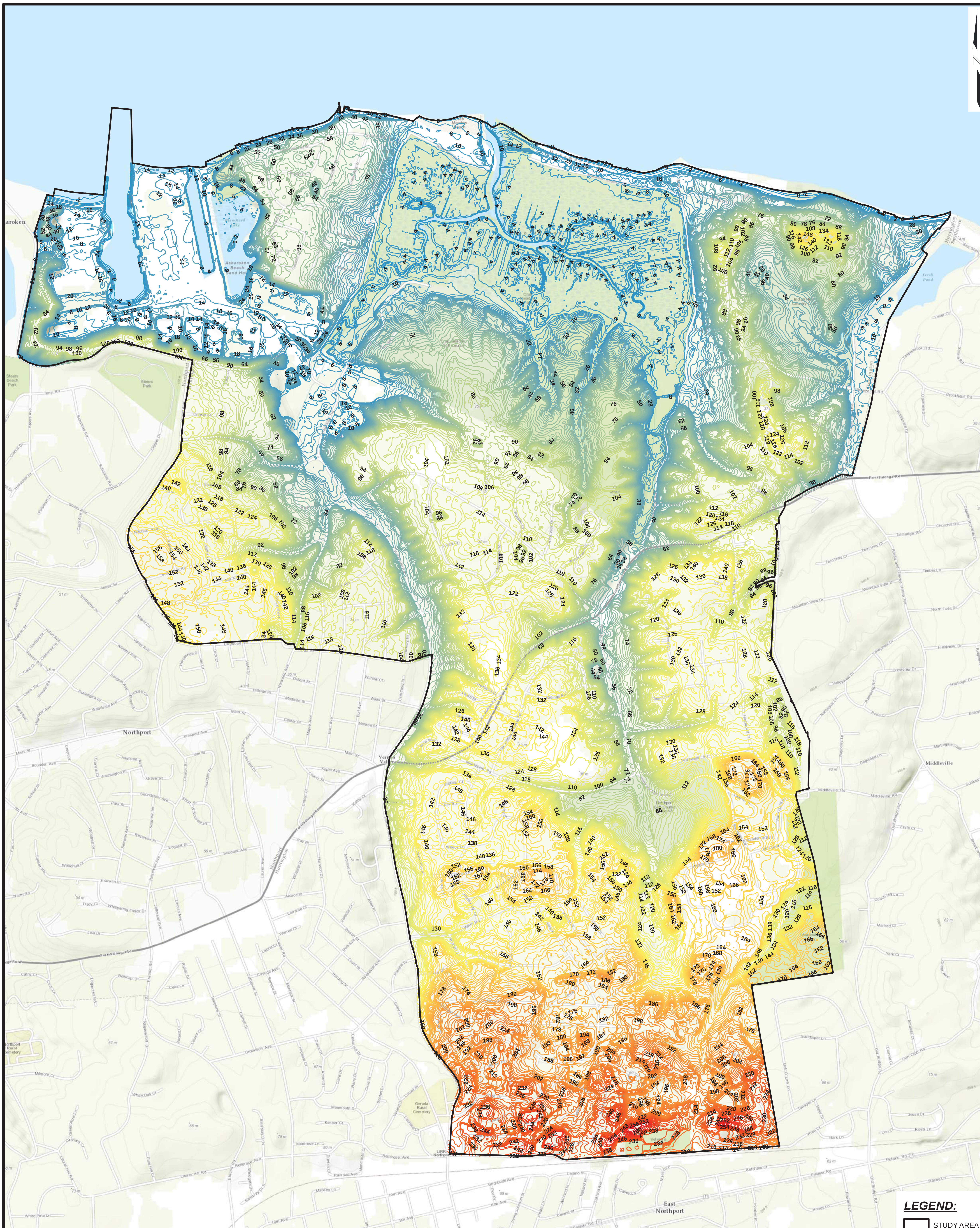

SOURCE:
1. BASEMAP ACCESSED VIA ARCGIS ONLINE SERVICES.
2. 2FT TOPOGRAPHIC CONTOURS PROVIDED BY THE TOWN OF HUNTINGTON.

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FLO-2D GRID ELEMENT ELEVATION RENDERING

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Figure 2

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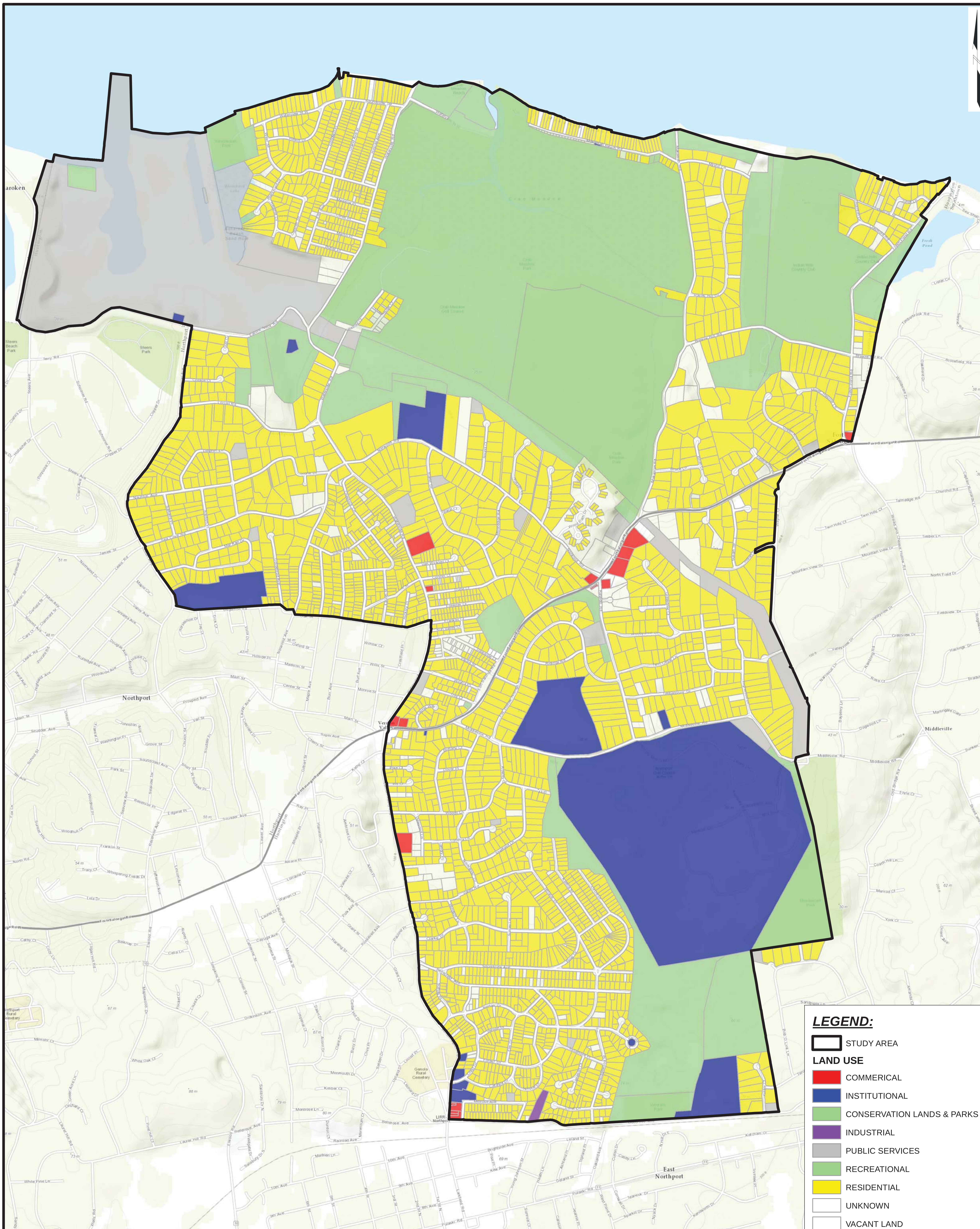

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2. LAND USE DATA FROM THE TOWN OF HUNTINGTON

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CRAB MEADOW WATERSHED LAND USE

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Figure 3

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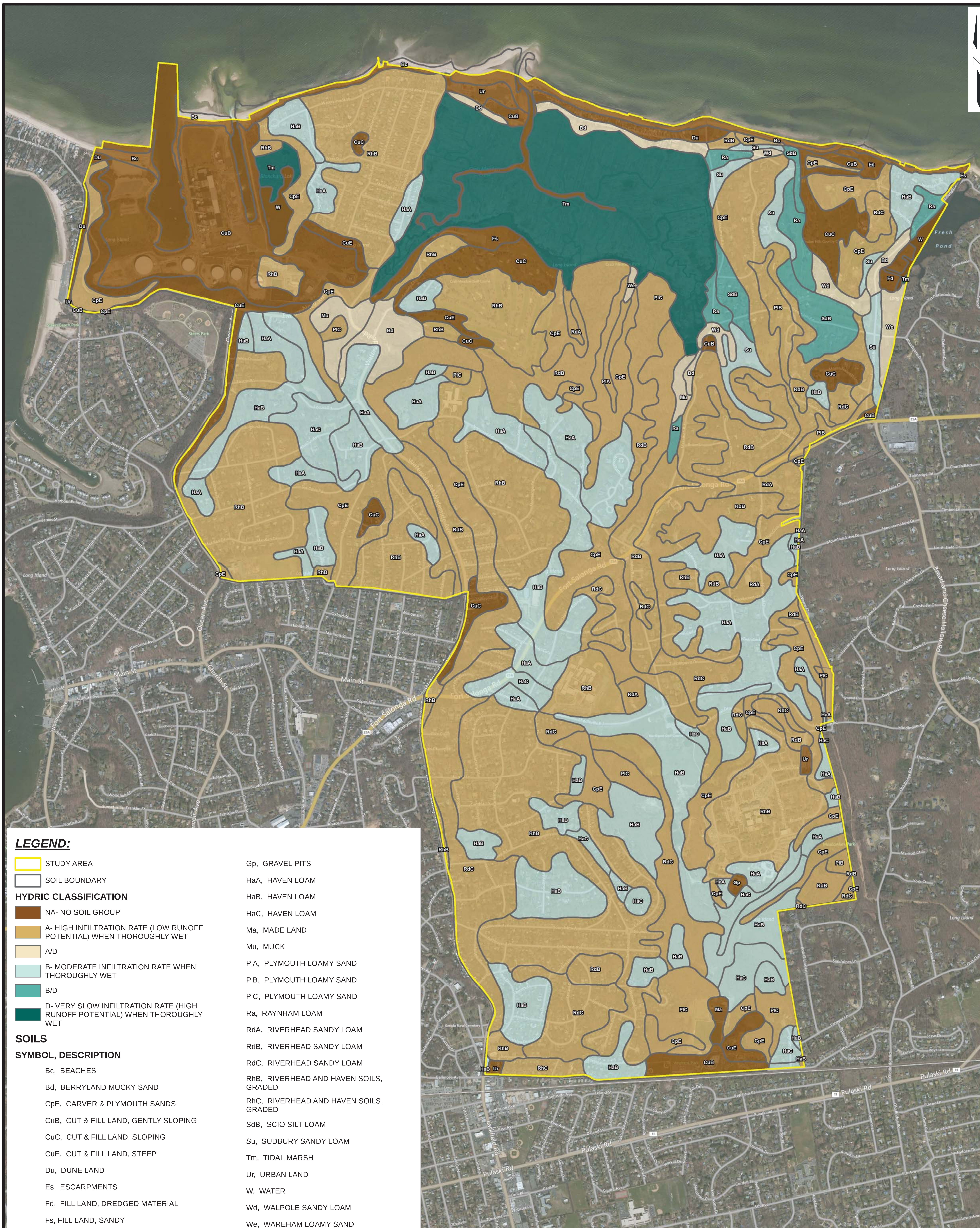

SOURCE:
1. BING MAPS, COPYRIGHT MICROSOFT CORPORATION AND ITS SUPPLIERS
2. SOIL SURVEY GEOGRAPHIC (SSURGO) NATURAL RESOURCES CONSERVATION SERVICE/UNITED STATES DEPARTMENT OF AGRICULTURE.

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CRAB MEADOW WATERSHED SOIL TYPES

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Figure 4

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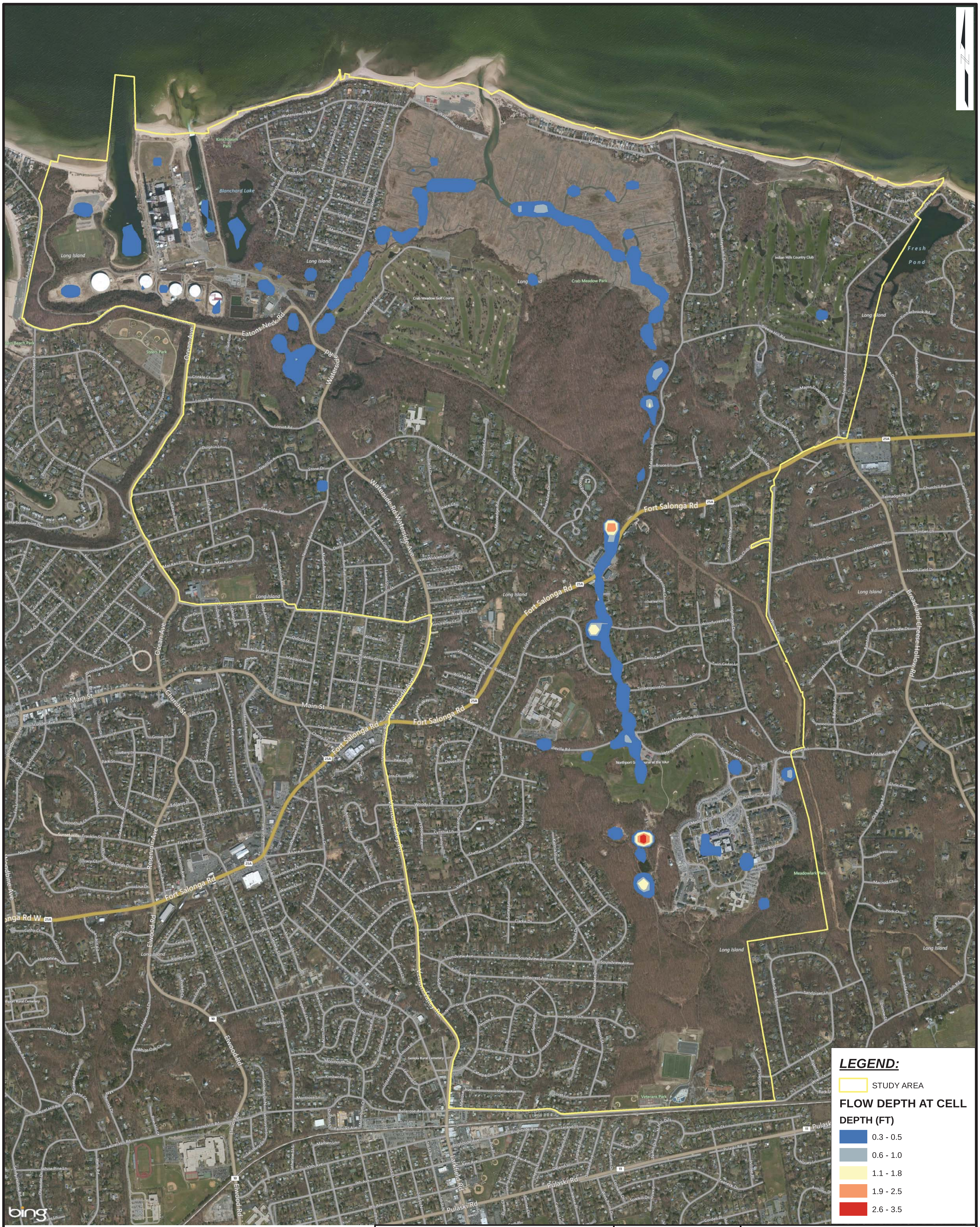

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PEAK FLOOD DEPTHS- 2-YEAR

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Figure 5

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LEGEND:

STUDY AREA

FLOW DEPTH AT CELL

DEPTH (FT)

Depth (ft)
0.3 - 0.7
0.8 - 1.5
1.6 - 2.8
2.9 - 4.0
4.1 - 5.0

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PEAK FLOOD DEPTHS- 10 YEAR

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Figure 6

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PEAK FLOOD DEPTHS- 100-YEAR

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Figure 7

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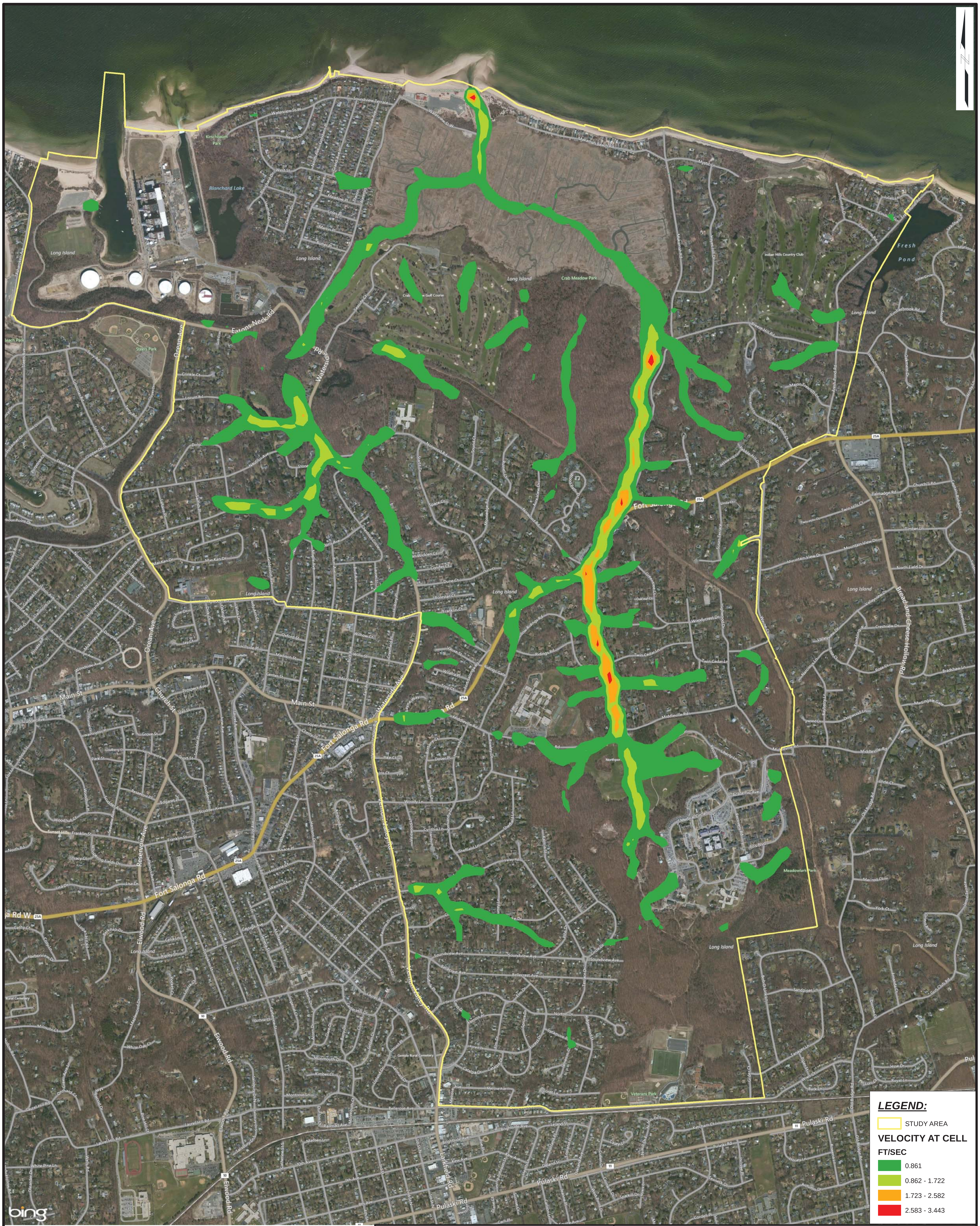

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PEAK VELOCITY 100-YEAR

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Figure 8

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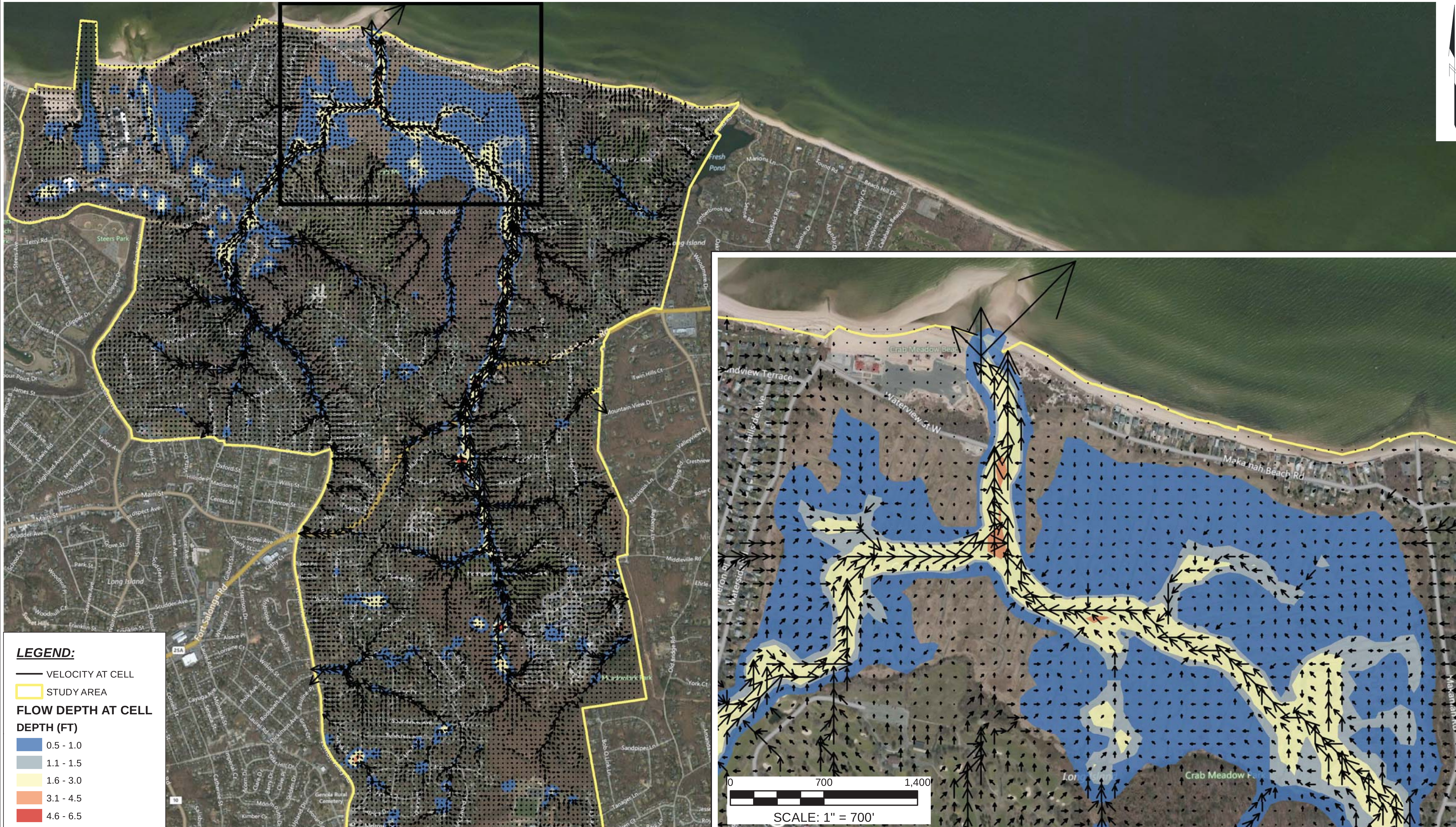

LEGEND:

- VELOCITY AT CELL
- STUDY AREA

FLOW DEPTH AT CELL

DEPTH (FT)

- 0.5 - 1.0
- 1.1 - 1.5
- 1.6 - 3.0
- 3.1 - 4.5
- 4.6 - 6.5

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SCALE: 1" = 2000'

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PEAK VELOCITY VECTORS IN THE JOHN A. AMBROSE WETLAND PRESERVE- 100- YEAR

Project 1323820 | January 2015 | Fig. 9

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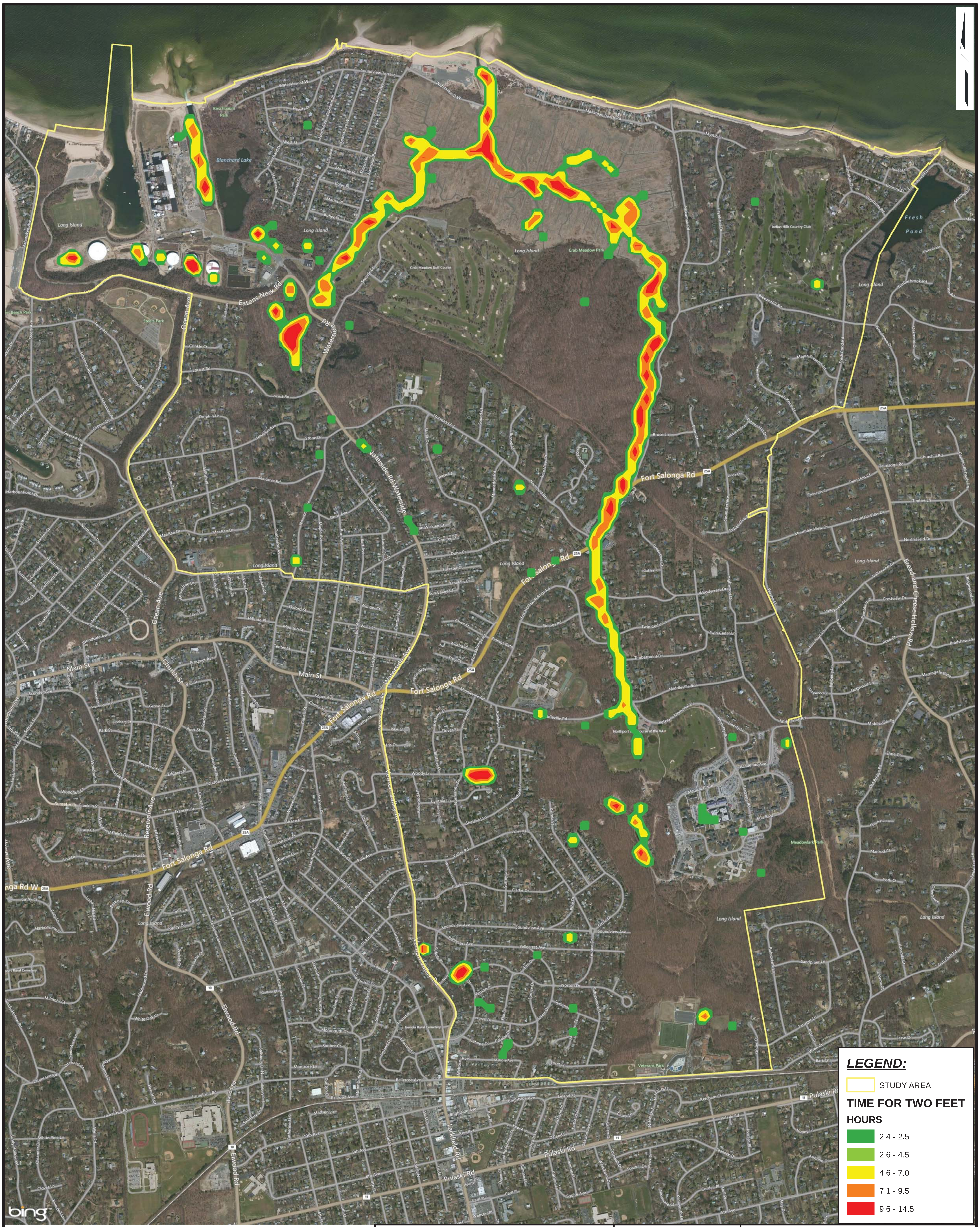

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TIME TO TWO FEET OF FLOOD DEPTHS-100-YEAR

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Figure 10

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Appendix A

FLO-2D MODEL INPUT AND OUTPUT FILES