Penobscot Climate Action Vulnerability Assessment

Basin Runoff Analysis - Results

Prepared by Linnean Solutions in cooperation with BSC Group

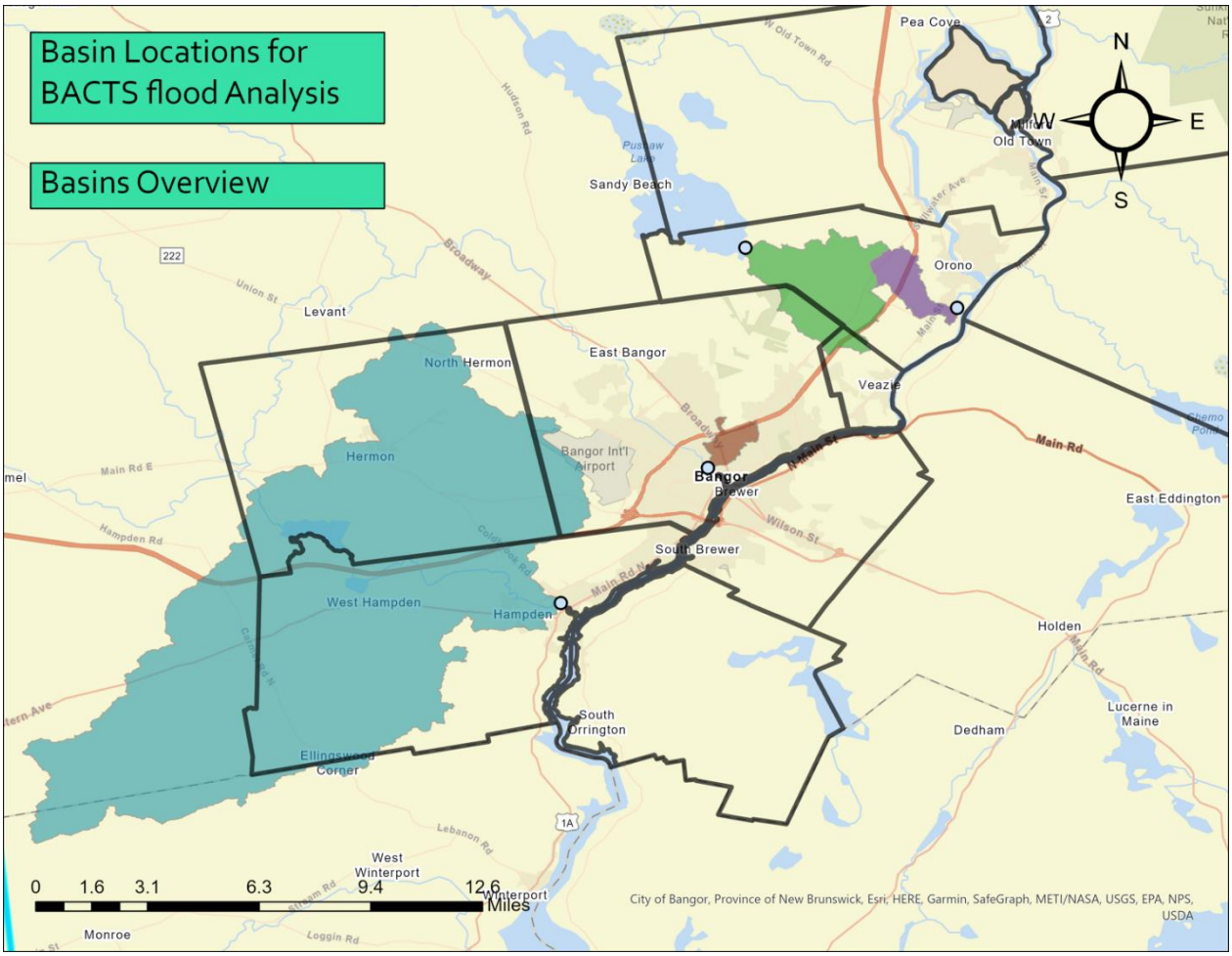
Introduction

This analysis is designed to allow for the calculation of surface runoff from a specific basin based on user defined rainfall inputs. Using simple data inputs, the excel spreadsheet that is created allows the user to model, iterate, and generally understand the runoff dynamics in a study area. For this analysis, the results point to a relationship between impervious surface and runoff, as well as the potential mitigating factor of more vegetated cover types. Further, by inputting various rainfall amounts and observing the runoff estimates we begin to see the non-linear relationship between rainfall and runoff.

This analysis, and the spreadsheet tool which accompanies this report, are very useful tools in planning, hazard mitigation, and future development planning. By manipulating the variables in the excel sheet, various scenarios are able to be modeled, which could be rain events, development proposals, or Green Infrastructure projects.

Simplified Methods

This analysis utilizes the NRCS TR-55 method of calculating runoff based on runoff coefficients (aka curve numbers) which are determined by the cover type and hydrologic soil group of a given area.



In order to calculate runoff for the basins chosen, land cover data and soil data were combined into a single GIS layer, and then each basin acted as a 'cookie cutter' to yield the surface data for just that area. This resulted in a soil/land cover layer for each basin. Then, an excel spreadsheet was used to perform the calculations. This spreadsheet allows for the iteration of various development scenarios, by allowing the user to change amounts of cover type and modeling the results.

There are several caveats to keep in mind when using this analysis, and when modeling in the spreadsheet. Firstly, this is only a high-level estimate of runoff potential, and does not account for sewer infrastructure, or for larger water bodies which may act as buffers to runoff depending on their water level at the time of a rainfall event. What this analysis does provide, in addition to the basin delineation, is a general sense of what an increase in precipitation will do to runoff. The user is encouraged to consult regional projections and input various scenarios into the spreadsheet—utilize the 24-hour storm when consulting rainfall projections/charts.

Results

The following tables compare the results of a 1", 2", and 4" rainfall event modeled in the four study area zones - maps of each of these zones can be found further in this report. While the study areas vary greatly in size, their per acre runoff appears to be fairly consistent. Another trend that's revealed when modeling multiple scenarios is that with each 100% increase in rainfall, there is a more than 100% increase in runoff, revealing that the relationship between rainfall and runoff is not linear.

1" Rainfall	**Acres**	**Runoff (gal.)**	**Runoff per Acre**
Zone 1	961.89	12,002,831.03	12,478.42
Zone 2	3,749.55	43,217,290.31	11,525.99
Zone 3	497.15	6,710,035.99	13,496.98
Zone 4	45,690.72	556,191,003.21	12,172.95

2" Rainfall	**Acres**	**Runoff (gal.)**	**Runoff per Acre**
Zone 1	961.89	33,196,525.62	34,511.88
Zone 2	3,749.55	122,586,452.59	32,693.64
Zone 3	497.15	18,063,200.22	36,333.42
Zone 4	45,690.72	1,549,881,952.38	33,921.16

4" Rainfall	**Acres**	**Runoff (gal.)**	**Runoff per Acre**
Zone 1	961.89	81,401,329.79	84,626.71
Zone 2	3,749.55	306,878,700.15	81,844.14
Zone 3	497.15	43,383,859.55	87,264.94
Zone 4	45,690.72	3,824,669,661.41	83,707.81

Another useful feature of this analysis is the ability to breakout data by cover type. Breaking down the zones by cover type helps to reveal the character of each basin. These categories can be further understood by referring to the spreadsheet tab 'LandCoverClass' to see how National Land Cover Datasets (NLCD) data was transformed to align with the categories found in the TR-55 method. These transformations were performed with consideration for the hydrologic characteristics of a given cover type, and in some cases the title can be misleading.

	Open space		Highly Developed		Woods	
Zone 1	53.91	6%	64.70	7%	714.53	74%
Zone 2	85.22	2%	62.88	2%	3,442.04	92%
Zone 3	82.13	17%	265.84	53%	5.85	1%
Zone 4	1,843.84	4%	1,618.32	4%	34,454.75	75%

Breaking out the data by cover type and comparing the composition of zones with their total runoff per acre reveals the impact of a seemingly small amount of development—i.e., impervious surface. Similarly, modeling can be done to 'visualize' the impact of revegetation for a certain number of acres, or conversion of one land cover to another.

Please refer to the attached spreadsheet for more detail and additional explanation.

Using the Spreadsheet

The accompanying spreadsheet offers a breakdown of the various surface and soil types, their surface area, and the amount of runoff for each type. It also has several colored cells which indicate that they are inputs into the calculation. If a cell is not colored in, do not edit it or you will impact the formulae which are automating the calculations.

The various inputs are as follows:

- Inputs: Allows the user to enter a custom rainfall value
- Grid Code & Soil Group: This variable allows for modeling of cover changes in the basin—it is suggested that a copy of the tab first be made to preserve the original tab.
- Acres: This also allows for the custom entry of area for each cover/soil combination, again allowing the user another way to model proposed or actual change in the landscape.

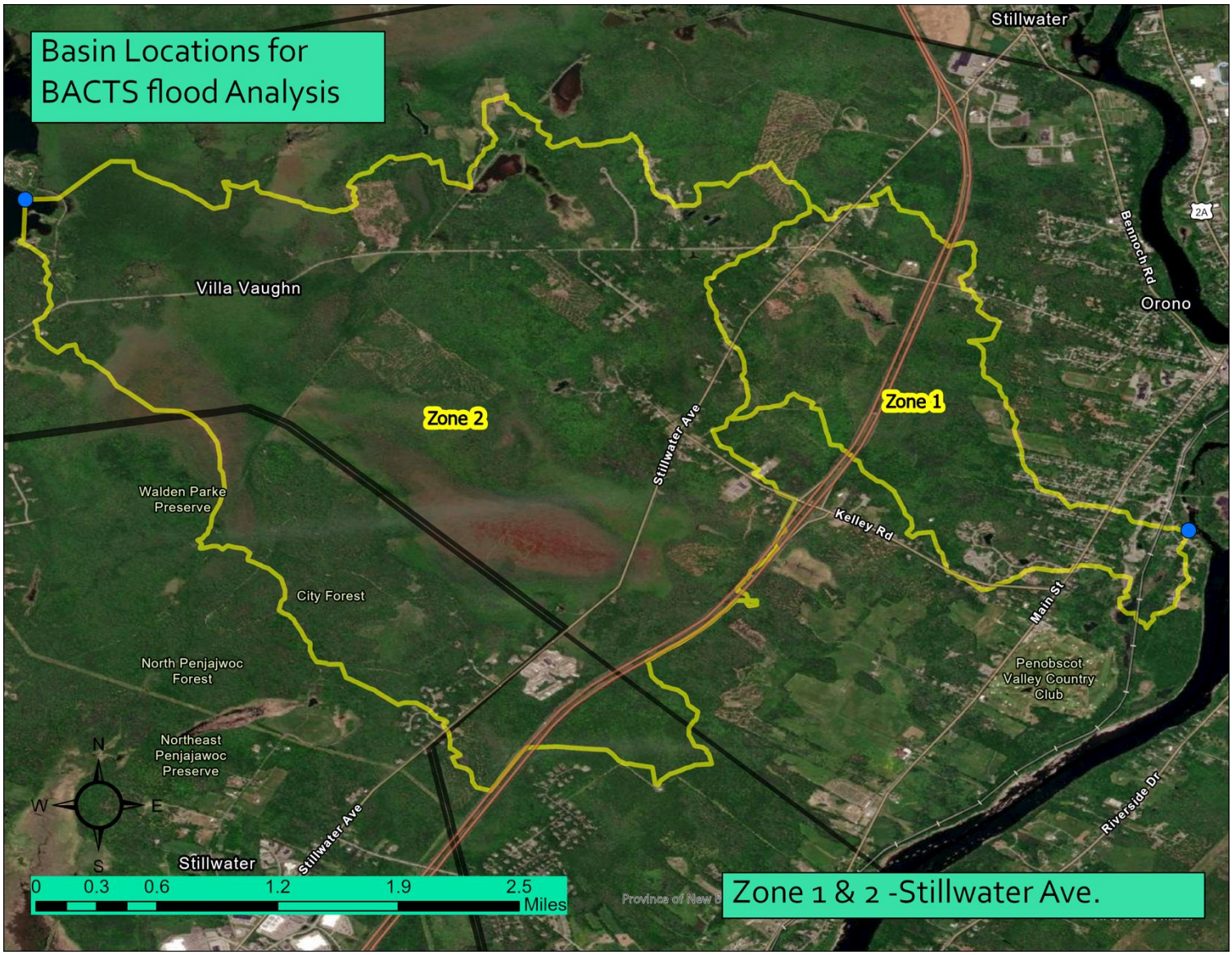
Inputs			Conversion table:	
			Gallon	Acre-Feet
Rainfall (P)	**1.00**		1.00	325850.00
			S= (1000/CN)/10	
			$Q= (P - 0.2S)^2 / (P + 0.8S)$	

Run-Off Calculations

Dataset: Zone

TR-55 Category	Grid Code	Soil Group	Concatenation	CN	Acres	Run-Off Calculations S-Number	Run-Off (Q) Inches	Conv. To feet	Acre-Feet	Gallons
Open Space -good condition	1	C	1C	74	3.06	1.35	0.45	0.04	0.12	37,767
Open Space -good condition	1	C/D	1C/D	77	65.15	1.30	0.47	0.04	2.53	823,188
Open Space -good condition	1	D	1D	80	13.92	1.25	0.48	0.04	0.55	179,650
1/4 acre Residential	2	C	2C	83	5.11	1.20	0.48	0.04	0.21	67,325
1/4 acre Residential	2	C/D	2C/D	85	126.79	1.18	0.49	0.04	5.19	1,691,174
1/4 acre Residential	2	D	2D	87	11.03	1.15	0.50	0.04	0.46	148,998
1/8 acre Residential	3	C	3C	90	9.54	1.11	0.51	0.04	0.40	131,053
1/8 acre Residential	3	C/D	3C/D	91	205.48	1.10	0.51	0.04	8.72	2,840,260
1/8 acre Residential	3	D	3D	92	14.91	1.09	0.51	0.04	0.64	207,232
Commercial & Business	4	C	4C	94	4.02	1.06	0.52	0.04	0.17	56,458
Commercial & Business	4	C/D	4C/D	95	26.25	1.06	0.52	0.04	1.13	369,805
Commercial & Business	4	D	4D	95	5.65	1.05	0.52	0.04	0.24	79,831
Gravel	5	C/D	5C/D	90	0.39	1.11	0.51	0.04	0.02	5,341
Woods -good condition	6	C/D	6C/D	74	5.85	1.36	0.45	0.04	0.22	71,953
Totals					**497.15**	**16.37**	**6.91**	**0.58**	**20.59**	**6,710,036**

Cartography



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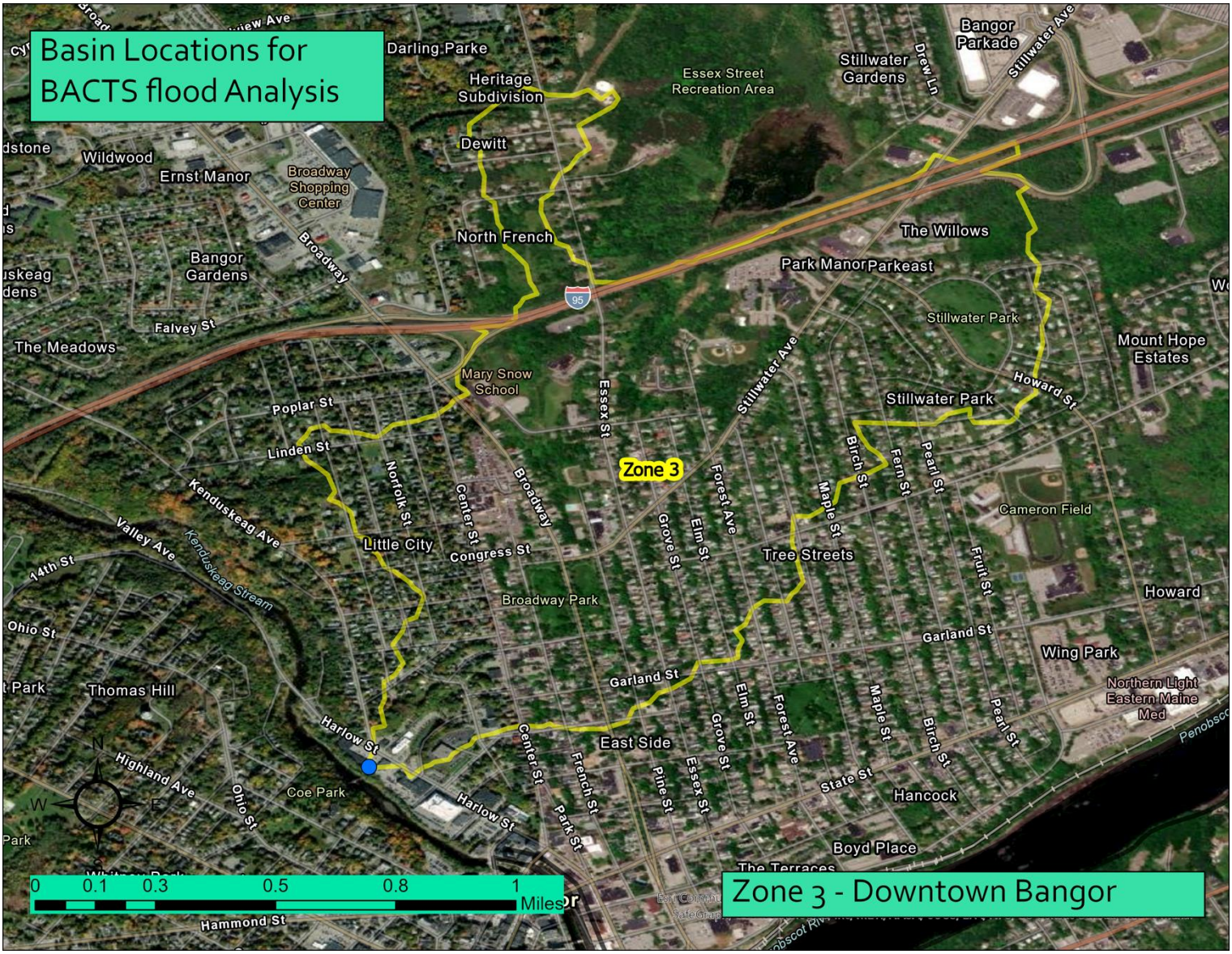

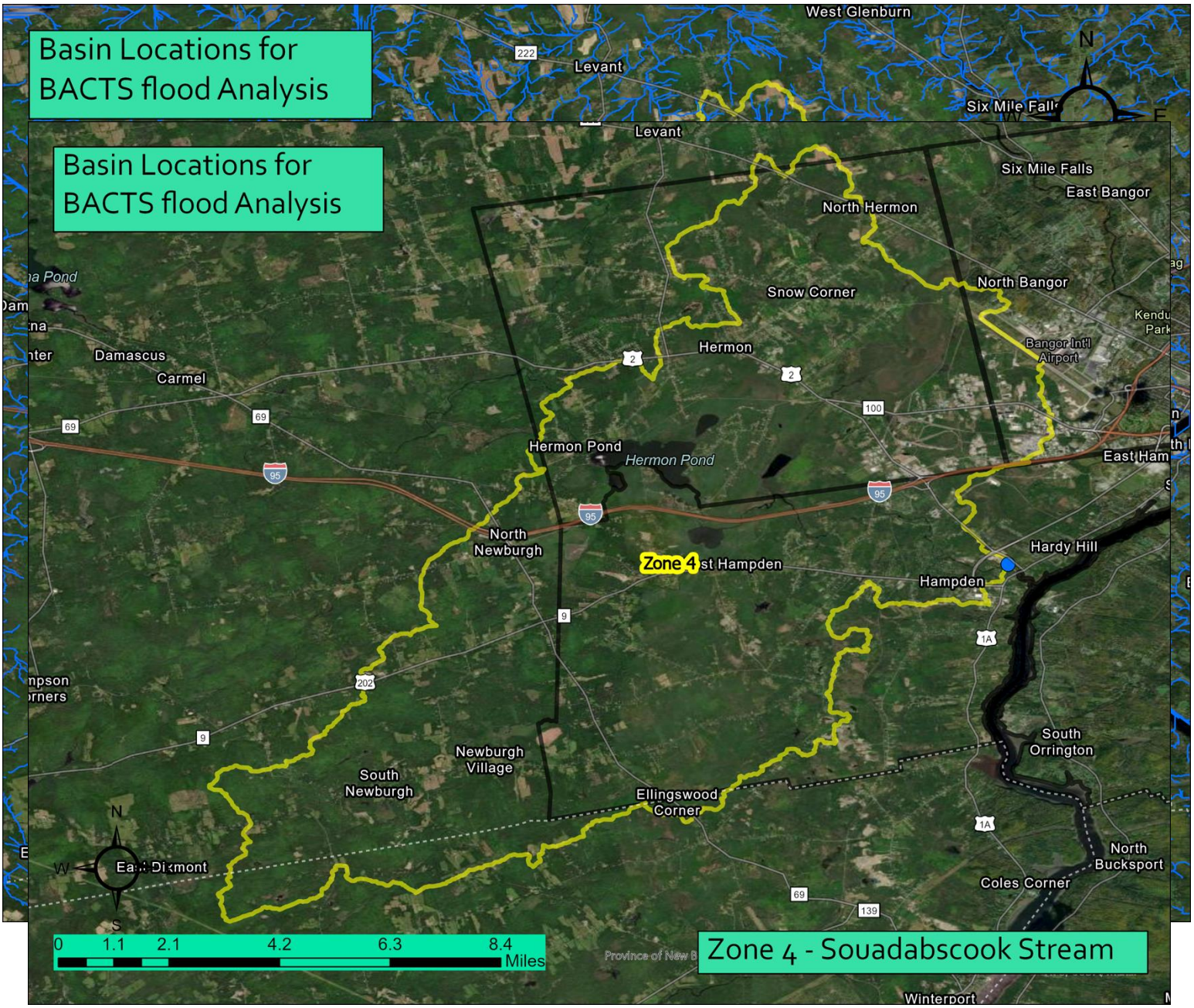
Basin Locations for BACTS flood Analysis
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West Glenburn
Levant
Six Mile Falls
East Bangor
North Hermon
Snow Corner
North Bangor
Hermon
Damascus
Carmel
Hermon Pond
Hermon Pond
Bangor Intl Airport
East Ham
North Newburgh
Zone 4
Hardy Hill
Hampden
South Orrington
Newburgh Village
South Newburgh
Ellingswood Corner
North Bucksport
Coles Corner
Winterport
0 1.1 2.1 4.2 6.3 8.4 Miles
Zone 4 - Souadabscook Stream