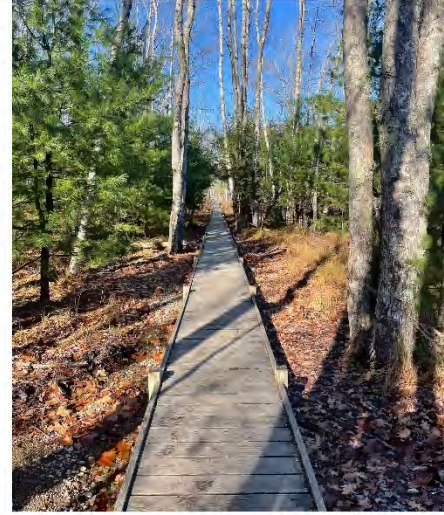




SUPPLEMENTAL HYDROLOGIC AND HYDRAULIC STUDY REPORT

Great Meadow Watershed Restoration Study

Acadia National Park

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JULY 2023

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1

Introduction

In September 2022, VHB completed a comprehensive study of the Cromwell Brook watershed and Great Meadow wetland, titled *Great Meadow and Cromwell Brook Restoration Study* (2022 study) for Acadia National Park and Friends of Acadia. The primary focus of this study was the replacement of a reinforced concrete pipe culvert that carries Cromwell Brook under Park Loop Road at the outlet of the Great Meadow. VHB performed a hydrologic and hydraulic (H&H) study to support the design of a new larger stream-simulation culvert crossing with a nature-like weir, which is aimed to mitigate flooding and restore healthy wetland function.

Based on the results of the 2022 study, VHB identified other opportunities to improve the health of the Great Meadow and Cromwell Brook watershed. VHB observed areas of poor wetland connectivity, concentrated flow, scour, and channel erosion in locations around the perimeter of the Great Meadow that required further investigation. Acadia National Park and Friends of Acadia asked VHB to refine the previously developed hydrologic and hydraulic models of the Great Meadow area to include detailed analysis of the cross-culverts and associated subwatersheds along Park Loop Road, Great Meadow Drive, Sieur de Monts entrance, and the Hemlock Path.

1.1 Study Area

The study area is located on Mount Desert Island within Acadia National Park and encompasses Cromwell Brook and its contributing watershed (**Figure 1**). The Cromwell Brook watershed is approximately 3 square miles of primarily undeveloped forest, wetlands, or bare land. The approximately 100-acre Great Meadow wetland lies in the center of the Cromwell Brook watershed and provides significant flood storage during rain events. Cromwell Brook flows northerly from its headwaters in the Tarn, a manmade lake on the south side of the study area. Cromwell Brook converges with numerous small unnamed tributaries within the Great Meadow as it flows northerly towards Bar Harbor. The outlet of the Cromwell Brook watershed is located just southeast of downtown Bar Harbor, where it flows into Cromwell Cove.

For this study, subwatersheds previously delineated for the 2022 study were revised to provide a greater level of detail around the perimeter of the Great Meadow. The 2022 study divided Cromwell Brook into seven watersheds, three of which flowed directly to the Great Meadow: "Great Meadow East," "Great Meadow West," and "Sieur de Monts." This study replaces those three generalized subwatersheds with twenty-four new sub-watersheds corresponding to cross-culverts and small tributaries contributing directly to the Great Meadow, revising the new total to

twenty-eight subwatersheds for the entire Cromwell Brook watershed. **Figure 2** illustrates the locations of these cross-culverts around the perimeter of the Great Meadow, and **Figure 3** provides an overview of the revised Cromwell Brook model subwatersheds.

1.2 Project Goals

The primary goals of this study are to update and refine the previously developed hydrologic and hydraulic models of the Great Meadow area. This includes:

- Developing a HEC-HMS hydrologic model to calculate runoff hydrographs for each of the new sub-watersheds.
- Updating the HEC-RAS hydraulic model to incorporate new detailed runoff inputs at sub-watershed design points around the perimeter of the Great Meadow (i.e., culverts).
- Evaluating model results in conjunction with field observations to identify locations of poor-functioning cross-culverts (such as undersized culverts, concentrated flows, or erosion/sedimentation).
- Identifying potential modifications or retrofits to improve the hydrologic function of the Great Meadow.
- Summarizing the findings and recommendations from the additional hydraulic modeling.

In addition to the project goals, it is important to note that Cromwell Brook and its watershed are significant resources for the local community and are heavily used for recreational activities such as hiking, bird watching, and historic preservation. This study's findings will help to inform future management decisions and ensure the long-term sustainability of Cromwell Brook and the Great Meadow wetland system.

2

Great Meadow Cross-Culverts

2.1 Field Hydraulic and Hydrologic Evaluation

On November 15 and 16, 2022, two VHB engineers visited the study area to evaluate existing conditions to help guide analysis. This evaluation included documenting cross-culvert conditions, assessing flow channel conditions near cross-culverts determining flow paths and delineating subwatersheds, and conducting a high-level hydrologic review of the entire study area.

During this site visit, VHB noted the following poorly functioning culverts. Photos of each crossing are included in **Exhibit 1**; crossing locations are shown in **Figure 2**.

Exhibit 1 Hydraulic Crossing Photographs



Photo 1: Culvert under Park Loop Road (Park Loop Rd-1). Channel erosion observed downstream of culvert outlet.



Photo 2: Culvert under Park Loop Road (Park Loop Rd-2). Outlet headwall is collapsing, and channel erosion observed downstream of culvert outlet.



Photo 3: Culvert under Park Loop Road (Park Loop Rd-5). Channel erosion observed downstream from concentrated flow at culvert.



Photo 4: Culvert under Park Loop Road (Park Loop Rd-6). An old roadbed within this watershed collects and concentrates flow from upland areas, causing erosion downstream.



Photo 5: Culvert under Park Loop Road (Park Loop Rd-8). Channel erosion observed downstream due to concentrated flow from culvert.



Photo 6: Culvert crossing diagonally under Park Loop Road at Route 3 (Route 3-1). Channel erosion observed downstream due to concentrated flow from culvert.



Photo 7: Outlet of culvert under Rt 3 (Route 3-2). Scour pool and major channel erosion observed downstream due to concentrated flow from culvert.



Photo 8: Newly constructed culvert under Sweet Water Circle (Sieur de Monts-1). There is no established drainage path to the culvert inlet. (Note: has since been replaced by dual 18" CMP)



Photo 9: Culvert under service road near Sweet Water Circle. This culvert conveys runoff to an undersized closed drainage system below the visitor center, causing localized flooding.



Photo 10: Culvert under Hemlock Path (Hemlock-2). Scour and sediment deposits observed at culvert outlet.



Photo 11: Overland flow over Hemlock Path (Hemlock-3). Flow path observed the path surface, causing areas of erosion.



Photo 12: Culvert under Hemlock Path (Hemlock-4). Channel erosion observed downstream of culvert outlet.



Photo 13: Southern culvert under Hemlock Path (Hemlock-6). Downstream erosion observed at culvert, with a significant scour hole at the outlet.



Photo 14: Northern culvert under Hemlock Path (Hemlock-6). Downstream erosion observed at culvert outlet.



Photo 15: Culvert under Hemlock Path (Hemlock-7). The concrete low-water crossing only conveys flow under flood conditions, and presents a barrier to aquatic organism passage and habitat connectivity.



Photo 16: Culvert under Hemlock Path (Hemlock-8). Hemlock Path splits the wetland to the west from the Great Meadow, concentrating flow through this culvert.

2.2 Field Topographic Survey

Following the initial field evaluation, VHB conducted a field topographic survey overseen by a licensed professional land surveyor of culvert crossings around the perimeter of the Great Meadow in December 2022. Survey at each culvert included the material, dimensions (diameter or height and width), elevation and location of the inlet and outlet, road or trail centerline profile crossing over the culvert, and topographic ground survey and location of large trees within 50 feet of the culvert. This topographic survey data was used for geolocation of culverts for hydrologic modeling and for culvert geometry for hydraulic modeling.

The following analysis focuses on twenty-three (23) primary crossing locations. The field evaluation identified a total of thirty-four (34) cross-culverts along the perimeter of the Great Meadow, in clockwise order: eight (8) across the Park Loop Road on the east side of the meadow, four (4) across US Route 3 and the Sieur de Monts connector, five (5) across the visitor circle and trails at Sieur de Monts and the Wild Gardens of Acadia, and eighteen (18) along the Hemlock Path on the west side of the meadow. However, some of these culverts were redundant due to multiple crossings where two roads or trails crossed the same flow path, or where flow crossing a trail split across multiple adjacent culverts. Therefore, these redundant culverts (located along the Hemlock Path and around Sieur de Monts and Wild Gardens of Acadia) were consolidated into representative crossings to reduce the effective number of crossings to twenty-three (23).

3

Hydrologic and Hydraulic Models

3.1 Hydrologic Model

This section summarizes VHB’s hydrologic analysis including delineating subwatershed boundaries, assessing land use and hydrologic soil groups, delineating flow paths and lag times, determining key hydrologic events, and calculating peak flows. This hydrologic analysis is built upon the data and methodology outlined in the *Great Meadow and Cromwell Brook Restoration Study (2022)* and is discussed in more detail below.

3.1.1 Watershed Delineation

The Cromwell Brook watershed is approximately 3 square miles of primarily undeveloped forest, wetlands, or bare land. During the November 2022 field visit, VHB identified twenty-three (23) culvert crossings corresponding to individual subwatersheds flowing directly to the Great Meadow (**Figure 2**), identifying the drainage patterns conveying runoff to each location. Using the ArcGIS Field Maps application, VHB collected GPS points in the field to identify flow paths and hydrologic divisions between each subwatershed. VHB developed the preliminary subwatershed areas based on topographic LiDAR and survey data, and then refined each subwatershed using our GPS locations and notes collected in the field. This refined hydrologic mapping was incorporated into the 2022 study hydrologic model, replacing the previous three subwatersheds flowing to the Great Meadow with twenty-four (24) newly delineated subwatersheds (the twenty-three noted above plus an additional subwatershed collected by the main stem of Cromwell Brook between the Tarn and the Great Meadow) corresponding to locations where concentrated flow enters the Great Meadow. The remaining four Cromwell Brook subwatershed boundaries (The Tarn, Cromwell-Middle, Kebo, and Bar Harbor) and the adjacent reference Otter Creek subwatershed remained unchanged from the 2022 model were not revised as part of this supplemental analysis. **Figure 3** illustrates the revised Cromwell Brook subwatershed delineation.

The calculation of hydrologic runoff parameters – runoff Curve Number, or “CN”, and time of concentration, or “Tc” – were based on topographic LiDAR and survey data, VHB field observations, aerial imagery, land cover data from the National Land Cover Database (2019), and hydrologic soil group (HSG) data publicly available from the NRCS Web Soil Survey. The CN and Tc for each watershed were calculated using Technical Release (TR-55) methodology. The surficial geology within the area is dominated by rock outcrops (~48%), soils characterized by cobbles, stones, or boulders (~28%), and various sandy or silty loam complexes (12%), with the remaining area comprised of waterbodies and other soil groups. The primary hydrologic soil group (HSG) within the area is “D” (69%), which indicates a relatively high potential for runoff (**Figure 3A**). Land cover within the Cromwell Brook watershed is approximately 42% medium density forest and 36% high density forest. Approximately 6% of land cover is open space (parks, golf courses, or open vegetated areas), 4% is residential and 2% is impervious cover. The Bar Harbor village is

the most developed area within the Cromwell Brook watershed and is covered by 34% residential areas, 27% medium density forest, 21% commercial or industrial areas, and remaining areas by roadways or open space. **Figure 3B** shows the land use/land cover for each subwatershed. Flow paths for each watershed were delineated from LiDAR topographic data supplemented by field observations, with corresponding Tc and lag time calculated based on path length, slope, and flow type. The subwatershed hydrologic parameters are summarized in **Table 1** below. The time of concentration calculations are included in **Appendix A**.

Table 1 Cromwell Brook Subwatershed Hydrologic Characteristics

Subwatershed Name	Area (ac)	CN	Tc (mins)	Lag (mins)
Bar Harbor	219.6	85	94.0	56.4
Cromwell Mid	143.7	74	165.1	99.1
Cromwell Upper	37.0	68	80.9	48.5
<i>Great Meadow¹</i>	<i>125.9</i>	<i>84</i>	<i>N/A</i>	<i>N/A</i>
Hemlock-1	9.0	77	35.4	21.3
Hemlock-2	6.1	75	29.1	17.5
Hemlock-3	21.3	76	35.9	21.6
Hemlock-4	15.6	72	39.3	23.6
Hemlock-5	15.0	71	37.7	22.6
Hemlock-6	23.6	70	33.9	20.3
Hemlock-7	41.8	69	47.9	28.7
Hemlock-8	94.2	65	102.0	61.2
Kebo	776.8	71	280.2	168.1
Park Loop Rd-1	6.6	68	27.3	16.4
Park Loop Rd-2	8.3	70	31.7	19.0
Park Loop Rd-3	12.1	61	38.7	23.2
Park Loop Rd-4	3.0	52	33.6	20.2
Park Loop Rd-5	20.9	64	49.7	29.8
Park Loop Rd-6	9.8	67	27.8	16.7
Park Loop Rd-7	0.6	73	17.3	10.4
Park Loop Rd-8	5.5	69	14.2	8.5
Route 3-1	13.1	60	28.1	16.9
Route 3-1A	5.5	74	19.8	11.9
Route 3-2	25.9	62	28.7	17.2
Route 3-3	2.1	63	31.4	18.8
Sieur de Monts-1	17.9	67	60.7	36.4
Sieur de Monts-2	15.2	71	43.4	26.1
Sieur de Monts-3	26.7	76	38.9	23.3
The Tarn	216.8	77	30.7	18.4
<i>Otter Creek at USGS Gage²</i>	<i>870.4</i>	<i>74</i>	<i>252.7</i>	<i>151.6</i>

1. The Great Meadow wetland is part of the overall watershed of Cromwell Brook but is a unique subwatershed as rainfall directly enters the waterbody of the Great Meadow with no transformation from rainfall to runoff. Refer to Section 3.2.2 for a discussion of how rainfall in this area is accounted for in the HEC-RAS hydraulic model.
2. The Otter Creek watershed was used for reference and calibration and is not included in the Cromwell Brook hydraulic model.

3.1.2 Hydrologic Modeling Approach

VHB modified and refined the hydrologic analysis developed for the 2022 study to better reflect unique hydrology of Mount Desert Island. To accommodate the increased model complexity and improve interoperability with the hydraulic HEC-RAS model of Cromwell Brook, VHB replaced the 2022 study HydroCAD model with a hydrologic model using the USACE Hydrologic Engineering Center's Hydrologic Modeling System (HEC-HMS) software.

The HEC-HMS model calculates runoff hydrographs from rainfall hyetographs using the Soil Conservation Service (SCS) TR-55 loss and transform method; this method is fundamentally the same as the methodology used by the HydroCAD model in the 2022 study, but each software uses slightly different parameters and inputs. Most notably, HEC-HMS uses lag time instead of time of concentration (T_c) to reflect the delay between rainfall over a watershed and the peak runoff flow at the watershed outlet. Lag time accounts for the time required for direct surface runoff to reach its maximum peak at the watershed outlet, while time of concentration considers the entire watershed's hydrologic response. Therefore, lag time is generally shorter than the time of concentration. Various researchers (Mockus 1957; Simas 1996) found that for average natural watershed conditions and an approximately uniform distribution of runoff:

$$Lag = T_c * 0.6$$

To ensure model consistency between the newly-delineated Great Meadow subwatersheds and the previously-delineated Cromwell Brook subwatersheds from the 2022 study, VHB calculated time of concentration times for all twenty-eight Cromwell Brook subwatersheds using the velocity method from the Natural Resources Conservation Service (NRCS) National Engineering Handbook (NEH) Chapter 15, then calculated lag time using the equation above. The time of concentration flows paths for each subwatershed are shown in **Figure 3C**.

Similar to the 2022 study, VHB next calibrated the HEC-HMS hydrologic model based on available historic empirical data including historic runoff hydrograph records from the nearby USGS Otter Creek stream gage and historic stream water level records along Cromwell Brook provided by Brian Henkel. Review indicated that calculated lag times for Kebo Brook and Otter Creek were consistent with observed historic lag times from the same calibration events used in the 2022 study, and but runoff volumes, peak flows, and hydrograph temporal distributions were not. As noted in the 2022 study, this difference was expected as there are multiple characteristics of Mount Desert Island that contribute to a unique hydrology.

To calibrate the HEC-HMS model, VHB adjusted the hydrograph peak rate factor (PRF) and initial abstraction (I_a) components to find a best-fit of historic site data for a range of rainfall events. The PRF modifies the shape of a hydrograph; NEH Chapter 16 notes that studies have shown a range from below 100 (for flat wetlands) to more than 600 (for steep terrain), with the default standard PRF of 484. Calibration indicated that a PRF of 550 provided a best fit of historic empirical data, and the higher value is expected considering the steep terrain of watersheds on the slopes of Dorr and Cadillac Mountains. Initial abstraction represents rainfall retained by soil or vegetation that does not contribute to runoff, and is a function of the runoff Curve Number (CN), where:

$$S = \frac{1,000}{CN} - 10 \quad \text{and} \quad I_a = \lambda * S$$

The default standard is $\lambda = 0.20$; this value was initially developed from NRCS studies of farmland. Recent studies (Woodward et al. 2003) fitting empirical data found values of λ ranging from 0.0005 to 0.1, with a median of 0.05. Calibration indicated that a value of $\lambda = 0.10$ provided a best fit for the Cromwell Brook watershed.

3.1.3 Hydrologic Modeling Results

The results of the HEC-HMS peak flows calculated for each subwatershed are shown in Table 2:

Table 2 Subwatershed Runoff Peak Flows

Subwatershed Name	Peak Flow (cfs) by Return Interval		
	2-Year	10-Year	50-Year
Bar Harbor	189.3	307.3	443.6
Cromwell Mid	58.4	105.0	162.9
Cromwell Upper	18.6	35.7	57.5
Hemlock-1	9.6	16.9	25.6
Hemlock-2	6.5	11.6	18.0
Hemlock-3	22.0	38.9	59.5
Hemlock-4	13.3	24.3	37.9
Hemlock-5	12.5	23.1	36.6
Hemlock-6	19.8	37.1	59.0
Hemlock-7	28.9	54.5	86.8
Hemlock-8	36.5	71.4	117.5
Kebo	195.0	360	570.1
Park Loop Rd-1	5.4	10.4	16.9
Park Loop Rd-2	7.2	13.4	21.2
Park Loop Rd-3	6.4	13.2	22.3
Park Loop Rd-4	1	2.4	4.4
Park Loop Rd-5	11.5	22.9	37.9
Park Loop Rd-6	7.7	14.9	24.4
Park Loop Rd-7	0.7	1.2	1.9
Park Loop Rd-8	5.8	10.9	17.5
Route 3-1	7.5	15.5	26.6
Route 3-1A	6.3	11.4	17.9
Route 3-2	16.0	32.7	55.0
Route 3-3	1.3	2.7	4.5
Sieur de Monts-1	10.2	19.7	31.9
Sieur de Monts-2	11.9	22.2	35.1
Sieur de Monts-3	26.5	46.7	71.5
The Tarn	244.8	427.0	644.9
<i>Otter Creek at USGS Gage¹</i>	265.3	475.6	738.2

1. The Otter Creek watershed was used for reference and calibration but was not included in the Cromwell Brook model.

3.2 Hydraulic Analysis

Based on the results of the hydrologic modeling, VHB prepared an abbreviated hydraulic analysis of cross-culverts around the perimeter of the Great Meadow and updated the existing HEC-RAS two-dimensional (2D) hydraulic model of the Great Meadow.

3.2.1 Cross-Culvert Hydraulic Analysis

Using the results of hydrologic modeling, VHB evaluated the hydraulic adequacy of the cross culverts by comparing the HEC-HMS model peak flows to the estimated hydraulic capacity of the culvert at each crossing. The purpose of this analysis is to quantify and supplement the field evaluation of culverts at risk of failure or significant outlet erosion by identifying culverts that are hydraulically undersized for storm flows. To estimate hydraulic capacity of each cross-culvert, VHB calculated the maximum potential flow based on two limiting factors:

- Inlet Control: flow limited by the rate that water can enter the culvert opening
- Outlet Control: flow limited by the hydraulic capacity of the culvert pipe itself or by downstream tailwater conditions

For inlet control, limiting flow was calculated by the simple orifice flow equation for culverts:

$$Q = C_d A \sqrt{2g(H_w - 0.5D)}$$

where Q is the flow rate, A is the cross-sectional area, D is the diameter or height of the culvert, H_w is the headwater depth, and C_d is the inlet discharge coefficient. For outlet control, the hydraulic capacity was calculated using Manning's Equation for just-under-full pipe flow:

$$Q = Av = \left(\frac{1.486}{n} \right) AR^{\frac{2}{3}} S^{\frac{1}{2}}$$

where Q is the flow rate, A is the cross-sectional area, v is the velocity, n is the Manning's roughness coefficient, R is the hydraulic radius, and S is the average slope. The lowest value calculated by these two limiting factors was used as the hydraulic capacity of the culvert based on the structure's geometry and material. Culvert dimensions (including area and slope) were determined from field topographic survey.

The resulting hydraulic capacity of each culvert was then compared to calculated peak flows from hydrologic modeling for the 1-inch, 2-year, 5-year, 10-year, 50-year and 100-year magnitude storm events, summarized in the hydrologic section above. Based on the results of the smaller events (2-year, 5-year, and 10-year), VHB identified culverts that pose a greater risk of scour and erosion due to road/trail overtopping or high outlet velocities, focusing on the 10-year flow event. It is important to note that although peak flows are smaller, these events are a significant contributor to erosion and sedimentation due to their higher frequency. Inadequately designed culverts can result in substantial erosion, scour, and flooding due to the cumulative effect of multiple smaller storms. Analysis also included large flood events (50- and 100-year magnitude), but due to the rare likelihood of these events and the relatively low risk of loss (hiking trails are not critical transportation infrastructure), hydraulic performance for smaller storms was given higher priority.

A summary the results of this hydraulic analysis for the 10-year storm event is shown in **Table 3**; full hydraulic analysis is provided in **Appendix B**.

Table 3 Cross-Culvert Hydraulic Analysis

Culvert	Size	Material	10-year Peak Flow (Q)	Hydraulic Capacity (Q)
Park Loop -1	› 1.5' Pipe	RCP	10.4	10.4
Park Loop -2	› 2'x2' Box	Stone	13.4	27.2
Park Loop -3	› 3.5'x2.3' Box	RCP	13.2	60.1
Park Loop-4	› 1.5' Pipe	RCP	2.4	10.4
Park Loop-5	› 1.5' Pipe	RCP	22.9	10.4
Park Loop-6	› 2.0' Pipe	RCP	14.9	21.4
Park Loop-7	› 1.5' Pipe	RCP	1.2	7.4 ⁴
Park Loop-8	› 1.5' Pipe	RCP	10.9	7.4 ⁴
Route 3-1	› 1.5' Pipe	RCP	15.5	10.4
Route 3-1A	› 2.0' Pipe	CMP	11.4	20.9
Route 3-2	› 1.5' Pipe	RCP	32.7	10.4
Route 3-3	› 2.0' Pipe	RCP	2.7	21.4
Sieur de Monts-1 ¹	› 2.0' Pipe	CMP	19.7	15.6
Sieur de Monts-2	› 3.0' Pipe	CMP	22.2	25.5 ⁴
Sieur de Monts-3	› 3.0' Pipe	CMP	46.7	25.5 ⁴
Hemlock-1	› 3.0' Pipe	CMP	16.9	59.0
Hemlock-2	› 1.5' Pipe	CMP	11.6	10.4
Hemlock-3 ²	› 1.5' Pipe	CMP	38.9	35.5
Hemlock-4 ²	› 1.5' Pipe	CMP	24.3	31.3
Hemlock-5 ²	› 1.5' Pipe	CMP	23.1	45.0 ⁴
Hemlock-6 ²	› 1.5' Pipe	CMP	37.1	18.0 ⁴
Hemlock-7 ³	› Level Crossing	Paved	54.5	77.0
Hemlock-8	› 3' Pipe	RCP	71.4	25.5 ⁴

1 Sieur de Monts-1 is located near the Cromwell Brook culvert crossing and excess flow is expected to be re-routed through the woods to Cromwell Brook

2 Hemlock-3, Hemlock-4, Hemlock-5, and Hemlock-6 are composite crossings representing multiple parallel culverts conveying flow from a single subwatershed drainage area

3 Hemlock-7 is a paved low-level crossing, not a culvert

4 Minimum slope of 0.005 ft/ft assumed for calculating Manning's equation flow where surveyed inlet elevation was lower than outlet elevation.

3.2.2 HEC-RAS Hydraulic Model

In addition to individual culvert hydraulic analysis, VHB updated the previously developed 2-dimensional (2D) HEC-RAS hydraulic model to incorporate the updated hydrology. Where the previous model modeled inflows to the Great Meadow at three broad areas (the eastern side, western side, and the Cromwell Brook inlet at the south), the revised model more accurately represents inflows by representing inflow at all twenty-four (24) flow discharge locations corresponding to the cross-culverts identified and surveyed for this supplemental study.

VHB adjusted the perimeter of the Great Meadow 2D flow area to correspond to the area encircled by the Park Loop Road, Sieur de Monts access road and circle, and Hemlock Path, then

added boundary inflow locations corresponding to the georeferenced location of each of the twenty-four (24) cross-culvert locations. Inflows at these boundary locations were linked directly from the HEC-HMS model .dss (HEC Data Storage System) output file. VHB then applied a uniform precipitation hydrograph over the 2D flow area to represent rainfall directly over the 125.9-acre wetland surface. These revised hydrologic inputs were applied for all design scenarios (half-inch, 1-inch, 2-year, 10-year, and 100-year magnitude rainfall events). Model terrain and geometry other than the 2D flow area perimeter remain unchanged from the 2022 study.

HEC-RAS model results show no significant change in overall Great Meadow hydrographs, water surface elevations, or outflows; this is expected as the 2022 study model indicated that the outlet at the Park Loop Road culvert is the dominant factor influencing the hydrology of the Great Meadow. However, the revised model now provides a far more detailed image of flow patterns around the perimeter of the wetland and allows for future modeling to analyze small-scale changes to the wetland. A summary of the revised model is provided in **Figure 4**.

4

Conclusions and Recommendations

The purpose of this study is to identify areas of poorly functioning culverts and recommend modifications to improve the health and function of the Great Meadow. VHB analyzed the twenty-three (23) distinct subwatersheds around the perimeter of the Great Meadow corresponding to culvert crossings under Park Loop Road, Great Meadow Drive, Sieur de Monts Road, and the Hemlock Path, identifying poorly-functioning culverts by field evaluation supplemented by hydrologic and hydraulic modeling. Model results showed a high correlation with field observations, as culverts with observed scour and erosion were also identified as hydraulically undersized by analysis. Based on the results of field observations and analysis, VHB identified modifications for 15 culvert crossings to reduce flooding and improve the hydrology and wetland health of the Great Meadow.

VHB conducted a comprehensive field evaluation of the hydrology, drainage patterns, and stream channels around the perimeter of the Great Meadow, identifying a common pattern that adversely impacted the hydrology and water quality of the wetland:

- **Diversion:** Historic roadways, drainage swales, and trails have re-routed the natural flow patterns around the Great Meadow. Flow diversion reduces the capacity for stormwater to infiltrate and recharge groundwater reserves needed to sustain wetland health during droughts, leading to concentration of flow at culvert crossings.
- **Concentration:** Where roadways traverse hillsides, runoff that is naturally dispersed across a wide area is collected by drainage swales and routed through a small number of cross-culverts. Concentrated flow can overwhelm the capacity of small cross-culverts leading to flooding, especially when culverts are blocked by sediment or debris. This concentration of flow also results in higher volumes of flow and velocities in downstream channels, leading to channel scour.
- **Scour:** Undersized culverts cause flow to exit at high velocities downstream, creating scour holes around the outlet. The concentrated, high-velocity flows exiting culverts exceed the natural capacity of the channel, eroding the streambed and banks and leading to sedimentation downstream.
- **Sedimentation:** Concentrated, high-velocity flow in downstream channels carries excessive sediment into the Great Meadow, increasing turbidity and reducing water quality. The increased sediment creates large deposits of sand and silt that buries native vegetation and impairs habitat, creating opportunities for invasive species.

Each of these elements impacts the next, and therefore effective mitigation of flooding, sedimentation and channel erosion should address the upstream causes as well as improvements to the crossing itself. To address these issues and improve the hydrology and health of the Great Meadow wetland, individual crossings should be improved by one or more of the following mitigation actions:

- **Upstream Diversion:** Historic roadways, drainage swales, and other improvements along the hillslopes above the Park Loop Road and Sieur de Monts have artificially concentrated flow to some crossings, creating local flooding. This mitigation action removes, breaches, or fills historic features to re-route flow back to natural patterns.
- **Disperse Flow:** At crossings across wetlands or along the perimeter of the Great Meadow, naturally dispersed flow is routed and concentrated through a single culvert. This mitigation action replaces a single culvert with multiple wetland crossings and/or boardwalks to connect wetlands on either side of the trail.
- **Upgrade Culvert:** Hydraulically undersized culverts lead to local flooding and scour. This mitigation action replaces an existing culvert with an enlarged culvert or small bridge, reducing flow velocities and improving stream connectivity.
- **Outlet Stabilization:** At crossings along roadways where culvert upgrades are less feasible, the downstream channel is vulnerable to further scour and erosion. This mitigation action installs a riprap plunge pool at the culvert outlet, protecting against scour and dissipating flow energy to reduce downstream channel erosion.
- **Stormwater Retrofit:** At crossings along roadways where upstream diversion or flow dispersion are less feasible, concentrated flow increases turbidity downstream and reduces groundwater recharge. This mitigation action installs a vegetated Best Management Practice (BMP) at the culvert outlet to detain, treat, and infiltrate stormwater runoff.

Table 4 below provides a summary of the evaluation and recommendations for each cross-culvert location. **Figure 5** illustrates the locations of the recommended mitigation actions.

Table 4 Recommended Mitigation Actions

Crossing	Mitigation Action	Notes
Park Loop -1	› Outlet Stabilization	This culvert is adequately sized for smaller flood flows, but there is a scour hole at the outlet. The outlet should be stabilized with a riprap plunge pool; this location is too forested and too close to the Great Meadow for a stormwater retrofit.
Park Loop -2	› Outlet Stabilization	This culvert is adequately sized, but the outlet headwall is collapsing and there is evidence of erosion in the downstream channel. The outlet should be repaired and stabilized with a riprap plunge pool.
Park Loop -3	›	This culvert is adequately sized, and due to its close proximity to the Great Meadow velocities are reduced by tailwater from the wetland.
Park Loop-4	›	This culvert has a small contributing watershed with low flows, and no evidence of scour or erosion.
Park Loop-5	› Upgrade Culvert › Stormwater Retrofit	This culvert is undersized and there is evidence of channel erosion downstream. The culvert should be replaced with a larger pipe size (or multiple pipes). The area downstream of the outlet appears well-suited for a vegetated stormwater basin to detain, treat, and infiltrate outflows.
Park Loop-6	› Upstream Diversion › Stormwater Retrofit	The old roadbed and drainage swales in the hillside above this crossing should be modified to better split flow between this crossing and Park Loop-7. The area downstream of the outlet appears well-suited for a vegetated stormwater basin to detain, treat, and infiltrate outflows.
Park Loop-7	›	The contributing watershed to this culvert is artificially reduced by the old roadbed and drainage swales above this crossing. Flow to this culvert would be restored by the upstream diversion to Park Loop-6
Park Loop-8	› Upgrade Culvert › Stormwater Retrofit	This culvert is undersized, but due to flat topography downstream there is minimal erosion. The outlet of this culvert extends approximately 60 feet beyond the Park Loop Road, likely due to historic road alignment. The culvert should be replaced with a larger pipe size and shorter length; the flat area downstream of the outlet appears well-suited for a vegetated stormwater basin to detain, treat, and infiltrate outflows.
Route 3-1	› Outlet Stabilization	This culvert is undersized and there is significant channel erosion at the perched outlet, but due to its location under the Park Loop Road and a stone arch bridge carrying Route 3 replacing the pipe is impractical. The outlet should be stabilized with a riprap plunge pool; this location is too steep for a stormwater retrofit.
Route 3-1A	›	This culvert is adequately sized with no evidence of scour or erosion.

Route 3-2	› Outlet Stabilization	This culvert is undersized and there is extensive channel erosion at the perched outlet, but due to its length crossing under Route 3 and the Park Loop Road/Sieur de Monts connector replacing the pipe is impractical. The outlet should be stabilized with a riprap plunge pool, and restoration of the downstream channel with boulder step-pools should be considered.
Route 3-3	›	This culvert is adequately sized with no evidence of scour or erosion.
Sieur de Monts-1	› Upstream Diversion	This is a new culvert, but old trails and culverts in the woods above the crossing divert flow away from this crossing and into the closed drainage system under the visitor center. The old diversions should be removed and a new guide channel constructed to divert flow towards the new culvert and Cromwell Brook. Although the culvert may still be hydraulically undersized due to cover limitations below the roadway, its location allows for excess flow to be diverted to Cromwell Brook where it would not present a threat of overtopping the roadway or flooding the visitor center.
Sieur de Monts-2	›	There are multiple crossings of this drainage, including dispersed wetland crossings and small bridges in the Wild Gardens and a single CMP under Hemlock Path. The Hemlock Path culvert is adequately sized with no evidence of scour, but replacement with a small bridge should be considered to improve aquatic connectivity.
Sieur de Monts-3	› Upgrade Culvert	There are multiple crossings of this drainage, including dispersed wetland crossings and small bridges in the Wild Gardens and a single CMP under Hemlock Path. The Hemlock Path culvert is undersized and should be replaced with a larger box or small bridge to reduce local flooding within the Wild Gardens area.
Hemlock-1	› Upgrade Culvert	This culvert is adequately sized, but it conveys a flashy intermitting mountain stream and the concentrated flow through the culvert barrel results in scour and sediment deposition downstream. The culvert should be replaced with a small bridge spanning the channel bankfull width to reduce velocities and improve stream connectivity.
Hemlock-2	› Upgrade Culvert	This culvert is undersized and the concentrated flow through the culvert barrel results in scour and sediment deposition downstream extending to and beyond the Jesup Path. The culvert should be replaced with a small bridge spanning the channel bankfull width to reduce velocities and improve stream connectivity.
Hemlock-3	› Disperse Flow	There are multiple individual culverts at this crossing as runoff coming down the slopes of Dorr Mountain is not concentrated in a single channel at this location. However, there is evidence of erosion from stormwater flowing over the treadway next to the southernmost culvert; additional culvert(s) should be added to capture this additional flow.
Hemlock-4	›	There are multiple individual culverts at this crossing as runoff coming down the slopes of Dorr Mountain is not concentrated in a single channel at this location; the culverts are adequately sized and there is little evidence of scour or erosion.

Hemlock-5	›	There are multiple individual culverts at this crossing as runoff coming down the slopes of Dorr Mountain is not concentrated in a single channel at this location; the culverts are adequately sized and there is little evidence of scour or erosion.
Hemlock-6	› Upgrade Culvert	There are two culverts at this location (1 HDPE and 1 CMP), conveying a flashy intermittent stream that splits into two channels at the trail crossing. The culverts are undersized and there is evidence of scour and erosion at both culvert outlets. Each culvert should be replaced with a small bridge spanning the channel bankfull width to reduce velocities and improve stream connectivity.
Hemlock-7	› Disperse Flow	Hemlock Path along this section is a raised causeway dividing the main Great Meadow wetland from a smaller wetland to the west; flow between the wetlands is concentrated at Hemlock-7 and Hemlock-8. This crossing is a paved low-level ford and not a culvert; it is adequately sized but presents a barrier to aquatic passage. The single crossing should be replaced with multiple small bridge wetland crossings, using the same design as the Jesup Path crossing of the same wetland just to the west.
Hemlock-8	› Disperse Flow	Hemlock Path along this section is a raised causeway dividing the main Great Meadow wetland from a smaller wetland to the west; flow between the wetlands is concentrated at Hemlock-7 and Hemlock-8. This crossing is undersized, but due to its close proximity to the Great Meadow velocities are reduced by tailwater from the wetland. The single crossing should be replaced with multiple small bridge wetland crossings, using the same design as the Jesup Path crossing of the same wetland just to the west.

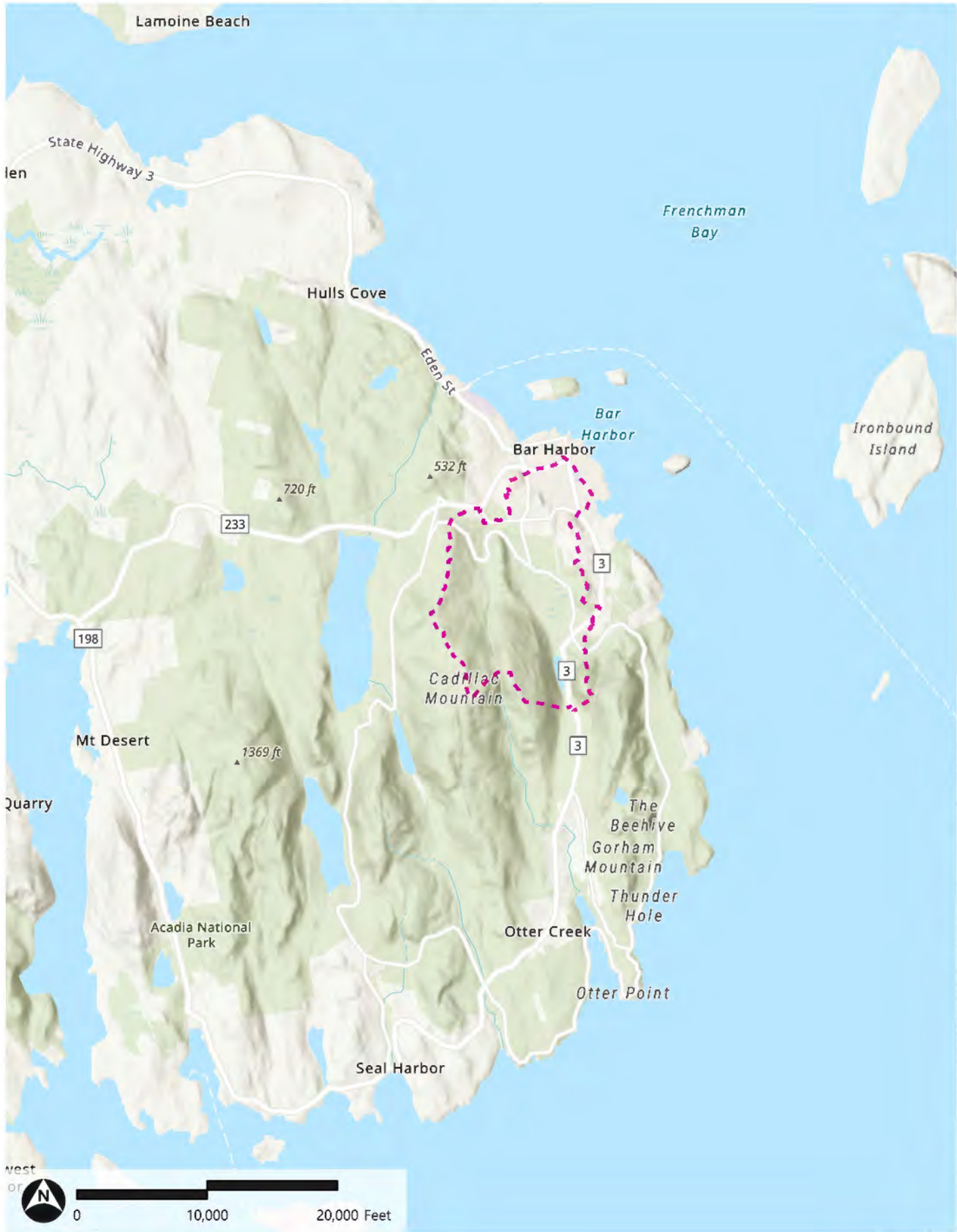
These mitigation actions would improve wetland health within the Great Meadow and reduce localized flooding at culvert crossings. It should be noted that these recommendations focus on reducing erosion and sedimentation from smaller, more frequent storms, and place a lower priority on larger infrequent storms. VHB recommends that upgrading culvert crossings also be considered at locations where culverts are adequately sized for the 10-year and smaller storms but are undersized for larger storms. Although those additional upgrades would provide less immediate value, they would improve future resiliency of Park infrastructure as climate change leads to larger and more frequent storm events.

5

Figures and Appendices

Figure 1: Site Locus Plan

Great Meadow Watershed Restoration Study | Acadia National Park, Maine



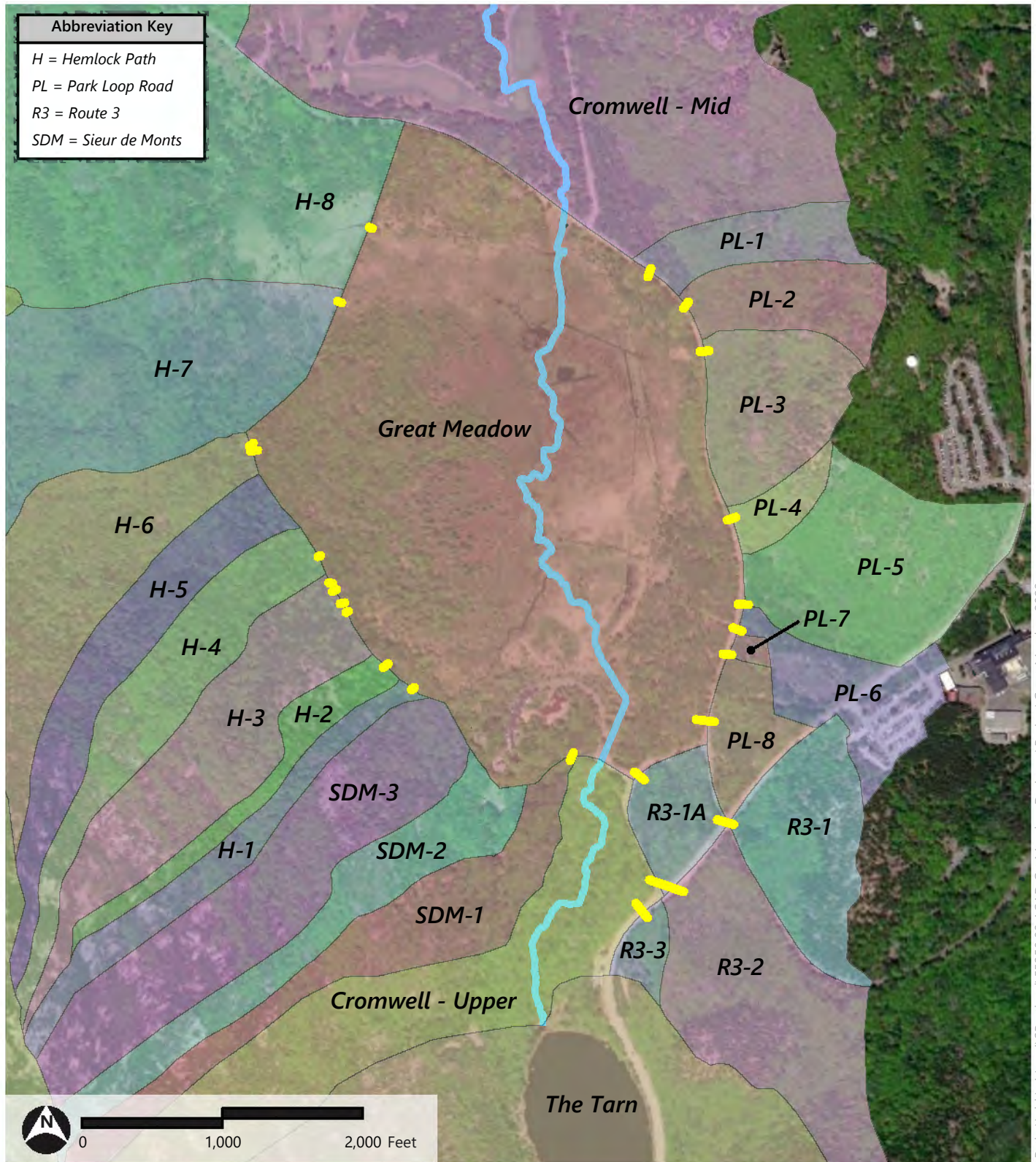
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Source: USGS

 Cromwell Brook Study Area

Figure 2: Key Culvert Locations

Great Meadow Watershed Restoration Study | Acadia National Park, Maine

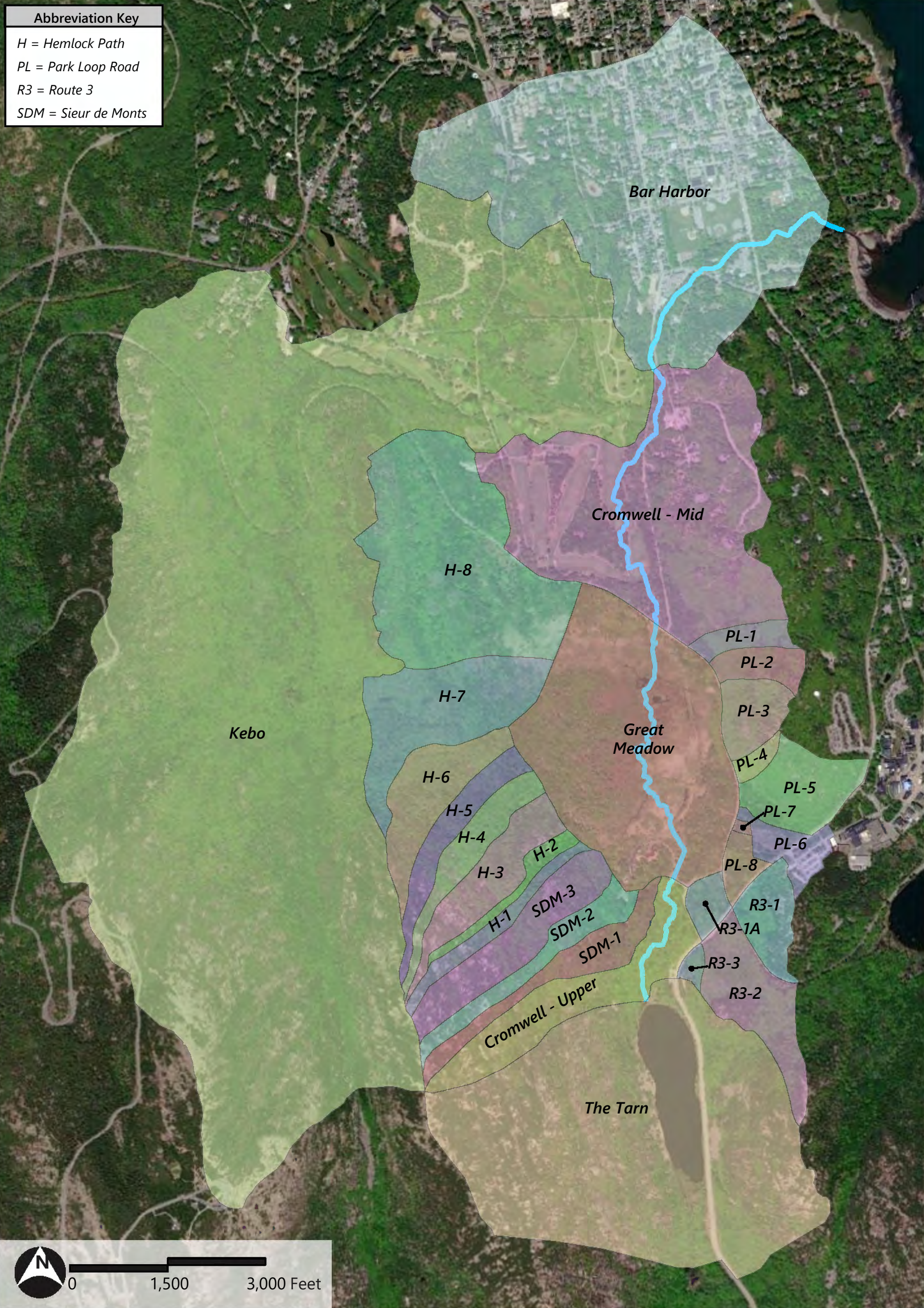


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Source: USGS

Culvert Locations	Hemlock - 2	Hemlock - 8	Park Loop Rd - 5	Rt 3 - 2
Cromwell Brook	Hemlock - 3	Kebo	Park Loop Rd - 6	Rt 3 - 3
Cromwell - Mid	Hemlock - 4	Park Loop Rd - 1	Park Loop Rd - 7	Sieur de Monts - 1
Cromwell - Upper	Hemlock - 5	Park Loop Rd - 2	Park Loop Rd - 8	Sieur de Monts - 2
Great Meadow	Hemlock - 6	Park Loop Rd - 3	Rt 3 - 1	Sieur de Monts - 3
Hemlock - 1	Hemlock - 7	Park Loop Rd - 4	Rt 3 - 1A	The Tarn

Figure 3: Cromwell Brook and Great Meadow Subwatersheds
Great Meadow Watershed Restoration Study | Acadia National Park, Maine

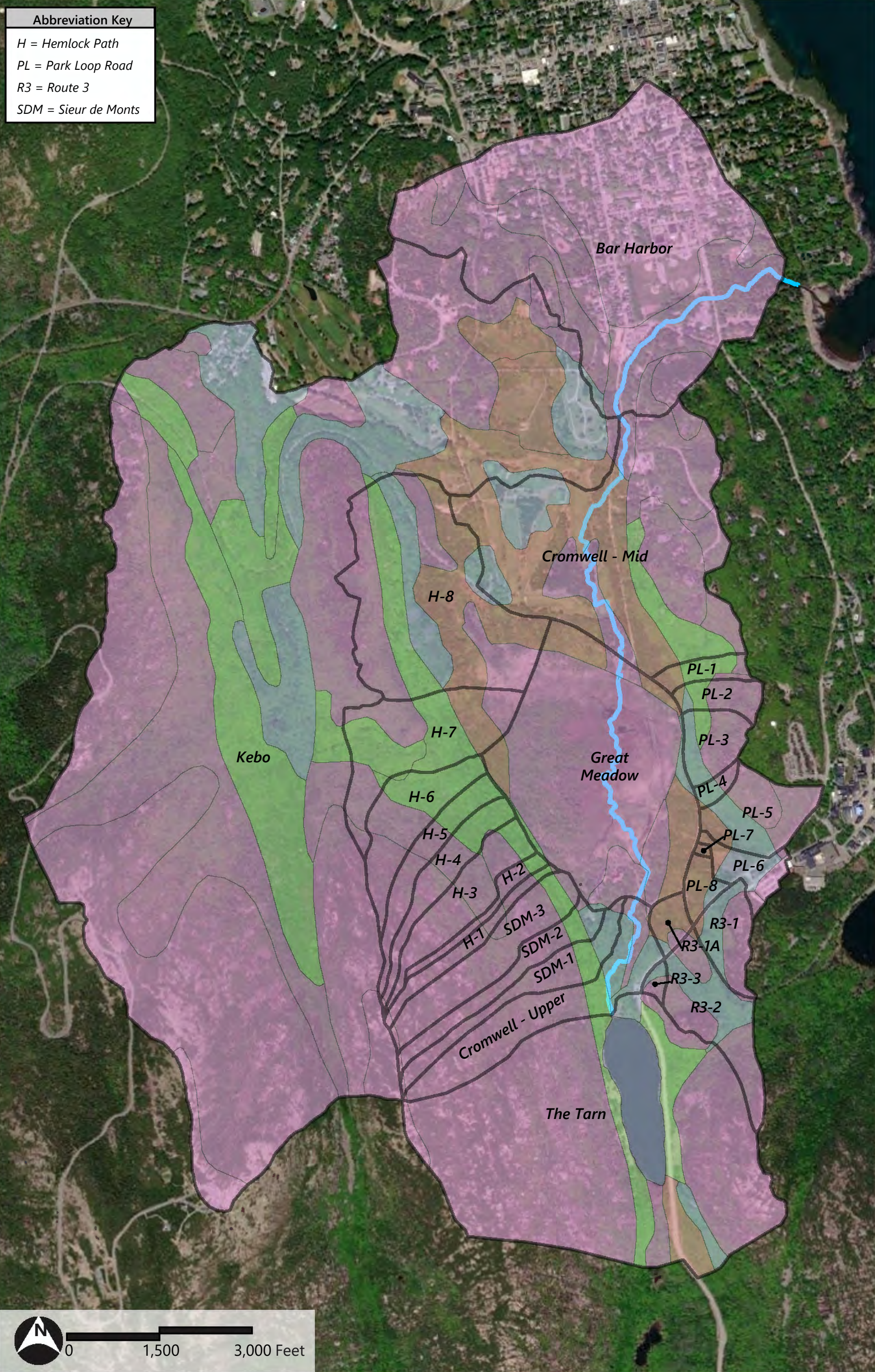


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Source: Maine.gov, USGS

- | | | | | |
|------------------|-------------|------------------|------------------|--------------------|
| Cromwell Brook | Hemlock - 2 | Hemlock - 8 | Park Loop Rd - 5 | Rt 3 - 2 |
| Bar Harbor | Hemlock - 3 | Kebo | Park Loop Rd - 6 | Rt 3 - 3 |
| Cromwell - Mid | Hemlock - 4 | Park Loop Rd - 1 | Park Loop Rd - 7 | Sieur de Monts - 1 |
| Cromwell - Upper | Hemlock - 5 | Park Loop Rd - 2 | Park Loop Rd - 8 | Sieur de Monts - 2 |
| Great Meadow | Hemlock - 6 | Park Loop Rd - 3 | Rt 3 - 1 | Sieur de Monts - 3 |
| Hemlock - 1 | Hemlock - 7 | Park Loop Rd - 4 | Rt 3 - 1A | The Tarn |

Figure 3A: Watershed Hydrology - Soils
Great Meadow Watershed Restoration Study | Acadia National Park, Maine



Cromwell Brook

Cromwell Brook Subwatersheds

Hydrologic Soil Group

A

B

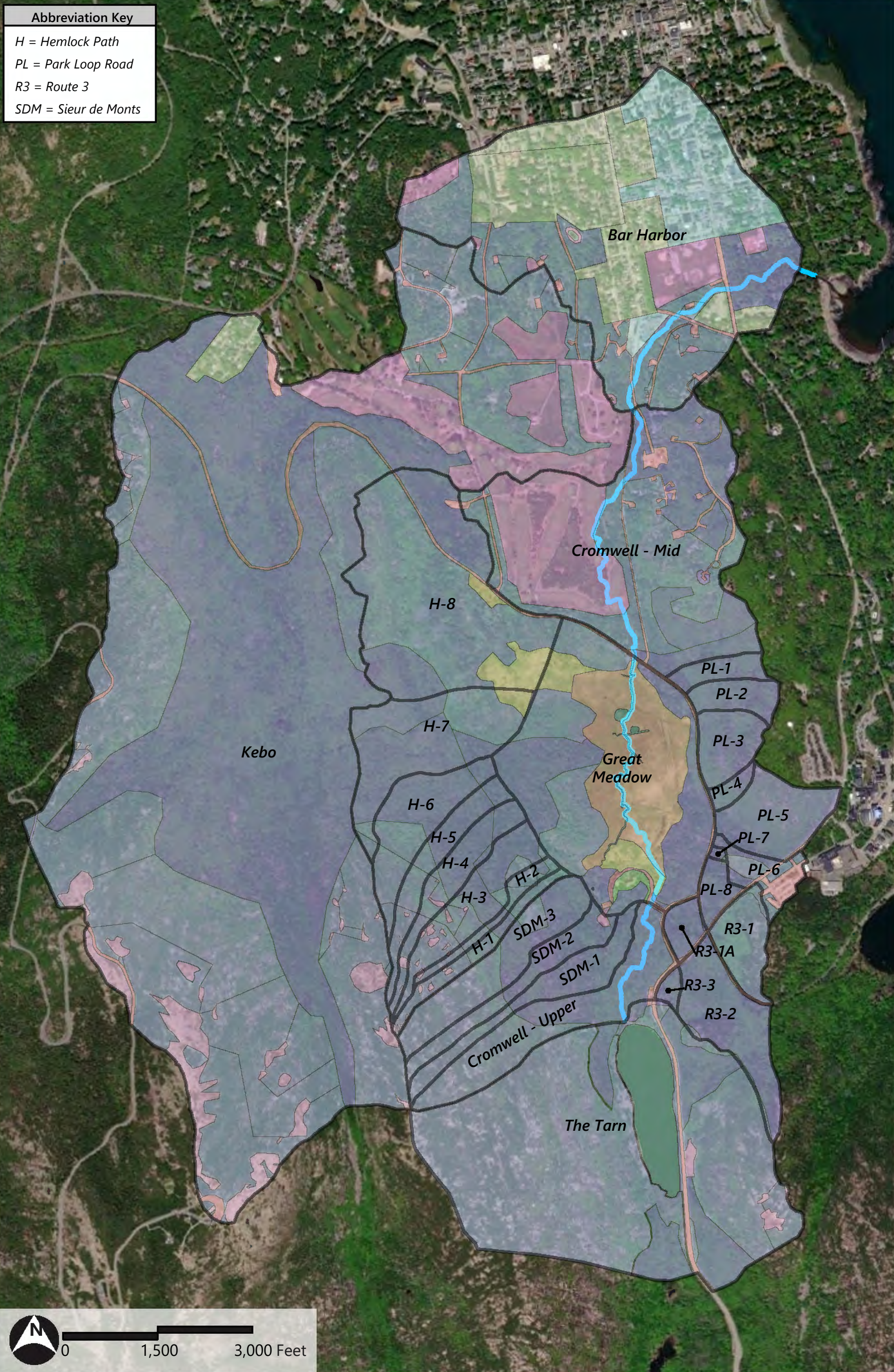
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D

Source: NRCS, USGS

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Figure 3B: Watershed Hydrology - Land Cover
Great Meadow Watershed Restoration Study | Acadia National Park, Maine



Source: NLCD, USGS

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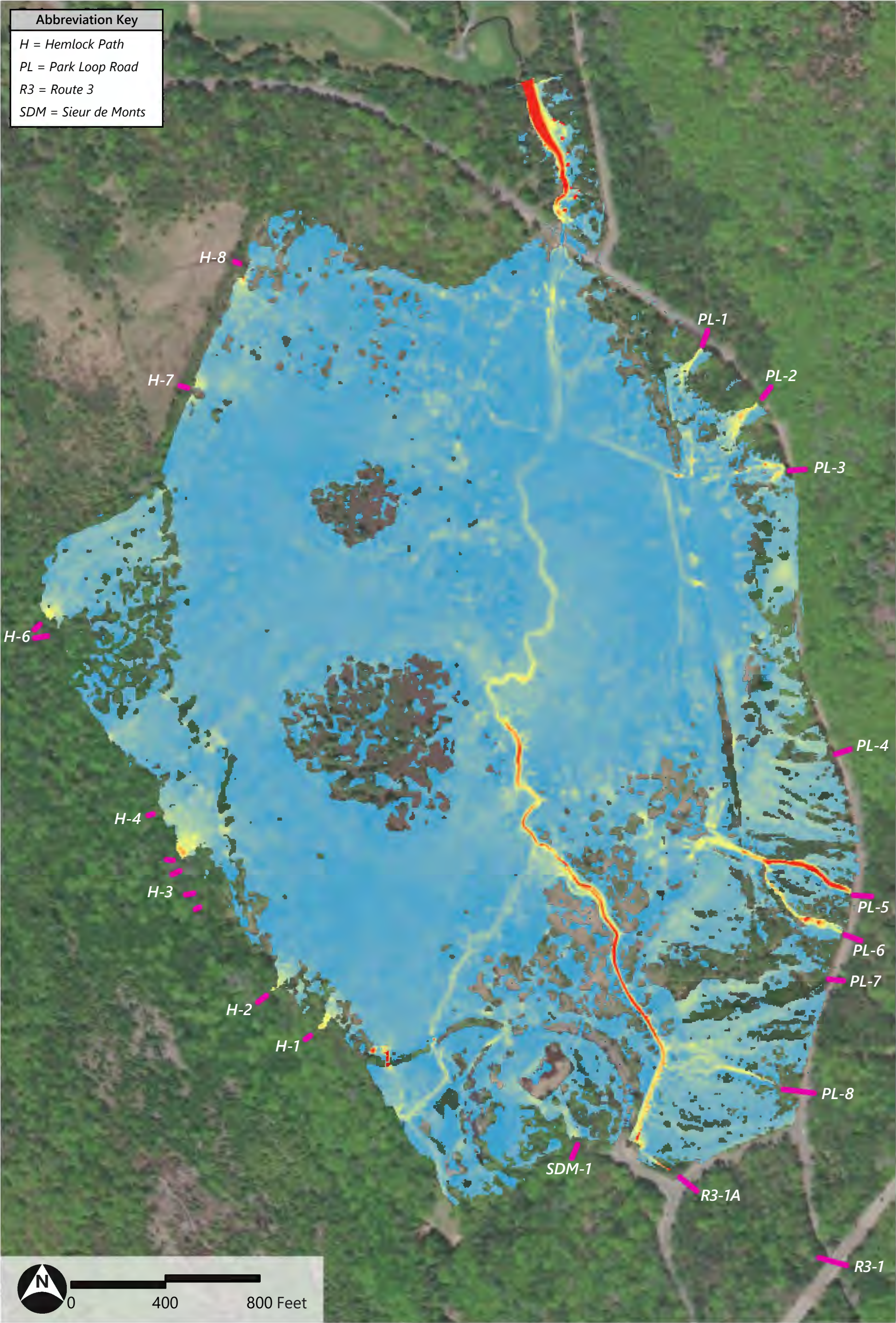
Figure 3C: Watershed Hydrology – Flow Patterns and Tc Paths
Great Meadow Watershed Restoration Study | Acadia National Park, Maine



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Source: Maine.gov, USGS

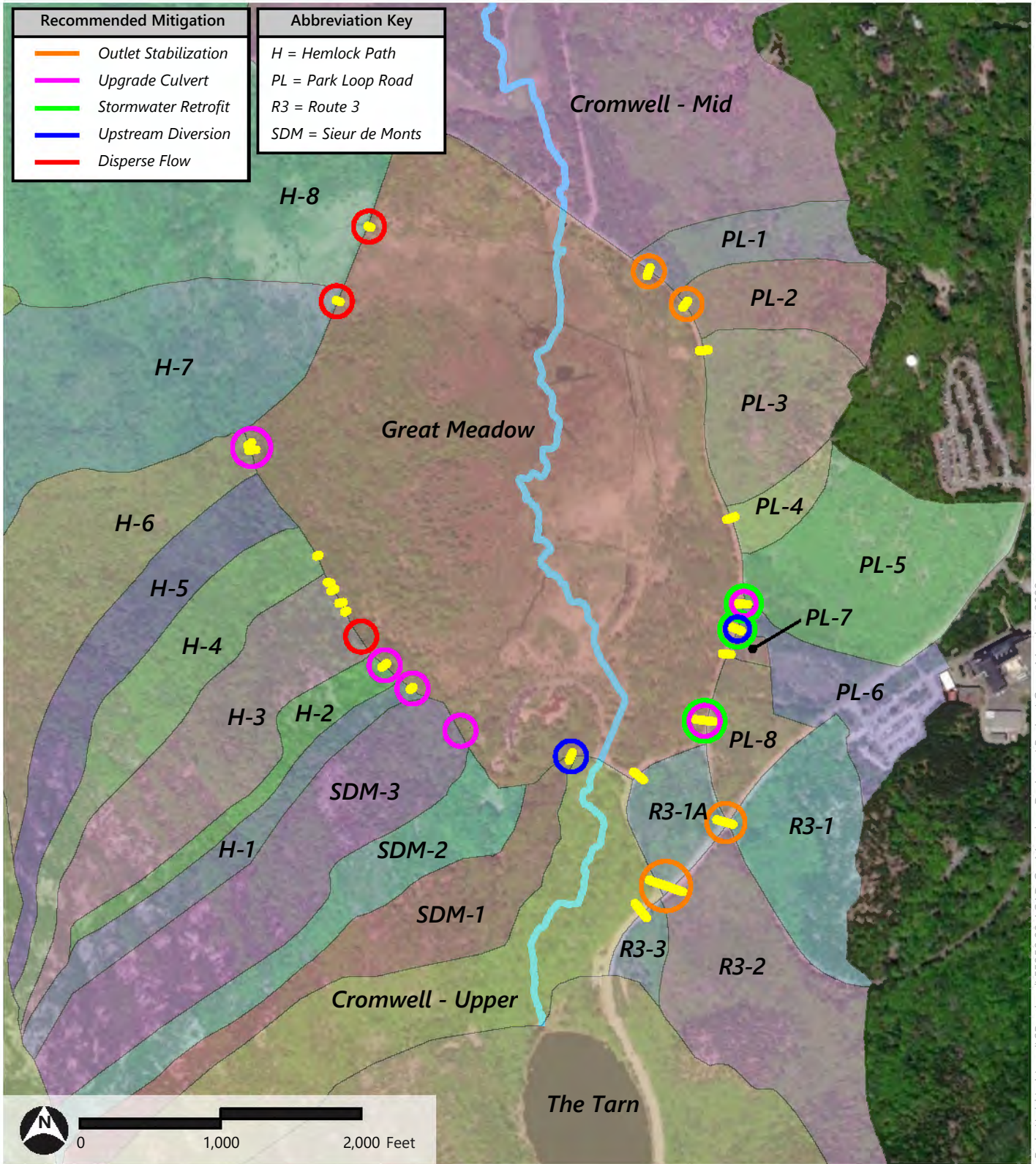
Figure 4: HEC-RAS Model Update
Great Meadow Watershed Restoration Study | Acadia National Park, Maine



Source: Maine.gov, USGS

Figure 3: Key Culvert Locations and Mitigation Actions

Great Meadow Watershed Restoration Study | Acadia National Park, Maine



Culvert Locations	Hemlock - 2	Hemlock - 8	Park Loop Rd - 5	Rt 3 - 2
Cromwell Brook	Hemlock - 3	Kebo	Park Loop Rd - 6	Rt 3 - 3
Cromwell - Mid	Hemlock - 4	Park Loop Rd - 1	Park Loop Rd - 7	Sieur de Monts - 1
Cromwell - Upper	Hemlock - 5	Park Loop Rd - 2	Park Loop Rd - 8	Sieur de Monts - 2
Great Meadow	Hemlock - 6	Park Loop Rd - 3	Rt 3 - 1	Sieur de Monts - 3
Hemlock - 1	Hemlock - 7	Park Loop Rd - 4	Rt 3 - 1A	The Tarn

A



Appendix A – Hydrologic Analysis

A.1 Subwatershed Hydrologic Inputs Summary

A.2 Runoff Curve Number (CN) and Initial Abstraction (Ia) Calculations

A.3 Time of Concentration (Tc) and Lag Calculations

A.4 Reach Time of Concentration Calculations

A.5 HEC-HMS Report

Appendix A.1 - Subwatershed Hydrologic Inputs Summary

Project:	Acadia Great Meadow Supplemental Work	Project #	55661.01
Location:	Acadia National Park		
Calculated by:	DMS	Date:	6/22/2023
Checked by:	DWC	Date:	7/12/2023

Cromwell Brook Subwatershed Hydrologic Characteristics

Subwatershed Name	Area (ac)	CN ¹	Tc (mins) ²	Lag (mins) ³
Bar Harbor	219.6	85	94.0	56.4
Cromwell Mid	143.7	74	165.1	99.1
Cromwell Upper	37.0	68	80.9	48.5
Great Meadow ⁴	125.9	84	N/A	N/A
Hemlock-1	9.0	77	35.4	21.3
Hemlock-2	6.1	75	29.1	17.5
Hemlock-3	21.3	76	35.9	21.6
Hemlock-4	15.6	72	39.3	23.6
Hemlock-5	15.0	71	37.7	22.6
Hemlock-6	23.6	70	33.9	20.3
Hemlock-7	41.8	69	47.9	28.7
Hemlock-8	94.2	65	102.0	61.2
Kebo	776.8	71	280.2	168.1
Park Loop Rd-1	6.6	68	27.3	16.4
Park Loop Rd-2	8.3	70	31.7	19.0
Park Loop Rd-3	12.1	61	38.7	23.2
Park Loop Rd-4	3.0	52	33.6	20.2
Park Loop Rd-5	20.9	64	49.7	29.8
Park Loop Rd-6	9.8	67	27.8	16.7
Park Loop Rd-7	0.6	73	17.3	10.4
Park Loop Rd-8	5.5	69	14.2	8.5
Route 3-1	13.1	60	28.1	16.9
Route 3-1A	5.5	74	19.8	11.9
Route 3-2	25.9	62	28.7	17.2
Route 3-3	2.1	63	31.4	18.8
Sieur de Monts-1	17.9	67	60.7	36.4
Sieur de Monts-2	15.2	71	43.4	26.1
Sieur de Monts-3	26.7	76	38.9	23.3
The Tarn	216.8	77	30.7	18.4
Otter Creek at USGS Gage ⁵	870.4	74	252.7	151.6

1. CN = Runoff Curve Number (H-NEH Calculations)

2. TC = Time of Concentration (Ref. SCS TR-55, Second Ed., June 1986)

3. Lag Time = TC * 0.6

4. Rainfall within Great Meadow applied directly in HEC-RAS model; no lag time.

5. Otter Creek is not part of Cromwell watershed, but used for the model calibration

Appendix A.2 - Runoff Curve Number (CN) and Initial Abstraction (I_a) Calculations

Project:	Acadia Great Meadow Supplemental Work	Project #	55661.01
Location:	Acadia National Park		
Calculated by:	DMS	Date:	6/22/2023
Checked by:	Checked DWC	Date:	7/12/2023

	Sum of Area (Acres)	Sum of Area (mi ²)	Curve Number (CN)	Sum of CN*A	S ¹	Initial Abstraction (I _a) ²
Bar Harbor	219.61	0.3431	85	18571.3	1.83	0.18
Cromwell Mid	143.73	0.2246	74	10589.9	3.57	0.36
Cromwell Upper	36.99	0.0578	68	2509.3	4.74	0.47
Great Meadow ³	125.94	0.1968	84	10557.6	1.93	0.19
Hemlock - 1	8.95	0.0140	77	687.8	3.01	0.30
Hemlock - 2	6.12	0.0096	75	455.6	3.42	0.34
Hemlock - 3	21.35	0.0334	76	1614.2	3.22	0.32
Hemlock - 4	15.57	0.0243	72	1119.3	3.91	0.39
Hemlock - 5	15.02	0.0235	71	1068.2	4.06	0.41
Hemlock - 6	23.59	0.0369	70	1645.6	4.34	0.43
Hemlock - 7	41.76	0.0652	69	2864.8	4.58	0.46
Hemlock - 8	94.16	0.1471	65	6161.6	5.28	0.53
Kebo	776.79	1.2137	71	54931.1	4.14	0.41
Park Loop Rd - 1	6.59	0.0103	68	446.5	4.75	0.47
Park Loop Rd - 2	8.34	0.0130	70	586.5	4.22	0.42
Park Loop Rd - 3	12.11	0.0189	61	733.9	6.51	0.65
Park Loop Rd - 4	3.01	0.0047	52	155.2	9.37	0.94
Park Loop Rd - 5	20.91	0.0327	64	1334.3	5.67	0.57
Park Loop Rd - 6	9.84	0.0154	67	654.7	5.02	0.50
Park Loop Rd - 7	0.58	0.0009	73	42.6	3.70	0.37
Park Loop Rd - 8	5.51	0.0086	69	379.1	4.52	0.45
Route 3 - 1	13.11	0.0205	60	788.3	6.63	0.66
Route 3 - 1A	5.53	0.0086	74	406.5	3.61	0.36
Route 3 - 2	25.94	0.0405	62	1597.4	6.24	0.62
Route 3 - 3	2.12	0.0033	63	132.5	5.99	0.60
Sieur de Monts - 1	17.93	0.0280	67	1202.0	4.92	0.49
Sieur de Monts - 2	15.24	0.0238	71	1075.3	4.18	0.42
Sieur de Monts - 3	26.75	0.0418	76	2020.3	3.24	0.32
The Tarn	216.79	0.3387	77	16641.1	3.03	0.30
Otter Creek	871.89	1.3623	74	64675.5	3.51	0.35

1. S = Potential maximum retention after runoff begins = (1000/CN)-10
2. Initial Abstraction (I_a) = 0.1 * S
3. Rainfall within Great Meadow applied directly in HEC-RAS model; no lag time.

Appendix A.3 - Time of Concentration (Tc) and Lag Calculations

Project:	Acadia Great Meadow Supplemental Work	Project #	55661.01
Location:	Acadia National Park		
Calculated by:	DMS	Date:	6/1/2023
Checked by:	DWC	Date:	7/12/2023

Ref. SCS TR-55, Second Ed., June 1986

2 Year, 24-hour storm depth (in): 3.57

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
Hemlock -1	1	Sheet	100.0	24%	0.4	0.22	7.6	4.5
	2	Forest with Heavy Litter	204.8	17%		1.04	3.3	2.0
	3	Forest with Heavy Litter	274.6	26%		1.28	3.6	2.1
	4	Forest with Heavy Litter	100.0	32%		1.42	1.2	0.7
	5	Forest with Heavy Litter	279.4	37%		1.52	3.1	1.8
	6	Forest with Heavy Litter	96.4	28%		1.34	1.2	0.7
	7	Forest with Heavy Litter	224.2	46%		1.71	2.2	1.3
	8	Forest with Heavy Litter	200.0	38%		1.55	2.2	1.3
	9	Forest with Heavy Litter	200.0	47%		1.73	1.9	1.2
	10	Forest with Heavy Litter	300.0	35%		1.49	3.4	2.0
	11	Forest with Heavy Litter	200.0	41%		1.61	2.1	1.2
	12	Forest with Heavy Litter	200.0	65%		2.03	1.6	1.0
	13	Open Woodlands	200.0	59%		3.86	0.9	0.5
	14	Open Woodlands	100.0	42%		3.28	0.5	0.3
	15	Open Woodlands	100.0	14%		1.88	0.9	0.5
Total			2779.3	0.2%		1.31	35.4	21.3
Total Elevation Drop			1056.9					
Hemlock - 2	1	Sheet	100.0	14%	0.4	0.18	9.3	5.6
	2	Forest with Heavy Litter	54.6	11%		0.84	1.1	0.6
	3	Forest with Heavy Litter	200.0	46%		1.71	1.9	1.2
	4	Forest with Heavy Litter	300.0	35%		1.48	3.4	2.0
	5	Forest with Heavy Litter	200.0	43%		1.64	2.0	1.2
	6	Forest with Heavy Litter	200.0	38%		1.54	2.2	1.3
	7	Forest with Heavy Litter	200.0	42%		1.63	2.0	1.2
	8	Forest with Heavy Litter	200.0	47%		1.72	1.9	1.2
	9	Forest with Heavy Litter	200.0	29%		1.36	2.4	1.5
	10	Open Woodlands	200.0	52%		3.63	0.9	0.6
	11	Open Woodlands	180.3	67%		4.11	0.7	0.4
	12	Open Woodlands	137.3	43%		3.28	0.7	0.4
	13	Open Woodlands	82.5	37%		3.05	0.5	0.3
Total			2254.6	0.2%		1.29	29.1	17.5
Total Elevation Drop			926.8					

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
Hemlock - 3	1	Sheet	100.0	17%	0.4	0.19	8.7	5.2
	2	Forest with Heavy Litter	199.5	23%		1.21	2.8	1.7
	3	Forest with Heavy Litter	200.0	27%		1.32	2.5	1.5
	4	Forest with Heavy Litter	200.0	12%		0.86	3.9	2.3
	5	Forest with Heavy Litter	200.0	43%		1.65	2.0	1.2
	6	Forest with Heavy Litter	156.1	31%		1.39	1.9	1.1
	7	Forest with Heavy Litter	122.5	48%		1.74	1.2	0.7
	8	Forest with Heavy Litter	67.9	43%		1.66	0.7	0.4
	9	Forest with Heavy Litter	50.0	43%		1.64	0.5	0.3
	10	Forest with Heavy Litter	203.5	35%		1.49	2.3	1.4
	11	Forest with Heavy Litter	226.5	42%		1.63	2.3	1.4
	12	Forest with Heavy Litter	173.5	39%		1.57	1.8	1.1
	13	Forest with Heavy Litter	200.0	53%		1.83	1.8	1.1
	14	Open Woodlands	200.0	37%		3.06	1.1	0.7
	15	Open Woodlands	100.0	45%		3.36	0.5	0.3
	16	Open Woodlands	58.6	82%		4.56	0.2	0.1
	17	Open Woodlands	141.4	45%		3.39	0.7	0.4
	18	Open Woodlands	200.0	40%		3.19	1.0	0.6
Total			2799.5	0.3%		1.3	35.9	21.6
Total Elevation Drop			1034.8					

Hemlock - 4	1	Sheet	100.0	13%	0.4	0.17	9.7	5.8
	2	Forest with Heavy Litter	150.3	23%		1.22	2.1	1.2
	3	Forest with Heavy Litter	200.0	24%		1.23	2.7	1.6
	4	Forest with Heavy Litter	222.3	22%		1.17	3.2	1.9
	5	Forest with Heavy Litter	123.4	33%		1.44	1.4	0.9
	6	Forest with Heavy Litter	154.3	35%		1.49	1.7	1.0
	7	Forest with Heavy Litter	200.0	30%		1.39	2.4	1.4
	8	Forest with Heavy Litter	300.0	34%		1.46	3.4	2.1
	9	Forest with Heavy Litter	200.0	33%		1.45	2.3	1.4
	10	Forest with Heavy Litter	200.0	45%		1.69	2.0	1.2
	11	Forest with Heavy Litter	200.0	53%		1.83	1.8	1.1
	12	Forest with Heavy Litter	200.0	45%		1.70	2.0	1.2
	13	Open Woodlands	351.8	41%		3.24	1.8	1.1
	14	Open Woodlands	131.6	19%		2.18	1.0	0.6

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
	15	Open Woodlands	216.5	42%		3.26	1.1	0.7
	16	Open Woodlands	100.0	22%		2.36	0.7	0.4
	Total		3050.3	0.2%		1.3	39.3	23.6
	Total Elevation Drop		1037.4					
Hemlock - 5	1	Sheet	100.0	21%	0.4	0.21	7.9	4.7
	2	Forest with Heavy Litter	125.3	33%		1.45	1.4	0.9
	3	Forest with Heavy Litter	200.0	23%		1.22	2.7	1.6
	4	Forest with Heavy Litter	200.0	25%		1.25	2.7	1.6
	5	Forest with Heavy Litter	200.0	32%		1.43	2.3	1.4
	6	Forest with Heavy Litter	200.0	31%		1.41	2.4	1.4
	7	Forest with Heavy Litter	200.0	27%		1.31	2.5	1.5
	8	Forest with Heavy Litter	200.0	37%		1.52	2.2	1.3
	9	Forest with Heavy Litter	200.0	32%		1.43	2.3	1.4
	10	Forest with Heavy Litter	269.6	39%		1.58	2.9	1.7
	11	Forest with Heavy Litter	230.4	55%		1.86	2.1	1.2
	12	Forest with Heavy Litter	200.0	39%		1.57	2.1	1.3
	13	Open Woodlands	200.0	36%		3.02	1.1	0.7
	14	Open Woodlands	200.0	24%		2.46	1.4	0.8
	15	Open Woodlands	200.0	34%		2.95	1.1	0.7
	16	Open Woodlands	100.0	34%		2.94	0.6	0.3
	Total		3025.3	33%		1.34	37.7	22.6
	Total Elevation Drop		1010.7					
Hemlock - 6	1	Sheet	100.0	35%	0.4	0.26	6.4	3.9
	2	Forest with Heavy Litter	145.8	29%		1.36	1.8	1.1
	3	Forest with Heavy Litter	200.0	27%		1.30	2.6	1.5
	4	Forest with Heavy Litter	200.0	31%		1.39	2.4	1.4
	5	Forest with Heavy Litter	200.0	33%		1.45	2.3	1.4
	6	Forest with Heavy Litter	200.0	28%		1.34	2.5	1.5
	7	Forest with Heavy Litter	200.0	38%		1.55	2.1	1.3
	8	Forest with Heavy Litter	232.2	40%		1.59	2.4	1.5
	9	Forest with Heavy Litter	128.2	51%		1.80	1.2	0.7
	10	Forest with Heavy Litter	319.4	36%		1.52	3.5	2.1
	11	Forest with Heavy Litter	122.0	10%		0.81	2.5	1.5
	12	Open Woodlands	298.1	24%		2.45	2.0	1.2

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
	13	Open Woodlands	200.0	34%		2.95	1.1	0.7
	14	Open Woodlands	100.0	12%		1.76	0.9	0.6
	Total		2645.8	31%		1.3	33.9	20.3
	Total Elevation Drop		830.7					
Hemlock-7	1	Sheet	100.0	30%	0.4	0.24	6.9	4.2
	2	Forest with Heavy Litter	160.0	24%		1.22	2.2	1.3
	3	Forest with Heavy Litter	200.0	28%		1.34	2.5	1.5
	4	Forest with Heavy Litter	200.0	30%		1.37	2.4	1.5
	5	Forest with Heavy Litter	200.0	29%		1.37	2.4	1.5
	6	Forest with Heavy Litter	200.0	21%		1.16	2.9	1.7
	7	Forest with Heavy Litter	300.0	20%		1.11	4.5	2.7
	8	Forest with Heavy Litter	200.0	9%		0.75	4.4	2.7
	9	Forest with Heavy Litter	200.0	13%		0.90	3.7	2.2
	10	Forest with Heavy Litter	200.0	33%		1.45	2.3	1.4
	11	Forest with Heavy Litter	200.0	40%		1.60	2.1	1.3
	12	Swamps No Channel	400.0	8%		1.30	5.1	3.1
	13	Swamps No Channel	500.0	0%		1.30	6.4	3.8
	Total		3060.0	18.5%		1.1	47.9	28.7
	Total Elevation Drop		566.7					
Hemlock-8	1	Sheet	100.0	10%	0.4	0.15	10.9	6.5
	2	Open Woodlands	300.0	4%		0.97	5.1	3.1
	3	Open Woodlands	600.0	3%		0.80	12.5	7.5
	4	Open Woodlands	400.0	0%		0.18	36.9	22.2
	5	Paved Shallow Concentrated	100.0	15%		7.89	0.2	0.1
	6	Open Woodlands	600.0	2%		0.71	14.1	8.5
	7	Open Woodlands	613.5	2%		0.63	16.3	9.8
	8	Swamps No Channel	461.5	1%		1.30	5.9	3.6
	Total		3175.0	2%		0.5	102.0	61.2
	Total Elevation Drop		76.8					
Route 3 - 1	1	Sheet	100.0	2%	0.4	0.08	22.2	13.3
	2	Open Woodlands	137.0	24%		2.48	0.9	0.6
	3	Open Woodlands	115.7	32%		2.87	0.7	0.4
	4	Open Woodlands	147.2	13%		1.83	1.3	0.8
	5	Open Woodlands	100.0	9%		1.50	1.1	0.7
	6	Open Woodlands	100.0	9%		1.51	1.1	0.7

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
	7	Open Woodlands	50.6	4%		1.02	0.8	0.5
	Total		750.6	15%		0.4	28.1	16.9
	Total Elevation Drop		111.8					
Route 3 -1A	1	Sheet	100.0	11%	0.4	0.16	10.3	6.2
	2	Open Woodlands	100.0	6%		1.25	1.3	0.8
	3	Open Woodlands	100.0	6%		1.26	1.3	0.8
	4	Open Woodlands	100.0	6%		1.21	1.4	0.8
	5	Open Woodlands	100.0	4%		1.04	1.6	1.0
	6	Open Woodlands	100.0	4%		1.03	1.6	1.0
	7	Open Woodlands	100.0	2%		0.73	2.3	1.4
	Total		700.0	6%		0.6	19.8	11.9
	Total Elevation Drop		39.9					
Route 3 - 2	1	Sheet	100.0	13%	0.4	0.18	9.5	5.7
	2	Open Woodlands	108.8	29%		2.70	0.7	0.4
	3	Open Woodlands	200.0	31%		2.82	1.2	0.7
	4	Open Woodlands	400.0	44%		3.35	2.0	1.2
	5	Open Woodlands	266.1	39%		3.15	1.4	0.8
	6	Open Woodlands	169.6	27%		2.62	1.1	0.6
	7	Open Woodlands	364.3	11%		1.65	3.7	2.2
	8	Open Woodlands	200.0	13%		1.79	1.9	1.1
	9	Open Woodlands	455.7	8%		1.41	5.4	3.2
	10	Open Woodlands	144.3	6%		1.22	2.0	1.2
	Total		2408.8	23%		1.4	28.7	17.2
	Total Elevation Drop		543.8					
Route 3 - 3	1	Sheet	100.0	1%	0.4	0.06	28.1	16.9
	2	Open Woodlands	80.8	8%		1.39	1.0	0.6
	3	Open Woodlands	200.0	22%		2.35	1.4	0.9
	4	Open Woodlands	100.0	14%		1.90	0.9	0.5
	Total		480.8	13%		0.3	31.4	18.8
	Total Elevation Drop		64.9					
Sieur de Monts - 1	1	Sheet	100.0	12%	0.4	0.17	10.0	6.0
	2	Forest with Heavy Litter	171.7	10%		0.80	3.6	2.1
	3	Forest with Heavy Litter	200.0	31%		1.40	2.4	1.4
	4	Forest with Heavy Litter	200.0	34%		1.47	2.3	1.4

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
	5	Forest with Heavy Litter	200.0	33%		1.44	2.3	1.4
	6	Forest with Heavy Litter	200.0	29%		1.35	2.5	1.5
	7	Forest with Heavy Litter	200.0	44%		1.66	2.0	1.2
	8	Forest with Heavy Litter	200.0	30%		1.38	2.4	1.5
	9	Forest with Heavy Litter	200.0	38%		1.55	2.1	1.3
	10	Forest with Heavy Litter	200.0	33%		1.45	2.3	1.4
	11	Forest with Heavy Litter	200.0	30%		1.38	2.4	1.4
	12	Open Woodlands	100.0	50%		3.57	0.5	0.3
	13	Open Woodlands	200.0	85%		4.65	0.7	0.4
	14	Open Woodlands	200.0	73%		4.30	0.8	0.5
	15	Open Woodlands	200.0	62%		3.96	0.8	0.5
	16	Open Woodlands	200.0	15%		1.92	1.7	1.0
	17	Open Woodlands	200.0	3%		0.91	3.6	2.2
	18	Open Woodlands	200.0	2%		0.70	4.8	2.9
	19	Open Woodlands	200.0	4%		0.98	3.4	2.1
	20	Open Woodlands	100.0	0%		0.26	6.4	3.8
	21	Open Woodlands	100.0	1%		0.46	3.6	2.2
Total			3771.7	31%		1.0	60.7	36.4
Total Elevation Drop			1172.6					

Sieur de Monts -2								
	1	Sheet	100.0	8%	0.4	0.14	11.9	7.1
	2	Forest with Heavy Litter	153.9	19%		1.11	2.3	1.4
	3	Forest with Heavy Litter	246.1	29%		1.36	3.0	1.8
	4	Forest with Heavy Litter	300.0	33%		1.44	3.5	2.1
	5	Forest with Heavy Litter	300.0	37%		1.52	3.3	2.0
	6	Forest with Heavy Litter	300.0	36%		1.51	3.3	2.0
	7	Forest with Heavy Litter	191.5	38%		1.55	2.1	1.2
	8	Forest with Heavy Litter	408.5	35%		1.48	4.6	2.8
	9	Forest with Heavy Litter	174.9	19%		1.10	2.6	1.6
	10	Forest with Heavy Litter	225.1	97%		2.48	1.5	0.9
	11	Forest with Heavy Litter	100.0	70%		2.10	0.8	0.5
	12	Open Woodlands	200.0	43%		3.31	1.0	0.6
	13	Open Woodlands	300.0	33%		2.91	1.7	1.0
	14	Open Woodlands	132.0	6%		1.19	1.8	1.1
Total			3132.0	37%		1.2	43.4	26.1
Total Elevation Drop			1158.2					

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
Sieur de Monts - 3	1	Sheet	100.0	16%	0.4	0.19	8.8	5.3
	2	Forest with Heavy Litter	83.1	19%		1.09	1.3	0.8
	3	Forest with Heavy Litter	100.0	30%		1.38	1.2	0.7
	4	Forest with Heavy Litter	100.0	20%		1.14	1.5	0.9
	5	Forest with Heavy Litter	200.0	26%		1.29	2.6	1.6
	6	Forest with Heavy Litter	200.0	36%		1.50	2.2	1.3
	7	Forest with Heavy Litter	200.0	39%		1.58	2.1	1.3
	8	Forest with Heavy Litter	200.0	29%		1.35	2.5	1.5
	9	Forest with Heavy Litter	200.0	46%		1.70	2.0	1.2
	10	Forest with Heavy Litter	227.1	40%		1.59	2.4	1.4
	11	Forest with Heavy Litter	521.0	32%		1.43	6.1	3.6
	12	Forest with Heavy Litter	281.4	67%		2.05	2.3	1.4
	13	Open Woodlands	270.5	60%		3.89	1.2	0.7
	14	Open Woodlands	200.0	33%		2.89	1.2	0.7
	15	Open Woodlands	100.0	4%		0.96	1.7	1.0
Total			2983.1	37%		1.3	38.9	23.3
Total Elevation Drop			1112.0					

Park Loop Rd - 1	1	Sheet	124.1	6%	0.40	0.13	15.6	9.4
	2	Open Woodlands	100.0	3%		0.93	1.8	1.1
	3	Open Woodlands	100.0	29%		2.72	0.6	0.4
	4	Open Woodlands	100.0	6%		1.19	1.4	0.8
	5	Open Woodlands	200.0	24%		2.49	1.3	0.8
	6	Open Woodlands	269.9	25%		2.54	1.8	1.1
	7	Open Woodlands	130.1	10%		1.56	1.4	0.8
	8	Open Woodlands	200.0	4%		0.99	3.4	2.0
Total			1224.1	0.1		0.7	27.3	16.4
Total Elevation Drop			183.4					

Park Loop Rd - 2	1	Sheet	100.0	5%	0.40	0.12	13.8	8.3
	2	Open Woodlands	150.0	20%		2.26	1.1	0.7
	3	Open Woodlands	152.4	9%		1.48	1.7	1.0
	4	Open Woodlands	112.4	25%		2.50	0.7	0.4
	5	Open Woodlands	141.9	47%		3.44	0.7	0.4
	6	Open Woodlands	262.8	22%		2.36	1.9	1.1
	7	Open Woodlands	182.9	0.3%		0.26	11.8	7.1

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
Total			1102.4	18%		0.6	31.7	19.0
Total Elevation Drop			201.3					
Park Loop Rd - 3	1	Sheet	100.0	3%	0.40	0.09	18.1	10.9
	2	Open Woodlands	74.0	29%		2.71	0.5	0.3
	3	Open Woodlands	100.0	48%		3.49	0.5	0.3
	4	Open Woodlands	300.0	39%		3.13	1.6	1.0
	5	Open Woodlands	100.0	6%		1.21	1.4	0.8
	6	Open Woodlands	100.0	2%		0.71	2.4	1.4
	7	Open Woodlands	122.5	2%		0.75	2.7	1.6
	8	Open Woodlands	177.5	2%		0.72	4.1	2.4
	9	Open Woodlands	127.4	2%		0.68	3.1	1.9
	10	Open Woodlands	172.6	2%		0.66	4.3	2.6
Total			1374.0	15%		0.6	38.7	23.2
Total Elevation Drop			207.9					
Park Loop Rd -4	1	Sheet	141.4	2%	0.40	0.08	28.2	16.9
	2	Open Woodlands	200.0	31%		2.82	1.2	0.7
	3	Open Woodlands	271.1	40%		3.20	1.4	0.8
	4	Open Woodlands	228.9	7%		1.36	2.8	1.7
Total			841.4	23%		0.4	33.6	20.2
Total Elevation Drop			192.0					
Park Loop Rd -5	1	Sheet	100.0	2%	0.40	0.08	21.9	13.1
	2	Open Woodlands	152.2	7%		1.30	2.0	1.2
	3	Open Woodlands	681.3	3%		0.81	14.0	8.4
	4	Open Woodlands	304.6	8%		1.38	3.7	2.2
	5	Open Woodlands	361.8	8%		1.45	4.2	2.5
	6	Open Woodlands	271.7	5%		1.14	4.0	2.4
Total			1871.7	5%		0.6	49.7	29.8
Total Elevation Drop			96.4					
Park Loop Rd -6	1	Sheet	100.0	0%	0.10	0.13	12.5	7.5
	2	Unpaved (Bare Ground)	46.6	5%		2.23	0.3	0.2
	3	Paved Shallow Concentrated	49.6	6%		5.02	0.2	0.1
	4	Unpaved (Bare Ground)	321.6	3%		1.79	3.0	1.8
	5	Paved Shallow Concentrated	73.4	2%		2.68	0.5	0.3
	6	Paved Shallow Concentrated	34.2	1%		2.05	0.3	0.2
	7	Open Woodlands	21.2	1%		0.46	0.8	0.5
	8	Open Woodlands	31.2	19%		2.22	0.2	0.1

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
	9	Open Woodlands	269.0	9%		1.51	3.0	1.8
	10	Open Woodlands	190.9	4%		1.05	3.0	1.8
	11	Open Woodlands	144.0	3%		0.92	2.6	1.6
	12	Open Woodlands	100.0	5%		1.12	1.5	0.9
	Total		1381.6	5%		0.8	27.8	16.7
	Total Elevation Drop		66.2					
Park Loop Rd -7	1	Sheet	100.0	4%	0.40	0.10	15.9	9.6
	2	Open Woodlands	41.6	8%		1.40	0.5	0.3
	3	Unpaved (Bare Ground)	95.1	3%		1.76	0.9	0.5
	Total		236.7	4%		0.2	17.3	10.4
	Total Elevation Drop		9.9					
Park Loop Rd -8	1	Sheet	100.0	14%	0.40	0.18	9.5	5.7
	2	Open Woodlands	233.8	9%		1.54	2.5	1.5
	3	Open Woodlands	200.0	9%		1.48	2.3	1.4
	Total		533.8	10%		0.6	14.2	8.5
	Total Elevation Drop		52.8					
Bar Harbor	1	Sheet	50.0	2%	0.40	0.07	11.7	7.0
	2	Short-Grass Pasture	50.0	2%		0.98	0.8	0.5
	3	Open Woodlands	720.0	16%		2.00	6.0	3.6
	4	Paved Shallow Concentrated	50.0	20%		9.09	0.1	0.1
	5	Short-Grass Pasture	3150.0	3%		1.11	47.3	28.4
	6	Open Woodlands	380.0	2%		0.63	10.0	6.0
	7	Small Tributary	615.0	3%		0.57	18.0	10.8
	Total		5015.0	5%		0.9	94.0	56.4
	Total Elevation Drop		229.5					
Cromwell Upper	1	Sheet	100.0	16%	0.40	0.19	8.8	5.3
	2	Forest with Heavy Litter	300.0	29%		1.34	3.7	2.2
	3	Forest with Heavy Litter	393.8	32%		1.42	4.6	2.8
	4	Forest with Heavy Litter	606.2	38%		1.55	6.5	3.9
	5	Forest with Heavy Litter	393.0	43%		1.66	4.0	2.4
	6	Open Woodlands	407.0	64%		4.04	1.7	1.0
	7	Open Woodlands	400.0	55%		3.74	1.8	1.1
	8	Open Woodlands	250.2	3%		2.52	1.0	0.6
	9	Large Tributary	149.8	25%		0.98	4.3	2.6

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
	10	Large Tributary	200.0	2%		0.72	4.6	2.8
	11	Large Tributary	200.0	2%		0.70	4.8	2.9
	12	Large Tributary	200.0	1%		0.55	6.1	3.7
	13	Large Tributary	200.0	2%		0.75	4.5	2.7
	14	Large Tributary	450.2	0.3%		0.30	24.6	14.8
	Total		4250.2	28%		0.9	80.9	48.5
	Total Elevation Drop		1170.7					
Cromwell Mid	1	Sheet	50.0	2%	0.40	0.07	11.7	7.0
	2	Open Woodlands	1280.0	11%		1.70	12.6	7.5
	3	Paved Shallow Concentrated	30.0	3%		3.71	0.1	0.1
	4	Large Tributary	3400.0	1%		0.40	140.7	84.4
	Total		4760.0	3%		0.5	165.1	99.1
	Total Elevation Drop		165.5					
Kebo	1	Sheet	50.0	4%	0.40	0.09	8.8	5.3
	2	Open Woodlands	5140.0	23%		2.41	35.6	21.4
	3	Small Tributary	2940.0	4%		0.70	69.6	41.8
	4	Paved Shallow Concentrated	30.0	3%		3.71	0.1	0.1
	5	Small Tributary	1950.0	3%		0.62	52.8	31.7
	6	Large Tributary	5100.0	2%		0.75	113.1	67.9
	Total		15210.0	10%		0.9	280.2	168.1
	Total Elevation Drop		1472.0					
The Tarn	1	Sheet	100.0	11%	0.40	0.16	10.3	6.2
	2	Forest with Heavy Litter	400.0	28%		1.32	5.0	3.0
	3	Forest with Heavy Litter	400.0	29%		1.35	4.9	3.0
	4	Forest with Heavy Litter	400.0	24%		1.24	5.4	3.2
	5	Open Woodlands	323.3	40%		3.18	1.7	1.0
	6	Open Woodlands	195.9	79%		4.47	0.7	0.4
	7	Open Woodlands	183.2	74%		4.32	0.7	0.4
	8	Open Woodlands	227.9	99%		5.00	0.8	0.5
	9	Open Woodlands	292.4	64%		4.02	1.2	0.7
	Total		2522.7	46%		1.4	30.7	18.4
	Total Elevation Drop		1164.7					
Otter Creek	1	Sheet	100.0	2%	0.40	0.08	20.2	12.1

Watershed	Segment	Flow Type	Length (feet)	Slope	'n'	Velocity (ft/s)	Travel Time (min)	Lag Time (min)
	2	Forest with Heavy Litter	300.0	9%		0.77	6.5	3.9
	3	Forest with Heavy Litter	100.0	38%		1.55	1.1	0.6
	4	Forest with Heavy Litter	200.0	12%		0.87	3.8	2.3
	5	Forest with Heavy Litter	200.0	21%		1.15	2.9	1.7
	6	Forest with Heavy Litter	200.0	19%		1.09	3.1	1.8
	7	Forest with Heavy Litter	300.0	4%		0.53	9.5	5.7
	8	Forest with Heavy Litter	300.0	14%		0.93	5.4	3.2
	9	Forest with Heavy Litter	300.0	35%		1.48	3.4	2.0
	10	Forest with Heavy Litter	300.0	43%		1.65	3.0	1.8
	11	Forest with Heavy Litter	300.0	23%		1.20	4.2	2.5
	12	Forest with Heavy Litter	300.0	27%		1.31	3.8	2.3
	13	Forest with Heavy Litter	300.0	60%		1.95	2.6	1.5
	14	Forest with Heavy Litter	200.0	62%		1.99	1.7	1.0
	15	Forest with Heavy Litter	300.0	29%		1.35	3.7	2.2
	16	Forest with Heavy Litter	200.0	32%		1.43	2.3	1.4
	17	Forest with Heavy Litter	349.8	19%		1.11	5.2	3.1
	18	Forest with Heavy Litter	350.2	8%		0.73	8.0	4.8
	19	Forest with Heavy Litter	500.0	7%		0.68	12.2	7.3
	20	Forest with Heavy Litter	300.0	10%		0.81	6.1	3.7
	21	Forest with Heavy Litter	400.0	10%		0.78	8.6	5.2
	22	Forest with Heavy Litter	500.0	8%		0.71	11.7	7.0
	23	Small Tributary	300.0	6%		0.83	6.0	3.6
	24	Small Tributary	300.0	3%		0.59	8.4	5.1
	25	Small Tributary	300.0	2%		0.50	10.0	6.0
	26	Small Tributary	300.0	2%		0.51	9.8	5.9
	27	Small Tributary	300.0	2%		0.46	10.8	6.5
	28	Small Tributary	300.0	1%		0.35	14.3	8.6
	29	Small Tributary	300.0	1%		0.37	13.7	8.2
	30	Small Tributary	300.0	1%		0.30	16.6	10.0
	31	Small Tributary	400.0	1%		0.35	18.9	11.3
	32	Large Tributary	200.0	8%		1.56	2.1	1.3
	33	Large Tributary	200.0	9%		1.67	2.0	1.2
	34	Large Tributary	300.0	5%		1.23	4.1	2.4
	35	Large Tributary	223.7	1%		0.52	7.1	4.3
Total			10023.7	14%		0.7	252.7	151.6
Total Elevation Drop			1421.6					

Ref. SCS TR-55, Second Ed., June 1986

Appendix A.4: Reach Time of Concentration Calculations

Project:	Acadia Great Meadow Supplemental Work	Project #	55661.01
Location:	Acadia National Park		
Calculated by:	DMS	Date:	6/1/2023
Checked by:	DWC	Date:	7/12/2023

2 Year, 24-hour storm depth (in)¹: 3.57

Watershed	Segment	Flow Type	Length (feet)	Slope	Velocity (ft/s)	Travel Time (min)	Lag Time (min) ²
RT 3 - 1 to RT 3-1A to Great Meadow		1 Small Tributary	100.0	12%	1.14	1.5	0.9
		2 Small Tributary	100.0	5%	0.74	2.3	1.4
		3 Small Tributary	100.0	11%	1.09	1.5	0.9
		4 Small Tributary	100.0	4%	0.63	2.7	1.6
		5 Small Tributary	117.5	4%	0.69	2.8	1.7
	Total		517.5	7%	0.80	10.7	6.4
	Total Elevation Drop		36.2				

RT 3- 2 to Cromwell Upper to Great Meadow		1 Small Tributary	123.5	7%	0.88	2.3	1.4
		2 Small Tributary	194.2	14%	1.23	2.6	1.6
		3 Large Tributary	519.9	2%	0.76	11.4	6.9
	Total		837.7	5%	0.85	16.4	9.8
	Total Elevation Drop		45.2				

RT 3- 3 to Cromwell Upper to Great Meadow		1 Open Woodlands	401.8	11%	1.64	4.1	2.5
		2 Large Tributary	500.9	2%	0.74	11.3	6.8
	Total		902.7	6%	0.98	15.3	9.2
	Total Elevation Drop		51.5				

1. SIR 2020-5092

2. Lag time (min) = Travel time * 0.6. A minimum lag time of 5 minutes was used

Ref. SCS TR-55, Second Ed., June 1986

Appendix A.5: HEC-HMS Report

Project: Cromwell_Brook

Simulation Run: 2-year

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 24:00

HMS Version: 4.10

Executed: 14 July 2023, 14:23

Global Parameter Summary - Subbasin

Element Name	Location	
	Longitude Degrees	Latitude Degrees
Bar Harbor	-68.21	44.38
Cromwell - Mid	-68.21	44.37
Upper - Cromwell	-68.21	44.36
Hemlock 1	-68.21	44.36
Hemlock - 2	-68.21	44.36
Hemlock - 3	-68.21	44.36
Hemlock - 4	-68.21	44.36
Hemlock - 5	-68.22	44.36
Hemlock - 6	-68.22	44.36
Hemlock - 7	-68.22	44.37
Hemlock - 8	-68.22	44.37
Kebo	-68.22	44.37
Otter Creek Gage	-68.22	44.34
LoopRoad - 1	-68.2	44.37
LoopRoad - 2	-68.2	44.37
LoopRoad - 3	-68.2	44.37
LoopRoad - 4	-68.2	44.37
LoopRoad - 5	-68.2	44.36
LoopRoad - 6	-68.2	44.36
LoopRoad - 7	-68.2	44.36
LoopRoad - 8	-68.2	44.36
Rt3 - 1	-68.2	44.36
Rt3 - 1A	-68.2	44.36
Rt3 - 2	-68.2	44.36
Rt3 - 3	-68.21	44.36
SieurdeMonts - 1	-68.21	44.36
SieurdeMonts - 2	-68.21	44.36
SieurdeMonts - 3	-68.21	44.36
The Tarn	-68.21	44.35

Element Name	Area (MI²)
Bar Harbor	0.34
Cromwell - Mid	0.22
Upper - Cromwell	0.06
Hemlock 1	0.01
Hemlock - 2	0.01
Hemlock - 3	0.03
Hemlock - 4	0.02
Hemlock - 5	0.02
Hemlock - 6	0.04
Hemlock - 7	0.07
Hemlock - 8	0.15
Kebo	1.21
Otter Creek Gage	1.36
LoopRoad - 1	0.01
LoopRoad - 2	0.01
LoopRoad - 3	0.02
LoopRoad - 4	0
LoopRoad - 5	0.03
LoopRoad - 6	0.02
LoopRoad - 7	0
LoopRoad - 8	0.01
Rt3 - 1	0.02
Rt3 - 1A	0.01
Rt3 - 2	0.04
Rt3 - 3	0
SieurdeMonts - 1	0.03
SieurdeMonts - 2	0.02
SieurdeMonts - 3	0.04
The Tarn	0.34

Loss Rate: Scs			
Element Name	Percent Impervious Area	Curve Number	Initial Abstraction
Bar Harbor	0	85	0.18
Cromwell - Mid	0	74	0.36
Upper - Cromwell	0	68	0.47
Hemlock 1	0	77	0.3
Hemlock - 2	0	75	0.34
Hemlock - 3	0	76	0.32
Hemlock - 4	0	72	0.39
Hemlock - 5	0	71	0.41
Hemlock - 6	0	70	0.43
Hemlock - 7	0	69	0.46
Hemlock - 8	0	65	0.53
Kebo	0	71	0.41
Otter Creek Gage	0	74	0.35
LoopRoad - 1	0	68	0.47
LoopRoad - 2	0	70	0.42
LoopRoad - 3	0	61	0.65
LoopRoad - 4	0	52	0.94
LoopRoad - 5	0	64	0.57
LoopRoad - 6	0	67	0.5
LoopRoad - 7	0	73	0.37
LoopRoad - 8	0	69	0.45
Rt3 - 1	0	60	0.66
Rt3 - 1A	0	74	0.36
Rt3 - 2	0	62	0.62
Rt3 - 3	0	63	0.6
SieurdeMonts - 1	0	67	0.49
SieurdeMonts - 2	0	71	0.42
SieurdeMonts - 3	0	76	0.32
The Tarn	0	77	0.3

Transform: Scs		
Element Name	Lag	Unitgraph Type
Bar Harbor	56.4	Prf550
Cromwell - Mid	99.1	Prf550
Upper - Cromwell	48.5	Prf550
Hemlock 1	21.3	Prf550
Hemlock - 2	17.5	Prf550
Hemlock - 3	21.6	Prf550
Hemlock - 4	23.6	Prf550
Hemlock - 5	22.6	Prf550
Hemlock - 6	20.3	Prf550
Hemlock - 7	28.7	Prf550
Hemlock - 8	61.2	Prf550
Kebo	168.1	Prf550
Otter Creek Gage	151.6	Prf550
LoopRoad - 1	16.4	Prf550
LoopRoad - 2	19	Prf550
LoopRoad - 3	23.2	Prf550
LoopRoad - 4	20.2	Prf550
LoopRoad - 5	29.8	Prf550
LoopRoad - 6	16.7	Prf550
LoopRoad - 7	10.4	Prf550
LoopRoad - 8	8.5	Prf550
Rt3 - 1	16.9	Prf550
Rt3 - 1A	11.9	Prf550
Rt3 - 2	17.2	Prf550
Rt3 - 3	18.8	Prf550
SieurdeMonts - 1	36.4	Prf550
SieurdeMonts - 2	26.1	Prf550
SieurdeMonts - 3	23.3	Prf550
The Tarn	18.4	Prf550

Global Parameter Summary - Reach

Downstream	
Element Name	Downstream
RT3 - 1_Reach	Outlet - RT3 - 1A
RT3_2 - Reach	Outlet - Cromwell
RT 3 - 3 Reach	Outlet - Cromwell
Cromwell - Reach	Outlet - Cromwell

Route: Lag			
Element Name	Method	Initial Variable	Lag
RT3 - 1_Reach	Lag	Combined Inflow	6.4
RT3_2 - Reach	Lag	Combined Inflow	9.8
RT 3 - 3 Reach	Lag	Combined Inflow	9.2

Route: Kinematic Wave												
Element Name	Method	Channel	Length (FT)	Energy Slope (FT/FT)	Mannings n	Shape	Number of Subreaches	Width (FT)	Side Slope (FT/FT)	Initial Variable	Index Parameter Type	Inlet Celerity
Cromwell - Reach	Kinematic Wave	Kinematic Wave	1400	0.02	0.04	Trapezoid	2	10	3	Combined Inflow	Index Celerity	4

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Bar Harbor	0.34	189.26	01Jan2000, 13:00	2.24
Cromwell - Mid	0.22	58.39	01Jan2000, 13:48	1.54
Upper - Cromwell	0.06	18.63	01Jan2000, 12:54	1.23
Hemlock 1	0.01	9.63	01Jan2000, 12:24	1.72
Hemlock - 2	0.01	6.49	01Jan2000, 12:24	1.6
Hemlock - 3	0.03	21.96	01Jan2000, 12:24	1.65
Hemlock - 4	0.02	13.27	01Jan2000, 12:30	1.44
Hemlock - 5	0.02	12.5	01Jan2000, 12:30	1.39
Hemlock - 6	0.04	19.79	01Jan2000, 12:24	1.33
Hemlock - 7	0.07	28.87	01Jan2000, 12:36	1.28
Hemlock - 8	0.15	36.46	01Jan2000, 13:12	1.1
Kebo	1.21	195.04	01Jan2000, 15:12	1.38
Otter Creek Gage	1.36	265.28	01Jan2000, 14:48	1.55
LoopRoad - 1	0.01	5.44	01Jan2000, 12:18	1.23
LoopRoad - 2	0.01	7.19	01Jan2000, 12:24	1.34
LoopRoad - 3	0.02	6.4	01Jan2000, 12:30	0.92
LoopRoad - 4	0	0.99	01Jan2000, 12:30	0.59
LoopRoad - 5	0.03	11.49	01Jan2000, 12:36	1.05
LoopRoad - 6	0.02	7.69	01Jan2000, 12:18	1.18
LoopRoad - 7	0	0.68	01Jan2000, 12:12	1.49
LoopRoad - 8	0.01	5.82	01Jan2000, 12:12	1.28
Rt3 - 1	0.02	7.45	01Jan2000, 12:24	0.89
Rt3 - 1A	0.01	6.34	01Jan2000, 12:12	1.54
Rt3 - 2	0.04	16.03	01Jan2000, 12:24	0.96
Rt3 - 3	0	1.34	01Jan2000, 12:24	1
SieurdeMonts - 1	0.03	10.19	01Jan2000, 12:42	1.19
SieurdeMonts - 2	0.02	11.94	01Jan2000, 12:30	1.38
SieurdeMonts - 3	0.04	26.52	01Jan2000, 12:30	1.65
RT3 - 1_Reach	0.02	7.45	01Jan2000, 12:30	0.89
The Tarn	0.34	244.76	01Jan2000, 12:24	1.71
The Tarn Pond	0.34	17.33	01Jan2000, 15:54	1.4
RT3_2 - Reach	0.04	15.83	01Jan2000, 12:30	0.96
RT 3 - 3 Reach	0	1.3	01Jan2000, 12:36	1
Outlet - RT3 - 1A	0.03	12.51	01Jan2000, 12:24	1.08
Cromwell - Reach	0.34	17.33	01Jan2000, 16:00	1.39
Outlet - Cromwell	0.44	38.89	01Jan2000, 12:48	1.33

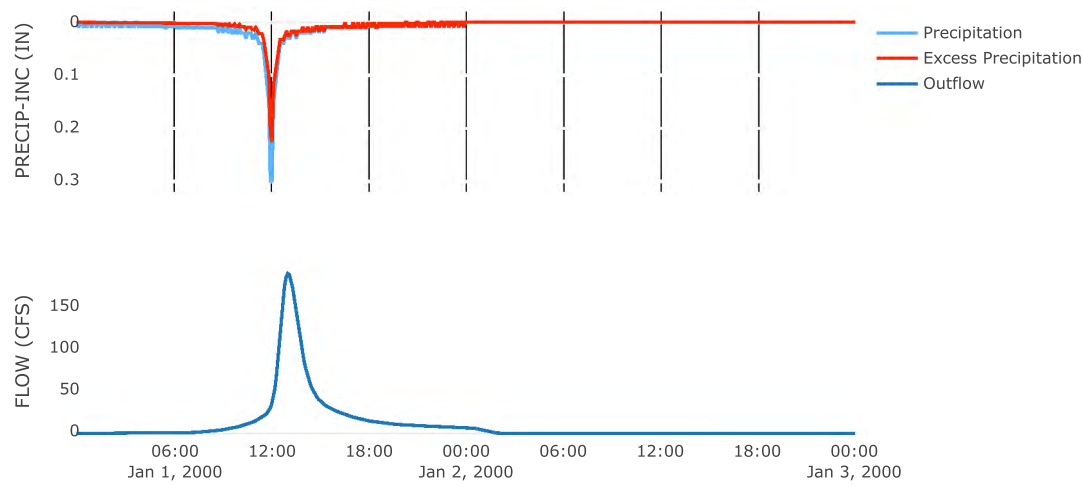
Subbasin: Bar Harbor

Area (MI²) : 0.34
Latitude Degrees : 44.38
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		85
Initial Abstraction		0.18
Transform: Scs		
Lag		56.4
Unitgraph Type		Prf550

Results: Bar Harbor		
Peak Discharge (CFS)		189.26
Time of Peak Discharge		01Jan2000, 13:00
Volume (IN)		2.24
Precipitation Volume (AC - FT)		65.51
Loss Volume (AC - FT)		24.6
Excess Volume (AC - FT)		40.91
Direct Runoff Volume (AC - FT)		40.91
Baseflow Volume (AC - FT)		0

Precipitation and Outflow

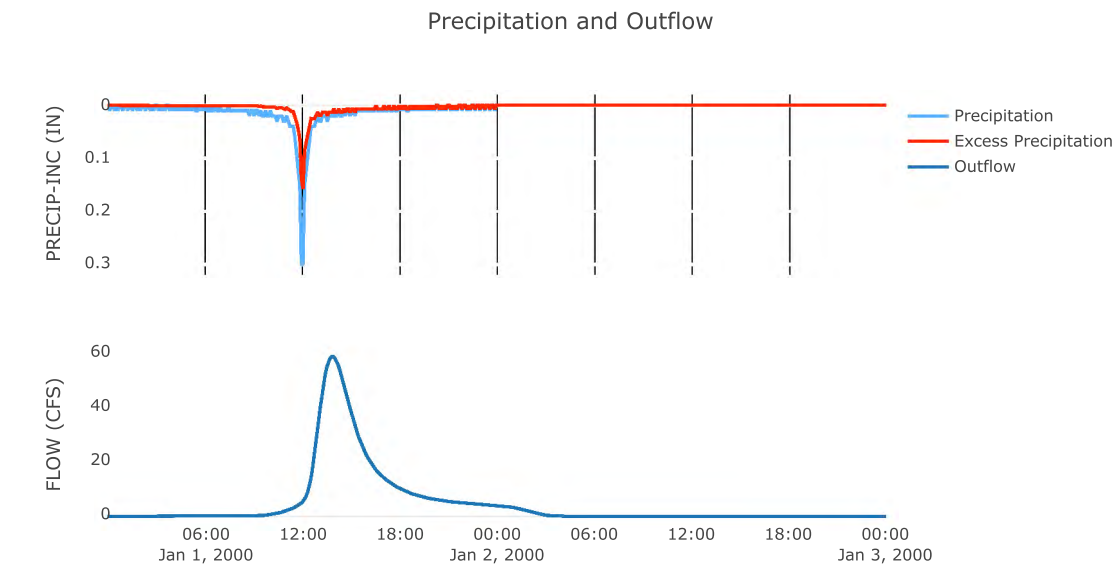


Subbasin: Cromwell - Mid

Area (MI2) : 0.22
Latitude Degrees : 44.37
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		74
Initial Abstraction		0.36
Transform: Scs		
Lag		99.1
Unitgraph Type		Prf550

Results: Cromwell - Mid	
Peak Discharge (CFS)	58.39
Time of Peak Discharge	01Jan2000, 13:48
Volume (IN)	1.54
Precipitation Volume (AC - FT)	42.88
Loss Volume (AC - FT)	24.41
Excess Volume (AC - FT)	18.47
Direct Runoff Volume (AC - FT)	18.47
Baseflow Volume (AC - FT)	0



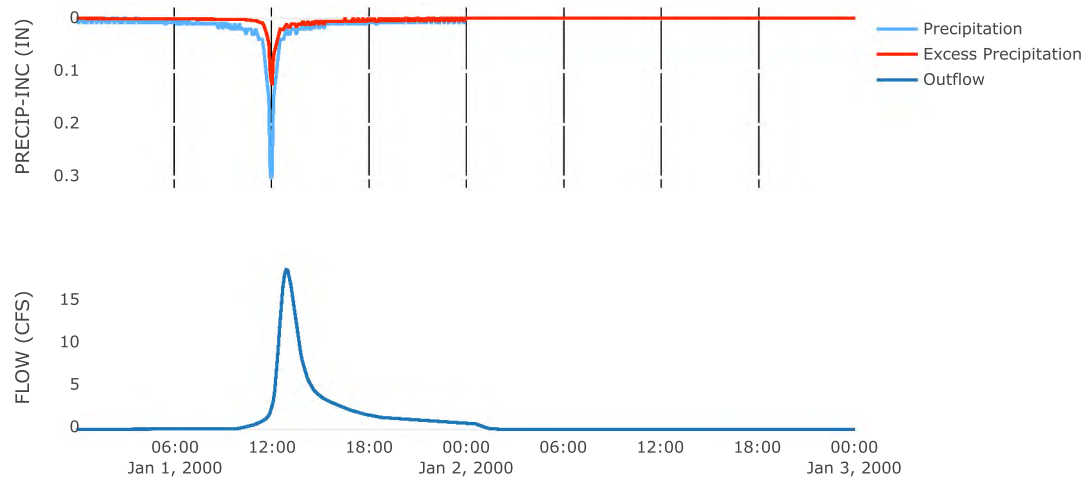
Subbasin: Upper-Cromwell

Area (MI2) : 0.06
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		68
Initial Abstraction		0.47
Transform: Scs		
Lag		48.5
Unitgraph Type		Prf550

Results: Upper-Cromwell	
Peak Discharge (CFS)	18.63
Time of Peak Discharge	01Jan2000, 12:54
Volume (IN)	1.23
Precipitation Volume (AC - FT)	11.04
Loss Volume (AC - FT)	7.23
Excess Volume (AC - FT)	3.81
Direct Runoff Volume (AC - FT)	3.81
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



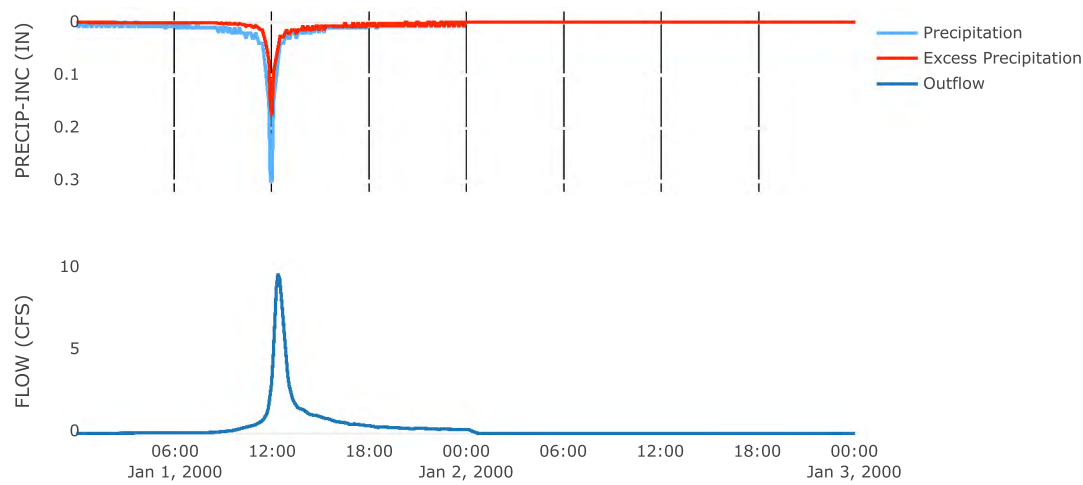
Subbasin: Hemlock 1

Area (MI2) : 0.01
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: SCS		
Percent Impervious Area		0
Curve Number		77
Initial Abstraction		0.3
Transform: SCS		
Lag		21.3
Unitgraph Type		Prf550

Results: Hemlock 1	
Peak Discharge (CFS)	9.63
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	1.72
Precipitation Volume (AC - FT)	2.67
Loss Volume (AC - FT)	1.39
Excess Volume (AC - FT)	1.28
Direct Runoff Volume (AC - FT)	1.28
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



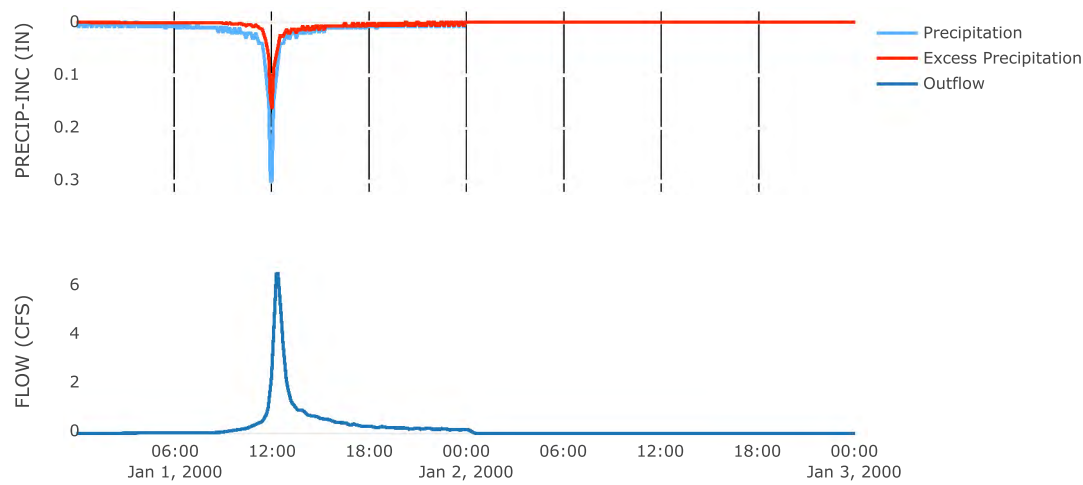
Subbasin: Hemlock-2

Area (MI2) : 0.01
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		75
Initial Abstraction		0.34
Transform: Scs		
Lag		17.5
Unitgraph Type		Prf550

Results: Hemlock-2	
Peak Discharge (CFS)	6.49
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	1.6
Precipitation Volume (AC - FT)	1.83
Loss Volume (AC - FT)	1.02
Excess Volume (AC - FT)	0.82
Direct Runoff Volume (AC - FT)	0.82
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



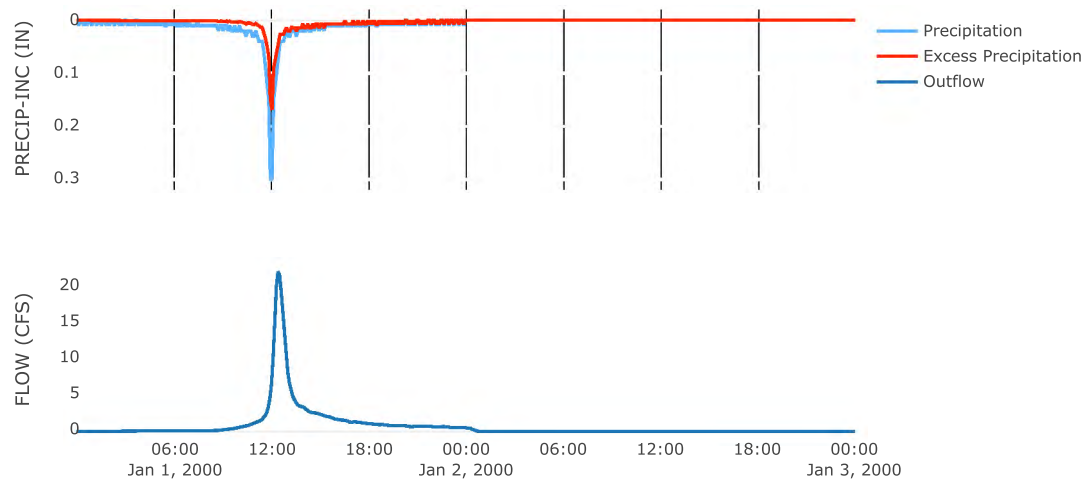
Subbasin: Hemlock-3

Area (MI2) : 0.03
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		76
Initial Abstraction		0.32
Transform: Scs		
Lag		21.6
Unitgraph Type		Prf550

Results: Hemlock-3	
Peak Discharge (CFS)	21.96
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	1.65
Precipitation Volume (AC - FT)	6.38
Loss Volume (AC - FT)	3.43
Excess Volume (AC - FT)	2.95
Direct Runoff Volume (AC - FT)	2.95
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



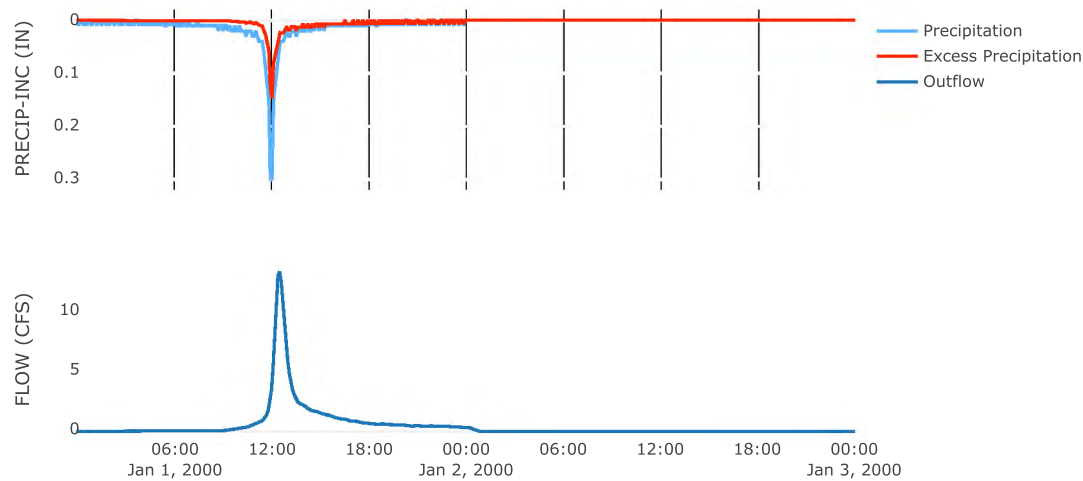
Subbasin: Hemlock-4

Area (MI2) : 0.02
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		72
Initial Abstraction		0.39
Transform: Scs		
Lag		23.6
Unitgraph Type		Prf550

Results: Hemlock-4	
Peak Discharge (CFS)	13.27
Time of Peak Discharge	01Jan2000, 12:30
Volume (IN)	1.44
Precipitation Volume (AC - FT)	4.64
Loss Volume (AC - FT)	2.78
Excess Volume (AC - FT)	1.86
Direct Runoff Volume (AC - FT)	1.86
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



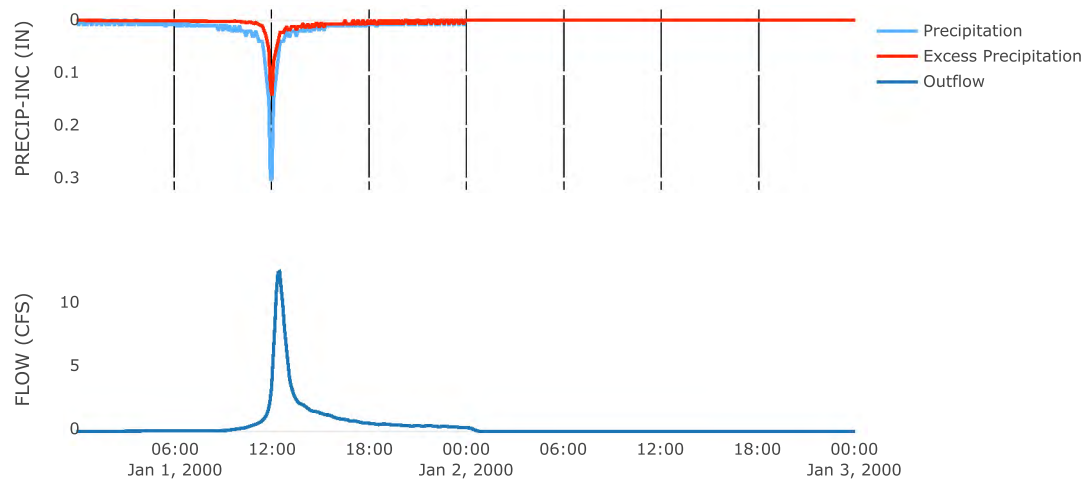
Subbasin: Hemlock-5

Area (MI2) : 0.02
Latitude Degrees : 44.36
Longitude Degrees : -68.22

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		71
Initial Abstraction		0.41
Transform: Scs		
Lag		22.6
Unitgraph Type		Prf550

Results: Hemlock-5	
Peak Discharge (CFS)	12.5
Time of Peak Discharge	01Jan2000, 12:30
Volume (IN)	1.39
Precipitation Volume (AC - FT)	4.49
Loss Volume (AC - FT)	2.75
Excess Volume (AC - FT)	1.74
Direct Runoff Volume (AC - FT)	1.74
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



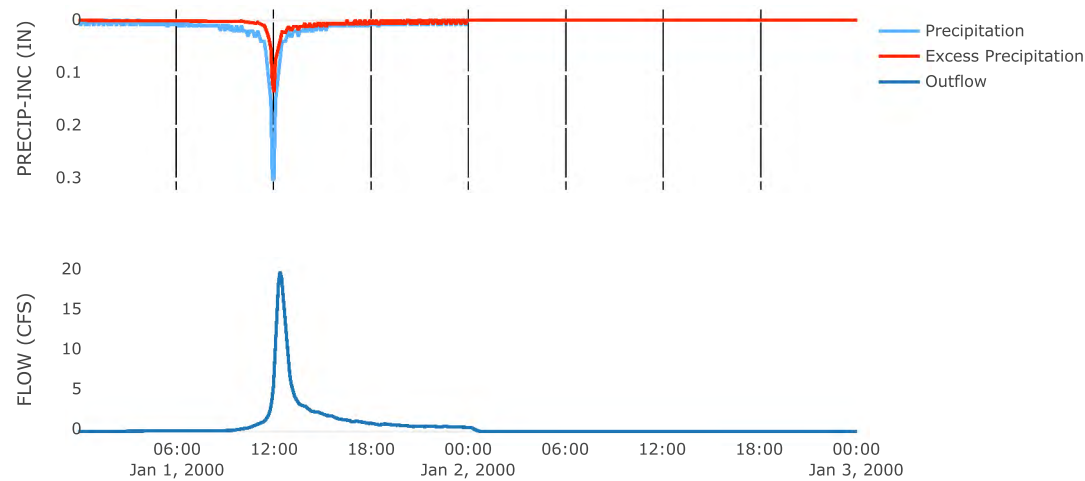
Subbasin: Hemlock-6

Area (MI2) : 0.04
Latitude Degrees : 44.36
Longitude Degrees : -68.22

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		70
Initial Abstraction		0.43
Transform: Scs		
Lag		20.3
Unitgraph Type		Prf550

Results: Hemlock-6	
Peak Discharge (CFS)	19.79
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	1.33
Precipitation Volume (AC - FT)	7.05
Loss Volume (AC - FT)	4.42
Excess Volume (AC - FT)	2.62
Direct Runoff Volume (AC - FT)	2.62
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



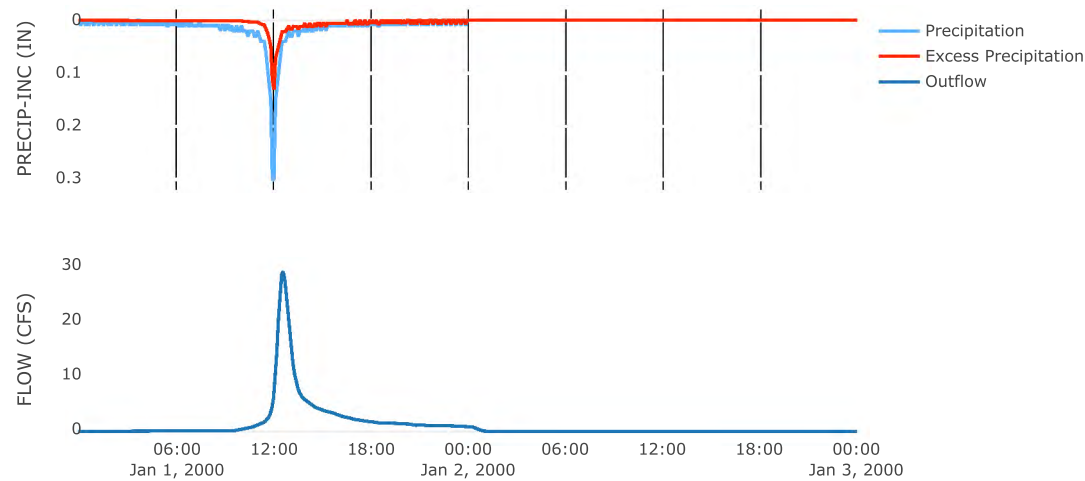
Subbasin: Hemlock-7

Area (MI2) : 0.07
Latitude Degrees : 44.37
Longitude Degrees : -68.22

Loss Rate: SCS		
Percent Impervious Area		0
Curve Number		69
Initial Abstraction		0.46
Transform: SCS		
Lag		28.7
Unitgraph Type		Prf550

Results: Hemlock-7		
Peak Discharge (CFS)		28.87
Time of Peak Discharge		01Jan2000, 12:36
Volume (IN)		1.28
Precipitation Volume (AC - FT)		12.45
Loss Volume (AC - FT)		8
Excess Volume (AC - FT)		4.45
Direct Runoff Volume (AC - FT)		4.45
Baseflow Volume (AC - FT)		0

Precipitation and Outflow



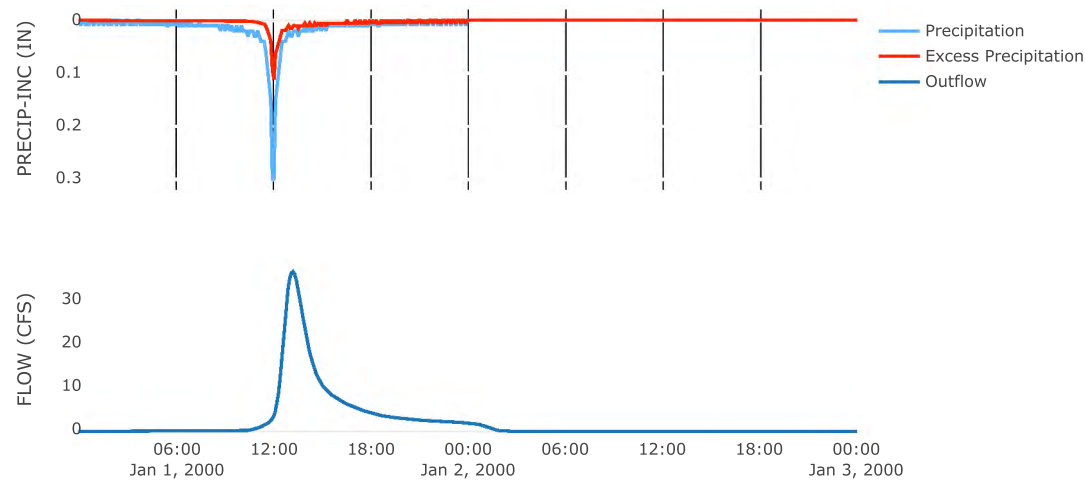
Subbasin: Hemlock-8

Area (MI2) : 0.15
Latitude Degrees : 44.37
Longitude Degrees : -68.22

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		65
Initial Abstraction		0.53
Transform: Scs		
Lag		61.2
Unitgraph Type		Prf550

Results: Hemlock-8	
Peak Discharge (CFS)	36.46
Time of Peak Discharge	01Jan2000, 13:12
Volume (IN)	1.1
Precipitation Volume (AC - FT)	28.09
Loss Volume (AC - FT)	19.42
Excess Volume (AC - FT)	8.66
Direct Runoff Volume (AC - FT)	8.66
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



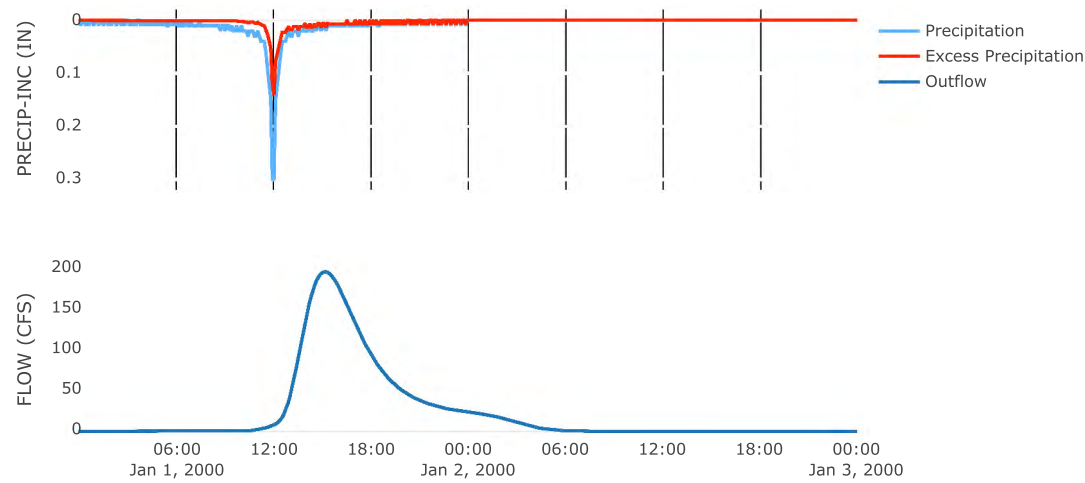
Subbasin: Kebo

Area (MI2) : 1.21
Latitude Degrees : 44.37
Longitude Degrees : -68.22

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		71
Initial Abstraction		0.41
Transform: Scs		
Lag		168.1
Unitgraph Type		Prf550

Results: Kebo	
Peak Discharge (CFS)	195.04
Time of Peak Discharge	01Jan2000, 15:12
Volume (IN)	1.38
Precipitation Volume (AC - FT)	231.74
Loss Volume (AC - FT)	142.25
Excess Volume (AC - FT)	89.49
Direct Runoff Volume (AC - FT)	89.49
Baseflow Volume (AC - FT)	0

Precipitation and Outflow

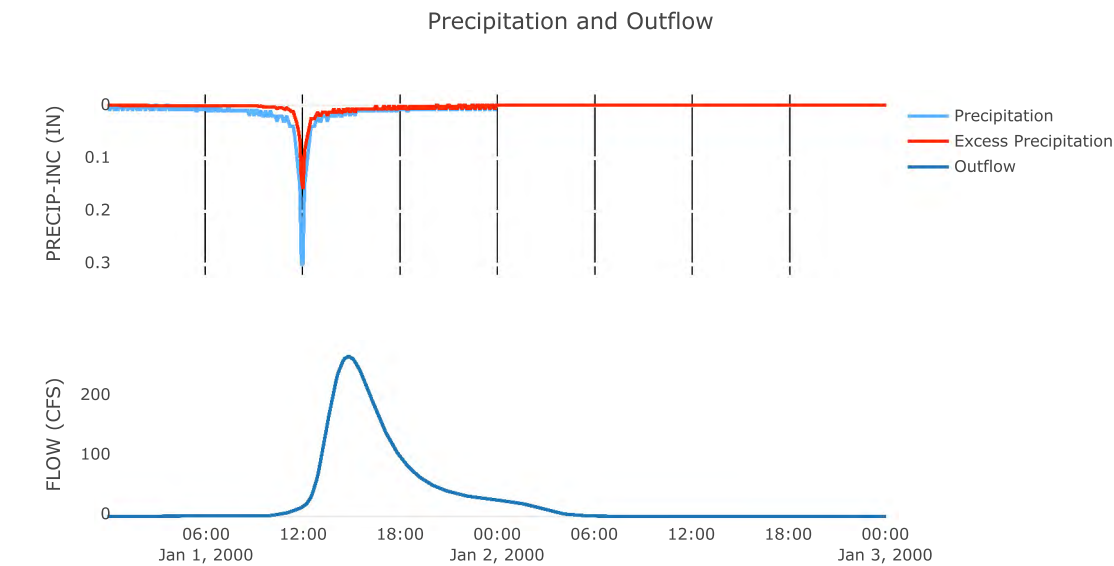


Subbasin: Otter Creek Gage

Area (MI2) : 1.36
Latitude Degrees : 44.34
Longitude Degrees : -68.22

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		74
Initial Abstraction		0.35
Transform: Scs		
Lag		151.6
Unitgraph Type		Prf550

Results: Otter Creek Gage	
Peak Discharge (CFS)	265.28
Time of Peak Discharge	01Jan2000, 14:48
Volume (IN)	1.55
Precipitation Volume (AC - FT)	260.11
Loss Volume (AC - FT)	147.78
Excess Volume (AC - FT)	112.33
Direct Runoff Volume (AC - FT)	112.33
Baseflow Volume (AC - FT)	0



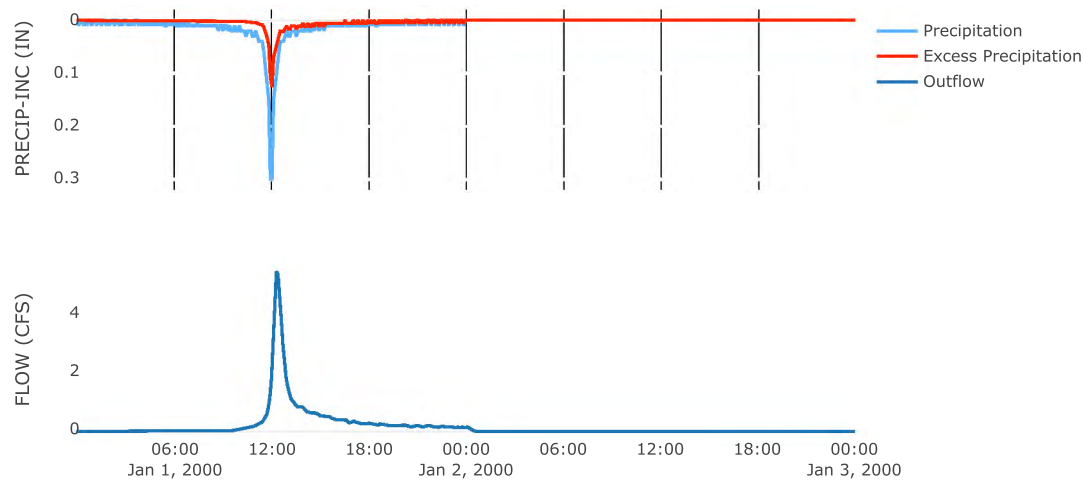
Subbasin: LoopRoad-1

Area (MI2) : 0.01
Latitude Degrees : 44.37
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		68
Initial Abstraction		0.47
Transform: Scs		
Lag		16.4
Unitgraph Type		Prf550

Results: LoopRoad-1		
Peak Discharge (CFS)		5.44
Time of Peak Discharge		01Jan2000, 12:18
Volume (IN)		1.23
Precipitation Volume (AC - FT)		1.97
Loss Volume (AC - FT)		1.29
Excess Volume (AC - FT)		0.68
Direct Runoff Volume (AC - FT)		0.68
Baseflow Volume (AC - FT)		0

Precipitation and Outflow



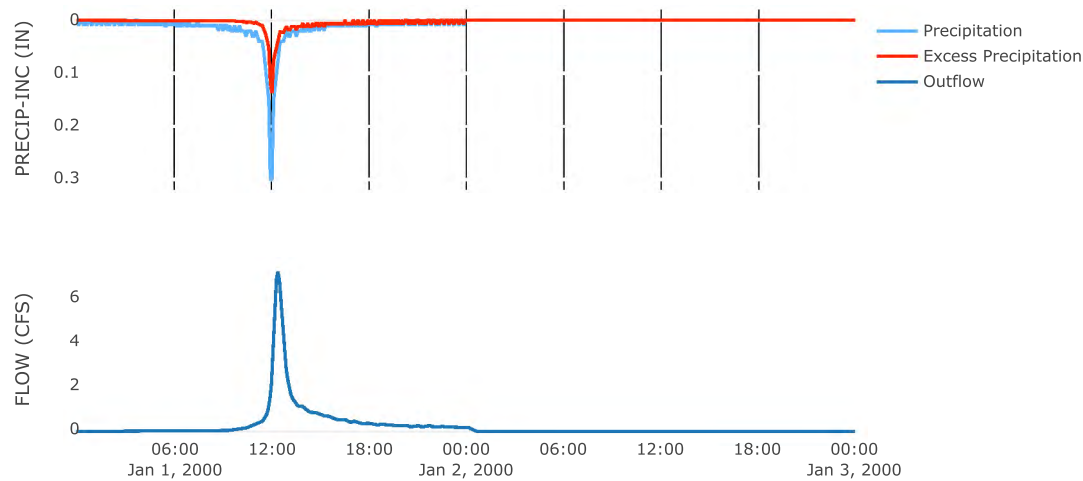
Subbasin: LoopRoad-2

Area (MI2) : 0.01
Latitude Degrees : 44.37
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		70
Initial Abstraction		0.42
Transform: Scs		
Lag		19
Unitgraph Type		Prf550

Results: LoopRoad-2	
Peak Discharge (CFS)	7.19
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	1.34
Precipitation Volume (AC - FT)	2.48
Loss Volume (AC - FT)	1.55
Excess Volume (AC - FT)	0.93
Direct Runoff Volume (AC - FT)	0.93
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



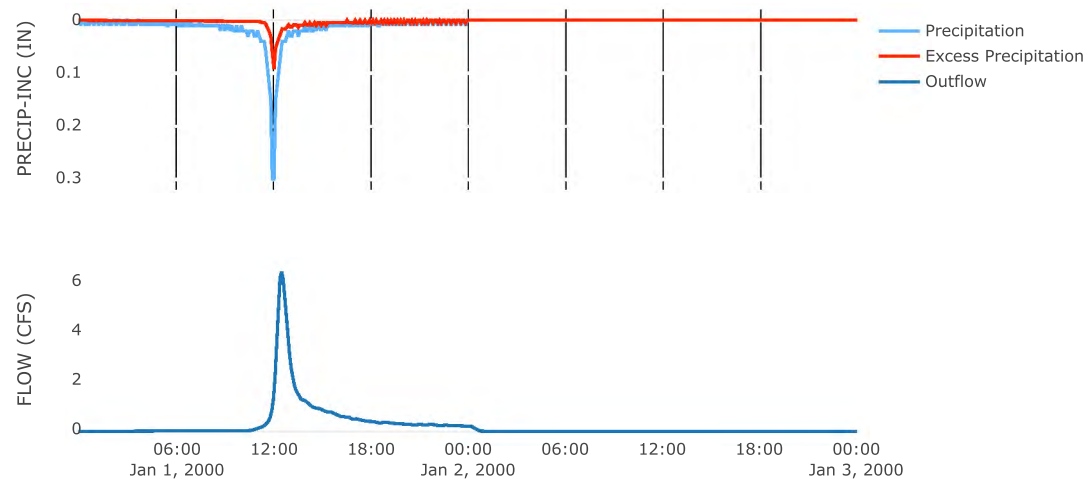
Subbasin: LoopRoad-3

Area (MI2) : 0.02
Latitude Degrees : 44.37
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		61
Initial Abstraction		0.65
Transform: Scs		
Lag		23.2
Unitgraph Type		Prf550

Results: LoopRoad-3		
Peak Discharge (CFS)		6.4
Time of Peak Discharge		01Jan2000, 12:30
Volume (IN)		0.92
Precipitation Volume (AC - FT)		3.61
Loss Volume (AC - FT)		2.68
Excess Volume (AC - FT)		0.93
Direct Runoff Volume (AC - FT)		0.93
Baseflow Volume (AC - FT)		0

Precipitation and Outflow



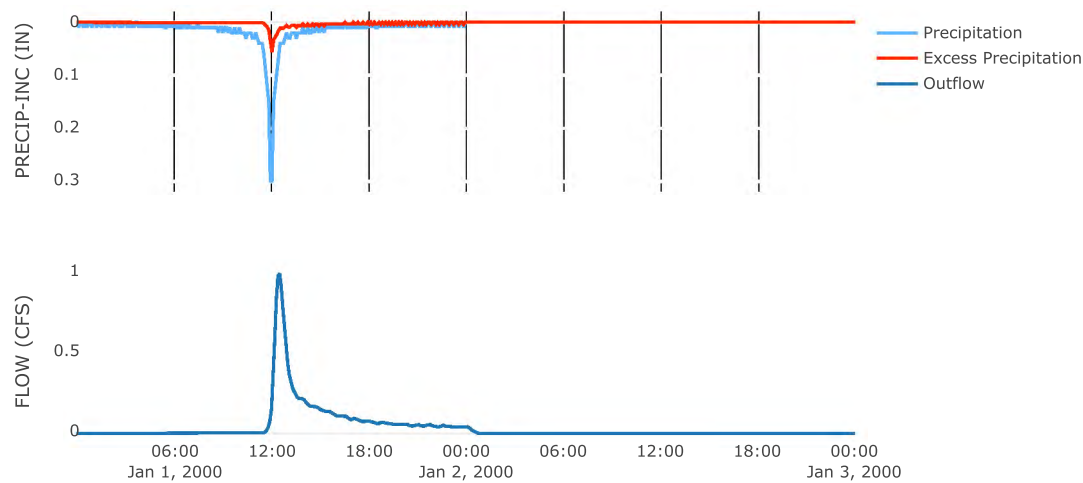
Subbasin: LoopRoad-4

Area (MI2) : 0
Latitude Degrees : 44.37
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		52
Initial Abstraction		0.94
Transform: Scs		
Lag		20.2
Unitgraph Type		Prf550

Results: LoopRoad-4		
Peak Discharge (CFS)		0.99
Time of Peak Discharge		01Jan2000, 12:30
Volume (IN)		0.59
Precipitation Volume (AC - FT)		0.9
Loss Volume (AC - FT)		0.75
Excess Volume (AC - FT)		0.15
Direct Runoff Volume (AC - FT)		0.15
Baseflow Volume (AC - FT)		0

Precipitation and Outflow



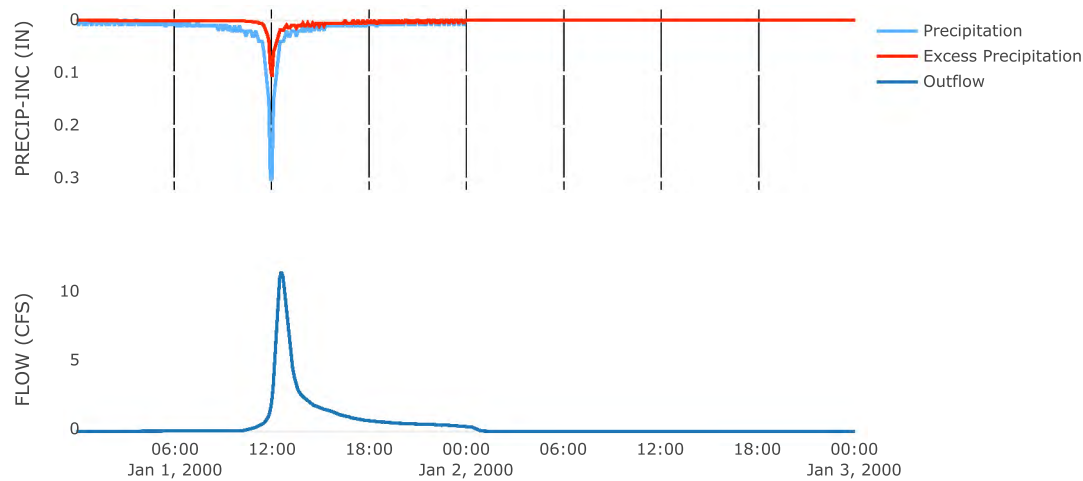
Subbasin: LoopRoad-5

Area (MI2) : 0.03
Latitude Degrees : 44.36
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		64
Initial Abstraction		0.57
Transform: Scs		
Lag		29.8
Unitgraph Type		Prf550

Results: LoopRoad-5		
Peak Discharge (CFS)		11.49
Time of Peak Discharge		01Jan2000, 12:36
Volume (IN)		1.05
Precipitation Volume (AC - FT)		6.24
Loss Volume (AC - FT)		4.41
Excess Volume (AC - FT)		1.83
Direct Runoff Volume (AC - FT)		1.83
Baseflow Volume (AC - FT)		0

Precipitation and Outflow



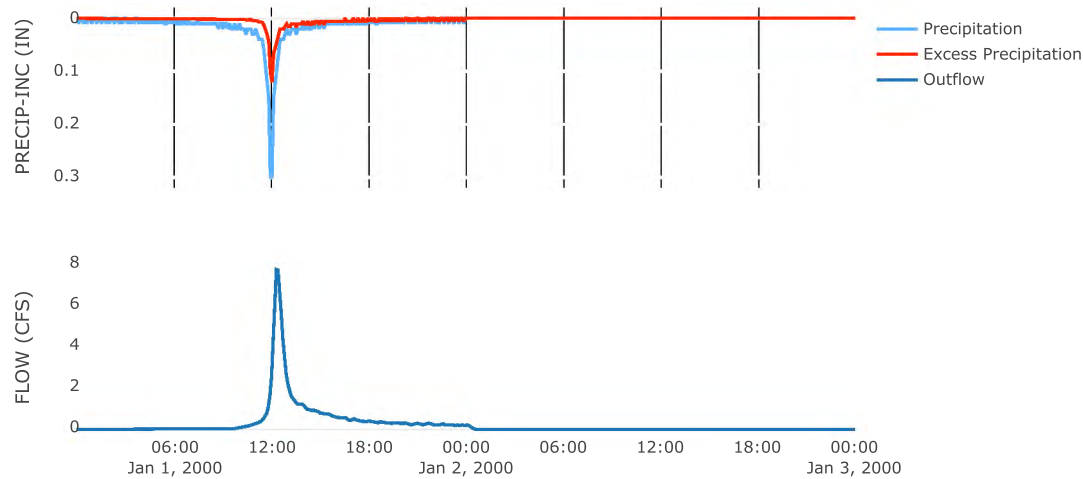
Subbasin: LoopRoad-6

Area (MI²) : 0.02
Latitude Degrees : 44.36
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		67
Initial Abstraction		0.5
Transform: Scs		
Lag		16.7
Unitgraph Type		Prf550

Results: LoopRoad-6	
Peak Discharge (CFS)	7.69
Time of Peak Discharge	01Jan2000, 12:18
Volume (IN)	1.18
Precipitation Volume (AC - FT)	2.94
Loss Volume (AC - FT)	1.97
Excess Volume (AC - FT)	0.97
Direct Runoff Volume (AC - FT)	0.97
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



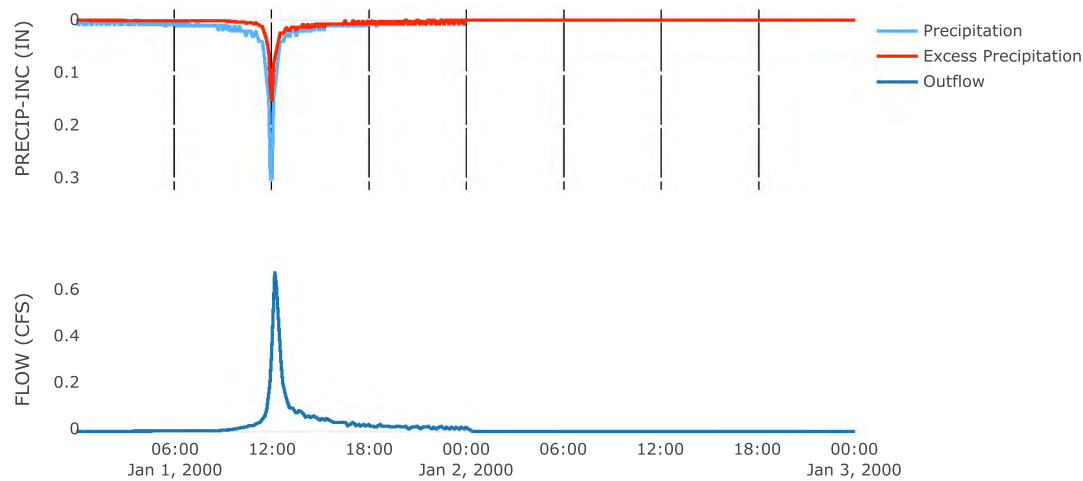
Subbasin: LoopRoad-7

Area (MI2) : 0
Latitude Degrees : 44.36
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		73
Initial Abstraction		0.37
Transform: Scs		
Lag		10.4
Unitgraph Type		Prf550

Results: LoopRoad-7		
Peak Discharge (CFS)		0.68
Time of Peak Discharge		01Jan2000, 12:12
Volume (IN)		1.49
Precipitation Volume (AC - FT)		0.17
Loss Volume (AC - FT)		0.1
Excess Volume (AC - FT)		0.07
Direct Runoff Volume (AC - FT)		0.07
Baseflow Volume (AC - FT)		0

Precipitation and Outflow



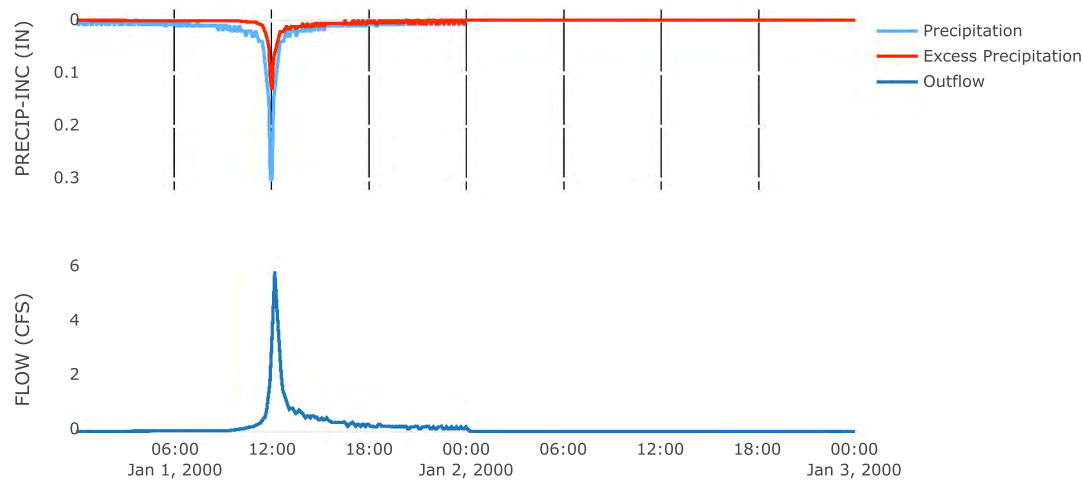
Subbasin: LoopRoad-8

Area (MI²) : 0.01
Latitude Degrees : 44.36
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		69
Initial Abstraction		0.45
Transform: Scs		
Lag		8.5
Unitgraph Type		Prf550

Results: LoopRoad-8	
Peak Discharge (CFS)	5.82
Time of Peak Discharge	01Jan2000, 12:12
Volume (IN)	1.28
Precipitation Volume (AC - FT)	1.64
Loss Volume (AC - FT)	1.05
Excess Volume (AC - FT)	0.59
Direct Runoff Volume (AC - FT)	0.59
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



Subbasin: Rt3-1

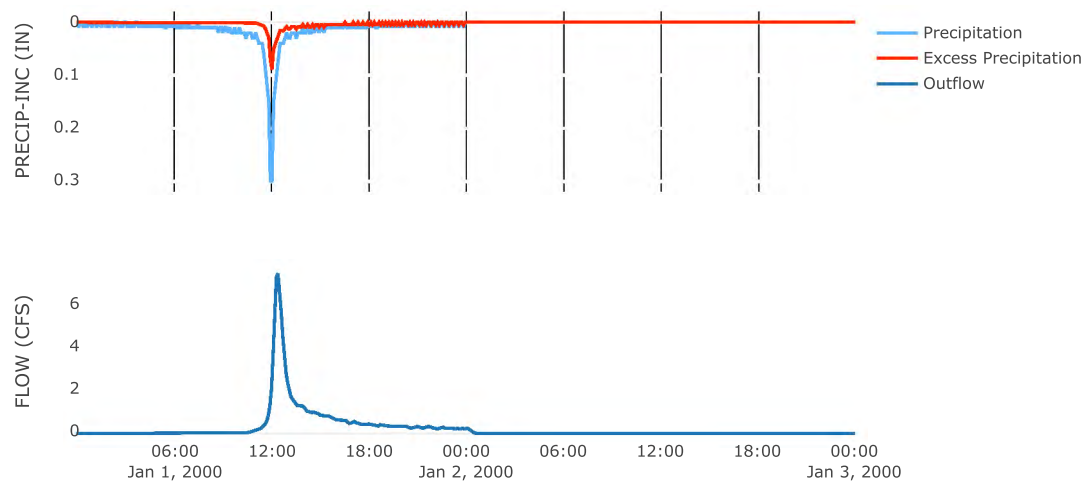
Area (MI2) : 0.02
Latitude Degrees : 44.36
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		60
Initial Abstraction		0.66

Transform: Scs		
Lag		16.9
Unitgraph Type		Prf550

Results: Rt3-1		
Peak Discharge (CFS)		7.45
Time of Peak Discharge		01Jan2000, 12:24
Volume (IN)		0.89
Precipitation Volume (AC - FT)		3.91
Loss Volume (AC - FT)		2.94
Excess Volume (AC - FT)		0.97
Direct Runoff Volume (AC - FT)		0.97
Baseflow Volume (AC - FT)		0

Precipitation and Outflow



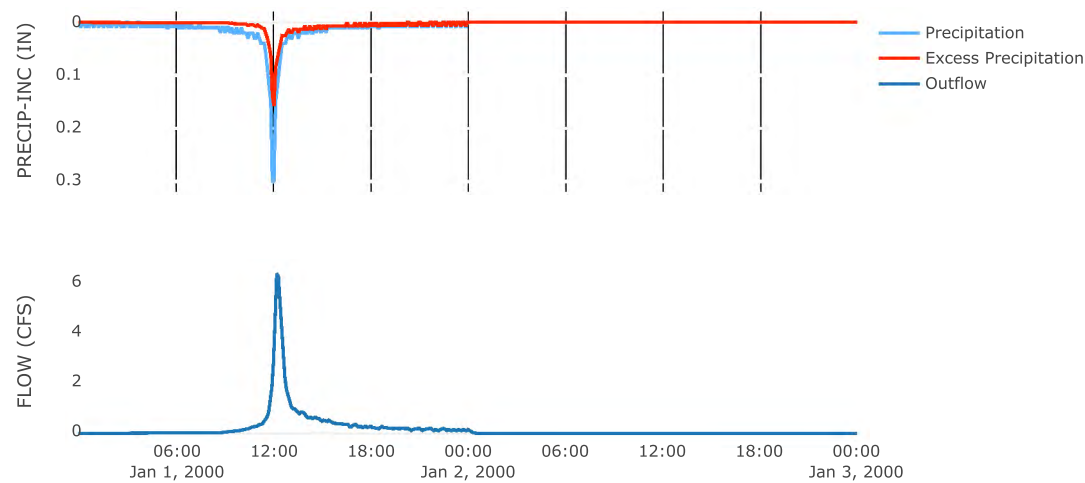
Subbasin: Rt3-1A

Area (MI²) : 0.01
Latitude Degrees : 44.36
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		74
Initial Abstraction		0.36
Transform: Scs		
Lag		11.9
Unitgraph Type		Prf550

Results: Rt3-1A	
Peak Discharge (CFS)	6.34
Time of Peak Discharge	01Jan2000, 12:12
Volume (IN)	1.54
Precipitation Volume (AC - FT)	1.64
Loss Volume (AC - FT)	0.94
Excess Volume (AC - FT)	0.71
Direct Runoff Volume (AC - FT)	0.71
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



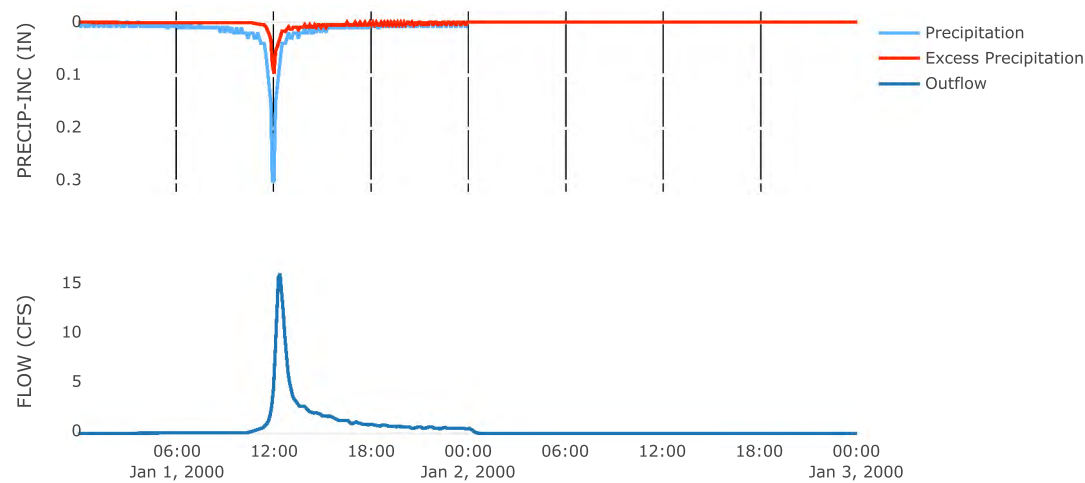
Subbasin: Rt3-2

Area (MI2) : 0.04
Latitude Degrees : 44.36
Longitude Degrees : -68.2

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		62
Initial Abstraction		0.62
Transform: Scs		
Lag		17.2
Unitgraph Type		Prf550

Results: Rt3-2	
Peak Discharge (CFS)	16.03
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	0.96
Precipitation Volume (AC - FT)	7.73
Loss Volume (AC - FT)	5.66
Excess Volume (AC - FT)	2.08
Direct Runoff Volume (AC - FT)	2.08
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



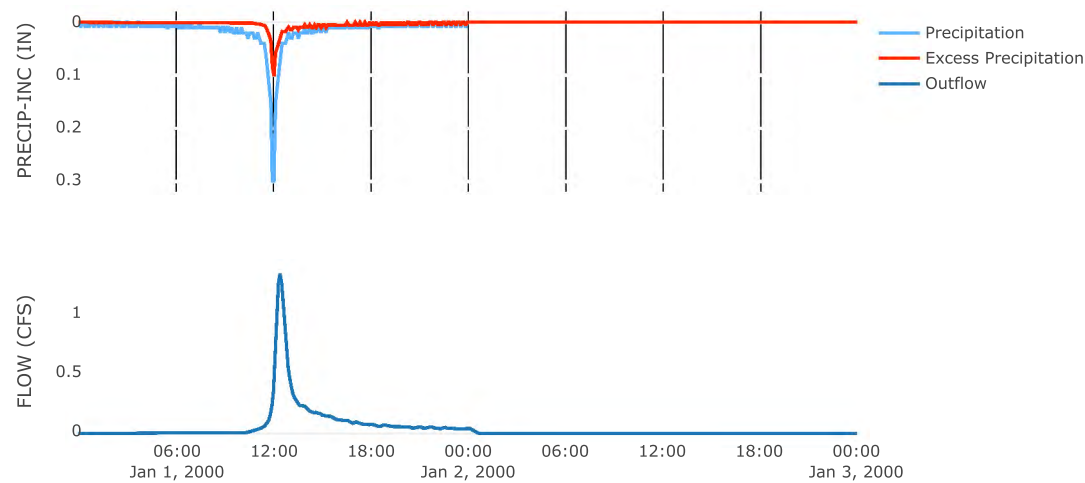
Subbasin: Rt3-3

Area (MI²) : 0
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		63
Initial Abstraction		0.6
Transform: Scs		
Lag		18.8
Unitgraph Type		Prf550

Results: Rt3-3	
Peak Discharge (CFS)	1.34
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	1
Precipitation Volume (AC - FT)	0.63
Loss Volume (AC - FT)	0.45
Excess Volume (AC - FT)	0.18
Direct Runoff Volume (AC - FT)	0.18
Baseflow Volume (AC - FT)	0

Precipitation and Outflow

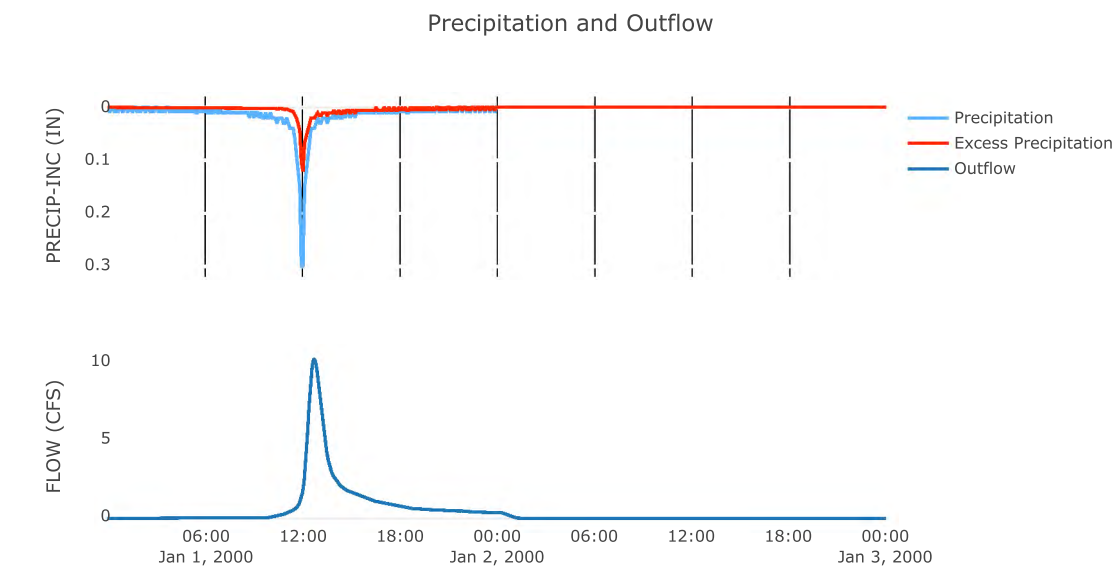


Subbasin: SieurdeMonts-1

Area (MI2) : 0.03
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: SCS		
Percent Impervious Area		0
Curve Number		67
Initial Abstraction		0.49
Transform: SCS		
Lag		36.4
Unitgraph Type		Prf550

Results: SieurdeMonts-1	
Peak Discharge (CFS)	10.19
Time of Peak Discharge	01Jan2000, 12:42
Volume (IN)	1.19
Precipitation Volume (AC - FT)	5.35
Loss Volume (AC - FT)	3.57
Excess Volume (AC - FT)	1.78
Direct Runoff Volume (AC - FT)	1.78
Baseflow Volume (AC - FT)	0



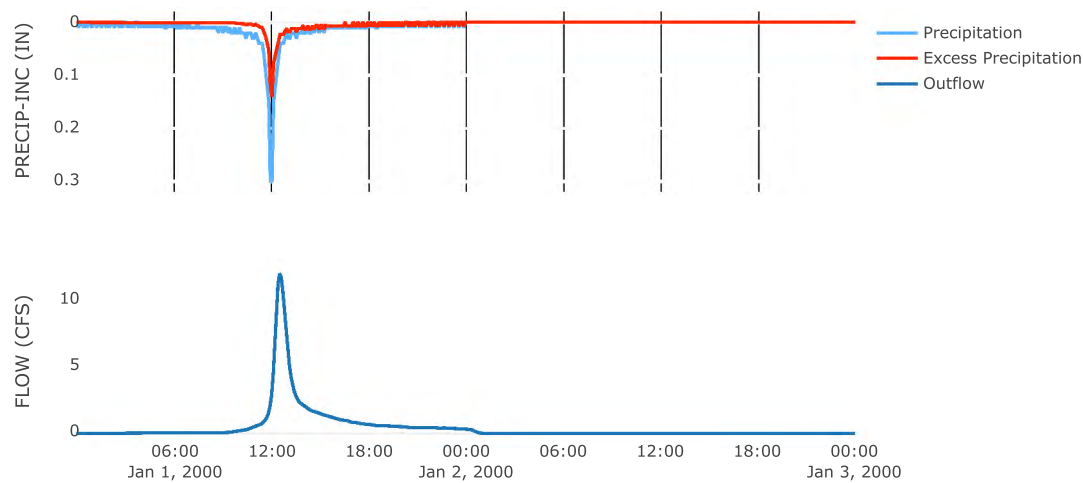
Subbasin: SieurdeMonts-2

Area (MI2) : 0.02
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		71
Initial Abstraction		0.42
Transform: Scs		
Lag		26.1
Unitgraph Type		Prf550

Results: SieurdeMonts-2	
Peak Discharge (CFS)	11.94
Time of Peak Discharge	01Jan2000, 12:30
Volume (IN)	1.38
Precipitation Volume (AC - FT)	4.54
Loss Volume (AC - FT)	2.79
Excess Volume (AC - FT)	1.75
Direct Runoff Volume (AC - FT)	1.75
Baseflow Volume (AC - FT)	0

Precipitation and Outflow



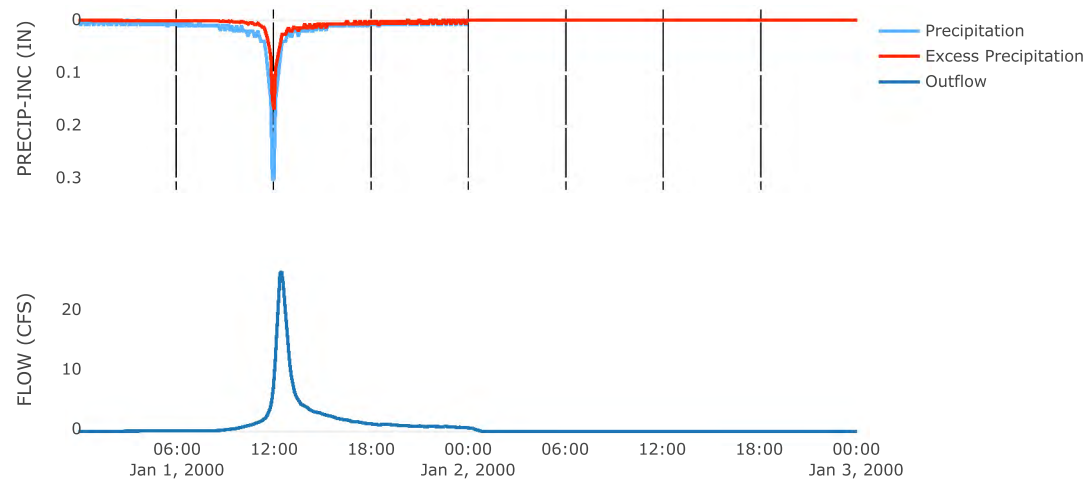
Subbasin: SieurdeMonts-3

Area (MI2) : 0.04
Latitude Degrees : 44.36
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		76
Initial Abstraction		0.32
Transform: Scs		
Lag		23.3
Unitgraph Type		Prf550

Results: SieurdeMonts-3	
Peak Discharge (CFS)	26.52
Time of Peak Discharge	01Jan2000, 12:30
Volume (IN)	1.65
Precipitation Volume (AC - FT)	7.98
Loss Volume (AC - FT)	4.3
Excess Volume (AC - FT)	3.68
Direct Runoff Volume (AC - FT)	3.68
Baseflow Volume (AC - FT)	0

Precipitation and Outflow

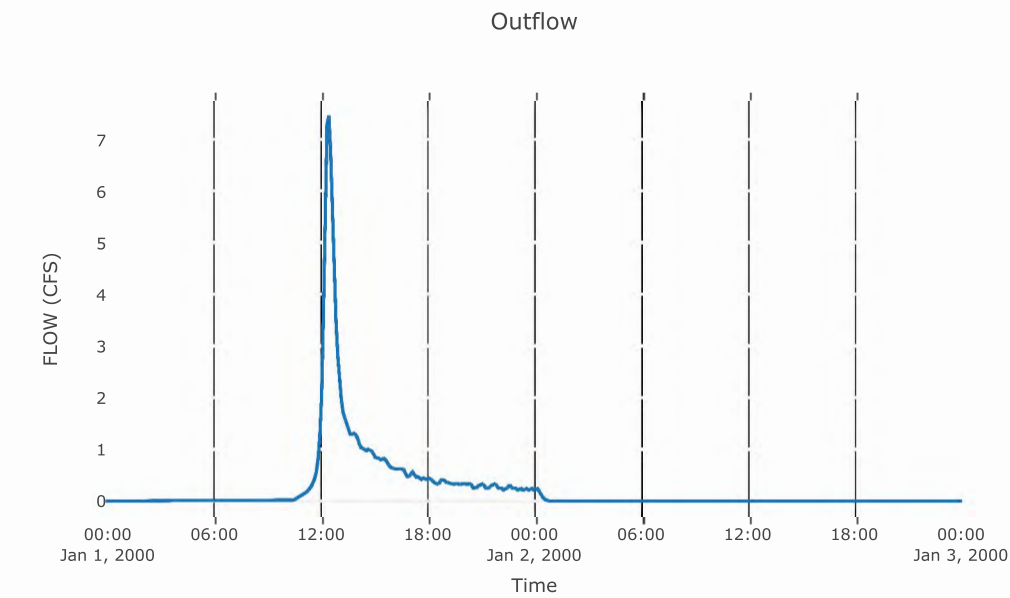


Reach: RT3-1_Reach

Downstream : Outlet - RT3 - 1A

Route: Lag	
Method	Lag
Initial Variable	Combined Inflow
Lag	6.4

Results: RT3-1_Reach	
Peak Discharge (CFS)	7.45
Time of Peak Discharge	01 Jan 2000, 12:30
Volume (IN)	0.89
Peak Inflow (CFS)	7.45
Inflow Volume (AC - FT)	0.97



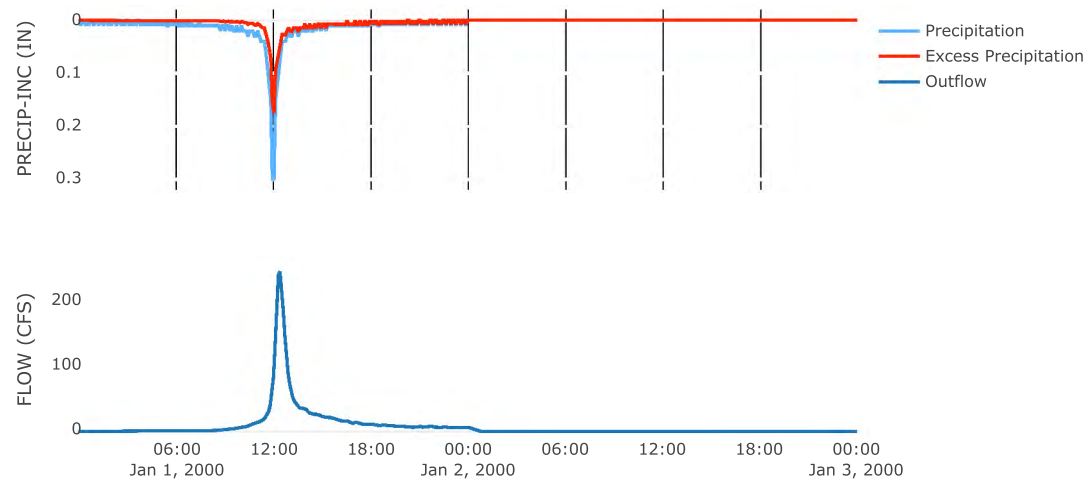
Subbasin: TheTarn

Area (MI2) : 0.34
Latitude Degrees : 44.35
Longitude Degrees : -68.21

Loss Rate: Scs		
Percent Impervious Area		0
Curve Number		77
Initial Abstraction		0.3
Transform: Scs		
Lag		18.4
Unitgraph Type		Prf550

Results: TheTarn	
Peak Discharge (CFS)	244.76
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	1.71
Precipitation Volume (AC - FT)	64.67
Loss Volume (AC - FT)	33.7
Excess Volume (AC - FT)	30.97
Direct Runoff Volume (AC - FT)	30.97
Baseflow Volume (AC - FT)	0

Precipitation and Outflow

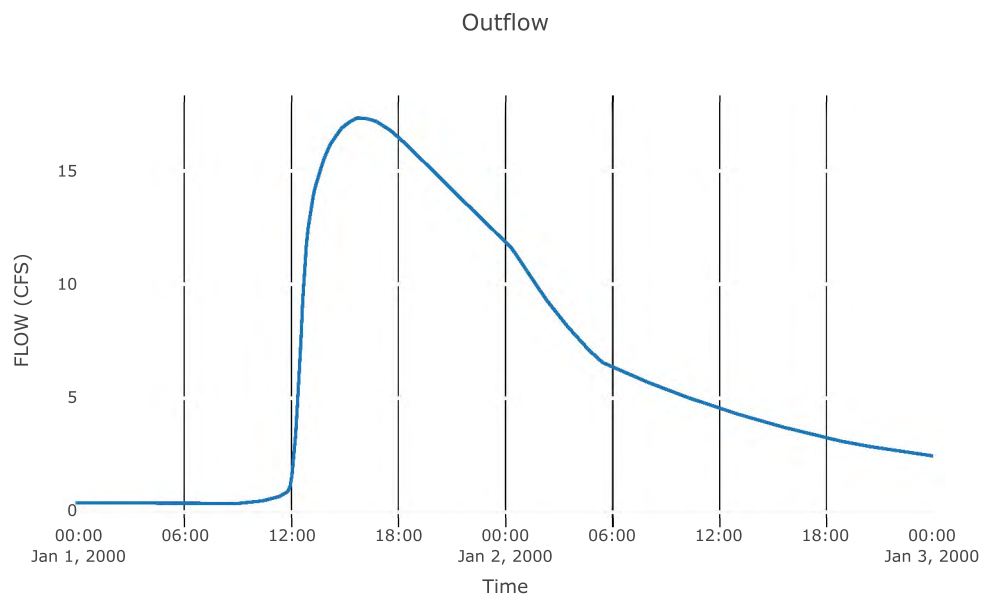


Reservoir: The Tarn Pond

Downstream : Cromwell - Reach

Results: The Tarn Pond

Peak Discharge (CFS)	17.33
Time of Peak Discharge	01Jan2000, 15:54
Volume (IN)	1.4
Peak Inflow (CFS)	244.76
Time of Peak Inflow	01Jan2000, 12:24
Inflow Volume (AC - FT)	30.97
Maximum Storage (AC - FT)	41.79
Peak Elevation (FT)	96.88
Discharge Volume (AC - FT)	25.2

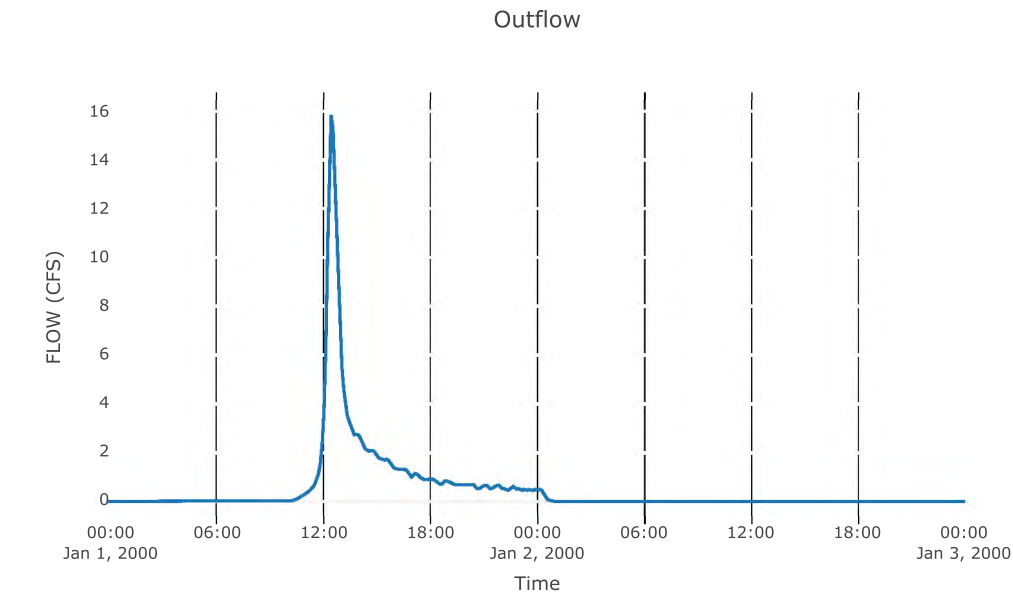


Reach: RT3_2-Reach

Downstream : Outlet - Cromwell

Route: Lag	
Method	Lag
Initial Variable	Combined Inflow
Lag	9.8

Results: RT3_2-Reach	
Peak Discharge (CFS)	15.83
Time of Peak Discharge	01 Jan 2000, 12:30
Volume (IN)	0.96
Peak Inflow (CFS)	16.03
Inflow Volume (AC - FT)	2.08

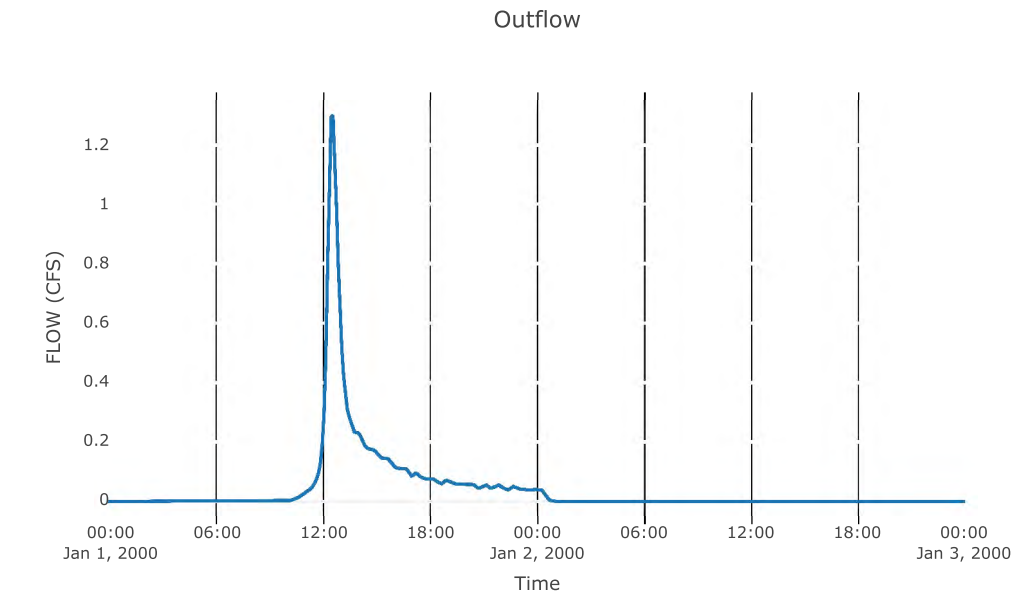


Reach: RT 3 - 3 Reach

Downstream : Outlet - Cromwell

Route: Lag	
Method	Lag
Initial Variable	Combined Inflow
Lag	9.2

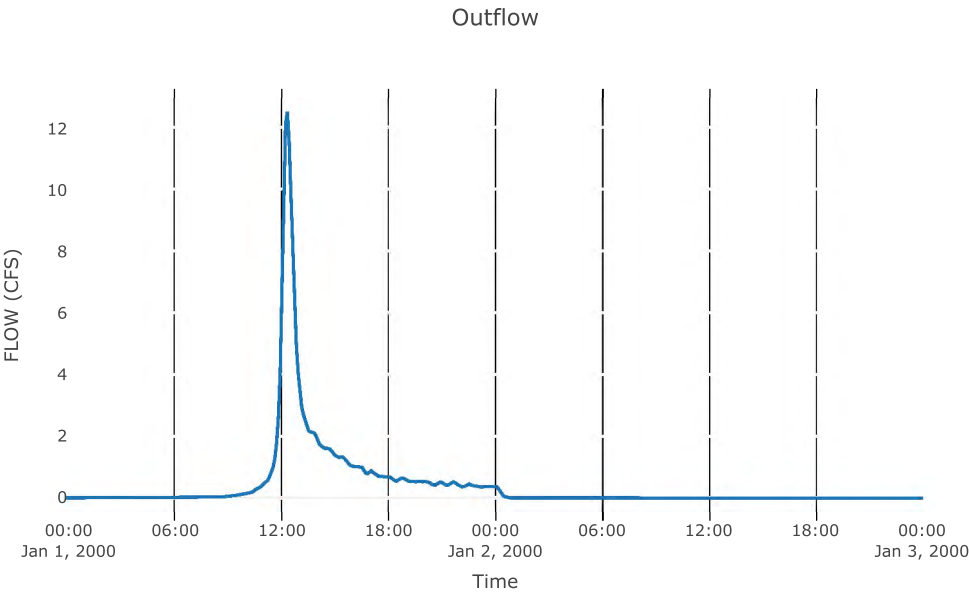
Results: RT 3 - 3 Reach	
Peak Discharge (CFS)	1.3
Time of Peak Discharge	01 Jan 2000, 12:36
Volume (IN)	1
Peak Inflow (CFS)	1.34
Inflow Volume (AC - FT)	0.18



Junction: Outlet-RT3-1A

Results: Outlet-RT3-1A

Peak Discharge (CFS)	12.51
Time of Peak Discharge	01Jan2000, 12:24
Volume (IN)	1.08

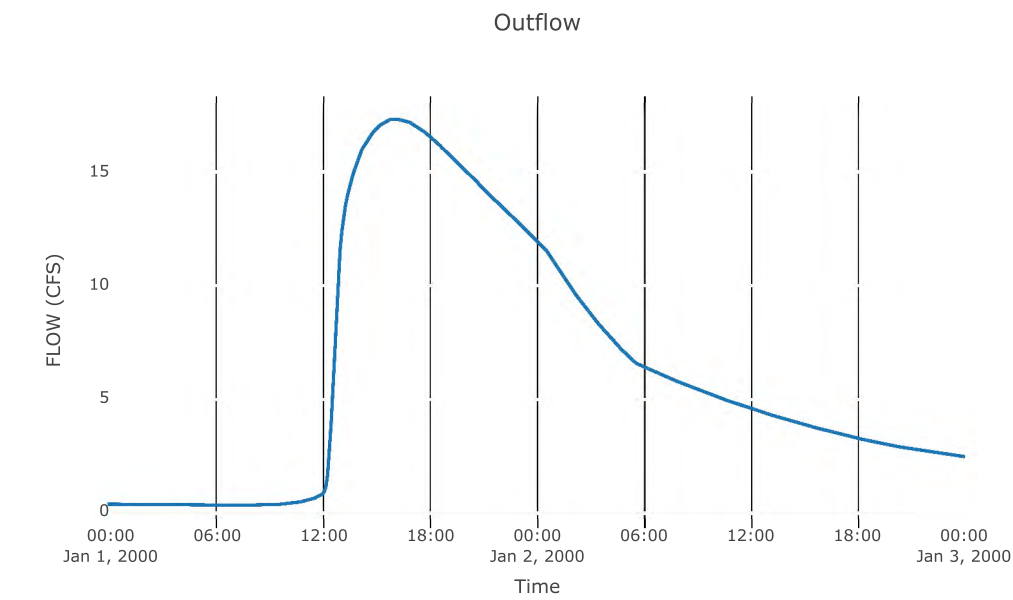


Reach: Cromwell-Reach

Downstream : Outlet - Cromwell

Route: Kinematic Wave	
Method	Kinematic Wave
Channel	Kinematic Wave
Length (FT)	1400
Energy Slope (FT/FT)	0.02
Mannings n	0.04
Shape	Trapezoid
Number of Subreaches	2
Width (FT)	10
Side Slope (FT/FT)	3
Initial Variable	Combined Inflow
Index Parameter Type	Index Celerity
Index Celerity	5

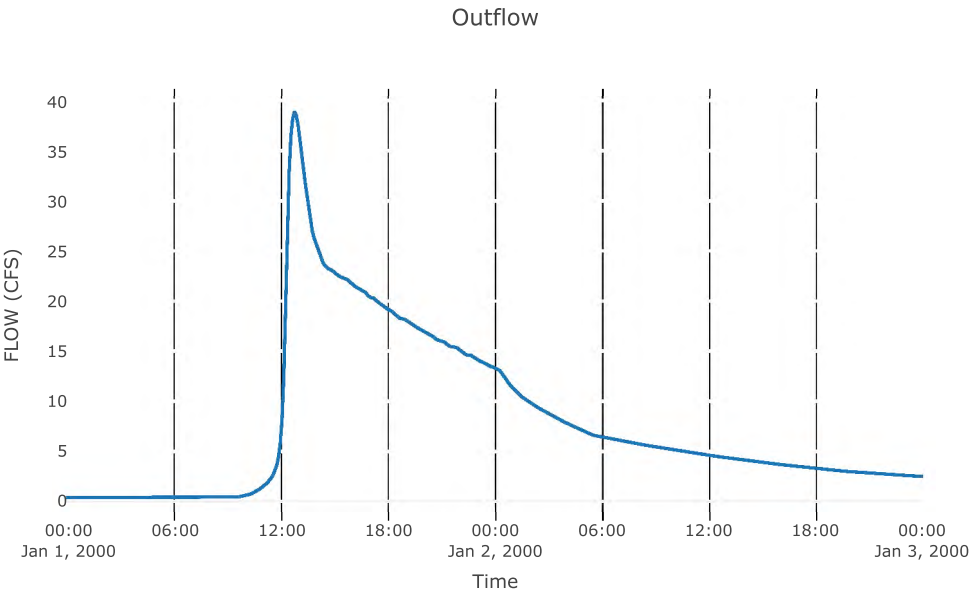
Results: Cromwell-Reach	
Peak Discharge (CFS)	17.33
Time of Peak Discharge	01Jan2000, 16:00
Volume (IN)	1.39
Peak Inflow (CFS)	17.33
Inflow Volume (AC - FT)	25.2



Junction: Outlet-Cromwell

Results: Outlet-Cromwell

Peak Discharge (CFS)	38.89
Time of Peak Discharge	01/Jan2000, 12:48
Volume (IN)	1.33



Project: Cromwell_Brook

Simulation Run: 1-inch rainfall

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 24:00

HMS Version: 4.10

Executed: 14 July 2023, 14:23

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Bar Harbor	0.34	25.54	01Jan2000, 13:06	0.26
Cromwell - Mid	0.22	3.74	01Jan2000, 14:06	0.1
Upper - Cromwell	0.06	0.66	01Jan2000, 13:12	0.05
Hemlock 1	0.01	0.81	01Jan2000, 12:30	0.13
Hemlock - 2	0.01	0.46	01Jan2000, 12:24	0.11
Hemlock - 3	0.03	1.69	01Jan2000, 12:30	0.12
Hemlock - 4	0.02	0.71	01Jan2000, 12:36	0.08
Hemlock - 5	0.02	0.62	01Jan2000, 12:36	0.08
Hemlock - 6	0.04	0.84	01Jan2000, 12:36	0.07
Hemlock - 7	0.07	1.09	01Jan2000, 12:48	0.06
Hemlock - 8	0.15	0.96	01Jan2000, 13:36	0.04
Kebo	1.21	9.86	01Jan2000, 15:36	0.07
Otter Creek Gage	1.36	17.26	01Jan2000, 15:12	0.1
LoopRoad - 1	0.01	0.18	01Jan2000, 12:30	0.05
LoopRoad - 2	0.01	0.32	01Jan2000, 12:30	0.07
LoopRoad - 3	0.02	0.06	01Jan2000, 13:06	0.02
LoopRoad - 4	0	0	01Jan2000, 23:36	0
LoopRoad - 5	0.03	0.21	01Jan2000, 13:00	0.03
LoopRoad - 6	0.02	0.21	01Jan2000, 12:36	0.05
LoopRoad - 7	0	0.04	01Jan2000, 12:18	0.09
LoopRoad - 8	0.01	0.21	01Jan2000, 12:18	0.06
Rt3 - 1	0.02	0.05	01Jan2000, 12:54	0.02
Rt3 - 1A	0.01	0.43	01Jan2000, 12:18	0.1
Rt3 - 2	0.04	0.18	01Jan2000, 12:48	0.02
Rt3 - 3	0	0.02	01Jan2000, 12:48	0.03
SieurdeMonts - 1	0.03	0.32	01Jan2000, 13:00	0.05

SieurdeMonts - 2	0.02	0.56	01Jan2000, 12:42	0.07
SieurdeMonts - 3	0.04	2.01	01Jan2000, 12:36	0.12
RT3 - 1_Reach	0.02	0.05	01Jan2000, 13:00	0.02
The Tarn	0.34	20.78	01Jan2000, 12:24	0.13
The Tarn Pond	0.34	0.68	01Jan2000, 21:18	0.12
RT3_2 - Reach	0.04	0.17	01Jan2000, 12:54	0.02
RT 3 - 3 Reach	0	0.02	01Jan2000, 12:54	0.03
Outlet - RT3 - 1A	0.03	0.43	01Jan2000, 12:18	0.04
Cromwell - Reach	0.34	0.68	01Jan2000, 21:36	0.12
Outlet - Cromwell	0.44	1.37	01Jan2000, 13:18	0.1

Project: Cromwell_Brook

Simulation Run: 5-year

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 24:00

HMS Version: 4.10

Executed: 14 July 2023, 14:23

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Bar Harbor	0.34	255.66	01Jan2000, 13:00	3.02
Cromwell - Mid	0.22	84.22	01Jan2000, 13:48	2.2
Upper - Cromwell	0.06	27.97	01Jan2000, 12:54	1.82
Hemlock 1	0.01	13.73	01Jan2000, 12:24	2.41
Hemlock - 2	0.01	9.39	01Jan2000, 12:18	2.27
Hemlock - 3	0.03	31.51	01Jan2000, 12:24	2.34
Hemlock - 4	0.02	19.42	01Jan2000, 12:30	2.07
Hemlock - 5	0.02	18.4	01Jan2000, 12:24	2.01
Hemlock - 6	0.04	29.47	01Jan2000, 12:24	1.94
Hemlock - 7	0.07	43.06	01Jan2000, 12:36	1.88
Hemlock - 8	0.15	55.49	01Jan2000, 13:12	1.65
Kebo	1.21	286.04	01Jan2000, 15:06	2.01
Otter Creek Gage	1.36	382.05	01Jan2000, 14:48	2.21
LoopRoad - 1	0.01	8.24	01Jan2000, 12:18	1.82
LoopRoad - 2	0.01	10.66	01Jan2000, 12:24	1.95
LoopRoad - 3	0.02	10.14	01Jan2000, 12:30	1.42
LoopRoad - 4	0	1.73	01Jan2000, 12:24	0.97
LoopRoad - 5	0.03	17.77	01Jan2000, 12:36	1.59
LoopRoad - 6	0.02	11.73	01Jan2000, 12:18	1.76
LoopRoad - 7	0	1	01Jan2000, 12:12	2.14
LoopRoad - 8	0.01	8.71	01Jan2000, 12:12	1.88
Rt3 - 1	0.02	11.86	01Jan2000, 12:24	1.37
Rt3 - 1A	0.01	9.24	01Jan2000, 12:12	2.2
Rt3 - 2	0.04	25.19	01Jan2000, 12:24	1.47
Rt3 - 3	0	2.09	01Jan2000, 12:24	1.53
SieurdeMonts - 1	0.03	15.41	01Jan2000, 12:42	1.76

SieurdeMonts - 2	0.02	17.66	01Jan2000, 12:30	2
SieurdeMonts - 3	0.04	37.9	01Jan2000, 12:30	2.34
RT3 - 1_Reach	0.02	11.86	01Jan2000, 12:30	1.37
The Tarn	0.34	348	01Jan2000, 12:24	2.41
The Tarn Pond	0.34	35.03	01Jan2000, 14:30	2.06
RT3_2 - Reach	0.04	25.01	01Jan2000, 12:30	1.47
RT 3 - 3 Reach	0	2.03	01Jan2000, 12:30	1.53
Outlet - RT3 - 1A	0.03	19.24	01Jan2000, 12:24	1.62
Cromwell - Reach	0.34	35.03	01Jan2000, 14:36	2.06
Outlet - Cromwell	0.44	63.73	01Jan2000, 12:48	1.97

Project: Cromwell_Brook

Simulation Run: 10-year

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 24:00

HMS Version: 4.10

Executed: 14 July 2023, 14:23

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Bar Harbor	0.34	307.33	01Jan2000, 13:00	3.63
Cromwell - Mid	0.22	105.01	01Jan2000, 13:48	2.73
Upper - Cromwell	0.06	35.68	01Jan2000, 12:54	2.3
Hemlock - 1	0.01	16.87	01Jan2000, 12:24	2.97
Hemlock - 2	0.01	11.61	01Jan2000, 12:18	2.81
Hemlock - 3	0.03	38.89	01Jan2000, 12:24	2.89
Hemlock - 4	0.02	24.28	01Jan2000, 12:30	2.59
Hemlock - 5	0.02	23.12	01Jan2000, 12:24	2.52
Hemlock - 6	0.04	37.12	01Jan2000, 12:24	2.44
Hemlock - 7	0.07	54.51	01Jan2000, 12:36	2.37
Hemlock - 8	0.15	71.43	01Jan2000, 13:12	2.11
Kebo	1.21	360.03	01Jan2000, 15:06	2.51
Otter Creek Gage	1.36	475.59	01Jan2000, 14:48	2.74
LoopRoad - 1	0.01	10.44	01Jan2000, 12:18	2.3
LoopRoad - 2	0.01	13.41	01Jan2000, 12:24	2.45
LoopRoad - 3	0.02	13.24	01Jan2000, 12:30	1.83
LoopRoad - 4	0	2.38	01Jan2000, 12:24	1.3
LoopRoad - 5	0.03	22.95	01Jan2000, 12:36	2.03
LoopRoad - 6	0.02	14.94	01Jan2000, 12:18	2.23
LoopRoad - 7	0	1.23	01Jan2000, 12:12	2.66
LoopRoad - 8	0.01	10.91	01Jan2000, 12:12	2.37
Rt3 - 1	0.02	15.5	01Jan2000, 12:24	1.78
Rt3 - 1A	0.01	11.44	01Jan2000, 12:12	2.73
Rt3 - 2	0.04	32.67	01Jan2000, 12:24	1.9
Rt3 - 3	0	2.7	01Jan2000, 12:24	1.96
SieurdeMonts - 1	0.03	19.69	01Jan2000, 12:42	2.23

SieurdeMonts - 2	0.02	22.2	01Jan2000, 12:30	2.51
SieurdeMonts - 3	0.04	46.72	01Jan2000, 12:30	2.88
RT3 - 1_Reach	0.02	15.5	01Jan2000, 12:30	1.78
The Tarn	0.34	427.03	01Jan2000, 12:24	2.96
The Tarn Pond	0.34	53.37	01Jan2000, 14:00	2.6
RT3_2 - Reach	0.04	32.5	01Jan2000, 12:30	1.9
RT 3 - 3 Reach	0	2.64	01Jan2000, 12:30	1.96
Outlet - RT3 - 1A	0.03	24.69	01Jan2000, 12:24	2.06
Cromwell - Reach	0.34	53.37	01Jan2000, 14:00	2.6
Outlet - Cromwell	0.44	95.15	01Jan2000, 12:54	2.49

Project: Cromwell_Brook

Simulation Run: 50-year

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 24:00

HMS Version: 4.10

Executed: 14 July 2023, 14:23

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Bar Harbor	0.34	443.56	01Jan2000, 13:00	5.28
Cromwell - Mid	0.22	162.89	01Jan2000, 13:48	4.22
Upper - Cromwell	0.06	57.47	01Jan2000, 12:54	3.68
Hemlock 1	0.01	25.63	01Jan2000, 12:24	4.51
Hemlock - 2	0.01	18	01Jan2000, 12:18	4.31
Hemlock - 3	0.03	59.51	01Jan2000, 12:24	4.41
Hemlock - 4	0.02	37.87	01Jan2000, 12:30	4.04
Hemlock - 5	0.02	36.63	01Jan2000, 12:24	3.95
Hemlock - 6	0.04	58.99	01Jan2000, 12:24	3.85
Hemlock - 7	0.07	86.83	01Jan2000, 12:36	3.76
Hemlock - 8	0.15	117.52	01Jan2000, 13:06	3.42
Kebo	1.21	570.14	01Jan2000, 15:06	3.95
Otter Creek Gage	1.36	738.23	01Jan2000, 14:42	4.23
LoopRoad - 1	0.01	16.93	01Jan2000, 12:18	3.68
LoopRoad - 2	0.01	21.21	01Jan2000, 12:24	3.87
LoopRoad - 3	0.02	22.33	01Jan2000, 12:30	3.06
LoopRoad - 4	0	4.38	01Jan2000, 12:24	2.32
LoopRoad - 5	0.03	37.92	01Jan2000, 12:36	3.32
LoopRoad - 6	0.02	24.44	01Jan2000, 12:18	3.58
LoopRoad - 7	0	1.94	01Jan2000, 12:12	4.13
LoopRoad - 8	0.01	17.51	01Jan2000, 12:12	3.77
Rt3 - 1	0.02	26.59	01Jan2000, 12:18	2.99
Rt3 - 1A	0.01	17.92	01Jan2000, 12:12	4.22
Rt3 - 2	0.04	55.04	01Jan2000, 12:18	3.14
Rt3 - 3	0	4.5	01Jan2000, 12:24	3.23
SieurdeMonts - 1	0.03	31.88	01Jan2000, 12:42	3.59

SieurdeMonts - 2	0.02	35.05	01Jan2000, 12:30	3.94
SieurdeMonts - 3	0.04	71.53	01Jan2000, 12:24	4.41
RT3 - 1_Reach	0.02	26.59	01Jan2000, 12:24	2.99
The Tarn	0.34	644.91	01Jan2000, 12:24	4.5
The Tarn Pond	0.34	149.78	01Jan2000, 13:06	4.12
RT3_2 - Reach	0.04	54.78	01Jan2000, 12:30	3.14
RT 3 - 3 Reach	0	4.43	01Jan2000, 12:30	3.23
Outlet - RT3 - 1A	0.03	40.56	01Jan2000, 12:24	3.35
Cromwell - Reach	0.34	149.51	01Jan2000, 13:06	4.12
Outlet - Cromwell	0.44	226.18	01Jan2000, 12:54	3.97

Project: Cromwell_Brook

Simulation Run: 100-year

Simulation Start: 31 December 1999, 24:00

Simulation End: 2 January 2000, 24:00

HMS Version: 4.10

Executed: 14 July 2023, 14:23

Global Results Summary

Hydrologic Element	Drainage Area (MI ²)	Peak Discharge (CFS)	Time of Peak	Volume (IN)
Bar Harbor	0.34	496.85	01Jan2000, 13:00	5.93
Cromwell - Mid	0.22	186.24	01Jan2000, 13:48	4.82
Upper - Cromwell	0.06	66.4	01Jan2000, 12:54	4.24
Hemlock 1	0.01	29.1	01Jan2000, 12:24	5.12
Hemlock - 2	0.01	20.51	01Jan2000, 12:18	4.92
Hemlock - 3	0.03	67.71	01Jan2000, 12:24	5.02
Hemlock - 4	0.02	43.39	01Jan2000, 12:30	4.63
Hemlock - 5	0.02	42.09	01Jan2000, 12:24	4.54
Hemlock - 6	0.04	67.86	01Jan2000, 12:24	4.43
Hemlock - 7	0.07	100.19	01Jan2000, 12:30	4.33
Hemlock - 8	0.15	136.64	01Jan2000, 13:06	3.97
Kebo	1.21	655.52	01Jan2000, 15:06	4.53
Otter Creek Gage	1.36	844.33	01Jan2000, 14:42	4.83
LoopRoad - 1	0.01	19.55	01Jan2000, 12:18	4.24
LoopRoad - 2	0.01	24.39	01Jan2000, 12:24	4.44
LoopRoad - 3	0.02	26.16	01Jan2000, 12:30	3.57
LoopRoad - 4	0	5.26	01Jan2000, 12:24	2.75
LoopRoad - 5	0.03	44.13	01Jan2000, 12:36	3.86
LoopRoad - 6	0.02	28.29	01Jan2000, 12:18	4.14
LoopRoad - 7	0	2.2	01Jan2000, 12:12	4.73
LoopRoad - 8	0.01	20.07	01Jan2000, 12:12	4.34
Rt3 - 1	0.02	31.22	01Jan2000, 12:18	3.49
Rt3 - 1A	0.01	20.4	01Jan2000, 12:12	4.82
Rt3 - 2	0.04	64.39	01Jan2000, 12:18	3.67
Rt3 - 3	0	5.25	01Jan2000, 12:24	3.76
SieurdeMonts - 1	0.03	36.88	01Jan2000, 12:42	4.15

SieurdeMonts - 2	0.02	40.27	01Jan2000, 12:30	4.53
SieurdeMonts - 3	0.04	81.44	01Jan2000, 12:24	5.02
RT3 - 1_Reach	0.02	31.22	01Jan2000, 12:24	3.49
The Tarn	0.34	731.73	01Jan2000, 12:24	5.12
The Tarn Pond	0.34	171.66	01Jan2000, 13:06	4.74
RT3_2 - Reach	0.04	64.04	01Jan2000, 12:30	3.67
RT 3 - 3 Reach	0	5.17	01Jan2000, 12:30	3.76
Outlet - RT3 - 1A	0.03	47.16	01Jan2000, 12:24	3.88
Cromwell - Reach	0.34	171.64	01Jan2000, 13:06	4.73
Outlet - Cromwell	0.44	278.14	01Jan2000, 12:48	4.56

B

Appendix B – Hydraulic Analysis

B.1 Culvert Hydraulic Analysis

B.2 HEC-RAS Model Summary

Appendix B.1: Culvert Hydraulic Analysis

Project:	Acadia Great Meadow Supplemental Work	Project #	55661.01
Location:	Acadia National Park		
Calculated by:	AMW	Date:	6/22/2023
Checked by:	DWC	Date:	7/12/2023

1) Calculate full pipe flow capacity using Manning's Equation (example calc):

W	7.5 ft	width, for box culverts (different equation, see below)
H	7.5 ft	height, for box culverts
D	1.5 ft	diameter, for circular pipes
R	1.33 ft	hydraulic radius
A	56.25 sf	cross sectional area
n	0.013	Mannings n
S	0.03 ft/ft	Slope
λ	1.486	Unit conversion factor

Mannings Eq - following equation used:

Culvert size can also be checked against just-full ($H_w/D = 1$) open-channel Manning's Equation flow. For circular pipes Manning's Equation is

$$Q = Av = (\pi D^2/4) \{ \lambda R_h^{2/3} S^{1/2} / n \} = (\pi D^2/4) \{ \lambda (D/4)^{2/3} S^{1/2} / n \}$$

$$D = \{ 4^{5/3} n / \lambda \pi S^{1/2} \}^{3/8} Q^{3/8} = a_{\lambda} Q^{3/8}$$

where $a_{\lambda} = \{ 4^{5/3} n / \lambda \pi S^{1/2} \}^{3/8}$

λ = Manning unit conversion factor (1.486 for US Customary; 1 for metric).

Q **42.4 cfs** based on inputs above

2) Calculate pipe inlet flow capacity using orifice flow equation (example calc):

Cd	0.6	Dimensionless discharge coefficient, assumed to be 0.6
A	1.8 sf	Pipe opening area
g	32.2 ft/s ²	acceleration due to gravity
Hw	2.3 ft	Assumed to be 1.5 times D
D	1.5 ft	Pipe diameter (or height for box culverts)

circular (pipe) culverts - following equation used:

$$Q = C_d A \{ 2g(H_w - 0.5D) \}^{0.5}$$

for box culverts - following equation used:

$$Q = VA = \left(\frac{1.49}{n} \right) AR^{2/3} \sqrt{S} \quad [\text{U.S.}]$$

Q **10.4 cfs** based on inputs above

Material	Mannings n
Concrete	0.013
Corrugated Metal	0.024
Plastic/PVC	0.011
Masonry	0.03

Mannings n Source:

<https://www.hec.usace.army.mil/confluence/rasdocs/ras1dtechref/latest/modeling-g-culverts/culvert-data-and-coefficients/manning-s-roughness-coefficient>

No.	Location	Dimensions (ft)	R (ft) ¹	A (sf) ²	P ³	n ⁴	S (ft/ft) ⁵	Q _{Manning} (cfs)	Q _{Inlet} (cfs)	Q _{min} (cfm)	Notes
1	Park Loop - 1	1.5	0.38	1.77	4.71	0.013	0.073	28.5	10.4	10.4	Circular
2	Park Loop - 2	2	0.67	4.00	6.00	0.03	0.044	31.9	27.2	27.2	Box culvert
3	Park Loop - 3	3.5 2.3	1.00	8.17	8.17	0.013	0.076	257.5	60.1	60.1	Box culvert
4	Park Loop - 4	1.5	0.38	1.77	4.71	0.013	0.054	24.5	10.4	10.4	Circular
5	Park Loop - 5	1.5	0.38	1.77	4.71	0.013	0.016	13.3	10.4	10.4	Circular
6	Park Loop - 6	2.0	0.50	3.14	6.28	0.013	0.018	29.9	21.4	21.4	Circular
7	Park Loop - 7	1.5	0.38	1.77	4.71	0.013	0.005	7.4	10.4	7.4	Circular
8	Park Loop - 8	1.5	0.38	1.77	4.71	0.013	0.005	7.4	10.4	7.4	Circular
9	Route 3-1	1.5	0.38	1.77	4.71	0.013	0.101	33.3	10.4	10.4	Circular
10	Route 3-1A	2.0	0.50	3.14	6.28	0.024	0.029	20.9	21.4	20.9	Circular
11	Route 3-2	1.5	0.38	1.77	4.71	0.013	0.026	17.0	10.4	10.4	Circular
12	Route 3-3	2.0	0.50	3.14	6.28	0.013	0.056	53.7	21.4	21.4	Circular
13	Sieur De Monts - 1*	1.5	0.38	1.77	4.71	0.024	0.019	7.8	10.4	15.6	Circular
14	Sieur De Monts - 2	3.0	0.75	7.07	9.42	0.024	0.005	25.5	59.0	25.5	Circular
15	Sieur De Monts - 3	3.0	0.75	7.07	9.42	0.024	0.005	25.5	59.0	25.5	Circular
16	Hemlock - 1	3.0	0.75	7.07	9.42	0.024	0.173	150.1	59.0	59.0	Circular
17	Hemlock - 2	1.5	0.38	1.77	4.71	0.024	0.034	10.5	10.4	10.4	Circular
18	Hemlock - 3*	1.5	0.38	1.77	4.71	0.024	0.024	8.9	10.4	35.5	Circular
19	Hemlock - 4*	1.5	0.38	1.77	4.71	0.024	0.035	10.7	10.4	31.3	Circular
20	Hemlock - 5*	1.5	0.38	1.77	4.71	0.024	0.025	9.0	10.4	45.0	Circular
21	Hemlock - 6*	1.5	0.38	1.77	4.71	0.024	0.025	9.0	10.4	18.0	Circular
22	Hemlock - 7**	10 1.0	0.83	10.00	12.00	0.03	0.001	77.0	152.3	77.0	Low Level Crossing
23	Hemlock - 8	3.0	0.75	7.07	9.42	0.024	0.005	25.5	59.0	25.5	Circular

Note: Inlet control orifice coefficient assumed to be 0.60 for generic culverts;

Note: Slope calculated from culvert length and inlet/outlet invert elevations (December 2022). Minimum slope of 0.005 ft/ft assumed for calculating Manning's equation flow where surveyed inlet elevation was lower than outlet elevation.

Note: At locations where there are multiple adjacent culverts, capacity is multiplied by the number of culverts: Sieur de Monts-1: 2 parallel culverts. Hemlock-3: 4 parallel culverts. Hemlock-4: 3 parallel culverts. Hemlock-5: 5 parallel culverts. Hemlock-6: 2 parallel culverts. Hemlock-7: low-level crossing, represented here as an equivalent size culvert

Note: Where there are multiple parallel culverts, a single representative slope was used

1 - Hydraulic radius; 2 - Cross-sectional area; 3 - Perimeter; 4 - Mannings n; 5 - Slope

3) Compare capacity to calculated peak flows from HEC-HMS hydrologic model.

Values highlighted where peak flow exceeds culvert capacity.

No.	Location	Qcapacity	Peak Flows (cfs) from HEC-HMS Model					
			1-in	Q2	Q5	Q10	Q50	Q100
1	Park Loop - 1	10.4	0.2	5.4	8.2	10.4	16.9	19.6
2	Park Loop - 2	27.2	0.3	7.2	10.7	13.4	21.2	24.4
3	Park Loop - 3	60.1	0.1	6.4	10.1	13.2	22.3	26.2
4	Park Loop - 4	10.4	0	1	1.7	2.4	4.4	5.3
5	Park Loop - 5	10.4	0.2	11.5	17.8	22.9	37.9	44.1
6	Park Loop - 6	21.4	0.2	7.7	11.7	14.9	24.4	28.3
7	Park Loop - 7	7.4	0	0.7	1	1.2	1.9	2.2
8	Park Loop - 8	7.4	0.2	5.8	8.7	10.9	17.5	20.1
9	Route 3-1	10.4	0.1	7.5	11.9	15.5	26.6	31.2
10	Route 3-1A	20.9	0.4	6.3	9.2	11.4	17.9	20.4
11	Route 3-2	10.4	0.2	16	25.2	32.7	55	64.4
12	Route 3-3	21.4	0	1.3	2.1	2.7	4.5	5.3
13	Sieur De Monts - 1*	15.6	0.3	10.2	15.4	19.7	31.9	36.9
14	Sieur De Monts - 2	25.5	0.6	11.9	17.7	22.2	35.1	40.3
15	Sieur De Monts - 3	25.5	2	26.5	37.9	46.7	71.5	81.4
16	Hemlock - 1	59.0	0.8	9.6	13.7	16.9	25.6	29.1
17	Hemlock - 2	10.4	0.5	6.5	9.4	11.6	18	20.5
18	Hemlock - 3*	35.5	1.7	22	31.5	38.9	59.5	67.7
19	Hemlock - 4*	31.3	0.7	13.3	19.4	24.3	37.9	43.4
20	Hemlock - 5*	45.0	0.6	12.5	18.4	23.1	36.6	42.1
21	Hemlock - 6*	18.0	0.8	19.8	29.5	37.1	59	67.9
22	Hemlock - 7**	77.0	1.1	28.9	43.1	54.5	86.8	100.2
23	Hemlock - 8	25.5	1	36.5	55.5	71.4	117.5	136.6



Path: \\vhb\gis\proj\SPortland\55350.09 ACAD Grt Meadow Drainage\Project\Great Meadow 2023

Source: Maine.gov, USGS

- Cromwell Downstream Model
- Great Meadow Model
- 2D Boundary Conditions
- 2D Computational Mesh
- Internal 2D Connections
- 2 Foot Contours