MUNICIPALITY OF EAST HANTS

Barneys Brook Flood Risk Study

FINAL REPORT

May 2026 – 25-2325

DILLON CONSULTING

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May 6, 2026

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Attention: Jared Mullet, P.Eng.
Project Engineer

RE: RFP50829 Barneys Brook Flood Risk Study

Dillon Consulting Limited (Dillon) is pleased to present the following report as part of the Barneys Brook Flood Risk Study. Enclosed in this submission is the final report, along with a map package and geodatabase including the hydraulic structure data and topographic data.

The attached report outlines the methodology and results used to develop the flood line maps for the Barneys Brook Watershed located in East Hants, Nova Scotia. Flood control recommendations are detailed in this study. The work has been largely completed in accordance with the *Nova Scotia Municipal Flood Line Mapping Technical Specifications*. Deviations from these specifications, and areas where we have applied professional judgment to address the unique characteristics of this watershed, have been noted and described in the report.

DILLON CONSULTING LIMITED

Jeff Melanson, P.Eng.
Project Manager, Partner

Vinay Dansinghani, EIT
Project Coordinator

Our file: 25-2325

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Executive Summary

Dillon Consulting Limited (Dillon) was engaged by the Municipality of East Hants (The Municipality) to perform a hydrologic and hydraulic assessment for Barneys Brook in Lantz, Nova Scotia. Supported by the Flood Risk Infrastructure Investment Program (FRIIP), this study aims to map flood extents, identify flood risk zones, and evaluate the condition and capacity of existing culverts to enhance community resilience against climate change.

Study Area and Data Collection
The study area spans approximately 8.5 km from the intersection of Barneys Brook and Nova Scotia Trunk 14 to its confluence with the Shubenacadie River. The assessment relied on high-resolution topographic data, specifically a 1-metre resolution provincial LiDAR Digital Elevation Model (DEM), which was validated through over 500 field-collected ground-truth sample points. A comprehensive field program was also conducted to survey eight key hydraulic structures (1 bridge and 7 culverts) along the study extent.

Modelling and Analysis
A hydrologic model was developed using HEC-HMS software to simulate peak flows for the 1-in-20-year (5% AEP) and 1-in-100-year (1% AEP) events for both existing and 2100 climate conditions.

Hydraulic modelling was performed using HEC-RAS (1-D) to simulate water surface profiles based on these design flows. Boundary conditions at the outlet were governed by the Shubenacadie River's hydraulic state, utilizing data from previously completed regional flood line mapping studies.

Key Findings and Inundation Behaviour
The study identified four primary areas of significant flooding and infrastructure risk:
1. The east side of Highway 102 towards the northern end of the watershed;
2. Highway 2 near Robert Scott Drive;
3. Highway 2 between Barneys Lane and Myers Lane; and
4. The outlet of Barneys Brook at the CN Railway.

Conceptual Mitigation and Next Steps
Preliminary mitigation strategies under consideration include:
1. Infrastructure upgrades (DCS001, DCS005, and DCS007);
2. Debris Cleanup and Channel Maintenance; and
3. Engagement with Infrastructure Owners.

To move toward long-term flood risk reduction, the Municipality should pursue a multi-phased implementation plan. Recommended immediate priority should be given to the detailed design and permitting of the DCS007 (CN Railway) crossing upgrade, as it represents a primary hydraulic bottleneck.

Simultaneously, the Municipality could establish a recurring maintenance program for debris removal and channel clearing to preserve hydraulic capacity. These proactive measures, combined with ongoing engagement with provincial and federal partners for funding, are expected to enhance community safety and protect critical infrastructure assets from the escalating risks of climate change.

1.0 Introduction

The Municipality of East Hants (the Municipality) retained Dillon Consulting Limited (Dillon) to complete a hydrologic and hydraulic assessment of a defined study area along Barneys Brook. Information regarding the methodology, analysis, recommendations, and flood line mapping for the watershed is provided in this document.

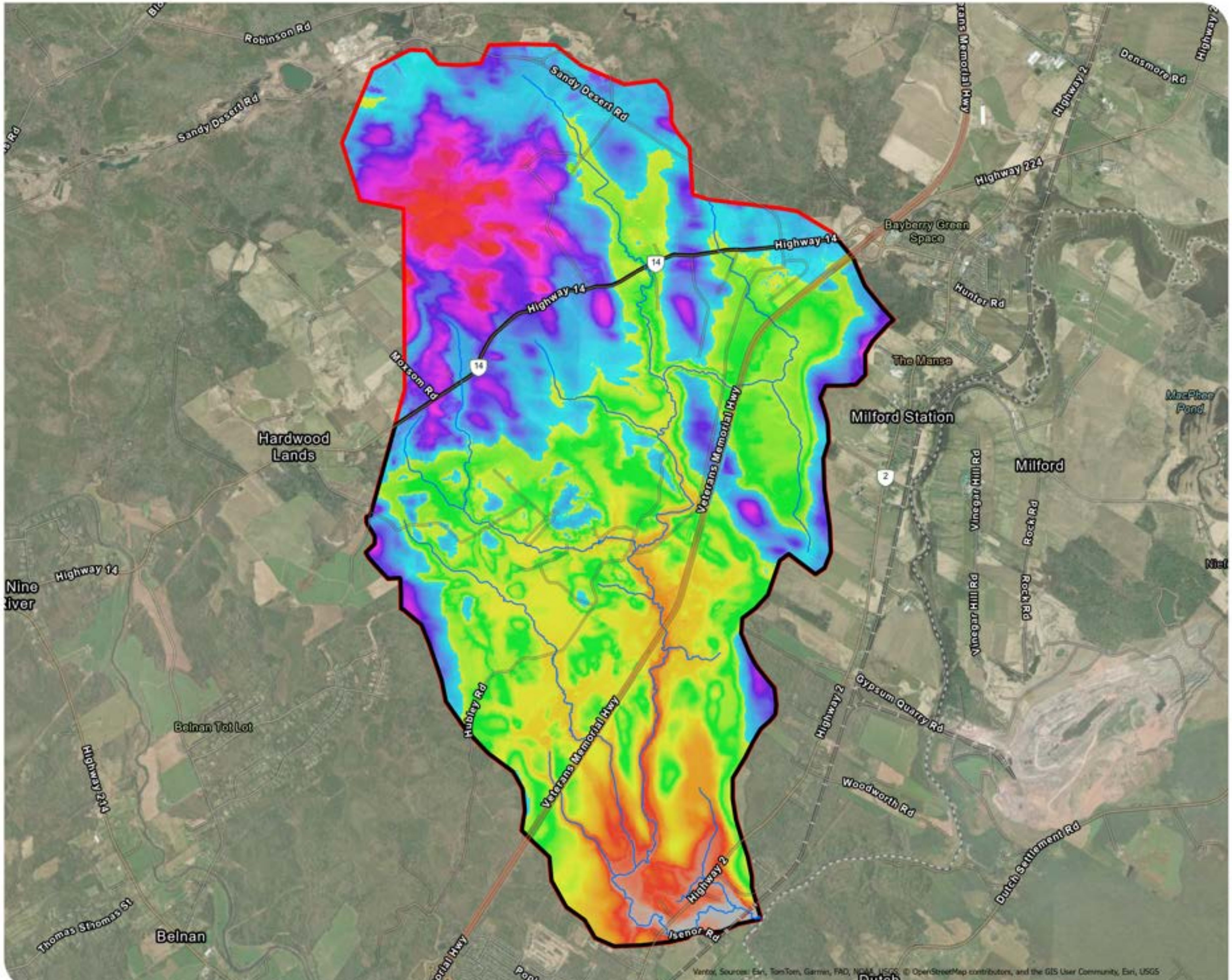
Primary project objectives include:

- Assessment of flood extents for the 1% and 5% Annual Exceedance Probability (AEP) events;
- Identification of hydraulic restrictions within the study area; and
- Development of recommendations for flood mitigation.

This study is part of a series of initiatives the Municipality is undertaking to help its communities prepare for the effects of climate change. The project is supported by provincial funding from the Flood Risk Infrastructure Investment Program (FRIIP).

1.1 Study Area

The defined study area, presented in **Figure 1**, extends from the intersection of Barneys Brook and Nova Scotia Trunk 14 to the confluence of Barneys Brook with the Shubenacadie River. The reach length is approximately 8.5 km in length. Based on the site's location, approximately 40km upstream of the Bay of Fundy, this river system is not believed to be tidally influenced.



EAST HANTS

BARNEYS BROOK FLOOD RISK ASSESSMENT

SITE OVERVIEW

FIGURE 1

- Barneys Brook Reaches - Province of Nova Scotia
- RFP Study Area
- Barneys Brook Watershed - Province of Nova Scotia

Barneys Brook Watershed (Provincial DEM)

68.7004

5.95

SCALE 1:36,000

0 0.38 0.75 1.5 Km

MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova, Esri & Dillon Consulting Ltd.

MAP CREATED BY: CHM
MAP CHECKED BY: VD
MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

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PROJECT: 25-2325
STATUS: FINAL
DATE: 2026-05-04

FILE LOCATION: K:\GIS\2025\252325\Product\Client\BB_Flood_Risk_Assessment\BB_Flood_Risk_Assessment.aprx; LAYOUT: Fig1 - Site Overview

2.0 Data Collection

A review of background documents and geospatial data was completed to build the foundation for the hydrologic and hydraulic modelling of the Barneys Brook study area. Data was compiled from municipal and provincial sources to develop an understanding of the study area. These include:

- **Client-Provided Information:** The Municipality of East Hants provided several background documents as part of the Request for Proposals (RFP) phase, including municipal standards and historical context. Furthermore, the RFP included an extensive log of photographs documenting the existing conditions along Barneys Brook, which highlighted areas of concern such as debris dams, as well as the conditions of various bridge and culvert crossings.
- **Provincial Topographic Data:** A 1-metre resolution topographic Light Detection and Ranging (LiDAR) Digital Elevation Model (DEM), sourced from the Province of Nova Scotia (GeoNova), was utilized. This high-resolution DEM served as the primary basis for processing the terrain surface, delineating subcatchments, and extracting geometric cross-sections for the hydraulic model.
- **Provincial Watershed Database:** The provincial watershed database was used to categorize and verify the watershed boundaries (Province of Nova Scotia, 2021). The watershed boundary found through this source was the Barneys Brook watershed (1DG-1-L).
- **Provincial Bridge and Culvert Database:** Hydraulic structure data was queried from the Nova Scotia Department of Public Works (NS DPW) bridge and culvert database (Province of Nova Scotia, 2023). This provided tabulated background data for relevant hydraulic structures, including structure types. Based on this review, no topographic or geometric data for structures in the study area was identified.
- **Soil Landscapes of Canada:** Soil data from the Soil Landscapes of Canada (Soil Landscapes of Canada Working Group, 2010) were used to characterize the study site's soil. These parameters were implemented in the Green and Ampt infiltration method to model infiltration in the hydrologic model.

2.1 Historical Flooding

Historical records and anecdotal evidence indicate that Barneys Brook is prone to overland flooding during high-intensity meteorological events. Photos and statements provided to the client by residents of the community suggest that Barneys Brook has inundated the transportation corridor at the crossing of Highway 2 and Barneys Brook (**Figure 2**) during historical storm events.

A notable instance occurred during a regional storm event in July 2023, which serves as a critical historical benchmark for this study. During this event, precipitation depths reached approximately 250 mm.

The following observations from residents of the community were collected and shared with Dillon by the Municipality regarding the performance of the system during this event:

- **Infrastructure Overtopping:** The bridge structure located at the crossing of Highway 2 and Barneys Brook, was completely overtopped as the water surface elevation exceeded the low chord of the bridge deck.
- **Transportation Disruption:** The resulting inundation rendered a section of Highway 2 impassable, creating a significant barrier to local traffic and emergency services.

This historical event underscores the necessity for the current hydraulic assessment, as the simulated 1% AEP (1:100 year) projects peak flows that could result in similar or greater inundation extents. The modeling process incorporates these high-water markers to provide a historic representation of the system's response to intense storm events.

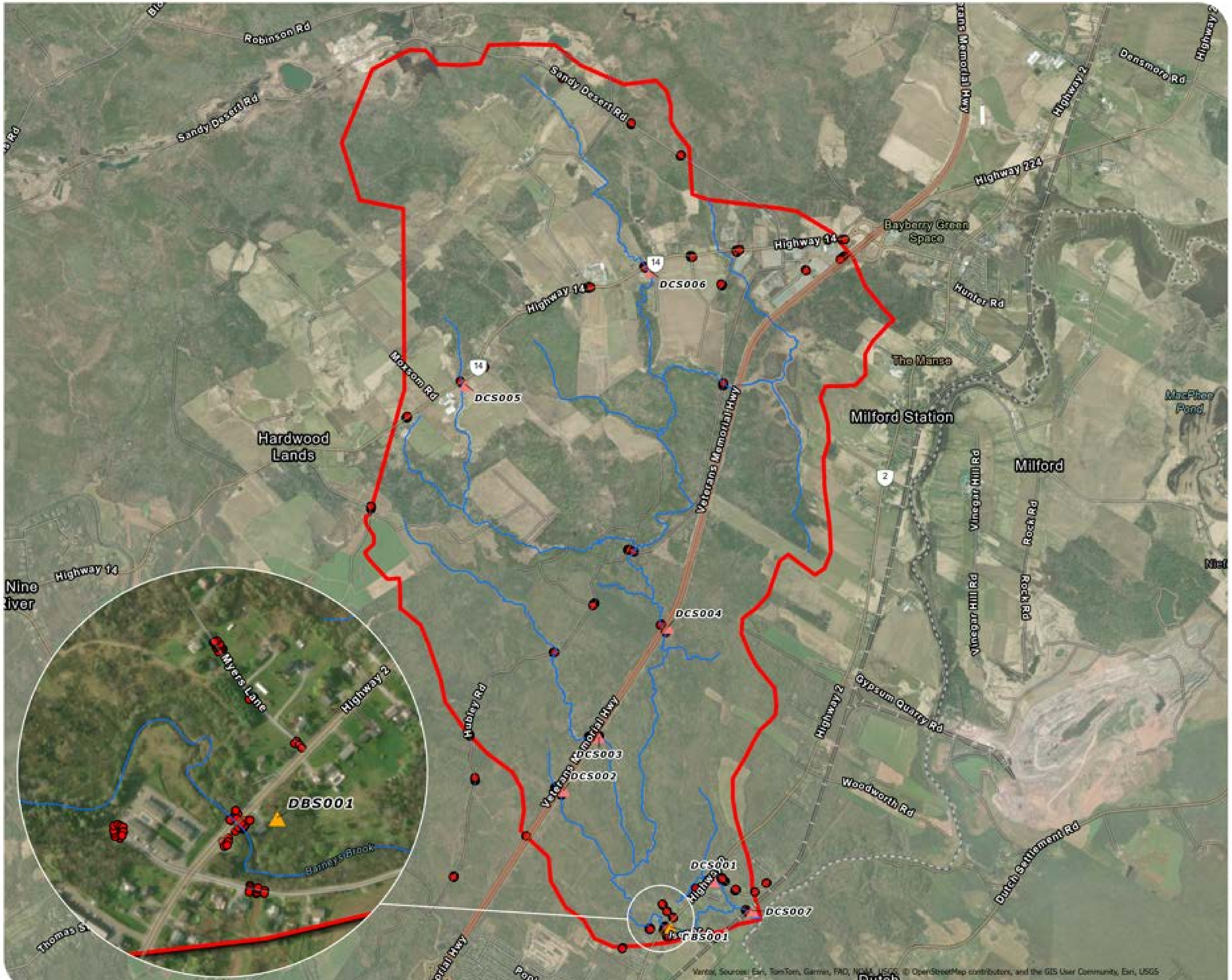
Figure 2: Highway 2 Crossing Over Barneys Brook – 2023-07-22 (Client Provided)

2.2 Site Survey

A field program was conducted to gather the data required to carry out the hydraulic and hydrologic assessment. A high-precision Trimble R10 Global Positioning System (GPS) unit, connected to Cannet's active control network, provided horizontal and vertical positional data. These surveys were undertaken with an approximate vertical and horizontal accuracy of ±50 mm.

Over 500 ground-truth sample points distributed evenly across the study area were collected to verify the vertical accuracy of the LiDAR data provided by the Municipality. A variety of land cover types and terrain features were captured to better evaluate the quality of the LiDAR data. Additionally, eight (8) hydraulic structure surveys were completed along the Barneys Brook study reach.

A table summarizing the surveyed hydraulic structures is provided in **Appendix A**. An overview figure with these culvert locations, along with the topographic points collected, is shown in **Figure 3** below.



EAST HANTS

BARNEYS BROOK FLOOD RISK ASSESSMENT

DATA COLLECTION OVERVIEW

Figure 3

- Bridge
- Culvert
- All Topographic Points Collected
- Barneys Brook Reaches - Province of Nova Scotia
- Barneys Brook Watershed - Province of Nova Scotia

SCALE 1:36,000

0 0.38 0.75 1.5 Km

MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova, Esri & Dillon Consulting Ltd.

MAP CREATED BY: CHM
MAP CHECKED BY: VD
MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

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STATUS: FINAL
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FILE LOCATION: K:\GIS\2025\252325\Product\Client\BB_Flood_Risk_Assessment\BB_Flood_Risk_Assessment.aprx; LAYOUT: Fig2 - Data Collection overview

General condition assessments for the eight hydraulic structures were conducted during the field program. The physical state of these structures was summarized using the Nova Scotia Department of Municipal Affairs Asset Management Data Collection Standard Operating Procedure. Technical notes, photographs, and survey data are provided in **Appendix A**. Notable observations include:

- DCS001 (900mm Corrugated Steel Pipe) – Poor condition with approximately 10% of the culvert being blocked.
- DCS002 (1,500 mm Concrete Culvert) – Upstream debris on the downstream side of the structure appear to raise water levels causing the culvert to be mostly blocked.
- DCS006 (Twin 1,800 mm Concrete Culverts) – Downstream side was approximately 50% blocked.

The existing condition of these structures may have the potential to contribute to upstream ponding as blockages and poor structure conditions may lead to ineffective flow conveyance.

2.3 Provincial LiDAR Accuracy

As previously noted, Dillon collected topographic points at several locations throughout the project area to compare against the publicly available provincial LiDAR DEM and comment on its suitability for use in developing the flood maps. A comparison of elevation differences is presented in **Figure 4**, and summary statistics are presented in **Table 1**.

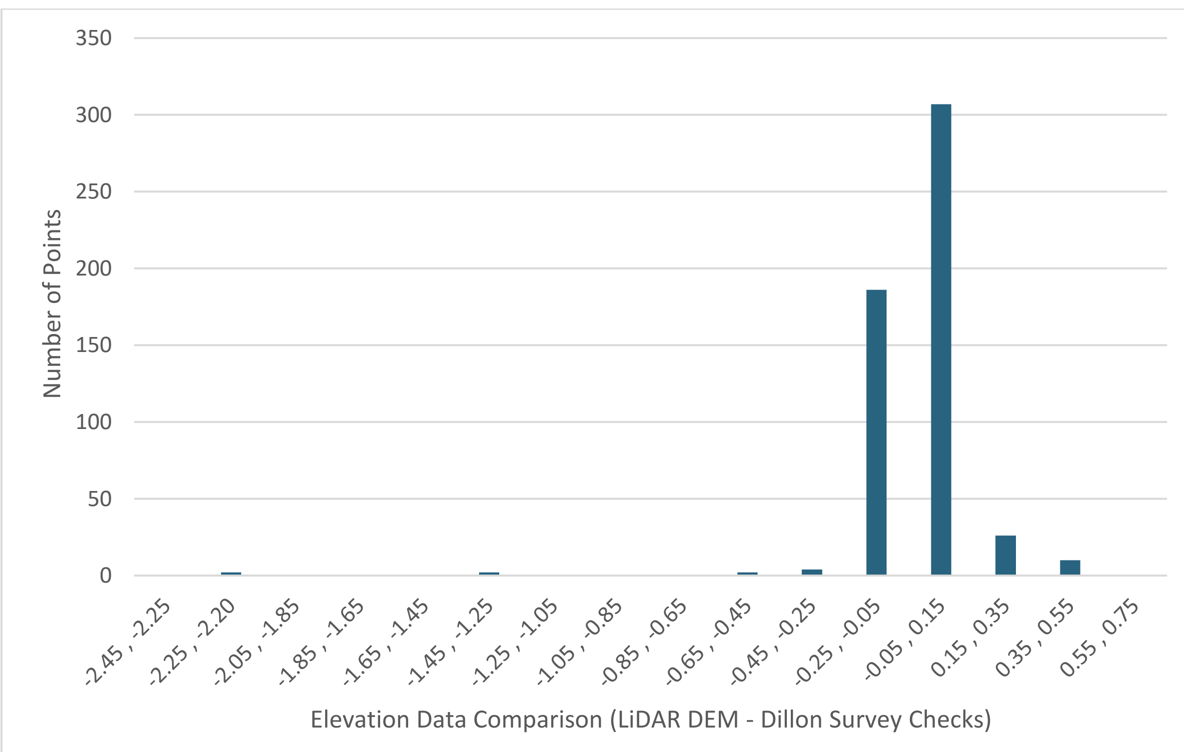


Figure 4: LiDAR DEM Against Dillon Topographic Points

Table 1: Summary Statistics – Survey Against LiDAR

	Elevation Difference (LiDAR - Dillon Survey Checks (m))
Maximum	0.530
Median	-0.028
Mean	-0.037
Minimum	-2.228

Based on the above results, the provincial LiDAR DEM is considered acceptable for the purposes of flood mapping. Most of the field-collected points were within 200mm of the provincial dataset, and the calculated median and mean both shows less than 0.05m difference between the 1m provincial DEM and the collected survey points. The largest discrepancies were noticed along Hubley Drive, in the eastern side of the watershed, where elevation differences range from 1.3 to 2.3m. These differences were adjusted based on the field survey in the DEM used in the hydraulic model for floodline mapping.

3.0 Hydrologic Analysis

Current industry standards and watershed considerations led to the use of the United States Army Corps of Engineers Hydrologic Engineering Center's Hydrological Modelling System (HEC-HMS). This program offers robust snowmelt subroutines, event-based rainfall capabilities, and a graphical user interface. The model structure within the package is divided into precipitation, rainfall loss, direct runoff, base flow, and reach and reservoir routing.

Details regarding model development, including watershed delineation, land use classification, and soil parameterization, are provided in the following subsections. Documentation regarding precipitation analysis and the integration of climate change projections is also included. Furthermore, results from the flood frequency analysis and hydrologic simulations are presented.

3.1 Model Development

The development of the Barneys Brook hydrologic model followed a multi-stage geospatial workflow. Land use and soil datasets were spatially distributed to represent the physical properties across the subbasins. The resulting geometries and parameters were then imported into HEC-HMS to simulate the hydrologic response of the Barneys Brook system. The HEC-HMS model was configured using the following methods:

- Surface Method: Simple Surface;
- Loss Method: Green and Ampt;
- Transform Method: SCS Unit Hydrograph;
- Baseflow Method: Recession; and
- Routing Method: Muskingum-Cunge.

Synthetic precipitation events were developed to simulate both existing and future (year 2100) flood conditions. The alternating block method was chosen to generate design storms for the events described in **Table 2** below.

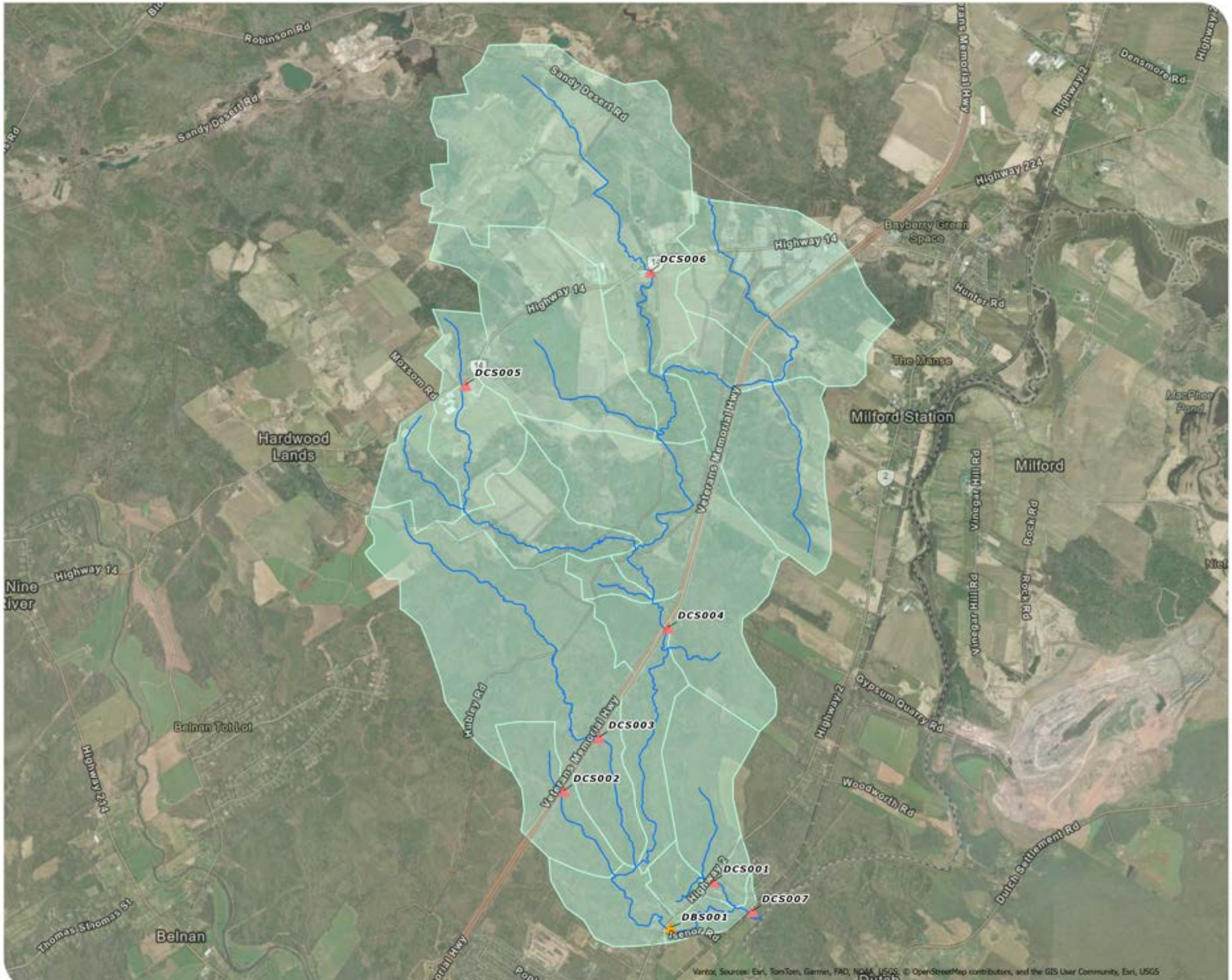
Table 2: Flood Mapping Scenarios

(AEP)	Description	Climate Scenario
5%	5% chance of occurrence in any given year. Also known as the '1-in-20-year return period.'	Existing
		2100
1%	1% chance of occurrence in any given year. Also known as the '1-in-100-year return period.'	Existing
		2100

3.1.1 Watershed Delineation

To better characterize localized hydrologic conditions, the watershed was partitioned into subbasins. Subbasins were delineated from surveyed hydraulic structures, and key tributary confluences were identified using the Nova Scotia Topographical Database (NSTDB) Water Feature Layer (GeoNova, 2025).

The delineated watershed configuration, including subbasins and surveyed structures, is illustrated below in **Figure 5**. Based on the watershed delineation, the Barneys Brook watershed has an area of 26.6km^2.



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BARNEYS BROOK FLOOD RISK ASSESSMENT

STUDY AREA SUBBASINS

Figure 5

- Bridge
- Culvert
- Barneys Brook Reaches - Province of Nova Scotia
- Subbasins

SCALE 1:36,000

0 0.38 0.75 1.5 Km

MAP DRAWING INFORMATION:
DATA PROVIDED BY GeoNova, Esri & Dillon Consulting Ltd.

MAP CREATED BY: CHM
MAP CHECKED BY: VD
MAP PROJECTION: NAD 1983 CSRS UTM Zone 20N

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PROJECT: 25-2325
STATUS: FINAL
DATE: 2026-05-04

FILE LOCATION: K:\GIS\2025\252325\Product\Client\BB_Flood_Risk_Assessment\BB_Flood_Risk_Assessment.aprx; LAYOUT: Fig4 - Subbasins

3.1.2 Land Use

Land use within the Barneys Brook watershed is predominantly rural, with large tracts of forest and agricultural land in the north. Residential development is localized in the south of the watershed, while industrial properties are situated in the northeast. Highway 14, Highway 102, and Highway 2 all represents a significant impervious feature, spanning the watershed from southwest to northeast. The estimated percentage coverage for each land-use type is summarized in **Table 3**.

Table 3: Land-Use Summary

Land-Use Type	Percent Coverage
Dense Forest	50.8%
Grass	29.9%
Gravel	0.4%
Heavy Brush	0.0%
Light Forest	2.8%
Low Density Development	3.1%
Medium Density Forest	6.3%
Road	3.5%
Rocky Outcrop	0.0%
Water	0.2%
Wetland	3.0%

3.1.3 Soils

Soil layers available from the province (Soil Landscapes of Canada Working Group, 2010) were spatially weighted to find parameters for the Green and Ampt loss method, such as hydraulic conductivity, saturated content, and suction. The soils within the Barneys Brook watershed are primarily loam and exhibit the soil characteristics as shown in **Table 4**.

Table 4: Soil Properties

Loss Method: Green and Ampt			
Conductivity (mm/hr)	Suction (mm)	Porosity	Initial Deficit[1]
3.3	88.9	4.6E-1	4.6E-3

[1]*An initial deficit of 1% was chosen to simulate saturated antecedent moisture conditions to provide conservative results*

3.1.4 Precipitation

The Halifax International Airport Environment and Climate Change Canada (ECCC) climate station (ID: 8202249/8202250/8202251) was identified as the closest climate station to the study site with recent data. Data from this station was used to develop the design storms and simulate historical events on the hydrological model. Station details are included in **Table 5**.

Table 5: Climate Station Summary

ID	Station Name	Interval	Start	End	Elev (m)	Lat.	Lon.	Distance to Outlet (km)
8202249/ 8202250/ 8202251	Halifax Intl A	Daily/Hourly	1953	2026	145	44.88	-63.51	12.8

Rainfall intensity duration frequency (IDF) statistics from ECCC were used to calculate the 24-hour and 48-hour rainfall depths, provided in **Table 6**.

Table 6: IDF Rainfall Depths for the Halifax International Airport ECCC Climate Station

AEP (%)	Halifax Intl A (8202251) 24-hour Rainfall Depth (mm)	Halifax Intl A (8202251) 48-hour Rainfall Depth (mm)
50	71.66	105.13
20	88.78	131.48
10	102.53	148.66
5	117.88	165.18
2	141.46	186.70
1	162.35	201.79

As per the *Nova Scotia Municipal Flood Line Mapping Technical Specifications (GNS, 2024)*, the Alternating Block (Chow et al., 1988) method was applied to distribute rainfall over a 48-hour period. The Alternating Block method follows a “nested” storm distribution in which any shorter duration depths are “embedded” within the design storm duration, with the maximum depth increment being placed at the intended peak intensity position. ECCC statistics and the IDF-CC tool only show up to a 24-hour rainfall duration; however, the interpolation equations provided were used to estimate the 48-hour rainfall depth. The Alternating Block method was then used to distribute the 48-hour rainfall depth across the storm duration. An example of the 100-year historical Alternating Block 48-hour rainfall event (201.79 mm) is presented in **Figure 6**.

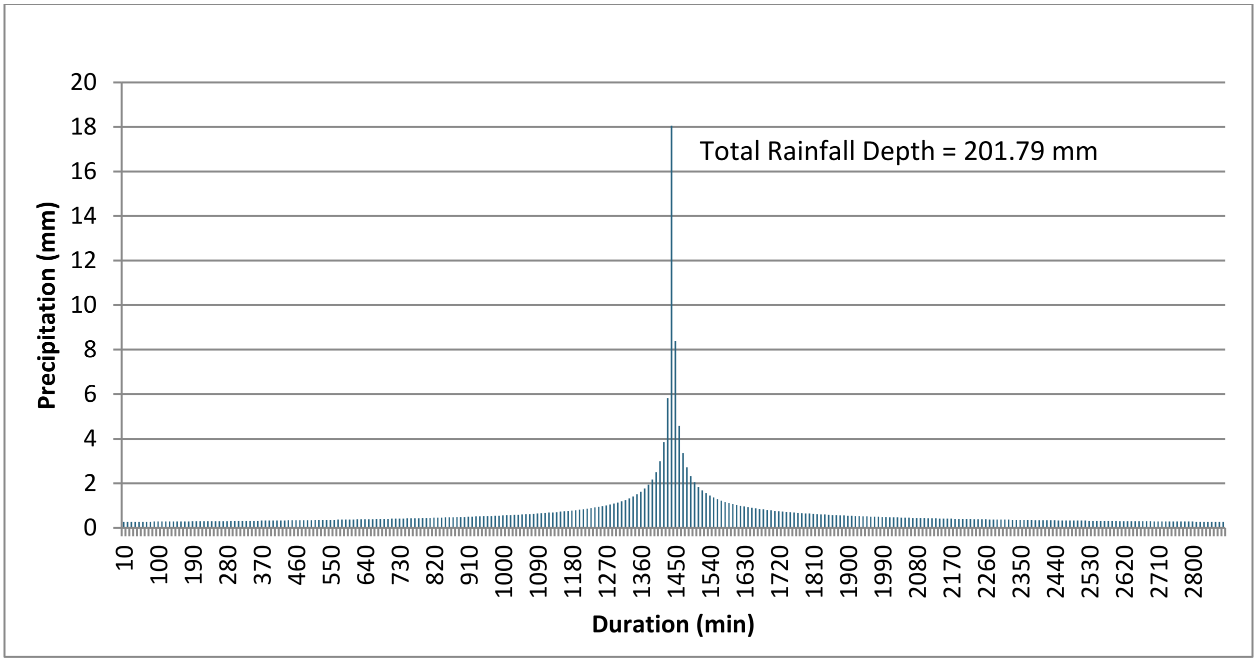


Figure 6: 100-year Historical Alternating Block 48-Hour Rainfall Distribution at the Halifax Intl A (8202251) Climate Station

3.1.5 Climate Change Impacts

Climate change is expected to increase high-intensity precipitation within the study area. In accordance with the *Nova Scotia Municipal Flood Line Mapping Technical Specifications (GNS, 2024)*, two methods have been used to estimate projected future IDF statistics for the study watershed as outlined below:

1. The Clausius-Clapeyron Scaling Method, in which a scaling factor of 7% per 1-degree Celsius rise in temperature was used to scale historical IDF relationships.
2. The IDF CC Tool developed and maintained by the University of Western Ontario (Simonovic et al., 2015), in which the complete “Bias Corrected Ensemble” was used when generating future IDF relationships.

As required in the *Nova Scotia Municipal Flood Line Mapping Technical Specifications* (GNS, 2024) and the East Hants Municipal Standards (East Hants, 2025), the Representative Concentration Pathways (RCP) and Shared Socioeconomic Pathways (SSP) high emission scenario (8.5) values were used to support this study. RCP and SSP are two distinct, but interconnected frameworks used in climate change research to explore and understand future scenarios of greenhouse gas emissions and associated climate impacts. The SSP-8.5 scenario still represents the highest emissions condition and has been used in this assessment. The results of this analysis for the projected future 2100 24-hour winter precipitation depth are presented in **Table 7**. The projected 24-hour rainfall depths were adjusted to represent a 48-hour storm using the Alternating Block (Chow et al., 1988) method; projected future 48-hour rainfall depths are included in **Table 8**.

Table 7: CC-Scaling Method vs. IDF CC Tool Climate Change Projections: 24-hour Precipitation

AEP (%)	Historical 24-hour Rainfall Depth (mm)	C-C Scaling Method Projected Future 2100 24-hour Rainfall Depth (mm)	IDFCC Tool Projected Future 2100 SSP 8.5 24-hour Rainfall Depth (mm)
Halifax Intl A Climate Station (8202251)			
5	115.04	171.72	137.55
1	140.78	210.15	164.62

Table 8: CC-Scaling Method vs. IDF CC Tool Climate Change Projections: 48-hour Precipitation

AEP (%)	Historical 48-hour Rainfall Depth (mm)	C-C Scaling Method Projected Future 2100 48-hour Rainfall Depth (mm)	IDFCC Tool Projected Future 2100 SSP 8.5 48-hour Rainfall Depth (mm)
Halifax Intl A Climate Station (8202251)			
5	165.18	246.58	197.43
1	201.79	301.22	237.01

Based on this analysis, the two methods are in close agreement with the CC Scaling Method values as more conservative. This aligns well with the Municipalities Standards, which are in accordance with the CSA W231 standards, that recognizes the CC Scaling Method.

3.2 Flood Frequency Analysis

In the absence of a dedicated hydrometric gauge on Barneys Brook, a Flood Frequency Analysis (FFA) was performed on a nearby ECCC hydrometric station with similar land use and soil. The FFA results were scaled to the Barneys Brook watershed based on relative drainage areas. Details regarding the ECCC station are provided in **Table 9**.

Table 9: ECCC Hydrometric Station Used for FFA

ID	Station Name	Drainage Area (km^2)	Status	Start Year	End Year
01DG043	St Andrews River at Stewiacke	98.2	Active	2011	2023

Characteristics for the watershed of the ECCC station and the watershed of Barneys Brook are shown below in **Table 10**.

Table 10: Watershed Characteristics of Barneys Brook and St. Andrews River at Stewiacke

Watershed	Drainage Area (km^2)	Predominant Soil Type	Predominant Land Class	Average Slope	Imperviousness
St. Andrews River at Stewiacke	98.2	Loam (64.9%)	Dense Forest (77.5%)	6.18%	5.4%
Barneys Brook	26.6	Loam (100%)	Dense Forest (50.8%)	4.26%	12.0%

Annual instantaneous peak discharge data from the St. Andrews River at Stewiacke ECCC hydrometric station were used to estimate peak flow return periods. Eight statistical distributions were evaluated, including:

- GEV;
- Gumbel;
- Gamma;
- Log-Pearson III;
- Pearson Type III;
- Weibull;
- Log-Normal; and
- Normal.

The Log-Normal distribution demonstrated the lowest Root Mean Square Error (RMSE) and was selected as most fit for the analysis. The resulting FFA for the St. Andrews River at Stewiacke station (01DG043), along with the area-scaled results for Barneys Brook, are presented in **Table 11**.

Table 11: Scaled Flows at Barneys Brook

AEP (%)	Flows at St. Andrews River at Stewiacke (m^3/s)	Expected Flow at Barneys Brook (m^3/s)
20	71.5	19.3
10	91.9	24.8
5	113.0	30.6
2	142.7	38.6
1	166.7	45.1
0.5	192.2	52.0
Watershed Area (km^2)	98.2	26.6
Unit Runoff Rate ($m^3/s/km^2$)*	1.70	

**Calculated from the 1% AEP*

3.3 Model Results

The hydrologic model estimated larger peak flows than the peak flow values indicated from the FFA in **Table 12**. Final flow magnitudes along with the updated unit runoff rate are shown in **Table 12**.

Table 12: Modelled Flows at Barneys Brook

Scenario	Modelled Flow (m^3/s)	FFA Flow (m^3/s)	Percent Difference
Existing 1:20 year	33.7	30.6	9.20%
Existing 1:100 year	52.7	45.1	14.4%
2100 1:20 year	75.3	-	-
2100 1:100 year	105.3	-	-
Unit Runoff Rate ($m^3/s/km^2$)*	1.98	1.70	16.47%

**Calculated from the historical 1% AEP*

As shown in **Table 12**, higher peak flows were estimated by the hydrologic model as compared to the FFA. Larger watersheds typically exhibit greater attenuation capacity than smaller basins (more lakes, wetlands, etc.), which generally results in higher unit runoff rates for smaller watersheds. The area pro-rating method assumes a uniform unit runoff rate between the reference and target basins; hence, it may underestimate the peak response of a smaller watershed. Therefore, using a slightly higher unit runoff rate for Barneys Brook adds conservatism.

4.0 Hydraulic Assessment

This section describes the development and execution of the hydraulic model for the study area. Documentation regarding model selection, cross-section extraction, model parameterization, and boundary conditions are further explained in the following sections.

A primary consideration for the study area was the selection of a one- or two-dimensional (1-D or 2-D) simulation approaches. With respect to the Barneys Brook watershed, the size of the system, number of channel crossings, and limited bathymetric data, a HEC- RAS 1-D model was selected as the appropriate choice for this study.

HEC-RAS is a computer program designed to simulate steady and unsteady flow for a network of natural and constructed channels. The steady flow component uses the 1-D energy equation to calculate water surface profiles for steady, gradually varied flow using subcritical, supercritical, and mixed flow regimes. The steady flow component calculates flow stages, maintaining a constant peak discharge through the model. Energy losses are calculated using friction (Manning's equation) and contraction and expansion coefficients.

4.1 Model Development

The HEC-RAS model was developed to cover the entire flood mapping area. A description of the model development, key parameters, and assumptions is provided below.

4.1.1 Cross-Sections

Each river was input as a reach in the HEC-RAS model. Cross sections were created along each reach to capture the extent of flooding. Additional cross sections were added upstream and downstream of bridges and culverts, and as required along each reach. These cross sections serve as flow change locations, informing the model of where a notable change in the channel occurs (such as a bend in the river). The LiDAR DEM, supported by the field-collected survey points, were used for cross-section extraction and floodplain representation within the model.

4.1.2 Hydraulic Structure Information

Hydraulic structures can have a significant influence on upstream flood elevations and downstream flows. Data was collected for eight hydraulic structures (7 culverts and 1 bridge) and incorporated into the hydraulic model. Inverts, obverts, bank elevations, and river bed topography were input into the hydraulic model.

Simulated structure configurations in HEC-RAS were based on surveyed points; assumptions were made based on LiDAR data and visual inspection for structures where a survey was unable to be completed, and/or bridge design drawings were not available.

4.1.3 Hydraulic Roughness Parameters

Hydraulic roughness parameters were estimated to characterize resistance within the channel and floodplain areas. Manning's n values were estimated using satellite imagery for overbank characteristics, field survey photographic records, and available street view data. Roughness coefficients were assigned to represent variations in vegetation density and land use within the floodplain. Values were established according to industry references, including Open Channel Hydraulics (Chow, 1959). These parameters were evaluated and refined based on site observations to reflect specific channel conditions. **Table 13** summarizes the roughness values used in this study.

Table 13: Land Cover Types and Roughness Values

Floodplain Classification	Roughness Values
Pasture, no brush (short grass)	0.035
Pasture, no brush (high grass)	0.05
Scattered brush, heavy weeds	0.05
Light brush and trees	0.07
Wetland	0.024
Water	0.011
Roads/Built Up Areas	0.013

Expansion and contraction coefficients were based on the recommended values in the HEC-RAS hydraulic reference manual and summarized below in **Table 14** (USACE, 2016).

Table 14: Contraction and Expansion Coefficients

	Contraction	Expansion
No transition loss computed	0.0	0.0
Gradual transitions	0.1	0.3
Typical Bridge sections	0.3	0.5
Abrupt transitions	0.6	0.8

4.1.4 Peak Flow

Peak flows derived from the previously described hydrologic modelling were applied at the upstream boundary and at tributary junctions within the model domain. Constant discharge was maintained through modelled reaches, consistent with the steady-flow component of the HEC-RAS software.

4.1.5 Shubenacadie River Tailwater Condition

The outlet of Barneys Brook is directly influenced by the conditions experienced in the Shubenacadie River. Because the watercourse outlets into this larger water body, water surface elevations at the outlet are governed by the Shubenacadie River's hydraulic condition during extreme events. High water levels in the Shubenacadie River act as a tailwater constraint, which can create a backwater effect upstream into the Barneys Brook channel. This condition reduces the energy gradient of the brook, leading to localized increases in water surface elevations and reduced flow velocities near the outlet.

The Shubenacadie-Stewiacke primary watershed is the second largest in Nova Scotia, encompassing approximately 2,800 km^2. The substantial difference in drainage area between Barneys Brook and the Shubenacadie River results in a temporal offset of peak flow occurrences. Since the Shubenacadie River responds to regional precipitation over a longer duration, the peak discharge within Barneys Brook typically passes before the Shubenacadie River reaches its maximum stage. Due to this scale, there is a significant delay in the hydraulic response of the Shubenacadie River compared to the relatively rapid response of the smaller Barneys Brook.

To account for this timing offset, the downstream boundary condition was assigned as half the CN Railway culvert depth (9m CGVD2013). As the existing 1% AEP design storm water elevation for the Shubenacadie River results in a complete cover of this downstream culvert, this approach assumes that the peak flow from Barneys Brook occurs before the peak stage of the Shubenacadie River is reached.

5.0 Flood Mapping Results

Flood extents and limitations to the model results are detailed in the following section. The computed water surface elevations, energy grade lines, and velocity distributions from the HEC-RAS model for each simulated event were exported to ArcGIS for the development of flood depth grids and inundation mapping.

Inundation generally expands first within the immediate overbank adjacent to the channel (i.e. floodplain), then transitions to the broader floodplain where valley geometry widens, overbank conveyance increases, and/or hydraulic controls (culverts/bridge openings) induce backwater.

The appended flood maps (**Appendix B**) display the simulated extent of flooding under the above conditions for the 1% and 5% for both existing and climate change scenarios. Performance of eight hydraulic structures against the baseline 1% AEP scenario is illustrated through cross-sectional profiles in **Appendix C**.

5.1 Mapping Limitations

The primary limitation of this study is related to the limited sources for data collection, particularly bathymetric data. The available resources were prioritized to more accurately account for the 8 structures selected for this project, along with the topographic points surrounding those structures (channel bottom, banks, high water marks, etc.). The influence of the low-flow channel during extreme flood conditions in these areas is expected to be minor and result in more conservative floodplain mapping. Future studies would benefit from a more robust bathymetric survey to confirm riverbed geometry in such areas.

Furthermore, the hydraulic analysis relies on LiDAR datasets provided by the Province. While topographic sample points were captured to validate vertical accuracy, LiDAR data inherently possess limitations in penetrating dense vegetation or capturing underwater features. Consequently, modelled water surface elevations and resulting flood extents represent approximations based on the available terrain model.

Hydrologic inputs were derived using industry-standard methodology to generate runoff hydrographs. These simulations are based on historical rainfall IDF data and provincially accepted climate change projections. Actual meteorological events may deviate from these statistical distributions, and the response of the watershed is subject to land-use changes that were captured at the time of data acquisition.

The assessment of culvert capacity is based on 1D hydraulic modelling. This approach assumes steady or gradually varied flow and may not account for complex flow patterns, debris blockage, or sediment transport that can occur during high-flow events.

Lastly, the flood line maps provided in this study are intended for information and planning purposes and are not categorized as regulatory documents. These results are intended to guide preliminary assessments and do not replace detailed site-specific engineering evaluations.

5.2 Areas of Concern

Primary regions of concern were identified based on inundation behaviour and infrastructure vulnerability. Areas of concern and simulated flood elevations under the existing and projected 1% AEP scenarios are detailed below in **Table 15**.

Table 15: Elevation Differences Between Flood Scenarios at Select Locations

#	Location	Existing 1% AEP Elevation (m CGVD2013)	Climate Change 1% AEP Elevation (m CGVD2013)	Difference (m CGVD2013)
1	The outlet of Barneys Brook at the CN Railway	16.0	17.5	1.5
2	Highway 2 near Robert Scott Drive	15.6	17.5	1.7
3	Highway 2 between Barneys Lane and Myers Lane	15.5	17.5	2.0
4	Highway 102: The east side of Highway 102 towards the northern end of the watershed	23.0	25.0	2.0

Elevation differences between the existing and projected 1% AEP events range from 1.5-2.0m. Please note, this elevation difference is considered to be conservative based on the climate change scaling factors and is likely a significant driver for this elevation difference. Simulated flood extents in these regions are further described in the following sections.

5.2.1 The Outlet of Barneys Brook at the CN Railway

As noted in the modeling parameters, the initial stage of the Shubenacadie River was set at 9 m CGVD2013, which represents a partial submergence of the structure.

An investigation was conducted using the existing 5% AEP elevation of the Shubenacadie River at the Barneys Brook confluence, as simulated in the Minas Basin MFLM project (Dillon, 2023). This downstream boundary elevation was simulated as approximately 14 m CGVD2013, a level at which the Railway culvert (DCS007) is entirely submerged. The hydraulic model simulated extensive inundation extending from the CN Railway crossing upstream to Highway 2. As discussed in **Section 4.0**, due to the difference in watershed sizes, the original 9 m elevation was used instead. **Table 16** below highlights the elevation difference at the outlet of the system, based on the stage of the Shubenacadie River.

Table 16: Elevation Differences Based on Stage in Shubenacadie River

Stage in the Shubenacadie River (m CGVD2013)	Elevation at the Outlet of Barneys Brook (m CGVD2013)
9.00	15.60
14.00	16.92
Difference	**1.32**

Based on these findings, the stage in the Shubenacadie River have a significant impact on simulated flood elevation in the Barneys Brook. **Figure 7** and **Figure 8** below show the primary outlet of the Barneys Brook system, a railroad crossing with a 2,400mm circular steel culvert, during the existing 1% AEP event. This represents a significant bottleneck in the system.

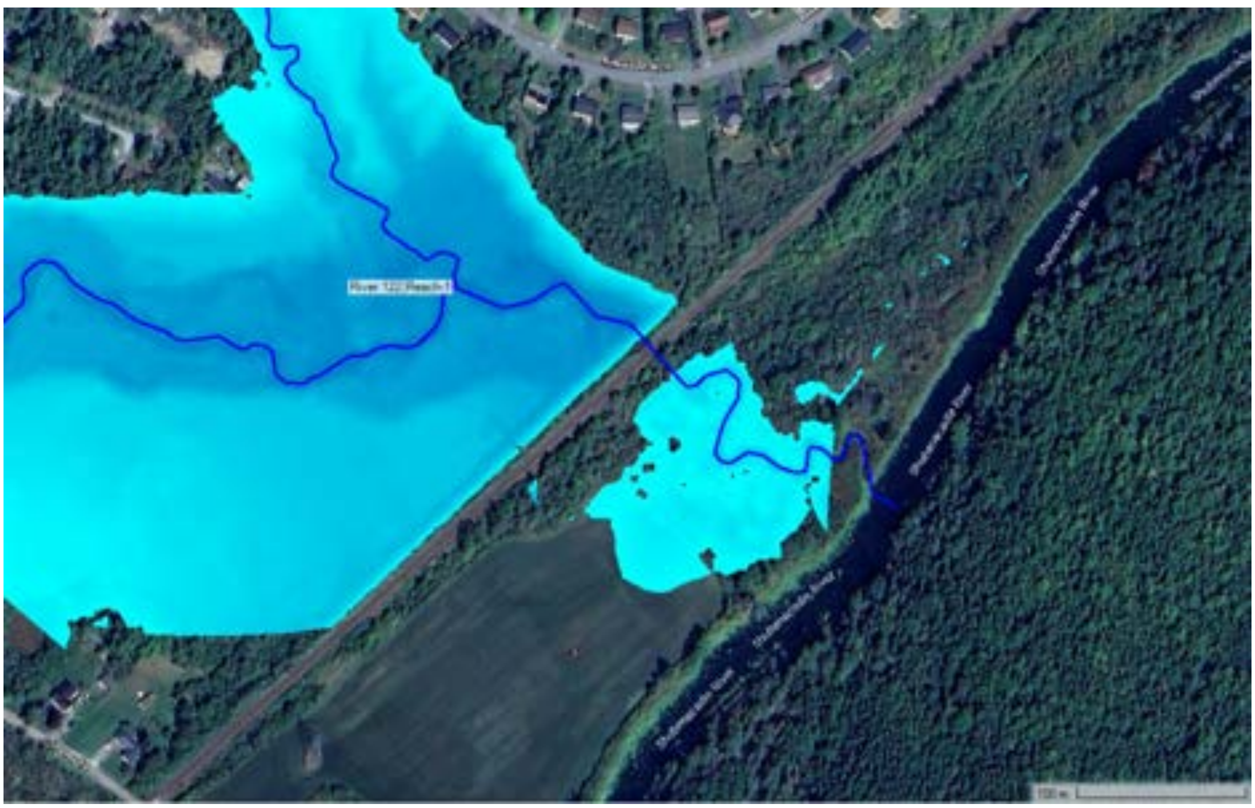


Figure 7: CN Railway at the outlet of the river – 1% AEP Existing

The 1% AEP water surface elevation is simulated to reach approximately 16 m during the existing 1% AEP event and approximately 17.5 m during the climate change 1% AEP event, and the railway has an elevation of approximately 19m CGVD2013. While the water surface elevation does not overtop the CN railway, the tailwater influence from the Shubenacadie River could exacerbate these effects. This can be prevalent in more intense and longer storm events. As stated above, this elevation difference is considered to be conservative.

Figure 8: CN Railway at the outlet of the river – 1% AEP Climate Change

Preliminary findings indicate upgrades to this structure will likely improve conveyance for the overall system, resulting in significantly lower flood extents.

5.2.2 Highway 2 near Robert Scott Drive

As seen in **Figure 9** and **Figure 10** below, model results show significant flooding occurring during the existing 1% AEP event near the intersection of Robert Scott Drive and Highway 2. The existing 900 mm and 1,200 mm circular culverts appear to be undersized based on the hydraulic analysis, resulting in significant ponding upstream and downstream of Highway 2. The simulated existing 1% AEP is estimated to affect 6 properties along Highway 2 (1450-1482 Highway2) along with 8 properties along Robert Scott Drive (2-16 Robert Scott Drive). This number is estimated to increase significantly under the climate change 1% AEP event.

Figure 9: Highway 2 near Robert Scott Drive - 1% AEP Existing

Figure 10: Highway 2 near Robert Scott Drive - 1% AEP 2100 Climate Change

**Please note while there is a gap in the model, this gap was compensated for in the mapping phase*

Resident statements indicate that during the high precipitation event that occurred in 2023, water levels within the Barneys Brook watershed overtopped its banks. This occurred along Highway 2, where a resident recorded a high-water mark of 16.49m CGVD2013 during a historical storm event, as seen in **Figure 9**. The simulated elevation during the 1% AEP existing was within 0.5m vertically (elevation of 13.99m CGVD2013) of this observed elevation, aligning well with the resident's noted flood depths.

This flood extent appears to be driven by the downstream bottleneck caused by the culvert under the CN Railway. As such, upgrades to DCS001 may not be effective unless the downstream CN Railway culvert is also upgraded. Upgrades to the CN Railway culvert should be prioritized as described in **Section 6.0**.

5.2.3 Highway 2 between Barneys Lane and Myers Lane

As seen in **Figure 11** and **Figure 12**, the Barneys Brook reach at the intersection of Highway 2 is inundated, aligning with the resident photos and statements. This represents a transportation bottleneck for residents on Highway 2, as this section of the Highway will be unpassable by car during these storm events. Along with this, during the project kickoff, Dillon was made aware of a lift station at this crossing. This piece of infrastructure can be considered at risk during these peak flood events.

Figure 11: Highway 2 between Barneys Lane and Myers Lane- 1% AEP Existing

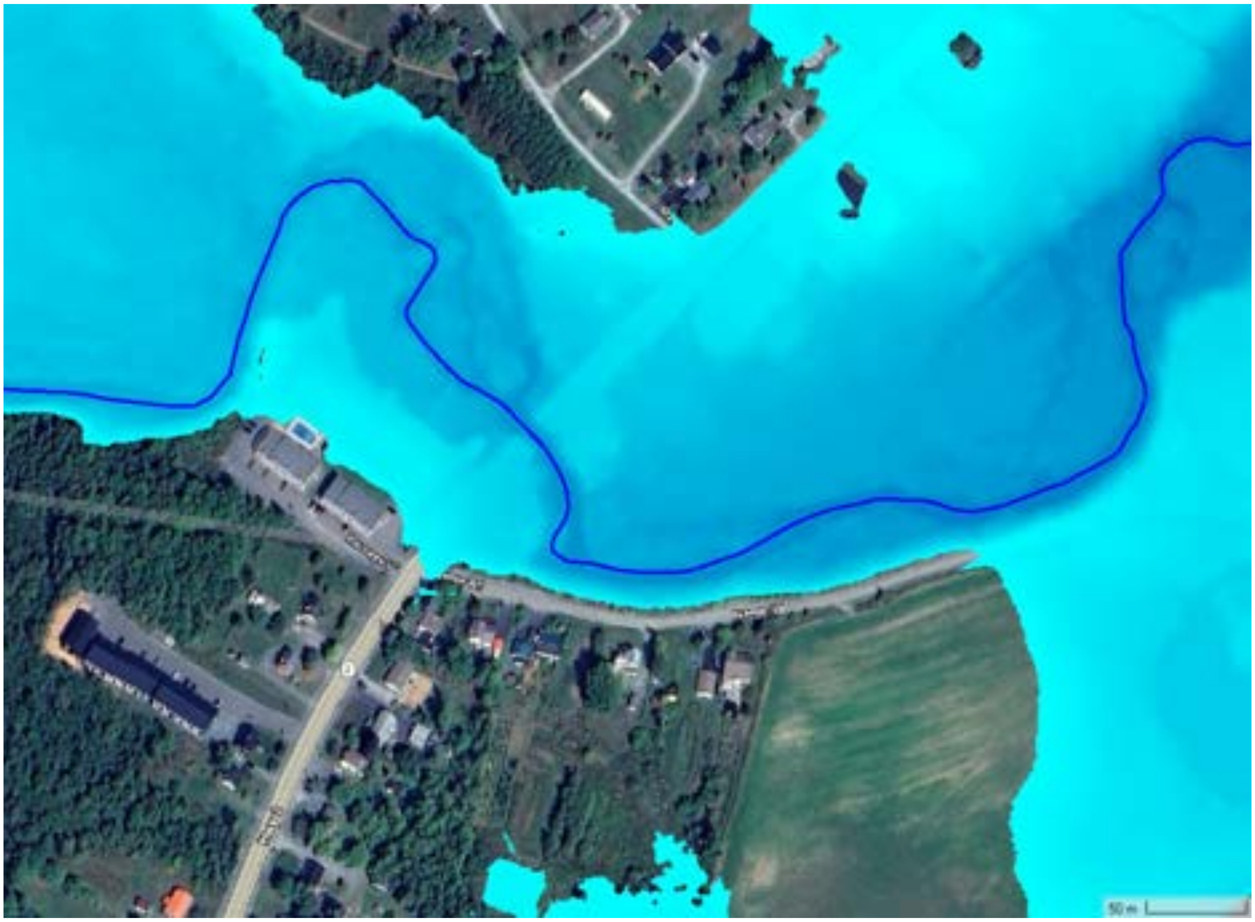


Figure 12: Highway 2 between Barneys Lane and Myers Lane- 1% AEP 2100 Climate Change

Similar to DCS001 (Highway 2 near Robert Scott Drive), upgrades to this structure may be ineffective due to the bottleneck caused by the CN Railway culvert. As such, upgrades to the CN Railway culvert should be prioritized as described in **Section 6.0**.

5.2.4 Highway 102

It is important to note flood extents may vary at this location as this structure was not included in the data collection phase. As illustrated in **Figure 13** and **Figure 14**, model results indicate inundation along the Barneys Brook reach in the forested region east of Highway 102 during the 1% AEP design event. This behaviour is likely attributed to a natural depression or ponded area on the western side of Highway 102 within the DEM that facilitates water storage during high-intensity discharge events. This assessment is supported by client-provided photos contained in the original request for proposal. Inundation extents in this region are considered approximations, as geometric data for natural features or unmapped structures in this upper reach were not gathered during the field program.

Figure 13: Highway 102 Flood Extent - 1% AEP Existing

Figure 14: Highway 102 Flood Extent - 1% AEP 2100 Climate Change

While the land use appears to be primarily agricultural, if future developments are planned in that area, flood mitigation will be required to allow the watercourse to convey this flow. Simulated flood extents did increase during the climate change event, however overtopping of Highway 102 is not expected.

6.0 Conceptual Mitigation Options

Based on the results and site assessments conducted for the Barneys Brook watershed, several conceptual mitigation strategies were evaluated and discussed with the Municipality. These are preliminary recommendations and require further refinement through detailed modelling and consultation with the Municipality during the detailed design stage.

Based on the flood scenarios, culverts located along the lower reaches of Barneys Brook impose hydraulic restrictions on conveyance. This results in elevated water levels, leading to key infrastructure and properties being affected. These structures include:

1. **DCS007** at the outlet of the system under the CN Railway;
2. **DCS001** at Highway 2 near Robert Scott Drive; and
3. **DBS001** at Highway 2 between Barneys Lane and Myers Lane.

Table 17 below summarizes potential conceptual infrastructure upgrades.

Table 17: Proposed Structure

Structure ID	Location	Existing Size and Material	Proposed Size and Material
DCS005*	Highway 14 near Moxsom Rd	900mm Concrete Circular Culvert	1,200mm Concrete Circular Culvert
DCS001	Highway 2 near Robert Scott Dr	A 900mm Steel Circular Culvert and a 1,500mm Concrete Circular Culvert.	2 x 2,400 Concrete Circular Culverts.
DCS007	Outlet of Barneys Brook	1 x 2,400 Corrugated Metal Semi-Circular Culvert	3 x 2,800mm Concrete Circular Culverts

**Existing infrastructure can be kept but upgrades can be considered as a proactive measure for projected design storms*

Further description of these recommendations is detailed below in the following section. Please note, each potential recommendation was evaluated one at a time. Additional evaluation of the identified mitigation strategies is suggested before advancing to the design stage. Furthermore, additional hydraulic modelling is encouraged to refine the proposed concepts based on decisions reached during the preliminary and detailed design phases.

6.1 Recommendation 1: DCS007 at the outlet of the system under the CN Railway

Our preliminary estimates indicate that a triple barrel 2,800mm circular concrete structure is recommended at this location. The transition from a single semi-circular opening to a triple-barrel system is proposed to provide a more distributed flow regime. Preliminary changes in flood extents for this option are seen below in **Table 18** and **Figure 15**.

Figure 15: Outlet of the system with triple barrel upgrade (existing condition left, proposed recommendations right)– 1% AEP (2100)

Table 18: Elevation Differences After Proposed Upgrades – DCS007

Structure ID	Location	Existing Size and Material	Proposed Recommendation	Existing Conditions Water Elevations – Climate Change (1% AEP)*	Proposed Upgrade Water Elevations – Climate Change (1% AEP)*	Elevation Difference*
DBS001	Highway 2 near Moxsom Rd	1 x 2,400 Corrugated Metal Semi-Circular Culvert at DCS007	3 x 2,800mm Concrete Circular Culverts at DCS007	17.5	14.4	3.1
DCS001	Highway 2 near Robert Scott Dr			17.5	15.2	2.3
DCS007	Outlet of Barneys Brook			17.5	14.5	3.0

**m CGVD2013*

DCS007 causes significant backup upstream of the river system, influencing the flood extents on Highway 2 at both DBS001 and DCS001. Improvements to this structure are estimated to significantly improve flood elevations and extents. This upgrade is a foundational step for the overall flood risk strategy of the watershed.

6.2 Recommendation #2: DCS001 Highway 2 near Robert Scott Drive

As seen in **Figure 16**, the stretch of roadway between Robert Scott Drive and Earls Court near the outlet of the system has a significant flood extent under the 2100 1% AEP climate scenario. DCS001 is influenced by the downstream bottleneck of DCS007, the CN Railway culvert. Infrastructure modifications to these culverts may not be effective if the existing CN Railway culvert is not upgraded.

Under the existing 1% AEP, these flosssod extents could be reduced through infrastructure modifications. Dillon proposes an upgrade to 2x 2,400mm concrete round culverts to better convey the flow from the upstream watersheds. **Table 19** and **Figure 16** below show the flood extent elevation difference from the existing 1% AEP storm event.

Figure 16: Highway 2 near Robert Scott Drive with twin 2,400mm upgrade (existing condition left, proposed recommendations right)– 1% AEP (Existing)

Table 19: Elevation Differences After Proposed Upgrades – DCS001

Structure ID	Location	Existing Size and Material	Proposed Recommendation	Existing Conditions Water Elevations – Existing (1% AEP)*	Proposed Upgrade Water Elevations – Existing (1% AEP)*	Elevation Difference*
DCS001	Highway 2 near Robert Scott Drive	A 900mm Steel Circular Culvert and a 1,500mm Concrete Circular Culvert.	Twin 2,400mm Circular Concrete Culvert	15.86	15.63	0.23

**m CGVD2013*

While the flood extent is reduced with the proposed upgrade, there is still upstream ponding near houses directly upstream of the structure. The simulated existing 1% AEP is estimated to affect 4 properties along Highway 2, reducing the affected properties from 6. This highlights the importance of upgrading the CN Railway culvert as the primary flood reduction recommendation for the most effective downstream impact.

6.3 Recommendation #3: DCS005 at Highway 14 near Moxsom Road

Simulated results from the climate change 1% AEP event indicate DCS005 under Highway 14 results in significant upstream flooding, indicating the existing 900mm concrete culvert does not have the capacity to convey the projected discharge expected in the river. While the water elevation does not overtop the road, the freeboard between the structure and the roadway does decrease under these significant rainfall events. While not an immediate priority, if development is planned for this area, upgrades to this structure should be considered.

To better convey this flow, a 1,200mm circular concrete culvert is recommended as a preliminary flood mitigation recommendation. The estimated change in flood extent difference is seen in **Table 20** and **Figure 17** below.

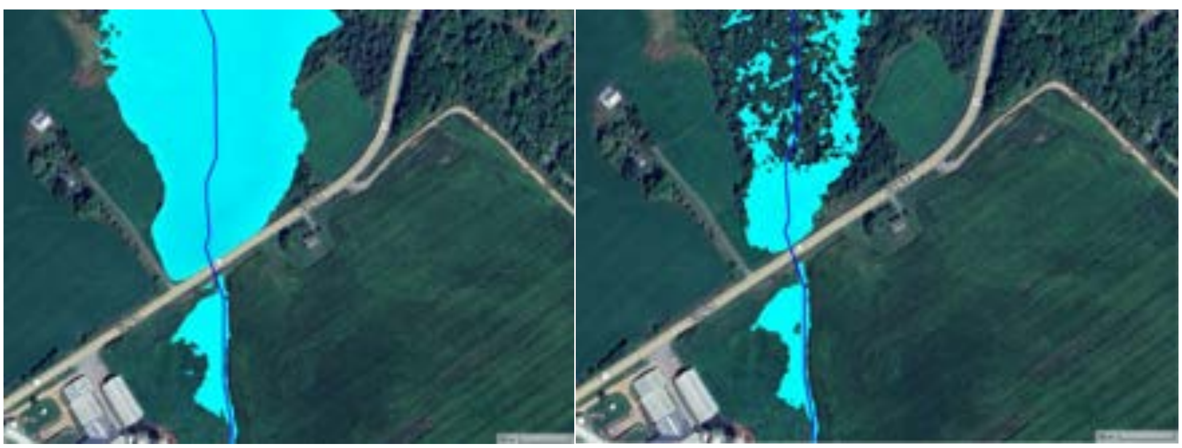


Figure 17: Highway 1 near Moxsom Road with 1,200mm upgrade (existing condition left, proposed recommendations right)– 1% AEP (2100)

This upgrade reduces the flood extent of the 2100 1% AEP, along with reducing the water surface elevation against the culvert to approximately 1.3m below the current elevation under the same design storm event. While the model does not simulate overtopping of the roadway, this proposed upgrade may support proactive measures the Municipality can take to reduce flooding.

Table 20: Elevation Differences After Proposed Upgrades – DCS005

Structure ID	Location	Existing Size and Material	Proposed Recommendation	Existing Conditions Water Elevations – Climate Change (1% AEP)*	Proposed Upgrade Water Elevations – Climate Change (1% AEP)*	Elevation Difference*
DCS005	Highway 1 near Moxsom Road	900 mm Circular Concrete Culvert	1,200 mm Circular Concrete Culvert	47.98	46.70	1.3

**m CGVD2013*

6.4 Recommendation #4: Debris Cleanup and Channel Maintenance

The hydrologic and hydraulic simulations are conducted under the assumption that hydraulic structures and the main channel of Barneys Brook remain free of significant debris or blockages. However, field observations conducted during the data collection phase identified several areas where debris accumulations and beaver dams are present within the study reach.

The presence of these obstructions has potential implications for the accuracy of flood line mapping and the performance of infrastructure:

- **Elevated Water Surface Elevations:** Debris at culvert inlets or dams within the channel increases the hydraulic roughness and restricts the available flow area. This leads to localized increases in water surface elevations, which can result in flow differences.
- **Reduced Level of Service:** Structures that are conceptually sized to convey a 1% AEP flood event could experience premature overtopping if the effective opening is reduced by debris or biological dams.
- **Backwater Effects:** Localized blockages function as unintended hydraulic pinch points, generating backwater effects that influence upstream drainage.
- **Structural Risks:** The accumulation of debris during high-intensity meteorological events increases the pressure on embankments and culvert headwalls, potentially leading to asset failure.

Ongoing monitoring and regular maintenance, particularly at DCS001, DCS002, and DCS006, are recommended to address these blockages. Removal of dams and debris is intended to maintain the channel's conveyance capacity and support the effectiveness of the proposed infrastructure upgrades. It is recognized that maintenance activities within the watercourse require coordination with environmental authorities to address potential impacts on the ecosystem.

7.0 Engagement with Infrastructure Owners

To facilitate the proposed infrastructure upgrades, a collaborative framework with infrastructure owners is required. Coordination with third-party owners should be established as a necessary component for the mitigation of regional flood risks. The following steps are proposed for the engagement process:

- **Information Sharing:**
  - Hydraulic modelling results and simulated energy grade line profiles can be provided to CN Rail to illustrate the impact of the existing culvert bottleneck on upstream water surface elevations. Based on preliminary results presented in this study, Dillon recommends an upgrade from the existing infrastructure at the railway crossing to triple barrel concrete 2,800 mm culverts to reduce upstream water surface elevations.
  - Hydraulic modelling results and simulated energy grade line profiles can be provided to the NSDPW to illustrate the impact of the existing hydraulic structures along provincial highways. These include DCS001 and DCS005.
- **Integrated Mitigation Planning:** The upgrades to the culvert under the railway crossing may be pursued in conjunction with upstream municipal or provincial infrastructure improvements. Based on previous studies conducted by Dillon, standalone upgrades to upstream bridges or culverts often result in negligible impacts if the primary downstream restriction remains unaddressed.
- **Cost-Sharing Framework:** Establish a formal negotiation with CN Rail regarding a cost-sharing agreement for the proposed upgrades. As the existing infrastructure is identified as a primary contributor to regional flood risk, a partnership model could be pursued that reflects the shared benefit of protecting both the rail corridor and upstream municipal assets.
- **Stakeholder Consultation:** Formal meetings are coordinated to review the technical feasibility and constructability of the proposed upgrades. Discussions are intended to align project objectives with the long-term maintenance and rehabilitation schedules of the railway.
- **Regulatory and Technical Refinement:** Refinement of the conceptual design should be undertaken during detailed engineering phases to address structural requirements, site conditions, and environmental permitting associated with work in the railway or roadway right-of-way.

8.0 Closing

Based on the hydrologic and hydraulic assessments performed, the Barneys Brook Flood Risk Study provides a technical foundation for understanding flood vulnerabilities along Barneys Brook. The analysis used HEC-HMS and HEC-RAS models, refined with provincial LiDAR data. This methodology allowed for the delineation of flood extents for 1% and 5% AEP under current and projected climate conditions.

The evaluation identified specific areas of concern, including the capacity and physical condition of hydraulic structures along the study reach. These findings are intended to support land-use planning, infrastructure investment, and emergency preparedness initiatives within the Municipality. Recommendations described in this study are preliminary and require additional considerations during the detailed design stages, such as environmental screenings, geotechnical investigations, high-precision topographic surveys, and additional hydraulic modelling.

Appendix A

Structure Survey Report

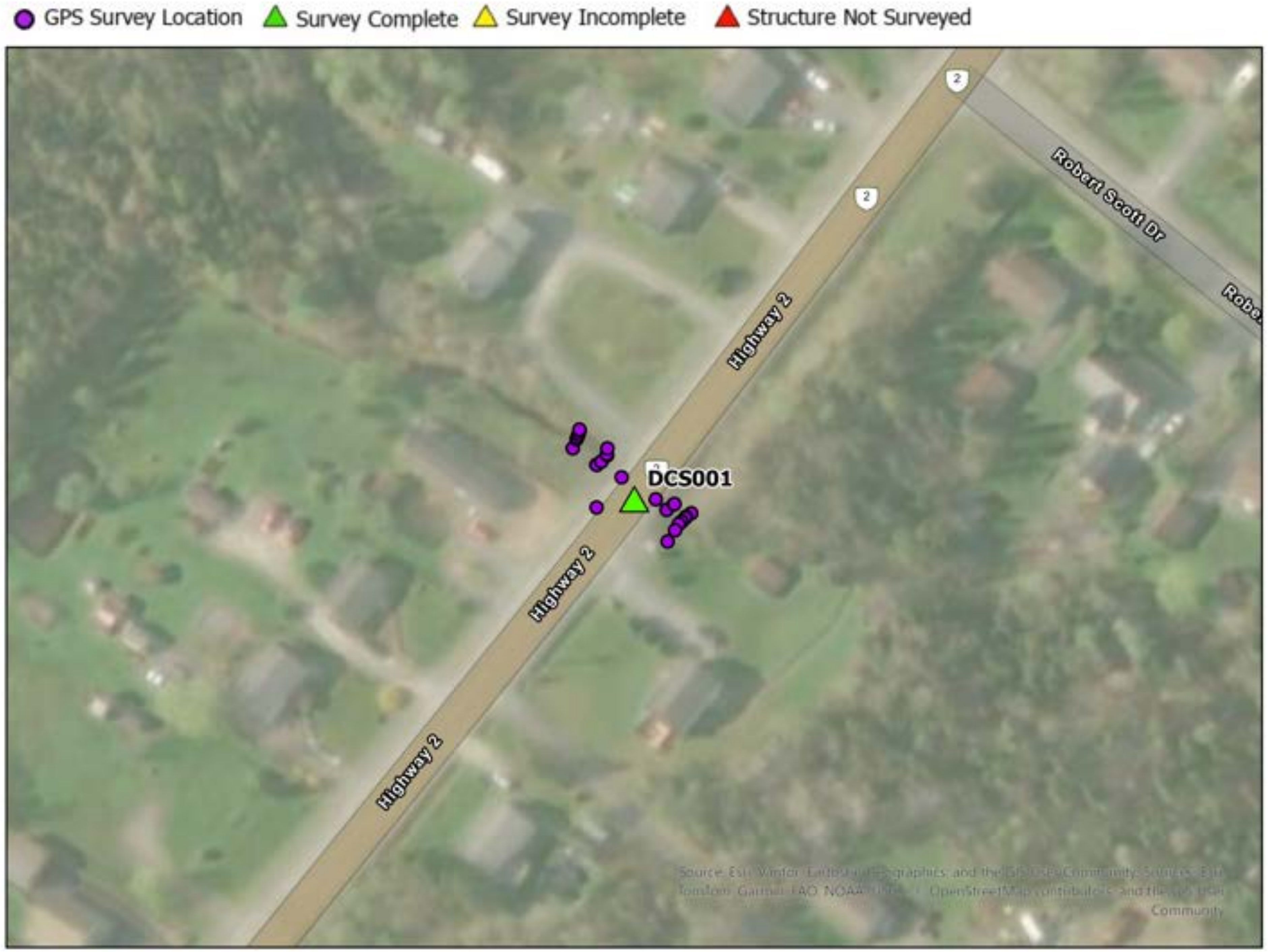
Table A1: Hydraulic Structure Details

Location	Dillon Assigned Name	Date Collected	Existing Size and Material	Invert In (m)	Invert Out (m)	Description	Field Notes
Outlet of Barneys Brook	DCS007	November 21, 2025	2,400mm Semi-Circular Culvert Under Railroad	7.96	7.84	Semi-Circular Culvert Under Railroad	Unable to safely access the complete downstream end. Steeper banks on the downstream end.
Highway 14 near Scotch Pine Dr.	DCS006	November 21, 2025	Two 1,800mm twin concrete circular culverts under Highway 14.	35.185	35.133	Two twin circular culverts under Highway 14.	Unable to safely access the downstream end.
Highway 14 near Moxsom Rd.	DCS005	November 21, 2025	900mm Circular Concrete Culvert under Highway 14.	45.528	45.263	Circular Culvert under Highway 14.	Not much flow through culvert, dense vegetation on either side.
Highway 102	DCS004	December 18, 2025	Two Concrete 3,300mmx2,800mm Box Culverts under Highway 102	20.979	20.852	Twin box culverts under Highway 102	NA
Highway 102	DCS003	December 18, 2025	1,800mm Circular Concrete Culvert under Highway 102.	24.488	23.707	Culvert under Highway 102.	Ice forming on downstream end.
Highway 102	DCS002	December 18, 2025	1,500mm Concrete Culvert under Highway 102.	25.206	24.798	Culvert under Highway 102.	Beaver dam on upstream and downstream ends. Culvert is mostly underwater.
Highway 2 near Robert Scott Dr.	DCS001 - 1	November 21, 2025	900mm Steel Circular Culvert under Highway 2.	14.058	14.056	Smaller Culvert under Highway 2.	2 other stormwater culverts outflow into the downstream end
Highway 2 near Robert Scott Dr.	DCS001 -2	November 21, 2025	1,500mm Concrete Circular Culvert under Highway 2.	13.843	13.746	Larger Culvert under Highway 2.	2 other stormwater culverts outflow into the downstream end
Highway 2 near Isenor Rd.	DBS001	November 21, 2025	10m Wide Opening Bridge along Highway 2.	NA*	NA*	Bridge along Highway 2.	NA

**No invert as natural riverbed*

Data Collection Report - Structure Surveys

Structure ID: DCS001 Structure Type: Culvert Material: Other



DCS001 – 1 Structure Condition

Category	Status	Notes
Structure Type	Culvert	
Roadway	Not much deterioration	
Culvert Material	Concrete	
General Appearance	Good condition. No visible damage, minor signs of wear/age.	
Blockage	Not much blockage	
Inlet/outlet condition	Good condition. No visual damage. Some sloughing in riprap protection	

DCS001 – 2 Structure Condition

Category	Status	Notes
Structure Type	Culvert	
Roadway	Not much deterioration	
Culvert Material	Corrugated Metal	
General Appearance	Poor condition. significant concrete spalling / CMP corrosion / HDPE/PVC cracking.	
Blockage	10% to 20% of diameter	
Inlet/outlet condition	Poor condition. Any of: Visible damage or corrosion to 50% of pipe, sloughing of riprap protection with visible bank erosion.	

Data Collection Report - Structure Surveys

Structure ID: DCS002 Structure Type: Culvert Material: Concrete

GPS Survey Location · Survey Complete · Survey Incomplete · Structure Not Surveyed

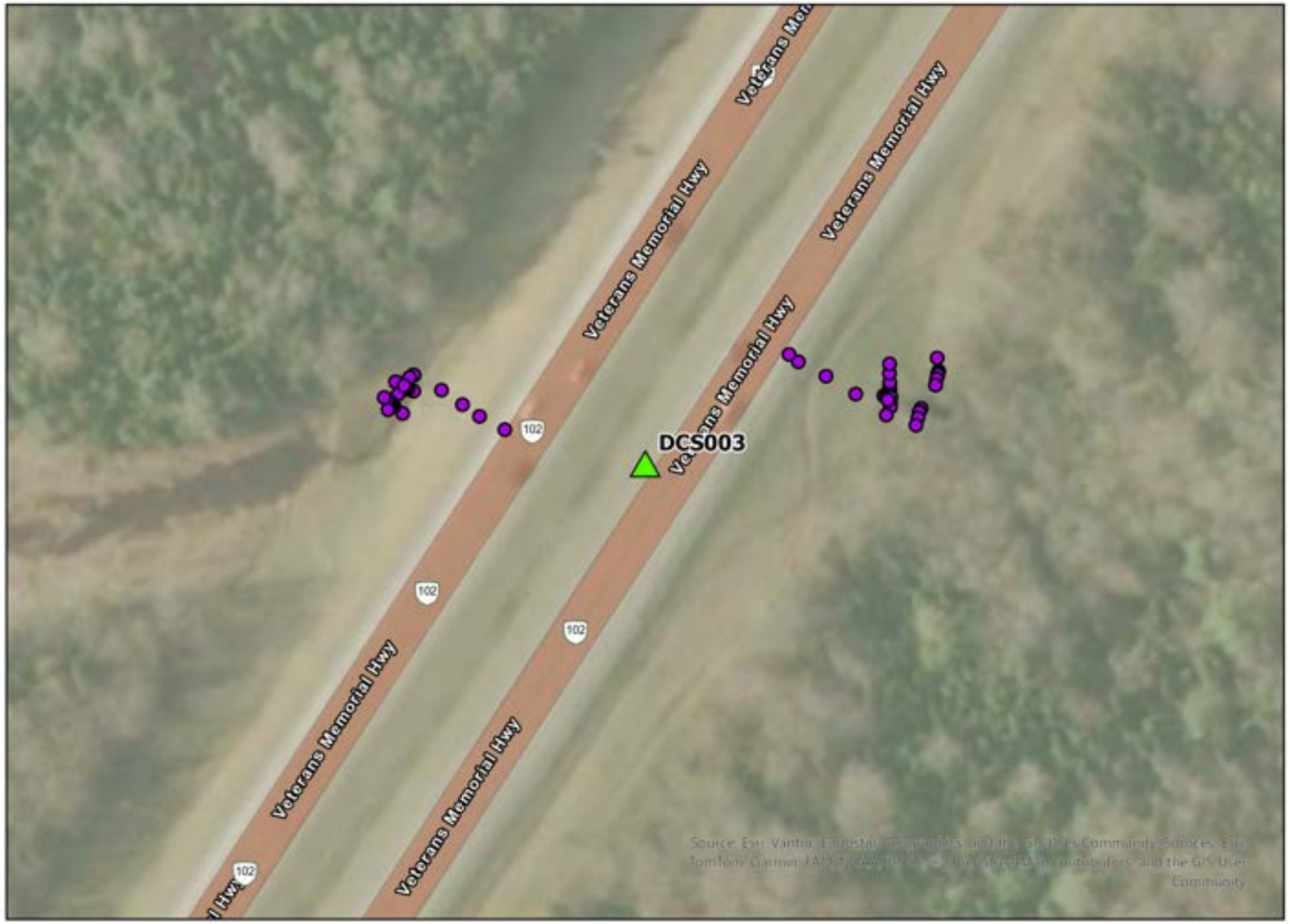
DCS002 Structure Condition

Category	Status	Notes
Structure Type	Culvert	
Roadway	No deterioration	
Culvert Material	Concrete bottom, Corrugated Metal Top	
General Appearance	Fair condition. Minor concrete spalling / CMP corrosion / HDPE/PVC cracking.	
Blockage	Over 50% of the diameter	Significant pooling on both sides of the culvert due to a beaver dam
Inlet/outlet condition	Fair condition. Any of: Visible damage to approximately 10% of the pipe, or small visible gaps in rock protection.	

Data Collection Report - Structure Surveys

Structure ID: DCS003 | Structure Type: Culvert | Material: Concrete

● GPS Survey Location ▲ Survey Complete △ Survey Incomplete ▲ Structure Not Surveyed



DCS003 Structure Condition

Category	Status	Notes
Structure Type	Culvert	
Roadway	No deterioration	
Culvert Material	Concrete	
General Appearance	Good condition. No visible damage, minor signs of wear/age.	
Blockage	Not much blockage	
Inlet/outlet condition	Good condition. No visual damage. Some sloughing in riprap protection	

Data Collection Report - Structure Surveys

Structure ID: DCS004 Structure Type: Culvert Material: Concrete

● GPS Survey Location ▲ Survey Complete ▲ Survey Incomplete ▲ Structure Not Surveyed

DCS004 Structure Condition

Category	Status	Notes
Structure Type	Culvert	
Roadway	Single transverse crack above culvert	
Culvert Material	Concrete	
General Appearance	Fair condition. Minor concrete spalling / CMP corrosion / HDPE/PVC cracking.	
Blockage	Not much blockage	
Inlet/outlet condition	Fair condition. Any of: Visible damage to approximately 10% of pipe, small visible gaps in rock protection.	

Data Collection Report - Structure Surveys

Structure ID: DCS005 Structure Type: Culvert Material: Concrete

GPS Survey Location · Survey Complete · Survey Incomplete · Structure Not Surveyed

DCS005 Structure Condition

Category	Status	Notes
Structure Type	Culvert	
Roadway	Not much deterioration	
Culvert Material	Concrete	
General Appearance	Good condition. No visible damage, minor signs of wear/age.	
Blockage	Not much blockage	
Inlet/outlet condition	Good condition. No visual damage. Some sloughing in riprap protection	

Data Collection Report - Structure Surveys

Structure ID: DCS006 Structure Type: Culvert Material: Concrete

GPS Survey Location | Survey Complete | Survey Incomplete | Structure Not Surveyed

DCS006 Structure Condition

Category	Status	Notes
Structure Type	Culvert	
Roadway	Alligator cracking and dip in the asphalt above culvert	
Culvert Material	Concrete	
General Appearance	Good condition. No visible damage, minor signs of wear/age.	
Blockage	20% to 50% of diameter	Downstream Side ~50% blocked
Inlet/outlet condition	Good condition. No visual damage. Some sloughing in riprap protection	

Data Collection Report - Structure Surveys

Structure ID: DCS007 Structure Type: Culvert Material: Steel

GPS Survey Location | Survey Complete | Survey Incomplete | Structure Not Surveyed

DCS007 - Structure Condition

Category	Status	Notes
Structure Type	Culvert	
Roadway	No deterioration	Not roadway. A railway
Culvert Material	Concrete bottom, Corrugated Metal Top	
General Appearance	Fair condition. Minor concrete spalling / CMP corrosion / HDPE/PVC cracking.	
Blockage	Not much blockage	
Inlet/outlet condition	Fair condition. Any of: Visible damage to approximately 10% of pipe, small visible gaps in rock protection.	

Data Collection Report - Structure Surveys

Structure ID: DBS001 Structure Type: Culvert Material: Concrete

GPS Survey Location · Survey Complete · Survey Incomplete · Structure Not Surveyed

DBS001 - Structure Condition

Category	Status	Notes
Structure Type	Bridge	
Roadway	Not much deterioration	
Culvert Material	Concrete	
General Appearance	Excellent condition. No signs of damage, No leaking evident	
Blockage	Not much blockage	
Inlet/outlet condition	Excellent Condition. No damage, riprap intact	

Appendix B

Floodline Maps

Map Prepared By: CHM

Map Reviewed By: VD

Flood Extent - 5% AEP
Lake
Highway
Local Road
Watercourse
Contour 10m
Bridge
Culvert

DILLON CONSULTING

N / W / E / S

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 200 400 800
Metres
SCALE 1:16,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 5% AEP

Figure Number: 1
FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.0 m
- 2.0 m - 3.0 m
- 3.0 m - 5.1 m
- Lake
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

N W E S

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

1 2 3 4 5 6 7

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 5% AEP

Figure Number: Page 1

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:	CHM
Map Reviewed By:	VD

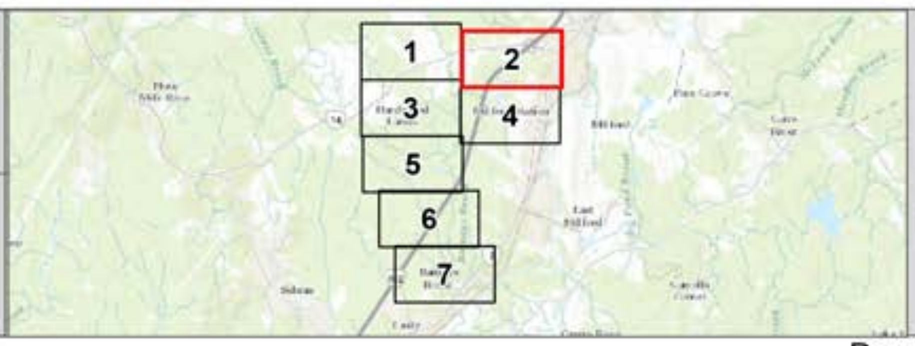
5% AEP Flood Line Depth
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.0 m
- 2.0 m - 3.0 m
- 3.0 m - 5.1 m
- Lake

- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 5% AEP

Figure Number: Page 2

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.0 m
- 2.0 m - 3.0 m
- 3.0 m - 5.1 m
- Lake
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 5% AEP

Figure Number: Page 3

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

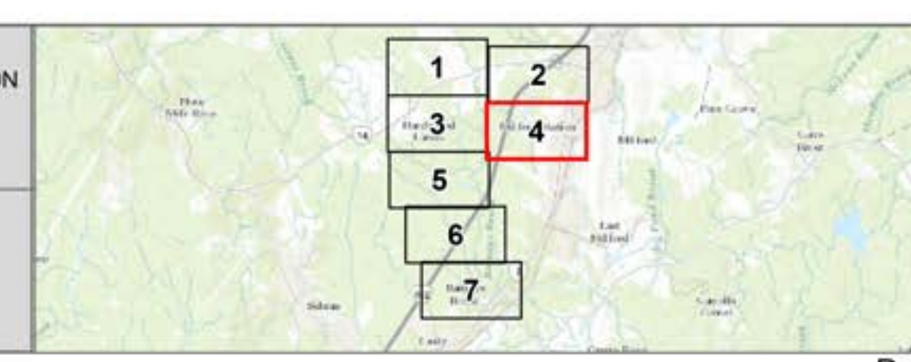
5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.0 m
- 2.0 m - 3.0 m
- 3.0 m - 5.1 m
- Lake
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 5% AEP

Figure Number: Page 4

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

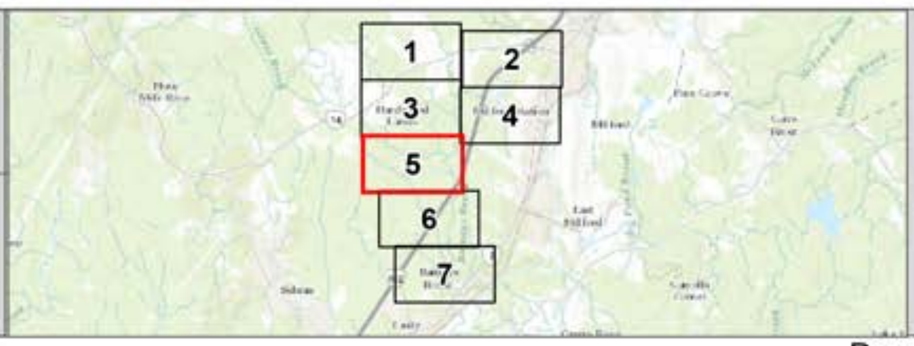
5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.0 m
- 2.0 m - 3.0 m
- 3.0 m - 5.1 m
- Lake
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 5% AEP

Figure Number: Page 5

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

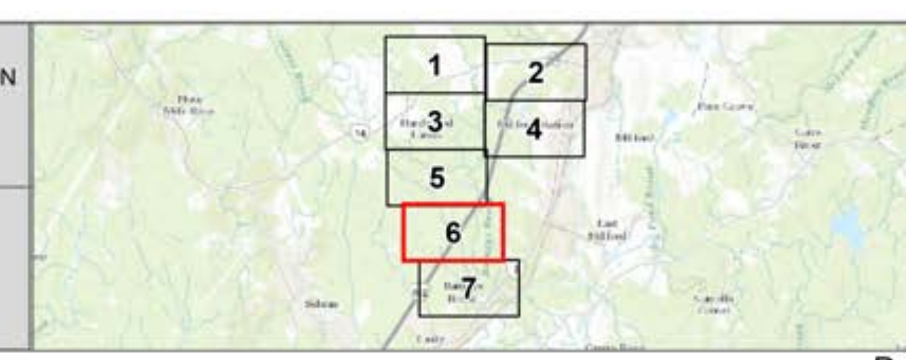
5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.0 m
- 2.0 m - 3.0 m
- 3.0 m - 5.1 m
- Lake
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 5% AEP

Figure Number: Page 6

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:	CHM
Map Reviewed By:	VD

5% AEP Flood Line Depth
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.0 m
- 2.0 m - 3.0 m
- 3.0 m - 5.1 m
- Lake

- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

N W E S

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

1 2 3 4 5 6 7

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 5% AEP

Figure Number: Page 7

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:			Coordinate System: NAD 1983 CSRS UTM Zone 20N Projection: Transverse Mercator Datum: North American 1983 CSRS	Figure Name:
CHM	Flood Extent - 1% AEP	Watercourse	0 200 400 800 Metres SCALE 1:16,000	Barneys Brook Watershed Existing - 1% AEP
Map Reviewed By:	Lake	Contour 10m		Figure Number: 2
VD	Highway	Bridge		FINAL
	Local Road	Culvert		

DILLON CONSULTING

EAST HANTS

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:	1% AEP Flood Line Depth			
CHM	0 m - 0.5 m	Property Parcel		
Map Reviewed By:	0.5 m - 1.0 m	Contours (5m)		
VD	1.0 m - 2.5 m	Highway		
	2.5 m - 5.0 m	Local Road		
	5.0 m - 8.3 m	Watercourse		
	Lake	Bridge		
		Culvert		

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 1% AEP

Figure Number: Page 1

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

1% AEP Flood Line Depth

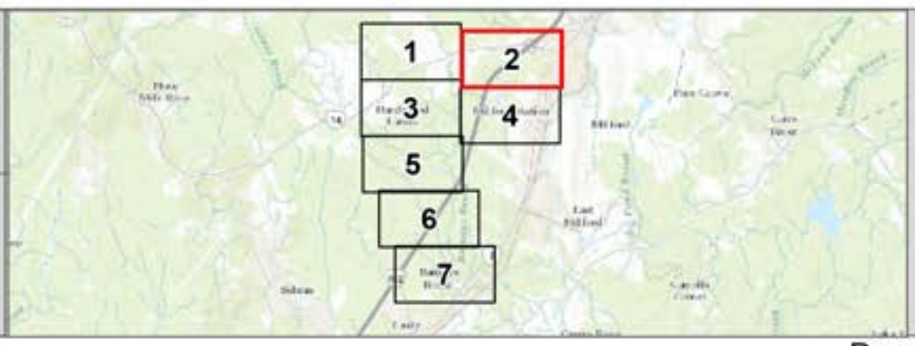
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 8.3 m
- Lake

- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 1% AEP

Figure Number: Page 2

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

1% AEP Flood Line Depth
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 8.3 m
- Lake

- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 1% AEP

Figure Number: Page 3

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

1% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 8.3 m
- Lake

- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 1% AEP

Figure Number: Page 4

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

1% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 8.3 m
- Lake

- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 1% AEP

Figure Number: Page 5

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

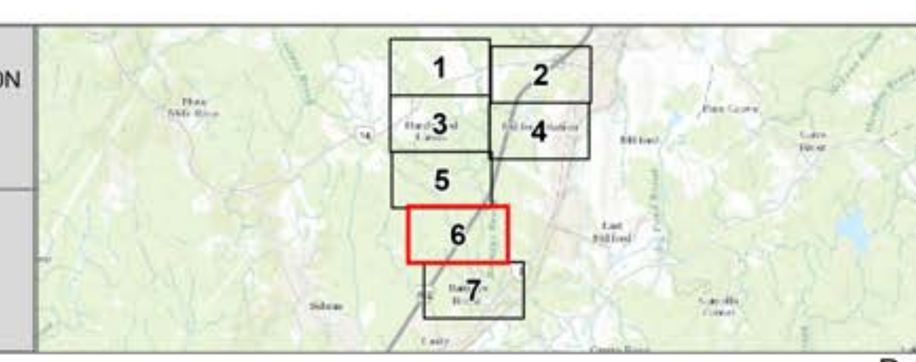
1% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 8.3 m
- Lake
- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 1% AEP

Figure Number: Page 6

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

1% AEP Flood Line Depth
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 8.3 m
- Lake

- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Existing - 1% AEP

Figure Number: Page 7

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:	Flood Extent - 5% AEP	Watercourse
CHM	Lake	Contour 10m
Map Reviewed By:	Highway	Bridge
VD	Local Road	Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 200 400 800
Metres
SCALE 1:16,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: 3

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

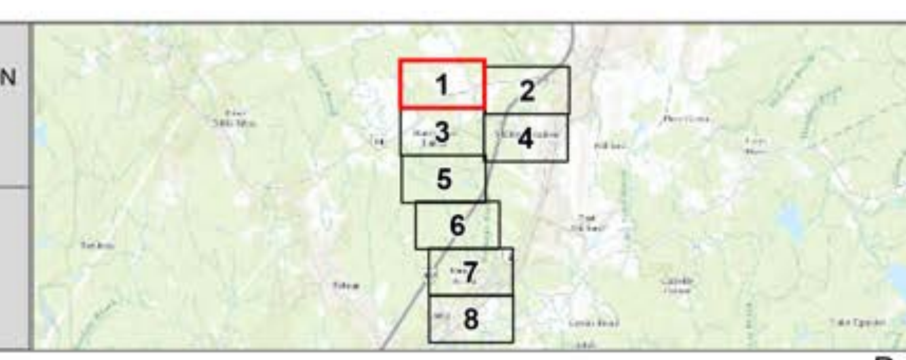
5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: Page 1

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake

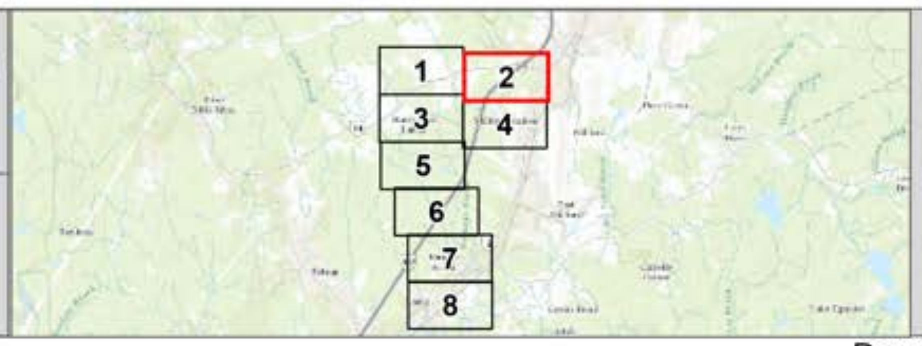
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

N S E W

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: Page 2

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

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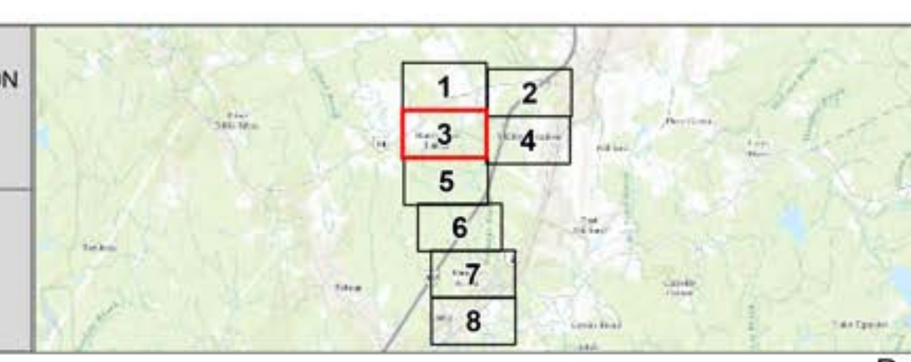
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: Page 3

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM	**5% AEP Flood Line Depth**	Property Parcel	
	0 m - 0.5 m	Watercourse	
	0.5 m - 1.0 m	Contours (5m)	
	1.0 m - 2.5 m	Highway	
Map Reviewed By: VD	2.5 m - 5.0 m	Local Road	
	5.0 m - 10.2 m	Bridge	
	Lake	Culvert	

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: Page 4

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:	CHM
Map Reviewed By:	VD

5% AEP Flood Line Depth

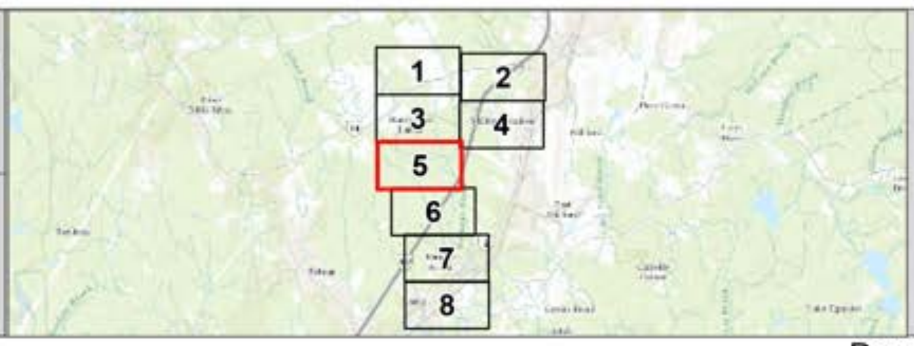
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake

- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: Page 5

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

5% AEP Flood Line Depth

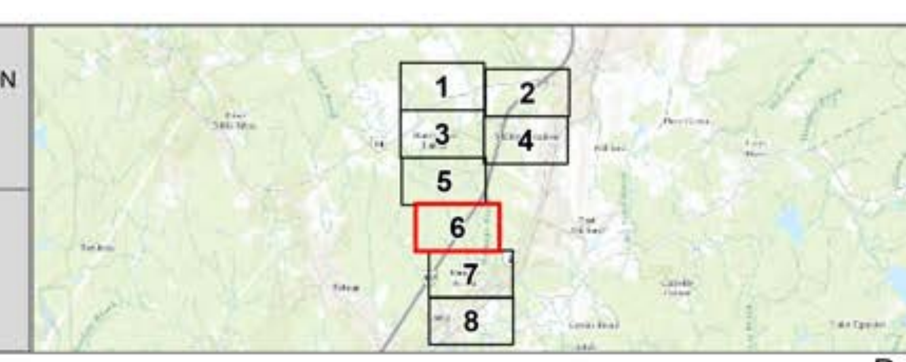
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake

- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: Page 6

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

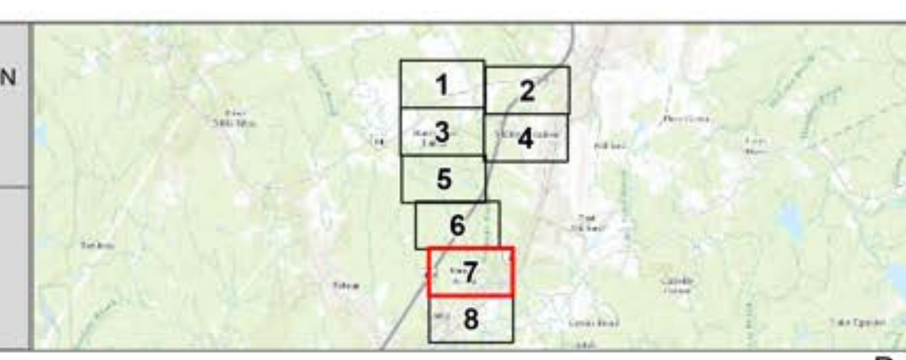
5% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake
- Property Parcel
- Watercourse
- Contours (5m)
- Highway
- Local Road
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: Page 7

FINAL

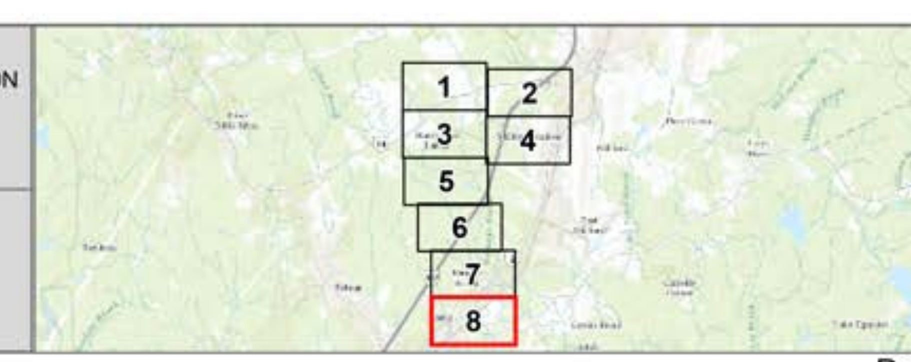
Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:	5% AEP Flood Line Depth	
CHM	0 m - 0.5 m	Property Parcel
Map Reviewed By:	0.5 m - 1.0 m	Watercourse
VD	1.0 m - 2.5 m	Contours (5m)
	2.5 m - 5.0 m	Highway
	5.0 m - 10.2 m	Local Road
	Lake	Bridge
		Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 5% AEP

Figure Number: Page 8

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

Flood Extent - 1% AEP
Lake
Highway
Local Road
Watercourse
Contour 10m
Bridge
Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 200 400 800
Metres
SCALE 1:16,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: 4

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:
CHM
Map Reviewed By:
VD

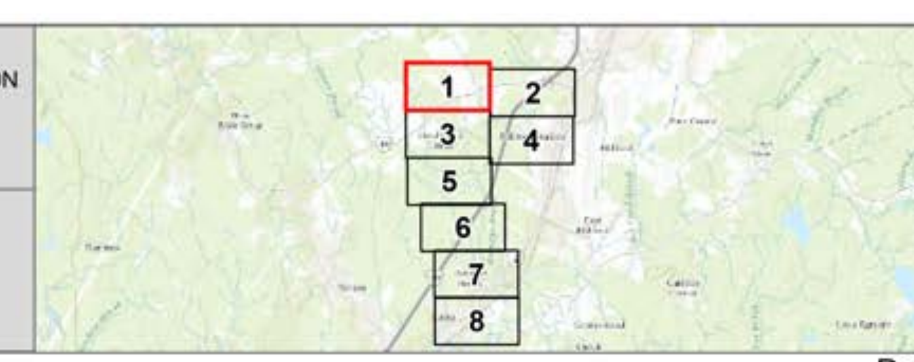
1% AEP Flood Line Depth
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake
- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

N W E S

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: Page 1
FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

1% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake
- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: Page 2

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:
CHM

Map Reviewed By:
VD

1% AEP Flood Line Depth

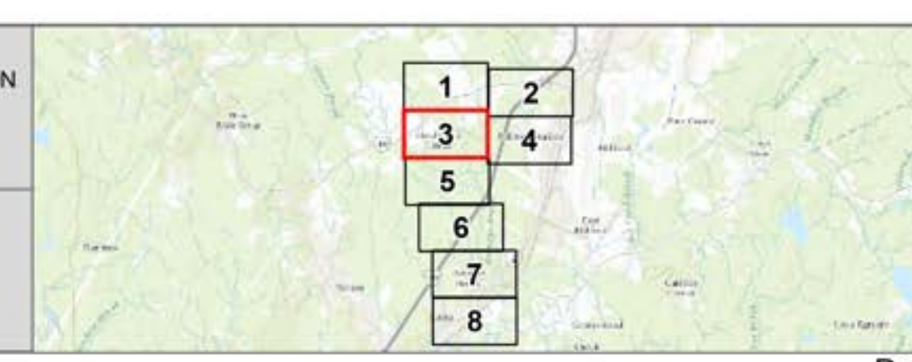
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake

- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: Page 3

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

1% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake
- Property Parcel
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- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

1 2 3 4 5 6 7 8

EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: Page 4

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:	CHM
Map Reviewed By:	VD

1% AEP Flood Line Depth

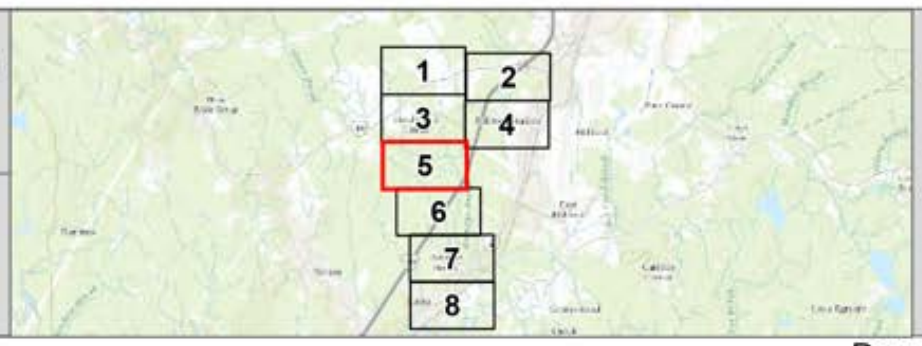
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake

- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: Page 5

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:
CHM
Map Reviewed By:
VD

1% AEP Flood Line Depth
- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake
- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

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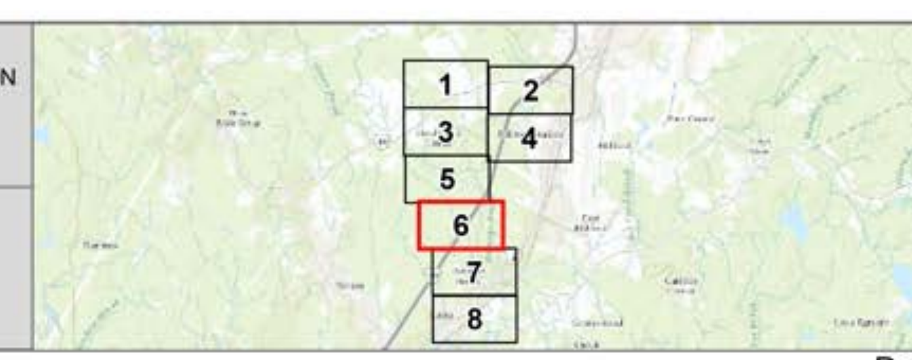

EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: Page 6

FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By:
CHM

Map Reviewed By:
VD

1% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
- Lake
- Property Parcel
- Contours (5m)
- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

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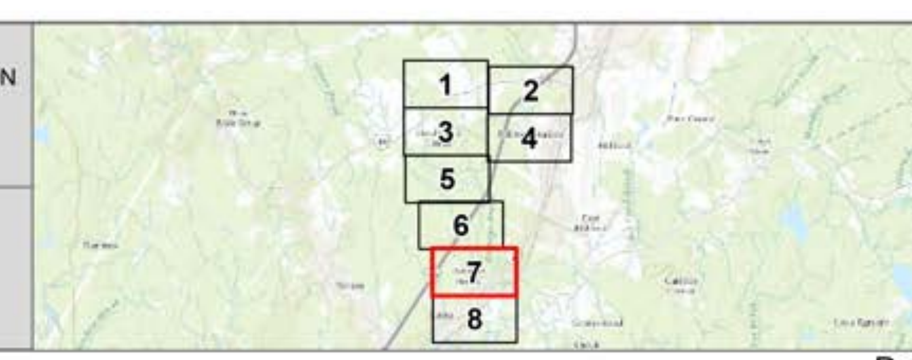
Metres
SCALE 1:3,000



EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: Page 7
FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

Map Prepared By: CHM

Map Reviewed By: VD

1% AEP Flood Line Depth

- 0 m - 0.5 m
- 0.5 m - 1.0 m
- 1.0 m - 2.5 m
- 2.5 m - 5.0 m
- 5.0 m - 10.2 m
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- Highway
- Local Road
- Watercourse
- Bridge
- Culvert

DILLON CONSULTING

Coordinate System: NAD 1983 CSRS UTM Zone 20N
Projection: Transverse Mercator
Datum: North American 1983 CSRS

0 50 100 200
Metres
SCALE 1:3,000

EAST HANTS

Figure Name:
Barneys Brook Watershed
Climate Change 2100 - 1% AEP

Figure Number: Page 8

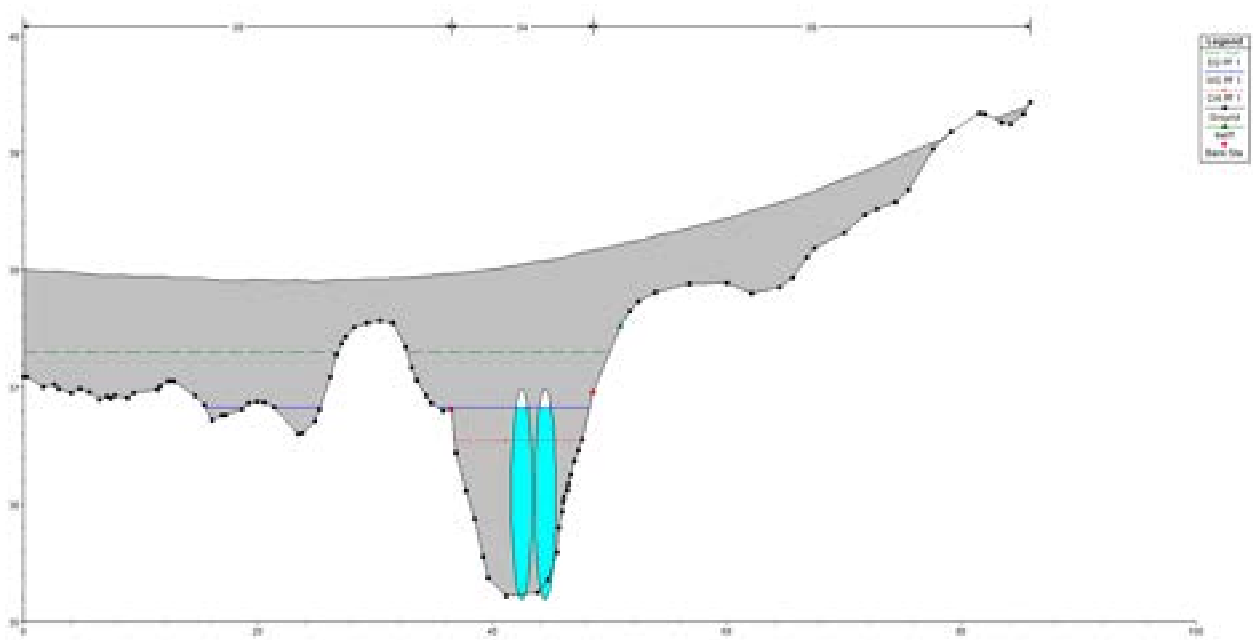
FINAL

Document Path: K:\GIS\2025\252325\Product\Client\Watershed_Figures\Watershed_Figures.aprx

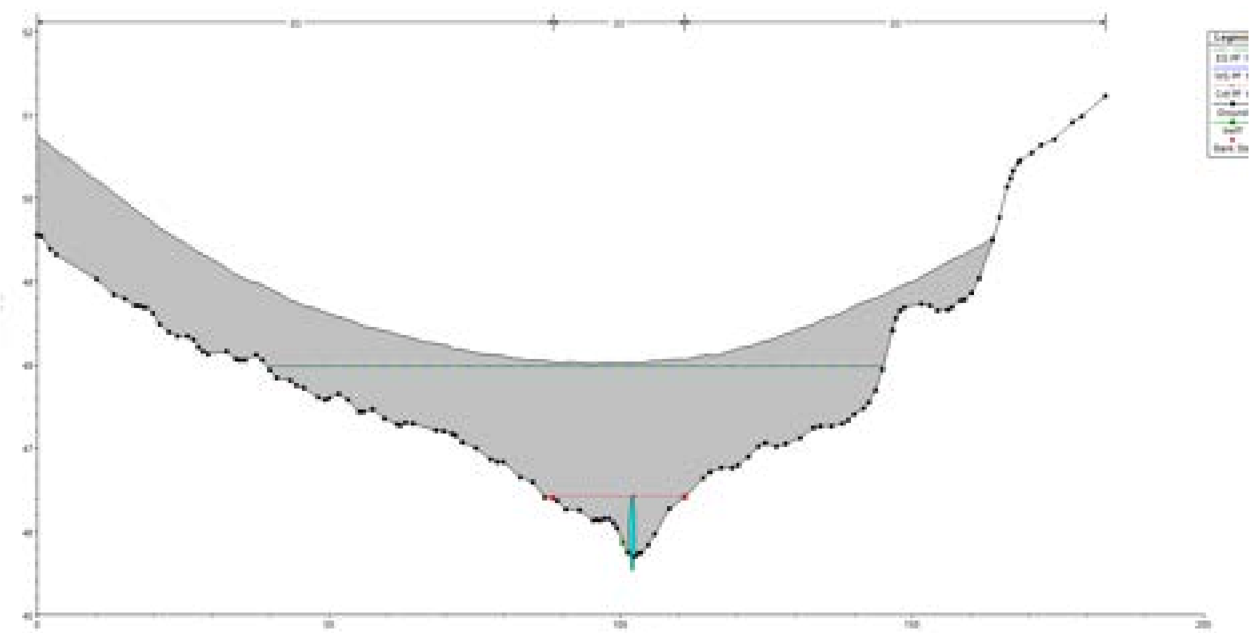
Appendix C

Structure Cross Sections

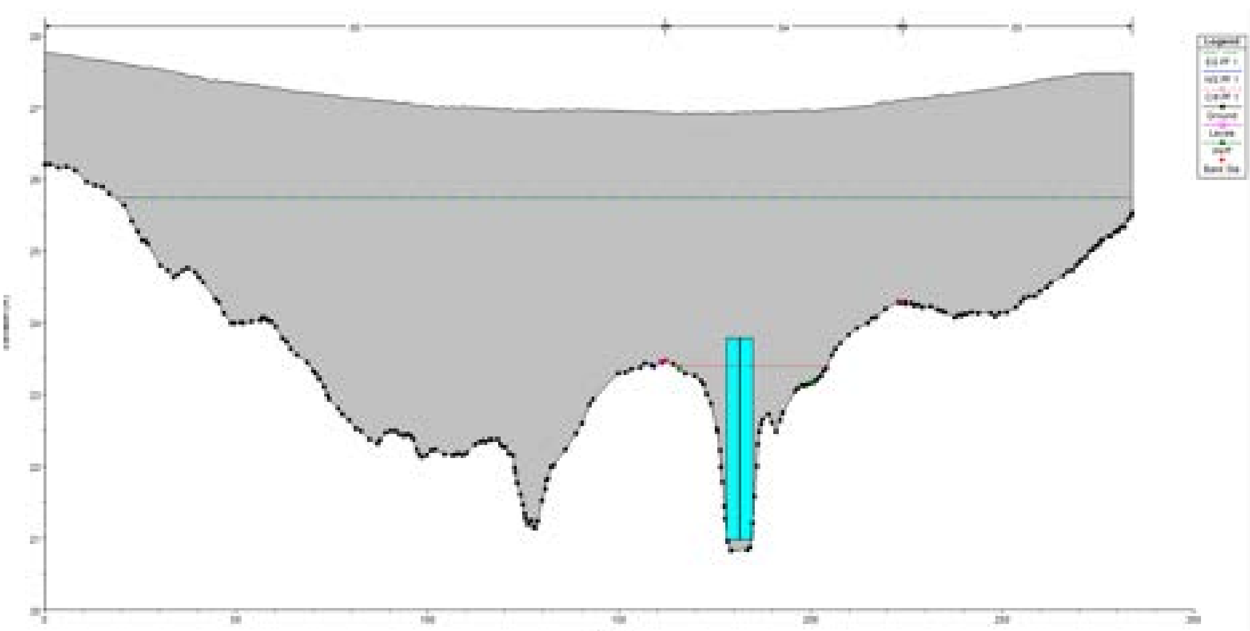
DCS006 – Highway 14 near Scotch Pine Drive - 1% AEP 2100 Climate Change



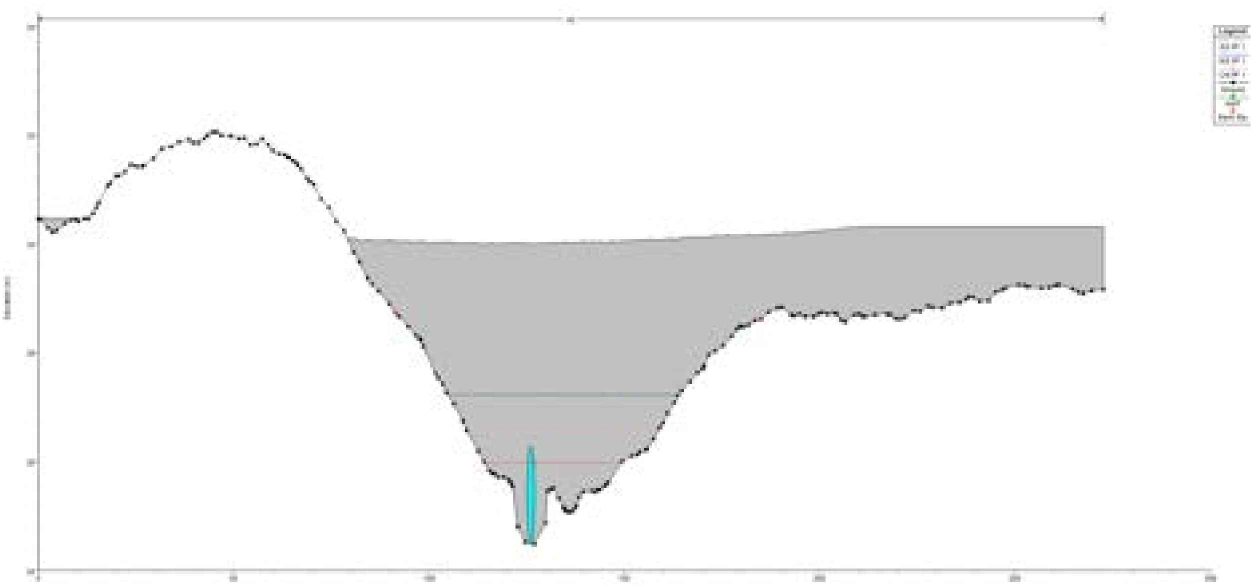
DCS005-Highway 14 near Moxsom Rd - 1% AEP 2100 Climate Change



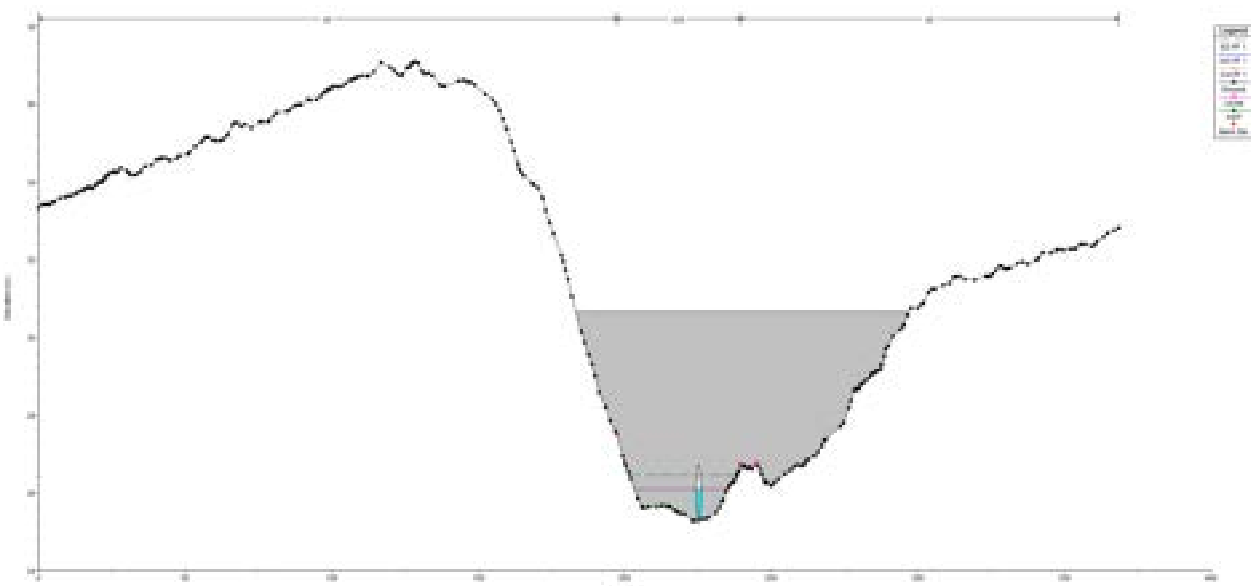
DCS004 - Highway 102 - 1% AEP 2100 Climate Change



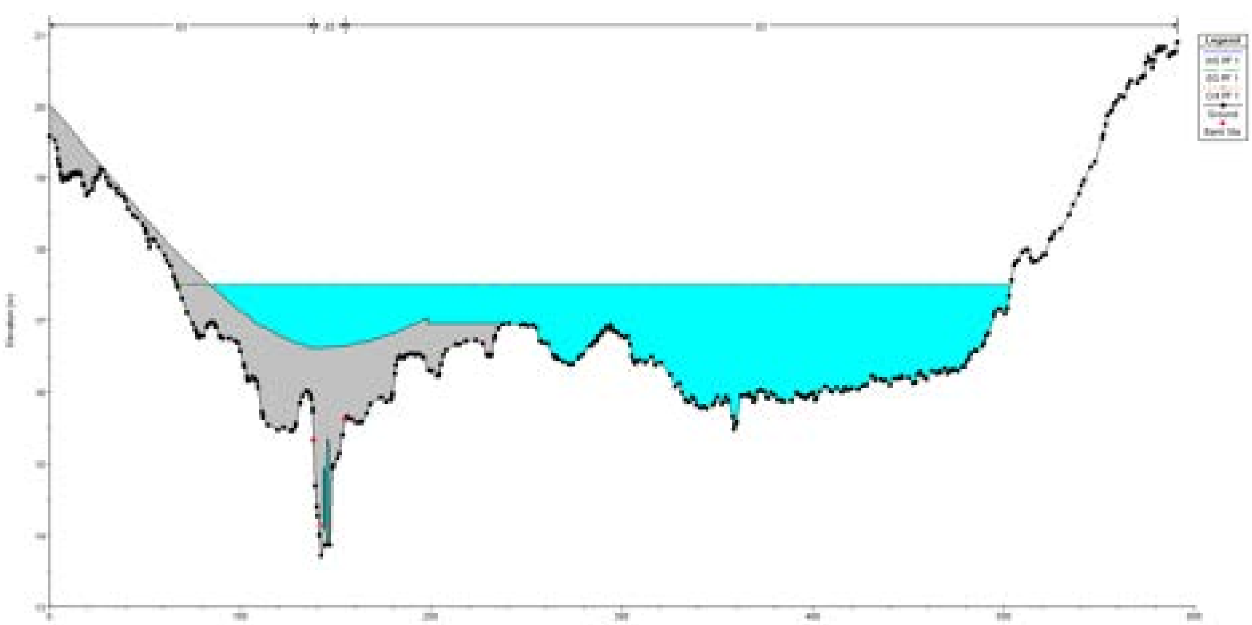
DCS003 - Highway 102 - 1% AEP 2100 Climate Change



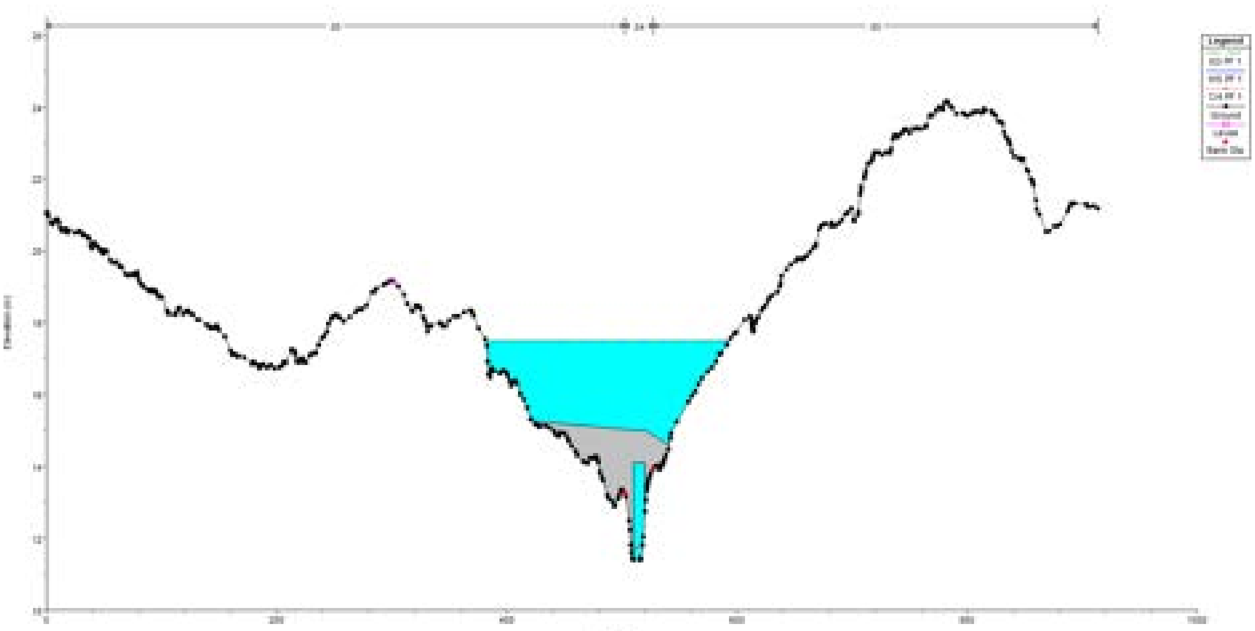
DCS002 - Highway 102 - 1% AEP 2100 Climate Change



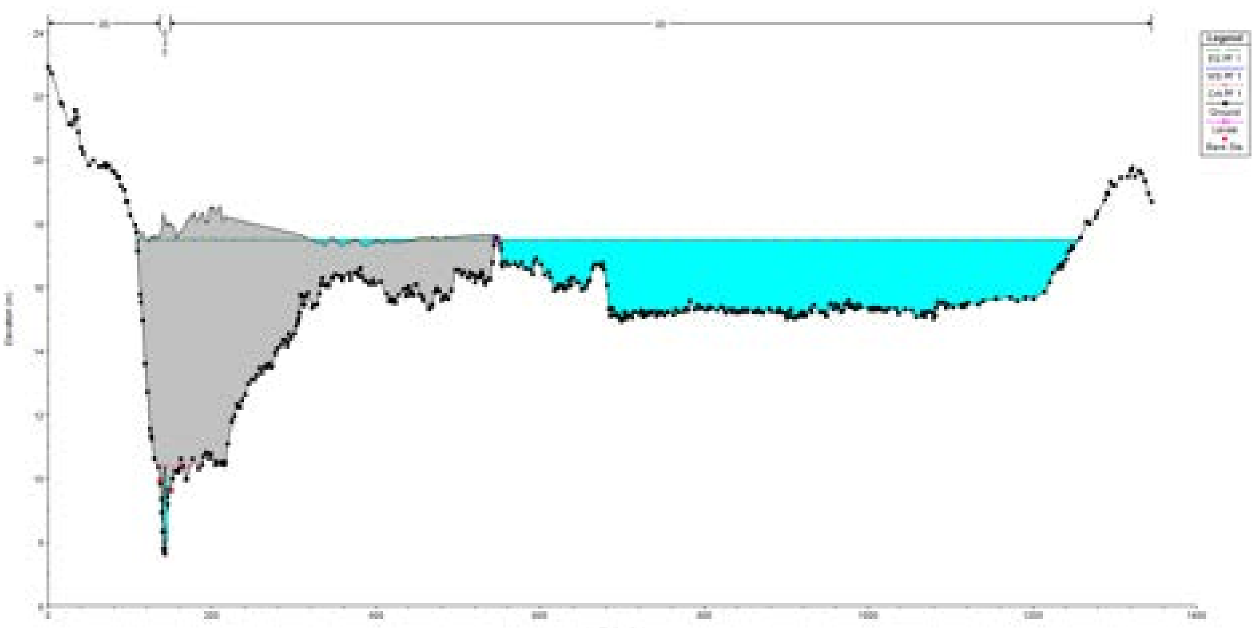
DCS001 - Highway 2 near Robert Scott Dr - 1% AEP 2100 Climate Change



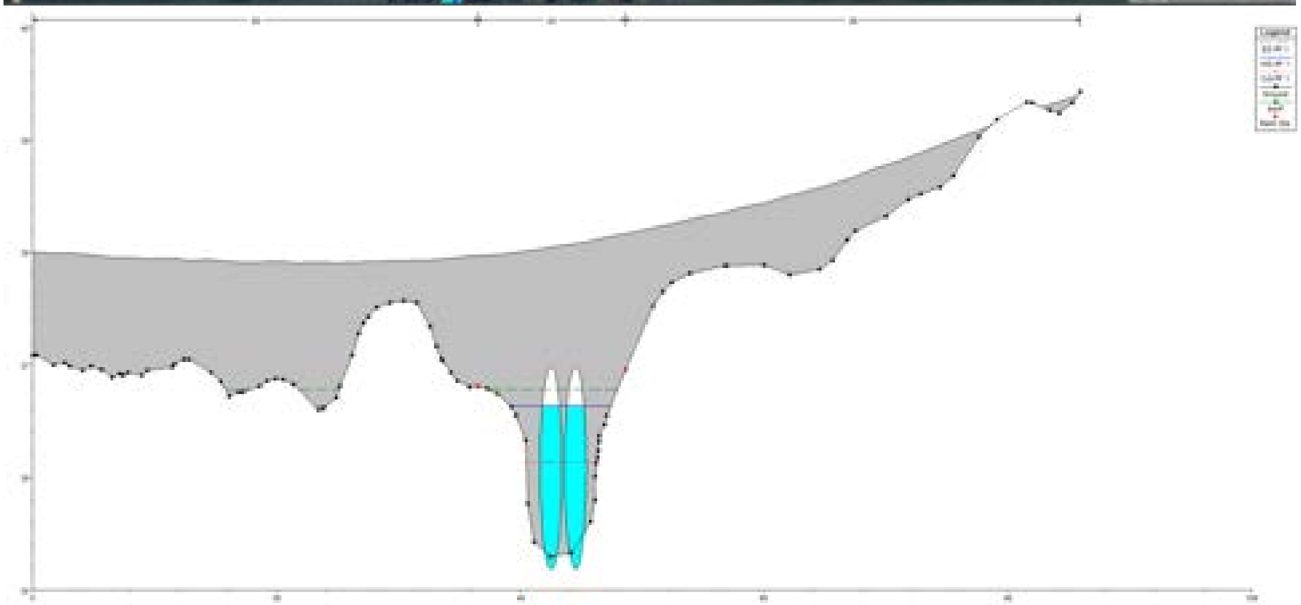
DBS001 - Highway 2 near Isenor Rd - 1% AEP 2100 Climate Change



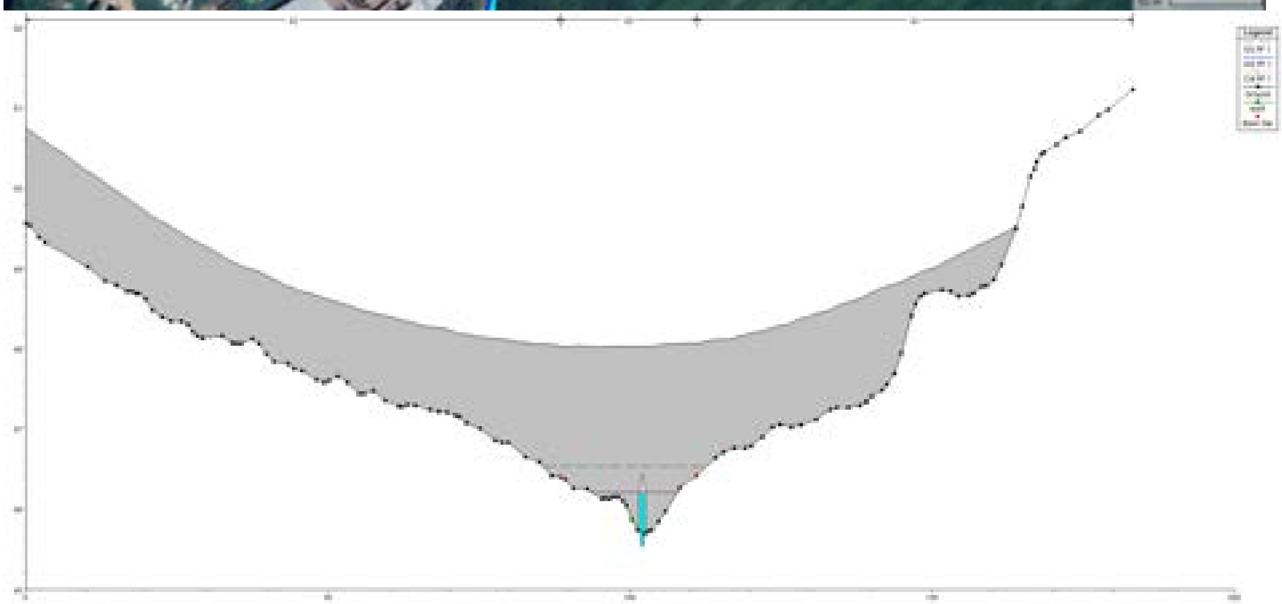
DCS007 - Outlet of Barneys Brook - 1% AEP 2100 Climate Change



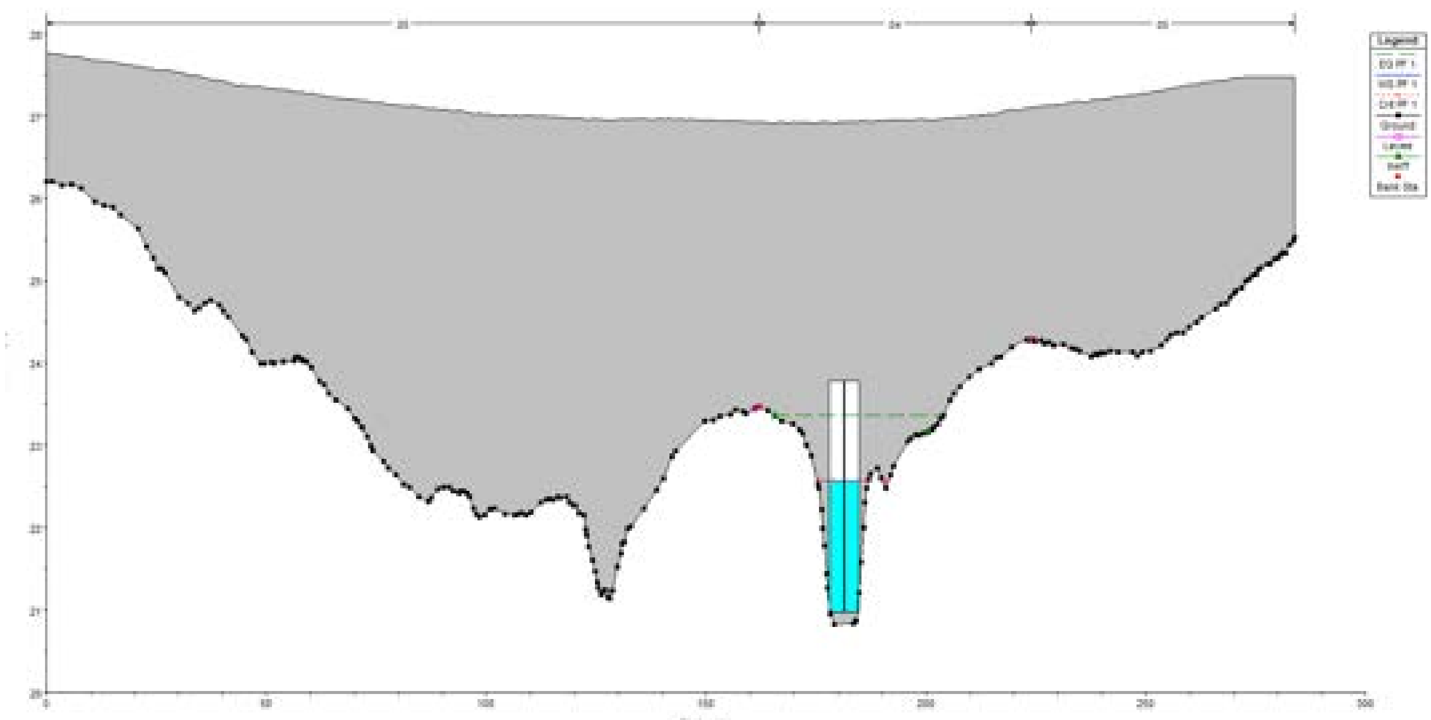
DCS006 – Highway 14 near Scotch Pine Drive - 1% AEP Historical



DCS005-Highway 14 near Moxsom Rd - 1% AEP Historical



DCS004 - Highway 102 - 1% AEP Historical



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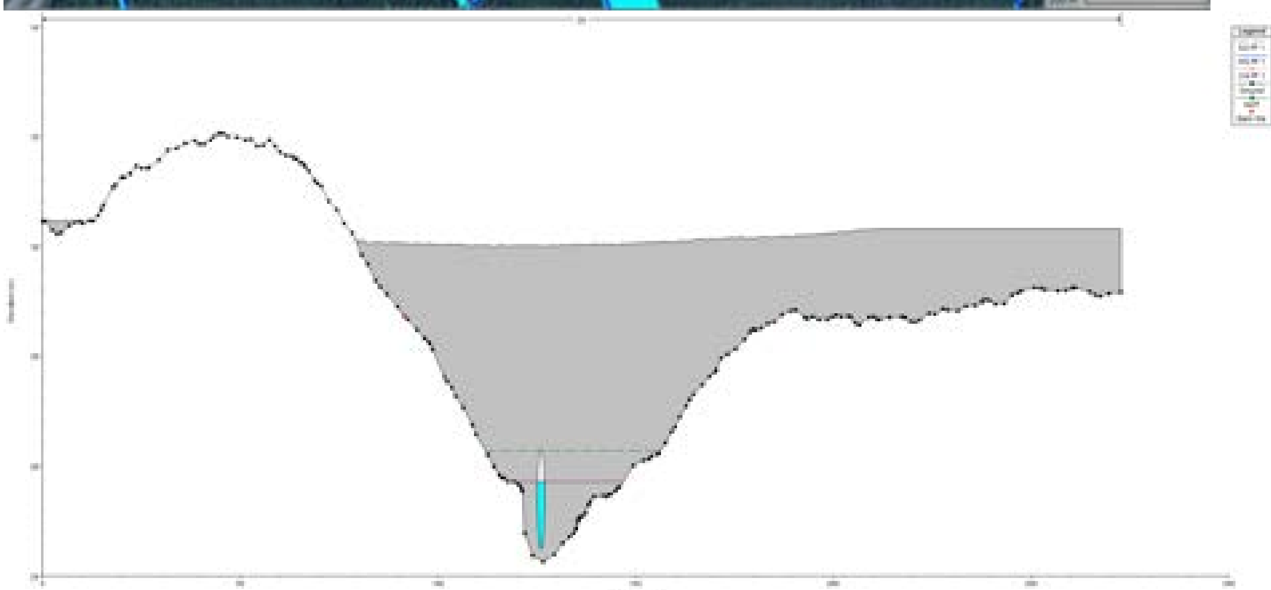
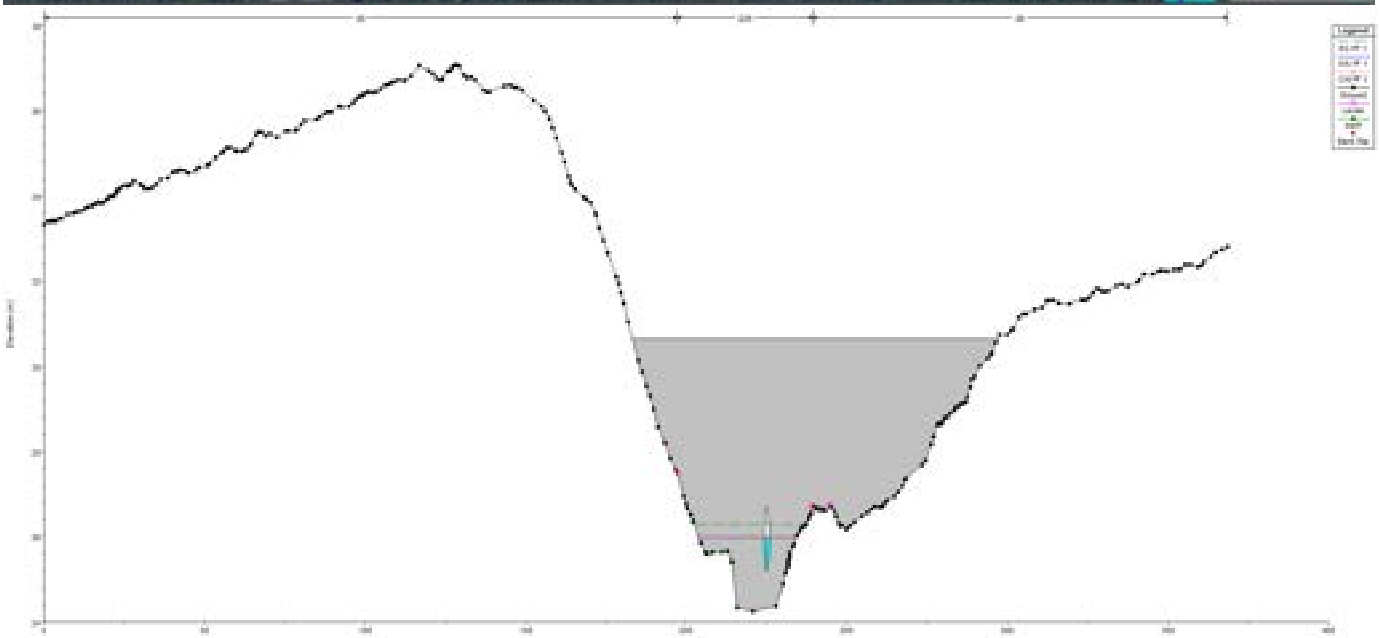
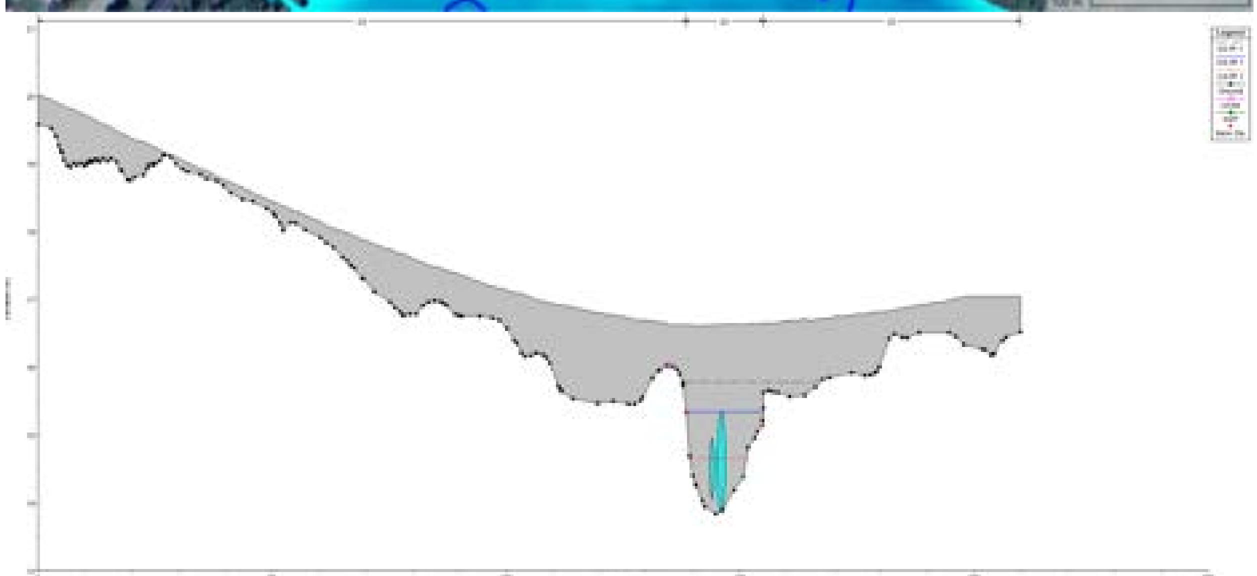


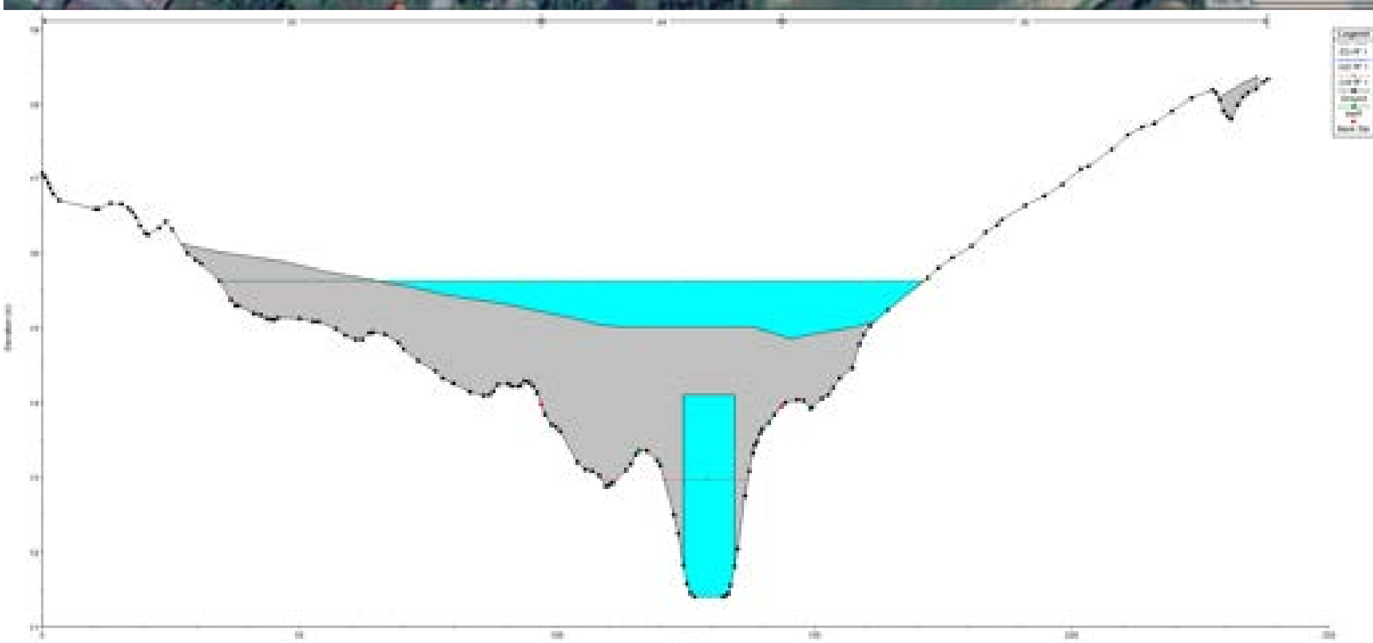
DCS002 - Highway 102 - 1% AEP Historical



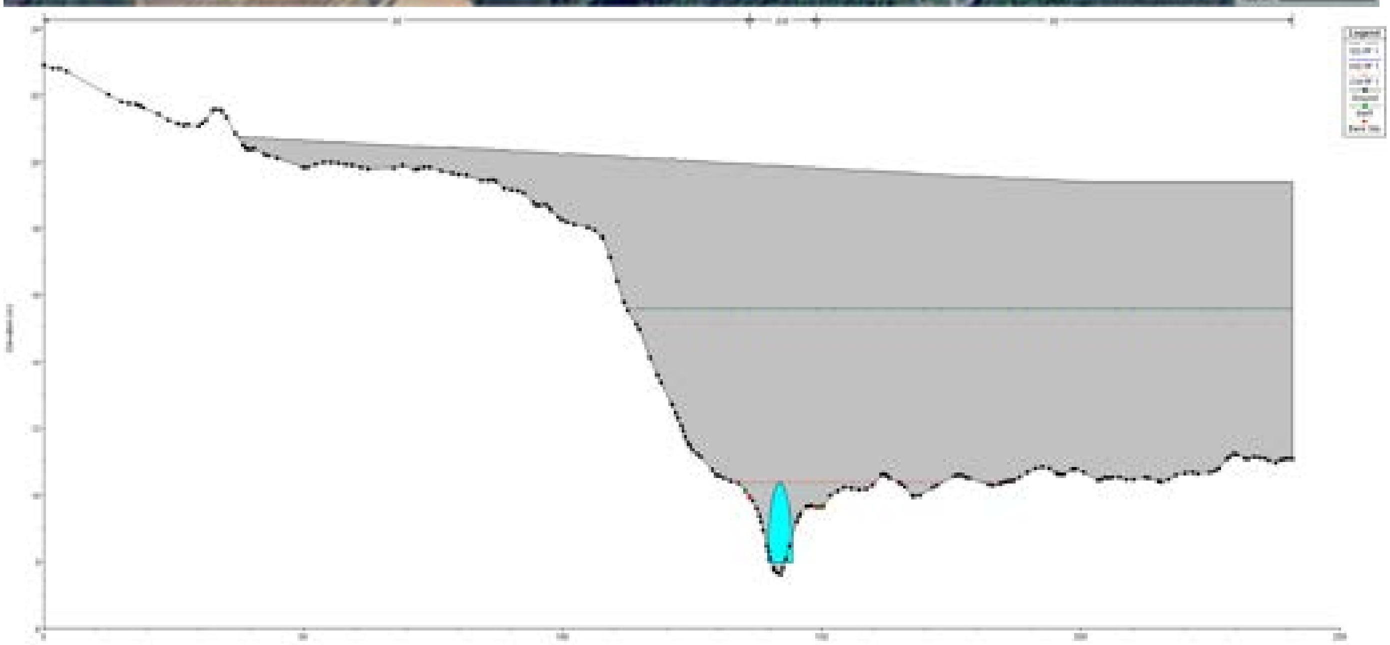
DCS001 - Highway 2 near Robert Scott Dr - 1% AEP Historical



DBS001 - Highway 2 near Isenor Rd - 1% AEP Historical



DCS007 - Outlet of Barneys Brook - 1% AEP Historical



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