



## Hinton Flood Study Survey Data Collection Report

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**Prepared for:**

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## Document Tracking

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DRAFT



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## DISCLAIMER

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## EXECUTIVE SUMMARY

Alberta Environment and Parks retained Northwest Hydraulic Consultants Ltd. in June 2021 to collect survey data for the Hinton Flood Study. The study area includes 22.9 km of the Athabasca River, 6.1 km of Hardisty Creek, 3.6 km of Happy Creek, 15.5 km of Maskuta Creek, and 2.8 km of Cold Creek. The study is being conducted under the provincial Flood Hazard Identification Program; the overall objectives are to enhance public safety and to reduce future flood damages and disaster assistance costs.

The survey program was carried out between July 2021 and January 2022. A total of 638 river cross sections were surveyed, including 54 on the Athabasca River, 125 on Hardisty Creek, 73 on Happy Creek, 333 on Maskuta Creek, and 53 on Cold Creek. In addition, a total of 26 bridges and 12 culverts were surveyed. Survey data and reach-representative photographs are provided with the digital study file that accompanies this report. The overall accuracy of the survey is estimated to be  $\pm 0.05$  m for ground survey points and  $\pm 0.07$  m for boat-based measurements obtained using the digital echo sounder.

Additional base data collected includes bridge file information from Alberta Transportation and hydrometric station information from Water Survey of Canada. No highwater mark data were found during the survey and background information review, and no flood control structures were identified within the study area.

A comparison of the LiDAR-derived DTM and the ground survey indicates that the two data sets are consistent, and the DTM supplied by Alberta Environment and Parks is suitable for overbank cross section extraction and flood mapping.

## CREDITS AND ACKNOWLEDGEMENTS

Northwest Hydraulic Consultants Ltd. would like to express appreciation to Alberta Environment and Parks for initiating this project, making background information available, and providing the project team with technical input throughout the project. Abdullah Mamun managed and directed the project on behalf of Alberta Environment and Parks, and the following NHC personnel were part of the study team:

- Robyn Andrishak (Project Manager) – responsible for the overall direction of the project.
- Luke Kostyk and Ken Roy (Survey Technologists) – responsible for field survey data collection.
- Will Skitmore (Geomatics Technologist) – responsible for review and quality control of survey data.
- Kate Neigel and Angela Thompson (Survey Assistants) – assisted with survey data collection.
- Michael Brayall (Hydraulic Modelling Specialist) – assisted with the survey program and reporting.
- Mary Bachynsky (Project Engineer) – assisted with survey data collection, hydraulic structure data assembly, and preparation of this report.
- Gary Van Der Vinne (Senior Technical Reviewer) – provided senior review input and advice.

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## APPENDICES

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# 1 INTRODUCTION

## 1.1 Study Background

The Hinton Flood Study Survey Data Collection project was initiated by Alberta Environment and Parks (AEP) to collect information that will later be used to identify and assess flood hazards along the Athabasca River, Hardisty Creek, Happy Creek, Maskuta Creek, and Cold Creek in the town of Hinton and adjacent areas of Yellowhead County. This study is being undertaken as part of the Flood Hazard Identification Program (FHIP) with the intent of enhancing public safety and reducing future flood damages within the Province of Alberta.

## 1.2 Study Objectives

This report provides details of the survey and base data collection program carried out between July 2021 and January 2022 to support the upcoming Hinton Flood Study. This work included:

- River cross section surveys;
- Discharge and water level measurements;
- Hydraulic and flood control structure data collection; and
- Survey and digital terrain model (DTM) comparison.

The objective of the program is to assemble the data required for subsequent development of a hydraulic model and preparation of flood mapping for the study area.

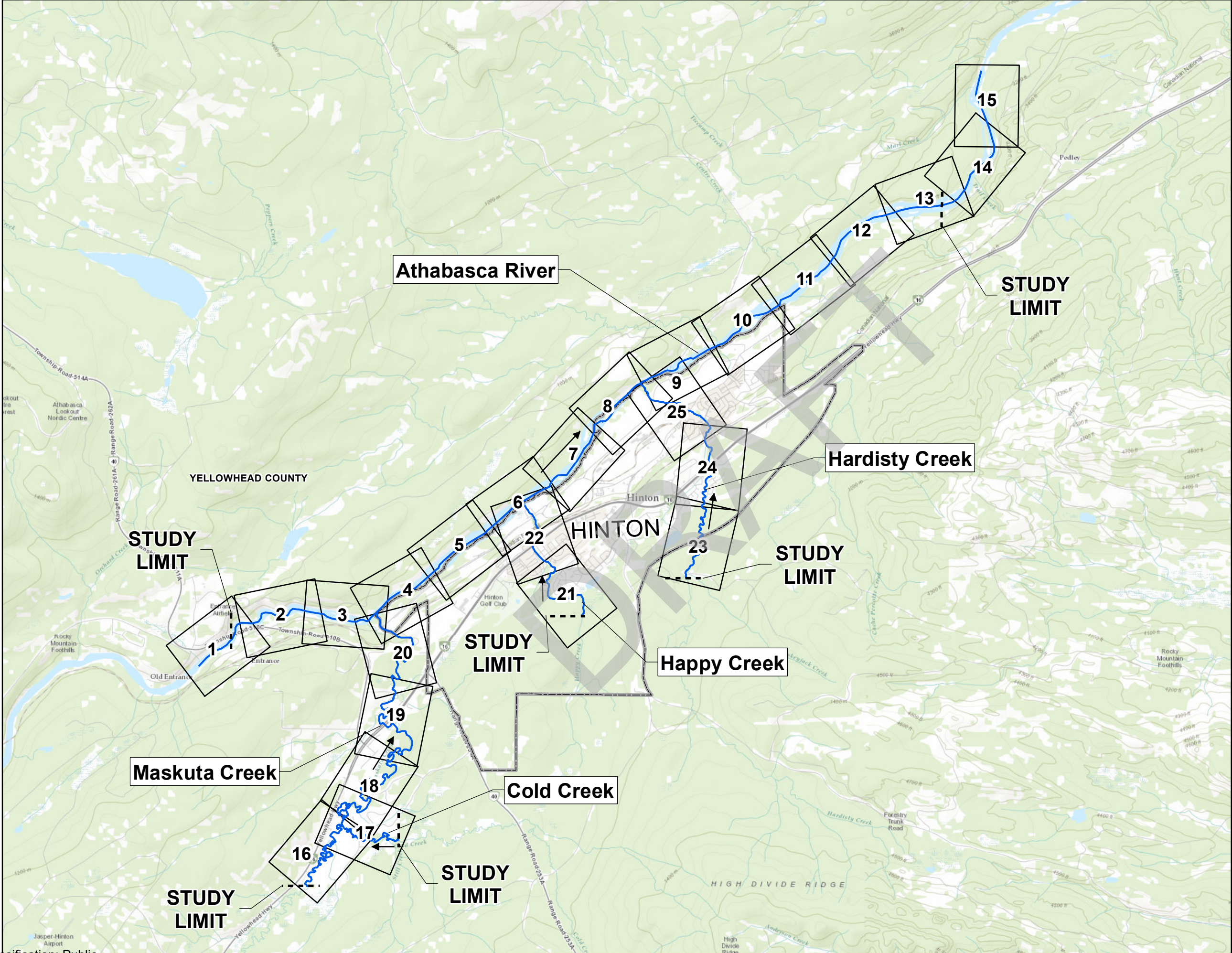
## 1.3 Study Area and Reach

The survey program was carried out between July 2021 and January 2022. A total of 638 river cross sections were surveyed, including 54 on the Athabasca River, 125 on Hardisty Creek, 73 on Happy Creek, 333 on Maskuta Creek, and 53 on Cold Creek. **Figure 1** shows the location and boundaries of the study area, which includes:

- 22.9 km of the Athabasca River from upstream of the Highway 40 bridge at the western edge of NE1-51-26 W5M down to the eastern edge of SW4-52-24 W5M below Hinton;
- 6.1 km of Hardisty Creek from the southern edge of NW12-51-25 W5M to the mouth;
- 3.6 km of Happy Creek from the southern edge of SE10-51-25 W5M to the mouth;
- 15.5 km of Maskuta Creek from the southern edge of NW24-50-26 W5M to the mouth; and
- 2.8 km of Cold Creek from the eastern edge of SW30-50-25 W5M to Maskuta Creek.

River cross section surveys were extended beyond these boundaries to accommodate potential hydraulic modelling and inundation mapping requirements. Local authorities within the study area include the town of Hinton and Yellowhead County.

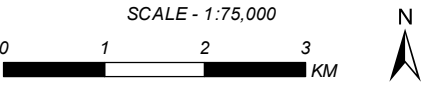




Classification: Public



- Town
- County or Municipal District
- Study Reach



Coordinate System: NAD 1983 3TM 117  
Units: METRES

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HINTON FLOOD STUDY  
SURVEY DATA COLLECTION

**STUDY AREA**

FIGURE 1

RBA, P:\Projects (Active)\1006665 Hinton Flood Study Survey Data Collection\04 Models\GIS\Figures\HintonFS\_StudyArea\_Fig01.mxd



## 2 SURVEY AND DATA COLLECTION

### 2.1 Methodology and Procedures

The survey program was completed between July 2021 and January 2022, beginning with an initial site visit by NHC and AEP personnel on 12 and 13 July 2021. Once the control network was established (as described in Section 2.1.2), horizontal and vertical coordinates were surveyed using Trimble real time kinematic (RTK) Global Navigation Satellite Systems (GNSS) receivers and a robotic total station.

Boat-based surveys of the Athabasca River were done using an Odom Hydrotrac single-frequency digital echosounder to measure water depth (typically in areas covered by water deeper than 0.30 m) and a Trimble R8 GNSS receiver to record position and elevation of the transducer. River bed elevations were derived from depth soundings by subtracting depth from the transducer elevation. Elsewhere, Trimble R10 and R12 GNSS receivers were mounted on a survey rod to record ground elevations directly. In a few areas where GNSS receivers could not be used due to overhead obstructions, a Trimble S6 robotic total station was used to complete the survey.

The channel banks and a portion of the overbank floodplains were surveyed to ensure overlap with the supplied LiDAR-derived DTM. Elevations and dimensions of bridges and culverts were also captured in the survey.

#### 2.1.1 Coordinate System and Datum

Horizontal positions were referenced to the local three-degree Transverse Mercator (3TM) projection of the Canadian Spatial Reference System (CSRS) North American Datum of 1983 (NAD83), which has a central meridian of 117°W. Orthometric heights are based on the Canadian Geodetic Vertical Datum of 1928 (CGVD28) and HTv2.0 hybrid geoid model.

#### 2.1.2 Control Network

A control network was established from static GNSS observations at seven control points to provide a spatial reference for the survey program. Each baseline observation in the network was a minimum of two hours in duration. Can-Net (<https://www.can-net.ca/>) also operates a permanent GNSS reference station in Hinton (HNTN), which provided additional baseline observations for the control network survey. Trimble Business Center was used to perform a network adjustment on the control point coordinates obtained from the Canadian Spatial Reference System Precise Point Positioning (CSRS-PPP) service (Natural Resources Canada, 2021) and the Can-Net station in Hinton.

Constraining the horizontal and vertical coordinates to the Can-Net reference station resulted in the smallest errors throughout the network. Adjusted coordinates for the control network are provided in **Table 1**. The largest horizontal and vertical errors in the network adjustment were 2.3 and 5.7 mm, respectively (**Table 2**). Supporting CSRS-PPP and network adjustment reports are provided in Appendix A for information.

**Table 1 Adjusted coordinates for control points in metres**

Point Name	Easting	Northing	Elevation
NHC 1	-51087.402	5915028.584	1053.655
NHC 2	-47318.135	5915767.418	1030.948
NHC 3	-43334.370	5916401.225	966.594
NHC 4	-43603.860	5912220.712	1037.329
NHC 5	-40141.722	5918718.779	984.493
NHC 6	-37383.967	5921631.608	958.818
NHC 7	-32616.800	5924298.946	967.363
Can-Net HNTN	-41188.399	5917343.898	1037.226

**Table 2 Control network errors in millimetres**

Point Name	Easting	Northing	Elevation
NHC 1	2.1	1.8	5.7
NHC 2	1.6	1.5	4.7
NHC 3	1.6	1.4	3.8
NHC 4	1.5	1.4	3.8
NHC 5	1.6	1.4	3.4
NHC 6	1.8	1.6	3.9
NHC 7	2.3	1.9	5.6
Can-Net HNTN	Constrained to published coordinates		

Five local Alberta Survey Control Monuments (ASCM) were tied into the control network. These monuments are no longer being maintained or inspected and are not included in the CSRS subset. In addition, ASCM 337097 was established by inertial survey methods that are accurate to between 0.5 and 1.0 m and should not be relied upon. Therefore, published coordinates for these ASCMs were not suitable to constrain the control network adjustment.

The coordinates of the specified ASCMs were adjusted to the control network reference, and adjusted coordinates for these ASCMs are provided in **Table 3**. Residuals between published and adjusted coordinates for the four remaining monuments (excluding ASCM 337097) were within 52 mm horizontally and 116 mm vertically.



**Table 3 Adjusted coordinates for local Alberta Survey Control Monuments in metres**

Point Name	Easting	Northing	Elevation
ASCM 42887	-42382.675	5916178.730	1032.795
ASCM 422758	-39357.133	5918674.907	1014.754
ASCM 337097	-35784.303	5924740.921	1018.187
ASCM 260273	-35833.419	5920202.670	1044.461
ASCM 185850	-47658.702	5915956.893	1049.984

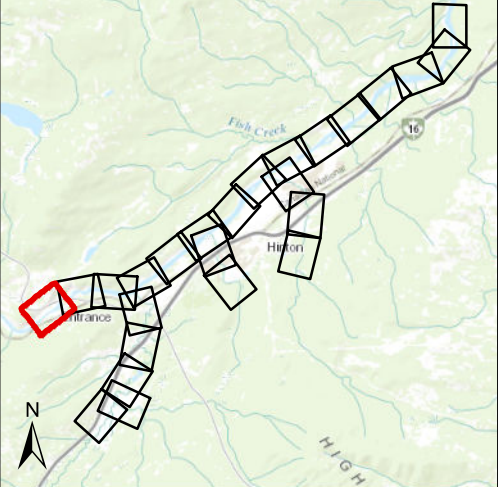
## 2.2 Cross Sections

River cross section locations were selected to ensure adequate representation of the channel geometry for hydraulic modelling. The cross section survey was divided into reaches corresponding to each river or creek. Each cross section was assigned an index number increasing in the upstream direction for reference purposes. In total, 638 cross sections were surveyed; a detailed breakdown by reach is provided in **Table 4**. Surveyed section locations and associated survey points are shown in **Figure 2**.

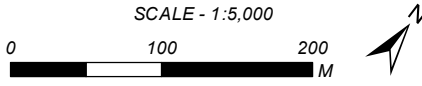
**Table 4 River cross section survey summary**

Stream	Approximate reach length	Number of cross sections	Average cross section spacing	Maximum cross section spacing
Athabasca River	22.9 km	54	433 m	702 m
Hardisty Creek	6.1 km	125	48.8 m	102 m
Happy Creek	3.6 km	73	50.0 m	330 m
Maskuta Creek	15.5 km	333	46.5 m	121 m
Cold Creek	2.8 km	53	53.5 m	138 m





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



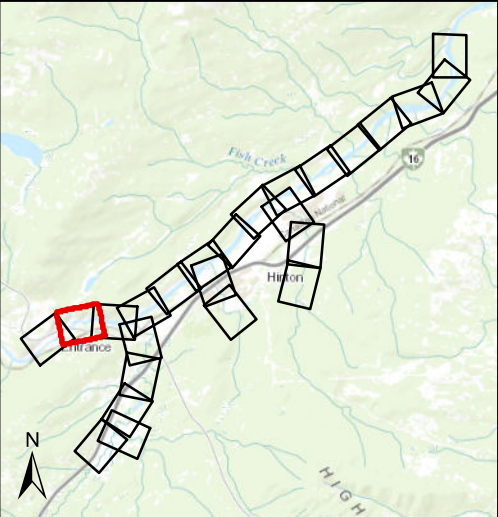
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Units: METRES

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Job Number	1006665	Date	02-MAR-2022		

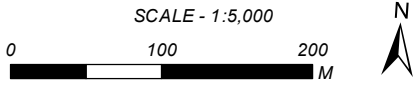
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [1/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



Coordinate System: NAD 1983 3TM 117  
Units: METRES

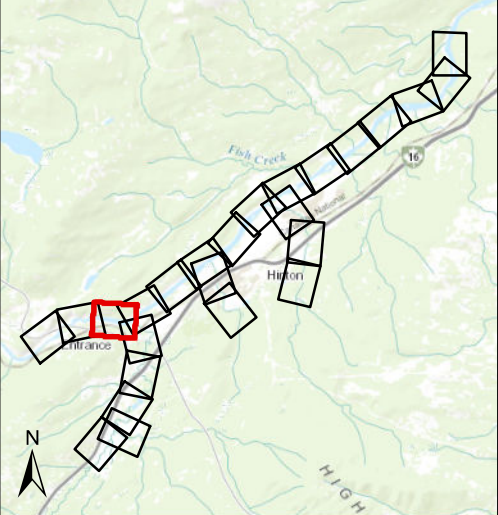
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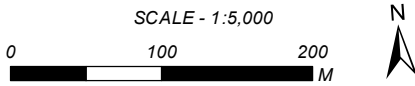
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [2/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

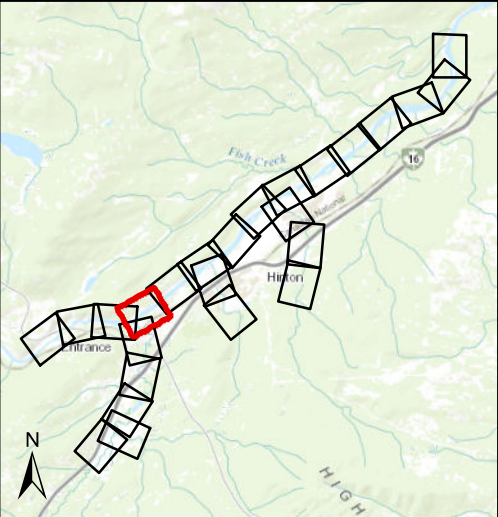


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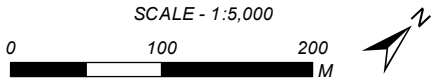
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [3/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



Coordinate System: NAD 1983 3TM 117  
Units: METRES

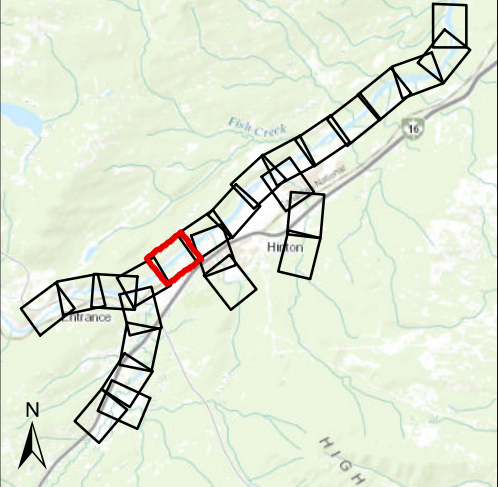
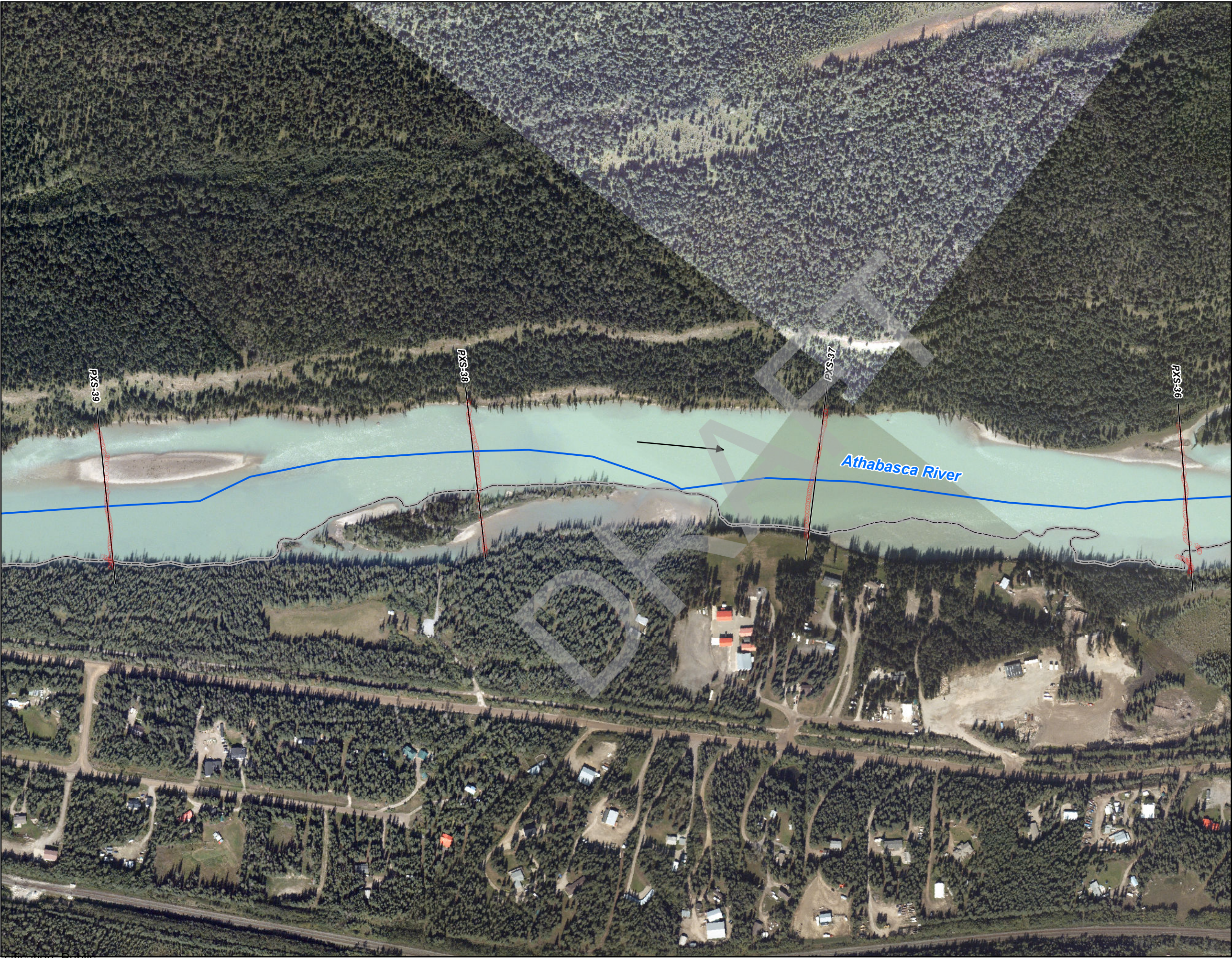
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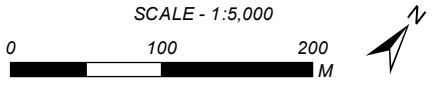
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [4/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



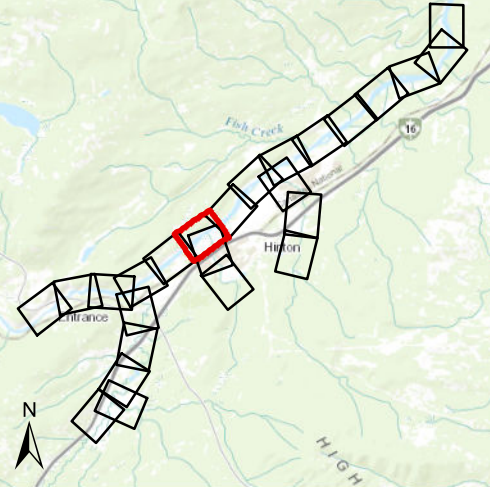
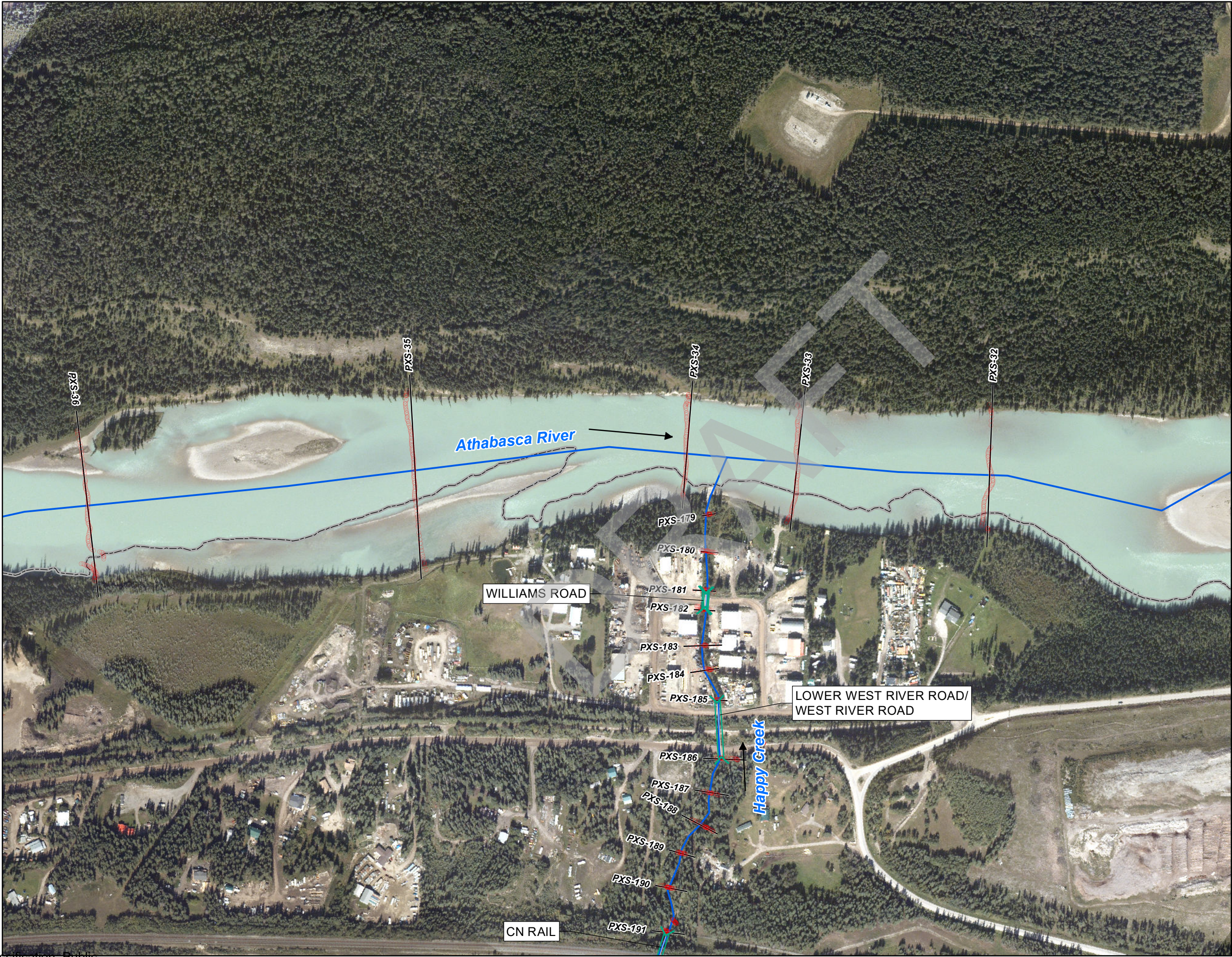
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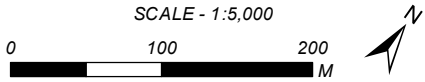
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [5/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



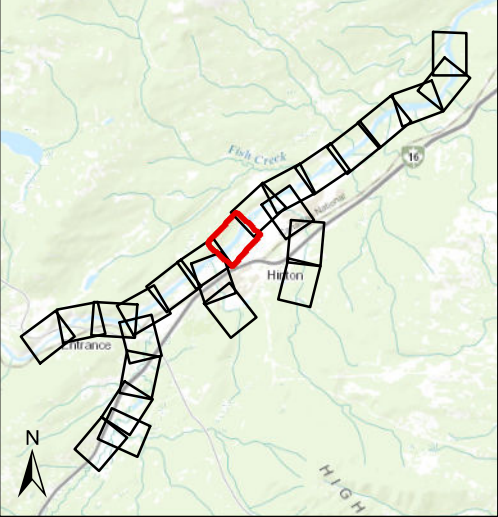
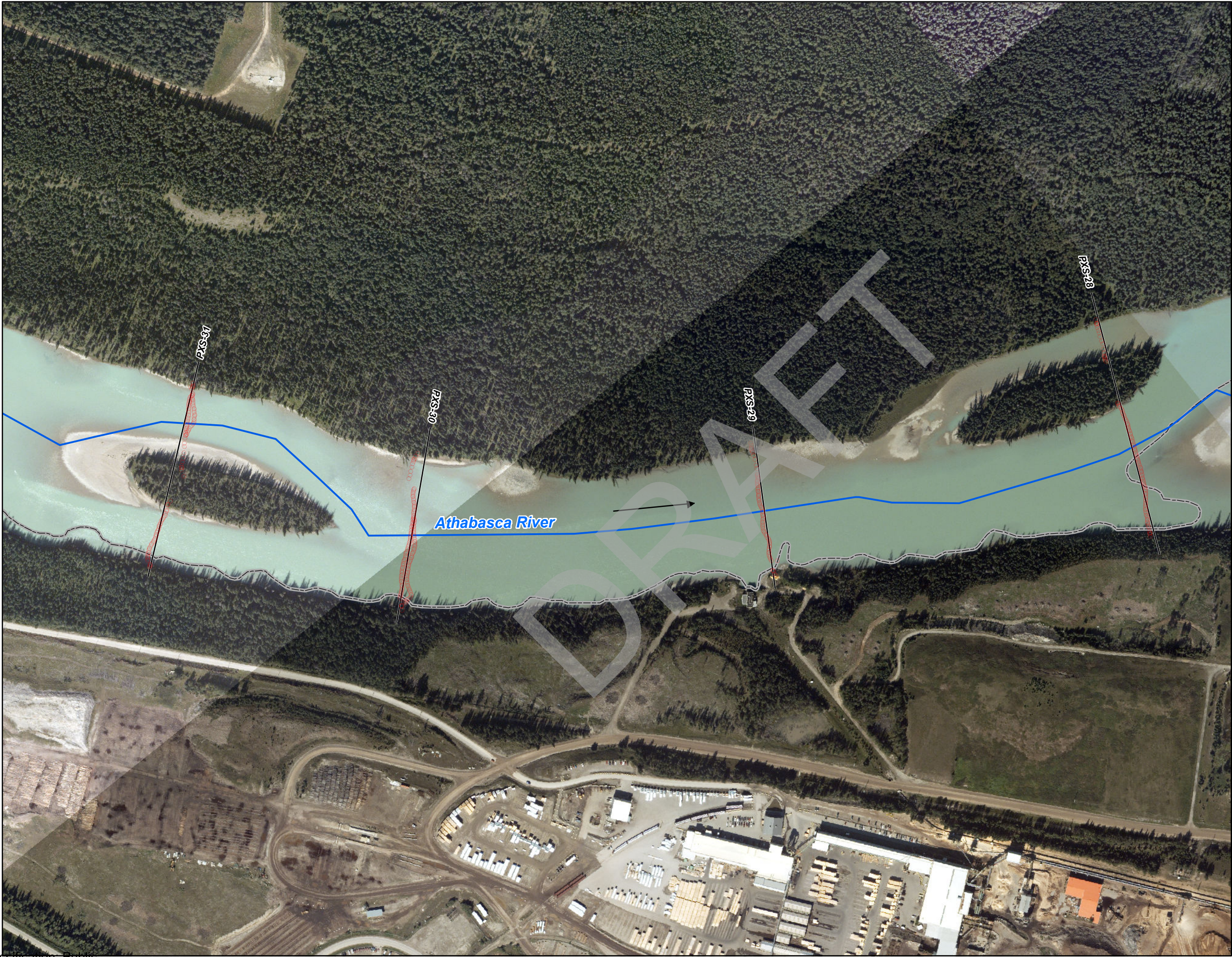
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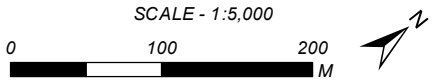
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [6/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



Coordinate System: NAD 1983 3TM 117  
Units: METRES

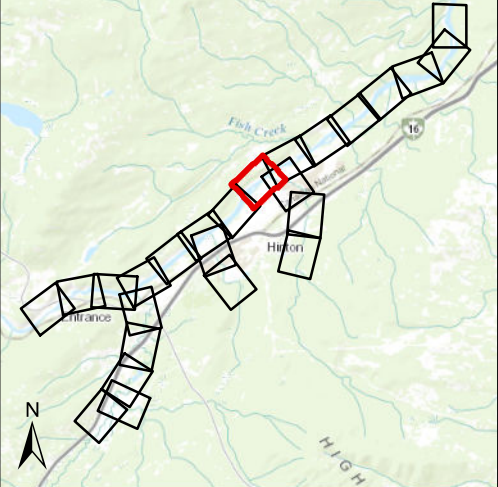
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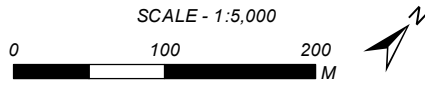
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [7/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

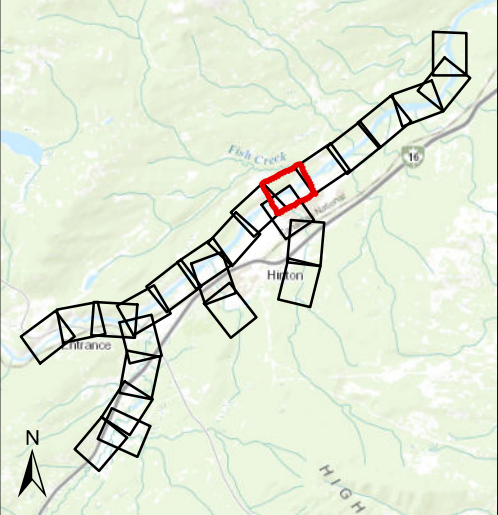


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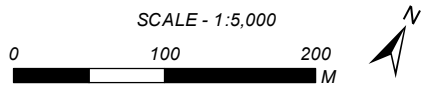
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [8/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

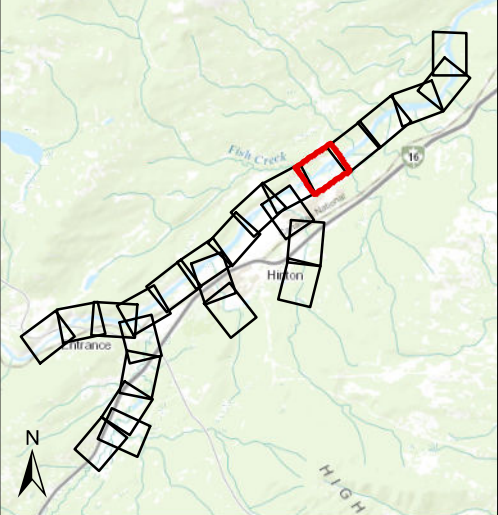


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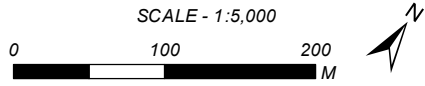
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [9/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



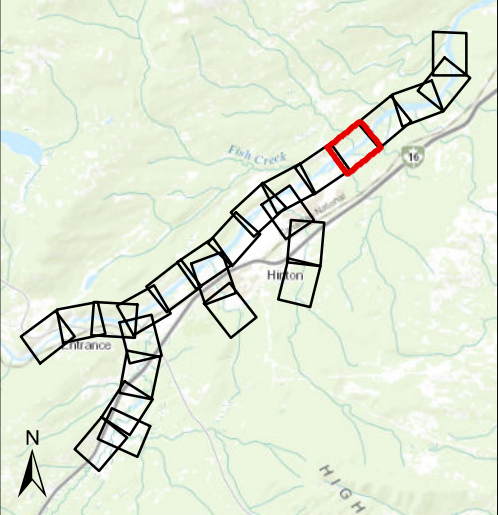
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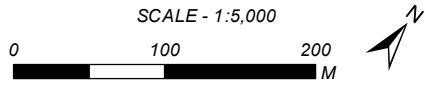
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [10/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



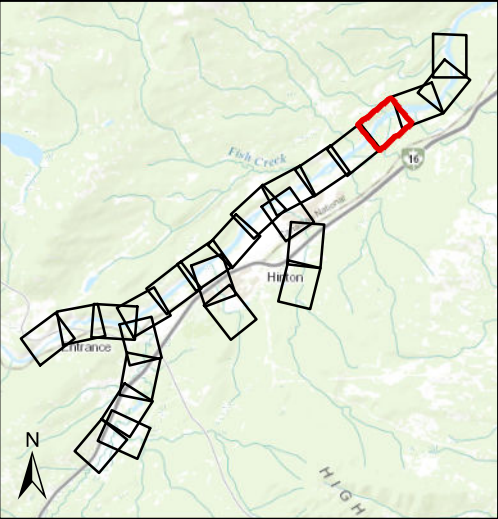
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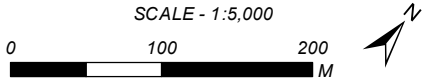
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [11/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
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- Survey Point



Coordinate System: NAD 1983 3TM 117  
Units: METRES

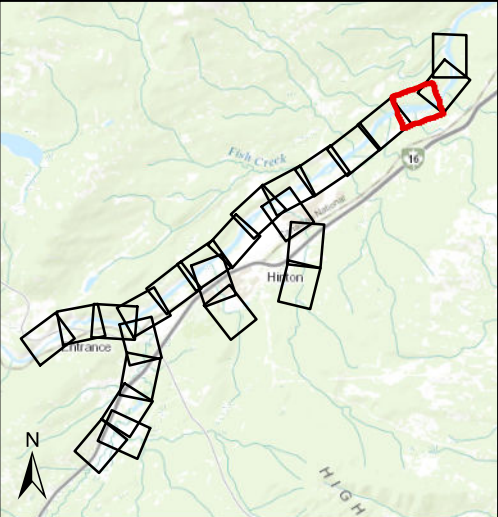
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Job Number	1006665	Date	02-MAR-2022
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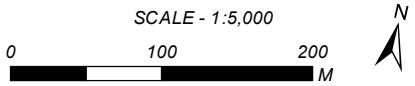
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [12/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



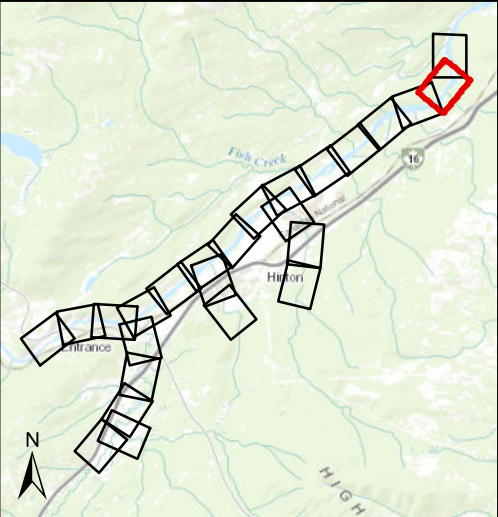
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Units: METRES

Engineer	RBA	GIS	RBA	Reviewer	PGV
Job Number	1006665	Date	02-MAR-2022		

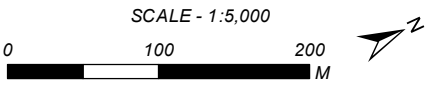
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [13/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



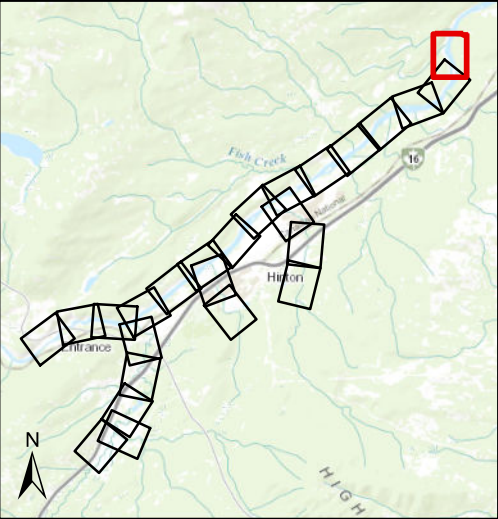
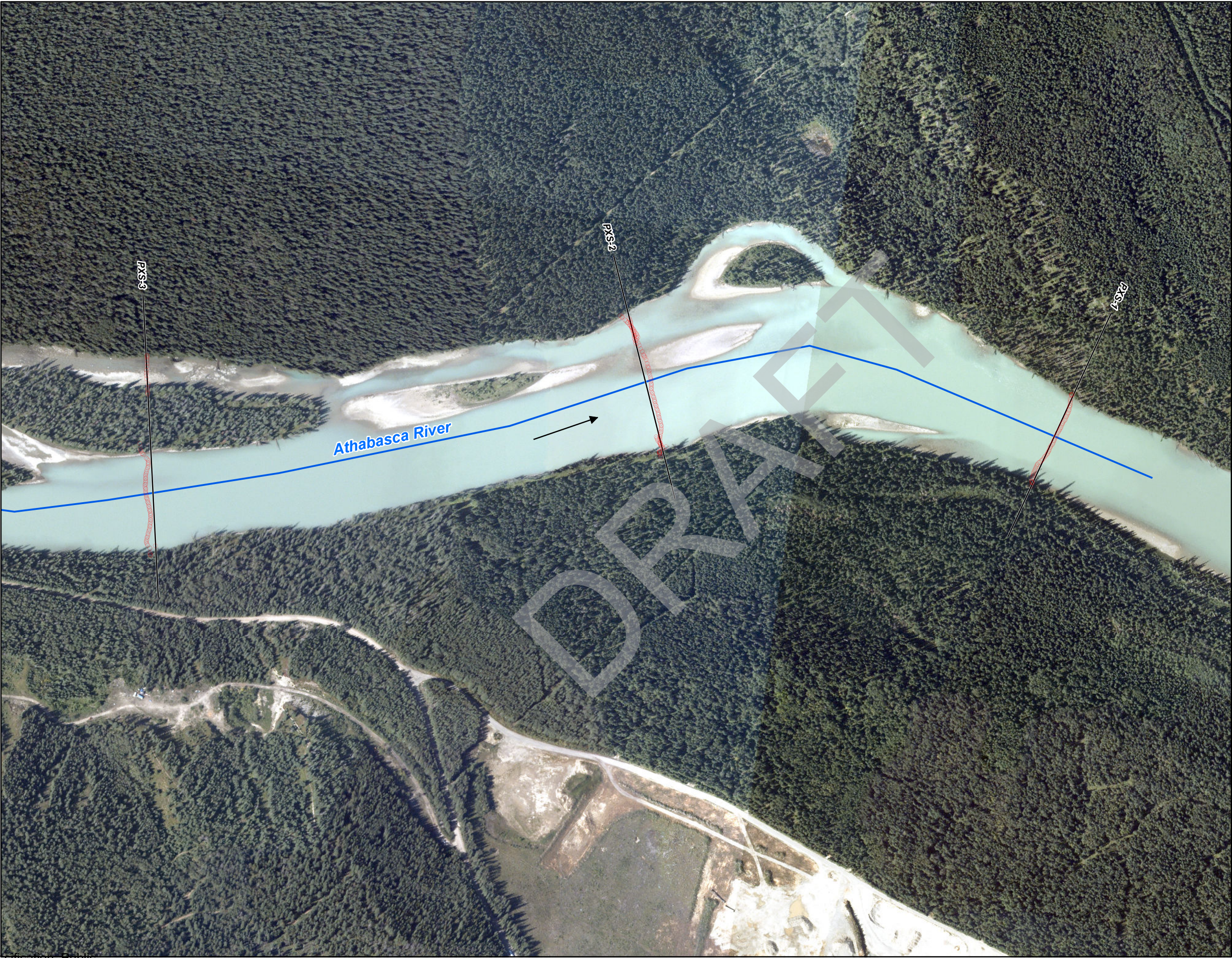
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Units: METRES

Engineer	RBA	GIS	RBA	Reviewer	PGV
Job Number	1006665		Date	02-MAR-2022	

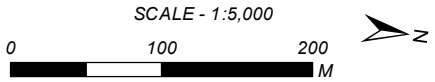
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [14/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



Coordinate System: NAD 1983 3TM 117  
Units: METRES

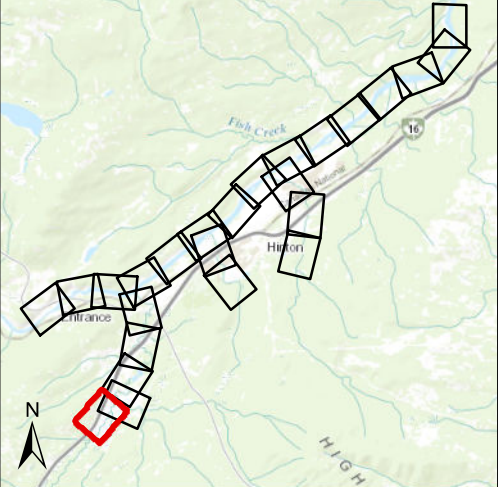
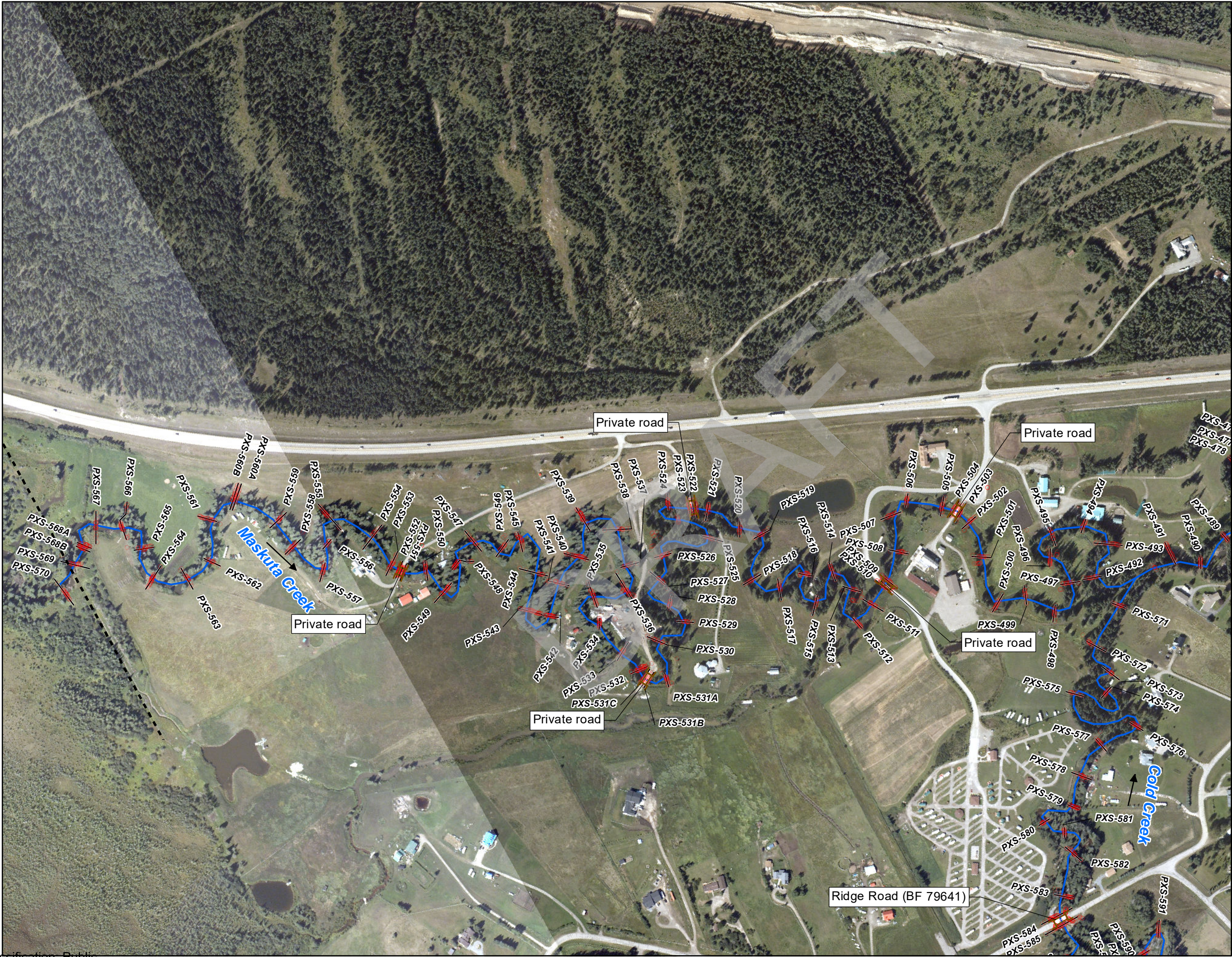
Engineer	RBA	GIS	RBA	Reviewer	PGV
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Job Number	1006665	Date	02-MAR-2022
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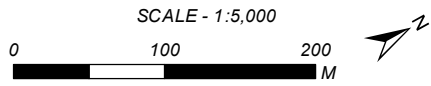
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [15/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

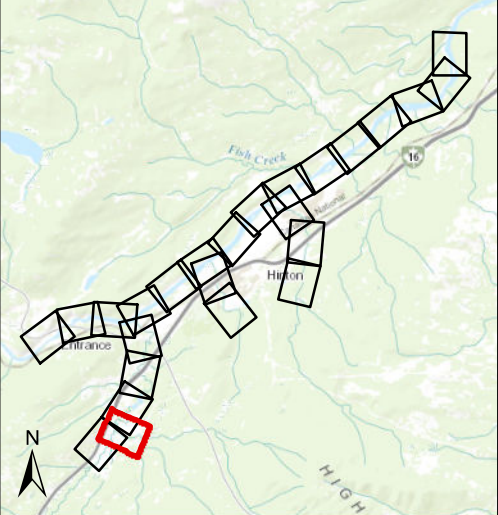
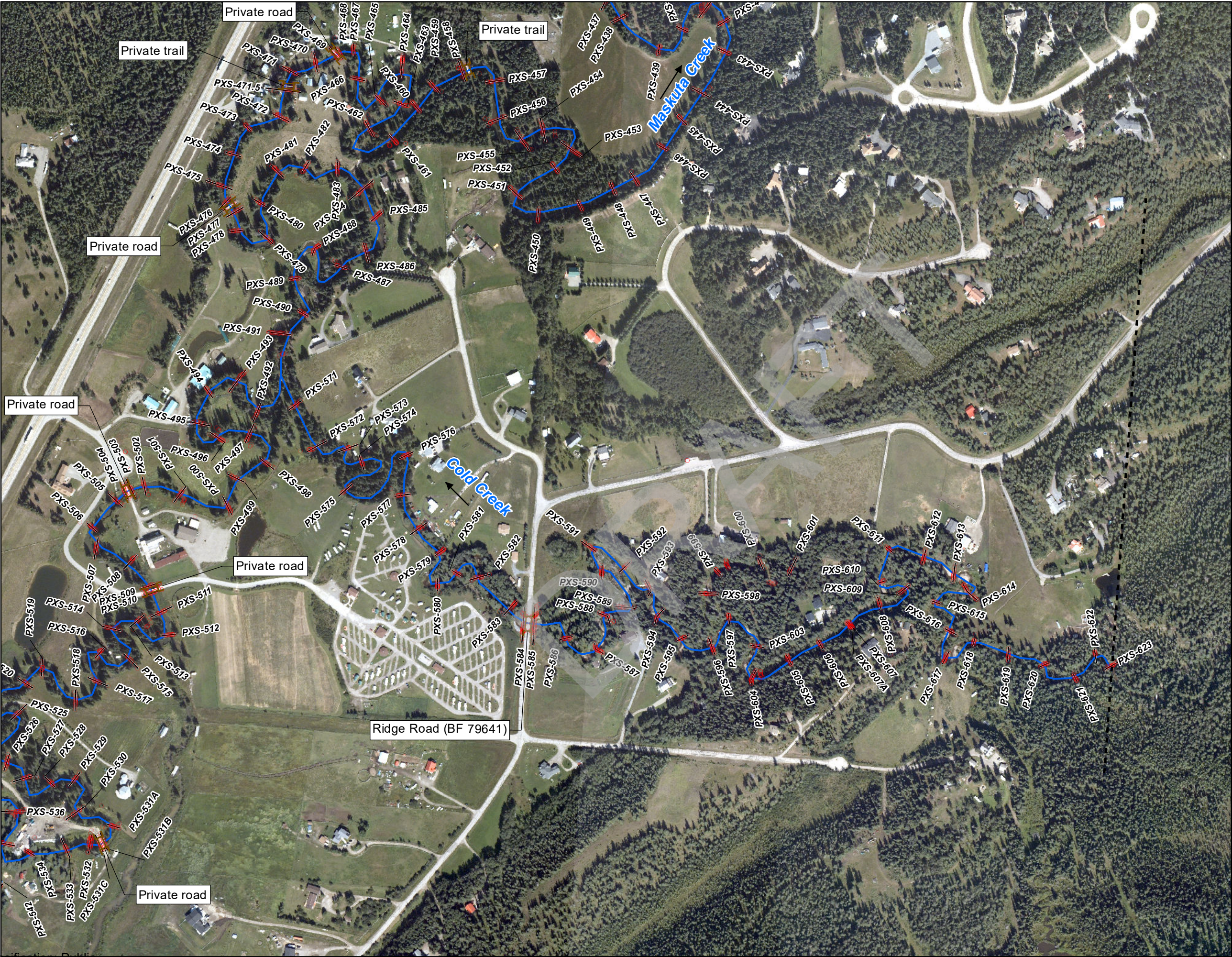


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Units: METRES			
Engineer	RBA	GIS	Reviewer
		RBA	PGV
Job Number		Date	
1006665		02-MAR-2022	

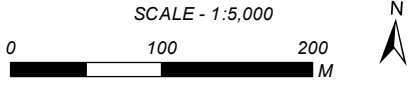
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [16/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

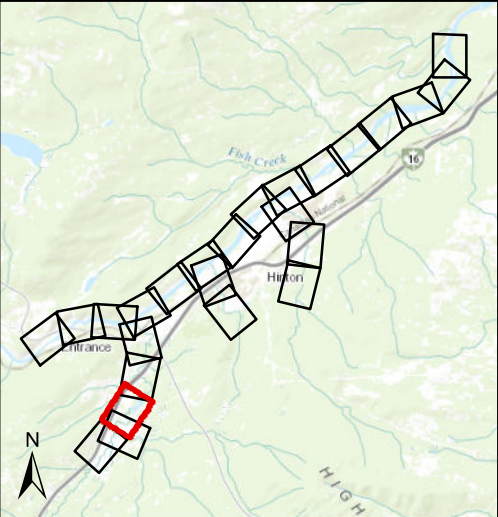
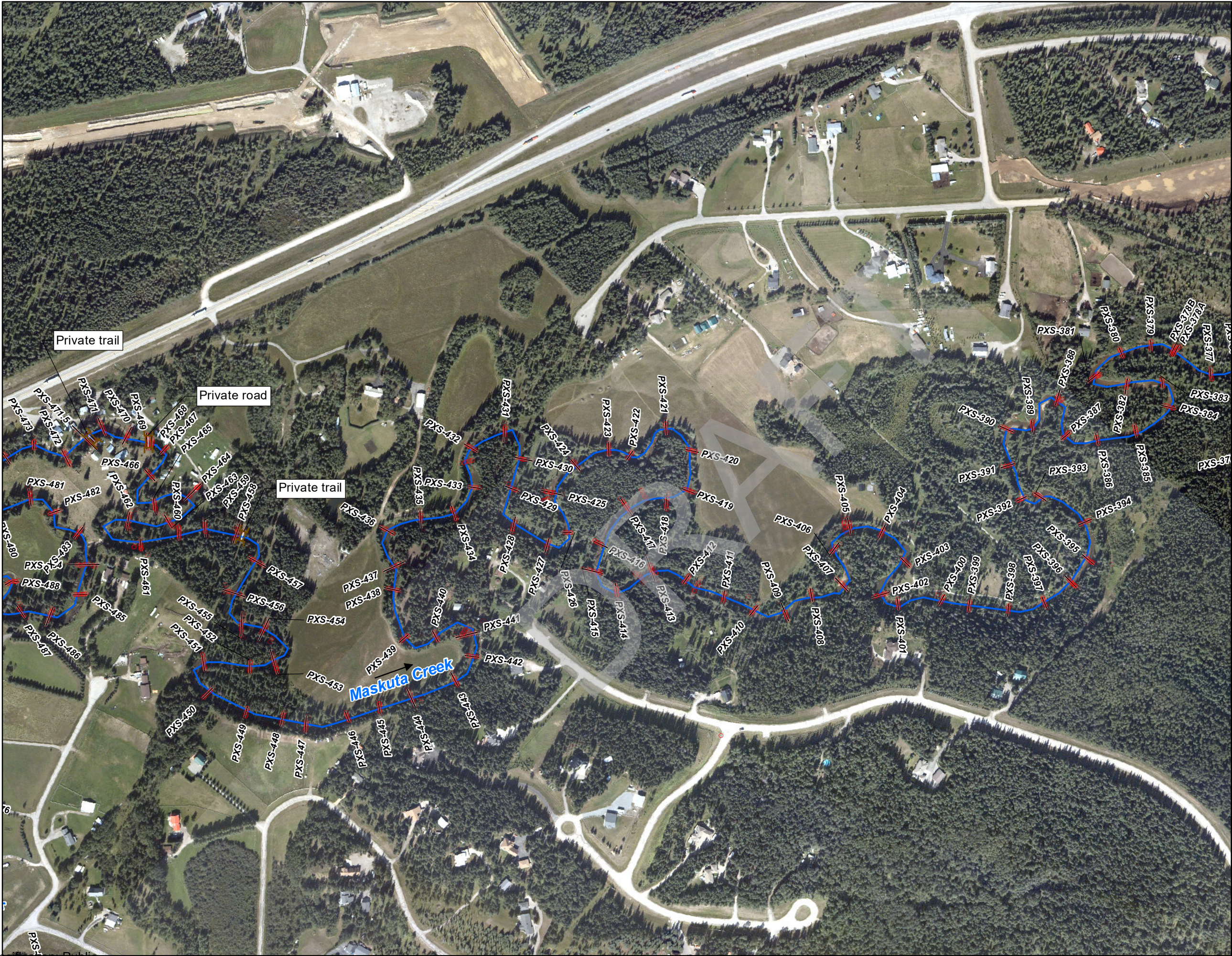


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Units: METRES

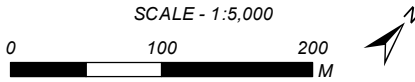
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Job Number	1006665	Date	02-MAR-2022		

HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

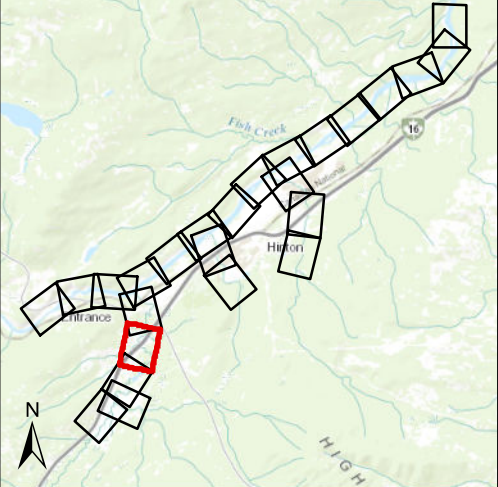


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Units: METRES

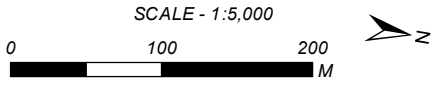
Engineer	RBA	GIS	RBA	Reviewer	PGV
Job Number	1006665		Date	02-MAR-2022	

HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



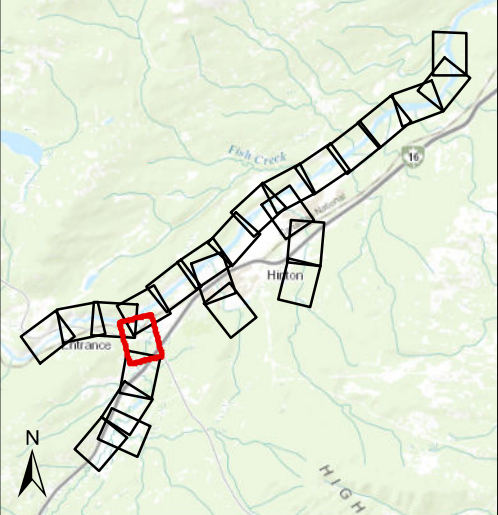
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Engineer	RBA	GIS	RBA	Reviewer	PGV
Job Number	1006665		Date	02-MAR-2022	

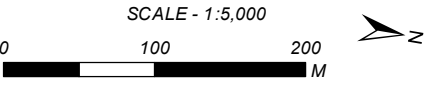
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [19/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

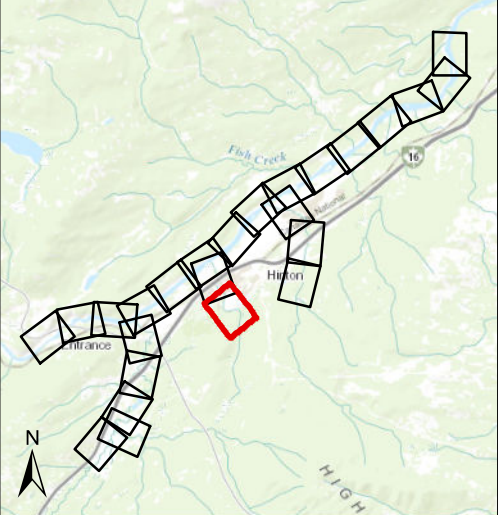


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Units: METRES

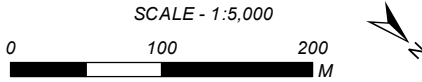
Engineer	RBA	GIS	RBA	Reviewer	PGV
Job Number	1006665		Date	02-MAR-2022	

HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



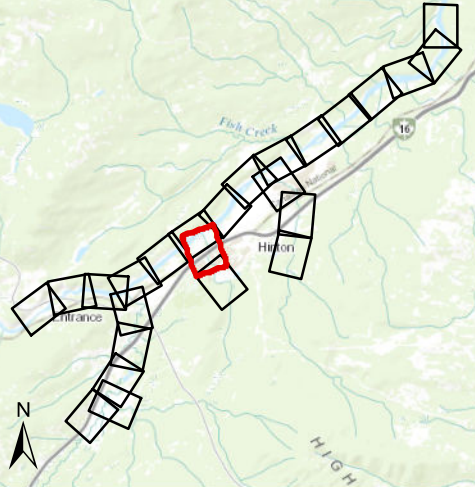
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Units: METRES

Engineer	RBA	GIS	RBA	Reviewer	PGV
Job Number	1006665	Date	02-MAR-2022		

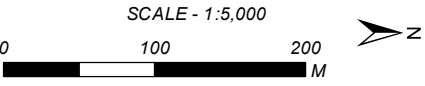
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [21/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

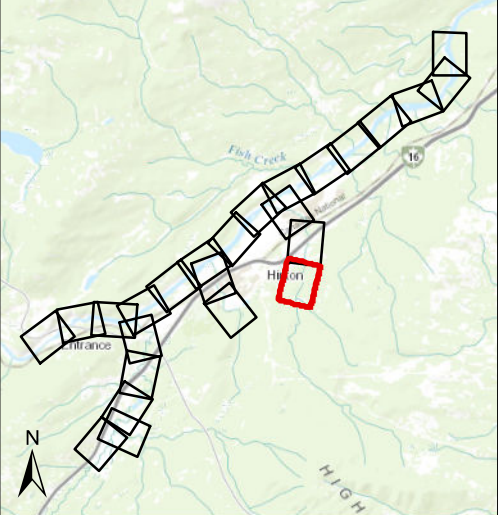
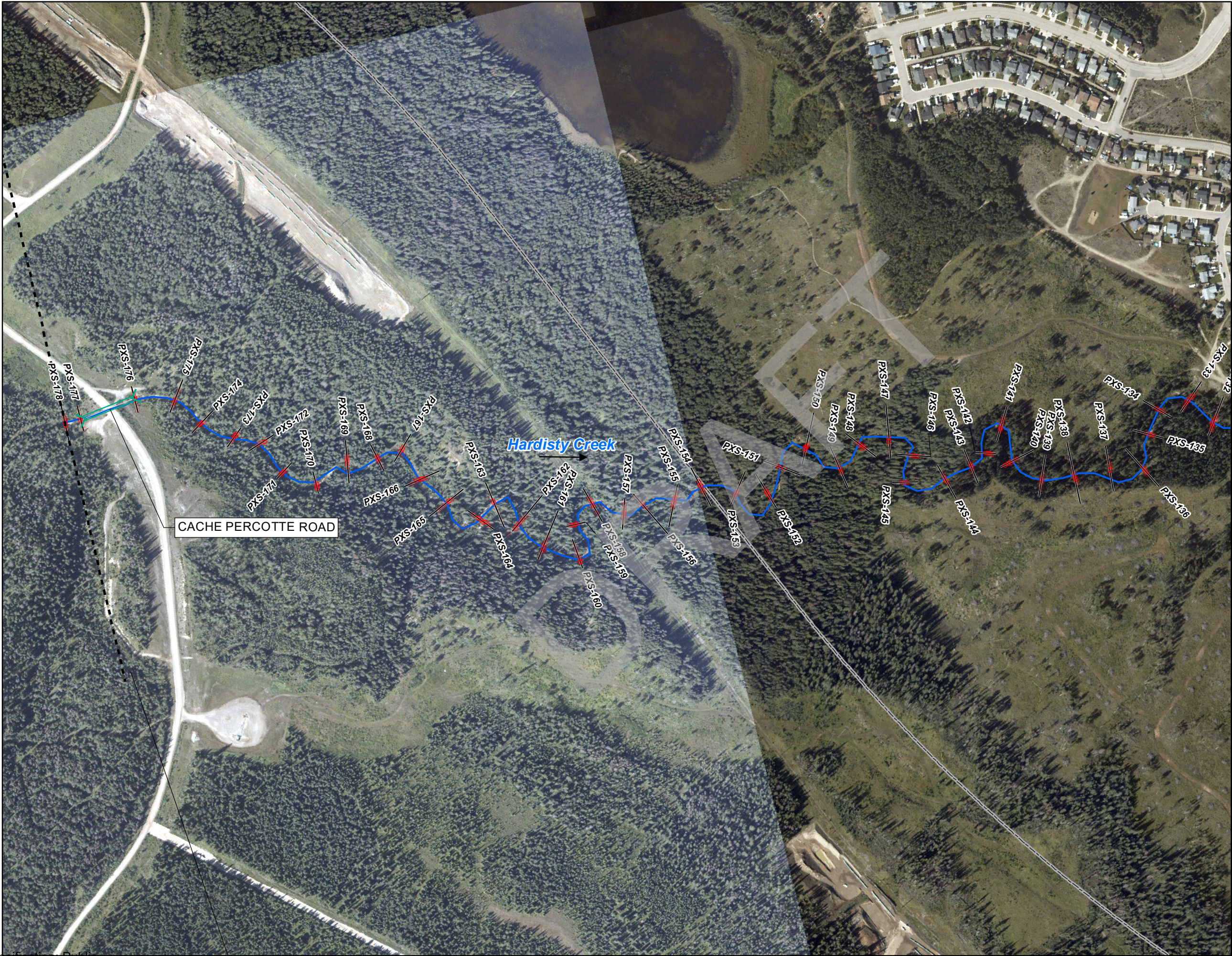


Coordinate System: NAD 1983 3TM 117 Units: METRES		
Engineer RBA	GIS RBA	Reviewer PGV
Job Number 1006665	Date 02-MAR-2022	

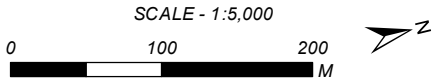
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [22/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



Coordinate System: NAD 1983 3TM 117  
Units: METRES

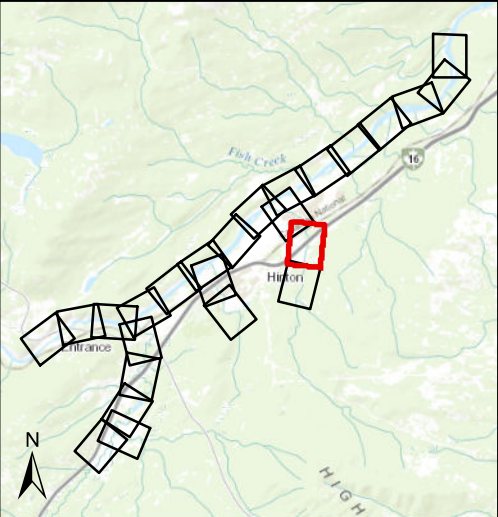
Engineer	RBA	GIS	RBA	Reviewer	PGV
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Job Number	1006665	Date	02-MAR-2022
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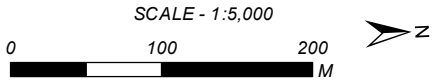
HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**

FIGURE 2 [23/25]





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point

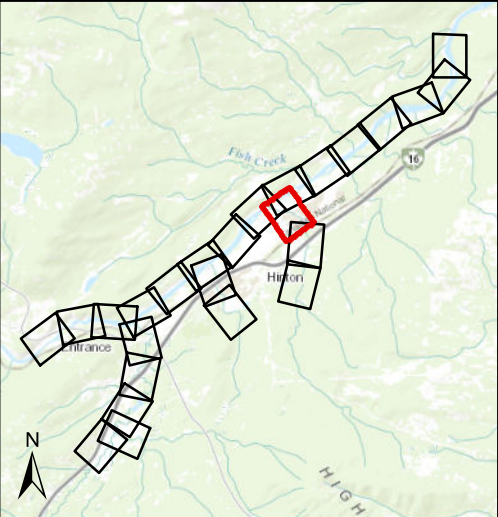


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Units: METRES

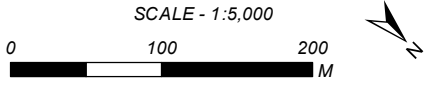
Engineer	RBA	GIS	RBA	Reviewer	PGV
Job Number	1006665	Date	02-MAR-2022		

HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**





- Town
- County or Municipal District
- Study Reach
- Bridge
- Culvert
- Cross Section
- Survey Point



Coordinate System: NAD 1983 3TM 117  
Units: METRES

Engineer	RBA	GIS	RBA	Reviewer	PGV
Job Number	1006665		Date	02-MAR-2022	

HINTON FLOOD STUDY  
SURVEY DATA COLLECTION  
**CROSS SECTION AND  
HYDRAULIC STRUCTURE  
LOCATIONS**



## 2.3 Hydraulic Structures

**Table 5** summarizes the hydraulic structures in the study reach. Alberta Transportation (AT) Bridge File (BF) numbers are provided with the structure description, where applicable. A total of 26 bridges and 12 culvert crossings were identified and surveyed. There are no weirs within the study area. Hydraulic structure locations are shown in **Figure 2**.

Additional bridge and culvert details are provided in Appendix B. The data collected at each bridge includes: span length; deck width; top of curb or solid guardrail elevations; low chord elevations; number, width, type, shape, and location of piers; top of deck elevations; and photographs of the bridge. Culvert information collected includes: culvert type, shape, dimensions and length; entrance condition; upstream and downstream invert elevations; road elevations; and photographs of the culvert.

**Table 5 Hydraulic structure summary**

Location	Structure type	Description
<b>Athabasca River</b>		
PXS-22/21	Bridge	Willow Creek Road (BF 76044)
PXS-51/50	Bridge	Highway 40 (BF 70580)
<b>Hardisty Creek</b>		
PXS-62/61	Bridge	West River Road
PXS-77/76	Bridge	Switzer Drive (BF 70883)
PXS-81B/81A	Bridge	Pedestrian trail
PXS-86/85	Culvert	Hardisty Avenue
PXS-96	Bridge	Pedestrian trail
PXS-98/97	Culvert	CN Rail
PXS-107	Bridge	Pedestrian trail
PXS-109/108	Culvert	Yellowhead Highway (BF 74348)
PXS-116/115	Culvert	Brookhart Street
PXS-130/129	Culvert	Bradwell Street
PXS-177/176	Culvert	Cache Percotte Road (BF 78284)
<b>Happy Creek</b>		
PXS-182/181	Culvert	Williams Road
PXS-186/185	Culvert	Lower West River Road and W River Road
PXS-192/191	Culvert	CN Rail
PXS-195/184	Culvert	Yellowhead Highway



**Table 5     Hydraulic structure summary (continued)**

Location	Structure type	Description
PXS-201.5B/A	Culvert	Pedestrian trail
PXS-203/202	Culvert	Wanyandi Way
PXS-210B/A	Bridge	Pedestrian trail
PXS-230.5B/A	Bridge	Pedestrian trail
PXS-237	Bridge	Pedestrian trail
PXS-241	Bridge	Beaver Boardwalk
<b>Maskuta Creek</b>		
PXS-259/258	Bridge	CN Rail
PXS-333/332	Bridge	Private road
PXS-341/340	Bridge	WB Yellowhead Highway
PXS-343/342	Bridge	EB Yellowhead Highway
PXS-350B/A	Bridge	Temporary construction access road
PXS-458	Bridge	Private trail
PXS-469/468	Bridge	Private road
PXS-471.5	Bridge	Private trail
PXS-477/476	Bridge	Private road
PXS-504/503	Bridge	Private road
PXS-510/509	Bridge	Private road
PXS-523/522	Bridge	Private road
PXS-531C/B	Bridge	Private road
PXS-552/551	Bridge	Private road
<b>Cold Creek</b>		
PXS-585/584	Bridge	Ridge Road (BF 79641)

## 2.4 Flood Control Structures

Based on the information available from AEP and local authorities, it was determined that there are no dedicated flood control structures within the study reach. This was also observed during the field survey.

Additional information regarding flood control structure classification is provided in Appendix C.



## 2.5 Other Features

Reach-representative channel and floodplain photographs are provided in Appendix D, and a complete set of geo-located photographs in Google Earth KMZ file format are included with the digital study file.

Some notable features within the study area include:

- hanging culvert outlets in several locations along Hardisty Creek;
- a large beaver dam and lake near the upper end of Happy Creek known as the Beaver Boardwalk park;
- a culvert with multiple drop manholes conveying Happy Creek under the Yellowhead Highway; and
- multiple beaver dams along Maskuta Creek, above the Yellowhead Highway.

The Athabasca River appears to have minimal floodplain, but the study reach does contain a number of large islands and mid-channel bars. Hardisty and Happy creeks are relatively steep streams, also with minimal floodplain evident from the survey. Above the Yellowhead Highway, Maskuta Creek is a tortuously meandering stream through a relatively wide, flat plain that is heavily treed in some areas. Cold Creek is also a meandering stream through dense forest. One significant oxbow channel was encountered between PXS-598 to 602.

## 2.6 Discharge Measurements

A discharge measurement of 296 m<sup>3</sup>/s was obtained 11 August 2021 on the Athabasca River that corresponds with the surveyed water surface profile along that reach. The discharge was measured using Water Survey of Canada (WSC) standard procedures and a boat-mounted Sontek M9 RiverSurveyor Acoustic Doppler Current Profiler (ADCP). The ADCP has an accuracy of  $\pm 0.25\%$  of measured velocity and can provide measurements in depths ranging from 0.06 m to 40 m.

There was no measurable discharge on the tributaries during the survey.

## 2.7 Flood Highwater Mark Investigation

There are no existing highwater mark surveys for the study area in AEP records. Flood history documentation for the area is also very limited. No substantive evidence of recent highwater marks were found during the cross section survey.

## 2.8 Survey Standards and Accuracy

The GNSS receivers used for the survey are accurate to  $\pm 0.02$  m under optimal operating conditions. Optimal operating conditions are when the GNSS receiver is mounted to a tripod with a clear view of the sky and sufficient satellites to accurately establish the receiver position. Additional error may be introduced when the receiver is off-level, obstructed by nearby trees or vegetation, or the instrument height is incorrectly recorded. The overall expected accuracy of ground-based survey points is  $\pm 0.05$  m,



except in rare cases when points were surveyed in tree cover or near high, steep banks. The digital echo sounder used for the boat-based surveys has an expected accuracy of  $\pm 0.01$  m. However, due to the pitch and roll of the boat when it is in motion, the overall expected accuracy of the boat-based survey is  $\pm 0.07$  m.

## 2.9 LiDAR-Derived DTM Comparison

A fully-processed and hydro-flattened bare earth DTM was provided by AEP on 25 January 2022. The LiDAR derived DTM is reported to have a vertical accuracy of  $\pm 0.15$  m at 95% on hard, flat, open surfaces, based on a set of independently collected verification points.

DTM elevations were compared with elevations obtained by NHC at selected ground topography survey coordinates. Based on 3869 sampled top of bank and overbank ground elevations surveyed, elevations in the DTM were on average 0.032 m higher than the survey with a standard deviation of 0.295 m. Since the sample set included mostly irregular, mildly sloping terrain in heavily treed areas, larger magnitude differences between the survey and DTM are to be expected. A visual comparison of surveyed and DTM cross section profiles indicated no significant horizontal or vertical inconsistencies between the two datasets. Based on this, there is satisfactory agreement between the survey and the DTM data.

## 3 CONCLUSIONS

River cross sections were surveyed along 22.9 km of the Athabasca River, 6.1 km of Hardisty Creek, 3.6 km of Happy Creek, 15.5 km of Maskuta Creek, and 2.8 km of Cold Creek. In total, 638 cross sections were surveyed using a combination of boat-based bathymetric and ground surveys to complement the LiDAR-derived DTM. In addition, geometric details were collected for 26 bridges and 12 culverts.

The expected overall accuracy of the measurements is  $\pm 0.07$  m horizontally and vertically for the boat-based bathymetric points and  $\pm 0.05$  m horizontally and vertically for the ground-based survey points. Comparison of the LiDAR-derived DTM and ground survey points showed that the two data sets are consistent, indicating that the DTM is suitable for use in hydraulic model development and flood mapping.

## 4 REFERENCES

Natural Resources Canada. (2021). Geodetic tools and data, Canadian Geodetic Survey, online resource <https://www.nrcan.gc.ca/earth-sciences/geomatics/geodetic-reference-systems/tools-applications/10925#ppp> [updated 8 November 2021; accessed 17 January 2022]



# **APPENDIX A**

## **CONTROL NETWORK SURVEY DETAILS**





# CSRS-PPP 3.50.0 (2021-03-10)



31272201.21o

1

<b>Data Start</b>	<b>Data End</b>	<b>Duration of Observations</b>
2021-08-08 14:23:00.00	2021-08-08 16:22:30.00	1:59:30
<b>Processing Time</b>		<b>Product Type</b>
23:54:28 UTC 2021/08/08		NRCan Ultra-rapid
<b>Observations</b>	<b>Frequency</b>	<b>Mode</b>
Phase and Code	Double	Static
<b>Elevation Cut-Off</b>	<b>Rejected Epochs</b>	<b>Fixed Ambiguities</b>
7.5 degrees	0.00 %	62.25 %
<b>Antenna Model</b>	<b>APC to ARP</b>	<b>ARP to Marker</b>
TRMR10 NONE	L1 = 0.128 m L2 = 0.120 m	H:1.826m / E:0.000m / N:0.000m

(APC = antenna phase center; ARP = antenna reference point)

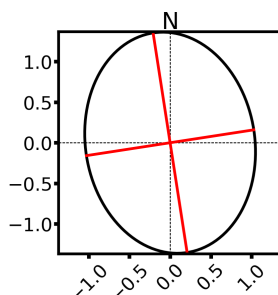
## Estimated Position for 31272201.21o

	<b>Latitude (+n)</b>	<b>Longitude (+e)</b>	<b>Ell. Height</b>
<b>NAD83(CSRS) (2021.6)</b>	53° 21' 57.37693"	-117° 46' 3.09671"	1039.383 m
<b>Sigmas(95%)</b>	0.011 m	0.008 m	0.041 m
<b>A priori*</b>	53° 21' 57.43586"	-117° 46' 3.13603"	1040.003 m
<b>Estimated -A priori</b>	-1.822 m	0.727 m	-0.619 m

**Orthometric Height**  
**CGVD28 (HTv2.0)†**

1053.652 m  
(click for height reference information)

**95% Error Ellipse (cm)**  
semi-major: 1.4 cm  
semi-minor: 1.0 cm  
semi-major azimuth: -8° 13' 5.25"



**UTM (North)**  
**Zone 11**

5913253.887 m (N)  
448927.991 m (E)  
Scale Factors  
0.99963201 (point)  
0.99946929 (combined)

\*(Coordinates from RINEX header used as a priori position)

†(Epoch transformation using velocity grid NAD83v70VG (click for documentation))



**~~~ Disclaimer ~~~**

**Natural Resources Canada does not assume any liability deemed to have been caused directly or indirectly by any content of its CSRS-PPP online positioning service.**

**If you have any questions, please feel free to contact:**

**Geodetic Integrated Services  
Canadian Geodetic Survey  
Surveyor General Branch  
Natural Resources Canada  
Government of Canada  
588 Booth Street, Room 334  
Ottawa, Ontario K1A 0Y7  
Phone: 343-292-6617**

**Email: [nrcan.geodeticinformation-informationgeodesique.rncan@canada.ca](mailto:nrcan.geodeticinformation-informationgeodesique.rncan@canada.ca)**



**Natural Resources  
Canada**

**Ressources naturelles  
Canada**

**Canada**

DRAFT





# CSRS-PPP 3.50.0 (2021-03-10)



29312200.21o  
2

<b>Data Start</b>	<b>Data End</b>	<b>Duration of Observations</b>
2021-08-08 14:40:30.00	2021-08-08 17:42:00.00	3:01:30
<b>Processing Time</b>		<b>Product Type</b>
23:53:43 UTC 2021/08/08		NRCan Ultra-rapid
<b>Observations</b>	<b>Frequency</b>	<b>Mode</b>
Phase and Code	Double	Static
<b>Elevation Cut-Off</b>	<b>Rejected Epochs</b>	<b>Fixed Ambiguities</b>
7.5 degrees	0.00 %	93.07 %
<b>Antenna Model</b>	<b>APC to ARP</b>	<b>ARP to Marker</b>
TRMR10 NONE	L1 = 0.128 m L2 = 0.120 m	H:1.935m / E:0.000m / N:0.000m
(APC = antenna phase center; ARP = antenna reference point)		

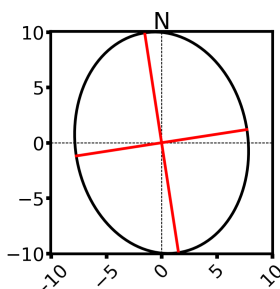
## Estimated Position for 29312200.21o

	Latitude (+n)	Longitude (+e)	Ell. Height
<b>NAD83(CSRS) (2021.6)</b>	53° 22' 22.53938"	-117° 42' 39.64890"	1016.589 m
<b>Sigmas(95%)</b>	0.008 m	0.006 m	0.030 m
<b>A priori*</b>	53° 22' 22.55086"	-117° 42' 39.72150"	1017.266 m
<b>Estimated -A priori</b>	-0.355 m	1.342 m	-0.677 m

**Orthometric Height**  
**CGVD28 (HTv2.0)†**

1031.006 m  
(click for height reference information)

**95% Error Ellipse (mm)**  
semi-major: 10 mm  
semi-minor: 8 mm  
semi-major azimuth: -8° 13' 58.09"



**UTM (North)**  
**Zone 11**

5913992.513 m (N)  
452696.127 m (E)  
Scale Factors  
0.99962746 (point)  
0.99946831 (combined)

\*(Coordinates from RINEX header used as a priori position)

†(Epoch transformation using velocity grid NAD83v70VG (click for documentation))



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# CSRS-PPP 3.50.0 (2021-03-10)



50962200.21o  
3

<b>Data Start</b>	<b>Data End</b>	<b>Duration of Observations</b>
2021-08-08 15:47:00.00	2021-08-08 19:02:30.00	3:15:30
<b>Processing Time</b>		<b>Product Type</b>
23:56:47 UTC 2021/08/08		NRCan Ultra-rapid
<b>Observations</b>	<b>Frequency</b>	<b>Mode</b>
Phase and Code	Double	Static
<b>Elevation Cut-Off</b>	<b>Rejected Epochs</b>	<b>Fixed Ambiguities</b>
7.5 degrees	0.00 %	96.68 %
<b>Antenna Model</b>	<b>APC to ARP</b>	<b>ARP to Marker</b>
TRM60158.00	L1 = 0.085 m L2 = 0.081 m	H:1.970m / E:0.000m / N:0.000m
(APC = antenna phase center; ARP = antenna reference point)		

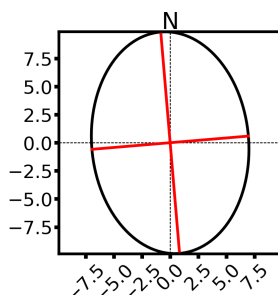
## Estimated Position for 50962200.21o

	<b>Latitude (+n)</b>	<b>Longitude (+e)</b>	<b>Ell. Height</b>
<b>NAD83(CSRS) (2021.6)</b>	53° 22' 44.27130"	-117° 39' 4.47736"	952.054 m
<b>Sigmas(95%)</b>	0.008 m	0.006 m	0.027 m
<b>A priori*</b>	53° 22' 44.27583"	-117° 39' 4.56149"	954.626 m
<b>Estimated -A priori</b>	-0.140 m	1.555 m	-2.572 m

**Orthometric Height**  
**CGVD28 (HTv2.0)†**

966.634 m  
(click for height reference information)

**95% Error Ellipse (mm)**  
semi-major: 10 mm  
semi-minor: 7 mm  
semi-major azimuth: -4° 9' 24.28"



**UTM (North)**  
**Zone 11**

5914626.131 m (N)  
456678.704 m (E)  
Scale Factors  
0.99962303 (point)  
0.99947399 (combined)

\*(Coordinates from RINEX header used as a priori position)

†(Epoch transformation using velocity grid NAD83v70VG (click for documentation))



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# CSRS-PPP 3.50.0 (2021-03-10)



31272202.21o  
4

<b>Data Start</b>	<b>Data End</b>	<b>Duration of Observations</b>
2021-08-08 16:50:00.00	2021-08-08 20:19:00.00	3:29:00
<b>Processing Time</b>		<b>Product Type</b>
23:55:39 UTC 2021/08/08		NRCan Ultra-rapid
<b>Observations</b>	<b>Frequency</b>	<b>Mode</b>
Phase and Code	Double	Static
<b>Elevation Cut-Off</b>	<b>Rejected Epochs</b>	<b>Fixed Ambiguities</b>
7.5 degrees	0.00 %	8.62 %
<b>Antenna Model</b>	<b>APC to ARP</b>	<b>ARP to Marker</b>
TRMR10 NONE	L1 = 0.128 m L2 = 0.120 m	H:1.690m / E:0.000m / N:0.000m
(APC = antenna phase center; ARP = antenna reference point)		

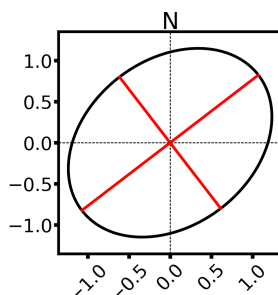
## Estimated Position for 31272202.21o

	<b>Latitude (+n)</b>	<b>Longitude (+e)</b>	<b>Ell. Height</b>
<b>NAD83(CSRS) (2021.6)</b>	53° 20' 28.96005"	-117° 39' 16.98322"	1022.867 m
<b>Sigmas(95%)</b>	0.009 m	0.010 m	0.029 m
<b>A priori*</b>	53° 20' 28.96925"	-117° 39' 17.06168"	1025.892 m
<b>Estimated -A priori</b>	-0.284 m	1.452 m	-3.025 m

**Orthometric Height**  
**CGVD28 (HTv2.0)†**

1037.347 m  
(click for height reference information)

**95% Error Ellipse (cm)**  
semi-major: 1.4 cm  
semi-minor: 1.0 cm  
semi-major azimuth: 52° 27' 13.59"



**UTM (North)**  
**Zone 11**

5910446.885 m (N)  
456409.282 m (E)  
Scale Factors  
0.99962332 (point)  
0.99946319 (combined)

\*(Coordinates from RINEX header used as a priori position)

†(Epoch transformation using velocity grid NAD83v70VG (click for documentation))



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# CSRS-PPP 3.50.0 (2021-03-10)



29312201.21o  
5

<b>Data Start</b>	<b>Data End</b>	<b>Duration of Observations</b>
2021-08-08 18:08:30.00	2021-08-08 21:08:00.00	2:59:30
<b>Processing Time</b>		<b>Product Type</b>
23:54:09 UTC 2021/08/08		NRCan Ultra-rapid
<b>Observations</b>	<b>Frequency</b>	<b>Mode</b>
Phase and Code	Double	Static
<b>Elevation Cut-Off</b>	<b>Rejected Epochs</b>	<b>Fixed Ambiguities</b>
7.5 degrees	0.00 %	0.00 %
<b>Antenna Model</b>	<b>APC to ARP</b>	<b>ARP to Marker</b>
TRMR10 NONE	L1 = 0.128 m L2 = 0.120 m	H:1.900m / E:0.000m / N:0.000m
(APC = antenna phase center; ARP = antenna reference point)		

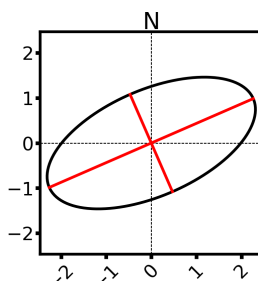
## Estimated Position for 29312201.21o

	Latitude (+n)	Longitude (+e)	Ell. Height
NAD83(CSRs) (2021.6)	53° 24' 0.14771"	-117° 36' 12.81915"	969.833 m
Sigmas(95%)	0.012 m	0.018 m	0.030 m
A priori*	53° 24' 0.22539"	-117° 36' 12.90237"	975.740 m
Estimated -A priori	-2.401 m	1.538 m	-5.906 m

**Orthometric Height**  
CGVD28 (HTv2.0)†

984.542 m  
(click for height reference information)

**95% Error Ellipse (cm)**  
semi-major: 2.5 cm  
semi-minor: 1.2 cm  
semi-major azimuth: 66° 28' 0.07"



**UTM (North)**  
Zone 11

5916942.988 m (N)  
459870.400 m (E)  
Scale Factors  
0.99961976 (point)  
0.99946793 (combined)

\*(Coordinates from RINEX header used as a priori position)

†(Epoch transformation using velocity grid NAD83v70VG (click for documentation))



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# CSRS-PPP 3.50.0 (2021-03-10)



50962201.21o  
6

<b>Data Start</b>	<b>Data End</b>	<b>Duration of Observations</b>
2021-08-08 19:34:30.00	2021-08-08 22:14:00.00	2:39:30
<b>Processing Time</b>		<b>Product Type</b>
00:06:45 UTC 2021/08/09		NRCan Ultra-rapid
<b>Observations</b>	<b>Frequency</b>	<b>Mode</b>
Phase and Code	Double	Static
<b>Elevation Cut-Off</b>	<b>Rejected Epochs</b>	<b>Fixed Ambiguities</b>
7.5 degrees	0.00 %	95.14 %
<b>Antenna Model</b>	<b>APC to ARP</b>	<b>ARP to Marker</b>
TRM60158.00	L1 = 0.085 m L2 = 0.081 m	H:1.970m / E:0.000m / N:0.000m
(APC = antenna phase center; ARP = antenna reference point)		

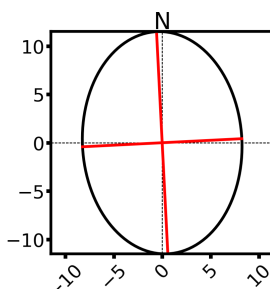
## Estimated Position for 50962201.21o

	<b>Latitude (+n)</b>	<b>Longitude (+e)</b>	<b>Ell. Height</b>
<b>NAD83(CSRS) (2021.6)</b>	53° 25' 35.10165"	-117° 33' 44.79624"	944.052 m
<b>Sigmas(95%)</b>	0.009 m	0.007 m	0.025 m
<b>A priori*</b>	53° 25' 35.15549"	-117° 33' 44.82986"	946.692 m
<b>Estimated -A priori</b>	-1.664 m	0.621 m	-2.640 m

**Orthometric Height**  
**CGVD28 (HTv2.0)†**

958.881 m  
(click for height reference information)

**95% Error Ellipse (mm)**  
semi-major: 11 mm  
semi-minor: 8 mm  
semi-major azimuth: -2° 5' 17.94"



**UTM (North)**  
**Zone 11**

5919854.942 m (N)  
462627.325 m (E)  
Scale Factors  
0.99961714 (point)  
0.99946935 (combined)

\*(Coordinates from RINEX header used as a priori position)

†(Epoch transformation using velocity grid NAD83v70VG (click for documentation))



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# CSRS-PPP 3.50.0 (2021-03-10)



31272203.21o  
7

<b>Data Start</b>	<b>Data End</b>	<b>Duration of Observations</b>
2021-08-08 20:45:00.00	2021-08-08 22:48:30.00	2:03:30
<b>Processing Time</b>		<b>Product Type</b>
00:05:31 UTC 2021/08/09		NRCan Ultra-rapid
<b>Observations</b>	<b>Frequency</b>	<b>Mode</b>
Phase and Code	Double	Static
<b>Elevation Cut-Off</b>	<b>Rejected Epochs</b>	<b>Fixed Ambiguities</b>
7.5 degrees	0.00 %	87.08 %
<b>Antenna Model</b>	<b>APC to ARP</b>	<b>ARP to Marker</b>
TRMR10 NONE	L1 = 0.128 m L2 = 0.120 m	H:1.780m / E:0.000m / N:0.000m

(APC = antenna phase center; ARP = antenna reference point)

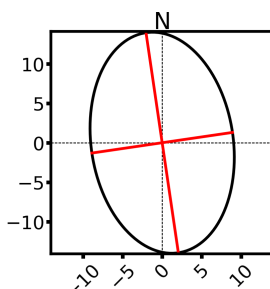
## Estimated Position for 31272203.21o

	<b>Latitude (+n)</b>	<b>Longitude (+e)</b>	<b>Ell. Height</b>
<b>NAD83(CSRS) (2021.6)</b>	53° 27' 2.52461"	-117° 29' 27.60130"	952.424 m
<b>Sigmas(95%)</b>	0.011 m	0.007 m	0.027 m
<b>A priori*</b>	53° 27' 2.55371"	-117° 29' 27.61823"	955.052 m
<b>Estimated -A priori</b>	-0.900 m	0.312 m	-2.628 m

**Orthometric Height**  
**CGVD28 (HTv2.0)†**

967.405 m  
(click for height reference information)

**95% Error Ellipse (mm)**  
semi-major: 14 mm  
semi-minor: 9 mm  
semi-major azimuth: -8° 38' 54.74"



**UTM (North)**  
**Zone 11**

5922521.477 m (N)  
467393.060 m (E)  
Scale Factors  
0.99961305 (point)  
0.99946395 (combined)

\*(Coordinates from RINEX header used as a priori position)

†(Epoch transformation using velocity grid NAD83v70VG (click for documentation))



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DRAFT



Project File Data		Coordinate System	
Name:	1006665 Hinton Flood Study Survey.vce	Name:	Canada/NAD 1983
Size:	97 KB	Zone:	CM117W
Modified:	2021-12-07 9:50:59 AM (UTC:-8)	Datum:	NAD 1983 (Canada)
Time zone:	Pacific Standard Time	Global reference datum:	NAD83(CSRs)v7
Reference number:		Global reference epoch:	2010
Description:		Geoid:	Canada Geoid Model HT2_2002v70
Comment 1:		Vertical datum:	
Comment 2:		Calibrated site:	
Comment 3:			

## Network Adjustment Report

### Adjustment Settings

#### Set-Up Errors

##### GNSS

Error in Height of Antenna: 0.0030 m

Centering Error: 0.0020 m

#### Covariance Display

##### Horizontal:

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.0000 m

Scale on Linear Error [S]: 1.000

##### Three-Dimensional

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.0000 m

Scale on Linear Error [S]: 1.000

### Adjustment Statistics

Number of Iterations for Successful Adjustment: 2

Network Reference Factor: 0.82

Chi Square Test (95%): Passed

Precision Confidence Level: DRMS



Degrees of Freedom:

33

### Post Processed Vector Statistics

Reference Factor: 0.82

Redundancy Number: 33.00

A Priori Scalar: 1.00

### Control Point Constraints

Point ID	Type	East $\sigma$ (Meter)	North $\sigma$ (Meter)	Height $\sigma$ (Meter)	Elevation $\sigma$ (Meter)
<a href="#">HNTN</a>	Global	Fixed	Fixed	Fixed	
Fixed = 0.000001(Meter)					

### Adjusted Grid Coordinates

Point ID	Easting (Meter)	Easting Error (Meter)	Northing (Meter)	Northing Error (Meter)	Elevation (Meter)	Elevation Error (Meter)	Constraint
<a href="#">1</a>	-51087.402	0.0018	5915028.584	0.0021	1053.655	0.0057	
<a href="#">2</a>	-47318.135	0.0015	5915767.418	0.0016	1030.948	0.0047	
<a href="#">3</a>	-43334.370	0.0014	5916401.225	0.0016	966.594	0.0038	
<a href="#">4</a>	-43603.860	0.0014	5912220.712	0.0015	1037.329	0.0038	
<a href="#">5</a>	-40141.722	0.0014	5918718.779	0.0016	984.493	0.0034	
<a href="#">6</a>	-37383.967	0.0016	5921631.608	0.0018	958.818	0.0039	
<a href="#">7</a>	-32616.800	0.0019	5924298.946	0.0023	967.363	0.0056	
<a href="#">HNTN</a>	-41188.398	?	5917343.898	?	1037.226	?	LLh

### Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (Meter)	Height Error (Meter)	Constraint
<a href="#">1</a>	N53°21'57.37727"	W117°46'03.10023"	1039.378	0.0057	
<a href="#">2</a>	N53°22'22.53927"	W117°42'39.65245"	1016.521	0.0047	
<a href="#">3</a>	N53°22'44.27115"	W117°39'04.48125"	952.006	0.0038	
<a href="#">4</a>	N53°20'28.95950"	W117°39'16.98646"	1022.840	0.0038	
<a href="#">5</a>	N53°24'00.14760"	W117°36'12.82334"	969.775	0.0034	



<a href="#">6</a>	N53°25'35.10157"	W117°33'44.80029"	943.980	0.0039	
<a href="#">7</a>	N53°27'02.52464"	W117°29'27.60532"	952.374	0.0056	
<a href="#">HNTN</a>	N53°23'15.38261"	W117°37'08.82960"	1022.562	?	LLh

### Adjusted ECEF Coordinates

Point ID	X (Meter)	X Error (Meter)	Y (Meter)	Y Error (Meter)	Z (Meter)	Z Error (Meter)	3D Error (Meter)	Constraint
<a href="#">1</a>	-1777211.154	0.0023	-3375416.455	0.0033	5095782.540	0.0048	0.0063	
<a href="#">2</a>	-1773584.302	0.0019	-3376602.942	0.0029	5096228.396	0.0039	0.0052	
<a href="#">3</a>	-1769792.801	0.0017	-3377939.493	0.0024	5096577.471	0.0032	0.0044	
<a href="#">4</a>	-1771575.370	0.0017	-3380843.194	0.0024	5094137.507	0.0031	0.0043	
<a href="#">5</a>	-1766113.321	0.0017	-3377751.723	0.0022	5097990.863	0.0029	0.0040	
<a href="#">6</a>	-1762590.937	0.0019	-3376914.771	0.0026	5099720.089	0.0033	0.0046	
<a href="#">7</a>	-1757378.909	0.0024	-3377188.367	0.0033	5101337.025	0.0048	0.0063	
<a href="#">HNTN</a>	-1767560.096	?	-3378284.440	?	5097207.870	?	?	LLh

### Error Ellipse Components

Point ID	Semi-major axis (Meter)	Semi-minor axis (Meter)	Azimuth
<a href="#">1</a>	0.0029	0.0026	2°
<a href="#">2</a>	0.0023	0.0022	176°
<a href="#">3</a>	0.0022	0.0020	179°
<a href="#">4</a>	0.0022	0.0020	175°
<a href="#">5</a>	0.0023	0.0020	174°
<a href="#">6</a>	0.0025	0.0022	175°
<a href="#">7</a>	0.0032	0.0027	175°

### Adjusted GNSS Observations

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
----------------	--	-------------	--------------------	----------	-----------------------



<a href="#">HNTN --&gt; 7 (PV14)</a>	<b>Az.</b>	50°26'48.3"	0.040 sec	0.052 sec	1.395
	<b>ΔHt.</b>	-70.1881 m	0.0056 m	-0.0065 m	-1.012
	<b>Ellip Dist.</b>	11039.2605 m	0.0020 m	0.0054 m	2.693
<a href="#">HNTN --&gt; 4 (PV15)</a>	<b>Az.</b>	204°44'45.5"	0.053 sec	0.009 sec	0.133
	<b>ΔHt.</b>	0.2781 m	0.0038 m	0.0047 m	1.119
	<b>Ellip Dist.</b>	5664.4937 m	0.0015 m	0.0040 m	2.049
<a href="#">HNTN --&gt; 6 (PV12)</a>	<b>Az.</b>	41°05'06.6"	0.060 sec	-0.040 sec	-0.620
	<b>ΔHt.</b>	-78.5818 m	0.0039 m	-0.0003 m	-0.090
	<b>Ellip Dist.</b>	5732.6681 m	0.0017 m	0.0037 m	2.030
<a href="#">5 --&gt; 6 (PV11)</a>	<b>Az.</b>	42°56'56.0"	0.096 sec	0.090 sec	0.739
	<b>ΔHt.</b>	-25.7950 m	0.0046 m	-0.0051 m	-0.642
	<b>Ellip Dist.</b>	4011.5345 m	0.0018 m	-0.0042 m	-1.912
<a href="#">6 --&gt; 7 (PV9)</a>	<b>Az.</b>	60°19'12.8"	0.085 sec	-0.084 sec	-1.052
	<b>ΔHt.</b>	8.3937 m	0.0059 m	-0.0015 m	-0.210
	<b>Ellip Dist.</b>	5463.1163 m	0.0020 m	-0.0034 m	-1.725
<a href="#">4 --&gt; 6 (PV10)</a>	<b>Az.</b>	32°56'10.3"	0.035 sec	-0.104 sec	-1.680
	<b>ΔHt.</b>	-78.8599 m	0.0046 m	0.0023 m	0.398
	<b>Ellip Dist.</b>	11281.5048 m	0.0020 m	-0.0047 m	-1.323
<a href="#">4 --&gt; 5 (PV2)</a>	<b>Az.</b>	27°31'23.0"	0.046 sec	0.048 sec	0.808
	<b>ΔHt.</b>	-53.0650 m	0.0045 m	0.0003 m	0.035
	<b>Ellip Dist.</b>	7363.4084 m	0.0017 m	-0.0033 m	-1.454
<a href="#">HNTN --&gt; 3 (PV13)</a>	<b>Az.</b>	245°47'18.0"	0.135 sec	-0.044 sec	-0.262
	<b>ΔHt.</b>	-70.5566 m	0.0038 m	-0.0001 m	-0.023
	<b>Ellip Dist.</b>	2344.0743 m	0.0015 m	0.0027 m	1.427
<a href="#">3 --&gt; 5 (PV7)</a>	<b>Az.</b>	53°30'04.4"	0.096 sec	0.095 sec	0.580
	<b>ΔHt.</b>	17.7698 m	0.0048 m	0.0123 m	0.980
	<b>Ellip Dist.</b>	3945.4414 m	0.0017 m	-0.0037 m	-1.427



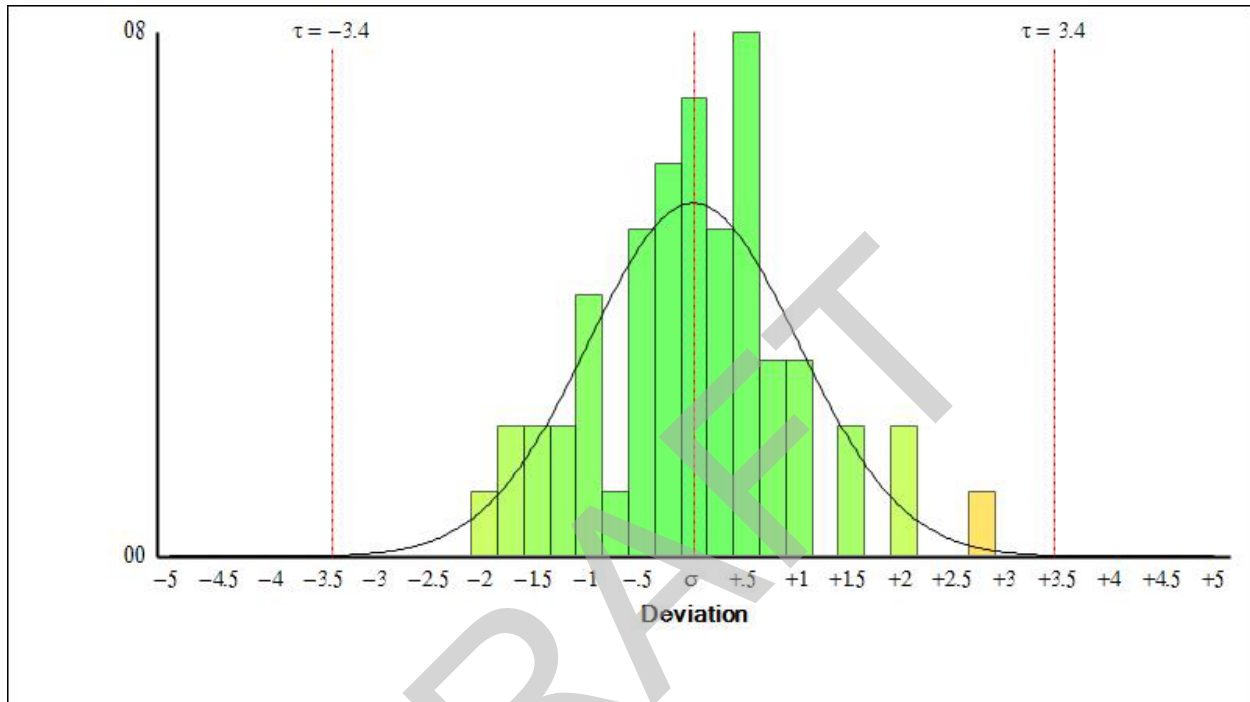
<a href="#">3 --&gt; 1 (PV6)</a>	<b>Az.</b>	259°26'14.7"	0.059 sec	-0.009 sec	-0.078
	<b>ΔHt.</b>	87.3720 m	0.0059 m	-0.0089 m	-1.149
	<b>Ellip Dist.</b>	7874.1763 m	0.0020 m	-0.0008 m	-0.241
<a href="#">HNTN --&gt; 5 (PV17)</a>	<b>Az.</b>	36°47'04.2"	0.181 sec	-0.241 sec	-1.122
	<b>ΔHt.</b>	-52.7869 m	0.0034 m	-0.0012 m	-0.508
	<b>Ellip Dist.</b>	1728.0931 m	0.0015 m	0.0000 m	0.014
<a href="#">5 --&gt; 7 (PV4)</a>	<b>Az.</b>	52°57'22.4"	0.054 sec	-0.033 sec	-0.205
	<b>ΔHt.</b>	-17.4013 m	0.0059 m	0.0106 m	0.987
	<b>Ellip Dist.</b>	9368.9595 m	0.0022 m	-0.0046 m	-1.046
<a href="#">4 --&gt; 2 (PV3)</a>	<b>Az.</b>	313°09'09.4"	0.071 sec	0.027 sec	0.278
	<b>ΔHt.</b>	-6.3188 m	0.0056 m	0.0113 m	0.756
	<b>Ellip Dist.</b>	5136.0389 m	0.0018 m	-0.0014 m	-0.502
<a href="#">HNTN --&gt; 1 (PV16)</a>	<b>Az.</b>	256°20'19.1"	0.041 sec	0.019 sec	0.460
	<b>ΔHt.</b>	16.8154 m	0.0057 m	0.0039 m	0.598
	<b>Ellip Dist.</b>	10166.9171 m	0.0019 m	0.0000 m	-0.003
<a href="#">4 --&gt; 3 (PV5)</a>	<b>Az.</b>	3°09'46.9"	0.077 sec	0.057 sec	0.582
	<b>ΔHt.</b>	-70.8347 m	0.0045 m	0.0025 m	0.448
	<b>Ellip Dist.</b>	4189.5114 m	0.0017 m	-0.0005 m	-0.256
<a href="#">HNTN --&gt; 2 (PV18)</a>	<b>Az.</b>	255°04'48.0"	0.053 sec	-0.034 sec	-0.551
	<b>ΔHt.</b>	-6.0407 m	0.0047 m	-0.0011 m	-0.289
	<b>Ellip Dist.</b>	6329.6954 m	0.0016 m	0.0004 m	0.228
<a href="#">2 --&gt; 1 (PV1)</a>	<b>Az.</b>	258°20'21.0"	0.112 sec	-0.048 sec	-0.438
	<b>ΔHt.</b>	22.8560 m	0.0061 m	0.0033 m	0.491
	<b>Ellip Dist.</b>	3841.2659 m	0.0019 m	0.0004 m	0.187
<a href="#">3 --&gt; 2 (PV8)</a>	<b>Az.</b>	260°26'14.9"	0.090 sec	0.009 sec	0.085
	<b>ΔHt.</b>	64.5160 m	0.0053 m	0.0037 m	0.408
	<b>Ellip Dist.</b>	4034.1702 m	0.0017 m	0.0006 m	0.280



## Histogram of Standardized Residuals

Critical Tau Value: 3.4

Observations Failing the Tau Test: 0



## Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision (Ratio)	3D Precision (Ratio)
<a href="#">1</a>	<a href="#">2</a>	Az.	78°17'37.7"	0.112 sec	1 : 2027451	1 : 2028022
		$\Delta$ Ht.	-22.8560 m	0.0061 m		
		$\Delta$ Elev.	-22.7073 m	0.0061 m		
		Ellip Dist.	3841.2659 m	0.0019 m		
<a href="#">1</a>	<a href="#">3</a>	Az.	79°20'38.8"	0.059 sec	1 : 3926888	1 : 3927494
		$\Delta$ Ht.	-87.3720 m	0.0059 m		
		$\Delta$ Elev.	-87.0610 m	0.0059 m		
		Ellip Dist.	7874.1763 m	0.0020 m		
<a href="#">1</a>	<a href="#">HNTN</a>	Az.	76°13'10.3"	0.041 sec	1 : 5467139	1 : 5464671
		$\Delta$ Ht.	-16.8154 m	0.0057 m		



		<b>ΔElev.</b>	-16.4288 m	0.0057 m		
		<b>Ellip Dist.</b>	10166.9171 m	0.0019 m		
<a href="#">2</a>	<a href="#">3</a>	<b>Az.</b>	80°23'22.2"	0.090 sec	1 : 2450334	1 : 2454376
		<b>ΔHt.</b>	-64.5160 m	0.0053 m		
		<b>ΔElev.</b>	-64.3537 m	0.0053 m		
		<b>Ellip Dist.</b>	4034.1702 m	0.0016 m		
<a href="#">2</a>	<a href="#">4</a>	<b>Az.</b>	133°06'26.8"	0.071 sec	1 : 2850188	1 : 2850875
		<b>ΔHt.</b>	6.3188 m	0.0056 m		
		<b>ΔElev.</b>	6.3817 m	0.0056 m		
		<b>Ellip Dist.</b>	5136.0389 m	0.0018 m		
<a href="#">2</a>	<a href="#">HNTN</a>	<b>Az.</b>	75°00'22.5"	0.053 sec	1 : 4081194	1 : 4079735
		<b>ΔHt.</b>	6.0407 m	0.0047 m		
		<b>ΔElev.</b>	6.2785 m	0.0047 m		
		<b>Ellip Dist.</b>	6329.6954 m	0.0016 m		
<a href="#">3</a>	<a href="#">HNTN</a>	<b>Az.</b>	65°45'45.2"	0.135 sec	1 : 1610059	1 : 1604157
		<b>ΔHt.</b>	70.5566 m	0.0038 m		
		<b>ΔElev.</b>	70.6322 m	0.0038 m		
		<b>Ellip Dist.</b>	2344.0743 m	0.0015 m		
<a href="#">4</a>	<a href="#">3</a>	<b>Az.</b>	3°09'46.9"	0.077 sec	1 : 2460103	1 : 2458601
		<b>ΔHt.</b>	-70.8347 m	0.0045 m		
		<b>ΔElev.</b>	-70.7353 m	0.0045 m		
		<b>Ellip Dist.</b>	4189.5114 m	0.0017 m		
<a href="#">4</a>	<a href="#">HNTN</a>	<b>Az.</b>	24°43'02.6"	0.053 sec	1 : 3751230	1 : 3749179
		<b>ΔHt.</b>	-0.2781 m	0.0038 m		
		<b>ΔElev.</b>	-0.1031 m	0.0038 m		
		<b>Ellip Dist.</b>	5664.4937 m	0.0015 m		
<a href="#">5</a>	<a href="#">3</a>	<b>Az.</b>	233°32'22.2"	0.096 sec	1 : 2271469	1 : 2268034
		<b>ΔHt.</b>	-17.7698 m	0.0048 m		
		<b>ΔElev.</b>	-17.8985 m	0.0048 m		
		<b>Ellip Dist.</b>	3945.4414 m	0.0017 m		
<a href="#">5</a>	<a href="#">4</a>	<b>Az.</b>	207°33'50.8"	0.046 sec	1 : 4226931	1 : 4225931
		<b>ΔHt.</b>	53.0650 m	0.0045 m		
		<b>ΔElev.</b>	52.8368 m	0.0045 m		
		<b>Ellip Dist.</b>	7363.4084 m	0.0017 m		
<a href="#">5</a>	<a href="#">6</a>	<b>Az.</b>	42°56'56.0"	0.096 sec	1 : 2225525	1 : 2223375
		<b>ΔHt.</b>	-25.7950 m	0.0046 m		



		<b>ΔElev.</b>	-25.6749 m	0.0046 m		
		<b>Ellip Dist.</b>	4011.5345 m	0.0018 m		
<a href="#">5</a>	<a href="#">7</a>	<b>Az.</b>	52°57'22.4"	0.054 sec	1 : 4304121	1 : 4297258
		<b>ΔHt.</b>	-17.4013 m	0.0059 m		
		<b>ΔElev.</b>	-17.1294 m	0.0059 m		
		<b>Ellip Dist.</b>	9368.9595 m	0.0022 m		
<a href="#">5</a>	<a href="#">HNTN</a>	<b>Az.</b>	216°47'49.1"	0.181 sec	1 : 1132645	1 : 1133044
		<b>ΔHt.</b>	52.7869 m	0.0034 m		
		<b>ΔElev.</b>	52.7336 m	0.0034 m		
		<b>Ellip Dist.</b>	1728.0931 m	0.0015 m		
<a href="#">6</a>	<a href="#">4</a>	<b>Az.</b>	213°00'36.9"	0.035 sec	1 : 5731658	1 : 5726905
		<b>ΔHt.</b>	78.8599 m	0.0046 m		
		<b>ΔElev.</b>	78.5117 m	0.0046 m		
		<b>Ellip Dist.</b>	11281.5048 m	0.0020 m		
<a href="#">6</a>	<a href="#">7</a>	<b>Az.</b>	60°19'12.8"	0.085 sec	1 : 2734418	1 : 2730781
		<b>ΔHt.</b>	8.3937 m	0.0059 m		
		<b>ΔElev.</b>	8.5455 m	0.0059 m		
		<b>Ellip Dist.</b>	5463.1163 m	0.0020 m		
<a href="#">6</a>	<a href="#">HNTN</a>	<b>Az.</b>	221°07'50.4"	0.060 sec	1 : 3442994	1 : 3439457
		<b>ΔHt.</b>	78.5818 m	0.0039 m		
		<b>ΔElev.</b>	78.4086 m	0.0039 m		
		<b>Ellip Dist.</b>	5732.6681 m	0.0017 m		
<a href="#">7</a>	<a href="#">HNTN</a>	<b>Az.</b>	230°32'58.7"	0.040 sec	1 : 5487789	1 : 5480929
		<b>ΔHt.</b>	70.1881 m	0.0056 m		
		<b>ΔElev.</b>	69.8630 m	0.0056 m		
		<b>Ellip Dist.</b>	11039.2605 m	0.0020 m		

Date: 2022-01-05 8:38:01 AM	Project: 1006665 Hinton Flood Study Survey.vce	Trimble Business Center
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# **APPENDIX B**

## **BRIDGE AND CULVERT DETAILS**

DRAFT



### Bridge Description

**Name:** Willow Creek Road

**River:** Athabasca River

**Bridge File No.:** BF76044

**Location:** PXS-22/21

### Geometry

**Span (m):** 192.45

**Width (m):** 5.14

**Pier Type:** steel

**Pier Shape:** trestle

**Minimum High Chord (m):** 959.728

**Minimum Low Chord (m):** 958.014

**No. of Piers:** 6

**Pier Width (m):** 0.31

### Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** Highway 40  
**River:** Athabasca River

**Bridge File No.:** BF70580  
**Location:** PXS-51/50

## Geometry

**Span (m):** 203.07  
**Width (m):** 10.09  
**Pier Type:** concrete  
**Pier Shape:** triangular nose, 46° 51' offset

**Minimum High Chord (m):** 980.856  
**Minimum Low Chord (m):** 968.426  
**No. of Piers:** 5  
**Pier Width (m):** Variable: 2.32 at bottom, 2.06 at top

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** West River Rd  
**River:** Hardisty Creek

**Bridge File No.:** n/a  
**Location:** PXS-62/61

## Geometry

**Span (m):** 10.94  
**Width (m):** 13.64  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 969.41  
**Minimum Low Chord (m):** 968.856  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from right bank**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** Switzer Drive  
**River:** Hardisty Creek

**Bridge File No.:** BF70883  
**Location:** PXS-77/76

## Geometry

**Span (m):** 12.13  
**Width (m):** 11.18  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 988.368  
**Minimum Low Chord (m):** 987.526  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from right bank**





### Bridge Description

**Name:** Pedestrian Trail

**River:** Hardisty Creek

**Bridge File No.:** n/a

**Location:** PXS-81B/81A

### Geometry

**Span (m):** 23.16

**Width (m):** 1.37

**Pier Type:** n/a

**Pier Shape:** n/a

**Minimum High Chord (m):** 990.397

**Minimum Low Chord (m):** 989.84

**No. of Piers:** 0

**Pier Width (m):** n/a

### Photo(s)

**Upstream of the bridge from right bank**



**Downstream of the bridge from right bank**





### Culvert Description

**Name:** Hardisty Avenue

**River:** Hardisty Creek

**Bridge File No.:** n/a

**Location:** PXS-86/85

### Geometry

**Length (m):** 40.48

**Diameter (m):** North barrel: 1.58  
South barrel: 1.18

**Material:** corrugated steel

**Upstream Invert (m):** North: 992.896  
South: 992.530

**Downstream Invert (m):** North: 991.900  
South: 991.842

### Photo(s)

**Upstream of the culvert**



**Downstream of the culvert**





## Bridge Description

**Name:** Pedestrian Trail

**River:** Hardisty Creek

**Bridge File No.:** n/a

**Location:** PXS-96

## Geometry

**Span (m):** 27.03

**Width (m):** 1.48

**Pier Type:** n/a

**Pier Shape:** n/a

**Minimum High Chord (m):** 1008.932

**Minimum Low Chord (m):** 1008.561

**No. of Piers:** 0

**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from right bank**



**Downstream of the bridge from left bank**





### Culvert Description

**Name:** CN Rail  
**River:** Hardisty Creek

**Bridge File No.:** n/a  
**Location:** PXS-98/97

### Geometry

**Length (m):** 53  
**Size (m):** Each culvert is 2.2 high x 1.1 wide  
**Material:** Concrete

**Upstream Invert (m):** North: 1008.069  
 South: 1008.051  
**Downstream Invert (m):** Centreline: 1007.792

### Photo(s)

Upstream of the culvert from left bank



Downstream of the culvert from left bank





## Bridge Description

**Name:** Pedestrian Trail

**River:** Hardisty Creek

**Bridge File No.:** n/a

**Location:** PXS-107

## Geometry

**Span (m):** 26.98

**Width (m):** 1.35

**Pier Type:** n/a

**Pier Shape:** n/a

**Minimum High Chord (m):** 1021.131

**Minimum Low Chord (m):** 1020.455

**No. of Piers:** 0

**Pier Width (m):** n/a

## Photo(s)

Upstream of the bridge from right bank



Downstream of the bridge from left bank





### Culvert Description

**Name:** Yellowhead Highway  
**River:** Hardisty Creek

**Bridge File No.:** BF74348  
**Location:** PXS-109/108

### Geometry

**Length (m):** 61.67  
**Size (m):** Each culvert is 1.985 wide, 2.438 tall  
**Material:** Concrete

**Upstream Invert (m):** 1020.453  
**Downstream Invert (m):** 1019.69

### Photo(s)

**Upstream of the culvert**



**Downstream of the culvert**





### Culvert Description

**Name:** Brookhart Street

**River:** Hardisty Creek

**Bridge File No.:** n/a

**Location:** PXS-116/115

### Geometry

**Length (m):** 46.26

**Diameter (m):** 2.6

**Material:** corrugated steel

**Upstream Invert (m):** North: 1026.390

South: 1026.284

**Downstream Invert (m):** North: 1025.602

South: 1025.751

### Photo(s)

**Upstream of the culvert**



**Downstream of the culvert**





### Culvert Description

**Name:** Bradwell Street

**River:** Hardisty Creek

**Bridge File No.:** n/a

**Location:** PXS-130/129

### Geometry

**Length (m):** 47.3

**Diameter (m):** 2.45

**Material:** corrugated steel

**Upstream Invert (m):** North: 1040.752

South: 1040.710

**Downstream Invert (m):** North: 1040.048

South: 1040.282

### Photo(s)

**Upstream of the culvert**



**Downstream of the culvert**





### Culvert Description

**Name:** Cache Percotte Road

**River:** Hardisty Creek

**Bridge File No.:** BF78284

**Location:** PXS-177/176

### Geometry

**Length (m):** 74.87

**Diameter (m):** 2.12

**Material:** corrugated steel

**Upstream Invert (m):** 1089.926

**Downstream Invert (m):** 1087.732

### Photo(s)

**Upstream of the culvert**



**Downstream of the culvert from left bank**





### Culvert Description

**Name:** Williams Road

**River:** Happy Creek

**Bridge File No.:** n/a

**Location:** PXS-182/181

### Geometry

**Length (m):** 23.85

**Diameter (m):** 1.22

**Upstream Invert (m):** North: 963.186

South: 963.151

**Downstream Invert (m):** North: 962.653

South: 962.701

**Material:** corrugated steel

### Photo(s)

**Upstream of the culvert**



**Downstream of the culvert**





**Culvert Description**

**Name:** Lower West River  
Road and West  
River Road  
**River:** Happy Creek

**Bridge File No.:** n/a

**Location:** PXS-186/185

**Geometry**

**Length (m):** 79.7  
**Diameter (m):** 2.134  
**Material:** corrugated steel

**Upstream Invert (m):** 977.28  
**Downstream Invert (m):** 968.88

**Photo(s)**

**Upstream of the culvert from left  
bank**



**Downstream of the culvert from  
right bank**





### Culvert Description

**Name:** CN Rail  
**River:** Happy Creek

**Bridge File No.:** n/a  
**Location:** PXS-192/191

### Geometry

**Length (m):** 75.8  
**Diameter (m):** 2.2  
**Material:** corrugated steel

**Upstream Invert (m):** 992.77  
**Downstream Invert (m):** 989.768

### Photo(s)

Upstream of the culvert from left bank



Downstream of the culvert





### Culvert Description

**Name:** Yellowhead  
Highway

**River:** Happy Creek

**Bridge File No.:** BF70884

**Location:** PXS-195/194

### Geometry

**Length (m):** 280.46

**Diameter (m):** 1.9

**Material:** corrugated steel

**Upstream Invert (m):** 1014.839

**Downstream Invert (m):** 997.273

### Photo(s)

Upstream of the culvert



Downstream of the culvert





### Culvert Description

**Name:** Pedestrian Trail

**River:** Happy Creek

**Bridge File No.:** n/a

**Location:** PXS-201.5B/A

### Geometry

**Length (m):** 4.7

**Diameter (m):** 1.25

**Material:** corrugated steel

**Upstream Invert (m):** 1022.814

**Downstream Invert (m):** 1022.894

### Photo(s)

**Upstream of the culvert**



**Downstream of the culvert**





### Culvert Description

**Name:** Wanyandi Way

**River:** Happy Creek

**Bridge File No.:** n/a

**Location:** PXS-203/202

### Geometry

**Length (m):** 19.62

**Diameter (m):** 1.2

**Material:** corrugated steel

**Upstream Invert (m):** 1023.631

**Downstream Invert (m):** 1023.481

### Photo(s)

**Upstream of the culvert**



**Downstream of the culvert**





### Bridge Description

**Name:** Pedestrian Trail

**River:** Happy Creek

**Bridge File No.:** n/a

**Location:** PXS 210B/A

### Geometry

**Span (m):** 8.12

**Width (m):** 2.4

**Pier Type:** n/a

**Pier Shape:** n/a

**Minimum High Chord (m):** 1032.618

**Minimum Low Chord (m):** 1032.515

**No. of Piers:** 0

**Pier Width (m):** n/a

### Photo(s)

**Upstream of the bridge**



**Downstream of the bridge from right bank**





## Bridge Description

**Name:** Pedestrian Trail

**River:** Happy Creek

**Bridge File No.:** n/a

**Location:** PXS-230.5B/A

## Geometry

**Span (m):** 6

**Width (m):** 1.75

**Pier Type:** n/a

**Pier Shape:** n/a

**Minimum High Chord (m):** 1053.094

**Minimum Low Chord (m):** 1053.008

**No. of Piers:** 0

**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** Pedestrian Trail

**River:** Happy Creek

**Bridge File No.:** n/a

**Location:** PXS-237

## Geometry

**Span (m):** 5.92

**Width (m):** 1.36

**Pier Type:** n/a

**Pier Shape:** n/a

**Minimum High Chord (m):** 1061.338

**Minimum Low Chord (m):** 1060.792

**No. of Piers:** 0

**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from right bank**



**Downstream of the bridge from right bank**





## Bridge Description

**Name:** Beaver Boardwalk

**River:** Happy Creek

**Bridge File No.:** n/a

**Location:** PXS-241

## Geometry

**Span (m):** 15.5

**Width (m):** 1.22

**Pier Type:** n/a

**Pier Shape:** n/a

**Minimum High Chord (m):** 1064.772

**Minimum Low Chord (m):** 1064.492

**No. of Piers:** 0

**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from N/A bank**





## Bridge Description

**Name:** CN Rail  
**River:** Maskuta Creek

**Bridge File No.:** BF82039  
**Location:** PXS-259/258

## Geometry

**Span (m):** 243.18  
**Width (m):** 5.05  
**Pier Type:** steel trestles  
**Pier Shape:** trestle

**Minimum High Chord (m):** 997.006  
**Minimum Low Chord (m):** 993.22  
**No. of Piers:** 13  
**Pier Width (m):** 1.5 m base

## Photo(s)

Upstream of the bridge from right bank



Downstream of the bridge from right bank





## Bridge Description

**Name:** Private Road  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-333/332

## Geometry

**Span (m):** 14.83  
**Width (m):** 3.27  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1008.357  
**Minimum Low Chord (m):** 1007.698  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from right bank**





## Bridge Description

**Name:** WB Yellowhead  
Highway

**River:** Maskuta Creek

**Bridge File No.:** BF8435

**Location:** PXS-341/340

## Geometry

**Span (m):** 40.63

**Width (m):** 14.85

**Pier Type:** n/a

**Pier Shape:** n/a

**Minimum High Chord (m):** 1012.85

**Minimum Low Chord (m):** 1010.749

**No. of Piers:** 0

**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from right  
bank**



**Downstream of the bridge from  
left bank**





## Bridge Description

**Name:** EB Yellowhead  
Highway

**River:** Maskuta Creek

**Bridge File No.:** BF8435

**Location:** PXS-343/342

## Geometry

**Span (m):** 43.3

**Width (m):** 14.12

**Pier Type:** concrete

**Pier Shape:** round nose

**Minimum High Chord (m):** 1012.416

**Minimum Low Chord (m):** 1010.504

**No. of Piers:** 2

**Pier Width (m):** variable, 0.838 m at  
bottom, 0.457 m at top

## Photo(s)

**Upstream of the bridge from right  
bank**



**Downstream of the bridge from  
left bank**





## Bridge Description

**Name:** Temporary construction access road  
**River:** Maskuta Creek

**Bridge File No.:** n/a

**Location:** PXS-350B/A

## Geometry

**Span (m):** 24.19  
**Width (m):** 6.21  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1010.088  
**Minimum Low Chord (m):** 1010.94  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** Private Trail  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-458

## Geometry

**Span (m):** 13.3  
**Width (m):** 3.13  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1027.604  
**Minimum Low Chord (m):** 1027.155  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from right bank**



**Downstream of the bridge from right bank**





## Bridge Description

**Name:** Private Road  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-469/468

## Geometry

**Span (m):** 17.89  
**Width (m):** 2.06  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1028.167  
**Minimum Low Chord (m):** 1028.055  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from right bank**



**Downstream of the bridge from right bank**





## Bridge Description

**Name:** Private Trail  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-471.5

## Geometry

**Span (m):** 15.09  
**Width (m):** 3.46  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1028.384  
**Minimum Low Chord (m):** 1027.705  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** Private Road  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-477/476

## Geometry

**Span (m):** 15.25  
**Width (m):** 2.79  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1029.522  
**Minimum Low Chord (m):** 1028.577  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

Upstream of the bridge from left bank



Downstream of the bridge from right bank





### Bridge Description

**Name:** Private Road  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-504/503

### Geometry

**Span (m):** 16.71  
**Width (m):** 3.63  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1031.617  
**Minimum Low Chord (m):** 1030.47  
**No. of Piers:** 0  
**Pier Width (m):** n/a

### Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** Private Road  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-510/509

## Geometry

**Span (m):** 18.29  
**Width (m):** 4.04  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1032.068  
**Minimum Low Chord (m):** 1031.101  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

Upstream of the bridge from left bank



Downstream of the bridge from left bank





## Bridge Description

**Name:** Private Road  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-523/522

## Geometry

**Span (m):** 18.53  
**Width (m):** 4.89  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1031.807  
**Minimum Low Chord (m):** 1031.392  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





### Bridge Description

**Name:** Private Road  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-531C/B

### Geometry

**Span (m):** 17.42  
**Width (m):** 3.99  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1031.979  
**Minimum Low Chord (m):** 1031.169  
**No. of Piers:** 0  
**Pier Width (m):** n/a

### Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** Private Road  
**River:** Maskuta Creek

**Bridge File No.:** n/a  
**Location:** PXS-552/551

## Geometry

**Span (m):** 12.43  
**Width (m):** 4.02  
**Pier Type:** n/a  
**Pier Shape:** n/a

**Minimum High Chord (m):** 1033.097  
**Minimum Low Chord (m):** 1032.292  
**No. of Piers:** 0  
**Pier Width (m):** n/a

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





## Bridge Description

**Name:** Ridge Road

**River:** Cold Creek

**Bridge File No.:** BF79641

**Location:** PXS-585/584

## Geometry

**Span (m):** 19.91

**Width (m):** 7.54

**Pier Type:** steel piles

**Pier Shape:** rectangular

**Minimum High Chord (m):** 1036.011

**Minimum Low Chord (m):** 1034.800

**No. of Piers:** 1

**Pier Width (m):** 0.200

## Photo(s)

**Upstream of the bridge from left bank**



**Downstream of the bridge from left bank**





**APPENDIX C**  
**FLOOD CONTROL STRUCTURE MEMORANDUM**



NHC Ref. No. 1006665

## MEMORANDUM

Prepared by:	Michael Brayall	Date:	2 March 2022
Reviewed by:	Robyn Andrishak	Contract Number:	22RSD862
Distribution:	Lance Katan (AEP)	No. of Pages:	2

**RE: Hinton Flood Study Survey Data Collection  
Flood Control Structure Details**

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### 1 INTRODUCTION

In June 2021, Alberta Environment and Parks (AEP) retained Northwest Hydraulic Consultants Ltd. (NHC) to complete a survey and collect various supporting data for the upcoming Hinton Flood Study. This memorandum outlines the details of any surveyed flood control structures to confirm ownership, maintenance, and operational responsibilities for them.

### 2 STUDY AREA

The Athabasca River originates from the eastern slopes of the Rocky Mountains and flows northeast through Yellowhead County past the Town of Hinton. The study area includes 26.8 km of the Athabasca River, starting from just upstream of the Highway 40 bridge, at the west edge of NE-1-51-26 W5M, through the Town of Hinton and Yellowhead County, to the east edge of SW-4-52-24-W5M. Four tributaries are also included in the study area:

- 6.2 km of Hardisty Creek, from the south edge of NW-12-51-25-W5M to the confluence of the Athabasca River;
- 15.4 km of Maskuta Creek, from the south edge of NW-24-50-26-W5M to the confluence of the Athabasca River;
- 3.7 km of Happy Creek, from the south edge of SE-10-51-25-W5M to the confluence of the Athabasca River; and
- 2.6 km of Cold Creek, from the east edge of SW-30-50-25-W5M to the confluence of the Maskuta Creek.



### 3 FLOOD CONTROL STRUCTURES

The provincial Flood Hazard Identification Program (FHIP) Guidelines (Alberta Environment, 2011) describe flood control structures as “walls constructed to prevent water from rivers or lakes from flooding surrounding lands. Often [flood control structures] are earthen berms but can also be constructed of concrete and other materials.”

Dedicated flood control structures such as berms and dikes typically require regulatory approval prior to construction, receive routine inspection and maintenance, and are officially recognized by AEP and local authorities as flood management infrastructure. As per the study terms of reference, geometric details for dedicated flood control structures identified by AEP and local authorities are collected either by survey or obtained from representative design drawings and survey-verified.

Some road and railway embankments or berms may perform as flood barriers and affect the river hydraulics but may not be classified as dedicated flood control structures. Railroad embankments are typically assumed to be permeable and are not considered natural ground features or dedicated flood control structures.

### 4 RESULTS AND CONCLUSION

Based on the information available from AEP and local authorities, it was determined that there are no dedicated flood control structures within the study reach. This was also observed during the field survey.

### 5 REFERENCES

Alberta Environment Water Management Operations, River Forecast Section (2011). Flood Hazard Identification Program Guidelines, July 2011.