



REPORT

Lamont Flood Study

Main Report

Submitted to:

Alberta Environment and Protected Areas

River Engineering and Technical Services

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23592565-Rev0

June 24, 2025



Executive Summary

Environment and Protected Areas (EPA) commissioned WSP Canada Inc. (WSP) to conduct the Lamont Flood Study (the study). The primary purpose of the study is to assess and identify river and flood hazards in vicinity of the Town of Lamont, through Lamont County. The study was conducted under the provincial Flood Hazard Identification Program (FHIP), the goals of which include enhancement of public safety and reduction of future flood damages through the identification of river and flood hazards. The most recent version of the FHIP Flood Study Technical Guidelines from June 2022 were used for technical guidance. Key project stakeholders include the Government of Alberta, Town of Lamont, and Lamont County.

This report documents the methodology and results for all components of the study which are listed below:

- Survey and base data collection;
- Open water hydrology assessment;
- Open water hydraulic modeling;
- Open water flood inundation mapping; and
- Design flood hazard identification and mapping.

The study reaches includes a 10.4 km long Lamont Creek study reach, a 1.8 km long Tributary A study reach, and a 1.0 km long Tributary B study reach. An additional 1.1 km length of the study reach was included in HEC-RAS hydraulic model beyond the downstream end of the required study reach of Lamont Creek to account for potential backwater effects. The downstream boundary of the hydraulic model is located on Lamont Creek, approximately 1.7 km downstream of the Range Road 195 Bridge.

The survey was conducted along the Lamont Creek, Tributary A, and Tributary B within the study area in June 2023 to collect bathymetric and hydraulic structure data for the model setup. A total of 137 cross sections and 24 hydraulic structures were surveyed.

A hydrology assessment was completed to provide the flood peak discharge estimates for the study area as inputs to the HEC-RAS model.

A 2D HEC-RAS hydraulic model was developed for the study area using an integrated digital elevation model (DEM), which was generated using surveyed river cross-sections data and topographic LiDAR data. The surveyed hydraulic structures were incorporated into the HEC-RAS model. The model was calibrated based on high flow conditions associated with the 2018 flood events on Lamont Creek using highwater marks collected by NHC.

In the absence of flow data for Lamont Creek, Tributary A, and Tributary B for model calibration, Manning's n values were selected based on WSP's modeling experience and professional judgment. WSP referred to the recently completed floodplain mapping for the Vermilion River at Vegreville, where a Manning's n of 0.060 was used for the main channel and 0.070 was used for tributaries. The Manning's n values for the floodplain areas were estimated and selected based on the land use types. The HEC-RAS model was used to simulate the water surface profiles for the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year flood events in the study area.

The model sensitivity was evaluated for the 100-year flood event. The results of the sensitivity analysis show that variations of the channel and floodplain roughness values have small impacts on the simulated water levels along Lamont Creek and two tributary study reaches. Changes of the energy slope at the downstream boundary also have small impacts on the simulated flood levels.

The 2D HEC-RAS model produces a continuous water surface of directly inundated areas for each simulated flood event. Directly inundated areas were mapped where there is a direct connection between the main creek channel and inundated areas on the floodplains. This includes areas where inundation is caused by topographic or structural overtopping points as well as backwater flooding. Flood inundation and hazard maps were prepared for the study reaches of Lamont Creek, Tributary A, and Tributary B using ArcGIS.

Based on the simulation results, Tawâw Park along Lamont Creek would be flooded starting at the 10-year flood and various residential areas would be impacted starting at the 50-year flood.

Flood hazard mapping showed no residential, commercial area, or industrial area is located in the floodway along Lamont Creek. However, Tawâw Park will experience areas of >1 m inundation depth outside of the main channel. There is no residential house, commercial area, or industrial area located in the floodway along Tributary A or Tributary B. There is no residence or key structure located within the high hazard flood fringe along Lamont Creek, Tributary A, or Tributary B.

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Acknowledgements

The study was completed by the Government of Alberta under the provincial Flood Hazard Identification Program, the goals of which include enhancement of public safety and reduction of future flood damages through the identification of river and flood hazards. The study was co-funded by the Government of Canada through the federal Flood Hazard Identification and Mapping Program.

WSP Canada Inc. (WSP) acknowledges the contributions of the following staff of Environment and Protected Areas (EPA):

- Mr. Hammad Javid, EPA's project manager for the study, coordinated the participation from EPA, provided technical advice and guidance for the overall project and review of this report.
- Mr. Michael Brayall, EPA's project advisor for the study, reviewed the hydraulic model and study report.
- Mr. Peter Onyshko, EPA's Flood Hazard Specialist, provided senior oversight and technical advice for the study.

The contributions of the following staff from WSP are acknowledged:

- Dr. Wolf Ploeger, project director, was responsible for senior oversight and provision of technical advice for the study.
- Dr. Nathan Schmidt, project manager and senior reviewer for this study, was responsible for regular communications with EPA, providing senior inputs and review, quality control and assurance for the study, and reviewing this report.
- Mr. Jie Chen, WSP's senior hydraulic modeling specialist and senior reviewer, was responsible for overseeing the HEC-RAS modeling, flood inundation mapping, flood hazard mapping as well as preparation of this report.
- Mr. Alexander Croswell, field survey lead and hydrodynamic modeler for this study, was responsible for field survey and hydraulic structure data collection, conducting HEC-RAS modeling, preparing flood hazard maps, and preparation of this report.
- Dr. Getu Biftu, senior hydrologist, was responsible for overseeing open water hydrology assessment and reviewing the hydrology memorandum.
- Dr. Mesgana Gizaw, hydrologist, was responsible for conducting open water hydrology assessment and preparation of hydrology memorandum.
- Mr. Sean Kurash, GIS specialist, was responsible for preparing the flood inundation maps and flood hazard maps for this report.
- Mr. Quinn Decent, field survey crew for this study, was responsible for field survey and hydraulic structure data collection.

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1.0 INTRODUCTION

1.1 Study Background

WSP Canada Inc. (WSP) was commissioned by Alberta Environment and Protected Areas (EPA) in March 2023 to undertake the Lamont Flood Study (the study). The primary purpose of the study is to assess and identify flood hazards along a 10.4 km reach of Lamont Creek running through the Town of Lamont, 1.8 km of a tributary downstream of Lamont (Tributary A), and 1.0 km of a tributary upstream of Lamont (Tributary B).

The study was conducted under the provincial Flood Hazard Identification Program (FHIP) the goals of which include enhancement of public safety and reduction of future flood damages through the identification of flood hazards. The most recent version of the FHIP Flood Study Technical Guidelines from June 2022 were used for technical guidance. Key project stakeholders include the Government of Alberta, Town of Lamont and Lamont County.

The previous provincial flood study for Lamont was completed by Stanley Associates Engineering Ltd. (Stanley 1998). This study will replace the previous study and expand the modeling and flood mapping coverage for open water flood scenarios.

This study is comprised of multiple components and deliverables. This report documents the methodology and results of all major study components listed below:

1. Survey and Base Data Collection
2. Open Water Hydrology Assessment
3. Open Water Hydraulic Modeling
4. Open Water Flood Inundation Mapping
5. Design Flood Hazard Identification and Mapping

1.2 Study Objective

The overall goal of the study is to enhance public safety and support the assessment and identification of flood hazards in the study area. The study results are intended to reduce potential future flood damages and associated disaster assistance costs, to mitigate flood impacts by informing land use planning decisions, and for emergency preparation.

This report summarizes the work of all five study components. The tasks and deliverables associated with this study are listed below:

- river cross section surveys
- hydraulic structure data collection
- flood history documentation
- open water flood hydrology assessment
- HEC-RAS hydraulic model creation for open water modeling
- flood simulations, water surface profile creation, and sensitivity analysis
- open water flood inundation mapping
- floodway criteria and flood hazard mapping

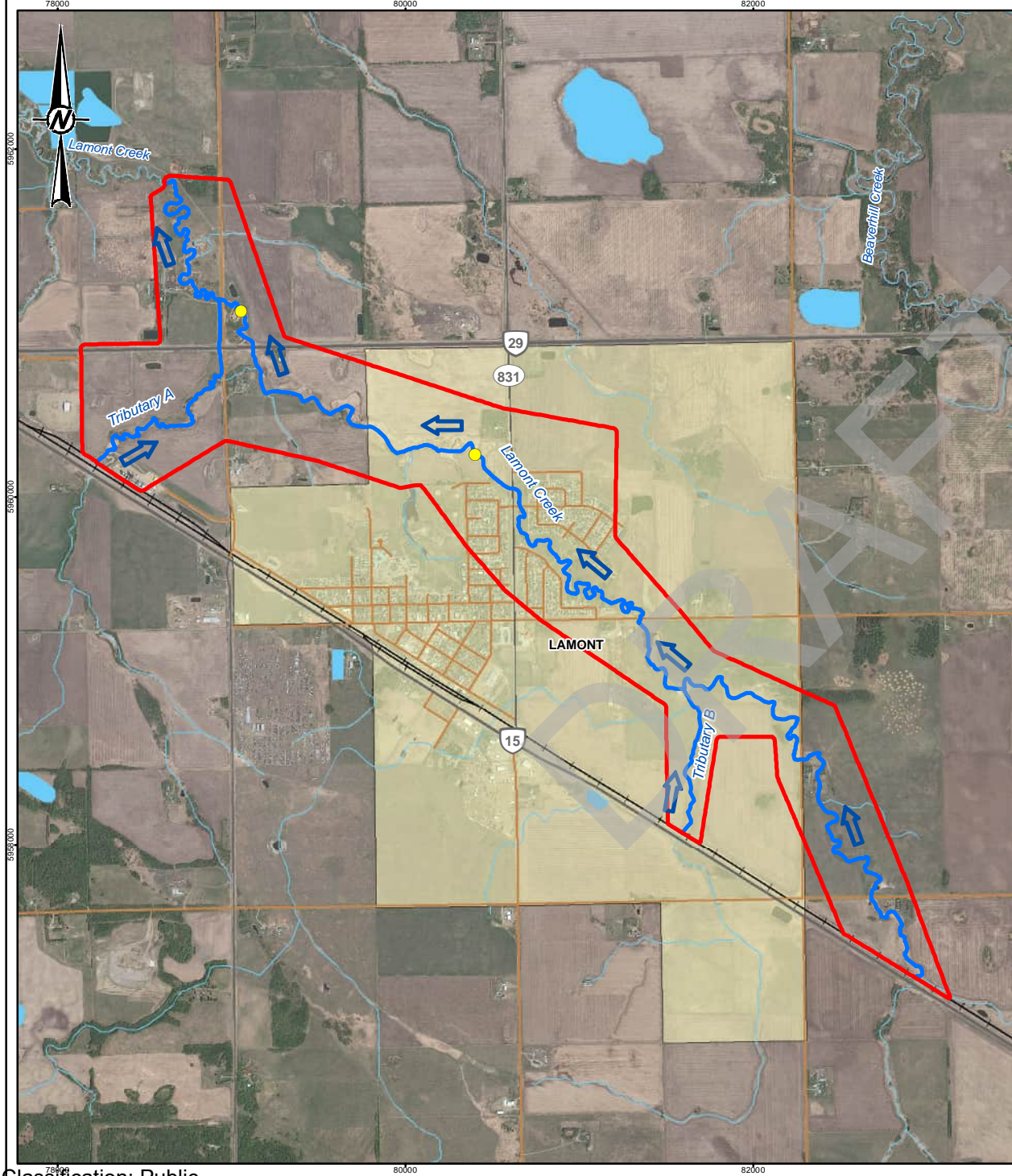
1.3 Study Area

Figure 1-1 provides an overview of the study area including the following:

- a 10.4 km long Lamont Creek reach study area, extending from the northern half of 11-10-55-19-W4M (north of Highway 15 and railway) to the western boundary of 9-30-55-19-W4
- a 1.8 km long Tributary reach study area downstream of Lamont, referred to as Tributary A, extending from the southern half of 10-19-55-19-W4 (north of Highway 15 and the Richardson Pioneer Grain Elevator) to the eastern boundary of 1-30-55-19-W4
- a 1.0 km long Tributary reach study area upstream of Lamont, referred to as Tributary B, extending from the northern half of 2-16-55-19-W4M (north of Highway 15 and railway) to the northern boundary of 10-16-55-19-W4 and its confluence with Lamont Creek

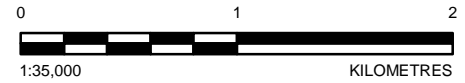
The downstream boundary of the hydraulic model is located on Lamont Creek approximately 1.7 km downstream of the Range Road 195 Bridge.

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LEGEND

- DISCHARGE MEASUREMENT LOCATION
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- RAILWAY
- ➔ FLOW DIRECTION
- SURVEY REACH
- WATERCOURSE
- WATERBODY
- TOWN OF LAMONT
- FLOOD STUDY AREA



REFERENCE(S)

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CLIENT
**ALBERTA ENVIRONMENT
 AND PROTECTED AREAS**

PROJECT
LAMONT FLOOD STUDY



TITLE
LOCATION MAP OF THE STUDY AREA

CONSULTANT	YYYY-MM-DD	2025-06-19
	DESIGNED	JC
	PREPARED	PMT
	REVIEWED	AC
	APPROVED	JC

PROJECT NO.	CONTROL	REV.	FIGURE
23592565	-	0	1-1

2.0 SURVEY AND BASE DATA COLLECTION

2.1 General

A site reconnaissance was conducted by representatives from EPA and WSP on June 7, 2023. The field visit involved the following steps:

- reviewed and confirmed the preliminary survey plan
- confirmed the locations and numbers of channel cross sections and hydraulic structures to be surveyed
- identified potential flood control structures
- familiarized EPA and WSP personnel with the study area

WSP conducted surveys of Lamont Creek, Tributary A, and Tributary B within the study area from June 8 to 11, 2023. Survey data were collected at 137 cross sections and for 24 hydraulic structures.

The survey scope included the following:

- survey of channel cross sections and hydraulic structures
- measurement of discharge and water surface profile

In addition, three Alberta Survey Control Monuments (ASCM) benchmarks were surveyed upon request of EPA in support of Light Detection and Ranging (LiDAR) remote sensing data collection (by others), for confirming that the LiDAR based digital terrain model (DTM) meets FHIP accuracy standards and that there is consistency between the LiDAR and ground surveys.

2.2 Procedures and Methodology

2.2.1 Survey Equipment and Control

The survey equipment used in collecting the topographic, bathymetric, and structure data for this study included the following:

- Real-time Kinematic (RTK) Global Positioning System (GPS): Trimble® R10 RTK rover units, which were paired to a Trimble® TSC3 hand-held data collector running Trimble Access® survey software, were used to survey ground features, water levels, and the channel bed in areas where hydraulic conditions allowed the surveyors to wade the channel and walk on the banks. The RTK system was also used to survey the following:
 - Control points and benchmarks within the study area.
 - Bridge and culvert structures.
- SonarMite Echo Sounder (SonarMite): A SonarMite, in combination with Trimble® R10 RTK paired to Trimble® TSC3 and mounted onto an inflatable kayak, was used to survey channel beds in areas where water depth was too deep to allow for the surveyors to wade the channel.
- Acoustic Doppler Velocimeter (ADV): A SonTek FlowTracker2® ADV in combination with a top-set wading rod was used to conduct discharge measurements on Lamont Creek and two tributaries.

The proposed locations of all cross sections were identified in a digital georeferenced vector format. The survey crew utilized those locations on the data collectors to guide the survey. A georeferenced survey plan was uploaded into the data collector to aid the surveyor in maintaining spacing and alignment of cross sections along each study reach.

The surveyed points were acquired by wading the channel and walking on the banks, except at locations where the water depth was too deep to safely wade. The surveyed points were collected by using a boat at those locations.

Typical ground-based and acoustic-based technologies were used for data collection and were referenced to the ASCM benchmarks (i.e., ASCM 307314, ASCM 291567, and ASCM 357178) situated within the study area.

All survey data were collected in the local 3-Degree Transverse Mercator (3TM) 114° W coordinate system and referenced to NAD83 (CSRS) horizontal and the CGVD28 vertical datums. The RTK survey data outputs provided an orthometric elevation with correct northing and easting coordinates. The survey data were acquired by pre-loading geoid files into the survey equipment. Ellipsoidal heights were transformed to CGVD28 orthometric heights using the HTv2.0 geoid model.

2.2.2 River Cross Sections and Longitudinal Profiles

The main objective of the cross section survey was to enable accurate definition of the main channel geometry. The locations of cross sections were selected to be representative of channel and floodplain characteristics. Cross sections captured the variations in the physical characteristics of the channel and floodplains that could affect flood levels along the study reaches.

Considerations of changes in the channel width, cross section area, channel slope, channel bed and bank materials, and the presence of any confluences or islands, flood control structures, bridges, and other channel irregularities, contributed to the selection of the cross section locations.

The alignment of each cross section was established so that it would be oriented perpendicular to the direction of creek flow. A shapefile showing the alignment of each cross section was provided to the survey crew and uploaded to the data collectors to provide guidance on where to acquire data.

Each survey point collected with the RTK utilized a schematic of survey point codes and corresponding locations as shown in Figure 2-1. It also includes a complete list of survey codes for the RTK.

The quality and accuracy of all survey data were checked by using a Trimble® data extraction and processing tool. All survey data were imported into ArcGIS to allow for validation and further processing. Data with horizontal or vertical accuracies of greater than ± 0.05 m were rejected. Daily quality and accuracy checks were conducted in the office. In cases where multiple points with low accuracy were detected at a cross section, the survey crew repeated that survey the next day.

Survey Codes for RTK GPS River Surveys (No Structures)

Purpose: - Create common definitions for survey points collected in the field for easier data processing in the office
 - Reduce confusion or uncertainty for field staff regarding coding of points

Location Code	
G	Ground
T	Top of Bank
B	Bank
O	Toe of Bank
W	Water Level
S	Stream Bottom (under water)
E	Edge of Road/Berm/Pathway/Railway
C	Centre Line of Road/Berm/Pathway/Railway
L	LIDAR control point

Material Code	
1	Mud/Silt (<0.063 mm)
2	Sand (0.063 mm - 2 mm)
3	Gravel (2 mm - 6.4 cm)
4	Cobble (6.4 cm - 25 cm)
5	Boulder (> 25 cm)
6	Bedrock
C	Concrete
G	Grass
R	Riprap
T	Trees (large, trunk > 10 cm)
W	Willows and Shrubs
B	Gabion Basket
A	Asphalt

Examples	
G2	Ground, Sand
G4	Ground, Cobble
W3	Water Level, Gravel
GG	Ground, Grass
GT	Ground, Trees
CA	Centre Line, Asphalt
BR	Bank, Riprap
LC	LiDAR control, Concrete

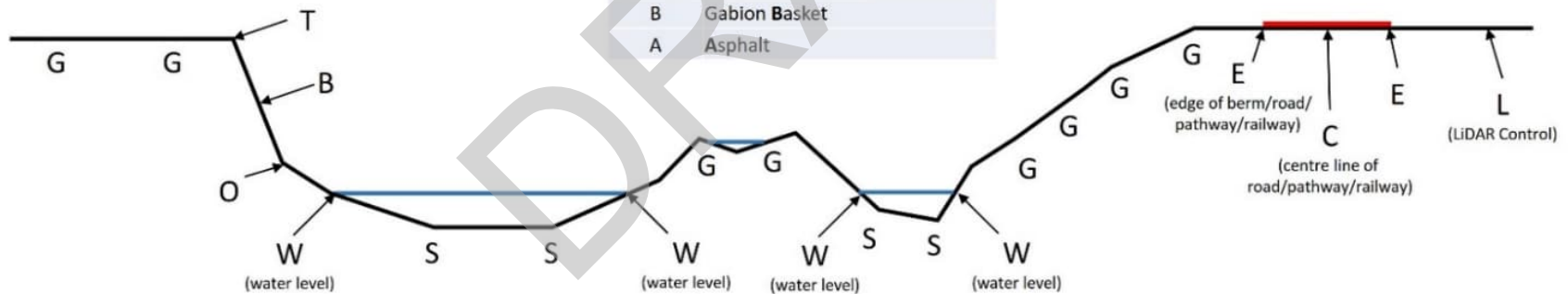


Figure 2-1: Schematic of Survey Point Locations and Code Descriptions

Flow was low in Lamont Creek, with many sections being completely dry during the survey. Additionally, the majority of Tributary A and Tributary B were dry during the survey except for small sections of stagnant water.

Limited overbank floodplain areas were also surveyed to overlap with the LiDAR survey where LiDAR coverage was assured. Data points were collected along each cross section to properly define the channel geometry and the near-bank floodplain.

Each survey data point recorded Northing and Easting coordinates, water surface or ground elevation, and an associated survey code indicating its location (e.g., bank, stream bottom, edge of water, water level, top of bank, etc.).

The following procedures were followed when conducting a bathymetric survey by wading:

- RTK rover units were used to collect cross sectional information from a location approximately 2 to 5 m beyond top of the bank on one side of the river channel, to a location approximately 2 to 5 m beyond top of bank on the other side. A minimum of 3 and up to 63 survey data points were established across the channel depending on the width of channel, and care was taken to reference points where the transverse bed slope changed significantly.
- Special attention was paid to surveying topographic slope breaks along the banks.
- Each of the surveyed data points was attributed with field codes that described substrate and vegetation types (see Figure 2-1).
- The water surface elevation was surveyed at all points along the cross section where the water had contact with the bank.

Reach-representative photographs were taken at key locations within the study area during the site reconnaissance and field survey. The photographs, including salient details and features at surveyed cross sections, were georeferenced with appropriate metadata.

2.2.3 Discharge and Water Level Measurements

Discharges and water levels along the study reaches were measured during the field program to support low-flow hydraulic model calibration.

Flow measurements were performed by wading the channel with a handheld Acoustic Doppler Velocimeter (*SonTek FlowTracker2[®] ADV*) and top-set wading rod in accordance with standard WSC protocols, including the following steps:

- Selected a defined measurement site with flowing water.
- Chose an even number of transects with equal left-to-right transects and right-to-left transects.
- Ensured that the data set of each transect was within a maximum standard deviation of five percent.

The measurement procedure involved the following:

- Locate a well-defined channel reach.
- Secure a measuring tape across the channel, anchoring it on both shores.
- Divide the channel into a minimum of 20 panels (flow segments across the stream) thus requiring a minimum of 21 velocity measurements points.

- Velocity readings were taken at 0.6 of the total depth at measurement locations, because flow depth was less than 1.0 m in all cases.
- Survey points were selected such that no panel discharge exceeded 10 percent of the total discharge

Water levels were measured along riverbanks at surface-ground intersections using RTK.

2.2.4 Hydraulic Structures

All hydraulic structures within the study area were surveyed. Applicable structures included road bridges and roadway culverts.

The hydraulic structures were surveyed using the RTK rover unit to receive signals from the GPS satellites. Georeferenced photographs of each hydraulic structure were taken during the field program. Two cross sections were surveyed at each bridge or culvert, each located within a short distance upstream and downstream of the bridge face or culvert opening. Ground and structure data were also collected at the inlet and outlet of the culvert to capture key elevations and dimensions.

The features of each bridge structure surveyed included the following:

- length of span (corner points, abutment to abutment)
- width of bridge (corner points, outside to outside)
- top of curb or solid guard rail elevations
- low chord elevations
- number and width of piers
- location of piers and the distance of each pier relative to the left abutment
- type of piers (e.g., concrete, pile bent, steel column)
- shape of pier (e.g., round nose, wedge, circular)
- top of road surface profile

The following data were collected on the roadway culverts within the study area:

- number of culverts
- barrel length
- culvert opening dimensions
- upstream and downstream invert elevations
- culvert type (e.g., corrugated steel pipe, concrete box, timber-framed)
- culvert shape (e.g., circular, arch, elliptical, square, rectangular)
- entrance condition (e.g., projecting from fill, mitered to conform to slope)
- top of roadway profile

2.3 Survey Standards and Accuracy

Quality assurance and quality control (QA/QC) of collected data were conducted in the field at the time of data collection and in the office during data processing. QA/QC of field data was conducted as described below:

- Position and elevation from the RTK rover unit were checked for accuracy each day, based on the ASCM benchmarks mentioned previously. All survey data collected during the field program were tied to an ASCM benchmarks.
- The field crew was provided with a shapefile showing cross section alignments for the purpose of guiding the survey along the selected cross sections.
- The RTK data collectors were set up to provide a warning when calculated maximum error exceeded 0.05 m for a manually recorded point. When notified, the surveyor either adjusted their location or waited for a better signal before surveying a point.

The RTK control network is considered accurate to within ± 0.02 m at 95 percent confidence in both horizontal and vertical directions. A high level of accuracy was maintained throughout the field program by daily calibration of the spatial position and elevation of each RTK rover unit to an ASCM benchmark. Furthermore, the daily protocol required that the survey crew calibrate to, and then open and close on, an ASCM benchmark to maintain positional accuracy.

The collected survey data were imported into a Geographic Information System (GIS) to allow for validation and further processing. In addition to the QA/QC procedures for field data collection, the technical lead for the field program reviewed the survey data within 24 hours of it being collected, to check for outliers (including erroneous or missing data) and to ensure appropriate coverage along each cross section and on the hydraulic structures.

2.4 Cross Sections and Longitudinal Profiles

Cross sections and longitudinal profiles were collected along Lamont Creek, Tributary A, and Tributary B to support the development of channel bathymetry for modeling. The surveyed lengths of the study area were approximately 9.3 km (Lamont Creek), 1.8 km (Tributary A), and 1.0 km (Tributary B).

An overview of the surveyed cross section locations is provided in Figures A-1 to A-3 of Appendix A. A total of 137 cross sections were surveyed within the study area. Table 2-1 provides a summary of surveyed cross sections.

Table 2-1: Surveyed Cross Sections within the Study Area

Waterbody	Reach Description	Cross Section ID	No. of Cross Sections	Average Cross Section Spacing (m)
Lamont Creek ^(a)	9.3 km long reach extending from Highway 15 to 180 m downstream of the Range Road 195 Bridge	Lamont Creek 1 to Lamont Creek 86	90	103
Tributary A	1.8 km long reach extending from Highway 15 to its confluence with Lamont Creek	Tributary A 1 to Relief Ditch 8	30	93
Tributary B	1.0 km long reach extending from Highway 15 to its confluence with Lamont Creek	Tributary B 1 to Tributary B 13	13	85
Extra Culverts	One additional culvert along Highway 24 and one additional culvert along Highway 831 were surveyed outside of the Lamont Creek Floodplain.	Extra 1 to Extra 4	4	30

Note:

(a) The study area was extended an additional 1.1 km downstream from the surveyed cross sections along Lamont Creek following the completion of the surveying program.

The profiles of the surveyed main channel thalweg and measured water levels along Lamont Creek and two tributaries are presented in Figure 2-2 to Figure 2-4.

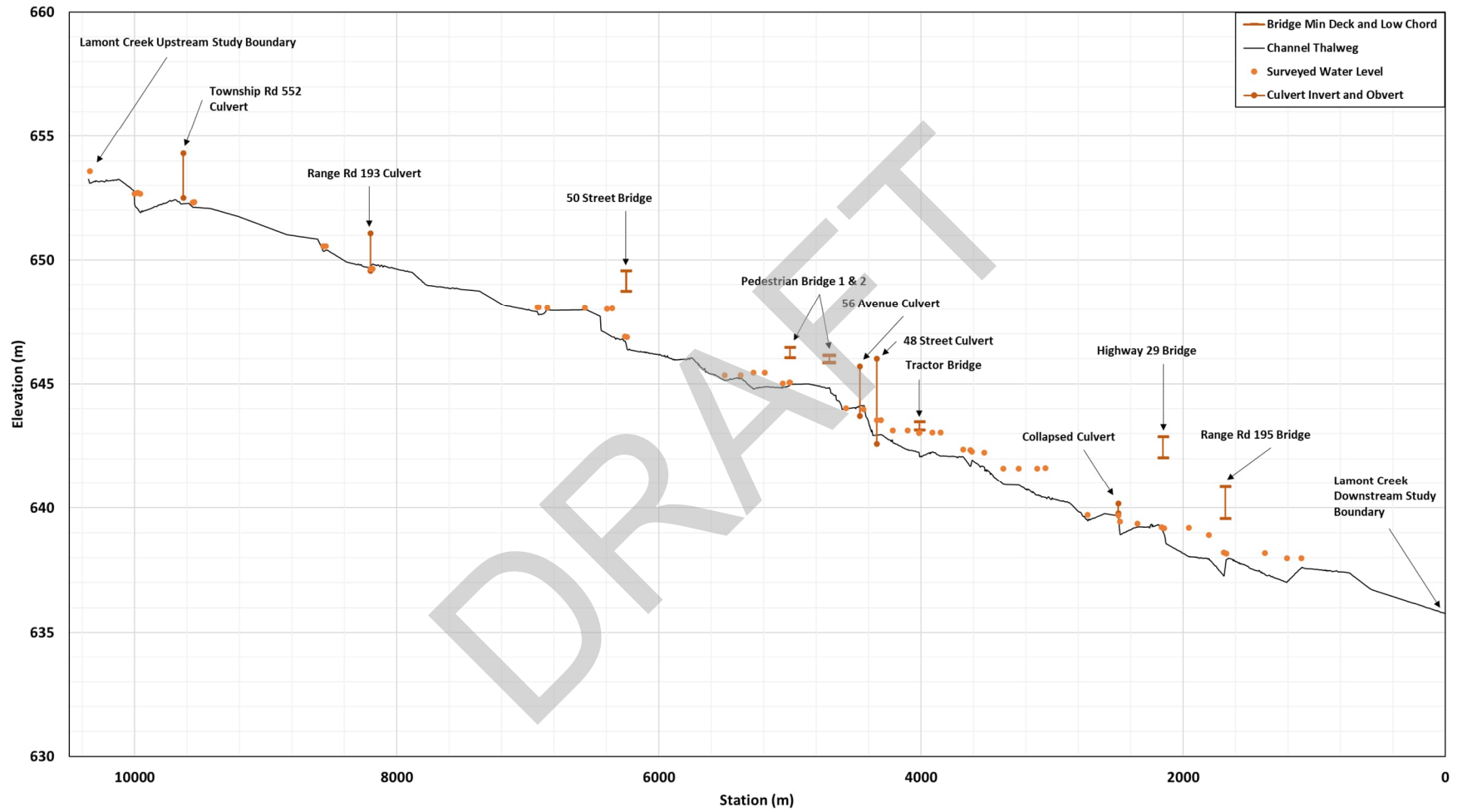


Figure 2-2: Surveyed Channel Thalweg and Surface Water Profile along Lamont Creek

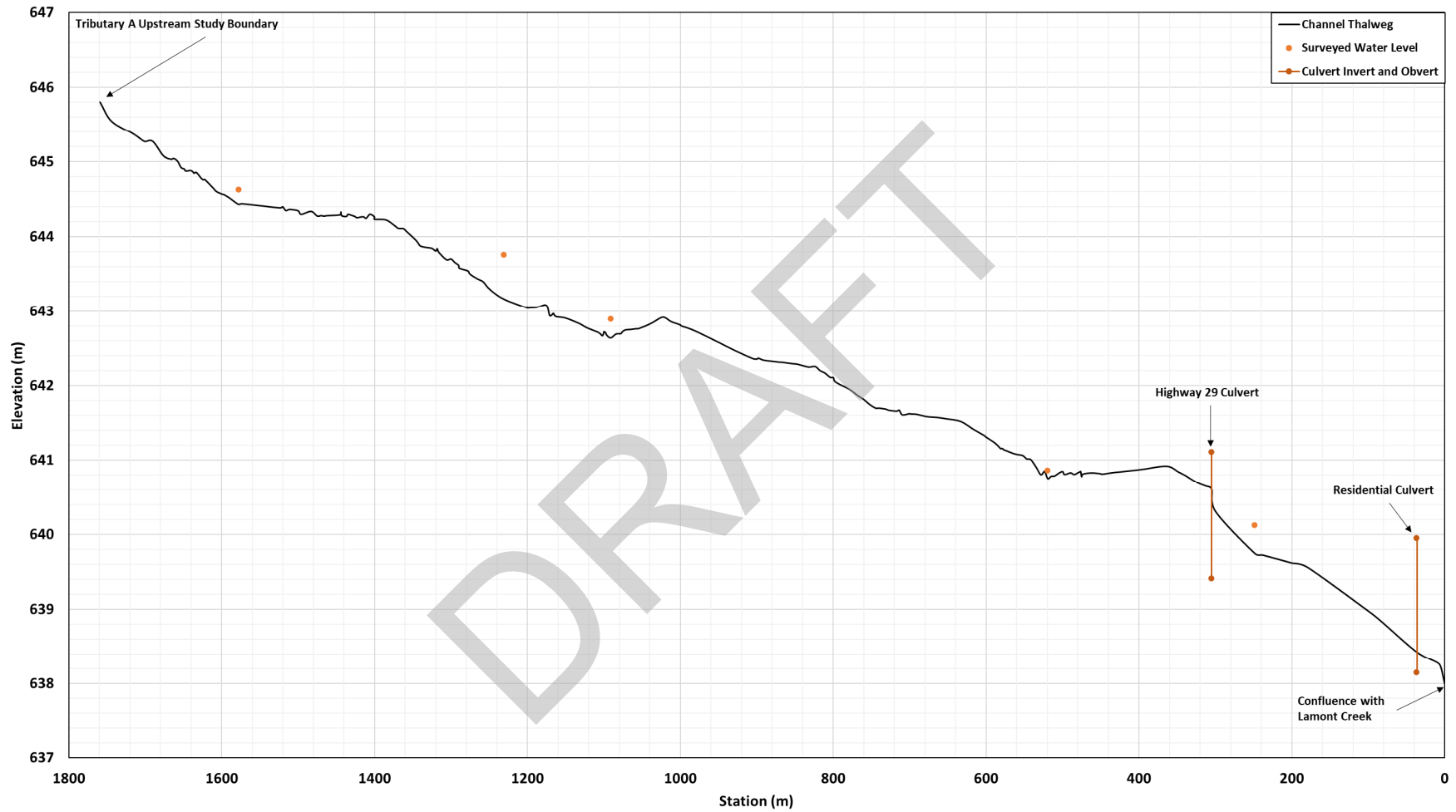


Figure 2-3: Surveyed Channel Thalweg along Tributary A

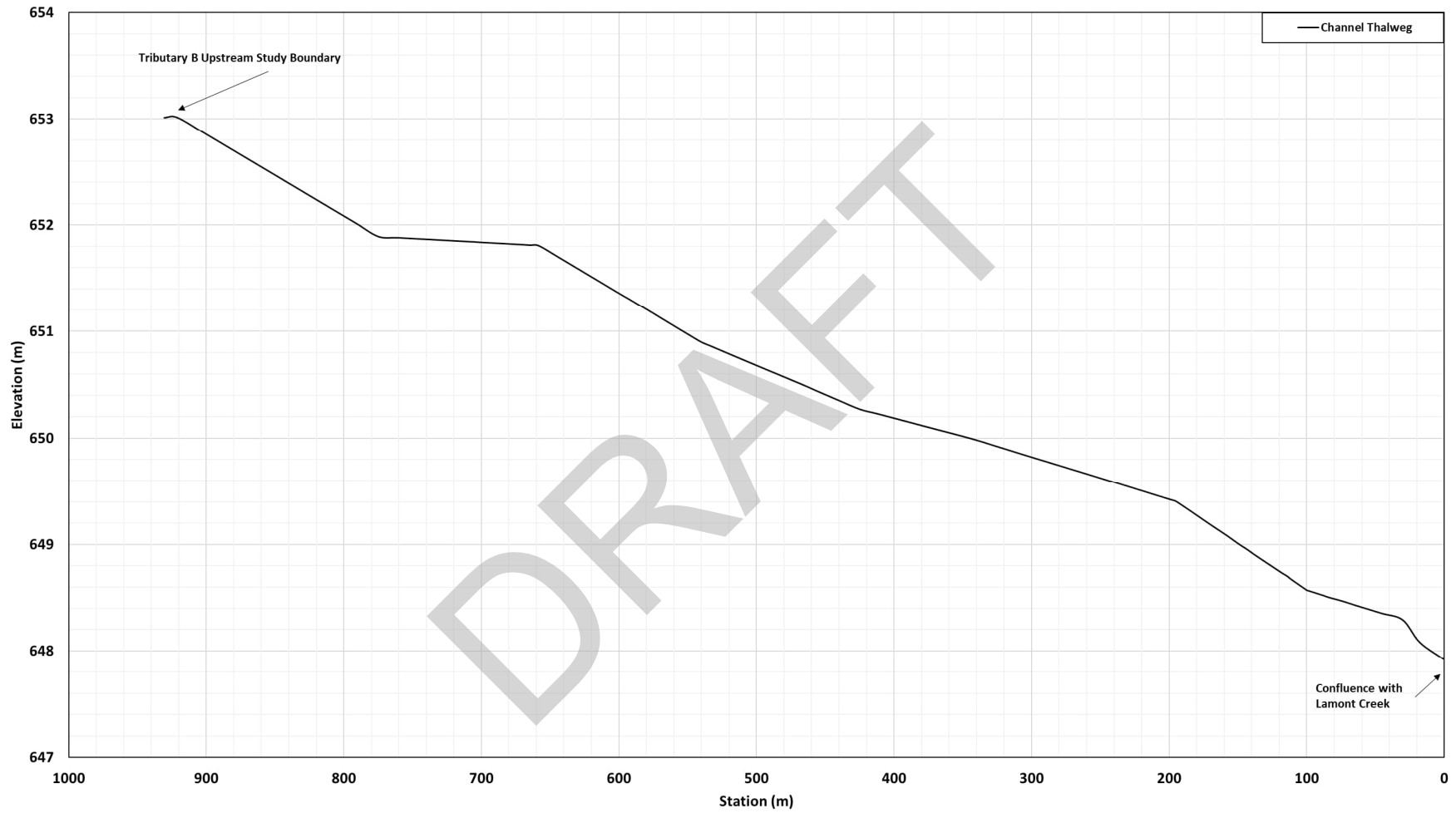


Figure 2-4: Surveyed Channel Thalweg along Tributary B

2.5 Discharge and Water Level Measurements

Two discharge measurements were completed along Lamont Creek on June 11, 2023. Water levels were recorded during the cross section surveys. Table 2-2 provides a summary of the discharge and water level measurement data.

No discharge measurements were completed along the two tributaries because no flowing water was present during the field survey. Many cross sections on the two tributaries and Lamont Creek upstream of 48 Street were completely dry.

Table 2-2: Discharge and Water Level Measurements

Waterbody	Date	Discharge Measurement Location	Water Level Measurement Locations		Measured Discharge (m ³ /s)
			Upstream Cross Section	Downstream Cross Section	
Lamont Creek	June 11, 2023	170 m upstream of Range Road 195 Bridge	Lamont Creek 80	Lamont Creek 81	0.004
Lamont Creek	June 11, 2023	Adjacent to Tractor Bridge, 300 m upstream of 44 Street Culvert	Lamont Creek 58	Lamont Creek 59	0.003

2.6 Hydraulic Structures

There are 24 hydraulic structures (i.e., 7 bridges and 17 culverts) in the study area. A summary of these hydraulic structures is provided in Table 2-3.

Table 2-3: Hydraulic Structures within the Study Area

Waterbody	Structure ID	Structure Name / Location	Type	No. of Spans or Pipes	Corresponding Figure Number in Appendix B
Lamont Creek	L1	Highway 15 Culvert	Traffic	1	B-15
	L2	Rail Culvert	Traffic	1	B-16
	L3	Township Rd 552 Culvert	Traffic	2	B-1
	L4	Range Rd 193 Culvert	Traffic	2	B-2
	L5	50 Ave Bridge	Traffic	1	B-3
	L6	Tawâw Park Bridge 1	Pedestrian	1	B-4
	L7	Tawâw Park Bridge 2	Pedestrian	1	B-5
	L8	56 Ave Culvert	Traffic	1	B-6
	L9	48 St Culvert	Traffic	1	B-7
	L10	Tractor Bridge	Traffic	1	B-8
	L11	Collapsed Culvert	Traffic	1	B-17
	L12	Highway 29 Bridge	Traffic	1	B-9
	L13	Range Rd 195 Bridge	Traffic	1	B-10

Table 2-3: Hydraulic Structures within the Study Area

Waterbody	Structure ID	Structure Name / Location	Type	No. of Spans or Pipes	Corresponding Figure Number in Appendix B
Tributary A	TA1	Highway 15 Culvert	Traffic	1	B-18
	TA2	Rail Bridge	Traffic	1	B-19
	TA3	Rail Yard Culvert	Rail	3	B-20
	TA4	Residential Culvert	Pedestrian	1	B-21
	TA5	Residential Culvert 2	Pedestrian	1	B-22
	R1 ^(a)	Highway 29 Culvert	Traffic	2	B-11
	R2 ^(a)	Residential Culvert	Traffic	2	B-12
Tributary B	TB1	Highway 15 Culvert	Traffic	2	B-23
	TB2	Rail Yard Culvert	Rail	2	B-24
Extra	E1	Highway 29 Culvert	Traffic	2	B-13
	E2	Range Road 831 Culvert	Traffic	1	B-14

Note:

(a) Structure is located along the former Relief Ditch, now part of Tributary A. Section 4.3.2 provides additional details about the Relief Ditch.

Bridge and culvert locations are shown in Figures A-1 to A-3 of Appendix A. The site photographs, survey data point locations, and salient information for each hydraulic structure are shown in Figures B-1 to B-22 of Appendix B.

2.7 Flood Control Structures

There are no flood control structures identified on Lamont Creek and the two tributaries within the study area.

2.8 Additional Base Data

Additional base data collected in support of hydraulic modeling and mapping included the following:

- LiDAR topographic data collected in October 2023 and provided by EPA.
- Recent orthorectified aerial imagery which was acquired by Orthoshop Geomatics Ltd. (OGL) in October 2023 and provided by EPA.

3.0 OPEN WATER HYDROLOGY ASSESSMENT

3.1 Overview

Lamont Creek originates south of the Town of Lamont and drains in a northwesterly direction through the Town, eventually discharging into the Beaverhill Creek. Two unnamed tributaries join Lamont Creek around the Town of Lamont. Tributary A joins the study reach of Lamont Creek just downstream of the Town and almost all of the watershed lies outside the boundaries of the Town. Tributary B joins Lamont Creek at the upstream stretches of the study reach in the southeastern portion of the Town and about half of its watershed lies within the Town of Lamont. The study reach for Lamont Creek extends from the downstream side of the CN Rail crossing within NW-10-55-19-W4M to the upstream side of the Range Road 195 bridge. The study reaches of the two tributaries extend from the downstream side of their respective CN Rail crossings to their confluences with Lamont Creek.

Documentation of a detailed open water hydrology assessment for Lamont, including the Lamont Creek, Tributary A, and Tributary B, is provided in Appendix C. The sections below provide a summary of that assessment.

3.2 Open Water Flooding History

Flood history and hydrometric data availability for Lamont Creek and its tributaries are limited, but anecdotal and surveyed records provide insights into significant past flood events. There are no WSC hydrometric stations on Lamont Creek or its tributaries. Based on anecdotal evidence, the worst flooding in Lamont Creek happened in 1974 due to spring snowmelt flooding (Stanley 1998). Other major flood events occurred in 1982 and 1990. The 1982 flooding led to drainage improvement work which involved re-routing of tributary flows west of the Town of Lamont, as well as channel improvements to Lamont Creek (Stanley 1998). In addition to these flood events at the Town of Lamont, flooding has been reported in 1974, 1982, 1997, 2014, 2015, 2016, 2018, and 2020 in Lamont County, which covers an area of about 2,530 km² and includes creeks such as Lamont, Beaverhill, Whiteford, Limestone, and Peno (NHC 2021). Limited highwater mark data exists for Lamont Creek; however, Northwest Hydraulic Consultants surveyed highwater marks for the 2018 flood.

3.3 Open Water Flood Frequency Analysis

The flood frequency estimates for Lamont Creek, Tributary A, and Tributary B were derived based on regional analysis. Published hydrometric data from WSC stations that are currently operational or were operated in the past were used in the regional analysis to estimate flood discharges of 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year return periods for Lamont Creek and its two tributaries.

3.3.1 Flow Adjustment

The flood magnitudes recommended for hydraulic modelling in the study reaches of Lamont Creek till upstream of Tributary B confluence, Tributary B, Tributary A, and Lamont Creek downstream of Tributary A are the same as those determined by the regional flood frequency analysis.

For the study reach of Lamont Creek between the Tributary B and Tributary A confluences, the recommended values for hydraulic modelling were derived by summing the flood magnitudes of Lamont Creek upstream of Tributary B and those derived for Tributary B. These estimates are just 1 to 2% higher than those derived directly from regional analysis. This adjustment simplifies subsequent hydraulic modelling because, for 2D HEC-RAS model configuration, flows downstream of confluences must match the sum of flows from Lamont Creek upstream of the confluence and flows from its tributary (i.e., Tributary B).

However, the flood flows of Lamont Creek downstream of the Tributary A confluence, if derived as the sum of the flood flows of Lamont Creek upstream of the confluences and its tributary (i.e., Tributary A), are about 11% higher than the flood magnitudes from regional analysis. This relatively larger difference could result in higher flood water level estimates by the HEC-RAS model for this stretch of Lamont Creek and consequently would result in a more conservative flood inundation extent. Therefore, the flood flows from regional analysis were used for this reach of Lamont Creek and adjustments to the 2D HEC-RAS model configuration were made to this stretch of Lamont Creek. Flow downstream of Tributary A was reduced by 11% by inserting an internal boundary into the 2D HEC-RAS model.

The recommended values for Lamont Creek between the confluences with Tributary B and Tributary A differ slightly from those in Table 6 of the hydrology memo for this reason. Table 3-1 presents the recommended flood magnitudes for modeling and mapping purposes.

Table 3-1: Flood Peak Discharge Estimates and their 95% Confidence Intervals for Lamont Creek, Tributary A, and Tributary B

Return Period	Annual Probability of Exceedance (%)	Lamont Creek upstream of Tributary B Confluence			Tributary B			Lamont Creek from downstream of Tributary B Confluence to upstream of Tributary A Confluence			Tributary A			Lamont Creek downstream of Tributary A Confluence		
		Value (m ³ /s)	Upper 95% limit (m ³ /s)	Lower 95% Limit (m ³ /s)	Value (m ³ /s)	Upper 95% limit (m ³ /s)	Lower 95% Limit (m ³ /s)	Value (m ³ /s)	Upper 95% limit (m ³ /s)	Lower 95% Limit (m ³ /s)	Value (m ³ /s)	Upper 95% limit (m ³ /s)	Lower 95% Limit (m ³ /s)	Value (m ³ /s)	Upper 95% limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	1.11	1.44	0.863	0.308	0.399	0.239	1.42	1.84	1.10	0.602	0.779	0.467	1.81	2.35	1.40
5	20	2.37	2.95	1.85	0.648	0.808	0.506	3.02	3.76	2.36	1.27	1.59	1.00	3.87	4.82	3.02
10	10	3.53	4.53	2.66	0.965	1.24	0.726	4.49	5.77	3.39	1.90	2.44	1.43	5.77	7.41	4.34
20	5.0	4.98	6.70	3.52	1.36	1.83	0.96	6.34	8.53	4.48	2.68	3.60	1.89	8.15	11.0	5.76
35	2.9	6.44	9.08	4.27	1.76	2.48	1.17	8.20	11.6	5.44	3.46	4.88	2.30	10.5	14.8	6.98
50	2.0	7.52	11.0	4.76	2.06	3.00	1.30	9.58	14.0	6.06	4.05	5.91	2.56	12.3	17.9	7.79
75	1.3	8.94	13.8	5.31	2.45	3.77	1.46	11.4	17.6	6.77	4.81	7.41	2.86	14.6	22.5	8.68
100	1.0	10.1	16.1	5.80	2.76	4.40	1.59	12.8	20.5	7.39	5.43	8.65	3.13	16.5	26.2	9.48
200	0.50	13.3	23.7	6.92	3.67	6.52	1.90	17.0	30.2	8.82	7.20	12.8	3.73	21.8	38.7	11.3
350	0.29	16.7	31.9	7.89	4.59	8.78	2.17	21.2	40.7	10.1	8.99	17.2	4.26	27.2	52.0	12.9
500	0.20	19.1	38.6	8.56	5.28	10.7	2.36	24.4	49.3	10.9	10.3	20.9	4.62	31.2	63.0	13.9
750	0.13	22.4	47.7	9.37	6.19	13.2	2.59	28.6	60.9	12.0	12.1	25.8	5.06	36.5	77.6	15.3
1,000	0.10	25.0	55.3	10.0	6.91	15.3	2.77	31.9	70.6	12.8	13.5	29.9	5.41	40.7	90.1	16.3

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3.4 Comparison with Previous Studies

The flood frequency estimates obtained in the hydrology assessment for Tributary A, Tributary B, and Lamont Creek were compared with the Stanley (1998) study that was prepared for Alberta Environmental Protection (now EPA). The flood frequency estimates were also compared with values estimated from the regional flow frequency curve that NHC (2021) developed for Lamont County. Table 3-2 and Table 3-3 show comparison of the flood frequency estimates derived in this study and the Stanley (1998) and NHC (2021) studies, respectively. It should be noted that Stanley (1998) and NHC (2021) used gross drainage areas when developing regional curves to estimate peak flows of Lamont Creek and its two tributaries. In this study, the effective drainage areas were used to develop the regional relationships.

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Table 3-2: Comparison of Flood Frequency Estimates with Stanley (1998) Study

Return Period (years) / Drainage Area	Tributary B (m ³ /s)		Tributary A (m ³ /s)		Lamont Creek upstream of Tributary B (m ³ /s)		Lamont Creek upstream of Tributary A (m ³ /s)		Lamont Creek downstream of Tributary A (m ³ /s)	
	This Study	Stanley (1998)	This Study	Stanley (1998)	This Study	Stanley (1998)	This Study	Stanley (1998)	This Study	Stanley (1998)
	5.74 km ²	3.4 km ²	13.3 km ²	15.8 km ²	28.7 km ²	38.2 km ²	38.2 km ²	45.8 km ²	51.5 km ²	61.6 km ²
2	0.308	0.218	0.602	0.768	1.11	1.59	1.40	4.09	1.77	2.35
5	0.648	0.480	1.27	1.70	2.37	3.52	2.98	6.05	3.79	5.22
10	0.96	0.714	1.90	2.52	3.53	5.21	4.44	8.00	5.65	7.71
20	1.36	0.945	2.68	3.34	4.98	6.89	6.27	10.8	7.97	10.2
50	2.06	1.27	4.05	4.50	7.52	9.28	9.46	13.0	12.0	13.7
100	2.76	1.54	5.43	5.44	10.1	11.2	12.7	11.2	16.1	16.6

Note:
 Effective drainage areas were used to estimate the peak flood discharges of Lamont Creek, Tributary B and Tributary A in this study and gross drainage areas were used in the Stanley (1998) study.

Table 3-3: Comparison of Flood Frequency Estimates with NHC (2021) Study

Return Period (years) / Drainage Area	Tributary B (m ³ /s)		Tributary A (m ³ /s)		Lamont Creek upstream of Tributary B (m ³ /s)		Lamont Creek downstream of Tributary B (m ³ /s)		Lamont Creek upstream of Tributary A (m ³ /s)		Lamont Creek downstream of Tributary A (m ³ /s)	
	This Study	NHC (2021)	This Study	NHC (2021)	This Study	NHC (2021)	This Study	NHC (2021)	This Study	NHC (2021)	This Study	NHC (2021)
	5.74 km ²	5.74 km ²	13.3 km ²	14.4 km ²	28.7 km ²	36.1 km ²	34.4 km ²	41.9 km ²	38.2 km ²	45.4 km ²	51.5 km ²	59.7 km ²
2	0.308	0.277	0.602	0.531	1.11	1.02	1.29	1.13	1.40	1.20	1.77	1.46
5	0.648	0.646	1.27	1.23	2.37	2.34	2.74	2.59	2.98	2.74	3.79	3.33
10	0.96	0.985	1.90	1.87	3.53	3.57	4.09	3.96	4.44	4.19	5.65	5.08
50	2.06	1.94	4.05	3.65	7.52	6.89	8.71	7.63	9.46	8.06	12.0	9.75
100	2.76	2.47	5.43	4.66	10.1	8.79	11.7	9.73	12.7	10.3	16.1	12.4

Note:
 Effective drainage areas were used to estimate the peak flood discharges of Lamont Creek, Tributary B and Tributary A in this study and gross drainage areas were used in the NHC (2021) study.

4.0 OPEN WATER HYDRAULIC MODELING

4.1 Overview

The following sections describe the methodology and results of the open water hydraulic modeling component of the study. The scope of this section included summary of available data and stream/valley features in the study area, hydraulic model setup, hydraulic model calibration and validation, selection of Manning's n roughness values, sensitivity analysis, and generation of open water flood frequency profiles. The results of this section were used in the flood inundation mapping, flood hazard identification, and governing design flood hazard mapping components.

4.2 Available Data

4.2.1 Digital Terrain Model

Digital Terrain Model (DTM) data were provided by EPA for this study. The DTM was derived from survey-verified high-accuracy Light Detection and Ranging (LiDAR) remote sensing data acquired during October 2023.

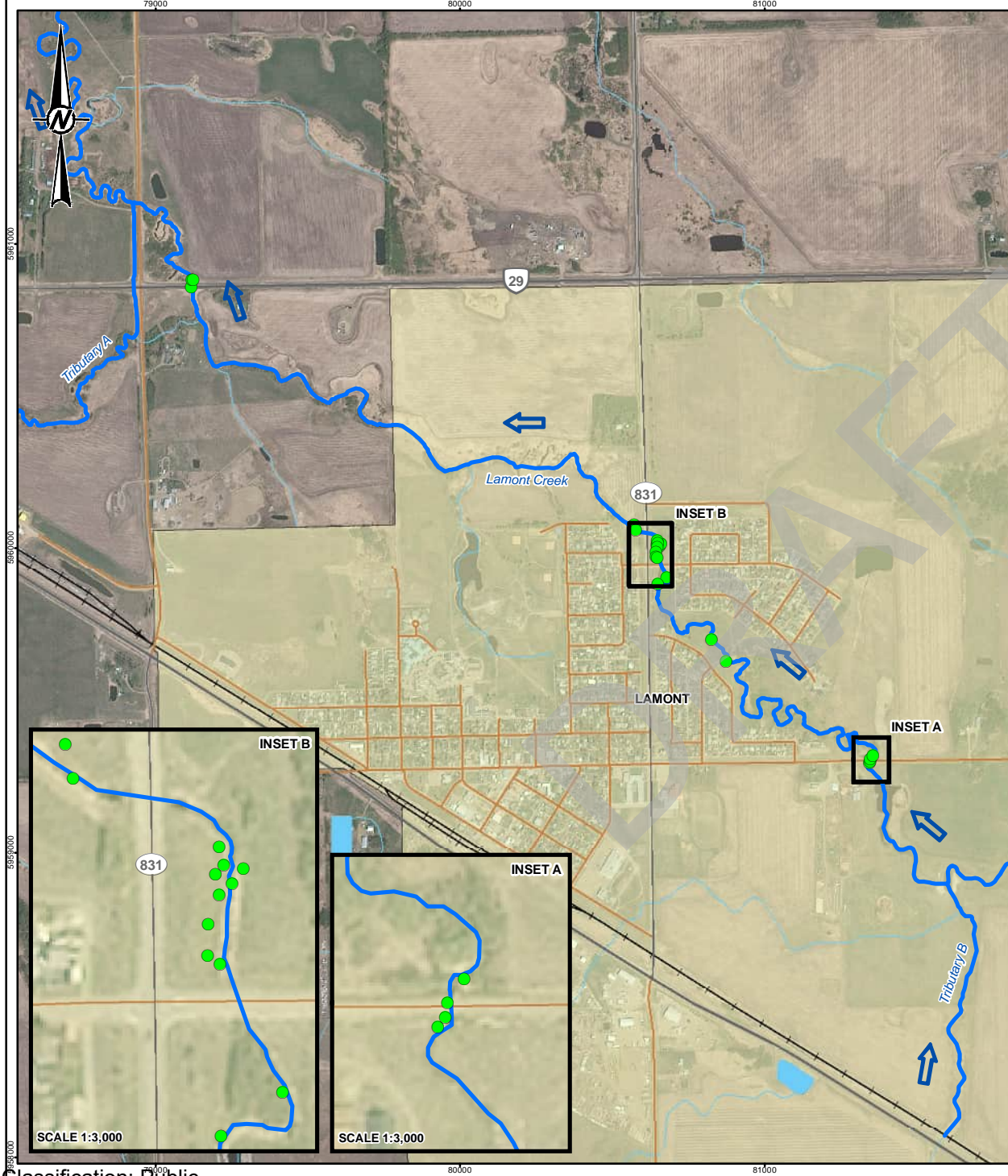
4.2.2 Existing Hydraulic Model

The HEC-2 hydraulic model previously developed for the study area in 1998 was available for the study. In the 1998 HEC-2 model, the study reach of Lamont Creek was 5.9 km, entirely within the current 10.4 km reach. Tributary A's study reach was 1.6 km, entirely within the present 1.8 km reach. Tributary B's study reach was 0.9 km, entirely within the current 1.0 km reach. The downstream boundary location in the 1998 study was close to the Range Road 195 Bridge at 4-29-55-19-W4M.

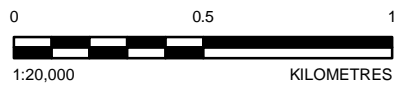
4.2.3 Highwater Marks

EPA provided one set of historic open water flood highwater mark (HWM) data (2018) along the Lamont Creek study reach. WSP also attempted to collect additional HWMs by investigating the availability of data from the Town of Lamont, Lamont County, Alberta Transportation and other sources. Unfortunately, no additional HWM data were available from those sources for model calibration. In addition, no anecdotal HWM data were identified by local residents during field inspection and field survey. The available HWMs along Lamont Creek for this study were provided by the AEPA in an Excel spreadsheet with accompanying photographs, locations of all HWMs are shown in Figure 4-1.

There were no HWM data available along the study reaches of Tributary A and Tributary B.



- LEGEND**
- 2018 HIGHWATER MARK
 - PRIMARY HIGHWAY
 - SECONDARY HIGHWAY
 - LOCAL ROAD
 - RAILWAY
 - ➔ FLOW DIRECTION
 - SURVEY REACH
 - WATERCOURSE
 - WATERBODY
 - ▭ TOWN OF LAMONT



REFERENCE(S)
 TOWN OF LAMONT BOUNDARY AND HYDROGRAPHY OBTAINED FROM ALTALIS, © GOVERNMENT OF ALBERTA 2024. ALL RIGHTS RESERVED. ROADS OBTAINED FROM GEOGRATIS, © DEPARTMENT OF NATURAL RESOURCES CANADA. ALL RIGHTS RESERVED. SPOT6 PROJECT IMAGERY CAPTURED IN 2023. DATUM: NAD 83 CSRS PROJECTION: 3TM 114

CLIENT
 ALBERTA ENVIRONMENT
 AND PROTECTED AREAS

PROJECT
 LAMONT FLOOD STUDY



TITLE
LOCATION OF HIGHWATER MARKS

CONSULTANT	YYYY-MM-DD	2025-06-19
	DESIGNED	JC
	PREPARED	PMT
	REVIEWED	AC
	APPROVED	JC

PROJECT NO. 23592565 CONTROL - REV. 0 FIGURE 4-1

4.2.4 Gauge Data and Rating Curve

There are no active Water Survey of Canada (WSC) hydrometric gauging stations located on Lamont Creek within the study area.

4.3 River and Valley Features

4.3.1 Channel Characteristics

The Lamont Creek study reach is approximately 10.4 km long (including additional 1.1 km length of the study reach beyond the downstream end of the required study reach). It extends from the upstream study boundary, north of Highway 15 (the northern half of 11-10-55-19-W4M), through the Town of Lamont, to a location approximately 1.7 km downstream of the Range Road 195 bridge crossing (the western boundary of 9-30-55-19-W4M). Lamont Creek develops from a wide, shallow, and undefined channel starting at Highway 15 and progressively changes into a narrow, deep, well-defined channel with a very flat channel bed slope at the end of the study area. Beaver dams and debris were observed in Lamont Creek during the survey for this study. Channel banks are generally stable and well vegetated with minimal erosion observed. The channel bed and bank materials consist of mainly silt, sand, and clay.

Tributary A historically converged with Lamont Creek upstream of the Highway 29 Bridge; however, the tributary was diverted north along the west side of Range Road 195 and now meets Lamont Creek downstream of the Highway 195 Bridge. Tributary A is a relatively straight and shallow channel with clearly defined channel banks. Downstream of Range Road 195, the channel becomes a wide and straight ditch. The channel bed and bank material consist of mainly silt, sand, and clay.

Tributary B is a shallow, wide, and poorly defined channel that is predominantly straight. The channel bed and bank material is primarily composed of silt, sand, and clay.

The typical channel bottom width, bankfull width, bankfull depth, average channel bed slope, and average sinuosity for these study reaches are summarized in Table 4-1.

Table 4-1: Typical Channel Characteristics of Study Reaches

River	Reach	Channel Bottom Width (m)	Bankfull Width (m)	Bankfull Depth (m)	Channel Bed Slope (m/m)	Channel Sinuosity
Lamont Creek	Lamont Creek	1.1	6.9	1.2	0.0018	1.3
Tributary A	Upper Reach ^(a)	0.6	7.5	1.2	0.0041	1.4
	Lower Reach ^(b)	4.8	19.4	1.3	0.0062	1.1
Tributary B	Tributary B	5.5	18.5	0.6	0.0056	1.1

Notes:

(a) Between Highway 15 and Range Road 195

(b) Between Range Road 195 to confluence with Lamont Creek

4.3.2 Floodplain Characteristics

The Lamont Creek study reach meanders in relatively flat landscape. The creek is cut about 3-4 m below the surrounding plains. A small floodplain can be found adjacent to one or both sides of the main channel. North of the Town of Lamont, abandoned side channels are present and typically retain water year around. Two developing oxbow channels exist near the downstream end of the study area and are the result of natural channel migration. The floodplain width is typically 60 m, with a range of 30 to 120 m. The vegetation cover on the floodplain within the study area consists mainly of grasses, scattered bushes, and trees. Parts of the floodplain are used as farmland.

The upper reach of Tributary A has a well-defined channel with a typical floodplain width of approximately 60 m, expanding out to 190 m near the lower reach at Range Road 195. Two abandoned channels are located in the floodplain near Range Road 195. The vegetation cover on the floodplain within the upper reach consists mainly of grasses, bushes, and trees. The lower reach of Tributary A consists primarily of a constructed Relief Ditch running along the west side of Range Road 195.

The 1982 flooding led to drainage improvement work which involved re-routing the Tributary A flows west of the Town of Lamont, as well as channel improvements to Lamont Creek (Stanley 1998). The flows of Tributary A were re-routed using a relief ditch just west of the Range Road 195 (RR 195) culvert crossing. This relief ditch runs north parallel to RR 195 for about 455 m and joins Lamont Creek just after the RR 195 bridge crossing on Lamont Creek. The relief ditch consists of two culverts with the first culvert passing through Highway 29 (R1) and the second culvert through a farm access road (R2). Information collected by AEPA from Lamont County indicates that the RR 195 culvert for Tributary A was removed sometime between 1999 and 2005. Consequently, the connection with the old Tributary A channel section east of RR 195 has been severed and the relief ditch is now considered part of the Tributary A channel alignment linking Tributary A with Lamont Creek.

Tributary B has a poorly defined channel with a typical floodplain width of approximately 30 m. There are no residences situated on the floodplain. The floodplain areas are mainly agricultural with scattered bushes and trees.

4.3.3 Anthropogenic Features

Lamont is a small agricultural community in central Alberta, known for its proximity to Edmonton and its predominantly farmland-based floodplain areas. The Town of Lamont is a community in central Alberta, located approximately 40 km northeast of Edmonton and adjacent to Highway 15. It is situated in Lamont County and has a population of 1,700, according to the 2021 Census of Population conducted by Statistics Canada. The floodplain land use areas are mainly farmland.

4.3.4 Bridges and Culverts

The man-made structures within the study reaches that are relevant to hydraulic modeling are listed in Table 4-2 and Appendix B. There are 6 bridge crossings and 4 culvert crossings on the Lamont Creek; 2 culvert crossings on Tributary A; and no crossings on Tributary B.

Table 4-2: Bridge and Culvert Crossings within the Study Area

No.	Station (m)	Name	Description	Type
1	9608	Township Road 552 Culvert	Township Road 552 Culvert Crossing Upstream of Lamont (Figure B-1; Appendix B)	2 round culverts with diameter of 1.80 m
2	8184	Range Road 193 Culvert	Range Road 193 Culvert Crossing Upstream of Lamont (Figure B-2; Appendix B)	1 round culvert with diameter of 1.50 m 1 round culvert with diameter of 1.20 m
3	6242	50 Ave Bridge	50 Ave Bridge Crossing Upstream of Lamont (Figure B-3; Appendix B)	1-Span
4	4999	Tawâw Park Bridge 1	Tawâw Park Bridge 1 Crossing inside Lamont Park (Figure B-4; Appendix B)	1-Span (Pedestrian)

Table 4-2: Bridge and Culvert Crossings within the Study Area

No.	Station (m)	Name	Description	Type
5	4699	Tawâw Park Bridge 2	Tawâw Park Bridge 2 Crossing inside Lamont Park (Figure B-5; Appendix B)	1-Span (Pedestrian)
6	4441	56 Ave Culvert	56 Ave Culvert Crossing inside Lamont (Figure B-6; Appendix B)	1 ellipse culvert 3.15 m x 2.00 m
7	4305	48 St Culvert	48 Street Culvert Crossing inside Lamont (Figure B-7; Appendix B)	1 ellipse culvert 3.429 m x 4.846 m
8	4010	Tractor Bridge	Tractor Bridge Downstream of Lamont (Figure B-8; Appendix B)	1-Span
9	2145	Highway 29 Bridge	Highway 29 Bridge Crossing Downstream of Lamont (Figure B-9; Appendix B)	1-Span
10	1656	Range Road 195 Bridge	Range Road 195 Bridge Crossing Downstream of Lamont (Figure B-10; Appendix B)	1-Span
11	248	Highway 29 Culvert	Highway 29 Culvert Crossing Downstream of Lamont (Figure B-11; Appendix B)	2 ellipse culverts 1.11 m x 1.30 m
12	11	Residential Culvert	Residential Culvert Crossing Downstream of Lamont (Figure B-12; Appendix B)	2 ellipse culverts 1.11 m x 1.30 m

All bridges listed in Table 4-2 were set up in the HEC-RAS model, based on the most recent survey data. The weir coefficient was set as 1.66 for all bridges, which is within the range as suggested by the HEC-RAS hydraulic reference manual (USACE 2022b). All bridges were modeled as clear of debris.

For the bridge modeling approach, the standard energy method was used for low flow conditions while the pressure method was applied for high flow conditions.

All culverts listed in Table 4-2 were set up in the HEC-RAS model based on survey data including culvert shape, length, size and invert elevations. Recommended values for the entrance and exit loss coefficients and Manning's n in the HEC-RAS hydraulic reference manual (USACE 2022b) were used for each type of culvert by default. The culvert input parameters were not adjusted during calibration, because there were no specific data available to support that level of calibration detail.

During the June survey, data were collected on ten additional culverts and one bridge, with seven located along the upstream boundary of the modeling domain. While gathered as a potential supplement for modeling, this information was ultimately not needed. Details on the surveyed structures are provided in Appendix B.

4.3.5 Weirs and Dams

There are no weirs or dams structures within the study area. However, some key linear structures were set up as weirs to simulate the flow pattern more accurately near those structures. Refer to Section 4.4.4.2 for additional details about weirs.

4.3.6 Flood Control Structure

There are no flood control structures within the study area.

4.4 Model Construction

4.4.1 HEC-RAS Program

HEC-RAS Version 6.6 was used to develop the two-dimensional (2D) hydraulic model for the study area. The HEC-RAS program was developed by the Hydrologic Engineering Center (HEC) of the U.S. Army Corps of Engineers (USACE). The software has a graphical user interface, separate hydraulic analysis components, data storage and management capabilities, and graphics and reporting facilities. HEC-RAS is a commonly-used program in North America and around the world.

The HEC-RAS program was designed to perform one-dimensional (1D), two dimensional (2D) or coupled 1D and 2D (1D/2D) hydraulic calculations for a full network of natural and constructed channels. The program supports steady-state and unsteady-state hydraulic simulation. HEC-RAS can be used to calculate water surface profiles for gradually varied flow.

The program can be used to simulate the effects of various obstructions such as bridges, culverts, weirs, levees and other structures. The program is capable of simulating the water surface profiles associated with subcritical, supercritical and mixed flow regimes.

4.4.2 Modeling Approach

In this study, a full 2D HEC-RAS model was set up for entire study area. The rationale for selecting the 2D HEC-RAS modeling approach is provided below:

- Lamont Creek downstream of Highway 29 consists of many tortuous meanders and a wide, flat floodplain on agricultural lands. It would be challenging to define cross section alignments using a 1D modeling approach in this area. Significant manual edit efforts and professional judgments would be required to define the cross sections.
- There are two oxbows and multiple wetlands and ponds situated within the study reaches, so a large number of ineffective areas would be required to represent the effective flow area per cross section.
- There are key linear infrastructures within the floodplains, including Highway 29 and Highway 831. Our past modeling experience indicates that in the event of overtopping of these linear infrastructures away from the main channel, limitations of a 1D model approach may lead to inaccuracies.
- Higher flooding events leave the floodplain system through additional boundaries along Highway 831 and 44 Street. Accounting for losses to the system through additional linkages provides additional challenges for a 1D model and may lead to inaccuracies.
- The mesh along the main channel of Lamont Creek and other tributaries can be further refined to represent the channel characteristics in 2D domain.

A supplementary rough 2D model was developed initially to support the field survey planning and inform the final 2D model setup.

4.4.3 Geometric Data Base

4.4.3.1 *Integrated DEM*

An integrated DEM is a digital elevation model that incorporates interpolated bathymetric surfaces, derived from surveyed cross-section data, to accurately represent channel bathymetry within water edge lines, ensuring a more precise terrain surface for hydraulic modeling. The LiDAR data provided for the study did not include channel bathymetry below the water surface when the LiDAR was collected. Therefore, a bathymetry terrain surface had to be generated to represent the channel bathymetry.

The surveyed cross section data along Lamont Creek, Tributary A, and Tributary B were imported to HEC-RAS. The left and right edges of water were delineated using the LiDAR and imagery. Using RAS Mapper, a bathymetry terrain surface was created within the water edge lines by interpolating surveyed cross-section data. These interpolated bathymetric surfaces replaced the existing topography within the water edges in the LiDAR data, resulting in an integrated DEM that included channel bathymetry. This integrated DEM was then used for HEC-RAS model development. Figure 4-2 compares the terrain surface with and without channel bathymetry.

The integrated DEM excludes the building layer, as incorporating building footprints would unnecessarily complicate the flood mapping process. Given that the volume of flow through developed areas within Lamont is minimal, the inclusion of building footprints is not expected to significantly influence the modeling results. Moreover, adding these features would increase the complexity of the computational mesh by introducing additional refinement zones. The integrated DEM was therefore generated using only bare-earth LiDAR data.

The integrated DEM was checked by spot checking of the integrated bathymetry with the LiDAR to ensure that it represented the channel features along all of the study reaches. Figure 4-2 compares a cross section based on the bare-earth LiDAR (without channel bathymetry) and integrated DEM (with channel bathymetry). The comparison illustrates that channel bathymetry was included in the integrated DEM.

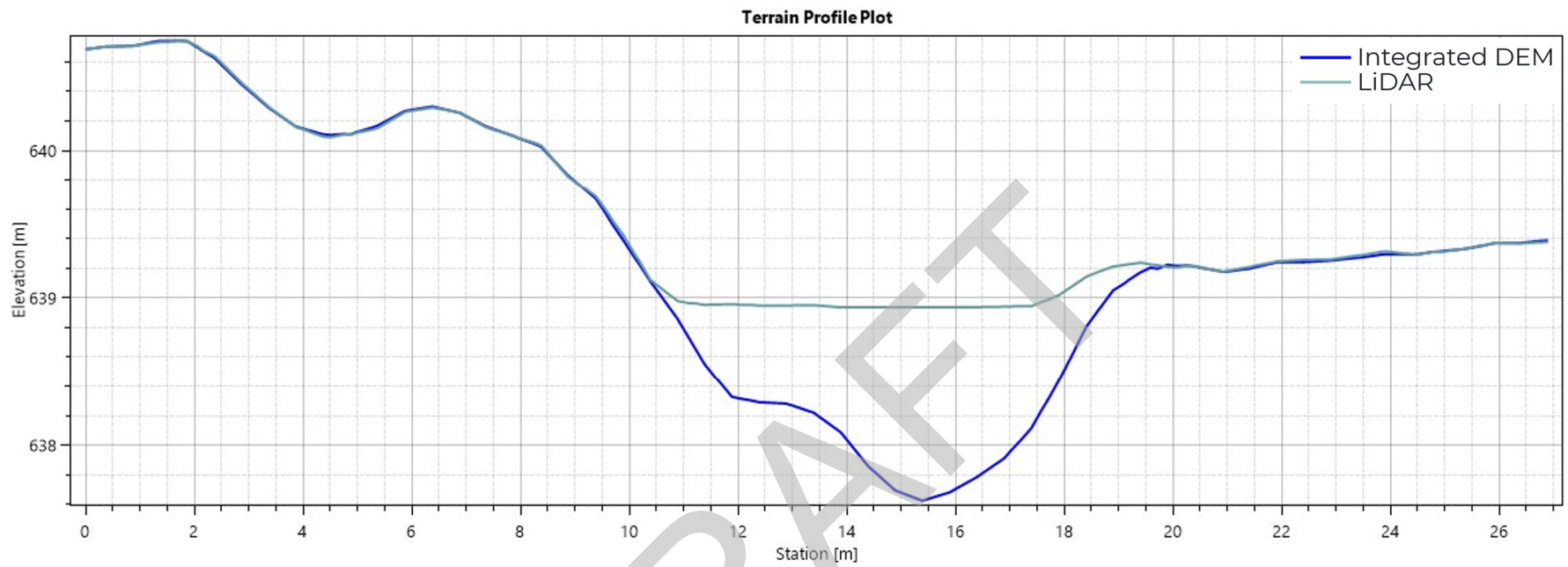


Figure 4-2: Comparison of LiDAR Channel Bathymetry and Channel Bathymetry in the Integrated DEM

4.4.3.2 Roughness Coefficients

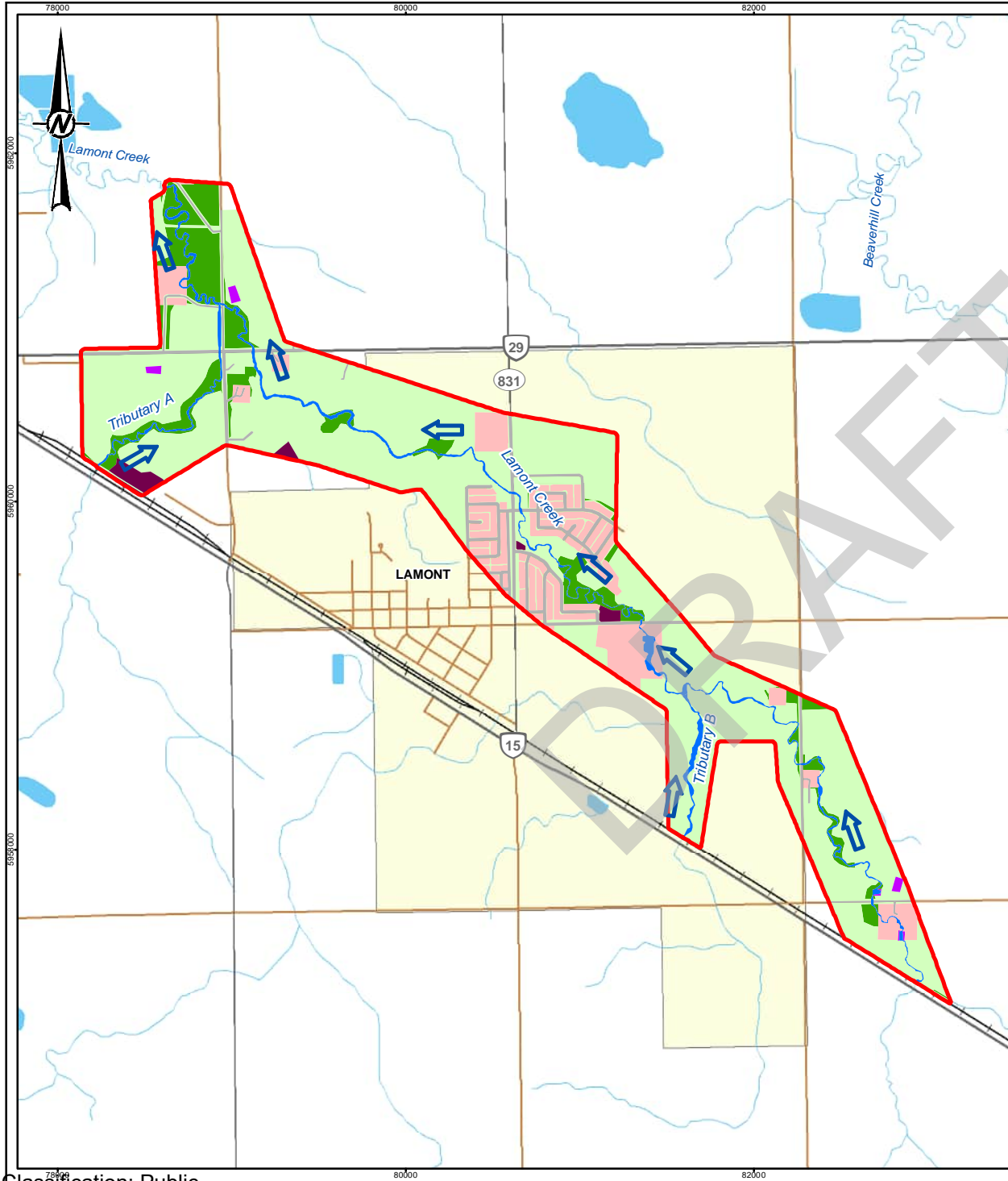
Accurate hydraulic modeling necessitates the spatial assignment of roughness values across the entire model domain to capture variations in surface characteristics and flow resistance. The left and right bank stations defining the main channel were determined using RAS Mapper based on the 2023 LiDAR data, 2023 aerial imagery, and 2023 field survey data. Manning's n values were specified using the distributed roughness approach, which allows for multiple, varying roughness values within the study area. The initial roughness distribution was specified based on the following data:

- Bank lines established from the LiDAR data, aerial imagery and surveys to identify the main channels.
- Land use information from the Government of Alberta (ABMI 2021).

Eight (8) roughness classes were used for the model setup. The initial Manning's n values assigned to the classes are listed in Table 4-3. These initial values were selected based on channel bed materials, and vegetation types (Chow 1959; USACE 2022b). These roughness values were modified at some locations during the model calibration. The roughness values were specified in the 2D domain using RAS Mapper. The distribution of the roughness classes is shown in Figure 4-3.

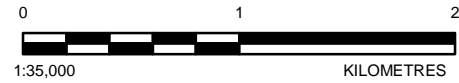
Table 4-3: Roughness Classes and Initial Manning's n Values

Number	Description	Initial Manning's n Value
1	Lamont Creek Channel	0.06
2	Tributary Channel	0.07
3	Urban Mixture (Residential)	0.10
4	Urban Mixture (Commercial)	0.06
5	Street/Road	0.03
6	Grassland and Open Space	0.06
7	Pond/Wetland	0.03
8	Dense Vegetation	0.07



LEGEND

- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- RAILWAY
- ➔ FLOW DIRECTION
- WATERCOURSE
- WATERBODY
- ▭ FLOOD HAZARD STUDY AREA
- ▭ TOWN OF LAMONT
- ▭ DENSE VEGETATION
- ▭ GRASSLAND AND OPEN SPACE
- ▭ MAIN CHANNEL
- ▭ POND
- ▭ STREET
- ▭ URBAN MIXTURE (INDUSTRIAL)
- ▭ URBAN MIXTURE (RESIDENTIAL)



REFERENCE(S)

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CLIENT
ALBERTA ENVIRONMENT
AND PROTECTED AREAS

PROJECT
LAMONT FLOOD STUDY



TITLE
DISTRIBUTION OF ROUGHNESS CLASS

CONSULTANT	YYYY-MM-DD	2025-06-19
	DESIGNED	JC
	PREPARED	PMT
	REVIEWED	AC
	APPROVED	JC

PROJECT NO. 23592565 CONTROL - REV. 0 FIGURE 4-3

4.4.3.3 Hydraulic Structures

In a 2D HEC-RAS model, hydraulic structures like bridges, culverts, and weirs are added to simulate their impact on water flow. The process begins by defining a connection within the 2D flow area, modifying the computational mesh, and specifying geometric and hydraulic properties. Break lines are set along the structure's centerline to refine the mesh, ensuring accurate flow discretization and hydraulic connectivity. Once everything is in place, unsteady flow simulations help evaluate water-structure interactions, including velocity distribution, energy losses, and localized hydraulic effects.

4.4.3.3.1 Bridges

The bridge geometries used in the HEC-RAS model were defined based on the river and bridge surveys conducted in June 2023 (Section 2.0).

Six (6) existing bridges along Lamont Creek (Section 4.3.4) were represented in the HEC-RAS model. The bridge deck, pier, and abutment information were included in the model. Losses through bridges were calculated in the model using the energy equation (i.e., standard step method). Flows over the bridge and approach embankment were calculated using the standard weir equation.

4.4.3.3.2 Culvert

There are six (6) culverts along the Lamont Creek and Tributary A reaches within the 2D model domain. The culverts were represented in the HEC-RAS model based on the survey data. The pertinent culvert information, including size, length, and upstream and downstream invert elevations, was specified in the model. For the culverts in the 2D domain, entrance and exit loss coefficients were selected based on the configuration of culvert inlet and outlet.

4.4.3.3.3 Weirs and Dams

There are no weirs or dams in the study area that were represented in the HEC-RAS model. However, some key linear structures were set up as weirs to simulate the flow pattern more accurately near those structures. Refer to Section 4.4.4.2 for additional details about weirs.

4.4.3.4 Flood Control Structure

There are no flood control structures in the study area that were represented in the HEC-RAS model.

4.4.4 General Model Setup

4.4.4.1 Model Domain

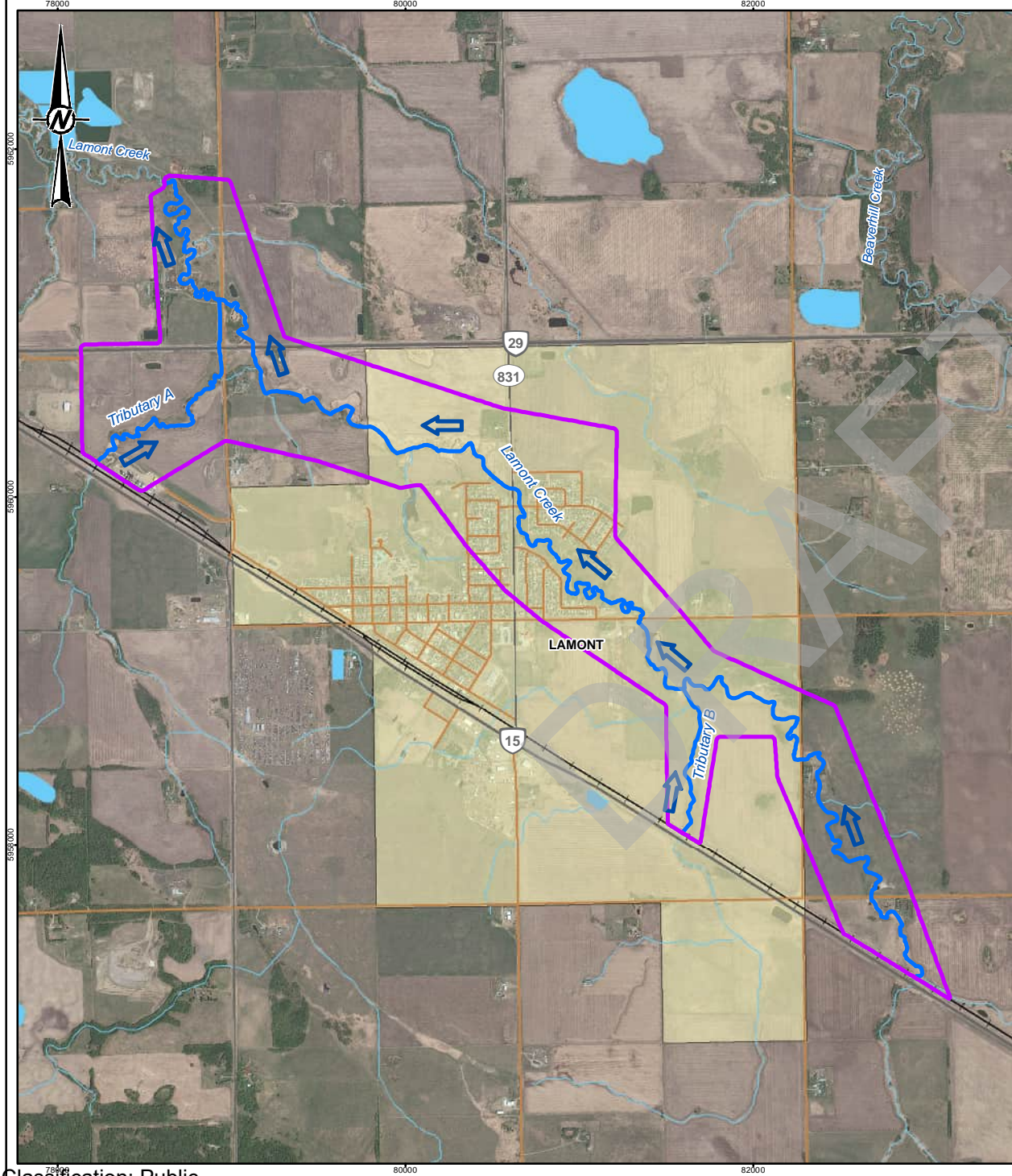
It is generally desirable to use a single geometry file to simulate floods of various return periods. Therefore, the model domain needs to be defined to cover inundation extents of the largest flood event to be simulated. The model domain extent was defined in consideration of the simulation results of a supplemental rough HEC-RAS 2D model, which was set up based on the LiDAR DEM without inclusion of the channel bathymetry, to provide conservative water level estimates.

The inundation extents of the 1,000-year flood event were estimated using the supplemental HEC-RAS 2D modeling results. The final 2D model domain was defined to include the flood extents from the supplemental 2D model and a buffer zone covering additional areas with elevations of 2 to 3 m higher than the flood levels from the supplemental 2D model.

The model domain was constrained along the Highway 831 ditch and 44 Street ditch on the northern edge of the Town of Lamont where flow can enter an adjacent watershed. No discharge or survey data were available for the unnamed tributary watersheds and could not be reliably modeled.

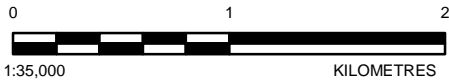
To account for downstream boundary effects, a short reach (approximately 1.1 km) of Lamont Creek downstream of the EPA-required study area (as specified in the Terms of Reference) was included in the 2D model. Figure 4-4 presents the model domain for this study.

DRAFT



LEGEND

- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- RAILWAY
- ➔ FLOW DIRECTION
- ➔ SURVEY REACH
- WATERCOURSE
- WATERBODY
- TOWN OF LAMONT
- MODEL DOMAIN



REFERENCE(S)
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CLIENT
 ALBERTA ENVIRONMENT
 AND PROTECTED AREAS

PROJECT
 LAMONT FLOOD STUDY



TITLE
MODEL DOMAIN

CONSULTANT	WSP	YYYY-MM-DD	2025-06-19
		DESIGNED	JC
		PREPARED	PMT
		REVIEWED	AC
		APPROVED	JC

PROJECT NO. 23592565 CONTROL - REV. 0 FIGURE 4-4

4.4.4.2 Model Mesh

The model mesh size along the main channel was determined based on the bankfull width of Lamont Creek. The main channel and floodplain model mesh was developed based on the following:

- Sections of Lamont Creek with bankfull widths ≤ 2 m caused inconsistencies in mesh generation when larger mesh sizes were used. A 2 m mesh size was selected for Lamont Creek, Tributary A, and Tributary B to balance computational efficiency with mesh resolution, ensuring proper alignment along the stream centerline.
- Breaklines were defined along both banks and channel centre line.
- Floodplains were defined with an average mesh size of 15 x 15 m, with further refinement in areas where topographic details were important to adequately simulate the local hydraulic conditions. Local refinement decreased mesh size to 5 x 5 m along key structures, side channels, and oxbow channels.
- Some key linear structures were set up as weirs to simulate the flow pattern more accurately near those structures. In HEC-RAS, the numerical solver for the Diffused Wave equation set can cause numerical leakage through high ground, even when the water surface elevation remains below the top elevation. This issue, particularly when using the breakline feature, may result in unrealistic inundation downstream of the structure. This was resolved by using weir features rather than just breaklines along some structures. The elevations of the weir features were defined to correspond with the top elevation of the structure from the LiDAR data or the survey data. These structures included: Highway 831 (48 Street), Highway 29, Range Road 193, Range Road 195, and several local roads. The mesh near these structures was also refined to a resolution of 5 m to better represent their physical features.
- Additional breaklines were defined along some local roads to capture highest elevation. These roads included 50a Avenue, 56 Avenue, 57 Avenue, 44 Street, 45 Street, and 46 Street.

Figure 4-5 illustrates a sample of the final model mesh and the mesh refinement near Highway 29.

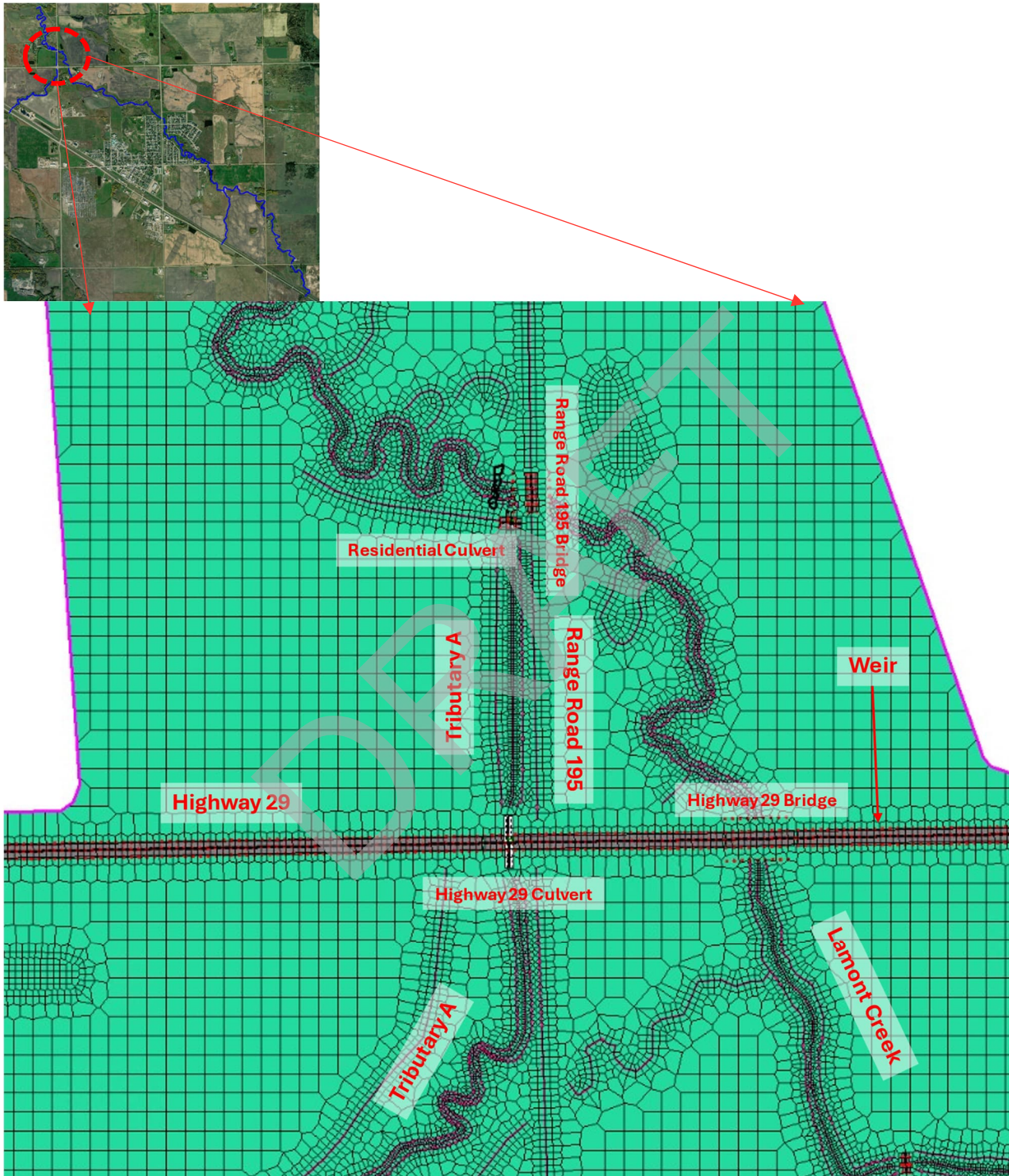


Figure 4-5: Example of Local Mesh Refinement

4.4.4.3 *Boundary Conditions*

The 2D HEC-RAS model requires specification of boundary conditions at all open boundaries. The open boundaries of the hydraulic model are shown in Figure 4-6 and listed below:

- discharges at the upstream model boundaries of Lamont Creek, Tributary A, and Tributary B
- normal flow condition (with an estimated energy slope of 0.0051 m/m) at downstream model boundary of Lamont Creek
- normal flow condition (with an estimated energy slope of 0.0031 m/m) at the 44 Street ditch on the north edge of the Town of Lamont, where the water would flow northeast for high flood events
- normal flow condition (with an estimated energy slope of 0.0028 m/m) at the Highway 831 (48 Street) ditch on the north edge of the Town of Lamont, where the water would flow north for high flood events

In most circumstances, the statistical peak flow in the mainstream downstream of a tributary confluence is smaller than the sum of both peak flows. This would require adjusting the flow below the tributary confluence in the HEC-RAS model. However, as described in Section 3.0, the peak flows below the Tributary B confluence are approximately equal to the sum of the peak flows from the two streams. Therefore, in this study, it was not necessary to adjust peak flows below the Tributary B confluence. Conversely, Section 3.0 also describes that the sum of peak flows below the Tributary A confluence resulted in a notably higher flow than the statistical peak, thus requiring adjustment. To address this, an internal boundary below the confluence was established using a negative flow to ensure that the total flow below Tributary A matched the statistical peak flow.

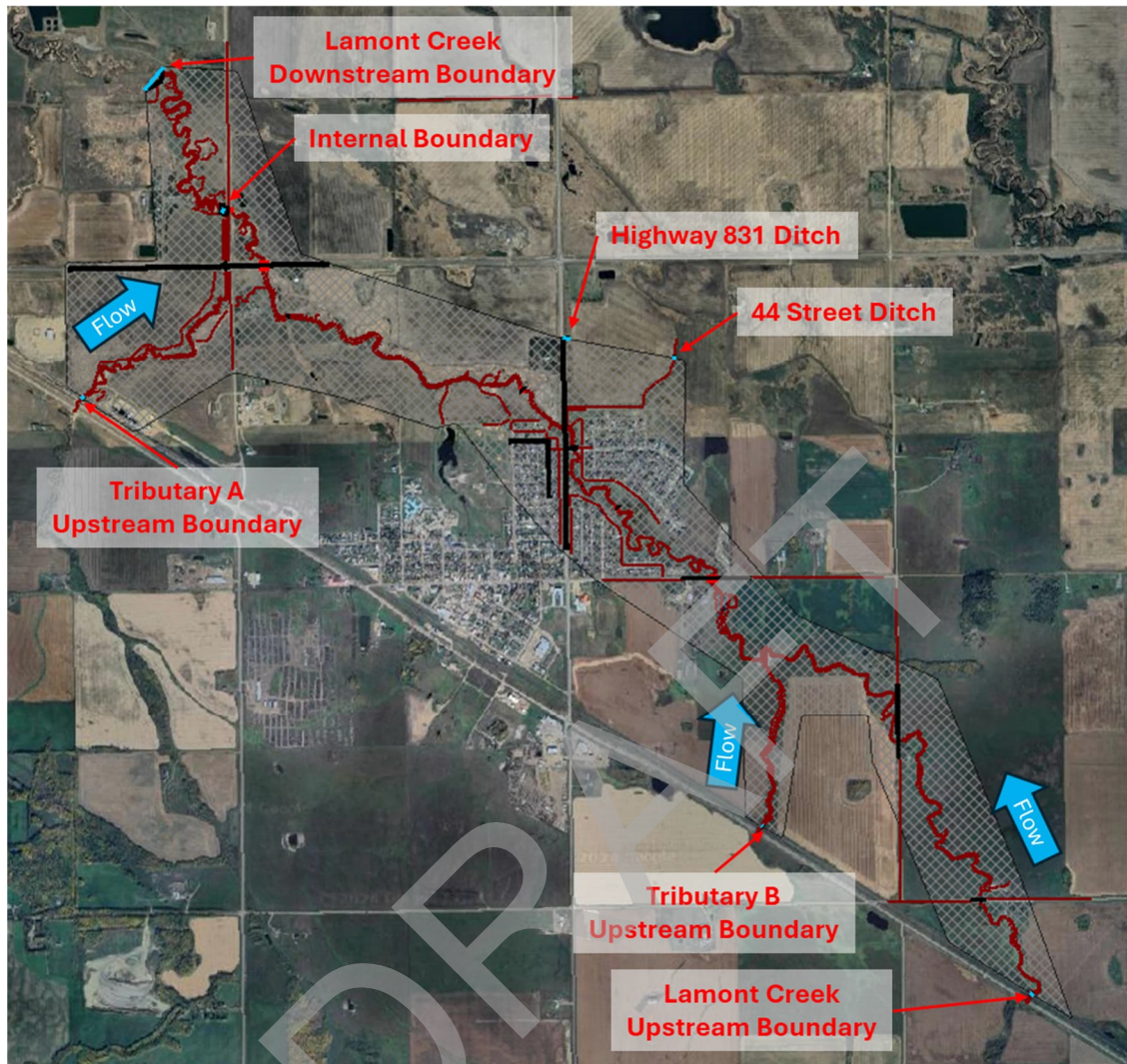


Figure 4-6: Boundary Conditions of the HEC-RAS Model

4.4.4.4 Simulation Period

Ensuring that the simulation period is sufficient to reach steady-state conditions is essential for accurate flood modeling. The simulation period was set to three days for floods with return periods up to and including 50 years, while it was set to 10 days for larger floods with return periods of 75 years and greater. This approach was based on the rationale that flooding is confined within Lamont Creek at lower return periods, allowing the model to reach a steady state in a shorter time. For larger peak flows, flooding extends beyond the system into the 44 Street ditch and the Highway 831 ditch, necessitating a longer simulation period to achieve steady-state conditions.

4.4.5 Model Calibration

4.4.5.1 Methodology

The Manning's n is the primary model calibration parameter. Selection of initial Manning's n values included consideration of creek bed/bank materials, vegetation cover, site information collected during the field inspection, and WSP's experience from previous hydraulic modeling studies.

Observed HWMs for Lamont Creek were available for the 1982 and 2018 flood events; however, no flow data were available for either event to aid in high flow calibration. Channel improvements to Lamont Creek were completed after the 1982 flood event, rendering the associated HWMs inapplicable to this study. Additionally, low flow calibrations could not be completed as no flow was observed in Lamont Creek, Tributary A, or Tributary B during the June 2023 survey. Large portions of Lamont Creek, as well as the entirety of Tributary A and Tributary B, were dry during the survey. Discharge measurements taken at two sections of Lamont Creek recorded flows of 0 m³/s.

Consequently, Manning's n values were selected based on previous experience with HEC-RAS floodplain modeling. WSP referred to the recently completed floodplain mapping for the Vermilion River at Vegreville (WSP 2024), approximately 50 km to the southeast, when calibrating for Lamont Creek. Although the Vermilion River is larger than Lamont Creek, its channel characteristics are similar.

This analysis aligns with the Stanley (1998) flood risk mapping study, which lacked high flow data for calibration. Significant modifications to the channel geometry were implemented following the 1982 flood event as part of channel improvement efforts. Consequently, the recorded high-water levels from the 1982 flood were unsuitable for selecting Manning's n values. Instead, floodplain roughness coefficients were compared to the SNC Lavalin Inc. (1994) Vegreville Flood Risk Mapping Study.

4.4.5.2 Flow Calibration

Lamont Creek's channel roughness values were based on Manning's n values used for the Vermilion River.

The sensitivity of the Manning's n values selected for Lamont Creek were tested for the 100-year flood over multiple model iterations. Figure 4-7 compares the simulated water surface elevations when changing the constant Manning's n within the streambed by ± 0.005 . Across all simulations, the resulting water surface elevation remained within 0.06 m, leading to the selection of a constant Manning's n of 0.06 for Lamont Creek's final model.

There was no measurable concurrent discharge along Tributary A and Tributary B, much like the tributaries observed along the Vermilion River, and calibrations of the tributaries were not performed. The tributary channel Manning's n values were selected to be 0.07 due to similarities in river bed/bank material types and vegetation cover on the banks between the two flood studies. Manning's n selection was based on published range of values for similar streams (USACE 2022b) as well as WSP's modeling experience and professional judgement.

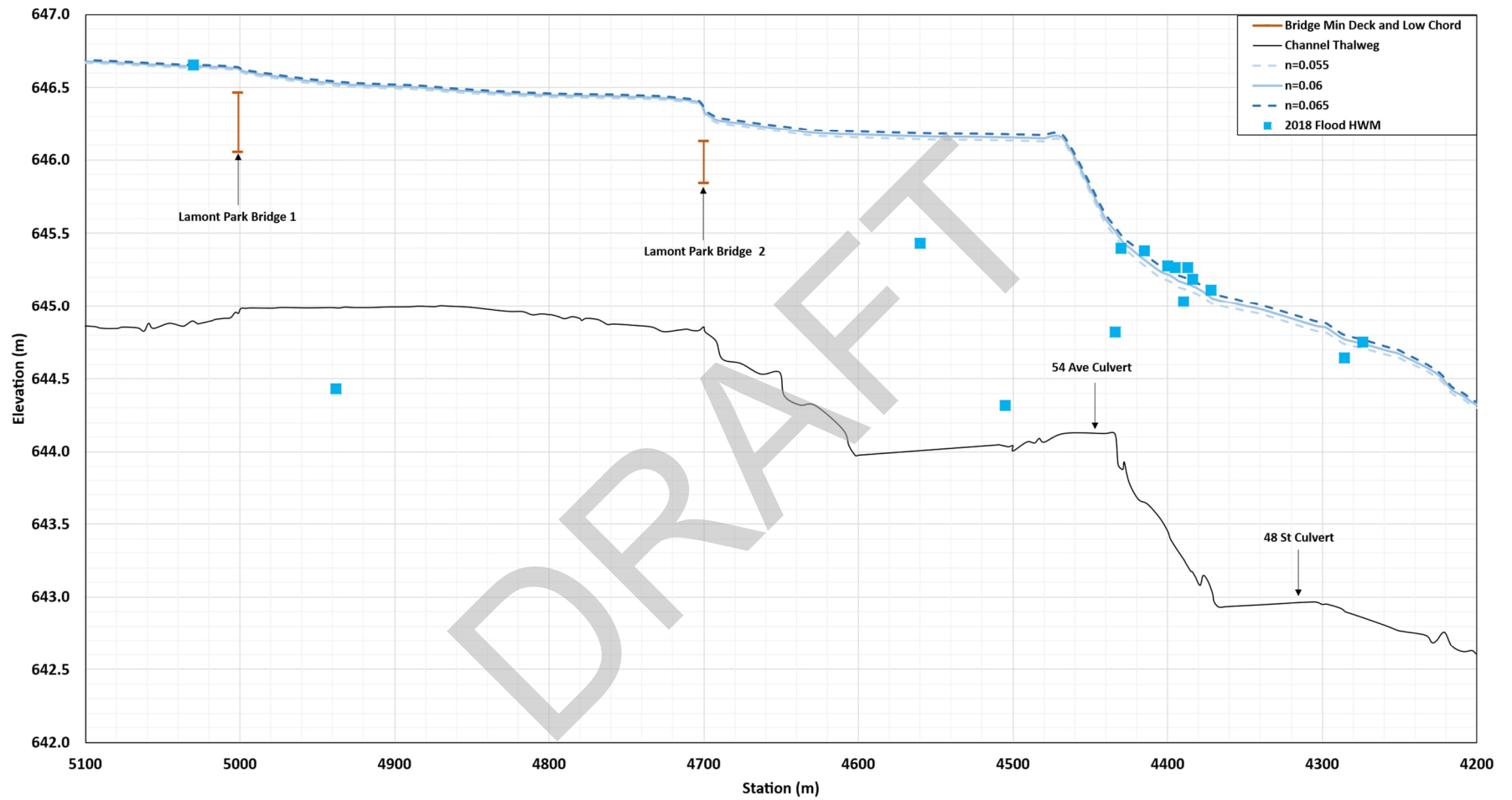


Figure 4-7: Comparison of Simulated Water Surface Profile to 2018 Flood HWMs. The figure also shows variation in water surface elevation due to change in Manning's n Values.

4.4.6 Model Parameters and Options

4.4.6.1 Manning's Roughness Values

Channel Roughness

A constant Manning's n value of 0.06 was selected for Lamont Creek's main channel, and a constant Manning's n value of 0.07 for Tributary A and Tributary B. The selections were based on the Vermilion River Flood Study (see Section 4.4.5), literature values, and WSP's modeling experience and professional judgement. The selected values are consistent with the Stanley (1998) flood risk mapping study, indicating an average Manning's n of 0.062 for Lamont Creek's main channel and 0.067 for Tributary A and Tributary B.

The selected Manning's n values are in the reasonable range in comparison to typical values of comparable streams (Chow 1959).

Overbank Roughness

The initial overbank Manning's n values selected in Table 4-3 were used in the model. Manning's n values were selected based on the recently completed floodplain mapping for the Vermilion River at Vegreville (WSP 2024), approximately 50 km to the southeast, and were found to be reasonable when selecting for Lamont Creek.

Table 4-4: Selected Manning's n Values for Various Land Use Types

Number	Land Use	Selected Manning's n Value
1	Lamont Creek Channel	0.06
2	Tributary Channel	0.07
3	Urban Mixture (Residential)	0.10
4	Urban Mixture (Commercial)	0.06
5	Street/Road	0.03
6	Grassland and Open Space	0.06
7	Pond/Wetland	0.03
8	Dense Vegetation	0.07

4.4.6.2 Expansion and Contraction Coefficients

Contraction and expansion coefficients are not required in a HEC-RAS 2D model.

4.4.6.3 Other 2D model parameters

Several 2D model parameters can be selected in HEC-RAS that can impact the model runtime and model results. The following 2D model parameters were selected for all simulation runs:

- Computation Interval: 2 second
- Equation Set: Diffusive Wave
- Turbulence Model: None
- Matrix Solver: PARDISO (Direct)

4.4.7 Open Water Flood Frequency Profiles

4.4.7.1 Calibrated HEC-RAS Model

The calibrated HEC-RAS model was based on the estimated Manning’s *n* values. The flood peak discharges used in the HEC-RAS production model were based on the hydrology assessment presented in Section 3.0. Surface water profiles were simulated using the calibrated model for the 2-, 5-, 10-, 20-, 35, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year flood events.

4.4.7.2 Internal Boundary

One internal boundary was included along Lamont Creek downstream of the confluence with Tributary A. The coincidental flows derived from the regional analysis downstream of Tributary A were 11% lower than the aggregate flood magnitudes produced by the calibrated model. In response, an internal boundary was included into the model to reduce the observed flow downstream of Tributary A, aligning discharge values with the hydrology assessment. Internal boundary values for Lamont Creek are listed in Table 4-5.

No internal boundary was considered downstream of Tributary B. Coincidental flows between Tributary B and Tributary A along Lamont Creek were about 2% lower than the summation of flood magnitudes and were considered acceptable for modeling.

Table 4-5: Summary of Internal Boundaries Used in the Calibrated Model

Location	Internal Boundary Flow Changes of Various Return Periods (m ³ /s)												
	2-year	5-year	10-year	20-year	35-year	50-year	75-year	100-year	200-year	350-year	500-year	750-year	1,000-year
Lamont Creek Downstream of Tributary A Confluence	-0.21	-0.42	-0.62	-0.87	-1.14	-1.33	-1.60	-1.79	-2.25	-2.58	-2.70	-2.54	-2.33

4.4.7.3 Flood Peak Discharges

The flood peak discharges listed in Table 4-6 were assigned at the upstream boundaries of Lamont Creek, Tributary A, and Tributary B in the calibrated model.

As stated in Section 4.4.4.3, in most circumstances, the statistical peak flow in the main stream downstream of a tributary confluence is smaller than the sum of the peak flows from both streams. In this study, no adjustment was needed for the peak flow below the Tributary B confluence. However, adjustments were required for the peak flow below the Tributary A confluence to ensure it aligned with the statistical peak flow. To achieve this, an internal boundary was introduced below Tributary A confluence using negative flow. Table 4-6 summarizes the flows for the 13 flood events used in the calibrated model.

Table 4-6: Summary of the Flood Peak Discharges Used in the Calibrated Model

Location	Discharges of Various Return Periods (m ³ /s)												
	2-year	5-year	10-year	20-year	35-year	50-year	75-year	100-year	200-year	350-year	500-year	750-year	1,000-year
Lamont Creek Upstream of Tributary B	1.11	2.37	3.53	4.98	6.44	7.52	8.94	10.1	13.4	16.7	19.1	22.4	25.0
Tributary B	0.308	0.648	0.965	1.36	1.76	2.06	2.45	2.76	3.67	4.59	5.28	6.19	6.91
Tributary A	0.602	1.27	1.90	2.68	3.46	4.05	4.81	5.43	7.20	8.99	10.3	12.1	13.5

4.4.7.4 Open Water Flood Frequency Profiles

Water levels were extracted from the 2D model results along the main channel in regular intervals of 100 m. The channel stations are presented in the inundation maps. The simulated open water flood profiles along the study reaches of the Lamont Creek, Tributary A, and Tributary B are presented in Figure D-1 to Figure D-3 in Appendix D. The simulated open water flood water levels for 100 m stationing intervals are listed in Table D-1 to Table D-3 in Appendix D.

4.4.8 Model Sensitivity

A model sensitivity analysis was conducted to evaluate the effects of changing model roughness values and downstream boundary conditions on the simulated water levels. The 100-year flood peak discharge was used for the model sensitivity analysis. The sensitivity analysis results were used to quantify the level of uncertainty associated with the simulated flood levels along the study reaches of Lamont Creek, Tributary A, and Tributary B.

The analysis of model sensitivity to Manning's n involves the following two sets of Manning's n values for the creek channels and floodplains and one set of downstream boundary conditions:

- $\pm 10\%$ changes of the base channel Manning's n values only
- $\pm 10\%$ changes of the base floodplain Manning's n values only
- $\pm 20\%$ changes of the specified energy slope for the downstream boundary

The differences between the simulated water levels for the 100-year flood along the study reaches of the Lamont Creek, Tributary A, and Tributary B, are graphically presented in Figures E-1 to E-9 in Appendix E. The results of the sensitivity analysis indicate the following:

- The uncertainty in the simulated flood levels along each channel is, on average, within a range of -0.021 to +0.017 m (Lamont Creek), -0.025 to +0.020 m (Tributary A), and -0.018 to +0.016 m (Tributary B), based on the differences in the simulated flood levels for a $\pm 10\%$ change to the base channel Manning's n value only.
- The uncertainty in the simulated flood levels along each channel is, on average, within a range of -0.013 to +0.012 m (Lamont Creek), ± 0.004 m (Tributary A), and -0.005 to +0.004 m (Tributary B), based on the differences in the simulated flood levels for a $\pm 10\%$ change to the base floodplain Manning's n values only.
- A $\pm 20\%$ change to the energy slope at the downstream boundary of Lamont Creek influences the simulated flood levels by a range of 0.000 to 0.001 m for approximately 800 m upstream of the downstream boundary.

5.0 FLOOD INUNDATION MAPS

5.1 Methodology

The flood inundation maps were prepared based on the following information:

- simulated water levels for the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500, 750-, and 1,000-year flood events
- topography from the October 2023 LiDAR survey
- aerial imagery of the study area obtained in October 2023

Direct flood inundation areas were identified either as being part of the actively-flowing river channels or flooded overbank areas directly connected to the actively-flowing areas. The following general procedure was used in ArcGIS to develop the inundation extent of the 13 open water flood events:

- Flood inundation boundaries, water level grids and depth grids were exported from the 2D HEC-RAS model. The last time step results were exported from HEC-RAS to ensure that the model reached a steady state.
- Areas that were not directly connected to the main river channels were manually removed. Areas where there was no direct overland connection but a hydraulic connection through culverts or other features, may be included in the inundation extent.

5.2 Inundation Polygon Modifications

5.2.1 Open Water Inundation Mapping

One set of open water flood inundation maps was prepared for each of the 13 flood events. The study area is covered by a total of five sheets in tabloid format (11 x 17 in). The mapping scale are 1:5,000. The maps were prepared using the local 3-Degree Transverse Mercator (3TM) zone and the Canadian Spatial Reference System North American Datum of 1983 (NAD83 CSRS) coordinate system and datum.

The maps include the 2023 aerial imagery and other base data (roads and railways) provided by EPA. The resulting inundation maps for the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year flood events are presented in a separate document (Appendix F: Open Water Flood Inundation Map Library).

The flood inundation maps were prepared in a geographical information system (ESRI ArcGIS 10.7). The maps including all layers were provided to EPA as digital files in the ESRI ArcGIS file format.

5.2.2 Manual Edits

Flood inundation mapping at some locations required manual edits to produce reasonable inundation extents. These manual edits are summarized in Table 5-1.

Table 5-1: Manual Edits for Flood Inundation Polygons

River	Floodplain	Closest River Station	Description	Flood Events
Lamont Creek	Left	2300	The low-lying area west of Residential Culvert 1 was flooded and linked to the modeled floodplain as an inundated region. Area is part of the original Tributary A before realignment.	35-year flood event
	Right	4300	Additional inundated area was added north of 44 Street. The modeling surface for the 44 Street ditch and Highway 381 ditch is assumed to contain brush and is permeable to flow. Additional inundation area was added by bridging gaps in model results.	200-year flood event
	Right and Left	8200	Additional inundated area was added to represent the overtopping of Range Road 193 culvert crossing. The inundated areas were derived by extending the modeled flood water levels from the upstream edge to the downstream edge of the road embankment as well as by linear interpolation between the downstream edge of the road and the modeled water levels downstream of the culvert.	20-year to 350-year flood events
	Right and Left	9600	Additional inundated area was added to represent the overtopping of Township Road 552 culvert crossing. The inundated areas were derived by extending the modeled flood water levels from the upstream edge to the downstream edge of the road embankment as well as by linear interpolation between the downstream edge of the road and the modeled water levels downstream of the culvert.	350-year to 1000-year flood events

After applying the manual edits, the flood inundation polygons underwent automated smoothing and filtering to create more simplified inundation extents. All dry areas fully enclosed by inundation polygons (“islands”) smaller than 25 m² were filled and added to the inundated areas. The flood inundation polygons were smoothed using the PAEK (Polynomial Approximation with Exponential Kernel) algorithm with a smoothing tolerance of 15 m. This smoothing tolerance generally results in changes to the inundation boundary well below 1 m in most areas.

5.3 Areas Affected by Floods

5.3.1 Properties Affected by Floods

The residential and commercial areas affected by direct inundation are described below. Detailed inundation maps are provided in Appendix F.

Lamont Creek

- The residential house on the right floodplain immediately upstream of the Township Road 552 Culvert will become inundated during flood events with return periods of 200-year or higher.
- The residential house on the left floodplain immediately upstream of the Highway 29 Bridge will become inundated during flood events with return periods of 200-year or higher.
- Residential houses near the east end of the 44 Street ditch will be impacted during flood events with return periods of 200-year or higher.
- Residential houses on the left floodplain adjacent to the 48 Street Culvert would be impacted during flood events with return periods of 100-year or higher. Houses will become inundated during flood events with return periods of 200-year or higher.
- Residential houses on the right floodplain immediately upstream of the 56 Avenue Culvert would be impacted during flood events with return periods of 50-year or higher.
- Tawâw Park would be impacted during flood events with return periods of 10-year or higher.

Tributary A

There is no inundation that would impact any residential, commercial area, or industrial area along Tributary A.

Tributary B

There is no inundation that would impact any residential house, commercial area, or industrial area along Tributary B.

5.3.2 Flooding of Bridges and Culverts

A bridge is considered affected by flooding when flood waters reach its low chord. A culvert is considered affected by flooding when the flood waters reach the road surface. Three (3) Culverts and four (4) bridges along Lamont Creek, including Lamont Park Bridge 1, Lamont Park Bridge 2, Tractor Bridge, and Range Road 195 Bridge, would be affected during the 100-year flood event. One (1) culvert along Tributary A would be affected during the 100-year flood event.

The simulated water levels at the bridges and culverts along Lamont Creek, Tributary A, and Tributary B for the various flood events, as well as the flow velocities and clearances during the 100-year flood event are summarized in Table 5-2.

5.4 Flood Depth Grids

The following GIS data were provided to EPA for each of the 13 open water flood events:

- Inundation polygons
- Water surface elevation rasters
- Flood depth rasters

All GIS data were created in ArcGIS 10.7 compatible format in the native study coordinate system [Canadian Spatial Reference System, North American Datum of 1983 (CSRS NAD83), Epoch 2002 and 3-Degree Transverse Mercator projection with the Central Meridian of 111° (3TM 111)]. All raster files have a spatial resolution of 0.5 m.

The inundation polygons and raster files were stored in ArcGIS file geodatabases, Version 10.7. The flood water level data, provided as rasters, cover all areas within the study area including dry areas. The flood water depth rasters only include the areas with a water depth of more than 0.01 m.

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Table 5-2: Flooding at the Bridges and Culverts along the Lamont Creek, Tributary A, and Tributary B

Bridge or Culvert Station (m)	Name	Minimum Deck or Road Surface Elevation (m)	Minimum Low Chord or Culvert Top Elevation (m)	Simulated Water Levels at the Bridges/Culverts for the Various Flood Events (m)													Average Flow Velocity for the 100-year Flood Event (m/s)	Clearance for the 100-year Flood Event ^(a) (m)	Return Period of Flood Event Causing Pressure Flow or Overtopping Road Surface
				2-year	5-year	10-year	20-year	35-year	50-year	75-year	100-year	200-year	350-year	500-year	750-year	1000-year			
Lamont Creek																			
9617	Township Road 552 Culvert	655.46	654.33	653.23	653.47	653.65	653.86	654.05	654.19	654.37	654.52	655.01	655.49	655.55	655.60	655.63	0.62	-0.19	75-year
8192	Range Road 193 Culvert	651.93	651.50	650.78	651.07	651.30	651.60	651.67	651.71	651.75	651.77	651.85	651.92	651.96	652.00	652.04	0.32	-0.27	20-year
6250	50 Avenue Bridge	649.58	648.74	647.53	647.93	648.13	648.24	648.33	648.39	648.46	648.52	648.71	648.92	649.01	649.15	649.26	1.37	0.22	350-year
5001	Lamont Park Bridge 1	646.47	646.06	645.99	646.22	646.36	646.49	646.58	646.63	646.70	646.75	646.86	646.94	647.00	647.07	647.12	0.89	-0.69	5-year
4700	Lamont Park Bridge 2	646.13	645.85	645.63	645.86	646.05	646.20	646.32	646.40	646.50	646.56	646.67	646.74	646.79	646.85	646.89	1.11	-0.71	5-year
4453	56 Avenue Culvert	646.94	646.06	644.92	645.29	645.52	645.75	645.97	646.14	646.33	646.41	646.52	646.59	646.63	646.68	646.71	1.35	-0.35	50-year
4321	48 Street Culvert	646.21	645.71	643.94	644.32	644.54	644.73	644.88	644.97	645.09	645.17	645.32	645.44	645.51	645.60	645.65	1.56	0.54	> 1000-year
4013	Tractor Bridge	643.48	643.15	643.11	643.41	643.59	643.72	643.80	643.85	643.89	643.93	644.01	644.07	644.11	644.16	644.19	0.69	-0.78	5-year
2155	Highway 29 Bridge	642.89	642.04	639.62	639.98	640.26	640.51	640.72	640.84	640.96	641.04	641.23	641.38	641.49	641.59	641.70	1.18	1.00	> 1000-year
1679	Range Road 195 Bridge	640.85	639.56	638.92	639.32	639.58	639.79	639.94	640.03	640.11	640.15	640.26	640.33	640.39	640.46	640.50	0.74	-0.59	10-year
Tributary A																			
23	Highway 29 Culvert	642.76	641.78	640.44	640.58	640.69	640.80	640.90	640.97	641.06	641.12	641.29	641.45	641.57	641.69	641.79	0.66	0.65	1000-year
275	Residential Culvert	640.47	640.00	638.92	639.32	639.56	639.76	639.91	640.01	640.11	640.17	640.27	640.33	640.37	640.41	640.44	0.19	-0.17	50-year

Note:

(a) The clearances for the 100-year flood event are the elevation differences between bridge low chord elevations or culvert road surface elevations and simulated water levels. A negative value indicates that the water depth above the low chord for a bridge or above the road surface for a culvert.

6.0 DESIGN FLOOD HAZARD MAPPING

6.1 Flood Hazard Mapping Approach

The flood hazard mapping approach is described in detail in the Flood Hazard Identification Program (FHIP) – Flood Study Technical Guidelines (AEP 2022). The major technical changes compared to previous mapping are outlined below:

- Encroachment analysis will no longer be used to define floodway limits or determine 100-year design flood levels. The 0.3 m water level rise criterion is no longer used to define the floodway limit.
- Existing floodways from previous flood studies will not typically get larger when flood hazard maps are updated. For areas with previously defined floodways, the initial new floodway location will typically correspond to the existing floodway. The floodway can only get larger or smaller if it is deemed necessary with new modeling results based on consultation with local authorities.
- A new high hazard flood fringe zone will highlight parts of the flood fringe with deeper or faster moving water than the rest of the flood fringe outside of the floodway. The new high hazard flood fringe zone will be defined where the water is 1 m deep or greater or local velocities are 1 m/s or faster within the flood fringe zone.
- The protection provided by dedicated flood berms will be reflected in new flood hazard maps. Areas behind flood berms will still be mapped as flooded if they are overtopped, but areas at risk of flooding behind dedicated flood berms that are not overtopped will be mapped as a protected flood fringe zone.
- Flood hazard maps will show areas at risk of more severe flooding than just the 100-year design flood. Areas of incremental flood risk outside of the 100-year flood hazard area will be highlighted, including the 200-year and 500-year flood extents.

6.2 Design Flood

The 100-year open water flood was selected as the design flood in accordance with the Flood Hazard Identification Program (FHIP) Flood Study Technical Guidelines (AEP 2022). The 100-year flood water levels simulated in open water flood frequency profiles (Section 4.4.7.4) were selected as the final design flood levels. The design flood levels for 100 m stationing intervals along Lamont Creek, Tributary A, and Tributary B are provided in Appendix D.

6.3 Floodway and Flood Fringe Terminology

The flood hazard area is the area of land that will be flooded during the design flood event. The flood hazard area is typically divided into two zones: floodway and flood fringe. Flood hazard maps can also show additional flood hazard information, including areas of high hazard within the flood fringe and incremental areas at risk for more severe floods, such as the 200-year and 500-year floods. Flood hazard mapping is typically used for long-term flood hazard area management and land-use planning. The floodway and flood fringe zones are defined as follows:

- **Floodway:** When a floodway is first defined on a flood hazard map, it typically represents the area of highest flood hazard where flows are deepest, fastest, and most destructive during the 100-year design flood. The floodway generally includes areas where the water is 1 m deep or greater and the local velocities are 1 m/s or faster. The floodway typically includes the main channel of a stream and a part of the adjacent overbank area. Previously mapped floodways do not typically become larger when a flood hazard map is updated, even if the flood hazard area becomes larger or design flood levels become higher. New development is discouraged in the floodway and may not be permitted in some communities.

- **Flood Fringe:** The flood fringe is the part of the flood hazard area outside of the floodway. The flood fringe typically represents areas with shallower (less than 1 m deep), slower (less than 1 m/s velocity), and less destructive flooding during the 100-year design flood. However, areas with deep or fast moving water may also be identified as high hazard flood fringe within the flood fringe. Areas at risk behind flood berms may also be mapped as protected flood fringe areas. New development in the flood fringe may be permitted in some communities.

6.4 Floodway Determination Criteria

In areas being mapped for the first time, the floodway typically represents the area of highest hazard where flows are deepest, fastest, and most destructive during the design flood. The following criteria, based on those described in current FHIP guidelines (AEP 2022), are used to delineate the floodway in such cases:

- Areas in which the depth of water exceeds 1 m or the flow velocities are greater than 1 m/s shall be part of the floodway.
- Exceptions may be made for small backwater areas, ineffective flow areas, and to support creation of a hydraulically smooth floodway.
- For reaches of supercritical flow, the floodway boundary should correspond to the edge of inundation or the main channel, whichever is larger.

When a flood hazard map is updated, an existing floodway will not change in most circumstances. Exceptions to this would be: (1) a floodway could become larger if the main channel has shifted outside of a previously-defined floodway, or (2) a floodway could become smaller if an area of previously-defined floodway is no longer flooded by the design flood. Furthermore, boundaries of the existing floodway may be modified to create a smoother transition between the current floodway and its updated extents, where the new floodway extends beyond the original limits.

Areas of deeper or faster moving water outside of the floodway are identified as high hazard flood fringe. These high hazard flood fringe zones are identified in all areas, whether they are newly-mapped or have an existing floodway.

All areas protected by dedicated flood berms that are not overtopped during the design flood are excluded from the floodway. Areas behind flood berms will still be mapped as flooded if they are overtopped, but areas at risk of flooding behind dedicated flood berms that are not overtopped will be mapped as a protected flood fringe zone.

The governing criteria for Lamont Creek, Tributary A, and Tributary B were based on the depth and velocity criteria as presented on the Floodway Criteria Maps in Appendix G.

6.5 Floodway Criteria Maps

Floodway criteria maps show the basis for determining the floodway, high hazard flood fringe zone, protected flood fringe areas and flood fringe zone for the design flood and documenting the results of water levels, depths, and flow velocities. The floodway criteria maps include the following information:

- inundation extents of the 100-year design flood
- areas meeting or exceeding the 1 m depth floodway criterion for the design flood
- areas meeting or exceeding the 1 m/s velocity floodway criterion for the design flood

- previous floodway
- proposed floodway boundary for the design flood
- background aerial imagery collected in 2023
- roads, bridges, culverts and flood control structures as applicable

The open water design flood water surface elevations and flow velocities were generated from the 2D HEC-RAS model. The model was run until it reached steady state conditions. The last simulation time step was then used to extract the flood water surface elevations and flow velocities directly from the RAS Mapper tool of the HEC-RAS model.

The floodway boundary was delineated in a way that is considered hydraulically smooth. Therefore, most of the side channels and oxbow channels were not included in the floodway.

The floodway criteria maps were produced using the same template as the inundation maps. The maps are provided in Appendix G.

6.5.1 Flood Hazard Maps

The flood hazard maps display the areas in the floodway and flood fringe zones. The floodway was determined as part of the floodway criteria mapping. Flood hazard maps can also show additional flood hazard information, including areas of high hazard within the flood fringe and incremental areas at risk for more severe floods, like the 200-year and 500-year floods. Flood hazard mapping is typically used for long-term flood hazard area management and land-use planning. All areas within the floodway boundary are shown as part of the floodway, even if the water levels of the design flood would not indicate a location as inundated (i.e., “islands” of dry ground within the floodway shown on the floodway criteria maps are not present on the flood hazard maps).

The flood hazard maps were produced using the same template as the inundation maps. The maps are provided in Appendix G.

Areas in the Floodway

Residential, commercial, or industrial areas located in the floodway within the study area are listed below:

Lamont Creek

There are no residential, commercial, or industrial areas located in the floodway along Lamont Creek. However, Tawâw Park will experience areas of >1 m inundation outside of the main channel.

Tributary A and Tributary B

There are no residential, commercial, or industrial areas located in the floodway along the Tributary A and Tributary B.

Areas in the High Hazard Flood Fringe

There are no residential, commercial, or industrial areas located within the high hazard flood fringe along Lamont Creek, Tributary A, and Tributary B.

Areas in the Flood Fringe

Residential, commercial, or industrial areas in the flood fringe zones within the study area are listed below:

Lamont Creek

- Residential houses on the left floodplain adjacent to the 48 Street Culvert.
- Residential houses on the right floodplain immediately upstream of the 56 Avenue Culvert

Tributary A and Tributary B

There are no residential, commercial, or industrial areas situated in the flood fringe along Tributary A and Tributary B.

6.6 Design Flood Grids

6.6.1 Water Surface Elevation Grids

The water surface elevation grid was output directly from the RAS Mapper tool of the HEC-RAS model. Where manual edits were applied to the flood inundation extents, these edits are reflected in the grids as well. Generally, the water surface elevations provided by RAS Mapper were replaced with higher elevations and slightly extended where required. The water surface elevation grid has the same resolution (0.5 m) and alignment as the DTM. The water surface elevation raster was then clipped to the directly-inundated areas. The results from the last time step of the simulation were used, when the model had reached steady state conditions.

6.6.2 Flood Depth Grids

The flood depth grid was created by subtracting the water surface elevation grid from the DTM. The flood depth grid has the same resolution (0.5 m) and alignment as the DTM. The extent of the depth grid is limited to the directly-inundated areas.

6.6.3 General Comments

All GIS data were created in ArcGIS Version 10.7 compatible format in the native study coordinate system [Canadian Spatial Reference System, North American Datum of 1983 (CSRS NAD83), Epoch 2002 and 3-Degree Transverse Mercator projection with the Central Meridian of 111° (3TM 111)].

6.7 Quantitative Climate Change Assessment

A cursory examination of potential increases in 100-year design water levels associated with climate change were performed to understand the possible impacts of climate changes on flood levels. The effect of the 100-year flood conditions more severe than the baseline was assessed under the following two flow scenarios:

- 1) 100-year open water flows +10%.
- 2) 100-year open water flows +20%.

No hydraulic modeling parameters were varied other than flows under the open-water conditions. Water level profiles were produced along the study reach for the two additional flow scenarios. The water level differences compared to the baseline 100-year open water flood flow were calculated and are summarized below. These water level differences were identified as potential “freeboards” that could be applied to the design water levels to account for flow changes that could result from climate change:

- For Lamont Creek, a 10% increase in flow raises flood levels by 0.04 m on average and up to a maximum of 0.14 m. A 20% increase raises levels by 0.08 m on average and up to a maximum of 0.28 m.

- For Tributary A, a 10% increase in flow raises flood levels by 0.03 m on average and up to a maximum of 0.05 m. A 20% increase raises levels by 0.05 m on average and up to a maximum of 0.10 m.
- For Tributary B, a 10% increase in flow raises flood levels by 0.02 m on average and up to a maximum of 0.04 m. A 20% increase raises levels by 0.04 m on average and up to a maximum of 0.07 m.

The above analyses are not based on a regional climate change impact assessment but on a simplified assumption that climate change could result in increased flood peak flows. The presented values can be viewed as a general range of potential climate change “freeboard” that could be considered in addition to the computed design flood water levels.

The difference between the simulated water levels for 100-year climate-affected flood along the study reaches, are presented in Figure H-1 to H-4 in Appendix H. The simulated climate-affected open water flood water levels at individual river stations are compared to the baseline 100-year open water discharge in Table H-1 to H-4 in Appendix H.

7.0 CONCLUSIONS

7.1 Survey and Base Data Collection

Topographic, bathymetric, and supporting base data required for this study were collected in accordance with the requirements by EPA. The following conclusions are made:

- *Cross Section Surveys* – Cross section survey data collected in June 2023 meet the current study requirements with regard to cross-section spacing and alignment, extents of cross sections on the floodplains, labeling of survey points, and data accuracy.
- *Hydraulic Structure Surveys* – Hydraulic structure survey data collected in June 2023 meet the study requirements and include the necessary details for the hydraulic modeling.
- *Digital Terrain Model* – The differences in elevation between the selected survey points and the DTM data are considered to be within an acceptable range. Therefore, the DTM is considered suitable for hydraulic modeling and flood mapping.

7.2 Open Water Hydrology Assessment

The flood frequency estimates obtained in the Hydrology Assessment are the most up-to-date for Lamont Creek at the Town of Lamont, Tributary A, and Tributary B. These estimates provide the updated flood hydrology information as inputs to the other components of the study (e.g., hydraulic modeling). Estimates of flood peak discharges were obtained for various return periods ranging from 2 to 1,000 years, including the 95% upper and lower confidence intervals.

7.3 Open Water Hydraulic Modeling

7.3.1 Selection of Manning’s n Values

No high flow data were available for calibrating the hydraulic model for Lamont Creek, Tributary A, and Tributary B. Therefore, a representative Manning’s n value of 0.06 for the Lamont Creek and 0.07 for Tributary A and Tributary B was estimated for these channels. Manning’s n values were selected based on previous experience with HEC-RAS floodplain modeling. WSP referred to the recently completed floodplain mapping for the Vermilion River at Vegreville (WSP 2024), approximately 50 km to the southeast, when calibrating for Lamont Creek.

Although the Vermilion River is larger than Lamont Creek, its channel characteristics are similar. This aligns with the previous Stanley (1998) flood risk study, which lacked high flow data for calibration and relied on the SNC Lavalin Inc. (1994) Vegreville floodplain study.

The Manning's n values for the floodplain areas were estimated based on the land use types (Chow 1959).

7.3.2 Model Sensitivity

The model sensitivity analysis was conducted for the 100-year flood event to evaluate the effects of changing model roughness values and downstream boundary conditions on the simulated water levels. The results of the sensitivity analysis indicate the following:

- The uncertainty in the simulated flood levels for changing roughness values, on average, is within a range of -0.020 to 0.018 m along the Lamont Creek, -0.025 to 0.020 m along Tributary A, and -0.018 to 0.016 m along Tributary B.
- The $\pm 20\%$ changes of the energy slope at the downstream boundary of Lamont Creek influence the simulated flood levels by a range of 0.000 to 0.001 m along approximately 800 m reach immediately upstream from the downstream boundary of Lamont Creek.

7.3.3 Flood Profiles

HEC-RAS was used to simulate the flood profiles of the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year flood events in the study area.

7.4 Flood Inundation Mapping

The HEC-RAS model results and the LiDAR DTM were used for preparing inundation maps for the 13 open water flood events (i.e., 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year open water floods), including direct flood inundation areas and other indirect flood inundation areas.

Based on the simulation results, the main areas to be affected by open water flooding have been identified as follows:

Lamont Creek and Tributary A

- Tawâw Park will be flooded during the 10-year flood events or higher.
- Residential areas on the right floodplain along Lamont Creek would be flooded during the 50-year flood. Additional residential areas along both sides of the Lamont Creek floodplain would be flooded during the 200-year flood or higher.
- Two rural houses, one near Highway 29 and one near Township Road 552, will flood during the 200-year flood.
- Three culverts and four bridges along Lamont Creek in addition to one culvert along Tributary A would be affected during the 100-year flood event or higher.

Tributary B

There are no residential, commercial, or industrial areas that would be inundated along Tributary B.

7.5 Design Flood Hazard Mapping

The 100-year open water flood is selected as the design flood for the study area in accordance with the Flood Hazard Identification Program (FHIP) Guidelines (AEP 2022). The floodway was determined as part of the floodway criteria mapping.

Areas in the Floodway

There are no residential, commercial, or industrial areas located in the floodway along Lamont Creek, Tributary A, and Tributary B.

Areas in the High Hazard Flood Fringe

There are no residential, commercial, or industrial areas within high hazard flood fringe zones.

Areas in the Flood Fringe

Residential and commercial areas in the flood fringe zones within the study area are listed below.

Lamont Creek

- Residential houses on the left floodplain near 48 Street Culvert.
- Residential houses on the right floodplain immediately upstream of the 56 Avenue Culvert.

Tributary A and Tributary B

There are no residential, commercial, or industrial areas situated in the flood fringe along Tributary A and Tributary B.

7.6 Quantitative Climate Change Assessments

The study examined the potential impact of climate change on open water floods through a sensitivity analysis, assessing flood water level differences due to 10% and 20% increases in the 100-year flood peak flows. These differences were considered potential freeboards that could be applied to design water levels to accommodate future flow changes. Results indicated that Lamont Creek, Tributary A, and Tributary B experienced average flood level increases ranging from 0.02 m to 0.08 m, depending on the magnitude of flow increase. The analysis was based on a simplified assumption of increased peak flows rather than a comprehensive regional climate change impact assessment.

Signature Page

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Third Party Disclaimer

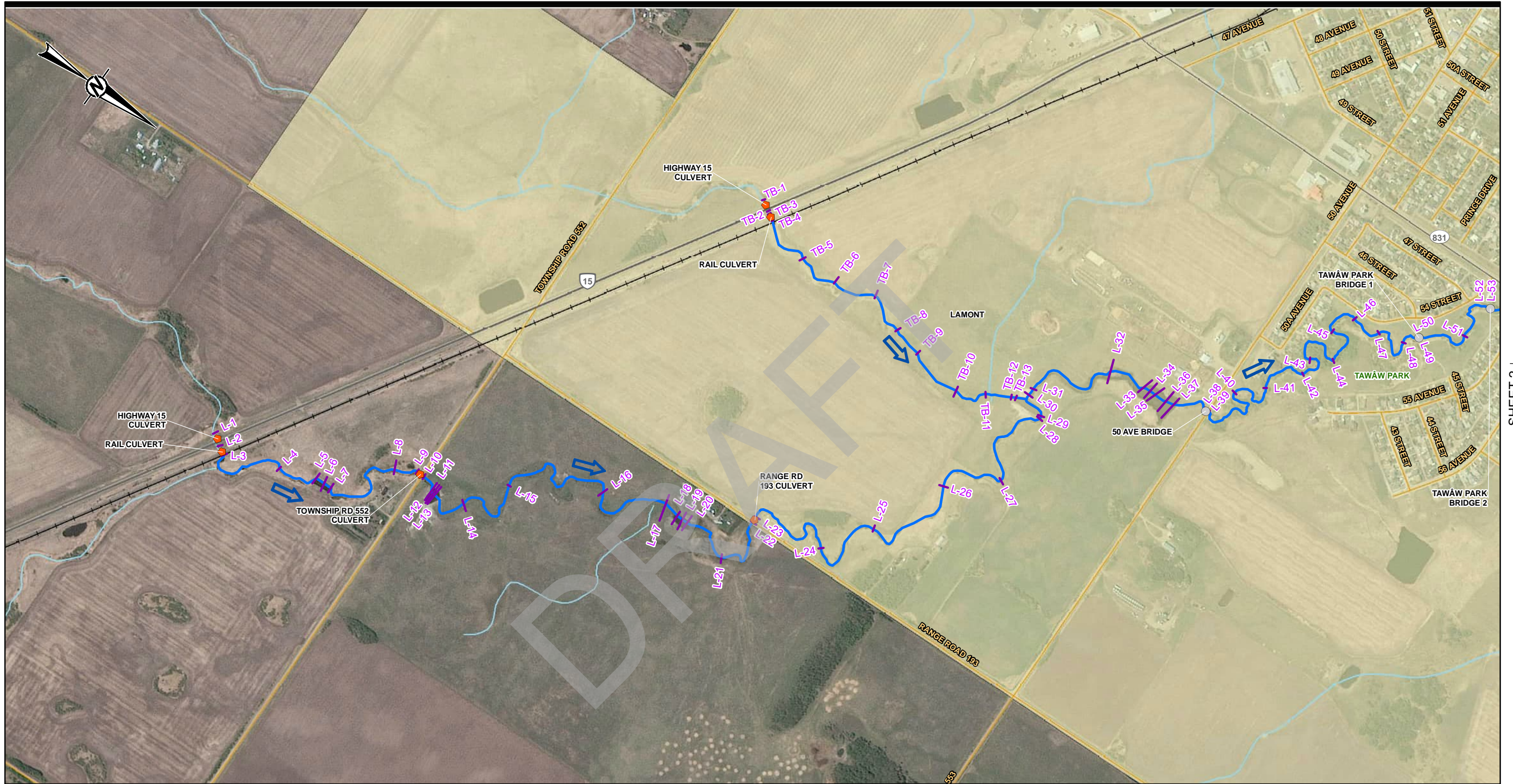
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APPENDIX A

**Locations of Cross Sections and
Hydraulic Structures**

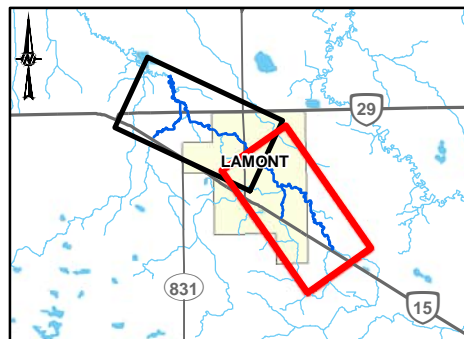
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SHEET 2 ↓

LEGEND

	BRIDGE		SURVEYED CROSS SECTION
	CULVERT		SURVEY REACH
	FLOW DIRECTION		
	PRIMARY HIGHWAY		
	SECONDARY HIGHWAY		
	LOCAL ROAD		
	WATERCOURSE		
	RAILWAY		
	TOWN OF LAMONT		



CLIENT
ALBERTA ENVIRONMENT
AND PROTECTED AREAS



CONSULTANT



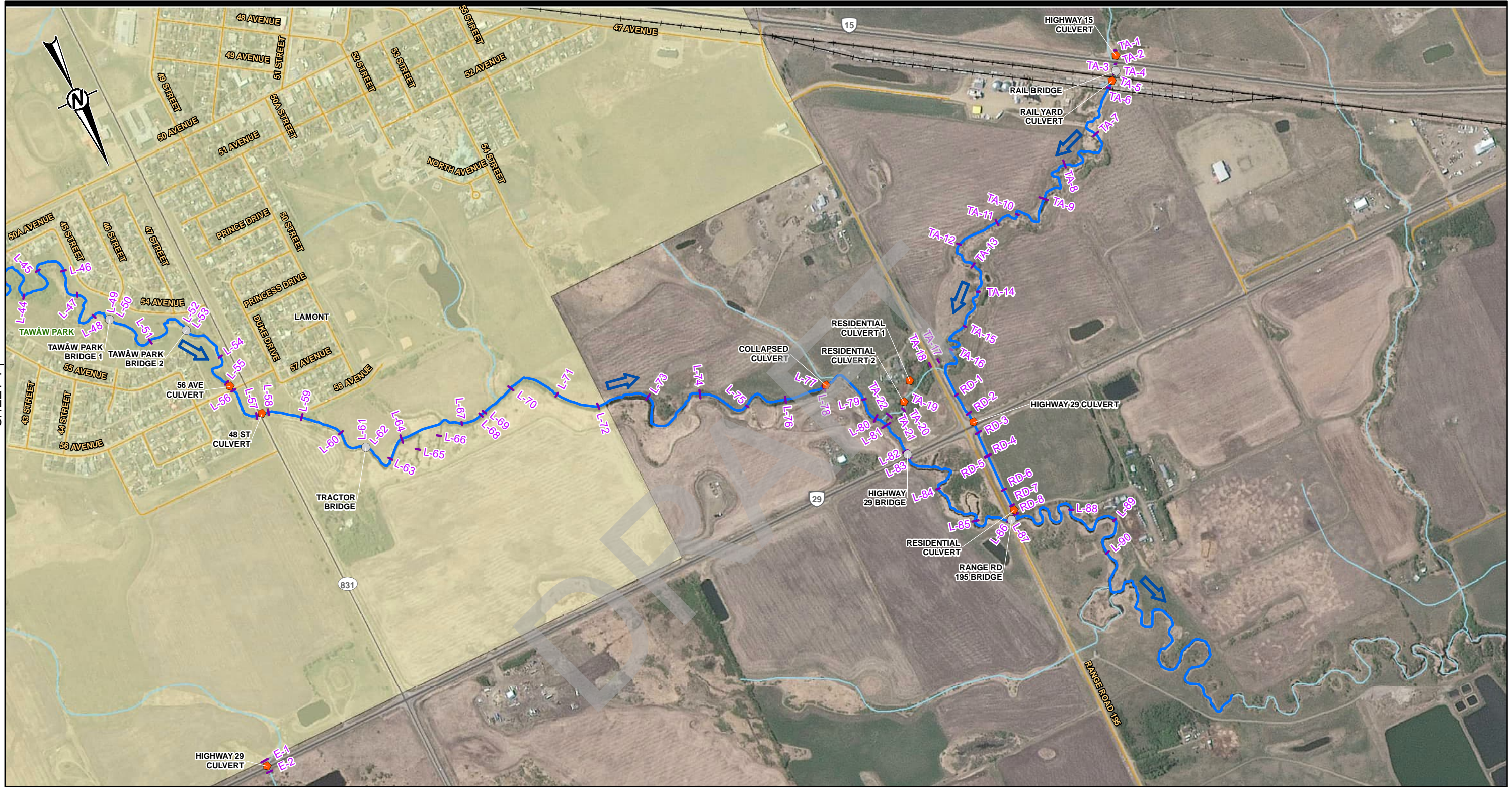
YYYY-MM-DD	2025-06-19
DESIGNED	JC
PREPARED	PMT
REVIEWED	AC
APPROVED	JC

REFERENCE(S)
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PROJECT
LAMONT FLOOD STUDY

TITLE
LOCATIONS OF CROSS SECTIONS AND HYDRAULIC STRUCTURES

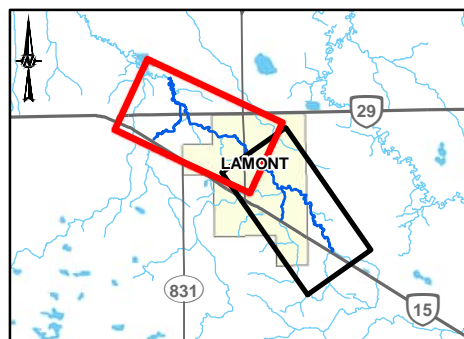
PROJECT NO.	CONTROL	REV.	FIGURE
23592565	-	0	A-1



SHEET 1 ↑

LEGEND

- BRIDGE
- CULVERT
- FLOW DIRECTION
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- WATERCOURSE
- RAILWAY
- TOWN OF LAMONT
- SURVEYED CROSS SECTION
- SURVEY REACH



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PROJECT
LAMONT FLOOD STUDY

**TITLE
LOCATIONS OF CROSS SECTIONS AND HYDRAULIC STRUCTURES**

PROJECT NO.	CONTROL	REV.	FIGURE
23592565	-	0	A-2

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM ANS B 28mm

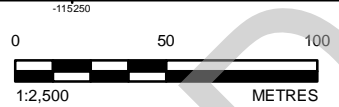
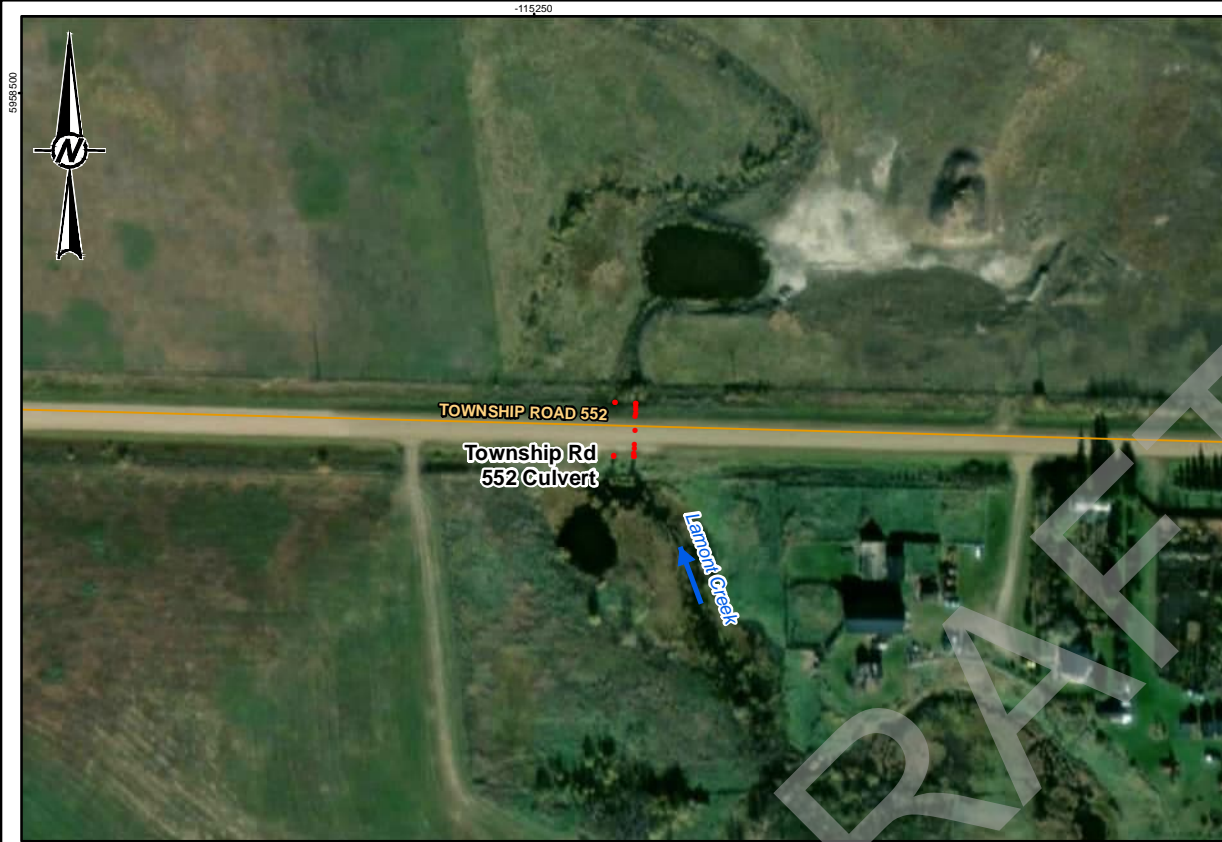
APPENDIX B

Hydraulic Structure Datasheets

DRAFT

Table B-1: Summary List of Hydraulic Structure Datasheets

Figure Number	Reach	Station	Structure Name	Structure Type
B-1	Lamont Creek	9608	Township Rd 552 Culvert	Culvert
B-2	Lamont Creek	8184	Range Rd 193 Culvert	Culvert
B-3	Lamont Creek	6242	50 Ave Bridge	Bridge
B-4	Lamont Creek	4999	Tawâw Park Bridge 1	Bridge
B-5	Lamont Creek	4699	Tawâw Park Bridge 2	Bridge
B-6	Lamont Creek	4441	56 Ave Culvert	Culvert
B-7	Lamont Creek	4305	48 St Culvert	Culvert
B-8	Lamont Creek	4010	Tractor Bridge	Bridge
B-9	Lamont Creek	2145	Highway 29 Bridge	Bridge
B-10	Lamont Creek	1656	Range Rd 195 Bridge	Bridge
B-11	Tributary A	248	Highway 29 Culvert	Culvert
B-12	Tributary A	11	Residential Culvert	Culvert
B-13	Lamont Creek	N/A	Highway 29 Culvert 2	Culvert
B-14	Lamont Creek	N/A	Range Road 831 Culvert	Culvert
B-15	Lamont Creek	10379	Highway 15 Culvert	Culvert
B-16	Lamont Creek	10344	Rail Culvert	Culvert
B-17	Lamont Creek	2482	Collapsed Culvert	Culvert
B-18	Tributary A	1809	Highway 15 Culvert	Culvert
B-19	Tributary A	1782	Rail Bridge	Bridge
B-20	Tributary A	1744	Rail Yard Culvert	Culvert
B-21	Tributary A	N/A	Residential Culvert 1	Bridge
B-22	Tributary A	N/A	Residential Culvert 2	Culvert
B-23	Tributary B	940	Highway 15 Culvert	Culvert
B-24	Tributary B	912	Rail Culvert	Culvert



TITLE
TOWNSHIP RD 552 CULVERT

LOCATION	LAMONT CREEK
NUMBER OF CULVERTS	2
TOTAL LENGTH OF CULVERT (m)	17.5 / 17.5
RISE OF CULVERT (m)	1.8 / 1.8
SPAN OF CULVERT (m)	1.8 / 1.8
DIAMETER OF CULVERT (m)	1.8 / 1.8
CULVERT TYPE	CSP / CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	652.532 / 652.528
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	652.500 / 652.572

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- FLOW DIRECTION

PHOTO 1 WEST CULVERT VIEW FROM UPSTREAM



PHOTO 2 WEST CULVERT VIEW FROM DOWNSTREAM



REFERENCE(S)

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FIGURE
B-1



TITLE	
RANGE RD 193 CULVERT	
LOCATION	LAMONT CREEK
NUMBER OF CULVERTS	2
TOTAL LENGTH OF CULVERT (m)	15.5 / 15.5
RISE OF CULVERT (m)	1.5 / 1.2
SPAN OF CULVERT (m)	1.5 / 1.2
DIAMETER OF CULVERT (m)	1.5 / 1.2
CULVERT TYPE	CSP / CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	649.550 / 650.304
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	649.575 / 650.268

LEGEND	
•	SURVEY POINT
+	RAILWAY
—	LOCAL ROAD
→	FLOW DIRECTION
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY

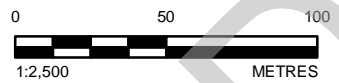


PHOTO 1 VIEW DOWNSTREAM TO SOUTH CULVERT



PHOTO 2 VIEW UPSTREAM TO SOUTH CULVERT



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PROJECT NO.	CONTROL	REV.	FIGURE
23592565	-	0	B-2



TITLE
50 AVE BRIDGE

LOCATION	LAMONT CREEK
DESCRIPTION	50 AVE BRIDGE
TOTAL LENGTH OF SPAN (m)	6.1
DECK WIDTH OF BRIDGE (m)	8.5
AVERAGE TOP OF CURB OR SOLID GUARD RAIL ELEVATION (m)	649.578
AVERAGE LOW CHORD ELEVATION (m)	648.741
BRIDGE OBSTRUCTION HEIGHT	0.84
NUMBER OF PIERS	0

PIER	CENTRE STATION (m)	WIDTH (m)	TYPE	SHAPE
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-

LEGEND

- BRIDGE SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- + RAILWAY
- ➔ FLOW DIRECTION

NOTE(S)

ALL DETAILS OF BRIDGE SURVEY WILL BE USED FOR HYDRAULIC MODELLING. PIERS HAVE VARIED WIDTH. PIER CENTRE STATION REFERS TO STATION IN THE HYDRAULIC MODEL.

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FIGURE
B-3

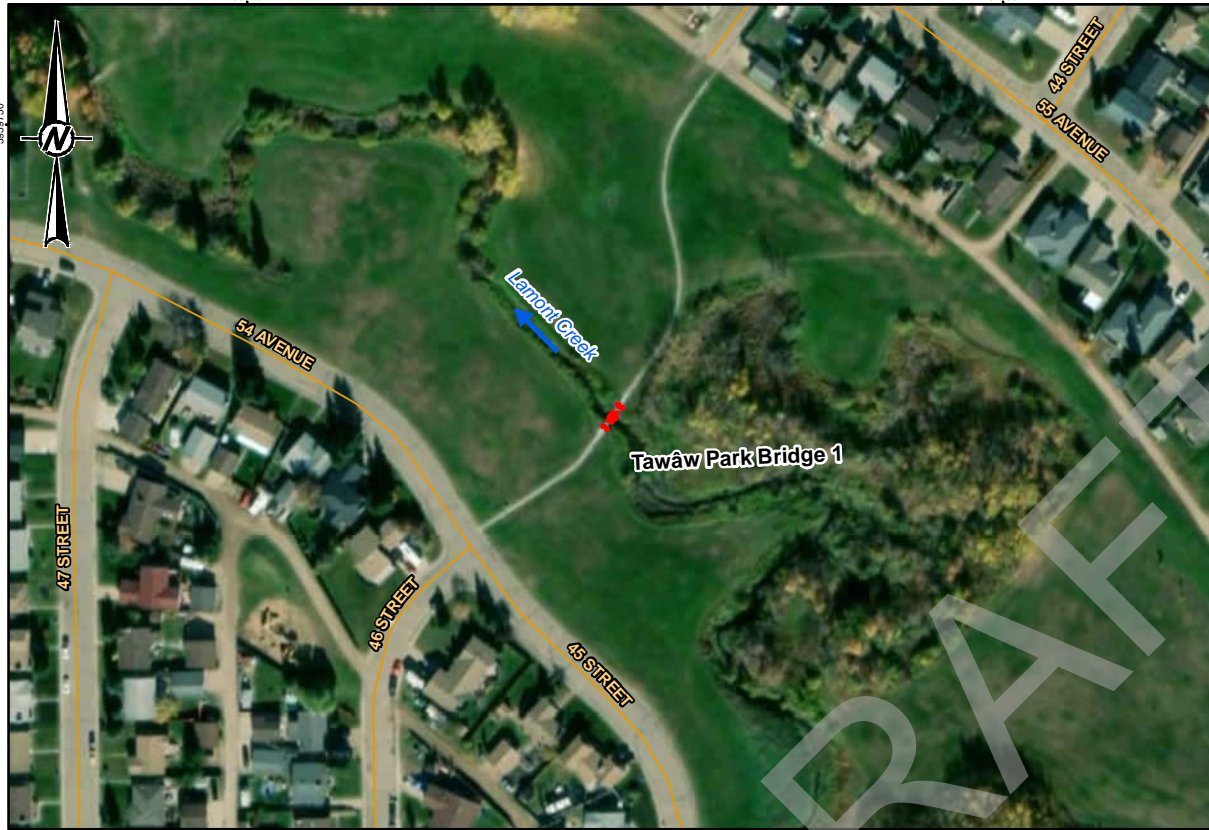
PHOTO 1 VIEW OF BRIDGE FROM UPSTREAM



PHOTO 2 VIEW OF BRIDGE FROM DOWNSTREAM



25mm IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET HAS BEEN MODIFIED FROM ANS/A



TITLE
TAWÂW PARK BRIDGE 1

LOCATION	LAMONT CREEK
DESCRIPTION	TAWÂW PARK BRIDGE 1
TOTAL LENGTH OF SPAN (m)	8.8
DECK WIDTH OF BRIDGE (m)	1.6
AVERAGE TOP OF CURB OR SOLID GUARD RAIL ELEVATION (m)	646.466
AVERAGE LOW CHORD ELEVATION (m)	646.055
BRIDGE OBSTRUCTION HEIGHT	0.41
NUMBER OF PIERS	0

PIER	CENTRE STATION (m)	WIDTH (m)	TYPE	SHAPE
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-

LEGEND

- BRIDGE SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- FLOW DIRECTION

NOTE(S)

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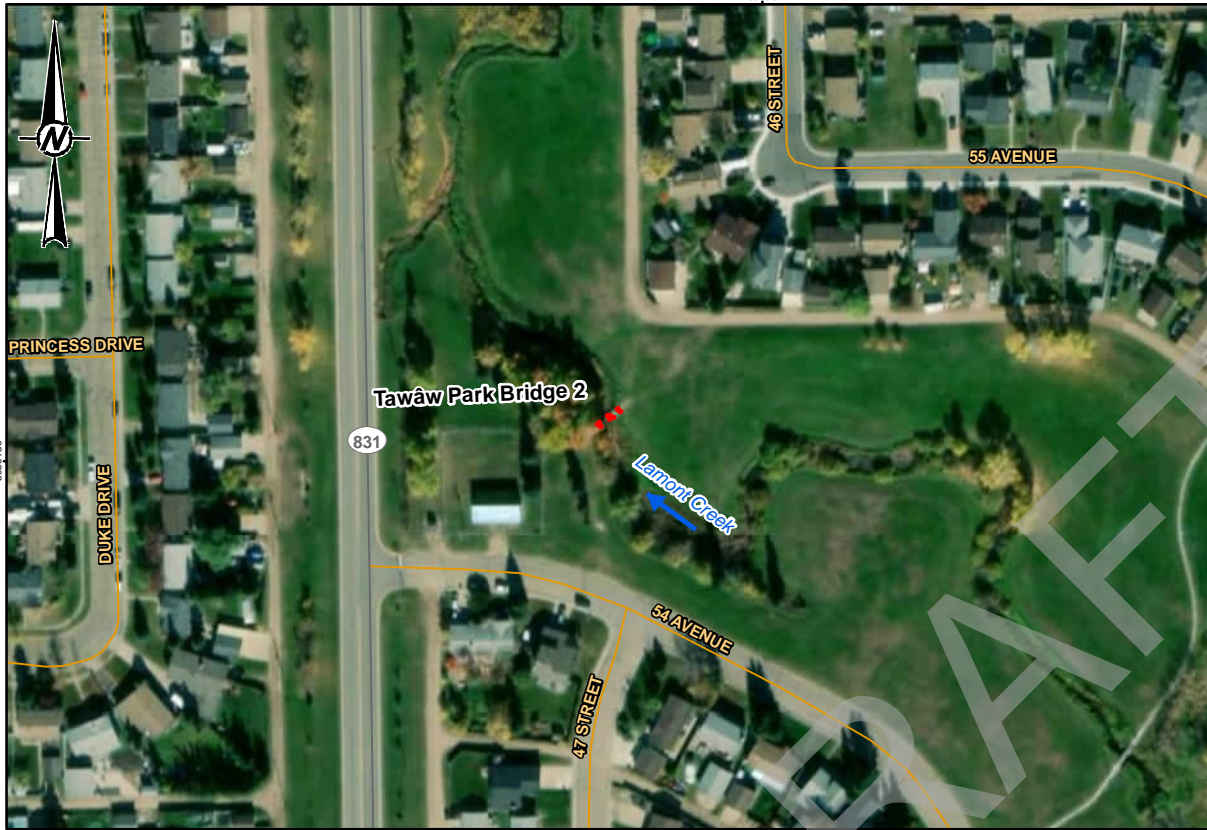
FIGURE
B-4

PHOTO 1 VIEW OF BRIDGE FROM UPSTREAM



PHOTO 2 VIEW OF BRIDGE FROM DOWNSTREAM





TITLE
TAWÂW PARK BRIDGE 2

LOCATION	LAMONT CREEK
DESCRIPTION	TAWÂW PARK BRIDGE 2
TOTAL LENGTH OF SPAN (m)	8.3
DECK WIDTH OF BRIDGE (m)	1.1
AVERAGE TOP OF CURB OR SOLID GUARD RAIL ELEVATION (m)	646.131
AVERAGE LOW CHORD ELEVATION (m)	645.846
BRIDGE OBSTRUCTION HEIGHT	0.28
NUMBER OF PIERS	0

PIER	CENTRE STATION (m)	WIDTH (m)	TYPE	SHAPE
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-

LEGEND

- BRIDGE SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- FLOW DIRECTION

NOTE(S)

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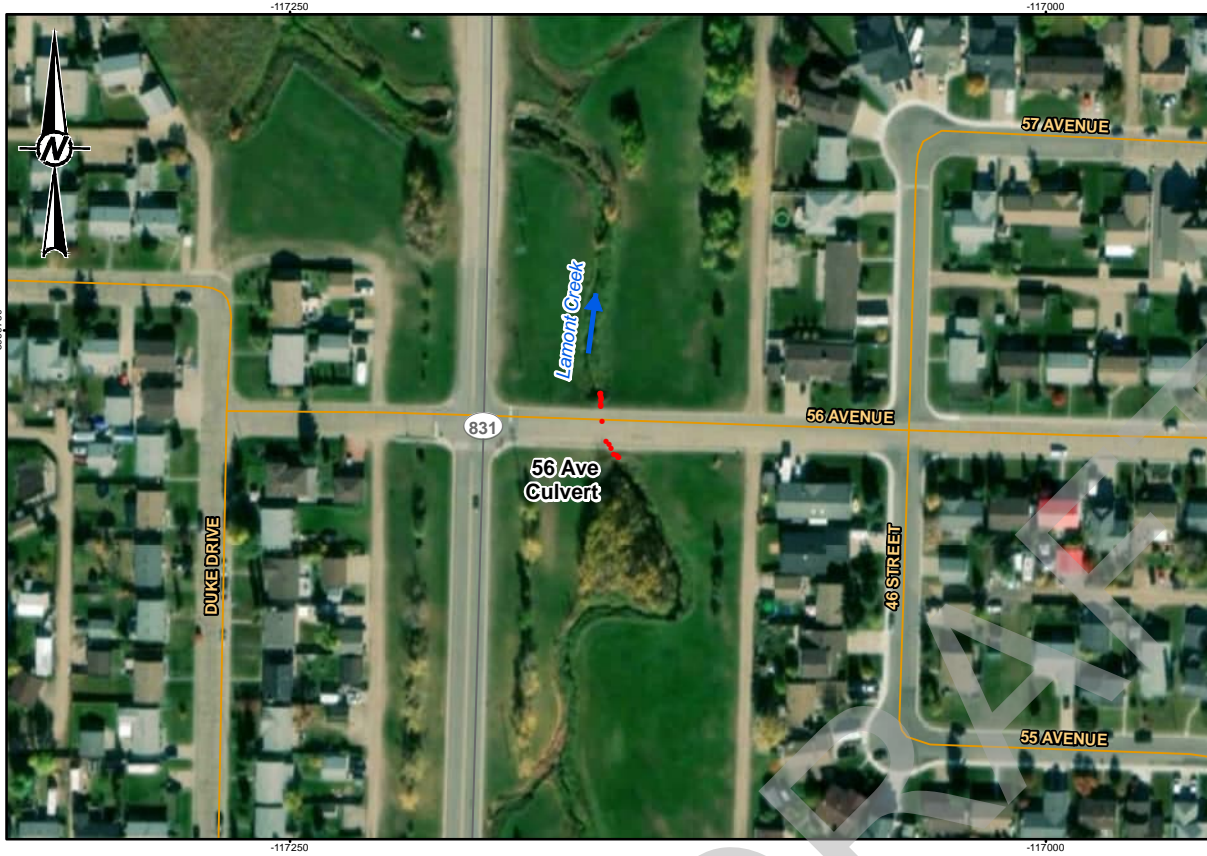
FIGURE
B-5

PHOTO 1 VIEW OF BRIDGE FROM UPSTREAM



PHOTO 2 VIEW OF BRIDGE FROM DOWNSTREAM





TITLE
56 AVE CULVERT

LOCATION	LAMONT CREEK
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	22
RISE OF CULVERT (m)	2.0
SPAN OF CULVERT (m)	3.15
DIAMETER OF CULVERT (m)	N/A
CULVERT TYPE	CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	644.064
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	643.706

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- ➔ FLOW DIRECTION

PHOTO 1 VIEW FROM UPSTREAM



PHOTO 2 VIEW FROM DOWNSTREAM



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FIGURE
B-6



TITLE	
48 ST CULVERT	
LOCATION	LAMONT CREEK
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	22.4
RISE OF CULVERT (m)	3.429
SPAN OF CULVERT (m)	4.846
DIAMETER OF CULVERT (m)	4.042 EQUIVALENT ROUND
CULVERT TYPE	RPE (SPCSP ELLIPSE)
CULVERT INVERT ELEVATION - UPSTREAM END (m)	642.279
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	642.587

LEGEND	
• SURVEY POINT	—+— RAILWAY
— LOCAL ROAD	➔ FLOW DIRECTION
— PRIMARY HIGHWAY	
— SECONDARY HIGHWAY	

PHOTO 1 VIEW OF BRIDGE FROM UPSTREAM



PHOTO 2 VIEW OF BRIDGE FROM DOWNSTREAM



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	APPROVED	JC

PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-7
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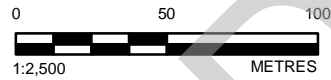


PHOTO 1 VIEW OF BRIDGE FROM UPSTREAM



PHOTO 2 VIEW OF BRIDGE FROM DOWNSTREAM



TITLE
TRACTOR BRIDGE

LOCATION	LAMONT CREEK
DESCRIPTION	TRACTOR BRIDGE
TOTAL LENGTH OF SPAN (m)	7
DECK WIDTH OF BRIDGE (m)	5.8
AVERAGE TOP OF CURB OR SOLID GUARD RAIL ELEVATION (m)	643.480
AVERAGE LOW CHORD ELEVATION (m)	643.153
BRIDGE OBSTRUCTION HEIGHT	0.327
NUMBER OF PIERS	0

PIER	CENTRE STATION (m)	WIDTH (m)	TYPE	SHAPE
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-

LEGEND

- BRIDGE SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- ➔ FLOW DIRECTION

NOTE(S)

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FIGURE
B-8

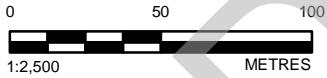


PHOTO 1 VIEW OF BRIDGE FROM UPSTREAM



PHOTO 2 VIEW OF BRIDGE FROM DOWNSTREAM



TITLE
HIGHWAY 29 BRIDGE

LOCATION	LAMONT CREEK
DESCRIPTION	HIGHWAY 29 BRIDGE
TOTAL LENGTH OF SPAN (m)	7.3
DECK WIDTH OF BRIDGE (m)	11.9
AVERAGE TOP OF CURB OR SOLID GUARD RAIL ELEVATION (m)	642.893
AVERAGE LOW CHORD ELEVATION (m)	642.038
BRIDGE OBSTRUCTION HEIGHT	0.856
NUMBER OF PIERS	0

PIER	CENTRE STATION (m)	WIDTH (m)	TYPE	SHAPE
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-

- LEGEND**
- BRIDGE SURVEY POINT
 - LOCAL ROAD
 - PRIMARY HIGHWAY
 - SECONDARY HIGHWAY
 - + RAILWAY
 - ➡ FLOW DIRECTION

NOTE(S)
ALL DETAILS OF BRIDGE SURVEY WILL BE USED FOR HYDRAULIC MODELLING. PIERS HAVE VARIED WIDTH. PIER CENTRE STATION REFERS TO STATION IN THE HYDRAULIC MODEL.

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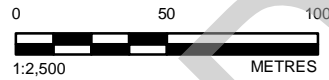
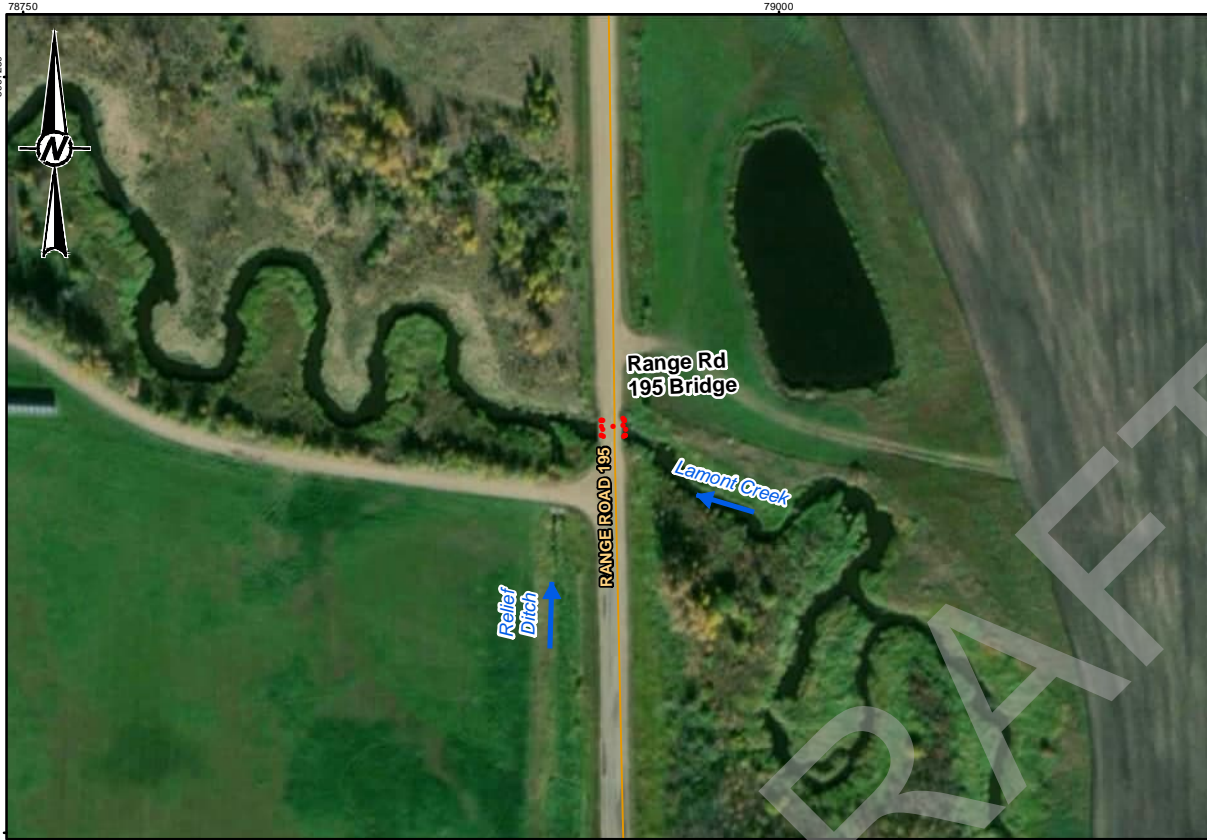
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PREPARED	PMT	
REVIEWED	AC	
APPROVED	JC	



PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-9
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TITLE
RANGE RD 195 BRIDGE

LOCATION	LAMONT CREEK
DESCRIPTION	RANGE RD 195 BRIDGE
TOTAL LENGTH OF SPAN (m)	5.8
DECK WIDTH OF BRIDGE (m)	6.9
AVERAGE TOP OF CURB OR SOLID GUARD RAIL ELEVATION (m)	640.850
AVERAGE LOW CHORD ELEVATION (m)	640.098
BRIDGE OBSTRUCTION HEIGHT	1.286
NUMBER OF PIERS	0

PIER	CENTRE STATION (m)	WIDTH (m)	TYPE	SHAPE
1	-	-	-	-
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-

LEGEND

- BRIDGE SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- ➔ FLOW DIRECTION

NOTE(S)

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PROJECT NO.
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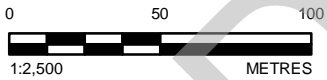
FIGURE
B-10

PHOTO 1 VIEW OF BRIDGE FROM UPSTREAM



PHOTO 2 VIEW OF BRIDGE FROM DOWNSTREAM





TITLE
HIGHWAY 29 CULVERT

LOCATION	RELIEF DITCH
NUMBER OF CULVERTS	2
TOTAL LENGTH OF CULVERT (m)	41.7 / 41.7
RISE OF CULVERT (m)	1.7 / 1.7
SPAN OF CULVERT (m)	TBD
DIAMETER OF CULVERT (m)	N/A
CULVERT TYPE	RPE (MULTIPLATE ELLIPSE) / RPE (MULTIPLATE ELLIPSE)
CULVERT INVERT ELEVATION - UPSTREAM END (m)	640.084 / 640.064
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	639.411 / 639.445

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- + RAILWAY
- ➔ FLOW DIRECTION

PHOTO 1 VIEW OF CULVERTS FROM UPSTREAM



PHOTO 2 VIEW OF CULVERTS FROM DOWNSTREAM



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PROJECT

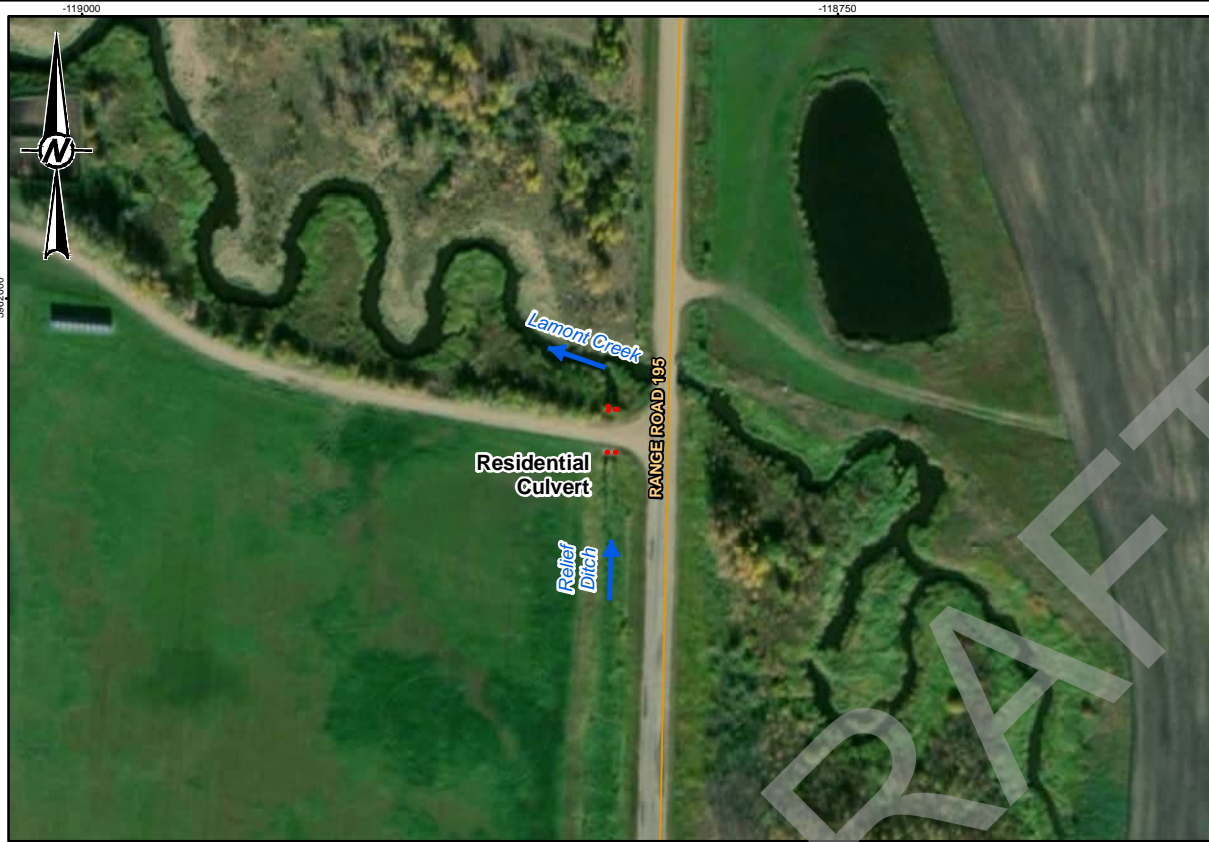
LAMONT FLOOD STUDY

CONSULTANT



YYYY-MM-DD	2025-06-19
DESIGNED	JC
PREPARED	PMT
REVIEWED	AC
APPROVED	JC

PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-11
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TITLE
RESIDENTIAL CULVERT

LOCATION	RELIEF DITCH
NUMBER OF CULVERTS	2
TOTAL LENGTH OF CULVERT (m)	15.5 / 15.5
RISE OF CULVERT (m)	1.8 / 2.2
SPAN OF CULVERT (m)	1.8 / 2.2
DIAMETER OF CULVERT (m)	1.8 / 2.2
CULVERT TYPE	CSP / CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	638.102 / 637.853
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	638.153 / 637.796

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- ⊕ RAILWAY
- ➔ FLOW DIRECTION

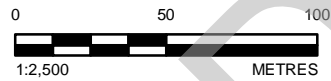


PHOTO 1 VIEW OF CULVERTS FROM UPSTREAM



PHOTO 2 VIEW OF CULVERTS FROM DOWNSTREAM



REFERENCE(S)

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ALBERTA ENVIRONMENT AND PROTECTED AREAS

PROJECT

LAMONT FLOOD STUDY

CONSULTANT



YYYY-MM-DD 2025-06-19

DESIGNED JC

PREPARED PMT

REVIEWED AC

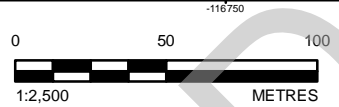
APPROVED JC

PROJECT NO.
23592565

CONTROL
-

REV.
0

FIGURE
B-12



TITLE
HIGHWAY 29 CULVERT

LOCATION	EXTRA
NUMBER OF CULVERTS	2
TOTAL LENGTH OF CULVERT (m)	25.8 / 25.8
RISE OF CULVERT (m)	0.9 / 0.9
SPAN OF CULVERT (m)	0.9 / 0.9
DIAMETER OF CULVERT (m)	0.9 / 0.9
CULVERT TYPE	CSP / CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	642.943 / 642.834
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	642.695 / 642.821

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- ➔ FLOW DIRECTION

PHOTO 1 VIEW DOWNSTREAM (SOUTH) TO EAST CULVERT



PHOTO 2 VIEW UPSTREAM (NORTH) TO EAST CULVERT



REFERENCE(S)

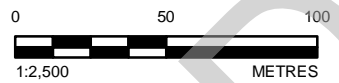
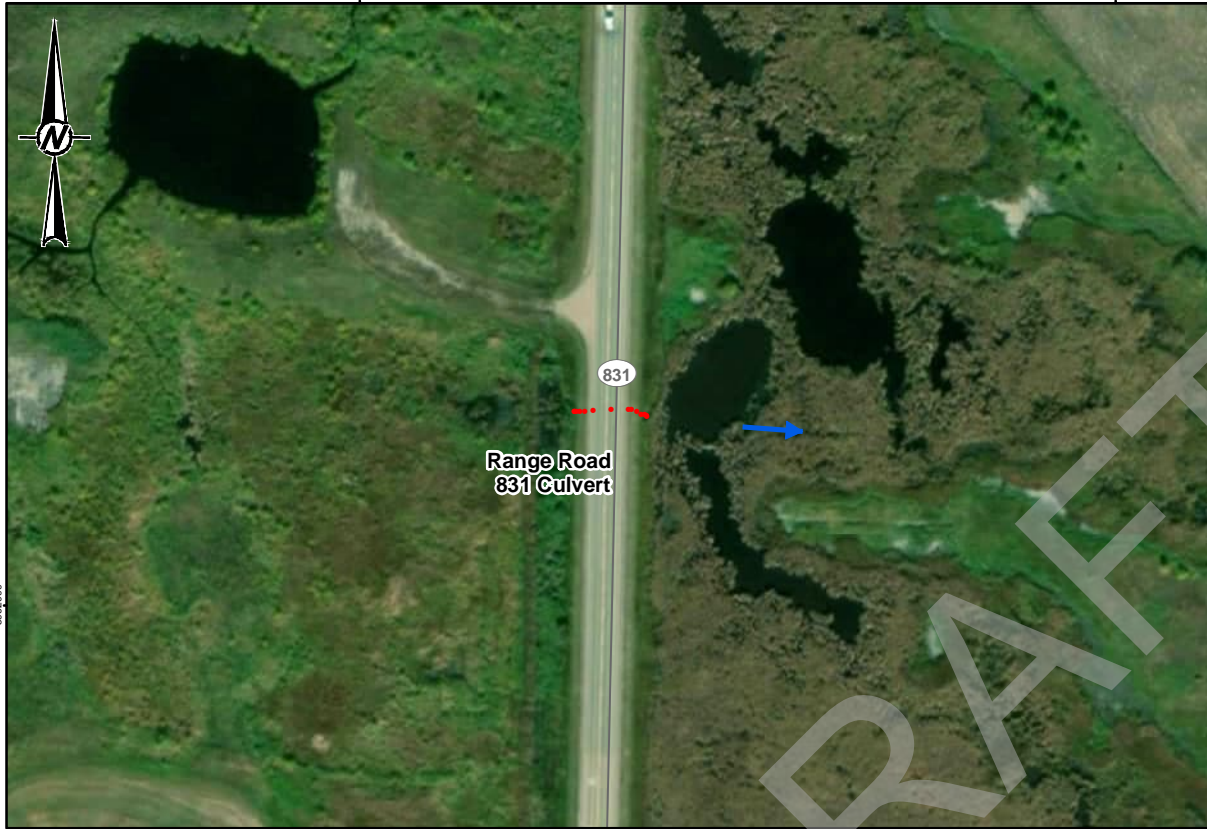
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ALBERTA ENVIRONMENT AND PROTECTED AREAS

PROJECT
LAMONT FLOOD STUDY

CONSULTANT	YYYY-MM-DD	2025-06-19
	DESIGNED	JC
	PREPARED	PMT
	REVIEWED	AC
	APPROVED	JC

PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-13
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TITLE	
RANGE ROAD 831 CULVERT	
LOCATION	EXTRA
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	24
RISE OF CULVERT (m)	0.5
SPAN OF CULVERT (m)	0.5
DIAMETER OF CULVERT (m)	0.5
CULVERT TYPE	CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	642.369
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	642.276

LEGEND	
•	SURVEY POINT
—	LOCAL ROAD
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY
	RAILWAY
	FLOW DIRECTION

PHOTO 1 VIEW DOWNSTREAM (WEST) TO CULVERT INLET



PHOTO 2 VIEW UPSTREAM (EAST) TO CULVERT OUTLET



REFERENCE(S)
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PROJECT
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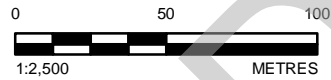
CONSULTANT	YYYY-MM-DD	2025-06-19
	DESIGNED	JC
	PREPARED	PMT
	REVIEWED	AC
	APPROVED	JC

PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-14
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-115000



-115000



TITLE
HIGHWAY 15 CULVERT

LOCATION	LAMONT CREEK
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	21.5
RISE OF CULVERT (m)	2.5
SPAN OF CULVERT (m)	2.5
DIAMETER OF CULVERT (m)	2.5
CULVERT TYPE	CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	653.171
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	653.078

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- + RAILWAY
- ➔ FLOW DIRECTION

PHOTO 1 VIEW FROM UPSTREAM



PHOTO 2 VIEW FROM DOWNSTREAM



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PROJECT

LAMONT FLOOD STUDY

CONSULTANT



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PREPARED PMT

REVIEWED AC

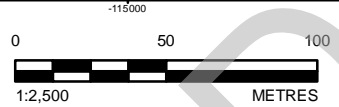
APPROVED JC

PROJECT NO.
23592565

CONTROL
-

REV.
0

FIGURE
B-15



TITLE	
RAIL CULVERT	
LOCATION	LAMONT CREEK
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	20
RISE OF CULVERT (m)	2.45
SPAN OF CULVERT (m)	2.45
DIAMETER OF CULVERT (m)	N/A
CULVERT TYPE	CONCRETE BOX
CULVERT INVERT ELEVATION - UPSTREAM END (m)	653.294
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	652.840

LEGEND	
•	SURVEY POINT
—	LOCAL ROAD
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY
+	RAILWAY
➔	FLOW DIRECTION

PHOTO 1 VIEW FROM UPSTREAM



PHOTO 2 VIEW FROM DOWNSTREAM



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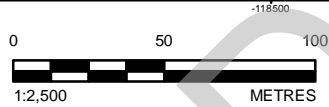
PROJECT
LAMONT FLOOD STUDY

CONSULTANT	YYYY-MM-DD	2025-06-19
DESIGNED	JC	
PREPARED	PMT	
REVIEWED	AC	
APPROVED	JC	



PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-16
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-118500



TITLE
COLLAPSED CULVERT

LOCATION	LAMONT CREEK
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	9.1
RISE OF CULVERT (m)	0.4
SPAN OF CULVERT (m)	0.4
DIAMETER OF CULVERT (m)	0.4
CULVERT TYPE	CONCRETE
CULVERT INVERT ELEVATION - UPSTREAM END (m)	639.931
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	639.783

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- ⊕ RAILWAY
- ➡ FLOW DIRECTION

PHOTO 1 VIEW FROM UPSTREAM



PHOTO 2 VIEW FROM DOWNSTREAM



REFERENCE(S)

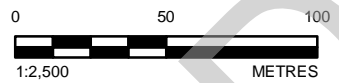
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ALBERTA ENVIRONMENT AND PROTECTED AREAS

PROJECT
LAMONT FLOOD STUDY

CONSULTANT	YYYY-MM-DD	2025-06-19
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	PREPARED	PMT
	REVIEWED	AC
	APPROVED	JC

PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-17
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TITLE
HIGHWAY 15 CULVERT

LOCATION	TRIBUTARY A
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	28.7
RISE OF CULVERT (m)	1.4
SPAN OF CULVERT (m)	1.4
DIAMETER OF CULVERT (m)	1.4
CULVERT TYPE	CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	646.792
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	646.474

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- +— RAILWAY
- ➔ FLOW DIRECTION

PHOTO 1 VIEW DOWNSTREAM TO CULVERT



PHOTO 2 VIEW UPSTREAM TO CULVERT



REFERENCE(S)

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ALBERTA ENVIRONMENT AND PROTECTED AREAS

PROJECT

LAMONT FLOOD STUDY

CONSULTANT	WSP
DESIGNED	JC
PREPARED	PMT
REVIEWED	AC
APPROVED	JC

PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-18
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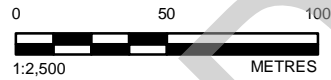


PHOTO 1 VIEW DOWNSTREAM TO BRIDGE



PHOTO 2 VIEW UPSTREAM TO BRIDGE



TITLE
RAIL BRIDGE

LOCATION	TRIBUTARY A
DESCRIPTION	RAIL BRIDGE
TOTAL LENGTH OF SPAN (m)	14.6
DECK WIDTH OF BRIDGE (m)	3.8
AVERAGE TOP OF CURB OR SOLID GUARD RAIL ELEVATION (m)	648.848
AVERAGE LOW CHORD ELEVATION (m)	648.067
BRIDGE OBSTRUCTION HEIGHT	0.78
NUMBER OF PIERS	3

PIER	CENTRE STATION (m)	WIDTH (m)	TYPE	SHAPE
1	-	0.4	WOOD	CIRCULAR
2	-	0.4	WOOD	CIRCULAR
3	-	0.4	WOOD	CIRCULAR
4	-	-	-	-
5	-	-	-	-
6	-	-	-	-

LEGEND

- BRIDGE SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- ➔ FLOW DIRECTION

NOTE(S)

ALL DETAILS OF BRIDGE SURVEY WILL BE USED FOR HYDRAULIC MODELLING. PIERS HAVE VARIED WIDTH. PIER CENTRE STATION REFERS TO STATION IN THE HYDRAULIC MODEL.

REFERENCE(S)

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ALBERTA ENVIRONMENT AND PROTECTED AREAS

PROJECT

LAMONT FLOOD STUDY

CONSULTANT



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PREPARED PMT

REVIEWED AC

APPROVED JC

PROJECT NO. 23592565

CONTROL -

REV. 0

FIGURE B-19

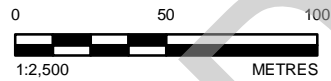
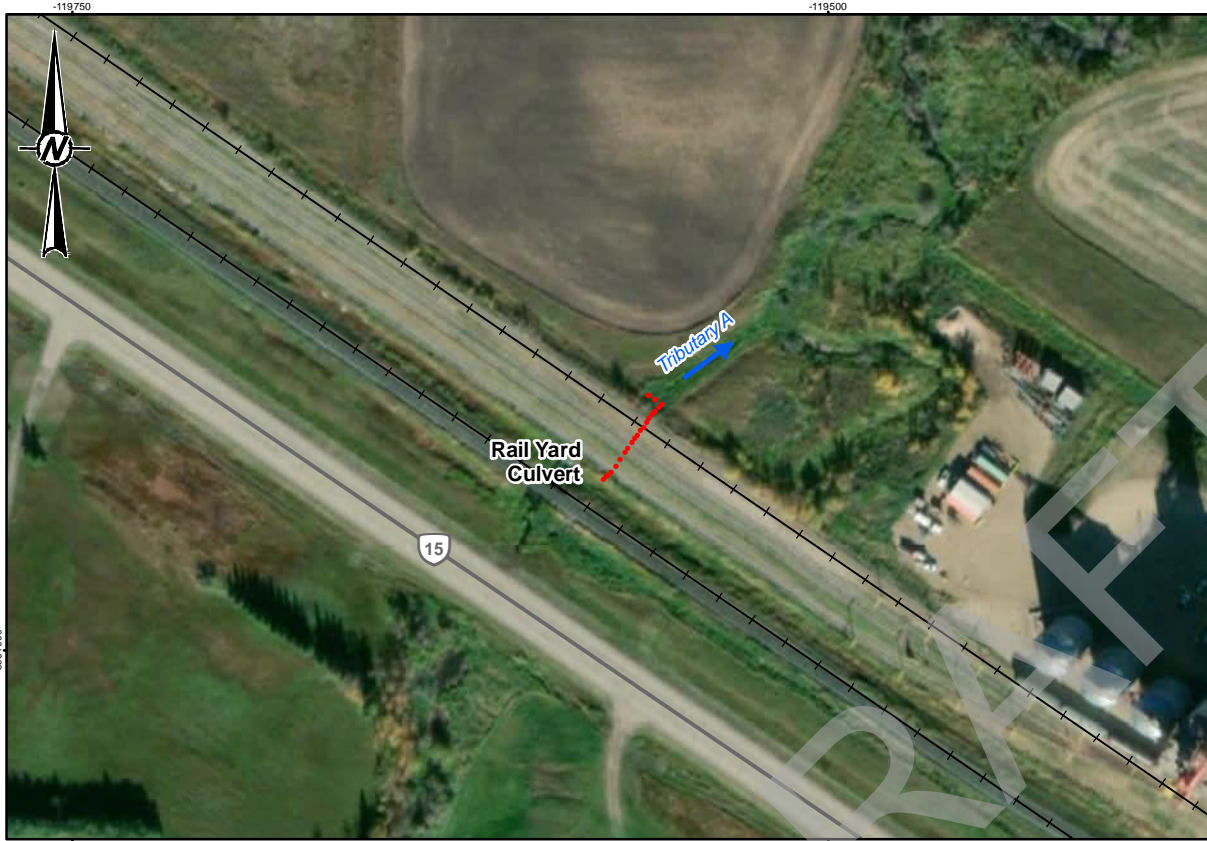


PHOTO 1 VIEW DOWNSTREAM TO CULVERTS



PHOTO 2 VIEW UPSTREAM TO CULVERTS



TITLE
RAIL YARD CULVERT

LOCATION	TRIBUTARY A
NUMBER OF CULVERTS	3
TOTAL LENGTH OF CULVERT (m)	35.4 / 35.4 / 35.4
RISE OF CULVERT (m)	2.8 / 2.8 / 2.8
SPAN OF CULVERT (m)	2.8 / 2.8 / 2.8
DIAMETER OF CULVERT (m)	2.8 / 2.8 / 2.8
CULVERT TYPE	CSP / CSP / CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	645.811 / 645.719 / 645.777
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	645.309 / 645.292 / 645.529

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- ➔ FLOW DIRECTION

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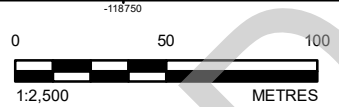
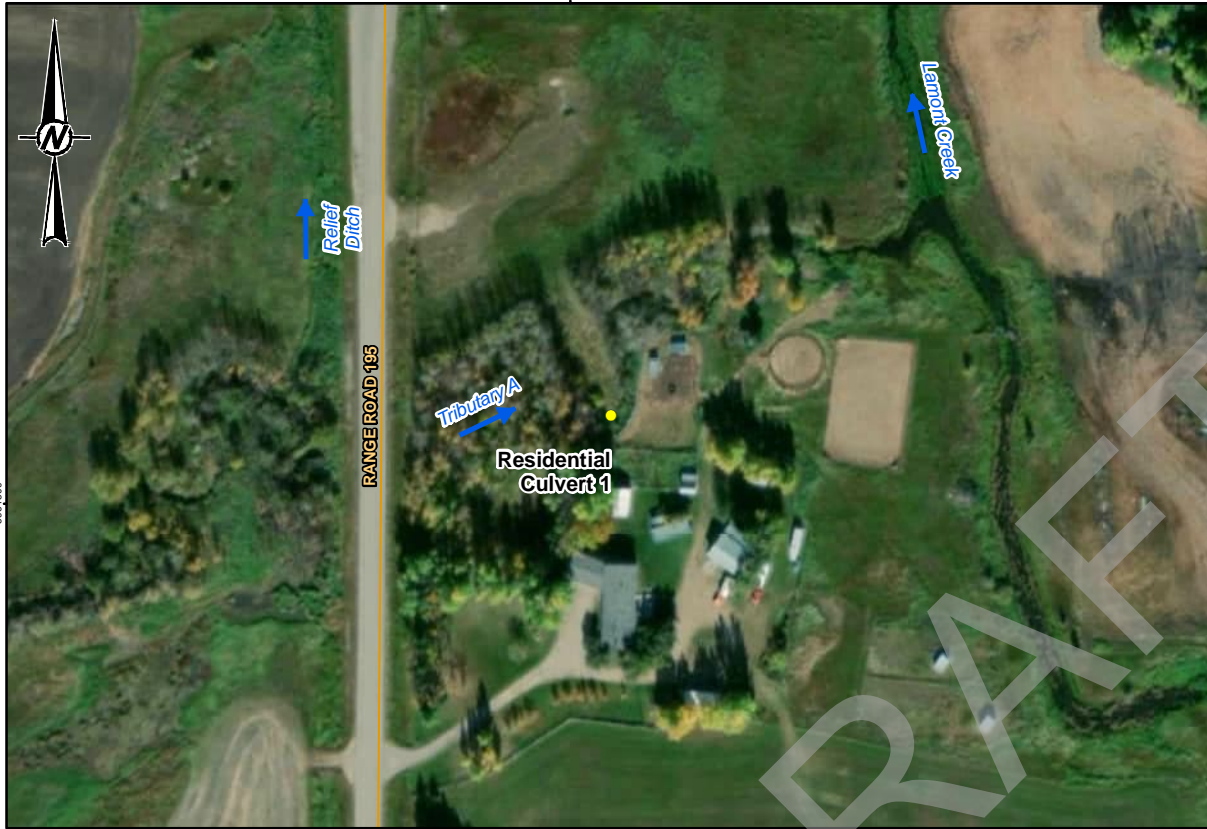
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ALBERTA ENVIRONMENT AND PROTECTED AREAS

PROJECT
LAMONT FLOOD STUDY

CONSULTANT	YYYY-MM-DD	2025-06-19
	DESIGNED	JC
	PREPARED	PMT
	REVIEWED	AC
	APPROVED	JC

PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-20
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-118750



TITLE
RESIDENTIAL CULVERT 1

LOCATION	TRIBUTARY A
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	SEE NOTE
RISE OF CULVERT (m)	0.3
SPAN OF CULVERT (m)	0.3
DIAMETER OF CULVERT (m)	0.3
CULVERT TYPE	SWSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	SEE NOTE
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	SEE NOTE

LEGEND

- CULVERT - NOT SURVEYED
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- RAILWAY
- FLOW DIRECTION

PHOTO 1 CULVERT INLET



PHOTO 2 CULVERT OUTLET



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PROJECT

LAMONT FLOOD STUDY

CONSULTANT



YYYY-MM-DD	2025-06-19
DESIGNED	JC
PREPARED	PMT
REVIEWED	AC
APPROVED	JC

PROJECT NO.
23592565

CONTROL
-

REV.
0

FIGURE
B-21



TITLE	
RESIDENTIAL CULVERT 2	
LOCATION	TRIBUTARY A
NUMBER OF CULVERTS	1
TOTAL LENGTH OF CULVERT (m)	4.9
RISE OF CULVERT (m)	0.3
SPAN OF CULVERT (m)	0.3
DIAMETER OF CULVERT (m)	0.3
CULVERT TYPE	SWSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	639.872
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	640.173

LEGEND	
•	SURVEY POINT
+	RAILWAY
—	LOCAL ROAD
→	FLOW DIRECTION
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY

PHOTO 1 VIEW OF CULVERT FROM UPSTREAM



PHOTO 2 VIEW OF CULVERT FROM DOWNSTREAM



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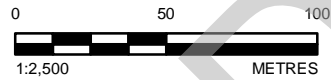
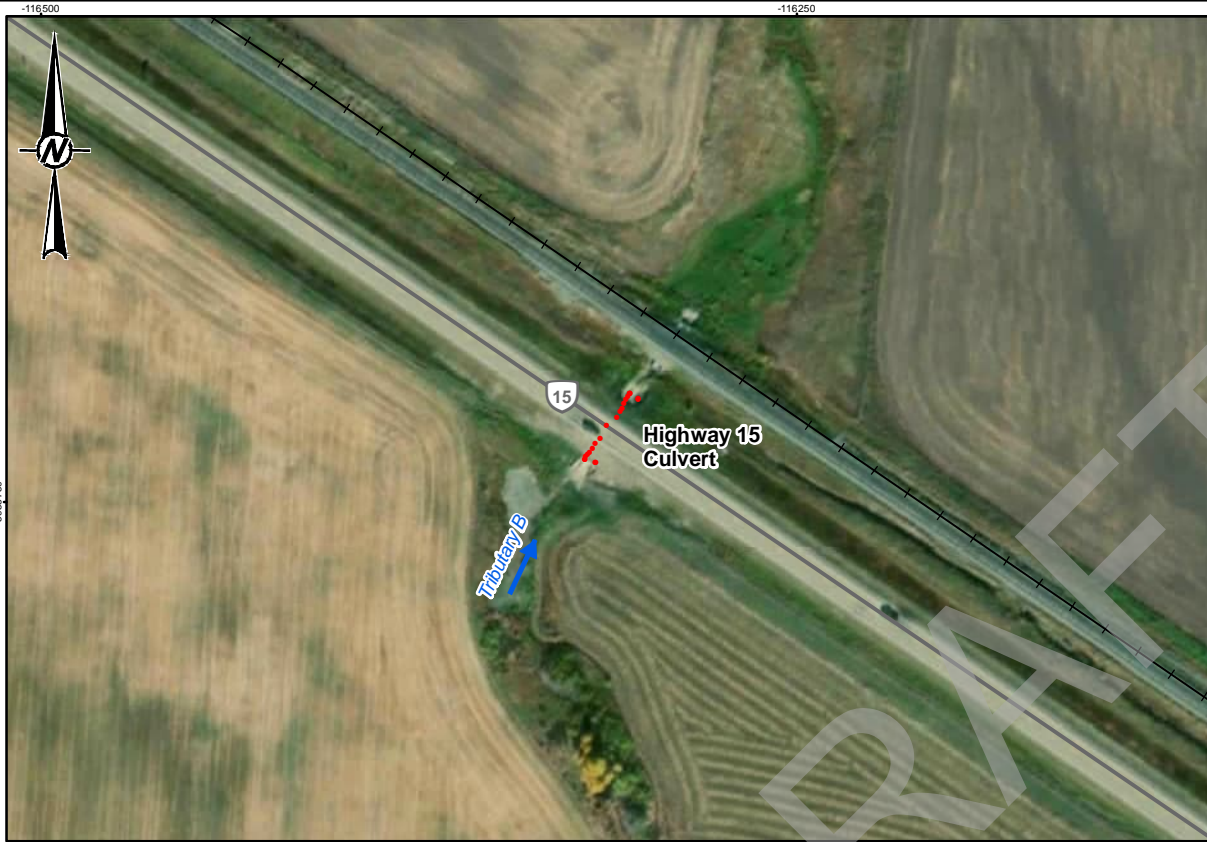
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ALBERTA ENVIRONMENT AND PROTECTED AREAS

PROJECT
LAMONT FLOOD STUDY

CONSULTANT	YYYY-MM-DD	2025-06-19
DESIGNED	JC	
PREPARED	PMT	
REVIEWED	AC	
APPROVED	JC	



PROJECT NO. 23592565	CONTROL -	REV. 0	FIGURE B-22
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TITLE
HIGHWAY 15 CULVERT

LOCATION	TRIBUTARY B
NUMBER OF CULVERTS	2
TOTAL LENGTH OF CULVERT (m)	25.2 / 25.2
RISE OF CULVERT (m)	0.9 / 1.2
SPAN OF CULVERT (m)	0.9 / 1.2
DIAMETER OF CULVERT (m)	0.9 / 1.2
CULVERT TYPE	SWSP / SWSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	653.101 / 653.194
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	653.060 / 652.955

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- + RAILWAY
- ➔ FLOW DIRECTION

PHOTO 1 VIEW OF CULVERT FROM UPSTREAM



PHOTO 2 VIEW OF CULVERT FROM DOWNSTREAM



REFERENCE(S)

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PROJECT

LAMONT FLOOD STUDY

CONSULTANT



YYYY-MM-DD 2025-06-19

DESIGNED JC

PREPARED PMT

REVIEWED AC

APPROVED JC

PROJECT NO.
23592565

CONTROL
-

REV.
0

FIGURE
B-23

-116250

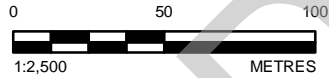
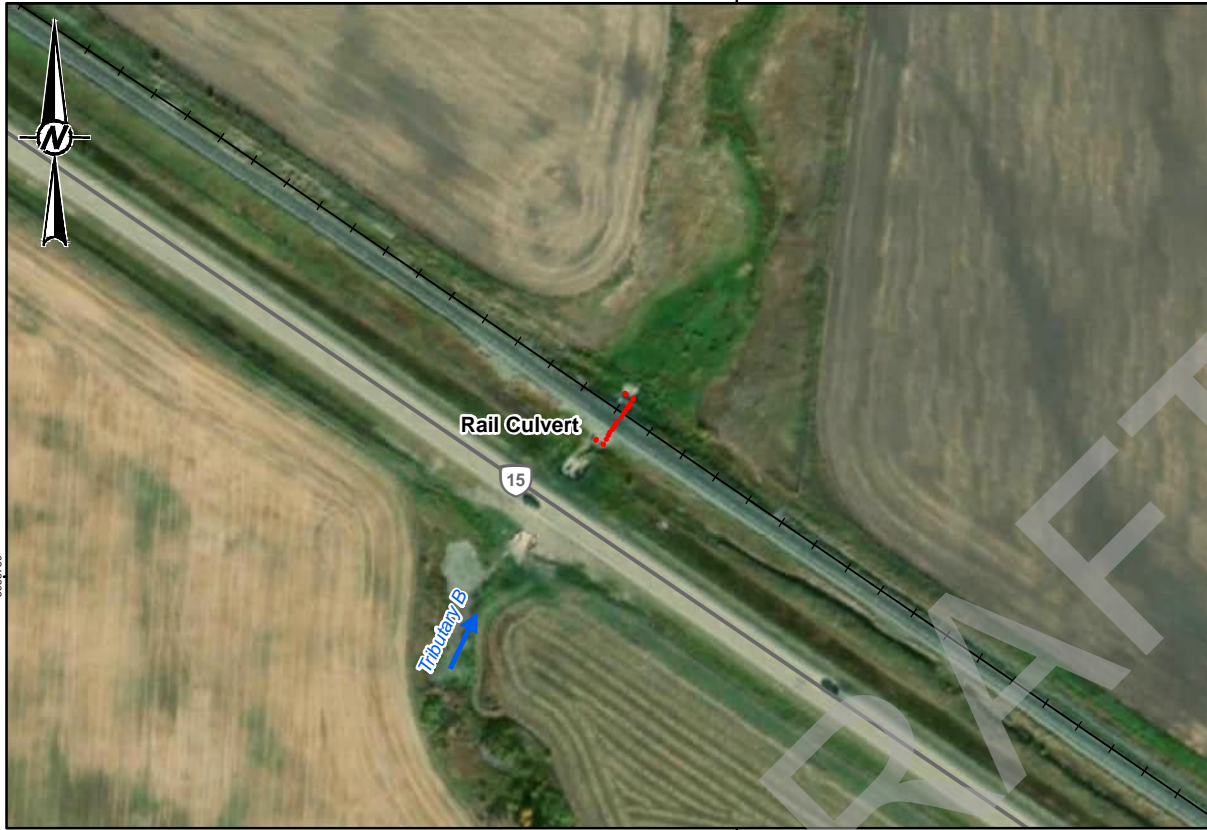


PHOTO 1 VIEW OF CULVERTS FROM UPSTREAM



PHOTO 2 VIEW OF CULVERTS FROM DOWNSTREAM



TITLE
RAIL CULVERT

LOCATION	TRIBUTARY B
NUMBER OF CULVERTS	2
TOTAL LENGTH OF CULVERT (m)	18.2 / 18.2
RISE OF CULVERT (m)	1.6 / 1.2
SPAN OF CULVERT (m)	1.6 / 1.2
DIAMETER OF CULVERT (m)	1.6 / 1.2
CULVERT TYPE	CSP / CSP
CULVERT INVERT ELEVATION - UPSTREAM END (m)	652.736 / 653.023
CULVERT INVERT ELEVATION - DOWNSTREAM END (m)	652.733 / 652.943

LEGEND

- SURVEY POINT
- LOCAL ROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- + RAILWAY
- ➔ FLOW DIRECTION

REFERENCE(S)

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ALBERTA ENVIRONMENT AND PROTECTED AREAS

PROJECT

LAMONT FLOOD STUDY

CONSULTANT



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DESIGNED JC

PREPARED PMT

REVIEWED AC

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APPENDIX C

**Technical Memorandum on Open
Water Hydrology Assessment**

DRAFT



TECHNICAL MEMORANDUM

DATE June 19, 2025

Project No. 23592565

TO Hammad Javid
Alberta Environment and Protected Areas

CC Nathan Schmidt

FROM Mesgana Gizaw and Getu Biftu

EMAIL mesgana.gizaw@wsp.com

OPEN WATER HYDROLOGY ASSESSMENT – LAMONT FLOOD STUDY

1.0 INTRODUCTION

1.1 Study Area and Scope

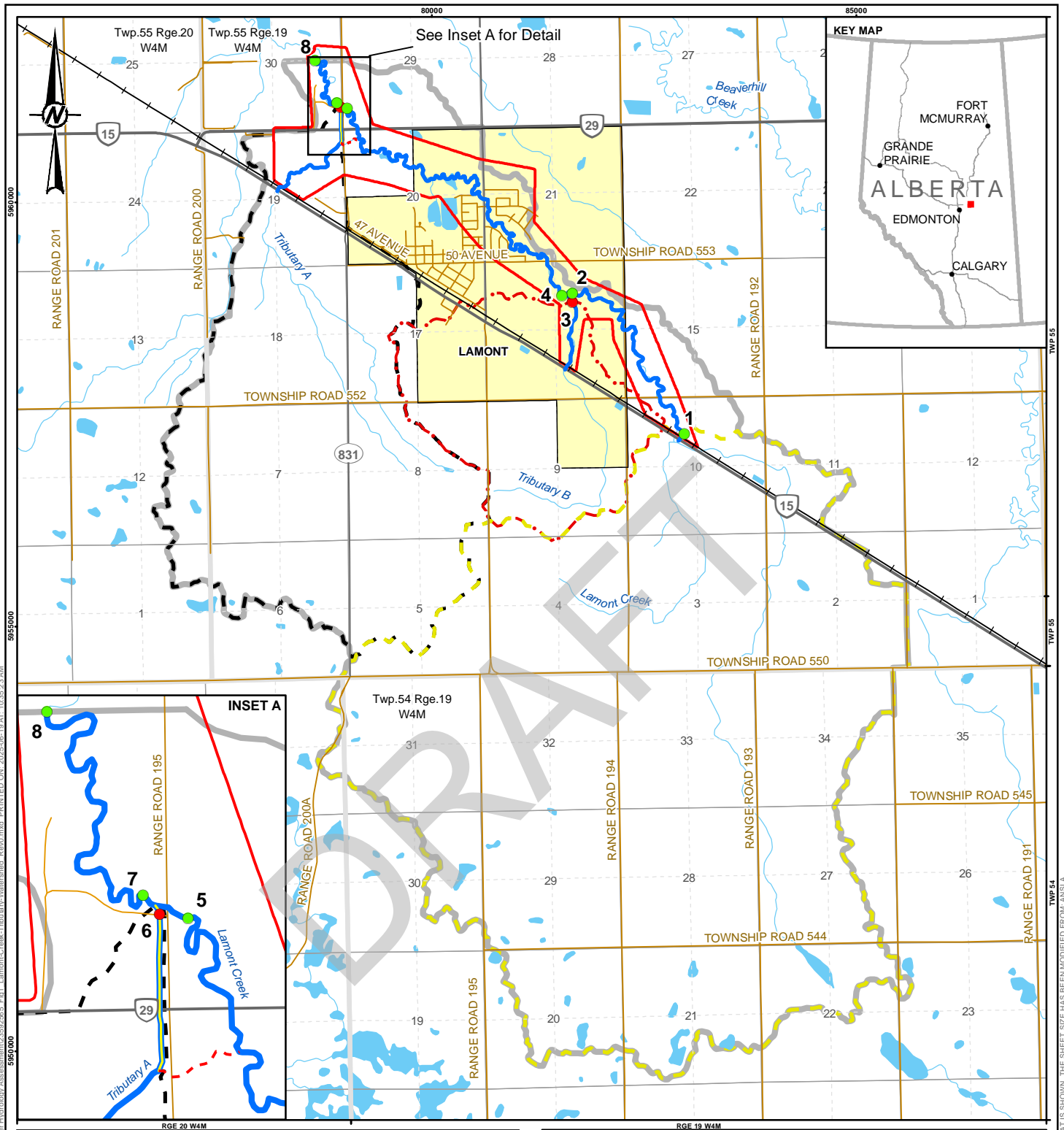
In March 2023 Alberta Environment and Protected Areas (EPA) commissioned WSP Canada Inc. (WSP) to conduct the Lamont Flood Study (the study). The purpose of this study is to assess and identify flood hazards along a 9 km reach of Lamont Creek and a 2 km reach along its two unnamed tributaries through the Town of Lamont and Lamont County (Figure 1). In this study, the larger and smaller unnamed tributaries of Lamont Creek are referred to as Tributary A and Tributary B, respectively.

The study is part of the provincial Flood Hazard Identification Program (FHIP), the goals of which include enhancement of public safety and reduction of future flood damages through the identification of river and flood hazards. Project stakeholders include the Government of Alberta (GOA), the Town of Lamont, and Lamont County.

The study comprises multiple components and deliverables. This memorandum documents the methodology and results of the open water hydrology assessment that will support the hydraulic modelling and open water flood mapping. The individual tasks associated with this hydrology assessment component include the following:

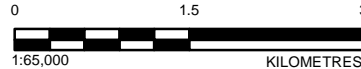
- **Data Series Preparation:** Develop flood flow data series by compiling available peak discharge information at regional gauged locations in a consistent database format and addressing any data gap.
- **Flood Frequency Analysis:** Estimate 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, 1,000-year open water flood peak discharges along the study reaches of Lamont Creek, Tributary A, and Tributary B.
- **Climate Change Commentary:** Provide comments and insight into how climate change processes may impact the flood peak discharges and flood frequency estimates used for flood inundation mapping.

The flood frequency estimates obtained in this study are the most up to date for the study area. These estimates provide the updated flood hydrology information as flow inputs to hydraulic modelling in this study.



LEGEND

- RAILROAD
- PRIMARY HIGHWAY
- SECONDARY HIGHWAY
- LOCAL ROAD
- FARM ACCESS ROAD
- WATERCOURSE
- OLD TRIBUTARY A CHANNEL
- STUDY REACH
- RELIEF DITCH
- WATERBODY
- TOWN OF LAMONT
- STUDY AREA
- WATERSHED**
- LAMONT CREEK
- TRIBUTARY A
- TRIBUTARY B
- UPSTREAM LAMONT CREEK
- ASSESSMENT LOCATIONS**
- ON LAMONT CREEK
- ON TRIBUTARY A OR B



REFERENCE(S)

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**ALBERTA ENVIRONMENT
 AND PROTECTED AREAS**

PROJECT
LAMONT FLOOD STUDY



TITLE
LAMONT CREEK AND ITS TRIBUTARIES AT THE TOWN OF LAMONT

CONSULTANT



YYYY-MM-DD 2025-06-19

DESIGNED MG

PREPARED NB/SK

REVIEWED AC

APPROVED JC

PROJECT NO.
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1.2 Study Objectives

The primary study objective is to identify and assess river-related hazards. The objective of the open water hydrology assessment is to generate flood peak discharge estimates along the study reaches of Lamont Creek, Tributary A, and Tributary B. The results of the frequency analysis include estimates of the 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750-, and 1,000-year open water flood peak discharges.

This study includes the use of some preliminary estimates of annual peak flows particularly for the period from 2021 to 2022 for the gauged regional watersheds, which were downloaded from EPA's website. Including these provisional data increases the sample sizes for the flood frequency analyses and reliability of the resulting flood frequency estimates.

It is important to note that the annual maximum instantaneous discharges for the period 2021 to 2022 are provisional and preliminary and may be subject to change when reviewed and corrected by the Water Survey Canada (WSC). Therefore, the flood frequency statistics presented in this memorandum should be used with caution and reviewed when the finalized discharge values are available.

1.3 Watershed Setting and Historical Flood

Lamont Creek originates south of the Town of Lamont and drains in a northwesterly direction through the Town, eventually discharging into the Beaverhill Creek. Two unnamed tributaries join Lamont Creek around the Town of Lamont. Tributary A joins Lamont Creek just north of the Town and almost all of the watershed lies outside the boundaries of the Town. Tributary B joins Lamont Creek from the southeastern portion of the Town and about half of the watershed lies within the Town of Lamont. The study reach for Lamont Creek extends from the downstream side of the CN Rail crossing within NW-10-55-19-W4M to the upstream side of the Range Road 195 bridge. The study reaches of the two tributaries extend from the downstream side of their respective CN Rail crossings to their confluences with Lamont Creek.

The gross drainage areas of Tributary B, Tributary A, and Lamont Creek downstream of Tributary A are estimated to be 5.74 km², 14.4 km², and 59.7 km², respectively. These drainage areas were estimated based on sub-watershed delineations for the "Lamont County Rural Drainage Management Plan" study that was prepared by NHC on behalf of Lamont County (NHC 2021). Comprehensive drainage network and sub-watershed delineations for the entire Lamont County were developed in the NHC (2021) study. The digital Geographic Information System (GIS) files from NHC (2021) study were provided by EPA. These drainage networks and watershed areas from NHC (2021) are comparable with 1:100,000 ALTALIS watercourse maps and watershed areas of larger watercourses from Agriculture and Agri-Food Canada's (AAFC) Watersheds Project (AAFC 2013) which consequently justifies the use of NHC (2021) data for delineating small watercourses such as Lamont Creek and its two tributaries. Non-contributing areas available in AAFC (2013) were subtracted from the gross drainage areas to estimate the corresponding effective drainage areas of Lamont Creek and its two tributaries. These non-contributing areas range from 7% to 21% of the gross drainage area of sub-watersheds of Lamont Creek study reach. At the most downstream location of the study reach, about 14% of the gross drainage area is non-contributing.

Widespread beaver activity in Lamont Creek and its tributaries have been known to exacerbate floodings as channel flow conveyance is reduced and water levels rise when beaver dams are washed out during high flow events. Ice jams floodings have not been identified to be an issue at the Town of Lamont.

Based on anecdotal evidence, the worst flooding in Lamont Creek happened in 1974 due to spring snowmelt flooding (Stanley 1998). Other major flood events happened in 1982, 1990, and 2018. The 1982 flood was attributed to a heavy rainstorm which dropped about 104 mm of rainfall around the Town of Lamont on July 22, 1982. Overgrown, beaver-infested, and debris-ridden conditions of Lamont Creek contributed significantly to the high-water conditions that led to the flooding in 1982. The 1990 flood is also likely driven by rainfall with high water levels in Lamont Creek resulting in stormwater backups onto streets (Stanley 1998). The 2018 flooding was snowmelt driven and was attributed to a sudden warming after a cold winter that led to a quick thaw while the ground is still frozen. This subsequently resulted in significant overland flooding as the frozen ground acted as an impervious surface (NHC 2021). In addition to these flood events at the Town of Lamont, flooding has been reported in 1974, 1982, 1997, 2014, 2015, 2016, 2018 and 2020 in Lamont County which covers an area of about 2,530 km² and includes creeks such as Lamont, Beaverhill, Whiteford, Limestone, Peno etc. (NHC 2021).

The 1982 flooding led to drainage improvement work which involved re-routing the Tributary A flows west of the Town of Lamont, as well as channel improvements to Lamont Creek (Stanley 1998). The flows of Tributary A were re-routed using a relief ditch just west of the Range Road 195 (RR 195) culvert crossing. This relief ditch runs north parallel to RR 195 for about 455 m and joins Lamont Creek just after the RR 195 bridge crossing on Lamont Creek. The relief ditch consists of two culverts with the first culvert passing through Highway 29 and the second culvert through a farm access road. Information collected by EPA from Lamont County indicates that the RR 195 culvert for Tributary A was removed sometime between 1999 and 2005. Consequently, the connection with the old Tributary A channel section east of RR 195 has been severed and the relief ditch is now considered part of the Tributary A channel alignment linking Tributary A with Lamont Creek. Inset A to Figure 1 shows details of the old and new channel alignments of Tributary A.

2.0 AVAILABLE FLOW DATA

2.1 Recorded Data

There are no WSC hydrometric stations on Lamont Creek. Therefore, the flood frequency estimates for Lamont Creek, Tributary A, and Tributary B were derived based on regional analysis. Published hydrometric data from WSC stations that are currently operational or were operated in the past were used in the regional analysis. In the absence of published data from WSC, preliminary annual maximum instantaneous discharge data were derived from provisional 15-min discharge data from GOA's River Basins database (2023). Although the use of preliminary data that is subject to change is generally not recommended, the flood peaks estimated using these preliminary data are all lower than the published historical maximums for the respective WSC Station. Therefore, the use of preliminary data to extend the period of record is not expected to have a significant effect on the flood frequency estimates.

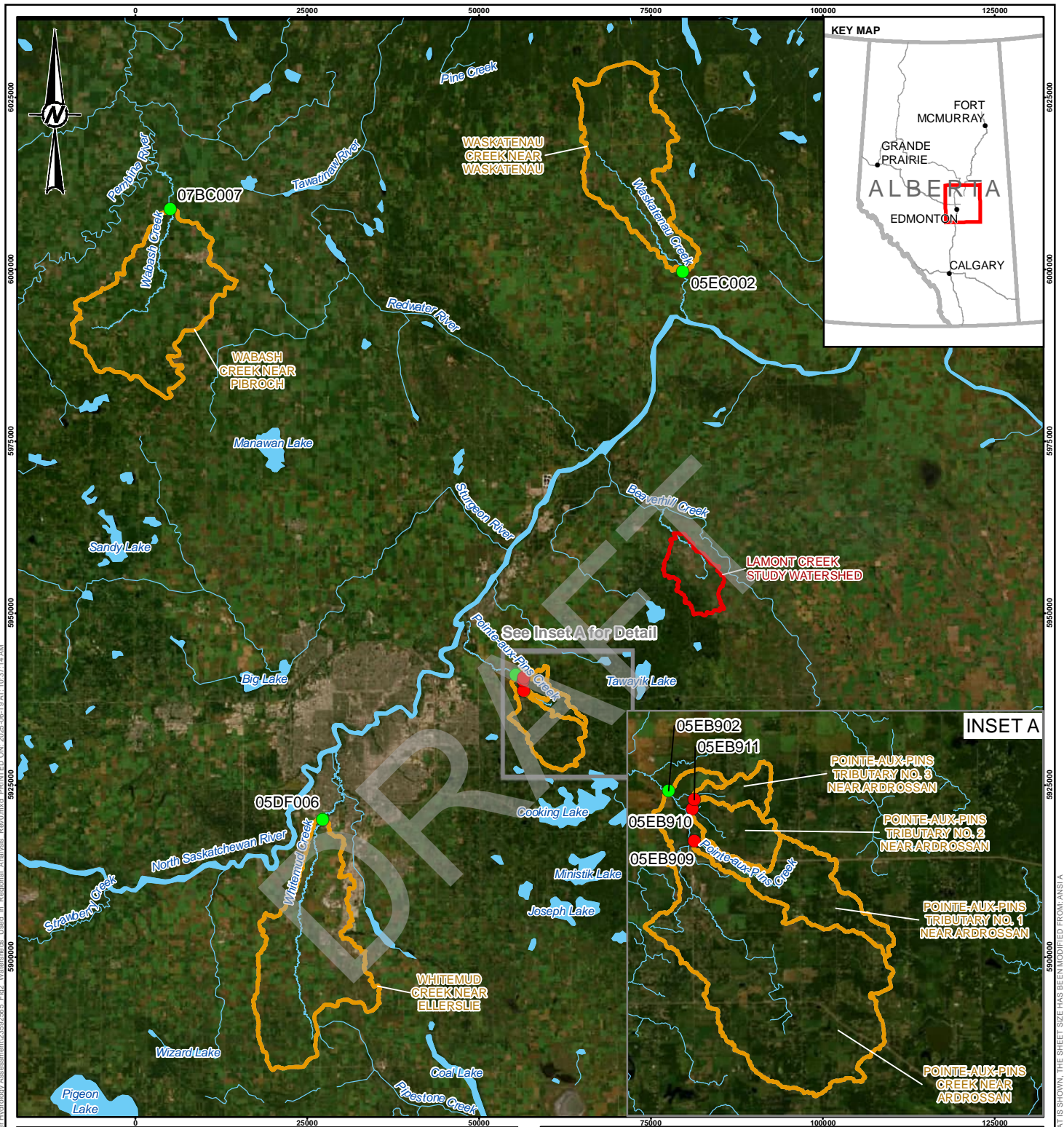
Summary of the basic hydrologic information used for regional analysis and to derive the flood frequency estimates for the study area are provided in Table 1. Figure 2 shows the locations of the regional hydrometric stations selected for analysis with additional detailed data provided in Appendix A. The regional hydrometric stations were selected based on their proximity (i.e., relatively close to the study area), size (i.e., reasonable range of gross and effective drainage area that can be used to establish the regional relationships), and physiographic characteristics (e.g., similar drainage characteristics, land types). As shown in Figure 2, watersheds of the selected regional hydrometric stations are dominated by agricultural land use, similar to the Lamont Creek watershed. Based on data available from Alberta Soil Information Viewer (GOA 2024), the regional watersheds also have reliefs similar to Lamont Creek watershed with undulating landforms and overland slopes generally ranging from 2% to 4%.

Table 1: Summary of Gauged Stations Considered in the Study

WSC Station Number	WSC Station Name	Latitude	Longitude	Approximate Distance from the Study Area (km) ^(a)	Gross Drainage Area (km ²)	Effective Drainage Area (km ²)	Length of Record (years)	Period of Record
05EB911	Pointe-Aux-Pins Tributary No.3 near Ardrossan	55°35'44" N	113°08'47" W	30	3.55	3.55	15	1981-1996
05EB910	Pointe-Aux-Pins Tributary No.2 near Ardrossan	55°35'30" N	113°08'51" W	30	8.1	8.1	28	1981-2009
05EB909	Pointe-Aux-Pins Tributary No.1 near Ardrossan	55°34'43" N	113°08'48" W	30	17.8	6.74	15	1981-1996
05EB902	Pointe-Aux-Pins Creek near Ardrossan	55°35'58" N	113°09'49" W	30	106	63.2	43	1979-2021
05EC002	Waskatenau Creek near Waskatenau	54°07'23" N	112°46'58" W	60	313	207	57	1966-2022
05DF006	Whitemud Creek near Ellerslie	53°24'45" N	113°35'27" W	75	330	301	54	1969-2022
07BC007	Wabash Creek near Pibroch	54°12'37" N	113°55'20" W	90	344	344	44	1979-2022

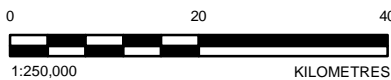
Note:

(a) Distance from study area is approximately measured from the center of Lamont Creek watershed to the center of the WSC gauged watershed. For comparison Lamont Creek watershed area for the study site is located at latitude of approximately 53°43'28" N and longitude of approximately 112°46'5" W and has gross and effective drainage areas of 59.7 km² and 51.3 km², respectively.



LEGEND

- WATERSHED USED IN REGIONAL ANALYSIS
- LAMONT CREEK STUDY WATERSHED
- WATERCOURSE
- WATERBODY
- ASSESSED WSC STATIONS**
- ACTIVE
- DISCONTINUED



REFERENCE(S)

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PROJECT
LAMONT FLOOD STUDY

TITLE
WATERSHEDS USED IN REGIONAL ANALYSIS

CONSULTANT	YYYY-MM-DD	2025-06-19
	DESIGNED	MG
	PREPARED	SK
	REVIEWED	AC
	APPROVED	JC

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2.2 Previous Studies

Several hydrology studies were completed over the last three decades. Some of these studies included assessments of open water hydrology. These studies include the following:

- Draft: Flood Frequency Analysis, Lamont Creek Floodplain Study, Alberta Environmental Protection (1994)
- Lamont Flood Risk Mapping Study, Stanley (1998)
- Lamont County Rural Drainage Management Plan, NHC (2021)

The review of previous studies involved documentation of the assumptions, limitations, and understanding of the hydrologic techniques applied in the past studies. The results of review of these past studies provided a frame of reference for interpretation of the results and comparison to this study. In addition, the review helped to identify data gaps and apparent discrepancies in the data that may affect their use in subsequent analyses.

3.0 PREPARATION OF FLOOD FLOW DATA SERIES

Preparation of the flood flow series involved consideration of many factors, including unequal and non-overlapping record lengths, and incomplete flow records. The methods used to compile the flood flow series and to address the data gaps are described in the following sections.

3.1 Flood Flow Series for Gauged Location

The flood frequency estimates for the gauged locations were derived based on the recorded annual maximum instantaneous discharge, and in case of missing data, the annual maximum daily discharges were used to estimate the instantaneous flood discharges.

The following method was used for estimating the annual maximum instantaneous discharges based on the annual maximum daily discharges to fill data gaps in the record:

- Annual maximum daily discharge series were developed using the recorded daily flow series.
- Relationships were established between event-based annual maximum daily and annual maximum instantaneous discharges in the record. If the reported annual maximum daily and annual maximum instantaneous discharges for the same year were not coincident (i.e., from the same flood event), the former values were replaced by the daily flow values for the events corresponding to the annual maximum instantaneous discharges. This relationship was used to estimate the annual maximum instantaneous discharges based on the recorded annual maximum daily discharges.

3.2 Flood Flow Series for Ungauged Locations

Empirical relationships between drainage areas and flood peak discharges were established based on the available regional flow records and for the return periods ranging from 2 to 1,000 years. The relationships were then used to derive the flood frequency estimates for Lamont Creek, Tributary A, and Tributary B in the study area.

The flood frequency estimates for Lamont Creek, Tributary A, and Tributary B were obtained as follows:

- The effective drainage areas at the WSC stations were compiled based on gross drainage areas published by WSC and non-contributing area maps from AAFC (2013). The gross drainage and effective drainage areas of Lamont Creek, Tributary A, and Tributary B were estimated in a GIS analysis using sub-watershed delineations from NHC (2021) and non-contributing area maps from AAFC (2013).
- The flood frequency estimates for the WSC stations (Appendix B) were obtained based on the annual maximum instantaneous flow series.
- Regional relationships between effective drainage area (DA) and peak discharge (Q) for a range of return periods (i.e., 2- to 1,000-years) were developed, as shown in Figure 3.
- The resulting regional relationships were then used to calculate the flood frequency estimates for Lamont Creek and its two tributaries for the various return periods.

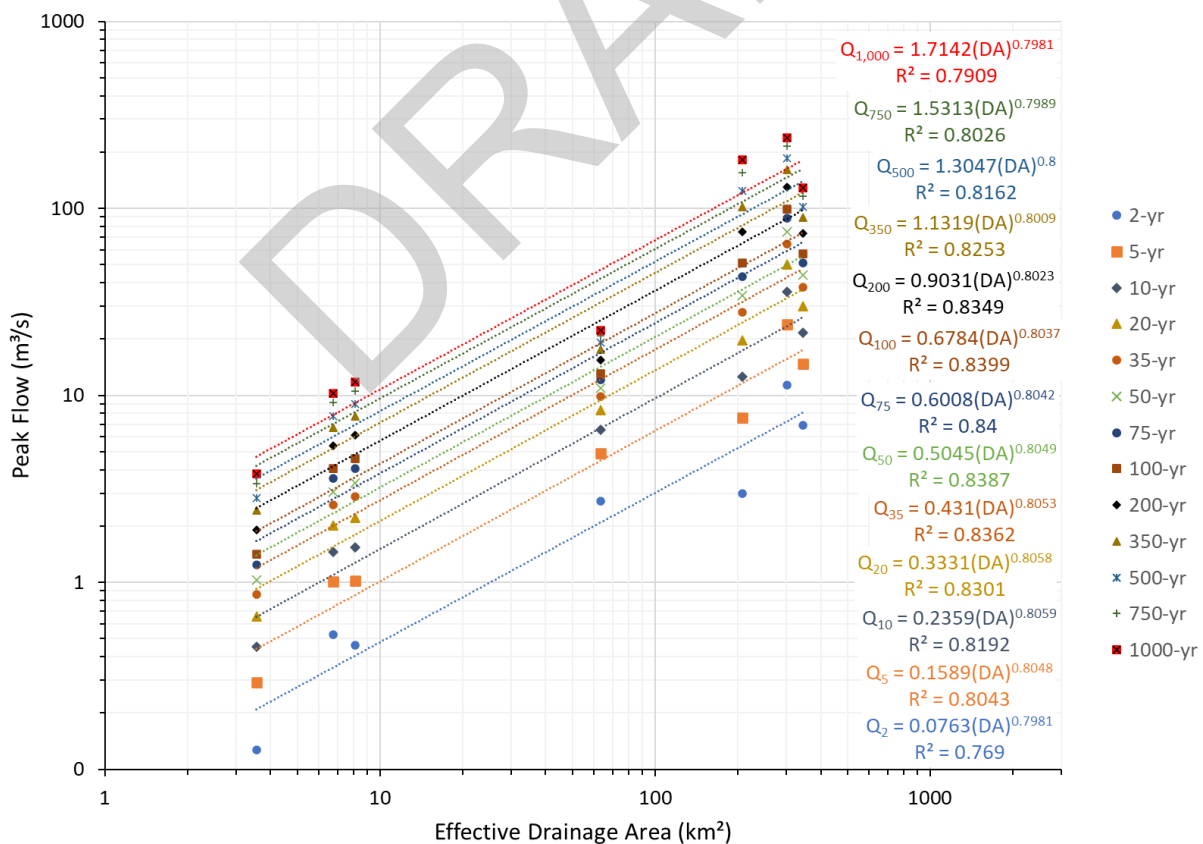


Figure 3: Empirical Relationships between Flood Peak Flows and Drainage Areas of Regional Stations

4.0 FLOOD FREQUENCY ANALYSIS

4.1 Statistical Tests

Prior to fitting the appropriate frequency distribution to the flood flow data, several statistical tests were performed to determine the quality of the developed annual maximum instantaneous discharge series. Software developed by WSP that is similar to Environment Canada's Consolidated Frequency Analysis (CFA), but with enhanced methodology, was used for: (i) flood frequency analyses and statistical tests for independence (not serially correlated); and (ii) trend, randomness, and homogeneity tests. WSP's software includes modern boot-strapping method and estimation of confidence intervals.

The following probability distributions were analyzed with select parameter estimation methods (i.e., method of moments [Moment], maximum likelihood estimation [MLH], and Method of L-moments [MLM]):

- Three-parameter Log Normal distribution (3P, Moment and MLH)
- Generalized Extreme Value distribution, which includes Extreme Value 1, 2, and 3 distributions (EV, MLM)
- Log-Pearson Type III distribution (LP3, Moment, and MLH)
- Weibull distribution (Moment)

Numerical goodness-of-fit tests were performed using the non-parametric Anderson-Darling test (Stephens 1974).

The results of statistical analysis for the regional stations are provided in Table A-2, Appendix A. The results that most of the annual maximum instantaneous discharge series are independent, random, and homogeneous. However, more than half of the WSC stations used in the regional display significant trends at 5% significance but only two stations show statistically significant trends at 1% significance. In addition, based on comparisons of the Anderson-Darling goodness of fit test results (Table A-2) and visual inspection of frequency distribution plots from the above four probability distribution functions (Appendix B), the EV2 distribution was found to best fit the maximum instantaneous discharge series of hydrometric stations selected for regional analysis. Therefore, EV2 was used for estimating the flood frequency values that were used in developing the regional relationship shown in Figure 3.

4.2 Flood Frequency Estimates

Flood frequency analyses of the annual maximum instantaneous discharge for regional stations, were conducted to estimate the discharges of various return periods (i.e., 2-, 5-, 10-, 20-, 35-, 50-, 75-, 100-, 200-, 350-, 500-, 750, and 1,000-year floods). The annual maximum instantaneous discharge series used in the flood frequency analyses, the various frequency distributions, and the best-fit distributions along with their 95% confidence intervals, are provided in Appendix B.

The flood frequency estimates for the Lamont Creek, Tributary A, and Tributary B were derived using the regional analysis described in Section 3.2. The locations on Lamont Creek, Tributary A, and Tributary B where flood frequency values were estimated are shown in Figure 1. The upper and lower 95% confidence limits estimates were derived using the factors calculated based on confidence intervals for Pointe-Aux-Pins Creek near Ardrossan (WSC Station #05EB902), which is located close to the study site, has comparable DA and relatively longer period of records. The flood discharge estimates and the associated upper and lower 95% confidence intervals are summarized in Tables 2 to 9 for Lamont Creek, Tributary B, and Tributary A.

**Table 2: Frequency Estimates for Lamont Creek upstream of Study Reach
(Location ID = 1, Effective Drainage Area = 27.0 km²)**

Return Period (years)	Annual Probability of Exceedance (%)	Value (m ³ /s)	Upper 95% Limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	1.06	1.37	0.823
5	20	2.26	2.81	1.76
10	10	3.36	4.32	2.53
20	5.0	4.75	6.39	3.36
35	2.9	6.13	8.65	4.07
50	2.0	7.17	10.5	4.54
75	1.3	8.52	13.1	5.07
100	1.0	9.60	15.3	5.53
200	0.50	12.7	22.6	6.60
350	0.29	15.9	30.4	7.52
500	0.20	18.3	36.8	8.16
750	0.13	21.3	45.5	8.94
1,000	0.10	23.8	52.8	9.54

Note:

Please refer to Figure 1 to identify the location ID.

**Table 3: Flood Frequency Estimates for Lamont Creek upstream of Tributary B Confluence
(Location ID = 2, Effective Drainage Area = 28.7 km²)**

Return Period (years)	Annual Probability of Exceedance (%)	Value (m ³ /s)	Upper 95% Limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	1.11	1.44	0.863
5	20	2.37	2.95	1.85
10	10	3.53	4.53	2.66
20	5.0	4.98	6.70	3.52
35	2.9	6.44	9.08	4.27
50	2.0	7.52	11.0	4.76
75	1.3	8.94	13.8	5.31
100	1.0	10.1	16.1	5.80
200	0.50	13.3	23.7	6.92
350	0.29	16.7	31.9	7.89
500	0.20	19.1	38.6	8.56
750	0.13	22.4	47.7	9.37
1,000	0.10	25.0	55.3	10.0

Table 4: Flood Frequency Estimates for Tributary B (Location ID = 3, Effective Drainage Area = 5.74 km²)

Return Period (years)	Annual Probability of Exceedance (%)	Value (m ³ /s)	Upper 95% Limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	0.308	0.399	0.239
5	20	0.648	0.808	0.506
10	10	0.96	1.24	0.726
20	5.0	1.36	1.83	0.96
35	2.9	1.76	2.48	1.17
50	2.0	2.06	3.00	1.30
75	1.3	2.45	3.77	1.46
100	1.0	2.76	4.40	1.59
200	0.50	3.67	6.52	1.90
350	0.29	4.59	8.78	2.17
500	0.20	5.28	10.7	2.36
750	0.13	6.19	13.2	2.59
1,000	0.10	6.91	15.3	2.77

Table 5: Flood Frequency Estimates for Lamont Creek downstream of Tributary B Confluence (Location ID = 4, Effective Drainage Area = 34.4 km²)

Return Period (years)	Annual Probability of Exceedance (%)	Value (m ³ /s)	Upper 95% Limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	1.29	1.67	0.998
5	20	2.74	3.42	2.14
10	10	4.09	5.25	3.08
20	5.0	5.77	7.76	4.08
35	2.9	7.45	10.5	4.95
50	2.0	8.71	12.7	5.52
75	1.3	10.4	15.9	6.15
100	1.0	11.7	18.6	6.72
200	0.50	15.5	27.5	8.01
350	0.29	19.3	36.9	9.13
500	0.20	22.1	44.7	9.90
750	0.13	25.9	55.1	10.8
1,000	0.10	28.9	64.0	11.6

**Table 6: Frequency Estimates for Lamont Creek upstream of Tributary A Confluence
(Location ID = 5, Effective Drainage Area = 38.2 km²)**

Return Period (years)	Annual Probability of Exceedance (%)	Value (m ³ /s)	Upper 95% Limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	1.40	1.81	1.08
5	20	2.98	3.71	2.33
10	10	4.44	5.70	3.34
20	5.0	6.27	8.43	4.43
35	2.9	8.10	11.4	5.37
50	2.0	9.46	13.8	6.00
75	1.3	11.2	17.3	6.68
100	1.0	12.7	20.2	7.30
200	0.50	16.8	29.8	8.70
350	0.29	20.9	40.1	9.91
500	0.20	24.0	48.5	10.7
750	0.13	28.1	59.9	11.8
1,000	0.10	31.4	69.4	12.6

Table 7: Flood Frequency Estimates for Tributary A (Location ID = 6, Effective Drainage Area = 13.3 km²)

Return Period (years)	Annual Probability of Exceedance (%)	Value (m ³ /s)	Upper 95% Limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	0.602	0.779	0.467
5	20	1.27	1.59	1.00
10	10	1.90	2.44	1.43
20	5.0	2.68	3.60	1.89
35	2.9	3.46	4.88	2.30
50	2.0	4.05	5.91	2.56
75	1.3	4.81	7.41	2.86
100	1.0	5.43	8.65	3.13
200	0.50	7.20	12.8	3.73
350	0.29	9.00	17.2	4.26
500	0.20	10.3	20.9	4.62
750	0.13	12.1	25.8	5.06
1,000	0.10	13.5	29.9	5.41

Table 8: Flood Frequency Estimates for Lamont Creek downstream of Tributary A Confluence (Location ID = 7, Effective Drainage Area = 51.5 km²)

Return Period (years)	Annual Probability of Exceedance (%)	Value (m ³ /s)	Upper 95% Limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	1.77	2.30	1.37
5	20	3.79	4.72	2.96
10	10	5.65	7.26	4.25
20	5.0	7.97	10.7	5.64
35	2.9	10.3	14.5	6.83
50	2.0	12.0	17.6	7.62
75	1.3	14.3	22.0	8.50
100	1.0	16.1	25.7	9.28
200	0.50	21.3	37.9	11.1
350	0.29	26.6	50.9	12.6
500	0.20	30.5	61.6	13.6
750	0.13	35.7	76.0	14.9
1,000	0.10	39.8	88.1	15.9

Table 9: Flood Frequency Estimates for Lamont Creek downstream of Study Reach (Location ID = 8, Effective Drainage Area = 52.9 km²)

Return Period (years)	Annual Probability of Exceedance (%)	Value (m ³ /s)	Upper 95% Limit (m ³ /s)	Lower 95% Limit (m ³ /s)
2	50	1.81	2.35	1.40
5	20	3.87	4.82	3.02
10	10	5.77	7.41	4.34
20	5.0	8.15	11.0	5.76
35	2.9	10.5	14.8	6.98
50	2.0	12.3	17.9	7.79
75	1.3	14.6	22.5	8.68
100	1.0	16.5	26.2	9.48
200	0.50	21.8	38.7	11.3
350	0.29	27.2	52.0	12.9
500	0.20	31.2	63.0	13.9
750	0.13	36.5	77.6	15.3
1,000	0.10	40.7	90.1	16.3

4.3 Comparison with Previous Studies

The flood frequency estimates obtained in this study for Tributary A, Tributary B, and Lamont Creek were compared with the Stanley (1998) study that was prepared for Alberta Environmental Protection (now EPA). The flood frequency estimates were also compared with values estimated from the regional flow frequency curve that NHC (2021) developed for Lamont County. Table 10 and Table 11 show comparison of the flood frequency estimates derived in this study and the Stanley (1998) and NHC (2021) studies, respectively. It should be noted that Stanley (1998) and NHC (2021) used gross DAs when developing regional curves to estimate peak flows of Lamont Creek and its two tributaries. In this study, the effective DAs were used to develop the regional relationships.

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Table 10: Comparison of Flood Frequency Estimates with Stanley (1998) Study

Return Period (years) / Drainage Area	Tributary B (m ³ /s)		Tributary A (m ³ /s)		Lamont Creek upstream of Tributary B (m ³ /s)		Lamont Creek upstream of Tributary A (m ³ /s)		Lamont Creek downstream of Tributary A (m ³ /s)	
	This Study	Stanley (1998)	This Study	Stanley (1998)	This Study	Stanley (1998)	This Study	Stanley (1998)	This Study	Stanley (1998)
	5.74 km ²	3.4 km ²	13.3 km ²	15.8 km ²	28.7 km ²	38.2 km ²	38.2 km ²	45.8 km ²	51.5 km ²	61.6 km ²
2	0.308	0.218	0.602	0.768	1.11	1.59	1.40	4.09	1.77	2.35
5	0.648	0.480	1.27	1.70	2.37	3.52	2.98	6.05	3.79	5.22
10	0.96	0.714	1.90	2.52	3.53	5.21	4.44	8.00	5.65	7.71
20	1.36	0.945	2.68	3.34	4.98	6.89	6.27	10.8	7.97	10.2
50	2.06	1.27	4.05	4.50	7.52	9.28	9.46	13.0	12.0	13.7
100	2.76	1.54	5.43	5.44	10.1	11.2	12.7	11.2	16.1	16.6

Note:

Effective drainage areas were used to estimate the peak flood discharges of Lamont Creek, Tributary B and Tributary A in this study and gross drainage areas were used in the Stanley (1998) study.

Table 11: Comparison of Flood Frequency Estimates with NHC (2021) Study

Return Period (years) / Drainage Area	Tributary B (m ³ /s)		Tributary A (m ³ /s)		Lamont Creek upstream of Tributary B (m ³ /s)		Lamont Creek downstream of Tributary B (m ³ /s)		Lamont Creek upstream of Tributary A (m ³ /s)		Lamont Creek downstream of Tributary A (m ³ /s)	
	This Study	NHC (2021)	This Study	NHC (2021)	This Study	NHC (2021)	This Study	NHC (2021)	This Study	NHC (2021)	This Study	NHC (2021)
	5.74 km ²	5.74 km ²	13.3 km ²	14.4 km ²	28.7 km ²	36.1 km ²	34.4 km ²	41.9 km ²	38.2 km ²	45.4 km ²	51.5 km ²	59.7 km ²
2	0.308	0.277	0.602	0.531	1.11	1.02	1.29	1.13	1.40	1.20	1.77	1.46
5	0.648	0.646	1.27	1.23	2.37	2.34	2.74	2.59	2.98	2.74	3.79	3.33
10	0.96	0.985	1.90	1.87	3.53	3.57	4.09	3.96	4.44	4.19	5.65	5.08
50	2.06	1.94	4.05	3.65	7.52	6.89	8.71	7.63	9.46	8.06	12.0	9.75
100	2.76	2.47	5.43	4.66	10.1	8.79	11.7	9.73	12.7	10.3	16.1	12.4

Note:

Effective drainage areas were used to estimate the peak flood discharges of Lamont Creek, Tributary B and Tributary A in this study and gross drainage areas were used in the NHC (2021) study.

4.4 Recommended Flood Frequency Estimates for Hydraulic Modelling

A 2D HEC-RAS hydraulic model will be used to determine the flood inundation extents for Lamont Creek, Tributary B, and Tributary A. All flood inundation extents will be modelled in a single 2D HEC-RAS model configuration (i.e., there will not be individual models for Lamont Creek, Tributary B and Tributary A). The flood frequency estimates summarized in Table 12 are recommended for use in this hydraulic model.

Table 12: Recommended Flood Frequency Estimates for Different Segments of the Study Reaches to be Used in the 2D HEC-RAS Model.

Return Period (years)	Study Reach				
	Lamont Creek u/s of Tributary B Confluence	Tributary B	Lamont Creek from d/s of Tributary B Confluence to u/s of Tributary A Confluence	Tributary A	Lamont Creek d/s of Tributary A Confluence
2	1.11	0.308	1.42	0.602	1.81
5	2.37	0.648	3.02	1.27	3.87
10	3.53	0.965	4.49	1.90	5.77
20	4.98	1.36	6.34	2.68	8.15
35	6.44	1.76	8.20	3.46	10.5
50	7.52	2.06	9.58	4.05	12.3
75	8.94	2.45	11.4	4.81	14.6
100	10.1	2.76	12.8	5.43	16.5
200	13.3	3.67	17.0	7.20	21.8
350	16.7	4.59	21.2	8.99	27.2
500	19.1	5.28	24.4	10.3	31.2
750	22.4	6.19	28.6	12.1	36.5
1,000	25.0	6.91	31.9	13.5	40.7

Note:

d/s = downstream, u/s = upstream.

In Table 12, the flood magnitudes recommended for hydraulic modelling in the study reaches of Lamont Creek till upstream of Tributary B confluence, Tributary B, Tributary A, and Lamont Creek downstream of Tributary A are the same as those determined by the regional flood frequency analysis (Table 3, Table 4, Table 7, and Table 9, respectively). For the study reach of Lamont Creek between Tributary B and Tributary A confluence, the recommended values for hydraulic modelling were derived by summing the flood magnitudes of Lamont Creek upstream of Tributary B and flood magnitudes derived for Tributary B. This is done to simplify subsequent hydraulic modelling because, for 2D HEC-RAS model configuration, flows downstream of confluences must match the sum of flows from Lamont Creek upstream of the confluence and flows from its tributary (i.e., Tributary B). However, the recommended values for hydraulic modelling for Lamont Creek downstream of Tributary A confluence were not derived by summing the flood magnitudes upstream of the confluences as explained below.

Peak floods downstream of a confluence derived by summing the flood magnitudes from individual watercourses are higher because peak floods in the individual watercourses are assumed to arrive at the same time at the confluence. However, peak flows of individual watercourses at a confluence are not generally coincident due to differences in peak flood travel times along the watercourses. The recommended values for the Lamont Creek study reach between Tributary B and Tributary A confluence are about 1% to 2% higher than the flood magnitudes from regional analysis in Table 6. The stretch of Lamont Creek between Tributary B and Tributary A confluence passes through the developed portion of the Town of Lamont. As such, it will be the primary focus in the flood inundation mapping. For this stretch of Lamont Creek, the difference in the flood magnitudes that will be used in the HEC-RAS model (i.e., presented in Table 12) and those derived using regional analysis and presented in Table 6 are about 1 to 2% higher, indicating that flood water levels simulated by the 2D HEC-RAS model will be slightly on the conservative side but very close to the flood water levels to be estimated based on the values in Table 6.

However, the flood flows of Lamont Creek study reach downstream of Tributary A confluence, if derived as the sum of the flood flows of Lamont Creek upstream of the confluences and its tributary (i.e., Tributary A), are about 11% higher than the flood magnitudes from regional analysis (i.e., those provided in Table 9). This relatively larger difference could result in higher flood water level estimates by the HEC-RAS model for this stretch of Lamont Creek and consequently would result in a more conservative flood inundation extent. Therefore, the flood flows from regional analysis (i.e., those provided in Table 9) will directly be used for this reach of Lamont Creek and adjustments to the 2D HEC-RAS model configuration will be made to this stretch of Lamont Creek.

5.0 POTENTIAL EFFECTS OF CLIMATE CHANGE ON FLOOD PEAK DISCHARGES AND FLOOD FREQUENCY ESTIMATES

Recent studies on the effect of climate change (e.g., Martz et al. 2007; Sturgess 2017; Droppo et al. 2018) indicate that climate change could result in increased air temperature, more frequent drought and water shortages, increased precipitation in some areas, and increased flooding. As a result of the expected change in both the systematic climate and its variability, many regions of Canada, including the Prairies, could experience warmer air temperatures and changes in streamflow magnitude and timing (e.g., higher winter stream flows, early spring peak streamflow, and lower summer stream flows).

Droppo et al. (2018) review of several studies indicates, with high confidence, that projected increases in extreme precipitation are expected to increase the potential for future urban flooding. There is medium confidence that projected higher temperatures will result in a shift toward earlier floods associated with spring snowmelt, ice jams, and rain-on-snow events. However, it is uncertain how projected higher temperatures and reductions in snow cover will affect the frequency and magnitude of future snowmelt-related flooding.

Anis and Sauchyn (2021) used the MESH hydrologic model forced with bias corrected ensemble climate simulations of Canadian Regional Climate Model (CanRCM4) for historical baseline (1951-2010) and future projections (2040-2100) under RCP 8.5 high emission climate change scenario for upper North Saskatchewan River (upstream of Edmonton). The RCP 8.5 is a severe climate change scenario where greenhouse gas emissions continue to increase indefinitely. Their results suggest that precipitation is projected to increase in every season with significant increasing trends in spring and fall seasons. Winter extreme minimum temperature and summer extreme maximum temperature were projected to increase by 2-3°C in the near future (2021-2050) and 5-6°C in the far future (2051-2080). Annual runoff is projected to increase by 19% compared to the baseline period. Golder (2008) also analyzed the impact of climate change on the upper North Saskatchewan River using

the MISBA hydrologic model forced with the European Center for Mid-Range Weather Forecast global re-analysis (ERA-40) baseline (1961-1990) climate data and the 2021-2050 climate projections from four Global Climate Models (GCMs). For GCMs most representative of the baseline climate, Golder (2008) results suggest a projected increase in the future annual water yield in the upper North Saskatchewan River that is mainly associated with an increase in spring flows.

The peak flow season of Lamont Creek watershed has been indirectly assessed using recorded peak instantaneous flows for Pointe-Aux-Pins Creek watershed (WSC Station #05EB902) which is located about 30 km away from Lamont Creek watershed. About 65% of peak flows recorded in Pointe-Aux-Pins Creek occurred in March-April-May (spring) period with the remaining peak flow events recorded during the June-July-August (summer) period (see Table 13). This indicates that we expect similar pattern for Lamont Creek in which the snowmelt dominated spring season as the dominant peak flow season followed by the rainfall dominated summer season.

Assessment of future climate scenarios depends on the climate model used for the prediction. Regardless, precipitation is projected to increase in Alberta, with less precipitation falling as snow and more rain-on-snow precipitation events (Valeo et al. 2007). Furthermore, although the study area in Anis and Sauchyn (2021) and Golder (2008) only considered the North Saskatchewan River upstream of Edmonton, similar climate change impacts are likely expected for the downstream portions of the North Saskatchewan watershed which include the Lamont Creek watershed. Therefore, it is anticipated that future changes in precipitation patterns could increase the frequency and intensity of extreme events (i.e., flood, drought, hail, and windstorms). It is also likely that the frequency and magnitude of projected flood events of Lamont Creek are expected to increase due to the projected increase in temperature and precipitation (particularly for winter and spring seasons) and the associated increase in frequency of rain-on-snow events.

Table 13: Timing of Annual Maximum Instantaneous Discharge in Pointe-Aux-Pins Creek near Ardrossan for 1979-2021 Record Period

Month	Number of Years Annual Peak Instantaneous Discharge occurred during Month	Frequency (%)
March	9	23%
April	12	31%
May	4	10%
June	2	5%
July	10	26%
August	2	5%

6.0 CONCLUSIONS

The results of this hydrology assessment support the following conclusions:

- The flood frequency estimates obtained in this study are the most up to date for Lamont Creek and its two tributaries (Tributary A and Tributary B). These estimates provide the updated flood hydrology information as inputs to the other components of the study (e.g., hydraulic modelling).
- This study uses provisional data from GOA to estimate annual maximum instantaneous flows in the absence of published data by WSC particularly for 2021 and 2022. Inclusion of the additional discharge information increases the sample size for flood frequency analyses and reliability of the resulting flood frequency estimates.
- The lengths of time period of the recorded flood flow data available and used in the regional flood frequency analyses are less than 60 years. Therefore, there are large uncertainties (i.e., the confidence intervals are very large) with flood frequency estimates for return periods greater than 100 years.
- The flood magnitudes recommended for hydraulic modelling in the study reach of Lamont Creek till upstream of Tributary B confluence, Tributary B, Tributary A and downstream of Tributary A confluence are the same as those determined by the regional flood frequency analysis. For the study reach of Lamont Creek between Tributary B and Tributary A confluence, the recommended values for hydraulic modelling were derived by summing the flood magnitudes at the confluences and are nominally higher than those determined by regional flood frequency analysis. This method was used to partly simplify the 2D HEC-RAS model since for the 2D HEC-RAS model configuration flows downstream of confluences should match the sum of flows from Lamont Creek and its tributary (i.e., Tributary B).

7.0 CLOSURE

This memorandum was prepared and reviewed by the undersigned.

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Attachments: Appendix A: Graphical and Tabulated Summaries of Flood Flow Series at Gauged Stations
Appendix B: Frequency Analysis – Graphs and Tables

8.0 THIRD PARTY DISCLAIMER

This report has been prepared by WSP Canada Inc. (WSP) for the benefit of the client to whom it is addressed. The information and data contained herein represent WSP's best professional judgment in light of the knowledge and information available to WSP at the time of preparation. Except as required by law, this report and the information and data contained herein are to be treated as confidential and may be used and relied upon only by the client, its officers and employees. WSP denies any liability whatsoever to other parties who may obtain access to this report for any injury, loss or damage suffered by such parties arising from their use of, or reliance upon, this report or any of its contents without the express written consent of WSP and the client.

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9.0 REFERENCES

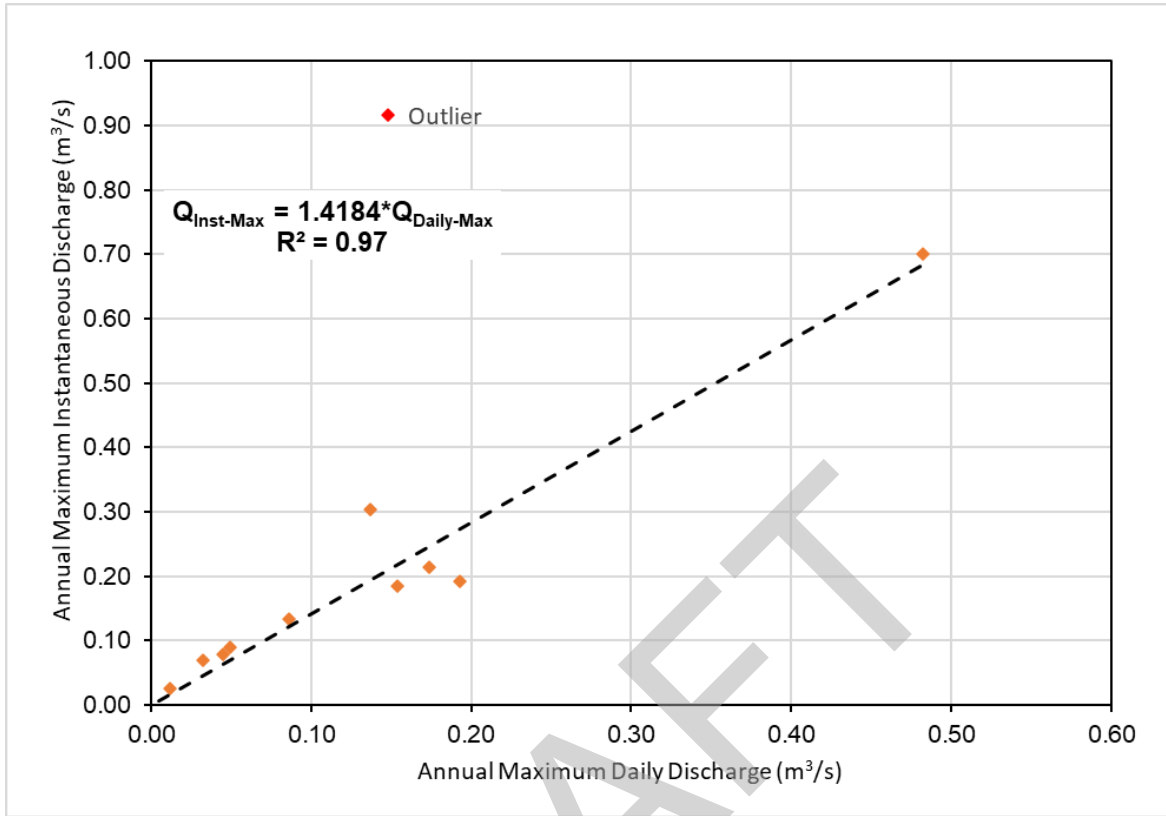
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APPENDIX A

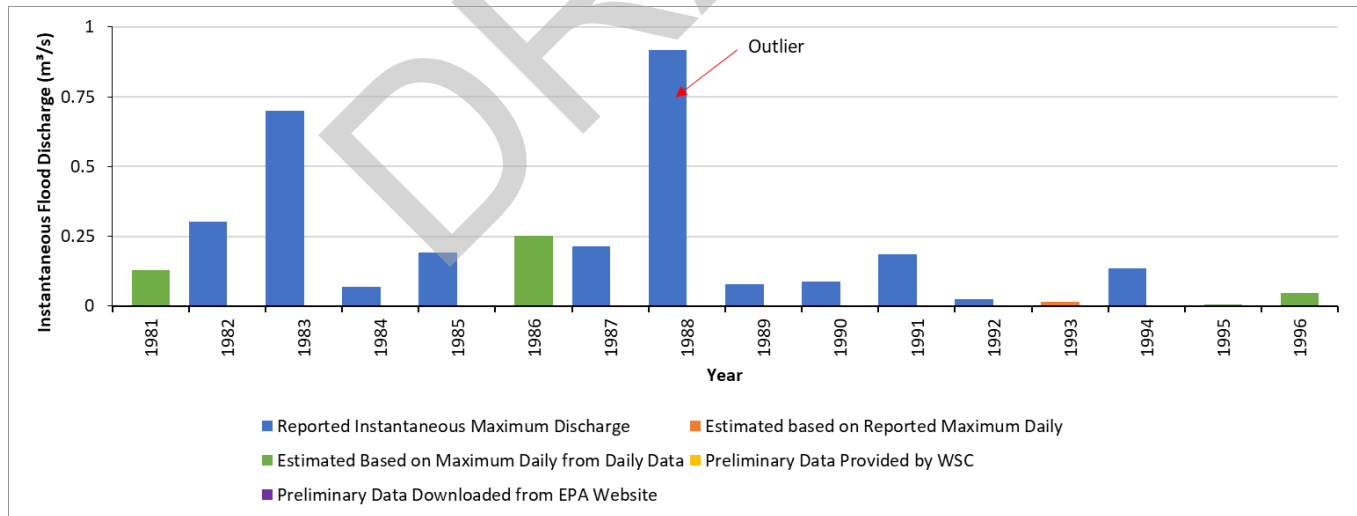
**Graphical and Tabulated Summaries of
Flood Flow Series at Gauged Stations**

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Figure A-1: WSC Station No. 05EB911, Pointe-Aux-Pins Tributary No.3 Near Ardrossan



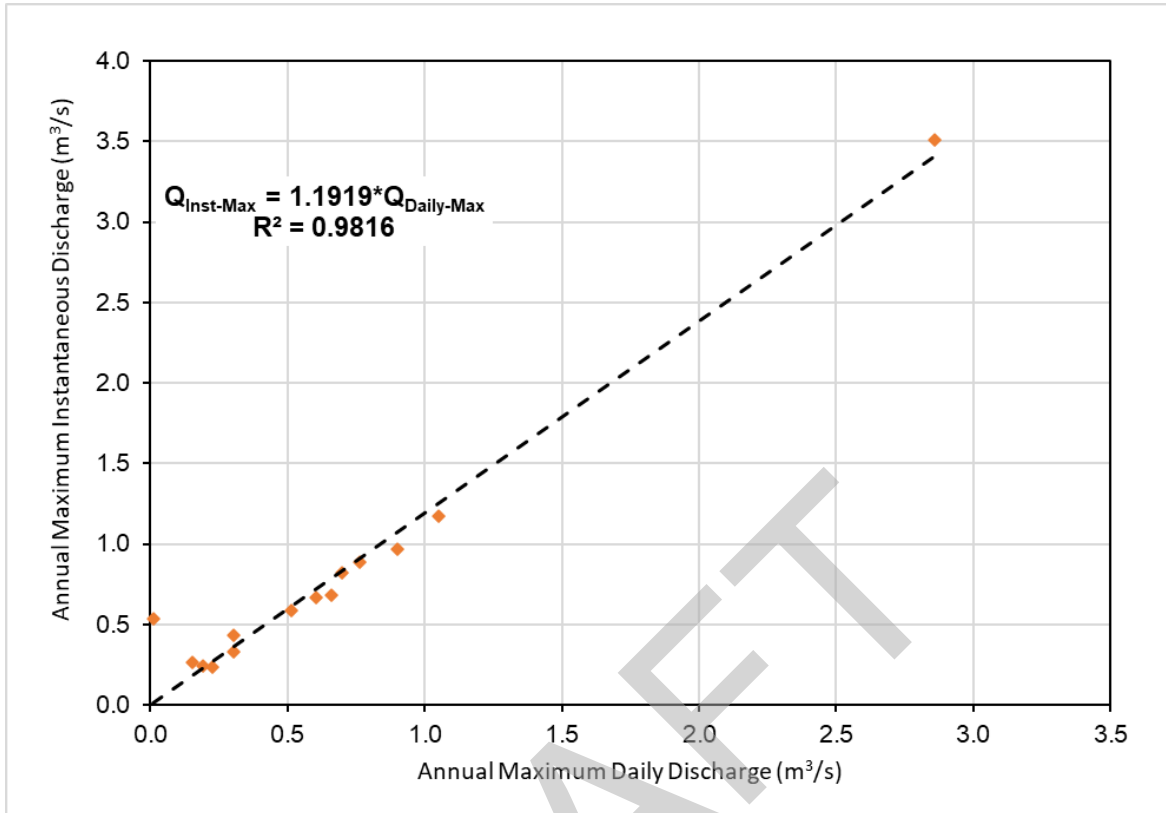
Relationship between Annual Maximum Daily and Annual Maximum Instantaneous Discharge at Pointe-Aux-Pins Tributary No.3 Near Ardrossan (WSC Station No. 05EB911)



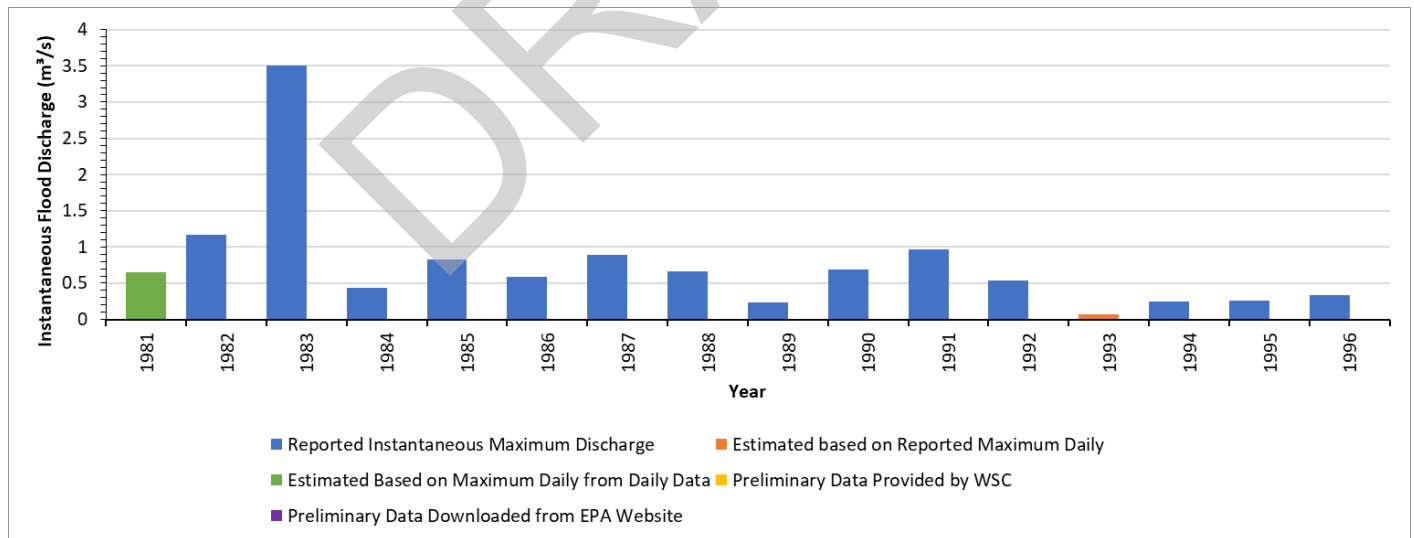
Maximum Instantaneous Flood Flow Series at Pointe-Aux-Pins Tributary No.3 Near Ardrossan (WSC Station No. 05EB911)

Note: The 1988 flood was excluded when developing the relationship between annual maximum instantaneous and annual maximum daily discharges as it skewed the relationship towards the most extreme floods. WSC has not provided cautionary remarks on using the 1988 instantaneous discharge in its online database. Therefore, although it was excluded from the development of the relationship, the 1988 annual maximum instantaneous discharge was still used when performing flood frequency analysis.

Figure A-2: WSC Station No. 05EB909, Pointe-Aux-Pins Tributary No.1 Near Ardrossan

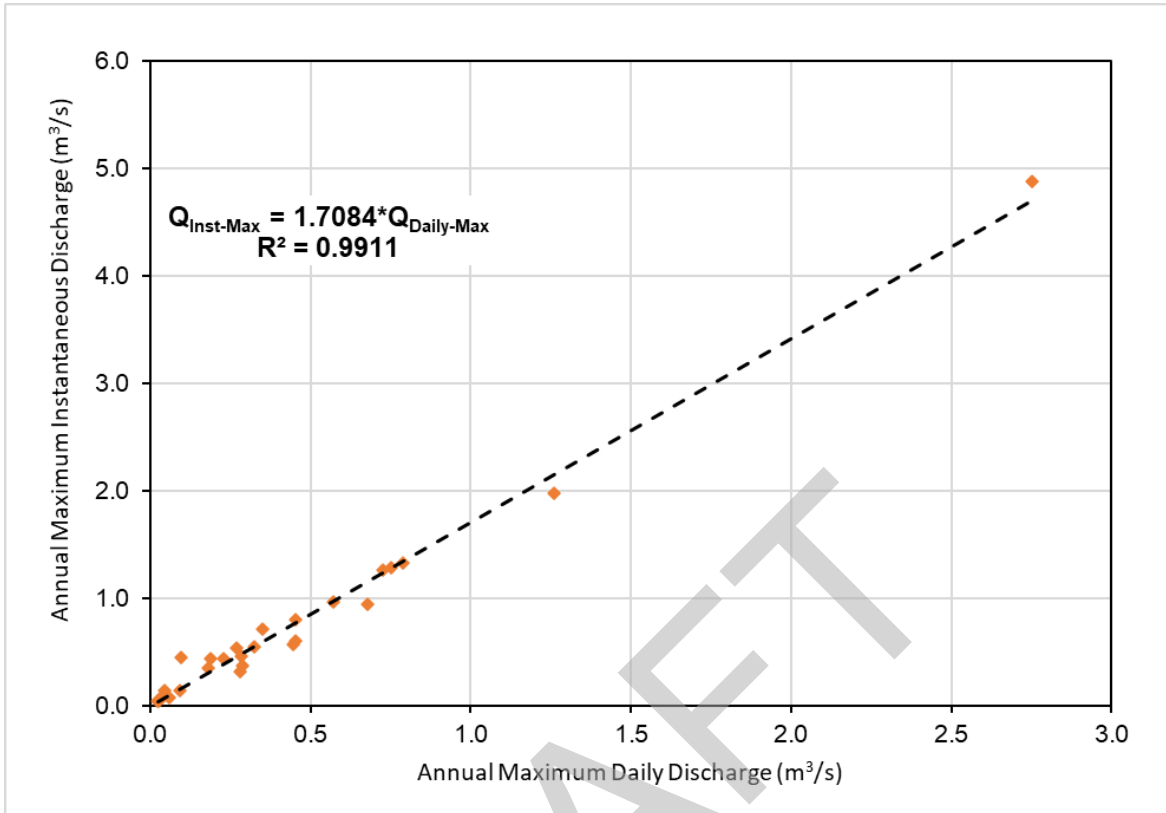


Relationship between Annual Maximum Daily and Annual Maximum Instantaneous Discharge at Pointe-Aux-Pins Tributary No.1 Near Ardrossan (WSC Station No. 05EB909)

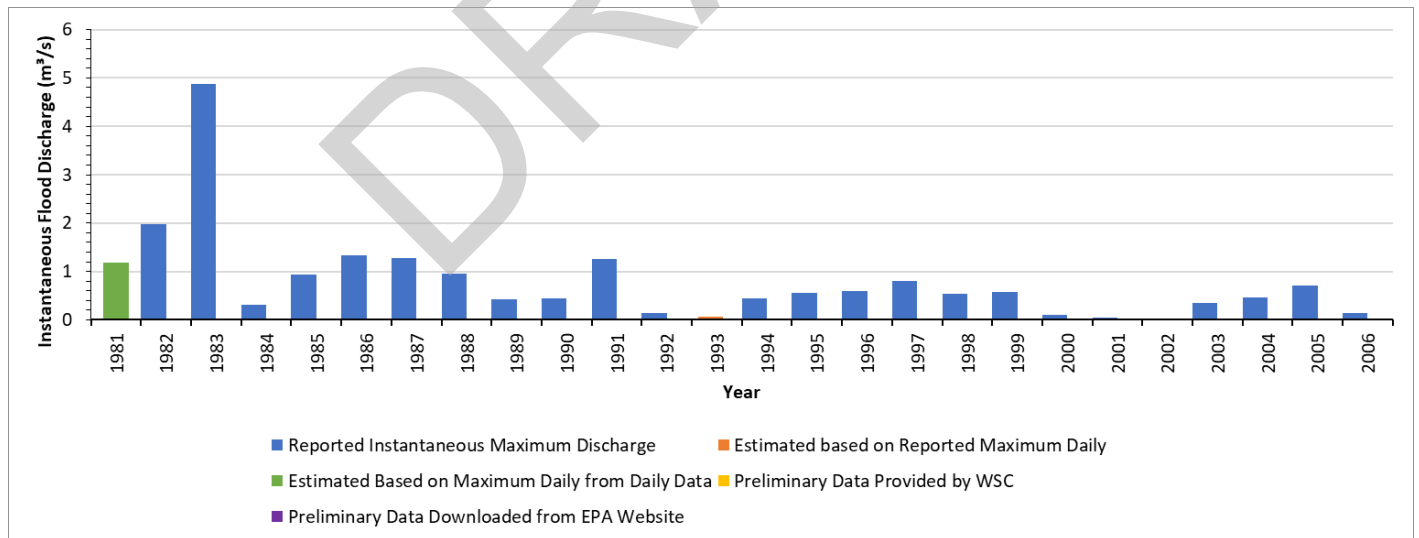


Maximum Instantaneous Flood Flow Series at Pointe-Aux-Pins Tributary No.3 Near Ardrossan (WSC Station No. 05EB909)

Figure A-3: WSC Station No. 05EB910, Pointe-Aux-Pins Tributary No.2 Near Ardrossan

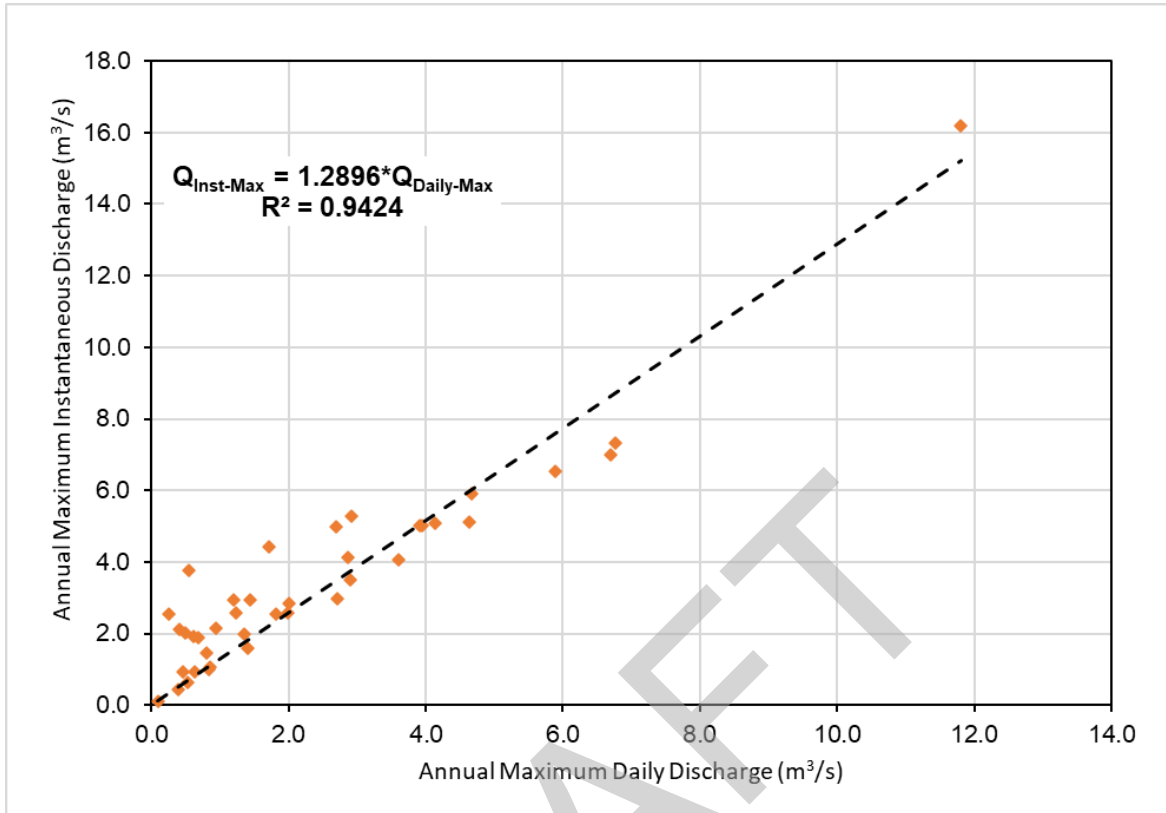


Relationship between Annual Maximum Daily and Annual Maximum Instantaneous Discharge at Pointe-Aux-Pins Tributary No.2 Near Ardrossan (WSC Station No. 05EB910)

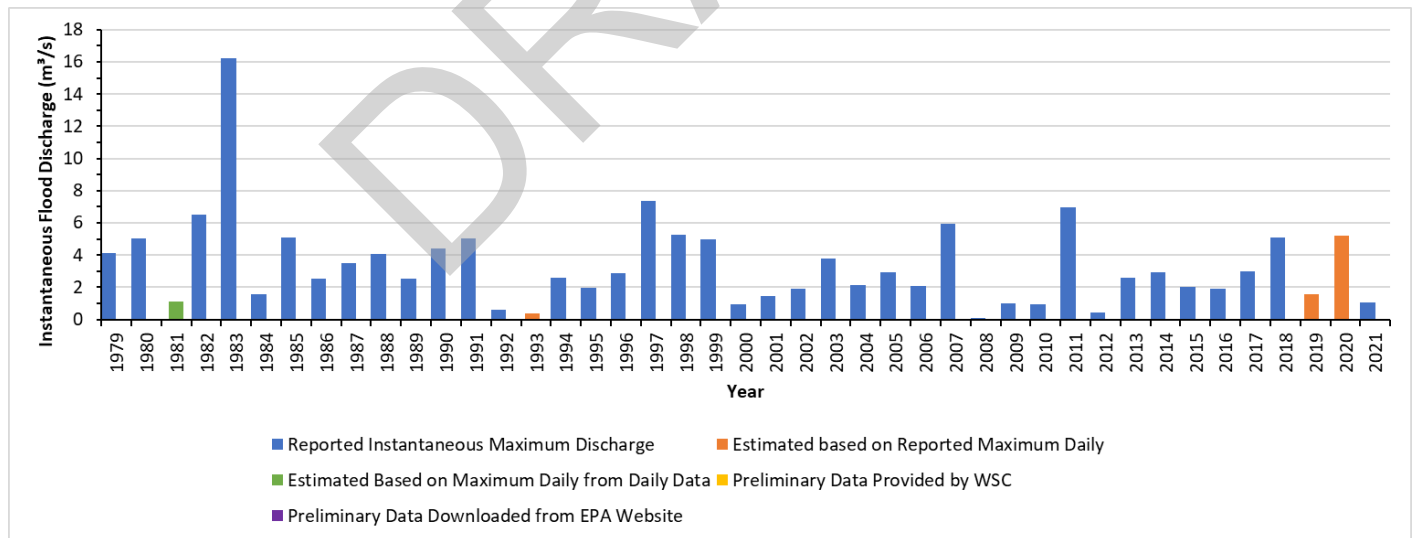


Maximum Instantaneous Flood Flow Series at Pointe-Aux-Pins Tributary No.2 Near Ardrossan (WSC Station No. 05EB910)

Figure A-4: WSC Station No. 05EB902, Pointe-Aux-Pins Near Ardrossan

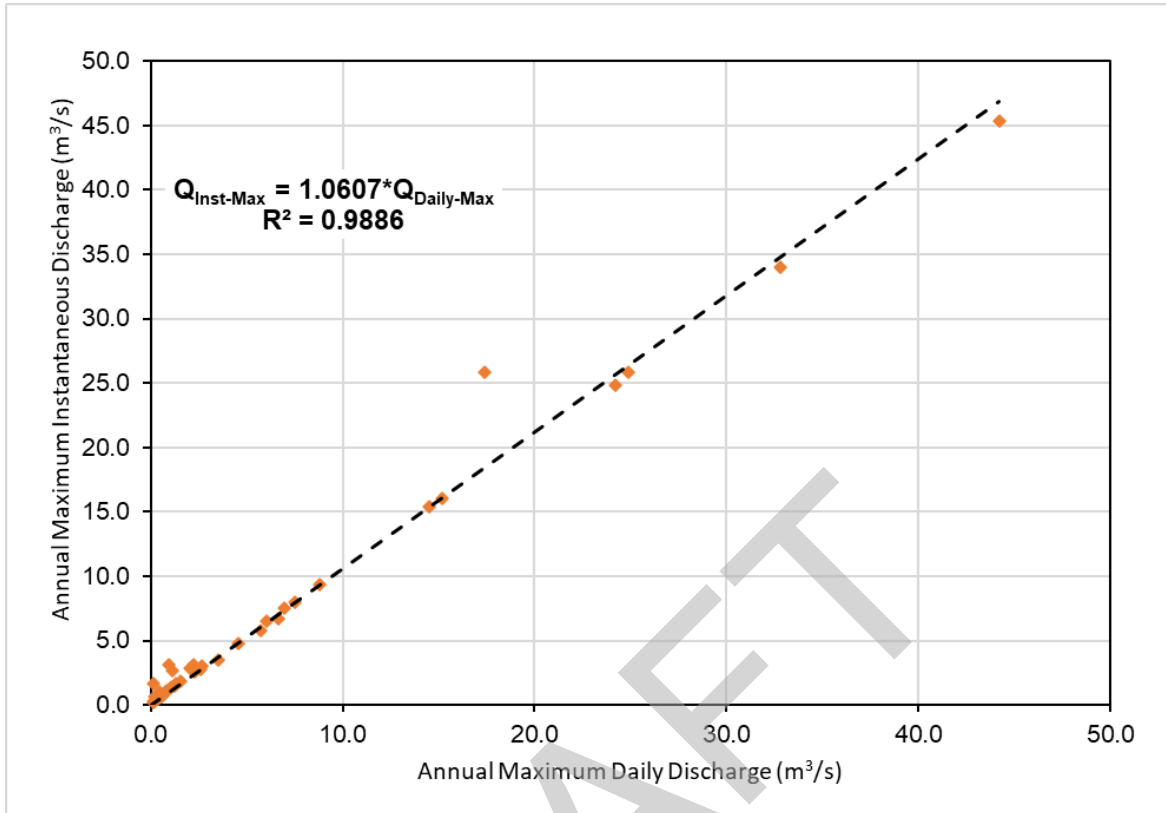


Relationship between Annual Maximum Daily and Annual Maximum Instantaneous Discharge at Pointe-Aux-Pins Near Ardrossan (WSC Station No. 05EB902)

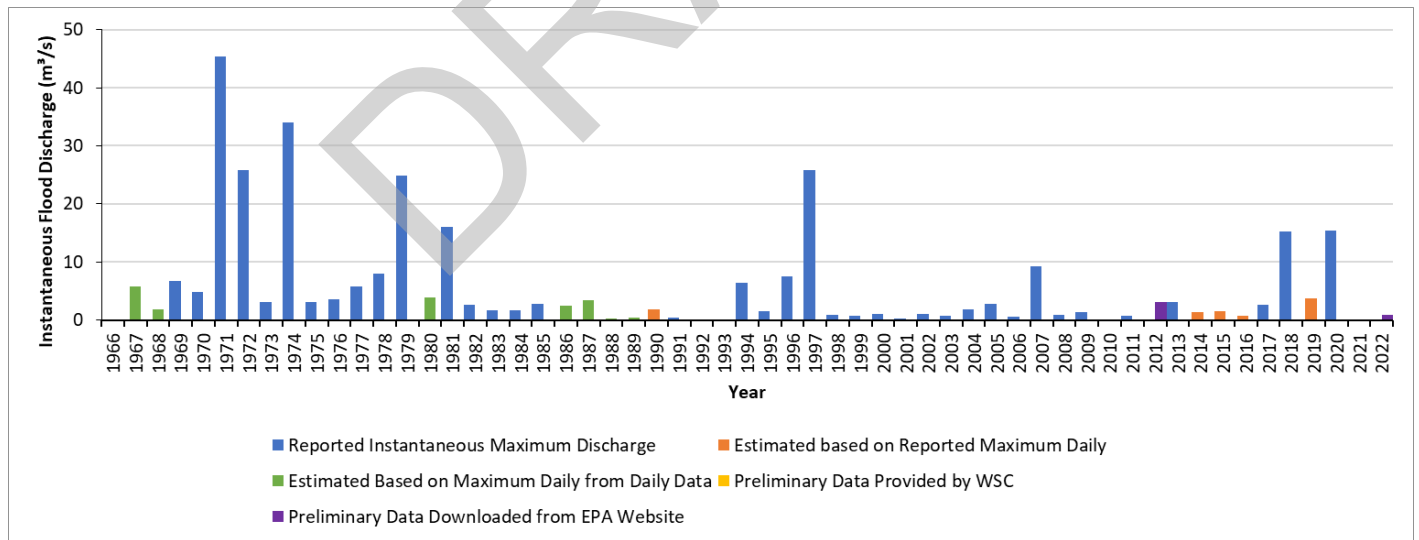


Maximum Instantaneous Flood Flow Series at Pointe-Aux-Pins Near Ardrossan (WSC Station No. 05EB902)

Figure A-5: WSC Station No. 05EC002, Waskatenau Creek near Waskatenau

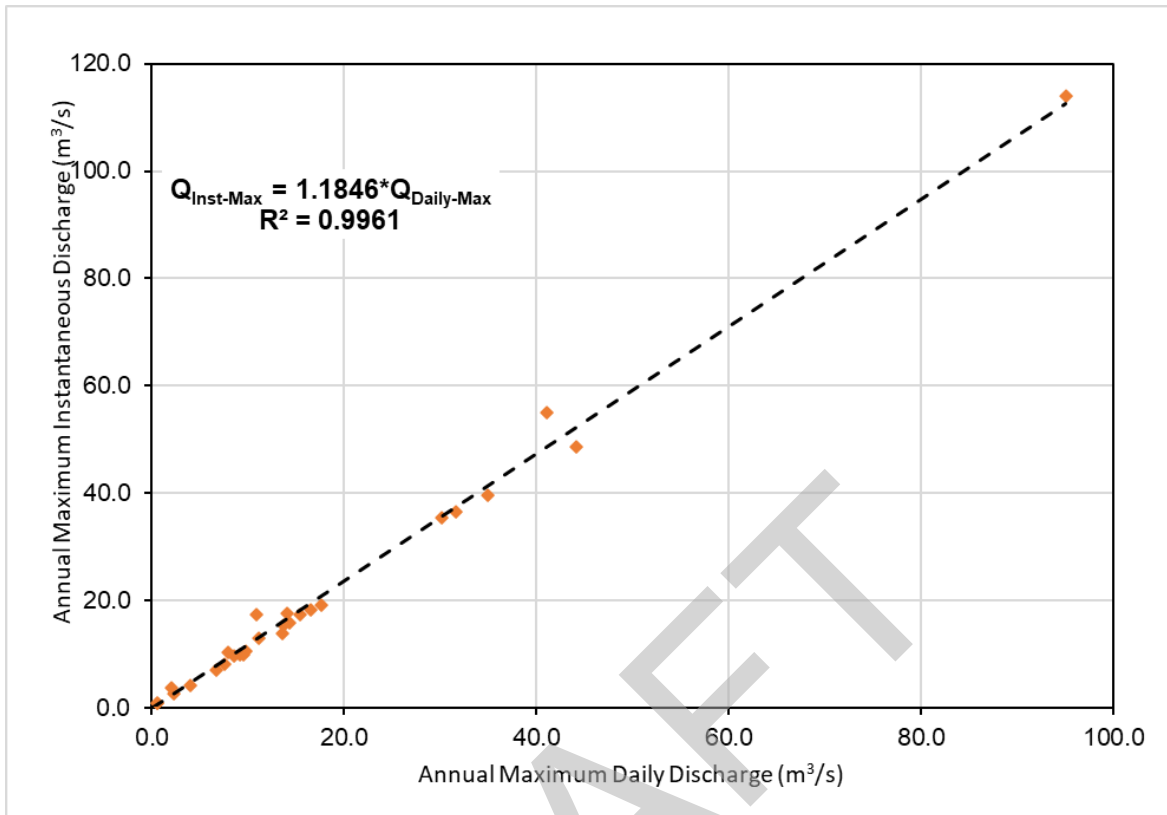


Relationship between Annual Maximum Daily and Annual Maximum Instantaneous Discharge at Waskatenau Creek near Waskatenau (WSC Station No. 05EC002)

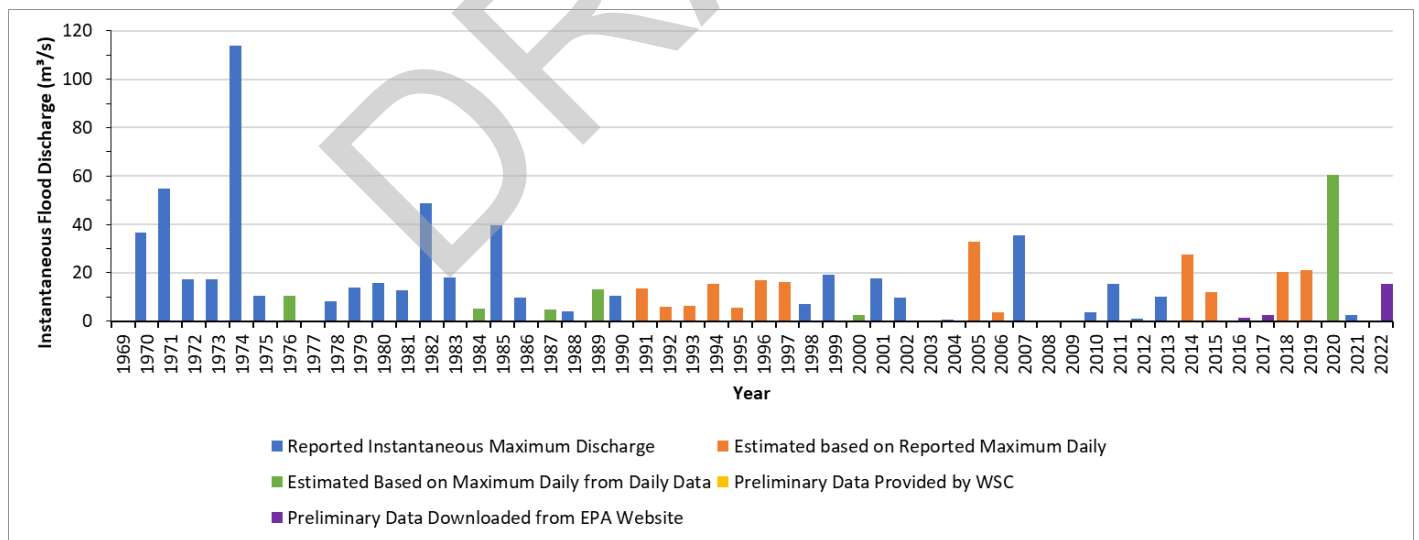


Maximum Instantaneous Flood Flow Series at Waskatenau Creek near Waskatenau (WSC Station No. 05EC002)

Figure A-6: WSC Station No. 05DF006, Whitemud Creek near Ellerslie

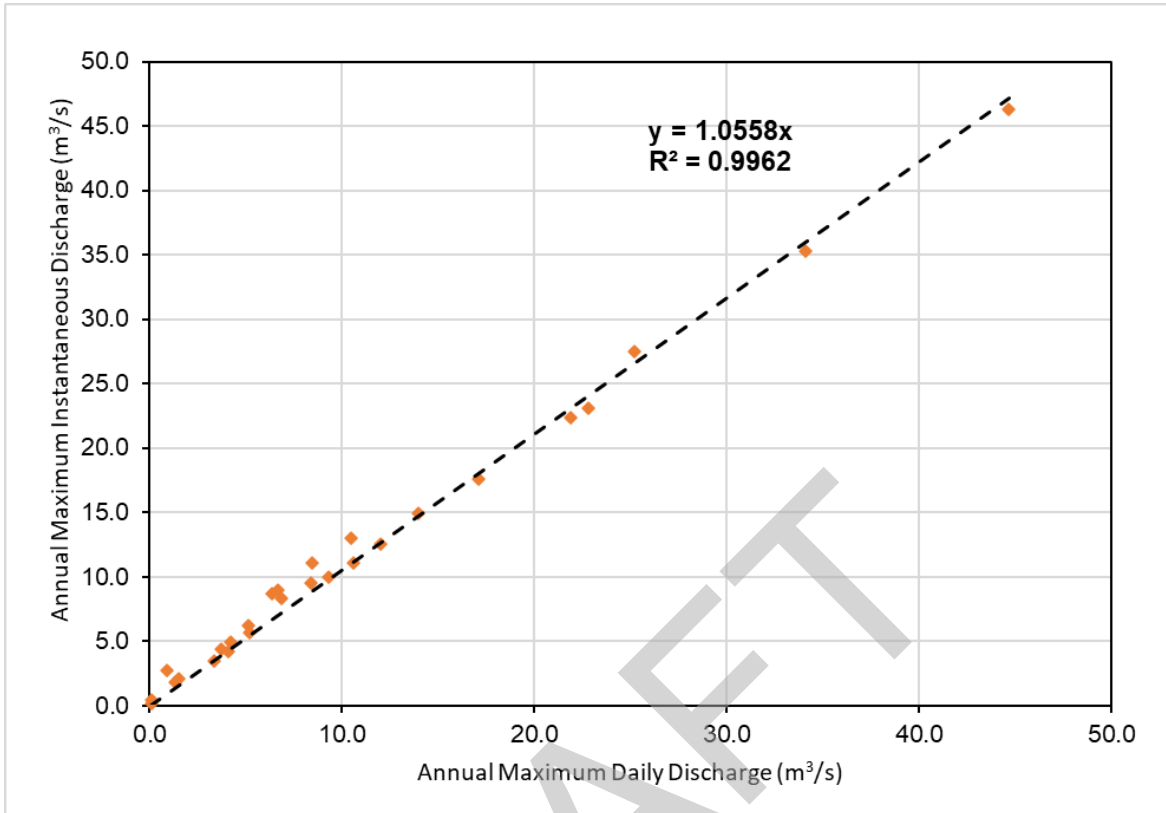


Relationship between Annual Maximum Daily and Annual Maximum Instantaneous Discharge at Whitemud Creek near Ellerslie (WSC Station No. 05DF006)

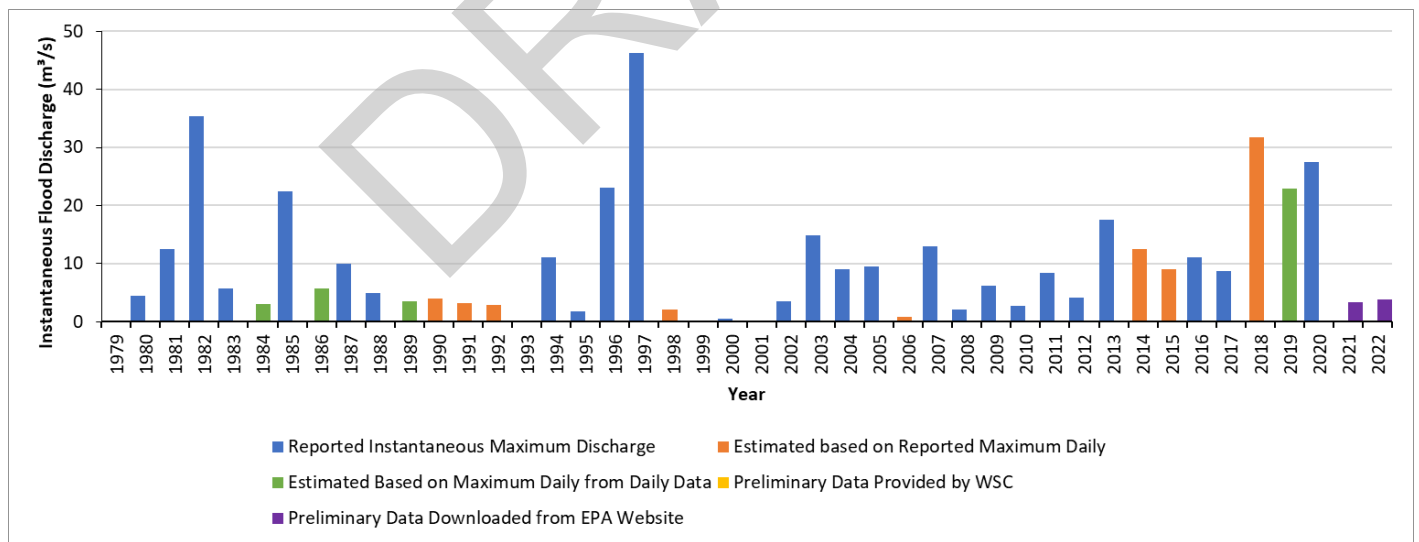


Maximum Instantaneous Flood Flow Series at Whitemud Creek near Ellerslie (WSC Station No. 05DF006)

Figure A-7: WSC Station No. 07BC007, Wabash Creek near Pibroch



Relationship between Annual Maximum Daily and Annual Maximum Instantaneous Discharge at Wabash Creek near Pibroch (WSC Station No. 07BC007)



Maximum Instantaneous Flood Flow Series at Wabash Creek near Pibroch (WSC Station No. 07BC007)

Table A-1: Data used for Flood Frequency Analysis

Year	WSC Station No. 05EB911, Pointe-Aux-Pins Tributary No.3 near Ardrossan	WSC Station No. 05EB909, Pointe-Aux-Pins Tributary No.1 near Ardrossan	WSC Station No. 05EB910, Pointe-Aux-Pins Tributary No.2 near Ardrossan	WSC Station No. 05EB902, Pointe-Aux-Pins near Ardrossan	WSC Station No. 05EC002, Waskatenau Creek near Waskatenau	WSC Station No. 05DF006, Whitemud Creek near Ellerslie	WSC Station No. 07BC007, Wabash Creek near Pibroch
	Effective Drainage Area (km ²)						
	3.55	6.74	8.1	63.2	207	301	344
Annual Maximum Instantaneous Discharge (m ³ /s)							
1966	-	-	-	-	-	-	-
1967	-	-	-	-	5.77	-	-
1968	-	-	-	-	1.87	-	-
1969	-	-	-	-	6.74	-	-
1970	-	-	-	-	4.76	36.50	-
1971	-	-	-	-	45.30	54.90	-
1972	-	-	-	-	25.80	17.40	-
1973	-	-	-	-	3.14	17.30	-
1974	-	-	-	-	34.00	114.00	-
1975	-	-	-	-	3.06	10.30	-
1976	-	-	-	-	3.54	10.40	-
1977	-	-	-	-	5.83	-	-
1978	-	-	-	-	8.01	8.07	-
1979	-	-	-	4.13	24.80	13.80	-
1980	-	-	-	5.03	3.95	15.80	4.37
1981	0.129	0.648	1.191	1.11	16.00	12.90	12.50
1982	0.303	1.170	1.980	6.52	2.58	48.60	35.30
1983	0.700	3.510	4.880	16.20	1.69	18.20	5.63
1984	0.069	0.434	0.317	1.59	1.70	5.06	2.95
1985	0.193	0.822	0.940	5.09	2.74	39.70	22.40
1986	0.252	0.586	1.330	2.54	2.41	9.75	5.69
1987	0.215	0.891	1.280	3.49	3.40	4.90	9.96
1988	0.916	0.670	0.960	4.06	0.27	4.15	4.90
1989	0.079	0.238	0.433	2.53	0.35	13.03	3.55
1990	0.089	0.683	0.450	4.43	1.87	10.60	3.96
1991	0.185	0.968	1.260	5.02	0.34	13.39	3.15
1992	0.025	0.539	0.135	0.62	-	5.92	2.81
1993	0.014	0.068	0.070	0.36	-	6.17	0.19
1994	0.134	0.243	0.440	2.57	6.48	15.28	11.10
1995	0.007	0.264	0.552	1.98	1.51	5.63	1.80
1996	0.045	0.334	0.599	2.85	7.51	16.94	23.10
1997	-	-	0.799	7.34	25.80	16.11	46.30
1998	-	-	0.535	5.28	0.94	7.14	2.11
1999	-	-	0.571	4.97	0.70	19.10	-
2000	-	-	0.095	0.93	1.07	2.59	0.48

Table A-1: Data used for Flood Frequency Analysis

Year	WSC Station No. 05EB911, Pointe-Aux-Pins Tributary No.3 near Ardrossan	WSC Station No. 05EB909, Pointe-Aux-Pins Tributary No.1 near Ardrossan	WSC Station No. 05EB910, Pointe-Aux-Pins Tributary No.2 near Ardrossan	WSC Station No. 05EB902, Pointe-Aux-Pins near Ardrossan	WSC Station No. 05EC002, Waskatenau Creek near Waskatenau	WSC Station No. 05DF006, Whitemud Creek near Ellerslie	WSC Station No. 07BC007, Wabash Creek near Pibroch
	Effective Drainage Area (km ²)						
	3.55	6.74	8.1	63.2	207	301	344
Annual Maximum Instantaneous Discharge (m ³ /s)							
2001	-	-	0.053	1.47	0.20	17.50	0.17
2002	-	-	0.037	1.89	1.11	9.91	3.46
2003	-	-	0.349	3.78	0.70	-	14.90
2004	-	-	0.457	2.14	1.86	0.79	8.94
2005	-	-	0.709	2.95	2.82	32.81	9.55
2006	-	-	0.140	2.10	0.51	3.53	0.74
2007	-	-	0.375	5.92	9.32	35.50	13.00
2008	-	-	0.036	0.12	0.80	0.35	2.08
2009	-	-	0.074	0.99	1.38	0.20	6.19
2010	-	-	-	0.92	-	3.73	2.78
2011	-	-	-	6.98	0.68	15.30	8.33
2012	-	-	-	0.44	3.131	0.98	4.18
2013	-	-	-	2.59	3.11	10.00	17.60
2014	-	-	-	2.94	1.30	27.36	12.46
2015	-	-	-	2.01	1.53	11.85	9.07
2016	-	-	-	1.91	0.78	1.25	11.10
2017	-	-	-	2.96	2.69	2.55	8.73
2018	-	-	-	5.10	15.20	20.26	31.67
2019	-	-	-	1.55	3.72	21.09	22.91
2020	-	-	-	5.18	15.40	60.41	27.50
2021	-	-	-	1.05	2.85	2.56	3.26
2022	-	-	-	-	0.87	15.36	3.86

Note:

“-” indicates no annual maximum instantaneous discharge data was available for that year.

Table A-2: Statistical Analysis of Regional Stations used in Flood Frequency Analysis

WSC Station ID	05EB911	05EB909	05EB910	05EB902	05EC002	05DF006	07BC007
WSC Station Name or Location of Interest	Pointe-Aux-Pins Tributary No.3 Near Ardrossan	Pointe-Aux-Pins Tributary No.1 Near Ardrossan	Pointe-Aux-Pins Tributary No.2 Near Ardrossan	Pointe-Aux-Pins Near Ardrossan	Waskatenau Creek near Waskatenau	Whitemud Creek near Ellerslie	Wabash Creek near Pibroch
Anderson-Darling statistic $A^2 = -N -S$							
3 Parameter Log-normal	0.207	0.341	0.715	0.275	0.248	0.373	0.247
Extreme Value	0.173	0.308	0.417	0.262	0.782	0.305	0.396
Log_Pearson III	0.185	0.399	0.465	0.777	0.215	1.051	0.395
Weibull	0.600	1.061	3.683	7.657	4.227	4.355	0.711
Serial correlation coefficient test for independence							
S1	0.2857	0.3107	0.5151	-0.0920	0.3544	-0.0242	0.1386
t	1.0750	1.1786	3.0639	-0.5841	2.6801	-0.1681	0.8740
t(a=0.05)	1.7709	1.7709	1.7056	-1.6839	1.6759	-1.6772	1.6849
t(a=0.01)	2.6503	2.6503	2.4786	-2.4233	2.4033	-2.4066	2.4258
Spearman rank order correlation coefficient test for trend							
rs	0.6147	0.6029	0.6414	0.2150	0.3664	0.2539	-0.1240
t	2.9160	2.8278	4.3438	1.4099	2.8119	1.8378	-0.7902
t(a=0.05)	2.1448	2.1448	2.0518	2.0195	2.0076	2.0096	-2.0211
t(a=0.01)	2.9768	2.9768	2.7707	2.7012	2.6757	2.6800	-2.7045
Mann-Whitney split sample test for homogeneity							
Size of earlier sample	8	8	15	22	27	26	21
z	-2.7305	-2.2054	-2.4004	-1.4821	-2.1618	-1.3566	-1.2327
z(a=0.05)				-1.6449	-1.6449	-1.6449	-1.6449
z(a=0.01)	8	8	15	-2.3263	-2.3263	-2.3263	-2.3263
Test of general randomness (Runs for above or below the median)							
Median	0.1	0.6	0.5	2.6	2.7	12.9	5.9
N1(for Q>=Median)	8	8	15	22	27	26	21
N2(for Q<Median)	8	8	14	21	26	25	21
Run_ab	9	8	10	26	20	29	21
z	0.0000	0.5175	2.0762	1.0846	2.0786	0.7103	0.3124
z(a=0.05)				1.9600	1.9600	1.9600	1.9600
z(a=0.01)				2.5758	2.5758	2.5758	2.5758

Notes:

1. Selected distribution based on best statistical fit and inspection of frequency plots 0.173.
2. Criteria for the respective statistical tests were not met 2.1448.

APPENDIX B

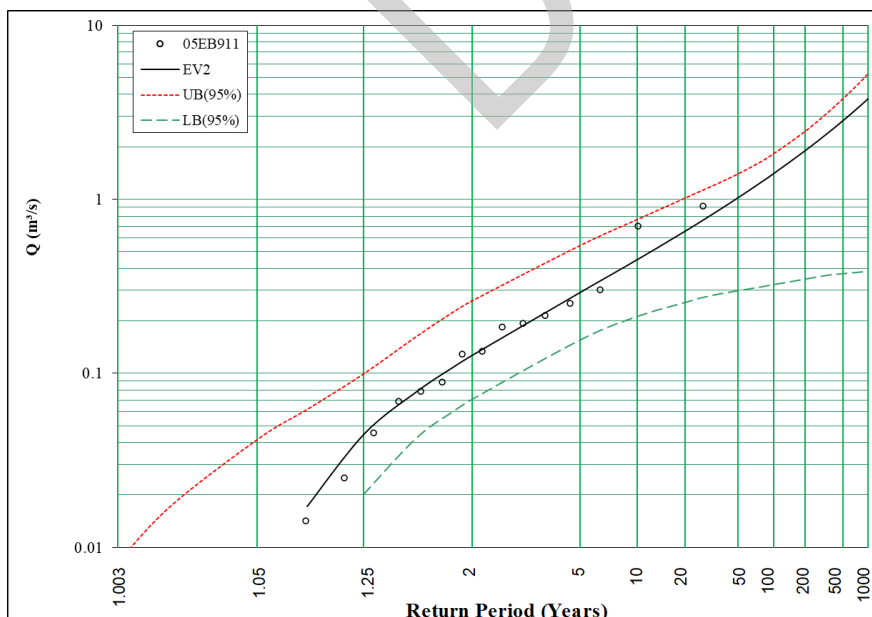
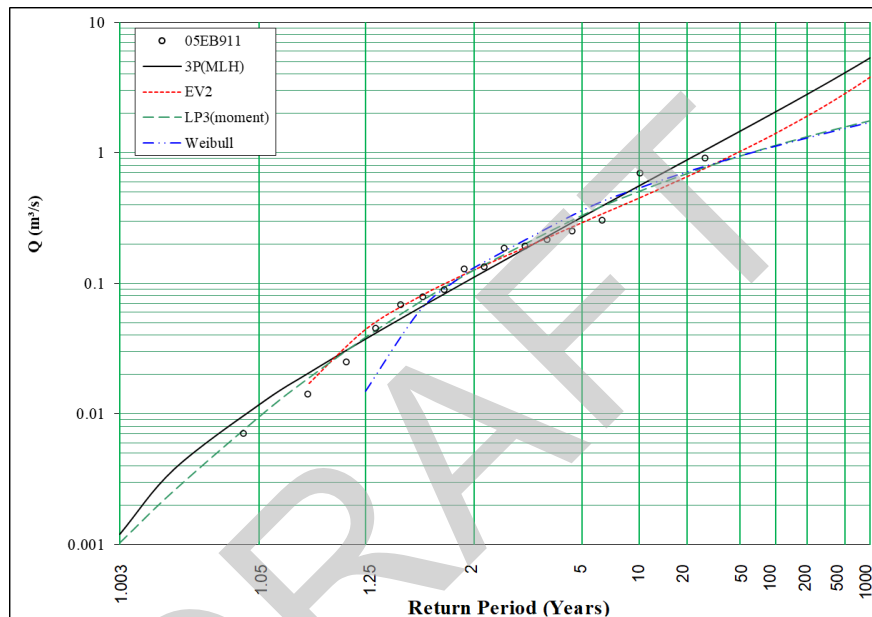
Frequency Analysis – Graphs and Tables

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This appendix includes the graphs and results from the frequency analysis of the compiled/derived maximum instantaneous flood flow series at the gauged stations that were used for regional flood frequency analysis. For each flood flow series, the following information is presented:

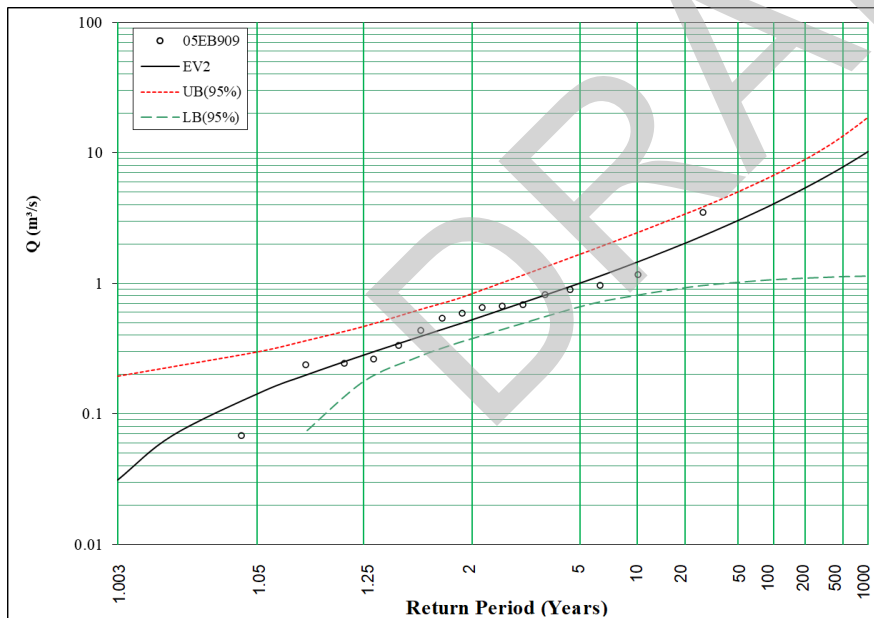
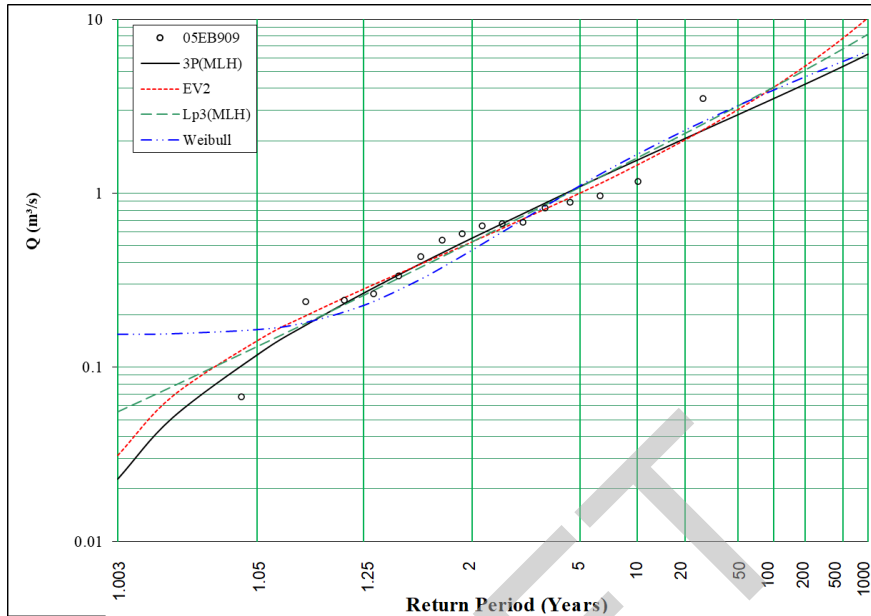
- Frequency distribution graph – all distributions
- Frequency distribution graph – best fit graph with confidence intervals; and
- Flood flow estimates – all distributions.

Figure B-1: WSC Station No. 05EB911 Pointe-Aux-Pins Tributary No.3 Near Ardrossan



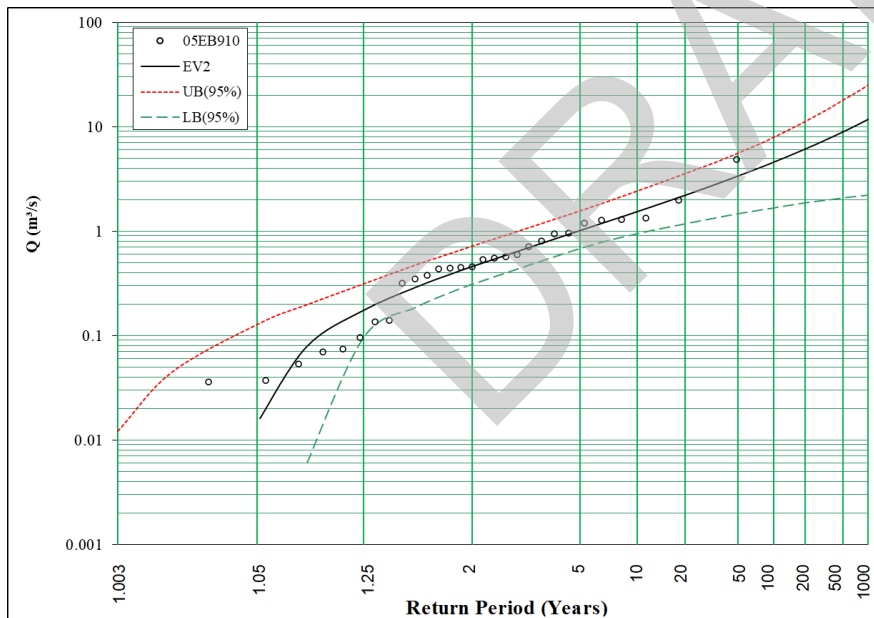
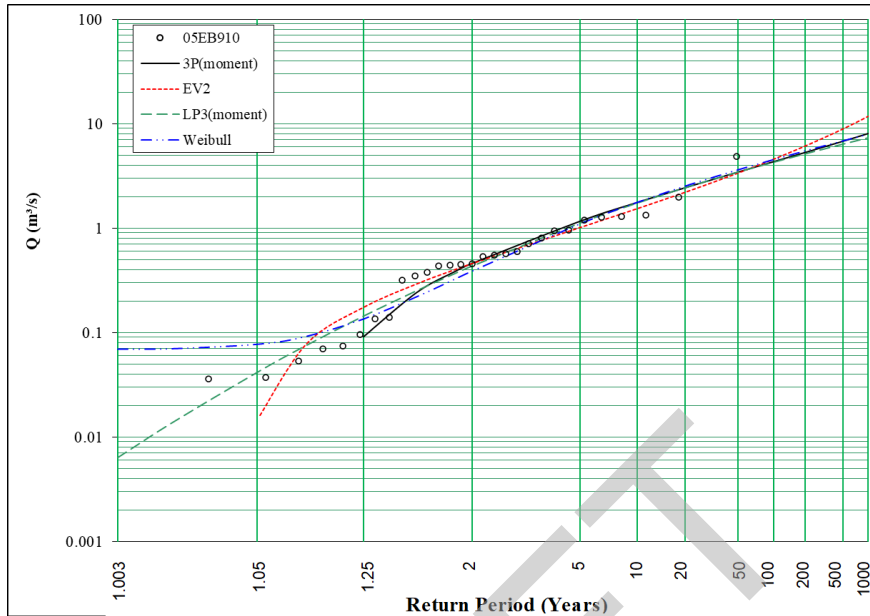
Return Period	3P (MLH)	EV2	LP3 (Moment)	Weibull
2	0.111	0.127	0.127	0.132
5	0.322	0.293	0.332	0.362
10	0.559	0.452	0.508	0.537
20	0.880	0.656	0.693	0.713
35	1.21	0.866	0.848	0.856
50	1.47	1.03	0.947	0.947
75	1.80	1.24	1.06	1.05
100	2.06	1.41	1.14	1.12
200	2.81	1.91	1.33	1.30
350	3.55	2.43	1.48	1.44
500	4.09	2.83	1.58	1.54
750	4.79	3.36	1.69	1.64
1,000	5.33	3.79	1.76	1.71

Figure B-2: WSC Station No. 05EB909, Pointe-Aux-Pins Tributary No.1 Near Ardrossan



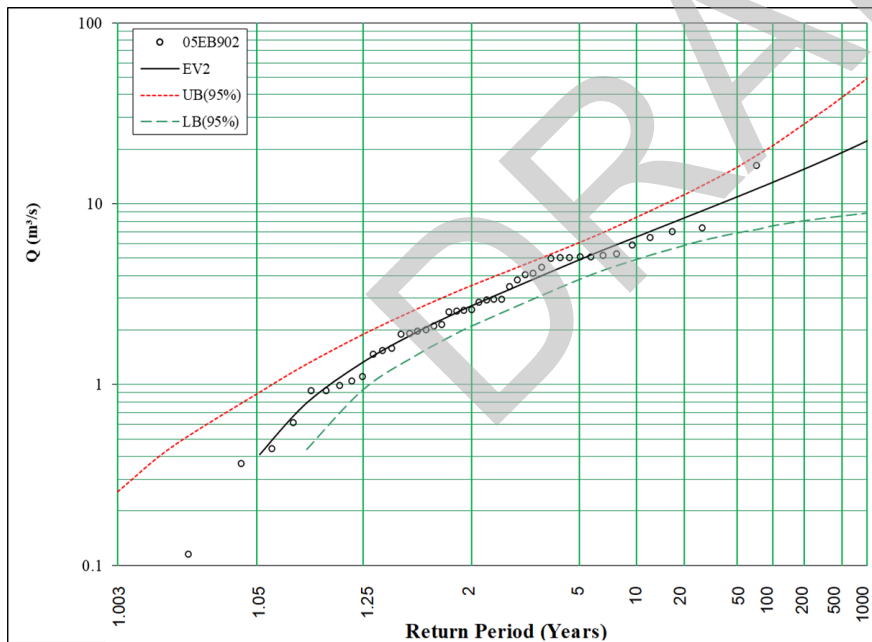
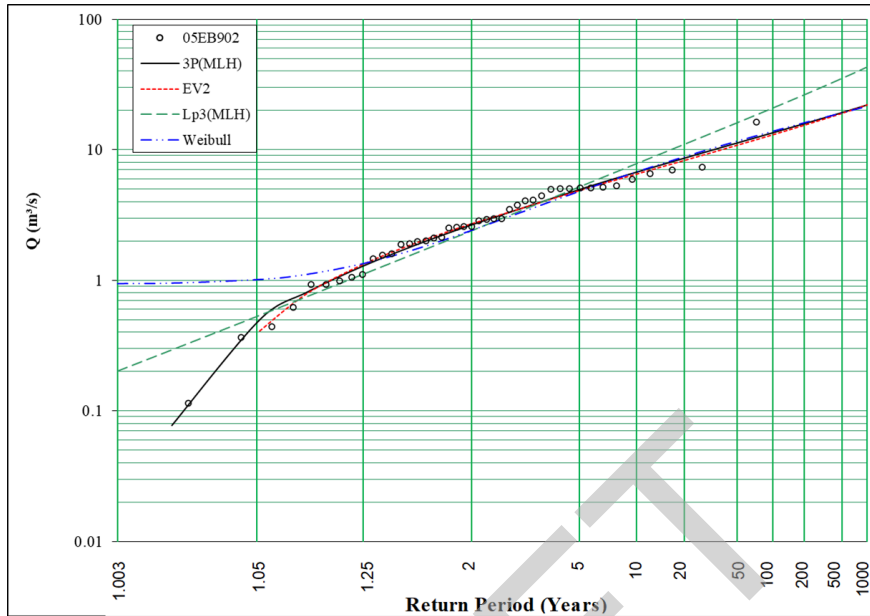
Return Period	3P(MLH)	EV2	LP3 (Moment)	Weibull
2	0.552	0.527	0.526	0.472
5	1.09	1.01	1.08	1.11
10	1.55	1.46	1.59	1.68
20	2.06	2.03	2.20	2.30
35	2.52	2.60	2.77	2.84
50	2.83	3.04	3.17	3.20
75	3.21	3.60	3.68	3.62
100	3.49	4.06	4.06	3.92
200	4.24	5.39	5.10	4.68
350	4.90	6.75	6.06	5.31
500	5.35	7.78	6.73	5.73
750	5.89	9.12	7.56	6.21
1,000	6.29	10.2	8.19	6.55

Figure B-3: WSC Station No. 05EB910, Pointe-Aux-Pins Tributary No.2 Near Ardrossan



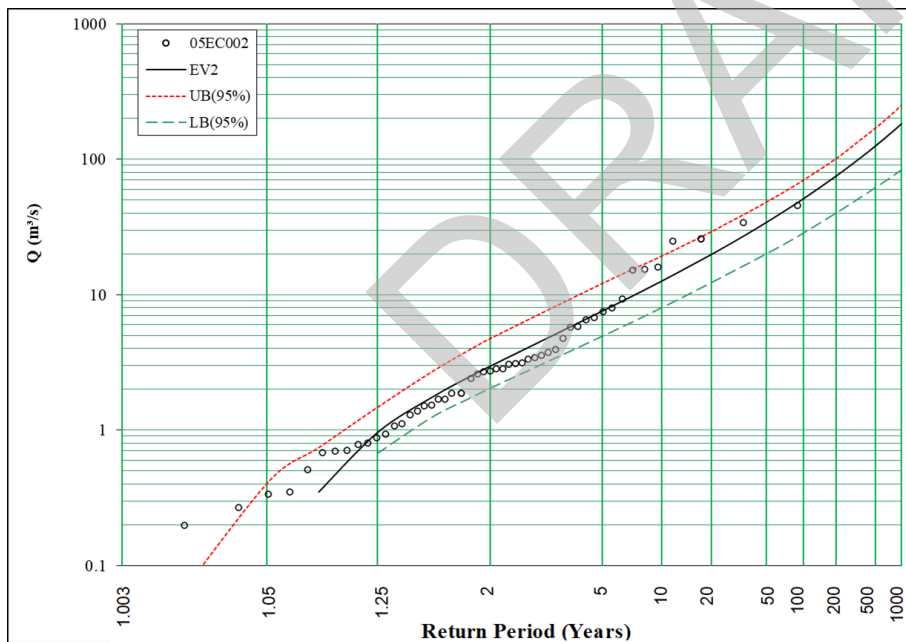
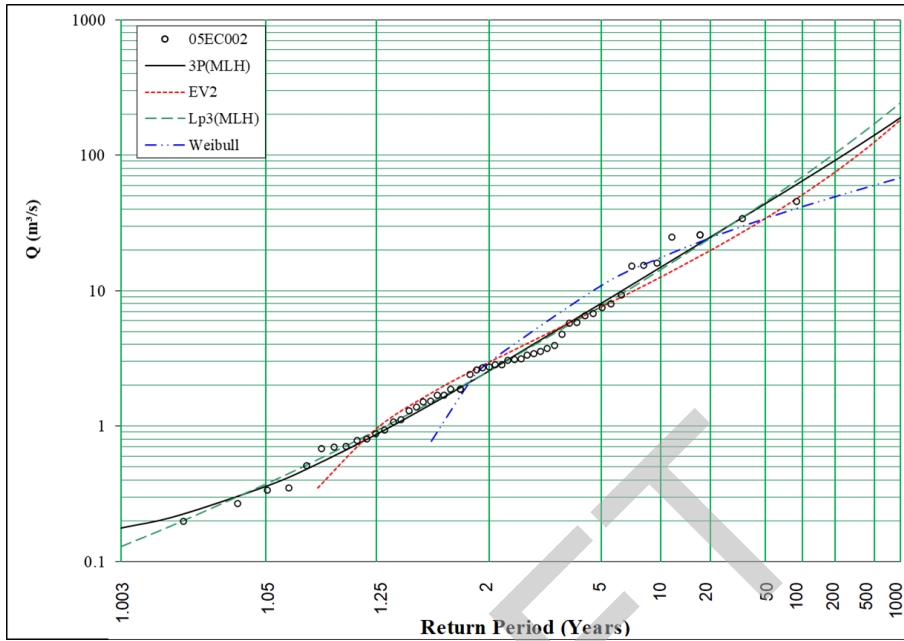
Return Period	3P (Moment)	EV2	LP3 (Moment)	Weibull
2	0.460	0.460	0.434	0.388
5	1.16	1.02	1.12	1.10
10	1.76	1.54	1.74	1.77
20	2.42	2.21	2.44	2.52
35	3.02	2.88	3.04	3.17
50	3.43	3.39	3.45	3.62
75	3.93	4.06	3.93	4.14
100	4.31	4.59	4.28	4.52
200	5.28	6.15	5.16	5.48
350	6.15	7.75	5.89	6.29
500	6.74	8.95	6.38	6.82
750	7.46	10.5	6.93	7.44
1,000	7.99	11.8	7.33	7.89

Figure B-4: WSC Station No. 05EB902, Pointe-Aux-Pins Near Ardrossan



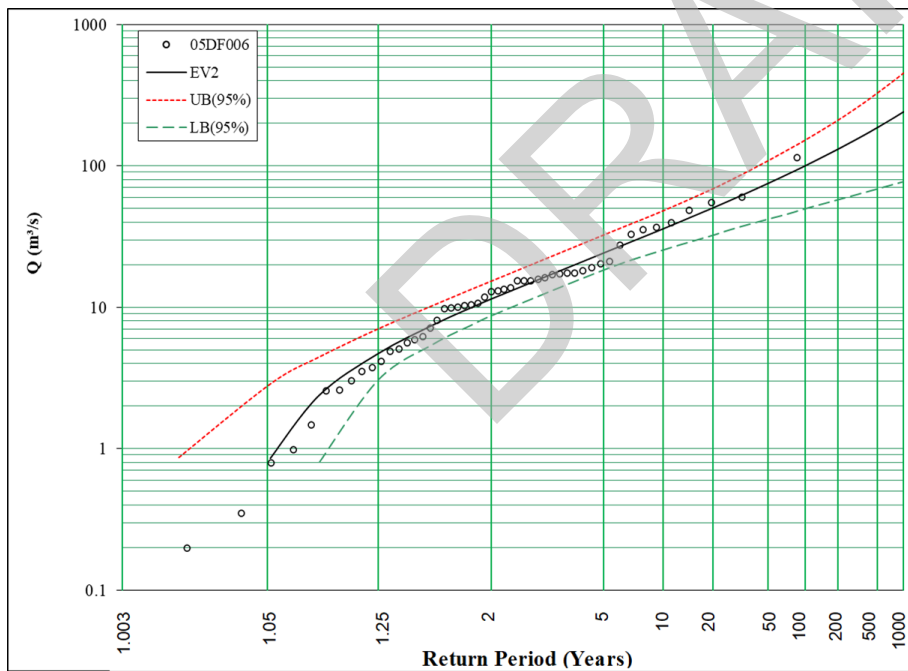
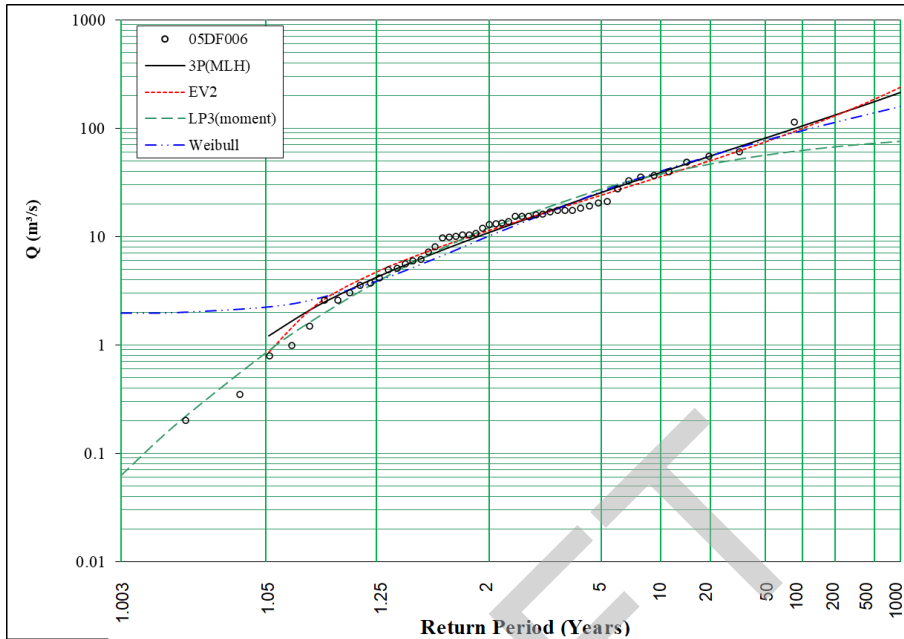
Return Period	3P(MLH)	EV2	LP3 (MLH)	Weibull
2	2.66	2.72	2.39	2.41
5	4.96	4.89	5.19	4.81
10	6.72	6.54	7.80	6.78
20	8.59	8.31	11.0	8.84
35	10.2	9.85	13.9	10.6
50	11.3	10.9	16.1	11.7
75	12.5	12.1	18.7	13.0
100	13.4	13.1	20.8	13.9
200	15.8	15.5	26.3	16.1
350	17.8	17.6	31.4	18.0
500	19.2	19.1	35.0	19.2
750	20.8	20.8	39.5	20.6
1,000	21.9	22.2	42.9	21.6

Figure B-5: WSC Station No. 05EC002, Waskatenau Creek near Waskatenau



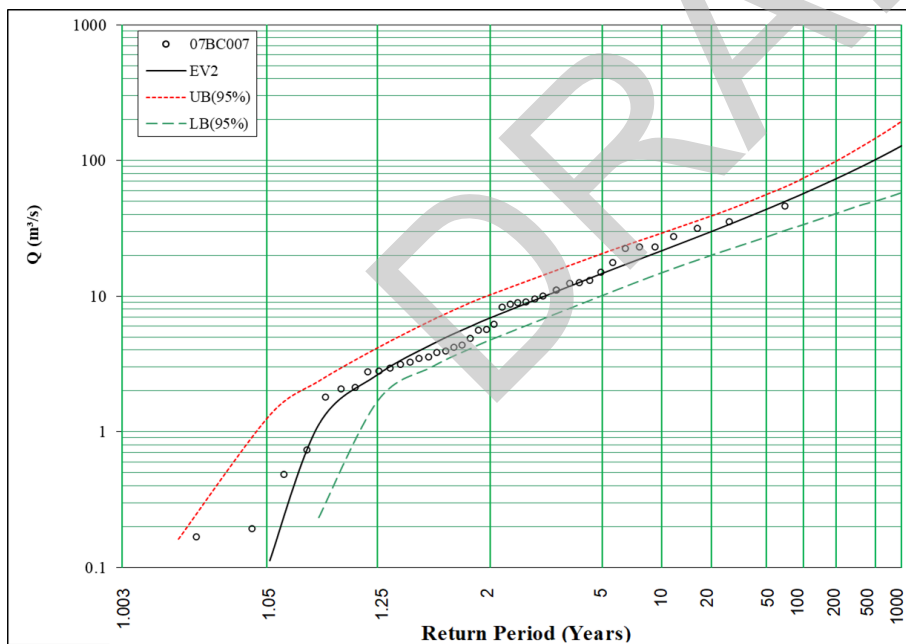
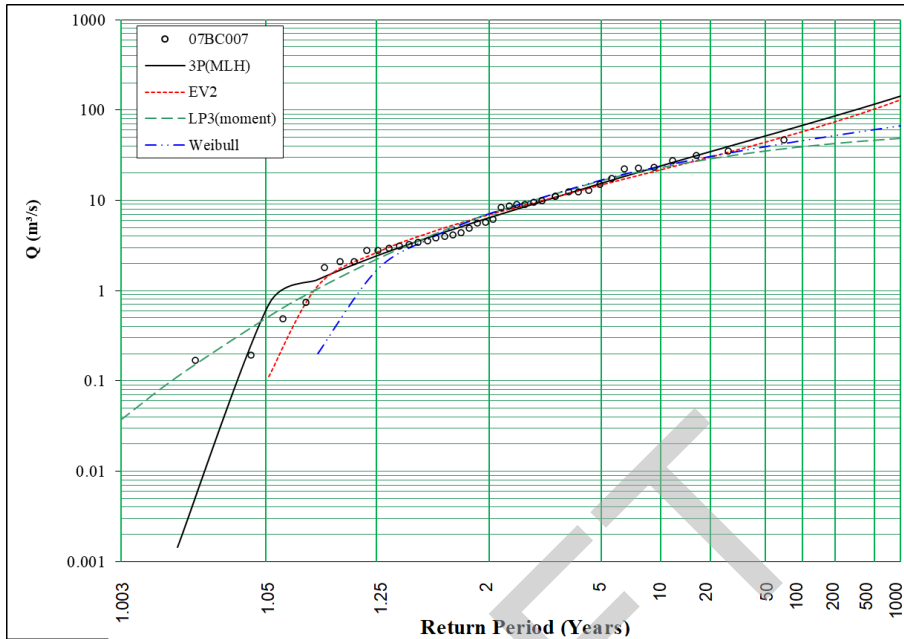
Return Period	3P (MLH)	EV2	LP3 (Moment)	Weibull
2	2.57	2.97	2.55	2.96
5	8.10	7.60	7.72	10.9
10	14.9	12.6	14.3	17.5
20	24.8	19.8	24.3	24.5
35	35.6	27.7	35.8	30.3
50	44.1	34.2	45.2	34.1
75	55.4	43.2	58.2	38.5
100	64.6	50.9	69.2	41.6
200	91.7	75.0	103.3	49.4
350	119	102	141	55.8
500	140	124	170	59.9
750	167	155	210	64.7
1,000	189	181	243	68.1

Figure B-6: WSC Station No. 05DF006, Whitemud Creek near Ellerslie



Return Period	3P(MLH)	EV2	LP3 (Moment)	Weibull
2	10.9	11.4	12.1	10.1
5	25.4	24.1	27.5	26.0
10	38.9	35.7	37.8	40.0
20	54.9	50.1	46.7	55.2
35	70.0	64.3	53.0	68.3
50	80.7	74.8	56.5	76.9
75	94.0	88.5	60.2	87.0
100	104	99	62.5	94.3
200	131	131	67.5	113
350	157	162	70.8	128
500	174	185	72.6	138
750	196	215	74.5	149
1,000	212	239	75.6	157

Figure B-7: WSC Station No. 07BC007, Wabash Creek near Pibroch



Return Period	3P (MLH)	EV2	LP3 (Moment)	Weibull
2	6.38	6.91	7.11	7.17
5	15.4	14.7	16.5	16.9
10	23.9	21.6	23.0	24.0
20	34.3	29.9	28.7	30.8
35	44.2	38.0	32.8	36.2
50	51.3	43.8	35.1	39.6
75	60.2	51.3	37.6	43.5
100	67.1	57.2	39.2	46.2
200	85.6	73.7	42.6	52.7
350	103	89.8	44.9	57.8
500	115	102	46.2	61.1
750	130	117	47.5	64.8
1,000	141	129	48.4	67.4

APPENDIX D

Open Water Flood Profiles

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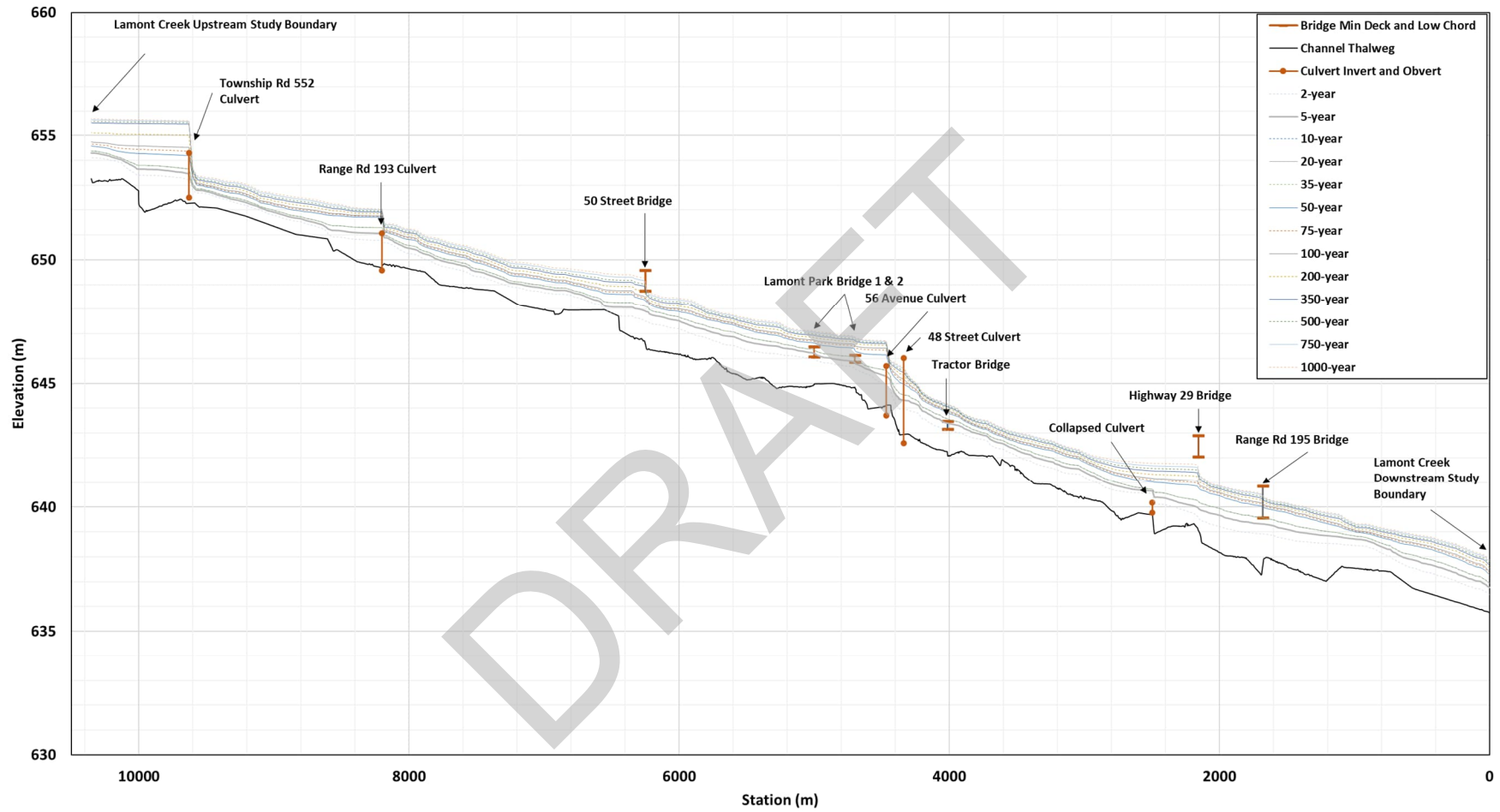


Figure D-1: Simulated Water Surface Profiles along Lamont Creek

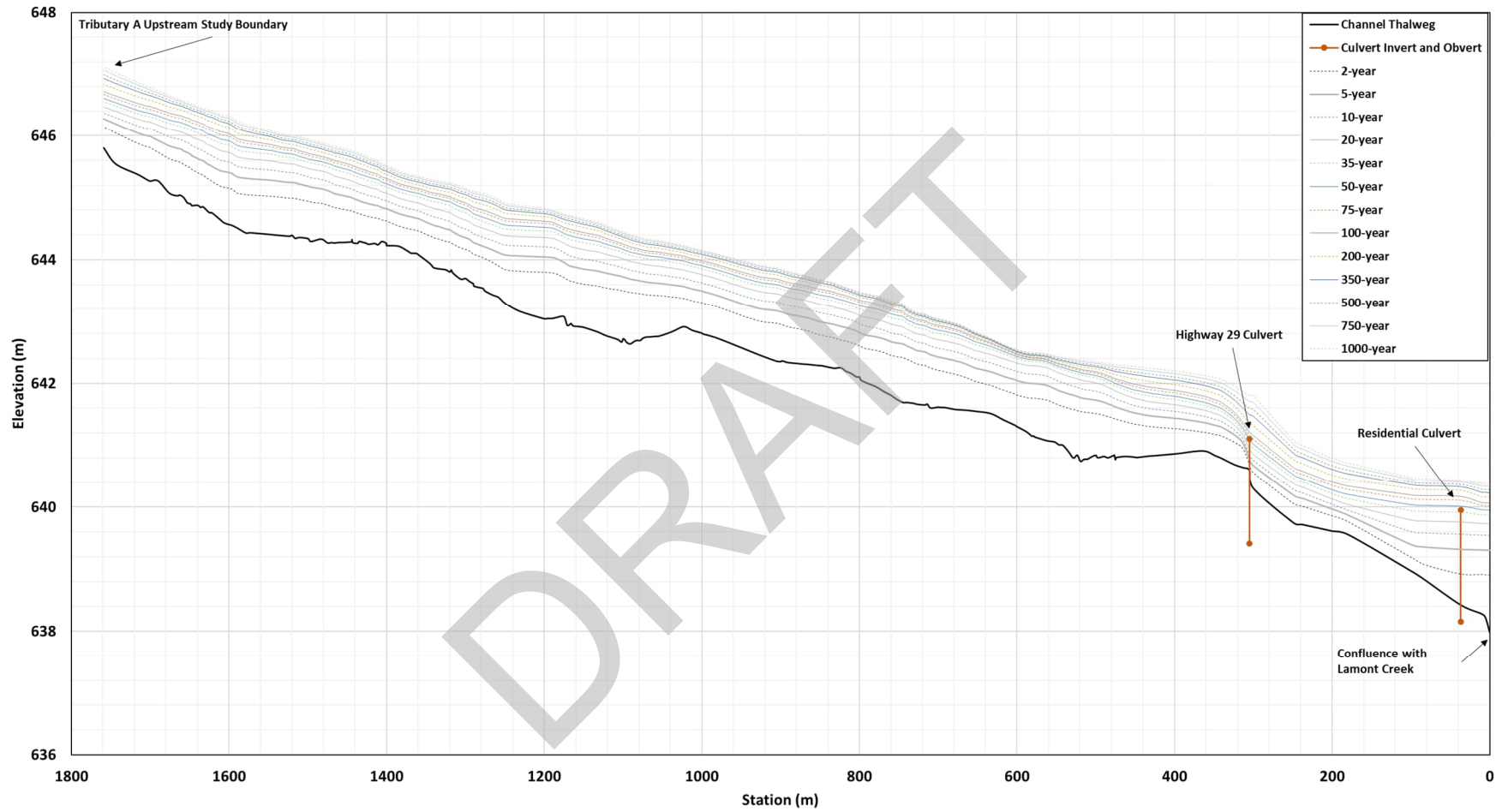


Figure D-2: Simulated Water Surface Profiles along Tributary A

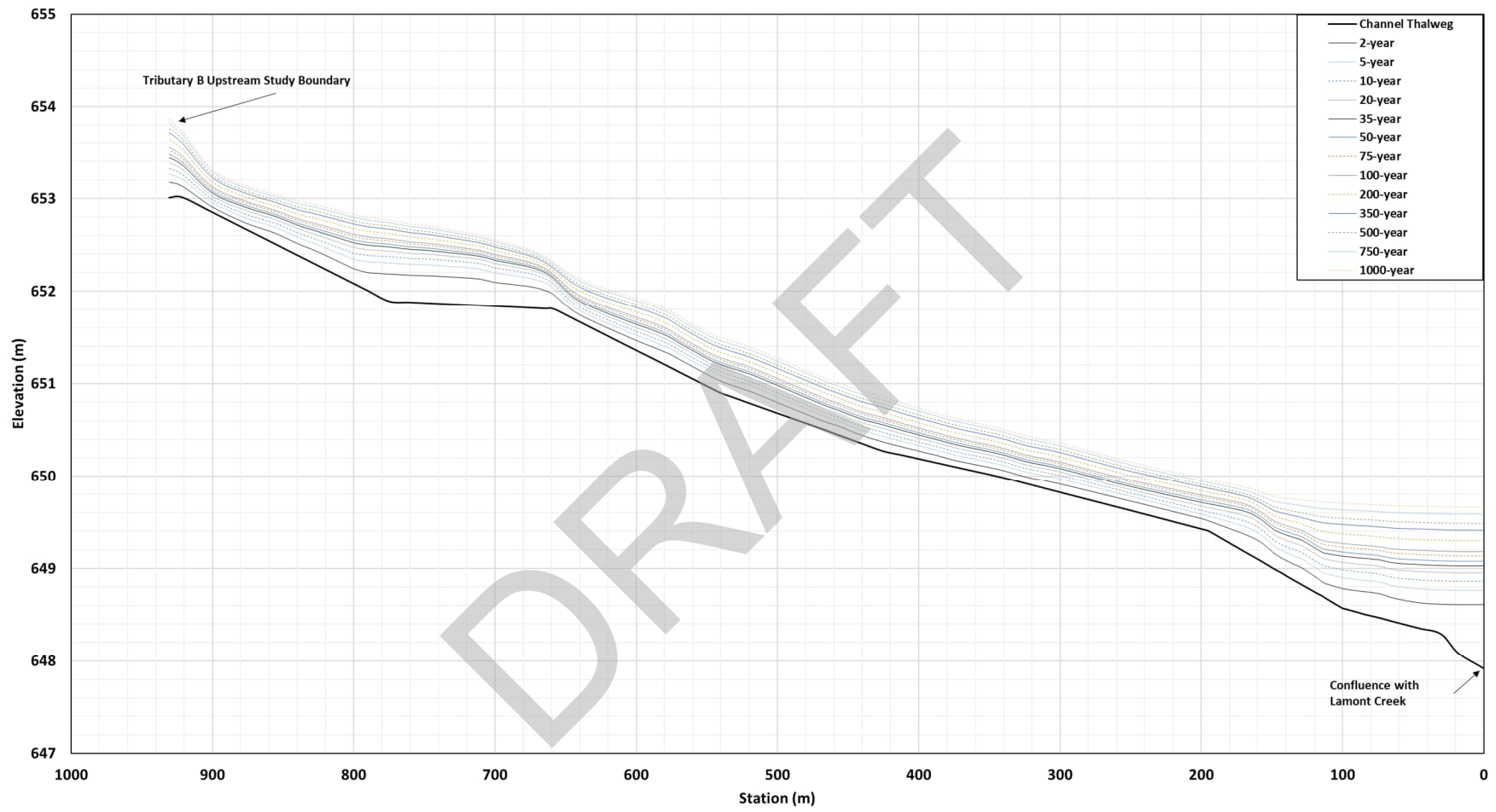


Figure D-3: Simulated Water Surface Profiles along Tributary B

Table D-1: Lamont Creek Flood Profiles

River	River Station (m)	Channel Thalweg (m)	Simulated Water Level (m)												
			2-Year Flood Event	5-Year Flood Event	10-Year Flood Event	20-Year Flood Event	35-Year Flood Event	50-Year Flood Event	75-Year Flood Event	100-Year Flood Event	200-Year Flood Event	350-Year Flood Event	500-Year Flood Event	750-Year Flood Event	1000-Year Flood Event
Lamont Creek	10300	653.16	654.09	654.27	654.35	654.35	654.35	654.54	654.63	654.71	655.09	655.54	655.60	655.66	655.70
Lamont Creek	10200	653.20	654.00	654.13	654.21	654.21	654.21	654.43	654.54	654.65	655.07	655.53	655.59	655.64	655.68
Lamont Creek	10100	653.18	653.73	653.93	654.01	654.01	654.01	654.32	654.47	654.60	655.05	655.52	655.58	655.63	655.67
Lamont Creek	10000	652.22	653.40	653.64	653.80	653.80	653.80	654.27	654.44	654.58	655.05	655.51	655.57	655.63	655.66
Lamont Creek	9900	652.04	653.39	653.63	653.78	653.78	653.78	654.25	654.42	654.56	655.04	655.51	655.57	655.62	655.65
Lamont Creek	9800	652.24	653.36	653.59	653.75	653.75	653.75	654.23	654.40	654.55	655.03	655.50	655.56	655.61	655.64
Lamont Creek	9700	652.42	653.31	653.53	653.70	653.70	653.70	654.21	654.38	654.53	655.02	655.50	655.55	655.60	655.63
Lamont Creek	9600	652.28	652.79	652.94	653.04	653.04	653.04	653.27	653.33	653.37	653.46	653.54	653.58	653.63	653.67
Lamont Creek	9500	652.11	652.66	652.75	652.80	652.80	652.80	652.93	652.97	653.00	653.07	653.15	653.20	653.26	653.31
Lamont Creek	9400	652.05	652.49	652.58	652.64	652.64	652.64	652.79	652.84	652.87	652.96	653.05	653.10	653.17	653.22
Lamont Creek	9300	651.90	652.32	652.43	652.50	652.50	652.50	652.68	652.73	652.77	652.87	652.95	653.01	653.09	653.14
Lamont Creek	9300	651.89	652.32	652.43	652.50	652.50	652.50	652.68	652.73	652.77	652.87	652.95	653.01	653.09	653.14
Lamont Creek	9200	651.74	652.18	652.29	652.36	652.36	652.36	652.55	652.60	652.64	652.74	652.83	652.89	652.96	653.02
Lamont Creek	9100	651.54	651.99	652.09	652.14	652.14	652.14	652.29	652.34	652.38	652.48	652.57	652.63	652.70	652.76
Lamont Creek	9000	651.34	651.79	651.91	651.99	651.99	651.99	652.17	652.22	652.26	652.37	652.46	652.52	652.60	652.66
Lamont Creek	9000	651.34	651.79	651.91	651.99	651.99	651.99	652.17	652.22	652.26	652.37	652.46	652.52	652.60	652.66
Lamont Creek	8900	651.15	651.62	651.75	651.83	651.83	651.83	652.05	652.11	652.15	652.26	652.36	652.43	652.51	652.57
Lamont Creek	8800	651.00	651.53	651.65	651.73	651.73	651.73	651.96	652.02	652.06	652.18	652.28	652.35	652.43	652.49
Lamont Creek	8700	650.92	651.37	651.50	651.60	651.60	651.60	651.89	651.95	651.99	652.11	652.21	652.28	652.35	652.41
Lamont Creek	8600	650.79	651.05	651.24	651.41	651.41	651.41	651.80	651.86	651.89	652.01	652.10	652.17	652.24	652.30
Lamont Creek	8500	650.30	650.90	651.16	651.36	651.36	651.36	651.77	651.82	651.85	651.95	652.04	652.10	652.16	652.22
Lamont Creek	8400	649.98	650.83	651.10	651.31	651.31	651.31	651.72	651.77	651.79	651.88	651.95	652.00	652.05	652.09
Lamont Creek	8300	649.82	650.80	651.08	651.30	651.30	651.30	651.72	651.76	651.78	651.87	651.93	651.98	652.03	652.06
Lamont Creek	8200	649.76	650.78	651.06	651.29	651.29	651.29	651.71	651.75	651.77	651.85	651.92	651.96	652.00	652.04
Lamont Creek	8100	649.76	650.52	650.69	650.78	650.78	650.78	650.99	651.04	651.08	651.17	651.25	651.30	651.37	651.42
Lamont Creek	8000	649.64	650.26	650.47	650.58	650.58	650.58	650.82	650.88	650.92	651.01	651.08	651.13	651.19	651.23
Lamont Creek	7900	649.53	650.05	650.26	650.37	650.37	650.37	650.57	650.62	650.66	650.76	650.85	650.91	650.98	651.03
Lamont Creek	7800	649.12	649.83	650.04	650.15	650.15	650.15	650.38	650.44	650.48	650.59	650.69	650.75	650.82	650.88
Lamont Creek	7700	648.93	649.68	649.88	649.99	649.99	649.99	650.22	650.27	650.32	650.42	650.51	650.57	650.64	650.70
Lamont Creek	7600	648.87	649.55	649.76	649.87	649.87	649.87	650.10	650.16	650.20	650.30	650.40	650.46	650.53	650.59
Lamont Creek	7500	648.82	649.33	649.53	649.64	649.64	649.64	649.88	649.95	650.00	650.11	650.22	650.28	650.36	650.42
Lamont Creek	7400	648.77	649.19	649.37	649.48	649.48	649.48	649.73	649.79	649.83	649.95	650.05	650.11	650.19	650.25
Lamont Creek	7300	648.53	649.01	649.19	649.29	649.29	649.29	649.52	649.58	649.62	649.73	649.83	649.90	649.98	650.05
Lamont Creek	7300	648.53	649.01	649.19	649.29	649.29	649.29	649.52	649.58	649.62	649.73	649.83	649.90	649.99	650.05
Lamont Creek	7200	648.22	648.88	649.03	649.12	649.12	649.12	649.34	649.40	649.44	649.56	649.67	649.74	649.83	649.90
Lamont Creek	7100	648.07	648.76	648.92	649.03	649.03	649.03	649.27	649.33	649.38	649.50	649.61	649.68	649.77	649.84



Table D-1: Lamont Creek Flood Profiles

River	River Station (m)	Channel Thalweg (m)	Simulated Water Level (m)												
			2-Year Flood Event	5-Year Flood Event	10-Year Flood Event	20-Year Flood Event	35-Year Flood Event	50-Year Flood Event	75-Year Flood Event	100-Year Flood Event	200-Year Flood Event	350-Year Flood Event	500-Year Flood Event	750-Year Flood Event	1000-Year Flood Event
Lamont Creek	7000	647.97	648.68	648.85	648.95	648.95	648.95	649.17	649.23	649.28	649.40	649.51	649.58	649.68	649.75
Lamont Creek	6900	647.79	648.61	648.77	648.86	648.87	648.87	649.08	649.14	649.19	649.31	649.42	649.49	649.59	649.67
Lamont Creek	6800	647.96	648.56	648.70	648.79	648.79	648.79	649.01	649.07	649.11	649.24	649.36	649.43	649.54	649.62
Lamont Creek	6800	647.96	648.56	648.70	648.79	648.79	648.79	649.01	649.07	649.11	649.24	649.36	649.43	649.54	649.62
Lamont Creek	6700	647.96	648.38	648.54	648.64	648.64	648.64	648.87	648.94	648.99	649.13	649.27	649.35	649.47	649.56
Lamont Creek	6600	647.97	648.20	648.35	648.47	648.47	648.47	648.74	648.82	648.88	649.03	649.19	649.28	649.40	649.50
Lamont Creek	6500	647.84	647.86	648.09	648.28	648.28	648.28	648.62	648.70	648.77	648.94	649.11	649.20	649.33	649.42
Lamont Creek	6400	647.02	647.72	648.08	648.27	648.27	648.27	648.61	648.69	648.75	648.92	649.09	649.18	649.30	649.40
Lamont Creek	6300	646.78	647.62	648.00	648.18	648.18	648.18	648.45	648.53	648.59	648.78	648.98	649.07	649.21	649.31
Lamont Creek	6200	646.34	647.40	647.75	647.92	647.92	647.92	648.13	648.18	648.22	648.32	648.41	648.48	648.56	648.62
Lamont Creek	6100	646.27	647.30	647.64	647.79	647.79	647.79	647.97	648.02	648.06	648.17	648.26	648.33	648.41	648.47
Lamont Creek	6000	646.16	647.20	647.52	647.67	647.67	647.67	647.90	647.96	648.01	648.13	648.23	648.30	648.39	648.45
Lamont Creek	5900	645.99	646.99	647.30	647.48	647.48	647.48	647.78	647.85	647.90	648.02	648.13	648.20	648.29	648.35
Lamont Creek	5800	645.99	646.84	647.15	647.32	647.32	647.32	647.59	647.64	647.68	647.78	647.86	647.91	647.98	648.03
Lamont Creek	5700	645.75	646.65	646.98	647.18	647.18	647.18	647.48	647.53	647.56	647.65	647.73	647.78	647.84	647.88
Lamont Creek	5600	645.40	646.53	646.88	647.07	647.07	647.07	647.36	647.41	647.44	647.53	647.60	647.65	647.72	647.76
Lamont Creek	5500	645.15	646.34	646.68	646.87	646.87	646.87	647.17	647.23	647.27	647.37	647.45	647.51	647.58	647.64
Lamont Creek	5400	645.25	646.25	646.58	646.76	646.76	646.76	647.04	647.09	647.14	647.25	647.35	647.41	647.49	647.54
Lamont Creek	5300	644.89	646.20	646.51	646.67	646.67	646.67	646.95	647.02	647.06	647.19	647.29	647.36	647.43	647.49
Lamont Creek	5200	644.88	646.13	646.40	646.55	646.55	646.55	646.80	646.86	646.90	647.00	647.09	647.15	647.21	647.26
Lamont Creek	5100	644.86	646.06	646.30	646.43	646.43	646.43	646.68	646.74	646.79	646.89	646.98	647.04	647.10	647.15
Lamont Creek	5100	644.86	646.06	646.30	646.43	646.43	646.43	646.68	646.74	646.79	646.89	646.98	647.04	647.10	647.15
Lamont Creek	5000	644.97	645.98	646.21	646.35	646.35	646.35	646.62	646.69	646.74	646.85	646.94	646.99	647.06	647.11
Lamont Creek	4900	644.99	645.82	646.03	646.18	646.18	646.18	646.51	646.60	646.66	646.77	646.86	646.92	646.99	647.04
Lamont Creek	4800	644.94	645.73	645.94	646.11	646.11	646.11	646.45	646.54	646.60	646.71	646.79	646.84	646.90	646.94
Lamont Creek	4700	644.86	645.61	645.83	646.00	646.00	646.00	646.36	646.47	646.53	646.64	646.72	646.77	646.83	646.87
Lamont Creek	4600	643.98	645.36	645.56	645.69	645.69	645.69	646.18	646.36	646.43	646.55	646.62	646.66	646.71	646.75
Lamont Creek	4500	644.01	645.02	645.35	645.56	645.56	645.56	646.15	646.34	646.42	646.53	646.60	646.64	646.69	646.72
Lamont Creek	4500	644.04	645.02	645.35	645.56	645.56	645.56	646.15	646.34	646.42	646.53	646.60	646.64	646.69	646.72
Lamont Creek	4400	643.45	644.21	644.58	644.80	644.80	644.80	645.22	645.33	645.40	645.54	645.64	645.70	645.77	645.81
Lamont Creek	4300	642.95	643.93	644.30	644.50	644.50	644.50	644.86	644.94	644.99	645.11	645.18	645.22	645.27	645.31
Lamont Creek	4200	642.60	643.59	643.90	644.05	644.05	644.05	644.32	644.38	644.42	644.51	644.57	644.60	644.64	644.67
Lamont Creek	4100	642.37	643.29	643.61	643.78	643.78	643.78	644.04	644.09	644.12	644.19	644.25	644.28	644.32	644.35
Lamont Creek	4000	642.11	643.09	643.39	643.55	643.55	643.55	643.79	643.84	643.87	643.96	644.02	644.06	644.11	644.14
Lamont Creek	3900	642.24	642.97	643.23	643.37	643.37	643.37	643.54	643.57	643.60	643.66	643.71	643.74	643.78	643.81
Lamont Creek	3800	642.10	642.79	643.00	643.11	643.11	643.11	643.27	643.31	643.33	643.40	643.46	643.50	643.55	643.59
Lamont Creek	3700	642.08	642.54	642.76	642.88	642.88	642.88	643.06	643.11	643.14	643.23	643.31	643.36	643.41	643.45



Table D-1: Lamont Creek Flood Profiles

River	River Station (m)	Channel Thalweg (m)	Simulated Water Level (m)												
			2-Year Flood Event	5-Year Flood Event	10-Year Flood Event	20-Year Flood Event	35-Year Flood Event	50-Year Flood Event	75-Year Flood Event	100-Year Flood Event	200-Year Flood Event	350-Year Flood Event	500-Year Flood Event	750-Year Flood Event	1000-Year Flood Event
Lamont Creek	3600	641.90	642.35	642.57	642.69	642.69	642.69	642.85	642.89	642.92	643.00	643.07	643.12	643.17	643.21
Lamont Creek	3500	641.49	642.08	642.31	642.45	642.45	642.45	642.64	642.68	642.72	642.81	642.89	642.94	643.00	643.04
Lamont Creek	3400	641.07	641.88	642.13	642.27	642.27	642.27	642.50	642.55	642.59	642.69	642.77	642.82	642.88	642.92
Lamont Creek	3300	640.93	641.67	641.92	642.07	642.07	642.07	642.35	642.41	642.45	642.54	642.62	642.67	642.73	642.77
Lamont Creek	3200	640.74	641.51	641.74	641.90	641.90	641.90	642.20	642.26	642.30	642.39	642.46	642.51	642.56	642.60
Lamont Creek	3100	640.50	641.36	641.59	641.73	641.73	641.73	642.02	642.07	642.11	642.20	642.27	642.32	642.37	642.41
Lamont Creek	3000	640.40	641.23	641.43	641.57	641.57	641.57	641.83	641.88	641.92	642.00	642.08	642.13	642.18	642.23
Lamont Creek	2900	640.24	640.97	641.17	641.31	641.31	641.31	641.58	641.63	641.66	641.76	641.84	641.90	641.98	642.04
Lamont Creek	2800	639.86	640.72	640.93	641.07	641.07	641.07	641.36	641.42	641.46	641.58	641.69	641.77	641.86	641.94
Lamont Creek	2700	639.55	640.62	640.78	640.91	640.91	640.91	641.22	641.29	641.34	641.47	641.59	641.68	641.77	641.86
Lamont Creek	2600	639.77	640.58	640.69	640.79	640.79	640.79	641.10	641.18	641.24	641.39	641.53	641.62	641.72	641.82
Lamont Creek	2500	639.69	640.56	640.65	640.72	640.72	640.72	641.03	641.12	641.18	641.34	641.48	641.58	641.68	641.79
Lamont Creek	2400	639.12	640.09	640.36	640.55	640.55	640.55	640.97	641.08	641.15	641.32	641.47	641.57	641.67	641.78
Lamont Creek	2300	639.24	639.93	640.18	640.40	640.40	640.40	640.92	641.04	641.12	641.30	641.45	641.55	641.66	641.76
Lamont Creek	2300	639.22	639.94	640.18	640.40	640.40	640.40	640.92	641.04	641.12	641.30	641.45	641.55	641.66	641.76
Lamont Creek	2200	639.30	639.77	640.06	640.32	640.32	640.32	640.88	641.01	641.09	641.28	641.43	641.54	641.64	641.75
Lamont Creek	2100	638.47	639.39	639.82	640.09	640.09	640.09	640.63	640.72	640.78	640.89	640.97	641.02	641.08	641.12
Lamont Creek	2000	638.17	639.22	639.67	639.95	639.95	639.95	640.46	640.55	640.59	640.68	640.74	640.79	640.84	640.87
Lamont Creek	1900	638.03	639.07	639.49	639.77	639.77	639.77	640.27	640.36	640.41	640.52	640.59	640.64	640.70	640.73
Lamont Creek	1800	637.91	638.98	639.40	639.67	639.67	639.67	640.15	640.23	640.28	640.39	640.47	640.53	640.60	640.64
Lamont Creek	1800	637.94	638.98	639.40	639.67	639.67	639.67	640.15	640.23	640.28	640.40	640.47	640.54	640.60	640.64
Lamont Creek	1700	637.34	638.93	639.33	639.59	639.59	639.59	640.05	640.14	640.19	640.30	640.37	640.44	640.52	640.56
Lamont Creek	1600	637.87	638.85	639.25	639.48	639.48	639.48	639.89	639.95	639.99	640.07	640.13	640.17	640.22	640.26
Lamont Creek	1500	637.62	638.71	639.10	639.34	639.34	639.34	639.78	639.85	639.89	639.97	640.04	640.08	640.14	640.17
Lamont Creek	1500	637.62	638.71	639.10	639.34	639.34	639.34	639.78	639.85	639.89	639.97	640.04	640.08	640.14	640.17
Lamont Creek	1400	637.39	638.62	638.98	639.20	639.20	639.20	639.61	639.69	639.73	639.83	639.90	639.95	640.01	640.05
Lamont Creek	1300	637.19	638.57	638.90	639.10	639.10	639.10	639.48	639.55	639.59	639.68	639.75	639.80	639.86	639.90
Lamont Creek	1200	637.08	638.54	638.85	639.02	639.02	639.02	639.33	639.39	639.44	639.54	639.62	639.68	639.74	639.79
Lamont Creek	1100	637.57	638.51	638.79	638.94	638.94	638.94	639.19	639.25	639.29	639.41	639.50	639.56	639.63	639.68
Lamont Creek	1000	637.54	638.46	638.72	638.84	638.84	638.84	639.01	639.05	639.08	639.15	639.22	639.27	639.32	639.36
Lamont Creek	900	637.49	638.38	638.63	638.75	638.75	638.75	638.93	638.97	639.00	639.08	639.15	639.20	639.26	639.30
Lamont Creek	800	637.44	638.15	638.40	638.55	638.55	638.55	638.77	638.82	638.85	638.94	639.01	639.06	639.12	639.16
Lamont Creek	700	637.26	637.87	638.16	638.32	638.32	638.32	638.62	638.68	638.72	638.82	638.91	638.96	639.03	639.07
Lamont Creek	600	636.86	637.59	637.92	638.11	638.11	638.11	638.49	638.56	638.60	638.71	638.79	638.84	638.90	638.94
Lamont Creek	500	636.61	637.42	637.75	637.95	637.95	637.95	638.38	638.45	638.49	638.60	638.68	638.74	638.80	638.85
Lamont Creek	400	636.44	637.29	637.62	637.83	637.83	637.83	638.24	638.31	638.35	638.47	638.56	638.62	638.69	638.74
Lamont Creek	300	636.27	637.13	637.45	637.65	637.65	637.65	638.04	638.12	638.18	638.31	638.40	638.46	638.53	638.58



Table D-1: Lamont Creek Flood Profiles

River	River Station (m)	Channel Thalweg (m)	Simulated Water Level (m)												
			2-Year Flood Event	5-Year Flood Event	10-Year Flood Event	20-Year Flood Event	35-Year Flood Event	50-Year Flood Event	75-Year Flood Event	100-Year Flood Event	200-Year Flood Event	350-Year Flood Event	500-Year Flood Event	750-Year Flood Event	1000-Year Flood Event
Lamont Creek	200	636.11	636.91	637.23	637.43	637.43	637.43	637.84	637.92	637.98	638.11	638.21	638.27	638.35	638.40
Lamont Creek	100	635.94	636.73	637.03	637.22	637.22	637.22	637.60	637.68	637.74	637.87	637.97	638.04	638.12	638.17
Lamont Creek	0	635.77	636.48	636.77	636.94	636.94	636.94	637.30	637.37	637.43	637.56	637.67	637.74	637.82	637.87

Table D-2: Tributary A Flood Profiles

River	River Station (m)	Channel Thalweg (m)	Simulated Water Level (m)												
			2-Year Flood Event	5-Year Flood Event	10-Year Flood Event	20-Year Flood Event	35-Year Flood Event	50-Year Flood Event	75-Year Flood Event	100-Year Flood Event	200-Year Flood Event	350-Year Flood Event	500-Year Flood Event	750-Year Flood Event	1000-Year Flood Event
Tributary A	1700	645.27	645.80	645.99	646.11	646.22	646.31	646.37	646.43	646.48	646.58	646.65	646.70	646.75	646.78
Tributary A	1600	644.57	645.15	645.40	645.57	645.73	645.84	645.91	645.99	646.03	646.13	646.20	646.24	646.28	646.31
Tributary A	1500	644.34	644.94	645.18	645.34	645.47	645.57	645.63	645.68	645.72	645.79	645.84	645.88	645.92	645.95
Tributary A	1400	644.23	644.63	644.82	644.95	645.07	645.17	645.22	645.28	645.31	645.38	645.42	645.46	645.49	645.52
Tributary A	1400	644.26	644.63	644.82	644.95	645.07	645.17	645.23	645.28	645.31	645.38	645.43	645.46	645.49	645.52
Tributary A	1300	643.70	644.17	644.36	644.50	644.64	644.76	644.82	644.88	644.92	644.99	645.05	645.09	645.13	645.16
Tributary A	1200	643.04	643.80	644.05	644.21	644.36	644.46	644.52	644.58	644.62	644.69	644.74	644.77	644.80	644.83
Tributary A	1100	642.72	643.50	643.73	643.87	644.02	644.12	644.17	644.22	644.25	644.32	644.37	644.39	644.42	644.45
Tributary A	1100	642.72	643.50	643.73	643.87	644.02	644.12	644.17	644.22	644.25	644.32	644.37	644.39	644.43	644.45
Tributary A	1000	642.81	643.31	643.50	643.63	643.76	643.86	643.91	643.96	643.99	644.05	644.09	644.11	644.14	644.16
Tributary A	900	642.35	642.95	643.16	643.30	643.44	643.53	643.58	643.64	643.67	643.74	643.79	643.81	643.84	643.85
Tributary A	800	642.10	642.60	642.82	642.96	643.10	643.20	643.26	643.31	643.35	643.40	643.43	643.45	643.47	643.48
Tributary A	700	641.62	642.21	642.43	642.57	642.70	642.80	642.86	642.91	642.93	642.98	643.00	643.01	643.03	643.04
Tributary A	600	641.30	641.81	642.04	642.19	642.33	642.40	642.43	642.46	642.47	642.49	642.51	642.52	642.53	642.54
Tributary A	500	640.84	641.52	641.73	641.87	642.01	642.09	642.13	642.16	642.19	642.23	642.27	642.29	642.32	642.35
Tributary A	400	640.87	641.27	641.44	641.55	641.66	641.74	641.79	641.85	641.89	641.98	642.05	642.10	642.16	642.20
Tributary A	300	640.30	640.56	640.67	640.76	640.86	640.96	641.02	641.10	641.16	641.32	641.47	641.58	641.69	641.80
Tributary A	200	639.61	639.86	639.97	640.05	640.13	640.22	640.28	640.35	640.41	640.52	640.61	640.67	640.75	640.80
Tributary A	100	638.97	639.19	639.40	639.60	639.79	639.94	640.04	640.13	640.20	640.30	640.36	640.41	640.45	640.48
Tributary A	0	637.98	638.91	639.30	639.54	639.73	639.87	639.95	640.02	640.07	640.16	640.23	640.28	640.33	640.37

Table D-3: Tributary B Flood Profiles

River	River Station (m)	Channel Thalweg (m)	Simulated Water Level (m)												
			2-Year Flood Event	5-Year Flood Event	10-Year Flood Event	20-Year Flood Event	35-Year Flood Event	50-Year Flood Event	75-Year Flood Event	100-Year Flood Event	200-Year Flood Event	350-Year Flood Event	500-Year Flood Event	750-Year Flood Event	1000-Year Flood Event
Tributary B	900	652.85	652.91	652.96	652.99	653.03	653.06	653.08	653.11	653.13	653.18	653.22	653.25	653.29	653.31
Tributary B	800	652.08	652.24	652.34	652.41	652.47	652.52	652.55	652.59	652.61	652.68	652.73	652.76	652.80	652.83
Tributary B	700	651.84	652.10	652.20	652.25	652.30	652.33	652.36	652.38	652.40	652.44	652.48	652.50	652.53	652.56
Tributary B	600	651.36	651.46	651.52	651.56	651.60	651.64	651.66	651.69	651.72	651.77	651.82	651.86	651.90	651.92
Tributary B	500	650.68	650.80	650.86	650.90	650.94	650.98	651.00	651.03	651.06	651.11	651.16	651.20	651.24	651.27
Tributary B	400	650.19	650.27	650.33	650.37	650.41	650.45	650.47	650.50	650.52	650.58	650.63	650.66	650.70	650.73
Tributary B	300	649.82	649.91	649.97	650.01	650.05	650.08	650.10	650.13	650.15	650.21	650.26	650.29	650.33	650.36
Tributary B	200	649.43	649.54	649.59	649.63	649.67	649.71	649.74	649.77	649.79	649.84	649.88	649.91	649.95	649.97
Tributary B	100	648.57	648.78	648.90	648.99	649.07	649.13	649.18	649.23	649.27	649.37	649.47	649.54	649.63	649.70
Tributary B	0	647.92	648.61	648.77	648.86	648.95	649.03	649.08	649.14	649.18	649.30	649.41	649.49	649.58	649.66

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APPENDIX E

Open Water Sensitivity Analysis

DRAFT

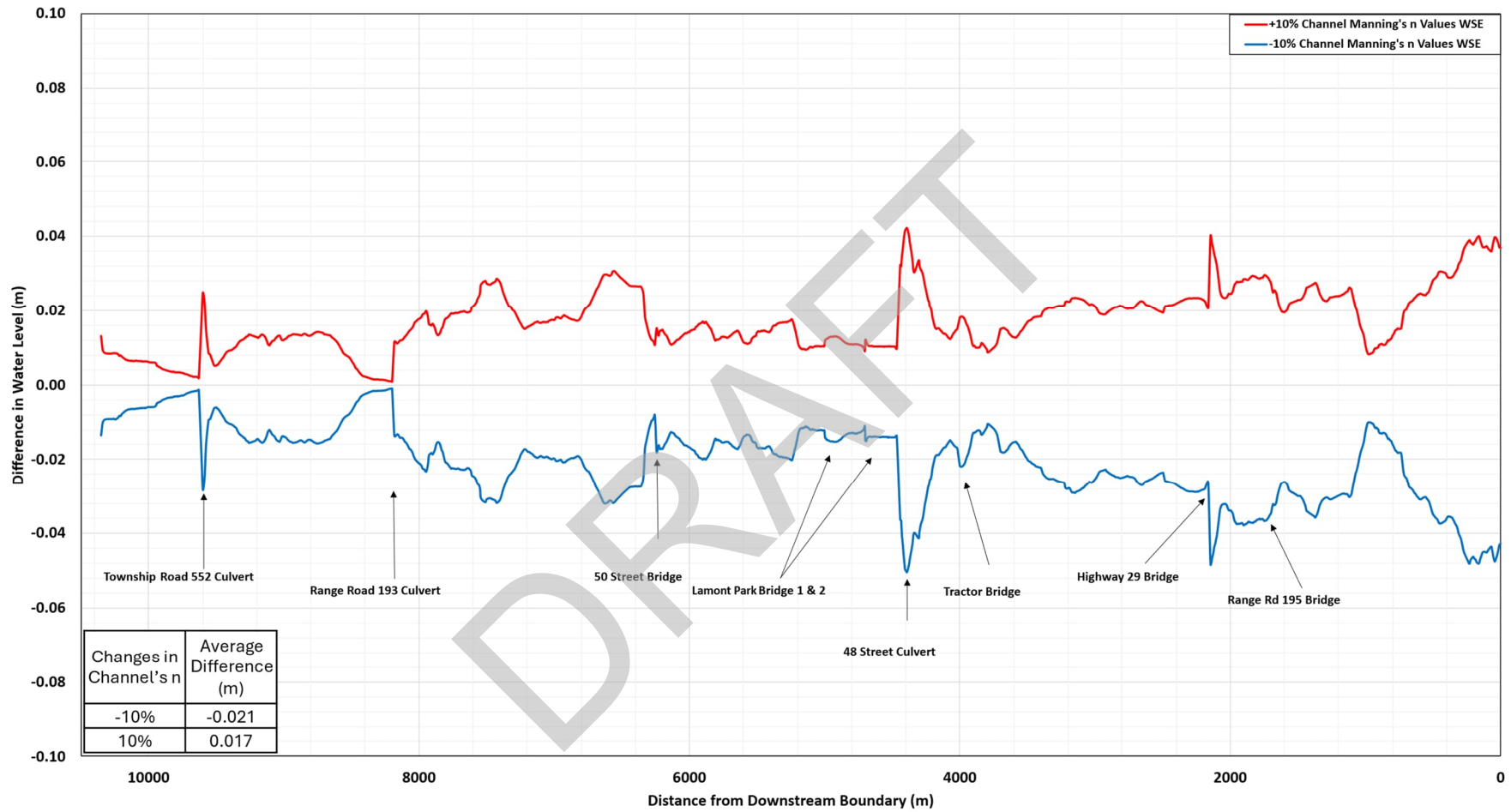


Figure E-1: Sensitivity of Simulated Water Level along Lamont Creek Study Reach for the 100-year Flood Event (Channel Manning's *n* Only)

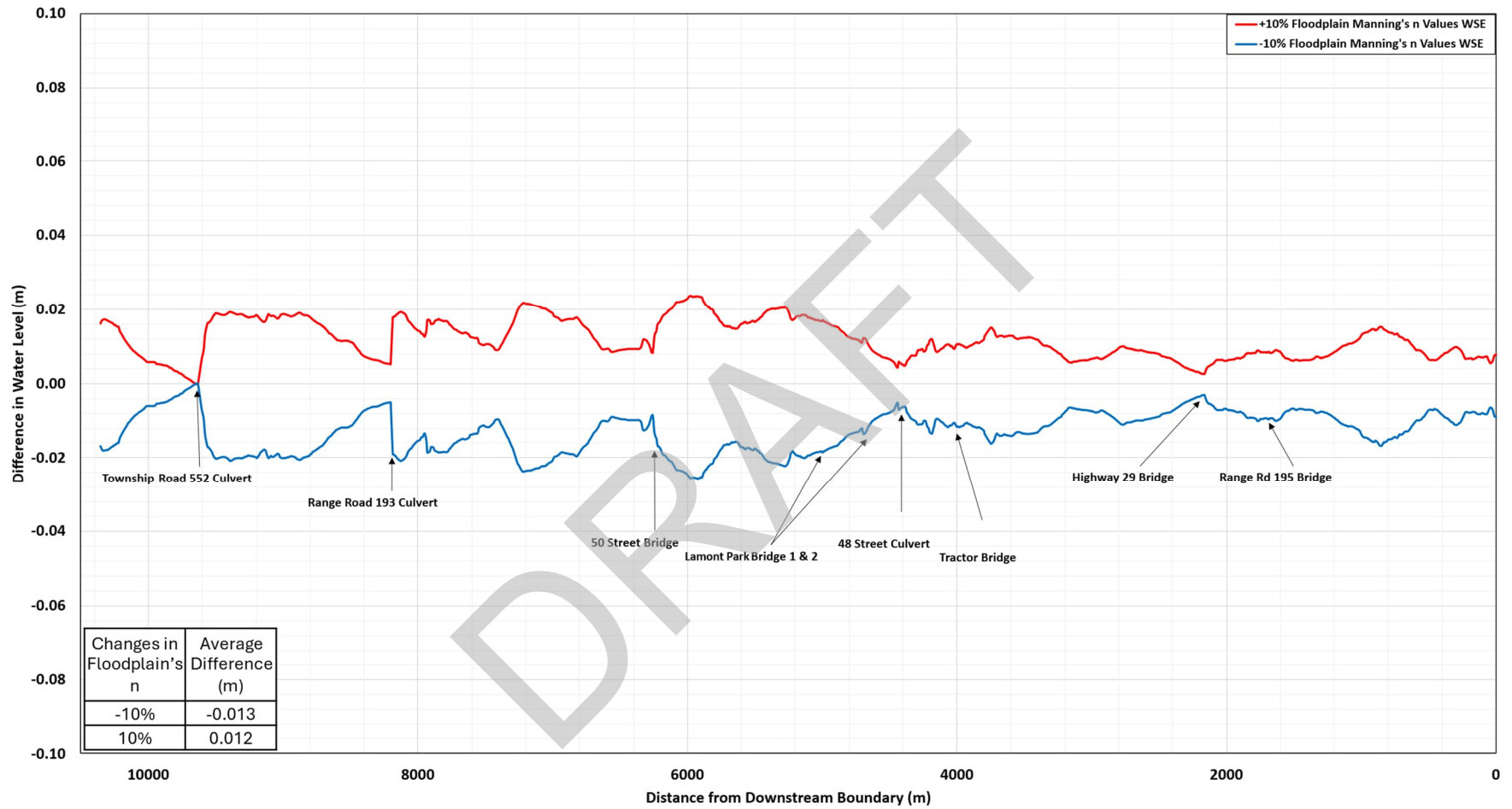


Figure E-2: Sensitivity of Simulated Water Level along Lamont Creek Study Reach for the 100-year Flood Event (Floodplain Manning's *n* Only)

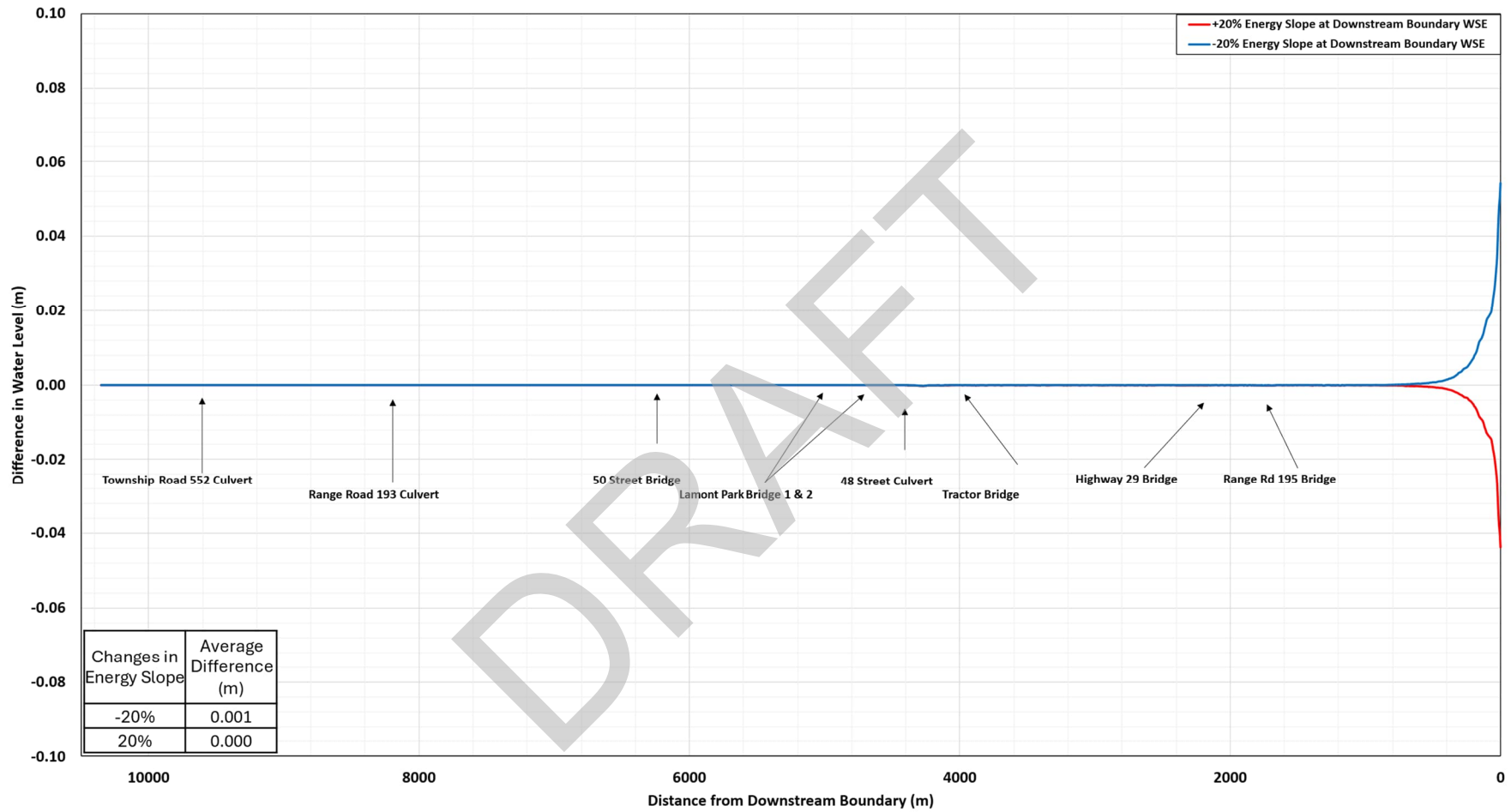


Figure E-3: Sensitivity of Simulated Water Level along Lamont Creek Study Reach for the 100-year Flood Event (Downstream Boundary)

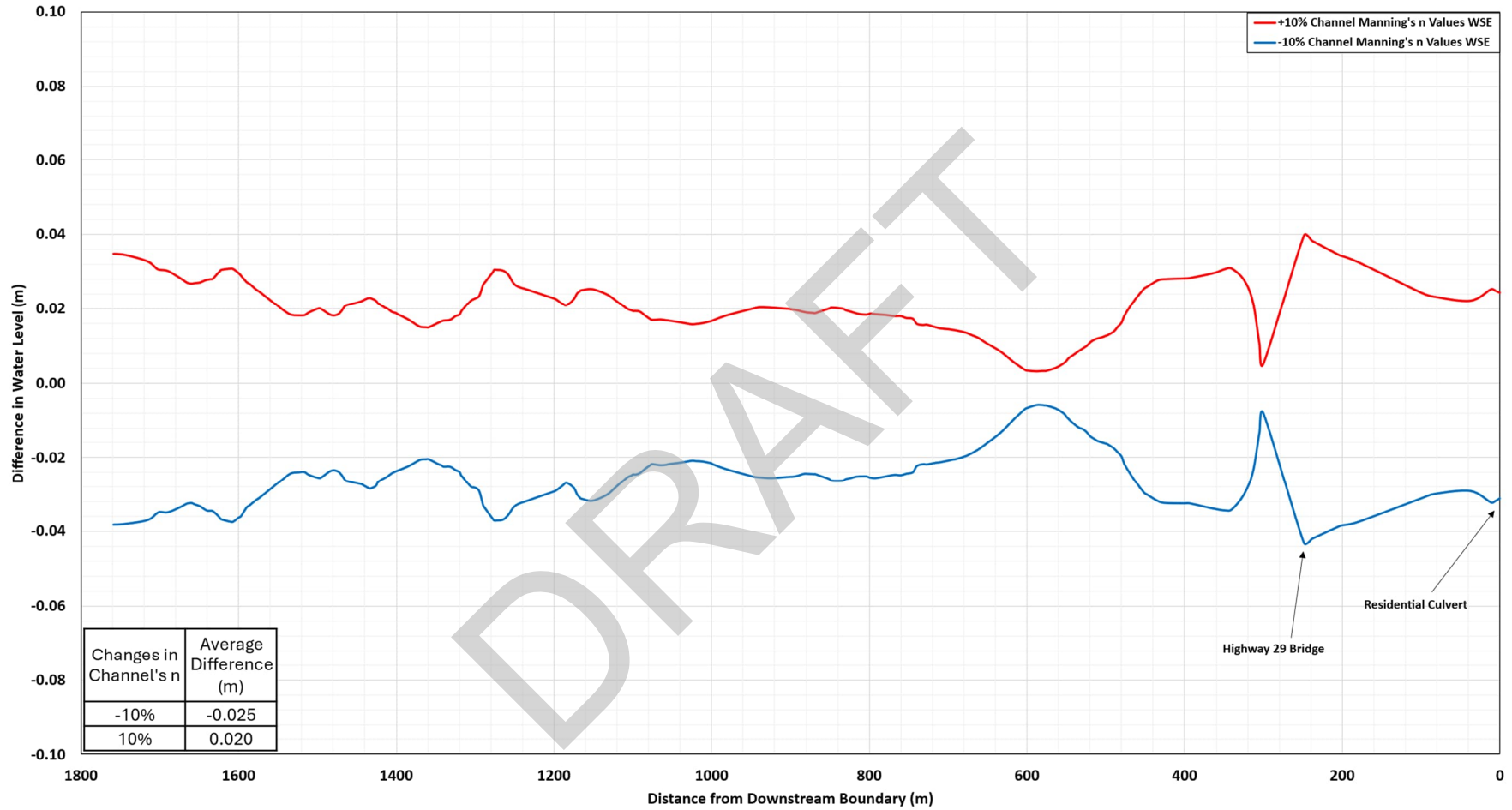


Figure E-4: Sensitivity of Simulated Water Level along Tributary A Study Reach for the 100-year Flood Event (Channel Manning's *n* Only)

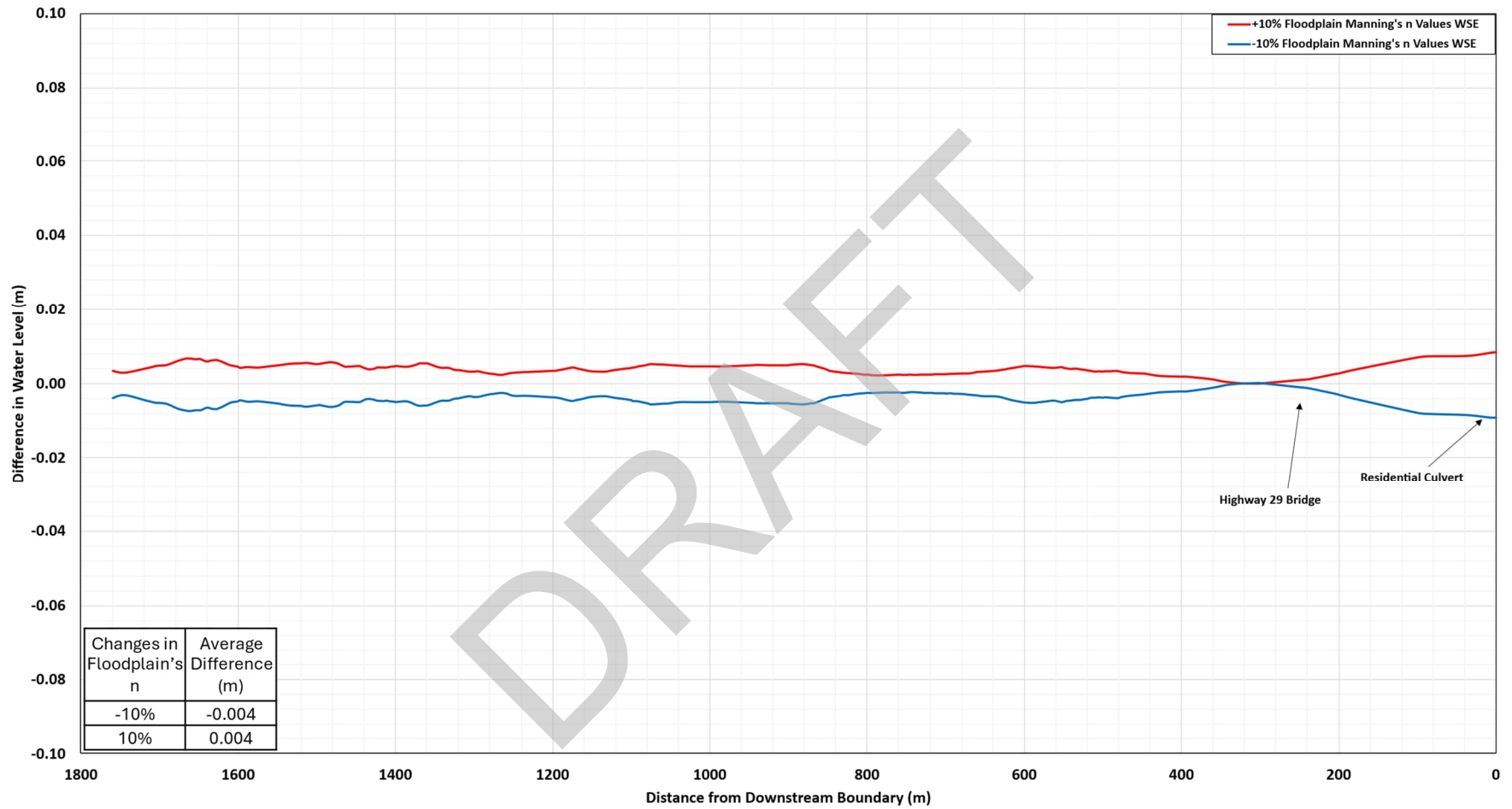


Figure E-5: Sensitivity of Simulated Water Level along Tributary A Study Reach for the 100-year Flood Event (Floodplain Manning's *n* Only)

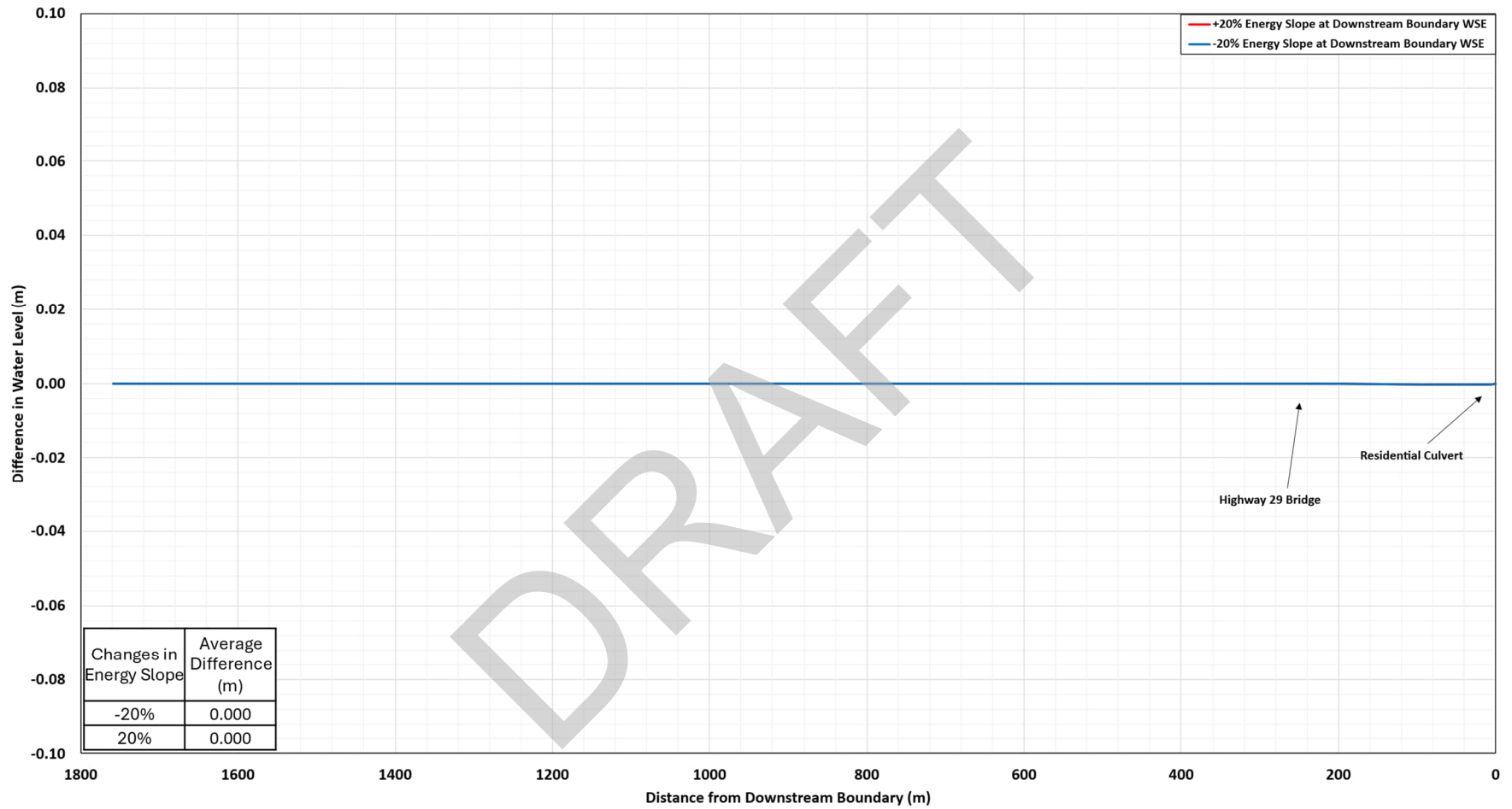


Figure E-6: Sensitivity of Simulated Water Level along Tributary A Study Reach for the 100-year Flood Event (Downstream Boundary)

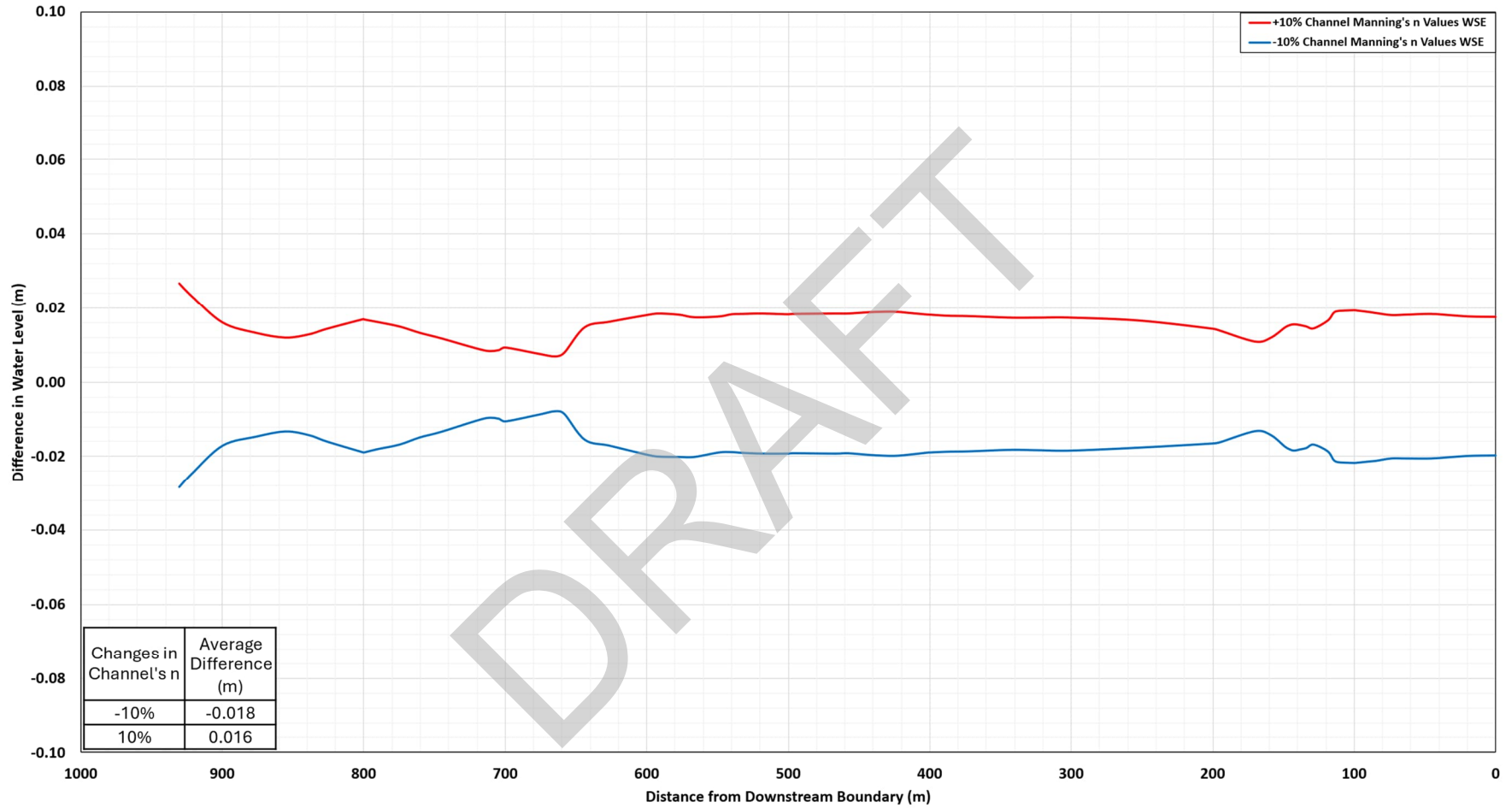


Figure E-7: Sensitivity of Simulated Water Level along Tributary B Study Reach for the 100-year Flood Event (Channel Manning's *n* Only)

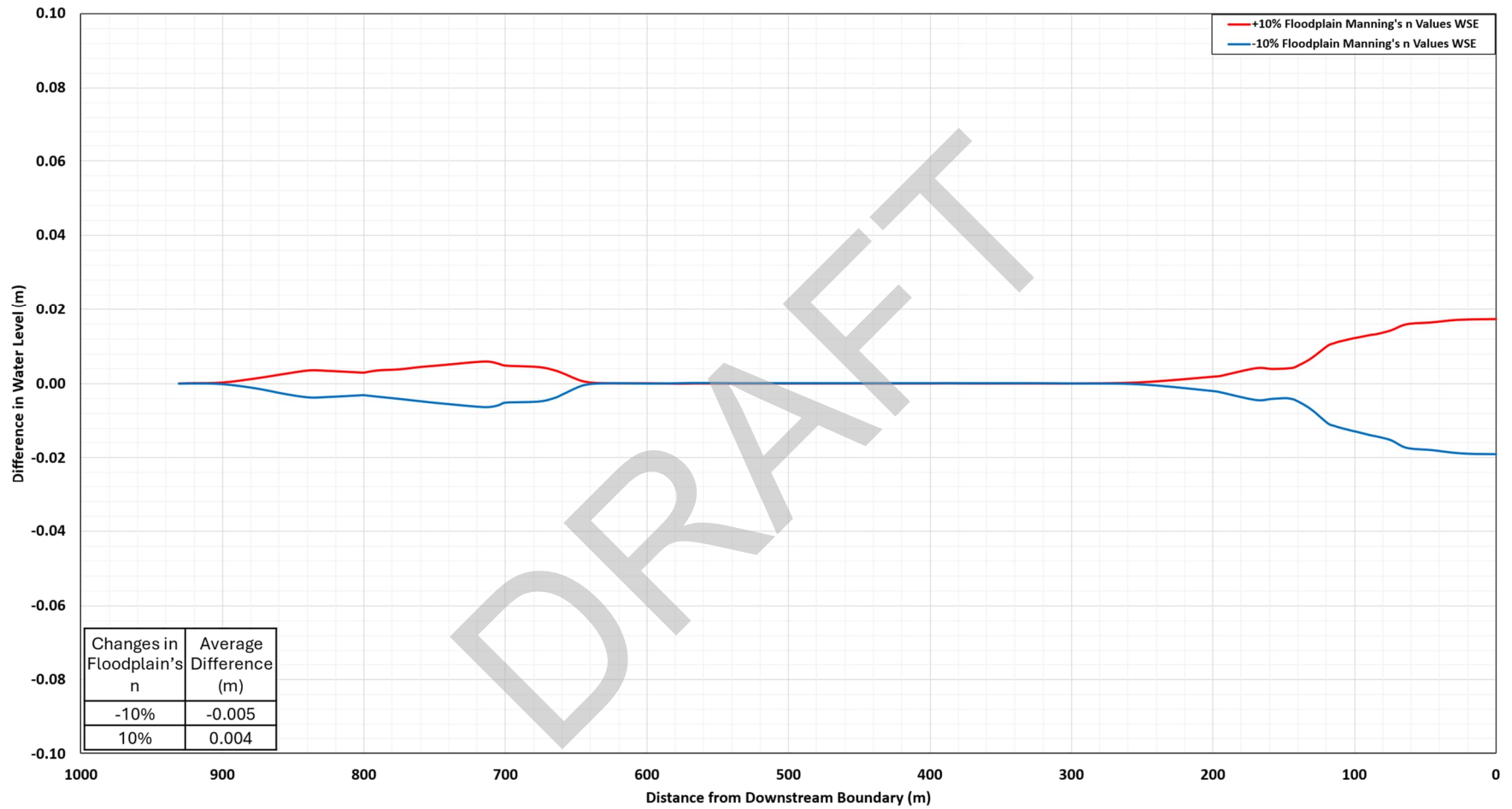


Figure E-8: Sensitivity of Simulated Water Level along Tributary B Study Reach for the 100-year Flood Event (Floodplain Manning's *n* Only)

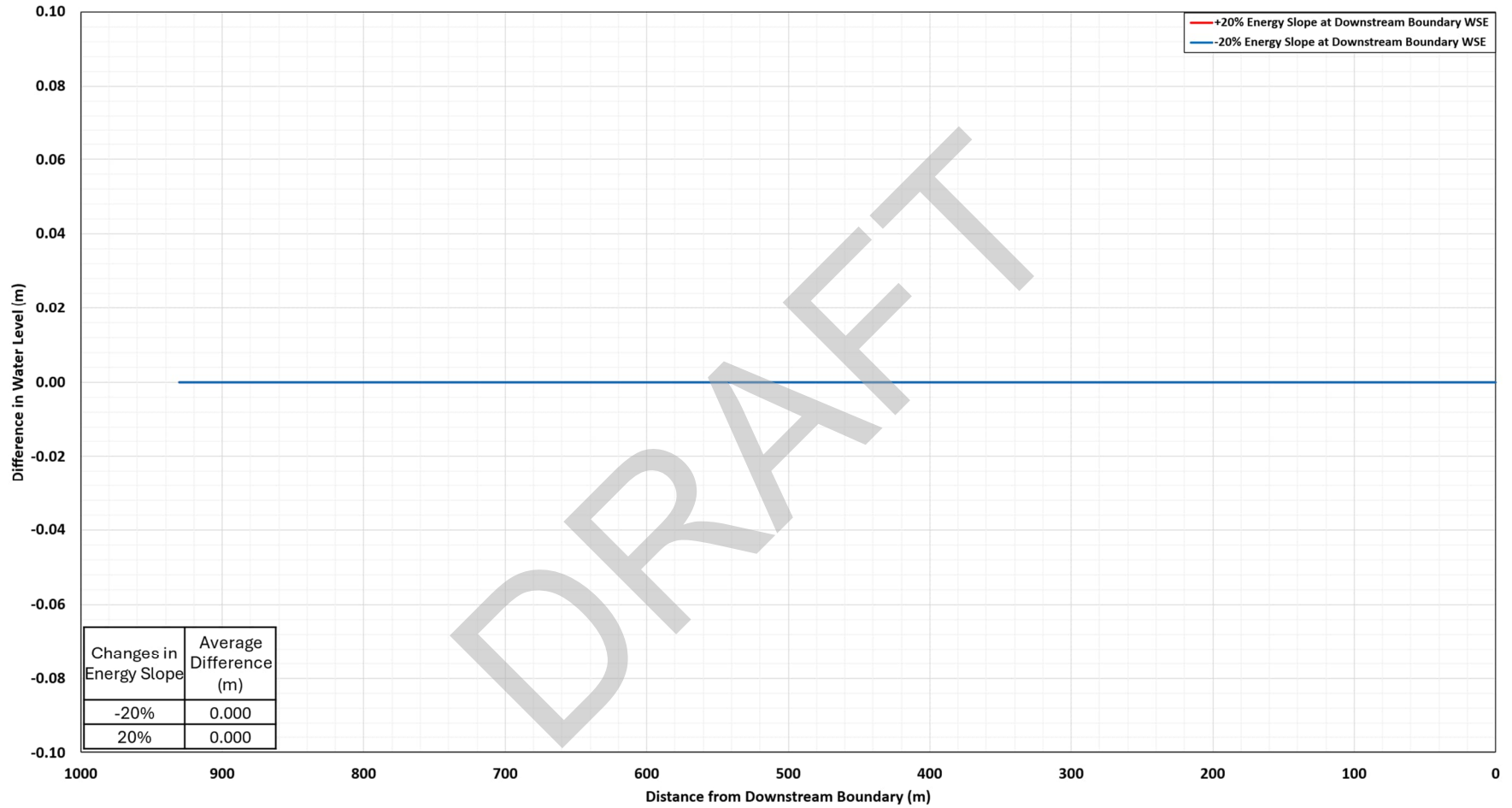


Figure E-9: Sensitivity of Simulated Water Level along Tributary B Study Reach for the 100-year Flood Event (Downstream Boundary)

APPENDIX F

**Open Water Flood Inundation
Map Library**

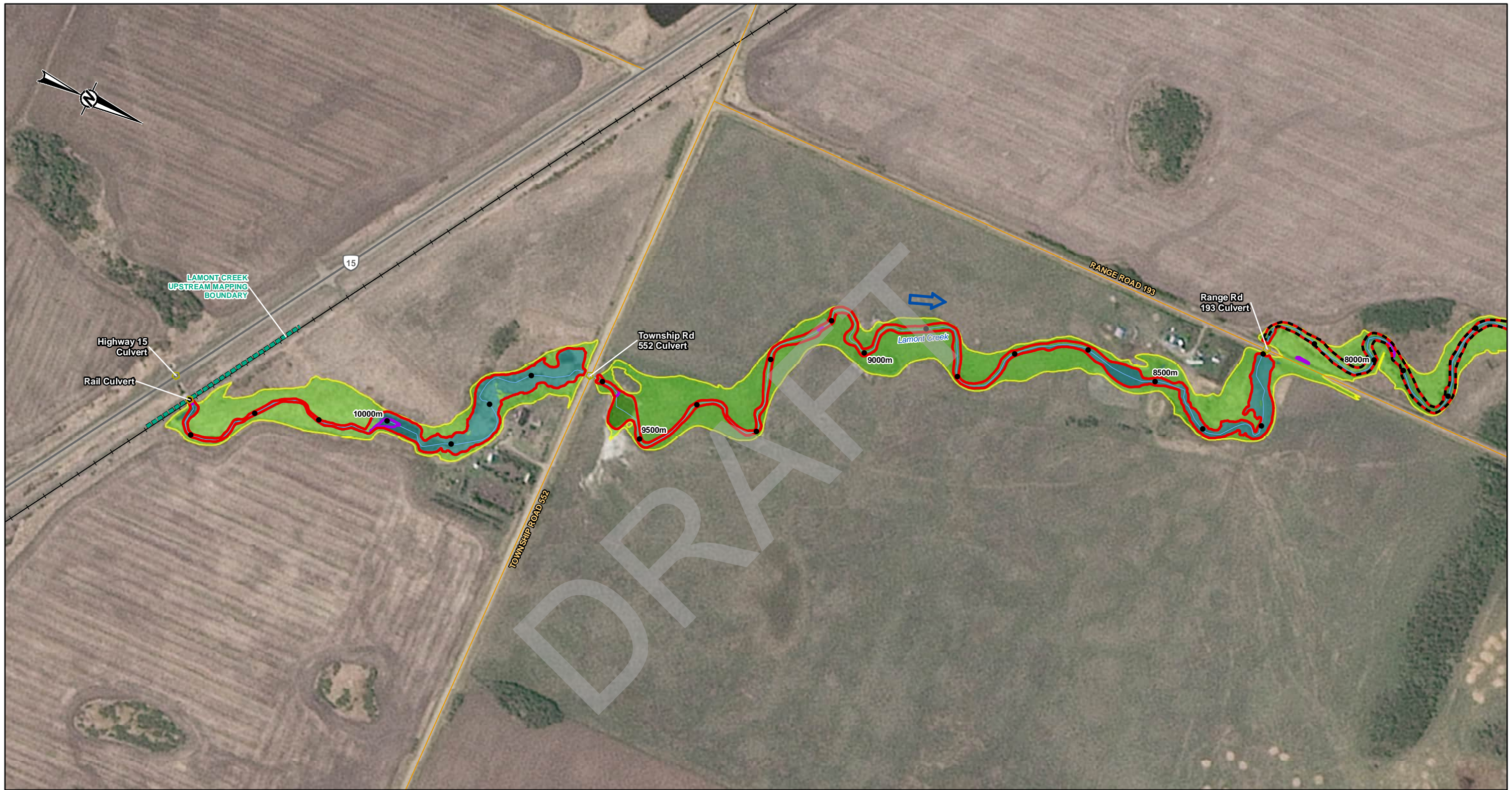
(Provided under separate cover)

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APPENDIX G

**Floodway Criteria Maps and Flood
Hazard Maps**

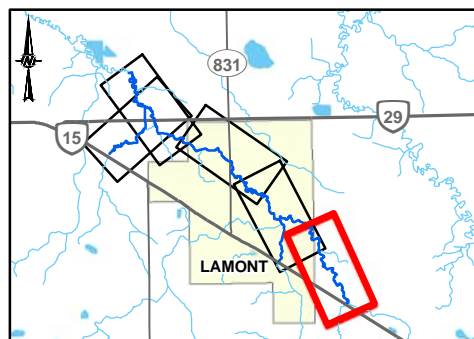
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LEGEND	
●	PROFILE STATION
■	MAPPING BOUNDARY
➔	FLOW DIRECTION
—	LOCAL ROAD
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY
+	RAILWAY
—	CHANNEL CENTRELINE
⬡	HYDRAULIC STRUCTURES
⬡	CULVERT
⬡	BRIDGE
—	PROPOSED FLOODWAY BOUNDARY
—	PREVIOUS FLOODWAY (ADJUSTED)*
—	DEPTH ≥ 1 M
—	100-YEAR DESIGN FLOOD EXTENT
—	VELOCITY ≥ 1 M/S
DESIGN DISCHARGE (100-YR) LAMONT CREEK UPSTREAM OF TRIBUTARY B = 10.1 M ³ /S	



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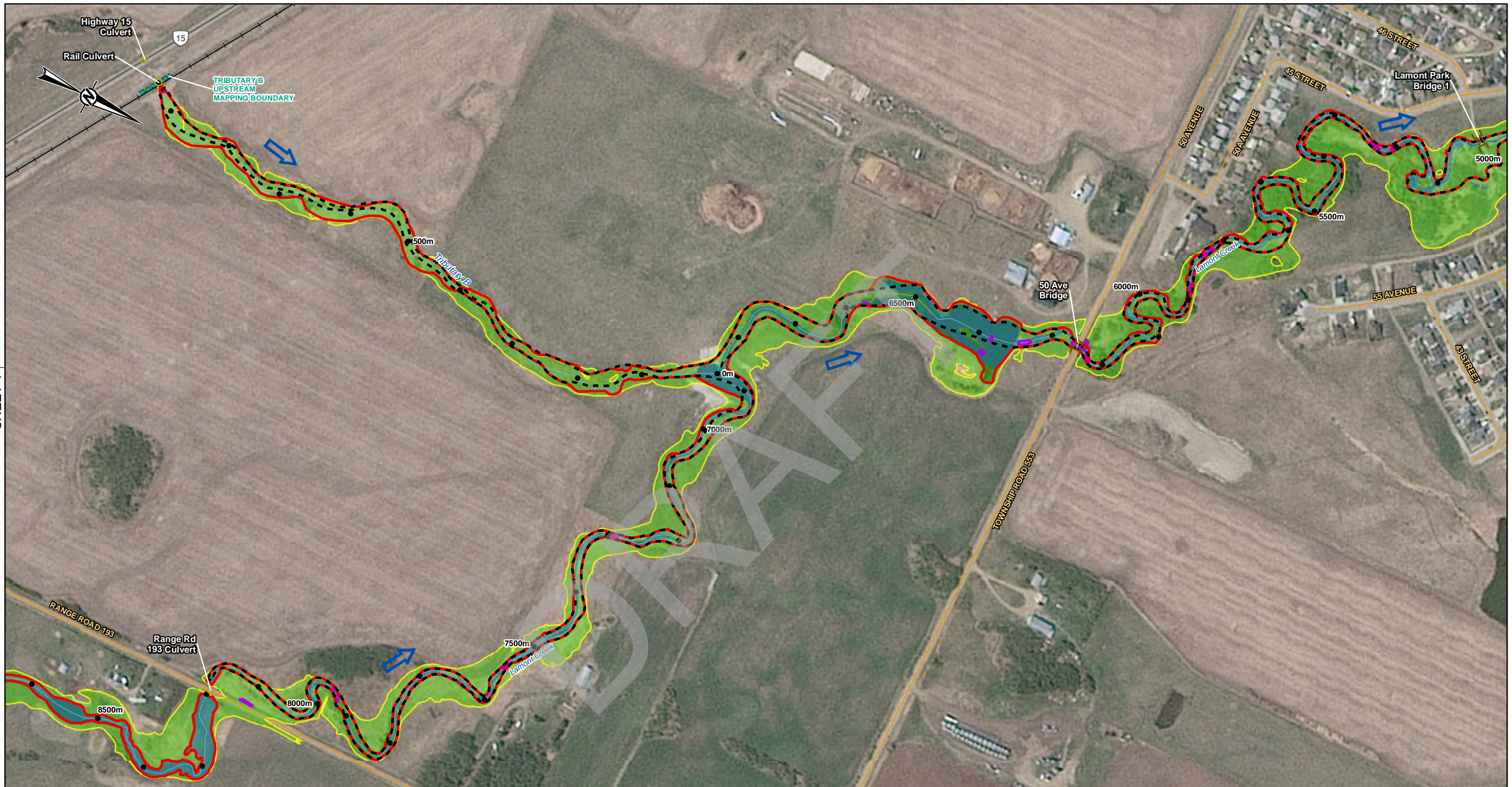
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LAMONT FLOOD STUDY	FLOODWAY CRITERIA MAP
PROJECT NO. 23592565	CONTROL -
REV. 1	FIGURE 1 OF 5

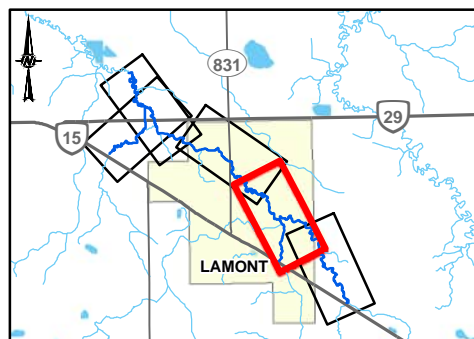
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—	MAPPING BOUNDARY
→	FLOW DIRECTION
—	LOCAL ROAD
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY
+	RAILWAY
—	CHANNEL CENTRELINE
HYDRAULIC STRUCTURES	
⬢	CULVERT
—	BRIDGE
—	PROPOSED FLOODWAY BOUNDARY
—	PREVIOUS FLOODWAY (ADJUSTED)*
—	DEPTH ≥ 1 M
—	100-YEAR DESIGN FLOOD EXTENT
—	VELOCITY ≥ 1 M/S
DESIGN DISCHARGE (100-YR)	
TRIBUTARY B = 2.76 M ³ /S	
LAMONT CREEK UPSTREAM OF TRIBUTARY B = 10.1 M ³ /S	
LAMONT CREEK BETWEEN TRIBUTARY B AND A = 12.8 M ³ /S	



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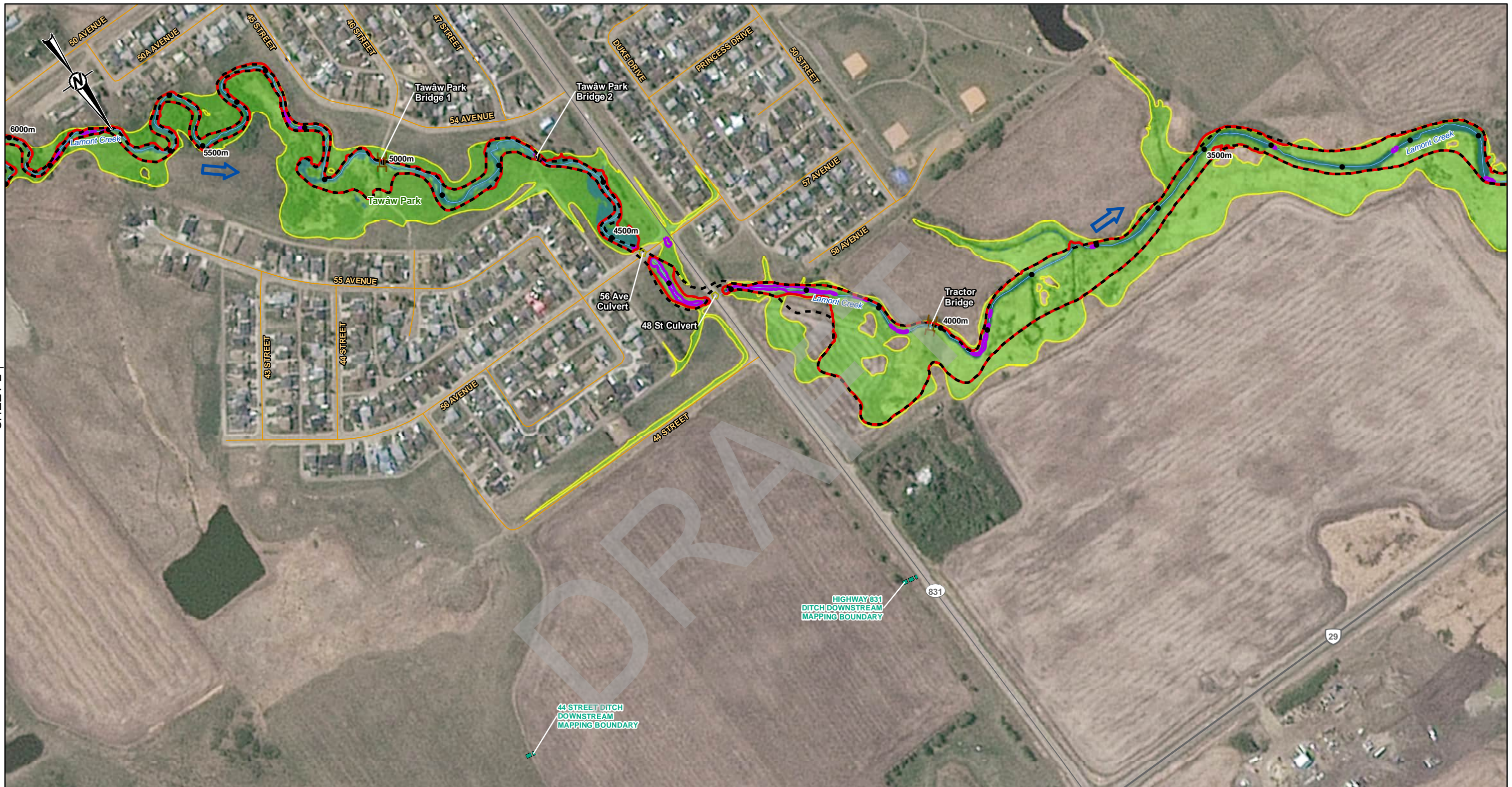


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TITLE		FLOODWAY CRITERIA MAP	
PROJECT NO.	CONTROL	REV.	FIGURE
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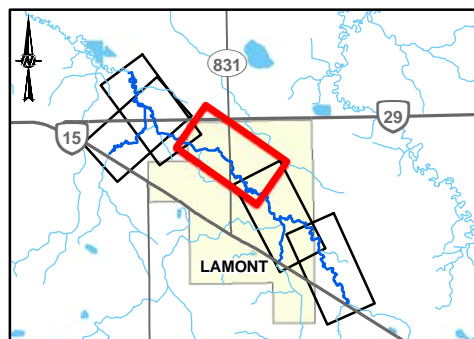
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■	MAPPING BOUNDARY
➔	FLOW DIRECTION
—	LOCAL ROAD
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY
+	RAILWAY
—	CHANNEL CENTRELINE
HYDRAULIC STRUCTURES	
⏏	CULVERT
⏏	BRIDGE
—	PROPOSED FLOODWAY BOUNDARY
- - -	PREVIOUS FLOODWAY (ADJUSTED)*
■	DEPTH ≥ 1 M
■	100-YEAR DESIGN FLOOD EXTENT
■	VELOCITY ≥ 1 M/S
DESIGN DISCHARGE (100-YR) LAMONT CREEK BETWEEN TRIBUTARY B AND A = 12.8 M ³ /S	



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AND PROTECTED AREAS

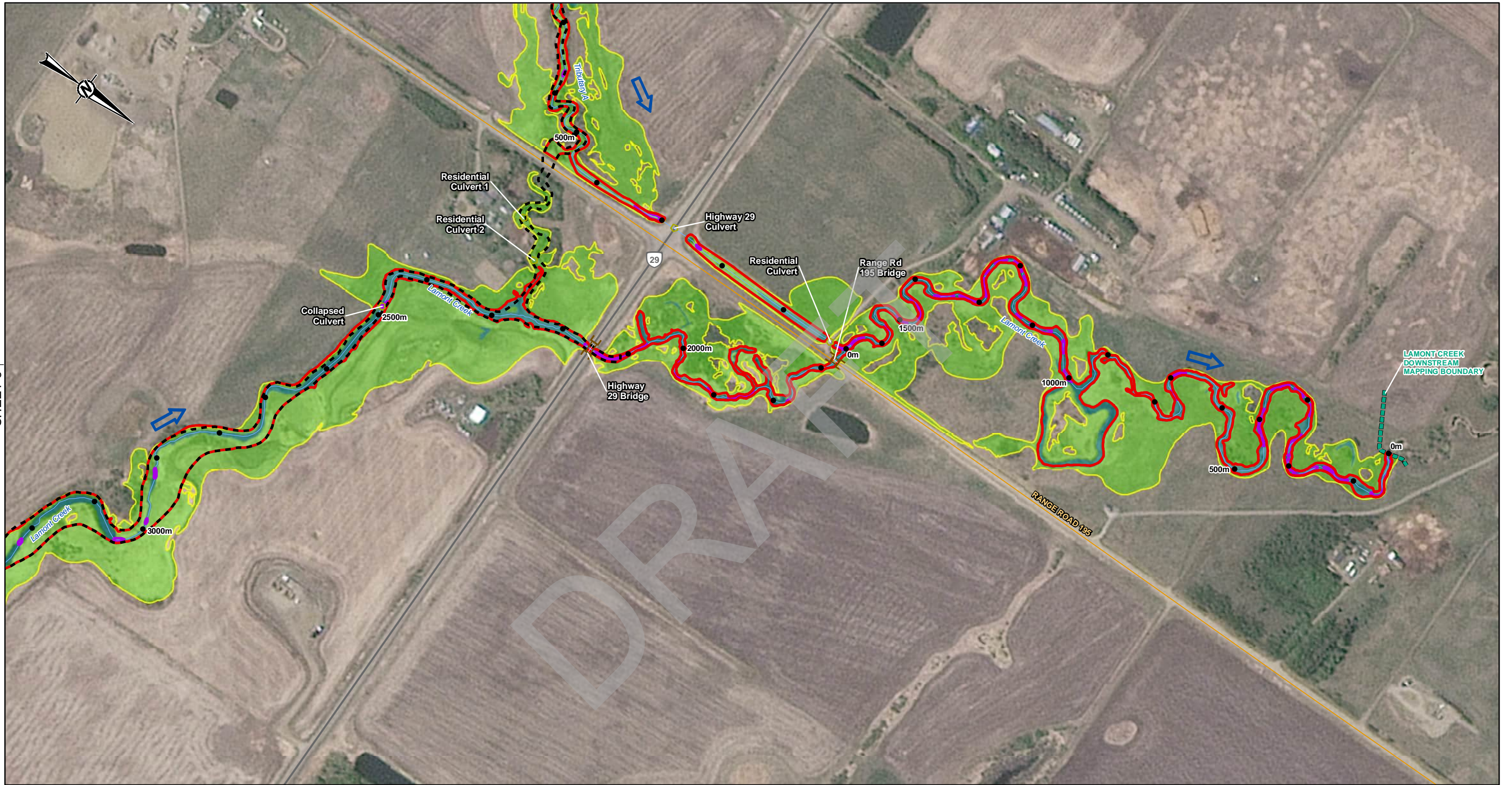


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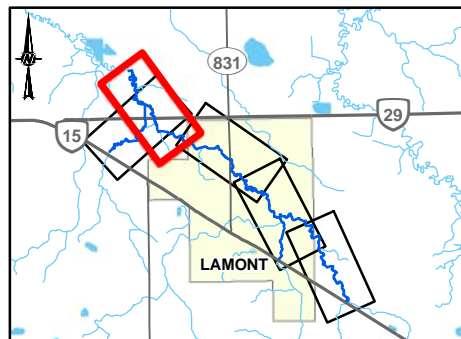
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PROJECT LAMONT FLOOD STUDY	
TITLE FLOODWAY CRITERIA MAP	
PROJECT NO. 23592565	CONTROL -
REV. 1	FIGURE 3 OF 5



LEGEND

- PROFILE STATION
 - MAPPING BOUNDARY
 - ➔ FLOW DIRECTION
 - LOCAL ROAD
 - PRIMARY HIGHWAY
 - SECONDARY HIGHWAY
 - RAILWAY
 - CHANNEL CENTRELINE
- HYDRAULIC STRUCTURES**
- ◻ CULVERT
 - BRIDGE
- PROPOSED FLOODWAY BOUNDARY
 - PREVIOUS FLOODWAY (ADJUSTED)*
 - DEPTH ≥ 1 M
 - 100-YEAR DESIGN FLOOD EXTENT
 - VELOCITY ≥ 1 M/S
- DESIGN DISCHARGE (100-YR)**
- TRIBUTARY A = 5.43 M³/S
 - LAMONT CREEK BETWEEN TRIBUTARY B AND A = 12.8 M³/S
 - LAMONT CREEK DOWNSTREAM OF TRIBUTARY A = 16.5 M³/S



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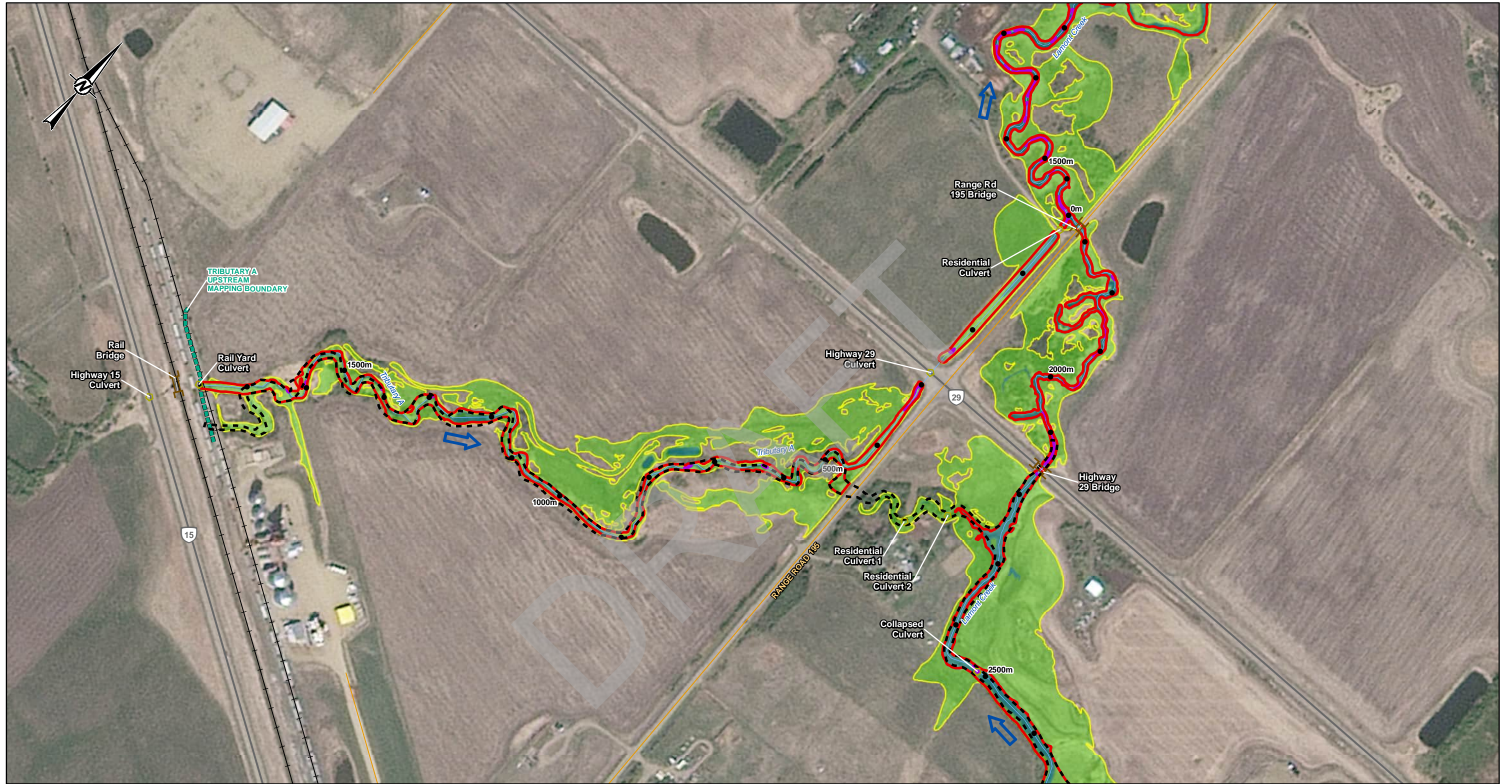
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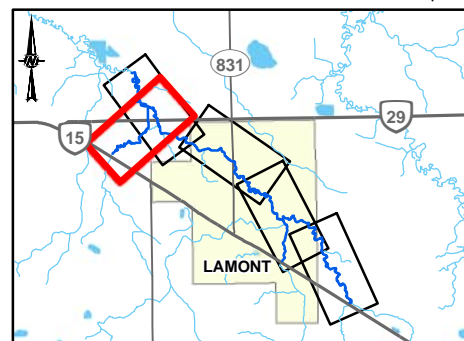
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TITLE
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■	MAPPING BOUNDARY
➔	FLOW DIRECTION
—	LOCAL ROAD
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY
+	RAILWAY
—	CHANNEL CENTRELINE
⬡	HYDRAULIC STRUCTURES
⬡	CULVERT
⬡	BRIDGE
—	PROPOSED FLOODWAY BOUNDARY
- - -	PREVIOUS FLOODWAY (ADJUSTED)*
■	DEPTH ≥ 1 M
■	100-YEAR DESIGN FLOOD EXTENT
■	VELOCITY ≥ 1 M/S
DESIGN DISCHARGE (100-YR)	
TRIBUTARY A = 5.43 M ³ /S	
LAMONT CREEK BETWEEN TRIBUTARY B AND A = 12.8 M ³ /S	
LAMONT CREEK DOWNSTREAM OF TRIBUTARY A = 16.5 M ³ /S	



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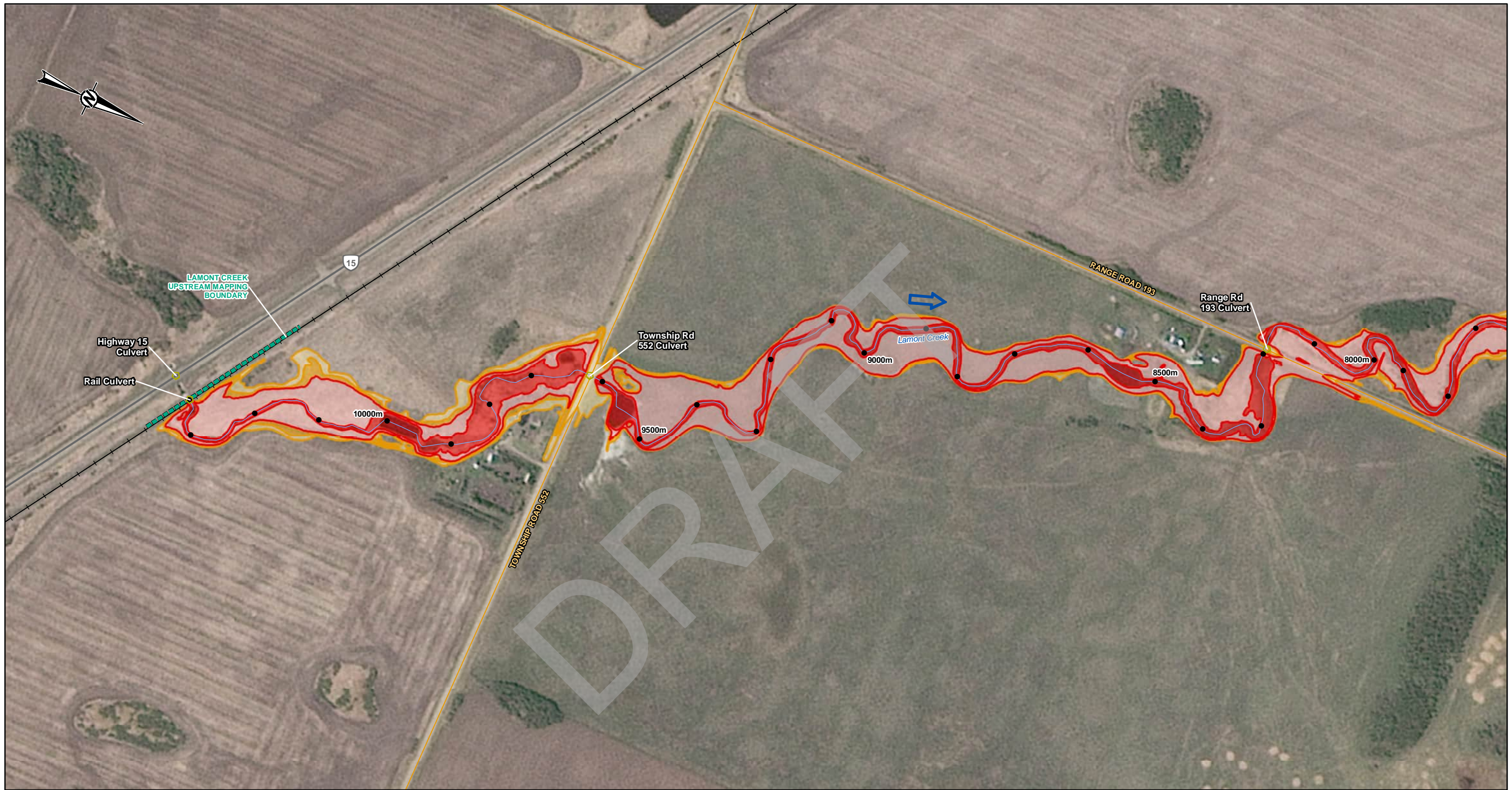
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PROJECT
LAMONT FLOOD STUDY

TITLE
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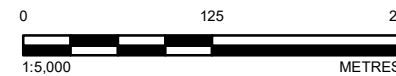
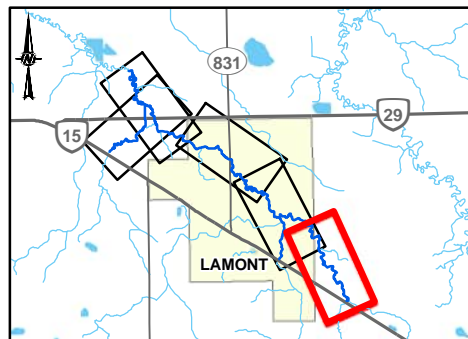
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| | MAPPING BOUNDARY | | HIGH HAZARD FLOOD FRINGE |
| | FLOW DIRECTION | | FLOOD FRINGE |
| | LOCAL ROAD | | 200-YEAR FLOOD EXTENT |
| | PRIMARY HIGHWAY | | 500-YEAR FLOOD EXTENT |
| | SECONDARY HIGHWAY | | |
| | RAILWAY | | |
| | CHANNEL CENTRELINE | | |
-
- | | |
|--|---------|
| | CULVERT |
| | BRIDGE |
-
- DESIGN DISCHARGE (100-YR)**
 LAMONT CREEK UPSTREAM OF TRIBUTARY B = 10.1 M³/S



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 AND PROTECTED AREAS



PROJECT
 LAMONT FLOOD STUDY

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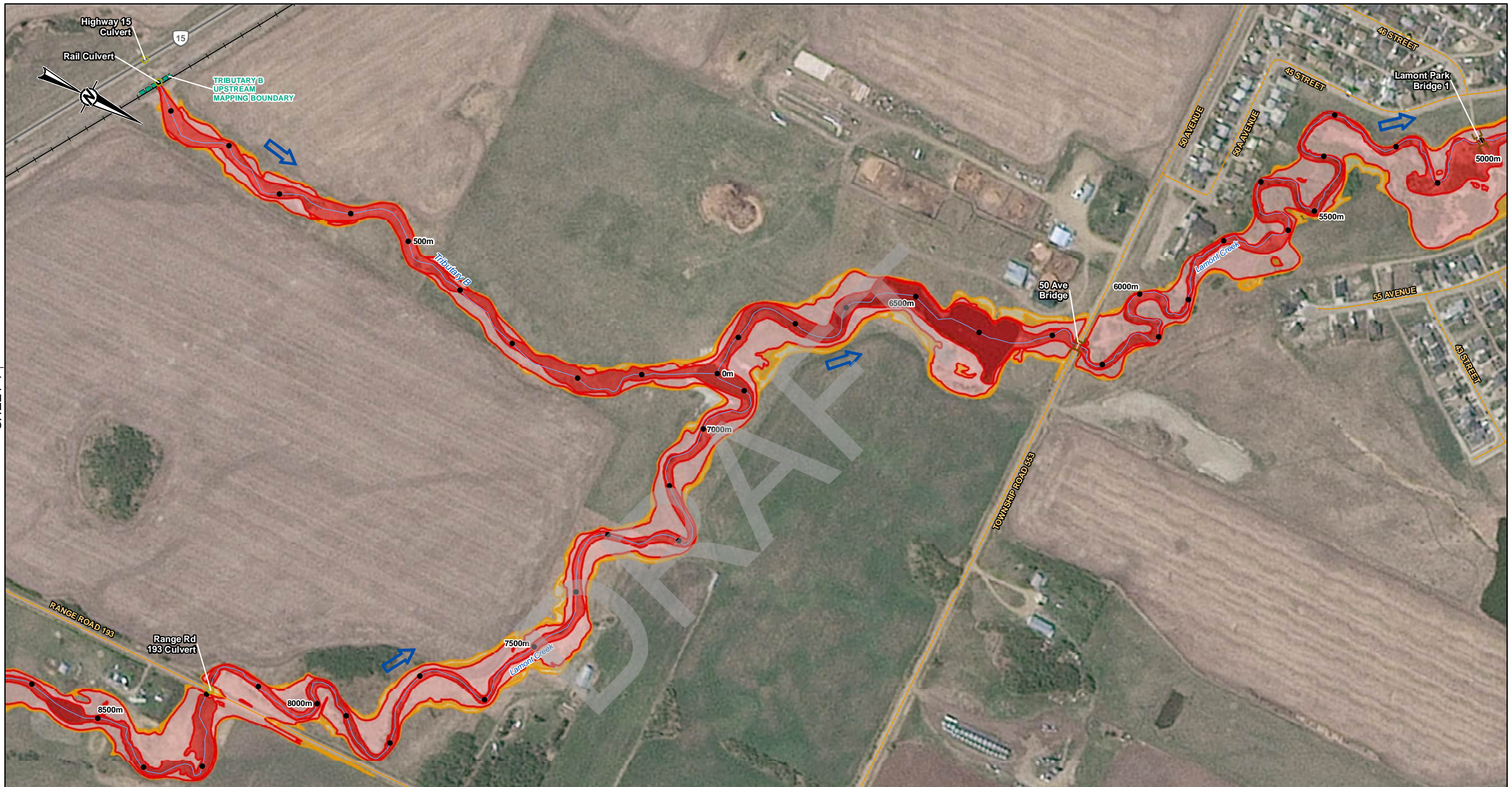


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APPROVED	JC

TITLE
FLOOD HAZARD MAP

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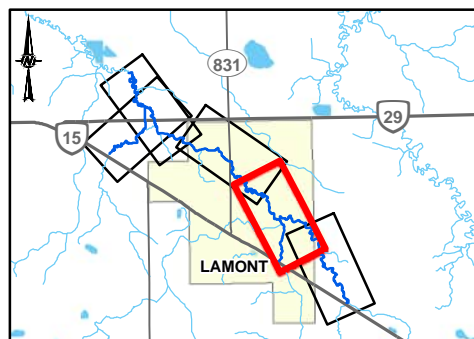
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	FLOW DIRECTION		FLOOD FRINGE
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	PRIMARY HIGHWAY		500-YEAR FLOOD EXTENT
	SECONDARY HIGHWAY		
	RAILWAY		
	CHANNEL CENTRELINE		

HYDRAULIC STRUCTURES

	CULVERT
	BRIDGE

DESIGN DISCHARGE (100-YR)

TRIBUTARY B = 2.76 M³/S
 LAMONT CREEK UPSTREAM OF TRIBUTARY B = 10.1 M³/S
 LAMONT CREEK BETWEEN TRIBUTARY B AND A = 12.8 M³/S



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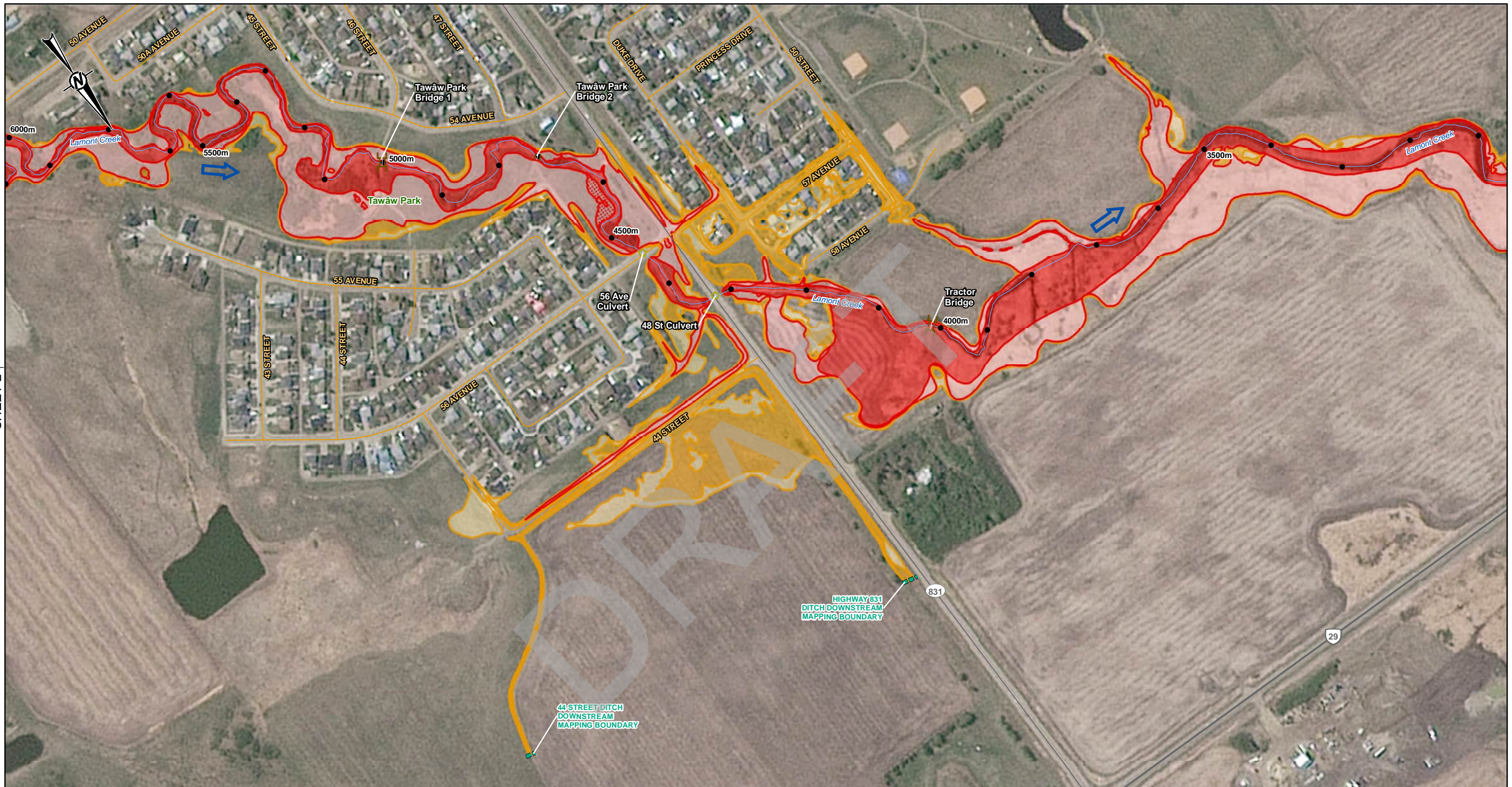
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PROJECT
LAMONT FLOOD STUDY

TITLE
FLOOD HAZARD MAP

PROJECT NO.	CONTROL	REV.	FIGURE
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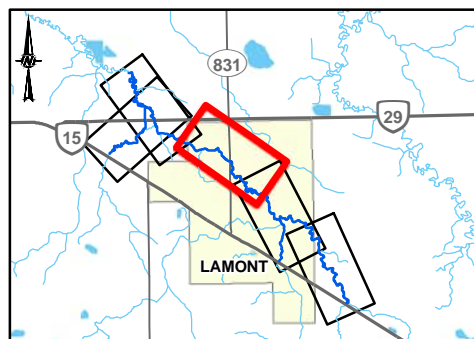
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➔	FLOW DIRECTION
—	LOCAL ROAD
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY
+	RAILWAY
—	CHANNEL CENTRELINE
HYDRAULIC STRUCTURES	
⏏	CULVERT
⏏	BRIDGE
■	FLOODWAY
■	HIGH HAZARD FLOOD FRINGE
■	FLOOD FRINGE
■	200-YEAR FLOOD EXTENT
■	500-YEAR FLOOD EXTENT
DESIGN DISCHARGE (100-YR) LAMONT CREEK BETWEEN TRIBUTARY B AND A = 12.8 M ³ /S	



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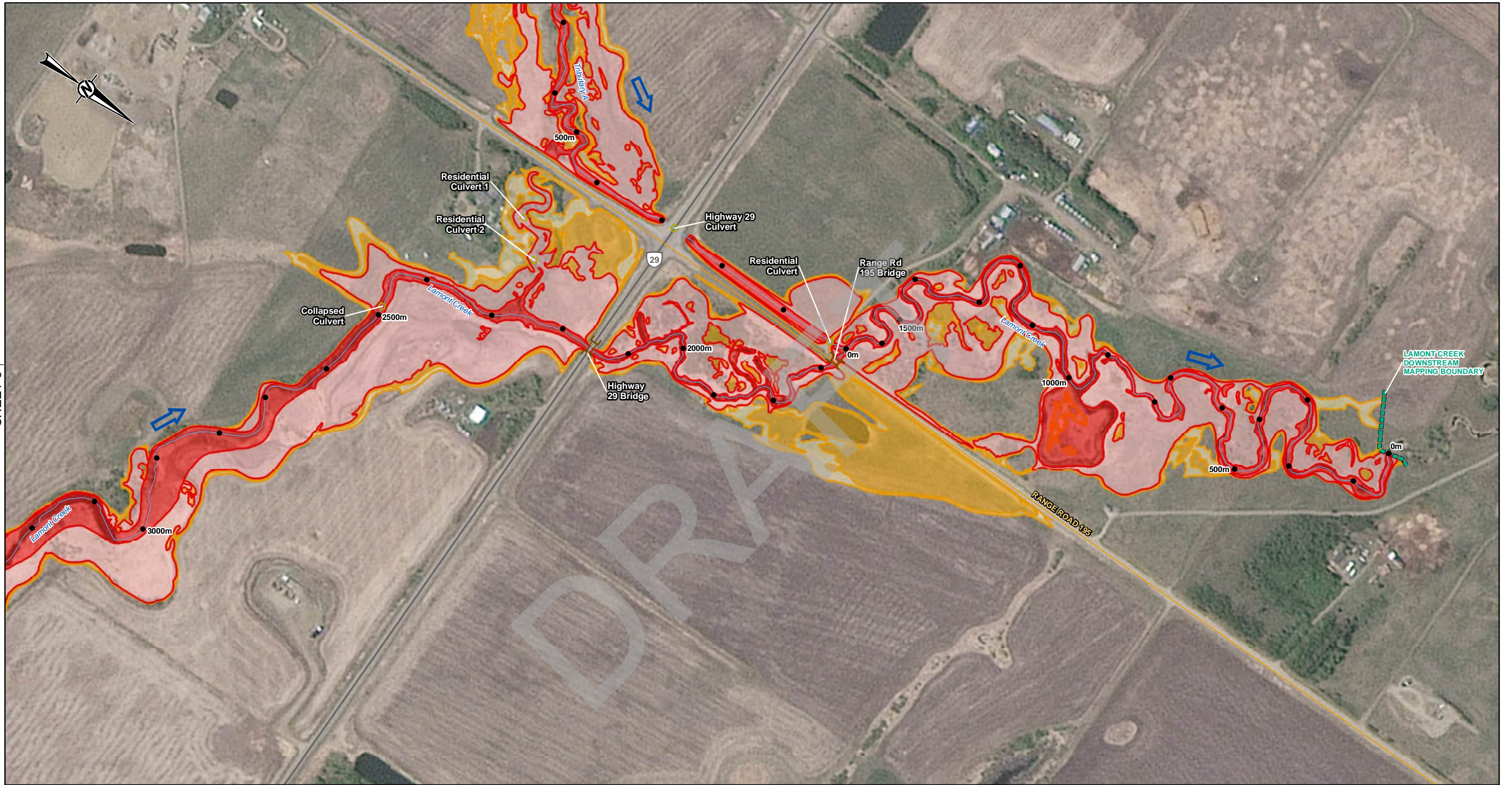
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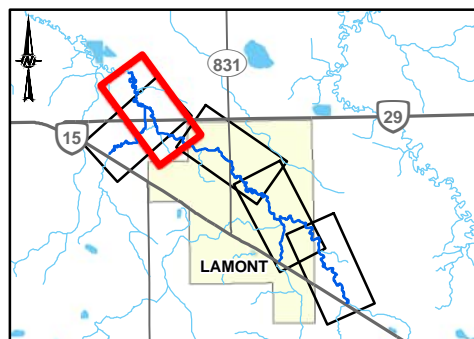
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TITLE
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➔	FLOW DIRECTION
—	LOCAL ROAD
—	PRIMARY HIGHWAY
—	SECONDARY HIGHWAY
+	RAILWAY
—	CHANNEL CENTRELINE
HYDRAULIC STRUCTURES	
⏏	CULVERT
⏏	BRIDGE
■	FLOODWAY
■	HIGH HAZARD FLOOD FRINGE
■	FLOOD FRINGE
■	200-YEAR FLOOD EXTENT
■	500-YEAR FLOOD EXTENT
DESIGN DISCHARGE (100-YR)	
TRIBUTARY A = 5.43 M ³ /S	
LAMONT CREEK BETWEEN TRIBUTARY B AND A = 12.8 M ³ /S	
LAMONT CREEK DOWNSTREAM OF TRIBUTARY A = 16.5 M ³ /S	



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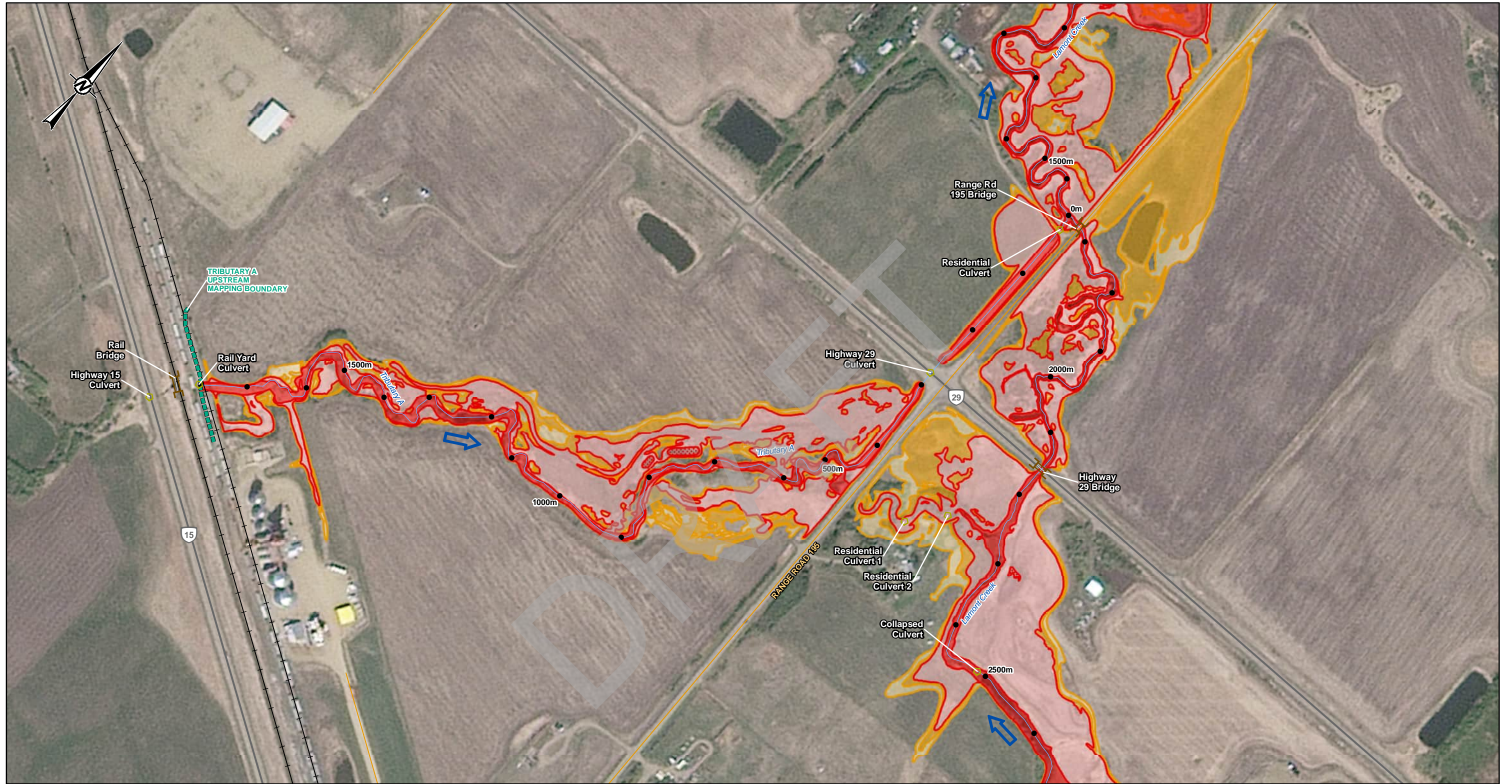
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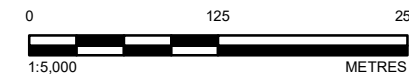
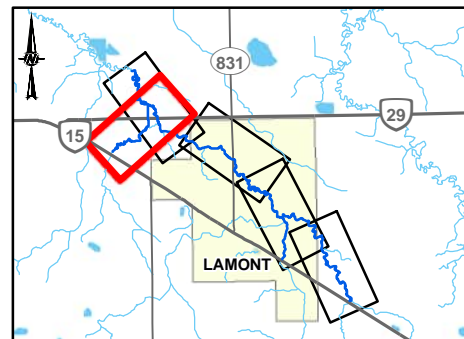
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REVIEWED	AC
APPROVED	JC

TITLE
FLOOD HAZARD MAP

PROJECT NO.	CONTROL	REV.	FIGURE
23592565	-	1	4 OF 5



LEGEND		HYDRAULIC STRUCTURES		DESIGN DISCHARGE (100-YR)	
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▬	MAPPING BOUNDARY	▨	HIGH HAZARD FLOOD FRINGE	LAMONT CREEK BETWEEN TRIBUTARY B AND A = 12.8 M ³ /S	
➡	FLOW DIRECTION	▭	FLOOD FRINGE	LAMONT CREEK DOWNSTREAM OF TRIBUTARY A = 16.5 M ³ /S	
—	LOCAL ROAD	▭	200-YEAR FLOOD EXTENT		
—	PRIMARY HIGHWAY	▭	500-YEAR FLOOD EXTENT		
—	SECONDARY HIGHWAY				
—	RAILWAY				
—	CHANNEL CENTRELINE				



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PROJECT
LAMONT FLOOD STUDY

TITLE
FLOOD HAZARD MAP

PROJECT NO.	CONTROL	REV.	FIGURE
23592565	-	1	5 OF 5

APPENDIX H

**Cursory Climate Change
Assessment Flood Profiles**

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Table H-1: Water Levels along Lamont Creek for Cursory Climate Change Assessment

River	River Station (m)	Water Level for 100-Year Peak Flow (Base Case) (m)	Water Level for 10% Increase in Peak Flow (m)	Water Level for 20% Increase in Peak Flow (m)	Difference due to 10% increase in Peak Flow (m)	Difference due to 20% increase in Peak Flow (m)
Lamont Creek	10300	654.71	654.81	654.92	0.09	0.20
Lamont Creek	10200	654.65	654.76	654.88	0.11	0.23
Lamont Creek	10100	654.60	654.72	654.85	0.13	0.25
Lamont Creek	10000	654.58	654.71	654.84	0.13	0.26
Lamont Creek	9900	654.56	654.69	654.83	0.13	0.27
Lamont Creek	9800	654.55	654.68	654.82	0.13	0.27
Lamont Creek	9700	654.53	654.67	654.80	0.14	0.28
Lamont Creek	9600	653.37	653.40	653.43	0.03	0.06
Lamont Creek	9500	653.00	653.02	653.05	0.02	0.05
Lamont Creek	9400	652.87	652.90	652.93	0.03	0.06
Lamont Creek	9300	652.77	652.80	652.83	0.03	0.06
Lamont Creek	9300	652.77	652.80	652.83	0.03	0.06
Lamont Creek	9200	652.64	652.67	652.70	0.03	0.06
Lamont Creek	9100	652.38	652.41	652.44	0.03	0.06
Lamont Creek	9000	652.26	652.30	652.33	0.03	0.07
Lamont Creek	9000	652.26	652.30	652.33	0.03	0.07
Lamont Creek	8900	652.15	652.19	652.22	0.04	0.07
Lamont Creek	8800	652.07	652.11	652.14	0.04	0.07
Lamont Creek	8700	652.00	652.03	652.07	0.04	0.07
Lamont Creek	8600	651.90	651.93	651.97	0.03	0.07
Lamont Creek	8500	651.86	651.89	651.92	0.03	0.06
Lamont Creek	8400	651.80	651.83	651.85	0.03	0.05
Lamont Creek	8300	651.79	651.81	651.84	0.03	0.05
Lamont Creek	8200	651.78	651.80	651.83	0.02	0.05
Lamont Creek	8100	651.08	651.11	651.14	0.03	0.06

Table H-1: Water Levels along Lamont Creek for Cursory Climate Change Assessment

River	River Station (m)	Water Level for 100-Year Peak Flow (Base Case) (m)	Water Level for 10% Increase in Peak Flow (m)	Water Level for 20% Increase in Peak Flow (m)	Difference due to 10% increase in Peak Flow (m)	Difference due to 20% increase in Peak Flow (m)
Lamont Creek	8000	650.92	650.95	650.98	0.03	0.06
Lamont Creek	7900	650.66	650.69	650.72	0.03	0.06
Lamont Creek	7800	650.48	650.52	650.55	0.04	0.07
Lamont Creek	7700	650.32	650.35	650.38	0.03	0.07
Lamont Creek	7600	650.20	650.23	650.27	0.03	0.07
Lamont Creek	7500	650.00	650.03	650.07	0.04	0.08
Lamont Creek	7400	649.83	649.87	649.91	0.04	0.07
Lamont Creek	7300	649.62	649.66	649.69	0.04	0.07
Lamont Creek	7300	649.62	649.66	649.69	0.04	0.07
Lamont Creek	7200	649.44	649.48	649.52	0.04	0.07
Lamont Creek	7100	649.38	649.42	649.46	0.04	0.08
Lamont Creek	7000	649.28	649.32	649.35	0.04	0.07
Lamont Creek	6900	649.19	649.22	649.26	0.04	0.07
Lamont Creek	6800	649.11	649.15	649.19	0.04	0.08
Lamont Creek	6800	649.11	649.15	649.19	0.04	0.08
Lamont Creek	6700	648.99	649.03	649.07	0.04	0.09
Lamont Creek	6600	648.88	648.92	648.97	0.05	0.10
Lamont Creek	6500	648.77	648.82	648.87	0.05	0.10
Lamont Creek	6400	648.75	648.80	648.85	0.05	0.10
Lamont Creek	6300	648.59	648.64	648.70	0.05	0.11
Lamont Creek	6200	648.22	648.25	648.28	0.03	0.06
Lamont Creek	6100	648.06	648.09	648.13	0.03	0.07
Lamont Creek	6000	648.01	648.05	648.08	0.04	0.07
Lamont Creek	5900	647.90	647.94	647.98	0.04	0.08
Lamont Creek	5800	647.68	647.71	647.74	0.03	0.06

Table H-1: Water Levels along Lamont Creek for Cursory Climate Change Assessment

River	River Station (m)	Water Level for 100-Year Peak Flow (Base Case) (m)	Water Level for 10% Increase in Peak Flow (m)	Water Level for 20% Increase in Peak Flow (m)	Difference due to 10% increase in Peak Flow (m)	Difference due to 20% increase in Peak Flow (m)
Lamont Creek	5700	647.56	647.59	647.62	0.03	0.06
Lamont Creek	5600	647.44	647.47	647.50	0.03	0.06
Lamont Creek	5500	647.27	647.30	647.33	0.03	0.06
Lamont Creek	5400	647.14	647.17	647.21	0.04	0.07
Lamont Creek	5300	647.06	647.10	647.14	0.04	0.08
Lamont Creek	5200	646.90	646.94	646.97	0.03	0.06
Lamont Creek	5100	646.79	646.82	646.86	0.03	0.07
Lamont Creek	5100	646.79	646.82	646.86	0.03	0.07
Lamont Creek	5000	646.74	646.78	646.81	0.04	0.07
Lamont Creek	4900	646.66	646.70	646.73	0.04	0.08
Lamont Creek	4800	646.60	646.64	646.67	0.04	0.07
Lamont Creek	4700	646.53	646.58	646.61	0.04	0.07
Lamont Creek	4600	646.43	646.48	646.51	0.04	0.08
Lamont Creek	4500	646.42	646.46	646.50	0.04	0.08
Lamont Creek	4500	646.42	646.46	646.50	0.04	0.08
Lamont Creek	4400	645.40	645.45	645.49	0.05	0.09
Lamont Creek	4300	644.99	645.03	645.07	0.04	0.07
Lamont Creek	4200	644.42	644.45	644.48	0.03	0.06
Lamont Creek	4100	644.12	644.14	644.17	0.02	0.05
Lamont Creek	4000	643.87	643.90	643.93	0.03	0.05
Lamont Creek	3900	643.60	643.62	643.64	0.02	0.04
Lamont Creek	3800	643.33	643.35	643.38	0.02	0.04
Lamont Creek	3700	643.14	643.17	643.20	0.03	0.06
Lamont Creek	3600	642.92	642.95	642.97	0.03	0.05
Lamont Creek	3500	642.72	642.75	642.78	0.03	0.06

Table H-1: Water Levels along Lamont Creek for Cursory Climate Change Assessment

River	River Station (m)	Water Level for 100-Year Peak Flow (Base Case) (m)	Water Level for 10% Increase in Peak Flow (m)	Water Level for 20% Increase in Peak Flow (m)	Difference due to 10% increase in Peak Flow (m)	Difference due to 20% increase in Peak Flow (m)
Lamont Creek	3400	642.59	642.62	642.65	0.03	0.06
Lamont Creek	3300	642.45	642.48	642.51	0.03	0.06
Lamont Creek	3200	642.30	642.33	642.36	0.03	0.06
Lamont Creek	3100	642.11	642.14	642.17	0.03	0.06
Lamont Creek	3000	641.92	641.95	641.97	0.03	0.06
Lamont Creek	2900	641.66	641.69	641.72	0.03	0.06
Lamont Creek	2800	641.46	641.50	641.54	0.04	0.07
Lamont Creek	2700	641.34	641.38	641.42	0.04	0.08
Lamont Creek	2600	641.24	641.29	641.34	0.05	0.09
Lamont Creek	2500	641.18	641.23	641.28	0.05	0.10
Lamont Creek	2400	641.15	641.20	641.26	0.05	0.11
Lamont Creek	2300	641.12	641.17	641.23	0.06	0.12
Lamont Creek	2300	641.12	641.17	641.23	0.06	0.12
Lamont Creek	2200	641.09	641.15	641.21	0.06	0.12
Lamont Creek	2100	640.78	640.82	640.85	0.04	0.07
Lamont Creek	2000	640.59	640.62	640.65	0.03	0.06
Lamont Creek	1900	640.41	640.45	640.48	0.04	0.07
Lamont Creek	1800	640.28	640.32	640.36	0.04	0.07
Lamont Creek	1800	640.28	640.32	640.36	0.04	0.07
Lamont Creek	1700	640.19	640.23	640.26	0.04	0.07
Lamont Creek	1600	639.99	640.02	640.04	0.03	0.05
Lamont Creek	1500	639.89	639.92	639.94	0.03	0.06
Lamont Creek	1500	639.89	639.92	639.94	0.03	0.06
Lamont Creek	1400	639.73	639.77	639.80	0.03	0.06
Lamont Creek	1300	639.59	639.62	639.65	0.03	0.06

Table H-1: Water Levels along Lamont Creek for Cursory Climate Change Assessment

River	River Station (m)	Water Level for 100-Year Peak Flow (Base Case) (m)	Water Level for 10% Increase in Peak Flow (m)	Water Level for 20% Increase in Peak Flow (m)	Difference due to 10% increase in Peak Flow (m)	Difference due to 20% increase in Peak Flow (m)
Lamont Creek	1200	639.44	639.47	639.50	0.03	0.06
Lamont Creek	1100	639.29	639.33	639.36	0.04	0.07
Lamont Creek	1000	639.08	639.10	639.12	0.02	0.05
Lamont Creek	900	639.00	639.02	639.05	0.03	0.05
Lamont Creek	800	638.85	638.88	638.90	0.03	0.05
Lamont Creek	700	638.72	638.76	638.79	0.03	0.06
Lamont Creek	600	638.60	638.64	638.67	0.03	0.07
Lamont Creek	500	638.49	638.53	638.56	0.04	0.07
Lamont Creek	400	638.35	638.39	638.43	0.04	0.07
Lamont Creek	300	638.18	638.22	638.26	0.04	0.08
Lamont Creek	200	637.98	638.03	638.07	0.05	0.09
Lamont Creek	100	637.74	637.78	637.82	0.05	0.09
Lamont Creek	0	654.71	654.81	654.92	0.09	0.20

Table H-2: Water Levels along Tributary A for Cursory Climate Change Assessment

River	River Station (m)	Water Level for 100-Year Peak Flow (Base Case) (m)	Water Level for 10% Increase in Peak Flow (m)	Water Level for 20% Increase in Peak Flow (m)	Difference due to 10% increase in Peak Flow (m)	Difference due to 20% increase in Peak Flow (m)
Tributary A	1700	646.48	646.51	646.54	0.04	0.07
Tributary A	1600	646.03	646.07	646.10	0.03	0.06
Tributary A	1500	645.72	645.74	645.77	0.03	0.05
Tributary A	1400	645.31	645.33	645.35	0.02	0.04
Tributary A	1400	645.31	645.33	645.35	0.02	0.04
Tributary A	1300	644.92	644.94	644.97	0.03	0.05
Tributary A	1200	644.62	644.65	644.67	0.03	0.05
Tributary A	1100	644.25	644.28	644.30	0.02	0.04
Tributary A	1100	644.25	644.28	644.30	0.02	0.04
Tributary A	1000	643.99	644.01	644.03	0.02	0.04
Tributary A	900	643.67	643.70	643.72	0.03	0.05
Tributary A	800	643.35	643.37	643.38	0.02	0.04
Tributary A	700	642.93	642.95	642.96	0.02	0.03
Tributary A	600	642.47	642.48	642.49	0.01	0.01
Tributary A	500	642.19	642.20	642.22	0.02	0.03
Tributary A	400	641.89	641.92	641.95	0.03	0.06
Tributary A	300	641.16	641.21	641.26	0.05	0.10
Tributary A	200	640.41	640.45	640.48	0.04	0.08
Tributary A	100	640.20	640.24	640.27	0.04	0.07
Tributary A	0	646.48	646.51	646.54	0.04	0.07

Table H-3: Water Levels along Tributary B for Cursory Climate Change Assessment

River	River Station (m)	Water Level for 100-Year Peak Flow (Base Case) (m)	Water Level for 10% Increase in Peak Flow (m)	Water Level for 20% Increase in Peak Flow (m)	Difference due to 10% increase in Peak Flow (m)	Difference due to 20% increase in Peak Flow (m)
Tributary B	900	653.13	653.14	653.16	0.02	0.03
Tributary B	800	652.61	652.63	652.65	0.02	0.04
Tributary B	700	652.40	652.41	652.42	0.01	0.03
Tributary B	600	651.72	651.73	651.75	0.02	0.04
Tributary B	500	651.06	651.07	651.09	0.02	0.04
Tributary B	400	650.52	650.54	650.56	0.02	0.04
Tributary B	300	650.15	650.17	650.19	0.02	0.03
Tributary B	200	649.79	649.81	649.82	0.02	0.03
Tributary B	100	649.27	649.30	649.33	0.03	0.06
Tributary B	0	653.13	653.14	653.16	0.02	0.03



Figure H-1: Water Level Difference along Lamont Creek from Cursory Climate Change Assessment

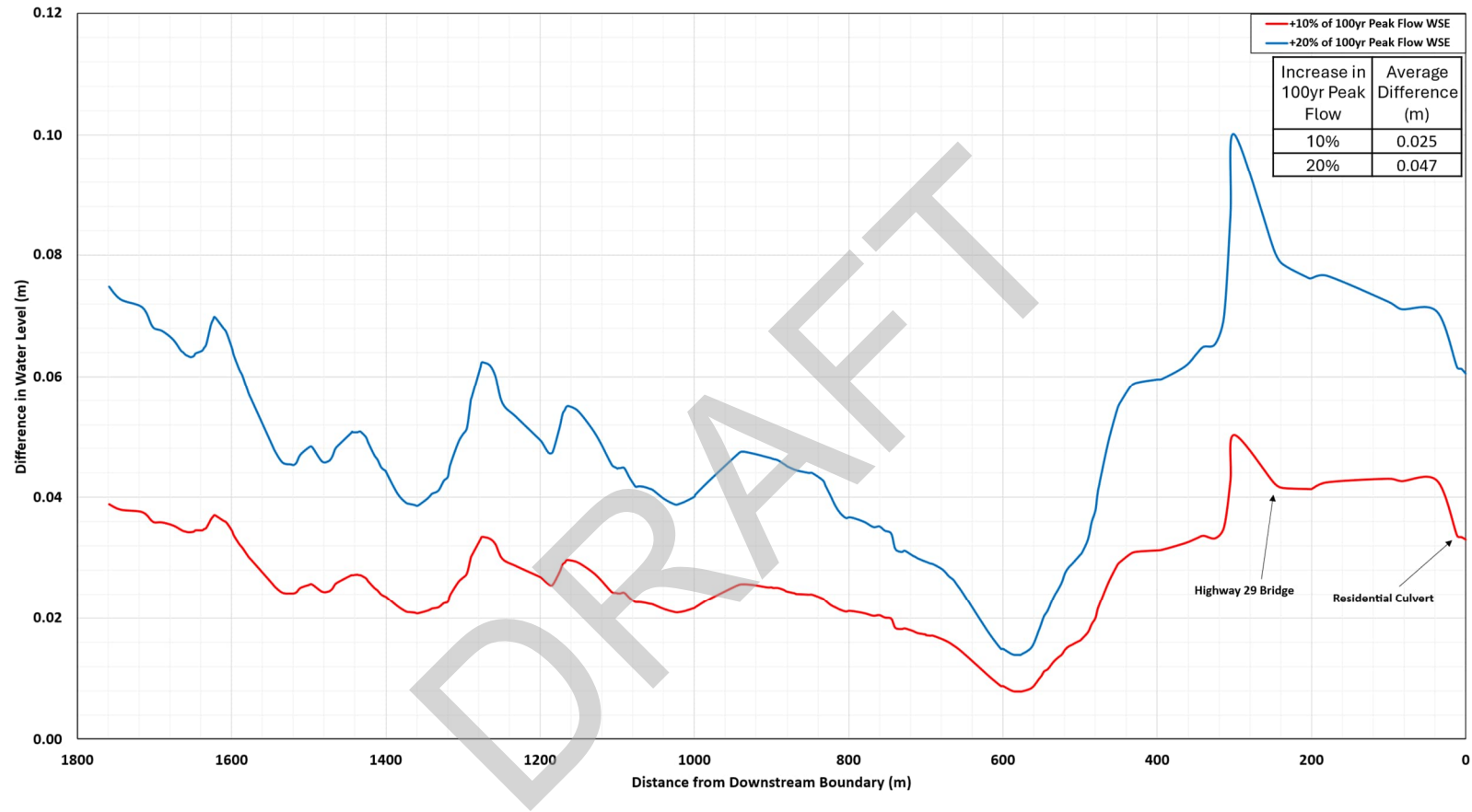


Figure H-2: Water Level Difference along Tributary A from Cursory Climate Change Assessment

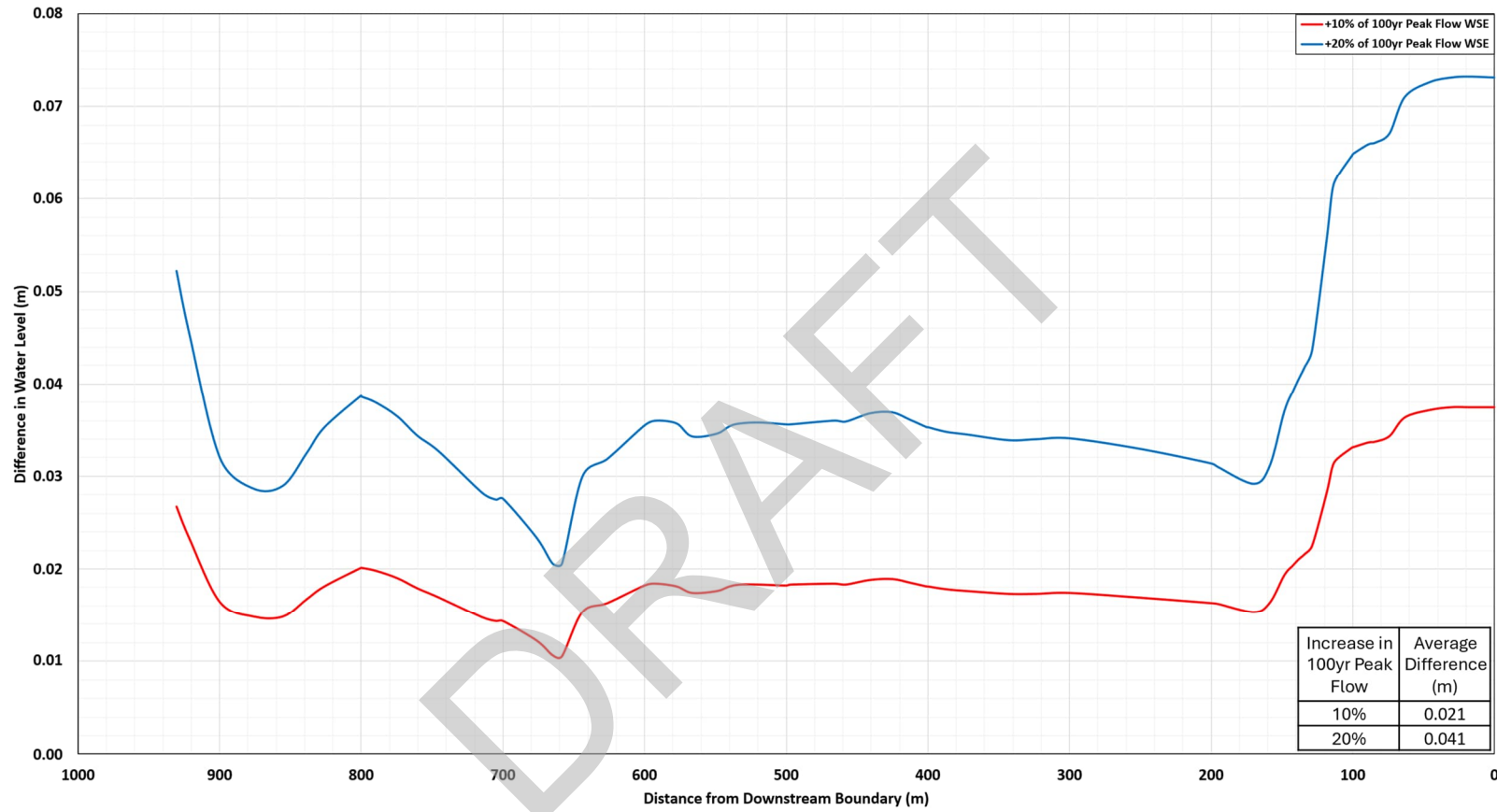


Figure H-3: Water Level Difference along Tributary B from Cursory Climate Change Assessment

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