Carmacks Flood Mapping Study – Final Report

May 22, 2024

Prepared for:
Water Resources Branch, Department of Environment, Government of Yukon

Prepared by:
Stantec Consulting Ltd.

Project Number:
123222320

Revision	Description	Author	Date	Quality Check	Date	Independent Review	Date
0	Final Report – DRAFT FOR CLIENT REVIEW	Dilling/ Muirhead	2024-03-24	Kimiaghalam/ Naghibi/Wood	2024-03-25	Brown	2024-03-25
1	Final Report	Dilling/ Muirhead	2024-05-09	Kimiaghalam/ Naghibi/Wood	2024-05-10	Brown	2024-05-10

Limitations and Sign-off

The conclusions in the Report titled Carmacks Flood Mapping Project – Final Report are Stantec's professional opinion, as of the time of the Report, and concerning the scope described in the Report. The opinions in the document are based on conditions and information existing at the time the scope of work was conducted and do not take into account any subsequent changes. The Report relates solely to the specific project for which Stantec was retained and the stated purpose for which the Report was prepared. The Report is not to be used or relied on for any variation or extension of the project, or for any other project or purpose, and any unauthorized use or reliance is at the recipient's own risk. Stantec has assumed all information received from Water Resources Branch, Department of Environment, Government of Yukon (the "Client") and third parties in the preparation of the Report to be correct. While Stantec has exercised a customary level of judgment or due diligence in the use of such information, Stantec assumes no responsibility for the consequences of any error or omission contained therein. This Report is intended solely for use by the Client in accordance with Stantec's contract with the Client. While the Report may be provided by the Client to applicable authorities having jurisdiction and to other third parties in connection with the project, Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any third party, and will not be liable to such third party for any damages or losses of any kind that may result.

Prepared by: PROFESSIONAL YUKON SCOTT DILLING TERRITORY 2024-05-22 ENGINEER

Seal

Scott Dilling, M.ASc., P.Eng.
Water Resources Engineer

Prepared by: PROFESSIONAL YUKON JEFFREY W. MUIRHEAD TERRITORY #3036 ENGINEER 2024-05-22

Seal

Jeff Muirhead, M.ASc., P.Eng.
River Engineer, Project Manager

Reviewed by:
(Section 3 and 4)

Digitally signed by Ali Naghibi
Date: 2024.05.23 15:00:52 -07'00'

Signature

Ali Naghibi, Ph.D., P.Eng.
Senior Water Resources Engineer

Reviewed by:
(Section 7 only)

Digitally signed by Kimiaghalam, Navid
Date: 2024.05.22 08:41:48 -04'00'

Signature

Navid Kimiaghalam, Ph.D., P.Eng.
(ON, MB, AB, BC)
Senior Hydrotechnical Engineer

Reviewed by:

Digitally signed by Wood, Matt (Calgary)
Date: 2024.05.22 09:25:05-06'00'

Signature

Matt Wood, P.Eng.
(AB, SK, BC, NWT/NU)
Principal Hydrotechnical Engineer
Canada West Water Resources Sector Lead

Approved by:

Digitally signed by Brown, Steve (Waterloo)
Date: 2024.05.22 10:48:08 -04'00'

Signature

Steve Brown, MBA, P.Eng.
(ON, MB, NWT/NU)
Canada East Surface Water Lead

PERMIT TO PRACTICE
STANTEC CONSULTING LTD.
Signature
Date May 23, 2024
PERMIT NUMBER: PP052
Association of Professional Engineers of Yukon

Executive Summary

Stantec was retained by Yukon Government Water Resources Branch to perform the Carmacks Flood Mapping Study (the Project) following the Federal Flood Mapping Guideline Series (NRCan 2018a; NRCan 2018b; NRCan 2019a; NRCan 2019b; NRCan 2022). The Project was funded in part by Natural Resources Canada through the Flood Hazard Information and Mapping Program. The final outcome of the Project are flood hazard maps (as defined in NRCan 2018a) for the Yukon River (*Tàgé Cho Gé*) and the Nordenskiold River (*Tsâwnjik Chu*) within the Study Area at Carmacks. The Study Area is located within the traditional territory of the Little Salmon/Carmacks First Nation (LS/CFN).

A hydrological assessment was completed to determine freeze-up, breakup, and open water flood frequency estimates on each of the Nordenskiold River and Yukon River. Individual datasets of the annual maximum instantaneous discharges during these three flooding periods were prepared. Single station flood frequency analyses were conducted to estimate annual exceedance probabilities (AEPs) of 50%, 20%, 10%, 5%, 2%, 1%, 0.5%, and 0.2% for Water Survey of Canada (WSC) Station 09AH004 (Nordenskiold River Below Rowlinson Creek) and WSC Station 09AH001 (Yukon River at Carmacks) during the freeze-up, breakup, and open water period (Table E1).

Table E1 Results of Hydrologic Assessment

AEP	Nordenskiold River Peak Instantaneous Discharge (m^3/s)			Yukon River Peak Instantaneous Discharge (m^3/s)		
	Freeze-up	**Breakup**	**Open Water**	**Freeze-up**	**Breakup**	**Open Water**
50% AEP (1:2-year event)	12	24	93	453	555	1900
20% AEP (1:5-year event)	17	48	140	579	773	2360
10% AEP (1:10-year event)	20	68	171	660	924	2650
5% AEP (1:20-year event)	23	91	201	737	1070	2910
2% AEP (1:50-year event)	26	124	239	835	1280	3250
1% AEP (1:100-year event)	29	153	267	908	1440	3500
0.5% AEP (1:200-year event)	31	185	296	981	1600	3740
0.2% AEP (1:500-year event)	34	231	333	1080	1830	4060

Flooding on the Nordenskiold River can occur from open water flows or from ice jamming. Nordenskiold River ice jams have been documented at three separate locations within the Study Reach: one near Casino Way, one near Ptarmigan Way; and one between River Drive and the confluence with the Yukon River. Flooding on the Yukon River is largely snowmelt driven with a single open water peak in late June/early July. Ice jam processes have not been documented as leading to extreme flooding on the Yukon River. Freeze-up processes are not considered to be driving the flood events in on the Yukon River or Nordenskiold River.

As part of the hydrologic analysis, a joint probably analysis was conducted to identify appropriate and plausible pairings of Nordenskiold River/Yukon River flow as to represent the AEP inundation under three separate dominant flood processes. For each design AEP scenario, a Nordenskiold River primary run (consisting of the AEP flow for the Nordenskiold River and an appropriate paired flow on the Yukon River) and a Yukon River primary run (consisting of the AEP flow for the Yukon River and an appropriate paired flow on the Nordenskiold River) were completed for the three flooding scenarios:

- Open water flooding on the Yukon River
- Open water flooding on the Nordenskiold River
- Breakup jams on the Nordenskiold River

Climate change in the Nordenskiold River and Yukon River at Carmacks watersheds is expected to result in higher precipitation (both annually and on an event-basis) and higher temperatures. It is likely that this will result in increased flood flow magnitudes on both rivers, but likely more magnified on the Nordenskiold River. The adopted climate change factors of safety for this Project are:

- 1.1 (+10%) for the Yukon River flows
- 1.2 (+20%) for the Nordenskiold River flows

To support development of the hydraulic model a total of 61 cross-sections and 300 m of bathymetry data was surveyed on the Nordenskiold River. For the Yukon River, a total of 30 cross-sections and 8.5 km of bathymetry data was surveyed. The River Drive bridge, Casino Way bridge and Klondike Highway bridges were surveyed. On the Nordenskiold River, a water surface elevation profile survey and flow measurement were collected for a high open water flow event in May 2023. High water marks, ice scars and relevant Nordenskiold River ice jam parameters were surveyed. On the Yukon River, water surface elevation profiles and flows for three open water events were compiled: June 2021, June 2022 and June 2023.

A one-dimensional (1D) HEC-RAS model was developed to perform the hydraulic analysis for the Study Area. The hydraulic model was a single model (one domain) which simultaneously performed hydraulic calculations in the Nordenskiold River and the Yukon River. Open water model calibration on the Nordenskiold River was completed for the May 2023 flood event. Simulated WSEs were compared to surveyed WSEs obtained during the event and model calibration indicates a strong and slightly conservative model. No open water validation event was available for this Project.

Open water model calibration on the Yukon River was completed for the June 2022 flood event. Simulated WSEs were compared to surveyed WSEs obtained during the event. Calibration indicates a strong and slightly conservative calibrated model. Open water validation events were performed for the June 2021 and June 2023 flood events, and WSEs compared in a similar manner to the calibration event. The validation results indicated that the calibrated model is conservative in simulating WSEs at flows in the range of the validation events.

Open water sensitivity analysis was completed for the 0.5% AEP design run for each river; the Nordenskiold River was evaluated for sensitivity to changes in Mannings n (+/-10%), and the Yukon River was evaluated for sensitivity to changes in Mannings n (+/-10%) as well as changes to the downstream

boundary condition (energy slope +/- 50%). WSEs increased with increases to Mannings and decreased with decreases to Mannings n. The downstream boundary condition sensitivity analysis indicated that the Yukon River downstream of the confluence is more affected than the reach upstream of the confluence.

Breakup ice jam modelling was completed for the Nordenskiold River. Breakup ice jam design AEP runs were completed for the Nordenskiold River using the calibrated breakup ice jam parameters at three separate ice jam locations. Each ice jam was simulated independently, and inundations combined following the ice jam runs. Downstream boundary conditions were the Yukon River WSE under the paired Yukon River flow for the given Nordenskiold River run assuming a 1.2 m Yukon River ice cover condition, consistent with observed characteristics of the Yukon River during Nordenskiold River breakup. Breakup ice jam calibration was completed for the April 22, 2020 breakup ice jam at Station 0+740 (downstream of River Drive bridge) using a flow estimated for that day and two surveyed ice jam high water marks from the event. The ice jam calibration achieved acceptable WSE differentials (2.6% and 6.5% of average maximum flow depth in the ice jam reach), given the uncertainty associated with ice jam modelling (e.g., data sparsity, model limitations). No ice jam validation events were available for this Project.

Using the results of the hydrologic analysis, hydraulic modelling was completed to support the development of flood maps for five design AEPs: 5% AEP, 5% AEP + climate change, 1% AEP, 0.5% AEP, and 0.5% AEP + climate change.

The results of the design AEP model runs (Nordenskiold River breakup ice jam run, a Nordenskiold River primary open water run, and a Yukon River primary open water run) were overlain to create a composite flood hazard inundation and WSE surface for that design AEP. The resulting composite design AEP inundations were considered representative of the overall flood hazard extent for the AEP. The separate model runs of flood processes and subsequent data overlay means that the entirety of the composite design AEP inundation is unlikely to occur in a single event.

The composite flood hazard inundation for each design AEP were detailed at locations of interest within the community. The inundation widths and depths along a representative alignment were provided at each location for each design AEP, and the impacts of inundation at each location were qualitatively described. The eight identified inundated locations within the community are:

- Robert Campbell Highway
- Klondike Highway north of Carmacks
- Klondike Highway Bridge
- River Drive in Carmacks Centre
- Little Salmon/Carmacks First Nation Development
- Ptarmigan Way Development
- Klondike Highway south of Carmacks
- Casino Way bridge.

Flood hazard maps developed for this project should be reviewed and potentially updated as new information, processes, flood events, or industry standards are observed.

Table of Contents

Limitations and Sign-off i

Executive Summary ii

Acronyms / Abbreviations xi

1 Introduction 1

2 Background and Available Data 3
- 2.1 Nordenskiold River 3
  - 2.1.1 Hydrometric Data 3
  - 2.1.2 Channel and Floodplain Characteristics 7
  - 2.1.3 Flood and Ice Processes 7
  - 2.1.4 Past Flood Events 11
  - 2.1.5 Summary of Dominant Flood Processes 17
- 2.2 Yukon River 17
  - 2.2.1 Hydrometric Data 17
  - 2.2.2 Channel and Floodplain Characteristics 20
  - 2.2.3 Flood and Ice Processes 20
  - 2.2.4 Past Flood Events 22
  - 2.2.5 Summary of Dominant Flood Processes 24

3 Hydrologic Analysis 25
- 3.1 Nordenskiold River 26
  - 3.1.1 Data Series Preparation 26
  - 3.1.2 Flood Frequency Analysis 28
- 3.2 Yukon River 32
  - 3.2.1 Data Series Preparation 32
  - 3.2.2 Flood Frequency Analysis 34

4 Joint Probability Analysis 37
- 4.1 Nordenskiold River Breakup Ice Jam Flood Scenario 37
- 4.2 Nordenskiold River Open Water Flood Scenario 38
- 4.3 Yukon River Open Water Flood Scenario 39

5 Climate Change, Land Use Change, and Geomorphic Change 41
- 5.1 Climate Change 41
  - 5.1.1 Quantitative Assessment 42
  - 5.1.2 Qualitative Assessment 50
  - 5.1.3 Factor of Safety for Climate Change 52
- 5.2 Land Cover Change 52
  - 5.2.1 Increase in Development / Impervious Cover 52
  - 5.2.2 Change to Vegetation Cover / Composition 53
  - 5.2.3 Increases in Bare / Hydrophobic Soil Coverage from Forest Fires 53
  - 5.2.4 Factor of Safety for Land Cover Change 54
- 5.3 Geomorphic Change 54
  - 5.3.1 Nordenskiold River 54
  - 5.3.2 Yukon River 55
  - 5.3.3 Factor of Safety for Geomorphic Change 55

6 Detailed Surveys 56
- 6.1 Survey Control 58

6.2 Datum Agreement ... 58
6.3 Benchmark Surveys ... 59
6.4 Nordenskiold River ... 59
6.4.1 Bathymetry and Cross-Section Survey ... 61
6.4.2 Hydraulic Structure Surveys ... 61
6.4.3 Surveyed Flood Events ... 64
6.5 Yukon River ... 72
6.5.1 Bathymetry and Cross-Section Surveys ... 74
6.5.2 Hydraulic Structure Surveys ... 74
6.5.3 Surveyed Flood Events ... 75
6.6 Digital Terrain Model ... 84

7 Hydraulic Modelling and Flood Mapping ... 89
7.1 Design Events for Flood Mapping ... 90
7.2 Model Setup ... 92
7.3 Open Water Modelling ... 96
7.3.1 Nordenskiold River ... 96
7.3.2 Yukon River ... 100
7.3.3 Design AEP Model Runs ... 111
7.3.4 Sensitivity Analysis ... 114
7.4 Breakup Ice Jam Modelling ... 118
7.4.1 Nordenskiold River ... 118
7.4.2 Yukon River ... 121
7.4.3 Design AEP Model Runs ... 121
7.4.4 Sensitivity Analysis ... 123
7.5 Composite Flood Hazard Maps ... 126
7.6 Inundated Infrastructure and Special Areas of Interest ... 126
7.6.1 Robert Campbell Highway (Yukon River) ... 126
7.6.2 Klondike Highway (north of Carmacks, Yukon River) ... 129
7.6.3 Klondike Highway Bridge (Yukon River) ... 132
7.6.4 River Drive in Carmacks Centre (Yukon River and Nordenskiold River) ... 134
7.6.5 Little Salmon/Carmacks First Nation Development – Lower Bench (Yukon River) ... 139
7.6.6 Ptarmigan Way Development (Nordenskiold River) ... 141
7.6.7 Klondike Highway (south of Carmacks, Nordenskiold River) ... 143
7.6.8 Casino Way Bridge Crossing (Nordenskiold River) ... 145

8 Assumptions and Limitations ... 147

9 Areas for Future Study ... 148

10 Summary ... 149

11 References ... 154

List of Tables

Table E1 Results of Hydrologic Assessment ... ii
Table 2-1 Available Hydrometric Data at WSC Station 09AH004 – Nordenskiold River Below Rowlinson Creek ... 3
Table 2-2 Available Yukon River Hydrometric Data at WSC Stations 09AH001 and 09CD001 ... 17
Table 3-1 Nordenskiold River FFA results for Freeze-up, Breakup, and Open Water ... 29
Table 3-2 Nordenskiold River Open Sater FFA Results Comparison to Previous Studies ... 31
Table 3-3 Yukon River FFA results for Freeze-up, Breakup, and Open Water ... 34

Table 3-4 Yukon River Open Sater FFA Results Comparison to Previous Studies 36
Table 5-1 Catchment-Averaged Meteorological Changes for 2081–2100 (IPCC WGI Interactive Atlas, CMIP6 GCMs, Gutierrez et al. 2021) 43
Table 6-1 Summary of Survey Methods 57
Table 6-2 Survey Control Points 58
Table 6-3 Coordinates of WSC Station Benchmarks and YG WRB Staff Gauge 59
Table 6-4 Ice Jam Location 0+740 HWM's, Ice Scars, and Toe/Head Locations for April 22, 2020 Breakup Ice Jam 68
Table 6-5 Nordenskiold River Surveyed Water Surface Elevations on May 19, 2023 71
Table 6-6 Yukon River Surveyed Water Surface Elevations on June 16, 2021 76
Table 6-7 Yukon River Surveyed Water Surface Elevations on June 23, 2022 80
Table 6-8 Yukon River Surveyed Water Surface Elevations on June 27, 2023 83
Table 7-1 Flow Inputs for Annual Exceedance Probability Design Events 91
Table 7-2 Calibrated Mannings n for Nordenskiold River Open Water Conditions 96
Table 7-3 WSE Summary Statistics for Nordenskiold River Open Water Calibration 97
Table 7-4 Calibrated Mannings n for Yukon River Open Water Conditions 100
Table 7-5 Yukon River Open Water Calibration Run WSE Summary Statistics 101
Table 7-6 Yukon River Open Water 2021 Validation Run WSE Summary Statistics (June 16, 2021 Event) 105
Table 7-7 Yukon River Open Water Validation Run WSE Summary Statistics (June 27, 2023 Event) 108
Table 7-8 Open Water Sensitivity Analysis Summary Statistics 115
Table 7-9 Nordenskiold River Breakup Ice Jam Calibration Run Surveyed and Modelled Elevations 119
Table 7-10 Nordenskiold River Ice Jam Sensitivity Analysis Summary Statistics between Nordenskiold River Station 0+556 and Station 1+895 124
Table 7-11 Approximate Inundation Lengths and Maximum Depths at Robert Campbell Highway 126
Table 7-12 Approximate Inundation Lengths and Maximum Depths at Klondike Highway (north of Carmacks) 129
Table 7-13 Approximate Inundation Lengths and Maximum Depths on River Drive 134
Table 7-14 Approximate Inundation Lengths and Maximum Depths at Lower Bench (South End) of Little Salmon/Carmacks First Nation Development 139
Table 7-15 Approximate Inundation Lengths and Maximum Depths at Ptarmigan Way Development 141
Table 7-16 Approximate Inundation Lengths and Maximum Depths at Klondike Highway (south of Carmacks) 143
Table 7-17 Approximate Inundation Lengths and Maximum Depths at Casino Way Bridge Crossing 145

List of Figures

Figure 1-1 Carmacks Flood Mapping Study – Study Area and Features 2
Figure 2-1 Nordenskiold River and Yukon River Watersheds 5
Figure 2-2 Annual Flow Hydrographs for All Years on Record (1982 – 2022) at WSC Station 09AH004 – Nordenskiold River Below Rowlinson Creek 6
Figure 2-3 Daily Flow Statistics for All Years on Approved Data Record (1982 – 2019) at WSC Station 09AH004 – Nordenskiold River Below Rowlinson Creek and Annual Hydrograph for Year with Highest Daily Flow (2009) 6
Figure 2-4 Annual Flow Hydrographs for All Years on Record (1951 – 1995) at WSC Station 09AH001 – Yukon River at Carmacks 19

Figure 2-5 Daily Flow Statistics for Years on Record Historical Data (1951 – 1995) at WSC Station 09AH001 – Yukon River at Carmacks and Annual Hydrograph for Year with Highest Peak Average Daily Flow (1962) ... 19
Figure 3-1 Hydrologic Procedures Flowchart from NRCan (2019a) ... 25
Figure 3-2 Nordenskiold River Freeze-up Flood Frequency Plot (LP3 Distribution) ... 29
Figure 3-3 Nordenskiold River Breakup Flood Frequency Plot (LP3 Distribution) ... 30
Figure 3-4 Nordenskiold River Open Water Flood Frequency Plot (LP3 Distribution) ... 30
Figure 3-5 Yukon River Freeze-up Flood Frequency Plot (LP3 Distribution) ... 34
Figure 3-6 Yukon River Breakup Flood Frequency Plot (LP3 Distribution) ... 35
Figure 3-7 Yukon River Open Water Flood Frequency Plot (LP3 Distribution) ... 35
Figure 4-1 Joint Probability Isolines for Yukon River Open Water AEP Flows as a Function of Nordenskiold River Open Water AEP Flows ... 39
Figure 4-2 Joint Probability Isolines for Nordenskiold River Open Water AEP Flows as a Function of Yukon River Open Water AEP Flows ... 40
Figure 5-1 Climate Change Analysis Procedures from NRCan (2019a) ... 42
Figure 5-2 Yukon River Drainage Area Upstream of Carmacks with IPCC Climate Model Grids Covering its Subbasins Including Nordenskiold River and Location of the Probable Maximum Precipitation Transposition Point (-134.433, 60.940, as shown in above) ... 43
Figure 5-3 Annual Maximum 24-hour Precipitation and its Trend (Sen's slope) at the Carmacks Weather Station (ID: 2100300) from 1963-2023 (GoC 2024b) ... 44
Figure 5-4 Annual Maximum Daily Mean and Minimum Air Temperatures and Trends (Sen's slope) at Carmacks Weather Station (ID: 2100300) from 1963-2023 (GoC 2024b) ... 45
Figure 5-5 Annual Maximum Snowfall and Snow Depth on the Ground and Trends (Sen's slope) at the Carmacks Weather Station (ID: 2100300) from 1963-2023 (GoC 2024b) ... 46
Figure 5-6 Event-based Precipitation Climate Change Projections for Carmacks, Yukon (Simonovic et al. 2015) ... 47
Figure 5-7 Air Temperature Changes from 1977 to 2085 under Two SSP2-4.5 and SSP5-8.5 Scenarios in Yukon River Upstream of Carmacks Obtained from Bias-corrected CMIP6 GCMs (PCIC 2023) ... 48
Figure 5-8 Winter (November to April) Precipitation Changes from 1977 to 2085 under SSP2-4.5 and SSP5-8.5 Scenarios in Yukon River Upstream of Carmacks Obtained from Bias-corrected CMIP6 GCMs (PCIC 2023) ... 49
Figure 6-1 Nordenskiold River Detailed Survey Features ... 60
Figure 6-2 River Drive Bridge Cross-Section Looking Downstream ... 62
Figure 6-3 Casino Way Bridge Cross-Section Looking Downstream ... 63
Figure 6-4 Ice Jam Location 0+740 HWM's, Ice Scars, and Toe/Head Locations for April 22, 2020 Breakup Ice Jam ... 69
Figure 6-5 Annual Maximum Instantaneous Breakup Period Discharge at WSC Station 09AH004 With Estimated Discharge during April 22, 2020 Breakup Ice Jam at Ice Jam Location 0+740 ... 70
Figure 6-6 Nordenskiold River Surveyed Water Surface Elevations on May 19, 2023 ... 70
Figure 6-7 Annual Maximum Instantaneous Flows at Water Survey of Canada Station 09AH004 With 2023 Nordenskiold River Open Water Flow ... 72
Figure 6-8 Yukon River Detailed Survey Features ... 73
Figure 6-9 Klondike Highway Bridge Cross-Section Looking Downstream ... 75
Figure 6-10 Yukon River Surveyed Water Surface Elevations on June 16, 2021 ... 76
Figure 6-11 Annual Maximum Daily Average Flows at Water Survey of Canada Station 09AH001 With Yukon River Open Water Surveyed High Flow Events from 2021, 2022, and 2023 ... 78
Figure 6-12 Yukon River Surveyed Water Surface Elevations on June 23, 2022 ... 79
Figure 6-13 Yukon River Surveyed Water Surface Elevations on June 27, 2023 ... 82

Figure 6-14 Survey Data and LiDAR Data Sources for Yukon River from Station 15+480 to 15+690 ... 85
Figure 6-15 Combined Digital Terrain Model for Yukon River from Station 15+480 to 15+690 ... 85
Figure 6-16 Combined Cross-Section at Yukon River Station 13+514 ... 86
Figure 6-17 Combined Cross-Section of Nordenskiold River Station 8+553 ... 87
Figure 6-18 Carmacks Flood Mapping Study Digital Terrain Model ... 88
Figure 7-1 Hydraulic Procedures Flowchart from NRCan (2019a) ... 89
Figure 7-2 Hydraulic Model Setup (Nordenskiold River) ... 94
Figure 7-3 Hydraulic Model Setup (Yukon River) ... 95
Figure 7-4 Nordenskiold River Open Water Calibration (May 19, 2023 Event) ... 98
Figure 7-5 Nordenskiold River Open Water Calibration Simulated WSEs vs. Surveyed WSEs (May 19, 2023 Event) ... 99
Figure 7-6 Nordenskiold River Open Water Calibration WSE Differentials (May 19, 2023 Event) ... 99
Figure 7-7 Yukon River Open Water Calibration (June 23, 2022 Event) ... 102
Figure 7-8 Yukon River Open Water Calibration Simulated WSEs vs. Surveyed WSEs (June 23, 2022 Event) ... 103
Figure 7-9 Yukon River Open Water Calibration WSE Differentials (June 23, 2022 Event) ... 103
Figure 7-10 Yukon River Open Water 2021 Validation (June 16, 2021 Event) ... 106
Figure 7-11 Yukon River Open Water 2021 Validation Simulated WSEs vs. Surveyed WSEs (June 16, 2021 Event) ... 107
Figure 7-12 Yukon River Open Water Validation WSE Differentials (June 16, 2021 Event) ... 107
Figure 7-13 Yukon River Open Water 2023 Validation (June 27, 2023 Event) ... 109
Figure 7-14 Yukon River Open Water 2023 Validation Simulated WSEs vs Surveyed WSEs (June 27, 2023 Event) ... 110
Figure 7-15 Yukon River Open Water 2023 Validation WSE Differentials (June 27, 2023 Event) ... 110
Figure 7-16 Nordenskiold River WSE Profiles for Open Water Nordenskiold River Primary Runs ... 112
Figure 7-17 Yukon River WSE Profiles for Open Water Yukon River Primary Runs ... 113
Figure 7-18 Nordenskiold River Open Water Sensitivity Analysis ... 116
Figure 7-19 Yukon River Open Water Sensitivity Analysis ... 117
Figure 7-20 Nordenskiold River Breakup Ice Jam Calibration (April 22, 2020 Event) ... 120
Figure 7-21 Nordenskiold River WSE Profiles for Breakup Ice Jam Runs ... 122
Figure 7-22 Nordenskiold River Ice Jam Sensitivity Analysis for Ice Jam Location 0+740 ... 125
Figure 7-23 Flood Hazard Inundation Plan and Profile – Robert Campbell Highway ... 128
Figure 7-24 Flood Hazard Inundation Plan and Profile – Klondike Highway (north of Carmacks) Along Highway ... 130
Figure 7-25 Flood Hazard Inundation Plan and Profile – Klondike Highway (north of Carmacks) Low Point Along Spill Path ... 131
Figure 7-26 Flood Hazard Inundation Plan and Profile – Klondike Highway Bridge ... 133
Figure 7-27 Flood Hazard Inundation Plan and Profile – River Drive in Carmacks Centre (Station 0 to 600) ... 135
Figure 7-28 Flood Hazard Inundation Plan and Profile – River Drive in Carmacks Centre (Station 600 to 1200) ... 136
Figure 7-29 Flood Hazard Inundation Plan and Profile – River Drive in Carmacks Centre (Station 1200 to 1800) ... 137
Figure 7-30 Flood Hazard Inundation Plan and Profile – River Drive in Carmacks Centre (Station 2400 to 3000) ... 138
Figure 7-31 Flood Hazard Inundation Plan and Profile – Little Salmon/Carmacks First Nation Development ... 140
Figure 7-32 Flood Hazard Inundation Plan and Profile – Ptarmigan Way Development ... 142

Figure 7-33 Flood Hazard Inundation Plan and Profile – Klondike Highway (south of Carmacks) ... 144
Figure 7-34 Flood Hazard Inundation Plan and Profile – Casino Way Bridge ... 146

List of Photos

Photograph 1 Ice Jam and Flooding Looking Downstream from River Drive Bridge (Ice Jam Location 0+740) on April 22, 2020 (photo courtesy YG WRB) ... 12
Photograph 2 Ice Jam and Flooding Looking Northwest Across River from Property on April 22, 2020 (email communication, L. Bodie, September 6, 2023) ... 12
Photograph 3 Satellite Image of Ice Conditions at Yukon River Confluence on April 22, 2020 (Sinergise Ltd. 2023) ... 13
Photograph 4 Ice Jam and Flooding at Lower Nordenskiold River on April 30, 2021 (YG WRB 2021b) ... 14
Photograph 5 Weakened Ice Cover at Confluence of Nordenskiold and Yukon Rivers on April 24, 2021; Yukon River Flowing Right to Left (YG CS 2021) ... 15
Photograph 6 Ice Chunks on Floodplain near Casino Way (Ice Jam Location 6+016) on April 30, 2021 (YG WRB 2021b) ... 15
Photograph 7 Ice Jam Remnants Downstream of WSC Station 09AH004 (Ice Jam Location 9+269) Looking Downstream on April 30, 2021 (YG WRB 2021b) ... 16
Photograph 8 Freeze-up Flooding along River Drive Boardwalk, Looking Upstream in December 2020 (YG WRB 2020) ... 23
Photograph 9 Open Water Flooding Along River Drive on June 15, 2022; Emergency Temporary Superbag Dike Being Installed ... 23
Photograph 10 River Drive Bridge Looking Southeast (photo taken May 5, 2023) ... 61
Photograph 11 Casino Way Bridge Looking Downstream (photo taken September 5, 2023) ... 63
Photograph 12 Ice Abutting Tree (on left, looking towards river in April 2020 from L. Bodie) and Resulting Ice Scar on Same Tree (right, looking away from river, on September 5, 2023) on Private Residence 360 m downstream of River Drive Bridge ... 65
Photograph 13 Ice Scar from April 2020 Breakup Ice Jam Event 10 m downstream of River Drive Bridge (photo taken May 5, 2023) ... 66
Photograph 14 Near Peak WSE During April 22, 2020 Breakup Ice Jam at Private Residence 360 m Downstream of River Drive Bridge; View from Residence towards River (photo courtesy L. Bodie) ... 66
Photograph 15 View Across River towards Private Residence Several Days After April 22, 2020 Breakup Ice Jam Peak WSE (Note Submerged Border Ice Along Opposite Bank) (photo courtesy L. Bodie) ... 67
Photograph 16 High Water on April 22, 2020 on River Right Approximately 10 m Downstream of River Drive Bridge; Water Line is at Corner Post of White Fence (photo courtesy YG WRB) ... 67
Photograph 17 Klondike Highway Bridge Looking Upstream (photo taken May 5, 2023) ... 74

List of Appendices

Appendix A Photographic Inventory
Appendix B Hydrology
Appendix C Electronic Files
Appendix D Hydraulic Modelling
Appendix E Flood Hazard Maps

Acronyms / Abbreviations

ADCP	Acoustic Doppler Current Profiler
ADD	Accumulated Degree Days
AEP	Annual Exceedance Probability
AFDD	Accumulated Freezing Degree Days
CDC	Carmacks Development Corporation
CGVD2013	Canadian Geodetic Vertical Datum 2013
CMIP	Coupled Model Intercomparison Project
CSRS	Canadian Spatial Referencing System
CQL	Canadian Quality Level
DTM	Digital Terrain Model
FFA	Flood Frequency Analysis
GCM	General Circulation Model
GHG	Greenhouse Gas
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
HWM	High Water Mark
IDF	Intensity Duration Frequency
km	kilometres
LiDAR	Light Detection and Ranging
LP3	Log Pearson Type III
LS/CFN	Little Salmon/Carmacks First Nation
m	metres
NRCan	Natural Resources Canada

RTK	Real Time Kinematic
SWE	Snow Water Equivalent
SSP	Shared Socioeconomic Pathway
TBC	Trimble Business Centre
WRB	Water Resources Branch
WSC	Water Survey of Canada
WSE	Water Surface Elevation
YG	Government of Yukon

1 Introduction

Stantec Consulting Ltd. (Stantec) was retained by the Government of Yukon (YG) Water Resources Branch (WRB) to perform the Carmacks Flood Mapping Study (the Project). The objective of the Project was to develop flood hazard maps as outlined in the Federal Flood Mapping Guideline Series (NRCan 2018a; NRCan 2018b; NRCan 2019a; NRCan 2019b; NRCan 2022) for the Yukon River (*Tàgé Cho Gé*) and the Nordenskiold River (*Tsâwnjik Chu*) within the Study Area at Carmacks (Figure 1-1). The Project was funded in part by the Natural Resources Canada (NRCan) Flood Hazard Identification and Mapping Program (FHIMP).

The Study Area is located within the Traditional Territory of the Little Salmon/Carmacks First Nation (LS/CFN). LS/CFN Settlement Lands are illustrated on Figure 1-1.

The Project consists of the following tasks pursuant to production of the flood hazard maps:

1. Background Data Gathering, Surveys, Digital Terrain Model (DTM)
2. Hydrologic Assessment
3. River Ice Assessment
4. Joint Probability Analysis
5. Climate Change and Land Cover Change Assessment
6. Modelling Inputs Memo
7. Hydraulic Analysis and Modelling
8. Flood Hazard Mapping
9. Engagement Support
10. Project Management
11. Deliverables

This document is the Final Report for the Project. The scope of the Final Report is to detail the methods and results of tasks 1 through 8 in the above list.

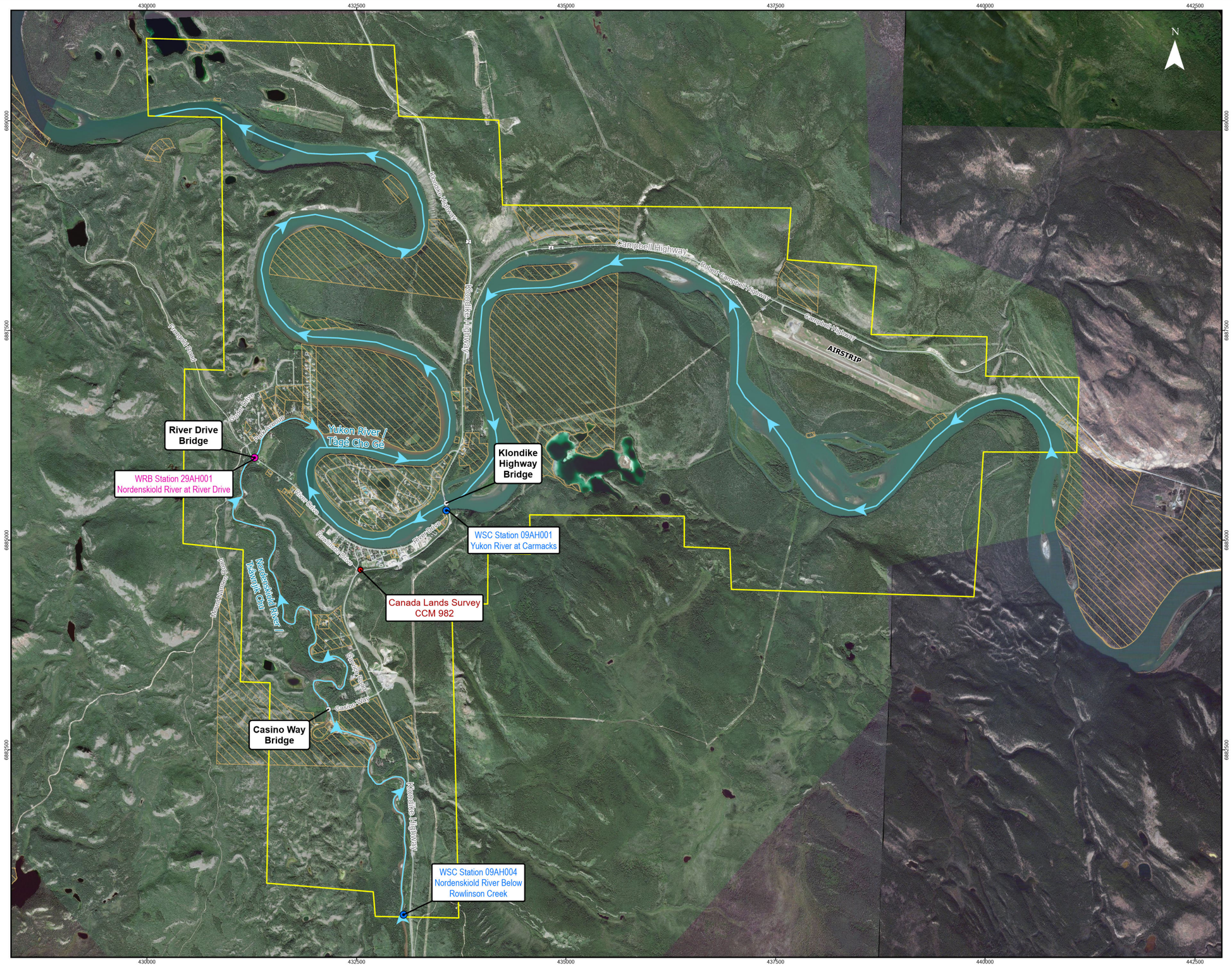


Figure No.

1-1

Title:

Carmacks Flood Mapping Study
Study Area and Features

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

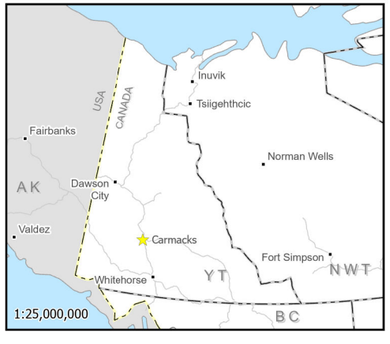
Carmacks, Yukon

Prepared by MANDERSON on 2024-05-16
Requested by JMUIRHEAD on 2023-09-29
Review by JMUIRHEAD on 2024-05-16

- Bridge Location
- Water Survey of Canada (WSC) Hydrometric Station
- Water Resources Branch (WRB) Hydrometric Station
- Survey Control Point
- Little Salmon / Carmacks First Nation Settlement Land
- Study Area
- Centerline Alignment (with Flow Direction Arrows)

0 400 800 1,200 1,600 2,000 m

(At original document size of 11 x 17) 1:45,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Imagery: Maxar
Yukon Satellites HighRes: Government of Yukon

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

2 Background and Available Data

2.1 Nordenskiold River

The Nordenskiold River is the smaller of the two rivers in Carmacks. The Nordenskiold River conveys snowmelt and rainfall induced runoff from its drainage basin south of Carmacks northwards before discharging into the Yukon River downstream of the main Carmacks community consolidation (Carmacks Centre) within the Study Area. The watershed delineation for Water Survey of Canada (WSC) Station 09AH004 (Nordenskiold River Below Rowlinson Creek, located at the upstream end of the Study Area) is illustrated in Figure 2-1 and has a gross drainage area of approximately 6,410 km² (GoC 2024a). The Nordenskiold River watershed is reported to be among the driest areas in the Yukon (Turcotte 2021).

2.1.1 Hydrometric Data

WSC maintains a hydrometric station on the Nordenskiold River at the upstream end of the Study Area (WSC Station 09AH004, GoC 2024a). WSC Station 09AH004 is approximately 9 km upstream of the confluence with the Yukon River (Figure 1-2). Table 2-1 summarizes the data available for this Project at WSC Station 09AH004.

Table 2-1 Available Hydrometric Data at WSC Station 09AH004 – Nordenskiold River Below Rowlinson Creek

Start Date/ End Date	Data Type	Source
1982–2019	Daily average discharge	WSC digital download
1982–2019	Annual maximum daily discharge	WSC digital download
1983–2019	Annual maximum instantaneous discharge	WSC digital download
1982–1994	Daily average local stage	WSC scanned hardcopies; many years open water data only
2011–2019	Annual maximum daily local stage	WSC digital download
2011–2019	Daily average local stage	WSC digital download
1995–2010	Hourly average local stage	WSC data request
2011–2019	Annual maximum instantaneous local stage	WSC digital download
2020	Daily average local stage, daily average discharge	WSC provisional data
2021–2022	Daily average local stage, daily average discharge	WSC digital download provisional data

Figure 2-2 illustrates annual flow hydrographs for all years on record at WSC Station 09AH004 (1982–2022). WSC has identified historical data during the 1982 – 2019 period as approved; 2020 – 2022 data are provisional. Figure 2-3 shows historical statistics for flows at WSC Station 09AH004 for the approved period (1982 – 2019), as well as annual hydrographs for the year with the highest recorded peak daily flow (2009; 206 m^3/s on May 8, 2009).

YG WRB installed a hydrometric station to record stage data at the River Drive Bridge in the fall of 2021 (WRB Station 29AH001 – Nordenskiold River at River Drive). The documentation of historical flooding from this station is currently limited, however will be of value in the future given the likely occurrence of downstream ice jams.

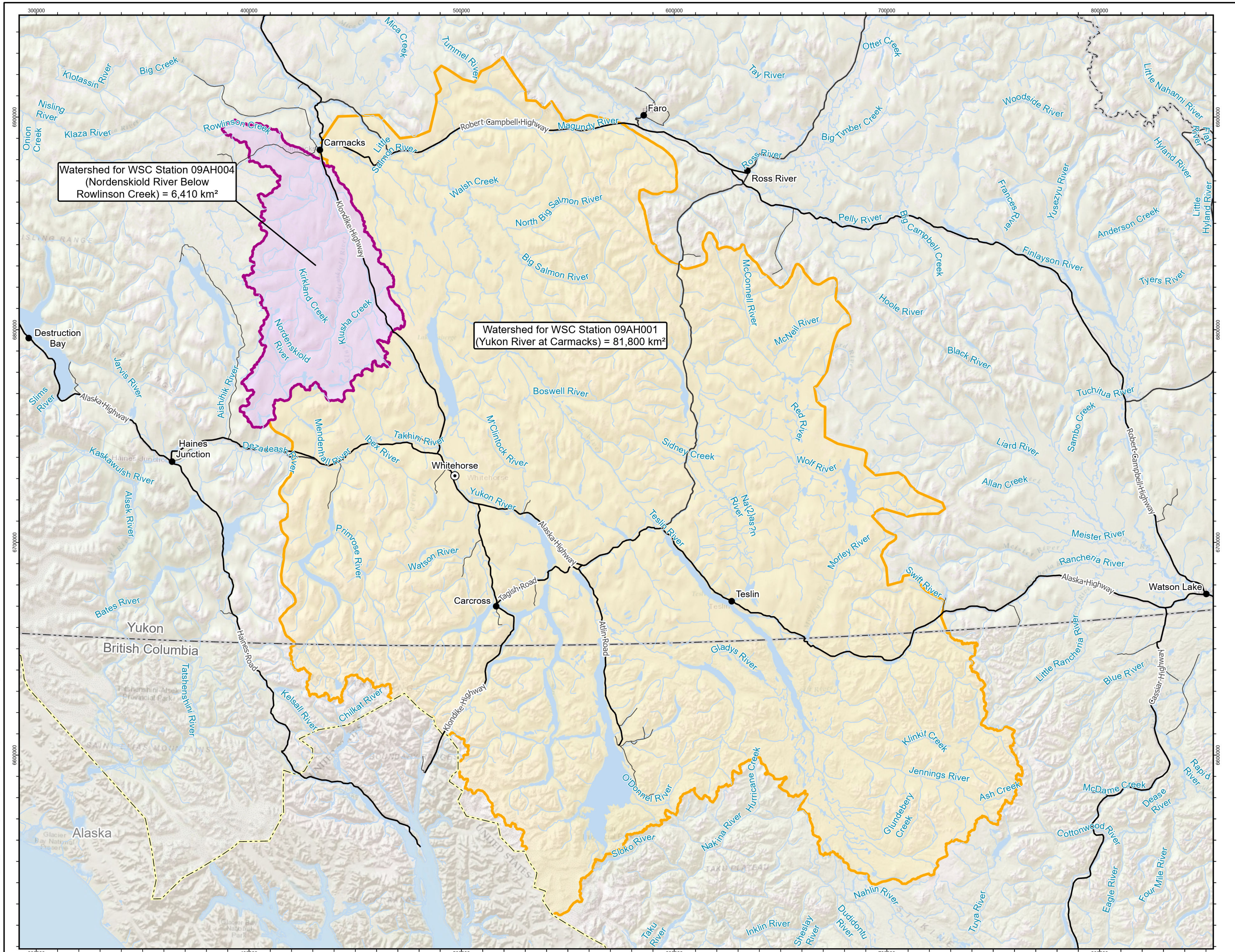


Figure No.

2-1

Title:

Nordenskiold River and Yukon River Watersheds

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

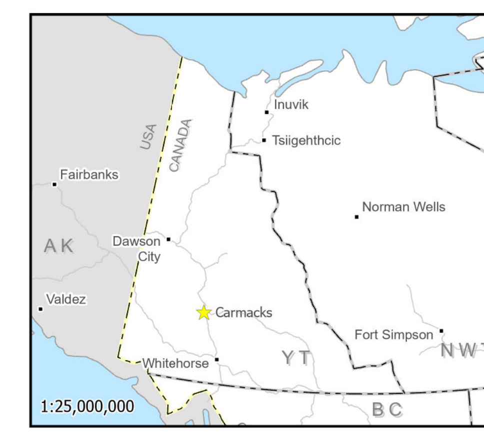
Carmacks, Yukon

Prepared by MANDERSON on 2024-05-07
Requested by JMUIRHEAD on 2023-09-29
Review by JMUIRHEAD on 2024-05-09

- Community
- Major City
- International Boundary
- Provincial Boundary
- Primary Highway
- Secondary Highway
- Road
- Watercourse
- Waterbody
- Watershed for WSC Station 09AH001 - Yukon River at Carmacks
- Watershed for WSC Station 09AH004 - Nordenskiold River Below Rowlinson Creek

0 25,000 50,000 75,000 m

(At original document size of 11 x 17) 1:1,750,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Underhill 2023 survey, Canvec.
3. Background: World_Topo_Map: Esri, HERE, Garmin, FAO, NOAA, USGS, EPA, NPS, AAFC, NRCan
World_Shaded_Relief: Copyright:(c) 2014 Esri

Stantec Yukon

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

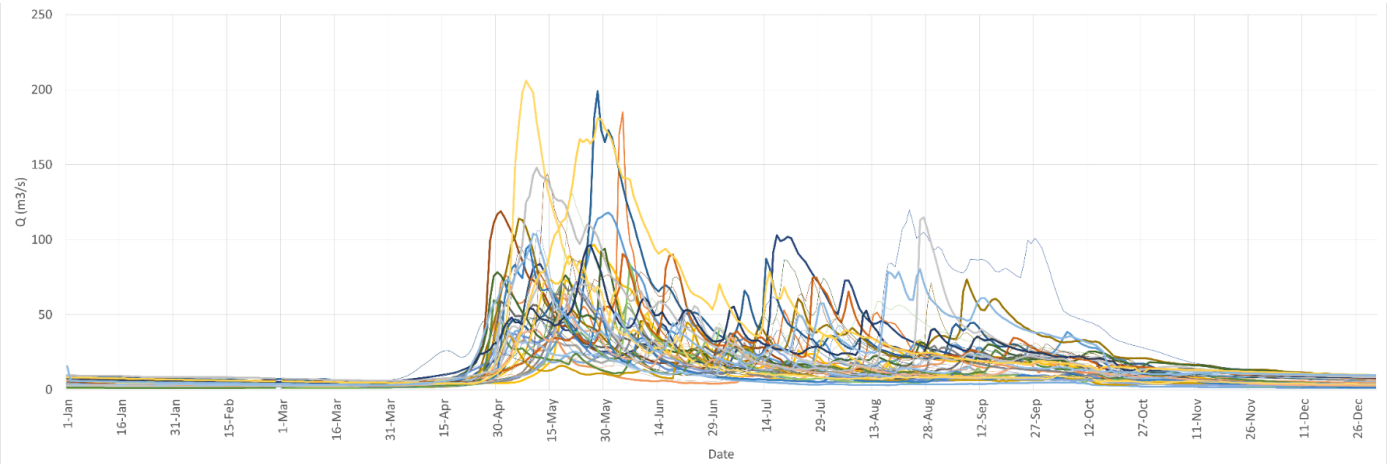


Figure 2-2 Annual Flow Hydrographs for All Years on Record (1982 – 2022) at WSC Station 09AH004 – Nordenskiold River Below Rowlinson Creek

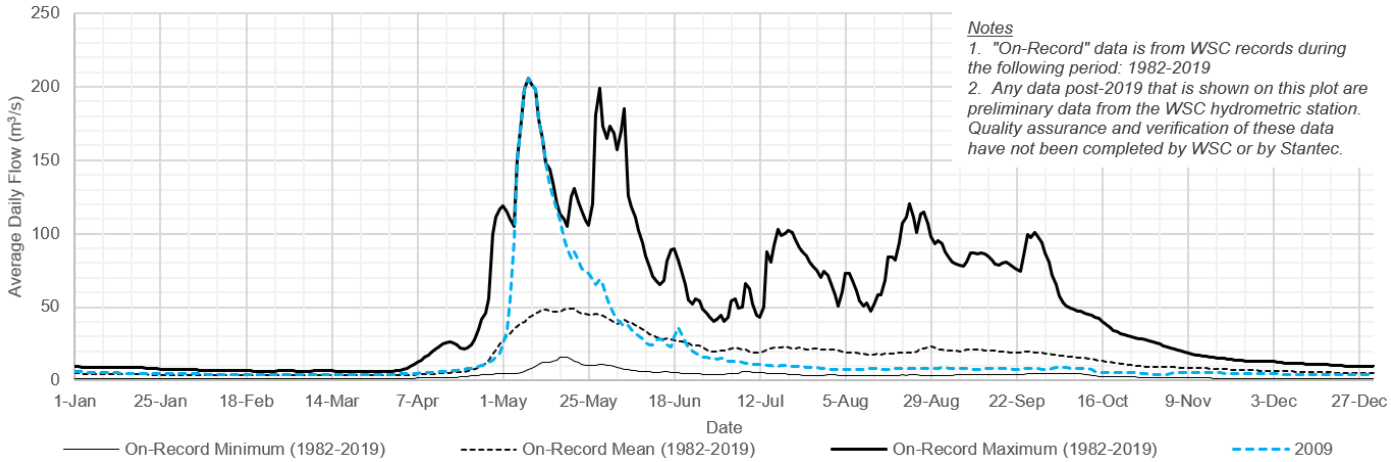


Figure 2-3 Daily Flow Statistics for All Years on Approved Data Record (1982 – 2019) at WSC Station 09AH004 – Nordenskiold River Below Rowlinson Creek and Annual Hydrograph for Year with Highest Daily Flow (2009)

2.1.2 Channel and Floodplain Characteristics

A photographic inventory of the channel, banks, and floodplain characteristics on the Nordenskiold River is provided in Appendix A. General observations include:

- River cross-sectional geometry typically consists of a 25 – 50 m wide bankfull channel, with riffles and runs being narrower than pools. The bankfull channel is generally U-shaped.
- Sinuosity varies, with some subreaches demonstrating tortuous meanders (predominantly riffle-pool morphology) and other subreaches demonstrating straighter channel plan (predominantly riffle-run morphology).
- Islands, medial bars, and meander cutoffs are common. Wood debris accumulation on outer banks of pools and on lateral/medial bars was frequently observed.
- Floodplain material is largely fluvially deposited gravels, sands and silts. Discrete sections of organic deposition (upstream-most subreach of the Study Area) and colluvial deposits (mid- to lower-subreaches) are present.
- The river bed consists mainly of large cobbles. Banks are generally steep and consist of non-cohesive silt, sand, gravel, and cobble held together by tree and shrub roots. No bedrock outcrops were observed within the floodplain.
- Actively eroding banks are common along with areas of recent sediment deposition and trees falling into the river.
- The bankfull channel is generally unconfined with no observed controlling features such as bedrock or coarse boulder deposits in the active channel or floodplain; the floodplain is typically accessible on both sides of the channel.
- The floodplain is vegetated with shrubs and trees. Understory growth consists of shrubs and grasses, with shrubs being more prevalent in near-channel areas.
- The Nordenskiold River becomes steeper in its most downstream 10 km before its confluence with the Yukon River, evolving from meandering to incised riffle-pools and rapids (with an average gradient of 0.35%) (Turcotte 2021). The WSC station on the Nordenskiold River is located at the upstream end of this steeper reach. The Study Area is entirely contained within this steeper reach of the Nordenskiold River.

2.1.3 Flood and Ice Processes

Open water and ice-related flooding have a long history in the Carmacks area; however, documentation of flood events on the Nordenskiold River for such events is generally limited. In numerous conversations with community members during the field surveys, recent flooding events were noted to be among the most significant events observed in the community. A summary of flood and ice processes for freeze-up, ice cover, ice breakup, and open water are provided below.

Regarding freeze-up processes:

- WSC Station 09AH004 records indicate that Nordenskiold River freeze-up at the upstream end of the Study Area typically occurs in late October to late November (Appendix B, GoC 2024a).
- Elevated water levels during freeze-up have been recorded at WSC Station 09AH004 (at the upstream extent of the Study Area), likely due to ice dams caused by the accumulation of anchor ice in the vicinity of the station.
- Freeze-up ice dams represent the dominant flooding processes in the localized vicinity of WSC Station 09AH004 as breakup ice jams have historically produced lower water levels at the station (Turcotte 2021). Turcotte (2021) notes an increase in late summer flows from 1983 to 2020, and a positive correlation between the discharge during freeze-up period and the maximum annual water level during ice formation. As such, Turcotte (2021) notes that freeze-up may continue to be a dominant flooding process at WSC Station 09AH004 in future climate change scenarios.
- One additional instance of freeze-up flooding was documented within the Study Area along Garvice Road (detailed in Section 2.1.4) (YG 2000).

Regarding the ice-covered period of the year:

- Ice conditions range from open leads persisting through the winter to sporadic thin ice to ice frozen to the bed (personal communication E.J. Bercier, September 5, 2023 and corroborated by local community members).
- At shallow sections on the river where ice has frozen to the bed, narrow channels cut through the nearby ice conveying small amounts of high-velocity flows (personal communication, E.J. Bercier, September 5, 2023 and corroborated by local community members). The presence of sustained low baseflows in the winter suggests groundwater contributions to the Nordenskiold River.
- An uneven ice cover has been noted along the Nordenskiold River with raised locations at gravel bars and ice dams (personal communication, B. Turcotte, October 23, 2023).
- Community observations reported a typical maximum ice thickness of 2 feet (~0.6 m) in the Nordenskiold River during winter which often rests directly on the bed in the outer portions of the channel.
- WSC provided winter discharge measurement files from 2001 to 2012 with 41 ice thickness measurements, ranging from 0.01 m to 1.0 m (email communication, WSC personnel, November 2, 2023).
- During the May 2023 site visit when the Nordenskiold River was at open water conditions, ice 0.5 to 1.5 m thick was observed immediately upstream of the confluence with the Yukon River. This thickness may be a result of Yukon River backwater during freeze-up or localized aufeis processes and is not considered representative of ice thickness in the Nordenskiold River throughout the Study Area.

Regarding ice breakup processes:

- WSC Station 09AH004 records indicate that Nordenskiold River ice breakup at the upstream end of the Study Area typically occurs in mid-April to mid-May (Appendix B, GoC 2024a), which is consistently before the Yukon River ice breakup.
  - This is corroborated by local community members, who reported to Stantec that the Nordenskiold River typically breaks up in late April, two to three weeks before the breakup of the Yukon River.
- On the Nordenskiold River, observational records indicate that ice processes have the potential to generate higher water levels than open water flows (Turcotte 2021) in certain areas.
- Local community members and available satellite imagery (Sinergise Ltd. 2023) indicate that the Yukon River immediately downstream of the confluence generally becomes ice free shortly after the Nordenskiold River breakup, whereas the ice cover on the Yukon River upstream of the confluence remains intact for another couple of weeks.
  - This was observed on May 5, 2023; intact ice cover was present on the Yukon River upstream of the confluence, but the Nordenskiold River was fully open and open water existed on the Yukon River downstream of the confluence for approximately 10 km.
  - The mechanism for the breakup downstream of the confluence is unknown; hydrologic processes on the Nordenskiold River, including the flushing of ice runs, may have the potential to degrade or break part of the ice cover on the Yukon River, but their power seems insufficient to induce large-scale dynamic breakup downstream of the confluence (personal communication, B. Turcotte, October 23, 2023). However, ice weakening downstream of the confluence from winter flows and warmer, higher velocity breakup flows may contribute to the earlier breakup downstream of the confluence.
- Breakup ice jams have been documented at three locations on the Nordenskiold River in the Study Area (note: river station is in the downstream to upstream direction; locations illustrated and discussed in Section 6.4):
  - <u>Ice Jam Location 0+740</u> is approximately 540 m downstream of the River Drive bridge at Nordenskiold River station 0+740. Community reports indicated that this ice jam occurs because of shallower channel depths (i.e., riffle crests) at this location. Breakup ice jams at this location have been a primary focus of YG WRB and community ice jam monitoring efforts due to its flooding impact on residences and community infrastructure. Anecdotal reports from local community members suggest ice jamming occurs at this location every three to four years, although the severity of the resultant flooding can vary.
  - <u>Ice Jam Location 6+016</u> is approximately 420 m downstream of the Casino Way bridge at Nordenskiold River station 6+016. Ice jams at this location were observed prior to the recent construction of the bridge and approach roads; it is uncertain what effect the bridge and roads will have on breakup dynamics in this area (personal communication, B. Turcotte, September 5, 2023). Reduction of the evacuation capacity of the floodplain by the construction of elevated approach roads may contribute to higher water levels or earlier mobilization of ice jams (personal communication, B. Turcotte, October 22, 2023).

  - Ice Jam Location 9+269 is approximately 600 m downstream of WSC Station 09AH004 and 2.8 km upstream of the Casino Way bridge, at Nordenskiold River station 9+269. Backwater caused by ice jams downstream of WSC Station 09AH004 are used as a data source for YG for monitoring breakup on the river (YG WRB 2021a). No existing infrastructure has been impacted by flooding in this area and the majority of the flooding caused by this jam would occur beyond the southern (upstream) extent of the Study Area.

- The potential for breakup ice jamming was documented at one additional location on the Nordenskiold River in the Study Area:
  - Ice Jam Location 4+109 is approximately 350 m downstream of Ptarmigan Road at Nordenskiold River Station 4+109. Historical flooding at the west end of Ptarmigan Road was noted by a local community member. It was unknown if the flooding was in response to open water or ice jam conditions; however, given the tortuous bends in the vicinity (increased risk of ice jams) and an ice jam location documented upstream (Ice Jam Location 6+016), Ice Jam Location 4+109 was considered to be a potential ice jam location for the purposes of this Project.
- Breakup Ice Jam Location 6+016 may be limiting the prevalence of ice jams at tortuous bends downstream (e.g., at Ice Jam Location 4+109) by limiting the downstream conveyance of large quantities of ice (personal communication, B. Turcotte, September 5, 2023).
- The interception of Nordenskiold River ice runs during breakup against an intact ice cover at the confluence with the Yukon River has not been observed by local community members. The breakup of the Yukon River at/downstream of the confluence shortly after the Nordenskiold River breakup potentially explains the lack of documented/reported ice jams on the Nordenskiold River against an intact Yukon River ice cover.
- The potential for ice jams in the other areas of the Nordenskiold River in the Study Area may exist but has not been documented to Stantec's knowledge.

Regarding open water processes:

- Available documentation of flooding during high open water conditions on the Nordenskiold River has not been noted to be as extreme as ice jam flooding. However, high open water levels from the Yukon River have caused backwater induced flooding along the lower reach of the Nordenskiold River downstream of River Drive.
- Maximum annual flows (and corresponding flood conditions) during the open water season can occur during spring freshet (snowmelt driven and/or rain on snow) or in the summer/fall (in response to rainfall events).

2.1.4 Past Flood Events

The Nordenskiold River flood events summarized below are a summary of the flooding documentation provided to Stantec at the time of writing; they do not represent a comprehensive review of flooding history in the Study Area.

2000 Flood Event (Freeze-up)

Localized flooding occurred in late November 2000 during freeze-up on the Nordenskiold River in the Industrial area (near Garvice Road) (YG 2000). Ice along the river was noted to be deflecting flow toward low-lying properties. In response, a 1 m high by 300 m long sandbag berm was constructed adjacent to the Nordenskiold River (YG 2000). Flows naturally cut a new channel away from the berm and properties a few days later, and no damage to infrastructure was noted (YG 2000).

2020 Flood Event (Breakup)

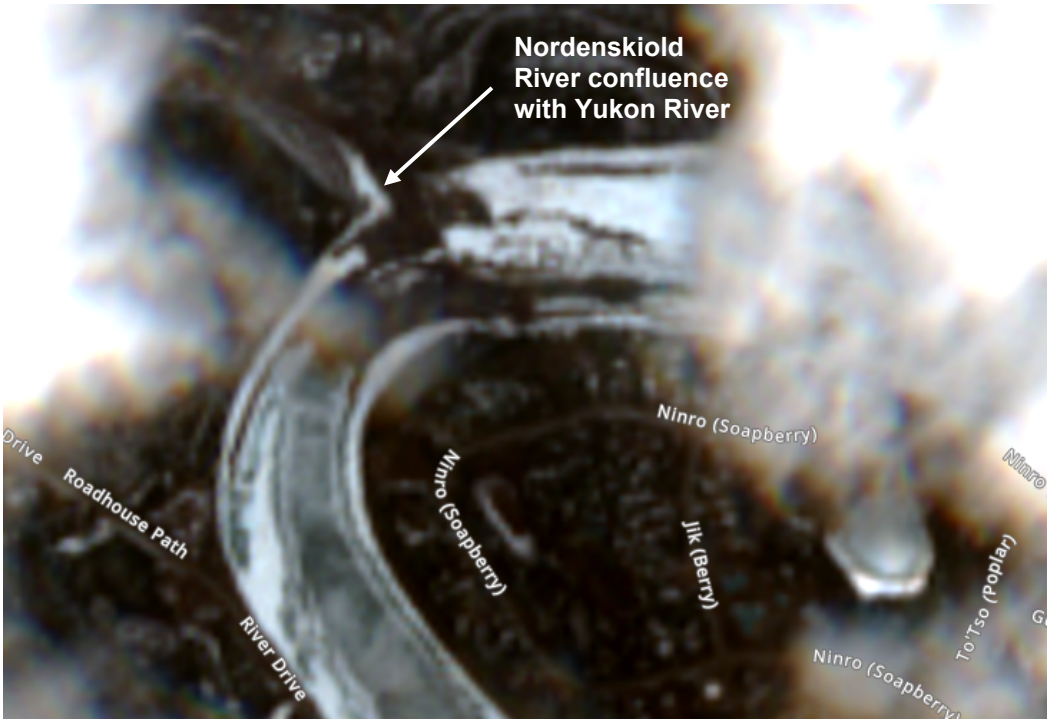
Flooding during the spring 2020 breakup period was the most significant in recent years and occurred at Ice Jam Location 0+740. Limited documentation is available for this flooding event despite the severity of flooding along the lower Nordenskiold River. Ice jamming was noted downstream of the River Drive bridge, in the general vicinity of the river adjacent to Taylor McGundy Place (Photograph 1). Water surface elevations (WSEs) peaked on April 22, 2020. A local property owner adjacent to the river noted that water levels went around their house and nearly reached their porch (Photograph 2). No sandbag berms were in place at the time of the peak flooding at the affected property. Local community members reported that an excavator became temporarily stuck in the river ice downstream of River Drive Bridge during efforts to manually breakup and excavate ice from the river during the event.

Although this was a significant dynamic breakup event, it is not considered to represent the maximum potential ice jamming. For example, submerged border ice was not mobilized and did not contribute to the size of the jam.

Photograph 1 Ice Jam and Flooding Looking Downstream from River Drive Bridge (Ice Jam Location 0+740) on April 22, 2020 (photo courtesy YG WRB)

Photograph 2 Ice Jam and Flooding Looking Northwest Across River from Property on April 22, 2020 (email communication, L. Bodie, September 6, 2023)

Local observations on the ice conditions at the mouth of the Yukon River in April 2020 were not documented. A review of satellite imagery (Sinergise Ltd. 2023) suggests a weakened, but largely intact ice cover on the Yukon River immediately downstream of the confluence with the Nordenskiold River (Photograph 3). These images align with reports from local community members that the ice cover on the Yukon River immediately downstream of the confluence with the Nordenskiold River is generally absent or sufficiently weakened when ice runs from the Nordenskiold River reach the Yukon River.



Photograph 3 Satellite Image of Ice Conditions at Yukon River Confluence on April 22, 2020 (Sinergise Ltd. 2023)

2021 Flood Events (Breakup)

During the 2021 breakup period, ice jamming caused localized flooding along the lower Nordenskiold River, but was less severe than in spring 2020. The 2021 breakup was preceded by the highest freeze-up level in the data record at WSC Station 09AH004 in November 2020 (Turcotte 2021; GoC 2024a). During this breakup period, three ice jams were documented along the Nordenskiold River within the Study Area.

The downstream-most ice jam on the Nordenskiold occurred at Ice Jam Location 0+740 on April 26, 2021. Growth and shifting of the jam occurred until it was mostly flushed to the Yukon River on May 3, 2021. During the peak of this jam, the toe was approximately adjacent to Taylor McGundy Place with water and ice on the floodplain with an estimated jam length of approximately 250 to 300 m (Photograph 4). Minor flooding at residential properties was observed during this breakup event that prompted sand bagging at two properties (YG WRB 2021a).

Photograph 4 Ice Jam and Flooding at Lower Nordenskiold River on April 30, 2021 (YG WRB 2021b)

Similar to the ice jam flooding in 2020, ice conditions at the mouth of the Yukon River in 2021 were not thoroughly documented at the time of the jam. A review of drone imagery (YG CS 2021) suggests a weakened, but largely intact ice cover on the Yukon River along the mouth of the Nordenskiold (Photograph 5). Open water leads from the Nordenskiold are oriented upstream and converge with larger open water leads on the Yukon River. No evidence of ice jamming at the confluence is visible in this video. Comparatively warmer water from the Nordenskiold River may have caused a weaking of the Yukon River ice cover and promote the formation of open leads.

Photograph 5 Weakened Ice Cover at Confluence of Nordenskiold and Yukon Rivers on April 24, 2021; Yukon River Flowing Right to Left (YG CS 2021)

An ice jam was noted just downstream of the Casino Way bridge (Photograph 6) at Ice Jam Location 6+016 and caused localized flooding at a single property on the east side of the Nordenskiold River. Observers onsite suspected that this jam was able to flush all the way to the Yukon River on May 4, 2021 (YG WRB 2021b), suggesting that no significant ice jams remained intact downstream of this location.

Photograph 6 Ice Chunks on Floodplain near Casino Way (Ice Jam Location 6+016) on April 30, 2021 (YG WRB 2021b)

The upstream-most jam was at Ice Jam Location 9+269. The toe of the jam was estimated to be approximately 500-600 m downstream of WSC Station 09AH004 (Photograph 7). The jam head was approximately 100 m downstream of WSC Station 09AH004 and resulted in WSEs rising approximately 1 m at the station. This jam was first noted on April 26, 2021 and flushed downstream to the jam at Ice Jam Location 6+016 (previously described) on April 30, 2021 (YG WRB 2021b).

Photograph 7 Ice Jam Remnants Downstream of WSC Station 09AH004 (Ice Jam Location 9+269) Looking Downstream on April 30, 2021 (YG WRB 2021b)

2.1.5 Summary of Dominant Flood Processes

Freeze-up dams at the upstream end of the Study Area are documented in WSC records and observational reports; however, the effects of the freeze-up ice damming at this location impact a marginal length of the Study Area. The single additional instance of freeze-up flooding in the Study Area (near Garvice Road in 2000) was noted to have been mitigated by the river cutting a new channel. Given the morphological change and the lack of documented freeze-up flooding since that time, freeze-up processes are currently not considered to be processes driving the flood events in the Study Area.

Breakup ice jams have been documented to produce the highest WSEs in certain areas of the Nordenskiold River, and for the purposes of this Project are considered the dominant flood processes at four locations (Ice Jam Locations 0+740, 4+109, 6+016, and 9+269). Open water flooding is considered the dominant flood process for the remainder of the Study Area. Figure 2-2 and Figure 2-3 illustrate that open water peaks can occur throughout the spring, summer, and fall from both snowmelt/rain-on-snow events and rainfall-only events.

2.2 Yukon River

The Yukon River is the larger of the two rivers in Carmacks. The Yukon River conveys snowmelt, rainfall induced runoff, and glacier melt from southern Yukon and northern British Columbia northwards into Alaska and eventually the Bering Sea. The watershed is largely composed of two main basins – the Southern Lakes basin (western portion), and the Teslin River basin (eastern portion). The Southern Lakes basin typically peaks in mid-August owing to lake storage, as well as high alpine snowmelt and glacier melt contributions. The Teslin River basin is predominantly snowmelt driven, and peaks in mid to late June. The watershed delineation for WSC Station 09AH001 (Yukon River at Carmacks, discussed in Section 2.2.1) is illustrated in Figure 1-2 and has a gross drainage area of approximately 81,800 km^2 (GoC 2024a). The watershed for the Yukon River at the downstream end of the Study Area is the combined delineation of the Yukon River and Nordenskiold River watersheds in Figure 1-2.

2.2.1 Hydrometric Data

WSC maintains a hydrometric station on the Yukon River in the middle of the Study Area (WSC Station 09AH001, GoC 2024a). WSC Station 09AH001 is located on the south bank of the Yukon River at the Klondike Highway Bridge (Figure 1-2). WSC Station 09CD001 (Yukon River Above White River) is located approximately 230 km downstream of Carmacks upstream of the White River confluence with the Yukon River, with a drainage area of 149,000 km^2. Table 2-2 summarizes the data available for this Project at WSC Stations 09AH001 and 09CD001.

Table 2-2 Available Yukon River Hydrometric Data at WSC Stations 09AH001 and 09CD001

Station Number	Station Name	Start Date/ End Date	Data Type	Source
WSC 09AH001	Yukon River at Carmacks	1951–1995	Daily average discharge	WSC digital download
		1952–1995	Annual maximum daily discharge	WSC digital download

		1961–1994	Annual maximum instantaneous discharge	WSC digital download
		1970–1995	Daily average local stage	WSC scanned hardcopies; generally open water data only
		2015–2020	Daily average local stage	WSC digital download
		2021–2022	Daily average local stage	WSC digital download provisional data
		2020	Maximum annual local stage	WSC digital download
		2015–2023	Rating Curve, Rating Table #7	WSC data request
WSC 09CD001	Yukon River Above White River	1957–2019	Annual maximum daily discharge	WSC digital download
		1996–2021	Daily average discharge	WSC digital download
		2022	Daily average local stage	WSC data request

Figure 2-4 illustrates annual flow hydrographs for all years on record at WSC Station 09AH001. Figure 2-5 illustrates historical statistics for flows at WSC Station 09AH001 as well as annual hydrographs for the year with the highest record peak flow (3,600 m^3/s on June 24, 1962). The Study Area of the Yukon River extends downstream of the confluence of the Nordenskiold River, and as such flows are slightly higher downstream of the confluence than those reported by WSC Station 09AH001.

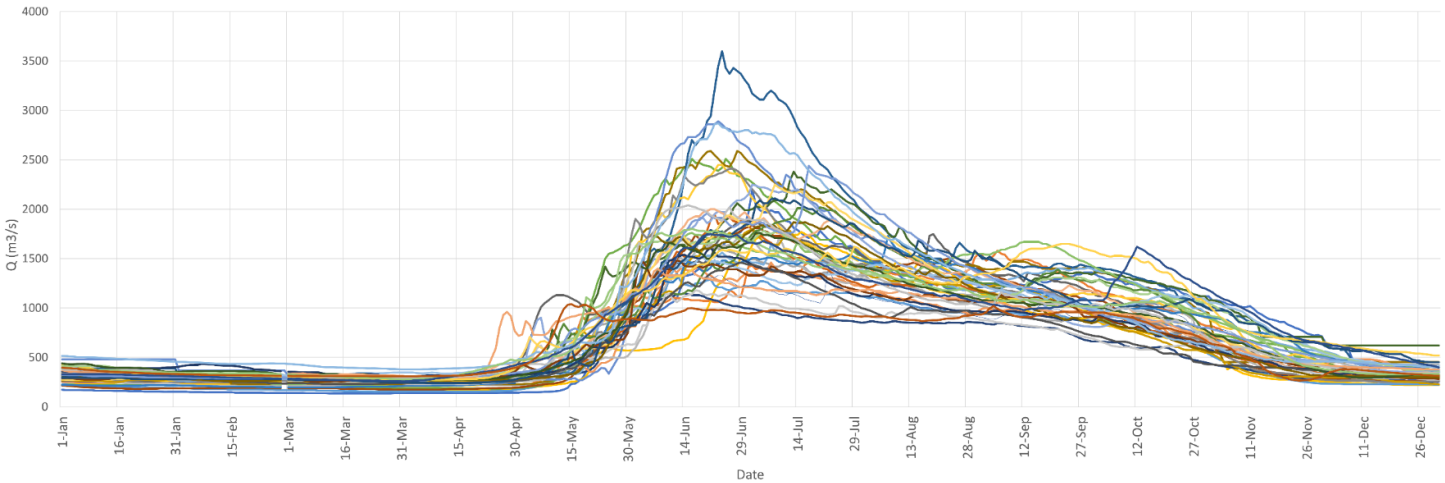


Figure 2-4 Annual Flow Hydrographs for All Years on Record (1951 – 1995) at WSC Station 09AH001 – Yukon River at Carmacks

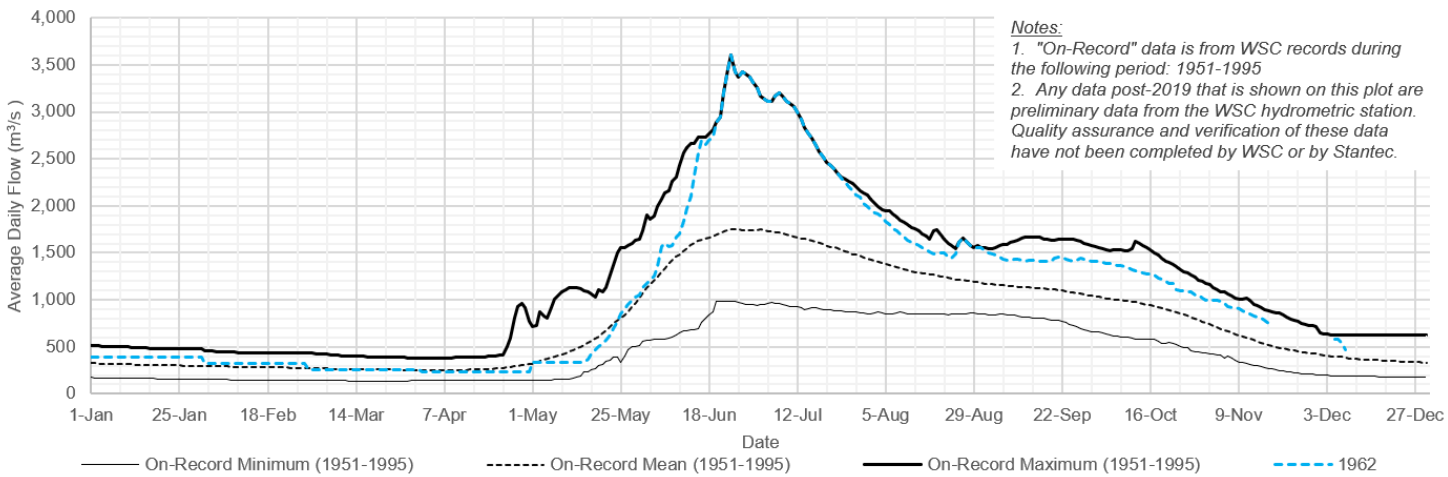


Figure 2-5 Daily Flow Statistics for Years on Record Historical Data (1951 – 1995) at WSC Station 09AH001 – Yukon River at Carmacks and Annual Hydrograph for Year with Highest Peak Average Daily Flow (1962)

2.2.2 Channel and Floodplain Characteristics

A photographic inventory of channel, banks and floodplain characteristics on the Yukon River is provided in Appendix A. General observations include:

- River cross-sectional geometry typically consists of a 200 – 400 m wide bankfull channel, although it may be wider in areas with islands or medial bars.
- Planform morphology is generally sinuous (sinuosity of approximately 1.8 – 2.0, depending on delineation of valley trend). A straight channel has a sinuosity near 1, and a highly meandering channel could have sinuosity greater than 2.5.
- The floodplain is predominantly fluvial gravels, sands, and silts in the upper subreaches of the Study Area. Colluvial deposits line the valley walls where the river flows up against them in the middle and lower reaches. Glaciofluvial deposits line the inner bank in the meander to the north of Carmacks, and along the left bank in the lower subreaches of the Study Area. No bedrock outcrops were observed within the active channel boundary.
- The bankfull channel is generally unconfined, although the bankfull channel abuts against the valley walls in several locations. At these locations, banks are high (in excess of 30 m) and are often exposed and eroding, contributing sediment to the river. Where banks are not abutting the valley wall, they are generally steep and consist of non-cohesive silt, sand, gravel, and cobble held together by tree and shrub roots. Large trees are tilted or falling into the river at many locations indicating active bank erosion processes.
- The bankfull channel is generally U-shaped. Bed material is unknown (not observable due to water clarity, and not sampled).
- Wood debris accumulation on outer banks and on lateral/medial bars was observed.
- The floodplain is vegetated with shrubs and trees. Understory growth consists of shrubs and grasses, with shrubs being more prevalent in near-channel areas.

2.2.3 Flood and Ice Processes

A summary of flood and ice processes for freeze-up, ice cover, ice breakup, and open water are provided below.

Regarding freeze-up processes:

- Local community members reported that freeze-up typically occurs in November or December; these reports are corroborated by WSC Station 09AH001 (GoC 2024a). Community members report that ice forms “from the bottom” during this time (frazil generation) and accumulates to cover the river.
- Engagement with local community members did not document historical occurrence of significant flooding during freeze-up.
- In 2018 when the WSC station 09AH001 started operating 12 months a year, the highest annual water level was measured at freeze-up for three consecutive years (2018-2020), with elevations

that compared with the highest open water levels of past decades (Turcotte et al. 2021). Therefore, the historic record at WSC station 09AH001 may not have captured the actual highest annual water level prior to the continuous operation of the station.

- While freeze-up stages correspond to above-average open WSEs, they are well below the peak open water flood WSEs recorded in 2021 and 2022.

Regarding the ice-covered period of the year:

- There are a limited number of ice thickness measurements available. WSC provided unpublished winter discharge measurement files that included eight ice thickness data from 1992 – 1995 and 2023, with thicknesses ranging from 0.37 m to 1.40 m (email communication, WSC personnel, November 2, 2023).
- Ice thickness on the Yukon River can be inconsistent, but local community members have indicated that ice thicknesses in excess of 2 m are not uncommon in certain locations. Local community members also reported that Yukon River ice will sag over the winter as flows drop, meaning that even if ice cover is established at an elevated WSE, the spring ice cover elevation is typically at a reduced, consistent level associated with late winter Yukon River flows.

Regarding ice breakup processes:

- Spring breakup scenarios are mostly thermal with limited ice jamming activity in the Carmacks reach of the Yukon River due to heat from Lake Laberge upstream, with a gradual upstream to downstream ice cover melt that rarely generates significant breakup intensity (Yukon University 2022). However, Turcotte et al. (2021) has reported that significant breakup ice jams are possible if a sudden and significant snowmelt event was to take place in Central Yukon.
- Local community members have indicated that ice breakup typically occurs in early to mid-May, two to three weeks after the Nordenskiold River breakup. The Yukon River downstream of the Nordenskiold River confluence is often first to open, potentially due to a weaker ice cover from warmer groundwater baseflows exiting the Nordenskiold River and increased energy from the Nordenskiold River breakup. This dynamic was previously discussed in Section 2.1.3 and is generally supported by available aerial imagery from 2017 to 2022 (Sinergise Ltd. 2023).
- Local community members have indicated that upstream of the Nordenskiold River confluence, the first open leads during breakup occur beneath and upstream of the Klondike Highway bridge. The formation and gradual enlargement of these open leads was observed by Stantec during a May 2023 site visit.
- There were no documented instances of flooding from breakup ice jams on the Yukon River in the Study Area.

Regarding open water processes:

- Community members consistently reported the highest water levels occurring in late June or early July during open water conditions. This is corroborated by water level records for WSC Station 09AH001 (GoC 2024a)

- The Teslin River contribution to the Yukon River at Carmacks is a significant driver of open water peak flows and flood conditions at Carmacks given the attenuated peak from the Southern Lakes basin (personal communication, A. Bier and C. O'Neill-Kizoff, May 5, 2023). WSC records (GoC 2024a) indicate Teslin Lake (and associated outflows to the Teslin River) typically peak in late June/early July (aligning with the Yukon River at Carmacks peak), whereas the Southern Lakes typically peak in August.
- Open water maximum annual WSEs were on average 1 m higher than the breakup maximum annual water surface elevations on the Yukon River at Carmacks (Turcotte 2021).
- Open water flooding on the Yukon River has been documented at multiple locations, including along River Drive and on the lower bench of the LS/CFN subdivision.
- Significant open water flood events occurred in June/July of 2021 and 2022, requiring emergency response actions by YG including temporary superbag and sandbag dikes and other temporary flood defenses.
- Open water flooding has led to elevated groundwater in the adjacent land and resulted in flooding issues for underground infrastructure (e.g., underground pipes, basements, and septic systems).

2.2.4 Past Flood Events

The Yukon River flood events summarized below are a summary of the flooding documentation provided to Stantec at the time of writing; they do not represent a comprehensive review of flooding history in the Study Area.

2020 Flood Event

Flooding along the Yukon River occurred in late 2020 in response to freeze-up ice jams. During this event the recorded stage rose approximately 3 m between November 20 and December 3, during a period of dynamic freeze-up and ice jamming (YG WRB 2020). Flooding during this event was associated with significant snow, rain and warm temperatures (up to 4°C) over a three-day period (GoC 2024b). Flooding was noted at the River Drive boardwalk (Photograph 8), but the road and low-lying infrastructure in the community were not noted to be at risk (YG WRB 2020).

Photograph 8 Freeze-up Flooding along River Drive Boardwalk, Looking Upstream in December 2020 (YG WRB 2020)

2021 and 2022 Flood Events

Severe flooding occurred in the Carmacks area in late spring of 2021 and 2022. The flooding was largely attributed to high snowpack accumulation in south/central Yukon over the winter of 2020–2021 and 2021–2022, combined with a cool and wet spring that delayed snowmelt. For 2021 in particular, warm temperatures in late-June resulted in rapid melting of the snowpack and record inflows to the local watersheds. Emergency flood mitigation measures, including superbag dikes and Aquadams/Tiger Dams, were installed along River Drive from late June through mid-July in both years (Photograph 9). Elevated groundwater in the adjacent land from elevated Yukon River WSEs resulted in flooding issues for underground infrastructure, including the sanitary pipe system.

Photograph 9 Open Water Flooding Along River Drive on June 15, 2022; Emergency Temporary Superbag Dike Being Installed

2.2.5 Summary of Dominant Flood Processes

Breakup ice jams on the Yukon River have not been documented to cause significant elevated WSEs in the Study Area. Although elevated WSEs can occur due to freeze-up processes, flood events from the Yukon River within the Study Area are driven by open water flows. As illustrated in Figure 2-4 and Figure 2-5, the Yukon River at Carmacks typically has a single annual peak in late June or early July which is largely influenced by the snowmelt peak of the Teslin River basin. The observed flood hydrology for the Yukon River at Carmacks does not suggest an appreciable sensitivity to rain-on-snow events or convective summer rainfall events. However, the observed flood hydrology does suggest sensitivity to snowpack accumulation and resulting snowmelt.

3 Hydrologic Analysis

The hydrologic analysis undertaken for the Project generally followed the single site flood frequency analysis (FFA) pathway from NRCan (2019a), illustrated in green overtop of the NRCan (2019a) flowchart in Figure 3-1. The hydrologic analysis produced a suite of annual exceedance probability (AEP) discharges (50%, 20%, 10%, 5%, 2%, 1%, 0.5%, and 0.2%) for both the Nordenskiold River and Yukon River, for i) freeze-up, ii) breakup, and iii) open water conditions.

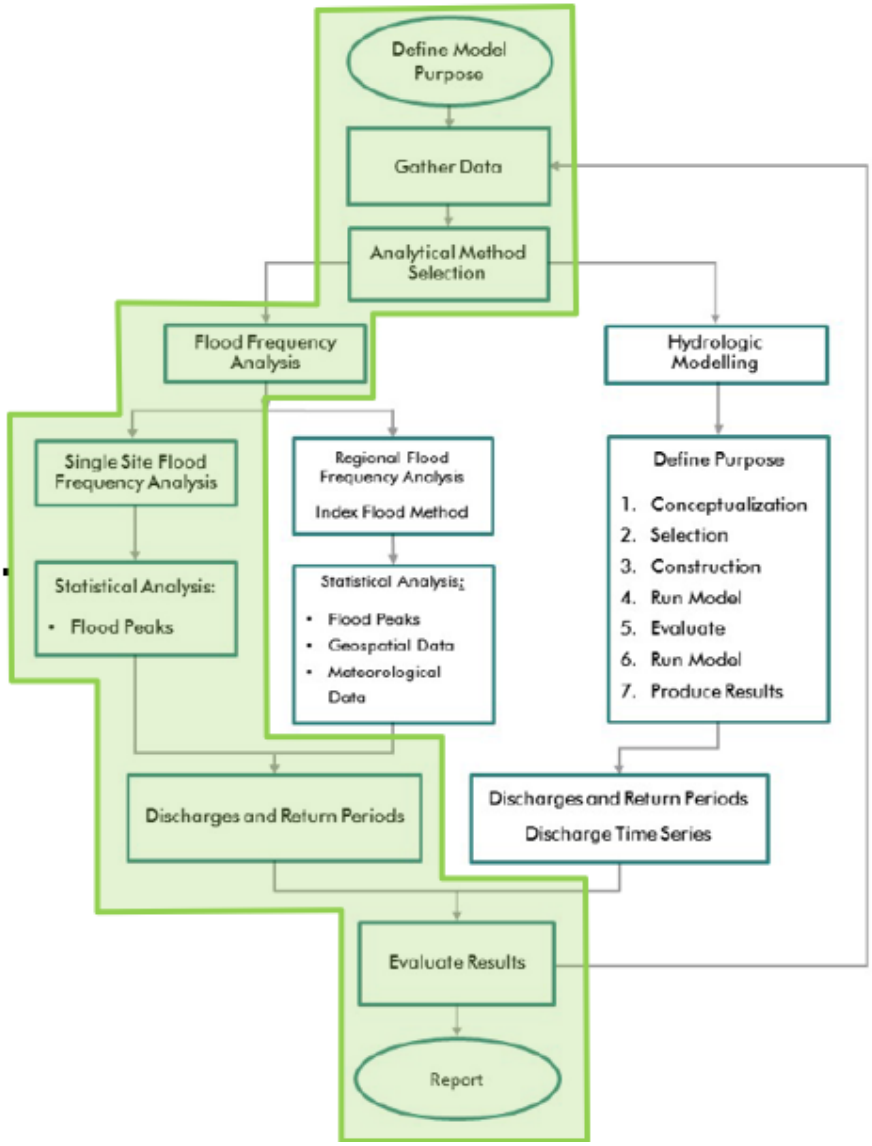


Figure 3-1 Hydrologic Procedures Flowchart from NRCan (2019a)

3.1 Nordenskiold River

Documented peak annual discharges have occurred during the open water period for all years in the record, except for in 2003 and 2005 when the peak flow occurred during breakup. Following a review of the annual hydrographs, open water peaks occur in response to spring snowmelt freshet (approximately 24 of 40 years in the record) and in response to convective storms producing significant rainfall in the Nordenskiold River watershed (approximately 16 of 40 years in the record). The maximum daily average flow occurring on each day (in any year) is provided in Figure 2-3.

3.1.1 Data Series Preparation

A hydrological assessment was completed to determine open water, breakup, and freeze-up flood frequency estimates at WSC Station 09AH004. A single station discharge FFAs were used to estimate annual exceedance probabilities (AEPs) of 50%, 20%, 10%, 5%, 2%, 1%, 0.5%, and 0.2% for each of these flood processes. The identification of peak seasonal flow estimates is based on historically available data, including peak water level (stage) and WSC estimated flows (Table 2-1).

Instantaneous single station FFAs were completed for open water, breakup and freeze-up conditions. A complete data set of open water peak seasonal instantaneous discharges was not available for WSC Station 09AH004, whereas daily maximum discharges were. As such, the annual ratio between daily maximum discharge (*QD*) and instantaneous peak discharge (*QP*) for open water conditions for the same hydrologic event was calculated. Instantaneous peak discharges during ice-covered conditions were limited to a few years and were not used to develop seasonal scaling factors. Years when the peak daily discharge and instantaneous peak discharge occurred during different events (timings) were excluded from the average. This annual ratio was used to estimate the station-specific scaling factor (*a*) for the period of record when both data sets overlapped:

$$QP = a * QD$$

A scaling factor of 1.10 was calculated for the Nordenskiold River as the average of the annual scaling factors, plus one standard deviation (Appendix B). The addition of one standard deviation is a common statistical approach to produce a more conservative scaling factor estimate than only using the average. This method was determined to be slightly more conservative than a linear regression model.

Annual hydrographs were developed using daily average discharge and daily average stage (when available). The hydrographs were reviewed to determine the timing and magnitude of peak daily open water discharge, peak daily breakup discharge and peak daily freeze-up discharge.

For each year of the dataset, the day and magnitude of the maximum open water discharge was identified at the WSC Station (GoC 2024a). For ice affected conditions, the timing and magnitude of maximum discharge during the annual breakup and freeze-up periods were estimated (Appendix B). When available, daily stage data was used to support the identification of ice timing events. Meteorological data were used to support the identification of timing of peak discharge during breakup and freeze-up events. Daily mean temperature from three Environment and Climate Change Canada (ECCC) stations was selected: Carmacks (ECCC Station 2100300), Carmacks CS

(ECCC Station 2100301) and Pelly Ranch (ECCC Station 2100880). Data from the Pelly Ranch station (approximately 100 km north of Carmacks) was used to fill gaps in the Carmacks station records (GoC 2024b). The correlation between the stations was assessed with overlapping data to confirm that the Pelly Ranch data is sufficiently similar to meteorological conditions in Carmacks for the intended purpose.

The duration of the breakup and freeze-up timing seasons were estimated as the 10th and 90th percentiles of the events identified directly from the hydrographs:

- Breakup: April 18 to May 13
- Freeze-up: October 22 to November 21

A dataset of peak daily open water discharge was compiled for each available year within the period of record, up to 2022, when the timing and magnitude could be determined directly from the hydrographs. Data sets of peak daily breakup discharge and peak daily freeze-up discharge were developed (Appendix B). Peak daily discharges were scaled up to peak instantaneous flows using the station-specific scaling factor.

3.1.1.1 Gap Filling Techniques

For years when the peak discharge during the breakup and/or freeze-up timing could not be directly identified from the annual hydrographs, a gap filling technique using meteorological data was developed to estimate these discharges. This technique used a temperature-based threshold as a surrogate for estimating the timing of breakup/freeze-up events. Gap filling was generally required during smooth transitions between ice-covered and open water conditions.

A dataset of the Accumulated Degree Days (ADD) and Accumulated Freezing Degree Days (AFDD) was developed for each year within the data record for the WSC station using average daily temperature data (Beltaos et al. 2013). The ADD and AFDD was recorded for each identified breakup and freeze-up event in the dataset. The median value of the ADDs and AFDDs were set as a threshold for estimating the temperature conditions associated with breakup/freeze-up. Environmental factors including ice thickness, insulating snow depth, cloud cover or precipitation were excluded from the estimation of this threshold.

For years when the breakup timing could not be identified from the hydrograph, the start of the breakup period was assumed to be the 10th percentile break-up date and the end of the breakup period was assumed to be the day on which the ADD threshold was reached. As a conservative approach to estimate the breakup discharge, the maximum discharge during this estimated breakup period was selected. Similarly, the day when the AFDD threshold was reached was assigned as the start of the freeze-up period and the 90th percentile freeze-up date was assumed to be the end of the freeze-up period. The maximum discharge during this assumed freeze-up period was selected as a conservative estimate of the peak freeze-up discharge for gap-filled years.

3.1.2 Flood Frequency Analysis

Following the methods described in the NRCan (2019a), datasets of annual maximum instantaneous discharge for the Nordenskiold River WSC Station 09AH004 were prepared for the single station FFAs. Individual datasets were prepared for the three seasons of interest for potential flooding in the community – freeze-up, breakup, and open water – for the period of record up to the end of 2022.

The stationarity of the datasets for the three seasons during the period of record were assessed to identify land use changes, development in the watershed and climate change impacts. The Kendall stationarity test did not identify a trend at a significance level of 5% and thus each of the three datasets are considered stationary.

Statistical tests on the homogeneity of the annual flood discharges for each of the three seasons were completed using a Wilcoxon test by subdividing each dataset and testing that the averages of the datasets were equal; all tests for homogeneity accepted that the averages of the subdivided sample sets were equal at a significance level of 5%.

Statistical tests on the independence within each of the three season datasets were completed to verify that the records of peak flows were independent random variables and the datasets were determined to be independent at a confidence level of 5% using the Wald-Wolfowitz test. All statistical tests were completed using built-in options in the HYFRAN-PLUS Version 2.2 statistical software.

Single station FFAs for freeze-up, breakup, and open water conditions were completed following the methods described by NRCan (NRCan 2019a) using the dataset of instantaneous maximum annual discharge for each condition. The Annual Maximum method was selected for the freeze-up, breakup, and open water FFAs. Annual Maximum FFAs are more common, and the use of separate FFAs flood processes was deemed an appropriate approach for estimating inputs for hydraulic modelling to determine flood extents for the dominant flooding processes along the Nordenskiold river.

FFAs were completed using HYFRAN-PLUS software for fitting several distributions to the freeze-up, breakup, and open water annual maximum instantaneous discharge datasets. The goodness of fit was checked for a range of distributions from different distribution classes, including log-Pearson Type 3 (LP3), Inverse Gamma, Gumbel, Gamma and Pearson Type 3, Exponential and Generalized Extreme Values. The LP3 distribution is recommended by the USGS as the basic distribution for estimating the flood flow frequency curve (USGS 2019) and was the selected distribution for all FFAs. The LP3 distribution provided sufficient goodness of fit for all FFAs. Instantaneous discharges for the suite of AEPs are provided in Table 3-1 for freeze-up, breakup, and open water. The LP3 distribution plots for freeze-up, breakup, and open water are provided in Figure 3-2**,** Figure 3-3, and Figure 3-4, respectively.

Table 3-1 Nordenskiold River FFA results for Freeze-up, Breakup, and Open Water

AEP	Peak Instantaneous Discharge (m^3/s)		
	Freeze-up	Breakup	Open Water
50% AEP (1:2-year event)	12	24	93
20% AEP (1:5-year event)	17	48	140
10% AEP (1:10-year event)	20	68	171
5% AEP (1:20-year event)	23	91	201
2% AEP (1:50-year event)	26	124	239
1% AEP (1:100-year event)	29	153	267
0.5% AEP (1:200-year event)	31	185	296
0.2% AEP (1:500-year event)	34	231	333

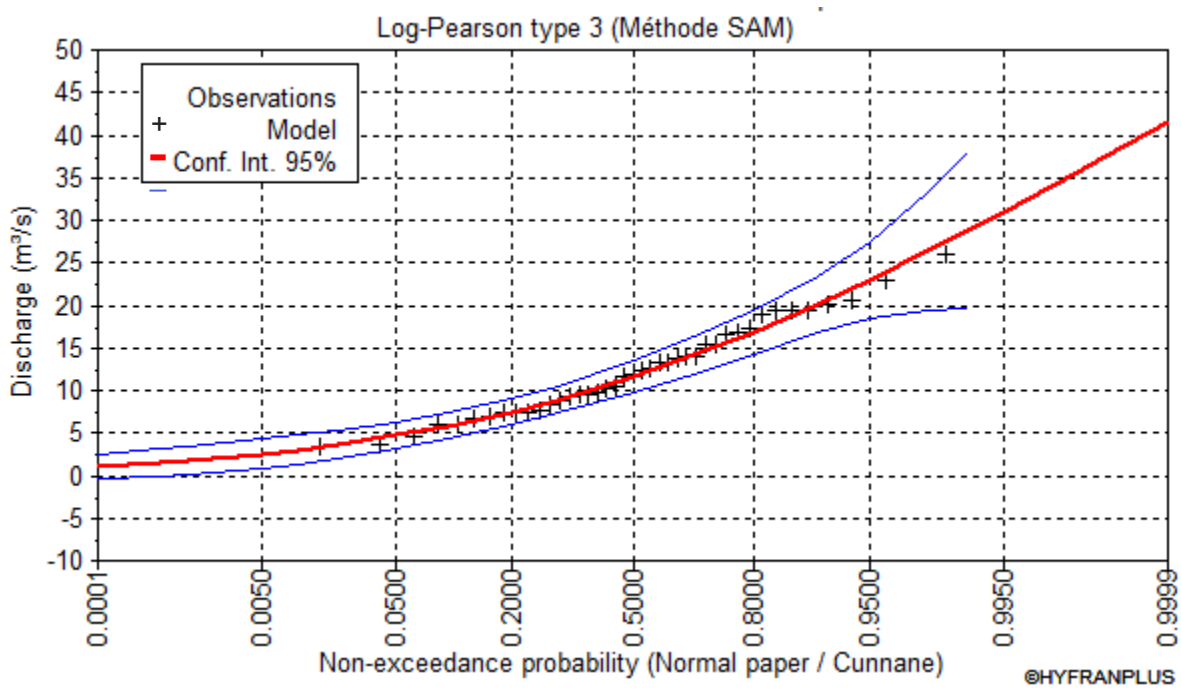


Figure 3-2 Nordenskiold River Freeze-up Flood Frequency Plot (LP3 Distribution)

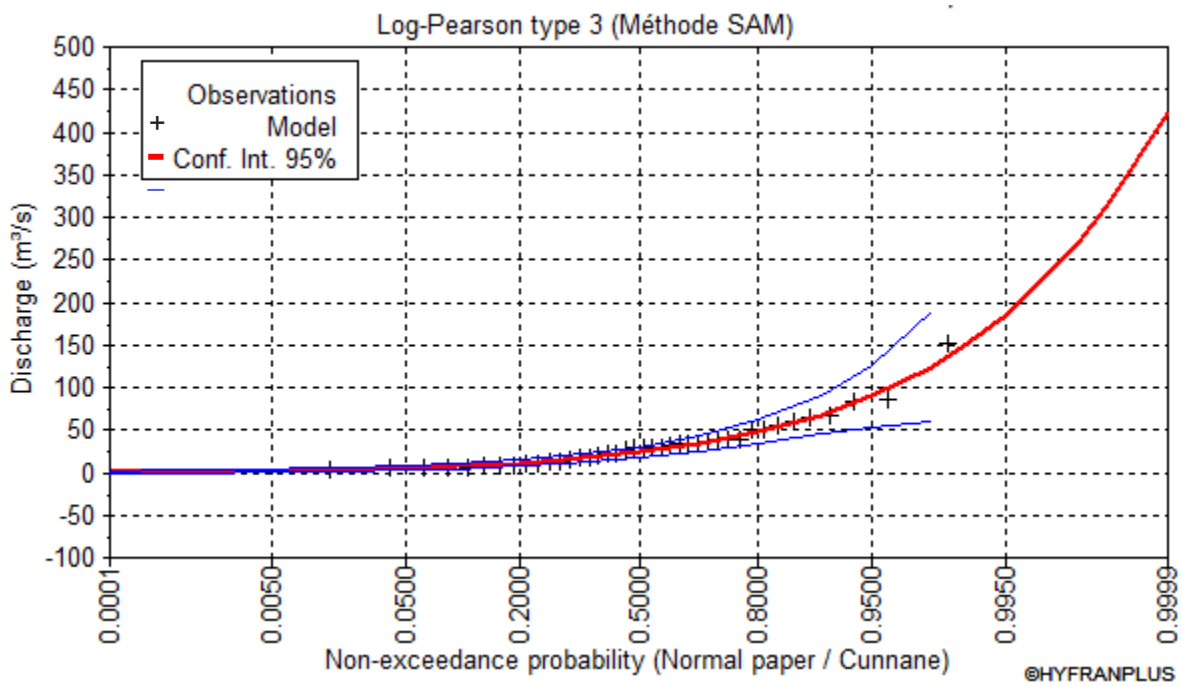


Figure 3-3 Nordenskiold River Breakup Flood Frequency Plot (LP3 Distribution)

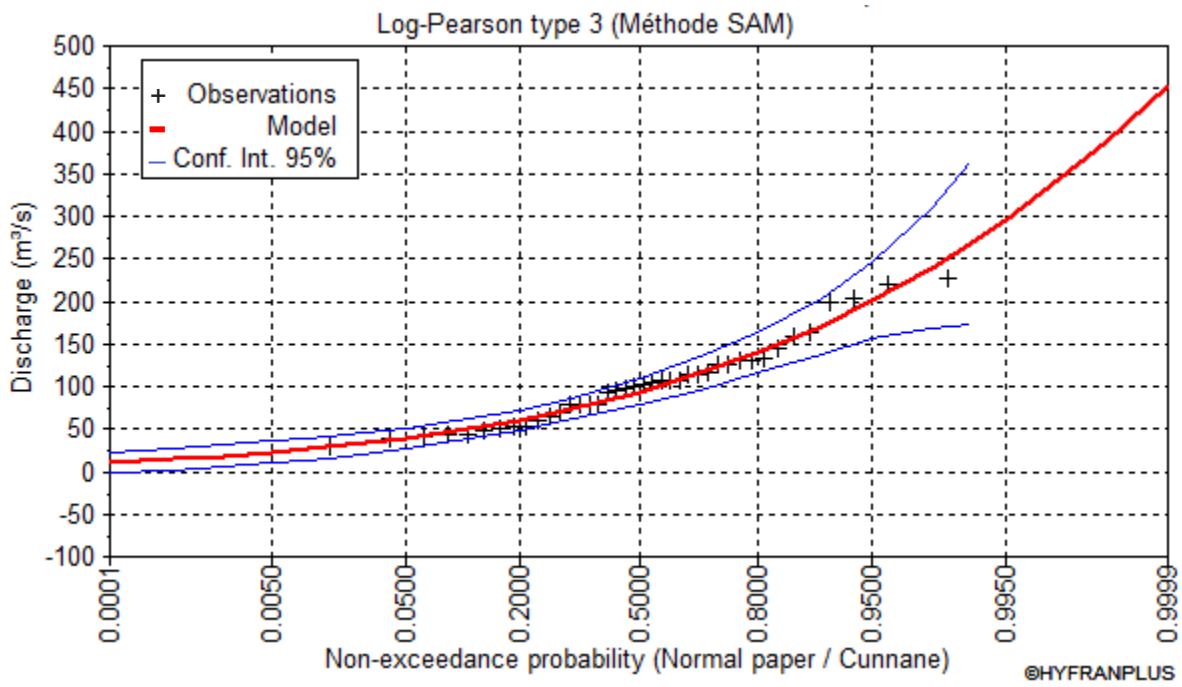


Figure 3-4 Nordenskiold River Open Water Flood Frequency Plot (LP3 Distribution)

The record length of 40 years at WSC Station 09AH004 is less than the extrapolated AEPs that have been selected. A common rule is to limit extrapolating to AEPs to no more than double the length of the available record length (NRCan 2019a). Given the project requirements of determining design flows of AEPs down to 1%, 0.5% and 0.2%, these flow estimates have been provided but should be interpreted with some additional caution as the underlying dataset record length is relatively short. The availability of a hydrometric dataset that is at least half the length of a 0.2% AEP would require a data record that is 250 years long.

One reference hydrotechnical engineering report was available for the Nordenskiold River (WSP 2018) and included an open water FFA. No consideration of ice conditions, including ice jamming, was documented in this report and flooding is noted to be produced by spring snowmelt events occurring in late April to early June (WSP 2018). It appears that a LP3 distribution was selected for the FFA. Some consideration was given to nearby WSC gauging stations at Big Creek Near the Mouth (WSC Station 09AH003) and Yukon River at Carmacks (WSC Station 09AH001), but it appears that only data from the 09AH004 station was used in the analysis. A comparison of these two FFA results indicates that WSP (2018) is slightly more conservative (Table 3-2) but the underlying data source is considered less robust.

Table 3-2 Nordenskiold River Open Sater FFA Results Comparison to Previous Studies

	Open Water FFA Instantaneous Discharge (m^3/s)	
	WSP (2018)	**This Project**
50% AEP (1:2-year event)	95	93
10% AEP (1:10-year event)	170	171
2% AEP (1:50-year event)	245	239
1% AEP (1:100-year event)	280	268
0.5% AEP (1:200-year event)	320	296

Three differences are noted between the FFA completed by WSP (2018) and this Project. Firstly, only open water conditions were considered and the potential for ice jam induced flooding was not documented. Secondly, the period of record incorporated by WSP uses discharge data between 1982 and 2016, which excludes relatively high flow events in 2021 and 2022. Thirdly, WSP (2018) notes that the highest discharge recorded at the station occurred in 1983 and was likely a localized event within the watershed. However, this instantaneous discharge (244 m^3/s) is approximately one-third higher than the maximum daily discharge for the same event (185 m^3/s) and is a significant outlier from the calculated annual scaling factors. Given that 1983 was the first full open water season with the WSC Station 09AH004 in place, it is suspected that the instantaneous discharge is unreliable. For this Project, the maximum daily discharge was scaled up to an instantaneous discharge (204 m^3/s) for use in the open water FFA.

Overall, the FFA results determined as part of this Project are deemed to be robust and appropriate to be used as inputs for hydraulic modelling to produce flood maps for the Study Area.

3.2 Yukon River

Peak annual discharges on the Yukon River have been recorded during the open water season for all years in the available discharge record. Most of these peaks occur during spring snowmelt freshet (estimated 46 of 52 peaks in the record), generally in late-June to mid-July. Occasionally, peak open water conditions occur later in summer when elevated flows respond to convective storm events producing significant rainfall in the watershed or to high water levels in Southern Lakes driven by glacial melt contributions (estimated 6 of 52 peaks in the record). The maximum daily average flow occurring on each day (in any year) is provided in Figure 2-5.

3.2.1 Data Series Preparation

A hydrological assessment was completed to determine freeze-up, breakup, and open water FFA estimates at WSC Station 09AH001 using the same methods as for the Nordenskiold River, including adoption of the annual maximum approach. As with the Nordenskiold River, the identification of peak daily flow estimates for open water and ice conditions (i.e., breakup and freeze-up) are based on historically available data.

A scaling factor of 1.02 at WSC Station 09AH001 was calculated as the average of the annual scaling factors plus one standard deviation using the same methods as for the Nordenskiold River (Appendix B). This method for calculating the scaling factor was slightly more conservative than a linear regression model.

The duration of the breakup and freeze-up timing seasons were estimated as the 10th and 90th percentiles of the peak events identified using the annual hydrographs:

- Breakup: May 2 to May 24
- Freeze-up: November 6 to December 17

A dataset of peak daily open water discharge was compiled for each available year within the period of record, up to 2022, when the timing and magnitude could be determined directly from the hydrographs. Data sets of peak daily breakup discharge and peak daily freeze-up discharge were developed (Appendix B). Peak daily discharges were scaled up to peak instantaneous flows using the station-specific scaling factor of 1.02.

3.2.1.1 Gap Filling Techniques

The timing and magnitude of most peak freeze-up, breakup, and open water events were determined directly from the annual hydrographs. Similar to the gap-filling approach for the Nordenskiold River, estimates were made for years when these events could not be identified directly. ADD and AFDD thresholds specific to WSC Station 09AH001 were calculated using the identified breakup and freeze-up events and were used to fill gaps in the peak annual discharge data sets using the method described for the Nordenskiold River.

Significant data gaps are present in the WSC data set from 1996 to 2022. To fill these gaps, a regression analysis and a WSC rating curve were used.

Gap filling with no available stage or discharge data (1996 to 2014)

WSC station 09AH001 includes a data gap from 1996 to 2014 when the station was not operated, and no stage or discharge data is available. To fill this gap during open water conditions, a regression analysis was completed using data from WSC station 09CD001 (Yukon River Above White River). Gap filling of discharges during the breakup or freeze-up periods was not attempted during these years. This station is located approximately 230 km downstream of Carmacks and provides a discharge dataset from 1957 to 2019. The use of WSC Station 09CD001 provided an improved statistical fit over the stage dataset upstream at Teslin Lake at Teslin (WSC station 09AE002).

A regression analysis was completed to estimate the relationship between annual daily maximum open water discharge at 09AH001 and 09CD001 using overlapping data from 1957 to 1995. To account for the delay between flows in Carmacks and at the downstream station, a two-day delay was applied to the WSC Station 09CD001 data. This delay was estimated using river velocity data collected during the June 27, 2023 open water calibration event in Carmacks and the distance between the two stations. For example, the peak annual open water discharge at 09AH001 in 1970 was recorded on July 22. For the regression analysis, the discharge two days later (July 24) was used to estimate the discharge relationship.

The regression analysis in Equation (1) had an R^2 of 0.90.

$$09AH001\ discharge = -0.00006 \times (09CD001\ discharge)^2 + 1.068\ (09CD001\ discharge) - 758.67 \qquad (1)$$

Equation (1) was used to fill gaps at the 09AH001 station between 1996 and 2014 (Appendix B). The statistical fit of this regression analysis is considered satisfactory for gap filling discharge. Flows estimated for two years (2012 and 2013) were deemed to be erroneously high based on the absence of flooding documentation in the Carmacks area that would be expected with flows comparable to those experienced in 2022. Elevated flows at WSC Station 09CD001 during these years were most likely due to above-average, localized contributions from tributaries downstream of Carmacks, including the Pelly River. In 2012 and 2013 peak open water flows on the Pelly River were above the upper quartile of peak flows as recorded at WSC Station 09BC001 (Pelly River at Pelly Crossing), approximately 50 km upstream of the confluence and were removed from the dataset.

Gap filling with new WSC rating curve (2015 to 2022)

In 2015, WSC Station 09AH001 resumed recording stage data. WSC updated the open water stage-discharge relationship rating curve at 09AH001 in September 2023 with rating curve #7 (email communication, A. Bier, September 13, 2023). The curve is as shown in Equation (2):

$$discharge = 295.08 * (stage - 0.8)^{1.316} \qquad (2)$$

Rating curve #7 was used to convert 2015 to 2022 daily maximum stage data to estimated daily maximum discharge (Appendix B).

3.2.2 Flood Frequency Analysis

Single station FFAs were completed for the freeze-up, breakup, and open water annual maximum instantaneous discharge datasets at WSC Station 09AH001 using the same methods described for the Nordenskiold River. Statistical tests on the independence, stationarity and homogeneity of the datasets for each season (freeze-up, breakup, and open water) were tested in HYFRAN-PLUS, with satisfactory results (1% significance level required for independence for open water conditions). Instantaneous discharges for the suite of AEPs are provided in Table 3-3**.** The LP3 distribution plots for freeze-up, breakup, and open water are provided in Figure 3-5, Figure 3-6 and Figure 3-7, respectively.

Table 3-3 Yukon River FFA results for Freeze-up, Breakup, and Open Water

AEP	Peak Instantaneous Discharge (m^3/s)		
	Freeze-up	Breakup	Open Water
50% AEP (1:2-year event)	453	555	1900
20% AEP (1:5-year event)	579	773	2360
10% AEP (1:10-year event)	660	924	2650
5% AEP (1:20-year event)	737	1070	2910
2% AEP (1:50-year event)	835	1280	3250
1% AEP 1:100-year event	908	1440	3500
0.5% AEP (1:200-year event)	981	1600	3740
0.2% AEP (1:500-year event)	1080	1830	4060

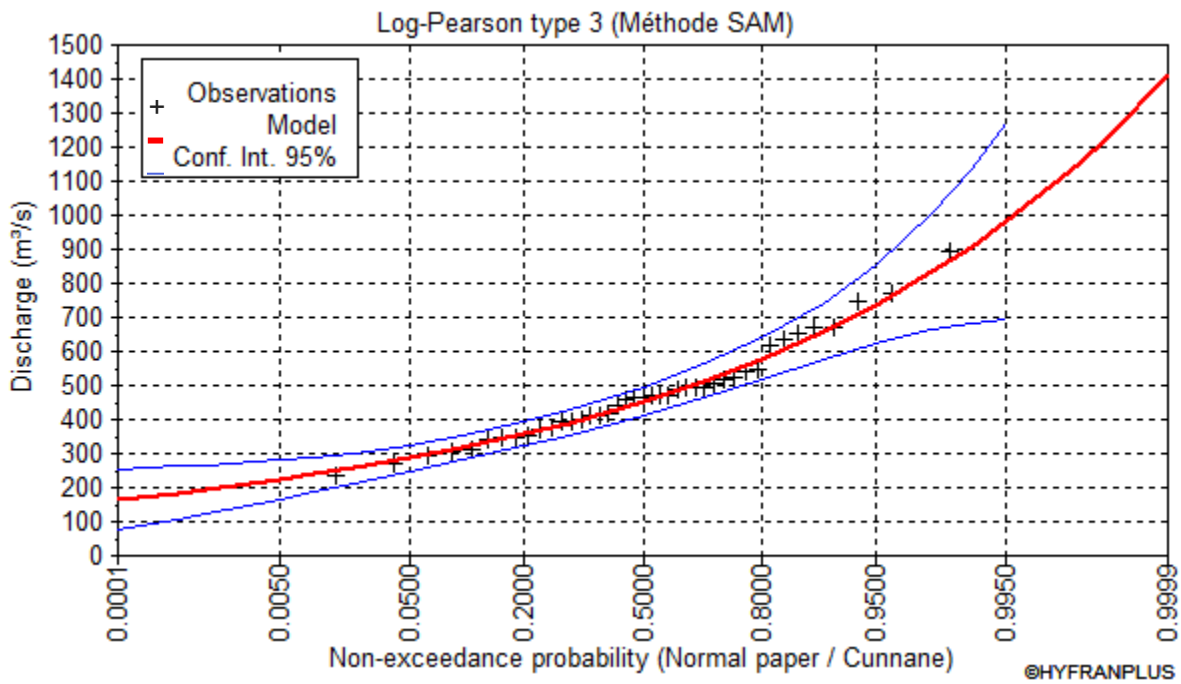


Figure 3-5 Yukon River Freeze-up Flood Frequency Plot (LP3 Distribution)

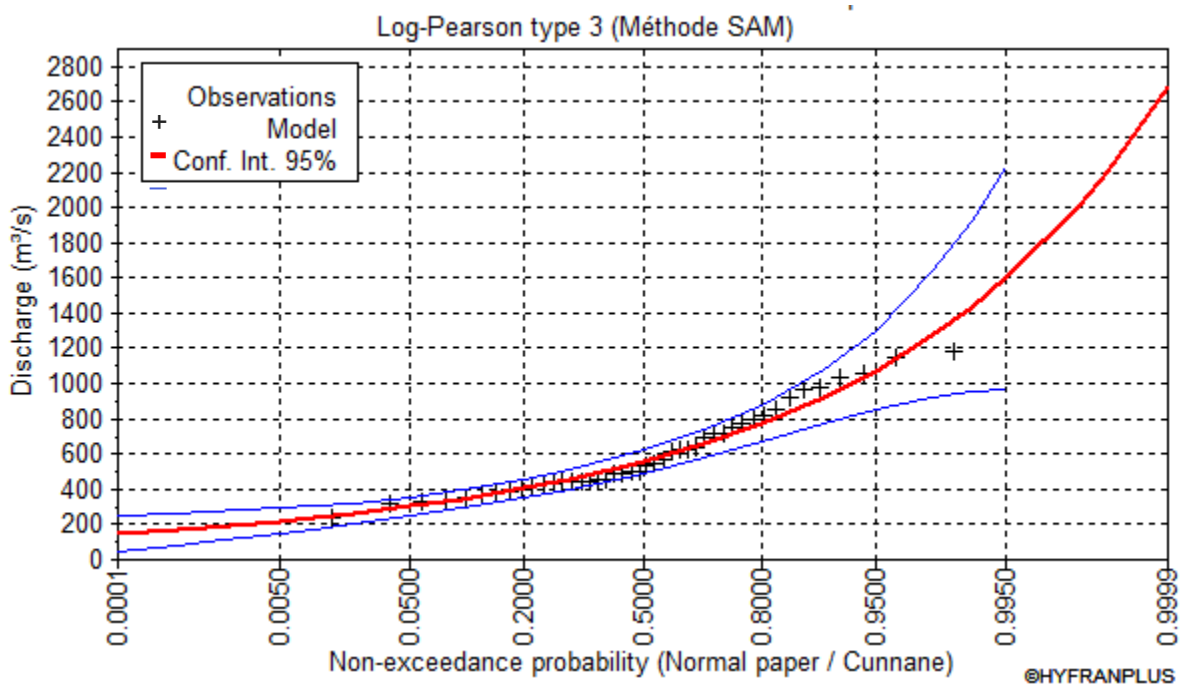


Figure 3-6 Yukon River Breakup Flood Frequency Plot (LP3 Distribution)

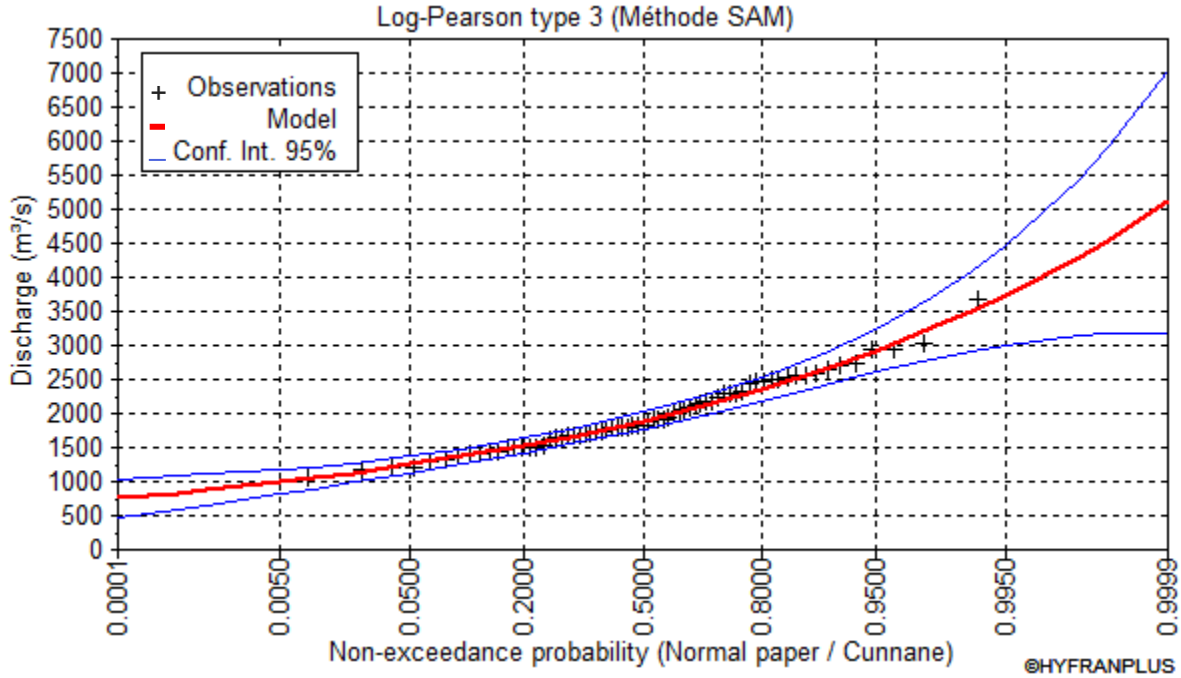


Figure 3-7 Yukon River Open Water Flood Frequency Plot (LP3 Distribution)

As with the Nordenskiold River, the record length for the WSC Station 09AH001 (53 years plus a 19 year data gap), is less than the extrapolated AEPs that have been selected. As such, additional caution should be used when interpreting the provided flows as the underlying data record length is relatively short.

Two existing stage FFA studies for the Yukon River at Carmacks were made available to Stantec for review and comparison: stage FFAs completed by Morrison Hershfield (2022) and Yukon University (2022) at WSC Station 09AH001. The Morrison Hershfield FFA considered only open water peak instantaneous stage data from 1969 to 2022, with a data gap from 1996 to 2014; no gap filling was completed. The FFA completed by Yukon University used WSC data from 1970 to 2022 and partially filled the 1996 to 2015 gap using Teslin Lake data. Yukon University (2022) considered freeze-up, breakup, and open water flooding events and provided a combined single stage FFA. WSC's rating curve #7 was used to convert the results of Morrison Hershfield (2022) and Yukon University (2022) stage FFAs to discharges to allow for a comparison between the results (Table 3-4).

Table 3-4 Yukon River Open Sater FFA Results Comparison to Previous Studies

	Open water FFA instantaneous discharge (m^3/s)		
	Morrison Hershfield (2022)	**Yukon University (2022)**	**This Project**
50% AEP (1:2-year event)	1668	2038	1900
10% AEP (1:10-year event)	2255	-	2650
5% AEP (1:20-year event)	2460	2677	2910
2% AEP (1:50-year event)	2722	-	3250
1% AEP (1:100-year event)	2915	-	3500
0.5% AEP (1:200-year event)	3105	3356	3740

The results of these three FFAs demonstrate general agreement, with this Project being the most conservative. An analysis of the source of the differences between these FFAs was completed. Both of the stage FFA exclude data from the 1952 to 1969 period when only discharge data is available at the WSC Station 09AH001. This period includes the highest recorded discharge in 1962 (3,600 m^3/s) as well as high discharge events in 1961 (2,590 m^3/s) and 1964 (2,890 m^3/s). Temporarily removing the 1952-1969 data points from this Project's FFA-discharge data set results in a 0.5% AEP discharge of 3440 m^3/s, which is slightly more conservative than the corresponding Yukon University (2022) discharge of 3356 m^3/s (modified analysis being 3% higher). Therefore, the difference in these AEP discharges can be attributed to the different regression analysis approaches used for the 1996 to 2015 gap filling, and potentially minor differences with the stage-discharge relationship modelled by WSC rating curve #7.

To compare with Morrison Hershfield (2022), data from 1952 – 1968 and 1996 – 2014 were temporarily removed from the current dataset, producing a corresponding 0.5% AEP discharge of 3500 m^3/s. Therefore, main difference between the results of these two analyses can be attributed to Morrison Hershfield's exclusion of several high water levels (e.g., 1961, 1962, 1964) and exclusion of high gap-filled years (e.g., 2001, 2004, 2005, 2009).

Overall, the FFA results determined as part of this Project are deemed robust and appropriate to be used as inputs for hydraulic modelling to produce flood maps for Carmacks.

4 Joint Probability Analysis

In this Project, the flood hazard map produced a given AEP consists of a single inundation extent representing the overall AEP ("composite" flood hazard map). It is possible that (within a given AEP) different flood processes may be dominant in different locations of the Study Area. To address this potential scenario, Stantec completed (for each AEP) separate hydraulic model runs for each of the dominant flood processes identified in Section 2.1.5 and Section 2.2.5, overlayed the inundation results, and adopted the outer inundation as the composite flood hazard extent for that AEP. These three dominant flood processes are henceforth referred to as flood scenarios:

i. Nordenskiold River breakup ice jams

ii. Nordenskiold River open water conditions

iii. Yukon River open water conditions

As the hydraulic model is a single model with both the Nordenskiold River and Yukon River, flows in both the Nordenskiold River and Yukon River are required for each of the three flood scenarios, for each of the AEPs being mapped. As discussed in Section 2, the three flood scenarios do not occur at the same time of year; Nordenskiold River breakup is typically in late April, Nordenskiold River open water peak flow could occur through the spring, summer, or fall, and Yukon River open water peak flow occurs in late June or early July. Therefore, it is important to identify appropriate and plausible pairings of Nordenskiold River/Yukon River flow as to represent the AEP inundation for the flood scenario in question. If this was not done, misrepresentation of the overall AEP inundation would result; for example, simultaneously modelling the 0.5% open water AEP Nordenskiold River flow and the 0.5% open water AEP Yukon River flow likely represents an overall AEP much rarer than 0.5%.

The method for joint probability analysis for each of the three flood scenarios are detailed in Section 4.1, Section 4.2, and Section 4.3.

4.1 Nordenskiold River Breakup Ice Jam Flood Scenario

This flood scenario consists of breakup jam(s) on the Nordenskiold River, with Nordenskiold River and Yukon River AEP flows appropriate for the time period when Nordenskiold River jams occur.

Nordenskiold River breakup AEP flows were provided in Section 3.1.2.

The Yukon River typically breaks up two to three weeks after Nordenskiold River breakup on the rising limb of spring freshet flows. This means that the flows considered in the Yukon River breakup FFA are higher than those which would occur during the Nordenskiold River breakup (when the Yukon River ice cover is intact). The highest estimated flow to occur in the Yukon River during the Nordenskiold River breakup period was 1190 m^3/s in 1952 (over a 44 year period of breakup record). This flow is estimated to represent the upper end of potential Yukon River flow during ice cover conditions and was adopted as the

paired flow for all AEPs for this flood scenario. Selected flows for hydraulic modelling are presented in Section 7.1.

4.2 Nordenskiold River Open Water Flood Scenario

This flood scenario consists of the Nordenskiold River open water AEP flows ("primary flow") and a paired Yukon River flow which would result in representation of the overall AEP flood scenario.

The Gumbel-Hougaard copula (Nelsen 2006) has been recommended by Kilgore et al. (2010) to make a reasonable estimate of the joint probability of floods at stream confluences. In this method, univarite probability distributions for two rivers are linked with the Gumbel-Hougaard copula to account for the dependence between two random variables. Kilgore et al. (2010) found that univariate distributions linked with copulas are more useful than bivariate distributions because bivariate distributions are limited by a minimum correlation requirement between the two streams and rely on presumed underlying distributions which may not be representative of observed data at the two streams.

The joint probability isolines for open water AEP flows on the Yukon River as a function of AEP flows on the Nordenskiold River are illustrated on Figure 4-1. Kendall's τ used in the Gumbel-Hougaard copula analysis is a rank correlation measure between two flood series in both rivers which ranges from –1 to 1. Figure 4-1 illustrates that the AEP flow on the Nordenskiold River ("primary flow") should be paired with a Yukon River flow of below the lowest AEP produced in the FFA (50%) in order to reasonably represent the overall AEP scenario. Therefore, as a conservative approach, the open water 50% AEP Yukon River flow (1,900 m^3/s) was used as the paired flow for all Nordenskiold River primary AEP flows in this flood scenario. Selected flows for hydraulic modelling are presented in Section 7.1.

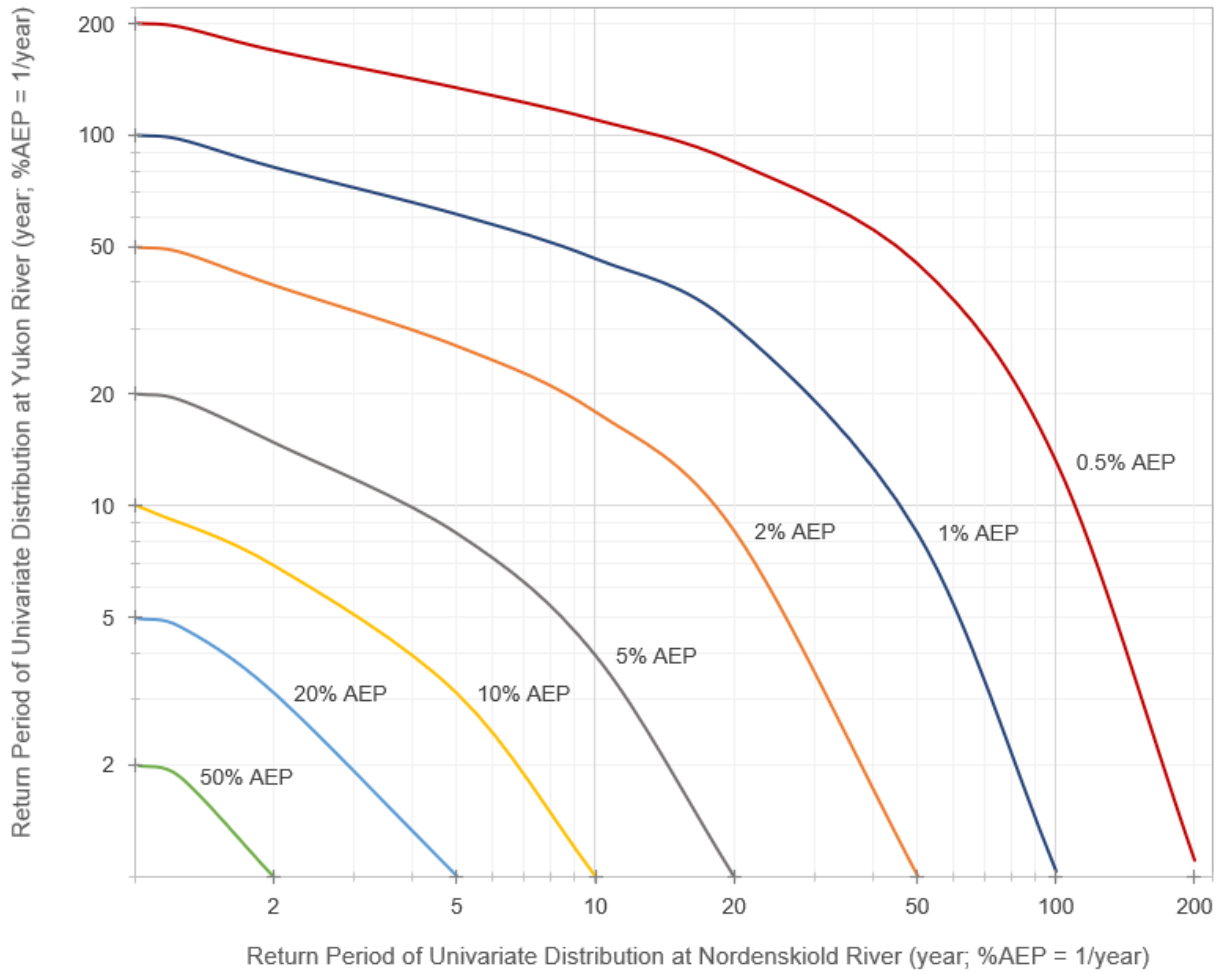


Figure 4-1 Joint Probability Isolines for Yukon River Open Water AEP Flows as a Function of Nordenskiold River Open Water AEP Flows

Intermediate combinations of flows which would result in an overall AEP scenario (e.g., the open water 1% AEP Nordenskiold River flow with the approximate open water 10% AEP Yukon River flow to produce the overall open water 0.5% AEP) were not considered. This is because the eventual overlay of inundations of a) Nordenskiold River open water AEP flow primary paired open water Yukon River flow (Section 4.2) and b) Yukon River open water AEP flow primary paired open water Nordenskiold River flow (Section 4.3) in the mapping stage is expected to spatially encompass the intermediate combinations.

4.3 Yukon River Open Water Flood Scenario

This flood scenario consists of the Yukon River open water AEP flows ("primary flow") and a paired Nordenskiold River flow which would result in representation of the overall AEP flood scenario.

A similar analysis to that presented in Section 4.2 (Gumbel-Hougaard copula per Kilgore et al. 2010) was performed. The joint probability isolines for open water AEP flows on the Nordenskiold River as a function

of AEP flows on the Yukon River are illustrated on Figure 4-2. Figure 4-2 shows that the AEP flow on the Yukon River ("primary flow") should be paired with a Nordenskiold River flow of below the lowest AEP produced in the FFA (50%) in order to reasonably represent the overall AEP scenario. Therefore, as a conservative approach, the open water 50% AEP Nordenskiold River flow (93 m^3/s) was used as the paired flow for all Yukon River primary AEP flows in this flood scenario. Selected flows for hydraulic modelling are presented in Section 7.1.

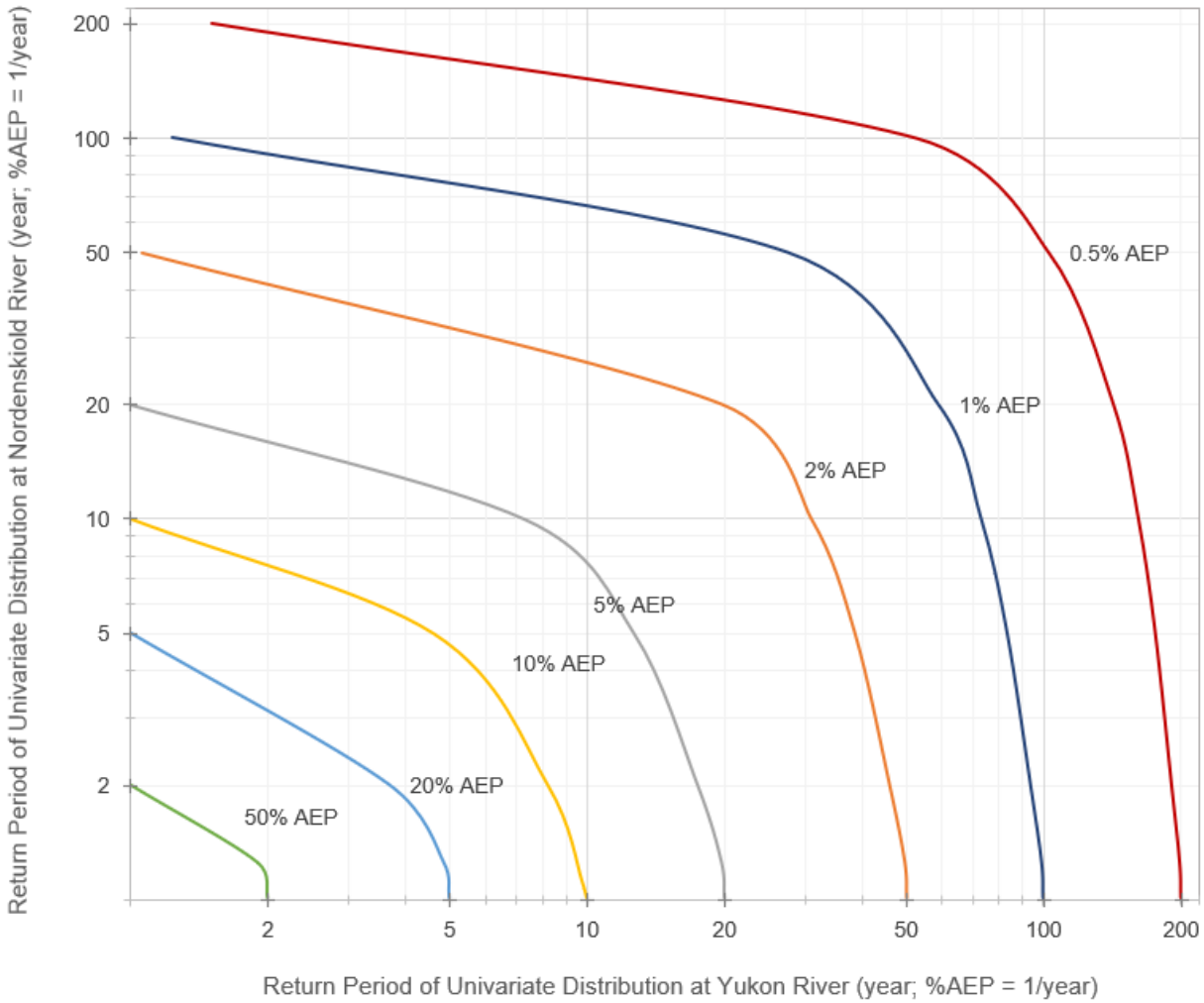


Figure 4-2 Joint Probability Isolines for Nordenskiold River Open Water AEP Flows as a Function of Yukon River Open Water AEP Flows

5 Climate Change, Land Use Change, and Geomorphic Change

5.1 Climate Change

The climate change assessment approach consisted of a hybrid version of quantitative and qualitative approaches from NRCan (2019a), illustrated in green overtop of the NRCan (2019a) flowchart in Figure 5-1. The components of the approach are summarized below.

- Quantitative Assessment:
  - Compilation of published meteorological projections for the watersheds in the Study Area
- Qualitative Assessment:
  - General characterization of flood hydrology of the Nordenskiold River and Yukon River at Carmacks watersheds
  - Review of published scientific literature on climate change impacts on flood hydrology in northern Canada
  - Review of jurisdictional case studies and policy precedents relevant to the Study Area
- Select Factor of Safety:
  - Combine quantitative and qualitative assessments to collaboratively (with Project partners YG and NRCan) select a reasonable factor of safety to apply to AEP flows for use in flood hazard mapping

This Project does not include a comprehensive review of climate change in the Yukon or in Carmacks. Investigation consisted of background review of select relevant scientific publications, existing projections, and approaches taken by neighbouring jurisdictions. No modelling was completed as part of Stantec's investigations. Accounting for changes to flooding processes as a result of climate change (e.g., historically open water dominated systems becoming ice jam dominated systems) is beyond the scope of this Project.

The timeframe considered was present day through to 2100. The range of Shared Socioeconomic Pathway (SSP) considered are between SSP2-4.5 (medium stabilization scenario where global mitigation efforts result in intermediate levels of greenhouse gas [GHG] emissions) and SSP5-8.5 (fossil-fueled development with high GHG emissions) as defined by Meinshausen et al. (2020). In this Project, Stantec has used the most recent climate change scenarios (i.e., SSPs; CMIP6) instead of the Representative Concentration Pathways (RCPs).

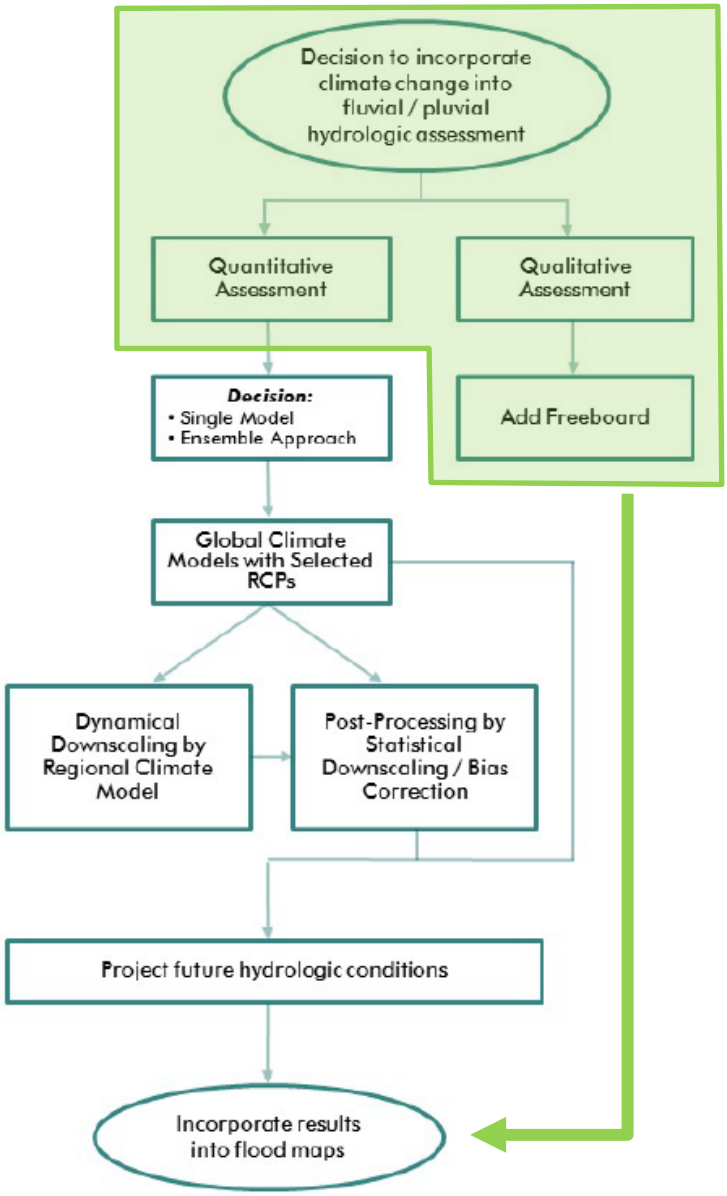


Figure 5-1 Climate Change Analysis Procedures from NRCan (2019a)

5.1.1 Quantitative Assessment

Table 5-1 summarizes projected change to select meteorological parameters averaged across the Nordenskiold River watershed, and across the Yukon River watershed at Carmacks. The meteorological data averaging was completed through a grid sampling of the Intergovernmental Panel on Climate Change (IPCC) Working Group I (WGI) Interactive Atlas, Coupled Model Intercomparison Project Phase 6 Global Climate Models (CMIP6-GCMs) (Gutiérrez et al. 2021) as illustrated in Figure 5-2.

Table 5-1 Catchment-Averaged Meteorological Changes for 2081–2100 (IPCC WGI Interactive Atlas, CMIP6 GCMs, Gutierrez et al. 2021)

Meteorological Variable	Climate Change Scenario	Median Change	
		Nordenskiold River Watershed	Yukon River Watershed at Carmacks
Mean Temperature Change (°C)	SSP2-4.5	3.8	3.7
	SSP5-8.5	6.6	6.5
Total Precipitation Change (%)	SSP2-4.5	17.4	15.5
	SSP5-8.5	28.7	26.4
Maximum 1-day Precipitation Change (%)	SSP2-4.5	22.1	19.5
	SSP5-8.5	45.9	39.3
Maximum 5-day Precipitation Change (%)	SSP2-4.5	21.1	17.8
	SSP5-8.5	40.7	33.9
Frost Days Change (days)	SSP2-4.5	-34.3	-37.2
	SSP5-8.5	-59.5	-64.9

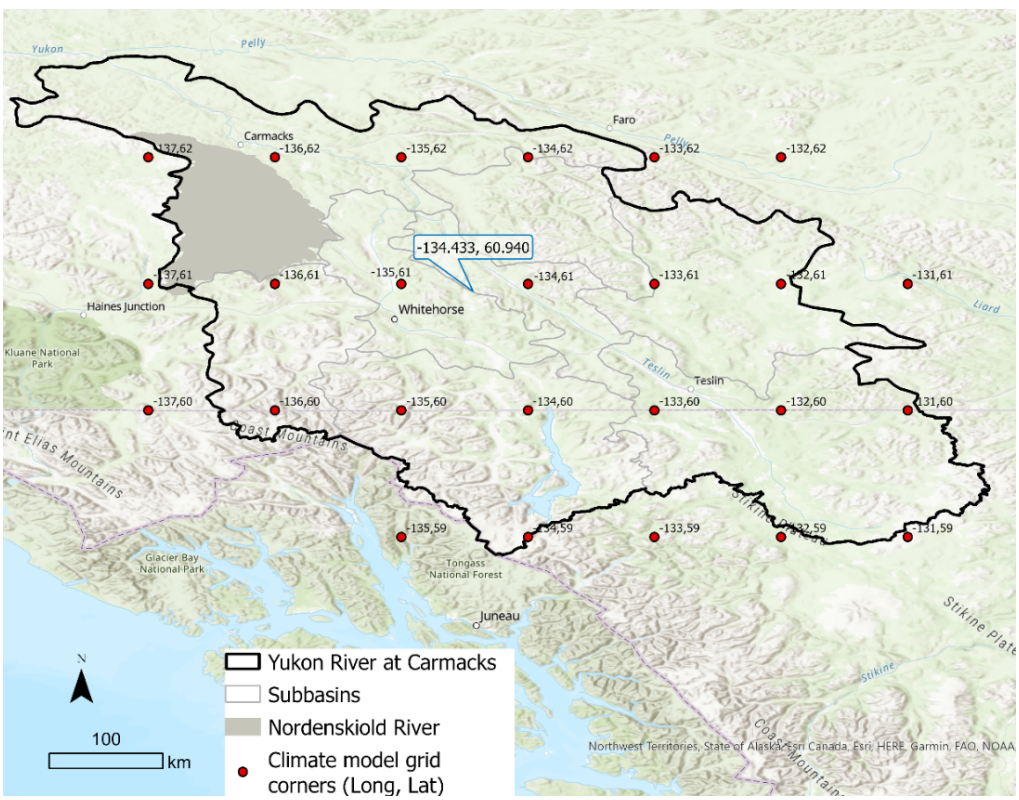


Figure 5-2 Yukon River Drainage Area Upstream of Carmacks with IPCC Climate Model Grids Covering its Subbasins Including Nordenskiold River and Location of the Probable Maximum Precipitation Transposition Point (-134.433, 60.940, as shown in above)

Figure 5-3, Figure 5-4, and Figure 5-5 present the temporal trend of the maximum daily precipitation, air temperature, snowfall, and snow depth as observed at the Carmacks ECCC weather station (ID: 2100300, GoC 2024b) from 1963 to 2023. These figures elucidate the historical trends associated with these variables. The trend analysis was conducted using the Sen's slope method (Sen 1968). This method is particularly effective in identifying trends in univariate time series data and is known for its resistance to outliers. Most variables exhibited an upward trend (except for snowfall), albeit these trends were not statistically significant. An exception to this was the minimum air temperature, which demonstrated a statistically significant increasing trend of 0.24°C per decade (Figure 5-4). This indicates a consistent rise in the minimum air temperature over the examined period. Stantec also conducted a trend analysis on April-May temperatures and found an increasing trend in maximum minimum daily temperature at the Carmacks weather station (0.5°C per decade) with p-value 0.001.

In summary, while most variables showed an increasing trend, only the minimum air temperature especially in April and May demonstrated a statistically significant increase. These findings provide valuable insights into the climatic changes observed at the Carmacks weather station over the past six decades.

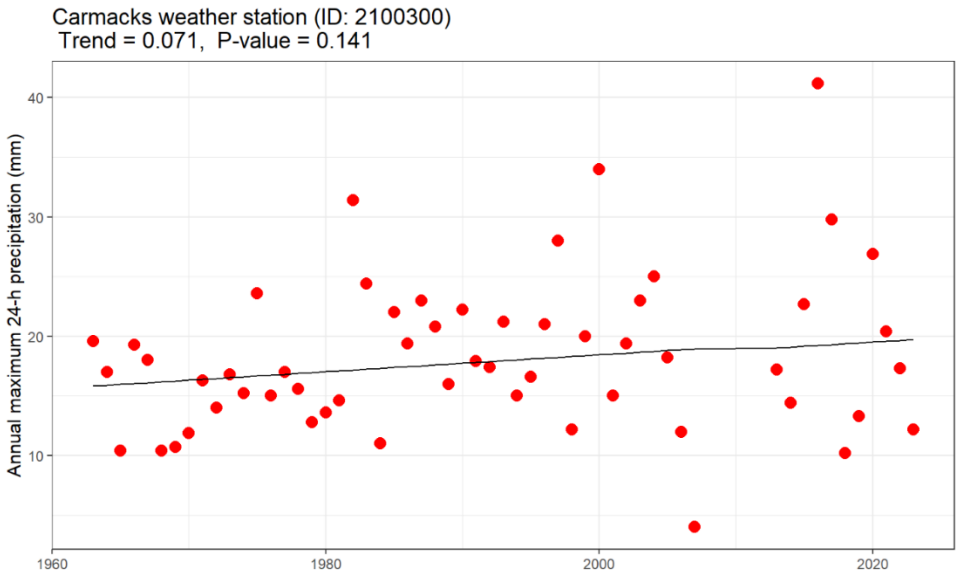


Figure 5-3 Annual Maximum 24-hour Precipitation and its Trend (Sen's slope) at the Carmacks Weather Station (ID: 2100300) from 1963-2023 (GoC 2024b)

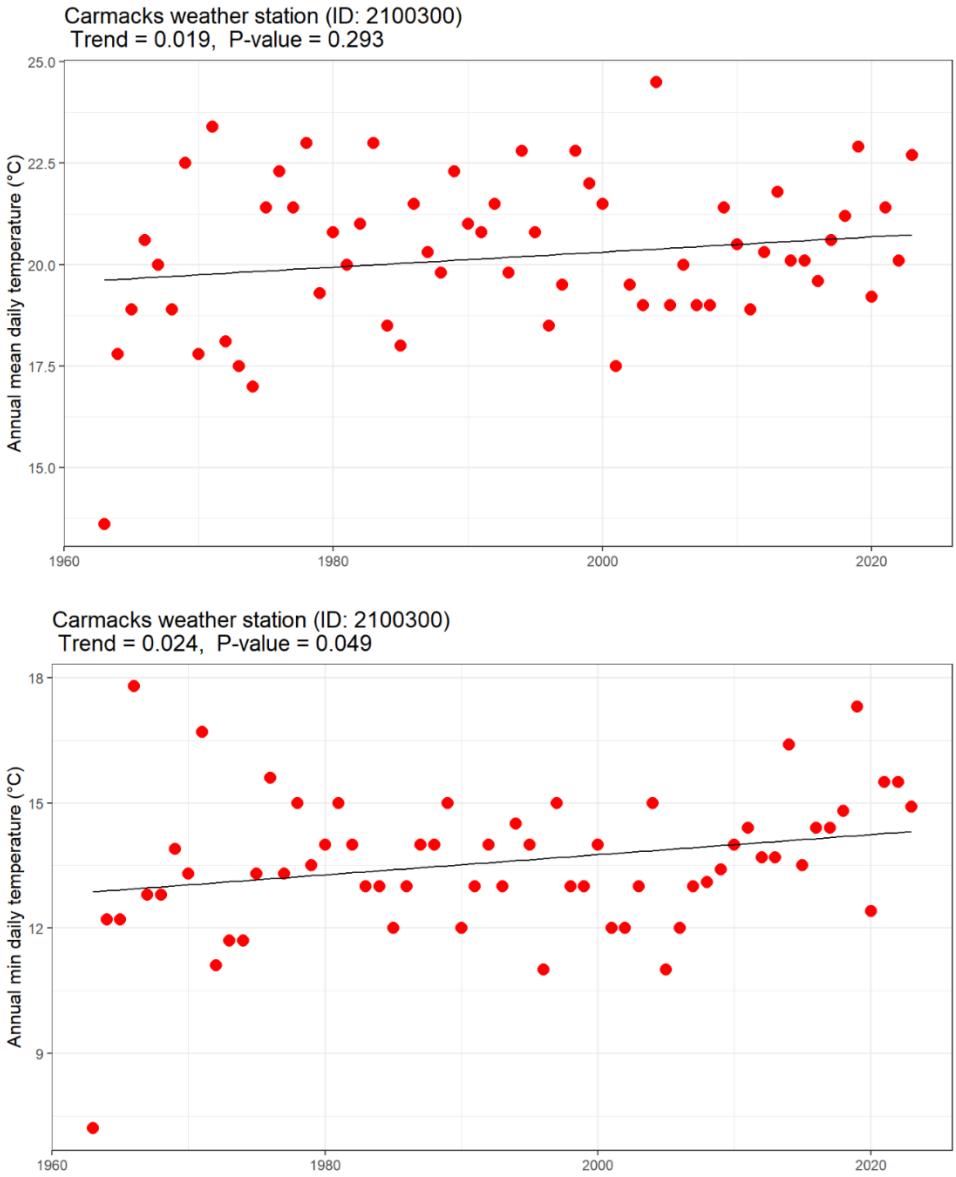


Figure 5-4 Annual Maximum Daily Mean and Minimum Air Temperatures and Trends (Sen's slope) at Carmacks Weather Station (ID: 2100300) from 1963-2023 (GoC 2024b)

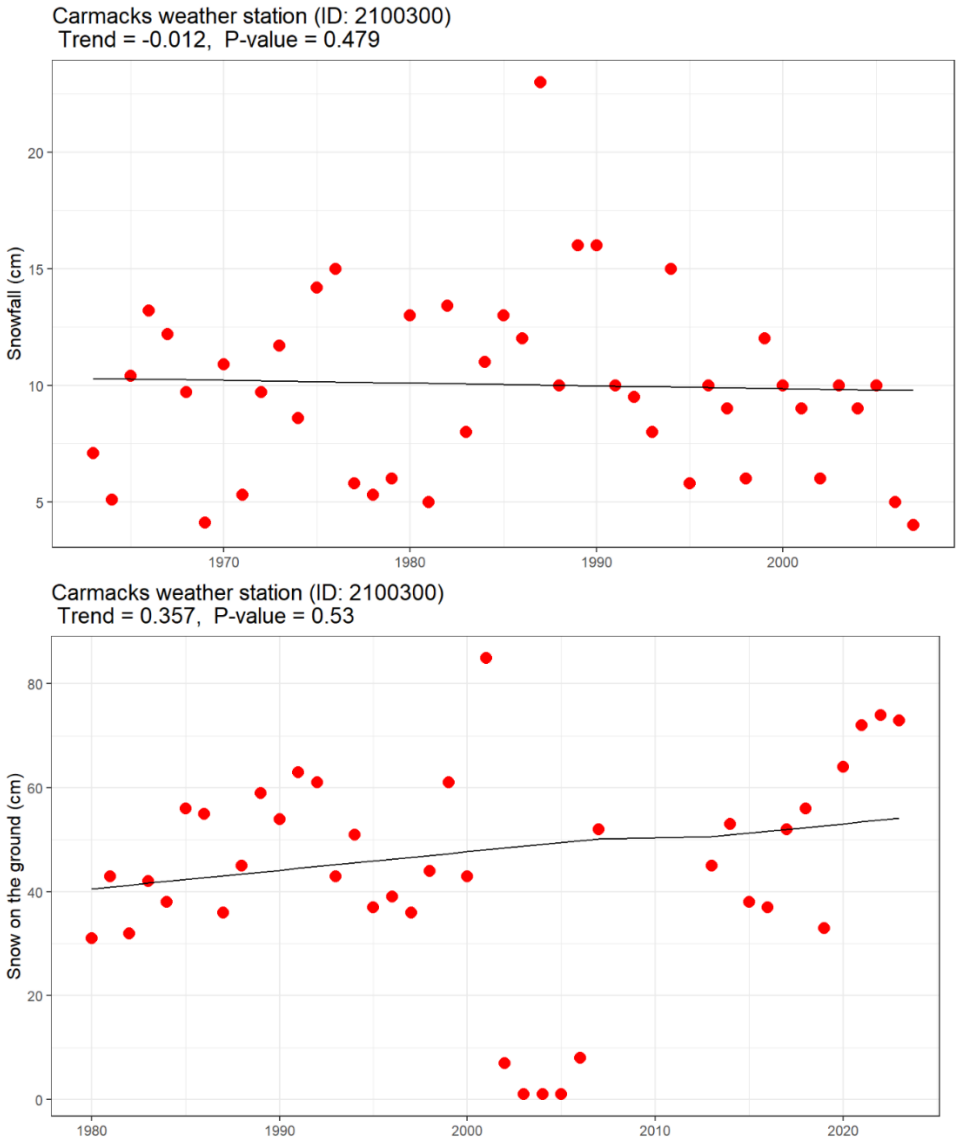


Figure 5-5 Annual Maximum Snowfall and Snow Depth on the Ground and Trends (Sen's slope) at the Carmacks Weather Station (ID: 2100300) from 1963-2023 (GoC 2024b)

Figure 5-6 summarizes intensity-duration-frequency (IDF) curves from Simonovic et al. (2015) for present climate as well as the periods from 2041 – 2070 and 2071 – 2100 under SSP2-4.5 and SSP5-8.5 at the Carmacks meteorological station. Event-based precipitation depths are projected to increase across all SSP scenarios, by 21–55%.

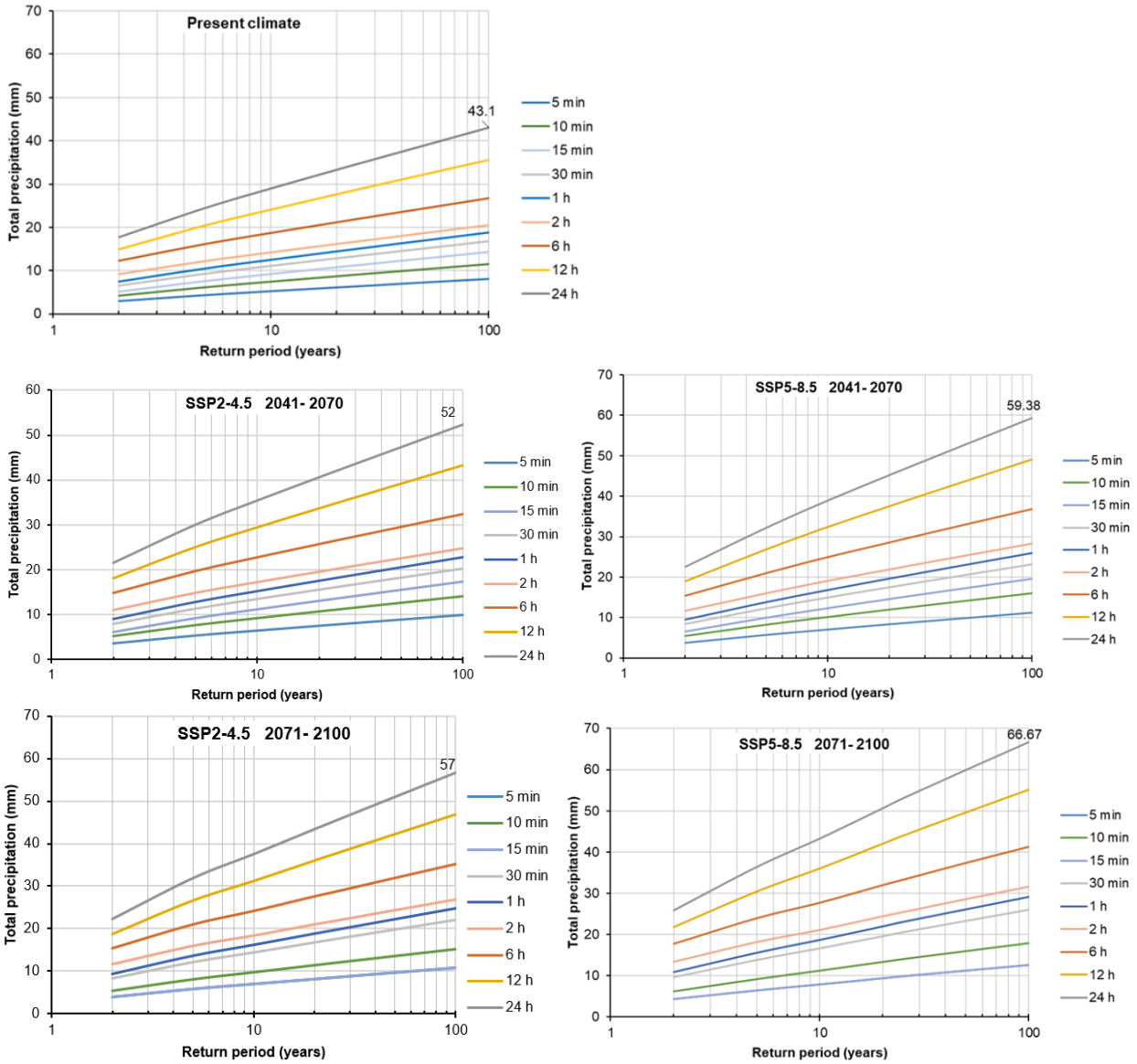


Figure 5-6 Event-based Precipitation Climate Change Projections for Carmacks, Yukon (Simonovic et al. 2015)

Figure 5-7 summarizes anticipated changes to average annual air temperature, from 1977 onwards from Pacific Climate Impacts Consortium (PCIC) (2023), for the Yukon River upstream of Carmacks.
Air temperature is anticipated to increase by 1.3°C and 1.5°C from 2025 to 2055 and 2.1°C and 4.2°C from 2025 to 2085 under SSP2-4.5 and SSP5-8.5 scenarios, respectively.

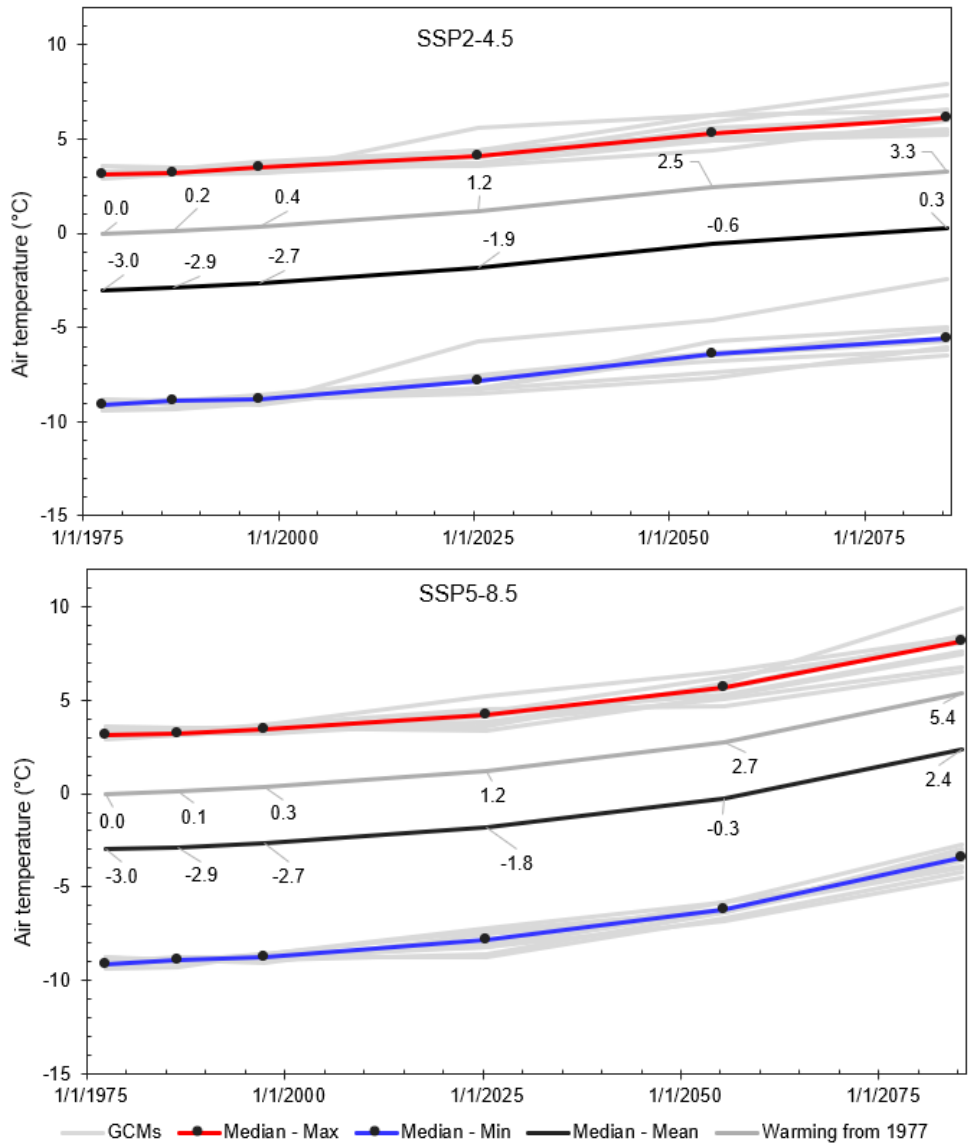


Figure 5-7 Air Temperature Changes from 1977 to 2085 under Two SSP2-4.5 and SSP5-8.5 Scenarios in Yukon River Upstream of Carmacks Obtained from Bias-corrected CMIP6 GCMs (PCIC 2023)

Figure 5-8 summarizes anticipated changes to winter (November – April) precipitation (assumed to be a proxy for snow water equivalent [SWE] accumulation) from 1977 onwards from PCIC (2023), for the Yukon River upstream of Carmacks. Under the SSP2-4.5 and SSP5-8.5 scenarios, winter precipitation increases between 4% and 5% from 2025 to 2055 and 9% and 16% from 2025 to 2085. The findings of Rasouli et al. (2022) suggest that the increases to winter precipitation in Figure 5-8 will not offset the temperature increase impacts on peak snowpack (Figure 5-7) until later in the century, meaning there is likely to be (at minimum) a short-term small increase in snowfall and SWE in the Nordenskiold River and Yukon River at Carmacks watersheds before later in the century.

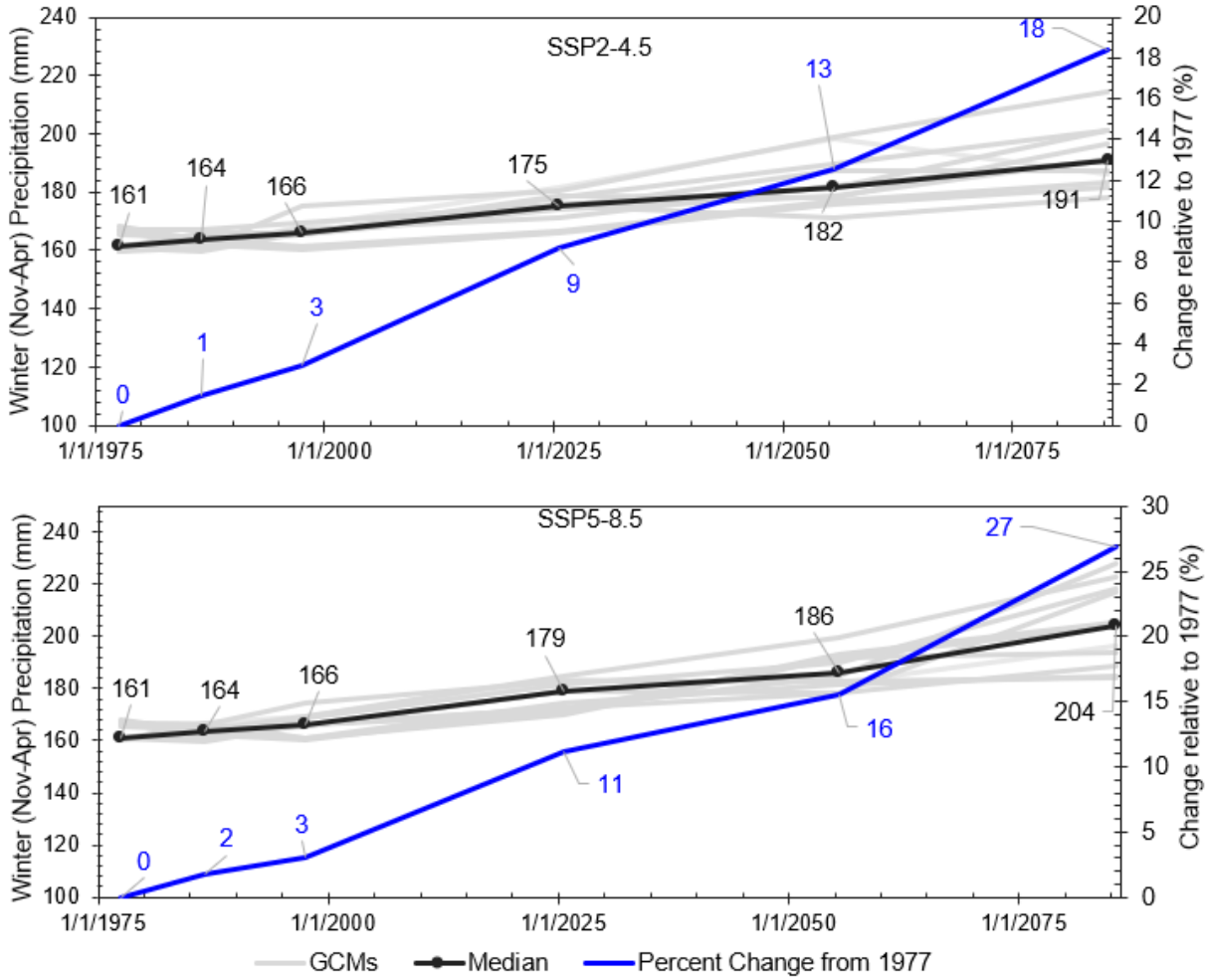


Figure 5-8 Winter (November to April) Precipitation Changes from 1977 to 2085 under SSP2-4.5 and SSP5-8.5 Scenarios in Yukon River Upstream of Carmacks Obtained from Bias-corrected CMIP6 GCMs (PCIC 2023)

In summary, the meteorological projection data suggests that due to climate change, the following are likely to occur in the Nordenskiold River and Yukon River at Carmacks watersheds:

- Air temperatures are likely to increase.
- Both annual and extreme event precipitation are likely to increase.
- The snow portion of the annual precipitation is likely to increase slightly although increasing temperatures may eventually cause an inflection in the SWE trend and result in decreasing SWE in the latter half of the century.

5.1.2 Qualitative Assessment

5.1.2.1 Characterization of Flood Hydrology in Study Area

As discussed in Section 2.1.5, the Nordenskiold River in the Study Area can experience flooding from open water and breakup ice jam events, impacted by both snowmelt and rainfall inputs (whether snowmelt, rain-on-snow, or convective rainstorms). Therefore, the increase in precipitation (snowpack and rainfall) associated with climate change in the watershed is likely to increase high flows in the Nordenskiold River at Carmacks.

As discussed in Section 2.2.5, the Yukon River flood hydrology suggests sensitivity to snowpack accumulation and resulting snowmelt. Therefore, the increase in snowpack associated with climate change in the watershed is likely to increase high flows in the Yukon River at Carmacks.

While flood flows in both the Nordenskiold River and Yukon River at Carmacks are anticipated to increase due to projected meteorological shifts due to climate change, the Nordenskiold River (medium system, snow- and/or rainfall-driven flood hydrology) is anticipated to be comparatively more sensitive to the meteorological shifts caused by climate change than the Yukon River (larger system, snowmelt-driven flood hydrology).

5.1.2.2 Overview of Published Literature

Hydrologic response of a given river to climate change is dependent on the hydrologic processes specific to that system, including glacier and permafrost regimes, temperature/precipitation trade-offs related to SWE and timing, evaporation and evapotranspiration rate, and basin size. Just as hydrologic processes can vary between systems, the impact of climate change on flood hydrology can also vary (e.g., Janowicz 2001; Hinzmann et al. 2005; Janowicz 2008; Janowicz 2010; Environment Yukon 2011; Rasouli et al. 2014; Rasouli et al. 2015; Streicker 2016; Rasouli et al. 2019).

Some of the expected changes to hydrology in the Yukon as a result of climate change include earlier lake and river breakup, increase in mean annual precipitation, increased winter precipitation, increased summer precipitation, more severe storm events, increased annual runoff, increased baseflows, increased snowpack with warmer springs leading to earlier and larger spring peak flows (YG WRB 2011; Streicker 2016). Temperature increases and precipitation increases have been observed over the past 50 years (Research Northwest and Morrison Hershfield 2017).

Factors affecting the degree and nature of change include local climate, hydrologic regime, topography and contributing area. Annual and winter temperature anomalies and annual precipitation departures over four northern regions from 1948 to 2005 show the greatest warming in Yukon and the Mackenzie District (2.2°C and 2.0°C, respectively; YG WRB 2011).

Some of the climate change impacts of greatest concern include greater frequency of ice jams, and earlier ice breakups (YG WRB 2011). Changes to river-ice flooding are projected to occur as a result of changes to air-temperature gradients, and the timing and magnitude of spring snowmelt (Larsen et al. 2014). Late season freeze-thaw cycles may increase flooding in freeze-up dam prone systems (Streicker 2016).

It is anticipated that climate change may lead to earlier but less intense flood events in response to earlier snowmelt under warming conditions (Rasouli et al. 2014). Climate change may reduce future peak flows by desynchronizing melt through accelerating the timing of spring flows and reducing summer and fall flows as evapotranspiration rates increase with warming temperatures and with longer snow-free periods occurring throughout the year (Rasouli et al. 2014). This claim holds true for the general hydrograph of northern basins, where climatic warming is expected to significantly alter both the timing (earlier) and magnitude (less intense) of high flows. It is important to note that the discussion here is focused on general hydrographs and does not consider individual flood events.

5.1.2.3 Jurisdictional Case Studies and Policy Precedents

There is a consistent acknowledgement in government guidance documents that climate change impacts need to be incorporated into flood hazard mapping (EGBC 2018; NRCan 2018a; NRCan 2018b; NRCan 2019a). The Yukon does not have a specific climate change policy that is applicable to flood mapping projects. To Stantec's knowledge, Alaska and the Northwest Territories also do not have specific climate change policies that are applicable to flood mapping projects. Further, there is no established method or universal best practice for incorporating climate change in flood hazard mapping (NRCan 2018a). Uncertainty in climate change projections and variability in individual system hydrologic responses is consistently emphasized in the majority of guidance documents.

The NRCan (2019a) framework provides quantitative and qualitative workflow pathways (Figure 5-1). These quantitative and qualitative options are mirrored in EGBC's professional practice guideline titled *Legislated Flood Assessments in a Changing Climate in BC* (EGBC 2018) which suggests completing a trend detection analysis on historical flows, and if no trend is detectable then using either adjusted IDF curves (if performing deterministic hydrologic modelling) or applying a 10% upward adjustment in design discharge (if local or regional frequency models are used). If a trend is detected, EGBC (2018) suggests adding the precipitation increment to the peak runoff rates in large seasonally driven basins, and in smaller basins either incorporating revised IDFs in hydrologic modelling or applying an upward adjustment of up to 20%.

NRCan (2018b) shared three case study examples of the quantitative deterministic modelling approach presented as an option to accounting for climate change in flood studies by NRCan (2019a) and EGBC (2018). These case studies identified changes to flood flows based on deterministic modelling, however those percentages were developed for river systems in regions which experience different

hydrologic processes than the Nordenskiold River and Yukon River at Carmacks rendering them not applicable/comparable to this Project.

5.1.3 Factor of Safety for Climate Change

Meetings with personnel from Stantec, YG WRB, NRCan, and ECCC were held on September 8, 2023 and November 6, 2023 to review the information presented in Section 5.1.1 and Section 5.1.2. The purpose of these meetings was to review the findings and collaboratively decide on a factor of safety to be applied to the FFA results.

The conclusions of the meetings were as follows:

- The quantitative and qualitative information presented in Section 5.1.1 and Section 5.1.2 suggests that both the Nordenskiold River and Yukon River at Carmacks are likely to see increased flood flows due to the impacts of climate change in their watersheds.
- It is likely that the Nordenskiold River will be impacted to a comparatively higher degree than the Yukon River, because of its flood hydrology sensitivity to rainfall events.
- Since deterministic modelling is not in the scope of this Project, the specific factor of safety to be applied is subjective. EGBC (2018) suggests 10-20%, depending on the situation.
- Two climate change scenarios were added to the set of flood mapping design events: the 5% AEP flows and the 0.5% AEP flows each with a factor of safety for climate change applied:
  - A factor of safety of 1.1 (+10%) was adopted for the Yukon River flows, and a factor of safety of 1.2 (+20%) was adopted for the Nordenskiold River
  - These factors of safety align with EGBC (2018) and are reflective of the relative hydrologic sensitivity anticipated for each river given the projected meteorological changes due to climate change

5.2 Land Cover Change

For the purposes of this Project, three potential watershed-scale land cover changes are anticipated to potentially impact flood hydrology of the Nordenskiold River and/or the Yukon River at Carmacks:

1. Increase in development / impervious cover
2. Change to forest cover / composition
3. Increases in bare / hydrophobic soil coverage from forest fires

5.2.1 Increase in Development / Impervious Cover

It is estimated that less than 1% of the 81,800 km^2 Yukon River watershed is currently urbanized, and less than 0.5% of the 6,410 km^2 Nordenskiold River drainage basin is currently urbanized. It is considered unlikely that anthropogenic development could be substantial enough in the future years to impact the current flood flow hydrology.

5.2.2 Change to Vegetation Cover / Composition

Insect infestations can impact vegetation composition and health, which then can impact hydrology. The Yukon Forest Health Report (YG 2016) classifies the cumulative severity of deforestation by active defoliators (Bruce Spanworm, Large Aspen Tortrix and Serpentine Leadminer). The Yukon River watershed upstream of Carmacks falls within Forest Health Zone 1 and Forest Health Zone 2. Approximately, 90% of both Zone 1 and Zone 2 fall within the low impact category for insect infestations. Therefore, the impacts of insect infestation on hydrology are, for the purposes of this Project, considered negligible.

The vegetation assemblage in the Yukon is expected to change with warming temperatures and increased precipitation as discussed in Section 5.1. Overall, it is expected that the forests within the Yukon may transition to deciduous (personal communication, YG Wildland Fire personnel, August 30, 2023; personal communication, Northern Plant Ecology Lab, September 1, 2023). It is anticipated that there will be non-trivial mitigating impacts for runoff but these impacts are unlikely to alter flood flows at the large spatial scales being considered in this Project.

An additional vegetation change in subarctic watersheds are shrub tundra expansion to higher elevations and latitudes as climate warms. While the hydrologic processes at these elevations – including snow accumulation, snow sublimation, snow interception, snowmelt, and evapotranspiration – are complex, a recent study by Rasouli et al. (2019) in the Wolf Creek basin near Whitehorse found decreases in peak flows of 15-25% associated with shrub tundra expansion.

In summary, Stantec did not find evidence that changes to vegetation cover and composition will increase flood flows in the Nordenskiold River and Yukon River basins.

5.2.3 Increases in Bare / Hydrophobic Soil Coverage from Forest Fires

The future wildfire risk in the Yukon was modelled by AECOM in 2016. Carmacks is located in Yukon Plateau-Central and it has among the highest wildfire risk levels (on average) in the territory. The Yukon Plateau-Central is one of the hottest (average temperature of 9. 7°C) and driest (average annual precipitation of 341 mm) and has a very long fire season with an average of 131 fire days in the valleys. However, it is anticipated that fire risk will remain stable or decrease in the future due to the anticipated increase in rain during the summer (AECOM 2016).

Historic fire data from the YG (email communication, YG Wildland Fire, September 5, 2023) was analyzed to determine the proportion of forest within the Yukon River and Nordenskiold River watersheds that burned historically over a 5-year floating window period. The 5-year floating window approach was selected because it is generally expected that post-fire regrowth in the Yukon occurs after 5 years, meaning bare/hydrophobic soil would persist for up to 5 years post-fire (personal communication, YG Wildland Fire, August 30, 2023). No data was available for the upstream end of the Yukon River watershed as it is in British Columbia. The maximum area burnt in the Yukon River Watershed north of the British Columbia border was 11% within the years of 1956 to 1960. However, these fires in the late 1950's were substantially larger than fires in the rest of the dataset. The largest fire in the last 50 years

occurred between 1994 to 1998 where 3% of the watershed was burned. In the last 20 years the percent burned within the watershed decreased to 2%.

Historic fires have had a larger impact to the Nordenskiold River watershed. The maximum area burnt within a 5 year period occurred between the years of 1957 to 1961 when 37% of the watershed was impacted by forest fire. In the past 50 years, the maximum area burned within a 5 year period decreased to 10% in 1994 to 1998. In the past 20 years, the maximum area burned over a 5 year period decreased to 7%.

Since fire risk within the Yukon is expected to remain stable or decrease in the future (AECOM 2016), it was assumed that forest fires will have limited effect on flood hydrology of the Yukon River and Nordenskiold River.

5.2.4 Factor of Safety for Land Cover Change

Given the information presented in Section 5.2.1, Section 5.2.2, and Section 5.2.3, no factors of safety are proposed to the FFA results to account for land cover change in the Nordenskiold River and Yukon River at Carmacks watersheds.

5.3 Geomorphic Change

This section considers Stantec's understanding of geomorphic change in the Nordenskiold and Yukon Rivers within the Study Area based on qualitative desktop and field observations and published studies, and identifies trends in observed historical geomorphic changes in consideration of implications to flood mapping.

5.3.1 Nordenskiold River

Within the Study Area, the Nordenskiold River is characterized by a predominantly meandering planform with minor straight reaches and runs. The average slope of the channel is 0.5% within the Study Area. The floodplain materials are almost entirely fluvially deposited gravels, sands and silts, with some discrete sections of fine organic and colluvial deposits near the active channel (Cronmiller et al. 2020). River banks composed of this material can be easily mobilized, with the exception of bank protection at the River Drive Bridge and Casino Way Bridge.

Recent reports have documented channel migration and avulsion on the Nordenskiold River (e.g., WSP 2018; Cronmiller et al. 2020; Hatton et al. 2023). Systematic (i.e., progressive) meander migration was identified at 16 separate locations on the Nordenskiold River, with an average erosion rate of 1.1 m/year observed in aerial imagery between 1953 and 2019 by Cronmiller et al. (2020). Three of these active migration locations could impact public and private infrastructure, including the Klondike Highway. Hatton et al. (2023) found that the channel migration in the Nordenskiold River from the confluence to 8 km upstream averaged at a rate of 0.22 m/year between 1961 and 2017. Migration distances are averaged over a number of years; channel migration rates are irregular and substantial channel shifts typically occur during large flood, debris jam, or ice jam events.

Evidence of two historically recent channel avulsions were identified within the Study Area of the Nordenskiold River by Cronmiller et al. (2020). Avulsions often result in local steepening of the channel as well as an increase in sediment supply and acceleration of erosion processes, including meander migration, downstream. Avulsions can form after meander bends become excessively wide or when the channel is blocked at a given location; the latter is documented on the Nordenskiold River (wood debris jams, ice jams).

Turcotte (2021) noted a sharp shift in the WSC Station 09AH004 rating curve. This shift may indicate that the channel is unstable from a geomorphological point of view, an interpretation also supported by the observation of large trees falling in the river and the presence of wide, vegetation-less gravel bars (likely newly formed). Change in the geomorphology of the Nordenskiold River may influence local river ice processes in the future.

5.3.2 Yukon River

Within the Study Area, the Yukon River consists of a 200 – 400 m wide channel meandering within a 2–3 km wide valley. The average slope of the channel is 0.04% within the Study Area. The planform morphology is generally sinuous with a tight meander near the central part of the community. The floodplain is predominantly composed of fluvial gravels, sands, and silts, however, the majority of the outer meanders of the channel flow along colluvial slopes of outwash terraces. At these locations, banks are high (in excess of 30 m) and are somewhat confining. Lateral bars, medial bars, islands, and side channels are common within the bankfull channel.

Systematic meander migration was identified along five outer bends within the Study Area along the Yukon River by Cronmiller et al. (2020) with one of the active migration locations identified as a concern for future impacts to a gravel road along the river. The average erosion rate for all observed meanders was estimated at 0.5 m/year based on aerial imagery available between 1953 and 2019. Migration distances are averaged over a number of years; erosion rates are irregular and substantial channel shifts typically occur during large flood, debris jam, or ice jam events.

No evidence of avulsions has been identified in available reports on the Yukon River within the Study Area; however, Cronmiller et al. (2020) did identify a low-elevation terrace across the Klondike Highway north of the Klondike Highway bridge that could be overtopped during an extreme high flow event or ice-jam scenario, and possibly trigger an avulsion.

5.3.3 Factor of Safety for Geomorphic Change

The scope of this Project does not include detailed erosion/fluvial hazard and channel migration study, and does not include projection of future morphological conditions. Therefore, no factors of safety are proposed to the FFA results to account for geomorphic change. Given the documented erosion and channel migration risks on the Nordenskiold River and Yukon River in the Study Area, erosion hazard and channel migration studies are recommended for the Nordenskiold River. Changes to Nordenskiold River and Yukon River channel morphology in the Study Area may require updates to the flood hazard mapping in the future.

6 Detailed Surveys

The detailed site survey was completed over multiple trips during the summer of 2023 (May, June, July, August, September) by Underhill Geomatics Ltd. (Underhill), Stantec, and Carmacks Development Corporation (CDC) staff. The detailed site survey included the following:

- Establishment of survey control
- Survey of "verification points" along certain areas of the roads/highways and river corridor overlapping the Canadian Quality Level 1 (CQL1) Light Detection and Ranging (LiDAR) data provided by YG to Stantec (collected June 8-10, 2019), to verify datum agreement between survey and LiDAR
- Survey of benchmarks at WSC Station 09AH001 (Yukon River at Carmacks) and WSC Station 09AH004 (Nordenskiold River Below Rowlinson Creek)
- Survey of WRB Station 29AH001 (Nordenskiold River at River Drive) staff gauge
- On the Nordenskiold River in Study Area:
  - Qualitative observation of bankfull and overbank conditions including photographic inventory
  - Documentation of anecdotal flooding/ice process information identified by LS/CFN contacts, community members, YG personnel, and/or Yukon University personnel
  - Open water high flow calibration event (flow and corresponding WSE profile)
  - Survey of high water marks (HWMs), ice scar marks and ice jam toe/head locations associated with historical flood events (where known/present)
  - Full bathymetry survey for approximately 300 m surrounding River Drive bridge
  - Survey of 61 cross-sections throughout the Study Area
  - Survey of River Drive bridge and Casino Way bridge (also referred to as the Carmacks bypass bridge or Freegold Road bridge) to a level of detail required for hydraulic modelling
  - Survey of general flooding/ice process information as identified by LS/CFN contacts, community members, YG personnel, and/or Yukon University personnel
- On Yukon River in Study Area:
  - Qualitative observation of bankfull and overbank conditions including photographic inventory
  - Documentation of anecdotal flooding/ice process information as identified by LS/CFN contacts, community members, YG personnel, and/or Yukon University personnel
  - Open water high flow calibration event (flow and corresponding WSE profile)
  - Survey of observed HWMs, ice scar marks, and ice jam toe/head locations (where known/present)

- Full bathymetric survey of approximately 8.5 km of river through the main part of the community (bathymetry reach)
- Survey of 30 cross-sections upstream and downstream of the bathymetry reach
- Survey of Klondike Highway bridge to a level of detail required for hydraulic modelling
- Survey of general flooding/ice process information as identified by LS/CFN contacts, community members, YG personnel, and/or Yukon University personnel

The survey methods used for collection of various components of the detailed site survey are summarized in Table 6-1.

Table 6-1 Summary of Survey Methods

Detailed Survey Component		Survey Equipment / Method				
		RTK GPS Handheld Rover Pole	**Single Beam Echosounder w/ RTK GPS Integration**	**Multi-Beam Echosounder w/ RTK GPS Integration**	**Total Station w/ RTK GPS Integration**	**Flow Meter or Acoustic Doppler Current Profiler**
Survey Control and LiDAR Verification		Y	Y	N	N	N
Nordenskiold River	Open Water High Flow Calibration Event	Y	N	N	N	Y
	HWMs, Ice Scars, Ice Jam Toe Locations	Y	N	N	N	N
	Bathymetry Reaches	Y	N	N	N	N
	Cross-Sections	Y	N	N	N	N
	Hydraulic Structures	Y	N	N	Y	Y
Yukon River	Open Water High Flow Calibration Event	Y	N	N	N	Y
	HWMs, Ice Scars, Ice Jam Toe Locations	Y	N	N	N	N
	Bathymetry Reaches	Y	Y	Y	N	N
	Cross-Sections	Y	Y	Y	N	N
	Hydraulic Structures	Y	N	N	Y	Y

6.1 Survey Control

One survey control point was established in the Study Area by Underhill (Figure 1-2). Control point coordinates are provided in Table 6-2 and are referenced to the relevant geodetic systems through a 10 hour Global Navigation Satellite System (GNSS) Precise Point Positioning (PPP) observation at Canada Lands Survey (CLS) CCM 982. The GNSS PPP observation was collected on June 27, 2023 and had occupational precision of +/- 0.015 m horizontally and +/- 0.020 m vertically.

Table 6-2 Survey Control Points

Survey Control Point	Northing (m) [1]	Easting (m) [1]	Elevation (m) [2]	Description
Canada Lands Survey (CLS) CCM 982	6884645.933	432544.609	535.406	brass cap set in concrete

Notes:
[1] Referenced to North American Datum of 1983 (NAD83), Canadian Spatial Referencing System (CSRS), Zone 8N
[2] Referenced to Canadian Geodetic Vertical Datum 2013 (CGVD2013)

6.2 Datum Agreement

Survey data collected during the detailed site survey was post-processed by Underhill in Trimble Business Centre (TBC). Following post-processing, the detailed survey data were all consistently within acceptable survey tolerances when compared to the LiDAR data provided to Stantec by YG:

- Rover pole survey data compared to LiDAR:
  - +/- 0.02 m horizontally
  - +/- 0.03 m vertically
- Single beam echosounder survey data compared to LiDAR:
  - +/- 0.06 m horizontally
  - +/- 0.10 m vertically
- Multibeam echosounder survey data compared to LiDAR:
  - +/- 0.04 m horizontally
  - +/- 0.06 m vertically

6.3 Benchmark Surveys

The coordinates for WSC Station 09AH001, WSC Station 09AH004, and the YG WRB Station 29AH004 staff gauge at the River Drive bridge crossing the Nordenskiold River are summarized in Table 6-3.

Table 6-3 Coordinates of WSC Station Benchmarks and YG WRB Staff Gauge

Location	Benchmark	Northing (m) [1]	Easting (m) [1]	Elevation (m) [2]	Description
WSC Station 09AH004 - Nordenskiold River Below Rowlinson Creek	BM1	not surveyed	not surveyed	554.05	rebar
	BM3	6880523.63	433054.67	554.16	rebar
	BM7	not surveyed	not surveyed	553.74	rebar
	BM8	not surveyed	not surveyed	553.92	rebar
YG WRB Station 29AH004 – Nordenskiold River at River Drive	SG	6885976.86	431301.09	524.53	top of staff gauge
WSC Station 09AH001 - Yukon River at Carmacks	BM6	6885437.46	433568.37	522.66	top of staff gauge (staff gauge functions as BM6)
	BM8	6885360.13	433589.94	523.24	top of staff gauge (staff gauge functions as BM8)
	BM9	6885319.25	433572.37	523.35	top of staff gauge (staff gauge functions as BM9)

Notes:
[1] Referenced to North American Datum of 1983 (NAD83), Canadian Spatial Referencing System (CSRS), Zone 8N
[2] Referenced to Canadian Geodetic Vertical Datum 2013 (CGVD2013)

6.4 Nordenskiold River

Detailed survey features for the Nordenskiold River are illustrated in Figure 6-1.

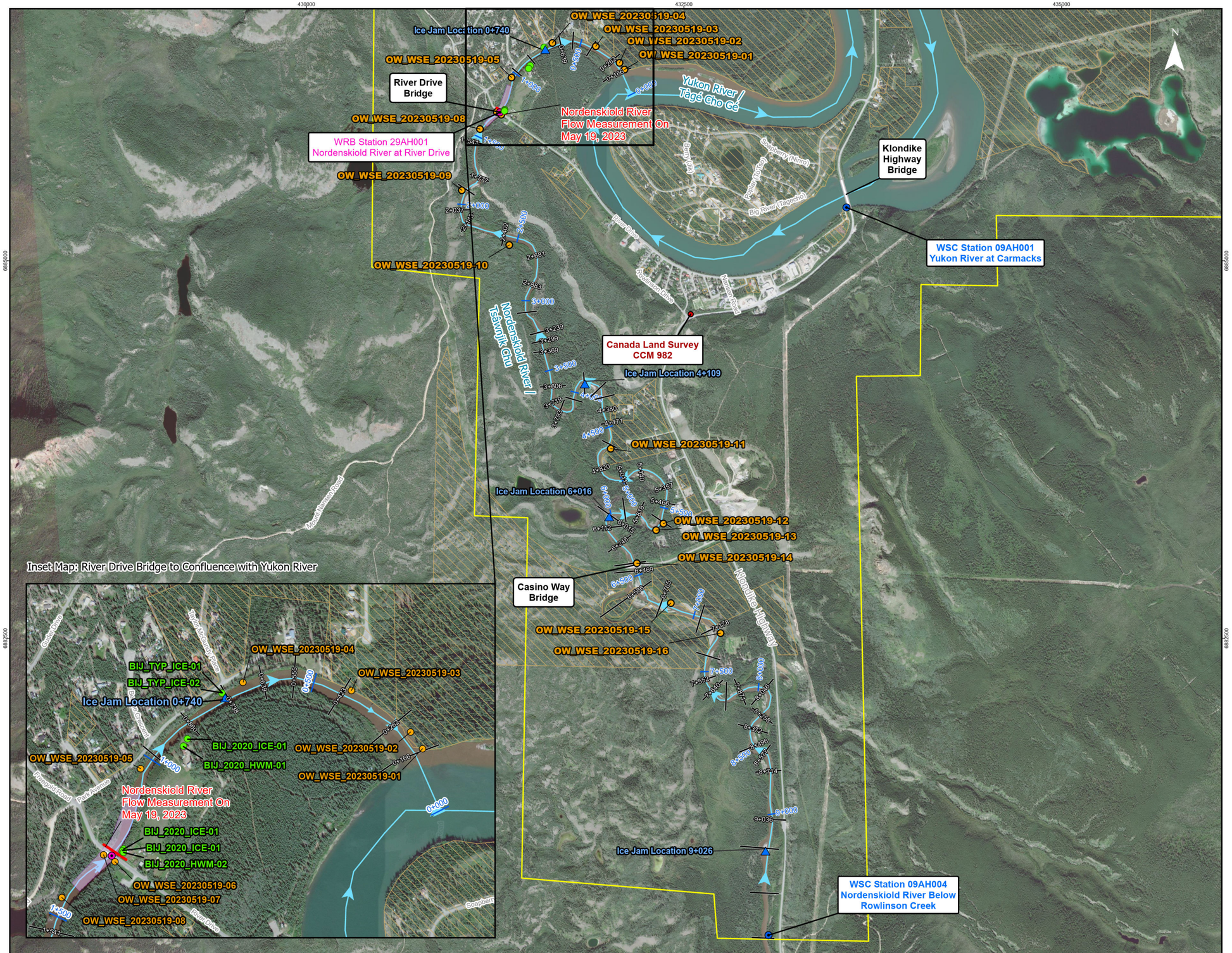


Figure No.

6-1

Title:

Nordenskiold River Detailed Survey Features

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

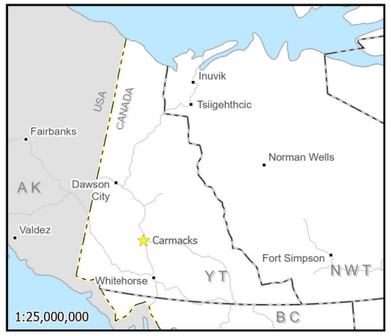
Carmacks, Yukon

Prepared by MANDERSON on 2024-05-16
Requested by JMUIRHEAD on 2024-03-26
Review by JMUIRHEAD on 2024-05-16

- High Flow WSE - May 19, 2023
- Potential Ice Jam Location
- Breakup Ice Jam (BIJ) Survey Points
- Water Survey of Canada (WSC) Hydrometric Station
- Water Resources Branch (WRB) Hydrometric Station
- Survey Control Point (CLS)
- Bridge
- 0+000 Alignment Stationiong
- Centerline Alignment (with Flow Direction Arrows)
- Flow Measurement Location
- Surveyed Cross Section Location
- Little Salmon / Carmacks First Nation Settlement Land
- Study Area
- Bathymetry Survey Reach

0 200 400 600 800 1,000 m

(At original document size of 11 x 17) 1:25,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canvec.
3. Background: Yukon Satellites HighRes: Government of Yukon

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

6.4.1 Bathymetry and Cross-Section Survey

Survey of bathymetry and cross-sections of the bankfull channel were obtained at various locations in the Nordenskiold River in the Study Area (Figure 6-1). Bathymetric data for the 300 m long bathymetry survey reach surrounding the River Drive bridge was obtained using RTK GPS survey pole and wading.

A total of 61 cross-sections were obtained in reaches upstream and downstream of the bathymetry survey reach in the Nordenskiold River using RTK GPS survey pole and wading as well as single beam echosounder integrated with the RTK GPS.

Integration of surveyed bathymetry and cross-section data into the DTM is detailed in Section 6.6.

6.4.2 Hydraulic Structure Surveys

Two hydraulic structures are present along the Nordenskiold River: i) the Casino Way bridge and ii) the River Drive bridge crossing.

The River Drive Bridge is located at Nordenskiold River station 1+280, approximately 1.3 km upstream of the Nordenskiold River confluence with the Yukon River (Figure 6-1, Photograph 10). Underhill surveyed the bridge soffit, rip rap extents and abutments and channel geometry during the detailed site survey. The bridge deck was surveyed by Stantec in October 2023. Figure 6-2 illustrates the cross-section at the River Drive bridge crossing.

Photograph 10 River Drive Bridge Looking Southeast (photo taken May 5, 2023)

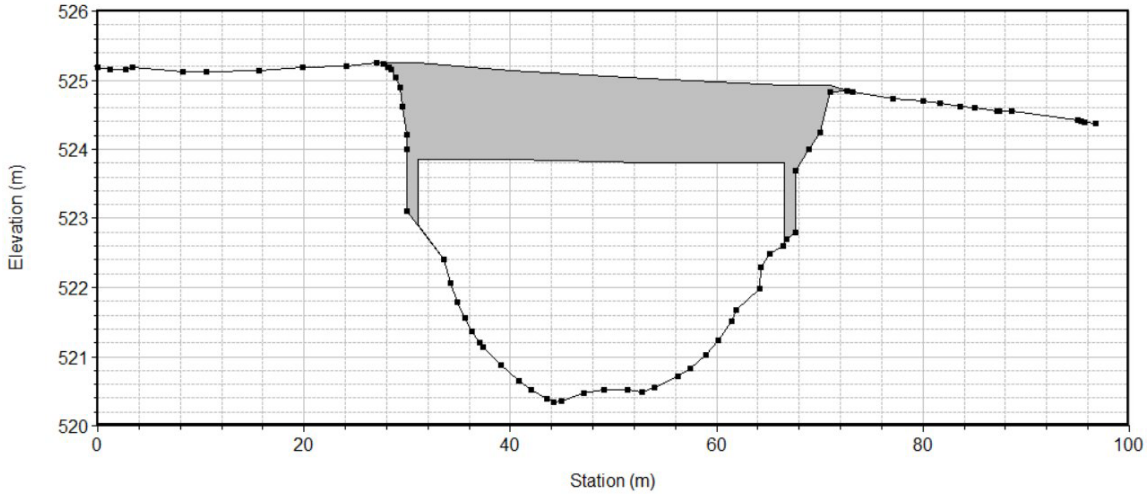


Figure 6-2 River Drive Bridge Cross-Section Looking Downstream

The Casino Way bridge crossing is located at Nordenskiold River station 6+430, approximately 6.4 km upstream of the confluence with the Yukon River (Figure 6-1, Photograph 11). Construction of the Casino Way bridge was ongoing through the summer of 2023 and was substantially completed in September 2023. Issued for Construction Design drawings were provided by YG to Stantec (email communication, A. Bier, September 11, 2023). As-recorded survey data of the constructed bridge, including bridge soffit, rip rap extents, abutments and channel cross-sections were provided by Underhill in November 2023. Additional survey data on the eastern approach road to the bridge were provided by Underhill in December 2023. Figure 6-3 illustrates the cross-section at the Casino Way bridge crossing.

Photograph 11 Casino Way Bridge Looking Downstream (photo taken September 5, 2023)

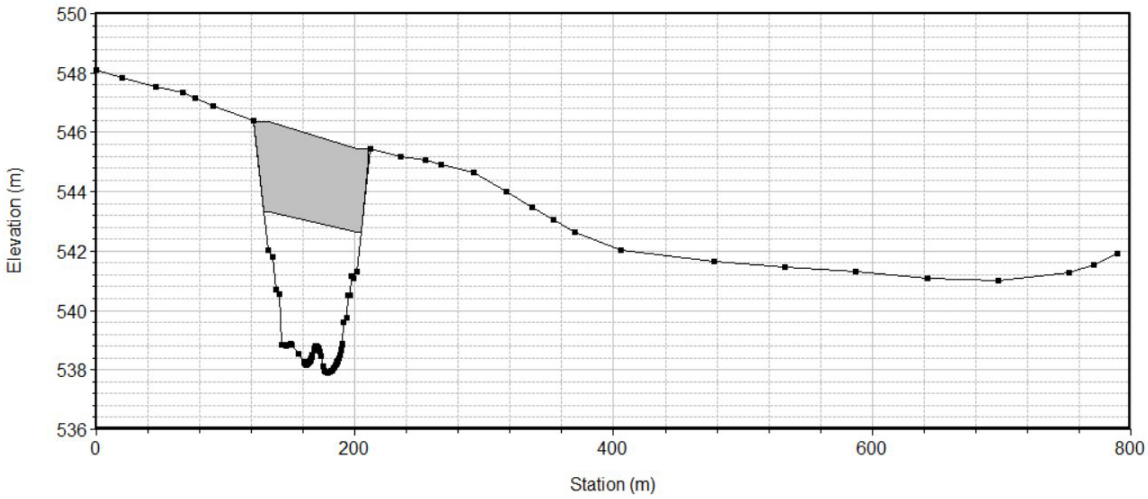


Figure 6-3 Casino Way Bridge Cross-Section Looking Downstream

6.4.3 Surveyed Flood Events

Two high water events were surveyed (either during the event or retroactive survey of HWMs and documented features) in two separate years: a breakup ice jam at Ice Jam Location 0+740 on April 22, 2020 and an open water event on May 19, 2023.

6.4.3.1 April 22, 2020 – Ice Jam Event

A breakup ice jam at Ice Jam Location 0+740 formed in late April 2020. The peak WSE from the breakup ice jam occurred on April 22, 2020 (personal communication, L. Bodie, February 15, 2024). A detailed accounting of the event was provided in Section 2.1.4. No WSEs or discharge measurements were surveyed at the time of this event; however, locations of high water and ice jam characteristics were noted and photographs taken. High water marks, ice scars, and ice jam toe/head from this event were surveyed on September 5, 2023:

- The ice jam toe location was at the typical location described in Section 2.1.3; that is, at a riffle crest approximately 540 m downstream of the River Drive bridge. The toe location was surveyed.
- The typical top of ice during breakup ice jams at the toe location was identified by local community members and surveyed.
- The ice jam head location was estimated based on photographs taken on April 22, 2020 (Photograph 1).
- Ice scars associated with the 2020 breakup ice jam event were identified at two locations and surveyed:
  - At the private residence on river right, approximately 360 m downstream of the River Drive bridge (Photograph 12).
  - On river right approximately 10 m downstream of the River Drive bridge (Photograph 13).
- The peak WSE which occurred during the April 22, 2020 breakup ice jam was documented at two locations and surveyed:
  - At the private residence on river right, peak WSE was identified as approximately 0.36 m below the deck surface (Photograph 14, personal communication, L. Bodie, September 5, 2023). This HWM was surveyed on September 5, 2023. A view of the private residence from river left several days after the 2020 breakup ice jam peak WSE is provided in Photograph 15, providing context for the WSE in Photograph 14.
  - Approximately 10 m downstream of the River Drive Bridge, peak WSE was approximately at the corner post of the white fence on river right (Photograph 16, email communication, A. Bier, September 5, 2023).

Survey points for the April 22, 2020 breakup ice jam toe, head, ice scars, and peak WSE HWM are summarized in Table 6-4 and illustrated in Figure 6-1.

Photograph 12 Ice Abutting Tree (on left, looking towards river in April 2020 from L. Bodie) and Resulting Ice Scar on Same Tree (right, looking away from river, on September 5, 2023) on Private Residence 360 m downstream of River Drive Bridge

Photograph 13 Ice Scar from April 2020 Breakup Ice Jam Event 10 m downstream of River Drive Bridge (photo taken May 5, 2023)

Photograph 14 Near Peak WSE During April 22, 2020 Breakup Ice Jam at Private Residence 360 m Downstream of River Drive Bridge; View from Residence towards River (photo courtesy L. Bodie)

Photograph 15 View Across River towards Private Residence Several Days After April 22, 2020 Breakup Ice Jam Peak WSE (Note Submerged Border Ice Along Opposite Bank) (photo courtesy L. Bodie)

Photograph 16 High Water on April 22, 2020 on River Right Approximately 10 m Downstream of River Drive Bridge; Water Line is at Corner Post of White Fence (photo courtesy YG WRB)

Table 6-4 Ice Jam Location 0+740 HWM's, Ice Scars, and Toe/Head Locations for April 22, 2020 Breakup Ice Jam

Point ID[1]	River Station (km+mmm from Downstream End of Nordenskiold River)	Northing (m)[2]	Easting (m)[2]	Elevation (m)[3]	Description
-	0+740	N/A	N/A	N/A	breakup ice jam toe location at riffle crest
-	1+088	N/A	N/A	N/A	breakup ice jam head location
BIJ_TYP_ICE-01	0+740	6886413.72	431574.32	522.42	typical top of ice elevation during breakup ice jams
BIJ_TYP_ICE-02	0+740	6886413.44	431574.75	521.86	typical top of ice elevation during breakup ice jams
BIJ_2020_ICE-01	0+891	6886292.23	431483.18	522.38	ice scar on tree at private residence (Photograph 12)
BIJ_2020_HWM-01	0+915	6886273.19	431472.74	522.93	peak WSE HWM at private residence on river right (Photograph 14)
BIJ_2020_ICE-02	1+247	6886000.61	431314.53	522.62	ice scar on tree DS of River Drive bridge (Photograph 13)
BIJ_2020_ICE-03	1+252	6885995.61	431311.17	522.11	ice scarring at vegetation trim line DS of River Drive bridge (Photograph 13)
BIJ_2020_HWM-02	1+255	6885991.47	431313.87	522.95	peak WSE HWM downstream of River Drive bridge (corner post of white fence) (Photograph 16)
-	1+280	N/A	N/A	523.86	bridge soffit
-	1+280	N/A	N/A	525.25	bridge deck

Notes:
1 As illustrated on Figure 6-1
2 Referenced to North American Datum of 1983 (NAD83), Canadian Spatial Referencing System (CSRS)
3 Referenced to Canadian Geodetic Vertical Datum 2013 (CGVD2013)

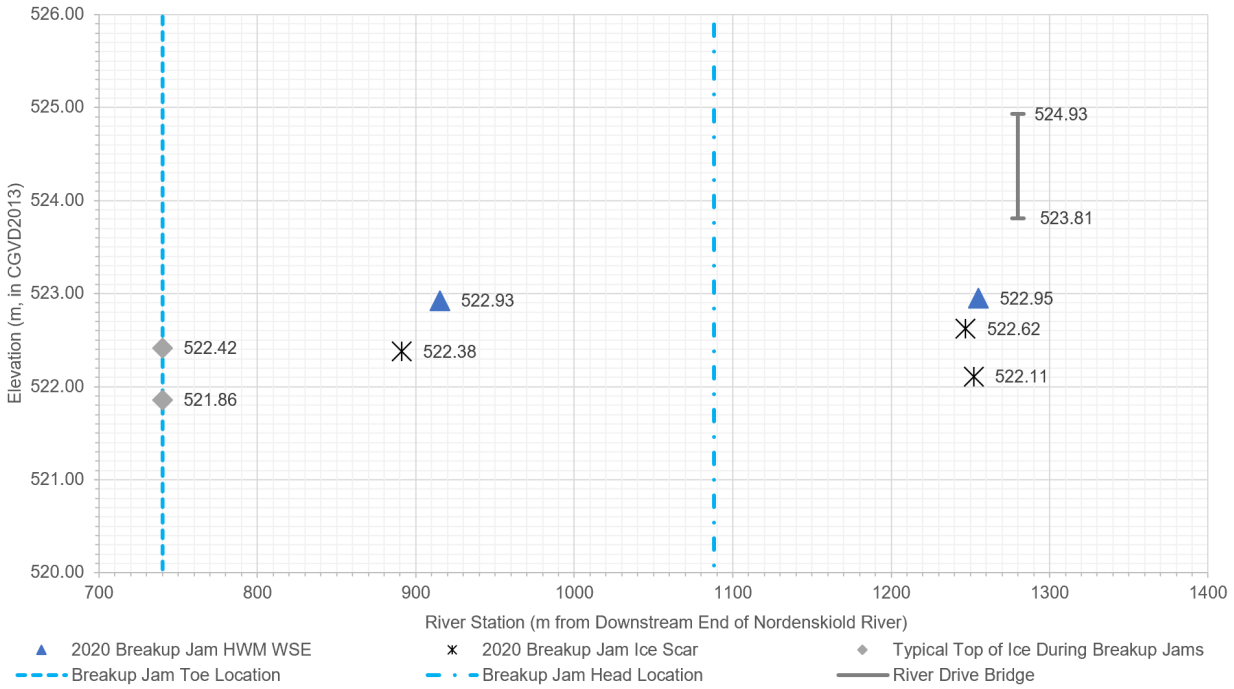


Figure 6-4 Ice Jam Location 0+740 HWM's, Ice Scars, and Toe/Head Locations for April 22, 2020 Breakup Ice Jam

WSC reported discharges at Station 09AH004 (approximately 9 km upstream of the breakup jam) at the time of the April 22, 2020 breakup jam peak are believed to underestimate the discharge. This underestimation is likely due to the simple trendline fitting technique used by WSC when recorded water levels are unstable due to varying ice conditions and associated backwater effects. An analysis completed to estimate and remove the backwater effect at the WSC Station 09AH004 produced an April 22, 2020 discharge estimate of 50.1 m^3/s (personal communication, B. Turcotte, March 3, 2024). This is consistent with earlier breakup jam discharge estimates made by Turcotte et al. (2021). Although calculated for the upstream WSC station, this estimated discharge was assumed to represent the discharge at the breakup jam at Ice Jam Location 0+740 for the purposes of this Project.

The discharge in the Yukon River at the time of the April 22, 2020 breakup jam peak was estimated to be 742 m^3/s using WSC rating curve #7 and the water level at WSC Station 09AH001.

Figure 6-5 provides the annual maximum breakup period discharges for the period of record considered in the breakup FFA compared to the estimated discharge during the April 20, 2022 breakup jam. The estimated maximum breakup flow for this event is at approximately the 80th percentile of peak breakup flows, and is associated with the most extensive documented flooding on the lower Nordenskiold River.

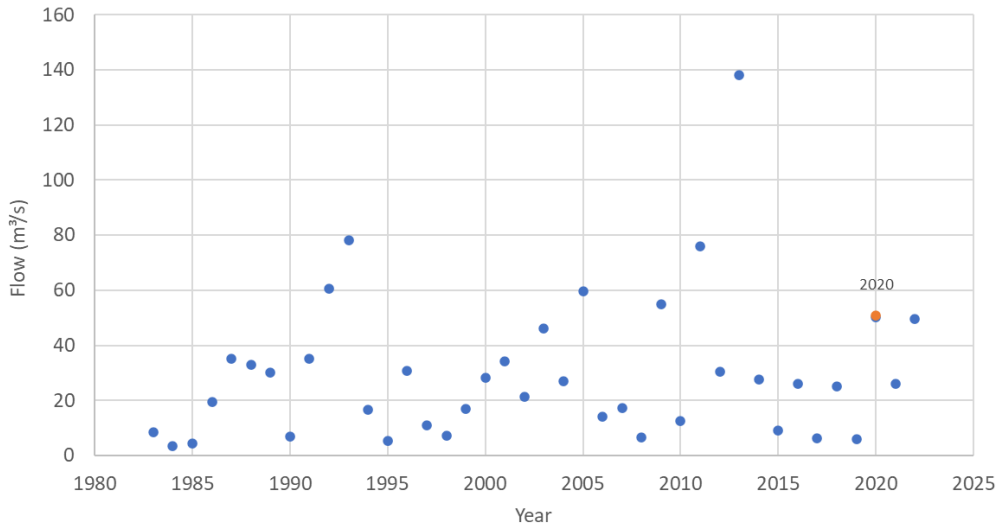


Figure 6-5 Annual Maximum Instantaneous Breakup Period Discharge at WSC Station 09AH004 With Estimated Discharge during April 22, 2020 Breakup Ice Jam at Ice Jam Location 0+740

6.4.3.2 May 19, 2023 – Open Water Event

Underhill obtained WSEs at 16 locations throughout the Nordenskiold River within the Study Area (Figure 6-1) during an open water high flow event on May 19, 2023. A profile of the surveyed WSEs is illustrated in Figure 6-6. The approximate river station (downstream to upstream direction), northing, easting, and the surveyed WSEs are provided in Table 6-5. The reach-averaged WSE slope from the surveyed WSEs was approximately 0.34%.

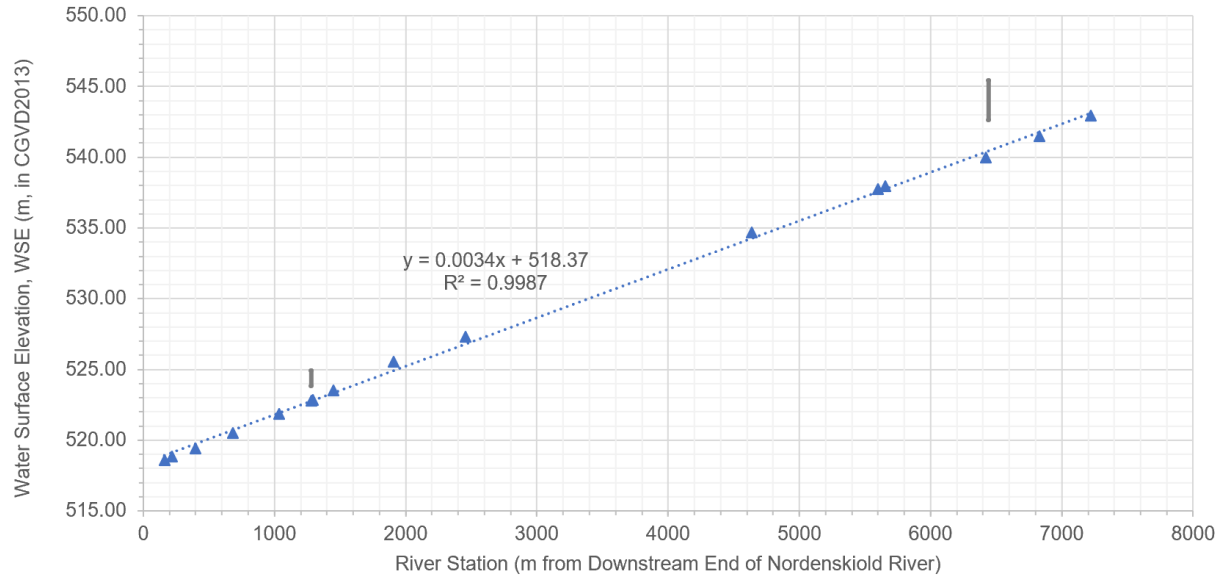


Figure 6-6 Nordenskiold River Surveyed Water Surface Elevations on May 19, 2023

Table 6-5 Nordenskiold River Surveyed Water Surface Elevations on May 19, 2023

Point ID [1]	River Station (km+mmm from Downstream End of Nordenskiold River)	Northing (m)[2]	Easting (m)[2]	Elevation (m)[3]
OW_WSE_20230519-01	0+163	6886266.10	432106.66	518.61
OW_WSE_20230519-02	0+218	6886310.50	432073.78	518.86
OW_WSE_20230519-03	0+401	6886420.35	431917.19	519.41
OW_WSE_20230519-04	0+686	6886441.87	431629.92	520.52
OW_WSE_20230519-05	1+036	6886213.42	431359.36	521.84
OW_WSE_20230519-06	1+283	6885966.92	431291.44	522.78
OW_WSE_20230519-07	1+294	6885985.30	431261.42	522.83
OW_WSE_20230519-08	1+449	6885871.94	431150.82	523.54
OW_WSE_20230519-09	1+910	6885466.60	431030.77	525.55
OW_WSE_20230519-10	2+456	6885104.00	431344.63	527.33
OW_WSE_20230519-11	4+636	6883755.72	432015.52	534.68
OW_WSE_20230519-12	5+598	6883259.74	432363.92	537.74
OW_WSE_20230519-13	5+654	6883216.22	432315.82	537.98
OW_WSE_20230519-14	6+423	6882996.97	432188.33	539.99
OW_WSE_20230519-15	6+827	6882733.16	432413.38	541.50
OW_WSE_20230519-16	7+223	6882534.30	432742.30	542.92

Notes:
1 As illustrated on Figure 6-1
2 Referenced to North American Datum of 1983 (NAD83), Canadian Spatial Referencing System (CSRS)
3 Referenced to Canadian Geodetic Vertical Datum 2013 (CGVD2013)

On May 19, 2023 at 14:00, YG WRB staff measured a flow of 181 m^3/s at the River Drive bridge (Figure 6-1) using a Sontek River Surveyor S5 Acoustic Doppler Current Profiler (ADCP) (email communication, C. O'Neill-Kizoff, May 26, 2023). This measured flow was within 5% of the reported discharge (191 m^3/s) on May 19, 2023 at 14:00 at WSC Station 09AH004 (8.5 km upstream of the flow measurement).

There is one notable tributary (from the Mt. Berdoe/Deadwood Mountain catchment) in the approximately 8.5 km of river between WSC Station 09AH004 and the River Drive bridge. Given that the downstream flow (with a tributary contribution) measured 5% lower than the reported discharge at WSC Station 09AH004, it is possible that WSC Station 09AH004 slightly overestimates high flows for the Nordenskiold River in the Study Area. Discharges reported by WSC have been relied upon for the purpose of this Project. This approach for high flow estimation at WSC Station 09AH004 is considered acceptable for use of reported discharges in this Project.

The measured and surveyed event on May 19, 2023 was the highest Nordenskiold River flow in 2023 and was within 25 m^3/s of the highest recorded flow at WSC Station 09AH004 between 1981 and 2019 (Figure 6-7).

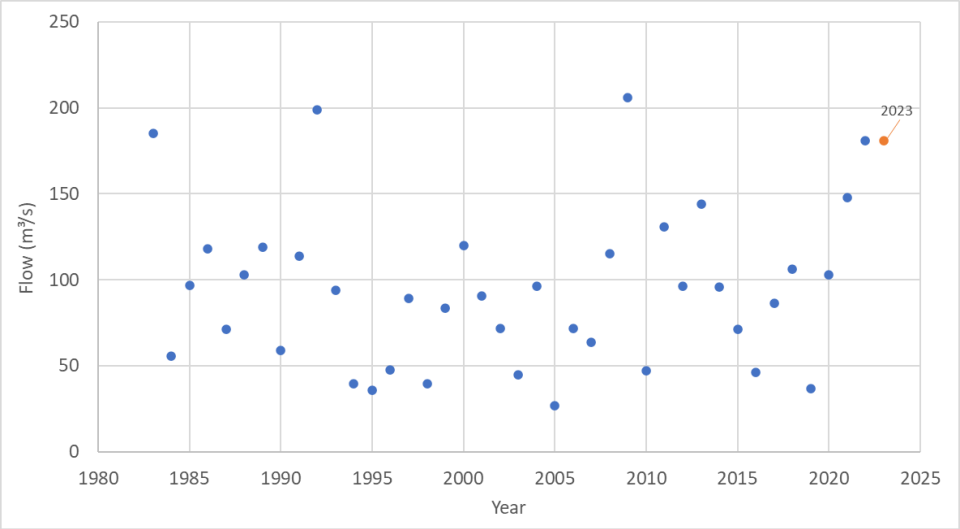


Figure 6-7 Annual Maximum Instantaneous Flows at Water Survey of Canada Station 09AH004 With 2023 Nordenskiold River Open Water Flow

6.5 Yukon River

Detailed survey features for the Yukon River are illustrated in Figure 6-8.

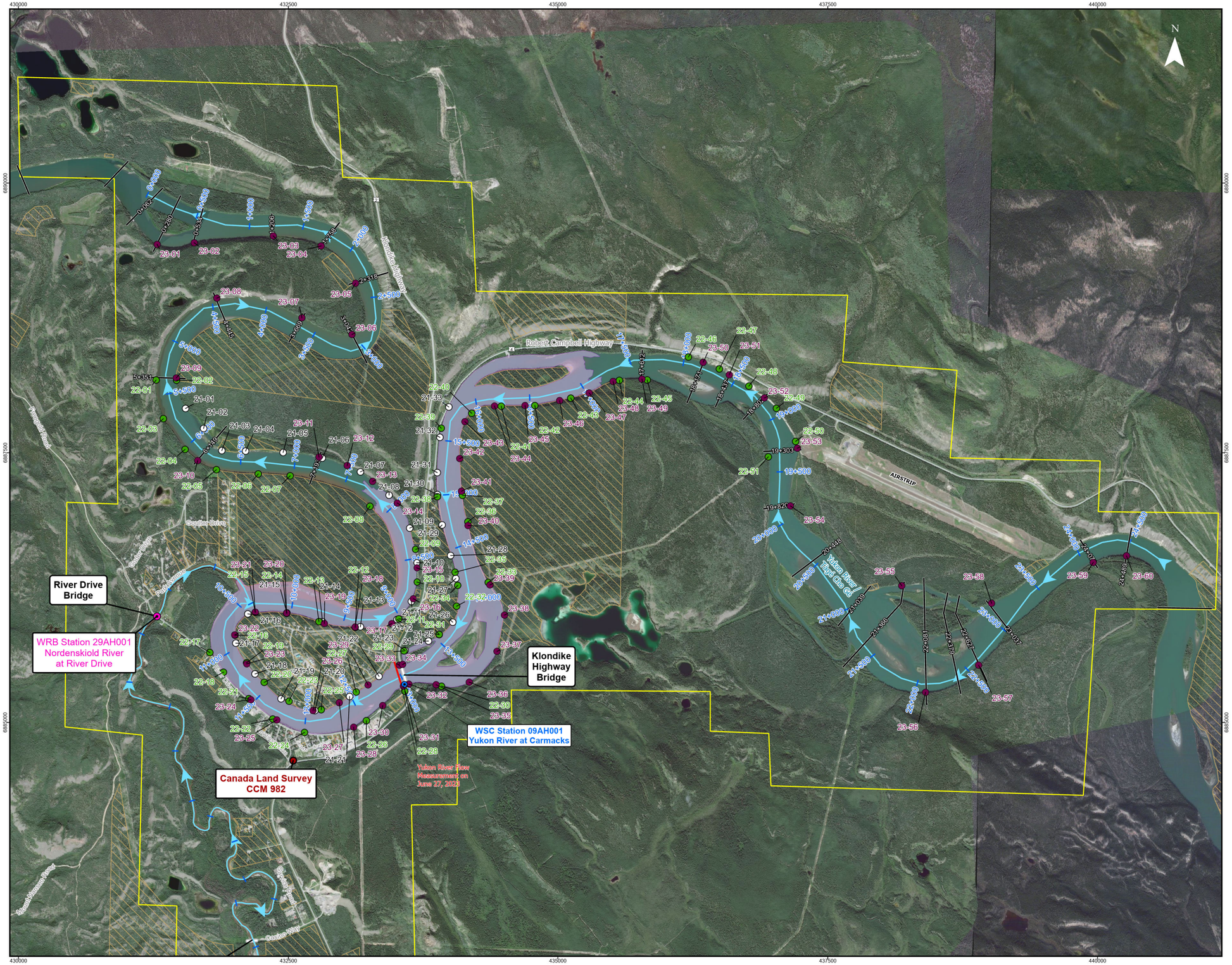


Figure No.

6-8

Title:

Yukon River
Detailed Survey Features

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

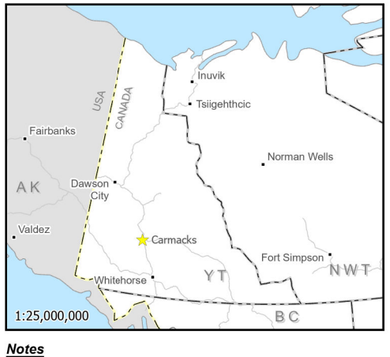
Project Location:

Carmacks, Yukon

Prepared by MANDERSON on 2024-05-16
Requested by JMUIRHEAD on 2023-03-26
Review by JMUIRHEAD on 2023-05-16

- High Flow WSE - June 16, 2021
- High Flow WSE - June 23, 2022
- High Flow WSE - June 27, 2023
- Water Survey of Canada (WSC) Hydrometric Station
- Water Resources Branch (WRB) Hydrometric Station
- Survey Control Point (CLS)
- Bridge
- 0+000 Alignment Stationing
- Centerline Alignment (with Flow Direction Arrows)
- Flow Measurement Location
- Surveyed Cross Section Location
- Study Area
- Little Salmon / Carmacks First Nation Settlement Land
- Bathymetry Survey Reach

0 300 600 900 1,200 1,500 m
(At original document size of 11 x 17) 1:35,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canvec.
3. Background: World Imagery: Earthstar Geographics
Yukon Satellites HighRes: Government of Yukon

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

6.5.1 Bathymetry and Cross-Section Surveys

Survey of bathymetry and cross-sections of the bankfull channel were obtained at various locations in the Yukon River in the Study Area (Figure 6-8). Bathymetric data for the approximately 9 km long bathymetry survey reach in the central part of the Study Area was obtained using RTK GPS survey pole as well as single beam and multibeam echosounders integrated with the RTK GPS.

A total of 30 cross-sections were obtained in reaches upstream and downstream of the bathymetry survey reach in the Yukon River using single beam and multibeam echosounders integrated with the RTK GPS.

Integration of surveyed bathymetry and cross-section data into the DTM is detailed in Section 6.6.

6.5.2 Hydraulic Structure Surveys

The Klondike Highway Bridge crosses the Yukon River to the east of the main part of the community, at station 13+030 of the Yukon River (Figure 6-8, Photograph 17). Three concrete piers in the river support the bridge span. Underhill surveyed the bridge soffit, pier bases and pillars, rip rap extents, and abutments during the detailed site survey. Bridge deck elevations were surveyed by Stantec in October 2023. Channel geometry at the bridge cross-section was derived from the bathymetry survey completed on the Yukon River. Figure 6-9 illustrates the cross-section at the Klondike River bridge crossing.

Photograph 17 Klondike Highway Bridge Looking Upstream (photo taken May 5, 2023)

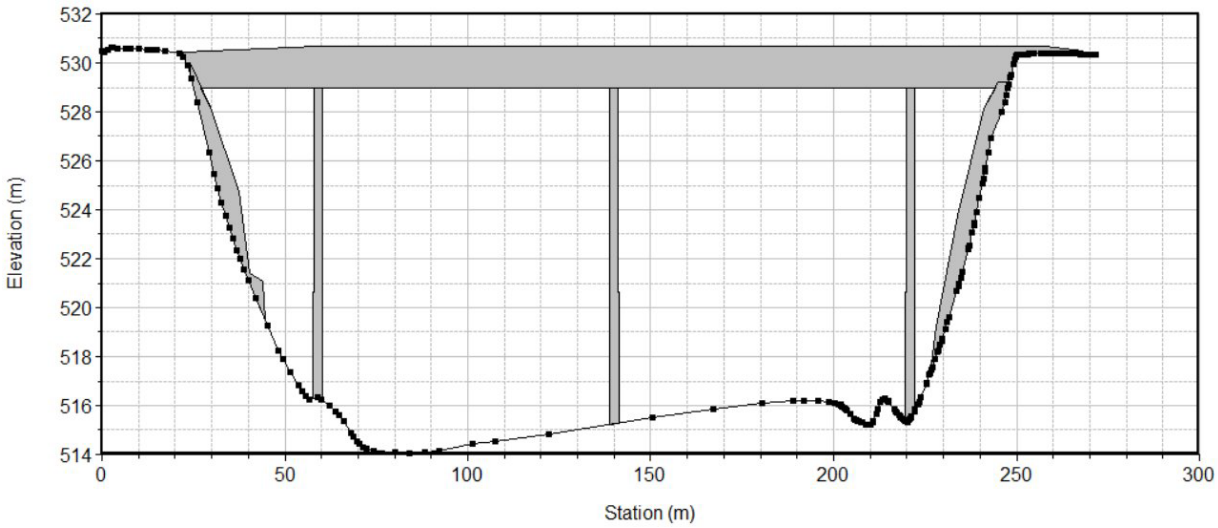


Figure 6-9 Klondike Highway Bridge Cross-Section Looking Downstream

6.5.3 Surveyed Flood Events

Three open water high flow events were surveyed in three separate years: June 16, 2021, June 23, 2022 and June 27, 2023.

6.5.3.1 June 16, 2021 – Open Water Event

YG contracted Underhill to obtain high water WSEs in 2021 while the Yukon River was in flood stage. On June 16, 2021, Underhill obtained 33 high water WSEs within the Study Area on the Yukon River (Figure 6-8). A profile of the surveyed WSEs is provided in Figure 6-10. The river station, northing, easting, and elevation of the surveyed WSEs are provided in Table 6-6. The reach-averaged WSE slope from the surveyed WSEs was approximately 0.04%.

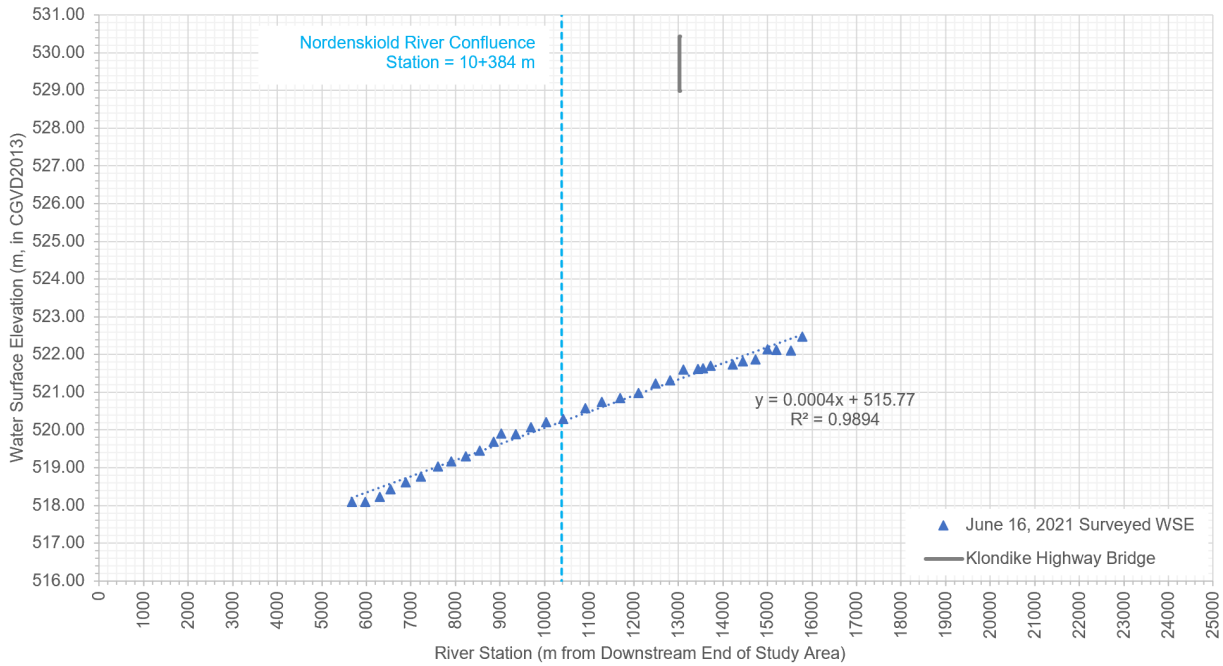


Figure 6-10 Yukon River Surveyed Water Surface Elevations on June 16, 2021

Table 6-6 Yukon River Surveyed Water Surface Elevations on June 16, 2021

Point ID	Short Point ID[1]	River Station (m from Downstream End of Study Area)	Northing (m)[2]	Easting (m)[2]	Elevation (m)[3]
OW_WSE_20210616-01	21-01	5675	6887910.53	431547.73	518.09
OW_WSE_20210616-02	21-02	5974	6887725.14	431714.88	518.09
OW_WSE_20210616-03	21-03	6305	6887519.88	431883.59	518.24
OW_WSE_20210616-04	21-04	6541	6887515.65	432103.74	518.44
OW_WSE_20210616-05	21-05	6882	6887502.36	432451.31	518.62
OW_WSE_20210616-06	21-06	7224	6887450.19	432813.48	518.77
OW_WSE_20210616-07	21-07	7600	6887322.66	433167.34	519.03
OW_WSE_20210616-08	21-08	7901	6887106.48	433432.59	519.17
OW_WSE_20210616-09	21-09	8238	6886801.08	433623.61	519.30
OW_WSE_20210616-10	21-10	8542	6886480.38	433691.89	519.46
OW_WSE_20210616-11	21-11	8859	6886121.33	433638.95	519.68
OW_WSE_20210616-12	21-12	9031	6885954.29	433506.16	519.91
OW_WSE_20210616-13	21-13	9351	6885886.81	433167.24	519.88

Point ID	Short Point ID[1]	River Station (m from Downstream End of Study Area)	Northing (m)[2]	Easting (m)[2]	Elevation (m)[3]
OW_WSE_20210616-14	21-14	9686	6885933.49	432815.75	520.08
OW_WSE_20210616-15	21-15	10038	6886015.34	432486.12	520.21
OW_WSE_20210616-16	21-16	10411	6886005.87	432124.18	520.30
OW_WSE_20210616-17	21-17	10917	6885734.75	432013.06	520.58
OW_WSE_20210616-18	21-18	11290	6885449.41	432190.75	520.74
OW_WSE_20210616-19	21-19	11698	6885218.98	432432.05	520.84
OW_WSE_20210616-20	21-20	12103	6885108.86	432745.50	520.98
OW_WSE_20210616-21	21-21	12488	6885240.26	433066.84	521.24
OW_WSE_20210616-22	21-22	12817	6885426.89	433338.88	521.31
OW_WSE_20210616-23	21-23	13120	6885667.34	433581.32	521.60
OW_WSE_20210616-24	21-24	13437	6885754.26	433801.81	521.62
OW_WSE_20210616-25	21-25	13548	6885813.65	433901.27	521.64
OW_WSE_20210616-26	21-26	13728	6885929.15	434026.82	521.70
OW_WSE_20210616-27	21-27	14216	6886334.28	434055.27	521.74
OW_WSE_20210616-28	21-28	14451	6886547.13	434006.74	521.83
OW_WSE_20210616-29	21-29	14733	6886830.53	433928.36	521.88
OW_WSE_20210616-30	21-30	15007	6887111.95	433884.81	522.13
OW_WSE_20210616-31	21-31	15199	6887316.03	433883.25	522.12
OW_WSE_20210616-32	21-32	15527	6887643.06	433908.02	522.11
OW_WSE_20210616-33	21-33	15785	6887924.02	433990.65	522.47

Notes:
1 As illustrated on Figure 6-8
2 Referenced to North American Datum of 1983 (NAD83), Canadian Spatial Referencing System (CSRS)
3 Referenced to Canadian Geodetic Vertical Datum 2013 (CGVD2013)

A flow measurement was not obtained on June 16, 2021 to pair with the surveyed WSEs.
WSC Station 09AH001 reported a water level (local datum) of 5.62 m on June 16, 2021; but did not report a discharge (discharges not reported at this station from 1995 to present). However, for the purposes of a high flow calibration event for hydraulic modelling in this Project, based on rating curve #7 for WSC Station 09AH001 provided by YG WRB and WSC, a flow of 2,335 m^3/s is estimated for this event.

The June 16, 2021 event is an above average annual maximum high flow for WSC Station 09AH001 over the period of record (2,335 m^3/s is approximately at the 75th percentile of recorded annual maximum open water flows) (Figure 6-11).

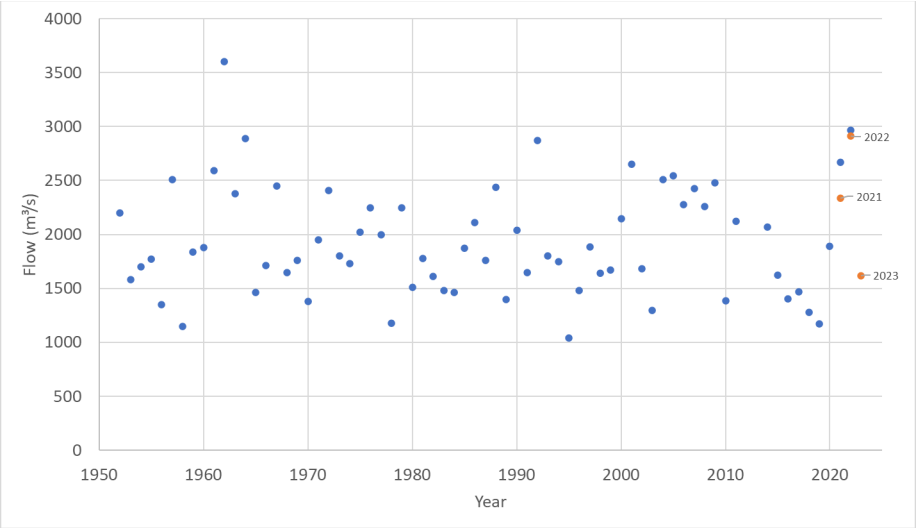


Figure 6-11 Annual Maximum Daily Average Flows at Water Survey of Canada Station 09AH001 With Yukon River Open Water Surveyed High Flow Events from 2021, 2022, and 2023

6.5.3.2 June 23, 2022 – Open Water Event

YG contracted Underhill to obtain high water WSEs during the flood conditions experienced in 2022. On June 23, 2022, Underhill obtained 51 high water WSEs within the Study Area on the Yukon River (Figure 6-8). A profile of the surveyed WSEs is provided in Figure 6-12. The river station, northing, easting, and elevation of the surveyed WSEs are provided in Table 6-7. The reach-averaged WSE slope from the surveyed WSEs was approximately 0.04%.

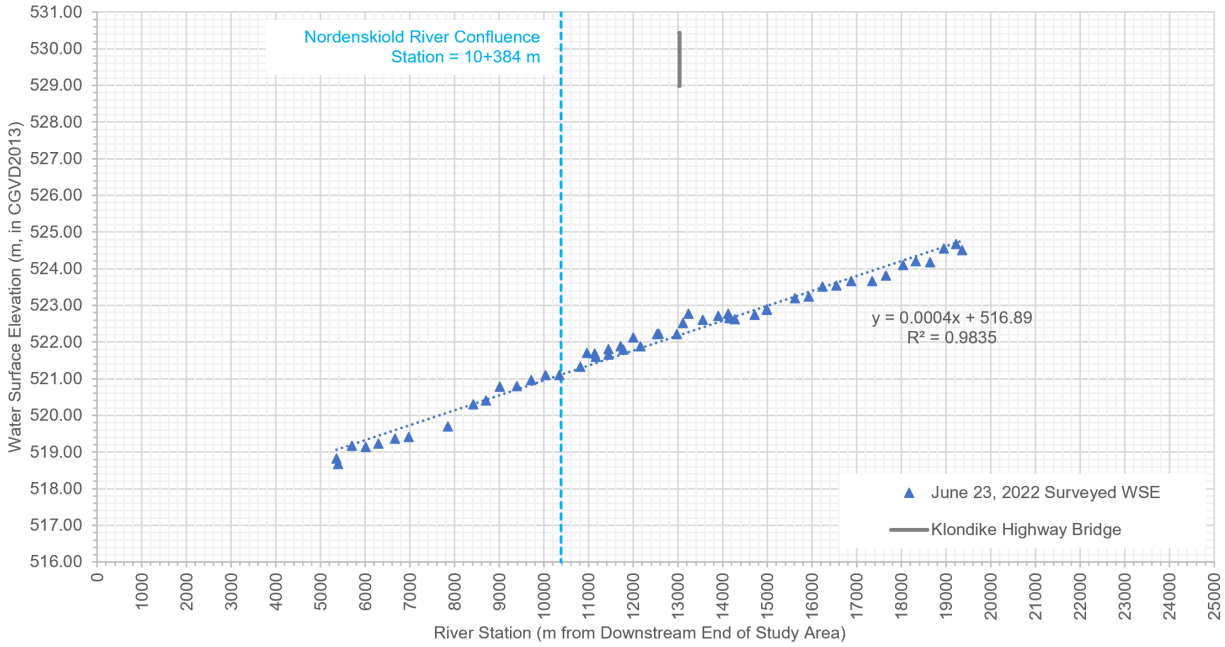


Figure 6-12 Yukon River Surveyed Water Surface Elevations on June 23, 2022

Table 6-7 Yukon River Surveyed Water Surface Elevations on June 23, 2022

Point ID	Short Point ID[1]	River Station (m from Downstream End of Study Area)	Northing (m)[2]	Easting (m)[2]	Elevation (m)[3]		Point ID	Short Point ID[1]	River Station (m from Downstream End of Study Area)	Northing (m)[2]	Easting (m)[2]	Elevation (m)[3]
OW_WSE_20220623-01	22-01	5355	6888174.14	431275.23	518.82		OW_WSE_20220623-27	22-27	12561	6885281.35	433128.07	522.23
OW_WSE_20220623-02	22-02	5389	6888172.25	431464.47	518.67		OW_WSE_20220623-28	22-28	12970	6885289.82	433577.58	522.22
OW_WSE_20220623-03	22-03	5708	6887815.86	431342.01	519.17		OW_WSE_20220623-29	22-29	13109	6885662.96	433571.21	522.52
OW_WSE_20220623-04	22-04	6011	6887531.16	431543.12	519.14		OW_WSE_20220623-30	22-30	13239	6885335.41	433922.60	522.77
OW_WSE_20220623-05	22-05	6297	6887342.77	431833.35	519.23		OW_WSE_20220623-31	22-31	13549	6885815.13	433901.23	522.60
OW_WSE_20220623-06	22-06	6667	6887303.45	432221.09	519.37		OW_WSE_20220623-32	22-32	13905	6886077.25	434062.44	522.72
OW_WSE_20220623-07	22-07	6970	6887286.06	432516.53	519.41		OW_WSE_20220623-33	22-33	14126	6886297.97	434355.49	522.78
OW_WSE_20220623-08	22-08	7851	6887003.63	433255.16	519.69		OW_WSE_20220623-34	22-34	14150	6886270.14	434072.45	522.65
OW_WSE_20220623-09	22-09	8418	6886604.49	433678.86	520.30		OW_WSE_20220623-35	22-35	14274	6886392.09	434047.96	522.62
OW_WSE_20220623-10	22-10	8701	6886301.37	433694.28	520.40		OW_WSE_20220623-36	22-36	14711	6886859.46	434166.78	522.74
OW_WSE_20220623-11	22-11	9014	6885959.96	433522.34	520.78		OW_WSE_20220623-37	22-37	14984	6887104.84	434116.27	522.88
OW_WSE_20220623-12	22-12	9400	6885881.17	433118.80	520.80		OW_WSE_20220623-38	22-38	14988	6887092.53	433884.49	522.90
OW_WSE_20220623-13	22-13	9718	6885934.34	432782.78	520.96		OW_WSE_20220623-39	22-39	15612	6887727.49	433920.15	523.19
OW_WSE_20220623-14	22-14	10040	6886010.92	432483.73	521.10		OW_WSE_20220623-40	22-40	15927	6887865.82	434202.36	523.24
OW_WSE_20220623-15	22-15	10342	6886020.85	432193.15	521.10		OW_WSE_20220623-41	22-41	16234	6887931.45	434475.88	523.51
OW_WSE_20220623-16	22-16	10819	6885808.60	432005.25	521.33		OW_WSE_20220623-42	22-42	16544	6887937.45	434786.78	523.54
OW_WSE_20220623-17	22-17	10958	6885647.77	431772.58	521.71		OW_WSE_20220623-43	22-43	16872	6888006.06	435119.82	523.67
OW_WSE_20220623-18	22-18	11129	6885465.20	431898.97	521.69		OW_WSE_20220623-44	22-44	17345	6888170.97	435569.96	523.66
OW_WSE_20220623-19	22-19	11164	6885552.74	432112.65	521.60		OW_WSE_20220623-45	22-45	17657	6888174.85	435827.40	523.81
OW_WSE_20220623-20	22-20	11441	6885371.63	432276.04	521.66		OW_WSE_20220623-46	22-46	18036	6888387.29	436208.98	524.10
OW_WSE_20220623-21	22-21	11448	6885220.59	432134.03	521.81		OW_WSE_20220623-47	22-47	18323	6888277.14	436495.71	524.21
OW_WSE_20220623-22	22-22	11719	6885031.52	432355.30	521.89		OW_WSE_20220623-48	22-48	18640	6888117.77	436769.17	524.18
OW_WSE_20220623-23	22-23	11773	6885196.64	432506.19	521.80		OW_WSE_20220623-49	22-49	18946	6887911.92	437024.32	524.55
OW_WSE_20220623-24	22-24	12003	6884907.08	432649.37	522.13		OW_WSE_20220623-50	22-50	19219	6887605.10	437202.06	524.68
OW_WSE_20220623-25	22-25	12162	6885117.55	432804.03	521.89		OW_WSE_20220623-51	22-51	19360	6887461.66	436949.10	524.51
OW_WSE_20220623-26	22-26	12530	6885016.32	433222.49	522.22							

Notes:
1 As illustrated on Figure 6-8
2 Referenced to North American Datum of 1983 (NAD83), Canadian Spatial Referencing System (CSRS)
3 Referenced to Canadian Geodetic Vertical Datum 2013 (CGVD2013)

A flow measurement was not obtained on June 23, 2022 to pair with the surveyed WSEs. WSC Station 09AH001 reported a water level (local datum) of approximately 6.49 m on June 23, 2022; but did not report a discharge (discharges not reported at this station from 1995 to present). However, for the purposes of a high flow calibration event for hydraulic modelling in this Project, it is estimated that the flow on June 23, 2022 was 2,911 m^3/s based on the following:

- A flow measurement of 2,830 m^3/s was obtained by WSC on July 6, 2022 (13 days after the Underhill survey). On this date, the water level at WSC Station 09AH001 was approximately 6.37 m (local datum).
- Rating curve #7 for WSC Station 09AH001 provided by YG WRB and WSC staff estimates a flow of 2,828 m^3/s on July 6, 2022.
- There is strong agreement between the July 6, 2022 flows which were measured (2,830 m^3/s) and estimated by the WSC rating curve #7 (2,828 m^3/s). This means the WSC rating curve #7 estimates flows well at this high flow stage.
- The WSC rating curve #7 was applied to the water level on June 23, 2022, when water levels were only 0.12 m higher than on July 6, 2022 (i.e., similar flood stage).
- The WSC rating curve #7 estimates a flow of 2,911 m^3/s at a water level of 6.49 m on June 23, 2022.

The measured and estimated flows on June 23, 2022 and July 6, 2022 are among the highest flows that have historically been observed in the Yukon River at Carmacks (Figure 6-11).

6.5.3.3 June 27, 2023 – Open Water Event

On June 27, 2023, Underhill obtained WSEs at 60 different locations throughout the Yukon River in the Study Area (Figure 6-8). A profile of the surveyed WSEs is provided in Figure 6-13. The river station, northing, easting, and elevation of the surveyed WSEs are provided in Table 6-8. The reach-averaged WSE slope from the surveyed WSEs was approximately 0.04%, although slopes appear to be slightly greater than 0.04% in the most upstream and most downstream thirds of the reach, and slightly less than 0.04% in the middle third (through the main community consolidation of Carmacks). A photographic inventory along the Yukon River was collected by Stantec during the high-flow event (Appendix A).

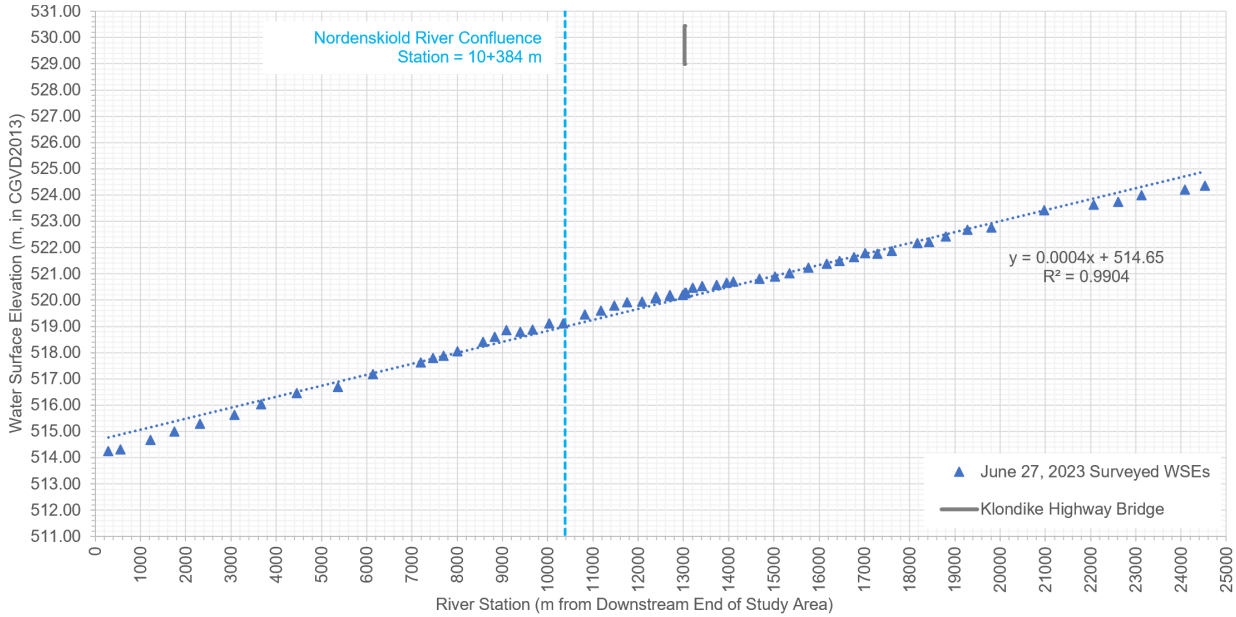


Figure 6-13 Yukon River Surveyed Water Surface Elevations on June 27, 2023

Table 6-8 Yukon River Surveyed Water Surface Elevations on June 27, 2023

Point ID	Short Point ID[1]	River Station (m from Downstream End of Study Area)	Northing (m)[2]	Easting (m)[2]	Elevation (m)[3]		Point ID	Short Point ID[1]	River Station (m from Downstream End of Study Area)	Northing (m)[2]	Easting (m)[2]	Elevation (m)[3]
OW_WSE_20230627-01	23-01	289	6889431.45	431284.84	514.26		OW_WSE_20230627-31	23-31	12979	6885336.32	433565.38	520.19
OW_WSE_20230627-02	23-02	559	6889446.28	431628.29	514.33		OW_WSE_20230627-32	23-32	13032	6885354.95	433615.14	520.28
OW_WSE_20230627-03	23-03	1217	6889510.25	432359.99	514.68		OW_WSE_20230627-33	23-33	13033	6885530.55	433528.77	520.26
OW_WSE_20230627-04	23-04	1747	6889417.31	432803.33	514.99		OW_WSE_20230627-34	23-34	13062	6885537.87	433558.24	520.28
OW_WSE_20230627-05	23-05	2316	6889071.42	433122.19	515.28		OW_WSE_20230627-35	23-35	13210	6885349.67	433872.62	520.47
OW_WSE_20230627-06	23-06	3072	6888596.34	433088.66	515.63		OW_WSE_20230627-36	23-36	13413	6885373.22	434179.74	520.53
OW_WSE_20230627-07	23-07	3671	6888751.02	432625.25	516.04		OW_WSE_20230627-37	23-37	13737	6885658.66	434436.03	520.59
OW_WSE_20230627-08	23-08	4452	6888933.52	431837.52	516.46		OW_WSE_20230627-38	23-38	13955	6885995.21	434505.76	520.66
OW_WSE_20230627-09	23-09	5368	6888193.50	431461.97	516.69		OW_WSE_20230627-39	23-39	14100	6886274.75	434370.96	520.71
OW_WSE_20230627-10	23-10	6138	6887427.18	431660.36	517.17		OW_WSE_20230627-40	23-40	14677	6886825.11	434168.23	520.82
OW_WSE_20230627-11	23-11	7193	6887459.52	432783.50	517.63		OW_WSE_20230627-41	23-41	15023	6887143.29	434107.27	520.90
OW_WSE_20230627-12	23-12	7465	6887380.98	433044.59	517.80		OW_WSE_20230627-42	23-42	15348	6887446.18	434091.41	521.03
OW_WSE_20230627-13	23-13	7702	6887234.74	433279.73	517.88		OW_WSE_20230627-43	23-43	15758	6887787.86	434139.25	521.23
OW_WSE_20230627-14	23-14	8006	6887033.05	433508.57	518.05		OW_WSE_20230627-44	23-44	16172	6887933.19	434413.80	521.39
OW_WSE_20230627-15	23-15	8570	6886433.00	433692.82	518.41		OW_WSE_20230627-45	23-45	16454	6887937.67	434696.23	521.50
OW_WSE_20230627-16	23-16	8828	6886146.32	433657.12	518.60		OW_WSE_20230627-46	23-46	16766	6887983.60	435016.39	521.63
OW_WSE_20230627-17	23-17	9092	6885915.98	433457.88	518.85		OW_WSE_20230627-47	23-47	17023	6888054.36	435289.24	521.79
OW_WSE_20230627-18	23-18	9401	6885884.44	433117.76	518.80		OW_WSE_20230627-48	23-48	17287	6888160.90	435512.07	521.77
OW_WSE_20230627-19	23-19	9665	6885917.19	432832.99	518.87		OW_WSE_20230627-49	23-49	17608	6888182.94	435779.00	521.88
OW_WSE_20230627-20	23-20	10040	6886013.29	432483.47	519.11		OW_WSE_20230627-50	23-50	18169	6888338.07	436345.78	522.17
OW_WSE_20230627-21	23-21	10342	6886022.22	432193.67	519.11		OW_WSE_20230627-51	23-51	18430	6888222.38	436587.58	522.21
OW_WSE_20230627-22	23-22	10817	6885811.21	432002.90	519.46		OW_WSE_20230627-52	23-52	18800	6888008.47	436912.51	522.43
OW_WSE_20230627-23	23-23	11174	6885542.79	432114.65	519.60		OW_WSE_20230627-53	23-53	19282	6887542.22	437217.75	522.68
OW_WSE_20230627-24	23-24	11468	6885210.30	432152.54	519.79		OW_WSE_20230627-54	23-54	19812	6887007.04	437153.65	522.77
OW_WSE_20230627-25	23-25	11756	6885023.17	432392.93	519.92		OW_WSE_20230627-55	23-55	20979	6886267.23	438189.04	523.42
OW_WSE_20230627-26	23-26	12086	6885110.17	432728.41	519.94		OW_WSE_20230627-56	23-56	22074	6885278.76	438409.26	523.64
OW_WSE_20230627-27	23-27	12377	6885182.88	432971.22	520.06		OW_WSE_20230627-57	23-57	22604	6885530.49	438900.23	523.75
OW_WSE_20230627-28	23-28	12397	6884955.69	433104.34	520.13		OW_WSE_20230627-58	23-58	23129	6886104.54	439020.08	524.00
OW_WSE_20230627-29	23-29	12701	6885347.56	433237.75	520.19		OW_WSE_20230627-59	23-59	24085	6886483.05	439960.13	524.20
OW_WSE_20230627-30	23-30	12706	6885156.43	433373.44	520.15		OW_WSE_20230627-60	23-60	24526	6886544.20	440268.16	524.35

Notes:
1 As illustrated in Figure 6-8
2 With reference to North American Datum of 1983 (NAD83), Canadian Spatial Referencing System (CSRS)
3 With reference to Canadian Geodetic Vertical Datum 2013 (CGVD2013)

On June 27, 2023 at 12:00 pm, Stantec staff measured an average flow of 1,615 m^3/s obtained over six passes at a single transect located approximately 75 m downstream of WSC Station 09AH001. A Teledyne RiverRay ADCP mounted to a boat was used for data collection.

The reported water level at WSC Station 09AH001 on June 27, 2023 at 12:00 pm was 4.49 m (local datum). This water level equates to a flow of approximately 1,645 m^3/s using WSC rating curve #7. The flow measured by Stantec is in acceptable agreement with the WSC rating curve (i.e., within 30 m^3/s, or approximately 1.8%).

Despite being among the highest flows observed in 2023, the measured and surveyed event on June 27, 2023 is not among the higher end of flood flows observed in the Yukon River at Carmacks over the period of record (1,645 m^3/s is approximately at the 25th percentile of annual maximum high flows for WSC Station 09AH001 from 1951 to 2023; Figure 6-11).

6.6 Digital Terrain Model

The DTM is the terrain input for the hydraulic model. The DTM for each of the Nordenskiold River and Yukon River in the Study Area was derived from surveyed bathymetric/channel data, surveyed cross-section locations, surveyed topographic data, and the LiDAR data provided by YG. Verification that survey data had datum agreement with the CQL1 LiDAR is documented in Section 6.2. To merge the surveyed channel data and the floodplain LiDAR data, Stantec completed data pre-processing in ArcGIS Desktop version 10.8 and ArcGIS Pro version 3.1.

For bathymetry reaches, the surveyed data (RTK GPS survey pole points, single beam echosounder points, or multibeam echosounder points) were used to create a three-dimensional (3D) surface raster which was integrated with the CQL1 LiDAR. Underhill completed the majority of the bathymetry surveys with a multibeam echosounder, which provides substantial bathymetry point cloud coverage and does not require advanced survey point interpolation approaches, such as “kriging”. Specific details on the steps taken to combine the different datasets can be provided upon request. Figure 6-14 displays the various data sources for the Yukon River for a sample reach on the Yukon River from approximate station 15+480 to 15+690; Figure 6-15 illustrates the seamless DTM of the same sample Yukon River reach.

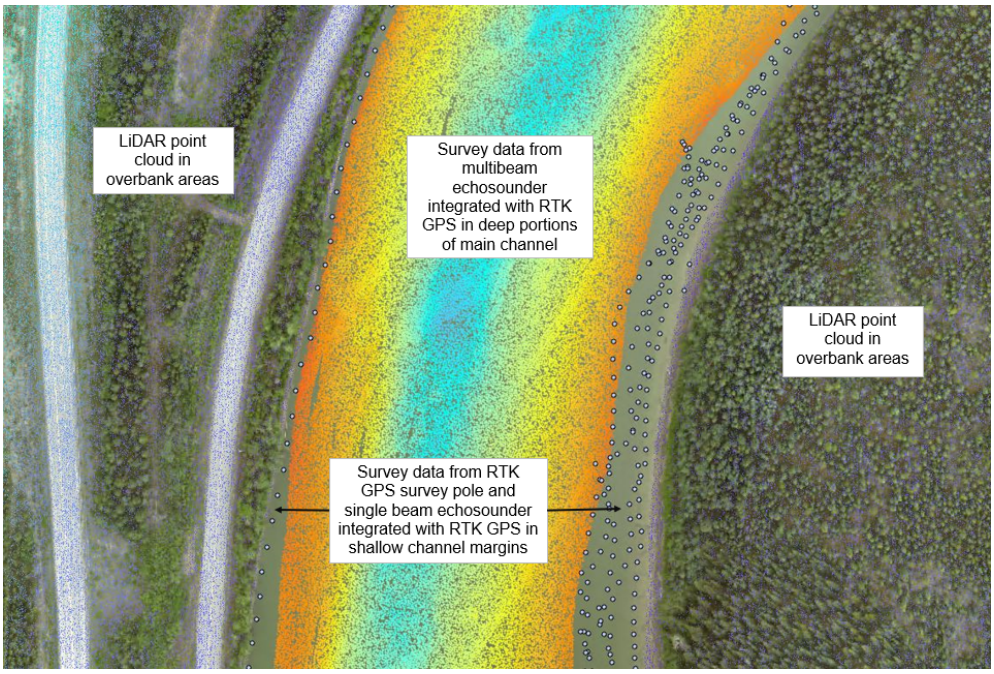


Figure 6-14 Survey Data and LiDAR Data Sources for Yukon River from Station 15+480 to 15+690

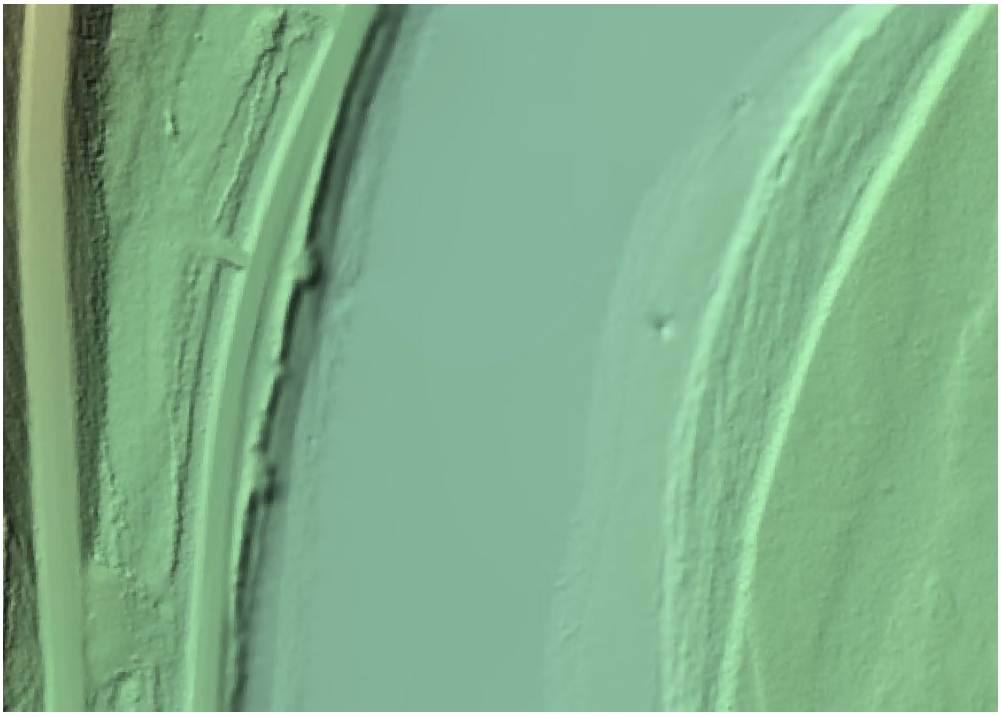


Figure 6-15 Combined Digital Terrain Model for Yukon River from Station 15+480 to 15+690

For the cross-sections, the surveyed points (either from RTK GPS survey pole, single beam echosounder, or multibeam echosounder) were converted into narrow (~15 m wide) surface rasters along each cross-section line. Example combined cross-section with multiple survey data sources for Yukon River Station 13+514 and Nordenskiold River Staton 8+533 are provided in Figure 6-16 and Figure 6-17, respectively. The surveyed points were combined with sampled points from the bank and floodplain LiDAR data to create a three-dimensional narrow surface raster representative of the surveyed channel and overbank for each section.

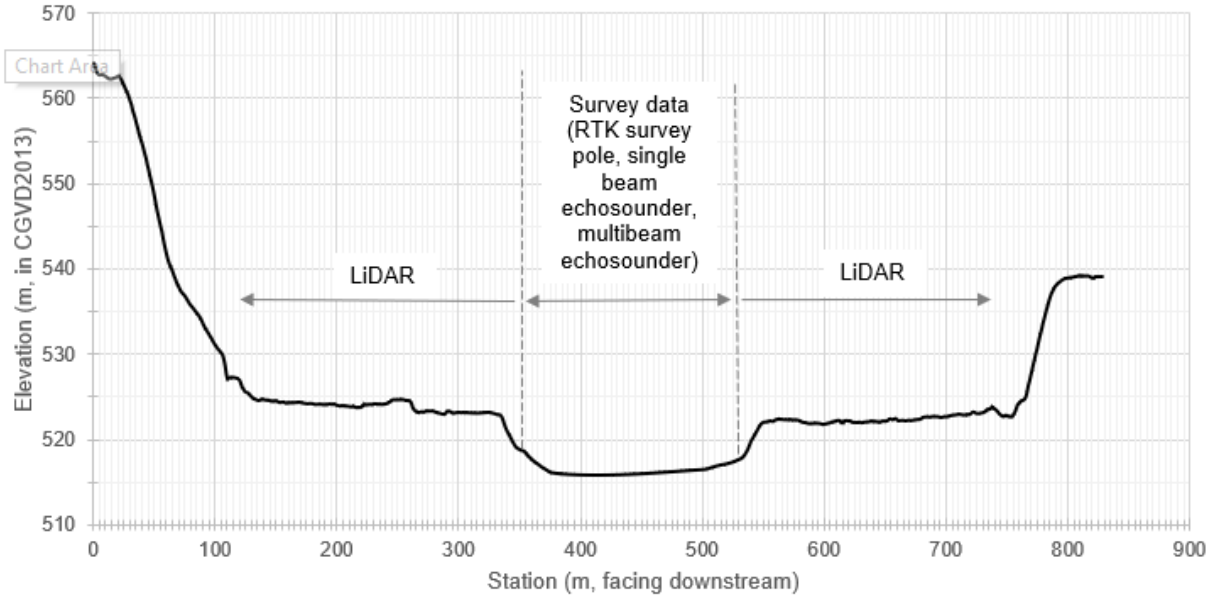


Figure 6-16 Combined Cross-Section at Yukon River Station 13+514

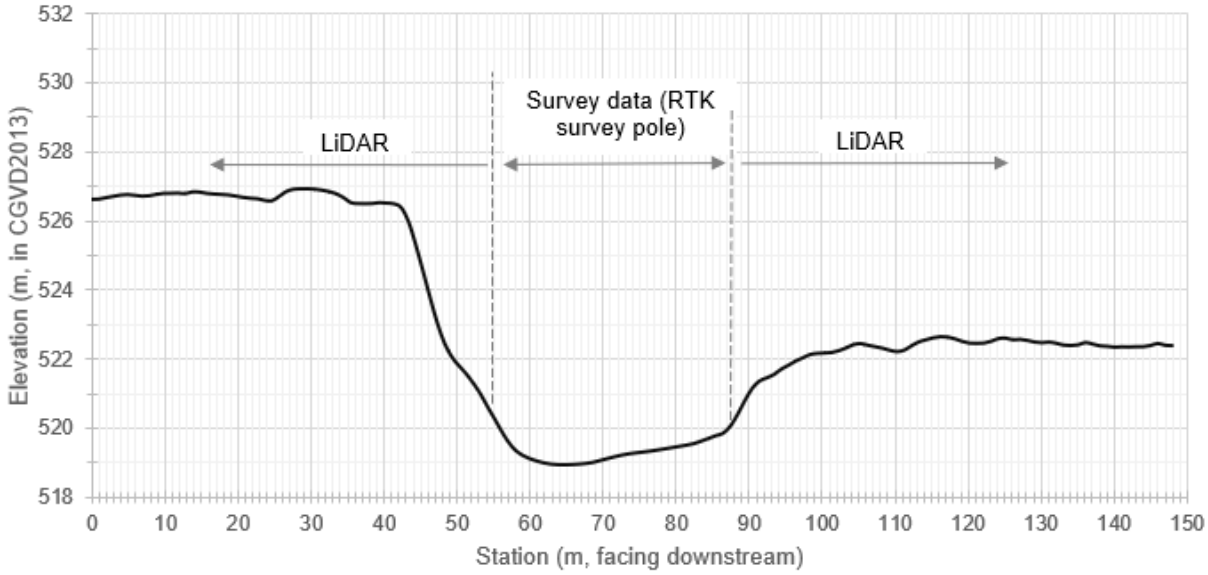


Figure 6-17 Combined Cross-Section of Nordenskiold River Station 8+553

This surface raster, the narrow cross-section surface rasters, and the bathymetric data were then combined with the floodplain LiDAR data using the raster calculator. At the locations of the survey and/or bathymetric data, the floodplain LiDAR elevations were replaced to create a continuous combined surface. All surface rasters use a 1 m cell resolution. Figure 6-18 illustrates the overall Study Area DTM.

Electronic file submission of the DTM is detailed in Appendix C.

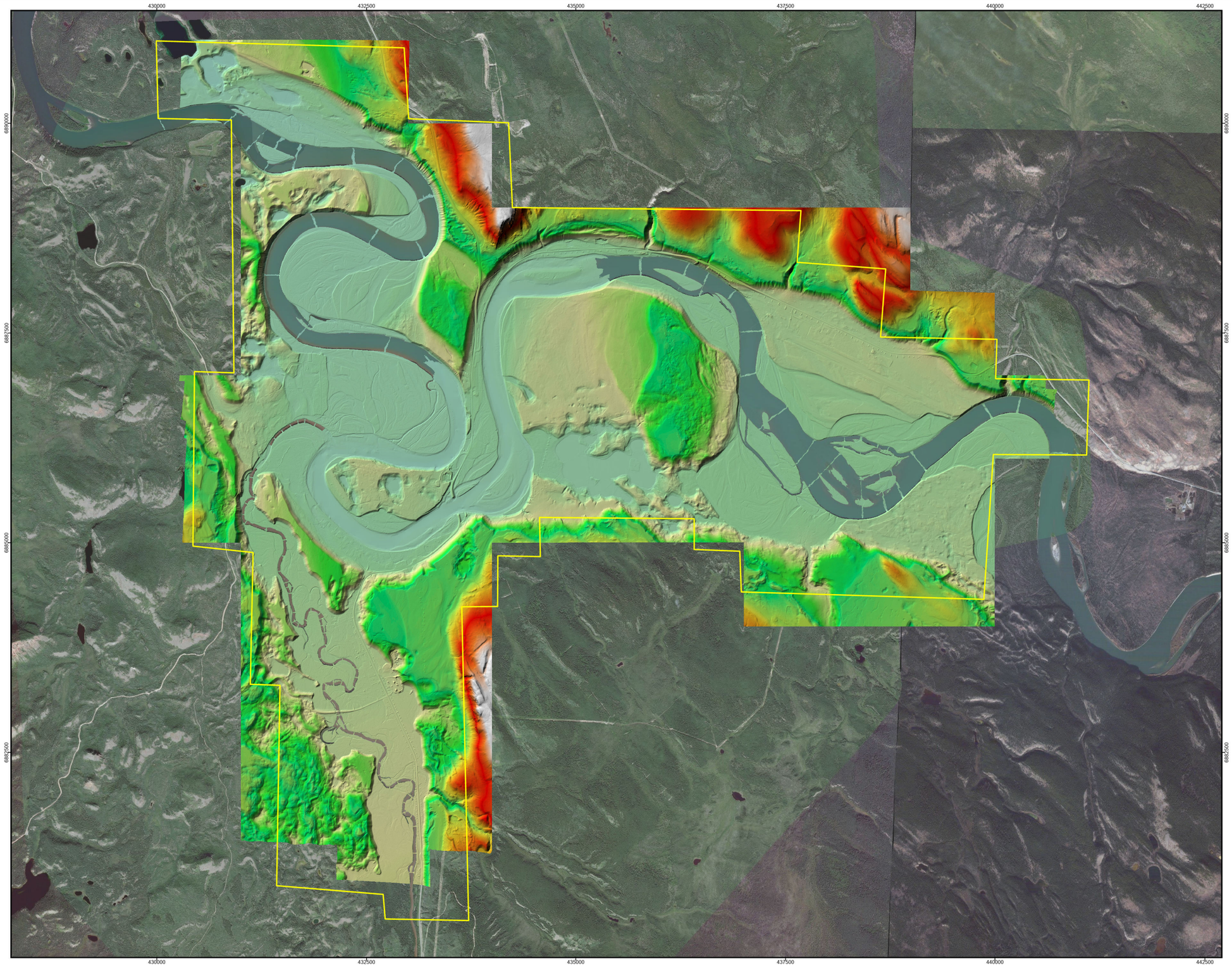


Figure No.

6-18

Title:

Carmacks Flood Mapping Study
Digital Terrain Model

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

Prepared by MANDERSON on 2024-05-08
Requested by JMUIRHEAD on 2024-03-06
Review by JMUIRHEAD on 2024-05-09

Elevation (m)

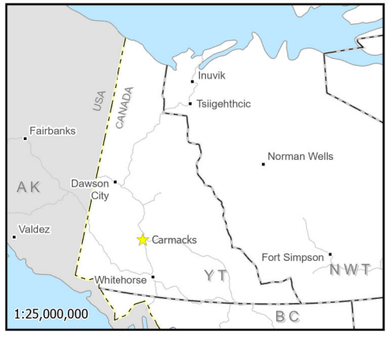
805

507

Study Area

0 400 800 1,200 1,600 2,000 m

(At original document size of 11 x 17) 1:45,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Underhill 2023 survey, Canvec.
3. Background: World Imagery: Earthstar Geographics
Yukon Satellites HighRes: Government of Yukon
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/ topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: This document has been prepared based on information provided by others as cited in the Notes section. Stantec has not verified the accuracy and/or completeness of this information and shall not be responsible for any errors or omissions which may be incorporated herein as a result. Stantec assumes no responsibility for data supplied in electronic format, and the recipient accepts full responsibility for verifying the accuracy and completeness of the data.

7 Hydraulic Modelling and Flood Mapping

The hydraulic analysis undertaken for the Project generally followed the one-dimensional hydraulic modelling pathway from NRCan (2019a), illustrated in green overtop of the NRCan (2019a) flowchart in Figure 7-1. The hydraulic modelling software for this Project was the Hydraulic Engineering Centre River Analysis Software (HEC-RAS) Version 6.3.1, produced by the United States Army Corps of Engineers (USACE). HEC-RAS allows users to perform one-dimensional (1D) steady and unsteady flow and two-dimensional (2D) unsteady flow calculations. HEC-RAS was selected for this Project because of its industry-wide acceptance as the standard hydraulic modelling program for flood mapping and because it is capable of modelling breakup ice jams (in 1D steady state analysis) (FEMA 2018).

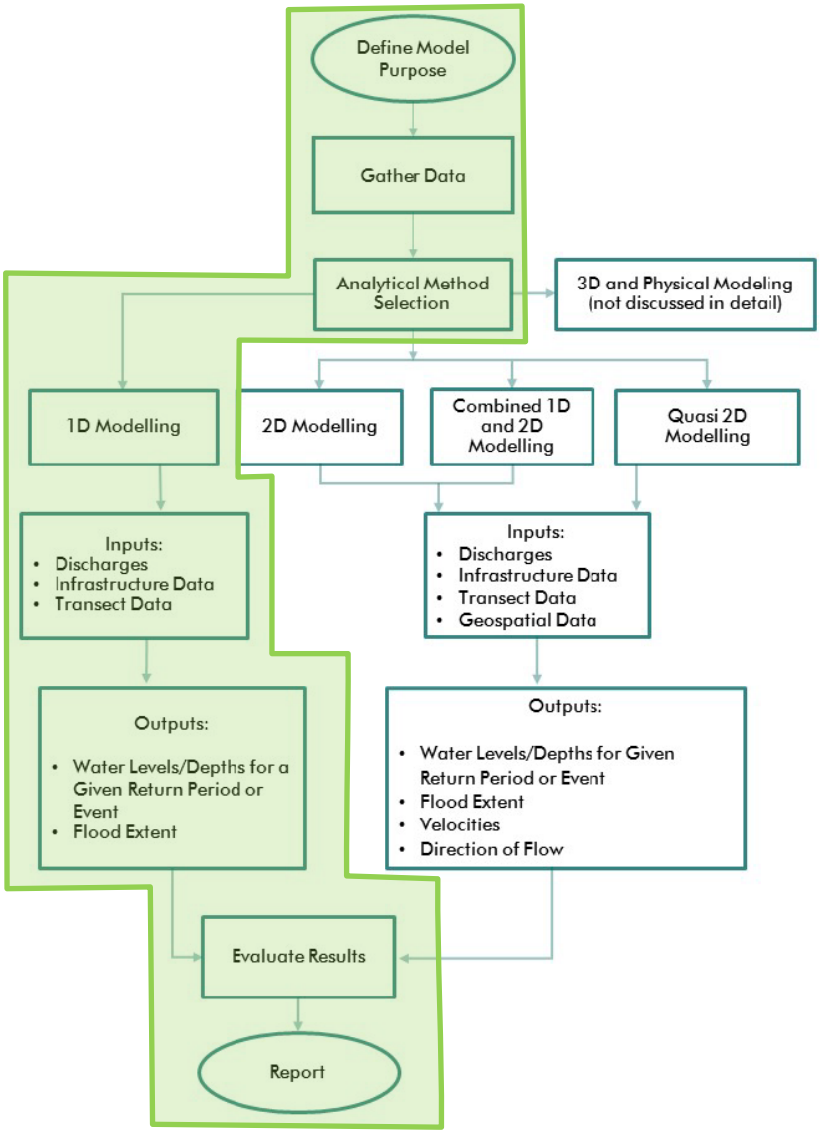


Figure 7-1 Hydraulic Procedures Flowchart from NRCan (2019a)

7.1 Design Events for Flood Mapping

Based on the findings and analysis of Section 2 through Section 6, the dominant flood processes considered in this Project are as follows:

- Breakup ice jam flood events on the Nordenskiold River
- Open water flood events on the Nordenskiold River and the Yukon River

The AEP design event flood hazard maps produced in this Project were composite maps built by overlaying results from model runs produced by a single Nordenskiold River/Yukon River hydraulic model that was run to simulate: i) Nordenskiold River breakup ice jams, ii) Nordenskiold River open water flows, and iii) Yukon River open water flows. Their combined maximum extent in the mapping represents the maximum extents of inundation from those simulations and is considered the delineation of the composite flood hazard at the given AEP.

Table 7-1 summarizes the flows that were considered in each of the model runs for each of the five AEP design events, based on the hydrologic analysis, joint probability analysis, climate change, and land cover change assessments previously described. These flows were the upstream boundary condition for respective modelling runs; downstream boundary conditions are discussed on a scenario-by-scenario basis in Section 7.3.1.1, Section 7.3.2.1, and Section 7.4.1.1.

Table 7-1 Flow Inputs for Annual Exceedance Probability Design Events

Annual Exceedance Probability (AEP) Design Event	Hydraulic Modelling Run	Nordenskiold River		Yukon River (Upstream of Nordenskiold River Confluence)		Yukon River (Downstream of Nordenskiold River Confluence)	
		Description	Peak Instantaneous Discharge (m^3/s)	Description	Peak Instantaneous Discharge (m^3/s)	Description	Peak Instantaneous Discharge (m^3/s)
5% AEP	Breakup Ice Jams - Nordenskiold River	5% AEP from Nordenskiold River breakup peak FFA	91	Maximum discharge threshold for Yukon River ice cover	1190	Nordenskiold River flow + Yukon River (upstream of confluence) flow	1161
	Open Water Flows - Nordenskiold River Primary	5% AEP from Nordenskiold River open water peak FFA	201	50% AEP from Yukon River open water peak FFA	1900	Nordenskiold River flow + Yukon River (upstream of confluence) flow	2101
	Open Water Flows - Yukon River Primary	50% AEP from Nordenskiold River open water peak FFA	93	5% AEP from Yukon River open water peak FFA	2910	Nordenskiold River flow + Yukon River (upstream of confluence) flow	3003
5% AEP with factors of safety for climate change [1]	Breakup Ice Jams - Nordenskiold River	5% AEP from Nordenskiold River breakup peak FFA * 1.2	110	Maximum discharge threshold for Yukon River ice cover	1190	Nordenskiold River flow + Yukon River (upstream of confluence) flow	1290
	Open Water Flows - Nordenskiold River Primary	5% AEP from Nordenskiold River open water peak FFA * 1.2	242	50% AEP from Yukon River open water peak FFA * 1.1	2090	Nordenskiold River flow + Yukon River (upstream of confluence) flow	2332
	Open Water Flows - Yukon River Primary	50% AEP from Nordenskiold River open water peak FFA * 1.2	112	5% AEP from Yukon River open water peak FFA * 1.1	3210	Nordenskiold River flow + Yukon River (upstream of confluence) flow	3322
1% AEP	Breakup Ice Jams - Nordenskiold River	1% AEP from Nordenskiold River breakup peak FFA	153	Maximum discharge threshold for Yukon River ice cover	1190	Nordenskiold River flow + Yukon River (upstream of confluence) flow	1593
	Open Water Flows - Nordenskiold River Primary	1% AEP from Nordenskiold River open water peak FFA	267	50% AEP from Yukon River open water peak FFA	1900	Nordenskiold River flow + Yukon River (upstream of confluence) flow	2167
	Open Water Flows - Yukon River Primary	50% AEP from Nordenskiold River open water peak FFA	93	1% AEP from Yukon River open water peak FFA	3500	Nordenskiold River flow + Yukon River (upstream of confluence) flow	3593
0.5% AEP	Breakup Ice Jams - Nordenskiold River	0.5% AEP from Nordenskiold River breakup peak FFA	185	Maximum discharge threshold for Yukon River ice cover	1190	Nordenskiold River flow + Yukon River (upstream of confluence) flow	1785
	Open Water Flows - Nordenskiold River Primary	0.5% AEP from Nordenskiold River open water peak FFA	296	50% AEP from Yukon River open water peak FFA	1900	Nordenskiold River flow + Yukon River (upstream of confluence) flow	2196
	Open Water Flows - Yukon River Primary	50% AEP from Nordenskiold River open water peak FFA	93	0.5% AEP from Yukon River open water peak FFA	3740	Nordenskiold River flow + Yukon River (upstream of confluence) flow	3833
0.5% AEP with factors of safety for climate change [1]	Breakup Ice Jams - Nordenskiold River	0.5% AEP from Nordenskiold River breakup peak FFA * 1.2	222	Maximum discharge threshold for Yukon River ice cover	1190	Nordenskiold River flow + Yukon River (upstream of confluence) flow	1982
	Open Water Flows - Nordenskiold River Primary	0.5% AEP from Nordenskiold River open water peak FFA * 1.2	356	50% AEP from Yukon River open water peak FFA	2090	Nordenskiold River flow + Yukon River (upstream of confluence) flow	2446
	Open Water Flows - Yukon River Primary	50% AEP from Nordenskiold River open water peak FFA * 1.2	112	0.5% AEP from Yukon River open water peak FFA * 1.1	4120	Nordenskiold River flow + Yukon River (upstream of confluence) flow	4232

NOTES:
[1] Nordenskiold River Factor of Safety = 1.2 and Yukon River Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
[2] Estimated maximum discharge for ice cover on Yukon River during breakup

7.2 Model Setup

Terrain import, mesh generation, visualization of hydraulic results, and cross-section delineation was completed in RAS Mapper, a mapping program produced by the USACE which interfaces with HEC-RAS. Hydraulic model features are illustrated in Figure 7-2 and Figure 7-3.

The domain of the hydraulic model was the smaller of the Study Reach extents and DTM extents. In total, the model domain contained 9.3 km of the Nordenskiold River and 24.5 km of the Yukon River. The hydraulic model was a single model which simultaneously performed hydraulic calculations in the Nordenskiold River and the Yukon River. A junction was established for the Nordenskiold River confluence with the Yukon River, using momentum method for steady flow analysis. The angle of approach for the junction was set as 50° and 20° for the Nordenskiold River and Yukon River, respectively. Calibration, validation, and design AEP runs were completed for each river independently; because of the one-model approach, an appropriate “paired” flow was assigned for the non-primary river for a given run.

The final hydraulic model for flood mapping in the Study Area was a single 1D model for the Nordenskiold River and Yukon River, with separate model runs for design AEP events. An initial 2D model run using the available LiDAR and bathymetry data was completed to delineate 1D cross-section alignments throughout the model domain which spanned the overbank zones and were perpendicular to flow. The results of this exercise were 69 cross-sections in the Nordenskiold River and 62 cross-sections in the Yukon River. Cross-sections were placed closer together in areas of hydraulic complexity on both rivers (e.g., bridges, bends, islands/constrictions).

- Excluding cross-sections at bridges (where spacing was 1 – 26 m apart), cross-section spacing on the Nordenskiold River was 23 – 323 m, with an average spacing of 146 m. Bankfull width on the Nordenskiold River is approximately 47 m (on average) meaning cross-section spacing was 0.5–6.9 bankfull widths, with an average of 3.1 bankfull widths.
- Excluding cross-sections at bridges (where spacing was 1 – 29 m apart), cross-section spacing on the Yukon River was 51 – 1042 m, with an average spacing of 427 m. Bankfull width on the Yukon River is approximately 316 m (on average) meaning cross-section spacing was 0.2–3.3 bankfull widths, with an average of 1.4 bankfull widths.

The 69 cross-sections on the Nordenskiold River and the 62 cross-sections on the Yukon River were exported from RAS Mapper into a 1D HEC-RAS model. Hydraulic structure data (from Section 6.4.2 and Section 6.5.2) were entered into HEC-RAS within the 1D model geometry editor. At bridges, cross-sections were located 1 m upstream and downstream of the structures. The bridge sections were extended to capture potential overtopping of the road deck adjacent to the bridge span. Ineffective flow areas were added based on the size of the bridge openings in the upstream and downstream cross-sections where the flow transition pattern occurs and meets the bridge surrounding cross-sections.

Contraction and expansion coefficients were increased to 0.3 and 0.5 for “Typical Bridge Sections” based on the HEC-RAS Hydraulic Reference Manual (USACE 2023). The values were updated for the two cross-sections upstream and one cross-section downstream of the bridges.

An initial 1D model run was completed using the 0.5% AEP open water flows as the upstream boundary conditions, initial Mannings n values from Chow (1959) and USACE (2023), and normal depth as the downstream boundary condition (energy slope = 0.04% based on surveyed WSE Yukon River slopes documented in Section 6.5.3.1, Section 6.5.3.2, and Section 6.5.3.3). As the hydraulic model was a single model for both the Nordenskiold River and Yukon River, a downstream boundary condition was only required for the Yukon River; the downstream boundary condition for the Nordenskiold River was the model's internally calculated WSE on the Yukon River at the confluence for that model run. Edge lines and downstream flow lengths were assigned in RAS Mapper based on the inundation results from the 1D model run. The result was an operating 1D HEC-RAS model consisting of both Nordenskiold River and Yukon River reaches within the model.

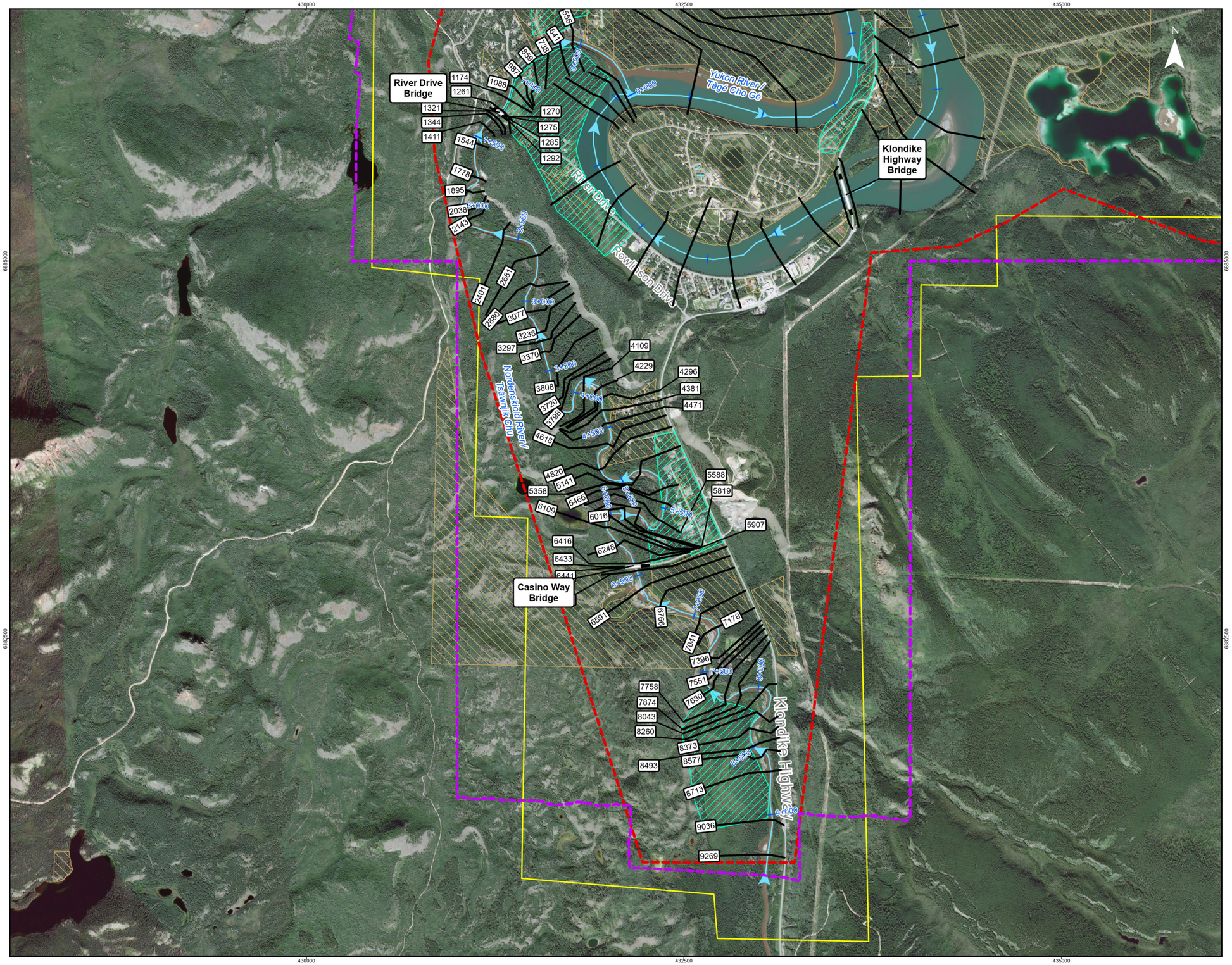


Figure No.

7-2

Title:

Carmacks Flood Mapping Study
Hydraulic Model Setup (Nordenskiold River)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

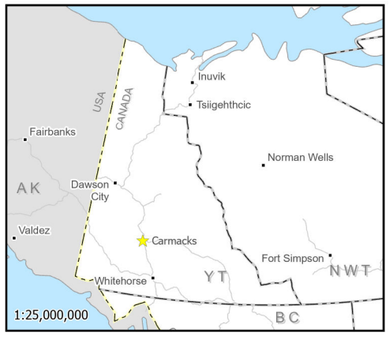
Carmacks, Yukon

Prepared by MANDERSON on 2024-05-16
Requested by JMUIRHEAD on 2023-03-27
Review by JMUIRHEAD on 2024-05-16

- Hydraulic Structures
- Centerline Alignment (with Flow Direction Arrows)
- Alignment Stationing (100 m)
- Hydraulic Model Cross-Sections
- Little Salmon / Carmacks First Nation Settlement Land
- Study Area
- Hydraulic Model Domain
- Manual Edits Domain
- Digital Terrain Model Extent

0 210 420 630 840 1,050 m

(At original document size of 11 x 17) 1:25,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: Yukon Satellites HighRes: Government of Yukon

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

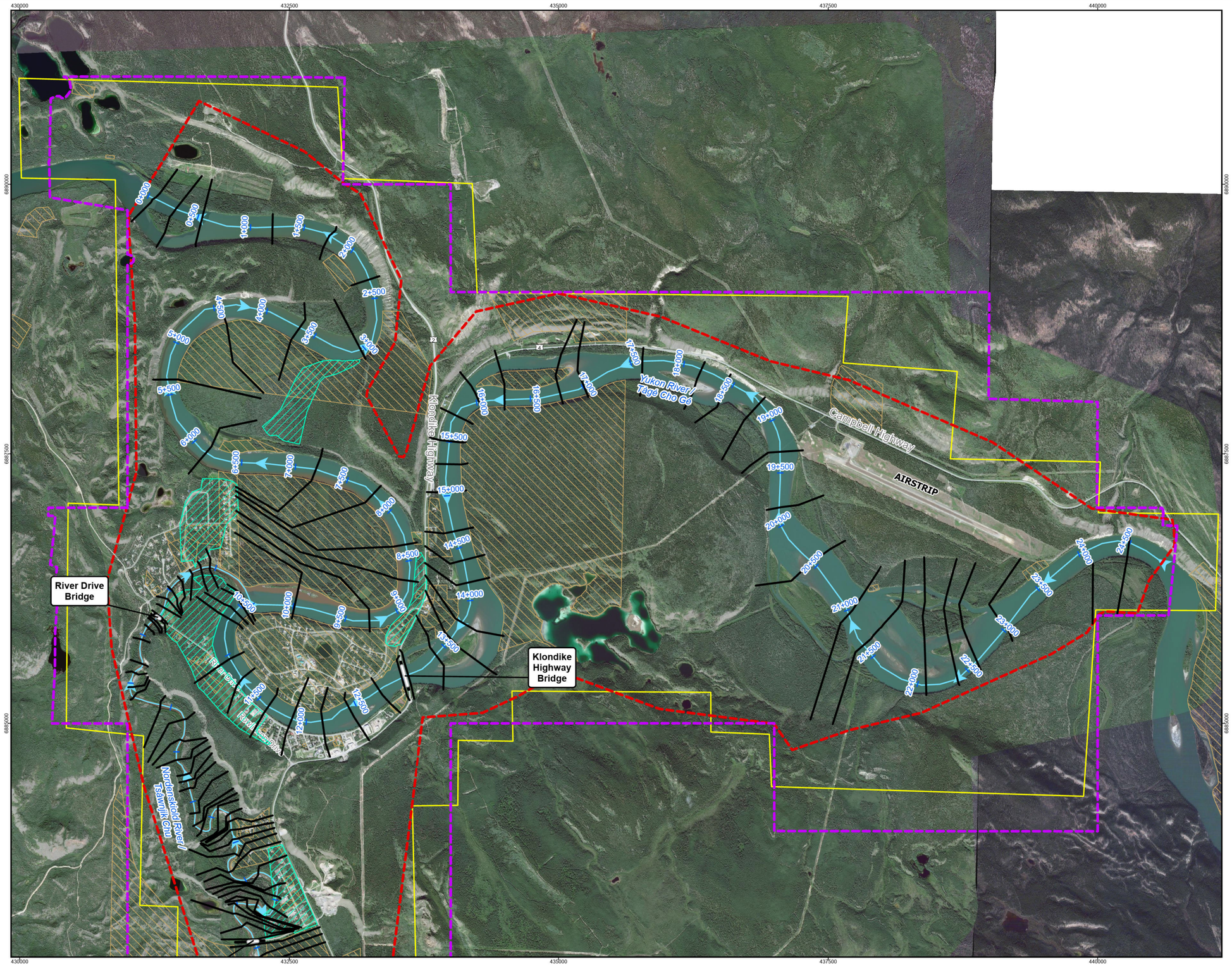


Figure No.

7-3

Title:

Carmacks Flood Mapping Study
Hydraulic Model Setup (Yukon River)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

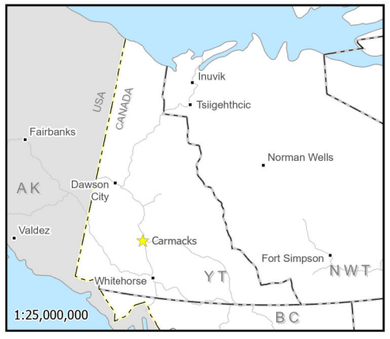
Carmacks, Yukon

Prepared by MANDERSON on 2024-05-16
Requested by JMUIRHEAD on 2023-03-27
Review by JMUIRHEAD on 2024-05-16

- Hydraulic Structures
- Centerline Alignment (with Flow Direction Arrows)
- Alignment Stationing (100 m)
- Hydraulic Model Cross-Sections
- Little Salmon / Carmacks First Nation Settlement Land
- Study Area
- Hydraulic Model Domain
- Manual Edits Domain
- Digital Terrain Model Extent

0 300 600 900 1,200 1,500 m

(At original document size of 11 x 17) 1:35,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: Yukon Satellites HighRes: Government of Yukon

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

7.3 Open Water Modelling

7.3.1 Nordenskiold River

7.3.1.1 Boundary Conditions

The upstream boundary condition for the Nordenskiold River open water hydraulic model was the flow specified for the run. The downstream boundary condition for the Nordenskiold River open water hydraulic model was the modelled WSE of the Yukon River under open water conditions at the junction (Yukon River station 10+381) using the paired flow in the Yukon River for the Nordenskiold River run being completed (Table 7-1) and a downstream boundary condition on the Yukon River of normal depth with a slope of 0.04% (consistent with the approximate channel and WSE slope from high flow WSE surveys in 2021, 2022, and 2021; Section 6.5.3).

7.3.1.2 Model Calibration

Open water hydraulic model calibration for the Nordenskiold River was completed for the May 19, 2023 event detailed in Section 6.4.3.2 (Nordenskiold River flow of 181 m^3/s). The flow in the Yukon River upstream of the confluence on May 19, 2023 was estimated to be 1,061 m^3/s (GoC 2024a) and was adopted as the paired Yukon River flow for the Nordenskiold River open water calibration.

Calibrated Mannings n values are summarized in Table 7-2.

Table 7-2 Calibrated Mannings n for Nordenskiold River Open Water Conditions

Land Use	Mannings n
Mature Forest	0.080
Sparse Shrub	0.070
Main Channel – Nordenskiold River	0.040[a] /0.028[b]
Low Intensity Development	0.030
Road – Gravel	0.020
Road – BST	0.015
Notes: [a] Upstream of River Drive [b] Downstream of River Drive	

Summary statistics for the final calibration run WSEs are provided in Table 7-3 as both a value (in m) and in a percentage of the average maximum flow depth across all cross-sections in the calibration run (2.14 m). The summary statistics in Table 7-3 consider the definitions of WSE Differential and Root Mean Square Error (RMSE) outlined in Equation (3) and Equation (4), where N is the number of surveyed WSEs (16 for the Nordenskiold River open water calibration run). The WSEs of the final calibration are illustrated in Figure 7-4. Simulated WSE is plotted against Surveyed WSE in Figure 7-5, demonstrating that the calibrated model effectively captures both trend and magnitude. The coefficient of determination

(R^2) and trendline slope are both near 1, indicating strong agreement. A profile of WSE Differential is provided in Figure 7-6.

The Nordenskiold River open water calibration detailed herein is considered reasonable for the purposes of this Project given the information available to Stantec at the time of writing. The calibration flow is within 25 m^3/s of the highest open water flow on record and represents a flow of between the 10% and 5% open water AEPs. The results of the calibration are slightly conservative (average WSE Differential of 0.03 m or 1.7% of average maximum cross-section flow depth). The maximum WSE Differential of 0.43 m is 0.1 m greater than the next highest WSE differential (0.33 m), and is located in the upstream portion of the Study Area. Increased cross-section survey data and increased resolution of WSE calibration points during high flows in the future may help refine model calibration, particularly given the bed profile variation and meandering planform of the Nordenskiold River. The main channel Mannings n are within given ranges in published literature such as Chow (1959) for roughness of gravel bed rivers during flood stage.

Table 7-3 WSE Summary Statistics for Nordenskiold River Open Water Calibration

	Value (m)	**Percentage of Average Maximum Flow Depth across all Cross-Sections (%)**
Average WSE Differential	0.03	1.4%
Minimum WSE Differential	-0.20	-9.3%
Maximum WSE Differential	0.43	20.0%
Root Mean Square Error	0.20	9.5%

$$WSE\ Differential = Simulated\ WSE - Surveyed\ WSE \quad (3)$$

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N}(WSE\ Residual)^2}{N}} \quad (4)$$

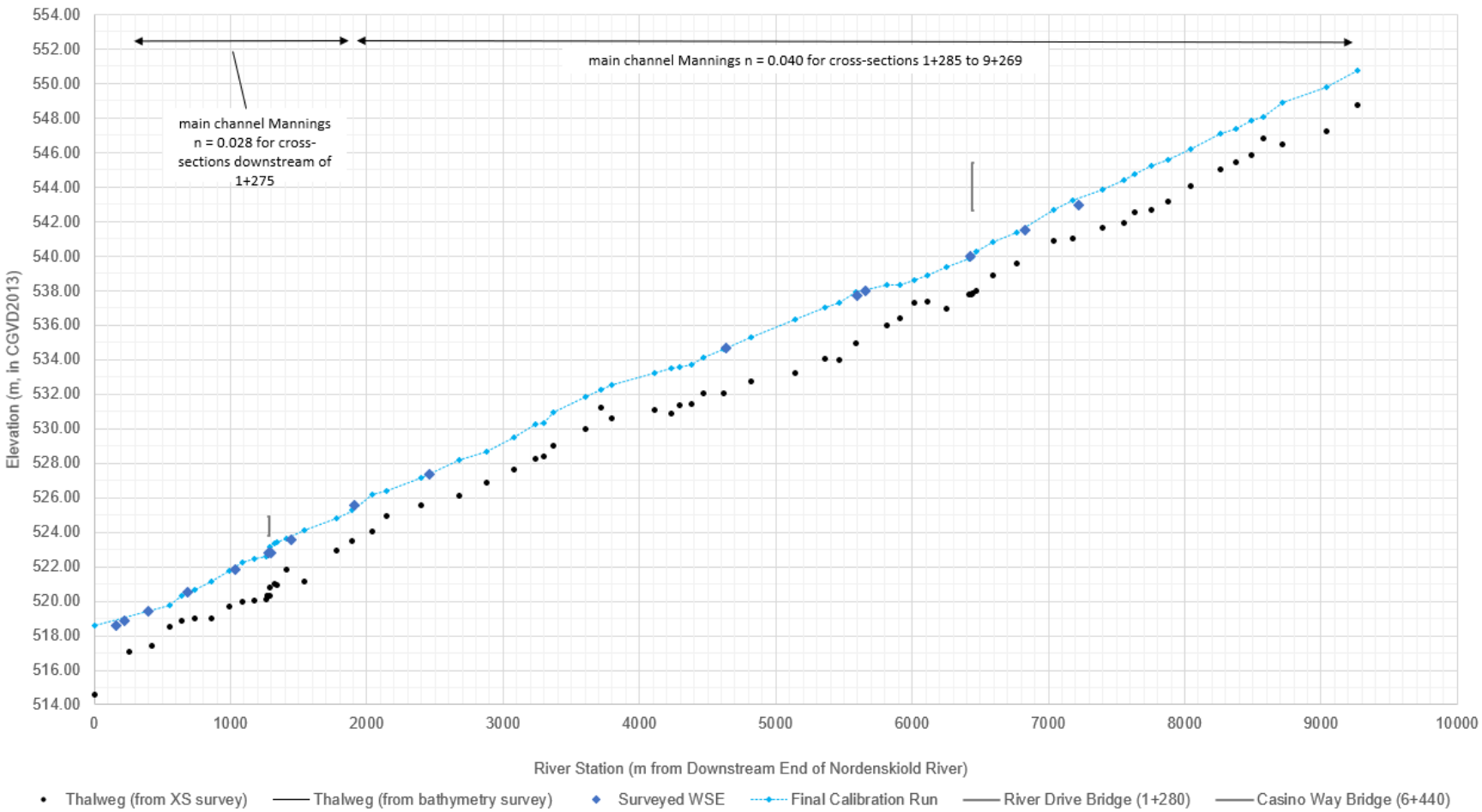


Figure 7-4 Nordenskiold River Open Water Calibration (May 19, 2023 Event)

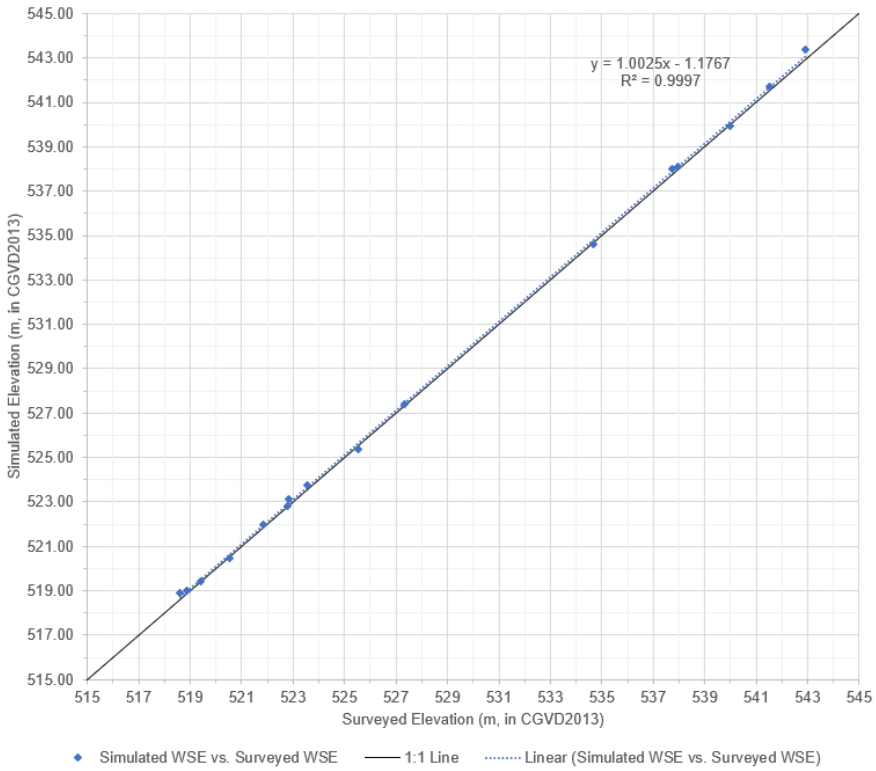


Figure 7-5 Nordenskiold River Open Water Calibration Simulated WSEs vs. Surveyed WSEs (May 19, 2023 Event)

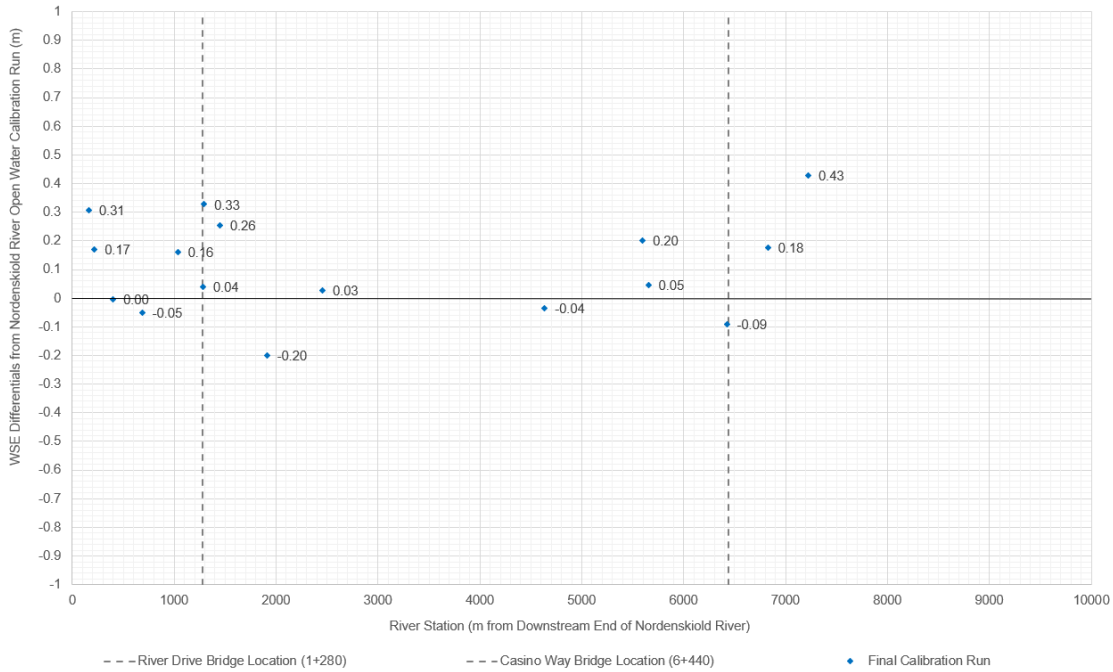


Figure 7-6 Nordenskiold River Open Water Calibration WSE Differentials (May 19, 2023 Event)

7.3.1.3 Model Validation

Flow and WSE data for an open water hydraulic model validation run on the Nordenskiold River was not available for this Project and validation could therefore not be completed. A sensitivity analysis on key model parameters was completed in Section 7.3.4.

7.3.2 Yukon River

7.3.2.1 Boundary Conditions

The upstream boundary condition for the Yukon River open water hydraulic model was the flow specified for the run. The downstream boundary condition for the Yukon River open water hydraulic model was normal depth assuming a slope of 0.04%, which is consistent with approximate channel slope as well as observed WSE slope from the high flow WSE profile surveys of 2021, 2022, and 2023 (Section 6.5.3). Flow in the Yukon River increased at the junction (Yukon River station 10+381) considering the paired Nordenskiold River flow for the Yukon River run being completed.

7.3.2.2 Model Calibration

Open water hydraulic model calibration for the Yukon River was completed for the June 23, 2022 event detailed in Section 6.5.3.2 (Yukon River flow upstream of confluence = 2,911 m^3/s). The flow in the Nordenskiold River on June 23, 2022 was estimated to be 64 m^3/s (GoC 2024a); this flow was adopted as the paired Nordenskiold River flow for the Yukon River open water calibration.

The calibrated Mannings n values are listed in Table 7-4.

Table 7-4 Calibrated Mannings n for Yukon River Open Water Conditions

Land Use	Mannings n
Mature Forest	0.080
Sparse Shrub	0.070
Main Channel - Yukon River	(0.020 – 0.031) [a]
Low Intensity Development	0.030
Road - Gravel	0.020
Road - BST	0.015
Note: [a] As illustrated in Figure 7-7	

Summary statistics for the final calibration run WSEs are provided in Table 7-5 as both a value (in m) and in a percentage of the average flow depth across all cross-sections in the calibration run (7.62 m). The summary statistics in Table 7-5 consider the definitions of WSE Differential and RMSE outlined in Equation (3) and Equation (4), where N is the number of surveyed WSEs (51 for the Yukon River open water calibration run). The results of the final calibration are illustrated in Figure 7-7. Simulated WSE is plotted against Surveyed WSE in Figure 7-8, demonstrating that the calibrated model effectively captures

both trend and magnitude. The coefficient of determination (R^2) and trendline slope are both 0.99, indicating strong agreement. A profile of WSE Differential is provided in Figure 7-9.

The Yukon River open water calibration detailed herein is considered reasonable for the purposes of this Project given the information available to Stantec at the time of writing. The calibration flow is among the highest flows recorded at WSC Station 09AH001 and is 1 m^3/s higher than the 5% open water AEP. The results of the calibration are slightly conservative (average WSE Differential of 0.08 m or 1.0% of average maximum cross-section flow depth). There are two surveyed WSEs (points 22-15 and 22-16 from Section 6.5.3.2) which are located on the inside of the meander bend at the confluence of the Yukon River; survey of outer bank WSEs were not obtained – potentially due to safety concerns during flood conditions. Comparison of surveyed WSEs on opposite banks at the entry to the bend (points 22-16 and 22-17) indicate that inside bend WSEs can be up to 0.38 m higher than outer bend WSEs. WSEs and WSE Differentials for points 22-15 and 22-16 have been retained in the figures and summary statistics for the calibration run but should be noted as not representative of average cross-section WSEs simulated by the hydraulic model. Future surveys of high water WSEs should consider obtaining points in the middle of the river (particularly at bends) for better comparison to average cross-section WSEs produced by 1D hydraulic models. The main channel Mannings n are within given ranges in published literature such as Chow (1959) for roughness of large sand/gravel bed rivers during flood stage.

Table 7-5 Yukon River Open Water Calibration Run WSE Summary Statistics

	Value (m)	**Percentage of Average Maximum Flow Depth across all Cross-Sections (%)**
Average WSE Differential	0.08	1.0
Minimum WSE Differential	-0.22	-2.9
Maximum WSE Differential	0.40	5.2
Root Mean Square Error	0.15	2.0

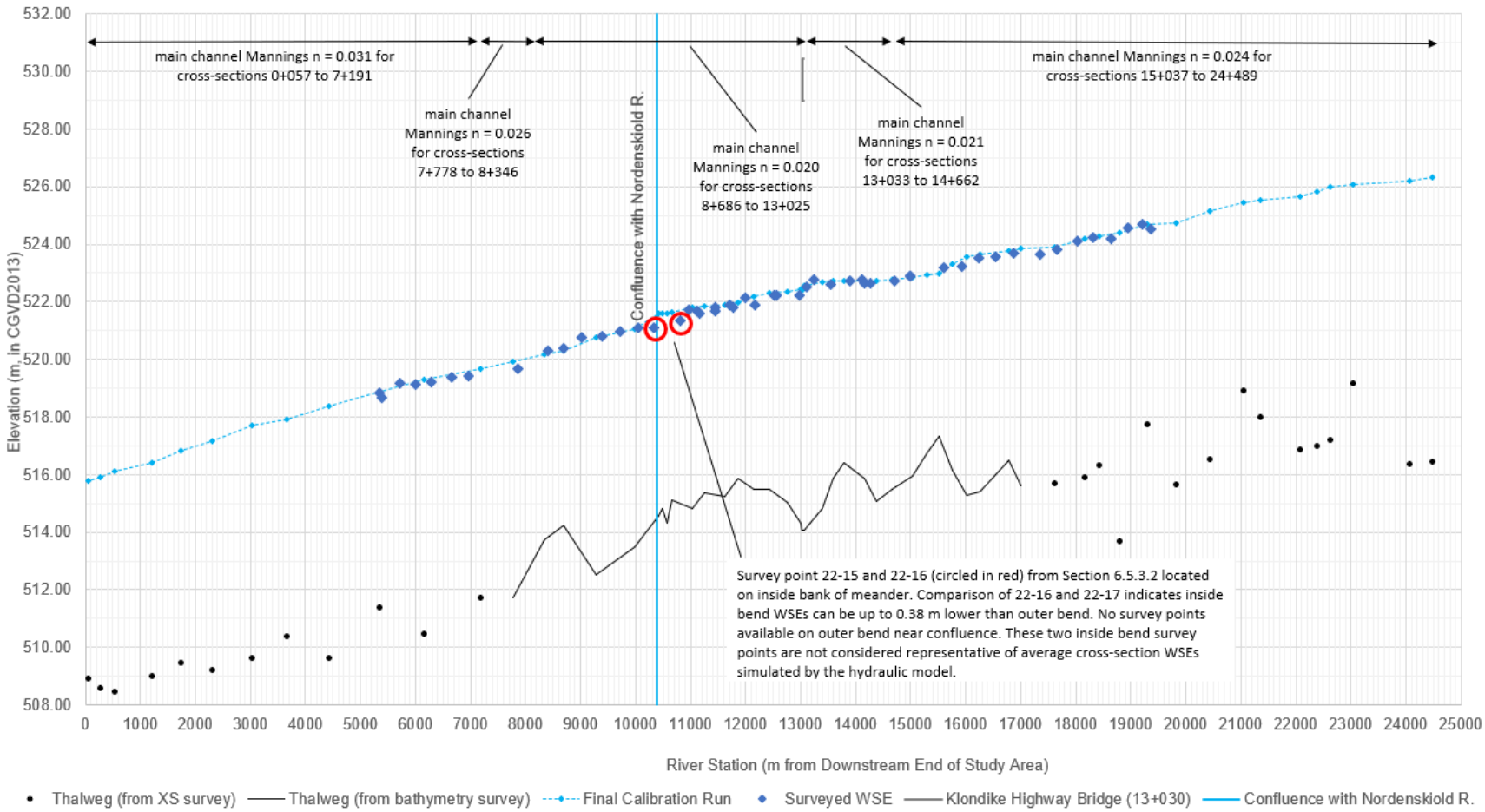


Figure 7-7 Yukon River Open Water Calibration (June 23, 2022 Event)

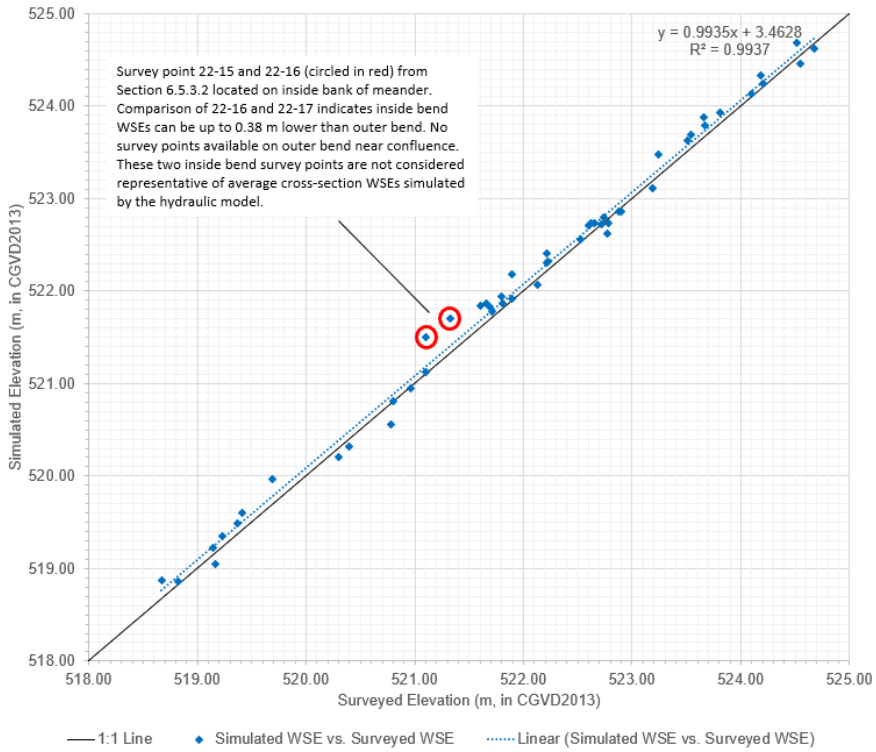


Figure 7-8 Yukon River Open Water Calibration Simulated WSEs vs. Surveyed WSEs (June 23, 2022 Event)

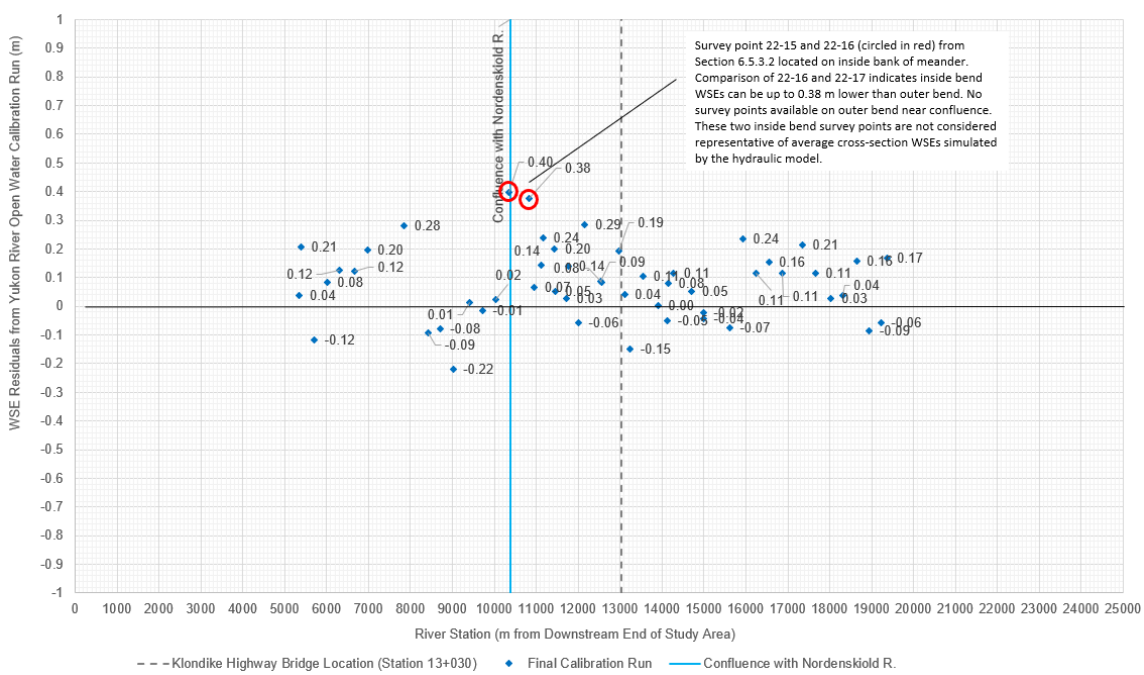


Figure 7-9 Yukon River Open Water Calibration WSE Differentials (June 23, 2022 Event)

7.3.2.3 Model Validation

Two open water model validation runs were completed for this Project: the first was for the June 16, 2021 event and the second was for the June 27, 2023 event.

The Yukon River calibration run demonstrated closer alignment to surveyed WSEs than the validation runs. The calibration event was the largest flow of the calibration and validation events, and the design events are at or above the calibration event flows. Therefore, the calibration event is the most applicable to this Project and strong alignment with surveyed WSEs under the calibration event was prioritized.

7.3.2.3.1 June 16, 2021 Event

Open water hydraulic model validation for the Yukon River was completed for the June 16, 2021 event detailed in Section 6.5.3.1 (Yukon River flow upstream of confluence = 2,335 m^3/s). The open water validation run used the Mannings n values determined in calibration (Section 7.3.2.2). The flow in the Nordenskiold River on June 16, 2021 was estimated to be 128 m^3/s (GoC 2024a); this flow was adopted as the paired Nordenskiold River flow for the Yukon River open water 2021 validation.

Summary statistics for the validation run WSEs are provided in Table 7-6 as both a value (in m) and in a percentage of the average flow depth at all cross-sections in the validation run (7.00 m). The summary statistics in Table 7-6 consider the definitions of WSE Differential and RMSE outlined in Equation (3) and Equation (4), where N is the number of surveyed WSEs (33 for the 2021 Yukon River open water validation run). The results of the validation run are illustrated in Figure 7-10. Simulated WSE is plotted against Surveyed WSE in Figure 7-11. A profile of WSE Differentials is provided in Figure 7-12.

The 2021 validation results indicate that the calibrated model overestimates the 2021 surveyed WSEs by 0.06–0.75 m (average 0.34 m). The coefficient of determination (R^2) and trendline slope are both approximately 0.99, which indicates generally strong agreement (albeit offset high). This suggests that the calibrated hydraulic model may be conservative in estimating WSEs (particularly through the main community consolidation of Carmacks) for this flow, which is just below the 20% open water AEP.

There are two surveyed WSEs (points 21-16 and 21-17 from Section 6.5.3.1) which are located on the inside of the meander bend at the confluence of the Yukon River; survey of outer bank WSEs were not obtained – potentially due to safety concerns during flood conditions. Comparison of surveyed WSEs on opposite banks at the entry to the bend in 2022 (points 22-16 and 22-17) indicate that inside bend WSEs can be up to 0.38 m higher than outer bend WSEs. WSEs and WSE Differentials for points 21-16 and 21-17 have been retained in the figures and summary statistics for the 2021 validation run but should be noted as not representative of average cross-section WSEs simulated by the hydraulic model.

Table 7-6 Yukon River Open Water 2021 Validation Run WSE Summary Statistics (June 16, 2021 Event)

	Value (m)	Percentage of Average Flow Depth across all Cross-Sections (%)
Average WSE Differential	0.34	4.8
Minimum WSE Differential	0.06	0.9
Maximum WSE Differential	0.75	10.7
Root Mean Square Error	0.37	5.3

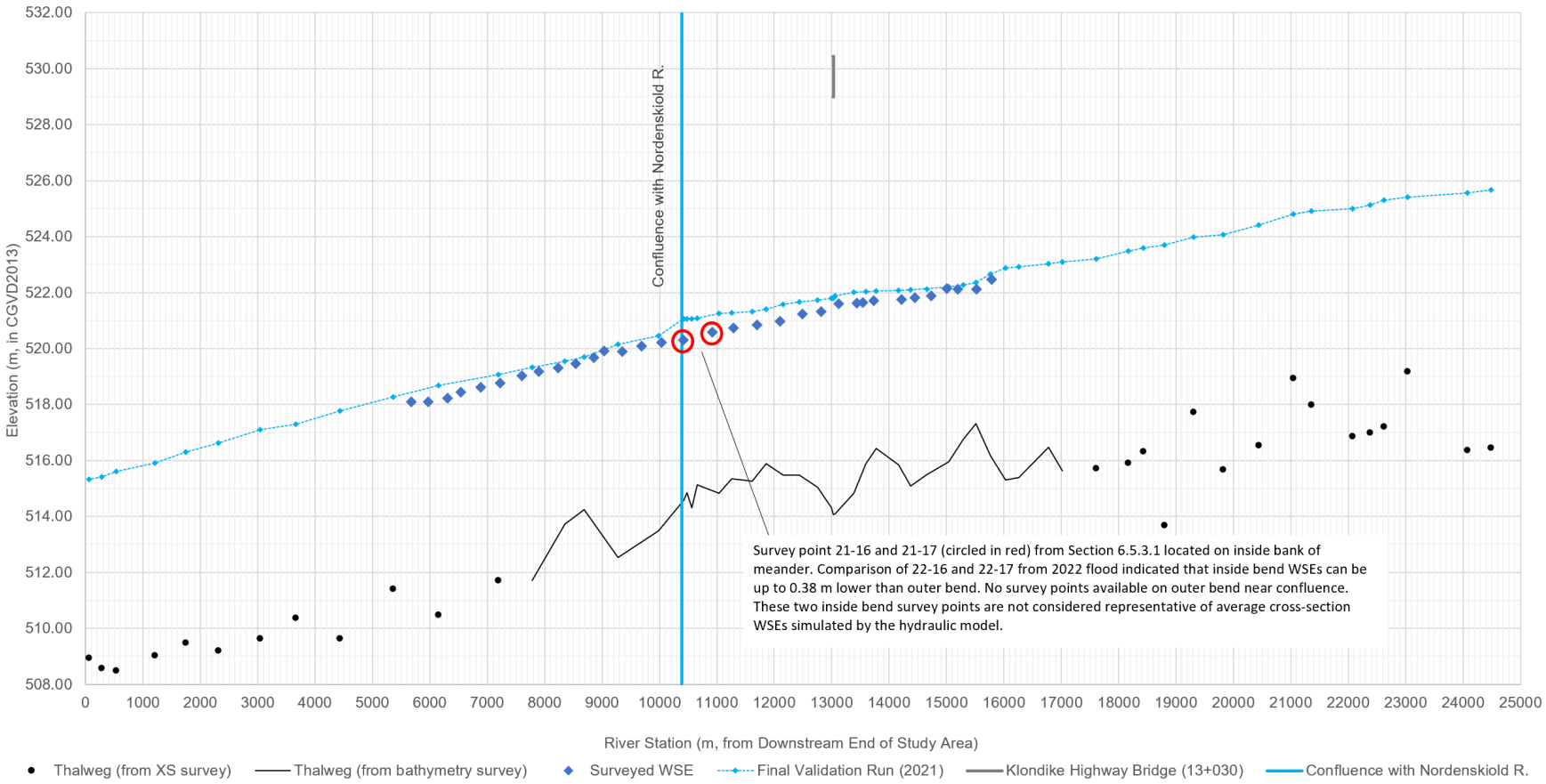


Figure 7-10 Yukon River Open Water 2021 Validation (June 16, 2021 Event)

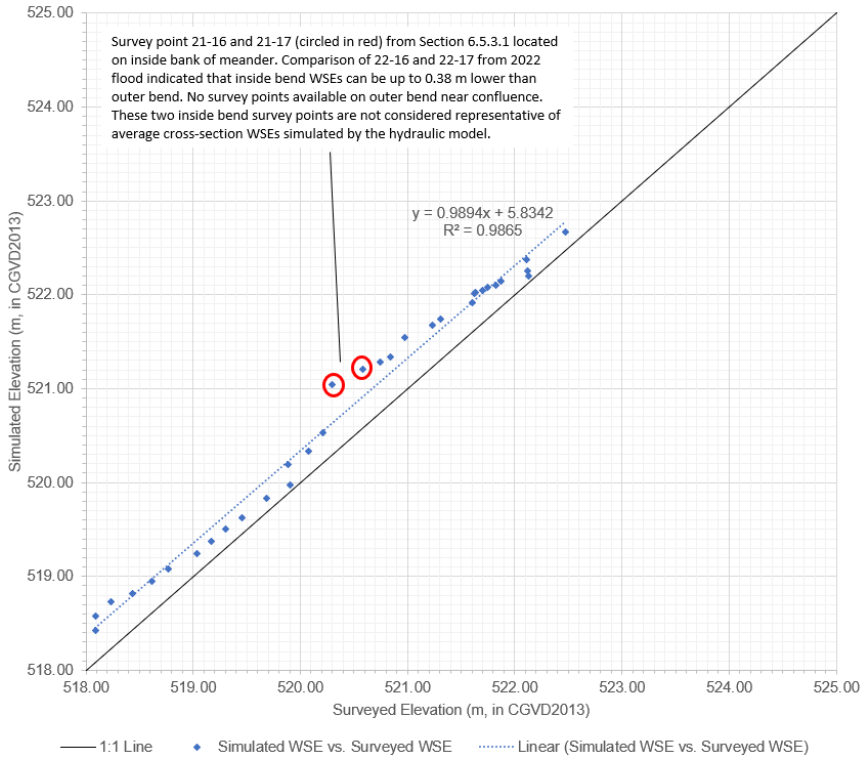


Figure 7-11 Yukon River Open Water 2021 Validation Simulated WSEs vs. Surveyed WSEs (June 16, 2021 Event)

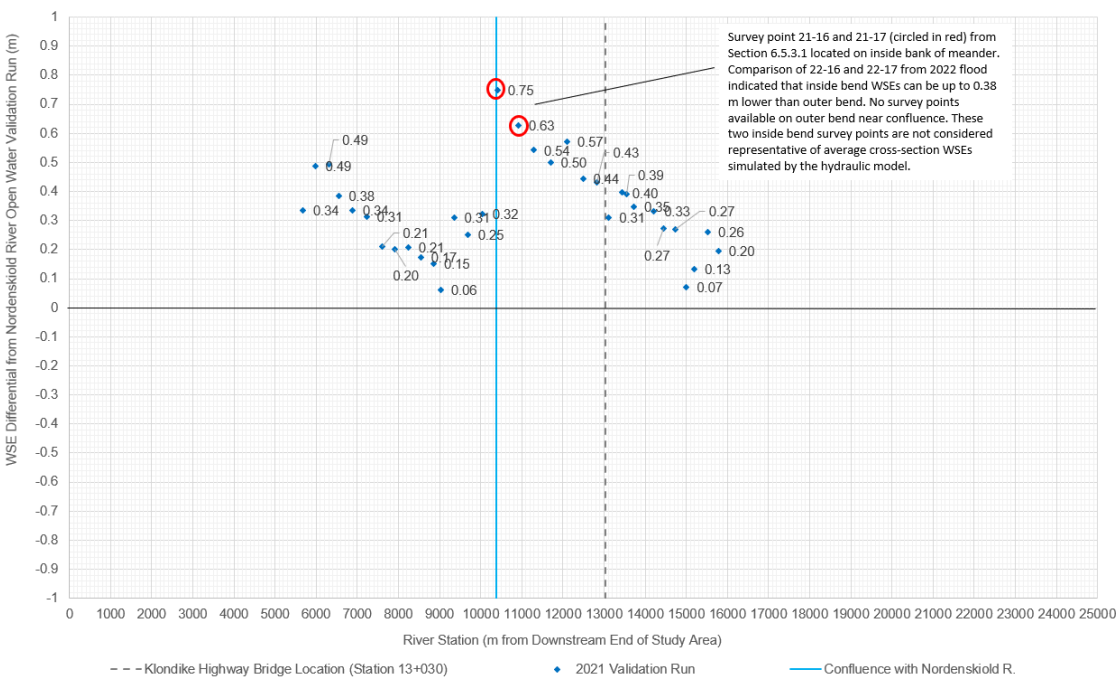


Figure 7-12 Yukon River Open Water Validation WSE Differentials (June 16, 2021 Event)

7.3.2.3.2 June 27, 2023 Event

Open water hydraulic model validation for the Yukon River was completed for the June 27, 2023 event detailed in Section 6.5.3.3 (Yukon River flow upstream of confluence = 1,645 m^3/s). The open water validation run used the Mannings n values determined in calibration (Section 7.3.2.2). The flow in the Nordenskiold River on June 27, 2023 was estimated to be 22 m^3/s (GoC 2024a); this flow was adopted as the paired Nordenskiold River flow for the Yukon River 2023 open water validation.

Summary statistics for the validation run WSEs are provided in Table 7-7 as both a value (in m) and in a percentage of the average flow depth all cross-sections in the validation run (5.87 m). The summary statistics in Table 7-7 consider the definitions of WSE Differential and RMSE outlined in Equation (3) and Equation (4), where N is the number of surveyed WSEs (60 for the 2023 Yukon River open water validation run). The results of the validation run are illustrated in Figure 7-13. Simulated WSE is plotted against Surveyed WSE in Figure 7-14. A profile of WSE Differentials is provided in Figure 7-15.

The 2023 validation results indicate that the calibrated model overestimates the 2023 surveyed WSEs by an average of 0.28 m, ranging from -0.04 m to 0.65 m. The coefficient of determination (R^2) and trendline slope are both approximately 0.99, which indicates generally strong agreement (albeit offset high). This suggests that the calibrated hydraulic model may be conservative in estimating WSEs (particularly through the main community consolidation of Carmacks) for this flow, which is below the 50% open water AEP.

There are three surveyed WSEs (points 23-20, 23-21, and 23-22 from Section 6.5.3.3) which are located on the inside of the meander bend at the confluence of the Yukon River; survey of outer bank WSEs were not obtained – potentially due to safety concerns during flood conditions. Comparison of surveyed WSEs on opposite banks at the entry to the bend in 2022 (points 22-16 and 22-17) indicate that inside bend WSEs can be up to 0.38 m higher than outer bend WSEs. WSEs and WSE Differentials for points 23-20, 23-21, and 23-22 have been retained in the figures and summary statistics for the 2023 validation run but should be noted as not representative of average cross-section WSEs simulated by the hydraulic model.

Table 7-7 Yukon River Open Water Validation Run WSE Summary Statistics (June 27, 2023 Event)

	Value (m)	Percentage of Average Flow Depth across all Cross-Sections (%)
Average WSE Differential	0.28	4.0
Minimum WSE Differential	-0.04	-0.6
Maximum WSE Differential	0.65	9.2
Root Mean Square Error	0.32	4.5

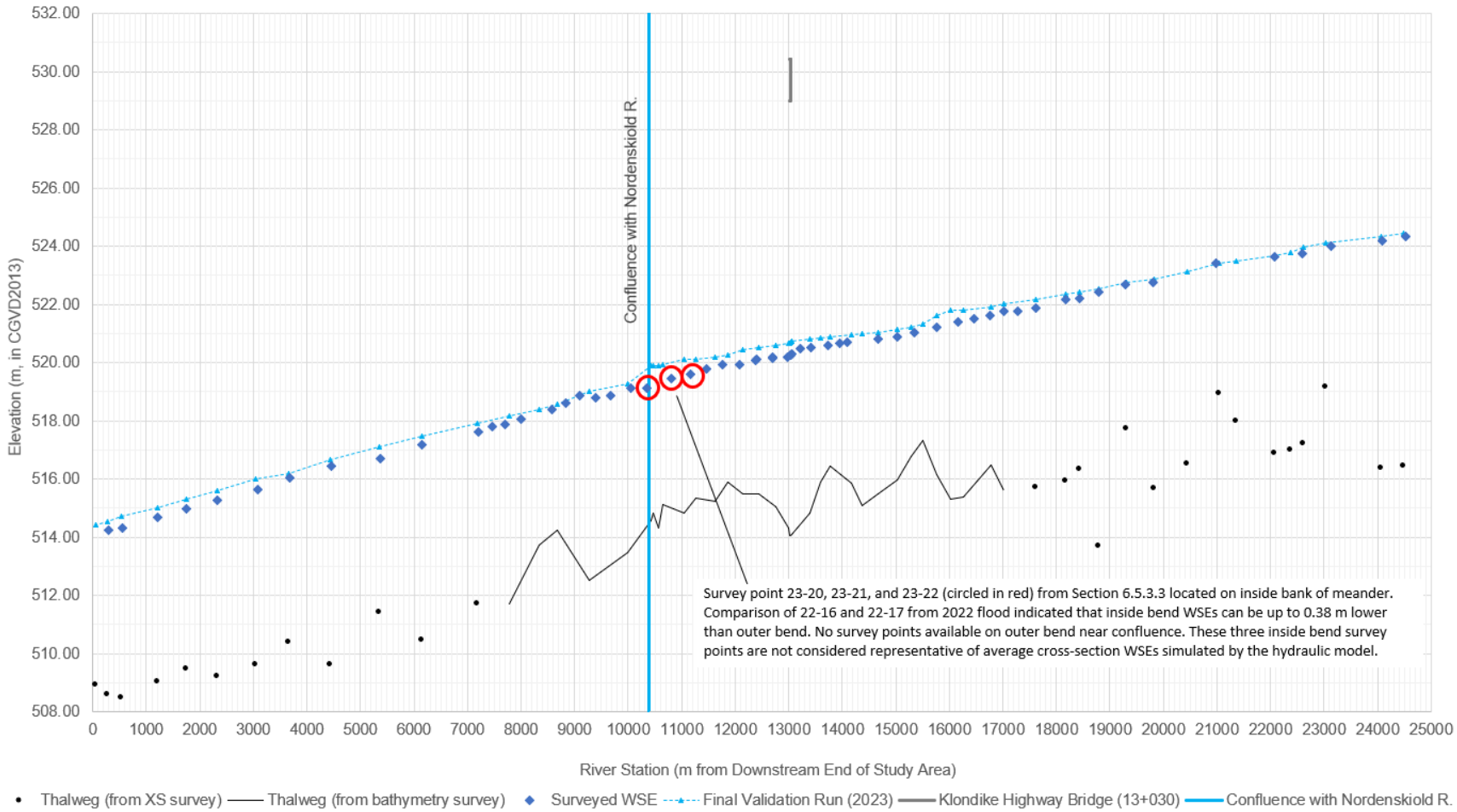


Figure 7-13 Yukon River Open Water 2023 Validation (June 27, 2023 Event)

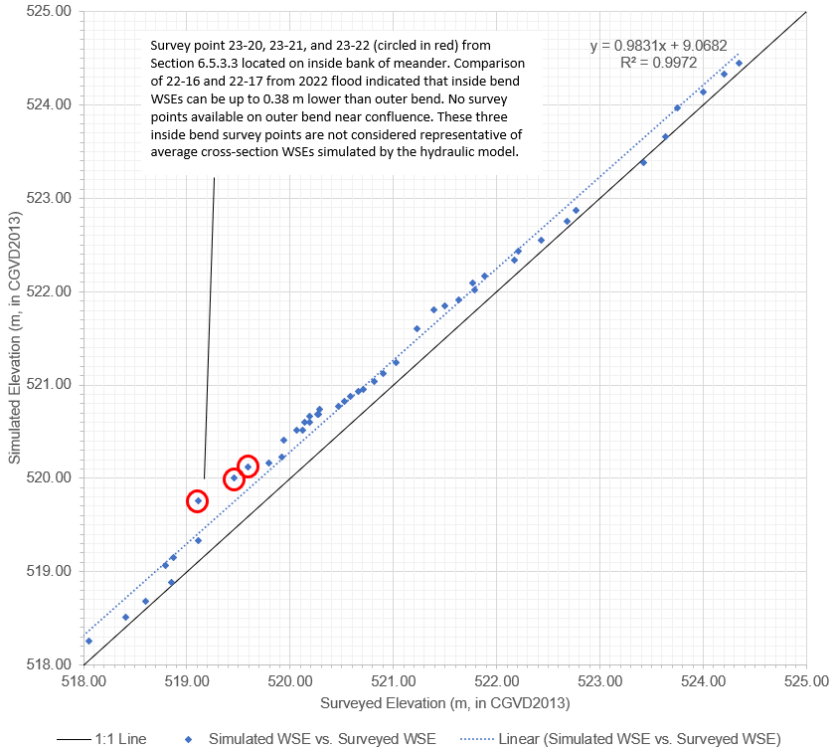


Figure 7-14 Yukon River Open Water 2023 Validation Simulated WSEs vs Surveyed WSEs (June 27, 2023 Event)

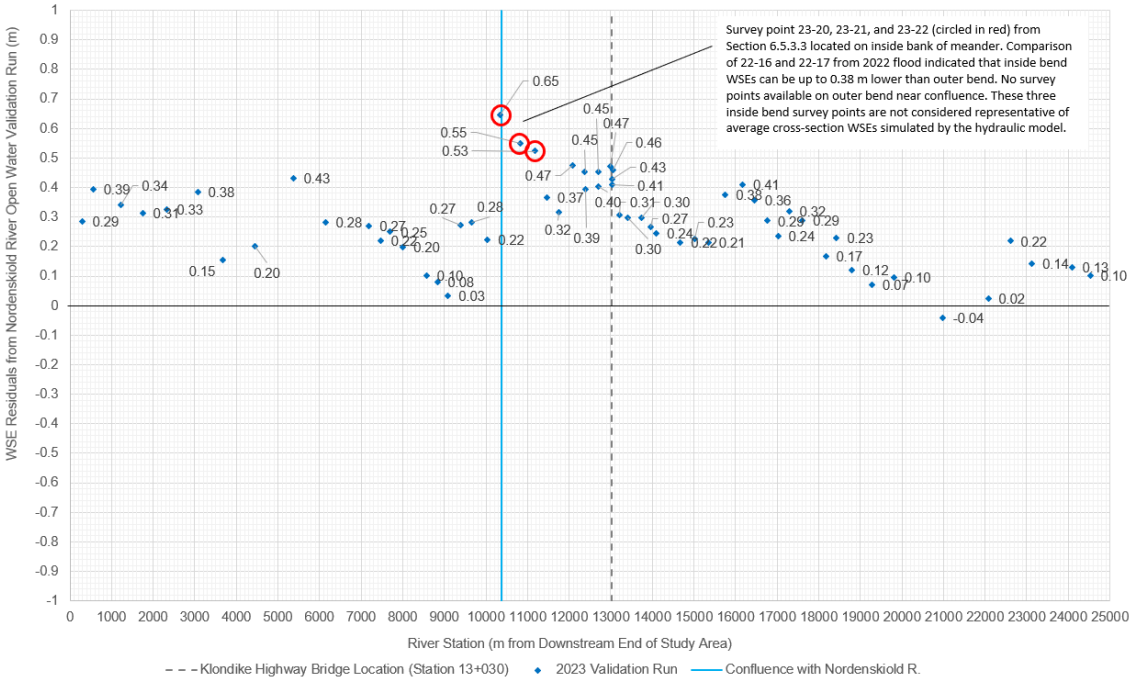


Figure 7-15 Yukon River Open Water 2023 Validation WSE Differentials (June 27, 2023 Event)

7.3.3 Design AEP Model Runs

The open water design AEP runs from Table 7-1 were completed in the calibrated hydraulic model. Results of each of the model runs are provided in tabular format in Appendix D. Figure 7-16 illustrates the WSE profiles in the Nordenskiold River for each of the open water Nordenskiold River primary runs. Figure 7-17 illustrates the WSE profiles in the Yukon River for each of the open water Yukon River primary runs.

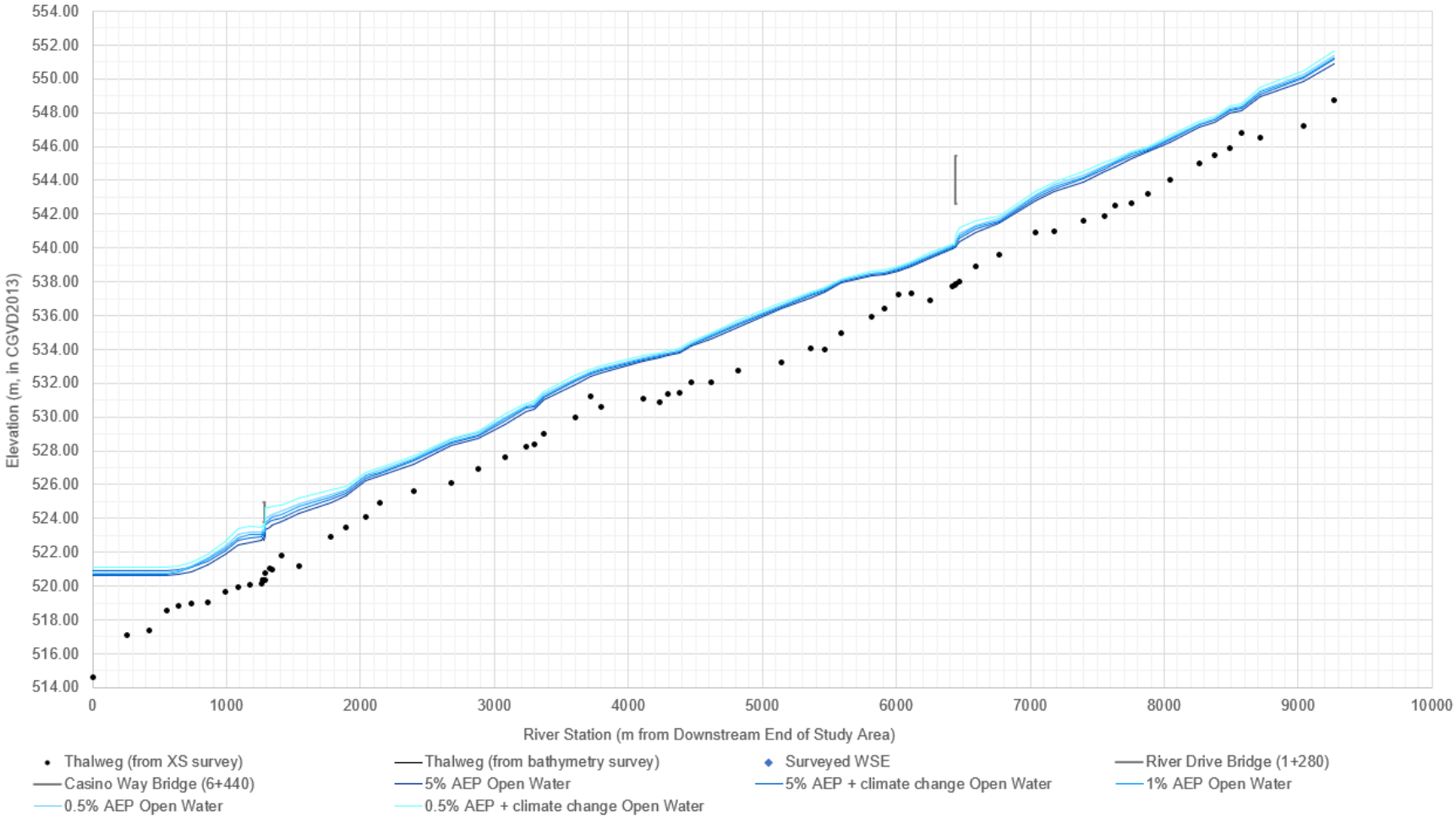


Figure 7-16 Nordenskiold River WSE Profiles for Open Water Nordenskiold River Primary Runs

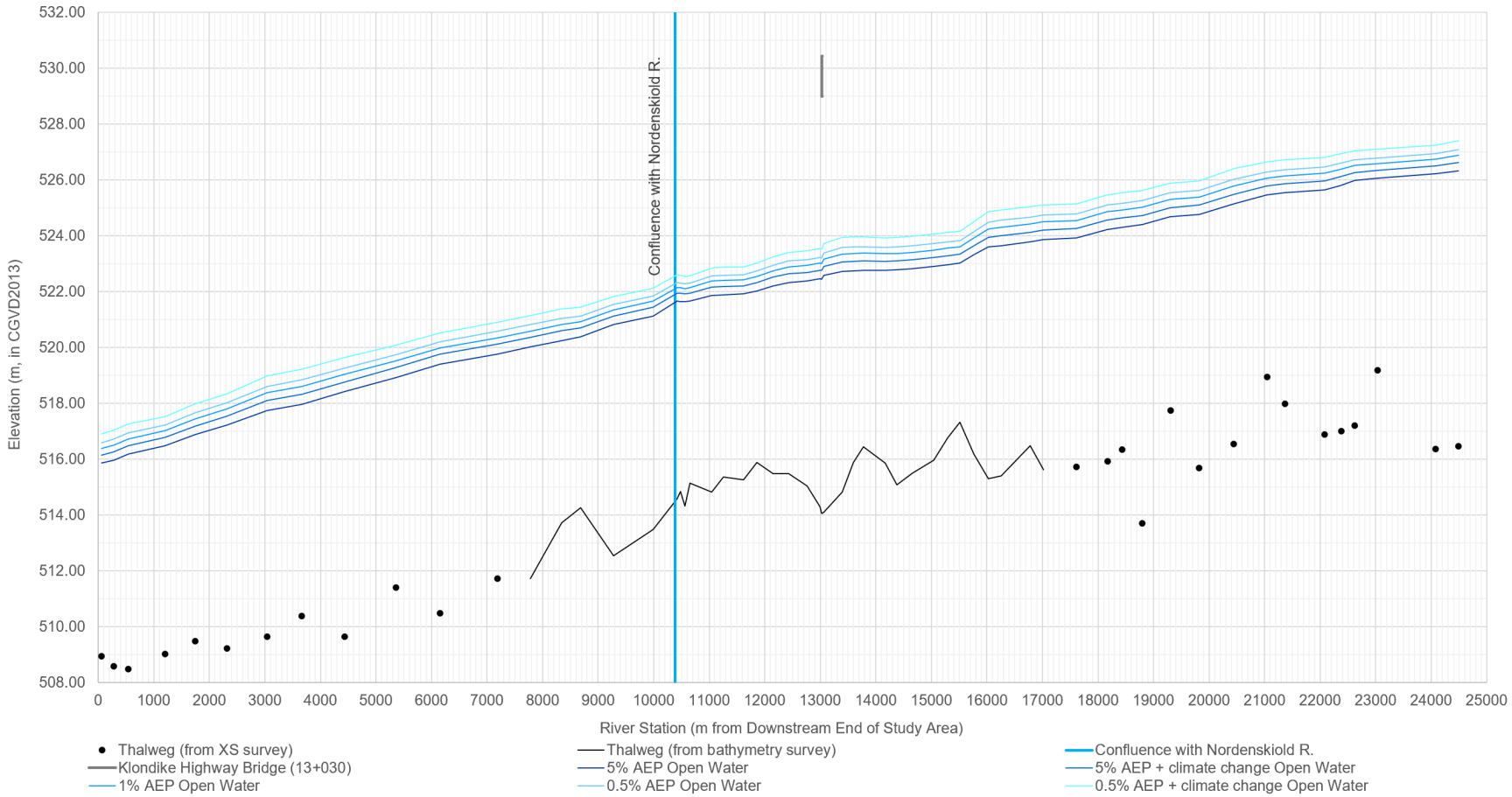


Figure 7-17 Yukon River WSE Profiles for Open Water Yukon River Primary Runs

7.3.4 Sensitivity Analysis

A total of six sensitivity analysis runs considering the 0.5% AEP open water design flows were completed to evaluate the sensitivity of the Nordenskiold River and Yukon River open water WSEs to main channel and floodplain Mannings n, as well as the downstream boundary condition of the model (Yukon River normal depth energy slope) on the Yukon River WSEs:

1. Sensitivity of Nordenskiold River WSEs to increasing main channel and floodplain Mannings n by 10%, considering the 0.5% AEP open water Nordenskiold River Primary run flows
2. Sensitivity of Nordenskiold River WSEs to decreasing main channel and floodplain Mannings n by 10%, considering the 0.5% AEP open water Nordenskiold River Primary run flows
3. Sensitivity of Yukon River WSEs to increasing main channel and floodplain Mannings n by 10%, considering the 0.5% AEP open water Yukon River Primary run flows
4. Sensitivity of Yukon River WSEs to decreasing main channel and floodplain Mannings n by 10%, considering the 0.5% AEP open water Yukon River Primary run flows
5. Sensitivity of Yukon River WSEs to increasing the Yukon River normal depth energy slope by 50% used for the downstream boundary condition, considering the 0.5% AEP open water Yukon River Primary run flows
6. Sensitivity of Yukon River WSEs to decreasing the Yukon River normal depth energy slope by 50% used for the downstream boundary condition, considering the 0.5% AEP open water Yukon River Primary run flows

The results of the sensitivity analysis were used to quantify the level of uncertainty associated with the simulated flood levels in the Study Area. Table 7-8 provides WSE summary statistics for the six open water sensitivity analysis runs. Figure 7-18 illustrates profiles of the changes to WSE in each of the open water sensitivity runs for the Nordenskiold River. Figure 7-19 illustrates profiles of the changes to WSE in each of the open water sensitivity runs for the Yukon River.

The results of the open water sensitivity analysis indicate that the uncertainty in the simulated flood levels, on average, is within ± 0.08 m along the Nordenskiold River and ±0.29 m along the Yukon River for the ±10% changed in Mannings n. Maximum difference in WSE values were at the Nordenskiold downstream end because of the backwater effects from Yukon River (see Figure 7-18). The results of downstream boundary sensitivity analysis specify that the uncertainty in WSE changes between -0.59 m (for +50% change in downstream boundary condition) and 1.13 m (for -50% change in downstream boundary condition) shown in Figure 7-19. The changes in downstream boundary condition could propagate upstream in the Yukon River and impact the WSEs by ± 0.02 m at the confluence and 600 m downstream of the Nordenskiold River).

Sensitivity analysis of the downstream boundary condition of the model (Yukon River normal depth energy slope) on the Nordenskiold River WSEs was not completed because as described above, the WSE profile from Yukon River normal depth energy slope sensitivity runs was within 0.02 m of the base run at the confluence with the Yukon River.

Table 7-8 Open Water Sensitivity Analysis Summary Statistics

River	Nordenskiold River	Nordenskiold River	Yukon River	Yukon River	Yukon River	Yukon River
AEP Design Flow	0.5% AEP Open Water Nordenskiold River Primary	0.5% AEP Open Water Nordenskiold River Primary	0.5% AEP Open Water Yukon River Primary	0.5% AEP Open Water Yukon River Primary	0.5% AEP Open Water Yukon River Primary	0.5% AEP Open Water Yukon River Primary
Sensitivity Run	Nordenskiold River Main Channel Mannings n + 10%	Nordenskiold River Main Channel Mannings n - 10%	Yukon River Main Channel Mannings n + 10%	Yukon River Main Channel Mannings n - 10%	Downstream Boundary Normal Depth Energy Slope + 50%	Downstream Boundary Normal Depth Energy Slope - 50%
Average WSE Differential (m)	0.08	-0.08	0.28	-0.29	-0.06	0.13
Minimum WSE Differential (m)	0.01	-0.26	0.23	-0.37	-0.61	0.00
Maximum WSE Differential (m)	0.26	0.11	0.35	-0.23	0.00	1.17

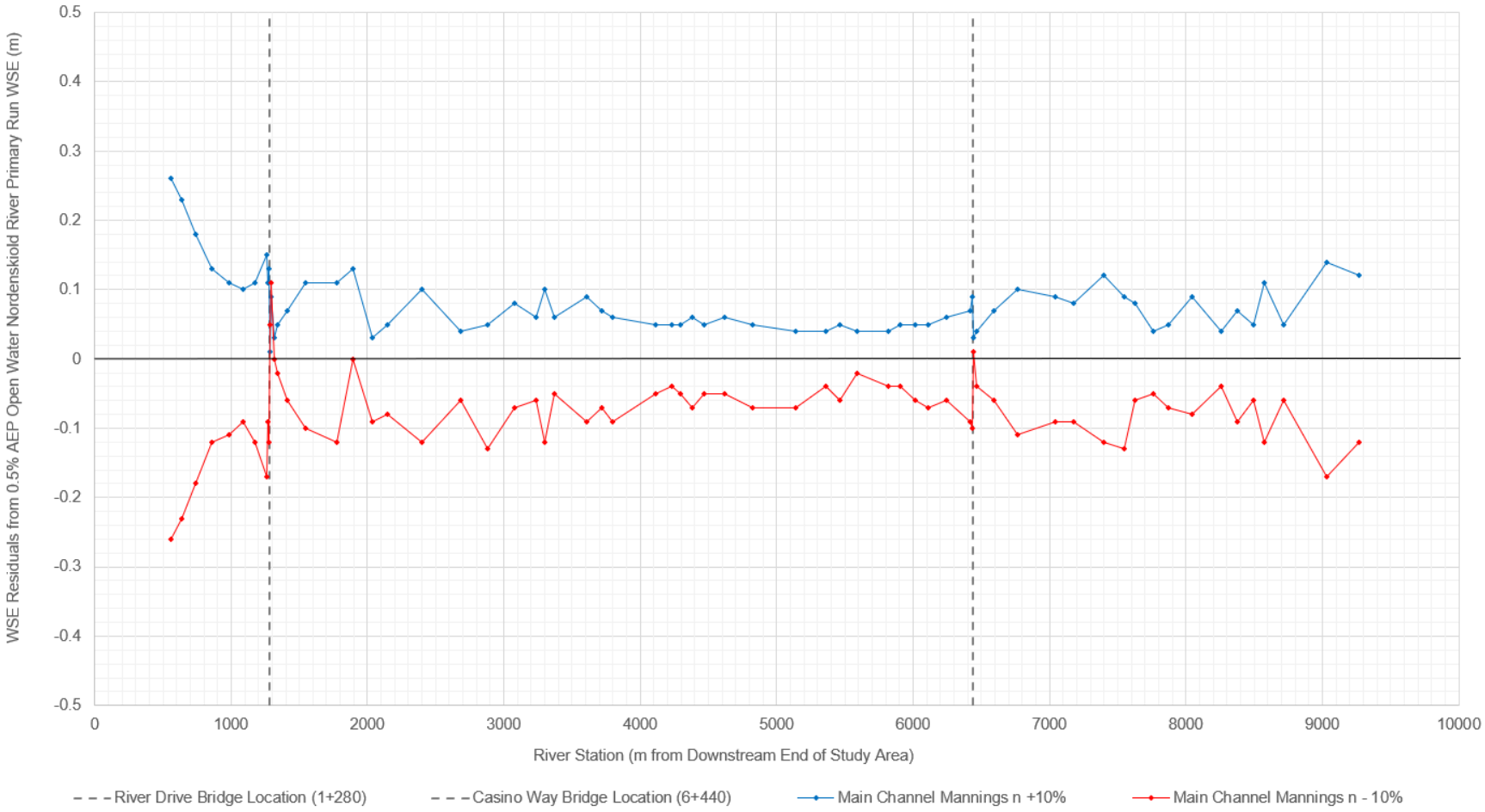


Figure 7-18 Nordenskiold River Open Water Sensitivity Analysis

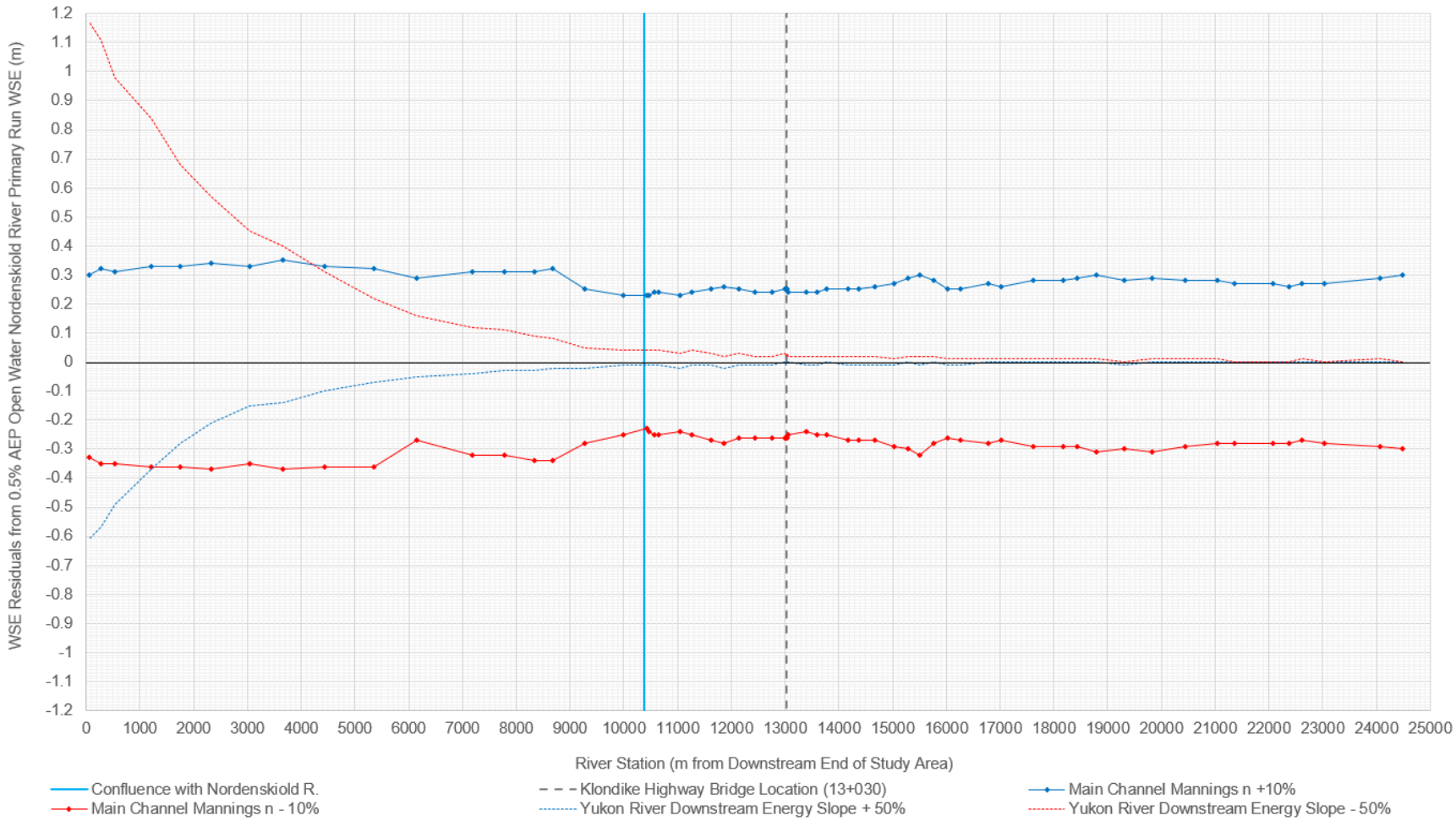


Figure 7-19 Yukon River Open Water Sensitivity Analysis

7.4 Breakup Ice Jam Modelling

7.4.1 Nordenskiold River

7.4.1.1 Boundary Conditions

The upstream boundary condition for the Nordenskiold River ice jam hydraulic model runs was the flow specified for the run. The downstream boundary condition for the Nordenskiold River ice jam hydraulic model runs was the modelled WSE of the Yukon River under ice covered conditions at the junction (Yukon River station 10+381), using the paired flow in the Yukon River for the Nordenskiold River run being completed. An ice cover of 1.2 m (considered a reasonable average based on ice thickness observations detailed in Section 2.2.3) and an ice cover roughness of 0.05 was used for the Yukon River across all Nordenskiold River ice jam runs. Ice covered conditions during Nordenskiold River breakup ice jam runs was considered reasonable for modelling purposes given that the Nordenskiold River typically breaks up two to three weeks before the Yukon River.

7.4.1.2 Model Calibration

The April 22, 2020 ice jam event detailed in Section 6.4.3.1 was used for calibration of breakup ice jams on the Nordenskiold River. Flow in the Nordenskiold River during the April 22, 2020 breakup ice jam was estimated to be 50.1 m^3/s (Section 6.4.3.1; personal communication, B. Turcotte, March 3, 2024). The flow in the Yukon River upstream of the confluence on April 22, 2020 was estimated to be 742 m^3/s (GoC 2024a).

The ice jam calibration considered the bed roughness values from the open water calibration (Section 7.3.1.2). The calibration breakup jam in HEC-RAS adopted the following based on jam observations detailed in Section 2.1.4 and Section 6.4.3.1:

- Toe of jam at cross-section 0+738 and head of jam at cross-section 1+088. For the cross-sections between the toe and the head of the jam (0+738, 0+859, 0+987, and 1+088), the model considered breakup jams in the main channel and ice cover (no jam) in the overbank with a thickness of 0.3 m. Overbank ice cover (and not jamming) was considered reasonable for the Nordenskiold River given the floodplain conveyance (which may include ice) that has been observed during jam events.
- Ice-free conditions upstream of cross-section 1+088.
- Ice cover (thickness of 0.6 m in main channel and 0.3 m in overbank) from cross-section 0+641 to the confluence with the Yukon River.
- Yukon River flow under ice assuming ice cover roughness of 0.050 and ice cover thickness of 1.2 m (note: this resulted in Yukon River WSEs within its banks which is considered reasonable for the April 22, 2020 event).
- Other ice jam parameters used for the ice jam model runs are based on typical values in alignment with USACE (2023) and Beltaos et al. (2013):
  - Ice Cover Specific Gravity: 0.916

- Internal Friction Angle: 45 degrees
- Ice Jam Porosity (fraction water filled): 0.4
- Coefficient K1 (lateral to longitude stress in jam): 0.33
- Maximum Mean Velocity (under ice cover): 4 m/s

The calibrated ice jam parameters were the ice jam roughness and the ice cover roughness in the main channel and in the overbank. The ice jam roughness was calibrated to be 0.100 in the main channel. The ice cover roughness was calibrated to be 0.100 in the main channel and 0.100 in the overbank in Nordenskiold River.

Comparison of surveyed and calibrated model elevations are provided in Table 7-9, including WSE Differentials as a value (in m) and as a percentage of the average thalweg depth in the calibration run between the confluence and the River Drive bridge. The WSE and ice profile of the final calibration are illustrated in Figure 7-20.

The calibrated ice jam and ice cover roughness values are within the ranges provided in the USACE (2023) and Beltaos et al. (2013) for the ice jams formed by the blocks of sheet ice. The simulated WSE has relatively low differential, particularly for the observed WSEs. Ice scars are all below the simulated peak WSE which supports model validity; it is considered unlikely to have ice scars consistently above the peak WSE. Based on the relatively low WSE differentials and acknowledging that ice jam modelling has inherent uncertainties due to available data, measurements, and modelling limitations, the calibration detailed herein is considered reasonable for use in this Project given the information available to Stantec at the time of writing.

Table 7-9 Nordenskiold River Breakup Ice Jam Calibration Run Surveyed and Modelled Elevations

Point Description	River Station (m from Downstream End of Reach)	Surveyed Elevation (m)	Modelled Elevation (m)	WSE Differential (m)	Residual (% of Average Thalweg Depth between Confluence and River Drive Bridge)
Peak WSE HWM at private residence on river right	915	522.93	523.01	0.08	2.7%
Peak WSE HWM downstream of River Drive bridge	1255	522.95	523.15	0.20	6.8%

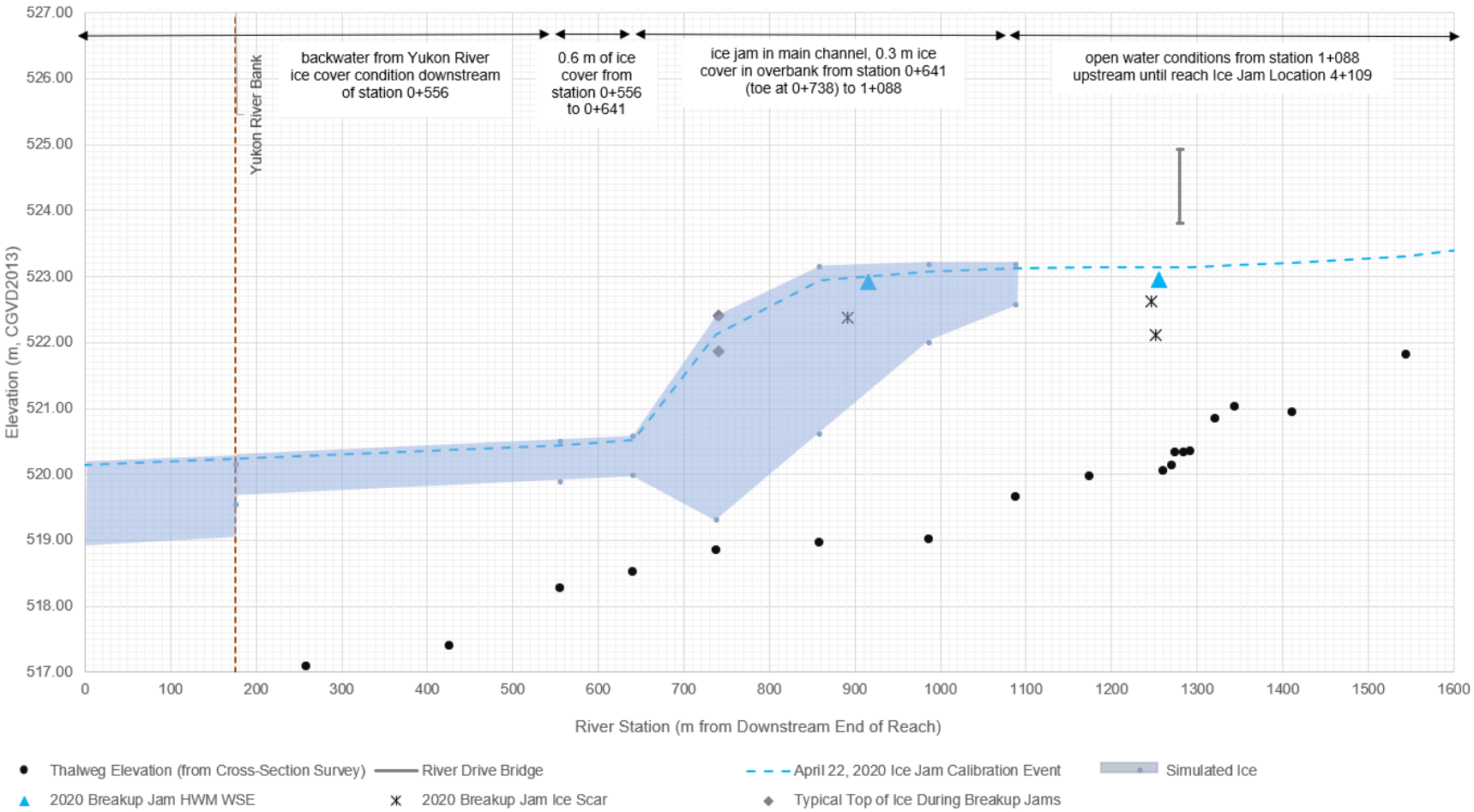


Figure 7-20 Nordenskiold River Breakup Ice Jam Calibration (April 22, 2020 Event)

7.4.1.3 Model Validation

Flow and WSE data for an ice jam hydraulic model validation run on the Nordenskiold River was not available for this Project and validation could therefore not be completed. A sensitivity analysis of key model parameters was completed in Section 7.4.4.

7.4.2 Yukon River

Ice jam hydraulic modelling was not completed for the Yukon River because ice jams were not identified as a dominant flood process on the Yukon River (Section 2.2.5).

7.4.3 Design AEP Model Runs

The design AEP modelling considered documented locations of breakup ice jams.

Ice Jam Location 9+269 is at the upstream extent of the LiDAR data available for this Project, and within 700 m of the upstream end of the Study Area. Due to the lack of overbank elevation data (LiDAR or equivalent) upstream of Ice Jam Location 9+269 which meets the standards required for flood mapping (CQL1, per NRCan 2019b and NRCan 2022), modelling and mapping of an ice jam at Ice Jam Location 9+269 was not possible in this Project.

The remaining three breakup ice jam locations identified in Section 2.1 (Ice Jam Location 0+740, 4+109, and 6+016) were modelled independently (separate runs) with the following characteristics, each of which are consistent with what was observed and/or calibrated in the April 22, 2020 event at Ice Jam Location 0+740:

- Ice jam toe locations as identified in Section 2.1.
- Ice jam head location approximately 325 – 510 m upstream of the toe.
- Open water conditions upstream of the ice jam head location.
- Ice cover for two cross-sections (180 – 386 m) downstream of the toe (considered reasonable representation of transition from jam to downstream open water).
- No ice conditions downstream of the aforementioned ice cover.
- For cross-sections with no ice: Mannings n as calibrated in Section 7.3.1.2.
- For cross-sections designated as ice cover: Mannings n as calibrated in Section 7.4.1.2; ice thickness of 0.6 m in the main channel and 0.3 m in the overbank.
- For cross-sections designated as having ice jam: Mannings n as calibrated in Section 7.4.1.2, ice jam in main channel and ice cover (thickness of 0.3 m) in the overbank.

Using the above characteristics, each of the three breakup ice jams (Ice Jam Location 0+740, 4+109, and 6+016) were modelled for each of the breakup ice jam design AEP runs from Table 7-1. Results of each of the model runs are provided in tabular format in Appendix D. Figure 7-21 illustrates the breakup ice jam WSE profiles in the Nordenskiold River for each of the breakup ice jam AEP runs.

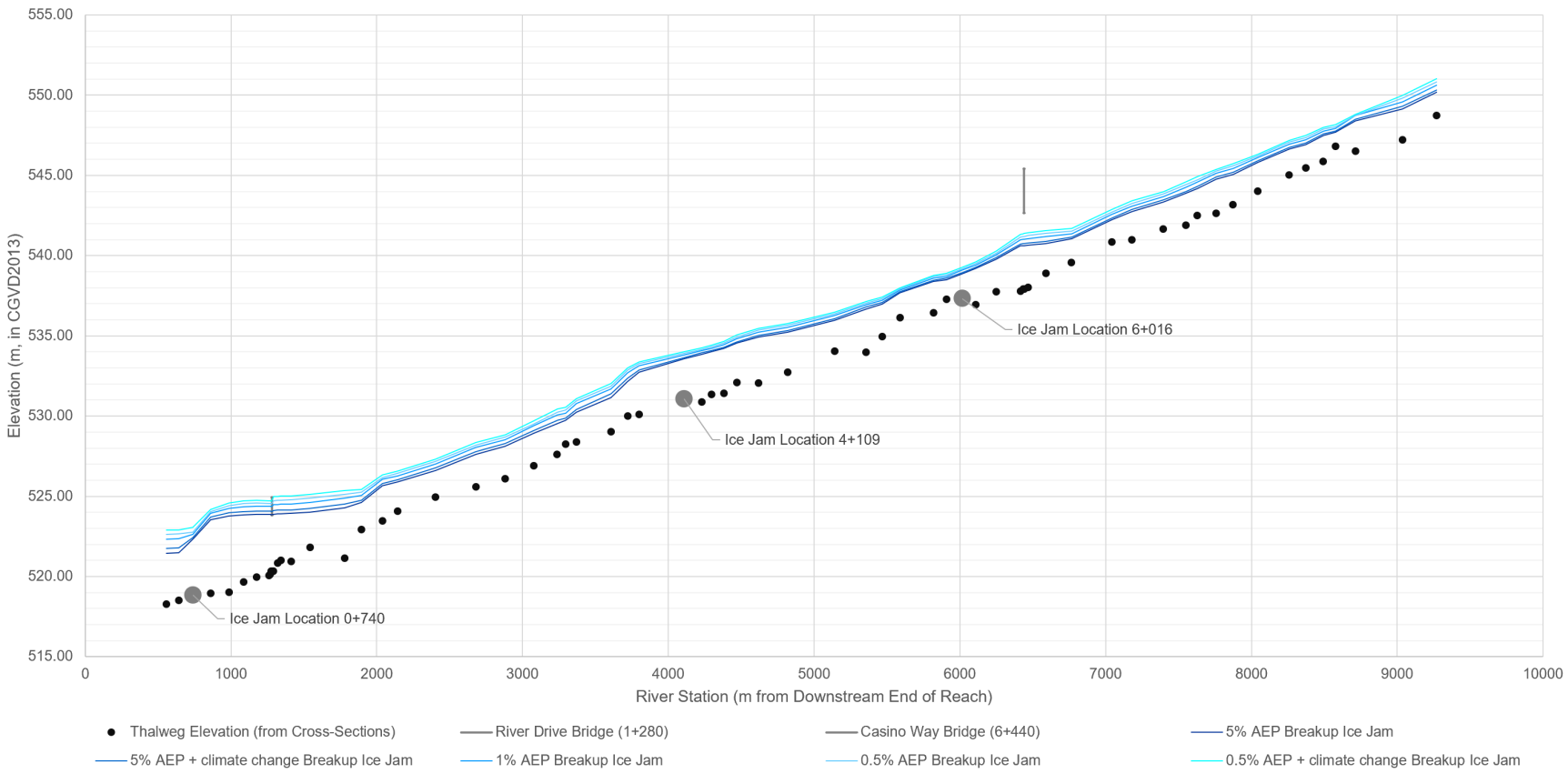


Figure 7-21 Nordenskiold River WSE Profiles for Breakup Ice Jam Runs

7.4.3.1 Ice Jam Volumes

The 1D HEC-RAS ice jam model estimates an ice jam volume for each design scenario while assuming an adequate supply of upstream ice is available to be transported to the jam location for its formation. Considering an ice thickness of 0.6 m across the main channel of the Nordenskiold River and an average Nordenskiold River channel width (with ice) of 15 m, the upstream length of river required to produce the HEC-RAS produced ice jam volume estimates were calculated:

- Ice Jam Location 0+740 requires approximately 1700 to 2200 m of ice to be transported downstream to supply the estimated ice jam volumes for the 5% to 0.5% + climate change AEPs.
- Ice Jam Location 4+109 requires approximately 2200 to 3200 m of ice to be transported downstream to supply the estimated ice jam volumes for the 5% to 0.5% + climate change AEPs.
- Ice Jam Location 6+016 requires approximately 1500 to 1900 m of ice to be transported downstream to supply the estimated ice jam volumes for the 5% to 0.5% + climate change AEPs.

Given that the required ice cover river lengths are within the total lengths of the Nordenskiold River (tens of km), the above analysis suggests that ice supply is unlikely to be a limiting factor for the breakup ice jams being simulated in this Project.

7.4.4 Sensitivity Analysis

A total of four sensitivity analysis runs were completed to evaluate the sensitivity of the model to overbank ice cover thickness and ice jam/ice cover roughness:

1. Sensitivity of Nordenskiold River WSEs to increasing overbank ice cover thickness by 0.2 m in cross-sections 0+738, 0+859, 0+987, and 1+088, considering the 0.5% AEP Nordenskiold River Breakup Ice Jam flows.
2. Sensitivity of Nordenskiold River WSEs to decreasing overbank ice cover thickness by 0.2 m in cross-sections 0+738, 0+859, 0+987, and 1+088, considering the 0.5% AEP Nordenskiold River Breakup Ice Jam flows.
3. Sensitivity of Nordenskiold River WSEs to increasing ice jam and ice cover roughness by 10% in cross-sections 0+738, 0+859, 0+987, and 1+088, considering the 0.5% AEP Nordenskiold River Breakup Ice Jam flows.
4. Sensitivity of Nordenskiold River WSEs to decreasing ice jam and ice cover roughness by 10% in cross-sections 0+738, 0+859, 0+987, and 1+088, considering the 0.5% AEP Nordenskiold River Breakup Ice Jam flows.

Sensitivity analysis of the downstream boundary condition of the model (Yukon River normal depth energy slope) on the Nordenskiold River WSEs during the ice jam scenarios was not completed because as described in Section 7.3.4, the WSE profile from the Yukon River normal depth energy slope sensitivity runs was within 0.02 m of the base run at the confluence which was considered represent a minimal effect on the Nordenskiold River hydraulics.

The effect of the breakup ice jam at Ice Jam Location 0+740 are limited to Nordenskiold River station 0+556 to station 1+895; the sensitivity analysis was evaluated for this portion of the Nordenskiold River only (upstream WSEs were not affected by the jam). Table 7-10 provides WSE summary statistics for each of the four breakup jam sensitivity analysis runs. Figure 7-22 illustrates the WSE profiles of the Nordenskiold River from Station 0+556 to 1+895 for the four sensitivity analysis runs.

The results of the breakup ice jam sensitivity analysis indicate that the uncertainty in the simulated flood levels, on average, is within ±0.12 m along the Nordenskiold River where the ice jam occurs and upstream of the jam head (Figure 7-22).

Table 7-10 Nordenskiold River Ice Jam Sensitivity Analysis Summary Statistics between Nordenskiold River Station 0+556 and Station 1+895

Design AEP Flows	0.5% AEP Breakup Ice Jam	0.5% AEP Breakup Ice Jam	0.5% AEP Breakup Ice Jam	0.5% AEP Breakup Ice Jam
Sensitivity Run	Overbank Ice Thickness + 0.2 m	Overbank Ice Thickness - 0.2 m	Ice Jam and Ice Cover Roughness + 10%	Ice Jam and Ice Cover Roughness - 10%
Average WSE Differential (m)	0.12	-0.12	0.06	-0.06
Minimum WSE Differential (m)	0.02	-0.19	0.00	-0.09
Maximum WSE Differential (m)	0.16	0.02	0.08	0.00

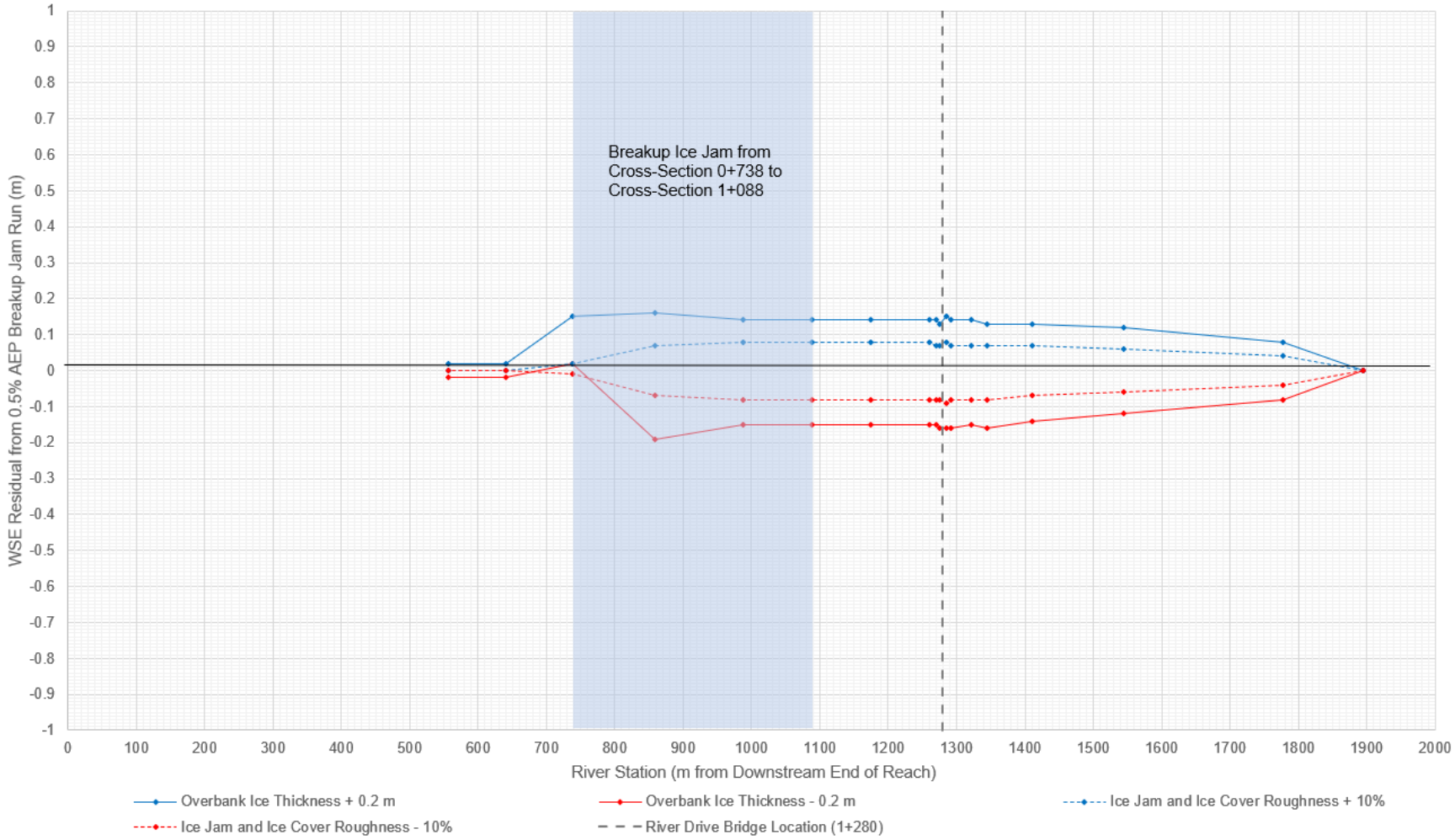


Figure 7-22 Nordenskiold River Ice Jam Sensitivity Analysis for Ice Jam Location 0+740

7.5 Composite Flood Hazard Maps

The result of the design AEP model runs described above were three separate runs within each AEP: i) a Nordenskiold River breakup ice jam run, ii) a Nordenskiold River primary open water run, and iii) a Yukon River primary open water run. Manual edits using 2D hydraulic model domains (Figure 7-2) were completed to refine and confirm flood inundations where the results at cross-sections were unable to accurately reflect inundation extents within each of the 1D model runs.

For each design AEP event (i.e., the 5% AEP, 5% AEP + climate change, 1% AEP, 0.5% AEP, and 0.5% AEP + climate change), the three separate model runs were overlain to create a composite flood hazard inundation and WSE surface for that design AEP. The resulting composite design AEP inundations were considered representative of the overall flood hazard extent for the AEP. The separate model runs of flood processes and subsequent data overlay means that the entirety of the composite design AEP inundation is unlikely to occur in a single event.

The composite flood hazard maps for each of the AEP design events are provided in Appendix E. The composite flood hazard maps indicate a single inundation extent for each AEP design event, but also identify the extent of the open water versus breakup ice jam flooding within that overall inundation extent. At the request of YG, the 50% AEP open water flow inundation extents (produced through separate model runs) is shown on the composite flood hazard maps for context.

7.6 Inundated Infrastructure and Special Areas of Interest

This section provides additional detail on the flood hazards at locations in the Study Area that are of interest to YG, VoC, and/or LS/CFN.

7.6.1 Robert Campbell Highway (Yukon River)

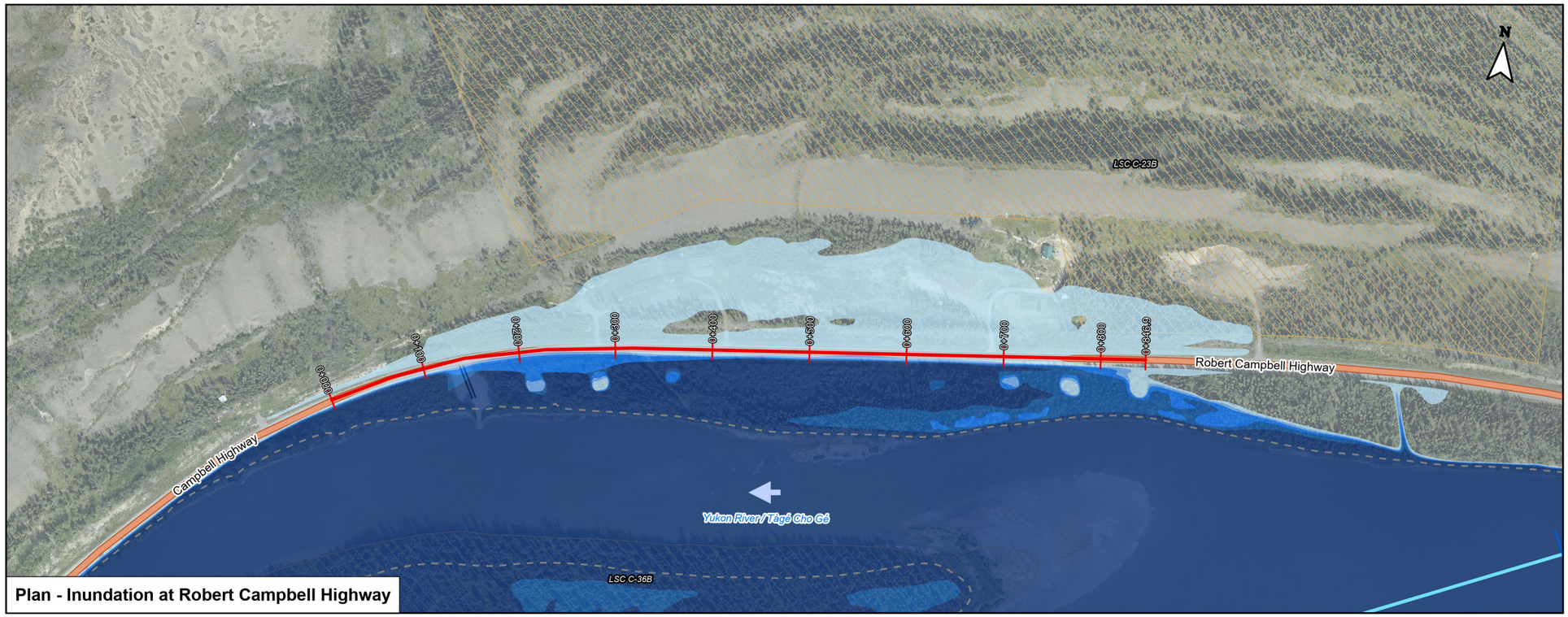
Figure 7-23 provides a plan and profile for inundation along the Robert Campbell Highway. The approximate lengths and maximum depths of inundation for each of the design AEP events are summarized in Table 7-11.

Table 7-11 Approximate Inundation Lengths and Maximum Depths at Robert Campbell Highway

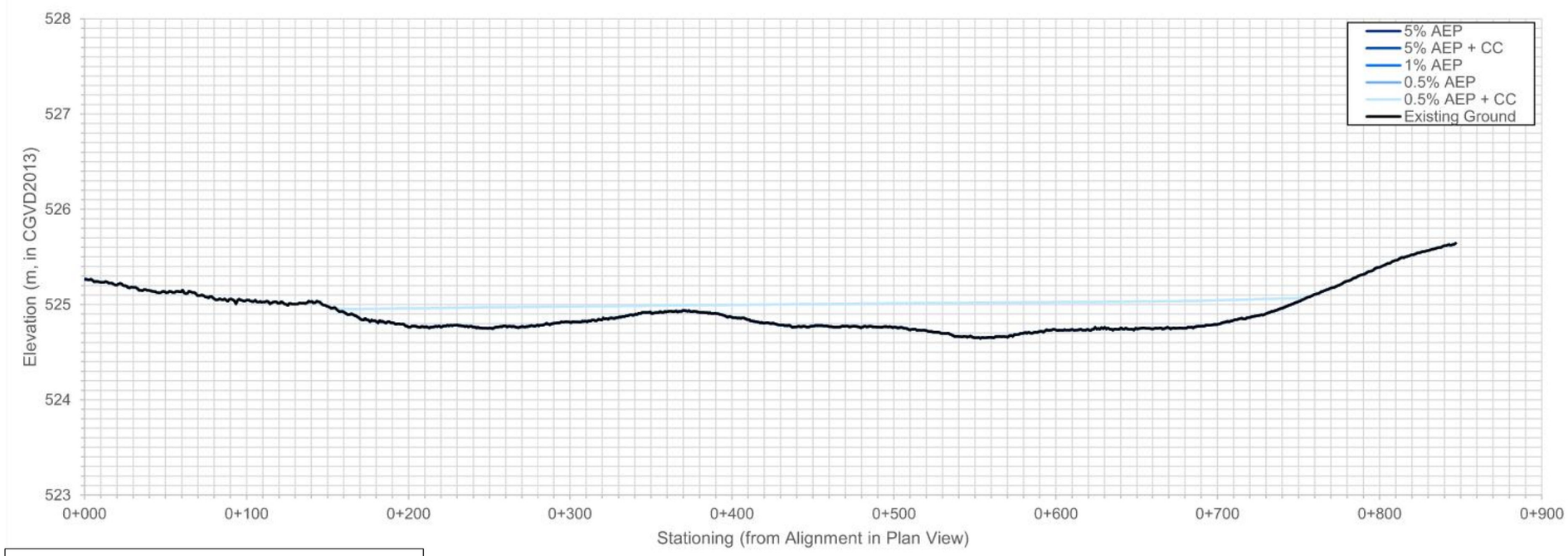
AEP Design Event	Approximate Width of Inundation along Alignment in Figure 7-23 (m)	Maximum Depth within Inundation (m)
5% AEP	N/A	N/A
5% AEP + climate change	N/A	N/A
1% AEP	N/A	N/A
0.5% AEP	N/A	N/A
0.5% AEP + climate change	600	0.35

The inundation at the Robert Campbell Highway is due to open water flood scenarios on the Yukon River. The Robert Campbell Highway inundation is on the outer bend of the Yukon River and is therefore likely to be subject to erosion hazards.

If the Robert Campbell Highway was inundated, vehicles could no longer use the highway. Access to the communities of Faro and Ross River would not be possible from Carmacks; vehicle access to these communities would need to be via the South Canol Road and/or Robert Campbell Highway from the southwest, which is a longer travel route on rougher road conditions (the majority of the South Canol Road and Robert Campbell Highway along this route is dirt road). Erosion hazards may pose structural risks to the highway; if the highway was damaged or lost, access would be restricted until the highway could be repaired or rebuilt.



Plan - Inundation at Robert Campbell Highway



Profile - Inundation at Robert Campbell Highway

Figure No.

7.23

Title: **Composite Flood Hazard Extent Plan and Profile Robert Campbell Highway**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

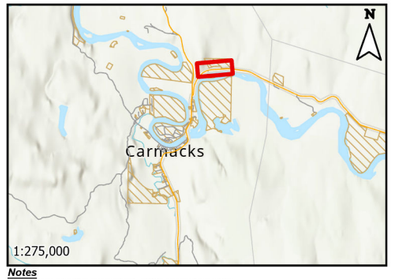
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

7.6.2 Klondike Highway (north of Carmacks, Yukon River)

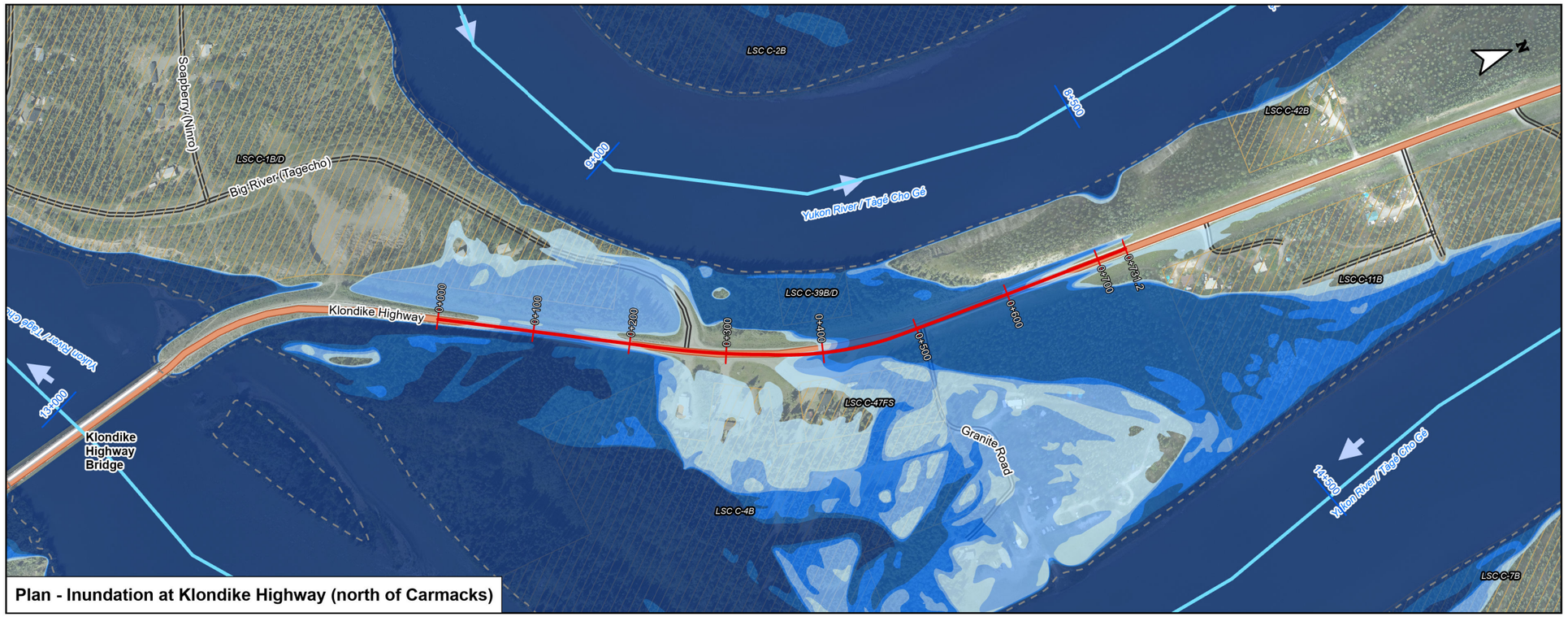
Figure 7-24 provides a plan and profile for inundation along the Klondike Highway north of Carmacks. Figure 7-25 provides a plan and profile for the inundation at the Klondike Highway north of Carmacks along the low point of the spill pathway across the isthmus of the meander bend, over the highway. The approximate lengths and maximum depths of inundation along the Klondike Highway for each of the design AEP events are summarized in Table 7-12.

Table 7-12 Approximate Inundation Lengths and Maximum Depths at Klondike Highway (north of Carmacks)

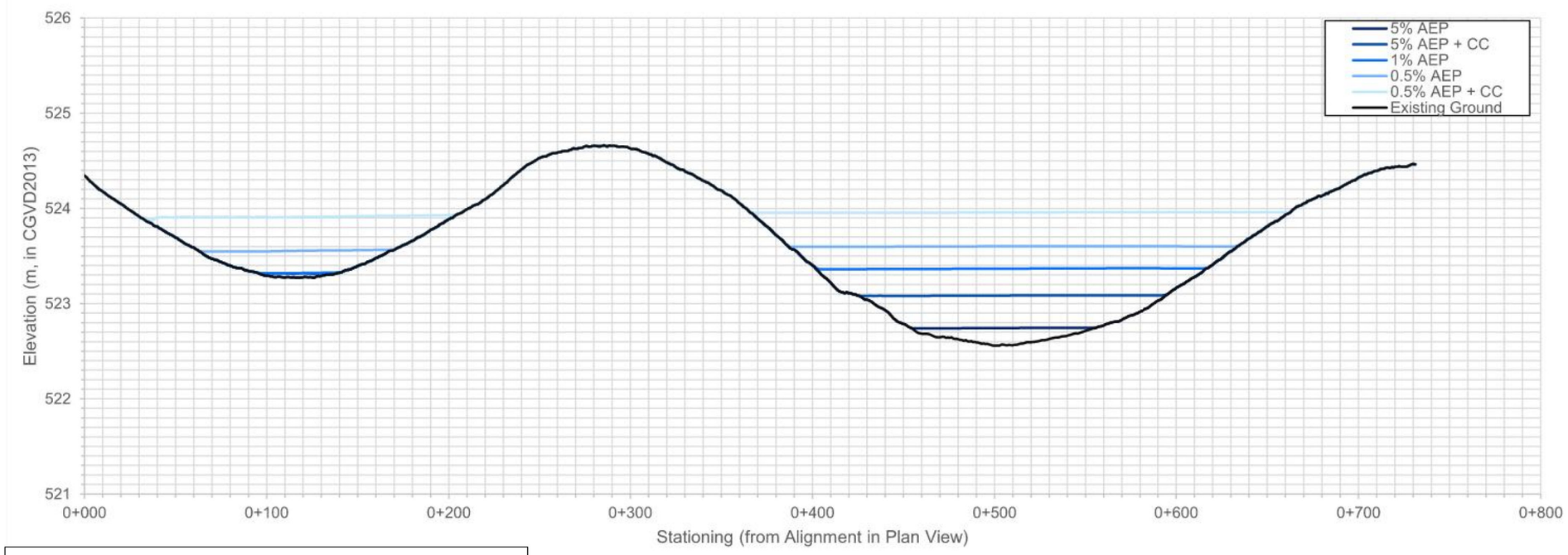
AEP Design Event	Klondike Highway (north of Carmacks) – south low point		Klondike Highway (north of Carmacks) – north low point	
	Approximate Width of Inundation along Alignment in Figure 7-24 (m)	Maximum Depth within Inundation (m)	Approximate Width of Inundation along Alignment in Figure 7-25 (m)	Maximum Depth within Inundation (m)
5% AEP	N/A	N/A	95	0.18
5% AEP + climate change	N/A	N/A	175	0.55
1% AEP	35	0.05	220	0.75
0.5% AEP	100	0.25	245	1.00
0.5% AEP + climate change	165	0.60	290	1.35

As illustrated in Figure 7-25, the banks of the Yukon River are higher than the low point(s) in the Klondike Highway. This means that once the banks of the Yukon River are breached, water would infill the low point flow pathway westwards and cause water to overtop of the highway. The WSEs in comparison to the bank spill elevation will not be directly observable from the highway. The inundation and overtopping of the highway are likely to happen quickly once the Yukon River banks are breached.

Once over the highway, water would be conveyed down the embankment back into the Yukon River, cutting off approximately 5.5 km of longitudinal channel length. This inundation flow pathway and energy gradient on the downstream side of the highway represents a substantial erosion and stability hazard to the highway, and a substantial avulsion and stability hazard for the Yukon River. The erosion may cause the highway to be lost, meaning vehicular access to communities north of Carmacks (Ross River, Faro, Pelly Crossing, Stewart Crossing, Dawson City) would be substantially longer until the highway was rebuilt, via the South Canol Road and/or Robert Campbell Highway from the southwest. This is a longer travel route on rougher road conditions (the majority of the South Canol Road and Robert Campbell Highway along this route is dirt road). The inundation and subsequent erosion may mean the Yukon River main channel would shift across the isthmus of the meander bend in a meander bend cutoff which would bypass 5.5 km of the Yukon River through Carmacks centre. An avulsion of this significance is likely to induce a cascade of changes to channel morphology and stability (erosion, sedimentation, channel migration) for an undetermined length of the Yukon River both upstream and downstream of Carmacks.



Plan - Inundation at Klondike Highway (north of Carmacks)



Profile - Inundation at Klondike Highway (north of Carmacks)

Figure No.

7.24

Title: **Composite Flood Hazard Extent Plan and Profile Klondike Highway (north of Carmacks)**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

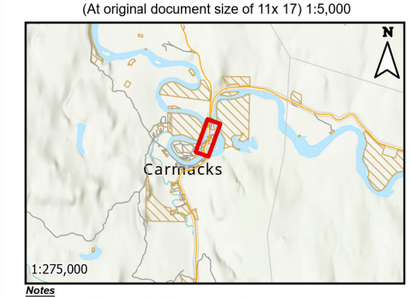
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

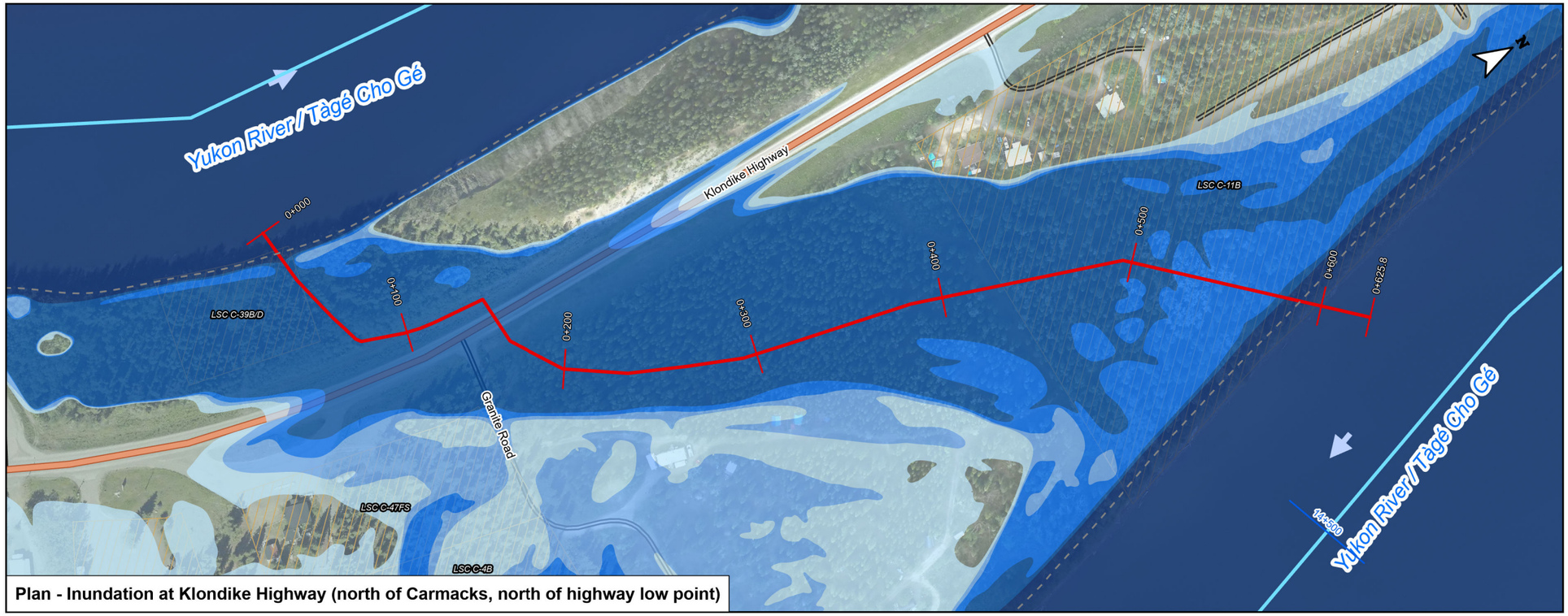
Stantec

Yukon

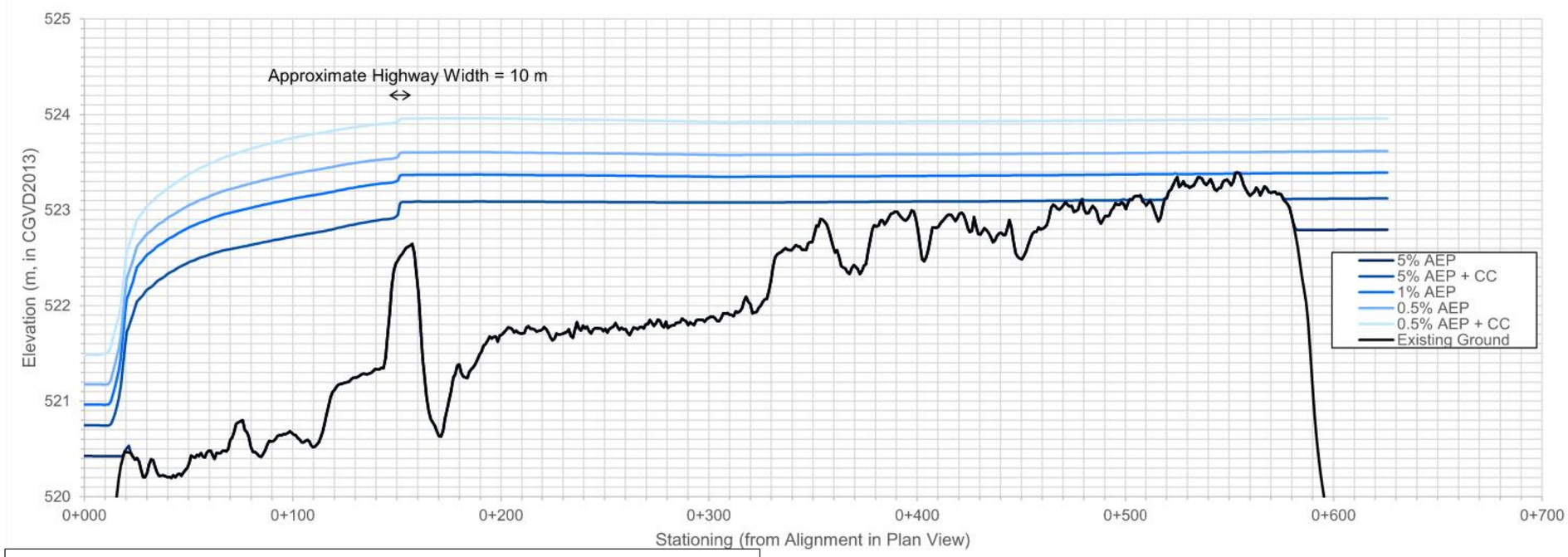
This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson



Plan - Inundation at Klondike Highway (north of Carmacks, north of highway low point)



Profile - Inundation at Klondike Highway (north of Carmacks, north of highway low point)

Figure No.

7.25

Title: **Composite Flood Hazard Extent Plan and Profile Klondike Highway (north of Carmacks, north of highway low point)**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

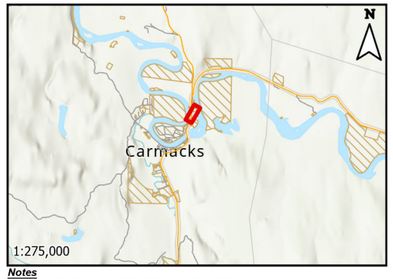
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 20 40 60 80 100 m

(At original document size of 11x 17) 1:2,500



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

Yukon

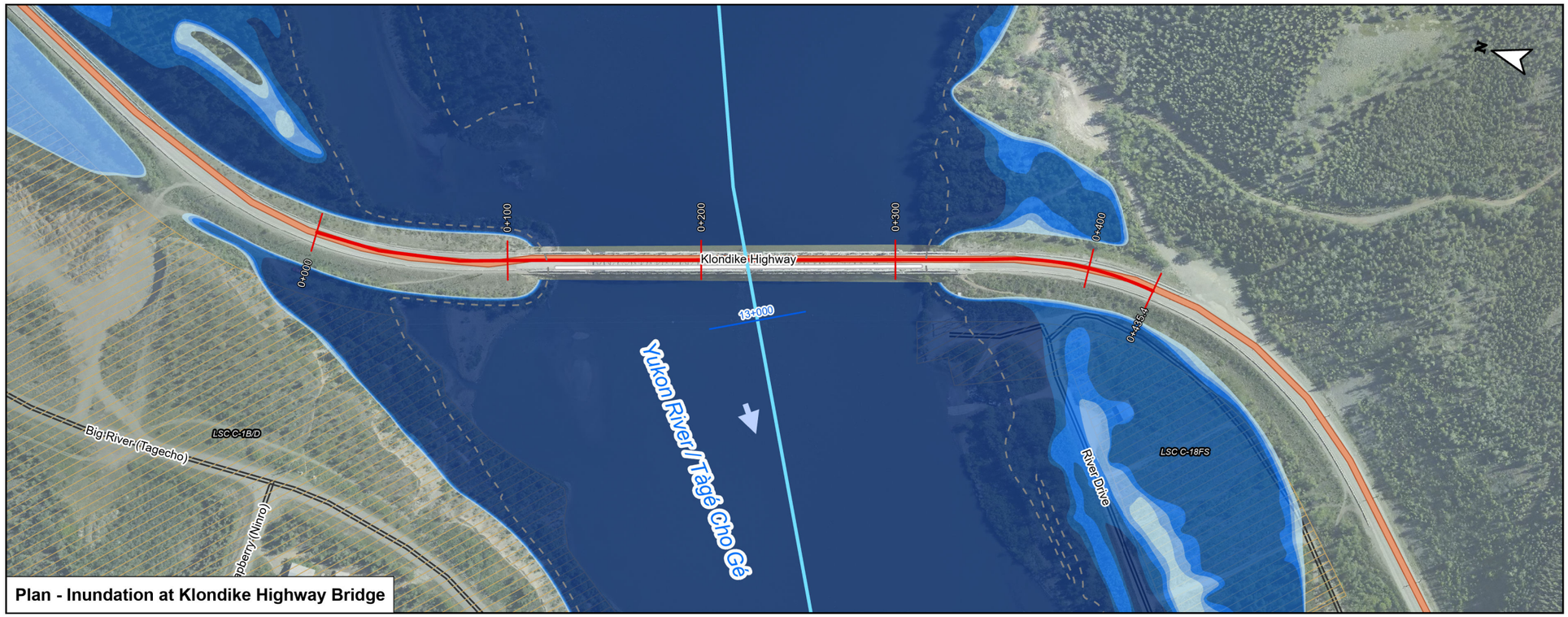
This project is funded in part by the Government of Canada Canada

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

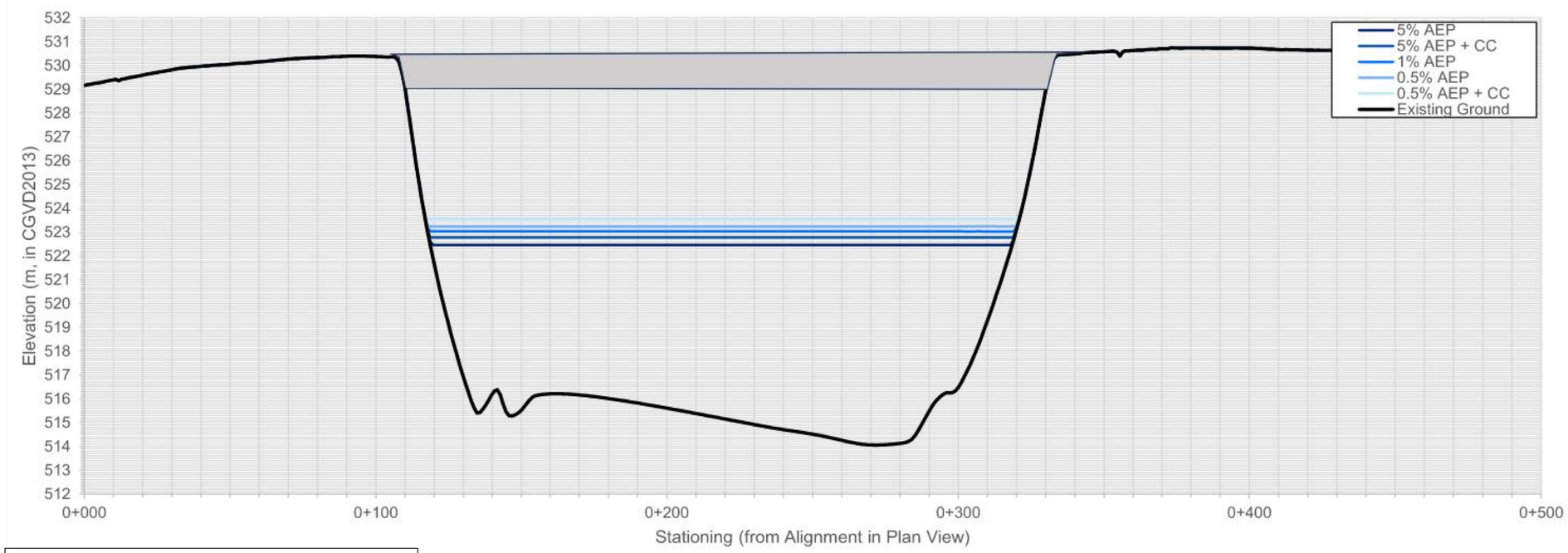
Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

7.6.3 Klondike Highway Bridge (Yukon River)

Figure 7-26 provides a plan and profile of WSEs at the Klondike Highway Bridge. None of the design AEP events contact the deck or overtop the bridge; the highest design AEP WSE (approximately 523.40 under the 0.5% AEP + climate change) has a soffit clearance of approximately 5.80 m.



Plan - Inundation at Klondike Highway Bridge



Profile - Inundation at Klondike Highway Bridge

Figure No.

7.26

Title: **Composite Flood Hazard Extent Plan and Profile Klondike Highway Bridge**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

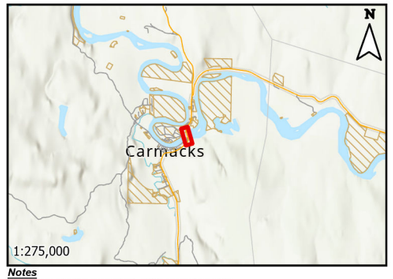
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 20 40 60 80 100 m

(At original document size of 11x 17) 1:2,500



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

7.6.4 River Drive in Carmacks Centre (Yukon River and Nordenskiold River)

Figure 7-27 through Figure 7-30 provide plan and profile for inundation on River Drive in Carmacks Centre. The approximate lengths and maximum depths of inundation along River Drive for each of the design AEP events are summarized in Table 7-13.

Table 7-13 Approximate Inundation Lengths and Maximum Depths on River Drive

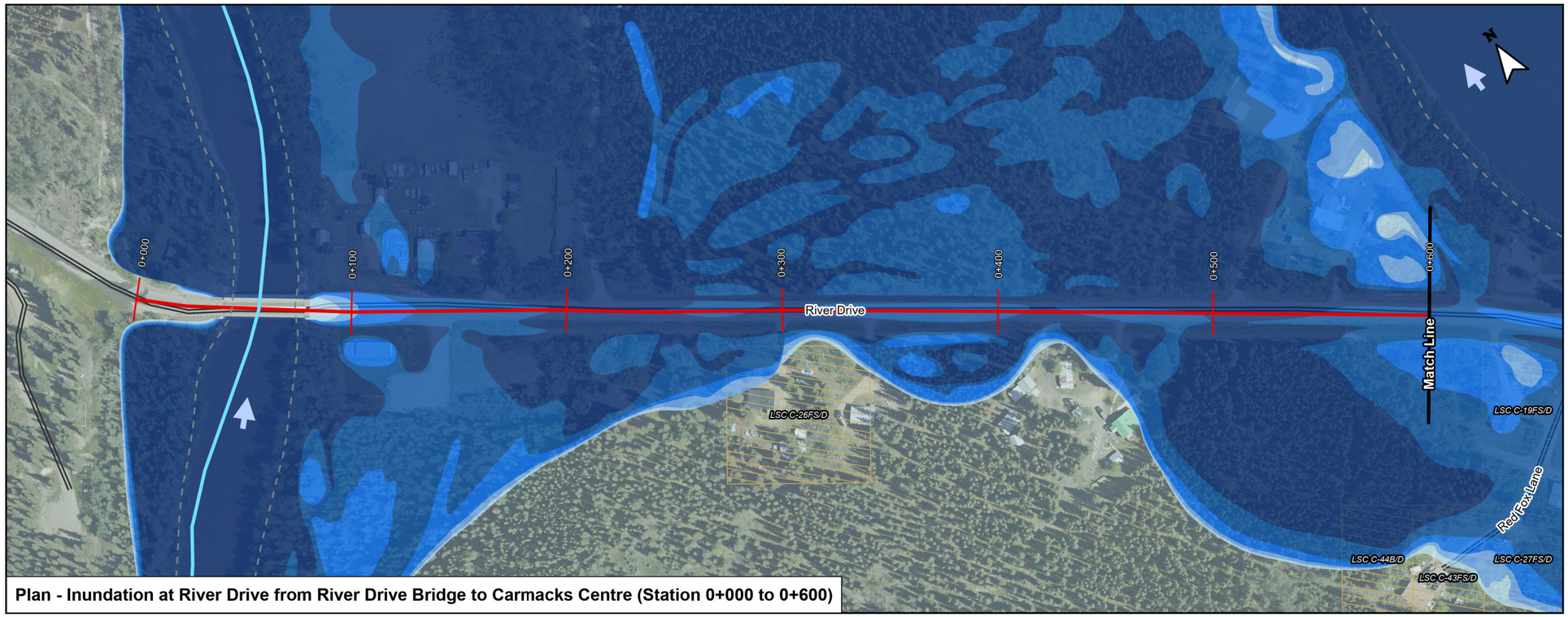
AEP Design Event	River Drive in Carmacks Centre - south of bridge	
	Approximate Width of Inundation along Alignment in Figure 7-27 to Figure 7-30 (m)	Maximum Depth within Inundation (m)
5% AEP	500	1.10
5% AEP + climate change	880	1.30
1% AEP	1030	1.60
0.5% AEP	1700	1.80
0.5% AEP + climate change	1810	2.10

At the west end of the inundation, the River Drive bridge is overtopped during the 0.5% AEP and above, although the majority of the conveyance is not over the bridge but rather over low points of River Drive to the east (river right, towards Carmacks centre). The inundation in this area is due to ice jamming on the Nordenskiold River which induces backwatered conditions past the bridge. Conveyance over River Drive may cause erosion/stability risks to River Drive given potential WSE drops on the downstream road embankment. Ice may be conveyed over River Drive during inundation.

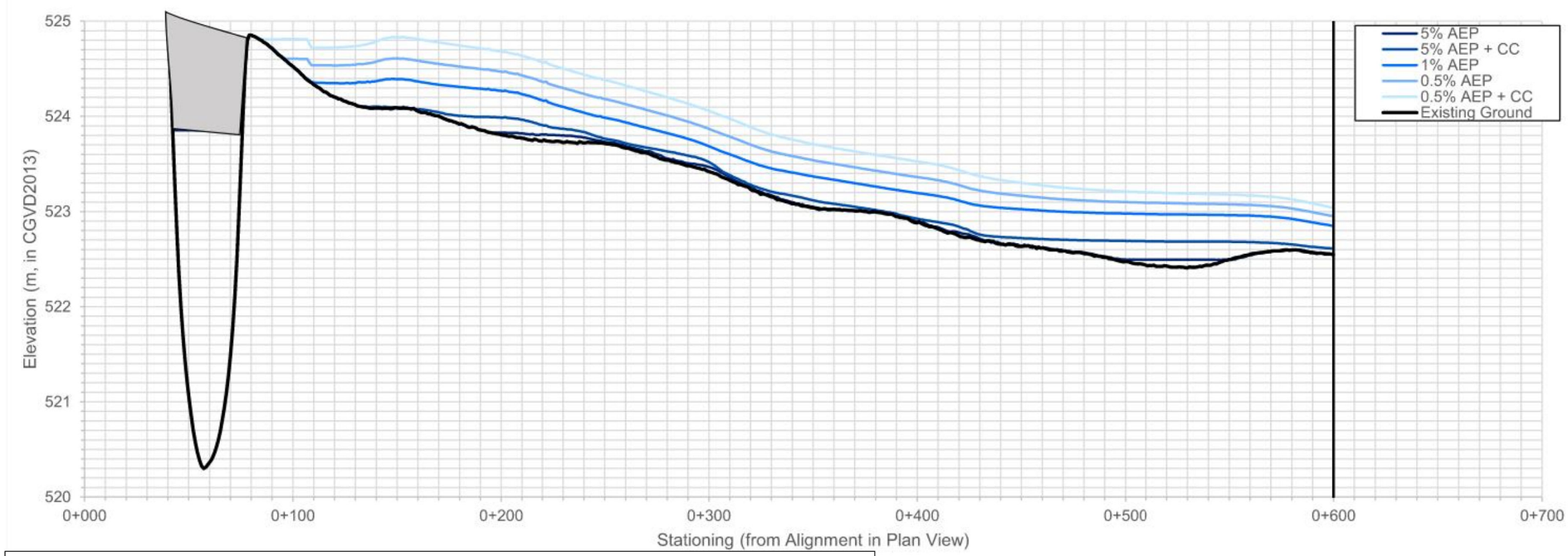
Farther west towards Carmacks centre, a sag in River Drive is centred about chainage 750 (as illustrated on Figure 7-28). Inundation in this sag is largely due to Yukon River open water flooding scenarios. Conveyance over/along River Drive during this Yukon River open water flooding is anticipated to be low. River Drive is along the outer bank of the Yukon River meaning elevated velocities and erosion hazards may be present along the river side of River Drive.

Immediately downstream of the Klondike Highway bridge, a sag in River Drive is centred about chainage 2570 (as illustrated on Figure 7-30). Inundation in this sag is largely due to Yukon River open water flooding scenarios. As this area is immediately downstream of a bridge constriction, scouring eddies may occur in the inundated area however slack water conditions and sedimentation may also occur depending on flood stage.

If River Drive or the River Drive bridge was inundated, vehicular access to Carmacks centre services and the residential area to the northwest of Carmacks would be restricted. If the road or bridge were lost due to erosion, vehicular access would also be lost until the road and/or bridge was rebuilt. Access to select areas within Carmacks Centre and the residential area to the northwest may be possible via local roads within Carmacks and/or the Mount Nansen Road.



Plan - Inundation at River Drive from River Drive Bridge to Carmacks Centre (Station 0+000 to 0+600)



Profile - Inundation at River Drive from River Drive Bridge to Carmacks Centre (Station 0+000 to 0+600)

Figure No.

7.27

Title: **Composite Flood Hazard Extent Plan and Profile River Drive from River Drive Bridge to Carmacks Centre (Station 0+000 to 0+600)**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

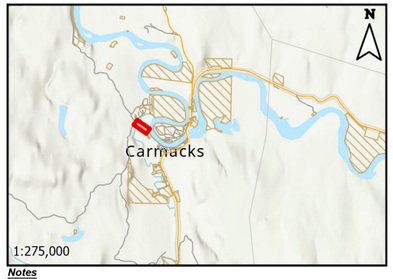
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 10 20 30 40 50 m

(At original document size of 11x 17) 1:2,250



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

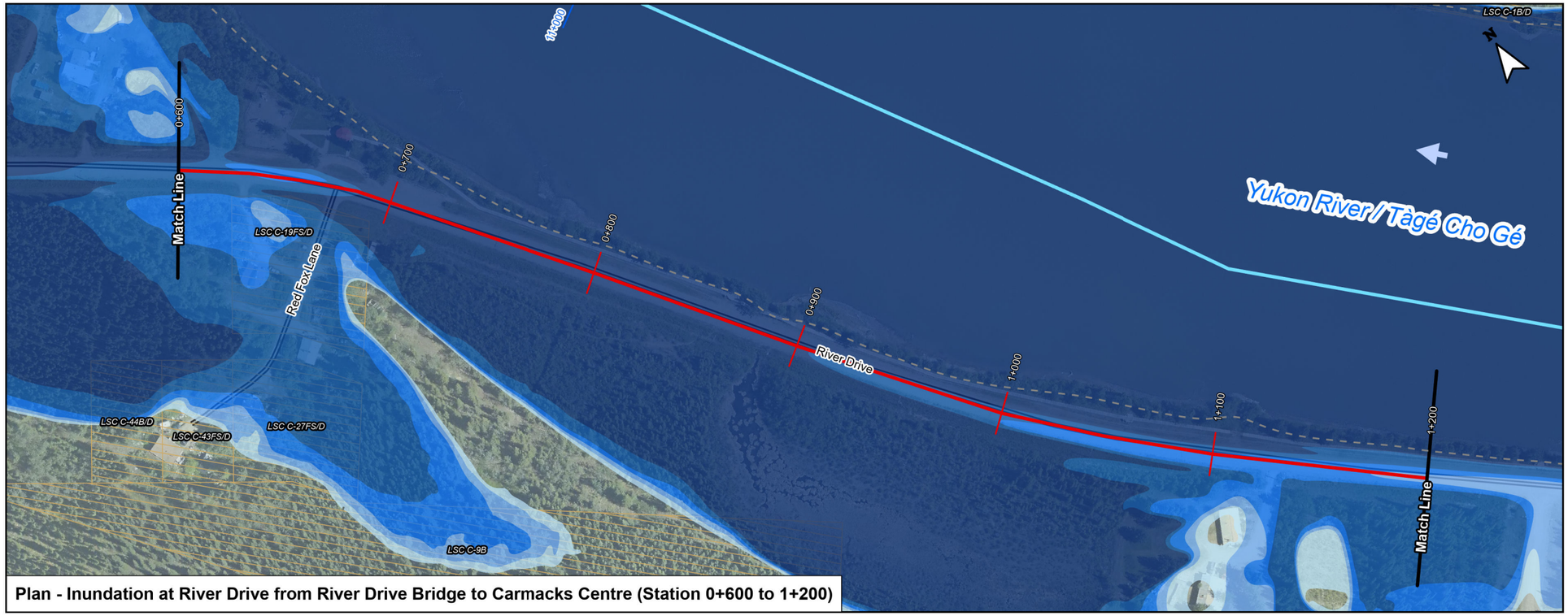
Yukon

This project is funded in part by the Government of Canada

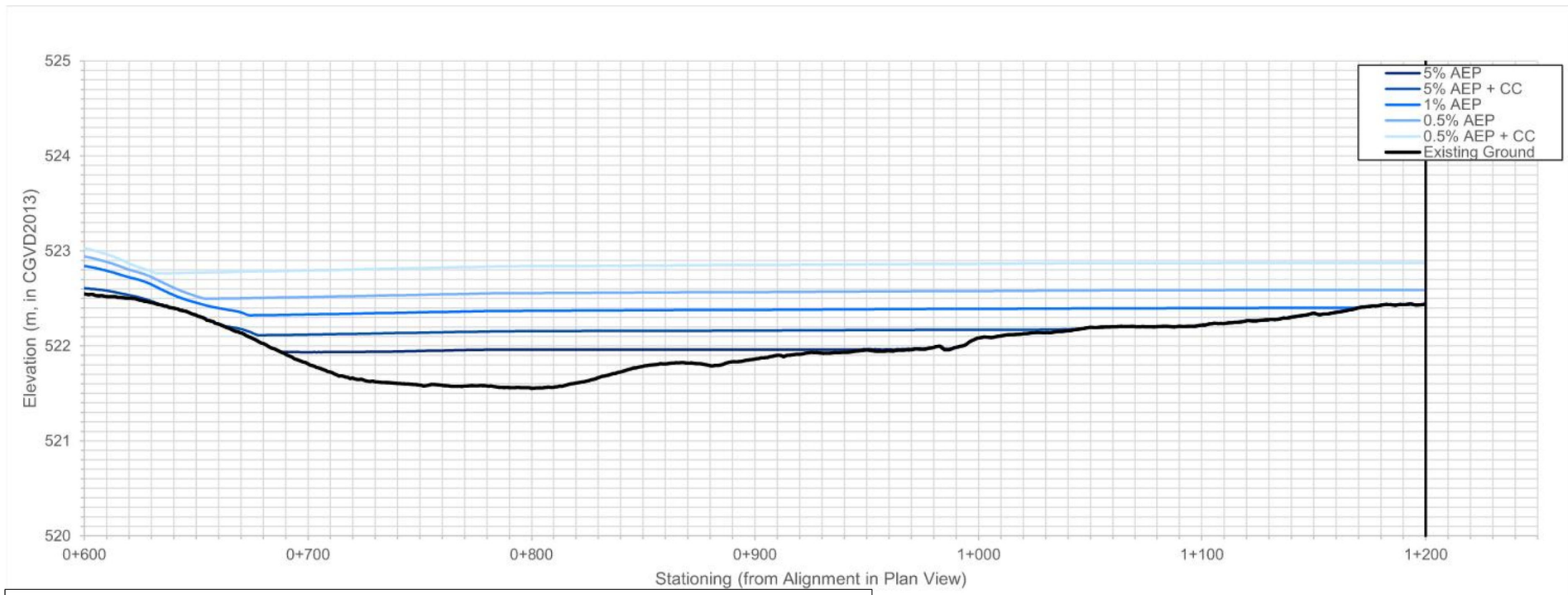
Canada

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Plan - Inundation at River Drive from River Drive Bridge to Carmacks Centre (Station 0+600 to 1+200)



Profile - Inundation at River Drive from River Drive Bridge to Carmacks Centre (Station 0+600 to 1+200)

Figure No.

7.28

Title: **Composite Flood Hazard Extent Plan and Profile River Drive from River Drive Bridge to Carmacks Centre (Station 0+600 to 1+200)**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

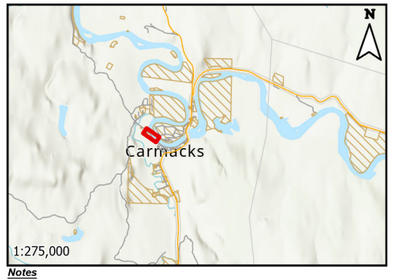
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 10 20 30 40 50 m

(At original document size of 11x 17) 1:2,250



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

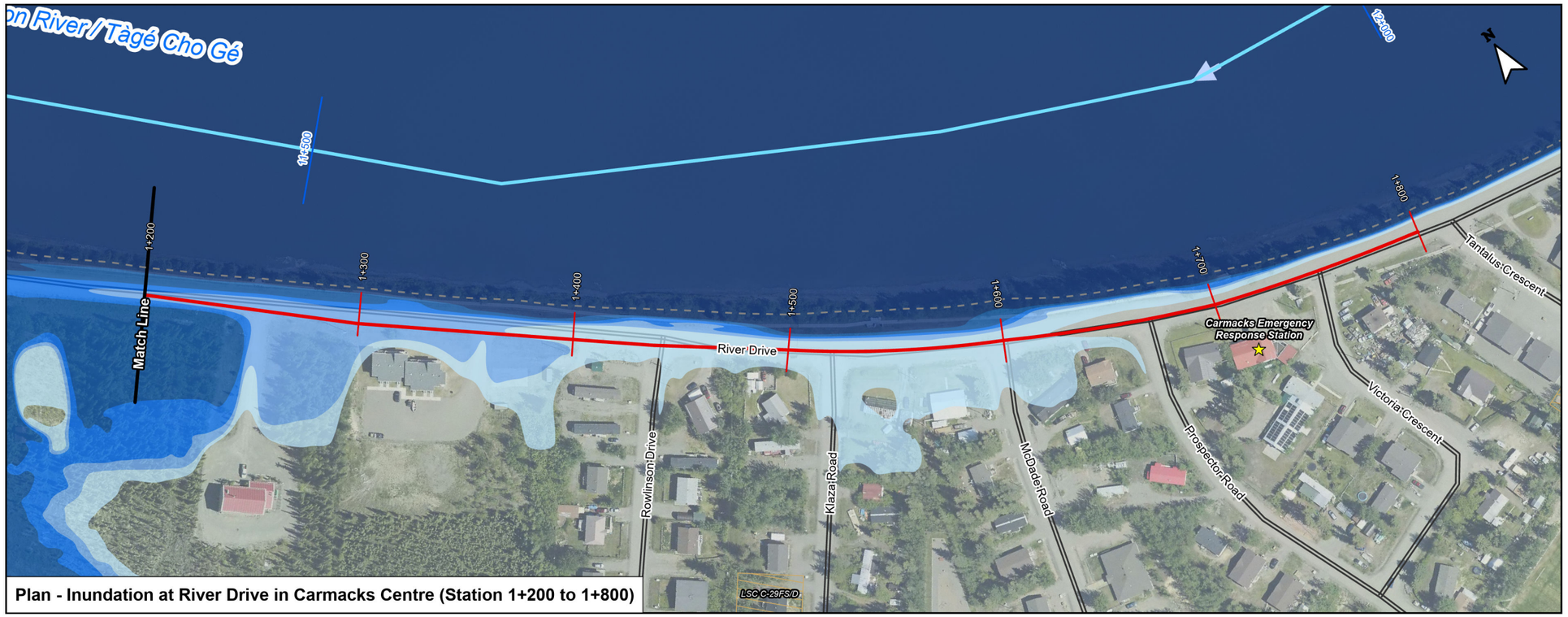
Yukon

This project is funded in part by the Government of Canada

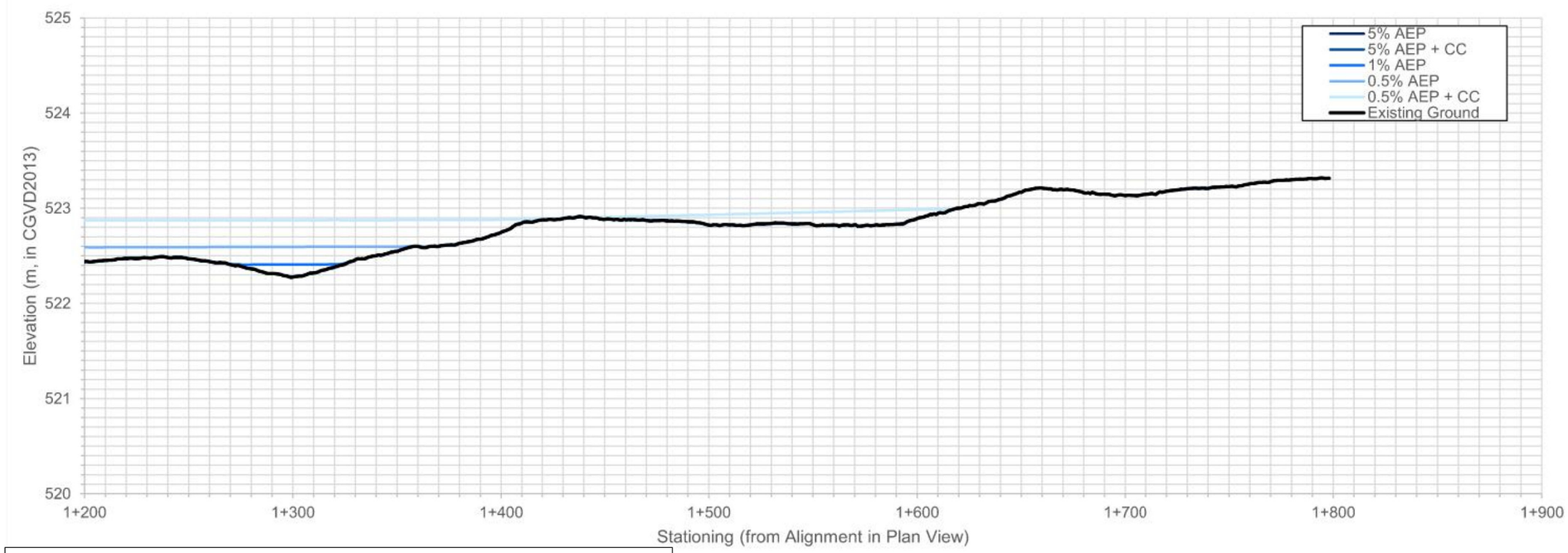
Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson



Plan - Inundation at River Drive in Carmacks Centre (Station 1+200 to 1+800)



Profile - Inundation at River Drive in Carmacks Centre (Station 1+200 to 1+800)

Figure No.

7.29

Title: **Composite Flood Hazard Extent Plan and Profile River Drive in Carmacks Centre (Station 1+200 to 1+800)**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

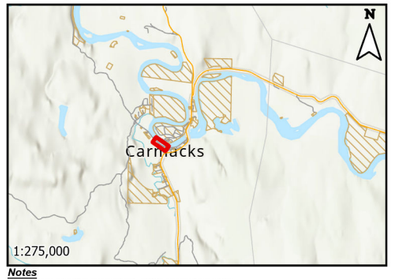
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 10 20 30 40 50 m

(At original document size of 11x 17) 1:2,250



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

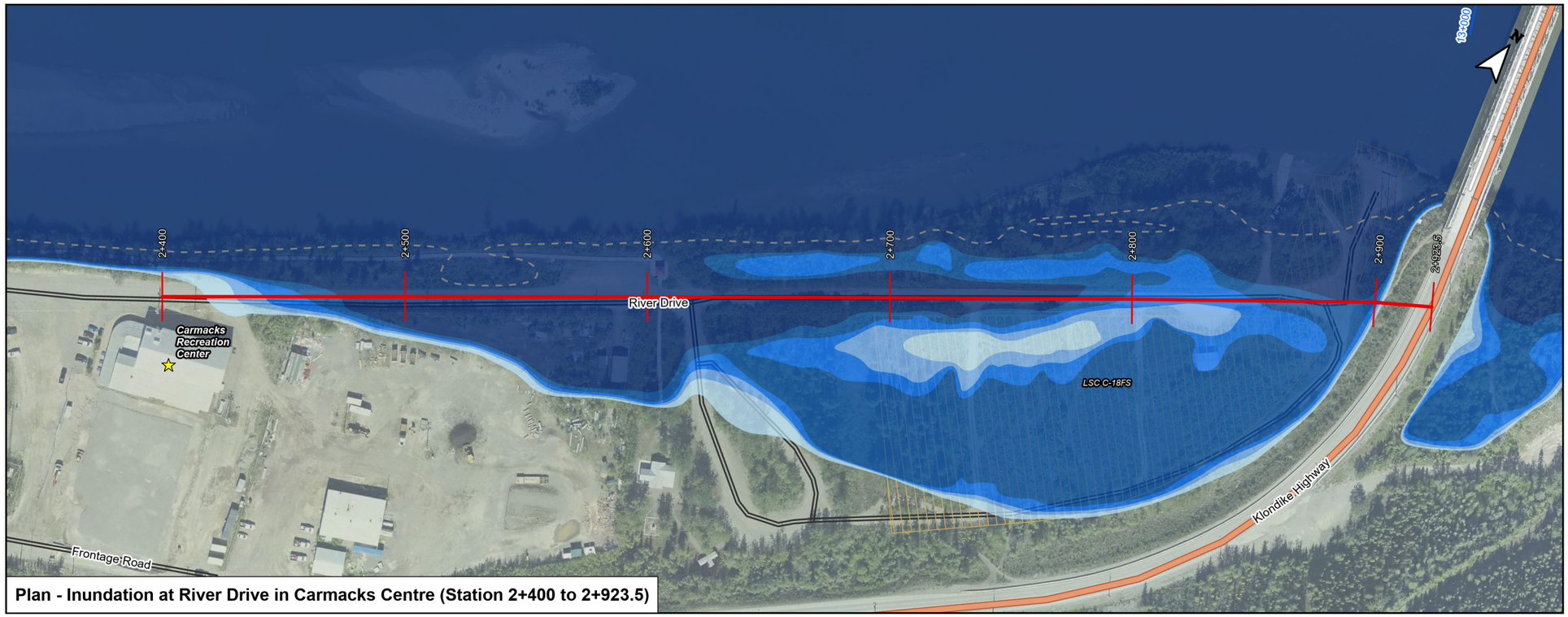
Yukon

This project is funded in part by the Government of Canada

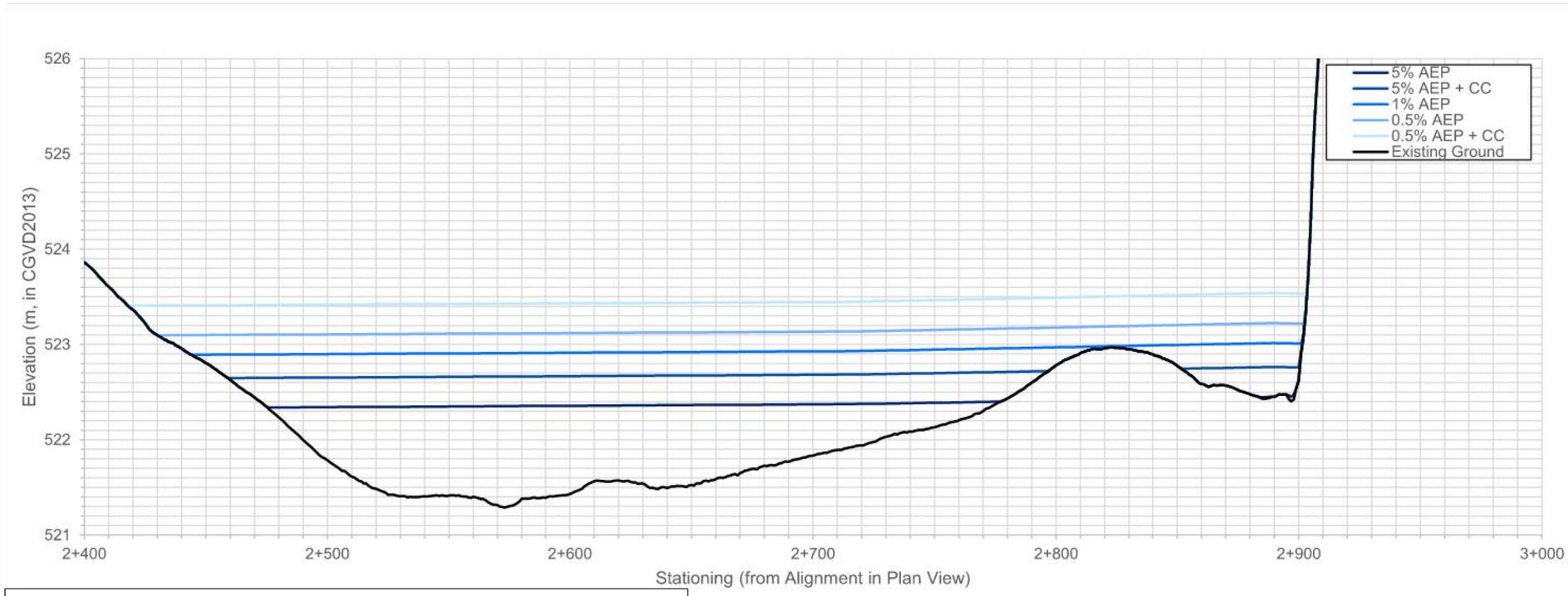
Canada

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Plan - Inundation at River Drive in Carmacks Centre (Station 2+400 to 2+923.5)



Profile - Inundation at River Drive in Carmacks Centre (Station 2+400 to 2+923.5)

Figure No.

7.30

Title: **Composite Flood Hazard Extent Plan and Profile River Drive in Carmacks Centre (Station 2+400 to 2+923.5)**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

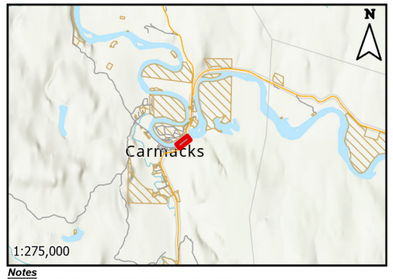
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 10 20 30 40 50 m

(At original document size of 11x 17) 1:2,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

7.6.5 Little Salmon/Carmacks First Nation Development – Lower Bench (Yukon River)

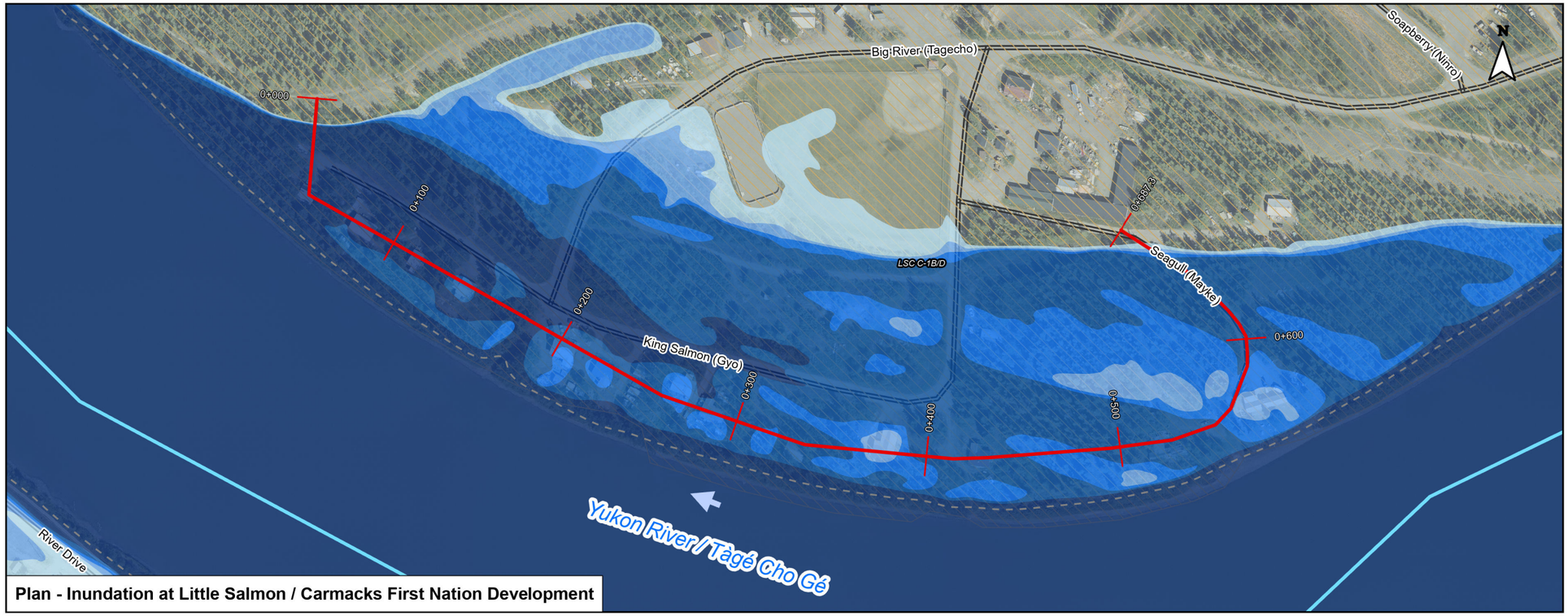
Figure 7-31 provides a plan and profile for inundation along the lower bench (south end) of the LS/CFN development. The approximate lengths and maximum depths of inundation along the Klondike Highway for each of the design AEP events are summarized in Table 7-14.

Table 7-14 Approximate Inundation Lengths and Maximum Depths at Lower Bench (South End) of Little Salmon/Carmacks First Nation Development

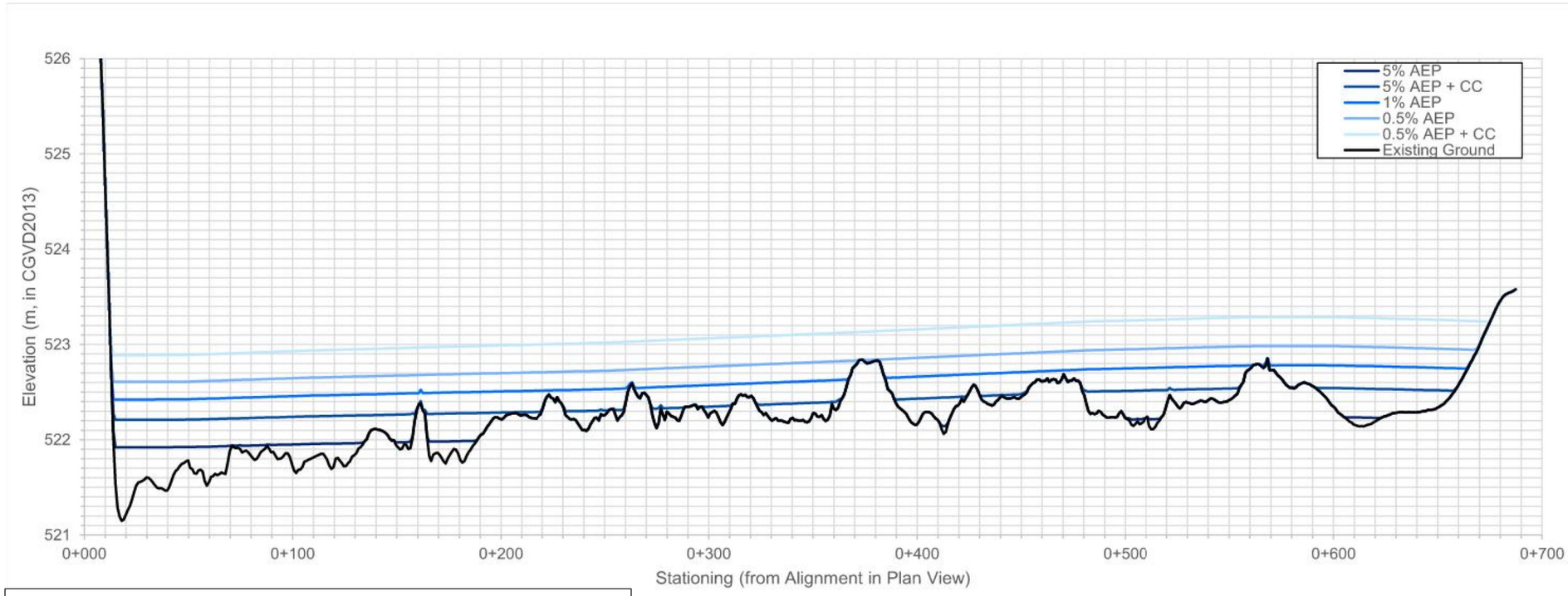
AEP Design Event	Approximate Width of Inundation along Alignment in Figure 7-31 (m)	Maximum Depth within Inundation (m)
5% AEP	190	0.75
5% AEP + climate change	530	1.05
1% AEP	625	1.25
0.5% AEP	645	1.45
0.5% AEP + climate change	660	1.65

The inundation at this location is due to Yukon River open water flooding scenarios. The alignment in Figure 7-31 is located over the buildings to characterize inundation at the structures. Portions of Big River Road and King Salmon Roads are inundated but not illustrated in the profile. If the LS/CFN development was inundated, access to and occupancy of the buildings would be affected.

The LS/CFN development is located along an inside bend of the Yukon River. This means flow velocities are expected to be lower than on the outer bend, however erosion hazards may be present depending on flood stage and flow patterns.



Plan - Inundation at Little Salmon / Carmacks First Nation Development



Profile - Inundation at Little Salmon / Carmacks First Nation Development

Figure No.

7.31

Title: **Composite Flood Hazard Extent Plan and Profile Little Salmon / Carmacks First Nation Development**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

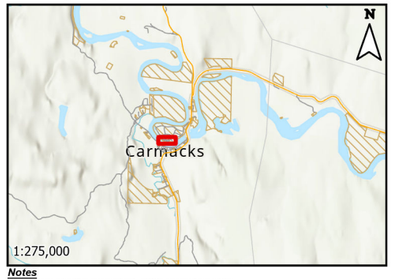
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 20 40 60 80 100 m

(At original document size of 11x 17) 1:2,500



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MAnderson

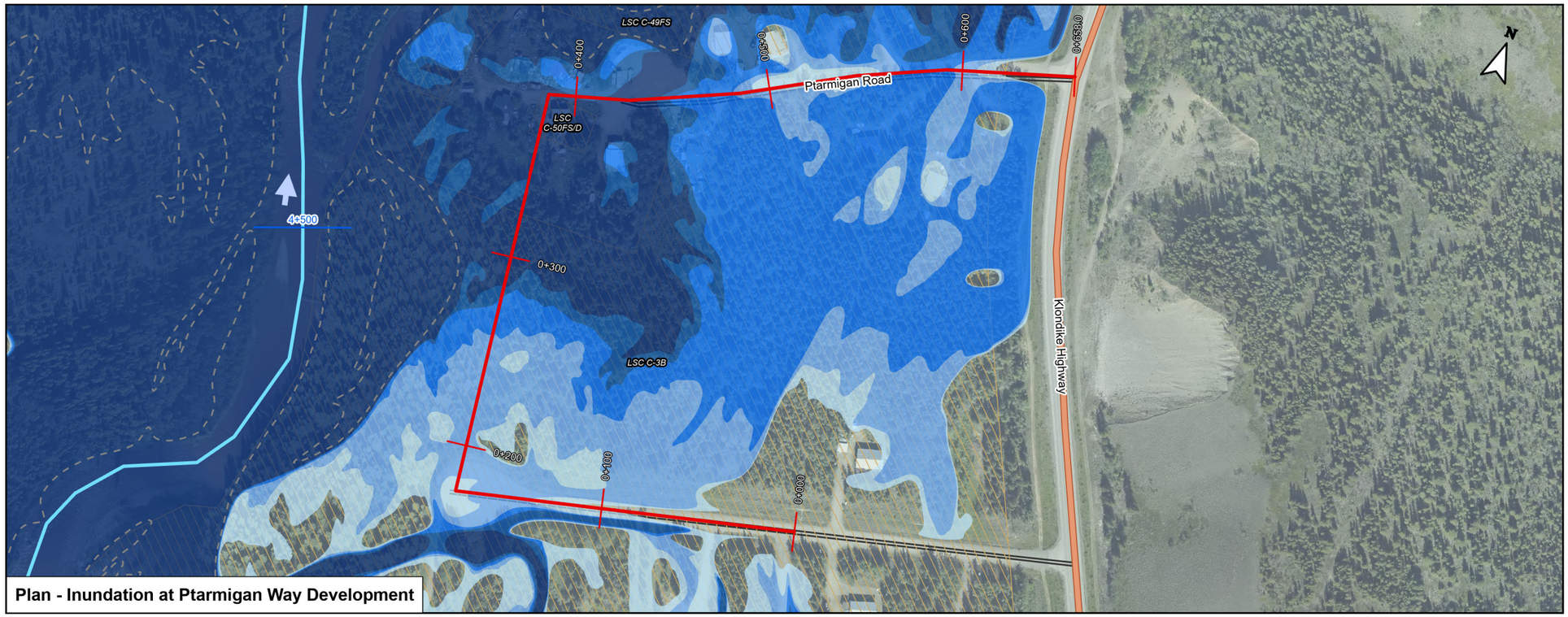
7.6.6 Ptarmigan Way Development (Nordenskiold River)

Figure 7-32 provides a plan and profile for inundation within the Ptarmigan Way Development, located west of the Klondike Highway. The approximate lengths and maximum depths of inundation along the Klondike Highway for each of the design AEP events are summarized in Table 7-15.

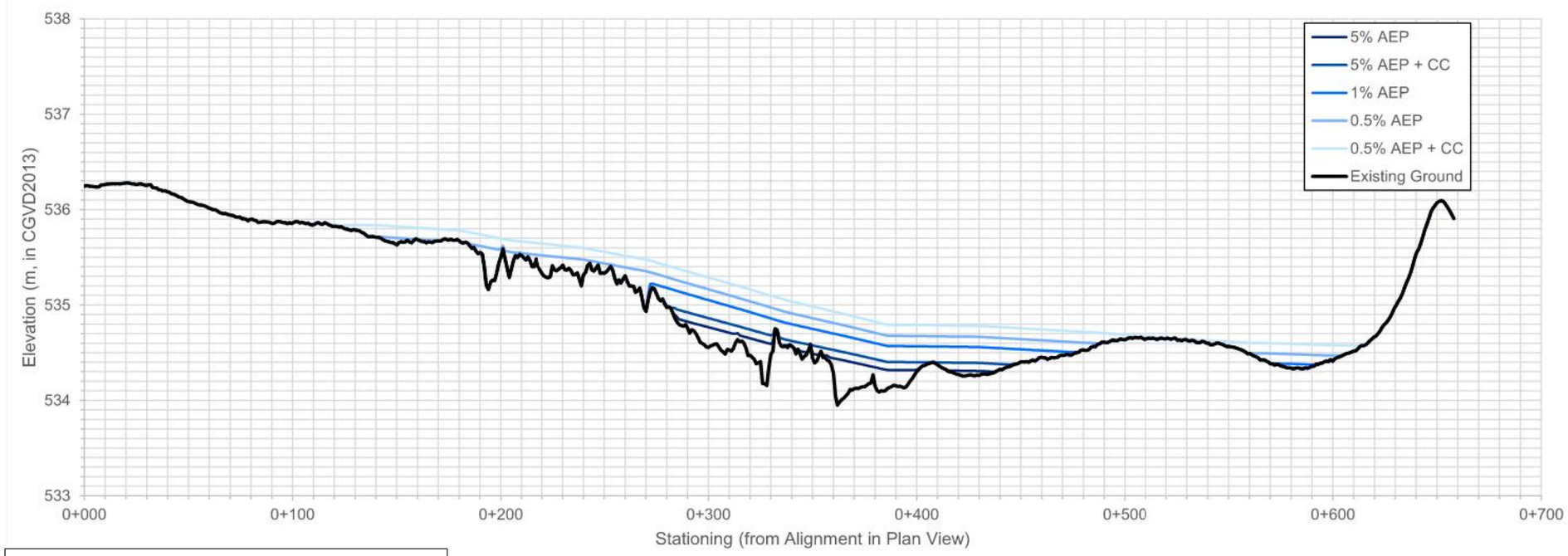
Table 7-15 Approximate Inundation Lengths and Maximum Depths at Ptarmigan Way Development

AEP Design Event	Approximate Width of Inundation along Alignment in Figure 7-32 (m)	Maximum Depth within Inundation (m)
5% AEP	125	0.45
5% AEP + climate change	XX	XX
1% AEP	270	0.75
0.5% AEP	360	0.85
0.5% AEP + climate change	460	0.95

The inundation at this location is predominantly due to Nordenskiold River ice jam flooding scenarios. The alignment in Figure 7-32 is located along the road to characterize impacts to access in the development. Several buildings adjacent to Ptarmigan Road are also inundated but not illustrated in the profile. If the Ptarmigan Way Development was inundated, access to and occupancy of the buildings would be affected. Down-valley floodplain conveyance and ice flows will be present within the inundations meaning erosion and ice hazards to the road and buildings may occur.



Plan - Inundation at Ptarmigan Way Development



Profile - Inundation at Ptarmigan Way Development

Figure No.

7.32

Title: **Composite Flood Hazard Extent Plan and Profile Ptarmigan Way Development**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

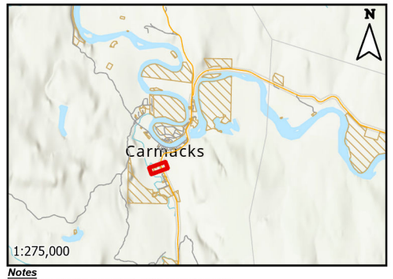
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 20 40 60 80 100 m

(At original document size of 11x 17) 1:2,500



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

7.6.7 Klondike Highway (south of Carmacks, Nordenskiold River)

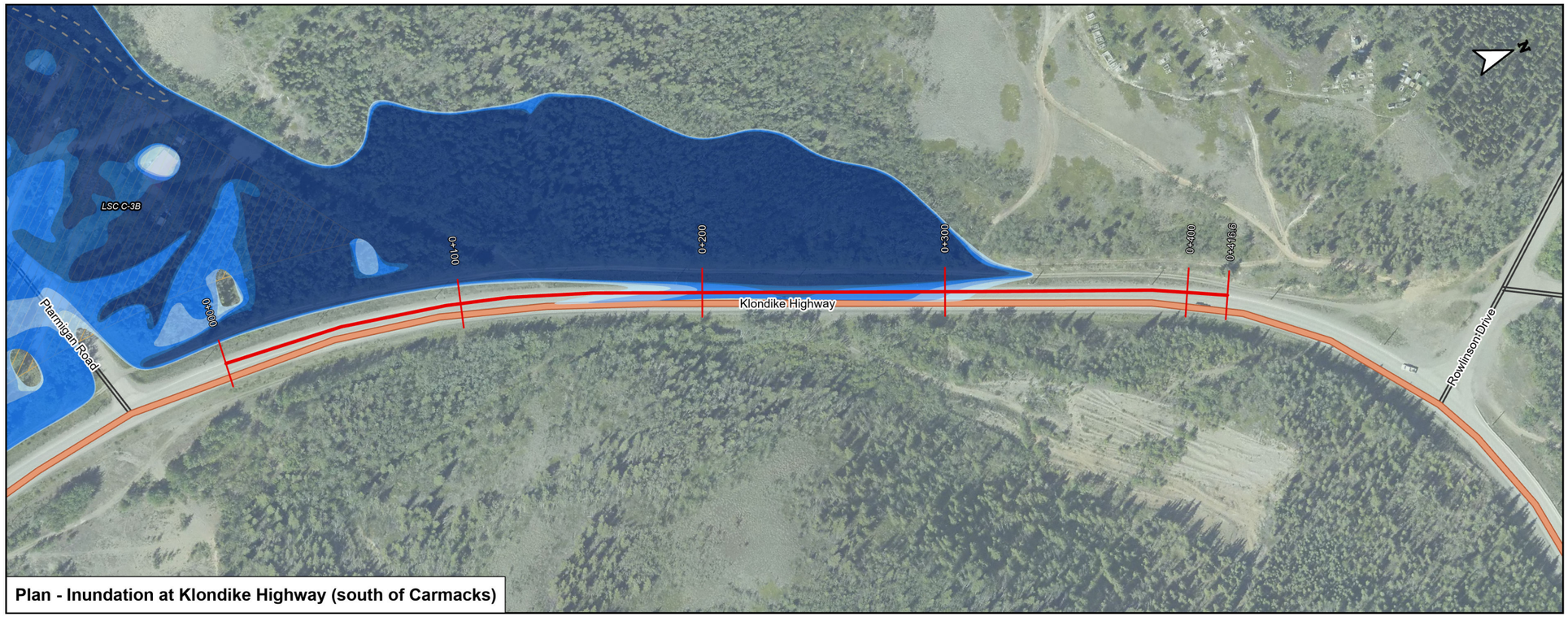
Figure 7-33 provides a plan and profile for inundation along the Klondike Highway south of Carmacks. The approximate lengths and maximum depths of inundation along the Klondike Highway for each of the design AEP events are summarized in Table 7-16.

Table 7-16 Approximate Inundation Lengths and Maximum Depths at Klondike Highway (south of Carmacks)

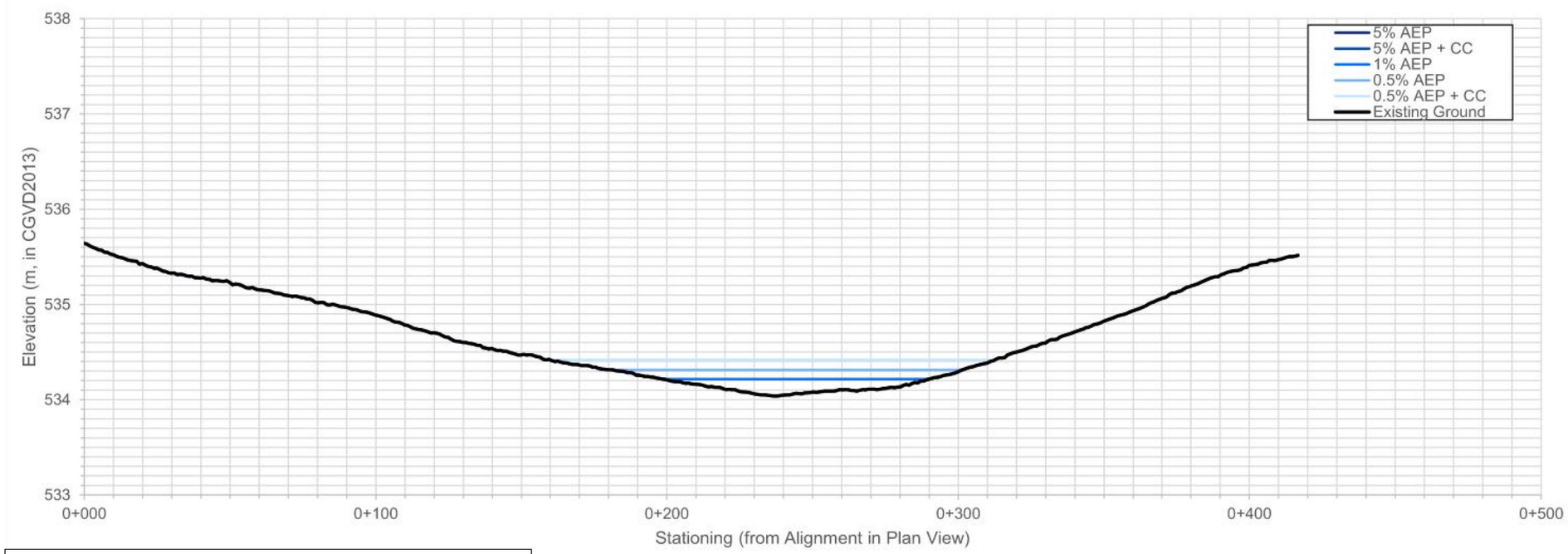
AEP Design Event	Approximate Width of Inundation along Alignment in Figure 7-33 (m)	Maximum Depth within Inundation (m)
5% AEP	N/A	N/A
5% AEP + climate change	N/A	N/A
1% AEP	120	0.2
0.5% AEP	155	0.3
0.5% AEP + climate change	180	0.4

The inundation at the Klondike Highway south of Carmacks is due to open water flood scenarios on the Yukon River. There is no conveyance which would occur over the Klondike Highway at this location (still water inundation in floodplain); meaning there are not expected to be fluvial erosion hazards for the highway.

If the Klondike Highway south of Carmacks was inundated, vehicular access to Carmacks and communities north of Carmacks (Ross River, Faro, Pelly Crossing, Stewart Crossing, Dawson City) would be substantially longer (via Robert Campbell Highway or South Canol Road) and over rougher road conditions (South Canol Road and large portions of the Robert Campbell Highway are dirt road) until WSEs recede.



Plan - Inundation at Klondike Highway (south of Carmacks)



Profile - Inundation at Klondike Highway (south of Carmacks)

Figure No.

7.33

Title: **Composite Flood Hazard Extent Plan and Profile Klondike Highway (south of Carmacks)**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

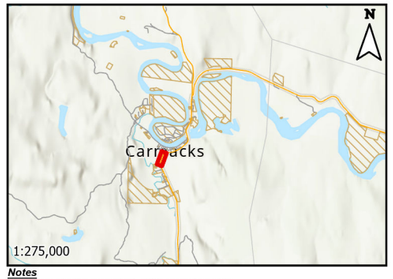
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 10 20 30 40 50 m

(At original document size of 11x 17) 1:2,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

7.6.8 Casino Way Bridge Crossing (Nordenskiold River)

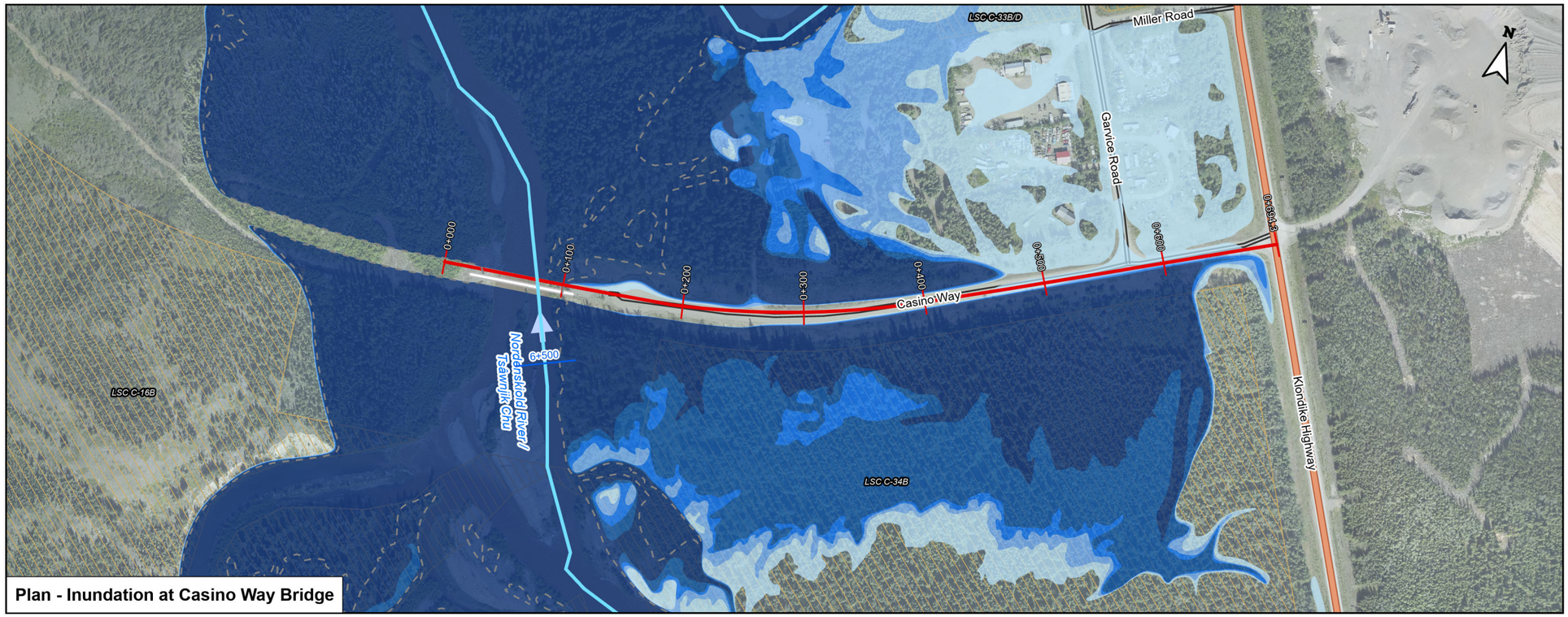
Figure 7-34 provides a plan and profile for WSEs at the Casino Way Bridge. The approximate lengths and maximum depths of inundation along Casino Way for each of the design AEP events are summarized in Table 7-17.

Table 7-17 Approximate Inundation Lengths and Maximum Depths at Casino Way Bridge Crossing

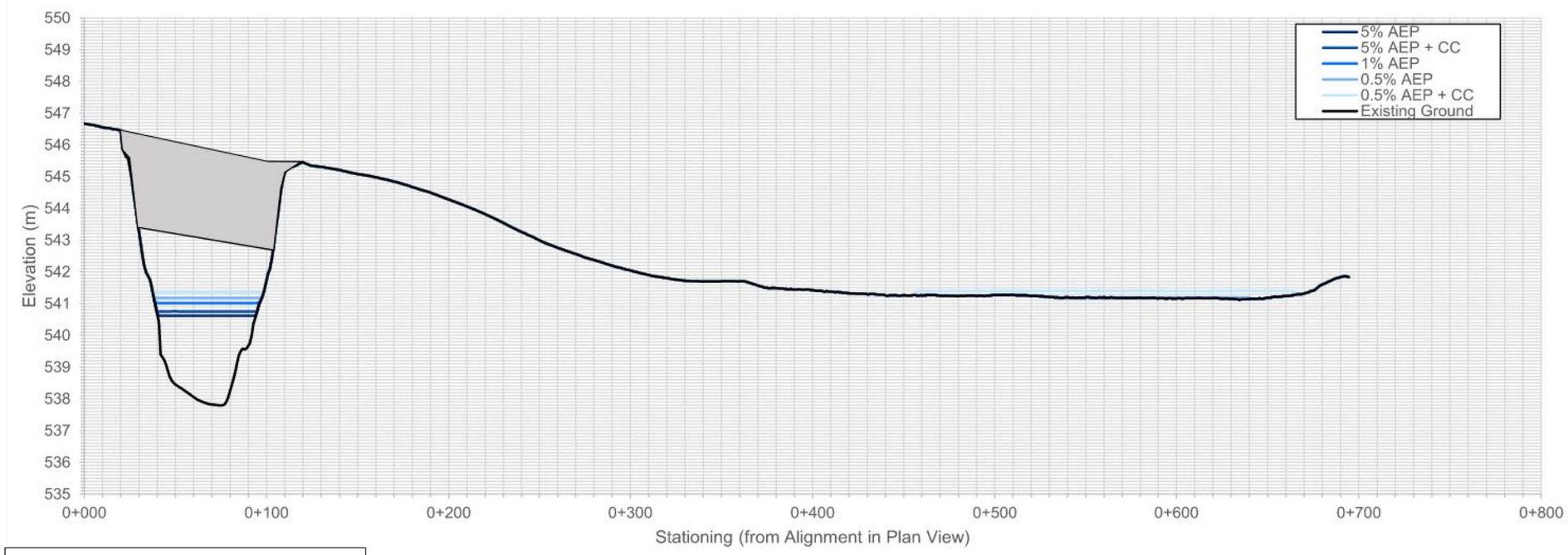
AEP Design Event	Approximate Width of Inundation along Alignment in Figure 7-34 (m)	Maximum Depth within Inundation (m)
5% AEP	N/A	N/A
5% AEP + climate change	N/A	N/A
1% AEP	N/A	N/A
0.5% AEP	70	0.02
0.5% AEP + climate change	260	0.08

The inundation at the Casino Way bridge crossing is due to ice jam flood scenarios on the Nordenskiold River. The Casino Way bridge is not contacted by design AEP WSEs; the highest design AEP WSE (approximately 541.40 under the 0.5% AEP + climate change) has a soffit clearance of approximately 1.20 m. When Casino Way (to the east of the bridge) is overtopped (0.5% AEP, 0.5% AEP + climate change design events), erosion hazards through the downstream development (around Garvice Road) and stability risks to Casino Way (from erosion of embankment) would be present. Down-valley floodplain conveyance and ice flows will be present within the inundations meaning erosion and ice hazards to the road and buildings may be present.

If Casino Way was overtopped or lost, vehicular access to the bypass around Carmacks towards Mount Nansen Mine and Casino Mine would be affected until WSEs recede and/or the road is repaired or rebuilt.



Plan - Inundation at Casino Way Bridge



Profile - Inundation at Casino Way Bridge

Figure No.

7.34

Title: **Composite Flood Hazard Extent Plan and Profile Casino Way Bridge**

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

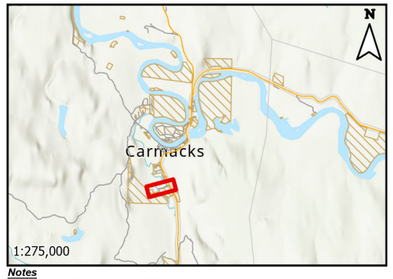
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- 50 % AEP Inundation Extent
- Profile Alignment (100m Stationing)
- 0+000 Alignment Stationing
- River Centreline
- 5% AEP Composite Flood Hazard Extent
- 5% AEP + Climate Change Composite Flood Hazard Extent
- 1% AEP Composite Flood Hazard Extent
- 0.5% AEP Composite Flood Hazard Extent
- 0.5% AEP + Climate Change Composite Flood Hazard Extent

Map Publication Date: May 21, 2024

0 30 60 90 120 150 m

(At original document size of 11x 17) 1:4,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.
6. Breakup ice jam and open water event inundations are provided in Flood Hazard Maps in Appendix E.
7. AEP inundation lines only shown on profile if design AEP event results in inundation along the alignment.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

D:\Local_models\123222320\123222320_Flood_model_basemaps\123222320_Flood_model_SingleSheet_Final_backup.aprx Revised: 2024-05-21 By: MaAnderson

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024, in progress).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

8 Assumptions and Limitations

The contents of this Report are subject to the following assumptions and limitations:

- WSC hydrometric data was used as the source for hydrologic data considered in the FFAs in freeze-up, breakup, and open water periods. Stantec did not perform any separate analyses to adjust WSC flows during any of these time periods with the exception of the 2020 ice jam event at Ice Jam Location 0+740 (which was used for breakup ice jam model calibration) as outlined in Section 6.4.3.1.
- The hydraulic analysis and flood mapping was based on the following elevation data:
  - CQL1 LiDAR collected on June 8-10, 2019 and provided to Stantec by YG WRB
  - Bathymetric and topographic survey data collected in July and August of 2023
- The breakup ice jam modelling completed in this Project was based on documented instances of ice processes which cause flooding events in the Study Area. This analysis is based on limited historical observations and may not represent the worst-case scenario and new or altered ice processes or anticipation of potential future ice jam events was not in the scope of this Project.
- Assessment of climate and land-cover change is based on reasonably available scientific data. Such data contains inherent limitations given that the climatic conditions measured by such data are constantly evolving and cannot be predicted with certainty.

9 Areas for Future Study

This Project has been completed using the information available to Stantec at the time of writing. Flood hazard maps should be updated as new information, processes, or industry standards are observed. The following items may facilitate improvements and refinements of the Carmacks Flood Hazard Maps in future years.

i. Continued ice process monitoring (freeze up, ice cover, breakup) on the Nordenskiold River and Yukon River, including but not limited to:
   - Freeze-up and breakup dates
   - Ice thickness measurements under ice cover conditions
   - Ice jam toe and head locations, particularly at peak WSEs
   - Aerial imagery and photographs of ice jam events throughout event but particularly at peak WSEs
   - Peak WSE profiles and inundated area extents associated with ice jam events
   - Timeline of events during ice jams (formation, growth, breakup)
   - Consider addition of remote cameras at known ice jam locations
   - If safe, collection of a flow measurement during/immediately after ice jam events

ii. Continued hydrometric monitoring at the WSC Station 09AH001, WSC Station 09AH004, and WRB Station 29AH001.

iii. Document (including photographs and high water mark surveys) peak conditions of flood events that occur in future years.

iv. Review and potentially update flow records during ice-affected periods (freeze-up, breakup) given the simplified trendline method currently applied by WSC and the implications of flow estimation during these time periods to FFA and AEP flow estimates.

v. Groundwater monitoring and modelling in adjacent areas under the design AEPs, given the observed impacts to basements, wells, and the sanitary infrastructure in the Village of Carmacks.

vi. Consider mitigating flood hazards at areas which affect the Village of Carmacks, LS/CFN developments, and access routes within the Study Area and to other communities in the Yukon. As outlined in Section 7.6, flood hazards that should be considered include:
   - Robert Campbell Highway
   - Klondike Highway north of Carmacks and south of Carmacks
   - River Drive in Carmacks centre
   - Little Salmon/Carmacks First Nation Subdivision lower bench
   - Access and residences along Ptarmigan Way
   - Casino Way and surrounding residences

10 Summary

Stantec was retained by YG WRB to perform the Carmacks Flood Mapping Study (the Project) following the Federal Flood Mapping Guideline Series (NRCan 2018a; NRCan 2018b; NRCan 2019a; NRCan 2019b; NRCan 2022). The Project was funded in part by NRCan through FHIMP. The final outcome of the Project is flood hazard maps (as defined in NRCan 2018a) for the Yukon River (*Tàgé Cho Gé*) and the Nordenskiold River (*Tsâwnjik Chu*) within the Study Area at Carmacks. The Study Area is located within the traditional territory of LS/CFN.

This Report is the Final Report for the Project, which documents the background data gathering, surveys, DTM development, hydrologic assessment, river ice assessment, joint probability analysis, climate change and land cover change assessments, geomorphic assessments, hydraulic analysis, and flood hazard mapping.

Background data review – including documentation of flood processes and history – was completed for both the Yukon River and Nordenskiold River in the Study Area. Findings indicated that flooding on the Nordenskiold River can occur from open water flows or from ice jamming which has been documented at four separate locations within the Study Reach: one at the upstream end of the Study Area, two in the middle reach around Casino Way and Ptarmigan Way; and one at the downstream end near the confluence with the Yukon River. High flows on the Nordenskiold River can result from snowmelt or precipitation events in the spring, summer, or fall. Flooding on the Yukon River is largely snowmelt driven with a single open water peak in late June/early July. Ice jam processes have not been documented as the process leading to extreme flooding on the Yukon River.

A hydrological assessment was completed to determine freeze-up, breakup, and open water flood frequency estimates on each of the Nordenskiold River and Yukon River. Individual datasets of the annual maximum instantaneous discharges during these three flooding periods were prepared. The timing and magnitude of peak annual discharges during each period were determined using available WSC hydrographs. A regression analysis using data from a downstream WSC hydrometric station was used to fill gaps in the Yukon River data set between 1996 and 2014. Single station FFAs were conducted using HYFRAN-PLUS software to estimate AEPs of 50%, 20%, 10%, 5%, 2%, 1%, 0.5%, and 0.2% for freeze-up, breakup, and open water conditions at WSC Station 09AH004 (Nordenskiold River Below Rowlinson Creek) and WSC Station 09AH001 (Yukon River at Carmacks). Comparison of the FFA results to existing FFA studies indicate an acceptable level of conservatism in the current Study.

A joint probably analysis was conducted to identify appropriate and plausible pairings of Nordenskiold River/Yukon River flow as to represent the AEP inundation under three separate dominant flood processes: breakup jams on the Nordenskiold River, open water flooding on the Nordenskiold River, and open water flooding on the Yukon River. The flow pairings were identified either through period-specific FFAs or through the Gumbel-Hougaard copula (Nelsen 2006) that has been recommended by Kilgore et al. (2010) to make a reasonable estimate of the joint probability of floods at stream confluences.

Climate change in the Nordenskiold River and Yukon River at Carmacks watersheds is expected to result in higher precipitation (both annually and on an event-basis) and higher temperatures. It is likely that this will result in increased flood flow magnitudes on both rivers, but likely more magnified on the Nordenskiold River given comparatively higher sensitivity of its flood flows to rainfall events. The Yukon does not have a policy regarding adjustment to AEPs for climate change; British Columbia suggests deterministic modelling (out of scope for this Project) or upward adjustment of AEPs by a percentage value. The collective decision made with YG, NRCan, and ECCC for this Project was to add a climate change scenario to the set of flood mapping design events, consisting of the 0.5% AEP flows with a factor of safety for climate change. The climate change events (5% AEP + climate change and 0.5% AEP + climate change) considered a factor of safety of 1.1 (+10%) for the Yukon River flows and a factor of safety of 1.2 (+20%) for the Nordenskiold River flows; these factors of safety align with EGBC (2018) and are reflective of the relative hydrologic sensitivity anticipated for each river given the projected meteorological changes due to climate change.

Land cover change in the Yukon which would occur at a scale impacting flood hydrology is likely restricted to three main areas: i) increase to development coverage, ii) changes to forest cover or composition, and iii) increases to bare/hydrophobic soils from forest fires. Regarding i), development is not anticipated to increase to a degree which would increase flood flows. Regarding ii), forest assemblage associated with increased precipitation is likely to be runoff mitigating and is not anticipated to increase flood flows. Regarding iii), fire indices are projected to decrease and when put in context of the overall watershed area are unlikely to increase flood flows. Therefore, no AEP factors of safety for land cover change are proposed in this Project.

The scope of this Project does not include erosion/fluvial hazard and channel migration study, and does not include projection of future morphological conditions. Documented erosion and channel migration on the two rivers in the Study Area suggest that erosion hazard and channel migration studies are recommended for both rivers. Changes to Nordenskiold River and Yukon River morphology in the Study Area may require updates to flood hazard mapping in the future.

Detailed site survey tasks (survey control, datum agreement verification, benchmark surveys, photographic inventory, open water high flow calibration events, bathymetry and cross-section surveys, high water mark and ice scar surveys) were completed over the summer of 2023.

For the Nordenskiold River, a total of 61 cross-sections and 300 m of bathymetry data was surveyed and successfully integrated with the CQL1 LiDAR data provided by YG WRB and NRCan to create an overall DTM for the Study Area. The River Drive bridge and Casino Way bridge were surveyed. High water marks, ice scars, and ice jam toe/head locations applicable to the April 2020 breakup jam event were surveyed, and the flow during the jam was estimated. An open water high flow event was measured and a water surface elevation profile through the Study Area was surveyed in May of 2023. The detailed survey efforts and integration with the LiDAR data have provided the required geometric/terrain data for hydraulic modelling of the Nordenskiold River.

For the Yukon River, a total of 30 cross-sections and 8.5 km of bathymetry data was surveyed and successfully integrated with the CQL1 LiDAR data provided by YG WRB and NRCan to create an overall DTM for the Study Area. Survey of the Klondike Highway bridge was completed as necessary for hydraulic modelling purposes. Water surface elevation profiles and flow estimates for two open water events were compiled: one from June 2021 and one from June 2022. An open water high flow event was measured and a water surface elevation profile through the Study Area was surveyed in June of 2023. Community feedback did not identify instances of ice jamming on the Yukon River causing floods. The detailed survey efforts and integration with the LiDAR data have provided the required geometric/terrain data (in the form of a DTM) for hydraulic modelling of the Yukon River in the Study Area.

A one-dimensional (1D) HEC-RAS model was developed to perform the hydraulic analysis for the Study Area. The hydraulic model was a single model (one domain) which simultaneously performed hydraulic calculations in the Nordenskiold River and the Yukon River. A junction was established for the Nordenskiold River confluence with the Yukon River, using momentum method for steady flow analysis. Calibration, validation, and design AEP runs were completed for each river independently; because of the one-model approach, an appropriate “paired” flow was assigned for the non-primary river for a given run based on WSC records (for calibration and validation runs) and FFA results (for design AEP runs). In total, the HEC-RAS model contained three river reaches (Nordenskiold River, Yukon River Upper, Yukon River Lower), 69 cross-sections on the Nordenskiold River, 62 cross-sections on the Yukon River, and three bridge crossings (Casino Way bridge and River Drive bridge on the Nordenskiold River and the Klondike Highway on the Yukon River).

Open water model calibration on the Nordenskiold River was completed for the May 2023 flood event, which is one of the highest flows on record and represents a flow between the 10% and 5% open water AEP flow. Simulated WSEs were compared to surveyed WSEs obtained during the event. Calibration achieved an average WSE Differential of 0.03 m (1.4% of average maximum flow depth) and a range of -0.17 m to 0.43 m, indicating a strong and slightly conservative calibrated model. No open water validation event was available for this Project.

Open water model calibration on the Yukon River was completed for the June 2022 flood event, which is one of the highest flows on record and represents a flow approximately equivalent to the 5% open water AEP. Simulated WSEs were compared to surveyed WSEs obtained during the event. Calibration achieved an average WSE Differential of 0.08 m (1.0% of average maximum flow depth) and a range of -0.22 m to 0.40 m, indicating a strong and slightly conservative calibrated model. Open water validation events were performed for the June 2021 and June 2023 flood events, and WSEs compared in a similar manner to the calibration event. The validation results indicated that the calibrated model is conservative in simulating WSEs at flows in the range of the validation events (below the 20% open water AEP flow).

Open water design runs were completed for the 5% AEP, 5% AEP + climate change, 1% AEP, 0.5% AEP, and 0.5% AEP + climate change design scenarios using the calibrated model. For each design AEP scenario, a Nordenskiold River primary run (consisting of the AEP open water flow for the Nordenskiold River and an appropriate paired flow on the Yukon River) and a Yukon River primary run (consisting of the AEP open water flow for the Yukon River and an appropriate paired flow on the Nordenskiold River) were completed. Open water sensitivity analysis was completed for the 0.5% AEP

design run for each river; the Nordenskiold River was evaluated for sensitivity to changes in Mannings n (+/-10%), and the Yukon River was evaluated for sensitivity to changes in Mannings n (+/-10%) as well as changes to the downstream boundary condition (energy slope +/- 50%). WSEs increased with increases to Mannings and decreased with decreases to Mannings n. The downstream boundary condition sensitivity analysis indicated that the Yukon River downstream of the confluence is more affected than the reach upstream of the confluence; at the confluence, the changes in WSE from the downstream boundary condition were +/-0.02 m.

Breakup ice jam modelling was completed for the Nordenskiold River. Downstream boundary conditions were the Yukon River WSE under the paired Yukon River flow for the given Nordenskiold River run assuming a 1.2 m Yukon River ice cover condition, consistent with observed characteristics of the Yukon River during Nordenskiold River breakup. Breakup ice jam calibration was completed for the April 22, 2020 breakup ice jam at Station 0+740 (downstream of River Drive bridge) using a flow estimated for that day and two surveyed ice jam high water marks from the event. The ice jam calibration achieved WSE differentials of 0.08 m and 0.19 m (2.6% and 6.5% of average maximum flow depth in the ice jam reach), which are considered acceptable given the uncertainty associated with ice jam modelling (e.g., data sparsity, model limitations). No ice jam validation events were available for this Project.

Breakup ice jam design runs were completed for the 5% AEP, 5% AEP + climate change, 1% AEP, 0.5% AEP, and 0.5% AEP + climate change design scenarios using the calibrated model at three separate ice jam locations (as identified through flood history review): 0+740, 4+109, and 6+016. Each ice jam was simulated independently, and inundations combined following the ice jam runs. Ice jam volumes in each jam were verified as not being supply limited, based on simulated ice volumes and assumed ice cover in the upstream main channel portions of the Nordenskiold River and Rowlinson Creek. Sensitivity analysis was completed for Ice Jam Location 0+740 considering changes to overbank ice thickness (+/- 0.2 m) and ice jam and ice cover roughness (+/- 10%). The breakup ice jam at Station 0+740 produced increased WSEs with increases to overbank ice thickness and increases to ice jam and ice cover roughness, and decreases to WSEs were observed with decreases to overbank ice thickness and decreases to ice jam and ice cover roughness.

Breakup ice jam modelling was not completed for the Yukon River because ice processes have not historically been the cause of flood events on the Yukon River in the Study Area.

At the completion of modelling, there were three separate runs within each AEP: i) a Nordenskiold River breakup ice jam run, ii) a Nordenskiold River primary open water run, and iii) a Yukon River primary open water run. Manual edits using 2D hydraulic model domains (Figure 7-2) were completed to refine/confirm flood inundations where the results at cross-sections were unable to accurately reflect inundation extents within each of the model runs. For each design AEP event (i.e., the 5% AEP, 5% AEP + climate change, 1% AEP, 0.5% AEP, and 0.5% AEP + climate change), the three separate model runs were overlain to create a composite flood hazard inundation and WSE surface for that design AEP. The resulting composite design AEP inundations were considered representative of the overall flood hazard extent for the AEP. The separate model runs of flood processes and subsequent data overlay means that the entirety of the composite design AEP inundation is unlikely to occur in a single event.

The composite flood hazard inundation for each design AEP were detailed at eight separate locations of interest within the Study Area: Robert Campbell Highway, Klondike Highway north of Carmacks, Klondike Highway Bridge, River Drive in Carmacks Centre, Little Salmon/Carmacks First Nation Development, Ptarmigan Way Development, Klondike Highway south of Carmacks, and Casino Way bridge. The inundation widths and depths along a representative alignment were provided at each location for each design AEP, and the impacts of inundation at each location were qualitatively described.

This Project has been completed using the information available to Stantec at the time of writing. Flood hazard maps should be reviewed and potentially updated as new information, processes, flood events, or industry standards are observed. YG or its partners may consider the following items for study in the future: i) continued ice process monitoring (freeze up, ice cover, breakup) on the Nordenskiold River and Yukon River, ii) continued hydrometric monitoring at the WSC Station 09AH001, WSC Station 09AH004, and WRB Station 29AH001, iii) document (including photographs and high water mark surveys) flood events that occur in future years, iv) review and potential updates to flow records during ice-affected periods (freeze-up, breakup) given the simplified trendline method currently applied by WSC and the implications of flow estimation during these time periods to FFA and AEP flow estimates, v) groundwater monitoring and modelling in adjacent areas under the design AEPs, given the observed impacts to basements, wells, and the sanitary infrastructure in the Village of Carmacks, and vi) consider mitigating flood hazards at areas which affect the Village of Carmacks, LS/CFN developments, and access routes within the Study Area and to other communities in the Yukon.

11 References

AECOM. 2016. Modeling Future Wildfire Risk in Yukon. Goovernment of Yukon Phase II – Modeling and Analysis Technical Report.

Beltaos, Spyros & Burrell, Brian & G.Ashton, & Clark, Shawn & Daly, S. & Malenchak, Jarrod & Ettema, Robert & Kempema, Edward & Morse, B. & Buffin-Bélanger, Thomas & Bergeron, Normand & Dubé, Jérôme & Tuthill, A. 2013. River Ice Formation.

Chow, V.T. 1959. Open Channel Hydraulics. McGraw-Hill, New York, NY.

Cronmiller, D.C., McParland, D.J., Gouguen, K.M., and McKillop, R.J. 2020. Carmacks surficial geology and community hazard susceptibility mapping. YGS Miscellaneous Report 20. Published under the authority of the Department of Energy, Mines, and Resources, Government of Yukon. 36 pp.

DTN. 2023. MetPortal. https://dtn-metportal.shinyapps.io/bc_region/ (accessed: 19 August 2023).

Engineers and Geoscientists British Columbia (EGBC). 2018. Legislated Flood Assessments in a Changing Climate in BC (version 2.1). Professional Practice Guidelines, Natural Hazards. 192 pp.

Federal Emergency Management Agency (FEMA). 2018. Guidance for Flood Risk Analysis and Mapping: Ice-Jam Analyses and Mapping. February 2018.

Gaur, A., Schardong, A., Simonovic, S.P. 2020 Gridded extreme precipitation Intensity—Duration-Frequency estimates for the Canadian landmass. J. Hydrol. Eng. 2020, 25.

Government of Canada (GoC). 2024a. Water Survey of Canada. Available at: < https://www.canada.ca/en/environment-climate-change/services/water-overview/quantity/monitoring/survey.html>.

Government of Canada (GoC). 2024b. Environment and Climate Change Canada – Historical Clime Data. Available at: < Historical Climate Data - Climate - Environment and Climate Change Canada (weather.gc.ca)https://www.canada.ca/en/environment-climate-change/services/water-overview/quantity/monitoring/survey.html>.

Government of Yukon (YG). 2011. Yukon Water: An Assessment of Climate Change Vulnerabilities. Environment Yukon Water Resources Branch. 98 pp.

Government of Yukon (YG). 2000. “Situation Report – Village of Carmacks Flooding”, November 2000.

Gutiérrez, J.M., R.G. Jones, G.T. Narisma, L.M. Alves, M. Amjad, I.V. Gorodetskaya, M. Grose, N.A.B. Klutse, S. Krakovska, J. Li, D. Martínez-Castro, L.O. Mearns, S.H. Mernild, T. Ngo-Duc, B. van den Hurk, and J.-H. Yoon, 2021: Atlas. In Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L.Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K.Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press. In Press. Interactive Atlas Available http://interactive-atlas.ipcc.ch/. Accessed September 2023.

Hatton, V., Ielpi, A., Cronmiller, D.C. and Painter, M., 2023. Geomorphic assessment of Tsäl̄njik Chú (Nordenskiold River) near Carmacks, Klondike region, Yukon. IN: Yukon Exploration and Feology. 2022, K.E. MacFarlane (ed.). Yukon Geological Survey, p. 77-91.

Hinzman, L.D., Bettez, N.D., Bolton, W.R., Chapin, F.S., Dyurgerov, M.B., Fastie, C.L., Griffith, B., Hollister, R.D., Hope, A., Huntington, H.P., Jensen, A.M., Jia, G.J., Jorgenson, T., Kane, D.L., Klein, D.R., Kofinas, G., Lynch, A.H., Lloyd, A.H., Mcguire, A.D., Nelson, F.E., Oechel, W.C., Osterkamp, T.E., Racine, C.H., Romanovsky, V.E., Stone, R.S., Stow, D.A., Sturm, M., Tweedie, C.E., Vourlitis, G.L., Walker, M.D., Walker, D.A., Webber, P.J., Welker, J.M., Winker, K., and Yoshikawa, K. 2005. Evidence and implications of recent climate change in northern Alaska and other arctic regions. Climatic Change 72: 251-298.

Janowicz, J.R. 2001. Impact of recent climatic variability on peak streamflow in northwestern Canada with implications for the design of the proposed Alaska Highway gas pipeline. Proceedings of the 13th Northern Research Basins International Symposium & Workshop, 19-14 August 2001, Saariselka, Finland and Murmansk, Russia, 161 – 169.

Janowicz, J.R. 2008. Apparent recent trends in hydrologic response in permafrost regions of northwest Canada. Hydrology Research 39(4): 267 – 275.

Janowicz, J.R. 2010. Observed trends in the river ice regimes of northwest Canada. Hydrology Research 41(6): 462-470.

King, L.M. and Z. Micovic. 2022. Application of the British Columbia MetPortal for Estimation of Probable Maximum Precipitation and Probable Maximum Flood for a Coastal Watershed. Water 14, Nr. 5 (2. March): 785. doi:10.3390/w14050785, https://www.mdpi.com/2073-4441/14/5/785.

Kilgore, R.T., D.B. Thompson, D.T. Ford. 2010. Estimating Joint Probabilities of Design Coincident Flows at Stream Confluences. National Cooperative Highway Research Program, NCHRP Report 15-36. Transportation Research Board, Washington, D.C. 257 pp.

Larsen, J.N., Anisimov, O.A., Constable, A., Hollowed, A.B., Maynard, N., Prestrud, P., Prowse, T.D., and Stone, J.M.R. 2014. Polar regions. In: Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part B: Regional Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Barros, V.R., C.B. Field, D.J. Dokken, M.D. Mastrandrea, K.J. Mach, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kissel, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1567-1612.

Meinshausen, M., Nicholls, Z.R., Lewis, J., Gidden, M.J., Vogel, E., Freund, M., Beyerle, U., Gessner, C., Nauels, A., Bauer, N. and Canadell, J.G. 2020. The shared socio-economic pathway (SSP) greenhouse gas concentrations and their extensions to 2500. Geoscientific Model Development, 13(8), pp.3571-3605.

Morrison Hershfield. 2022. Water Level – Return Period Relationships for Rivers and Lakes in Yukon – 2022 Update. Final report submitted to Yukon Infrastructure Development Branch. 16 pp.

Natural Resources Canada (NRCan). 2018a. Federal Flood Mapping Framework (Version 2.0). Federal Flood Mapping Guideline Series, General Information Product 112e. 28 pp.

Natural Resources Canada (NRCan). 2018b. Case Studies on Climate Change in Floodplain Mapping (Volume 1.0). Federal Flood Mapping Guideline Series, General Information Product 118e. 93 pp.

Natural Resources Canada (NRCan). 2019a. Federal Hydrologic and Hydraulic Procedures for Flood Hazard Delineation (Version 1.0). Federal Flood Mapping Guideline Series, General Information Product 113e. 75 pp.

Natural Resources Canada (NRCan). 2019b. Federal Geomatics Guidelines for Flood Mapping (Version 1.0). Federal Flood Mapping Guideline Series, General Information Product 114e. 59 pp.

Natural Resources Canada (NRCan). 2022. Federal Airborne LiDAR Data Acquisition Guideline (Version 3.1). Federal Flood Mapping Guideline Series, General Information Product 117e. 78 pp.

Nelsen, R.B., 2006. An Introduction to Copulas, (Second edition) Springer Series in Statistics, New York: Springer-Verlag.

Pacific Climate Impacts Consortium (PCIC). 2023. PCIC Climate Explorer (PCEX), Version 2.3.3, accessed September 2023.

Rasouli, K., Pomeroy, J.W., Janowicz, J.R., Carey, S.K. and Williams, T.J., 2014. Hydrological sensitivity of a northern mountain basin to climate change. Hydrological Processes, 28(14), pp.4191-4208.

Rasouli, K., Pomeroy, J.W. and Whitfield, P.H. 2019. Are the effects of vegetation and soil changes as important as climate change impacts on hydrological processes? Hydrology and Earth System Sciences, 23(12), pp.4933-4954.

Rasouli, K., Pomeroy, J.W. and Whitfield, P.H., 2022. The sensitivity of snow hydrology to changes in air temperature and precipitation in three North American headwater basins. Journal of Hydrology, 606, p.127460.

Research Northwest and Morrison Hershfield 2017. Yukon “state of play”: Analysis of climate change impacts and adaptation. 74 pp.

Sen, P.K., 1968. Estimates of the Regression Coefficient Based on Kendall’s Tau. Journal of the American Statistical Association, 63(324), 1379-1389.

Simonovic, S.P., A. Schardong, R. Srivastav, and D. Sandink 2015. IDF_CC Web-based Tool for Updating Intensity-Duration-Frequency Curves to Changing Climate – ver 6.5, Western University Facility for Intelligent Decision Support and Institute for Catastrophic Loss Reduction, open access https://www.idf-cc-uwo.ca.

Sinergise Ltd. (2023) EO Browser, Sentinel-2 L2A dataset. Accessed September 2023. Accessed from: https://apps.sentinel-hub.com/eo-browser/.

Stantec Consulting Ltd. (Stantec) 2019. Proposed Cultural Centre (LSCFN) Site Investigation – Flood Risk. Technical Memorandum, file reference 144902799. 8 pp.

Stantec Consulting Ltd. (Stantec) 2023. Carmacks Flood Mapping Study: Detailed Survey Plan. Presentation submitted to Government of Yukon Water Resources Branch 11 July 2023. 15 pp.

Streicker, J. 2016. Yukon Climate Change Indicators and Key Findings 2015. Northern Climate ExChange, Yukon Research Centre, Yukon College. 84 pp.

Turcotte, B. 2021. Flooding processes and recent trends in ice-induced high-water levels along rivers of Northwestern Canada. 21st Worskshop on the Hydraulics of Ice Covered Rivers. 29 pp.

Turcotte, B., Saal, S., Horton, B., 2021. Preliminary assessment of flood exposure for future development areas in Dawson and Carmacks. Presented to the Land Development Branch, Department of Community Services, Government of Yukon. YukonU Research Centre, Yukon University, 42 p.

United States Army Corps of Engineers (USACE). 2023. HEC-RAS Hydraulic Reference Manual. Available at: <https://www.hec.usace.army.mil/confluence/rasdocs/ras1dtechref/latest>.

United Stated Geological Survey (USGS). 2019. Guidelines for determining flood flow frequency – Bulletin 17C (version 1.1). Survey Techniques and Methods, Book 4, 149 pp.

WMO. 2009. World Meteorological Organization. Manual on estimation of probable maximum precipitation (PMP). World meteorological organization.

WSP. 2018. Nordenskiold River Bridge: Hydrotechnical Design Report. Report submitted to Government of Yukon Highway and Public Works – Transportation Engineering Branch. 51 pp.

Government of Yukon (YG). 2016. Yukon Forest Health Report. Accessed September 2023. Available at: <https://emrlibrary.gov.yk.ca/forestry/forest_health/2016.pdf>.

Government of Yukon (YG). 2000. “Situation Report – Village of Carmacks Flooding”, November 2000.

Government of Yukon Community Services (YG CS). 2021. Nordenskiold mouth April 24 2021. YouTube Video, 1:12, https://www.youtube.com/watch?v=BFJZdYxUg0Q.

Government of Yukon Water Resources Branch (YG WRB) 2011. Yukon Water: An Assessment of Climate Change Vulnerabilities. ISBN 978-1-55362-516-2. Funding provided by Indian and Northern Affairs Canada, Climate Change Adaptation Program. 98 pp.

Government of Yukon Water Resources Branch (YG WRB). 2020. Post Event Summary – Yukon River at Carmacks High Water, Freeze-up Driven December 2020.

Government of Yukon Water Resources Branch (YG WRB). 2021a. Post Event Summary – Nordenskiold River at Carmacks High Water, Break-up Driven, April/May 2021.

Government of Yukon Water Resources Branch (YG WRB). 2021b. Nordenskiold River Update, April 30 2021.

Yukon University. 2022. Flooding Information Form: Yukon River (Tàgé Cho Gé) at Carmacks. Prepared by Climate Change Research, YukonU Research Centre on 1 August 2022. 1 pp.

Appendices

Appendix A Photographic Inventory

Stantec

Photographic Log

Client:	**Government of Yukon Water Resources Branch**	**Project:**	**Carmacks Flood Mapping Study**
Site Name:	**Nordenskiold River, Yukon River**	**Site Location:**	**Carmacks, YT**

Photograph ID: 1

Photo Location:
Yukon River, upstream end of Study Area

Direction:
looking upstream from high terrace adjacent to highway

Survey Date:
5/5/2023

Comments:
Intact ice cover on May 5, 2023; note forested floodplain

Photograph ID: 2

Photo Location:
Yukon River, downstream of airport

Direction:
looking downstream from high terrace adjacent to highway

Survey Date:
5/5/2023

Comments:
Ice cover with open leads on May 5, 2023; note forested floodplain

Client:	**Government of Yukon Water Resources Branch**	**Project:**	**Carmacks Flood Mapping Study**
Site Name:	**Nordenskiold River, Yukon River**	**Site Location:**	**Carmacks, YT**

Photograph ID: 3

Photo Location:
Yukon River, downstream side of Klondike River bridge

Direction:
looking north

Survey Date:
5/5/2023

Comments:
Open lead developing beneath bridge

Photograph ID: 4

Photo Location:
Yukon River, adjacent to River Drive

Direction:
looking upstream

Survey Date:
5/6/2023

Comments:
Open channels developed overnight May 5-6, 2023 through Carmacks; photo taken morning of May 6, 2023

Client:	**Government of Yukon Water Resources Branch**	**Project:**	**Carmacks Flood Mapping Study**
Site Name:	**Nordenskiold River, Yukon River**	**Site Location:**	**Carmacks, YT**

Photograph ID: 5

Photo Location:
Yukon River, immediately downstream of confluence with Nordenskiold River

Direction:
looking across channel

Survey Date:
5/5/2023

Comments:
Open water below confluende (ice cover in place upstream of confluence per previous photos)

Photograph ID: 6

Photo Location:
Yukon River, downstream end of Study Area at island

Direction:
looking downstream from terrace adjacent to highway

Survey Date:
5/5/2023

Comments:
Open water conditions on May 5, 2023 persisted to the downstream end of the Study Area; ice present at island at downstream end

Client:	**Government of Yukon Water Resources Branch**	**Project:**	**Carmacks Flood Mapping Study**
Site Name:	**Nordenskiold River, Yukon River**	**Site Location:**	**Carmacks, YT**

Photograph ID: 7

Photo Location:
WSC Station 09AH001 - Yukon River at Carmacks

Direction:
looking at upstream at station from river left

Survey Date:
5/5/2023

Comments:

Photograph ID: 8

Photo Location:
WSC Station 09AH004 - Nordenskiold River Below Rowlinson Creek

Direction:
looking across channel from river right

Survey Date:
5/5/2023

Comments:
Flow left to right in photo; cableway for WSC Station flow measurements; note forested floodplain.

Client:	**Government of Yukon Water Resources Branch**	**Project:**	**Carmacks Flood Mapping Study**
Site Name:	**Nordenskiold River, Yukon River**	**Site Location:**	**Carmacks, YT**

Photograph ID: 9

Photo Location:
WSC Station 09AH004 - Nordenskiold River Below Rowlinson Creek

Direction:
looking downstream from river right

Survey Date:
5/3/2023

Comments:
Open water conditions; WSC Station 09AH004 visible on right

Photograph ID: 10

Photo Location:
Nordenskiold River at Casino Way

Direction:
looking downstream towards bridge (in construction)

Survey Date:
5/3/2023

Comments:
Open water conditions at bridge crossing; ; note forested floodplain.

Client:	**Government of Yukon Water Resources Branch**	**Project:**	**Carmacks Flood Mapping Study**
Site Name:	**Nordenskiold River, Yukon River**	**Site Location:**	**Carmacks, YT**

Photograph ID: 11

Photo Location:
River Drive Bridge

Direction:
looking upstream at left bank

Survey Date:
5/3/2023

Comments:
YG WRB Hydrometric Station Staff Gage

Photograph ID: 12

Photo Location:
River Drive Bridge

Direction:
looking downstream at station

Survey Date:
5/3/2023

Comments:
YG WRB Hydrometric Station

Client:	**Government of Yukon Water Resources Branch**	**Project:**	**Carmacks Flood Mapping Study**
Site Name:	**Nordenskiold River, Yukon River**	**Site Location:**	**Carmacks, YT**

Photograph ID: 13

Photo Location:
Nordenskiold River at Ice Jam Toe Location below River Drive bridge

Direction:
looking slightly upstream from river left

Survey Date:
7/21/2023

Comments:
Ice Jam Toe Location below River Drive bridge; note forested floodplain.

Photograph ID: 14

Photo Location:
Nordenskiold River near confluence with Yukon River

Direction:
looking downstream from river left

Survey Date:
5/3/2023

Comments:
Open water on the Nordenskiold River and in Yukon River downstream of confluence; ice thickness ~0.5 - 1.0 m

Appendix B Hydrology

WSC Station 09AH004 - NORDENSKIOLD RIVER BELOW ROWLINSON CREEK
Break-up, Open Water and Freeze-up Summary - Event Timing and Magnitudes

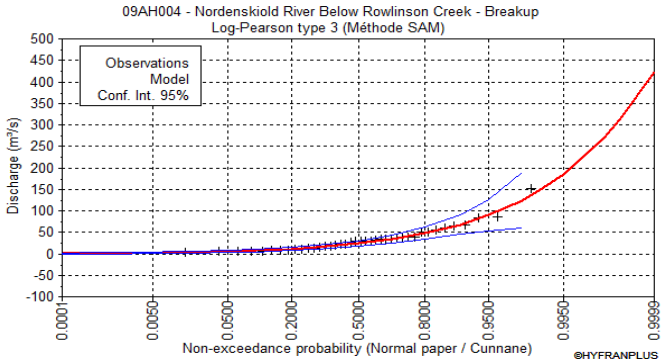
Breakup						Open Water			Freeze-up					
Peak Breakup Date	Peak Timing/Magnitude Method	Hydrograph: Peak Q during breakup (m3/s)	Gap filling: Estimated Peak breakup Q (m3/s)	Final peak breakup Q (m3/s)	Peak Stage During Break-up (m)	Open Water Peak Date	Peak Q During Open Water (m3/s)	Peak Stage During Open Water (m)	Freeze-up Peak Date	Peak Timing/Magnitude Method	Hydrograph: Peak Q During Freeze-up (m3/s)	Gap filling: Estimated Peak Freeze-up Q (m3/s)	Final Peak Freeze-up Q (m3/s)	Peak Stage During Freeze-up (m)
n/a	Annual Hydrograph	n/a			n/a	n/a	n/a	n/a	22-Nov-82	Annual Hydrograph	9		9	n/a
26-Apr-83	Annual Hydrograph	9		9	n/a	04-Jun-83	185	4.13	10-Nov-83	Gap filling	Unknown	7	7	n/a
16-Apr-84	Annual Hydrograph	4		4	n/a	05-Jun-84	56	3.57	9-Nov-84	Annual Hydrograph	4		4	n/a
2-May-85	Annual Hydrograph	5		5	n/a	27-May-85	97	3.76	9-Nov-85	Annual Hydrograph	9		9	n/a
13-May-86	Gap filling	Unknown	20	20	n/a	31-May-86	118	3.91	25-Oct-86	Annual Hydrograph	17		17	n/a
13-May-87	Annual Hydrograph	35		35	3.69	18-May-87	71	3.69	12-Oct-87	Annual Hydrograph	8		8	n/a
5-May-88	Annual Hydrograph	33		33	3.36	17-Jul-88	103	3.87	28-Oct-88	Annual Hydrograph	12		12	n/a
26-Apr-89	Annual Hydrograph	30		30	n/a	01-May-89	119	3.99	29-Nov-89	Annual Hydrograph	7		7	n/a
25-Apr-90	Annual Hydrograph	7		7	n/a	01-May-90	59	3.58	16-Oct-90	Annual Hydrograph	11		11	n/a
28-Apr-91	Gap filling	Unknown	35	35	n/a	06-May-91	114	3.96	29-Oct-91	Annual Hydrograph	21		21	n/a
17-May-92	Annual Hydrograph	61		61	3.615	28-May-92	199	4.38	24-Oct-92	Annual Hydrograph	18		18	n/a
30-Apr-93	Annual Hydrograph	78		78	3.695	30-May-93	94	3.80	30-Oct-93	Annual Hydrograph	18		18	n/a
26-Apr-94	Gap filling	Unknown	17	17	n/a	16-May-94	40	3.39	31-Oct-94	Annual Hydrograph	10		10	n/a
24-Apr-95	Gap filling	Unknown	5	5	n/a	03-May-95	36	3.36	24-Oct-95	Annual Hydrograph	11		11	n/a
4-May-96	Annual Hydrograph	31		31	3.29	17-Jul-96	48	3.48	4-Nov-96	Annual Hydrograph	6		6	n/a
2-May-97	Gap filling	Unknown	11	11	n/a	20-May-97	89	3.76	21-Oct-97	Annual Hydrograph	6		6	n/a
24-Apr-98	Gap filling	Unknown	7	7	n/a	06-May-98	40	3.38	8-Nov-98	Annual Hydrograph	3		3	n/a
13-May-99	Annual Hydrograph	17		17	3.11	06-Jun-99	84	3.7	5-Nov-99	Gap filling	Unknown	3	3	2.97
30-Apr-00	Annual Hydrograph	28		28	n/a	23-Aug-00	120	3.97	11-Nov-00	Gap filling	Unknown	18	18	n/a
17-May-01	Annual Hydrograph	34		34	n/a	04-Jun-01	91	3.78	20-Oct-01	Annual Hydrograph	18		18	n/a
12-May-02	Gap filling	Unknown	21	21	n/a	18-May-02	72	n/a	20-Nov-02	Gap filling	Unknown	6	6	n/a
1-May-03	Annual Hydrograph	46		46	n/a	22-Jun-03	45	3.44	2-Nov-03	Annual Hydrograph	5		5	n/a
2-May-04	Gap filling	Unknown	27	27	n/a	09-May-04	96	3.82	2-Nov-04	Annual Hydrograph	7		7	2.98
29-Apr-05	Annual Hydrograph	60		60	3.97	16-Sep-05	27	3.27	6-Nov-05	Annual Hydrograph	11		11	3.72
11-May-06	Annual Hydrograph	14		14	3.51	22-May-06	72	3.63	5-Nov-06	Annual Hydrograph	7		7	3.36
2-May-07	Gap filling	Unknown	17	17	n/a	19-May-07	64	3.57	21-Nov-07	Annual Hydrograph	9		9	3.76
30-Apr-08	Annual Hydrograph	7		7	3.21	27-Aug-08	115	3.9	20-Nov-08	Annual Hydrograph	16		16	4.22
3-May-09	Gap filling	Unknown	55	55	n/a	08-May-09	206	4.26	9-Nov-09	Annual Hydrograph	8		8	3.49
27-Apr-10	Annual Hydrograph	13		13	2.95	01-May-10	47	3.31	8-Nov-10	Annual Hydrograph	13		13	3.63
10-May-11	Annual Hydrograph	76		76	3.49	21-May-11	131	3.85	11-Nov-11	Annual Hydrograph	24		24	4.66
29-Apr-12	Annual Hydrograph	31		31	3.25	26-May-12	96	3.64	10-Nov-12	Annual Hydrograph	19		19	4.64
15-May-13	Gap filling	Unknown	138	138	n/a	14-May-13	144	3.93	20-Nov-13	Annual Hydrograph	11		11	4.3
1-May-14	Annual Hydrograph	28		28	3.77	06-May-14	96	3.64	19-Nov-14	Annual Hydrograph	12		12	4.13
26-Apr-15	Gap filling	Unknown	9	9	n/a	29-Aug-15	71	3.46	22-Nov-15	Annual Hydrograph	13		13	4.61
16-Apr-16	Annual Hydrograph	26		26	3.43	12-May-16	46	3.24	27-Oct-16	Annual Hydrograph	15		15	3.69
24-Apr-17	Annual Hydrograph	6		6	3.19	20-Jul-17	87	3.56	5-Nov-17	Annual Hydrograph	13		13	n/a
3-May-18	Gap filling	Unknown	25	25	n/a	12-May-18	106	3.69	5-Nov-18	Annual Hydrograph	9		9	3.48
2-Apr-19	Annual Hydrograph	6		6	3.65	04-Jun-19	37	3.16	16-Nov-19	Annual Hydrograph	9		9	4.14
22-Apr-20	Hydrograph Analysis	50		50	3.8	10-May-20	103	3.67	21-Nov-20	Annual Hydrograph	15		15	4.86
29-Apr-21	Annual Hydrograph	26		26	4.2	11-May-21	148	3.89	21-Nov-21	Annual Hydrograph	14		14	4.57
8-May-22	Gap filling	Unknown	50	50	n/a	28-May-22	181	4.05	17-Nov-22	Annual Hydrograph	15		15	4.16

WSC Station 09AH004 - NORDENSKIOLD RIVER BELOW ROWLINSON CREEK
FFA results for Breakup, Open Water and Freeze-up Summary

Breakup

Date	Daily Average Max Q (m3/s)	Scaled Max Q (m3/s)
26-Apr-83	9	9
16-Apr-84	4	4
2-May-85	5	5
13-May-86	20	21
13-May-87	35	39
5-May-88	33	36
26-Apr-89	30	33
25-Apr-90	7	8
28-Apr-91	35	39
17-May-92	61	67
30-Apr-93	78	86
26-Apr-94	17	18
24-Apr-95	5	6
4-May-96	31	34
2-May-97	11	12
24-Apr-98	7	8
13-May-99	17	19
30-Apr-00	28	31
17-May-01	34	38
12-May-02	21	23
1-May-03	46	51
2-May-04	27	30
29-Apr-05	60	66
11-May-06	14	15
2-May-07	17	19
30-Apr-08	7	7
3-May-09	55	61
27-Apr-10	13	14
10-May-11	76	83
29-Apr-12	31	34
15-May-13	138	152
1-May-14	28	30
26-Apr-15	9	10
16-Apr-16	26	29
24-Apr-17	6	7
3-May-18	25	28
2-Apr-19	6	7
22-Apr-20	-	50.1
29-Apr-21	26	28.7
8-May-22	50	54.5

T	q	XT	Standard	C.I.
500	0.998	231	110	N/D
200	0.995	185	71.3	N/D
100	0.99	153	49.4	N/D
50	0.98	124	33.1	59.5 - 189
20	0.95	91	18.6	54.1 - 127
10	0.9	68	11.8	44.9 - 91.0
5	0.8	48	7.29	33.3 - 61.9
2	0.5	24	3.44	16.9 - 30.4

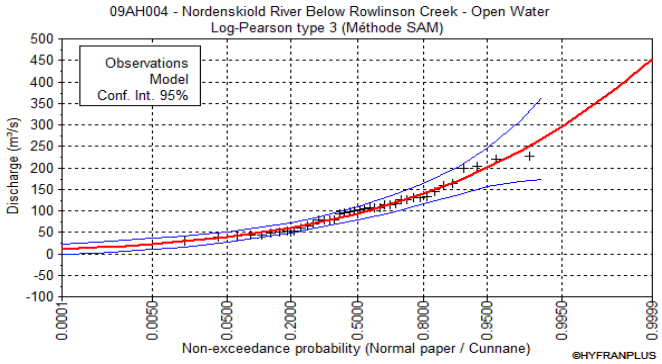


WSC Station 09AH004 - NORDENSKIOLD RIVER BELOW ROWLINSON CREEK
FFA results for Breakup, Open Water and Freeze-up Summary

Open Water

Date	Daily Average Max Q (m3/s)	Scaled Max Q (m3/s)
4-Jun-83	185	204
5-Jun-84	55.5	61
27-May-85	96.7	106
31-May-86	118	130
18-May-87	71.2	78
17-Jul-88	103	113
1-May-89	119	131
1-May-90	59	65
6-May-91	114	125
28-May-92	199	219
30-May-93	94	103
16-May-94	39.6	44
3-May-95	35.9	39
17-Jul-96	47.7	52
20-May-97	89.1	98
6-May-98	39.6	44
6-Jun-99	83.7	92
23-Aug-00	120	132
4-Jun-01	90.5	100
18-May-02	71.7	79
22-Jun-03	44.8	49
9-May-04	96.3	106
16-Sep-05	26.6	29
22-May-06	71.9	79
19-May-07	63.7	70
27-Aug-08	115	127
8-May-09	206	227
1-May-10	47.1	52
21-May-11	131	144
26-May-12	96.4	106
14-May-13	144	158
6-May-14	95.7	105
29-Aug-15	71.3	78
12-May-16	46.2	51
20-Jul-17	86.6	95
12-May-18	106	117
4-Jun-19	36.9	41
10-May-20	103	113
11-May-21	148	163
28-May-22	181	199

T	q	XT	Standard	C.I.
500	0.998	333	88.7	N/D
200	0.995	296	64.1	N/D
100	0.99	267	48.6	172 - 363
50	0.98	239	35.7	169 - 309
20	0.95	201	23	156 - 246
10	0.9	171	16.5	139 - 203
5	0.8	140	12.1	116 - 164
2	0.5	93.3	7.98	77.7 - 109

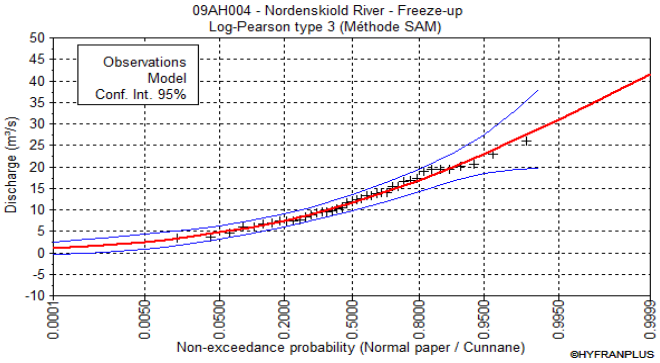


WSC Station 09AH004 - NORDENSKIOLD RIVER BELOW ROWLINSON CREEK
FFA results for Breakup, Open Water and Freeze-up Summary

Freeze-Up

Date	Daily Average Max Q (m3/s)	Scaled Max Q (m3/s)
22-Nov-82	8.5	9.4
10-Nov-83	6.8	7.5
9-Nov-84	4.3	4.7
9-Nov-85	8.8	9.7
25-Oct-86	17.3	19.0
12-Oct-87	8.1	8.9
28-Oct-88	12.1	13.3
29-Nov-89	6.6	7.3
16-Oct-90	11.3	12.4
29-Oct-91	20.9	23.0
24-Oct-92	17.5	19.3
30-Oct-93	18.3	20.1
31-Oct-94	9.6	10.5
24-Oct-95	10.7	11.8
4-Nov-96	6.3	6.9
21-Oct-97	6.2	6.8
8-Nov-98	3.0	3.3
5-Nov-99	3.4	3.7
11-Nov-00	17.6	19.4
20-Oct-01	17.7	19.5
20-Nov-02	5.5	6.1
2-Nov-03	5.4	5.9
2-Nov-04	6.7	7.4
6-Nov-05	10.5	11.6
5-Nov-06	6.9	7.6
21-Nov-07	9.3	10.2
20-Nov-08	15.6	17.2
9-Nov-09	7.7	8.4
8-Nov-10	12.5	13.8
11-Nov-11	23.7	26.1
10-Nov-12	18.7	20.6
20-Nov-13	11.4	12.5
19-Nov-14	12.1	13.3
22-Nov-15	12.7	14.0
27-Oct-16	15.0	16.5
5-Nov-17	12.7	14.0
5-Nov-18	8.7	9.5
16-Nov-19	8.8	9.6
21-Nov-20	15.0	16.5
21-Nov-21	14.0	15.4
17-Nov-22	15.3	16.8

T	q	XT	Standard	C.I.
500	0.998	34	8.18	N/D
200	0.995	31	6.13	N/D
100	0.99	29	4.74	19.5 - 38.1
50	0.98	26	3.52	19.5 - 33.3
20	0.95	23	2.26	18.5 - 27.4
10	0.9	20	1.65	16.9 - 23.3
5	0.8	17	1.3	14.3 - 19.4
2	0.5	12	0.968	9.66 - 13.5



WSC Station 09AH004 - Nordenskiold River Below Rowlinson Creek
Scaling Factor

Annual Max Instantaneous Discharge				Annual Maximum Daily Discharge		
Year	HH:MM	MM--DD	Max Q (m3/s)	MM--DD	Max Q (m3/s)	Annual Scaling Factor - Peak Instantaneous : Maximum Daily Discharge
1983	22:30	06--03	244	06--04	185	1.32
1984	5:04	06--05	55.8	06--05	55.5	1.01
1985	4:25	05--27	98	05--27	96.7	1.01
1986	10:37	05--31	119	05--31	118	1.01
1987	21:15	05--18	76	05--18	71.2	1.07
1988	5:20	07--17	106	07--17	103	1.03
1989	18:42	04--30	124	05--01	119	1.04
1990	19:44	05--01	63.6	05--01	59	1.08
1991	1:41	05--07	117	05--06	114	1.03
1992	9:57	05--28	207	05--28	199	1.04
1993	19:46	05--29	101	05--30	94	1.07
1994	4:07	05--16	40.1	05--16	39.6	1.01
1995	21:00	05--03	38.1	05--03	35.9	1.06
1996	21:30	07--16	53.3	07--17	47.7	1.12
1997	20:00	05--20	90.6	05--20	89.1	1.02
1998	23:15	05--05	43.4	05--06	39.6	1.10
1999	6:00	06--06	85.5	06--06	83.7	1.02
2000	11:30	08--23	121	08--23	120	1.01
2001	21:00	06--17	97.3	06--04	90.5	-
2002	0:00	05--18	71.7	05--18	71.7	1.00
2003	-	-	-	05--01	46	-
2004	23:55	05--08	109	05--09	96.3	1.13
2005	22:18	04--29	67.9	04--29	59.6	1.14
2006	5:00	05--22	77.2	05--22	71.9	1.07
2007	4:30	05--19	70.9	05--19	63.7	1.11
2008	14:05	08--26	123	08--27	115	1.07
2009	4:50	05--08	224	05--08	206	1.09
2010	18:35	05--01	52.9	05--01	47.1	1.12
2011	6:15	05--21	144	05--21	131	1.10
2012	11:25	05--25	102	05--26	96.4	1.06
2013	3:45	05--15	150	05--14	144	1.04
2014	8:30	05--06	98.1	05--06	95.7	1.03
2015	-	-	-	08--29	71.3	-
2016	-	-	-	05--12	46.2	-
2017	-	-	-	07--19	86.6	-
2018	19:45	05--11	114	05--11	106	1.08
2019	18:10	06--04	37.3	06--04	36.9	1.01
2011	12:00	11--15	4.682	11--15	4.659	-
2012	8:30	11--08	4.653	11--08	4.642	-
2013	-	-	-	-	-	-
2014	22:45	11--18	4.175	11--18	4.126	-
2015	-	-	-	-	-	-
2016	-	-	-	-	-	-
2017	-	-	-	-	-	-
2018	-	-	-	-	-	-
2019	12:05	11--16	4.154	11--16	4.146	-

Average Scaling Factor
(avg + 1 std dev)

1.10

WSC Station 09AH001 - YUKON RIVER AT CARMACKS

Break-up, Open Water and Freeze-up Summary - Event Timing and Magnitudes

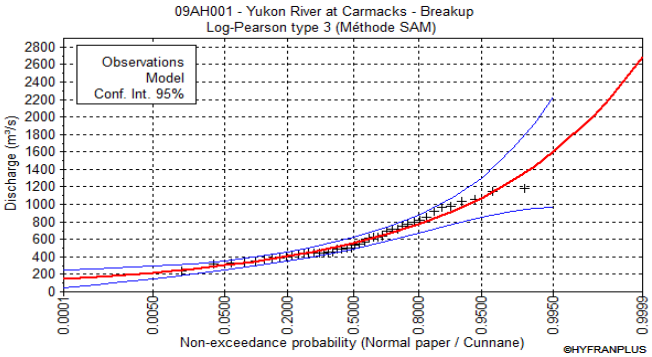
Breakup						Open Water							Freeze-up					
Break-up Peak Q Date	Peak Timing/Magnitude Method	Hydrograph: Peak Q during breakup (m3/s)	Gap Filling: Estimated Peak breakup Q (m3/s)	Final peak breakup Q (m3/s)	Peak Stage During Breakup (m)	Open Water Peak Date	Peak Timing/Magnitude Method	Peak Q During Open Water (m3/s)	Gap Filling: Regression (09CD001) (m3/s)	WSC Rating Curve #7	Peak break-up with gap filling (m3/s)	Peak Stage During Open Water (m)	Freeze-up Peak Date	Peak Timing/Magnitude Method	Hydrograph: Peak Q During Freeze-up (m3/s)	Gap filling: Estimated Peak Freeze-up Q (m3/s)	Final Peak Freeze-up Q (m3/s)	Peak Stage During Freeze-up (m)
n/a		n/a	No MET data		n/a	n/a		n/a				n/a	Unknown	Data gap	Unknown	430		n/a
15-May-52	Annual Hydrograph	234	Unknown	234	n/a	2-Jul-52	Annual Hydrograph	2200			2200	n/a	3-Dec-52	Annual Hydrograph	623	No MET data	623	n/a
25-May-53	Gap filling	Unknown	1010	1010	n/a	5-Sep-53	Annual Hydrograph	1580			1580	n/a	6-Nov-53	Gap filling	Unknown	733	733	n/a
28-May-54	Annual Hydrograph	1160		1160	n/a	14-Jun-54	Annual Hydrograph	1700			1700	n/a	23-Nov-54	Annual Hydrograph	493		493	n/a
25-May-55	Annual Hydrograph	606		606	n/a	8-Jul-55	Annual Hydrograph	1770			1770	n/a	6-Nov-55	Annual Hydrograph	402		402	n/a
24-May-56	Gap filling	Unknown	697	697	n/a	12-Jun-56	Annual Hydrograph	1350			1350	n/a	2-Dec-56	Gap filling	Unknown	233	233	n/a
18-May-57	Gap filling	Unknown	736	736	n/a	16-Jun-57	Annual Hydrograph	2510			2510	n/a	23-Nov-57	Annual Hydrograph	538		538	n/a
9-May-58	Annual Hydrograph	354		354	n/a	15-Jun-58	Annual Hydrograph	1150			1150	n/a	7-Dec-58	Annual Hydrograph	289		289	n/a
18-May-59	Gap filling	Unknown	425	425	n/a	1-Jul-59	Annual Hydrograph	1840			1840	n/a	24-Nov-59	Gap filling	Unknown	300	300	n/a
12-May-60	Annual Hydrograph	1130		1130	n/a	1-Jul-60	Annual Hydrograph	1880			1880	n/a	17-Nov-60	Gap filling	484		484	n/a
16-May-61	Gap filling	Unknown	345	345	n/a	21-Jun-61	Annual Hydrograph	2590			2590	n/a	Unknown	Data Gaps	Data Gaps	Data Gaps	-	n/a
17-May-62	Gap filling	Unknown	422	422	n/a	24-Jun-62	Annual Hydrograph	3600			3600	n/a	Unknown	Data Gaps	Data Gaps	Data Gaps	-	n/a
10-May-63	Annual Hydrograph	784		784	n/a	13-Jul-63	Annual Hydrograph	2380			2380	n/a	Unknown	Data Gaps	Data Gaps	Data Gaps	-	n/a
23-May-64	Annual Hydrograph	394		394	n/a	23-Jun-64	Annual Hydrograph	2890			2890	n/a	6-Nov-64	Annual Hydrograph	756		756	n/a
17-May-65	Annual Hydrograph	408		408	n/a	7-Jul-65	Annual Hydrograph	1460			1460	n/a	6-Dec-65	Annual Hydrograph	481		481	n/a
13-May-66	Annual Hydrograph	450		450	n/a	18-Jun-66	Annual Hydrograph	1710			1710	n/a	30-Nov-66	Annual Hydrograph	878		878	n/a
18-May-67	Gap filling	Unknown	617	617	n/a	24-Jun-67	Annual Hydrograph	2450			2450	n/a	24-Nov-67	Annual Hydrograph	532		532	n/a
23-May-68	Annual Hydrograph	946		946	n/a	7-Jul-68	Annual Hydrograph	1650			1650	n/a	7-Dec-68	Gap filling	Unknown	453	453	n/a
31-May-69	Annual Hydrograph	1040		1040	n/a	16-Jun-69	Annual Hydrograph	1760			1760	n/a	11-Dec-69	Gap filling	Unknown	447	447	n/a
9-May-70	Annual Hydrograph	320		320	2.4	22-Jul-70	Annual Hydrograph	1380			1380	3.89	20-Dec-70	Annual Hydrograph	411		411	n/a
14-May-71	Annual Hydrograph	524		524	2.2	22-Jun-71	Annual Hydrograph	1950			1950	4.68	26-Nov-71	Annual Hydrograph	368		368	n/a
23-May-72	Annual Hydrograph	759		759	2.8	27-Jun-72	Annual Hydrograph	2410			2410	5.22	6-Dec-72	Annual Hydrograph	266		266	n/a
17-May-73	Annual Hydrograph	801		801	2.8	2-Jul-73	Annual Hydrograph	1800			1800	4.46	24-Nov-73	Annual Hydrograph	306		306	n/a
12-May-74	Annual Hydrograph	436		436	2.8	7-Aug-74	Annual Hydrograph	1730			1730	4.39	17-Dec-74	Annual Hydrograph	402		402	n/a
13-May-75	Annual Hydrograph	841		841	3.0	20-Jul-75	Annual Hydrograph	2020			2020	4.76	23-Nov-75	Gap filling	Unknown	453	453	n/a
7-May-76	Annual Hydrograph	903		903	4.5	2-Jul-76	Annual Hydrograph	2250			2250	5.03	14-Dec-76	Annual Hydrograph	391		391	n/a
27-Apr-77	Annual Hydrograph	439		439	3.5	21-Jun-77	Annual Hydrograph	2000			2000	4.74	26-Nov-77	Annual Hydrograph	484		484	n/a
7-May-78	Annual Hydrograph	623		623	2.9	17-Jun-78	Annual Hydrograph	1180			1180	3.56	29-Nov-78	Annual Hydrograph	343		343	n/a
4-May-79	Annual Hydrograph	708		708	3.3	8-Jul-79	Annual Hydrograph	2250			2250	5.09	17-Dec-79	Annual Hydrograph	513		513	n/a
17-May-80	Annual Hydrograph	615		615	2.5	19-Jun-80	Annual Hydrograph	1510			1510	3.99	9-Dec-80	Annual Hydrograph	485		485	n/a
9-May-81	Annual Hydrograph	536		536	3.0	24-Jun-81	Annual Hydrograph	1780			1780	4.46	13-Dec-81	Gap filling	Unknown	430	430	n/a
18-May-82	Annual Hydrograph	490		490	2.6	21-Jun-82	Annual Hydrograph	1610			1610	4.21	22-Nov-82	Gap filling	Unknown	387	387	n/a
28-May-83	Annual Hydrograph	677		677	2.7	12-Jun-83	Annual Hydrograph	1480			1480	4.01	8-Dec-83	Gap filling	Unknown	332	332	n/a
8-May-84	Annual Hydrograph	313		313	2.7	29-Jun-84	Annual Hydrograph	1460			1460	3.98	26-Oct-80	Annual Hydrograph	509		509	n/a
14-May-85	Annual Hydrograph	326		326	2.6	13-Jul-85	Annual Hydrograph	1870			1870	4.57	20-Nov-85	Gap filling	Unknown	365	365	n/a
15-May-86	Annual Hydrograph	475		475	3.1	8-Jul-86	Annual Hydrograph	2110			2110	4.87	24-Nov-86	Gap filling	Unknown	655	655	n/a
19-May-87	Annual Hydrograph	553		553	2.7	3-Jul-87	Annual Hydrograph	1760			1760	4.42	29-Dec-87	Annual Hydrograph	340		340	n/a
5-May-88	Annual Hydrograph	367		367	2.9	18-Jul-88	Annual Hydrograph	2440			2440	5.24	5-Dec-88	Gap filling	Unknown	459	459	n/a
28-Apr-89	Annual Hydrograph	960		960	3.7	7-Jun-89	Annual Hydrograph	1400			1400	3.897	18-Nov-89	Gap filling	Unknown	460	460	n/a
2-May-90	Annual Hydrograph	436		436	2.0	15-Jun-90	Annual Hydrograph	2040			2040	4.78	8-Nov-90	Annual Hydrograph	604		604	n/a
7-May-91	Annual Hydrograph	492		492	2.6	24-Sep-91	Annual Hydrograph	1650			1650	4.22	28-Nov-91	Gap filling	Unknown	655	655	n/a
30-May-92	Annual Hydrograph	450		450	3.4	23-Jun-92	Annual Hydrograph	2870			2870	5.89	20-Nov-92	Annual Hydrograph	460		460	n/a
4-May-93	Annual Hydrograph	481		481	2.7	17-Jun-93	Annual Hydrograph	1800			1800	4.49	7-Dec-93	Gap filling	Unknown	344	344	n/a
1-May-94	Gap filling	Unknown	430	430	n/a	21-Jun-94	Annual Hydrograph	1750			1750	4.43	28-Nov-94	Gap filling	Unknown	640	640	n/a
28-Apr-95	Gap filling	Unknown	378	378	n/a	15-May-95	Annual Hydrograph	1040			1040	n/a	6-Dec-95	Annual Hydrograph	384		384	n/a
1996	Data gap			-		31-May-96	Regression Analysis		1479		1479		1996	Data gap			-	
1997	Data gap			-		9-Jun-97	Regression Analysis		1886		1886		1997	Data gap			-	
1998	Data gap			-		31-May-98	Regression Analysis		1641		1641		1998	Data gap			-	
1999	Data gap			-		17-Jun-99	Regression Analysis		1670		1670		1999	Data gap			-	
2000	Data gap			-		29-Sep-00	Regression Analysis		2147		2147		2000	Data gap			-	
2001	Data gap			-		17-Jun-01	Regression Analysis		2653		2653		2001	Data gap			-	
2002	Data gap			-		2-Sep-02	Regression Analysis		1684		1684		2002	Data gap			-	
2003	Data gap			-		12-Jun-03	Regression Analysis		1295		1295		2003	Data gap			-	
2004	Data gap			-		9-Jun-04	Regression Analysis		2510		2510		2004	Data gap			-	
2005	Data gap			-		21-May-05	Regression Analysis		2543		2543		2005	Data gap			-	
2006	Data gap			-		18-Jun-06	Regression Analysis		2275		2275		2006	Data gap			-	
2007	Data gap			-		7-Jun-07	Regression Analysis		2427		2427		2007	Data gap			-	
2008	Data gap			-		30-May-08	Regression Analysis		2257		2257		2008	Data gap			-	
2009	Data gap			-		8-Jun-09	Regression Analysis		2477		2477		2009	Data gap			-	
2010	Data gap			-		1-Jul-10	Regression Analysis		1387		1387		2010	Data gap			-	
2011	Data gap			-		4-Jun-11	Regression Analysis		2122		2122		2011	Data gap			-	
2012	Data gap			-		2012	Data gap		-		-		2012	Data gap			-	
2013	Data gap			-		2013	Data gap		-		-		2013	Data gap			-	
2014	Data gap			-		23-May-14	Regression Analysis		2071		2071		2014	Data gap			-	
5-May-15		n/a		-	3.05	4-Jun-15	WSC Rating Curve			1623	1623	4.45	2015		n/a		-	n/a
1-May-16		n/a		-	3.35	17-Jun-16	WSC Rating Curve			1403	1403	4.07	2016		n/a		-	n/a
21-May-17		n/a		-	2.88	20-Jul-17	WSC Rating Curve			1470	1470	4.19	2017		n/a		-	n/a
15-May-18		n/a		-	2.98	29-Jun-18	WSC Rating Curve			1277	1277	3.85	19-Dec-18		n/a		-	4.17
7-May-19		n/a		-	2.57	26-Jun-19	WSC Rating Curve			1169	1169	3.65	14-Dec-19		n/a		-	4.62
9-May-20		n/a		-	3.35	22-Jun-20	WSC Rating Curve			1892	1892	4.90	3-Dec-20		n/a		-	5.03
1-May-21		n/a		-	3.70	26-Jun-21	WSC Rating Curve			2672	2672	6.14	4-Dec-21		n/a		-	4.68
3-May-22		n/a		-	3.18	1-Jul-22	WSC Rating Curve			2964	2964	6.57	21-Nov-22		n/a		-	3.47

WSC Station 09AH001 - YUKON RIVER AT CARMACKS
FFA results for Breakup, Open Water and Freeze-up Summary

Breakup

Date	Daily Average Max Q (m3/s)	Scaled Max Q (m3/s)
15-May-52	234	239
25-May-53	1010	1030
28-May-54	1160	1183
25-May-55	606	618
24-May-56	697	711
18-May-57	736	751
9-May-58	354	361
18-May-59	425	434
12-May-60	1130	1153
16-May-61	345	352
17-May-62	422	430
10-May-63	784	800
23-May-64	394	402
17-May-65	408	416
13-May-66	450	459
18-May-67	617	629
23-May-68	946	965
31-May-69	1040	1061
9-May-70	320	326
14-May-71	524	534
23-May-72	759	774
17-May-73	801	817
12-May-74	436	445
13-May-75	841	858
7-May-76	903	921
27-Apr-77	439	448
7-May-78	623	635
4-May-79	708	722
17-May-80	615	627
9-May-81	536	547
18-May-82	490	500
28-May-83	677	691
8-May-84	313	319
14-May-85	326	333
15-May-86	475	485
19-May-87	553	564
5-May-88	367	374
28-Apr-89	960	979
2-May-90	436	445
7-May-91	492	502
30-May-92	450	459
4-May-93	481	491
1-May-94	430	439
28-Apr-95	378	386

T	q	XT	Standard	C.I.
500	0.998	1830	446	N/D
200	0.995	1600	323	968 - 2230
100	0.99	1440	246	955 - 1920
50	0.98	1280	181	922 - 1630
20	0.95	1070	115	848 - 1300
10	0.9	924	79.2	769 - 1080
5	0.8	773	54.6	666 - 880
2	0.5	555	34.7	487 - 623

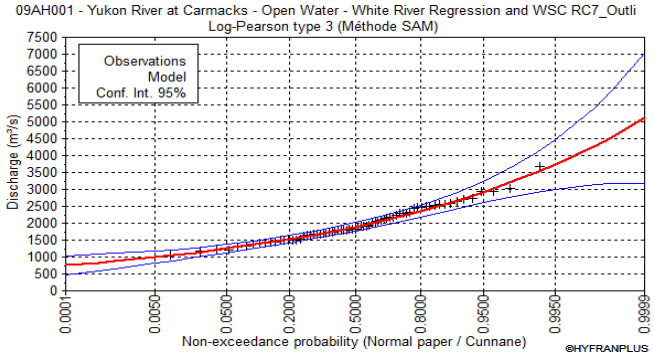


WSC Station 09AH001 - YUKON RIVER AT CARMACKS
FFA results for Breakup, Open Water and Freeze-up Summary

Open Water

Date	Daily Average Max Q (m3/s)	Scaled Max Q (m3/s)
2-Jul-52	2200	2244
5-Sep-53	1580	1612
14-Jun-54	1700	1734
8-Jul-55	1770	1805
12-Jun-56	1350	1377
16-Jun-57	2510	2560
15-Jun-58	1150	1173
1-Jul-59	1840	1877
1-Jul-60	1880	1918
21-Jun-61	2590	2642
24-Jun-62	3600	3672
13-Jul-63	2380	2428
23-Jun-64	2890	2948
7-Jul-65	1460	1489
18-Jun-66	1710	1744
24-Jun-67	2450	2499
7-Jul-68	1650	1683
16-Jun-69	1760	1795
22-Jul-70	1380	1408
22-Jun-71	1950	1989
27-Jun-72	2410	2458
2-Jul-73	1800	1836
7-Aug-74	1730	1765
20-Jul-75	2020	2060
2-Jul-76	2250	2295
21-Jun-77	2000	2040
17-Jun-78	1180	1204
8-Jul-79	2250	2295
19-Jun-80	1510	1540
24-Jun-81	1780	1816
21-Jun-82	1610	1642
12-Jun-83	1480	1510
29-Jun-84	1460	1489
13-Jul-85	1870	1907
8-Jul-86	2110	2152
3-Jul-87	1760	1795
18-Jul-88	2440	2489
7-Jun-89	1400	1428
15-Jun-90	2040	2081
24-Sep-91	1650	1683
23-Jun-92	2870	2927
17-Jun-93	1800	1836
21-Jun-94	1750	1785
15-May-95	1040	1061
31-May-96	1479	1508
9-Jun-97	1886	1924
31-May-98	1641	1674
17-Jun-99	1670	1703
29-Sep-00	2147	2190
17-Jun-01	2653	2706
2-Sep-02	1684	1718
12-Jun-03	1295	1320
9-Jun-04	2510	2561
21-May-05	2543	2594
18-Jun-06	2275	2321
7-Jun-07	2427	2476
30-May-08	2257	2303
8-Jun-09	2477	2527
1-Jul-10	1387	1415
4-Jun-11	2122	2164
23-May-14	2071	2112
4-Jun-15	1623	1656
17-Jun-16	1403	1431
20-Jul-17	1470	1499
29-Jun-18	1277	1303
26-Jun-19	1169	1193
22-Jun-20	1892	1930
26-Jun-21	2672	2726
1-Jul-22	2964	3023

T	q	XT	Standard	C.I.
500	0.998	4060	490	3100 - 5020
200	0.995	3740	374	3010 - 4470
100	0.99	3500	297	2910 - 4080
50	0.98	3250	230	2800 - 3700
20	0.95	2910	157	2610 - 3220
10	0.9	2650	116	2420 - 2870
5	0.8	2360	86.7	2190 - 2530
2	0.5	1900	63	1770 - 2020

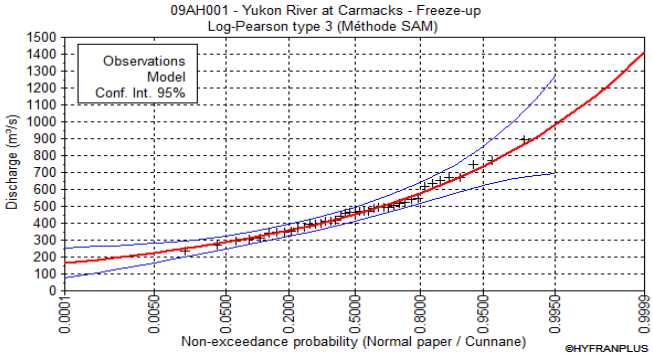


WSC Station 09AH001 - YUKON RIVER AT CARMACKS
FFA results for Breakup, Open Water and Freeze-up Summary

Freeze-up

Date	Daily Average Max Q (m3/s)	Scaled Max Q (m3/s)
3-Dec-52	623	635
6-Nov-53	733	748
23-Nov-54	493	503
6-Nov-55	402	410
2-Dec-56	233	238
23-Nov-57	538	549
7-Dec-58	289	295
24-Nov-59	300	306
17-Nov-60	484	494
6-Nov-64	756	771
6-Dec-65	481	491
30-Nov-66	878	896
24-Nov-67	532	543
7-Dec-68	453	462
11-Dec-69	447	456
20-Dec-70	411	419
26-Nov-71	368	375
6-Dec-72	266	271
24-Nov-73	306	312
17-Dec-74	402	410
23-Nov-75	453	462
14-Dec-76	391	399
26-Nov-77	484	494
29-Nov-78	343	350
17-Dec-79	513	523
9-Dec-80	485	495
13-Dec-81	430	439
22-Nov-82	387	395
8-Dec-83	332	339
26-Oct-80	509	519
20-Nov-85	365	372
24-Nov-86	655	668
29-Dec-87	340	347
5-Dec-88	459	468
18-Nov-89	460	469
8-Nov-90	604	616
28-Nov-91	655	668
20-Nov-92	460	469
7-Dec-93	344	351
28-Nov-94	640	653
6-Dec-95	384	392

T	q	XT	Standard	C.I.
500	0.998	1080	194	698 - 1460
200	0.995	981	146	694 - 1270
100	0.99	908	115	683 - 1130
50	0.98	835	87.9	662 - 1010
20	0.95	737	59	621 - 853
10	0.9	660	42.6	577 - 744
5	0.8	579	31.2	518 - 641
2	0.5	453	21.9	410 - 496



WSC Station 09AH001 - YUKON RIVER AT CARMACKS
Scaling Factor

	Annual Max Instantaneous Discharge			Annual Maximum Daily Discharge		Annual Scaling Factor - Peak Instantaneous : Maximum Daily Discharge
Year	HH:MM	MM--DD	Max Q (m3/s)	MM--DD	Max Q (m3/s)	
1952	-	-	-	07--02	2200	-
1953	-	-	-	09--05	1580	-
1954	-	-	-	06--14	1700	-
1955	-	-	-	07--08	1770	-
1956	-	-	-	06--12	1350	-
1957	-	-	-	06--16	2510	-
1958	-	-	-	06--14	1150	-
1959	-	-	-	07--02	1840	-
1960	-	-	-	07--01	1880	-
1961	8:00	06--21	2620	06--21	2590	1.01
1962	-	-	-	06--24	3600	-
1963	11:00	07--14	2390	07--13	2380	1.00
1964	3:30	06--23	2890	06--23	2890	1.00
1965	5:00	07--07	1470	07--07	1460	1.01
1966	18:15	07--09	1760	07--09	1710	1.03
1967	21:15	06--23	2490	06--23	2450	1.02
1968	9:00	07--07	1670	07--07	1650	1.01
1969	4:30	06--16	1770	06--16	1760	1.01
1970	16:30	07--22	1400	07--22	1380	1.01
1971	13:53	06--22	1970	06--22	1950	1.01
1972	10:42	06--26	2420	06--26	2410	1.00
1973	8:00	07--02	1810	07--02	1800	1.01
1974	10:42	08--07	1750	08--07	1730	1.01
1975	18:21	07--14	2040	07--20	2020	-
1976	17:05	07--02	2380	07--02	2250	1.06
1977	11:00	06--21	2010	06--21	2000	1.01
1978	10:20	06--17	1190	06--17	1180	1.01
1979	10:45	07--08	2260	07--08	2250	1.00
1980	18:21	06--18	1530	06--18	1510	1.01
1981	8:45	06--24	1790	07--05	1780	-
1982	7:25	06--21	1630	06--21	1610	1.01
1983	13:06	06--12	1490	06--12	1480	1.01
1984	14:30	06--29	1470	06--29	1460	1.01
1985	13:44	07--13	1880	07--13	1870	1.01
1986	1:10	07--04	2120	07--08	2110	-
1987	7:09	07--04	1780	07--03	1760	1.01
1988	11:16	07--17	2450	07--17	2440	1.00
1989	4:58	06--07	1420	06--07	1400	1.01
1990	2:05	06--26	2050	06--15	2040	-
1991	-	-	-	09--22	1650	-
1992	0:25	06--23	2890	06--23	2870	1.01
1993	14:29	06--16	1800	06--16	1800	1.00
1994	9:35	06--21	1760	06--21	1750	1.01
1995	-	-	-	05--15	1040	-

Average Scaling Factor
(avg + 1 std dev)

1.02

Appendix C Electronic Files

123222320 - Carmacks Flood Mapping Project

The following electronic files will be submitted to the Yukon Government Water Resources Branch:

File/Folder Name	Description of Contents	Method of Transfer
carmacks_dtm.tif	digital terrain model incorporating LiDAR elevation data from June 8th - 10th 2019 provided by YG and survey data collected by Stantec and Underhill in the summer of 2023	https://tmpsftp.stantec.com Login name: s0528151011 Password: 6008771
carmacks_dtm_bath.tif	same as carmacks_dtm.tif but areas where bathymetry data was collected has been removed.	
composite_0_5AEP_CC.tif	composite water surface elevation and digital terrain model raster file for 0.5% AEP.	
composite_0_5AEP.tif	composite water surface elevation and digital terrain model raster file for 0.5% AEP.	
composite_1AEP.tif	composite water surface elevation and digital terrain model raster file for 1% AEP.	
composite_5AEP_CC.tif	composite water surface elevation and digital terrain model raster file for 5% AEP + climate change.	
composite_5AEP.tif	composite water surface elevation and digital terrain model raster file for 5% AEP.	
Composite_Results.gdb	File Geodatabase of the open water, ice jam, and composite inundation results for all AEPs.	
HEC-RAS model	HEC-RAS hydraulic model, including plans (geometry and flow files) for: •Open water 1D calibration runs (plan ID: "1D_CalibrationRuns_FinalCalibration") •Open water 1D design runs (plan ID: "1D_DesignRuns_FinalCalibration" •1D open water sensitivity analysis, Mannings n increased 10% (plan ID: "1D_Sensitivity_Openwater_n+10%" •1D open water sensitivity analysis, Mannings n decreased 10% (plan ID: "1D_Sensitivity_Openwater_n-10%" •1D open water sensitivity analysis, downstream boundary condition increased 50% (plan ID: "1D_Sensitivity_Openwater_DSB+50%") •1D open water sensitivity analysis, downstream boundary condition decreased 50% (plan ID: "1D_Sensitivity_Openwater_DSB-50%") •1D open water design runs for 5 AEPS (5% to 0.5% + climate change) •1D ice jam model for three ice jam scenarios (0+740, 4+109 and 6+016) on Nordenskiold River (plan IDs: "1D_WithIceJam_0+740_FinalCalib", "1D_WithIceJam_4+109_FinalCalib" and "1D_WithIceJam_6+016" •1D ice jam sensitivity analysis, Mannings n increased 10% (plan ID: "1D_WithIceJam_Sensitivity+10%" •1D ice jam sensitivity analysis, Mannings n decreased 10% (plan ID: "1D_WithIceJam_Sensitivity-10%" •1D ice jam sensitivity analysis, overbank ice thickness increased by 0.2 m (plan ID: "1D_WithIceJam_Sensitivity+0.2m" •1D ice jam sensitivity analysis, overbank ice thickness decreased by 0.2 m (plan ID: "1D_WithIceJam_Sensitivity-0.2m"	

Appendix D Hydraulic Modelling

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration River: Nordenskiold Reach: Nordenskiold

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	9269	5_Nord_Primary	201.00	548.75	550.90	550.44	551.15	0.004725	2.22	90.64	61.14	0.58
Nordenskiold	9269	1_Nord_Primary	267.00	548.75	551.26	550.66	551.54	0.004149	2.37	112.58	62.59	0.56
Nordenskiold	9269	0.5_Nord_Primary	296.00	548.75	551.40	550.75	551.70	0.003998	2.44	121.44	63.23	0.56
Nordenskiold	9269	0.5_CC_Nord_Prim	356.00	548.75	551.67	550.94	552.01	0.003779	2.57	138.75	64.94	0.55
Nordenskiold	9269	5_CC_Nord_Primar	242.00	548.75	551.13	550.58	551.40	0.004330	2.32	104.50	62.01	0.57
Nordenskiold	9036	5_Nord_Primary	201.00	547.22	549.86	549.17	550.15	0.003915	2.38	84.47	44.27	0.55
Nordenskiold	9036	1_Nord_Primary	267.00	547.22	550.13	549.46	550.52	0.004547	2.76	96.75	45.86	0.60
Nordenskiold	9036	0.5_Nord_Primary	296.00	547.22	550.27	549.59	550.69	0.004610	2.88	103.07	47.12	0.61
Nordenskiold	9036	0.5_CC_Nord_Prim	356.00	547.22	550.45	549.82	550.96	0.005213	3.19	118.99	97.29	0.66
Nordenskiold	9036	5_CC_Nord_Primar	242.00	547.22	550.04	549.35	550.39	0.004280	2.61	92.61	45.30	0.58
Nordenskiold	8713	5_Nord_Primary	201.00	546.51	548.96	548.34	549.11	0.002469	1.89	166.64	174.37	0.44
Nordenskiold	8713	1_Nord_Primary	267.00	546.51	549.19	548.58	549.37	0.002574	2.09	214.00	247.25	0.46
Nordenskiold	8713	0.5_Nord_Primary	296.00	546.51	549.31	548.68	549.50	0.002674	2.20	244.53	278.52	0.47
Nordenskiold	8713	0.5_CC_Nord_Prim	356.00	546.51	549.50	548.77	549.69	0.002631	2.30	299.56	572.54	0.47
Nordenskiold	8713	5_CC_Nord_Primar	242.00	546.51	549.10	548.50	549.27	0.002595	2.03	191.79	186.91	0.45
Nordenskiold	8577	5_Nord_Primary	201.00	546.82	548.10	548.02	548.47	0.011946	2.95	93.93	132.00	0.89
Nordenskiold	8577	1_Nord_Primary	267.00	546.82	548.30	548.26	548.72	0.011356	3.20	125.34	174.38	0.89
Nordenskiold	8577	0.5_Nord_Primary	296.00	546.82	548.38	548.26	548.84	0.011312	3.33	141.46	198.02	0.90
Nordenskiold	8577	0.5_CC_Nord_Prim	356.00	546.82	548.51	548.38	549.03	0.011643	3.59	169.69	238.72	0.92
Nordenskiold	8577	5_CC_Nord_Primar	242.00	546.82	548.23	548.20	548.62	0.011132	3.07	114.74	162.68	0.87
Nordenskiold	8493	5_Nord_Primary	201.00	545.87	547.95	547.36	548.04	0.002094	1.44	176.68	156.90	0.39
Nordenskiold	8493	1_Nord_Primary	267.00	545.87	548.16	547.54	548.28	0.002187	1.62	220.01	209.76	0.40
Nordenskiold	8493	0.5_Nord_Primary	296.00	545.87	548.25	547.60	548.38	0.002297	1.72	238.87	213.93	0.42
Nordenskiold	8493	0.5_CC_Nord_Prim	356.00	545.87	548.40	547.71	548.55	0.002364	1.84	271.47	214.91	0.43
Nordenskiold	8493	5_CC_Nord_Primar	242.00	545.87	548.09	547.48	548.19	0.002162	1.56	199.50	173.72	0.40
Nordenskiold	8373	5_Nord_Primary	201.00	545.46	547.44	547.26	547.65	0.006922	2.45	132.56	146.77	0.69
Nordenskiold	8373	1_Nord_Primary	267.00	545.46	547.60	547.40	547.87	0.007540	2.77	157.60	162.65	0.73
Nordenskiold	8373	0.5_Nord_Primary	296.00	545.46	547.66	547.47	547.95	0.007874	2.91	167.94	186.48	0.76
Nordenskiold	8373	0.5_CC_Nord_Prim	356.00	545.46	547.76	547.59	548.10	0.008538	3.17	193.11	218.79	0.80
Nordenskiold	8373	5_CC_Nord_Primar	242.00	545.46	547.57	547.35	547.81	0.006610	2.57	153.88	161.06	0.69
Nordenskiold	8260	5_Nord_Primary	201.00	545.02	547.15	546.46	547.26	0.002059	1.46	148.94	143.21	0.39
Nordenskiold	8260	1_Nord_Primary	267.00	545.02	547.31	546.64	547.43	0.002182	1.62	256.01	546.44	0.40
Nordenskiold	8260	0.5_Nord_Primary	296.00	545.02	547.38	546.72	547.50	0.002200	1.67	292.85	566.64	0.41
Nordenskiold	8260	0.5_CC_Nord_Prim	356.00	545.02	547.50	546.85	547.63	0.002202	1.75	369.28	608.54	0.41
Nordenskiold	8260	5_CC_Nord_Primar	242.00	545.02	547.27	546.57	547.40	0.002262	1.62	168.09	172.03	0.41
Nordenskiold	8043	5_Nord_Primary	201.00	544.03	546.24	546.21	546.54	0.007605	2.83	136.03	222.54	0.74
Nordenskiold	8043	1_Nord_Primary	267.00	544.03	546.44	546.35	546.74	0.007139	2.98	181.49	240.07	0.73
Nordenskiold	8043	0.5_Nord_Primary	296.00	544.03	546.50	546.42	546.81	0.007207	3.07	197.35	244.35	0.74
Nordenskiold	8043	0.5_CC_Nord_Prim	356.00	544.03	546.64	546.55	546.96	0.007129	3.21	231.83	258.77	0.75
Nordenskiold	8043	5_CC_Nord_Primar	242.00	544.03	546.38	546.32	546.67	0.007088	2.90	167.01	235.48	0.72
Nordenskiold	7874	5_Nord_Primary	201.00	543.17	545.66	545.21	545.80	0.002930	2.01	212.45	368.11	0.48
Nordenskiold	7874	1_Nord_Primary	267.00	543.17	545.83	545.57	545.99	0.003222	2.24	269.83	428.23	0.51
Nordenskiold	7874	0.5_Nord_Primary	296.00	543.17	545.90	545.64	546.06	0.003253	2.30	293.29	467.08	0.51
Nordenskiold	7874	0.5_CC_Nord_Prim	356.00	543.17	546.00	545.69	546.18	0.003532	2.48	346.78	532.61	0.54
Nordenskiold	7874	5_CC_Nord_Primar	242.00	543.17	545.77	545.52	545.93	0.003166	2.18	249.81	405.72	0.50
Nordenskiold	7758	5_Nord_Primary	201.00	542.65	545.31		545.49	0.003131	2.21	196.80	354.93	0.50
Nordenskiold	7758	1_Nord_Primary	267.00	542.65	545.54		545.70	0.002803	2.25	280.48	500.30	0.48
Nordenskiold	7758	0.5_Nord_Primary	296.00	542.65	545.60		545.77	0.002857	2.31	310.89	530.33	0.48
Nordenskiold	7758	0.5_CC_Nord_Prim	356.00	542.65	545.70		545.87	0.003103	2.47	361.61	553.14	0.51
Nordenskiold	7758	5_CC_Nord_Primar	242.00	542.65	545.43		545.61	0.003176	2.31	237.15	427.65	0.50
Nordenskiold	7630	5_Nord_Primary	201.00	542.51	544.82	544.63	545.07	0.005207	2.71	154.77	277.44	0.63
Nordenskiold	7630	1_Nord_Primary	267.00	542.51	545.08	544.86	545.33	0.005030	2.85	234.95	424.67	0.63
Nordenskiold	7630	0.5_Nord_Primary	296.00	542.51	545.15	544.90	545.40	0.005075	2.91	267.80	482.05	0.64
Nordenskiold	7630	0.5_CC_Nord_Prim	356.00	542.51	545.30		545.52	0.004776	2.90	343.03	566.80	0.62
Nordenskiold	7630	5_CC_Nord_Primar	242.00	542.51	545.01		545.23	0.004608	2.68	209.58	379.18	0.60
Nordenskiold	7551	5_Nord_Primary	201.00	541.91	544.49	544.10	544.75	0.004248	2.39	119.65	226.25	0.57
Nordenskiold	7551	1_Nord_Primary	267.00	541.91	544.76	544.38	545.04	0.004000	2.54	170.52	313.61	0.56
Nordenskiold	7551	0.5_Nord_Primary	296.00	541.91	544.89	544.45	545.13	0.003626	2.46	221.04	406.87	0.54
Nordenskiold	7551	0.5_CC_Nord_Prim	356.00	541.91	545.08	544.84	545.29	0.003111	2.41	306.33	508.41	0.50
Nordenskiold	7551	5_CC_Nord_Primar	242.00	541.91	544.67	544.30	544.94	0.004127	2.50	147.06	275.16	0.57
Nordenskiold	7396	5_Nord_Primary	201.00	541.65	543.91		544.13	0.003939	2.09	98.36	79.16	0.53
Nordenskiold	7396	1_Nord_Primary	267.00	541.65	544.18		544.45	0.004130	2.35	120.65	151.26	0.55
Nordenskiold	7396	0.5_Nord_Primary	296.00	541.65	544.28		544.58	0.004158	2.45	130.80	174.80	0.56
Nordenskiold	7396	0.5_CC_Nord_Prim	356.00	541.65	544.48	543.87	544.80	0.004104	2.59	166.96	217.18	0.57
Nordenskiold	7396	5_CC_Nord_Primar	242.00	541.65	544.08		544.34	0.004097	2.26	112.15	112.79	0.55
Nordenskiold	7178	5_Nord_Primary	201.00	540.99	543.33	542.72	543.44	0.002562	1.67	150.04	109.84	0.43
Nordenskiold	7178	1_Nord_Primary	267.00	540.99	543.61	542.88	543.76	0.002485	1.83	182.03	111.81	0.44
Nordenskiold	7178	0.5_Nord_Primary	296.00	540.99	543.73	542.95	543.88	0.002458	1.90	195.35	114.37	0.44
Nordenskiold	7178	0.5_CC_Nord_Prim	356.00	540.99	543.92	543.08	544.09	0.002552	2.04	255.93	291.63	0.45
Nordenskiold	7178	5_CC_Nord_Primar	242.00	540.99	543.51	542.82	543.64	0.002490	1.77	170.61	110.69	0.43
Nordenskiold	7041	5_Nord_Primary	201.00	540.84	542.78	542.34	543.00	0.004460	2.12	100.53	79.03	0.56

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	7041	1_Nord_Primary	267.00	540.84	543.04	542.54	543.32	0.004501	2.38	122.75	89.56	0.58
Nordenskiold	7041	0.5_Nord_Primary	296.00	540.84	543.14	542.63	543.45	0.004574	2.49	132.11	99.22	0.59
Nordenskiold	7041	0.5_CC_Nord_Prim	356.00	540.84	543.31	542.79	543.65	0.004615	2.65	171.33	237.67	0.60
Nordenskiold	7041	5_CC_Nord_Primar	242.00	540.84	542.95	542.47	543.21	0.004476	2.29	114.70	87.66	0.58
Nordenskiold	6766	5_Nord_Primary	201.00	539.57	541.45		541.66	0.005340	2.06	98.02	141.75	0.60
Nordenskiold	6766	1_Nord_Primary	267.00	539.57	541.64		541.92	0.005801	2.36	116.02	322.89	0.64
Nordenskiold	6766	0.5_Nord_Primary	296.00	539.57	541.72		542.03	0.005839	2.46	125.31	392.29	0.65
Nordenskiold	6766	0.5_CC_Nord_Prim	356.00	539.57	541.91	541.50	542.25	0.005610	2.60	148.74	501.81	0.64
Nordenskiold	6766	5_CC_Nord_Primar	242.00	539.57	541.57		541.83	0.005693	2.26	108.88	259.83	0.63
Nordenskiold	6591	5_Nord_Primary	201.00	538.90	540.93		541.02	0.002365	1.31	163.82	659.52	0.40
Nordenskiold	6591	1_Nord_Primary	267.00	538.90	541.23		541.32	0.001837	1.35	214.82	823.39	0.36
Nordenskiold	6591	0.5_Nord_Primary	296.00	538.90	541.36		541.45	0.001664	1.36	238.26	858.94	0.35
Nordenskiold	6591	0.5_CC_Nord_Prim	356.00	538.90	541.64		541.73	0.001356	1.37	292.51	875.95	0.32
Nordenskiold	6591	5_CC_Nord_Primar	242.00	538.90	541.12		541.21	0.002007	1.34	195.68	766.82	0.37
Nordenskiold	6467	5_Nord_Primary	201.00	538.01	540.39		540.59	0.004838	2.00	106.37	613.86	0.49
Nordenskiold	6467	1_Nord_Primary	267.00	538.01	540.71		540.95	0.004627	2.20	130.77	746.24	0.49
Nordenskiold	6467	0.5_Nord_Primary	296.00	538.01	540.86		541.11	0.004489	2.27	141.38	746.82	0.49
Nordenskiold	6467	0.5_CC_Nord_Prim	356.00	538.01	541.16		541.43	0.004115	2.36	163.99	748.26	0.48
Nordenskiold	6467	5_CC_Nord_Primar	242.00	538.01	540.59		540.82	0.004728	2.13	121.60	731.78	0.49
Nordenskiold	6441	5_Nord_Primary	201.00	537.91	540.09	539.68	540.41	0.005780	2.51	80.20	51.91	0.64
Nordenskiold	6441	1_Nord_Primary	267.00	537.91	540.33	539.94	540.75	0.006482	2.89	92.40	52.50	0.70
Nordenskiold	6441	0.5_Nord_Primary	296.00	537.91	540.44	540.04	540.90	0.006505	3.01	98.46	52.78	0.70
Nordenskiold	6441	0.5_CC_Nord_Prim	356.00	537.91	540.75	540.24	541.23	0.006199	3.08	115.49	58.02	0.69
Nordenskiold	6441	5_CC_Nord_Primar	242.00	537.91	540.24	539.84	540.62	0.006306	2.76	87.64	52.27	0.68
Nordenskiold	6440		Bridge									
Nordenskiold	6433	5_Nord_Primary	201.00	537.91	539.98		540.35	0.007366	2.70	74.37	51.63	0.72
Nordenskiold	6433	1_Nord_Primary	267.00	537.91	540.11		540.66	0.009760	3.28	81.31	51.96	0.84
Nordenskiold	6433	0.5_Nord_Primary	296.00	537.91	540.16	540.04	540.80	0.010918	3.54	83.73	52.08	0.89
Nordenskiold	6433	0.5_CC_Nord_Prim	356.00	537.91	540.24	540.24	541.08	0.013574	4.06	87.79	52.27	1.00
Nordenskiold	6433	5_CC_Nord_Primar	242.00	537.91	540.07		540.55	0.008818	3.07	78.94	51.85	0.79
Nordenskiold	6416	5_Nord_Primary	201.00	537.80	539.93		540.19	0.003867	2.28	91.36	567.05	0.57
Nordenskiold	6416	1_Nord_Primary	267.00	537.80	540.09		540.43	0.004454	2.60	104.46	609.31	0.62
Nordenskiold	6416	0.5_Nord_Primary	296.00	537.80	540.15		540.52	0.004696	2.73	109.47	615.39	0.64
Nordenskiold	6416	0.5_CC_Nord_Prim	356.00	537.80	540.25		540.72	0.005205	2.99	118.62	616.46	0.68
Nordenskiold	6416	5_CC_Nord_Primar	242.00	537.80	540.03		540.34	0.004237	2.48	99.82	602.30	0.60
Nordenskiold	6248	5_Nord_Primary	201.00	537.74	539.40		539.51	0.004717	1.83	199.53	478.91	0.56
Nordenskiold	6248	1_Nord_Primary	267.00	537.74	539.55		539.67	0.005003	2.04	236.11	537.71	0.58
Nordenskiold	6248	0.5_Nord_Primary	296.00	537.74	539.60		539.73	0.005146	2.13	250.21	577.84	0.60
Nordenskiold	6248	0.5_CC_Nord_Prim	356.00	537.74	539.71		539.86	0.005358	2.29	278.30	640.00	0.62
Nordenskiold	6248	5_CC_Nord_Primar	242.00	537.74	539.49		539.61	0.004905	1.97	222.79	511.96	0.57
Nordenskiold	6109	5_Nord_Primary	201.00	536.93	538.91		539.01	0.004890	2.06	233.08	697.84	0.59
Nordenskiold	6109	1_Nord_Primary	267.00	536.93	539.03		539.15	0.005152	2.24	278.62	709.45	0.61
Nordenskiold	6109	0.5_Nord_Primary	296.00	536.93	539.10		539.21	0.005041	2.27	300.95	717.42	0.61
Nordenskiold	6109	0.5_CC_Nord_Prim	356.00	536.93	539.19		539.32	0.005277	2.42	335.21	744.53	0.62
Nordenskiold	6109	5_CC_Nord_Primar	242.00	536.93	538.99		539.10	0.005058	2.17	262.14	705.80	0.60
Nordenskiold	6016	5_Nord_Primary	201.00	537.33	538.65	538.34	538.71	0.005434	1.62	240.66	370.27	0.56
Nordenskiold	6016	1_Nord_Primary	267.00	537.33	538.77	538.43	538.84	0.005613	1.79	286.61	406.74	0.58
Nordenskiold	6016	0.5_Nord_Primary	296.00	537.33	538.83	538.48	538.90	0.005925	1.91	307.55	435.19	0.61
Nordenskiold	6016	0.5_CC_Nord_Prim	356.00	537.33	538.92	538.54	539.01	0.006002	2.03	343.91	459.76	0.62
Nordenskiold	6016	5_CC_Nord_Primar	242.00	537.33	538.73	538.40	538.79	0.005519	1.73	270.03	388.17	0.58
Nordenskiold	5907	5_Nord_Primary	201.00	537.27	538.39		538.44	0.004870	1.44	262.90	441.68	0.53
Nordenskiold	5907	1_Nord_Primary	267.00	537.27	538.53		538.57	0.004701	1.57	322.01	461.50	0.53
Nordenskiold	5907	0.5_Nord_Primary	296.00	537.27	538.57		538.63	0.004710	1.63	344.86	479.66	0.54
Nordenskiold	5907	0.5_CC_Nord_Prim	356.00	537.27	538.67		538.73	0.004774	1.75	391.51	510.41	0.55
Nordenskiold	5907	5_CC_Nord_Primar	242.00	537.27	538.48		538.53	0.004667	1.51	302.24	454.29	0.53
Nordenskiold	5819	5_Nord_Primary	201.00	536.43	538.34		538.36	0.001012	0.94	430.30	519.92	0.25
Nordenskiold	5819	1_Nord_Primary	267.00	536.43	538.47		538.50	0.001180	1.07	497.79	530.02	0.27
Nordenskiold	5819	0.5_Nord_Primary	296.00	536.43	538.52		538.55	0.001259	1.13	523.02	540.26	0.28
Nordenskiold	5819	0.5_CC_Nord_Prim	356.00	536.43	538.61		538.65	0.001404	1.24	573.90	572.72	0.30
Nordenskiold	5819	5_CC_Nord_Primar	242.00	536.43	538.43		538.46	0.001103	1.02	475.95	525.53	0.26
Nordenskiold	5588	5_Nord_Primary	201.00	536.14	537.95	537.85	538.04	0.006448	1.85	239.60	577.67	0.52
Nordenskiold	5588	1_Nord_Primary	267.00	536.14	538.05		538.15	0.006899	1.99	300.80	586.72	0.54
Nordenskiold	5588	0.5_Nord_Primary	296.00	536.14	538.08		538.19	0.007166	2.06	320.37	587.20	0.55
Nordenskiold	5588	0.5_CC_Nord_Prim	356.00	536.14	538.16		538.27	0.007414	2.16	361.94	587.64	0.57
Nordenskiold	5588	5_CC_Nord_Primar	242.00	536.14	538.01		538.11	0.007175	1.99	274.21	584.58	0.55
Nordenskiold	5466	5_Nord_Primary	201.00	534.94	537.36		537.50	0.004982	2.14	236.19	577.32	0.59
Nordenskiold	5466	1_Nord_Primary	267.00	534.94	537.51		537.64	0.004721	2.21	320.03	608.27	0.58
Nordenskiold	5466	0.5_Nord_Primary	296.00	534.94	537.56		537.68	0.004540	2.22	353.52	612.84	0.57
Nordenskiold	5466	0.5_CC_Nord_Prim	356.00	534.94	537.66		537.78	0.004318	2.25	417.03	621.63	0.56
Nordenskiold	5466	5_CC_Nord_Primar	242.00	534.94	537.45		537.58	0.004711	2.16	287.86	596.14	0.58

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	5358	5_Nord_Primary	201.00	533.98	537.07	536.76	537.15	0.002833	1.69	281.51	549.65	0.40
Nordenskiold	5358	1_Nord_Primary	267.00	533.98	537.22	536.92	537.30	0.002876	1.76	368.30	609.77	0.41
Nordenskiold	5358	0.5_Nord_Primary	296.00	533.98	537.28	537.03	537.35	0.002949	1.82	401.86	636.74	0.41
Nordenskiold	5358	0.5_CC_Nord_Prim	356.00	533.98	537.39	537.09	537.46	0.002900	1.87	476.37	669.47	0.41
Nordenskiold	5358	5_CC_Nord_Primar	242.00	533.98	537.17	536.90	537.24	0.002855	1.72	335.92	575.81	0.40
Nordenskiold	5141	5_Nord_Primary	201.00	534.04	536.41		536.55	0.005383	2.10	174.33	496.52	0.51
Nordenskiold	5141	1_Nord_Primary	267.00	534.04	536.55		536.71	0.005803	2.30	234.97	611.36	0.54
Nordenskiold	5141	0.5_Nord_Primary	296.00	534.04	536.62		536.77	0.005740	2.34	263.94	651.79	0.54
Nordenskiold	5141	0.5_CC_Nord_Prim	356.00	534.04	536.73	536.53	536.90	0.005995	2.49	326.67	718.32	0.56
Nordenskiold	5141	5_CC_Nord_Primar	242.00	534.04	536.51	536.22	536.66	0.005585	2.22	214.71	573.27	0.53
Nordenskiold	4820	5_Nord_Primary	201.00	532.74	535.32	534.99	535.43	0.004206	1.92	202.76	252.41	0.49
Nordenskiold	4820	1_Nord_Primary	267.00	532.74	535.52	535.19	535.64	0.003999	2.03	254.53	257.96	0.48
Nordenskiold	4820	0.5_Nord_Primary	296.00	532.74	535.59	535.24	535.71	0.004138	2.11	271.56	270.90	0.49
Nordenskiold	4820	0.5_CC_Nord_Prim	356.00	532.74	535.69	535.33	535.82	0.004296	2.23	333.15	457.99	0.51
Nordenskiold	4820	5_CC_Nord_Primar	242.00	532.74	535.43	535.09	535.55	0.004254	2.02	231.41	253.30	0.49
Nordenskiold	4618	5_Nord_Primary	201.00	532.05	534.64	534.23	534.71	0.003912	1.64	234.16	353.37	0.39
Nordenskiold	4618	1_Nord_Primary	267.00	532.05	534.82	534.39	534.90	0.004571	1.88	299.50	381.48	0.43
Nordenskiold	4618	0.5_Nord_Primary	296.00	532.05	534.87	534.44	534.96	0.004606	1.93	321.65	386.19	0.43
Nordenskiold	4618	0.5_CC_Nord_Prim	356.00	532.05	534.98	534.54	535.07	0.004603	1.99	379.62	501.22	0.43
Nordenskiold	4618	5_CC_Nord_Primar	242.00	532.05	534.74	534.34	534.82	0.004121	1.74	271.44	374.97	0.40
Nordenskiold	4471	5_Nord_Primary	201.00	532.08	534.17		534.27	0.003747	1.87	204.11	332.31	0.45
Nordenskiold	4471	1_Nord_Primary	267.00	532.08	534.31		534.42	0.003898	2.01	250.43	352.20	0.47
Nordenskiold	4471	0.5_Nord_Primary	296.00	532.08	534.37		534.48	0.003970	2.07	268.08	362.56	0.48
Nordenskiold	4471	0.5_CC_Nord_Prim	356.00	532.08	534.47		534.59	0.004076	2.17	302.36	400.31	0.49
Nordenskiold	4471	5_CC_Nord_Primar	242.00	532.08	534.26		534.37	0.003818	1.96	234.50	344.20	0.46
Nordenskiold	4381	5_Nord_Primary	201.00	531.42	533.75		533.89	0.007069	2.21	188.14	343.23	0.56
Nordenskiold	4381	1_Nord_Primary	267.00	531.42	533.90		534.03	0.007224	2.36	234.35	352.73	0.57
Nordenskiold	4381	0.5_Nord_Primary	296.00	531.42	533.95		534.09	0.007215	2.41	252.57	363.91	0.57
Nordenskiold	4381	0.5_CC_Nord_Prim	356.00	531.42	534.06		534.21	0.007229	2.51	287.48	384.36	0.58
Nordenskiold	4381	5_CC_Nord_Primar	242.00	531.42	533.85		533.98	0.007237	2.32	217.81	349.60	0.57
Nordenskiold	4296	5_Nord_Primary	201.00	531.36	533.63		533.68	0.001378	1.20	307.88	499.18	0.29
Nordenskiold	4296	1_Nord_Primary	267.00	531.36	533.76		533.82	0.001577	1.34	372.57	520.18	0.32
Nordenskiold	4296	0.5_Nord_Primary	296.00	531.36	533.81		533.87	0.001642	1.40	400.38	552.11	0.33
Nordenskiold	4296	0.5_CC_Nord_Prim	356.00	531.36	533.91		533.98	0.001728	1.49	459.61	593.18	0.34
Nordenskiold	4296	5_CC_Nord_Primar	242.00	531.36	533.71		533.77	0.001507	1.29	349.25	504.53	0.31
Nordenskiold	4229	5_Nord_Primary	201.00	530.89	533.52		533.59	0.002556	1.45	279.97	467.61	0.40
Nordenskiold	4229	1_Nord_Primary	267.00	530.89	533.64		533.72	0.002771	1.60	336.56	468.02	0.42
Nordenskiold	4229	0.5_Nord_Primary	296.00	530.89	533.69		533.77	0.002831	1.65	359.88	468.18	0.43
Nordenskiold	4229	0.5_CC_Nord_Prim	356.00	530.89	533.80		533.88	0.002883	1.74	407.50	468.52	0.43
Nordenskiold	4229	5_CC_Nord_Primar	242.00	530.89	533.60		533.67	0.002684	1.54	316.66	467.87	0.41
Nordenskiold	4109	5_Nord_Primary	201.00	531.07	533.27		533.36	0.003148	1.70	269.07	548.98	0.47
Nordenskiold	4109	1_Nord_Primary	267.00	531.07	533.44		533.51	0.002679	1.70	360.41	563.97	0.44
Nordenskiold	4109	0.5_Nord_Primary	296.00	531.07	533.50		533.57	0.002598	1.71	393.09	566.52	0.44
Nordenskiold	4109	0.5_CC_Nord_Prim	356.00	531.07	533.62		533.68	0.002374	1.72	462.36	568.03	0.42
Nordenskiold	4109	5_CC_Nord_Primar	242.00	531.07	533.39		533.46	0.002761	1.68	331.18	562.49	0.44
Nordenskiold	3798	5_Nord_Primary	201.00	530.10	532.59		532.71	0.002592	1.70	183.02	272.39	0.41
Nordenskiold	3798	1_Nord_Primary	267.00	530.10	532.81		532.94	0.002671	1.87	267.36	456.93	0.42
Nordenskiold	3798	0.5_Nord_Primary	296.00	530.10	532.90		533.03	0.002621	1.90	309.03	493.48	0.42
Nordenskiold	3798	0.5_CC_Nord_Prim	356.00	530.10	533.03		533.18	0.002805	2.05	378.49	544.71	0.44
Nordenskiold	3798	5_CC_Nord_Primar	242.00	530.10	532.73		532.86	0.002692	1.82	233.35	415.18	0.42
Nordenskiold	3720	5_Nord_Primary	201.00	530.00	532.37		532.51	0.002579	1.76	156.09	254.56	0.44
Nordenskiold	3720	1_Nord_Primary	267.00	530.00	532.59		532.75	0.002633	1.92	233.17	446.49	0.46
Nordenskiold	3720	0.5_Nord_Primary	296.00	530.00	532.66		532.83	0.002783	2.03	265.36	479.85	0.47
Nordenskiold	3720	0.5_CC_Nord_Prim	356.00	530.00	532.79		532.97	0.002804	2.13	334.03	529.75	0.48
Nordenskiold	3720	5_CC_Nord_Primar	242.00	530.00	532.52		532.67	0.002577	1.86	203.37	385.76	0.45
Nordenskiold	3608	5_Nord_Primary	201.00	529.02	531.93	531.11	532.12	0.004409	2.03	147.12	302.21	0.45
Nordenskiold	3608	1_Nord_Primary	267.00	529.02	532.19	531.57	532.36	0.003984	2.08	251.27	514.69	0.43
Nordenskiold	3608	0.5_Nord_Primary	296.00	529.02	532.27		532.43	0.003744	2.07	297.49	541.18	0.42
Nordenskiold	3608	0.5_CC_Nord_Prim	356.00	529.02	532.44		532.57	0.003372	2.05	387.38	567.38	0.41
Nordenskiold	3608	5_CC_Nord_Primar	242.00	529.02	532.10	531.41	532.28	0.004177	2.08	208.43	452.01	0.44
Nordenskiold	3370	5_Nord_Primary	201.00	528.38	531.01		531.19	0.003777	2.03	139.66	140.59	0.45
Nordenskiold	3370	1_Nord_Primary	267.00	528.38	531.25		531.46	0.004085	2.26	176.37	176.12	0.47
Nordenskiold	3370	0.5_Nord_Primary	296.00	528.38	531.35		531.56	0.004166	2.35	195.36	222.45	0.48
Nordenskiold	3370	0.5_CC_Nord_Prim	356.00	528.38	531.52		531.76	0.004290	2.49	245.90	351.61	0.49
Nordenskiold	3370	5_CC_Nord_Primar	242.00	528.38	531.16		531.36	0.003998	2.18	162.00	154.92	0.46
Nordenskiold	3297	5_Nord_Primary	201.00	528.24	530.44	530.09	530.78	0.008027	2.81	105.96	134.03	0.69
Nordenskiold	3297	1_Nord_Primary	267.00	528.24	530.70		531.05	0.007271	2.94	143.12	150.54	0.67
Nordenskiold	3297	0.5_Nord_Primary	296.00	528.24	530.79	530.62	531.15	0.007340	3.04	156.97	183.47	0.68
Nordenskiold	3297	0.5_CC_Nord_Prim	356.00	528.24	530.94	530.80	531.32	0.007591	3.24	187.39	233.96	0.70
Nordenskiold	3297	5_CC_Nord_Primar	242.00	528.24	530.62	530.47	530.95	0.007344	2.87	130.65	143.12	0.67
Nordenskiold	3238	5_Nord_Primary	201.00	527.62	530.33		530.44	0.002878	1.55	157.03	192.08	0.37

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	3238	1_Nord_Primary	267.00	527.62	530.59		530.72	0.002895	1.67	219.64	283.22	0.38
Nordenskiold	3238	0.5_Nord_Primary	296.00	527.62	530.68		530.81	0.002969	1.73	245.45	332.60	0.38
Nordenskiold	3238	0.5_CC_Nord_Prim	356.00	527.62	530.82		530.97	0.003162	1.86	298.50	401.48	0.40
Nordenskiold	3238	5_CC_Nord_Primar	242.00	527.62	530.51		530.63	0.002823	1.62	197.25	255.53	0.37
Nordenskiold	3077	5_Nord_Primary	201.00	526.90	529.59	528.99	529.89	0.004010	2.51	107.98	141.33	0.56
Nordenskiold	3077	1_Nord_Primary	267.00	526.90	529.89	529.46	530.20	0.003882	2.66	173.17	287.33	0.56
Nordenskiold	3077	0.5_Nord_Primary	296.00	526.90	529.99	529.60	530.30	0.003801	2.71	202.26	301.45	0.56
Nordenskiold	3077	0.5_CC_Nord_Prim	356.00	526.90	530.19	529.98	530.48	0.003484	2.74	264.44	325.27	0.54
Nordenskiold	3077	5_CC_Nord_Primar	242.00	526.90	529.79	529.24	530.10	0.003966	2.62	146.73	253.36	0.57
Nordenskiold	2880	5_Nord_Primary	201.00	526.09	528.76	528.33	529.04	0.005175	2.46	96.07	89.26	0.62
Nordenskiold	2880	1_Nord_Primary	267.00	526.09	528.97	528.60	529.35	0.005773	2.83	122.20	165.33	0.67
Nordenskiold	2880	0.5_Nord_Primary	296.00	526.09	529.06	528.70	529.46	0.005879	2.94	139.03	218.67	0.68
Nordenskiold	2880	0.5_CC_Nord_Prim	356.00	526.09	529.15	528.80	529.64	0.006926	3.29	160.89	256.06	0.74
Nordenskiold	2880	5_CC_Nord_Primar	242.00	526.09	528.89	528.54	529.24	0.005618	2.71	110.96	126.94	0.65
Nordenskiold	2681	5_Nord_Primary	201.00	525.59	528.28	527.42	528.41	0.001908	1.71	190.42	237.69	0.39
Nordenskiold	2681	1_Nord_Primary	267.00	525.59	528.54	527.83	528.67	0.001853	1.83	253.58	246.58	0.39
Nordenskiold	2681	0.5_Nord_Primary	296.00	525.59	528.64	527.98	528.77	0.001842	1.88	278.02	246.83	0.39
Nordenskiold	2681	0.5_CC_Nord_Prim	356.00	525.59	528.74	528.17	528.88	0.001912	1.97	417.18	544.17	0.40
Nordenskiold	2681	5_CC_Nord_Primar	242.00	525.59	528.44	527.65	528.58	0.001877	1.79	230.25	243.94	0.39
Nordenskiold	2401	5_Nord_Primary	201.00	524.94	527.23	526.89	527.54	0.005967	2.49	93.21	127.53	0.65
Nordenskiold	2401	1_Nord_Primary	267.00	524.94	527.45	527.19	527.82	0.006111	2.76	123.40	142.25	0.68
Nordenskiold	2401	0.5_Nord_Primary	296.00	524.94	527.54	527.35	527.92	0.006158	2.86	135.44	149.79	0.68
Nordenskiold	2401	0.5_CC_Nord_Prim	356.00	524.94	527.71	527.53	528.07	0.005501	2.88	211.38	440.86	0.66
Nordenskiold	2401	5_CC_Nord_Primar	242.00	524.94	527.38	527.08	527.72	0.005955	2.65	113.47	140.32	0.66
Nordenskiold	2143	5_Nord_Primary	201.00	524.06	526.49	525.66	526.63	0.002187	1.78	171.36	248.25	0.41
Nordenskiold	2143	1_Nord_Primary	267.00	524.06	526.74	525.96	526.90	0.002165	1.92	236.63	255.68	0.42
Nordenskiold	2143	0.5_Nord_Primary	296.00	524.06	526.83	526.10	526.99	0.002202	1.98	258.42	256.51	0.42
Nordenskiold	2143	0.5_CC_Nord_Prim	356.00	524.06	526.98	526.26	527.15	0.002308	2.12	297.66	257.64	0.44
Nordenskiold	2143	5_CC_Nord_Primar	242.00	524.06	526.65	525.85	526.80	0.002222	1.89	212.23	254.66	0.42
Nordenskiold	2038	5_Nord_Primary	201.00	523.48	526.25	525.70	526.41	0.002552	2.03	162.49	172.88	0.45
Nordenskiold	2038	1_Nord_Primary	267.00	523.48	526.49		526.68	0.002848	2.29	209.06	210.98	0.48
Nordenskiold	2038	0.5_Nord_Primary	296.00	523.48	526.58		526.77	0.002850	2.34	228.38	211.47	0.49
Nordenskiold	2038	0.5_CC_Nord_Prim	356.00	523.48	526.72		526.94	0.003039	2.50	258.99	212.55	0.51
Nordenskiold	2038	5_CC_Nord_Primar	242.00	523.48	526.40		526.58	0.002761	2.20	190.72	206.16	0.47
Nordenskiold	1895	5_Nord_Primary	201.00	522.94	525.33	525.33	525.80	0.010694	3.16	82.02	117.82	0.84
Nordenskiold	1895	1_Nord_Primary	267.00	522.94	525.58	525.58	526.06	0.009721	3.33	113.91	134.42	0.82
Nordenskiold	1895	0.5_Nord_Primary	296.00	522.94	525.66	525.66	526.16	0.009740	3.44	124.68	134.80	0.83
Nordenskiold	1895	0.5_CC_Nord_Prim	356.00	522.94	525.90	525.81	526.37	0.008030	3.40	157.24	136.04	0.77
Nordenskiold	1895	5_CC_Nord_Primar	242.00	522.94	525.50	525.50	525.97	0.009724	3.23	103.97	134.07	0.81
Nordenskiold	1778	5_Nord_Primary	201.00	521.16	524.91		525.08	0.001962	1.79	116.09	80.92	0.40
Nordenskiold	1778	1_Nord_Primary	267.00	521.16	525.27		525.47	0.001988	2.00	154.19	136.71	0.41
Nordenskiold	1778	0.5_Nord_Primary	296.00	521.16	525.41		525.62	0.001968	2.07	174.17	146.62	0.41
Nordenskiold	1778	0.5_CC_Nord_Prim	356.00	521.16	525.68		525.90	0.001900	2.17	214.22	149.35	0.41
Nordenskiold	1778	5_CC_Nord_Primar	242.00	521.16	525.14		525.32	0.001991	1.93	137.61	114.53	0.41
Nordenskiold	1544	5_Nord_Primary	201.00	521.81	524.27		524.50	0.003105	2.15	105.01	85.37	0.49
Nordenskiold	1544	1_Nord_Primary	267.00	521.81	524.69		524.93	0.002637	2.25	145.14	111.88	0.47
Nordenskiold	1544	0.5_Nord_Primary	296.00	521.81	524.85		525.10	0.002497	2.29	164.94	124.20	0.46
Nordenskiold	1544	0.5_CC_Nord_Prim	356.00	521.81	525.19		525.43	0.002164	2.32	207.73	129.33	0.44
Nordenskiold	1544	5_CC_Nord_Primar	242.00	521.81	524.53		524.77	0.002815	2.22	128.33	100.83	0.48
Nordenskiold	1411	5_Nord_Primary	201.00	520.95	523.78		524.07	0.003290	2.40	92.05	62.45	0.52
Nordenskiold	1411	1_Nord_Primary	267.00	520.95	524.21		524.54	0.003063	2.60	124.65	98.11	0.51
Nordenskiold	1411	0.5_Nord_Primary	296.00	520.95	524.41		524.74	0.002846	2.62	144.61	110.69	0.50
Nordenskiold	1411	0.5_CC_Nord_Prim	356.00	520.95	524.81		525.12	0.002373	2.61	190.87	115.94	0.47
Nordenskiold	1411	5_CC_Nord_Primar	242.00	520.95	524.05		524.37	0.003138	2.52	110.48	78.60	0.52
Nordenskiold	1344	5_Nord_Primary	201.00	521.02	523.58		523.78	0.004905	2.03	109.31	80.16	0.44
Nordenskiold	1344	1_Nord_Primary	267.00	521.02	524.06		524.27	0.004011	2.10	145.74	114.38	0.41
Nordenskiold	1344	0.5_Nord_Primary	296.00	521.02	524.26		524.48	0.003909	2.18	167.52	154.61	0.41
Nordenskiold	1344	0.5_CC_Nord_Prim	356.00	521.02	524.73		524.91	0.002807	2.04	237.74	165.92	0.36
Nordenskiold	1344	5_CC_Nord_Primar	242.00	521.02	523.88		524.09	0.004306	2.08	131.55	94.61	0.42
Nordenskiold	1321	5_Nord_Primary	201.00	520.85	523.48		523.67	0.003742	1.95	108.22	86.37	0.42
Nordenskiold	1321	1_Nord_Primary	267.00	520.85	523.98		524.19	0.003196	2.07	143.40	148.78	0.41
Nordenskiold	1321	0.5_Nord_Primary	296.00	520.85	524.18		524.40	0.003025	2.11	165.62	175.60	0.40
Nordenskiold	1321	0.5_CC_Nord_Prim	356.00	520.85	524.67		524.85	0.002167	1.99	243.18	186.67	0.35
Nordenskiold	1321	5_CC_Nord_Primar	242.00	520.85	523.80		524.00	0.003353	2.02	129.13	107.06	0.41
Nordenskiold	1292	5_Nord_Primary	201.00	520.35	523.30	522.36	523.57	0.002864	2.33	89.45	66.23	0.48
Nordenskiold	1292	1_Nord_Primary	267.00	520.35	523.76	522.69	524.09	0.002854	2.56	108.64	87.48	0.49
Nordenskiold	1292	0.5_Nord_Primary	296.00	520.35	523.95	522.82	524.30	0.002858	2.65	116.70	105.90	0.50
Nordenskiold	1292	0.5_CC_Nord_Prim	356.00	520.35	524.64	523.10	524.80	0.001180	1.96	252.00	226.43	0.33
Nordenskiold	1292	5_CC_Nord_Primar	242.00	520.35	523.59	522.56	523.90	0.002857	2.48	101.56	77.76	0.49
Nordenskiold	1285	5_Nord_Primary	201.00	520.34	523.01	522.56	523.49	0.004097	3.09	66.14	37.12	0.65
Nordenskiold	1285	1_Nord_Primary	267.00	520.34	523.43	522.91	524.00	0.003721	3.32	81.11	37.60	0.64

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	1285	0.5_Nord_Primary	296.00	520.34	523.60	523.06	524.20	0.003630	3.41	86.97	37.60	0.64
Nordenskiold	1285	0.5_CC_Nord_Prim	356.00	520.34	523.98	523.32	524.63	0.003298	3.54	100.07	38.89	0.63
Nordenskiold	1285	5_CC_Nord_Primar	242.00	520.34	523.28	522.78	523.81	0.003830	3.23	75.73	37.60	0.64
Nordenskiold	1280		Bridge									
Nordenskiold	1275	5_Nord_Primary	201.00	520.34	522.74	522.55	523.40	0.003745	3.64	56.66	35.31	0.82
Nordenskiold	1275	1_Nord_Primary	267.00	520.34	523.06	522.91	523.89	0.003865	4.09	67.30	37.40	0.85
Nordenskiold	1275	0.5_Nord_Primary	296.00	520.34	523.19	523.07	524.08	0.003914	4.26	71.60	37.60	0.87
Nordenskiold	1275	0.5_CC_Nord_Prim	356.00	520.34	523.41	523.34	524.47	0.004100	4.63	79.28	37.60	0.90
Nordenskiold	1275	5_CC_Nord_Primar	242.00	520.34	522.94	522.78	523.71	0.003821	3.93	63.41	36.81	0.84
Nordenskiold	1270	5_Nord_Primary	201.00	520.13	522.84		523.25	0.007515	2.83	72.35	51.38	0.64
Nordenskiold	1270	1_Nord_Primary	267.00	520.13	523.19		523.70	0.007593	3.17	86.54	52.63	0.66
Nordenskiold	1270	0.5_Nord_Primary	296.00	520.13	523.33		523.89	0.007672	3.32	92.09	58.10	0.67
Nordenskiold	1270	0.5_CC_Nord_Prim	356.00	520.13	523.59		524.24	0.008004	3.61	102.35	62.90	0.70
Nordenskiold	1270	5_CC_Nord_Primar	242.00	520.13	523.07		523.54	0.007551	3.05	81.42	52.03	0.65
Nordenskiold	1261	5_Nord_Primary	201.00	520.05	522.69		523.19	0.003795	3.14	69.14	65.79	0.72
Nordenskiold	1261	1_Nord_Primary	267.00	520.05	523.04		523.64	0.003749	3.49	85.63	81.10	0.74
Nordenskiold	1261	0.5_Nord_Primary	296.00	520.05	523.18	522.83	523.83	0.003740	3.62	92.81	93.23	0.74
Nordenskiold	1261	0.5_CC_Nord_Prim	356.00	520.05	523.45	523.08	524.18	0.003685	3.86	107.93	125.03	0.75
Nordenskiold	1261	5_CC_Nord_Primar	242.00	520.05	522.91		523.48	0.003760	3.36	79.50	76.99	0.73
Nordenskiold	1174	5_Nord_Primary	201.00	519.97	522.59	522.02	522.89	0.002130	2.43	89.84	67.36	0.58
Nordenskiold	1174	1_Nord_Primary	267.00	519.97	523.02	522.33	523.34	0.001764	2.53	120.07	70.97	0.56
Nordenskiold	1174	0.5_Nord_Primary	296.00	519.97	523.20	522.45	523.52	0.001672	2.57	132.30	71.85	0.55
Nordenskiold	1174	0.5_CC_Nord_Prim	356.00	519.97	523.52	522.69	523.87	0.001542	2.67	156.21	74.07	0.53
Nordenskiold	1174	5_CC_Nord_Primar	242.00	519.97	522.87	522.22	523.18	0.001866	2.49	109.08	69.97	0.57
Nordenskiold	1088	5_Nord_Primary	201.00	519.66	522.43	521.51	522.67	0.002446	2.20	92.34	46.16	0.48
Nordenskiold	1088	1_Nord_Primary	267.00	519.66	522.87	521.83	523.16	0.002407	2.39	113.05	48.23	0.48
Nordenskiold	1088	0.5_Nord_Primary	296.00	519.66	523.04	521.96	523.35	0.002352	2.47	123.35	70.74	0.48
Nordenskiold	1088	0.5_CC_Nord_Prim	356.00	519.66	523.38	522.22	523.71	0.002195	2.58	151.18	86.99	0.47
Nordenskiold	1088	5_CC_Nord_Primar	242.00	519.66	522.71	521.71	522.98	0.002451	2.32	105.55	47.50	0.48
Nordenskiold	987	5_Nord_Primary	201.00	519.02	521.88		522.33	0.004340	3.00	70.50	41.18	0.65
Nordenskiold	987	1_Nord_Primary	267.00	519.02	522.22		522.80	0.004664	3.40	85.48	45.98	0.69
Nordenskiold	987	0.5_Nord_Primary	296.00	519.02	522.36		522.99	0.004776	3.55	91.86	47.67	0.70
Nordenskiold	987	0.5_CC_Nord_Prim	356.00	519.02	522.62		523.35	0.004939	3.84	105.09	69.10	0.73
Nordenskiold	987	5_CC_Nord_Primar	242.00	519.02	522.09		522.63	0.004591	3.26	79.61	44.50	0.68
Nordenskiold	859	5_Nord_Primary	201.00	518.97	521.27		521.78	0.004244	3.16	63.58	37.77	0.78
Nordenskiold	859	1_Nord_Primary	267.00	518.97	521.57		522.21	0.004425	3.56	75.45	41.75	0.81
Nordenskiold	859	0.5_Nord_Primary	296.00	518.97	521.68	521.44	522.39	0.004501	3.73	80.25	43.01	0.83
Nordenskiold	859	0.5_CC_Nord_Prim	356.00	518.97	521.90	521.68	522.73	0.004656	4.05	89.78	45.23	0.86
Nordenskiold	859	5_CC_Nord_Primar	242.00	518.97	521.49		522.07	0.004176	3.36	72.17	40.79	0.78
Nordenskiold	738	5_Nord_Primary	201.00	518.85	520.87		521.30	0.003308	2.90	69.42	40.79	0.71
Nordenskiold	738	1_Nord_Primary	267.00	518.85	521.10		521.69	0.003970	3.38	78.93	42.22	0.79
Nordenskiold	738	0.5_Nord_Primary	296.00	518.85	521.19	520.93	521.85	0.004205	3.58	82.67	43.53	0.82
Nordenskiold	738	0.5_CC_Nord_Prim	356.00	518.85	521.41	521.16	522.17	0.004276	3.87	93.83	55.95	0.84
Nordenskiold	738	5_CC_Nord_Primar	242.00	518.85	521.13		521.60	0.003104	3.02	80.16	42.56	0.70
Nordenskiold	641	5_Nord_Primary	201.00	518.52	520.69		520.98	0.002516	2.38	84.31	49.25	0.58
Nordenskiold	641	1_Nord_Primary	267.00	518.52	520.84		521.27	0.003675	2.91	91.78	53.08	0.69
Nordenskiold	641	0.5_Nord_Primary	296.00	518.52	520.90		521.40	0.004051	3.12	95.13	54.91	0.73
Nordenskiold	641	0.5_CC_Nord_Prim	356.00	518.52	521.17	520.73	521.72	0.003758	3.27	114.68	92.81	0.72
Nordenskiold	641	5_CC_Nord_Primar	242.00	518.52	520.98		521.29	0.002355	2.44	99.91	62.05	0.56
Nordenskiold	556	5_Nord_Primary	201.00	518.27	520.61		520.80	0.001362	1.94	103.84	56.65	0.46
Nordenskiold	556	1_Nord_Primary	267.00	518.27	520.70		521.01	0.002048	2.45	109.16	57.24	0.56
Nordenskiold	556	0.5_Nord_Primary	296.00	518.27	520.74		521.10	0.002359	2.66	111.41	57.49	0.61
Nordenskiold	556	0.5_CC_Nord_Prim	356.00	518.27	521.08		521.44	0.001960	2.68	153.56	120.69	0.57
Nordenskiold	556	5_CC_Nord_Primar	242.00	518.27	520.92		521.12	0.001193	1.99	121.69	58.66	0.44

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Upper	24489	5_Yukon_Primary	2910.00	516.45	526.32	522.10	526.55	0.000221	2.14	1653.26	575.37	0.27
Upper	24489	1_Yukon_Primary	3500.00	516.45	526.87	522.58	527.14	0.000235	2.34	1969.98	578.26	0.28
Upper	24489	0.5_Yukon_Primar	3740.00	516.45	527.07	522.76	527.36	0.000241	2.41	2087.59	586.00	0.29
Upper	24489	0.5_CC_Yukon_Pri	4120.00	516.45	527.39	523.05	527.70	0.000248	2.52	2272.06	612.71	0.29
Upper	24489	5_CC_Yukon_Prima	3210.00	516.45	526.61	522.35	526.86	0.000228	2.24	1821.06	576.98	0.28
Upper	24077	5_Yukon_Primary	2910.00	516.36	526.21	522.52	526.45	0.000247	2.19	1433.03	329.83	0.28
Upper	24077	1_Yukon_Primary	3500.00	516.36	526.74	522.92	527.03	0.000269	2.41	1608.29	337.42	0.30
Upper	24077	0.5_Yukon_Primar	3740.00	516.36	526.93	523.08	527.25	0.000278	2.50	1673.91	361.54	0.30
Upper	24077	0.5_CC_Yukon_Pri	4120.00	516.36	527.24	523.32	527.58	0.000292	2.63	1783.43	464.39	0.31
Upper	24077	5_CC_Yukon_Prima	3210.00	516.36	526.49	522.73	526.76	0.000258	2.30	1526.15	331.01	0.29
Upper	23035	5_Yukon_Primary	2910.00	519.17	526.05	522.55	526.20	0.000192	1.73	1724.52	617.88	0.24
Upper	23035	1_Yukon_Primary	3500.00	519.17	526.58	522.84	526.76	0.000199	1.87	2100.62	738.40	0.24
Upper	23035	0.5_Yukon_Primar	3740.00	519.17	526.78	522.96	526.97	0.000201	1.93	2305.70	808.18	0.25
Upper	23035	0.5_CC_Yukon_Pri	4120.00	519.17	527.09	523.13	527.29	0.000204	2.01	2569.87	887.68	0.25
Upper	23035	5_CC_Yukon_Prima	3210.00	519.17	526.33	522.70	526.50	0.000194	1.80	1948.12	644.43	0.24
Upper	22623	5_Yukon_Primary	2910.00	517.20	525.97	522.55	526.05	0.000618	1.25	2398.56	859.29	0.21
Upper	22623	1_Yukon_Primary	3500.00	517.20	526.52	523.02	526.60	0.000552	1.29	2903.48	935.00	0.20
Upper	22623	0.5_Yukon_Primar	3740.00	517.20	526.72	523.21	526.81	0.000530	1.30	3094.32	936.77	0.20
Upper	22623	0.5_CC_Yukon_Pri	4120.00	517.20	527.04	523.34	527.13	0.000498	1.32	3393.10	941.30	0.20
Upper	22623	5_CC_Yukon_Prima	3210.00	517.20	526.26	522.76	526.34	0.000585	1.27	2664.65	921.23	0.21
Upper	22377	5_Yukon_Primary	2910.00	517.00	525.80	522.55	525.87	0.000835	1.16	2547.51	958.07	0.21
Upper	22377	1_Yukon_Primary	3500.00	517.00	526.38	522.97	526.45	0.000659	1.16	3137.15	1024.00	0.20
Upper	22377	0.5_Yukon_Primar	3740.00	517.00	526.60	523.07	526.67	0.000616	1.16	3355.01	1025.54	0.19
Upper	22377	0.5_CC_Yukon_Pri	4120.00	517.00	526.93	523.22	527.00	0.000559	1.17	3713.77	1105.45	0.18
Upper	22377	5_CC_Yukon_Prima	3210.00	517.00	526.11	522.83	526.18	0.000727	1.16	2860.40	1019.21	0.20
Upper	22079	5_Yukon_Primary	2910.00	516.87	525.64	522.61	525.70	0.000405	1.04	2801.19	888.86	0.19
Upper	22079	1_Yukon_Primary	3500.00	516.87	526.23	522.93	526.29	0.000447	1.04	3374.71	1025.35	0.18
Upper	22079	0.5_Yukon_Primar	3740.00	516.87	526.46	522.99	526.51	0.000411	1.04	3604.99	1026.72	0.18
Upper	22079	0.5_CC_Yukon_Pri	4120.00	516.87	526.80	523.10	526.86	0.000365	1.04	4012.93	1128.08	0.17
Upper	22079	5_CC_Yukon_Prima	3210.00	516.87	525.95	522.82	526.01	0.000449	1.04	3091.50	982.09	0.19
Upper	21362	5_Yukon_Primary	2910.00	517.98	525.54	522.35	525.59	0.000079	0.94	3346.09	1035.39	0.15
Upper	21362	1_Yukon_Primary	3500.00	517.98	526.13	522.54	526.18	0.000073	0.97	3958.35	1039.14	0.15
Upper	21362	0.5_Yukon_Primar	3740.00	517.98	526.36	522.61	526.41	0.000071	0.99	4195.41	1039.93	0.15
Upper	21362	0.5_CC_Yukon_Pri	4120.00	517.98	526.71	522.70	526.76	0.000069	1.01	4568.49	1157.48	0.14
Upper	21362	5_CC_Yukon_Prima	3210.00	517.98	525.85	522.45	525.90	0.000075	0.96	3667.62	1038.18	0.15
Upper	21041	5_Yukon_Primary	2910.00	518.94	525.46		525.53	0.000588	1.17	2500.50	730.98	0.20
Upper	21041	1_Yukon_Primary	3500.00	518.94	526.06		526.13	0.000512	1.20	2938.61	906.81	0.19
Upper	21041	0.5_Yukon_Primar	3740.00	518.94	526.28		526.36	0.000486	1.21	3108.37	1046.36	0.19
Upper	21041	0.5_CC_Yukon_Pri	4120.00	518.94	526.64		526.71	0.000451	1.23	3376.26	1166.64	0.18
Upper	21041	5_CC_Yukon_Prima	3210.00	518.94	525.77		525.84	0.000548	1.18	2730.48	746.96	0.19
Upper	20443	5_Yukon_Primary	2910.00	516.53	525.13		525.20	0.000506	1.19	2497.17	796.92	0.20
Upper	20443	1_Yukon_Primary	3500.00	516.53	525.78		525.85	0.000416	1.21	3030.45	842.24	0.19
Upper	20443	0.5_Yukon_Primar	3740.00	516.53	526.02		526.10	0.000392	1.21	3237.42	844.68	0.18
Upper	20443	0.5_CC_Yukon_Pri	4120.00	516.53	526.40		526.47	0.000361	1.23	3552.89	850.26	0.18
Upper	20443	5_CC_Yukon_Prima	3210.00	516.53	525.48		525.55	0.000452	1.20	2774.96	836.79	0.19
Upper	19822	5_Yukon_Primary	2910.00	515.67	524.76		524.98	0.000233	2.10	1561.55	455.32	0.26
Upper	19822	1_Yukon_Primary	3500.00	515.67	525.38		525.64	0.000254	2.28	1846.81	468.36	0.27
Upper	19822	0.5_Yukon_Primar	3740.00	515.67	525.61		525.88	0.000261	2.35	1956.27	469.15	0.28
Upper	19822	0.5_CC_Yukon_Pri	4120.00	515.67	525.96		526.26	0.000273	2.45	2122.90	470.43	0.28
Upper	19822	5_CC_Yukon_Prima	3210.00	515.67	525.09		525.33	0.000244	2.20	1711.91	467.44	0.27
Upper	19304	5_Yukon_Primary	2910.00	517.73	524.67		524.85	0.000244	1.84	1690.81	457.85	0.25
Upper	19304	1_Yukon_Primary	3500.00	517.73	525.29		525.49	0.000245	1.97	1994.01	502.78	0.25
Upper	19304	0.5_Yukon_Primar	3740.00	517.73	525.53		525.73	0.000246	2.02	2112.17	503.93	0.25
Upper	19304	0.5_CC_Yukon_Pri	4120.00	517.73	525.88		526.10	0.000246	2.10	2292.99	518.54	0.26
Upper	19304	5_CC_Yukon_Prima	3210.00	517.73	525.00		525.19	0.000244	1.91	1848.75	501.22	0.25
Upper	18801	5_Yukon_Primary	2910.00	513.69	524.39	520.15	524.64	0.000783	2.22	1410.52	427.47	0.31
Upper	18801	1_Yukon_Primary	3500.00	513.69	525.01	520.68	525.28	0.000753	2.34	1778.49	589.96	0.31
Upper	18801	0.5_Yukon_Primar	3740.00	513.69	525.25	520.88	525.53	0.000740	2.38	1921.23	598.99	0.30
Upper	18801	0.5_CC_Yukon_Pri	4120.00	513.69	525.62	521.37	525.90	0.000717	2.43	2149.43	642.57	0.30
Upper	18801	5_CC_Yukon_Prima	3210.00	513.69	524.72	520.41	524.98	0.000766	2.29	1607.78	573.10	0.31
Upper	18434	5_Yukon_Primary	2910.00	516.33	524.29		524.47	0.000239	1.87	1680.79	493.67	0.27
Upper	18434	1_Yukon_Primary	3500.00	516.33	524.92		525.12	0.000228	1.98	2003.82	535.05	0.27
Upper	18434	0.5_Yukon_Primar	3740.00	516.33	525.16		525.37	0.000226	2.02	2133.58	543.02	0.27
Upper	18434	0.5_CC_Yukon_Pri	4120.00	516.33	525.53		525.75	0.000221	2.08	2334.37	547.17	0.27
Upper	18434	5_CC_Yukon_Prima	3210.00	516.33	524.63		524.81	0.000232	1.93	1848.32	513.04	0.27
Upper	18170	5_Yukon_Primary	2910.00	515.92	524.21		524.37	0.000606	1.80	1632.78	395.86	0.27

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Upper	18170	1_Yukon_Primary	3500.00	515.92	524.85		525.03	0.000553	1.88	1894.14	417.55	0.27
Upper	18170	0.5_Yukon_Primar	3740.00	515.92	525.09		525.28	0.000538	1.91	1997.20	430.86	0.27
Upper	18170	0.5_CC_Yukon_Pri	4120.00	515.92	525.46		525.66	0.000518	1.96	2160.50	444.23	0.26
Upper	18170	5_CC_Yukon_Prima	3210.00	515.92	524.55		524.72	0.000573	1.83	1770.96	411.07	0.27
Upper	17611	5_Yukon_Primary	2910.00	515.72	523.91	520.45	524.14	0.000285	2.11	1383.83	248.11	0.28
Upper	17611	1_Yukon_Primary	3500.00	515.72	524.53	520.83	524.80	0.000291	2.28	1580.00	349.09	0.29
Upper	17611	0.5_Yukon_Primar	3740.00	515.72	524.77	520.98	525.05	0.000293	2.35	1662.46	351.45	0.29
Upper	17611	0.5_CC_Yukon_Pri	4120.00	515.72	525.13	521.19	525.43	0.000296	2.44	1789.86	357.85	0.30
Upper	17611	5_CC_Yukon_Prima	3210.00	515.72	524.25	520.65	524.49	0.000287	2.20	1467.07	252.69	0.29
Upper	17014	5_Yukon_Primary	2910.00	515.62	523.85	521.00	523.97	0.000198	1.54	1894.39	428.40	0.23
Upper	17014	1_Yukon_Primary	3500.00	515.62	524.49	521.23	524.62	0.000189	1.62	2182.24	466.24	0.23
Upper	17014	0.5_Yukon_Primar	3740.00	515.62	524.73	521.32	524.87	0.000186	1.65	2296.15	471.70	0.23
Upper	17014	0.5_CC_Yukon_Pri	4120.00	515.62	525.10	521.45	525.25	0.000182	1.70	2471.40	473.66	0.23
Upper	17014	5_CC_Yukon_Prima	3210.00	515.62	524.19	521.12	524.32	0.000192	1.57	2045.03	454.12	0.23
Upper	16781	5_Yukon_Primary	2910.00	516.48	523.77	520.78	523.91	0.000231	1.71	1702.47	405.77	0.27
Upper	16781	1_Yukon_Primary	3500.00	516.48	524.41	521.08	524.57	0.000216	1.75	2065.40	552.84	0.26
Upper	16781	0.5_Yukon_Primar	3740.00	516.48	524.66	521.20	524.82	0.000211	1.78	2194.46	606.60	0.26
Upper	16781	0.5_CC_Yukon_Pri	4120.00	516.48	525.04	521.37	525.20	0.000205	1.81	2419.28	628.68	0.26
Upper	16781	5_CC_Yukon_Prima	3210.00	516.48	524.11	520.94	524.27	0.000223	1.73	1852.69	444.48	0.27
Upper	16260	5_Yukon_Primary	2910.00	515.39	523.64	519.66	523.74	0.000431	1.41	2074.83	476.19	0.21
Upper	16260	1_Yukon_Primary	3500.00	515.39	524.30	519.97	524.41	0.000397	1.48	2389.14	478.85	0.21
Upper	16260	0.5_Yukon_Primar	3740.00	515.39	524.55	520.08	524.66	0.000388	1.51	2508.20	479.96	0.21
Upper	16260	0.5_CC_Yukon_Pri	4120.00	515.39	524.92	520.26	525.05	0.000377	1.56	2692.68	488.52	0.21
Upper	16260	5_CC_Yukon_Prima	3210.00	515.39	523.99	519.82	524.10	0.000409	1.45	2243.47	477.63	0.21
Upper	16025	5_Yukon_Primary	2910.00	515.30	523.59	518.80	523.70	0.000097	1.45	2000.39	296.80	0.18
Upper	16025	1_Yukon_Primary	3500.00	515.30	524.23	519.10	524.36	0.000105	1.60	2192.48	300.51	0.19
Upper	16025	0.5_Yukon_Primar	3740.00	515.30	524.48	519.22	524.62	0.000108	1.65	2265.53	301.47	0.19
Upper	16025	0.5_CC_Yukon_Pri	4120.00	515.30	524.85	519.40	525.00	0.000112	1.73	2381.65	313.39	0.20
Upper	16025	5_CC_Yukon_Prima	3210.00	515.30	523.94	518.95	524.05	0.000101	1.53	2103.43	298.14	0.18
Upper	15762	5_Yukon_Primary	2910.00	516.17	523.32		523.63	0.000393	2.48	1183.96	226.57	0.32
Upper	15762	1_Yukon_Primary	3500.00	516.17	523.92		524.29	0.000415	2.70	1325.90	239.35	0.34
Upper	15762	0.5_Yukon_Primar	3740.00	516.17	524.14		524.54	0.000424	2.79	1379.84	240.30	0.34
Upper	15762	0.5_CC_Yukon_Pri	4120.00	516.17	524.49		524.92	0.000437	2.92	1462.35	242.44	0.35
Upper	15762	5_CC_Yukon_Prima	3210.00	516.17	523.64		523.99	0.000402	2.59	1260.37	238.12	0.33
Upper	15509	5_Yukon_Primary	2910.00	517.31	523.01	520.94	523.49	0.000673	3.05	958.89	222.69	0.45
Upper	15509	1_Yukon_Primary	3500.00	517.31	523.60	521.32	524.14	0.000659	3.27	1093.01	229.88	0.45
Upper	15509	0.5_Yukon_Primar	3740.00	517.31	523.82	521.48	524.39	0.000657	3.35	1143.52	230.64	0.45
Upper	15509	0.5_CC_Yukon_Pri	4120.00	517.31	524.15	521.72	524.77	0.000655	3.48	1220.91	234.27	0.46
Upper	15509	5_CC_Yukon_Prima	3210.00	517.31	523.33	521.14	523.84	0.000658	3.15	1032.04	228.80	0.45
Upper	15295	5_Yukon_Primary	2910.00	516.76	522.95		523.33	0.000531	2.72	1072.70	224.07	0.39
Upper	15295	1_Yukon_Primary	3500.00	516.76	523.55		523.98	0.000541	2.91	1207.82	228.88	0.40
Upper	15295	0.5_Yukon_Primar	3740.00	516.76	523.77		524.23	0.000540	2.98	1259.05	230.42	0.40
Upper	15295	0.5_CC_Yukon_Pri	4120.00	516.76	524.11		524.60	0.000539	3.10	1337.53	232.20	0.40
Upper	15295	5_CC_Yukon_Prima	3210.00	516.76	523.28		523.68	0.000539	2.81	1146.30	226.48	0.39
Upper	15037	5_Yukon_Primary	2910.00	515.96	522.89		523.19	0.000394	2.44	1194.91	229.21	0.34
Upper	15037	1_Yukon_Primary	3500.00	515.96	523.48		523.84	0.000415	2.63	1332.25	231.53	0.35
Upper	15037	0.5_Yukon_Primar	3740.00	515.96	523.71		524.08	0.000424	2.71	1384.02	232.43	0.35
Upper	15037	0.5_CC_Yukon_Pri	4120.00	515.96	524.05		524.45	0.000440	2.82	1463.24	234.27	0.36
Upper	15037	5_CC_Yukon_Prima	3210.00	515.96	523.21		523.54	0.000401	2.53	1269.87	230.44	0.34
Upper	14662	5_Yukon_Primary	2910.00	515.50	522.81	519.73	523.06	0.000240	2.24	1297.78	246.71	0.31
Upper	14662	1_Yukon_Primary	3500.00	515.50	523.40	520.08	523.70	0.000244	2.42	1464.59	295.37	0.32
Upper	14662	0.5_Yukon_Primar	3740.00	515.50	523.63	520.22	523.94	0.000246	2.49	1531.08	298.43	0.32
Upper	14662	0.5_CC_Yukon_Pri	4120.00	515.50	523.97	520.42	524.31	0.000249	2.59	1635.71	313.06	0.33
Upper	14662	5_CC_Yukon_Prima	3210.00	515.50	523.13	519.91	523.41	0.000240	2.33	1386.47	278.50	0.31
Upper	14380	5_Yukon_Primary	2910.00	515.08	522.77	519.07	523.00	0.000186	2.12	1386.11	272.31	0.28
Upper	14380	1_Yukon_Primary	3500.00	515.08	523.36	519.43	523.63	0.000197	2.31	1556.09	306.73	0.29
Upper	14380	0.5_Yukon_Primar	3740.00	515.08	523.59	519.58	523.87	0.000199	2.38	1721.66	448.32	0.29
Upper	14380	0.5_CC_Yukon_Pri	4120.00	515.08	523.93	519.79	524.24	0.000203	2.48	1876.42	474.65	0.30
Upper	14380	5_CC_Yukon_Prima	3210.00	515.08	523.09	519.25	523.34	0.000191	2.21	1476.15	283.78	0.28
Upper	14168	5_Yukon_Primary	2910.00	515.85	522.75	519.36	522.95	0.000175	1.98	1478.56	362.13	0.27
Upper	14168	1_Yukon_Primary	3500.00	515.85	523.35	519.68	523.58	0.000182	2.15	1647.58	389.55	0.28
Upper	14168	0.5_Yukon_Primar	3740.00	515.85	523.58	519.81	523.82	0.000186	2.19	1855.98	560.52	0.28
Upper	14168	0.5_CC_Yukon_Pri	4120.00	515.85	523.92	520.00	524.18	0.000188	2.28	2066.23	634.69	0.28
Upper	14168	5_CC_Yukon_Prima	3210.00	515.85	523.08	519.53	523.29	0.000177	2.06	1570.78	380.14	0.27
Upper	13778	5_Yukon_Primary	2910.00	516.43	522.75	519.74	522.86	0.000144	1.48	2017.02	670.33	0.23
Upper	13778	1_Yukon_Primary	3500.00	516.43	523.37	520.03	523.49	0.000128	1.53	2568.68	820.52	0.22

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Upper	13778	0.5_Yukon_Primar	3740.00	516.43	523.60	520.15	523.72	0.000124	1.55	2765.96	884.91	0.22
Upper	13778	0.5_CC_Yukon_Pri	4120.00	516.43	523.96	520.36	524.09	0.000118	1.58	3101.35	963.39	0.22
Upper	13778	5_CC_Yukon_Prima	3210.00	516.43	523.09	519.90	523.20	0.000135	1.51	2213.90	755.05	0.23
Upper	13595	5_Yukon_Primary	2910.00	515.88	522.74	519.17	522.83	0.000119	1.35	2356.51	812.38	0.21
Upper	13595	1_Yukon_Primary	3500.00	515.88	523.36	519.70	523.46	0.000112	1.39	2861.86	851.05	0.20
Upper	13595	0.5_Yukon_Primar	3740.00	515.88	523.60	519.80	523.70	0.000109	1.41	3052.61	892.56	0.20
Upper	13595	0.5_CC_Yukon_Pri	4120.00	515.88	523.96	519.98	524.06	0.000107	1.44	3366.62	971.62	0.20
Upper	13595	5_CC_Yukon_Prima	3210.00	515.88	523.08	519.56	523.17	0.000114	1.36	2632.83	838.27	0.21
Upper	13390	5_Yukon_Primary	2910.00	514.82	522.71	519.23	522.80	0.000176	1.31	2371.50	640.50	0.19
Upper	13390	1_Yukon_Primary	3500.00	514.82	523.34	519.56	523.43	0.000165	1.38	2814.81	734.16	0.19
Upper	13390	0.5_Yukon_Primar	3740.00	514.82	523.57	519.67	523.67	0.000162	1.40	2987.37	736.73	0.19
Upper	13390	0.5_CC_Yukon_Pri	4120.00	514.82	523.93	519.84	524.03	0.000157	1.44	3251.66	747.93	0.19
Upper	13390	5_CC_Yukon_Prima	3210.00	514.82	523.05	519.41	523.14	0.000167	1.34	2608.51	727.56	0.19
Upper	13062	5_Yukon_Primary	2910.00	514.09	522.57		522.74	0.000122	1.84	1588.38	367.94	0.23
Upper	13062	1_Yukon_Primary	3500.00	514.09	523.16		523.37	0.000133	2.03	1738.81	419.14	0.24
Upper	13062	0.5_Yukon_Primar	3740.00	514.09	523.38		523.61	0.000137	2.11	1794.87	420.96	0.25
Upper	13062	0.5_CC_Yukon_Pri	4120.00	514.09	523.72		523.97	0.000144	2.22	1879.82	422.08	0.26
Upper	13062	5_CC_Yukon_Prima	3210.00	514.09	522.90		523.09	0.000127	1.94	1671.37	398.47	0.24
Upper	13033	5_Yukon_Primary	2910.00	514.06	522.47	518.39	522.72	0.000188	2.21	1316.36	200.20	0.28
Upper	13033	1_Yukon_Primary	3500.00	514.06	523.03	518.79	523.34	0.000220	2.45	1430.48	202.36	0.29
Upper	13033	0.5_Yukon_Primar	3740.00	514.06	523.24	518.95	523.57	0.000234	2.54	1473.07	203.21	0.30
Upper	13033	0.5_CC_Yukon_Pri	4120.00	514.06	523.56	519.19	523.93	0.000254	2.68	1537.76	204.31	0.31
Upper	13033	5_CC_Yukon_Prima	3210.00	514.06	522.78	518.60	523.06	0.000203	2.33	1379.53	201.38	0.28
Upper	13030		Bridge									
Upper	13025	5_Yukon_Primary	2910.00	514.06	522.44		522.69	0.000192	2.22	1310.40	200.08	0.28
Upper	13025	1_Yukon_Primary	3500.00	514.06	523.00		523.30	0.000225	2.46	1422.78	202.22	0.30
Upper	13025	0.5_Yukon_Primar	3740.00	514.06	523.20		523.53	0.000239	2.55	1464.61	203.04	0.30
Upper	13025	0.5_CC_Yukon_Pri	4120.00	514.06	523.51		523.88	0.000260	2.70	1528.04	204.14	0.31
Upper	13025	5_CC_Yukon_Prima	3210.00	514.06	522.75		523.03	0.000207	2.34	1372.75	201.26	0.29
Upper	12997	5_Yukon_Primary	2910.00	514.30	522.45		522.66	0.000277	2.07	1419.21	341.88	0.27
Upper	12997	1_Yukon_Primary	3500.00	514.30	523.01		523.27	0.000292	2.26	1565.46	388.58	0.28
Upper	12997	0.5_Yukon_Primar	3740.00	514.30	523.22		523.50	0.000299	2.33	1619.59	389.93	0.29
Upper	12997	0.5_CC_Yukon_Pri	4120.00	514.30	523.54		523.84	0.000309	2.45	1701.38	391.84	0.30
Upper	12997	5_CC_Yukon_Prima	3210.00	514.30	522.76		523.00	0.000282	2.16	1500.44	378.88	0.28
Upper	12758	5_Yukon_Primary	2910.00	515.04	522.37	519.00	522.61	0.000180	2.15	1361.95	243.54	0.29
Upper	12758	1_Yukon_Primary	3500.00	515.04	522.93	519.35	523.21	0.000195	2.36	1516.20	332.00	0.30
Upper	12758	0.5_Yukon_Primar	3740.00	515.04	523.14	519.48	523.44	0.000200	2.44	1574.29	337.18	0.31
Upper	12758	0.5_CC_Yukon_Pri	4120.00	515.04	523.45	519.69	523.78	0.000207	2.56	1664.69	354.22	0.31
Upper	12758	5_CC_Yukon_Prima	3210.00	515.04	522.68	519.18	522.94	0.000185	2.25	1448.58	309.67	0.29
Upper	12434	5_Yukon_Primary	2910.00	515.48	522.32		522.54	0.000213	2.07	1403.68	281.01	0.30
Upper	12434	1_Yukon_Primary	3500.00	515.48	522.88		523.14	0.000223	2.24	1568.15	316.11	0.30
Upper	12434	0.5_Yukon_Primar	3740.00	515.48	523.09		523.36	0.000226	2.31	1634.99	323.37	0.31
Upper	12434	0.5_CC_Yukon_Pri	4120.00	515.48	523.40		523.70	0.000229	2.41	1736.73	325.63	0.31
Upper	12434	5_CC_Yukon_Prima	3210.00	515.48	522.63		522.87	0.000218	2.15	1492.44	295.30	0.30
Upper	12150	5_Yukon_Primary	2910.00	515.48	522.20	519.01	522.48	0.000216	2.31	1262.29	265.84	0.31
Upper	12150	1_Yukon_Primary	3500.00	515.48	522.74	519.37	523.07	0.000231	2.52	1425.32	346.39	0.33
Upper	12150	0.5_Yukon_Primar	3740.00	515.48	522.94	519.51	523.29	0.000238	2.61	1495.82	375.89	0.33
Upper	12150	0.5_CC_Yukon_Pri	4120.00	515.48	523.24	519.74	523.62	0.000247	2.73	1605.35	389.34	0.34
Upper	12150	5_CC_Yukon_Prima	3210.00	515.48	522.51	519.20	522.80	0.000221	2.41	1349.93	293.60	0.32
Upper	11862	5_Yukon_Primary	2910.00	515.88	522.01	519.43	522.39	0.000336	2.71	1074.43	213.54	0.38
Upper	11862	1_Yukon_Primary	3500.00	515.88	522.53	519.82	522.97	0.000352	2.95	1227.53	327.51	0.40
Upper	11862	0.5_Yukon_Primar	3740.00	515.88	522.73	519.97	523.19	0.000356	3.04	1291.23	331.88	0.40
Upper	11862	0.5_CC_Yukon_Pri	4120.00	515.88	523.02	520.21	523.52	0.000363	3.17	1396.35	376.66	0.41
Upper	11862	5_CC_Yukon_Prima	3210.00	515.88	522.31	519.62	522.71	0.000340	2.82	1155.82	303.21	0.39
Upper	11616	5_Yukon_Primary	2910.00	515.25	521.91		522.30	0.000335	2.77	1065.68	241.82	0.38
Upper	11616	1_Yukon_Primary	3500.00	515.25	522.41		522.88	0.000357	3.03	1189.86	250.62	0.40
Upper	11616	0.5_Yukon_Primar	3740.00	515.25	522.60		523.10	0.000367	3.14	1236.40	256.13	0.41
Upper	11616	0.5_CC_Yukon_Pri	4120.00	515.25	522.88		523.43	0.000381	3.30	1311.24	274.37	0.42
Upper	11616	5_CC_Yukon_Prima	3210.00	515.25	522.20		522.63	0.000341	2.89	1136.60	248.97	0.39
Upper	11257	5_Yukon_Primary	2910.00	515.35	521.88	518.75	522.17	0.000236	2.38	1224.48	229.23	0.32
Upper	11257	1_Yukon_Primary	3500.00	515.35	522.39	519.13	522.74	0.000262	2.60	1459.20	419.03	0.34
Upper	11257	0.5_Yukon_Primar	3740.00	515.35	522.58	519.26	522.95	0.000272	2.68	1539.40	429.56	0.34
Upper	11257	0.5_CC_Yukon_Pri	4120.00	515.35	522.87	519.49	523.26	0.000283	2.81	1664.58	438.11	0.35
Upper	11257	5_CC_Yukon_Prima	3210.00	515.35	522.17	518.94	522.49	0.000249	2.50	1291.26	234.06	0.33
Upper	11041	5_Yukon_Primary	2910.00	514.82	521.86		522.12	0.000190	2.23	1332.40	292.69	0.29

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Upper	11041	1_Yukon_Primary	3500.00	514.82	522.37		522.67	0.000207	2.46	1483.36	301.82	0.31
Upper	11041	0.5_Yukon_Primar	3740.00	514.82	522.56		522.88	0.000214	2.55	1539.58	302.91	0.32
Upper	11041	0.5_CC_Yukon_Pri	4120.00	514.82	522.84		523.20	0.000224	2.68	1625.68	309.70	0.33
Upper	11041	5_CC_Yukon_Prima	3210.00	514.82	522.15		522.43	0.000196	2.34	1418.67	299.77	0.30
Upper	10654	5_Yukon_Primary	2910.00	515.13	521.66	518.81	522.01	0.000316	2.63	1110.39	219.52	0.36
Upper	10654	1_Yukon_Primary	3500.00	515.13	522.13	519.21	522.56	0.000345	2.91	1222.46	250.79	0.39
Upper	10654	0.5_Yukon_Primar	3740.00	515.13	522.30	519.38	522.76	0.000357	3.01	1265.55	254.18	0.39
Upper	10654	0.5_CC_Yukon_Pri	4120.00	515.13	522.56	519.62	523.07	0.000374	3.17	1384.33	423.92	0.41
Upper	10654	5_CC_Yukon_Prima	3210.00	515.13	521.94	519.02	522.32	0.000325	2.76	1174.40	241.34	0.37
Upper	10564	5_Yukon_Primary	2910.00	514.31	521.63	519.01	521.98	0.000320	2.64	1102.99	240.84	0.38
Upper	10564	1_Yukon_Primary	3500.00	514.31	522.10	519.43	522.53	0.000355	2.90	1230.74	281.66	0.40
Upper	10564	0.5_Yukon_Primar	3740.00	514.31	522.27	519.57	522.73	0.000365	3.00	1279.27	284.36	0.41
Upper	10564	0.5_CC_Yukon_Pri	4120.00	514.31	522.54	519.80	523.04	0.000379	3.15	1417.92	478.84	0.42
Upper	10564	5_CC_Yukon_Prima	3210.00	514.31	521.91	519.24	522.29	0.000337	2.76	1176.27	275.90	0.39
Upper	10478	5_Yukon_Primary	2910.00	514.84	521.64	518.86	521.93	0.000411	2.38	1246.95	403.68	0.34
Upper	10478	1_Yukon_Primary	3500.00	514.84	522.13	519.20	522.47	0.000440	2.60	1451.63	429.89	0.35
Upper	10478	0.5_Yukon_Primar	3740.00	514.84	522.30	519.34	522.67	0.000450	2.68	1527.41	430.25	0.36
Upper	10478	0.5_CC_Yukon_Pri	4120.00	514.84	522.57	519.55	522.97	0.000464	2.81	1643.70	430.86	0.37
Upper	10478	5_CC_Yukon_Prima	3210.00	514.84	521.93	519.03	522.24	0.000420	2.48	1365.64	429.14	0.34
Upper	10427	5_Yukon_Primary	2910.00	514.58	521.65		521.91	0.000231	2.27	1486.78	417.33	0.32
Upper	10427	1_Yukon_Primary	3500.00	514.58	522.14		522.44	0.000245	2.48	1693.43	427.73	0.33
Upper	10427	0.5_Yukon_Primar	3740.00	514.58	522.31		522.64	0.000251	2.56	1769.36	428.29	0.34
Upper	10427	0.5_CC_Yukon_Pri	4120.00	514.58	522.59		522.94	0.000259	2.69	1885.84	429.01	0.35
Upper	10427	5_CC_Yukon_Prima	3210.00	514.58	521.93		522.21	0.000234	2.37	1607.17	426.73	0.32
Lower	9988	5_Yukon_Primary	3003.00	513.48	521.11		521.35	0.000281	2.16	1393.43	843.42	0.32
Lower	9988	1_Yukon_Primary	3593.00	513.48	521.65		521.92	0.000275	2.30	1762.02	907.25	0.32
Lower	9988	0.5_Yukon_Primar	3833.00	513.48	521.84		522.12	0.000275	2.35	1935.29	955.49	0.33
Lower	9988	0.5_CC_Yukon_Pri	4232.00	513.48	522.11		522.41	0.000280	2.45	2201.81	1032.36	0.33
Lower	9988	5_CC_Yukon_Prima	3322.00	513.48	521.43		521.68	0.000276	2.24	1562.13	865.87	0.32
Lower	9276	5_Yukon_Primary	3003.00	512.53	520.81	517.42	521.14	0.000291	2.56	1452.46	1088.10	0.34
Lower	9276	1_Yukon_Primary	3593.00	512.53	521.34	517.86	521.71	0.000297	2.74	2076.66	1483.42	0.35
Lower	9276	0.5_Yukon_Primar	3833.00	512.53	521.54	518.03	521.91	0.000296	2.80	2366.34	1540.68	0.35
Lower	9276	0.5_CC_Yukon_Pri	4232.00	512.53	521.81	518.30	522.20	0.000300	2.89	2798.55	1596.58	0.35
Lower	9276	5_CC_Yukon_Prima	3322.00	512.53	521.12	517.66	521.47	0.000292	2.66	1755.92	1363.35	0.34
Lower	8686	5_Yukon_Primary	3003.00	514.25	520.37	518.42	520.87	0.000743	3.16	1162.03	611.68	0.46
Lower	8686	1_Yukon_Primary	3593.00	514.25	520.91	518.80	521.44	0.000738	3.32	1649.05	1311.11	0.46
Lower	8686	0.5_Yukon_Primar	3833.00	514.25	521.12	518.95	521.65	0.000716	3.34	1942.48	1423.40	0.45
Lower	8686	0.5_CC_Yukon_Pri	4232.00	514.25	521.43	519.19	521.95	0.000686	3.36	2436.08	1697.01	0.44
Lower	8686	5_CC_Yukon_Prima	3322.00	514.25	520.69	518.64	521.20	0.000729	3.23	1405.05	957.27	0.45
Lower	8346	5_Yukon_Primary	3003.00	513.72	520.24	517.64	520.61	0.000553	2.73	1361.98	928.96	0.38
Lower	8346	1_Yukon_Primary	3593.00	513.72	520.81	518.03	521.20	0.000516	2.82	2120.01	1503.70	0.37
Lower	8346	0.5_Yukon_Primar	3833.00	513.72	521.04	518.19	521.41	0.000494	2.83	2467.76	1595.70	0.37
Lower	8346	0.5_CC_Yukon_Pri	4232.00	513.72	521.37	518.43	521.73	0.000466	2.84	2998.02	1659.59	0.36
Lower	8346	5_CC_Yukon_Prima	3322.00	513.72	520.59	517.86	520.96	0.000522	2.77	1799.97	1296.85	0.37
Lower	7778	5_Yukon_Primary	3003.00	511.72	520.01	516.72	520.32	0.000433	2.49	1341.14	710.83	0.33
Lower	7778	1_Yukon_Primary	3593.00	511.72	520.58	517.12	520.93	0.000433	2.64	1880.36	999.14	0.33
Lower	7778	0.5_Yukon_Primar	3833.00	511.72	520.81	517.27	521.16	0.000427	2.68	2113.36	1039.89	0.33
Lower	7778	0.5_CC_Yukon_Pri	4232.00	511.72	521.14	517.52	521.50	0.000424	2.75	2469.26	1156.53	0.33
Lower	7778	5_CC_Yukon_Prima	3322.00	511.72	520.36	516.92	520.69	0.000427	2.56	1661.88	924.19	0.33
Lower	7191	5_Yukon_Primary	3003.00	511.72	519.76	516.61	520.03	0.000523	2.32	1361.84	480.52	0.31
Lower	7191	1_Yukon_Primary	3593.00	511.72	520.34	516.98	520.64	0.000522	2.48	1730.58	683.13	0.32
Lower	7191	0.5_Yukon_Primar	3833.00	511.72	520.57	517.08	520.88	0.000516	2.52	1894.42	728.16	0.32
Lower	7191	0.5_CC_Yukon_Pri	4232.00	511.72	520.90	517.34	521.23	0.000517	2.61	2143.75	805.78	0.32
Lower	7191	5_CC_Yukon_Prima	3322.00	511.72	520.12	516.81	520.40	0.000511	2.39	1585.57	619.41	0.31
Lower	6152	5_Yukon_Primary	3003.00	510.48	519.39	515.55	519.57	0.000352	2.03	1856.10	444.76	0.25
Lower	6152	1_Yukon_Primary	3593.00	510.48	519.97	516.21	520.18	0.000359	2.17	2128.26	476.04	0.26
Lower	6152	0.5_Yukon_Primar	3833.00	510.48	520.19	516.40	520.41	0.000380	2.28	2368.13	755.50	0.27
Lower	6152	0.5_CC_Yukon_Pri	4232.00	510.48	520.52	516.68	520.75	0.000380	2.35	2623.81	770.05	0.27
Lower	6152	5_CC_Yukon_Prima	3322.00	510.48	519.76	515.94	519.95	0.000346	2.09	2027.15	473.28	0.25
Lower	5357	5_Yukon_Primary	3003.00	511.40	518.92	515.24	519.23	0.000559	2.46	1221.53	191.61	0.31
Lower	5357	1_Yukon_Primary	3593.00	511.40	519.51	515.64	519.84	0.000579	2.58	1882.97	867.51	0.31
Lower	5357	0.5_Yukon_Primar	3833.00	511.40	519.73	515.81	520.06	0.000582	2.63	2071.89	871.17	0.32
Lower	5357	0.5_CC_Yukon_Pri	4232.00	511.40	520.07	516.07	520.41	0.000578	2.69	2371.71	887.64	0.32
Lower	5357	5_CC_Yukon_Prima	3322.00	511.40	519.27	515.47	519.61	0.000589	2.58	1287.58	193.41	0.32
Lower	4436	5_Yukon_Primary	3003.00	509.63	518.42	515.15	518.70	0.000581	2.37	1273.14	246.54	0.33
Lower	4436	1_Yukon_Primary	3593.00	509.63	519.03	515.59	519.33	0.000546	2.46	1865.99	841.86	0.32

HEC-RAS Plan: 1D_DesignRuns_FinalCalibration (Continued)

Reach	River Sta	Profile	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
			(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Lower	4436	0.5_Yukon_Primar	3833.00	509.63	519.26	515.77	519.56	0.000535	2.49	2062.88	876.36	0.32
Lower	4436	0.5_CC_Yukon_Pri	4232.00	509.63	519.63	516.14	519.93	0.000515	2.54	2393.30	916.65	0.32
Lower	4436	5_CC_Yukon_Prima	3322.00	509.63	518.75	515.39	519.06	0.000583	2.46	1356.52	251.58	0.33
Lower	3659	5_Yukon_Primary	3003.00	510.38	517.95	514.92	518.25	0.000586	2.42	1240.92	228.18	0.33
Lower	3659	1_Yukon_Primary	3593.00	510.38	518.59	515.29	518.91	0.000553	2.53	1703.49	556.23	0.33
Lower	3659	0.5_Yukon_Primar	3833.00	510.38	518.83	515.43	519.15	0.000544	2.57	1867.21	649.70	0.33
Lower	3659	0.5_CC_Yukon_Pri	4232.00	510.38	519.21	515.66	519.54	0.000530	2.63	2119.92	691.32	0.32
Lower	3659	5_CC_Yukon_Prima	3322.00	510.38	518.31	515.13	518.62	0.000564	2.47	1546.32	545.81	0.33
Lower	3037	5_Yukon_Primary	3003.00	509.63	517.74	513.63	517.95	0.000335	2.03	1478.10	322.56	0.26
Lower	3037	1_Yukon_Primary	3593.00	509.63	518.37	514.00	518.62	0.000355	2.21	1688.60	462.18	0.27
Lower	3037	0.5_Yukon_Primar	3833.00	509.63	518.60	514.14	518.86	0.000358	2.26	1861.47	508.93	0.27
Lower	3037	0.5_CC_Yukon_Pri	4232.00	509.63	518.97	514.36	519.25	0.000366	2.36	2062.14	564.22	0.27
Lower	3037	5_CC_Yukon_Prima	3322.00	509.63	518.09	513.84	518.32	0.000347	2.13	1558.54	404.01	0.26
Lower	2317	5_Yukon_Primary	3003.00	509.21	517.22		517.58	0.000765	2.69	1116.17	204.15	0.37
Lower	2317	1_Yukon_Primary	3593.00	509.21	517.80		518.23	0.000809	2.91	1235.52	207.46	0.38
Lower	2317	0.5_Yukon_Primar	3833.00	509.21	518.01		518.47	0.000819	3.00	1280.36	212.24	0.38
Lower	2317	0.5_CC_Yukon_Pri	4232.00	509.21	518.34		518.85	0.000840	3.14	1353.31	222.77	0.39
Lower	2317	5_CC_Yukon_Prima	3322.00	509.21	517.54		517.94	0.000796	2.81	1182.32	205.84	0.37
Lower	1747	5_Yukon_Primary	3003.00	509.48	516.87	513.95	517.18	0.000618	2.46	1219.33	225.00	0.34
Lower	1747	1_Yukon_Primary	3593.00	509.48	517.44	514.31	517.80	0.000641	2.67	1348.05	227.34	0.35
Lower	1747	0.5_Yukon_Primar	3833.00	509.48	517.65	514.44	518.03	0.000648	2.75	1396.52	228.24	0.35
Lower	1747	0.5_CC_Yukon_Pri	4232.00	509.48	517.98	514.67	518.40	0.000664	2.88	1472.02	230.01	0.36
Lower	1747	5_CC_Yukon_Prima	3322.00	509.48	517.18	514.15	517.52	0.000630	2.57	1290.40	226.30	0.34
Lower	1204	5_Yukon_Primary	3003.00	509.02	516.47		516.81	0.000732	2.59	1164.90	221.82	0.35
Lower	1204	1_Yukon_Primary	3593.00	509.02	517.01		517.41	0.000770	2.82	1288.13	232.73	0.37
Lower	1204	0.5_Yukon_Primar	3833.00	509.02	517.21		517.64	0.000786	2.91	1335.34	233.58	0.37
Lower	1204	0.5_CC_Yukon_Pri	4232.00	509.02	517.52		518.00	0.000816	3.05	1407.95	234.68	0.38
Lower	1204	5_CC_Yukon_Prima	3322.00	509.02	516.77		517.14	0.000752	2.71	1232.27	227.64	0.36
Lower	539	5_Yukon_Primary	3003.00	508.48	516.17	513.51	516.36	0.000504	1.97	1523.69	327.77	0.29
Lower	539	1_Yukon_Primary	3593.00	508.48	516.72	513.78	516.95	0.000506	2.11	1706.79	329.74	0.30
Lower	539	0.5_Yukon_Primar	3833.00	508.48	516.93	513.88	517.17	0.000509	2.16	1775.11	330.50	0.30
Lower	539	0.5_CC_Yukon_Pri	4232.00	508.48	517.25	514.05	517.50	0.000517	2.25	1943.41	550.57	0.30
Lower	539	5_CC_Yukon_Prima	3322.00	508.48	516.48	513.66	516.69	0.000504	2.04	1625.18	328.83	0.29
Lower	281	5_Yukon_Primary	3003.00	508.58	515.96	513.30	516.17	0.001199	2.05	1470.91	370.71	0.33
Lower	281	1_Yukon_Primary	3593.00	508.58	516.50	513.64	516.73	0.001658	2.14	1688.97	440.59	0.34
Lower	281	0.5_Yukon_Primar	3833.00	508.58	516.71	513.77	516.95	0.001764	2.16	1784.95	480.95	0.35
Lower	281	0.5_CC_Yukon_Pri	4232.00	508.58	517.03	513.96	517.28	0.001750	2.19	2009.13	720.70	0.34
Lower	281	5_CC_Yukon_Prima	3322.00	508.58	516.26	513.49	516.48	0.001460	2.10	1586.36	408.99	0.34
Lower	57	5_Yukon_Primary	3003.00	508.94	515.85	513.11	516.01	0.000400	1.76	1709.65	380.32	0.26
Lower	57	1_Yukon_Primary	3593.00	508.94	516.37	513.36	516.56	0.000400	1.89	1908.82	383.50	0.27
Lower	57	0.5_Yukon_Primar	3833.00	508.94	516.58	513.45	516.77	0.000401	1.94	1986.17	383.78	0.27
Lower	57	0.5_CC_Yukon_Pri	4232.00	508.94	516.89	513.61	517.10	0.000401	2.02	2181.93	616.73	0.27
Lower	57	5_CC_Yukon_Prima	3322.00	508.94	516.14	513.25	516.31	0.000400	1.84	1819.04	382.59	0.26

HEC-RAS River: Nordenskiold Reach: Nordenskiold

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	9269	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	548.75	550.19	549.99	550.37	0.007574	1.90	47.91	58.39	0.67
Nordenskiold	9269	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	548.75	550.19	549.99	550.37	0.007574	1.90	47.91	58.39	0.67
Nordenskiold	9269	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	548.75	550.19	549.99	550.37	0.007574	1.90	47.91	58.39	0.67
Nordenskiold	9269	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	548.75	550.32	550.08	550.52	0.006709	1.97	55.91	58.95	0.65
Nordenskiold	9269	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	548.75	550.32	550.08	550.52	0.006709	1.97	55.91	58.95	0.65
Nordenskiold	9269	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	548.75	550.32	550.08	550.52	0.006709	1.97	55.91	58.95	0.65
Nordenskiold	9269	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	548.75	550.61	550.26	550.84	0.005486	2.10	72.98	60.02	0.61
Nordenskiold	9269	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	548.75	550.61	550.26	550.84	0.005486	2.10	72.98	60.02	0.61
Nordenskiold	9269	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	548.75	550.61	550.26	550.84	0.005486	2.10	72.98	60.02	0.61
Nordenskiold	9269	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	548.75	550.81	550.38	551.05	0.004972	2.18	84.71	60.78	0.59
Nordenskiold	9269	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	548.75	550.81	550.38	551.05	0.004972	2.18	84.71	60.78	0.59
Nordenskiold	9269	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	548.75	550.81	550.38	551.05	0.004972	2.18	84.71	60.78	0.59
Nordenskiold	9269	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	548.75	551.02	550.51	551.28	0.004473	2.26	101.80	83.84	0.57
Nordenskiold	9269	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	548.75	551.02	550.51	551.28	0.004473	2.26	101.80	83.84	0.57
Nordenskiold	9269	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	548.75	551.02	550.51	551.28	0.004473	2.26	101.80	83.84	0.57
Nordenskiold	9036	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	547.22	549.15	548.57	549.29	0.003072	1.67	54.37	40.46	0.46
Nordenskiold	9036	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	547.22	549.15	548.57	549.29	0.003072	1.67	54.37	40.46	0.46
Nordenskiold	9036	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	547.22	549.15	548.57	549.29	0.003072	1.67	54.37	40.46	0.46
Nordenskiold	9036	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	547.22	549.30	548.69	549.47	0.003205	1.82	60.56	41.10	0.48
Nordenskiold	9036	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	547.22	549.30	548.69	549.47	0.003205	1.82	60.56	41.10	0.48
Nordenskiold	9036	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	547.22	549.30	548.69	549.47	0.003205	1.82	60.56	41.10	0.48
Nordenskiold	9036	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	547.22	549.58	548.93	549.81	0.003622	2.12	72.27	42.63	0.52
Nordenskiold	9036	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	547.22	549.58	548.93	549.81	0.003622	2.12	72.27	42.63	0.52
Nordenskiold	9036	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	547.22	549.58	548.93	549.81	0.003622	2.12	72.27	42.63	0.52
Nordenskiold	9036	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	547.22	549.81	549.09	550.07	0.003621	2.26	82.01	43.93	0.53
Nordenskiold	9036	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	547.22	549.81	549.09	550.07	0.003621	2.26	82.01	43.93	0.53
Nordenskiold	9036	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	547.22	549.81	549.09	550.07	0.003621	2.26	82.01	43.93	0.53
Nordenskiold	9036	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	547.22	549.99	549.26	550.30	0.003890	2.46	90.41	45.05	0.55
Nordenskiold	9036	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	547.22	549.99	549.26	550.30	0.003890	2.46	90.41	45.05	0.55
Nordenskiold	9036	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	547.22	549.99	549.26	550.30	0.003890	2.46	90.41	45.05	0.55
Nordenskiold	8713	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	546.51	548.40	547.75	548.48	0.001992	1.36	86.44	102.60	0.37
Nordenskiold	8713	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	546.51	548.40	547.75	548.48	0.001992	1.36	86.44	102.60	0.37
Nordenskiold	8713	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	546.51	548.40	547.75	548.48	0.001992	1.36	86.44	102.60	0.37
Nordenskiold	8713	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	546.51	548.51	547.87	548.61	0.002127	1.48	99.01	116.15	0.39
Nordenskiold	8713	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	546.51	548.51	547.87	548.61	0.002127	1.48	99.01	116.15	0.39
Nordenskiold	8713	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	546.51	548.51	547.87	548.61	0.002127	1.48	99.01	116.15	0.39
Nordenskiold	8713	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	546.51	548.73	548.11	548.85	0.002302	1.68	147.23	258.58	0.41
Nordenskiold	8713	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	546.51	548.73	548.11	548.85	0.002302	1.68	147.23	258.58	0.41
Nordenskiold	8713	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	546.51	548.73	548.11	548.85	0.002302	1.68	147.23	258.58	0.41
Nordenskiold	8713	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	546.51	548.73	548.28	548.91	0.003376	2.03	146.83	257.20	0.50
Nordenskiold	8713	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	546.51	548.73	548.28	548.91	0.003376	2.03	146.83	257.20	0.50
Nordenskiold	8713	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	546.51	548.73	548.28	548.91	0.003376	2.03	146.83	257.20	0.50
Nordenskiold	8713	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	546.51	548.81	548.43	549.02	0.003827	2.23	174.34	335.26	0.54
Nordenskiold	8713	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	546.51	548.81	548.43	549.02	0.003827	2.23	174.34	335.26	0.54
Nordenskiold	8713	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	546.51	548.81	548.43	549.02	0.003827	2.23	174.34	335.26	0.54
Nordenskiold	8577	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	546.82	547.68	547.62	547.91	0.012994	2.27	49.40	94.66	0.86
Nordenskiold	8577	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	546.82	547.68	547.62	547.91	0.012994	2.27	49.40	94.66	0.86
Nordenskiold	8577	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	546.82	547.68	547.62	547.91	0.012994	2.27	49.40	94.66	0.86
Nordenskiold	8577	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	546.82	547.77	547.71	548.02	0.012516	2.40	58.29	103.66	0.86
Nordenskiold	8577	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	546.82	547.77	547.71	548.02	0.012516	2.40	58.29	103.66	0.86
Nordenskiold	8577	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	546.82	547.77	547.71	548.02	0.012516	2.40	58.29	103.66	0.86
Nordenskiold	8577	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	546.82	547.94	547.89	548.24	0.011721	2.64	77.94	119.01	0.86
Nordenskiold	8577	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	546.82	547.94	547.89	548.24	0.011721	2.64	77.94	119.01	0.86
Nordenskiold	8577	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	546.82	547.94	547.89	548.24	0.011721	2.64	77.94	119.01	0.86
Nordenskiold	8577	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	546.82	548.04	548.00	548.24	0.008176	2.36	145.12	340.44	0.73
Nordenskiold	8577	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	546.82	548.04	548.00	548.24	0.008176	2.36	145.12	340.44	0.73
Nordenskiold	8577	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	546.82	548.04	548.00	548.24	0.008176	2.36	145.12	340.44	0.73
Nordenskiold	8577	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	546.82	548.16	548.05	548.35	0.007014	2.35	194.35	423.45	0.69
Nordenskiold	8577	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	546.82	548.16	548.05	548.35	0.007014	2.35	194.35	423.45	0.69
Nordenskiold	8577	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	546.82	548.16	548.05	548.35	0.007014	2.35	194.35	423.45	0.69
Nordenskiold	8493	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	545.87	547.50	546.95	547.55	0.001745	1.03	106.33	155.18	0.33
Nordenskiold	8493	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	545.87	547.50	546.95	547.55	0.001745	1.03	106.33	155.18	0.33
Nordenskiold	8493	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	545.87	547.50	546.95	547.55	0.001745	1.03	106.33	155.18	0.33
Nordenskiold	8493	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	545.87	547.59	547.06	547.65	0.001826	1.12	120.69	155.49	0.34
Nordenskiold	8493	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	545.87	547.59	547.06	547.65	0.001826	1.12	120.69	155.49	0.34
Nordenskiold	8493	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	545.87	547.59	547.06	547.65	0.001826	1.12	120.69	155.49	0.34
Nordenskiold	8493	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	545.87	547.77	547.22	547.85	0.001969	1.28	149.24	156.11	0.37
Nordenskiold	8493	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	545.87	547.77	547.22	547.85	0.001969	1.28	149.24	156.11	0.37
Nordenskiold	8493	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	545.87	547.77	547.22	547.85	0.001969	1.28	149.24	156.11	0.37
Nordenskiold	8493	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	545.87	547.88	547.32	547.95	0.001769	1.28	228.94	380.17	0.35
Nordenskiold	8493	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	545.87	547.88	547.32	547.95	0.001769	1.28	228.94	380.17	0.35
Nordenskiold	8493	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	545.87	547.88	547.32	547.95	0.001769	1.28	228.94	380.17	0.35
Nordenskiold	8493	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	545.87	548.01	547.42	548.08	0.001718	1.34	282.01	446.39	0.35
Nordenskiold	8493	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	545.87	548.01	547.42	548.08	0.001718	1.34	282.01	446.39	0.35
Nordenskiold	8493	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	545.87	548.01	547.42	548.08	0.001718	1.34	282.01	446.39	0.35
Nordenskiold	8373	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	545.46	546.92	546.86	547.13	0.010558	2.23	60.59	126.47	0.79
Nordenskiold	8373	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	545.46	546.92	546.86	547.13	0.010558	2.23	60.59	126.47	0.79
Nordenskiold	8373	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	545.46	546.92	546.86	547.13	0.010558	2.23	60.59	126.47	0.79
Nordenskiold	8373	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	545.46	547.03	546.92	547.24	0.009470	2.28	74.51	134.81	0.76
Nordenskiold	8373	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	545.46	547.03	546.92	547.24	0.009470	2.28	74.51	134.81	0.76
Nordenskiold	8373	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	545.46	547.03	546.92	547.24	0.009470	2.28	74.51	134.81	0.76
Nordenskiold	8373	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	545.46	547.23	547.11	547.45	0.007982	2.38	103.34	143.85	0.72
Nordenskiold	8373	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	545.46	547.23	547.11	547.45	0.007982	2.38	103.34	143.85	0.72
Nordenskiold	8373	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	545.46	547.23	547.11	547.45	0.007982	2.38	103.34	143.85	0.72
Nordenskiold	8373	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	545.46	547.37	547.20	547.59	0.007249	2.43	123.06	145.64	0.70
Nordenskiold	8373	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	545.46	547.37	547.20	547.59	0.007249	2.43	123.06	145.64	0.70
Nordenskiold	8373	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	545.46	547.37	547.20	547.59	0.007249	2.43	123.06	145.64	0.70
Nordenskiold	8373	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	545.46	547.50	547.31	547.73	0.006847	2.53	142.65	152.47	0.69
Nordenskiold	8373	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	545.46	547.50	547.31	547.73	0.006847	2.53	142.65	152.47	0.69
Nordenskiold	8373	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	545.46	547.50	547.31	547.73	0.006847	2.53	142.65	152.47	0.69
Nordenskiold	8260	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	545.02	546.63	546.09	546.68	0.001866	1.05	88.13	104.51	0.34
Nordenskiold	8260	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	545.02	546.63	546.09	546.68	0.001866	1.05	88.13	104.51	0.34
Nordenskiold	8260	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	545.02	546.63	546.09	546.68	0.001866	1.05	88.13	104.51	0.34
Nordenskiold	8260	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	545.02	546.74	546.16	546.81	0.001849	1.12	100.91	108.82	0.35

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	8260	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	545.02	546.74	546.16	546.81	0.001849	1.12	100.91	108.82	0.35
Nordenskiold	8260	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	545.02	546.74	546.16	546.81	0.001849	1.12	100.91	108.82	0.35
Nordenskiold	8260	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	545.02	546.95	546.31	547.03	0.001989	1.30	123.18	114.78	0.37
Nordenskiold	8260	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	545.02	546.95	546.31	547.03	0.001989	1.30	123.18	114.78	0.37
Nordenskiold	8260	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	545.02	546.95	546.31	547.03	0.001989	1.30	123.18	114.78	0.37
Nordenskiold	8260	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	545.02	547.08	546.41	547.18	0.002071	1.42	139.35	131.37	0.38
Nordenskiold	8260	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	545.02	547.08	546.41	547.18	0.002071	1.42	139.35	131.37	0.38
Nordenskiold	8260	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	545.02	547.08	546.41	547.18	0.002071	1.42	139.35	131.37	0.38
Nordenskiold	8260	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	545.02	547.19	546.52	547.31	0.002264	1.57	155.59	158.90	0.41
Nordenskiold	8260	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	545.02	547.19	546.52	547.31	0.002264	1.57	155.59	158.90	0.41
Nordenskiold	8260	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	545.02	547.19	546.52	547.31	0.002264	1.57	155.59	158.90	0.41
Nordenskiold	8043	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	544.03	545.81	545.63	546.01	0.006775	2.13	61.61	114.86	0.66
Nordenskiold	8043	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	544.03	545.81	545.63	546.01	0.006775	2.13	61.61	114.86	0.66
Nordenskiold	8043	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	544.03	545.81	545.63	546.01	0.006775	2.13	61.61	114.86	0.66
Nordenskiold	8043	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	544.03	545.92	545.71	546.14	0.006750	2.27	76.56	149.59	0.67
Nordenskiold	8043	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	544.03	545.92	545.71	546.14	0.006750	2.27	76.56	149.59	0.67
Nordenskiold	8043	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	544.03	545.92	545.71	546.14	0.006750	2.27	76.56	149.59	0.67
Nordenskiold	8043	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	544.03	546.12	545.91	546.35	0.006493	2.47	115.87	209.22	0.67
Nordenskiold	8043	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	544.03	546.12	545.91	546.35	0.006493	2.47	115.87	209.22	0.67
Nordenskiold	8043	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	544.03	546.12	545.91	546.35	0.006493	2.47	115.87	209.22	0.67
Nordenskiold	8043	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	544.03	546.20	546.07	546.47	0.007179	2.70	132.50	217.24	0.72
Nordenskiold	8043	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	544.03	546.20	546.07	546.47	0.007179	2.70	132.50	217.24	0.72
Nordenskiold	8043	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	544.03	546.20	546.07	546.47	0.007179	2.70	132.50	217.24	0.72
Nordenskiold	8043	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	544.03	546.31	546.26	546.58	0.006922	2.79	158.57	228.13	0.71
Nordenskiold	8043	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	544.03	546.31	546.26	546.58	0.006922	2.79	158.57	228.13	0.71
Nordenskiold	8043	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	544.03	546.31	546.26	546.58	0.006922	2.79	158.57	228.13	0.71
Nordenskiold	7874	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	543.17	545.07	544.64	545.21	0.003678	1.79	67.30	114.57	0.50
Nordenskiold	7874	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	543.17	545.07	544.64	545.21	0.003678	1.79	67.30	114.57	0.50
Nordenskiold	7874	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	543.17	545.07	544.64	545.21	0.003678	1.79	67.30	114.57	0.50
Nordenskiold	7874	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	543.17	545.20	544.76	545.36	0.003587	1.88	89.74	204.93	0.50
Nordenskiold	7874	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	543.17	545.20	544.76	545.36	0.003587	1.88	89.74	204.93	0.50
Nordenskiold	7874	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	543.17	545.20	544.76	545.36	0.003587	1.88	89.74	204.93	0.50
Nordenskiold	7874	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	543.17	545.44	545.03	545.60	0.003497	2.02	146.80	275.61	0.51
Nordenskiold	7874	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	543.17	545.44	545.03	545.60	0.003497	2.02	146.80	275.61	0.51
Nordenskiold	7874	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	543.17	545.44	545.03	545.60	0.003497	2.02	146.80	275.61	0.51
Nordenskiold	7874	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	543.17	545.60	545.21	545.74	0.002932	1.98	195.70	345.74	0.47
Nordenskiold	7874	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	543.17	545.60	545.21	545.74	0.002932	1.98	195.70	345.74	0.47
Nordenskiold	7874	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	543.17	545.60	545.21	545.74	0.002932	1.98	195.70	345.74	0.47
Nordenskiold	7874	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	543.17	545.72	545.47	545.87	0.003063	2.10	232.11	388.08	0.49
Nordenskiold	7874	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	543.17	545.72	545.47	545.87	0.003063	2.10	232.11	388.08	0.49
Nordenskiold	7874	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	543.17	545.72	545.47	545.87	0.003063	2.10	232.11	388.08	0.49
Nordenskiold	7758	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	542.65	544.77		544.88	0.002354	1.60	81.22	104.83	0.41
Nordenskiold	7758	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	542.65	544.77		544.88	0.002354	1.60	81.22	104.83	0.41
Nordenskiold	7758	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	542.65	544.77		544.88	0.002354	1.60	81.22	104.83	0.41
Nordenskiold	7758	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	542.65	544.90		545.03	0.002467	1.72	96.67	157.46	0.43
Nordenskiold	7758	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	542.65	544.90		545.03	0.002467	1.72	96.66	157.42	0.43
Nordenskiold	7758	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	542.65	544.90		545.03	0.002467	1.72	96.66	157.42	0.43
Nordenskiold	7758	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	542.65	545.13		545.28	0.002685	1.94	144.37	283.33	0.45
Nordenskiold	7758	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	542.65	545.13		545.28	0.002685	1.94	144.37	283.33	0.45
Nordenskiold	7758	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	542.65	545.13		545.28	0.002685	1.94	144.37	283.33	0.45
Nordenskiold	7758	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	542.65	545.27		545.44	0.003001	2.14	183.55	328.84	0.48
Nordenskiold	7758	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	542.65	545.27		545.44	0.003001	2.14	183.55	328.84	0.48
Nordenskiold	7758	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	542.65	545.27		545.44	0.003001	2.14	183.55	328.84	0.48
Nordenskiold	7758	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	542.65	545.38		545.56	0.003071	2.24	220.69	398.25	0.49
Nordenskiold	7758	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	542.65	545.38		545.56	0.003071	2.24	220.69	398.25	0.49
Nordenskiold	7758	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	542.65	545.38		545.56	0.003071	2.24	220.69	398.25	0.49
Nordenskiold	7630	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	542.51	544.19		544.44	0.006402	2.40	56.19	89.13	0.66
Nordenskiold	7630	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	542.51	544.19		544.44	0.006402	2.40	56.19	89.13	0.66
Nordenskiold	7630	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	542.51	544.19		544.44	0.006402	2.40	56.19	89.13	0.66
Nordenskiold	7630	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	542.51	544.32	544.07	544.59	0.006320	2.52	69.55	114.86	0.67
Nordenskiold	7630	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	542.51	544.32	544.07	544.59	0.006319	2.52	69.55	114.86	0.67
Nordenskiold	7630	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	542.51	544.32	544.07	544.59	0.006319	2.52	69.55	114.86	0.67
Nordenskiold	7630	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	542.51	544.58	544.38	544.85	0.005897	2.67	103.72	174.89	0.66
Nordenskiold	7630	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	542.51	544.58	544.38	544.85	0.005897	2.67	103.72	174.89	0.66
Nordenskiold	7630	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	542.51	544.58	544.38	544.85	0.005897	2.67	103.72	174.89	0.66
Nordenskiold	7630	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	542.51	544.74	544.59	545.00	0.005633	2.75	134.29	242.84	0.65
Nordenskiold	7630	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	542.51	544.74	544.59	545.00	0.005633	2.75	134.28	242.82	0.65
Nordenskiold	7630	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	542.51	544.74	544.59	545.00	0.005633	2.75	134.28	242.82	0.65
Nordenskiold	7630	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	542.51	544.92	544.78	545.16	0.004935	2.71	183.29	334.38	0.62
Nordenskiold	7630	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	542.51	544.92	544.78	545.16	0.004935	2.71	183.29	334.38	0.62
Nordenskiold	7630	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	542.51	544.92	544.78	545.16	0.004935	2.71	183.29	334.38	0.62
Nordenskiold	7551	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	541.91	543.87	543.34	544.03	0.004089	1.83	54.63	70.39	0.53
Nordenskiold	7551	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	541.91	543.87	543.34	544.03	0.004090	1.83	54.62	70.39	0.53
Nordenskiold	7551	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	541.91	543.87	543.34	544.03	0.004090	1.83	54.62	70.39	0.53
Nordenskiold	7551	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	541.91	544.00	543.47	544.19	0.004172	1.96	64.34	82.32	0.54
Nordenskiold	7551	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	541.91	544.00	543.47	544.19	0.004173	1.96	64.34	82.31	0.54
Nordenskiold	7551	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	541.91	544.00	543.47	544.19	0.004173	1.96	64.34	82.31	0.54
Nordenskiold	7551	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	541.91	544.25	543.83	544.48	0.004289	2.21	88.51	135.88	0.56
Nordenskiold	7551	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	541.91	544.25	543.83	544.48	0.004289	2.21	88.51	135.88	0.56
Nordenskiold	7551	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	541.91	544.25	543.83	544.48	0.004289	2.21	88.51	135.88	0.56
Nordenskiold	7551	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	541.91	544.41	544.01	544.66	0.004254	2.33	108.74	200.18	0.57
Nordenskiold	7551	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	541.91	544.41	544.01	544.66	0.004253	2.33	108.74	200.19	0.57
Nordenskiold	7551	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	541.91	544.41	544.01	544.66	0.004253	2.33	108.74	200.19	0.57
Nordenskiold	7551	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	541.91	544.58	544.20	544.85	0.004212	2.46	134.34	257.38	0.57
Nordenskiold	7551	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	541.91	544.58	544.20	544.85	0.004211	2.46	134.36	257.41	0.57
Nordenskiold	7551	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	541.91	544.58	544.20	544.85	0.004211	2.46	134.36	257.41	0.57
Nordenskiold	7396	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	541.65	543.35		543.46	0.003209	1.46	62.12	58.50	0.45
Nordenskiold	7396	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	541.65	543.35		543.46	0.003217	1.47	62.07	58.49	0.45
Nordenskiold	7396	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	541.65	543.35		543.46	0.003217	1.47	62.07	58.49	0.45
Nordenskiold	7396	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	541.65	543.47		543.60	0.003385	1.60	68.86	59.37	0.47
Nordenskiold	7396	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	541.65	543.47		543.60	0.003386	1.60	68.86	59.37	0.47
Nordenskiold	7396	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	541.65	543.47		543.60	0.003386	1.60	68.86	59.37	0.47
Nordenskiold	7396	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	541.65	543.69		543.87	0.003671	1.86	82.92	66.56	0.51
Nordenskiold	7396	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	541.65	543.69		543.87	0.003672	1.86	82.91	66.56	0.51

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	7396	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	541.65	543.69		543.87	0.003672	1.86	82.91	66.56	0.51
Nordenskiold	7396	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	541.65	543.84		544.05	0.003850	2.02	93.14	71.05	0.52
Nordenskiold	7396	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	541.65	543.84		544.05	0.003851	2.02	93.14	71.05	0.52
Nordenskiold	7396	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	541.65	543.84		544.05	0.003851	2.02	93.14	71.05	0.52
Nordenskiold	7396	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	541.65	544.00		544.24	0.004046	2.18	105.29	95.69	0.54
Nordenskiold	7396	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	541.65	544.00		544.24	0.004040	2.18	105.36	95.93	0.54
Nordenskiold	7396	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	541.65	544.00		544.24	0.004040	2.18	105.36	95.93	0.54
Nordenskiold	7178	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	540.99	542.75	542.38	542.82	0.002778	1.29	87.23	107.49	0.42
Nordenskiold	7178	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	540.99	542.75	542.38	542.82	0.002755	1.28	87.48	107.50	0.41
Nordenskiold	7178	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	540.99	542.75	542.38	542.82	0.002755	1.28	87.48	107.50	0.41
Nordenskiold	7178	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	540.99	542.86	542.45	542.94	0.002725	1.37	99.52	108.17	0.42
Nordenskiold	7178	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	540.99	542.86	542.45	542.94	0.002725	1.37	99.53	108.17	0.42
Nordenskiold	7178	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	540.99	542.86	542.45	542.94	0.002725	1.37	99.53	108.17	0.42
Nordenskiold	7178	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	540.99	543.09	542.58	543.19	0.002649	1.53	124.53	109.01	0.43
Nordenskiold	7178	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	540.99	543.09	542.58	543.19	0.002630	1.52	124.81	109.02	0.43
Nordenskiold	7178	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	540.99	543.09	542.58	543.19	0.002630	1.52	124.81	109.02	0.43
Nordenskiold	7178	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	540.99	543.25	542.67	543.36	0.002615	1.63	141.32	109.55	0.43
Nordenskiold	7178	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	540.99	543.25	542.67	543.36	0.002586	1.62	141.84	109.56	0.43
Nordenskiold	7178	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	540.99	543.25	542.67	543.36	0.002586	1.62	141.84	109.56	0.43
Nordenskiold	7178	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	540.99	543.41	542.77	543.54	0.002583	1.74	159.50	110.19	0.44
Nordenskiold	7178	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	540.99	543.42	542.77	543.55	0.002511	1.72	160.97	110.26	0.43
Nordenskiold	7178	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	540.99	543.42	542.77	543.55	0.002511	1.72	160.97	110.26	0.43
Nordenskiold	7041	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	540.84	542.24	541.93	542.36	0.004393	1.55	60.61	71.93	0.52
Nordenskiold	7041	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	540.84	542.21	541.93	542.34	0.004992	1.61	58.17	71.70	0.55
Nordenskiold	7041	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	540.84	542.21	541.93	542.34	0.004992	1.61	58.17	71.70	0.55
Nordenskiold	7041	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	540.84	542.34	542.01	542.49	0.004494	1.68	67.99	72.68	0.53
Nordenskiold	7041	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	540.84	542.33	542.01	542.47	0.004779	1.71	66.66	72.52	0.55
Nordenskiold	7041	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	540.84	542.33	542.01	542.47	0.004779	1.71	66.66	72.52	0.55
Nordenskiold	7041	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	540.84	542.54	542.18	542.73	0.004856	1.95	82.06	74.34	0.57
Nordenskiold	7041	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	540.84	542.56	542.18	542.74	0.004540	1.91	83.84	74.55	0.55
Nordenskiold	7041	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	540.84	542.56	542.18	542.74	0.004540	1.91	83.84	74.55	0.55
Nordenskiold	7041	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	540.84	542.66	542.29	542.89	0.005046	2.13	91.54	75.43	0.59
Nordenskiold	7041	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	540.84	542.71	542.29	542.92	0.004486	2.06	95.06	75.84	0.56
Nordenskiold	7041	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	540.84	542.71	542.29	542.92	0.004486	2.06	95.06	75.84	0.56
Nordenskiold	7041	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	540.84	542.80	542.41	543.07	0.005190	2.31	102.14	80.26	0.61
Nordenskiold	7041	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	540.84	542.87	542.41	543.11	0.004474	2.21	107.85	83.96	0.57
Nordenskiold	7041	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	540.84	542.87	542.41	543.11	0.004474	2.21	107.85	83.96	0.57
Nordenskiold	6766	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	539.57	540.99		541.10	0.004784	1.49	61.24	89.95	0.53
Nordenskiold	6766	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	539.57	541.07		541.16	0.003658	1.35	67.29	93.63	0.47
Nordenskiold	6766	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	539.57	541.07		541.16	0.003658	1.35	67.29	93.63	0.47
Nordenskiold	6766	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	539.57	541.11		541.23	0.004616	1.56	70.39	94.38	0.53
Nordenskiold	6766	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	539.57	541.15		541.26	0.004033	1.50	73.35	95.34	0.50
Nordenskiold	6766	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	539.57	541.15		541.26	0.004033	1.50	73.35	95.34	0.50
Nordenskiold	6766	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	539.57	541.35		541.50	0.004045	1.71	89.90	112.10	0.51
Nordenskiold	6766	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	539.57	541.30		541.46	0.004764	1.79	85.38	105.46	0.55
Nordenskiold	6766	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	539.57	541.30		541.46	0.004764	1.79	85.38	105.46	0.55
Nordenskiold	6766	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	539.57	541.52		541.68	0.003746	1.79	104.45	207.97	0.51
Nordenskiold	6766	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	539.57	541.40		541.60	0.005159	1.98	93.92	120.96	0.58
Nordenskiold	6766	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	539.57	541.40		541.60	0.005159	1.98	93.92	120.96	0.58
Nordenskiold	6766	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	539.57	541.69		541.87	0.003554	1.89	121.46	366.88	0.50
Nordenskiold	6766	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	539.57	541.51		541.75	0.005542	2.17	103.45	198.66	0.61
Nordenskiold	6766	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	539.57	541.51		541.75	0.005542	2.17	103.45	198.66	0.61
Nordenskiold	6591	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	538.90	540.74		540.77	0.000881	0.71	133.43	481.38	0.24
Nordenskiold	6591	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	538.90	540.37		540.44	0.004497	1.20	77.75	269.51	0.49
Nordenskiold	6591	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	538.90	540.37		540.44	0.004497	1.20	77.75	269.51	0.49
Nordenskiold	6591	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	538.90	540.89		540.92	0.000790	0.74	157.88	626.86	0.23
Nordenskiold	6591	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	538.90	540.48		540.55	0.003842	1.21	93.95	332.35	0.46
Nordenskiold	6591	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	538.90	540.48		540.55	0.003842	1.21	93.95	332.35	0.46
Nordenskiold	6591	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	538.90	541.19		541.22	0.000669	0.80	207.70	813.27	0.22
Nordenskiold	6591	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	538.90	540.70		540.78	0.002924	1.26	126.75	449.75	0.43
Nordenskiold	6591	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	538.90	540.70		540.78	0.002924	1.26	126.75	449.75	0.43
Nordenskiold	6591	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	538.90	541.38		541.42	0.000623	0.84	241.78	860.51	0.21
Nordenskiold	6591	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	538.90	540.85		540.94	0.002544	1.30	151.05	590.73	0.41
Nordenskiold	6591	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	538.90	540.85		540.94	0.002544	1.30	151.05	590.73	0.41
Nordenskiold	6591	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	538.90	541.57		541.61	0.000606	0.89	278.31	874.51	0.22
Nordenskiold	6591	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	538.90	541.03		541.11	0.002168	1.33	180.20	717.38	0.38
Nordenskiold	6591	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	538.90	541.03		541.11	0.002168	1.33	180.20	717.38	0.38
Nordenskiold	6467	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	538.01	540.65		540.68	0.000602	0.78	125.93	744.10	0.18
Nordenskiold	6467	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	538.01	539.78		539.88	0.004446	1.44	63.23	214.44	0.44
Nordenskiold	6467	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	538.01	539.78		539.88	0.004446	1.44	63.23	214.44	0.44
Nordenskiold	6467	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	538.01	540.79		540.83	0.000689	0.87	136.55	746.56	0.19
Nordenskiold	6467	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	538.01	539.90		540.02	0.004611	1.57	70.37	231.84	0.45
Nordenskiold	6467	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	538.01	539.90		540.02	0.004611	1.57	70.37	231.84	0.45
Nordenskiold	6467	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	538.01	541.07		541.12	0.000865	1.06	157.25	747.81	0.22
Nordenskiold	6467	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	538.01	540.14		540.31	0.004843	1.81	87.77	362.07	0.48
Nordenskiold	6467	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	538.01	540.14		540.31	0.004843	1.81	87.77	362.07	0.48
Nordenskiold	6467	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	538.01	541.25		541.31	0.000982	1.18	170.63	748.69	0.24
Nordenskiold	6467	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	538.01	540.31		540.50	0.004858	1.94	100.29	528.74	0.49
Nordenskiold	6467	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	538.01	540.31		540.50	0.004858	1.94	100.29	528.74	0.49
Nordenskiold	6467	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	538.01	541.41		541.50	0.001133	1.32	183.21	752.77	0.26
Nordenskiold	6467	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	538.01	540.49		540.71	0.004787	2.07	114.25	682.53	0.49
Nordenskiold	6467	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	538.01	540.49		540.71	0.004787	2.07	114.25	682.53	0.49
Nordenskiold	6441	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	537.91	540.63	539.17	540.66	0.000483	0.84	108.59	56.48	0.19
Nordenskiold	6441	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	537.91	539.64	539.17	539.77	0.003399	1.59	57.20	49.39	0.47
Nordenskiold	6441	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	537.91	539.64	539.17	539.77	0.003399	1.59	57.20	49.39	0.47
Nordenskiold	6441	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	537.91	540.76	539.27	540.81	0.000576	0.95	116.44	58.09	0.21
Nordenskiold	6441	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	537.91	539.74	539.27	539.90	0.003918	1.77	62.13	50.81	0.51
Nordenskiold	6441	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	537.91	539.74	539.27	539.90	0.003918	1.77	62.13	50.81	0.51
Nordenskiold	6441	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	537.91	541.03	539.47	541.10	0.000740	1.16	131.89	85.01	0.25
Nordenskiold	6441	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	537.91	539.92	539.47	540.16	0.004876	2.14	71.36	51.48	0.58
Nordenskiold	6441	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	537.91	539.92	539.47	540.16	0.004876	2.14	71.36	51.48	0.58
Nordenskiold	6441	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	537.91	541.20	539.60	541.28	0.000853	1.31	142.11	183.04	0.27
Nordenskiold	6441	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	537.91	540.04	539.60	540.33	0.005500	2.39	77.35	51.77	0.62
Nordenskiold	6441	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	537.91	540.04	539.60	540.33	0.005500	2.39	77.35	51.77	0.62

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	6441	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	537.91	541.38	539.77	541.47	0.000870	1.39	181.82	261.64	0.27
Nordenskiold	6441	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	537.91	540.17	539.77	540.52	0.006059	2.64	84.09	52.10	0.66
Nordenskiold	6441	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	537.91	540.17	539.77	540.52	0.006059	2.64	84.09	52.10	0.66
Nordenskiold	6440			Bridge									
Nordenskiold	6433	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	537.91	540.62		540.66	0.000486	0.84	108.38	56.41	0.19
Nordenskiold	6433	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	537.91	539.61		539.74	0.003724	1.64	55.43	48.89	0.49
Nordenskiold	6433	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	537.91	539.61		539.74	0.003724	1.64	55.43	48.89	0.49
Nordenskiold	6433	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	537.91	540.76		540.80	0.000580	0.95	116.18	58.07	0.21
Nordenskiold	6433	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	537.91	539.70		539.87	0.004362	1.84	59.84	50.15	0.54
Nordenskiold	6433	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	537.91	539.70		539.87	0.004362	1.84	59.84	50.15	0.54
Nordenskiold	6433	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	537.91	541.02		541.09	0.000747	1.17	131.55	80.93	0.25
Nordenskiold	6433	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	537.91	539.85		540.11	0.005762	2.26	67.75	51.31	0.63
Nordenskiold	6433	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	537.91	539.85		540.11	0.005762	2.26	67.75	51.31	0.63
Nordenskiold	6433	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	537.91	541.19		541.28	0.000861	1.31	141.69	179.84	0.27
Nordenskiold	6433	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	537.91	539.94		540.28	0.006800	2.55	72.41	51.53	0.69
Nordenskiold	6433	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	537.91	539.94		540.28	0.006800	2.55	72.41	51.53	0.69
Nordenskiold	6433	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	537.91	541.37		541.46	0.000886	1.40	179.71	258.07	0.27
Nordenskiold	6433	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	537.91	540.03		540.45	0.008097	2.89	76.82	51.75	0.76
Nordenskiold	6433	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	537.91	540.03		540.45	0.008097	2.89	76.82	51.75	0.76
Nordenskiold	6416	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	537.80	540.60		540.64	0.004921	0.90	112.52	618.45	0.22
Nordenskiold	6416	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	537.80	539.56		539.68	0.002499	1.55	60.38	367.19	0.44
Nordenskiold	6416	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	537.80	539.56		539.68	0.002499	1.55	60.38	367.19	0.44
Nordenskiold	6416	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	537.80	540.73		540.78	0.005350	0.99	124.01	619.77	0.23
Nordenskiold	6416	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	537.80	539.64		539.79	0.002816	1.71	66.94	439.26	0.47
Nordenskiold	6416	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	537.80	539.64		539.79	0.002816	1.71	66.94	439.26	0.47
Nordenskiold	6416	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	537.80	540.99		541.05	0.006179	1.15	146.71	622.77	0.25
Nordenskiold	6416	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	537.80	539.80		539.99	0.003354	2.01	79.87	510.66	0.52
Nordenskiold	6416	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	537.80	539.80		539.99	0.003354	2.01	79.87	510.66	0.52
Nordenskiold	6416	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	537.80	541.16		541.23	0.006705	1.26	161.77	625.68	0.26
Nordenskiold	6416	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	537.80	539.89		540.13	0.003691	2.19	87.89	538.86	0.55
Nordenskiold	6416	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	537.80	539.89		540.13	0.003691	2.19	87.89	538.86	0.55
Nordenskiold	6416	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	537.80	541.33		541.41	0.007236	1.37	178.06	630.16	0.28
Nordenskiold	6416	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	537.80	539.99		540.27	0.004059	2.39	95.84	591.01	0.58
Nordenskiold	6416	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	537.80	539.99		540.27	0.004059	2.39	95.84	591.01	0.58
Nordenskiold	6248	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	537.74	539.79		539.80	0.008457	0.27	167.76	484.88	0.19
Nordenskiold	6248	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	537.74	539.08		539.15	0.004449	1.42	116.52	410.11	0.51
Nordenskiold	6248	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	537.74	539.08		539.15	0.004449	1.42	116.52	410.11	0.51
Nordenskiold	6248	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	537.74	539.87		539.89	0.008743	0.28	185.95	544.94	0.20
Nordenskiold	6248	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	537.74	539.15		539.22	0.004531	1.51	133.11	429.68	0.52
Nordenskiold	6248	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	537.74	539.15		539.22	0.004531	1.51	133.11	429.68	0.52
Nordenskiold	6248	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	537.74	540.05		540.07	0.009317	0.29	221.99	626.46	0.20
Nordenskiold	6248	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	537.74	539.28		539.37	0.004684	1.68	166.24	457.27	0.54
Nordenskiold	6248	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	537.74	539.28		539.37	0.004683	1.68	166.25	457.28	0.54
Nordenskiold	6248	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	537.74	540.16		540.19	0.009640	0.30	246.18	650.67	0.21
Nordenskiold	6248	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	537.74	539.36		539.46	0.004804	1.80	187.57	473.42	0.56
Nordenskiold	6248	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	537.74	539.36		539.46	0.004804	1.80	187.57	473.42	0.56
Nordenskiold	6248	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	537.74	540.28		540.32	0.009959	0.31	271.94	686.27	0.21
Nordenskiold	6248	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	537.74	539.45		539.56	0.004815	1.90	211.73	492.29	0.56
Nordenskiold	6248	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	537.74	539.45		539.56	0.004816	1.90	211.72	492.28	0.57
Nordenskiold	6109	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	536.93	539.19		539.20	0.007643	0.54	207.52	686.50	0.22
Nordenskiold	6109	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	536.93	538.62		538.69	0.003997	1.59	133.62	630.29	0.52
Nordenskiold	6109	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	536.93	538.62		538.69	0.003997	1.59	133.62	630.29	0.52
Nordenskiold	6109	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	536.93	539.26		539.28	0.007686	0.55	232.54	694.45	0.22
Nordenskiold	6109	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	536.93	538.68		538.76	0.004189	1.69	153.23	642.26	0.53
Nordenskiold	6109	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	536.93	538.68		538.76	0.004189	1.69	153.23	642.26	0.53
Nordenskiold	6109	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	536.93	539.41		539.43	0.007758	0.57	283.29	721.35	0.23
Nordenskiold	6109	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	536.93	538.80		538.88	0.004524	1.87	192.83	672.82	0.56
Nordenskiold	6109	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	536.93	538.79		538.88	0.004525	1.87	192.82	672.81	0.56
Nordenskiold	6109	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	536.93	539.51		539.53	0.007901	0.58	315.86	763.27	0.23
Nordenskiold	6109	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	536.93	538.87		538.96	0.004712	1.98	218.92	691.31	0.57
Nordenskiold	6109	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	536.93	538.87		538.96	0.004712	1.98	218.92	691.31	0.57
Nordenskiold	6109	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	536.93	539.61		539.63	0.008215	0.59	348.19	795.29	0.23
Nordenskiold	6109	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	536.93	538.95		539.05	0.004982	2.12	248.24	701.20	0.59
Nordenskiold	6109	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	536.93	538.95		539.05	0.004983	2.12	248.23	701.19	0.59
Nordenskiold	6016	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	537.33	538.87	538.41	538.89	0.009177	0.26	190.28	334.15	0.20
Nordenskiold	6016	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	537.33	538.39	538.14	538.42	0.004685	1.19	148.19	329.99	0.50
Nordenskiold	6016	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	537.33	538.39	538.14	538.42	0.004685	1.19	148.19	329.99	0.50
Nordenskiold	6016	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	537.33	538.94	538.45	538.96	0.009500	0.27	213.06	346.59	0.20
Nordenskiold	6016	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	537.33	538.44	538.19	538.47	0.005012	1.29	164.67	342.16	0.52
Nordenskiold	6016	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	537.33	538.44	538.19	538.47	0.005012	1.29	164.67	342.16	0.52
Nordenskiold	6016	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	537.33	539.09	538.52	539.10	0.010216	0.28	260.31	407.15	0.21
Nordenskiold	6016	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	537.33	538.55	538.27	538.59	0.005273	1.47	202.89	355.04	0.55
Nordenskiold	6016	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	537.33	538.55	538.27	538.59	0.005273	1.47	202.89	355.04	0.55
Nordenskiold	6016	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	537.33	539.18	538.57	539.20	0.010658	0.29	292.34	432.00	0.21
Nordenskiold	6016	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	537.33	538.62	538.32	538.67	0.005374	1.57	227.99	363.55	0.56
Nordenskiold	6016	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	537.33	538.62	538.32	538.67	0.005374	1.57	227.99	363.55	0.56
Nordenskiold	6016	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	537.33	539.27	538.62	539.29	0.010818	0.29	325.00	452.94	0.21
Nordenskiold	6016	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	537.33	538.69	538.36	538.75	0.005502	1.68	255.52	375.54	0.57
Nordenskiold	6016	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	537.33	538.69	538.36	538.75	0.005504	1.68	255.49	375.50	0.57
Nordenskiold	5907	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	537.27	538.51		538.52	0.012050	0.50	181.26	409.99	0.26
Nordenskiold	5907	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	537.27	538.06		538.09	0.008048	1.25	125.45	367.36	0.62
Nordenskiold	5907	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	537.27	538.06		538.09	0.008053	1.25	125.42	367.32	0.62
Nordenskiold	5907	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	537.27	538.58		538.59	0.011655	0.49	211.16	428.84	0.25
Nordenskiold	5907	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	537.27	538.15		538.18	0.006155	1.23	157.90	389.13	0.56
Nordenskiold	5907	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	537.27	538.15		538.18	0.006155	1.23	157.90	389.13	0.56
Nordenskiold	5907	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	537.27	538.71		538.73	0.010882	0.58	271.53	448.46	0.26
Nordenskiold	5907	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	537.27	538.28		538.32	0.005043	1.31	214.11	425.98	0.52
Nordenskiold	5907	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	537.27	538.28		538.32	0.005046	1.31	214.06	425.96	0.52
Nordenskiold	5907	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	537.27	538.80		538.82	0.010650	0.64	310.44	461.34	0.26
Nordenskiold	5907	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	537.27	538.36		538.40	0.004889	1.39	247.35	437.33	0.53
Nordenskiold	5907	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	537.27	538.36		538.40	0.004893	1.39	247.27	437.32	0.53
Nordenskiold	5907	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	537.27	538.89		538.91	0.010634	0.70	352.75	491.50	0.27
Nordenskiold	5907	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	537.27	538.44		538.48	0.004798	1.48	282.18	448.31	0.53

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	5907	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	537.27	538.44		538.48	0.004805	1.48	282.05	448.28	0.53
Nordenskiold	5819	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	536.43	538.38		538.38	0.003262	0.47	290.05	507.88	0.15
Nordenskiold	5819	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	536.43	538.01		538.02	0.000716	0.68	259.97	487.55	0.20
Nordenskiold	5819	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	536.43	538.01		538.02	0.000716	0.68	259.94	487.52	0.20
Nordenskiold	5819	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	536.43	538.45		538.46	0.003382	0.50	327.36	512.12	0.16
Nordenskiold	5819	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	536.43	538.09		538.11	0.000776	0.74	302.30	506.58	0.21
Nordenskiold	5819	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	536.43	538.09		538.11	0.000776	0.74	302.30	506.58	0.21
Nordenskiold	5819	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	536.43	538.59		538.60	0.003545	0.56	400.14	519.33	0.16
Nordenskiold	5819	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	536.43	538.23		538.25	0.000870	0.83	373.27	516.42	0.23
Nordenskiold	5819	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	536.43	538.23		538.25	0.000871	0.83	373.24	516.41	0.23
Nordenskiold	5819	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	536.43	538.68		538.69	0.003762	0.60	443.85	523.85	0.17
Nordenskiold	5819	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	536.43	538.31		538.33	0.000967	0.91	412.34	519.11	0.24
Nordenskiold	5819	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	536.43	538.31		538.33	0.000967	0.91	412.23	519.11	0.24
Nordenskiold	5819	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	536.43	538.76		538.77	0.004010	0.65	488.85	534.97	0.18
Nordenskiold	5819	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	536.43	538.38		538.41	0.001073	0.99	452.35	523.40	0.26
Nordenskiold	5819	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	536.43	538.38		538.41	0.001074	0.99	452.16	523.39	0.26
Nordenskiold	5588	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	536.14	537.68		537.76	0.004832	1.41	99.46	486.76	0.44
Nordenskiold	5588	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	536.14	537.68		537.76	0.004822	1.41	99.58	487.27	0.44
Nordenskiold	5588	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	536.14	537.68		537.76	0.004832	1.41	99.46	486.76	0.44
Nordenskiold	5588	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	536.14	537.75		537.83	0.004984	1.49	132.14	540.26	0.45
Nordenskiold	5588	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	536.14	537.75		537.83	0.005031	1.50	131.19	539.28	0.45
Nordenskiold	5588	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	536.14	537.75		537.83	0.004984	1.49	132.14	540.26	0.45
Nordenskiold	5588	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	536.14	537.87	537.62	537.96	0.005592	1.67	196.99	571.24	0.48
Nordenskiold	5588	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	536.14	537.87	537.62	537.96	0.005612	1.67	196.65	571.11	0.48
Nordenskiold	5588	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	536.14	537.87	537.62	537.96	0.005592	1.67	196.99	571.24	0.48
Nordenskiold	5588	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	536.14	537.92	537.70	538.02	0.006158	1.79	226.48	576.66	0.51
Nordenskiold	5588	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	536.14	537.92	537.70	538.02	0.006205	1.79	225.68	576.54	0.51
Nordenskiold	5588	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	536.14	537.92	537.70	538.02	0.006158	1.79	226.48	576.66	0.51
Nordenskiold	5588	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	536.14	537.98		538.08	0.006722	1.91	256.52	581.54	0.53
Nordenskiold	5588	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	536.14	537.97		538.07	0.006814	1.92	255.03	581.15	0.53
Nordenskiold	5588	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	536.14	537.98		538.08	0.006722	1.91	256.52	581.54	0.53
Nordenskiold	5466	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	534.94	536.99		537.15	0.006324	1.96	71.76	207.84	0.63
Nordenskiold	5466	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	534.94	536.99		537.15	0.006354	1.97	71.60	207.03	0.63
Nordenskiold	5466	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	534.94	536.99		537.15	0.006324	1.96	71.76	207.84	0.63
Nordenskiold	5466	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	534.94	537.08	536.93	537.25	0.006004	2.03	96.41	349.33	0.62
Nordenskiold	5466	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	534.94	537.09	536.93	537.25	0.005915	2.02	97.50	354.47	0.62
Nordenskiold	5466	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	534.94	537.08	536.93	537.25	0.006004	2.03	96.41	349.33	0.62
Nordenskiold	5466	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	534.94	537.23	537.18	537.39	0.005692	2.14	159.71	514.08	0.62
Nordenskiold	5466	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	534.94	537.23	537.18	537.39	0.005667	2.13	160.15	515.13	0.62
Nordenskiold	5466	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	534.94	537.23	537.18	537.39	0.005692	2.14	159.71	514.08	0.62
Nordenskiold	5466	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	534.94	537.32	537.26	537.47	0.005201	2.14	212.53	571.05	0.60
Nordenskiold	5466	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	534.94	537.33		537.47	0.005108	2.13	214.53	571.94	0.59
Nordenskiold	5466	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	534.94	537.32	537.26	537.47	0.005201	2.14	212.53	571.05	0.60
Nordenskiold	5466	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	534.94	537.41		537.54	0.004828	2.15	263.30	586.31	0.58
Nordenskiold	5466	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	534.94	537.41		537.54	0.004746	2.13	265.37	586.78	0.58
Nordenskiold	5466	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	534.94	537.41		537.54	0.004828	2.15	263.30	586.31	0.58
Nordenskiold	5358	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	533.98	536.64	536.14	536.73	0.002697	1.56	103.78	183.63	0.41
Nordenskiold	5358	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	533.98	536.69	536.14	536.77	0.002239	1.44	114.17	190.83	0.37
Nordenskiold	5358	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	533.98	536.64	536.14	536.73	0.002697	1.56	103.78	183.63	0.41
Nordenskiold	5358	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	533.98	536.74	536.37	536.84	0.002821	1.64	122.69	193.48	0.42
Nordenskiold	5358	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	533.98	536.80	536.37	536.88	0.002313	1.51	134.92	198.79	0.38
Nordenskiold	5358	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	533.98	536.74	536.37	536.84	0.002821	1.64	122.69	193.48	0.42
Nordenskiold	5358	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	533.98	536.91	536.63	537.00	0.002823	1.71	197.93	444.65	0.42
Nordenskiold	5358	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	533.98	536.95	536.63	537.03	0.002406	1.59	219.56	486.56	0.39
Nordenskiold	5358	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	533.98	536.91	536.63	537.00	0.002823	1.71	197.93	444.65	0.42
Nordenskiold	5358	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	533.98	537.02	536.73	537.10	0.002809	1.70	255.46	536.32	0.41
Nordenskiold	5358	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	533.98	537.06	536.73	537.13	0.002467	1.58	277.26	548.71	0.38
Nordenskiold	5358	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	533.98	537.02	536.73	537.10	0.002809	1.70	255.46	536.32	0.41
Nordenskiold	5358	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	533.98	537.13	536.82	537.20	0.002841	1.69	310.98	559.12	0.40
Nordenskiold	5358	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	533.98	537.16	536.82	537.23	0.002455	1.59	332.59	572.05	0.37
Nordenskiold	5358	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	533.98	537.13	536.82	537.20	0.002841	1.69	310.98	559.12	0.40
Nordenskiold	5141	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	534.04	535.98		536.09	0.004686	1.62	87.61	206.30	0.46
Nordenskiold	5141	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	534.04	535.81	535.57	536.00	0.009355	2.07	61.78	141.16	0.63
Nordenskiold	5141	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	534.04	535.98		536.09	0.004686	1.62	87.61	206.30	0.46
Nordenskiold	5141	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	534.04	536.08		536.19	0.004809	1.72	103.32	247.51	0.47
Nordenskiold	5141	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	534.04	535.89	535.78	536.10	0.009721	2.22	73.87	168.76	0.65
Nordenskiold	5141	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	534.04	536.08		536.19	0.004809	1.72	103.32	247.51	0.47
Nordenskiold	5141	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	534.04	536.26		536.38	0.004985	1.90	135.56	387.13	0.49
Nordenskiold	5141	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	534.04	536.07	535.98	536.29	0.009596	2.42	101.79	243.30	0.66
Nordenskiold	5141	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	534.04	536.26		536.38	0.004985	1.90	135.56	387.13	0.49
Nordenskiold	5141	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	534.04	536.36		536.50	0.005274	2.04	157.30	465.35	0.50
Nordenskiold	5141	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	534.04	536.17		536.41	0.009782	2.56	119.57	323.57	0.67
Nordenskiold	5141	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	534.04	536.36		536.50	0.005274	2.04	157.30	465.35	0.50
Nordenskiold	5141	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	534.04	536.46		536.61	0.005497	2.16	195.52	530.30	0.52
Nordenskiold	5141	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	534.04	536.28		536.53	0.009749	2.68	139.79	409.45	0.68
Nordenskiold	5141	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	534.04	536.46		536.61	0.005497	2.16	195.52	530.30	0.52
Nordenskiold	4820	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	532.74	534.91	534.50	534.99	0.003608	1.46	105.70	192.61	0.43
Nordenskiold	4820	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	532.74	535.23	534.50	535.26	0.001196	0.98	179.01	251.72	0.26
Nordenskiold	4820	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	532.74	534.91	534.50	534.99	0.003608	1.46	105.70	192.61	0.43
Nordenskiold	4820	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	532.74	535.01	534.67	535.09	0.003755	1.57	125.14	229.20	0.44
Nordenskiold	4820	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	532.74	535.33	534.67	535.36	0.001217	1.04	205.41	252.49	0.26
Nordenskiold	4820	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	532.74	535.01	534.67	535.09	0.003755	1.57	125.14	229.20	0.44
Nordenskiold	4820	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	532.74	535.18	534.86	535.28	0.004070	1.77	166.45	251.35	0.47
Nordenskiold	4820	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	532.74	535.54	534.86	535.58	0.001255	1.14	258.89	260.17	0.27
Nordenskiold	4820	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	532.74	535.18	534.86	535.28	0.004070	1.77	166.45	251.35	0.47
Nordenskiold	4820	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	532.74	535.27	534.94	535.38	0.004178	1.87	190.95	252.07	0.48
Nordenskiold	4820	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	532.74	535.66	534.94	535.69	0.001284	1.20	317.32	423.17	0.28
Nordenskiold	4820	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	532.74	535.27	534.94	535.38	0.004178	1.87	190.95	252.07	0.48
Nordenskiold	4820	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	532.74	535.38	535.07	535.50	0.004237	1.97	217.63	252.84	0.49
Nordenskiold	4820	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	532.74	535.78	535.07	535.82	0.001326	1.27	376.39	561.29	0.28
Nordenskiold	4820	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	532.74	535.38	535.07	535.50	0.004237	1.97	217.63	252.84	0.49
Nordenskiold	4618	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	532.05	534.16	533.72	534.23	0.004511	1.47	104.52	184.09	0.40
Nordenskiold	4618	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	532.05	534.94	534.20	534.95	0.002673	0.78	235.20	366.58	0.20

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	4618	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	532.05	534.16	533.72	534.23	0.004511	1.47	104.52	184.09	0.40
Nordenskiold	4618	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	532.05	534.28	533.92	534.35	0.004259	1.49	128.07	227.15	0.39
Nordenskiold	4618	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	532.05	535.04	534.29	535.05	0.002802	0.83	274.02	401.38	0.21
Nordenskiold	4618	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	532.05	534.28	533.92	534.35	0.004259	1.49	128.07	227.15	0.39
Nordenskiold	4618	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	532.05	534.48	534.07	534.55	0.003933	1.55	182.12	300.55	0.38
Nordenskiold	4618	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	532.05	535.24	534.46	535.25	0.003127	0.94	361.27	493.45	0.22
Nordenskiold	4618	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	532.05	534.48	534.07	534.55	0.003933	1.55	182.12	300.55	0.38
Nordenskiold	4618	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	532.05	534.60	534.15	534.66	0.003845	1.60	218.84	344.01	0.38
Nordenskiold	4618	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	532.05	535.35	534.53	535.37	0.003196	0.99	418.73	527.84	0.23
Nordenskiold	4618	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	532.05	534.60	534.15	534.66	0.003845	1.60	218.84	344.01	0.38
Nordenskiold	4618	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	532.05	534.69	534.23	534.77	0.004018	1.69	253.08	366.33	0.40
Nordenskiold	4618	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	532.05	535.47	534.63	535.49	0.003171	1.03	484.76	552.83	0.23
Nordenskiold	4618	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	532.05	534.69	534.23	534.77	0.004018	1.69	253.08	366.33	0.40
Nordenskiold	4471	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	532.08	533.75		533.82	0.002523	1.43	104.73	142.04	0.38
Nordenskiold	4471	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	532.08	534.55		534.56	0.005969	0.50	189.31	338.76	0.30
Nordenskiold	4471	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	532.08	533.75		533.82	0.002523	1.43	104.73	142.04	0.38
Nordenskiold	4471	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	532.08	533.85		533.93	0.002817	1.55	119.89	176.54	0.40
Nordenskiold	4471	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	532.08	534.63		534.65	0.006086	0.49	214.76	353.49	0.30
Nordenskiold	4471	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	532.08	533.85		533.93	0.002817	1.55	119.89	176.54	0.40
Nordenskiold	4471	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	532.08	534.03		534.12	0.003392	1.68	161.15	298.29	0.43
Nordenskiold	4471	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	532.08	534.81		534.83	0.005933	0.62	274.03	436.27	0.32
Nordenskiold	4471	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	532.08	534.03		534.12	0.003392	1.68	161.15	298.29	0.43
Nordenskiold	4471	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	532.08	534.13		534.22	0.003712	1.83	190.90	327.77	0.45
Nordenskiold	4471	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	532.08	534.92		534.94	0.005951	0.63	325.62	516.38	0.32
Nordenskiold	4471	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	532.08	534.13		534.22	0.003712	1.83	190.90	327.77	0.45
Nordenskiold	4471	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	532.08	534.22		534.32	0.003747	1.91	221.02	338.15	0.46
Nordenskiold	4471	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	532.08	535.05		535.07	0.006396	0.66	392.27	595.68	0.33
Nordenskiold	4471	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	532.08	534.22		534.32	0.003747	1.91	221.02	338.15	0.46
Nordenskiold	4381	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	531.42	533.39		533.51	0.006210	1.83	87.35	222.34	0.51
Nordenskiold	4381	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	531.42	534.21		534.22	0.004464	0.87	218.85	353.53	0.29
Nordenskiold	4381	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	531.42	533.39		533.51	0.006210	1.83	87.35	222.34	0.51
Nordenskiold	4381	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	531.42	533.48		533.60	0.006304	1.90	108.32	273.76	0.52
Nordenskiold	4381	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	531.42	534.29		534.31	0.004643	0.91	244.85	373.31	0.29
Nordenskiold	4381	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	531.42	533.48		533.60	0.006304	1.90	108.32	273.76	0.52
Nordenskiold	4381	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	531.42	533.63		533.75	0.006774	2.05	149.56	309.94	0.54
Nordenskiold	4381	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	531.42	534.46		534.47	0.005175	0.97	294.42	425.74	0.31
Nordenskiold	4381	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	531.42	533.63		533.75	0.006774	2.05	149.56	309.94	0.54
Nordenskiold	4381	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	531.42	533.71		533.84	0.006976	2.16	175.37	336.66	0.55
Nordenskiold	4381	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	531.42	534.56		534.58	0.005448	1.01	327.92	496.18	0.32
Nordenskiold	4381	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	531.42	533.71		533.84	0.006976	2.16	175.37	336.66	0.55
Nordenskiold	4381	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	531.42	533.80		533.94	0.007275	2.28	203.67	347.02	0.57
Nordenskiold	4381	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	531.42	534.67		534.69	0.005614	1.04	381.70	537.73	0.32
Nordenskiold	4381	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	531.42	533.80		533.94	0.007275	2.28	203.67	347.02	0.57
Nordenskiold	4296	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	531.36	533.32		533.35	0.000817	0.85	160.96	399.31	0.23
Nordenskiold	4296	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	531.36	534.00		534.01	0.003329	0.62	271.22	497.25	0.26
Nordenskiold	4296	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	531.36	533.32		533.35	0.000817	0.85	160.96	399.31	0.23
Nordenskiold	4296	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	531.36	533.39		533.43	0.000938	0.93	193.64	450.64	0.24
Nordenskiold	4296	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	531.36	534.08		534.08	0.003495	0.65	306.44	536.12	0.27
Nordenskiold	4296	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	531.36	533.39		533.43	0.000938	0.93	193.64	450.64	0.24
Nordenskiold	4296	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	531.36	533.52		533.56	0.001182	1.07	253.35	488.31	0.27
Nordenskiold	4296	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	531.36	534.22		534.23	0.003731	0.69	383.60	598.41	0.28
Nordenskiold	4296	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	531.36	533.52		533.56	0.001182	1.07	253.35	488.31	0.27
Nordenskiold	4296	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	531.36	533.59		533.64	0.001328	1.16	289.49	496.12	0.29
Nordenskiold	4296	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	531.36	534.32		534.33	0.003789	0.71	440.60	655.85	0.28
Nordenskiold	4296	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	531.36	533.59		533.64	0.001328	1.16	289.49	496.12	0.29
Nordenskiold	4296	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	531.36	533.67		533.73	0.001447	1.25	329.81	500.81	0.30
Nordenskiold	4296	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	531.36	534.42		534.44	0.003840	0.74	506.60	679.17	0.29
Nordenskiold	4296	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	531.36	533.67		533.73	0.001447	1.25	329.81	500.81	0.30
Nordenskiold	4229	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	530.89	533.24		533.28	0.001875	1.06	152.98	381.26	0.33
Nordenskiold	4229	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	530.89	533.86		533.87	0.005313	0.66	241.33	438.33	0.32
Nordenskiold	4229	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	530.89	533.24		533.28	0.001875	1.06	152.98	381.26	0.33
Nordenskiold	4229	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	530.89	533.31		533.36	0.002002	1.14	181.75	429.25	0.34
Nordenskiold	4229	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	530.89	533.93		533.94	0.005447	0.67	270.41	439.27	0.32
Nordenskiold	4229	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	530.89	533.31		533.36	0.002002	1.14	181.75	429.25	0.34
Nordenskiold	4229	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	530.89	533.42		533.48	0.002348	1.32	231.82	465.70	0.38
Nordenskiold	4229	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	530.89	534.07		534.08	0.005765	0.69	327.03	441.43	0.33
Nordenskiold	4229	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	530.89	533.42		533.48	0.002348	1.32	231.82	465.70	0.38
Nordenskiold	4229	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	530.89	533.49		533.55	0.002542	1.42	262.78	467.49	0.39
Nordenskiold	4229	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	530.89	534.16		534.17	0.005914	0.70	365.14	442.61	0.33
Nordenskiold	4229	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	530.89	533.49		533.55	0.002542	1.42	262.78	467.49	0.39
Nordenskiold	4229	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	530.89	533.57		533.63	0.002615	1.49	299.62	467.75	0.40
Nordenskiold	4229	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	530.89	534.26		534.27	0.006018	0.71	406.52	444.34	0.34
Nordenskiold	4229	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	530.89	533.57		533.63	0.002615	1.49	299.62	467.75	0.40
Nordenskiold	4109	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	531.07	532.92	532.64	533.02	0.004010	1.57	102.68	321.54	0.50
Nordenskiold	4109	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	531.07	533.57		533.58	0.008060	0.41	235.67	546.22	0.21
Nordenskiold	4109	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	531.07	532.92	532.64	533.02	0.004010	1.57	102.68	321.54	0.50
Nordenskiold	4109	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	531.07	532.99		533.09	0.003944	1.63	131.11	415.66	0.50
Nordenskiold	4109	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	531.07	533.65		533.66	0.007249	0.41	278.02	556.23	0.20
Nordenskiold	4109	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	531.07	532.99		533.09	0.003944	1.63	131.11	415.66	0.50
Nordenskiold	4109	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	531.07	533.13		533.23	0.003581	1.69	195.61	496.79	0.49
Nordenskiold	4109	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	531.07	533.81		533.82	0.005879	0.42	362.91	561.87	0.19
Nordenskiold	4109	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	531.07	533.13		533.23	0.003581	1.69	195.61	496.79	0.49
Nordenskiold	4109	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	531.07	533.23		533.31	0.003259	1.69	243.08	536.53	0.47
Nordenskiold	4109	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	531.07	533.91		533.92	0.005464	0.43	416.60	563.85	0.18
Nordenskiold	4109	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	531.07	533.23		533.31	0.003259	1.69	243.08	536.53	0.47
Nordenskiold	4109	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	531.07	533.34		533.41	0.002889	1.68	303.98	558.54	0.45
Nordenskiold	4109	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	531.07	534.01		534.02	0.005176	0.44	473.21	565.72	0.18
Nordenskiold	4109	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	531.07	533.34		533.41	0.002889	1.68	303.98	558.54	0.45
Nordenskiold	3798	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	530.10	531.91		532.02	0.003245	1.47	71.47	108.84	0.44
Nordenskiold	3798	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	530.10	532.73		532.78	0.002972	1.00	139.43	198.87	0.27
Nordenskiold	3798	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	530.10	531.91		532.02	0.003245	1.47	71.47	108.84	0.44
Nordenskiold	3798	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	530.10	532.06		532.17	0.003013	1.52	89.71	130.02	0.43
Nordenskiold	3798	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	530.10	532.88		532.92	0.002928	1.05	173.93	288.45	0.27
Nordenskiold	3798	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	530.10	532.06		532.17	0.003013	1.52	89.71	130.02	0.43

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	3798	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	530.10	532.35		532.47	0.002704	1.60	133.61	177.98	0.41
Nordenskiold	3798	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	530.10	533.13		533.18	0.002904	1.14	275.38	475.37	0.27
Nordenskiold	3798	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	530.10	532.35		532.47	0.002704	1.60	133.61	177.98	0.41
Nordenskiold	3798	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	530.10	532.52		532.64	0.002600	1.66	166.29	224.27	0.40
Nordenskiold	3798	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	530.10	533.26		533.31	0.002963	1.20	341.94	532.14	0.28
Nordenskiold	3798	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	530.10	532.52		532.64	0.002600	1.66	166.29	224.27	0.40
Nordenskiold	3798	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	530.10	532.66		532.79	0.002680	1.78	206.99	357.48	0.42
Nordenskiold	3798	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	530.10	533.39		533.44	0.003056	1.28	411.32	557.81	0.28
Nordenskiold	3798	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	530.10	532.66		532.79	0.002680	1.78	206.99	357.48	0.42
Nordenskiold	3720	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	530.00	531.60		531.74	0.003974	1.64	58.61	76.08	0.54
Nordenskiold	3720	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	530.00	532.15		532.26	0.029195	1.54	66.53	97.12	0.51
Nordenskiold	3720	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	530.00	531.60		531.74	0.003974	1.64	58.61	76.08	0.54
Nordenskiold	3720	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	530.00	531.81		531.94	0.003118	1.59	76.73	93.48	0.48
Nordenskiold	3720	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	530.00	532.38		532.47	0.019966	1.40	91.94	129.44	0.42
Nordenskiold	3720	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	530.00	531.81		531.94	0.003118	1.59	76.73	93.48	0.48
Nordenskiold	3720	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	530.00	532.13		532.26	0.002695	1.63	112.79	141.26	0.45
Nordenskiold	3720	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	530.00	532.70		532.77	0.015474	1.36	152.60	306.05	0.37
Nordenskiold	3720	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	530.00	532.13		532.26	0.002695	1.63	112.79	141.26	0.45
Nordenskiold	3720	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	530.00	532.30		532.44	0.002600	1.72	140.84	197.41	0.44
Nordenskiold	3720	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	530.00	532.86		532.93	0.013383	1.35	213.02	443.34	0.35
Nordenskiold	3720	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	530.00	532.30		532.44	0.002600	1.72	140.84	197.41	0.44
Nordenskiold	3720	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	530.00	532.45		532.60	0.002592	1.82	178.56	330.34	0.45
Nordenskiold	3720	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	530.00	532.99		533.06	0.012539	1.38	278.14	498.22	0.34
Nordenskiold	3720	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	530.00	532.45		532.60	0.002592	1.82	178.56	330.34	0.45
Nordenskiold	3608	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	529.02	531.15		531.29	0.003979	1.65	56.20	58.00	0.43
Nordenskiold	3608	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	529.02	531.15		531.29	0.003979	1.65	56.20	58.00	0.43
Nordenskiold	3608	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	529.02	531.15		531.29	0.003979	1.65	56.20	58.00	0.43
Nordenskiold	3608	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	529.02	531.37		531.52	0.004442	1.71	68.57	74.90	0.44
Nordenskiold	3608	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	529.02	531.37		531.52	0.004442	1.71	68.57	74.90	0.44
Nordenskiold	3608	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	529.02	531.37		531.52	0.004442	1.71	68.57	74.90	0.44
Nordenskiold	3608	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	529.02	531.69		531.86	0.004482	1.88	97.10	125.39	0.44
Nordenskiold	3608	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	529.02	531.69		531.86	0.004482	1.88	97.10	125.39	0.44
Nordenskiold	3608	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	529.02	531.69		531.86	0.004482	1.88	97.10	125.39	0.44
Nordenskiold	3608	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	529.02	531.86		532.05	0.004457	1.99	127.49	242.02	0.45
Nordenskiold	3608	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	529.02	531.86		532.05	0.004457	1.99	127.49	242.02	0.45
Nordenskiold	3608	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	529.02	531.86		532.05	0.004457	1.99	127.49	242.02	0.45
Nordenskiold	3608	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	529.02	532.02	531.30	532.20	0.004294	2.06	175.82	371.39	0.44
Nordenskiold	3608	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	529.02	532.02	531.30	532.20	0.004294	2.06	175.82	371.39	0.44
Nordenskiold	3608	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	529.02	532.02	531.30	532.20	0.004294	2.06	175.82	371.39	0.44
Nordenskiold	3370	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	528.38	530.25		530.39	0.003657	1.64	62.36	66.57	0.43
Nordenskiold	3370	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	528.38	530.25		530.39	0.003657	1.64	62.36	66.57	0.43
Nordenskiold	3370	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	528.38	530.25		530.39	0.003657	1.64	62.36	66.57	0.43
Nordenskiold	3370	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	528.38	530.42		530.56	0.003717	1.74	74.54	80.98	0.44
Nordenskiold	3370	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	528.38	530.42		530.56	0.003717	1.74	74.54	80.98	0.44
Nordenskiold	3370	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	528.38	530.42		530.56	0.003717	1.74	74.54	80.98	0.44
Nordenskiold	3370	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	528.38	530.79		530.94	0.003533	1.82	110.57	121.09	0.42
Nordenskiold	3370	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	528.38	530.79		530.94	0.003533	1.82	110.57	121.09	0.42
Nordenskiold	3370	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	528.38	530.79		530.94	0.003533	1.82	110.57	121.09	0.42
Nordenskiold	3370	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	528.38	530.94		531.11	0.003711	1.96	130.17	137.43	0.44
Nordenskiold	3370	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	528.38	530.94		531.11	0.003711	1.96	130.17	137.43	0.44
Nordenskiold	3370	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	528.38	530.94		531.11	0.003711	1.96	130.17	137.43	0.44
Nordenskiold	3370	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	528.38	531.09		531.28	0.003903	2.11	151.06	148.70	0.46
Nordenskiold	3370	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	528.38	531.09		531.28	0.003903	2.11	151.06	148.70	0.46
Nordenskiold	3370	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	528.38	531.09		531.28	0.003903	2.11	151.06	148.70	0.46
Nordenskiold	3297	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	528.24	529.73		529.98	0.008516	2.34	45.65	49.57	0.72
Nordenskiold	3297	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	528.24	529.73		529.98	0.008516	2.34	45.65	49.57	0.72
Nordenskiold	3297	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	528.24	529.73		529.98	0.008516	2.34	45.65	49.57	0.72
Nordenskiold	3297	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	528.24	529.88		530.16	0.008416	2.45	53.66	56.88	0.71
Nordenskiold	3297	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	528.24	529.88		530.16	0.008416	2.45	53.66	56.88	0.71
Nordenskiold	3297	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	528.24	529.88		530.16	0.008416	2.45	53.66	56.88	0.71
Nordenskiold	3297	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	528.24	530.19	529.89	530.52	0.009214	2.70	75.48	98.74	0.72
Nordenskiold	3297	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	528.24	530.19	529.89	530.52	0.009214	2.70	75.48	98.74	0.72
Nordenskiold	3297	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	528.24	530.19	529.89	530.52	0.009214	2.70	75.48	98.74	0.72
Nordenskiold	3297	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	528.24	530.36	530.06	530.70	0.008372	2.78	95.59	129.30	0.70
Nordenskiold	3297	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	528.24	530.36	530.06	530.70	0.008372	2.78	95.59	129.30	0.70
Nordenskiold	3297	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	528.24	530.36	530.06	530.70	0.008372	2.78	95.59	129.30	0.70
Nordenskiold	3297	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	528.24	530.54	530.14	530.87	0.007592	2.83	119.13	140.07	0.68
Nordenskiold	3297	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	528.24	530.54	530.14	530.87	0.007592	2.83	119.13	140.07	0.68
Nordenskiold	3297	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	528.24	530.54	530.14	530.87	0.007592	2.83	119.13	140.07	0.68
Nordenskiold	3238	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	527.62	529.54		529.63	0.003377	1.30	69.92	66.05	0.40
Nordenskiold	3238	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	527.62	529.54		529.63	0.003377	1.30	69.92	66.05	0.40
Nordenskiold	3238	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	527.62	529.54		529.63	0.003377	1.30	69.92	66.05	0.40
Nordenskiold	3238	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	527.62	529.72		529.81	0.003141	1.35	82.21	73.64	0.39
Nordenskiold	3238	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	527.62	529.72		529.81	0.003141	1.35	82.21	73.64	0.39
Nordenskiold	3238	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	527.62	529.72		529.81	0.003141	1.35	82.21	73.64	0.39
Nordenskiold	3238	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	527.62	530.06		530.16	0.003072	1.45	113.91	127.22	0.38
Nordenskiold	3238	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	527.62	530.06		530.16	0.003072	1.45	113.91	127.22	0.38
Nordenskiold	3238	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	527.62	530.06		530.16	0.003072	1.45	113.91	127.22	0.38
Nordenskiold	3238	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	527.62	530.24		530.36	0.002937	1.52	141.71	171.07	0.37
Nordenskiold	3238	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	527.62	530.24		530.36	0.002937	1.52	141.71	171.07	0.37
Nordenskiold	3238	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	527.62	530.24		530.36	0.002937	1.52	141.71	171.07	0.37
Nordenskiold	3238	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	527.62	530.43		530.55	0.002829	1.58	177.61	220.44	0.37
Nordenskiold	3238	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	527.62	530.43		530.55	0.002829	1.58	177.61	220.44	0.37
Nordenskiold	3238	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	527.62	530.43		530.55	0.002829	1.58	177.61	220.44	0.37
Nordenskiold	3077	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	526.90	528.93	528.26	529.09	0.003191	1.79	50.76	35.21	0.48
Nordenskiold	3077	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	526.90	528.93	528.26	529.09	0.003191	1.79	50.76	35.21	0.48
Nordenskiold	3077	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	526.90	528.93	528.26	529.09	0.003191	1.79	50.76	35.21	0.48
Nordenskiold	3077	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	526.90	529.09	528.40	529.28	0.003324	1.95	57.25	46.61	0.49
Nordenskiold	3077	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	526.90	529.09	528.40	529.28	0.003324	1.95	57.25	46.61	0.49
Nordenskiold	3077	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	526.90	529.09	528.40	529.28	0.003324	1.95	57.25	46.61	0.49
Nordenskiold	3077	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	526.90	529.41	528.68	529.64	0.003335	2.17	85.68	103.64	0.51
Nordenskiold	3077	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	526.90	529.41	528.68	529.64	0.003335	2.17	85.68	103.64	0.51
Nordenskiold	3077	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	526.90	529.41	528.68	529.64	0.003335	2.17	85.68	103.64	0.51
Nordenskiold	3077	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	526.90	529.51	528.89	529.80	0.003968	2.45	97.66	122.07	0.56

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	3077	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	526.90	529.51	528.89	529.80	0.003968	2.45	97.66	122.07	0.56
Nordenskiold	3077	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	526.90	529.51	528.89	529.80	0.003968	2.45	97.66	122.07	0.56
Nordenskiold	3077	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	526.90	529.70	529.11	530.01	0.003968	2.58	126.15	199.59	0.56
Nordenskiold	3077	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	526.90	529.70	529.11	530.01	0.003968	2.58	126.15	199.59	0.56
Nordenskiold	3077	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	526.90	529.70	529.11	530.01	0.003968	2.58	126.15	199.59	0.56
Nordenskiold	2880	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	526.09	528.12	527.75	528.31	0.005139	1.93	47.12	41.64	0.58
Nordenskiold	2880	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	526.09	528.12	527.75	528.31	0.005139	1.93	47.12	41.64	0.58
Nordenskiold	2880	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	526.09	528.12	527.75	528.31	0.005139	1.93	47.12	41.64	0.58
Nordenskiold	2880	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	526.09	528.28	527.86	528.49	0.005009	2.04	53.79	42.77	0.58
Nordenskiold	2880	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	526.09	528.28	527.86	528.49	0.005009	2.04	53.79	42.77	0.58
Nordenskiold	2880	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	526.09	528.28	527.86	528.49	0.005009	2.04	53.79	42.77	0.58
Nordenskiold	2880	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	526.09	528.54	528.10	528.81	0.005543	2.34	65.63	50.08	0.63
Nordenskiold	2880	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	526.09	528.54	528.10	528.81	0.005543	2.34	65.63	50.08	0.63
Nordenskiold	2880	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	526.09	528.54	528.10	528.81	0.005543	2.34	65.63	50.08	0.63
Nordenskiold	2880	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	526.09	528.69	528.26	528.96	0.005034	2.36	90.78	81.80	0.60
Nordenskiold	2880	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	526.09	528.69	528.26	528.96	0.005034	2.36	90.78	81.80	0.60
Nordenskiold	2880	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	526.09	528.69	528.26	528.96	0.005034	2.36	90.78	81.80	0.60
Nordenskiold	2880	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	526.09	528.83	528.44	529.15	0.005470	2.60	103.19	108.28	0.64
Nordenskiold	2880	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	526.09	528.83	528.44	529.15	0.005470	2.60	103.19	108.28	0.64
Nordenskiold	2880	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	526.09	528.83	528.44	529.15	0.005470	2.60	103.19	108.28	0.64
Nordenskiold	2681	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	525.59	527.62	526.83	527.71	0.001817	1.35	73.49	92.22	0.36
Nordenskiold	2681	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	525.59	527.62	526.83	527.71	0.001817	1.35	73.49	92.22	0.36
Nordenskiold	2681	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	525.59	527.62	526.83	527.71	0.001817	1.35	73.49	92.22	0.36
Nordenskiold	2681	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	525.59	527.77	526.95	527.87	0.001945	1.45	90.16	136.08	0.38
Nordenskiold	2681	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	525.59	527.77	526.95	527.87	0.001945	1.45	90.16	136.08	0.38
Nordenskiold	2681	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	525.59	527.77	526.95	527.87	0.001945	1.45	90.16	136.08	0.38
Nordenskiold	2681	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	525.59	528.04	527.18	528.16	0.001954	1.59	137.68	198.92	0.38
Nordenskiold	2681	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	525.59	528.04	527.18	528.16	0.001954	1.59	137.68	198.92	0.38
Nordenskiold	2681	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	525.59	528.04	527.18	528.16	0.001954	1.59	137.68	198.92	0.38
Nordenskiold	2681	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	525.59	528.20	527.33	528.33	0.001942	1.68	172.64	231.07	0.39
Nordenskiold	2681	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	525.59	528.20	527.33	528.33	0.001942	1.68	172.64	231.07	0.39
Nordenskiold	2681	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	525.59	528.20	527.33	528.33	0.001942	1.68	172.64	231.07	0.39
Nordenskiold	2681	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	525.59	528.37	527.52	528.49	0.001894	1.75	211.18	241.65	0.39
Nordenskiold	2681	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	525.59	528.37	527.52	528.49	0.001894	1.75	211.18	241.65	0.39
Nordenskiold	2681	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	525.59	528.37	527.52	528.49	0.001894	1.75	211.18	241.65	0.39
Nordenskiold	2401	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	524.94	526.62	526.38	526.81	0.006890	1.95	47.35	54.76	0.65
Nordenskiold	2401	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	524.94	526.62	526.38	526.81	0.006890	1.95	47.35	54.76	0.65
Nordenskiold	2401	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	524.94	526.62	526.38	526.81	0.006890	1.95	47.35	54.76	0.65
Nordenskiold	2401	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	524.94	526.78	526.49	526.98	0.005962	2.00	56.52	58.09	0.62
Nordenskiold	2401	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	524.94	526.78	526.49	526.98	0.005962	2.00	56.52	58.09	0.62
Nordenskiold	2401	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	524.94	526.78	526.49	526.98	0.005962	2.00	56.52	58.09	0.62
Nordenskiold	2401	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	524.94	527.02	526.67	527.27	0.005986	2.25	72.23	79.55	0.64
Nordenskiold	2401	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	524.94	527.02	526.67	527.27	0.005986	2.25	72.23	79.55	0.64
Nordenskiold	2401	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	524.94	527.02	526.67	527.27	0.005986	2.25	72.23	79.55	0.64
Nordenskiold	2401	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	524.94	527.17	526.83	527.46	0.005902	2.40	85.75	103.61	0.65
Nordenskiold	2401	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	524.94	527.17	526.83	527.46	0.005902	2.40	85.75	103.61	0.65
Nordenskiold	2401	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	524.94	527.17	526.83	527.46	0.005902	2.40	85.75	103.61	0.65
Nordenskiold	2401	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	524.94	527.32	526.98	527.64	0.005854	2.56	104.82	136.59	0.65
Nordenskiold	2401	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	524.94	527.32	526.98	527.64	0.005854	2.56	104.82	136.59	0.65
Nordenskiold	2401	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	524.94	527.32	526.98	527.64	0.005854	2.56	104.82	136.59	0.65
Nordenskiold	2143	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	524.06	525.88	525.11	525.98	0.001781	1.36	67.12	47.84	0.37
Nordenskiold	2143	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	524.06	525.88	525.11	525.98	0.001781	1.36	67.12	47.84	0.37
Nordenskiold	2143	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	524.06	525.88	525.11	525.98	0.001781	1.36	67.12	47.84	0.37
Nordenskiold	2143	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	524.06	526.03	525.22	526.14	0.001949	1.48	74.70	54.17	0.39
Nordenskiold	2143	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	524.06	526.03	525.22	526.14	0.001949	1.48	74.70	54.17	0.39
Nordenskiold	2143	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	524.06	526.03	525.22	526.14	0.001949	1.48	74.70	54.17	0.39
Nordenskiold	2143	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	524.06	526.28	525.44	526.40	0.002047	1.61	128.26	170.04	0.40
Nordenskiold	2143	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	524.06	526.28	525.44	526.40	0.002047	1.61	128.26	170.04	0.40
Nordenskiold	2143	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	524.06	526.28	525.44	526.40	0.002047	1.61	128.26	170.04	0.40
Nordenskiold	2143	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	524.06	526.42	525.60	526.56	0.002156	1.73	155.76	224.16	0.41
Nordenskiold	2143	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	524.06	526.42	525.60	526.56	0.002156	1.73	155.76	224.16	0.41
Nordenskiold	2143	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	524.06	526.42	525.60	526.56	0.002156	1.73	155.76	224.16	0.41
Nordenskiold	2143	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	524.06	526.58	525.76	526.73	0.002222	1.85	194.02	253.84	0.42
Nordenskiold	2143	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	524.06	526.58	525.76	526.73	0.002222	1.85	194.02	253.84	0.42
Nordenskiold	2143	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	524.06	526.58	525.76	526.73	0.002222	1.85	194.02	253.84	0.42
Nordenskiold	2038	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	523.48	525.65		525.77	0.002348	1.59	75.34	112.74	0.41
Nordenskiold	2038	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	523.48	525.65		525.77	0.002348	1.59	75.34	112.74	0.41
Nordenskiold	2038	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	523.48	525.65		525.77	0.002348	1.59	75.34	112.74	0.41
Nordenskiold	2038	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	523.48	525.80		525.93	0.002372	1.69	94.03	133.31	0.42
Nordenskiold	2038	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	523.48	525.80		525.93	0.002372	1.69	94.03	133.31	0.42
Nordenskiold	2038	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	523.48	525.80		525.93	0.002372	1.69	94.03	133.31	0.42
Nordenskiold	2038	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	523.48	526.05	525.40	526.19	0.002421	1.86	129.34	150.34	0.43
Nordenskiold	2038	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	523.48	526.05	525.40	526.19	0.002421	1.86	129.34	150.34	0.43
Nordenskiold	2038	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	523.48	526.05	525.40	526.19	0.002421	1.86	129.35	150.34	0.43
Nordenskiold	2038	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	523.48	526.18	525.62	526.34	0.002549	1.99	150.73	162.56	0.45
Nordenskiold	2038	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	523.48	526.18	525.62	526.34	0.002549	1.99	150.73	162.56	0.45
Nordenskiold	2038	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	523.48	526.18	525.62	526.34	0.002549	1.99	150.73	162.56	0.45
Nordenskiold	2038	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	523.48	526.33	525.87	526.51	0.002710	2.14	176.56	197.76	0.47
Nordenskiold	2038	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	523.48	526.33	525.87	526.51	0.002710	2.14	176.56	197.76	0.47
Nordenskiold	2038	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	523.48	526.33	525.87	526.51	0.002710	2.14	176.56	197.76	0.47
Nordenskiold	1895	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	522.94	524.60	524.60	525.04	0.016984	2.96	30.77	45.70	1.01
Nordenskiold	1895	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	522.94	524.60	524.60	525.04	0.016984	2.96	30.77	45.70	1.01
Nordenskiold	1895	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	522.94	524.60	524.60	525.04	0.016984	2.96	30.77	45.70	1.01
Nordenskiold	1895	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	522.94	524.74	524.74	525.22	0.015597	3.08	36.10	47.31	0.99
Nordenskiold	1895	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	522.94	524.74	524.74	525.22	0.015597	3.08	36.10	47.31	0.99
Nordenskiold	1895	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	522.94	524.74	524.74	525.22	0.015597	3.08	36.10	47.31	0.99
Nordenskiold	1895	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	522.94	525.06	525.06	525.54	0.012019	3.13	55.43	78.19	0.89
Nordenskiold	1895	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	522.94	525.06	525.06	525.54	0.012019	3.13	55.43	78.19	0.89
Nordenskiold	1895	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	522.94	525.06	525.06	525.54	0.012019	3.13	55.43	78.19	0.89
Nordenskiold	1895	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	522.94	525.27	525.27	525.72	0.010422	3.10	75.03	106.04	0.83
Nordenskiold	1895	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	522.94	525.27	525.27	525.72	0.010422	3.10	75.03	106.04	0.83
Nordenskiold	1895	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	522.94	525.27	525.27	525.72	0.010422	3.10	75.03	106.04	0.83
Nordenskiold	1895	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	522.94	525.43	525.43	525.89	0.009943	3.17	94.55	130.00	0.82
Nordenskiold	1895	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	522.94	525.43	525.43	525.89	0.009943	3.17	94.55	130.00	0.82

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	1895	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	522.94	525.43	525.43	525.89	0.009943	3.17	94.55	130.00	0.82
Nordenskiold	1778	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	521.16	524.11		524.20	0.001763	1.31	69.49	49.32	0.35
Nordenskiold	1778	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	521.16	524.11		524.20	0.001763	1.31	69.49	49.32	0.35
Nordenskiold	1778	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	521.16	524.28		524.35	0.001259	1.16	78.24	51.34	0.30
Nordenskiold	1778	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	521.16	524.29		524.39	0.001826	1.40	78.44	51.39	0.36
Nordenskiold	1778	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	521.16	524.29		524.39	0.001826	1.40	78.44	51.39	0.36
Nordenskiold	1778	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	521.16	524.50		524.58	0.001230	1.23	89.60	53.75	0.30
Nordenskiold	1778	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	521.16	524.62		524.75	0.001902	1.59	96.11	55.78	0.38
Nordenskiold	1778	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	521.16	524.62		524.75	0.001902	1.59	96.11	55.78	0.38
Nordenskiold	1778	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	521.16	524.87		524.97	0.001223	1.40	112.63	76.09	0.31
Nordenskiold	1778	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	521.16	524.82		524.97	0.001941	1.73	108.97	73.47	0.39
Nordenskiold	1778	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	521.16	524.82		524.97	0.001941	1.73	108.97	73.47	0.39
Nordenskiold	1778	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	521.16	525.11		525.22	0.001216	1.50	134.49	111.72	0.32
Nordenskiold	1778	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	521.16	525.03		525.21	0.001981	1.87	126.24	96.52	0.40
Nordenskiold	1778	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	521.16	525.03		525.21	0.001981	1.87	126.24	96.52	0.40
Nordenskiold	1778	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	521.16	525.36		525.48	0.001190	1.59	167.21	145.27	0.32
Nordenskiold	1544	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	521.81	523.43		523.59	0.004103	1.76	51.75	44.60	0.52
Nordenskiold	1544	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	521.81	523.43		523.59	0.004103	1.76	51.75	44.60	0.52
Nordenskiold	1544	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	521.81	524.01		524.08	0.001072	1.15	84.07	75.43	0.28
Nordenskiold	1544	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	521.81	523.61		523.78	0.003894	1.85	59.64	47.71	0.52
Nordenskiold	1544	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	521.81	523.61		523.78	0.003894	1.85	59.64	47.71	0.52
Nordenskiold	1544	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	521.81	524.25		524.32	0.000977	1.19	102.84	84.45	0.28
Nordenskiold	1544	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	521.81	523.95		524.15	0.003476	2.01	79.42	67.67	0.51
Nordenskiold	1544	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	521.81	523.95		524.15	0.003476	2.01	79.42	67.67	0.51
Nordenskiold	1544	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	521.81	524.63		524.71	0.000962	1.34	138.32	108.87	0.28
Nordenskiold	1544	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	521.81	524.17		524.39	0.003231	2.11	96.22	82.58	0.50
Nordenskiold	1544	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	521.81	524.17		524.39	0.003231	2.11	96.22	82.58	0.50
Nordenskiold	1544	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	521.81	524.87		524.97	0.000943	1.42	167.59	124.94	0.28
Nordenskiold	1544	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	521.81	524.41		524.64	0.002954	2.19	116.63	88.86	0.49
Nordenskiold	1544	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	521.81	524.41		524.64	0.002954	2.19	116.63	88.86	0.49
Nordenskiold	1544	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	521.81	525.14		525.24	0.000908	1.48	200.99	128.96	0.28
Nordenskiold	1411	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	520.95	522.91		523.08	0.003485	1.83	49.68	36.73	0.50
Nordenskiold	1411	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	520.95	522.91		523.08	0.003485	1.83	49.68	36.73	0.50
Nordenskiold	1411	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	520.95	523.93		523.98	0.000538	1.01	101.22	66.94	0.21
Nordenskiold	1411	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	520.95	523.09		523.29	0.003470	1.96	56.44	39.12	0.51
Nordenskiold	1411	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	520.95	523.09		523.29	0.003470	1.96	56.44	39.12	0.51
Nordenskiold	1411	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	520.95	524.16		524.22	0.000564	1.10	119.48	93.03	0.22
Nordenskiold	1411	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	520.95	523.45		523.69	0.003407	2.19	72.38	49.70	0.52
Nordenskiold	1411	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	520.95	523.45		523.69	0.003407	2.19	72.38	49.70	0.52
Nordenskiold	1411	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	520.95	524.53		524.61	0.000644	1.28	158.54	114.66	0.24
Nordenskiold	1411	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	520.95	523.67		523.95	0.003347	2.34	85.23	61.34	0.52
Nordenskiold	1411	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	520.95	523.67		523.95	0.003347	2.34	85.23	61.34	0.52
Nordenskiold	1411	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	520.95	524.77		524.86	0.000672	1.38	186.70	115.79	0.25
Nordenskiold	1411	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	520.95	523.92		524.22	0.003220	2.47	100.94	66.68	0.52
Nordenskiold	1411	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	520.95	523.92		524.22	0.003220	2.47	100.94	66.68	0.52
Nordenskiold	1411	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	520.95	525.03		525.13	0.000694	1.48	216.83	116.90	0.26
Nordenskiold	1344	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	521.02	522.61		522.76	0.006766	1.73	52.82	44.14	0.49
Nordenskiold	1344	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	521.02	522.61		522.76	0.006766	1.73	52.82	44.14	0.49
Nordenskiold	1344	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	521.02	523.90		523.93	0.000591	0.77	133.05	95.63	0.16
Nordenskiold	1344	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	521.02	522.80		522.97	0.006461	1.81	61.56	46.54	0.48
Nordenskiold	1344	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	521.02	522.80		522.97	0.006461	1.81	61.56	46.54	0.48
Nordenskiold	1344	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	521.02	524.14		524.17	0.000613	0.84	152.62	131.21	0.16
Nordenskiold	1344	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	521.02	523.19		523.38	0.005852	1.94	82.28	67.74	0.47
Nordenskiold	1344	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	521.02	523.19		523.38	0.005852	1.94	82.28	67.74	0.47
Nordenskiold	1344	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	521.02	524.51		524.55	0.000712	0.98	204.21	160.79	0.18
Nordenskiold	1344	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	521.02	523.45		523.65	0.005217	2.01	100.22	79.28	0.45
Nordenskiold	1344	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	521.02	523.45		523.65	0.005217	2.01	100.22	79.28	0.45
Nordenskiold	1344	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	521.02	524.75		524.80	0.000729	1.05	241.93	166.04	0.18
Nordenskiold	1344	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	521.02	523.74		523.94	0.004586	2.06	120.64	82.96	0.43
Nordenskiold	1344	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	521.02	523.74		523.94	0.004586	2.06	120.64	82.96	0.43
Nordenskiold	1344	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	521.02	525.02		525.07	0.000730	1.10	282.61	167.26	0.19
Nordenskiold	1321	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	520.85	522.49		522.62	0.004829	1.64	55.58	44.77	0.47
Nordenskiold	1321	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	520.85	522.49		522.62	0.004829	1.64	55.58	44.77	0.47
Nordenskiold	1321	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	520.85	523.89		523.92	0.000417	0.73	136.49	135.34	0.15
Nordenskiold	1321	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	520.85	522.68		522.83	0.004722	1.71	64.72	47.26	0.46
Nordenskiold	1321	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	520.85	522.68		522.83	0.004722	1.71	64.72	47.26	0.46
Nordenskiold	1321	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	520.85	524.13		524.16	0.000445	0.80	157.76	171.88	0.15
Nordenskiold	1321	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	520.85	523.09		523.26	0.004369	1.83	84.78	69.20	0.44
Nordenskiold	1321	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	520.85	523.09		523.26	0.004369	1.83	84.78	69.20	0.44
Nordenskiold	1321	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	520.85	524.50		524.54	0.000512	0.93	215.11	185.16	0.17
Nordenskiold	1321	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	520.85	523.35		523.54	0.003936	1.91	100.10	83.31	0.43
Nordenskiold	1321	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	520.85	523.35		523.54	0.003936	1.91	100.10	83.31	0.43
Nordenskiold	1321	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	520.85	524.74		524.79	0.000531	1.00	254.69	187.66	0.17
Nordenskiold	1321	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	520.85	523.64		523.84	0.003542	1.99	118.75	94.99	0.42
Nordenskiold	1321	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	520.85	523.64		523.84	0.003542	1.99	118.75	94.99	0.42
Nordenskiold	1321	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	520.85	525.00		525.05	0.000542	1.06	297.42	189.82	0.18
Nordenskiold	1292	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	520.35	522.37	521.69	522.52	0.002784	1.73	53.00	35.92	0.45
Nordenskiold	1292	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	520.35	522.37	521.69	522.52	0.002784	1.73	53.00	35.92	0.45
Nordenskiold	1292	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	520.35	523.87	521.69	523.91	0.000292	0.84	113.50	104.38	0.16
Nordenskiold	1292	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	520.35	522.55	521.82	522.73	0.002821	1.86	59.76	37.23	0.46
Nordenskiold	1292	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	520.35	522.55	521.82	522.73	0.002821	1.86	59.76	37.23	0.46
Nordenskiold	1292	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	520.35	524.11	521.82	524.15	0.000297	0.88	155.39	220.25	0.16
Nordenskiold	1292	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	520.35	522.92	522.09	523.15	0.002877	2.11	74.19	45.62	0.47
Nordenskiold	1292	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	520.35	522.92	522.09	523.15	0.002877	2.11	74.19	45.62	0.47
Nordenskiold	1292	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	520.35	524.49	522.09	524.52	0.000287	0.94	223.65	225.57	0.16
Nordenskiold	1292	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	520.35	523.18	522.27	523.43	0.002882	2.26	84.38	58.96	0.48
Nordenskiold	1292	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	520.35	523.18	522.27	523.43	0.002882	2.26	84.38	58.96	0.48
Nordenskiold	1292	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	520.35	524.74	522.27	524.77	0.000271	0.96	269.36	226.81	0.16
Nordenskiold	1292	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	520.35	523.45	522.46	523.74	0.002867	2.41	95.64	70.17	0.49
Nordenskiold	1292	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	520.35	523.45	522.46	523.74	0.002867	2.41	95.64	70.17	0.49
Nordenskiold	1292	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	520.35	525.00	522.46	525.04	0.000254	0.97	318.09	227.79	0.16
Nordenskiold	1285	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	520.34	522.18	521.81	522.46	0.004456	2.35	39.35	30.29	0.62
Nordenskiold	1285	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	520.34	522.18	521.81	522.46	0.004456	2.35	39.35	30.29	0.62

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

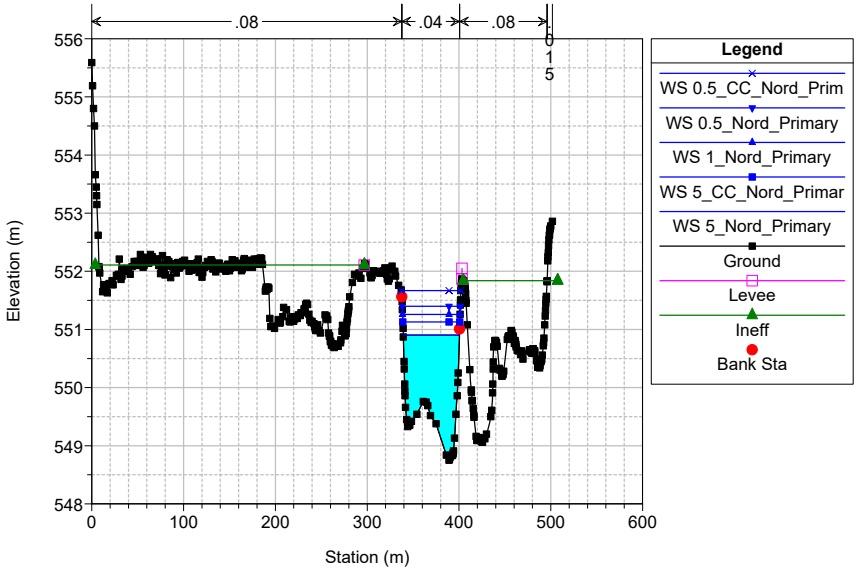
Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	1285	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	520.34	523.86	521.81	523.90	0.000248	0.95	95.91	38.36	0.17
Nordenskiold	1285	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	520.34	522.34	521.97	522.66	0.004457	2.53	44.24	30.84	0.63
Nordenskiold	1285	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	520.34	522.34	521.97	522.66	0.004457	2.53	44.24	30.84	0.63
Nordenskiold	1285	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	520.34	524.08	521.97	524.14	0.000280	1.05	103.71	39.32	0.18
Nordenskiold	1285	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	520.34	522.66	522.26	523.07	0.004386	2.85	54.62	34.45	0.65
Nordenskiold	1285	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	520.34	522.66	522.26	523.07	0.004386	2.85	54.62	34.45	0.65
Nordenskiold	1285	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	520.34	524.42	522.26	524.51	0.000403	1.35	117.14	42.06	0.22
Nordenskiold	1285	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	520.34	522.89	522.47	523.35	0.004243	3.03	62.11	36.53	0.66
Nordenskiold	1285	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	520.34	522.89	522.47	523.35	0.004243	3.03	62.11	36.53	0.66
Nordenskiold	1285	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	520.34	524.64	522.47	524.75	0.000465	1.51	127.83	55.20	0.24
Nordenskiold	1285	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	520.34	523.14	522.67	523.65	0.003994	3.17	70.92	37.60	0.65
Nordenskiold	1285	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	520.34	523.14	522.67	523.65	0.003994	3.17	70.92	37.60	0.65
Nordenskiold	1285	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	520.34	524.86	522.67	525.00	0.000556	1.72	141.71	67.38	0.27
Nordenskiold	1280			Bridge									
Nordenskiold	1275	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	520.34	522.08		522.41	0.003096	2.54	36.45	30.06	0.69
Nordenskiold	1275	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	520.34	522.08		522.41	0.003096	2.54	36.45	30.06	0.69
Nordenskiold	1275	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	520.34	523.85		523.90	0.000154	0.99	94.23	38.33	0.18
Nordenskiold	1275	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	520.34	522.23		522.61	0.003161	2.75	40.84	30.41	0.71
Nordenskiold	1275	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	520.34	522.23		522.61	0.003161	2.75	40.84	30.41	0.71
Nordenskiold	1275	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	520.34	524.06		524.12	0.000177	1.11	101.40	39.25	0.19
Nordenskiold	1275	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	520.34	522.51		523.01	0.003317	3.16	49.51	32.47	0.75
Nordenskiold	1275	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	520.34	522.51		523.01	0.003317	3.16	49.51	32.47	0.75
Nordenskiold	1275	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	520.34	524.36		524.46	0.000268	1.45	112.89	40.36	0.24
Nordenskiold	1275	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	520.34	522.69		523.28	0.003459	3.44	55.11	34.68	0.78
Nordenskiold	1275	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	520.34	522.69		523.28	0.003459	3.44	55.11	34.68	0.78
Nordenskiold	1275	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	520.34	524.53		524.66	0.000326	1.65	120.54	47.98	0.27
Nordenskiold	1275	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	520.34	522.87	522.67	523.57	0.003619	3.74	61.04	36.45	0.81
Nordenskiold	1275	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	520.34	522.87	522.67	523.57	0.003619	3.74	61.04	36.45	0.81
Nordenskiold	1275	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	520.34	524.70		524.86	0.000395	1.87	129.58	58.01	0.30
Nordenskiold	1270	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	520.13	522.13		522.32	0.004295	1.94	47.05	32.42	0.51
Nordenskiold	1270	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	520.13	522.13		522.32	0.004295	1.94	47.05	32.42	0.51
Nordenskiold	1270	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	520.13	523.86		523.89	0.000379	0.84	113.43	62.90	0.15
Nordenskiold	1270	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	520.13	522.29		522.52	0.004791	2.12	52.07	33.33	0.53
Nordenskiold	1270	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	520.13	522.29		522.52	0.004791	2.12	52.07	33.33	0.53
Nordenskiold	1270	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	520.13	524.07		524.11	0.000439	0.94	122.10	62.90	0.17
Nordenskiold	1270	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	520.13	522.59		522.90	0.006176	2.48	62.34	38.32	0.59
Nordenskiold	1270	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	520.13	522.59		522.90	0.006176	2.48	62.34	38.32	0.59
Nordenskiold	1270	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	520.13	524.37		524.44	0.000630	1.20	137.26	62.90	0.20
Nordenskiold	1270	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	520.13	522.78		523.15	0.007081	2.69	69.89	50.61	0.62
Nordenskiold	1270	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	520.13	522.78		523.15	0.007081	2.69	69.89	50.61	0.62
Nordenskiold	1270	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	520.13	524.55		524.64	0.000771	1.37	146.55	62.90	0.23
Nordenskiold	1270	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	520.13	522.98		523.41	0.007264	2.91	78.00	51.74	0.64
Nordenskiold	1270	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	520.13	522.98		523.41	0.007264	2.91	78.00	51.74	0.64
Nordenskiold	1270	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	520.13	524.72		524.84	0.000944	1.56	155.47	62.90	0.25
Nordenskiold	1261	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	520.05	522.06		522.29	0.002305	2.13	42.70	30.34	0.57
Nordenskiold	1261	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	520.05	522.06		522.29	0.002305	2.13	42.70	30.34	0.57
Nordenskiold	1261	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	520.05	523.86		523.89	0.000146	0.85	129.96	158.07	0.15
Nordenskiold	1261	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	520.05	522.20		522.48	0.002628	2.33	47.45	40.03	0.61
Nordenskiold	1261	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	520.05	522.20		522.48	0.002628	2.33	47.45	40.03	0.61
Nordenskiold	1261	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	520.05	524.07		524.11	0.000171	0.95	147.16	178.90	0.17
Nordenskiold	1261	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	520.05	522.48		522.85	0.003258	2.71	59.23	59.49	0.66
Nordenskiold	1261	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	520.05	522.48		522.85	0.003258	2.71	59.23	59.49	0.66
Nordenskiold	1261	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	520.05	524.37		524.43	0.000225	1.16	188.93	179.38	0.20
Nordenskiold	1261	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	520.05	522.66		523.09	0.003440	2.95	67.43	65.43	0.69
Nordenskiold	1261	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	520.05	522.66		523.09	0.003440	2.95	67.43	65.43	0.69
Nordenskiold	1261	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	520.05	524.56		524.63	0.000261	1.29	214.34	179.66	0.21
Nordenskiold	1261	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	520.05	522.85		523.36	0.003539	3.19	76.32	72.22	0.71
Nordenskiold	1261	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	520.05	522.85		523.36	0.003539	3.19	76.32	72.22	0.71
Nordenskiold	1261	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	520.05	524.74		524.82	0.000301	1.43	239.13	179.94	0.23
Nordenskiold	1174	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	519.97	521.95	521.40	522.10	0.001691	1.71	53.15	41.83	0.49
Nordenskiold	1174	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	519.97	521.95	521.40	522.10	0.001691	1.71	53.15	41.83	0.49
Nordenskiold	1174	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	519.97	523.86	521.40	523.88	0.000067	0.60	182.30	80.53	0.11
Nordenskiold	1174	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	519.97	522.08	521.53	522.26	0.001887	1.87	59.12	49.84	0.52
Nordenskiold	1174	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	519.97	522.08	521.53	522.26	0.001887	1.87	59.12	49.84	0.52
Nordenskiold	1174	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	519.97	524.08	521.53	524.09	0.000065	0.61	293.43	236.44	0.11
Nordenskiold	1174	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	519.97	522.36	521.77	522.59	0.001960	2.13	74.90	61.79	0.54
Nordenskiold	1174	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	519.97	522.36	521.77	522.59	0.001960	2.13	74.90	61.79	0.54
Nordenskiold	1174	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	519.97	524.39	521.77	524.41	0.000081	0.72	366.94	236.86	0.13
Nordenskiold	1174	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	519.97	522.56	521.93	522.82	0.001900	2.27	88.04	67.14	0.55
Nordenskiold	1174	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	519.97	522.56	521.93	522.82	0.001900	2.27	88.04	67.14	0.55
Nordenskiold	1174	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	519.97	524.58	521.93	524.60	0.000092	0.79	411.85	237.13	0.13
Nordenskiold	1174	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	519.97	522.79	522.12	523.08	0.001793	2.38	103.69	69.33	0.55
Nordenskiold	1174	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	519.97	522.79	522.12	523.08	0.001793	2.38	103.69	69.33	0.55
Nordenskiold	1174	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	519.97	524.76	522.12	524.79	0.000104	0.87	455.88	237.38	0.14
Nordenskiold	1088	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	519.66	521.86	520.88	521.96	0.001206	1.35	67.64	40.30	0.33
Nordenskiold	1088	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	519.66	521.86	520.88	521.96	0.001206	1.35	67.64	40.30	0.33
Nordenskiold	1088	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	519.66	523.84	521.43	523.86	0.000373	0.67	190.82	216.81	0.12
Nordenskiold	1088	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	519.66	521.98	521.01	522.10	0.001468	1.52	72.25	41.38	0.37
Nordenskiold	1088	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	519.66	521.98	521.01	522.10	0.001468	1.52	72.25	41.38	0.37
Nordenskiold	1088	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	519.66	524.06	521.56	524.08	0.000395	0.72	241.67	242.21	0.13
Nordenskiold	1088	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	519.66	522.24	521.26	522.41	0.001878	1.84	83.47	45.19	0.42
Nordenskiold	1088	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	519.66	522.24	521.26	522.41	0.001878	1.84	83.47	45.19	0.42
Nordenskiold	1088	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	519.66	524.36	521.81	524.40	0.000485	0.85	316.04	243.88	0.14
Nordenskiold	1088	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	519.66	522.43	521.43	522.64	0.002075	2.02	92.29	46.16	0.44
Nordenskiold	1088	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	519.66	522.43	521.43	522.64	0.002075	2.02	92.29	46.16	0.44
Nordenskiold	1088	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	519.66	524.55	521.97	524.59	0.000545	0.93	361.61	245.00	0.15
Nordenskiold	1088	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	519.66	522.65	521.61	522.89	0.002230	2.19	102.59	47.21	0.45
Nordenskiold	1088	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	519.66	522.65	521.61	522.89	0.002230	2.19	102.59	47.21	0.45
Nordenskiold	1088	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	519.66	524.73	522.16	524.77	0.000615	1.02	406.32	245.97	0.16
Nordenskiold	987	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	519.02	521.73		521.84	0.001127	1.46	64.47	39.66	0.33
Nordenskiold	987	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	519.02	521.73		521.84	0.001127	1.46	64.47	39.66	0.33
Nordenskiold	987	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	519.02	523.75		523.80	0.001172	1.05	141.92	255.78	0.22
Nordenskiold	987	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	519.02	521.80		521.94	0.001477	1.71	67.16	40.35	0.38

HEC-RAS River: Nordenskiold Reach: Nordenskiold (Continued)

Reach	River Sta	Profile	Plan	Q Total	Min Ch El	W.S. Elev	Crit W.S.	E.G. Elev	E.G. Slope	Vel Chnl	Flow Area	Top Width	Froude # Chl
				(m3/s)	(m)	(m)	(m)	(m)	(m/m)	(m/s)	(m2)	(m)	
Nordenskiold	987	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	519.02	521.80		521.94	0.001477	1.71	67.16	40.35	0.38
Nordenskiold	987	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	519.02	523.96		524.02	0.001336	1.13	183.46	269.79	0.23
Nordenskiold	987	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	519.02	521.95		522.19	0.002260	2.20	73.43	42.04	0.47
Nordenskiold	987	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	519.02	521.95		522.19	0.002260	2.20	73.43	42.04	0.47
Nordenskiold	987	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	519.02	524.25		524.31	0.002094	1.37	234.02	271.18	0.29
Nordenskiold	987	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	519.02	522.06		522.38	0.002804	2.53	78.24	43.84	0.53
Nordenskiold	987	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	519.02	522.06		522.38	0.002804	2.53	78.24	43.84	0.53
Nordenskiold	987	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	519.02	524.42		524.49	0.002808	1.51	262.56	272.46	0.33
Nordenskiold	987	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	519.02	522.19		522.60	0.003368	2.87	84.03	45.73	0.59
Nordenskiold	987	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	519.02	522.19		522.60	0.003368	2.87	84.03	45.73	0.59
Nordenskiold	987	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	519.02	524.59		524.66	0.003453	1.61	292.82	272.46	0.36
Nordenskiold	859	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	518.97	521.67		521.74	0.000431	1.15	79.89	42.92	0.26
Nordenskiold	859	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	518.97	521.67		521.74	0.000431	1.15	79.89	42.92	0.26
Nordenskiold	859	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	518.97	523.52	523.04	523.58	0.003088	1.38	160.35	274.99	0.41
Nordenskiold	859	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	518.97	521.72		521.82	0.000583	1.36	81.96	43.44	0.30
Nordenskiold	859	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	518.97	521.72		521.82	0.000583	1.36	81.96	43.44	0.30
Nordenskiold	859	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	518.97	523.71	523.15	523.77	0.003422	1.46	215.28	340.36	0.43
Nordenskiold	859	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	518.97	521.83		521.99	0.000959	1.80	86.55	44.55	0.39
Nordenskiold	859	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	518.97	521.83		521.99	0.000959	1.80	86.55	44.55	0.39
Nordenskiold	859	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	518.97	523.93	523.32	523.99	0.003678	1.53	284.45	342.76	0.45
Nordenskiold	859	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	518.97	521.90		522.12	0.001254	2.10	89.86	45.25	0.44
Nordenskiold	859	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	518.97	521.90		522.12	0.001254	2.10	89.86	45.25	0.44
Nordenskiold	859	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	518.97	524.02	523.40	524.08	0.004478	1.66	310.72	342.96	0.49
Nordenskiold	859	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	518.97	521.98		522.28	0.001601	2.43	93.62	46.10	0.50
Nordenskiold	859	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	518.97	521.98		522.28	0.001601	2.43	93.62	46.10	0.50
Nordenskiold	859	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	518.97	524.14	523.52	524.20	0.004833	1.74	347.02	343.55	0.51
Nordenskiold	738	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	518.85	521.66		521.70	0.000191	0.88	110.52	72.60	0.18
Nordenskiold	738	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	518.85	521.66		521.70	0.000191	0.88	110.52	72.60	0.18
Nordenskiold	738	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	518.85	522.32	522.32	522.55	0.182305	2.33	43.45	100.49	1.09
Nordenskiold	738	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	518.85	521.70		521.76	0.000262	1.04	113.86	81.96	0.21
Nordenskiold	738	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	518.85	521.70		521.76	0.000262	1.04	113.86	81.96	0.21
Nordenskiold	738	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	518.85	522.42	522.42	522.66	0.181287	2.35	51.55	117.23	1.09
Nordenskiold	738	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	518.85	521.80		521.89	0.000443	1.39	121.82	88.78	0.28
Nordenskiold	738	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	518.85	521.80		521.89	0.000443	1.39	121.82	88.78	0.28
Nordenskiold	738	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	518.85	522.61	522.61	522.84	0.174373	2.36	72.21	160.03	1.08
Nordenskiold	738	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	518.85	521.86		522.00	0.000590	1.63	127.89	94.51	0.32
Nordenskiold	738	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	518.85	521.86		522.00	0.000590	1.63	127.89	94.51	0.32
Nordenskiold	738	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	518.85	522.35	522.35	522.75	0.091114	3.10	76.08	109.37	0.90
Nordenskiold	738	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	518.85	521.94		522.12	0.000767	1.90	135.12	101.01	0.37
Nordenskiold	738	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	518.85	521.94		522.12	0.000767	1.90	135.12	101.01	0.37
Nordenskiold	738	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	518.85	522.52	522.52	522.88	0.067317	2.99	100.84	147.22	0.80
Nordenskiold	641	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	518.52	521.66		521.68	0.000119	0.66	171.24	139.33	0.13
Nordenskiold	641	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	518.52	521.66		521.68	0.000119	0.66	171.24	139.33	0.13
Nordenskiold	641	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	518.52	521.74		521.77	0.000579	0.82	131.23	123.04	0.18
Nordenskiold	641	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	518.52	521.70		521.73	0.000164	0.78	177.49	151.32	0.15
Nordenskiold	641	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	518.52	521.70		521.73	0.000164	0.78	177.49	151.32	0.15
Nordenskiold	641	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	518.52	521.79		521.84	0.000778	0.96	137.75	129.62	0.21
Nordenskiold	641	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	518.52	521.79		521.85	0.000282	1.04	192.73	179.90	0.20
Nordenskiold	641	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	518.52	521.79		521.85	0.000282	1.04	192.73	179.90	0.20
Nordenskiold	641	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	518.52	521.90		521.98	0.001250	1.25	153.12	136.60	0.26
Nordenskiold	641	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	518.52	521.86		521.93	0.000375	1.22	205.36	196.25	0.24
Nordenskiold	641	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	518.52	521.86		521.93	0.000375	1.22	205.36	196.25	0.24
Nordenskiold	641	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	518.52	521.99		522.09	0.001611	1.46	164.97	152.93	0.30
Nordenskiold	641	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	518.52	521.94		522.03	0.000483	1.41	220.96	214.92	0.27
Nordenskiold	641	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	518.52	521.94		522.03	0.000483	1.41	220.96	214.92	0.27
Nordenskiold	641	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	518.52	522.08		522.22	0.002016	1.67	180.94	182.63	0.34
Nordenskiold	556	5%_AEP	1D_WithIceJam_6+016_FinalCalib	91.00	518.27	521.66		521.67	0.000054	0.52	252.82	267.55	0.10
Nordenskiold	556	5%_AEP	1D_WithIceJam_4+109_FinalCalib	91.00	518.27	521.66		521.67	0.000054	0.52	252.82	267.55	0.10
Nordenskiold	556	5%_AEP	1D_WithIceJam_0+740_FinalCalib	91.00	518.27	521.71		521.73	0.000267	0.64	188.08	168.12	0.13
Nordenskiold	556	5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	110.00	518.27	521.70		521.72	0.000074	0.61	264.47	274.15	0.11
Nordenskiold	556	5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	110.00	518.27	521.70		521.72	0.000074	0.61	264.47	274.15	0.11
Nordenskiold	556	5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	110.00	518.27	521.76		521.79	0.000364	0.76	195.95	189.93	0.16
Nordenskiold	556	1%_AEP	1D_WithIceJam_6+016_FinalCalib	153.00	518.27	521.79		521.82	0.000124	0.81	290.57	280.68	0.15
Nordenskiold	556	1%_AEP	1D_WithIceJam_4+109_FinalCalib	153.00	518.27	521.79		521.82	0.000124	0.81	290.57	280.68	0.15
Nordenskiold	556	1%_AEP	1D_WithIceJam_0+740_FinalCalib	153.00	518.27	521.85		521.90	0.000606	1.00	216.45	250.28	0.20
Nordenskiold	556	0.5%_AEP	1D_WithIceJam_6+016_FinalCalib	185.00	518.27	521.86		521.90	0.000168	0.95	309.31	281.71	0.17
Nordenskiold	556	0.5%_AEP	1D_WithIceJam_4+109_FinalCalib	185.00	518.27	521.86		521.90	0.000168	0.95	309.31	281.71	0.17
Nordenskiold	556	0.5%_AEP	1D_WithIceJam_0+740_FinalCalib	185.00	518.27	521.92		521.99	0.000796	1.17	233.97	266.46	0.23
Nordenskiold	556	0.5%_AEP+CC	1D_WithIceJam_6+016_FinalCalib	222.00	518.27	521.94		521.99	0.000215	1.10	331.30	282.12	0.20
Nordenskiold	556	0.5%_AEP+CC	1D_WithIceJam_4+109_FinalCalib	222.00	518.27	521.94		521.99	0.000215	1.10	331.30	282.12	0.20
Nordenskiold	556	0.5%_AEP+CC	1D_WithIceJam_0+740_FinalCalib	222.00	518.27	522.00		522.08	0.001012	1.35	255.35	277.10	0.26

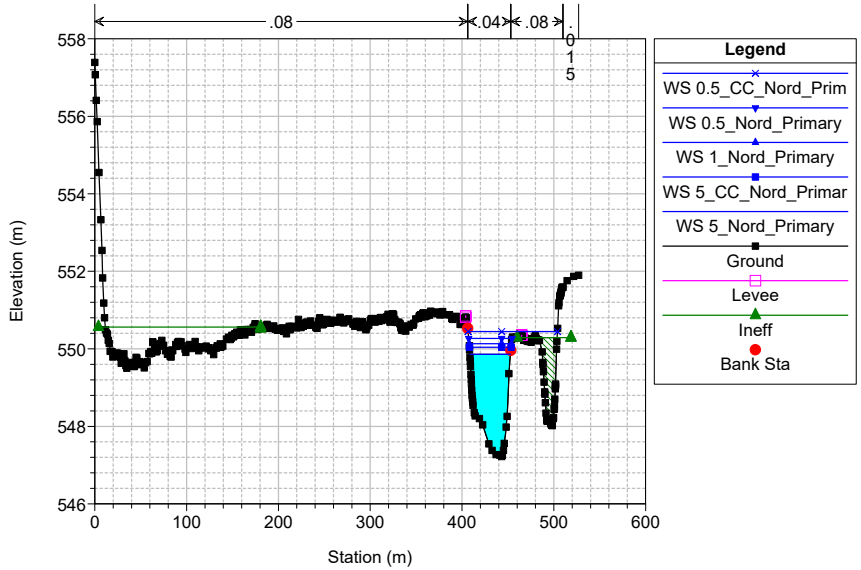
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-XS extended to road on RB to prevent overspilling at edge of XS



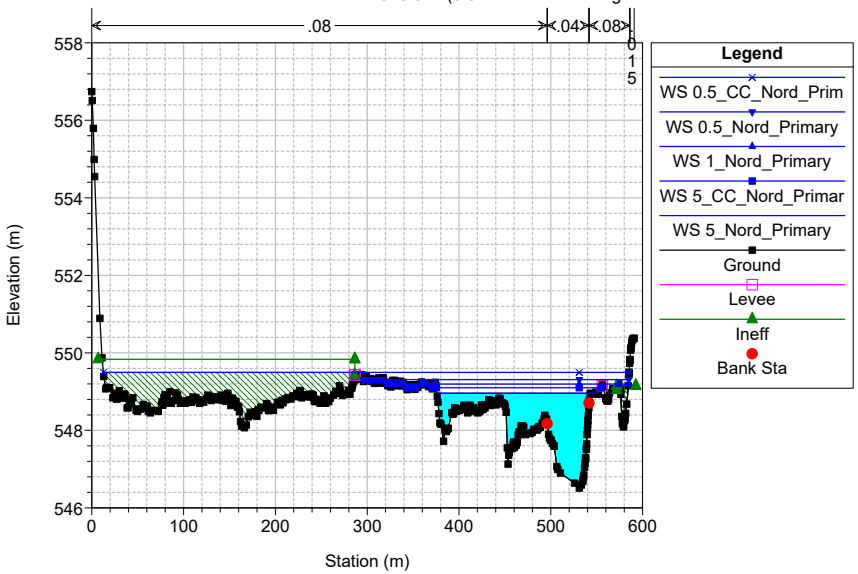
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on LB with elev = 550.9 m (at same WSEs adjacent to XS at



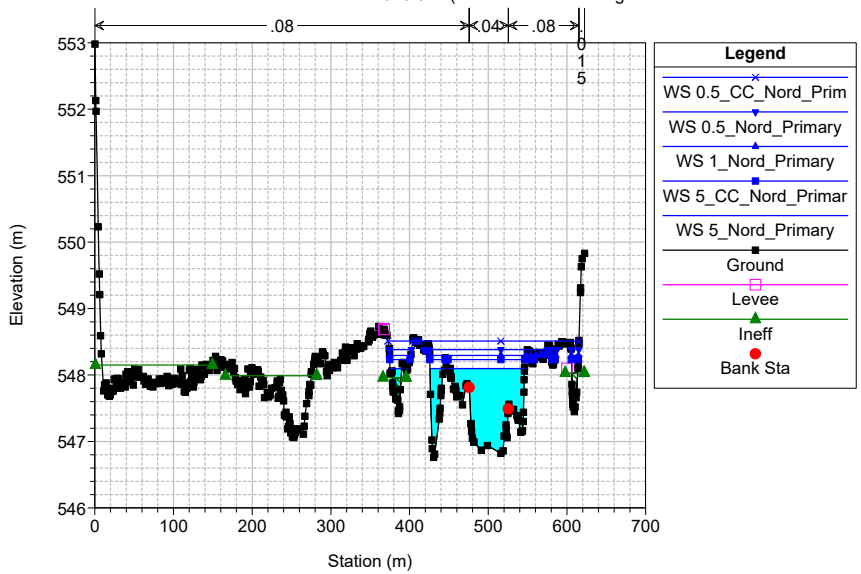
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

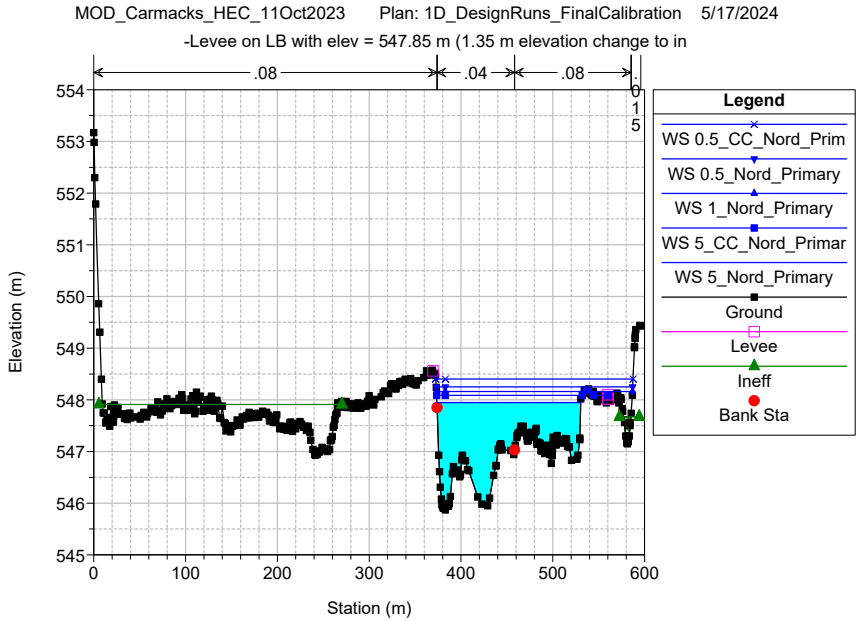
-Levee on LB with elev = 548.6 m (0.6 m elevation change to inle

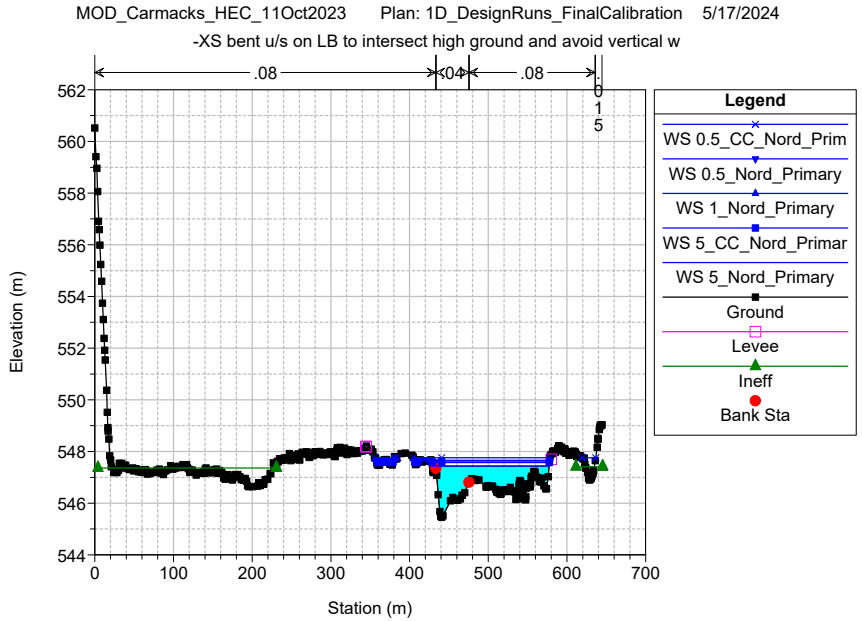


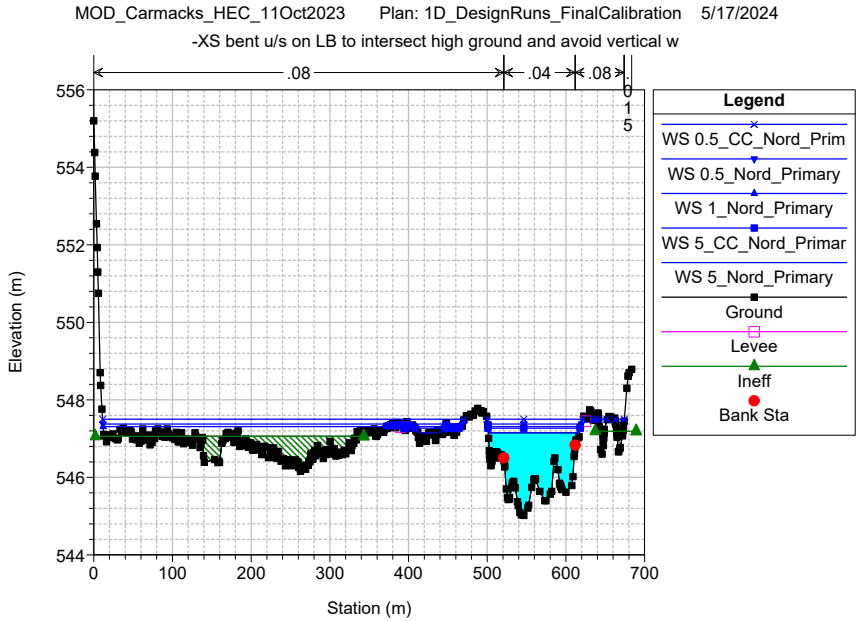
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

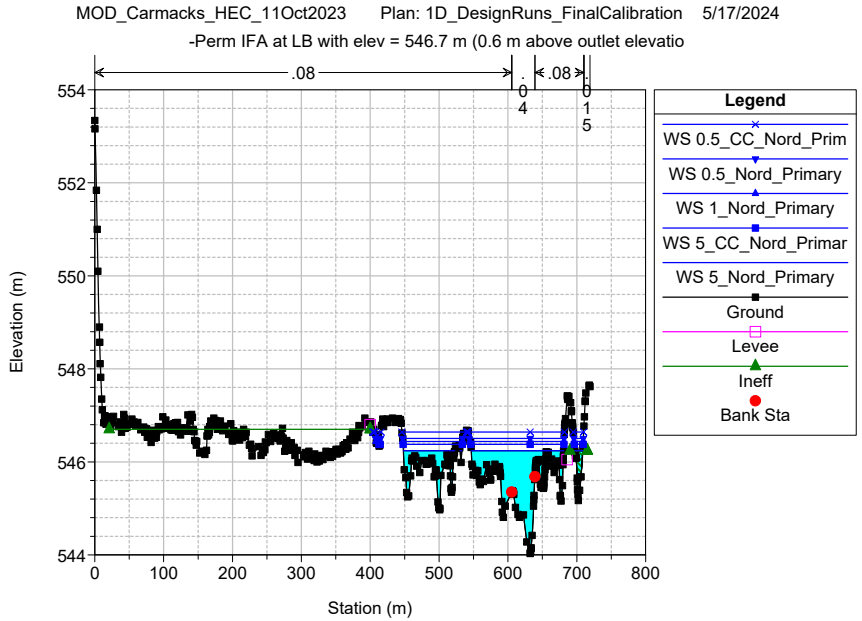
-Levee on LB with elev = 548.0 m (1.2 m elevation change to inle




MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee on LB with elev = 547.85 m (1.35 m elevation change to in
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Levee
Ineff
Bank Sta

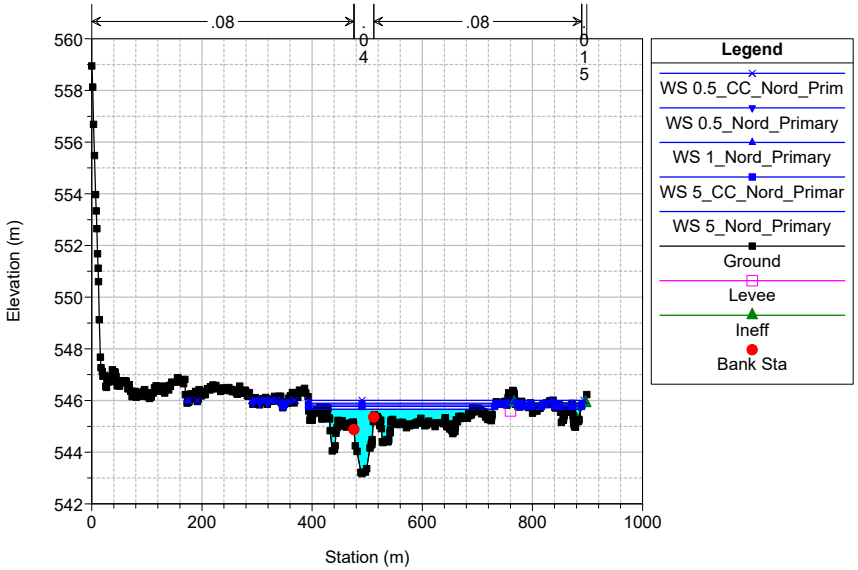

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-XS bent u/s on LB to intersect high ground and avoid vertical w
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Levee
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-XS bent u/s on LB to intersect high ground and avoid vertical w
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Levee
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at LB with elev = 546.7 m (0.6 m above outlet elevatio
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Levee
Ineff
Bank Sta

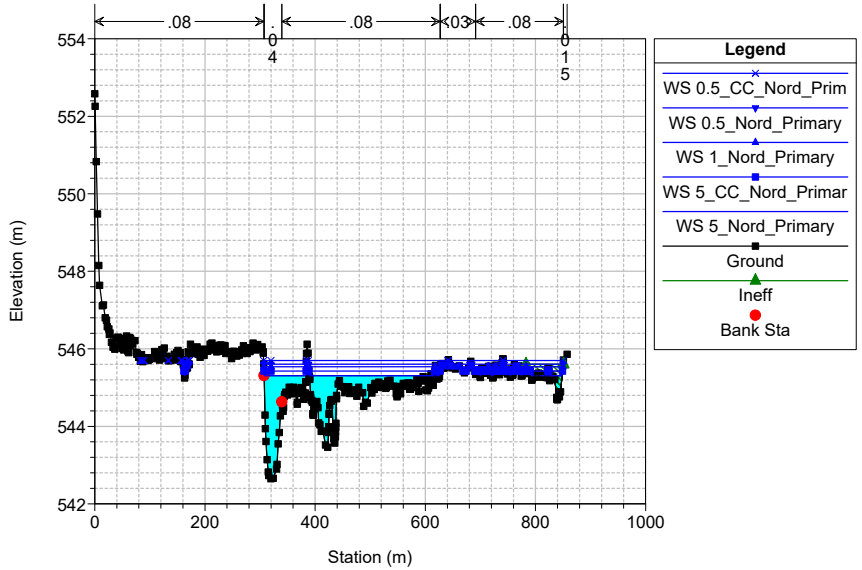
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on RB with elev = 545.6m (adjacent to XS)



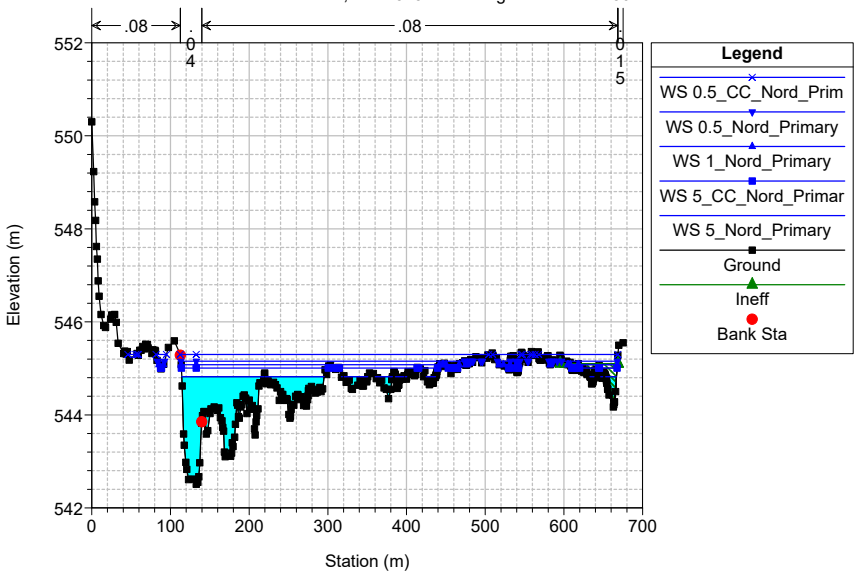
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Perm IFA on RB ditch, elev=545.6m from grade control 200 m down



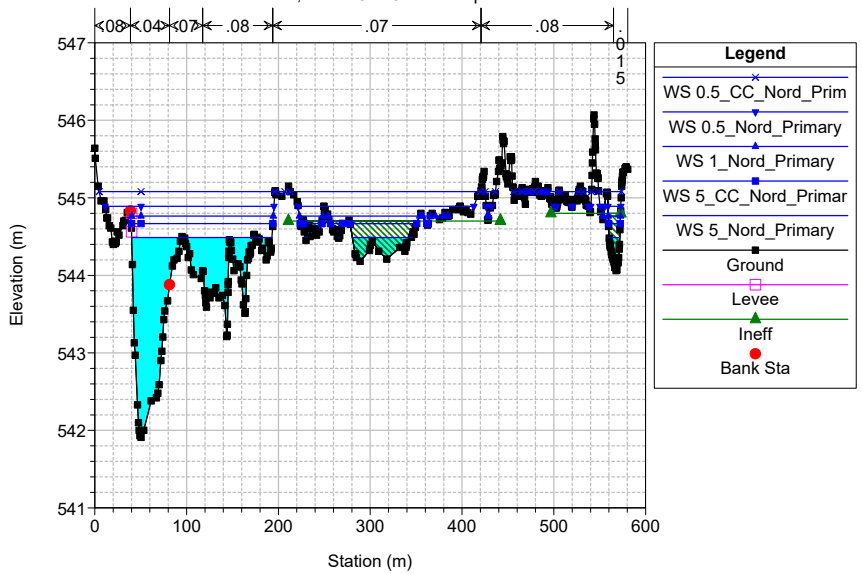
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Perm IFA on RB ditch, elev=545.1m from grade control 150 m down



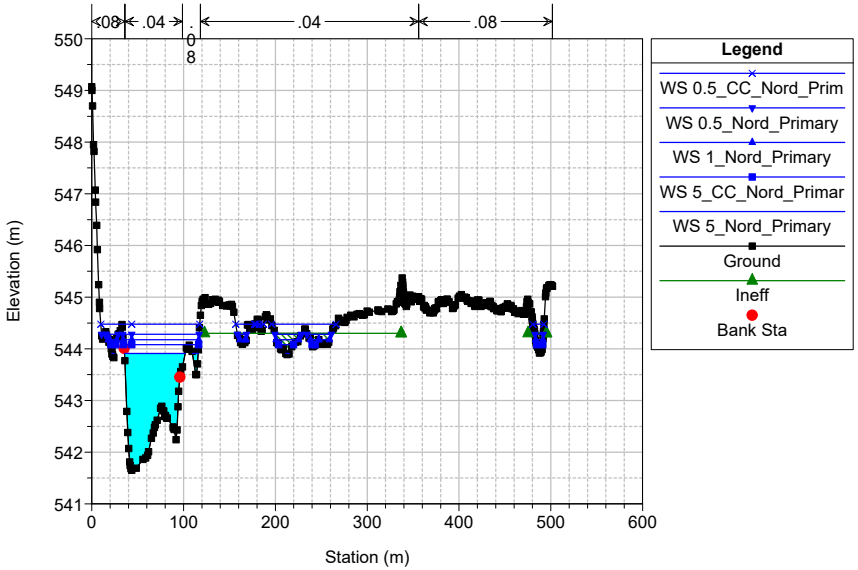
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on LB, elev = 544.8 m from upstream inlet elev at inlet 4



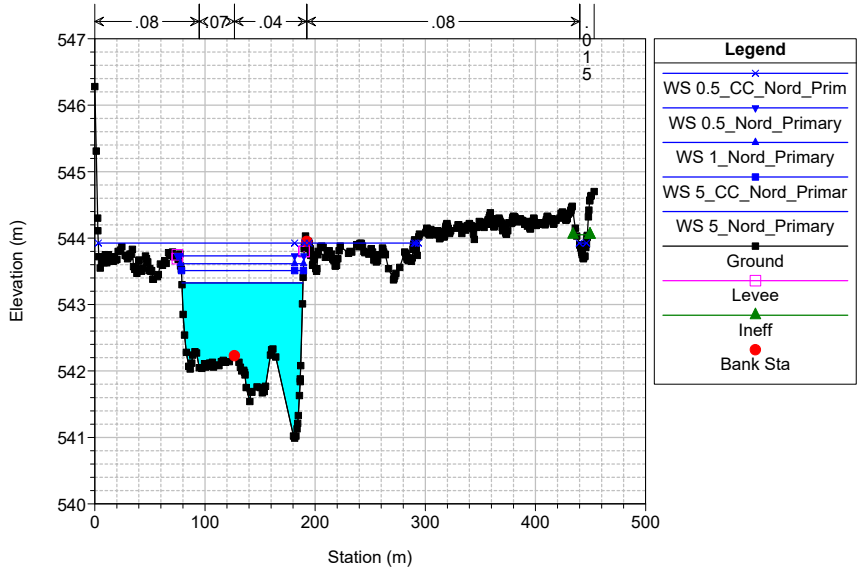
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Perm IFA on RB, elev = 544.3 m (0.2 m above downstream control



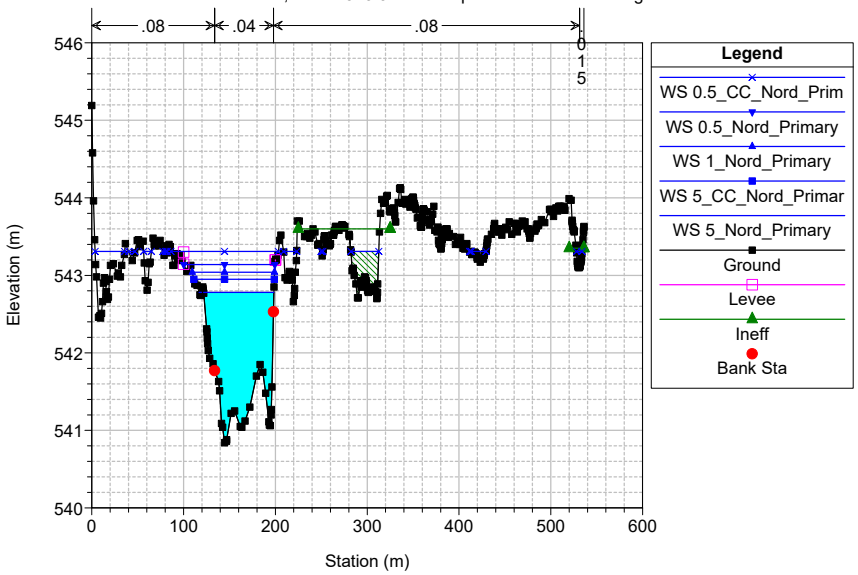
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on LB, elev = 543.75 m from upstream inlet elev along ban



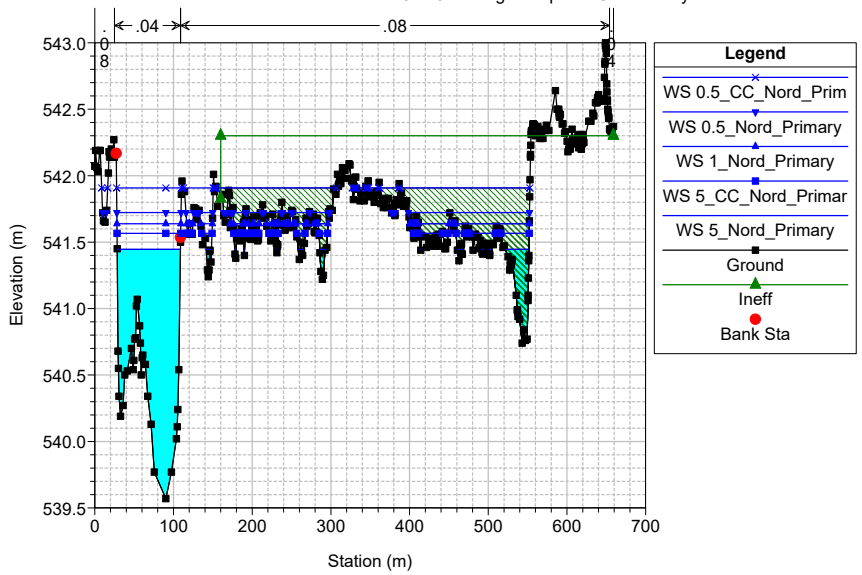
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on LB, elev = 543.3 m from upstream inlet elev along bank



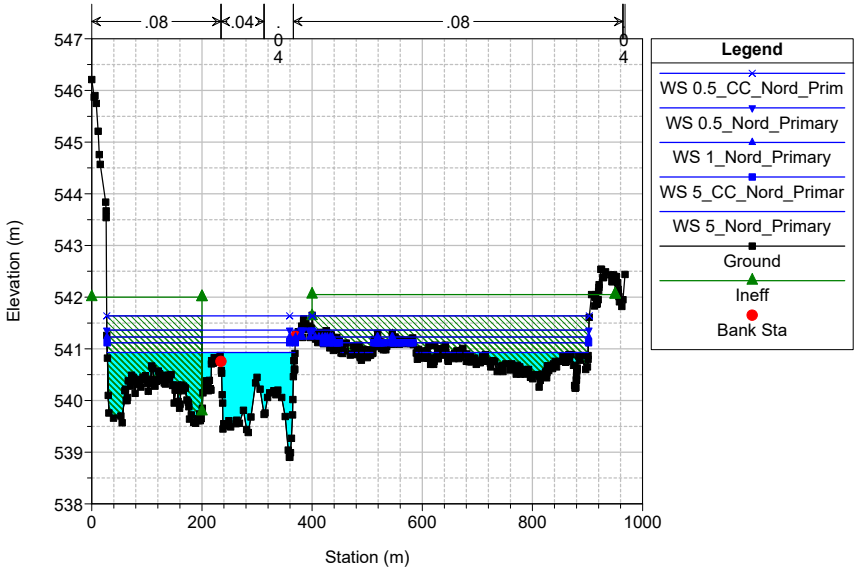
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Perm IFA on RB with elev = 542.3m using low spot in Casino Way



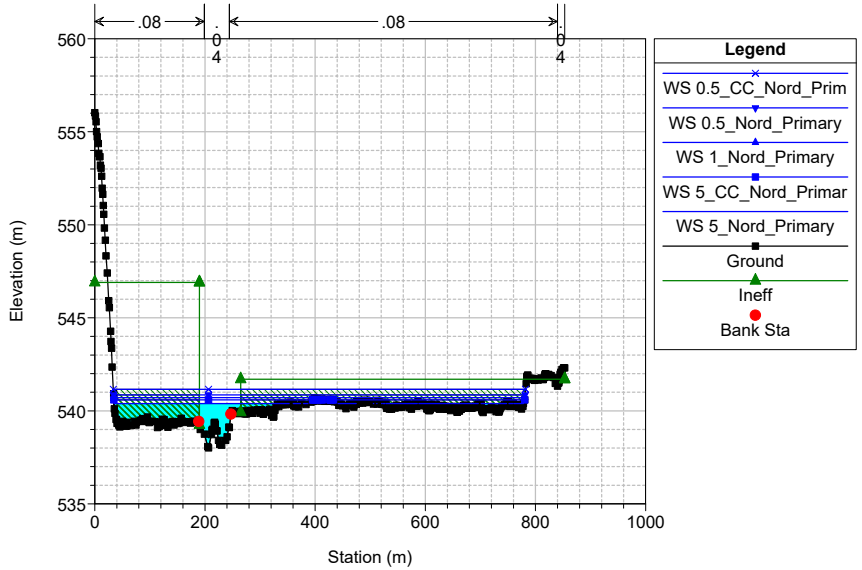
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Perm IFA on LB with elev = 542m using from no flow pathway



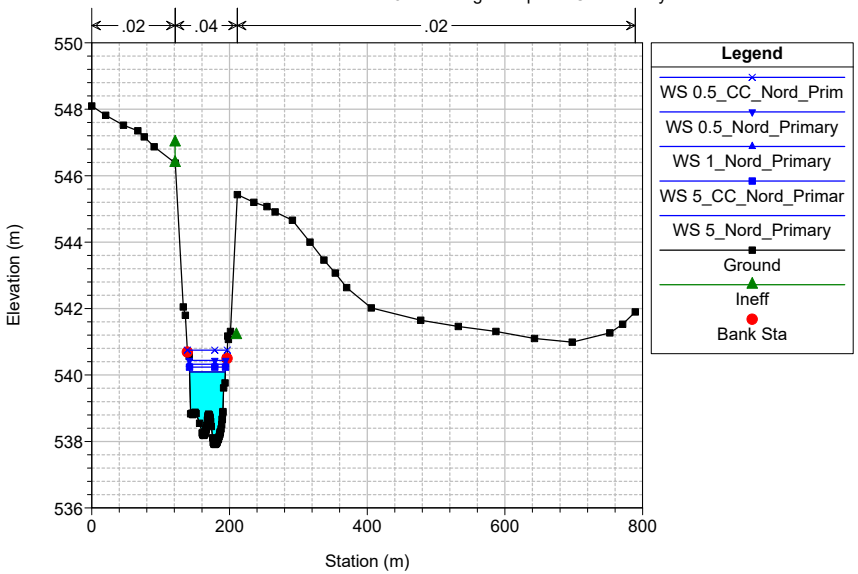
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Perm IFA on LB with elev = 546.9m using low spot in Casino Way



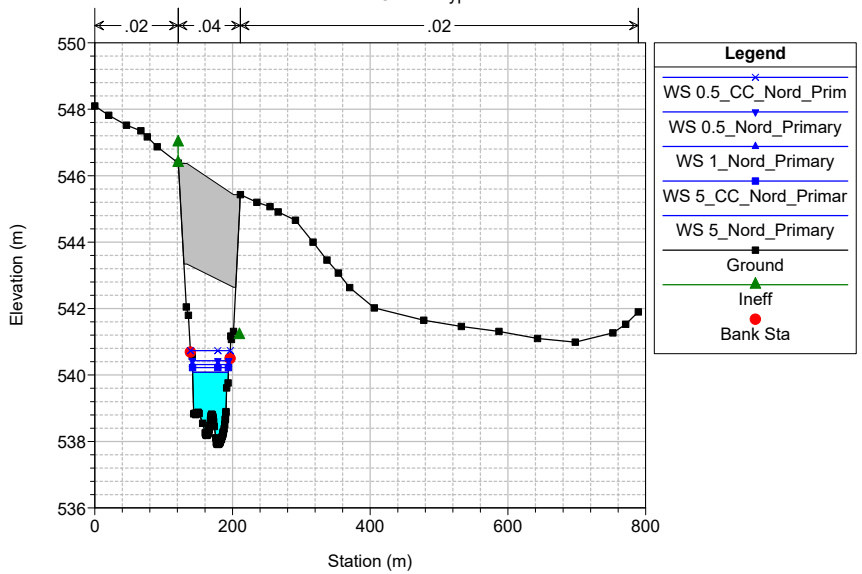
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

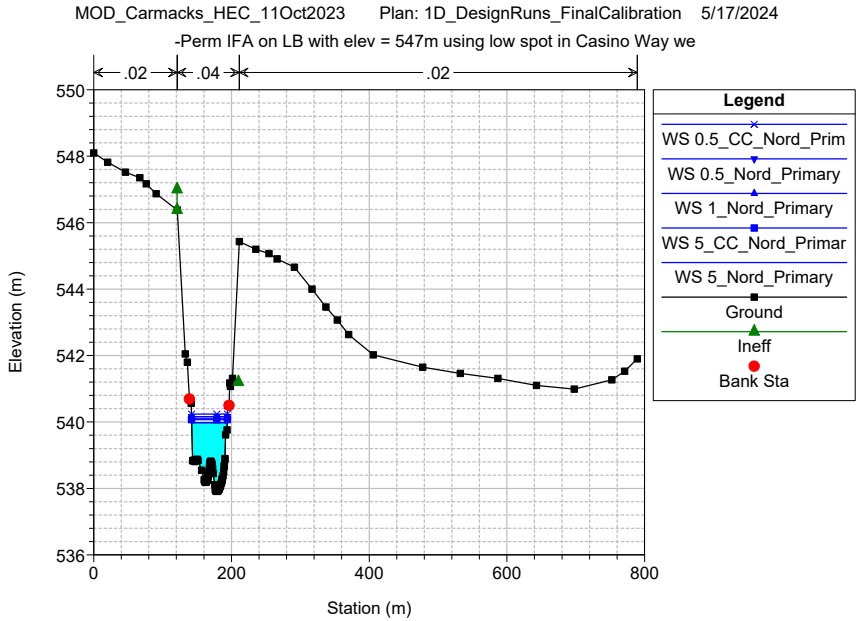
-Perm IFA on LB with elev = 547m using low spot in Casino Way we

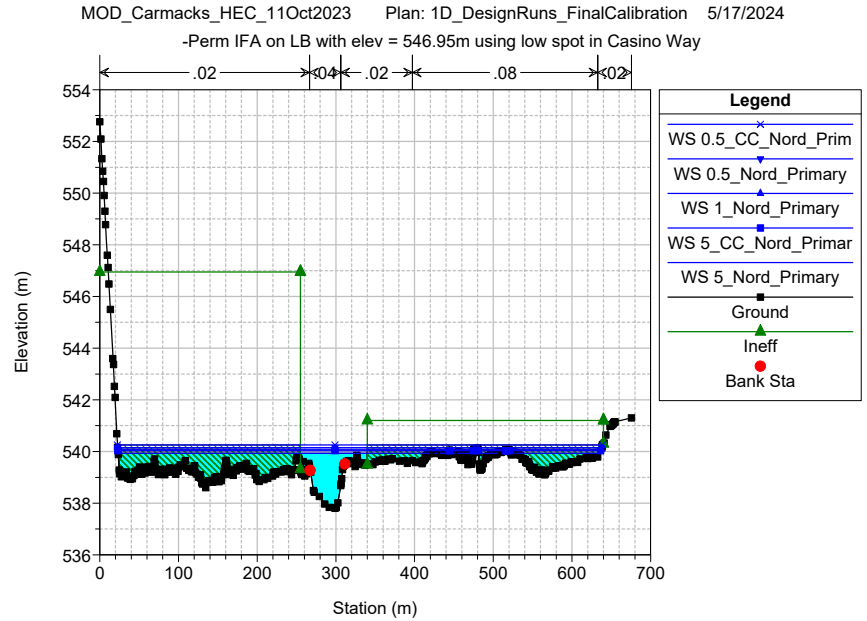


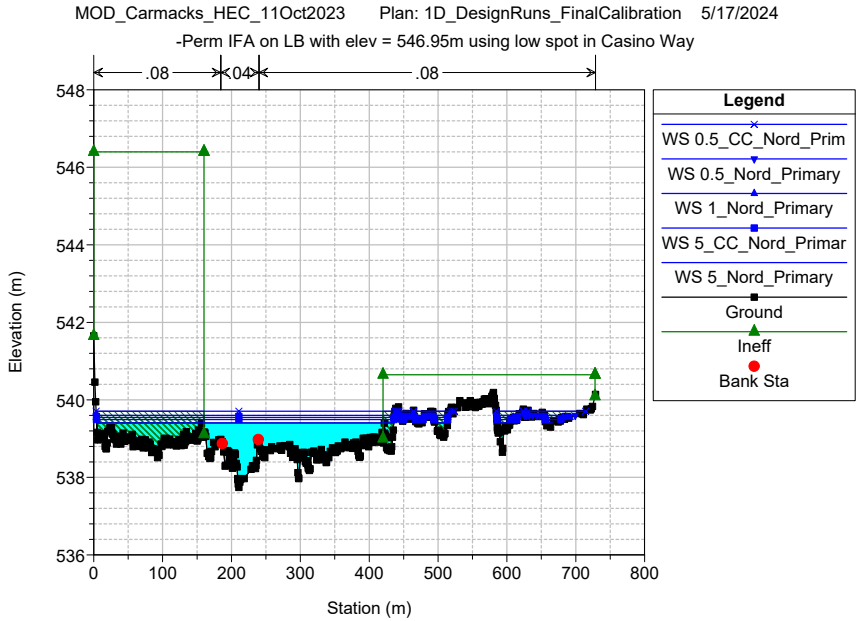
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

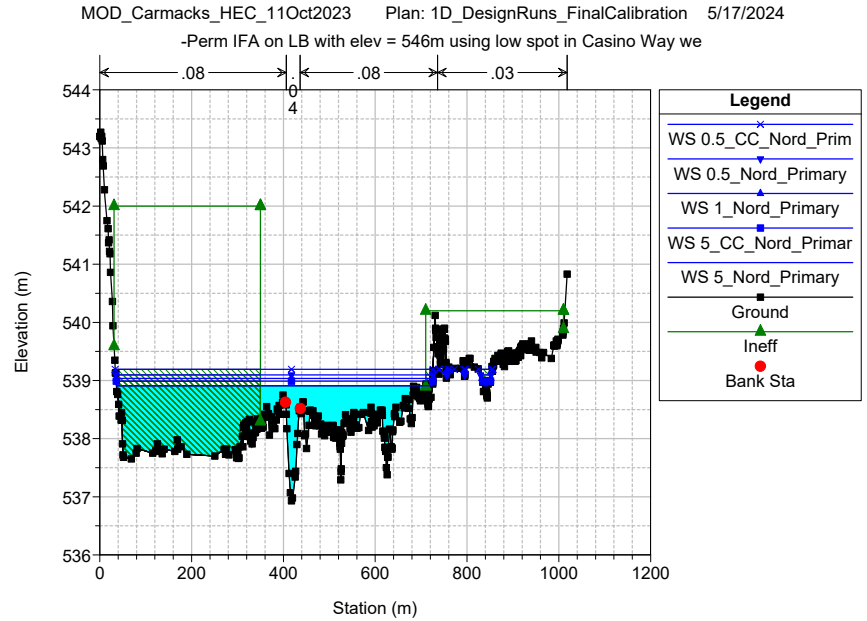
Casino Bypass




MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on LB with elev = 547m using low spot in Casino Way we
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta

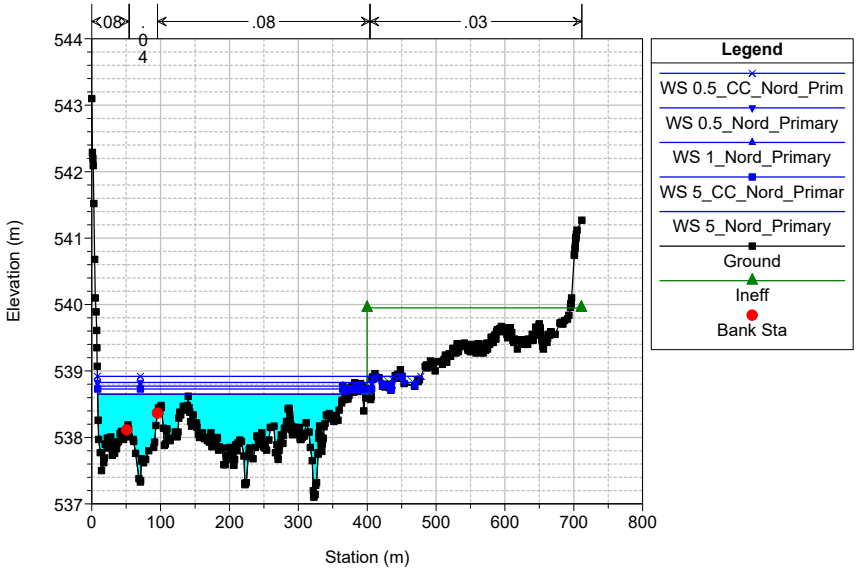

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on LB with elev = 546.95m using low spot in Casino Way
.02
.04
.02
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on LB with elev = 546.95m using low spot in Casino Way
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta

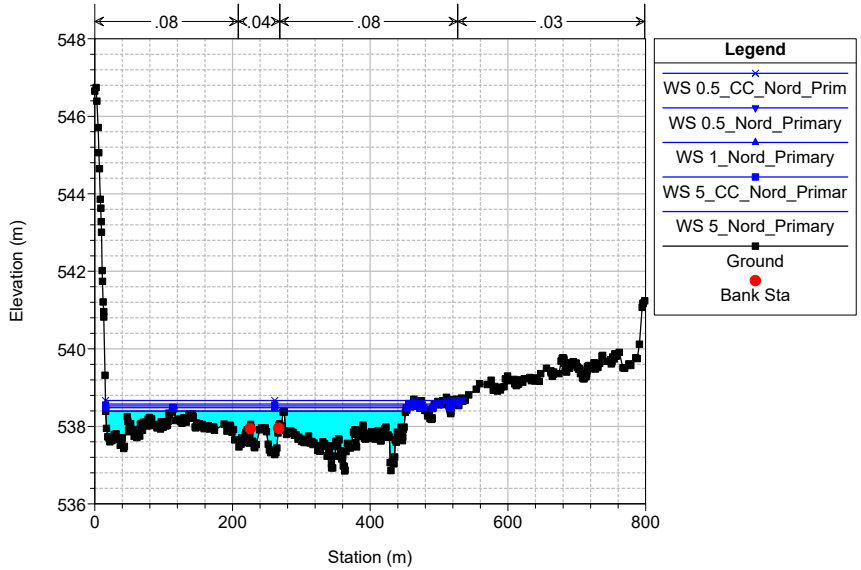

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on LB with elev = 546m using low spot in Casino Way we
.08
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

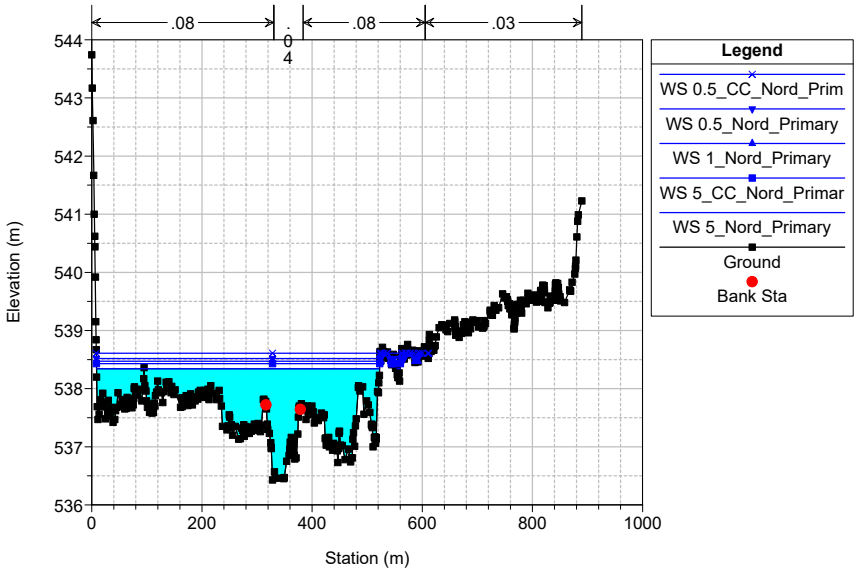
-Perm IFA on RB with elev = 539.95m using low spot in Casino Way



MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

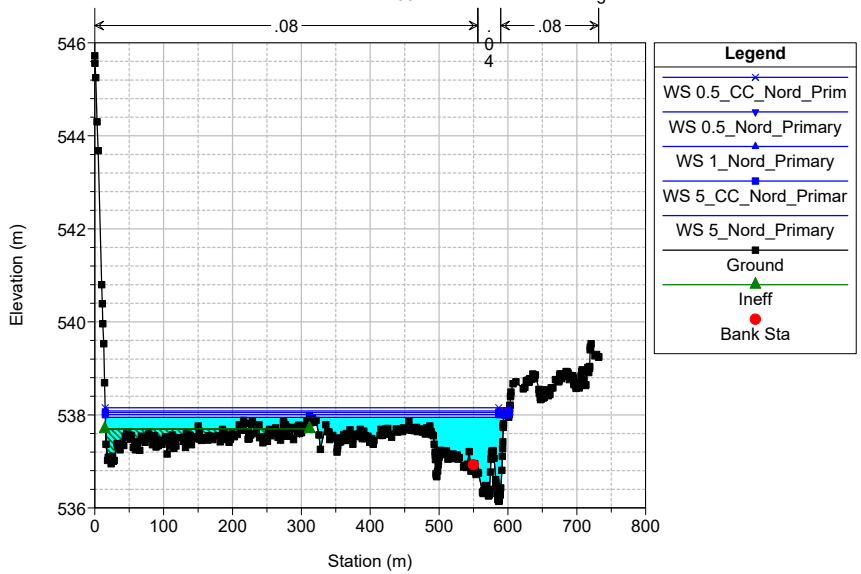


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024



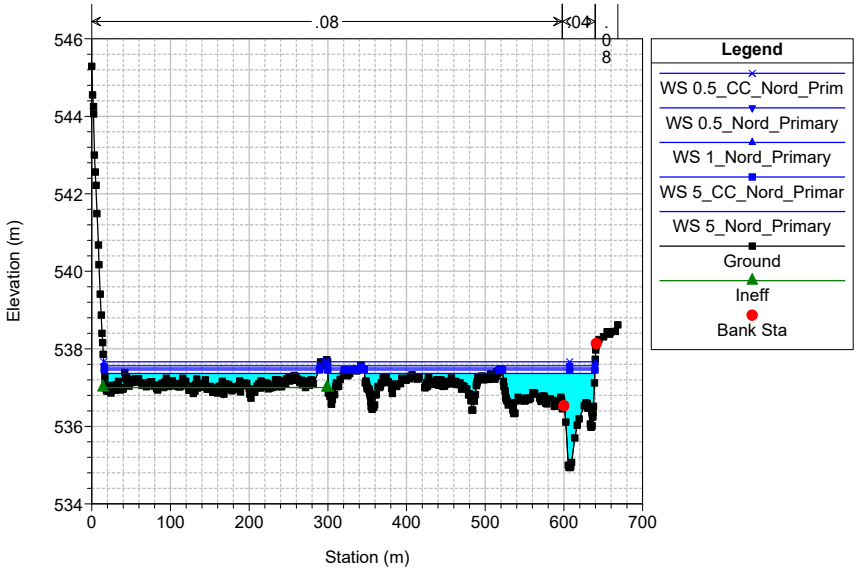
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Perm IFA on LB with elev = 537.7m from downstream grade control



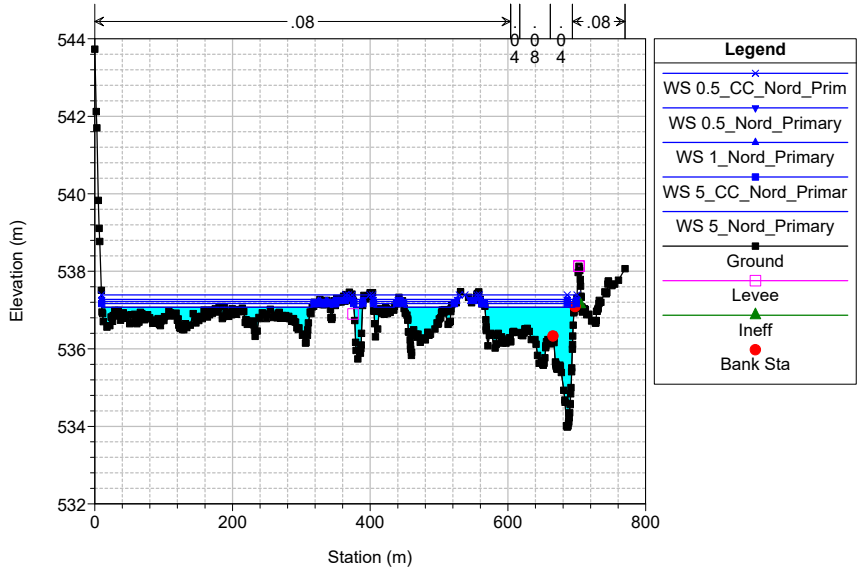
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Perm IFA on LB with elev = 537.0m from downstream grade control



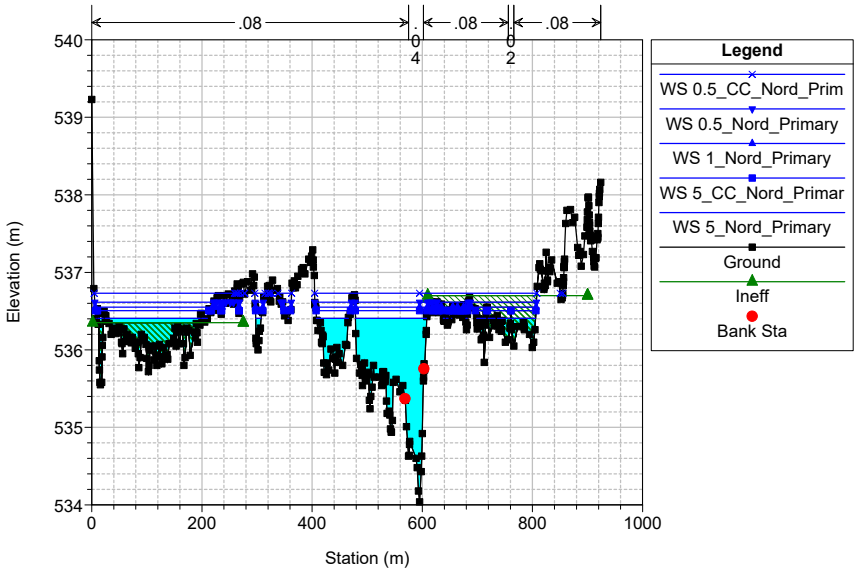
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on LB with elev = 536.9m from upstream ridge on floodplai



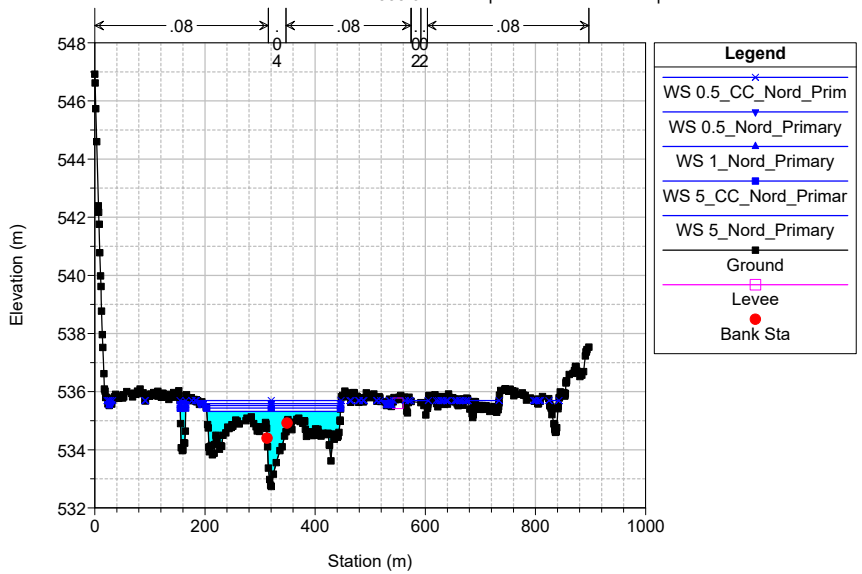
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

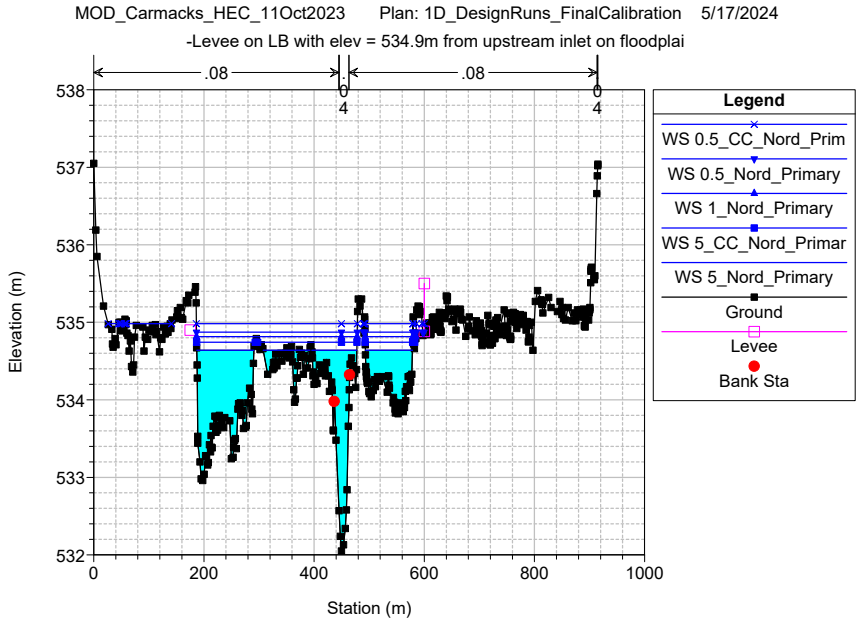
-Perm IFA on LB at elev = 536.35m from d/s outlet control 40m d/

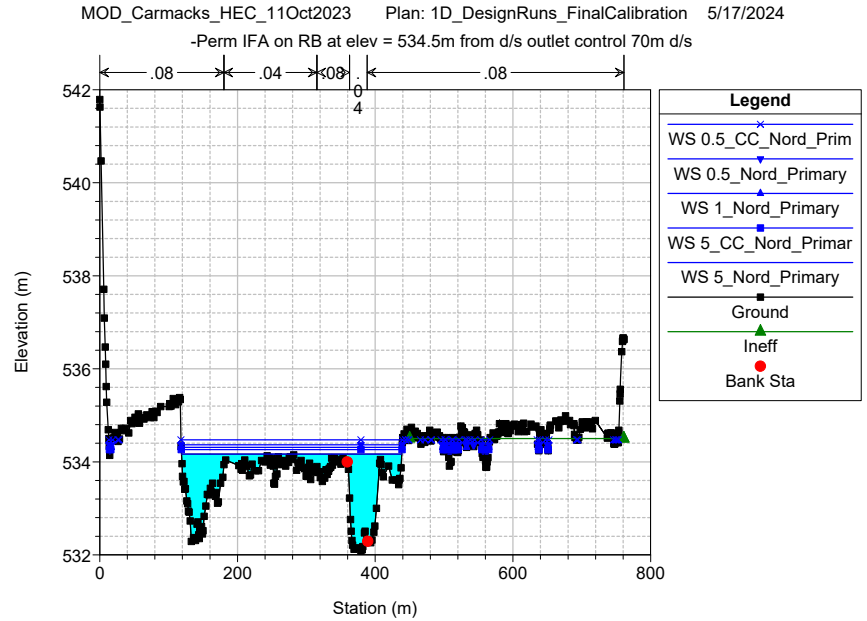


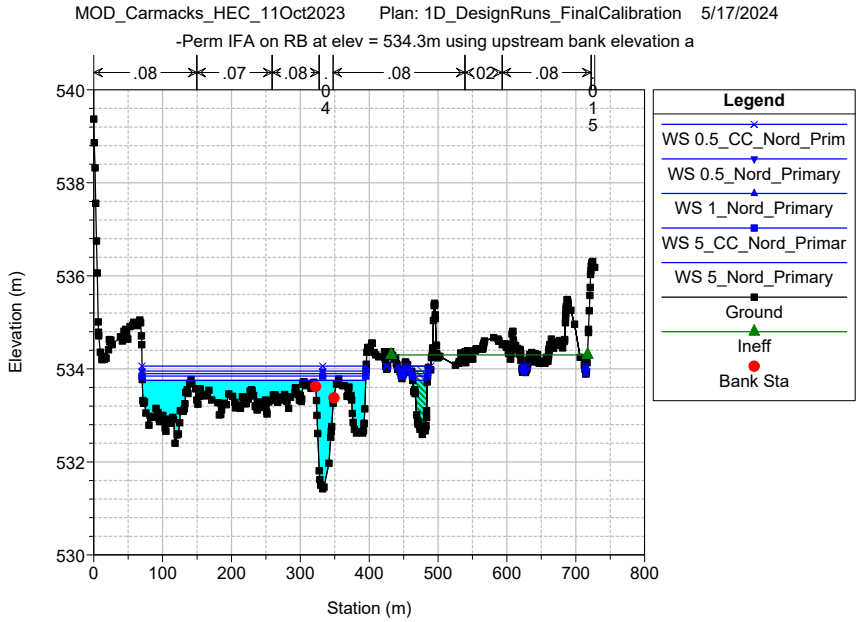
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

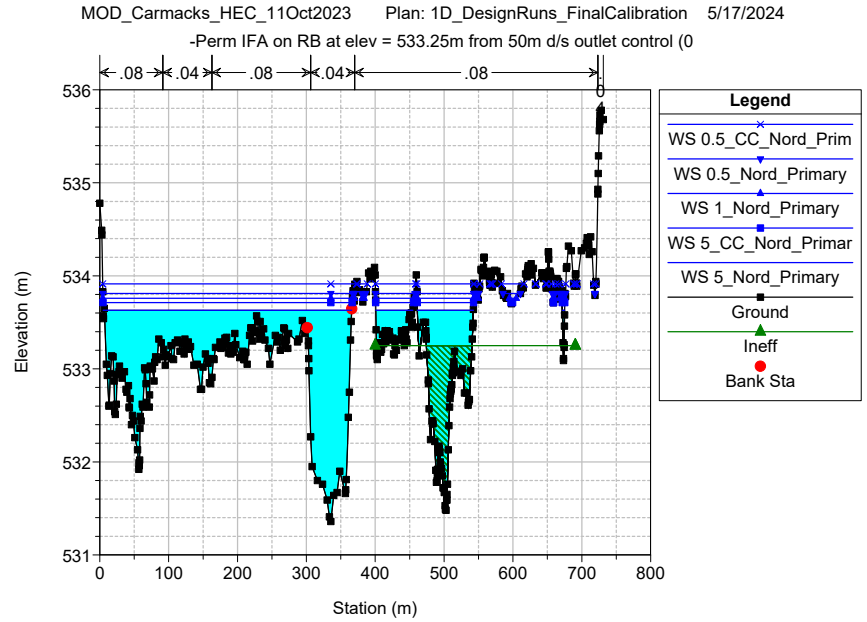
-Levee on RB with elev = 535.6m from upstream road on floodplain

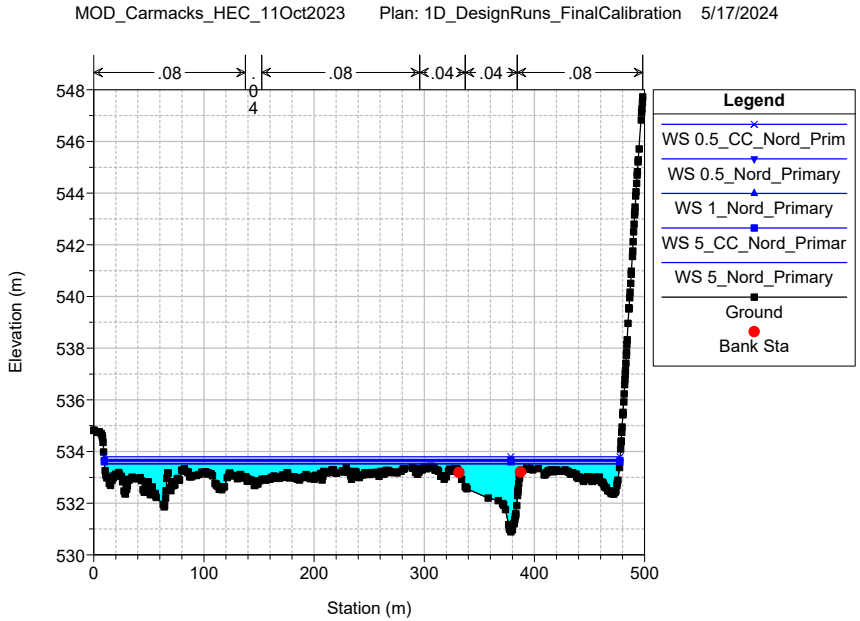


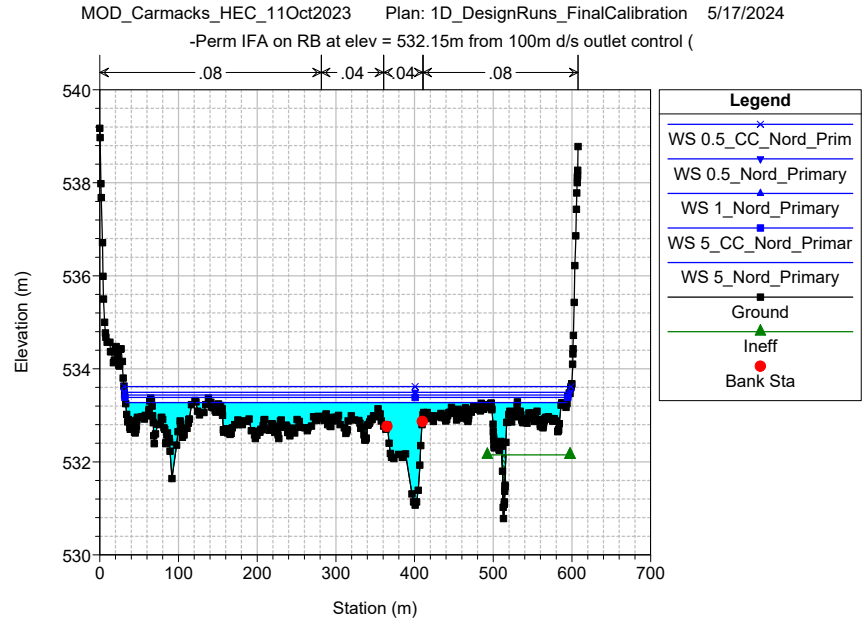

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee on LB with elev = 534.9m from upstream inlet on floodplai
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Levee
Bank Sta

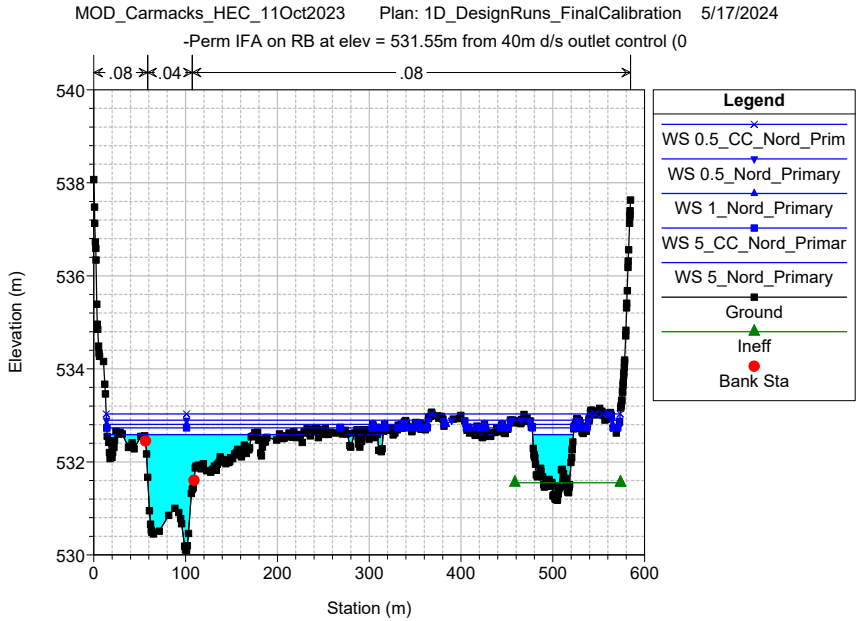

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on RB at elev = 534.5m from d/s outlet control 70m d/s
.08
.04
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta

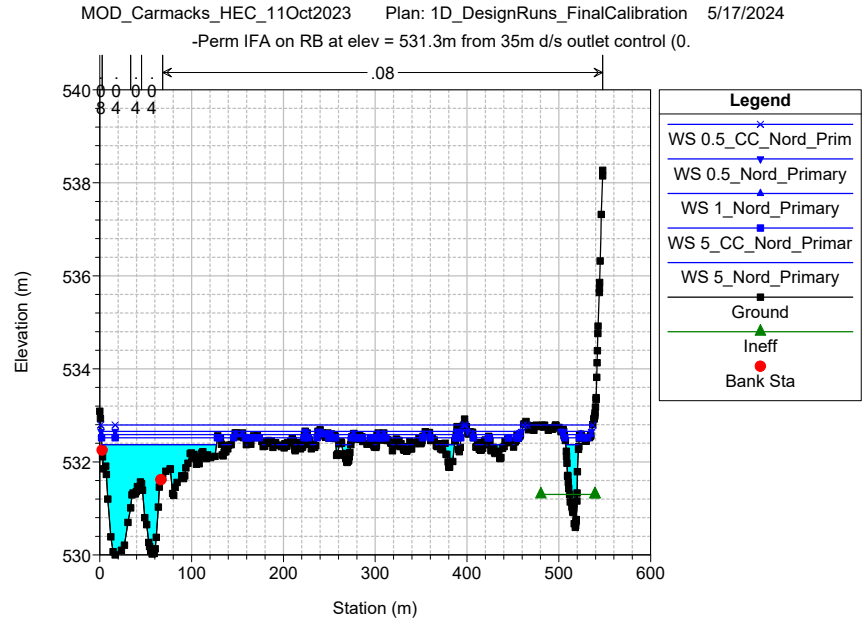

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on RB at elev = 534.3m using upstream bank elevation a
.08
.07
.08
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta

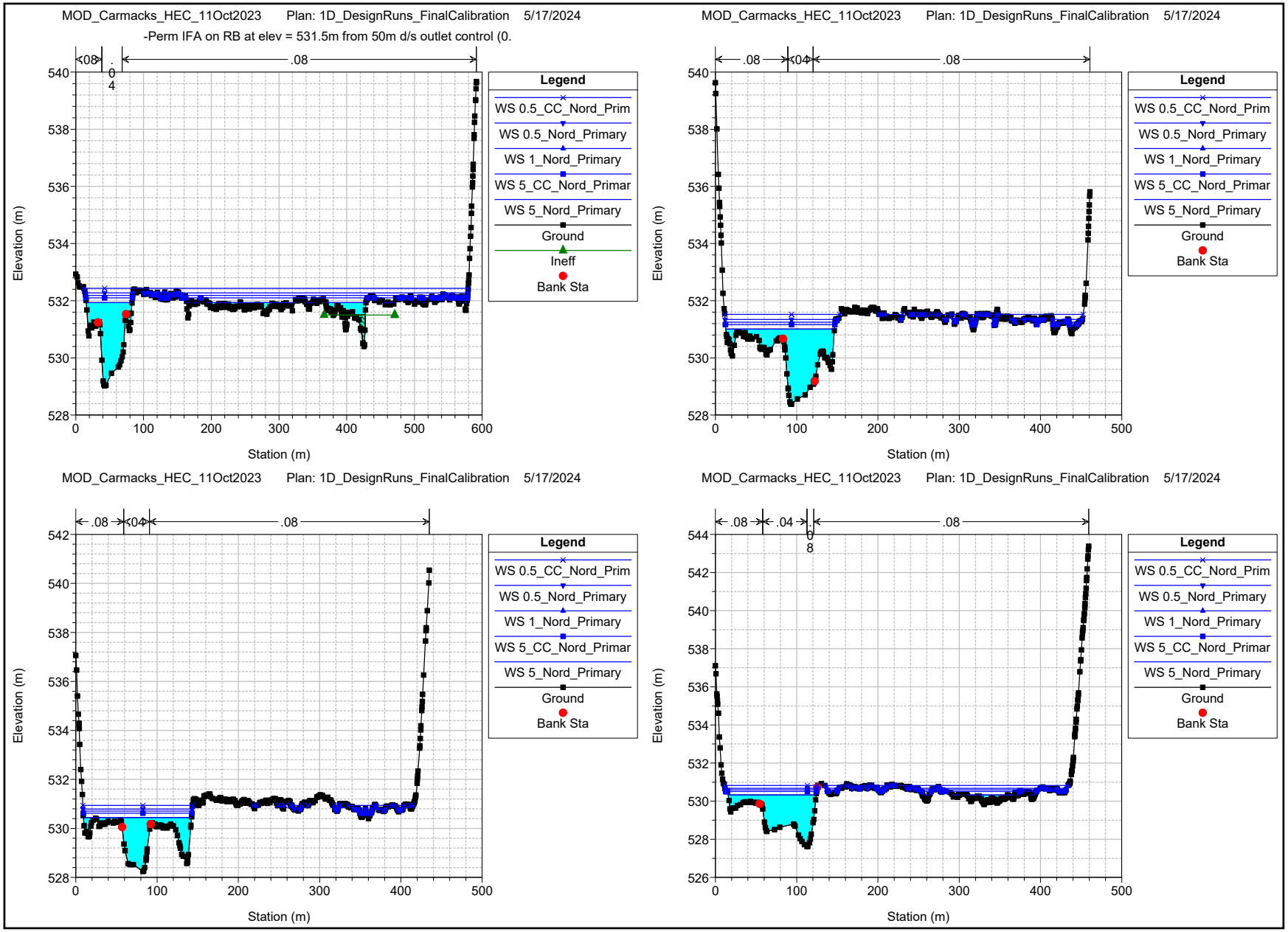

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on RB at elev = 533.25m from 50m d/s outlet control (0
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.04
.04
.08
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Bank Sta
Elevation (m)
Station (m)


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on RB at elev = 532.15m from 100m d/s outlet control (
.08
.04
.04
.08
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

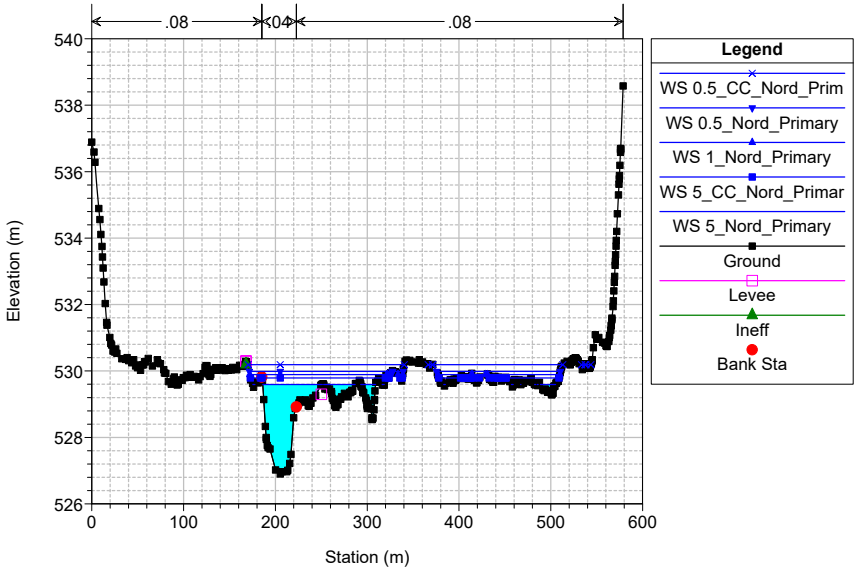

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on RB at elev = 531.55m from 40m d/s outlet control (0
.08
.04
.08
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on RB at elev = 531.3m from 35m d/s outlet control (0.
.08
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on RB at elev = 531.5m from 50m d/s outlet control (0.
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Bank Sta

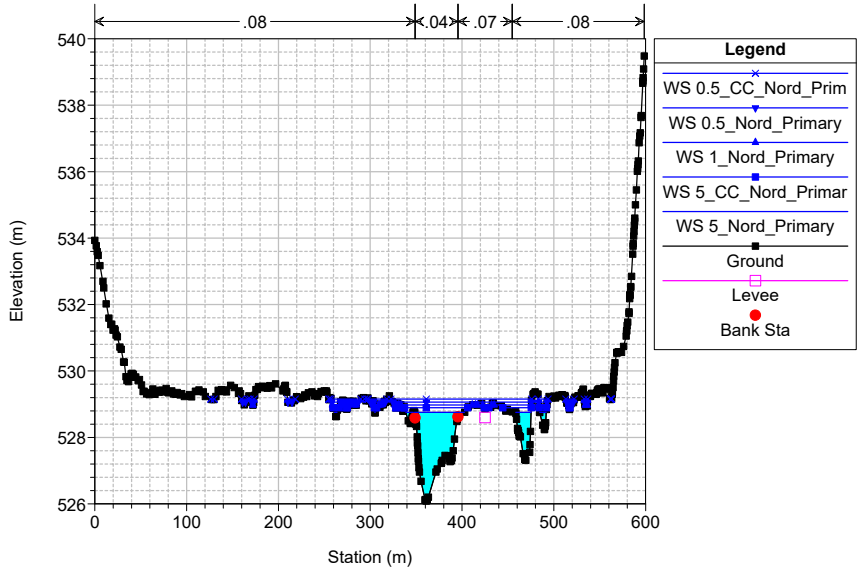
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on LB at elev = 530.3m from bank along XS



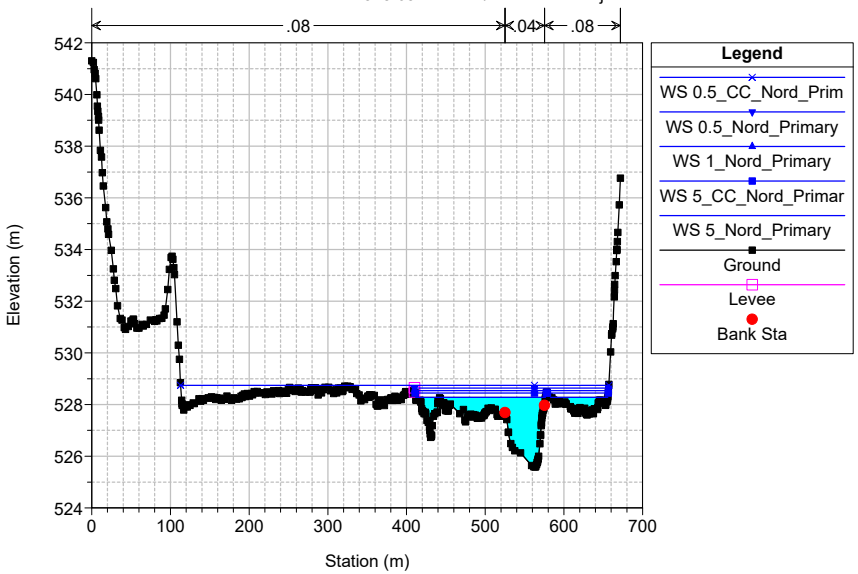
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on RB at elev = 528.6m from u/s inlet bank (250m u/s with



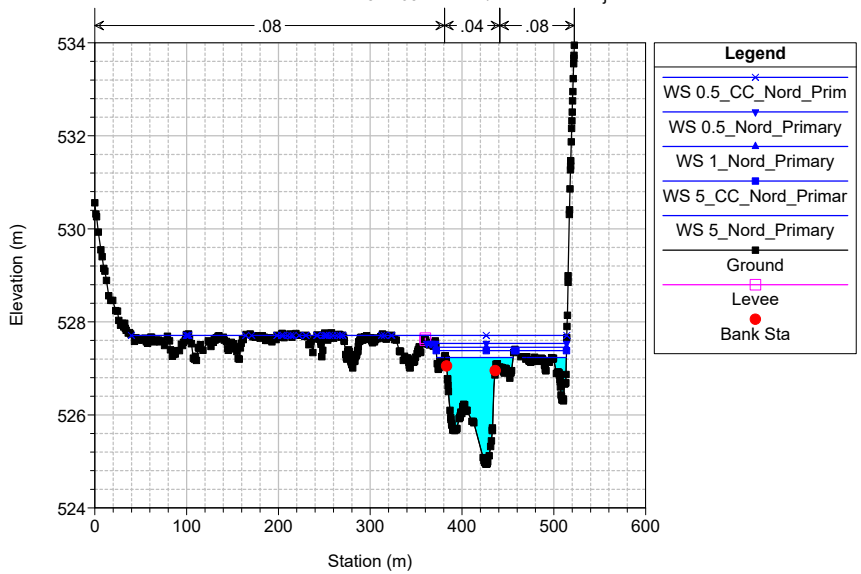
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on LB at elev = 528.65m from u/s inlet bank adjacent to X



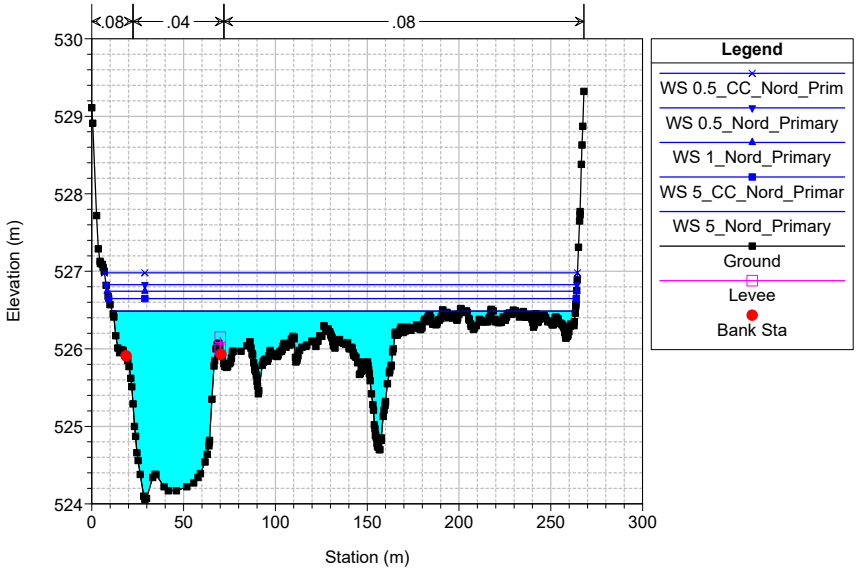
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee on LB at elev = 527.65m from u/s inlet bank adjacent to X

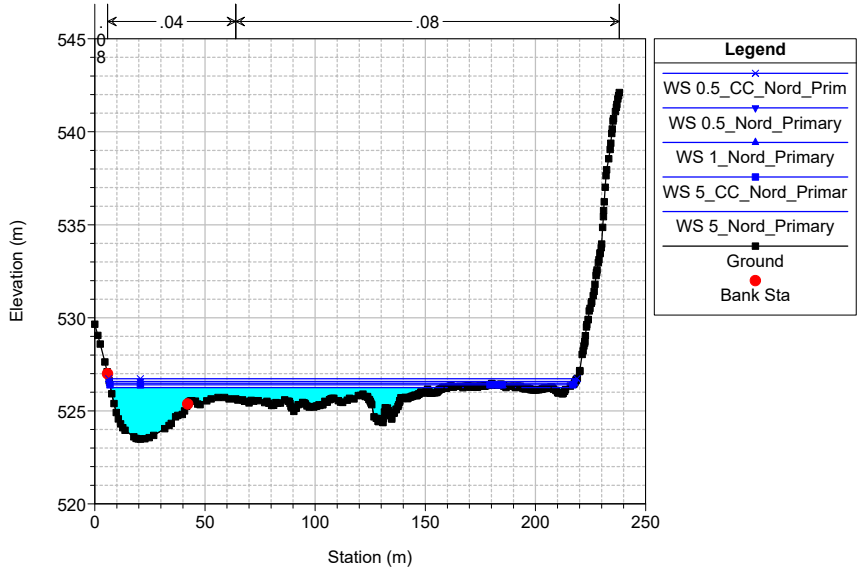


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

-Levee added on RB from u/s inlet control at low flow conditions

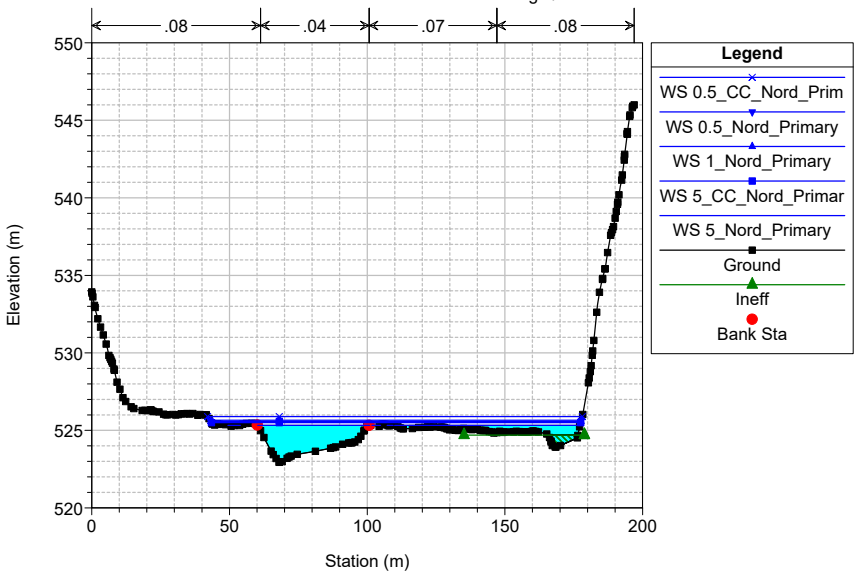


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

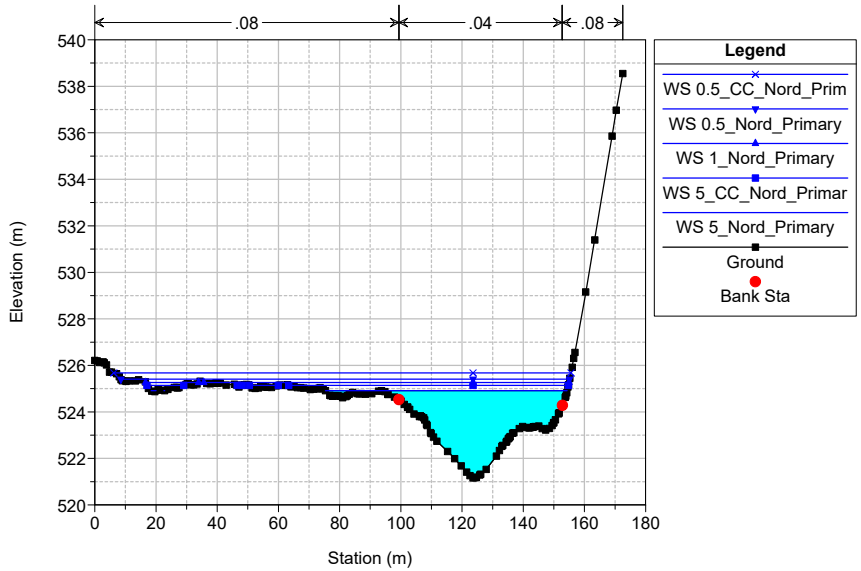


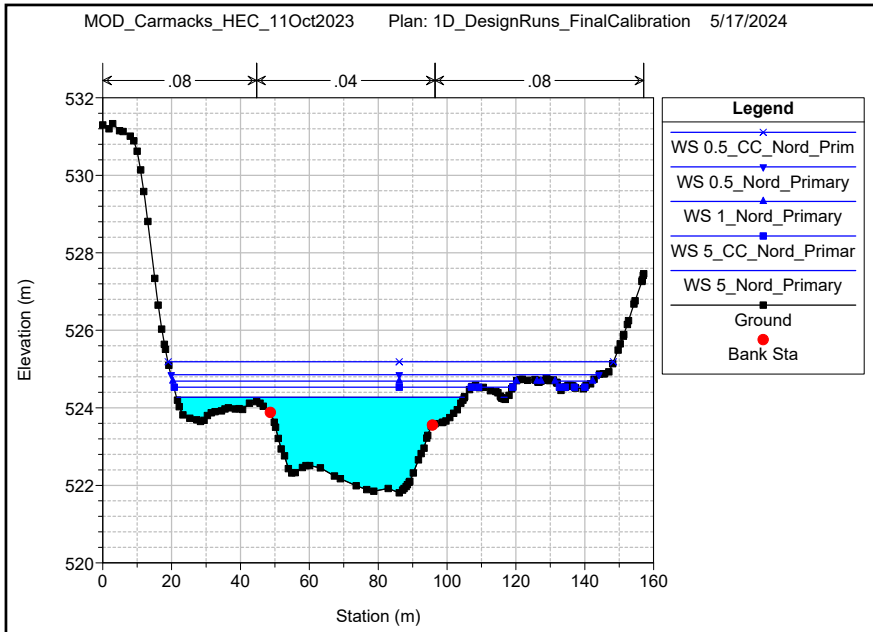
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

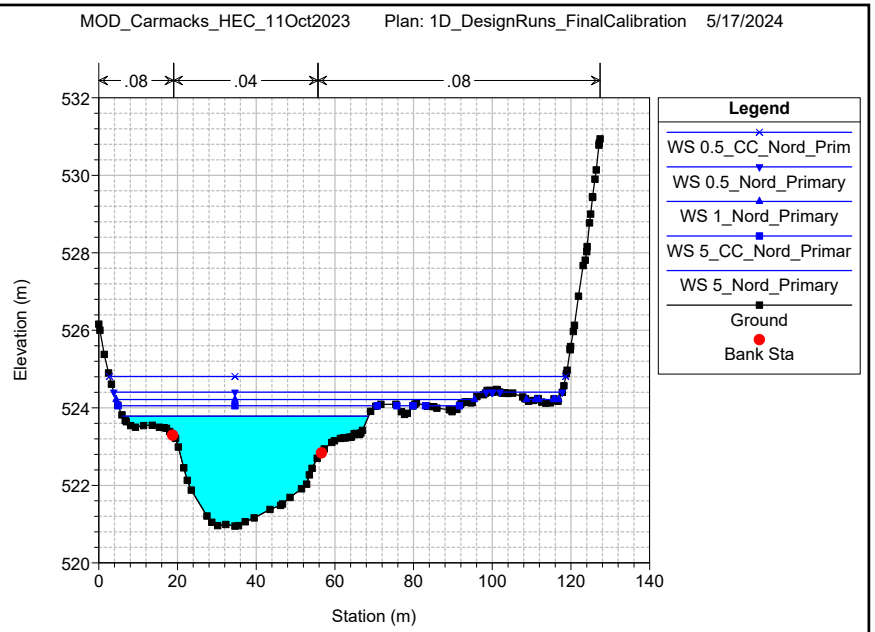
-Perm IFA added on side channel on RB using d/s outlet control e

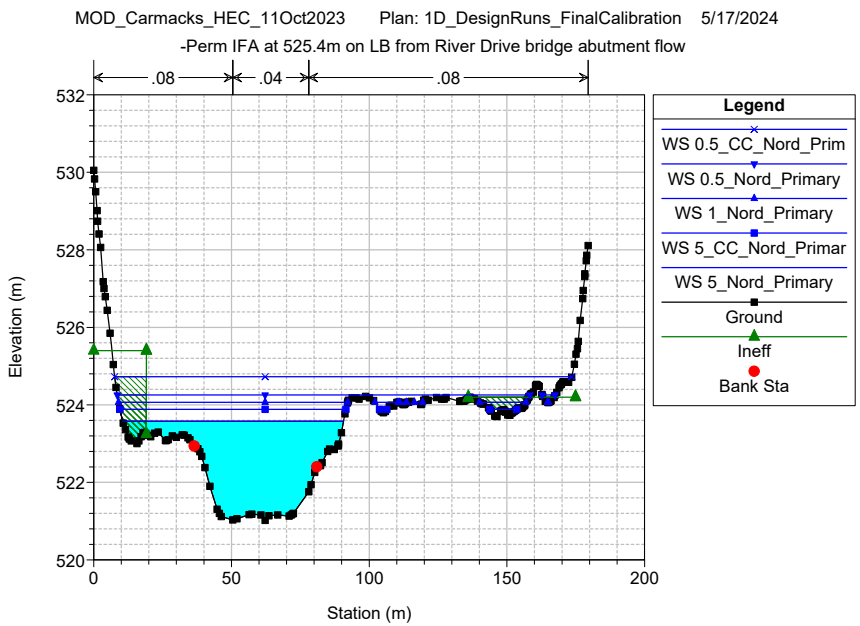


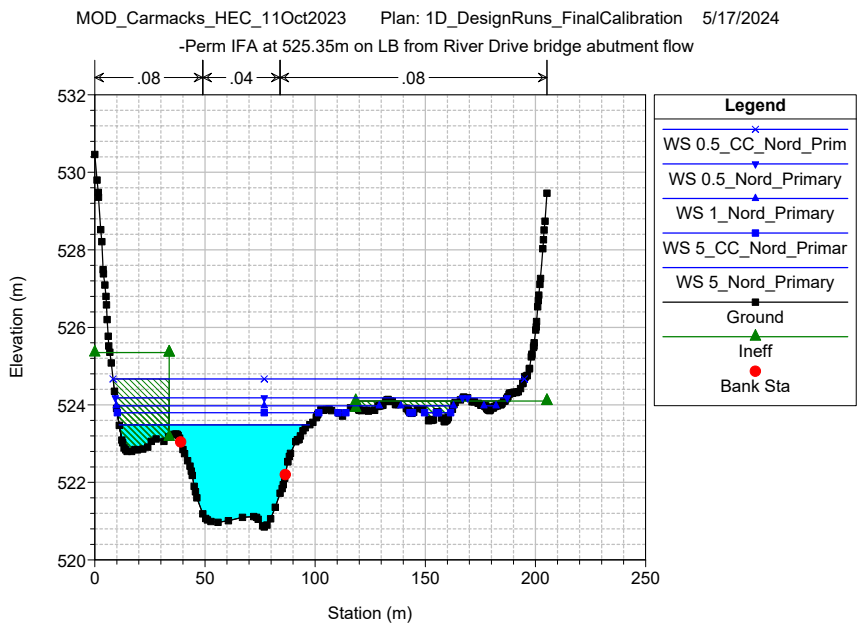
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

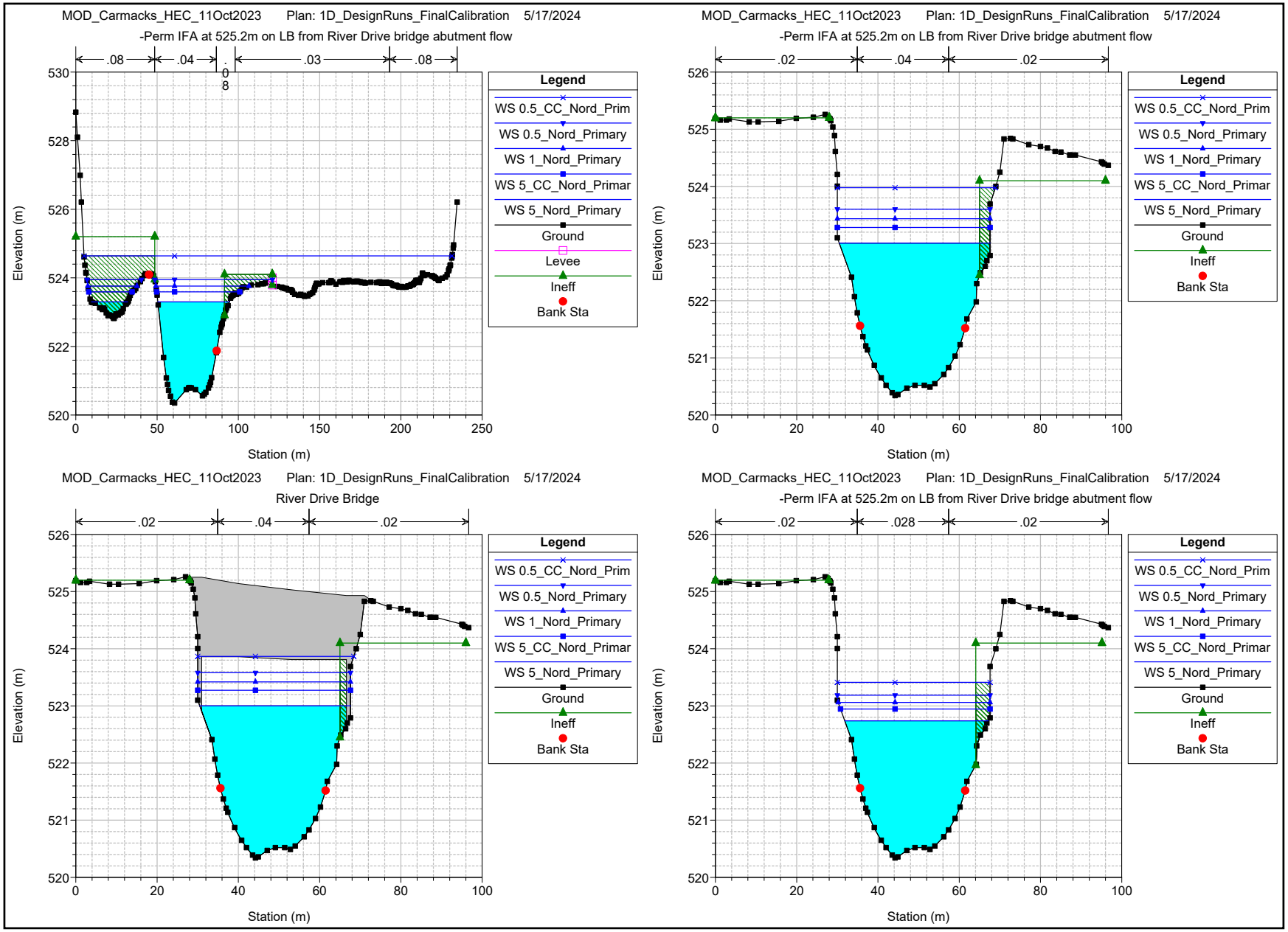


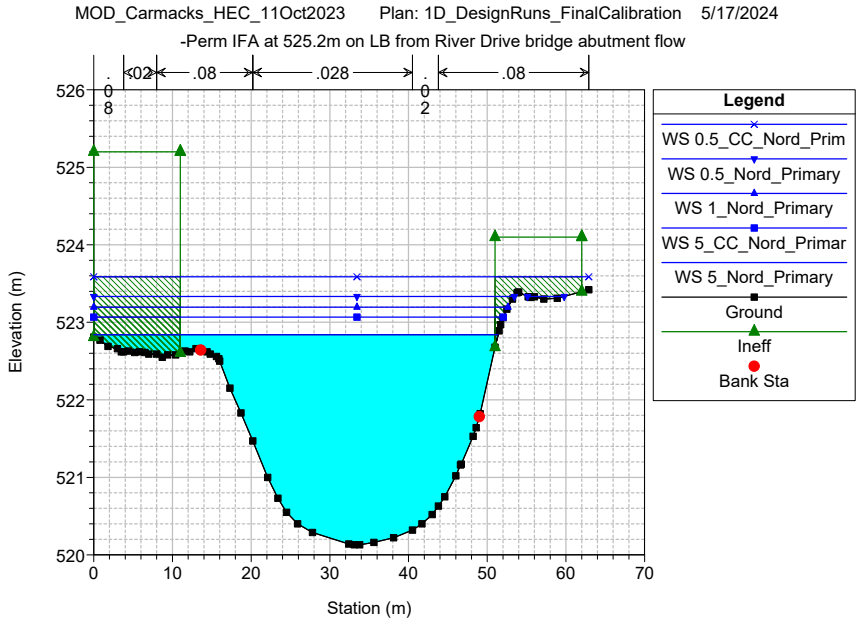

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Bank Sta

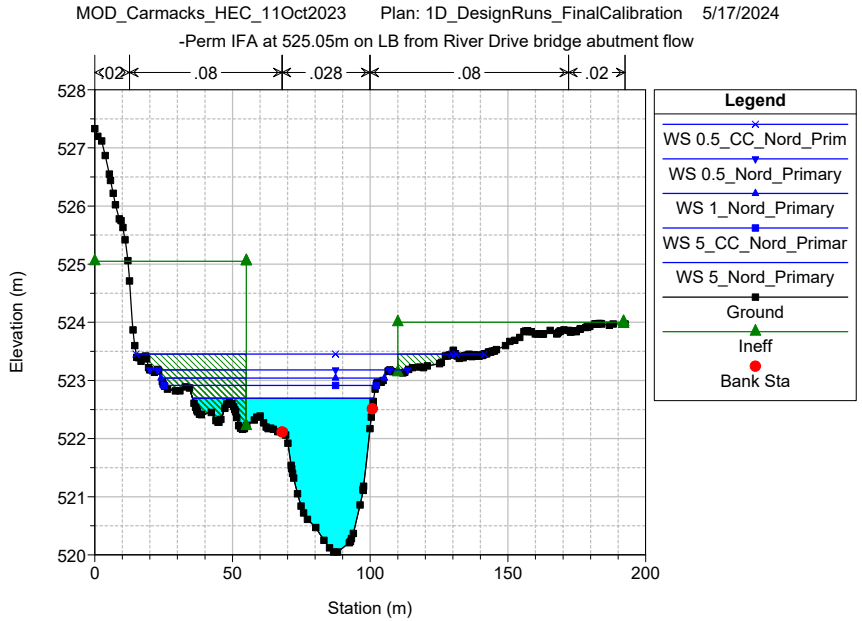

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Bank Sta

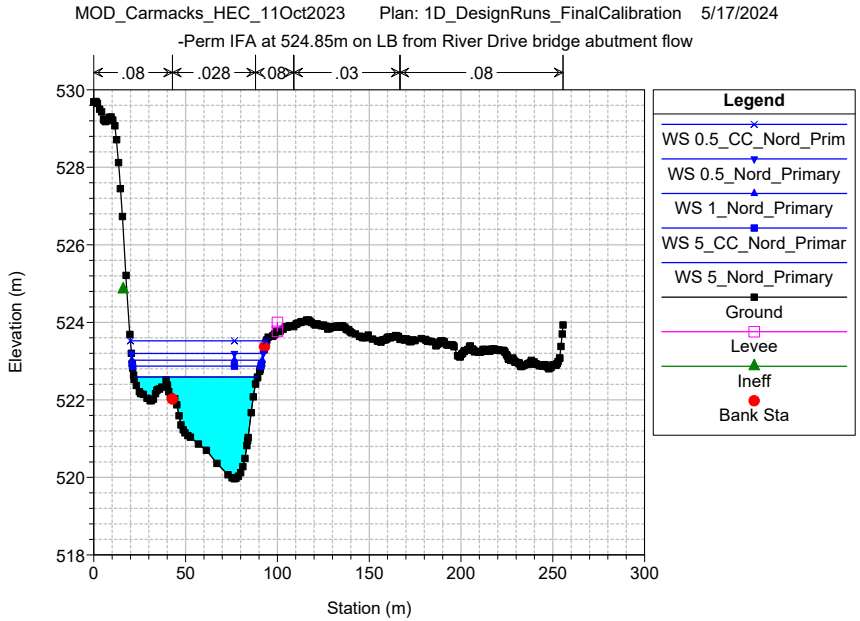

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 525.4m on LB from River Drive bridge abutment flow
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta

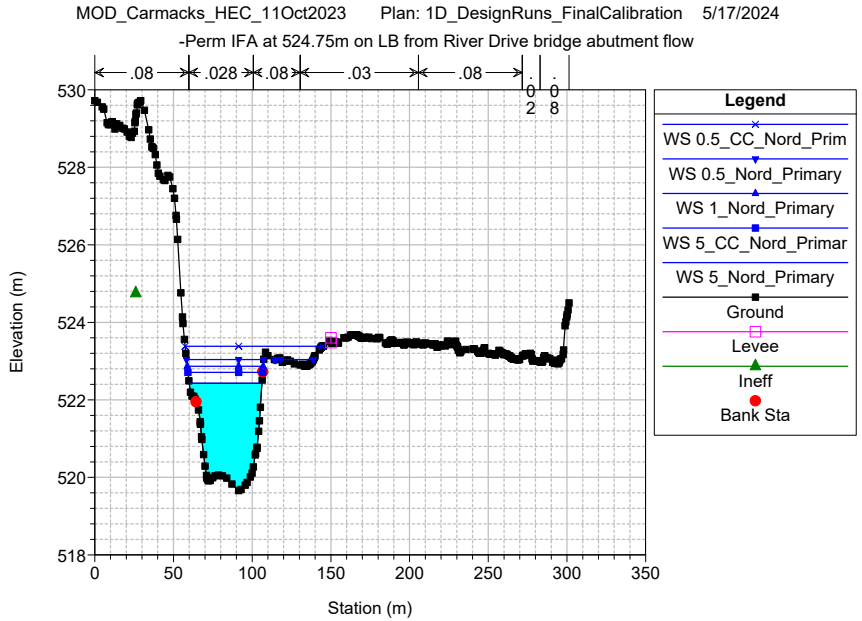

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 525.35m on LB from River Drive bridge abutment flow
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta

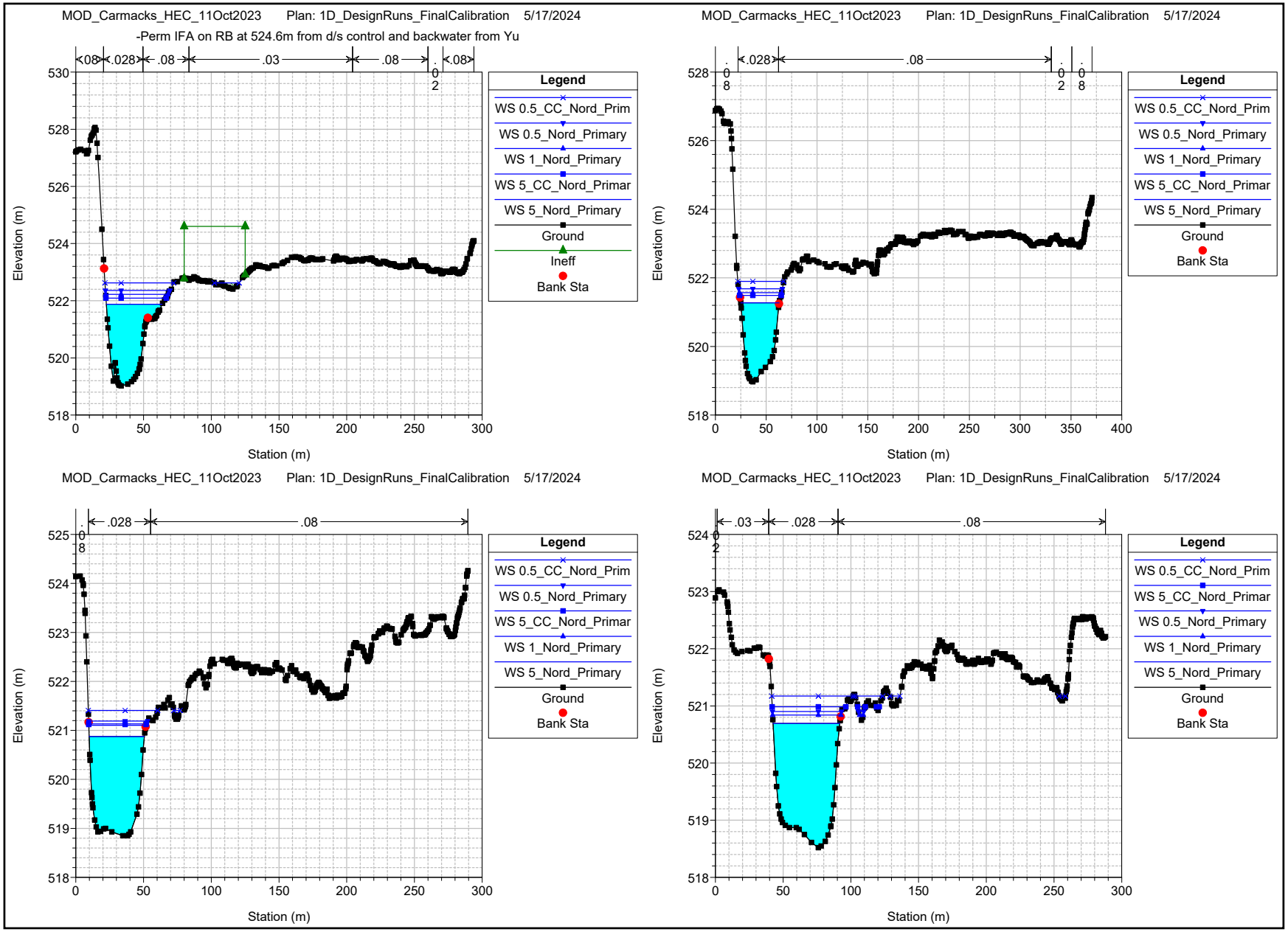

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.08
.04
.03
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Levee
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
River Drive Bridge
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.02
.028
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.08
.02
.028
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 525.05m on LB from River Drive bridge abutment flow
.02
.08
.028
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta

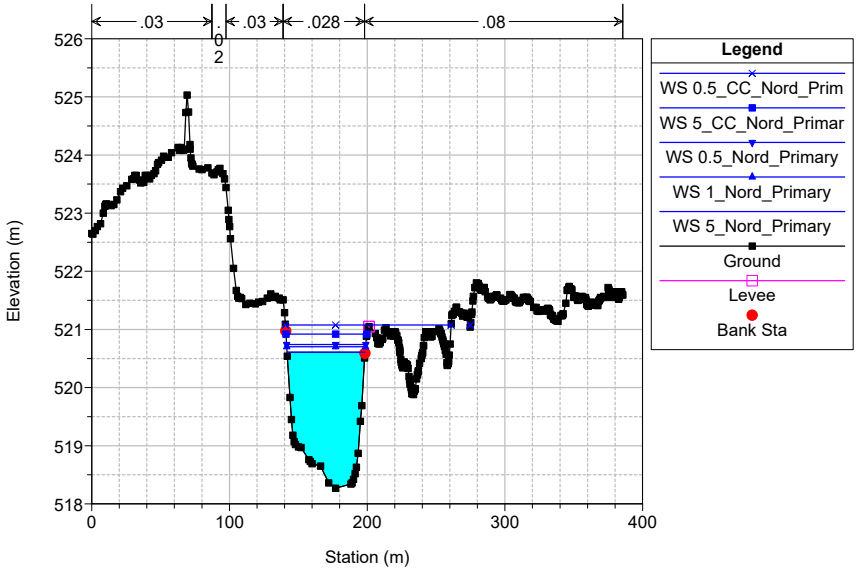

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 524.85m on LB from River Drive bridge abutment flow
.08
.028
.08
.03
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Levee
Ineff
Bank Sta

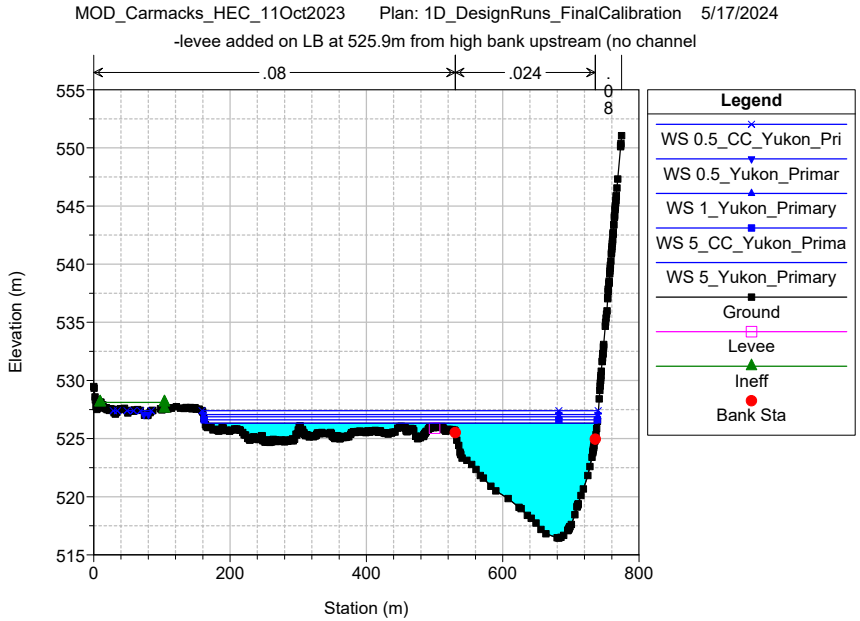

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at 524.75m on LB from River Drive bridge abutment flow
.08
.028
.08
.03
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Levee
Ineff
Bank Sta

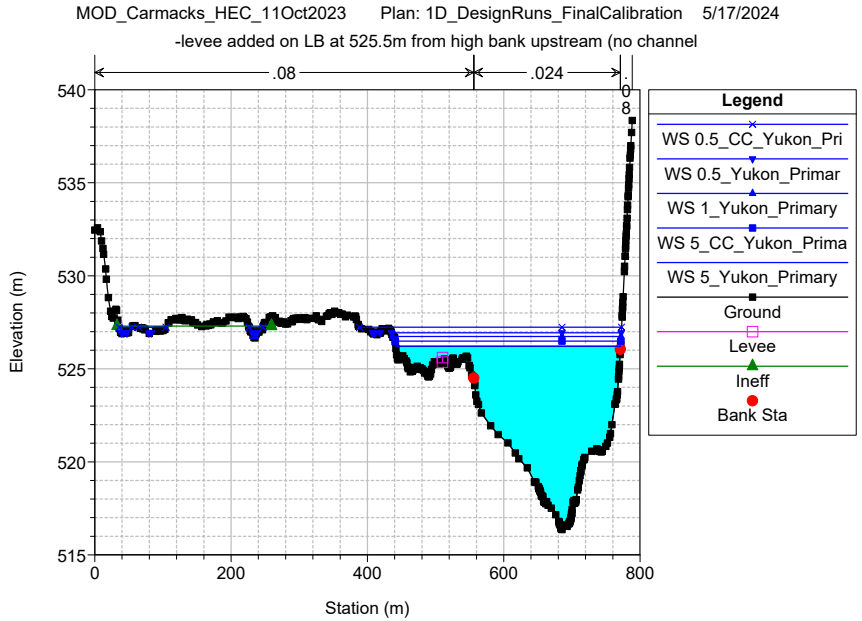

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA on RB at 524.6m from d/s control and backwater from Yu
.08
.028
.08
.03
.08
.02
.08
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.028
.08
.02
.08
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_CC_Nord_Primar
WS 5_Nord_Primary
Ground
Bank Sta
Elevation (m)
Station (m)
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.028
.08
Legend
WS 0.5_CC_Nord_Prim
WS 0.5_Nord_Primary
WS 5_CC_Nord_Primar
WS 1_Nord_Primary
WS 5_Nord_Primary
Ground
Bank Sta
Elevation (m)
Station (m)
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.03
.028
.08
.02
Legend
WS 0.5_CC_Nord_Prim
WS 5_CC_Nord_Primar
WS 0.5_Nord_Primary
WS 1_Nord_Primary
WS 5_Nord_Primary
Ground
Bank Sta
Elevation (m)
Station (m)

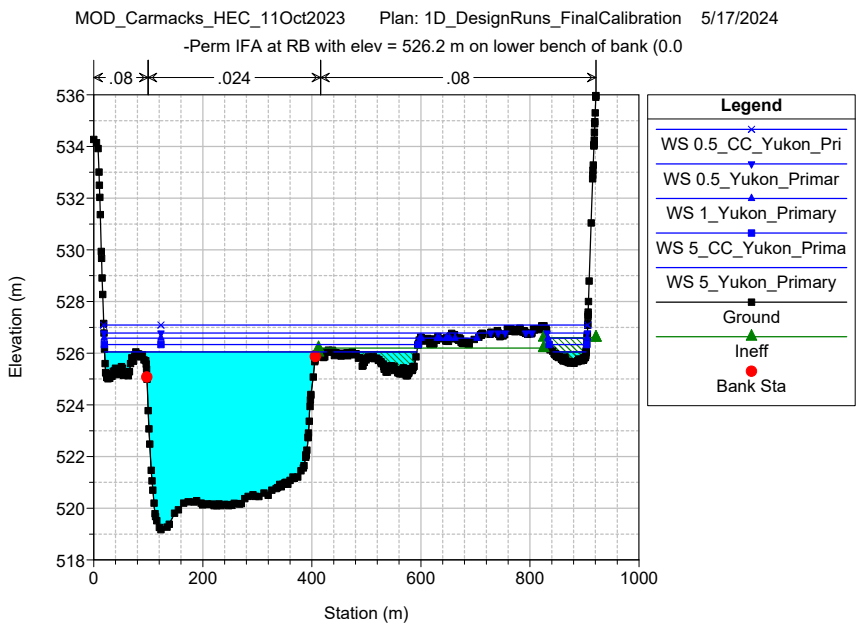
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

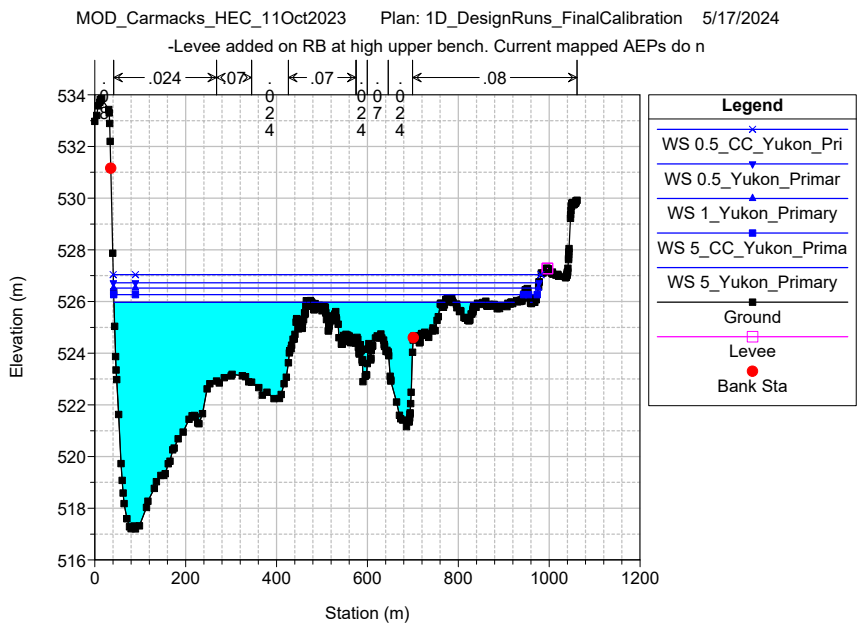
-Levee added on RB at 521.2m from adjacent bank elevation

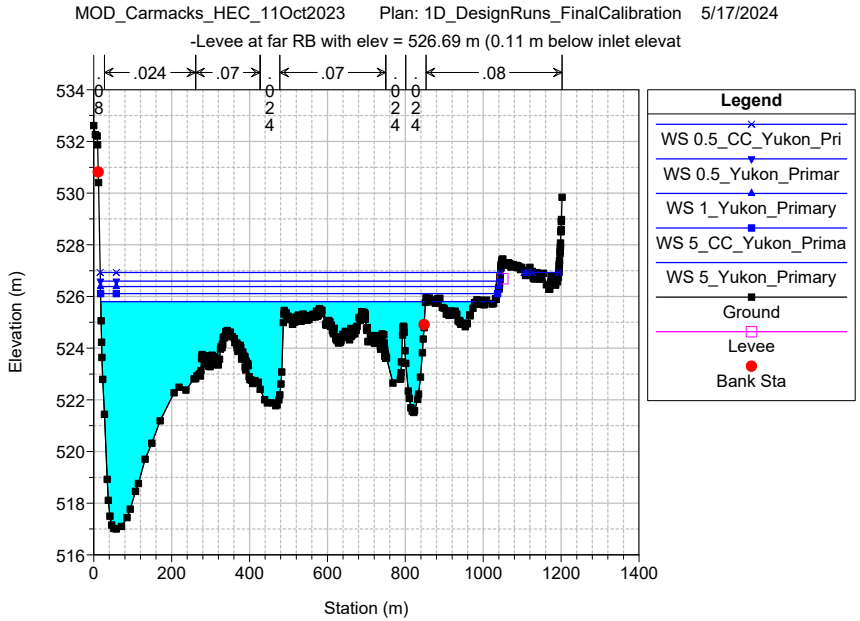


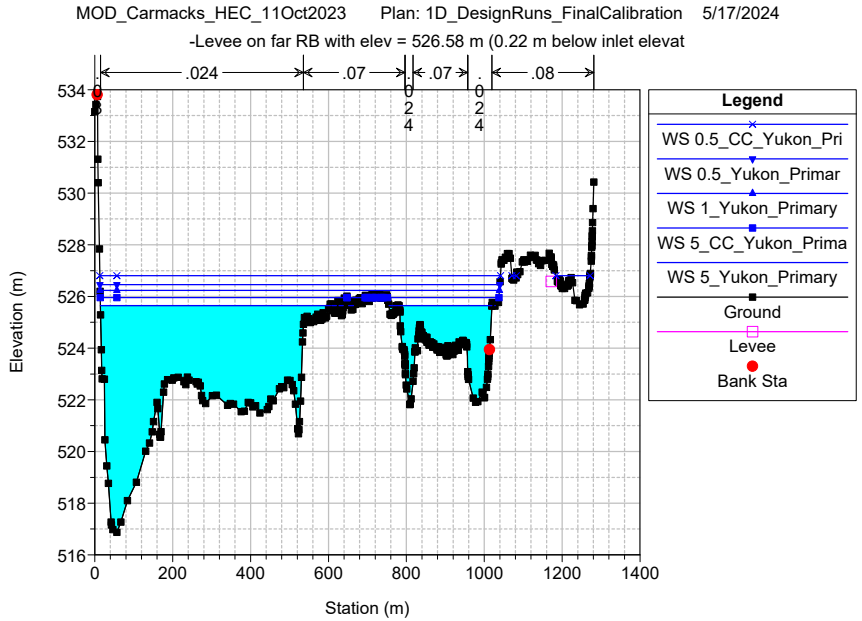

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-levee added on LB at 525.9m from high bank upstream (no channel
.08
.024
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

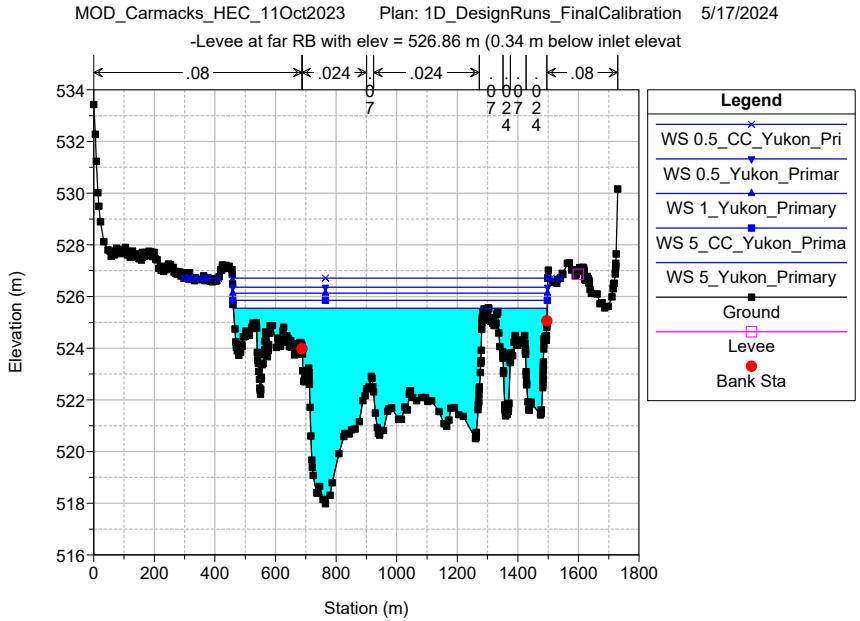

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-levee added on LB at 525.5m from high bank upstream (no channel
.08
.024
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

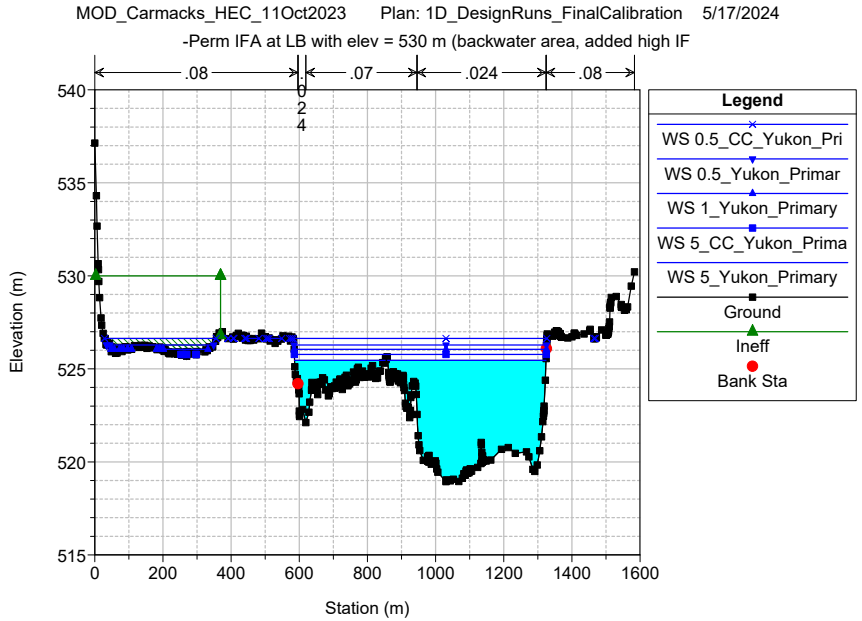

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at RB with elev = 526.2 m on lower bench of bank (0.0
.08
.024
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

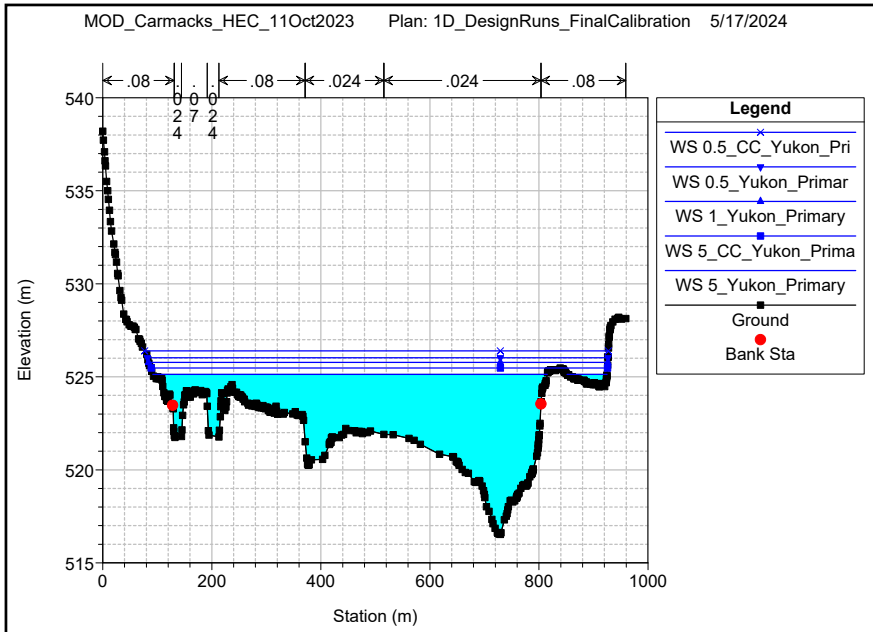

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee added on RB at high upper bench. Current mapped AEPs do n
.024
.07
.07
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

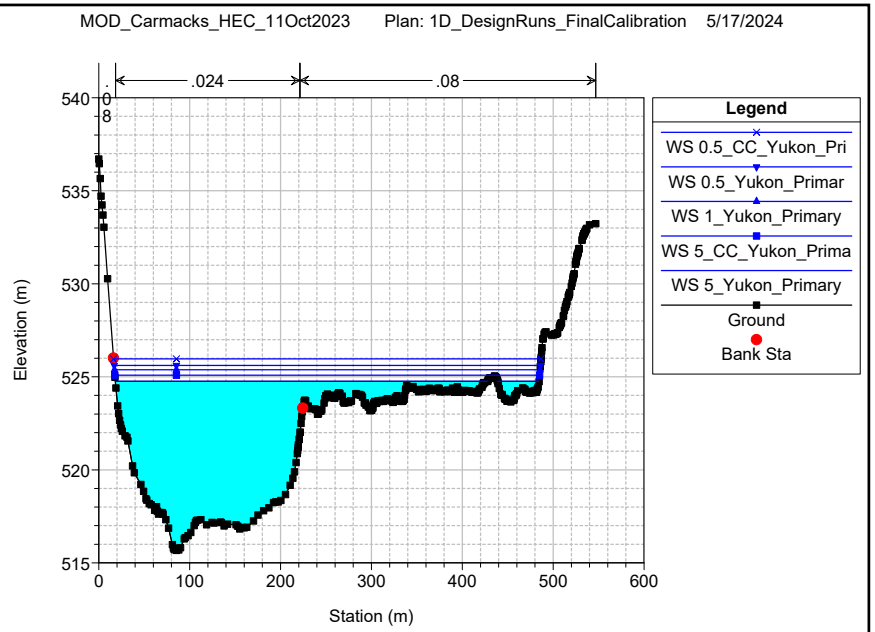

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at far RB with elev = 526.69 m (0.11 m below inlet elevat
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

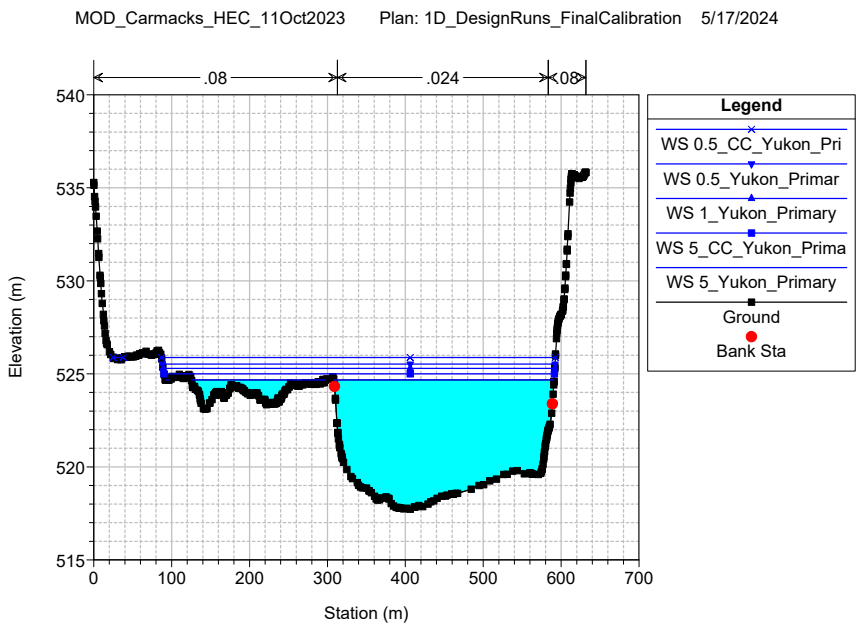

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee on far RB with elev = 526.58 m (0.22 m below inlet elevat
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

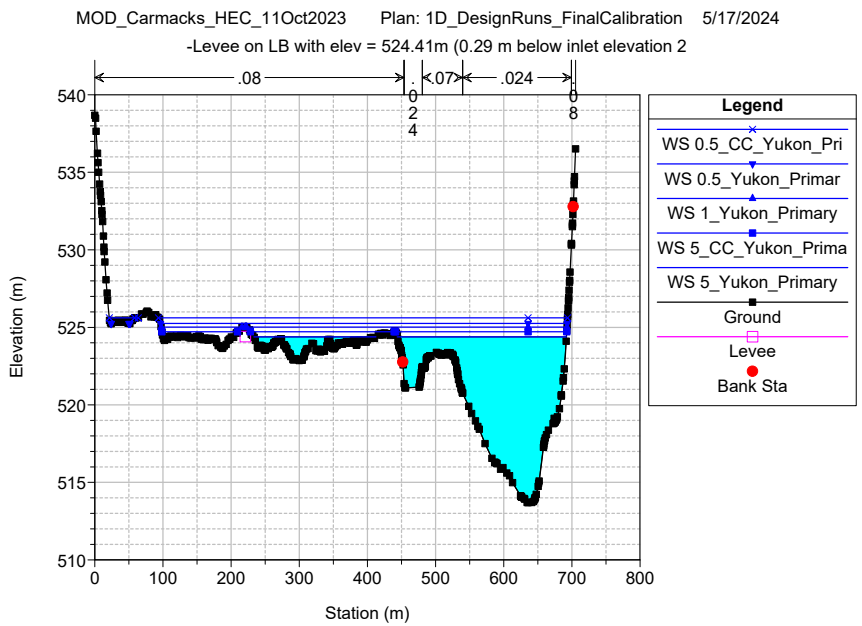

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at far RB with elev = 526.86 m (0.34 m below inlet elevat
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at LB with elev = 530 m (backwater area, added high IF
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

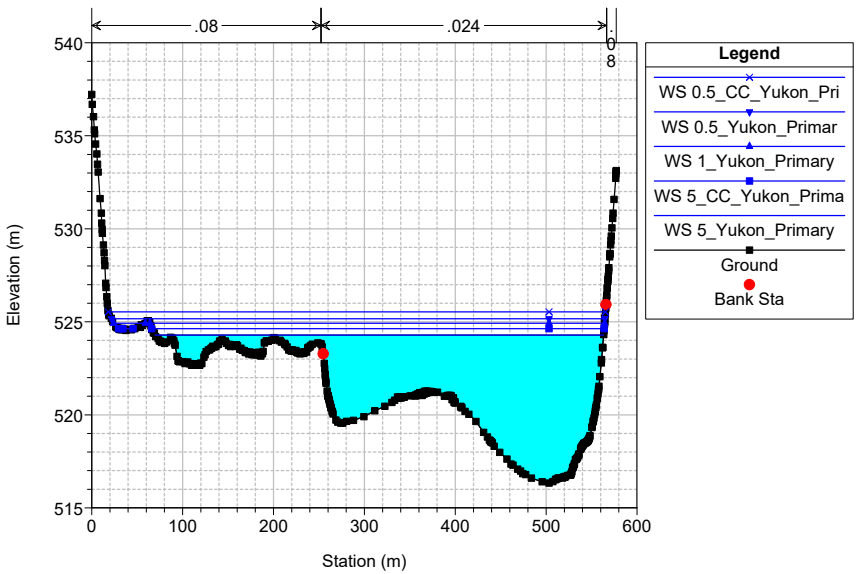

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.024
.024
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.024
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta

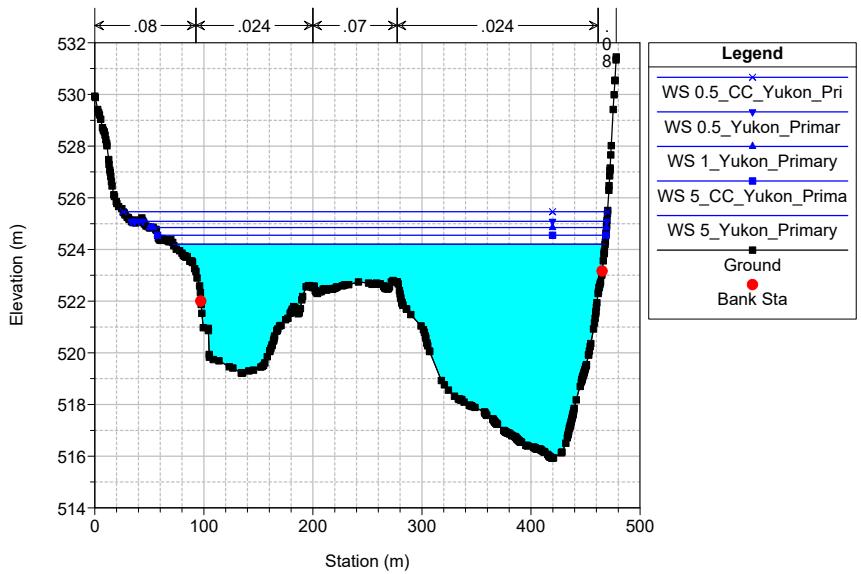

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.024
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee on LB with elev = 524.41m (0.29 m below inlet elevation 2
.08
.07
.024
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

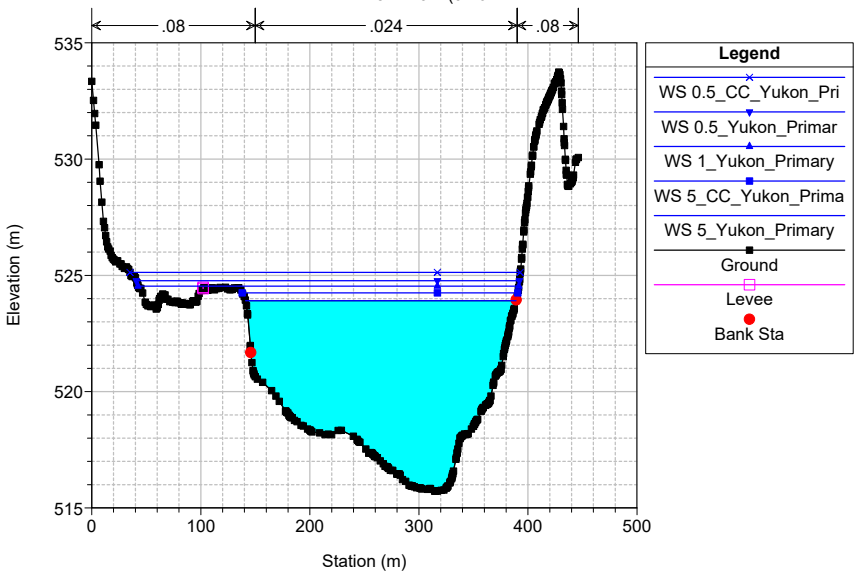


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024



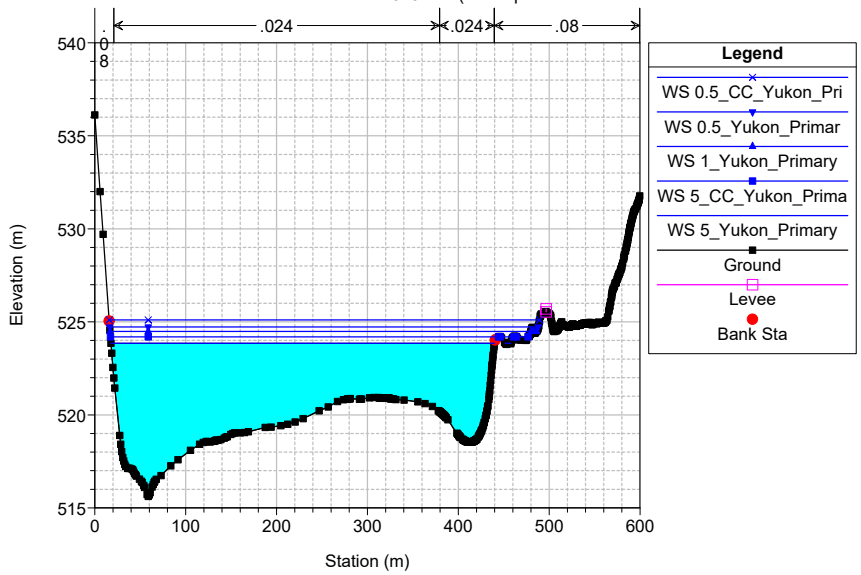
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

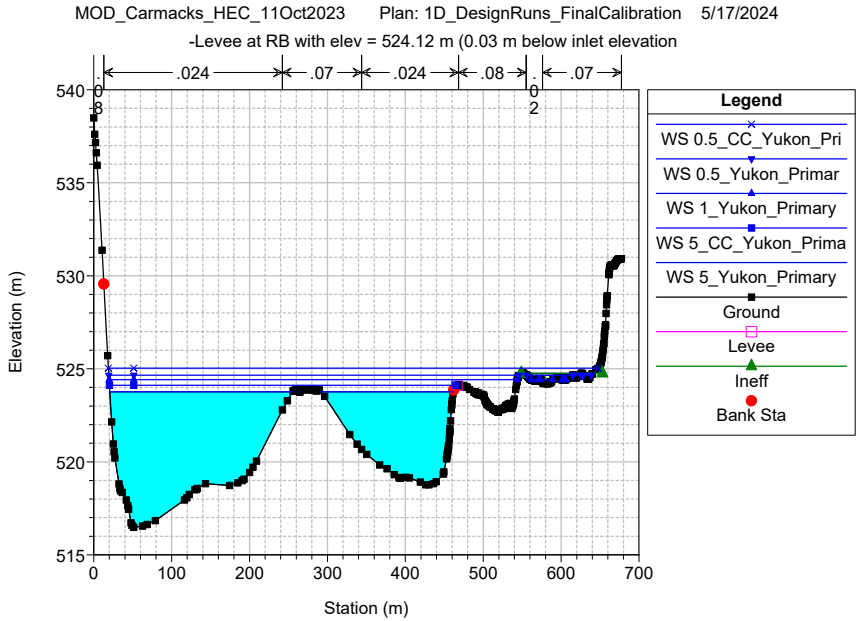
-Levee at LB with elev = 524.49m (0.16 m below inlet elevation 2

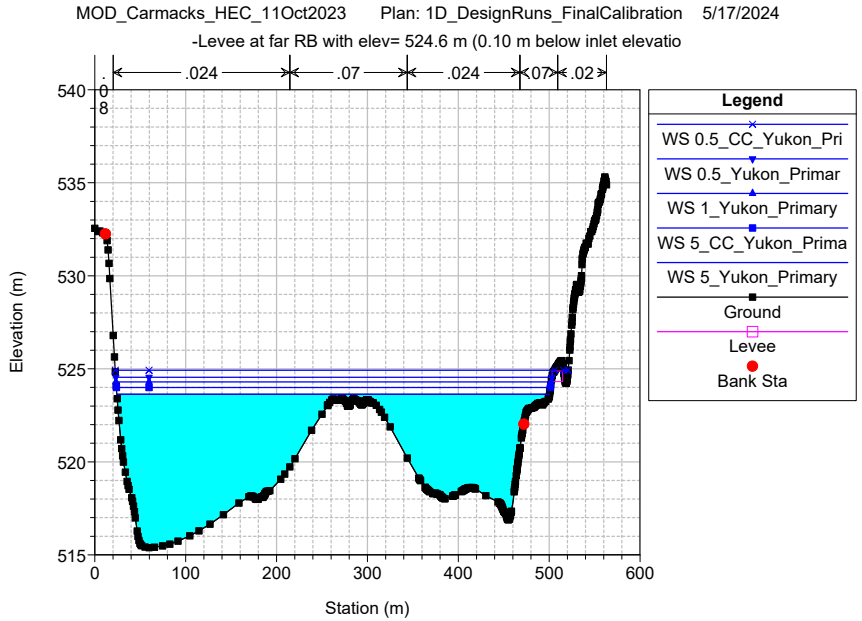


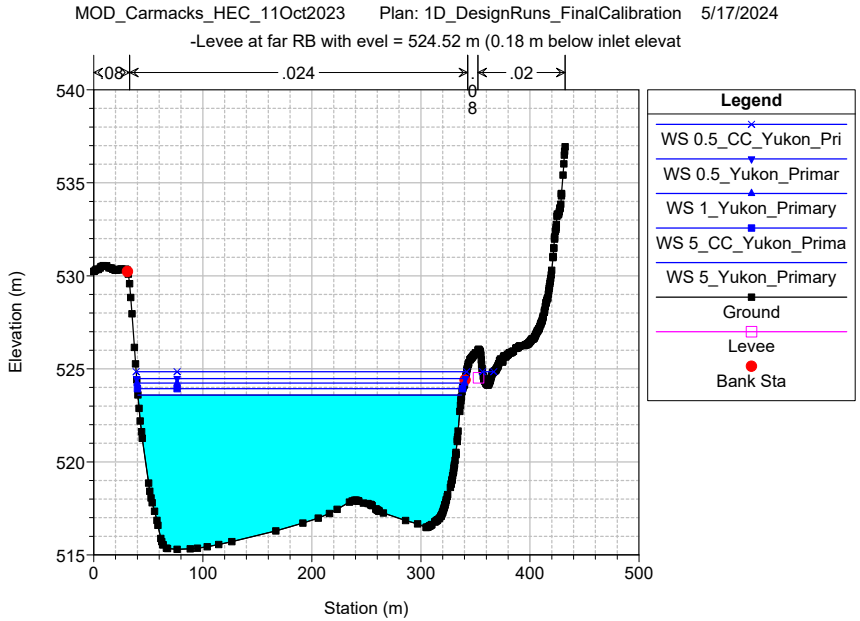
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

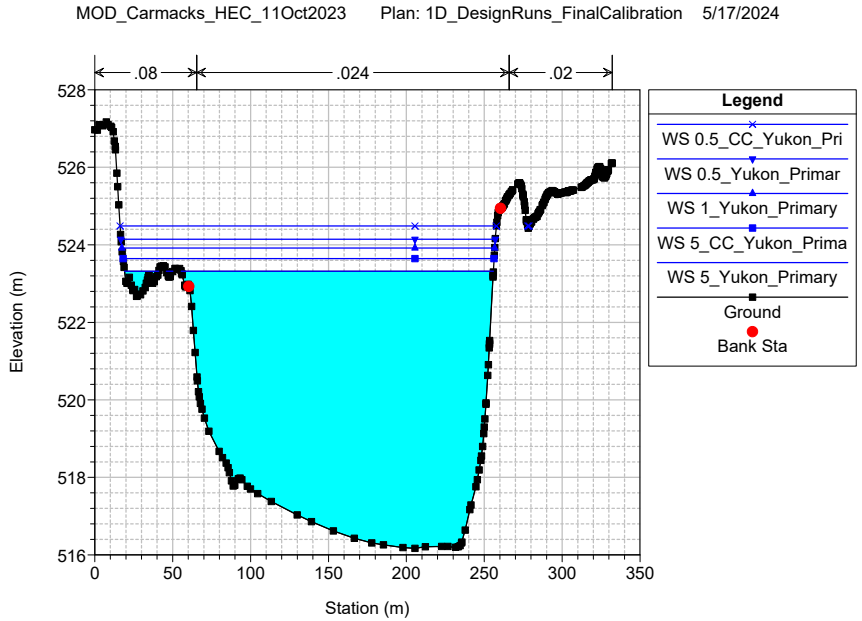
-Levee on RB with elev = 525.7 m (at low point in road crest ele




MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at RB with elev = 524.12 m (0.03 m below inlet elevation
.024
.07
.024
.08
.07
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

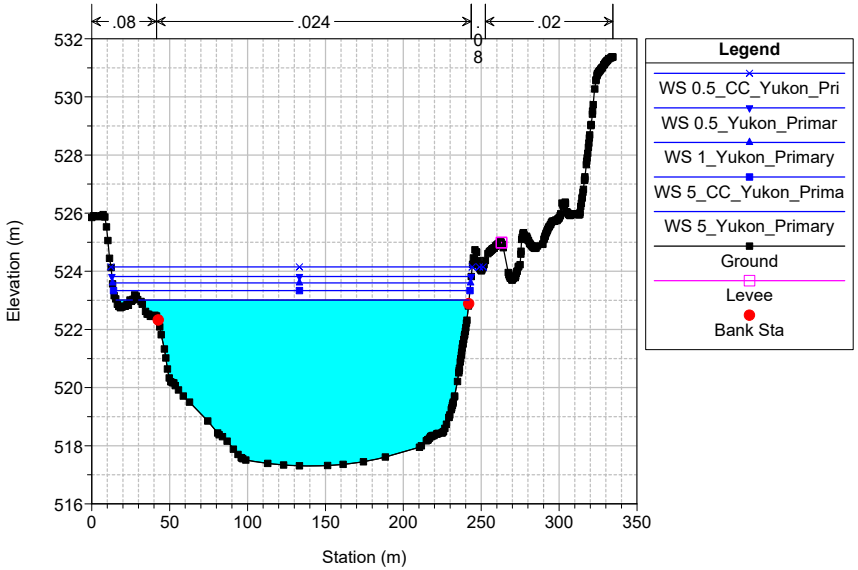

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at far RB with elev= 524.6 m (0.10 m below inlet elevatio
.024
.07
.024
.07
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at far RB with evel = 524.52 m (0.18 m below inlet elevat
.08
.024
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

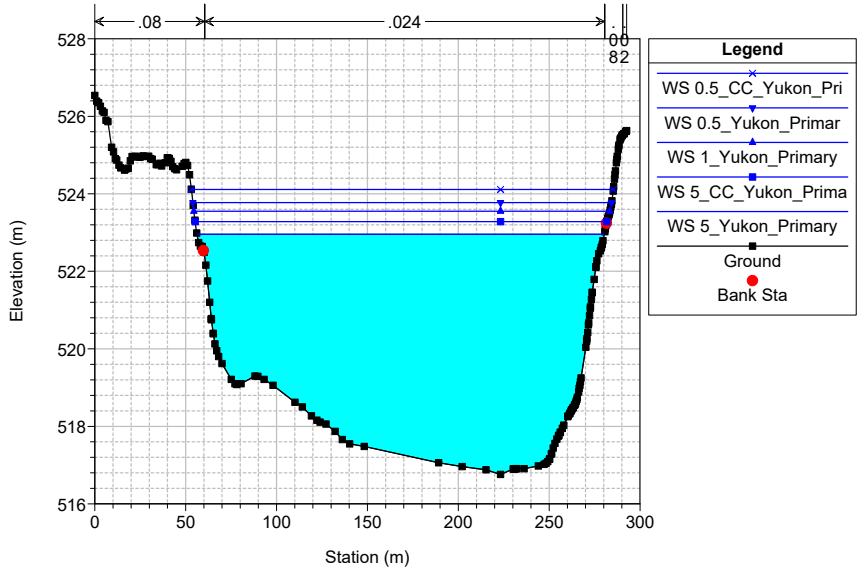

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.024
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

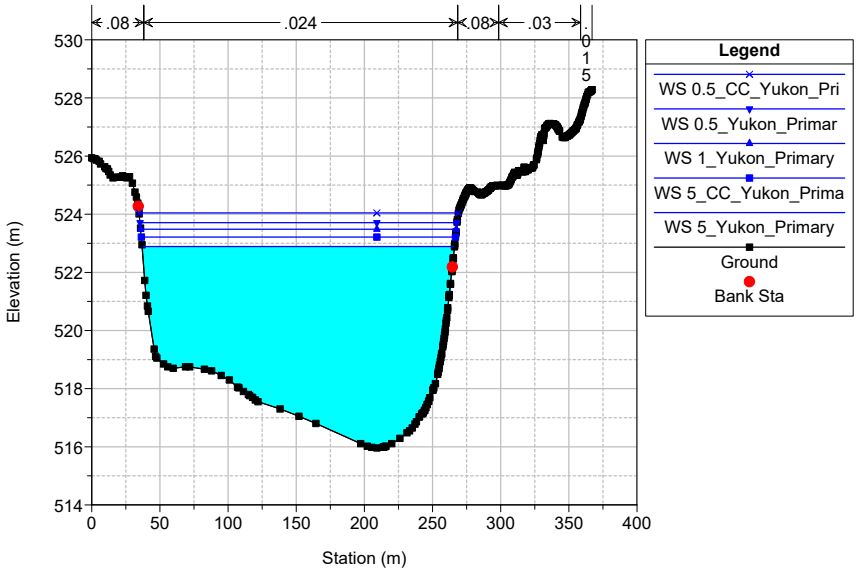
-Levee at RB with evel = 525 m (low spot along dat XS and water



MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

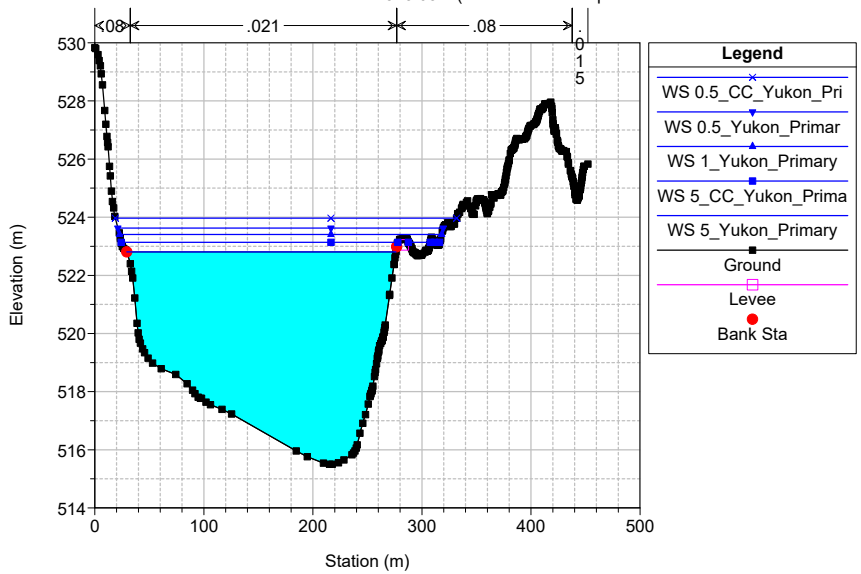


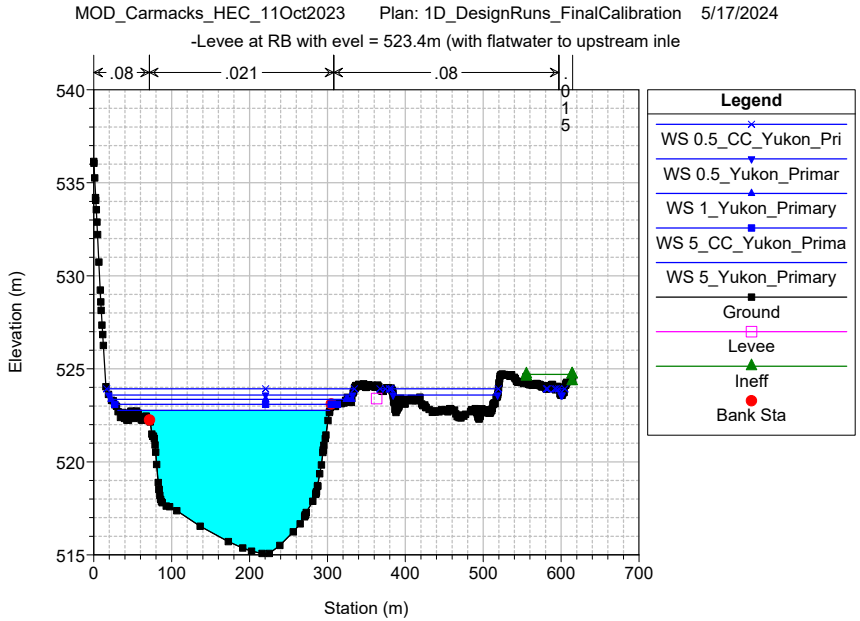
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

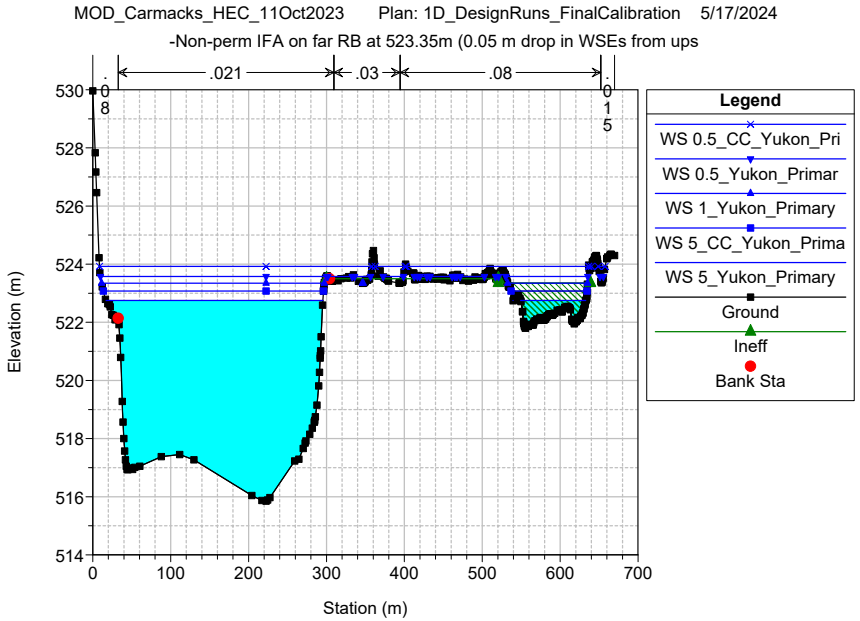


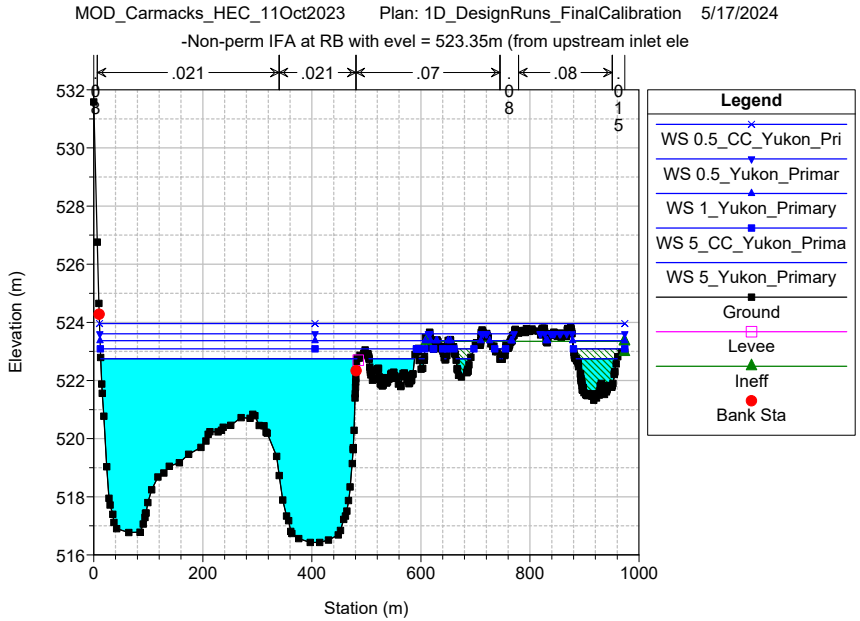
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

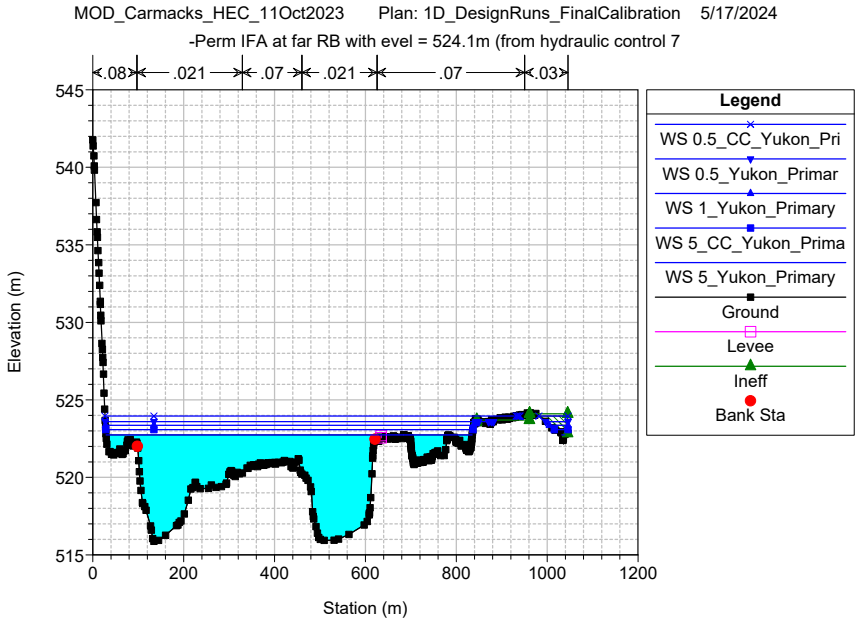
-Levee at RB with evel = 523.05m (with flatwater to upstream inl

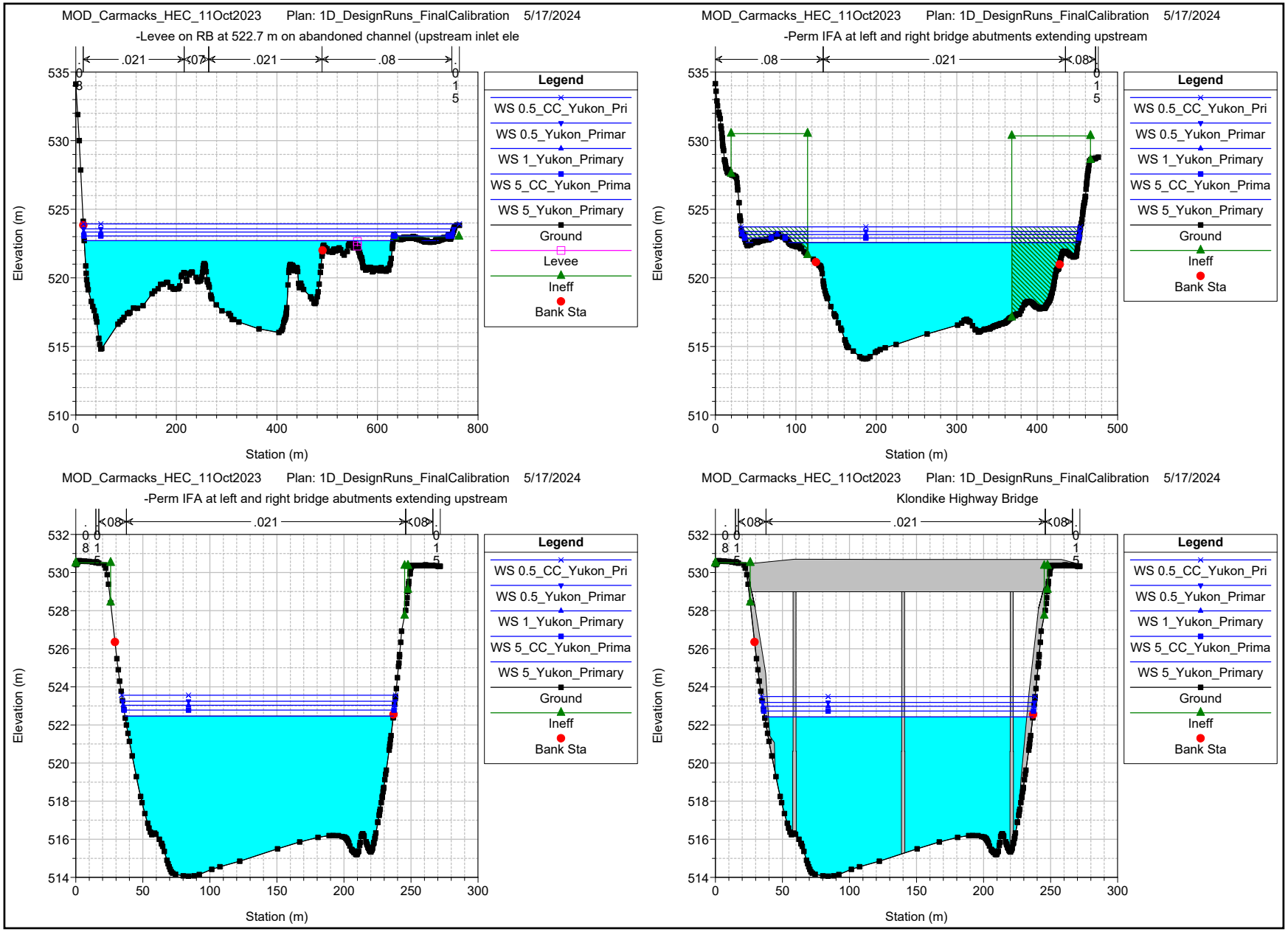


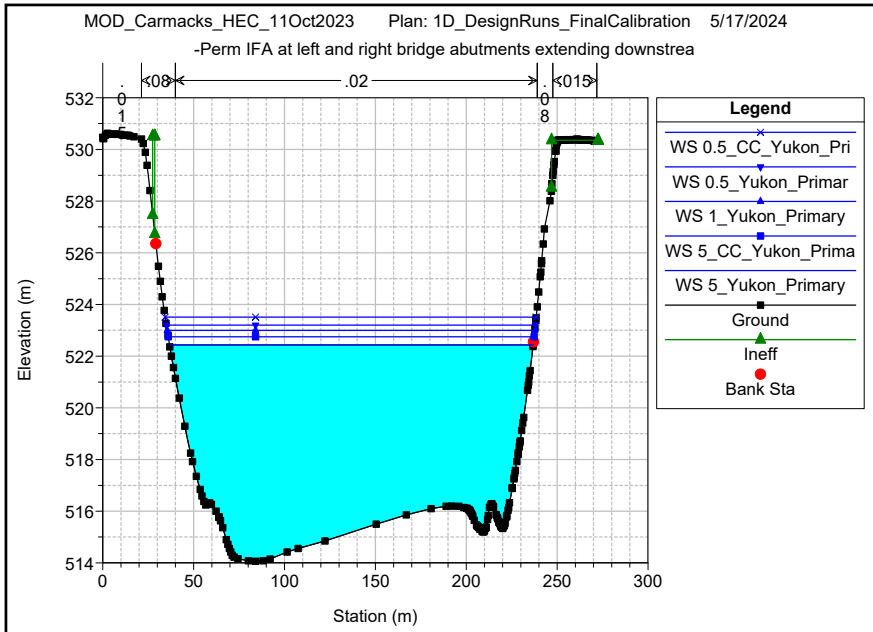

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at RB with evel = 523.4m (with flatwater to upstream inle
.08
.021
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

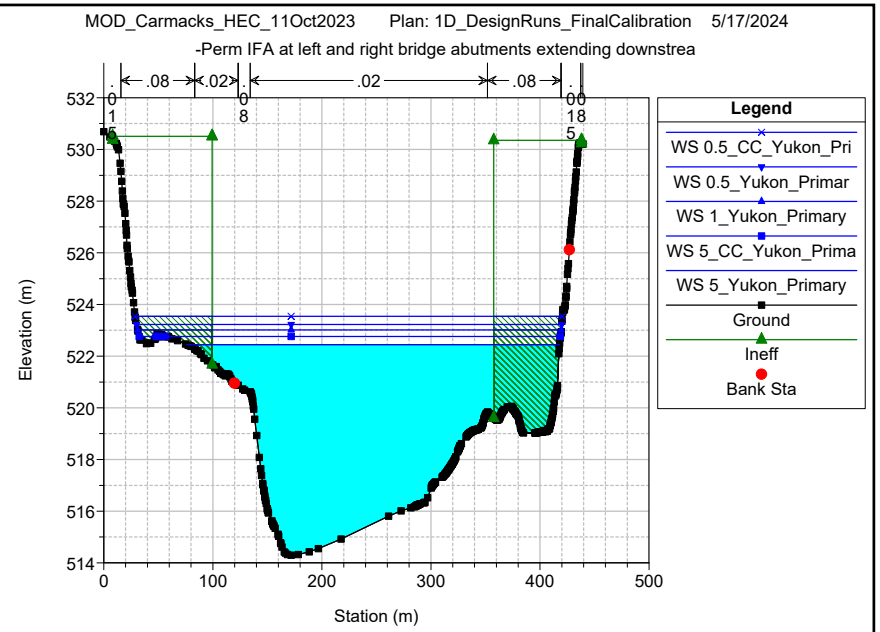

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Non-perm IFA on far RB at 523.35m (0.05 m drop in WSEs from ups
.021
.03
.08
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

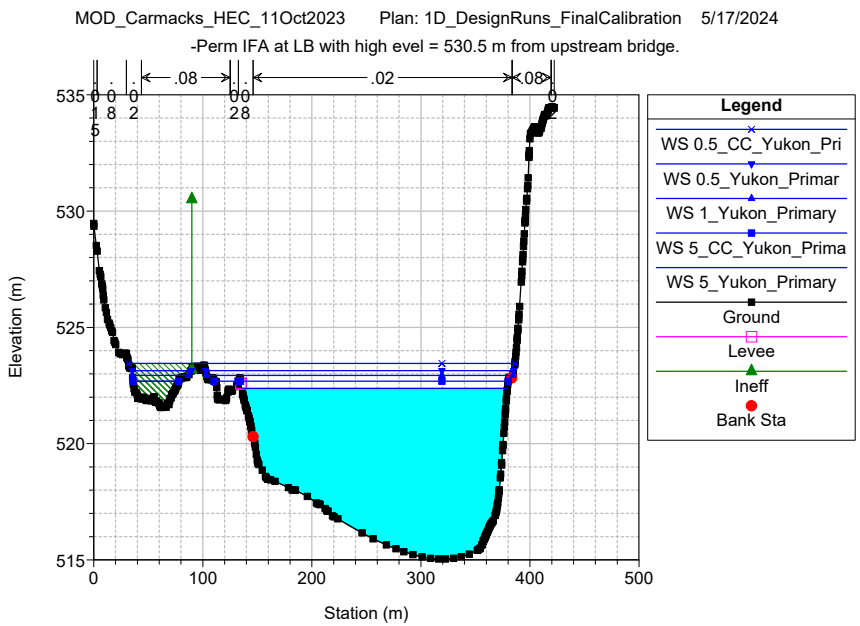

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Non-perm IFA at RB with evel = 523.35m (from upstream inlet ele
.021
.021
.07
.08
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

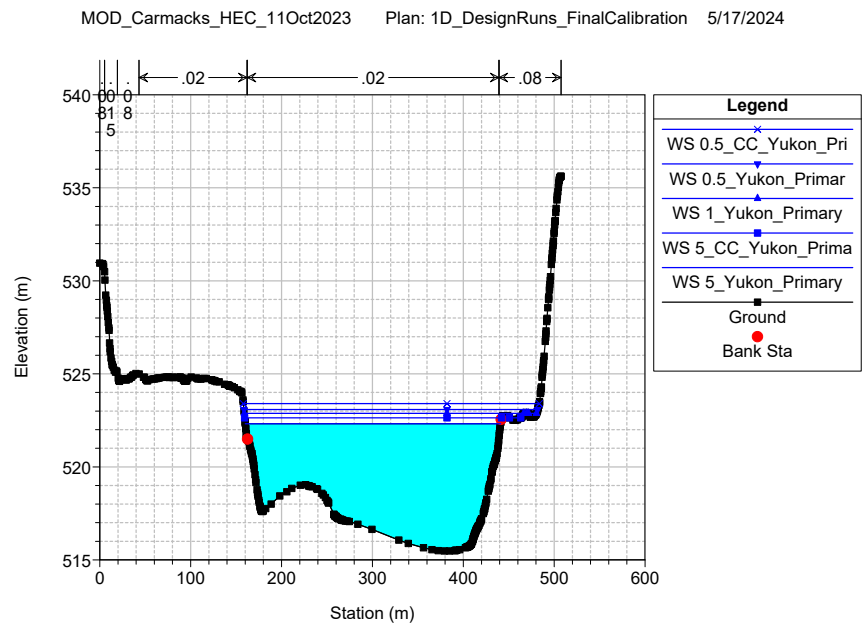

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at far RB with evel = 524.1m (from hydraulic control 7
.08
.021
.07
.021
.07
.03
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

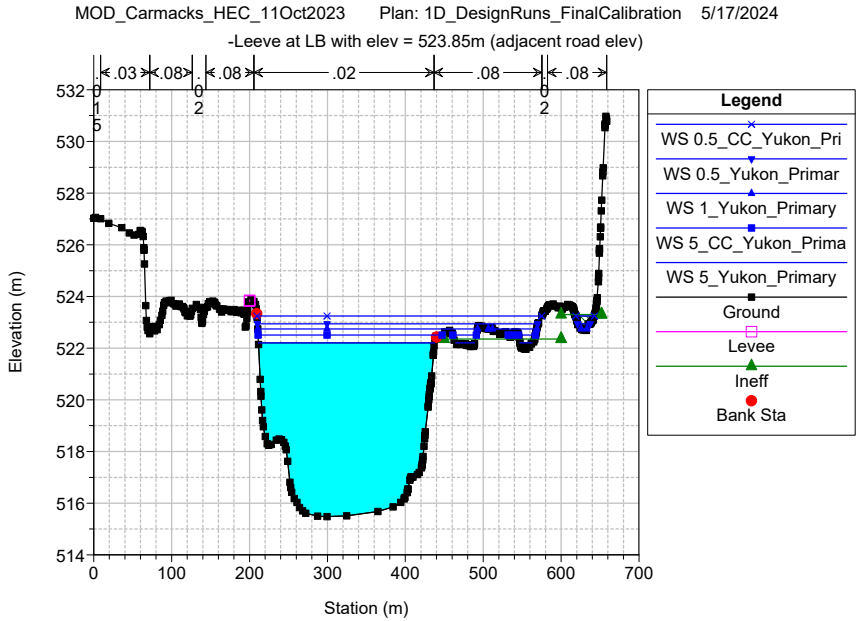

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee on RB at 522.7 m on abandoned channel (upstream inlet ele
.021
.07
.021
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at left and right bridge abutments extending upstream
.08
.021
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at left and right bridge abutments extending upstream
.08
.021
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
Klondike Highway Bridge
.08
.021
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

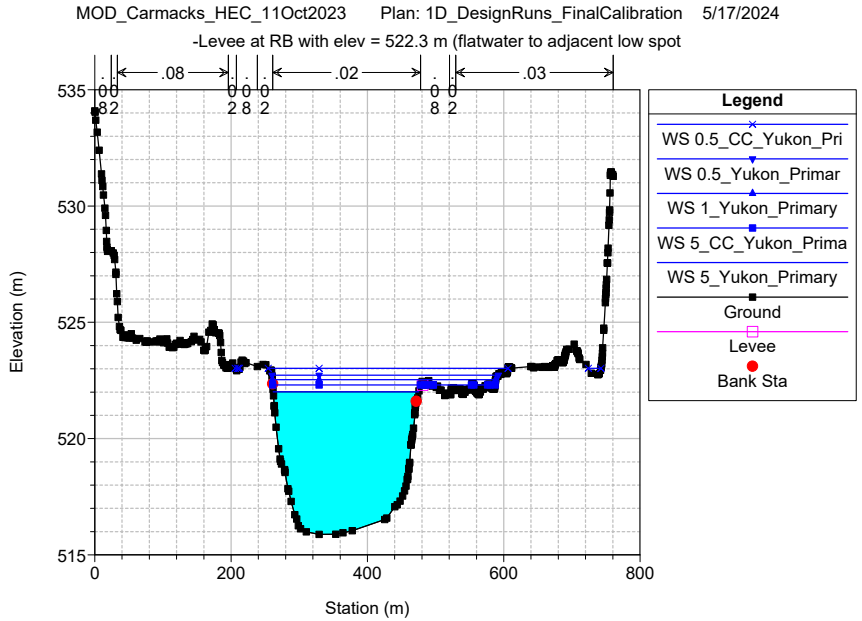

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at left and right bridge abutments extending downstrea
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

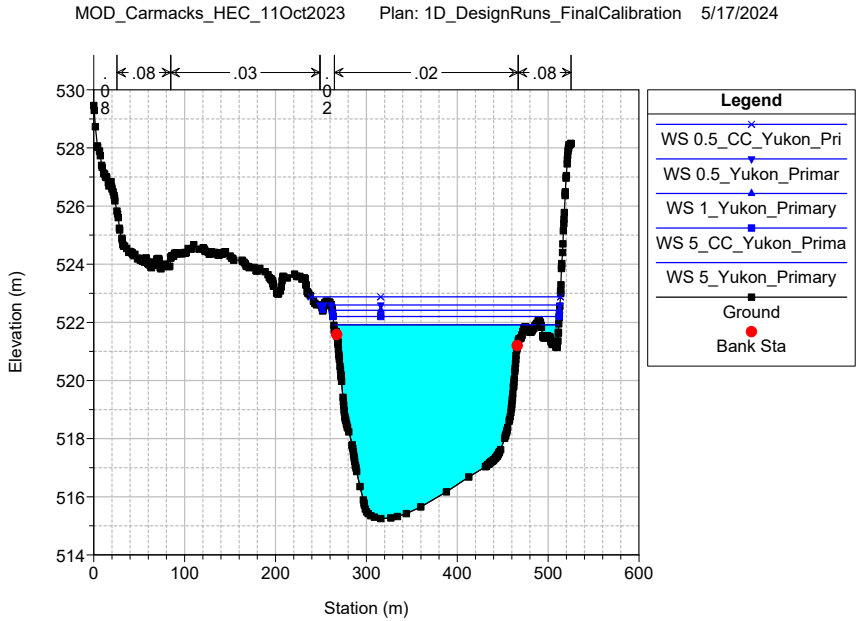

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at left and right bridge abutments extending downstrea
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

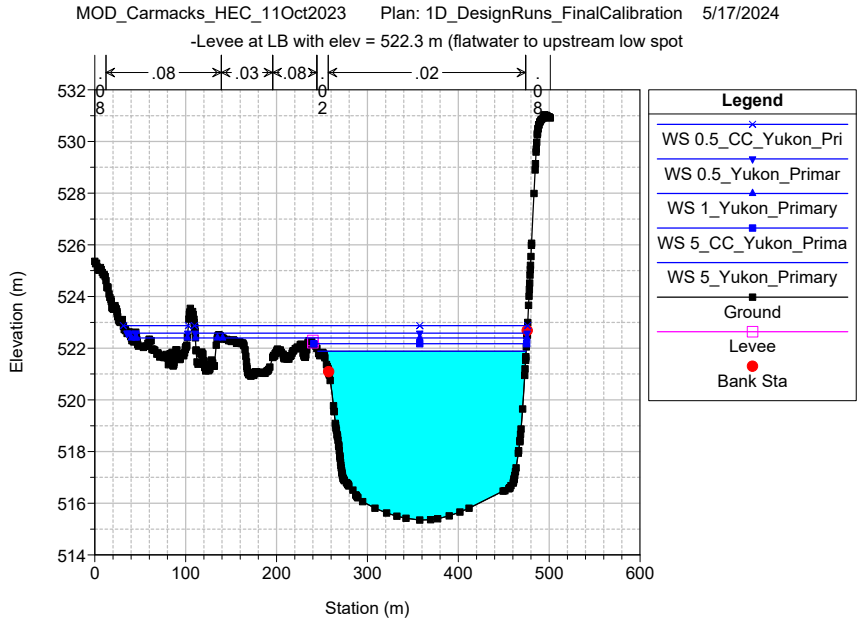

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at LB with high evel = 530.5 m from upstream bridge.
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

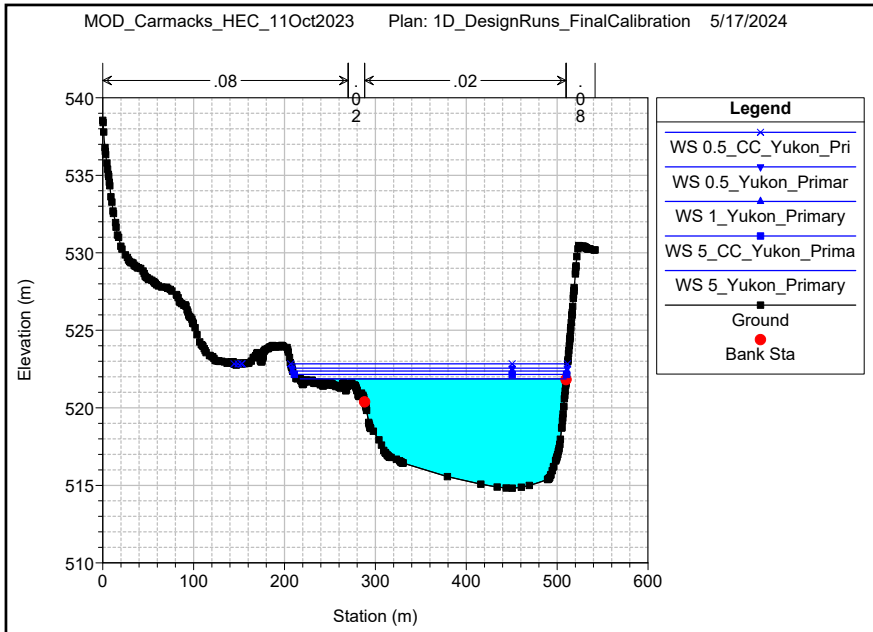

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta

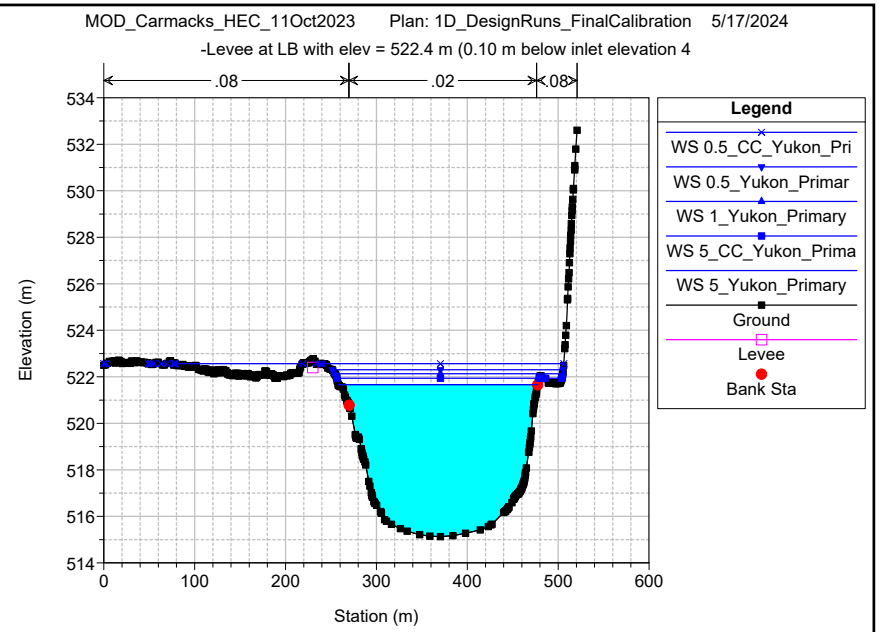

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Leeve at LB with elev = 523.85m (adjacent road elev)
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

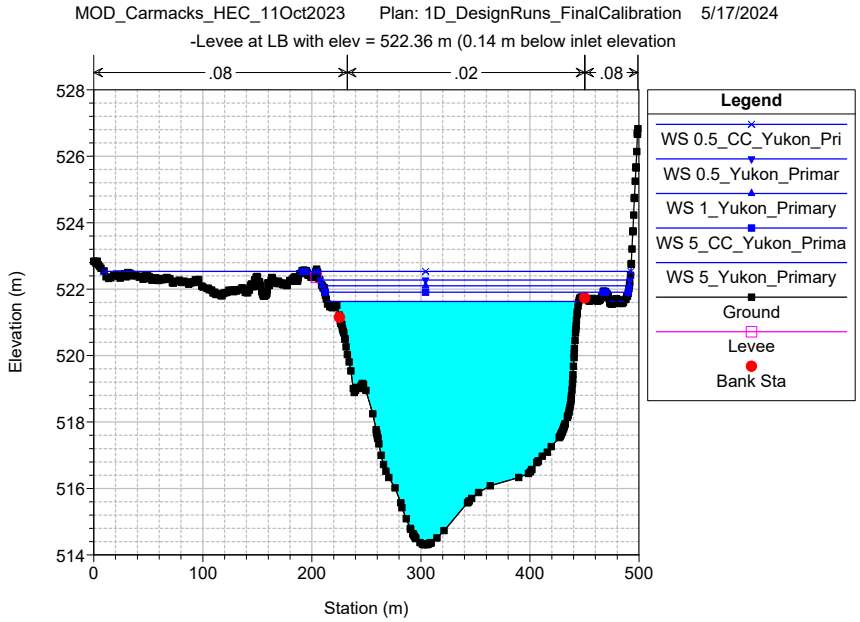

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at RB with elev = 522.3 m (flatwater to adjacent low spot
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

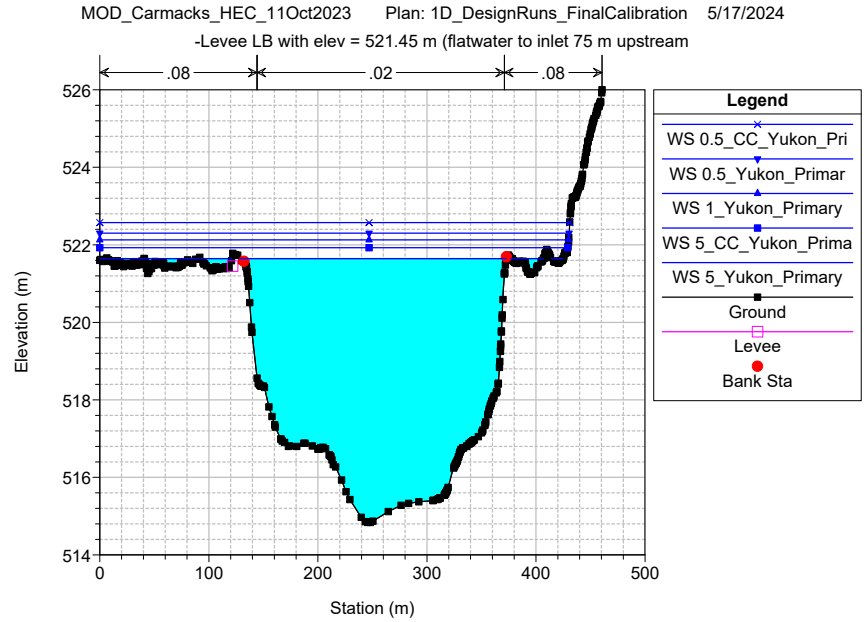

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta

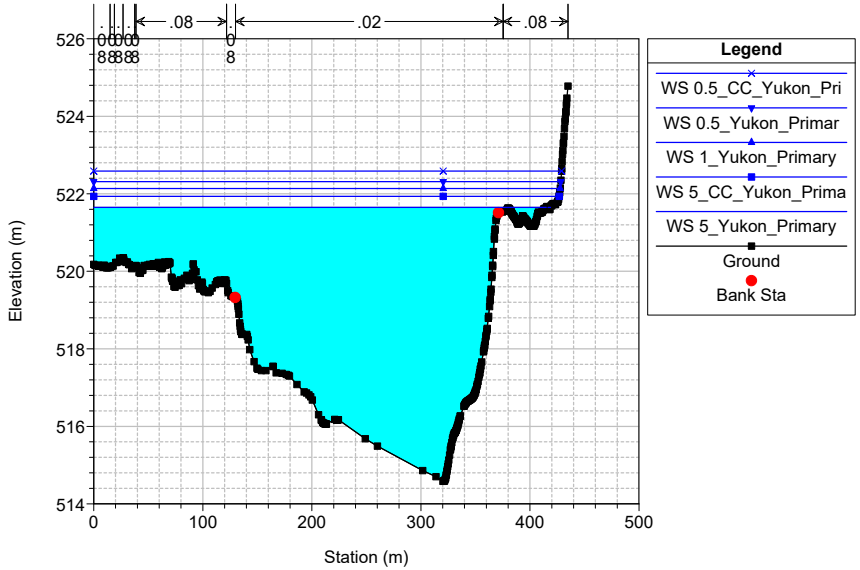

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at LB with elev = 522.3 m (flatwater to upstream low spot
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

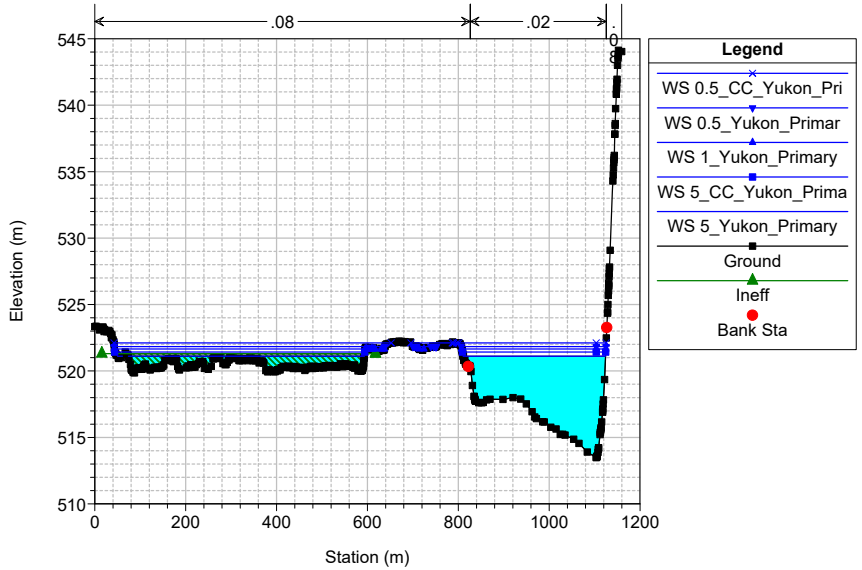

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.02
.08
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta
Elevation (m)
Station (m)

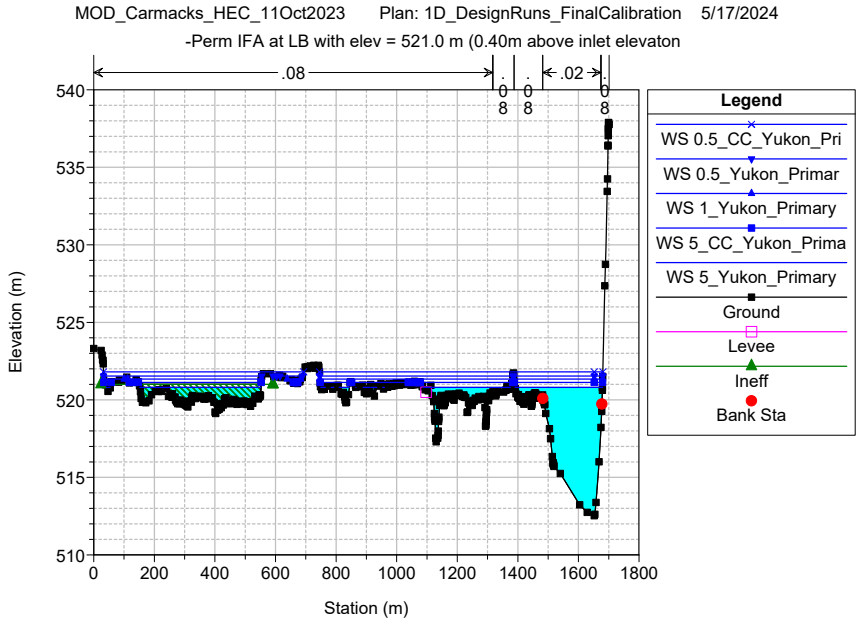

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at LB with elev = 522.4 m (0.10 m below inlet elevation 4
.08
.02
.08
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta
Elevation (m)
Station (m)

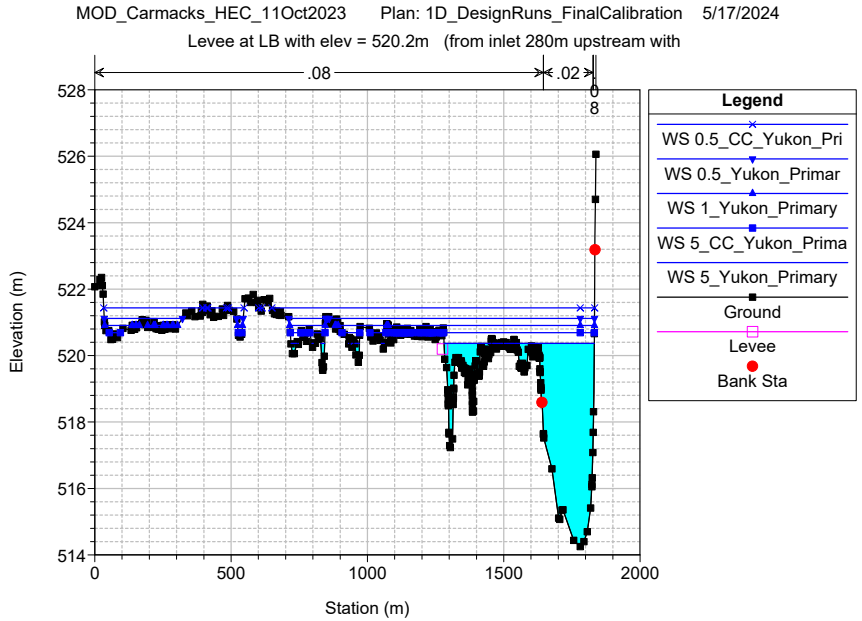

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at LB with elev = 522.36 m (0.14 m below inlet elevation
.08
.02
.08
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta
Elevation (m)
Station (m)

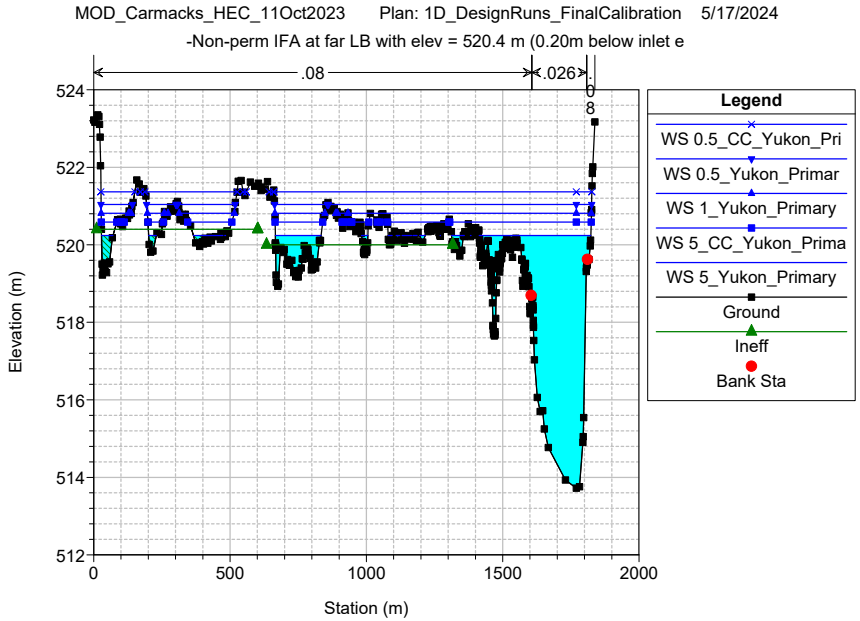

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee LB with elev = 521.45 m (flatwater to inlet 75 m upstream
.08
.02
.08
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta
Elevation (m)
Station (m)

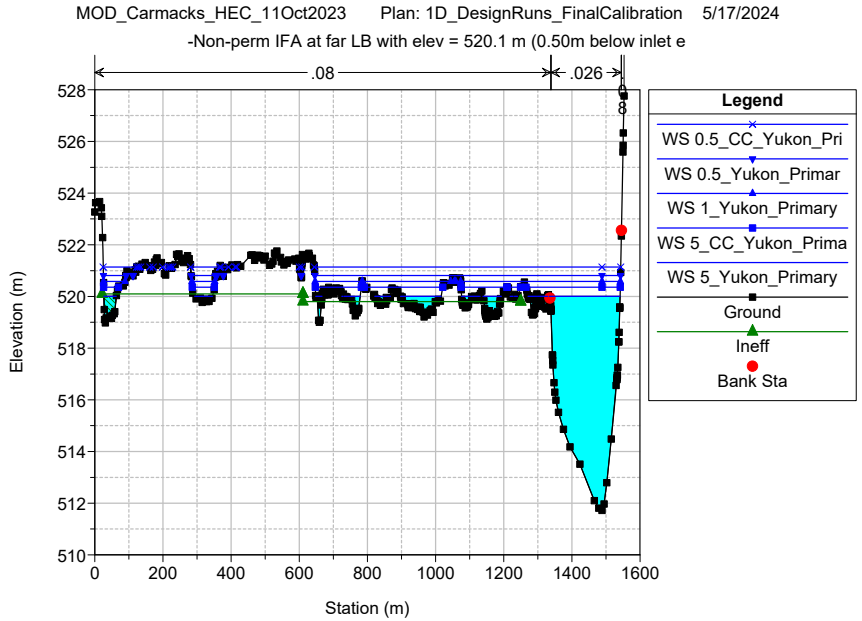

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta

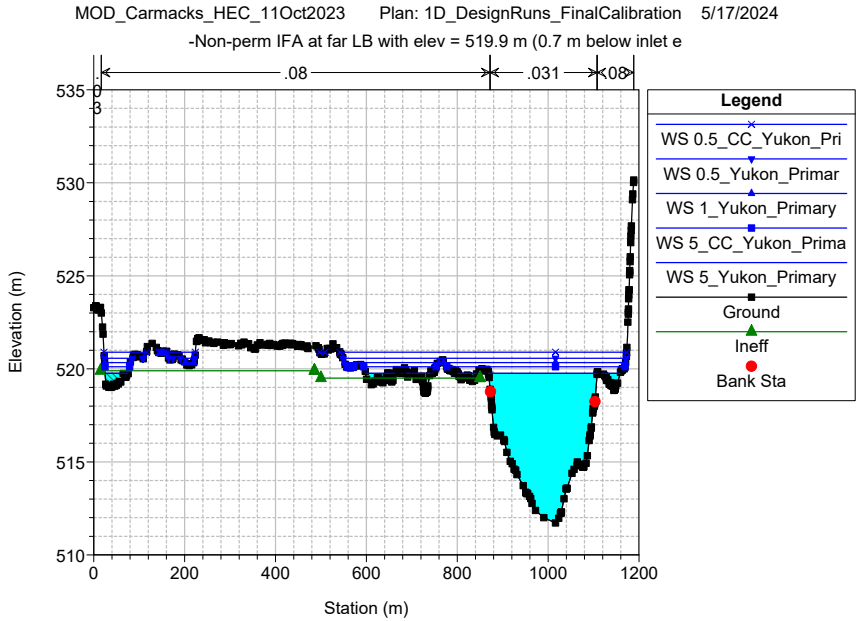

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at LB with elev = 521.3 m (0.70m above inlet elevaton
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

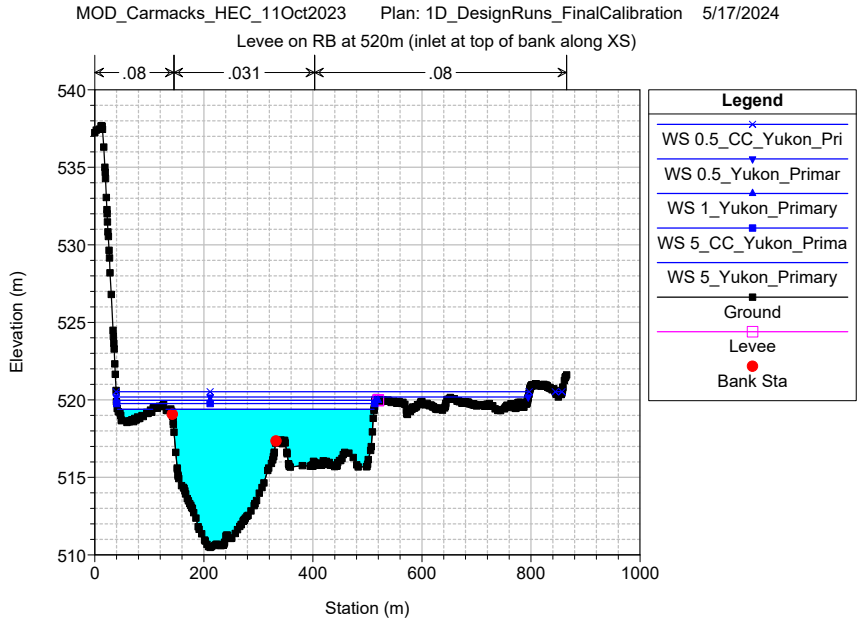

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Perm IFA at LB with elev = 521.0 m (0.40m above inlet elevaton
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

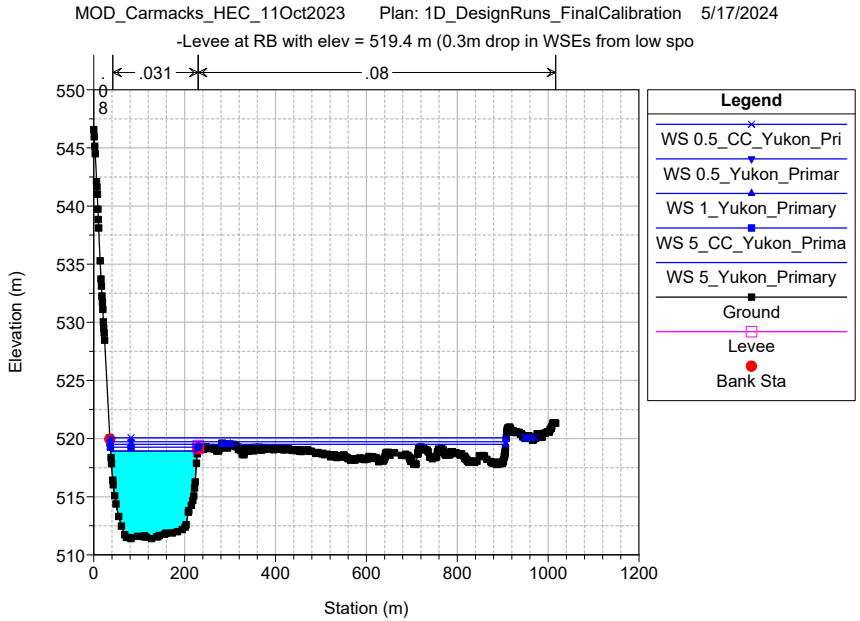

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
Levee at LB with elev = 520.2m (from inlet 280m upstream with
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

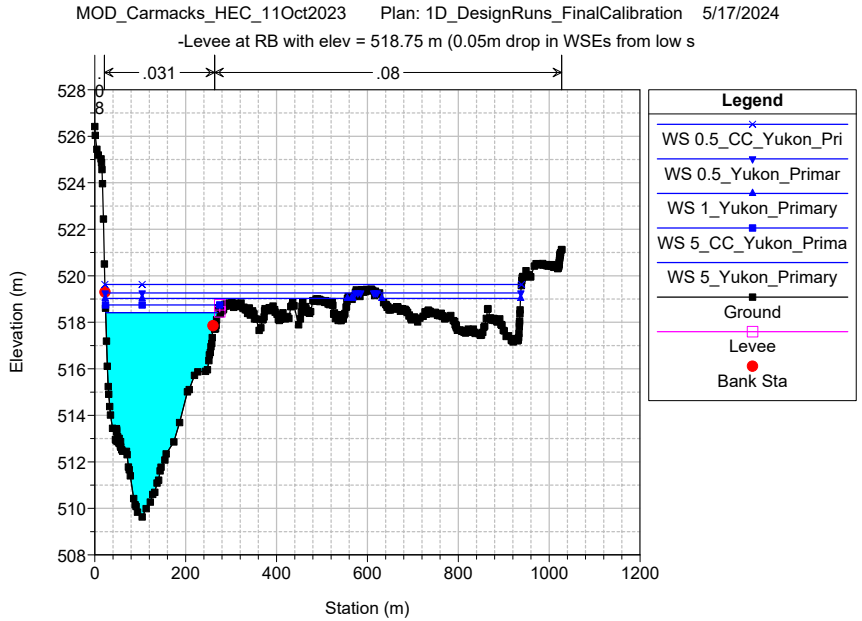

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Non-perm IFA at far LB with elev = 520.4 m (0.20m below inlet e
.08
.026
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

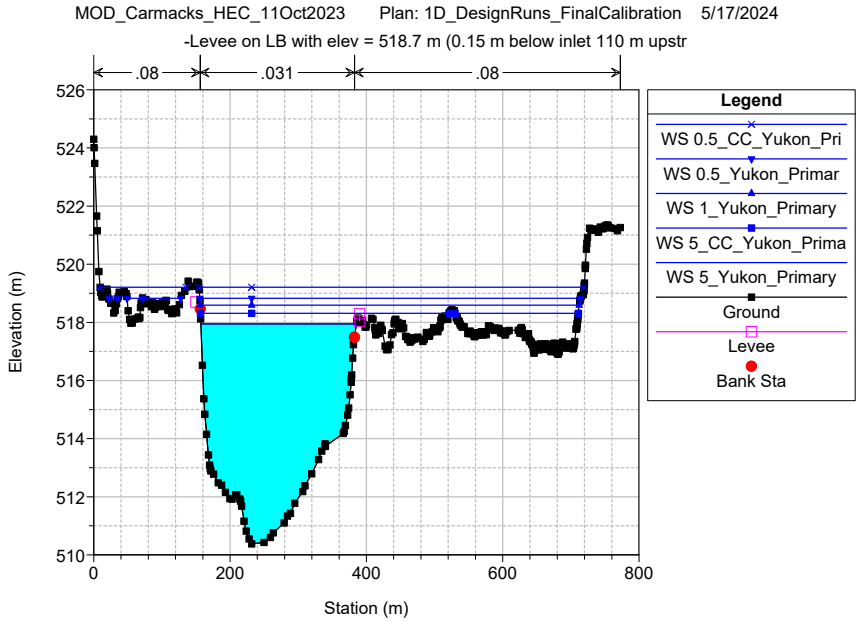

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Non-perm IFA at far LB with elev = 520.1 m (0.50m below inlet e
.08
.026
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

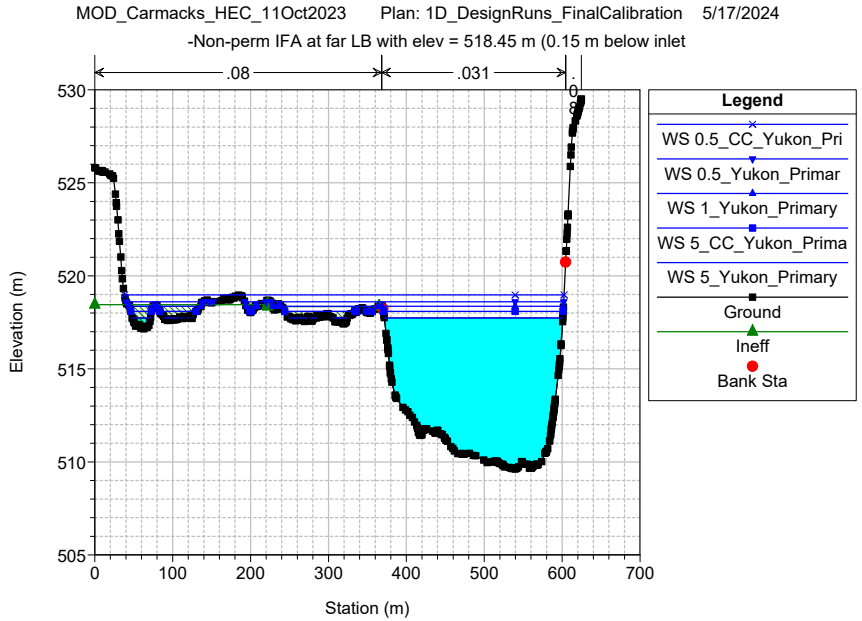

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Non-perm IFA at far LB with elev = 519.9 m (0.7 m below inlet e
.08
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta

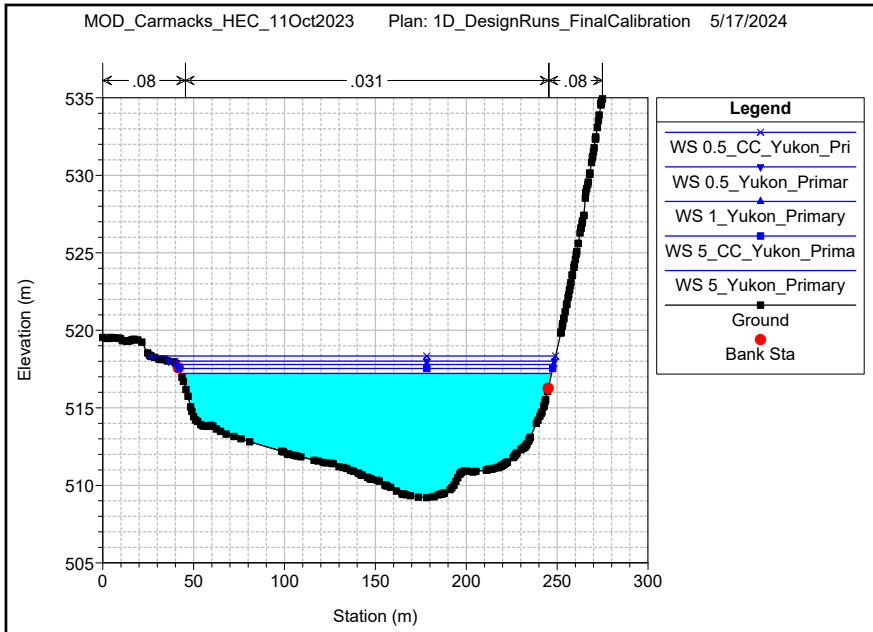

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
Levee on RB at 520m (inlet at top of bank along XS)
.08
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

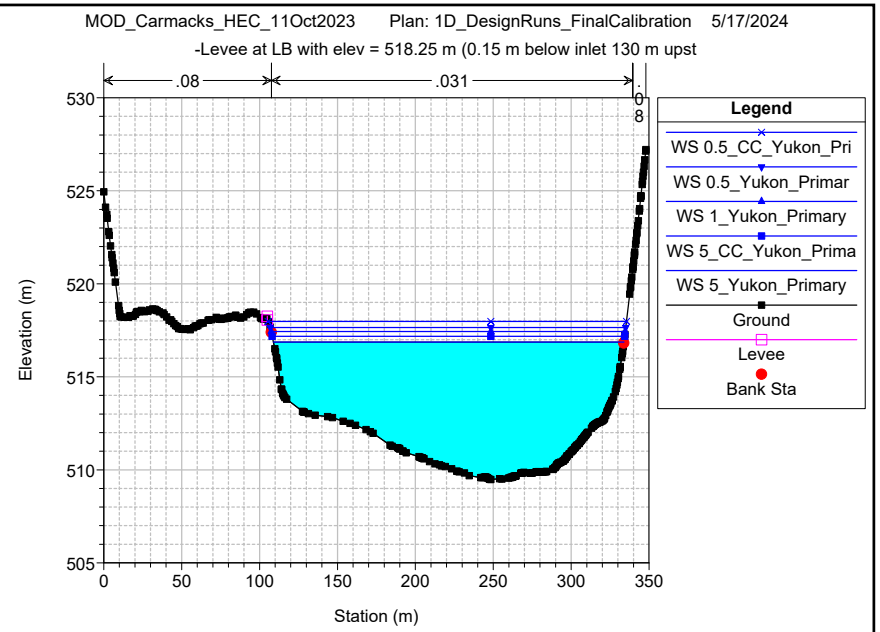

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at RB with elev = 519.4 m (0.3m drop in WSEs from low spo
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

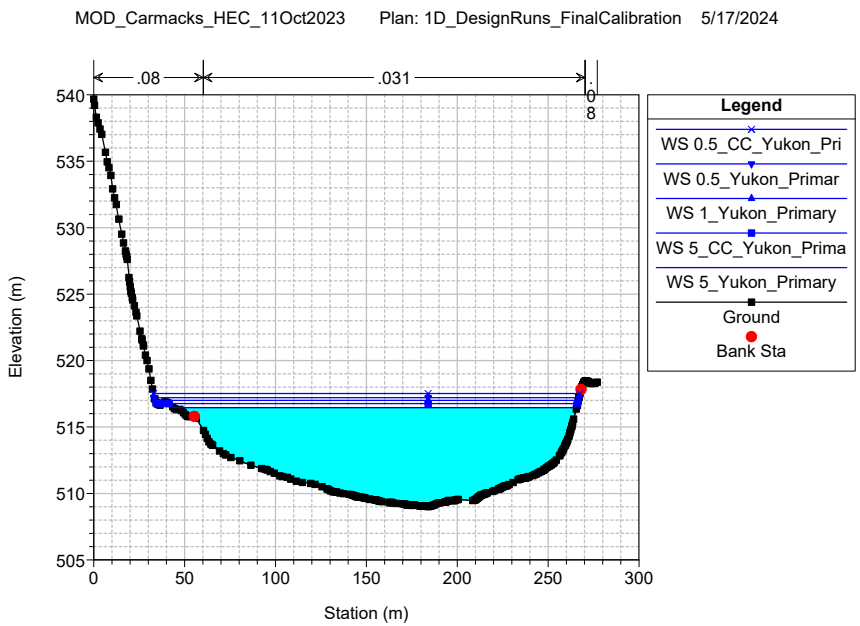

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at RB with elev = 518.75 m (0.05m drop in WSEs from low s
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta

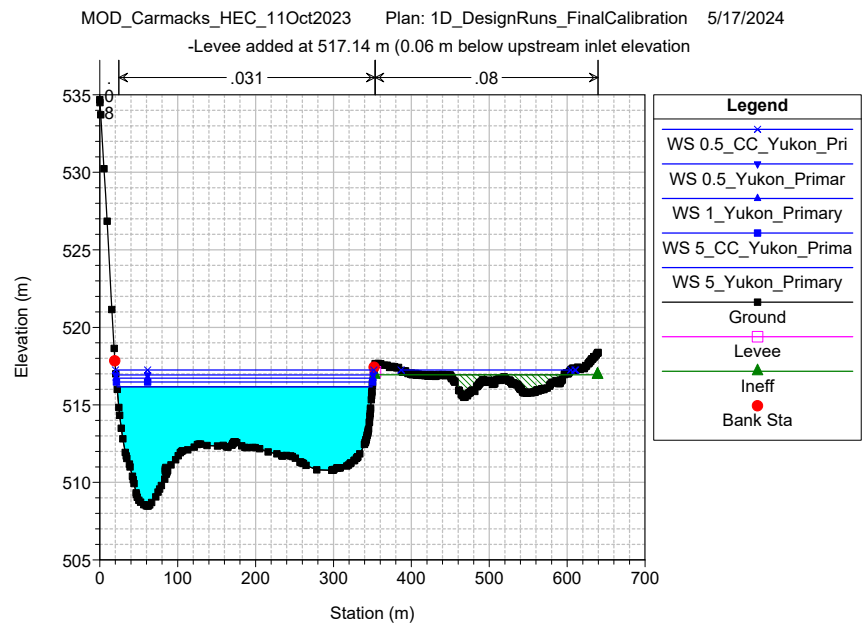

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee on LB with elev = 518.7 m (0.15 m below inlet 110 m upstr
.08
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Non-perm IFA at far LB with elev = 518.45 m (0.15 m below inlet
.08
.031
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta

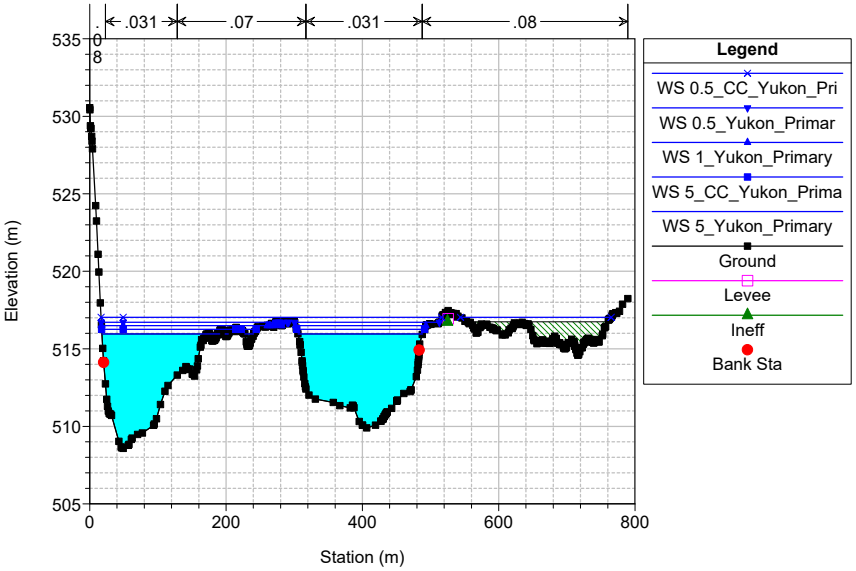

MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee at LB with elev = 518.25 m (0.15 m below inlet 130 m upst
.08
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
.08
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024
-Levee added at 517.14 m (0.06 m below upstream inlet elevation
.031
.08
Elevation (m)
Station (m)
Legend
WS 0.5_CC_Yukon_Pri
WS 0.5_Yukon_Primar
WS 1_Yukon_Primary
WS 5_CC_Yukon_Prima
WS 5_Yukon_Primary
Ground
Levee
Ineff
Bank Sta

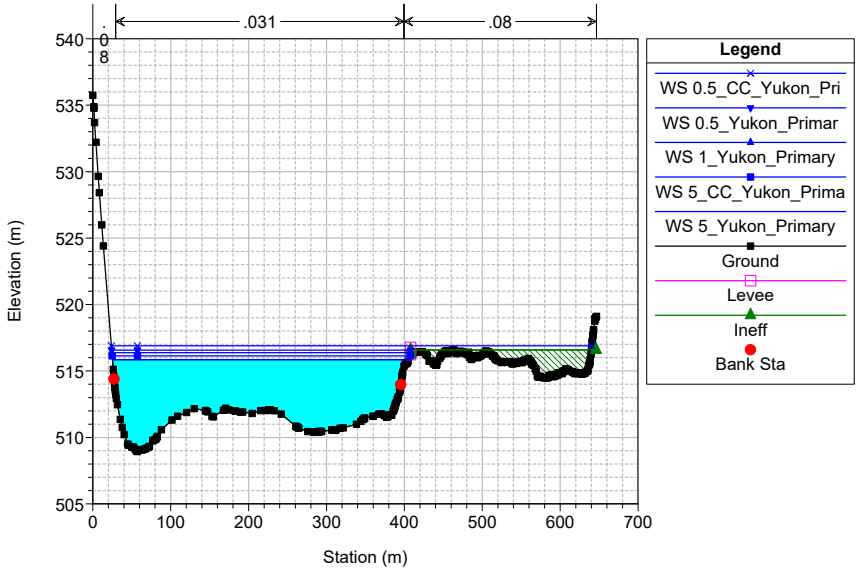
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

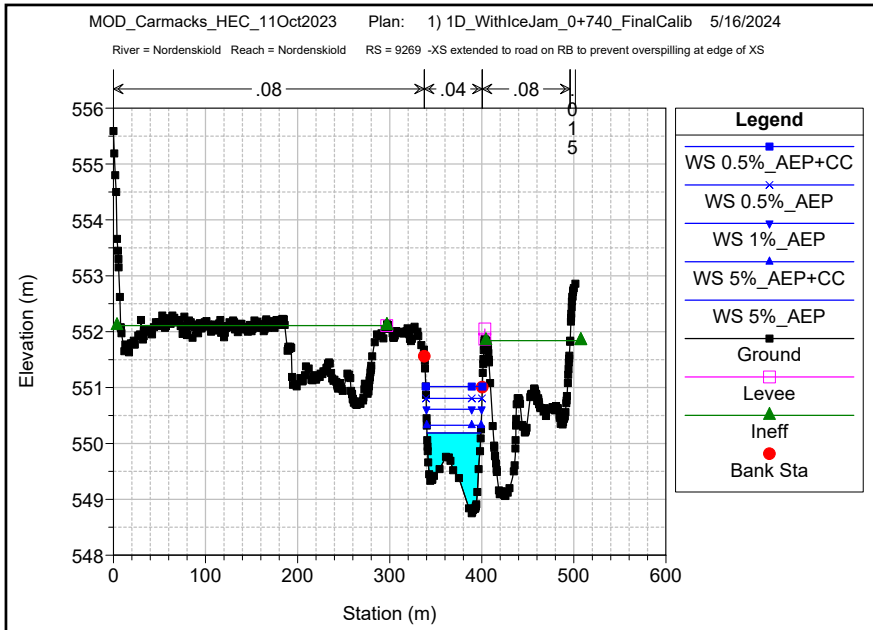
-Levee added at 516.94 m (0.26 m below upstream inlet elevation

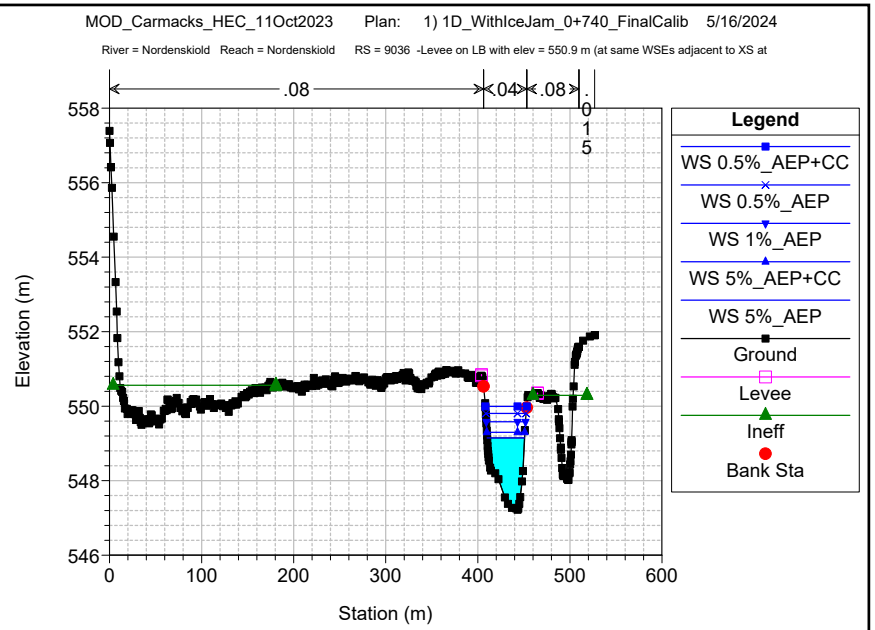


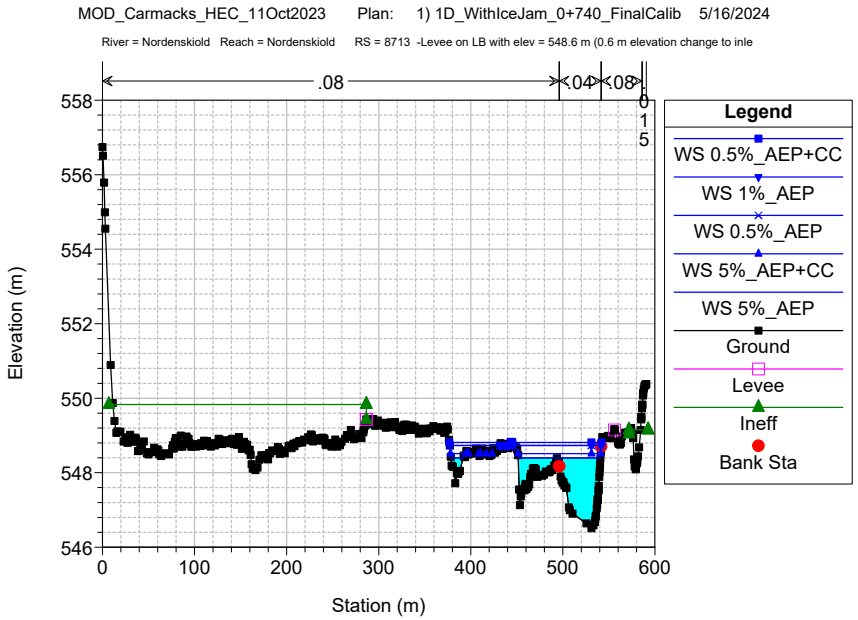
MOD_Carmacks_HEC_11Oct2023 Plan: 1D_DesignRuns_FinalCalibration 5/17/2024

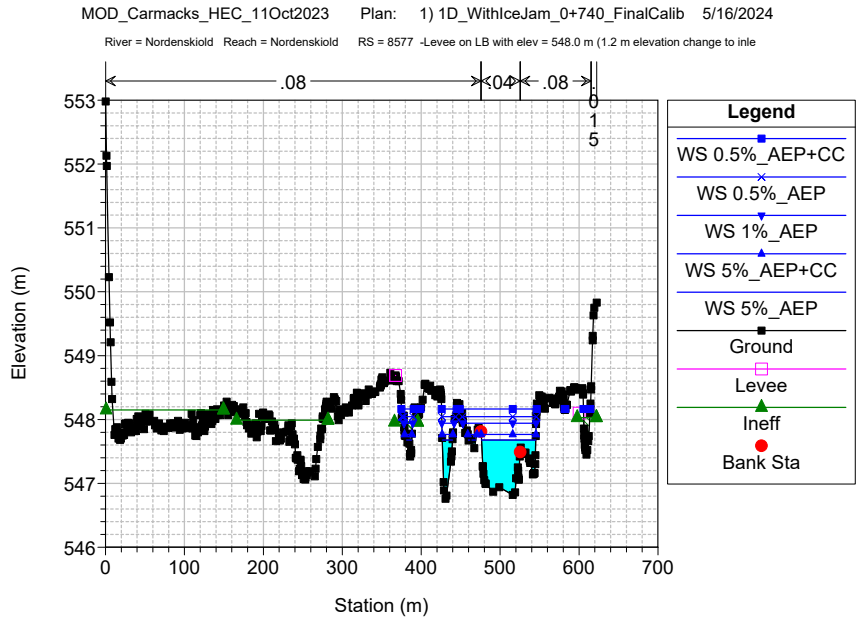
-Levee added at 516.78 m (0.42 m below upstream inlet elevation

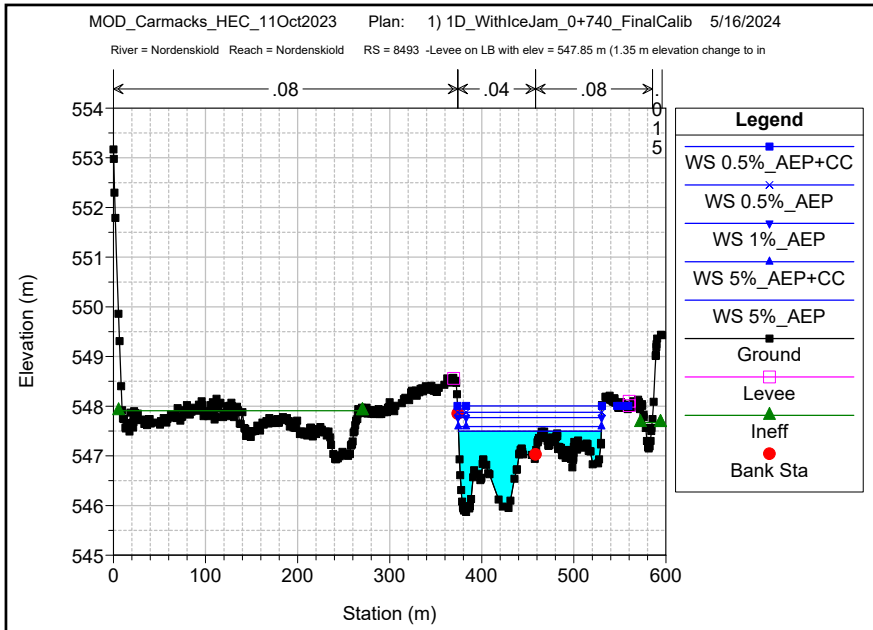


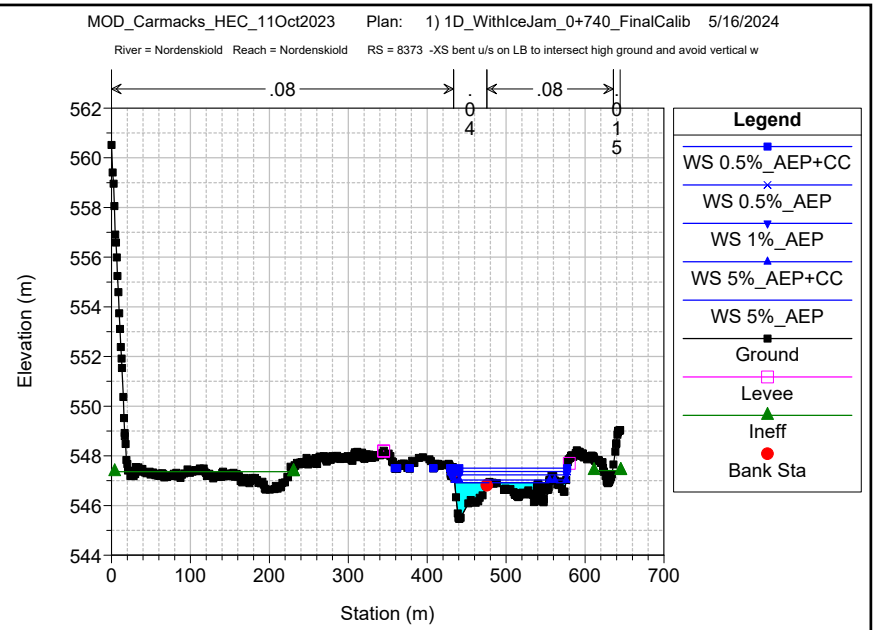

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 9269 -XS extended to road on RB to prevent overspilling at edge of XS
.08
.04
.08
0
1
5
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

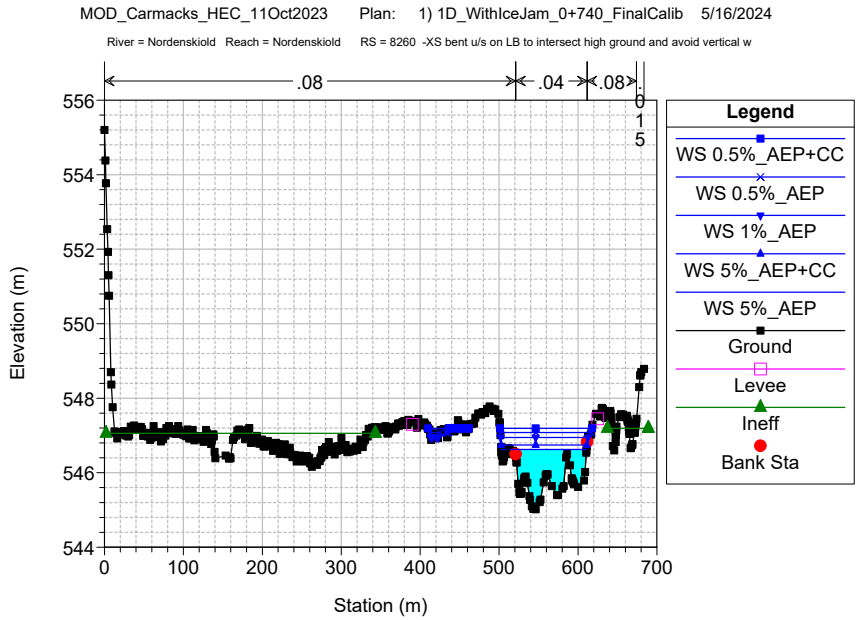

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 9036 -Levee on LB with elev = 550.9 m (at same WSEs adjacent to XS at
.08
.04
.08
0
1
5
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

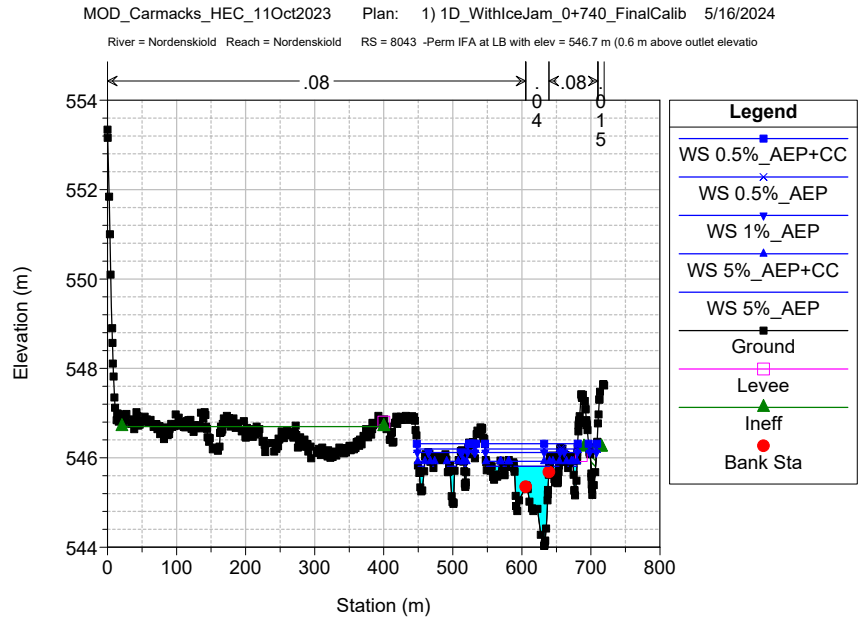

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 8713 -Levee on LB with elev = 548.6 m (0.6 m elevation change to inle
.08
.04
.08
0
1
5
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 1%_AEP
WS 0.5%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 8577 -Levee on LB with elev = 548.0 m (1.2 m elevation change to inle
.08
.04
.08
0
1
5
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 8493 -Levee on LB with elev = 547.85 m (1.35 m elevation change to in
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

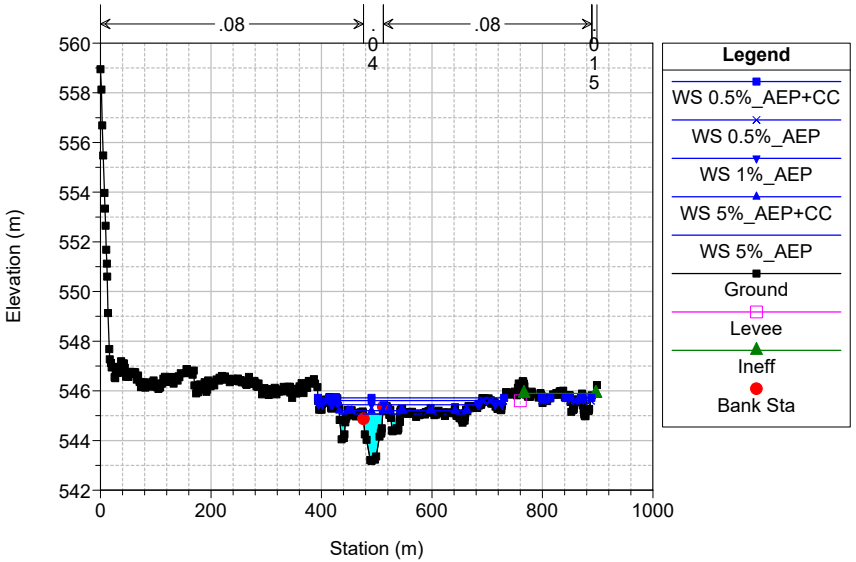

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 8373 -XS bent u/s on LB to intersect high ground and avoid vertical w
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 8260 -XS bent u/s on LB to intersect high ground and avoid vertical w
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 8043 -Perm IFA at LB with elev = 546.7 m (0.6 m above outlet elevatio
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

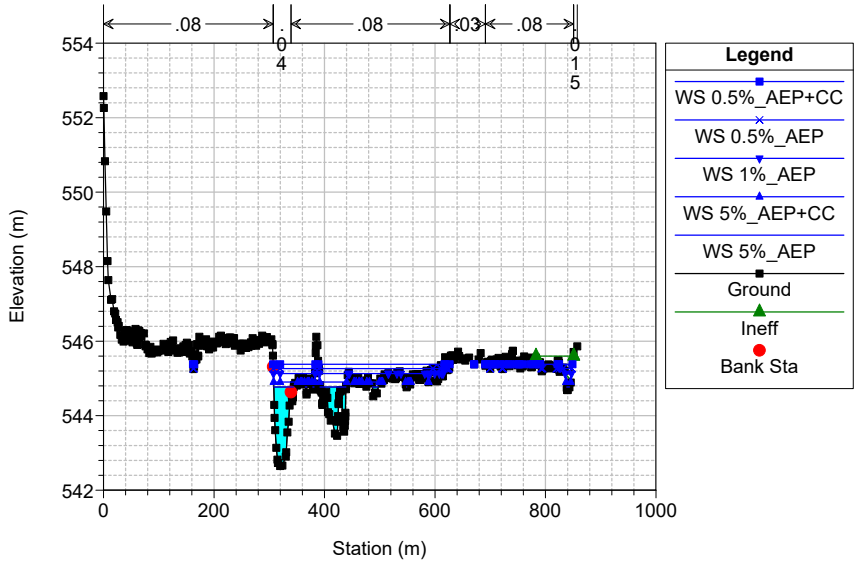
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

River = Nordenskiold Reach = Nordenskiold RS = 7874 -Levee on RB with elev = 545.6m (adjacent to XS)



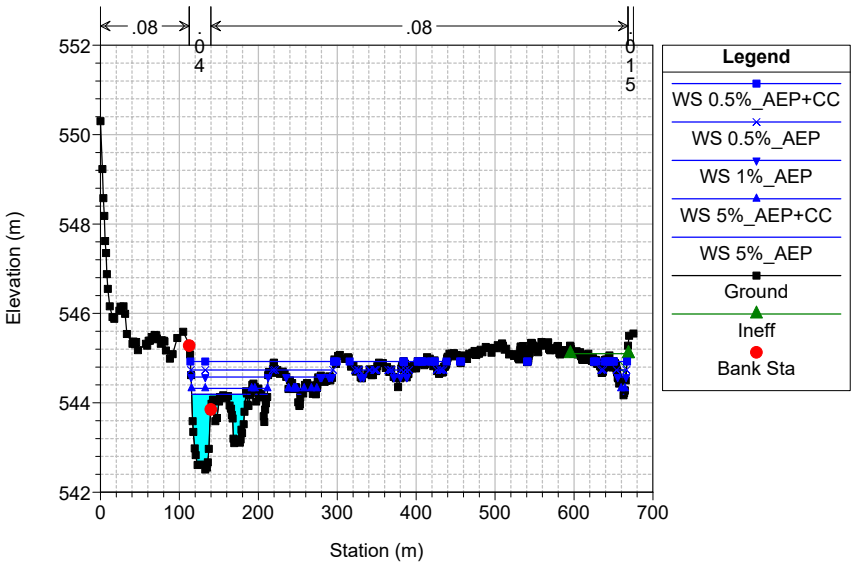
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

River = Nordenskiold Reach = Nordenskiold RS = 7758 -Perm IFA on RB ditch, elev=545.6m from grade control 200 m down



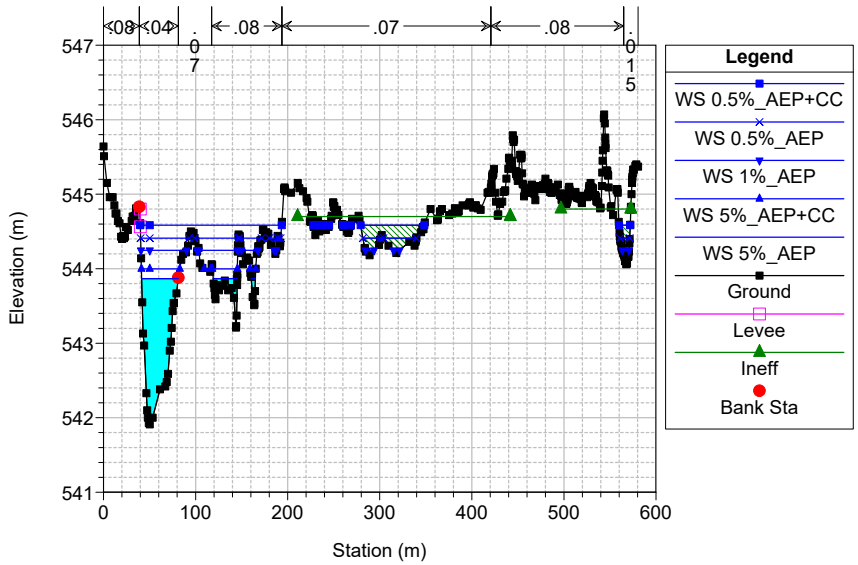
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

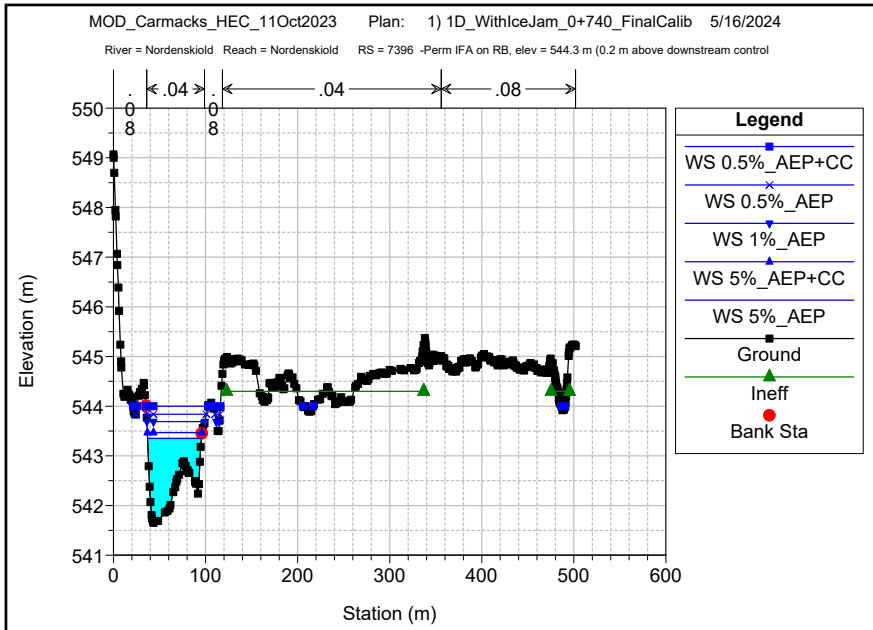
River = Nordenskiold Reach = Nordenskiold RS = 7630 -Perm IFA on RB ditch, elev=545.1m from grade control 150 m down

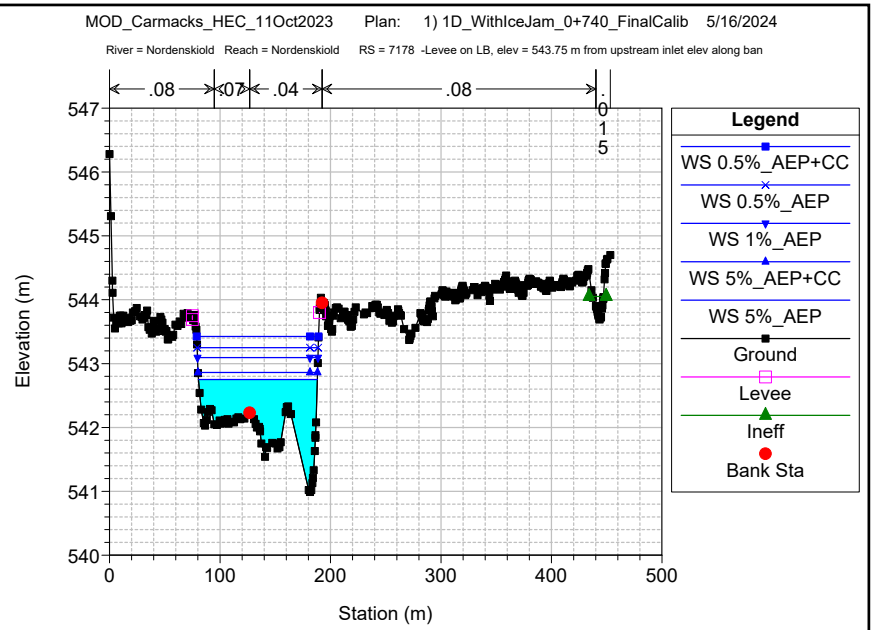


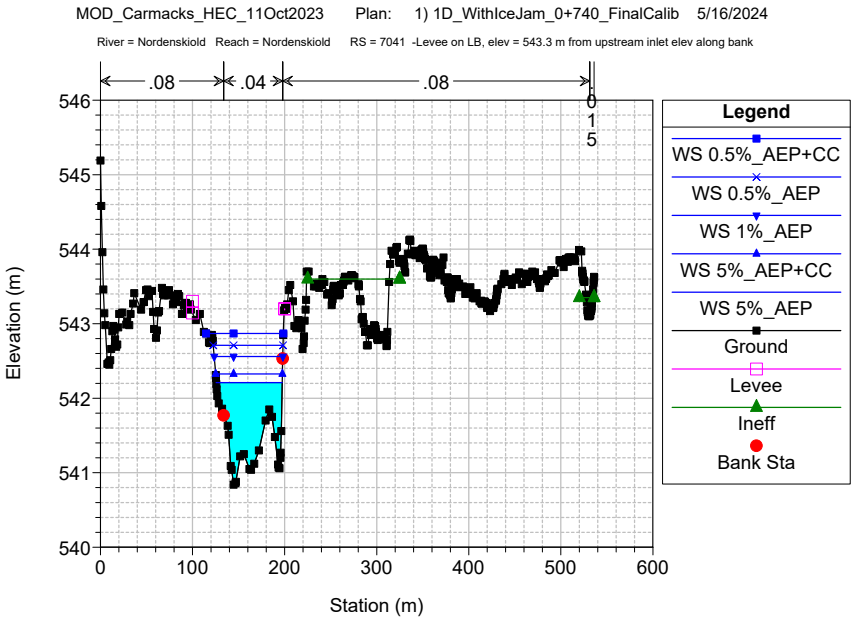
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

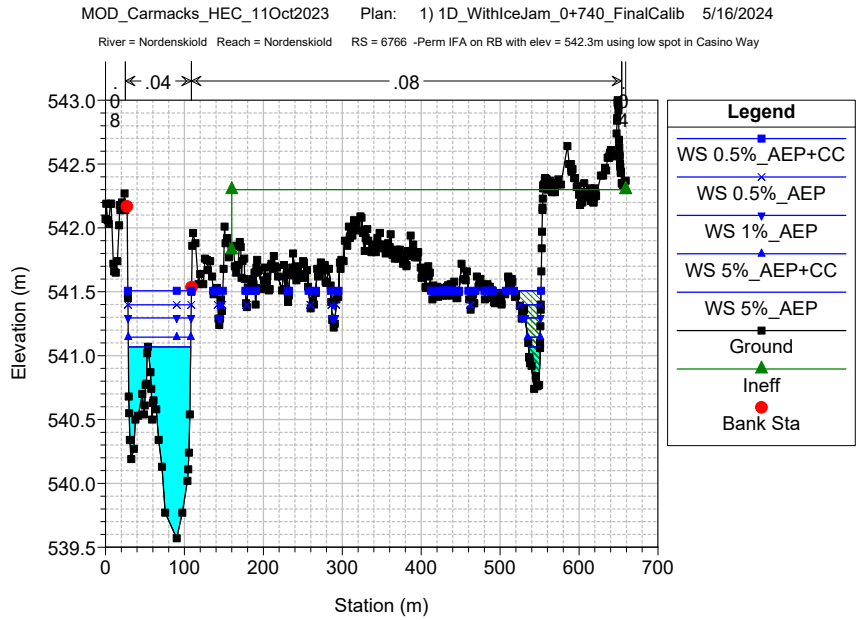
River = Nordenskiold Reach = Nordenskiold RS = 7551 -Levee on LB, elev = 544.8 m from upstream inlet elev at inlet 4

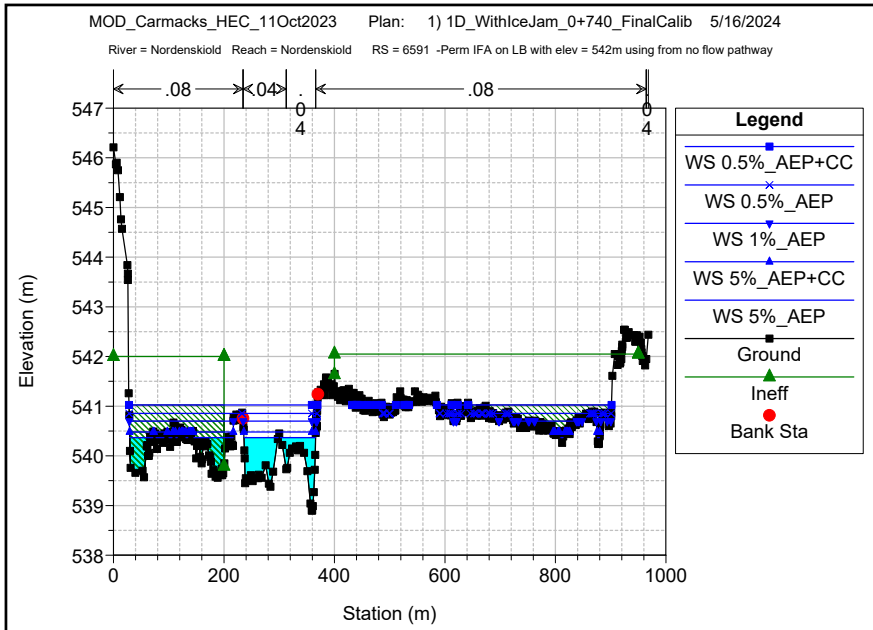


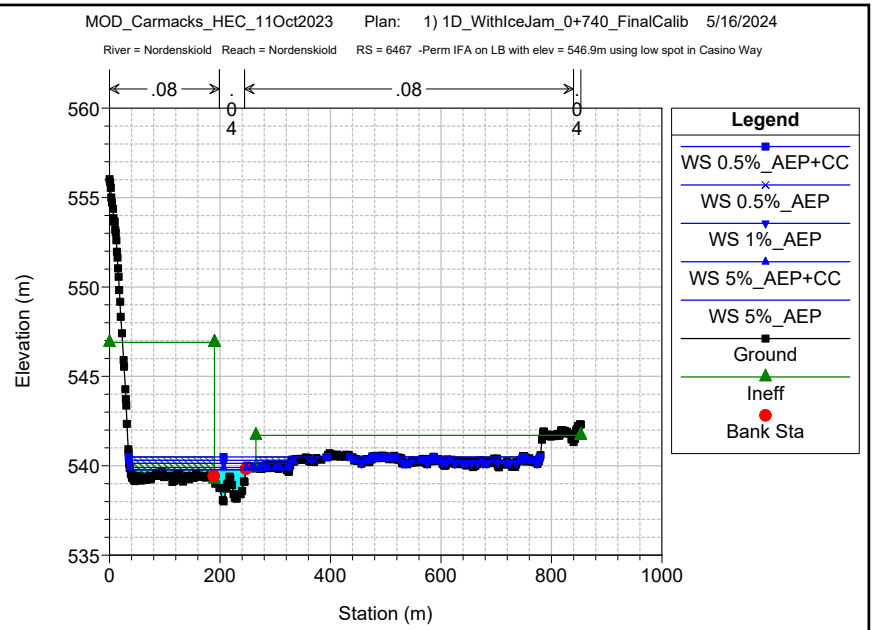

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 7396 -Perm IFA on RB, elev = 544.3 m (0.2 m above downstream control
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

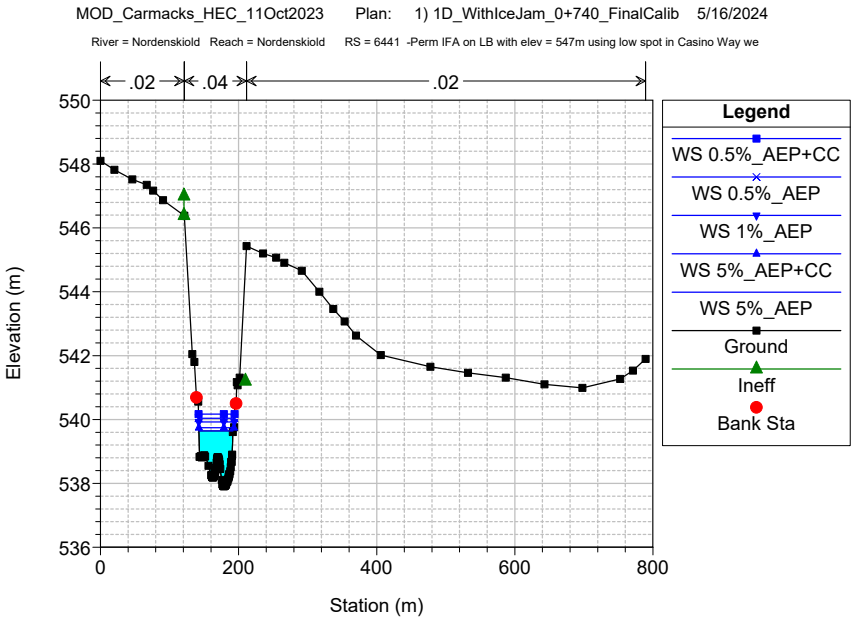

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 7178 -Levee on LB, elev = 543.75 m from upstream inlet elev along ban
.08
.07
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

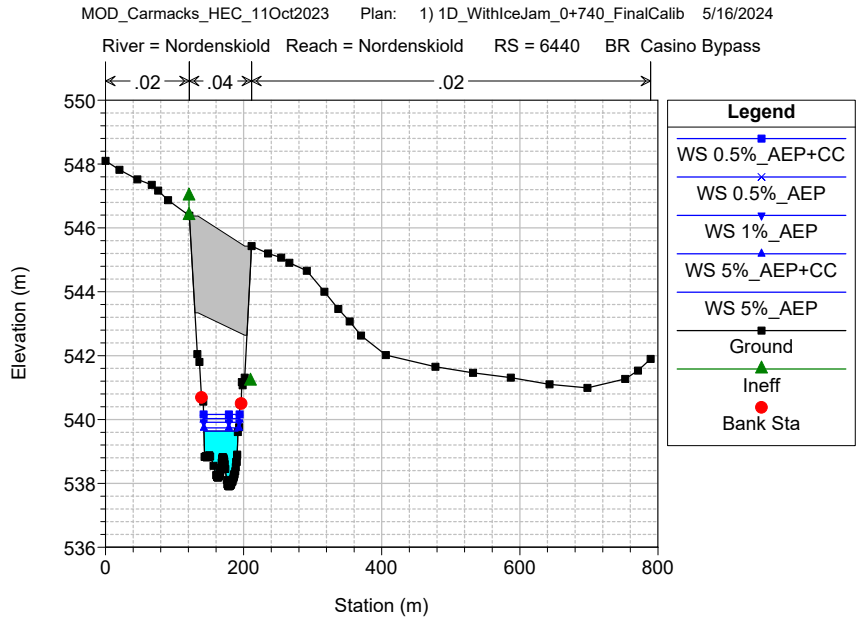

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 7041 -Levee on LB, elev = 543.3 m from upstream inlet elev along bank
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

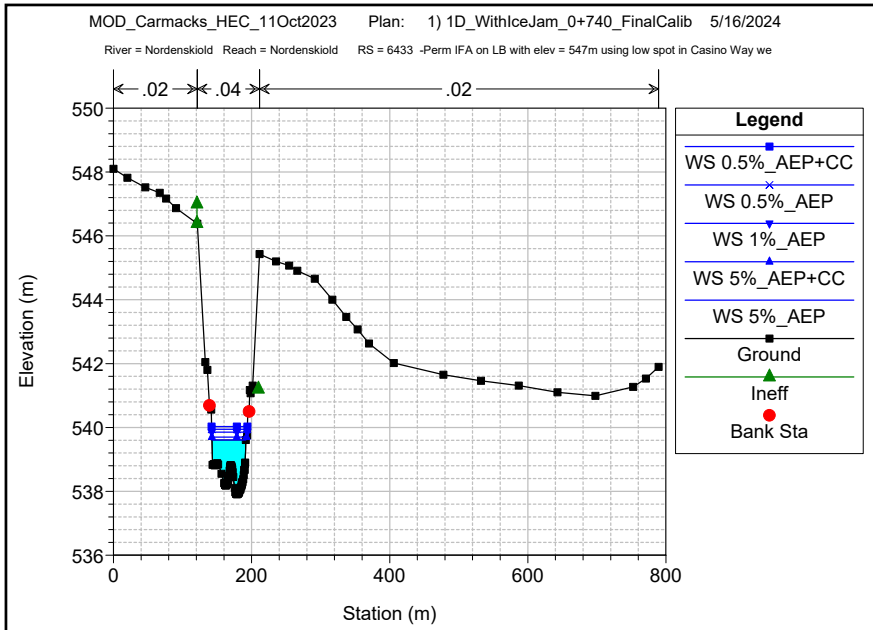

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6766 -Perm IFA on RB with elev = 542.3m using low spot in Casino Way
.04
.08
.08
.04
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

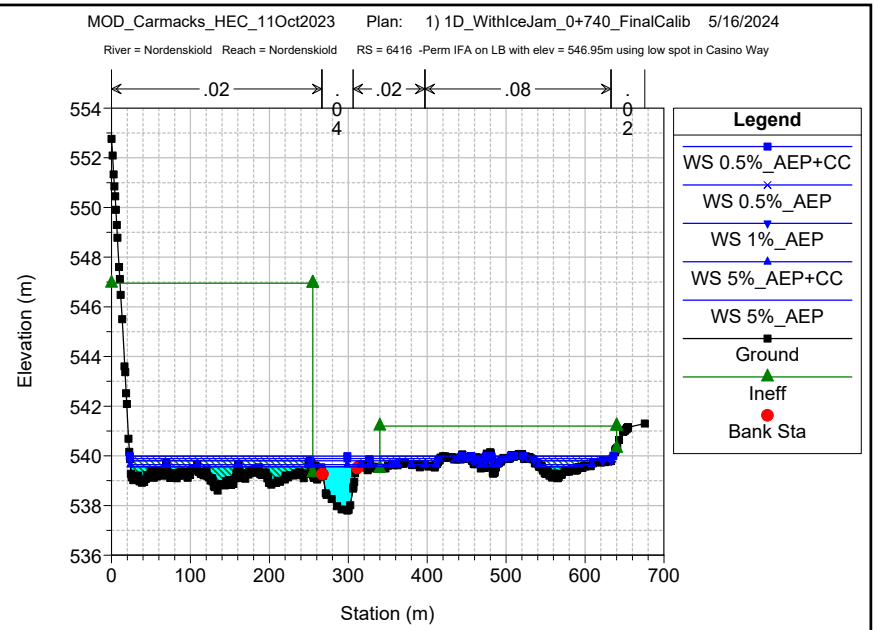

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6591 -Perm IFA on LB with elev = 542m using from no flow pathway
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

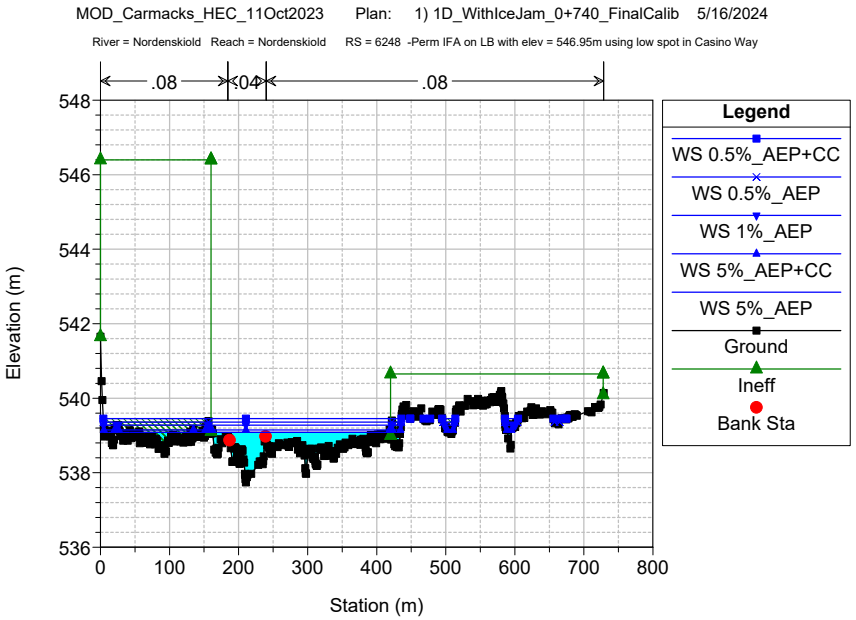

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6467 -Perm IFA on LB with elev = 546.9m using low spot in Casino Way
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

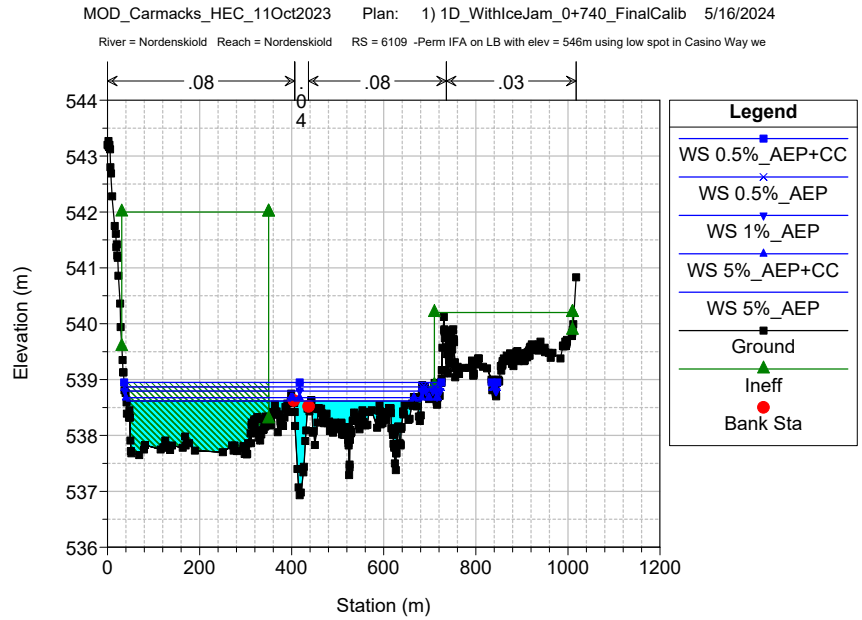

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6441 -Perm IFA on LB with elev = 547m using low spot in Casino Way we
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

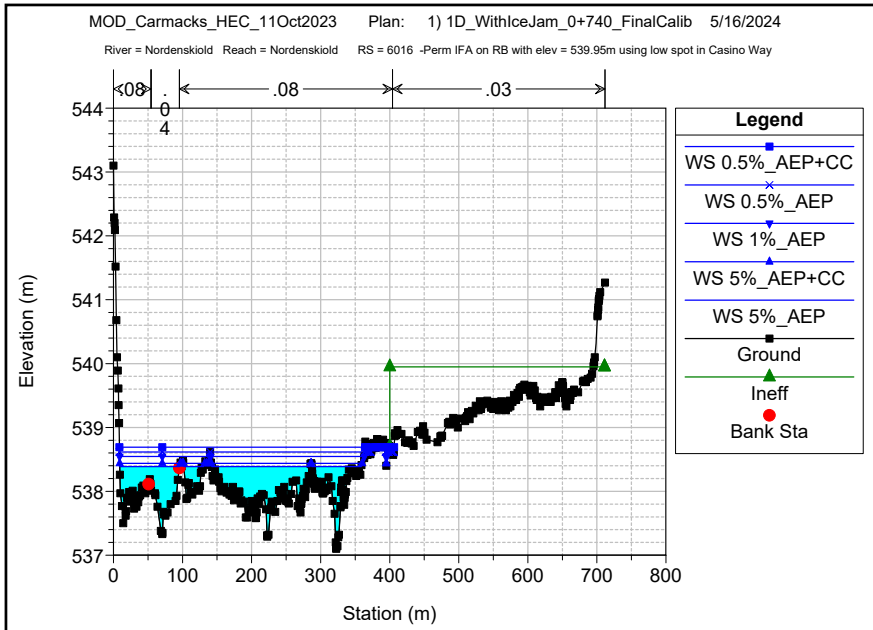

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6440 BR Casino Bypass
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

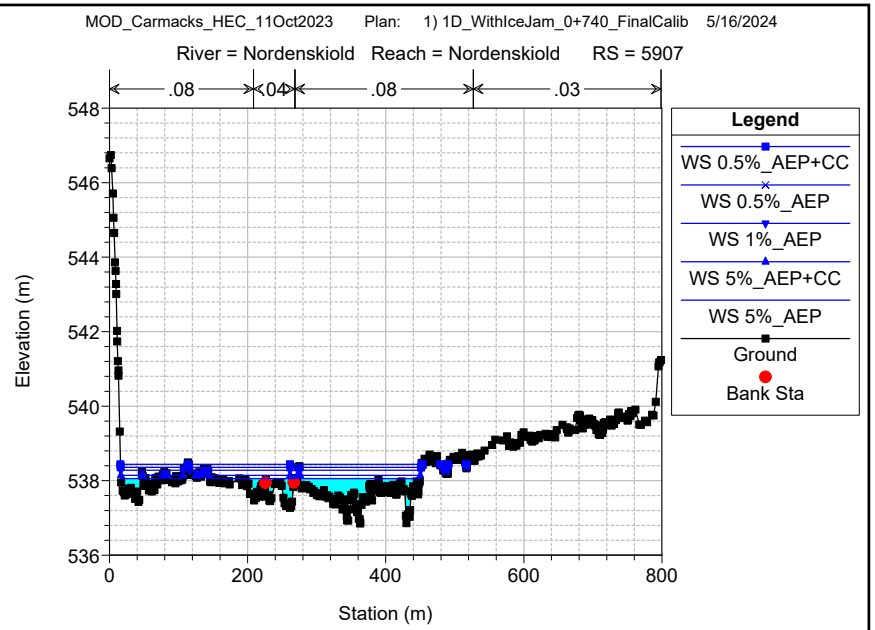

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6433 -Perm IFA on LB with elev = 547m using low spot in Casino Way we
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

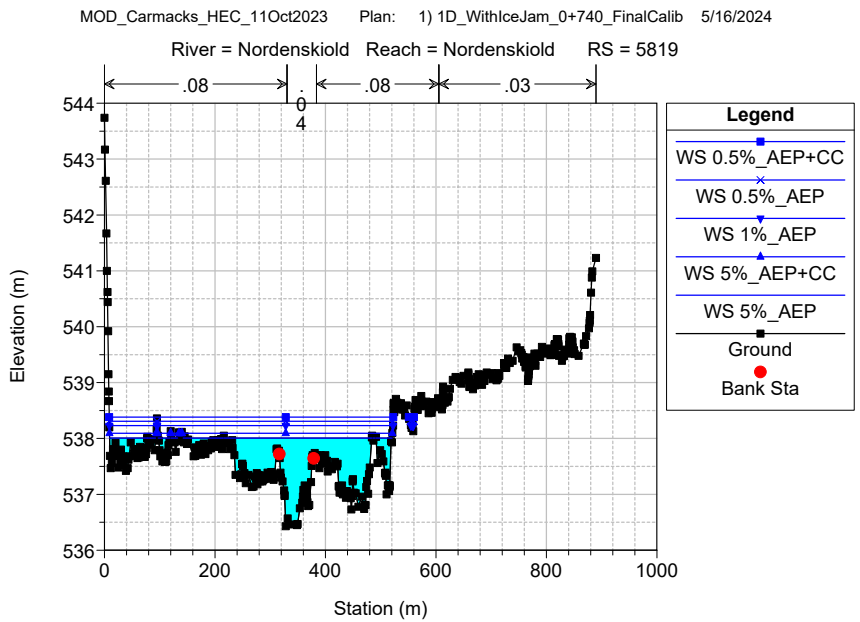

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6416 -Perm IFA on LB with elev = 546.95m using low spot in Casino Way
.02
.04
.02
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

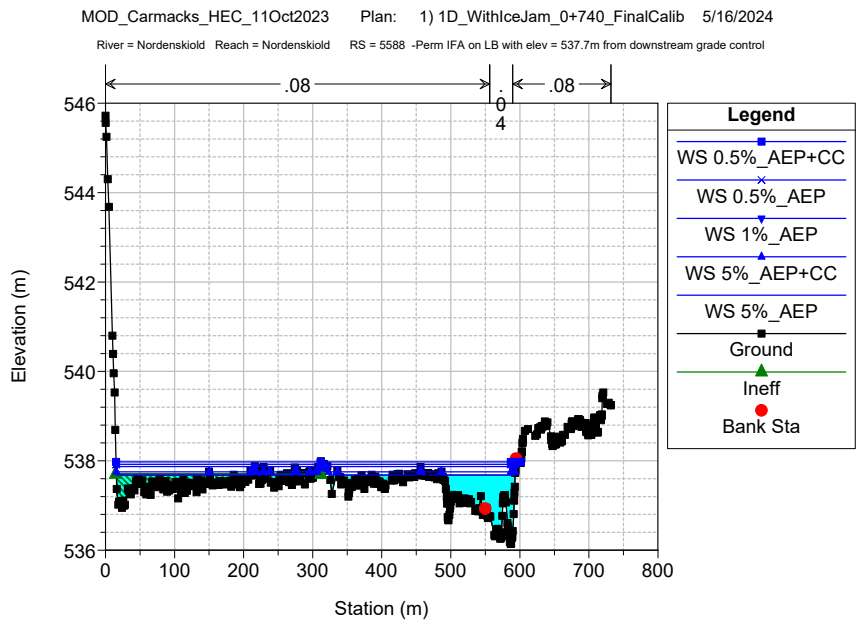

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6248 -Perm IFA on LB with elev = 546.95m using low spot in Casino Way
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

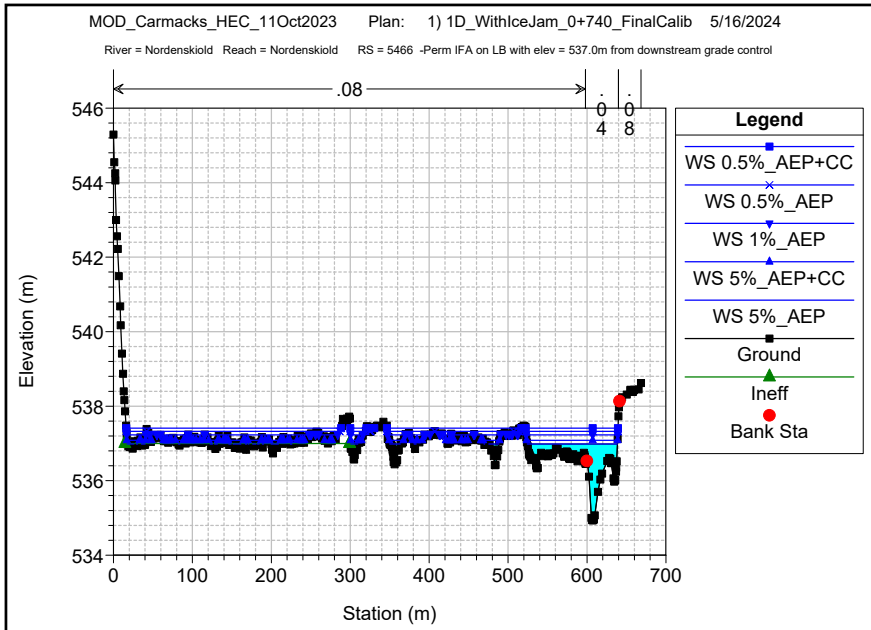

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6109 -Perm IFA on LB with elev = 546m using low spot in Casino Way we
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

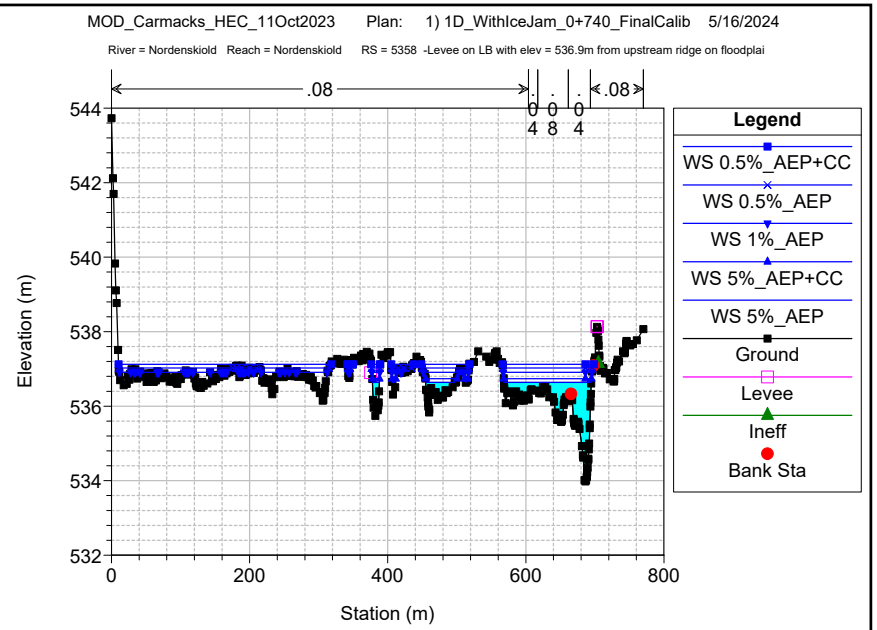

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 6016 -Perm IFA on RB with elev = 539.95m using low spot in Casino Way
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

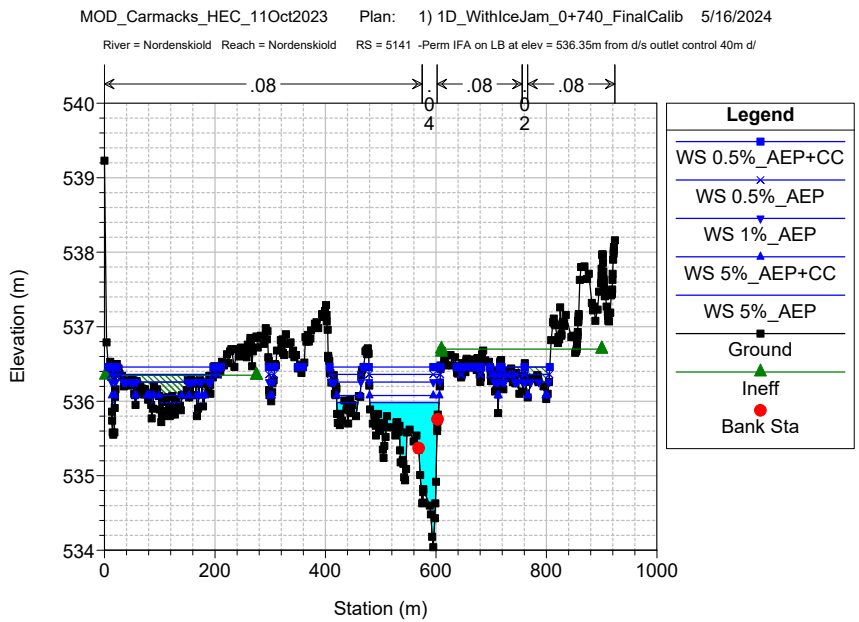

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 5907
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

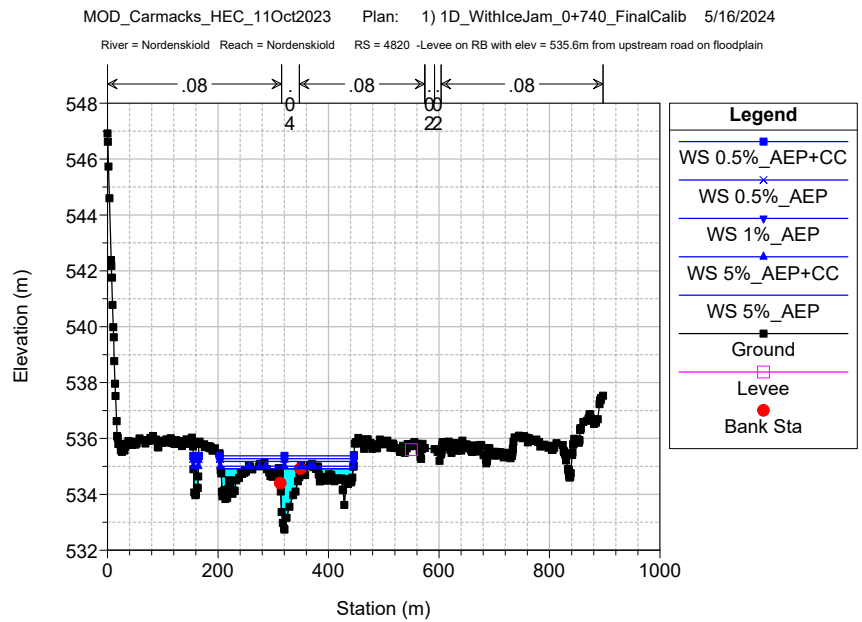

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 5819
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

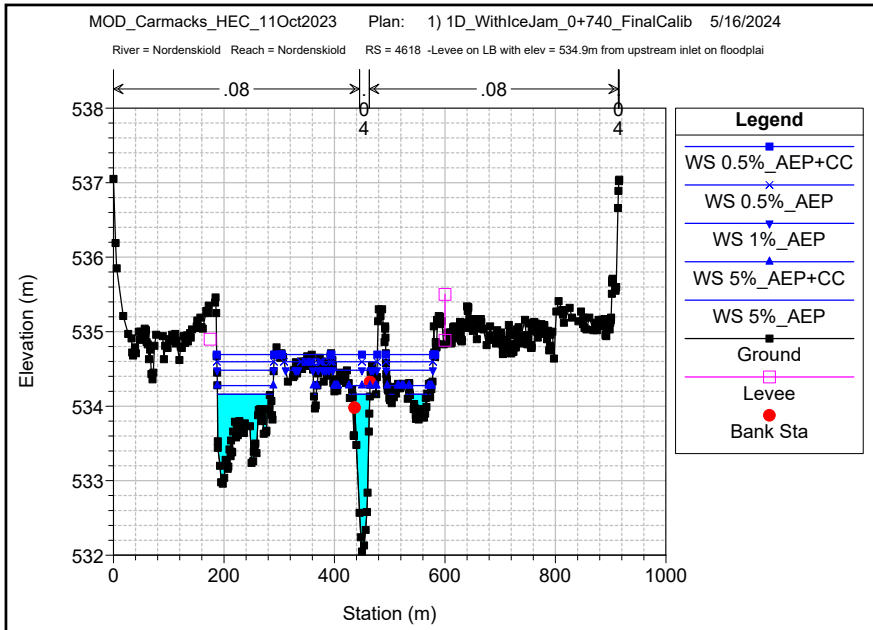

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 5588 -Perm IFA on LB with elev = 537.7m from downstream grade control
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

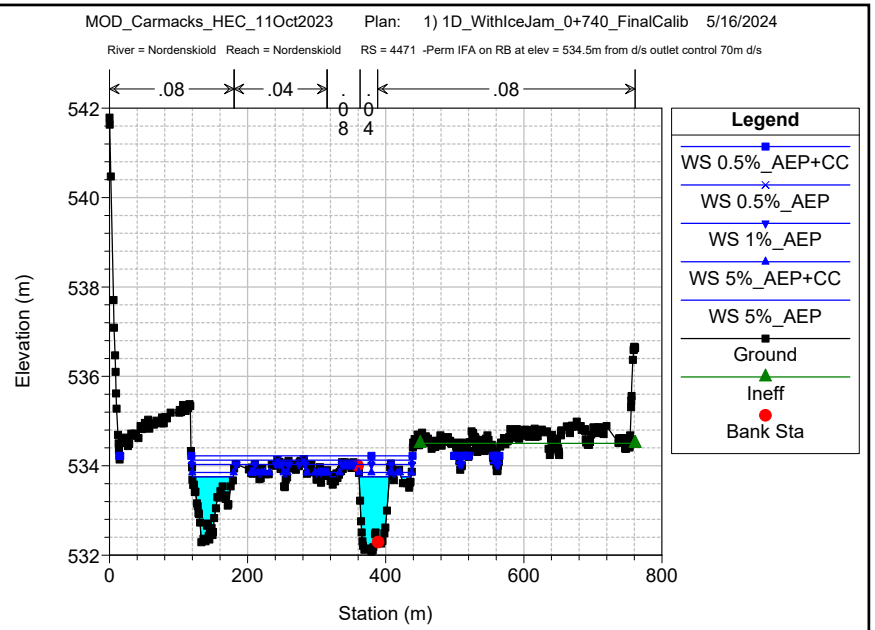

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 5466 -Perm IFA on LB with elev = 537.0m from downstream grade control
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

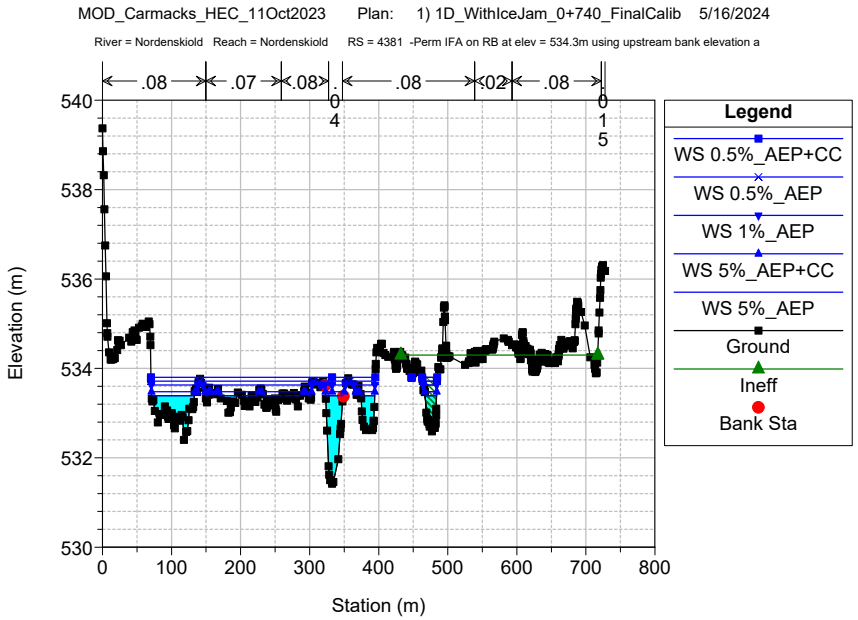

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 5358 -Levee on LB with elev = 536.9m from upstream ridge on floodplai
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

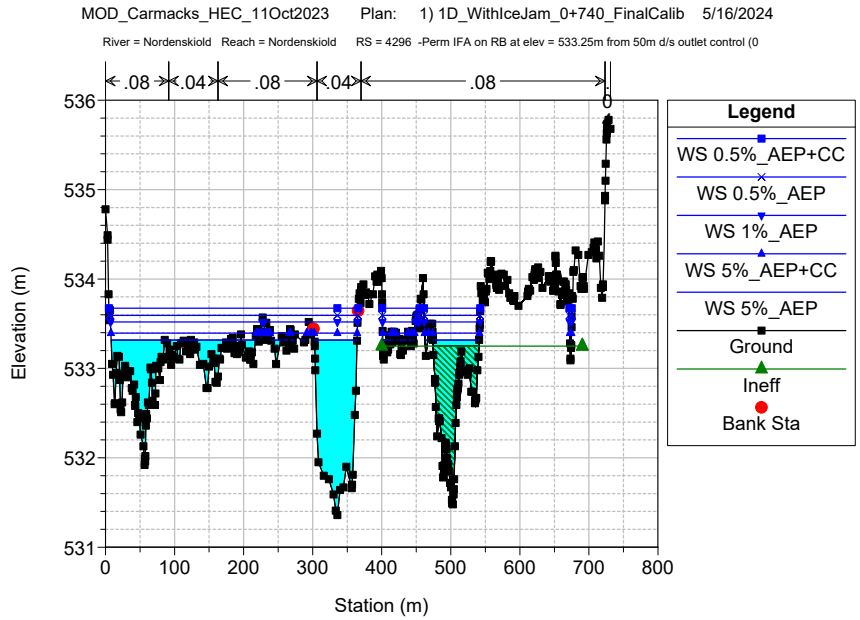

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 5141 -Perm IFA on LB at elev = 536.35m from d/s outlet control 40m d/
.08
.04
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

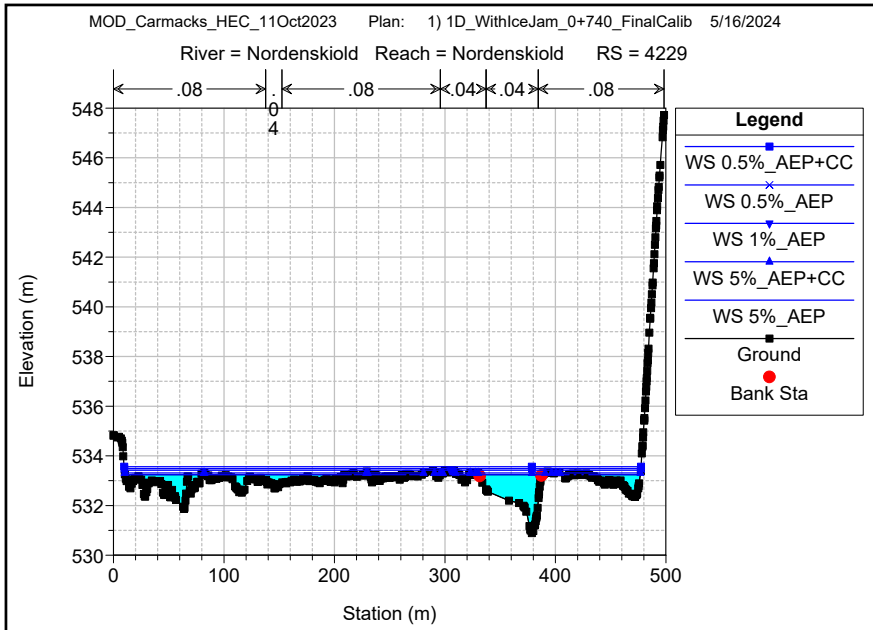

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 4820 -Levee on RB with elev = 535.6m from upstream road on floodplain
.08
.04
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

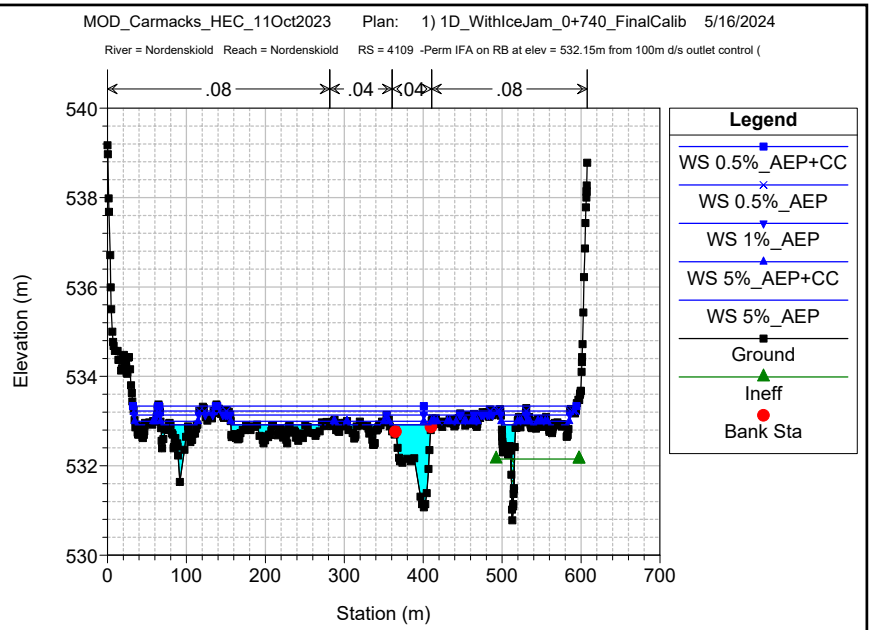

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 4618 -Levee on LB with elev = 534.9m from upstream inlet on floodplai
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

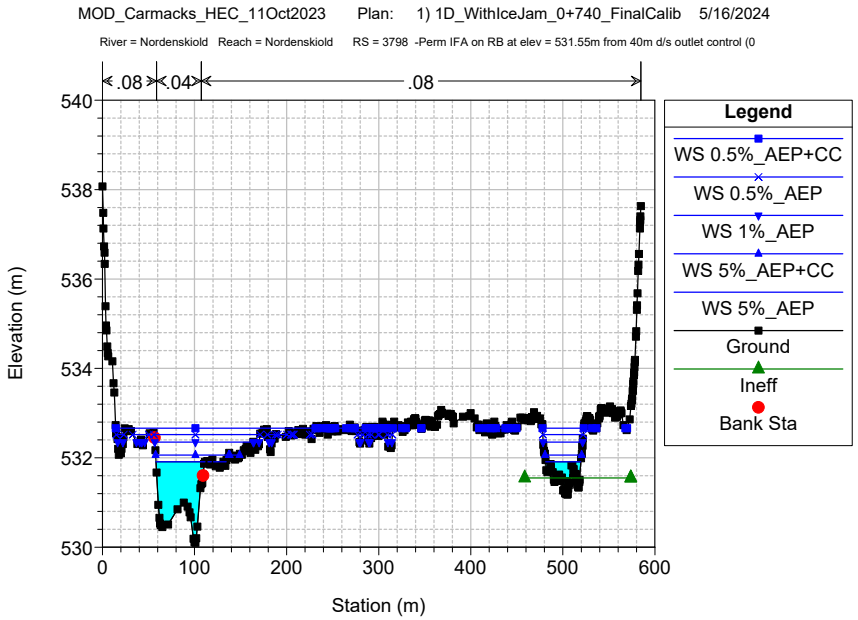

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 4471 -Perm IFA on RB at elev = 534.5m from d/s outlet control 70m d/s
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

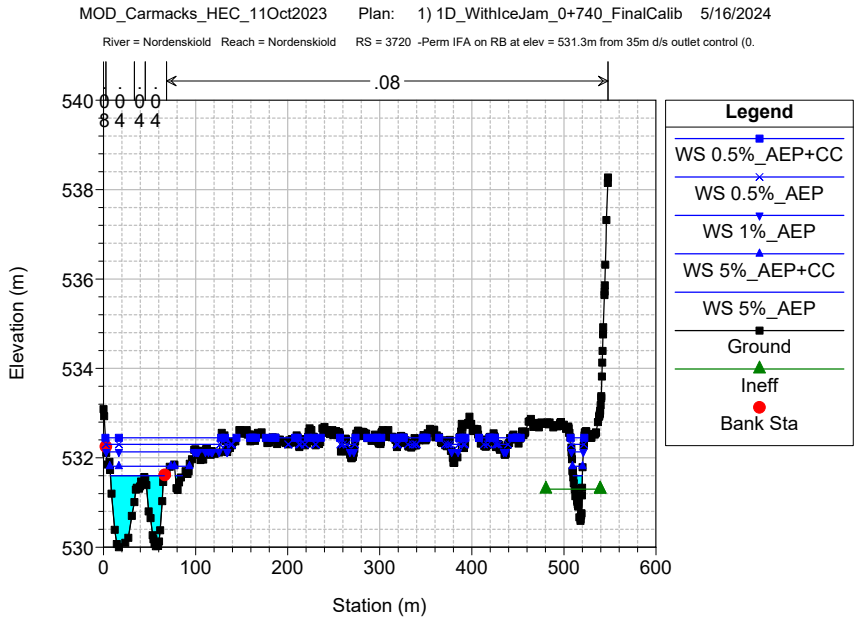

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 4381 -Perm IFA on RB at elev = 534.3m using upstream bank elevation a
.08
.07
.08
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

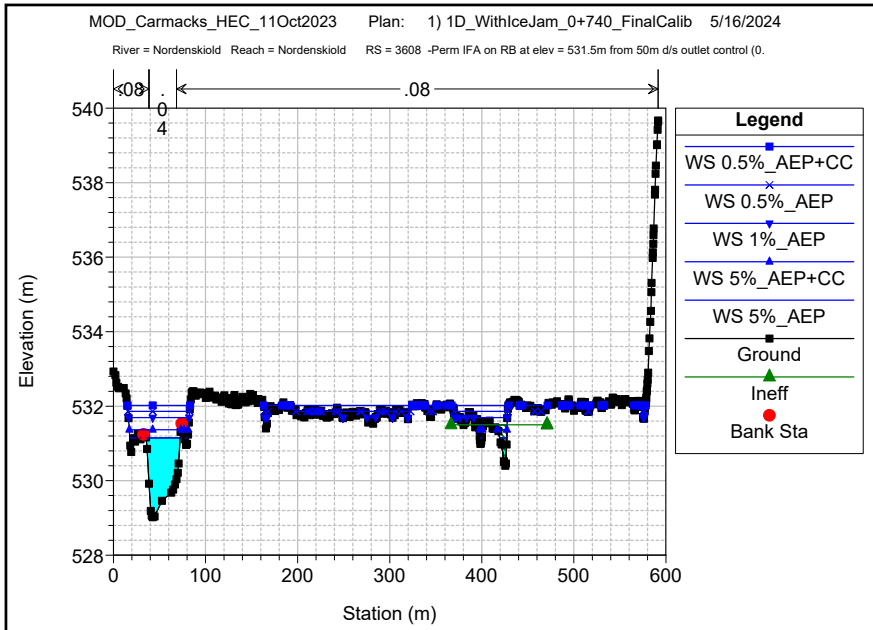

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 4296 -Perm IFA on RB at elev = 533.25m from 50m d/s outlet control (0
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

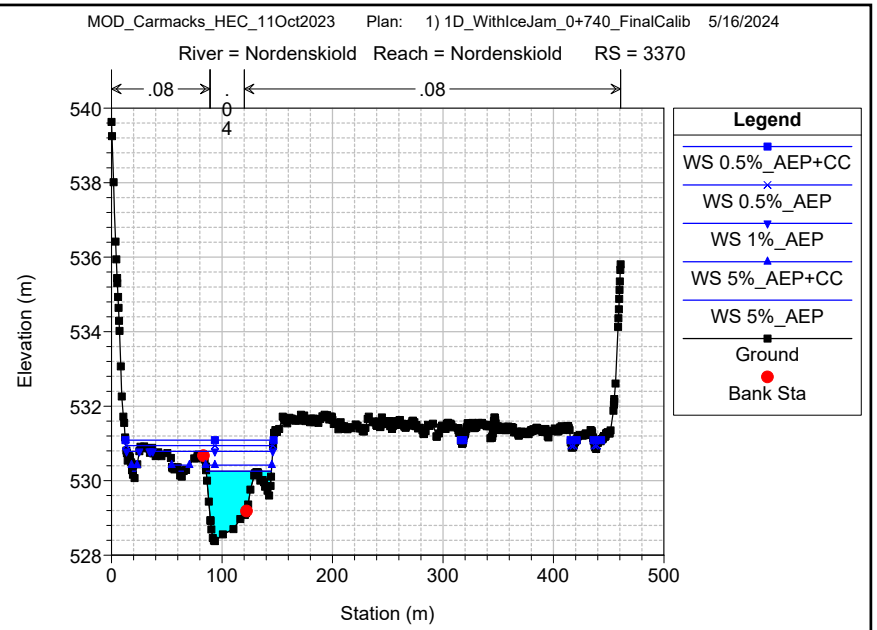

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 4229
.08
.04
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

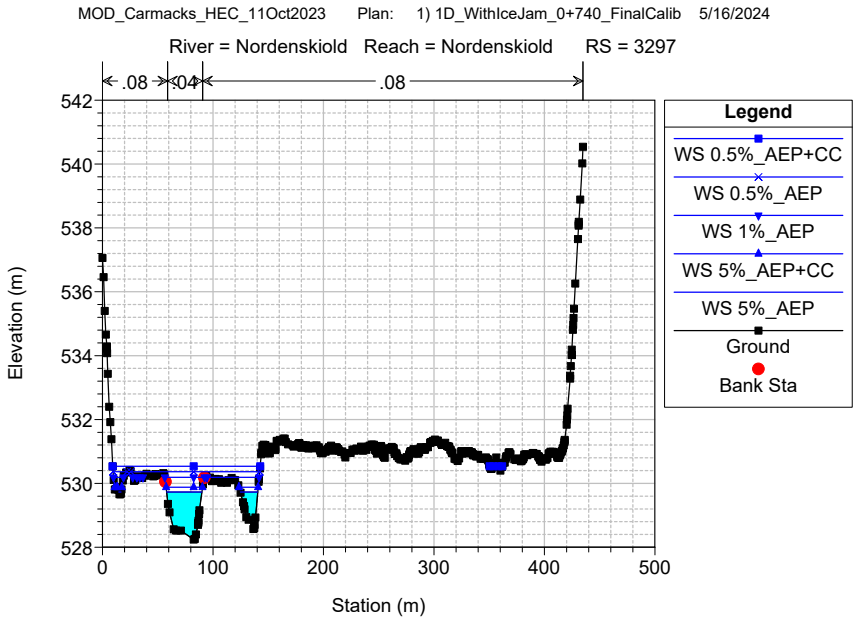

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 4109 -Perm IFA on RB at elev = 532.15m from 100m d/s outlet control (
.08
.04
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

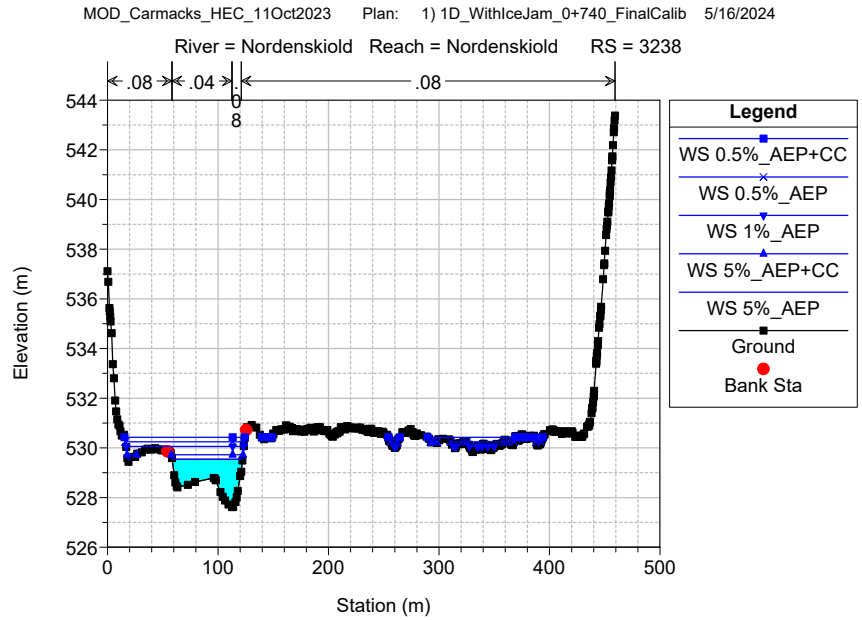

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 3798 -Perm IFA on RB at elev = 531.55m from 40m d/s outlet control (0
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

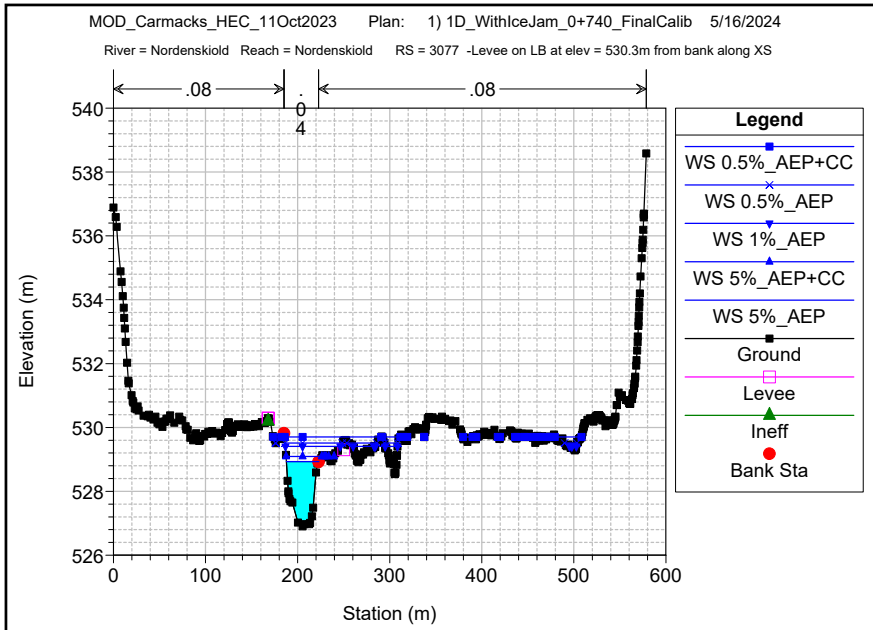

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 3720 -Perm IFA on RB at elev = 531.3m from 35m d/s outlet control (0.
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

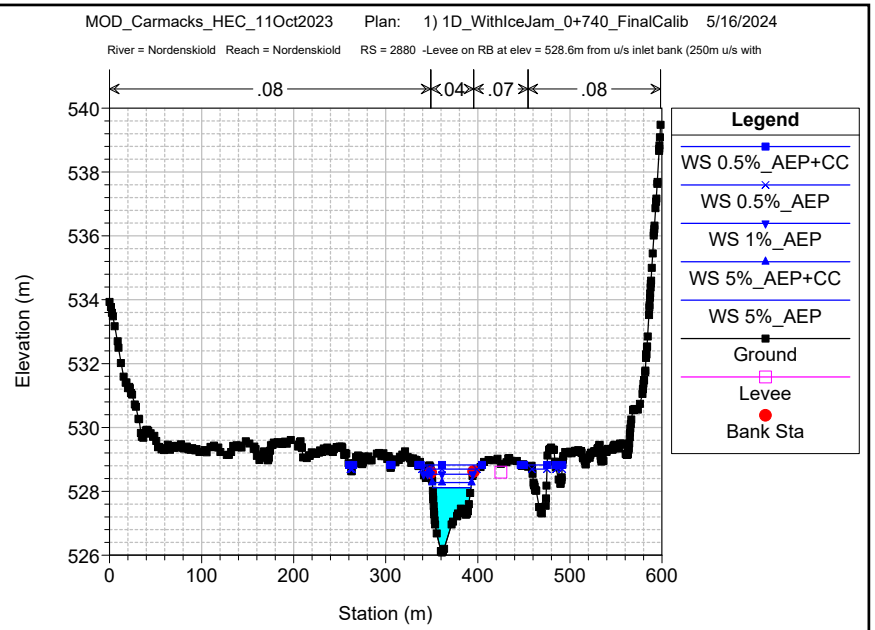

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 3608 -Perm IFA on RB at elev = 531.5m from 50m d/s outlet control (0.
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

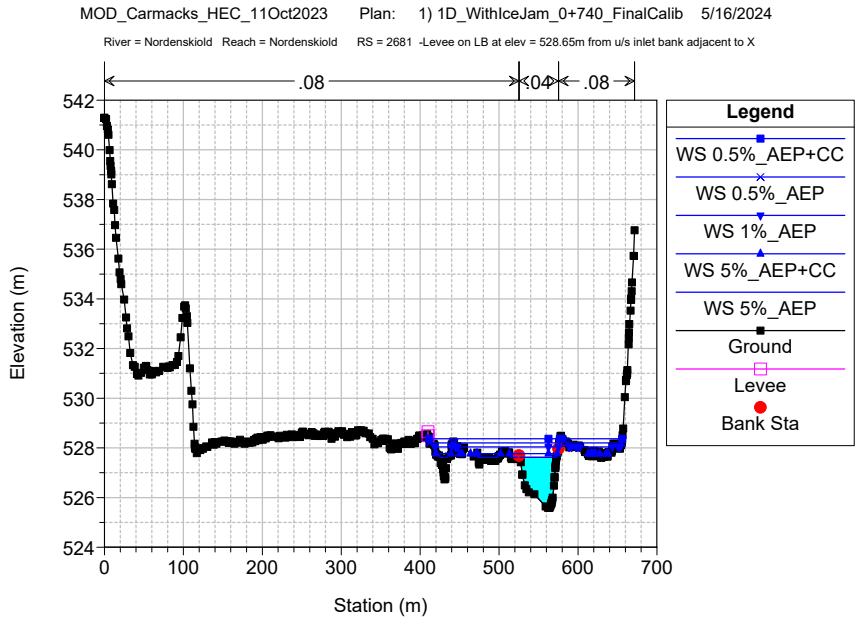

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 3370
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

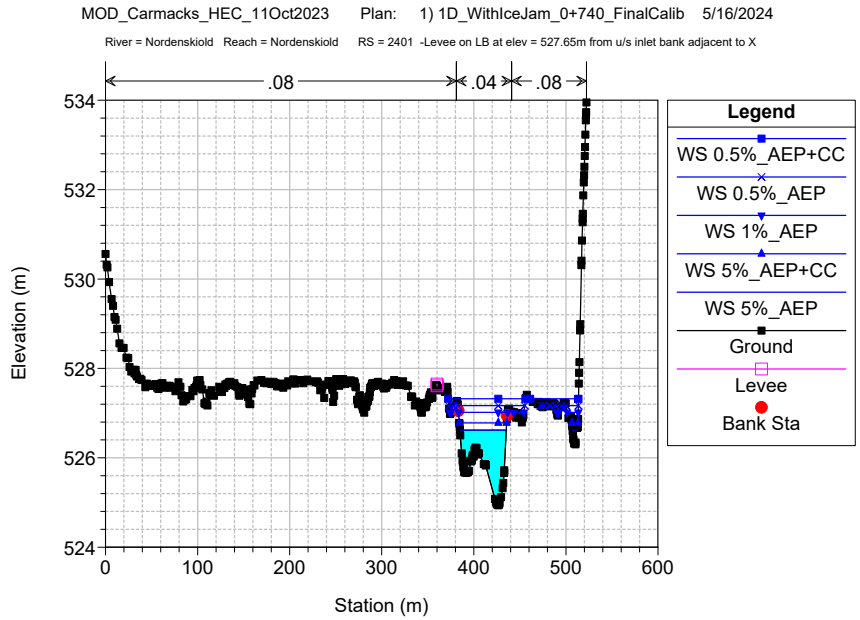

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 3297
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

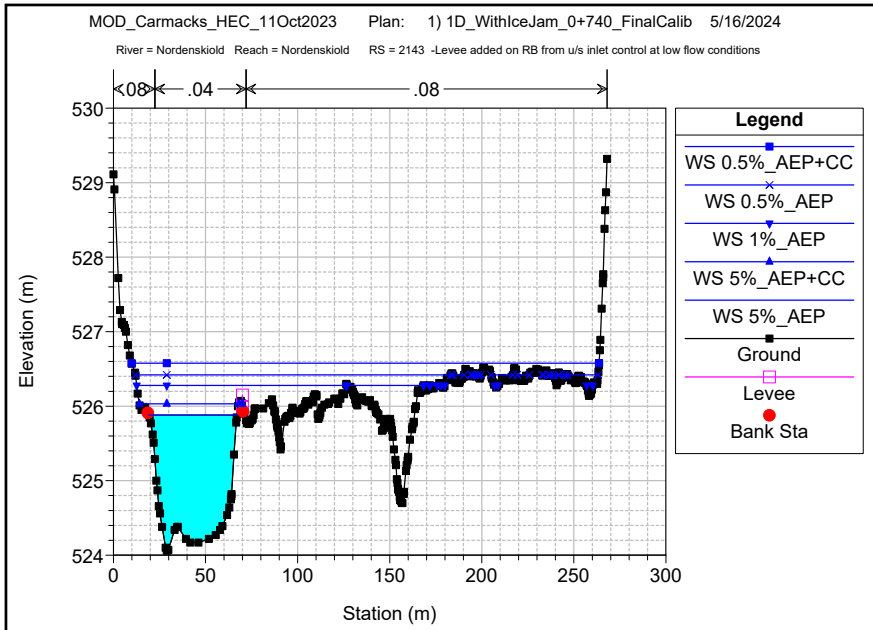

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 3238
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

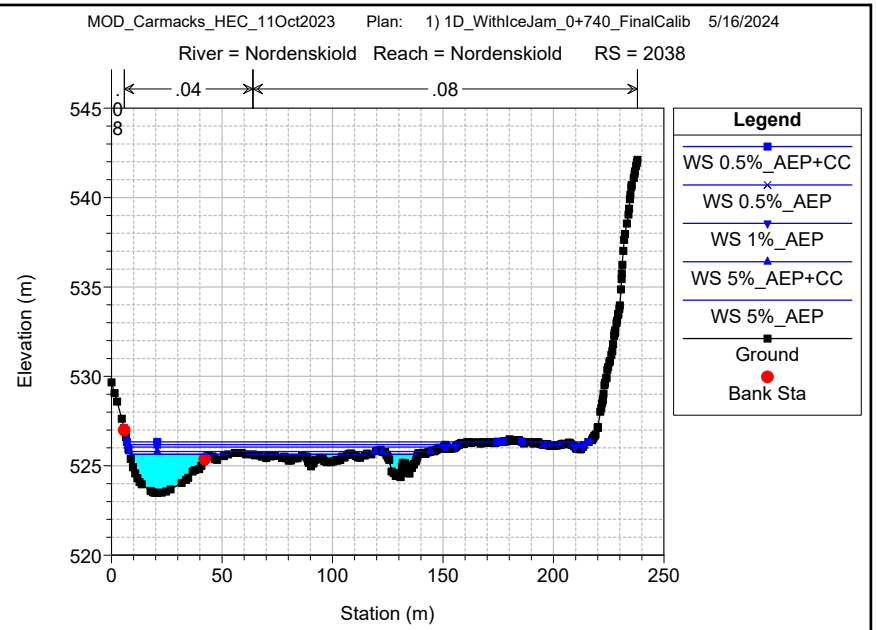

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 3077 -Levee on LB at elev = 530.3m from bank along XS
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

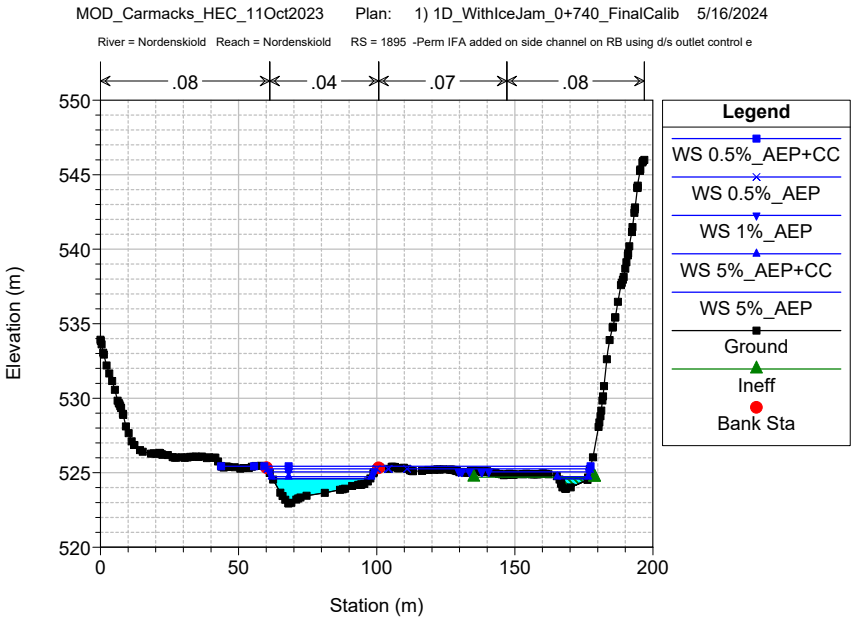

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 2880 -Levee on RB at elev = 528.6m from u/s inlet bank (250m u/s with
.08
.04
.07
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

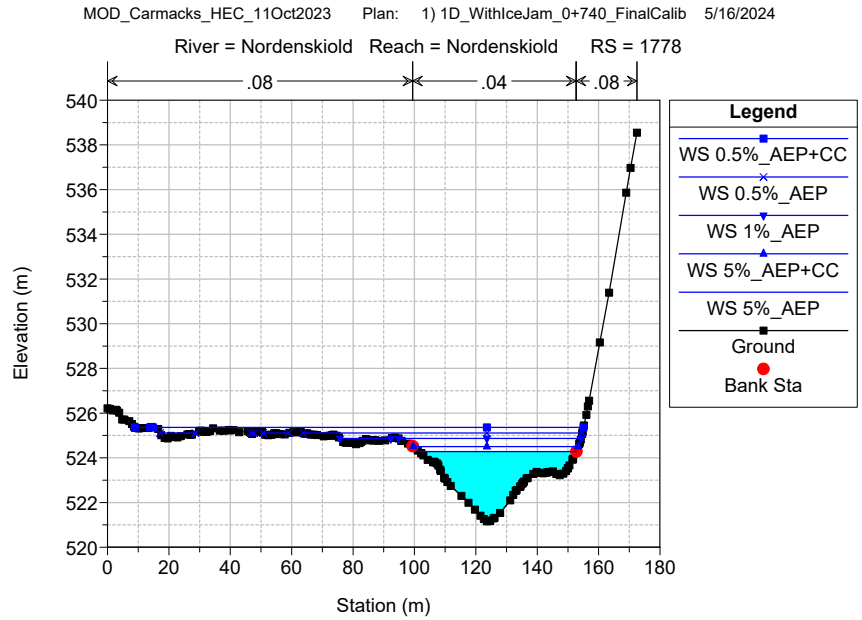

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 2681 -Levee on LB at elev = 528.65m from u/s inlet bank adjacent to X
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

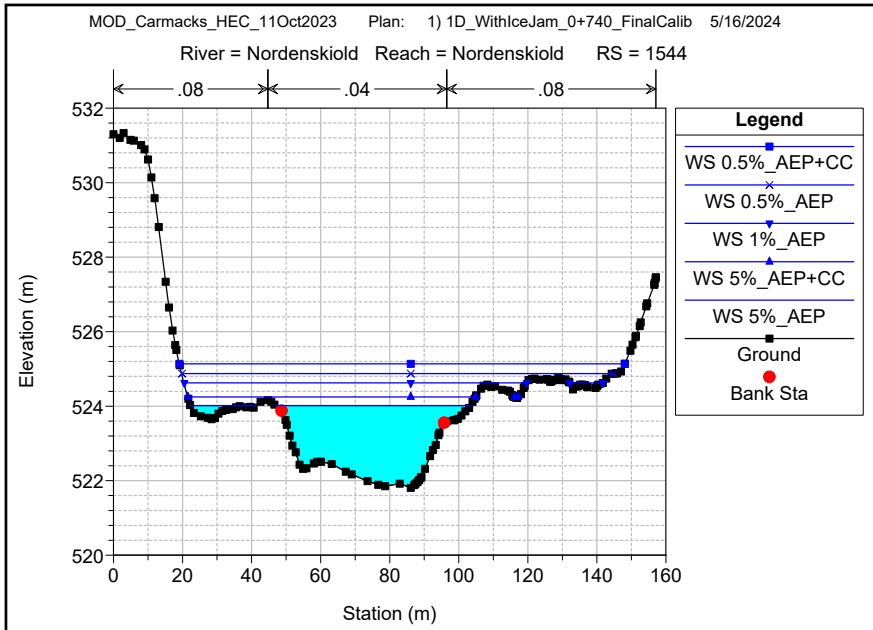

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 2401 -Levee on LB at elev = 527.65m from u/s inlet bank adjacent to X
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

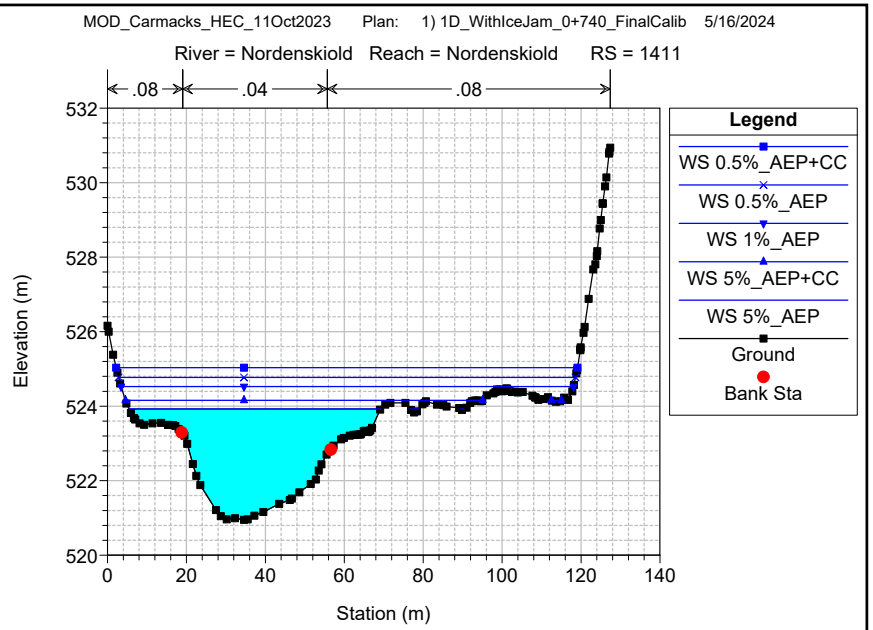

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 2143 -Levee added on RB from u/s inlet control at low flow conditions
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

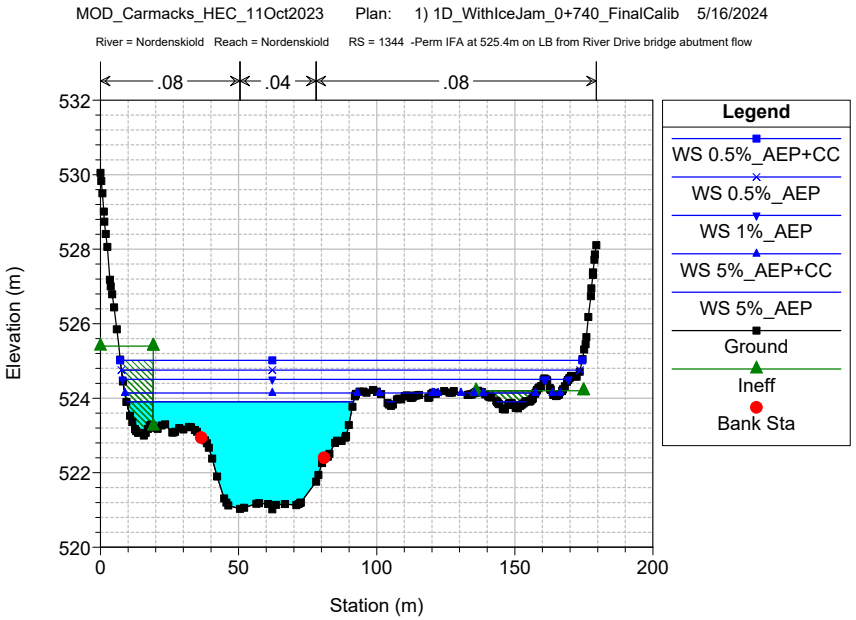

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 2038
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

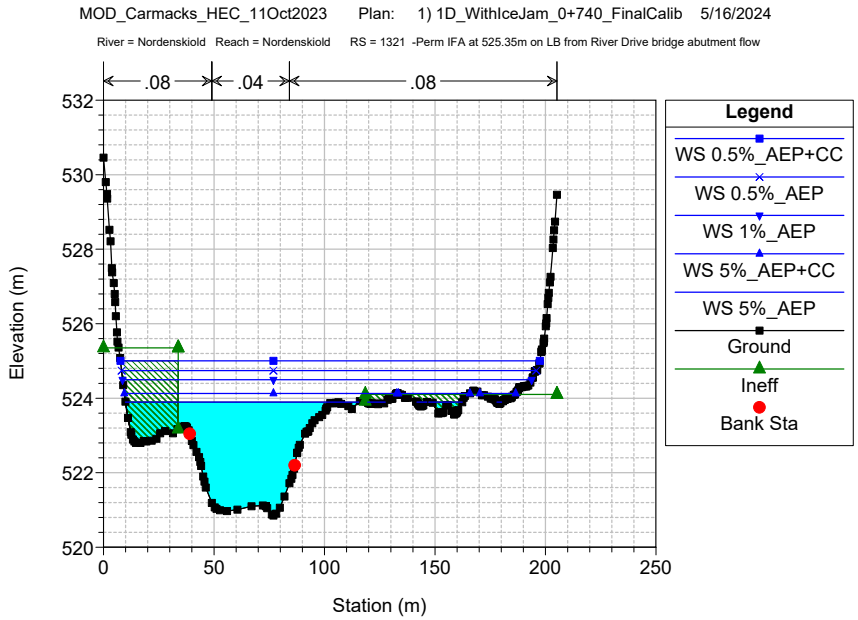

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1895 -Perm IFA added on side channel on RB using d/s outlet control e
.08
.04
.07
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

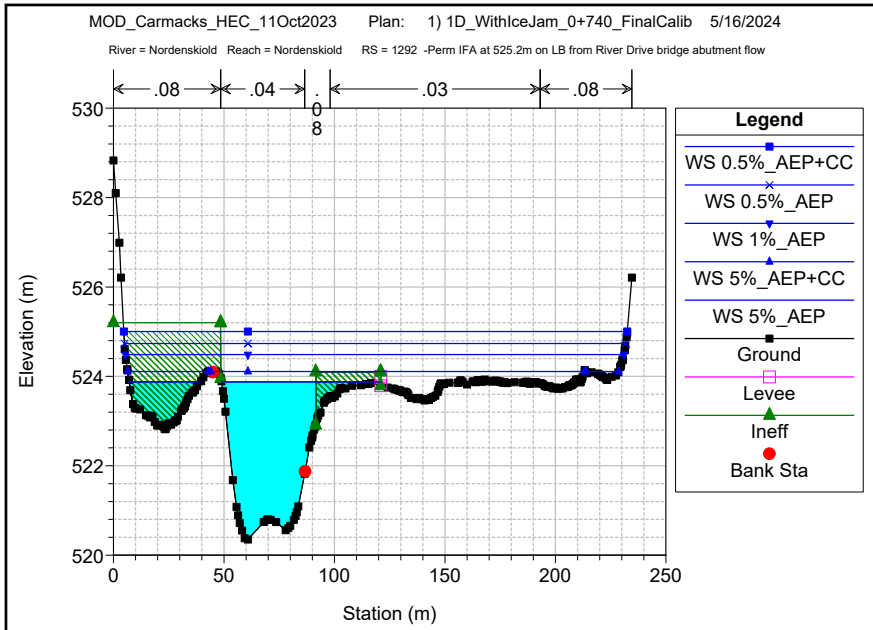

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1778
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

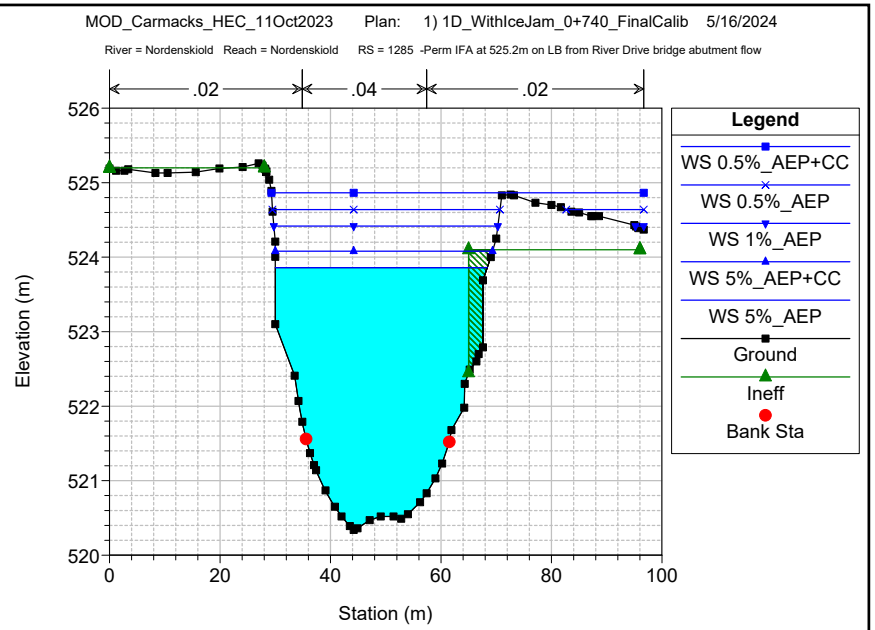

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1544
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

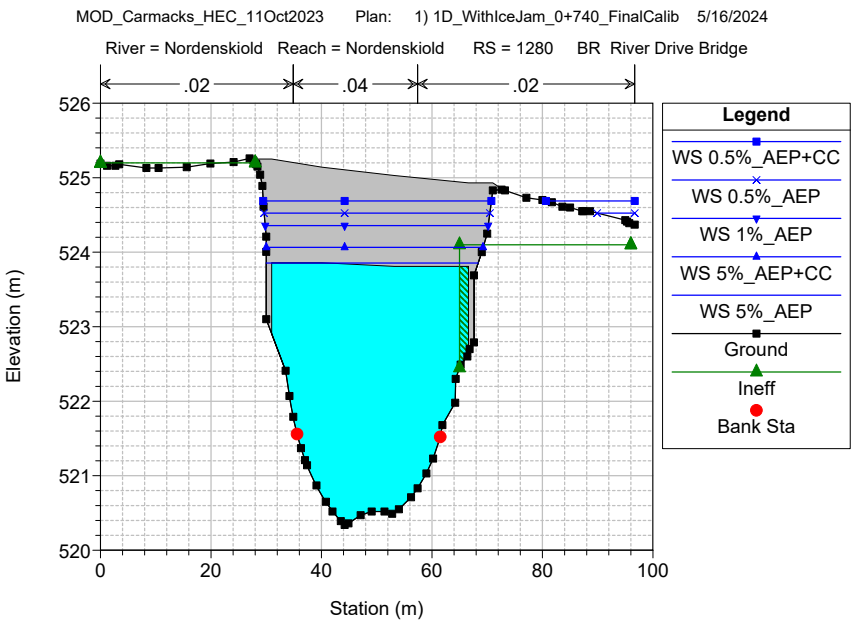

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1411
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

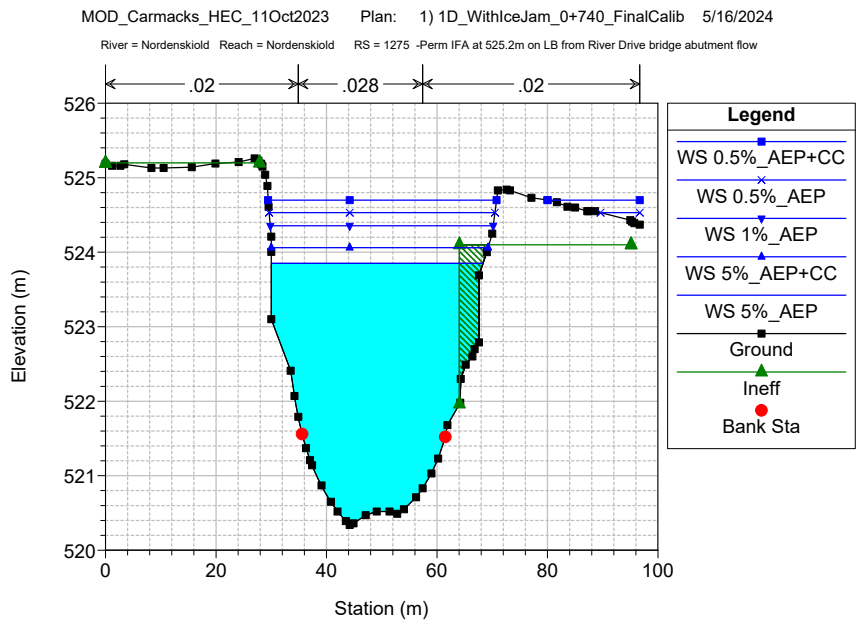

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1344 -Perm IFA at 525.4m on LB from River Drive bridge abutment flow
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1321 -Perm IFA at 525.35m on LB from River Drive bridge abutment flow
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1292 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.08
.04
.08
.03
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

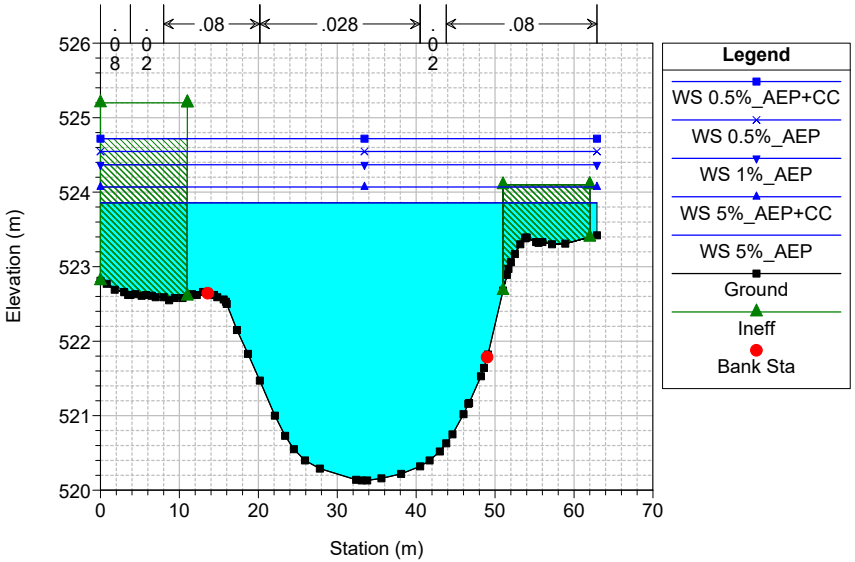

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1285 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1280 BR River Drive Bridge
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 1275 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.02
.028
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

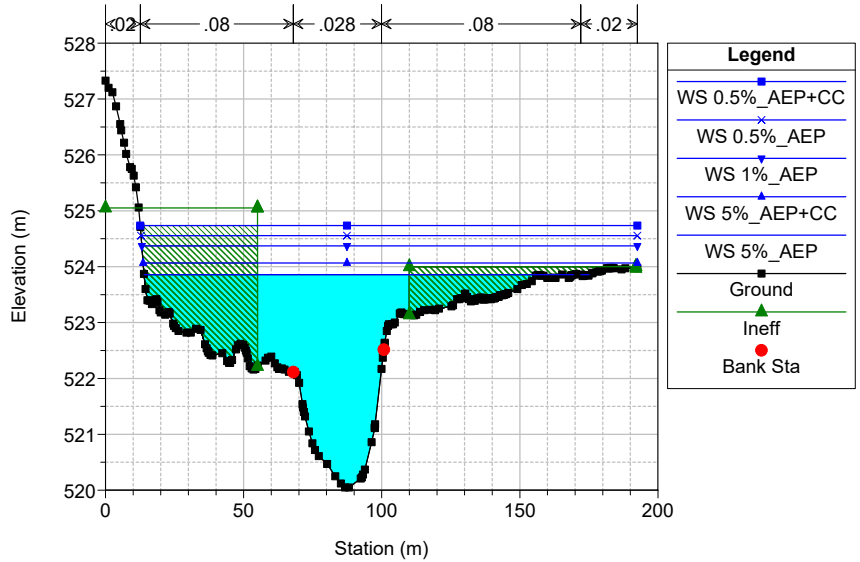
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

River = Nordenskiold Reach = Nordenskiold RS = 1270 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow



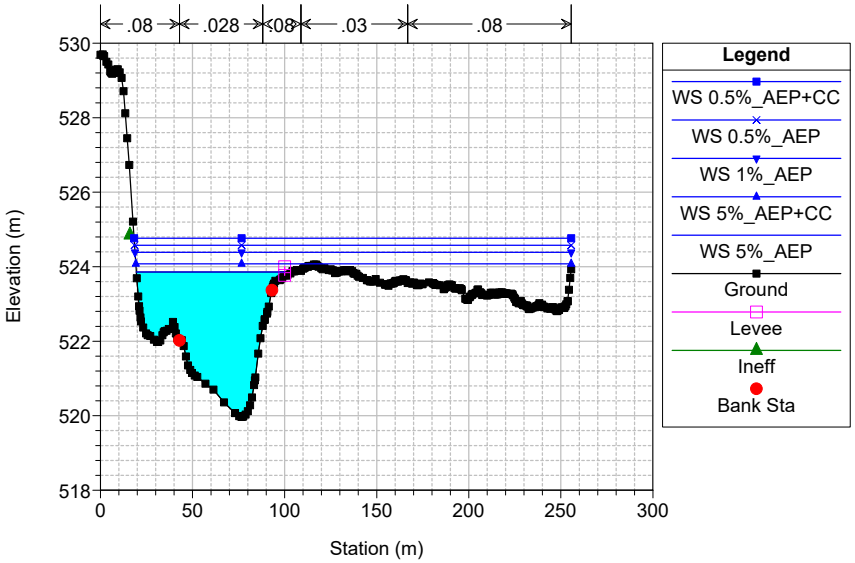
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

River = Nordenskiold Reach = Nordenskiold RS = 1261 -Perm IFA at 525.05m on LB from River Drive bridge abutment flow



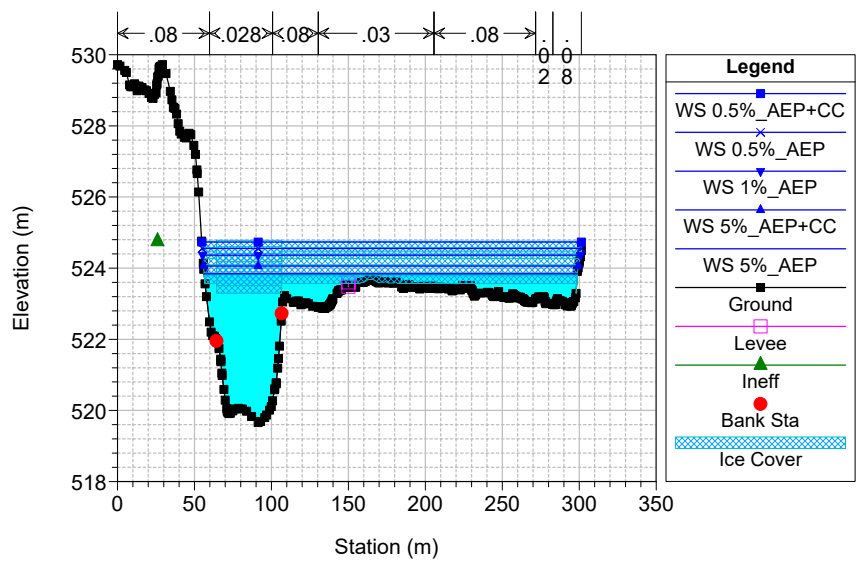
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

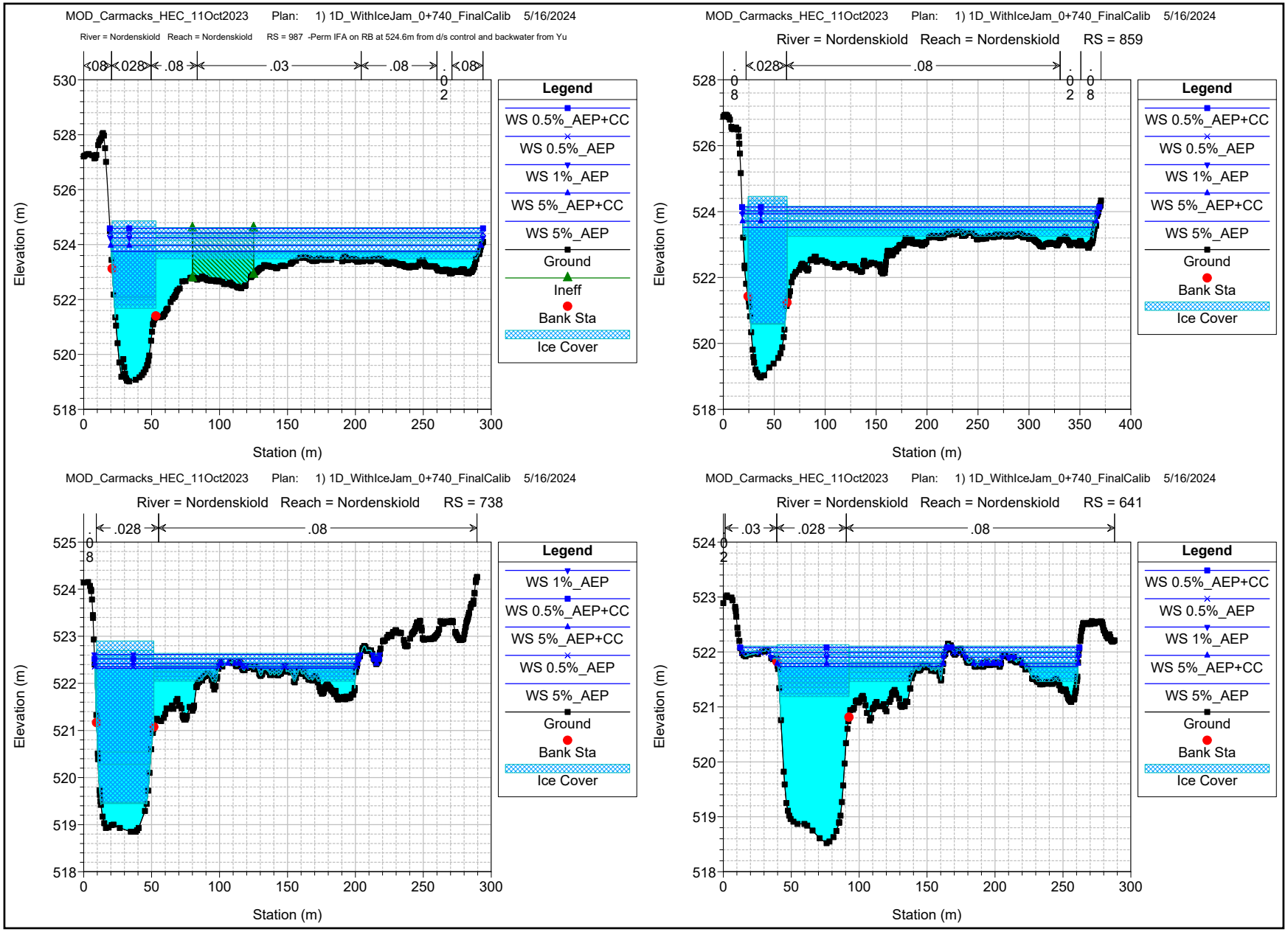
River = Nordenskiold Reach = Nordenskiold RS = 1174 -Perm IFA at 524.85m on LB from River Drive bridge abutment flow



MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

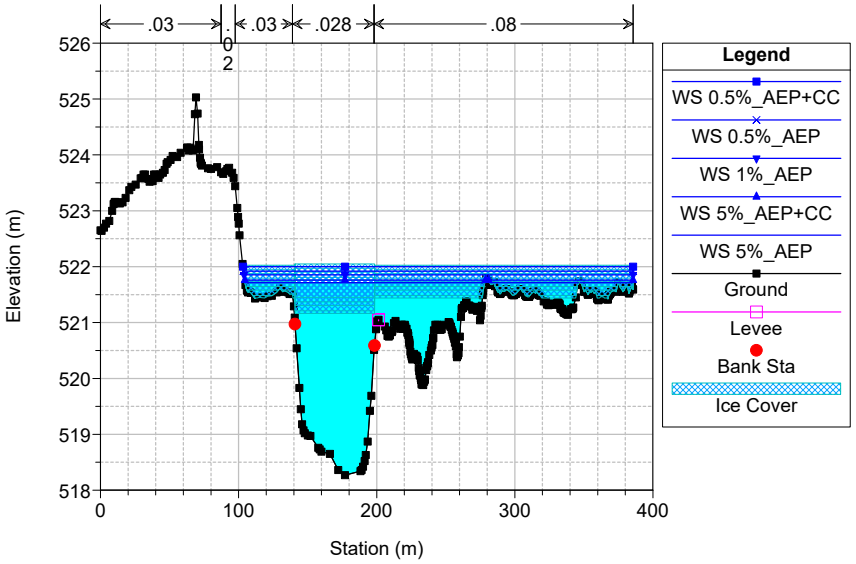
River = Nordenskiold Reach = Nordenskiold RS = 1088 -Perm IFA at 524.75m on LB from River Drive bridge abutment flow




MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 987 -Perm IFA on RB at 524.6m from d/s control and backwater from Yu
.08 .028 .08 .03 .08 .02 .08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 859
.08 .028 .08 .02 .08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta
Ice Cover
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 738
.08 .028 .08
Elevation (m)
Station (m)
Legend
WS 1%_AEP
WS 0.5%_AEP+CC
WS 5%_AEP+CC
WS 0.5%_AEP
WS 5%_AEP
Ground
Bank Sta
Ice Cover
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024
River = Nordenskiold Reach = Nordenskiold RS = 641
.03 .028 .08 .02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta
Ice Cover

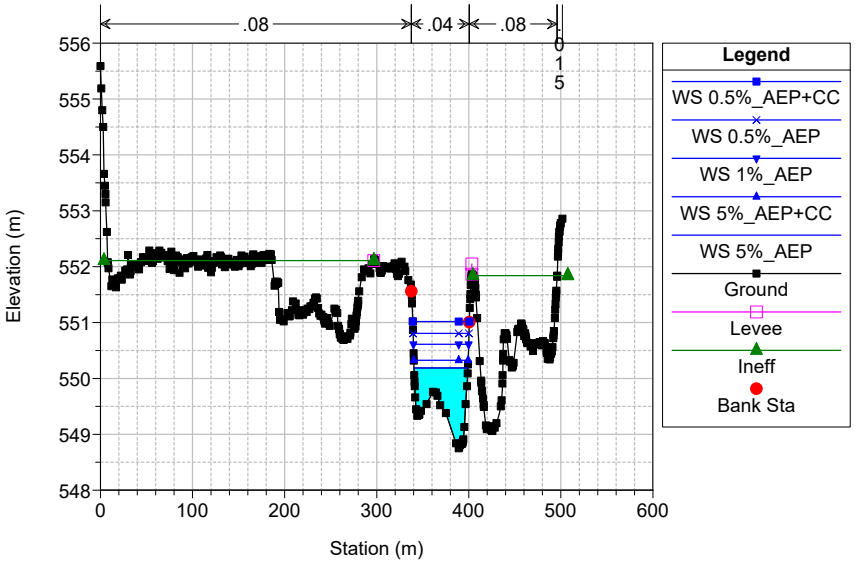
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_0+740_FinalCalib 5/16/2024

River = Nordenskiold Reach = Nordenskiold RS = 556 -Levee added on RB at 521.2m from adjacent bank elevation



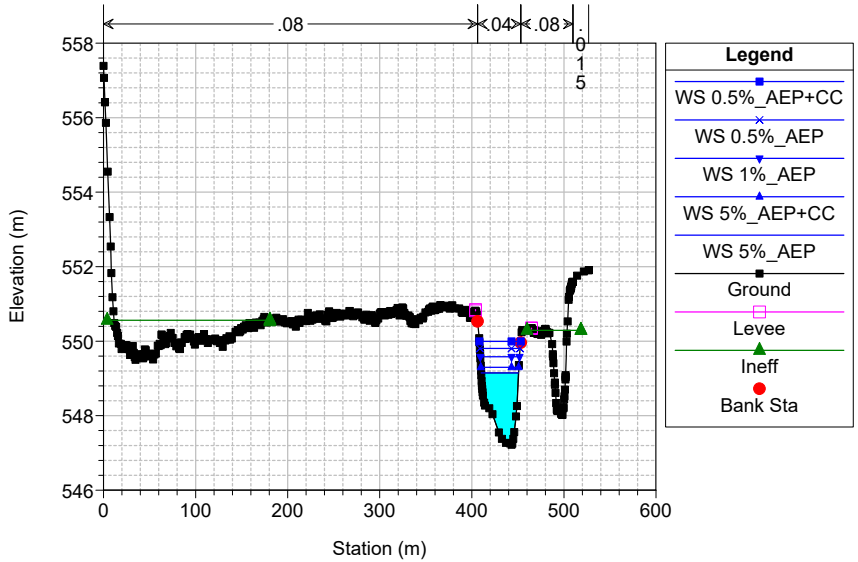
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024

River = Nordenskiold Reach = Nordenskiold RS = 9269 -XS extended to road on RB to prevent overspilling at edge of XS



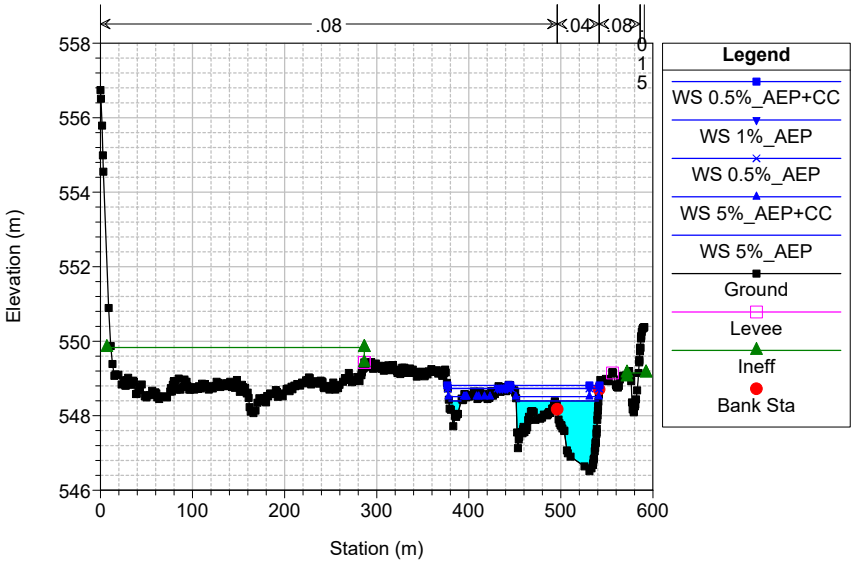
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024

River = Nordenskiold Reach = Nordenskiold RS = 9036 -Levee on LB with elev = 550.9 m (at same WSEs adjacent to XS at



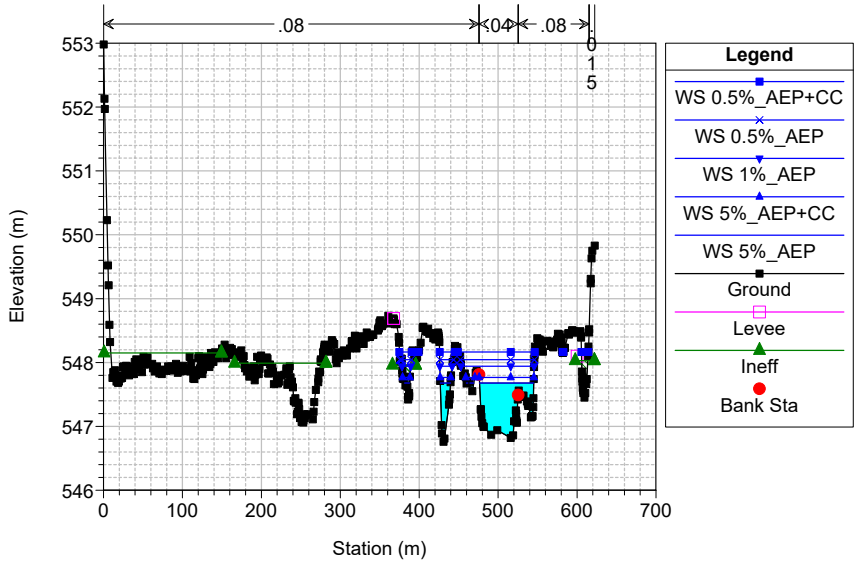
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024

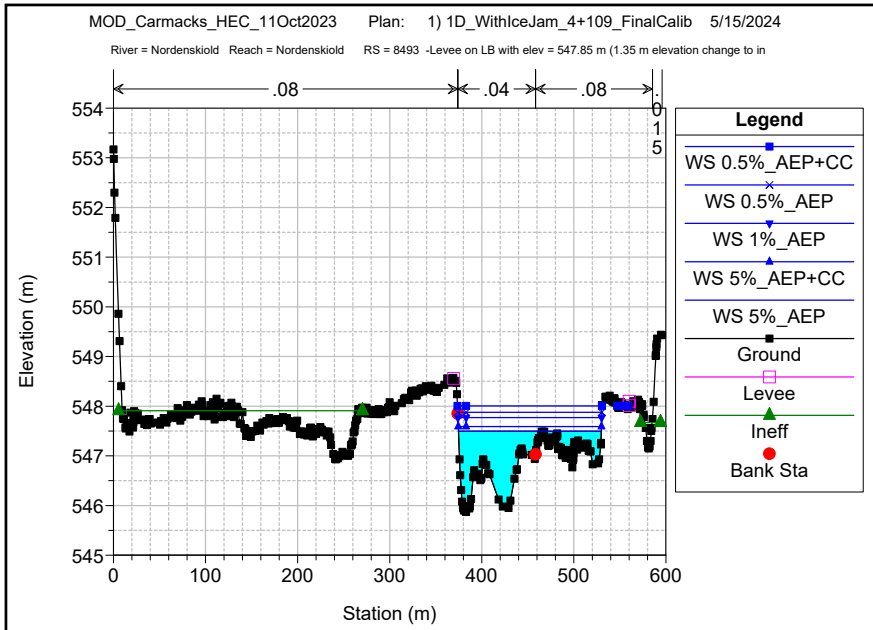
River = Nordenskiold Reach = Nordenskiold RS = 8713 -Levee on LB with elev = 548.6 m (0.6 m elevation change to inle

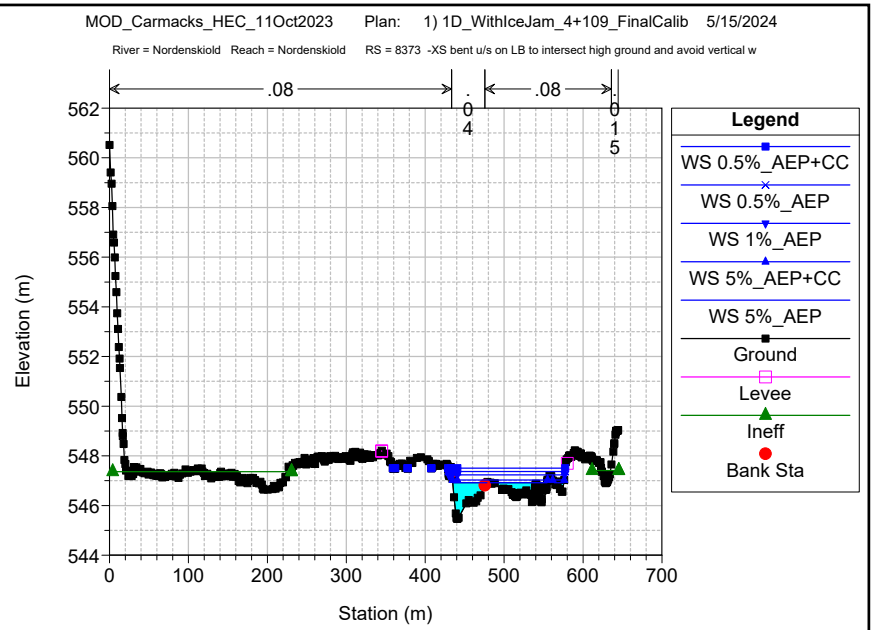


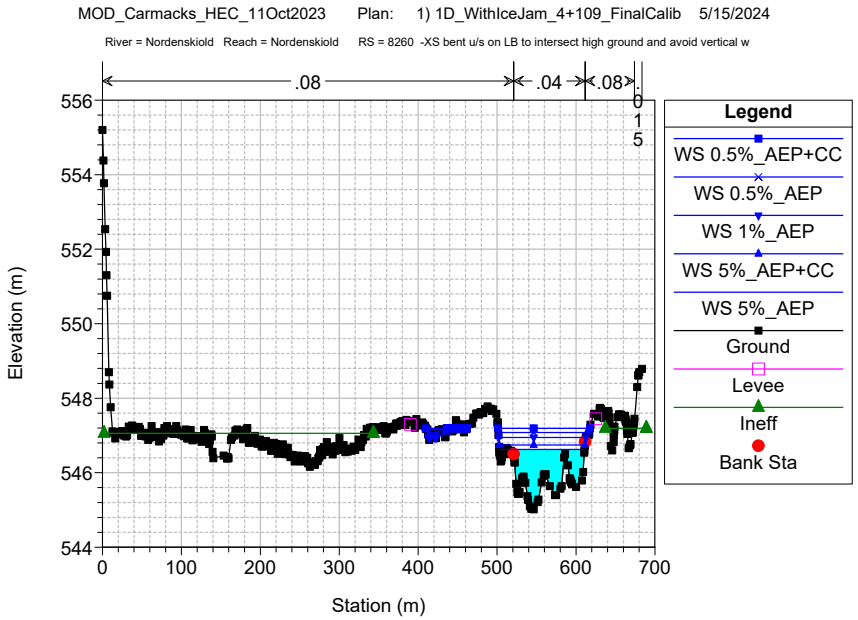
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024

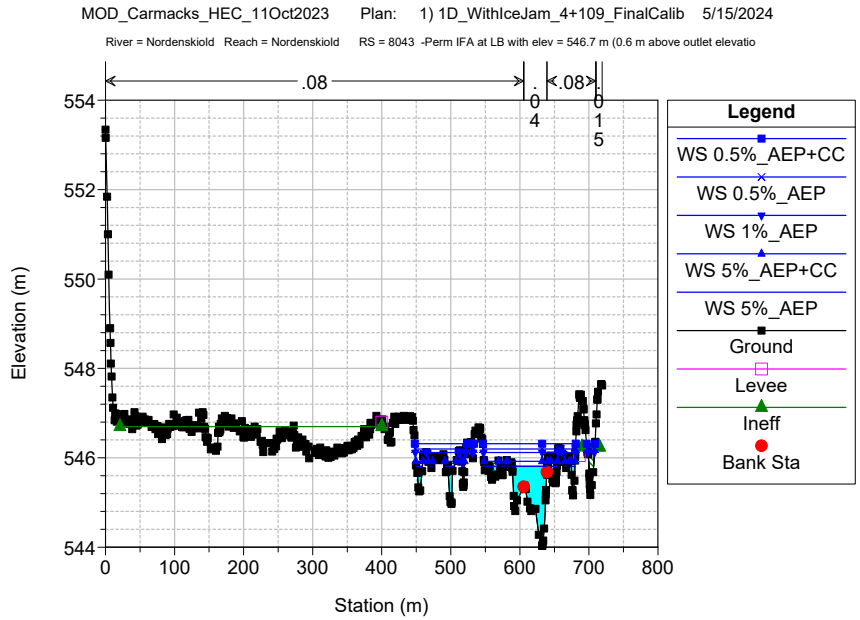
River = Nordenskiold Reach = Nordenskiold RS = 8577 -Levee on LB with elev = 548.0 m (1.2 m elevation change to inle

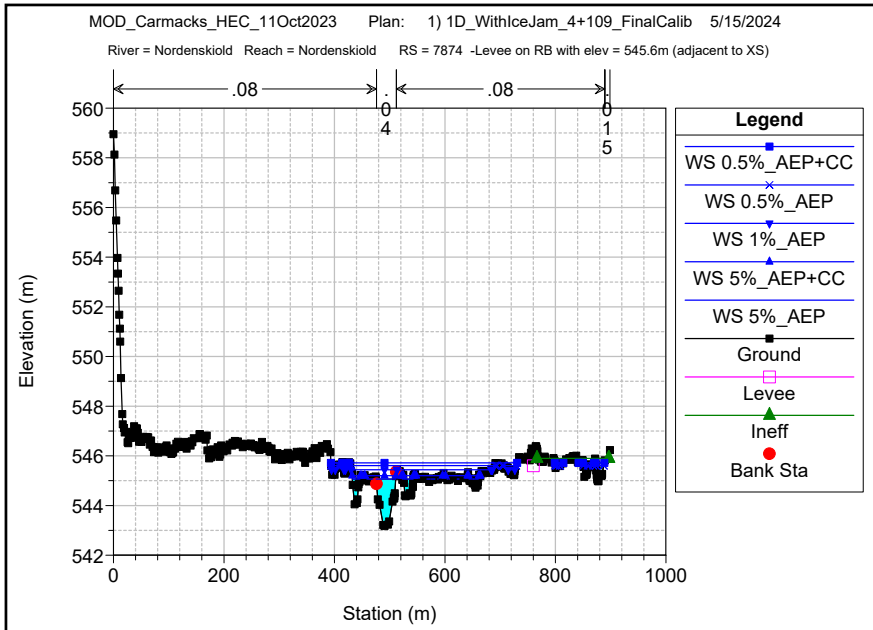


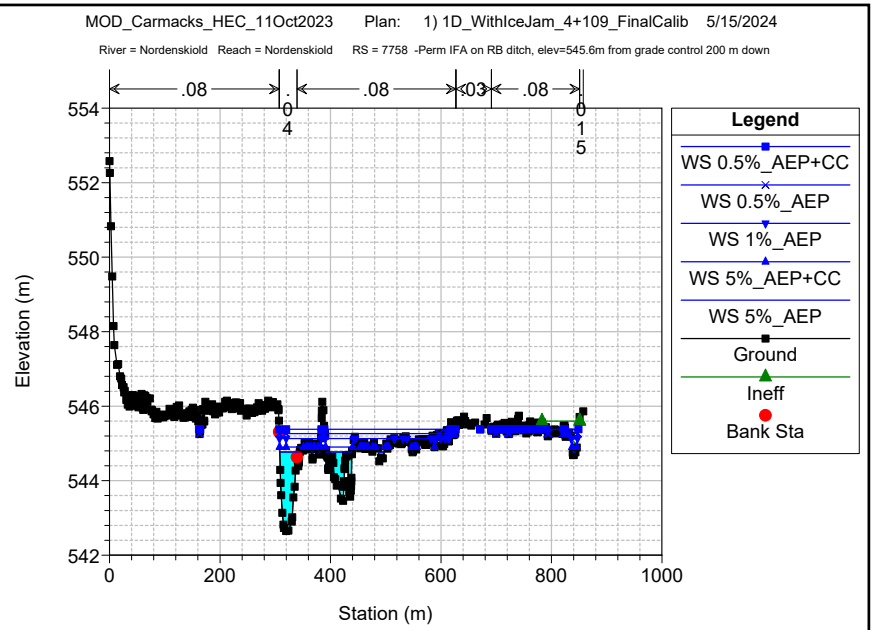

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 8493 -Levee on LB with elev = 547.85 m (1.35 m elevation change to in
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

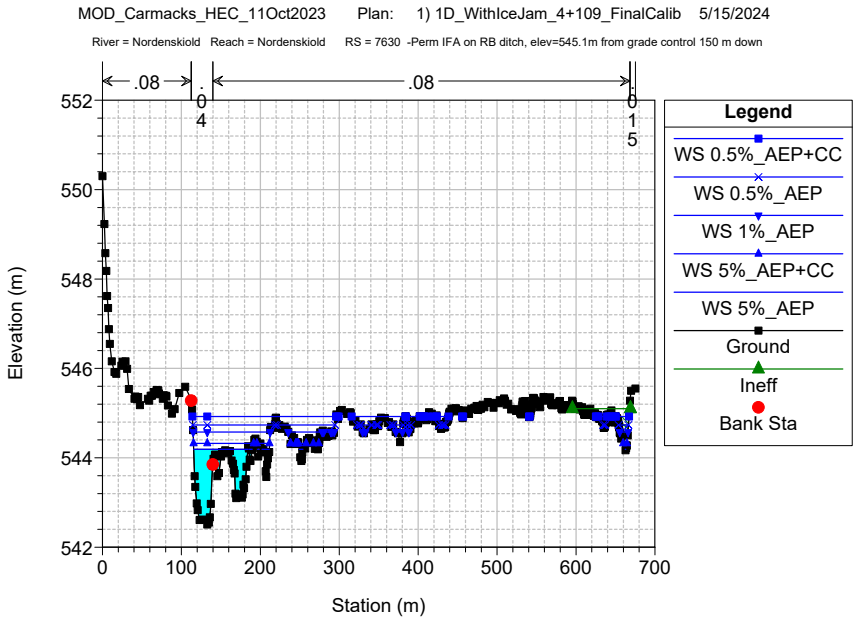

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 8373 -XS bent u/s on LB to intersect high ground and avoid vertical w
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

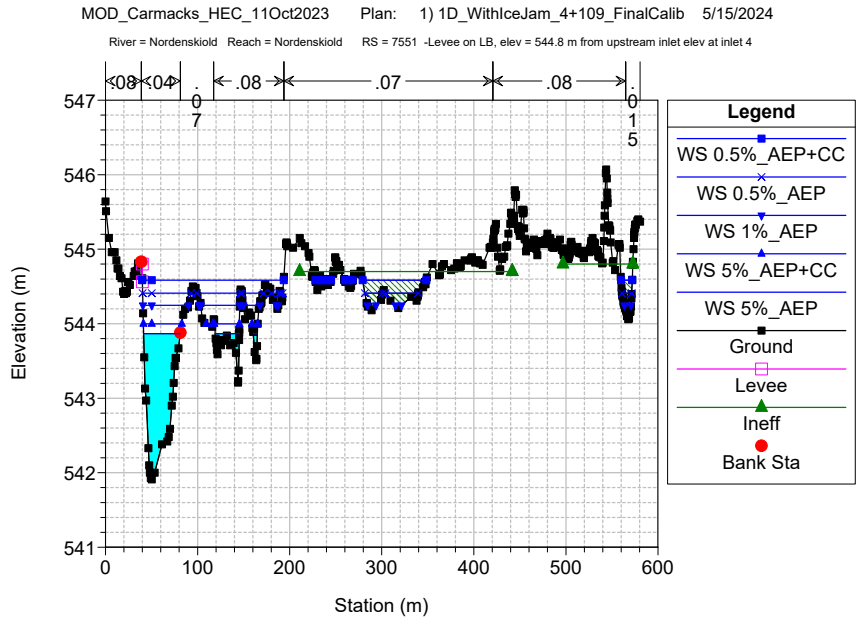

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 8260 -XS bent u/s on LB to intersect high ground and avoid vertical w
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

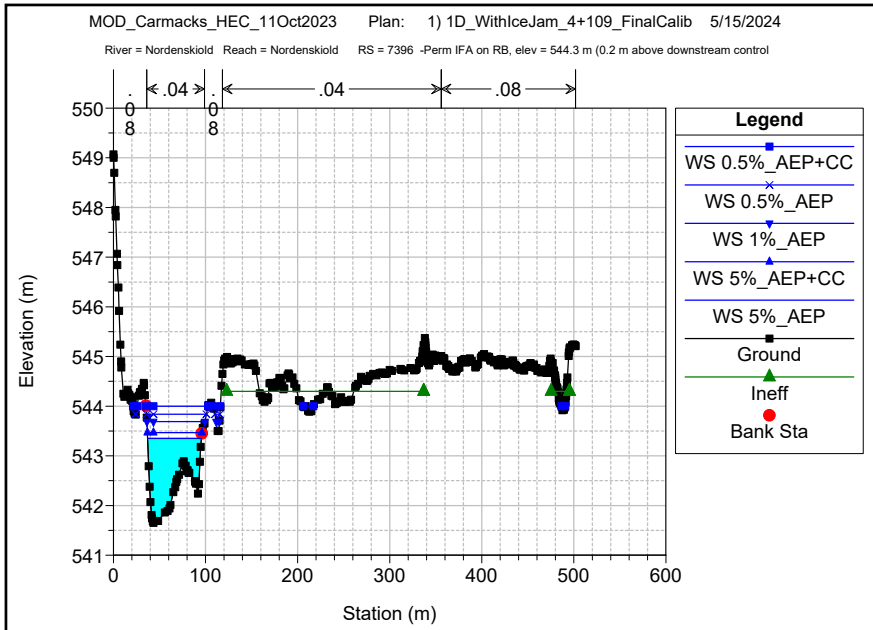

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 8043 -Perm IFA at LB with elev = 546.7 m (0.6 m above outlet elevatio
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

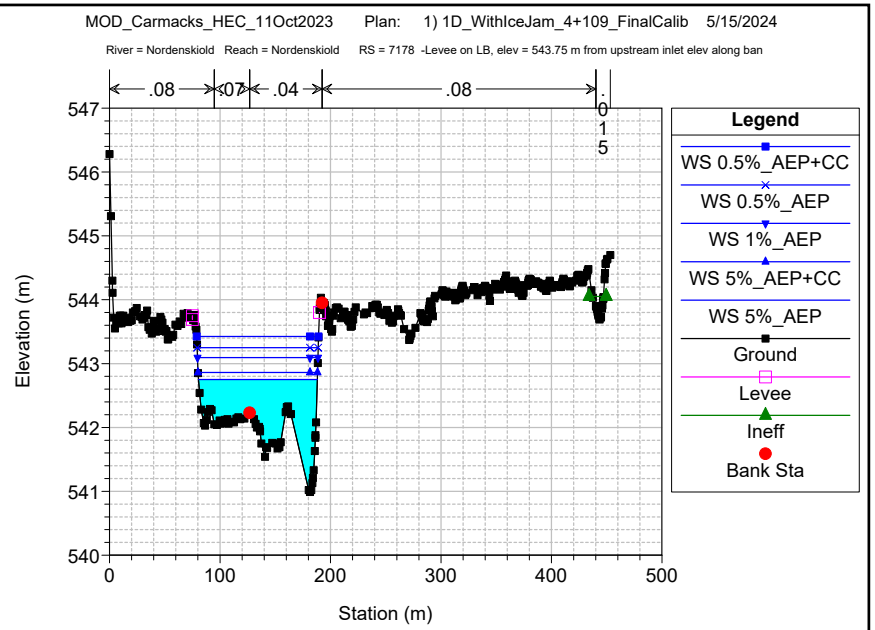

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7874 -Levee on RB with elev = 545.6m (adjacent to XS)
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

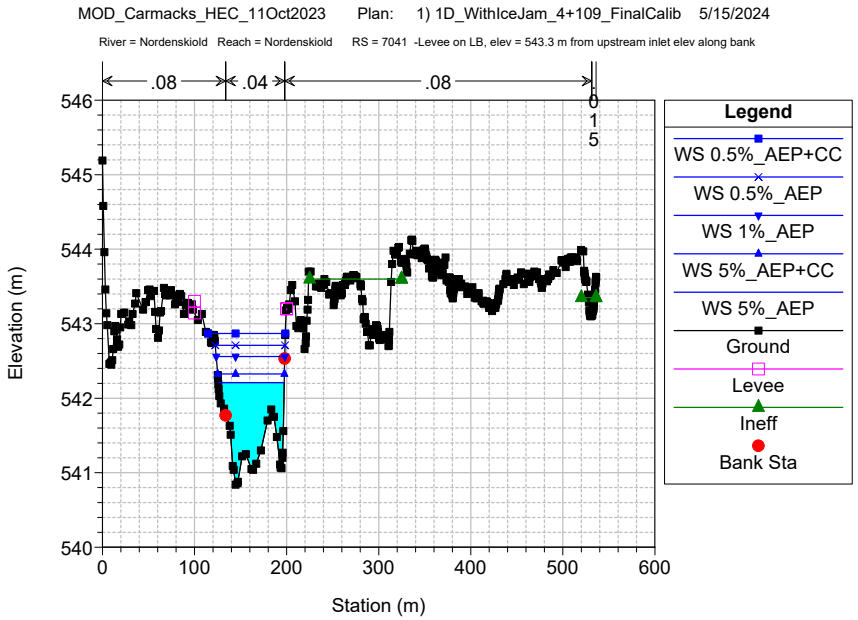

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7758 -Perm IFA on RB ditch, elev=545.6m from grade control 200 m down
.08
.04
.08
.03
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

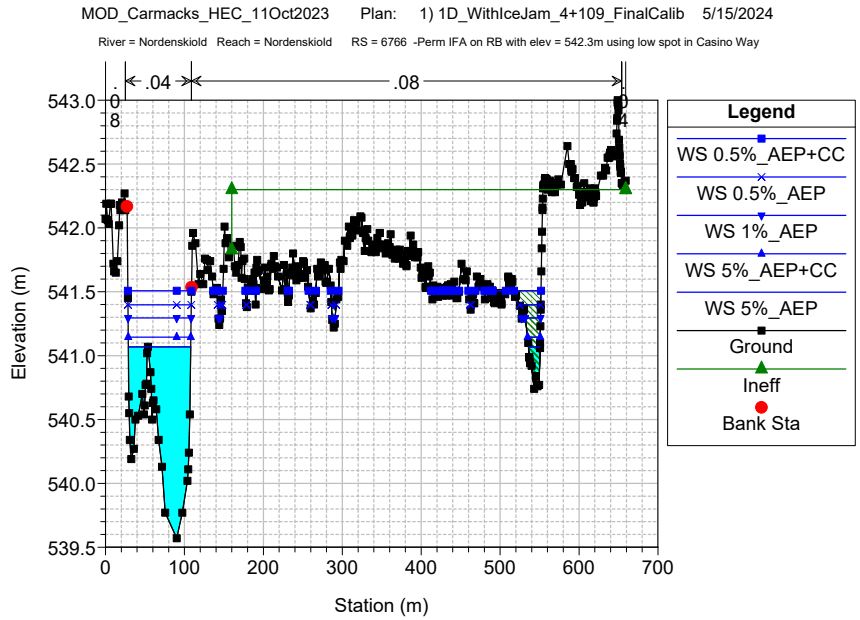

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7630 -Perm IFA on RB ditch, elev=545.1m from grade control 150 m down
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

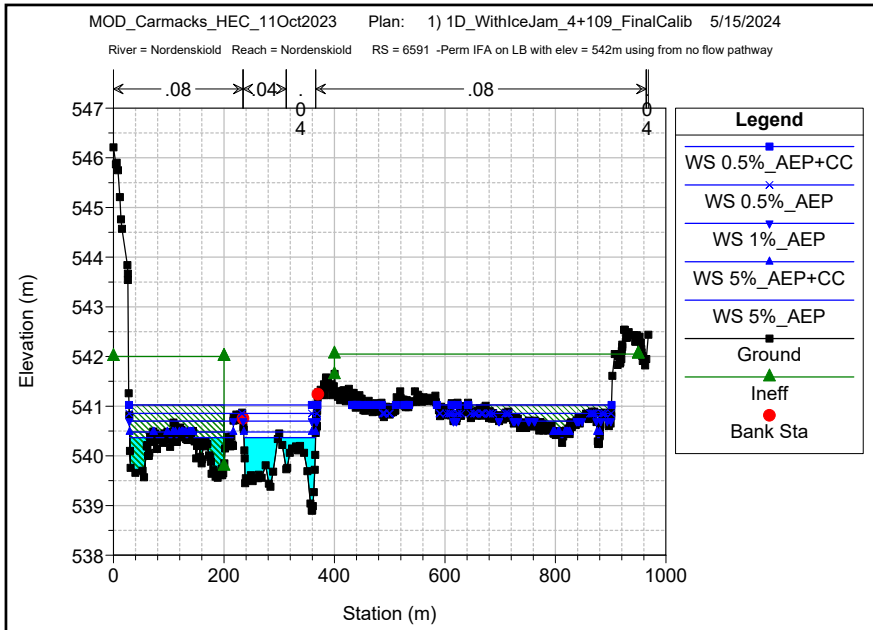

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7551 -Levee on LB, elev = 544.8 m from upstream inlet elev at inlet 4
.08
.04
.07
.08
.07
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

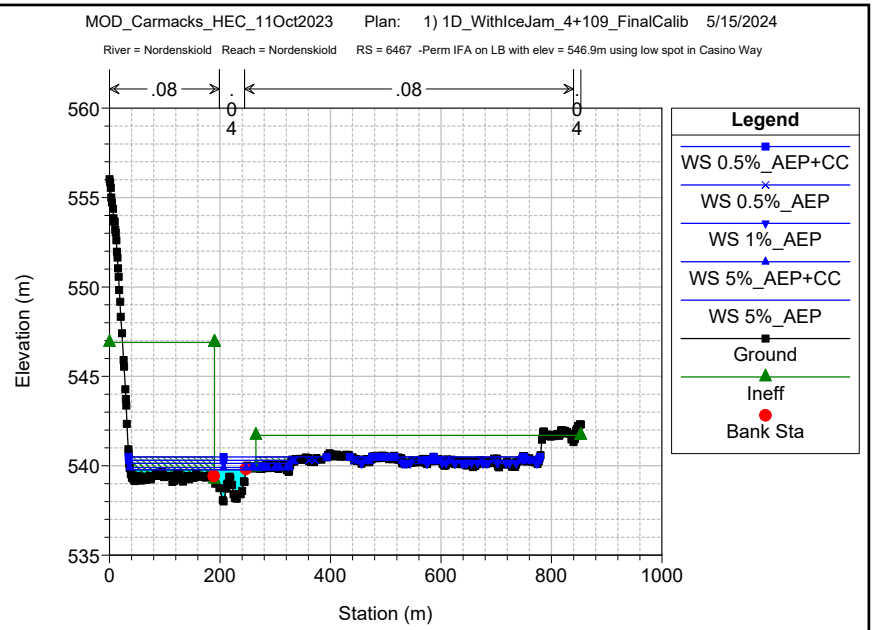

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7396 -Perm IFA on RB, elev = 544.3 m (0.2 m above downstream control
.04
.04
.08
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

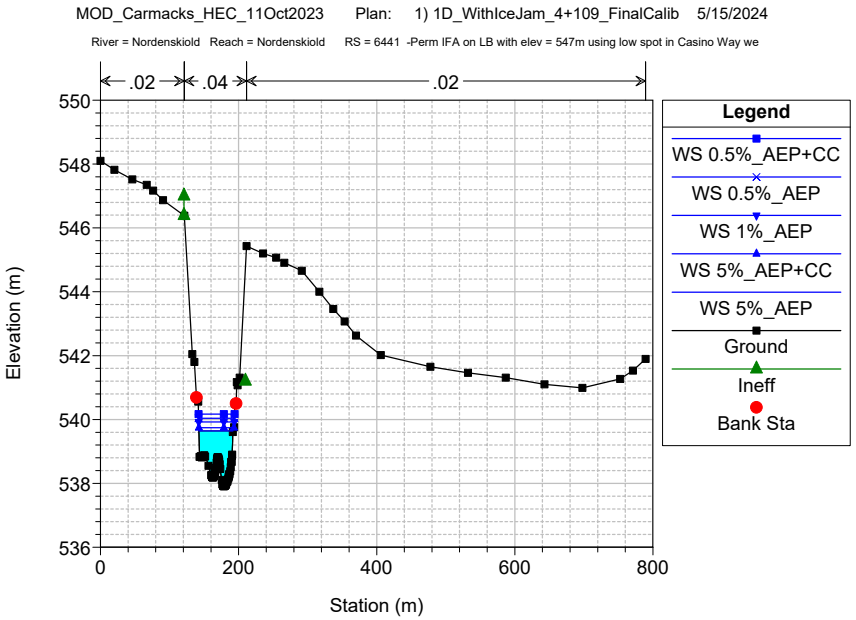

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7178 -Levee on LB, elev = 543.75 m from upstream inlet elev along ban
.08
.07
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

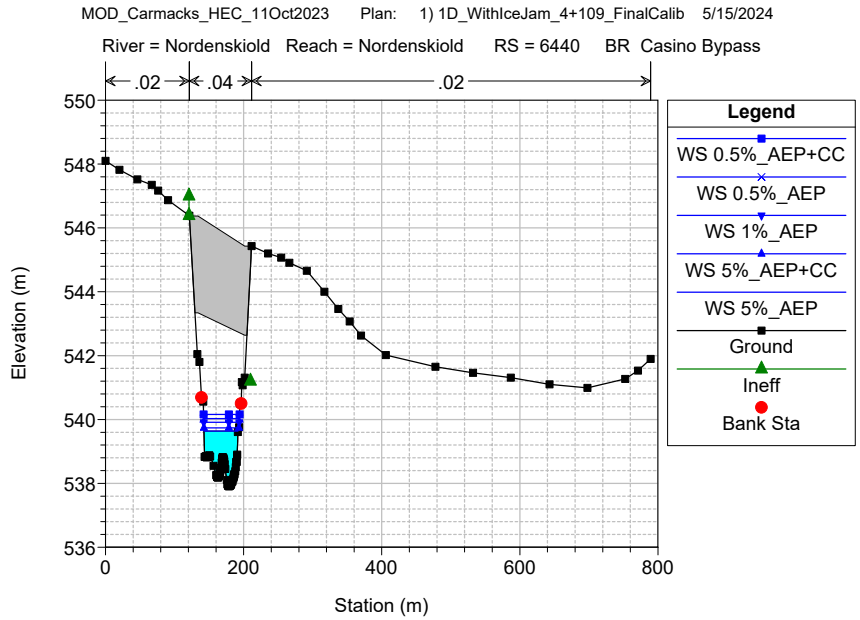

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7041 -Levee on LB, elev = 543.3 m from upstream inlet elev along bank
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

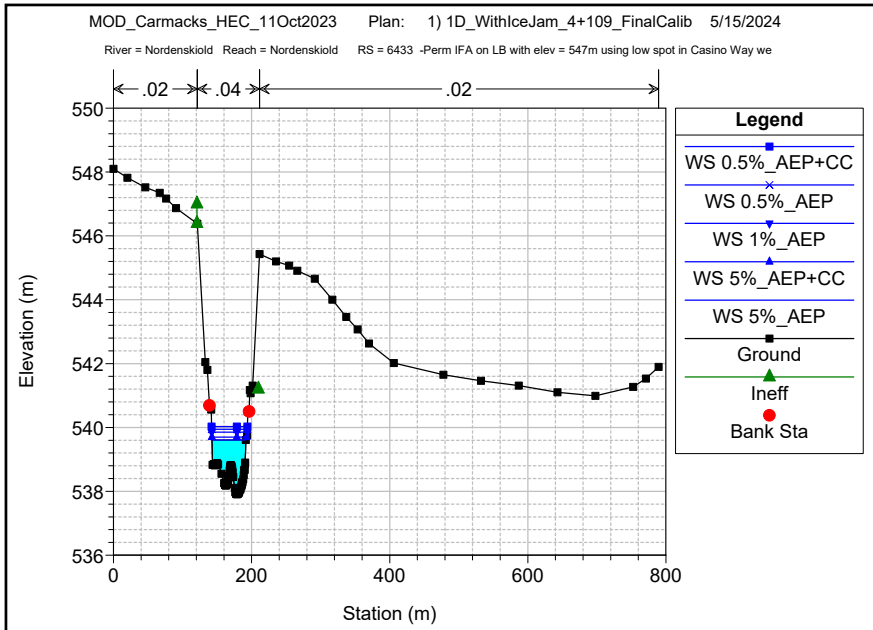

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6766 -Perm IFA on RB with elev = 542.3m using low spot in Casino Way
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

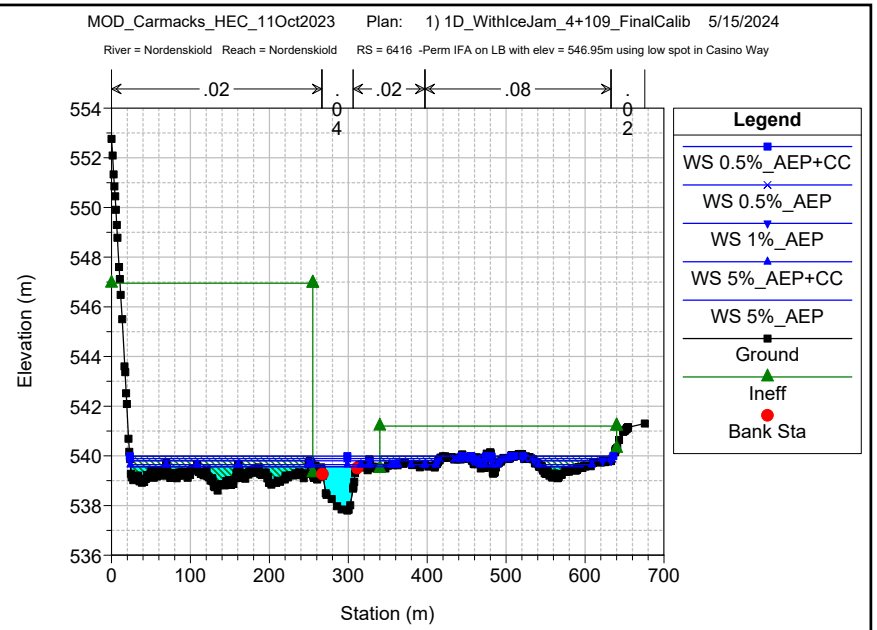

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6591 -Perm IFA on LB with elev = 542m using from no flow pathway
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

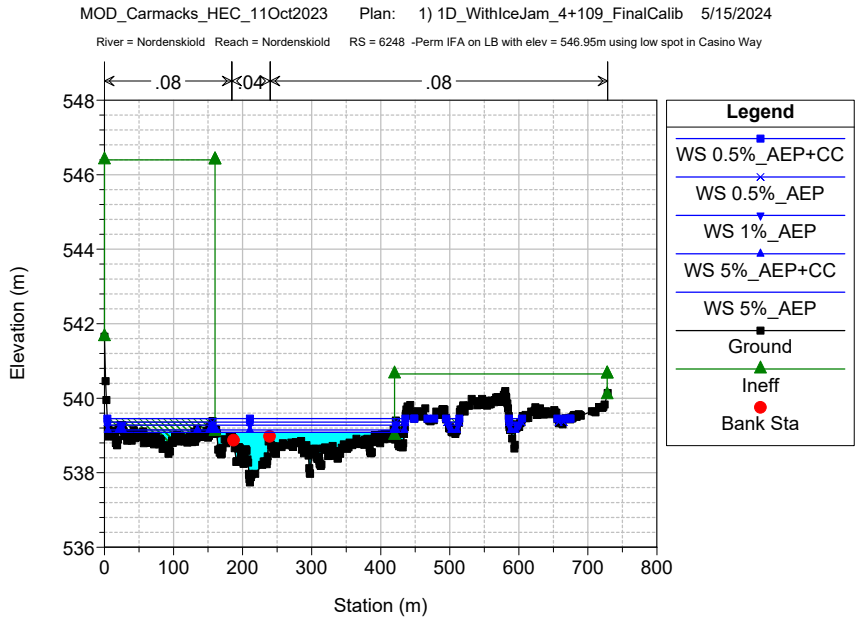

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6467 -Perm IFA on LB with elev = 546.9m using low spot in Casino Way
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

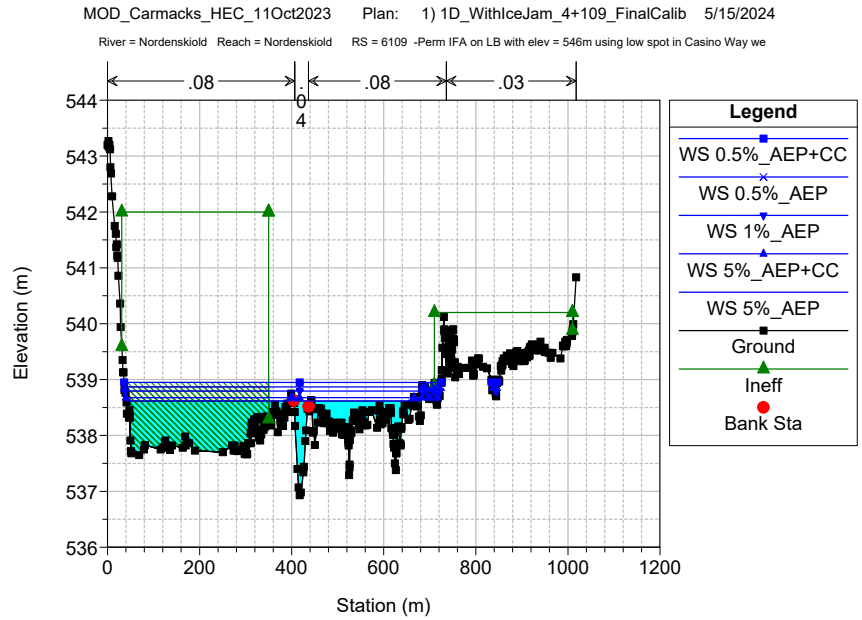

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6441 -Perm IFA on LB with elev = 547m using low spot in Casino Way we
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

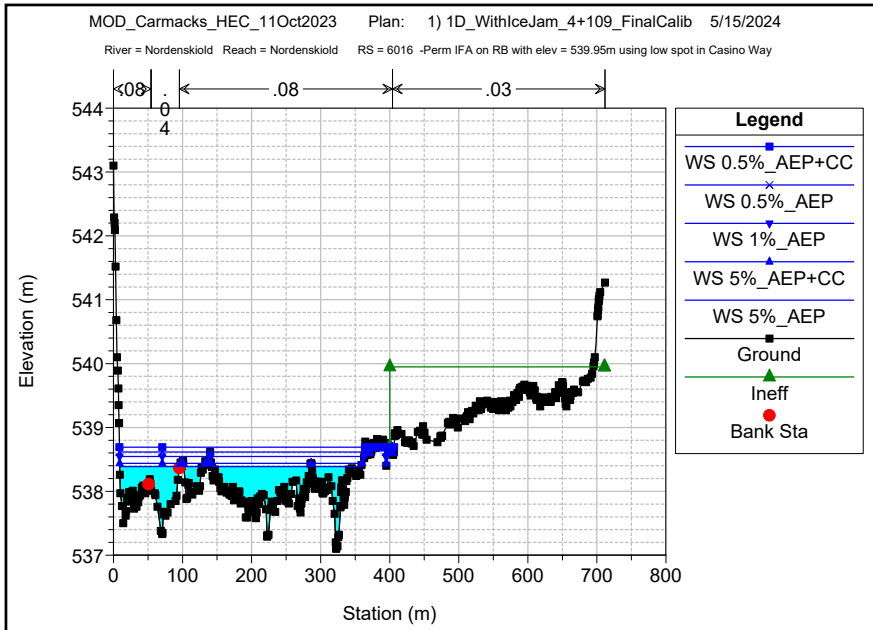

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6440 BR Casino Bypass
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

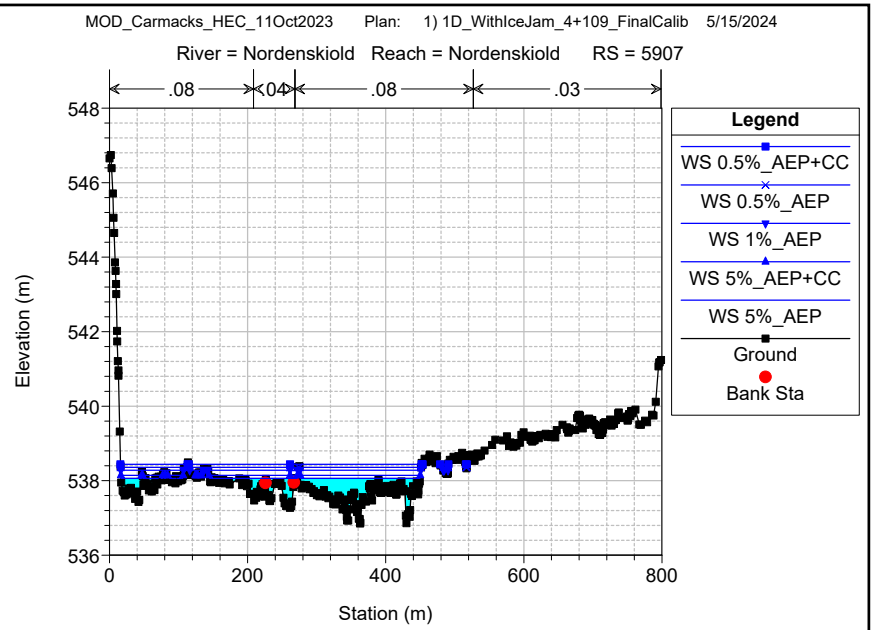

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6433 -Perm IFA on LB with elev = 547m using low spot in Casino Way we
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

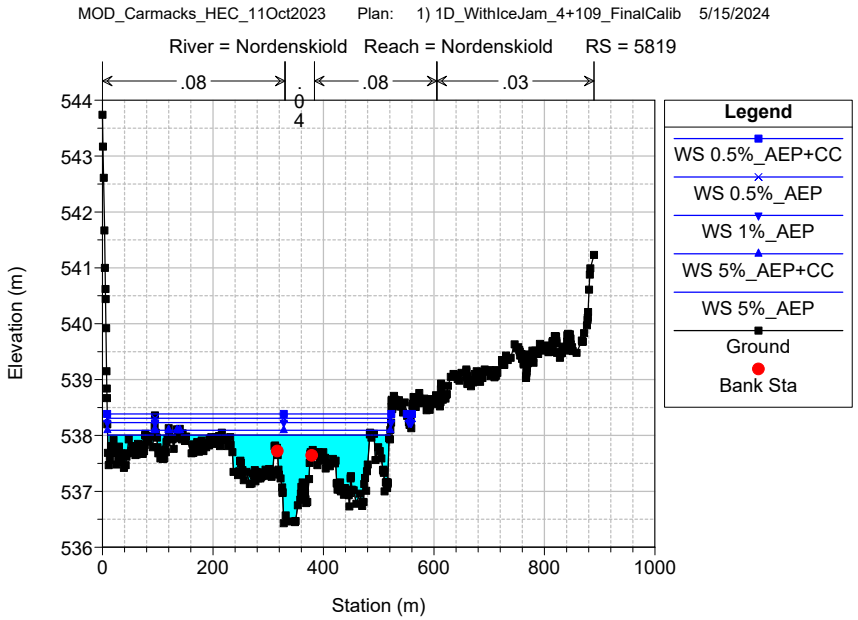

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6416 -Perm IFA on LB with elev = 546.95m using low spot in Casino Way
.02
.04
.02
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

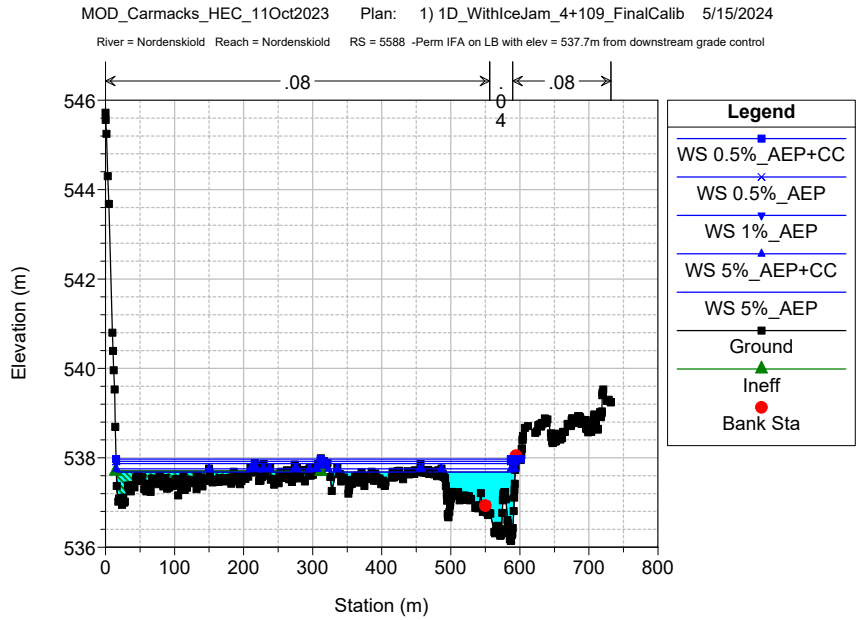

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6248 -Perm IFA on LB with elev = 546.95m using low spot in Casino Way
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

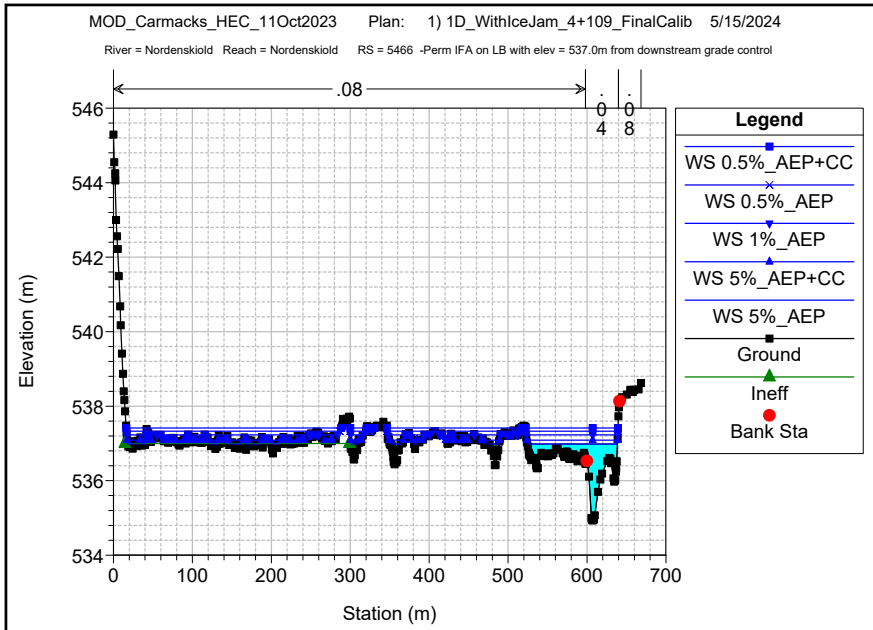

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6109 -Perm IFA on LB with elev = 546m using low spot in Casino Way we
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

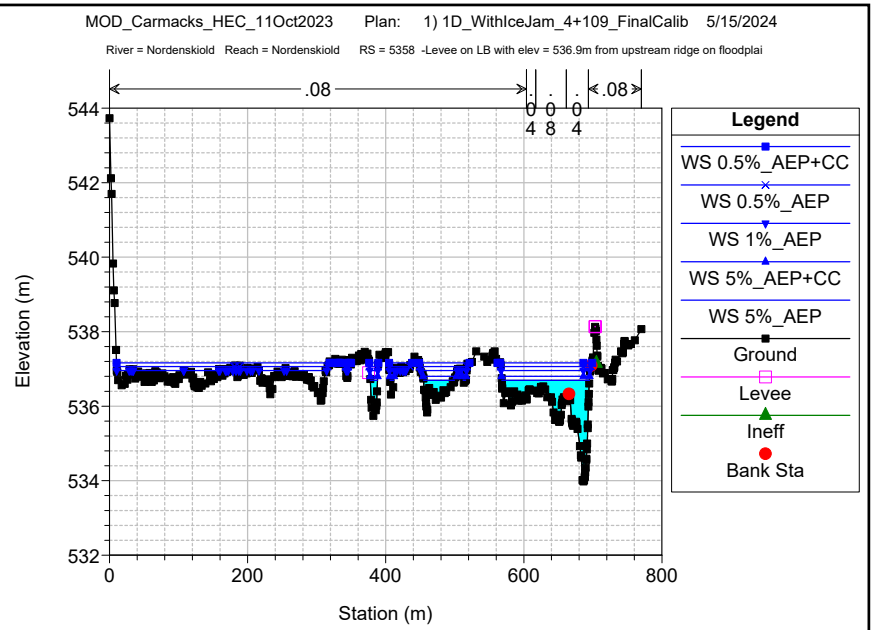

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6016 -Perm IFA on RB with elev = 539.95m using low spot in Casino Way
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

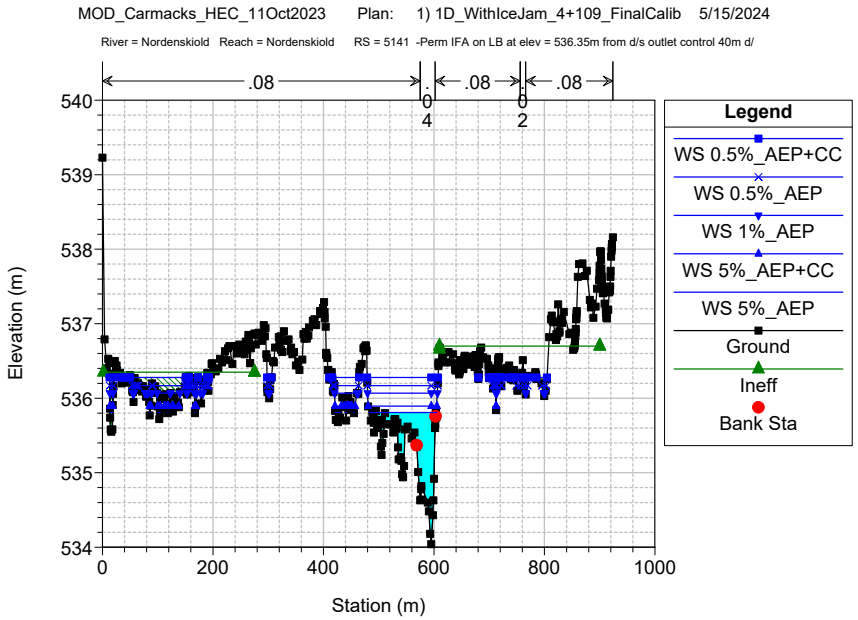

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5907
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

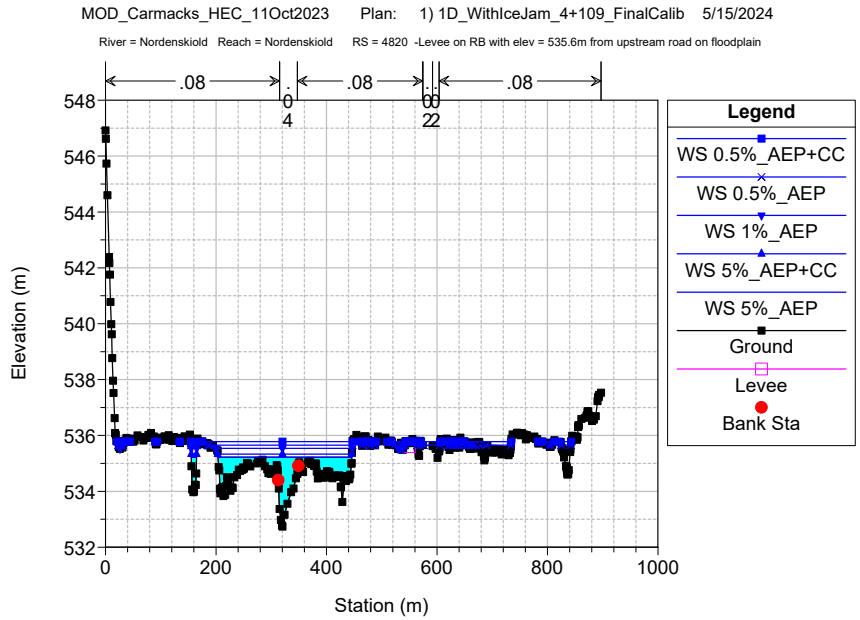

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5819
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

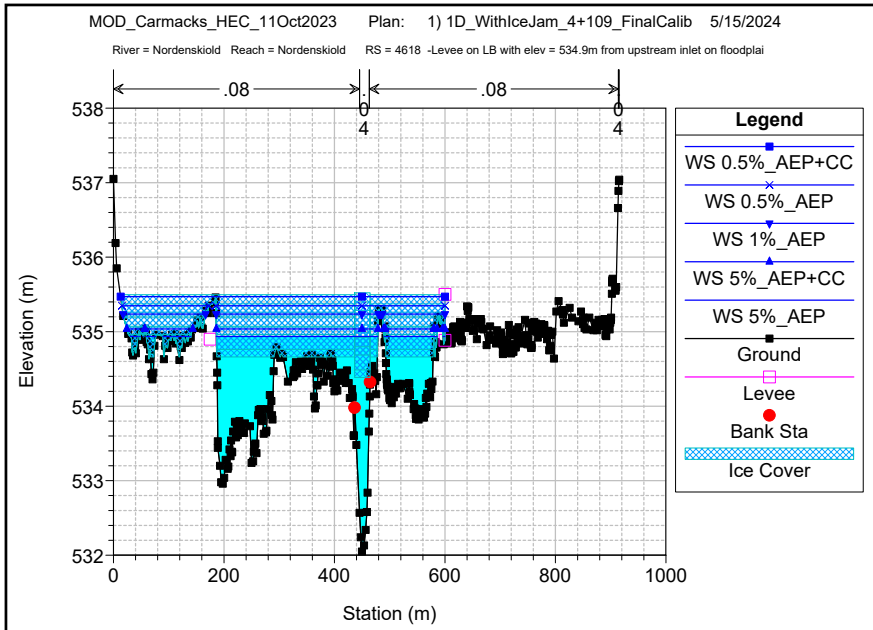

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5588 -Perm IFA on LB with elev = 537.7m from downstream grade control
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

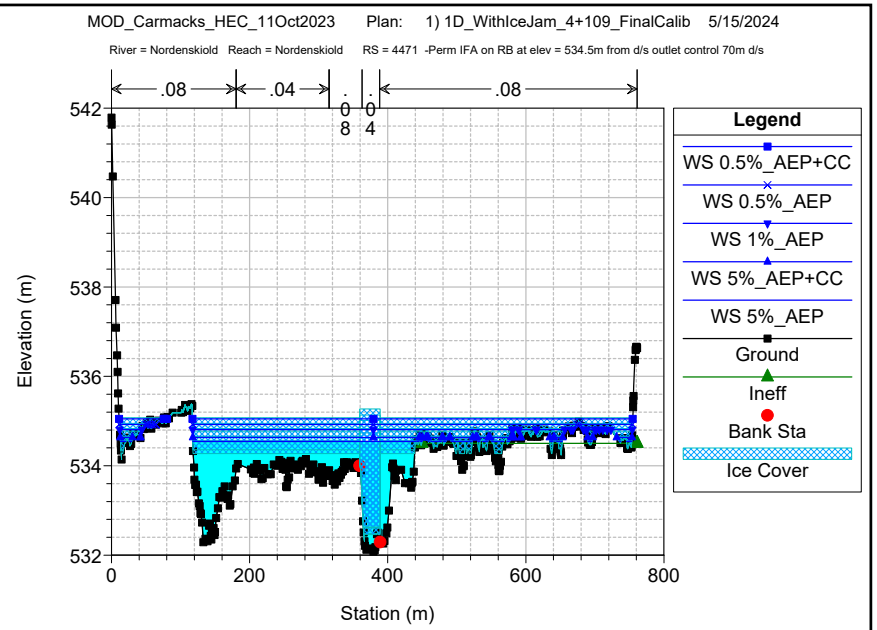

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5466 -Perm IFA on LB with elev = 537.0m from downstream grade control
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

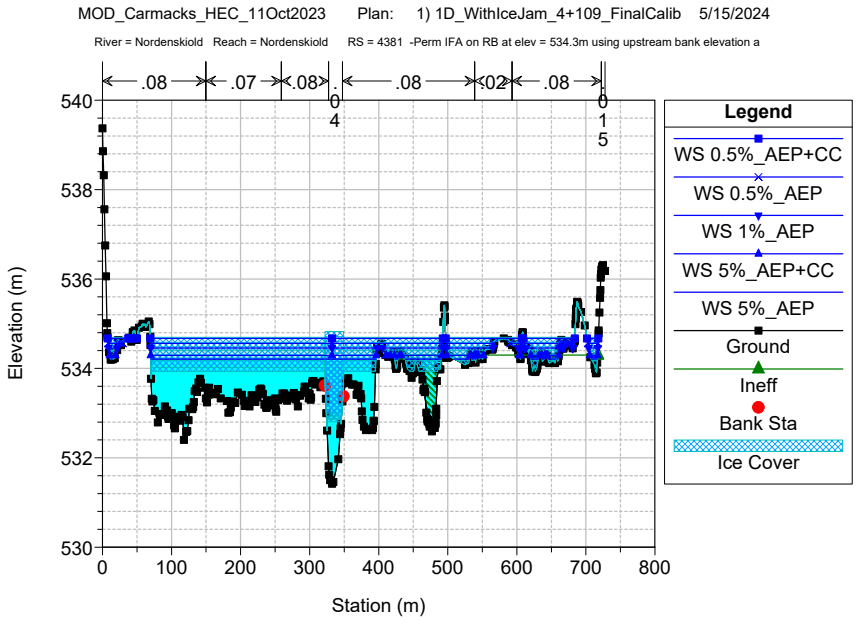

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5358 -Levee on LB with elev = 536.9m from upstream ridge on floodplai
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

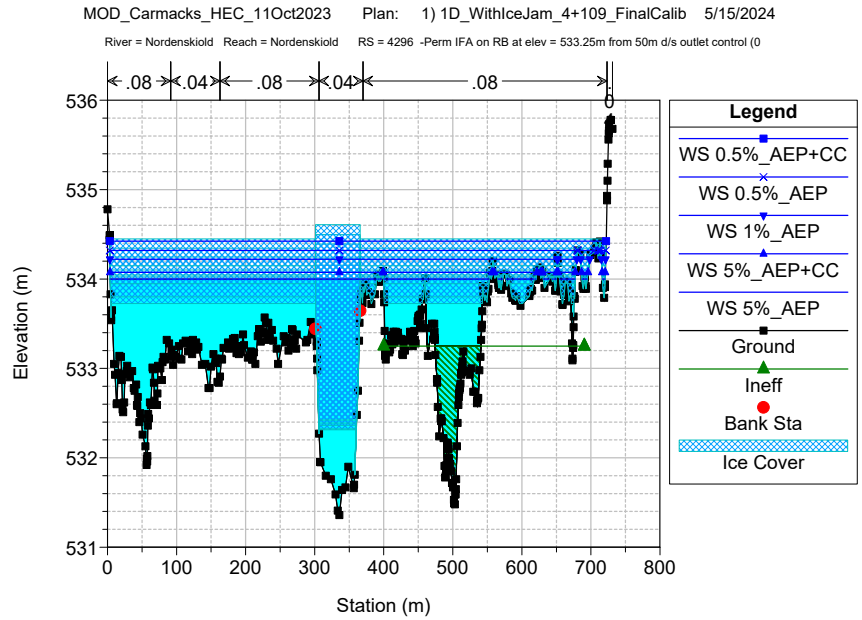

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5141 -Perm IFA on LB at elev = 536.35m from d/s outlet control 40m d/
.08
.04
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

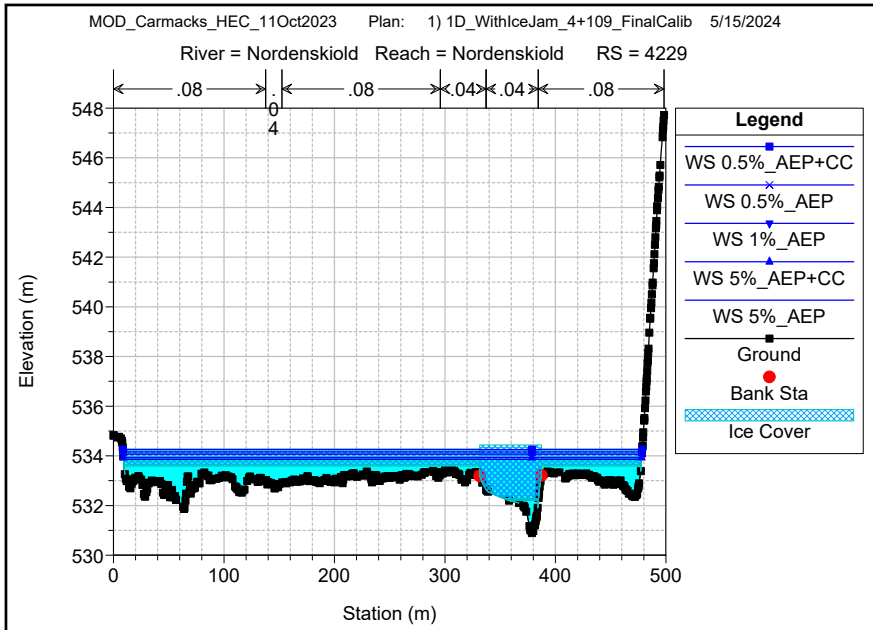

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4820 -Levee on RB with elev = 535.6m from upstream road on floodplain
.08
.04
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

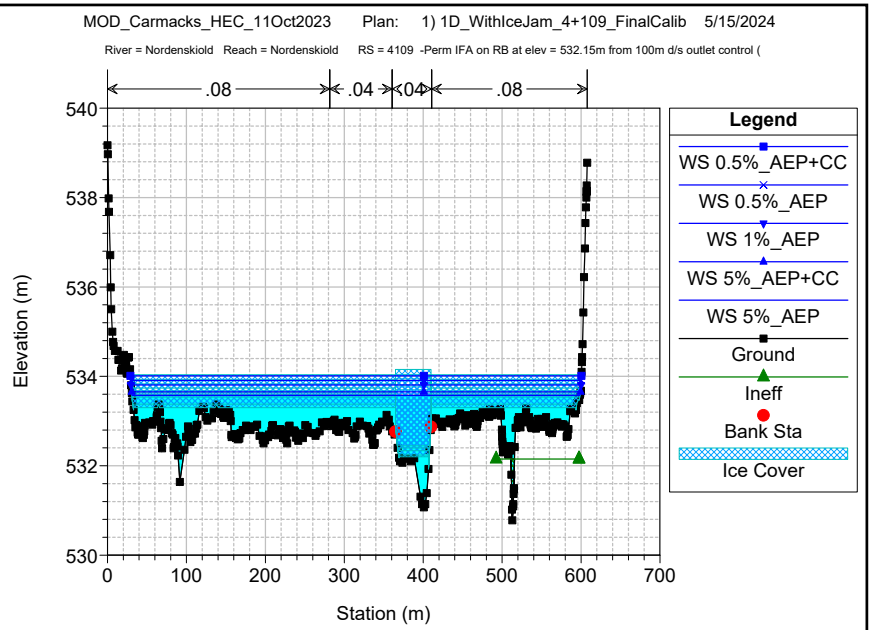

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4618 -Levee on LB with elev = 534.9m from upstream inlet on floodplai
.08
.08
.04
.04
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta
Ice Cover

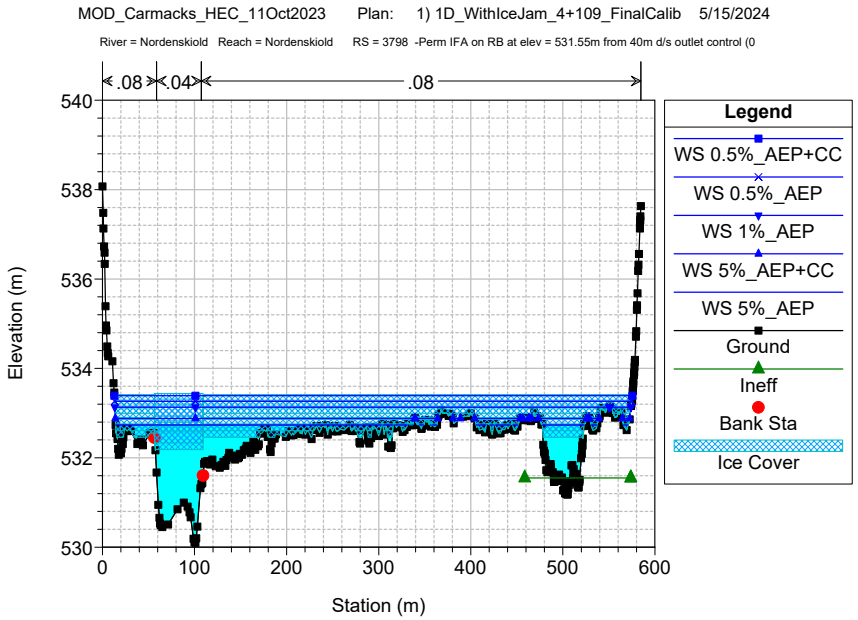

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4471 -Perm IFA on RB at elev = 534.5m from d/s outlet control 70m d/s
.08
.04
.08
.08
.04
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

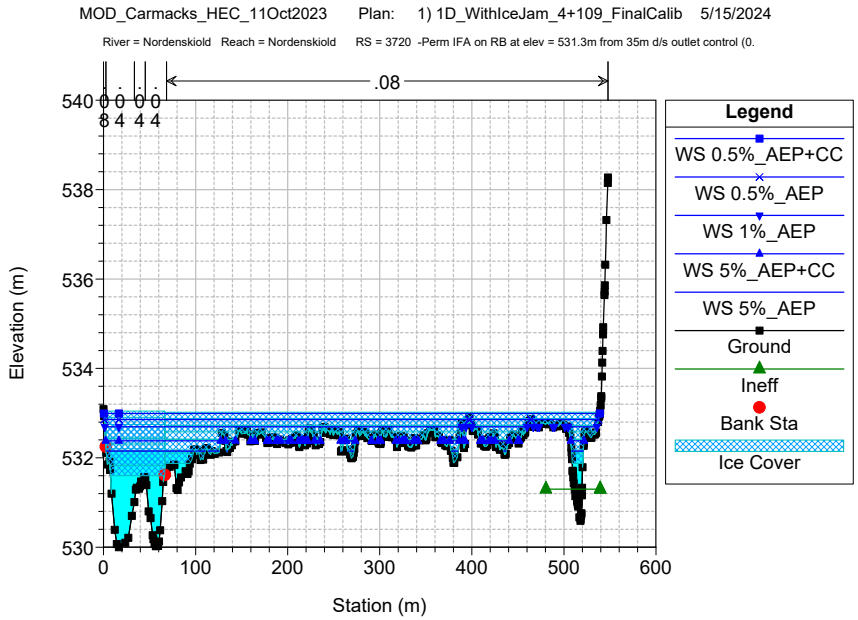

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4381 -Perm IFA on RB at elev = 534.3m using upstream bank elevation a
.08
.07
.08
.08
.02
.08
.04
.15
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

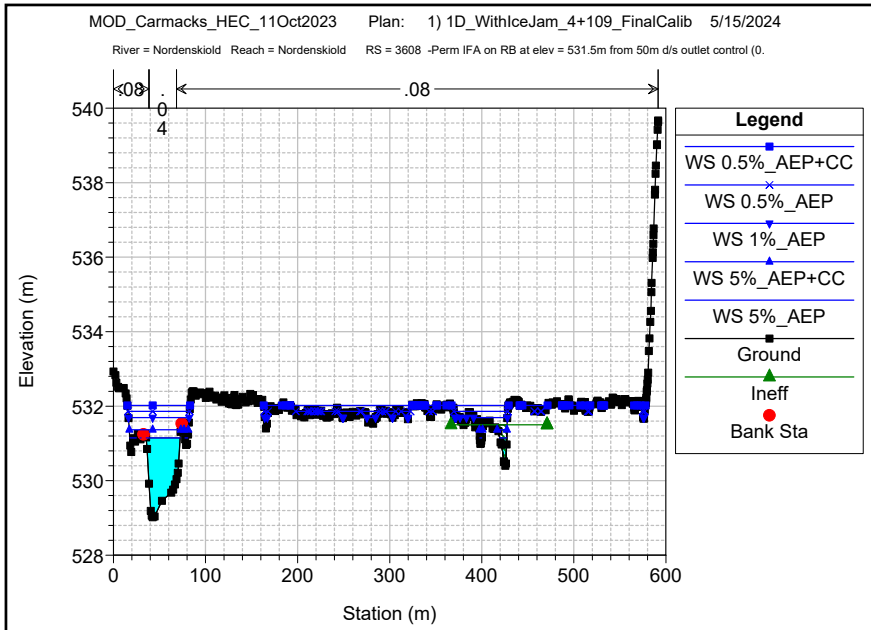

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4296 -Perm IFA on RB at elev = 533.25m from 50m d/s outlet control (0
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

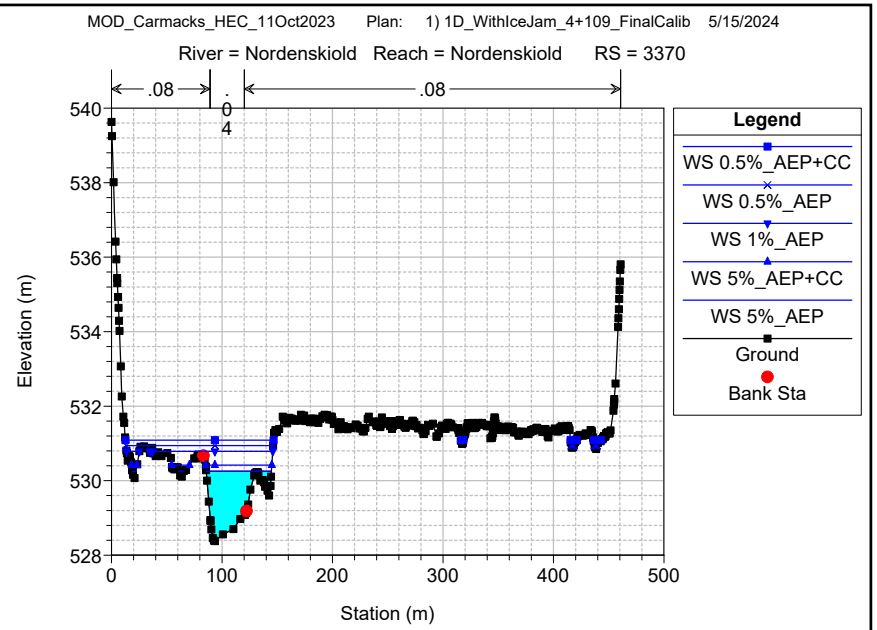

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4229
.08
.04
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta
Ice Cover

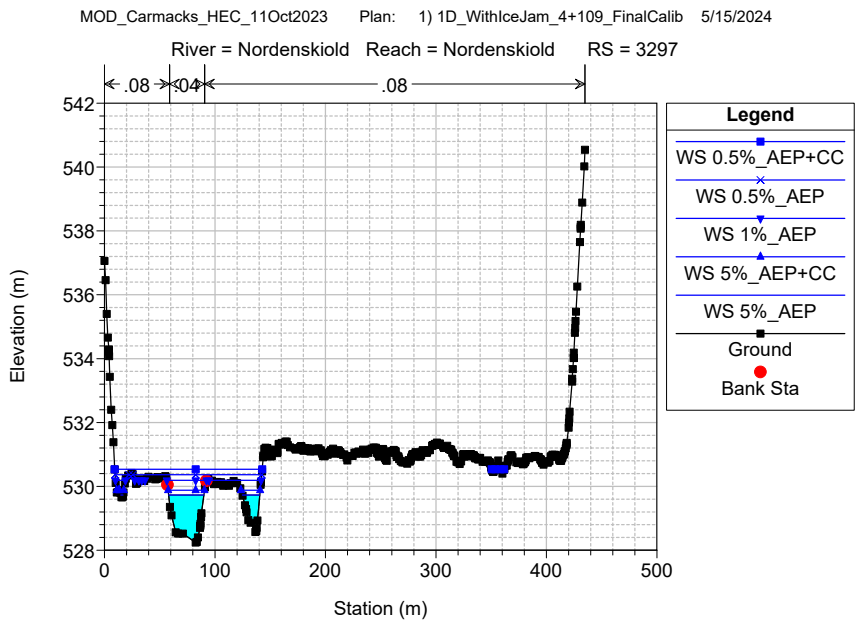

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4109 -Perm IFA on RB at elev = 532.15m from 100m d/s outlet control (
.08
.04
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

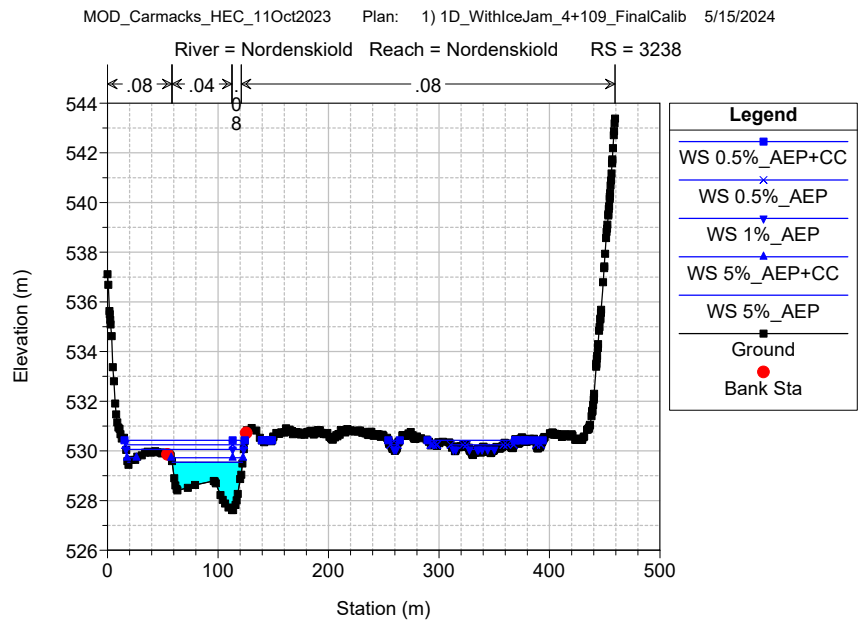

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3798 -Perm IFA on RB at elev = 531.55m from 40m d/s outlet control (0
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

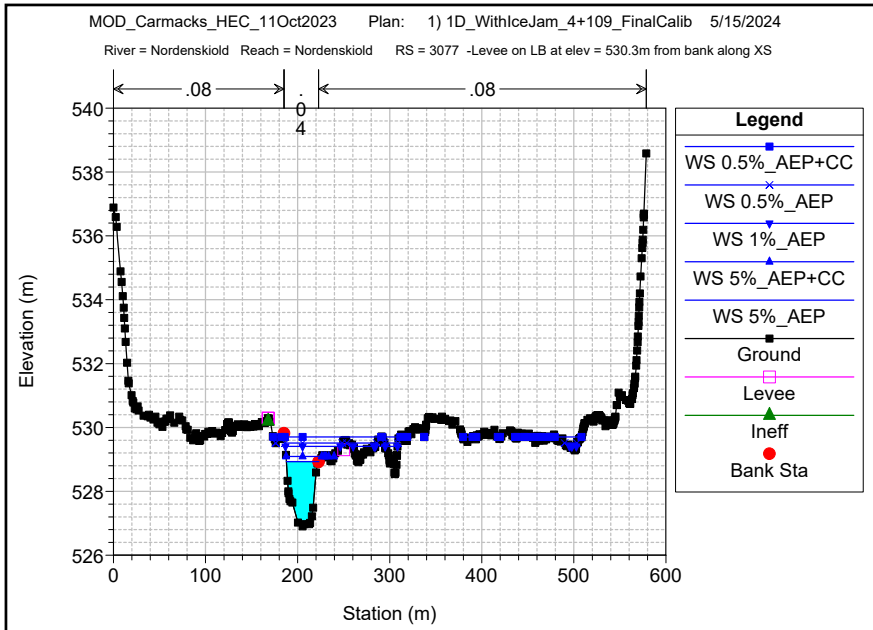

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3720 -Perm IFA on RB at elev = 531.3m from 35m d/s outlet control (0.
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

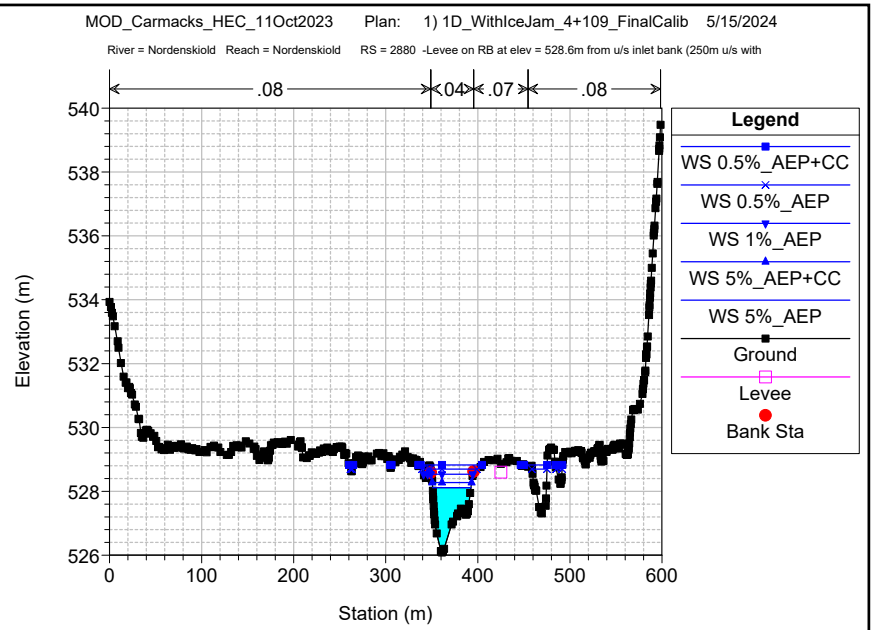

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3608 -Perm IFA on RB at elev = 531.5m from 50m d/s outlet control (0.
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

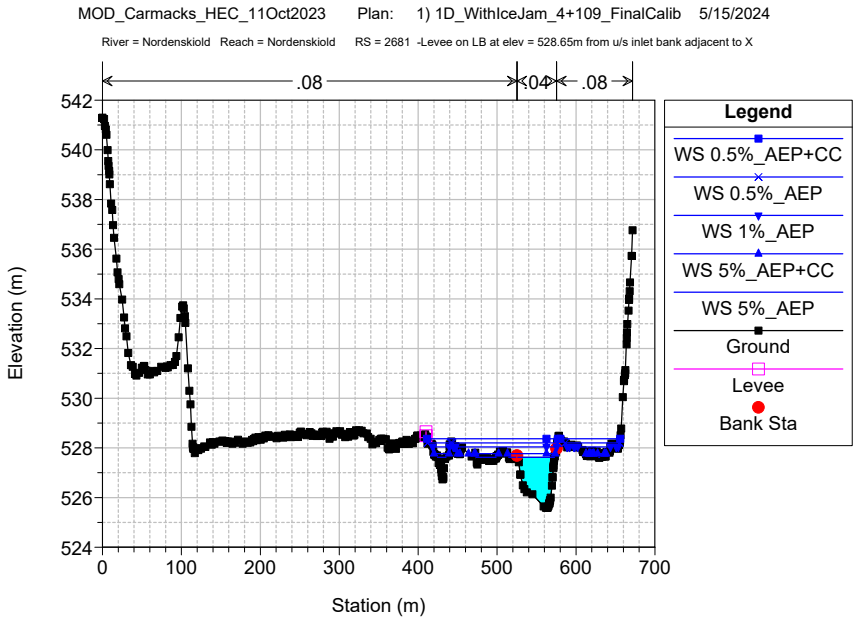

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3370
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

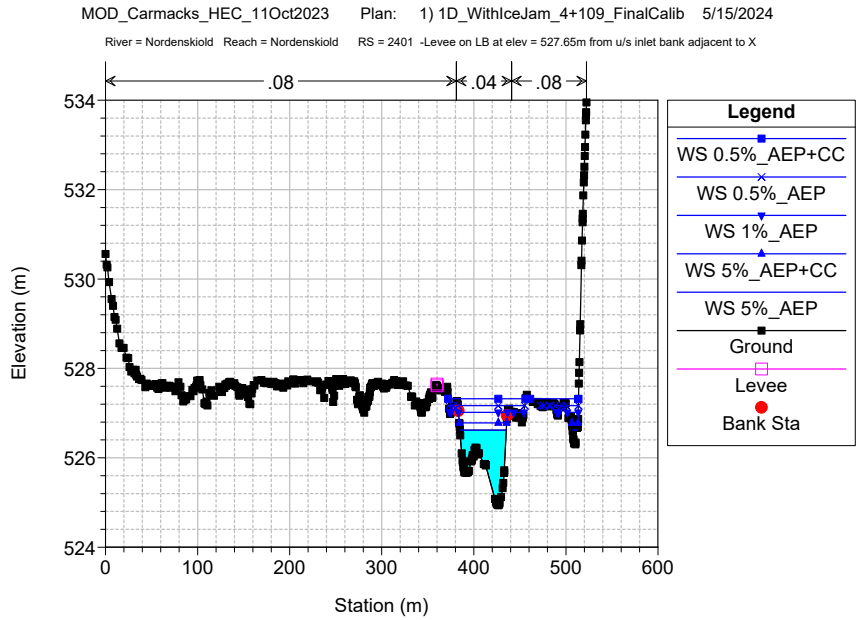

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3297
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

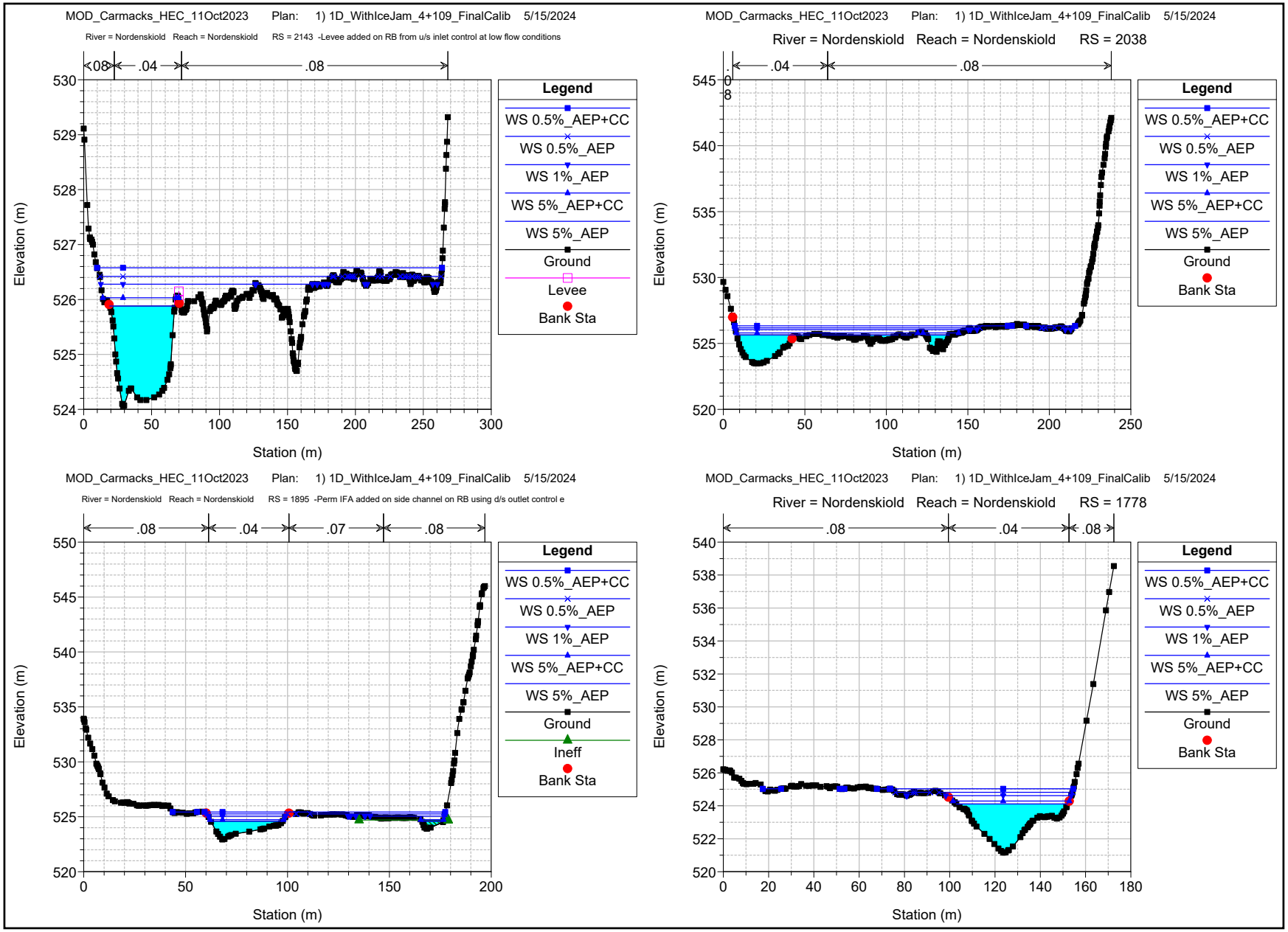

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3238
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

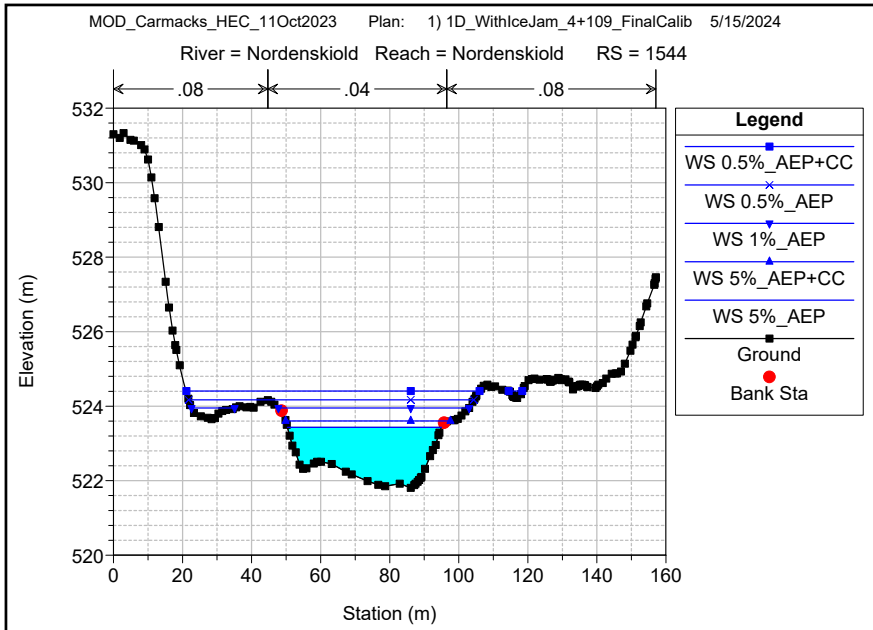

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3077 -Levee on LB at elev = 530.3m from bank along XS
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

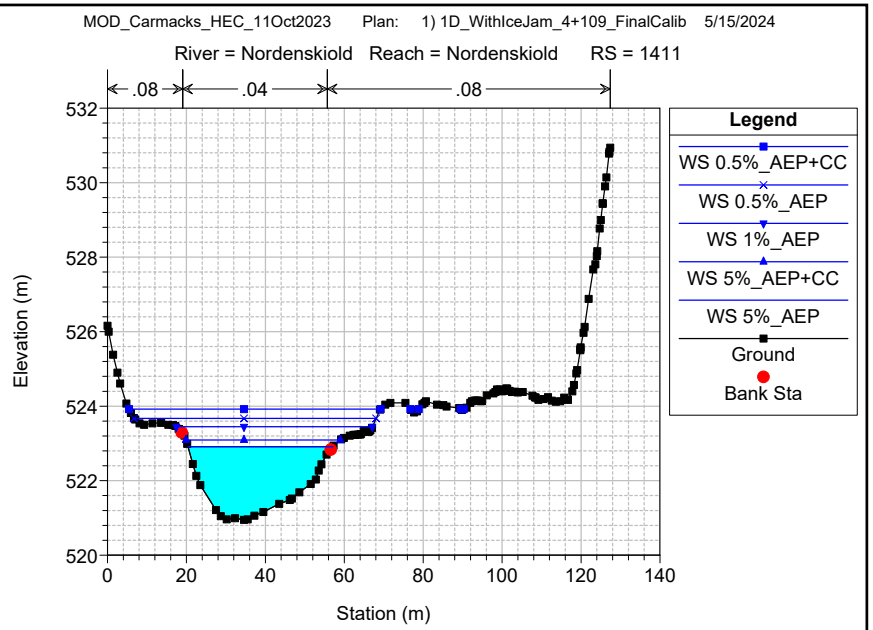

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2880 -Levee on RB at elev = 528.6m from u/s inlet bank (250m u/s with
.08
.04
.07
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

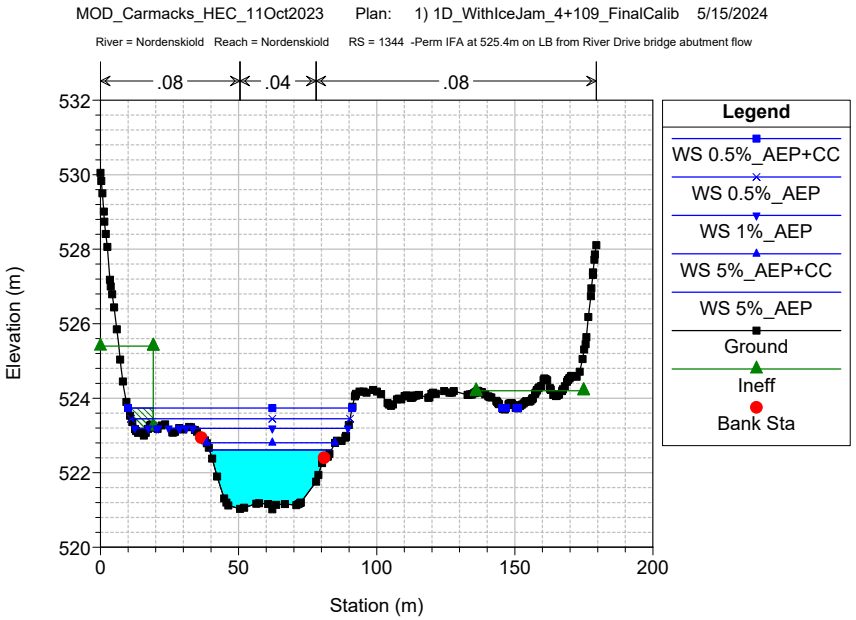

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2681 -Levee on LB at elev = 528.65m from u/s inlet bank adjacent to X
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

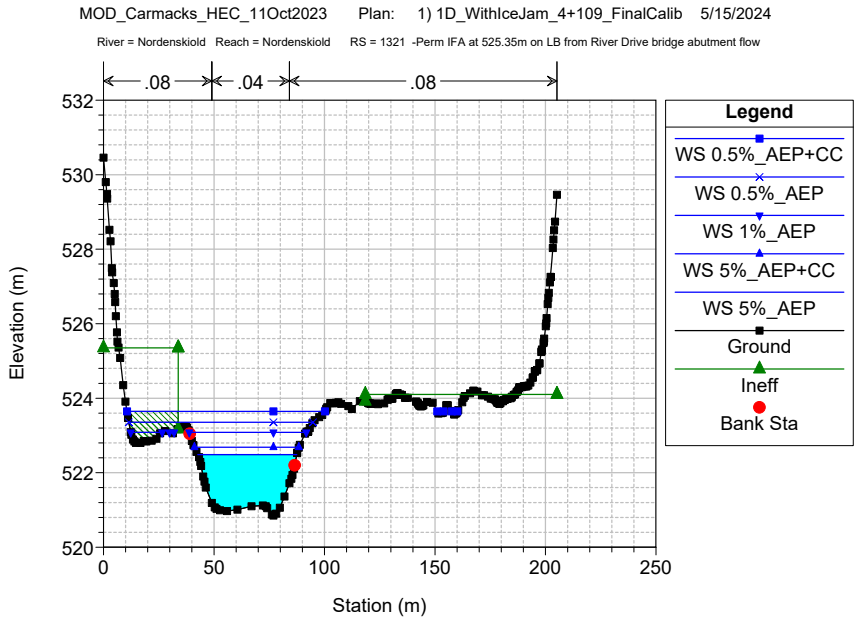

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2401 -Levee on LB at elev = 527.65m from u/s inlet bank adjacent to X
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

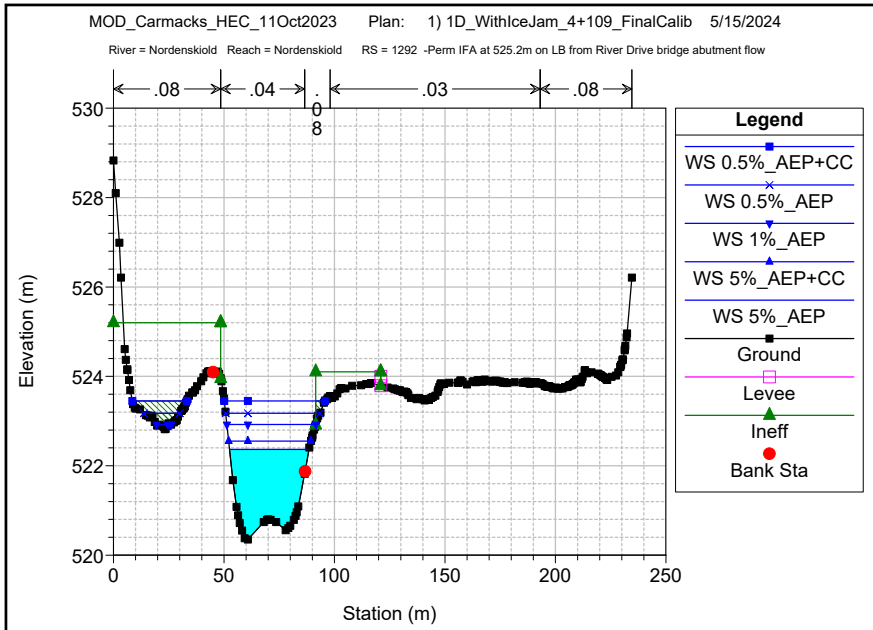

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2143 -Levee added on RB from u/s inlet control at low flow conditions
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2038
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1895 -Perm IFA added on side channel on RB using d/s outlet control e
.08
.04
.07
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1778
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

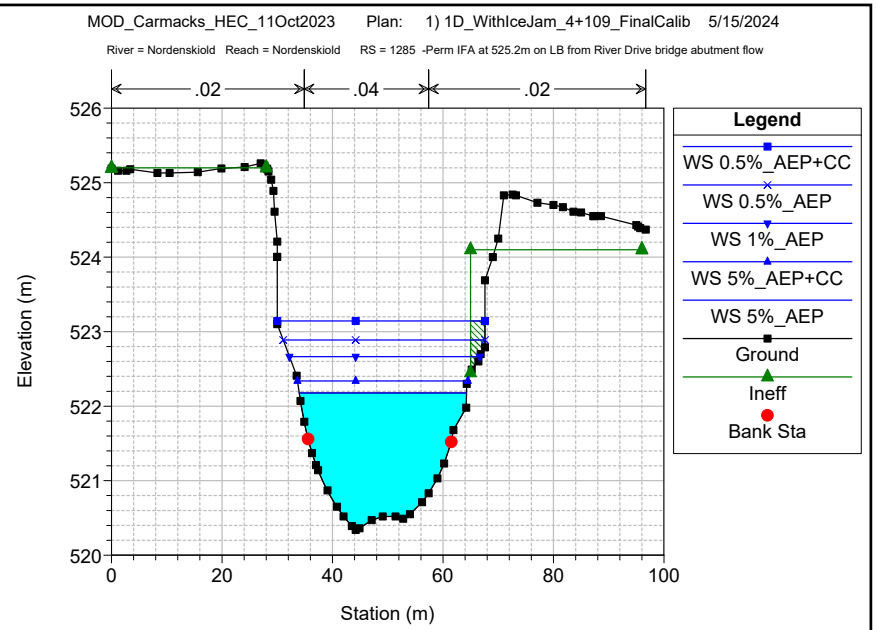

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1544
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

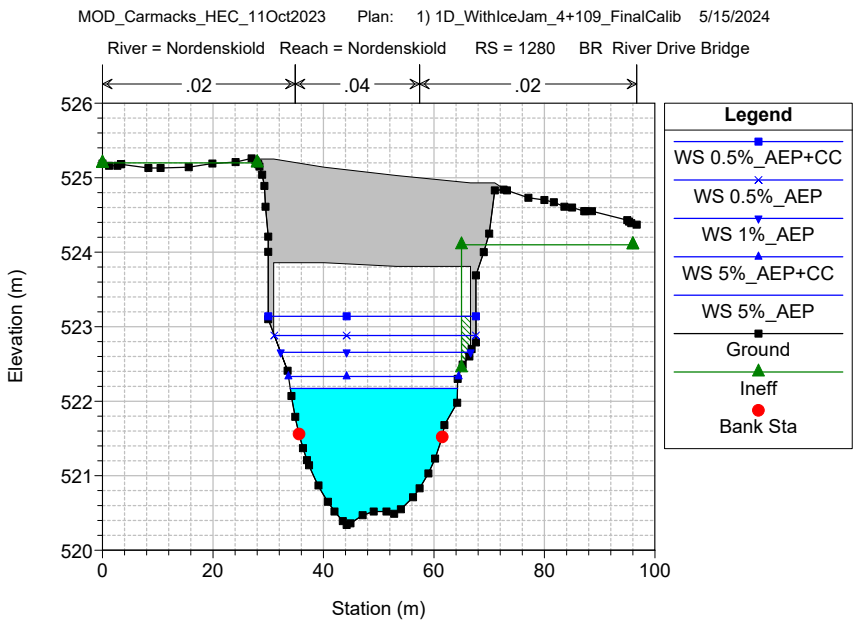

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1411
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

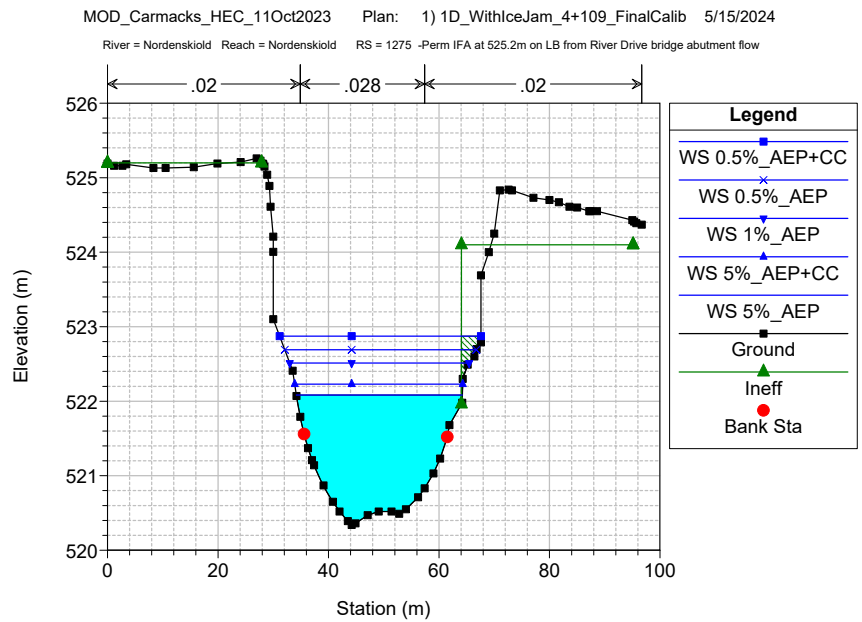

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1344 -Perm IFA at 525.4m on LB from River Drive bridge abutment flow
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

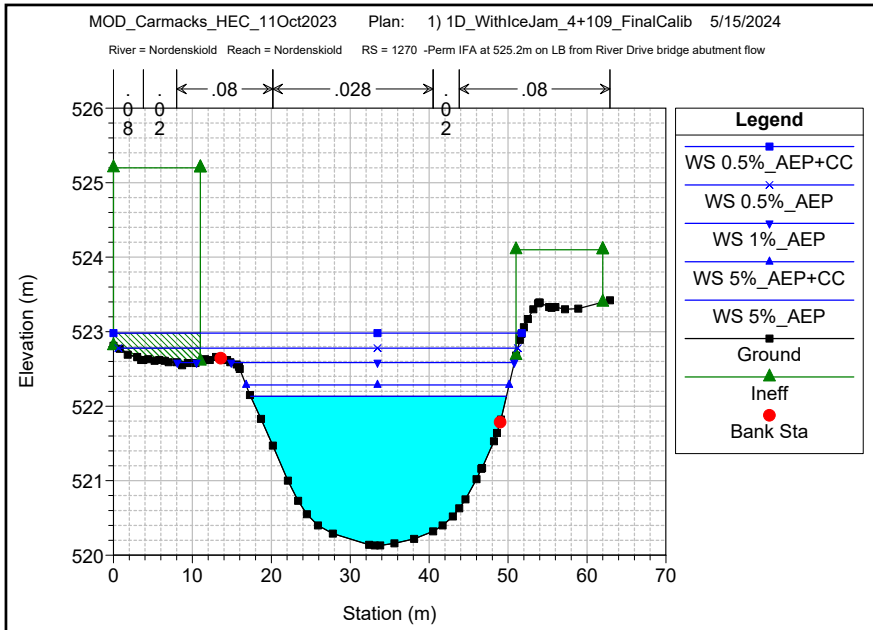

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1321 -Perm IFA at 525.35m on LB from River Drive bridge abutment flow
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

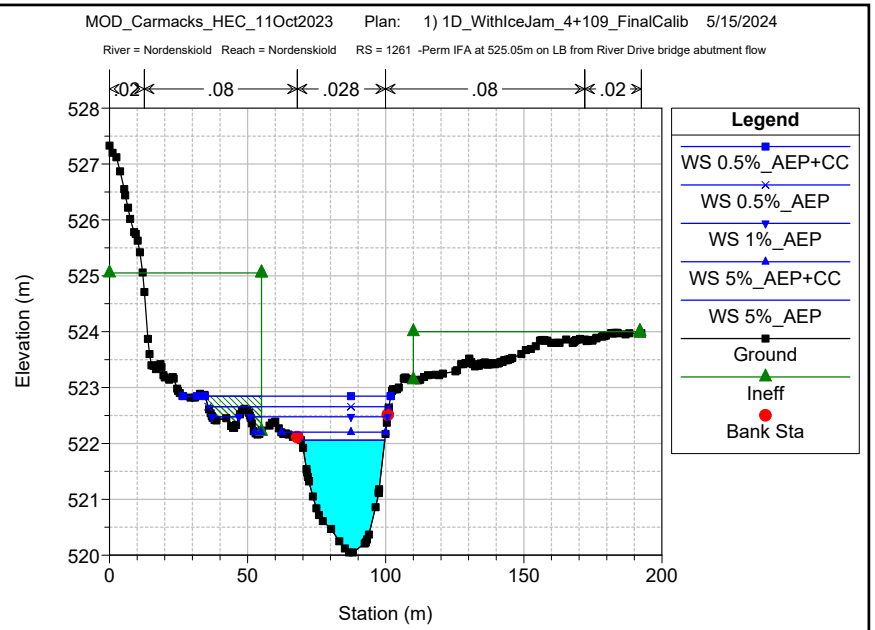

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1292 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.08
.04
.08
.03
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

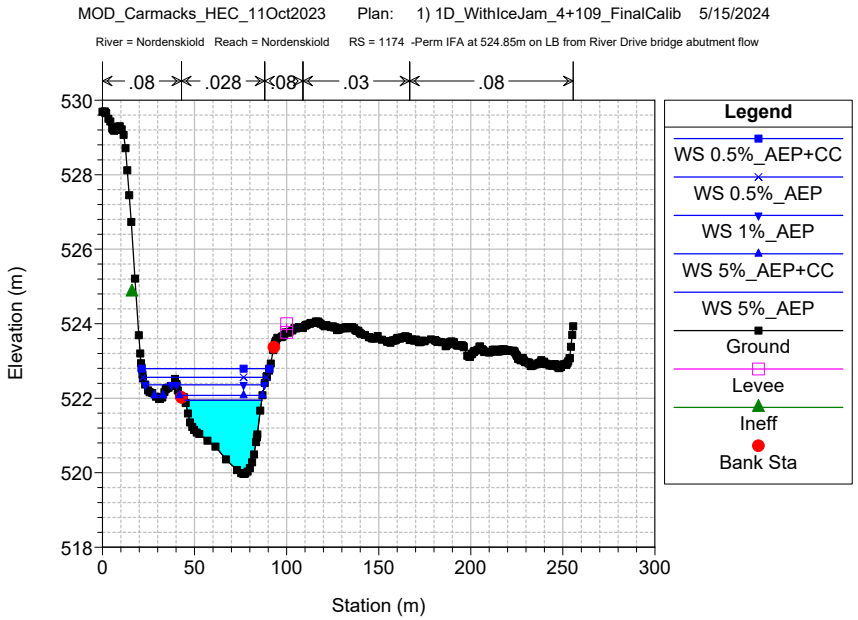

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1285 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

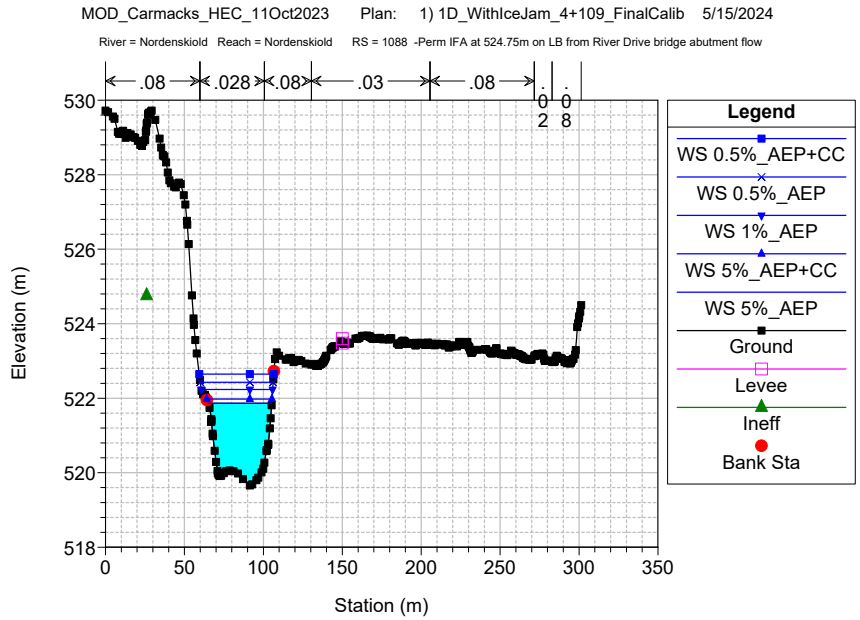

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1280 BR River Drive Bridge
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

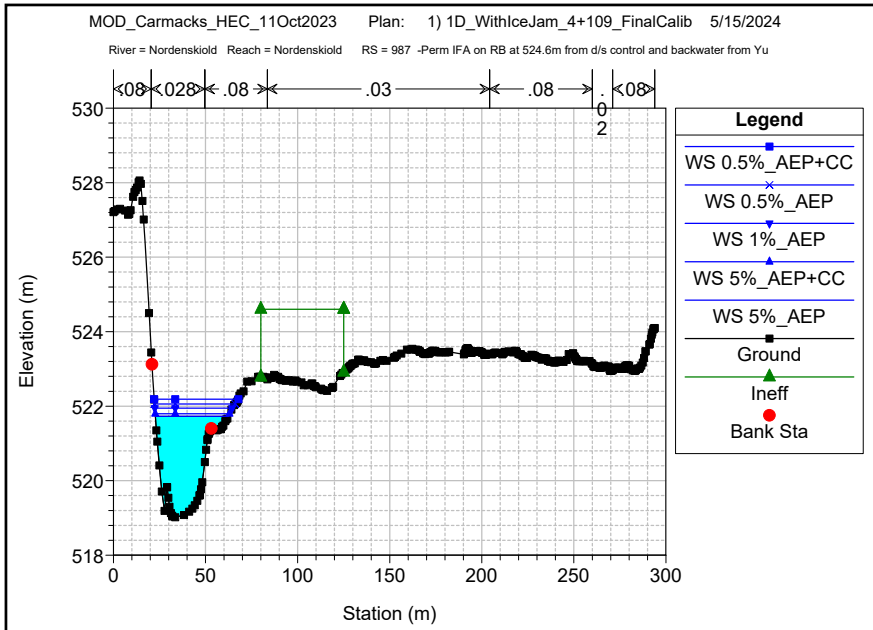

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1275 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.02
.028
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

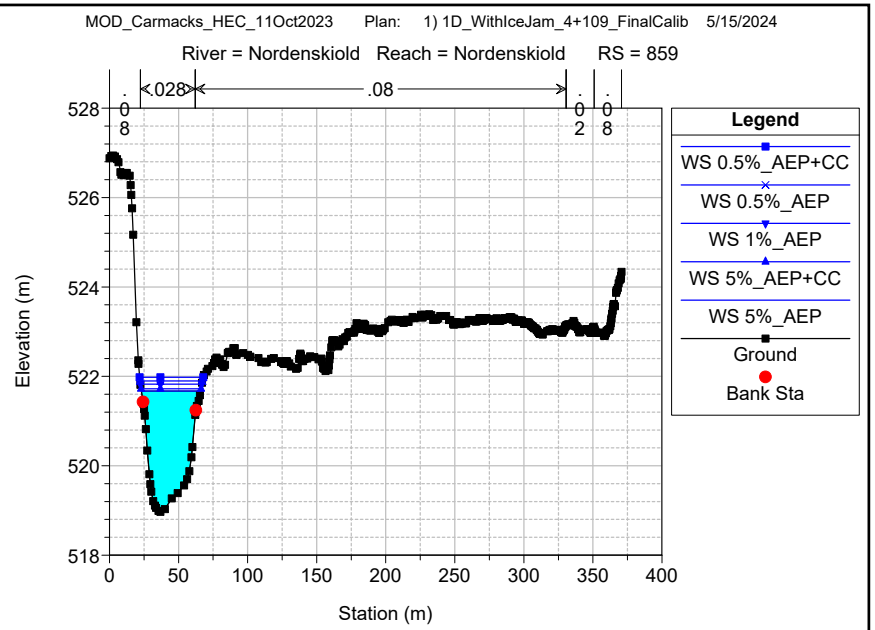

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1270 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.08
.028
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

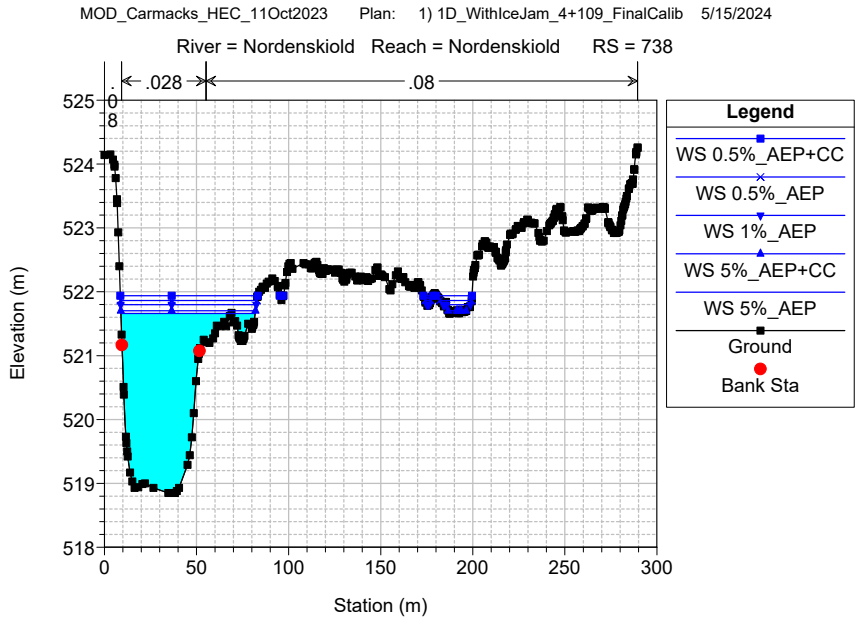

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1261 -Perm IFA at 525.05m on LB from River Drive bridge abutment flow
.02
.08
.028
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

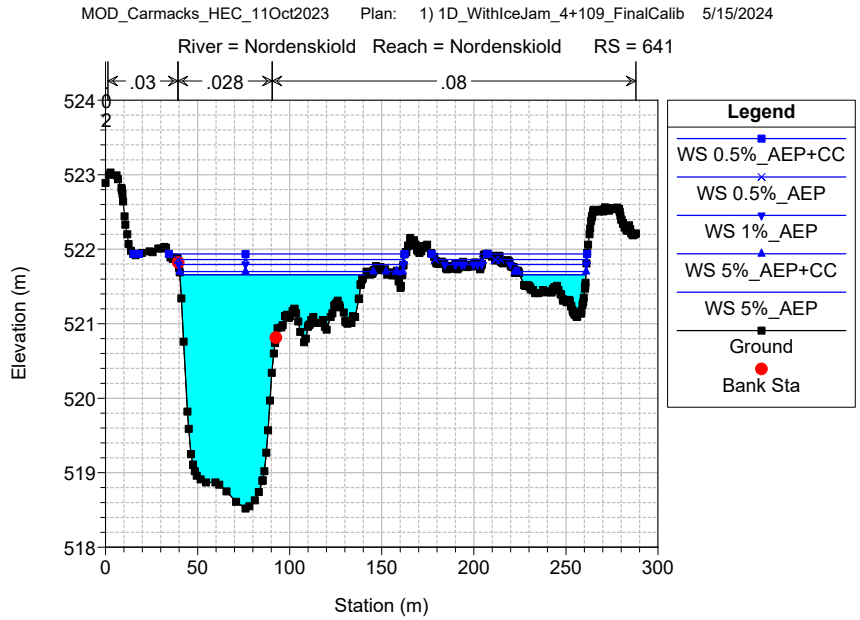

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1174 -Perm IFA at 524.85m on LB from River Drive bridge abutment flow
.08
.028
.08
.03
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1088 -Perm IFA at 524.75m on LB from River Drive bridge abutment flow
.08
.028
.08
.03
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 987 -Perm IFA on RB at 524.6m from d/s control and backwater from Yu
.08
.028
.08
.03
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

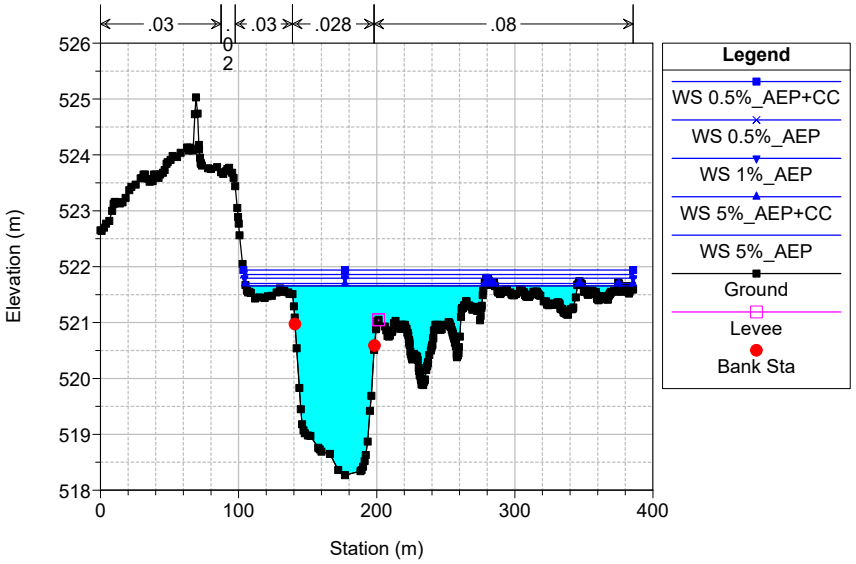

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 859
.08
.028
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 738
.08
.028
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 641
.03
.028
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

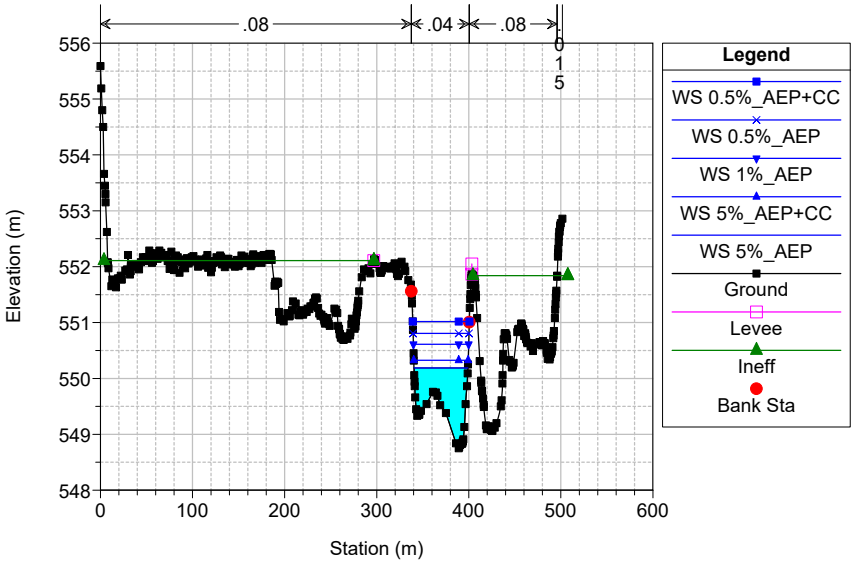
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_4+109_FinalCalib 5/15/2024

River = Nordenskiold Reach = Nordenskiold RS = 556 -Levee added on RB at 521.2m from adjacent bank elevation



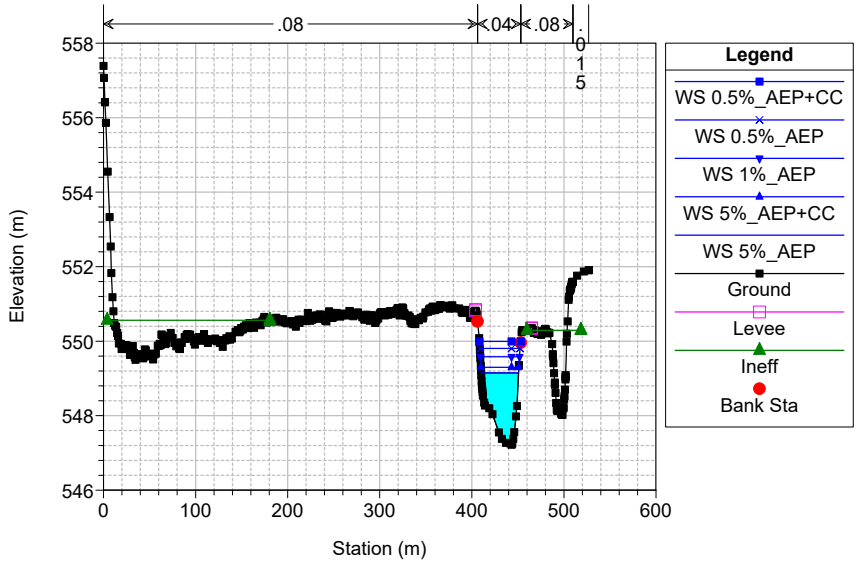
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024

River = Nordenskiold Reach = Nordenskiold RS = 9269 -XS extended to road on RB to prevent overspilling at edge of XS



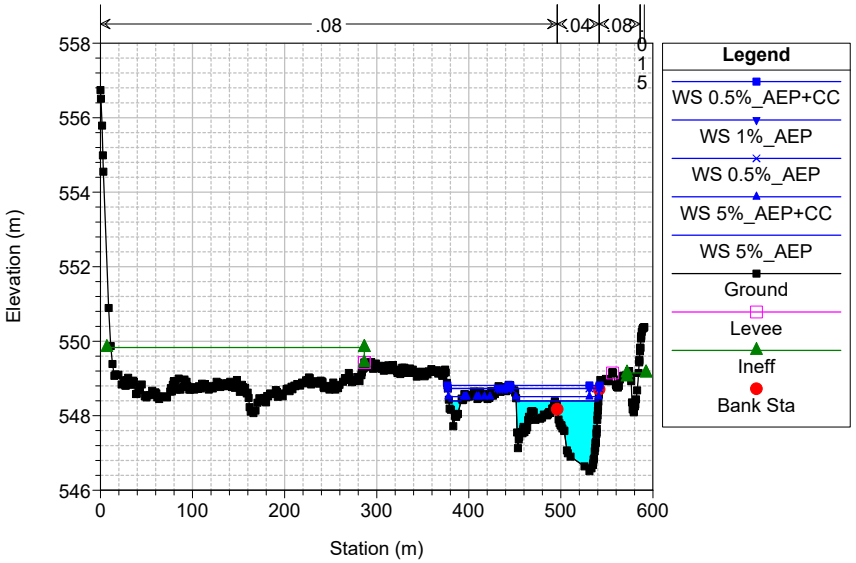
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024

River = Nordenskiold Reach = Nordenskiold RS = 9036 -Levee on LB with elev = 550.9 m (at same WSEs adjacent to XS at



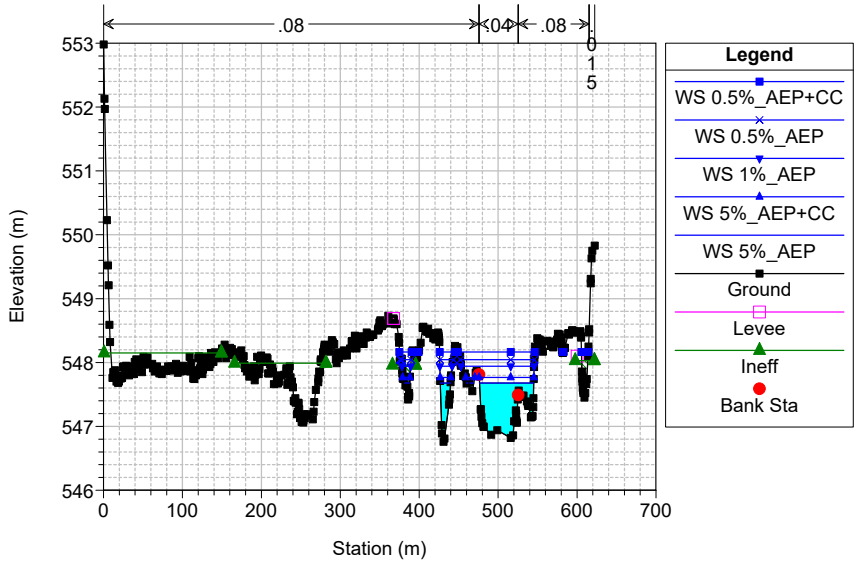
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024

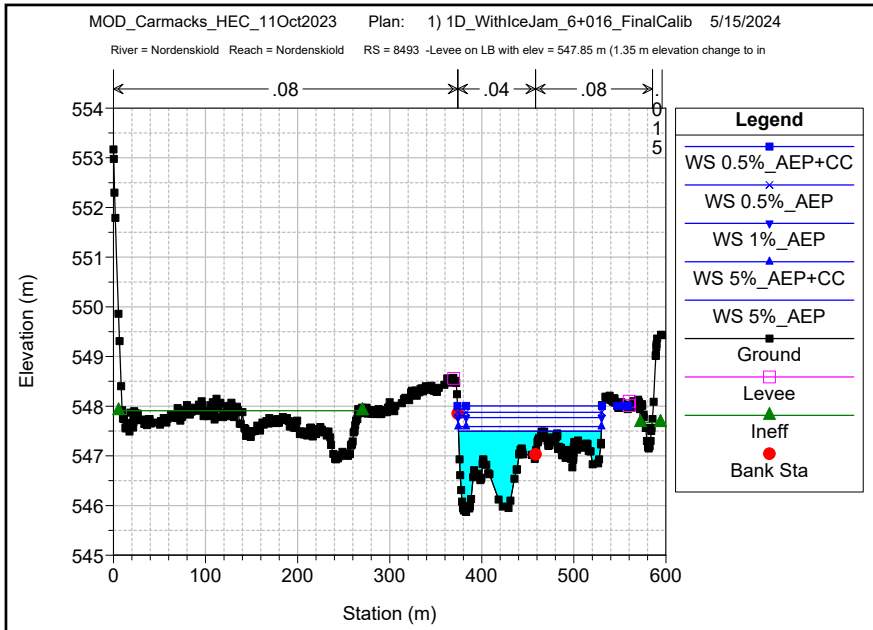
River = Nordenskiold Reach = Nordenskiold RS = 8713 -Levee on LB with elev = 548.6 m (0.6 m elevation change to inle

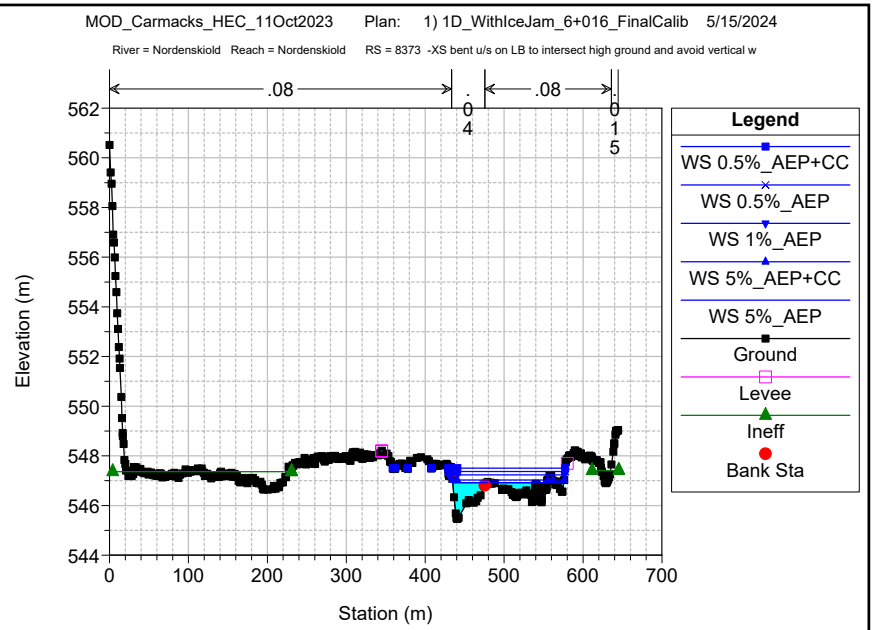


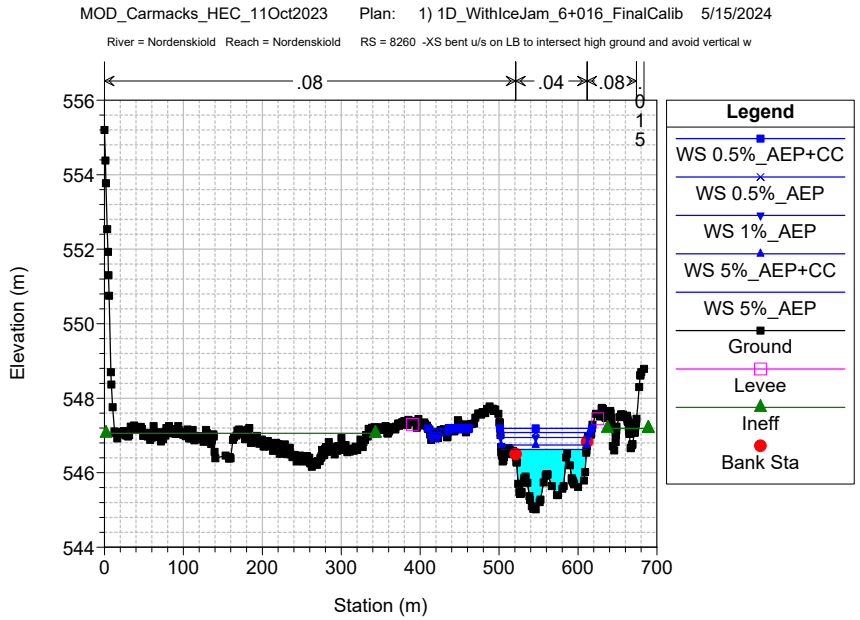
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024

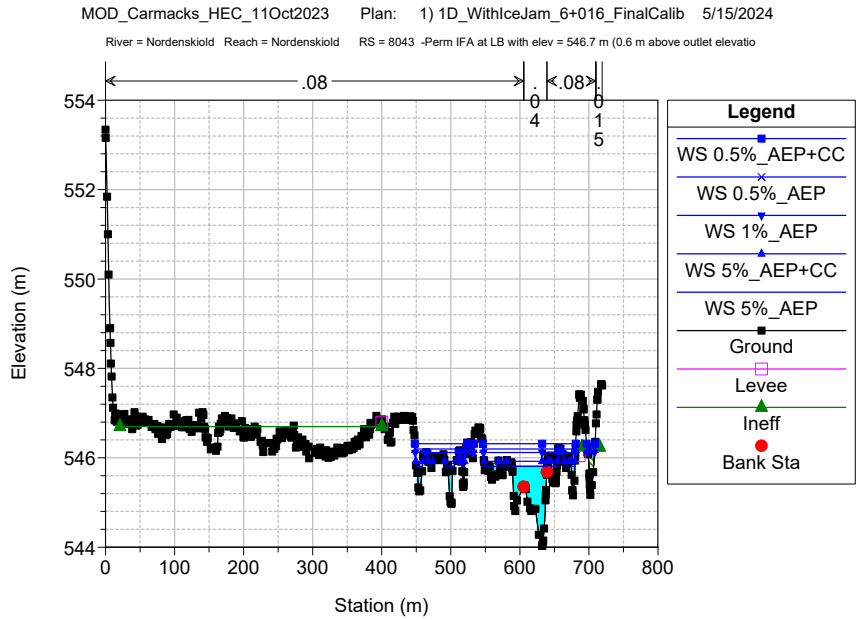
River = Nordenskiold Reach = Nordenskiold RS = 8577 -Levee on LB with elev = 548.0 m (1.2 m elevation change to inle

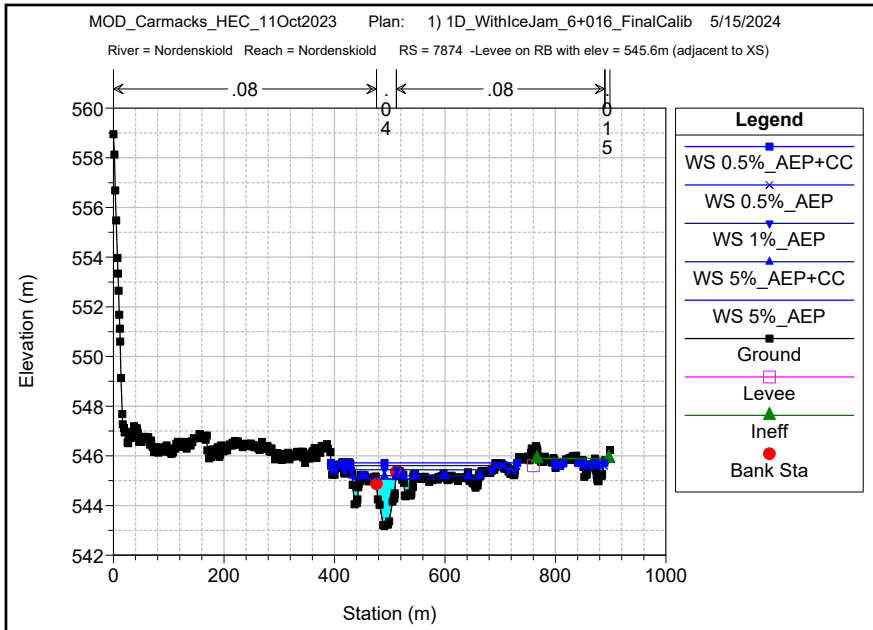


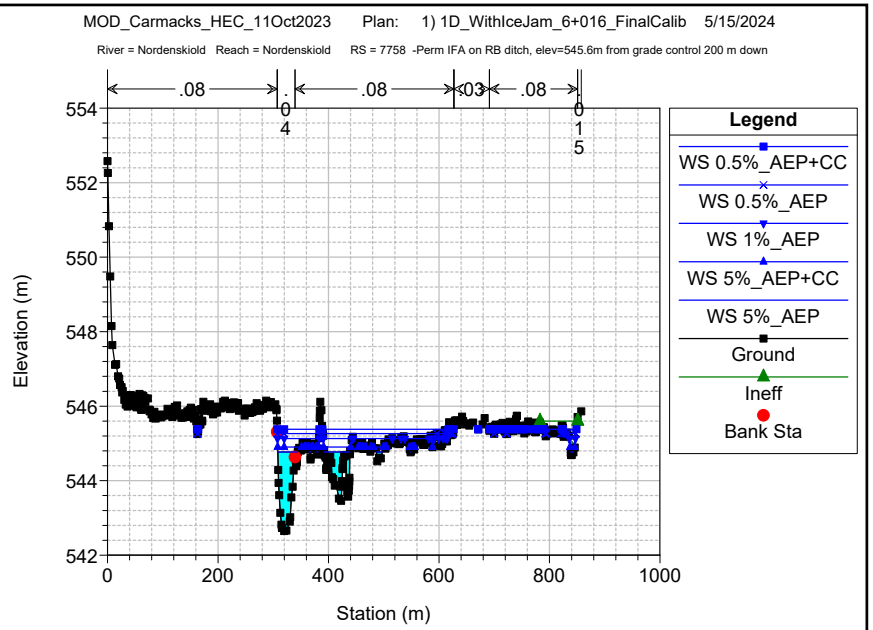

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 8493 -Levee on LB with elev = 547.85 m (1.35 m elevation change to in
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

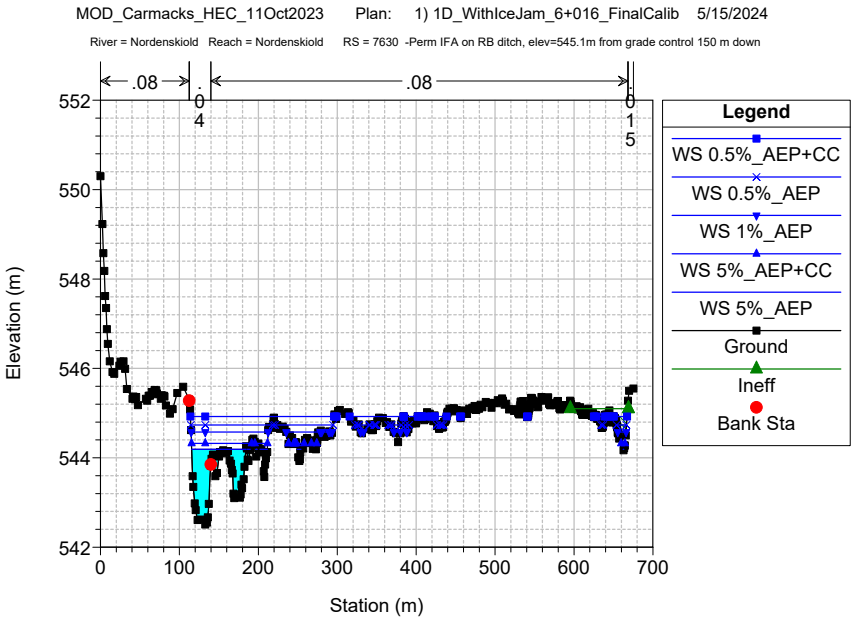

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 8373 -XS bent u/s on LB to intersect high ground and avoid vertical w
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

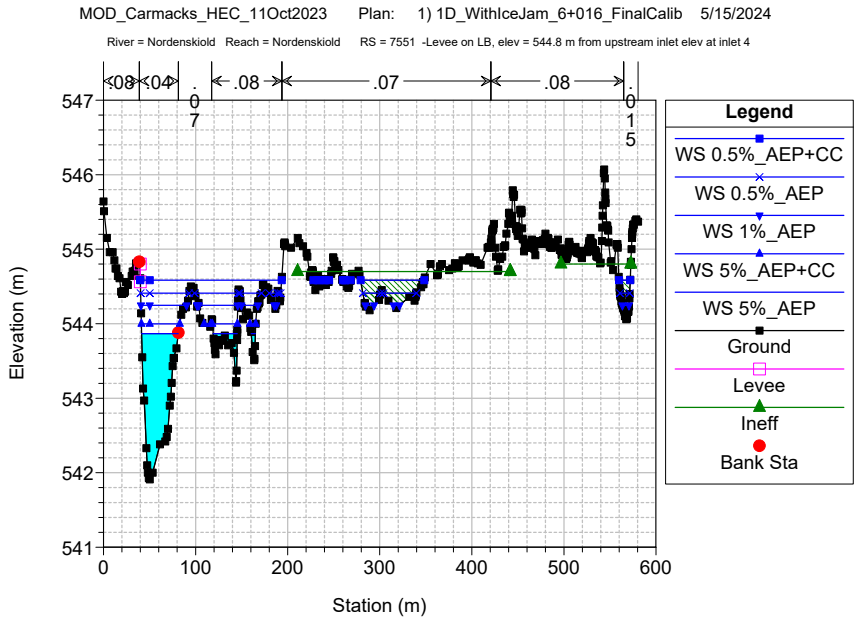

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 8260 -XS bent u/s on LB to intersect high ground and avoid vertical w
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

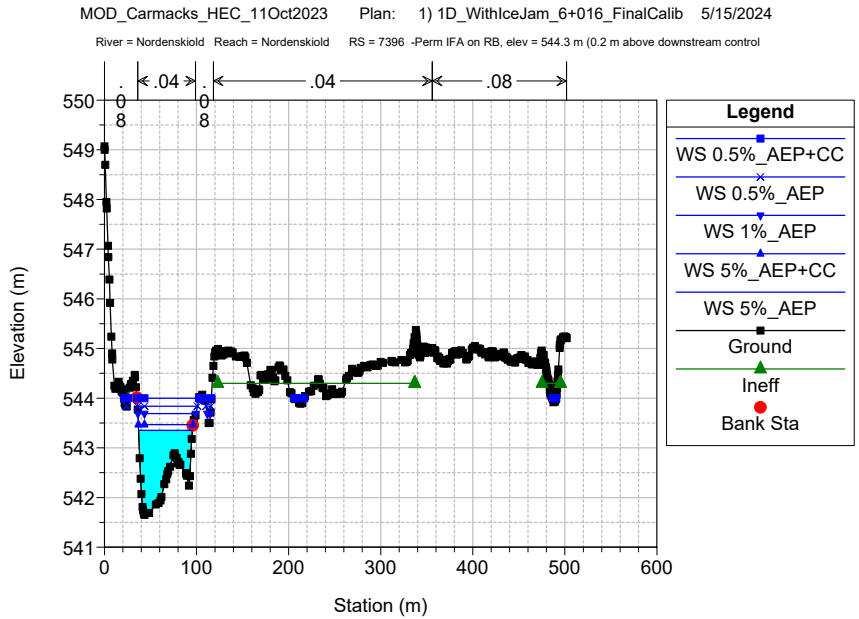

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 8043 -Perm IFA at LB with elev = 546.7 m (0.6 m above outlet elevatio
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

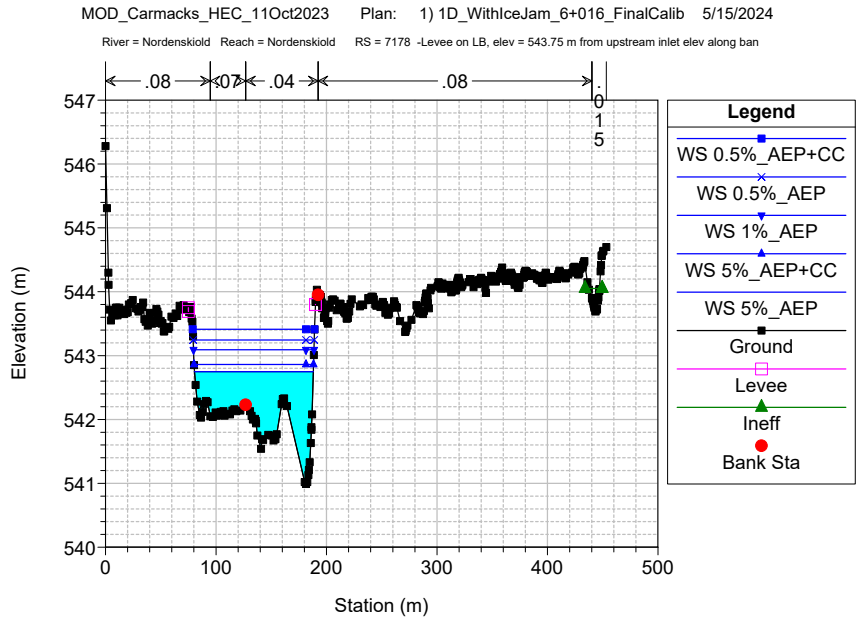

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7874 -Levee on RB with elev = 545.6m (adjacent to XS)
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

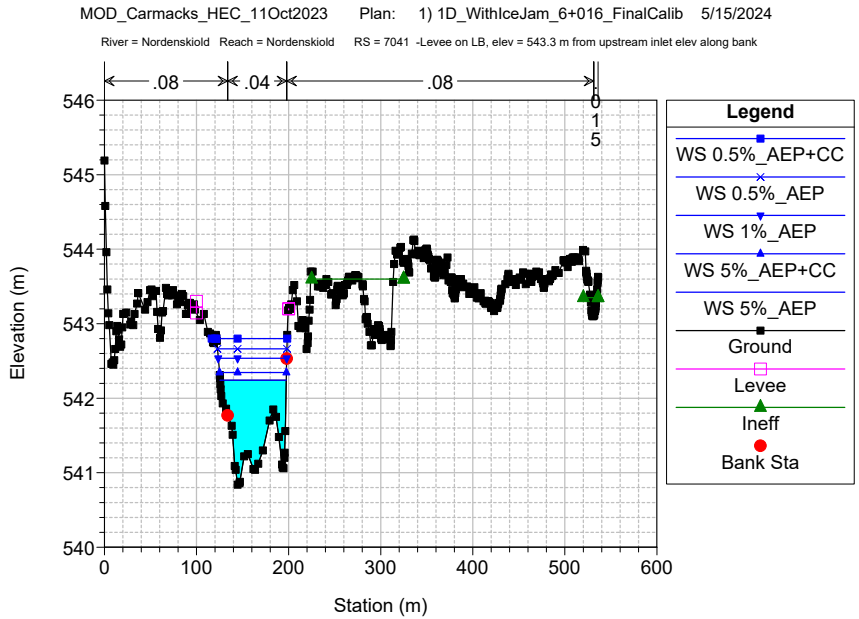

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7758 -Perm IFA on RB ditch, elev=545.6m from grade control 200 m down
.08
.04
.08
.03
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

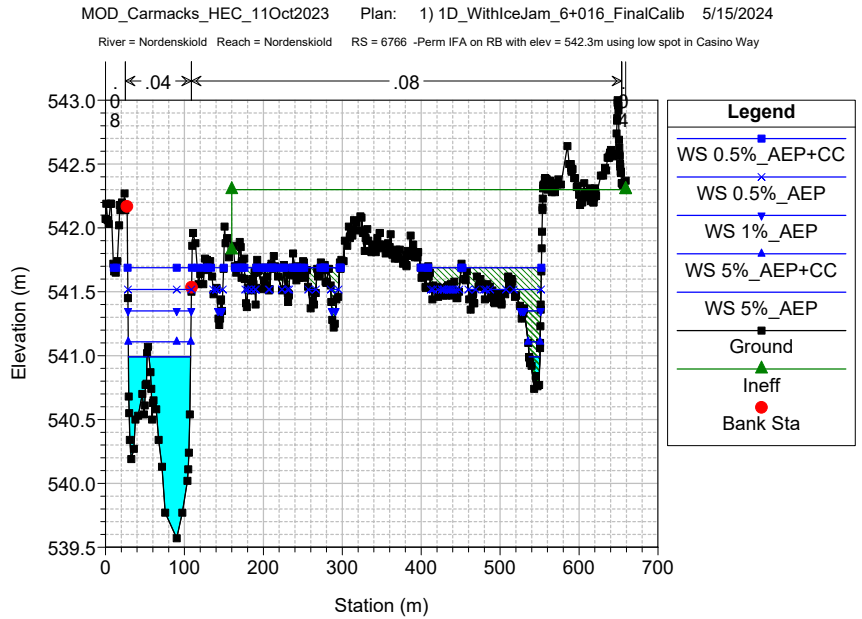

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7630 -Perm IFA on RB ditch, elev=545.1m from grade control 150 m down
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

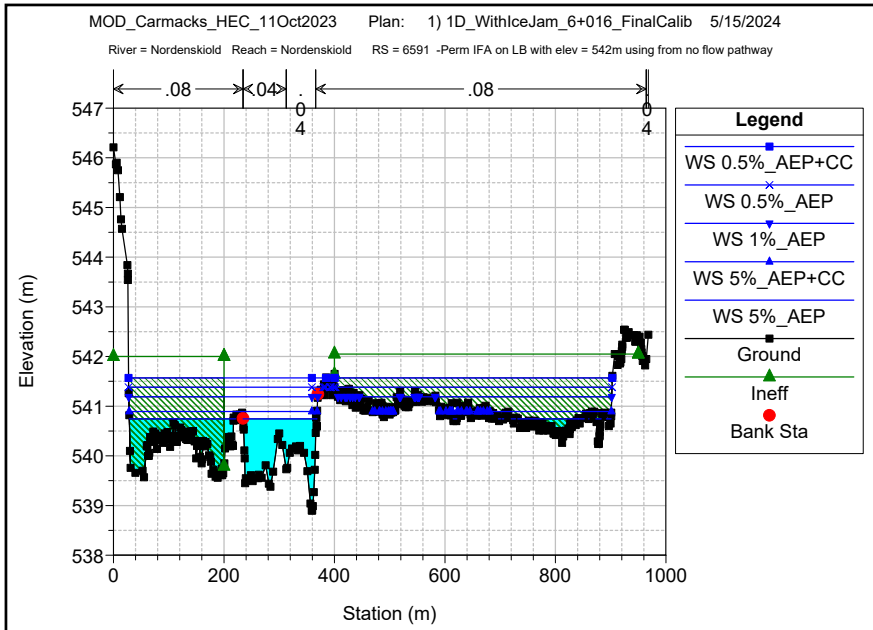

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7551 -Levee on LB, elev = 544.8 m from upstream inlet elev at inlet 4
.08
.04
.07
.08
.07
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

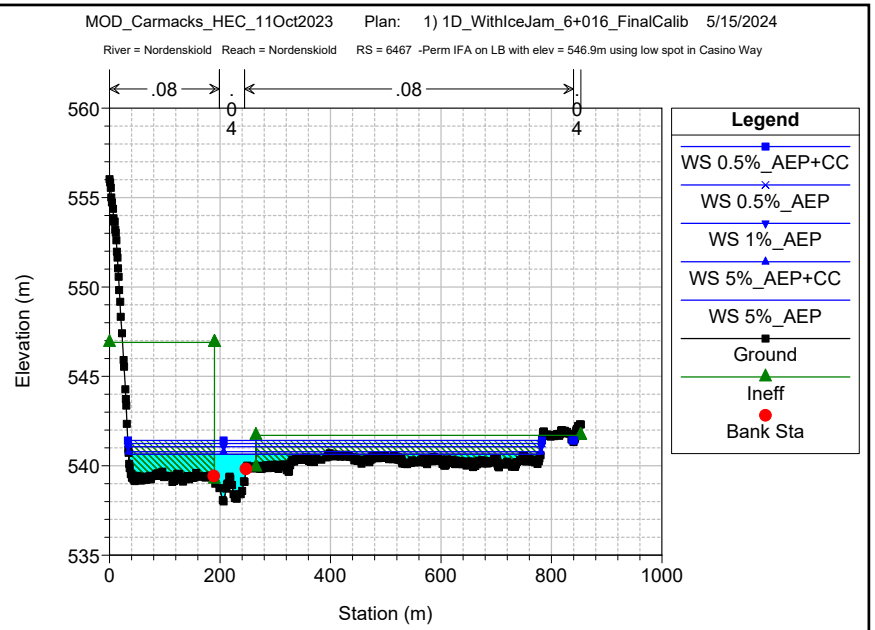

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7396 -Perm IFA on RB, elev = 544.3 m (0.2 m above downstream control
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

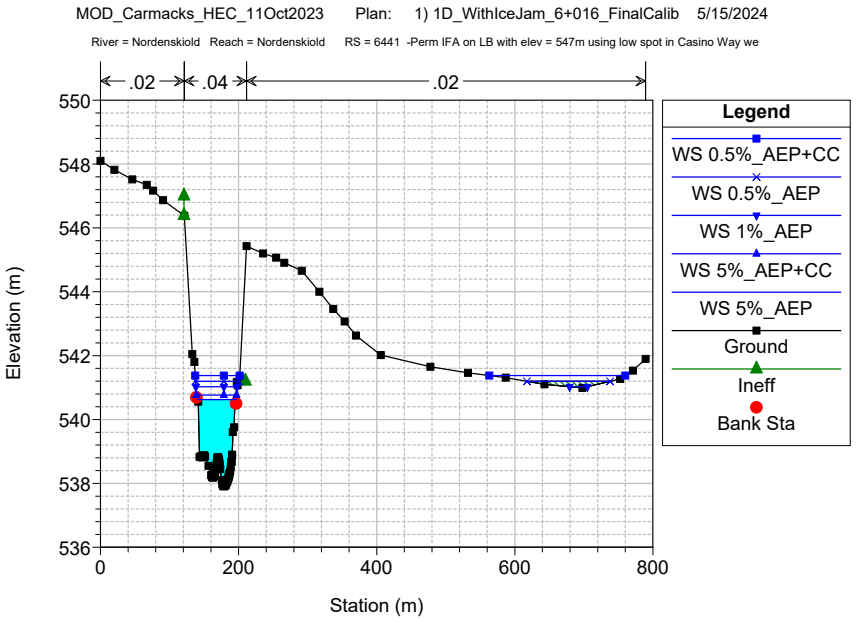

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7178 -Levee on LB, elev = 543.75 m from upstream inlet elev along ban
.08
.07
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

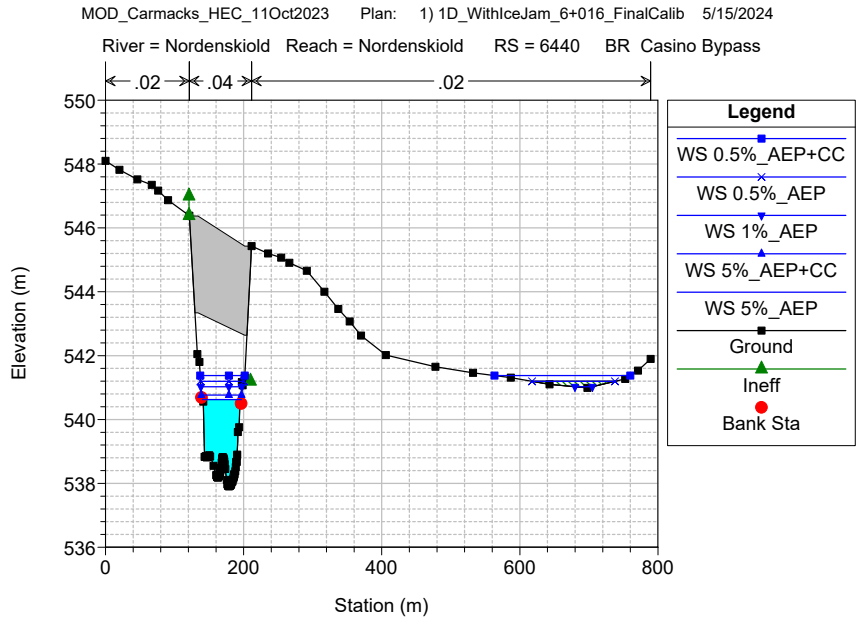

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 7041 -Levee on LB, elev = 543.3 m from upstream inlet elev along bank
.08
.04
.08
.015
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

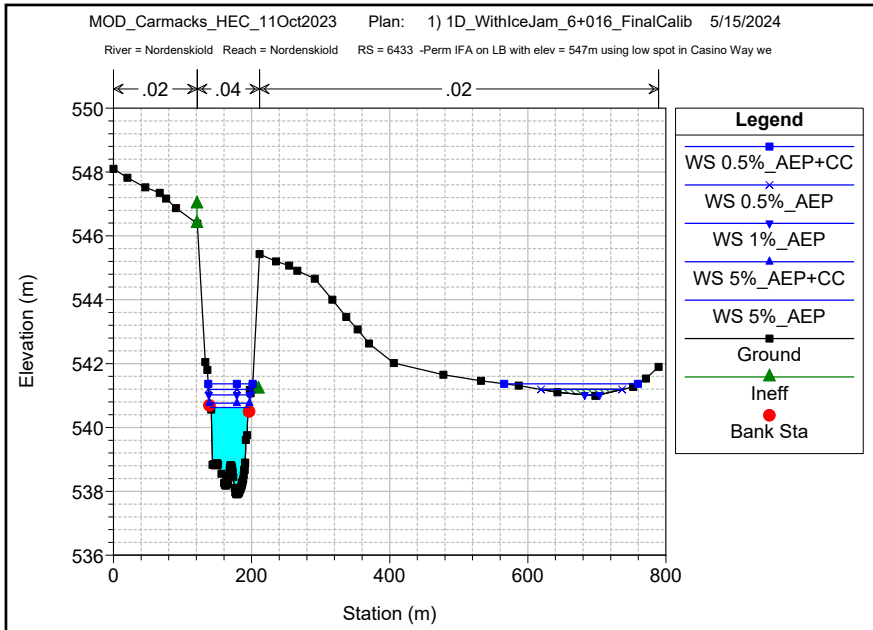

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6766 -Perm IFA on RB with elev = 542.3m using low spot in Casino Way
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

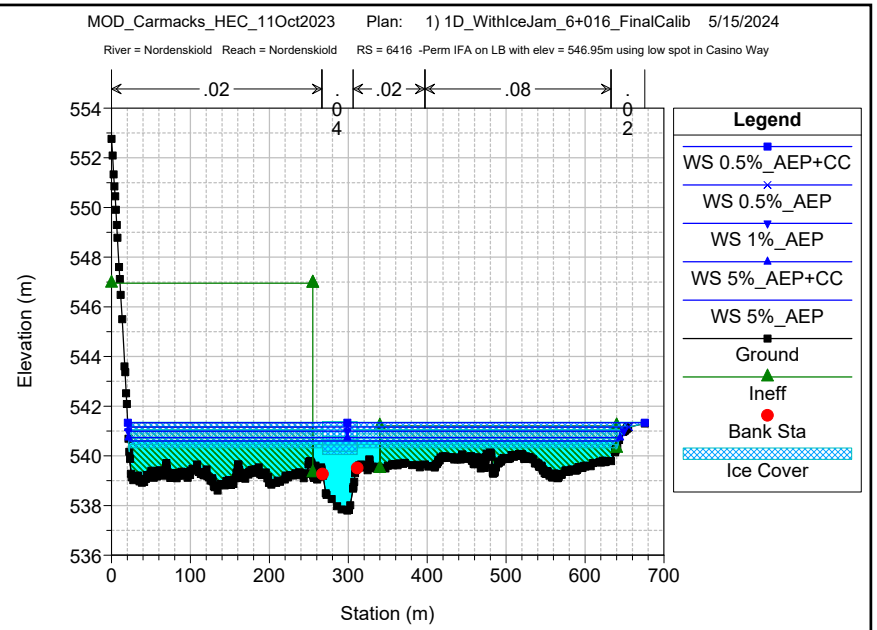

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6591 -Perm IFA on LB with elev = 542m using from no flow pathway
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

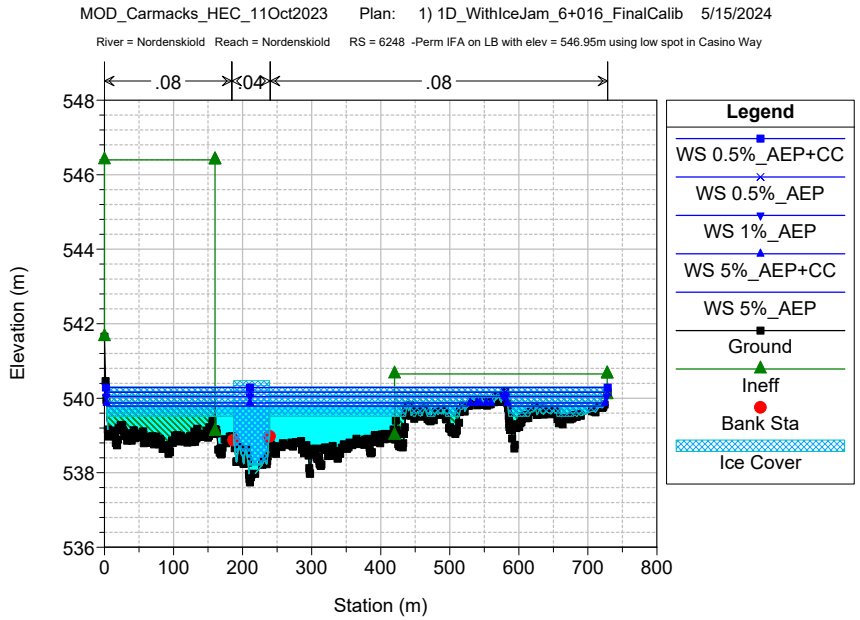

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6467 -Perm IFA on LB with elev = 546.9m using low spot in Casino Way
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

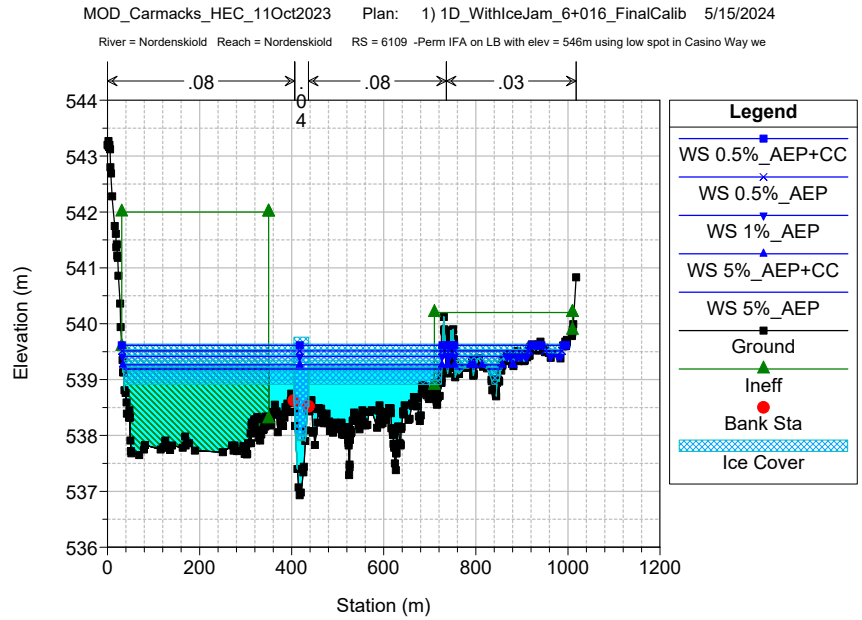

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6441 -Perm IFA on LB with elev = 547m using low spot in Casino Way we
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

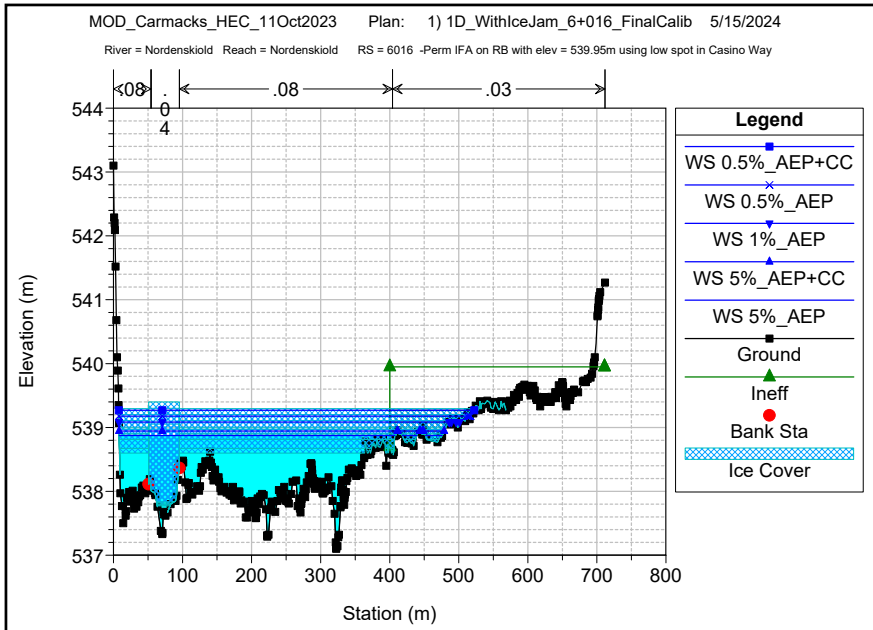

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6440 BR Casino Bypass
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

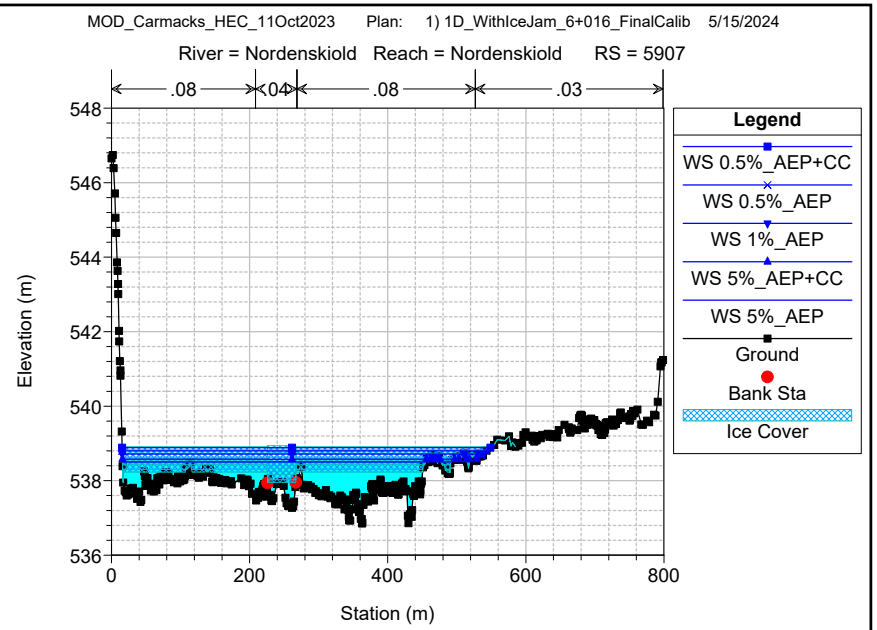

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6433 -Perm IFA on LB with elev = 547m using low spot in Casino Way we
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

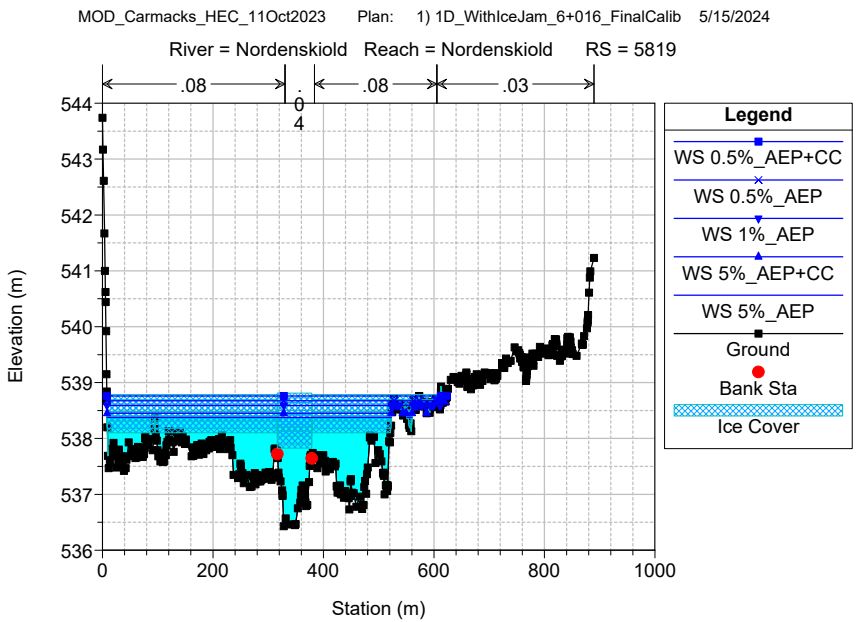

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6416 -Perm IFA on LB with elev = 546.95m using low spot in Casino Way
.02
.04
.02
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

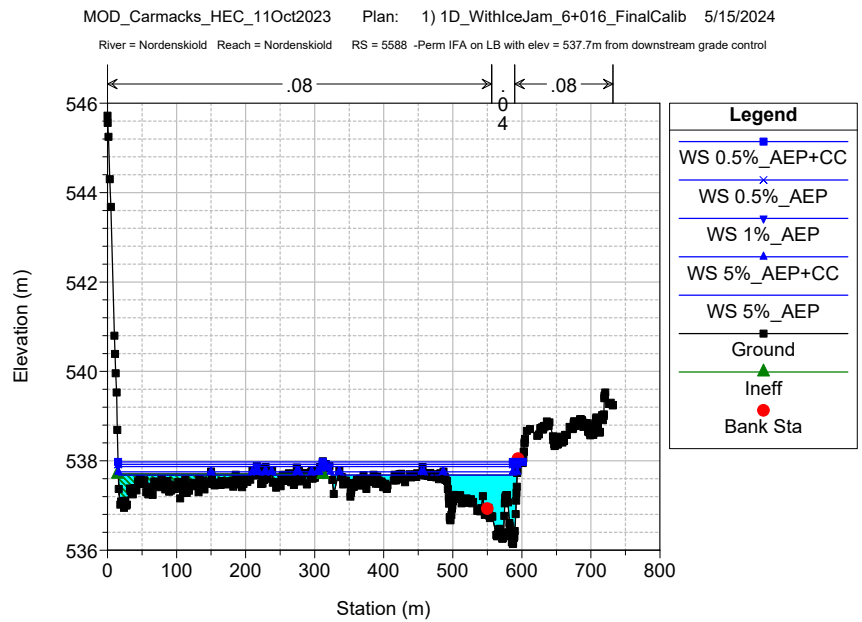

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6248 -Perm IFA on LB with elev = 546.95m using low spot in Casino Way
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

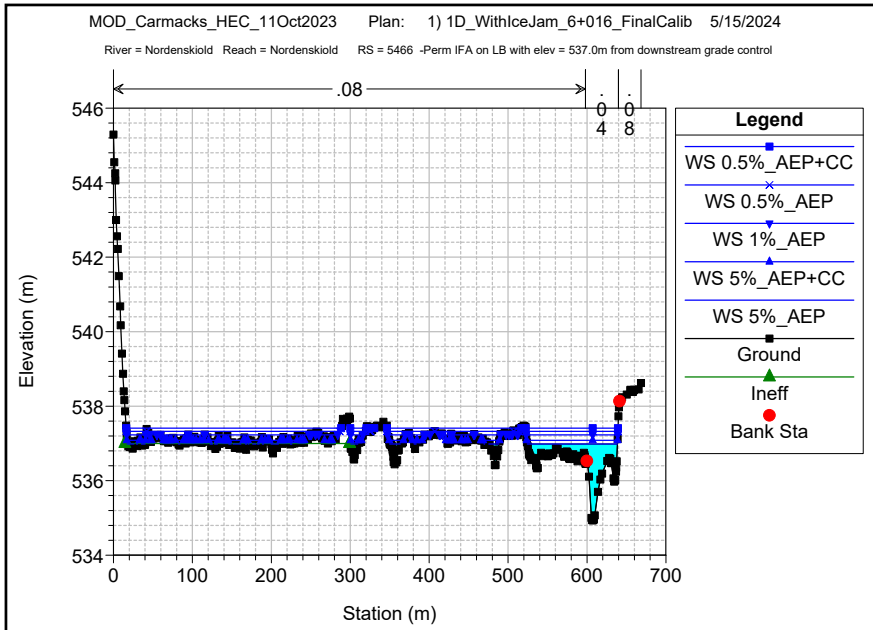

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6109 -Perm IFA on LB with elev = 546m using low spot in Casino Way we
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

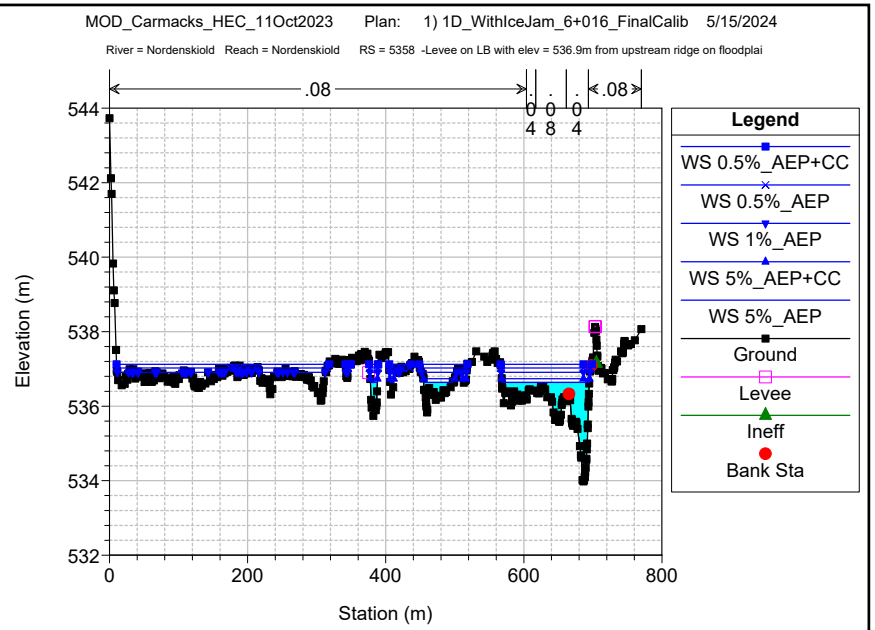

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 6016 -Perm IFA on RB with elev = 539.95m using low spot in Casino Way
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Ice Cover

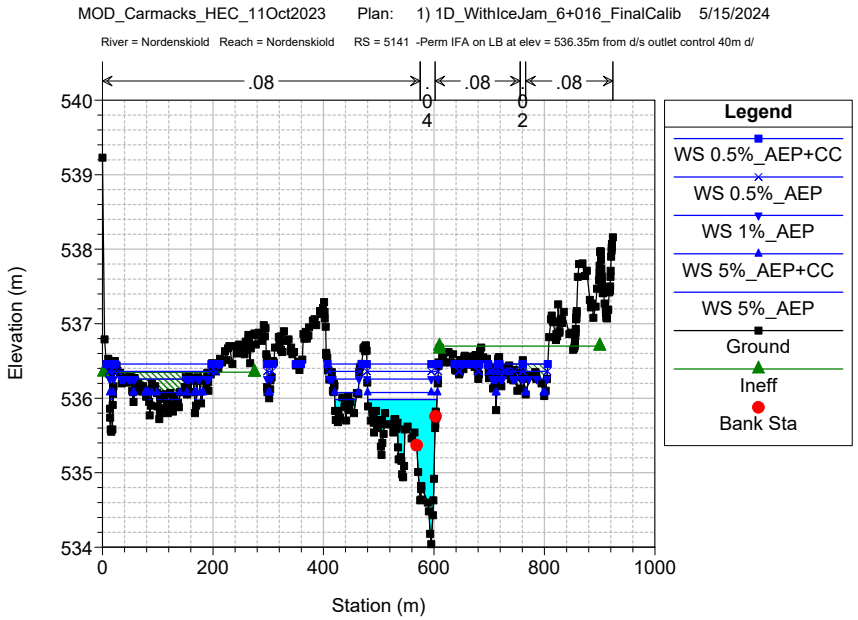

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5907
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta
Ice Cover

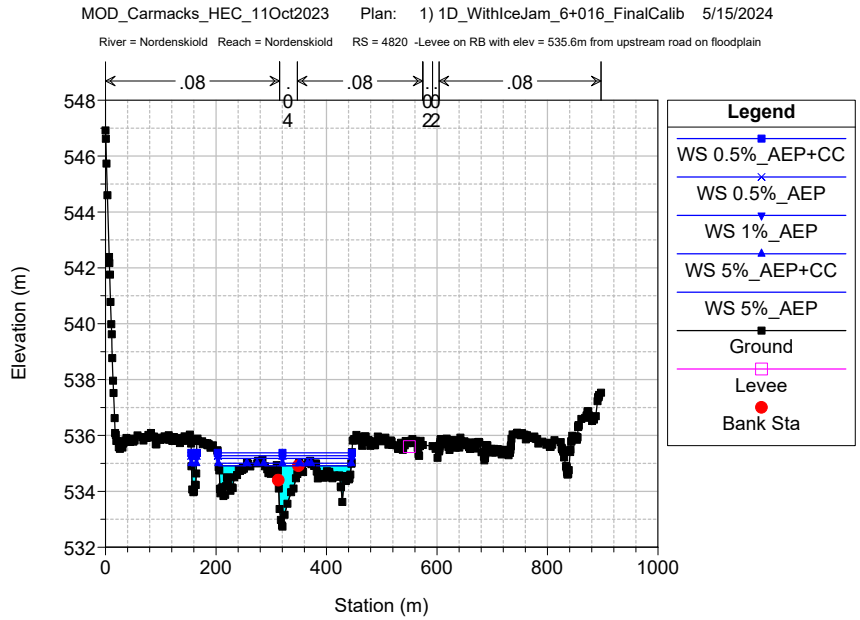

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5819
.08
.04
.08
.03
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta
Ice Cover

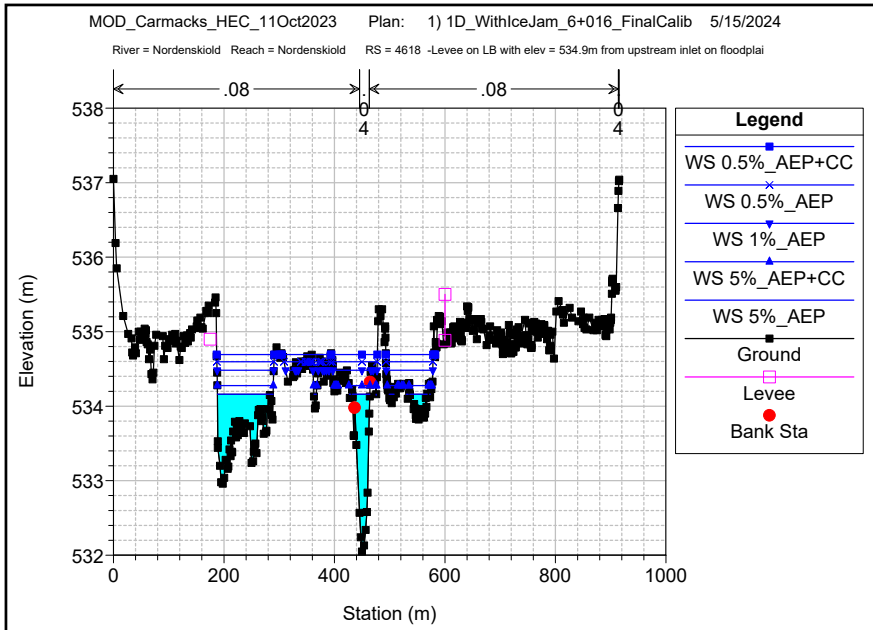

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5588 -Perm IFA on LB with elev = 537.7m from downstream grade control
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

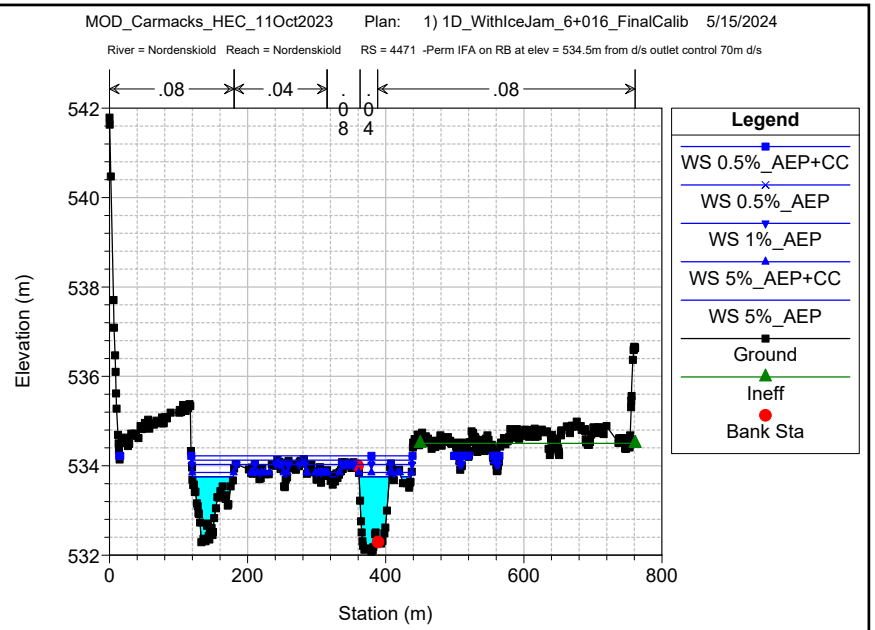

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5466 -Perm IFA on LB with elev = 537.0m from downstream grade control
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

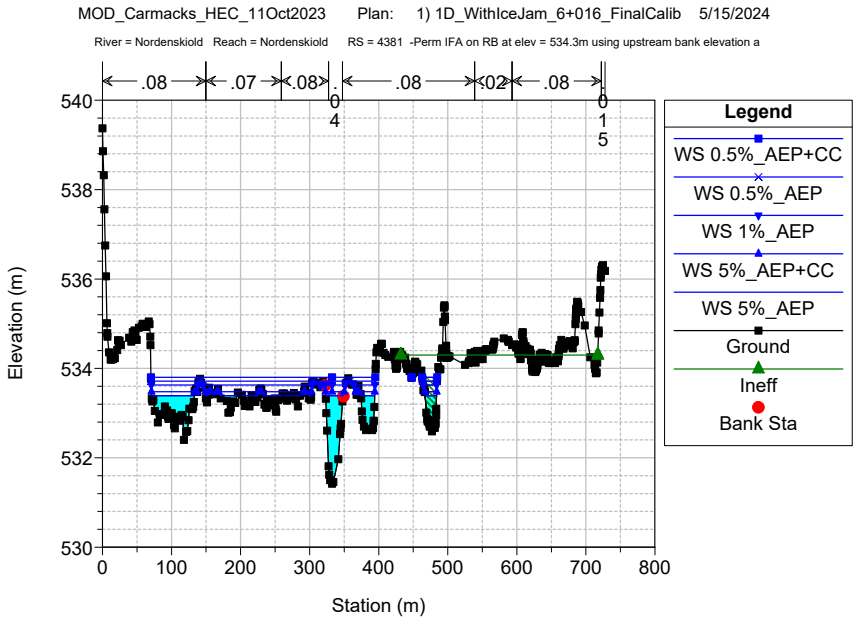

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5358 -Levee on LB with elev = 536.9m from upstream ridge on floodplai
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

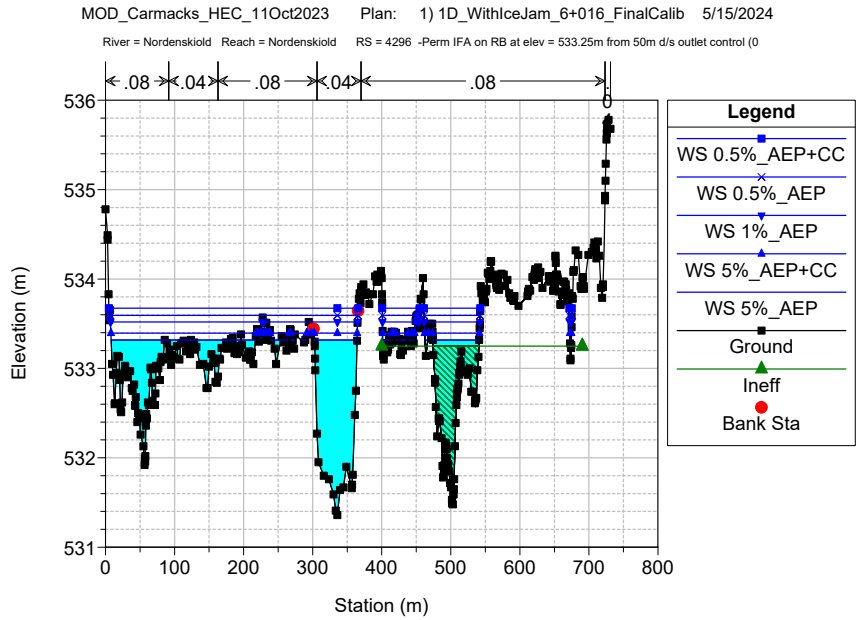

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 5141 -Perm IFA on LB at elev = 536.35m from d/s outlet control 40m d/
.08
.04
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

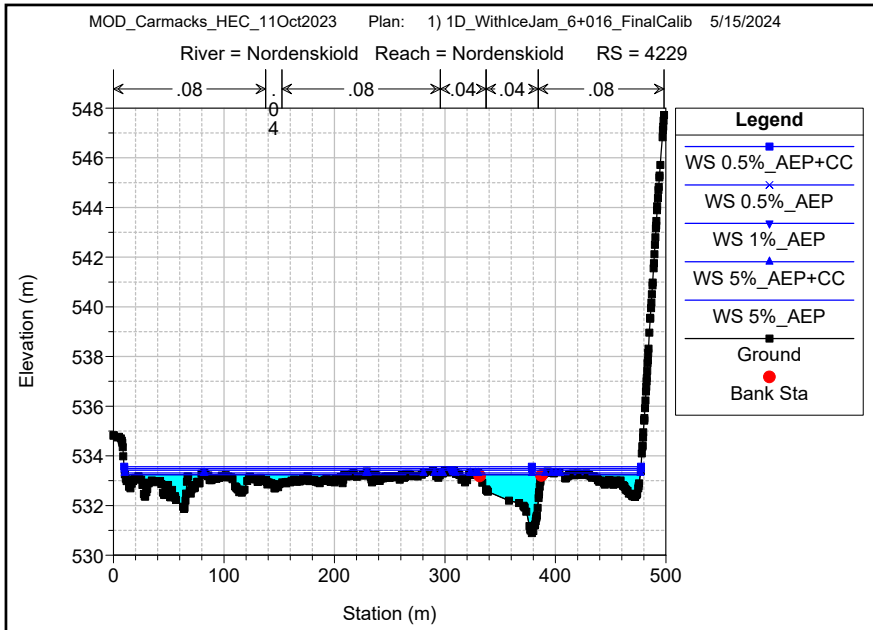

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4820 -Levee on RB with elev = 535.6m from upstream road on floodplain
.08
.04
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

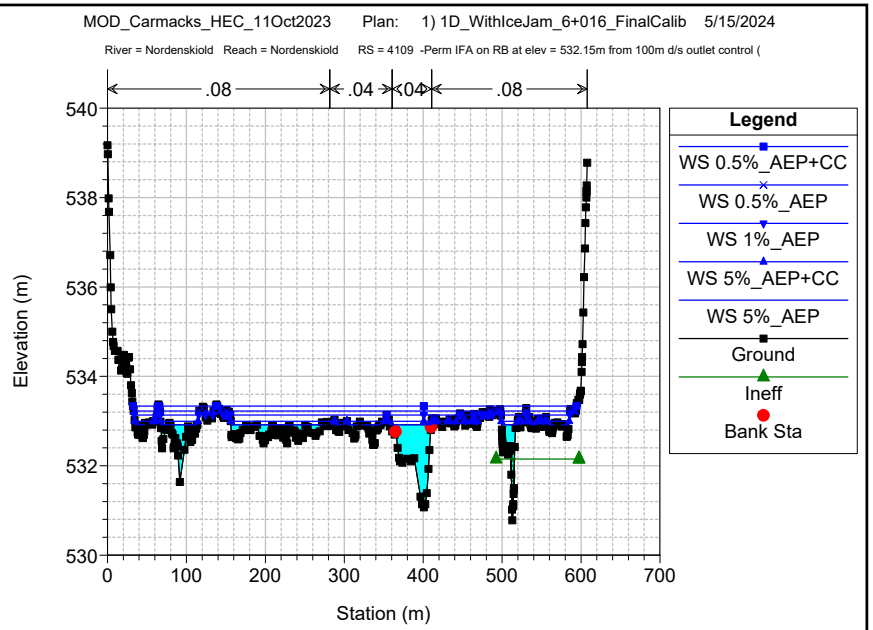

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4618 -Levee on LB with elev = 534.9m from upstream inlet on floodplai
.08
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

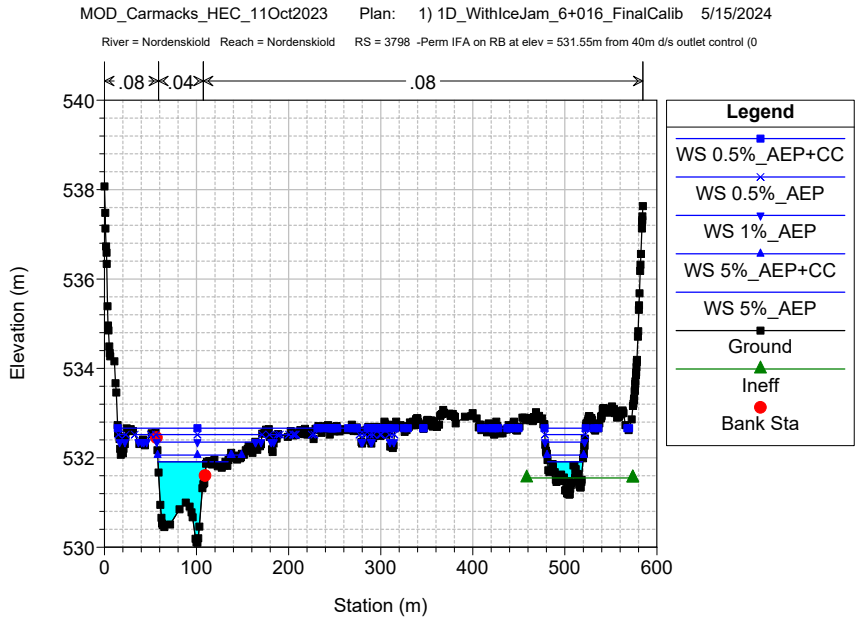

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4471 -Perm IFA on RB at elev = 534.5m from d/s outlet control 70m d/s
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

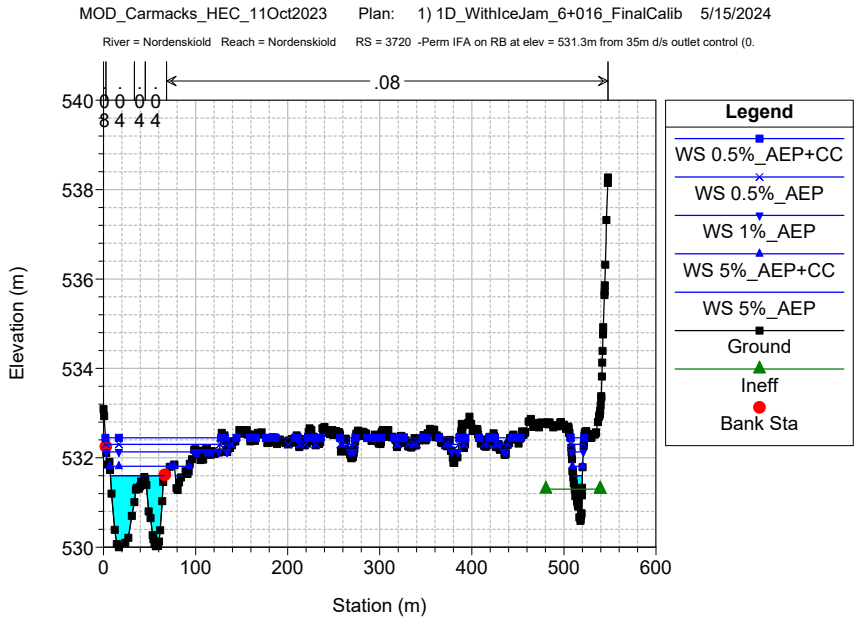

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4381 -Perm IFA on RB at elev = 534.3m using upstream bank elevation a
.08
.07
.08
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

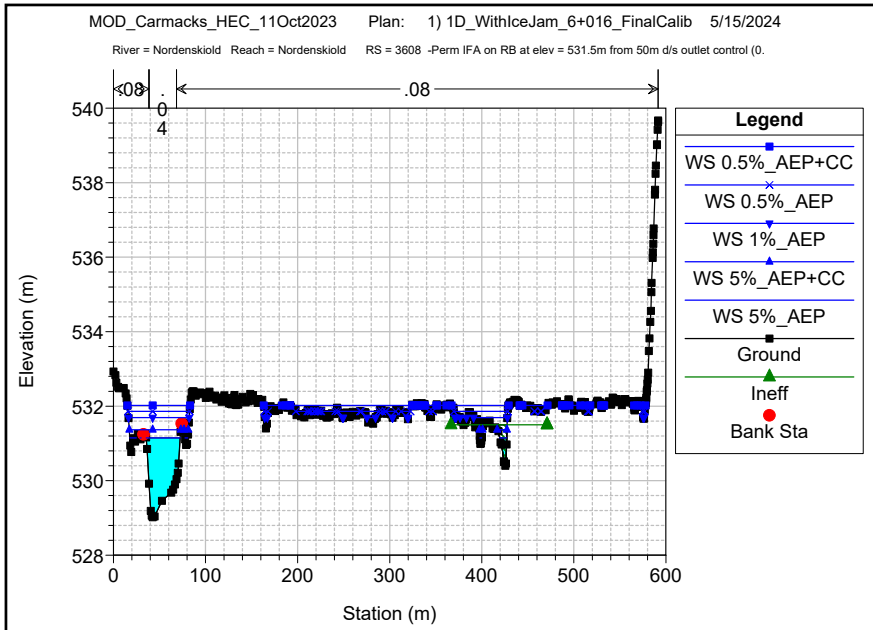

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4296 -Perm IFA on RB at elev = 533.25m from 50m d/s outlet control (0
.08
.04
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

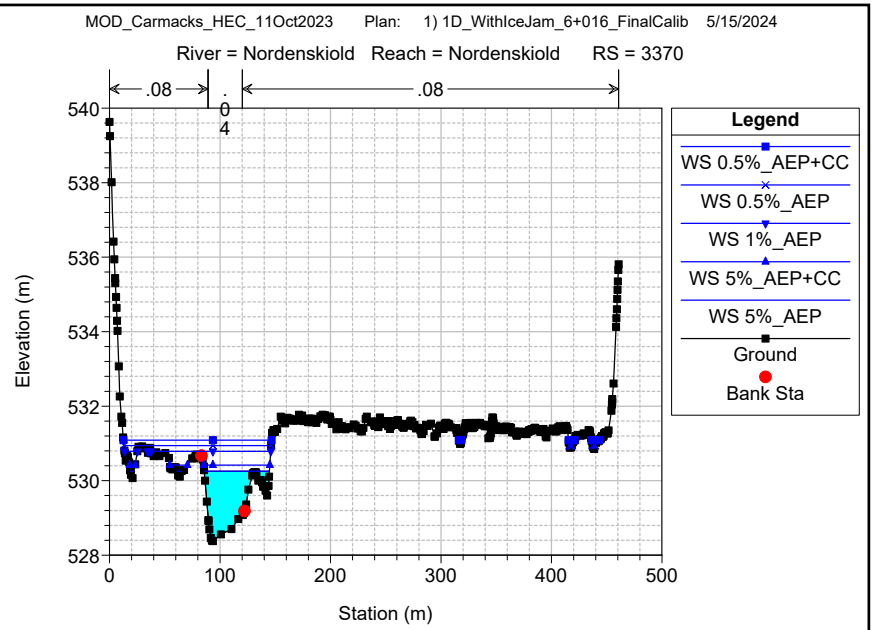

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4229
.08
.04
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

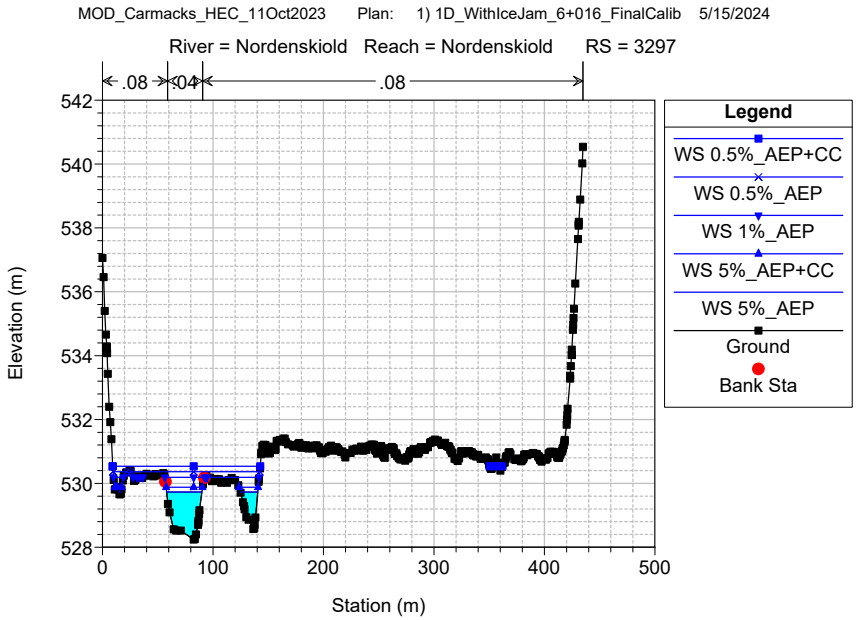

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 4109 -Perm IFA on RB at elev = 532.15m from 100m d/s outlet control (
.08
.04
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

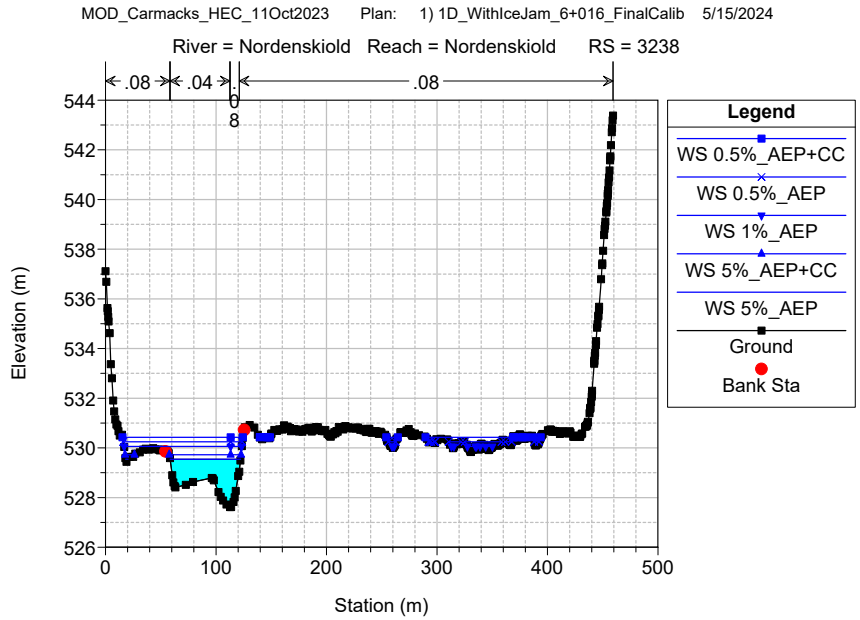

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3798 -Perm IFA on RB at elev = 531.55m from 40m d/s outlet control (0
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

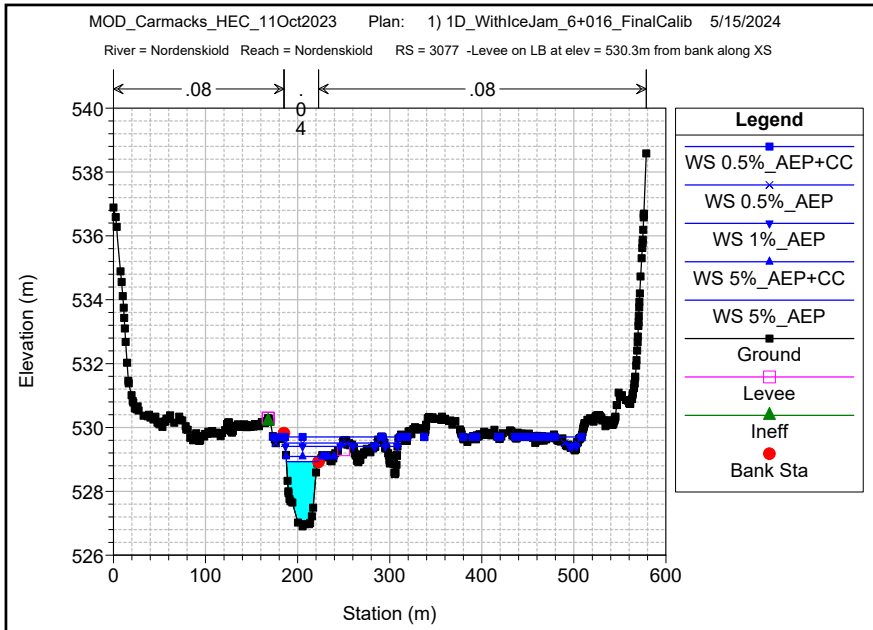

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3720 -Perm IFA on RB at elev = 531.3m from 35m d/s outlet control (0.
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

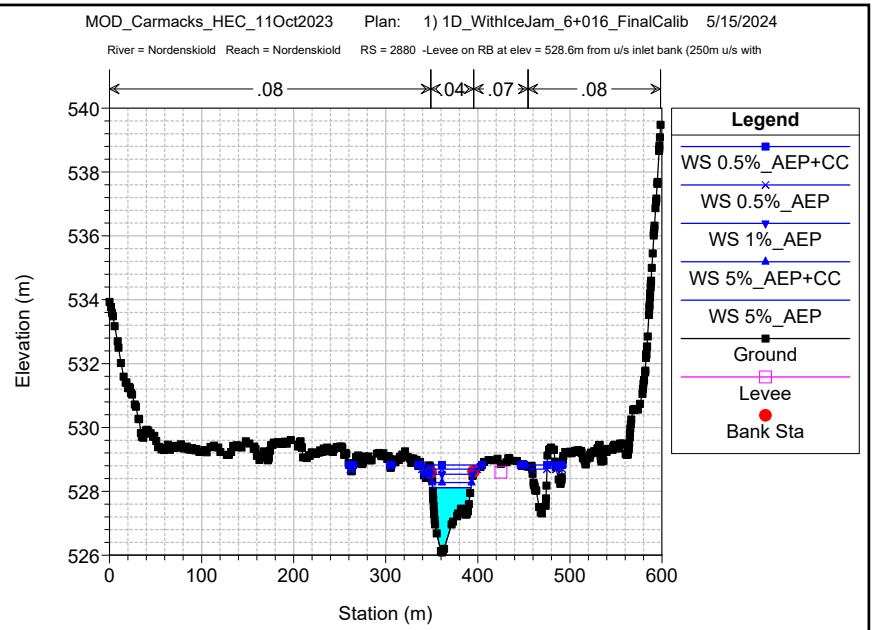

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3608 -Perm IFA on RB at elev = 531.5m from 50m d/s outlet control (0.
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

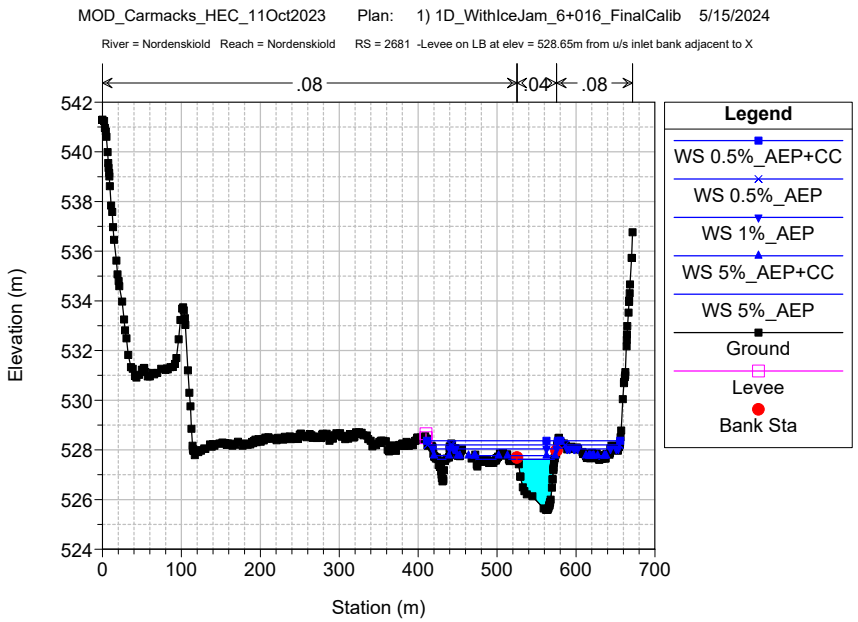

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3370
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

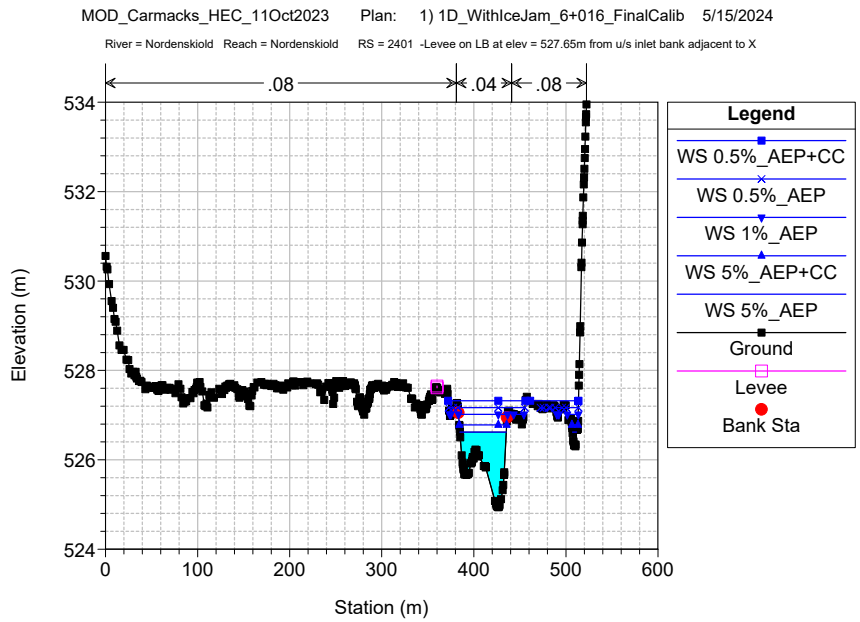

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3297
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

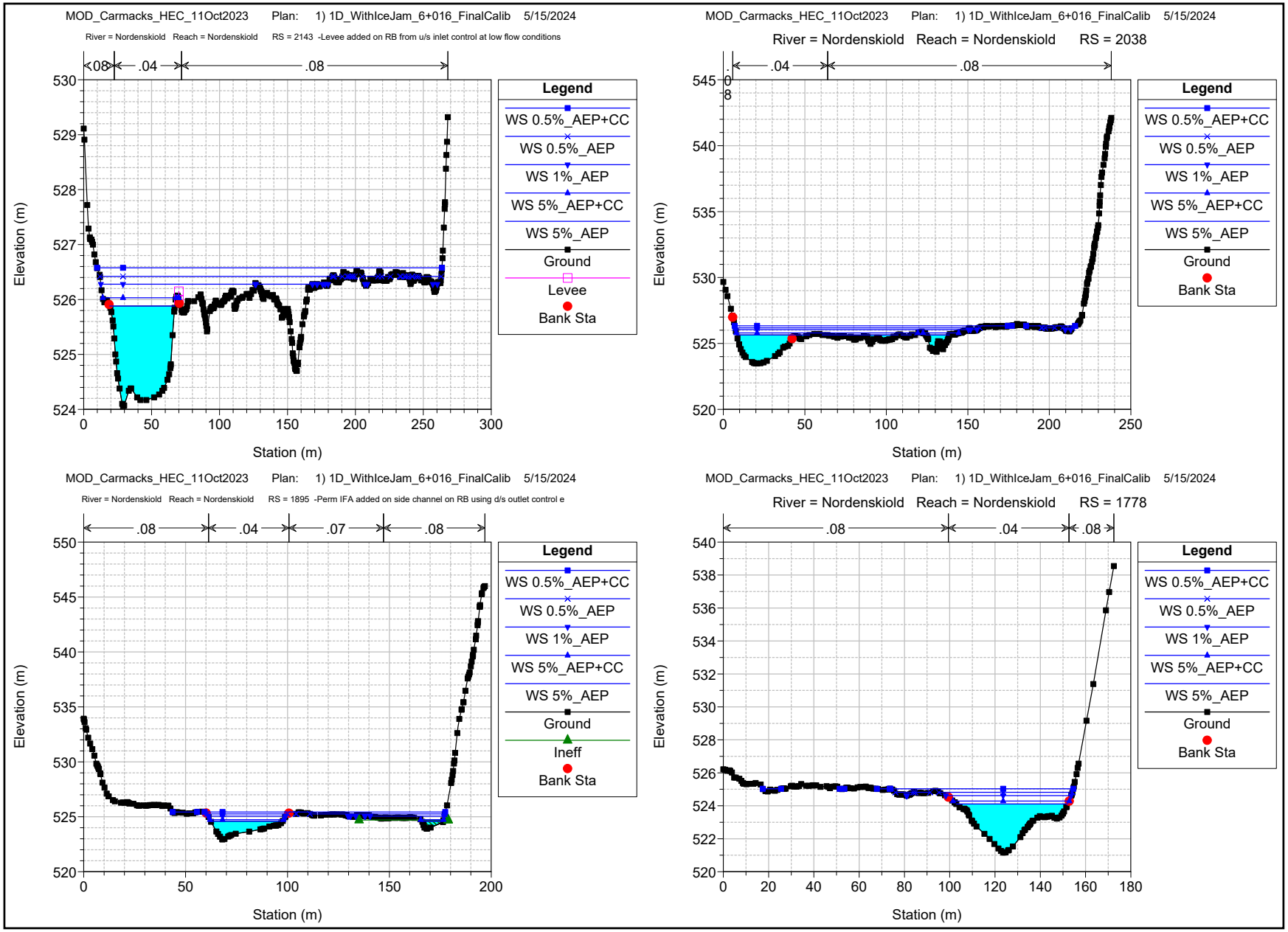

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3238
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

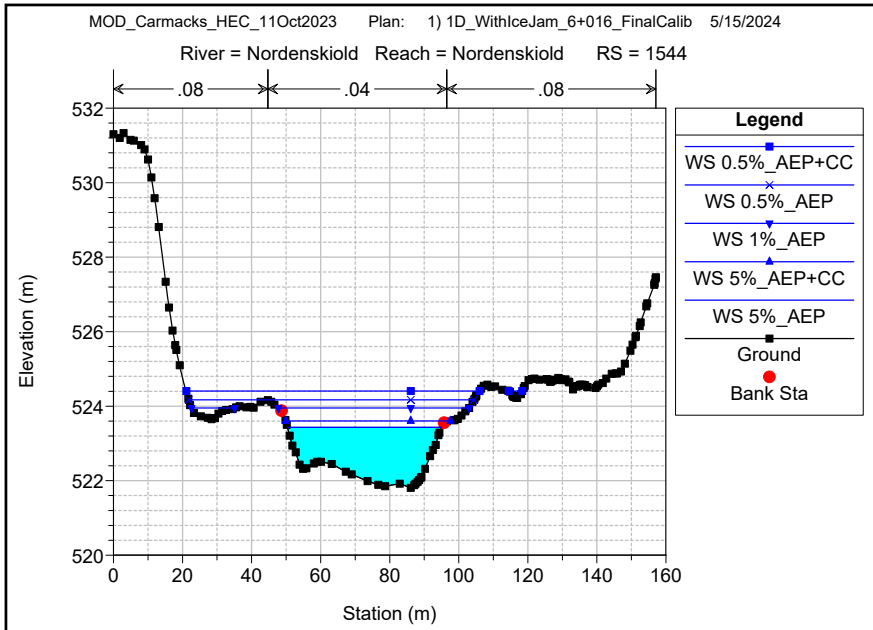

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 3077 -Levee on LB at elev = 530.3m from bank along XS
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

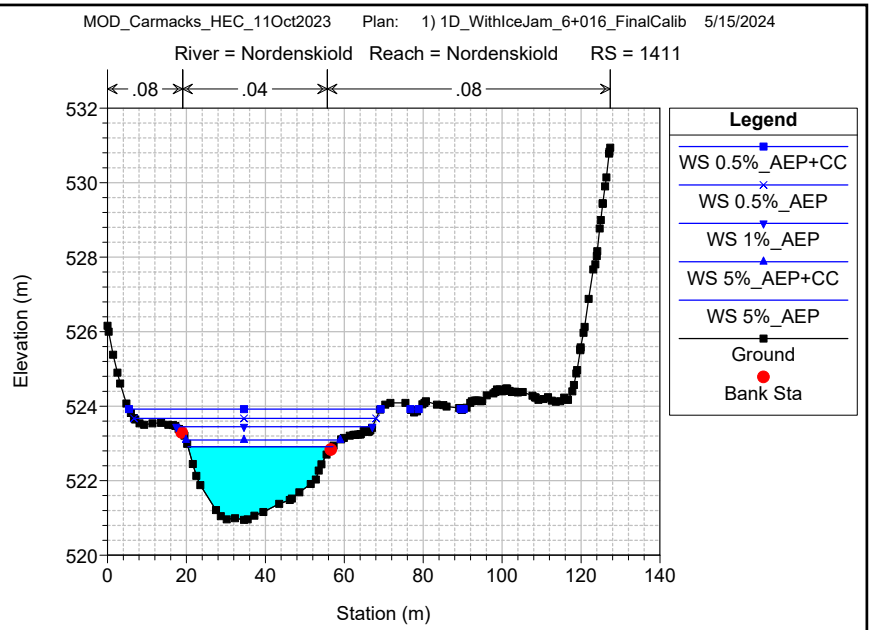

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2880 -Levee on RB at elev = 528.6m from u/s inlet bank (250m u/s with
.08
.04
.07
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

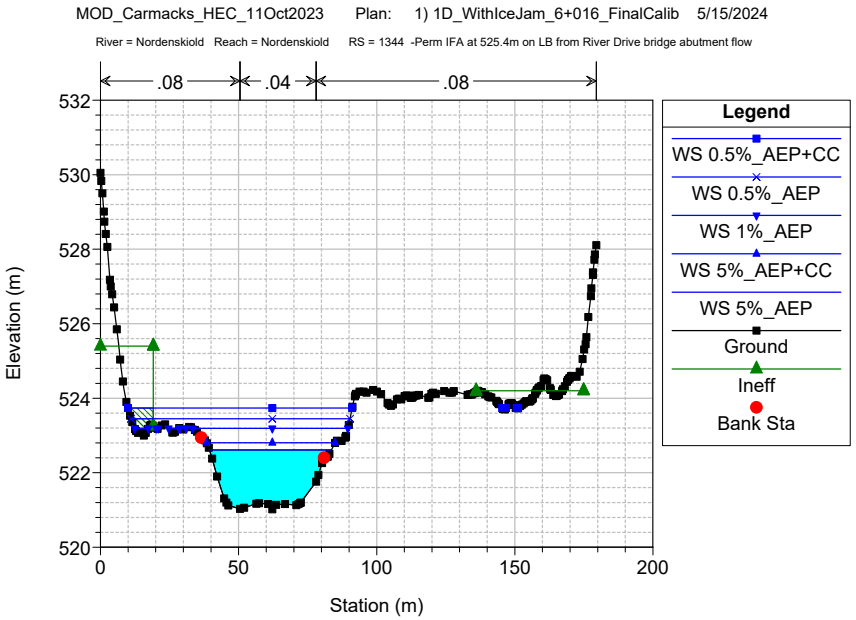

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2681 -Levee on LB at elev = 528.65m from u/s inlet bank adjacent to X
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

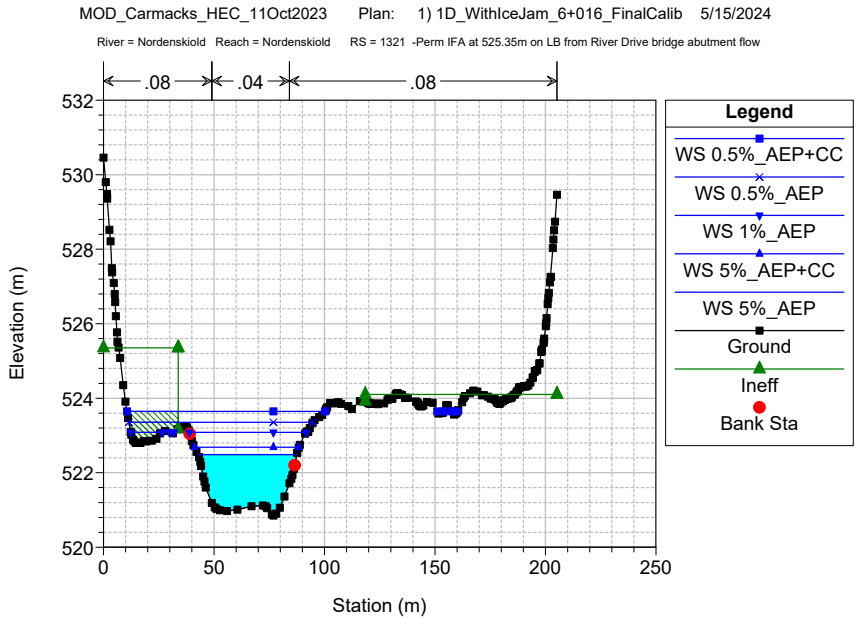

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2401 -Levee on LB at elev = 527.65m from u/s inlet bank adjacent to X
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta

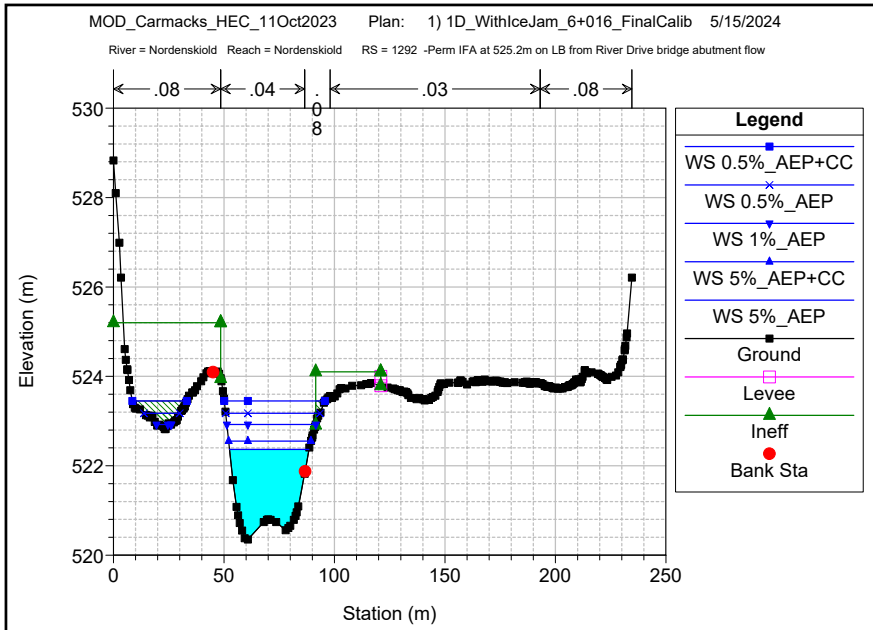

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2143 -Levee added on RB from u/s inlet control at low flow conditions
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 2038
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1895 -Perm IFA added on side channel on RB using d/s outlet control e
.08
.04
.07
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1778
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

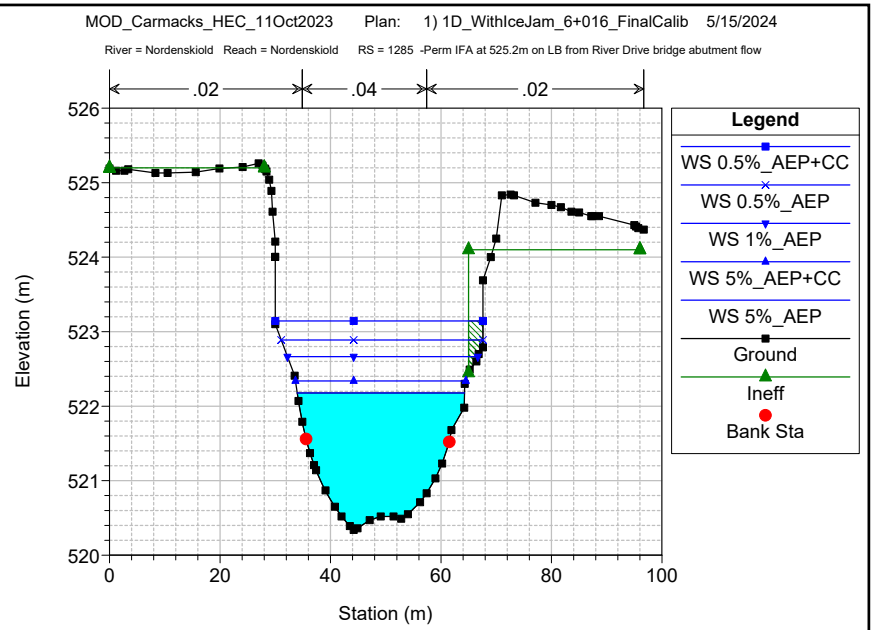

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1544
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

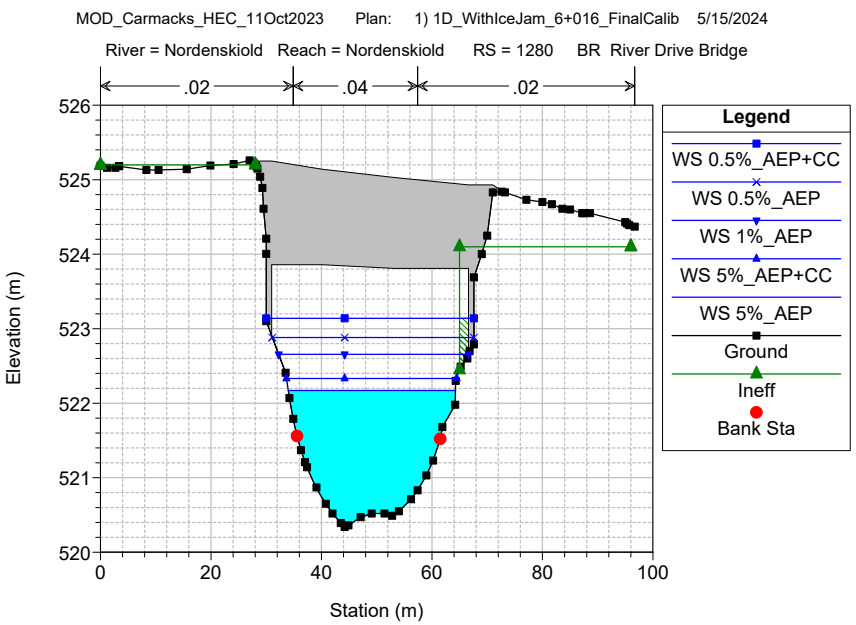

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1411
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

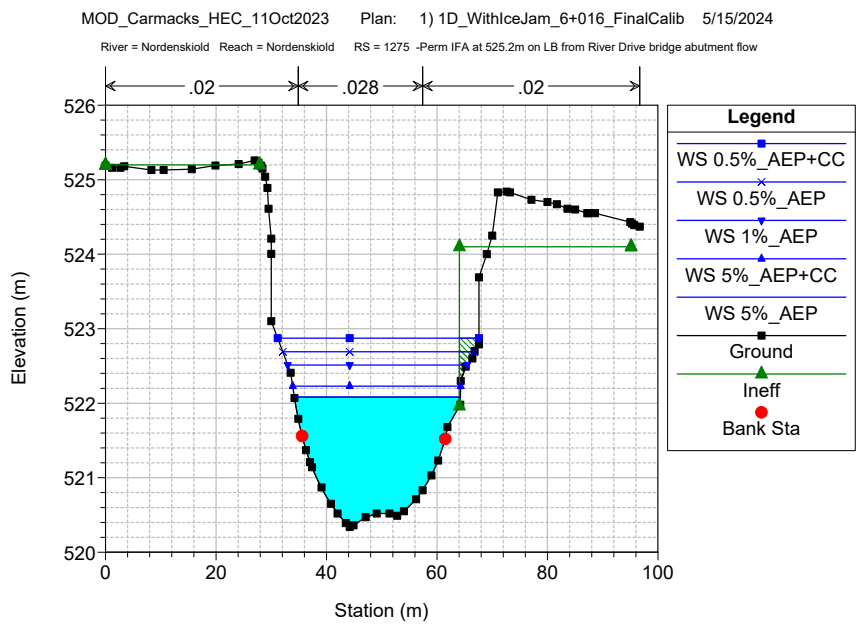

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1344 -Perm IFA at 525.4m on LB from River Drive bridge abutment flow
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

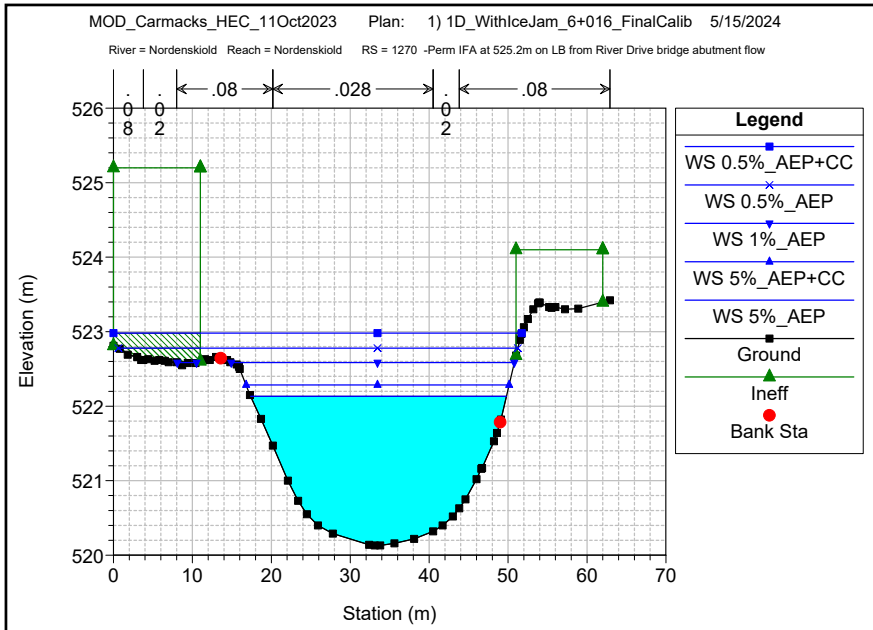

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1321 -Perm IFA at 525.35m on LB from River Drive bridge abutment flow
.08
.04
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

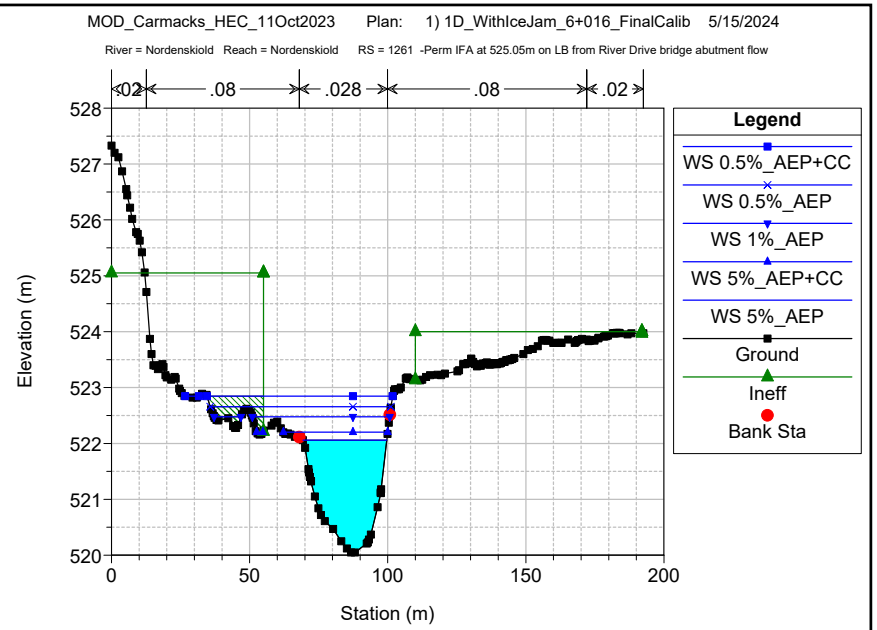

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1292 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.08
.04
.08
.03
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta

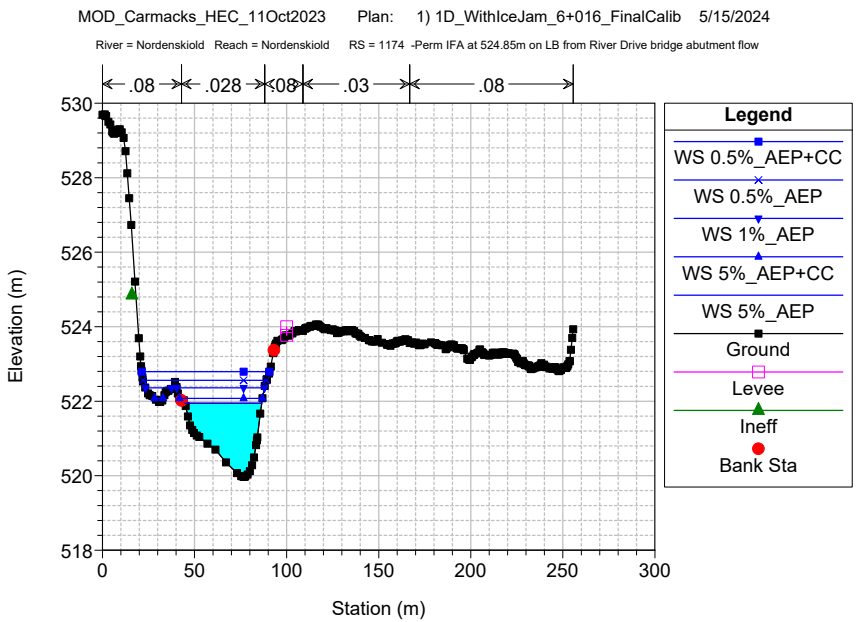

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1285 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

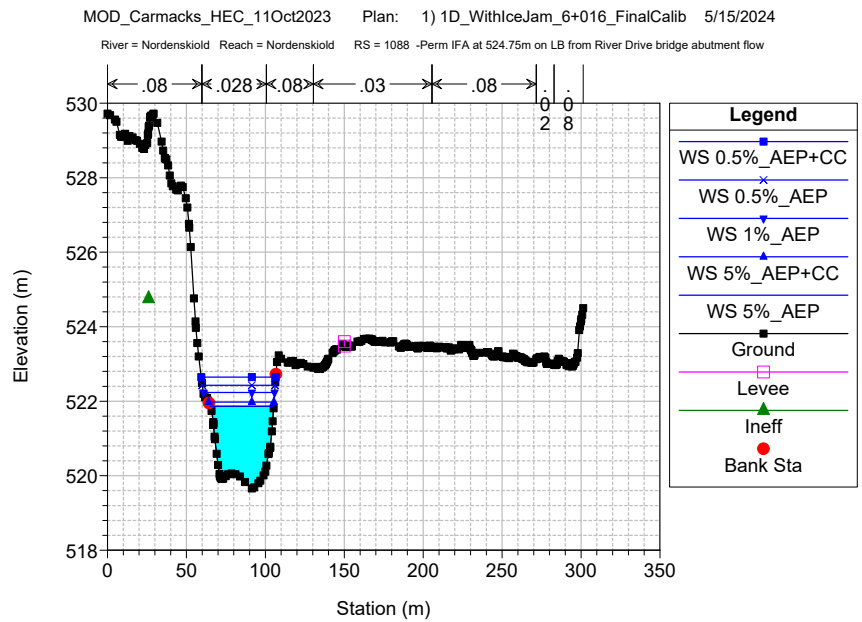

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1280 BR River Drive Bridge
.02
.04
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

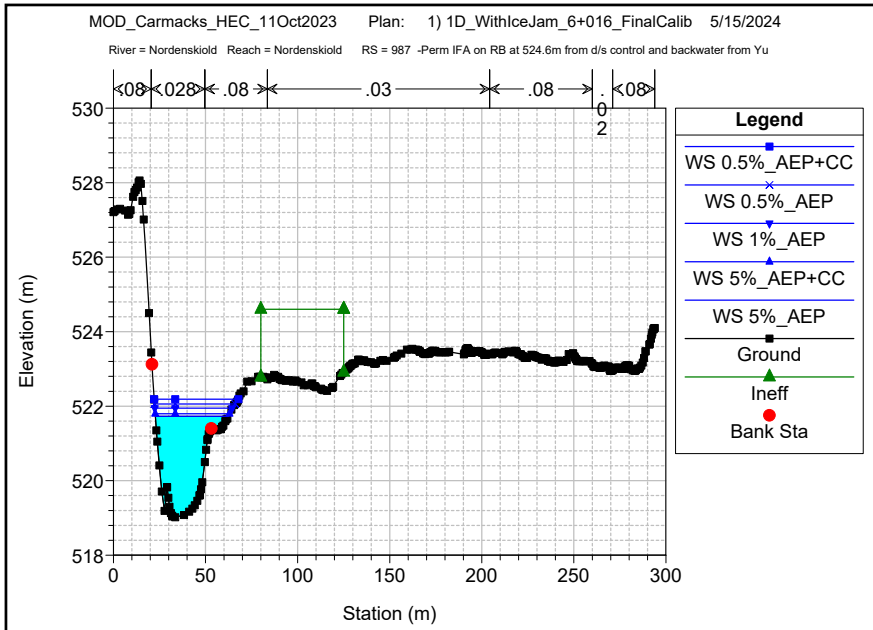

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1275 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.02
.028
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

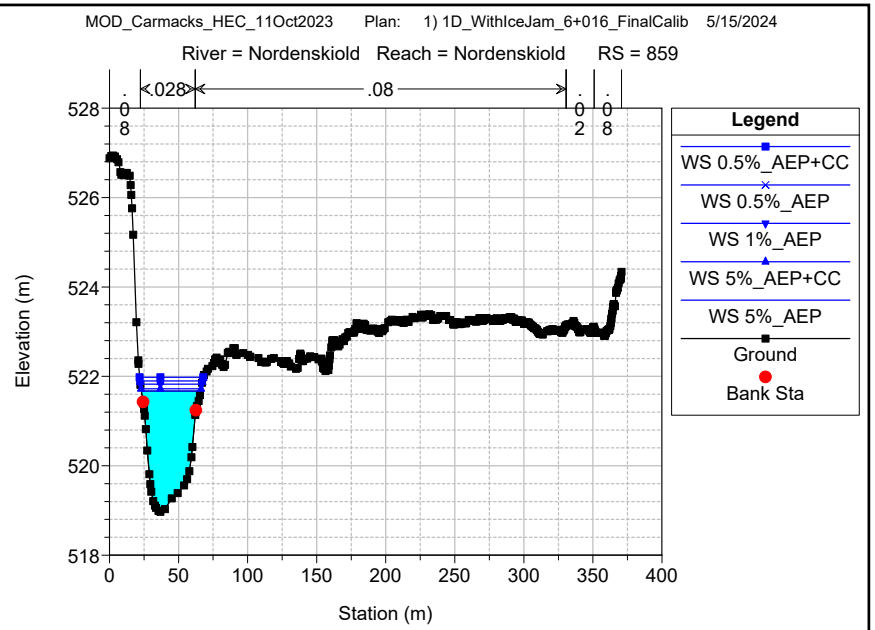

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1270 -Perm IFA at 525.2m on LB from River Drive bridge abutment flow
.08
.028
.08
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

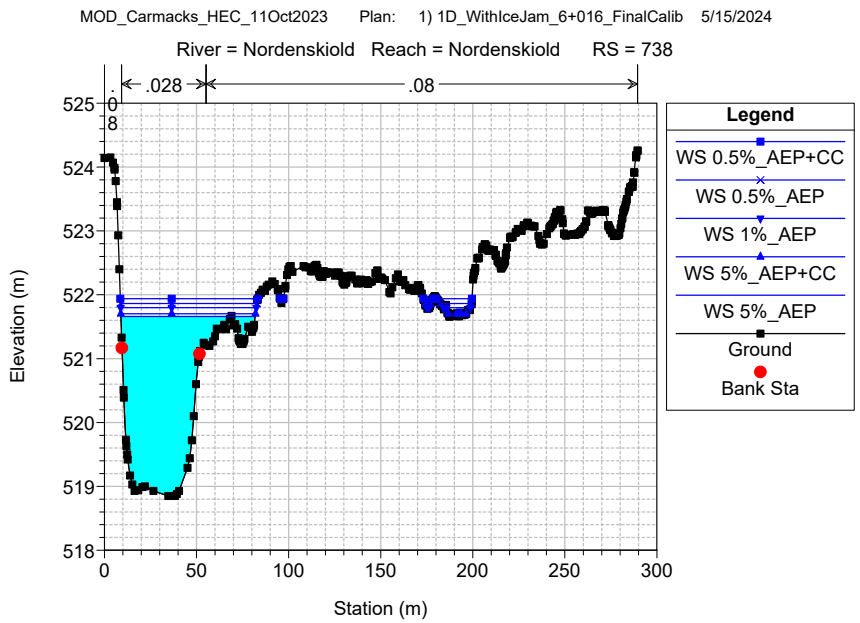

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1261 -Perm IFA at 525.05m on LB from River Drive bridge abutment flow
.02
.08
.028
.08
.02
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta
Elevation (m)
Station (m)

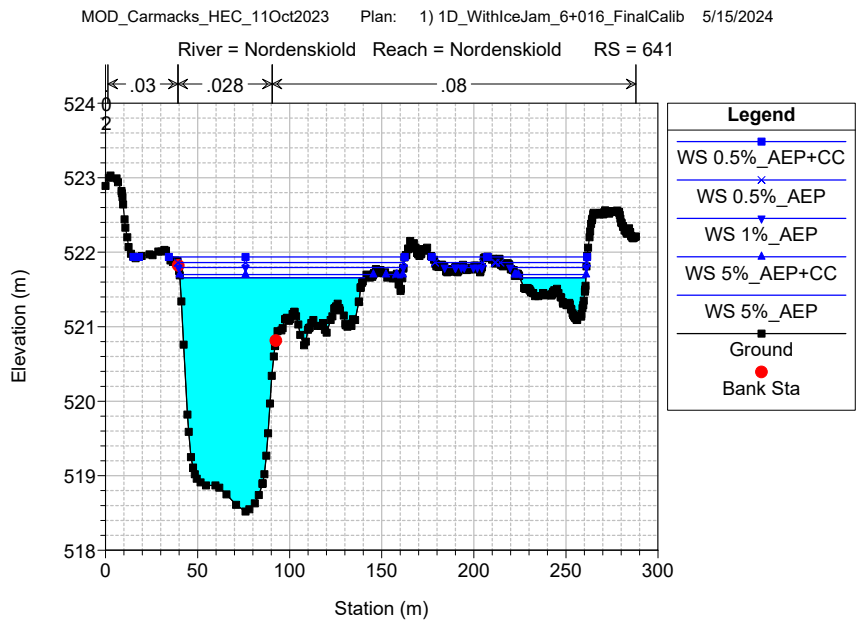

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1174 -Perm IFA at 524.85m on LB from River Drive bridge abutment flow
.08
.028
.08
.03
.08
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 1088 -Perm IFA at 524.75m on LB from River Drive bridge abutment flow
.08
.028
.08
.03
.08
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Levee
Ineff
Bank Sta
Elevation (m)
Station (m)


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 987 -Perm IFA on RB at 524.6m from d/s control and backwater from Yu
.08
.028
.08
.03
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Ineff
Bank Sta

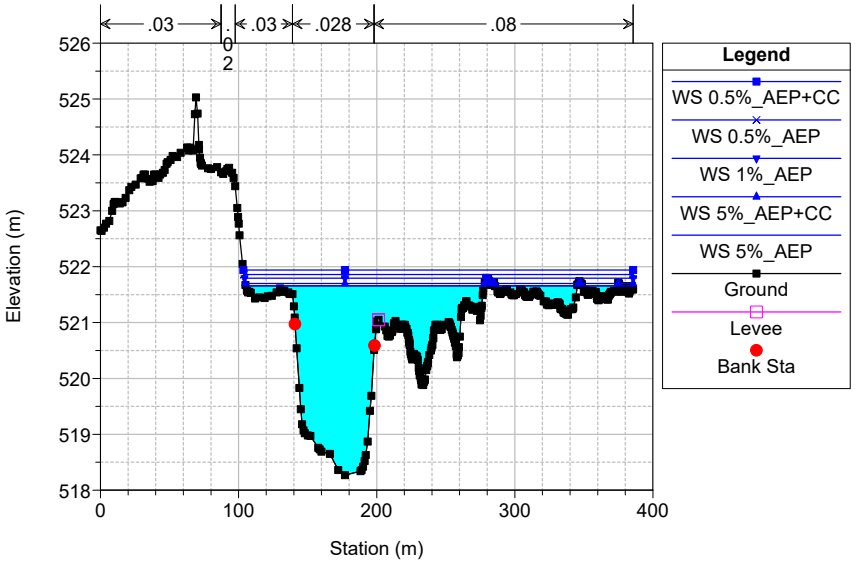

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 859
.08
.028
.08
.02
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 738
.08
.028
.08
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta


MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024
River = Nordenskiold Reach = Nordenskiold RS = 641
.03
.028
.08
.02
Elevation (m)
Station (m)
Legend
WS 0.5%_AEP+CC
WS 0.5%_AEP
WS 1%_AEP
WS 5%_AEP+CC
WS 5%_AEP
Ground
Bank Sta

MOD_Carmacks_HEC_11Oct2023 Plan: 1) 1D_WithIceJam_6+016_FinalCalib 5/15/2024

River = Nordenskiold Reach = Nordenskiold RS = 556 -Levee added on RB at 521.2m from adjacent bank elevation



Appendix E Flood Hazard Maps

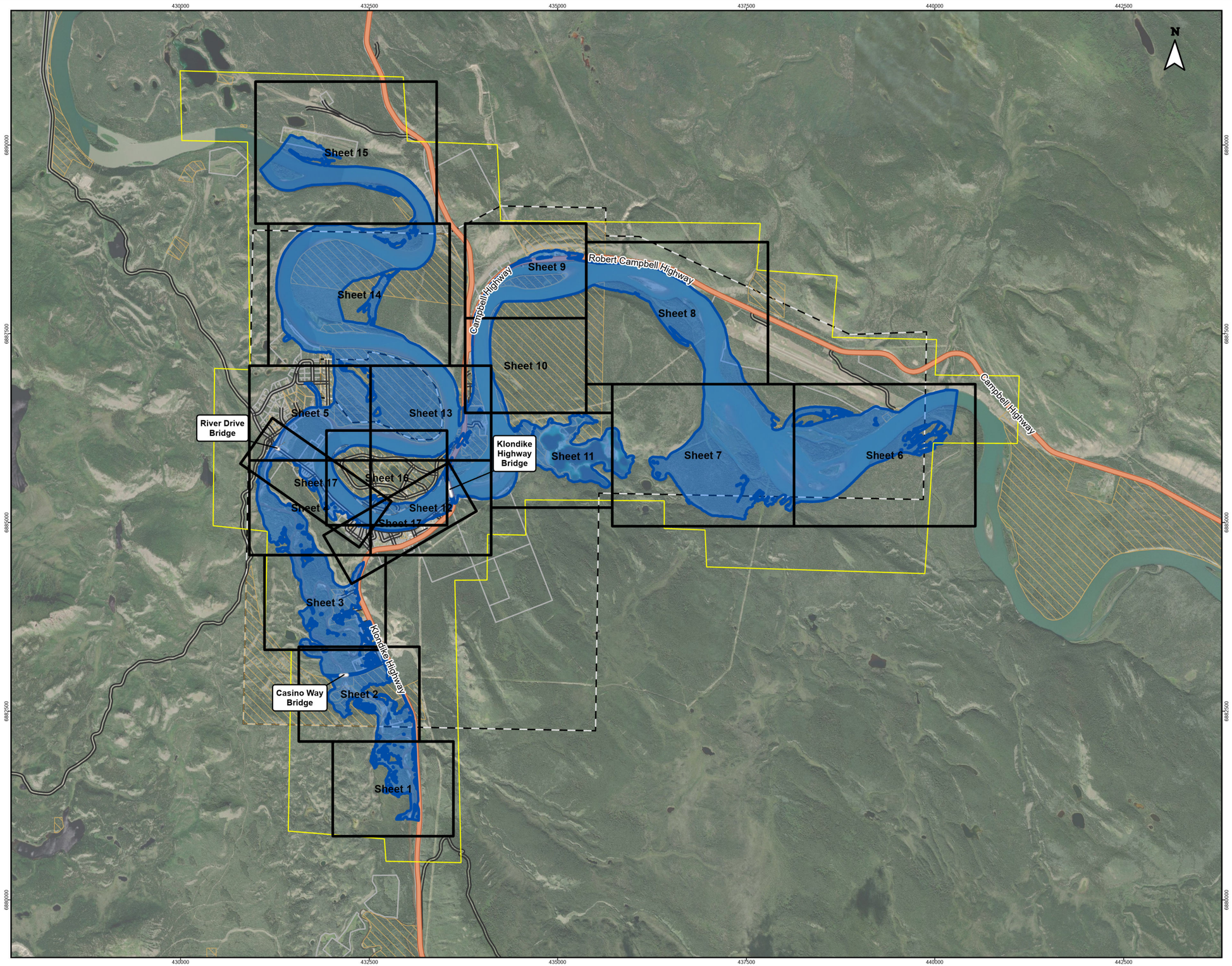


Figure No.

E.0

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

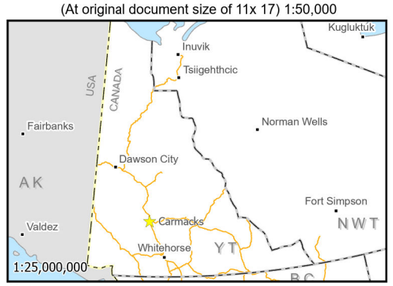
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2023-11-07
Review by JMUIRHEAD on 2024-05-21

- Bridge
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Mapping Index Sheets
- Study Area
- Highway
- Local Road
- 0.5% AEP With Factors of Safety for Climate Change

Map Publication Date: May 21, 2024

0 500 1,000 1,500 2,000 m

(At original document size of 11x 17) 1:50,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Imagery: Maxar
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/ topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

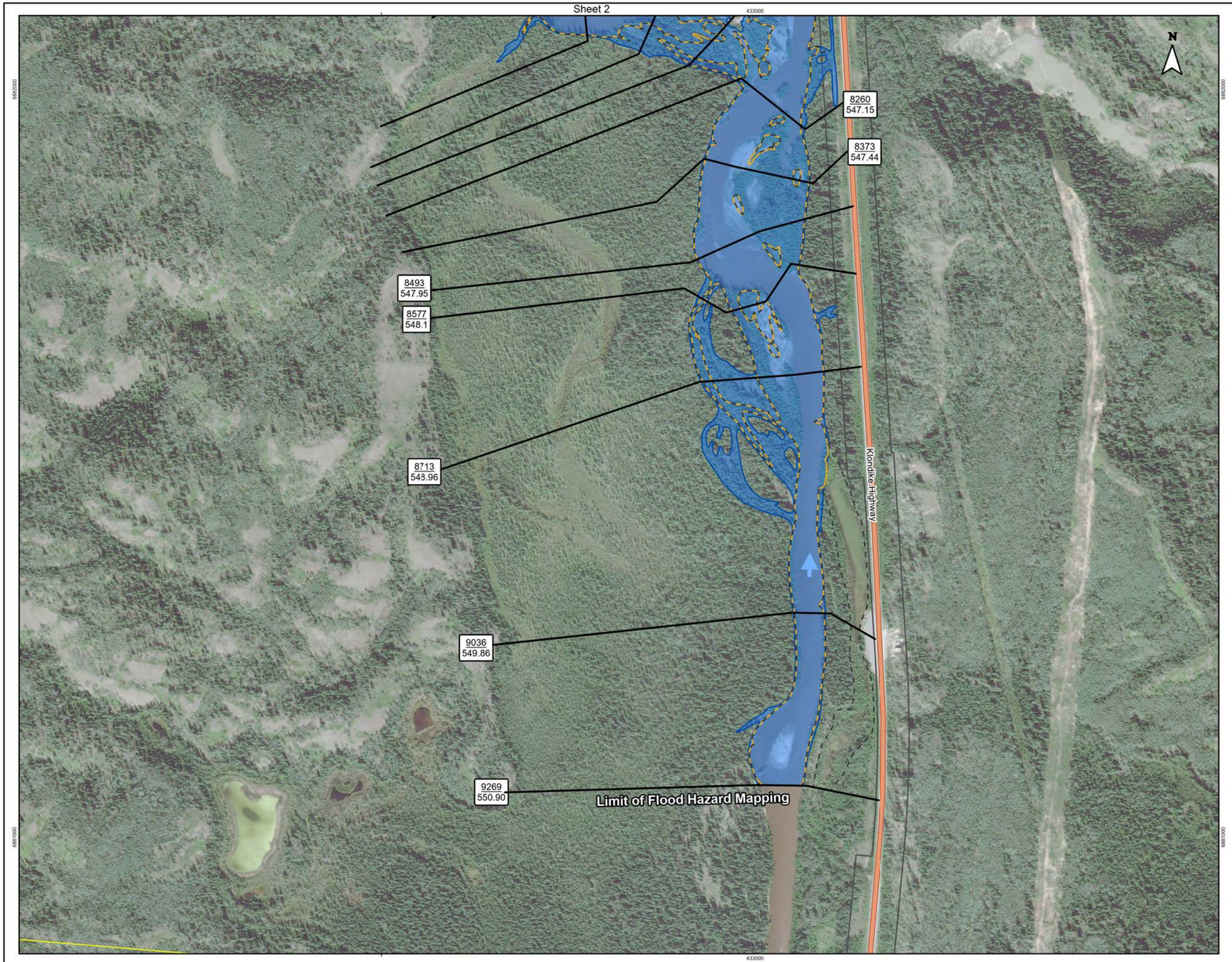


Figure No.

E.1.1

Sheet 1 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

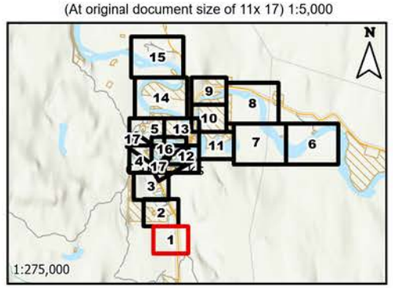
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: Yukon Satellites HighRes: Government of Yukon
World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

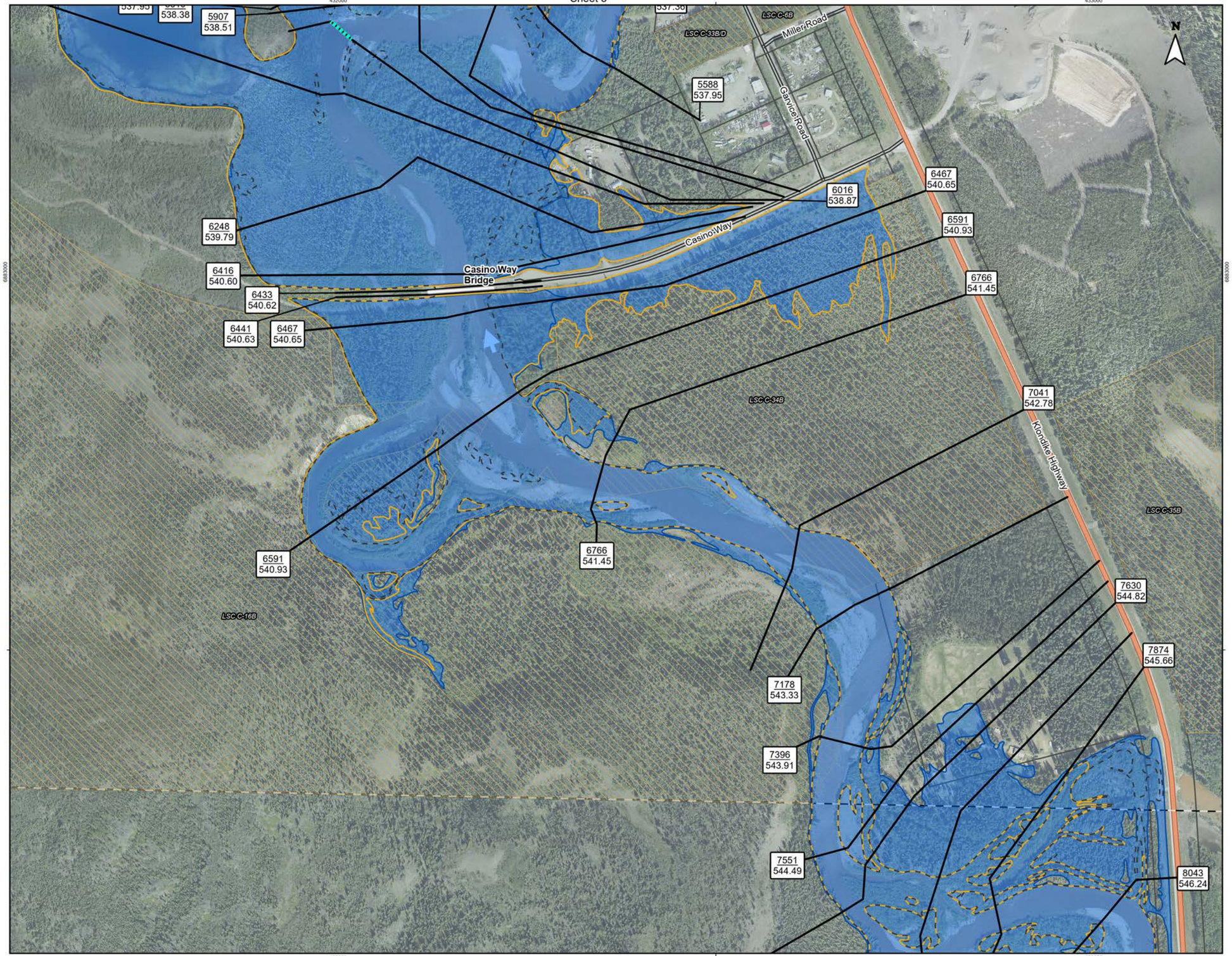
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 3



Sheet 1

Figure No.

E.1.2

Sheet 2 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

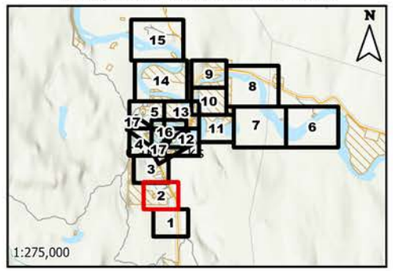
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

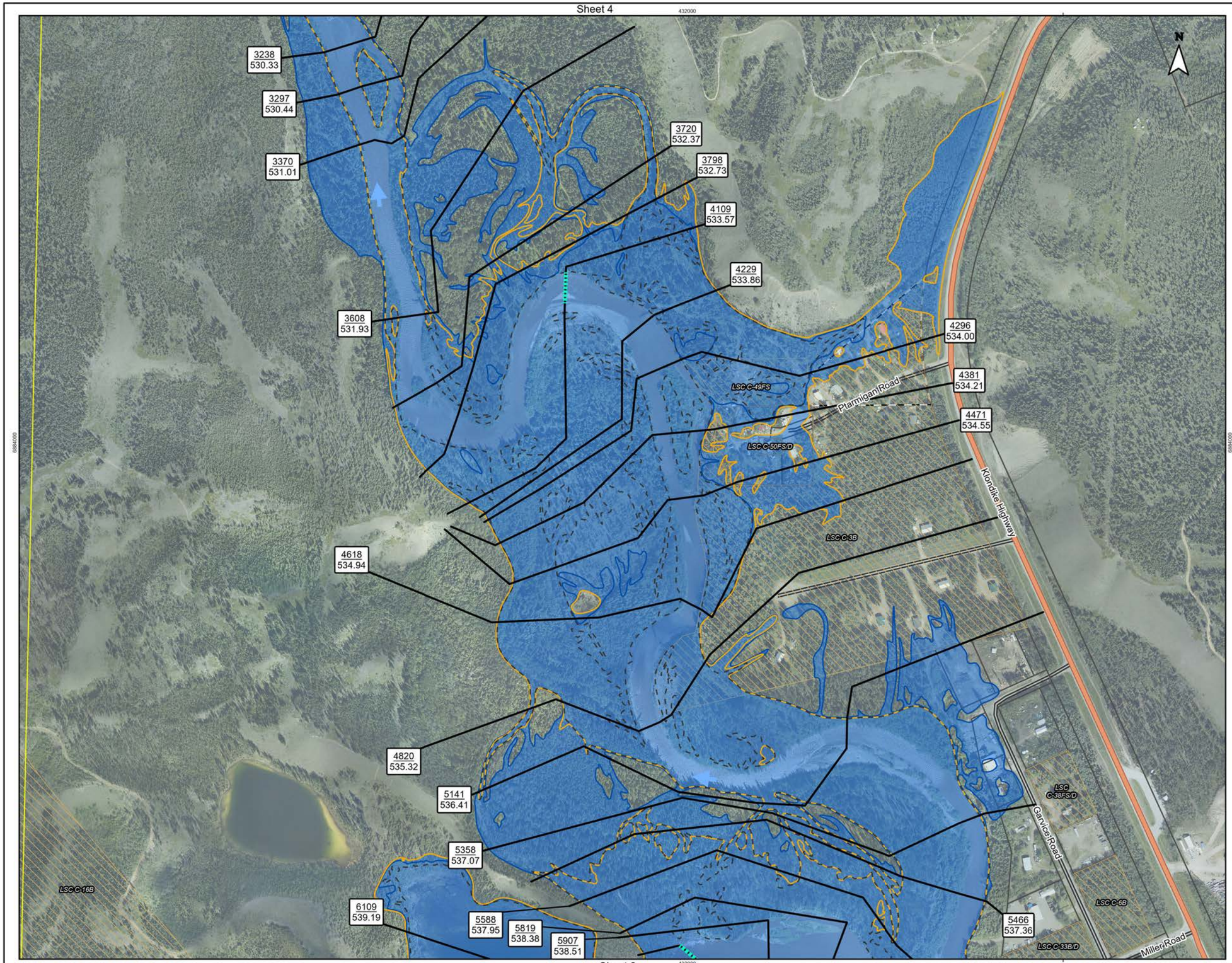
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 4



Sheet 2

Figure No.

E.1.3 **Sheet 3 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

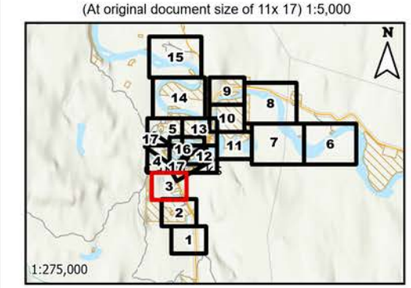
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 5

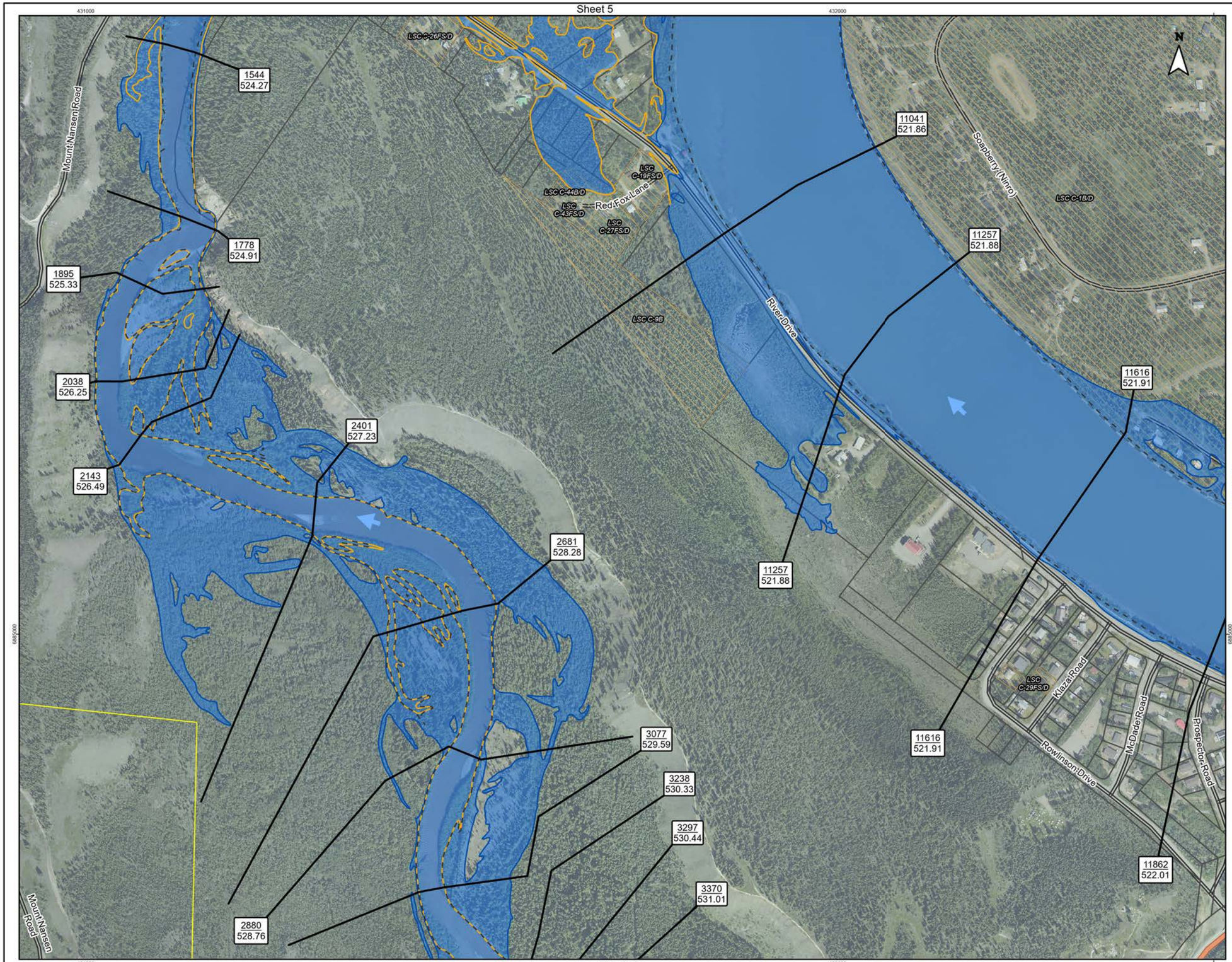


Figure No.

E.1.4 **Sheet 4 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

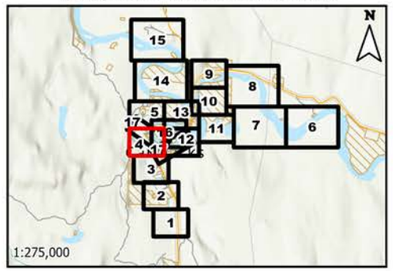
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

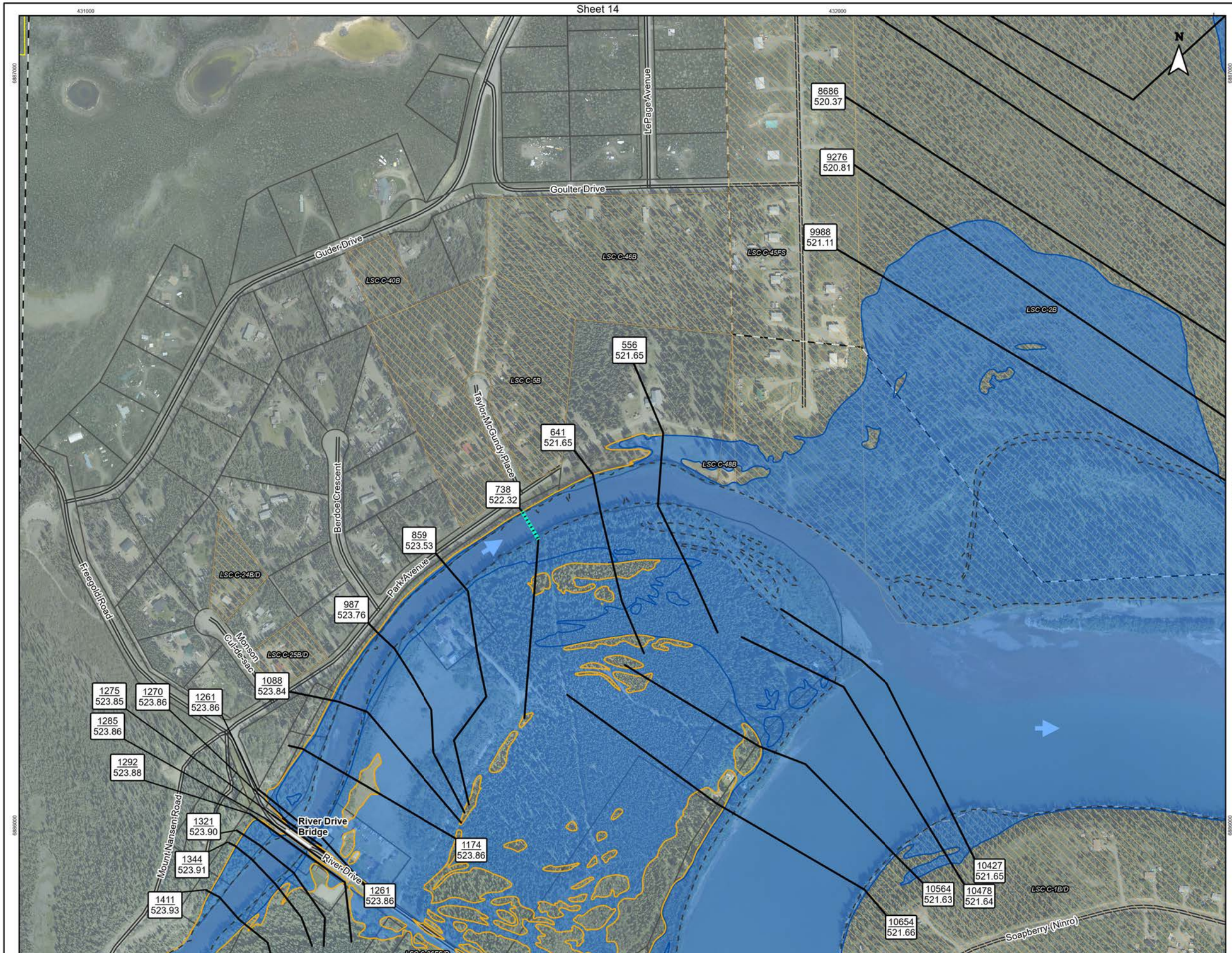


Figure No.

E.1.5

Sheet 5 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

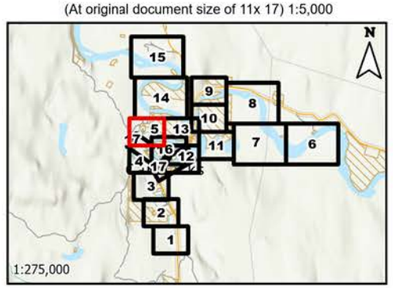
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

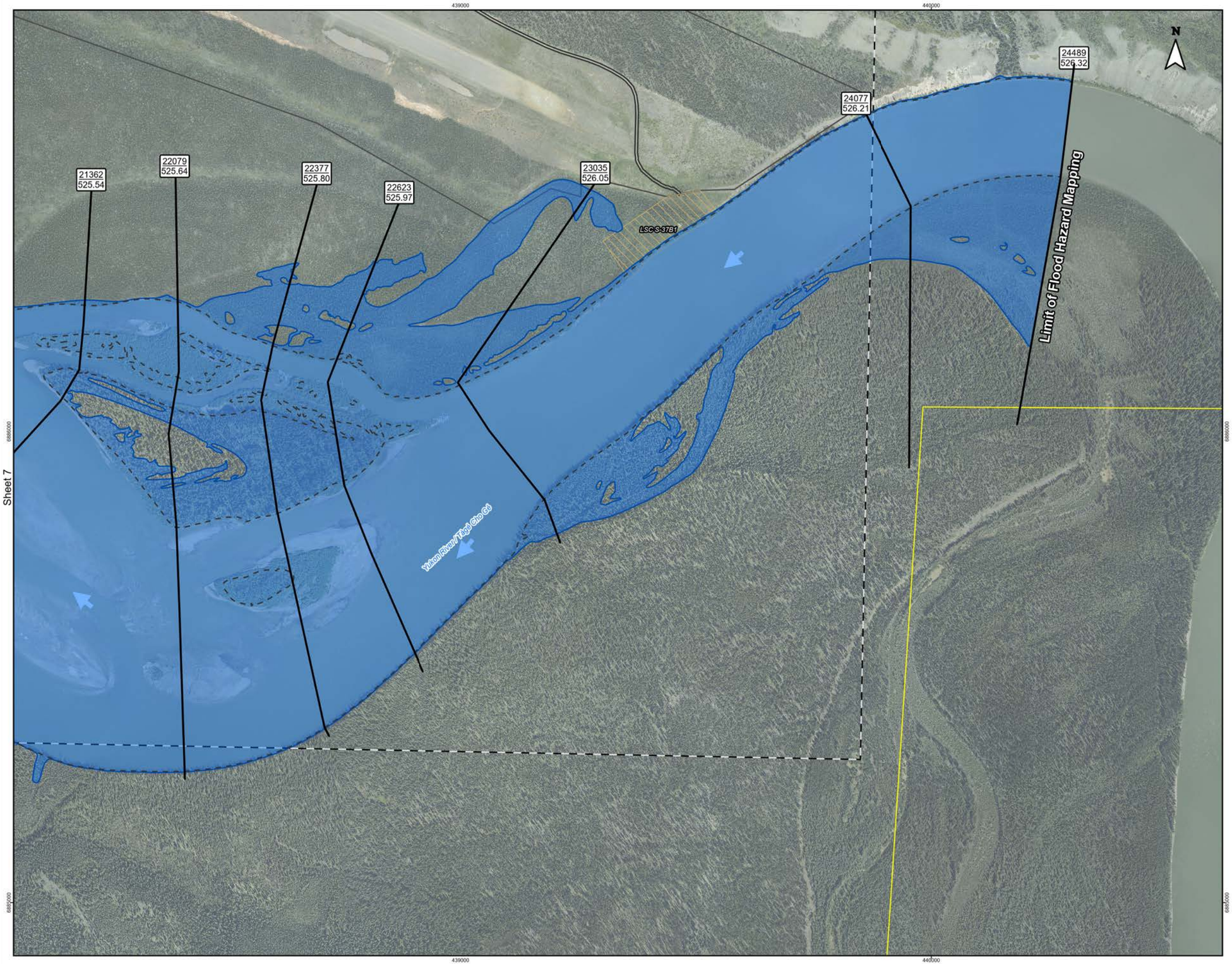
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Sheet 7

Figure No.

E.1.6

Sheet 6 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

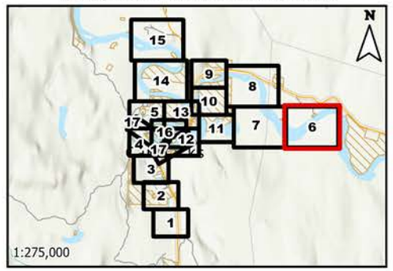
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

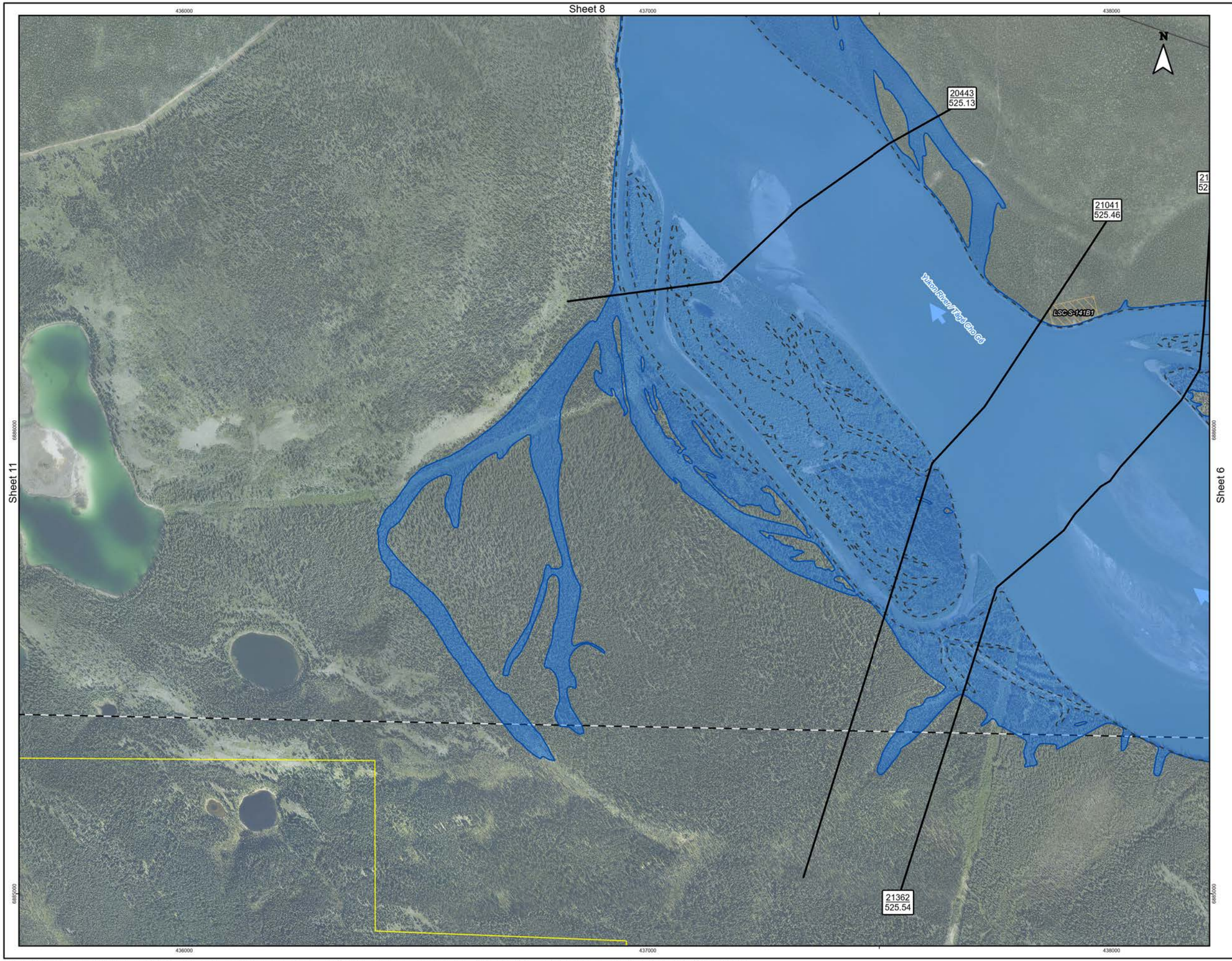


Figure No.

E.1.7

Sheet 7 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

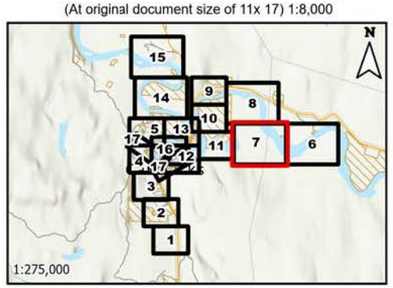
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

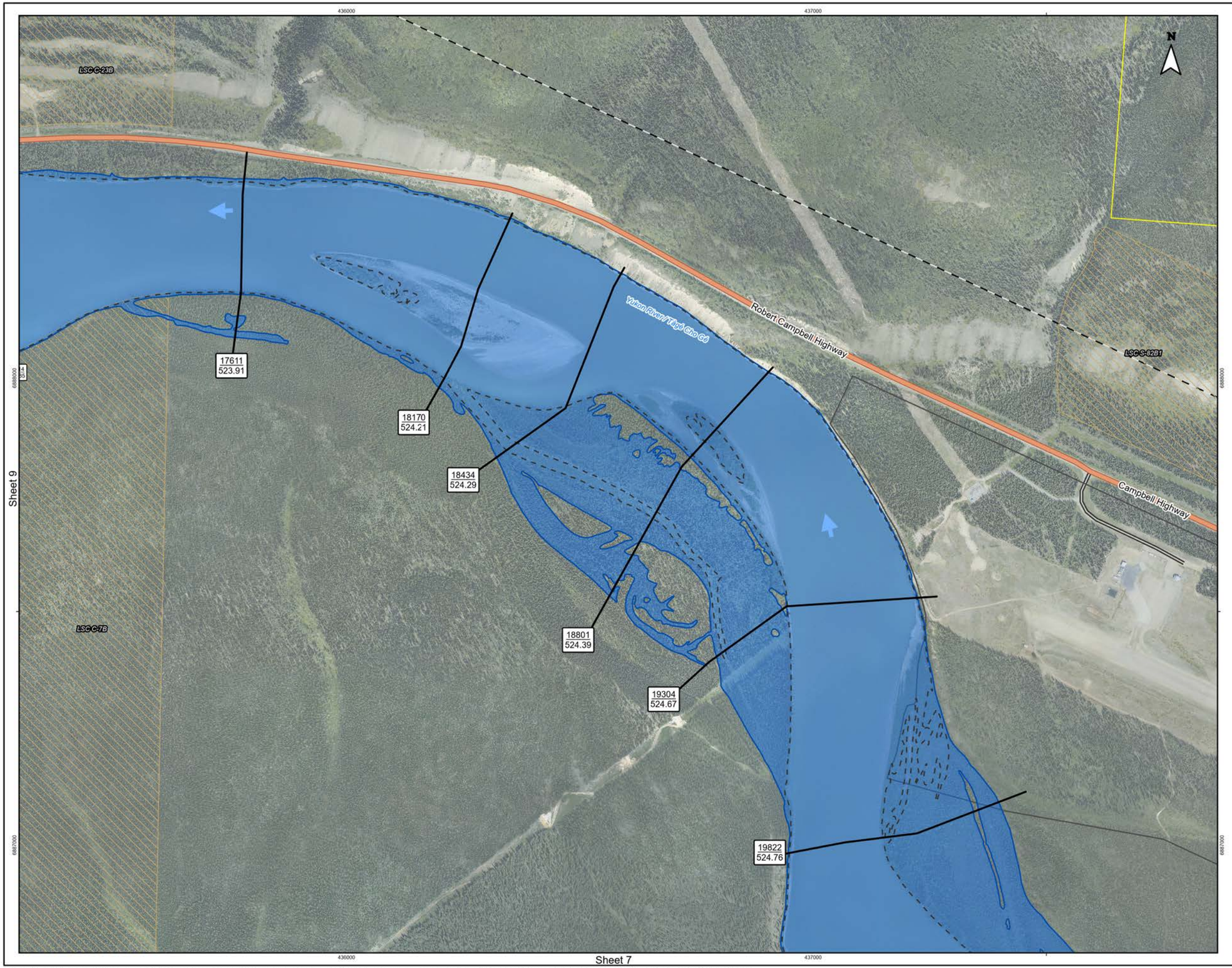


Figure No.

E.1.8

Sheet 8 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

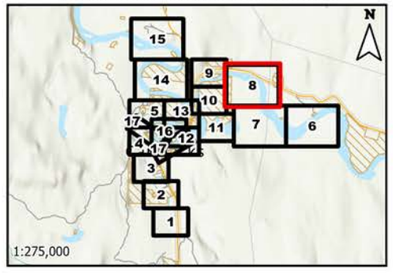
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

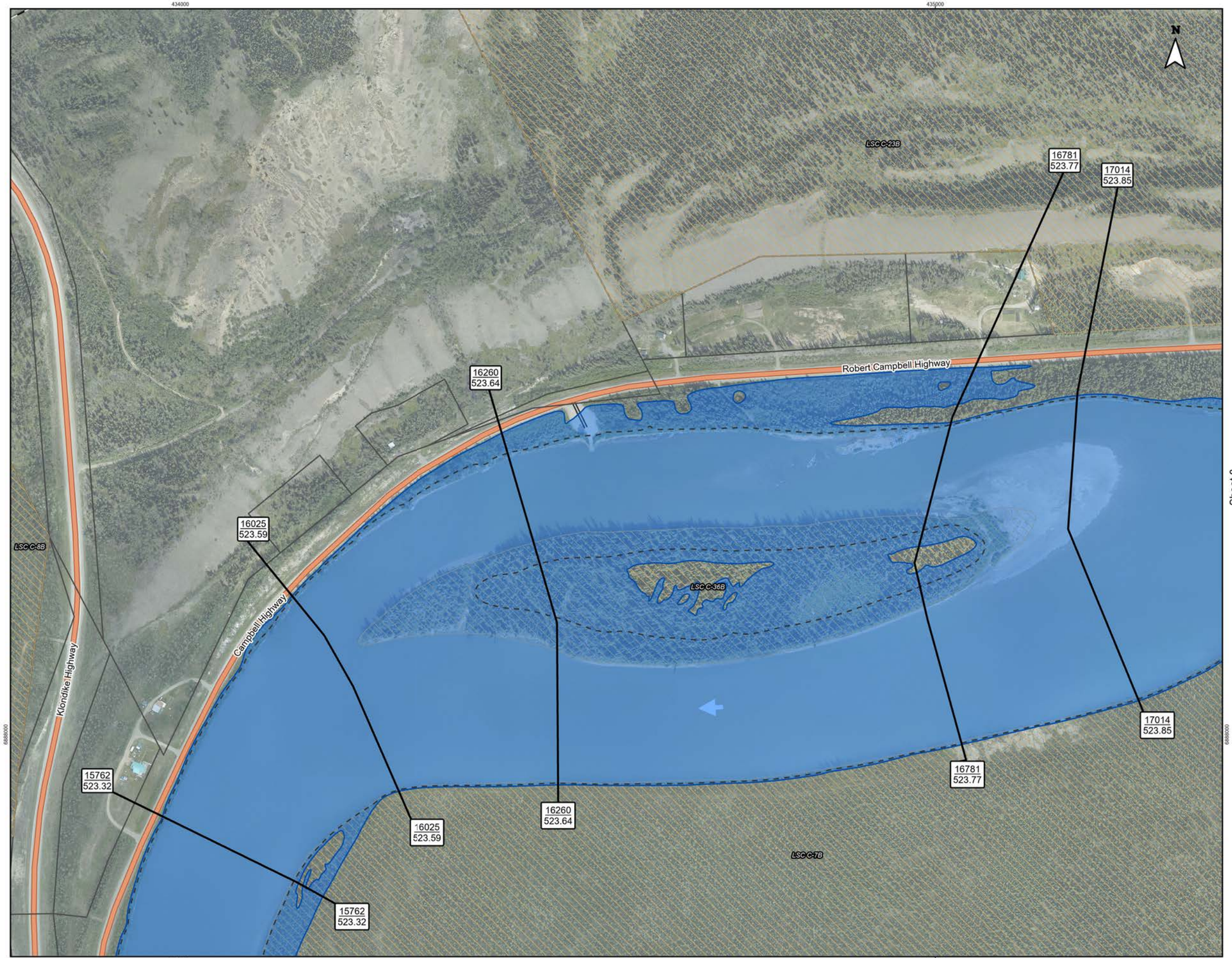


Figure No.

E.1.9

Sheet 9 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

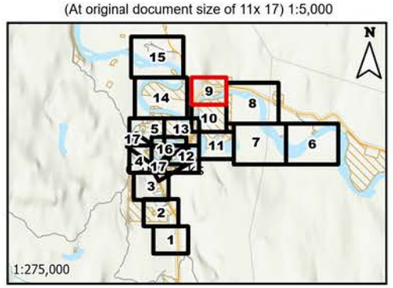
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

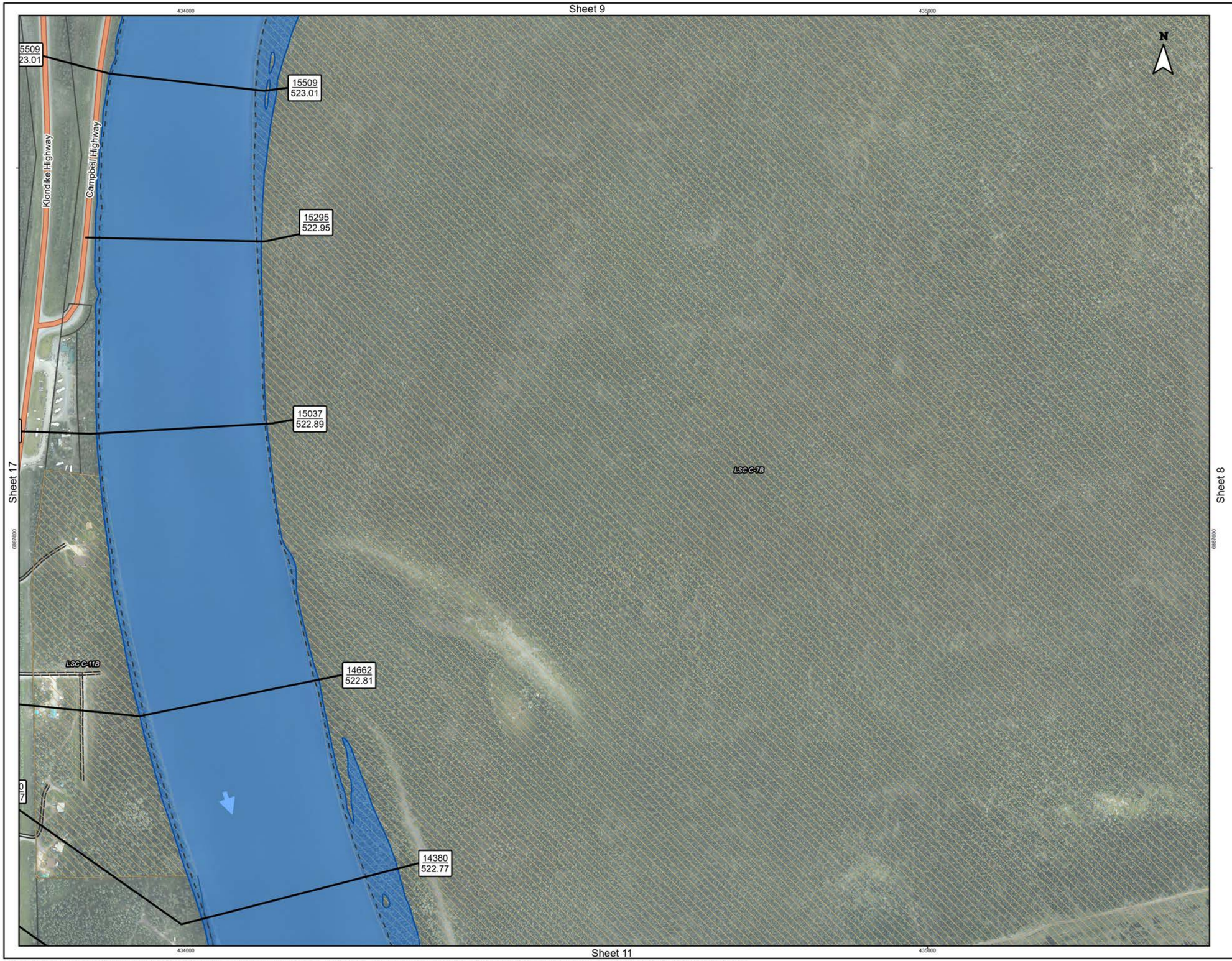


Figure No.

E.1.10

Sheet 10 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

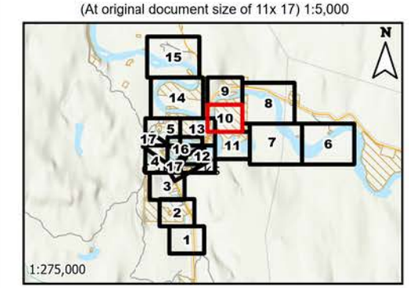
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

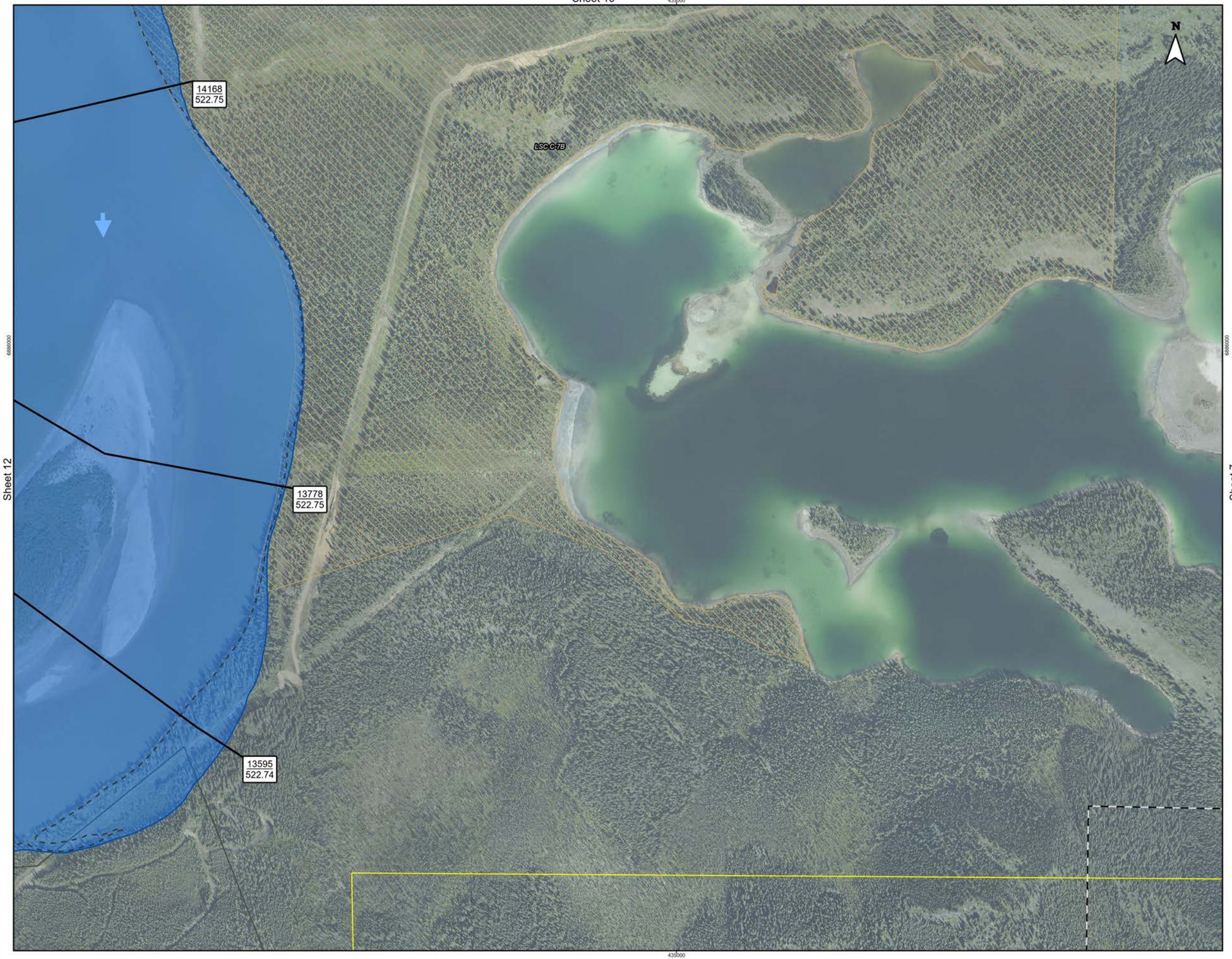


Figure No.

E.1.11

Sheet 11 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

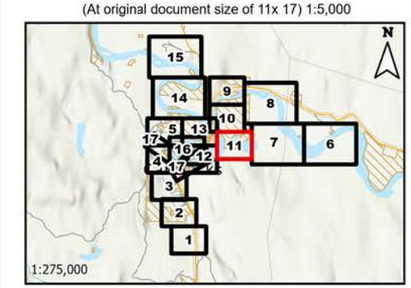
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 13

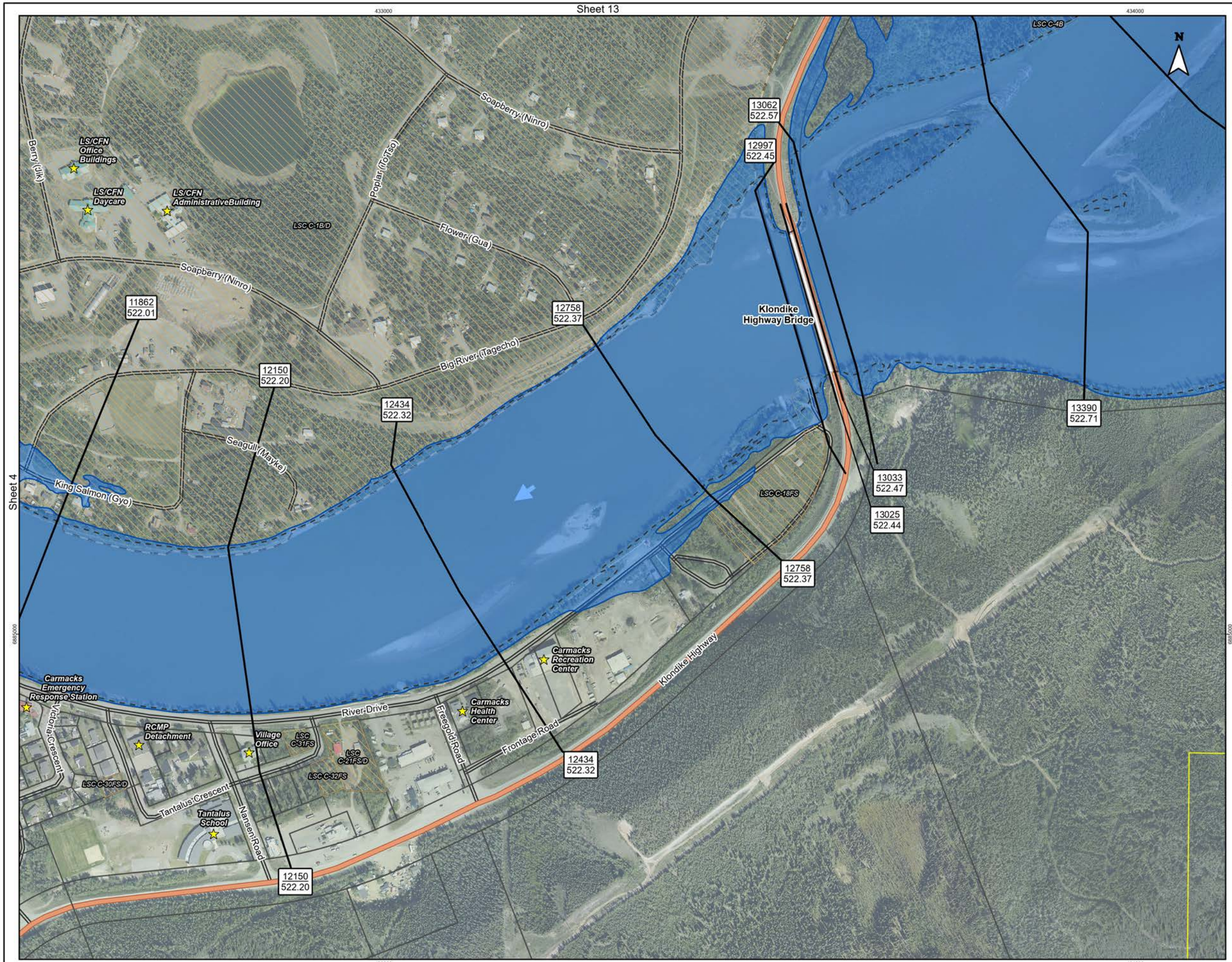


Figure No.

E.1.12

Sheet 12 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

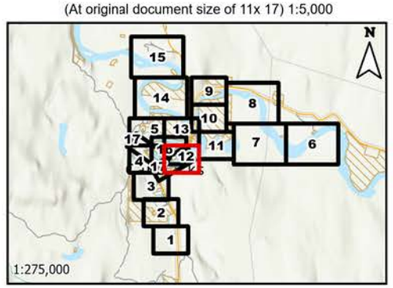
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

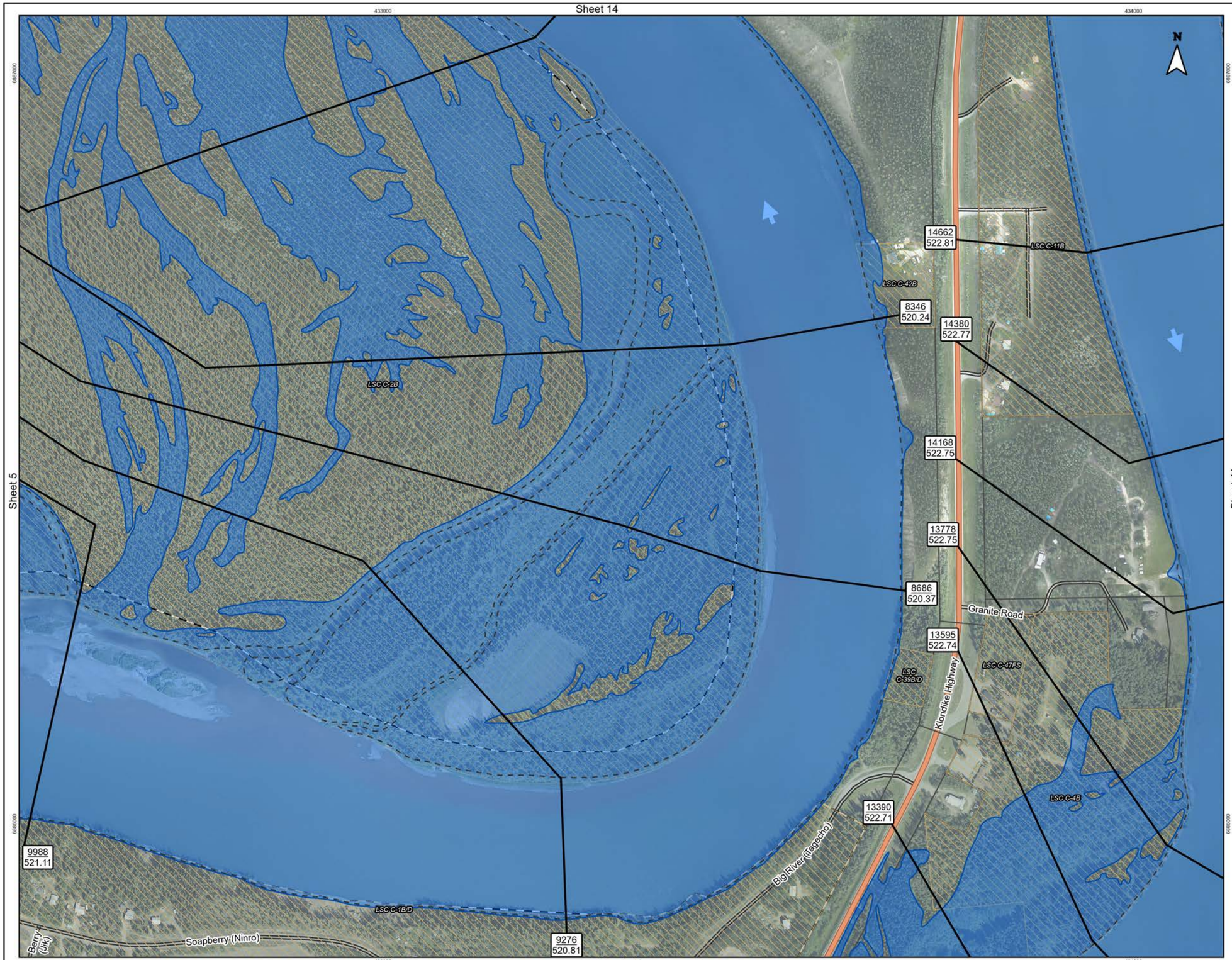


Figure No.

E.1.13

Sheet 13 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

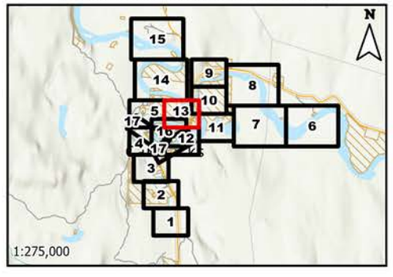
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

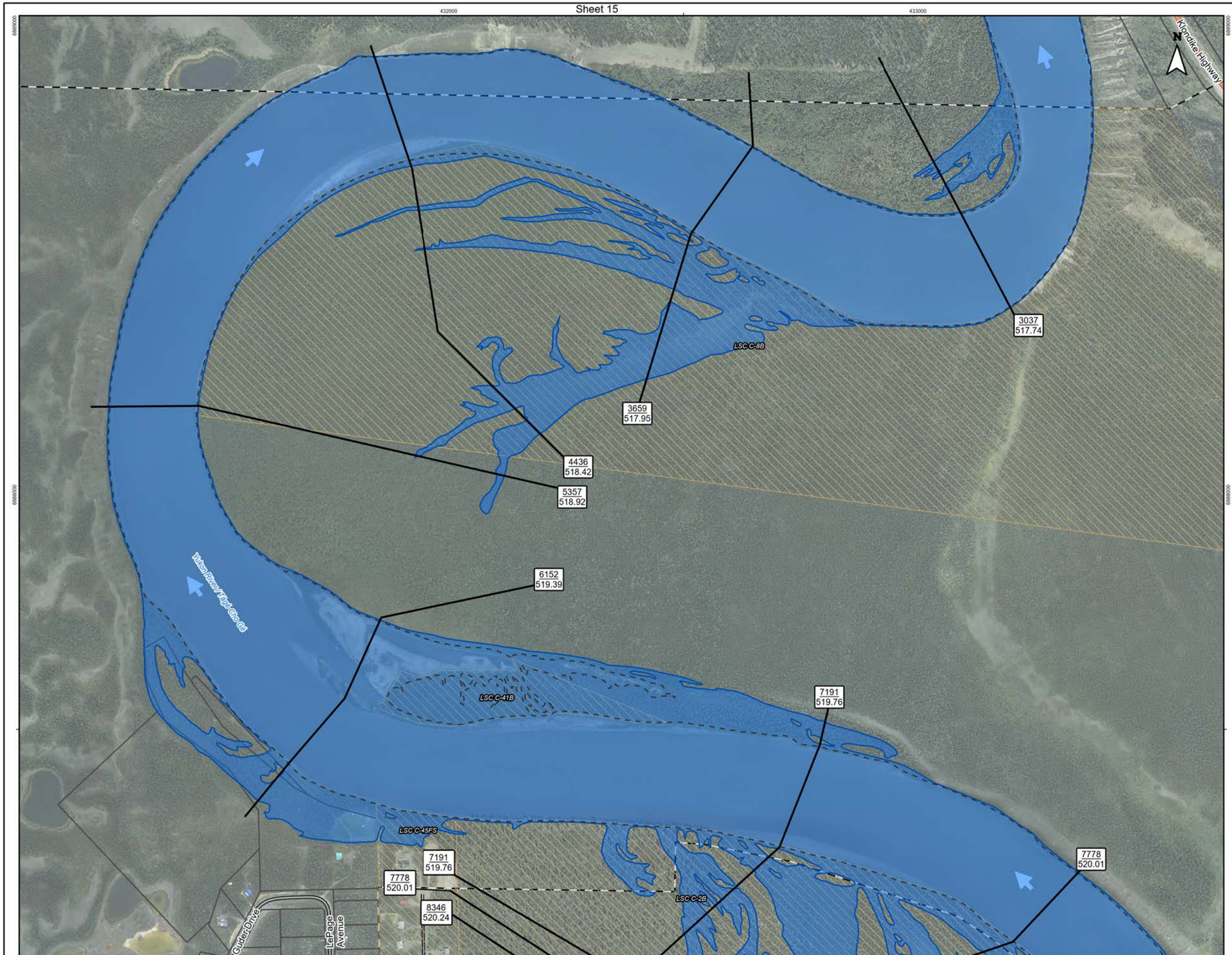


Figure No.

E.1.14

Sheet 14 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

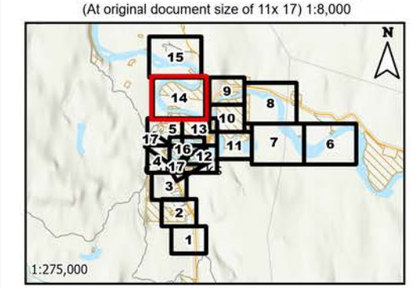
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

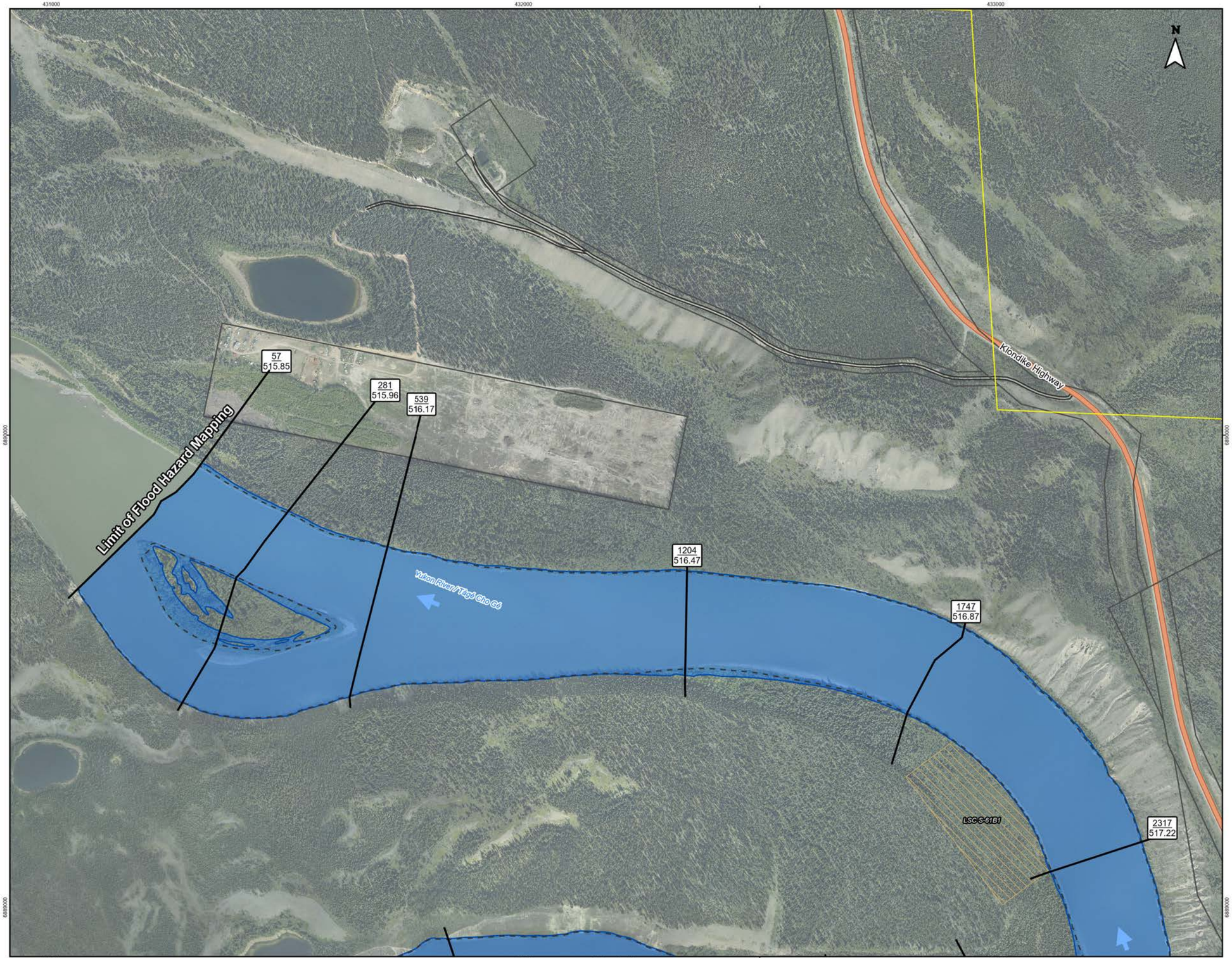
Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Sheet 14

Figure No.

E.1.15 **Sheet 15 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

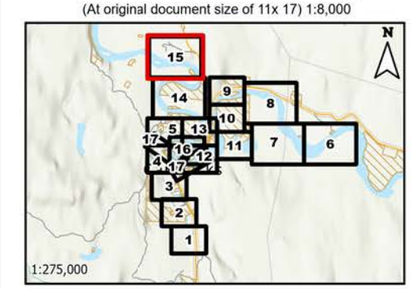
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

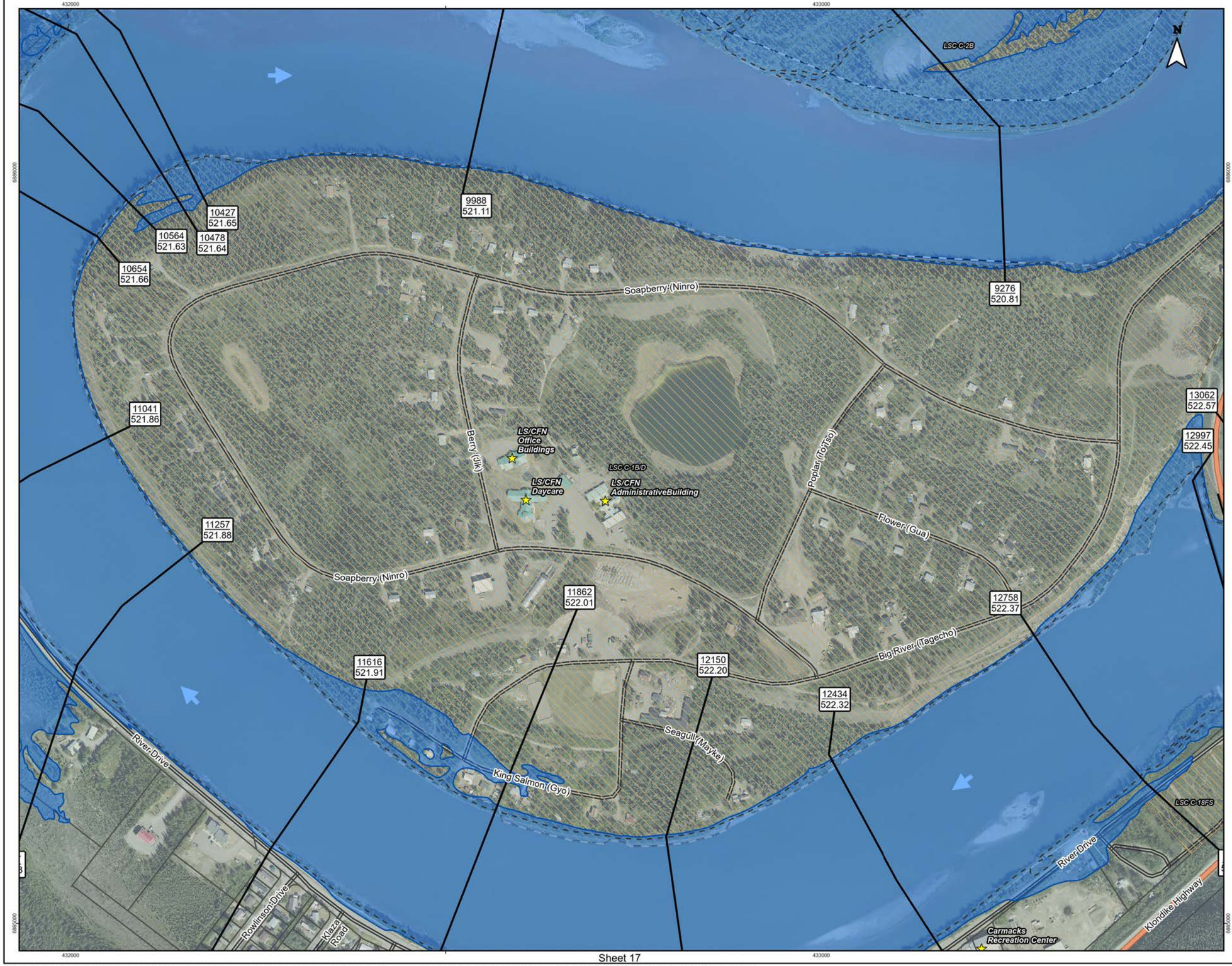
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Sheet 17

Figure No.

E.1.16

Sheet 16 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

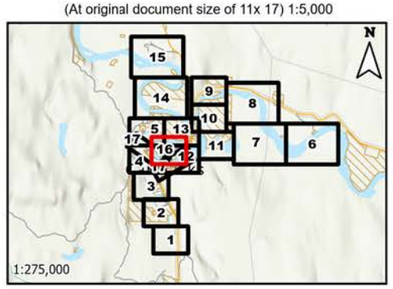
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

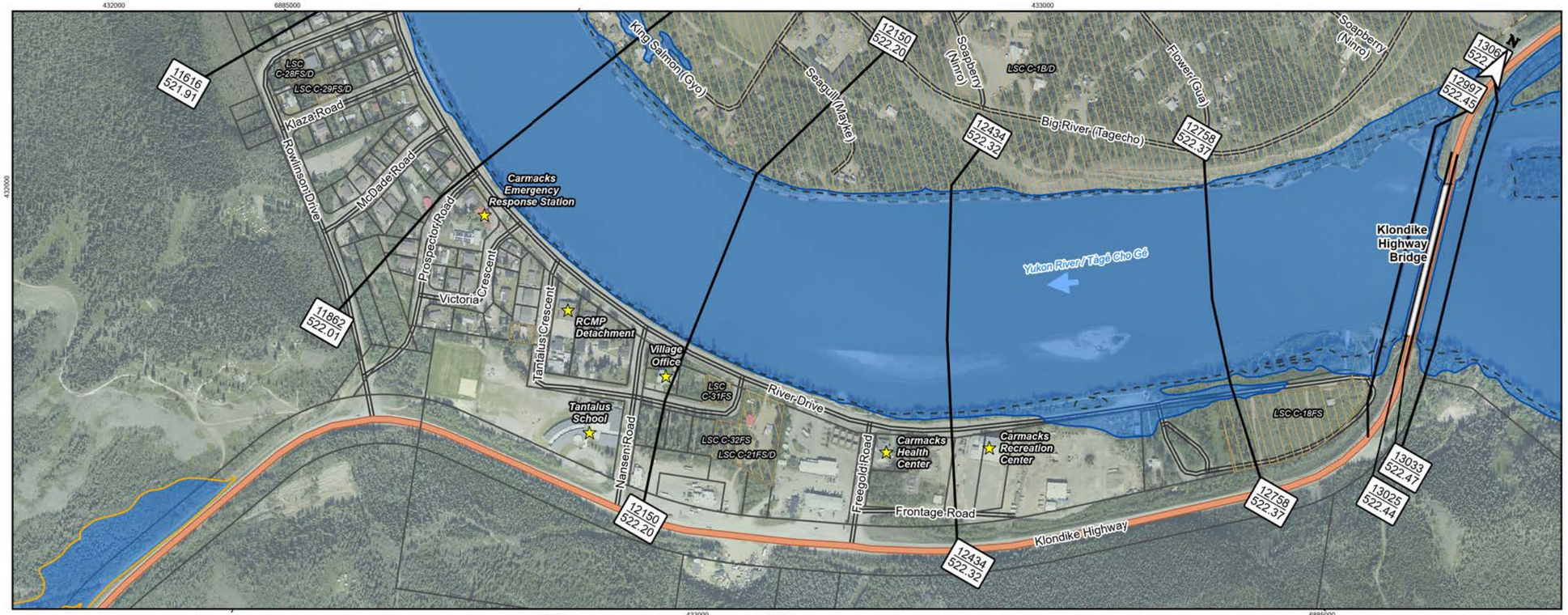
Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



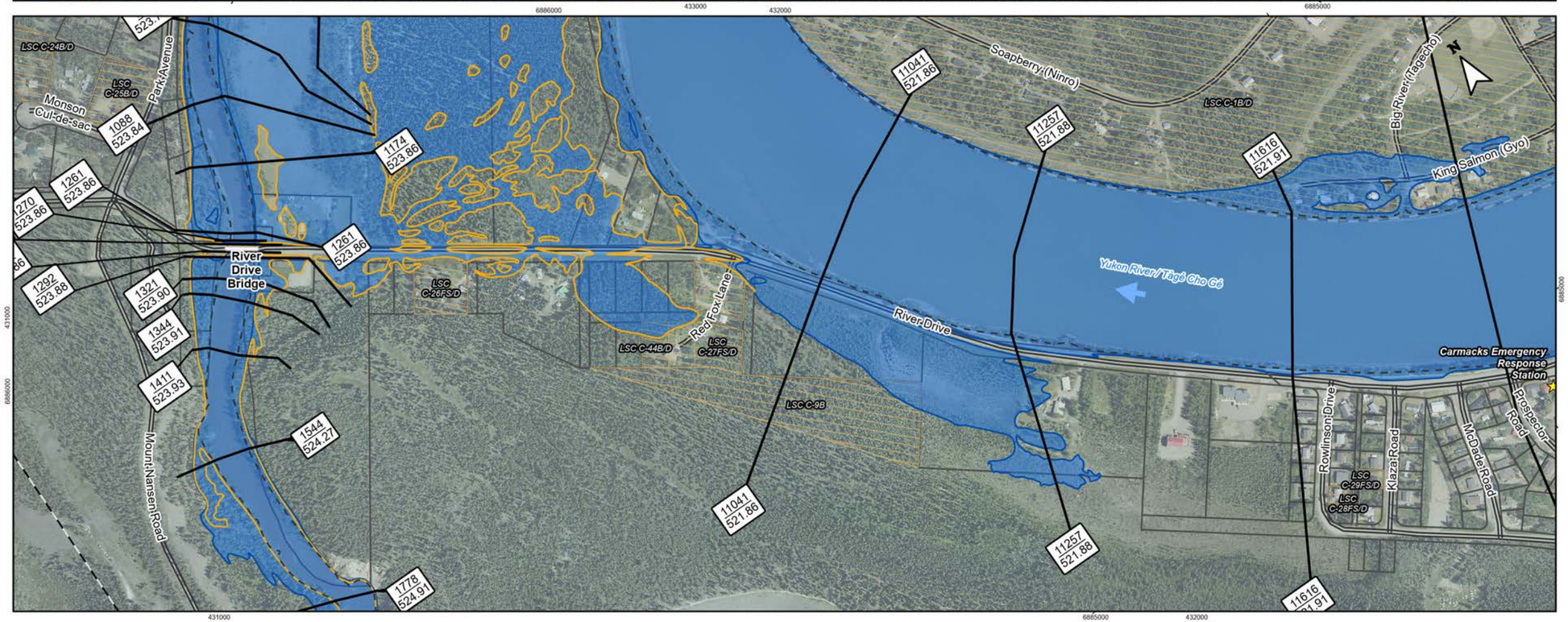


Figure No.

E.1.17

Sheet 17 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

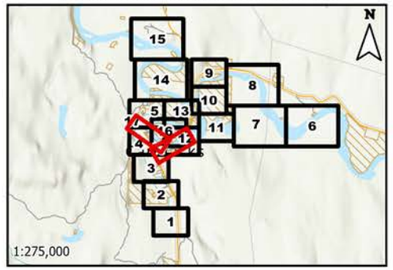
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 50 100 150 200 250 m

(At original document size of 11x 17) 1:6,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

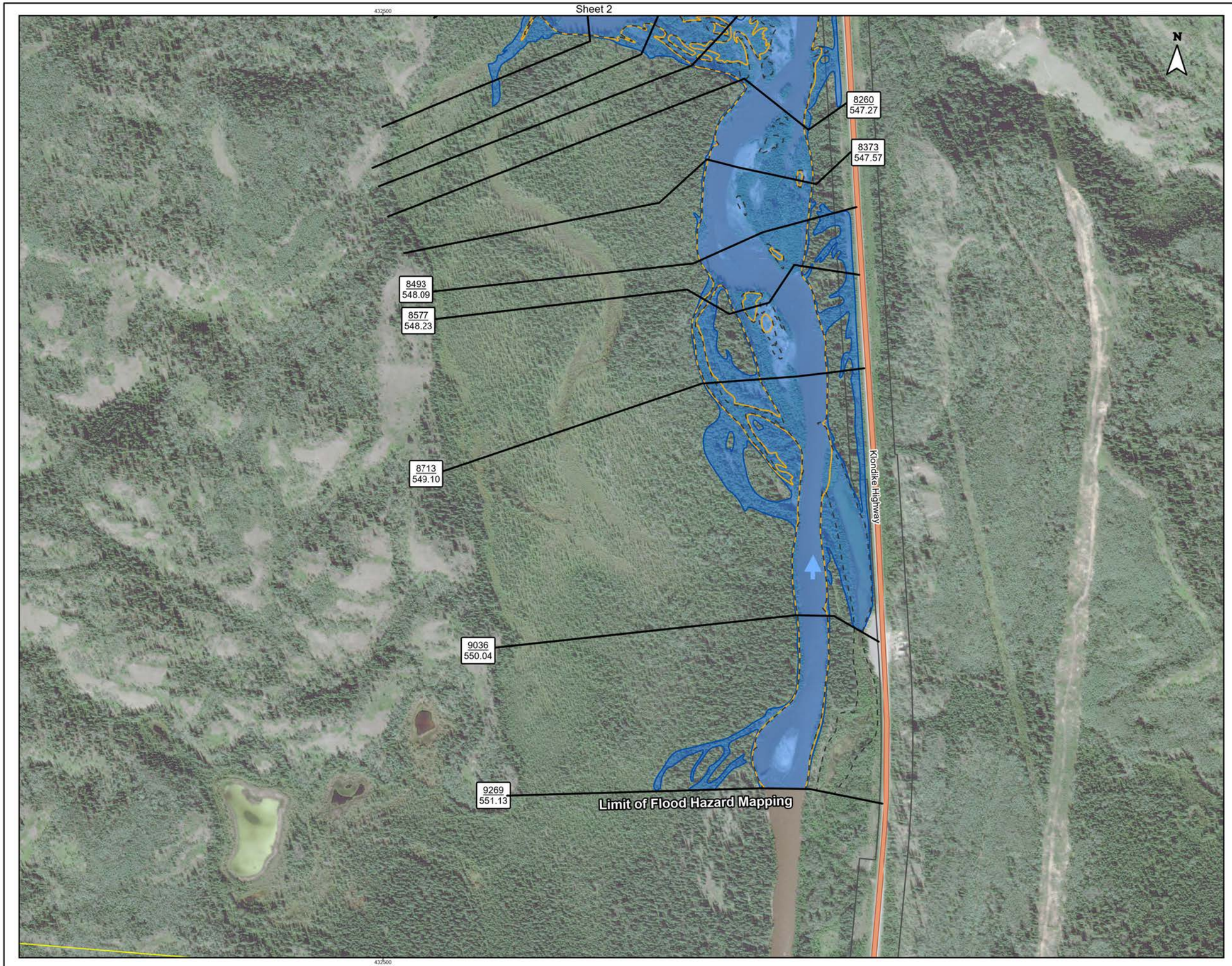


Figure No.

E.2.1

Sheet 1 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

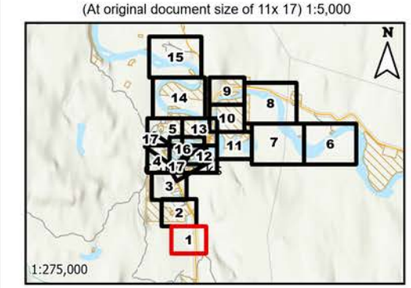
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: Yukon Satellites HighRes: Government of Yukon
World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

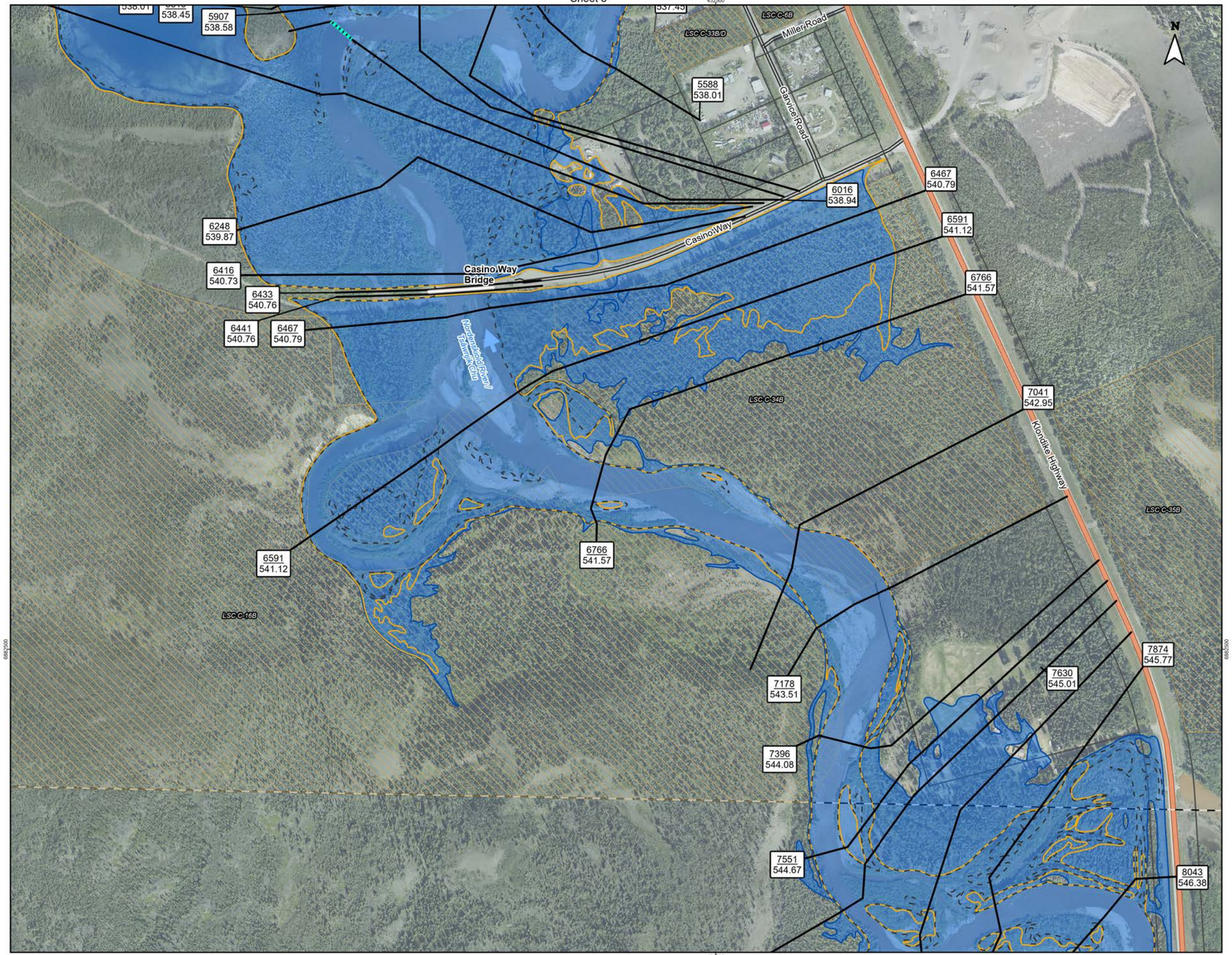
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 3



Sheet 1

Figure No.

E.2.2 **Sheet 2 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

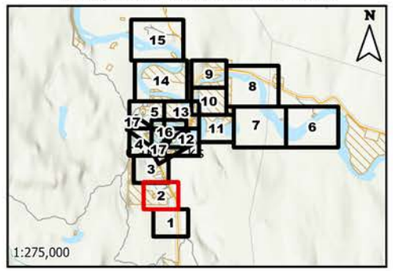
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

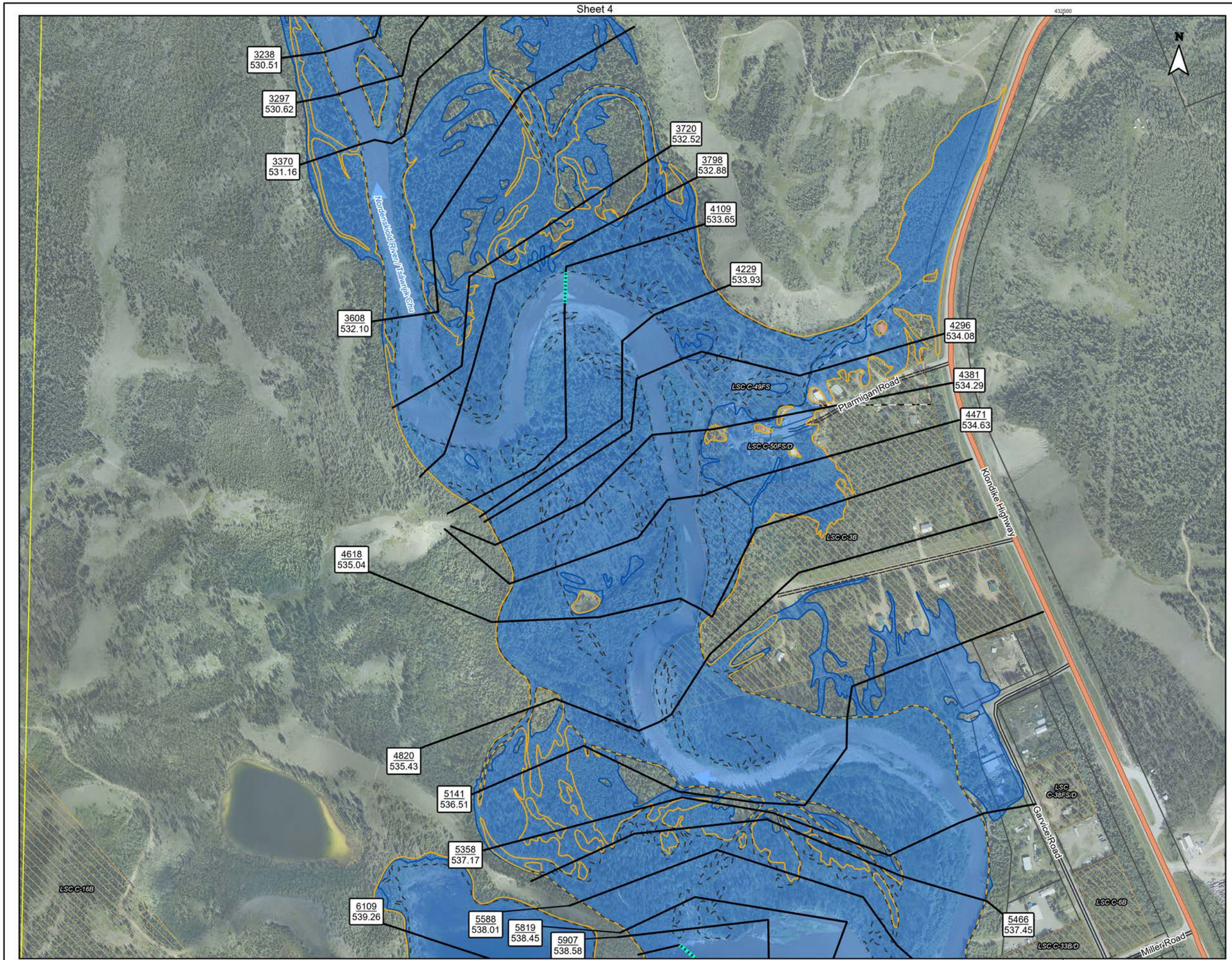
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 4



Sheet 2

Figure No.

E.2.3 **Sheet 3 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

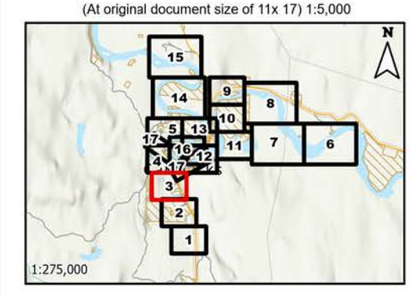
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 5

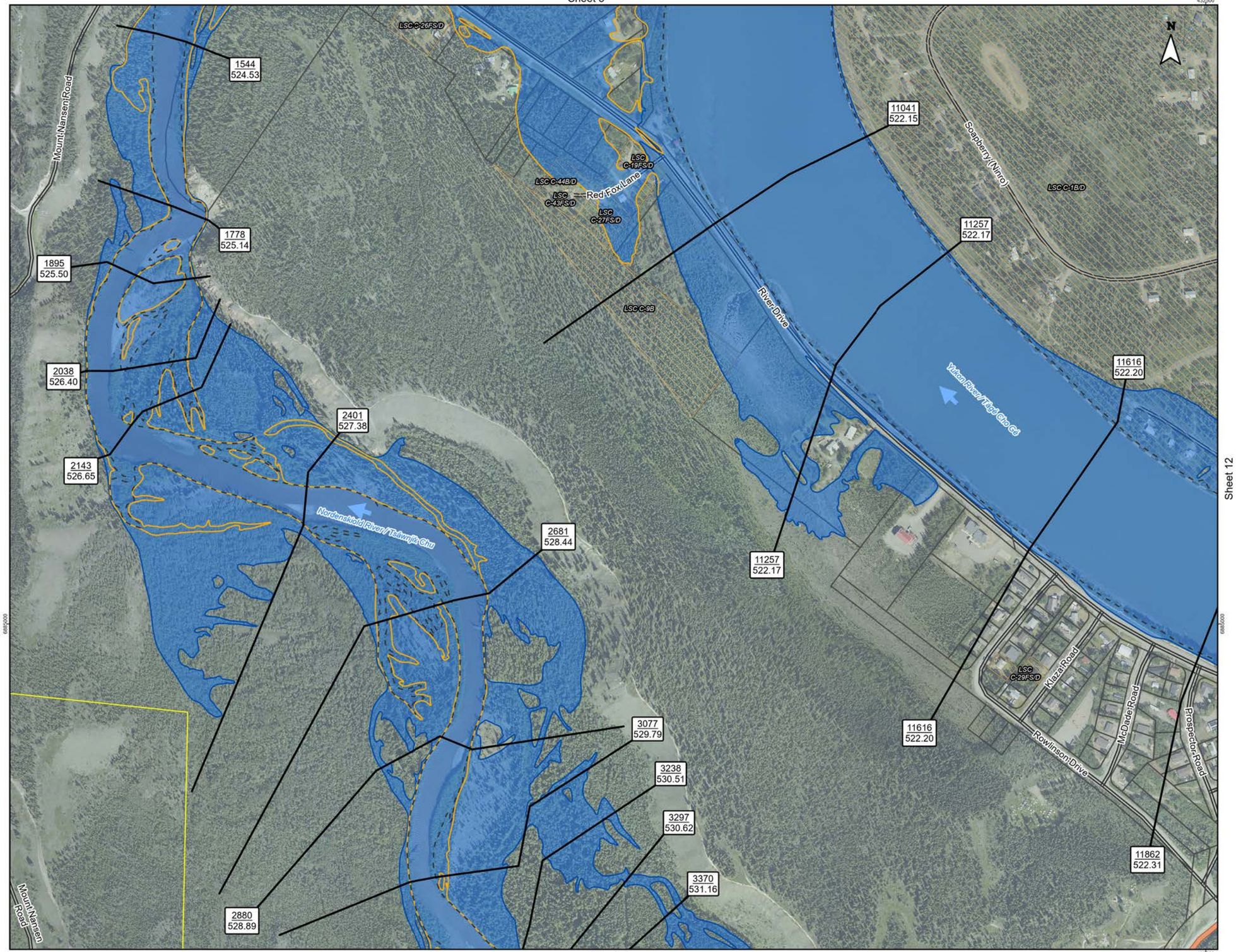


Figure No.

E.2.4 **Sheet 4 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

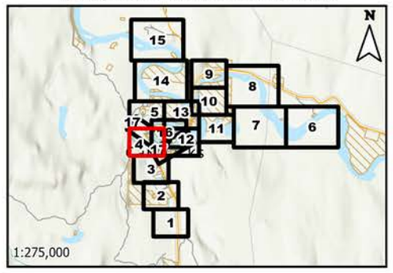
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

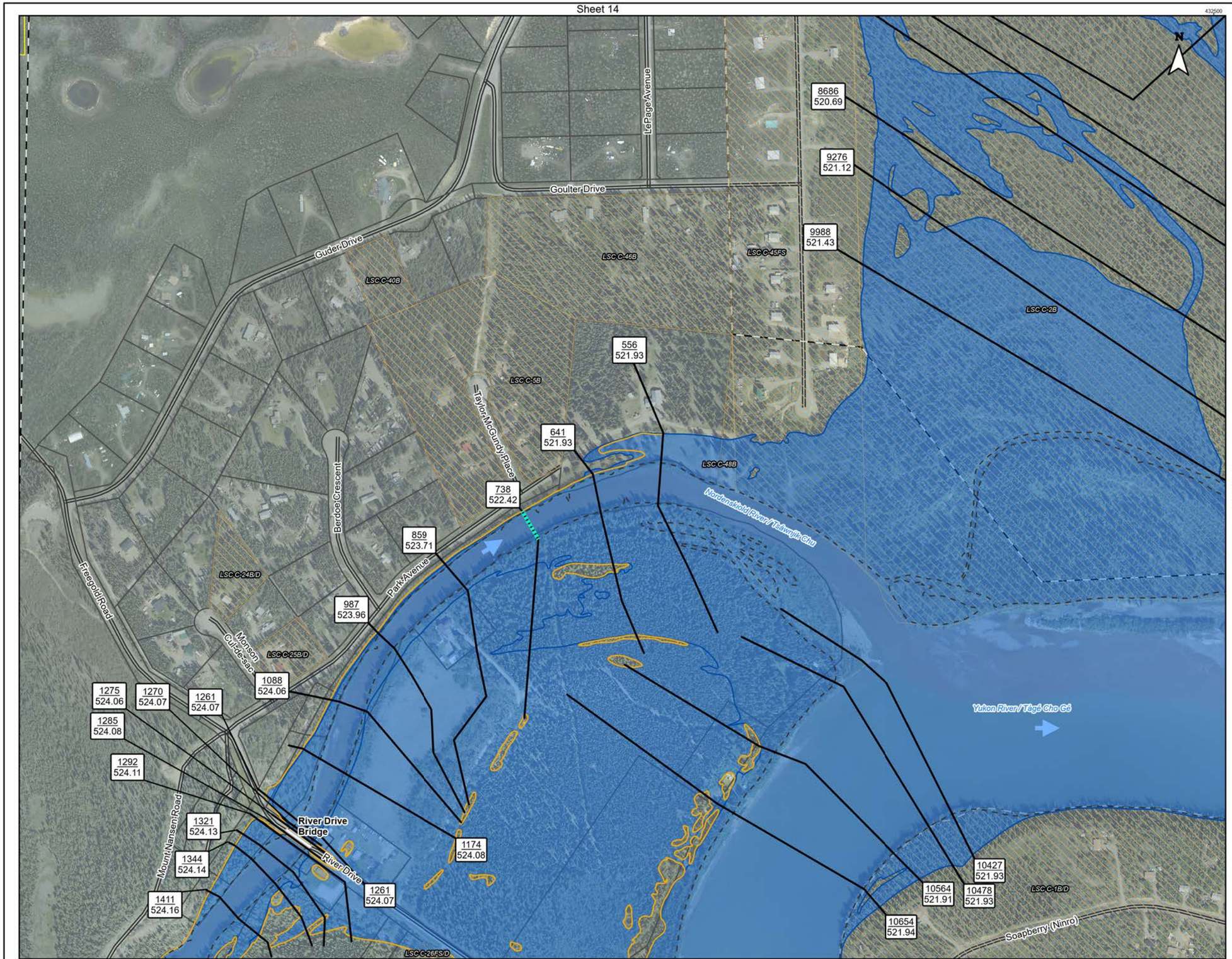
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 14



Sheet 13

Sheet 4

432500

Figure No.

E.2.5

Sheet 5 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

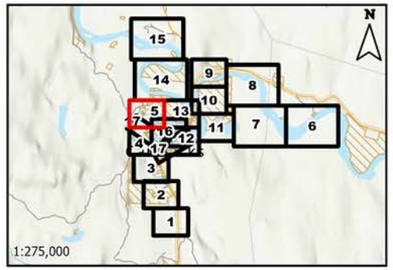
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

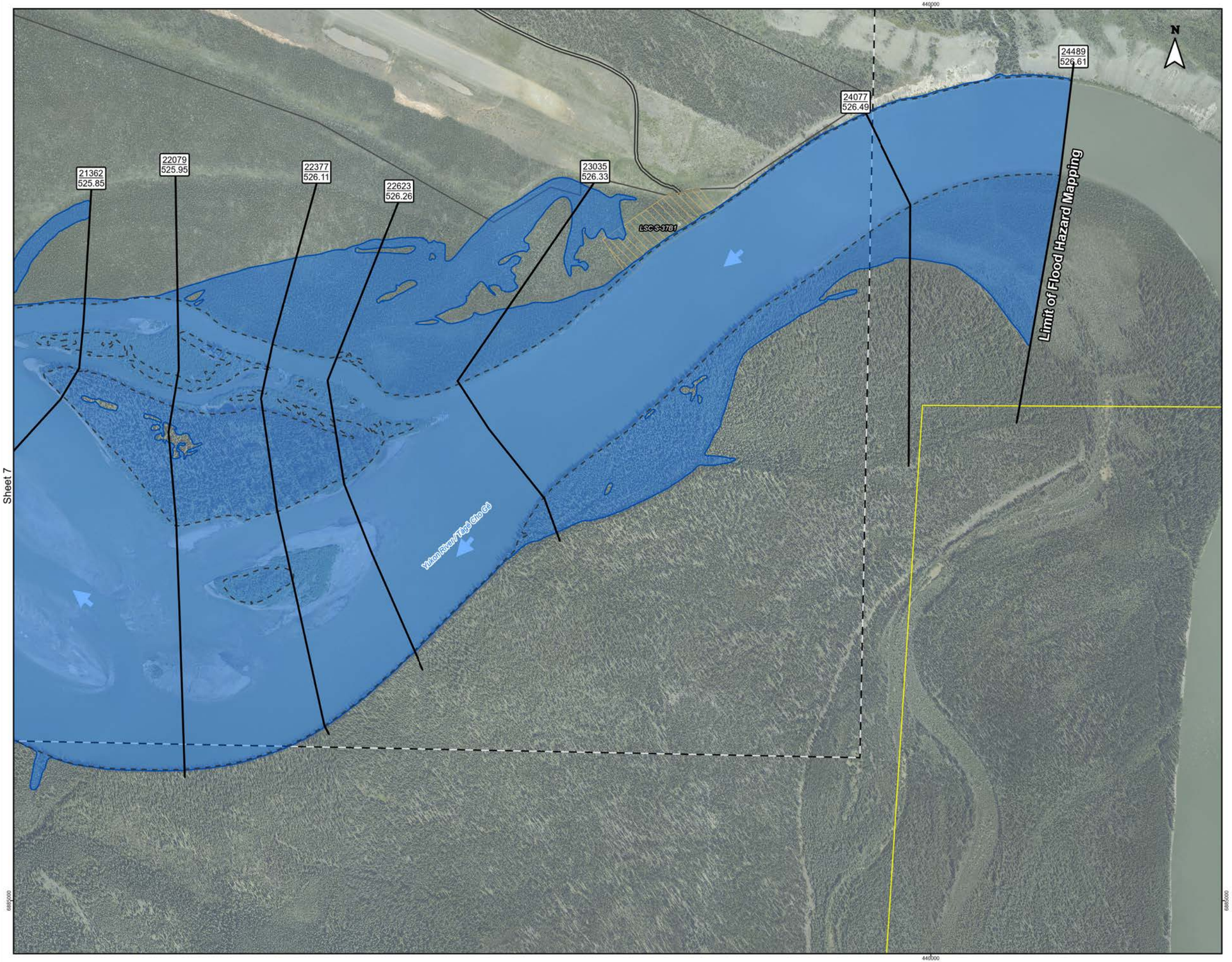


Figure No.

E.2.6 **Sheet 6 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

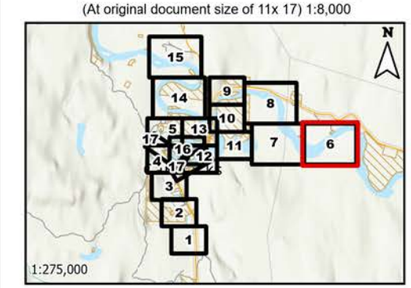
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 8

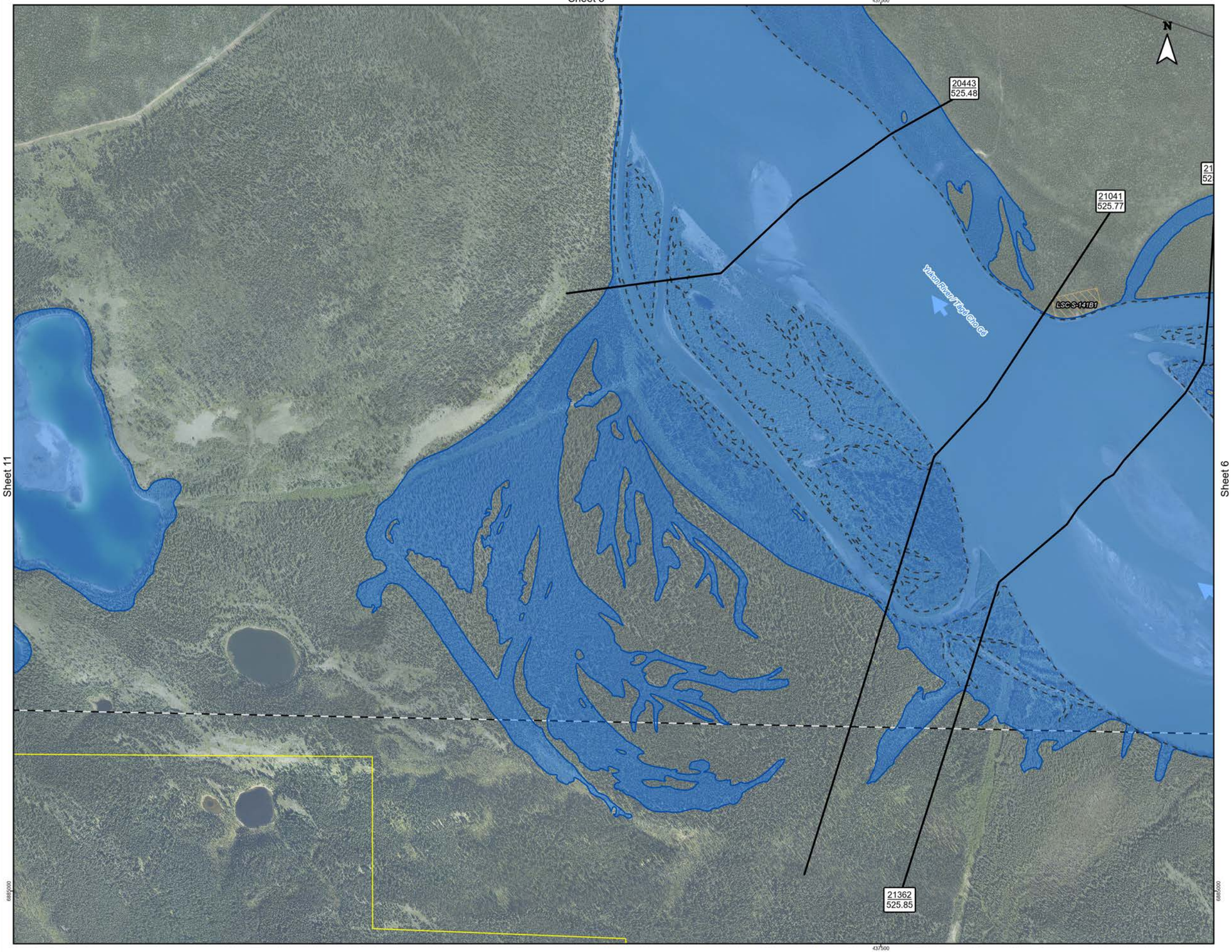


Figure No.

E.2.7

Sheet 7 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

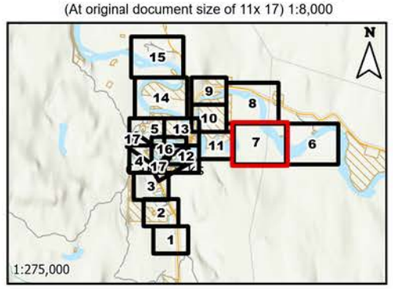
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

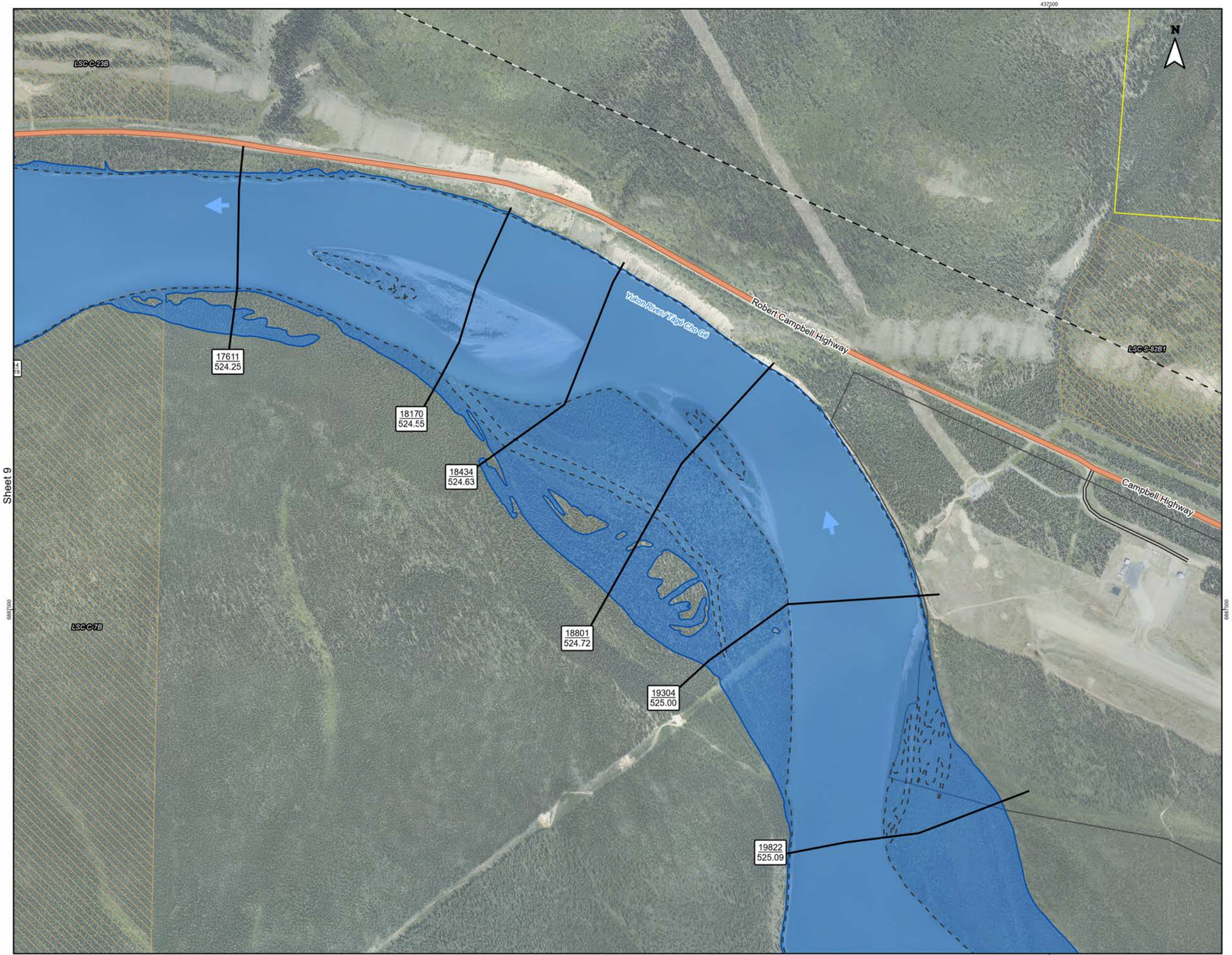


Figure No.

E.2.8 **Sheet 8 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

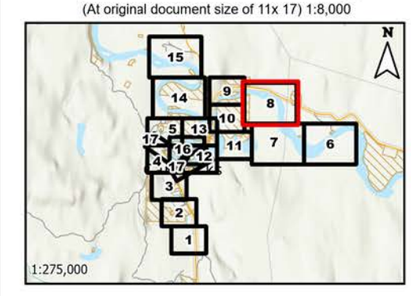
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

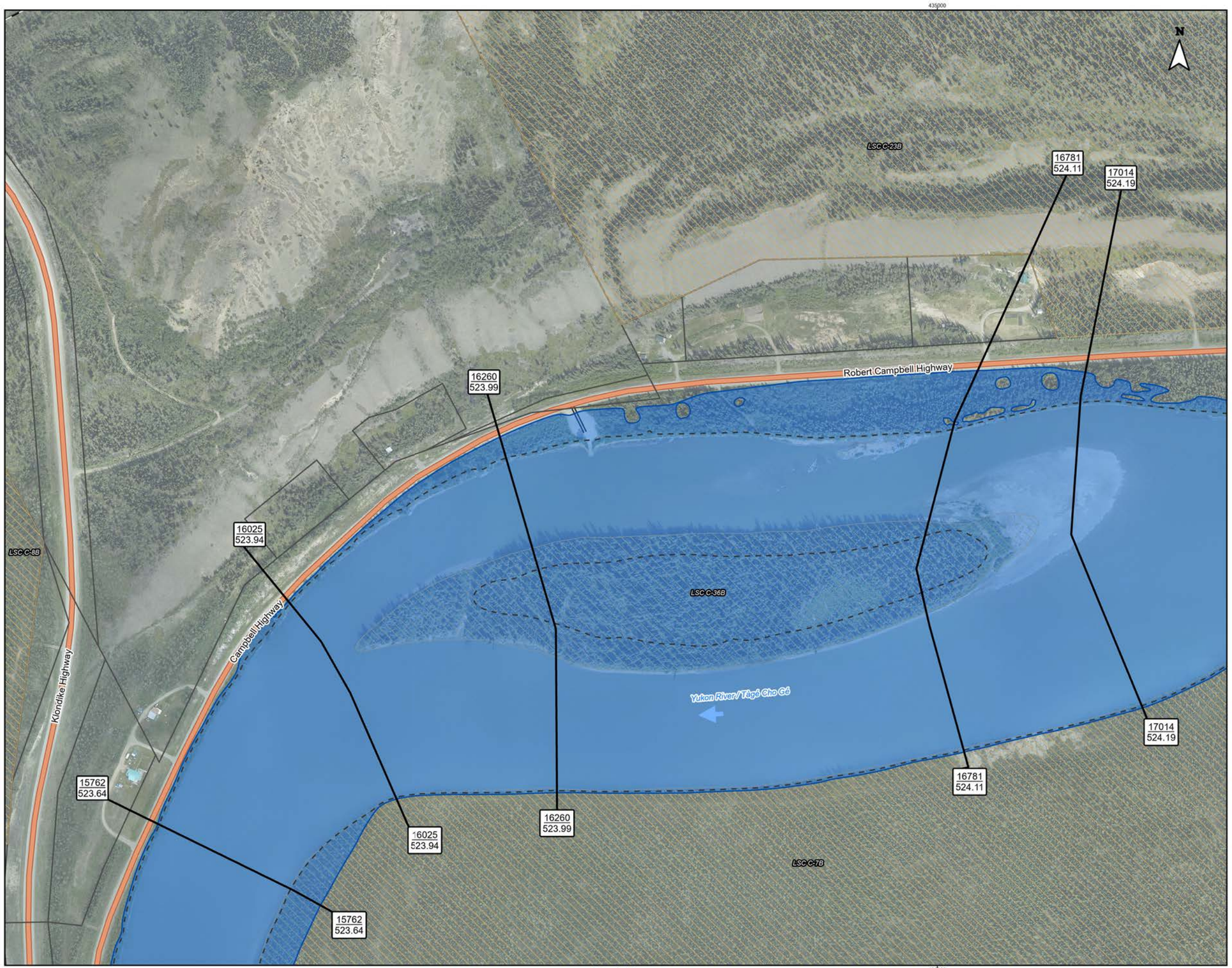


Figure No.

E.2.9 **Sheet 9 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

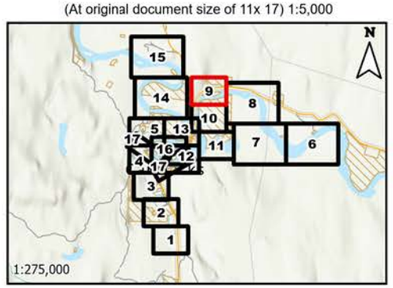
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

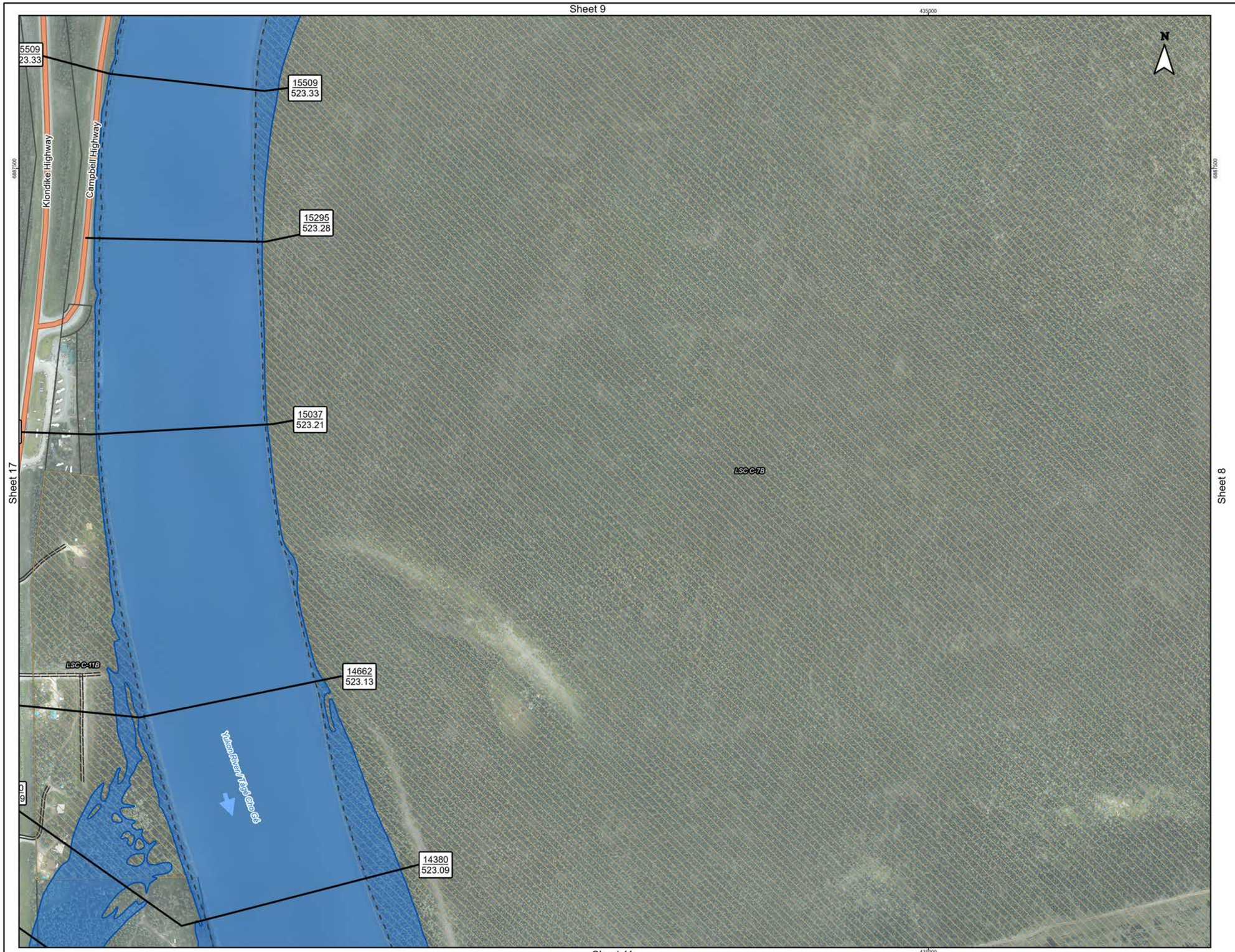


Figure No.

E.2.10

Sheet 10 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

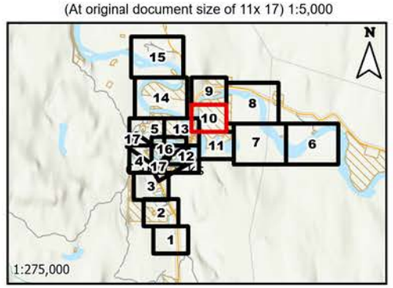
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 10

Sheet 12

Sheet 7

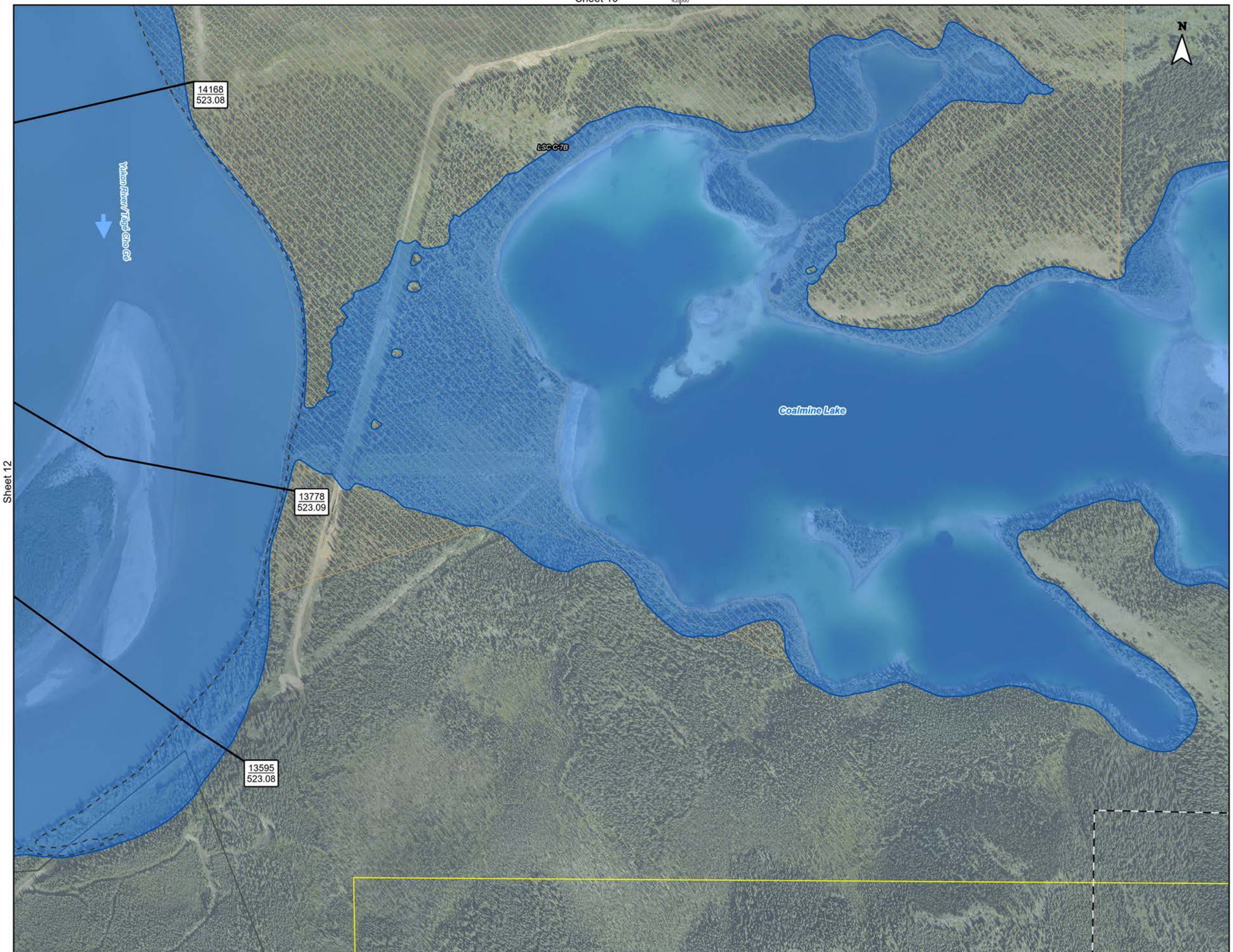


Figure No.

E.2.11

Sheet 11 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

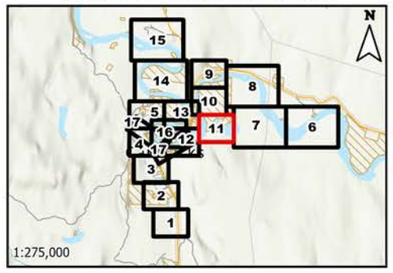
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 13

Sheet 4

Sheet 11

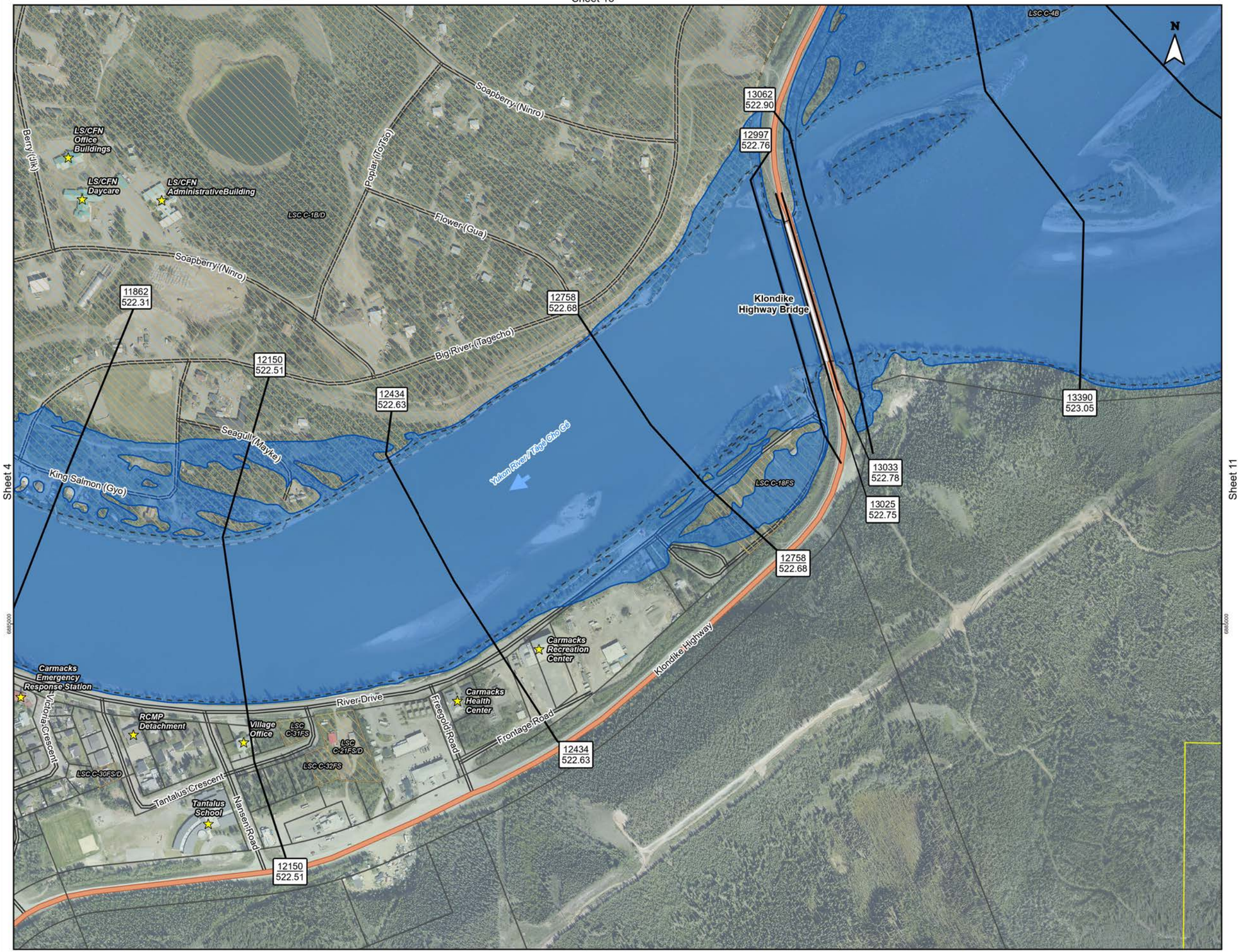


Figure No.

E.2.12

Sheet 12 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

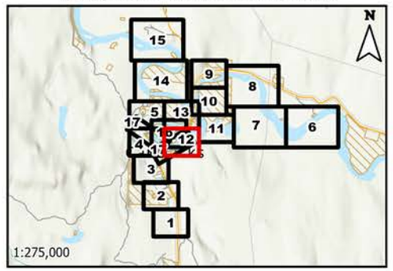
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

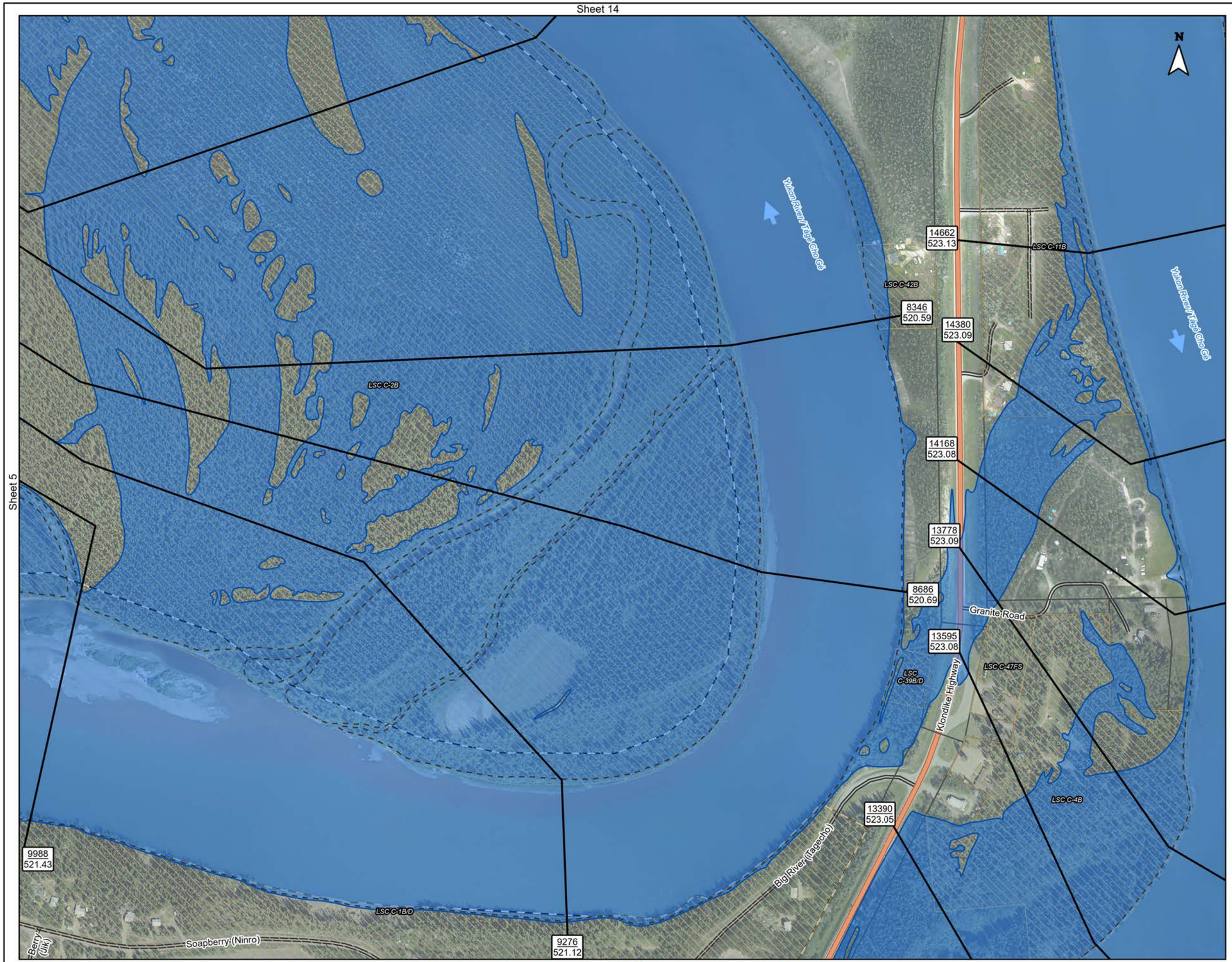
Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 14



Sheet 5

Sheet 11

Sheet 12

Figure No.

E.2.13

Sheet 13 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

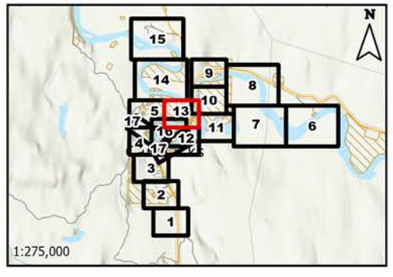
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

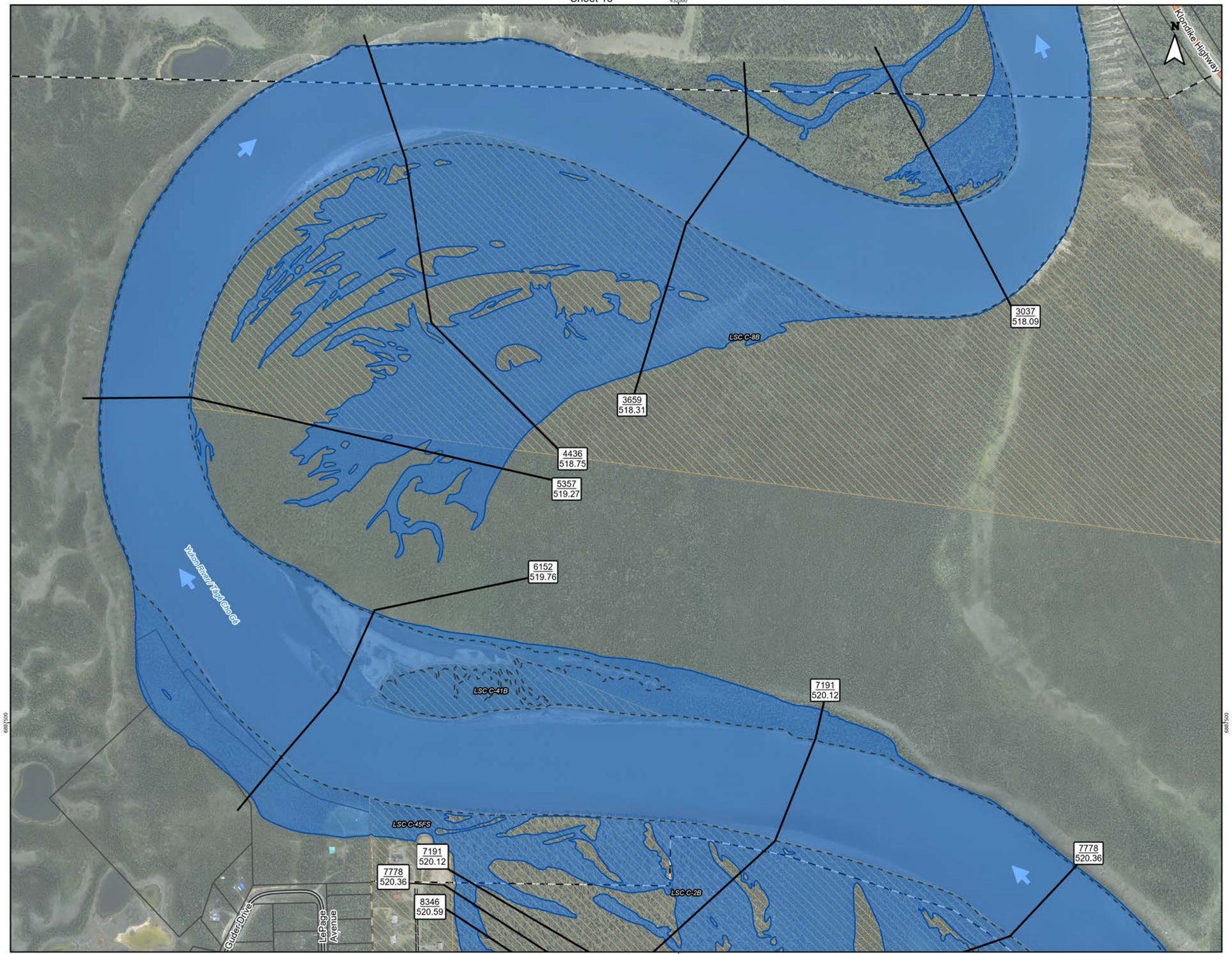


Figure No.

E.2.14

Sheet 14 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

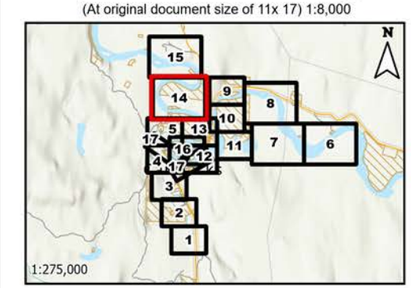
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

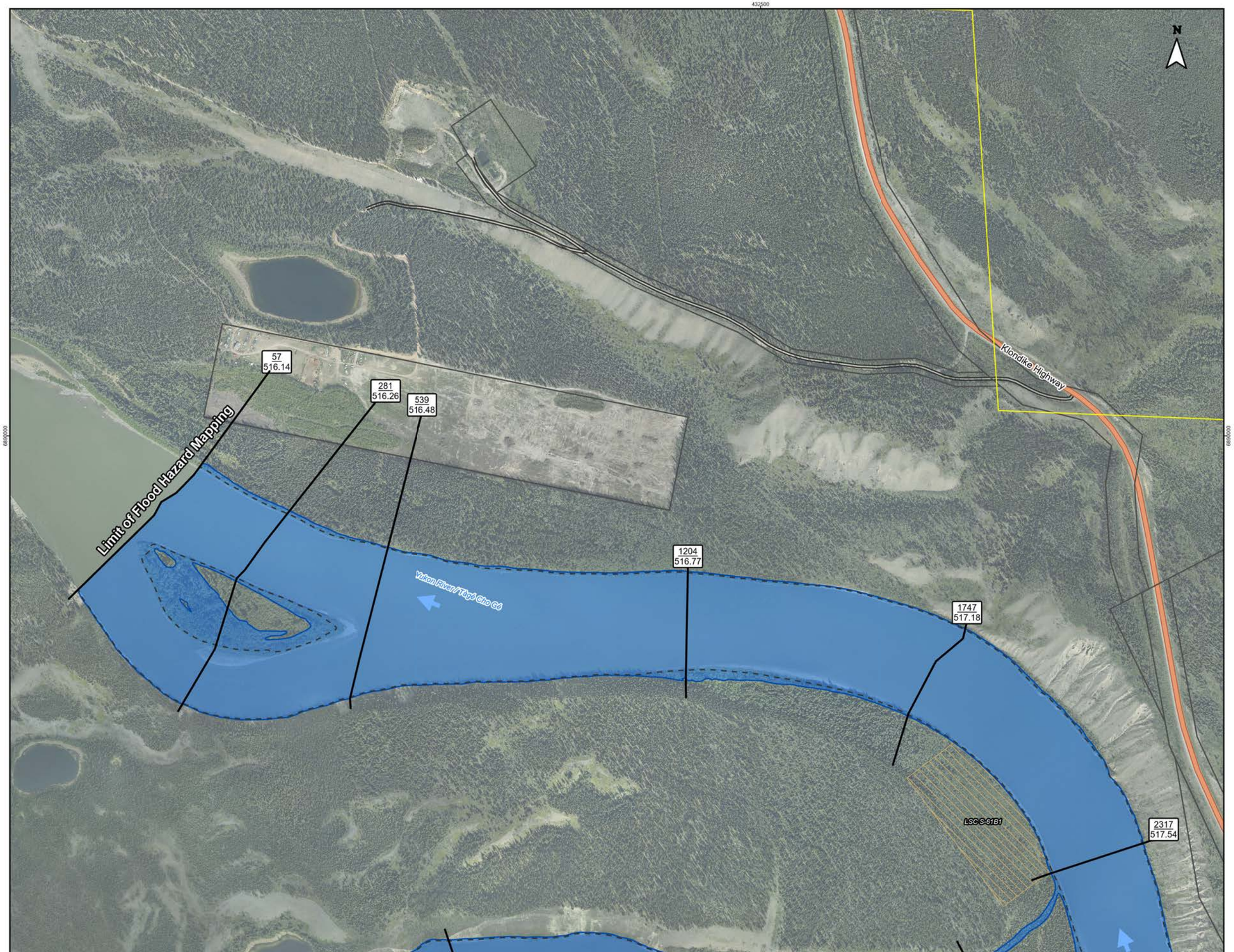
1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Sheet 14

Figure No.

E.2.15 **Sheet 15 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

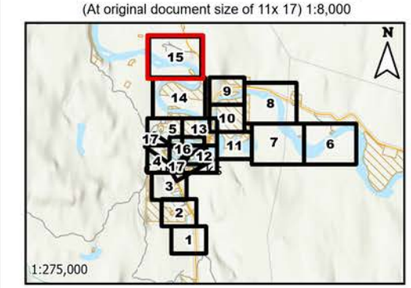
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 17

Figure No.

E.2.16

Sheet 16 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

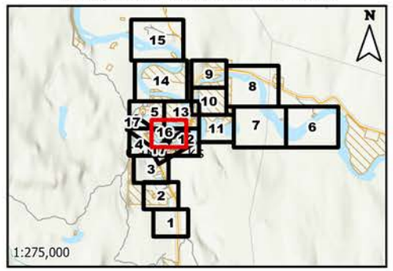
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

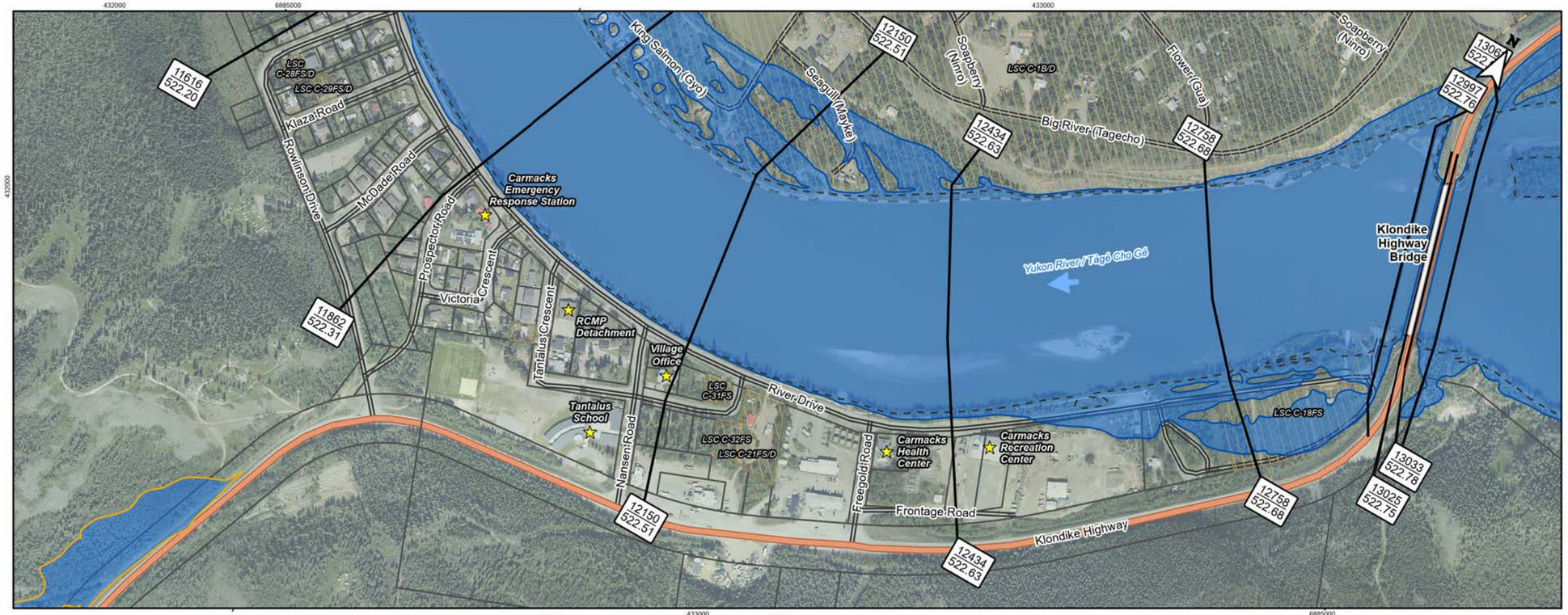
Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



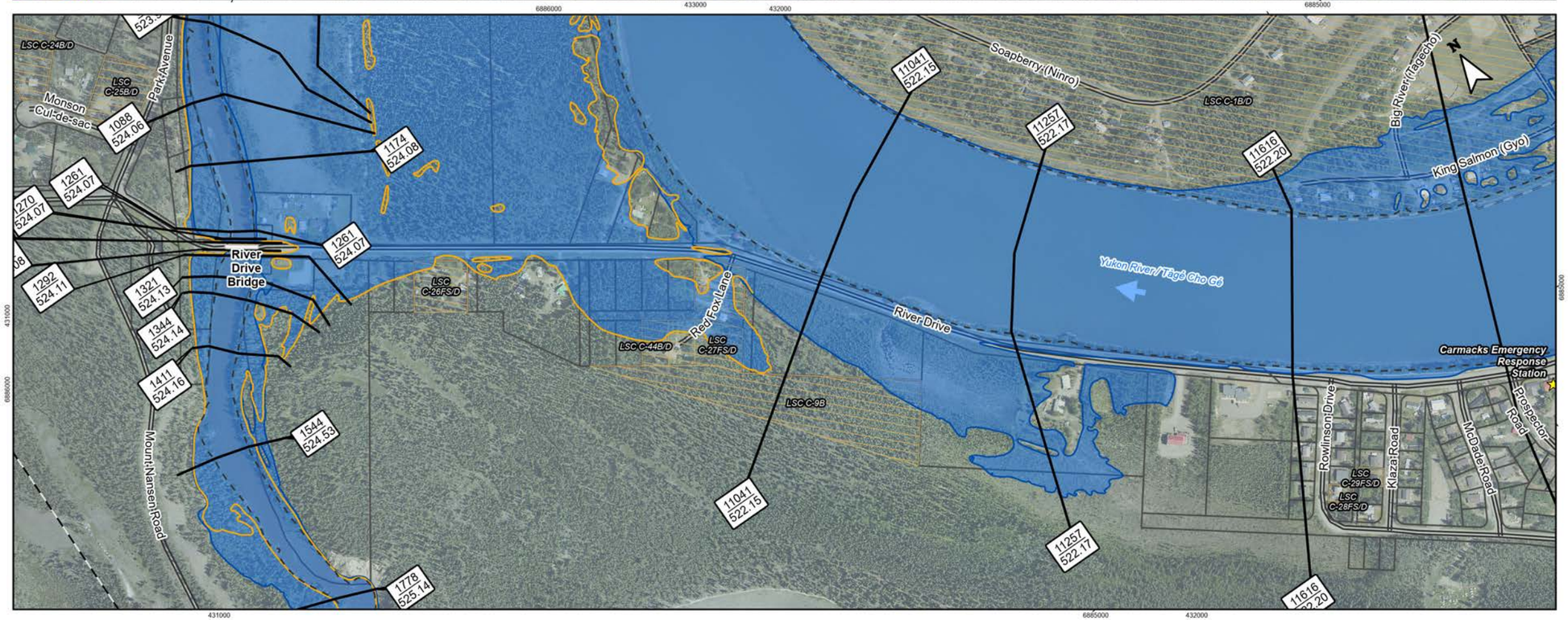


Figure No.

E.2.17

Sheet 17 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

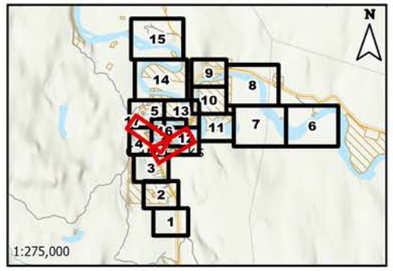
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 50 100 150 200 250 m

(At original document size of 11x 17) 1:6,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

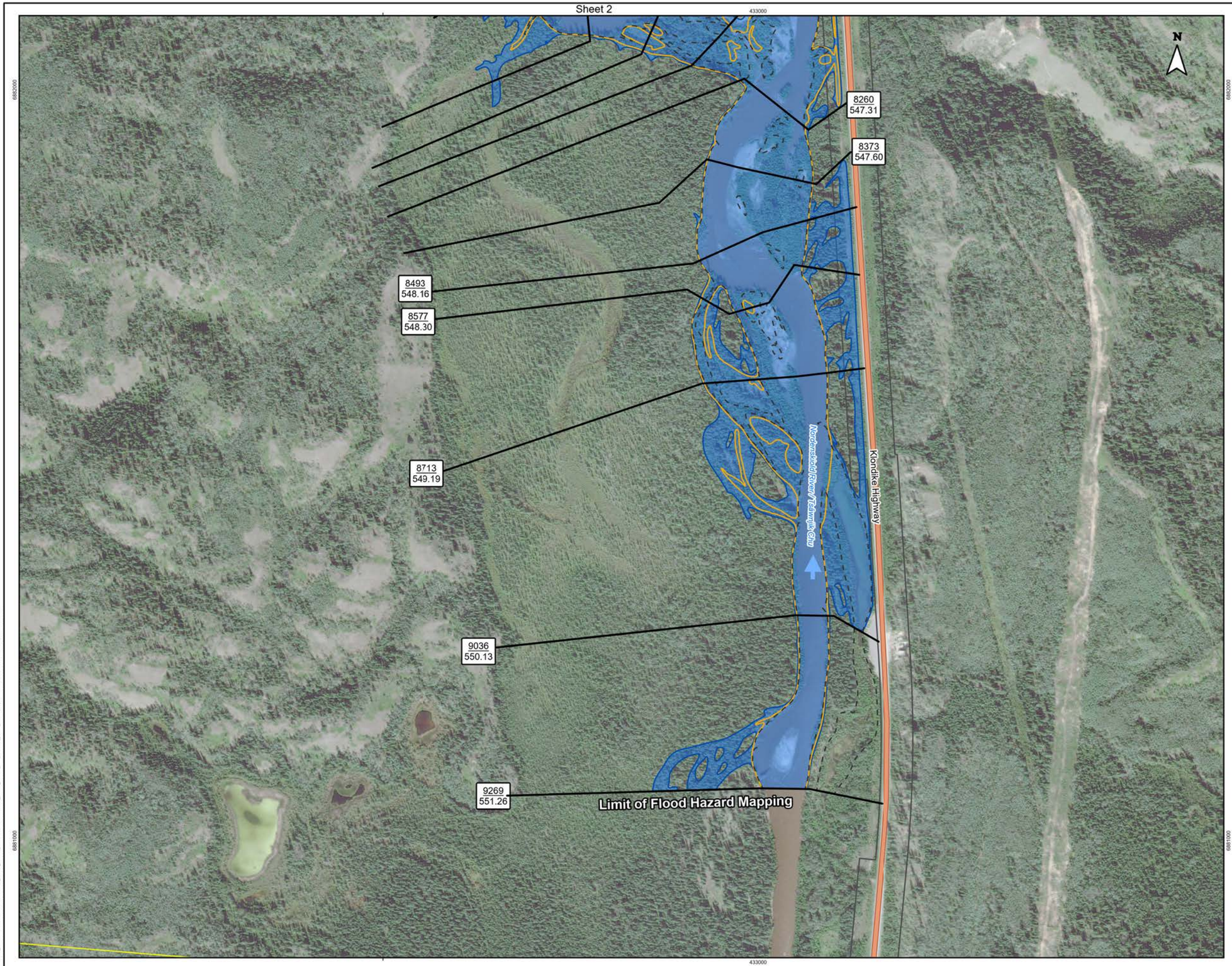


Figure No.

E.3.1

Sheet 1 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

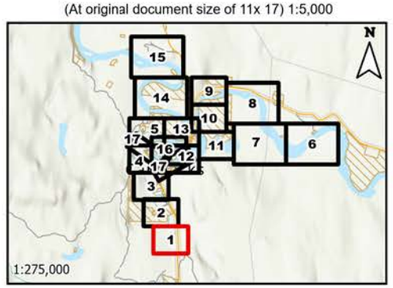
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: Yukon Satellites HighRes: Government of Yukon
World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 3

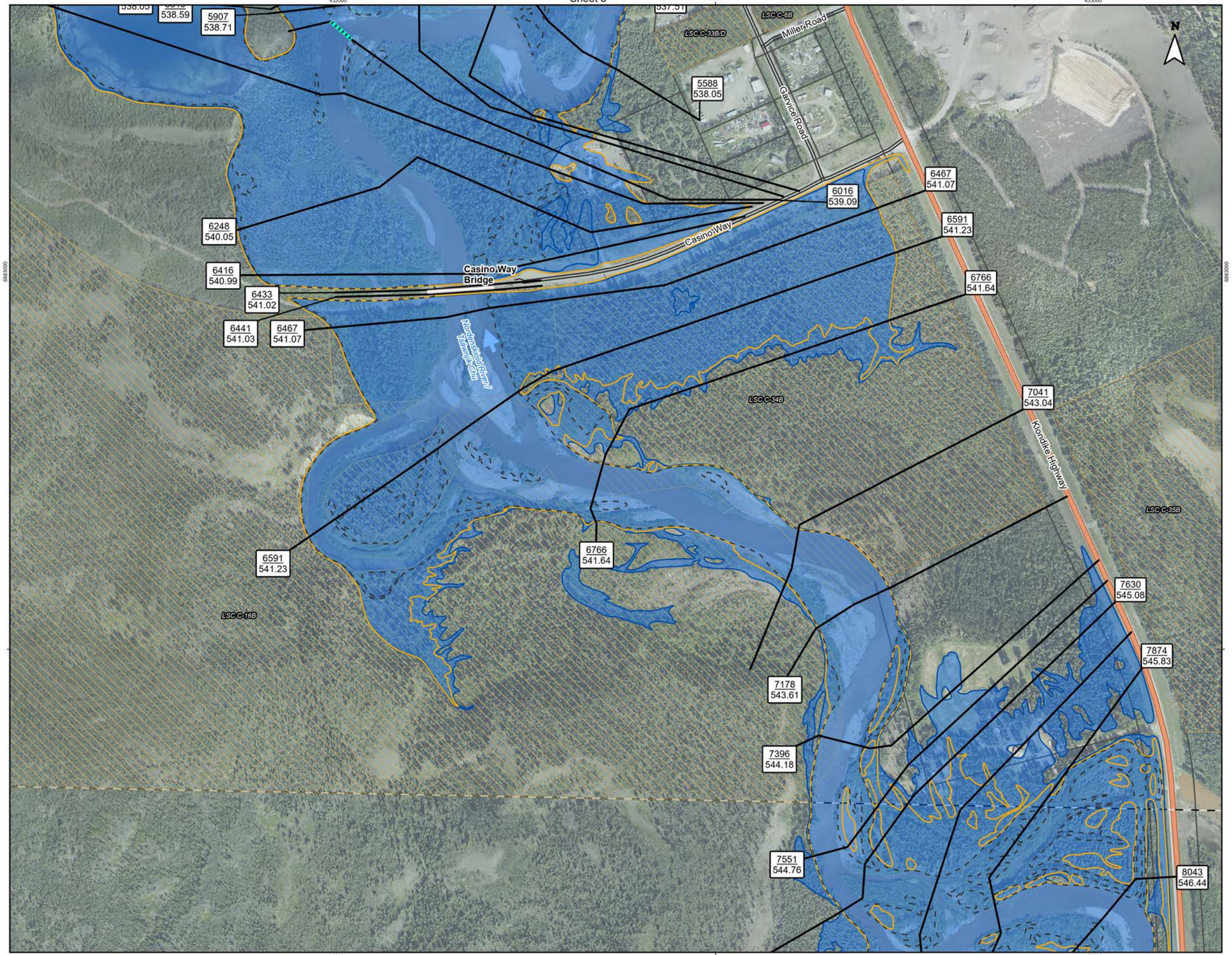


Figure No.

E.3.2

Sheet 2 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

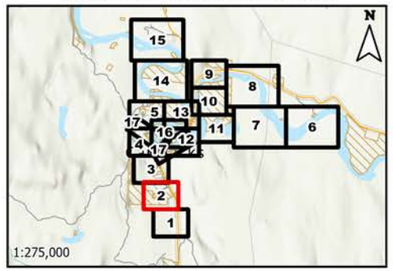
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

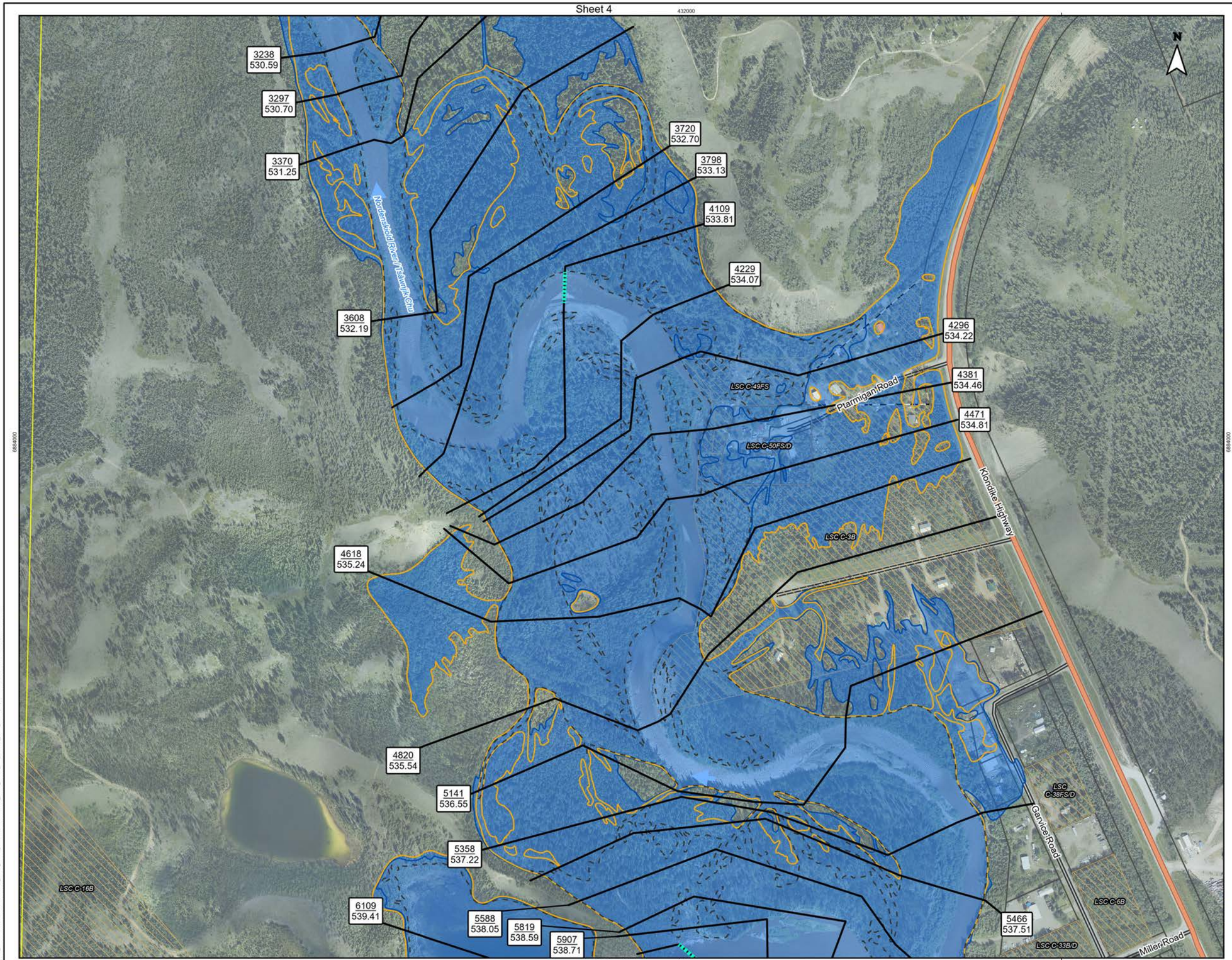


Figure No.

E.3.3 **Sheet 3 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

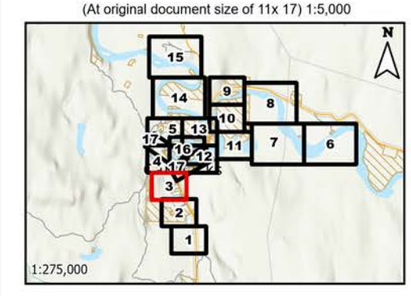
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 5

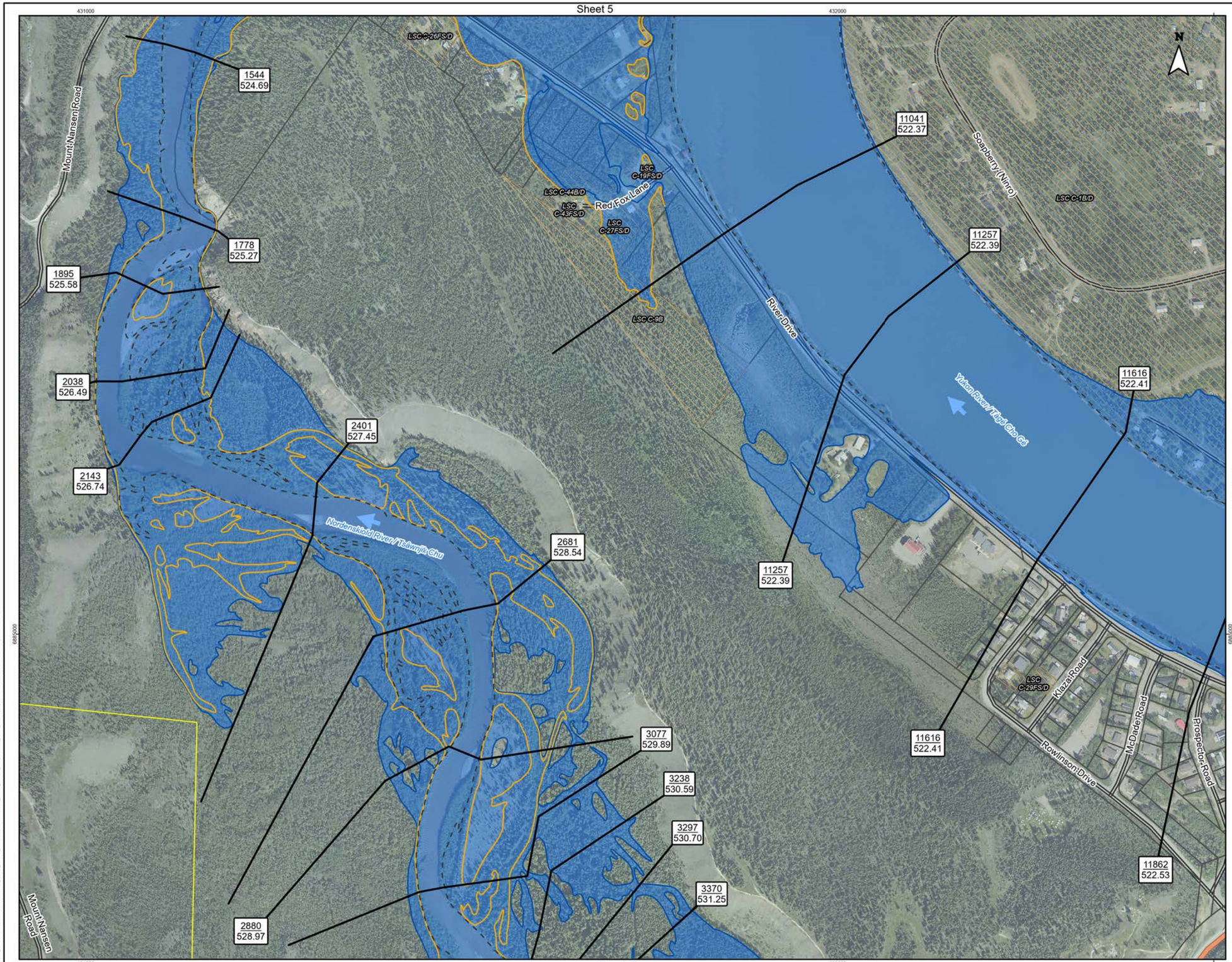


Figure No.

E.3.4 **Sheet 4 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

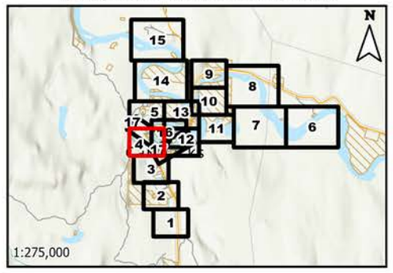
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

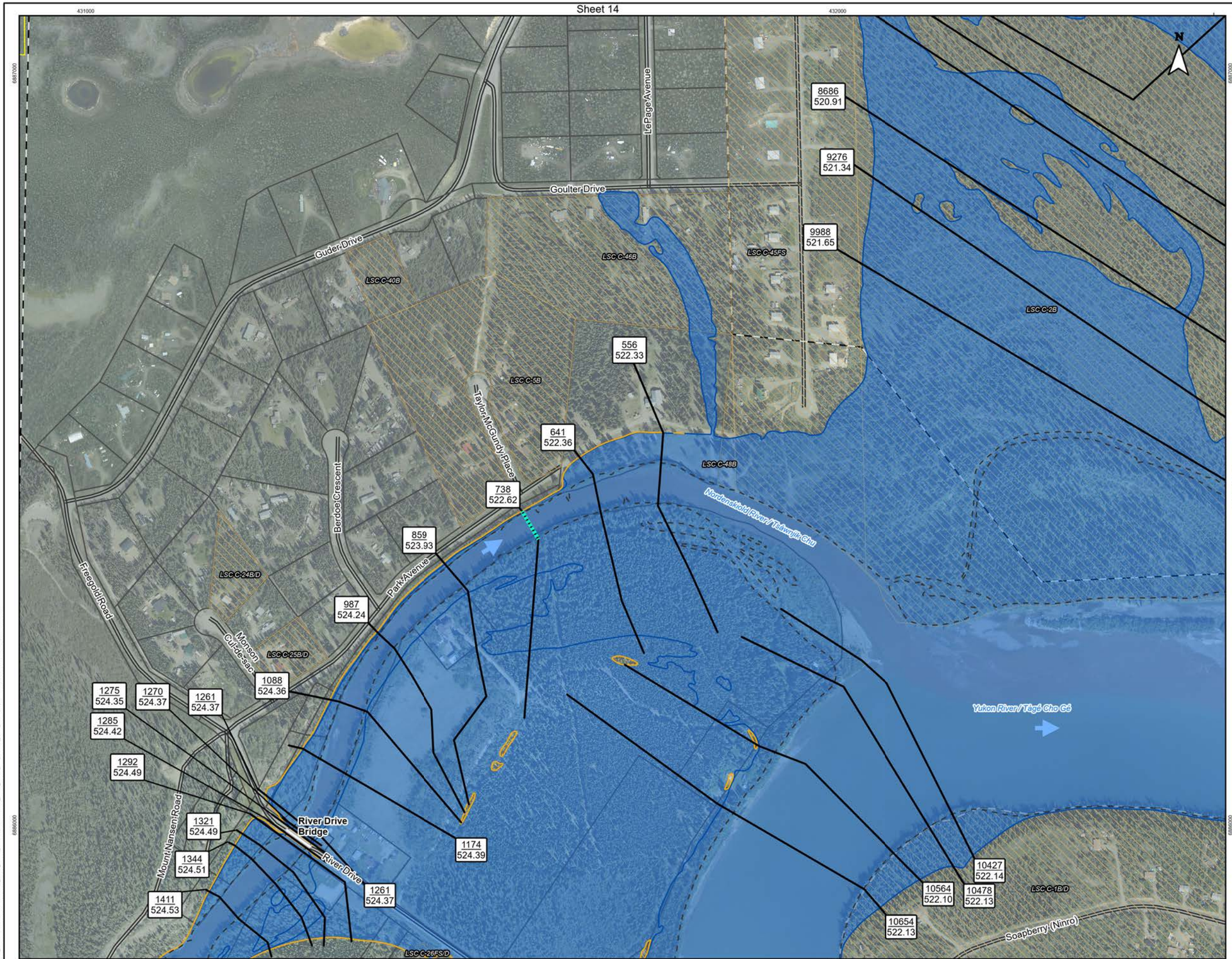


Figure No.

E.3.5

Sheet 5 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

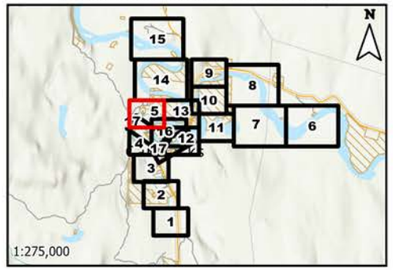
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

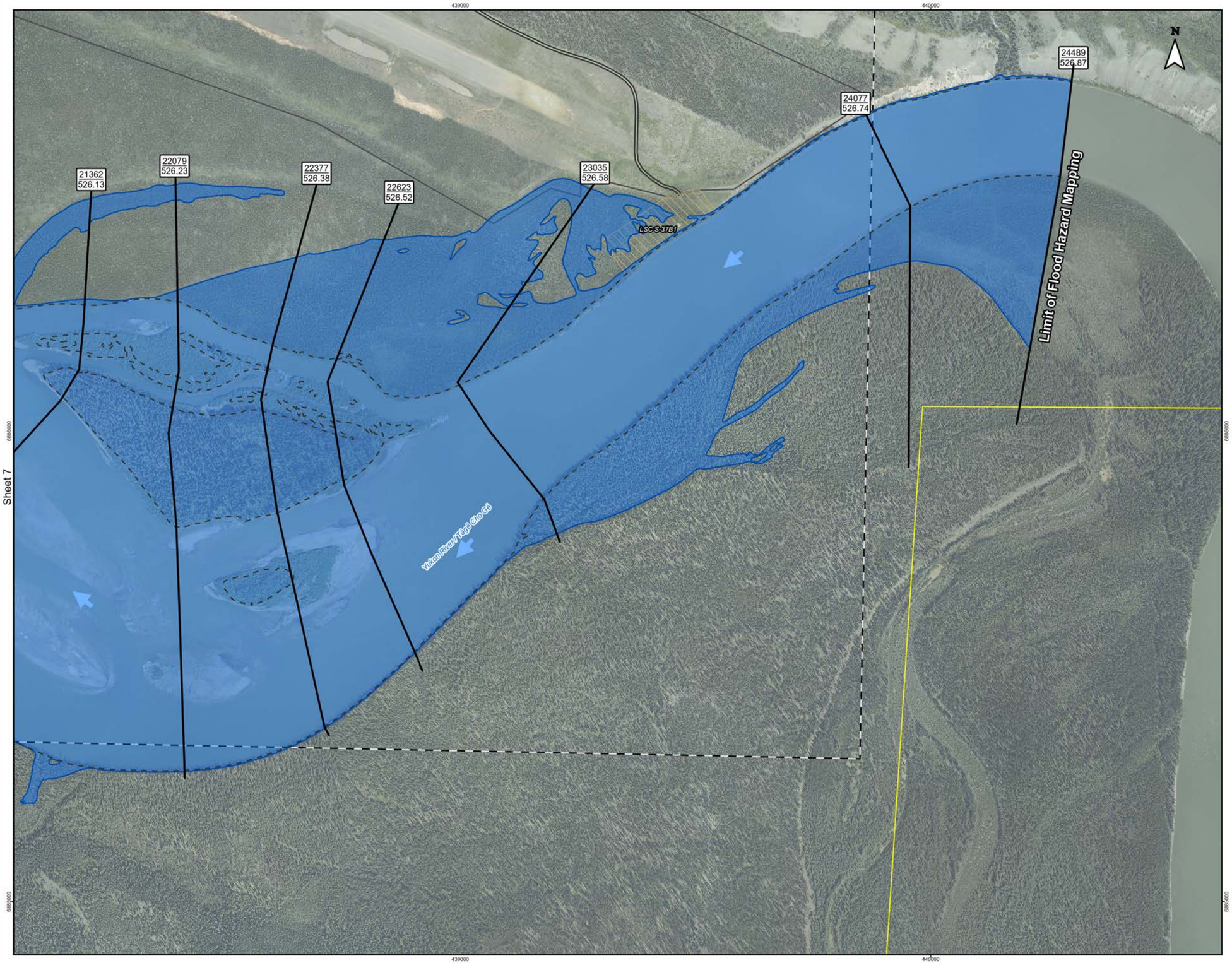


Figure No.

E.3.6

Sheet 6 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

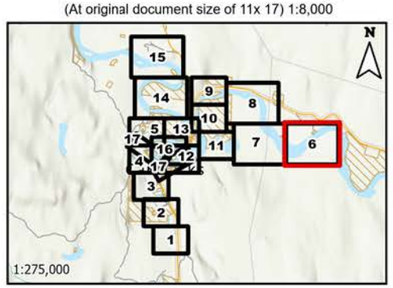
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

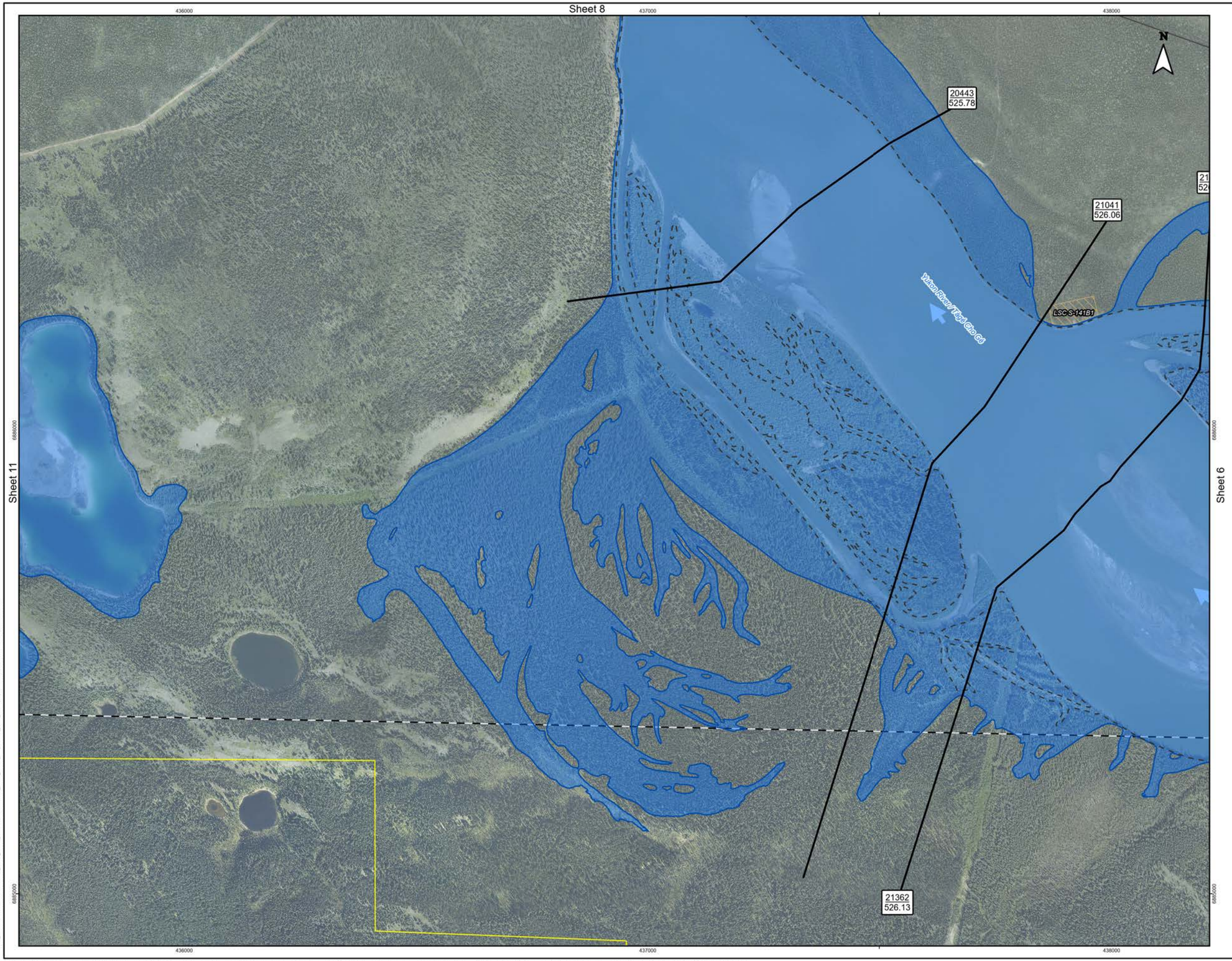


Figure No.

E.3.7 **Sheet 7 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

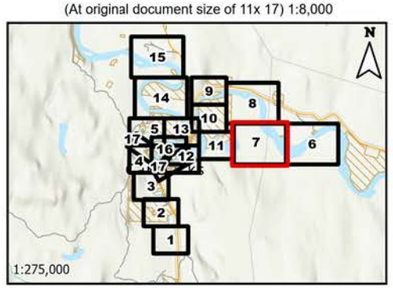
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

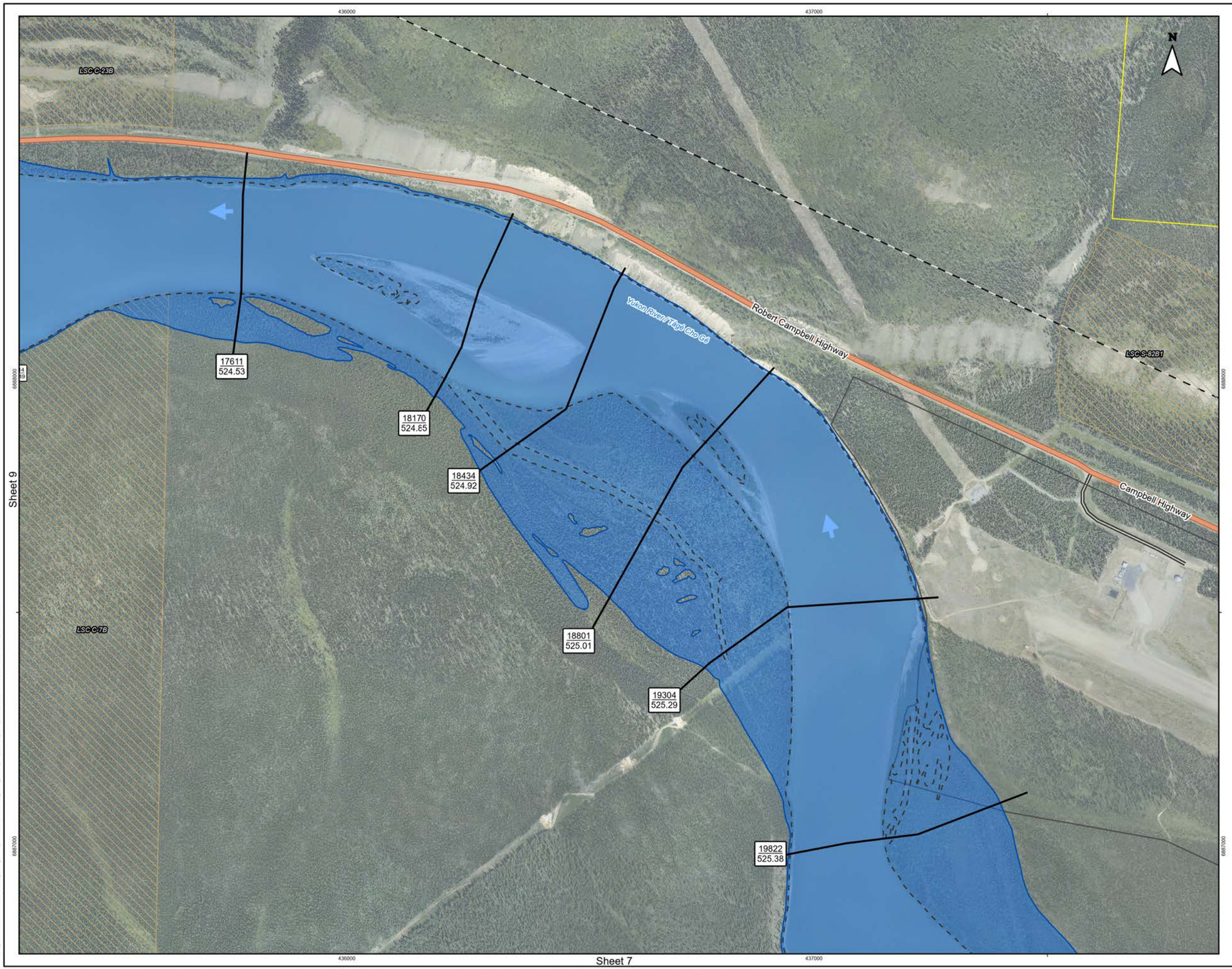


Figure No.

E.3.8

Sheet 8 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

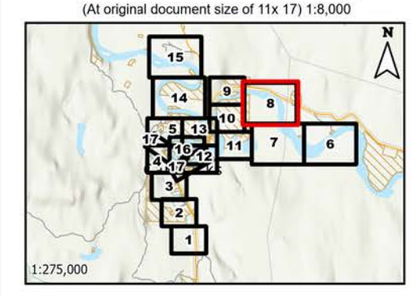
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

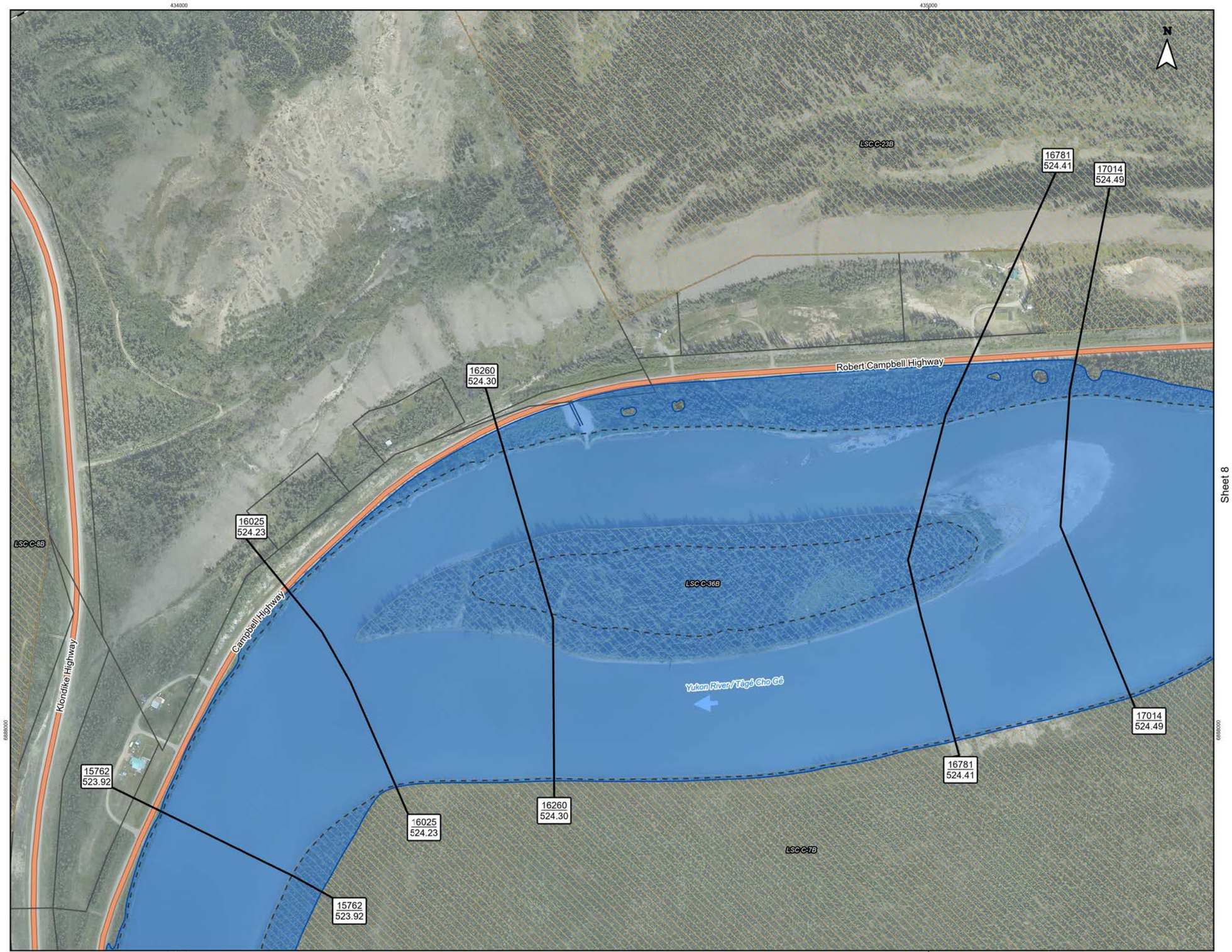


Figure No.

E.3.9

Sheet 9 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

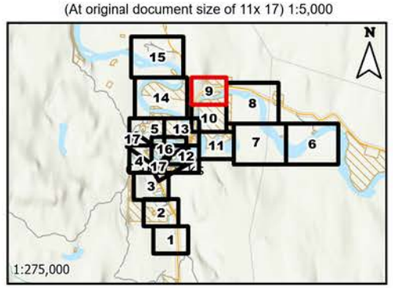
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

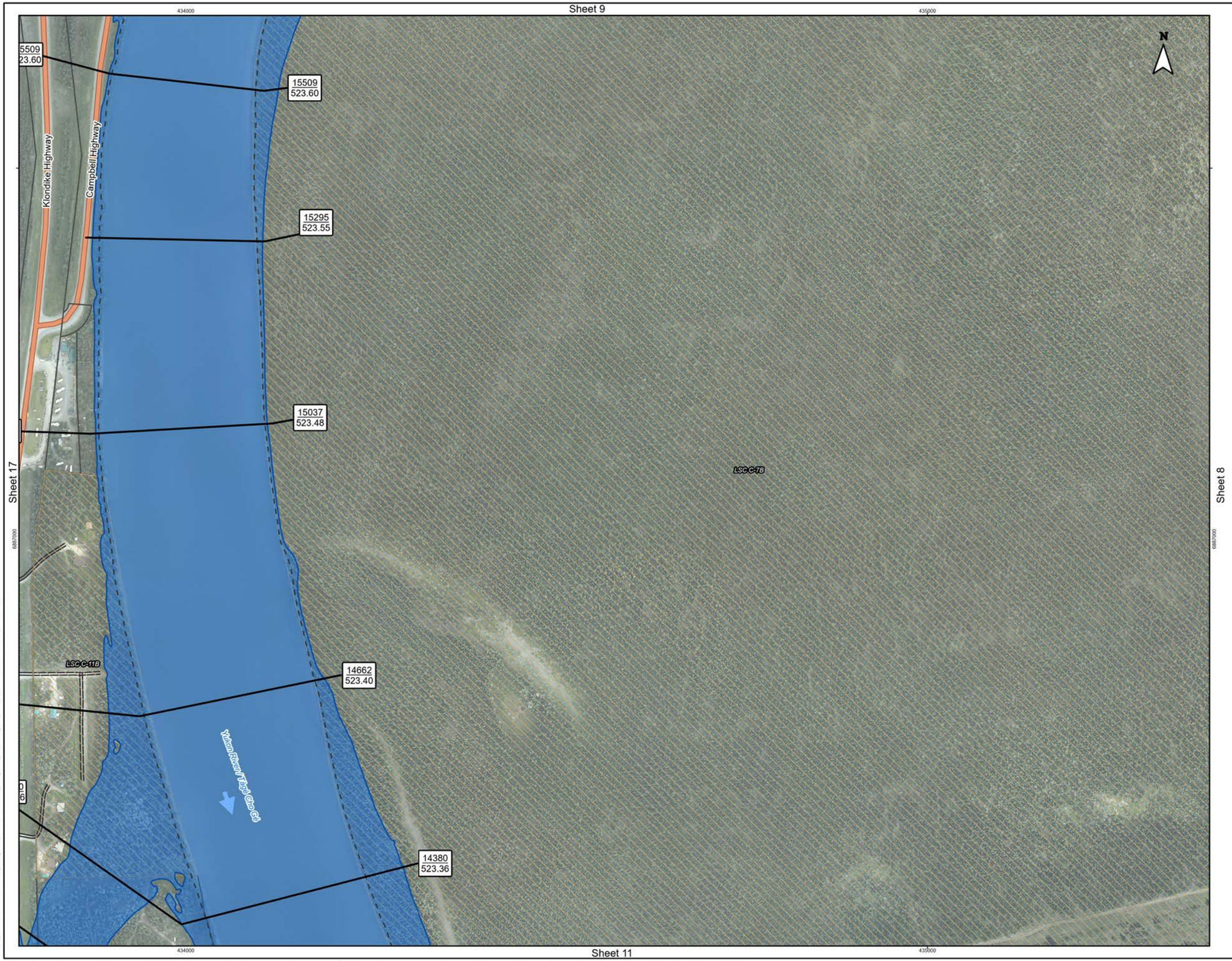


Figure No.

E.3.10

Sheet 10 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

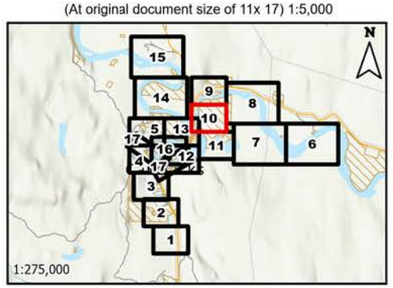
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

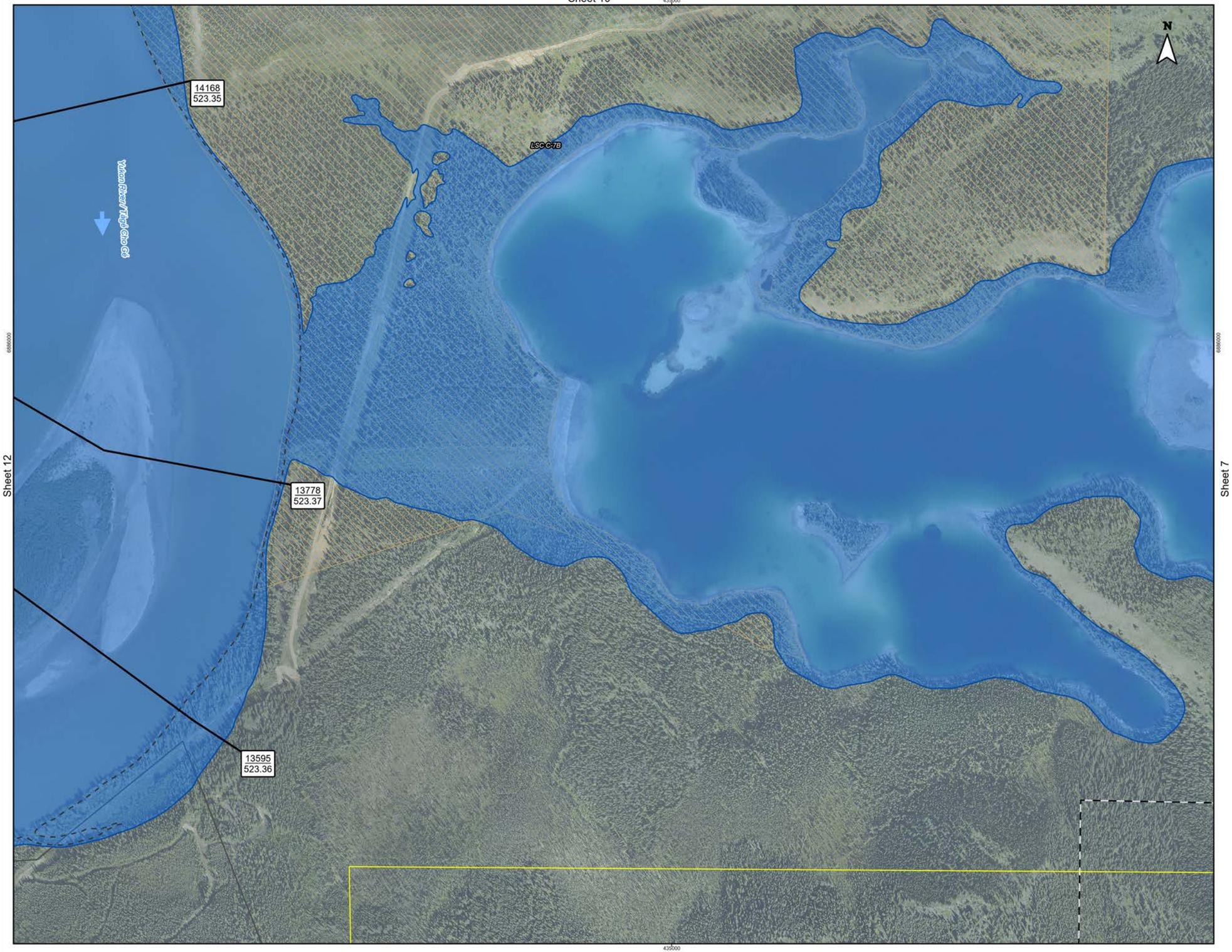


Figure No.

E.3.11

Sheet 11 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

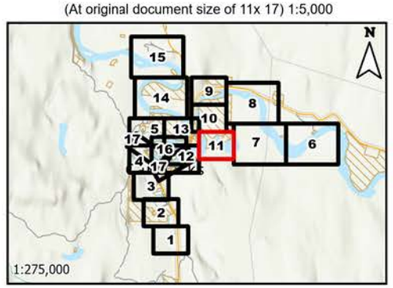
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 13

Sheet 4

Sheet 11

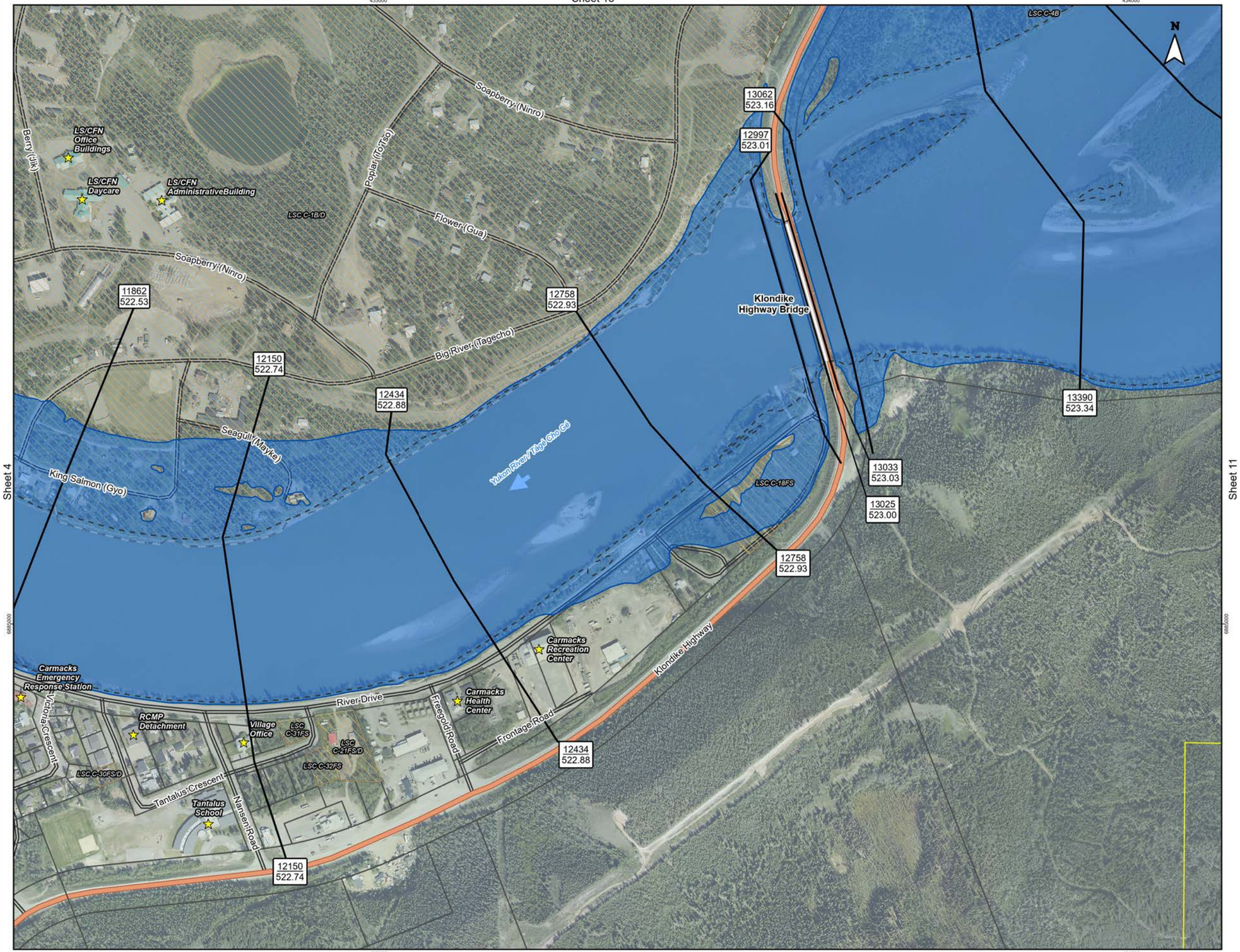


Figure No.

E.3.12

Sheet 12 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

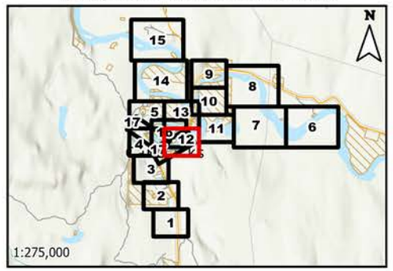
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

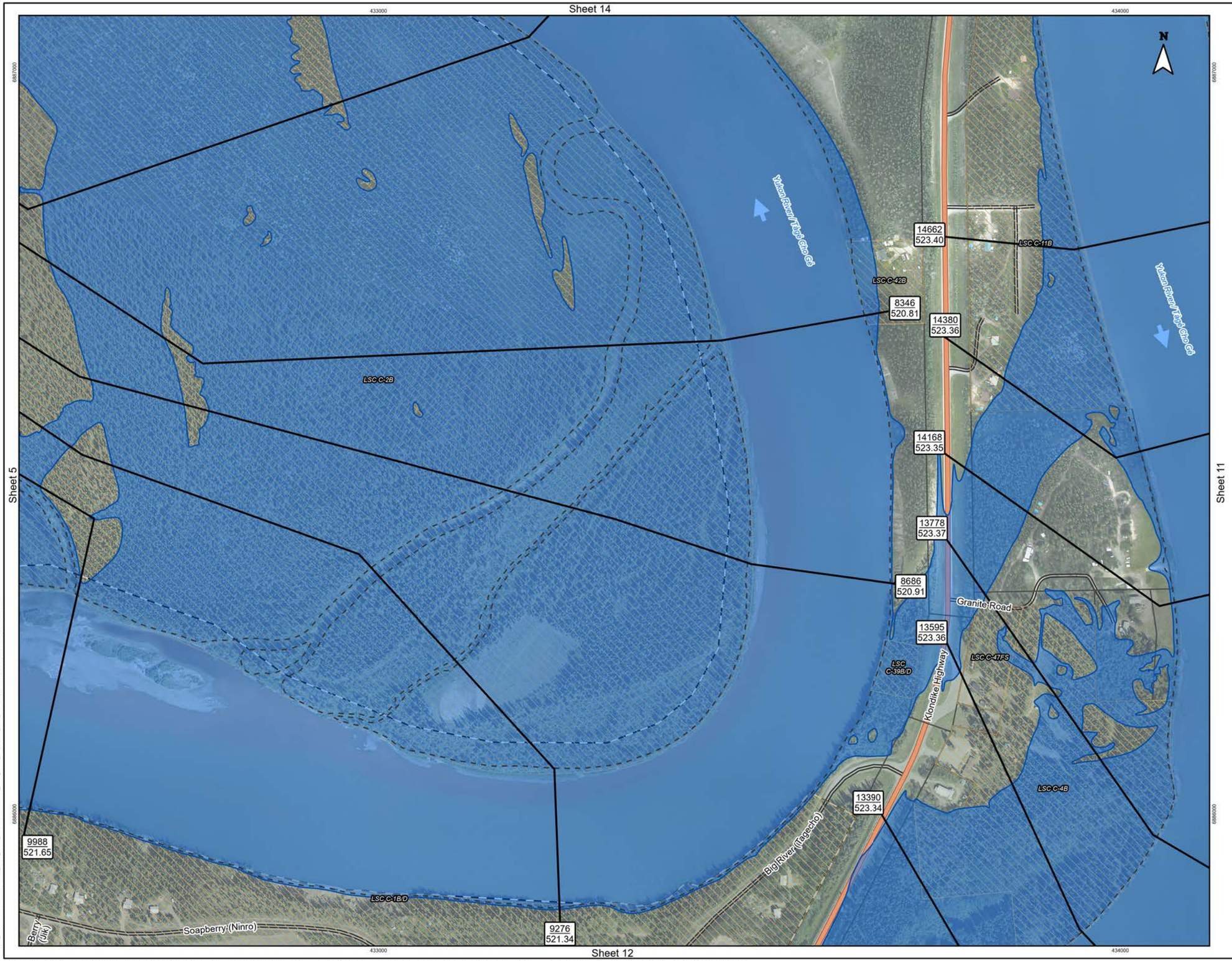


Figure No.

E.3.13

Sheet 13 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

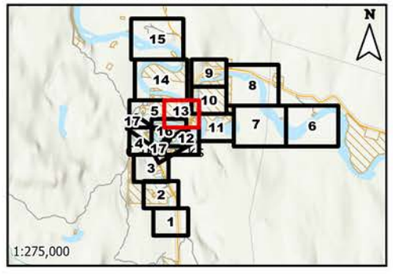
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

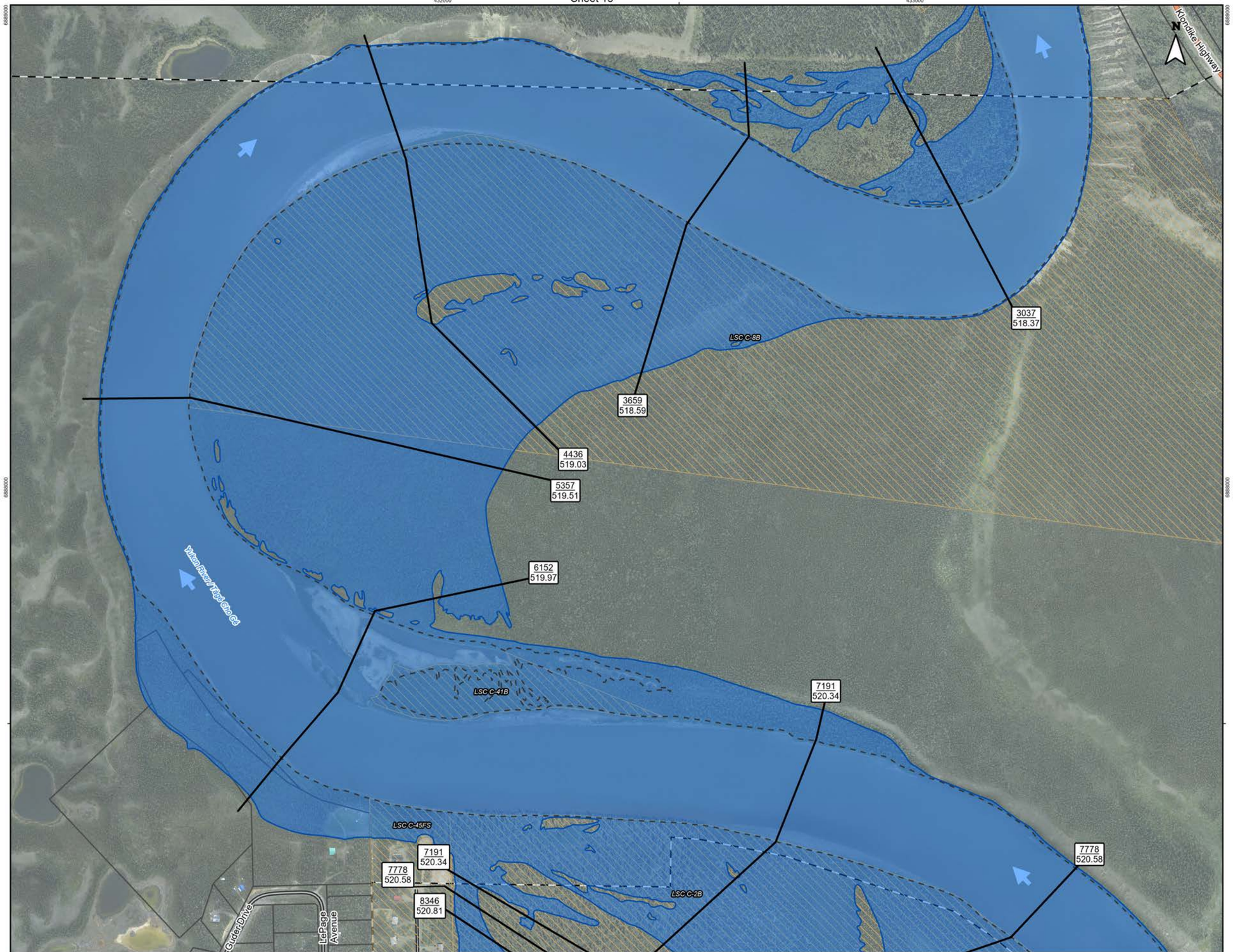
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 15



Sheet 13

Figure No.

E.3.14

Sheet 14 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

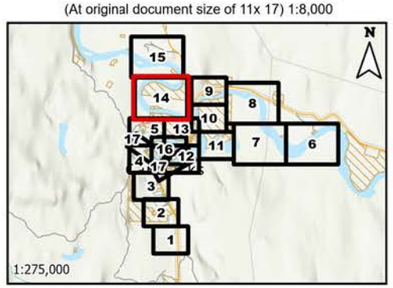
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

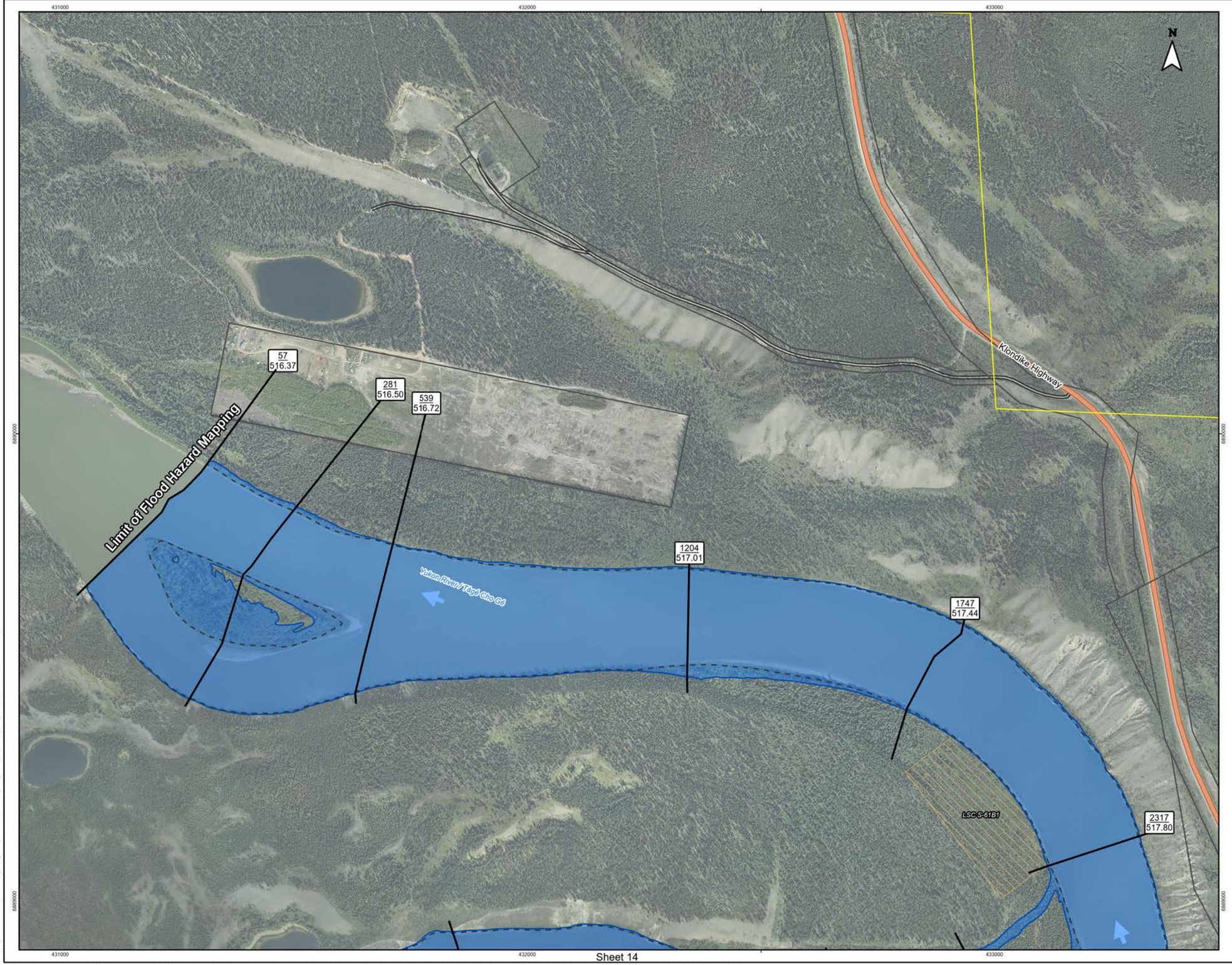
1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Sheet 14

Figure No.

E.3.15 **Sheet 15 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

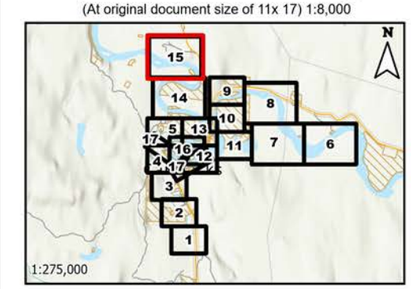
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 17

Figure No.

E.3.16

Sheet 16 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

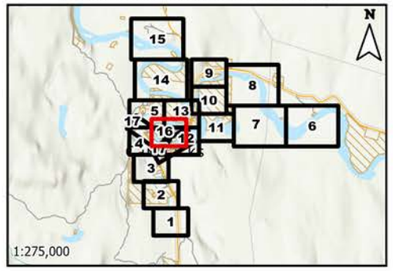
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

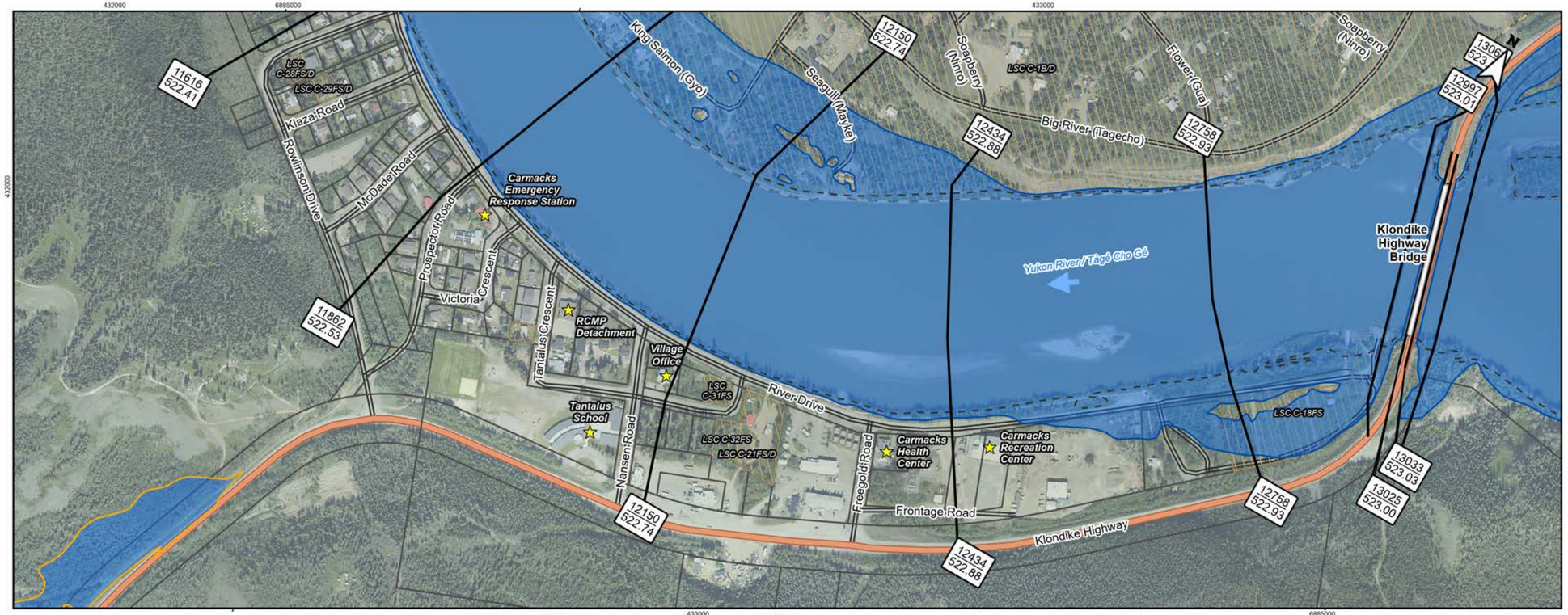
Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



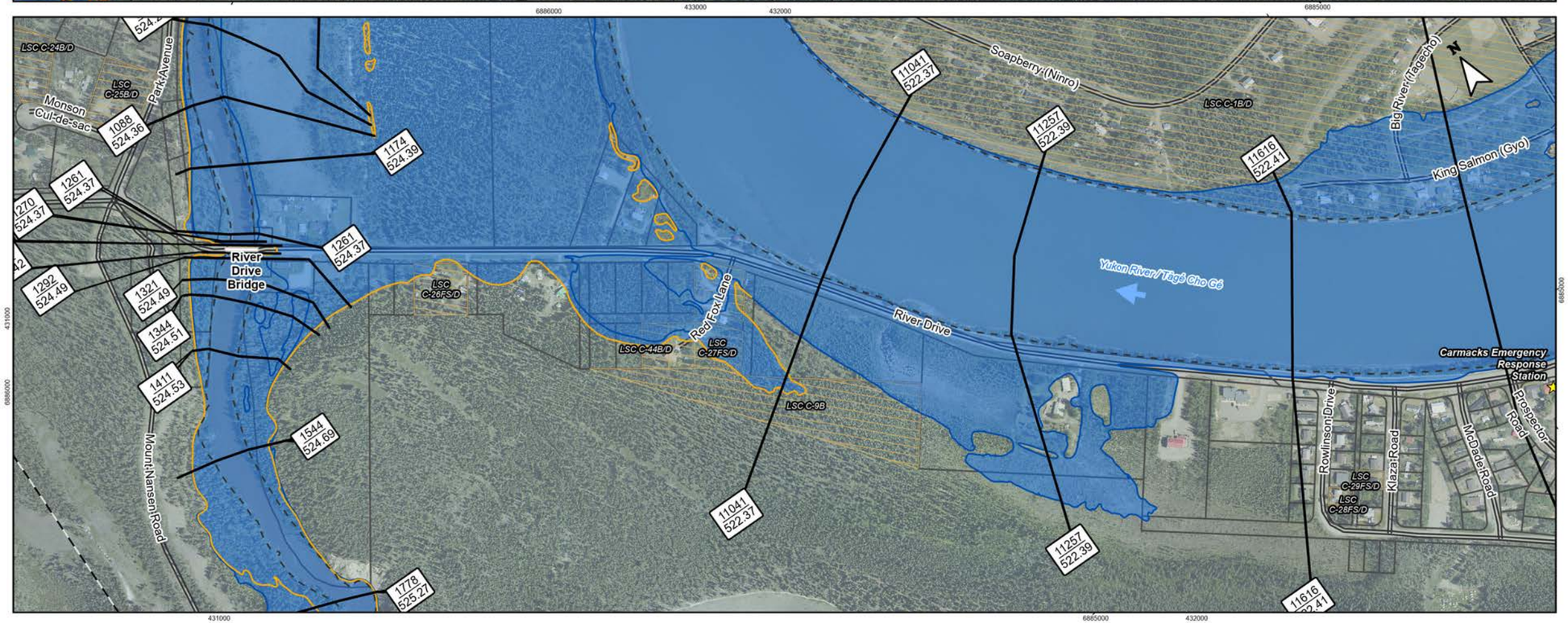


Figure No.

E.3.17 Sheet 17 of 17

Title: **Carmacks Flood Mapping Study**
Composite Flood Hazard Extents
1% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

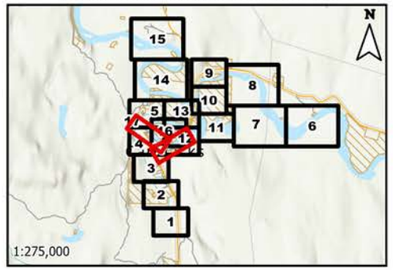
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 50 100 150 200 250 m

(At original document size of 11x 17) 1:6,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

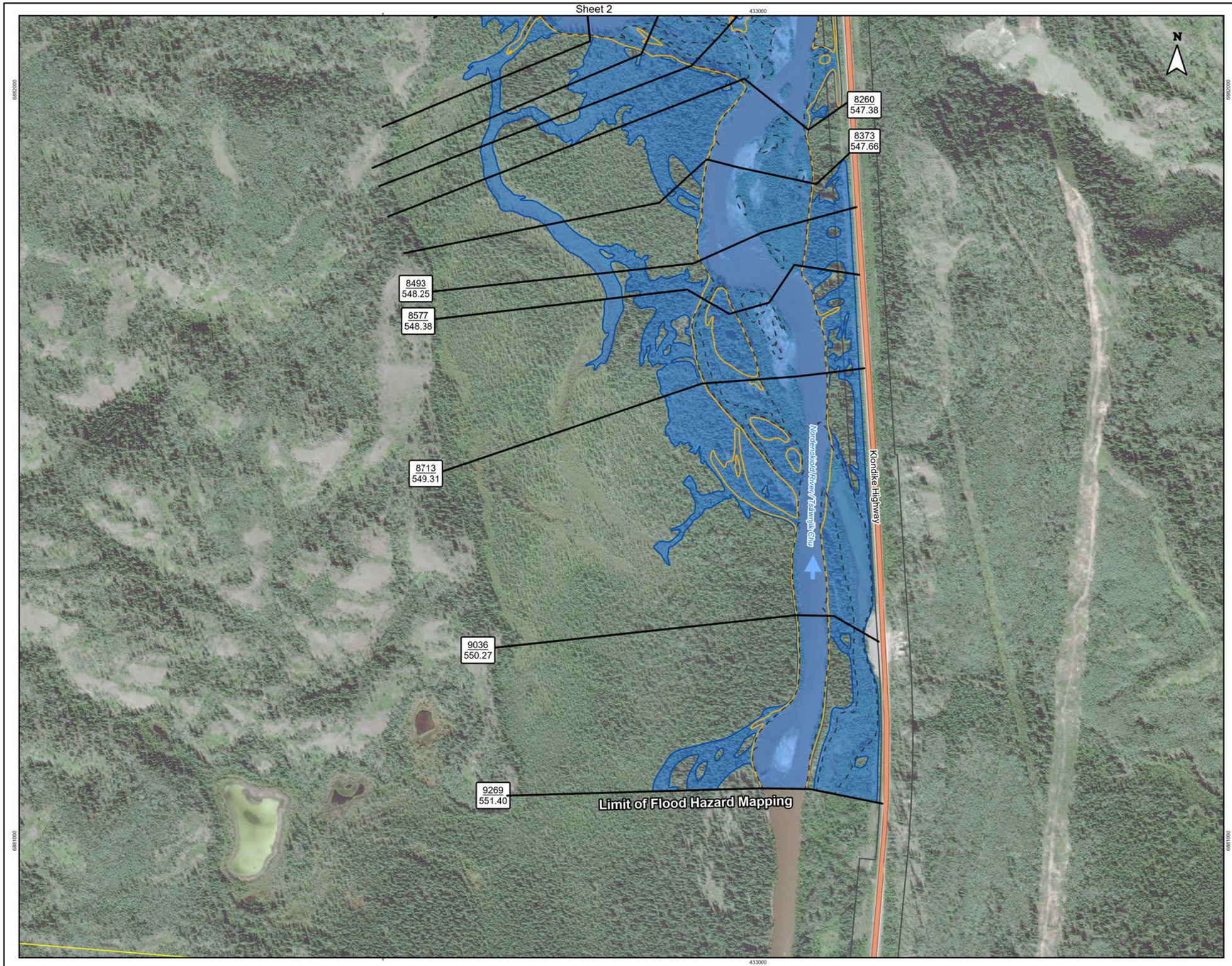


Figure No.

E.4.1

Sheet 1 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

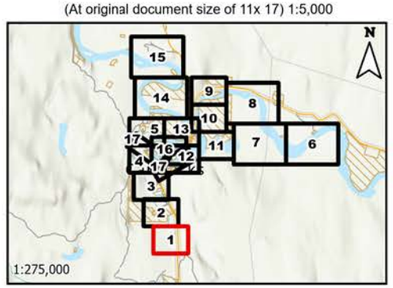
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: Yukon Satellites HighRes: Government of Yukon
World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

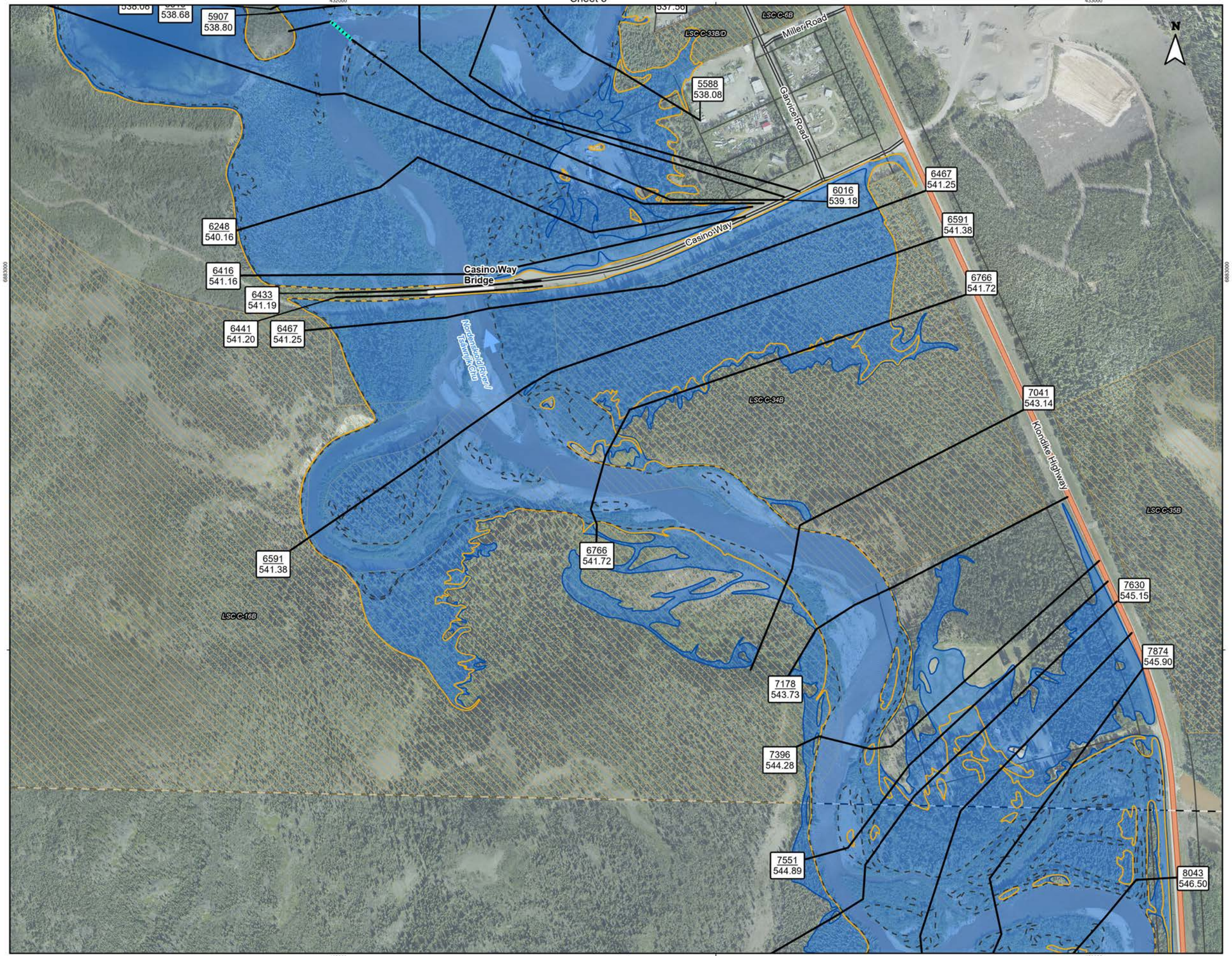
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 3



Sheet 1

Figure No.

E.4.2

Sheet 2 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

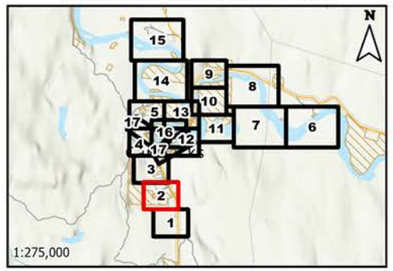
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

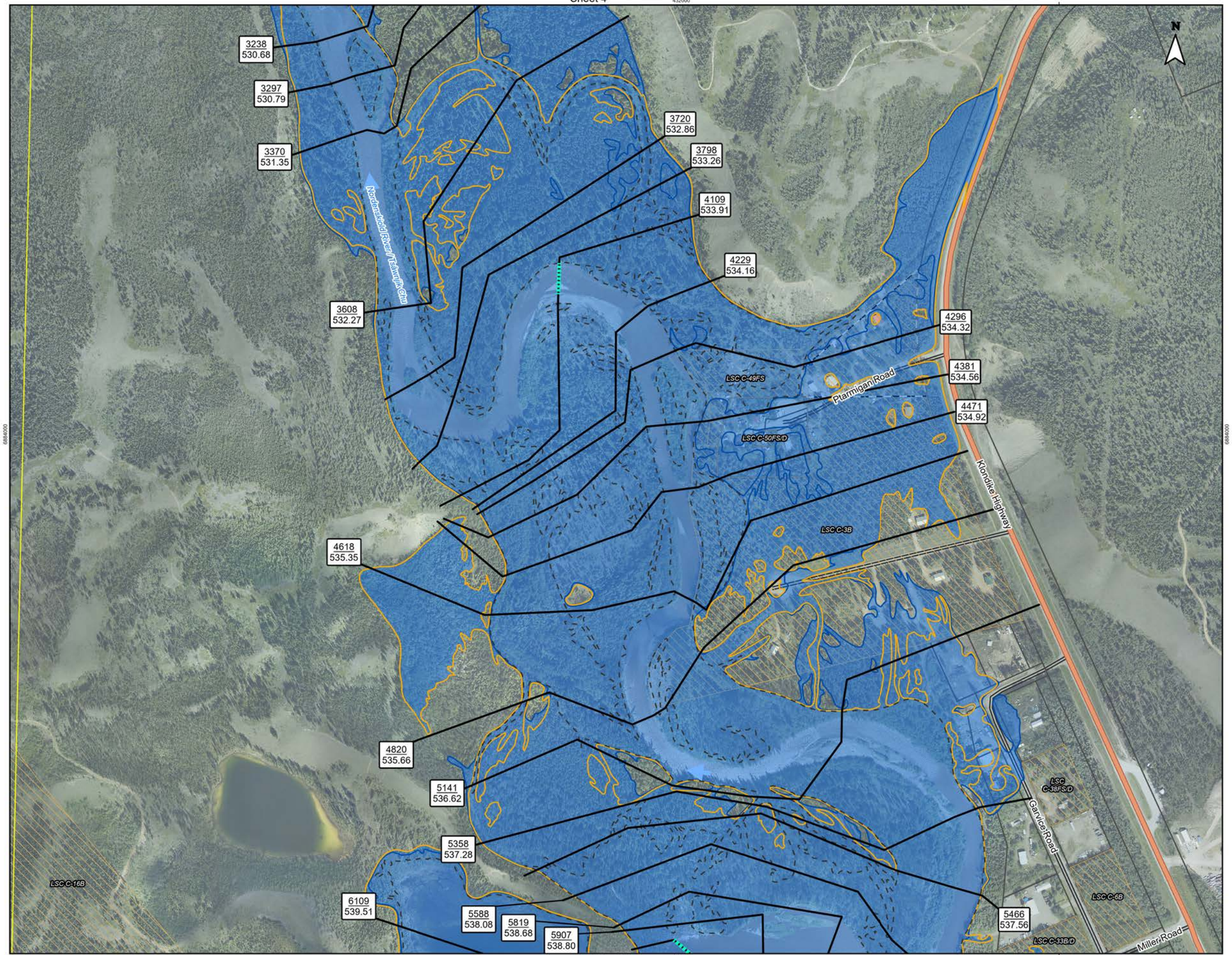
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 4



Sheet 2

Figure No.

E.4.3 **Sheet 3 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

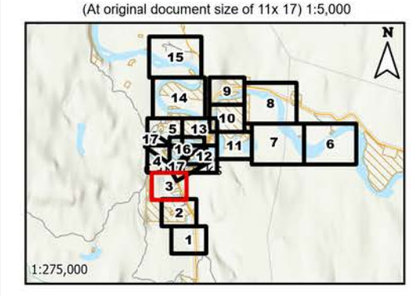
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

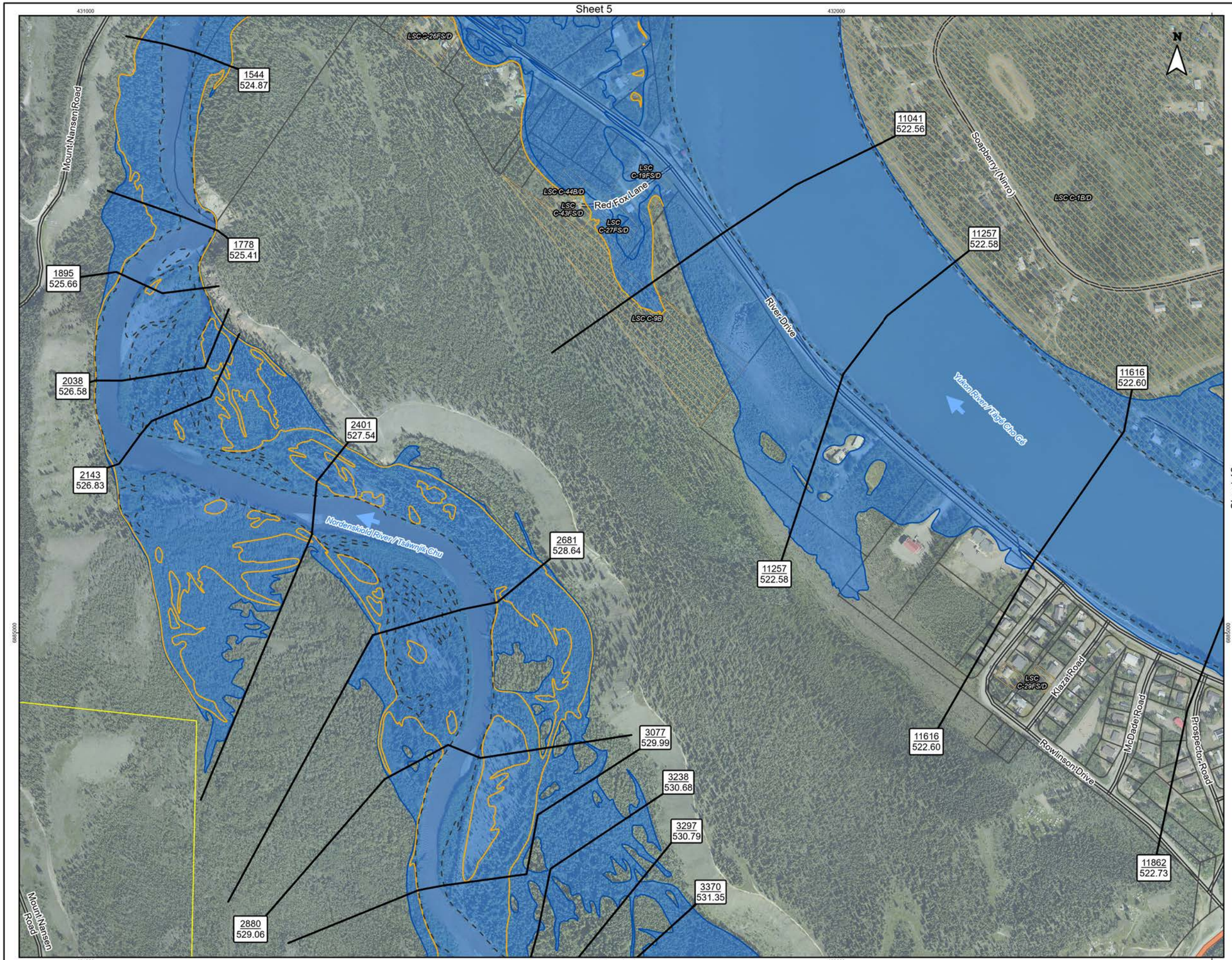


Figure No.

E.4.4 **Sheet 4 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

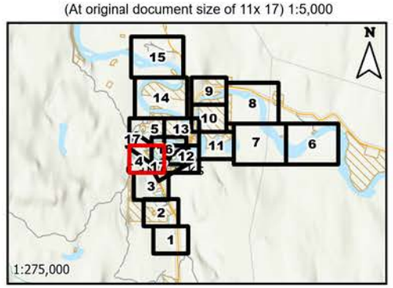
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

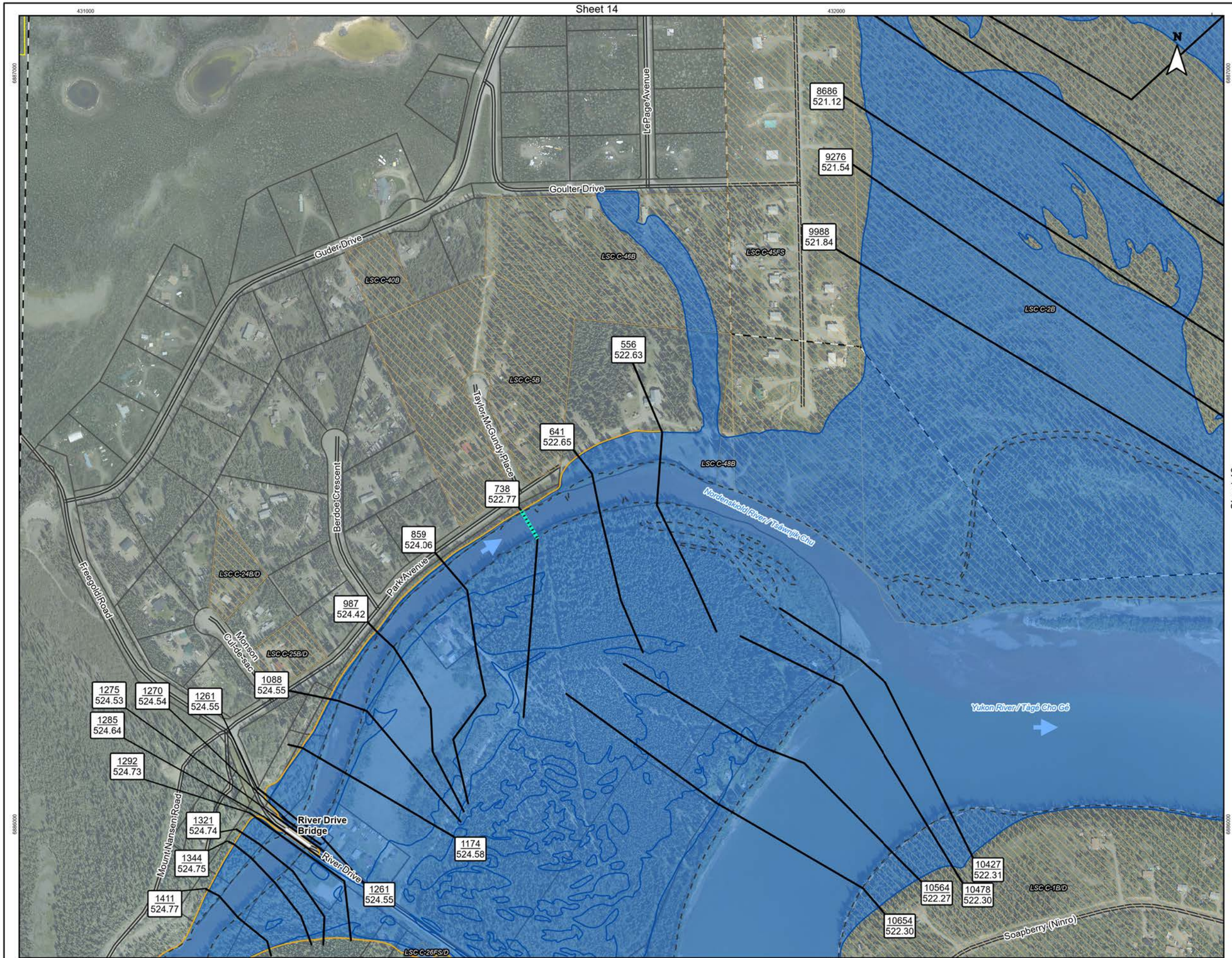
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 14



Sheet 13

Sheet 4

Figure No.

E.4.5

Sheet 5 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

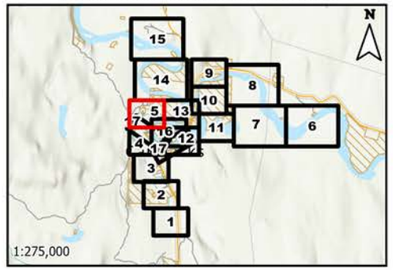
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

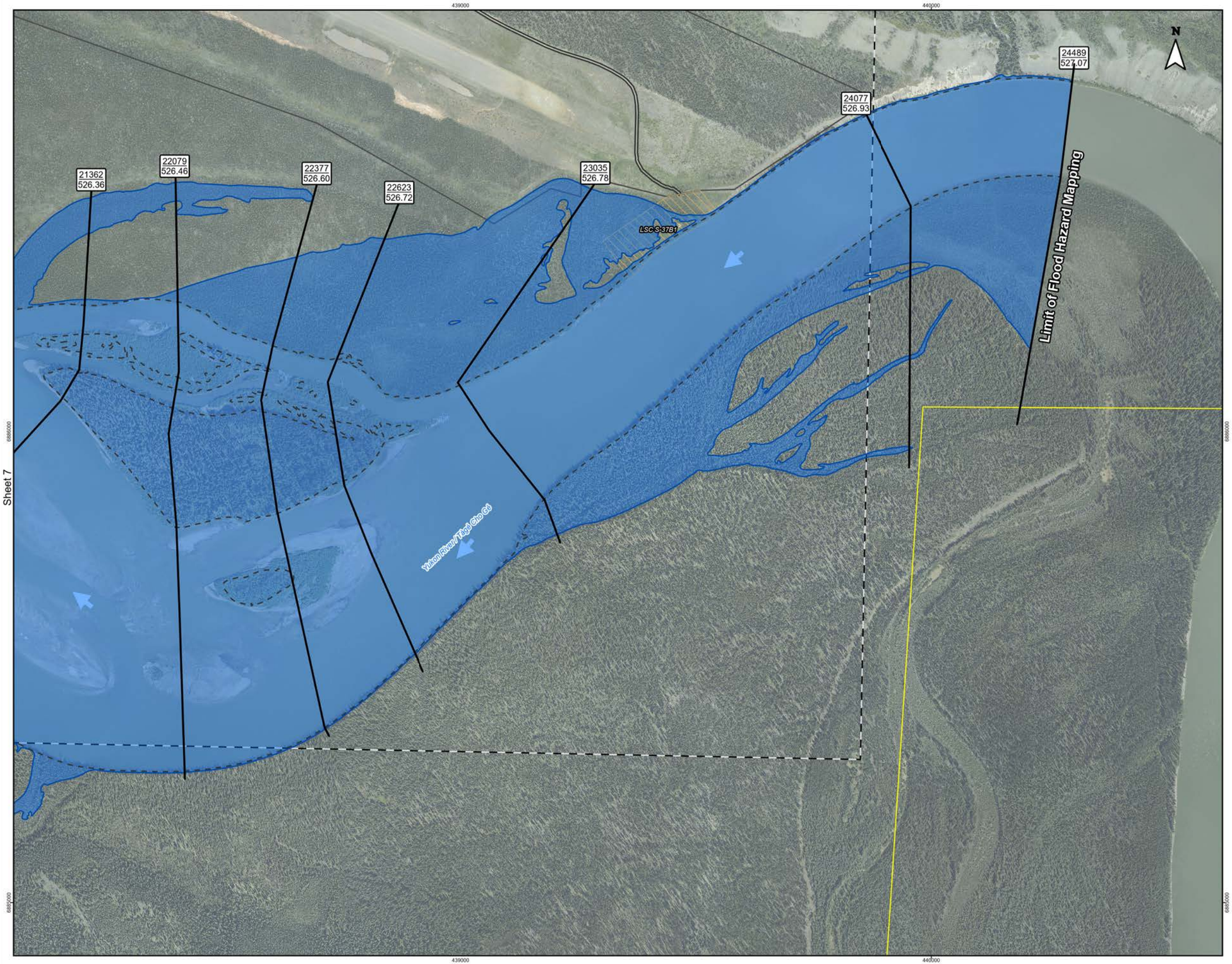
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Sheet 7

Figure No.

E.4.6

Sheet 6 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

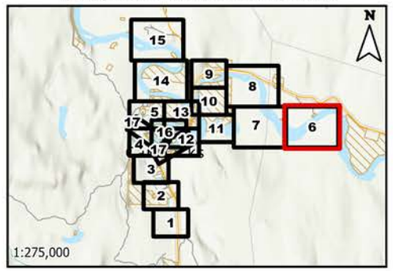
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

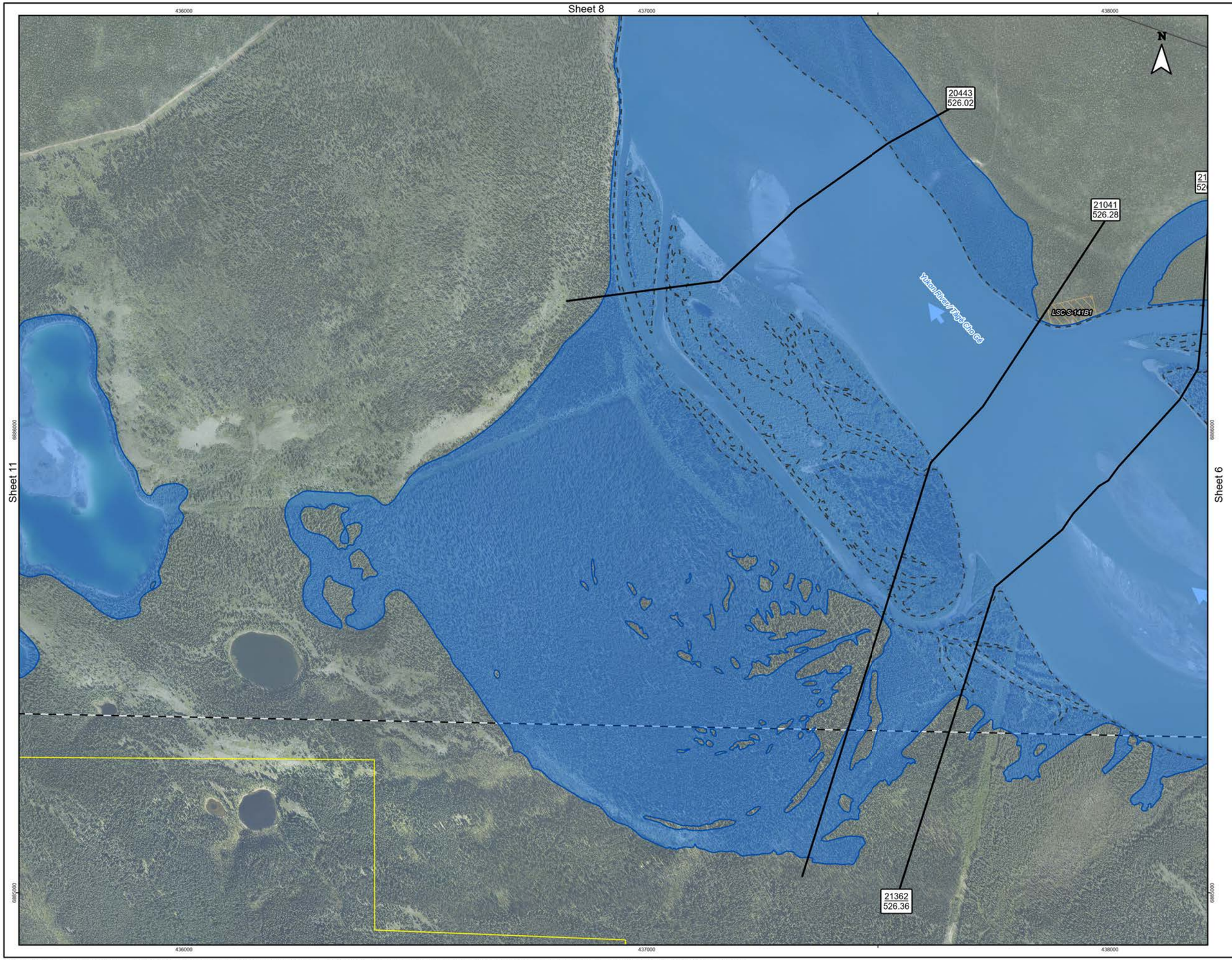


Figure No.

E.4.7

Sheet 7 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

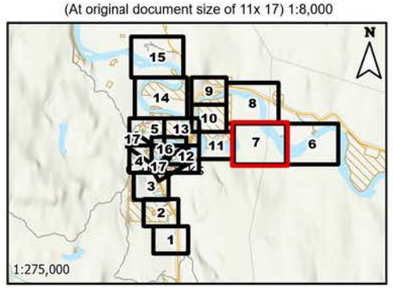
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

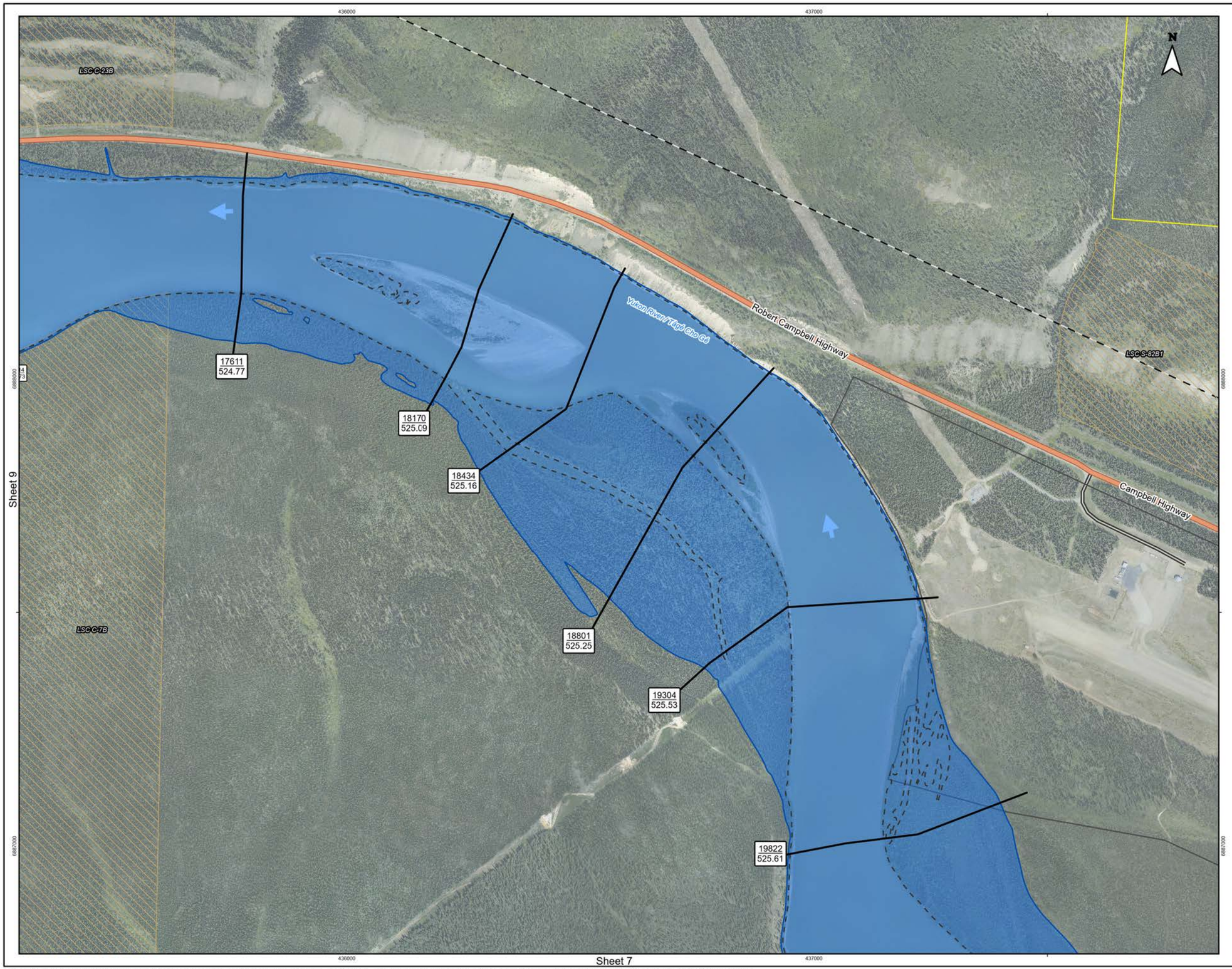


Figure No.

E.4.8

Sheet 8 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

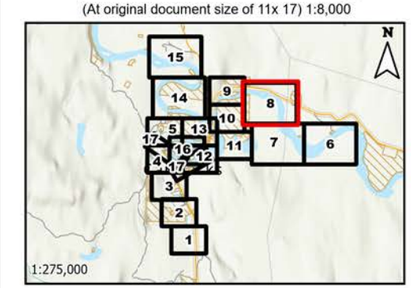
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

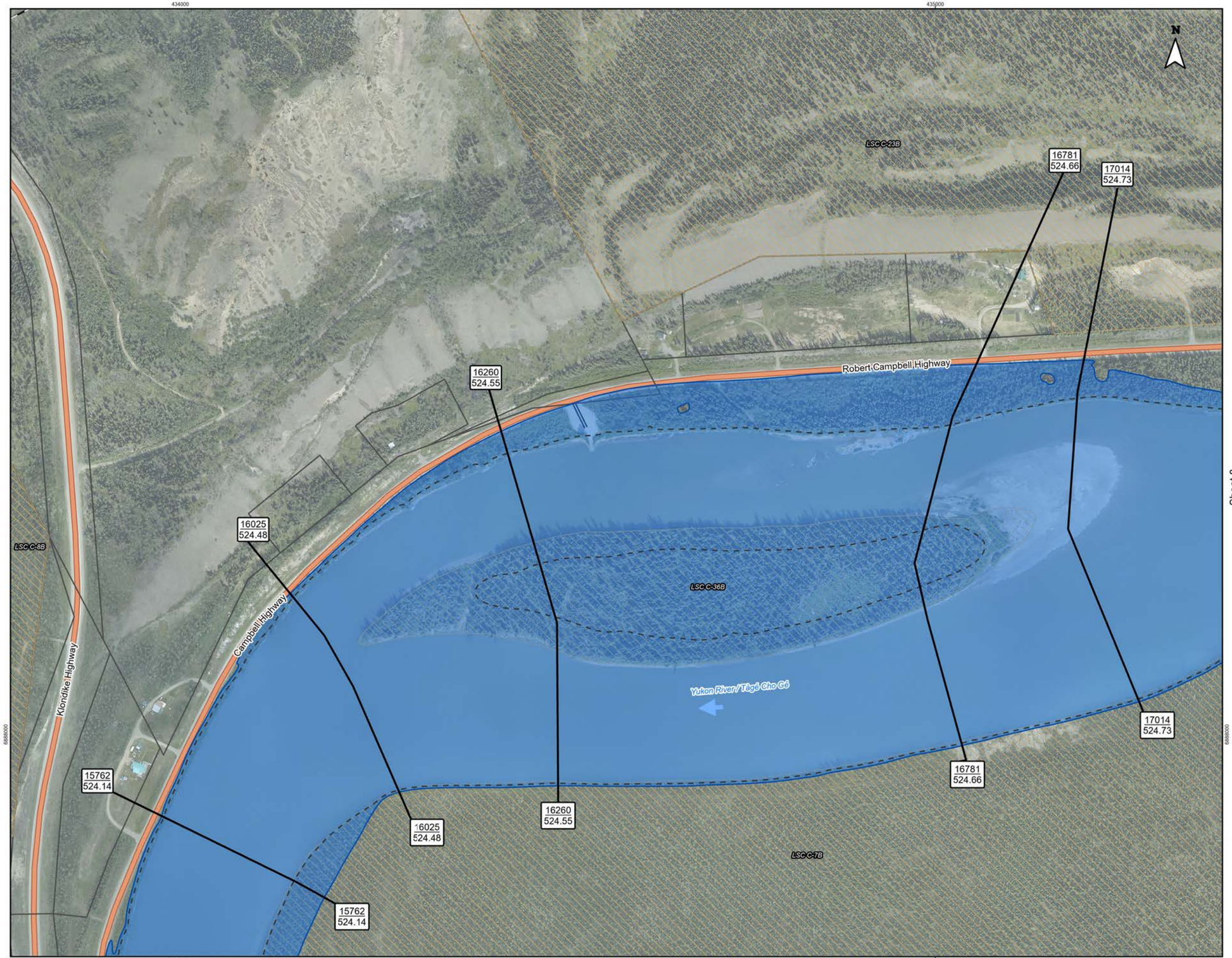


Figure No.

E.4.9 **Sheet 9 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

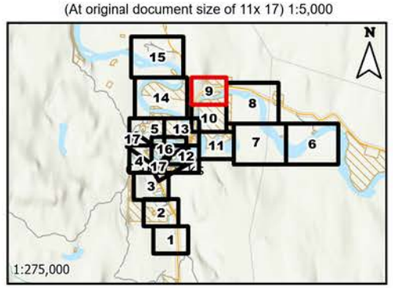
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

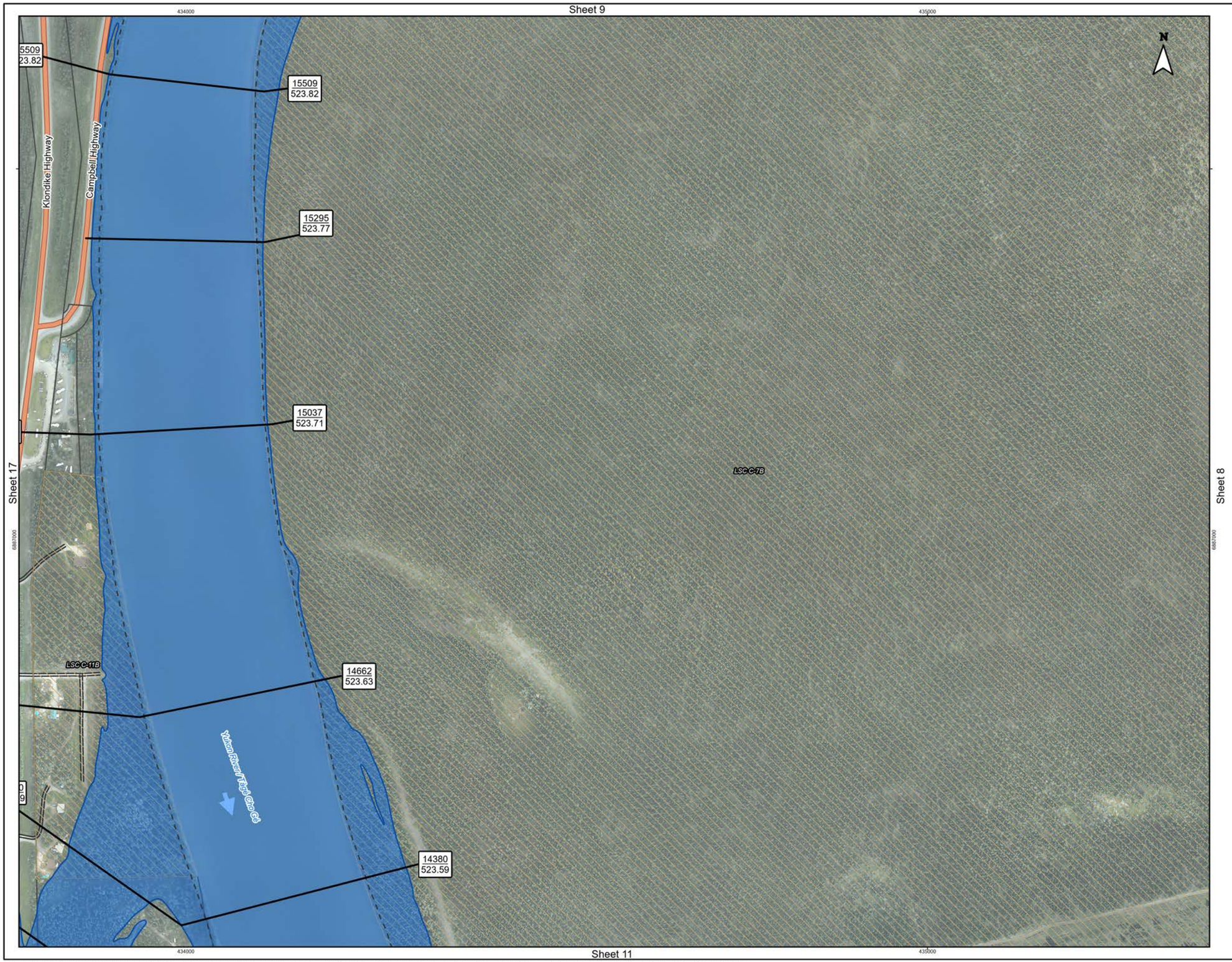


Figure No.

E.4.10

Sheet 10 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

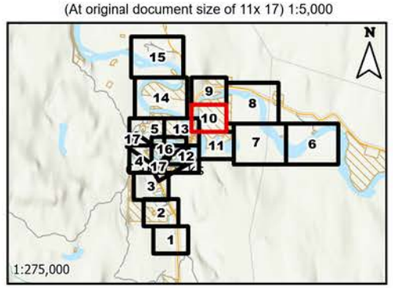
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

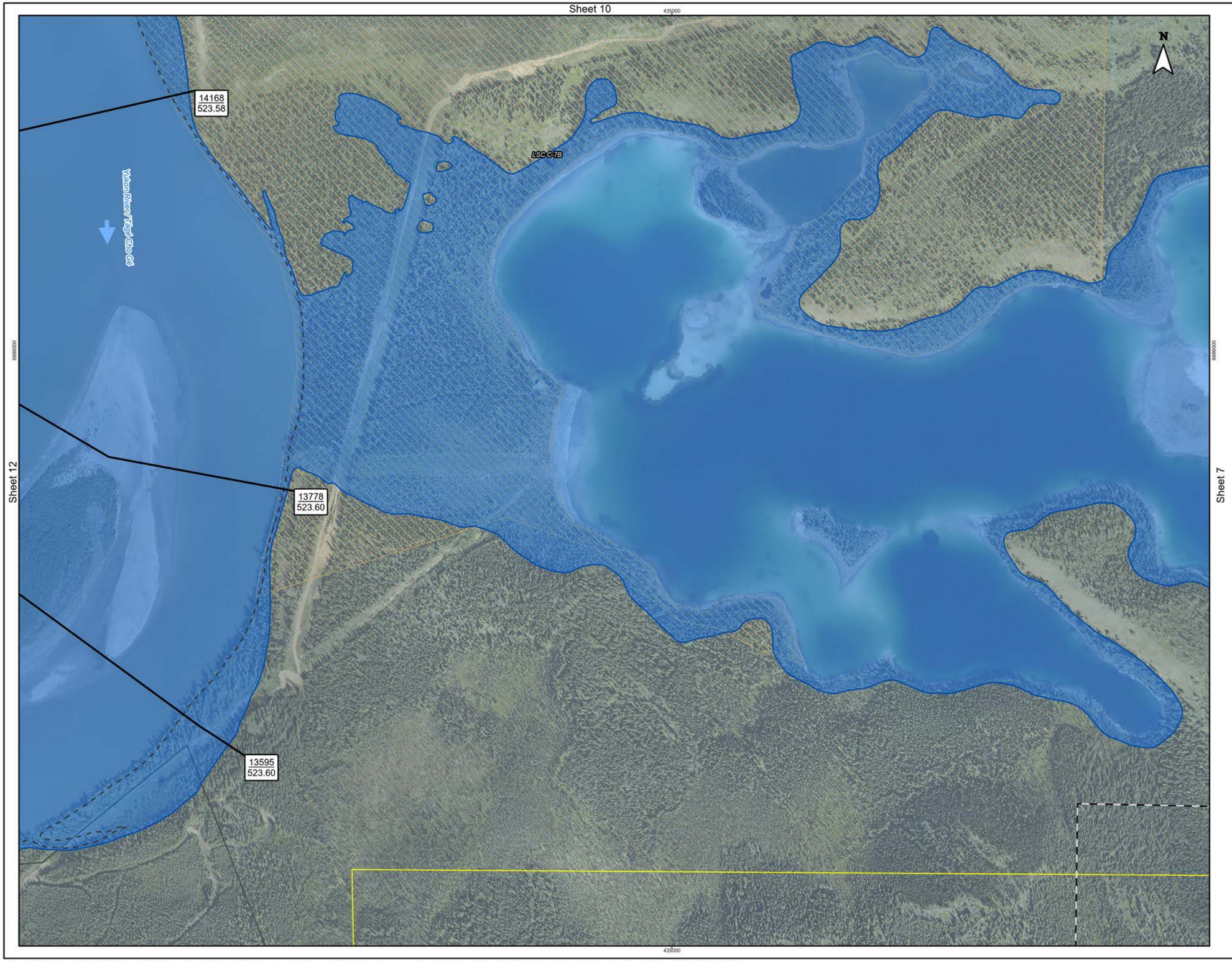


Figure No.

E.4.11

Sheet 11 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

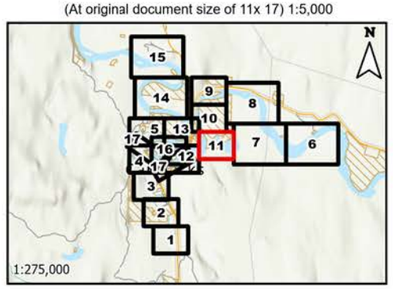
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 13

Sheet 4

Sheet 11

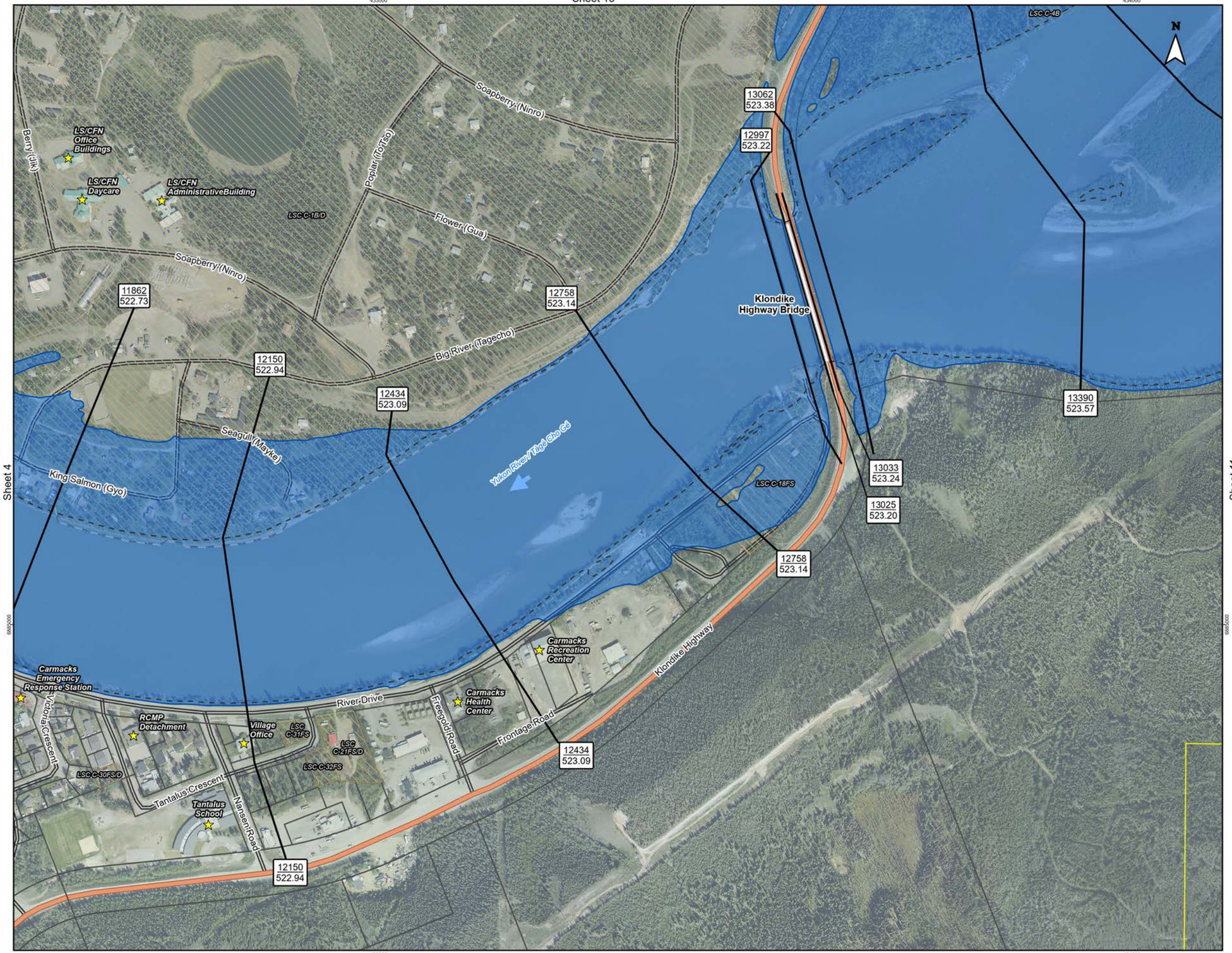


Figure No.

E.4.12 **Sheet 12 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

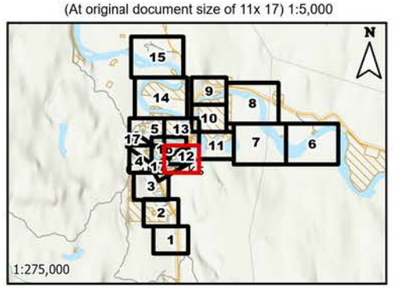
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

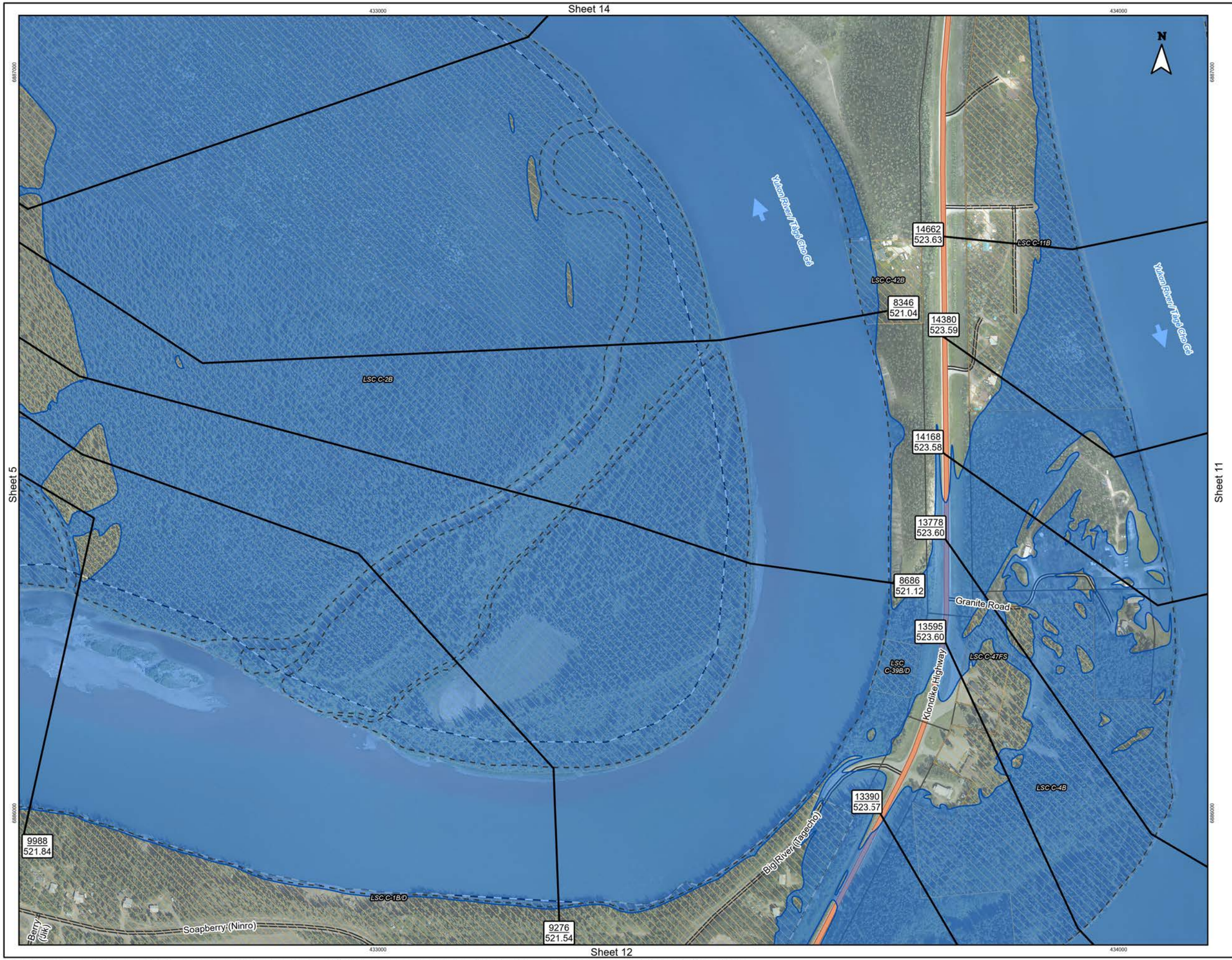


Figure No.

E.4.13

Sheet 13 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

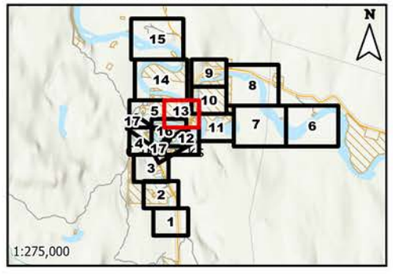
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a

2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.

3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS

4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

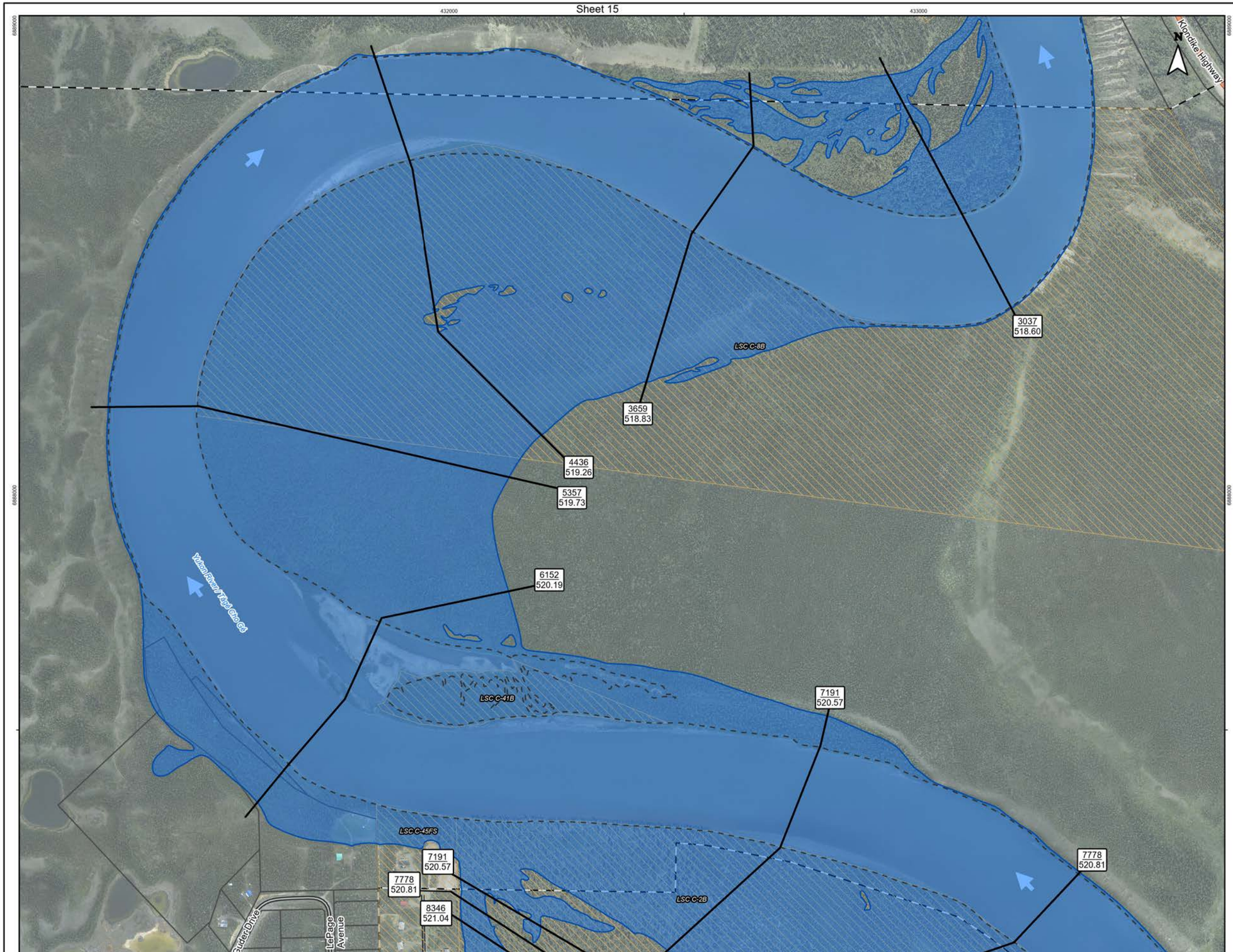


Figure No.

E.4.14

Sheet 14 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

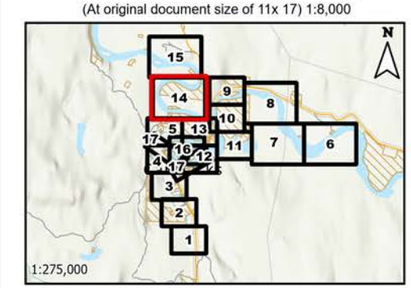
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

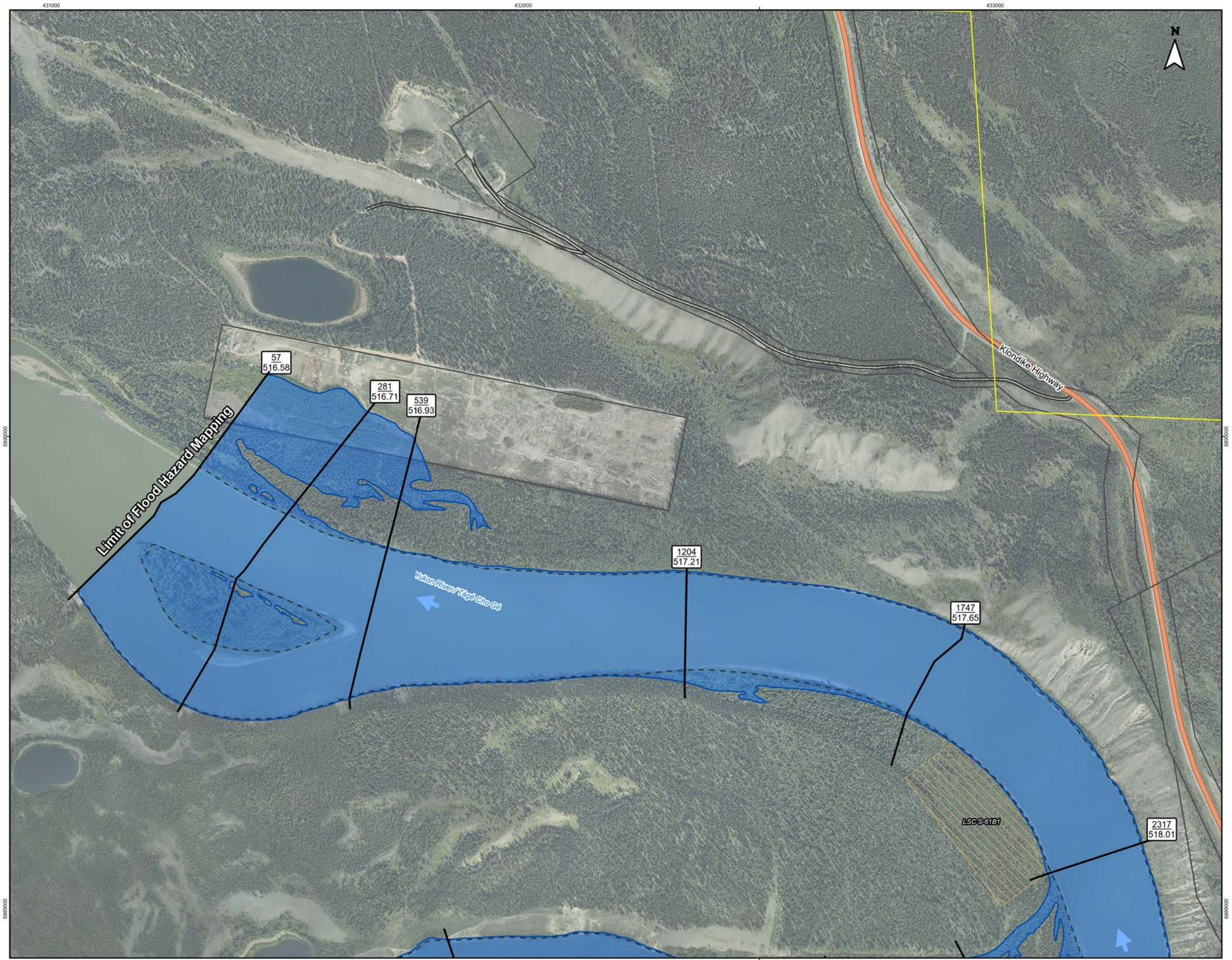
1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Sheet 14

Figure No.

E.4.15

Sheet 15 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

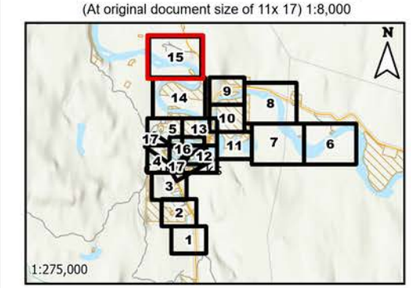
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 17

Figure No.

E.4.16

Sheet 16 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

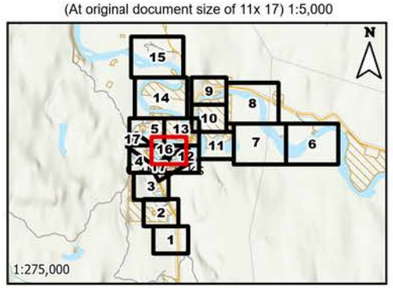
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flood Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

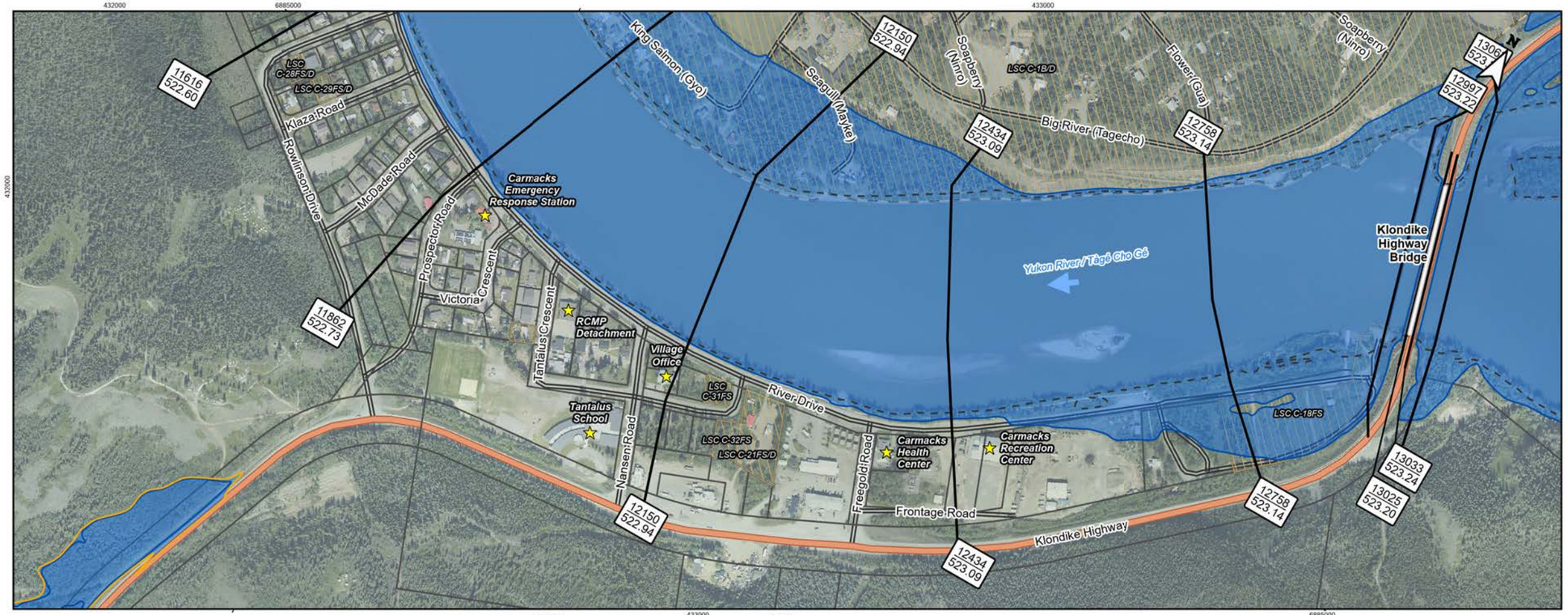
1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



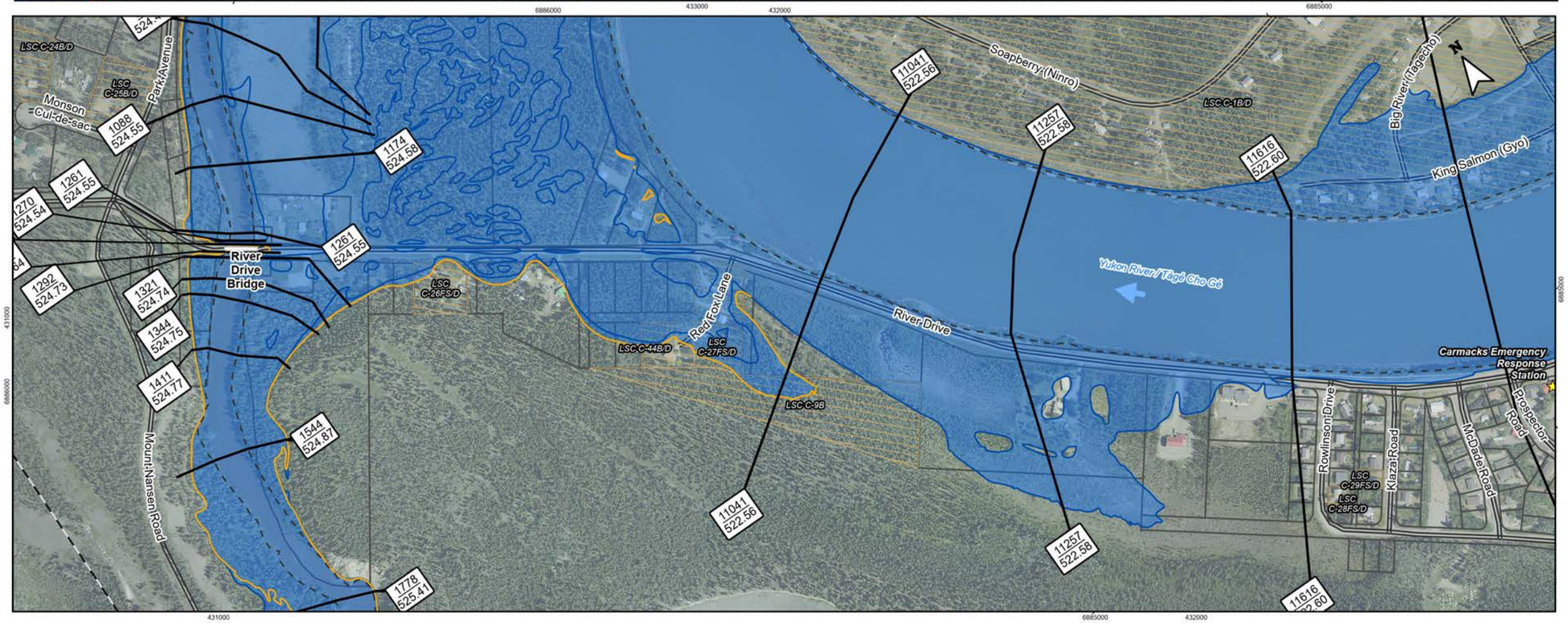


Figure No.

E.4.17 Sheet 17 of 17

Title: **Carmacks Flood Mapping Study**
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP)

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:
Carmacks, Yukon

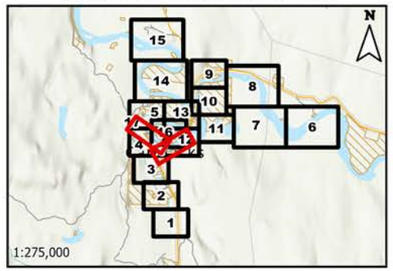
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Ice Jam Location (toe of jam)
- Composite Flood Hazard Extent
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 50 100 150 200 250 m

(At original document size of 11x 17) 1:6,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

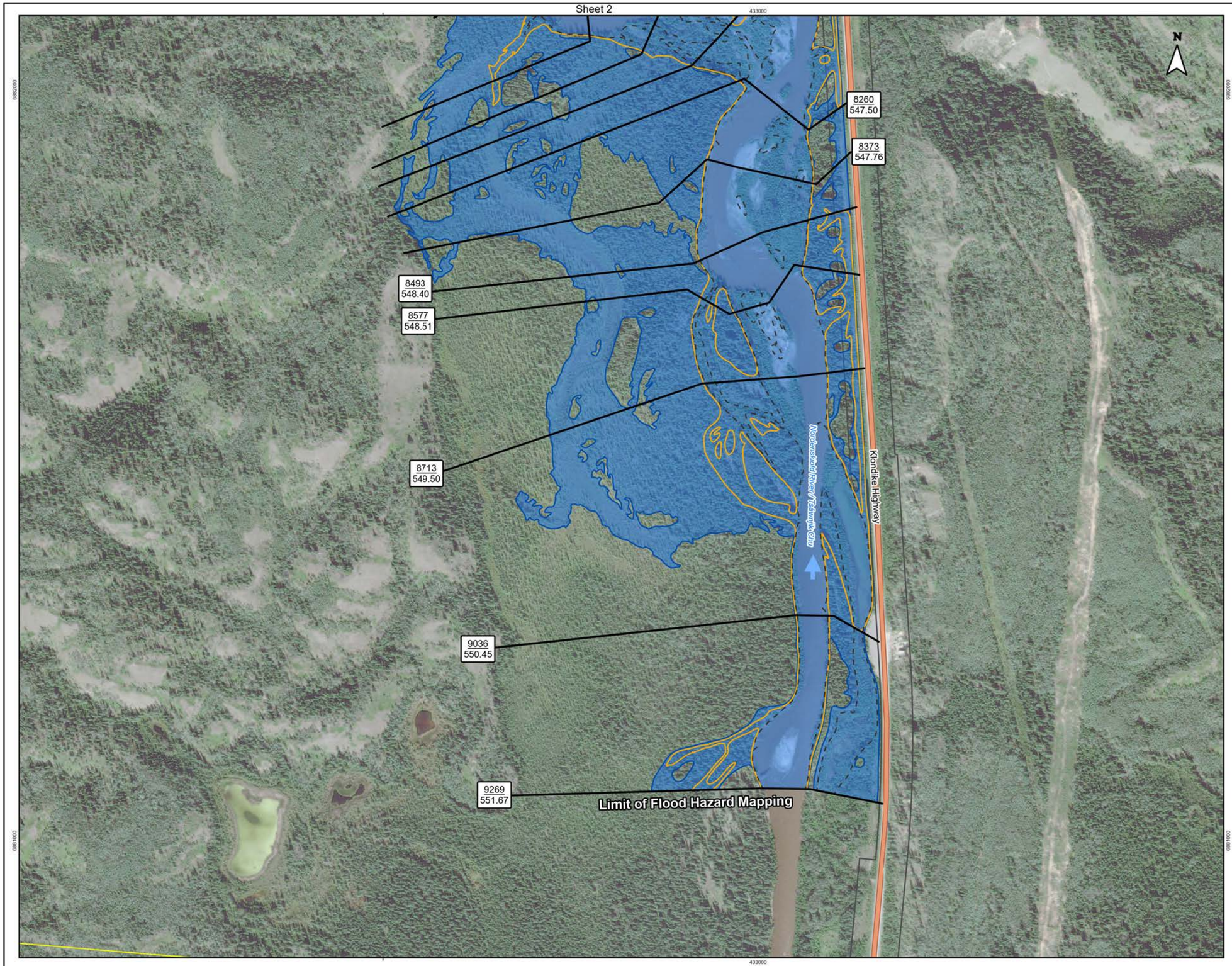


Figure No.

E.5.1 **Sheet 1 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

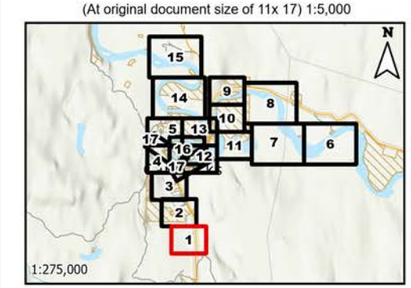
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: Yukon Satellites HighRes: Government of Yukon
World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

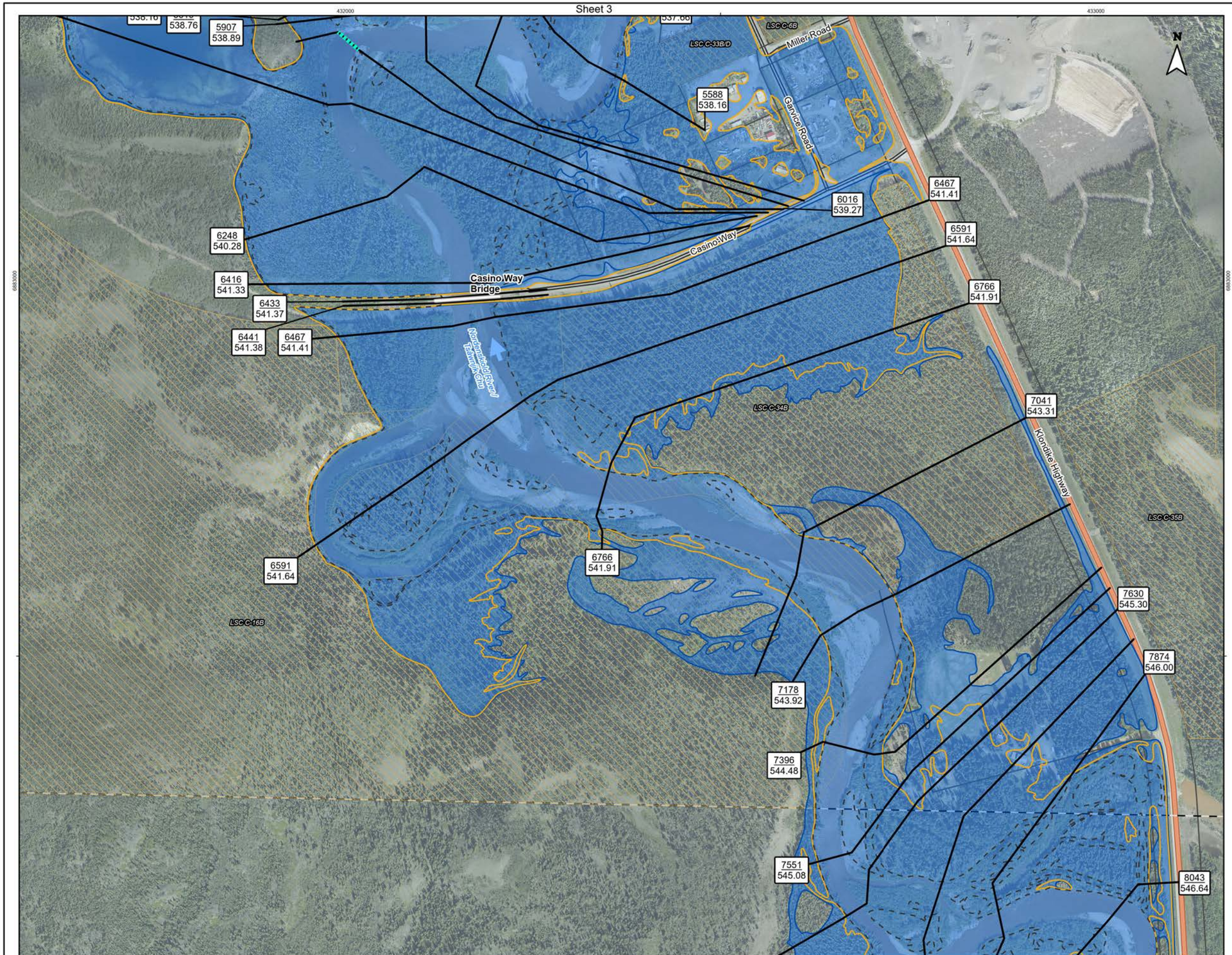


Figure No.

E.5.2 **Sheet 2 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

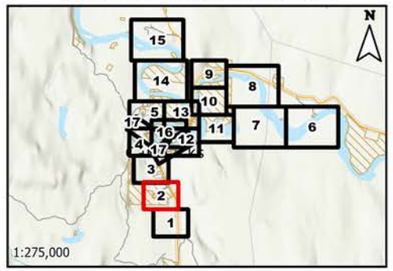
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

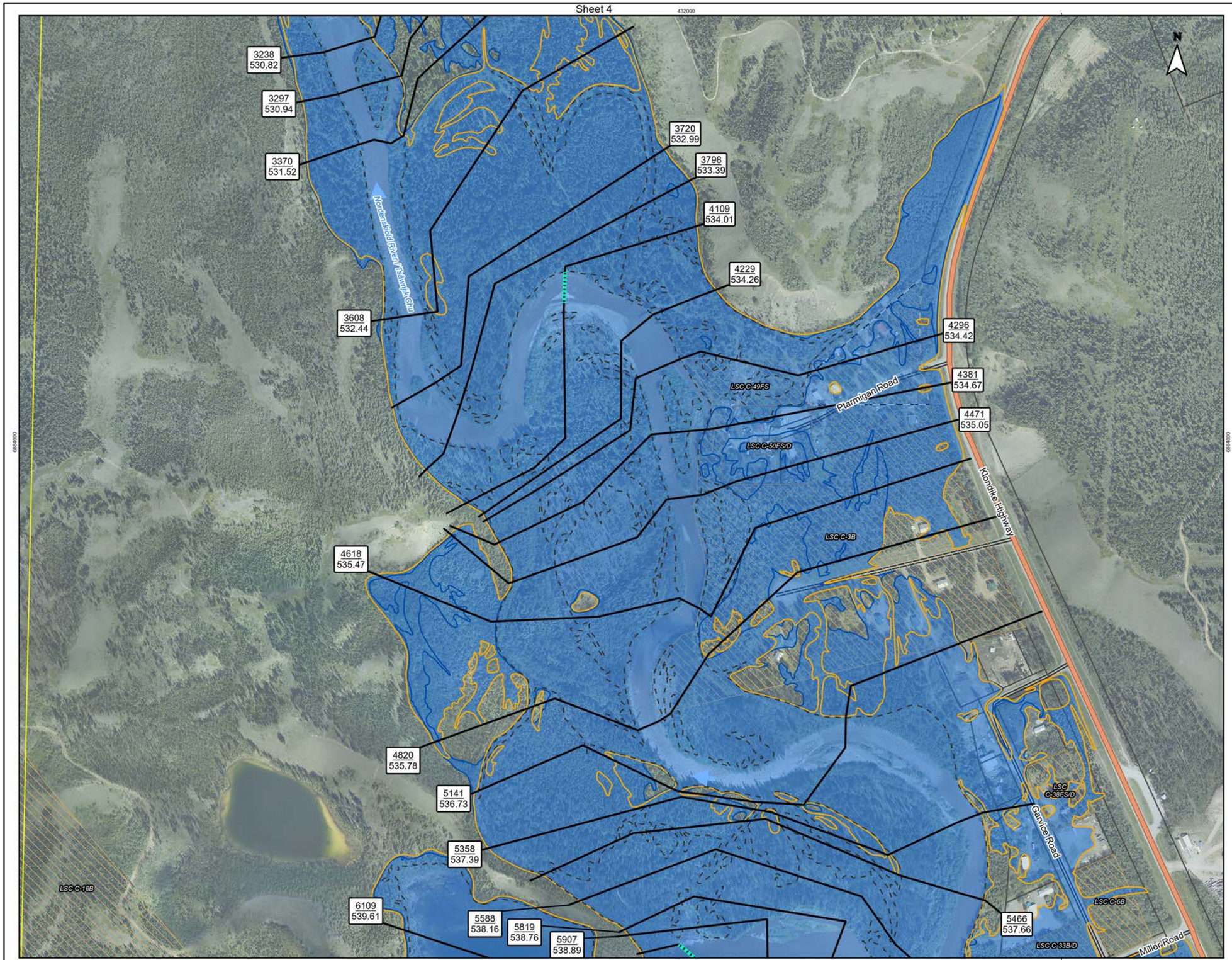


Figure No.

E.5.3

Sheet 3 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

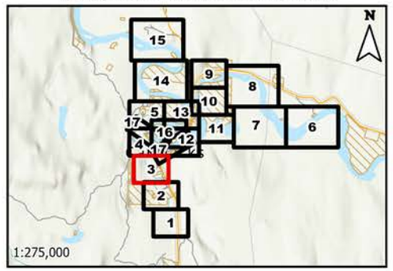
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 5

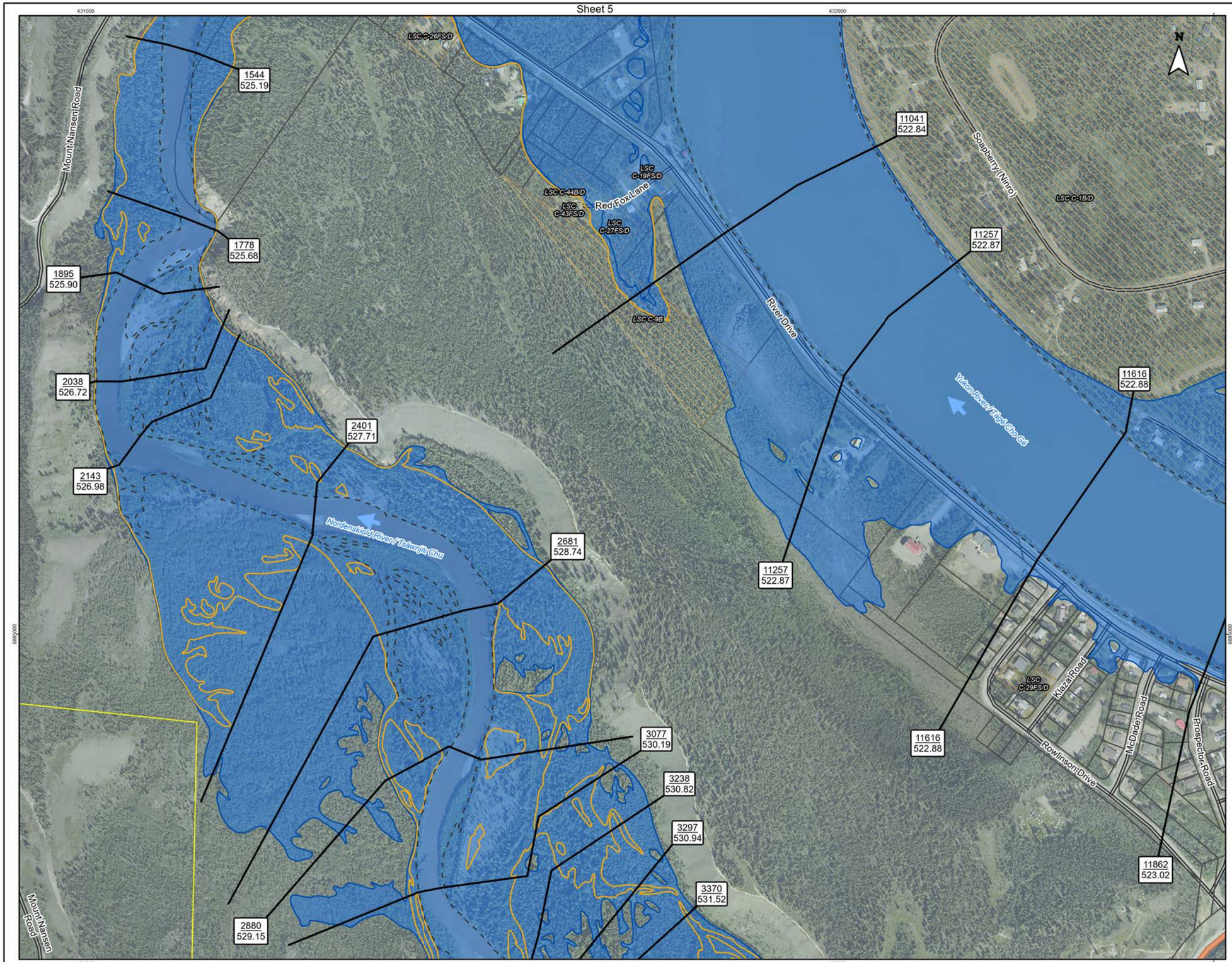


Figure No.

E.5.4 **Sheet 4 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

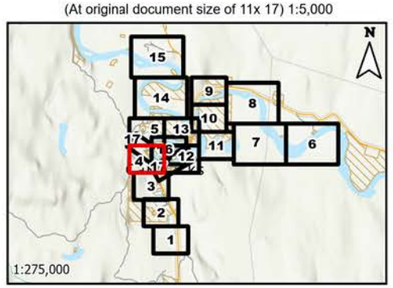
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

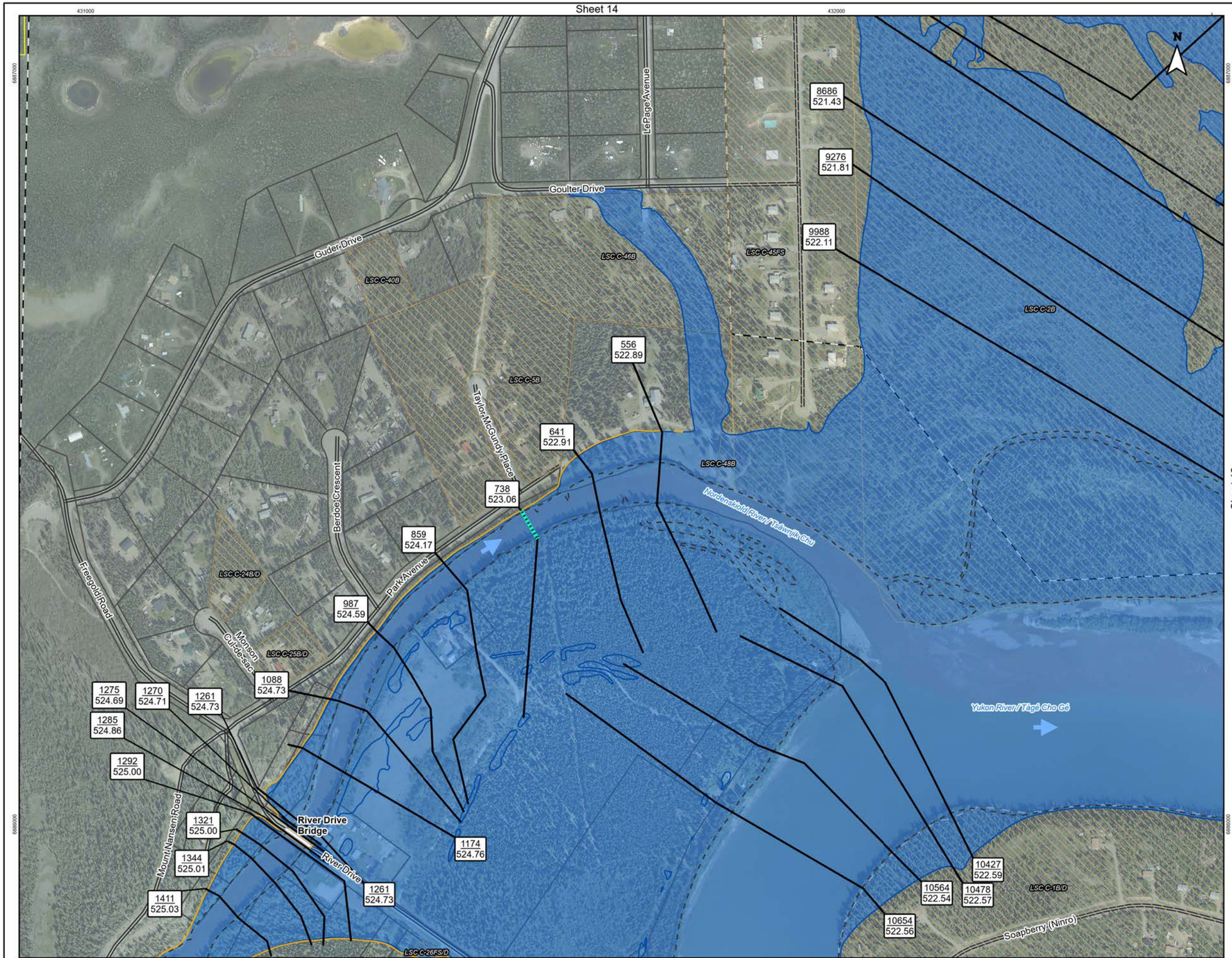


Figure No.

E.5.5

Sheet 5 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

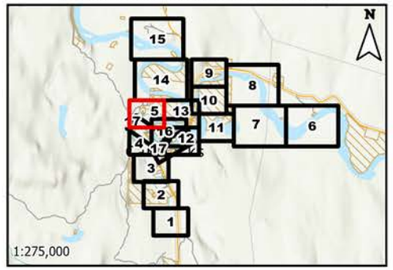
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

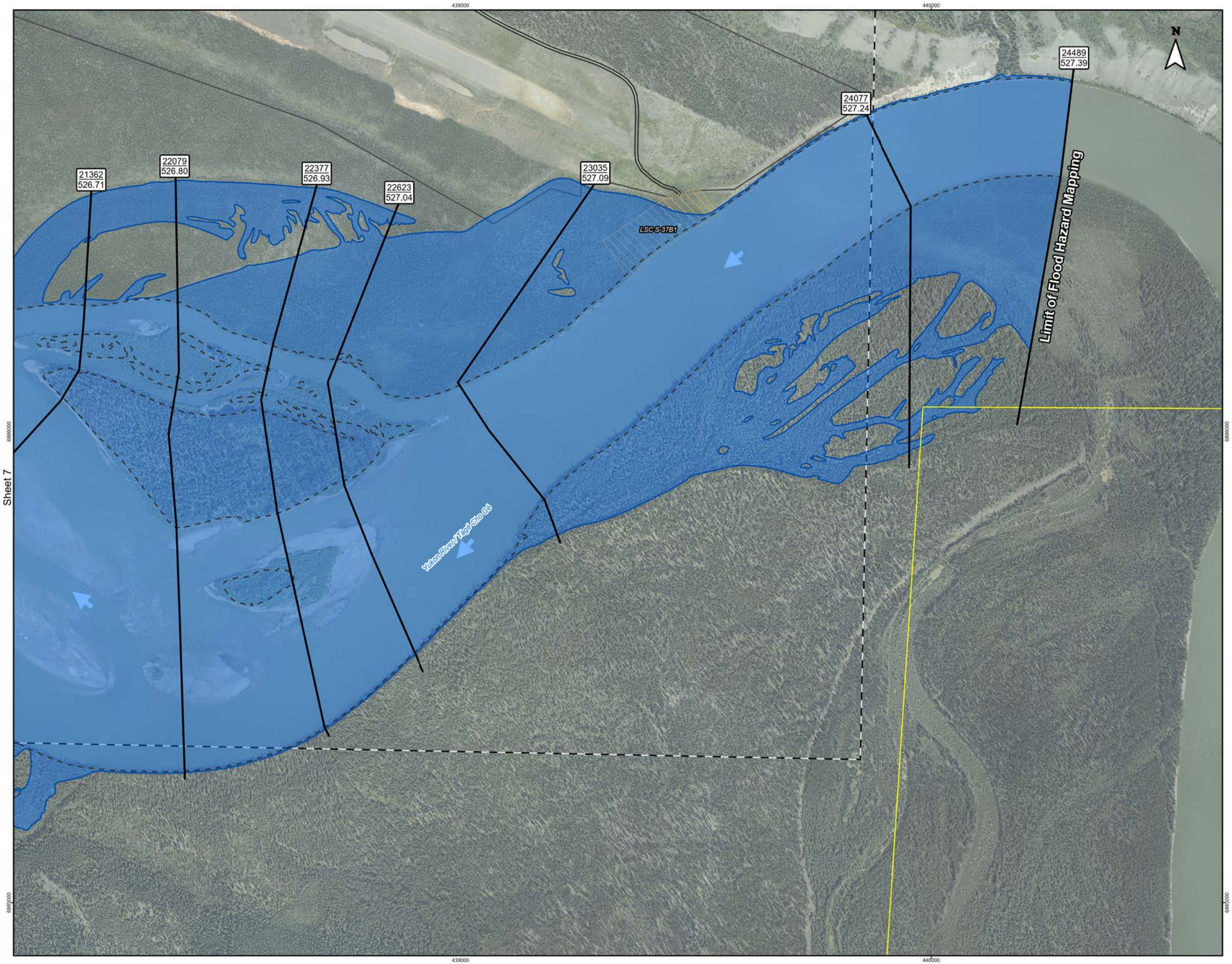


Figure No.

E.5.6

Sheet 6 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

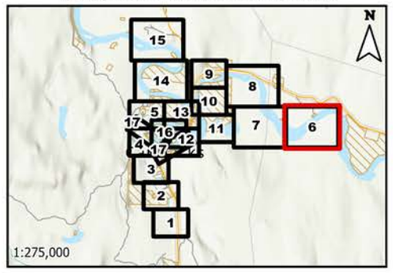
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

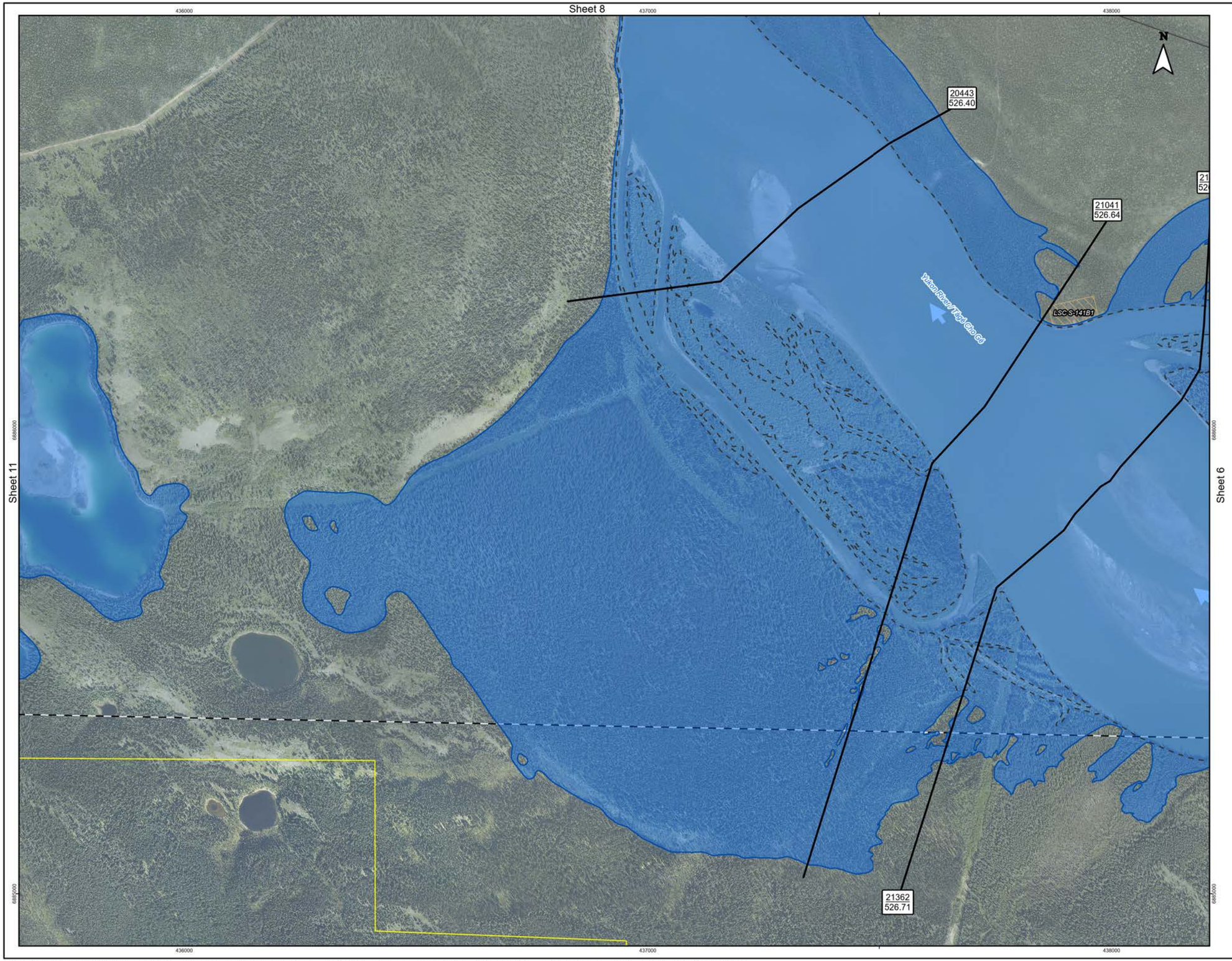


Figure No.

E.5.7 **Sheet 7 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

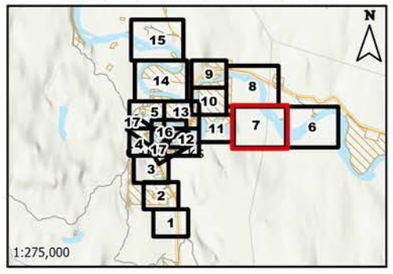
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

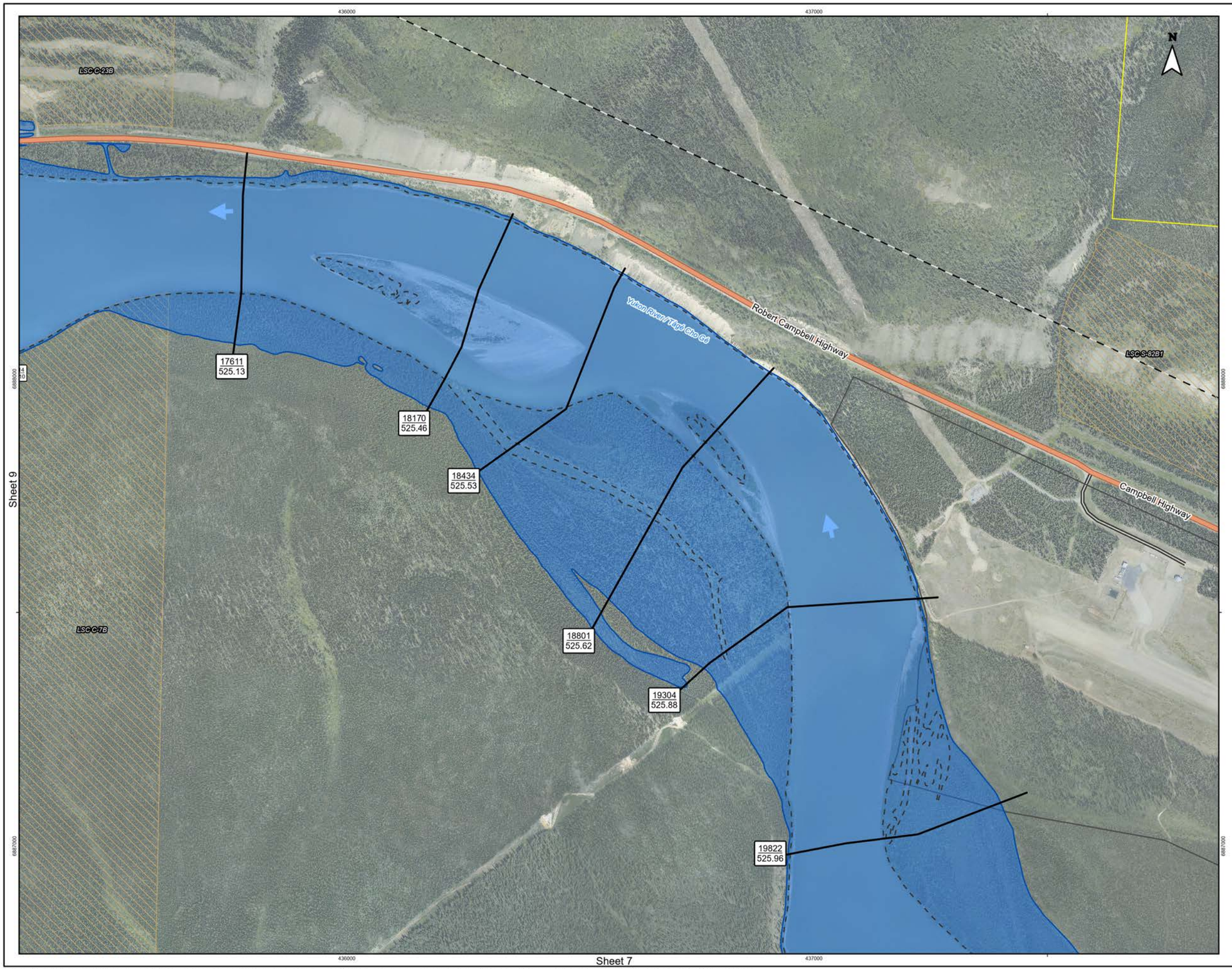


Figure No.

E.5.8 **Sheet 8 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

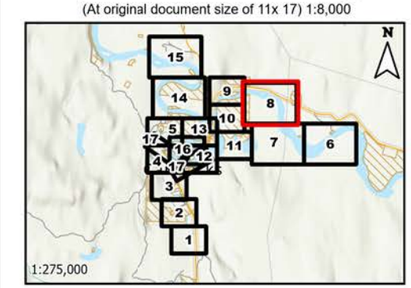
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

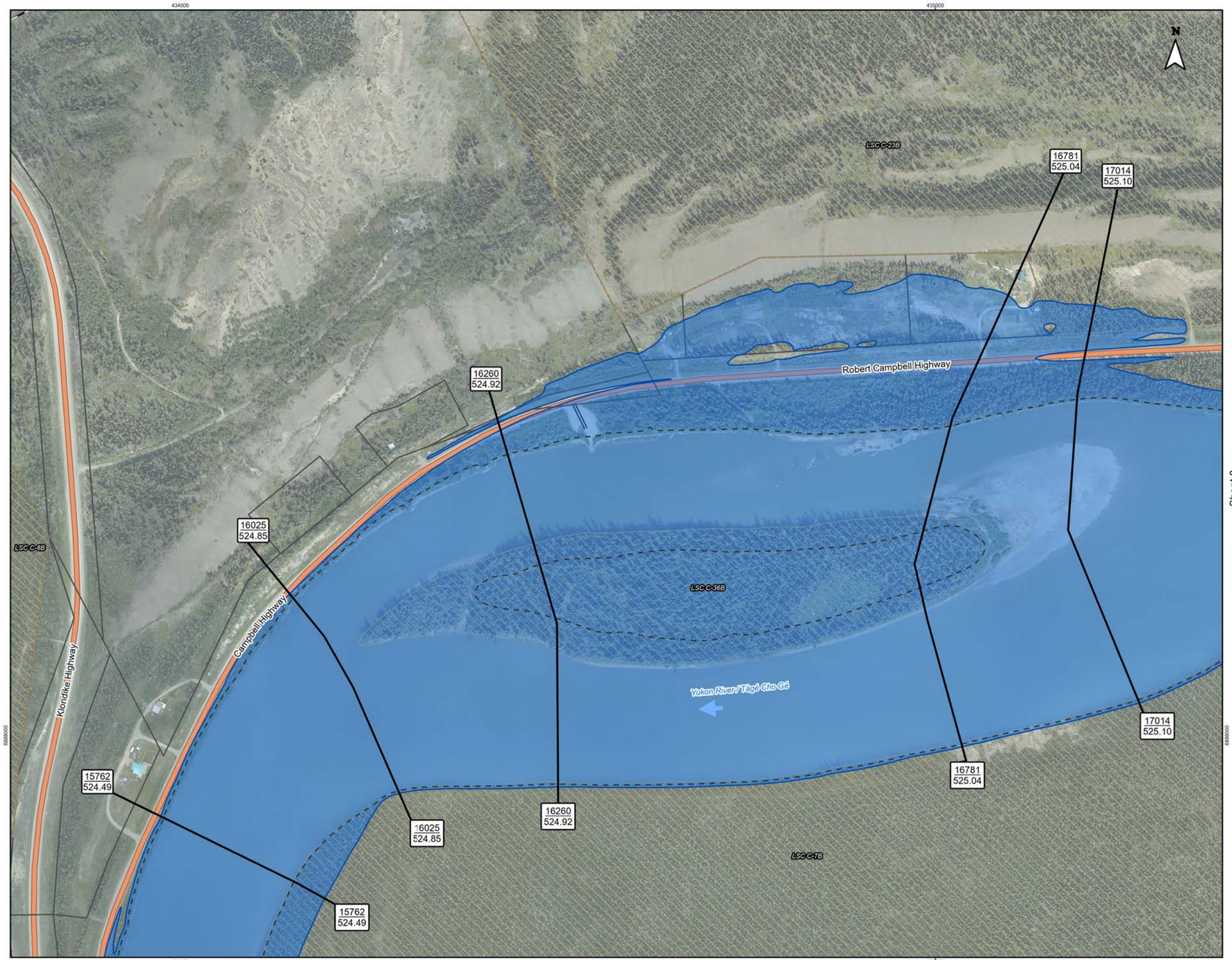


Figure No.

E.5.9 **Sheet 9 of 17**

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

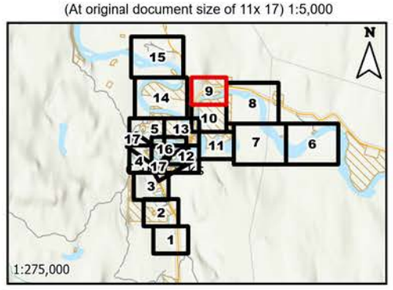
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

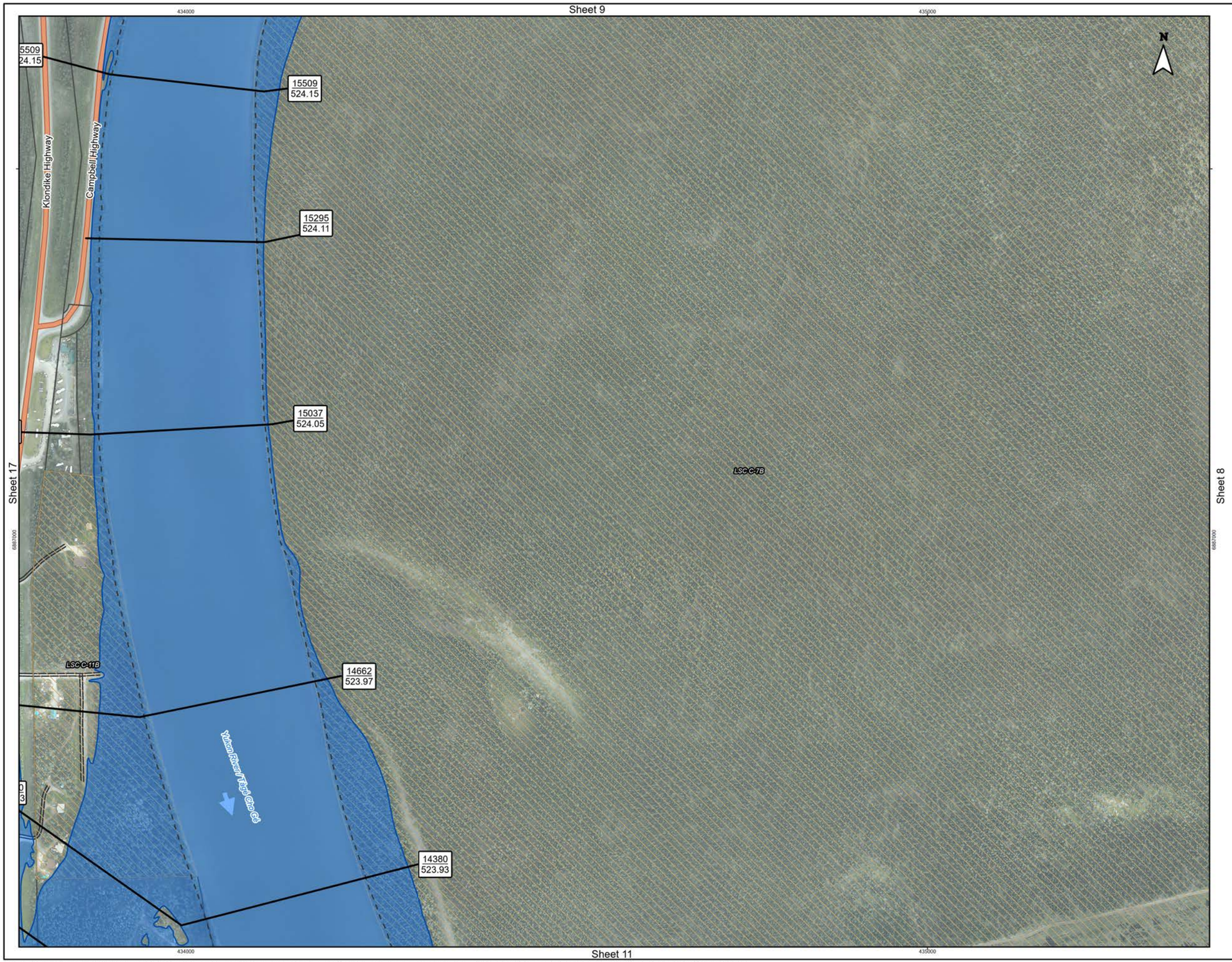


Figure No.

E.5.10

Sheet 10 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

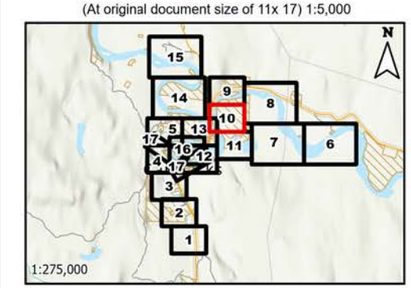
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

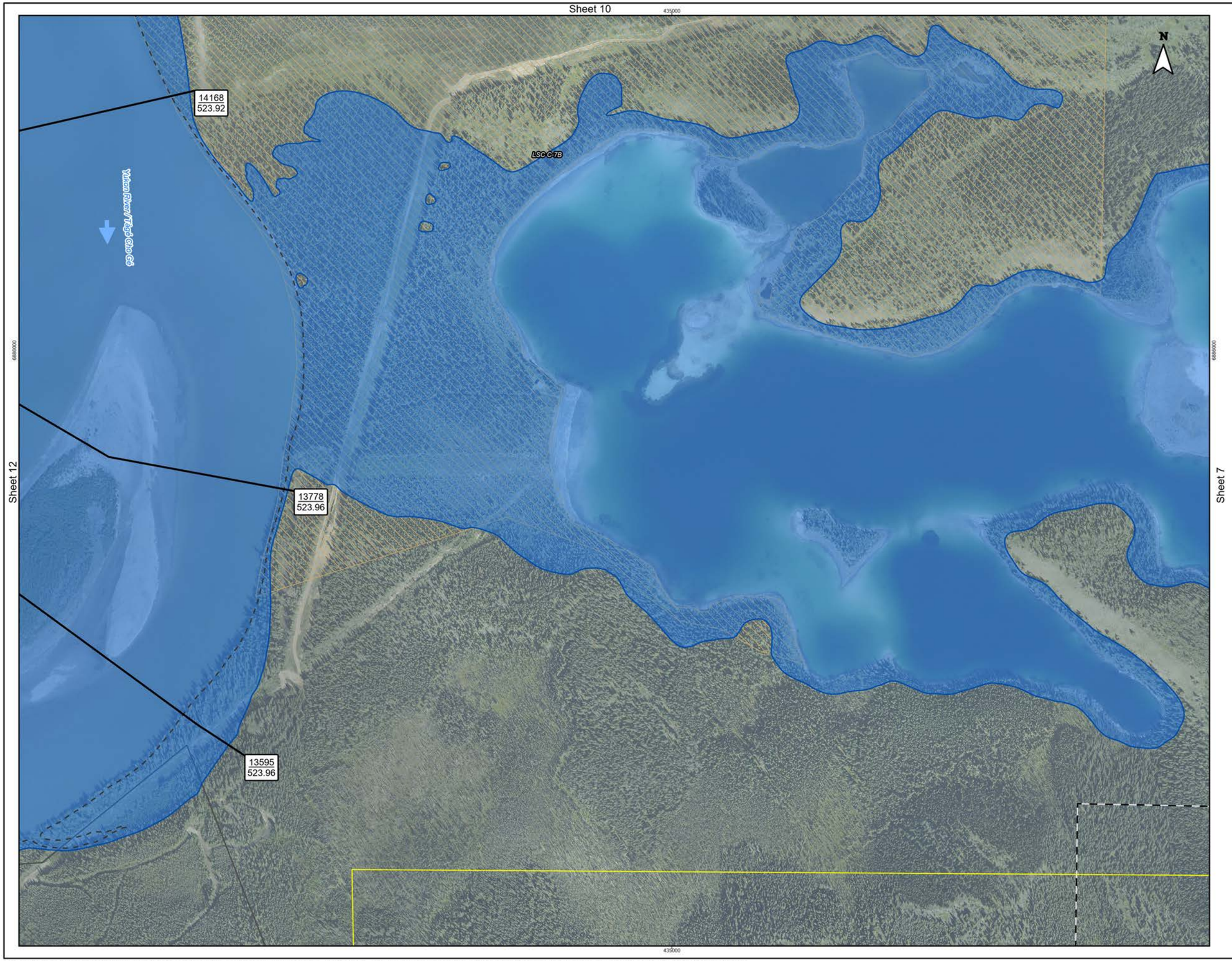


Figure No.

E.5.11

Sheet 11 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

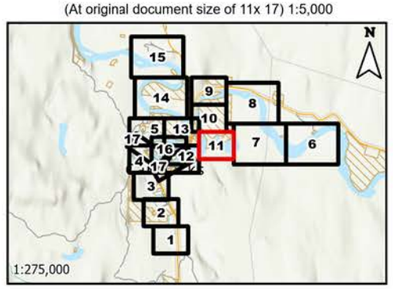
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

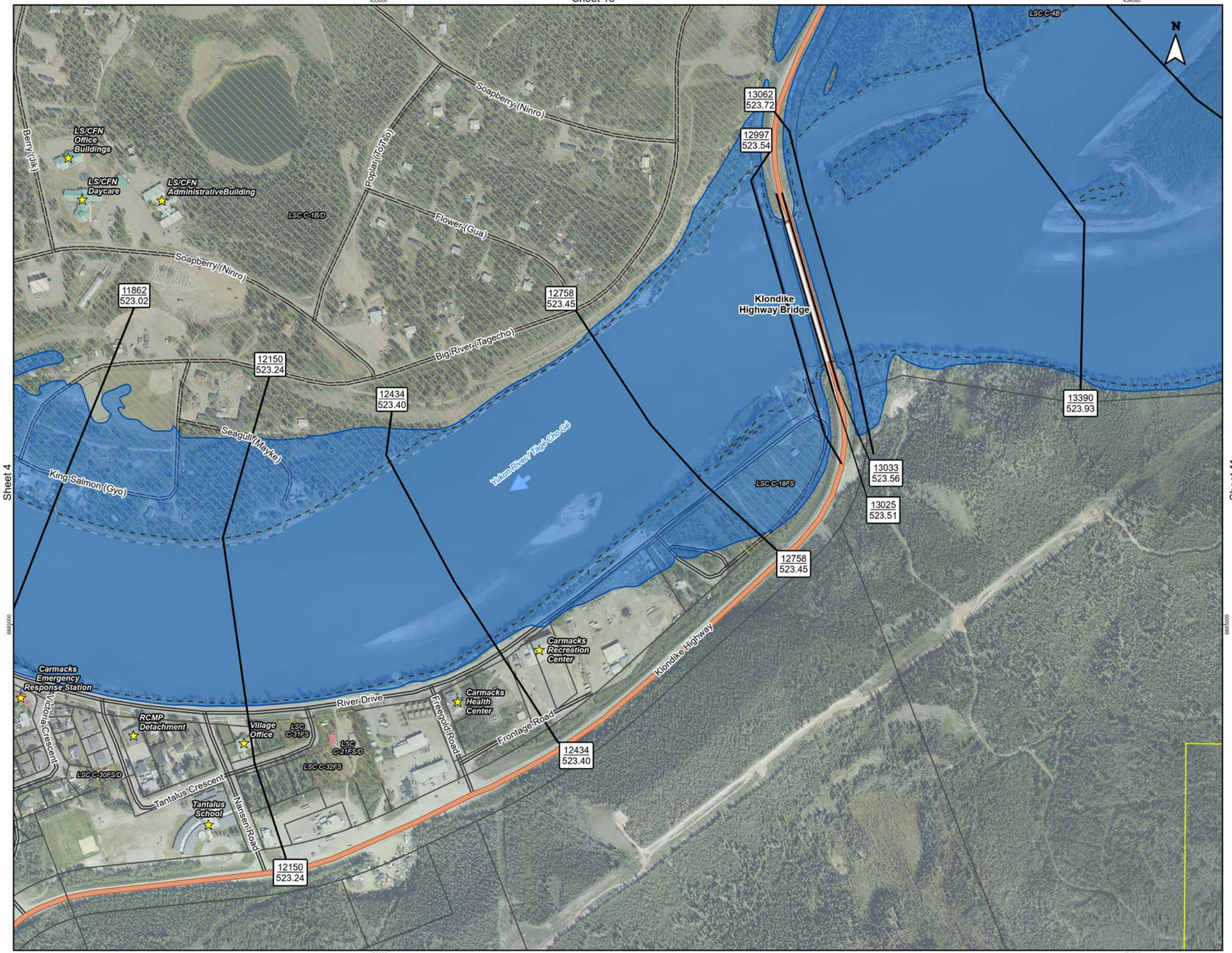
Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 13



Sheet 4

Sheet 11

Figure No.

E.5.12

Sheet 12 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

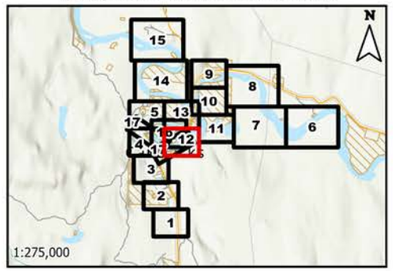
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

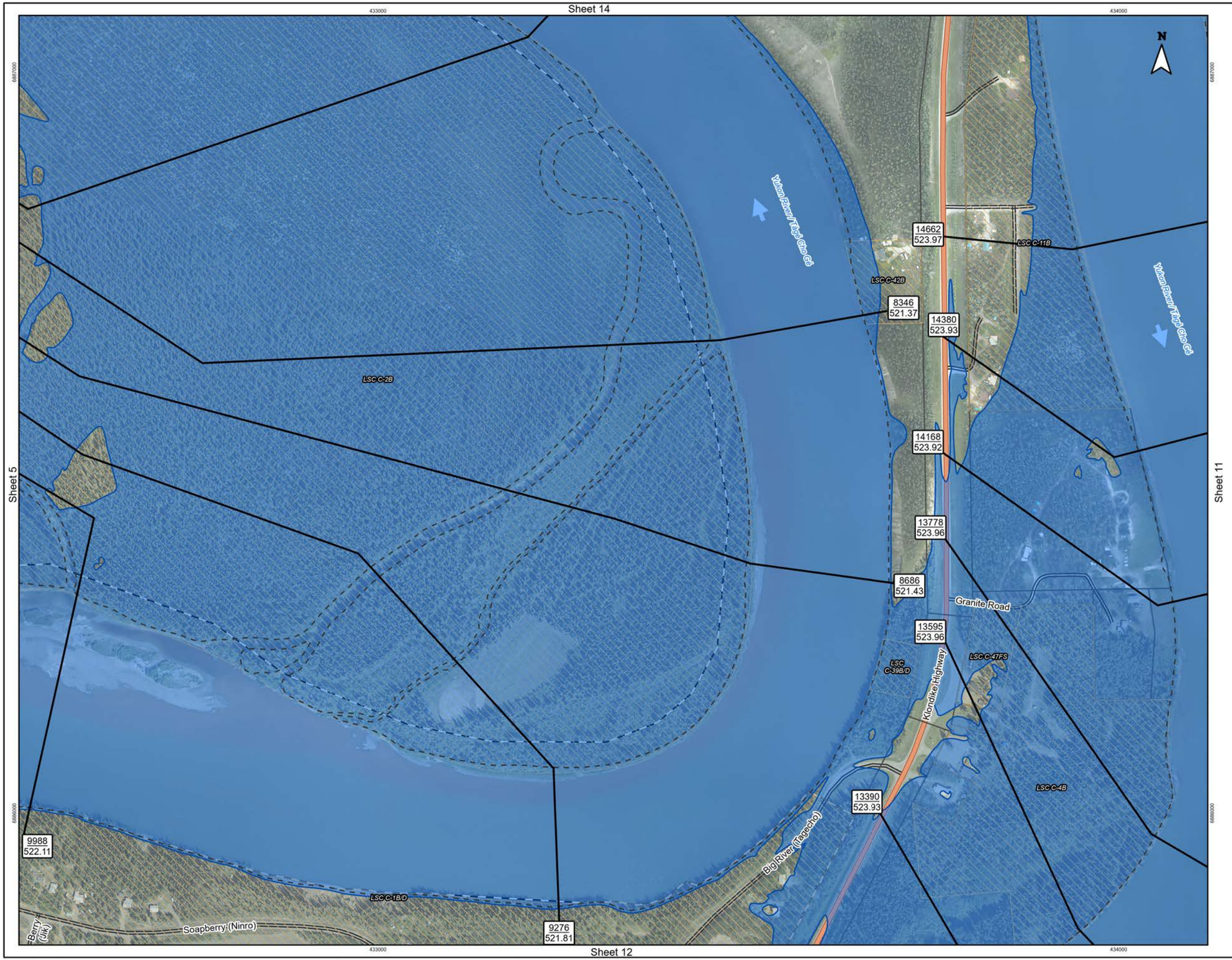


Figure No.

E.5.13

Sheet 13 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

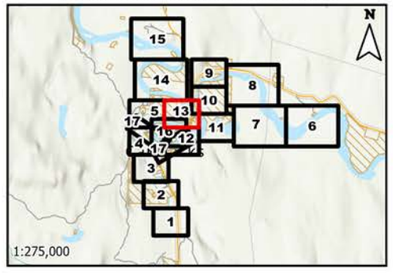
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

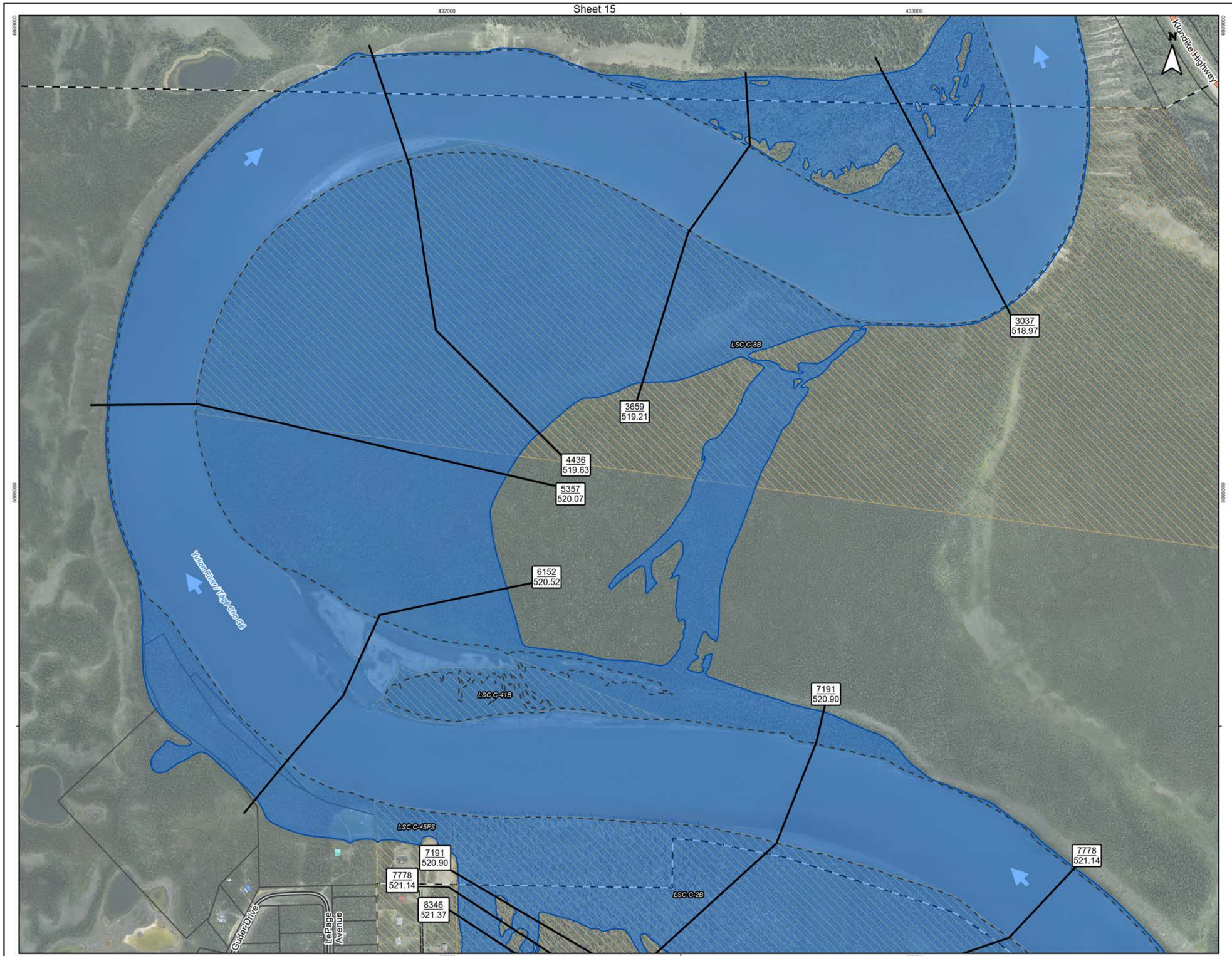


Figure No.

E.5.14

Sheet 14 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

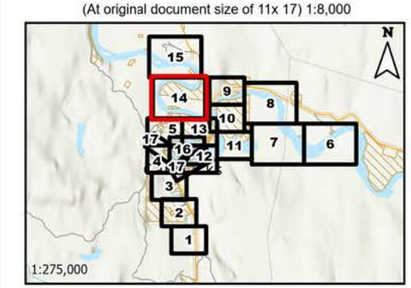
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

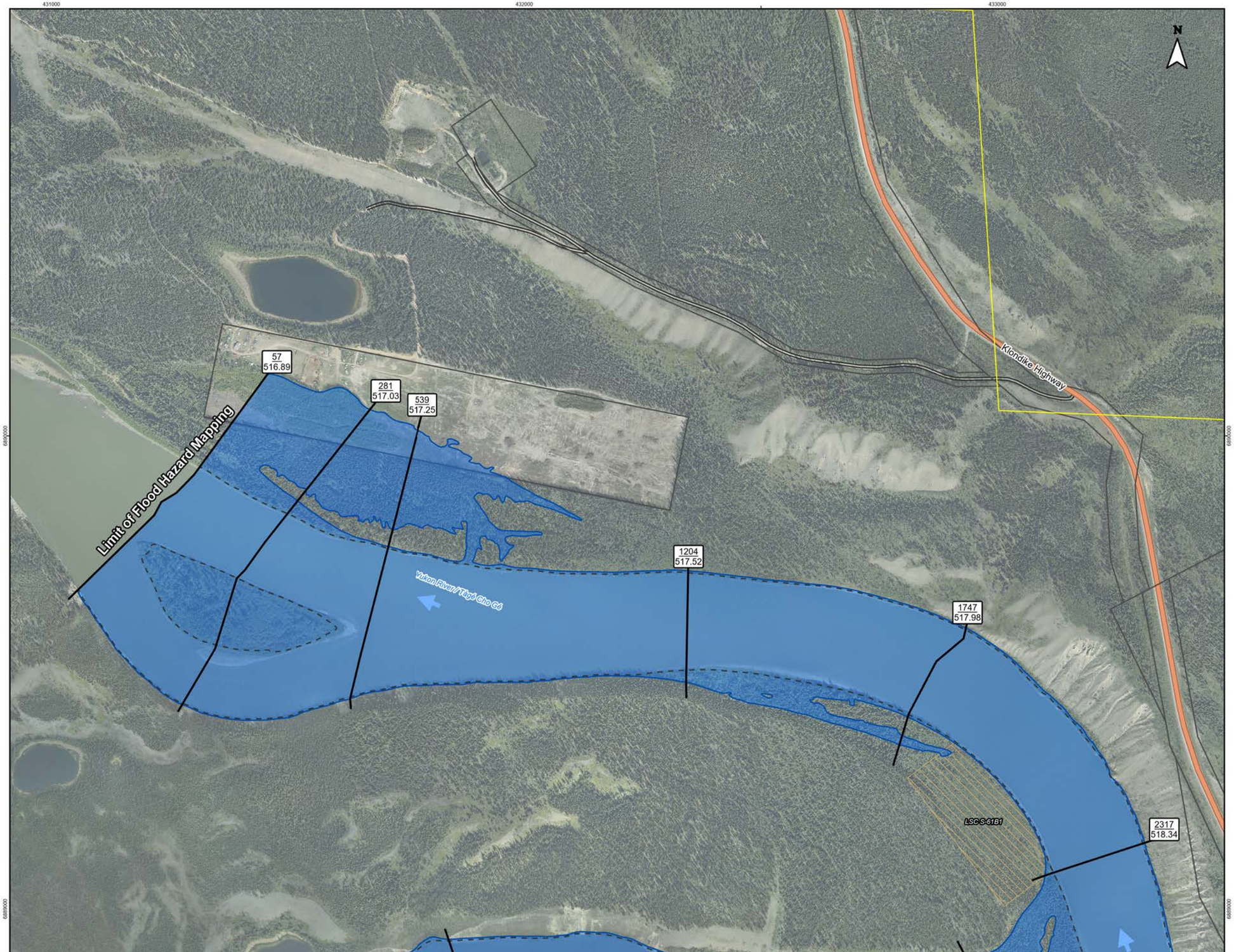
1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



Sheet 14

Figure No.

E.5.15

Sheet 15 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

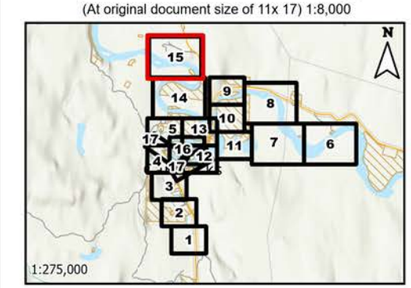
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 70 140 210 280 350 m

(At original document size of 11x 17) 1:8,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.

Sheet 17

Figure No.

E.5.16

Sheet 16 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

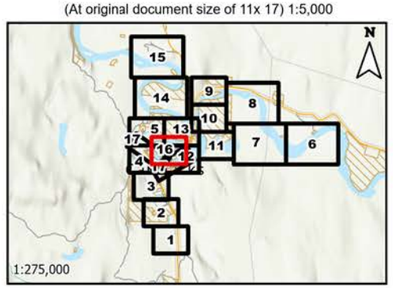
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 40 80 120 160 200 m

(At original document size of 11x 17) 1:5,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

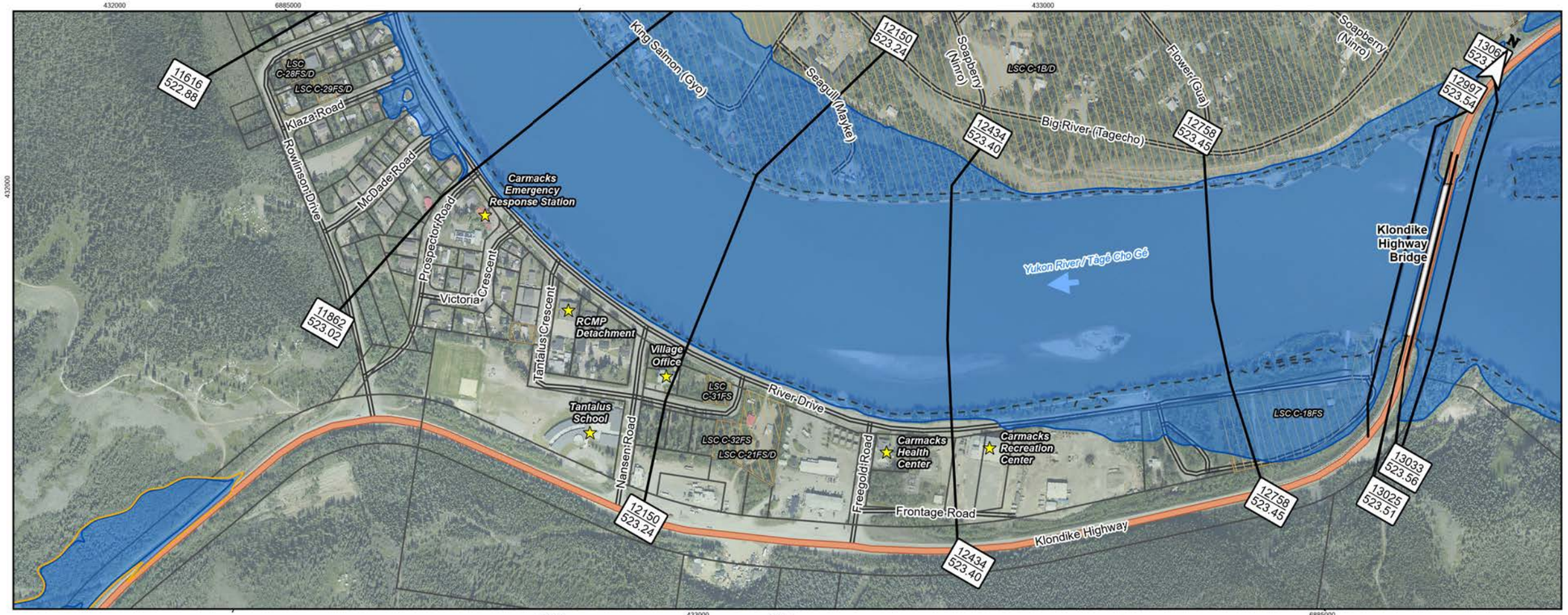
Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.



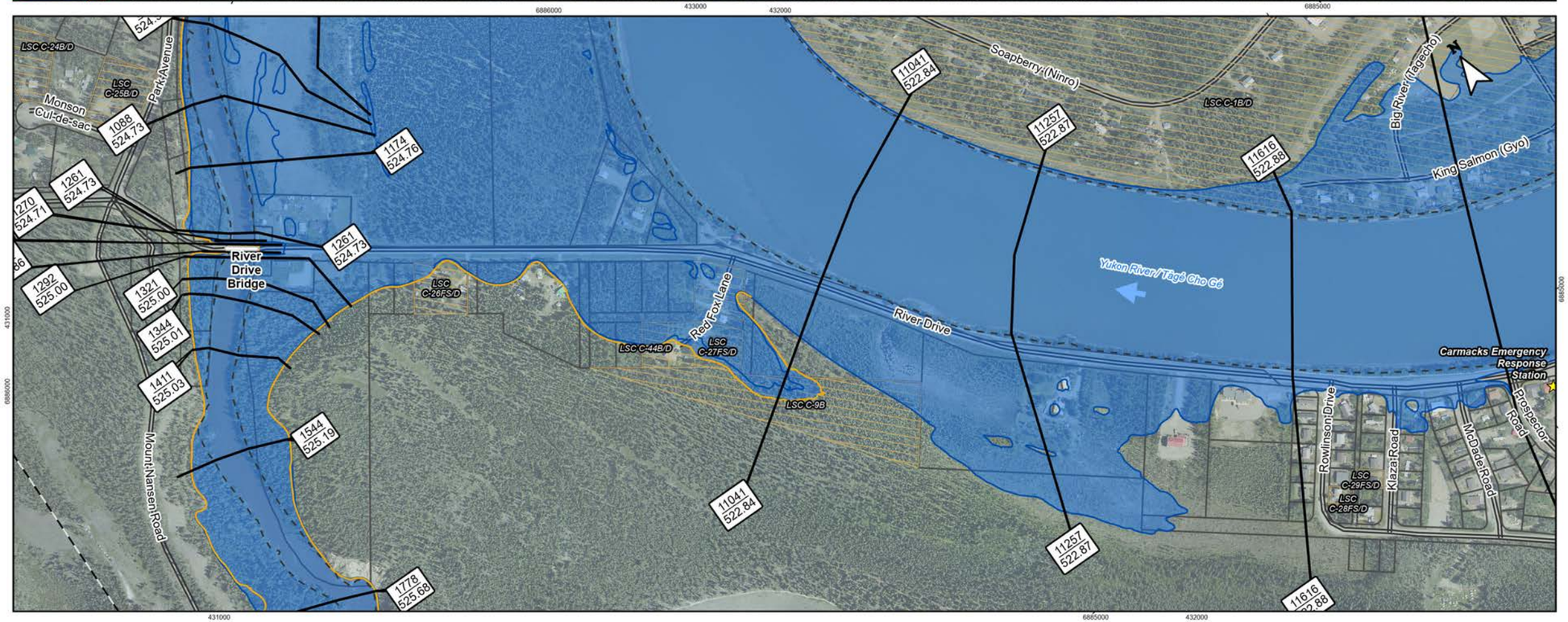


Figure No.

E.5.17

Sheet 17 of 17

Title:

Carmacks Flood Mapping Study
Composite Flood Hazard Extents
0.5% Annual Exceedance Probability (AEP) with Factor of Safety for Climate Change

Client/Project:

Government of Yukon
Department of Environment
Water Resources Branch

Project: 123222320

Project Location:

Carmacks, Yukon

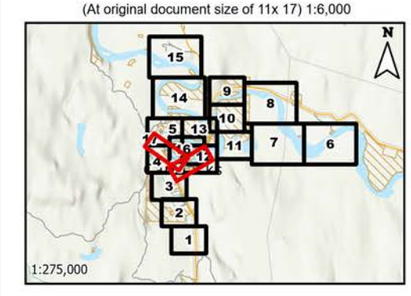
Prepared by MANDERSON on 2024-05-21
Requested by JMUIRHEAD on 2024-01-07
Review by JMUIRHEAD on 2024-05-21

- Flow Direction
- Point of Interest
- Bridge
- Highway
- Local Road
- Little Salmon / Carmacks First Nation Settlement Land
- Land Parcels
- Municipal Boundary
- Study Area
- Hydraulic Model Cross-Sections
- Inundation under Modelled Ice Jam Runs
- Inundation under Modelled Open Water Runs
- Composite Flod Hazard Extent
- Ice Jam Location (toe of jam)
- 50 % AEP Extent
- Hydraulic Model Cross-Sections
- 57 / 517.2 — Cross-Section Number / WSE (m) in Main Channel of Cross-Section

Map Publication Date: May 21, 2024

0 50 100 150 200 250 m

(At original document size of 11x 17) 1:6,000



Notes

1. Coordinate System: NAD 1983 UTM Zone 8N
Vertical Datum: CGVD2013, Geoid: CGG2013a
2. Data Sources: GeoYukon, Canada Lands Survey (CLS) CCM 982, Canvec.
3. Background: World Topographic Map: Northwest Territories, State of Alaska, Esri Canada, Esri, TomTom, Garmin, SafeGraph, METI/NASA, USGS, EPA, NPS, USDA, NRCan, Parks Canada
World Hillshade: Esri, USGS
4. Nordenskiold River Climate Change Factor of Safety = 1.2 and Yukon River Climate Change Factor of Safety = 1.1 as identified during meetings with YG, NRCan, ECCC on September 8, 2023 and November 6, 2023
5. Flood hazard extents shown on these maps are based on LiDAR collected on June 8 - 10 of 2019, and bathymetric/topographic survey collected in July and August of 2023.

Stantec

Yukon

This project is funded in part by the Government of Canada

Canada

Disclaimer: The content of these Draft Maps is based on the methods, assumptions, limitations, and analysis documented in the Carmacks Flood Mapping Study Final Report (Stantec 2024).
Any unauthorized use or reliance of Draft Maps is at the User's own risk. Stantec disclaims any legal duty based upon warranty, reliance or any other theory to any User, and will not be liable to any User for any damages or losses of any kind that may result.