srk consulting

SRK Consulting (Canada) Inc.
320 Granville Street, Suite 2600
Vancouver, BC V6C 1S9
Canada

+1 604 681 4196 office
+1 778 508 3584 fax
vancouver@srk.com
www.srk.com

FINAL

Memo

To	Brett Lucas, Lisa Henault (Hatfield)	**Client**	Hatfield Consultants
From	Camilo Gallard	**Project**	CAPR003790
Cc	Christina James, Rajib Kamal	**Date**	December 16, 2025

Subject East Creek Hydraulics – Discharge Capacity Assessment

File name: CAPR003790_Erosion_Assessment_Memo_FINAL_12162025.docx

1 Introduction

SRK Consulting (Canada) Inc. was contracted by Hatfield Consultants to evaluate the impacts of increased discharge scenarios from the Water Treatment Plant (WTP) located at the Eagle Mountain-Woodfibre Gas Pipeline (EGP) Project, led by Fortis BC. This report documents the hydraulic modelling completed on open channel and culverts of the East Creek reach located downstream of the Water Treatment Plant discharge location, including:

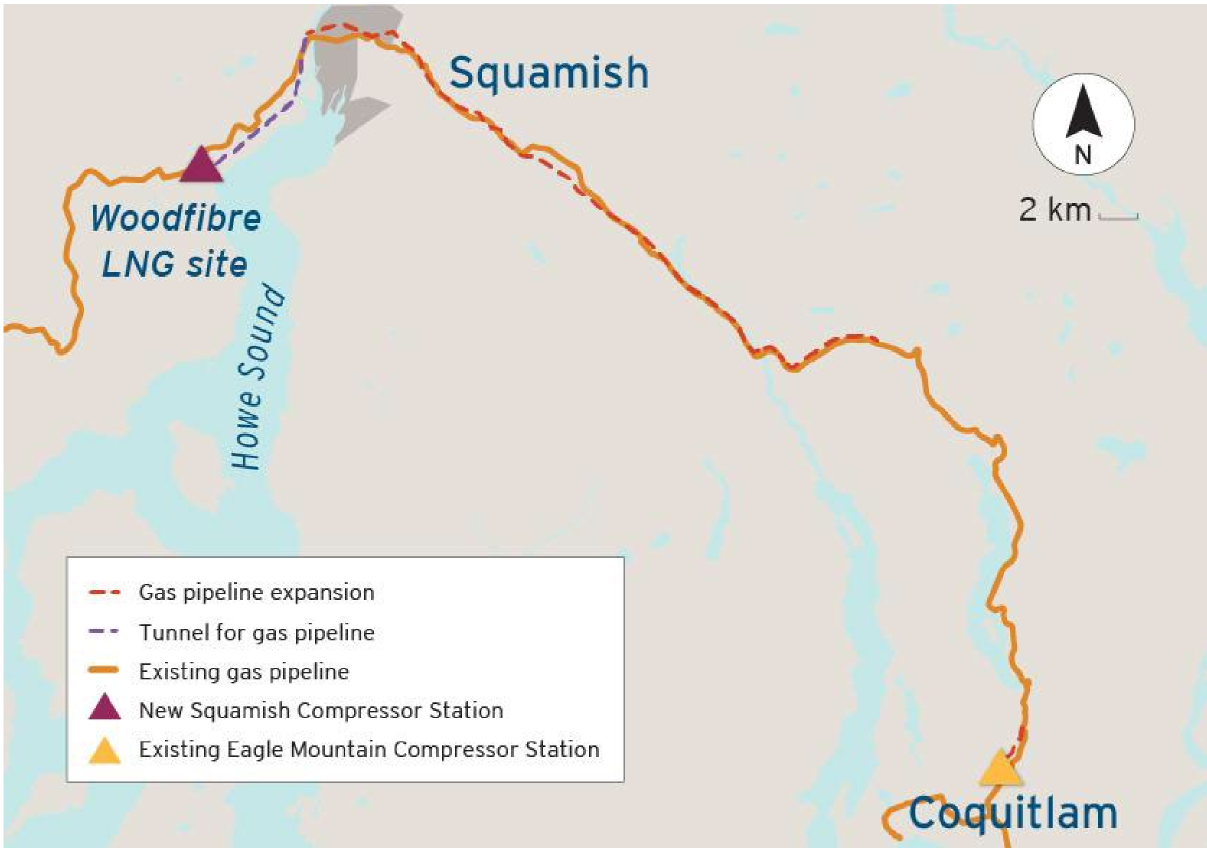
- 2D flood modelling of the natural open channel simulated with the HEC-RAS 2D software (USACE, 2024), and
- Capacity verification of the conveyance structures (culverts and constructed channels) completed with the HY-8 (USDT, 2025) software and the Hydraulic Toolbox software (USDT, 2024).

These exercises were completed to inform a potential amendment to the existing Water Treatment Plant discharge permit (WDP) PE-110163 (BCER, 2024).

1.1 Background

East Creek is a partially impacted, non-fish bearing stream within the footprint of the Eagle Mountain-Woodfibre Gas Pipeline (EGP) Project, which includes tunneling activities and a WTP at the Woodfibre Liquefied Natural Gas (WLNG) site. The WTP manages water from precipitation, runoff, groundwater ingress, and tunnel boring operations. Discharge from the WTP flows into East Creek, a non-fish bearing stream that ultimately drains into Howe Sound. The Woodfibre LNG Project location is represented in Figure 1.

Figure 1: Woodfibre LNG Site Project Location



Sources: Fortis BC, 2025, retrieved from https://talkingenergy.ca/project/eagle-mountain-woodfibre-gas-pipeline-project

Previous studies completed on East Creek provide a solid foundation for the understanding of East Creek hydrology. In 2020 Jacobs prepared a memorandum (Jacobs, 2020) describing the hydrology of East Creek, assessing its capacity to handle proposed discharges from the EGP project and associated developments, while highlighting inconsistencies in hydrological data, potential erosion risks, and the need for stream stabilization and capacity assessments. Also in 2020, Golder completed a flood hazard assessment and hydrologic characterization comprising the East Creek catchment (Golder, 2020). In 2022, Stantec performed a hydraulic capacity assessment of East Creek, identifying flood risks, and proposing mitigation measures to address hydraulic inadequacies and erosion risks associated with site developments (Stantec, 2022). Most recently, in 2023 a WSP report updated the East Creek hydrological assessment to account for updated EGP project layout and designs, and provided a modelling framework to estimate peak flows in East Creek (WSP, 2023).

The permitted discharge rate of the WTP to East Creek under Waste Discharge Permit (WDP) PE-110163 is 1,500 m³/day (17.4 L/s) (BCER, 2024). However, higher-than-expected groundwater ingress into the tunnel has led to exceedances of this limit, with recorded discharges typically between 2,000 m³/day and 3,000 m³/day (23.1 L/s to 34.7 L/s) since April 2025.

These exceedances prompted hydrometric and geomorphological monitoring conducted since May 2025 to assess the impacts of increased discharge on East Creek. The initial findings of this monitoring (May to August 2025) are described in the Hatfield Consultants memorandum East Creek Hydrometric Flow Monitoring and Geomorphological Assessment Summary (Hatfield, 2025b).

1.2 Objective

This document summarizes the findings of the hydraulic modelling of East Creek to assess stream channel and structures capacities and quantify the impacts of increased discharge from the Woodfibre Water Treatment Plant (WTP) during the construction period of the EGP tunnel.

This study, together with the (Hatfield, 2025b) report, aim to provide a picture of the current understanding of the potential impacts of increased WTP effluent discharge on East Creek's stability and erosion potential.

2 Components of Interest

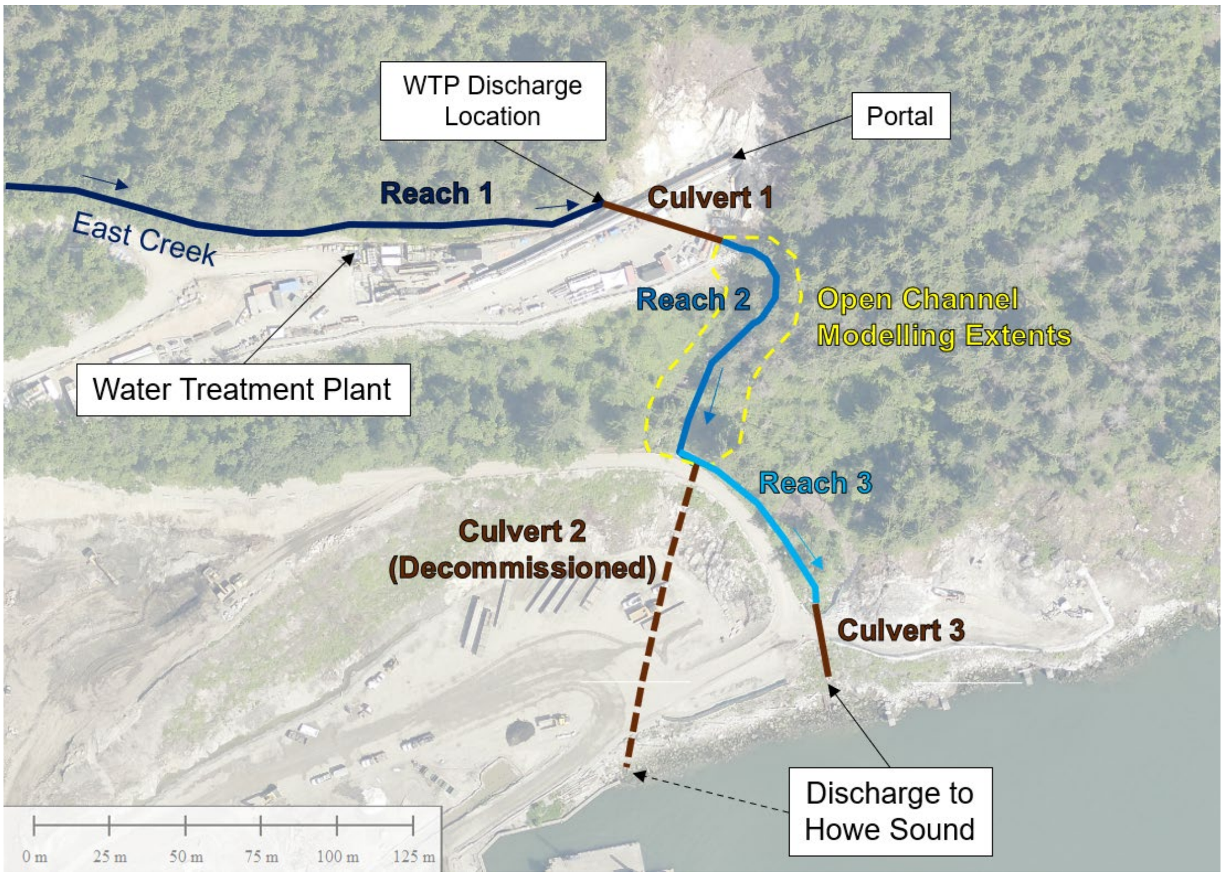
The components of interest for the hydraulic assessment include East Creek reaches and engineered structures conveying East Creek flows, located downstream of the WTP discharge location. The components of interest to this study are listed below and are represented in Figure 2. Same nomenclature as in (Hatfield, 2025b) was utilized.

- WTP Discharge Location: The WTP treated effluent is discharged into East Creek at the end of Reach 1 of East Creek. Note that Reach 1 of East Creek is channelized, and is located upstream of the WTP discharge location, and was therefore excluded from this analysis.
- Culvert 1: The WTP effluent is discharged at the mouth of a culvert that crosses below the WLNG tunnel portal platform. The design for this culvert is detailed in a report (Aldea, 2022), and its capacity review is relevant to this study. The culvert is a 35 m long, single barrel, circular concrete pipe with a diameter of 1.5 m.
- Reach 2 of East Creek: This reach is a natural open channel section of East Creek located downstream of Culvert 1. This reach is about 90 m long with steep slopes (~30%), and is the main area of focus to assess potential erosion impacts due to increased discharge from the WTP. A detailed description of the morphology of this reach can be found in (Hatfield, 2025b).
- Culvert 2: This culvert conveyed the flow from Reach 2 of East Creek to Howe Sound, passing under the Woodfiber site construction area. This culvert was a temporary structure and was decommissioned in November 2025 when the Reach 3 channel upgrades and Culvert 3 rehabilitation were completed. Its characteristics were observed on site and confirmed by the Woodfibre site operators. This culvert was a 100 m long, single barrel, corrugated HDPE pipe with a diameter of 0.5 m. This assessment was completed when this culvert was operational, and its hydraulic capacity analysis results are presented in this report for reference.
- Reach 3 of East Creek: This reach is a constructed open channel section of East Creek located downstream of Reach 2. This reach is about 80 m long with steep slopes (~15%) and was

commissioned in November 2025. This Reach was designed to be able to contain and convey the 200-year flood, and consists of an excavated channel armored with rip-rap and concrete (McDermott, 2025).

- Culvert 3: This is an existing double barrel 1.2 m diameter pipes culvert conveying Reach 3 water into Howe Sound (Stantec, 2023). This culvert was disconnected from East Creek while Reach 3 and Woodfibre site construction progressed. Culvert 2 was used instead during this time.

Figure 2: East Creek Area of Interest Components



Sources: SRK

3 Open Channel Hydraulic Modelling

The assessment of erosion potential due to increased discharge from the WTP on Reach 2 of East Creek was supported by an open channel hydraulic modelling exercise.

3.1 Scenarios

A series of flow scenarios were defined to assess changes in the hydraulic erosion potential of East Creek during regular and extreme hydrological conditions. These were built by combining hydrological events together with different discharge rates from the WTP.

The three hydrological events selected to represent regular operations of a temporary work such as the tunnelling operations are the following:

- Low Flow: Dry Creek. As noted in the monitoring report (Hatfield, 2025b), there have been instances where flow recorded in East Creek has been close to null or null, therefore the lower boundary of flow conditions for erosion potential assessment corresponds to a no natural flow condition.
- Rainfall driven hydrological event: In August 15 and 16, 2025, an atmospheric river event was recorded in the project region, generating a significant rainfall event with recorded flow data on site. The peak flow registered during this event was of 43 L/s on Reach 1, upstream of the WTP discharge location (Hatfield, 2025b).
- Typical year peak flow: The 1 in 2-year flood is the flow that has a 50% probability of occurring in any given year. This flood was selected as a representation of typical peak flow conditions in any given year. These flows usually present themselves during freshest and are driven by rain-on-snow events. For the purpose of this project, the 1 in 2-year flood value was estimated to 2.08 m^3/s (see Section 3.2.2).

Note that extreme flood events, typically associated with return periods longer than 10 years, are expected to generate natural flows orders of magnitude above any WTP discharge capacity. These events are likely drivers of significant natural erosion unrelated to WTP discharge. Because of this, extreme events were not considered relevant to assess impacts on erosion processes related to WTP discharge on East Creek, but were modelled to assess the creek capacity.

In addition to the hydrological scenarios, four different WTP discharge scenarios were also proposed:

- Base Case: The WTP discharges up to the current permitted capacity of 17.4 L/s (1,500 m^3/day). This scenario represents the condition approved under the current permit for the creek.
- Current Conditions: The WTP discharges up to the maximum observed discharge capacity of 34.7 L/s (3,000 m^3/day). This scenario represents current conditions at site.
- Current Treatment Capacity: The WTP discharges at maximum throughput achievable with its current design of 47.3 L/s (4,090 m^3/day). This scenario represents maximum discharge achievable by the current WTP.
- Additional Treatment: The WTP undergoes improvements allowing it to increase its throughput and discharge up to 78.9 L/s (6,800 m^3/day). This scenario represents an option that is under consideration by Fortis that would attenuate risks related to unforeseen inflows during tunneling operations.

The combination of these discharge scenarios with the hydrological events described above are expected to cover the range of flow conditions in East Creek relevant to the erosion potential assessment. These scenarios are summarized in Table 1 below.

Table 1: Flow Scenarios for East Creek Erosion Potential Assessment

WTP Discharge / Hydrological Condition	1. Base Case: permitted WTP discharge of 17.4 L/s (1,500 m³/day)	2. Current Conditions: observed discharge capacity of 34.7 L/s (3,000 m³/day)	3. Current Treatment Capacity: maximum currently available WTP throughput and discharge of 47.3 L/s (4,090 m³/day)	4. Additional Treatment Capacity: increased throughput and discharge to 78.9 L/s (6,800 m³/day)
A. Dry conditions (no flow)	**A1**: Constant 17.4 L/s from WTP discharge	**A2**: Constant 34.7 L/s from WTP discharge	**A3**: Constant 47.3 L/s from WTP discharge	**A4**: Constant 78.9 L/s from WTP discharge
B. Rainfall driven hydrological event	**B1**: 17.4 L/s from WTP discharge added to the August 15th hydrograph	**B2**: 34.7 L/s from WTP discharge added to the August 15th hydrograph	**B3**: 47.3 L/s from WTP discharge added to the August 15th hydrograph	**B4**: 78.9 L/s from WTP discharge added to the August 15th hydrograph
C. Typical year peak flow (rain-on-snow driven)	**C1**: 17.4 L/s from WTP discharge added to the 24h 1 in 2 year flood	**C2**: 34.7 L/s from WTP discharge added to the 24h 1 in 2 year flood	**C3**: 47.3 L/s from WTP discharge added to the 24h 1 in 2 year flood	**C4**: 78.9 L/s from WTP discharge added to the 24h 1 in 2 year flood

Sources: SRK

3.2 Methods

3.2.1 Erosion Potential Assessment

Erosion and sediment transport modeling is often challenging due to model imperfections, oversimplified physical processes, and challenges with data and scale. Models often struggle with the complexity and variability of real-world erosion and deposition, the heterogeneity of sediment properties and landscapes, and the need for accurate input data over a wide range of spatial and temporal scales (Andualem, 2023). However, simple hydraulic modelling results can be relevant indicators of the erosion potential of a stream.

- Water flow velocity is directly related to the rate and type of erosion because higher velocities increase the water's kinetic energy and turbulence, allowing it to detach, transport, and deposit sediment.
- Shear stress represents the force of the water on a given surface; therefore, it is generally considered a good predictor of erosion potential.

Due to the lack of long-term monitoring, the absence of detailed stream bed mapping, and the high energy profile of the East Creek alignment on Reach 2, this analysis will focus on the interpretation of hydraulic modelling results to assess the variations in erosion potential due to incremental discharge of treated water from the WTP to East Creek.

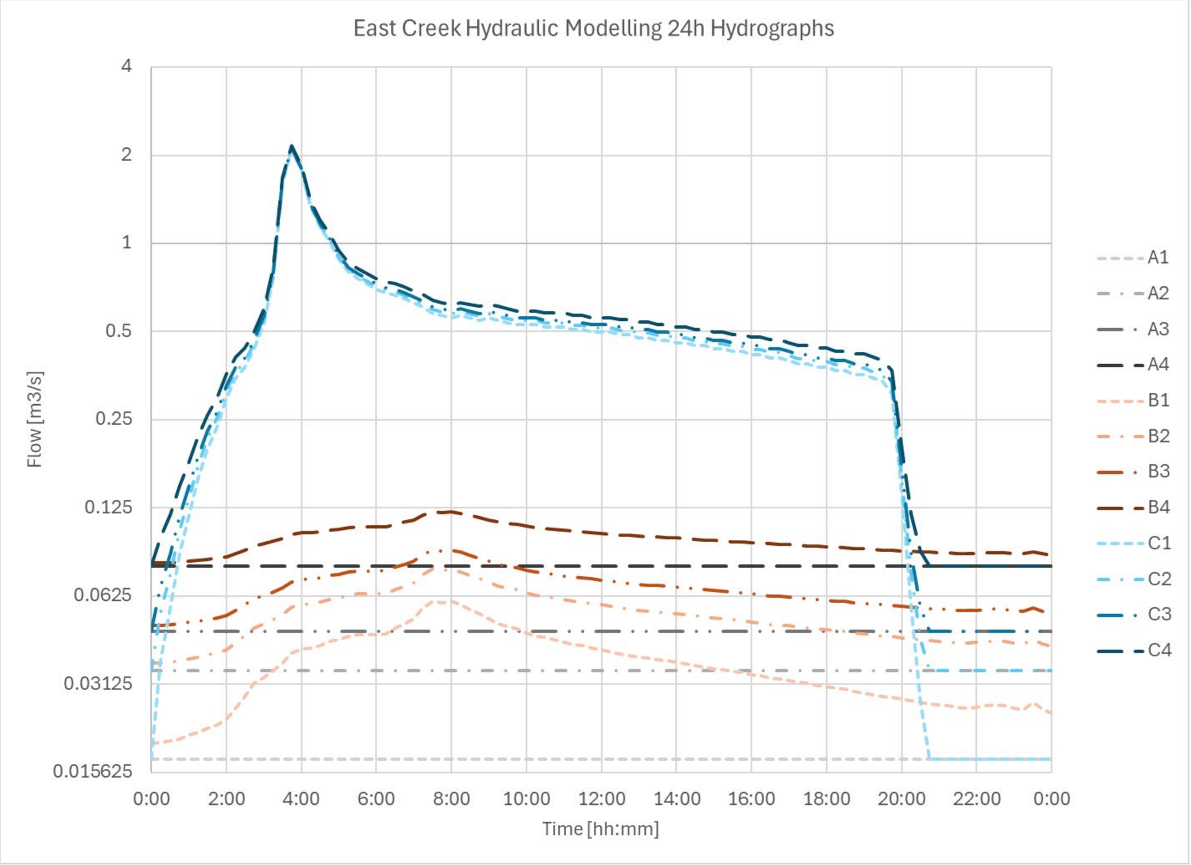
3.2.2 Hydrograph generation

The hydrographs for the scenarios proposed in Section 3.1 were developed by combining different methods as outlined below:

- High flow event hydrographs (rain-on-snow) were generated from frequency storm depths by replicating the method and inputs outlined in (WSP, 2023) using the HEC-HMS software (USACE, 2025).
- The hydrograph recorded for the August 15 event at the East Creek hydrometric station was used as-is.
- WTP discharge flows were considered constant over the length of the simulations.

These hydrographs were then combined as needed to obtain scenario specific hydrographs. Note that climate change considerations were not included in this analysis due to the transitory and short-term nature of the EGP tunneling operations. Resulting hydrographs for the selected scenarios are presented in Figure 3. Peak flows associated to flood events for different return periods are presented in Table 2.

Figure 3: Hydrographs for Hydraulic Modelling of East Creek



Sources: https://srk.sharepoint.com/sites/NACAPR003790/Internal/Erosion%20Modelling/Hydrographs/Hydrographs_r1.xlsx?web=1

Notes: Flows are represented in a logarithmic scale.

Table 2: Peak Instantaneous Flows Estimated for Reach 2 of East Creek for Different Return Periods

Return Period	Event depth [mm]	Peak flow [m3/s]
2 years	142	2.08
5 years	178	3.08
10 years	202	3.77
25 years	232	4.66
50 years	254	5.32
100 years	276	5.99
200 years	298	6.65

Sources: (WSP, 2023), SRK

Notes: Event depths were developed with the Squamish Airport IDF curves (ECCC, 2025) coupled with an orographic correction factor and a snowmelt depth of 15mm (WSP, 2023).

3.2.3 2D Flood Modelling

A HEC-RAS 2D (USACE, 2024) hydraulic model was built to simulate East Creek flows conditions corresponding to the selected scenarios. HEC-RAS 2D capabilities were used to simulate water flows in two dimensions, allowing for a more detailed analysis of flood behavior on Reach 2 of East Creek.

- Topography inputs to the model were derived from a July 2025 LiDAR survey provided by Fortis. The digital elevation model (DEM) used for the simulations has grid size of 0.5 m. Note that generally LiDAR surfaces do not represent channel bed/bathymetry. However, flows in East Creek during July 2025 were below 5 L/s (Hatfield, 2025b), so this approximation is considered appropriate for the level of this study.
- HEC-RAS 2D Diffusion Wave Equations (DWE) simulation option was preferred. This dynamic wave model accounts for inertial and pressure forces, making it suitable for a wide range of flow conditions, including high-velocity and dynamic waves like those likely to appear in steep terrains such as the area of interest.
- Boundary conditions were defined at the start and end of Reach 2, to cover the open channel section of interest of East Creek. The culverts upstream and downstream of the open channel were reviewed in a separate analysis.
- Land cover was defined for riprap sections, stream bed sections, and wooded terrain, with attributed manning's roughness coefficient values of 0.035, 0.05, and 0.1 respectively (Chow, 1959).
- Sediment transport was not simulated in the absence of detailed bed gradation information over the length of Reach 2.

3.3 Results

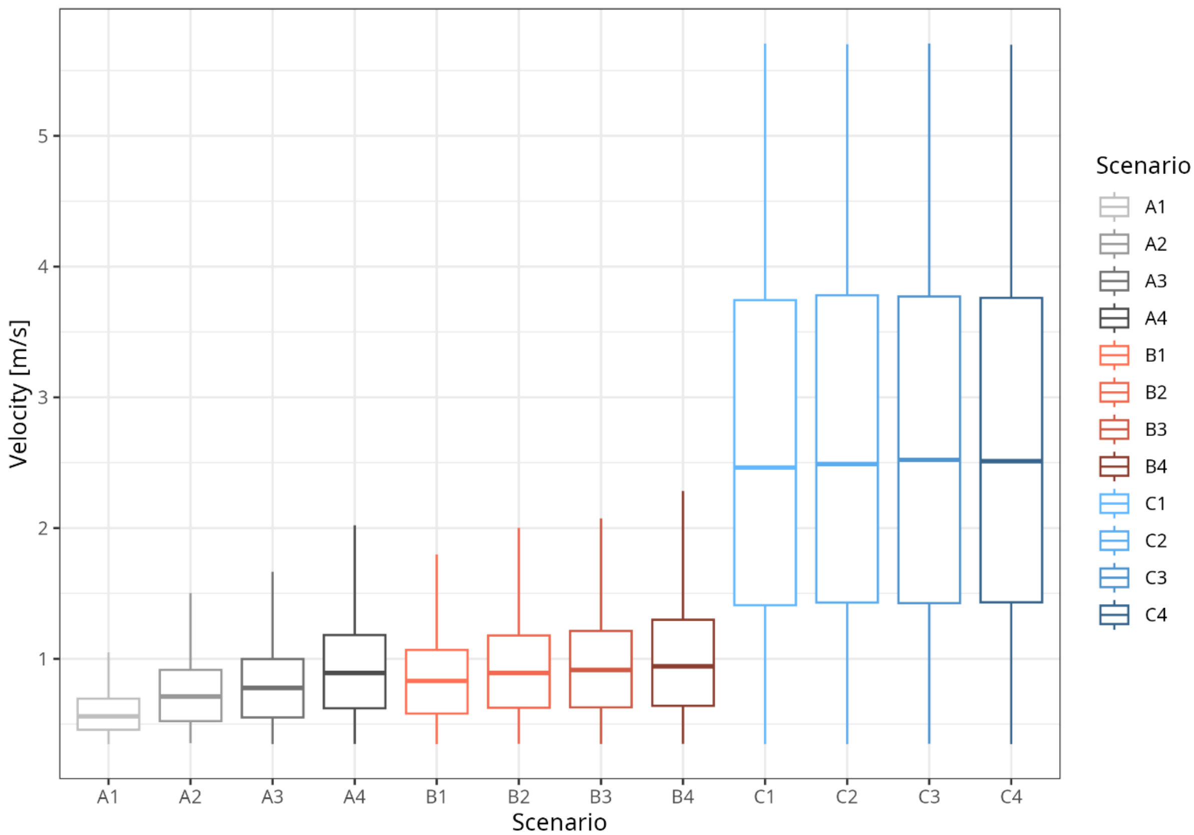
The model runs were stable and completed without significant errors for each scenario.

Shear stress and flow velocity were simulated. Shear stress represents the force exerted by the water on the bed and banks of a stream. Flow velocity drives the amount of kinetic energy of the water available for hydraulic forces perform work and contribute to erosion. In combination, they are a reasonable indicator of erosion potential at a macroscopic scale.

Maximum shear stress and maximum velocity over the simulation period was extracted for each grid element over the modelling extents. Detailed maximum shear stress and maximum velocity mapping results for each scenario are presented in Attachment 1.

To compare the outcomes of the hydraulic model, maximum velocity and shear stress values computed for each scenario simulation were combined and represented as boxplots in Figure 4 and Figure 5 respectively. The boxplot representation allows the comparison of all the scenario results over their respective inundation area on the same scale by giving a snapshot of the spread of modelled erosion potential indicator values over the East Creek stream bed.

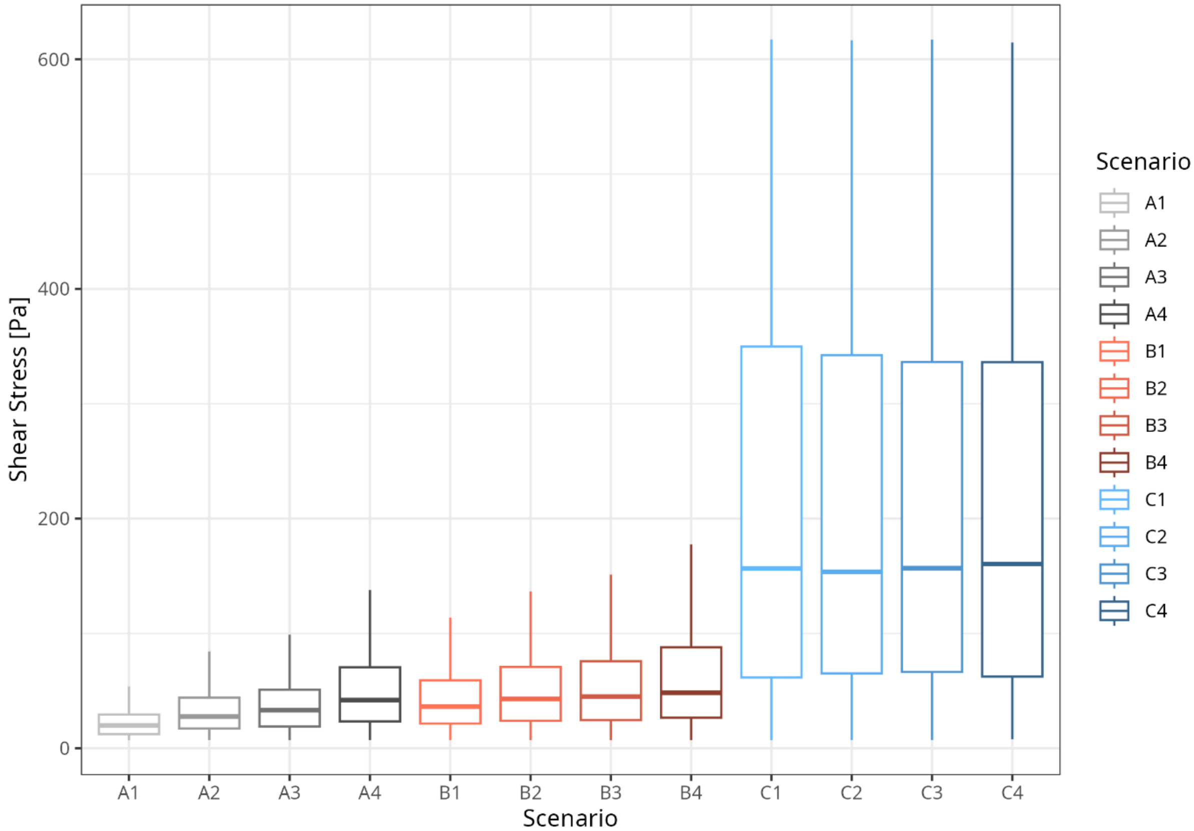
Figure 4: Maximum Velocity Compilation Over the Modelling Extents per Scenario



Sources: NA CAPR003790 Eagle Mountain Pipeline Project Waste Discharge Permit Amendment Support - Internal\R workspace\03_Reports\Erosion_plots.qmd"

Notes: Outlier values not plotted

Figure 5: Maximum Shear Stress Compilation Over the Modelling Extents per Scenario



Sources: NA CAPR003790 Eagle Mountain Pipeline Project Waste Discharge Permit Amendment Support - Internal\R workspace\03_Reports\Erosion_plots.qmd"

Notes: Outlier values not plotted

The maximum computed shear stress values for Reach 2 of East Creek are consistent with typical permissible shear stress values for engineered channel linings (Chen, 1986), and maximum velocities fall within expected values for East Creek channel type and slope.

Computed velocity average was between 0.5 m/s and 2.5 m/s for all the scenarios. All scenarios with the same hydrology conditions (letter group) presented results within the same order of magnitude. As expected, the spread of the higher velocity quantiles increases as peak flow increases. Maximum velocity values (outside of outliers) vary from 1 m/s (scenario A1) to under 7 m/s (scenarios in the C group). Note that outliers correspond to locations where the stream behaves like a chute or waterfall.

Computed shear stress median was between 15 Pa and 160 Pa for all the scenarios. Scenarios from group A and B presented median shear stress below 50 Pa. All scenarios with the same hydrology conditions (letter group) presented results within the same order of magnitude. As expected, the spread of the higher shear stress quantiles increases as peak flow increases. Maximum shear stress values (outside of outliers) vary from 50 Pa (scenario A1) to around 620 Pa (scenarios in the C group).

As a reminder, the difference between each scenario within the same letter group is the WTP discharge rate. The effects of the WTP discharge rate on erosion potential on Reach 2 of East Creek can be interpreted as follows:

- Scenarios within group A (dry conditions) present the highest relative increase in simulated shear stress and velocity statistics relative to WTP discharge. The maximum shear stress profile for scenario A4 remains similar to expected values under usual wet conditions like the ones represented by scenario group B.
- While an increase in potential erosion is apparent with increased discharge from the WTP for low flows, the areas presenting the most significant increases are localized around a few sections of Reach 2 around high to low slope transitions (see Attachment 1).
- The higher the flow, the lower the relative erosion potential increase due to increasing WTP discharge (scenario group C).
- Modelled maximum shear stress and velocity values for increased discharge of the WTP remain within the same order of magnitude as the scenarios simulating permitted conditions (A1, B1 and C1).

Higher peak flow events were also simulated to assess bank capacity for Reach 2 of East Creek at a high level. Minor overland flow paths started appearing for peak flows above 6 m^3/s within the model. Significant uncertainty is intrinsically tied to this value as factors like terrain and mesh resolution, roughness coefficients, and boundary conditions can have significant effects on the modelling extent results, particularly for higher flows. Dynamic geomorphological changes can also play a significant role during high flow events that cannot be predicted by this model.

4 Conveyance Structures Review

4.1 Culverts

4.1.1 Methodology

Culvert 1, Culvert 2 (decommissioned) and Culvert 3 convey East Creek flows downstream of the WTP discharge location. In order to assess incremental discharge consequences from the WTP on these structures, the hydraulic capacity of these culverts was verified.

HY-8 is a software program developed by the Federal Highway Administration (FHWA) used for the hydraulic analysis and design of culverts (USDT, 2025). It calculates upstream headwater depth and culvert flow based on methods from the FHWA's Hydraulic Design Series 5 (HDS-5) manual. The program can handle complex scenarios, such as broken-back, horizontal, and adverse-sloped culverts, and is widely used to design waterway crossings.

All culverts in their current configuration were modelled in the HY-8 software. All the inputs to the model and resulting water profiles are presented in Attachment 2.

4.1.2 Results

Estimated maximum flow capacity for each culvert are presented in Table 3 below. Flood return periods were also associated to each capacity result, representing the likelihood of the flood event for which culvert capacity is reached accounting for different WTP discharge scenarios.

Table 3: East Creek Culverts Hydraulic Capacity verification

Culvert	Estimated Maximum Flow Capacity (L/s)	Associated Flood Return Period at Maximum Capacity Considering WTP discharge at:			
		Base Case 17.4 L/s (1,500 m^3/day)	Current Conditions 34.7 L/s (3,000 m^3/day)	Current Max. Treatment 47.3 L/s (4,090 m^3/day)	Additional Treatment 78.9 L/s (6,800 m^3/day)
Culvert 1	5,610	1 in 66 years	1 in 65 years	1 in 64 years	1 in 62 years
Culvert 2 (Decommissioned)	510	< 1 in 2 years	< 1 in 2 years	< 1 in 2 years	< 1 in 2 years
Culvert 3	10,310	>1 in 200 years	>1 in 200 years	>1 in 200 years	>1 in 200 years

Sources: https://srk.sharepoint.com/sites/NACAPR003790/Internal/Erosion%20Modelling/Hydrographs/Hydrographs_r1.xlsx?web=1

Culvert 2 would only have been able to convey flows below 510 L/s, however, Culvert 3 is expected to have sufficient capacity to convey the 200 year-flood in any WTP discharge scenario (Jacobs, 2020).

Culvert 1 presents adequate capacity to convey East Creek flows in the short term (construction phase) (Jacobs, 2020). Increasing WTP discharge has a minor effect on risk associated to culvert capacity.

4.2 Constructed Channel

4.2.1 Methodology

Reach 3 constructed channel design is expected to contain the 200-year flood (McDermott, 2025).

WTP discharge increase relative impact on typical channel design criteria for Reach 3 was estimated by modelling a typical section as presented in the design issued for construction (McDermott, 2025) in the FHWA Hydraulic Toolbox software. Hydraulic Toolbox is a stand-alone suite of calculators that performs routine hydrologic and hydraulic analysis and design computations (USDT, 2024).

Constructed channel design criteria, as built drawings, or post construction topography were unavailable when this assessment was completed, therefore this analysis is not a verification or validation of the East Creek Reach 3 channel engineering. This verification aims to quantify the relative impacts that the WTP increased discharge could have on typical channel design criteria, such as flow depth (relevant to cross section design and available freeboard) and velocity (relevant to channel armoring and energy dissipation measures).

This verification was completed for the 200-year peak flow presented for Reach 2 in Section 3.2.2.

4.2.2 Results

East Creek water velocity and flow depth results for a typical Reach 3 constructed channel cross-section are presented in Table 4. Calculation settings and assumptions are presented in Attachment 3.

Table 4: Reach 3 change in flow depth and velocity for a typical section based on WTP discharge scenarios during the 200-year flood

WTP Discharge Scenario	Base Case 17.4 L/s (1,500 m^3/day)	Current Conditions 34.7 L/s (3,000 m^3/day)	Current Max. Treatment 47.3 L/s (4,090 m^3/day)	Additional Treatment 78.9 L/s (6,800 m^3/day)
Velocity [m/s]	8.000	8.006	8.009	8.019
Velocity change relative to Base Case [%]	N/A	+0.08%	+0.11%	+0.24%
Flow Depth [m]	0.697	0.697	0.698	0.700
Flow Depth change relative to Base Case [%]	N/A	+0.00%	+0.14%	+0.43%

Sources: https://srk.sharepoint.com/sites/NACAPR003790/Internal/Erosion%20Modelling/Hydrographs/Hydrographs_r1.xlsx?web=1

Relative impacts that the WTP increased discharge could have on Reach 3 design criteria is negligeable and should be comfortably absorbed by safety measures built in best practice channel design methods. WTP increased discharge is not expected to significantly impact Reach 3 constructed channel performance or stability.

5 Conclusions and Recommendations

Modeling was completed to assess the capacity of East Creek's stream channel and conveyance structures under increased WTP discharge scenarios.

The main takeaways of the erosion potential assessment supported by the hydraulic modelling of Reach 2 of East Creek are:

- Localized increases in erosion potential are expected as discharge volumes from the WTP increases. These changes would be more significant for the lower flows (Scenarios A, B) and become negligeable for the larger East Creek flows (Scenarios C).
- Most of the time East Creek flows are expected to be between scenarios A and B. As expected, these lower flow conditions present overall lower erosion potential relative to freshet conditions (scenarios C).
- The velocity and shear stress profiles during usual conditions (scenarios A and B) increase with WTP discharge, however the order of magnitude of modelled maximum velocity and shear stress statistics over the flooded areas is unchanged, suggesting hydraulics-driven erosion behavior would not change significantly with increased discharge from the WTP.

- Natural erosion driven by flood events (scenarios C) is expected to be the main driver for geomorphological changes on Reach 2 of East Creek.
- Scenario C flow is expected to remain confined within the stream banks, regardless of the WTP discharge condition. Higher flows may be contained but estimation of this number carries significant uncertainty due to model limitations.

The main takeaways of the structure capacity verification are:

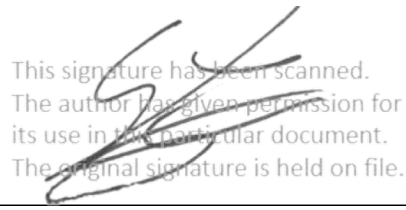
- Culvert 1 and Culvert 3 are adequate to convey East Creek flows during the construction phase of the WLNG site, independently of the WTP discharge scenario.
- Culvert 2 decommissioning and East Creek redirection through Reach 3 constructed channel and Culvert 3 represent a significant improvement to East Creek conveyance capacity and operability, significantly reducing overtopping likelihood and associated risks.
- Potential increases in WTP discharge are unlikely to impact constructed channel performance on Reach 3.

The combined findings from the erosion risk assessment and monitoring program suggest that Reach 2 of East Creek can accommodate increased discharge volumes from the WTP without significant acceleration of erosion processes, relative to current conditions. However, continued monitoring and adaptive management are essential to ensure the long-term health of the channel, particularly around the high velocity/shear stress areas along the channel banks.

In case of an extreme flood event, Culvert 1 is the first East Creek conveyance structure expected to reach its capacity at around 5,600 L/s flows. Implementation of mitigation strategies such as peak flow attenuation could help avoid overtopping Culvert 1 and potential damage to other structures.

Conveyance structures should be regularly inspected and cleared of ice build-up, debris, garbage and accumulated sediment, particularly within vicinity of the culverts.

Regards,
SRK Consulting (Canada) Inc.



2025-12-16 EGBC 1003655

Camilo Gallard, MScEng, PEng/Ing.
Senior Consultant

Reviewed By:

Rajib Kamal, PhD, PEng
Consultant
EGBC Permit to Practice: 1003655

Attachments:

Attachment 1	Hydraulic Modelling Results
Attachment 2	Culvert Capacity Verification
Attachment 3	Reach 3 Typical Section Verification

SRK Consulting (Canada) Inc. has prepared this document for Hatfield Consultants, our client. Any use or decisions by which a third party makes of this document are the responsibility of such third parties. In no circumstance does SRK accept any consequential liability arising from commercial decisions or actions resulting from the use of this report by a third party.

The opinions expressed in this document have been based on the information available to SRK at the time of preparation. SRK has exercised all due care in reviewing information supplied by others for use on this project. While SRK has compared key supplied data with expected values, the accuracy of the results and conclusions from the review are entirely reliant on the accuracy and completeness of the supplied data. SRK does not accept responsibility for any errors or omissions in the supplied information, except to the extent that SRK was hired to verify the data.

References

Aldea, 2022. Woodfibre Portal Design Report Culvert and Bulkhead/Weir Eagle Mountain – Woodfibre Gas Pipeline Project. October 10, 2022. Package Number: DU2.1. Aldea Engineering Services Inc.

Andualem, 2023. Andualem, T.G.; Hewa, G.A.; Myers, B.R.; Peters, S.; Boland, J. Erosion and Sediment Transport Modeling: A Systematic Review. Land 2023, 12, 1396. https://doi.org/10.3390/land12071396

Bagnold, 1966. An approach to the sediment transport problem from general physics. USGS Professional Paper 422-I. By: Ralph A. Bagnold 1966. https://doi.org/10.3133/pp422I

BCER, 2024. Waste Discharge Permit PE 110163 issued to FortisBC Energy Inc. March 25, 2024. British Columbia Energy Regulator. Environmental Protection Branch.

Chen, 1986. Chen Y.H. and G.K. Cotton. 1986. "Design of Roadside Channels with Flexible Linings." Hydraulic Engineering Circular No. 15, Report No. FHWA-IP-86-5. Washington, D.C., Federal Highway Administration.

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

ECCC, 2025. Intensity-Duration-Frequency (IDF) Files retrieved from https://climate.weather.gc.ca/prods_servs/engineering_e.html

Golder, 2020. Flood Hazard Assessment and Site Hydrology V2 Compressor Station and CTS Sites, Woodfibre, BC. Golder Associates Ltd.

Hatfield, 2025a. Memo: Evaluation of potential environmental impacts associated with Request for a temporary authorization for exceedances of discharge rate limits associated with Permit PE-110163 for the FortisBC Eagle Mountain – Woodfibre Pipeline Project. Hatfield Consultants. May 12, 2025.

Hatfield, 2025b. Memo: East Creek Hydrometric Flow Monitoring and Geomorphological Assessment Summary for the Period of May to August 2025. Hatfield Consultants. September 26, 2025.

Jacobs, 2020. Memorandum: Summary of Stream Hydrology for Stream X. EGP Tunnel Discharge Capacity Assessment

McDermott, 2025. East Creek Improvement Plan. Project No. 350106-4100. Rev 1 Issued for Construction. August 2025.

Stantec, 2022. Woodfibre LNG Project – Hydrology and Hydraulics Assessment of East Creek. August 2, 2022. Revision 1. Stantec Consulting Ltd. Project Number: 123221907 Document Number: 350106-SC-EN-013-SD-000025 SDR Code: A17.

Stantec, 2023. Woodfibre LNG Project – East Creek Improvement – Plan View and Post-Development Layout. Stantec Consulting Ltd. Project No. 123221907. Document No. 350106-SC-EN-013-SD-000073 Re-issued for Construction. May 16, 2023.

USACE, 2024. Hydrologic Engineering Center. HEC-RAS Version 6.6, U.S. Army Corps of Engineers, Davis CA. September 2024.

USACE, 2025. U.S. Army Corps of Engineers, Hydrologic Engineering Center. HEC-HMS Hydrologic Modeling System, Version 4.13. July 2025. Hydrologic Engineering Center, Davis, CA.

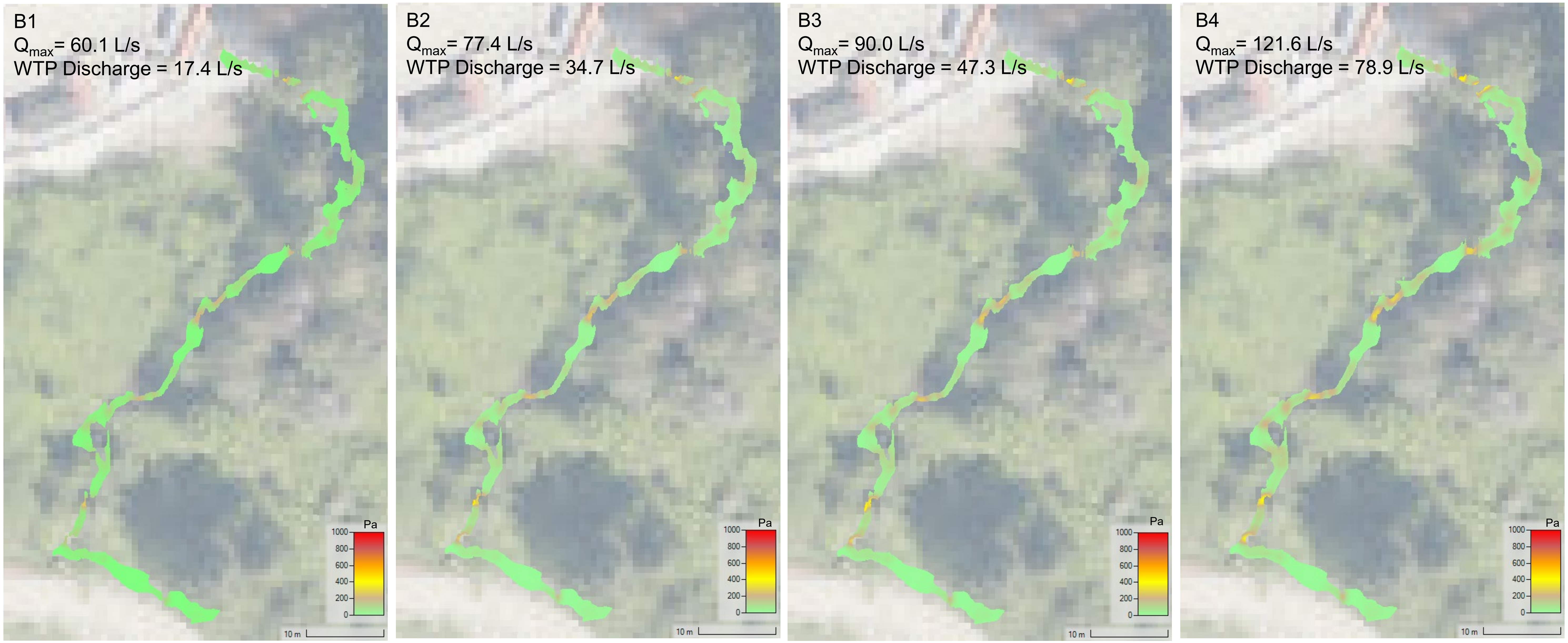
USDT, 2024. U.S. Department of Transportation. Federal Highway Administration (FHWA) Hydraulic Toolbox Version 5.4.0. February 21, 2024.

USDT, 2025 U.S. Department of Transportation. HY-8 Culvert Analysis Software Version 8.0.1.2. March 5, 2025.

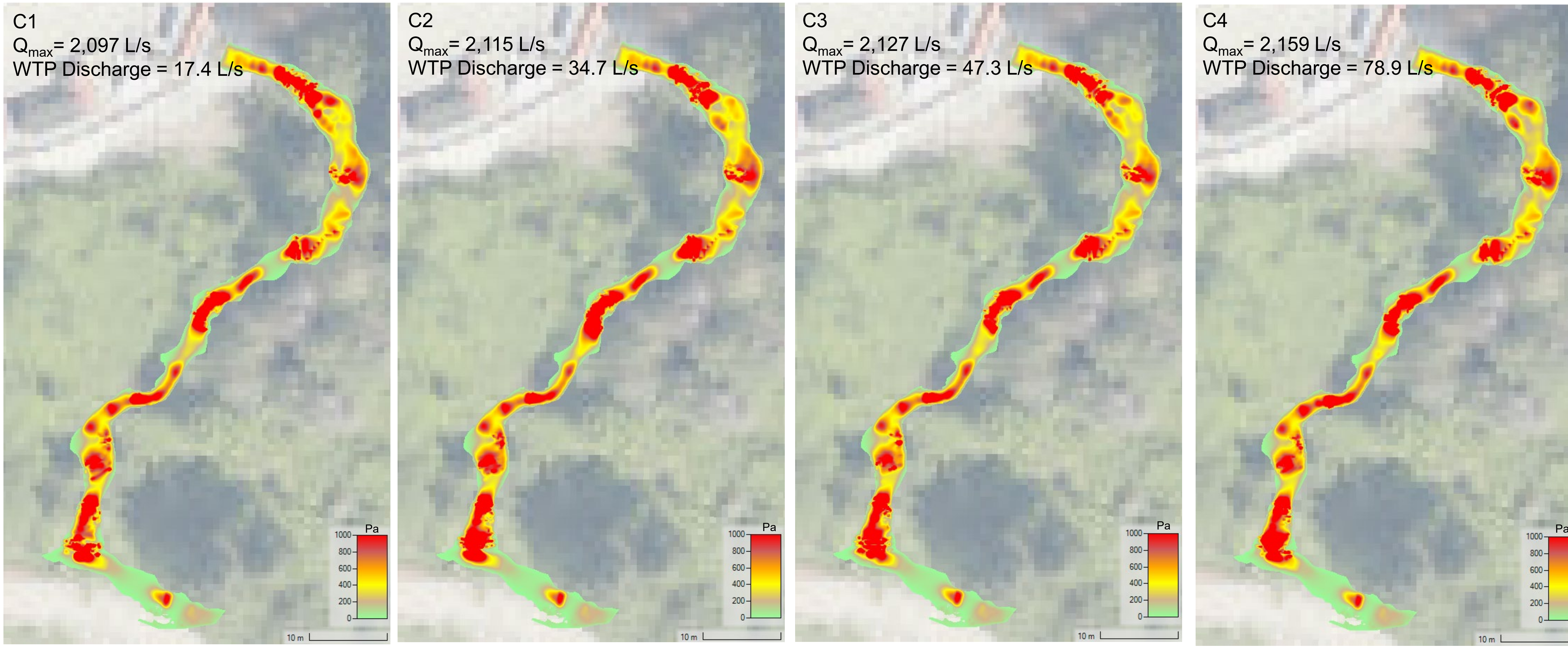
WSP, 2023. Technical Memorandum: Woodfibre – 2023 East Creek Hydrological Assessment Reference No. 19122690-044-TM-Rev0

Attachment 1 Hydraulic Modelling Results

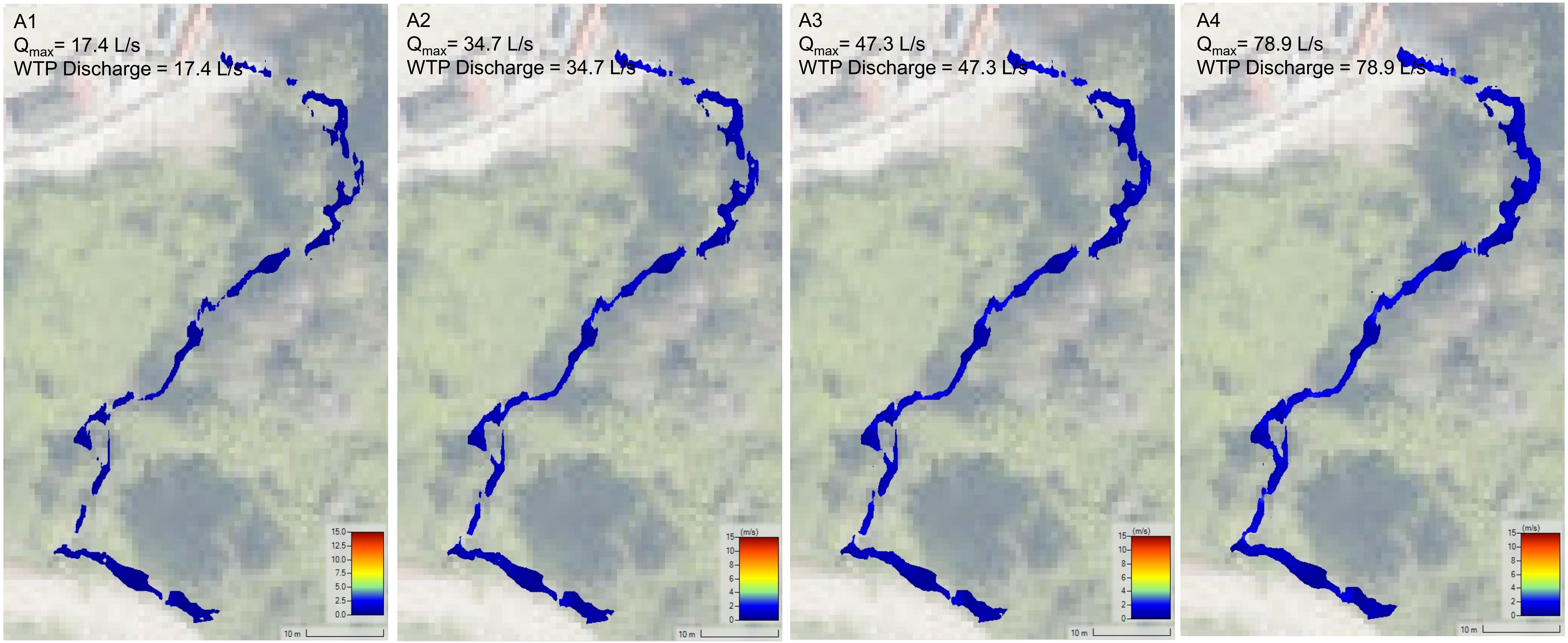
srk consulting	FORTIS BC	East Creek Discharge Capacity Assessment
		Maximum Sheer Stress Map for Scenarios A1, A2, A3, and A4
Job No: CAPR003790 Filename: CAPR003790_Appendix_1_Maps_r02.pptx	Woodfibre LNG	Date: 2025-10-21 | Approved: CG | Figure: **A1.1**



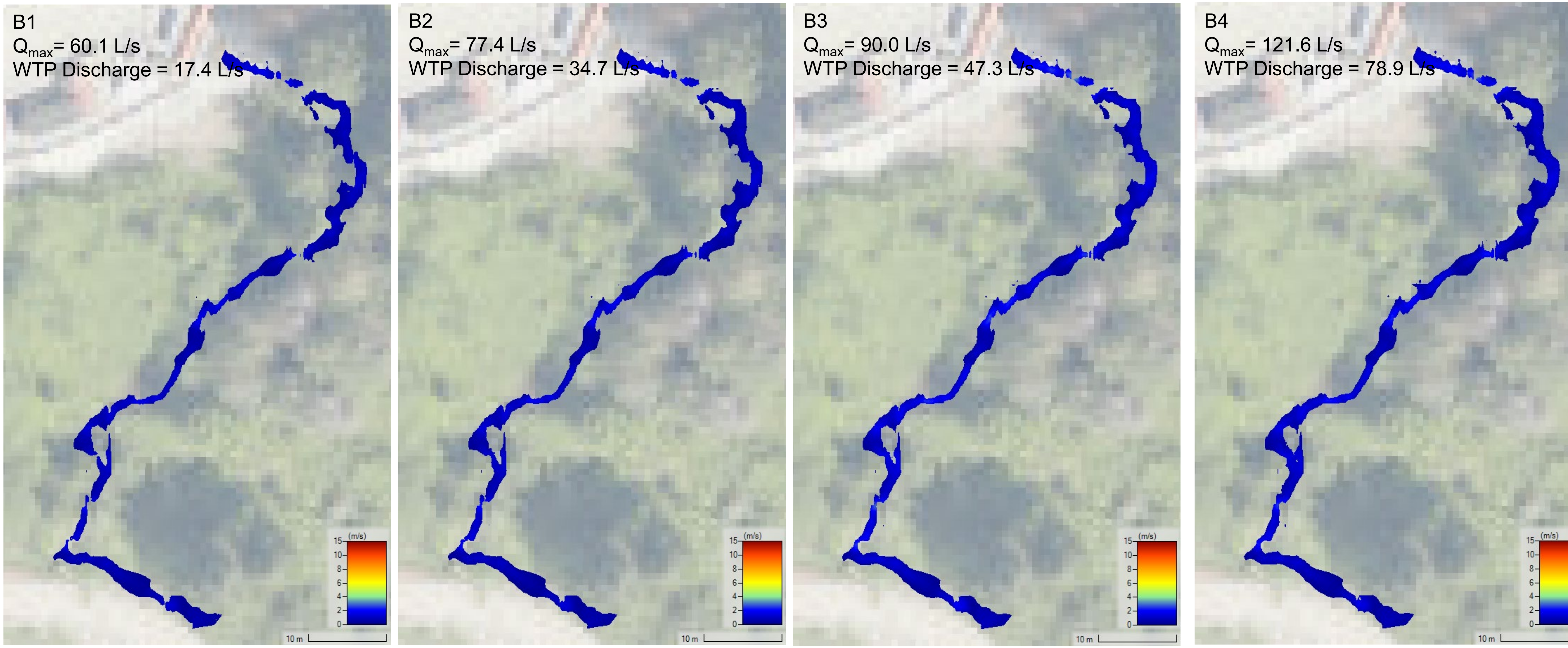
srk consulting	FORTIS BC	East Creek Discharge Capacity Assessment
		Maximum Sheer Stress Map for Scenarios B1, B2, B3, and B4
Job No: CAPR003790 Filename: CAPR003790_Appendix_1_Maps_r02.pptx	Woodfibre LNG	Date: 2025-10-21 · Approved: CG · Figure: **A1.2**



srk consulting	FORTIS BC	East Creek Discharge Capacity Assessment
		Maximum Sheer Stress Map for Scenarios C1, C2, C3, and C4
Job No: CAPR003790 Filename: CAPR003790_Appendix_1_Maps_r02.pptx	Woodfibre LNG	Date: 2025-10-21 · Approved: CG · Figure: **A1.3**



srk consulting	FORTIS BC	East Creek Discharge Capacity Assessment
		Maximum Velocity Map for Scenarios A1, A2, A3, and A4
Job No: CAPR003790 Filename: CAPR003790_Appendix_1_Maps_r02.pptx	Woodfibre LNG	Date: 2025-10-21 / Approved: CG / Figure: **A1.4**



srk consulting

Job No: CAPR003790
Filename: CAPR003790_Appendix_1_Maps_r02.pptx

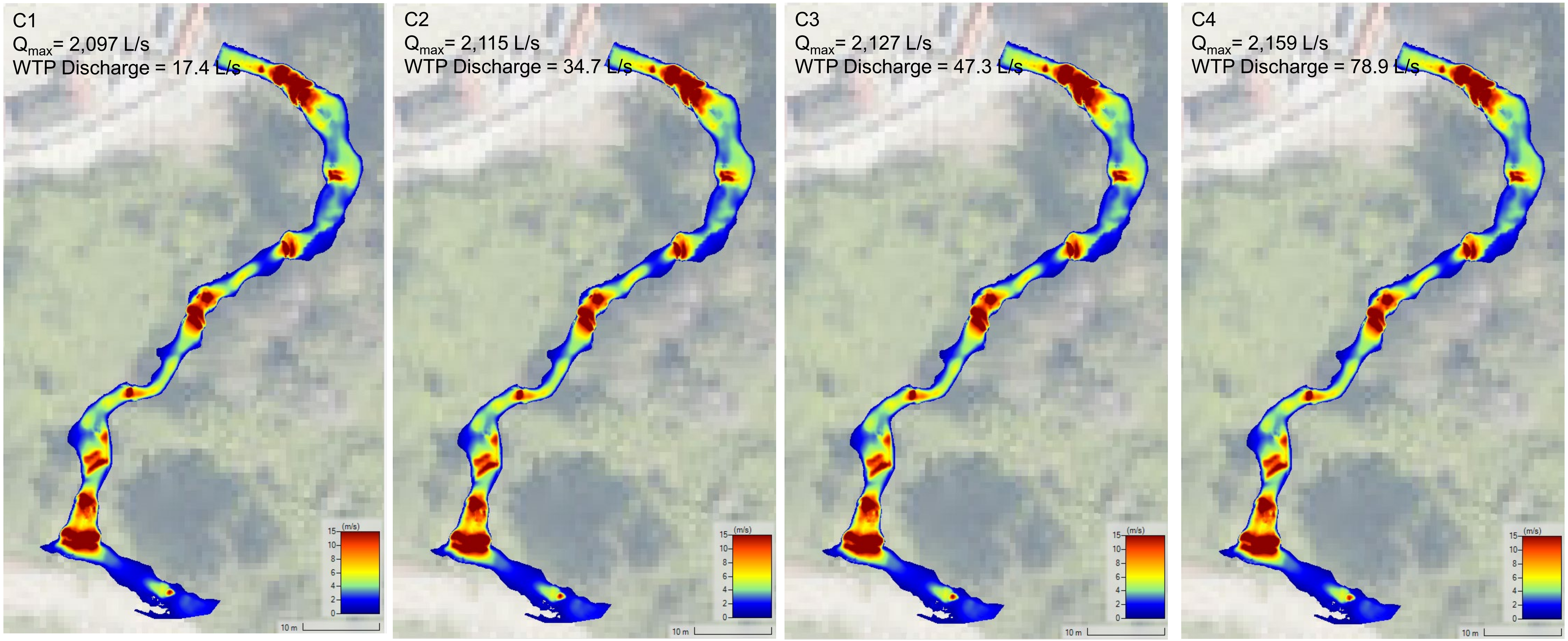
FORTIS BC

Woodfibre LNG

East Creek Discharge Capacity Assessment

Maximum Velocity Map for Scenarios B1, B2, B3, and B4

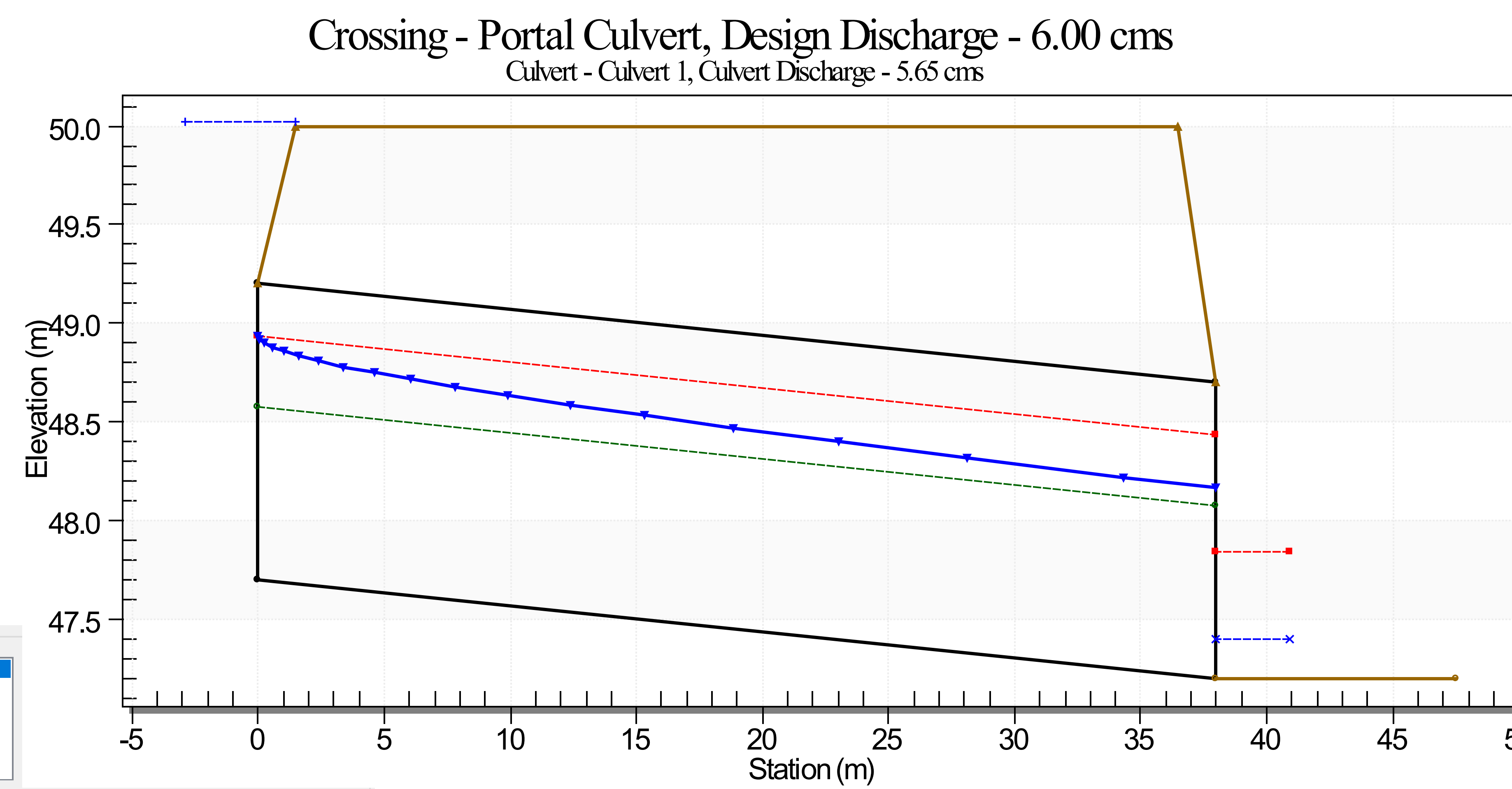
Date: 2025-10-21 | Approved: CG | Figure: **A1.5**



srk consulting	FORTIS BC	East Creek Discharge Capacity Assessment
		Maximum Velocity Map for Scenarios C1, C2, C3, and C4
Job No: CAPR003790 Filename: CAPR003790_Appendix_1_Maps_r02.pptx	Woodfibre LNG	Date: 2025-10-21 · Approved: CG · Figure: **A1.6**

Attachment 2 Culvert Capacity Verification

Headwater Elevation (m)	Total Discharge (cms)	Culvert 1 Discharge (cms)	Roadway Discharge (cms)	Iterations
48.39	1.00	1.00	0.00	1
48.76	2.00	2.00	0.00	1
49.06	3.00	3.00	0.00	1
49.37	4.00	4.00	0.00	1
49.74	5.00	5.00	0.00	1
50.02	6.00	5.65	0.35	9
50.00	5.61	5.61	0.00	Overtopping



Crossing Properties

Name: Portal Culvert

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	User-Defined	
Discharge List	Define...	
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	3.000	m
Side Slope (H:V)	2.000	_:1
Channel Slope	0.0200	m/m
Manning's n (channel)	0.005	
Channel Invert Elevation	47.200	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	0.000	m
Crest Length	100.000	m
Crest Elevation	50.000	m
Roadway Surface	Gravel	
Top Width	35.000	m

Culvert Properties

Culvert 1

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 1	
Shape	Circular	
Material	Concrete	
Diameter	1500.000	mm
Embedment Depth	0.000	mm
Manning's n	0.012	
Culvert Type	Straight	
Inlet Configuration	Square Edge with Headwall (Ke=0.5)	
Inlet Depression?	No	
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	0.000	m
Inlet Elevation	47.700	m
Outlet Station	38.000	m
Outlet Elevation	47.200	m
Number of Barrels	1	
Computed Culvert Slope	0.013158	m/m

srk consulting

FORTIS BC

Woodfibre LNG

East Creek Discharge Capacity Assessment

HY8 Culvert 1 Settings and Results

Job No: CAPR003790

Filename: CAPR003790_Appendix_2_Culverts_r02.pptx

Date: 2025-12-08

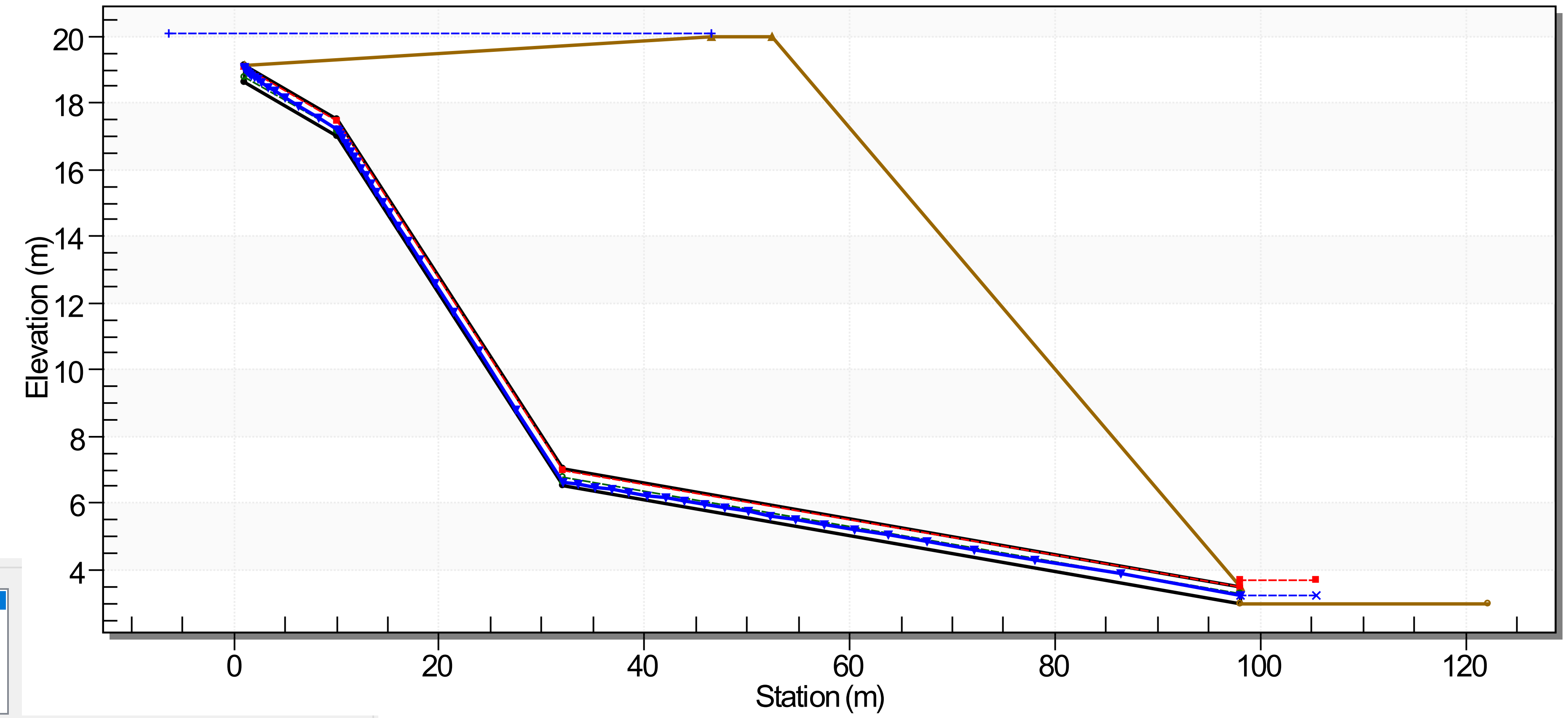
Approved: CG

Figure: **A2.1**

Headwater Elevation (m)	Total Discharge (cms)	Culvert 2 Discharge (cms)	Roadway Discharge (cms)	Iterations
18.88	0.10	0.10	0.00	1
19.96	0.50	0.50	0.00	1
20.06	1.00	0.52	0.48	9
20.10	1.50	0.53	0.97	7
20.13	2.00	0.54	1.46	6
20.16	2.50	0.54	1.96	5
20.19	3.00	0.55	2.45	5
20.23	4.00	0.56	3.44	5
20.27	5.00	0.56	4.44	4
20.31	6.00	0.57	5.43	3
20.00	0.51	0.51	0.00	Overtopping

Crossing - East Creek Discharge to Howe Sound, Design Discharge - 6.00 cms

Culvert - Culvert 2, Culvert Discharge - 0.52 cms



Crossing Properties

Name: East Creek Discharge to Howe

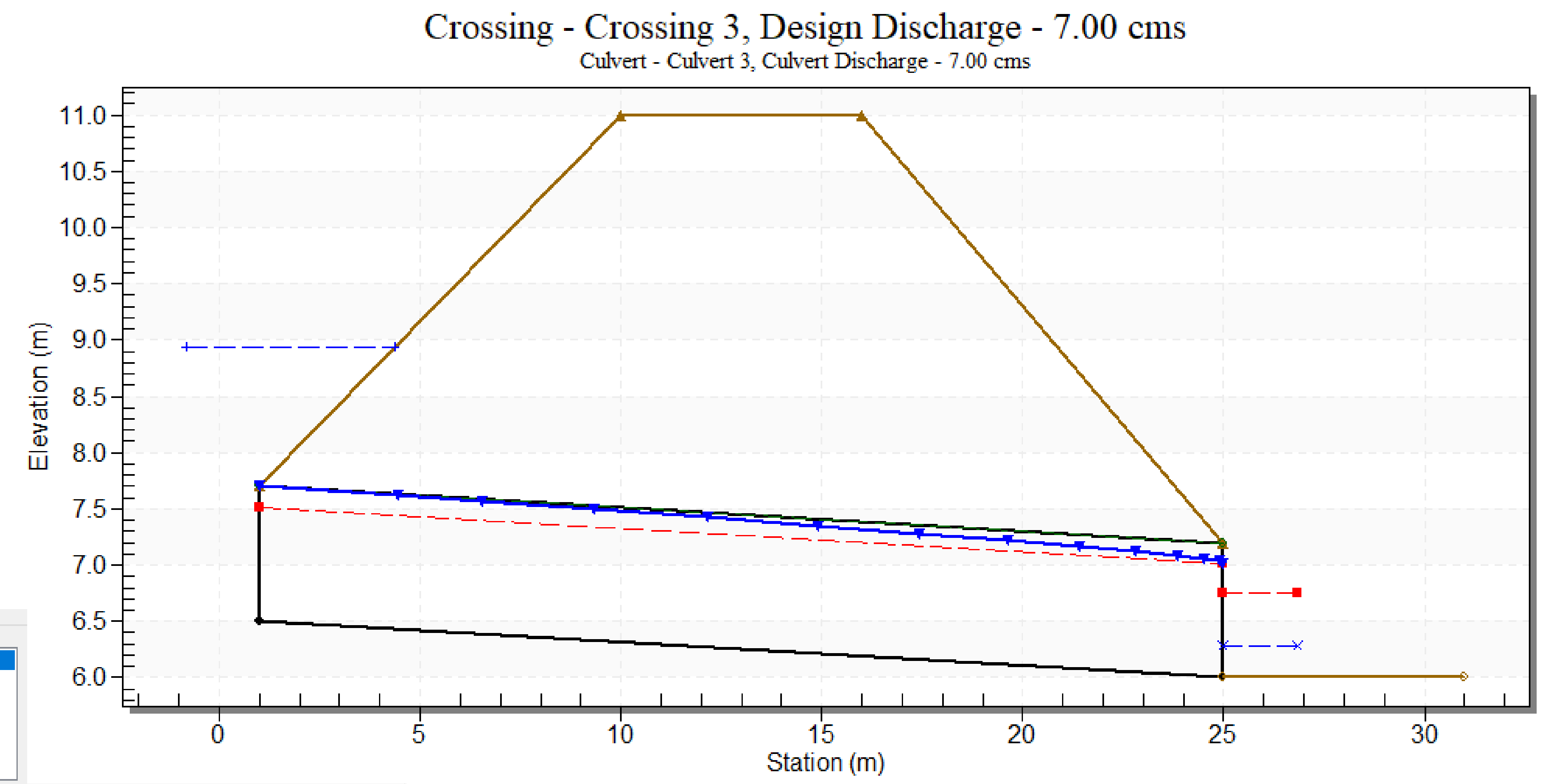
Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	User-Defined	
Discharge List	Define...	
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	3.000	m
Side Slope (H:V)	1.000	_:1
Channel Slope	1.0000	m/m
Manning's n (channel)	0.050	
Channel Invert Elevation	3.000	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	2.000	m
Crest Length	20.000	m
Crest Elevation	20.000	m
Roadway Surface	Gravel	
Top Width	6.000	m

Culvert Properties

Culvert 2
Culvert 2 Improved

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 2	
Shape	Circular	
Upper & Middle Section Mate...	Corrugated PE	
Lower Section Material	Corrugated PE	
Diameter	508.000	mm
Upper & Middle Section Manning's n	0.012	
Lower Section Manning's n	0.012	
Culvert Type	Double Broken-back	
Inlet Configuration	Thin Edge Projecting (Ke=0.9)	
Inlet Depression?	No	
SITE DATA		
Inlet Station	1.000	m
Inlet Elevation	18.600	m
Upper Break Station	10.000	m
Upper Break Elevation	17.000	m
Lower Break Station	32.000	m
Lower Break Elevation	6.500	m
Outlet Station	98.000	m
Outlet Elevation	3.000	m
Number of Barrels	1	
Computed Culvert Slope	0.177778	m/m
Computed Culvert Slope	0.477273	m/m
Computed Culvert Slope	0.053030	m/m

Headwater Elevation (m)	Total Discharge (cms)	Culvert 3 Discharge (cms)	Roadway Discharge (cms)	Iterations
6.67	0.10	0.10	0.00	1
6.88	0.50	0.50	0.00	1
7.05	1.00	1.00	0.00	1
7.19	1.50	1.50	0.00	1
7.32	2.00	2.00	0.00	1
7.44	2.50	2.50	0.00	1
7.57	3.00	3.00	0.00	1
7.83	4.00	4.00	0.00	1
8.13	5.00	5.00	0.00	1
8.49	6.00	6.00	0.00	1
8.93	7.00	7.00	0.00	1
11.00	10.31	10.31	0.00	Overtopping



Crossing Properties

Name: Crossing 3

Parameter	Value	Units
DISCHARGE DATA		
Discharge Method	User-Defined	
Discharge List	Define...	
TAILWATER DATA		
Channel Type	Trapezoidal Channel	
Bottom Width	3.000	m
Side Slope (H:V)	1.000	_:1
Channel Slope	1.0000	m/m
Manning's n (channel)	0.050	
Channel Invert Elevation	6.000	m
Rating Curve	View...	
ROADWAY DATA		
Roadway Profile Shape	Constant Roadway Elevation	
First Roadway Station	2.000	m
Crest Length	11.000	m
Crest Elevation	11.000	m
Roadway Surface	Gravel	
Top Width	6.000	m

Culvert Properties

Culvert 3

Parameter	Value	Units
CULVERT DATA		
Name	Culvert 3	
Shape	Circular	
Material	Corrugated Steel	
Diameter	1200.000	mm
Embedment Depth	0.000	mm
Manning's n	0.024	
Culvert Type	Straight	
Inlet Configuration	Thin Edge Projecting (Ke=0.9)	
Inlet Depression?	Yes	
Depression	0.001	m
Depression Slope (2-3)	3.000	(_:1)
Crest Width	1.000	m
SITE DATA		
Site Data Input Option	Culvert Invert Data	
Inlet Station	1.000	m
Inlet Elevation	6.500	m
Outlet Station	25.000	m
Outlet Elevation	6.000	m
Number of Barrels	2	
Computed Culvert Slope	0.020833	m/m

srk consulting | FORTIS BC | East Creek Discharge Capacity Assessment

HY8 Culvert 3 Settings and Results

Job No: CAPR003790

Filename: CAPR003790_Appendix_2_Culverts_r02.pptx

Woodfibre LNG

Date: 2025-12-08 | Approved: CG | Figure: A2.3

Attachment 3 Reach 3 Typical Section Verification

Base Case

Type: Trapezoidal | Define...

Side Slope 1 (Z1):	1.0	H : 1V
Side Slope 2 (Z2):	1.0	H : 1V
Channel Width (B):	0.5	(m)
Pipe Diameter (D):	0.0	(m)
Longitudinal Slope:	0.109	(m/m)
Manning's Roughness:	0.0200	

(•) Enter Flow: 6.667 (cms)
( ) Enter Depth: 0.697 (m)

Parameter	Value	Units
Flow	6.667	cms
Depth	0.697	m
Area of Flow	0.833	m^2
Wetted Perimeter	2.470	m
Hydraulic Radius	0.337	m
Average Velocity	8.000	m/s
Top Width (T)	1.893	m
Froude Number	3.849	
Critical Depth	1.328	m
Critical Velocity	2.747	m/s
Critical Slope	0.00638	m/m
Critical Top Width	3.156	m
Calculated Max Shear Stress	744.175	N/m^2
Calculated Avg Shear Stress	360.487	N/m^2

Current Conditions

Type: Trapezoidal | Define...

Side Slope 1 (Z1):	1.0	H : 1V
Side Slope 2 (Z2):	1.0	H : 1V
Channel Width (B):	0.5	(m)
Pipe Diameter (D):	0.0	(m)
Longitudinal Slope:	0.109	(m/m)
Manning's Roughness:	0.0200	

(•) Enter Flow: 6.685 (cms)
( ) Enter Depth: 0.697 (m)

Parameter	Value	Units
Flow	6.685	cms
Depth	0.697	m
Area of Flow	0.835	m^2
Wetted Perimeter	2.472	m
Hydraulic Radius	0.338	m
Average Velocity	8.006	m/s
Top Width (T)	1.895	m
Froude Number	3.849	
Critical Depth	1.329	m
Critical Velocity	2.749	m/s
Critical Slope	0.00638	m/m
Critical Top Width	3.159	m
Calculated Max Shear Stress	745.108	N/m^2
Calculated Avg Shear Stress	360.842	N/m^2

Current Max Treatment

Type: Trapezoidal | Define...

Side Slope 1 (Z1):	1.0	H : 1V
Side Slope 2 (Z2):	1.0	H : 1V
Channel Width (B):	0.5	(m)
Pipe Diameter (D):	0.0	(m)
Longitudinal Slope:	0.109	(m/m)
Manning's Roughness:	0.0200	

(•) Enter Flow: 6.697 (cms)
( ) Enter Depth: 0.698 (m)

Parameter	Value	Units
Flow	6.697	cms
Depth	0.698	m
Area of Flow	0.836	m^2
Wetted Perimeter	2.474	m
Hydraulic Radius	0.338	m
Average Velocity	8.009	m/s
Top Width (T)	1.896	m
Froude Number	3.850	
Critical Depth	1.331	m
Critical Velocity	2.750	m/s
Critical Slope	0.00638	m/m
Critical Top Width	3.161	m
Calculated Max Shear Stress	745.750	N/m^2
Calculated Avg Shear Stress	361.086	N/m^2

Additional Treatment

Type: Trapezoidal | Define...

Side Slope 1 (Z1):	1.0	H : 1V
Side Slope 2 (Z2):	1.0	H : 1V
Channel Width (B):	0.5	(m)
Pipe Diameter (D):	0.0	(m)
Longitudinal Slope:	0.109	(m/m)
Manning's Roughness:	0.0200	

(•) Enter Flow: 6.729 (cms)
( ) Enter Depth: 0.700 (m)

Parameter	Value	Units
Flow	6.729	cms
Depth	0.700	m
Area of Flow	0.839	m^2
Wetted Perimeter	2.479	m
Hydraulic Radius	0.339	m
Average Velocity	8.019	m/s
Top Width (T)	1.899	m
Froude Number	3.851	
Critical Depth	1.333	m
Critical Velocity	2.752	m/s
Critical Slope	0.00638	m/m
Critical Top Width	3.167	m
Calculated Max Shear Stress	747.441	N/m^2
Calculated Avg Shear Stress	361.728	N/m^2

srk consulting

FORTIS BC

Woodfibre LNG

East Creek Discharge Capacity Assessment

Reach 3 Typical Section Settings and Results

Job No: CAPR003790

Filename: CAPR003790_Appendix_3_Channel_r01.pptx

Date: 2025-12-08 | Approved: CG | Figure: A3.1