Allnorth Consultants Ltd.

CN Yard Watermain Replacement Project – CN Railway Auger Bore Crossing

Auger Bore Feasibility Report

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Revision: B

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CCI Project No. 4952

Allnorth Consultants Ltd.

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Auger Bore Crossing
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Revision Log

Revision	Issue Status	Prepared by	Reviewed by	Approved by	Date
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B	IFR	B. Erdman	B. Wilhelm	A. Hebert	2025-01-08

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1 INTRODUCTION

Allnorth Consultants Ltd. (Allnorth) is planning to replace a section of watermain in the town of Smithers, BC. The section of line to be replaced is located near the Railway Avenue and Manitoba street junction, and perpendicular to Zobnick Road. The line crosses perpendicularly, a Canadian National Railway (CN Rail) yard which consists of six (6) parallel rail tracks. The existing watermain below the railway is to be abandoned in place or removed

The crossing of the CN Rail yard has been identified as requiring a trenchless installation. This report will focus on the feasibility of the CN Railway crossing utilizing the cased Auger Bore trenchless installation method.

This report is provided as a feasibility assessment of site conditions, incorporating the available geotechnical information and a geometric review of the proposed NPS 20 cased bore alignment into which a DIPS 14 (356 mm O.D.) HDPE Watermain is to be installed. Also included are some challenges the Contractor will face and some mitigation strategies that may be implemented to minimize the risks on the project.

2 DESIGN PARAMETERS

The parameters utilized in the design of the crossing are as follows:

a) The crossing is designed to incorporate the geotechnical information provided, aboveground/buried facilities in the area, topography, surficial infrastructure such as access roads, and space limitations.

b) API design guidelines (API 1102) were utilized to model the earth and mechanical stresses imposed on the casing pipe during and after installation. The calculations consider the pipe diameter, wall thickness, grade, and depth of the crossing.

c) Designs were developed in accordance with “Standards Respecting Pipeline Crossings Under Railways” (TC_E_10), Pipeline Research Council International (PRCI) design guidelines (PR-277-144507-R01), CSA National Standard of Canada document CSA B137.1, Canadian National Railway Specification “Utility Crossing/Encroachment Application Package”.

d) The geotechnical conditions and associated settlement at the site were considered in an effort to design the bore for progression primarily through formations that are favorable for the type of trenchless installation while maintaining settlement within allowable.

e) Space limitations associated with the right of way (ROW) and achievable temporary workspace (TWS) were also considered. Temporary workspace has been shown to ensure that the required equipment can be set up on site to complete the work.

f) The launch (entry) and receiving (exit) positions have been identified by boring convention rather than pipeline placement convention. The launch point is the location where the boring machine is set up and equipment/casing installation while the receiving pit is where the bore will be intercepted and helps facilitate the removal equipment/casing.

3 CN RAILWAY AUGER BORE CROSSING

3.1 CROSSING LOCATION AND SITE DESCRIPTION

The CN Railway borders the southwestern edge of the Town of Smithers. Southwest of the rail, the land is heavily forested with multiple utility ROWs. The town is to the northeast with Railway Ave. running parallel to the railway. A section of watermain is to be replaced beneath the CN Railyard which contains 6 rail tracks. The crossing requires trenchless installation where cased Auger Bore methodology has been chosen as the most feasible installation method.

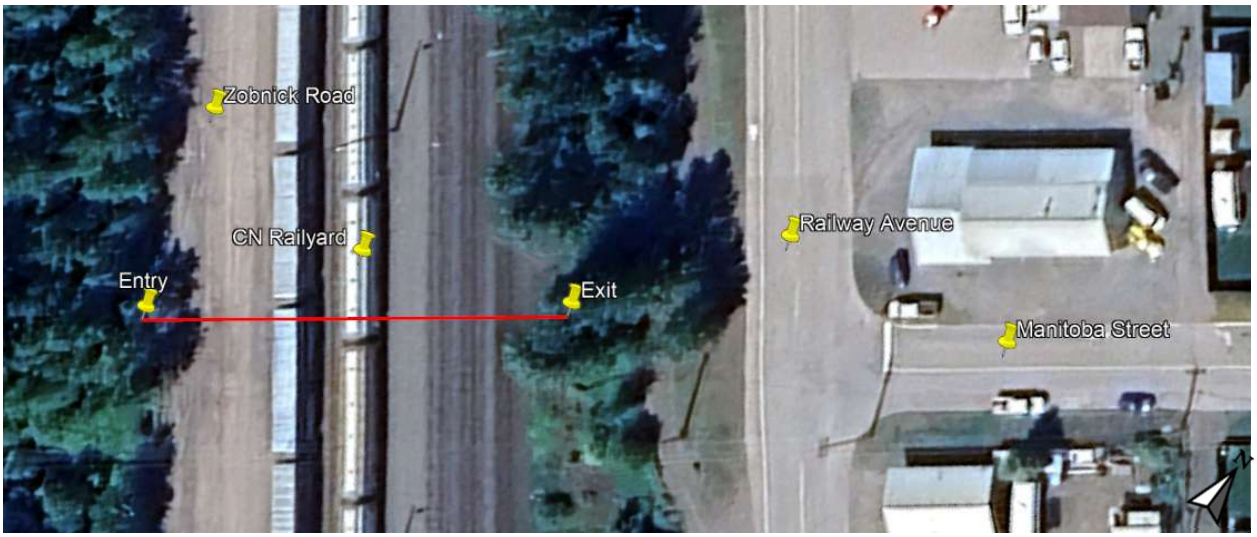


Figure 1. Proposed Auger Bore Crossing Location

3.2 GEOTECHNICAL CONDITIONS

A geotechnical investigation for the proposed crossing alignment was conducted by GeoNorth Engineering Ltd. (Geonorth), and the document "*Summary of Site Conditions and Subsurface Investigation, Proposed HDD Watermain Installation, Railway Avenue to Zobnick Road at Manitoba Street, Smithers, B.C.*" (File No. 43517) was provided to CCI for HDD design purposes.

A total of two boreholes (designated as Boreholes DH23-01 and DH23-02) were drilled at the site location approximately 20 m northeast of the exit location and 152 m southwest of the entry location respectively. Borehole locations are shown in Figure 2, below.

Figure 2. Borehole Location Plan for CN Yard Watermain Replacement Project

A summary of the borehole descriptions is presented in Table 1.

Table 1. Summary of Borehole Logs for CN Railway Auger Bore Crossing

Borehole ID	Depth (m)	Approximate Location	Stratigraphy (depth range in m)	Primary Geotechnical Concerns
DH 23-01	19.7	35 m NE of Railyard	0 – 0.1 Organic Silt 0.1 – 2.3 Sandy Silt (Fill) 2.3 – 4.6 Silty, Sandy, Gravelly Clay 4.6 – 6.1 Silty Sand 6.1 – 6.9 Silty Clay 6.9 – 19.7 Sandy Clay (Till)	-Groundwater was observed at 3.0 m depth. Ground water above the bottom of the pit may be encountered.
DH 23-02	19.7	165 m SW of Railyard	0.0 – 1.7 Silty Sand (Fill) 1.7 – 3.0 Silty Clay 3.0 – 3.8 Silty Sand 3.8 – 4.7 Silty Clay 4.7 – 19.7 Silty, Sandy Clay (Till)	-Soft clay and loose sand could be encountered in the launch pit. Groundwater as observed at 1.5m depth and groundwater above the bottom of the pit may be encountered.

Below the surficial fill, the silty, sandy, gravelly clay layer is found in DH 23-01 is described as medium plastic and stiff. Beneath this, the silty sand layer encountered in both boreholes is described as very loose to compact and wet. Encountered beneath these, the silty clay deposits are generally medium to high plastic with trace sand noted in some areas and are described as very soft to soft in DH23-02 and firm to very stiff in DH23-01. Finally, the clay (till) layer that both boreholes terminated in is described as sandy, firm to hard and low plastic.

The designed auger bore is expected to primary encounter the sandy gravelly clay shown in Borehole DH23-01, and silty sand and silty clay shown in Borehole DH23-02. The silty sand had SPT N value of 1 indicating the very loose state of the material. The silty clay had SPT N value of 1 indicating the very

soft clay with less than 25 kPa of unconfined compressive strength. Groundwater was reported at 3.0 and 1.5 m depths in BH23-01 and -02, respectively.

It should be noted that Borehole DH23-02 was drilled approximately 150 m southwest of the crossing. Ground conditions—particularly in the vicinity of the launch pit—may differ from those observed in DH23-02.

3.3 CROSSING CONSIDERATIONS

3.3.1 Pipe Specifications

The proposed casing pipeline specifications are summarized in Table 2. These parameters were used in the engineering design of CN Railway auger bore crossing.

Table 2. Pipe Specifications for the CN Railway Auger Bore Crossing

Pipe Specifications	Casing	Product Pipe
Pipe Material	Steel	HDPE
Pipe Size	NPS 20	DIPS 14
Outer Diameter (OD) (mm)	508.0	356.0
Wall Thickness (WT) / DR	6.35 mm	DR 13.5
Grade	GR. 291 (MPa)	PE4710
Product	N/A	Water
Specification	CSA Z245.1	CSA B137.1
Maximum Allowable Operating Pressure (kPa)	101	738
Maximum Installation Temperature (°C)	N/A	N/A
Internal Coating	N/A	N/A
Outer Coating	Dual FBE	N/A

3.3.2 Bore Alignment

The proposed bore is planned to have a southwest to northeast boring alignment, measuring 56 m horizontally and will cross beneath the railyard which contains six (6) tracks and the adjacent Zobnick Road. The proposed entry point is located 19 m to the southwest of the southwestern most rail track and the exit point is located 11 m northeast of the northeastern most rail track, crossing beneath the railway and its associated ROW. The details of the design are shown on drawing 4952-EG-0101 provided in Appendix A

3.3.3 Bore Pits

The entry excavation on the southwest side of the rail lines and Zobnick Road has been shown with dimensions 15 m long by 4.5 m wide to accommodate an auger boring machine, individual pipe

segments, welding operations, and tie-in. The expected depth of the entry pit is expected to be approximately 4.4 m.

The exit excavation will be on the northeast side of the rail lines within a green space adjacent to Railway Ave. The dimensions of the pit shown measure 8 m long by 4 m wide to accommodate removal of boring equipment, intermediate pipe segment removal, pipe cutting, and tie-ins. The expected depth of the exit pit is approximately 4.3 m deep.

The final design of the bore pits will be completed by the Contractor, with a proposed minimum 4.5 m wide for the entry excavation.

3.3.4 Cased Bore Details

For the proposed crossing, the overall radial overcut will be a maximum of 0.5" with a total maximum bore size of 21" (533.4 mm) to facilitate the NPS 20 casing pipe. The proposed cased bore is to be within the sandy and gravelly clay formation, and it provides a minimum 3.3 m of cover beneath the six (6) CN rail tracks.

3.3.5 API 1102 – Stress Analysis (Earth and Mechanical Loading)

An API loading analysis was carried out to confirm that the selected size and grade of casing pipe can withstand the earth loads and induced live loads from locomotive loading on surface based on a minimum depth of cover of 3.3 m. The earth load and live load for each case are shown in Table 3.

Table 3. Load Considerations for Casing Pipe

Load Type	Road Loading
Circumferential Stress due to Earth Load	66.06 MPa
Live Load	108.00 kPa
Cyclic Circumferential Stresses due to Rail Load	61,097 kPa
Cyclic Longitudinal Stresses due to Rail Load	57,087 kPa
Total Effective Stress	120,792 kPa
% Allowable	46.7%

Fatigue checks were also completed and were calculated to be 86% and 44% of allowable on the girth and longitudinal welds, respectively. An API 1102 stress summary is provided in Appendix B.

3.3.6 Settlement Analysis

The benefit of auger boring is the installation of the NPS 20 pipe is progressed through the ground allowing the overburden soil to only settle up to a maximum of the overcut, assuming no over excavation by the bore operator. A settlement analysis was completed at the crossing location using a minimum depth below the rail of 3.3 m. The analysis considered a 0.5" radial overcut, soft clay parameters, and values of 0.87 for the soil loosening factor and 0.50 for the arching factor. The maximum settlement, as a result of this analysis, is estimated to be 3.57mm, which is within the acceptable limits.

3.3.7 Casing Pipe Maximum Installation Force and Stress

The maximum allowable force which can be exerted on the casing pipe is calculated to be 301,000 lbs. This is much higher than the expected forces for an installation of this size and length, estimated to be 53,000 lbs. However, this force will vary depending on Contractor equipment, cleaning frequencies, tooling, and other factors.

As the casing pipe is installed into the ground, it is subjected to two primary loading conditions, axial compression and hoop stress. As part of the design process, the individual stresses and their combined effect on the pipe were evaluated to check the pipeline potential failure. The maximum combined installation stresses were calculated to be 14.5% of allowable for this installation.

3.4 DESIGN SUMMARY

For the proposed CN Railway bore, the surface loading and installation stresses on the casing pipe governs the design of the crossing, not the operational stress due to its primary use as casing pipe. Calculations carried out by CCI indicate that a wall thickness of 6.35 mm for the NPS 20 casing pipe using Gr. 291 steel is suitable for the crossing. Table 4 shows a summary of the design for the proposed crossing as part of the CN Yard Watermain Replacement.

Table 4. Design Summary for CN Railway Auger Bore Crossing

Parameters	Casing Pipe	Product Pipe
Pipe Specification	508 mm O.D. x 6.35 mm W.T. CSA Z245.1, GR. 291	356.0 mm O.D. x DR 13.5 CSA B137.1, PE4710
Length (m)	56	
Min. Depth under CN Rail (m)	3.3	
Live Loading Stress (% Allowable)	46.7%	N/A
Maximum Axial Compressive Force (lbs)	301,000	N/A
Estimated Maximum Rail Track Settlement (mm)	3.57	
Combined Installation Stress (% Allowable)	14.5%	N/A
Max. Earth Load (MPa)	66.06	N/A
Max. Circumferential Live Load (kPa)	61,097	N/A
Max. Longitudinal Live Load (kPa)	57,087	N/A

4 TRENCHLESS CONSTRUCTION

4.1 AUGER BORE CONSTRUCTION RISK ASSESSMENT

The main construction risks and challenges for the CN Railway crossing were identified based on the risk assessment conducted by CCI and previous experience. The risk items are ranked into the risk categories ranging from low risk to very high risk based on the probability and the consequence of each risk factor.

The following are the major risks and the main mitigation strategies developed to minimize the challenges that may arise during construction. The risks associated within each bore process have

been grouped together. The descriptions of risk items and a summary of the risk assessment for the crossing detailing the risks prior to any mitigation and after mitigation are presented are Appendix C.

Installation of Casing

Heaving or Settlement of Railway (Risk 2b)

Risk: The casing deflects causing the railway to heave, or over augering the soil creates a void that causes settlement of the railway greater than allowable limits. This may result in a stoppage of construction and/or a shut down of the railway. Borehole DH23-02 indicates very loose sand around bore depth that could increase the risk of over excavation and settlement.

Mitigation: A settlement monitoring plan shall be in place to ensure early detection of settlement. The Contractor shall leave a soil plug at the front of the casing during installation. The Contractor shall have a response plan in place and follow their approved execution plan. Contractor to ensure rate of progression is aligned with the rate of removal of soils.

Contractor, Construction Access, and Operations

Pit Construction/Shoring (3c)

Risk: It is anticipated that shoring/trench boxes will be required due to depth of excavations and potential soil types. Borehole DH23-02 indicates very loose, wet sand around pit depth which can contribute to unstable side slopes.

Mitigation: Pits shall be engineered and meet all WorkSafe BC requirements. Proper engineered shoring plan should be completed if required to ensure excavation walls are properly supported for the operations.

Other Risks

Traffic Management (4a)

Risk: Contractor to travel to site from off-project location. Project location is adjacent to public roadways within Smithers.

Mitigation: Develop a mobilization plan and travel management plan for project workers that is to be followed for the project duration. Contractor to consider a traffic management plan for Railway Ave. and Manitoba street.

Dewatering Excavations (4b)

Risk: Water ingress into the excavations can cause slope instabilities and delay construction. Ground water seepage was encountered at 3.0m and 1.5m in DH23-01 and DH23-02 respectively.

Mitigation: Pumps shall be available for both entry and exit pits, if required, for dewatering. The responsible party shall be clearly defined prior to construction. Contractor to develop and have in place a dewatering plan in their execution plan.

Construction Noise (4c)

Risk: Operational noise can have a negative effect on nearby residents and commercial buildings. There are several homes/developments near the crossing location.

Mitigation: Provide residents in the area with notice of construction noise and what to expect. Operations with loud construction noise should occur within reasonable working hours. The Contractor shall ensure volumes do not exceed those allowed by the municipality. Ensure proper permits and approvals are in place for the construction duration. Contactor to consider a noise mitigation plan.

Flowing Material into the Casing (4d)

Risk: Groundwater near or below the depth of the bore can allow for materials to flow into the bore casing leading to bore instability and potential over excavation.

Mitigation: Contractor shall continuously monitor the rate of penetration and the soil volume within the casing. Maintain a sufficient soil plug at the end of the casing to prevent uncontrolled inflow of water and flowing material. Implement appropriate dewatering or pressure control measures if excessive water ingress is observed.

4.2 SUMMARY OF TRENCHLESS DURATION

Table 5 shows the overall schedule for the CN Railway crossing.

Table 5. Estimated Duration for the CN Railway Bore Construction

Task	Guided Auger Bore
Entry Site Preparation (Access, grading & excavations)	4.0 shifts
Exit Site Preparation (Access, grading & excavations)	2.0 shifts
Mobilization	0.5 shift
Rig-in/Set-up	2.0 shifts
Casing Installation (Jacking, cleaning, welding)	3.0 shifts
Rig-out/Tear-down	1.0 shift
Demob.	0.5 shift
Total Shifts	**15.0 Shifts**

Assumptions:

- The schedule is based on working 7 days a week.
- The schedule for all operations is based on a 12 hour work per day (1 x 12 hr shifts).
- Schedule assumes the project is completed in sequence, not in parallel, which could be completed for the pits.
- Standard production rates, with no large delays.

5 RECOMMENDATIONS

The following recommendations outline the main action items that should be completed in order to ensure smooth progression of the project into the construction phase:

a) Ensure all required ROW and TWS, environmental notifications and permits, and water withdrawal and disposal sites are acquired.

b) Review any new environmental concerns with respect to the crossings and develop contingency plans if required.

c) Acquire an abrasion/corrosive specialist to determine if the ground conditions will effect the integrity of the casing over its proposed period of use, considering DFBE coating.

d) Entry/exit (launch and receiving) pits must be fully scoped, costed, designed, and constructed by a reputable contractor to ensure safe operations during construction.

e) The contractor should review the requirements for a drive shoe on the leading edge of the casing and consider having one engineered.

f) Conduit material selection and spacer design should be completed, reviewing the length of pipe sections and diameter of the joints to confirm that the proposed NPS 20 casing is adequate for the proposed installation and spacer design.

g) Complete crossing application (Initial Notification of Intent to Construct Utility Crossing/Encroachment) and complete review/approval process by CN Railway.

h) Review the contractor prepared Execution Plan, including but not limited to, Excavation Plan, Water Management and Dewatering Plan, Railway/Heave Settlement Plan, HDPE Product Pipe Installation Plan, and Site-Specific Environmental Plan.

i) Select an appropriate level of qualified supervision on site for all stages of the bore to ensure that the bore profile is adhered to and within limits set forth on the IFC drawing with the proper boring techniques and equipment are utilized, and schedule and costs are controlled.

6 CONCLUSIONS

This assessment shows the risks identified on the CN Railway Auger Bore crossing and if adequately mitigated, reduces the overall impact on the project. Based on the available data, it should be feasible to construct the CN Railway Auger Bore crossing along the proposed CN Yard Watermain Replacement project.

7 LIMITATIONS

This report has been prepared based on the available site-specific information for the exclusive use of Allnorth in the construction of the proposed CN Railway Auger Bore crossing. No other warranty is expressed or implied and the information presented within this report shall not be applied to other projects.

Although subsurface conditions are not expected to vary significantly from those shown on the drawings, it should be appreciated that extrapolation of subsurface conditions between boreholes and to depths below the depth of exploration is subject to interpretation and could be at variance with actual field conditions.

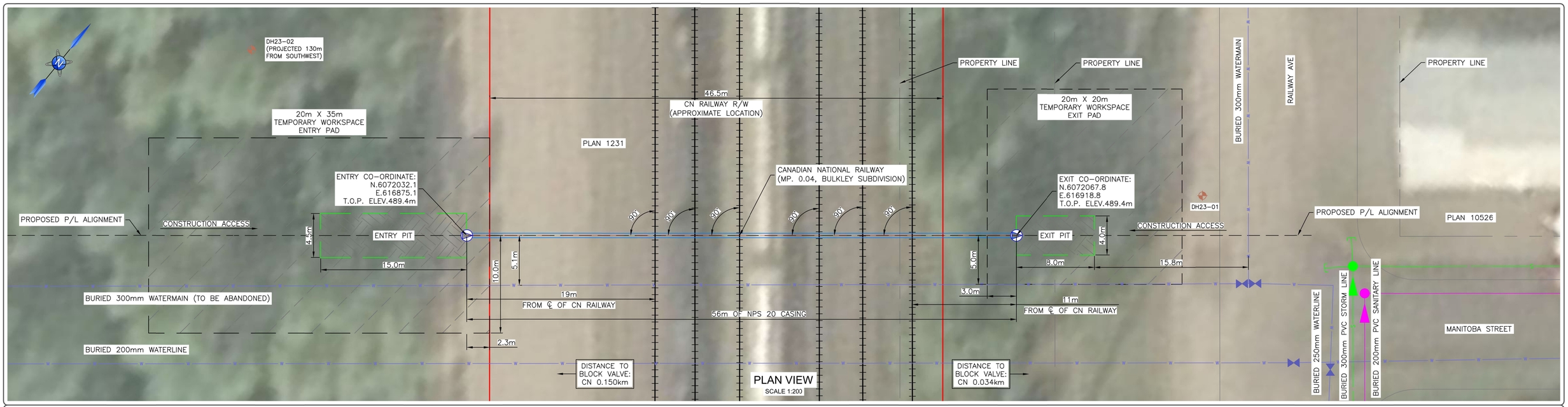
8 REFERENCE DOCUMENTS

- This report is based on the following HDD design drawings.

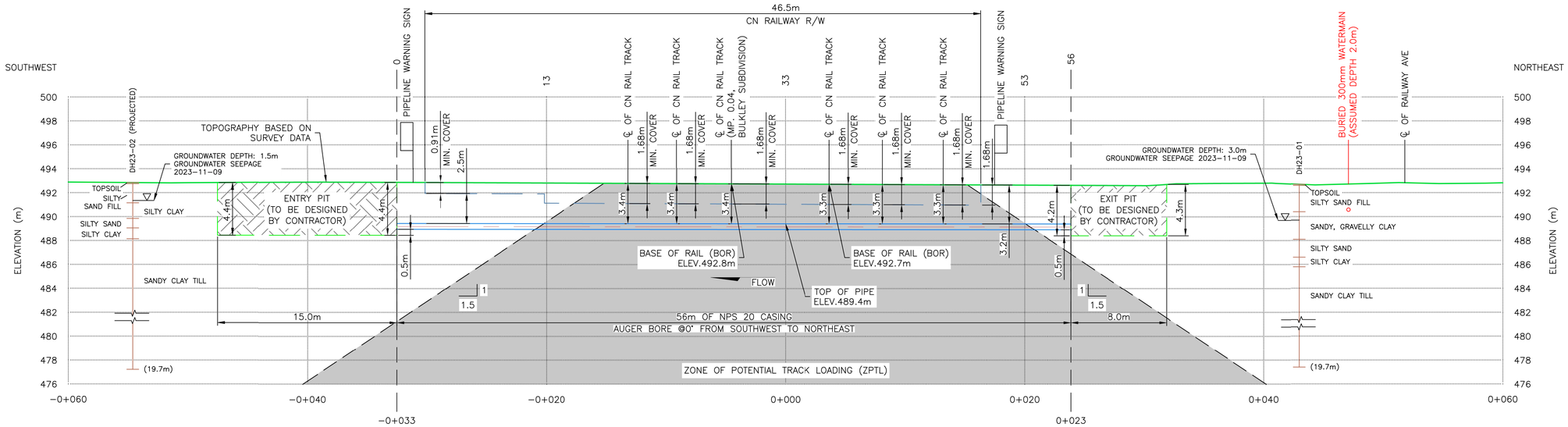
Type	Drawing Number
Bore Plan and Profile	4952-EG-0101
Construction Notes	4952-EG-0102

- Geotechnical Report: 4952-GEO-RPT-0001 Rev. B, titled “CN Yard Watermain Replacement Project – Geotechnical Report” by CCI Inc., dated October 15, 2025.

APPENDIX A – AUGER BORE DRAWINGS



PLAN VIEW
SCALE 1:200



PROFILE ALONG PROPOSED PIPELINE
SCALE 1:200 HORIZONTAL
SCALE 1:200 VERTICAL

TOTAL BORE LENGTH 56m

REFERENCE DOCUMENT NO.	DATE
1. Town As-Built Master in UTM	2025-08-05
2. 4952-API 1102 Analysis-02	2026-01-06
3. 4952-STRAIGHT PIPE STRESS-01	2025-12-31
4. 4952-SettlementAnalysis-01	2025-12-31

ENGINEER AND PERMIT STAMPS

PROFESSIONAL ENGINEER — PROVINCE OF BRITISH COLUMBIA — B. S. WILHELM — 39035 — 2026-01-08

PERMIT TO PRACTICE — CCI Inc. — Signature: ID# 203065 — Date: January 8, 2026 — PERMIT NUMBER: 1000703 — Engineers and Geoscientists BC

CCI

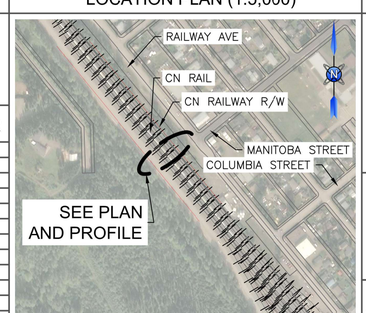
PIPELINE SPECIFICATIONS

	NPS 20	DIPS 14
OUTSIDE DIAMETER (OD)(mm)	508.0	356.0
WALL THICKNESS (WT)(mm) / DR	6.35	DR 13.5
GRADE	291	PE4710
PRODUCT	CASING	WATER
MATERIAL	STEEL	HDPE
SPECIFICATIONS	CSA Z245.1	CSA B137.1
INTERNAL COATING	N/A	N/A
OUTER COATING	DUAL FBE	N/A
MAX. OPER. PRESSURE (kPa)	101	738
MIN. TEST PRESSURE (kPa)	N/A	N/A
MAX. INSTALLATION TEMP (°C)	N/A	N/A

m: 0 — 10 — 20
1:200

DRAWING STATUS	DATE	DRN	CHK	DES	GEO	APR	CR
ISSUED FOR PERMIT	2026-01-06	GS	BO	BE	ML	AH	RJ

LOCATION PLAN (1:5,000)



UTM - ZONE 9 - NAD 83 (CSRS)

Allnorth

CN YARD WATERMAIN REPLACEMENT PROJECT
CN RAILWAY AUGER BORE CROSSING
PLAN AND PROFILE - NPS 20 CASING
TOWN OF SMITHERS

SCALE	DWG. #	REVISION	SHEET
AS SHOWN	4952-EG-0101	0	1 OF 2

File Name: S:\Current Jobs\4952-Allnorth Consultants Ltd- CN Yard Watermain Repl\Eng\Drawings\01-CN Rail\IFC\4952-EG-0101-0.dwg Date/Time: 2026-01-07 / 10:32:23 AM Last Saved By: Gary.Sargeant

NOTES:

CONSTRUCTION

1. IT IS RECOMMENDED THAT THE BORING CONTRACTOR INDEPENDENTLY EVALUATE THE FEASIBILITY OF BORING THE CROSSING WITH DUE CONSIDERATION GIVEN TO THE SUITABILITY OF THEIR EQUIPMENT AND PROPOSED CONSTRUCTION PROCEDURES. SPECIFIC BORING METHOD AND EQUIPMENT SELECTION IS THE SOLE RESPONSIBILITY OF THE CONTRACTOR WITH APPROVAL FROM THE COMPANY.
2. THE CONTRACTOR MUST SUBMIT A BORING EXECUTION PLAN FOR COMPANY APPROVAL (PRIOR TO START OF DRILLING OPERATIONS) THAT MEETS THESE MINIMUM REQUIREMENTS. THE EXECUTION PLAN SHALL BE ADHERED TO AND DEVIATION FROM THIS PLAN SHALL ONLY BE EXECUTED ONCE COMPANY APPROVED.
3. ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED. ALL DIMENSIONS ARE TO THE CENTRELINE OF BOREHOLE UNLESS OTHERWISE SPECIFIED.
4. ALL LENGTHS ARE ROUNDED TO THE NEAREST METRE AND ALL ANGLES ARE ROUNDED TO THE NEAREST DEGREE UNLESS OTHERWISE SPECIFIED.
5. ALL BORE LENGTHS ARE ROUNDED TO THE NEAREST METRE UNLESS OTHERWISE SPECIFIED.
6. THE INSTALLED PIPE AND EXISTING UTILITIES BEING CROSSED SHALL HAVE A MINIMUM SEPARATION OF 2m.
7. CONTRACTOR SHALL ENSURE THE BORE IS COMPLETED SUCH THAT BOREHOLE COLLAPSE AND SETTLEMENT IS MINIMIZED.
8. ALL EXISTING UTILITY DEPTHS ARE ASSUMED AND SHALL BE VERIFIED IN THE FIELD BY THE CONTRACTOR PRIOR TO THE START OF INSTALLATION. THE CONTRACTOR SHALL ENSURE ANY UTILITIES IN THE AREA ARE PROTECTED AND NOT DAMAGED DUE TO ANY CONSTRUCTION ACTIVITIES. VERIFICATION SHALL BE IN ACCORDANCE WITH COMPANY SPECIFICATIONS AND GROUND DISTURBANCE PROCEDURES.
9. ALL EXCAVATIONS ARE APPROXIMATE IN DIMENSION. THE CONTRACTOR SHALL ASSESS THE SITE CONDITIONS AND EXCAVATE APPROPRIATELY ADHERING TO OH&S GUIDELINES.
10. RIG MATTING AND GRAVEL BASE MAY BE REQUIRED WITHIN ENTRY PIT TO STABILIZE EQUIPMENT DURING INSTALLATION.
11. CASING SHALL BE SUPPLIED BY THE CONTRACTOR.
12. CONTRACTOR SHALL COMPLETE THE INSTALLATION IN ACCORDANCE WITH THE SUPPLIED PIPELINE CONSTRUCTION SPECIFICATIONS.
13. ALTERNATE METHODS OF COMPLETING THE CROSSING MUST BE APPROVED IN ADVANCE BY THE OWNER.
14. ENTRY AND EXIT PITS MUST BE COMPACTED FOLLOWING INSTALLATION TO PREVENT SETTLEMENT.
15. CONTRACTOR TO PROVIDE A DETAILED EXECUTION PLAN FOR APPROVAL BY THE OWNER IN ADVANCE OF THE CONSTRUCTION.
16. THIS BORE SHALL BE COMPLETED UTILIZING A BORE MACHINE AND MAINTAINED WITH A STEERING TOLERANCE OF +-10cm FROM THE DESIGN DRAWING ALIGNMENT.

ENVIRONMENTAL

17. NO REFUELING OF PUMPS OR EQUIPMENT WITHIN 100M OF THE WATER BODY SHALL BE COMPLETED.
18. EMERGENCY RESPONSE SPILL KITS MUST BE ON-SITE AND AVAILABLE FOR USE FOR THE DURATION OF THE PROJECT.
19. ANY NEARBY WATERCOURSE MUST BE MONITORED FOR IMMEDIATE EFFECTS OF THE WORKS ON THE AQUATIC ENVIRONMENT IN ACCORDANCE WITH THE BRITISH COLUMBIA GOVERNMENT'S CODE OF PRACTICE.
20. THE CONTRACTOR SHALL ENSURE THAT THE FOLLOWING DOCUMENTATION IS ON-SITE AND READILY AVAILABLE AT ALL TIMES (AT A MINIMUM):
    a. BRITISH COLUMBIA ENERGY REGULATOR (BCER) NOTIFICATION;
    b. EMERGENCY RESPONSE PROCEDURE (ERP);
    c. ENVIRONMENTAL PROTECTION PLAN (EPP);
    d. SDS FOR ALL ON-SITE MATERIAL;
    e. BRITISH COLUMBIA ENERGY REGULATOR (BCER) PERMITS;
    f. APPLICABLE LAND USE AGREEMENTS.

GEOTECHNICAL

21. A GEOTECHNICAL INVESTIGATION WAS COMPLETED AT THIS SITE BY GEONORTH ENGINEERING LTD. AND CAN BE REFERENCED FROM CCI INC. REPORT NO. 4952-GEO-RPT-0001.
22. SUBSURFACE CONDITIONS ARE BELIEVED TO BE SUITABLE FOR CONSTRUCTION OF THE PROPOSED AUGER BORE CROSSING BASED ON THE DATA AVAILABLE.
23. SOIL STRATIGRAPHY SHOWN IS BASED ON INTERPRETATION OF DATA FROM TWO (2) BOREHOLES, DRILLED BY OTHERS AT THE LOCATIONS SHOWN AND CCI'S UNDERSTANDING OF THE LOCAL GEOLOGY. DUE TO NATURAL VARIATIONS IN SUBSURFACE CONDITIONS AND INHERENT UNCERTAINTIES ASSOCIATED WITH THE INTERPRETATION OF SUBSURFACE DATA, SOME VARIATION IN STRATIGRAPHY ALONG THE LENGTH OF THE BORE SHOULD BE EXPECTED.
24. A DETAILED SETTLEMENT MONITORING PLAN (SMP) WILL BE COMPLETED PRIOR TO CONSTRUCTION OUTLINING THE REQUIRED SETTLEMENT MONITORING PROGRAM DURING INSTALLATION.
25. THE MAXIMUM ALLOWABLE RADIAL OVER-CUT IS 12.7mm (0.5").

CN RAIL REQUIREMENTS

26. INSTALLATION AND MAINTENANCE TO BE IN ACCORDANCE WITH TC E-10 AND THE LATEST EDITION OF APPLICABLE CSA STANDARD CSA Z662.
27. AS A MINIMUM, THE CROSSING SHALL BE CONSTRUCTED AND TESTED IN ACCORDANCE WITH ALL APPLICABLE FEDERAL, PROVINCIAL, MUNICIPAL AND COUNTY REGULATIONS.
28. THIS DRAWING IS BASED ON INFORMATION SUPPLIED BY VARIOUS SOURCES. THE CONTRACTOR SHALL CONFIRM THE ACCURACY OF INFORMATION PRIOR TO CONSTRUCTION.
29. NEAREST SHUT-OFF VALVES LOCATED AT:
    APPROXIMATELY 0.150km TO THE SOUTHWEST AS MEASURED ALONG THE ROW.
    APPROXIMATELY 0.034km TO THE NORTHEAST AS MEASURED ALONG THE ROW.
30. THE MINIMUM DEPTH OF COVER OVER THE ENCASED PIPE SHALL BE:
    a. 1.68m BELOW THE BASE-OF-RAIL AND WITHIN 7m OF CENTER OF THE OUTSIDE RAIL, MEASURED AT RIGHT ANGLES TO THE CENTERLINE OF THE TRACK.
    b. 0.91m BELOW GRADE OR BOTTOM OF DITCH WITHIN ALL PORTIONS OF THE CN RAIL RIGHT-OF-WAY WHERE THE PIPELINE IS NOT UNDER THE TRACK. WARNING SIGNS TO BE INSTALLED NEAR RAILWAY PROPERTY LINES.
31. CN RAILWAY SUBDIVISION/RAILWAY MILEAGE: BULKLEY SUBDIVISION, MILEAGE 0.04.

CASING INFO

Pipe Name:	CN YARD WATERMAIN REPLACEMENT PROJECT
Pipe Size:	NPS 20 (508.0mm OD)
Wall Thickness:	6.35mm
Inside Diameter:	495.3mm
Material:	STEEL
Specification & Grade:	CSA Z245.1, GRADE 291
Yield Strength:	291 MPa
Contents to be Handled:	DIPS 14 HDPE WATERMAIN
Coating:	DUAL FBE
M.O.P.:	101 kPa
Min. Test Pressure:	N/A
Min. Installation Temperature:	N/A
Max. Operating Temperature:	N/A
Type of Joint:	WELDED CONNECTION
Joint Factor:	1.0
Geotechnical Bore Holes:	YES
Installation Method:	AUGER BORE
Cathodic Protection Method:	N/A
Number of Tracks:	SIX
D/T Ratio:	80.00
Design Loading:	COOPER E-90
Railway Mileage & Subdivision:	MP 0.04, BULKLEY SUBDIVISION
Hoop Strength:	NPS 20, 0.00% SMYS (291MPa)

CONTACT

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Edmonton, AB CANADA T5S 1M3
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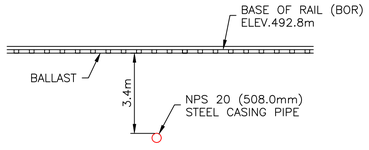
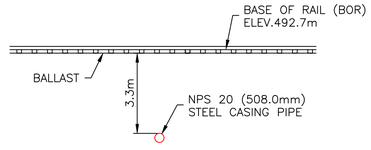
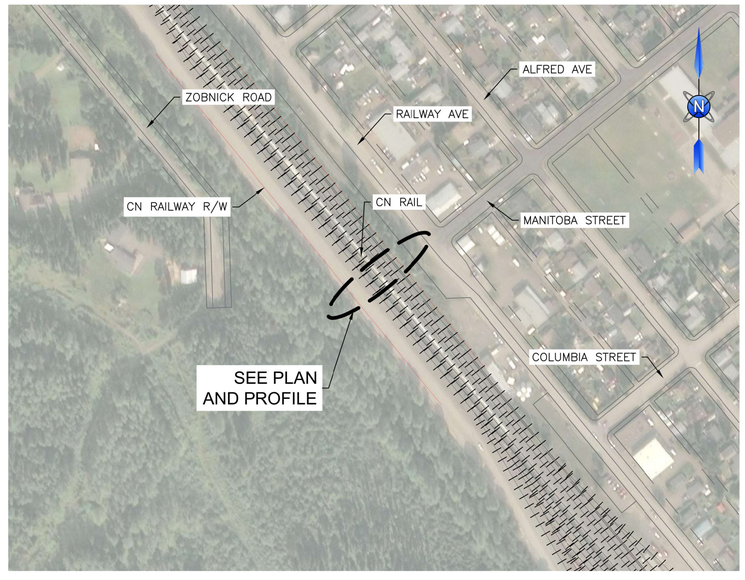
Matthew.LaBrecque@ccisolutions.ca



CN RAIL ALIGNMENT PROFILE
NTS



CN RAIL ALIGNMENT PROFILE
NTS



LOCATION PLAN
SCALE 1:2,500

REFERENCE DOCUMENT NO.	DATE
1. Town As-Built Master in UTM	2025-08-05
2. 4952-API 1102 Analysis-02	2026-01-06
3. 4952-STRAIGHT PIPE STRESS-01	2025-12-31

ENGINEER AND PERMIT STAMPS

PROFESSIONAL ENGINEER
PROVINCE OF BRITISH COLUMBIA
B. S. WILHELM
39695
2026-01-08

PERMIT TO PRACTICE
CCI Inc.
Signature: ID# 203065
Date: January 8, 2026
PERMIT NUMBER: 1000703
Engineers and Geoscientists BC

PIPELINE SPECIFICATIONS

	NPS 20	DIPS 14
OUTSIDE DIAMETER (OD)(mm)	508.0	356.0
WALL THICKNESS (WT)(mm) / DR	6.35	DR 13.5
GRADE	291	PE4710
PRODUCT	CASING	WATER
MATERIAL	STEEL	HDPE
SPECIFICATIONS	CSA Z245.1	CSA B137.1
INTERNAL COATING	N/A	N/A
OUTER COATING	DUAL FBE	N/A
MAX. OPER. PRESSURE (kPa)	101	738
MIN. TEST PRESSURE (kPa)	N/A	N/A
MAX. INSTALLATION TEMP (°C)	N/A	N/A

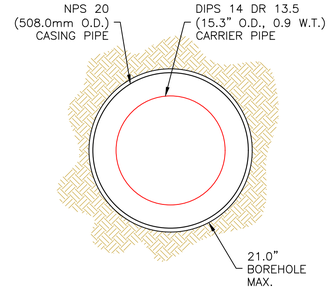
STEERING TOLERANCES

PULL FORCE / RIG SIZE / STRESS

DRAWING STATUS

DRAWING STATUS	DATE	DRN	CHK	DES	GEO	APR	CR
ISSUED FOR PERMIT	2026-01-06	GS	BO	BE	ML	AH	RJ

BOREHOLE CROSS SECTION



Allnorth

CN YARD WATERMAIN REPLACEMENT PROJECT
CN RAILWAY AUGER BORE CROSSING
CONSTRUCTION NOTES AND PIPELINE INFORMATION - NPS 20 CASING
TOWN OF SMITHERS

SCALE	DWG. #	REVISION	SHEET
AS SHOWN	4952-EG-0102	0	2 OF 2

CCI

File Name: S:\Current Jobs\4952-Allnorth Consultants Ltd- CN Yard Watermain Repl\Eng\Drawings\01-CN Rail\VFC\4952-EG-0101-0.dwg Date/Time: 2026-01-08 / 11:56:43 AM Last Saved By: Gary.Sargeant

APPENDIX B – API 1102 SUMMARY

Owner:	Town of Smithers
Project:	4952
Date:	2025-12-31
Applicable Crossings:	CN Yard Watermain Replacement - Casing
Reference Drawing:	4952-EG-0101

Completed By: BE Reviewed By: BW

Pipe Information			Design Criteria				Crossing Characteristics	
Pipe Diameter (mm)	Pipe W.T. (mm)	Pipe Grade	MOP (kPa)	Max. Operating Temperature (°Celsius)	Installation Temperature (°Celsius)	Design Radius (m)	Maximum Depth From Entry Location (m)	Crossing Length (m)
508.0	6.4	359	0	21	-5	0	3	56

Internal Load

Circumferential Stress due to Internal Pressure S_{Hi} (Barlow) = 0.00 MPa

Circumferential Stress Check (Liquids) % of Allowable 0.0%

Circumferential Stress Check (Natural Gas) % of Allowable 0.0%

Earth Load

Circumferential Stress due to Earth Load (S_{He}) S_{He} = 66.06 MPa

RAILROAD SPECIFIC

Live Load

w_{rail} = 108 kPa

Circumferential Stress

Railroad Cyclic Circumferential Stresses due to Rail Load (ΔS_{Hr})

S_{Hr} = 61,097 kPa

Railroad Cyclic Longitudinal Stress due to Live Load

S_{Lr} = 57,087 kPa

Principle Stresses

Principal Stress 1: Maximum Circumferential Stress (S_1)

S_1 = 127,156 kPa

Principal Stress 2: Maximum Longitudinal Stress (S_2)

S_2 = 13,935 kPa

Principal Stress 3: Maximum Radial Stress (S_3)

S_3 = 0 kPa

Total Effective Stress (S_{eff})

S_{eff} = 120,792 kPa

% Allowable 46.7%

Fatigue Checks

Girth Welds

% Allowable 86%

Longitudinal Welds

% Allowable 44%

APPENDIX C– RISK ASSESMENT SUMMARY

Risk Assessment Legends

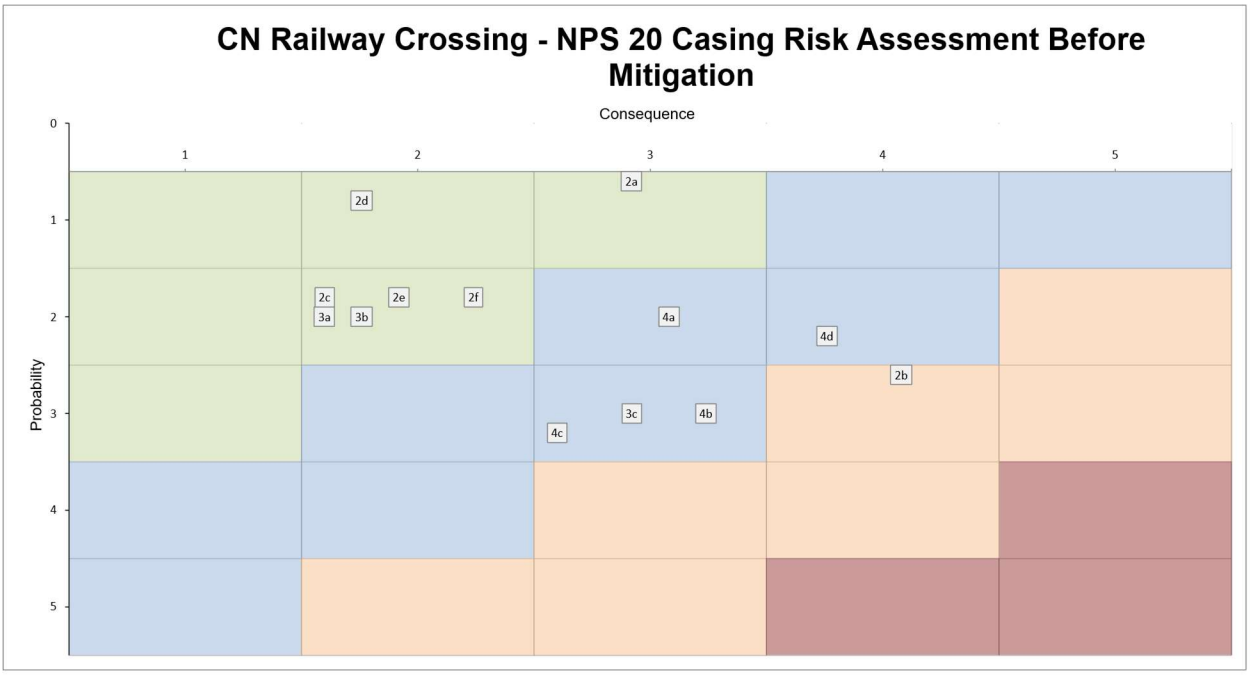
Probability		
Value	**Description**	**Chance**
1	Rare	≤ 5%
2	Unlikely	~ 25%
3	Possible	~ 50%
4	Likely	~ 75%
5	Almost Certain	≥ 95%

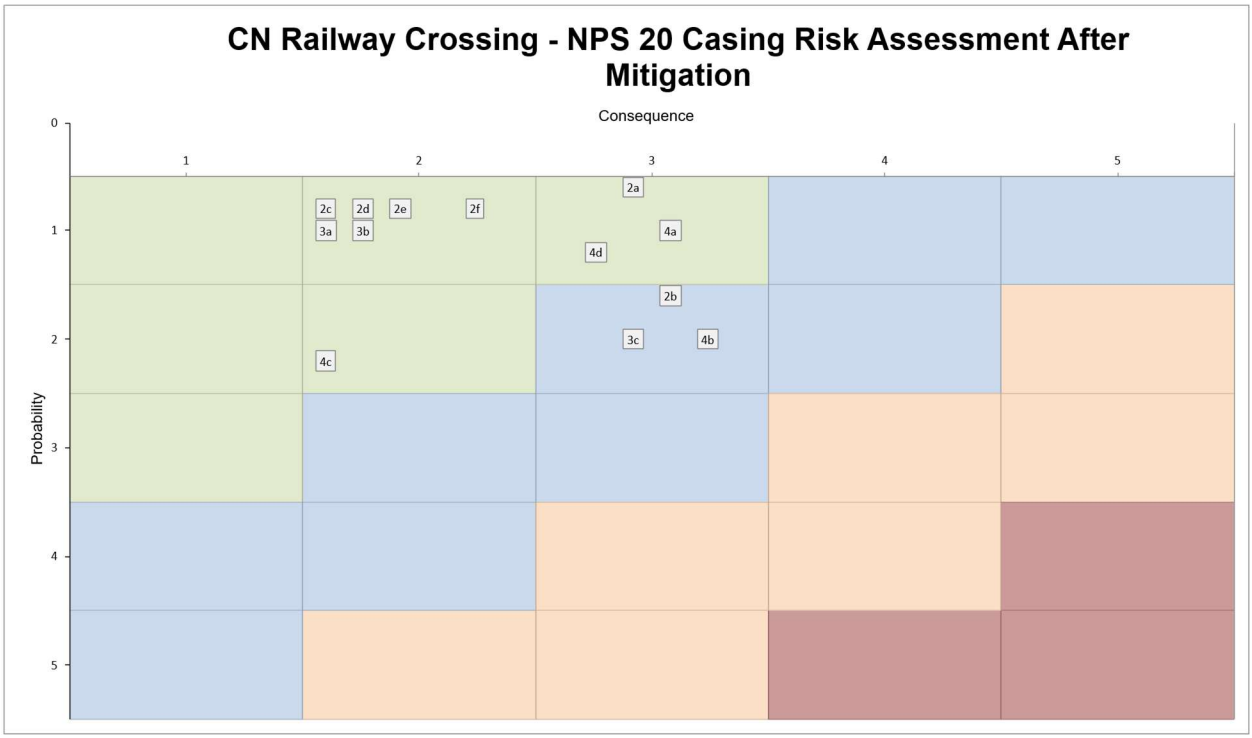
Consequence	
Value	**Description**
1	Insignificant
2	Minor
3	Moderate
4	Major
5	Catastrophic

Risk Types	1 - Insignificant	2 - Minor	3 - Moderate	4 - Major	5 - Catastrophic
Safety and Health	**First Aid Case**	**Minor Injury** - Medical treatment case with/or Restricted Work Case	**Serious Injury** or Lost Work Case	**Major or Multiple Injuries** - permanent injury or disability	**Fatality**
Environment	**No Impact** on baseline environment. Localized to point source. No action required.	**Localised** within site boundaries. Recovery measureable within 1 month of impact	**Moderate** harm with possible wider effect. Recovery in 1 year	**Significant** harm with local effect. Recover longer than 1 year	**Significant** harm with widespread effect. Recovery longer than 1 year. Limited prospect of full recovery
Financial	1 - 5% over Budget	5 - 20% over Budget	20 - 50% over Budget	50 - 100% over Budget	> 100% over Budget
Production/Schedule	< 1 - 5 days	6 days - 2 weeks	3 - 4 weeks	5 - 6 weeks	> 6 weeks
Reputation	Localised temporary impact	Localised, short term impact	Localised, long term impact but manageable	Localised, long term impact with unmanageable outcomes	Long term regional impact
Business Impact	Impact can be absorbed through normal activity	An adverse event which can be absorbed with some management effort	A serious event which requires additional management effort	A critical event which required extraordinary management effort	Disaster with potential to lead to collapse of the project

Probability	Consequence					
		1	2	3	4	5
	1	L	L	L	M	M
	2	L	L	M	M	H
	3	L	M	M	H	H
	4	M	M	H	H	VH
	5	M	H	H	VH	VH

L	Low Risk - Managed by routine procedures
M	Medium Risk - Planned mitigation strategy required
H	High Risk - Prioritized mitigation strategy required
VH	Very High Risk - Immediate mitigation strategy required


CN Railway Crossing - NPS 20 Casing Risk Assessment Before Mitigation
Consequence
Probability
0
1
2
3
4
5
2a
2d
2c
3a
3b
2e
2f
4a
4d
2b
3c
4b
4c


CN Railway Crossing - NPS 20 Casing Risk Assessment After Mitigation
Consequence
Probability
0
1
2
3
4
5
2a
2c
2d
2e
2f
3a
3b
4a
4d
2b
3c
4b
4c

CN Railway Crossing - NPS 20 Casing Risk Assessment Summary

Phase	#	Description	Safety and Health Risk	Environmental Risk	Financial Risk	Production/Schedule Risk	Reputation Risk	Business Impact Risk	Risk Before Mitigation	Risk After Mitigation
Installation of Casing	2a	Not Being Installed to Length on First Attempt			✓	✓			Low Risk	Low Risk
	2b	Heaving or Settlement of the Rail Tracks			✓	✓			High Risk	Medium Risk
	2c	Unwanted Pipe Deflection Greater than Tolerance			✓	✓			Low Risk	Low Risk
	2d	Over-Schedule Risk			✓	✓			Low Risk	Low Risk
	2e	Disposal of Cuttings		✓	✓	✓			Low Risk	Low Risk
	2f	HDPE Watermain is Damaged During Installation			✓	✓			Low Risk	Low Risk
Contractor, Construction Access & Operations	3a	Inadequate Tooling, Improper Methodology				✓	✓		Low Risk	Low Risk
	3b	Construction Access	✓		✓	✓			Low Risk	Low Risk
	3c	Pit Construction/Shoring	✓		✓	✓			Medium Risk	Medium Risk
Other Risks	4a	Traffic Management		✓					Medium Risk	Low Risk
	4b	Dewatering Excavations		✓		✓	✓		Medium Risk	Medium Risk
	4c	Construction Noise		✓		✓	✓		Medium Risk	Low Risk
	4d	Flowing Materials into the Casing			✓	✓			Medium Risk	Low Risk
	-									
	-									

Attendance: BE ML AH RJ

CN Railway Crossing - NPS 20 Casing

Date: November 13, 2025
Rev: 0

Auger Bore Risk Assessment

No.	Risk/Issue	Type of Risk/Issue		Pre-Mitigation Probability	Pre-Mitigation Consequence	Post-Mitigation Probability	Post-Mitigation Consequence	Review Cost Needed?
Installation of Casing								
2a	Not Being Installed to Length on First Attempt	Safety and Health	-	1	3	1	3	Select
		Environment	-	Low Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	There is a risk of not being able to install the casing on the first attempt.		Contractor shall ensure equipment is adequately sized and in good condition prior to starting construction. The Contactor shall prepare an Execution Plan outlining execution strategy including equipment. Contractor to have properly designed casing shoe.		
		Reputation	-					
		Business Impact	-					
2b	Heaving or Settlement of the Rail Tracks	Safety and Health	-	3	4	2	3	Select
		Environment	-	High Risk		Medium Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	The casing deflects causing the railway to heave, or over augering the soil creates a void that causes settlement of the railway greater than allowable limits. This may result in a stoppage of construction and/or a shut down of the railway. Borehole DH23-02 indicates very loose sand around bore depth that could increase the risk of over excavation and settlement.		A settlement monitoring plan shall be in place to ensure early detection of settlement. The Contractor shall leave a soil plug at the front of the casing during installation. The Contractor shall have a response plan in place and follow their approved execution plan. Contractor to ensure rate of progression is aligned with the rate of removal of soils.		
		Reputation	-					
		Business Impact	-					
2c	Unwanted Pipe Deflection Greater than Tolerance	Safety and Health	-	2	2	1	2	Select
		Environment	-	Low Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	Casing encounters unexpected geotechnical conditions or obstacles and deflects from designed path.		Contractor to monitor pipe deflection and the Contractor shall provide a plan if a deflection occurs. Any buried utilities should be located and exposed prior to construction.		
		Reputation	-					
		Business Impact	-					
2d	Over-Schedule Risk	Safety and Health	-	1	2	1	2	Select
		Environment	-	Low Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	Crossing takes longer than scheduled to complete due to unforeseen geotechnical conditions, deflections, etc.		Contractor to supply schedule with consideration given to the geotechnical formations and risk mitigations. Contractor shall supply equipment in good condition. Contractor to develop and have an approved site-specific Execution Plan.		
		Reputation	-					
		Business Impact	-					
2e	Disposal of Cuttings	Safety and Health	-	2	2	1	2	Select
		Environment	Yes	Low Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	Cuttings during boring operations will need to be managed.		Execution plan shall detail a plan for storing/disposing of cuttings during construction. Ensure temporary workspace accounts for the requirements for the operations and any storing/disposal requirements specific to the plan.		
		Reputation	-					
		Business Impact	-					
2f	HDPE Watermain is Damaged During Installation	Safety and Health	-	2	2	1	2	Select
		Environment	-	Low Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	There is a risk that the HDPE Watermain is damaged due to mishandling into the pit or into the casing.		There should be proper communication set-up between all necessary parties while installing the HDPE line. Casing should be surveyed for line and grade and inspected following the installation to confirm its suitability for the HDPE installations. Clear any debris out of the casing following casing installation.		
		Reputation	-					
		Business Impact	-					
Contractor, Construction Access & Operations								
3a	Inadequate Tooling, Improper Methodology	Safety and Health	-	2	2	1	2	Select
		Environment	-	Low Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	Contractor selects incorrect tooling for the anticipated formations or completes the crossing without industry best practices.		Select experienced construction oversight/inspectors. The selected Contractor should have experience with this methodology, length, pipe size, and geotechnical conditions. Ensure contractor utilizes a proper casing shoe.		
		Reputation	-					
		Business Impact	-					
3b	Construction Access	Safety and Health	Yes	2	2	1	2	Select
		Environment	-	Low Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	The project site is located within Smithers, in proximity to roads in an urban area. Access to the exit side will be off Railway Ave.		Contractor should review access prior to construction and develop a traffic management plan for the site, considering signs, cones, barriers, and minimize disruptions to local traffic.		
		Reputation	-					
		Business Impact	-					Edit
3c	Pit Construction/Shoring	Safety and Health	Yes	3	3	2	3	Select
		Environment	-	Medium Risk		Medium Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	It is anticipated that shoring/trench boxes will be required due to depth of excavations and potential soil types. Borehole DH23-02 indicates very loose, wet sand around pit depth which can contribute to unstable side slopes.		Pits shall be engineered and meet all WorkSafe BC requirements. Proper engineered shoring plan should be completed if required to ensure excavation walls are properly supported for the operations.		
		Reputation	-					
		Business Impact	-					
Other Risks								
4a	Traffic Management	Safety and Health	Yes	2	3	1	3	Select
		Environment	-	Medium Risk		Low Risk		
		Financial	-	**Description**		**Mitigation Strategy**		
		Production/Schedule	-	Contractor to travel to site from off-project location. Project location is adjacent to public roadways within Smithers.		Develop a mobilization plan and travel management plan for project workers that is to be followed for the project duration. Contractor to consider a traffic management plan for Railway Ave. and Manitoba street.		
		Reputation	-					
		Business Impact	-					
4b	Dewatering Excavations	Safety and Health	Yes	3	3	2	3	Select
		Environment	-	Medium Risk		Medium Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	Water ingress into the excavations can cause slope instabilities and delay construction. Ground water seepage was encountered at 3.0m and 1.5m in DH23-01 and DH23-02 respectively.		Pumps shall be available for both entry and exit pits, if required, for dewatering. The responsible party shall be clearly defined prior to construction. Contractor to develop and have in place a dewatering plan in their execution plan.		
		Reputation	-					
		Business Impact	-					
4c	Construction Noise	Safety and Health	Yes	3	3	2	2	Select
		Environment	-	Medium Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	Operational noise can have a negative effect on nearby residents and commercial buildings. There are several homes/developments near the crossing location.		Provide residents in the area with notice of construction noise and what to expect. Operations with loud construction noise should occur within reasonable working hours. The Contractor shall ensure volumes do not exceed those allowed by the municipality. Ensure proper permits and approvals are in place for the construction duration. Contactor to consider a noise mitigation plan.		
		Reputation	-					
		Business Impact	-					
4d	Flowing Materials into the Casing	Safety and Health	-	2	4	1	3	Select
		Environment	-	Medium Risk		Low Risk		
		Financial	Yes	**Description**		**Mitigation Strategy**		
		Production/Schedule	Yes	Groundwater near or below the depth of the bore can allow for materials to flow into the bore casing leading to bore instability and potential over excavation.		Contractor shall continuously monitor the rate of penetration and the soil volume within the casing. Maintain a sufficient soil plug at the end of the casing to prevent uncontrolled inflow of water and flowing material. Implement appropriate dewatering or pressure control measures if excessive water ingress is observed.		
		Reputation	-					
		Business Impact	-					

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