UTILITY CROSSING APPLICATION FORM

Applicant: AECOM on behalf of City of Winnipeg Date: December 17, 2021

Description of Utility Crossing location:

City/Town: Winnipeg	**Lot: NA**	**Concession/Legal Land Desc.: Saskatchewan Ave 80 m east of Empress St**
Township: Click or tap here to enter text.	**County: Canada**	**Province:MB**
GPS Coordinates of exact utility crossing (latitude/longitude, decimal degrees only): **Latitude: 49 D 54'25" Longitude: - 97d11'38"** **Name of Road where the utility is crossing CP tracks: NA**		
Railway Mileage & Subdivision if known: Mile 0.35 Saskatchewan Ave Lead, off Mile 0.91 La Riviere Subdivision		

Utility Owner Information:

Full Legal Name Of Utility Crossing Owner: City of Winnipeg
Address:110- 1199 Pacific Ave **Province: MB** **City/Town: Winnipeg** **Postal Code: R3E 3S8**
Contact/Signatory: Paul Bortoluzzi
Phone: 2 0 4 - 9 8 6 - 2 3 0 2
Email Address: PBortoluzzi@winnipeg.ca
24HR Owner Utility Emergency Response Number: 204-986-7589 **Approximate start date of proposed utility installation work: May 1, 2022** **Number of days a CP flagman will be required for: (10) Days (estimated)** **Purpose of utility installation: Modification of existing water pipeline adjacent to track**
Does applicant have an existing pipeline, hydro/power/fibre line crossing over/under the railway tracks at this exact location? YES
Does applicant have an existing permit / agreement in place with CP for this existing installation? Y E S **Provide copy of document or CP file number with application. Attached**
Will existing utility be removed from the railway corridor? N O
Who owns the property where the utility i.e. pipe/cable/conduit/hydro line etc. crosses the railway tracks? (Check off box beside the property owner.) **Municipal_☐ County ☐ City ☑ Region ☐_ CP ☐**
Description of work/notes: Install temporary structural shoring, excavate to expose existing air release valve, install new air release valve and manhole chamber.

Drawing No.: Click or tap here to enter text. **Date:** Click or tap to enter

UTILITY CROSSING FEES

Description	Payment to include with application:	One-time fee to be invoiced (aerial):	One-time fee to be invoiced (below ground):
Utility Crossing Permits Over/Under railway tracks and crossing within Regional/Municipal roads and property not owned by the railway.	Application & Engineering review Fee (Non-refundable) $700.00 + taxes*	One-time Permit Fee: $575.00 + taxes* Fee will be invoiced to applicant once approved	One-time Permit Fee: $575.00 + taxes* Fee will be invoiced to applicant once approved.
Utility Crossing Agreements Over/Under railway tracks & crossing within Canadian Pacific owned lands/right of way.	Application & Engineering review Fee (Non-refundable) $700.00 + taxes*	One-Time Aerial Crossing Fees: (Hydro/Power, Fibre, Coaxial etc.) $2,000.00 + taxes*	One-Time Pipe Crossing Fees: (Natural Gas, Oil, Sewer, Watermain, Storm Culverts etc.) ~ less than 30”(750mm) outer diameter of casing: $2,000.00 + taxes* ~ 30” (750mm) to less than 96”(2400mm) outer diameter of casing: $5,000.00 + taxes* Fee will be invoiced to applicant once approved.

OTHER APPLICATION FEES

Railway property/title searches	$400.00 + taxes*	Non-refundable
Utility searches and or copies of agreements/permits	$200.00 + taxes*/document	Non-refundable
Permit / Drawing Revisions (Substitution of Prints)	$525.00 + taxes*	Non-refundable
Additional Engineering review fees	$400.00 + taxes*	Non-refundable
Assignments	$500.00 + taxes*/agreement	Non-refundable

Express Fee*: (Permit/Agreements/Assignments reviewed within 10 business days):
Add $1,200.00 + taxes* to Application/Documentation & Engineering Review Fee above.

Check off the box to the right if requesting this level of service: ☐

Fast Track Fee*: (Permit/Agreements/Assignments reviewed within 5 business days):
Add $2,000.00 + taxes* to Application/Documentation & Engineering Review Fee above.

Check off the box to the right if requesting this level of service: ☐

***Express / Fast Track utility applications do not apply to installations that require Geotechnical review.**

Above-mentioned fees do not apply to utility crossings within major rail yards, or running parallel within the railway right of way.
CP reserves the right to review these fees from time to time. CP does not grant easements for utility crossings over/under the railway right of way.
Typical utility crossing application turnaround time: 30-60 business days.

Revised January 8, 2021

***GST and any provincial sales taxes must be included with all fees. Tax rate is based on physical location of the utility installation.**

Underground Pipe Crossing Information:

Does CP Geotechnical Protocol apply to this installation?	**YES**

If yes – Applicant to send a copy of the Geotechnical report along with a track settlement monitoring plan to CP Geotechnical Service provider for review and installation oversite. All additional fees associated with this review and onsite supervision will be borne by the applicant. Refer to CP Geotechnical Protocol for all required details before submitting.

Number of new underground pipes crossing CPR tracks: 0
Material being carried in pipe i.e. storm, watermain, gas etc.: Water
Depth below base of rail to top of steel casing pipe:no. m carrier pipe:3 m
Depth below bottom of ditch to top of pipe: NA m
Angle of crossing to the tracks: NA (shall not be less than 45 degrees)
Number of tracks being crossed: NA
Number of manholes within CPR property: NA
Number of shut off valves within CPR property: NA
Will existing pipe be removed or grouted in place? no

Bridge Information:

Does pipe cross underneath a Railway Bridge?	NO
Depth below grade to top of steel casing pipe: click **m**	
Distance from edge of bridge abutments to centerline of steel casing pipe: no. **m** **Distance from edge of bridge footings to centerline of steel casing pipe:** no. **m** **Installation should not come within the Zone of Potential Influence or that of any part of a railway bridge structure (footings, abutments, columns, piers, etc.). A cross-section of proposed installation must be provided along with Engineer's report if encroaching into these areas.**	

Pipe Specifications:	**Carrier Pipe (mm)**	**Casing Pipe (mm)**
Outside Diameter	NA	1080
Wall Thickness	NA	85
Pipe Material	NA	Concrete Pressure Pipe
Specification & Grade	NA	Class 14 (140 psi operating typical)
Type of Joint	NA	Bell and Spigot
Coating	NA	No
Cathodic Protection	NA	No
Specified Min. Yield Strength	NA	NA
Max operating pressure	NA	550 KPa
Max operating temperature	NA	20C
Max surge & test pressure	NA	NA
Min. Operating Temperature	NA	4 C
Vents: No	**Are Both Ends of the pipe sealed?**	NO
Types of Seals:	NA	
Distance of shut off valves to closest track centerline: NA m		
Distance from nearest point of sending/receiving pits to the nearest rail: 4.4 m		
Sending pit: Click or tap **m Receiving pit:**Click or tap **m** **Shared right of way. See shoring details attached**		

Method of installation: NA no crossing
Steel casing pipe to conform to Cooper E80 railway loading and must span the complete railway right of way width.

Aerial/Underground Wire Crossing Information:

Aerial Information:

- **Number of NEW wires crossing over the tracks:** Click or tap here to enter text.
  Hydro/Power: no. **Neutral:** no. **Fibre:** no. **Fibre count:** no.
- **Number of existing hydro wires / power lines / fibre optic cables crossing over the tracks:** no.
- **Maximum voltage of proposed hydro/power crossing:** no. **EMF output:** no.
- **Height above top of rail to proposed installation:** no. **m**
  No cable/wire shall be less than 7.6m from top of rail to lowest wire including sag. If crossing within railway yards lowest wire with sag should not be less than 10m from top of rail.
- **Number of poles being placed within CPR property:** Click **(Property plan must be shown.)**
  Pole Owner: Click or tap here to enter text.
- **If not the Pole Owner, does your company have permission/permit to use these poles?** .
  (provide permission document with application)
- **Number of cabinets within Railway property:** Click or tap here to enter text.
- **Number of guy wires within railway property:** Click or tap here to enter text.
- **Angle of crossing to the tracks:** Click **degrees (should not be less than 45 degrees)**
- **Number of tracks crossed by installation:** Click or tap here to enter text.

Underground Cable/Wire Crossing Information:

- **Number of wires/cables within the conduit/casing crossing under the tracks:** Click
- **Type of wires/cable crossing underneath the tracks i.e. fiber, hydro etc.** Click
- **Number of manholes, cabinets on railway property:** Click
- **If fibre optic cable duct, Fibre Count:** Click or tap here to enter text.
- **Provide material specification of casing pipe/conduit i.e. HDPE, PVC etc.** Click or tap here
- **Depth below base of rail to top of conduit/casing:** Click **m (must not be less than 1.52m)**
- **Conduit outside diameter:** Click **mm Wall thickness:** Click **mm**
- **Steel casing pipe outside diameter:** Click **mm Wall thickness:** Click **mm**
- **Distance from nearest point of sending/receiving pits to nearest rail:**
  Excavation pits should be placed outside the railway corridor and not come within 10m of the nearest rail.
  Sending pit: Click **m** **Receiving pit:** Click **m**
- **Method of installation: Jack & Bore, Directional drilling etc.:** Click or tap here to enter text.

Bridge Information :

- **Does conduit/pipe cross underneath a Railway Bridge?** Choose an item.
- **Depth below grade to top of casing pipe:** Click **m**
- **Distance from edge of bridge abutments to centerline of conduit/casing pipe:** Click **m**
- **Distance from edge of bridge footings to centerline of conduit/casing pipe:** Click **m**

Installation should not come within the Zone of Potential Influence or that of any part of a railway bridge structure (footings, abutments, columns, piers, etc.) A cross-section of proposed installation must be provided along with Engineers report if encroaching into the zone.

Drawing No.: Click or tap here to enter text. **Date:** Click or tap to enter

UTILITY PACKAGE TO INCLUDE

- ☑ **CP Utility Application Form**
- ☑ **PDF drawing to scale and stamped, (11 X 17 in color preferred).**
- **Complete installation should be shown on 1 drawing with plan view, profile and cross-section along with an aerial image showing exact crossing location with a solid red line across the rail corridor. (see attached examples) Please do not forward full-sized contract drawings.**
- ☑ ☐ **Advance payment made in the amount of $700 plus taxes to cover the Non-refundable Application & Engineering Review Fee, to be made by EFT or Wire Payment – see payment details on the following page.**
- **Geotechnical report if pipe outer diameter is 300mm or larger or if soil conditions are not conducive to the proposed bore. Ensure items 13.4 to 13.12 within table 5 of the Geotechnical protocol checklist are addressed and the track settlement-monitoring plan is within the report being submitted in order to avoid delays.**
- **1 copy of the complete Geotech package is to be sent to CP Geotechnical service provider for initial review. All additional fees undertaken by CP service provider i.e. review and installation oversight will be borne by the applicant and paid directly to CP service provider.**
- **Payment confirmation must accompany Utility Application, including taxes and any applicable provincial tax. Tax rate is based on physical location of the installation.**
- **The One-Time Permit or Agreement Fee will be invoiced once document is fully executed. If unsure of payment process or fee, send email to the regional contact below.**
- **Insufficient information will result in review delays and additional review fees.**
- **No permit/agreement will be processed unless proof of payment is included with application.**

☑

I have verified all required information and payment are being provided with this application and understand any missing items will result in delays or rejection of my application.

Email completed package to:

Western Canada (BC, AB, SK)	**Eastern Canada (MB, ON)**
Attn: Graeme Dales, Supervisor, Utilities & Flagging (West) (graeme_dales@cpr.ca) Canadian Pacific 7550 Ogden Dale Rd SE Calgary, AB T2C 4X9	Attn: Jack Carello SR/WA Manager Utilities & Flagging Engineering Eastern Region (jack_carello@cpr.ca) Canadian Pacific 1290 Central Parkway West, Suite 800 Mississauga, ON L5C 4R3

***GST and any provincial sales taxes must be included with all fees. Tax rate is based on physical location of the utility installation.**

CP Banking Information

For: EFT - Electronic Funds Transfer Instructions

Company Name:	Canadian Pacific Railway Company
Company Address:	7550 Ogden Dale Rd. SE Calgary, AB, T2C 4X9
Company Transit:	00109
Company Account #:	1967-771
Institution #:	001
Bank Address:	Bank of Montreal 350 7th Avenue SW Calgary, AB T2P 0X4

For: Wire Payment Instructions

Beneficiary Name:	Canadian Pacific Railway Company
Beneficiary Address:	7550 Ogden Dale Rd. E Calgary, AB T2P 04X

Beneficiary Transit and Account #: 00101967771

Bank Routing Code:	000100109
Beneficiary Address:	Bank of Montreal 350 7th Avenue SW Calgary, AB T2P 0X4

Bank of Montreal Swift Code: BOFMCAM2 International Banking, Head Office Montreal, QC
Bank of Montreal's USD Corresponding Bank: Wells Fargo Bank (FKA Wachovia Bank),
SWIFT CODE: PNBPUS3NNYC, ABA/Routing #: 026005092

THURBER ENGINEERING LTD.

April 26, 2022 File No.: 33030

AECOM
99 Commerce Drive
Winnipeg, MB R3P 0Y7

Attention: Marv McDonald, C.E.T.

GEOTECHNICAL REVIEW
PROPOSED CHAMBER STRUCTURE ADJACENT TO THE CANADIAN PACIFIC RAILWAY MILE 0.35 SASKATCHEWAN AVE LEAD, OFF MILE 0.91 LA RIVIERE SUBDIVISION WINNIPEG, MANITOBA

Dear Mr. McDonald:

Thurber Engineering Ltd. (Thurber) is pleased to provide this letter summarizing the results of our Geotechnical Review of the proposed temporary shoring system to be installed adjacent to the Canadian Pacific (CP) Railway Right-of-Way (ROW) near Mile 0.35 of the Saskatchewan Ave Lead, off Mile 0.91 of the La Riviere Subdivision in Winnipeg, Manitoba.

The Terms of Reference for Thurber's review are included in our proposal dated September 29, 2021. Authorization to proceed with the geotechnical review was received in the form of an email on December 23, 2021, from Mr. Marv McDonald of AECOM.

The geotechnical review has been carried out based on the information provided in the following documents prepared by AECOM:

- AECOM Drawing No. 1-0798E-C0003-001, titled "Provision of Pipeline Access Modifications, Cleaning and Support Services for River Crossing Inspections – Phase Three, Site 8, West End Feedermain (at Omand's Creek)", dated January 27, 2022
- AECOM Drawing No. 1-0798E-C0006-001, titled "Provision of Pipeline Access Modifications, Cleaning and Support Services for River Crossing Inspections – Phase Three, Site 8, Temporary Shoring Details (at Omand's Creek)", dated January 27, 2022
- AECOM Technical Memorandum No. 60645745, titled "Geotechnical Recommendations and Plaxis Analysis for Shoring Design, West End Feedermain – Site 8, City of Winnipeg", dated January 31, 2022

Thurber's geotechnical review is based on the CP Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks (dated February 25, 2020).

Thurber's review has been completed in the context of railway infrastructure protection only. Overall technical suitability of the proposed design and construction methods as they relate to other aspects of the project were not reviewed or addressed by Thurber.

THURBER

1. BACKGROUND

The proposed temporary shoring system is to be installed approximately 100 m east of the intersection of Saskatchewan Avenue and Empress Street. It is understood that a temporary shoring system will be required during excavation to expose the existing 900 mm diameter feedermain and access an air release valve. Excavation support will be required for the construction of a new air release manhole structure. It is understood that the proposed temporary shoring system will consist of a solder pile retaining wall with timber lagging. The footprint of the excavation will be approximately 4.5 m wide by 4.5 m long by 4.8 m deep. In addition, the excavation will be constructed adjacent to the CP ROW.

Four previously advanced boreholes, three by UMA Engineering Ltd. (UMA) in 1987 (designated as TH-45, TH-46 and TH-47) and one by TREK Geotechnical Inc. (TREK) in 2015 (designated as TH15-01) were referenced by AECOM. The boreholes were advanced in the vicinity of the new air release valve chamber to depths ranging from 5.0 to 16.5 m. Based on the boreholes advanced by UMA and TREK, the encountered stratigraphy consisted of surficial fill overlying a thin layer of silt underlain by a deposit of high plastic clay over silt till.

Monitoring wells were not installed as part of the previous geotechnical investigations; although, water was noted in TH15-01 at 6.7 m.

2. PROPOSED CONSTRUCTION

The footprint of the excavation will be approximately 4.5 m wide by 4.5 m long by 4.8 m deep and adjacent to the CP ROW. The existing feedermain connecting to the air release valve structure runs along the south side of the tracks. The centreline of the nearest track is approximately 4.4 m from the limit of the temporary shoring system.

The currently proposed temporary excavation is within the zone of potential track loading (ZPTL). It is understood that temporary shoring consisting of soldier piles, timber lagging and internal bracing will be used to support the excavation.

AECOM has completed a settlement monitoring plan which specifies the installation of surface settlement monitoring points along the tracks. The settlement monitoring plan specifies the frequency of readings at various monitoring points prior to construction, during construction and upon completion of construction. The Review and Alert Thresholds are noted as 11 and 22 mm, respectively, based on a Class 1 track.

Construction monitoring of the temporary shoring system is included on AECOM's Drawing No. 1-0798E-C0006-001. Targets will be provided on all piles and vertical and horizontal locations will be initialized before excavation. Horizontal pile readings will be taken daily during active excavation and weekly thereafter. Vertical pile readings will be taken at installation, after waler/brace installation and after every significant cut greater than 1.2 m daily.

THURBER

3. GEOTECHNICAL REVIEW COMMENTS

Based on our review of the available information summarized above, the following geotechnical review comments are provided:

1. AECOM is understood to be the Geotechnical Engineer of Record (GER) for this construction.
2. A complete 24-hour CP Emergency Contact list, including local personnel must be compiled and in place before any work proceeds within the CP ROW.
3. A recovery plan must be provided by the Contractor and reviewed by the GER outlining the steps to be implemented in the event of failure (i.e., excessive ground loss or settlement/collapse, heaving, etc.). The recovery plan should include having CP work crews on standby during construction with additional ballast material and their track levelling equipment to ensure that the railway tracks remain operational.
4. Once a Contractor has been selected, the GER must review and approve the shop drawings (including but not limited to excavation/shoring plan, dewatering plan, shoring installation plan, recovery plan, etc.) submitted by the Contractor before any work proceeds within the CP ROW. These submissions/drawings along with the GER's review comments should be provided to CP and CP approved service provider (i.e., Thurber).
5. Prior to commencement of any work within CP property/ROW, the GER or their designate shall arrange a pre-construction meeting with all stakeholders to discuss project and construction details including work description, construction methods, restrictions, safety, and CP requirements and agreed upon protocol. It is the responsibility of the GER or their designate to ensure that flagging protection has been arranged for the duration of the project, all construction oversight and track settlement/shoring monitoring has been arranged with CP approved service provider and that the expectations have been clearly communicated.
6. The GER may assign a competent/trained person to act as site inspector who will be present onsite during the full duration of the construction and any other ground disturbance activity within railway operating corridor, unless, otherwise directed by CP Public Works – Utilities Supervisor. The site inspector must ensure that the work is being carried out in accordance with the approved designs, permits and procedures, and/or relevant specifications. The site inspector must immediately report any issues encountered during construction work that could have an impact on CP assets and its operations. Any concerns about the imminent stability of the grade shall immediately be escalated to CP Flagger or representative in order to protect against train operations.
7. The site inspector must provide a daily report to CP approved service provider (i.e. Thurber) copying CP Public Works – Utilities Supervisor, CP's Director Geotechnical Engineering and the GER, outlining the progress during the day, any deviations from the original plans, any unexpected ground conditions, or any other issues that were encountered during the construction. The report shall also contain relevant information that assures CP that the field activities are being monitored and documented to ensure that the construction is proceeding in accordance with approved plans and no unexpected conditions/issues are expected. The daily report must also include all settlement/shoring monitoring data, along with any pertinent photos. If applicable, this report will also make

notes and highlight any measures taken for “out of compliance” practice or when conditions requiring attention are expected or encountered.

8. Upon completion of the construction, the GER will provide a final sealed and stamped letter/construction report to CP approved service provider (i.e., Thurber) with a copy to CP Public Works – Utilities Supervisor conforming that the work has been completed in accordance with the approved plans and procedures. If there are any deviations from the approved plans/procedures, these must be noted in the final letter/report. As-built stamped drawings are to be submitted along with final settlement data collected and correspondence.

4. CLOSURE

This letter presents a summary of our geotechnical review of the information provided to us addressing the installation of the proposed structure adjacent to the CP ROW. This review is limited to assessment of the information provided as it relates to the potential risk to the track(s). It should be noted that even after the above review comments have been implemented, there is still potential that variation in subsurface conditions may occur with resulting hazards from loss of ground, settlement or heave with potential to disrupt CP operations. Should AECOM decide to proceed with the work as planned, it is understood that the risks associated with AECOM activities and any additional costs associated with track disruptions will be carried solely by AECOM.

We trust this letter meets your requirements. If you have any questions or require further information, please contact the undersigned at your convenience.

Yours truly,
Thurber Engineering Ltd.

Jason Lee, P.Eng.
Review Principal

Michael Eastman

Michael Eastman, P.Eng.
Associate | Geotechnical Engineer

AECOM Canada Ltd.
101 – 18817 Stony Plain Road NW
Edmonton, AB T5S 0C2
Canada

T: 780.486.7000
F: 780.486.7070
aecom.com

Project name:
West End Feedermain - Site 8

Project ref:
60645745

To:
Marvin McDonald

CC:
Rab Nawaz

From:
Faris Alobaidy, Usman Raja, Hanh Hong

Date:
December 22, 2021

Technical Memorandum

Subject: **Geotechnical Recommendations and Plaxis Analysis for Shoring Design, West End Feedermain - Site 8, City of Winnipeg**

1. Introduction

This technical memorandum was prepared to provide geotechnical analysis and recommendations to support the structural design of a shoring system for the West End Feedermain at Site 8 in the City of Winnipeg, Manitoba. The shoring system will provide lateral support during excavation to expose the existing 900-mm diameter feedermain and access to an air release value. Excavation support will be required for the construction of a new air release manhole structure. It is understood that the proposed temporary shoring system will consist of a soldier pile retaining wall with timber lagging. The footprint of the excavation will be approximately 4.5 m wide, 4.5 m long and 4.8 m deep. In addition, the excavation will be constructed adjacent to a Canadian Pacific Railway right-of-way.

The location of the excavation and proposed construction is shown in Figure 1 – Site Plan, attached.

2. Background and Existing Information

For this project, AECOM was provided with the following geotechnical reports for review:

- The City of Winnipeg, West End Feedermain, Geotechnical Investigation (UMA Engineering Ltd., 1987); and,
- Saskatchewan Avenue at Omand's Creek Bridge Replacement Geotechnical Report (TREK Geotechnical Inc., 2015).

Subsurface information from four testholes located within the vicinity of the proposed excavation were used in the analysis. The testholes included TH-45, TH-46 and TH-47 from the UMA (1987) report, and TH15-01 from the TREK (2015) report. The approximate locations of the testholes are shown in **Figure 1**. The logs of testholes are attached for reference.

The testholes were drilled to depths ranging from 5 to 16.5 m below the existing ground surface (mGBS). The soil stratigraphy encountered in the testholes generally consisted of:

- 2 to 2.5 m of fill/silt; overlying
- Soft to firm/stiff, high plasticity clay to a depth of approximately 12 to 13 mBGS; overlying,
- Glacial till (silt and clay with some gravel) to the maximum exploratory depth of 16.5 mBGS.

No groundwater seepage was noted in TH-47 and TH15-01 at the completion of drilling.

3. Excavation Support

The soldier pile retaining wall will utilize H-section steel beams, timber lagging and internal bracing to support the excavation. The following guidelines may be used for design purposes:

- H-section steel beams may be installed in pre-bored holes of at least 600 mm in diameter and concreted up to the base of the excavation to provide adequate shaft and passive resistance. Above the excavation level, fillcrete or a low strength sand/cement mixture may be used to provide temporary backfilling of the pile holes.
- As the excavation is being carried out, a survey monitoring program of the top of the excavation should be carried out. This should include an inspection for any signs of movement at periodic intervals through out the excavation and construction period.
- Groundwater seepage may be encountered during excavation within the depth of excavation. Where necessary, sumps and pumps may be required to control groundwater seepage at the base of the excavation.

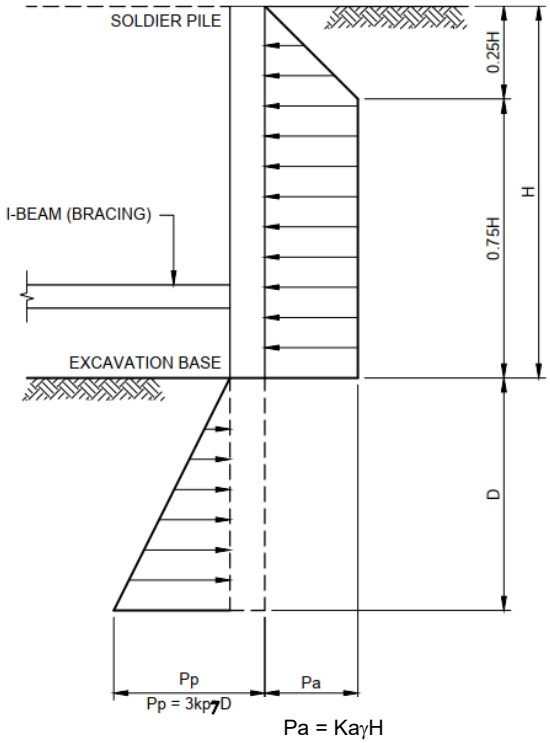
4. Lateral Earth Pressure Distribution

For shoring systems where internal bracing or tiebacks are installed at several levels as the excavation proceeds and where lateral wall movement is to be reduced, the design may be based on a trapezoidal earth pressure distribution shown in **Figure 2** below. Soil parameters for shoring design are provided in **Table 1**, and include the soil type and depth, unit weight (γ) and coefficients of earth pressure (Ka, Kp).

Table 1: Soil Parameters for Shoring Design

Soil Type	Approximate Depth (m)	Bulk Unit Weight, γ (kN/m^3)	Active Earth Pressure Coefficient, Ka	Passive Earth Pressure Coefficient, Kp	Notes
Fill/Silt/Clay	0 – 12	18.0/19.0/17.0	0.41/0.39/0.49	2.46/2.56/2.04	-
Glacial Till (Silt/Clay)	> 12	19.0	0.41	2.46	-
Pit Run Gravel Backfill	0 – 5	20.0	0.27	n/a	Behind retaining wall for excavation face perpendicular to the feedermain

The City of Winnipeg confirmed that pit run gravel (compacted to approximately 95% standard Proctor dry density) was used as backfill material during the construction of the feedermain. Therefore, soil parameters for pit run gravel should be used for the design of the soldier pile retaining wall where the excavation face is perpendicular to the feedermain.



GENERAL NOTES

1. ASSUMES STIFF COHESIVE SOIL.
2. SURCHARGE LOADS ON THE GROUND SURFACE ARE NOT INCLUDED IN THE DIAGRAMS.
3. HYDROSTATIC GROUNDWATER PRESSURES ARE NOT INCLUDED IN THE DIAGRAMS AND MUST BE INCLUDED WHERE APPROPRIATE.
4. Pa IS APPLIED TO WALL FACE. Pp IS APPLIED TO THE DIAMETER OF THE PILE OR FLANGE OF THE H SECTION.

DESIGN PARAMETERS

Pa = DESIGN LATERAL EARTH PRESSURE (kPa) (APPLIED TO WALL FACE)

Pp = DESIGN LATERAL EARTH PRESSURE (kPa) Pp IS APPLIED TO THE DIAMETER OF THE PILE OR FLANGE OF H SECTION

D = DEPTH OF PILE BELOW EXCAVATION BASE (m)

H = TOTAL DEPTH OF EXCAVATION (m)

Figure 2: Lateral Earth Pressure Distribution for Braced Excavations

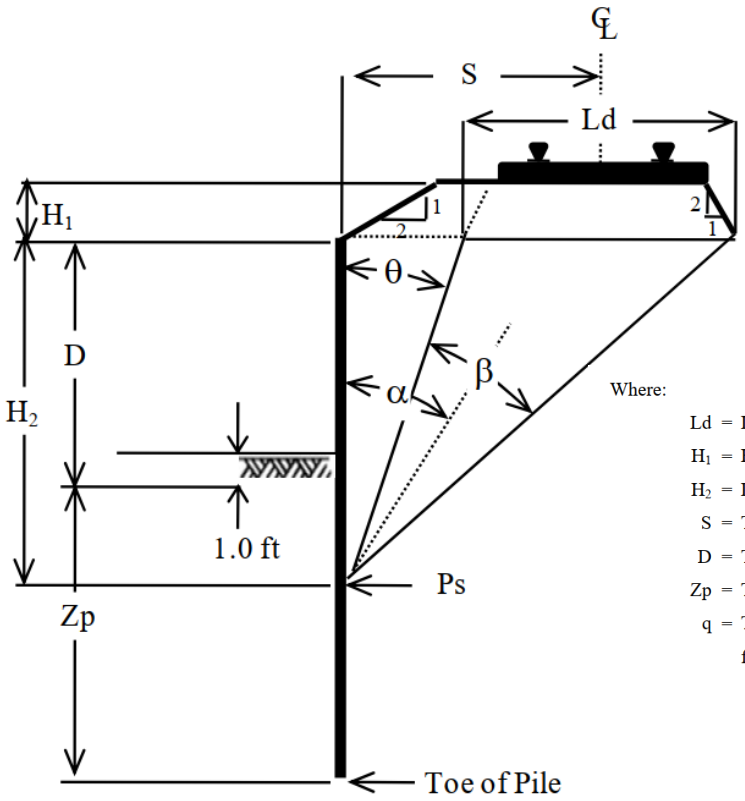
4.1 Lateral Earth Pressure due to Live Rail Loads

Surcharge loading due to live rail loads will be based on the Cooper E80 loading criteria and should be considered in the design of the shoring system. The lateral pressure from the rail loads should be determined using the Boussinesq Strip Loading procedure as shown in **Figure 3**. The horizontal pressure at any point on the retaining wall, Ps, due to E80 loading for a rail track parallel to the shoring system is calculated using the Boussinesq Strip Load Equation provided below.

$$Ps = \frac{2q}{\pi}\left(\beta + \sin\beta\sin^2\alpha - \sin\beta\cos^2\alpha\right) = \frac{2q}{\pi}\left(\beta - \sin\beta\cos(2\alpha)\right)$$

Where α and β are angles measured in radians,

$$\alpha = \theta + \beta/2$$



Where:

Ld = Length of the tie plus H_1.
H_1 = Height from the bottom of tie to the top of shoring
H_2 = Depth of point being evaluated with Boussinesq equation
S = The distance perpendicular from centerline of track to the face of shoring
D = The distance from top of shoring to one foot below dredge line.
Zp = The minimum embedment depth
q = The intensity of strip load due to E80 Railroad live load and can be calculated as follows:

For $H_1 = 0$, Ld = Length of Tie or
For $H_1 > 0$, Ld = Length of Tie + H_1

$$q = \frac{80{,}000}{5\text{ ft}(\text{Ld})} \quad \text{(psf)}$$

Figure 3: Live Load Pressure due to Cooper E80

5. Laterally Loaded Piles (Modulus of Subgrade Reaction)

The resistance of vertical piles to horizontal loads involves soil-structure interaction and is commonly analyzed using computer structural analysis software. The soil response (subgrade reaction) to lateral loads can be modeled in a simplified manner that assumes the soil around a pile can be simulated by a series of horizontal springs for the preliminary design and analysis of soldier piles. The soil behaviour can be estimated using an equivalent spring constant referred to as the modulus of horizontal subgrade reaction (k_s).

The modulus of the horizontal subgrade reaction has been estimated based on subsurface information obtained from previous geotechnical investigations (UMA, 1987).

For cohesive soils (silts, clay and clay till), k_s can be estimated using the following:

$$k_s = 67S_u/B \text{ (kPa/m)}$$

where:

S_u = undrained shear strength of cohesive soil (kPa)

B = Pile diameter (m)

For H-section piles, ‘B’ would be the effective width in the direction of the anticipated lateral load and would change depending on the orientation of the H-section in relation to the lateral load.

The undrained shear strengths to be used in determining the modulus of horizontal subgrade reaction are summarized in **Table 2**.

Table 2: Undrained Shear Strength for Cohesive Strength, Su (kPa)

Soil Type	Approximate Depth (m)	Undrained Shear Strength, S_u (kPa)
Fill/Silt/Clay	0 – 12	40
Glacial Till (Silt/Clay)	> 12	60

6. PLAXIS ANALYSIS

The Finite Element Model (FEM) using the software PLAXIS 2D was created for the most critical soldier pile wall section. A 90 kPa surcharge load was applied 2.5 m away from the proposed excavation (4.8 m deep) along the edge of the existing rail tracks to simulate the Cooper E80 live loads. Assumptions were made for the geotechnical parameters of the various soil layers used in the PLAXIS model based on the available geotechnical information reviewed. To support the 4.8 m deep excavation a soldier pile wall was analyzed. The soldier pile wall consisted of H-Pile (360x132 spaced at 1.2 m) with timber lagging and a lateral brace (310x110 spaced at 1.2 m) installed at 1.5 m below ground surface. The assumed geotechnical parameters for the soil layers and structural elements (as provided by AECOM's structural engineer) are summarized in **Table 3** and **Table 4**, respectively.

Mohr-Coulomb failure model was assigned for all the soil layers and elastic model was assigned for the concrete model.

Table 3: Summary of Geotechnical Parameters for Soils

Material	Failure Model	Unit Weight (kN/m^3)	Effective Friction Angle (degree)	Effective Cohesion (kPa)	Elastic Modulus (MPa)	Poisson's Ratio
Existing Fill	Mohr-Coulomb	18	25	3	20	0.35
Silt	Mohr-Coulomb	19	26	1	15	0.33
High Plastic Clay	Mohr-Coulomb	17	20	5	15	0.4
Till	Mohr-Coulomb	19	25	1	30	0.3

Table 4: Summary of Parameters for Structural Elements

Element	Elastic Modulus (kN/m^2)	Moment of Inertia (m^4/m)	Area (m^2 /m)
Wall (HP360x132)	200 x 10^6	0.000375	0.0168
Bracing (Steel Section)	200 x 10^6	0.000237	0.0141

The FEM mesh was created using 15 nodded triangular elements and plain strain analysis was completed using PLAXIS 2D. Construction sequences were modelled at different phases below:

1. Initial phase – Existing ground condition and geometry with train load
2. Pile installation
3. 1.5 m excavation depth
4. Bracing installation and additional excavation depth ranging of 1.7 to 1.8 m
5. Final phase with excavation depth of 4.8 m below ground surface

Groundwater level was taken at the base of the excavation. A rail load of 90 kPa was also included in the analyses. The wall was analyzed per meter run of wall.

The results of PLAXIS 2D analyses (maximum displacements) are summarized in **Table 5** and illustrated in **Figures 4 to 6. Figures 4 and 5** illustrate the maximum lateral displacement at 1.5 m and 4.8 m depth, respectively. The maximum vertical displacement beneath the existing rail track is shown in **Figure 6**.

Table 5: Summary of Parameters for Structural Elements

Lateral Movement and Settlement	Magnitude	Figure
Lateral movement of the pile top after 1.5 m depth of excavation	3.0 mm	Figure 4
Lateral movement of the pile top after 4.8 m depth of excavation	14 mm	Figure 5
Settlement underneath the existing rail track due to excavation	9 mm	Figure 6

Drainage should be provided in the excavation to help prevent water ponding and maintain the groundwater level below the surface of excavation.

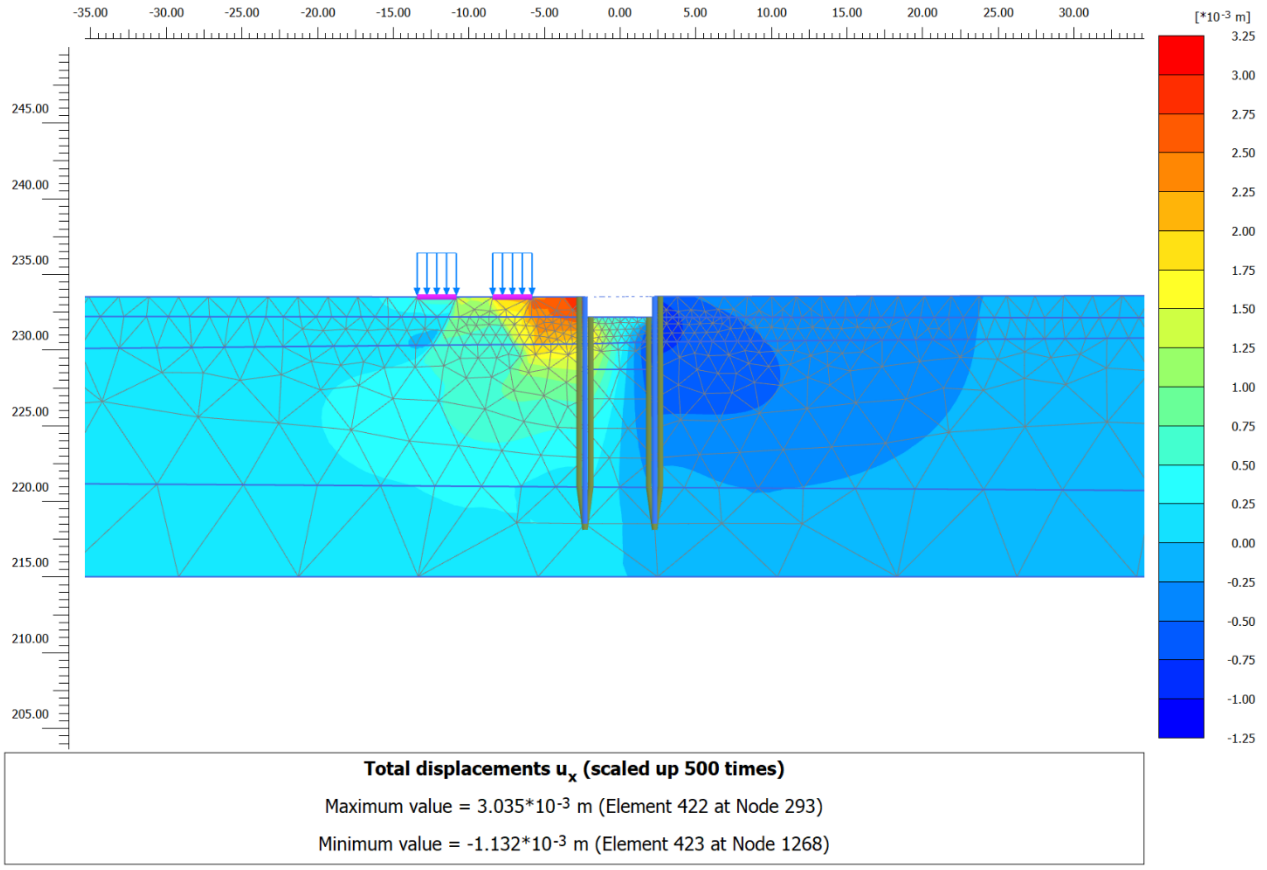


Figure 4: Lateral Displacements after 1.5 m Depth of Excavation

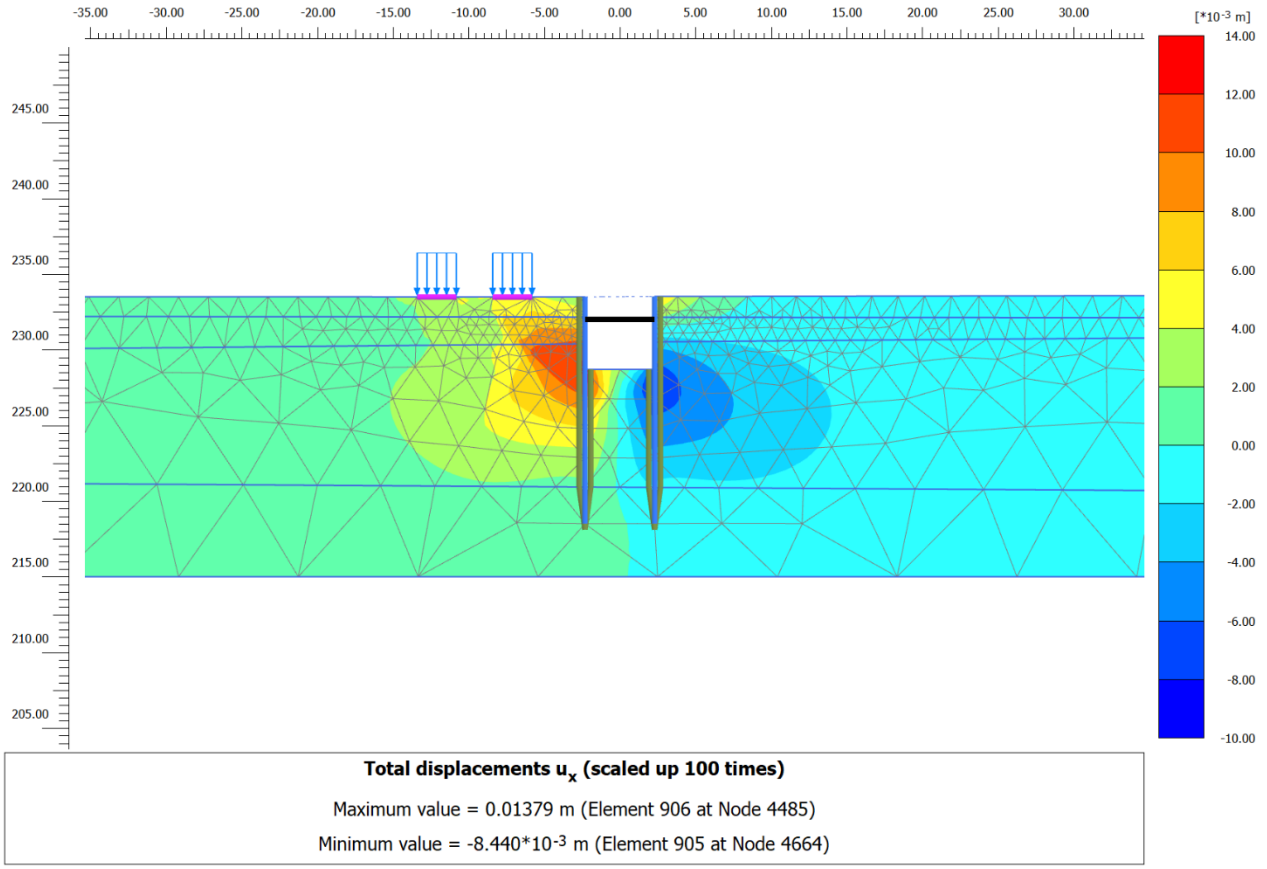


Figure 5: Lateral Displacements after 4.8 m Depth of Excavation

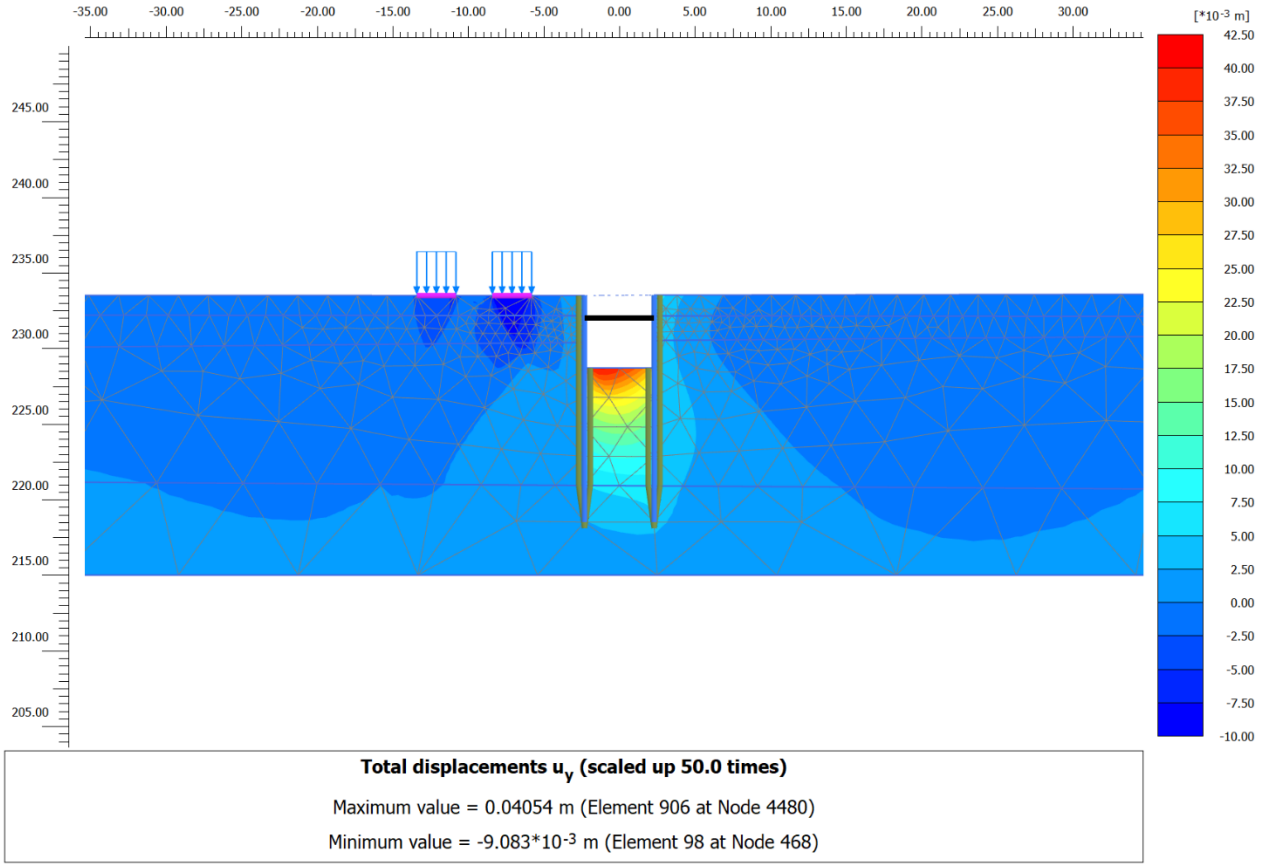


Figure 6: Vertical Settlement Beneath the Rail Tracks due to Excavation

7. RAILTRACK MONITORING REQUIREMENTS

- The existing embankment supporting the rail lines shall not be disturbed and shall be protected at all times.
- The monitoring of track settlement should be carried out by means of surface settlement points in accordance with the general requirements of the CP Geotechnical Protocol **(Appendix C)** for Track Movement Monitoring Guidelines for Trenchless Pipe and Utility Crossing(s) Installation under Railway Tracks (February 25, 2020), as appropriate.
- A proposed layout for surface settlement monitoring points along the rail track is provided in **Figure 7**

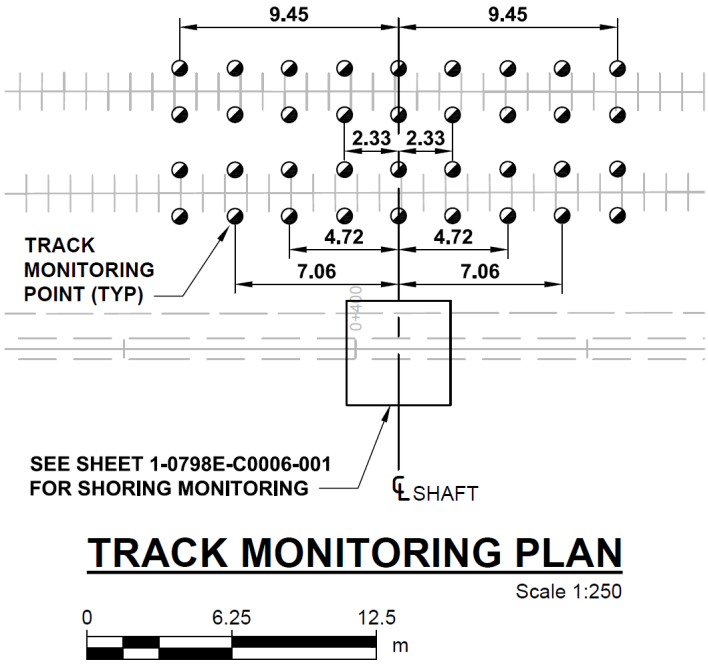


Figure 7: Proposed Layout of Surface Settlement Monitoring Points for Rail Track

- Settlement monitoring of the rail track shall commence a minimum of 2 days prior to construction/excavation in order to establish baseline coordinates and elevations.
- The monitoring points should be surveyed at least twice per day during the duration of construction and at least 3 days after the completion of construction.
- **Table 6** identifies settlement threshold that will trigger two levels of alarm and the appropriate action item.
- It is understood that this track segment would be defined as Class 1 as per Transport Canada Rules Respecting Track Safety, Subpart A, and allowable movement would fall under Subpart C – Track Geometry Section 6, Track Surface for Class 1 Track.
- The survey results shall be submitted daily to AECOM's geotechnical engineer for review.

Table 6: Settlement Alarm Threshold and Action Item

Alarm Levels	Settlement Threshold	Action Item
Level 1 – Warning	≥ 16 mm to < 38 mm	A survey of surface points will then be carried out and work will be authorized to continue if no movement of the surface points have been measured from the previous reading.
Level 2 – Critical	≥ 38 mm	Notify CP Roadmaster or their designate and stop work immediately. A survey of the surface points will then be carried out and work will be authorized to continue if no movement is measured for at least two (2) readings taken 12 hours apart. If movement of the rails is recorded, AECOM's structural engineer will be notified to provide appropriate recommendations.

8. CLOSURE

We trust that the information provided meets your requirements. Should you require any additional information, or further clarification regarding any of the above, please do not hesitate to contact the undersigned.

Prepared by

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Geotechnical, Environment
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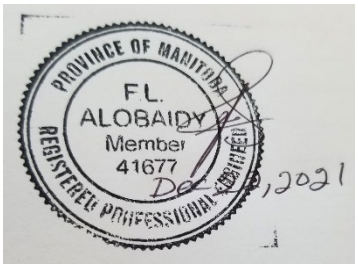
Prepared by



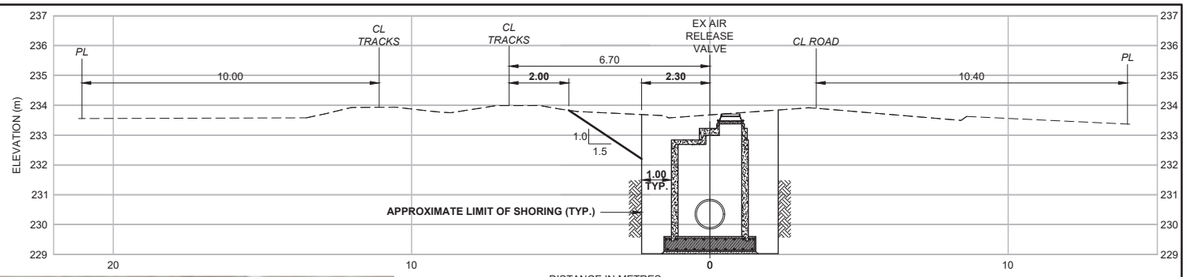
Faris Alobaidy, M.Sc., P.Eng.
Senior Geotechnical Engineer
faris.alobaidy@aecom.com

REFERENCES

UMA Engineering Ltd., 1987. The City of Winnipeg, West End Feedermain, Geotechnical Investigation. A report prepared for the City of Winnipeg, dated August 5, 1987. UMA File Number: 41-06-0265-238-01-02.

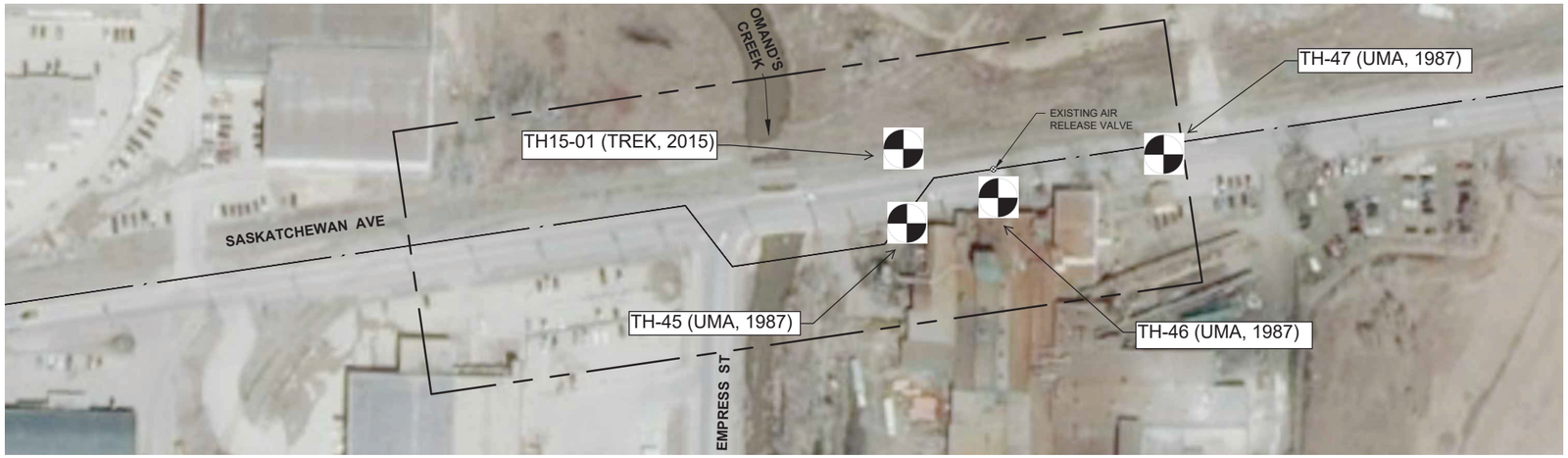
TREK Geotechnical, 2015. Saskatchewan Avenue at Omand's Creek, Bridge Replacement, Geotechnical Investigation. A report prepared for Morrison Hershfield Ltd., dated September 23, 2015, Project Number: 0035 020 00.

Canadian Pacific, 2020. Geotechnical Protocol for Pipeline and Utility Crossing(s) Under Railway Tracks, Appendix C, Track Movement Monitoring Guidelines for Trenchless Pipe Installation, last updated February 25, 2020.

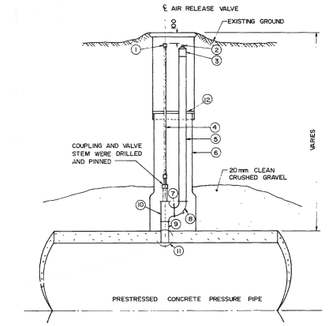


X-SEC No.1 - STA. 4+01.80

HORIZONTAL SCALE = 1:100
VERTICAL SCALE = 1:100



Approximate location previous testholes



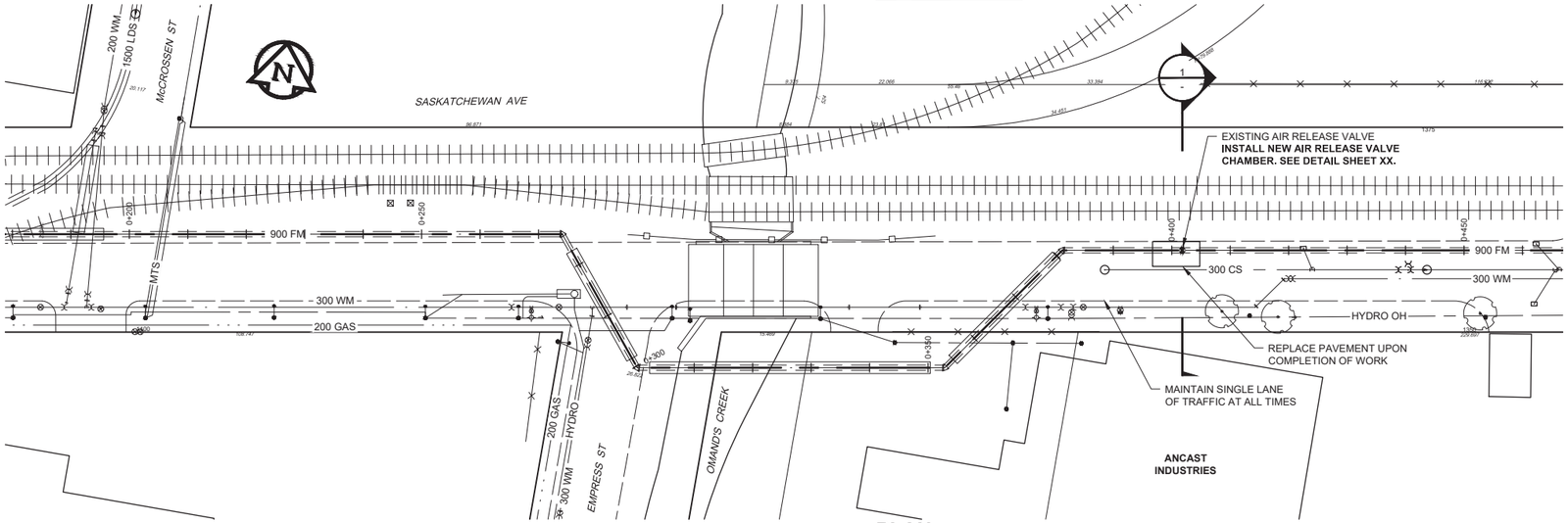
- EXISTING AIR RELEASE VALVE

- REFERENCED FROM CITY DWG NUMBER D-1627 Scale N.T.S.

SITE PLAN

Scale 1:1000

0 25 50 m



PLAN

Scale 1:500

0 12.5 25 m

METRIC

WHOLE NUMBERS INDICATE MILLIMETRES
DECIMALIZED NUMBERS INDICATE METRES

EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PLAN	NEW	EXISTING	LEGEND - PROFILE	NEW
150 WM	WATERMAIN	150 WM		CURB STOP		150 WM	WATERMAIN	150 WM
	HYDRANT			REDUCER			HYDRANT	
	VALVE			COUPLING			VALVE	
300 LDS	LAND DRAINAGE SEWER	300 LDS		ANODE		300 LDS	LAND DRAINAGE SEWER	300 LDS
250 WWS	WASTE WATER SEWER	250 WWS		HYDRO		250 WWS	WASTE WATER SEWER	250 WWS
	MANHOLE			MTS			PAVEMENT CROWN	
	CATCH BASIN			GAS			N/W PROPERTY LINE	
	CURB INLET			TESTHOLE			S/E PROPERTY LINE	
	CULVERT			LAMP STANDARD			N/W GUTTER	
	PIPE ABANDONMENTS			TREE			S/E GUTTER	
	SURVEY BAR							

LOCATION APPROVED

UNDERGROUND STRUCTURES

SUPR. U/G STRUCTURES COMMITTEE DATE

NOTE:

LOCATION OF UNDERGROUND STRUCTURES AS SHOWN ARE BASED ON THE BEST INFORMATION AVAILABLE. BUT NO GUARANTEE IS GIVEN THAT ALL EXISTING UTILITIES ARE SHOWN OR THAT THE GIVEN LOCATIONS ARE EXACT. CONFIRMATION OF EXISTENCE AND EXACT LOCATION OF ALL SERVICES MUST BE OBTAINED FROM THE INDIVIDUAL UTILITIES BEFORE PROCEEDING WITH CONSTRUCTION.

NO.	REVISIONS	YY/MM/DD	BY
A	ISSUED FOR REVIEW	21/06/16	KLC

ENGINEERS GEOSCIENTISTS MANITOBA
Certificate of Authorization
AECOM Canada Ltd.
No. 4671 Date:

AECOM

DESIGNED BY	NJK	CHECKED BY	
DRAWN BY	KLC	APPROVED BY	
HOR. SCALE	AS NOTED	RELEASED FOR CONSTRUCTION	
VERT. SCALE	N/A		
DATE		DATE	

PROFESSIONAL'S SEAL

CONSULTANT DRAWING NO.
60645745-SHT-30-0000-C-1008

Winnipeg

THE CITY OF WIN EG
WATER AND WASTE DEPA ENT

PROVISION OF PIPELINE ACCESS MODIFICATIONS, CLEANING AND SUPPORT SERVICES FOR RIVER CROSSING INSPECTIONS - PHASE THREE

SITE 8

WEST END FEEDER MAIN (at OMAND'S CREEK)

BID OPPOR O. 507-2021

SH OF 10

CIT UMBER REV

FIGURE 1 - PLAN

TH15-01 (TREK, 2015)

UMA Engineering Ltd.
Engineers & Planners
1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7

PROJECT: WEST END FEEDERMAIN
CLIENT: CITY OF WINNIPEG
JOB NO.: 0265-238-01-02
DRILLING DATE: DECEMBER 16, 1986
DRILLED BY: SUBTERRANEAN LTD.

TEST HOLE NO. 45

SURFACE ELEVATION: 233.43m
CO-ORDINATES:

MOISTURE CONTENT —○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△
20 40 60 80%

feet / DEPTH / metres	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	STANDARD PEN.(N)	COMP. STRENGTH □psf □kPa	MISC TESTS AND REMARKS
		FILL				
1		CLAY - black - organic				
		SILT - light brown - wet				
2		- soft				
		CLAY - brown - stratified - occasional thin silt layers - weathered - stiff	1B			PI = 54% γ_d=10.78 KN/m^3 γ_w=16.46 KN/m^3 L_v=65 kPa
3		SILT - oxidized				
4		CLAY - brown - trace of small silt pockets - stiff to firm	2B			Apparent Slickenside @ 35° from horizontal γ_d=10.35 KN/m^3 L_v=75.2 kPa
5						
6		CLAY - grey - plastic - occasional till pockets - stiff to firm with depth	3B			γ_d=10.55 KN/m^3 γ_w=16.55 KN/m^3 L_v=80.4 kPa
7						
			4B			γ_d=10.87 KN/m^3 γ_w=16.68 KN/m^3 L_v=27.9 kPa
8						

UMA Engineering Ltd.
Engineers & Planners
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PROJECT: WEST END FEEDERMAIN
CLIENT: CITY OF WINNIPEG
JOB NO.: 0265-238-01-02
DRILLING DATE: DECEMBER 16, 1986
DRILLED BY: SUBTERRANEAN LTD.

TEST HOLE NO. 45 Contin.

SURFACE ELEVATION: 233.43m
CO-ORDINATES:

MOISTURE CONTENT —○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△
20 40 60 80%

feet / DEPTH / metres	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	STANDARD PEN.(N)	COMP. STRENGTH □psf □kPa	MISC TESTS AND REMARKS
9						
			5B			
10						
11			6B			γ_d=11.69 KN/m^3 γ_w=17.58 KN/m^3 L_v=40.1 kPa
12						
			7B			
		TILL - silt and clay layers - sandy - some gravel - light brown - soft @ clay interface - dense to very dense with depth				
13						
			8G			
14			9G			
15						
		Auger refusal at 15.5 m.				
16						

UMA Engineering Ltd.
Engineers & Planners
1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7

PROJECT: WEST END FEEDERMAIN
CLIENT: CITY OF WINNIPEG
JOB NO.: 0265-238-01-02
DRILLING DATE: DECEMBER 18, 1986
DRILLED BY: SUBTERRANEAN LTD.

TEST HOLE NO. 46

SURFACE ELEVATION: 233.35m
CO-ORDINATES:

MOISTURE CONTENT —○
LIQUID LIMIT ——□
PLASTIC LIMIT ——△
20 40 60 80%

feet / DEPTH / metres	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	STANDARD PEN.(N)	COMP. STRENGTH □psf □kPa	MISC TESTS AND REMARKS
		FILL - gravel and slag - frozen				
1		SILT - light brown - wet - soft				
2						
		CLAY - brown - highly plastic - trace of silt - damp - stiff to firm with depth	B1			
3			B2			
4						
5		CLAY - grey - highly plastic - moist - firm to soft at 4.6 mm - occasional pebble and trace of silt at 6.0 m				
6			B3			
7		- very soft at 7.5 m				
8						

UMA Engineering Ltd.
Engineers & Planners
1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7

PROJECT: WEST END FEEDERMAIN
CLIENT: CITY OF WINNIPEG
JOB NO.: 0265-238-01-02
DRILLING DATE: DECEMBER 16, 1986
DRILLED BY: SUBTERRANEAN LTD.

TEST HOLE NO. 46 Contin.

SURFACE ELEVATION: 233.35m
CO-ORDINATES:

MOISTURE CONTENT — ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △
20 40 60 80%

feet / metres DEPTH	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	STANDARD PEN.(N)	COMP. STRENGTH □psf □kPa	MISC TESTS AND REMARKS
			G1			
9		End of hole at 9.0 m.				
10		NOTES: - some sloughing from silt layer during drilling.				
11						
12						
13						
14						
15						
16						

UMA Engineering Ltd.
Engineers & Planners
1479 Buffalo Place, Winnipeg, Manitoba, Canada R3T 1L7

PROJECT: WEST END FEEDERMAIN
CLIENT: CITY OF WINNIPEG
JOB NO.: 0265-238-01-02
DRILLING DATE: DECEMBER 19, 1986
DRILLED BY: BM DRILLING LTD.

TEST HOLE NO. 47

MOISTURE CONTENT — ○
LIQUID LIMIT ——— □
PLASTIC LIMIT ——— △
20 40 60 80%

SURFACE ELEVATION: 233.41m
CO-ORDINATES: _____

feet / metres DEPTH	SOIL PROFILE	SOIL DESCRIPTION	SAMPLE NO.	STANDARD PEN.(N)	COMP. STRENGTH □psf □kPa	MISC TESTS AND REMARKS
0		FILL - clay and stones - frozen				
1		CLAY - brown - plastic - weathered - damp - stiff				
2		SILT - light brown - wet - soft				
3		CLAY - highly plastic - trace of silt - damp to moist				
4		- stiff to soft at 4.5 m				
5		End of hole at 5.0 m.				
6		NOTES: - no seepage during drilling.				

TREK GEOTECHNICAL

Sub-Surface Log

Client:	Morrison Hershfield	**Project Number:**	0035 020 00
Project Name:	Saskatchewan over Omand's Creek	**Location:**	UTM N-5529845.75, E-629659.55
Contractor:	Maple Leaf Drilling	**Ground Elevation:**	233.66 m Existing Ground
Method:	125 mm Solid Stem Auger, B37X Track Mount	**Date Drilled:**	7 April 2015

Sample Type: Grab (G), Shelby Tube (T), Split Spoon (SS), Split Barrel (SB), Core (C)

Particle Size Legend: Fines, Clay, Silt, Sand, Gravel, Cobbles, Boulders

Column headings: Elevation (m); Depth (m); Soil Symbol; MATERIAL DESCRIPTION; Sample Type; Sample Number; SPT (N); □ Bulk Unit Wt (kN/m³) 16 17 18 19 20 21; Particle Size (%) 0 20 40 60 80 100; PL MC LL 0 20 40 60 80 100; Undrained Shear Strength (kPa) — Test Type: △ Torvane △, ✪ Pocket Pen. ✪, ⊠ Qu ⊠, ○ Field Vane ○ — 0 50 100 150 200 250

Elevation (m)	Depth (m)	Material Description	Samples
	0.0	ORGANIC CLAY (FILL) - silty, trace sand, trace gravel <15 mm - black - moist to dry, stiff, frozen from 1.2 m to 1.5 m - intermediate to high plasticity	G1
232.1	1.5	CLAY - silty, brown - moist, stiff, intermediate plasticity	G2
231.8	1.8	SILT - trace clay - light brown - moist, firm to soft - low plasticity	G3
230.9	2.8	CLAY - silty - mottled brown / grey - moist, very stiff - intermediate plasticity - trace oxidation, trace silt inclusions <5 mm below 3.7 m - firm to stiff below 4.3 m - grey below 5.2 m - soft below 6.1 m - trace till inclusions below 8.2 m	G4, T5, G6, T7, G8, G9

Logged By: Syl Precourt **Reviewed By:** Michael Van Helden **Project Engineer:** Michael Van Helden

TREK GEOTECHNICAL

Sub-Surface Log

Test Hole TH15-01

Elevation (m)	Depth (m)	Soil Symbol	MATERIAL DESCRIPTION	Sample Type	Sample Number	SPT (N)
	10.5				G10	
	11.0					
	11.5					
	12.0				G11	
	12.5					
220.6	13.0					
			SILT TILL - trace gravel <20 mm - light grey - moist to wet, soft - non plastic		G12	
	13.5					
	14.0					
	14.5					
	15.0				G13	
	15.5					
	16.0					
217.2					G14	
					SPT15	

Bulk Unit Wt (kN/m³): 16 17 18 19 20 21

Particle Size (%): 0 20 40 60 80 100

PL MC LL: 0 20 40 60 80 100

Undrained Shear Strength (kPa)

Test Type
△ Torvane △
✥ Pocket Pen. ✥
☒ Qu ☒
○ Field Vane ○

0 50 100 150 200 250

END OF TEST HOLE AT 16.5 m IN SILT TILL

Notes:
1) Power auger refusal encountered at 16.5 m.
2) No seepage or sloughing observed.
3) Water at 6.7 m
4) Test hole was backfilled with auger cuttings 0.5 m bentonite at bottom of test hole and 0.5 m bentonite at top
5) Test hole was open to 11.6 m

Logged By: Syl Precourt **Reviewed By:** Michael Van Helden **Project Engineer:** Michael Van Helden