GEOTECHNICAL PROTOCOL

FOR

PIPELINE AND UTILITY CROSSING(S) UNDER

RAILWAY TRACKS

Engineering

Geotechnical and Public Works – Utilities

Last Updated: May 16, 2022

2	May 16, 2022	DJW	Fig C – Pg 39 & other sections highlighted
1	Feb 25, 2020	MR	Level 2 criteria – Pg 36
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CP Geotechnical Protocol for
Pipeline and Utility Crossing(s) under Railway Tracks

Last Updated: May 16, 2022
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1.0 Limitations of the Document

The following protocol is independent of the requirements for assessing the structural components of the pipeline and pipeline crossing. The structural requirements for all pipeline crossings are included in CP – SP-TS-2.39- Pipeline and Cable Installations within Railway Right of Way. An agreement or permit from Canadian Pacific Railway's Public Works - Utilities is required before commencing with any work within the railway corridor. **Proposals for pipelines and utilities parallel to the track(s) are not covered under this protocol.**

In addition, this document does not cover review on any of the engineering design aspects of the proposed pipelines and utility crossings. Suitable engineering design is the sole responsibility of the applicant. Geotechnical approval of a proposed pipeline crossing by Canadian Pacific (CP) in no way warrants the suitability of construction methods/techniques for anticipated ground conditions, nor does it warrant the suitability of existing ground and site conditions for the use proposed by the applicant of the crossing. CP does not take any responsibility for the suitability of the construction method or warrantee the ground and/or site conditions. CP geotechnical approval of a pipeline and utility installation application merely indicates that based on the provided and available information, the proposed construction and design addresses CP's needs at the time of review and approval. CP does not provide engineering recommendations, directions or minimum standards to the applicant or their contractor(s) for design and execution of their work within CP Right-of-Way (ROW).

Due to third party work on CP ROW, CP will not be liable for any damages or delays to the applicant and/or CP assets and operation because of its approval of an application. In addition, any damages incurred to CP due to third party pipeline and utility crossing(s) will be the responsibility of the applicant.

CP requires that the applicant provide adequate documentation as outlined in this protocol; clearly identify the responsible Professional Engineer of Record and the components of the project for which they are responsible.

2.0 General Terminology

Base of Rail (BOR): is the bottom surface of the rail and is frequently used as a local datum from which vertical measurements are referenced. If an external datum is utilized the elevation of the BOR will be identified.

Geotechnical Engineer of Record's onsite designate/representative: A geotechnical trained and competent person assigned by the Geotechnical Engineer of Record to act as site inspector

who will be present onsite during the full duration of the construction and installation within railway operating corridor, unless, otherwise directed by CP Public Works - Utilities Supervisor. The site inspector must have the required training, experience and understanding of the site conditions, proposed design, and construction methodology to make sound engineering judgement and decisions, and reports during the course of the work.

Service Provider(s): include professional engineering firm(s) or individual(s) representing relevant or applicable engineering disciplines, to be retained on behalf of CP for engineering related review and/or oversight of fieldwork and track settlement monitoring results, for which the compensation will be paid by the applicant.

Zone of Potential Track Loading (ZPTL): is considered as the area under the track and within a 1V to 1.5H soil zone extending down from a point at the level of the BOR and 2 m (6.6 ft.) from The centerline of track as shown in Figure 3.

FRA: Federal Railroad Administration.

TC: Transport Canada.

3.0 Introduction

The purpose of this document is to ensure efficient application process and ensure safety and uninterrupted operation of Canadian Pacific (CP) Railway's operations during the execution of proposed third party pipeline and utility crossing(s) within CP ROW. This document is intended to guide the applicant of the minimum application requirements, review and approval process for proposed pipeline and utility crossing(s) as completed by CP Public Works - Utilities and Geotechnical groups. The goal of this protocol is to:

3.1 Provide safe track(s) conditions during and after the installation of proposed pipeline and utility crossing(s);

3.2 Establish requirements and procedures to be followed by the applicant(s) to minimize difficulties and risks to CP's operations and its assets during the installation and operation of pipeline and utility crossing(s) under CP's tracks and within its ROW;

3.3 Specify minimum criteria to be met for CP's review;

3.4 Ensure adequate subsurface information including geotechnical and groundwater information is available and an assessment by CP's geotechnical group or a CP approved service provider has been completed prior to providing approval; and

3.5 Allow timely processing of application for pipeline and utility crossing(s) approvals.

4.0 Emergencies

In the event of any occurrence due to construction/contractor activities that does or could pose a hazard, immediately contact CP at **1-800-716-9132**.

5.0 Winter Work Restriction within CP ROW

No construction and installation of pipeline and utility crossing(s) will take place from January 1st to March 31st. This restriction is particularly critical to areas where frost penetrates the ground and may make it difficult to observe surface settlement and loss of soil from underneath the track substructure due to misperception of a levelled frozen surface. Such conditions pose a risk to the stability of CP's track and its substructure during thawing season and are not acceptable.

In areas where the applicant does not consider frost as a potential risk, the applicant is required to assure and demonstrate to CP as to why winter work restriction is not applicable to their proposed work. Exceptions to winter work restriction will be evaluated on case by case basis.

6.0 Application Process Identification

To identify the applicable process, complete appropriate level of assessment and allow timely processing of a pipeline and utility crossing(s) proposal, the requirement criteria have been divided into three levels as identified in Table 1, i.e. Minimum, Intermediate and Detailed. These processes are categorized based on the size, cover, location and proximity of pipeline from tracks and other structures, and construction methodology of the proposed pipeline and utility crossing(s).

Applicant is expected to consult Table 1 to identify the level of effort and detail of submission required to meet CP review requirements for review. Details of each process are discussed in the following sections.

Table 1 – Process Identification

		Process Levels		
		1. Minimum[1]	**2. Intermediate**	**3. Detailed**
Dimension Criteria	Outside diameter of pipe	Less than 300 mm (12 in.)	300 mm (12 inches) to 1500 mm (59 in.)	Greater than 1500 mm (59 in.)
	Cover between BOR and top of pipe	Greater than 1.5 m (5 ft.) or three pipe diameters whichever is greater.	Greater than 1.5 m (5 ft.) or two (2) pipe diameters whichever is greater.	Less than 1.5 m (5 ft.) or two (2) pipe diameters.
	Adjacent structures including switches and signals	Greater than 10 m (32.8 ft.) from centerline	Within 2.5 times, cover between BOR and top of pipe.	
	Depth of pipes outside ZPTL	Refer to SP-TS 2.39 All pipes will be at least 0.91 m (3 ft.) below ground (below sub-ballast layer) where pipes are not below the ZPTL.	Less than 0.91 m (3 ft.) burial within ZPTL.	
Excavation Criteria	Excavation close to CP track(s)	Jacking/access pits shall be more than 10 m (32.8 ft.) from the closest track centerline and shall not encroach on the ZPTL.	Excavations or jacking/access pits within 10 m (32.8 ft.) of the closest track centerline.	
	Crossing angle	Less than 45 degrees off perpendicular to the track.	More than 45 degrees off perpendicular to the track.	

<table>
<tr><td></td><td colspan="3">Process Levels</td></tr>
<tr><td></td><td>1. Minimum[1]</td><td>2. Intermediate</td><td>3. Detailed</td></tr>
<tr><td rowspan="2">Construction Method</td><td colspan="2">Trenchless method[2]</td><td rowspan="2">All methods considered.</td></tr>
<tr><td colspan="2">Pipe bursting will only be considered where the predicted heave is less than 10% of the movement that would result in a change of the FRA or TC track class.</td></tr>
<tr><td>Approval Process</td><td>Public Works - Utility group to approve with no geotechnical submission.</td><td colspan="2">Full review of design, geotechnical and construction method Applicant to pay for the review cost of CP approved service provider.</td></tr>
</table>

[1] Move to next class if one or more criteria are not met.

[2] Trenchless methods include Auger Boring (AB), Pipe Jacking, Pipe Ramming (PR), Horizontal Directional Drilling (HDD) except high pressure fluid jetting method, Microtunnelling (MT) but exclude any type of mining techniques where any stand up time is required before the tunnel support is placed.

7.0 Minimum Information Requirements

7.1 All proposals for pipeline and utility crossing(s) approvals will be under the signature and seal of a locally registered professional Geotechnical Engineer referred to as Geotechnical Engineer of Record (GER). The objective is to ensure that a registered professional from applicant's design firm or organization is given the opportunity and responsibility to assess the site and subsurface conditions and demonstrates due diligence to assure CP that the proposal is appropriate for such conditions. This, however, depending on the complexity of design and proposal, may be in addition to the requirements of meeting industry standards or current regulatory requirements for structural integrity of the pipeline/utility. Such design will also require signature and seal by a professional geotechnical and/or structural engineer.

7.2 The application package must include a construction plan that specifies the terms and conditions for the execution of the proposed work, including assignment of responsibility. The applicant of the crossing(s) is responsible to ensure that the work is executed in accordance with the terms of the agreement with CP.

7.3 **Engineering Drawings:** All pipeline and utility crossing(s) application packages will be accompanied by following documents, at minimum, showing features on drawings in true scale.

7.3.1 Plan of the proposed pipe and utility crossing(s) under the track (Appendix A, Figure 1). This drawing will show the following features:

7.3.1.1 Location of the crossing(s), referencing identifiable landmarks including Mileage and Subdivision of the proposed crossing(s) as per CP Subdivision naming and Mileage convention. Applicant can obtain the Mileage and Subdivision information from CP Public Works - Utilities group; The title of the plan will include the subdivision name and mileage of the location.

7.3.1.2 Pipe centerline, diameter, length, size, limits, thickness and material;

7.3.1.3 Location of any adjacent structures including but not limited to signals, switches, culverts, other existing underground/buried services including Fibre Optics Transmission Systems (FOTS) and relevant distances from the centerline of the track(s);

7.3.1.4 Location of the ditch line and any breaks in slope;

7.3.1.5 Location of drilled boreholes or test pits from geotechnical investigation;

7.3.1.6 Location of all tracks and distances from track centerline to the proposed work area location; and

7.3.1.7 Location of all access pits, size, depth and details of support of excavation, if applicable.

7.3.2 Profile of the track and proposed pipeline and utility crossing(s) along the centerline of the track (Appendix A, Figure 2). The profile will show the following features:

7.3.2.1 Location of the crossing(s), referencing identifiable landmarks including Mileage and Subdivision of the proposed crossing(s) as per CP Subdivision naming and Mileage convention. Applicant can obtain the Mileage and Subdivision information from CP Public Works - Utilities Group;

7.3.2.2 Pipe centerline, diameter, length, size, limits, thickness and material;

7.3.2.3 Location of any adjacent structures including but not limited to signals, switches, culverts, other existing underground/buried services including Fibre Optics Transmission Systems (FOTS) and vertical distance from BOR;

7.3.2.4 Elevation of surface water in ditches, elevation of the ground water table in all boreholes and the date it was measured;

7.3.2.5 Test pit/borehole locations along with the stratigraphic profile as determined through the geotechnical investigation;

7.3.2.6 Depth of top of pipe to the BOR; and

7.3.2.7 Location of all jacking/access pits, size, depth and details of support of excavation, if applicable.

7.3.3 Section of the track along the centerline of the proposed pipeline and utility crossing(s) (Appendix A, Figure 3). This drawing will show the following features:

7.3.3.1 Location of the crossing(s), referencing identifiable landmarks including Mileage and Subdivision of the proposed crossing(s) as per CP Subdivision naming and Mileage convention. Applicant can obtain the Mileage and Subdivision information from CP Public Works - Utilities group;

7.3.3.2 Pipe centerline, diameter, length, size, limits, thickness and material;

7.3.3.3 Any adjacent structures including but not limited to signals, switches, culverts, other existing underground/buried services including FOTS and vertical distance from BOR;

7.3.3.4 Elevation of surface water in ditches, elevation of the ground water table in all boreholes and the date they were measured;

7.3.3.5 Test pit/borehole locations along with the stratigraphic profile as determined through the geotechnical investigation;

7.3.3.6 Location of jacking or access pits and proposed cut slope angles;

7.3.3.7 Location of the centerline of all tracks;

7.3.3.8 Depth of the top of pipe to the BOR; and

7.3.3.9 Any excavations that encroach on the ZPTL; Indicate ZPTL and distance from ground to the top of pipe.

7.3.3.10 Cross-Sections of perpendicular to the track shall be displayed as viewing in the direction of increasing CPR mileage; left and right-hand being so determined.

7.4 Geotechnical Investigation Report (if applicable) signed and sealed by a locally registered professional Geotechnical Engineer;

7.5 Settlement Monitoring Plan indicating layout and types of settlement monitors to be installed, frequency of measurements, alarm thresholds i.e. “Warning” and “Critical” thresholds, reporting protocol, and immediate actions to take when required. General track movement monitoring guidelines are provided in Appendix C.

7.6 Other Information: This includes information related to additional design and requirements based on the ground conditions and proposed construction. This may include excavation support/shoring, dewatering requirements etc. If required, complete design and relevant drawings will be required.

7.7 Applicant is expected to restore the site to its original condition.

7.8 Proposals for open cut will only be considered at sites where conditions make other installation techniques impractical or where rail traffic is low. This, however, will be assessed on case by case basis.

7.9 Installations using high pressure fluid jetting will not be considered.

7.10 The cost of remediation incurred to CP as a result of pipeline and utility crossing(s) construction and installation and related activities will be borne by the crossing(s) applicant. Some of the issues include settlement or soil heave induced by the crossing(s) installation during and after the construction.

7.11 All pipelines and utilities installed below the highest ground water level predicted will be sealed during construction.

7.12 All pipelines that will or could carry water shall be:

7.12.1 Installed with even bearing throughout its length to limit local settlement; and

7.12.2 Sloped to one end and prevent standing water. Special exemptions will be considered for inverted siphons or other applications requiring level pipes.

8.0 Process 1 – Minimum

8.1 Criteria

The general requirements included in Table 1 in conjunction with the following requirements must be met to obtain approval for a pipeline and utility crossing(s) that qualifies as a Process 1 crossing(s).

Table 2: Process 1 – Minimum

Dimension Criteria	
Outside pipe diameter	Less than 300 mm (12 in.)
Cover between BOR and top of pipe	Greater than 1.5 m (5 ft.) or three pipe diameters whichever is greater.
Adjacent structures including switches and signals	Greater than 10 m (32.8 ft.) centerline.
Depth of pipes outside ZPTL	Refer to SP-TS 2.39 All pipes will be at least 0.91 m (3 ft.) below ground where pipes are not below the ZPTL.
Excavation Criteria	
Excavation close to CP track(s)	Jacking/access pits shall be more than 10 m (33 ft.) from the closest track centerline and not encroach on the ZPTL.
Crossing angle	Less than 45 degrees off perpendicular to the track.
Construction Method	

1. Trenchless method[1]
2. Pipe bursting will only be considered where the predicted soil heave is less than 10% of the movement that would result in a change of the FRA or TC track class.

[1] Trenchless methods include Auger Boring (AB), Pipe Jacking, Pipe Ramming (PR), Horizontal Directional Drilling (HDD) except high pressure fluid jetting method, Microtunnelling (MT) but exclude any type of mining techniques where any stand up time is required before the tunnel support is placed.

8.2 Application Requirements

8.2.1 The applicant will provide documents and drawings containing the information identified in Section 7.0.

8.2.2 Generally,a geotechnical investigation is not required. However, in areas or conditions where problems have arisen with similar pipe crossings CP reserves the right to require a geotechnical investigation to be completed and submitted with the application.

8.2.3 Even if not required by CP, a geotechnical investigation may be completed at the discretion of the applicant.

8.3 Application Review and Approval Process

8.3.1 Applicant submits engineering documents to CP Public Works - Utilities.

8.3.2 CP Public Works – Utilities reviews documents to ensure applicable and complete engineering documents are provided.

8.3.3 An assessment is completed by CP Public Works – Utilities to provide decision/approval documentation.

9.0 Process 2 – Intermediate

The Intermediate process pertains to those proposed pipeline/track crossing(s) that exceed the minimum criteria but do not exceed the maximum criteria. The applicant will be required to submit information for review and approval by CP Geotechnical group, Public Works – Utilities or a CP

approved service provider but may not be subjected to additional engineering, monitoring and construction requirements.

9.1 Criteria

The general requirements included in Table 1 in conjunction with the following requirements must be met to obtain approval for a pipeline and utility crossing(s) that qualifies as a Process 2 crossing(s).

Table 3: Process 2 – Intermediate

Dimension Criteria	
Outside pipe diameter	300 mm (12 in.) to 1500 mm (59 in.)
Cover between BOR and top of pipe	Greater than 1.5 m (5 ft.) or two (2) pipe diameters whichever is greater.
Adjacent structures including switches and signals	Within 2.5 times, cover between BOR and top of pipe.
Depth of pipes outside ZPTL	Less than 0.91 m (3 ft.) burial within ZPTL.
Excavation Criteria	
Excavation close to CP track(s)	Excavations or jacking/access pits within 10 m (32.8 ft.) of the closest track centerline.

Crossing angle	More than 45 degrees off perpendicular to the track.
Construction Method	
	1. Trenchless method[1] 2. Pipe bursting will only be considered where the predicted soil heave is less than 10% of the movement that would result in a change of the FRA or TC track class.

[1] Trenchless methods include Auger Boring (AB), Pipe Jacking, Pipe Ramming (PR), Horizontal Directional Drilling (HDD) except high pressure fluid jetting method, Microtunnelling (MT) but exclude any type of mining techniques where any stand up time is required before the tunnel support is placed.

9.2 Application Requirements

9.2.1 Identification of the Geotechnical Engineer of Record (GER). The GER will be responsible for the proposed works on CP's ROW from project start up to project closeout including submission of construction summary report and as-built drawing.

9.2.2 Description of the subsurface soil and ground water conditions within and adjacent to CP embankment along the proposed pipe/track crossing alignment and to a depth no less that 1.5 times the invert depth below the BOR. This will consider the impact of silt, fine sand or sand soil, and their relation to the water table and pipe depth.

9.2.3 An estimate of the expected extent and magnitude of ground movement over time based on the proposed pipe installation method will be provided.

9.2.4 A program of ground surface and subsurface (settlement plates) movement monitoring will be implemented. The program must be capable of detecting movement of no less than 50 percent of the movement that would result in a change of the track class as determined by the FRA or TC track safety rules.

9.2.5 A procedure for notification of the appropriate CP personnel in the event that excessive or unexpected settlement occurs. A complete 24HR CP Emergency

contact list, including local personnel and OC will be compiled and in place before any work proceeds within the railway right of way.

9.2.6 A recovery plan will be provided outlining the steps to be implemented in the event of failure (excessive ground loss or settlement / collapse, heaving etc).

9.2.7 Design of de-watering control measures where applicable for the proposed construction method.

9.2.8 Temporary track support system will be required if any of the excavation is closer than 6 m (19.7 feet) from the centre of track and encroaches on the zone of potential track loading. The length of the excavation and an estimated stand-up time of the proposed cut within these limits must be provided and demonstrated to be safe.

9.2.9 A complete description of the proposed construction method.

9.2.10 Confirmation that the proposed construction/installation technique is suited to the site conditions and performance criteria. An assessment of the influence of construction on the track structure including estimated settlement/heave and assessment of risk associated with uncontrolled loss of ground or heaving.

9.2.11 Based on CP's review of the conditions, CP Geotechnical group may elevate a proposed crossing to Process 3 if deemed necessary.

9.2.12 A qualified independent CP approved engineer is required to provide periodic or continuous (at the discretion of CP) on-site supervision and document conditions during construction.

9.3 Application Review and Approval Process

9.3.1 Applicant submits engineering documents and applications to CP Public Works – Utilities.

9.3.2 CP Public Works – Utilities reviews documents to check if appropriate engineering documents have been provided.

9.3.3 CP approved service provider to review initially & sign off on behalf of CP at applicant's expense. CP Geotechnical to provide final geotechnical approval.

9.3.4 CP Structural Engineering Group may have to provide structural approval, if required.

9.3.5 CP Public Works – Utilities to provide final decision or permits.

10.0 Process 3 – Detailed

Process 3 will be applicable to those crossing(s) applications that do not meet the conditions of Process 2. In this case, expert engineering submissions are required, along with additional work such as dewatering as well as monitoring by on site engineering consultants during construction.

10.1 Criteria

The general requirements included in Table 1 in conjunction with the following requirements must be met to obtain approval for a pipeline crossing(s) that qualifies as a Process 3 crossing.

Table 4: Process 3 – Detailed

Dimension Criteria	
Outside pipe diameter	Greater than 1500 mm (59 in.)
Cover between BOR and top of pipe	Less than 1.5 m (5 ft.) or two (2) pipe diameters.
Adjacent structures, switches and signals	Within 2.5 times, cover between BOR and top of pipe.
Depth of pipes outside ZPTL	Less than 0.91 m (3 ft.) burial within ZPTL.

Excavation close to CP track(s)	Excavations or jacking/access pits within 10 m (33 ft.) of the closest track centerline.
Excavation Criteria	
Excavation close to CP track(s)	Excavations or jacking/access pits within 10 m (30 ft) of the closest track centerline.
Crossing angle	More than 45 degrees off perpendicular to the track.
Construction Method	
All methods considered	
Ground conditions, complex installation method, and/or the complexity of the project warrant that specialist-engineering personnel review the design and or construction of the pipe/track crossing(s).	

10.2 Application Requirements

10.2.1 The applicant will meet the requirement outlined in Process 2 - Section 9.2.

10.2.2 The applicant will provide resources for CP to retain CP approved service provider(s) or experts(s) to assess and review the application and advise CP on the impact of the applicant's proposal on CP ROW.

10.3 Application Process and Approval Process

10.3.1 Applicant submits engineering documents to CP Public Works – Utilities. All applications will be processed as per the procedure outlined in Section 9.3.

11.0 Pre-Construction Meeting Requirement

Prior to commencement of any work within CP property/ROW, the Geotechnical Engineer of Record (GER) or their designate shall arrange a pre-construction meeting with all stakeholders to discuss project and construction details including work description, construction methods and

schedule, restrictions, safety, hours/days of work, start time, Daily Reporting & other CP requirements and agreed upon Protocols governing Extreme Weather/Rainfall Warning Alerts issued from Local/National weather offices. This may mean that drilling operations ceases until these Alerts are no longer in effect. 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 monitoring review has been arranged with CP approved service provider and that the expectations have been clearly communicated before construction commences.

12.0 Daily Inspection & Reporting during Construction

This section is applicable to Process Levels 2 and 3 application proposals. The agreement holder or applicant will identify a Geotechnical Engineer of Record (GER) responsible for the complete work and installation of proposed crossing/excavation within CP ROW from start to finish. The Geotechnical Engineer of Record may assign a competent/trained person to act as Site Inspector/Engineer who will be present onsite during the full duration of the bore or any other ground disturbance activity within railway operating corridor, unless, otherwise directed by CP Public Works - Utilities Supervisor. Depending on the complexity of the installation and or field issues encountered during the installation that may adversely impact CP Infrastructure, CP may, at their discretion, assign a full time Geotech Monitor, of their choice, to be on site, at the Applicant's expense.

CP flagger or assigned representative must be present at all times when working or drilling within CP property or rail operating corridor. The Site Inspector/Engineer must have the required training, experience and understanding of the site conditions, proposed design, and construction methodology to make sound engineering judgement and decisions, and reports during the course of the work.

The Site Inspector/Engineer 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/Engineer must immediately report any issues encountered during construction work and could have an impact on CP assets and its operations. Some examples include instability or potential of instability of the embankment or potential ground settlements either future or immediate.

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. In addition, refer to CP 24HR Emergency Contact list to use in case of emergency. The concerns shall also be escalated to the GER and CP Public Work - Utilities supervisor so immediate remediation plans can be implemented.

The Site Inspector/Engineer will provide a daily report to CP approved service provider, 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 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 installation is proceeding in accordance with approved plans and no unexpected conditions/issues are expected. Some examples of relevant information examples include some of the following information:

- A quantitative estimation of amount of material removed versus theoretical material;
- Auger location - Location of both, the leading edge of the pipe and the location of the leading edge of the auger should be documented;
- A description of the progress and any observations or issues encountered during the pipe installation including geologic conditions, change in material composition, characteristics, etc.

The daily report will also include all settlement 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. See Appendix B for a Sample Report.

Upon completion of the construction and installation of pipeline and utility crossing(s), the GER will provide a final sealed and stamped letter/construction report to CP approved service provider with a copy to CP Public Works – Utilities supervisor confirming 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 to the CP Public Works – Utilities along with final settlement data collected and correspondence.

All costs associated with above mentioned i.e. complete geotechnical review, track settlement monitoring, flagging and construction oversight provided CP approved service provider will be borne by the applicant.
A contract between CP approved service provider(s) and the applicant must be place before proceeding with this work proposal.

13.0 Review Steps

The following is a checklist of steps that will be completed to ensure that the appropriate level of care has been taken for Process 2 and 3 pipe crossings below the track.

Table 5 – Review Steps

No.	Step	Action/Review by
13.1	Submission of crossing(s) proposal by applicant including details of the crossing(s) specification and potential construction method(s) to CP Public Works - Utilities.	Applicant
13.2	Review of the proposal as per this protocol to determine what level of geotechnical engineering and review is required.	CP Public Works - Utilities
13.3	Designation of review i.e. CP approved service provider. (ASP)	CP Public Works - Utilities
13.4	Identification of the Applicant's Geotechnical Engineer of Record.	CP Geotech Engineering/ASP
13.5	Assessment of adequacy of the geotechnical investigation and other required information.	CP Geotech Engineering/ASP
13.6	Applicant's geotechnical engineer determines that the proposed construction/installation method will not cause settlement of the CP track or structures.	CP Geotech Engineering/ASP
13.7	Settlement monitoring program, if required and developed by the applicant's geotechnical engineer.	CP Geotech Engineering/ASP
13.8	Once a contractor has been selected, the Geotechnical Engineer of Record (GER) will review the shop drawings submitted by the contractor or the sub-contractor(s) to determine if the tunnelling and dewatering (if required) method proposed could cause track settlement.	CP Geotech Engineering/ASP
13.9	Applicant will provide CP with written documentation of who will be completing the onsite review of the contractor's construction practice and the specifics of the assignment.	CP Geotech Engineering/ASP
13.10	Applicant will enlist the services of a Geotechnical Engineer of Record(GER) with the responsibility for inspection of the tunnelling contractor's work. They will also assure that adequate measures are in place to minimize the potential for track settlement. The intention is to assign an appropriate group with the task of assuring that actions undertaken by the contractor do not endanger the track structure because of ground loss during tunneling which may affect CP Train operations.	CP Geotech Engineering/ASP

No.	Step	Action/Review by
13.11	An emergency response will be developed and posted on site and will reside with key personnel.	CP Geotech Engineering/ASP
13.12	A contingency plan will be prepared and submitted by Tunneling contractor prior to start of construction, identifying tasks/activities that can be completed within hours to get track back in service, if significant track settlement is experienced.	CP Geotech Engineering/ASP
13.13	24 Hour Emergency Contact List to be provided prior to commencement of construction.	CP Public Works - Utilities

14.0 Abandoned Pipe/Track Crossing(s)

In the event that an existing installation is abandoned or a proposed crossing(s) is abandoned during construction, all potential hazards to CP property must be removed or abated. This may be achieved by removal of any buried pipes and the backfill and compaction of any excavations. Alternately, upon approval of the CP Geotechnical group any voids within ground may be backfilled with non-shrinkable fill, or pressured grout sufficient to prevent future sloughing or track settlement. Any buried material (wood or metal) that could increase or decrease volume over time due to chemical reaction (oxidation) or decomposition must be removed or stabilized to the satisfaction of CP.

----------*END OF TEXT*----------

APPENDIX A

SAMPLE FIGURES 1 TO 3

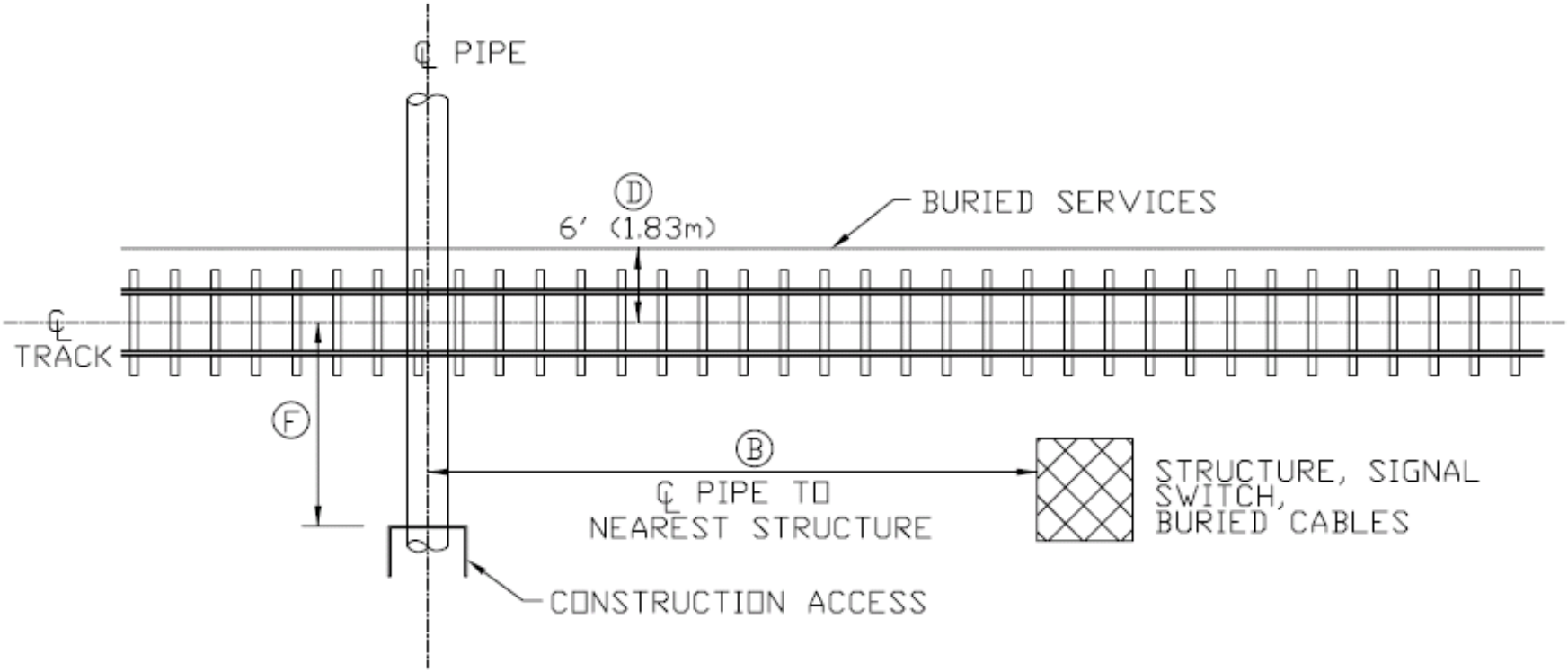


Figure 1 – Plan of the proposed pipe crossing

SAMPLE

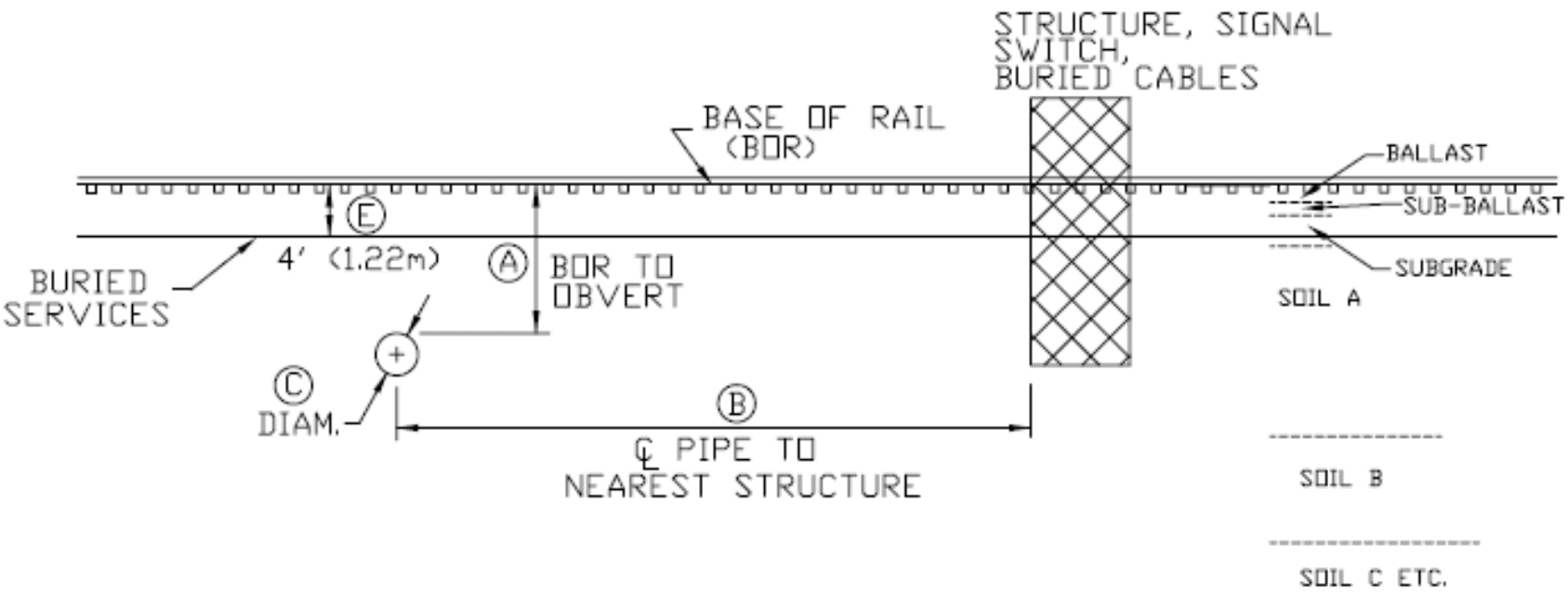


Figure 2 – Profile of the track and proposed pipe crossing along the centerline of track

SAMPLE

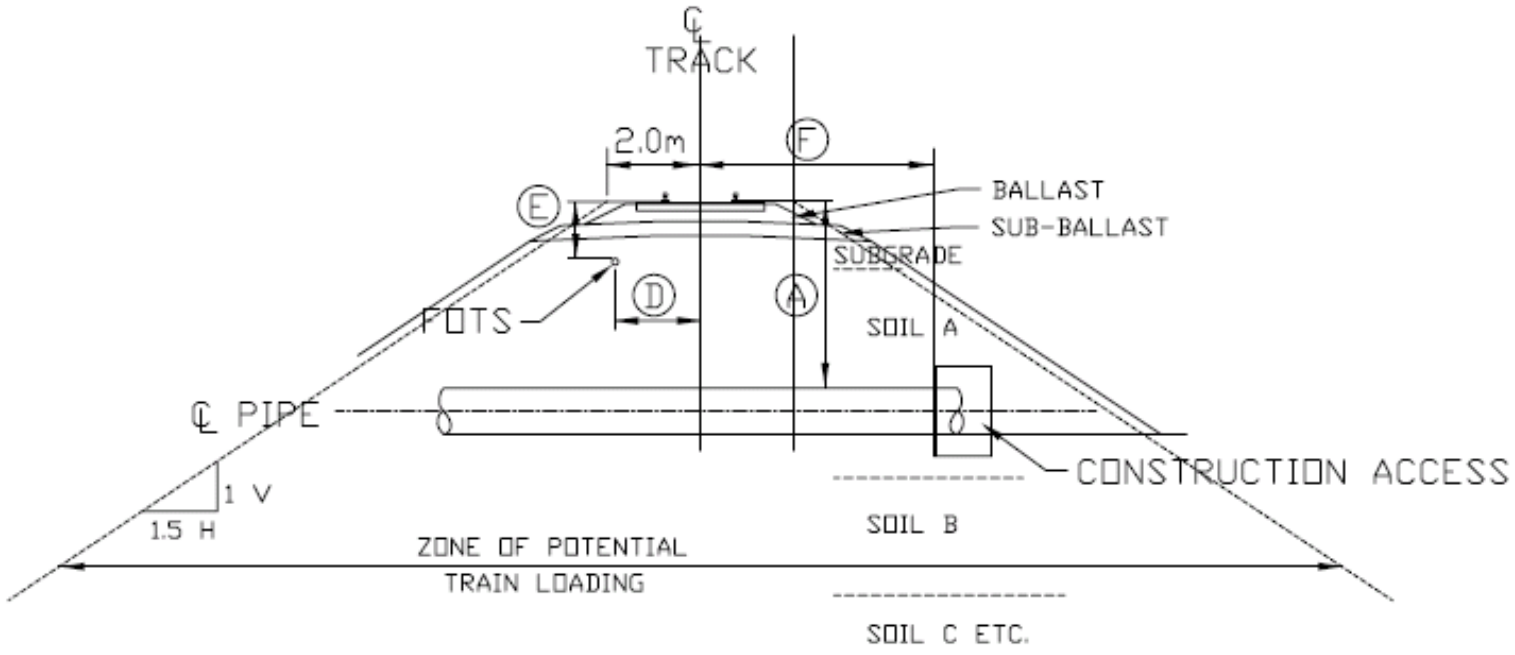


Figure 3 – Section of Track along centerline of proposed pipe

SAMPLE

Appendix B

SAMPLE DAILY REPORT AND SETTLEMENT REPORT

SAMPLE DAILY REPORT

PROJECT INFORMATION

Project Name:

Date: July 11, 2019

Location:

Contractor:

Client:

Site Rep:

DAILY SUMMARY

Excavation Details:

[i.e., depth, sideslopes, trench boxes, sloughing, etc.]

No additional casing installed today. No sloughing of CPR embankment noted.
See attached sketch.

Construction Summary:

[i.e., soil type, issues, etc.]

Contractor attaching shoes (wedges) to the casing exterior near the casing head behind the gravel plug (approx. station 0+031). One shoe on track west side of casing approx. 250 mm X 300 mm X 50 mm(deep outside of casing). One shoe on bottom of casing approx. 275 mm X 300 mm X 25 mm(deep outside of casing).

Cumulative Settlement Movement (mm): ☒ Minimal Movement (<8) ☐ Level 1 – Warning (≥8 to <16) ☐ Level 2 – Critical (≥16)

Compliance with Design: ☐ Yes ☒ No If No, discuss below

Issues with Installation: ☒ Yes ☐ No If Yes, discuss below

Other Notes, if any:

Casing was out of alignment by approximately 40 mm track west and 25 mm lower than designed location at about station 0+031. Contractor attaching shoes (wedges) to the casing exterior near the casing head behind the gravel plug (approx. station 0+031) for alignment correction.

Prepared By:

Reviewed By:

SAMPLE

SAMPLE DAILY SETTLEMENT MONITORING REPORT

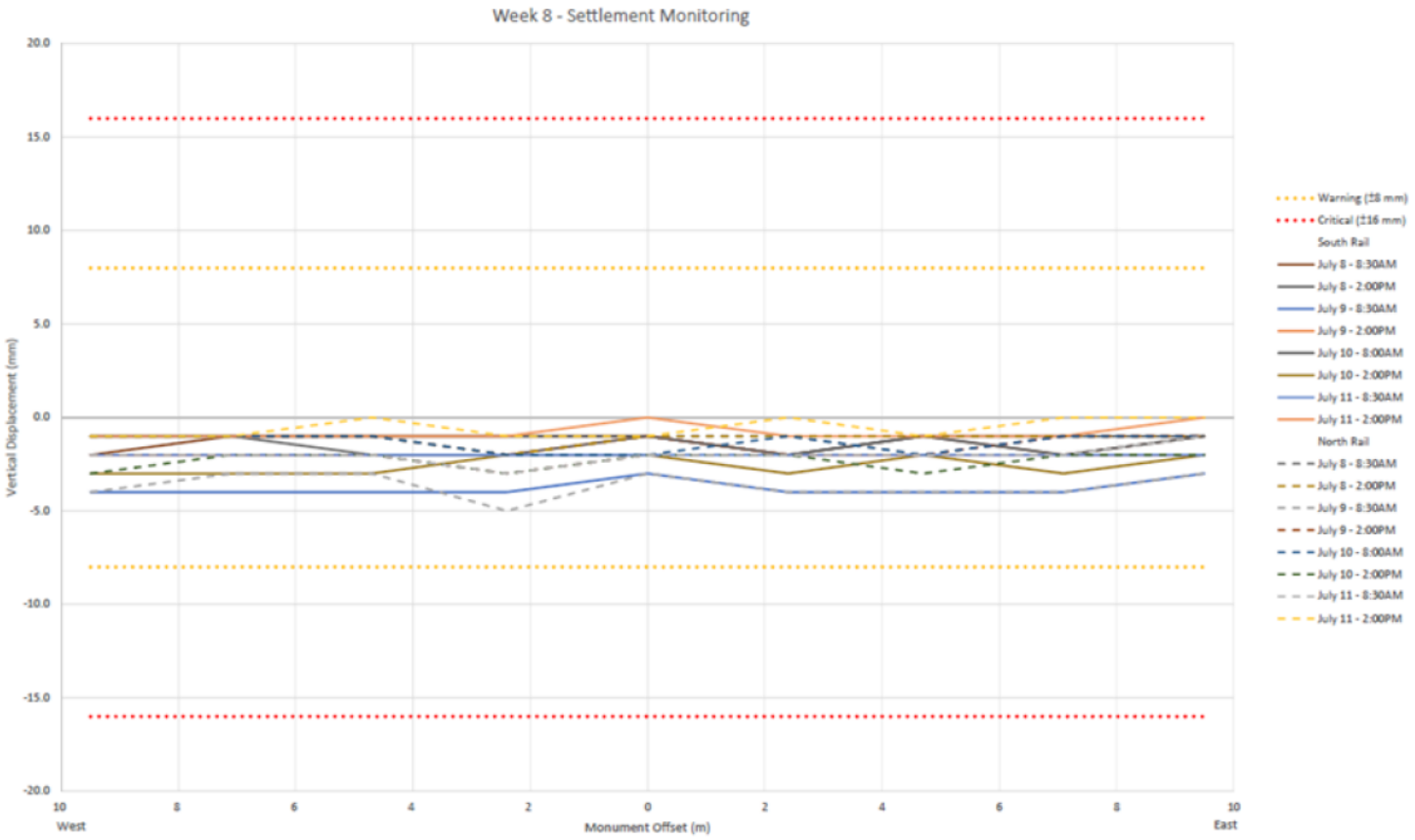
SETTLEMENT MONITORING

Surveyor: **Date:** July 11, 2019 CP Flagger
Weather: Sunny **Temperature:** 16°C at 8:30 am; 27°C at 2:00 pm

*Survey locations along the top of the rails. **Baseline elevation is average of 2 surveys on June 12, 2019. ***Positive numbers correspond to heave and negative numbers correspond to settlement

Rail Location	Location Description and Monument ID*	Baseline Elevation (m)**	Reading 1			Reading 2		
			Time	Elevation (m)	Cumulative Movement (mm)***	Time	Elevation (m)	Cumulative Movement (mm)***
South Rail	9.45 m East (S9)	1034.587	8:30 am	1034.585	-2	2:00 pm	1034.587	0
	7.08 m East (S8)	1034.593		1034.591	-2		1034.592	-1
	4.72 m East (S7)	1034.597		1034.595	-2		1034.596	-1
	2.36 m East (S6)	1034.601		1034.599	-2		1034.600	-1
	Centerline (S5)	1034.605		1034.603	-2		1034.605	0
	2.36 m West (S4)	1034.612		1034.610	-2		1034.611	-1
	4.75 m West (S3)	1034.618		1034.616	-2		1034.617	-1
	7.08 m West (S2)	1034.622		1034.620	-2		1034.621	-1
	9.45 m West (S1)	1034.626		1034.624	-2		1034.625	-1
North Rail	9.45 m West (N1)	1034.624		1034.622	-2		1034.623	-1
	7.08 m West (N2)	1034.621		1034.619	-2		1034.620	-1
	4.75 m West (N3)	1034.617		1034.615	-2		1034.617	0
	2.36 m West (N4)	1034.612		1034.609	-3		1034.611	-1
	Centerline (N5)	1034.604		1034.602	-2		1034.603	-1
	2.36 m East (N6)	1034.599		1034.597	-2		1034.599	0
	4.75 m East (N7)	1034.597		1034.595	-2		1034.596	-1
	7.08 m East (N8)	1034.590		1034.588	-2		1034.590	0
	9.45 m East (N9)	1034.586		1034.585	-1		1034.586	0

SAMPLE


Week 8 - Settlement Monitoring
Vertical Displacement (mm)
20.0
15.0
10.0
5.0
0.0
-5.0
-10.0
-15.0
-20.0
10
8
6
4
2
0
2
4
6
8
10
West
Monument Offset (m)
East
Warning (±8 mm)
Critical (±16 mm)
South Rail
July 8 - 8:30AM
July 8 - 2:00PM
July 9 - 8:30AM
July 9 - 2:00PM
July 10 - 8:00AM
July 10 - 2:00PM
July 11 - 8:30AM
July 11 - 2:00PM
North Rail
July 8 - 8:30AM
July 8 - 2:00PM
July 9 - 8:30AM
July 9 - 2:00PM
July 10 - 8:00AM
July 10 - 2:00PM
July 11 - 8:30AM
July 11 - 2:00PM

SAMPLE

SAMPLE TRENCHLESS INSTALLATION MONITORING REPORT

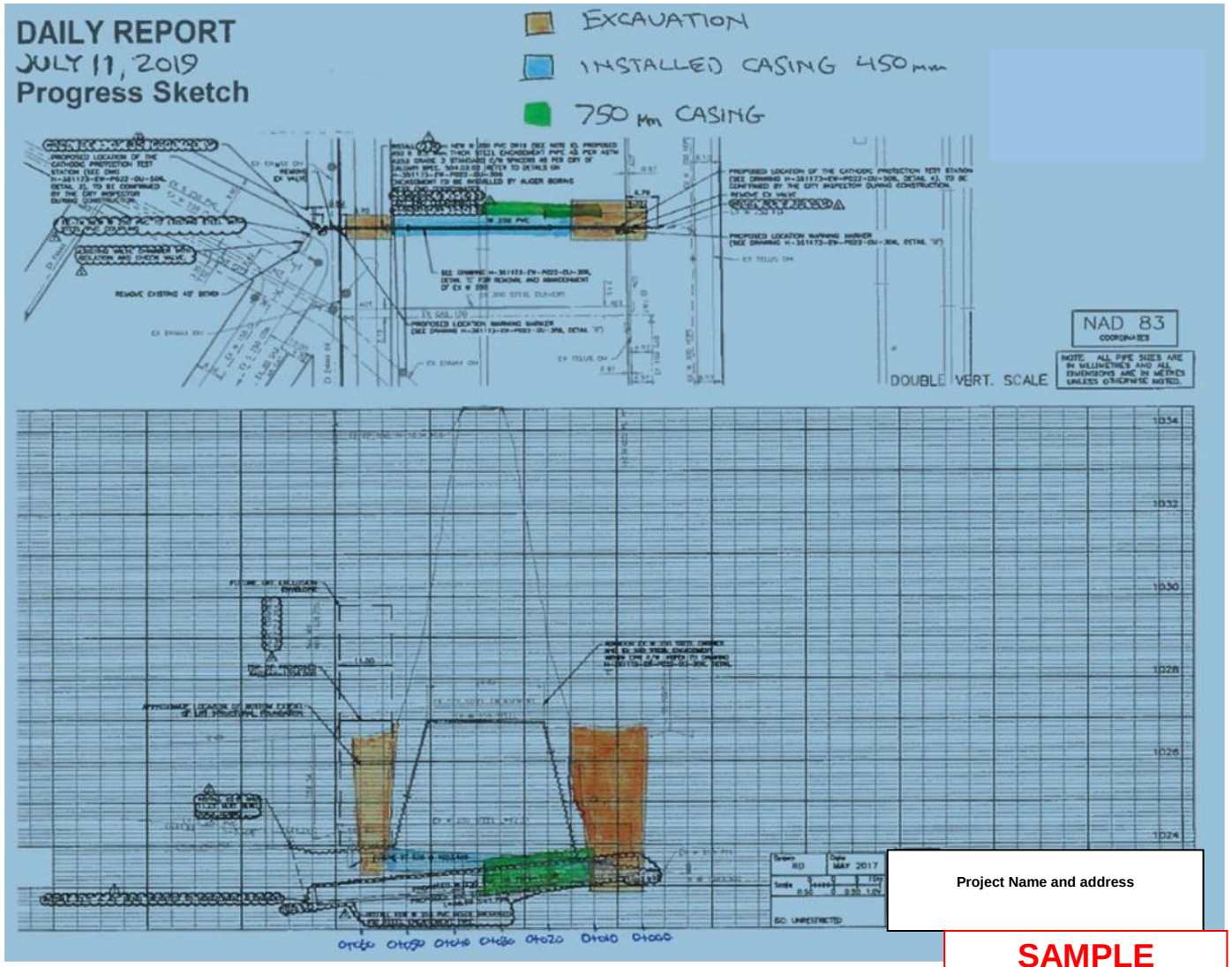
TRENCHLESS INSTALLATION MONITORING

Equipment:	Air Hammer	**Operator:**
Casing Pipe Diameter:	750 mm	16 mm overcut on casing head
Date:	July 11, 2019	2m plug at casing head during installation

Date	Segment No.	Segment Length (m)	Station Interval along the Face of Installation	Length of Pipe Installed (m)	Distance of Head to CL Track (S or N) (m)	Soils Condition/Description
July 7, 2019	1	6.0	0+015	6.0	18 m N	Gravel, sandy, some silt, trace clay. Dry
July 8, 2019	2	6.0	0+021	6.0	12 m N	Gravel, sandy, some silt, trace clay. Dry
July 9, 2019	3	6.0	0+027	6.0	6 m N	Gravel, sandy, some silt. Damp
July 9, 2019	4	6.0	0+033	6.0	0 m (CL Track)	Gravel, sandy, some silt. Damp
July 10, 2019 July 11, 2019						No casing installed, contractor attaching shoes (wedges) to casing at station 0+031

SAMPLE


N1
N2
N3
N4
N5
N6
N7
N8
N9
S1
S2
S3
S4
S5
S6
S7
S8
S9
9.45 m
7.08 m
4.72 m
2.36 m
UPDATED CL OF WATERMAIN
CL OF 450 WATERMAIN (ORIGINAL)
26A STREET SE
LEGEND
SURFACE SETTLEMENT MONITORING POINT (PREVIOUS)
UPDATED SURFACE SETTLEMENT MONITORING POINT (JUNE 12)
0
20m
LOCATION OF
SETTLEMENT MONITORING MONUMENTS
PROJECT NO.
C12103500PKG-022.4
DWN
LCH
CKD
KH
REV
0
OFFICE
TT Cal
DATE
May 2019
Figure


DAILY REPORT
JULY 11, 2019
Progress Sketch
EXCAVATION
INSTALLED CASING 450 mm
750 mm CASING
NAD 83
DOUBLE VERT. SCALE
Project Name and address
SAMPLE

Appendix C

TRACK MOVEMENT MONITORING GUIDELINES FOR TRENCHLESS PIPE INSTALLATION

Track Movement Monitoring Guidelines for Trenchless Pipe and Utility Crossing(s) Installation under Railway Tracks

(Last updated – May 16, 2022)

The monitoring of track settlement should be carried out by means of surface and subsurface settlement points. The intent of subsurface settlement points is to measure voids created just in the vicinity and above the pipe during construction in order to predict the potential movement of overlying CP tracks.

The settlement point essentially consists of a small diameter pipe anchored at the bottom of a vertical borehole and an outer casing to isolate the pipe from down drag forces caused by settlement of soil above the anchor (see Figure B). The subsurface settlement points would be installed to 1 m above the crown of the casing profile. The total number of subsurface settlement points within CP Right-of-Way (ROW) along the axis of the proposed pipe crossing(s) would be installed as per the configuration shown in Figure A – Sample Surface and Subsurface Settlement Monitoring Layout.

Surface points installed directly along the base of both rails at a spacing of 9.45 m (31 ft.) over the projected settlement trough would be used to monitor differential transversal elevation between both rails. The total number of surface settlement points within CP ROW would be installed as per the configuration shown in Figure A – Sample Surface and Subsurface Settlement Monitoring Layout. These points shall be monitored simultaneously with the subsurface settlement points that would act as a precursor to potential surface movement during pipe installation.

Once the installation is complete, a monitoring program of all points is to be carried out in accordance with the following instructions:

1. Monitoring should start before the excavation of the pits and pipe installation begins and readings should be taken at least twice per day for no less than two days. This is required to establish a reliable methodology and demonstrate the accuracy to be achieved.

2. Monitoring should proceed through the construction period and should be completed:

    1) For branch lines/lines with low traffic - (Class 1-2 Track) - At least twice daily.

    2) For main lines and heavy traffic lines – (Class 3-5 Track) Every 2 hours or after each train, whichever provides the most number of readings while the boring operation is within the ZPTL (Zone of Potential Train Loading).

3. Monitoring should continue for at least 3 days after the completion of construction.

4. If there is any loss of ground during pipe installation, any reason to believe settlement may be delayed or any settlement is identified during the installation of pipe or subsequent

monitoring period, the monitoring must be continued until the applicant's Geotechnical Engineer of Record deems it is safe to discontinue such monitoring. This must be approved by CP Geotechnical Engineering group or CP approved service provider reviewing the monitoring results.

Monitoring measurements should be taken with sufficient frequency (as noted above) to capture the unexpected performance at the earliest possible stage and be evaluated in a timely manner. Additional measures will be proposed should this monitoring protocol be considered insufficient based on the ground conditions or installation process. Track survey preference would be for survey shots to be taken remotely (i.e. off CP property) and without the requirement of a CP Flagger or representative presence on site.

Two alarm levels are proposed:-

Level 1:

"WARNING/ALERT" will be indicated on the field memo/report when a settlement of **50 (%)** of the critical monitoring threshold is obtained from the subsurface and/or surface settlement points. A survey of the surface points will then be carried out and work will be authorized to continue if no movement of the subsurface point has been measured from the previous reading. If movement of the rails is recorded, monitoring will be continued until rail movement is stopped. At this point, the drilling work will then be authorized to continue. See Figure C – Track Settlement Monitoring Review and Alert Threshold for Threshold values per Class of Track designation. Please contact CP Public Work-Utilities Supervisor to obtain Class of Track designation pertaining to the proposed Utility Crossing location.

Level 2:

"CRITICAL/REVIEW" will be indicated on the field memo/report when a settlement of specified monitoring threshold is obtained from the subsurface settlement point. 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, monitoring will be continued until movement is stopped and the applicant has submitted a new pipe installation procedure. This procedure must be reviewed and approved by CP Geotechnical Engineering group or CP approved service provider reviewing the monitoring results.

The applicant and their Geotechnical Engineer of Record are responsible for ensuring that track settlement does not occur and for notifying CP Roadmaster or their designate, as indicated on the 24 hr Emergency Contact List, should unforeseeable track settlement occur or be expected.

The above guidelines do not relieve the applicant and their engineer(s) of this responsibility. The applicant or their engineer(s) shall provide the settlement information and their interpretation of the data including information such as. no track settlement, deep settlement etc., a quantitative number of how much track settlement has occurred, is likely to occur and when it is likely to occur. This information should be provided in easily understandable terms for

all parties involved in the construction and monitoring and should be directed to local CP Roadmaster, CP approved service provider, Supervisor – CP Public Works – Utilities and Director of Geotechnical Engineering.

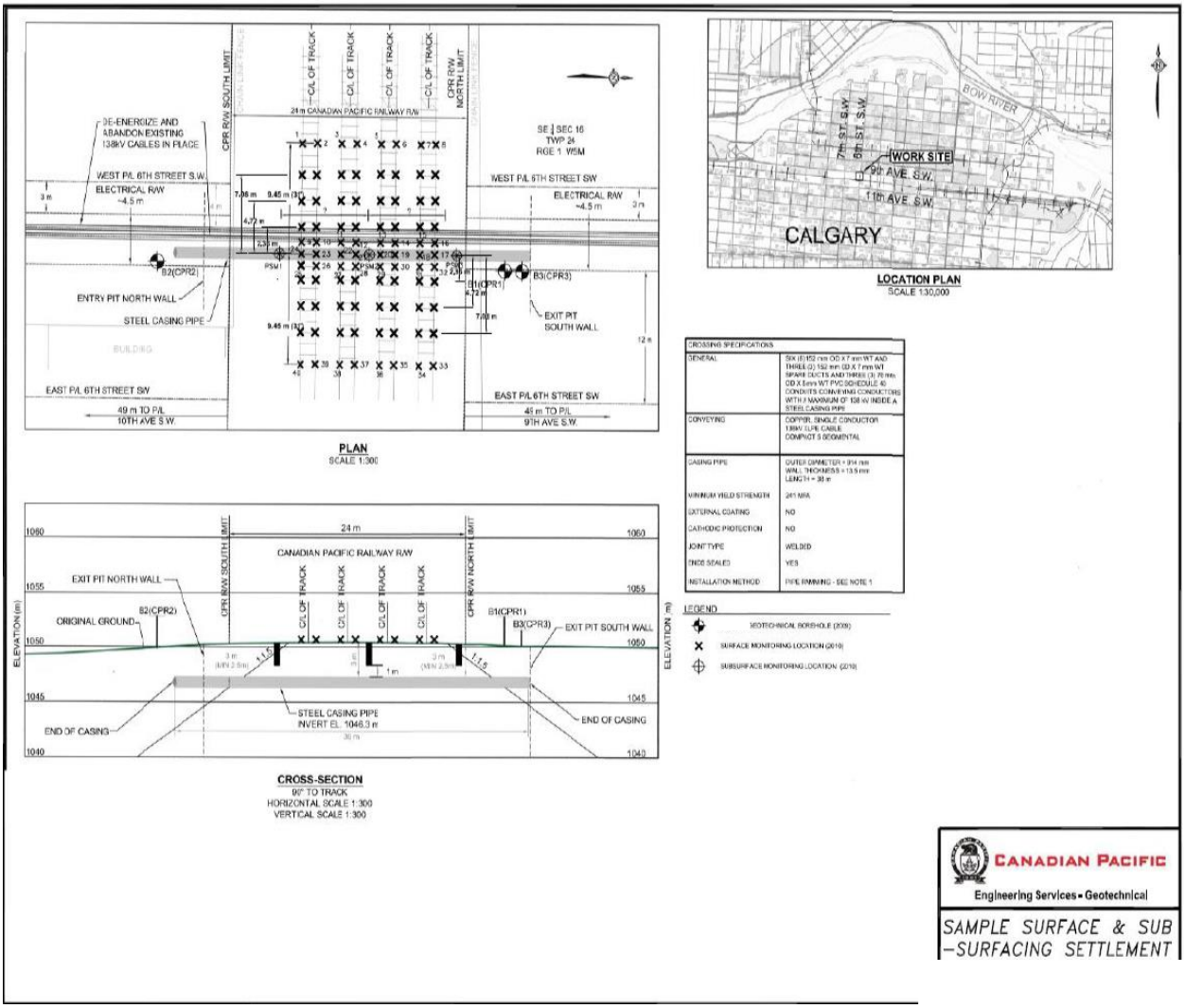


Figure A - Sample Surface and Subsurface Settlement Monitoring Layout

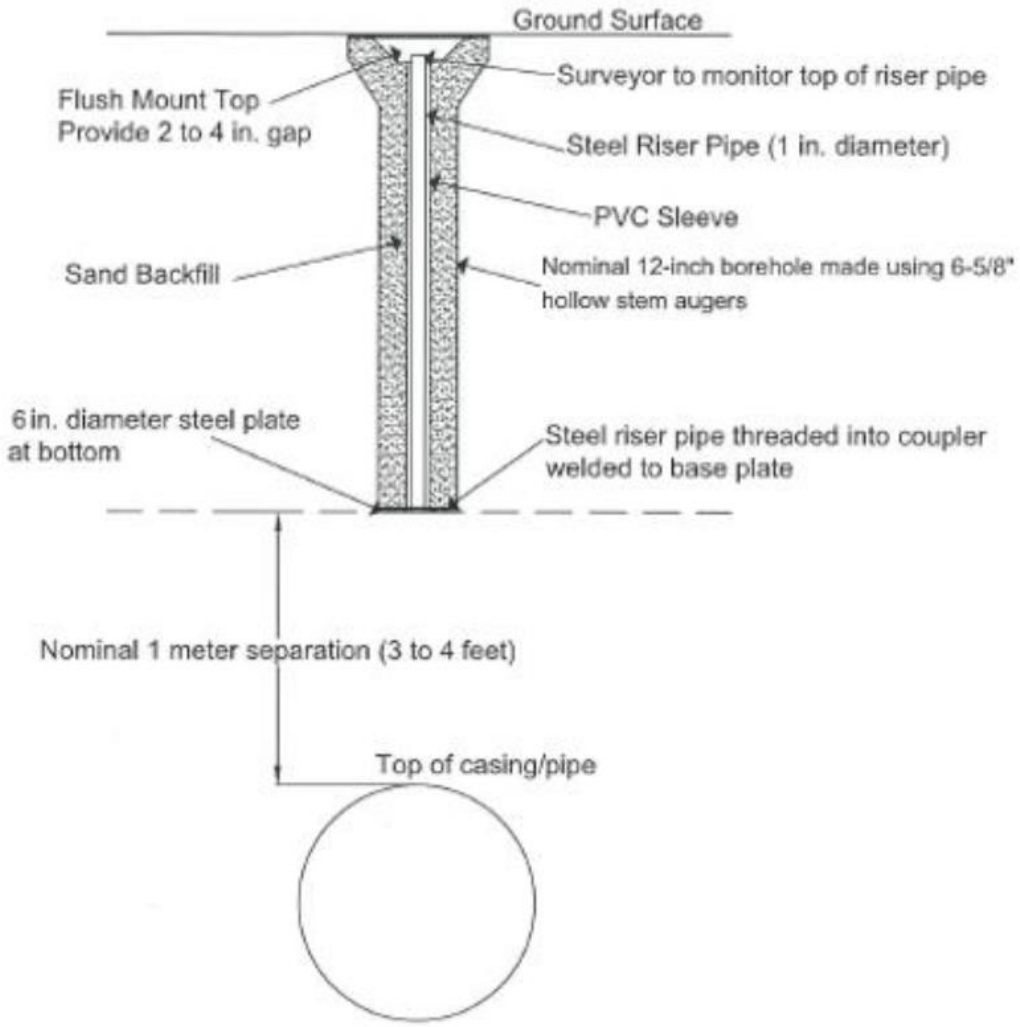


Figure B - Typical Subsurface Settlement Point Detail

Figure C – Track Settlement Monitoring Review and Alert Thresholds (Surface and Subsurface)

Class of track	Critical/Review Threshold	Alert/Warning Threshold
1	22 mm	11 mm
2	22 mm	11 mm
3	19 mm	10 mm
4	16 mm	8 mm
5	13 mm	6 mm
6	10 mm	5 mm

Note – All above numbers are maximum values

Class of Track

TRACK CLASSES

Class	Freight Train Speed	Passenger Train Speed
1	10 MPH	15MPH
2	25 MPH	30 MPH
3	40 MPH	60 MPH
4	60 MPH	80 MPH
5	80 MPH	95 MPH* 90 MPH **
*Denotes for LRC trains – 100 MPH	** - Applies to US only	Note – Numbers above are maximum values