

# Westridge Marine Terminal Upgrade and Expansion Project Application to Vancouver Fraser Port Authority



**TRANSMOUNTAIN**

Trans Mountain Pipeline ULC  
Kinder Morgan Canada Inc.  
Suite 2700, 300 – 5 Avenue S.W.  
Calgary, Alberta T2P 5J2  
Ph: 403-514-6400

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H	Golder Associates Geophysical Investigation Report for Supplemental Offshore Geotechnical Investigation, May 13, 2016

# Acronyms and Abbreviations

CPR	Canadian Pacific (Railway)
NBCC	National Building Code of Canada
NEB	National Energy Board
SW	Shannon and Wilson
TMEP/the Project	Trans Mountain Expansion Project
VFPA	Vancouver Fraser Port Authority
WMT/the Terminal	Westridge Marine Terminal
WSP	WSP Canada Inc. (previously named Levelton Consultants Ltd.)

# Introduction

Trans Mountain Pipeline ULC (Trans Mountain) submitted a Facilities Application to the National Energy Board (NEB) in December 2013 for the Trans Mountain Expansion Project (the Project or TMEP). On November 29, 2016, the Government of Canada concluded the Project was in the public interest of Canada. A Certificate of Public Convenience and Necessity and other authorizations allowing the Project to proceed, subject to 157 conditions, was issued and became effective on December 1, 2016.

As part of the Project, the Westridge Marine Terminal (WMT) will require expansion, including construction of three new loading berths within an expanded water lot and infilling along the existing shoreline to accommodate new onshore infrastructure. It will also require the removal of existing marine structures is necessary to facilitate the expansion of the WMT facilities.

This report covers the information requirements listed by Vancouver Fraser Port Authority (VFPA) for a Geotechnical Report:

- A description of site seismic and geologic hazards.
- A description of construction measures, precautions and corrective actions recommended for preventing structural damage and reducing the risk of terrestrial, marine, and riparian geotechnical hazards.

## Onshore Geotech

The Project includes a planned expansion of the WMT in Burnaby, British Columbia. The WMT is located on Burrard Inlet at the base of the Burnaby Mountain, which rises about 300 m to the southeast of the facility. The onshore portion of WMT is subdivided into two main components: a “foreshore” area located north of the Canadian Pacific Railway (CPR) property and extending about 45 m to the north (toward the water), and an “uplands” portion, which includes infrastructure located south of the CPR property to where it meets the incoming pipelines in the vicinity of where they exit the tunnel portal. The expansion of the WMT includes construction of a new foreshore bulkhead, manifold, pipe racks and other infrastructure to support terminal operations.

Trans Mountain is submitting geotechnical information that provides feasibility-level geotechnical design recommendations for the new onshore facilities at the WMT. The following documents, are attached which describe the subsurface investigation programs and associated laboratory testing program for the WMT expansion:

1. Appendix A Shannon & Wilson Geotechnical Feasibility Report Preliminary Recommendations Foreshore Bulkhead Westridge Marine Terminal, February 8, 2017
2. Appendix B Levelton TMEP “Enhanced FEED Study” Geotechnical Foreshore Investigation - Findings Report Westridge Loading Facility, Burnaby, BC, April 7, 2015
3. Appendix C WSP TMEP “Enhanced FEED Study” Geotechnical Foreshore Investigation #2 (Marine Component) - Findings Report, Westridge Loading Facility, Burnaby, BC, March 9, 2016
4. Appendix D WSP TMEP Westridge Marine Terminal On-Shore Geotechnical Feasibility Report, Revision 1, February 7, 2017
5. Appendix E WSP TMEP Westridge Marine Terminal Geotechnical Investigation Findings Report No. 3, Revision 1, February 7, 2017

6. Appendix F Golder Associates Geotechnical Factual Report on Westridge Marine Terminal Offshore Geotechnical Investigations, December 23, 2016.

The first document, Appendix A, prepared by Shannon and Wilson (SW), relates to the foreshore bulkhead structure north of CPR property. The second document, Appendix B, prepared by WSP Canada Inc. (WSP) (previously named Levelton Consultants Ltd.), relates to infrastructure located south of the foreshore bulkhead. Descriptions of the subsurface investigation program and associated laboratory testing program for the WMT expansion are included in the balance of the documents.

## Foreshore Bulkhead and Ancillary Facilities

SW prepared feasibility level geotechnical design recommendations for the foreshore bulkhead and ancillary facilities located north of the CPR property in Appendix A. A free standing sheet piles cellular structure (bulkhead) is proposed for the foreshore bulkhead. The bulkhead will be constructed of interlocking steel sheet piles driven to the underlying glacially consolidated soils. Loose fill and non-glacially consolidated materials located within the bulkhead cells will be excavated and replaced with angular crushed rock.

*Design Criteria and Recommendations:* Appendix A, Section 2.0 contains a discussion regarding the foreshore development including the bulkhead and ancillary facilities. Section 4.0 provides the seismic design criteria specified for the Project. Section 5.2.1 contains the bulkhead design criteria and assumptions. Section 5.2.2 provides the results of internal and external stability for the bulkhead including: sliding, overturning, rotational stability, bearing capacity, vertical shear, horizontal shear, pile interlock strength and global stability. Discussion on static and seismic settlements for the foreshore ancillary facilities is included in Section 5.3.

*Seismic Evaluation:* Appendix A, Section 5.0 contains a discussion regarding the seismic design approach and preliminary engineering results. The following topics are discussed in Section 5.0: 2010 National Building Code of Canada (NBCC) and 2015 NBCC ground motions, liquefaction potential and seismic loading on the cellular cofferdam bulkhead. Global stability results and estimated lateral displacement of the bulkhead under seismic loading is discussed in Section 5.2.3. Discussion on estimated seismic ground deformations and ground improvements for the foreshore ancillary facilities are included in Section 5.3.

## Southern Foreshore and Uplands

WSP prepared feasibility level geotechnical design recommendations for the infrastructure located south of the foreshore bulkhead and ancillary facilities in Appendix B2.

*Design Criteria and Recommendations:* Appendix A, Section 2.0 contains a discussion regarding the Project design criteria and Project components including: pipe racks, derailment protection structure, buried pipe crossings and the new manifold. Preliminary design recommendations for the southern foreshore presented in Section 5.0 include: bearing capacity and settlement considerations for the derailment protect structure, settlement and earthwork recommendations for the buried pipe crossing at CPR and preliminary deep foundation recommendations for the foreshore pipe rack. Preliminary design recommendations for the uplands area presented in Section 6.0 include: earthwork and foundation considerations for the manifold, preliminary deep foundation recommendations for the pipe rack and preliminary foundation recommendations for the proposed electrical building.

*Seismic Evaluation:* Appendix A, Section 4.0 contains discussion regarding the seismic evaluation for the WMT. The following topics are discussed in Section 4.0: 2010 NBCC and 2015 NBCC seismic hazard models, site response analysis, and liquefaction assessment. The 2017 WSP report (Appendix B of Appendix B) contains ground motion time-histories for the WMT prepared by Onur Seemann Consulting,

Inc. Seismic Site Response Spectra Figures for the 475, 975, and 2475 return periods are included in the 2017 WSP report (Appendix C of Appendix B).

# Offshore Geotech

Trans Mountain is submitting a final preliminary geotechnical report on the offshore portion of the WMT expansion. The following documents, which describe the subsurface investigation programs and associated laboratory testing program for the offshore portion of the WMT expansion:

1. Appendix G Shannon & Wilson (SW) Geotechnical Engineering Report Preliminary Recommendations Marine Facilities, Westridge Marine Terminal, February 10, 2017
2. Appendix B Levelton TMEP “Enhanced FEED Study” Geotechnical Foreshore Investigation - Findings Report Westridge Loading Facility, Burnaby, BC, April 7, 2015
3. Appendix C WSP TMEP “Enhanced FEED Study” Geotechnical Foreshore Investigation #2 (Marine Component) - Findings Report, Westridge Loading Facility, Burnaby, BC, March 9, 2016
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6. Appendix H Golder Associates Geophysical Investigation Report for Supplemental Offshore Geotechnical Investigation, May 13, 2016

The first document, Appendix G, prepared by Shannon and Wilson, contains the results of the geotechnical investigation. A description of the subsurface investigation program and associated laboratory testing program for the WMT offshore expansion are included in the balance of the documents.

*Pile Foundation Recommendation:* Pile foundation design recommendations for the new offshore structures at the WMT are included in Section 8.0 of the SW report. Topics discussed in Section 8.0 include: pile design criteria, axial resistance analyses, pile foundation settlement, lateral response analysis, and pile installation. Table 5 provides the recommended pile embedment for the trestle, junction platforms, loading platforms, and utility dock. Table 6 provides recommended pile embedment for berthing and mooring dolphins.

*Seismic Analysis:* Section 2.3 of the SW report (Appendix G) contains discussion with respect to regional seismicity inclusive of the Geological Survey of Canada hazard models used for the 2010 and 2015 editions of NBCC and 2015 NBCC seismic hazard models. Section 6.0 discusses time history development, ground response analysis, liquefaction evaluation and shoreline stability. Section 7.0 provides commentary on the trestle structural design methodology including the seismic design approach.

## Enclosures:

Appendix A: Shannon & Wilson Geotechnical Engineering Report Preliminary Recommendations Marine Facilities, Westridge Marine Terminal, February 10, 2017

Appendix G: Shannon & Wilson Geotechnical Feasibility Report Preliminary Recommendations Foreshore Bulkhead Westridge Marine Terminal, February 8, 2017

Appendix B: WSP Canada Inc. TMEP Westridge Marine Terminal On-Shore Geotechnical Feasibility Report, Revision 1, February 7, 2017

Appendix C: Levelton TMEP “Enhanced FEED Study” Geotechnical Foreshore Investigation - Findings Report Westridge Loading Facility, Burnaby, BC, April 7, 2015

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