

GEOTECHNICAL REVIEW of TRANS MOUNTAIN EXPANSION PROJECT (TMEP)

BURNABY TERMINAL GEOTECHNICAL INVESTIGATION

BURNABY, BC

May 1, 2015
Project No. : 1000522-1

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Mr. D. Doepker/Development Engineer
City of Burnaby- City Hall/Engineering Department 4949 Canada Way
Burnaby, BC
V5G 1M2

Dear Mr. Doepker,

Re: Third Party Geotechnical Review of Burnaby Terminal Tank Facility

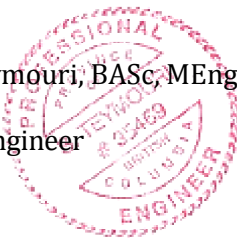
Please find attached our report submitted to the City of Burnaby captioned above. Please contact the undersigned if you have any questions.

This report summarizes my comments and observations as to the Levelton's 2014 Geotechnical Investigation of Burnaby Tank Facility for TMEP for Phase 1 and Phase 2. There has not been a site visit to the existing Burnaby Tank Farm during this review. The report will provide opinion to the City of Burnaby on the Levelton's Nov 6, 2014 Preliminary Geotechnical Review of the project.

Yours sincerely,

MineIt Consulting Inc.

Shervin Teymouri, BASc, MEng, P.Eng.
Principal Engineer



INTRODUCTION

Background

Levelton Consultants Ltd. (Levelton) has completed a preliminary geotechnical review associated with the TMEP FEED Study for proposed upgrades to the existing Kinder Morgan facilities at the tank facility in Burnaby, BC in May and September 2014. The scope of the geotechnical work for this project included a review of available site and soils information to assess the general geological/geotechnical conditions at the site, a geotechnical subsurface investigation to obtain basic information regarding the existing fills, native soils, and bedrock present at key areas of the site that will be developed, and preliminary analyses and engineering review based on initial design concepts as provided by CH2M Hill. The field investigation focused on the key project components of tank foundations and secondary containment dykes. It also provides preliminary data to assist in evaluation of the pipe racks, manifold area and remote impoundment pond.

Mineit Consultants Inc. (Mineit) has reviewed the following report(s):

1. Levelton B325-4_-Burnaby_Terminal_Phase_1_Findings_Report_Part1_-A4I6J2 – May 28, 2014
2. Levelton B325-11_-Burnaby_Terminal_Phase_2_Findings_Report_-A4I6K2 – Sept 22, 2014
3. Levelton B325-12_-Burnaby_Terminal_Preliminary_Geotechnical_Report_-A4I6K3 – Nov 06, 2014 (Levelton File # R713-1879-00)
4. B372-3_-Trans_Mountain_Response_to_City_of_Burnaby_IR_No.2(c)_-A4K5A7 – April 2015
5. B372-4_-Trans_Mountain_Response_to_City_of_Burnaby_IR_No.2(c).1.22f-Attachment_1_Part1_-A4K5A8 – June 26, 2014
6. B373-2_-Response_to_City_of_Burnaby_IR_No.2(c)_-Notice_of_Motion_-A4K6X8 – April 2015
7. C69-40-1_-City_of_Burnaby_-Reply_Notice_of_Motion_IR_No_2(c)_-A4K7Q6 – April 2015

Project Description

The Kinder Morgan Burnaby Tank Farm is a facility for liquid product storage and distribution. Currently, the site includes thirteen large liquid storage tanks, and supporting infrastructure. The TMEP development will involve the installation of an additional fourteen (14) large diameter product storage tanks with secondary containment dykes, a new manifold area, retention and impound areas, pipe racks, roads, and borrow/spoil areas.

Project Components

The report discussed the tanks, secondary containment, pipe racks, manifolds, storm water retention pond, borrow/spoil area, and road crossings. The project layout map is included in Appendix 1.

Geotechnical Review

The review was on the Levelton's Preliminary Geotechnical Assessment Report Levelton File #R713-1879-00 on Nov 6, 2014 and the Phase 1 and Phase 2 Burnaby Terminal Investigation Reports. The reports will be on Appendix 2 of this report and will be only referenced during this report due to redundancy elimination.

The following will provide the reader with geotechnical comments, recommendations, issues, area of concern and deficiencies per each discussed project component and project investigation items.

General Discussion and Global Site-Wide Geotechnical Review

Main area of concern is lack of review of historical geotechnical performance, geotechnical investigation of existing 13 storage tanks facility. This includes settlement rates, differential settlements, seismic performance and overall geotechnical issues that are associated with such facilities.

As the site is located on the south side of Burnaby Mountain, and in general has a downward overall topography of northeast to southwest, there is the risk of overall slope failure as circular or creep failure or other modes of failure even in low probabilities. These failures have not been addressed nor modelled in detail by the report. If there are assumptions on very low probabilities of occurrence, then the assumptions must be validated, argued and due diligence must be done so. Building the critical infrastructure and the close proximity to large populated urban area requires getting this overall slope hazard assessment done in great detail (including groundwater and seismic considerations into the overall site slope stability). The author acknowledges that the **global slope stability** analysis might not have been part of Levelton's scope of work, but this **assessment is a critical part** of the project.

The seismic consideration and discussion in the report, aside from BCBC 2012, is minimal and there has been minimal discussion on foundation performance. No discussion on tanks and their foundation on the seismic response is made. Pseudostatic or permanent-displacement slope stability analysis should be performed using the seismic hazard analysis to identify and evaluate seismic displacement.

Lateral spreading hazards and other seismic related hazards assessments (seismic settlement, ...) have not been addressed in this report. Although the report mentions liquefaction is of minimal concern, this hazard and other seismic related hazards need to be addressed in the report and the liquefaction susceptibility in seismic events needs to be fully addressed.

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The Levelton report (R713-1879-00) appears to be in draft form or “issued for client review” only. This report should be finalized.

1- Site Description and Project Layout (Levelton File # R713-1879-00 Section 2.XX)

It is unclear as whether the secondary containment dyke(s) are built for each tank or it is built surrounding the overall tank farm facility. It appears that the height of the dyke will meet the 110% volume capacity required for the Canadian secondary containment regulations (Hazardous Waste Regulation B.C. Reg. 63/2009, April 1, 2009). This regulation needs to be confirmed and met.

There is minimal description, geotechnical investigation, and foundation design specifics on the manifold area, pipe racks and other project components in the Levelton report. Levelton uses language of “we understand that this structure will” in few areas which conveys unclear purpose and design specifics on those project components. This language of uncertainty at this stage of study will hinder the type of specific geotechnical test and foundation design specifics needed to forward the project. Project components need to be clear for the design criteria and specifics.

2- Subsurface Conditions (Levelton File # R713-1879-00 Section 4.XX)

The site investigation report does not provide necessary information for preliminary design criteria. Major areas of concern and risk are noted below:

- 1- Only 65% of planned auger holes were completed. The rationale was due to costs, location, accessibility and other factors.
 - a. It is noted that the client-side costing was a major issue for completion. This is of concern because there is incomplete soil profiling, but also lack of data collection and soil sampling from other areas of the site.
 - b. No auger tests were performed outside of the Phase I and Phase II design area.
- 2- Rotary drill cores (Rock cores) were only performed at the base of each of proposed tanks. However, a site wide or perimeter wide rock core testing must be performed to provide an overall profiling of the bedrock at the site. Levelton classifies the bedrock in as being weak to very weak in most of 20 ft to 60 ft range below grade. A site wide rock core testing plan would provide adequate information for the design.
- 3- The following items have not been addressed in this part of the report and need to be addressed:
 - a. Detailed dewatering and drainage plans
 - b. Ground water monitoring including piezometer installation
 - c. Consolidated and un-consolidated shear strength for saturated soils

3- Design Recommendations (Levelton File # R713-1879-00 Section 5.XX)

- 1- The foundation design for the tanks is not adequate for this stage of the study. There is also no mention of foundation anchoring and whether it is needed or not in this report.
- 2- The following items have not been addressed in this part of the report:
 - a. Differential settlements for the tanks, pipe racks, and manifolds
 - b. bedrock performance in seismic events
 - c. Preloading of material (if any)
 - d. Footing design and pile design for the pipe racks, and manifold area
 - e. Settlement monitoring and ground movement monitoring systemsSeismic response of foundations (tanks, manifolds, and pipe racks)

General Conclusion and Recommendations

In author's professional opinion, the Levelton's Preliminary Geotechnical Review **does not** provide a comprehensive geotechnical assessment of the site. There are many areas of concern and deficiencies and they need to be fully addressed, included and considered in design, and be provided to the City of Burnaby and other project stakeholders. **The geotechnical deficiencies observed in this report should be addressed before this project progresses.** The deficiencies and recommendations presented in this report are intended to reduce geotechnical risks and are in accordance with generally accepted geotechnical engineering practices.

The following list is areas of concern or lack of information:

- Differential settlements for the tanks, pipe racks, and manifolds
- Bedrock performance in seismic events
- Preloading of material (if any)
- Footing design and pile design for the pipe racks, and manifold area
- Settlement monitoring and ground movement monitoring systems
- Seismic response of foundations
- review of historical geotechnical performance of current tank farm facility
- Overall slope hazard assessment
- Clear design criteria and specifics. test holes at other site areas manifold area, retentions pond, new pipe racks, and containment dykes)
- rock core testing Detailed dewatering and drainage plans
- Consolidated and un-consolidated shear strength for saturated soils are not addressed

Closure

We trust the above satisfies your requirements at this time. Should you have any questions or comments, please do not hesitate to contact us.

Yours sincerely,

MineIt Consulting Inc.

Shervin Teymouri, M.Eng., P.Eng.

Principal Engineer



LIMITATIONS

Mineit Consulting Inc. (Mineit) prepared this document for the account of City of Burnaby, BC. The material in it reflects the judgment of Mineit staff in light of the information available to Mineit at the time of document preparation. Any use which a third party makes of this document or any reliance on decisions to be based on it is the responsibility of such third parties. Mineit accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this document.

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REFERENCES

Levelton B325-4_-Burnaby_Terminal_Phase_1_Findings_Report_Part1_-A4I6J2 – May 28, 2014

Levelton B325-11_-Burnaby_Terminal_Phase_2_Findings_Report_-A4I6K2 – Sept 22, 2014

Levelton B325-12_-Burnaby_Terminal_Preliminary_Geotechnical_Report_-A4I6K3 – Nov 06, 2014

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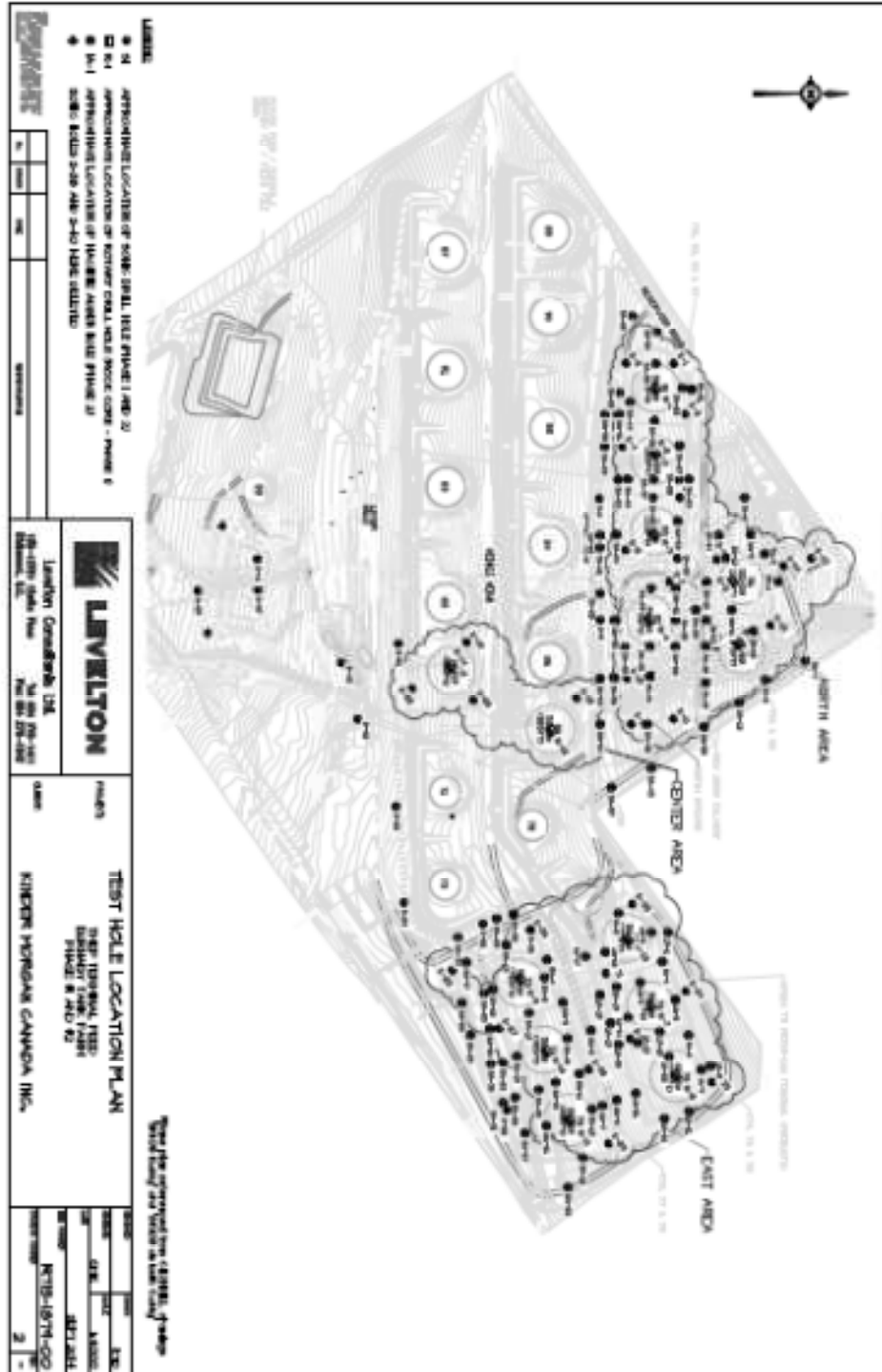
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