THURBER ENGINEERING LTD.

July 13, 2023 File No.: 32079

Associated Engineering
#500 – 2889 East 12th Avenue
Vancouver, BC
V5M 4T5

Attention: Priscilla Tsang, P.Eng.

HIGHWAY 1 WIDENING – 264TH STREET TO WHATCOM ROAD – SEGMENT 1
MEDIAN TEST FILL RECOMMENDATIONS

Dear Priscilla Tsang,

We understand that the Ministry of Transportation and Infrastructure would like to complete a median test fill at three locations within the median of Highway 1 to assist the design build team with settlement information. The three proposed locations for the test fill are Sta. 1026+95 to Sta. 1028+00, Sta. 1028+20 to 1029+60 and Sta. 1042+75 to 1043+40. This letter provides geotechnical recommendations for the construction and instrumentation of the median test fills. It is a condition of this report that Thurber's performance of its professional services is subject to the attached Statement of Limitations and Conditions.

1. BACKGROUND

Thurber has provided geotechnical design recommendations for the Highway 1 median as part of our Highway 1 264 Street to Whatcom Road – Segment 1 Mainline Highway - 50% Detailed Design report dated June 3, 2023. In particular, we noted that the west section of the project between approximately Sta. 1014+90 and Sta. 1035+60 is characterized by a thick, over-consolidated clay crust underlain by near-normally consolidated clay. The section between approximately Sta. 1035+60 and Sta. 1064+00 is more overconsolidated than west of Sta. 1035+60 based on CPTs completed, however, later drilling completed indicate the amount of overconsolidation may be less than the CPT estimates.

Piezometers installed within the 264th Street Interchange area suggests that the groundwater profile is not hydrostatic. Two deep piezometers installed in the dense sand below the clay encountered relatively little to no pore pressure. The challenging groundwater conditions in both sections described above make it difficult to accurately estimate the overconsolidation of the clay.

Estimated long-term settlement between Sta. 1024+60 to Sta. 1028+00 where the median fill is thickest is estimated to be about 425 mm using sand and gravel backfill. The long-term settlement near Sta. 1043+00 is estimated to be between 100 mm and 125 mm. Settlement plots from our 50% Detailed Design report are attached for reference.

2. TEST FILL CONSTRUCTION RECOMMENDATIONS

We believe that the proposed test fills will provide meaningful settlement data that can be used to assist the Design-Build team with their design. The test fills should be instrumented with settlement gauges and piezometers to assist with understanding the consolidation of the clay.

Ideally, the test fills would be constructed with well-graded sand and gravel because it would have a more uniform and higher density when compacted compared to typical Type D material. However, we understand that the Ministry would like to use suitable Type D material excavated from the median between Sta. 1037+30 to Sta. 1042+50 to the greatest extent possible.

In our opinion, suitable Type D material can be used for median infill for the test fill sites provided they are constructed during dry periods. The Type D material is primarily clay that will be sensitive to the moisture content of the soil during compaction. The Type D material will be very difficult to handle and compact during wet weather. Well-graded sand and gravel should be considered for test fill construction if the test fills will be constructed during wet weather months. Further, well-graded sand and gravel should be used to complete the test fills if insufficient volume of suitable Type D material is obtained from the median.

We anticipate between 50% and 75% of the material within the median between Sta. 1037+30 and Sta. 1042+50 will be suitable Type D material and can be reused. The remaining material is anticipated to have relatively high organic content and may also include areas of construction debris. The Type D material is primarily clay that will be sensitive to the moisture content of the soil during compaction. The Type D material will be difficult to handle and compact during wet weather. Using well-graded sand and gravel should be considered if the test fill compaction occurs during wet weather months.

The test fills should be constructed in accordance with the Ministry's 2020 Standard Specifications for Highway Construction (Standard Specifications). The subgrade at the base of the embankments should be stripped and free from deleterious, loose/soft, organic or otherwise unsuitable soils. A 0.5 m thick layer of select granular subbase (SGSB) should be constructed at the base of the test fill to act as a drainage layer. The drainage layer should be wrapped with non-woven geotextile. The test fills should be compacted to 95% standard Proctor maximum dry

density (SPMDD) in lift thicknesses as outlined in Table 201-A of the Standard Specifications. Note the fill should be compacted to 100% SPMDD lifts between the top of fill and 300 mm below the design base of road structure. If using suitable Type D, the material should be compacted with a sheepsfoot roller.

Note, it is important to recognize that these test fills are to improve our understanding of the consolidation of the underlying clay. The test fills should be compacted as if they are permanent embankment fill. However, it is possible that the material from the test fills (Type D or imported) may need to be removed and replaced with a lightweight fill should the settlement data indicate that the settlement will continue to occur over a long duration. The Design-Build team would likely be able to reuse excavated sand and gravel easier than Type D excavation material comprising clay.

We recommend that the test fills between Sta. 1028+20 to 1029+60 and Sta. 1042+75 to 1043+40 are constructed to underside of proposed asphalt. The test fill between Sta. 1026+95 to Sta. 1028+00 should include a 2 m surcharge. The surcharge should be sloped at 2.H:1V and hydroseeded to reduce the risk of erosion. The surcharge can comprise compacted, suitable Type D excavation material.

The test fill will cause settlement of the inside shoulder and travelled lane of the existing highway. It is anticipated that this settlement may be on the order of 25 mm to 50 mm. As such, the Ministry should anticipate completing regrading adjacent to this section of highway should reconstruction of the highway not proceed.

3. GEOTECHNICAL INSTRUMENTATION

3.1 Piezometers

Vibrating wire piezometers should be installed prior to placement of embankment fill to characterize the excess pore water pressure response due to embankment loading. The piezometers should be installed near the middle of the test fill, where the test fill is thickest. Two nested piezometers should be installed in the test fill between Sta. 1026+95 to Sta. 1028+00 and one nested piezometer installed in each of the other two test fills (Sta. 1028+20 to 1029+60 and Sta. 1042+75 to 1043+40).

The vibrating wire piezometers should be installed at the following elevations:

Table 1: Anticipated Piezometer/Transducer Installation Depths

Location	Elevation (m)
Sta. 1027+40	82 m 72 m
Sta. 1027+80	82 m 72 m
Sta. 1029+40	84 m 74 m
Sta. 1043+00	88 m 78 m

The actual depths installed should be confirmed in the field based on soil conditions encountered during drilling. This should be a hold point for Thurber to review.

The contract documents should clearly make the Contractor responsible for protecting the piezometer and associated cables during test fill construction. The Contractor should also be responsible for repair or replacement of the instrumentation if it is damaged by their operations. The piezometers must have protective surface covers to protect the instrumentation from vandalism during the monitoring period.

Data loggers should be used to record the piezometer data hourly. The data should be collected twice a month.

3.2 Settlement Gauges

We recommend settlement gauges be placed in the middle of the test fill, where the test fill is thickest, at 25 m longitudinal spacing. The settlement gauges should be installed on approved native subgrade prior to embankment construction. The top of gauge, fill, elevation, extension length and notes on potential gauge damage and disturbance should be collected weekly during construction and for the following three months following full construction of the preload. The settlement monitoring frequency can be decreased to twice a month 3 months after construction of the preload. Monitoring points should be considered along the edge of pavement to assess settlement of the existing highway. The monitoring points can be situated at the same stationing as the settlement gauges (i.e. spaced 25 m apart).

Survey control should be established to allow the settlement gauges to be surveyed with an accuracy of +/- 5 mm.

THURBER ENGINEERING LTD.

Yours truly,
Thurber Engineering Ltd.
Paul Evans, P.Eng.
Review Principal

Thurber Engineering Ltd.
Permit to Practice #1001319

Christopher Clarke, P.Eng.
Geotechnical Engineer

Attachment
- Statement of Limitations and Conditions
- Settlement Plots

THURBER

STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

This Report has been prepared in accordance with generally accepted engineering or environmental consulting practices in the applicable jurisdiction. No other warranty, expressed or implied, is intended or made.

2. COMPLETE REPORT

All documents, records, data and files, whether electronic or otherwise, generated as part of this assignment are a part of the Report, which is of a summary nature and is not intended to stand alone without reference to the instructions given to Thurber by the Client, communications between Thurber and the Client, and any other reports, proposals or documents prepared by Thurber for the Client relative to the specific site described herein, all of which together constitute the Report.

IN ORDER TO PROPERLY UNDERSTAND THE SUGGESTIONS, RECOMMENDATIONS AND OPINIONS EXPRESSED HEREIN, REFERENCE MUST BE MADE TO THE WHOLE OF THE REPORT. THURBER IS NOT RESPONSIBLE FOR USE BY ANY PARTY OF PORTIONS OF THE REPORT WITHOUT REFERENCE TO THE WHOLE REPORT.

3. BASIS OF REPORT

The Report has been prepared for the specific site, development, design objectives and purposes that were described to Thurber by the Client. The applicability and reliability of any of the findings, recommendations, suggestions, or opinions expressed in the Report, subject to the limitations provided herein, are only valid to the extent that the Report expressly addresses proposed development, design objectives and purposes, and then only to the extent that there has been no material alteration to or variation from any of the said descriptions provided to Thurber, unless Thurber is specifically requested by the Client to review and revise the Report in light of such alteration or variation.

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client, the BC Ministry of Transportation and Infrastructure (MoTI) and Authorized Users as defined in the MoTI Special Conditions Form H0461d. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Any use which an unauthorized third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any unauthorized third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.

b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.

c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.

d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

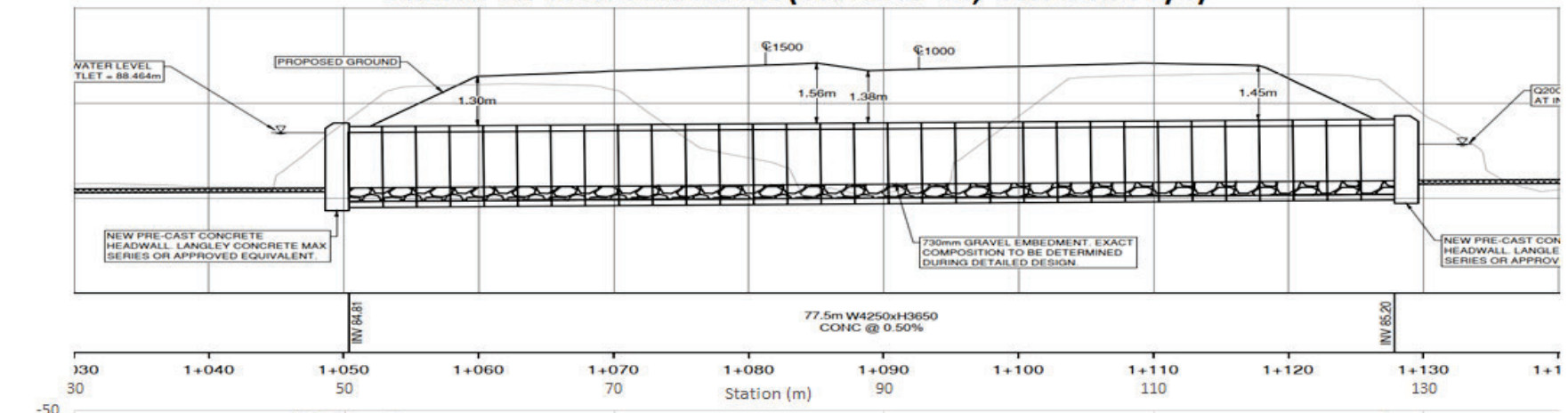
6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

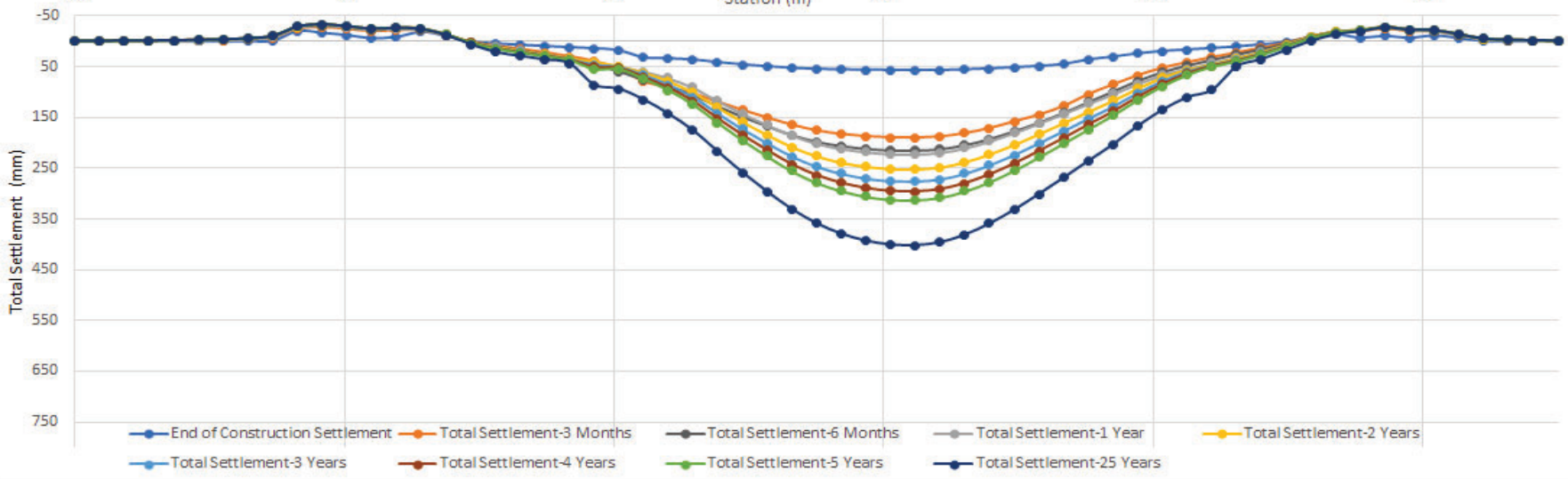
Geotechnical engineering and environmental consulting projects often have the potential to encounter pollutants or hazardous substances and the potential to cause the escape, release or dispersal of those substances. Thurber shall have no liability to the Client under any circumstances, for the escape, release or dispersal of pollutants or hazardous substances, unless such pollutants or hazardous substances have been specifically and accurately identified to Thurber by the Client prior to the commencement of Thurber's professional services.

7. INDEPENDENT JUDGEMENTS OF CLIENT

The information, interpretations and conclusions in the Report are based on Thurber's interpretation of conditions revealed through limited investigation conducted within a defined scope of services. Thurber does not accept responsibility for independent conclusions, interpretations, interpolations and/or decisions of the Client, or others who may come into possession of the Report, or any part thereof, which may be based on information contained in the Report. This restriction of liability includes but is not limited to decisions made to develop, purchase or sell land.

Station vs. Total Settlement (Sta 1024+90, Culvert #C-2/3)





REV	DATE	REVISION	BY
1	YYYY-MM-DD	-	-

LEGEND / NOTES

SEAL

PERMIT TO PRACTICE

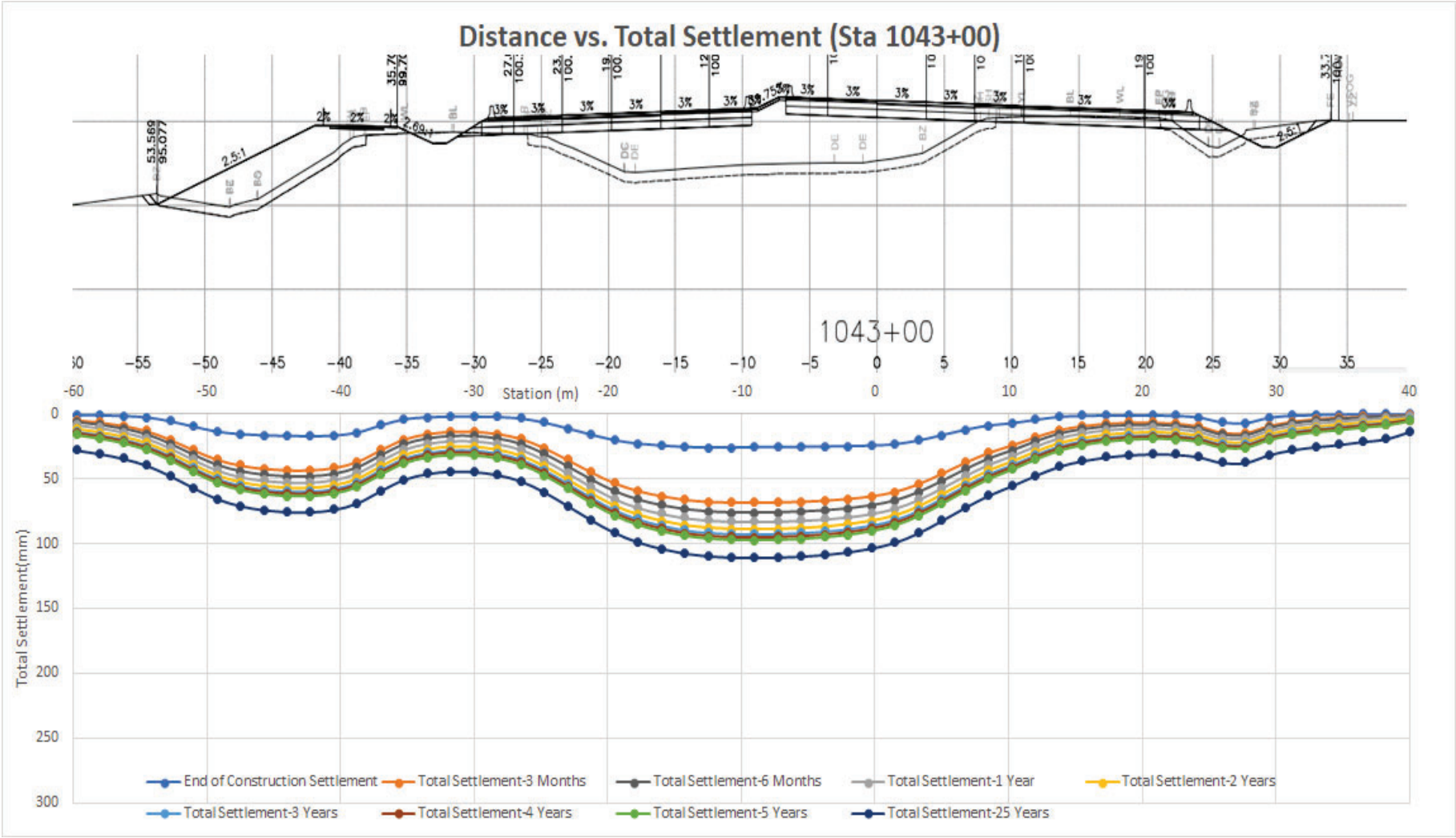
THURBER

CLIENT NAME: Associated Engineering / ISL Engineering and Land Services Ltd.

DRAWING TITLE: Settlement Analysis Sta. 1024+90 - Total Settlement Plots with 6 Month Surcharge

PROJECT NAME AND LOCATION: Highway 1 Widening - 264th Street to Whatcom Road (Segment 1)
Abbotsford, BC

DRAWN BY	DATE
SY	2023-05-24
DESIGNED BY	SCALE
CJC	NTS
APPROVED BY	PROJECT No.
-	32079
DRAWING / FIGURE No.	REV.
Figure D4	-



REV	DATE	REVISION	BY
1	YYYY-MM-DD	-	-

LEGEND / NOTES	SEAL		CLIENT NAME: Associated Engineering / ISL Engineering and Land Services Ltd.	DRAWN BY: SY	DATE: 2023-05-24
	PERMIT TO PRACTICE	THURBER	DRAWING TITLE: Settlement Analysis Sta. 1043+00 - Total Settlement	DESIGNED BY: CJC	SCALE: NTS
			PROJECT NAME AND LOCATION: Highway 1 Widening - 264th Street to Whatcom Road (Segment 1) Abbotsford, BC	APPROVED BY: -	PROJECT No.: 32079
				DRAWING / FIGURE No.: Figure D31	REV.: -