CAVEAT
FORBIDDING REGISTRATION

TO THE REGISTRAR OF THE ALBERTA LAND REGISTRATION DISTRICT:

TAKE NOTICE THAT: THE CITY OF CALGARY

claims an interest in the following lands:

LOTS 1 TO 5 AND 6 MR, BLOCK 8
LOT 1, BLOCK 9
LOT 1, BLOCK 10
LOT 1, BLOCK 11

ALL ON PLAN 241 0605
EXCEPTING THEREOUT ALL MINES AND MINERALS

(the "Servient Lots")

standing in the register in the name of: **THE CITY OF CALGARY**

under and by virtue of a: **Restrictive Covenant** as contained in the **Development and Geotechnical Covenant (Setbacks)** made between the Developer and The City, a copy of which Covenant is attached hereto as Schedule "A" and made part of this Caveat, and which Covenant sets out the terms and conditions governing the use of the Servient Lots for the benefit of both the Servient Lots and The City's streets, lanes and public reserves adjacent to the Servient Lots (the Servient Lots and the streets, lanes and public reserves being collectively the "Dominant Tenement")

It forbids the registration of any person as transferee or owner of, or of any instrument affecting the said estate or interest, unless the instrument or certificate of title, as the case may be, is expressed to be subject to its claim.

It appoints Law, Legal Services, Municipal Building, 12th Floor, 800 Macleod Trail S.E., Calgary, Alberta, T2G 2M3 as the place at which notices and proceedings relating hereto may be served.

DATED this 6 day of February, 2024.

THE CITY OF CALGARY
By its Agent in that behalf

JENNIFER NDIRANGU
PARALEGAL – PLANNING
PLANNING & REAL ESTATE
LAW, LEGAL SERVICES

AFFIDAVIT IN SUPPORT OF CAVEAT

I, **JENNIFER NDIRANGU**, of the City of Calgary, in the Province of Alberta **MAKE OATH AND SAY**:

1. I am the agent for the above named Caveator; and

2. I believe that the said Caveator has a good and valid claim upon the said lands and I say that this Caveat is not being filed for the purpose of delaying or embarrassing any person interested in or proposing to deal therewith.

SWORN BEFORE ME at the City of Calgary, in the Province of Alberta, this 12 day of February, 2024.

A Roberts

ALANNA ROBERTS
A COMMISSIONER FOR OATHS
IN AND FOR ALBERTA
MY APPOINTMENT EXPIRES DEC. 24, 2025

Jennifer Ndirangu

CAVEAT
FORBIDDING REGISTRATION

LAW, LEGAL SERVICES
THE CITY OF CALGARY (#8053)
FLOOR 12, CALGARY MUNICIPAL BUILDING
800 MACLEOD TRAIL SE
P.O. BOX 2100, POSTAL STATION "M"
CALGARY, ALBERTA T2G 2M3
FAX: 403.268.4634

File: P10888

This Agreement dated on the 30th day of January, 2024. **SCHEDULE "A" TO CAVEAT**

BETWEEN:

THE CITY OF CALGARY, having corporate offices and carrying on business in the City of Calgary, in the Province of Alberta

("the Grantor")

- and -

THE CITY OF CALGARY, a municipal corporation carrying on business in and pursuant to the Province of Alberta

("the City")

DEVELOPMENT AND GEOTECHNICAL COVENANT (SETBACKS)

RECITALS:

WHEREAS the Grantor is the registered owner of an estate in fee simple, subject however to such encumbrances, liens and interests as noted in this Covenant or as endorsed on the existing Certificate of Title of lands legally described as:

ATTACHED SCHEDULE "A"

("the Servient Lands")

AND WHEREAS pursuant to the Grantor's subdivision file number **SB2021-0144**, the City approved the development of the Servient Lands subject to certain conditions of approval, including a condition requiring the parties enter into a Development and Geotechnical Covenant and register such agreement concurrently with the registration of the final subdivision plan;

AND WHEREAS Section 67 of the *Land Titles Act*, R.S.A. 2000 c. L-4, as amended provides that when an easement or an incorporeal right in or over land for which a certificate of title has been granted is created for the purpose of being annexed to or used and enjoyed together with other land for which a certificate of title has also been granted, the Registrar shall make a memorandum of the instrument creating the easement or incorporeal right on the existing certificates of title of the dominant and servient tenements respectively;

AND WHEREAS Section 68(1) of the *Land Titles Act* provides that an owner may grant to himself or herself an easement or restrictive covenant for the benefit of land that the owner owns and against land that the owner owns and the easement or restrictive covenant may be registered under the Act;

AND WHEREAS the City is the owner of streets, lanes and public reserves adjacent to the Servient Lands.

IN CONSIDERATION of the approval of subdivision **SB2021-0144**, the mutual covenants contained herein, the payment of Ten Dollars ($10.00) from the City to the Grantor and such other valuable consideration, the receipt and sufficiency of which is hereby acknowledged, the parties hereby agree as follows:

1. that the Grantor does agree for the Development and the Grantor's successors-in-title to observe and be bound by the hereinafter mentioned covenants which shall be deemed to be and shall be covenants running with the land and shall be appurtenant to all of the

Servient Lands or any portion or portions thereof for the benefit of each of the Servient Lands and the following adjacent lands, owned by the City, namely:

MONCTON ROAD, NIMBUS WAY NE AND CIRRUS CIRCLE NE
("the Dominant Lands")

2. The Servient Lands or any portion or portions thereof shall not be developed or redeveloped in any way other than in strict compliance with the Geotechnical Report (the "Geotechnical Report") for the Servient Lands prepared by Report 1: 2020 Feb 7 - Tetra Tech - Preliminary Geotechnical Evaluation and Slope Stability Assessment (Revision 1) Redevelopment of Midfield Mobile Home Park, Former RCMP Property, and EMS Station #4 Moncton Road NE and 16 Avenue NE Calgary, Alberta and Report 2: 2022 Jul 6 - Tetra Tech - Geotechnical Milestone No. M#4 Supplemental Slope Stability Investigation Redevelopment of Midfield Mobile Home Park, Former RCMP Property, and EMS Station #4 Moncton Road NE and 16 Avenue NE Calgary, Alberta and Report 3: 2023 Jan 27 – Tetra Tech - Milestone No. O#4 Geotechnical Surcharge Loading Setback Slope Stability Assessment, Case 3 (100 kPa and 200 kPa), Redevelopment of Midfield Mobile Home Park, Calgary, Alberta and dated 2023-01-27, a copy of which is attached hereto as **Schedule "B"**, and with The City of Calgary Geotechnical Report Requirements then current at the time development occurs and any further geotechnical reports (the "Additional Reports") that may from time to time be submitted prior to development on behalf of the Grantor by a professional geotechnical engineering consultant (the "Consultant"), which is a member in good standing of the Association of Professional Engineers, Geologists, and Geophysicists of Alberta, and who is licensed to practice engineering in the Province of Alberta, all of which reports referred to above being subject to the acceptance by the Manager, Development Engineering.

3. The Grantor further specifically agrees for the Development and the Grantor's successors-in-title that any development on the Servient Lands will comply with the Development Setback shown on the Development Setback Plan registered at the Alberta Land Titles Office as Plan 241 0006 ________. The Grantor acknowledges and agrees, for itself and for its successors in title, that the Development Setback is based on the conditions described in the Geotechnical Report, and is subject to change, at the discretion of the development or subdivision authority, based on findings of Additional Reports provided to or required by the development or subdivision authority in connection with a future development.

4. The covenants set out herein are enforceable against the Grantor or the Grantor's successors-in-title; and by the owner or owners, or any of them, of the Dominant Lands, or any portion thereof.

5. No action shall be maintainable against the Grantor or the Grantor's successors-in-title for damages for breach of the covenants contained in this Covenant unless the Grantor is or was, or the Grantor's successor-in-title is or was, the registered owner of the Servient Lands, or a portion thereof, at the time of the alleged breach of this Covenant. This paragraph shall constitute an absolute defence to any such action and may be pleaded as such.

6. If any provision of this Covenant, or the application thereof to any person or circumstance, shall to any extent be invalid or unenforceable, the remainder of this Covenant shall not be affected thereby and each remaining provision shall be valid and shall be enforceable to the extent permitted by law.

7. Any notice or communication to be given or made to either party shall be in writing and may be sufficiently given if messenger delivered or faxed to such party at the following addresses:

To the Grantor: THE CITY OF CALGARY, RE&DS
P.O. Box 2100, Stn. M, Mail Code #195, Calgary, Alberta T2P 2M5
Email: N/A
Fax: N/A
Attention: Project Engineer, Development Engineering & Construction, Real Estate & Development Services

To the City: The City of Calgary, Development Engineering (#8032)
5th Floor, Municipal Building, 800 Macleod Trail S.E.
Calgary, Alberta T2P 2M5
Fax: 403-268-3636
Attention: Manager, Development Engineering

With a copy to: The City of Calgary, Law, Legal Services (#8053)
12th Floor, Municipal Building, 800 Macleod Trail S.E.
Calgary, Alberta T2P 2M3
Fax: 403-268-4634
Email: law.reception@calgary.ca
Attention: Manager, Planning & Real Estate Section

Either party may change its address by notice given to the other in accordance with this section in which event this section shall be deemed to have been amended accordingly.

Any notice or communication given in the foregoing manner shall be deemed to have been given and received on the date of delivery or fax.

IN WITNESS WHEREOF the parties have executed this Agreement as evidenced by their signatures, as of the day and year first above written.

APPROVED AS TO CONTENT REAL ESTATE & DEVELOPMENT SERVICES	INITIALS
Sherry Shimek	SS
APPROVED AS TO FORM BY LAW, LEGAL SERVICES	**INITIALS**
Jennifer Ndirangu	JN

THE CITY OF CALGARY

Per: ______________________
Manager, Land & Asset Management
Real Estate & Development Services (Corporate Seal)

Per: K. Martin
Katarzyna Martin
City Clerk FEB 01 2024

Affix Corporate Seal OR
use Affidavit of Corporate Signing Authority AND Affidavit of Execution

APPROVED AS TO CONTENT	INITIALS
Bus. Unit: Development Engineering Name: Dayna Forsythe	DF
APPROVED AS TO FORM BY LAW, LEGAL SERVICES	**INITIALS**
Name: Jennifer Ndirangu File: P10888	JN

THE CITY OF CALGARY

Per: ______________________
Coordinator, Utility Generalists

Per: K. Martin
City Clerk
Katarzyna Martin
City Clerk FEB 01 2024

SCHEDULE "A"

LOTS 1 TO 5 AND 6MR, BLOCK 8,
LOT 1, BLOCK 9,
LOT 1, BLOCK 10,
LOT 1, BLOCK 11

ALL ON PLAN 2410605

EXCEPTING THEREOUT ALL MINES AND MINERALS

Schedule 'B'

TETRA TECH

Preliminary Geotechnical Evaluation and Slope Stability Assessment (Revision 1)
Redevelopment of Midfield Mobile Home Park, Former RCMP Property, and EMS Station #4
Moncton Road NE and 16 Avenue NE
Calgary, Alberta

PRESENTED TO
The City of Calgary

FEBRUARY 2020
ISSUED FOR USE ISC CONFIDENTIAL – REVISION 1
FILE 704-ENG CGEO03639-01

Tetra Tech Canada Inc
Suite 110, 140 Quarry Park Blvd SE
Calgary AB T2C 3G3 CANADA
Tel 403 203 3355 Fax 403 203 3301

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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of The City of Calgary and the third parties noted below. Tetra Tech Canada Inc. does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than The City of Calgary and the third parties noted below, or for any project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. This report is subject to the terms and conditions of the Master Consulting Terms and Conditions executed between The City of Calgary and Tetra Tech Canada Inc.

This report has been prepared for The City of Calgary and their agents. The City of Calgary shall at all times be entitled to fully use and rely on this report, including all attachments, drawings, and schedules, for the specific purpose for which the report was prepared, in each case notwithstanding any provision, disclaimer, or waiver in the report that reliance is not permitted.

The City of Calgary shall at all times be entitled to provide copies of the report to City Council, City of Calgary regulatory boards, City of Calgary employees, officers, agents, affiliates, advisors, consultants, parties contracting with The City of Calgary, lenders and assignees and other governmental authorities and regulatory bodies having jurisdiction, each of whom shall also be similarly entitled to fully use and rely on the report in the same manner and to the same extent as The City of Calgary for the specific purpose for which the report was prepared.

Recommendations presented herein are based on a preliminary geotechnical evaluation of the findings in 11 boreholes. The conditions encountered during the fieldwork are considered to be reasonably representative of the site. If, however, conditions other than those reported are noted during subsequent phases of the project, Tetra Tech Canada Inc. should be notified and given the opportunity to review the current recommendations in light of new findings. Recommendations presented herein may not be valid if an adequate level of field review is not provided during construction or if relevant Building Code requirements are not met.

This report has been prepared for the exclusive use of The City of Calgary and the third parties noted above for specific application to the details described in this report. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty is made, either express or implied. Any such unauthorized use of this report is at the sole risk of the user.

1.0 INTRODUCTION

This report presents the results of a preliminary geotechnical evaluation and slope stability assessment conducted by Tetra Tech Canada Inc. (Tetra Tech) for the proposed site redevelopment of the former Midfield Mobile Home Park (MMHP), former RCMP property, and a portion of EMS Station #4 in Calgary, Alberta.

The objective of the work was to obtain subsurface information to develop preliminary geotechnical and slope stability recommendations for the future redevelopment of the project site.

It is understood that The City of Calgary (The City) will procced with redeveloping the project site, including but not limited to land use re-designation, outline plan, deep and shallow utility construction, road construction, and landscaping. Once the site has been redeveloped by The City, it will be subdivided into individual lots and sold to respective lot purchasers. A lot-specific geotechnical evaluation should be conducted for each lot by the respective owner based on the proposed development plan.

The scope of this evaluation was set out in The City of Calgary's (The City) Statement of Requirements 18-2006-A05-S01, dated February 14, 2019. Authorization to proceed with this work was received in the signed Scope and Fee Schedule 18-2006-A05-S01, dated March 12, 2019, under RFSO No. 18-2006.

This report was conducted in accordance with 'The City of Calgary's Geotechnical Report Guidelines for Land Development Applications,' dated July 2017.

This work was completed concurrently with a Phase II Environmental Site Assessment (ESA) by Tetra Tech, herein referred to as the '2019 Phase II ESA'. The ESA report is provided under separate cover.

As requested by The City, the slope stability results presented in this report have been updated. This report (Revision 1) shall supersede the previously submitted report entitled "Preliminary Geotechnical Evaluation and Slope Stability Assessment, Redevelopment of Midfield Mobile Home Park, Former RCMP Property, and EMS Station #4, Moncton Road NE and 16 Avenue NE, Calgary, Alberta," dated September 2019.

2.0 PROJECT DETAILS

The project site is located northeast of the 16 Avenue NE and Moncton Road NE intersection in northeast Calgary, Alberta. The site location is presented on Figure 1.

Based on the information provided by The City, the proposed site redevelopment covers an approximate area of 9.6 hectares (23.7 acres) and comprises three separate properties, listed below. The project site plan is presented on Figure 2.

- Former Midfield Mobile Home Park with the municipal addresses of 954, 970, 990, and 1020 – 16 Avenue NE;
- Former RCMP property with the municipal address of 920 – 16 Avenue NE; and
- Existing EMS Station #4 with the municipal address of 16 Moncton Road NE.

It is understood that the future development plans may comprise commercial and/or residential buildings with heights varying from 6 to 14 storeys above grade. The development may also comprise below-grade structures including basements and/or underground parkades up to three levels deep (i.e., approximately 9.0 m below ground surface). Further development details such as final site grade, floor elevations, or potential loads were not available at the time of this report.

As part of this preliminary geotechnical evaluation, a slope stability assessment was conducted on the slope located along the north/northeast boundary of the project site. Details regarding the slope (i.e., height and gradient) are discussed further in Section 4.0.

3.0 PROJECT BACKGROUND

3.1 General

Based on historical photographs, three ravines were located along the north portion of the project site and were backfilled in the late 1960s. The ravines were estimated to range between 5.2 m and 13.7 m deep based on the subsurface information obtained from the fieldwork program. It is understood that the fill was not placed in a controlled manner (compacted and/or screened for organics and/or miscellaneous debris). The estimated boundary of the ravines (i.e., the backfilled areas) is presented on Figure 3.

According to the information provided by The City, the northeast slope leading into The Winston Golf Club (formerly Calgary Elks Golf & Country Club) was repaired/reinforced in 1999 and 2007 after slope failures occurred in 1998 and 2006, respectively. The 1998 slope failure occurred near the middle of the slope and the 2006 slope failure occurred near the toe of the slope. Both the slopes were repaired/reinforced using soil berms based on the evaluation studies completed by Geo Engineering Ltd. (Geo Engineering) in 1999 and 2006, summarized in Sections 3.2 and 3.3, respectively.

Compaction records for the former Midfield Mobile Home Park were provided by The City for reference purposes and are discussed in Section 3.4.

In addition, several environmental assessments were conducted previously at the project site and were reviewed as part of Tetra Tech's 2019 Phase II ESA (presented under separate cover). Monitoring well locations from previous environmental assessments are presented on Figure 2 along with a brief description of the subsurface soil conditions.

3.2 1999 Slope Stability Evaluation

A slope stability evaluation was previously completed by Geo Engineering to investigate a slope failure that occurred in the middle of the northeast slope and appeared to be a block type failure. The results of the slope stability evaluation were provided in a report entitled *Midfield Mobile Home Park Slide, Report on Slope Stabilization Measures*, dated March 1999, herein referred to as the '1999 Slope Stability Evaluation'.

As part of this evaluation, four boreholes, designated as TP-1 through TP-4, were drilled in 1998 in the upper to mid portion of the northeast slope to determine the subsurface conditions and the potential slope failure mechanism to provide slope stabilization recommendations. The borehole locations and subsurface summary are presented on Figure 2.

The subsurface soils generally consisted of clay/silt till with intermittent layers of medium to high-plastic clays and silt. A layer of high-plastic clay between the elevations of 1058.5 m and 1059.5 m was noted during Geo Engineering's field program. Two groundwater tables were identified at the project site at approximate depths of 3.4 m and 15.0 m below the existing ground surface and designated as the shallow/perched and deep groundwater tables, respectively.

Based on the findings of the 1999 Slope Stability Evaluation, the slope failure was attributed to the layer of medium to high-plastic clay (shear zone) and precipitation/infiltration. It was recommended that a berm be constructed in the middle of the slope to improve the overall global slope stability. It is understood that this mid-slope berm was constructed as per the recommendations provided in the 1999 Slope Stability Evaluation.

3.3 2006 Slope Stability Evaluation

Another slope stability evaluation was completed by Geo Engineering in 2006 to investigate a second slope failure (block type) that occurred immediately downslope of the 1998 slope failure near the toe of the northeast slope. The results of the slope stability evaluation were provided in a report entitled *Midfield Mobile Home Park, Slope Stabilization Evaluation*, dated December 2006, herein referred to as the '2006 Slope Stability Evaluation'.

As part of this evaluation, four additional boreholes, designated as MTP-1 through MTP-4, were drilled in 2006 in the mid to lower portion of the northeast slope to determine the subsurface conditions and the slope failure mechanism to provide slope stabilization measures for improvement. The borehole locations and subsurface summary are presented on Figure 2.

The subsurface soils generally consisted of clay till underlying topsoil with intermittent layers of medium to high-plastic clay and sand/silt. Bedrock was encountered underlying the overburden soils at depths varying between 6.3 m and 16.2 m. Two groundwater tables were identified at the project site at approximate depths of 4.0 m and 13.0 m below the existing ground surface and designated as the shallow/perched and deep groundwater tables, respectively.

Based on the findings of the 2006 Slope Stability Evaluation, the slope failure was attributed to the medium to high-plastic clay (same shear zone as the 1998 slope failure) and heavy precipitation/infiltration. Several recommendations were presented in the 2006 Slope Stability Evaluation report and included unloading the mid slope berm, construction of a toe berm, excavation to remove the shear zone, and construction of a shear key. It is understood that the construction of a toe berm was selected for slope stabilization and it was constructed in 2007.

3.4 2018 Compaction Records

The underground utilities for the former Midfield Mobile Home Park were removed between June and August in 2018 and the backfill compaction was monitored by Wilco Contractors Southwest Inc. The following three compaction letter reports were provided by The City to Tetra Tech for information purposes only:

- *Midfield Mobile Home Park, Compaction & Concrete Testing & Inspection – June 2018*;
- *Midfield Mobile Home Park, Compaction & Concrete Testing & Inspection – July 2018*; and
- *Midfield Mobile Home Park, Compaction & Concrete Testing & Inspection – August 2018*.

Based on the above-listed compaction letter reports (herein referred to as the '2018 Compaction Records'), the backfill compaction for the utility removals were completed in accordance with the project requirements.

A detailed review of the compaction records, including compaction test locations, were not conducted as part of this evaluation. The compaction records, along with a utility and unit layout map, are included in Appendix A for information. These documents should be reviewed by the relevant contractors once development plans are finalized.

4.0 SITE DESCRIPTION

The project site comprises the former Midfield Mobile Home Park, former RCMP property, and existing EMS Station #4. The project was generally bound to the north and east by The Winston Golf Club, to the south by 16 Avenue NE, and to the west by Moncton Road NE.

At the time of the fieldwork, the Midfield Mobile Home Park and RCMP properties were both vacant and fenced along the perimeter. Several trees and shrubs were located in the former RCMP property. The EMS station comprised one building with an asphalt parking lot located in the back of the building (on the east side).

The overall project site was generally level with slight undulations noted in the vacant properties (i.e., Midfield Mobile Home Park and RCMP property). The majority of the ground surface was grass covered. Some ponding water was noted at the time of the fieldwork near the north boundary of the Midfield Mobile Home Park and is identified on Figure 2. The existing site topography survey was provided by The City and is presented on Figure 2.

The project site was elevated approximately 30 m above The Winston Golf Club (located along the north boundary of the project site) and joined with a slope where gradients varied between 2H:1V and 4H:1V with benches scattered throughout the slope. A paved pedestrian pathway was located near the north property line/crest of the slope. Several trees, bushes, and shrubbery were also present along the slope face.

5.0 GEOLOGY

Based on the surficial geological map (Moran[1]), the project site is located along several geological boundaries and the native soils in the project site were anticipated to consist of pebble loam till, sand, and/or silt.

The site assessment results were generally consistent with the published data with the exception that bedrock and fill soils were encountered.

6.0 FIELD AND LABORATORY WORK

6.1 Fieldwork

Following utility clearances by Alberta One-Call, DigShaw, and The Utility Locators (private utility contractor), borehole drilling commenced on April 16, 2019, and was completed on April 22, 2019, using a truck-mounted drill rig equipped with solid-stem augers contracted from All Service Drilling Inc., of Airdrie, Alberta.

A total of 11 boreholes, designated as Boreholes BH19-01 through BH19-11, were drilled to depths ranging from 3.5 m to 30.6 m below the existing ground surface.

Disturbed bulk samples were recovered at regular intervals from the auger flights. Standard Penetration Tests (SPTs) were performed at 1.5 m intervals and the blow counts were recorded. Split-spoon samples were recovered from the SPTs. Soil samples were examined visually and classified during the drilling process. Soil stratigraphy was logged noting the depths of stratigraphic boundaries and other significant features. The borehole logs are presented in Appendix B.

Hand-slotted 25 mm diameter and machine-slotted 50 mm diameter polyvinyl chloride standpipes were installed in all the boreholes for future monitoring of the groundwater levels, with the exception of Boreholes BH19-08, BHA19-09, and BH19-10.

The borehole locations (coordinates and ground elevations) were surveyed by Tierra Geomatic Services Inc. upon completion of the drilling. The borehole locations are presented on Figure 2 and the survey information (coordinates and ground elevations) are presented on the borehole logs in Appendix B.

A summary of the borehole drill depths, standpipe installation, and survey data are presented in Table 1.

[1] Moran, S.R. 1986. Surficial Geology of the Calgary Urban Area. Alberta Research Council, Bulletin No. 53.

Table 1: Borehole Locations and Depths

Borehole No.	Ground Surface Elevation (m)	Borehole Depth Below Existing Ground Surface (m)	Coordinates (3TM)		Standpipe Depth Below Existing Ground Surface (m)	
			Northing (m)	Easting (m)	50 mm Diameter Standpipe	25 mm Diameter Standpipe
BH19-01	1074.4	11.1	5659182.770	-2884.103	10.4	-
BH19-02	1076.0	9.6	5659046.157	-2916.126	8.8	-
BH19-03	1074.8	9.6	5659094.091	-2775.863	7.0	-
BH19-04	1076.1	9.6	5659036.641	-2653.843	9.1	-
BH19-05	1073.2	26.2	5659155.711	-2648.286	12.2	25.9
BH19-06	1075.3	12.6	5659103.101	-2527.545	12.2	-
BH19-07	1074.9	30.6	5659044.743	-2424.118	15.2	24.4
BH19-08	1075.6	3.5	5659084.482	-2851.410	-	-
BH19-09	1075.6	3.5	5659055.879	-2850.913	-	-
BH19-10	1075.7	3.5	5659033.340	-2851.587	-	-
BH19-11	1073.9	15.7	5659191.575	-2757.827	7.9	-

6.2 Laboratory Work

Following the fieldwork program, laboratory testing was performed on selected samples collected from the field program to aid in the evaluation of their engineering properties. Laboratory tests included the following:

- Natural moisture content;
- Particle size analysis;
- Atterberg limits; and
- Soluble sulphate concentration.

Laboratory test results are presented on the borehole logs in Appendix B and the test result sheets are attached in Appendix C.

7.0 SUBSURFACE CONDITIONS

7.1 General

The following subsections present a summary of the soil conditions encountered in the boreholes advanced at the project site. The details of the soil and groundwater conditions encountered at each borehole location are presented on the borehole logs in Appendix B. All noted depths in the following subsections refer to depth below the existing ground surface at the time of the fieldwork.

7.2 Topsoil

Surficial topsoil with an approximate thickness ranging between 200 mm and 300 mm was encountered at the existing ground surface in Boreholes BH19-01, BH19-02, and BH19-10. The topsoil was generally described as clay, silty, sandy, trace gravel, damp, dark brown, and containing trace organics and trace rootlets.

The exact lateral and vertical extents of the topsoil in the areas surrounding the boreholes was not determined as part of this evaluation and it should be expected to vary.

7.3 Fill Soils

Fill soils consisting of clay, gravel, and sand were encountered in all boreholes at the project site to depths ranging from 1.5 m to 13.7 m. Note that fill thicknesses and lateral extents of the fill materials may vary across the project site and were not determined as part of this evaluation.

Clay Fill

Clay fill was encountered at the ground surface in Boreholes BH19-03 through BH19-09 and BH19-11, and below the topsoil in Boreholes BH19-01 and BH19-02. The clay fill ranged in thickness from 1.5 m to 8.8 m.

The clay fill was generally described as silty, some sand to sandy, trace to some gravel, damp to moist, low to medium plastic, and brown to grey in colour. The clay fill across the site contained trace amounts of oxides, organics, coal specks, rootlets, bedrock fragments, debris (wood, plastic, and paper), and trace ambient odour. SPT blow counts (N-values) ranging from 4 to 29 were encountered within the clay fill.

Gravel Fill

Gravel fill was encountered below the clay fill in Borehole BH19-11 at a depth of 6.7 m and with a thickness of 0.6 m. The gravel fill can generally be described as sandy, some silt, trace clay, damp, subrounded to subangular, fine to coarse gravel, and dark brown in colour. SPT blow counts were not able to be conducted in the gravel fill due to sloughing and the thickness of the layer.

Sand Fill

Sand fill was encountered below the topsoil in Borehole BH19-10 with a thickness of 2.0 m. The sand fill was generally described as silty, trace clay, trace gravel, damp, loose, fine sand, and containing trace wood debris. An SPT blow count of 8 was encountered in the sand fill.

7.4 Clay Till

An upper layer of clay till was encountered in all boreholes, with the exception of Boreholes BH19-01 and BH19-11, at depths ranging from 1.5 m to 7.6 m and varied in thickness from 2.4 m to 7.4 m. Multiple lower layers of clay till were encountered in Boreholes BH19-05 and BH19-07 at depths ranging from 17.3 m to 24.7 m.

Boreholes BH19-02 through BH19-05 and BH19-08 through BH19-10 were terminated within the clay till at depths ranging from 3.5 m to 26.2 m.

The clay till was generally described as silty, trace sand to sandy, trace gravel, damp to moist, firm to hard, low to medium plastic, brown to grey, and containing trace oxidization and coal specks.

Note that while not encountered in the boreholes, till deposits typically contain cobbles and boulders which may be present in the subsurface soils at the project site.

7.5 Silt

Silt till was encountered in Boreholes BH19-05 and BH19-07 at respective depths of 14.2 m and 15.7 m. A lower silt till layer was encountered in Borehole BH19-07 at a depth of 18.2 m. The silt till had thicknesses varying from 1.7 m to 10.5 m.

The silt material was generally described as some sand to sandy, trace clay, damp to moist, very stiff to hard, trace to no plasticity, brown in colour, and containing trace oxides and trace coal specks.

7.6 Clay

Clay was encountered in Boreholes BH19-01, BH19-05, BH19-06, BH19-07, and BH19-11 at depths ranging from 7.6 m to 13.7 m.

The clay was generally described as silt, trace to some sand, trace gravel, damp to wet, soft to hard, medium plastic, brown to grey in colour, and containing trace oxides and trace coal specks. The clay had a thickness of 6.6 m and 7.2 m in Boreholes BH19-05 and BH19-07, respectively, and extended to termination depths of 11.1 m, 12.7 m, and 15.7 m in respective Boreholes BH19-01, BH19-06, and BH19-11.

7.7 Sand

Sand was encountered in Borehole BH19-07 at a depth of 22.3 m and was approximately 2.7 m thick. The sand was described as silty, trace clay, trace gravel, damp to wet, very dense, brown in colour, fine to medium grained, and containing trace oxides and trace coal specks.

7.8 Bedrock

Bedrock consisting of mudstone and sandstone was encountered beneath the clay till in Borehole BH19-07 at a depth of 27.4 m (elevation of 1047.5 m). Borehole BH19-07 was terminated within the bedrock at a depth of 30.6 m.

The bedrock consisting of mudstone was generally described as extremely weathered, extremely weak, fine grained, and brown in colour. The bedrock consisting of sandstone was generally described as extremely weathered, very weak, fine to medium grained, and brown in colour.

7.9 Groundwater Conditions

At the time of drilling, groundwater seepage was encountered in Boreholes BH19-01, BH19-03, BH19-05, BH19-06, BH19-07, and BH19-11 at depths ranging from 6.1 m to 21.0 m below the existing ground. Groundwater levels were measured in all installed standpipes on upon completion of the drilling and again on May 1, 2019. The groundwater measurements are summarized in Table 2.

Table 2: Summary of Groundwater Depths

Borehole No.	Ground Surface Elevation (m)	Standpipe Depth below Existing Ground Surface (m)		Groundwater Level Below Existing Grade (m)				Highest Groundwater Elevation (m)
		50 mm Diameter Standpipe	25 mm Diameter Standpipe	Upon Drilling Completion		May 1, 2019		
				50 mm	25 mm	50 mm	25 mm	
BH19-01	1074.4	10.4	-	9.1		9.3		1065.3
BH19-02	1076.0	8.8	-	Dry		5.9		1070.1
BH19-03	1074.8	7.0	-	6.7		5.6		1068.1
BH19-04	1076.1	9.1	-	Dry		6.9		1069.2
BH19-05	1073.2	12.2	25.9	Dry	21.0	Dry	22.1	1052.2*
BH19-06	1075.3	12.2	-	6.1		7.1		1069.2
BH19-07	1074.9	15.2	24.4	Dry	21.0	Dry	Dry	1053.9*
BH19-11	1073.9	7.9	-	Dry		5.7		1068.2

Based on the groundwater level measurements, the project site appears to have an upper and lower water table. The upper water table appears to range between elevations of 1065.3 m and 1070.1 m (depths ranging between 5.6 m and 9.3 m below the existing ground surface). The lower water table appears to range between elevations of 1052.2 m and 1053.9 m (depths ranging between 21.0 m and 22.1 m below the existing ground surface). The upper water table may be perched on top of semi-impermeable to impermeable soils such as the clay soils encountered at the project site.

The water level in the standpipes may not have been finalized by the time of the last measurement reported above. Groundwater levels typically fluctuate seasonally (high in late spring and early summer) and due to climatic conditions. Groundwater levels should be monitored prior to construction and/or during planning stages to reassess groundwater levels and their potential to impact the future redevelopment.

8.0 PRELIMINARY RECOMMENDATIONS AND CONSIDERATIONS

The following geotechnical recommendations provided in this report are valid for the project details discussed in Section 2.0 and are preliminary in nature. The recommendations may offer varying options intended to aid in the development of project concepts and specifications.

It is understood that The City of Calgary (The City) will procced with redeveloping the project site, including but not limited to land use re-designation, outline plan, deep and shallow utility construction, road construction, and landscaping. Once the site has been redeveloped by The City, it will be subdivided into individual lots and sold to respective lot purchasers. A lot-specific geotechnical evaluation should be conducted for each lot by the respective owner based on the proposed development plan.

Note that geological conditions are innately variable. At the time of preparation of this report, information on the subsurface stratigraphy was available only at discrete borehole locations. In order to develop preliminary design recommendations from this information, it is necessary to make some assumptions concerning conditions other than those present at the borehole locations. The site conditions should be confirmed at specific structure locations once they are determined to support the detailed design.

8.1 General

Based on the historic photos of the project site, the soils located within the ravines were placed in the 1960s and have been consolidation for approximately 50 years. In addition to consolidation and compaction, soil behaviour (i.e., differential settlement, strength) can be affected by soil composition such as inclusions of organics and debris and can behave differently under load. Fill soils were encountered at the project site to depths ranging from 1.5 m to 13.7 m. Apart from the areas identified in the 2018 Compaction Records (utility backfill), due to the lack of compaction records and the presence of organics and miscellaneous debris (wood, paper, plastic, etc.), the fill materials at the project site are considered uncontrolled fill.

Recommendations regarding the uncontrolled fill are discussed in Section 8.2.

General recommendations for site preparation are discussed further in Section 8.3.

Suitable foundation options for the project site are provided Section 8.4.

Preliminary floor slabs-on-grade recommendations are provided in Section 8.5.

Preliminary frost protection measures are presented in Section 8.6.

It is understood that below-grade structures may be utilized at the project site. Preliminary recommendations for below-grade structures are discussed in Section 8.6.

A preliminary slope stability assessment of the existing slopes located on the north, east, and southeast sides of the project site was conducted as part of this evaluation to determine potential impacts the slope stability may have on the future development (i.e., development setback) and is presented in Section 9.0.

8.2 Uncontrolled Fill

Uncontrolled fill soils were generally encountered up to depths varying from 1.5 m to 3.0 m across the project site. The deepest fills were located near Boreholes BH19-01, BH19-03, BH19-05, and BH19-11 with fill depths up to 9.1 m, 7.6 m, 5.2 m, and 13.7 m, respectively. The deep fills were located near previously backfilled ravines and the extents of the uncontrolled fill were estimated and are presented on Figure 3. Note that the lateral extent of the uncontrolled fill was not determined as part of this evaluation and the fill may vary in depth in areas surrounding the boreholes and areas shown on Figure 3.

It is recommended that all uncontrolled fill soils be removed and replaced with general engineered fill if any structures/buildings are to be placed in uncontrolled fill areas.

Complete removal of uncontrolled fills may not be economically feasible. Precautions should be taken for any developments located in areas where uncontrolled fills are not removed, discussed below.

- The uncontrolled fill soils encountered at the project site are not considered suitable to support shallow or deep foundations. Any developments located over uncontrolled fills should utilize a deep foundation system and should be founded in native soils below the uncontrolled fills (discussed further in Section 8.4).
- The uncontrolled fills are not considered suitable to support floor slabs-on-grade. Structural slabs should be utilized for any developments located in areas with uncontrolled fills (discussed further in Section 8.5).
- The uncontrolled fill soils contained trace organics, which may affect the consolidation and the behavior of the soil under load (i.e., settlement). In addition, organics may also produce methane. An environmental assessment of the project site was conducted by Tetra Tech to evaluate the requirements for methane management and those findings are presented under separate cover. Refer to the environmental assessment report for recommendations regarding methane risk management and mitigation.

8.3 Site Preparation

The following provides preliminary site preparation recommendations for planning purposes only. These recommendations may require revision and should be reviewed when the project details or proposed grading plans become available.

The project site should be stripped of deleterious soils including topsoil, organics/vegetation, uncontrolled fill, and any soft or loose soils.

As discussed in Section 8.2, complete removal of uncontrolled fills may not be economically feasible, particularly the uncontrolled fills located in the backfilled ravine. Removal of these soils may be required depending on the proposed development and should be assessed once the development plans are finalized.

Following initial site stripping of deleterious soils, the areas identified for fill placement should be proof-rolled (discussed in Section 8.3.1) to identify soft areas. Any soft areas should be over-excavated and backfilled to a minimum 98% standard proctor maximum dry density (SPMDD) using general engineered fill as defined in the construction guidelines provided in Appendix D.

Should greater than 2.0 m of general engineered fill be required to restore or establish the required subgrade elevation for the proposed structure, then post-construction slab settlements (consolidation settlements) should be anticipated. The amount of the anticipated settlement may be provided after conducting a deep fill study as an additional scope of work, if requested

Prior to the placement of deep fills, all existing natural and excavation cutslopes shall be graded to a maximum of 5H:1V. If cutslopes steeper than 5H:1V are to remain, it is recommended that benching of sideslopes of the native soils be performed prior to fill placement.

All fill required for the project to raise the subgrade elevation should meet the requirements as defined in "Backfill Materials and Compaction" in Appendix D. General engineered fill should be placed in lifts not exceeding 150 mm in compacted thickness and a density of 98% SPMDD, and should be moisture conditioned between optimum to 3% above the optimum moisture content (OMC) for fine-grained soils and between 3% below to 3% above OMC for coarse-grained soils. If required, structural fill should be placed in lifts not exceeding 150 mm in compacted thickness at a density of 98% SPMDD.

Full-time monitoring and compaction testing should be provided during any fill placement to ensure suitable subgrade conditions are prepared. Qualified persons, independent of the contractor, should complete this monitoring.

8.3.1 Proof-Rolling

These guidelines are intended to present standards of good practice and are not intended to represent detailed specifications for the construction.

Proof-rolling is a method of detecting soft areas in an 'as-excavated' subgrade for fill placement, foundations, or detecting non-uniformity of compacted fill. The intent is to detect soft areas or areas of low shear strength not otherwise revealed by means of testholes, density testing, or visual examination of the site surface and to check that any fill placed or subgrade meets the necessary design strength requirements. Proof-rolling should be observed by qualified geotechnical personnel.

Proof-rolling is generally accomplished by the use of a heavy (15 to 60 tonne) rubber-tired roller having four wheels abreast on independent axles with high-contact wheel pressures (inflation pressures ranging from 550 kPa [80 psi] up to 1030 kPa [150 psi]).

A heavily-loaded tandem axle gravel truck may be used in lieu of the equipment described in the paragraph above. The truck should be loaded to approximately 10 tonnes per axle and a minimum tire pressure of 550 kPa (80 psi).

Ground speed should be maximum 8 km/hr, whereas the recommended speed is 4 km/hr.

The recommended procedure is two complete coverages with the proof-rolling equipment in one direction and a second series of two coverages made at right angles to the first series; one 'coverage' means that every point of the proof-rolled surface has been subjected to the tire pressure of a loaded wheel. Less rigorous procedures may be acceptable under certain conditions subject to the approval of an engineer.

Any areas of soft, rutted, or displaced materials detected should either be recompacted with additional fill or the existing material removed and replaced with general engineered fill, or properly moisture conditioned as necessary.

The surface of the grade under the action of the proof-roller should be observed, noting visible deflection and rebound of the surface, formation of a crack pattern in the compacted surface, or shear failure in the surface of granular soils as ridging between wheel tracks.

If any part of an area indicates significantly more distress than other parts, the cause should be investigated by, for example, shallow auger holes.

In the case of granular subgrades, distress will generally consist of either compression due to insufficient compaction or shearing under the tires. In the first case, rolling should be continued until no further compression occurs. In the second case, the tire pressure should be reduced to a point where the subgrade can carry the load without significant deflection and subsequently gradually increased to its specified pressure as the subgrade increases in shear strength under this compaction.

8.4 Foundations

8.4.1 General

The uncontrolled fill soils at the project site are not considered suitable to support shallow or deep foundations. All foundation systems should be founded in native soil or engineered fill.

Any foundation loads placed in proximity of the north property line (refer to Section 9.0 for development setback guidelines) should be evaluated with a slope stability assessment to ensure surcharge and/or structural loads do not compromise the global slope stability of the north slope and meet the required global slope stability factor of safety, per The City guidelines.

Preliminary foundation recommendations for shallow and deep foundation systems are provided in the following subsections.

8.4.2 Shallow Foundations

A shallow foundation system, consisting of spread footings and strip footings founded on engineered fill or the native very stiff to hard clay till, is considered suitable to support light to moderately-loaded structures (e.g., wood-framed buildings).

The preliminary ultimate bearing resistance on the engineered fill or native stiff clay till may be taken in the range of 250 kPa to 350 kPa (i.e., factored bearing resistance of 125 kPa to 175 kPa). The bearing resistance parameters should be confirmed or updated during a lot-specific geotechnical evaluation by the respective land owner.

Footings should be placed on a single material type to minimize the potential for post-construction settlement of foundation elements (differential and consolidation settlement).

Footing excavations should be protected from freezing temperatures, the ingress of free water, disturbance by construction traffic, and excessive drying. Groundwater was measured at a depth of 5.6 m below the existing ground surface and may fluctuate such that groundwater seepage may be encountered during footing exactions.

Exposed bearing surfaces should be protected with a mud slab if groundwater seepage is encountered.

Recommendations for minimum depth of cover for footings for frost consideration are presented in Section 8.7.

Design and construction of the shallow foundations should comply with the relevant Building Code requirements.

8.4.3 Bored Cast-in-Place Piles

A deep foundation system consisting of bored cast-in-place piles founded in the native stiff to very stiff clay/silt till may be considered for moderately to heavily-loaded structures (e.g., concrete-framed buildings or high-rise buildings).

In areas where uncontrolled fills are located, deep foundations may be considered; however, deep foundations must be founded below the uncontrolled fill and must be designed adequately to support the structural loads. Shaft and/or end-bearing resistances should not be considered for uncontrolled fills.

Sand and silt layers may be encountered during piling operations and are typically prone to sloughing, particularly if groundwater seepage is encountered, and may cause challenges during installation. Medium-plastic clays may also be encountered, presenting challenges for loading and settlement.

Foundations founded in the bedrock may also be considered; however, bedrock was encountered approximately 30 m below the existing ground surface and it may not be economically feasible to install pile foundations to these depths.

Groundwater seepage was encountered at depths of 5.6 m (upper water table) and 21.0 m (lower water table) below the existing ground surface and will likely be encountered during pile installation. Casing, dewatering, and/or pumping may be required during pile installation.

Design recommendations, including geotechnical design parameters, for deep foundations should be based on site-specific geotechnical evaluations for individual structures. The geotechnical evaluation should be completed by the lot owner based on the respective development plan.

8.4.4 Foundation Settlements

Calculations of the foundation settlement should be undertaken during the lot-specific geotechnical evaluation by the respective lot owner.

Differential settlements, rather than total settlements, are usually the governing factor in structural and architectural design. For pad footings, the degree of settlement is directly dependent on the quality of construction and adherence to the recommendations of this report.

8.5 Floor Slabs-on-Grade

Uncontrolled fill soils are not considered suitable for floor slabs-on-grade. Structural slabs should be utilized for any developments located above areas with uncontrolled fill.

Slab-on-grade construction is considered feasible for native site soils provided the following precautions are undertaken:

- Any unsuitable soils (topsoil, uncontrolled fill soil, or soils containing organics, soft/wet or otherwise disturbed portions of the native soils) encountered in slab-on-grade areas should be completely removed. The exposed slab subgrade should be proof-rolled and any soft, loose, or otherwise disturbed areas detected should be over-excavated and replaced with general engineered fill.
- Should greater than 2.0 m of general engineered fill be required to restore the slab subgrade elevation, then post-construction slab settlements (consolidation settlements) should be anticipated and assessed with a deep fills study.
  - Consolidation time lag may be required for deep fill areas and should be accounted for in construction scheduling. Settlement monitoring is recommended to track consolidation.

A structurally supported floor slab may be considered as an alternative to a slab-on-grade if slab movement or differential movement between the slab and adjacent walls or foundations cannot be tolerated.

8.6 Frost Protection

For protection against frost action, perimeter footings in heated structures should be extended to such depths as to provide a minimum soil cover of 1.4 m. Isolated or exterior footings in unheated structures should have a minimum soil cover of 2.1 m unless provided with equivalent insulation.

Grade beams should be provided with the same soil cover as for footings. Grade beams that do not have adequate soil cover for frost protection should have a minimum of 100 mm void space on the underside of the grade beam to reduce the risk of interaction with the underlying soil.

Pipes buried with less than 2.1 m of soil cover should be protected with insulation to avoid damage or breakage as a result of frost action.

8.7 Wall Pressures and Perimeter Drainage for Below-Grade Structures

Basement walls should be designed to resist lateral earth pressures in the at-rest condition If foundation perimeter drainage is not provided, allowances should be made for hydrostatic pressures.

It is recommended that a permanent foundation perimeter drainage system be provided for structures with basements to accommodate seasonal fluctuations of groundwater levels and, if any, post-development groundwater level changes.

8.8 Construction Excavations

The consistencies of the soils encountered at the site are such that conventional hydraulic excavators should be able to remove these materials.

Groundwater was encountered at depths as shallow as 5.6 m below the existing ground surface. The soils at the project site that are below or within 1.0 m of the groundwater table are expected to be sensitive to construction disturbance and may slough when exposed to construction traffic or vibratory compaction. Remote excavation techniques would be utilized if excavations are anticipated to be within 1.0 m of the groundwater table.

It is anticipated that sloping of excavation sides will be feasible to provide short-term stability. It is recommended that sideslopes be trimmed to 1.5H:1V for temporary excavations in the stiff to very stiff native clay/silt till soils up a depth of 3.0 m. If sloping of excavation sidewalls is not feasible (due to space limitations) or if excavations deeper than 3.0 m are anticipated, shoring may be required and these situations should be reviewed on an individual basis. Occupational Health and Safety standards must be adhered to.

If groundwater seepage is encountered, excavation sideslopes should be reviewed and dewatering may be required. Construction dewatering recommendations are presented in Section 8.9.

8.9 Construction Dewatering

Based on the groundwater levels measured in the standpipes to date, groundwater seepage is not expected to be encountered during shallow excavation (less than 3.0 m) as groundwater was encountered at a depth of 5.6 m below the existing ground surface.

Groundwater seepage may be encountered above the measured groundwater levels if the excavation intercepts a perched water zone or if excavations are anticipated to be greater than 3.0 m.

A system of ditches leading to sumps equipped with pumps may be used to dewater excavations depending on the rate of seepage if groundwater is encountered. If vigorous seepage is encountered, dewatering the soil in advance of the excavation may be necessary for excavation stability and seepage control.

8.10 Site Grading and Drainage

It is recommended that final site grading be provided to direct water to areas remote from any proposed structures. Minimum landscape gradients of 1.5% are recommended to reduce the risk of runoff ponding in localized areas.

Parking lots or landscaping within a zone of approximately 2.0 m laterally from the exterior perimeter of any structure should be graded to drain away from the structures at a minimum gradient of 2%.

Downspouts should be positively directed away from buildings or, if local regulations permit, directed into the storm drain system. Downspouts should not be directed into the foundation perimeter drains, if utilized, or towards any slope areas.

8.11 Buried Utilities

Underground utilities installed in the native soils at the project site may be designed according to conventional utility line design with no special precautionary measures necessary. However, where utilities are to be installed in fill soils, some precaution may be required. For utilities installed in fill soils, provisions should be made to protect buried utilities from potential damage due to potential future differential settlement.

Service connections to buildings should be designed to permit some relative vertical movement.

8.12 Backfill Materials and Compaction

The existing site soils comprising native clay till are considered suitable for use as general engineered fill, providing the materials are free of organics, cobbles, and boulders.

The existing topsoil and organic soils should be recovered for landscape fill. Soils containing organics or comprising blended organic soils may be considered for use as backfill provided special precautions are taken, discussed further in Section 8.13.

Any imported fill materials should be free of miscellaneous debris, organics, cobbles, and boulders.

Backfill comprising silty clay soils to a lesser extent should be considered frost-susceptible and should not be used in areas where it may become frozen and where frost heaving would be unacceptable.

The existing site soils to be used for backfilling may require moisture conditioning for proper compaction. Backfill soils should be uniformly conditioned to a suitable moisture content (wetting or drying the fill as necessary) prior to compaction.

8.13 Backfill Materials Containing Organics and Blending Recommendations

Per the Federal Highway Administration (FHWA) Technical Report (Report No. FHWA/IN/JTRP-2008/2) entitled *Classification of Organic Soils*, dated September 2009 (herein referred to as the FHWA Organic Soils Report), soils with organic content less than 3% would be considered mineral soils and the presence of organics would not significantly change the soil's properties.

Backfill materials containing organics and/or using organic soils blended with clean fill soils may be considered for use as engineered backfill, provided the following recommendations are followed.

- Any soils containing organics must not exceed 3% organic content or contain cobbles and/or boulders.
- Soils containing organics and blended fill soils must not exceed 3% organic content and must meet the atterberg limit classification for inorganic fine-grained soils, per the Modified Unified Soil Classification (i.e., ML, MH, CL, CL, or CH).
- Soils with organic contents greater than 10% should not be considered for blending and should be reserved for landscape fill.
- Strict quality control measures and testing should be implemented during construction for any soils that are blended with organic soils. Blending operations should ensure that fill soils are uniformly mixed prior to placement.
- Soils containing organics or blended fill soils should be tested for organic content and atterberg limits after blending and must comply to the above-mentioned specifications. The number of tests should be determined based on the volume of blended fill. No pockets, seams, or layers of organics should be present within the fill during or after placement.
- Per the FHWA Organic Soils Report, it is recommended that the dry combustion test method (LECO Analysis) is used to determine organic content in soils. Blended soils should be screened and tested after blending.
- Note that soils containing organics may generate methane. Fill soils with organics and blended soils should be evaluated by an environmental specialist to review potential methane generation and the need for methane mitigation.
- Soils that contain organics may experience loss of strength, increased compressibility, and differential settlement and should be considered in the planning and development stages of the project, discussed further in Section 8.13.1.

8.13.1 Risks Associated with Backfill Containing Organics

The engineering properties of backfill materials will be affected by organics including compaction behavior, strength, permeability, and compressibility. Based on the FHWA Organics Report, the following changes in soil engineering properties should be anticipated for soils containing up to 3% organics:

- A 5-10% decrease in maximum dry density and a 3-5% increase in optimum moisture.
- A 5-10% decrease in unconfined compressive strength.
- An increase in permeability and compressibility, which can lead to more consolidation/settlement. These values can vary significantly and depend on the type and state of organics present.

The geotechnical properties, mentioned above, of backfill materials will be affected by the amount of organics, type of organics, and state of organics (i.e., degree of decomposition). These considerations should be carefully assessed during the planning and development stages for projects that intend to use organic backfill material.

8.14 Concrete Type

Four tests were conducted to determine the water-soluble sulphate content of soil samples recovered from this site. The tests indicated sulphate concentrations of 0.05%, 0.06%, 0.06%, and 0.11% in Boreholes BH19-02, BH19-04, BH19-06, and BH-11, respectively. These results indicate the potential degree of a sulphate attack on the concrete as "negligible" for the clay till, and "negligible" to "moderate" for the clay fill. Accordingly, sulphate-resistant concrete, meeting the requirements of Canadian Standards Association (CSA) A23.1-14 exposure Class S-3, is recommended where in contact with site soils.

A more stringent exposure classification may be required due to structural requirements or other exposure considerations (CSA A23.1-14, Table 1). Should any imported fill be placed in contact with concrete, that fill should also be tested for water-soluble sulphate content and the above recommendations should be re-evaluated.

9.0 PRELIMINARY SLOPE STABILITY ASSESSMENT

9.1 General

Preliminary slope stability analyses of the existing slopes located to the north, east, and southeast of the project site were carried out to establish a preliminary development setback from the property line for conceptual planning of the project site. These slope stability assessments were conducted in accordance with The City's guidelines for developments located along slopes (i.e., global slope stability factor of safety of 1.5 or greater).

As part of the preliminary slope stability assessment, a Tetra Tech representative conducted a site visit of the existing north slope at the project site on April 24, 2019, to visually observe the existing slope and to identify any potential slope stability issues. A summary of the site observations is provided in Section 9.2.

9.2 Site Reconnaissance

Photographs of the existing slope, designated as Photos 1 through 10, are presented in the Photo Appendix, and the approximate locations of where the photos were taken are presented on Figure 3.

A summary of site observations made during the site visit is provided below:

- The existing slope is approximately 30 m in height and has variable surface gradients raging from 2H:1V to 4H:1V with benches scattered through the slope, as shown in Photo 1 and Photo 10. Several steeper, smaller slopes with gradients less than 3H:1V were noted, as shown in Photo 6 and Photo 8. The topography (elevation contours) of the project site is presented on Figure 2.
- Several manhole covers were noted along the face of the slope (see Photo 1 for an example) and indicate that utilities might be present in the existing slope. Slope disturbance and regraded slopes may also be present as result of the manholes.
- A number of trees were noted in the central portion of the north slope and to the north of the project site, as shown in Photo 6. In general, more vegetation/shrubbery and bushes were located in the east portion of the slope.
- Some localized slumping/tension cracks and erosions were noted along the face of the slope, as shown in Photos 4, 5, 7, 8, and 9 (refer to Figure 3 for approximate locations).

9.3 Slope Stability Analysis and Results

A site-specific slope stability analysis was carried out on three representative cross-sections, designated as Cross-Sections A-A', B-B', and C-C', using the software program *GeoStudio 2018 (SLOPE/W)*. The cross-sections were based on site topography provided by The City (LIDAR file entitled *DEM_2018_Midfield_Park_Area*). The cross-section locations were selected to represent the steepest portions of the existing north slope. The site topography is presented on Figure 2 and the cross-section locations are presented on Figure 3.

The slopes located along the southeast corner of the project site were reviewed internally as part of the preliminary slope stability analysis. Theses slopes were determined to provide an adequate factor of safety (i.e., global factor of safety greater than 1.5).

The soil parameters utilized for the global stability analyses are summarized in Table 3 and were based on the subsurface information collected during the fieldwork program (i.e., based on boreholes drilled at the crest of the slope only within the project boundary), and Tetra Tech's experience with similar soil types.

In addition, a back-analysis of the 1998 slope failure was conducted to cross reference the soil parameters utilized in this assessment. The slope cross-section was based on the 1999 Slope Stability Evaluation completed by Geo Engineering. The back-analysis results are presented as part of this slope stability assessment.

Although boreholes were not drilled at/near the toe of the slope at this stage, subsurface conditions encountered in the boreholes drilled at the crest of the slope were extrapolated for the toe area in the current slope stability assessment.

Table 3: Soil Parameters

Soil Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (Degrees)	Porewater Coefficient (r_u)[1]
Clay Fill	19	0.5	25	0.1
Clay	19.5	0	15	0.1
Clay Till	19.5	2.0	27	0.1
Silt	20	0	20	0.1
Bedrock	30	10	45	0.0

Note: [1] r_u **reflects an assumed porewater pressure as a fraction of the overburden stress and was only applied to soil layers located above the piezometric line.**

A piezometric line (groundwater table) was incorporated in the analyses based on the highest measured groundwater levels and adjusted for seasonal fluctuations (raised 0.25 m) per The City's 2011 Stormwater Management & Design Manual (Figure 3-20) for groundwater adjustments.

The porewater coefficient (r_u) is defined as the "ratio of excess pore pressure to the total stress," and was modelled in the soil layers located above the piezometric line to simulate porewater pressure that may be present.

As the project details regarding the future development (i.e., building details including loads, depths of foundations, and locations) are unknown at this time, the slope stability assessments were conducted under the following two cases of surcharge loads to establish a setback line for conceptual planning purposes.

- Case 1: A uniform surcharge load of up to 100 kPa was applied at a depth of 1.4 m below the ground surface within the property boundaries to simulate potential light foundation loads/lightly-loaded buildings (e.g., one to two-storey wood frame structures with zero to one level below grade).
- Case 2: A uniform surcharge load of 200 kPa was applied at a depth of 1.4 m below the ground surface within the property boundaries to simulate potential heavy foundation loads (e.g. high-rise concrete building structures with two to three levels below grade).

Note that loads/structures placed at deeper depths (i.e., below-grade structures between one and three levels below grade) and/or deep foundation systems will improve the overall global slope stability. The analysis was conducted by placing loads at/near the surface to simulate a worst-case scenario.

A site visit was also conducted for the existing north slope to assess the existing slope conditions and to identify any potential slope stability issues. A description and notes from the site visit are presented in Section 9.2.

In order to establish the setback line for the surcharge loads, the analyses were completed in an iterative process starting with surcharge loads placed up to the property line and shifted back as necessary until the minimum factor of safety was achieved.

The results of the back-analysis and preliminary slope stability assessment are presented in Table 4.

Table 4: Slope Stability Results

Cross-Section	Slope / Surcharge Load Condition	Factor of Safety	Minimum Setback Distance from North Property Line[1] (m)	Reference Figure
Back Analysis	1999 mid-slope failure	1.0	n/a	Figure 4
Cross-Section A-A'	Up to 100 kPa at a depth of 1.4 m below the existing ground surface	> 1.5	25	Figure 5
	200 kPa at a depth of 1.4 m below the existing ground surface	> 1.5	40	
Cross-Section B-B'	Up to 100 kPa at a depth of 1.4 m below the existing ground surface	> 1.5	30	Figure 6
	200 kPa at a depth of 1.4 m below the existing ground surface	> 1.5	55	
Cross-Section C-C'	Up to 100 kPa at a depth of 1.4 m below the existing ground surface	> 1.5	30	Figure 7
	200 kPa at a depth of 1.4 m below the existing ground surface	> 1.5	55	

Note: [1]. Development setback lines were rounded to the nearest 1 m interval to account for any potential variations in soil conditions that may be encountered.

The minimum setback distance to maintain a global slope stability factor of safety of 1.5 is dependent on the surcharge load and location in relation to the existing slope. The development setback line with respect to surcharge loads and location is presented on Figure 8.

9.4 Discussion and Recommendations

The results of this preliminary slope stability assessment should only be used for conceptual planning purposes and are based on limited subsurface information available from the boreholes drilled at the crest of the slope only and the loading conditions as discussed in Section 9.3. The slope stability should be reassessed once development details (such as foundation type, loads, elevations, locations, etc.) are finalized.

- For conceptual planning purposes, the following recommendations are provided to maintain a global slope stability factor of safety of 1.5 or greater. Given that the current preliminary slope stability assessment has been undertaken based on limited subsurface information obtained from the boreholes drilled at the crest of the slope only, it is recommended that an additional subsurface investigation program be undertaken at/near the toe of the slope to confirm the subsurface conditions. The current analyses will need to be updated/revised if the actual subsurface conditions at/near the toe of the slope vary from those assumed in the current analyses.

  Given that the subject slope has experienced instabilities in the past, it is recommended that monitoring instruments (such as slope inclinometers, survey monuments, etc.) be installed to monitor future slope movements, if any.

- The recommended development setback distance shown on Figure 8 should be used for conceptual planning purposes only. Detailed, development-specific slope stability for each of the proposed structures should be conducted once further details become available. Depending on the development details and additional subsurface information, a revision/update of the current setback distances may be required.
- Based on the site observations, some signs of slope instability (i.e., slumping and tension cracks) were noted in localized areas along the face of the slope (refer to the Photo Appendix and Figure 3). The perched groundwater table may contribute to the tension cracks/slumping noted in the mid slope; however, no groundwater seepage was noted at the time of the site visit.

  These areas should be further investigated for slope stability and monitored on a regular basis. It is recommended that these areas are repaired as slumping and tension cracks may retrogress and potentially lead to additional slope movements/failure and/or reduce the overall slope factor of safety. If additional tension cracks, slumping, and/or slope movement are noted, the slope stability presented in this report should be reassessed.
- Future structures with basements, if any, should be installed with a foundation perimeter drainage system to control the rise in the soil's porewater pressure and to maintain the slope stability.
- To maintain or improve the stability of the existing slope, permanent surface and subsurface drainage systems should be designed for the proposed development to minimize the impact on the existing groundwater table and to minimize the potential for the long-term development of 'new' perched water tables. Drainage system outlets or downspouts should not be diverted towards the slope. Surface water runoff should be directed away from the slope.
- Shrubs/trees typically provide additional slope stability. It is generally recommended to keep slopes vegetated, unless grades are further flattened and/or reinforced.
- Infiltration, utility leakage (i.e., existing utilities), and surface water can reduce the stability of the existing slope. It is recommended that surface water at the project site be properly managed to prevent ponding and infiltration near the existing slope.
- Shallow slumps on relatively steep slopes (steeper than approximately 4H:1V) may occur if seepage from or parallel to the slopes occurs due to heavy precipitation or due to the presence of uncontrolled fill or other factors. These shallow slumps are not expected to impact the developed areas but may trigger retrogressive slumping, which may require repair.
- Waterbodies should not be constructed at the project site without the approval of a geotechnical engineer and confirmation of the slope stability assessment considering such waterbodies.

10.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

PROFESSIONAL ENGINEER
KEVIN LEE
ALBERTA

February 7, 2020

FILE: 704-ENG.CGEO03639-01
FILE: 704-ENG.CGEO03639-01
FILE: 704-ENG.CGEO03639-01

Prepared by:
Kevin Lee, P.Eng.
Geotechnical Engineer
Engineering Practice, Prairie Region
Direct Line: 403.723.6942
kevin.lee@tetratech.com

PROFESSIONAL ENGINEER
DEEPAK KUMAR
ALBERTA

February 7, 2020

FILE: 704-ENG.CGEO03639-01
FILE: 704-ENG.CGEO03639-01
FILE: 704-ENG.CGEO03639-01

Prepared by:
Deepak Kumar, M.Sc., P.Eng.
Project Engineer
Engineering Practice, Prairie Region
Direct Line: 403.723.6944
deepak.kumar@tetratech.com

FILE: 704-ENG.CGEO03639-01
FILE: 704-ENG.CGEO03639-01
FILE: 704-ENG.CGEO03639-01

Reviewed by:
Joseph Yonan, Ph.D., P.Eng.
Principal Consultant
Engineering Practice
Direct Line: 403.723.6885
joseph.yonan@tetratech.com

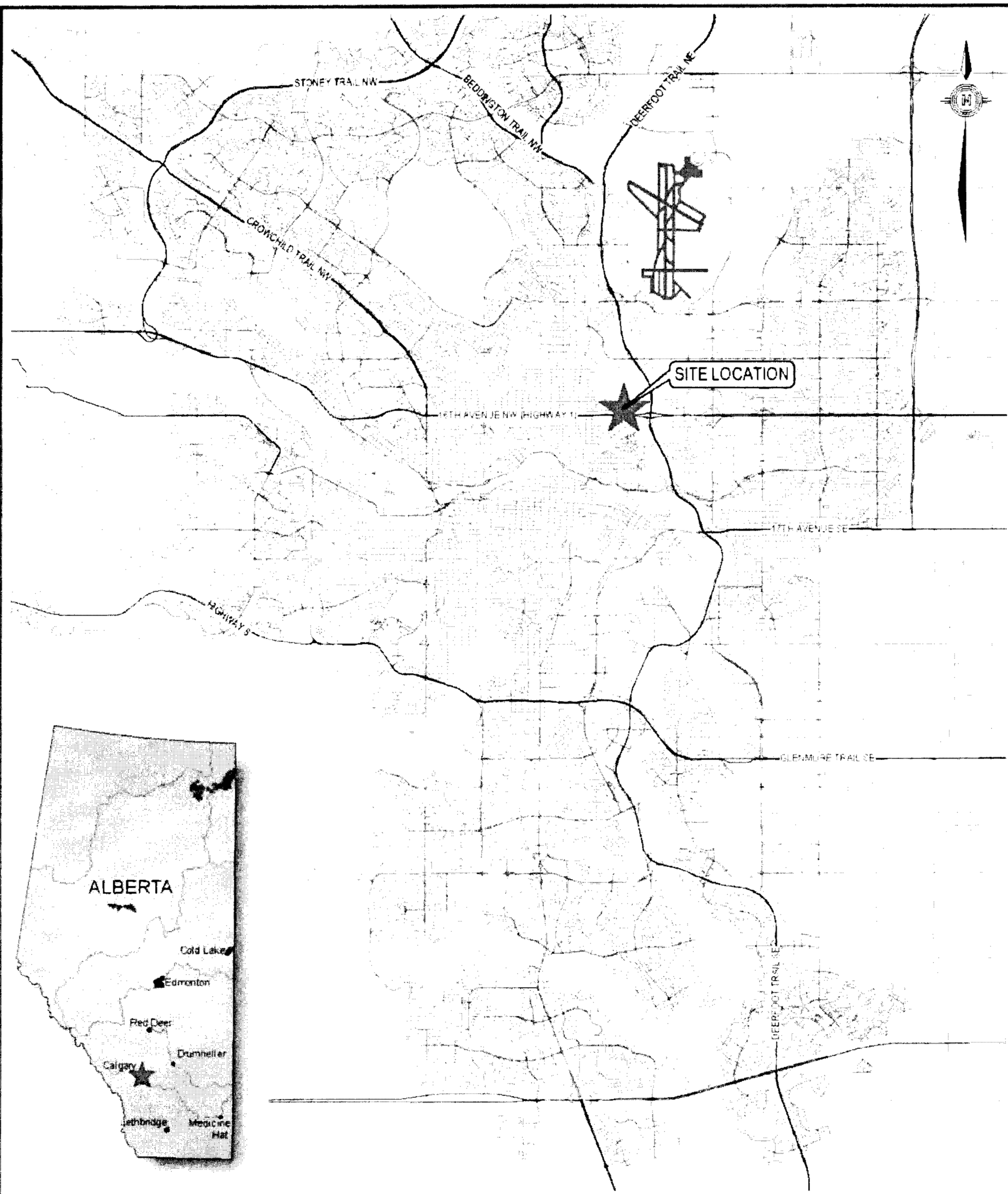
PERMIT TO PRACTICE
TETRA TECH CANADA INC.

RM SIGNATURE: ____________
RM APEGA ID #: 61732
DATE: Feb 7/2020

PERMIT NUMBER: P013774
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

/mh

FIGURES



0 5,000m

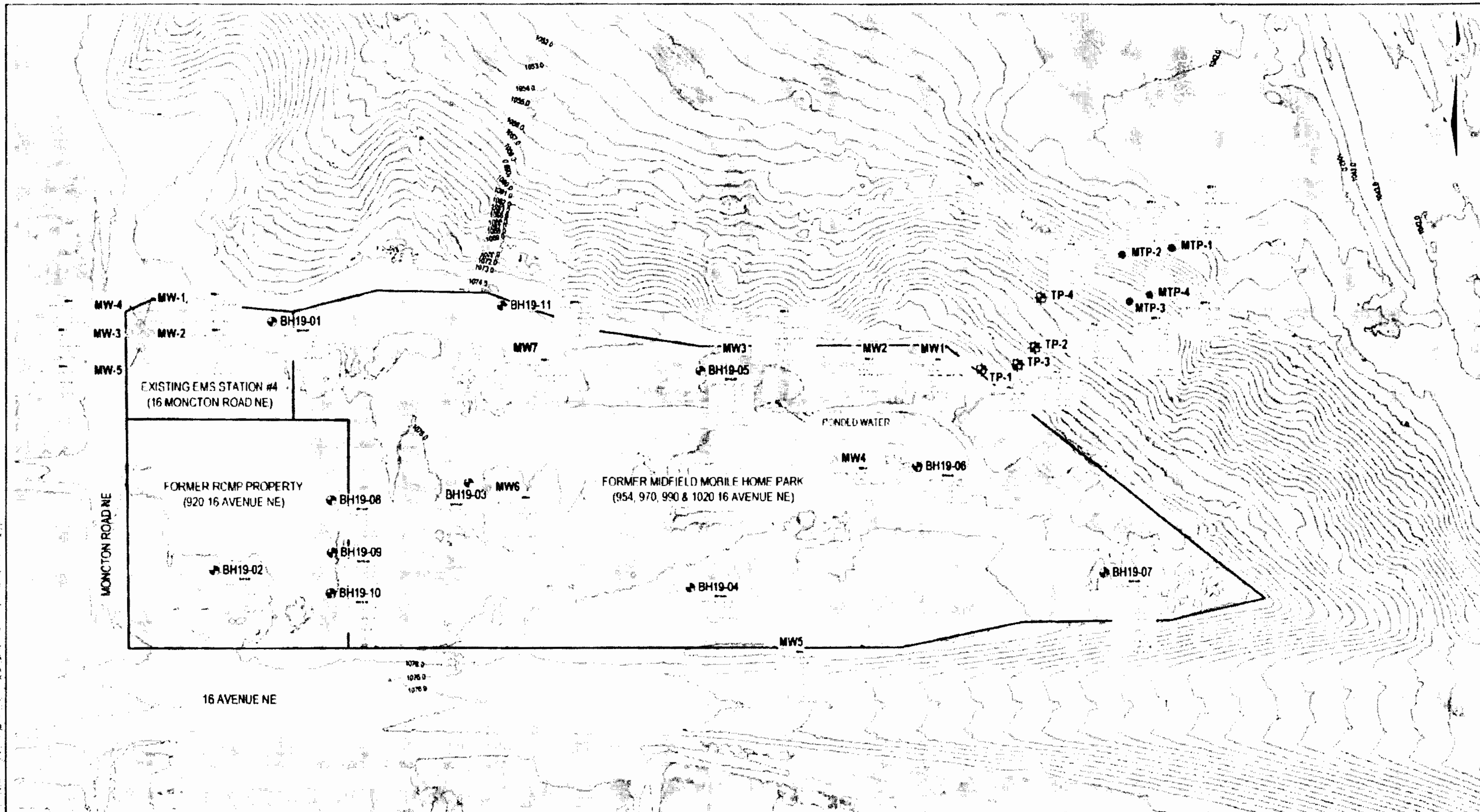
Scale 1:150,000 @ 8.5"x11"

TETRA TECH

REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

SITE LOCATION PLAN

Figure 1



LEGEND

SITE BOUNDARY

TETRA TECH BOREHOLE LOCATION (APRIL 2019)

APPROXIMATE HISTORICAL BOREHOLE LOCATION (GEO-ENGINEERING LTD. JULY 1998)

APPROXIMATE HISTORICAL BOREHOLE LOCATION (GEO-ENGINEERING LTD. JULY 2008)

APPROXIMATE HISTORICAL MONITORING WELL LOCATION (JACQUES WHITFORD FEB. 2002)

APPROXIMATE HISTORICAL MONITORING WELL LOCATION (JACQUES WHITFORD ENVIRONMENT LTD. DEC. 1996)

0 100m

Scale 1:2 000 @ 11"x17"

Calgary

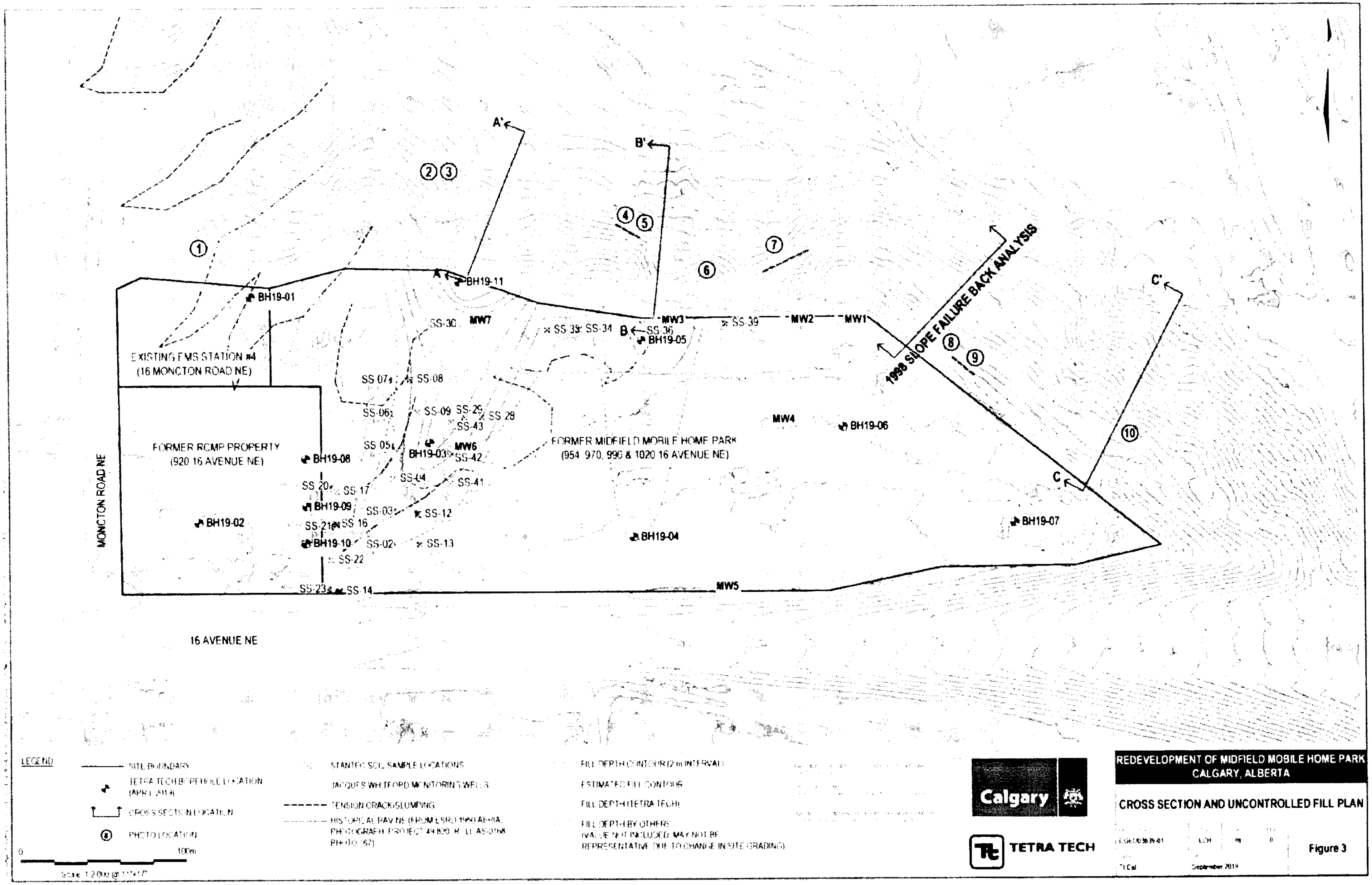
TETRA TECH

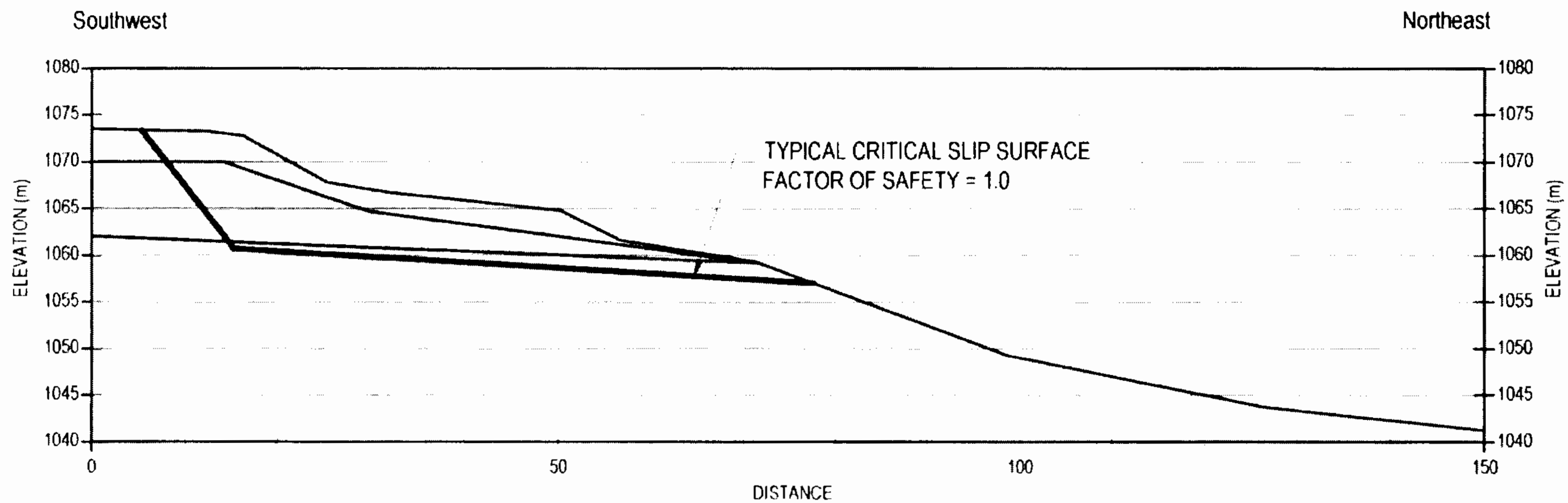
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

BOREHOLE LOCATION PLAN

CGE00361501	1:2M	NB	0
Tt Cal	September 2019		

Figure 2


A'
B'
C'
A
B
C
1998 SLOPE FAILURE BACK ANALYSIS
BH19-01
BH19-02
BH19-03
BH19-04
BH19-05
BH19-06
BH19-07
BH19-08
BH19-09
BH19-10
BH19-11
MW1
MW2
MW3
MW4
MW5
MW6
MW7
SS-39
SS-35
SS-34
SS-36
SS-30
SS-07
SS-08
SS-06
SS-09
SS-29
SS-43
SS-28
SS-05
SS-42
SS-04
SS-41
SS-20
SS-17
SS-03
SS-12
SS-21
SS-16
SS-02
SS-13
SS-22
SS-23
SS-14
EXISTING EMS STATION #4
(16 MONCTON ROAD NE)
FORMER RCMP PROPERTY
(920 16 AVENUE NE)
FORMER MIDFIELD MOBILE HOME PARK
(954, 970, 990 & 1020 16 AVENUE NE)
MONCTON ROAD NE
16 AVENUE NE
LEGEND
SITE BOUNDARY
TETRA TECH BOREHOLE LOCATION (APRIL 2019)
CROSS SECTION LOCATION
PHOTO LOCATION
STANTEC SOIL SAMPLE LOCATIONS
JACQUES WHITFORD MONITORING WELLS
TENSION CRACK/SLUMPING
FILL DEPTH CONTOUR (2 m INTERVAL)
ESTIMATED FILL CONTOUR
FILL DEPTH (TETRA TECH)
0
100m
Calgary
TETRA TECH
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA
CROSS SECTION AND UNCONTROLLED FILL PLAN
September 2019
Figure 3



SYMBOL	SOIL TYPE	UNIT WEIGHT (kN/m³)	COHESION (kPa)	PHI (°)
	CLAY	19.5	0	15
	CLAY TILL	19.5	2	27

0 25m

Scale: 1:750 @ 8.5"x11"

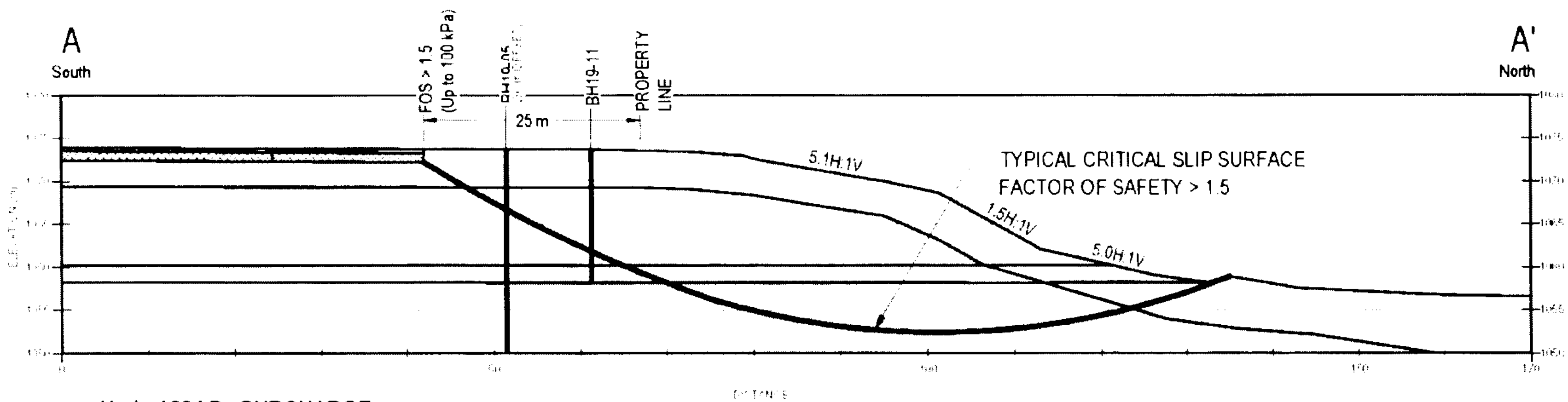
Calgary

TETRA TECH

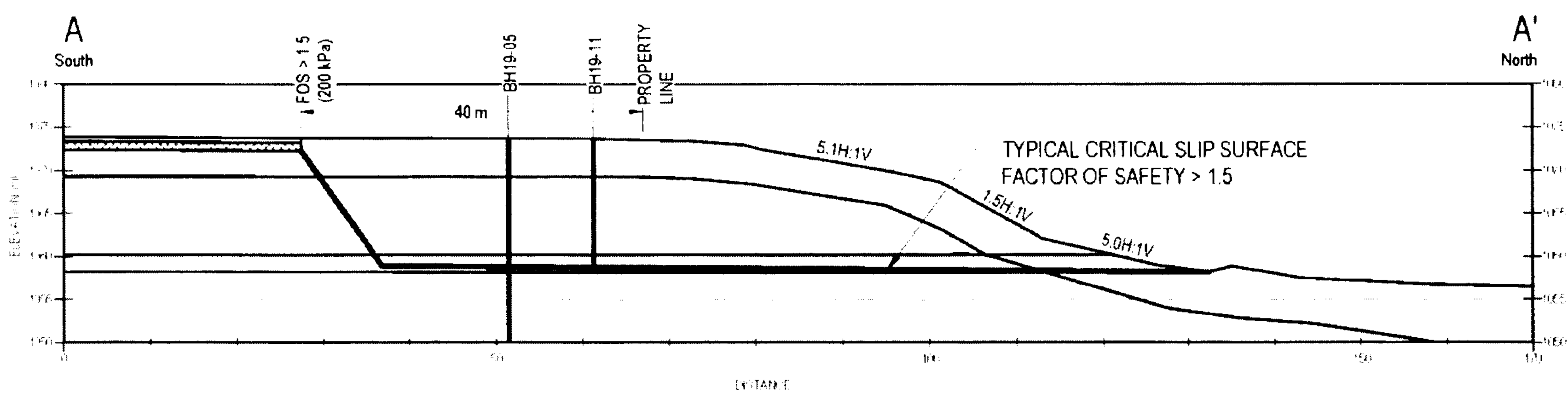
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

1998 SLOPE FAILURE BACK ANALYSIS

PROJECT NO.	DWN	CKD	REV	
CGE03639.01	LCH	KL	0	Figure 4
OFFICE: Tt Cal	DATE: June 2019			



Up to 100 kPa SURCHARGE



200 kPa SURCHARGE

SYMBOL	SOIL TYPE	UNIT WEIGHT (kN/m³)	COHESION (kPa)	PHI (°)
	CLAY FILL	19	[illegible]	25
	CLAY	[illegible]	[illegible]	[illegible]
	SILT	[illegible]	[illegible]	[illegible]

0 25m

Scale: 1:750 @ 8.5"x11"

Calgary

TETRA TECH

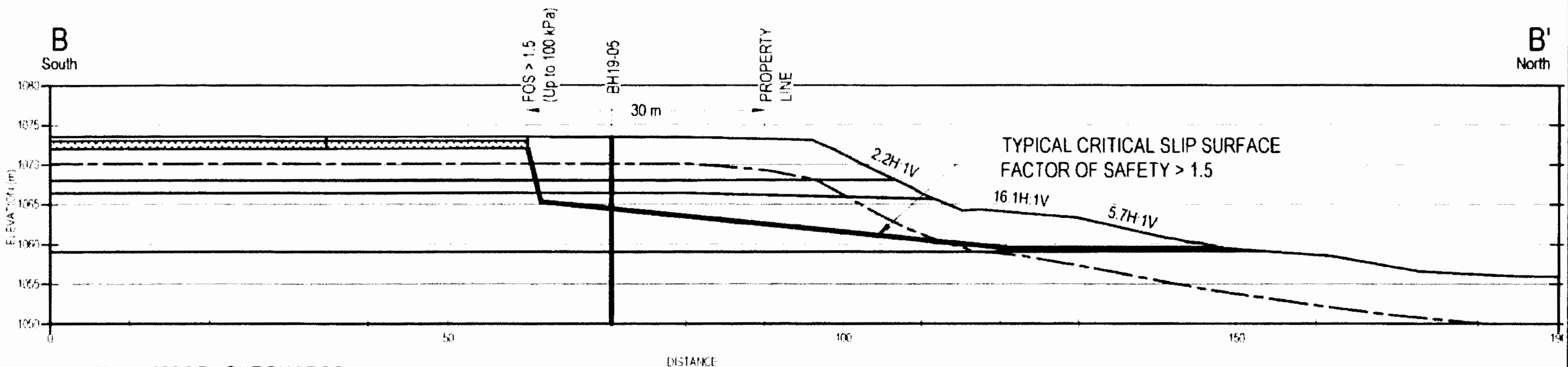
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

CROSS SECTION A-A'

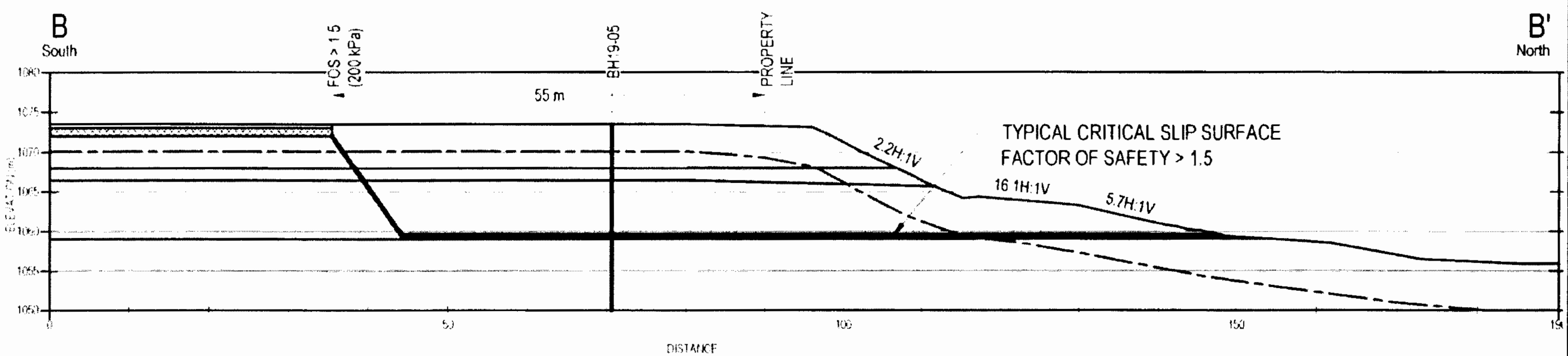
PROJECT NO.	DWN	CKD	REV
[illegible]	LCH	KL/RM	1

OFFICE	DATE
Tt Cal	January 2020

Figure 5



Up to 100 kPa SURCHARGE



200 kPa SURCHARGE

SYMBOL	SOIL TYPE	UNIT WEIGHT (kN/m³)	COHESION (kPa)	PHI (°)
	CLAY	19.5	0	15
	CLAY FILL	19	0.5	25
	CLAY TILL	19.5	2	27
	SILT	20	0	20

0 25m

Scale 1:750 @ 8.5"x11"

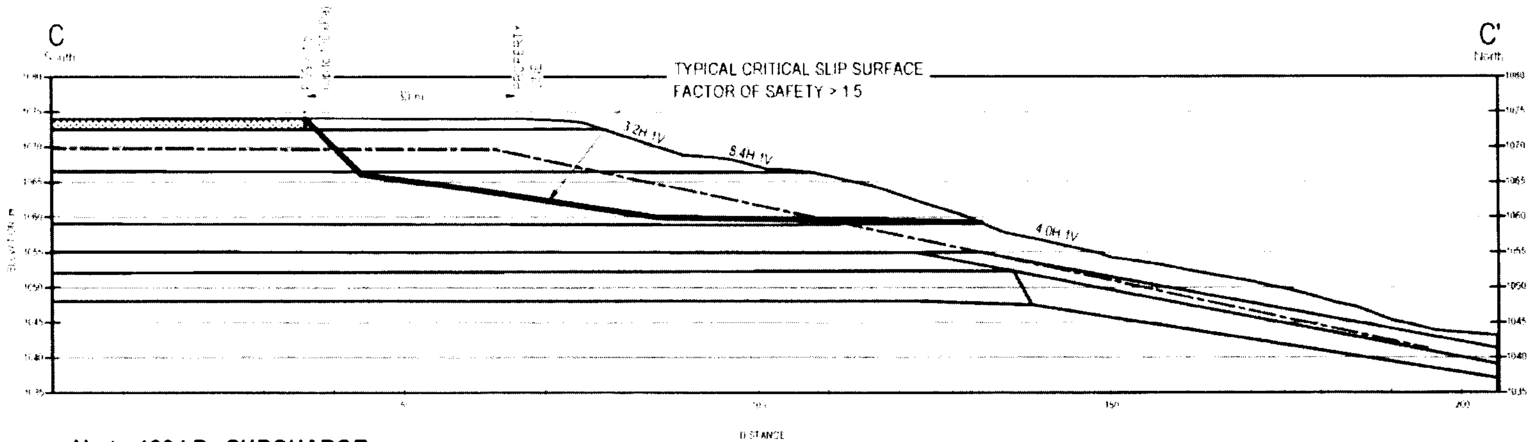
Calgary

TETRA TECH

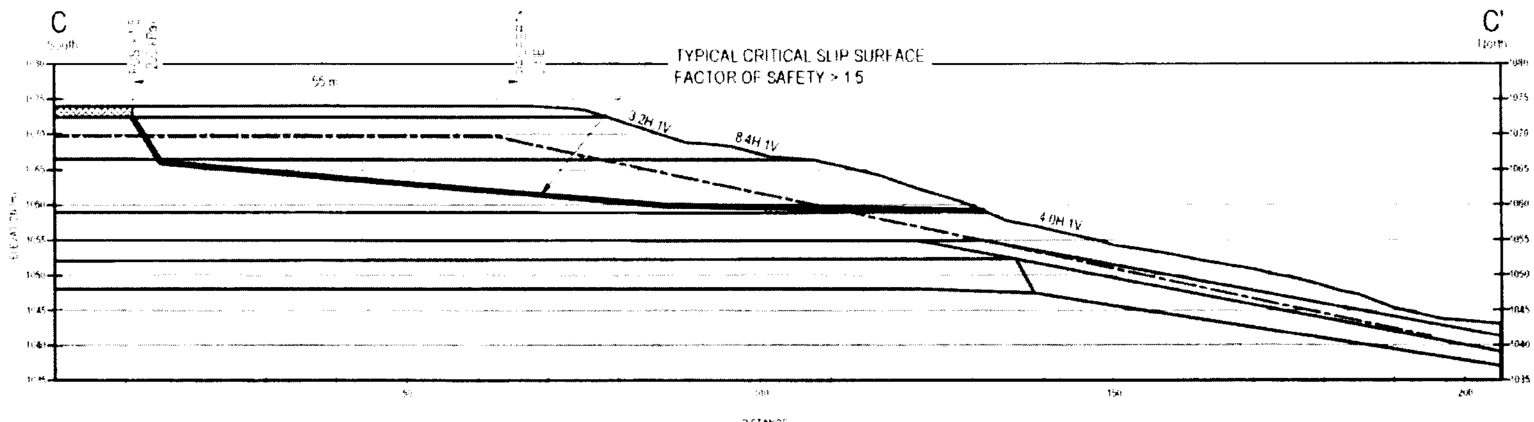
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

CROSS SECTION B-B'

PROJECT NO.	DWN	CKD	REV	
CGE03639.01	LCH	KL/RM	1	**Figure 6**
OFFICE: Tt Cal	DATE: January 2020			



Up to 100 kPa SURCHARGE



200 kPa SURCHARGE

SYMBOL	SOIL TYPE	UNIT WEIGHT (kN/m³)	COHESION (kPa)	PHI (°)
	CLAY	19.5	0	15
	CLAY FILL	19	0.5	25
	CLAY TILL	19.5	2	27
	SILT	20	0	20
	BEDROCK	30	10	45

0 — 50m

Scale 1:1,000 @ 8.5"x11"

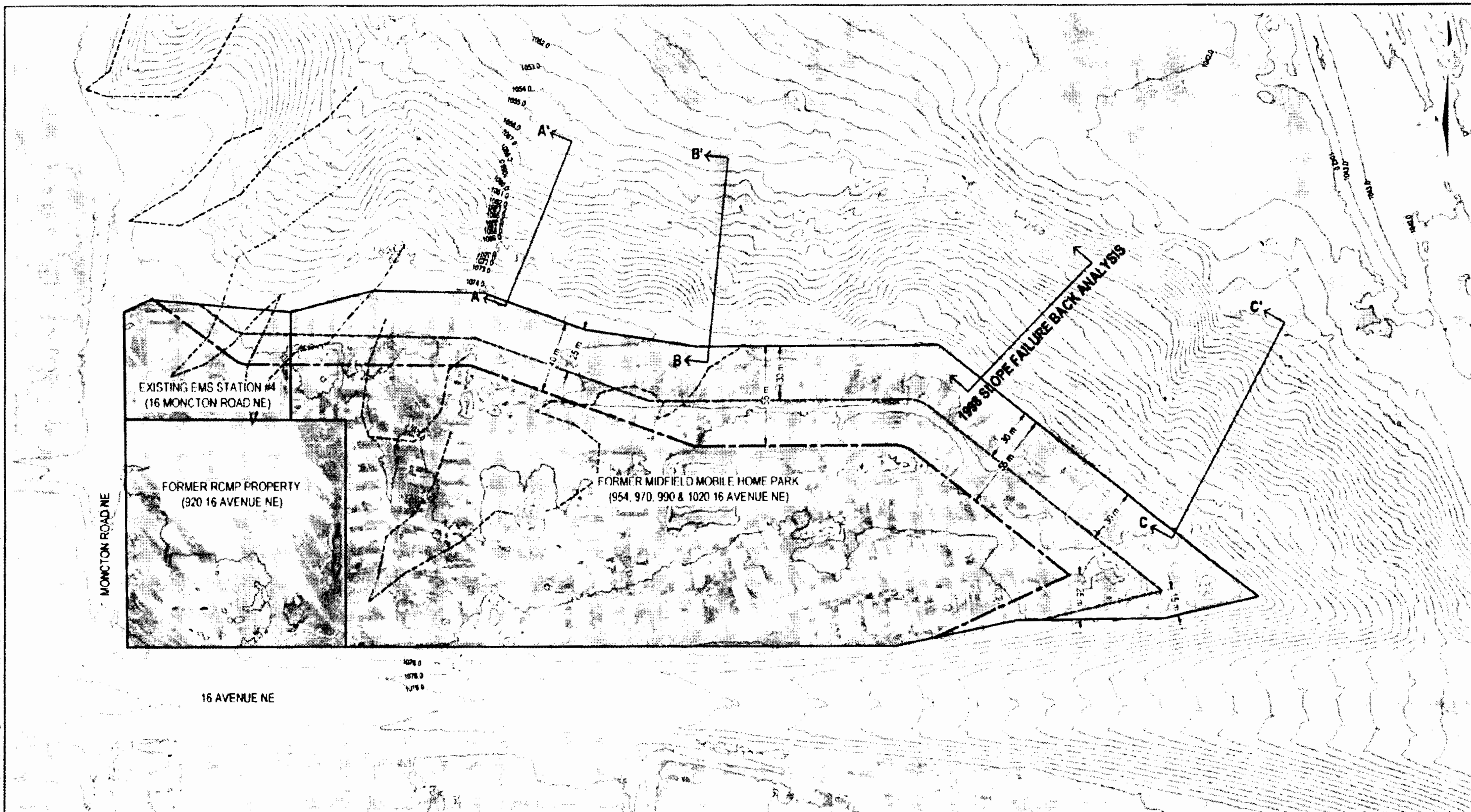
Calgary

TETRA TECH

REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

CROSS SECTION C-C'

CGEO03639-01	LCH	KL/RM	1	**Figure 7**
Tt Cal	January 2020			



LEGEND

SITE BOUNDARY

CASE 1 Up to 100 kPa SETBACK LINE (FOS > 1.5)
- DEVELOPMENT SETBACK FOR LIGHTLY LOADED BUILDINGS
(EG. 1 TO 2 STOREY WOOD FRAME STRUCTURES WITH 0 TO 1
LEVEL BELOW GRADE AND PARKING/ROADWAYS)

CASE 2 200 kPa SETBACK LINE (FOS > 1.5)
- DEVELOPMENT SETBACK FOR MODERATE TO HEAVY LOADED
STRUCTURES (EG. HIGH RISE CONCRETE BUILDING
STRUCTURES WITH 2 TO 3 LEVELS BELOW GRADE)

MUNICIPAL RESERVE (PUBLIC PARK LANDSCAPING)
NO IRRIGATION AND LAND GRADED TO DIRECT STORMWATER AWAY
FROM THE TOP OF SLOPE AND TOWARD FUTURE STORMWATER SYSTEM

CROSS SECTION LOCATION

HISTORICAL RAVINE (FROM ESRD 1950 AERIAL PHOTOGRAPH
PROJECT #9 820, ROLL AS-0169, PHOTO 167)

0 100m

Scale 1:2,000 @ 11"x17"

Calgary

TETRA TECH

REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

DEVELOPMENT SETBACK LINE

January 2016

Figure 8

PHOTOGRAPHS

Photo 1	Looking East, General Slope and Existing Manhole Cover
Photo 2	Looking Southeast, Natural Slope with Existing Trees
Photo 3	Looking Southeast, Existing Slope
Photo 4	Looking Southwest, Shallow Slumping
Photo 5	Looking Southwest, Slumping
Photo 6	Looking West, Existing Trees and Slope Gradient
Photo 7	Looking Southeast, Shallow Slumping/Tension Crack
Photo 8	Looking Southeast, Erosion along Face of Slope
Photo 9	Looking South, Shallow Slumping
Photo 10	Looking West, Existing Slope and Vegetation

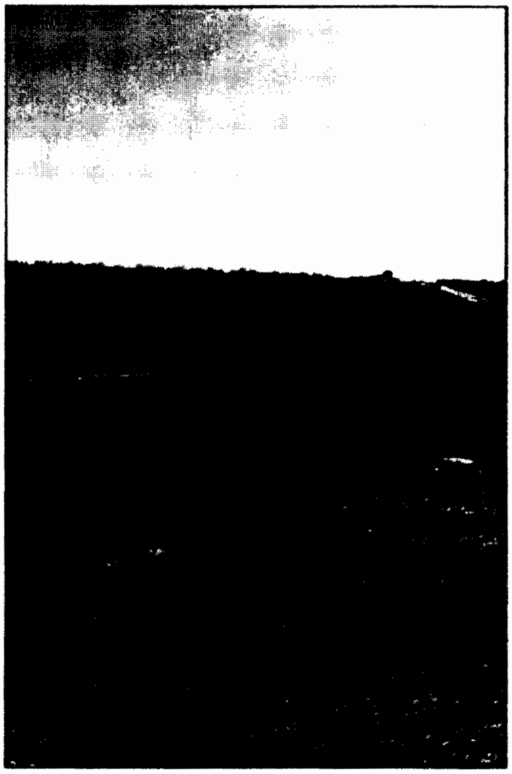


Photo 1: Looking east
General slope and existing manhole cover.

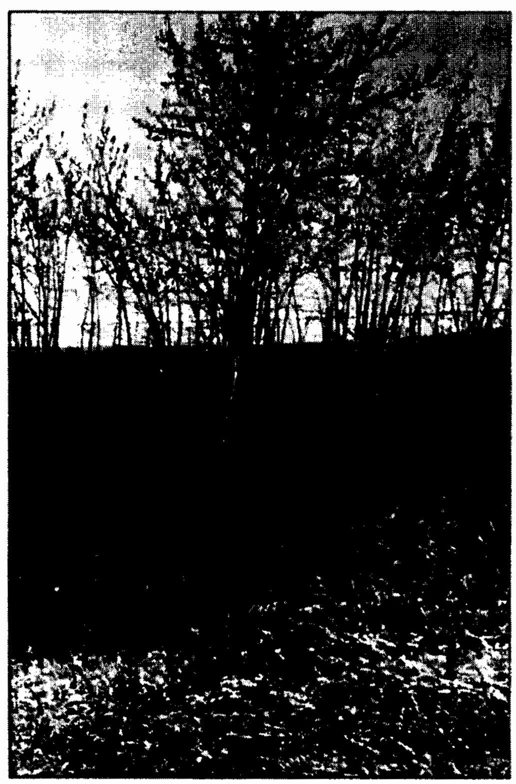


Photo 2: Looking southeast
Natural slope with existing trees.

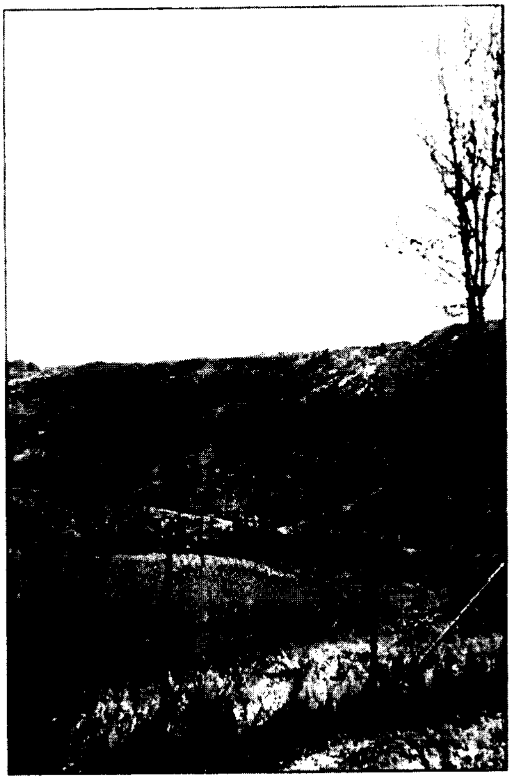


Photo 3: Looking southeast
Existing slope

Photo 4: Looking southwest
Shallowing slumping

Photo 5: Looking southwest
Slumping

Photo 6: Looking west
Existing trees and slope gradient

Photo 7: Looking southeast
Shallow slumping/tension crack

Photo 8: Looking southeast
Erosion along face of slope

Photo 9: Looking south
Shallow slumping

Photo 10: Looking west
Existing slope and vegetation

APPENDIX A
2018 COMPACTION TEST RESULTS

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

M&B 25 YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736
Email: office@mbtechtesting.com

July 23, 2018

Project No. 18-06-005

WILCO CONTRACTORS SOUTHWEST INC.
4700 - 110 Avenue S.E.
Calgary, AB
T2C 2T8

ATTENTION: MR. MICHAEL HEGARTY

RE: MIDFIELD MOBILE HOME PARK
COMPACTION & CONCRETE TESTING & INSPECTION – JUNE 2018

Dear Sir,

Please find enclosed compaction test reports for the above listed project. As indicated from the density testing conducted, the materials placed agrees with project requirements with the exception of tests # 1 to 4 (June 21, 2018) where the compaction levels are below the minimum requirements of 98 %.

If you have any questions, or require any additional information, please contact this office.

Respectfully submitted,

M & B TECHNICAL TESTING SERVICES LTD.

Mike O'Connor, P.Tech.(Eng.)

CCIL

M&B TECHNICAL TESTING SERVICES LTD. Est. 1993

25 YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Procto Sample #	Proctor Density (kg/m³)	Opt. Wate (%)	Compaction Level (%)

Lots 171 to 172 — **Removal of Water & Sanitary Line**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Procto Sample #	Proctor Density (kg/m³)	Opt. Wate (%)	Compaction Level (%)
Jun 21 am	* 1	15 m N of S end of Lot #171	-1.5	Silty Clay	1785	13.7	101	1865	13.8	* 95.7
	* 2	15 m S of N end of Lot #172	-1.5	Silty Clay	1780	13.4	101	1865	13.8	* 95.4
Jun 21 pm	* 3	20 m N of S end of Lot #171	-1.0	Silty Clay	1786	13.4	101	1865	13.8	* 95.8
	* 4	20 m S of N end of Lot #172	-1.0	Silty Clay	1779	13.4	101	1865	13.8	* 95.4
	* Test # 1 to 4 does not meet the minimum compaction requirements. The contractor was notified and will rework the area and have it tested at a at a later date.									

Lots 171 to 172 — **Removal of Water & Sanitary Line**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Procto Sample #	Proctor Density (kg/m³)	Opt. Wate (%)	Compaction Level (%)
Jun 22 am	* 5	10 m N of S end of Lot #171	-0.5	Silty Clay	1780	13.5	101	1865	13.8	* 95.4
	6	10 m S of N end of Lot #172	-0.5	Silty Clay	1860	13.8	101	1893	13.8	98.3
	* 7	**Retest of test # 5**	-0.5	Silty Clay	1830	13.7	101	1865	13.8	98.1
	* Test # 7 represents retest of test # 5 after further compaction effort was applied.									
Jun 22 pm		Scheduled PM testing cancelled due to rain								
Jun 23		Scheduled testing cancelled due to rain								

W of Lot 130 — **Removal of Water & Sanitary Line**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Procto Sample #	Proctor Density (kg/m³)	Opt. Wate (%)	Compaction Level (%)
Jun 25 pm	* 8	25 25m W of E side of Lot #130	-1.5	Silty Clay	1730	* 17.6	101	1865	13.8	* 92.8
	* 9	**Retest of test # 1**	-1.5	Silty Clay	1780	* 17.8	101	1865	13.8	* 95.4
	* Test # 8 & 9 does not meet the minimum compaction and moisture requirements. The backfill matial is wet. The contractor was notified and will rework the area at a later date.									

W of Lot 170, W of Lot 62, E of Lot 141, Lot 140 to 130 — **Removal of Water & Sanitary Line**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Procto Sample #	Proctor Density (kg/m³)	Opt. Wate (%)	Compaction Level (%)
Jun 26 am	10	15 m E of W side of Lot #140	-2.0	Silty Clay	1890	10.2	101	1893	13.2	99.8
	11	35 m E of W side of Lot #140	-2.0	Silty Clay	1860	13.4	101	1893	13.2	98.3
	12	55 m E of W side of Lot #140	-2.0	Silty Clay	1875	13.7	101	1893	13.2	99.0
	* 13	**Retest of test # 8 & 9** (Jun 25)	-2.0	Silty Clay	1870	13.8	101	1893	13.2	98.8
	* Test # 13 represents retest of test # 8 & 9 (June 25) after the wet soil was removed and mixed with drier soil, reworked and compacted..									

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

25 YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jun 26 pm	14	12 m W of E side of Lot 170	-0.5	Silty Clay	1838	14.2	101	1865	13.8	98.6
	15	29 m W of E side of Lot 170	-0.5	Silty Clay	1857	13.6	101	1893	13.2	98.1
	16	43 m W of E side of Lot 170	-0.5	Silty Clay	1860	13.2	101	1893	13.2	98.3
	17	11 m W of E side of Lot 62	-1.5	Silty Clay	1823	14.1	101	1865	13.8	97.7
	18	21 m W of E side of Lot 62	-1.5	Silty Clay	1822	14.6	101	1865	13.8	97.7
	19	33 m W of E side of Lot 62	-1.5	Silty Clay	1848	13.1	101	1865	13.8	99.1
	20	17 m E of W side of Lot 141	-1.5	Silty Clay	1827	14.3	101	1865	13.8	98.0
	21	32 m E of W side of Lot 141	-1.5	Silty Clay	1823	14.3	101	1865	13.8	97.7
	22	51 m E of W side of Lot 141	-1.5	Silty Clay	1837	13.9	101	1865	13.8	98.5
Jun 26 pm	23	18 m W of E side of Lot 170	-0.2	Silty Clay	1849	15.4	101	1893	13.2	97.7
	24	41 m W of E side of Lot 170	-0.2	Silty Clay	1857	12.4	101	1893	13.2	98.1
	25	27 m E of W side of Lot 141	-1.2	Silty Clay	1868	15.0	101	1893	13.2	98.7
	26	45 m E of W side of Lot 141	-1.2	Silty Clay	1818	13.0	101	1865	13.8	97.5
	27	60 m E of W side of Lot 141	-1.2	Silty Clay	1846	13.5	101	1865	13.8	99.0
	28	82 m E of W side of Lot 141	-1.2	Silty Clay	1837	14.6	101	1865	13.8	98.5

W of Lot 62, E of Lot 141, W of Lot 170 **Removal of Water & Sanitary Line**

Jun 27 am	29	22 m W of E side of Lot 62	-1.5	Silty Clay	1845	13.1	101	1865	13.8	98.9
	30	40 m W of E side of Lot 62	-1.5	Silty Clay	1829	12.0	101	1865	13.8	98.1
	31	68 m W of E side of Lot 62	-1.5	Silty Clay	1845	12.0	101	1865	13.8	98.9
	32	45 m E of W side of Lot 141	-1.2	Silty Clay	1876	11.9	101	1893	13.2	99.1
	33	65 m E of W side of Lot 141	-1.2	Silty Clay	1883	11.5	101	1893	13.2	99.5
	34	86 m E of W side of Lot 141	-1.2	Silty Clay	1868	11.3	101	1893	13.2	98.7
Jun 27 pm	35	17 m W of E side of Lot 62	-1.3	Silty Clay	1858	13.7	101	1893	13.2	98.2

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993
25 YEARS 1993-2018
11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE
M&B Project #: 18-06-005
Job #: 5318237
Client: Wilco Contractors Southwest Inc.
Minimum Specified Compaction: 98%
Contractor: Wilco Contractors Southwest Inc.
Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.C.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	36	42 m W of E side of Lot 62	-1.3	Silty Clay	1847	14.3	101	1893	13.2	97.6
	37	70 m W of E side of Lot 62	-1.3	Silty Clay	1845	14.1	101	1893	13.2	97.5
	38	89 m W of E side of Lot 62	-1.3	Silty Clay	1855	14.6	101	1893	13.2	98.0
	39	8 m W of E side of Lot 170	-0.5	Silty Clay	1880	11.8	101	1893	13.2	99.3
	40	28 m W of E side of Lot 170	-0.5	Silty Clay	1900	13.0	101	1922	12.6	98.9
	41	48 m W of E side of Lot 170	-0.5	Silty Clay	1877	13.8	101	1893	13.2	99.2
	42	38 m W of E side of Lot 141	-1.0	Silty Clay	1900	11.2	101	1922	12.6	98.9
	43	59 m W of E side of Lot 141	-1.0	Silty Clay	1889	12.6	101	1922	12.6	98.3
	44	75 m W of E side of Lot 141	-1.0	Silty Clay	1874	11.3	101	1893	13.2	99.0
Jun 27 pm	45	3 m W of E side of Lot 170	-0.3	Silty Clay	1874	11.7	101	1922	12.6	97.5
	46	26 m W of E side of Lot 170	-0.3	Silty Clay	1885	12.9	101	1922	12.6	98.1
	47	47 m W of E side of Lot 170	-0.3	Silty Clay	1890	11.1	101	1922	12.6	98.3
	48	10 m E of W side of Lot 141	-0.7	Silty Clay	1903	13.5	101	1922	12.6	99.0
	49	35 m E of W side of Lot 141	-0.7	Silty Clay	1859	14.9	101	1893	13.2	98.2
	50	65 m E of W side of Lot 141	-0.7	Silty Clay	1866	13.8	101	1893	13.2	98.6
W of Lot 62, E of Lot 141, W of Lot 170				**Removal of Water & Sanitary Line**						
Jun 28 am	51	10 m W of E side of Lot 170	0.0	Silty Clay	1895	11.6	101	1922	12.6	98.6
	52	20 m W of E side of Lot 170	0.0	Silty Clay	1900	11.8	101	1922	12.6	98.9
	53	5 m W of E side of Lot 62	-2.0	Silty Clay	1890	12.2	101	1922	12.6	98.3
	54	20 m W of E side of Lot 62	-2.0	Silty Clay	1888	12.4	101	1922	12.6	98.2
	55	35 m W of E side of Lot 62	-2.0	Silty Clay	1899	13.0	101	1922	12.6	98.8
	56	50 m W of E side of Lot 62	-2.0	Silty Clay	1910	13.4	101	1922	12.6	99.4
	57	10 m S. 15m W of E side of Lot 62	-1.1	Silty Clay	1887	13.5	101	1922	12.6	98.2

M&B TECHNICAL TESTING SERVICES LTD.
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25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	58	10 m S, 30m W of E side of Lot 62	-1.1	Silty Clay	1905	13.6	101	1922	12.6	99.1
	59	10 m S, 45m W of E side of Lot 62	-1.1	Silty Clay	1890	13.7	101	1922	12.6	98.3
	60	10 m S, 60m W of E side of Lot 62	-1.1	Silty Clay	1915	13.4	101	1922	12.6	99.6
Jun 28 pm	* 61	10 m S, 10m W of E side of Lot 62	-0.8	Silty Clay	1800	10.6	101	1922	12.6	* 93.7
	* 62	10 m S, 28m W of E side of Lot 62	-0.8	Silty Clay	1810	11.5	101	1922	12.6	* 94.2
	63	10 m S, 45m W of E side of Lot 62	-0.8	Silty Clay	1900	10.9	101	1922	12.6	98.9
	* 64	10 m S, 69m W of E side of Lot 62	-0.8	Silty Clay	1820	12.1	101	1922	12.6	* 94.7
	* 65	**Retest of Test # 61**	-0.8	Silty Clay	1890	12.4	101	1922	12.6	98.3
	* 66	**Retest of Test # 62**	-0.8	Silty Clay	1895	11.9	101	1922	12.6	98.6
	* 67	**Retest of Test # 64**	-0.8	Silty Clay	1911	11.7	101	1922	12.6	99.4
	68	10 m W of E side of Lot 62	-1.8	Silty Clay	1835	12.4	101	1922	12.6	* 95.5
	69	30 m W of E side of Lot 62	-1.8	Silty Clay	1844	12.6	101	1922	12.6	* 95.9
	70	50 m W of E side of Lot 62	-1.8	Silty Clay	1920	11.4	101	1952	12.6	98.4
	71	70 m W of E side of Lot 62	-1.8	Silty Clay	1905	13.0	101	1922	12.6	99.1
	72	90 m W of E side of Lot 62	-1.8	Silty Clay	1901	12.5	101	1922	12.6	98.9
	73	110 m W of E side of Lot 62	-1.8	Silty Clay	1900	12.9	101	1922	12.6	98.9
	* 74	**Retest of Test # 68**	-1.8	Silty Clay	1903	13.4	101	1922	12.6	99.0
	* 75	**Retest of Test # 69**	-1.8	Silty Clay	1910	12.6	101	1922	12.6	99.4
	* Test # 65, 66, 67, 74 & 55 represents retest of test # 61, 62, 64, 68 & 69 after further compaction effort was applied.									
Jun 28 pm	* 76	15 m E of W side of Lot 141	-0.5	Silty Clay	1850	12.4	101	1922	12.6	* 96.3
	* 77	30 m E of W side of Lot 141	-0.5	Silty Clay	1844	12.6	101	1922	12.6	* 95.9
	78	45 m E of W side of Lot 141	-0.5	Silty Clay	1905	13.1	101	1922	12.6	99.1
	79	60 m E of W side of Lot 141	-0.5	Silty Clay	1910	13.3	101	1922	12.6	99.4

M&B TECHNICAL TESTING SERVICES LTD. Est 1993

25 M&B 1993-2018 YEARS

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Contractor: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
	80	75 m E of W side of Lot 141	-0.5	Silty Clay	1900	13.5	101	1922	12.6	98.9
	* 81	**Retest of Test # 76**	-0.5	Silty Clay	1896	12.4	101	1922	12.6	98.6
	* 82	**Retest of Test # 77**	-0.5	Silty Clay	1920	12.7	101	1922	12.6	99.9
	* 83	20 m E of W side of Lot 141	-0.25	Silty Clay	1852	11.4	101	1922	12.6	* 96.4
	84	40 m E of W side of Lot 141	-0.25	Silty Clay	1901	11.6	101	1922	12.6	98.9
	85	60 m E of W side of Lot 141	-0.25	Silty Clay	1905	12.1	101	1922	12.6	99.1
	* 86	80 m E of W side of Lot 141	-0.25	Silty Clay	1880	12.3	101	1922	12.6	* 97.8
	* 87	**Retest of Test # 83**	-0.25	Silty Clay	1910	12.6	101	1922	12.6	99.4
	* 88	**Retest of Test # 86**	-0.25	Silty Clay	1903	12.1	101	1922	12.6	99.0
	* Test # 81, 82, 87 & 88 represents retest of test # 76, 77, 83 & 86 after further compaction effort was applied.									

W of Lot 62, E of Lot 118, N of Lot 140 **Removal of Water & Sanitary Line**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
Jun 29 am	89	10 m W of E side of Lot 62	-1.6	Silty Clay	1900	13.7	101	1922	12.6	98.9
	90	25 m W of E side of Lot 62	-1.6	Silty Clay	1885	13.9	101	1922	12.6	98.1
	91	45 m W of E side of Lot 62	-1.6	Silty Clay	1890	13.4	101	1922	12.6	98.3
	* 92	10 m E of W side of Lot 118	-2.0	Silty Clay	1833	12.5	101	1922	12.6	* 95.4
	* 93	25 m W of W side of Lot 118	-2.0	Silty Clay	1840	12.6	101	1922	12.6	* 95.7
	* 94	45 m E of W side of Lot 118	-2.0	Silty Clay	1825	16.0	101	1922	12.6	* 95.0
	* 95	65 m E of W side of Lot 118	-2.0	Silty Clay	1820	13.9	101	1922	12.6	* 94.7
	* 96	85 m E of W side of Lot 118	-2.0	Silty Clay	1815	15.8	101	1922	12.6	* 94.4
	* 97	5 m E of W side of Lot 140	0.0	Silty Clay	1886	13.8	101	1922	12.6	98.1
	* 98	**Retest of Test #92**	-2.0	Silty Clay	1888	13.0	101	1922	12.6	98.2
	* 99	**Retest of Test #93**	-2.0	Silty Clay	1884	13.7	101	1922	12.6	98.0
	* 100	**Retest of Test #94**	-2.0	Silty Clay	1890	13.5	101	1922	12.6	98.3

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11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
	* 101	**Retest of Test #95**	-2.0	Silty Clay	1895	13.4	101	1922	12.6	98.6
	* 102	**Retest of Test #96**	-2.0	Silty Clay	1885	13.1	101	1922	12.6	98.1
Jun 29 pm	103	15 m N of Lot 140	-2.0	Silty Clay	1885	12.9	101	1922	12.6	98.1
	104	30 m N of Lot 140	-2.0	Silty Clay	1888	13.7	101	1922	12.6	98.2
	105	45 m N of Lot 140	-2.0	Silty Clay	1884	13.6	101	1922	12.6	98.0
	106	15 m N of Lot 140	-2.0	Silty Clay	1888	13.4	101	1922	12.6	98.2
	107	30 m N of Lot 140	-2.0	Silty Clay	1896	13.9	101	1922	12.6	98.6
	* Test # 98 to 102 represents retest of test # 92 to 96 after further compaction effort was applied.									

M&B TECHNICAL TESTING SERVICES LTD.
11551 – 42nd Street S.E.
Calgary, Alberta T2Z 4K4
office (403)243-9733
fax (403)243-9736

MOISTURE DENSITY (PROCTOR) RELATIONSHIP

Project: Midfield Mobile Home Park
954 - 16 Avenue NE
(5318237)

Project #: 18-06-001

Date : June 21, 2018 **Technician:** C.M.

Client: Wilco Contractors Southwest Inc.

Sample #: 101
Location: Site - Lot 170 to 172

Sample Description: Silty Clay

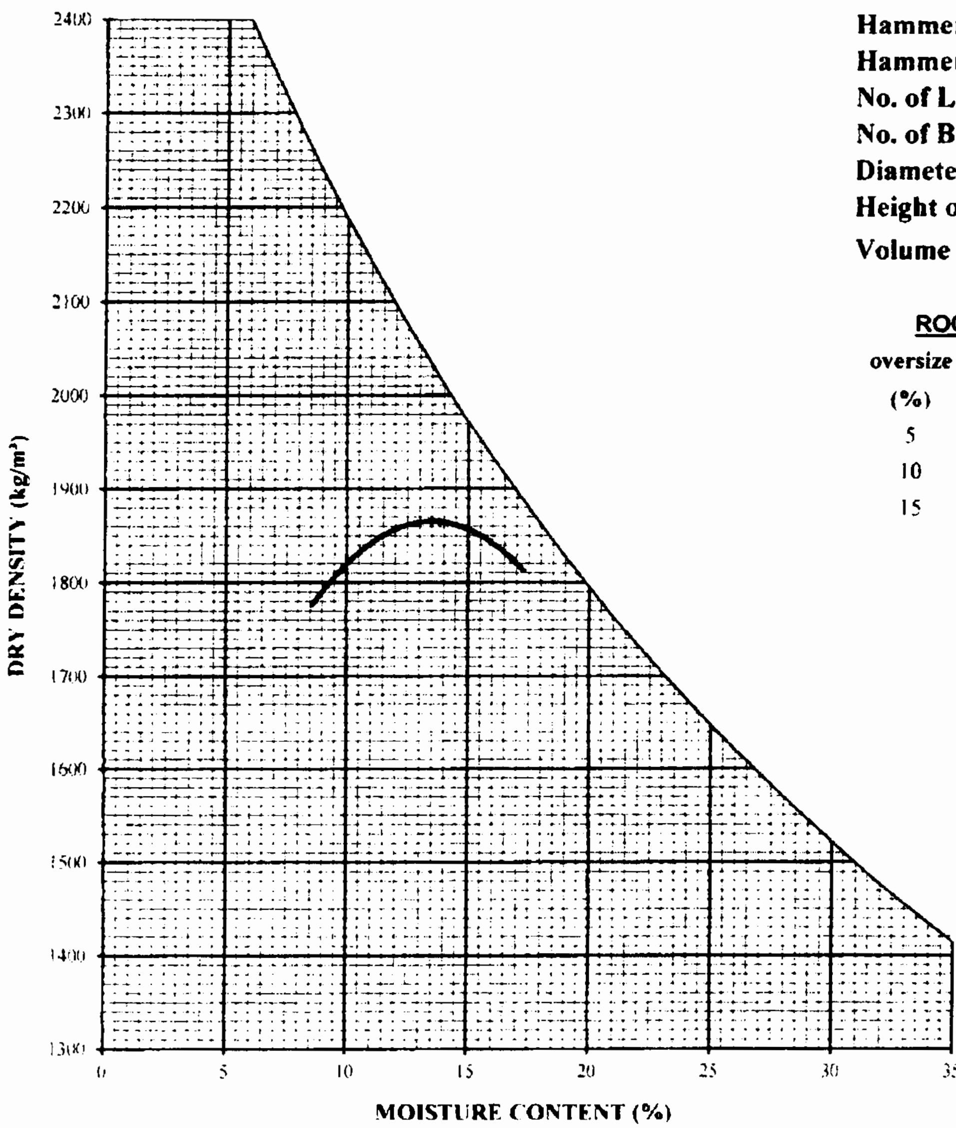
Source:

Minimum Dry Density (kg/m3)
Maximum Dry Density (kg/m3) 1865
Optimum Moisture Content: (%) 13.8
Natural Moisture Content: (%)
Compaction Standard: ASTM D 698
Method 'A'

Hammer Weight:	2.5	kg
Hammer Drop	305	mm
No. of Layers	3	
No. of Blows/Layer:	25	
Diameter of Mold:	102	mm
Height of Mold:	116	mm
Volume of Mold:	0.000943	m^3

ROCK CORRECTIONS

oversize (%)	dry density (kg/m^3)	moisture (%)
5	1893	13.2
10	1922	12.6
15	1952	12.0



CCIL

All tests performed in accordance with ASTM Standard D698, D1557, or D2049 unless otherwise noted.

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

M&B 25 YEARS 1993-2018

11551 - 42 Street SE. Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736
Email: office@mbtechtesting.com

August 17, 2018

Project No. 18-06-005

WILCO CONTRACTORS SOUTHWEST INC.
4700 - 110 Avenue S.E.
Calgary, AB
T2C 2T8

ATTENTION: MR. MICHAEL HEGARTY

RE: MIDFIELD MOBILE HOME PARK
COMPACTION & CONCRETE TESTING & INSPECTION – JULY 2018

Dear Sir,

Please find enclosed compaction test reports for the above listed project. As indicated from the density testing conducted, the materials placed agrees with project requirements.

If you have any questions, or require any additional information, please contact this office.

Respectfully submitted,

M & B TECHNICAL TESTING SERVICES LTD.

Mike O'Connor, P.Tech.(Eng.)

CCIL

M&B TECHNICAL TESTING SERVICES LTD.
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25 years 1993-2018
11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE
M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.
Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.
Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

N of Lot 82, 83,62, E of Lot 118 — **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 03 am	108	21 m N of S side of Lot #83	-1.2	Silty Clay	1838	14.1	101	1922	12.6	* 95.6
	* 109	**Retest of Test # 108**	-1.2	Silty Clay	1876	14.0	101	1922	12.6	97.6
	110	45 m N of S side of Lot #83	-1.5	Silty Clay	1881	12.5	101	1922	12.6	97.9
	111	15 m N of S side of Lot #82	-1.5	Silty Clay	1934	12.6	101	1922	12.6	100.6
	112	38 m N of S side of Lot #82	-1.5	Silty Clay	1885	12.1	101	1922	12.6	98.1
	113	28 m E of W side of Lot #118	-1.8	Silty Clay	1852	13.6	101	1922	12.6	* 96.4
	114	66 m E of W side of Lot #118	-1.8	Silty Clay	1896	13.6	101	1922	12.6	98.6
	* 115	**Retest of Test # 113**	-1.8	Silty Clay	1885	13.6	101	1922	12.6	98.1
	116	19 m N of S side of Lot #62	-0.5	Silty Clay	1900	14.0	101	1922	12.6	98.9
	117	47 m N of S side of Lot #62	-0.5	Silty Clay	1876	12.1	101	1922	12.6	97.6
	118	15 m W of E side of Lot #63	-2.5	Silty Clay	1902	11.0	101	1922	12.6	99.0
	119	52 m W of E side of Lot #63	-2.5	Silty Clay	1889	12.6	101	1922	12.6	98.3
	* Test # 109 & 115 represents retest of test # 108 & 113 after further compaction effort was applied.									

N of Lot 82, 83,62, E of Lot 118 — **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 03 pm	120	17 m N of S side of Lot #83	-0.9	Silty Clay	1912	13.0	101	1922	12.6	99.5
	121	48 m N of S side of Lot #83	-0.9	Silty Clay	1909	13.1	101	1922	12.6	99.3
	122	17 m N of S side of Lot #82	-1.3	Silty Clay	1858	14.5	101	1922	12.6	* 96.7
	* 123	**Retest of Test # 122**	-1.3	Silty Clay	1887	14.2	101	1922	12.6	98.2
	124	20 m E of W side of Lot #118	-1.5	Silty Clay	1818	14.5	101	1922	12.6	* 94.6
	* 125	**Retest of Test # 124**	-1.5	Silty Clay	1879	14.5	101	1922	12.6	97.8
	126	63 m E of W side of Lot #118	-1.5	Silty Clay	1899	12.6	101	1922	12.6	98.8

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25 YEARS 1993-2018
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Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	127	11 m N of S side of Lot #62	-2.0	Silty Clay	1895	13.3	101	1922	12.6	98.6
	128	44 m N of S side of Lot #62	-2.0	Silty Clay	1903	12.3	101	1922	12.6	99.0
	129	44 m N of S side of Lot #62	-2.0	Silty Clay	1875	13.8	101	1922	12.6	97.6
	130	25 m N of S side of Lot #83	-0.6	Silty Clay	1867	15.0	101	1922	12.6	97.1
	131	56 m N of S side of Lot #83	-0.6	Silty Clay	1923	13.7	101	1922	12.6	100.1
	132	20 m N of S side of Lot #82	-1.0	Silty Clay	1903	12.9	101	1922	12.6	99.0
	133	60 m N of S side of Lot #82	-1.0	Silty Clay	1889	14.5	101	1922	12.6	98.3
	* Test # 123 & 125 represents retest of test # 122 & 124 after further compaction effort was applied.									
Jul 03 pm	134	12 m N of S side of Lot #83	-0.3	Silty Clay	1814	14.9	101	1922	12.6	* 94.4
	* 135	**Retest of Test # 134**	-0.3	Silty Clay	1892	14.7	101	1922	12.6	98.4
	136	49 m N of S side of Lot #83	-0.3	Silty Clay	1895	14.1	101	1922	12.6	98.6
	137	19 m N of S side of Lot #82	-0.6	Silty Clay	1805	15.0	101	1922	12.6	* 93.9
	* 138	**Retest of Test # 137**	-0.6	Silty Clay	1880	14.8	101	1922	12.6	97.8
	139	52 m N of S side of Lot #82	-0.6	Silty Clay	1888	13.0	101	1922	12.6	98.2
	* Test # 135 & 138 represents retest of test # 134 & 137 after further compaction effort was applied.									

N of Lot 82, 83,62, E of Lot 118 **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 04 am	140	19 m N of S side of Lot #83	0.0	Silty Clay	1912	11.2	102	1922	12.4	99.5
	141	45 m N of S side of Lot #83	0.0	Silty Clay	1925	12.1	102	1922	12.4	100.2
	142	20 m N of S side of Lot #82	0.0	Silty Clay	1866	14.2	102	1922	12.4	* 97.1
	143	42 m N of S side of Lot #82	0.0	Silty Clay	1810	14.1	102	1922	12.4	* 94.2
	* 144	**Retest of Test # 142**	0.0	Silty Clay	1893	14.0	102	1922	12.4	98.5
	* 145	**Retest of Test # 143**	0.0	Silty Clay	1883	14.1	102	1922	12.4	98.0

M&B TECHNICAL TESTING SERVICES LTD. Est. 1993

25 YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	* Test # 144 & 145 represents retest of test # 134 & 137 after further compaction effort was applied.									
Jul 04 pm	* 146	44 m N, 60m W of S side of Lot #62	-1.8	Silty Clay	1816	13.0	102	1922	12.4	* 94.5
	147	44 m N, 85m W of S side of Lot #62	-1.8	Silty Clay	1879	14.8	102	1922	12.4	97.8
	* 148	44 m N, 120m W of S side of Lot #62	-1.8	Silty Clay	1831	13.3	102	1922	12.4	* 95.3
	* 149	**Retest of Test # 146**	-1.8	Silty Clay	1895	13.0	102	1922	12.4	98.6
	* 150	**Retest of Test # 148**	-1.8	Silty Clay	1880	13.3	102	1922	12.4	97.8
	151	20 m E of W side of Lot #118	-1.5	Silty Clay	1929	12.5	102	1922	12.4	100.4
	152	64 m E of W side of Lot #118	-1.5	Silty Clay	1891	13.3	102	1922	12.4	98.4
	153	106 m E of W side of Lot #118	-1.5	Silty Clay	1818	15.3	102	1922	12.4	* 94.6
	* 154	**Retest of Test # 153**	-1.5	Silty Clay	1883	15.0	102	1922	12.4	98.0
	* Test # 149, 150 & 154 represents retest of test # 146, 148, 153 after further compaction effort was applied.									
Jul 04 pm	155	44 m N, 60m W of S side of Lot #62	-1.5	Silty Clay	1879	14.8	102	1922	12.4	97.8
	156	44 m N, 107m W of S side of Lot #62	-1.5	Silty Clay	1874	14.5	102	1922	12.4	97.5
	157	44 m N, 127m W of S side of Lot #62	-1.5	Silty Clay	1920	13.7	102	1922	12.4	99.9
	* 158	44 m N, 163m W of S side of Lot #62	-1.5	Silty Clay	1814	12.1	102	1922	12.4	* 94.4
	* 159	**Retest of Test # 158**	-1.5	Silty Clay	1885	12.0	102	1922	12.4	98.1
	* Test # 159 represents retest of test # 158 after further compaction effort was applied.									

N & W of Lot 62, E of Lot 118, W of Lot 63, N of Lot 73 & 74 **Removal of Water & Sanitary Lines**

Jul 05 am	160	9 m W, of E side of Lot #63	-2.2	Silty Clay	1904	10.1	102	1922	12.4	99.1
	161	46 m W, of E side of Lot #63	-2.2	Silty Clay	1914	9.9	102	1922	12.4	99.6
	162	85 m W, of E side of Lot #63	-2.2	Silty Clay	1878	11.5	102	1922	12.4	97.7
	163	44 m N, 58m W of S side of Lot #62	-1.2	Silty Clay	1877	13.0	102	1922	12.4	97.7

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25 YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Contractor: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
	164	44 m N, 104m W of S side of Lot #62	-1.2	Silty Clay	1917	12.5	102	1922	12.4	99.7
	165	44 m N, 188m W of S side of Lot #62	-1.2	Silty Clay	1880	14.8	102	1922	12.4	97.8
Jul 05 am	166	15 m E, of W side of Lot #118	0.9	Silty Clay	1906	11.0	102	1922	12.4	99.2
	167	80 m E, of W side of Lot #118	0.9	Silty Clay	1881	12.7	102	1922	12.4	97.9
	168	176 m E, of W side of Lot #118	0.9	Silty Clay	1884	12.8	102	1922	12.4	98.0
Jul 05 pm	169	20 m E, of W side of Lot #118	-0.6	Silty Clay	1880	12.8	102	1922	12.4	97.8
	170	80 m E, of W side of Lot #118	-0.6	Silty Clay	1900	12.3	102	1922	12.4	98.9
	171	136 m E. of W side of Lot #118	-0.6	Silty Clay	1883	11.6	102	1922	12.4	98.0
	172	10 m W, of E side of Lot #63	-1.9	Silty Clay	1914	13.5	102	1922	12.4	99.6
	173	60 m W, of E side of Lot #63	-1.9	Silty Clay	1903	14.0	102	1922	12.4	99.0
	174	100 m W. of E side of Lot #63	-1.9	Silty Clay	1914	14.6	102	1922	12.4	99.6

E of Lot 118, W of Lot 63, N of Lot 73 & 74 **Removal of Water & Sanitary Lines**

Jul 06 am	175	19 m E, of W side of Lot #118	-0.3	Silty Clay	1889	13.6	102	1922	12.4	98.3
	176	56 m E. of W side of Lot #118	-0.3	Silty Clay	1914	12.3	102	1922	12.4	99.6
	177	25 m W. of E side of Lot #63	-1.6	Silty Clay	1920	11.5	102	1922	12.4	99.9
	178	85 m W, of E side of Lot #63	-1.6	Silty Clay	1903	13.0	102	1922	12.4	99.0
	179	18 m N, of S side of Lot #74	-1.3	Silty Clay	1854	14.5	102	1922	12.4	* 96.5
	* 180	**Retest of Test # 179**	-1.3	Silty Clay	1880	14.3	102	1922	12.4	97.8
	181	15 m N. of S side of Lot #73	-1.3	Silty Clay	1902	13.9	102	1922	12.4	99.0
	* Test # 180 represents retest of test # 179 after further compaction effort was applied.									
Jul 06 pm	182	30 m W. of E side of Lot #63	-1.0	Silty Clay	1891	13.0	102	1922	12.4	98.4
	183	120 m W. of E side of Lot #63	-1.0	Silty Clay	1879	14.6	102	1922	12.4	97.8

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954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
	184	180 m W. of E side of Lot #63	-1.6	Silty Clay	1902	13.7	102	1922	12.4	99.0
	185	250 m W. of E side of Lot #63	-1.6	Silty Clay	1912	13.3	102	1922	12.4	99.5
	186	15 m N. of S side of Lot #74	-1.0	Silty Clay	1874	14.0	102	1922	12.4	97.5
	187	15 m N. of S side of Lot #73	-1.0	Silty Clay	1889	14.3	102	1922	12.4	98.3
Jul 06 pm	188	25 m W. of E side of Lot #63	-0.7	Silty Clay	1904	13.8	102	1922	12.4	99.1
	189	89 m W. of E side of Lot #63	-0.7	Silty Clay	1895	14.2	102	1922	12.4	98.6
	190	176 m W. of E side of Lot #63	-1.0	Silty Clay	1906	14.2	102	1922	12.4	99.2
	191	264 m W. of E side of Lot #63	-1.0	Silty Clay	1908	13.7	102	1922	12.4	99.3
	192	20 m N. of S side of Lot #74	-0.7	Silty Clay	1883	14.3	102	1922	12.4	98.0
	193	20 m N. of S side of Lot #73	-0.7	Silty Clay	1833	15.0	102	1922	12.4	* 95.4
	* 194	**Retest of Test # 193**	-0.7	Silty Clay	1880	14.9	102	1922	12.4	97.8
	195	44 m N. 60m W of S side of Lot #62	-0.6	Silty Clay	1920	12.3	102	1922	12.4	99.9
	* Test # 194 represents retest of test # 193 after further compaction effort was applied.									

N of Lot 73 & 74, W of Lot 63, E of Lot 169 **Removal of Water & Sanitary Lines**

Jul 07 am	196	12 m N. of S side of Lot #74	-0.4	Silty Clay	1849	13.0	102	1922	12.4	* 96.2
	197	13 m N. of S side of Lot #73	-0.4	Silty Clay	1822	13.8	102	1922	12.4	* 94.8
	* 198	**Retest of Test #196**	-0.4	Silty Clay	1893	13.2	102	1922	12.4	98.5
	* 199	**Retest of Test #197**	-0.4	Silty Clay	1902	13.5	102	1922	12.4	99.0
	200	162 m W. of E side of Lot #63	-1.0	Silty Clay	1918	14.0	102	1922	12.4	99.8
	201	250 m W. of E side of Lot #63	-1.0	Silty Clay	1881	15.0	102	1922	12.4	97.9
	* Test # 198 & 199 represents retest of test # 196 & 197 after further compaction effort was applied.									
Jul 07 pm	202	165 m W. of E side of Lot #63	-0.7	Silty Clay	1904	13.5	102	1922	12.4	99.1

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Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Procto Sample #	Proctor Density (kg/m³)	Opt. Wate (%)	Compaction Level (%)
	203	255 m W, of E side of Lot #63	-0.7	Silty Clay	1918	14.3	102	1922	12.4	99.8
	204	20 m W, of E side of Lot #169	-2.0	Silty Clay	1885	11.3	102	1922	12.4	98.1
	205	60 m W, of E side of Lot #169	-2.0	Silty Clay	1908	12.6	102	1922	12.4	99.3

W of lot 63, 154, 169 **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Procto Sample #	Proctor Density (kg/m³)	Opt. Wate (%)	Compaction Level (%)
Jul 09 am	206	128 m W. of E side of Lot #63	-1.0	Silty Clay	1880	10.6	102	1922	12.4	97.8
	* 207	206 m W. of E side of Lot #63	-1.0	Silty Clay	1822	11.7	102	1922	12.4	* 94.8
	* 208	**Retest of Test # 207**	-1.0	Silty Clay	1881	11.7	102	1922	12.4	97.9
	209	256 m W, of E side of Lot #63	-1.0	Silty Clay	1874	11.9	102	1922	12.4	97.5
	* Test # 208 represents retest of test # 207 after further compaction effort was applied.									
Jul 09 pm	210	108 m W, of E side of Lot #63	-0.7	Silty Clay	1887	11.6	102	1922	12.4	98.2
	211	192 m W, of E side of Lot #63	-0.7	Silty Clay	1824	10.8	102	1922	12.4	* 94.9
	* 212	**Retest of Test # 211**	-0.7	Silty Clay	1895	10.6	102	1922	12.4	98.6
	213	20 m W, of E side of Lot #154	-2.0	Silty Clay	1804	11.8	102	1922	12.4	* 93.9
	* 214	**Retest of Test # 213**	-2.0	Silty Clay	1878	11.9	102	1922	12.4	97.7
	215	60 m W, of E side of Lot #154	-2.0	Silty Clay	1825	12.1	102	1922	12.4	* 95.0
	* 216	**Retest of Test # 215**	-2.0	Silty Clay	1883	11.7	102	1922	12.4	98.0
	217	10 m W, of E side of Lot #169	-1.7	Silty Clay	1876	12.0	102	1922	12.4	97.6
	218	70 m W, of E side of Lot #169	-1.7	Silty Clay	1883	12.8	102	1922	12.4	98.0
	219	160 m W, of E side of Lot #169	-1.7	Silty Clay	1901	12.7	102	1922	12.4	98.9
	* Test # 212, 214,& 216 represents retest of test # 211, 213 & 215 after further compaction effort was applied.									
Jul 09 pm	220	29 m E. of W side of Lot #169	-1.4	Silty Clay	1881	12.9	102	1922	12.4	97.9
	221	89 m E. of W side of Lot #169	-1.4	Silty Clay	1837	11.0	102	1922	12.4	* 95.6

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Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	* 222	**Retest of Test # 221**	-1.4	Silty Clay	1880	11.0	102	1922	12.4	97.8
	223	30 m W. of E side of Lot #154	-1.7	Silty Clay	1918	13.0	102	1922	12.4	99.8
	224	65 m W. of E side of Lot #154	-1.7	Silty Clay	1902	12.1	102	1922	12.4	99.0
	* Test # 212, 214,& 216 represents retest of test # 211, 213 & 215 after further compaction effort was applied.									

W of lot 63, 154, E of Lot 169 **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 10 am	225	106 m W. of E side of Lot #63	-0.4	Silty Clay	1878	12.8	102	1922	12.4	97.7
	226	210 m W. of E side of Lot #63	-0.4	Silty Clay	1806	12.0	102	1922	12.4	* 94.0
	227	250 m W. of E side of Lot #63	-0.4	Silty Clay	1837	13.1	102	1922	12.4	* 95.6
	* 228	**Retest of Test #226**	-0.4	Silty Clay	1874	12.2	102	1922	12.4	97.5
	* 229	**Retest of Test #227**	-0.4	Silty Clay	1883	12.3	102	1922	12.4	98.0
	230	15 m E. of W side of Lot #169	-1.0	Silty Clay	1841	12.1	102	1922	12.4	* 95.8
	231	60 m E. of W side of Lot #169	-1.0	Silty Clay	1883	11.6	102	1922	12.4	98.0
	232	130 m E. of W side of Lot #169	-1.0	Silty Clay	1875	12.9	102	1922	12.4	97.6
	* 233	**Retest of Test #230**	-1.0	Silty Clay	1904	11.3	102	1922	12.4	99.1
	* Test # 228, 229 & 233 represents retest of test # 226, 227 & 230 after further compaction effort was applied.									
Jul 10 pm		Schedule testing cancelled on site due to rain								

E of Lot 169, W of Lot 53, 117 & 154, N of Lot 93 & 94, S of Lot 32 **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 11 pm	234	20 m E. of W side of Lot #169	-1.2	Silty Clay	1885	13.1	102	1922	12.4	98.1
	235	40 m E. of W side of Lot #169	-1.2	Silty Clay	1905	13.5	102	1922	12.4	99.1
	236	60 m E. of W side of Lot #169	-1.2	Silty Clay	1890	13.4	102	1922	12.4	98.3
	237	20 m W. of E side of Lot #117	-1.9	Silty Clay	1900	13.2	102	1922	12.4	98.9
	238	40 m W. of E side of Lot #117	-1.9	Silty Clay	1888	11.9	102	1922	12.4	98.2

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Project: Midfield Mobile Home Park
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M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	239	60 m W, of E side of Lot #117	-1.9	Silty Clay	1915	11.8	102	1922	12.4	99.6
	240	20 m W, of E side of Lot #154	-1.4	Silty Clay	1889	12.4	102	1922	12.4	98.3
	241	40 m W, of E side of Lot #154	-1.4	Silty Clay	1910	12.6	102	1922	12.4	99.4
	242	60 m W, of E side of Lot #154	-1.4	Silty Clay	1903	12.8	102	1922	12.4	99.0
	243	20 m N, of S side of Lot #94	-0.8	Silty Clay	1920	12.5	102	1922	12.4	99.9
	244	40 m N, of S side of Lot #94	-0.8	Silty Clay	1910	12.5	102	1922	12.4	99.4
	245	20 m N, of S side of Lot #93	-0.8	Silty Clay	1890	12.7	102	1922	12.4	98.3
	246	40 m N, of S side of Lot #93	-0.8	Silty Clay	1915	11.7	102	1922	12.4	99.6
	247	20 m N, 10m W of S side of Lot #93	-0.8	Silty Clay	1885	11.9	102	1922	12.4	98.1
	248	40 m N, 10m W of S side of Lot #93	-0.8	Silty Clay	1903	12.5	102	1922	12.4	99.0
Jul 11 pm	249	20 m E, of W side of Lot #169	1.0	Silty Clay	1888	13.0	102	1922	12.4	98.2
	250	40 m E, of W side of Lot #169	1.0	Silty Clay	1890	13.2	102	1922	12.4	98.3
	251	60 m E, of W side of Lot #169	1.0	Silty Clay	1900	13.4	102	1922	12.4	98.9
	252	20 m W, of E side of Lot #53	-0.6	Silty Clay	1905	12.9	102	1922	12.4	99.1
	253	40 m W, of E side of Lot #53	-0.6	Silty Clay	1886	12.7	102	1922	12.4	98.1
	254	60 m W, of E side of Lot #53	-0.6	Silty Clay	1920	12.5	102	1922	12.4	99.9
	255	80 m W, of E side of Lot #53	-0.6	Silty Clay	1903	11.0	102	1922	12.4	99.0
	256	100 m W, of E side of Lot #53	-0.6	Silty Clay	1910	11.5	102	1922	12.4	99.4
	257	15 m N, of S side of Lot #94	-0.6	Silty Clay	1915	11.7	102	1922	12.4	99.6
	258	30 m N, of S side of Lot #94	-0.6	Silty Clay	1889	11.9	102	1922	12.4	98.3
	259	15 m N, of S side of Lot #93	-0.6	Silty Clay	1911	13.1	102	1922	12.4	99.4
	260	30 m N, of S side of Lot #93	-0.6	Silty Clay	1902	13.7	102	1922	12.4	99.0

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Job #:	5318237		
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SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	261	15 m N. 10m W of S side of Lot #93	-0.6	Silty Clay	1918	13.5	102	1922	12.4	99.8
	262	30 m N. of S side of Lot #93	-0.6	Silty Clay	1900	13.2	102	1922	12.4	98.9
	263	15 m S, of N side of Lot #32	-2.3	Silty Clay	1906	13.1	102	1922	12.4	99.2
	264	30 m S, of N side of Lot #32	-2.3	Silty Clay	1903	11.9	102	1922	12.4	99.0
	265	20 m E. of W side of Lot #169	-0.7	Silty Clay	1889	12.7	102	1922	12.4	98.3
	266	40 m E. of W side of Lot #169	-0.7	Silty Clay	1905	12.5	102	1922	12.4	99.1
	267	60 m E. of W side of Lot #169	-0.7	Silty Clay	1910	12.3	102	1922	12.4	99.4
	268	80 m E. of W side of Lot #169	-0.7	Silty Clay	1920	12.4	102	1922	12.4	99.9

N of Lot 32, 93 & 94, W of Lot 117 & 154, E of Lot 169 **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 12 am	269	20 m N. of S side of Lot #94	-0.5	Silty Clay	1833	12.0	102	1922	12.4	* 95.4
	270	20 m N. of S side of Lot #93	-0.5	Silty Clay	1880	13.1	102	1922	12.4	97.8
	* 271	**Retest of Test # 269**	-0.5	Silty Clay	1883	12.0	102	1922	12.4	98.0
	272	30 m W. of E side of Lot #154	-1.5	Silty Clay	1906	11.6	102	1922	12.4	99.2
	273	80 m W. of E side of Lot #154	-1.5	Silty Clay	1900	12.3	102	1922	12.4	98.9
	274	36 m W. of E side of Lot #117	-1.5	Silty Clay	1881	13.2	102	1922	12.4	97.9
	275	100 m W. of E side of Lot #117	-1.5	Silty Clay	1893	12.8	102	1922	12.4	98.5
	276	50 m E. of W side of Lot #169	-0.7	Silty Clay	1924	11.8	102	1922	12.4	100.1
	277	30 m N. of S side of Lot #32	-1.0	Silty Clay	1918	12.2	102	1922	12.4	99.8
	* Test # 271 represents retest of test # 269 after further compaction effort was applied.									
Jul 12 pm	278	40 m E. of W side of Lot #169	-0.5	Silty Clay	1918	12.3	102	1922	12.4	99.8
	279	80 m E. of W side of Lot #169	-0.5	Silty Clay	1903	13.0	102	1922	12.4	99.0
Jul 12 pm	280	22 m N. of S side of Lot #94	-0.3	Silty Clay	1904	11.9	102	1922	12.4	99.1

M&B TECHNICAL TESTING SERVICES LTD. Est. 1993

25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	281	25 m N. of S side of Lot #93	-0.3	Silty Clay	1885	12.2	102	1922	12.4	98.1
	282	30 m E. of W side of Lot #169	-0.4	Silty Clay	1874	12.9	102	1922	12.4	97.5
	283	100 m E. of W side of Lot #169	-0.4	Silty Clay	1833	14.0	102	1922	12.4	* 95.4
	* 284	**Retest of Test #283**	-0.4	Silty Clay	1881	13.8	102	1922	12.4	97.9
	285	50 m W. of E side of Lot #154	-1.3	Silty Clay	1913	12.8	102	1922	12.4	99.5
	286	150 m W. of E side of Lot #154	-1.3	Silty Clay	1903	12.6	102	1922	12.4	99.0
	287	140 m W. of E side of Lot #117	-1.3	Silty Clay	1887	13.3	102	1922	12.4	98.2
	288	120 m W. of E side of Lot #117	-1.3	Silty Clay	1897	12.6	102	1922	12.4	98.7
	289	50 m N. of S side of Lot #32	-0.9	Silty Clay	1908	12.0	102	1922	12.4	99.3
	* Test # 284 represents retest of test # 283 after further compaction effort was applied.									

N of Lot 32, 93 & 94/ W of Lot 154, 169, 117, 112 — **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 13 am	290	20 m N. of S side of Lot #94	-0.3	Silty Clay	1864	12.9	102	1922	12.4	* 97.0
	* 291	**Retest of Test # 290**	-0.3	Silty Clay	1891	12.9	102	1922	12.4	98.4
	292	20 m N. of S side of Lot #93	-0.3	Silty Clay	1876	14.8	102	1922	12.4	97.6
	293	30 m W. of E side of Lot #154	-1.0	Silty Clay	1911	13.8	102	1922	12.4	99.4
	294	100 m W. of E side of Lot #154	-1.0	Silty Clay	1902	13.1	102	1922	12.4	99.0
	295	25 m W. of E side of Lot #169	-0.6	Silty Clay	1914	12.2	102	1922	12.4	99.6
	296	130 m W. of E side of Lot #169	-0.6	Silty Clay	1883	12.9	102	1922	12.4	98.0
	297	50 m N. of S side of Lot #32	-0.7	Silty Clay	1812	12.5	102	1922	12.4	* 94.3
	* 298	**Retest of Test # 297**	-0.7	Silty Clay	1883	12.6	102	1922	12.4	98.0
	* Test # 291 & 298 represents retest of test # 290 & 297 after further compaction effort was applied.									
Jul 13 pm	299	25 m W. of E side of Lot #154	-0.6	Silty Clay	1848	12.6	102	1922	12.4	* 96.1

M&B TECHNICAL TESTING SERVICES LTD. Est. 1993

25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	300	100 m W. of E side of Lot #154	-0.6	Silty Clay	1826	15.4	102	1922	12.4	* 95.0
	* 301	**Retest of Test # 299**	-0.6	Silty Clay	1901	12.3	102	1922	12.4	98.9
	* 302	**Retest of Test # 300**	-0.6	Silty Clay	1879	15.0	102	1922	12.4	97.8
	303	15 m W. of E side of Lot #117	-0.6	Silty Clay	1913	12.6	102	1922	12.4	99.5
	304	30 m N. of S side of Lot #94	0.0	Silty Clay	1893	12.6	102	1922	12.4	98.5
	305	30 m N. of S side of Lot #93	0.0	Silty Clay	1908	13.5	102	1922	12.4	99.3
	* Test # 301 & 302 represents retest of test # 299 & 300 after further compaction effort was applied.									
Jul 13 pm	306	30 m W. of E side of Lot #154	-0.3	Silty Clay	1883	12.3	102	1922	12.4	98.0
	307	120 m W. of E side of Lot #154	-0.3	Silty Clay	1902	12.9	102	1922	12.4	99.0
	* 308	46 m W. of E side of Lot #112	-0.3	Silty Clay	1860	13.8	102	1922	12.4	* 96.8
	309	130 m W. of E side of Lot #112	-0.3	Silty Clay	1901	12.6	102	1922	12.4	98.9
	* 310	**Retest of Test # 308**	-0.3	Silty Clay	1908	13.5	102	1922	12.4	99.3
	* Test # 310 represents retest of test # 308 after further compaction effort was applied.									

W of lot 117, 154, 18 & 63/ N of Lot 1, 28 & 32 **Removal of Water & Sanitary Lines**

Jul 14 am	311	40 m W. of E side of Lot #117	0.0	Silty Clay	1818	11.2	102	1922	12.4	* 94.6
	312	120 m W. of E side of Lot #117	0.0	Silty Clay	1860	11.5	102	1922	12.4	* 96.8
	* 313	**Retest of Test # 311**	0.0	Silty Clay	1901	11.8	102	1922	12.4	98.9
	* 314	**Retest of Test # 312**	0.0	Silty Clay	1902	11.6	102	1922	12.4	99.0
	315	37 m W. of E side of Lot #154	0.0	Silty Clay	1865	11.7	102	1922	12.4	* 97.0
	316	125 m W. of E side of Lot #154	0.0	Silty Clay	1859	11.7	102	1922	12.4	* 96.7
	* 317	**Retest of Test #315**	0.0	Silty Clay	1893	12.3	102	1922	12.4	98.5
	* 318	**Retest of Test #316**	0.0	Silty Clay	1887	11.6	102	1922	12.4	98.2

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25 M&B YEARS 1993-2018

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Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	319	100 m W, of E side of Lot #63	0.0	Silty Clay	1918	11.5	102	1922	12.4	99.8
	320	200 m W, of E side of Lot #63	0.0	Silty Clay	1904	12.6	102	1922	12.4	99.1
	* Test # 313, 314, 317 & 318 represents retest of test # 311, 312, 315 & 316 after further compaction effort was applied.									
Jul 14 pm	321	25 m N, of S side of Lot #28	-2.0	Silty Clay	1891	13.9	102	1922	12.4	98.4
	322	95 m N, of S side of Lot #28	-2.0	Silty Clay	1883	14.5	102	1922	12.4	98.0
	323	10 m N, of S side of Lot #1	-2.0	Silty Clay	1787	13.5	102	1922	12.4	* 93.0
	324	100 m N, of S side of Lot #1	-2.0	Silty Clay	1802	14.0	102	1922	12.4	* 93.8
	* 325	**Retest of Test # 323**	-2.0	Silty Clay	1881	13.3	102	1922	12.4	97.9
	* 326	**Retest of Test # 324**	-2.0	Silty Clay	1889	13.8	102	1922	12.4	98.3
	327	25 m N, of S side of Lot #32	-1.7	Silty Clay	1885	13.6	102	1922	12.4	98.1
	328	100 m N, of S side of Lot #32	-1.7	Silty Clay	1903	14.6	102	1922	12.4	99.0
	329	40 m W, of E side of Lot #17	-2.0	Silty Clay	1880	15.1	102	1922	12.4	97.8
	330	30 m W, of E side of Lot #181	-2.0	Silty Clay	1885	15.0	102	1922	12.4	98.1
	* Test # 325 & 326 represents retest of test # 323 & 324 after further compaction effort was applied.									

W of lot 17, 131 & 181/ N of Lot 1, 28 & 32 — **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 16 am	331	25 m W, of E side of Lot #17	-1.7	Silty Clay	1901	15.5	102	1922	12.4	98.9
	332	30 m W, of E side of Lot #181 (South)	-1.7	Silty Clay	1822	14.5	102	1922	12.4	* 94.8
	333	30 m W, of E side of Lot #181 (North)	-0.7	Silty Clay	1859	14.8	102	1922	12.4	* 96.7
	* 334	**Retest of Test # 332**	-0.7	Silty Clay	1900	14.9	102	1922	12.4	98.9
	* 335	**Retest of Test # 333**	-0.7	Silty Clay	1888	14.5	102	1922	12.4	98.2
	336	60 m W, of E side of Lot #181 (South)	-1.7	Silty Clay	1914	14.3	102	1922	12.4	99.6
	* Test # 334 & 335 represents retest of test # 332 & 333 after further compaction effort was applied.									

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Est. 1993
25 YEARS M&B 1993-2018
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Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 16 pm	337	30 m N. of S side of Lot #1	-1.7	Silty Clay	1889	12.1	102	1922	12.4	98.3
	338	100 m N. of S side of Lot #1	-1.7	Silty Clay	1869	12.6	102	1922	12.4	* 97.2
	* 339	**Retest of Test # 338**	-1.7	Silty Clay	1914	12.0	102	1922	12.4	99.6
	340	28 m N. of S side of Lot #28	-1.7	Silty Clay	1810	13.6	102	1922	12.4	* 94.2
	341	125 m N. of S side of Lot #28	-1.7	Silty Clay	1802	12.6	102	1922	12.4	* 93.8
	* 342	**Retest of Test # 340**	-1.7	Silty Clay	1882	12.9	102	1922	12.4	97.9
	* 343	**Retest of Test # 341**	-1.7	Silty Clay	1902	12.5	102	1922	12.4	99.0
	* Test # 339, 342 & 343 represents retest of test # 338, 340 &341 after further compaction effort was applied.									
Jul 16 pm	344	25 m N. of S side of Lot #28	-1.5	Silty Clay	1850	12.8	102	1922	12.4	* 96.3
	345	109 m N. of S side of Lot #28	-1.5	Silty Clay	1839	12.9	102	1922	12.4	* 95.7
	* 346	**Retest of Test # 344**	-1.5	Silty Clay	1903	12.5	102	1922	12.4	99.0
	* 347	**Retest of Test # 345**	-1.5	Silty Clay	1890	12.9	102	1922	12.4	98.3
	348	37 m W. of E side of Lot #181 (North)	-0.4	Silty Clay	1916	10.1	102	1922	12.4	99.7
	349	40 m W. of E side of Lot #181 (South)	-1.4	Silty Clay	1901	12.6	102	1922	12.4	98.9
	350	10 m N. of S side of Lot #1	-1.4	Silty Clay	1789	13.7	102	1922	12.4	* 93.1
	351	80 m N. of S side of Lot #1	-1.4	Silty Clay	1818	11.4	102	1922	12.4	* 94.6
	352	140 m N. of S side of Lot #1	-1.4	Silty Clay	1803	12.7	102	1922	12.4	* 93.8
	* 353	**Retest of Test # 350**	-1.4	Silty Clay	1878	13.3	102	1922	12.4	97.7
	* 354	**Retest of Test # 351**	-1.4	Silty Clay	1904	12.0	102	1922	12.4	99.1
	* 355	**Retest of Test # 352**	-1.4	Silty Clay	1895	12.4	102	1922	12.4	98.6
	356	40 m W. of E side of Lot #17	-1.4	Silty Clay	1914	10.1	102	1922	12.4	99.6
	* Test # 346, 347, 353,354 & 355 represents retest of test # 344, 345, 350, 351 & 352 after further compaction effort was applied.									

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

25 YEARS 1993-2018

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Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

N of Lot 1, 28 & 32/ W of lot 17 & 181 — **Removal of Water & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 17 am	357	20 m N, of S side of Lot #1	-1.3	Silty Clay	1800	12.7	102	1922	12.4	* 93.7
	358	90 m N, of S side of Lot #1	-1.3	Silty Clay	1785	13.7	102	1922	12.4	* 92.9
	* 359	**Retest of Test # 357**	-1.3	Silty Clay	1897	11.8	102	1922	12.4	98.7
	* 360	**Retest of Test # 358**	-1.3	Silty Clay	1881	12.9	102	1922	12.4	97.9
	361	15 m N, of S side of Lot #28	-1.3	Silty Clay	1914	10.1	102	1922	12.4	99.6
	362	105 m N, of S side of Lot #28	-1.3	Silty Clay	1902	11.8	102	1922	12.4	99.0
	363	35 m W, of E side of Lot #17	-1.1	Silty Clay	1863	13.3	102	1922	12.4	* 96.9
	* 364	**Retest of Test # 363**	-1.1	Silty Clay	1905	13.0	102	1922	12.4	99.1
	* Test # 359, 360 & 364 represents retest of test # 357, 358 & 363 after further compaction effort was applied.									
Jul 17 pm	* 365	15 m N, of S side of Lot #32	-1.0	Silty Clay	1853	11.4	102	1922	12.4	* 96.4
	* 366	80 m N, of S side of Lot #32	-1.0	Silty Clay	1839	11.1	102	1922	12.4	* 95.7
	* 367	**Retest of Test # 365**	-1.0	Silty Clay	1885	11.6	102	1922	12.4	98.1
	* 368	**Retest of Test # 366**	-1.0	Silty Clay	1899	10.8	102	1922	12.4	98.8
	369	25 m N, of S side of Lot #28	-1.0	Silty Clay	1855	11.8	102	1922	12.4	96.5
	* 370	120 m N, of S side of Lot #28	-1.0	Silty Clay	1787	13.1	102	1922	12.4	* 93.0
	* 371	**Retest of Test # 370**	-1.0	Silty Clay	1889	12.7	102	1922	12.4	98.3
	* Test # 367, 368 & 371 represents retest of test # 365, 366 & 370 after further compaction effort was applied.									
Jul 17 pm	372	30 m W, of E side of Lot #181 (South)	-1.1	Silty Clay	1774	13.1	102	1922	12.4	* 92.3
	* 373	**Retest of Test # 372**	-1.1	Silty Clay	1894	12.8	102	1922	12.4	98.5
	374	30 m W, of E side of Lot #17	-0.8	Silty Clay	1778	14.7	102	1922	12.4	* 92.5
	* 375	**Retest of Test # 374**	-0.8	Silty Clay	1880	14.3	102	1922	12.4	97.8

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25 M&B YEARS 1993-2018

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Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
	376	20 m N. of S side of Lot #28	-0.8	Silty Clay	1829	13.9	102	1922	12.4	* 95.2
	377	127 m N. of S side of Lot #28	-0.8	Silty Clay	1834	13.1	102	1922	12.4	* 95.4
	378	10 m N. of S side of Lot #32	-0.7	Silty Clay	1879	14.4	102	1922	12.4	97.8
	379	110 m N. of S side of Lot #32	-0.7	Silty Clay	1901	13.2	102	1922	12.4	98.9
	* 380	**Retest of Test # 376**	-0.7	Silty Clay	1906	13.5	102	1922	12.4	99.2
	* 381	**Retest of Test # 377**	-0.7	Silty Clay	1899	13.7	102	1922	12.4	98.8
	382	20 m N. of S side of Lot #1	-1.0	Silty Clay	1776	13.6	102	1922	12.4	* 92.4
	383	120 m N. of S side of Lot #1	-1.0	Silty Clay	1837	14.0	102	1922	12.4	* 95.6
	* 384	**Retest of Test # 382**	-1.0	Silty Clay	1907	13.9	102	1922	12.4	99.2
	* 385	**Retest of Test # 383**	-1.0	Silty Clay	1897	13.8	102	1922	12.4	98.7
	* Test # 373, 375, 380, 381, 384 & 385 represents retest of test # 372, 374, 376, 377, 382 & 383 after further compaction effort was applied.									

N of Lot 1, 28 & 32/ W of Lot 131, 181, 72 & 17

Removal of Water, Storm & Sanitary Lines

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
Jul 18 am	386	25 m N. of S side of Lot #1	-0.7	Silty Clay	1793	12.5	102	1922	12.4	* 93.3
	387	125 m N. of S side of Lot #1	-0.7	Silty Clay	1883	13.0	102	1922	12.4	98.0
	* 388	**Retest of Test # 386**	-0.7	Silty Clay	1885	12.5	102	1922	12.4	98.1
	389	30 m W. of E side of Lot #131 (South)	-0.8	Silty Clay	1878	14.7	102	1922	12.4	97.7
	390	35 m W. of E side of Lot #181 (North)	-0.4	Silty Clay	1817	12.9	102	1922	12.4	* 94.5
	* 391	**Retest of Test # 390**	-0.4	Silty Clay	1880	12.0	102	1922	12.4	97.8
	392	30 m W. of E side of Lot #17	-0.7	Silty Clay	1895	12.0	102	1922	12.4	98.6
	393	25 m N. of S side of Lot #28	-0.6	Silty Clay	1790	11.9	102	1922	12.4	* 93.1
	394	130 m N. of S side of Lot #28	-0.6	Silty Clay	1812	11.5	102	1922	12.4	94.3
	* 395	**Retest of Test # 393**	-0.6	Silty Clay	1905	11.6	102	1922	12.4	99.1

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Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	396	25 m N. of S side of Lot #32	-0.3	Silty Clay	1831	13.0	102	1922	12.4	* 95.3
	397	130 m N. of S side of Lot #32	-0.3	Silty Clay	1818	12.0	102	1922	12.4	* 94.6
	* 398	**Retest of Test # 396**	-0.3	Silty Clay	1895	12.8	102	1922	12.4	98.6
	* 399	**Retest of Test # 397**	-0.3	Silty Clay	1879	12.2	102	1922	12.4	97.8
	* Test # 388, 391, 395, 398 & 399 represents retest of test # 386, 390, 393, 396 & 397 after further compaction effort was applied.									
Jul 18 pm	400	50 m W. of E side of Lot #72	-2.0	Silty Clay	1855	14.1	102	1922	12.4	* 96.5
	* 401	**Retest of Test # 400**	-2.0	Silty Clay	1901	13.5	102	1922	12.4	98.9
	402	20 m NW. of E side of Lot #129	-2.0	Silty Clay	1909	13.0	102	1922	12.4	99.3
	403	20 m SW. of E side of Lot #129	-2.0	Silty Clay	1900	12.6	102	1922	12.4	98.9
	404	30 m N. of S side of Lot #28	-0.6	Silty Clay	1812	13.3	102	1922	12.4	* 94.3
	405	130 m N. of S side of Lot #28	-0.6	Silty Clay	1876	14.0	102	1922	12.4	97.6
	* 406	**Retest of Test # 404**	-0.6	Silty Clay	1884	13.8	102	1922	12.4	98.0
	407	30 m W. of E side of Lot #17	-0.4	Silty Clay	1862	12.1	102	1922	12.4	* 96.9
	* 408	**Retest of Test # 407**	-0.4	Silty Clay	1903	11.8	102	1922	12.4	99.0
	409	30 m W. of E side of Lot #181	-0.4	Silty Clay	1897	13.3	102	1922	12.4	98.7
	410	30 m W. of E side of Lot #181 (North)	0.0	Silty Clay	1840	11.0	102	1922	12.4	* 95.7
	* 411	**Retest of Test # 410**	0.0	Silty Clay	1914	11.3	102	1922	12.4	99.6
	412	20 m N. of S side of Lot #32	0.0	Silty Clay	1820	13.5	102	1922	12.4	* 94.7
	413	120 m N. of S side of Lot #32	0.0	Silty Clay	1829	14.6	102	1922	12.4	* 95.2
	* 414	**Retest of Test # 412**	0.0	Silty Clay	1878	13.0	102	1922	12.4	97.7
	* 415	**Retest of Test # 413**	0.0	Silty Clay	1903	14.8	102	1922	12.4	99.0
	* Test # 401, 406, 411, 414 & 415 represents retest of test # 400, 404, 407, 410, 412 & 413 after further compaction effort was applied.									

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993
25 YEARS 1993-2018
11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 18 pm	416	30 m N. of S side of Lot #1	-0.4	Silty Clay	1884	12.7	102	1922	12.4	98.0
	417	120 m N. of S side of Lot #1	-0.4	Silty Clay	1860	13.3	102	1922	12.4	* 96.8
	* 418	**Retest of Test # 417**	-0.4	Silty Clay	1903	13.0	102	1922	12.4	99.0
	419	30 m N. of S side of Lot #28	-0.4	Silty Clay	1851	13.4	102	1922	12.4	* 96.3
	420	120 m N. of S side of Lot #28	-0.4	Silty Clay	1812	12.0	102	1922	12.4	* 94.3
	* 421	**Retest of Test # 419**	-0.4	Silty Clay	1901	13.7	102	1922	12.4	98.9
	* 422	**Retest of Test # 420**	-0.4	Silty Clay	1912	12.4	102	1922	12.4	99.5
	* Test # 418. 421 & 422 represents retest of test # 417. 419 & 420 after further compaction effort was applied.									
Jul 19		Scheduled Testing cancelled on site due to wet site conditions								

N of Lot 1, 28/S Lot 28/E Lot 22 & 129/W of Lot 17, 181/S of Lot 129 **Removal of Water, Storm & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 20 am	423	30 m N. of S side of Lot #1	0.0	Silty Clay	1753	13.0	102	1922	12.4	* 91.2
	424	150 m N. of S side of Lot #1	0.0	Silty Clay	1801	13.2	102	1922	12.4	* 93.7
	* 425	**Retest of Test # 423**	0.0	Silty Clay	1900	13.2	102	1922	12.4	98.9
	* 426	**Retest of Test # 424**	0.0	Silty Clay	1889	13.7	102	1922	12.4	98.3
	427	30 m N. of S side of Lot #28	-0.5	Silty Clay	1885	13.5	102	1922	12.4	98.1
	428	150 m N. of S side of Lot #28	-0.5	Silty Clay	1897	13.1	102	1922	12.4	98.7
Jul 20 pm	429	30 m W. of E side of Lot #72	-1.0	Silty Clay	1887	13.2	102	1922	12.4	98.2
	430	100 m W. of E side of Lot #72	-1.0	Silty Clay	1904	13.8	102	1922	12.4	99.1
	431	40 m E. of W side of Lot #17	-1.0	Silty Clay	1916	13.7	102	1922	12.4	99.7
	432	80 m E. of W side of Lot #17	-1.0	Silty Clay	1920	13.1	102	1922	12.4	99.9
	433	40 m E. of W side of Lot #181	-1.0	Silty Clay	1753	13.1	102	1922	12.4	* 91.2
	434	80 m E. of W side of Lot #181	-1.0	Silty Clay	1724	13.2	102	1922	12.4	* 89.7

M&B TECHNICAL TESTING SERVICES LTD.
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25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	* 435	**Retest of Test # 433**	-1.0	Silty Clay	1891	13.7	102	1922	12.4	98.4
	* 436	**Retest of Test # 434**	-1.0	Silty Clay	1897	13.3	102	1922	12.4	98.7
	437	20 m N, of S side of Lot #129	-2.0	Silty Clay	1899	14.1	102	1922	12.4	98.8
	438	20 m W, of E side of Lot #129	-2.0	Silty Clay	1887	13.9	102	1922	12.4	98.2
	* Test # 425, 426, 435 & 436 represents retest of test # 423, 424, 433 & 434 after further compaction effort was applied.									

SW of Lot #129, W of MH 13 & 14, W of Lot #172 & #72 **Removal of Water, Storm & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 21 am	439	20 m SW, of E side of Lot #129	-1.5	Silty Clay	1871	9.8	102	1922	12.4	* 97.3
	440	40 m SW, of E side of Lot #129	-1.5	Silty Clay	1910	9.7	102	1922	12.4	99.4
	* 441	**Retest of Test # 439**	-1.5	Silty Clay	1884	9.5	102	1922	12.4	98.0
	442	15 m W. of E side of MH14	-2.0	Silty Clay	1914	11.3	102	1922	12.4	99.6
	443	20 m W. 6m N of E side of MH14	-2.0	Silty Clay	1893	12.5	102	1922	12.4	98.5
	444	31 m W. 6m N of E side of MH14	-2.0	Silty Clay	1891	13.0	102	1922	12.4	98.4
	445	33 m W. 5m N of E side of MH14	-2.0	Silty Clay	1891	12.4	102	1922	12.4	98.4
	446	30 m W. of E side of Lot 72	-0.8	Silty Clay	1840	9.6	102	1922	12.4	* 95.7
	447	130 m W. of E side of Lot 72	-0.8	Silty Clay	1876	10.3	102	1922	12.4	97.6
	* 448	**Retest of Test # 446**	-0.8	Silty Clay	1901	10.0	102	1922	12.4	98.9
Jul 21 pm	449	50 m W. of E side of MH13	-1.7	Silty Clay	1895	11.3	102	1922	12.4	98.6
	450	150 m W. of E side of MH13	-1.7	Silty Clay	1860	13.0	102	1922	12.4	* 96.8
	451	250 m W. of E side of MH13	-1.7	Silty Clay	1903	11.6	102	1922	12.4	99.0
	452	300 m W. of E side of MH13	-1.7	Silty Clay	1893	10.5	102	1922	12.4	98.5
	* 453	**Retest of Test # 450**	-1.7	Silty Clay	1882	13.2	102	1922	12.4	97.9
	454	10 m W. of E side of Lot 72	-0.6	Silty Clay	1861	12.9	102	1922	12.4	* 96.8

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Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.C.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
	455	100 m W. of E side of Lot 72	-0.6	Silty Clay	1903	13.6	102	1922	12.4	99.0
	* 456	**Retest of Test # 454**	-0.6	Silty Clay	1892	12.5	102	1922	12.4	98.4
	* Test # 441, 448, 453 & 456 represents retest of test # 439, 446, 450 & 454 after further compaction effort was applied.									

W of Lot #129, W of MH14, W of Lot #63, W of Lot #72 **Removal of Water, Storm & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.C.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
Jul 23 am	457	15 m W. of E side of Lot 129	-1.7	Silty Clay	1832	13.2	102	1922	12.4	95.3
	458	40 m W. of E side of Lot 129	-1.7	Silty Clay	1883	13.9	102	1922	12.4	98.0
	459	20 m W. of E side of MH14	-1.7	Silty Clay	1860	10.7	102	1922	12.4	* 96.8
	460	20 m W. 6m N of E side of MH14	-1.7	Silty Clay	1887	13.6	102	1922	12.4	98.2
	461	31 m W. 6m N of E side of MH14	-1.7	Silty Clay	1901	11.8	102	1922	12.4	98.9
	462	33 m W. 5m N of E side of MH14	-1.7	Silty Clay	1864	13.0	102	1922	12.4	97.0
	* 463	**Retest of Test # 459**	-1.7	Silty Clay	1903	11.0	102	1922	12.4	99.0
	* 464	**Retest of Test # 462**	-1.7	Silty Clay	1899	13.3	102	1922	12.4	98.8
Jul 23 pm	465	250 m W. of E side of Lot 63	0.0	Silty Clay	1907	10.2	102	1922	12.4	99.2
	466	280 m W. of E side of Lot 63	0.0	Silty Clay	1846	12.8	102	1922	12.4	* 96.0
	* 467	**Retest of Test # 466**	0.0	Silty Clay	1879	12.3	102	1922	12.4	97.8
	468	30 m W. of E side of Lot 72	-0.5	Silty Clay	1883	10.9	102	1922	12.4	98.0
	469	130 m W. of E side of Lot 72	-1.0	Silty Clay	1924	9.4	102	1922	12.4	100.1
	470	170 m W. of E side of Lot 72	-1.5	Silty Clay	1873	10.9	102	1922	12.4	* 97.5
	* 471	**Retest of Test # 470**	-1.5	Silty Clay	1889	10.6	102	1922	12.4	98.3
	472	20 m W. of E side of Lot 129	-1.4	Silty Clay	1880	11.8	102	1922	12.4	97.8
	473	40 m W. of E side of Lot 129	-1.4	Silty Clay	1889	11.0	102	1922	12.4	98.3
	* Test # 463, 464, 467 & 471 represents retest of test # 459, 462, 466 & 470 after further compaction effort was applied.									

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OFFICE: 403-243-9733 FAX: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 24		Scheduled Testing cancelled due to wet site conditions								
Jul 25		Scheduled Testing cancelled on site due to wet site conditions								

W of MH-13 & 14, W of Lot #129 — Removal of Water, Storm & Sanitary Lines

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 26 am	474	20 m W. of E of MH13	0.0	Silty Clay	1889	11.2	102	1922	12.4	98.3
	475	100 m W. of E of MH13	0.0	Silty Clay	1904	10.4	102	1922	12.4	99.1
	476	200 m W. of E of MH13	0.0	Silty Clay	1903	10.8	102	1922	12.4	99.0
	477	300 m W. of E of MH13	0.0	Silty Clay	1854	11.4	102	1922	12.4	* 96.5
	* 478	**Retest of Test # 477**	0.0	Silty Clay	1902	11.1	102	1922	12.4	99.0
Jul 26 pm	479	23 m W. of E of MH14	-1.3	Silty Clay	1864	13.4	102	1922	12.4	* 97.0
	480	23 m W. 8m W of E of MH14	-1.3	Silty Clay	1905	11.3	102	1922	12.4	99.1
	481	36 m W. 8m W of E of MH14	-1.3	Silty Clay	1885	11.9	102	1922	12.4	98.1
	482	36 m W. of E of MH14	-1.3	Silty Clay	1906	12.7	102	1922	12.4	99.2
	* 483	**Retest of Test # 479**	-1.3	Silty Clay	1889	13.0	102	1922	12.4	98.3
	484	10 m W. of E side of Lot 129	-1.3	Silty Clay	1859	12.6	102	1922	12.4	* 96.7
	485	40 m W. of E side of Lot 129	-1.3	Silty Clay	1835	13.8	102	1922	12.4	* 95.5
	* 486	**Retest of Test # 484**	-1.3	Silty Clay	1903	12.4	102	1922	12.4	99.0
	* 487	**Retest of Test # 485**	-1.3	Silty Clay	1897	12.9	102	1922	12.4	98.7
	* Test # 478, 483, 486 & 487 represents retest of test # 477, 479, 484 & 485 after further compaction effort was applied.									

W of MH-14/ W of Lot #63 & 129, N of Lot #118 — Removal of Water, Storm & Sanitary Lines

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 27 am	488	15 m W. of E side of Lot 129	-1.0	Silty Clay	1889	9.7	101	1922	12.4	98.3
	489	23 m W. of E side of Lot 129	-1.0	Silty Clay	1888	10.3	101	1922	12.4	98.2
	490	23 m W. 7m N of E side of Lot 129	-1.0	Silty Clay	1855	13.9	101	1922	12.4	* 96.5

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Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	* 491	**Retest of Test # 490**	-1.0	Silty Clay	1910	12.5	101	1922	12.4	99.4
	492	13 m W. of E of MH14	-1.0	Silty Clay	1889	11.2	101	1922	12.4	98.3
	493	23 m W, 8m N of E of MH14	-1.0	Silty Clay	1914	10.6	101	1922	12.4	99.6
	494	35 m W. of E of MH14	-1.0	Silty Clay	1825	12.3	101	1922	12.4	* 95.0
	495	35 m W, 8m N of E of MH14	-1.0	Silty Clay	1906	11.5	101	1922	12.4	99.2
	* 496	**Retest of Test # 494**	-1.0	Silty Clay	1876	12.0	101	1922	12.4	97.6
	497	120 m W of E side of Lot # 72	-0.3	Silty Clay	1850	11.6	101	1922	12.4	* 96.3
	498	180 m W of E side of Lot # 72	-0.3	Silty Clay	1823	10.4	101	1922	12.4	94.8
	* 499	**Retest of Test # 497**	-0.3	Silty Clay	1895	11.8	101	1922	12.4	98.6
Jul 27 pm	500	12 m N of S side of Lot # 118	-2.0	Silty Clay	1830	14.2	101	1922	12.4	* 95.2
	501	12 m N, 12m W of S side of Lot # 118	-2.0	Silty Clay	1866	14.6	101	1922	12.4	* 97.1
	502	35 m N. of S side of Lot # 118	-2.0	Silty Clay	1803	15.7	101	1922	12.4	* 93.8
	* 503	**Retest of Test # 500**	-2.0	Silty Clay	1901	13.7	101	1922	12.4	98.9
	* 504	**Retest of Test # 501**	-2.0	Silty Clay	1883	14.0	101	1922	12.4	98.0
	* 505	**Retest of Test # 502**	-2.0	Silty Clay	1906	14.6	101	1922	12.4	99.2
	506	200 m W. of E side of Lot # 63	-0.3	Silty Clay	1884	15.3	101	1922	12.4	98.0
	507	250 m W. of E side of Lot # 63	-0.3	Silty Clay	1828	14.0	101	1922	12.4	* 95.1
	* 508	**Retest of Test # 507**	-0.3	Silty Clay	1878	14.3	101	1922	12.4	97.7
Jul 27 pm	509	15 m W. of E of MH14	-0.7	Silty Clay	1824	13.7	101	1922	12.4	* 94.9
	510	30 m W. of E of MH14	-0.7	Silty Clay	1849	13.0	101	1922	12.4	* 96.2
	511	30 m W, 10m N of E of MH14	-0.7	Silty Clay	1880	11.9	101	1922	12.4	97.8
	* 512	**Retest of Test # 509**	-0.7	Silty Clay	1899	13.3	101	1922	12.4	98.8

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25 YEARS M&B 1993-2018
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Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	* 513	**Retest of Test # 510**	-0.7	Silty Clay	1904	12.9	101	1922	12.4	99.1
	* Test # 491, 496, 499, 503, 504, 505, 508, 512, 513 represents retest of test # 490, 494, 497, 500, 501, 502, 507, 509, 510 after further compaction effort was applied.									

N of Lot #118/ W of Lot #129/ W of MH-14 — **Removal of Water, Storm & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 28 am	514	9 m N. of S side of Lot # 118	-1.7	Silty Clay	1852	13.6	102	1922	12.4	* 96.4
	515	9 m N. 12m W of S side of Lot # 118	-1.7	Silty Clay	1845	13.9	102	1922	12.4	* 96.0
	516	35 m N. of S side of Lot # 118	-1.7	Silty Clay	1835	12.7	102	1922	12.4	95.5
	517	9 m N, 3m E of S side of Lot # 118	-1.7	Silty Clay	1879	11.3	102	1922	12.4	97.8
	* 518	**Retest of Test # 514**	-1.7	Silty Clay	1882	13.0	102	1922	12.4	97.9
	* 519	**Retest of Test # 515**	-1.7	Silty Clay	1875	14.5	102	1922	12.4	97.6
	520	15 m W. of E side of Lot # 129	-0.7	Silty Clay	1855	11.5	102	1922	12.4	* 96.5
	521	25 m W. of E side of Lot # 129	-0.7	Silty Clay	1835	10.9	102	1922	12.4	* 95.5
	522	24 m W. 8m N of S side of Lot # 129	-0.7	Silty Clay	1858	12.0	102	1922	12.4	* 96.7
	* 523	**Retest of Test # 520**	-0.7	Silty Clay	1901	11.1	102	1922	12.4	98.9
	* 524	**Retest of Test # 521**	-0.7	Silty Clay	1889	11.8	102	1922	12.4	98.3
	* 525	**Retest of Test # 522**	-0.7	Silty Clay	1878	11.8	102	1922	12.4	97.7
	526	15 m W. of E of MH14	-0.4	Silty Clay	1925	9.5	102	1951	11.5	98.7
	527	30 m W. 10m N of E of MH14	-0.4	Silty Clay	1861	10.6	102	1922	12.4	* 96.8
	* 528	**Retest of Test # 527**	-0.4	Silty Clay	1885	10.2	102	1922	12.4	98.1
	* Test # 518, 519, 523, 524, 525, 528 represents retest of test # 514, 515, 520, 521, 522, 527 after further compaction effort was applied.									

W of Lot #129, N of Lot #118 — **Removal of Water, Storm & Sanitary Lines**

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Jul 30 am	529	16 m W. of E side of Lot # 129	0.0	Silty Clay	1911	9.2	102	1951	11.5	97.9
	530	22 m W. of E side of Lot # 129	0.0	Silty Clay	1931	10.6	102	1951	11.5	99.0

M&B TECHNICAL TESTING SERVICES LTD. Est. 1993

25 YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	531	4 m N. of S side of Lot # 118	-1.4	Silty Clay	1844	9.8	102	1922	12.4	* 95.9
	532	4 m N. 11m W of S side of Lot # 118	-1.4	Silty Clay	1855	10.4	102	1922	12.4	* 96.5
	533	33 m N. of S side of Lot # 118	-1.4	Silty Clay	1908	10.1	102	1922	12.4	99.3
	534	17 m N. of S side of Lot # 118	-1.4	Silty Clay	1899	9.5	102	1922	12.4	98.8
	* 535	**Retest of Test # 531**	-1.4	Silty Clay	1897	9.8	102	1922	12.4	98.7
	* 536	**Retest of Test # 532**	-1.4	Silty Clay	1884	10.6	102	1922	12.4	98.0
Jul 30 pm	537	10 m N. of S side of Lot # 118	0.0	Silty Clay	1885	9.7	102	1922	12.4	98.1
	538	35 m N. of S side of Lot # 118	0.0	Silty Clay	1879	9.5	102	1922	12.4	97.8
	539	10 m N. 12m W of S side of Lot # 118	-1.0	Silty Clay	1854	10.0	102	1922	12.4	* 96.5
	* 540	**Retest of Test # 539**	-1.0	Silty Clay	1899	9.5	102	1922	12.4	98.8
	541	350 m W. of S side of Lot # 118	-0.3	Silty Clay	1847	11.2	102	1922	12.4	* 96.1
	* 542	**Retest of Test # 541**	-0.3	Silty Clay	1884	11.5	102	1922	12.4	98.0
	* Test # 535, 536, 540, 542 represents retest of test # 531, 532, 539, 541 after further compaction effort was applied.									

W of Lot #1 & Lot #72 **Removal of Water, Storm & Sanitary Lines**

July 31	Schedule am Testing cancelled on site.									
July 31	543	200 m W. of E side of Lot # 72	-1.0	Silty Clay	1810	11.3	102	1922	12.4	* 94.2
	544	220 m W. of E side of Lot # 72	-1.0	Silty Clay	1885	11.8	102	1922	12.4	98.1
	* 545	**Retest of Test # 543**	-1.0	Silty Clay	1901	11.6	102	1922	12.4	98.9
	546	15 m W. of E side of front gate Lot #1	-2.0	Silty Clay	1833	14.9	102	1922	12.4	* 95.4
	547	75 m W. of E side of front gate Lot #1	-2.0	Silty Clay	1811	15.2	102	1922	12.4	* 94.2
	* 548	**Retest of Test # 546**	-2.0	Silty Clay	1897	14.8	102	1922	12.4	98.7
	* 549	**Retest of Test # 547**	-2.0	Silty Clay	1885	14.9	102	1922	12.4	98.1

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3%

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	550	35 m W, 10m N of E side of front gate Lot #1	-2.0	Silty Clay	1849	15.4	102	1922	12.4	* 96.2
	551	35 m W, 90m N of E side of front gate Lot #1	-2.0	Silty Clay	1938	9.9	102	1951	11.5	99.3
	* 552	**Retest of Test # 550**	-2.0	Silty Clay	1880	15.2	102	1922	12.4	97.8
	* Test # 545, 548, 549, 552 represents retest of test # 543, 546, 547, 550 after further compaction effort was applied.									

M&B TECHNICAL TESTING SERVICES LTD.
11551 – 42nd Street S.E.
Calgary, Alberta T2Z 4K4
office (403)243-9733
fax (403)243-9736

MOISTURE DENSITY (PROCTOR) RELATIONSHIP

Project: Midfield Mobile Home Park
954 - 16 Avenue NE
(5318237)

Project #: 18-06-001

Date : July 4, 2018 **Technician:** C.M.

Client: Wilco Contractors Southwest Inc.

Sample #: 102
Location: Site - N of Lot 62

Sample Description: Silty Clay, trace of gravel

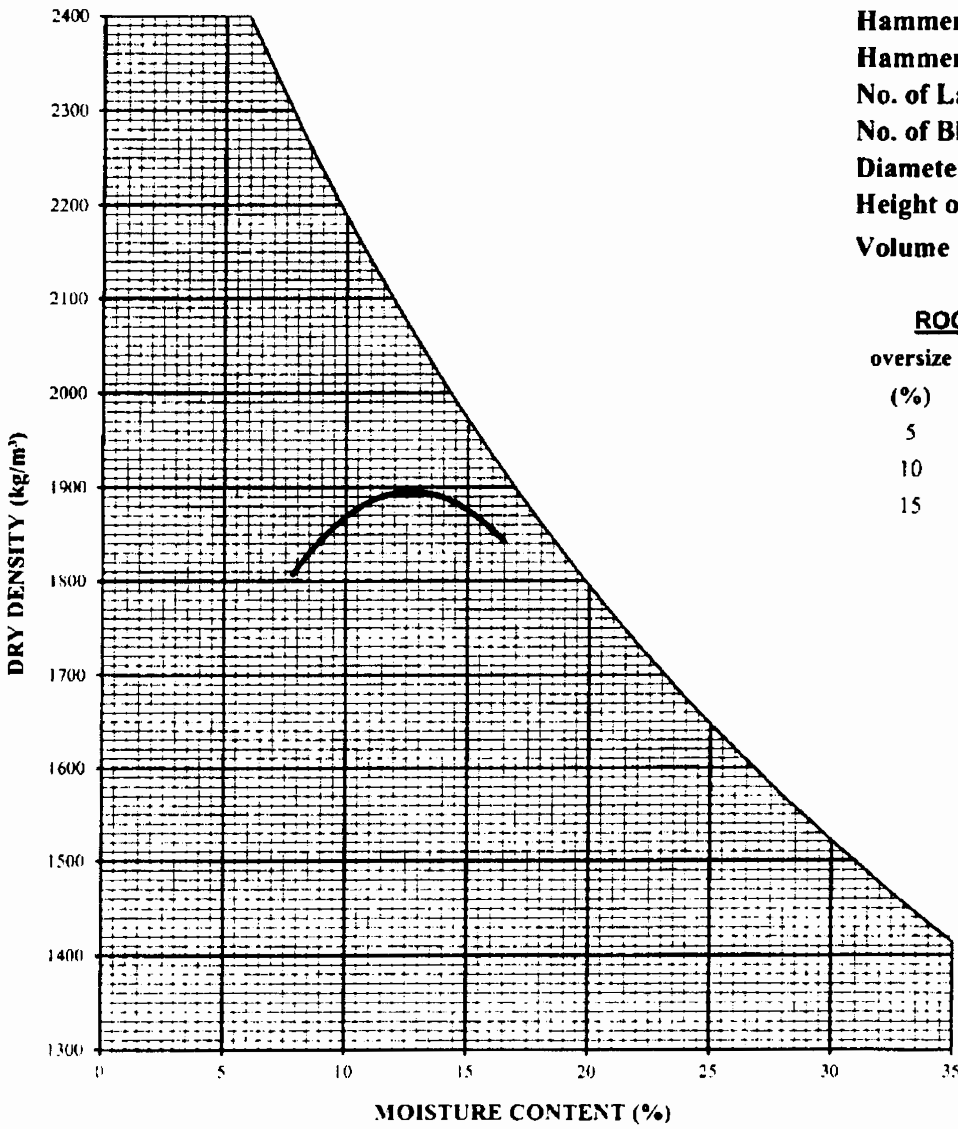
Source:

Minimum Dry Density (kg/m3)
Maximum Dry Density (kg/m3) 1895
Optimum Moisture Content: (%) 13.0
Natural Moisture Content: (%)
Compaction Standard: ASTM D 698
Method 'A'

Hammer Weight:	2.5	kg
Hammer Drop	305	mm
No. of Layers	3	
No. of Blows/Layer:	25	
Diameter of Mold:	102	mm
Height of Mold:	116	mm
Volume of Mold:	0.000943	m^3

ROCK CORRECTIONS

oversize (%)	dry density (kg/m^3)	moisture (%)
5	1922	12.4
10	1951	11.9
15	1980	11.3



All tests performed in accordance with ASTM Standard D698, D1557, or D2049 unless otherwise noted.

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

M&B 25 YEARS 1993-2018

11551 - 42 Street SE. Calgary. AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736
Email: office@mbtechtesting.com

September 17, 2018

Project No. 18-06-005

WILCO CONTRACTORS SOUTHWEST INC.
4700 - 110 Avenue S.E.
Calgary, AB
T2C 2T8

ATTENTION: MR. MICHAEL HEGARTY

RE: MIDFIELD MOBILE HOME PARK
COMPACTION & CONCRETE TESTING & INSPECTION – AUGUST 2018

Dear Sir,

Please find enclosed compaction test reports for the above listed project. As indicated from the density testing conducted, the material placed agrees with project requirements.

If you have any questions, or require any additional information, please contact this office.

Respectfully submitted,

M & B TECHNICAL TESTING SERVICES LTD.

Mike O'Connor, P.Tech.(Eng.)

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Removal of Water & Sanitary Line

Lot #1, Lot #72

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Aug 01 am	553	15 m W, of E side of front gate Lot #1	-1.7	Silty Clay	1883	11.8	102	1922	12.4	98.0
	554	75 m W, of E side of front gate Lot #1	-1.7	Silty Clay	1844	11.3	102	1922	12.4	* 95.9
	555	35 m W, 10m N of E side of front gate Lot #1	-1.7	Silty Clay	1893	13.9	102	1922	12.4	98.5
	556	35 m W, 30m N of E side of front gate Lot #1	-0.5	Silty Clay	1864	14.9	102	1922	12.4	* 97.0
	557	35 m W, 90m N of E side of front gate Lot #1	-0.3	Silty Clay	1937	9.0	102	1922	12.4	100.8
	* 558	**Retest of Test #554**	-1.7	Silty Clay	1908	11.5	102	1922	12.4	99.3
	* 559	**Retest of Test #556**	-0.5	Silty Clay	1922	14.0	102	1922	12.4	100.0
Aug 01 pm	560	15 m W, of E side of front gate Lot #1	-1.5	Silty Clay	1895	11.6	102	1922	12.4	98.6
	561	75 m W, of E side of front gate Lot #1	-1.5	Silty Clay	1841	10.8	102	1922	12.4	* 95.8
	562	30 m W, 12m N of E side of front gate Lot #1	-2.0	Silty Clay	1847	15.4	102	1922	12.4	* 96.1
	563	30 m W, 6m N, 10m E of E side of front gate Lot #1	-2.0	Silty Clay	1850	14.4	102	1922	12.4	* 96.3
	564	30 m W, 32m N, 7m W of E side of front gate Lot #1	-2.0	Silty Clay	1921	13.3	102	1922	12.4	99.9
	* 565	**Retest of Test #561**	-1.5	Silty Clay	1899	11.0	102	1922	12.4	98.8
	* 566	**Retest of Test #562**	-2.0	Silty Clay	1902	15.2	102	1922	12.4	99.0
	* 567	**Retest of Test #563**	-2.0	Silty Clay	1885	14.6	102	1922	12.4	98.1
Aug 01 pm	568	30 m W, 6m N, 12m E of E side of front gate Lot #1	-2.0	Silty Clay	1789	16.1	102	1922	12.4	* 93.1
	569	30 m W, 15m N of E side of front gate Lot #1	-2.0	Silty Clay	1890	12.0	102	1922	12.4	98.3
	570	30 m W, 32m N, 7m W of E side of front gate Lot #1	-2.0	Silty Clay	1906	12.4	102	1922	12.4	99.2
	571	35 m W, 10m N of E side of front gate Lot #1	-1.4	Silty Clay	1839	13.2	102	1922	12.4	* 95.7
	572	35 m W, 30m N of E side of front gate Lot #1	-0.3	Silty Clay	1880	14.0	102	1922	12.4	97.8

M&B TECHNICAL TESTING SERVICES LTD.
EST. 1993

25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
	573	35 m W. 90m N of E side of front gate Lot #1	0.0	Silty Clay	1908	10.6	102	1922	12.4	99.3
	* 574	**Retest of Test #568**	0.0	Silty Clay	1876	15.5	102	1922	12.4	97.6
	* 575	**Retest of Test #571**	0.0	Silty Clay	1901	13.5	102	1922	12.4	98.9
	576	200 m W. of E side of Lot #72	0.0	Silty Clay	1803	10.8	102	1922	12.4	* 93.8
	577	220 m W. of E side of Lot #72	0.0	Silty Clay	1847	10.2	102	1922	12.4	* 96.1
	* 578	**Retest of Test #576**	0.0	Silty Clay	1912	10.7	102	1922	12.4	99.5
	* 579	**Retest of Test #577**	0.0	Silty Clay	1895	9.9	102	1922	12.4	98.6
	* Test # 558, 559, 565, 566, 567, 574, 575, 578, 579 represents retest of test # 554, 556, 561, 562, 563, 568, 571, 576, 577 after further compaction effort was applied.									

Lot #1

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
Aug 02 am	580	35 m W. 15m N of E side of front gate Lot #1	-0.6	Silty Clay	1916	15.5	101	1922	12.6	99.7
	581	35 m W. 30m N of E side of front gate Lot #1	0.0	Silty Clay	1927	14.2	101	1922	12.6	100.3
	582	15 m W of E side of front gate Lot #1	-1.3	Silty Clay	1789	16.9	101	1922	12.6	* 93.1
	583	75 m W of E side of front gate Lot #1	-1.3	Silty Clay	1822	15.5	101	1922	12.6	* 94.8
	584	30 m W. 7m N of E side of front gate Lot #1	-1.7	Silty Clay	1889	10.9	101	1922	12.6	98.3
	585	30 m W. 7m N. 10m E of E side of front gate Lot #1	-1.7	Silty Clay	1893	11.9	101	1922	12.6	98.5
	586	30 m W. 32m N of E side of front gate Lot #1	-1.7	Silty Clay	1837	14.6	101	1922	12.6	* 95.6
	* 587	**Retest of Test #582**	-1.3	Silty Clay	1887	15.3	101	1922	12.6	98.2
	* 588	**Retest of Test #583**	-1.3	Silty Clay	1897	15.3	101	1922	12.6	98.7
	* 589	**Retest of Test #586**	-1.7	Silty Clay	1914	14.0	101	1922	12.6	99.6
Aug 02 pm	590	15 m W of E side of front gate Lot #1	-1.0	Silty Clay	1904	14.9	101	1922	12.6	99.1
	591	75 m W of E side of front gate Lot #1	-1.0	Silty Clay	1881	15.9	101	1922	12.6	97.9
	592	35 m W. 10m N of E side of front gate Lot #1	-0.3	Silty Clay	1835	13.0	101	1922	12.6	* 95.5

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	593	30 m W. 10m N of E side of front gate Lot #1	-1.4	Silty Clay	1810	14.7	101	1922	12.6	* 94.2
	594	30 m W. 10m N. 10m E of E side of front gate Lot #1	-1.4	Silty Clay	1889	14.0	101	1922	12.6	98.3
	595	30 m W. 30m N. 7m E of E side of front gate Lot #1	-1.4	Silty Clay	1901	15.0	101	1922	12.6	98.9
	* 596	**Retest of Test #592**	-0.3	Silty Clay	1883	13.5	101	1922	12.6	98.0
	* 597	**Retest of Test #593**	-1.4	Silty Clay	1876	14.9	101	1922	12.6	97.6
Aug 02 pm		Site was shutdown due to weather 3:30pm								
	* Test # 587, 588, 589, 596, 597 represents retest of test # 582, 583, 586, 592, 593 after further compaction effort was applied.									
Aug 03	Scheduled texting cancelled on site due to wet site comditions									

Lot #1

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Aug 07 am	598	15 m W of E side of front gate Lot #1	-0.6	Silty Clay	1932	10.4	102	1922	12.4	100.5
	599	75 m W of E side of front gate Lot #1	-0.6	Silty Clay	1908	12.9	102	1922	12.4	99.3
	600	30 m W. 8m N of E side of front gate Lot #1	-1.0	Silty Clay	1862	13.7	102	1922	12.4	* 96.9
	601	30 m W. 8m N. 12m E of E side of front gate Lot #1	-1.0	Silty Clay	1883	12.0	102	1922	12.4	98.0
	602	30 m W. 30m N of E side of front gate Lot #1	-1.0	Silty Clay	1918	12.6	102	1922	12.4	99.8
	603	30 m W. 30m N. 7m E of E side of front gate Lot #1	-1.0	Silty Clay	1822	14.6	102	1922	12.4	* 94.8
	* 604	**Retest of Test #600**	-1.0	Silty Clay	1880	13.2	102	1922	12.4	97.8
	* 605	30 **Retest of Test #603**	-1.0	Silty Clay	1885	14.6	102	1922	12.4	98.1
Aug 07 pm	606	15 m W of E side of front gate Lot #1	-0.3	Silty Clay	1901	13.7	102	1922	12.4	98.9
	607	75 m W of E side of front gate Lot #1	-0.3	Silty Clay	1903	11.6	102	1922	12.4	99.0
	608	30 m W. 10m N of E side of front gate Lot #1	-0.7	Silty Clay	1878	13.5	102	1922	12.4	97.7
	609	30 m W. 10m N. 10m E of E side of front gate Lot #1	-0.7	Silty Clay	1864	14.2	102	1922	12.4	* 97.0
	610	30 m W, 30m N of E side of front gate Lot #1	-0.7	Silty Clay	1889	10.3	102	1922	12.4	98.3

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993
25 M&B YEARS 1993-2018
11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	611	30 m W, 30m N, 7m W of E side of front gate Lot #1	-0.7	Silty Clay	1900	12.9	102	1922	12.4	98.9
	* 612	**Retest of Test #609**	-0.7	Silty Clay	1889	14.0	102	1922	12.4	98.3
Aug 07 pm	613	15 m W of E side of front gate Lot #1	0.0	Silty Clay	1876	13.0	102	1922	12.4	97.6
	614	75 m W of E side of front gate Lot #1	0.0	Silty Clay	1900	11.2	102	1922	12.4	98.9
	615	30 m W, 8m N of E side of front gate Lot #1	-0.4	Silty Clay	1841	13.9	102	1922	12.4	* 95.8
	616	30 m W, 8m N, 10m E of E side of front gate Lot #1	-0.4	Silty Clay	1807	12.4	102	1922	12.4	* 94.0
	617	30 m W, 30m N, 10m W of E side of front gate Lot #1	-0.4	Silty Clay	1899	13.6	102	1922	12.4	98.8
	* 618	**Retest of Test #615**	-0.4	Silty Clay	1893	13.0	102	1922	12.4	98.5
	* 619	**Retest of Test #616**	-0.4	Silty Clay	1880	12.2	102	1922	12.4	97.8
	* Test #604, 605, 612, 618, 619 represents retest of test #600, 603, 609, 615, 616 after further compaction effort was applied.									
Lot #1										
Aug 08 am	620	15 m W of E side of front gate Lot #1	0.0	Silty Clay	1889	13.9	102	1922	12.4	98.3
	621	75 m W of E side of front gate Lot #1	0.0	Silty Clay	1831	13.0	102	1922	12.4	* 95.3
	622	30 m W, 15m N of E side of front gate Lot #1	0.0	Silty Clay	1812	11.5	102	1922	12.4	* 94.3
	623	30 m W, 10m N, 10m E of E side of front gate Lot #1	0.0	Silty Clay	1861	13.9	102	1922	12.4	* 96.8
	624	30 m W, 30m N of E side of front gate Lot #1	0.0	Silty Clay	1904	12.6	102	1922	12.4	99.1
	625	30 m W, 30m N, 10m W of E side of front gate Lot #1	0.0	Silty Clay	1899	13.7	102	1922	12.4	98.8
	* 626	**Retest of Test #621**	0.0	Silty Clay	1891	13.0	102	1922	12.4	98.4
	* 627	**Retest of Test #622**	0.0	Silty Clay	1876	12.0	102	1922	12.4	97.6
	* 628	**Retest of Test #623**	0.0	Silty Clay	1889	13.5	102	1922	12.4	98.3
	* Test #626, 627, 628 represents retest of test #621, 622, 623 after further compaction effort was applied.									

Lot #2, #169

M&B TECHNICAL TESTING SERVICES LTD.
Est. 1993

25 M&B YEARS 1993-2018

11551 - 42 Street SE, Calgary, AB T2Z 4K4
Office: 403-243-9733 Fax: 403-243-9736

Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Aug 09 am	629	5 m N of S side of front gate Lot #2	-2.0	Silty Clay	1810	12.8	102	1922	12.4	* 94.2
	630	10 m N of S side of front gate Lot #2	-2.0	Silty Clay	1848	13.8	102	1922	12.4	* 96.1
	631	15 m N of S side of front gate Lot #2	-1.5	Silty Clay	1891	13.0	102	1922	12.4	98.4
	* 632	**Retest of Test #629**	-2.0	Silty Clay	1901	12.6	102	1922	12.4	98.9
	* 633	**Retest of Test #630**	-2.0	Silty Clay	1893	13.5	102	1922	12.4	98.5
Aug 09 pm	634	6 m N of S side of front gate Lot #2	-1.5	Silty Clay	1908	11.3	102	1922	12.4	99.3
	635	15 m N of S side of front gate Lot #2	-1.5	Silty Clay	1891	13.0	102	1922	12.4	98.4
	636	26 m N of S side of front gate Lot #2	-1.2	Silty Clay	1922	9.7	102	1922	12.4	100.0
Aug 09 pm	637	6 m N of S side of front gate Lot #2	-1.3	Silty Clay	1812	14.8	102	1922	12.4	* 94.3
	638	15 m N of S side of front gate Lot #2	-1.3	Silty Clay	1858	13.5	102	1922	12.4	* 96.7
	639	25 m N of S side of front gate Lot #2	-0.9	Silty Clay	1845	14.0	102	1922	12.4	* 96.0
	640	10 m S of N side of Lot #169	-2.0	Silty Clay	1829	8.5	102	1922	12.4	* 95.2
	641	30 m S of N side of Lot #169	-2.0	Silty Clay	1885	9.3	102	1922	12.4	98.1
	* 642	**Retest of Test #637**	-1.3	Silty Clay	1875	14.5	102	1922	12.4	97.6
	* 643	**Retest of Test #638**	-1.3	Silty Clay	1900	13.0	102	1922	12.4	98.9
	* 644	**Retest of Test #639**	-0.9	Silty Clay	1883	13.8	102	1922	12.4	98.0
	* 645	**Retest of Test #640**	-2.0	Silty Clay	1902	8.9	102	1922	12.4	99.0
	* Test #632, 633, 642, 643, 644, 645 represents retest of test #629, 630, 637, 638, 639, 640 after further compaction effort was applied.									

Lot #2, #169

Aug 10 am	646	5 m N of S side of front gate Lot #2	-0.9	Silty Clay	1896	12.7	102	1922	12.4	98.6
	647	12 m N of S side of front gate Lot #2	-0.9	Silty Clay	1845	12.2	102	1922	12.4	* 96.0
	648	26 m N of S side of front gate Lot #2	-0.6	Silty Clay	1883	11.6	102	1922	12.4	* 98.0

M&B TECHNICAL TESTING SERVICES LTD. Est. 1993

25 M&B YEARS 1993-2018

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Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N 39134, Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	649	10 m S of N side of front gate Lot #169	-1.6	Silty Clay	1862	8.9	102	1922	12.4	96.9
	650	30 m S of N side of front gate Lot #169	-1.6	Silty Clay	1887	9.3	102	1922	12.4	98.2
	* 651	**Retest of Test #647**	-0.9	Silty Clay	1889	12.0	102	1922	12.4	98.3
	* 652	**Retest of Test #649**	-1.6	Silty Clay	1897	8.5	102	1922	12.4	98.7
Aug 10 pm	653	5 m N of S side of front gate Lot #2	-0.6	Silty Clay	1831	13.0	102	1922	12.4	* 95.3
	654	15 m N of S side of front gate Lot #2	-0.6	Silty Clay	1866	13.2	102	1922	12.4	* 97.1
	655	25 m N of S side of front gate Lot #2	-0.3	Silty Clay	1901	12.5	102	1922	12.4	98.9
	656	10 m S of N side of front gate Lot #169	-1.3	Silty Clay	1816	12.8	102	1922	12.4	* 94.5
	657	30 m S of N side of front gate Lot #169	-1.3	Silty Clay	1851	12.0	102	1922	12.4	* 96.3
	* 658	**Retest of Test #653**	-0.6	Silty Clay	1880	12.8	102	1922	12.4	97.8
	* 659	**Retest of Test #654**	-0.6	Silty Clay	1889	13.2	102	1922	12.4	98.3
	* 660	**Retest of Test #656**	-1.3	Silty Clay	1884	12.6	102	1922	12.4	98.0
	* 661	**Retest of Test #657**	-1.3	Silty Clay	1893	11.5	102	1922	12.4	98.5
Aug 10 pm	662	5 m N of S side of front gate Lot #2	-0.3	Silty Clay	1853	11.9	102	1922	12.4	* 96.4
	663	12 m N of S side of front gate Lot #2	-0.3	Silty Clay	1891	12.5	102	1922	12.4	98.4
	664	26 m N of S side of front gate Lot #2	0.0	Silty Clay	1883	13.1	102	1922	12.4	98.0
	665	10 m S of N side of front gate Lot #169	-1.0	Silty Clay	1912	9.7	102	1922	12.4	99.5
	666	30 m S of N side of front gate Lot #169	-1.0	Silty Clay	1897	9.3	102	1922	12.4	98.7
	* 667	**Retest of Test #662**	-0.3	Silty Clay	1889	11.5	102	1922	12.4	98.3
	* Test #651, 652, 658, 659, 660, 661, 667 represents retest of test #647, 649, 653, 654, 656, 657, 662 after further compaction effort was applied.									

Lot #2, #3, #169

Aug 11 am	668	10 m S of N side of front gate Lot #169	-0.3	Silty Clay	1849	9.5	102	1922	12.4	* 96.2

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M&B 25 YEARS 1993-2018
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Office: 403-243-9733 Fax: 403-243-9736

Project:	Midfield Mobile Home Park 954 - 16 Avenue NE	M&B Project #: 18-06-005	
Job #:	5318237		
Client:	Wilco Contractors Southwest Inc.	Minimum Specified Compaction:	98%
Contractor:	Wilco Contractors Southwest Inc.	Moisture Content:	Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Procto Sample #	Proctor Density (kg/m³)	Opt. Wate (%)	Compaction Level (%)
	669	30 m S of N side of front gate Lot #169	-0.3	Silty Clay	1893	8.9	102	1922	12.4	98.5
	670	5 m N of S side of front gate Lot #2	0.0	Silty Clay	1815	10.5	102	1922	12.4	* 94.4
	671	15 m N of S side of front gate Lot #2	0.0	Silty Clay	1824	10.1	102	1922	12.4	* 94.9
	672	26 m N of S side of front gate Lot #2	0.0	Silty Clay	1829	12.0	102	1922	12.4	* 95.2
	* 673	**Retest of Test #668**	-0.3	Silty Clay	1889	9.0	102	1922	12.4	98.3
	* 674	**Retest of Test #670**	0.0	Silty Clay	1879	10.3	102	1922	12.4	97.8
	* 675	**Retest of Test #671**	0.0	Silty Clay	1885	10.5	102	1922	12.4	98.1
	* 676	**Retest of Test #672**	0.0	Silty Clay	1881	10.2	102	1922	12.4	97.9
Aug 11 pm	677	4 m N of S side of front gate Lot #3	-1.7	Silty Clay	1875	14.2	102	1922	12.4	97.6
	678	12 m N of S side of front gate Lot #3	-1.7	Silty Clay	1806	14.8	102	1922	12.4	* 94.0
	679	26 m N of S side of front gate Lot #3	-1.7	Silty Clay	1860	13.7	102	1922	12.4	* 96.8
	* 680	**Retest of Test #678**	-1.7	Silty Clay	1878	14.5	102	1922	12.4	97.7
	* 681	**Retest of Test #679**	-1.7	Silty Clay	1887	13.5	102	1922	12.4	98.2
	* Test #673, 674, 675, 676, 680, 681 represents retest of test #668, 670, 671, 672, 678, 679 after further compaction effort was applied.									

Lot #3, #169, #171, #172

Aug 13 am	682	4 m N of S side of front gate Lot #3	-1.4	Silty Clay	1864	11.9	102	1922	12.4	* 97.0
	683	12 m N of S side of front gate Lot #3	-1.4	Silty Clay	1831	12.9	102	1922	12.4	* 95.3
	684	26 m N of S side of front gate Lot #3	-1.4	Silty Clay	1843	11.6	102	1922	12.4	* 95.9
	* 685	**Retest of Test #682**	-1.4	Silty Clay	1899	11.6	102	1922	12.4	98.8
	* 686	**Retest of Test #683**	-1.4	Silty Clay	1839	12.5	102	1922	12.4	95.7
	* 687	**Retest of Test #684**	-1.4	Silty Clay	1880	11.4	102	1922	12.4	97.8
Aug 13 pm	688	4 m N of S side of front gate Lot #3	-1.0	Silty Clay	1851	10.9	102	1922	12.4	* 96.3

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Project: Midfield Mobile Home Park
954 - 16 Avenue NE

M&B Project #: 18-06-005

Job #: 5318237

Client: Wilco Contractors Southwest Inc.

Minimum Specified Compaction: 98%

Contractor: Wilco Contractors Southwest Inc.

Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	689	12 m N of S side of front gate Lot #3	-1.0	Silty Clay	1843	12.0	102	1922	12.4	* 95.9
	690	26 m N of S side of front gate Lot #3	-1.0	Silty Clay	1875	12.2	102	1922	12.4	97.6
	* 691	**Retest of Test #688**	-1.0	Silty Clay	1897	10.5	102	1922	12.4	98.7
	* 692	**Retest of Test #689**	-1.0	Silty Clay	1881	12.2	102	1922	12.4	97.9
	693	15 m S of N side of front gate Lot #169	-0.3	Silty Clay	1832	13.1	102	1922	12.4	* 95.3
	694	35 m S of N side of front gate Lot #169	-0.3	Silty Clay	1862	12.5	102	1922	12.4	* 96.9
	* 695	**Retest of Test #693**	-0.3	Silty Clay	1889	12.8	102	1922	12.4	98.3
	* 696	**Retest of Test #694**	-0.3	Silty Clay	1883	12.1	102	1922	12.4	98.0
Aug 13 pm	697	10 m S of N side of front gate Lot #169	0.0	Silty Clay	1837	11.8	102	1922	12.4	* 95.6
	698	25 m S of N side of front gate Lot #169	0.0	Silty Clay	1787	12.9	102	1922	12.4	* 93.0
	699	40 m S of N side of front gate Lot #169	0.0	Silty Clay	1824	12.5	102	1922	12.4	* 94.9
	* 700	**Retest of Test #697**	0.0	Silty Clay	1881	11.5	102	1922	12.4	97.9
	* 701	**Retest of Test #698**	0.0	Silty Clay	1873	12.3	102	1922	12.4	97.5
	* 702	**Retest of Test #699**	0.0	Silty Clay	1893	12.3	102	1922	12.4	98.5
	703	10 m N of S side of front gate Lot #3	-0.7	Silty Clay	1889	10.5	102	1922	12.4	98.3
	704	22 m N of S side of front gate Lot #3	-0.7	Silty Clay	1904	10.1	102	1922	12.4	99.1
	705	15 m N of S side of front gate Lot #171	-1.5	Silty Clay	1804	13.5	102	1922	12.4	* 93.9
	706	15 m N of S side of front gate Lot #172	-1.5	Silty Clay	1845	12.8	102	1922	12.4	* 96.0
	* 707	**Retest of Test #705**	-1.5	Silty Clay	1880	13.0	102	1922	12.4	97.8
	* 708	**Retest of Test #706**	-1.5	Silty Clay	1893	12.3	102	1922	12.4	98.5

* Test #685, 686, 687, 691, 692, 695, 696, 700, 701, 702,707, 708 represents retest of test #682, 683, 684, 688, 689, 693, 694, 697, 698, 699, 705, 706 after further compaction effort was applied.

* Test # 707 & 708 represents retest of test # 1 to 4 (June 1) after the material at that area was removed, reworked and compacted.

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Job #: 5318237

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Moisture Content: Optimum +/- 3

SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
Lot #3, #169, MH #2, MH #3, MH # 14										
Aug 15 am	709	2 m N of S side of Lot #169	-2.0	Silty Clay	1875	7.8	102	1922	12.4	97.6
	710	5 m N of S side of Lot #169	-2.0	Silty Clay	1860	10.2	102	1922	12.4	* 96.8
	* 711	**Retest of Test #710**	-2.0	Silty Clay	1901	10.5	102	1922	12.4	98.9
	712	1.5 m N of S side of front gate Lot #3	-2.0	Silty Clay	1926	8.1	102	1922	12.4	100.2
	713	5 m N of S side of front gate Lot #3	-1.5	Silty Clay	1808	8.4	102	1922	12.4	* 94.1
	714	12 m N of S side of front gate Lot #3	-0.6	Silty Clay	1899	10.4	102	1922	12.4	* 98.8
	715	22 m N of S side of front gate Lot #3	-0.3	Silty Clay	1851	8.9	102	1922	12.4	* 96.3
	* 716	**Retest of Test #713**	-1.5	Silty Clay	1881	8.5	102	1922	12.4	97.9
	* 717	**Retest of Test #714**	-0.6	Silty Clay	1874	10.0	102	1922	12.4	97.5
	* 718	**Retest of Test #715**	-0.3	Silty Clay	1895	8.4	102	1922	12.4	98.6
Aug 15 pm	719	4 m W MH #14	-2.0	Silty Clay	1931	7.5	102	1922	12.4	100.5
	720	2 m N MH #14	-2.0	Silty Clay	1914	9.1	102	1922	12.4	99.6
	721	2 m N of S side of Lot #169	-1.7	Silty Clay	1885	8.5	102	1922	12.4	98.1
	722	5 m N of S side of Lot #169	-1.7	Silty Clay	1897	7.7	102	1922	12.4	98.7
	723	1.5 m N MH #3	-2.0	Silty Clay	1793	11.3	102	1922	12.4	* 93.3
	724	2 m N MH #3	-2.0	Silty Clay	1781	12.0	102	1922	12.4	* 92.7
	725	4 m N MH #3	-2.0	Silty Clay	1805	11.6	102	1922	12.4	* 93.9
	* 726	**Retest of Test #723**	-2.0	Silty Clay	1899	11.0	102	1922	12.4	98.8
	* 727	**Retest of Test #724**	-2.0	Silty Clay	1882	12.5	102	1922	12.4	97.9
	* 728	**Retest of Test #725**	-2.0	Silty Clay	1903	11.4	102	1922	12.4	99.0
	729	1 m E MH #2	-2.0	Silty Clay	1850	10.0	102	1922	12.4	* 96.3

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SUMMARY of FIELD DENSITY TESTS

Troxler 3430 S.N. 39134. Calibrated 02-02-2017 by Troxler Canada West Inc

Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m^3)	Opt. Water (%)	Compaction Level (%)
	730	5 m E MH #2	-2.0	Silty Clay	1840	11.0	102	1922	12.4	* 95.7
	731	12 m E MH #2	-1.0	Silty Clay	1836	11.6	102	1922	12.4	* 95.5
	732	20 m E MH #2	-0.5	Silty Clay	1901	10.8	102	1922	12.4	98.9
	* 733	**Retest of Test #729**	-2.0	Silty Clay	1895	9.3	102	1922	12.4	98.6
	* 734	**Retest of Test #730**	-2.0	Silty Clay	1882	10.5	102	1922	12.4	97.9
	* 735	**Retest of Test #731**	-1.0	Silty Clay	1879	11.5	102	1922	12.4	97.8
	736	1 m N of S side of front gate Lot #3	-1.5	Silty Clay	1885	9.5	102	1922	12.4	98.1
	737	10 m N of S side of front gate Lot #3	-0.3	Silty Clay	1874	8.1	102	1922	12.4	97.5
	738	22 m N of S side of front gate Lot #3	0.0	Silty Clay	1891	8.9	102	1922	12.4	98.4
Aug 15 pm	739	1 m N of S side of Lot #169	-1.3	Silty Clay	1807	9.7	102	1922	12.4	* 94.0
	740	5 m N of S side of Lot #169	-1.3	Silty Clay	1789	11.2	102	1922	12.4	* 93.1
	* 741	**Retest of Test #739**	-1.3	Silty Clay	1883	10.1	102	1922	12.4	98.0
	* 742	**Retest of Test #740**	-1.3	Silty Clay	1878	11.0	102	1922	12.4	97.7
	743	3 m E MH #3	-1.5	Silty Clay	1886	11.5	102	1922	12.4	98.1
	744	2 m N MH #3	-1.5	Silty Clay	1852	11.1	102	1922	12.4	* 96.4
	745	1.5 m S MH #3	-1.5	Silty Clay	1876	12.2	102	1922	12.4	97.6
	* 746	**Retest of Test #744**	-1.5	Silty Clay	1899	10.7	102	1922	12.4	98.8
	747	1 m N of S side of front gate Lot #3	-0.9	Silty Clay	1878	9.9	102	1922	12.4	97.7
	748	10 m N of S side of front gate Lot #3	0.0	Silty Clay	1912	8.5	102	1922	12.4	99.5
	749	1 m E MH #2	-1.7	Silty Clay	1803	12.8	102	1922	12.4	* 93.8
	750	5 m E MH #2	-1.7	Silty Clay	1881	13.0	102	1922	12.4	97.9
	751	12 m E MH #2	-0.7	Silty Clay	1841	12.1	102	1922	12.4	* 95.8

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SUMMARY of FIELD DENSITY TESTS

Troxler 3430, S.N. 39134, Calibrated 02-02-2017 by Troxler Canada West Inc.

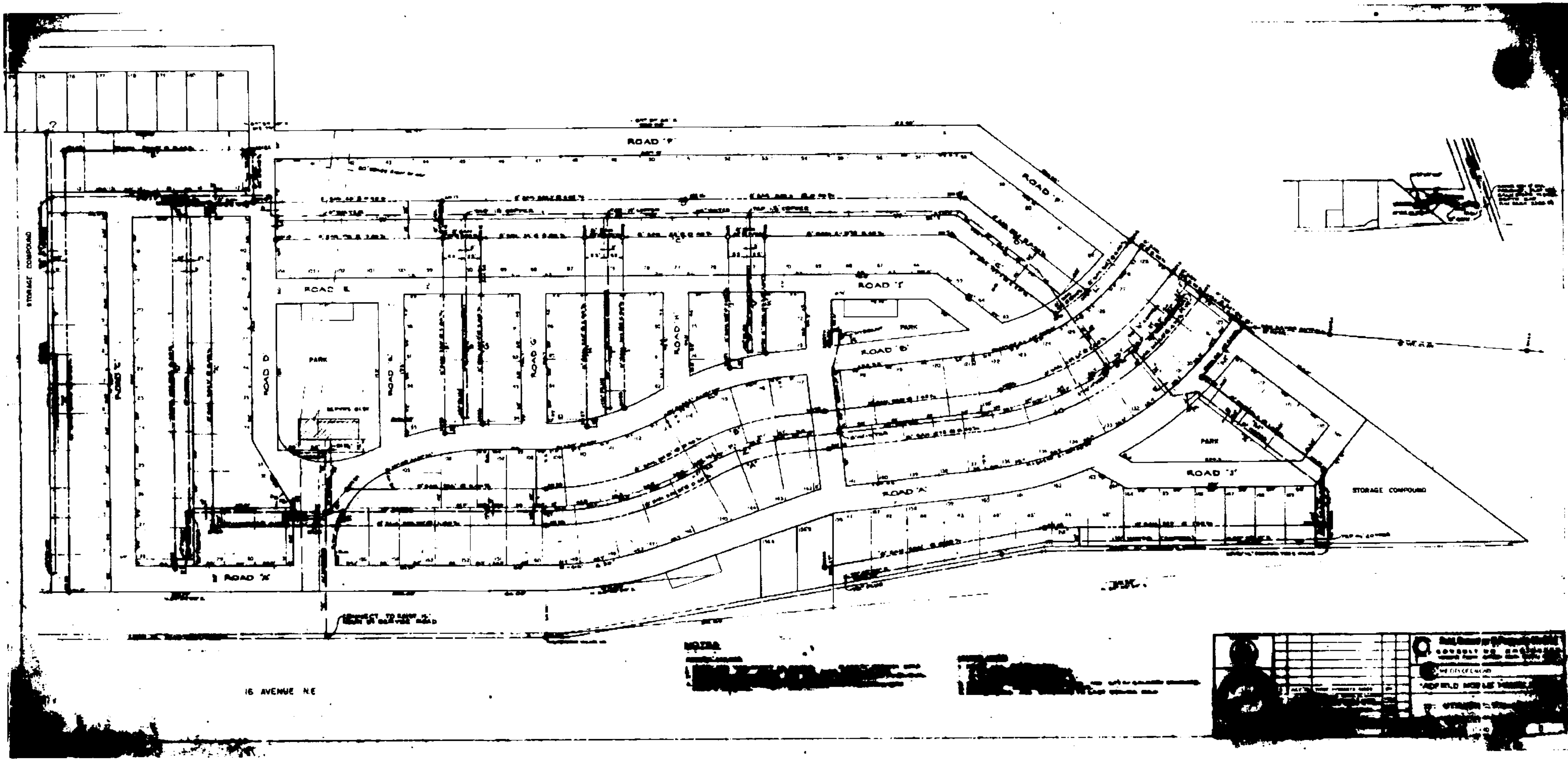
Date 2018	Test #	Location	Elev. (m) T.O.S.G.	Soil Type	Dry Unit Wt. (kg/m3)	Water Content (%)	Proctor Sample #	Proctor Density (kg/m³)	Opt. Water (%)	Compaction Level (%)
	752	20 m E MH #2	-0.3	Silty Clay	1903	10.3	102	1922	12.4	99.0
	* 753	**Retest of Test #749**	-1.7	Silty Clay	1889	12.3	102	1922	12.4	98.3
	* 754	**Retest of Test #751**	-0.7	Silty Clay	1899	11.5	102	1922	12.4	98.8
	* Test #711, 716, 717, 718, 726, 727, 728, 733, 734, 735, 741, 742, 746, 753, 754 represents retest of test #710, 713, 714, 715, 723, 724, 725, 729, 730,731,739, 740, 744, 749,751 after further compaction effort was applied.									

Lot #3, #169, MH #2, MH #3, MH # 14

Aug 16	755	5 m E MH #3	0.0	Silty Clay	1860	12.5	102	1922	12.4	* 96.8
	756	2 m N MH #3	0.0	Silty Clay	1885	11.9	102	1922	12.4	98.1
	757	2 m W MH #3	0.0	Silty Clay	1827	9.8	102	1922	12.4	* 95.1
	* 758	**Retest of Test #755**	0.0	Silty Clay	1901	12.0	102	1922	12.4	98.9
	* 759	**Retest of Test #757**	0.0	Silty Clay	1906	10.2	102	1922	12.4	99.2
	760	1 m E MH #2	0.0	Silty Clay	1918	8.9	102	1922	12.4	99.8
	761	10 m E MH #2	0.0	Silty Clay	1933	9.3	102	1922	12.4	100.6
	762	1 m N MH #14	0.0	Silty Clay	1822	8.7	102	1922	12.4	* 94.8
	763	3 m W MH #14	0.0	Silty Clay	1876	11.2	102	1922	12.4	97.6
	* 764	**Retest of Test #762**	0.0	Silty Clay	1881	8.5	102	1922	12.4	97.9
	765	2 m N of S side of Lot #169	0.0	Silty Clay	1804	10.8	102	1922	12.4	* 93.9
	766	5 m N of S side of Lot #169	0.0	Silty Clay	1839	10.2	102	1922	12.4	* 95.7
	* 767	**Retest of Test #765**	0.0	Silty Clay	1895	10.5	102	1922	12.4	98.6
	* 768	**Retest of Test #766**	0.0	Silty Clay	1881	10.9	102	1922	12.4	97.9
	769	1 m N of S side of front gate Lot #3	0.0	Silty Clay	1889	8.8	102	1922	12.4	98.3
	770	5 m N of S side of front gate Lot #3	0.0	Silty Clay	1899	10.1	102	1922	12.4	98.8
	* Test #758, 759, 764, 767,768 represents retest of test #755, 757, 762, 765, 766 after further compaction effort was applied.									

Midfield Mobile Home Park

DATE PLOTTED NOVEMBER 2017


ROAD 'F'
ROAD 'E'
ROAD 'I'
ROAD 'B'
ROAD 'C'
ROAD D
ROAD 'A'
ROAD 'J'
ROAD 'G'
ROAD 'H'
ROAD 'K'
PARK
STORAGE COMPOUND
16 AVENUE N.E.
NOTES

APPENDIX B
BOREHOLE LOGS

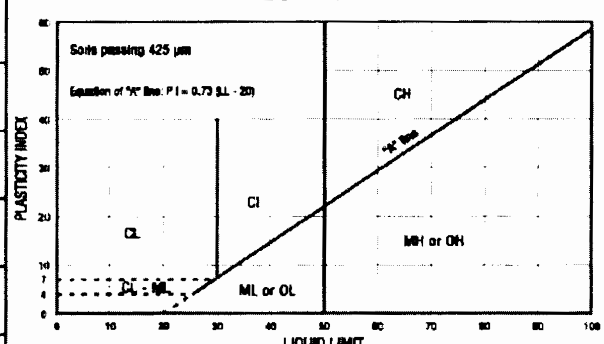
MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE-GRAINED SOILS More than 50% retained on 75 µm sieve*	GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	$C_u = D_{60} / D_{10}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines	Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures	Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures	Atterberg limits plot above "A" line or plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines	$C_u = D_{60}/D_{10}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines	Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures	Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures	Atterberg limits plot above "A" line or plasticity index greater than 7	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 µm sieve*	SILTS	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity		
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts		
	CLAYS Above "A" line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays		
		Liquid limit 30-50	CI	Inorganic clays of medium plasticity, silty clays		
		Liquid limit >50	CH	Inorganic clays of high plasticity, fat clays		
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity		
		Liquid limit >50	OH	Organic clays of medium to high plasticity		
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils		

Classification on basis of percentage of fines:
Less than 5% Pass 75 µm sieve: GW, GP, SW, SP
More than 12% Pass 75 µm sieve: GM, GC, SM, SC
5% to 12% Pass 75 µm sieve: Borderline Classification requiring use of dual symbols

For classification of fine-grained soils and fine fraction of coarse-grained soils.

PLASTICITY CHART



*Based on the material passing the 75 mm sieve
Reference: ASTM Designation D2487, for identification procedure see D2488. USC as modified by PFRA

SOIL COMPONENTS				
FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENTAGE	DESCRIPTOR
GRAVEL coarse	75 mm	19 mm	>35 %	"and"
GRAVEL fine	19 mm	4.75 mm	21 to 35 %	"y-adjective"
SAND coarse	4.75 mm	2.00 mm	10 to 20 %	"some"
SAND medium	2.00 mm	425 µm	>0 to 10 %	"trace"
SAND fine	425 µm	75 µm		
SILT (non plastic) or CLAY (plastic)	75 µm		as above but by behavior	

OVERSIZE MATERIAL	
Rounded or subrounded	
COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm
Not rounded	
ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

TETRA TECH

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075 mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

descriptive term	relative density	n (blows per 0.3 m)
Very Loose	0 to 20%	0 to 4
Loose	20 to 40%	4 to 10
Compact	40 to 75%	10 to 30
Dense	75 to 90%	30 to 50
Very Dense	90 to 100%	greater than 50

The number of blows, N, on a 51 mm O.D. split spoon sampler of a 63.5 kg weight falling 0.76 m, required to drive the sampler a distance of 0.3 m from 0.15 m to 0.45 m.

FINE GRAINED SOILS (major portion passing 0.075 mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

descriptive term	unconfined compressive strength (kPa)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying colour and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.;
Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

TETRA TECH

BOREHOLE KEYSHEET

Water Level Measurement

▼	Measured in standpipe, piezometer or well	▽	Inferred

Sample Types

A-Casing	Core	Disturbed, Bag Grab	HQ Core	Jar
Jar and Bag	NQ Core	No Recovery	Split Spoon/SPT	Tube
CRREL Core				

Backfill Materials

Asphalt	Bentonite	Cement/ Grout	Drill Cuttings	Grout
Gravel	Sand	Slough	Topsoil Backfill	

Lithology - Graphical Legend[1]

Asphalt	Bedrock	Cobbles/Boulders	Clay	Coal
Concrete	Fill	Gravel	Limestone	Mudstone
Organics	Peat	Sand	Sandstone	Shale
Silt	Siltstone	Till	Topsoil	

1 The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale.

TETRA TECH

Calgary

Borehole No: BH19-01

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGEO03639-01
Location: 16 Moncton Road NE	Ground Elev: 1074.385 m
Calgary, Alberta	3TM: -2884.103 E; 5659182.77 N

Method: Solid Stem Auger

Depth (m)	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
0	TOPSOIL - clay, silty, sandy, trace gravel, damp, dark brown, trace organics, trace rootlets				
	CLAY (FILL) - silty, some sand, trace gravel, damp, low plastic, brown, trace oxides				
		Bulk	B1		15
		SPT	S1	11	16.3
		Bulk	B2		
	- dark brown, trace organics, trace wood debris	SPT	S2	9	26
		Bulk	B3		
	- brown				
	- moist	SPT	S3	6	18.5
	- dark brown staining	Bulk	B4		
	- stiff, dark brown, trace rootlets, trace wood debris	SPT	S4	9	30.5
	- brown	Bulk	B5		
	- grey, trace ambient odour	SPT	S5	14	27
	- brown, trace cobbles	Bulk	B6		
	CLAY - silty, sandy, trace gravel, wet, soft, medium plastic, brown, trace oxides, trace coal specks	SPT	S6	4	25.4
10.5		Bulk	B7		

Plastic Limit — Moisture Content — Liquid Limit: 20 40 60 80

■ SPT (N) ■: 20 40 60 80

▲ Pocket Pen. (kPa) ▲: 100 200 300 400

Well

Elevation (m): 1074, 1073, 1072, 1071, 1070, 1069, 1068, 1067, 1066, 1065, 1064

May 1/19

TETRA TECH

Contractor: All Service	Completion Depth: 11.1 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 18
Logged By: IB	Completion Date: 2019 April 18
Reviewed By: KL	Page 1 of 2

GEOTECHNICAL ENG CGEO03639-01.GPJ EBA.GDT 19/06/05

Borehole No: BH19-01

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 16 Moncton Road NE	Ground Elev: 1074.385 m
Calgary, Alberta	3TM: -2884.103 E; 5659182.77 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	■SPT (N)■ 20 40 60 80 / ▲Pocket Pen. (kPa)▲ 100 200 300 400	Well	Elevation (m)
10.5 – 11		- stiff		S7	12	23.6				
11 – 21		END OF HOLE AT 11.1 m. 50 mm standpipe installed to 10.4 m. Groundwater seepage at 9.1 m upon completion. Groundwater seepage at 9.3 m on May 1, 2019.								1063, 1062, 1061, 1060, 1059, 1058, 1057, 1056, 1055, 1054

Depth scale: 10.5, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21

TETRA TECH

Contractor: All Service	Completion Depth: 11.1 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 18
Logged By: IB	Completion Date: 2019 April 18
Reviewed By: KL	Page 2 of 2

GEOTECHNICAL ENG CGE03639-01 GPJ EBA GDT

Borehole No: BH19-02

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 920 16 Avenue NE	Ground Elev: 1075.983 m
Calgary, Alberta	3TM: -2916.126 E; 5659046.157 N

Method: Solid stem auger

Depth (m)	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Elevation (m)
0	TOPSOIL - clay, silty, sandy, trace gravel, damp, dark brown, trace organics, trace rootlets					
	CLAY (FILL) - silty, some sand, trace gravel, damp, low to medium plastic, brown					
1			B1		18.3	1075
	- stiff, trace oxides, trace coal specks		S1	14	14.4	
2	- trace wood debris		B2		15.2	1074
3	CLAY (TILL) - silty, trace to some sand, trace gravel, damp, stiff, low to medium plastic, brown, trace oxides, trace coal specks		S2	11		1073
4			B3		20.4	1072
	- trace sand, low to medium plastic		S3	10		
5			B4		21.3	1071
6 (May 1/19)			S4	13		1070
7			B5		16.1	1069
	- very stiff		S5	16		
8			B6		15.1	1068
9	- damp to moist		S6	19		1067
	END OF HOLE AT 9.6 m. 50 mm standpipe installed to 8.8 m. Dry upon completion. Groundwater seepage at 5.9 m on May 1, 2019.					
10						1066
10.5						

Chart axes: Soluble Sulphates (%) 1 2 3 4; Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80; SPT (N) 20 40 60 80; Well

TETRA TECH

Contractor: All Service	Completion Depth: 9.6 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 22
Logged By: IB	Completion Date: 2019 April 22
Reviewed By: KL	Page 1 of 1

GEOTECHNICAL ENG CGE03639-01.GPJ EBA.GDT 19/06/05

Calgary

Borehole No: BH19-03

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 954 16 Avenue NE	Ground Elev: 1074.827 m
Calgary, Alberta	3TM: -2775.863 E; 5659094.091 N

Method: Solid stem auger

Soil Description

CLAY (FILL) - silty, sandy, trace to some gravel, damp, stiff, low plastic, brown to grey, trace oxides, trace coal specks, trace rootlets

- dark brown, trace ambient odour, paper debris, wood debris

- grey, strong ambient odour

- bluish grey, trace bedrock fragments

- gravel seam, approximately 300 mm thick
Material Proportion in Sample B3
Gravel 61%, Sand 16%, Silt 15%, Clay 8%

- trace rootlets, wood debris

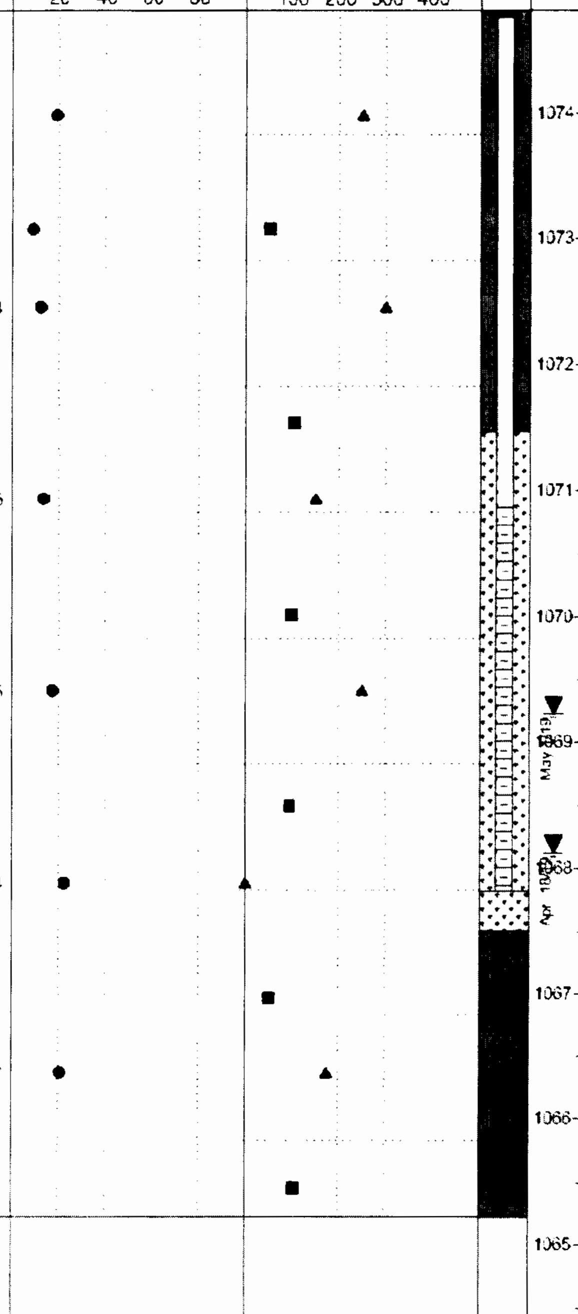
- wet, grey

CLAY (TILL) - silty, trace to some sand, trace gravel, damp to moist, very stiff, medium plastic, brown, trace oxides

- trace coal specks

END OF HOLE AT 9.6 m.
50 mm standpipe installed to 7.0 m.
Groundwater seepage at 6.7 m upon completion.
Groundwater seepage at 5.6 m on May 1, 2019.

Sample Number	SPT (N)	Moisture Content (%)
B1		19
S1	10	9
B2		12.4
S2	21	
B3		13.5
S3	20	
B4		17.5
S4	19	
B5		22.4
S5	10	
B6		20.7
S6	21	



Contractor: All Service	Completion Depth: 9.6 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 18
Logged By: IB	Completion Date: 2019 April 18
Reviewed By: KL	Page 1 of 1

TETRA TECH

Borehole No: BH19-04

Calgary

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 951 16 Avenue NE	Ground Elev: 1076.137 m
Calgary, Alberta	3TM: -2653.843 E; 5659036.641 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
0	Solid stem auger	CLAY (FILL) - silty, some sand, trace gravel, damp, low plastic, brown to dark brown, trace rootlets, trace organics				
		- sandy, brown, trace coal specks, trace oxides		B1		12.8
1		- grey, moist, trace ambient odour		S1	17	
2		- trace wood debris				
		- brown with grey staining		B2		16.6
3		CLAY (TILL) - silty, trace sand, trace gravel, damp to moist, low to medium plastic, brown, trace coal specks, trace oxides, trace odour, grey staining		S2	16	
4				B3		20.1
5				S3	12	
				B4		14.8
6		- some sand, damp, very stiff, no grey staining		S4	16	
7				B5		17.1
8				S5	17	
				B6		14
9				S6	19	
10		END OF HOLE AT 9.6 m. 50 mm standpipe installed to 9.1 m. Dry upon completion. Groundwater seepage at 6.9 m on May 1, 2019.				
10.5						

Groundwater level marker at approx. 7 m: May 1/19

▼Soluble Sulphates (%)▼ 1 2 3 4

Plastic Limit — Moisture Content — Liquid Limit: 20 40 60 80

■SPT (N)■ 20 40 60 80

▲Pocket Pen. (kPa)▲ 100 200 300 400

Well

Elevation (m): 1076, 1075, 1074, 1073, 1072, 1071, 1070, 1069, 1068, 1067, 1066

TETRA TECH

Contractor: All Service	Completion Depth: 9.6 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 18
Logged By: IB	Completion Date: 2019 April 18
Reviewed By: KL	Page 1 of 1

Calgary

Borehole No: BH19-05

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 951 16 Avenue NE	Ground Elev: 1073.308 m
Calgary, Alberta	3TM: -2648.286 E: 5659155.711 N

Depth (m) | Method | Soil Description | Sample Type | Sample Number | SPT (N) | Moisture Content (%) | Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80) | ■ SPT (N) ■ (20 40 60 80) / ▲ Pocket Pen. (kPa) ▲ (100 200 300 400) | Well 1 | Well 2 | Elevation (m)

Method: Solid stem auger

Soil Description

- 0 m: CLAY (FILL) - silty, sandy, trace gravel, damp, low to medium plastic, brown, trace rootlets, trace organics
- ~1.6 m: - trace oxides, trace grey staining
- ~2.2 m: - some sand, trace to no gravel, soft, grey, trace ambient odour
- ~3.1 m: - sandy, very stiff, low plastic, dark grey, trace wood debris.
- ~3.7 m: - dark grey to black
- ~4.6 m: - grey
- ~5.2 m: CLAY (TILL) - silty, sandy, trace gravel, damp, very stiff, low to medium plastic, brown, trace coal specks, trace oxides
- ~6.8 m: - some sand
- ~7.6 m: CLAY - silty, trace sand, damp, very stiff, low plastic, brown

Sample Number	SPT (N)	Moisture Content (%)
B1		18.3
S1	18	16.9
B2		21.6
S2	20	16.2
B3		
S3	17	16.4
B4		
S4	19	14
B5		
S5	21	15.3
B6		
S6	52	13.1
B7		

Depth (m): 0 1 2 3 4 5 6 7 8 9 10 10.5

Elevation (m): 1073 1072 1071 1070 1069 1068 1067 1066 1065 1064 1063

TETRA TECH

Contractor: All Service	Completion Depth: 26.2 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 16
Logged By: IB	Completion Date: 2019 April 18
Reviewed By: KL	Page 1 of 3

Borehole No: BH19-05

Calgary

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGEO03639-01
Location: 951 16 Avenue NE	Ground Elev: 1073.308 m
Calgary, Alberta	3TM: -2648.286 E; 5659155.711 N

Method: Solid stem auger

Depth (m)	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
10.5–11	- brown to grey	SPT	S7	18	16.8
11.5		Bag	B8		
12.4	- moist, brown	SPT	S8	15	26.3
13		Bag	B9		
14		SPT	S9	23	26.1
14.2	SILT - some clay, trace sand, damp to moist, very stiff, low to medium plastic, brown, trace oxides				
14.6		Bag	B10		
15.5	Material Proportion in Sample S10 Silt 81%, Clay 15%, Sand 2%	SPT	S10	24	23.7
16	- some sand, moist	Bag	B11		
17	- trace clay	SPT	S11	27	11.5
17.6		Bag	B12		
18.5	- hard	SPT	S12	44	7.3
19.1		Bag	B13		
20	- trace clay, moist, hard, low plastic, brown	SPT	S13	52	19.3
20.7		Bag	B14		

Plastic Limit — Moisture Content — Liquid Limit: 20 40 60 80

■ SPT (N) ■: 20 40 60 80

▲ Pocket Pen. (kPa) ▲: 100 200 300 400

Well 1 | Well 2 | Elevation (m): 1062, 1061, 1060, 1059, 1058, 1057, 1056, 1055, 1054, 1053

TETRA TECH

Contractor: All Service	Completion Depth: 26.2 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 16
Logged By: IB	Completion Date: 2019 April 18
Reviewed By: KL	Page 2 of 3

Calgary	Borehole No: **BH19-05**	
	Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
	Location: 951 16 Avenue NE	Ground Elev: 1073.308 m
	Calgary, Alberta	3TM: -2648.286 E; 5659155.711 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
21 (Apr 16/19)	Solid stem auger	- wet, groundwater seepage		S14	36	20.4
22 (May 1/19)				B15		
23		Material Proportion in Sample S15 Silt 82%, Clay 9%, Sand 9%		S15	37	24.7
				B16		
24				S16	50	17.5
25		CLAY (TILL) - silty, some sand, trace gravel, damp, medium plastic, brown to grey		B17		
26				S17	50 150mm	11.6
27		END OF HOLE AT 26.2 m. Well 1 - 25 mm standpipe installed to 25.9 m. Well 2 - 50 mm standpipe installed to 12.2 m. Groundwater at 21.0 m upon completion. Well 1 - Groundwater seepage at 22.1 m on May 1, 2019. Well 2 - Dry on May 1, 2019.				
28						
29						
30						
31						
31.5						

Plastic Limit — Moisture Content — Liquid Limit: 20 40 60 80

■ SPT (N) ■: 20 40 60 80 (>100 at 26 m)

▲ Pocket Pen. (kPa) ▲: 100 200 300 400

Well 1 | Well 2 | Elevation (m): 1052, 1051, 1050, 1049, 1048, 1047, 1046, 1045, 1044, 1043, 1042 (Apr 16/19; May 1/19)

TETRA TECH	Contractor: All Service	Completion Depth: 26.2 m
	Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 16
	Logged By: IB	Completion Date: 2019 April 18
	Reviewed By: KL	Page 3 of 3

Borehole No: BH19-06

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 951 16 Avenue NE	Ground Elev: 1076.263 m
Calgary, Alberta	3TM: -2527.545 E; 5659103.101 N

Calgary

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
0	Solid stem auger	CLAY (FILL) - silty, some sand, trace to some gravel, damp, firm, low to medium plastic, brown, trace oxides				
				B1		17.1
		CLAY (TILL) - silty, trace to some sand, trace gravel, damp, stiff, low to medium plastic, brown, trace oxides		S1	6	16.8
				B2		14.4
		- very stiff, trace coal specks		S2	21	
				B3		13.4
		- some sand		S3	25	
		- sandy Material Proportion in Sample B4 Silt 48%, Sand 30%, Clay 19%, Gravel 3%		B4		12.5
Apr 18/19		- wet		S4	22	
		- damp				
May 1/19				B5		11.6
		- hard		S5	34	
				B6		11.9
		CLAY - silty, trace sand, damp, very stiff, low plastic, brown		S6	26	
10				B7		15.3
10.5						

Soluble Sulphates (%): 1 2 3 4

Plastic Limit, Moisture Content, Liquid Limit: 20 40 60 80

SPT (N): 20 40 60 80

Pocket Pen. (kPa): 100 200 300 400

Well

Elevation (m): 1075, 1074, 1073, 1072, 1071, 1070, 1069, 1068, 1067, 1066, 1065

Apr 18/19

May 1/19

TETRA TECH

Contractor: All Service	Completion Depth: 12.7 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 18
Logged By: IB	Completion Date: 2019 April 18
Reviewed By: KL	Page 1 of 2

Calgary

Borehole No: BH19-06

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGEO03639-01
Location: 951 16 Avenue NE	Ground Elev: 1075.263 m
Calgary, Alberta	3TM: -2527.545 E; 5659103.101 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	Well	Elevation (m)
10.5										
11	Solid stem auger			S7	25					1064
	Solid stem auger			B8		12.6				
12	Solid stem auger	- hard		S9	40					1063
13		END OF HOLE AT 12.7 m. 50 mm standpipe installed to 12.2 m. Groundwater seepage at 6.1 m upon completion. Groundwater seepage at 7.1 m on May 1, 2019.								1062
14										1061
15										1060
16										1059
17										1058
18										1057
19										1056
20										1055
21										

TETRA TECH

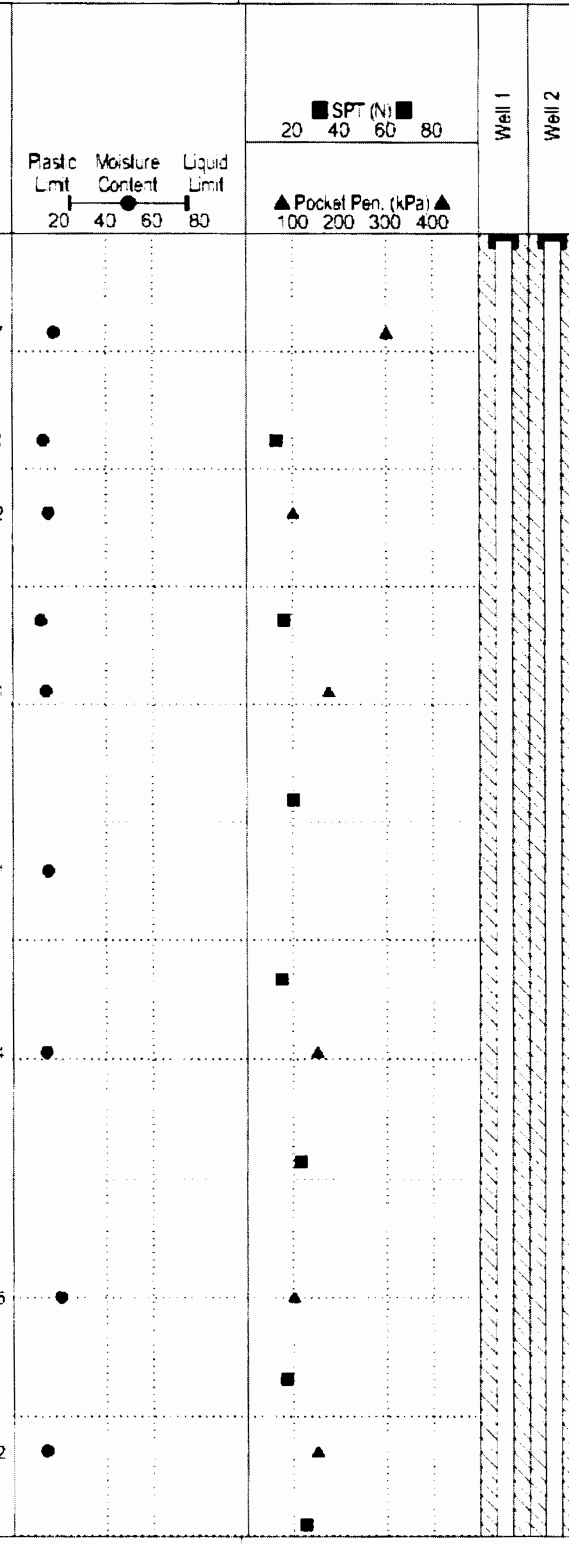
Contractor: All Service	Completion Depth: 12.7 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 18
Logged By: IB	Completion Date: 2019 April 18
Reviewed By: KL	Page 2 of 2

Borehole No: BH19-07

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 951 16 Avenue NE	Ground Elev: 1074.87 m
Calgary, Alberta	3TM -2424.118 E; 5659044.743 N

Method: Solid stem auger

Depth (m)	Soil Description	Sample Number	SPT (N)	Moisture Content (%)	Elevation (m)
0	TOPSOIL - clay, silty, some sand, some gravel, damp, low plastic, dark brown, trace organics				
	CLAY (FILL) - silty, some sand, trace gravel, damp, low plastic, brown	B1		17.7	1074
	- trace bedrock fragments	S1	13	13.1	1073
2	CLAY (TILL) - silty, some sand, trace gravel, damp, stiff, low plastic, brown, trace coal specks	B2		15.2	1072
	- very stiff	S2	16	12	
		B3		14.1	1071
	- trace oxides	S3	20		1070
	- sandy				
	- some sand	B4		15.1	1069
	- hard	S4	15		
		B5		14.4	1068
	- very stiff	S5	23		1067
	CLAY - silty, trace sand, damp, very stiff, medium plastic, brown	B6		20.5	1066
		S6	17		1065
		B7		14.2	
11		S7	25		1064



Contractor: All Service	Completion Depth: 30.6 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 17
Logged By: IB	Completion Date: 2019 April 17
Reviewed By: KL	Page 1 of 3

TETRA TECH

GEOTECHNICAL ENG-CGE03639-01.GPJ EBA.GDT 19/06/05

Borehole No: **BH19-07**

Calgary

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 951 16 Avenue NE	Ground Elev: 1074.87 m
Calgary, Alberta	3TM: -2424.118 E; 5659044.743 N

Method: Solid stem auger

Soil Description	Sample Number	SPT (N)	Moisture Content (%)
	B8		19.5
	S-1		
- hard	S8	32	
- grey	B9		16.7
- trace sand, very stiff, low to medium plastic	S9	21	19.5
	B10		32.4
	S-2		
SILT - sandy, trace clay, trace gravel, damp, hard, trace plasticity, brown, trace oxides, trace coal specks	S10	34	
	B11		13
	S11	32	
CLAY (TILL) - silty, some sand, trace gravel, damp, hard, low to medium plastic, brown, trace oxides, trace coal specks	B12		13.3
SILT - some sand, some clay, trace gravel, damp, hard, trace to no plasticity, brown, trace oxides	S12	36	
Material Proportion in Sample B13 Silt 77%, Clay 13%, Sand 10%	B13		13.4
	S13	44	
SAND - silty, trace clay, trace gravel, damp to moist, very dense, brown, fine to medium sand, trace oxides, trace coal specks	B14		13.3
- wet, groundwater seepage	S14	50/150mm	

Depth (m): 11 – 22 | Elevation (m): 1063 – 1053

Apr 17/19 (groundwater level)

SPT (N): >100

Contractor: All Service	Completion Depth: 30.6 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 17
Logged By: IB	Completion Date: 2019 April 17
Reviewed By: KL	Page 2 of 3

TETRA TECH

GEOTECHNICAL ENG-CGE03639-01.GPJ EBA.GDT

Borehole No: BH19-07

Calgary

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGEO03639-01
Location: 951 16 Avenue NE	Ground Elev: 1074.87 m
Calgary, Alberta	3TM -2424.118 E; 5659044.743 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	■ SPT (N) ■ 20 40 60 80 / ▲ Pocket Pen. (kPa) ▲ 100 200 300 400	Well 1	Well 2	Elevation (m)
22	Solid stem auger			Bulk 1 B15		18.5	●				
23		CLAY (TILL) - silty, trace to some sand, trace gravel, damp, hard, low plastic, grey, trace oxidation, coal specks		S15	50 150mm			>100			1052
24				B16		10.9	●				1051
				S16	50 150mm			>100			
25				B17		10.7	●				1050
26				S17	50 150mm			>100			1049
				B18		11.7	●				
27											1048
		BEDROCK (MUDSTONE) - extremely weathered, extremely weak, fine grained, brown		S18	50 125mm			>100			1047
28				B19		6.9	●				
29		SANDSTONE - extremely weathered, very weak, fine to medium grained, brown		S19	50 125mm			>100			1046
30				B20							1045
				S20	50 175mm			>100			
31		END OF HOLE AT 30.6 m. Well 1 - 25 mm standpipe installed to 24.4 m. Well 2 - 50 mm standpipe installed to 15.2 m. Groundwater at 21.0 m upon completion. Well 1 - Dry on May 1, 2019. Well 2 - Dry on May 1, 2019.									1044
32											1043
33											1042

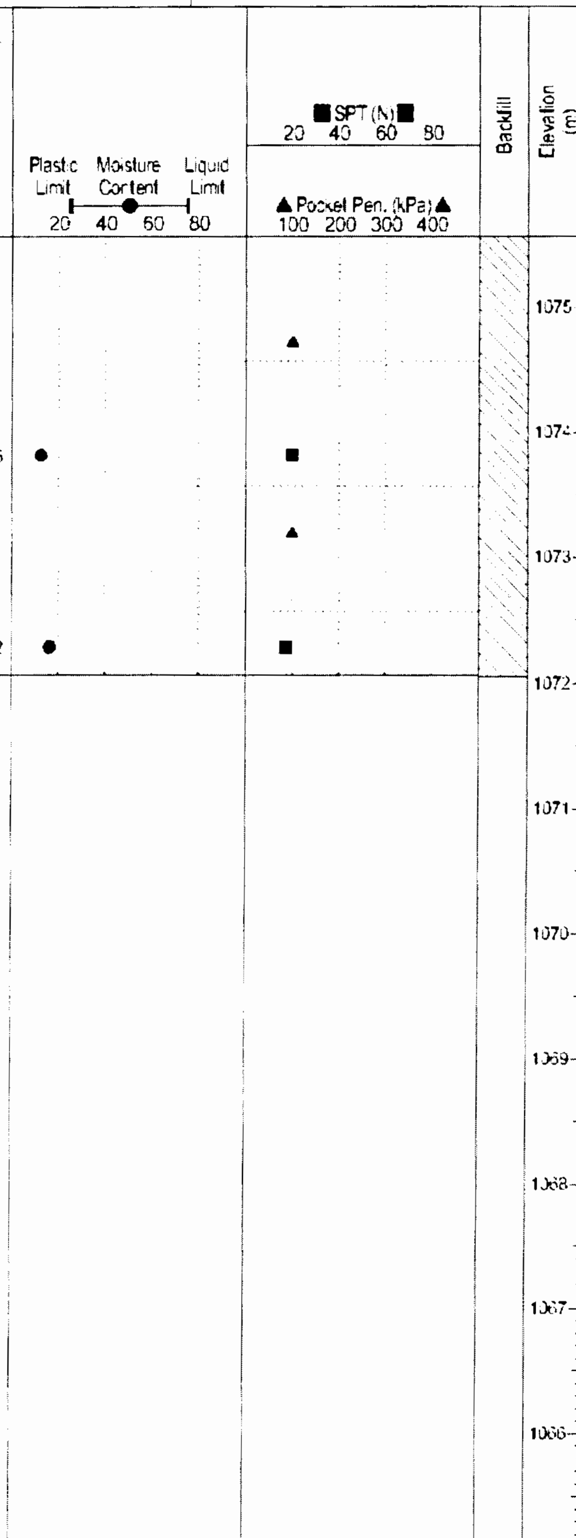
TETRA TECH

Contractor: All Service	Completion Depth: 30.6 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 17
Logged By: IB	Completion Date: 2019 April 17
Reviewed By: KL	Page 3 of 3

Borehole No: **BH19-08**

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 951 16 Avenue NE	Ground Elev: 1075.564 m
Calgary, Alberta	3TM: -2851.41 E; 5659084.482 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
0	Solid stem auger	GRAVEL - 25-50 mm thick layer				
		CLAY (FILL) - silty, trace to some sand, trace gravel, damp, low to medium plastic, brown, trace oxides				
		- trace wood debris		B1		
				S1	20	12.6
2		CLAY (TILL) - silty, trace sand, trace gravel, damp, very stiff, low to medium plastic, brown, trace oxides, trace coal specks		B2		
				S2	17	16.2
3.5		END OF HOLE AT 3.5 m. Backfilled with cuttings. Dry upon completion.				



TETRA TECH	
Contractor: All Service	Completion Depth: 3.5 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 22
Logged By: IB	Completion Date: 2019 April 22
Reviewed By: KL	Page 1 of 1

GEOTECHNICAL ENG-CGE03639-1 GPJ EBA GDT 19/05/08

Borehole No: BH19-09

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 920 16 Avenue NE	Ground Elev: 1075.602 m
Calgary, Alberta	3TM: -2850.913 E; 5659055.879 N

Calgary

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Plastic Limit / Moisture Content / Liquid Limit (20 40 60 80)	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	Backfill	Elevation (m)
0	Solid stem auger	CLAY (FILL) - silty, some sand, trace gravel, damp, low plastic, brown, trace oxides, trace wood debris								
1				B1		14.7				1075
2				S1	4					1074
2.2		CLAY (TILL) - silty, some sand, trace gravel, damp, low plastic, brown, trace oxides, trace coal specks		B2		15.6				1073
3.3				S2	50 /100mm			>100		
3.5		END OF HOLE AT 3.5 m. Backfilled with cuttings. Dry upon completion.								1072

Depth scale: 0–10.5 m; Elevation scale: 1075–1066 m.

TETRA TECH

Contractor: All Service	Completion Depth: 3.5 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 22
Logged By: IB	Completion Date: 2019 April 22
Reviewed By: KL	Page 1 of 1

Calgary

Borehole No: BH19-10

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 920 16 Avenue NE	Ground Elev: 1075.748 m
Calgary, Alberta	3TM: -2851.587 E; 5659033.34 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
0	Solid stem auger	TOPSOIL - clay, silty, sandy, trace gravel, damp, dark brown, trace rootlets, trace organics				
		SAND (FILL) - silty, trace clay, trace gravel, damp, fine sand, trace wood debris				
				B1		
				S1	6	6.4
		CLAY (TILL) - silty, sandy, trace gravel, damp to moist, stiff, low to medium plastic, brown, trace oxides, trace coal specks		B2		
				S2	10	20.2
3.5		END OF HOLE AT 3.5 m. Backfilled with cuttings. Dry upon completion.				

Plastic Limit — Moisture Content — Liquid Limit: 20 40 60 80

■ SPT (N) ■: 20 40 60 80

▲ Pocket Pen. (kPa) ▲: 100 200 300 400

Backfill

Elevation (m): 1075, 1074, 1073, 1072, 1071, 1070, 1069, 1068, 1067, 1066

Depth (m): 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 10.5

TETRA TECH

Contractor: All Service	Completion Depth: 3.5 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 22
Logged By: IB	Completion Date: 2019 April 22
Reviewed By: KL	Page 1 of 1

Borehole No: BH19-11

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGEO03639-01
Location: 954 16 Avenue NE	Ground Elev: 1073.933 m
Calgary, Alberta	3TM -2757.827 E: 5659191.575 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
0	Solid stem auger	CLAY (FILL) - silty, some sand, trace gravel, damp, low to medium plastic, dark brown, trace organics, trace plastic debris				
1				B1		22.4
		- some gravel, grey/dark brown, trace ambient odour		S1	21	13.6
2				B2		13.4
3		- firm, trace wood debris		S2	6	19.9
		- trace sand, trace gravel		B3		23
4		- trace wood debris		S3	11	10.5
5		- damp to moist, brick pieces		B4		23.5
6		- stiff		S4	14	
		GRAVEL (FILL) - sandy, some silt, trace clay, damp, subrounded to subangular, dark brown, fine to coarse gravel		B5		6.2
7		CLAY (FILL) - silty, some sand, trace gravel, damp, low to medium plastic, grey/dark brown, trace rootlets, trace ambient odour				
8				S5	22	
		- some gravel				
9		- trace gravel		B6		16.4
		- wood debris		S6	16	
10				B7		19.6
10.5						

Groundwater level: May 1/19

▼Soluble Sulphates (%)▼ 1 2 3 4

Plastic Limit — Moisture Content — Liquid Limit: 20 40 60 80

■SPT (N)■ 20 40 60 80

▲Pocket Pen. (kPa)▲ 100 200 300 400

Well

Elevation (m): 1073, 1072, 1071, 1070, 1069, 1068, 1067, 1066, 1065, 1064

TETRA TECH

Contractor: All Service	Completion Depth: 15.7 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 22
Logged By: IB	Completion Date: 2019 April 22
Reviewed By: KL	Page 1 of 2

GEOTECHNICAL ENG-CGEO03639-01.GPJ EBA.GDT 19/06/05

Borehole No: BH19-11

Calgary

Project: Redevelopment of Midfield Mobile Home Park	Project No: CGE03639-01
Location: 954 16 Avenue NE	Ground Elev: 1073.933 m
Calgary, Alberta	3TM: -2757.827 E; 5659191.575 N

Method: Solid stem auger

Soil Description

- trace metal debris
- some gravel, moist

CLAY - silty, some sand, trace gravel, moist to wet, stiff, medium plastic, grey
- sandy, brown
- firm

END OF HOLE AT 15.7 m.
Standpipe installed to 7.9 m.
Dry upon completion.
Groundwater seepage at 5.7 m on May 1, 2019.

Depth (m)	Sample Number	SPT (N)	Moisture Content (%)	Elevation (m)
11	S7	20		1063
11.5	B8		21	
12.4	S8	29		
13.2	B9		13.2	1061
14	S9	15		1060
14.8	B10		25	
15.5	S10	7		

TETRA TECH

Contractor: All Service	Completion Depth: 15.7 m
Drilling Rig Type: Solid Stem Auger	Start Date: 2019 April 22
Logged By: IB	Completion Date: 2019 April 22
Reviewed By: KL	Page 2 of 2

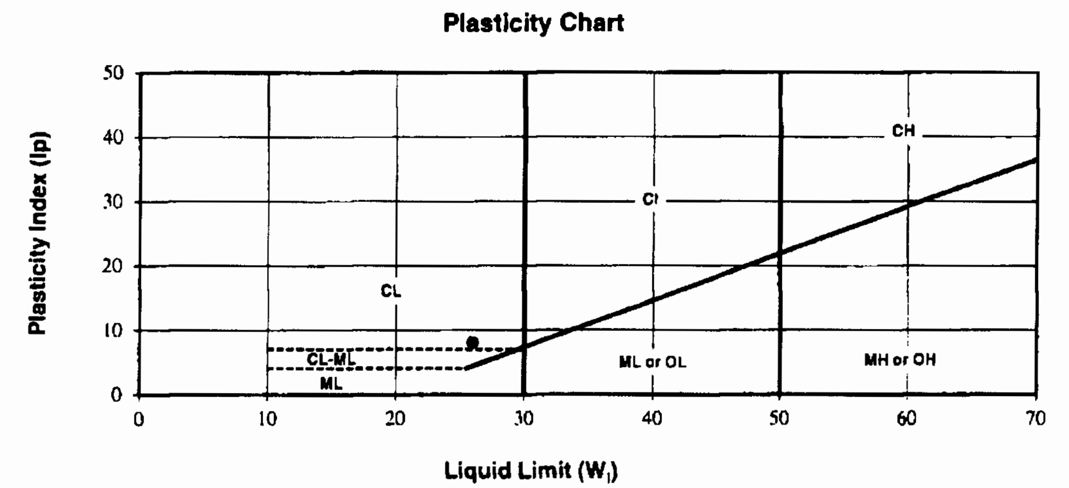
APPENDIX C
LABORATORY TEST RESULTS

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	B2
		Borehole Number:	BH-05
Project No:	704-ENG.CGEO03639-01	Depth:	1.8-2.1 m
Client:	The City of Calgary	Sampled By:	IB Tested By: JB
Attention:		Date Sampled:	April 22, 2019
Email:		Date Tested:	May 13, 2019

Sample Description: SILT, sandy, some clay



Liquid Limit (W_l):	26	Natural Moisture (%)	21.6
Plastic Limit :	18	Soil Plasticity:	Low
Plasticity Index (Ip) :	8	Mod.USCS Symbol:	ML - CL

Remarks:

Reviewed By: ____________ P.Eng.

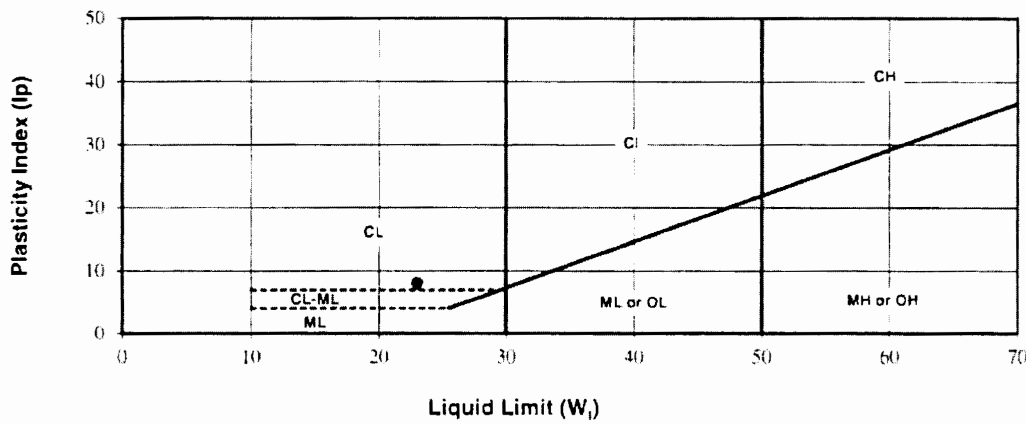
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	S5
Project No:	704-ENG.CGEO03639-01	Borehole Number:	BH-05
Client:	The City of Calgary	Depth:	7.6-8.1 m
Attention:		Sampled By:	IB Tested By: JB
Email:		Date Sampled:	April 22, 2019
		Date Tested:	May 13, 2019

Sample Description: CLAY, silty, sandy, trace gravel



Liquid Limit (W$_l$) :	23	Natural Moisture (%)	15.3
Plastic Limit :	15	Soil Plasticity:	Low
Plasticity Index (Ip) :	8	Mod.USCS Symbol:	CL-ML

Remarks:

Reviewed By: ____________ P.Eng.

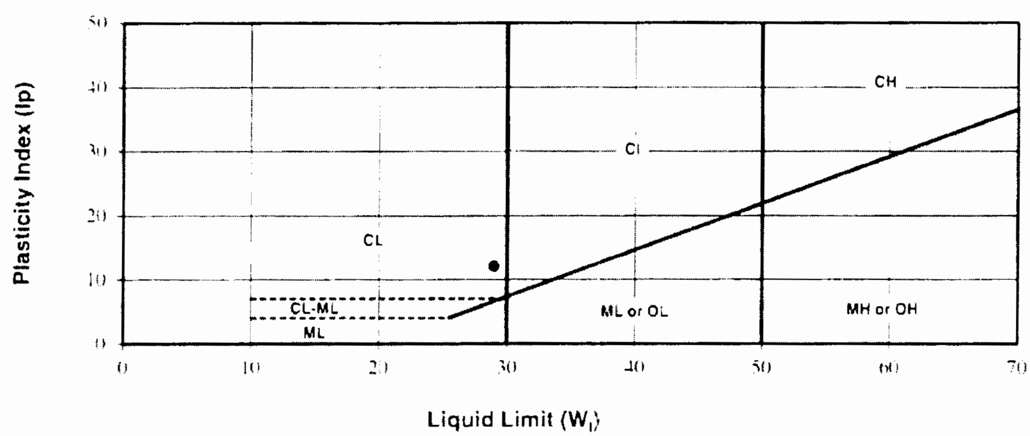
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	S9
		Borehole Number:	BH-07
Project No:	704-ENG.CGEO03639-01	Depth:	13.7-14.2 m
Client:	The City of Calgary	Sampled By: IB	Tested By: JB
Attention:		Date Sampled:	April 22, 2019
Email:		Date Tested:	May 13, 2019

Sample Description: CLAY, silty (Lacustrine)



Liquid Limit (W$_L$) :	29	Natural Moisture (%)	19.5
Plastic Limit :	17	Soil Plasticity:	Low to Medium
Plasticity Index (Ip) :	**12**	Mod.USCS Symbol:	CL-CI

Remarks:

Reviewed By: ______________ P.Eng.

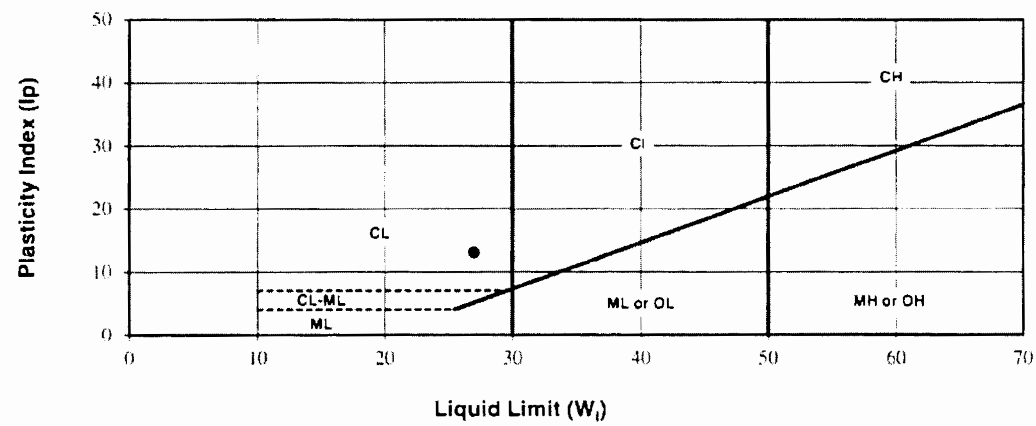
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	B7
Project No:	704-ENG.CGEO03639-01	Borehole Number:	BH-06
Client:	The City of Calgary	Depth:	9.9-10.1 m
Attention:		Sampled By:	IB Tested By: JB
Email:		Date Sampled:	April 22, 2019
		Date Tested:	May 13, 2019

Sample Description: CLAY, silty, sandy, trace gravel



Liquid Limit (W$_l$) :	27	Natural Moisture (%)	15.3
Plastic Limit :	14	Soil Plasticity:	Low
Plasticity Index (Ip) :	**13**	Mod.USCS Symbol:	CL

Remarks:

Reviewed By: ______________ P.Eng.

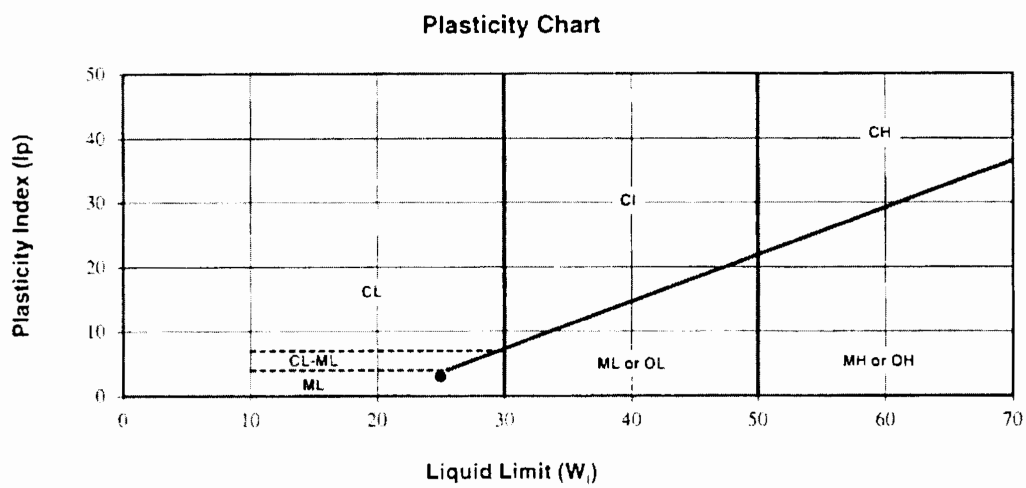
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	S9
		Borehole Number:	BH-05
Project No:	704-ENG.CGEO03639-01	Depth:	13.7-14.2 m
Client:	The City of Calgary	Sampled By:	IB Tested By: MS
Attention:		Date Sampled:	April 22, 2019
Email:		Date Tested:	May 29, 2019

Sample Description: SILT, some clay, trace sand (Lacustrine)



Liquid Limit (W_{l1}):	25	Natural Moisture (%)	26.1
Plastic Limit :	22	Soil Plasticity:	Low
Plasticity Index (Ip) :	**3**	Mod.USCS Symbol:	ML

Remarks:

Reviewed By: ______________________ P.Eng.

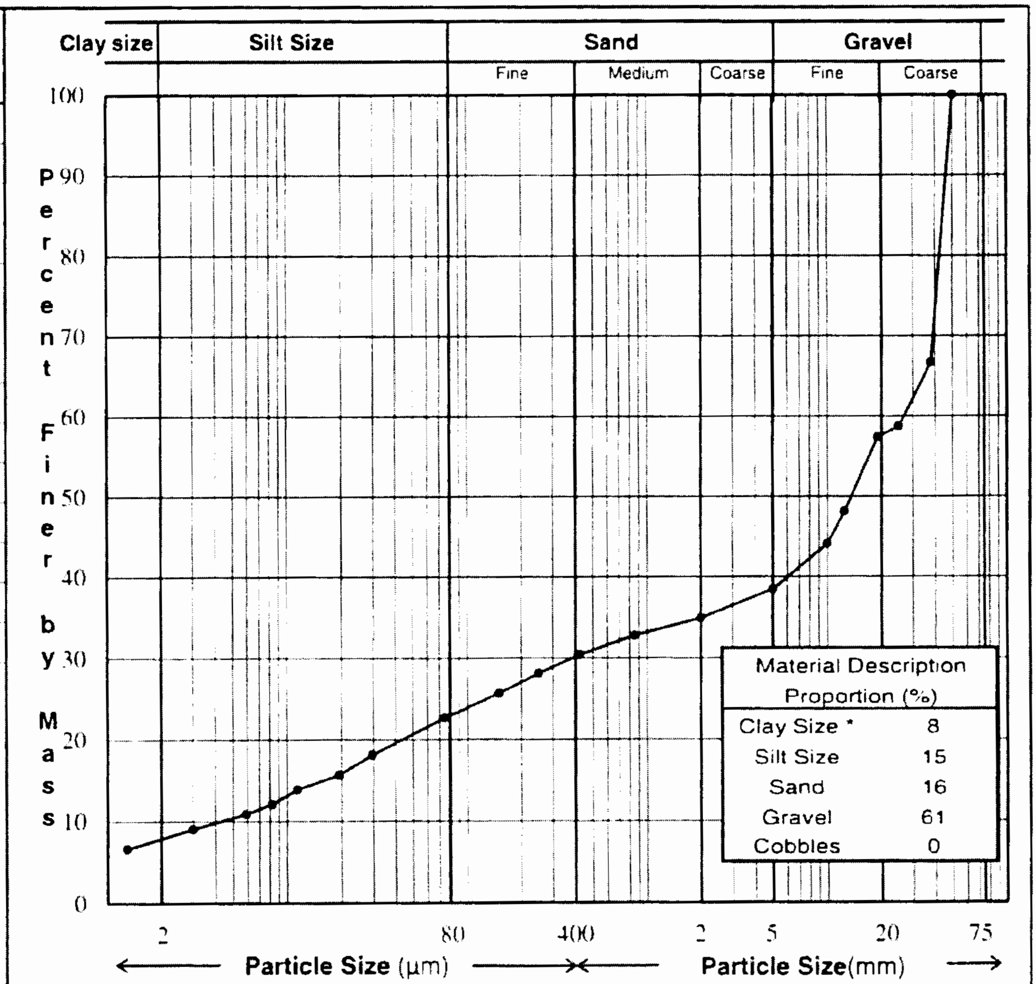
TETRA TECH

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D7928

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	B3
Client:	The City of Calgary	Borehole/ TP:	BH-03
Project No.:	704-ENG.CGEO03639-01	Depth:	3.8-4.0 m
Location:	Former Midfield Mobile Home Park	Date Tested	May 13, 2019
Description **:	GRAVEL, some sand, some silt, trace clay	Tested By:	MS

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	100
38 mm	67
25 mm	59
19 mm	57
13 mm	48
10 mm	44
5 mm	38
2 mm	35
850 µm	33
425 µm	30
250 µm	28
150 µm	26
75 µm	23
30 µm	18
19 µm	16
11 µm	14
8 µm	12
6 µm	11
3 µm	9
1 µm	7



Remarks: * The description is behaviour based & subject to Tetra Tech Canada description protocols.

** Unless expressly stated, this test was performed by the Air Dry Method

Reviewed By: ______________________ P.Eng.

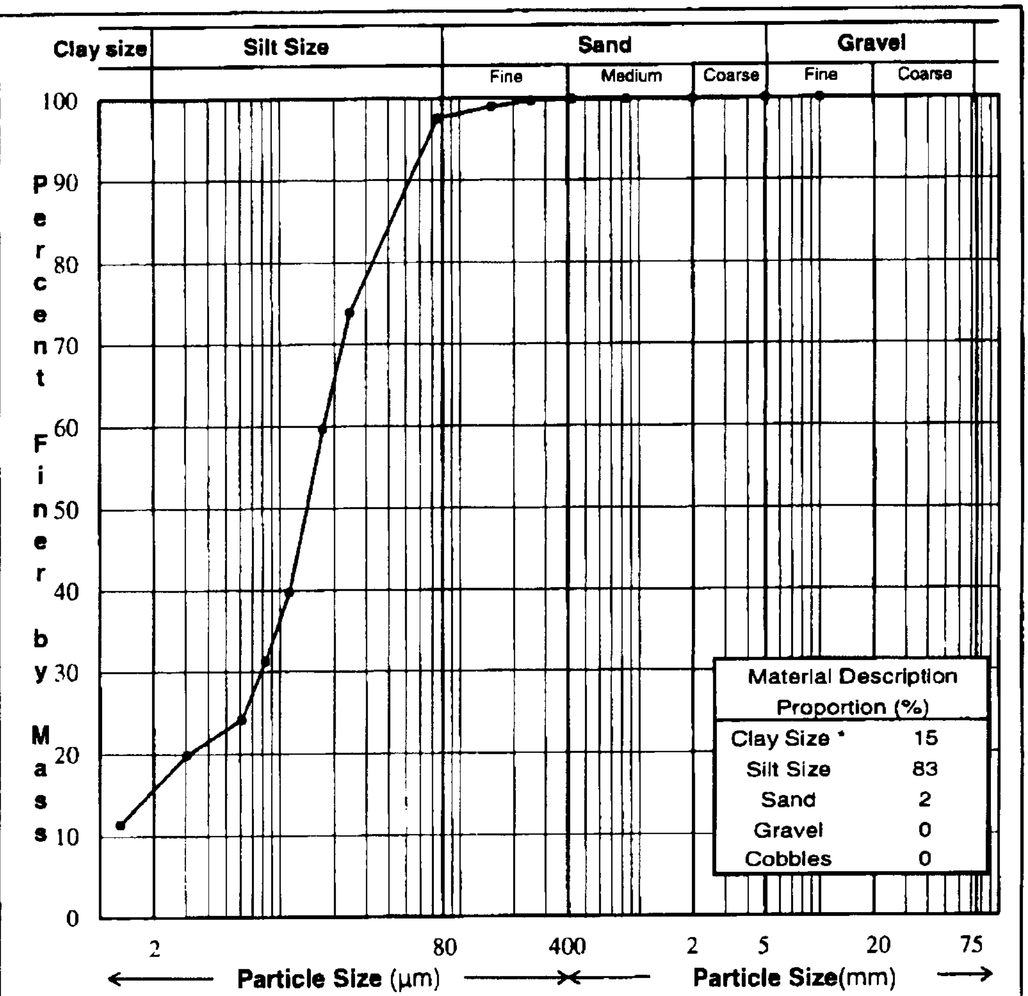
TETRA TECH

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D7928

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	S10
Client:	The City of Calgary	Borehole/ TP:	BH-05
Project No.:	704-ENG.CGEO03639-01	Depth:	15.2-15.7 m
Location:	Former Midfield Mobile Home Park	Date Tested	May 13, 2019
Description **:	SILT, some clay, trace sand (Lacustrine)	Tested By:	MS

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	100
5 mm	100
2 mm	100
850 µm	100
425 µm	100
250 µm	100
150 µm	99
75 µm	98
24 µm	74
17 µm	60
11 µm	40
8 µm	31
6 µm	24
3 µm	20
1 µm	11



Material Description	Proportion (%)
Clay Size *	15
Silt Size	83
Sand	2
Gravel	0
Cobbles	0

Remarks: * The description is behaviour based & subject to Tetra Tech Canada description protocols.

** Unless expressly stated, this test was performed by the Air Dry Method

Reviewed By: ____________ P.Eng.

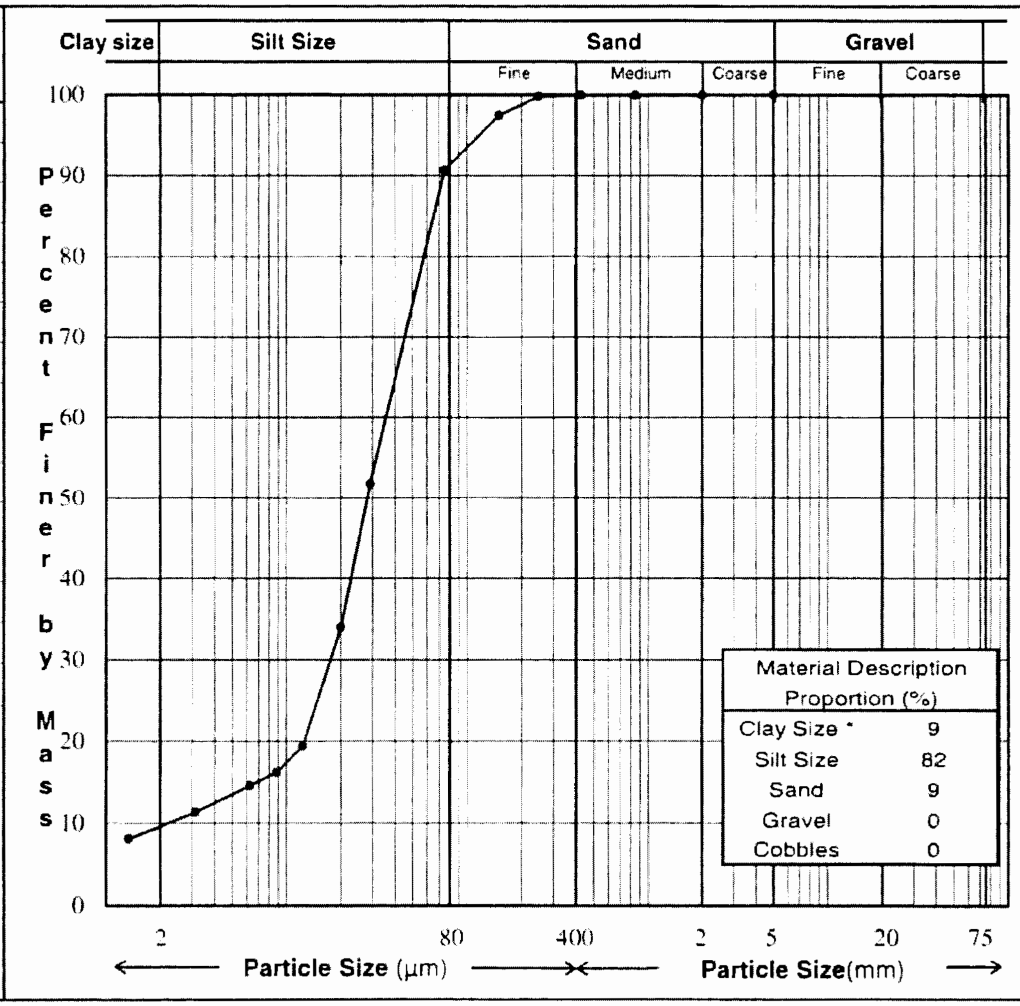
TETRA TECH

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D7928

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	S15
Client:	The City of Calgary	Borehole/ TP:	BH-05
Project No.:	704-ENG.CGEO03639-01	Depth:	22.9-23.3 m
Location:	Former Midfield Mobile Home Park	Date Tested	May 13, 2019
Description **:	SILT, trace clay, trace sand (Lacustrine)	Tested By:	MS

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	
5 mm	100
2 mm	100
850 μm	100
425 μm	100
250 μm	100
150 μm	97
75 μm	91
29 μm	52
20 μm	34
12 μm	19
9 μm	16
6 μm	15
3 μm	11
1 μm	8



Remarks: * The description is behaviour based & subject to Tetra Tech Canada description protocols.

** Unless expressly stated, this test was performed by the Air Dry Method

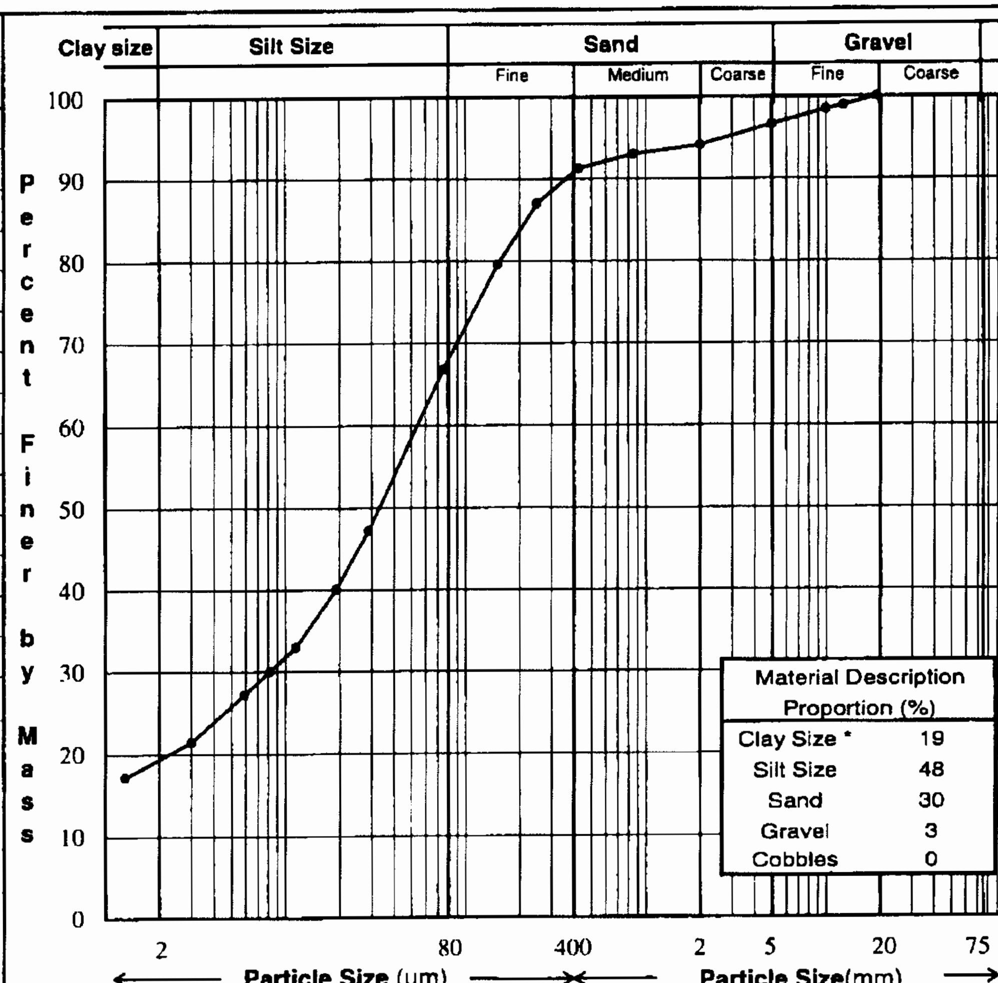
Reviewed By: ______________ P.Eng.

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D7928

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	B4
Client:	The City of Calgary	Borehole/ TP:	BH-06
Project No.:	704-ENG.CGEO03639-01	Depth:	5.3-5.5 m
Location:	Former Midfield Mobile Home Park	Date Tested	May 13, 2019
Description **:	CLAY, silty, sandy, trace gravel	Tested By:	MS

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	100
13 mm	99
10 mm	98
5 mm	97
2 mm	94
850 µm	93
425 µm	91
250 µm	87
150 µm	80
75 µm	67
29 µm	47
19 µm	40
11 µm	33
8 µm	30
6 µm	27
3 µm	21
1 µm	17



Material Description	Proportion (%)
Clay Size *	19
Silt Size	48
Sand	30
Gravel	3
Cobbles	0

Remarks: * The description is behaviour based & subject to Tetra Tech Canada description protocols.
** Unless expressly stated, this test was performed by the Air Dry Method

Reviewed By: ______________________ P.Eng.

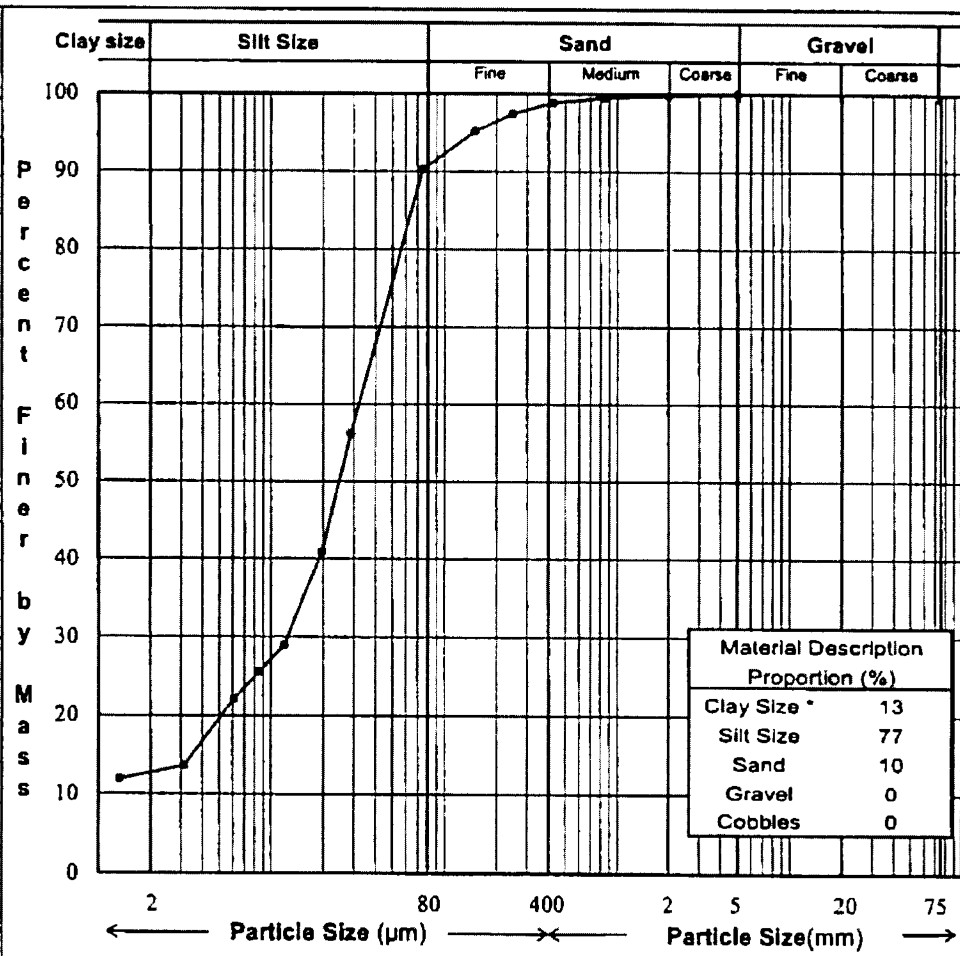
TETRA TECH

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D7928

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	B13
Client:	The City of Calgary	Borehole/ TP:	BH-07
Project No.:	704-ENG.CGEO03639-01	Depth:	19.1-19.2 m
Location:	Former Midfield Mobile Home Park	Date Tested	May 13, 2019
Description **:	CLAY, silty, some sand	Tested By:	MS

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	
5 mm	100
2 mm	100
850 μm	100
425 μm	99
250 μm	97
150 μm	95
75 μm	90
29 μm	56
20 μm	41
12 μm	29
9 μm	26
6 μm	22
3 μm	14
1 μm	12



Material Description	Proportion (%)
Clay Size *	13
Silt Size	77
Sand	10
Gravel	0
Cobbles	0

Remarks: * The description is behaviour based & subject to Tetra Tech Canada description protocols.
** Unless expressly stated, this test was performed by the Air Dry Method

Reviewed By: ____________ P.Eng.

TETRA TECH

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	BH-01 - BH-03
Project Number:	704-ENG.CGEO03639-01	Date Tested:	May 9, 2019
Client:	The City of Calgary	Tested By:	MS
Project Manager:		Page:	1

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH-01	B1	15.0	CLAY, silty, sandy, trace gravel
	S1	16.3	CLAY, silty, sandy, trace gravel, trace organics
	S2	28.0	Organic SOIL
	S3	18.5	CLAY, silty, sandy, trace gravel
	S4	30.5	CLAY, silty, sandy, some organics, trace gravel
	S5	27.0	CLAY, silty, sandy, some organics, trace gravel
	S6	25.4	CLAY, silty, trace sand
	S7	23.8	SAND, silty, some clay
BH-02	B1	18.3	CLAY, silty, sandy
	S1	14.4	CLAY, silty, sandy, trace gravel
	B2	15.2	CLAY, silty, sandy, trace gravel
	B3	20.4	CLAY, silty, some sand
	B4	21.3	CLAY, silty, some sand
	B5	16.1	CLAY, silty, sandy, trace gravel
	B6	15.1	CLAY, silty, sandy, trace gravel
BH-03	B1	19.0	CLAY, silty, sandy, trace gravel, trace organics
	S1	9.0	CLAY, silty, sandy, gravelly, trace organics
	B2	12.4	CLAY, silty, sandy, trace gravel
	B3	13.5	GRAVEL, some sand, some silt, trace clay
	B4	17.5	CLAY, silty, sandy, trace gravel
	B5	22.4	CLAY, silty, sandy, trace gravel
	B6	20.7	CLAY, silty, some sand

Reviewed By: ______________ P.Eng.

TETRA TECH

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	BH-04, BH-06
Project Number:	704-ENG.CGEO03639-01	Date Tested:	May 9, 2019
Client:	The City of Calgary	Tested By:	MS
Project Manager:		Page:	2

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH-04	B1	12.8	CLAY, silty, sandy, trace gravel
	B2	18.6	CLAY, silty, sandy
	B3	20.1	CLAY, silty, sandy
	B4	14.8	CLAY, silty, sandy, trace gravel
	B5	17.1	CLAY, silty, sandy, trace gravel
	B6	14.0	CLAY, silty, sandy, trace gravel
BH-06	B1	17.1	CLAY, silty, sandy
	S1	16.8	SILT, sandy, some clay
	B2	14.4	CLAY, silty, sandy, trace gravel
	B3	13.4	CLAY, silty, sandy, trace gravel
	B4	12.5	CLAY, silty, sandy, trace gravel
	B5	11.8	CLAY, silty, sandy, trace gravel
	B6	11.9	CLAY, silty, sandy, trace gravel
	B7	15.3	CLAY, silty, sandy, trace gravel
	B8	12.6	CLAY, silty, sandy, trace gravel

Reviewed By: ____________ P.Eng.

TETRA TECH

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	BH-05
Project Number:	704-ENG.CGEO03639-01	Date Tested:	May 9, 2019
Client:	The City of Calgary	Tested By:	MS
Project Manager:		Page:	3

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH-05	B1	18.3	CLAY, silty, sandy, trace gravel
	S1	16.9	CLAY, silty, sandy, trace gravel
	B2	21.6	SILT, sandy, some clay
	S2	16.2	CLAY, silty, sandy, trace gravel
	S3	16.4	CLAY, silty, sandy, trace gravel
	S4	14.0	CLAY, silty, sandy, trace gravel
	S5	15.3	CLAY, silty, sandy, trace gravel
	S6	13.1	CLAY, silty, sandy, trace gravel
	S7	16.8	CLAY, silty, sandy with layer of medium to high plastic clay
	S8	26.3	SILT, some clay, trace sand (Lacustrine)
	S9	26.1	SILT, some clay, trace sand (Lacustrine)
	S10	23.7	SILT, some clay, trace sand (Lacustrine)
	S11	11.5	Fine SAND, silty, some clay
	S12	7.3	Fine SAND, silty, some clay
	S13	19.3	CLAY, silty, sandy
	S14	20.4	SILT, trace clay, trace sand (Lacustrine)
	S15	24.7	SILT, trace clay, trace sand (Lacustrine)
	S16	17.5	SAND, some silt, some clay
	S17	11.8	CLAY, silty, sandy, trace gravel

Reviewed By: ____________ P.Eng.

TETRA TECH

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	BH-07
Project Number:	704-ENG.CGEO03639-01	Date Tested:	May 9, 2019
Client:	The City of Calgary	Tested By:	MS
Project Manager:		Page:	4

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH-07	B1	17.7	SILT, sandy, some clay (Lacustrine)
	S1	13.1	CLAY, silty, sandy, trace gravel
	B2	15.2	CLAY, silty, sandy, trace gravel
	S2	12.0	CLAY, silty, sandy, trace gravel
	B3	14.1	CLAY, silty, sandy, trace gravel
	B4	15.1	SAND, silty, some clay
	B5	14.4	CLAY, silty, sandy, trace gravel
	B6	20.5	CLAY, silty, sandy, trace gravel
	B7	14.2	CLAY, silty, sandy, trace gravel
	B8	19.5	CLAY, silty, sandy, trace gravel
	B9	15.7	CLAY, silty, sandy, trace gravel
	S9	19.5	CLAY, silty (Lacustrine)
	B10	32.4	CLAY, silty (Lacustrine)
	B11	13.0	CLAY, silty, sandy, trace gravel
	B12	13.3	CLAY, silty, sandy, trace gravel
	B13	13.4	CLAY, silty, some sand
	B14	13.3	CLAY, silty, sandy, trace gravel
	B15	18.5	SAND, some silt, trace clay
	B16	10.9	Weathered SHALE
	B17	10.7	Weathered SHALE
	S17	11.7	Weathered SHALE
	B19	8.9	Weathered SHALE

Reviewed By: ______________ P.Eng.

TETRA TECH

MOISTURE CONTENT TEST RESULTS

ASTM D2216

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	BH-08 - BH-11
Project Number:	704-ENG.CGEO03639-01	Date Tested:	May 9, 2019
Client:	The City of Calgary	Tested By:	MS
Project Manager:		Page:	5

B.H. Number	Sample Number	Moisture Content (%)	Visual Description of Soil
BH-08	S1	12.6	CLAY, silty, sandy, trace gravel
	S2	16.2	CLAY, silty, sandy, trace gravel
BH-09	B1	14.7	CLAY, silty, sandy, trace gravel
	B2	15.6	CLAY, silty, sandy, trace gravel
BH-10	S1	6.4	SAND, some silt, trace gravel
	S2	20.2	CLAY, silty, sandy, trace gravel
BH-11	B1	22.4	CLAY, silty, sandy, trace gravel
	S1	13.6	CLAY, silty, sandy, trace gravel
	B2	13.4	CLAY, silty, sandy, trace gravel
	S2	19.9	CLAY, silty, sandy, trace gravel, trace organics
	B3	23.0	CLAY, silty, sandy, trace gravel, trace organics
	S3	10.5	Rock and wood
	B4	23.5	CLAY, silty, sandy, trace gravel, trace organics
	B5	6.2	SAND abd GRAVEL, trace organics
	B6	18.4	ORGANIC SOIL
	B7	19.8	CLAY, silty, sandy, some organics, trace gravel
	B8	21.0	CLAY, silty, sandy, trace gravel, trace organics
	B9	13.2	CLAY, silty, sandy, trace gravel
	B10	25.0	CLAY, silty, some sand

Reviewed By: ____________ P.Eng.

TETRA TECH

SOLUBLE SULPHATE ION CONTENT OF SOIL

(CSA Designation A23.2-2B & A23.2-3B)

Project:	Midfield Mobile Home Park Redevelopment	Date Tested:	May 10, 2019
Project No.:	704.ENG.CGEO03639-01	Tested By:	EM
Client:	The City of Calgary	Sample Source:	see below
Location:	Former Midfield Mobile Home Park	Laboratory:	Calgary

Sample Number	B3	B2	S1	S2		
Borehole Number	BH-02	BH-04	BH-06	BH-11		
Depth (m)	3.8-4.0	1.8-2.1	1.5-2.0	3.0-3.5		
Sulphate Content %	0.05	0.06	0.06	0.11		
Degree of Exposure (Class)	Negligible	Negligible	Negligible	Moderate		

Class of exposure	Degree of exposure	Water-soluble sulphate (SO_4)† in soil sample, %	Sulphate (SO_4) in groundwater samples, mg/L‡	Water soluble sulphate (SO_4) in recycled aggregate sample, %	Cementing materials to be used§
S-1	Very severe	> 2.0	> 10 000	> 2.0	HS or HSb
S-2	Severe	0.20–2.0	1500–10 000	0.60–2.0	HS or HSb
S-3	Moderate	0.10–0.20	150–1500	0.20–0.60	MS, MSb, LH, HS, or HSb

**For sea water exposure, see Clause 4.1.1.5.*
†In accordance with CSA A23.2-3B.
‡In accordance with CSA A23.2-2B.
§Cementing material combinations with equivalent performance may be used (see Clauses 4.2.1.2, 4.2.1.3, and 4.2.1.4). Type HS cement shall not be used in reinforced concrete exposed to both chlorides and sulphates. Refer to Clause 4.1.1.6.3.

Limitations:

i) The degree of exposure class included herein are valid only if drainage and weeping systems meet the requirements of the site conditions.

ii) The degree exposure class should be re-verified if backfill soils for foundation walls originate from an unknown source.

Remarks:

Reviewed By: ______________ P.Geol.

TETRA TECH

APPENDIX D
DESIGN AND CONSTRUCTION GUIDELINES

BACKFILL MATERIALS AND COMPACTION (GENERAL)

1.0 DEFINITIONS

"Landscape fill" is typically used in areas such as berms and grassed areas where settlement of the fill and noticeable surface subsidence can be tolerated. "Landscape fill" may comprise soils without regard to engineering quality.

"General engineered fill" is typically used in areas where a moderate potential for subgrade movement is tolerable, such as asphalt (i.e., flexible) pavement areas. "General engineered fill" should comprise clean, granular or clay soils.

"Select engineered fill" is typically used below slabs-on-grade or where high volumetric stability is desired, such as within the footprint of a building. "Select engineered fill" should comprise clean, well-graded granular soils or inorganic low to medium plastic clay soils.

"Structural engineered fill" is used for supporting structural loads in conjunction with shallow foundations. "Structural engineered fill" should comprise clean, well-graded granular soils.

"Lean-mix concrete" is typically used to protect a subgrade from weather effects including excessive drying or wetting. "Lean-mix concrete" can also be used to provide a stable working platform over weak subgrades. "Lean-mix concrete" should be low strength concrete having a minimum 28-day compressive strength of 3.5 MPa.

Standard Proctor Density (SPD) as used herein means Standard Proctor Maximum Dry Density (ASTM Test Method D698). Optimum moisture content is defined in ASTM Test Method D698.

2.0 GENERAL BACKFILL AND COMPACTION RECOMMENDATIONS

Exterior backfill adjacent to abutment walls, basement walls, grade beams, pile caps and above footings, and below highway, street, or parking lot pavement sections should comprise "general engineered fill" materials as defined above.

Exterior backfill adjacent to footings, foundation walls, grade beams and pile caps and within 600 mm of final grade should comprise inorganic, cohesive "general engineered fill". Such backfill should provide a relatively impervious surficial zone to reduce seepage into the subsoil against the structure.

Backfill should not be placed against a foundation structure until the structure has sufficient strength to withstand the earth pressures resulting from placement and compaction. During compaction, careful observation of the foundation wall for deflection should be carried out continuously. Where deflections are apparent, the compactive effort should be reduced accordingly.

In order to reduce potential compaction induced stresses, only hand-held compaction equipment should be used in the compaction of fill within 1 m of retaining walls or basement walls. If compacted fill is to be placed on both sides of the wall, they should be filled together so that the level on either side is within 0.5 m of each other.

All lumps of materials should be broken down during placement. Backfill materials should not be placed in a frozen state, or placed on a frozen subgrade.

Where the maximum-sized particles in any backfill material exceed 50% of the minimum dimension of the cross-section to be backfilled (e.g., lift thickness), such particles should be removed and placed at other more suitable locations on site or screened off prior to delivery to site.

Excavation and construction operations expose materials to climatic elements (freeze/thaw, wet/dry) and/or mechanical disturbance which can cause severe deterioration of performance. Unless otherwise specifically indicated in this report, the walls and floors of excavations, and stockpiles, must be protected from the elements, particularly moisture, desiccation, frost, and construction activities. Should desiccation occur, bonding should be provided between backfill lifts. For fine-grained materials the previous lift should be scarified to the base of the desiccated layer, moisture-conditioned, and recompacted and bonded thoroughly to the succeeding lift. For granular materials, the surface of the previous lift should be scarified to about a 75 mm depth followed by proper moisture-conditioning and recompaction.

3.0 COMPACTION AND MOISTURE CONDITIONING

"Landscape fill" material should be placed in compacted lifts not exceeding 300 mm and compacted to a density of not less than 90% of SPD unless a higher percentage is specified by the jurisdiction.

"General engineered fill" and "select engineered fill" materials should be placed in layers of 150 mm compacted thickness and should be compacted to not less than 98% of SPD. Note that the contract may specify higher compaction levels within 300 mm of the design elevation. Cohesive materials placed as "general engineered fill" or "select engineered fill" should be compacted at 0 to 2% above the optimum moisture content. Note that there are some silty soils which can become quite unstable when compacted above optimum moisture content. Granular materials placed as "general engineered fill" or "select engineered fill" should be compacted at slightly below (0 to 2%) the optimum moisture content.

"Structural engineered fill" material should be placed in compacted lifts not exceeding 150 mm in thickness and compacted to not less than 100% of SPD at slightly below (0 to 2%) the optimum moisture content.

4.0 "GENERAL ENGINEERED FILL"

Low to medium plastic clay is considered acceptable for use as "general engineered fill," assuming this material is inorganic and free of deleterious materials

Materials meeting the specifications for "select engineered fill" or "structural engineered fill" as described below would also be acceptable for use as "general engineered fill."

5.0 "SELECT ENGINEERED FILL"

Low to medium plastic clay with the following range of plasticity properties is generally considered suitable for use as "select engineered fill":

Liquid Limit	= 20 to 40%
Plastic Limit	= 10 to 20%
Plasticity Index	= 10 to 30%

Test results should be considered on a case-by-case basis.

"Pit-run gravel" and "fill sand" are generally considered acceptable for use as "select engineered fill." See exact project or jurisdiction for specifications.

The "pit-run gravel" should be free of any form of coating and any gravel or sand containing clay, loam or other deleterious materials should be rejected. No material oversize of the specified maximum sieve size should be tolerated. This material would typically have a fines content of less than 10%.

The materials above are also suitable for use as "general engineered fill."

6.0 "STRUCTURAL ENGINEERED FILL"

Crushed gravel used as "structural engineered fill" should be hard, clean, well graded, crushed aggregate, free of organics, coal, clay lumps, coatings of clay, silt, and other deleterious materials. The aggregates should conform to the requirement when tested in accordance with ASTM C136 and C117. See exact project or jurisdiction for specifications. This material would typically have a fines content of less than 10%.

In addition to the above, further specification criteria identified below should be met:

"Structural Engineered Fill" – Additional Material Properties

Material Type	Percentage of Material Retained on 5 mm Sieve having Two or More Fractured Faces	Plasticity Index (<400 μm)	L.A. Abrasion Loss (percent Mass)
Various sized Crushed Gravels	See exact project or jurisdiction for specifications	See exact project or jurisdiction for specifications	See exact project or jurisdiction for specifications

Materials that meet the grading limits and material property criteria are also suitable for use as "select engineered fill."

7.0 DRAINAGE MATERIALS

"Coarse gravel" for drainage or weeping tile bedding should be free draining. Free-draining gravel or crushed rock generally containing no more than 5% fine-grained soil (particles passing No. 200 sieve) based on the fraction passing the 3/4-inch sieve or material with sand equivalent of at least 30.

"Coarse sand" for drainage should conform to the following grading limits:

"Coarse Sand" Drainage Material – Percent Passing by Weight

Sieve Size	Coarse Sand*
10 mm	100
5 mm	95 – 100
2.5 mm	80 – 100
1.25 mm	50 – 90
630 μm	25 – 65
315 μm	10 – 35
160 μm	2 – 10
80 μm	0 – 3

* From CSA A23.1-09, Table 10, "Grading Limits for Fine Aggregate", Class FA1

Note that the "coarse sand" above is also suitable for use as pipe bedding material. See exact project or jurisdiction for specifications.

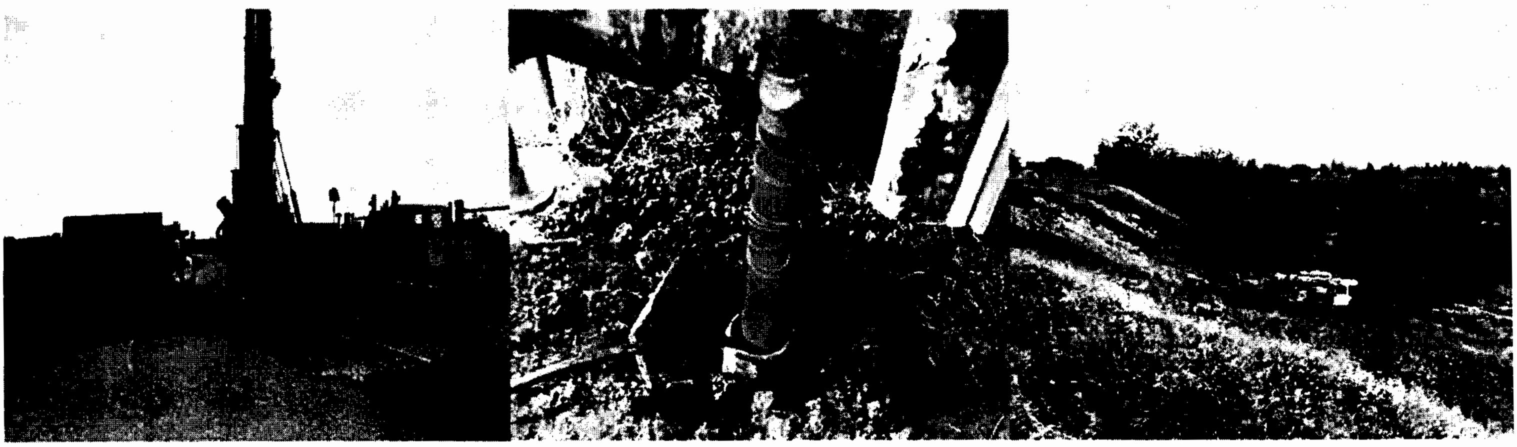
8.0 BEDDING MATERIALS

The "Coarse Sand "gradation presented above in Section 7.0 is suitable for use as pipe bedding and as backfill within the pipe embedment zone, however see exact project or jurisdiction for specifications.

TETRA TECH

Schedule 'B'

Geotechnical Milestone No. M#4
Supplemental Slope Stability Investigation
Redevelopment of Midfield Mobile Home Park, Former RCMP Property, and EMS Station #4
Moncton Road NE and 16 Avenue NE
Calgary, Alberta



PRESENTED TO

The City of Calgary

JULY 2022
ISSUED FOR USE CONFIDENTIAL
FILE 704-ENG CGEO04110-01

Tetra Tech Canada Inc
Suite 110, 140 Quarry Park Blvd SE
Calgary, AB T2C 3G3 CANADA
Tel 403 203 3355 Fax 403 203 3301

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LIMITATIONS OF REPORT

This report and its contents are intended for the sole use of The City of Calgary and the third parties noted below. Tetra Tech Canada Inc. does not accept any responsibility for the accuracy of any of the data, the analysis, or the recommendations contained or referenced in the report when the report is used or relied upon by any party other than The City of Calgary and the third parties noted below, or for any project other than the proposed development at the subject site. Any such unauthorized use of this report is at the sole risk of the user. This report is subject to the terms and conditions of the Master Consulting Terms and Conditions executed between The City of Calgary and Tetra Tech Canada Inc.

This report has been prepared for The City of Calgary and their agents. The City of Calgary shall at all times be entitled to fully use and rely on this report, including all attachments, drawings, and schedules, for the specific purpose for which the report was prepared, in each case notwithstanding any provision, disclaimer, or waiver in the report that reliance is not permitted.

The City of Calgary shall at all times be entitled to provide copies of the report to City Council, City of Calgary regulatory boards, City of Calgary employees, officers, agents, affiliates, advisors, consultants, parties contracting with The City of Calgary, lenders and assignees and other governmental authorities and regulatory bodies having jurisdiction, each of whom shall also be similarly entitled to fully use and rely on the report in the same manner and to the same extent as The City of Calgary for the specific purpose for which the report was prepared.

Recommendations presented herein are based on the findings in 6 boreholes. The conditions encountered during the fieldwork are considered to be reasonably representative of the site. If, however, conditions other than those reported are noted during subsequent phases of the project, Tetra Tech Canada Inc. should be notified and given the opportunity to review the current recommendations in light of new findings. Recommendations presented herein may not be valid if an adequate level of field review is not provided during construction or if relevant Building Code requirements are not met.

This report has been prepared for the exclusive use of The City of Calgary and the third parties noted above for specific application to the details described in this report. It has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty is made, either express or implied. Any such unauthorized use of this report is at the sole risk of the user.

1.0 INTRODUCTION

This report presents a summary of the slope monitoring instrumentation installations, slope monitoring results collected to date, and supplemental slope stability analyses results for the Redevelopment of Midfield Mobile Home Park project in northeast Calgary, Alberta. Tetra Tech Canada Inc. (Tetra Tech) was retained by The City of Calgary (The City) to provide the necessary geotechnical services for this redevelopment project.

More specifically, this report represents the Milestone No. M#4 *Final Geotechnical Report* deliverable as scoped within Tetra Tech's response to Supplemental Scope and Fee Schedule No. 18-2006-A05-S01-05, under Master Agreement RFSO 18-2006 Category E – Land Development, dated November 30, 2018. Authorization to proceed with this work was received from The City via Extension No. 5, dated April 21, 2021, of Purchase Order No. 0000728644P. This Milestone No. M#4 addresses the comments received from The City on the Milestone No. M#3 *Draft Geotechnical Report* dated April 28, 2022.

The Extension No. 5 scope of work, which includes 'Milestone M-Supplemental Slope Stability Investigation' and 'Milestone N-Regular Monitoring of Slope Inclinometers', was requested by The City following a surficial slope failure located just north of an existing asphalt pedestrian walkway in June 2020. Subsequently, an additional 'Milestone N-Regular Monitoring of Slope Inclinometers' interval was incorporated within the Extension No. 8 scope of work (Fee Schedule No. 18-2006-A05-S0108). This was a result of the Milestone No. N#6 interval being brought forward to provide an up-to-date representation of the existing conditions for use in the development of the geotechnical slope stabilization detailed design (Milestone No. O#1), while also maintaining instrumentation readings at a twelve-month interval.

The main objectives of Extension No. 5 and Extension No. 8 Milestone No. N#7 included the following:

- Mitigate future slope failures through the installation and regular monitoring of geotechnical slope instrumentation (i.e., Slope Inclinometers [SI] and Vibrating Wire Piezometers [VWP]). The instrumentation accomplishes this by pre-emptively identifying areas experiencing subsurface horizontal displacements and/or elevated porewater pressures that could result in a slope failure so that preventative stabilization measures can be applied.
- Further delineate the subsurface soil/groundwater conditions along the project site's northern slopes.
- Confirm and/or update the previously determined development construction setback distances through supplemental slope stability analyses integrating the additionally collected subsurface information and considering the results of the regular instrumentation monitoring program.
- Assess the previously observed slope instability areas, inclusive of the June 2020 failure area, and discuss potential slope stabilization measures for input into a detailed geotechnical design.

The purpose of this report is to provide a summary of the above-mentioned main objectives.

2.0 SITE DESCRIPTION

2.1 Location

The general proposed redevelopment project site is located northeast of the 16th Avenue NE and Moncton Road NE intersection in northeast Calgary, Alberta. The project site location is presented on **Figure 1**.

The proposed redevelopment covers an approximate area of 9.6 hectares (23.7 acres) and comprises three separate properties, listed below and outlined on **Figure 2**.

- Former Midfield Mobile Home Park with the municipal addresses of 954, 970, 990, and 1020 – 16th Avenue NE.
- Former Royal Canadian Mounted Police (RCMP) property with the municipal address of 920 – 16th Avenue NE.
- Existing Emergency Medical Services (EMS) Station #4 with the municipal address of 16 Moncton Road NE

2.2 Surface Condition

At the time of the geotechnical slope monitoring instrumentation installation program, the general proposed redevelopment project site was largely vacant (except for the EMS Station #4) and fenced along the perimeter. The temporary excavations for environmental remediation were in progress to replace the contaminated uncontrolled ravine fills with general engineered fill within areas slated for infrastructure construction. The EMS Station #4 property comprised one building with an asphalt parking lot located on the east side of the building.

The overall proposed redevelopment project site was generally level, apart from the temporary excavations for environmental remediation, with slight undulations noted in the vacant properties (i.e., Midfield Mobile Home Park and RCMP properties). Much of the existing ground surface within the fenced area was stripped of topsoil down to fill materials or native till soils while the existing slopes to the north, east, and south were grass covered with occasional pockets of shrubs/trees.

The proposed redevelopment project site north and east boundaries were elevated approximately 30.0 m above The Winston Golf Club and joined with a slope where gradients varied between roughly 2H:1V and 4H:1V with intermittent vegetated benches throughout (i.e., larger trees and short bushes). A paved asphalt pedestrian pathway was located near the north property line/crest of the existing slope. The slope to the south of the project site blended as required into the gradient of 16th Avenue NE.

The project site topography around the approximate time of the instrumentation installation program was provided by The City through LiDAR survey and is presented as contours on **Figure 2**.

2.3 Surficial Geology

Based on surficial geological mapping (Moran[1]) and Tetra Tech's experience in the area, the proposed redevelopment project site is understood to be located along several geological boundaries with the native soils expected to consist generally of pebble loam till, sand, and/or silt.

Three historical ravines were located along the north portion of the project site which were filled in the late 1960s with material containing organics and miscellaneous debris placed in an uncontrolled manner without proper compaction. The ravines were estimated to range between approximately 5.2 m to 13.7 m in depth based on the subsurface information obtained from the previous fieldwork programs conducted within the project site. The estimated boundaries of the historical ravines (i.e., uncontrolled filled areas) are presented on **Figure 2**.

2.4 Site Development History

The below **Table 1** presents a summary of the site development history in chronological order that is relevant to the main objectives of this work scope from a geotechnical perspective (i.e., reporting related to the environmental aspects of the redevelopment have been omitted); accordingly, the referenced deliverables may be referred to for any necessary supplementary background information.

[1] Moran, S.R. 1986. Surficial Geology of the Calgary Urban Area. Alberta Research Council, Bulletin No. 53

Table 1: Relevant Geotechnical Historical Site Development Documents

Document Title	Author	Date Issued	Geotechnically Pertinent Details
Midfield Mobile Home Park Slide, Report on Slope Stabilization Measures*	Geo-Engineering (M.S.T.) Ltd.	March 12, 1999	▪ Refer to dashed box area on **Figure 2** identified as 'Previous Geo-Engineering (M.S.T.) Ltd. Toe Berm Slope Stability Design Area'. ▪ A layer of high-plastic clay (approximate downslope daylight elevation of 1058.5 m to 1059.5 m) and leakage from a compromised stormwater sewer system near the slope crest were identified as the major contributors to a July 1998 slope failure. ▪ Advancement of four boreholes, designated TP-1 through TP-04 (refer to **Figure 2**), to support the detailed toe berm design. ▪ Installation of one slope inclinometer (Borehole TP-02), and eight standpipe piezometers (Boreholes TP-01 [one], TP-03 [four], and TP-04 [three]); however, no horizontal displacement monitoring results were provided. ▪ Suggested peak and residual soil strength friction angles for the high-plastic clay layer of 25 degrees and 15 degrees, respectively. ▪ A detailed slope stabilization design by means of a general engineered fill toe berm was developed (and eventually constructed) as a mitigation measure to increase the slope stability factor of safety to 1.2. ▪ Toe berm design included the placement of approximately 7,000 m^3 of general engineered fill to an overall elevation of approximately 1061.0 m prior to topsoil coverage.
Midfield Mobile Home Park, Slope Stability Evaluation*	Geo-Engineering (M.S.T.) Ltd.	December 6, 2006	▪ Refer to dashed box area on **Figure 2** identified as 'Previous Geo-Engineering (M.S.T.) Ltd. Toe Berm Slope Stability Design Area'. ▪ Reactivation of June 1998 slope failure area mid-slope and further downslope in summer 2005 and spring 2006, respectively, following heavy rainfall events. ▪ Advancement of four boreholes, designated MTP-1 through MTP-4 (refer to **Figure 2**), to further delineate features of the failure area. ▪ Installation of one slope inclinometer (Borehole MTP-3), and four standpipe piezometers (Boreholes MTP-1 [one], MTP-2 [two], and MTP-4 [one]); however, the slope inclinometer sheared at an approximate elevation of 1052.3 m prior to acquiring a reading. ▪ A detailed slope stabilization design by means of a general engineered fill toe berm was developed (and eventually constructed) as a mitigation measure to increase the slope stability factor of safety to 1.2. ▪ Toe berm design included the placement of approximately 8,000 m^3 of general engineered fill to an overall elevation of approximately 1057.0 m inclusive of the relocation of Teebox No. 14.
Midfield Mobile Home Park, Compaction & Concrete Testing & Inspection – June 2018 / July 2018 / August 2018*	M&B Technical Testing Services Ltd.	July 23, 2018 August 17, 2018 September 17, 2018	▪ Three letter reports detailing compaction effort and resulting in situ (field) density measurements of general engineered backfill following underground utility removals as conducted by Wilco Contractors Southwest Inc. ▪ Indicates general areas where backfill materials have been properly placed and compacted in a controlled manner.

Table 1: Relevant Geotechnical Historical Site Development Documents

Document Title	Author	Date Issued	Geotechnically Pertinent Details
Preliminary Geotechnical Evaluation and Slope Stability Assessment (Revision 1)	Tetra Tech Canada Inc.	February 7, 2020	▪ Preliminary geotechnical evaluation for the provision of design parameters and construction recommendations for the proposed redevelopment. Included the establishment of construction setback distances offset from the historically instable north slope required to achieve a factor of safety of 1.5 or greater (in accordance with The City's guidelines for developments along a slope). ▪ Advancement of eleven boreholes, designated BH19-01 through BH19-11, to further delineate the subsurface conditions within the entire project site. ▪ Recommended continued monitoring of identified observable slope instability areas (i.e., slumps and tension cracks).
Redevelopment of Midfield Mobile Home Park, Midfield M#1 Desktop and Site Review	Tetra Tech Canada Inc.	April 20, 2021	▪ Extension No. 5 Milestone No. M#1 *Desktop and Site Review* (attached as **Appendix A**). ▪ Site visit to determine the borehole locations for the slope monitoring instrumentation installations. ▪ Included an assessment of the existing condition of the 70 mm diameter slope inclinometer casing installed within Borehole TP-2, which was found to be functional. ▪ Document constituted the overall work plan for the fieldwork program executed as part of this Milestone No. M#4 deliverable and discussed further in **Section 3.0**.

Note: * As provided by The City of Calgary.

As highlighted above, the northeast slope leading into The Winston Golf Club (formerly Calgary Elks Golf & Country Club) was repaired/reinforced in 1999 and 2007 after slope failures that occurred in 1998 and 2006, respectively (general approximate area depicted within dashed box on **Figure 2**). The 1998 slope failure occurred mid-slope while the 2006 slope failure occurred near the slope toe. Both the slopes were repaired/reinforced using soil berms as evaluated and designed by Geo-Engineering (M.S.T.) Ltd. (Geo-Engineering).

A limited amount of the uncontrolled backfill was replaced with controlled general engineered backfill in 2018 during the removal of the previous Mobile Home Park and RCMP property underground utilities, as conducted by Wilco Contractors Southwest Inc. and verified/documented by M&B Technical Testing Services Ltd.

As part of Tetra Tech's response to Supplemental Scope and Fee Schedule No. 18-2006-A05-S01-05, Milestone No. M#1 *Desktop and Site Review* was planned to review the background data and conduct a site visit to observe the existing site conditions to determine the optimal locations for slope monitoring instruments. This Milestone No. M#1 *Desktop and Site Review* is attached as **Appendix A** for reference and formed the basis of the instrument installation program discussed further in **Section 3.0**.

Note that environmental remediation through soil removal and replacement with controlled general engineered backfill was in progress at the time of this report's preparation. The eventual construction summary document (i.e., as constructed) presenting the extent of material removal and backfilling, once completed, should be referred to when considering geotechnical design and construction requirements/specifications for any future structure(s) within the project site.

3.0 FIELD AND LABORATORY WORK

3.1 Fieldwork

The underground utility services within the vicinity of the proposed borehole locations for the installation of slope monitoring instrumentation were located using Alberta One-Call and private locator Tierra Geomatic Services Inc. (Tierra) prior to advancement.

The slope monitoring instruments were installed from May 17 to May 21, 2021 (inclusive), utilizing track-mounted rig(s) equipped with 150 mm (6 inch) diameter solid-stem continuous flight augers, 159 mm (6¼ inch) diameter hollow-stem augers, or a high-frequency sonic vibratory drill contracted from Mobile Augers and Research Ltd., of Calgary, Alberta. The selection of the drill equipment was dependant on rig availability, the expected/observed subsurface conditions (soil and groundwater), and the need to otherwise interchange techniques for drilling efficiencies.

A total of six boreholes, designated as Boreholes BH21-12 through BH21-17 (continuation of the numbering system from the preliminary geotechnical evaluation fieldwork), were drilled to completion depths ranging from approximately 10.7 m to 25.5 m below the existing ground surface. The borehole locations (coordinates and ground elevations) were surveyed by Tierra at the time of private utility locating. The borehole locations are presented on **Figure 2** with a summary, inclusive of locations and completion depths, presented in **Table 2**.

Table 2: Borehole Locations and Depths

Borehole No.	Northing (m)*	Easting (m)*	Elevation (m)*	Borehole Depth Below Existing Ground Surface (m)	Installed Instrumentation Depth / Elevation (m)*	
					Slope Inclinometer**	Vibrating Wire Piezometer** (Serial No.)
BH21-12	5659201.8	-2760.0	1075.9	25.5	25.0 / 1050.9	15.2 / 1060.7 (#132946)
BH21-13	5659245.5	-2744.2	1063.6	10.7	10.4 / 1053.2	9.1 / 1054.5 (#132933)
BH21-14	5659172.1	-2637.7	1075.4	19.8	19.5 / 1055.9	13.7 / 1061.7 (#132926)
BH21-15	5659170.0	-2579.3	1075.2	19.8	18.9 / 1056.3	13.7 / 1061.5 (#132945)
BH21-16	5659196.8	-2578.9	1064.5	12.2	11.6 / 1052.9	11.6 / 1052.9 (#132925)
BH21-17***	5659206.0	-2439.9	1059.9	15.2	14.6 / 1045.3	14.6 / 1045.2 (#132947)

Notes: * Coordinates are based on 3TM grid surveyed to a geodetic benchmark, as provided by Tierra Geomatic Services Inc.
** Additional details pertaining to the installed slope monitoring instrumentation are provided in **Section 3.3**.
*** Installed slope inclinometer casing is 70 mm in diameter (opposed to the generally installed 85 mm throughout the project site).

Disturbed soil samples were recovered at regular intervals from the solid-stem auger flights or sonic cuttings within each borehole except for Borehole BH21-12 which was advanced using hollow-stem augers. Standard Penetration Tests (SPTs) were typically performed with the blow counts recorded at regular 1.5 m intervals mostly taken within the native soils. Relatively undisturbed thin-walled Shelby Tube samples were collected at selected locations targeting observed/perceived softer soils that may be more prone to horizontal displacements for advanced laboratory testing (i.e., direct shear testing). Additionally, Pocket Penetration (PP) tests were conducted on select cohesive soil grab samples.

All soil samples were visually classified in the field, and the individual soil strata and interfaces between them were noted. The resulting instrumentation installation borehole logs and an explanation of the terms and symbols used on the logs are provided in **Appendix B.**

The high-frequency sonic vibratory drill method, as well as certain obtained SPT samples, enabled observation of relatively continuous subsurface soil samples (where that drilling equipment or sampling methodology was employed), which were photographed if deemed appropriate in the field. These photographs, where obtained and considered added value, have been provided on the installation borehole logs in **Appendix B** for supplementary visual information purposes; however, in the event of discrepancy between the installation borehole log data and the photographs, the installation borehole log data takes precedence.

3.2 Laboratory Work

Following the completion of the subsurface fieldwork, laboratory testing was performed on selected samples collected from the boreholes to aid in the evaluation of their engineering properties. Laboratory testing included the following:

- Natural moisture content (American Society for Testing and Materials [ASTM] D2216).
- Atterberg limits (ASTM D4318).
- Particle size analysis hydrometer (ASTM D7928).
- Direct shear (ASTM D3080).

Laboratory testing results are summarized in **Table 3** as well as presented on the borehole logs in **Appendix B** with the individual laboratory result sheets attached for reference in **Appendix C**.

Table 3: Laboratory Test Results Summary

ID	Sample Location		MC (ASTM D2216) (%)	Particle Size Analysis (ASTM D7928)				Atterberg Limits (ASTM D4318)			Direct Shear Strength (ASTM D3080) (Cohesion / Angle)	
	Avg. Depth (m)	Avg. Elev. (m)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Peak (kPa/°)	Residual (kPa/°)
BH21-12	1.7	1074.2	19.8									
	5.4	1070.5	41.2									
	10.0	1065.9	13.4									
	13.0	1062.9	8.6									
	14.9	1061.0	17.7					25	14	11		
	17.6	1058.3	27.3									
	20.7	1055.3	20.9									
	25.2	1050.7	26.0									

Table 3: Laboratory Test Results Summary

ID	Sample Location		MC (ASTM D2216) (%)	Particle Size Analysis (ASTM D7928)				Atterberg Limits (ASTM D4318)			Direct Shear Strength (ASTM D3080) (Cohesion / Angle)	
	Avg. Depth (m)	Avg. Elev. (m)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Peak (kPa/°)	Residual (kPa/°)
BH21-13	3.1	1060.5	18.2									
	4.6	1059.7	16.6									
	6.1	1057.5	16.7									
	7.6	1056.0	25.4					32	20	12		
	8.5	1055.1									7.8 / 31.8	5.8 / 28.9
	10.0	1053.6	16.8									
BH21-14	2.3	1073.2	26.2									
	4.1	1071.3	20.9									
	8.1	1067.4	18.4									
	11.4	1064.0	17.6									
	13.3	1062.2	30.9	1	20	46	33	38	19	19		
	13.9	1061.6	30.0					56	23	33		
	15.5	1060.0									18.3 / 26.3	11.7 / 23.0
	16.3	1059.1	26.7									
	19.4	1056.1	9.4									
BH21-15	2.0	1073.2	22.2									
	5.3	1069.9	22.1									
	7.2	1068.0	35.2									
	8.4	1066.8	18.5									
	14.5	1060.7	28.1	1	5	77	17	27	20	7		
	16.9	1058.3	10.1									
	18.5	1056.7	16.2									
	19.1	1056.2	14.1									
BH21-16	1.4	1063.1	15.6									
	3.2	1061.3	4.2									
	4.7	1059.8	6.6	0	78	14	8					
	6.3	1058.2	3.2									
	7.8	1056.7	2.8									
	9.3	1055.2	5.7									
	10.8	1053.7	10.2									

Table 3: Laboratory Test Results Summary

ID	Sample Location		MC (ASTM D2216) (%)	Particle Size Analysis (ASTM D7928)				Atterberg Limits (ASTM D4318)			Direct Shear Strength (ASTM D3080) (Cohesion / Angle)	
	Avg. Depth (m)	Avg. Elev. (m)		Gravel (%)	Sand (%)	Silt (%)	Clay (%)	LL (%)	PL (%)	PI (%)	Peak (kPa/°)	Residual (kPa/°)
BH21-17	1.7	1058.2	16.0									
	3.2	1056.7	17.1					32	16	16		
	4.4	1055.4	13.1									
	6.3	1053.6	15.1									
	7.8	1052.1	14.5									
	10.8	1049.0	14.8									
	13.9	1046.0	14.6									

Notes: * MC = Moisture Content; LL = Liquid Limit; PL = Plastic Limit; PI = Plasticity Index.

3.3 Slope Monitoring Instrumentation Installation Procedures

3.3.1 General

The following subsections describe the means and methods associated with the installation of the slope monitoring instrumentation within the subsurface investigation borehole locations. Note that the details of the instruments are also presented on the borehole logs within **Appendix B**. Material specification product sheets for the installed instruments from Durham Geo Slope Indicator (DGSI) and RST Instruments Ltd. (RST) are provided in **Appendix D** for reference.

3.3.2 Slope Inclinometer (SI) Installation

The installation of the SI instruments included the following:

- Glue and snap 85 mm outside diameter (73 mm inside diameter) casings supplied by RST and 70 mm outside diameter (59 mm inside diameter) casings supplied by DGSI with casing anchors attached at the base. The 70 mm casing was installed at Borehole BH21-17 to better correlate any measured horizontal displacements with the existing 70 mm casing installed immediately upslope within historical Borehole TP-2.
- A 25 mm polyvinyl chloride grout tube was attached to the outside of the casings for grout tremie purposes which extended to the borehole bottom with the casing and anchor.
- The casings were inserted into the borehole with one set of grooves oriented approximately parallel to the slope crest alignment and the other set perpendicular. Attempts were made to limit casing rotation during installation. The casings had the following angle offsets for the grooves relative to perpendicular (downslope) orientation following installation: BH21-12 at 12° counter-clockwise; BH21-13 at 6° clockwise; BH21-14 at 3° counter-clockwise; BH21-15 at 2° counter-clockwise; BH21-16 at 7° clockwise; BH21-17 at 14° counter-clockwise. In addition, the previously installed casing within Borehole TP-2 has an orientation relative to perpendicular of 7° clockwise.
- Once the casing reached the bottom depth the anchor 'wings' were released to resist uplift forces during grouting.
- The SIs were grouted in-place from the bottom up using a mixture of water, cement, and bentonite with an approximate mix ration of 100 kg, 40 kg, and 10 kg, respectively.

- Protective covers were installed over the top of the SI casings which were grouted into place.

3.3.3 Vibrating Wire Piezometer (VWP) Installation

The installation of the VWP instruments included the following:

- Piezometer tips supplied by RST with pressure range between 0 kPa and 350 kPa (Model No. VW2100). The calibration sheets for the piezometer tips are included in **Appendix E** which are required to calculate the water pressure from the instrument readings. The serial numbers of the VWPs within each borehole are provided in **Table 2**.
- Prior to installation, the VWP tips were soaked in water for more than 24 hours per manufacturer specifications and read prior to installation while comparing to the calibration sheet 'zero pressure' reading to ensure proper functionality.
- Once the borehole reached completion depth, the location of the VWP was determined targeting areas of observed increased groundwater seepage and/or soil layers suspected to be susceptible to excess porewater pressures (i.e., high plastic clays).
- The VWP was taped tip up to the outside of the SI at the predetermined installation depth during lowering of the casings. The VWP cable wires were then taped to the SI casings at regular intervals together with the grout tube to the surface.
- The VWP's were then grouted in-place together with the SI casings using a mixture of water, cement, and bentonite with an approximate mix ration of 100 kg, 40 kg, and 10 kg, respectively.
- The excess VWP cable wire was then housed within the protective cover.

4.0 SUBSURFACE CONDITIONS

4.1 General

The following subsections present a summary of the soil and groundwater conditions based only on the six boreholes advanced during this instrument installation fieldwork program (i.e., excludes results of previous subsurface investigations conducted by Tetra Tech and others for brevity). The details of the soil and groundwater conditions encountered at each discrete borehole location are presented on the individual logs in **Appendix B**. Note that geological conditions are innately variable.

4.2 Soil Conditions

4.2.1 Topsoil

Topsoil was encountered in all the boreholes at the existing ground surface with thicknesses ranging from approximately 150 mm to 300 mm. The topsoil was variable but can generally be described as containing some sand to sandy, some clay, some silt to silty, trace gravel, dry to damp, and dark brown in colour, with organics.

The exact lateral and vertical extent of the topsoil in the areas surrounding the boreholes may vary and was not determined as part of this instrumentation installation stability assessment.

4.2.2 Fill Soils

As mentioned in **Section 2.0**, the project site is understood to contain a significant amount of uncontrolled backfill material containing organics and miscellaneous debris most notably within/in proximity to the three previously existing ravines (estimated to generally range between approximately 5.2 m to 13.7 m in depth within the project site). Consequently, sand and/or clay fill materials were encountered below the topsoil within all the boreholes apart from Borehole BH21-16 which is conceivable given its position relative to the understood location of the historical ravines.

Sand fill was encountered within Borehole BH21-12 below the topsoil overlying clay fill with a thickness of approximately 1.1 m. The sand fill can generally be described as containing some silt, trace clay, trace gravel, fine grained, poorly graded, and dark brown in colour.

Clay fill was encountered in every borehole, apart from Borehole BH21-16, below the topsoil or sand fill (as in Borehole BH21-12) with thicknesses ranging from approximately 2.5 m to 13.1 m. The clay fill can generally be described as containing some silt to silty, trace sand to sandy, trace to some gravel, low plastic, damp to wet, brown to grey in colour, with organics including wood debris and hydrocarbon odours. Field soil consistency measurements were taken within the clay fill which resulted in SPT values ranging from 4 to 19 (average of approximately 12) and PP values ranging from 50 kPa to 450 kPa (average of approximately 165 kPa).

Consider that the thickness and composition of the fill soils may vary in areas surrounding the boreholes. A detailed assessment of the fill thickness and composition was not undertaken as part of this assessment. Note that environmental remediation through soil removal and replacement with controlled general engineered backfill was in progress at the time of this report's preparation. The eventual construction summary document (i.e., as constructed) presenting the extent of material removal and backfilling, once completed, should be referred to when considering the ultimate uncontrolled backfill and controlled backfill extents.

4.2.3 Glacial Till (Silt/Clay)

Glacial silt and/or clay till was encountered underlying the topsoil, fill materials, or clay layer within every borehole at initial depths ranging from approximately 0.3 m to 25.0 m below the existing ground surface and typically progressed to the borehole completion depth.

Silt till was encountered within Boreholes BH21-12, BH21-14, BH21-15, and BH21-17 at depths ranging from approximately 4.1 m to 25.0 m below the existing ground surface and thicknesses ranging from approximately 1.5 m to 3.1 m or otherwise progressing to the borehole completion depth (Borehole BH21-12). The silt till can generally be described as containing trace sand to sandy, trace to some clay, trace gravel, stiff to very stiff in consistency (SPTs ranging from 11 to 24 [average of 18]), moist to wet, low to non-plastic, and brown in colour. A direct shear strength laboratory test was conducted on a Shelby Tube sample collected from Borehole BH21-14 at a depth of approximately 15.5 m with the results summarized in **Table 3** and provided in **Appendix C**.

Clay till was encountered in every borehole, apart from Borehole BH21-12, at depths ranging from approximately 0.3 m to 8.2 m below the existing ground surface and thicknesses ranging from approximately 1.5 m to 5.5 m or otherwise progressing to the borehole completion depth (BH21-17). The clay till can generally be described as containing trace sand to sandy, some silt to silty, trace gravel, trace cobbles, firm to very stiff in consistency (SPTs ranging from 8 to 26 [average of 19]; PPs ranging from 50 kPa to 200 kPa [average of approximately 150 kPa]), dry to moist, low to medium plastic, and brown to grey in colour. Two VWPs were installed in the clay till within Boreholes BH21-15 and BH21-17 at depths of approximately 13.7 m and 14.6 m, respectively.

4.2.4 Clay

A primarily clay deposit, as distinguished by its decreased percentage of secondary constituents and increased plasticity, was encountered within Boreholes BH21-12, BH21-13, and BH21-14 at depths ranging from approximately 7.2 m to 14.3 m below the existing ground surface and thicknesses of 2.4 m and 10.7 m or otherwise progressing to the borehole completion depth (Borehole BH21-13). The clay deposit can generally be described as silty, containing trace to some sand, trace gravel, firm to hard in consistency (SPTs ranging from 7 to 32 [average of 16]; PPs of 50 kPa and 75 kPa), damp to wet, low to high plastic, and brown in colour.

Three VWPs were installed in the clay deposit within Boreholes BH21-12, BH21-13, and BH21-14 at depths of approximately 15.2 m, 9.1 m, and 13.7 m, respectively.

A direct shear strength laboratory test was conducted on a Shelby Tube sample collected from Borehole BH21-13 at a depth of approximately 8.5 m with the results summarized in **Table 3** and provided in **Appendix C**.

4.2.5 Sand

Sand deposits were encountered within Boreholes BH21-14, BH21-15, and BH21-16 at depths ranging from approximately 2.1 m to 17.7 m below the existing ground surface and progressed to the borehole completion depths. The sand deposits can generally be described as containing some silt to silty, trace clay, trace gravel, fine grained, poorly graded, compact to very dense in consistency (SPTs ranging from 12 to 72 [average of 29]), damp to moist, and brown in colour.

One VWP was installed in the sand deposit within Borehole BH21-16 at a depth of approximately 11.6 m.

4.3 Groundwater Conditions

The borehole locations were visually observed for groundwater seepage levels during advancement and the groundwater levels were calculated from the VWP readings during the execution of the 'Milestone N-Regular Monitoring of Slope Inclinometers'. A summary of the groundwater level readings taken to date is presented in Table 4.

Table 4: Groundwater Level Readings to Date

Borehole No.	VWP Tip Depth (m)	VWP Tip Elev. (m)*	Soil Unit	Approximate Observed Seepage During Drilling*	Date	Calculated Piezometric Elev. (m)**
BH21-12	15.2	1060.7	Clay	7.6 m (El. 1068.3 m)	June 4, 2021	1061.2
					June 14, 2021	1061.2
					July 5, 2021	1061.3
					August 21, 2021	1061.2
					October 19, 2021	1061.2
					November 22, 2021	1061.2
					February 25, 2022	1061.1
					June 21, 2022	1061.1
BH21-13	9.1	1054.5	Clay	8.7 m (El. 1054.9 m)	June 4, 2021	1054.5
					June 14, 2021	<1054.5
					July 5, 2021	<1054.5
					August 21, 2021	<1054.5
					October 19, 2021	<1054.5
					November 22, 2021	<1054.5
					February 25, 2022	<1054.5
					June 21, 2022	<1054.5

Table 4: Groundwater Level Readings to Date

Borehole No.	VWP Tip Depth (m)	VWP Tip Elev. (m)*	Soil Unit	Approximate Observed Seepage During Drilling*	Date	Calculated Piezometric Elev. (m)**
BH21-14	13.7	1061.7	Clay	14.6 m (El. 1060.8 m)	June 4, 2021	1061.8
					June 14, 2021	1061.8
					July 5, 2021	1061.8
					August 21, 2021	1061.8
					October 19, 2021	1061.8
					November 22, 2021	1061.8
					February 25, 2022	1061.8
					June 21, 2022	1061.7
BH21-15	13.7	1061.5	Clay Till	13.7 m (El. 1061.5 m)	June 4, 2021	1061.5
					June 14, 2021	<1061.5
					July 5, 2021	<1061.5
					August 21, 2021	1061.6
					October 19, 2021	<1061.5
					November 22, 2021	<1061.5
					February 25, 2022	1061.5
					June 21, 2022	1061.5
BH21-16	11.6	1052.9	Sand	Not observed	June 4, 2021	1052.9
					June 14, 2021	<1052.9
					July 5, 2021	<1052.9
					August 21, 2021	<1052.9
					October 19, 2021	1052.9
					November 22, 2021	<1052.9
					February 25, 2022	<1052.9
					June 21, 2022	<1052.9
BH21-17	14.6	1045.2	Clay Till	Not observed	June 4, 2021	1045.3
					June 14, 2021	1045.2
					July 5, 2021	<1045.2
					August 21, 2021	<1045.2
					October 19, 2021	<1045.2
					November 22, 2021	<1045.2
					February 25, 2022	1045.3
					June 21, 2022	1045.3

Notes: * Elevations are based on 3TM grid surveyed to a geodetic benchmark, as provided by Tierra Geomatic Services Inc.
** Piezometric elevations are calculated using the VWP calibration sheets, as provided in **Appendix E**, and the survey data provided by Tierra Geomatic Services Inc.

Groundwater seepage was observed during the advancement of the boreholes at depths ranging from approximately 7.6 m to 14.6 m below the exiting ground surface (elevations of approximately 1054.9 m to 1068.3 m). The groundwater seepage that was observed during drilling within Borehole BH21-12 at a depth of approximately 7.6 m, representing an elevation of 1068.3 m, can likely be attributed to a perched groundwater table as also observed during the preliminary geotechnical evaluation fieldwork (which reported a perched groundwater table between elevations of approximately 1065.3 m to 1070.1 m).

The groundwater levels were calculated using the data collected from the VWPs which resulted in groundwater table elevations ranging from approximately 1045.2 m to 1061.8 m. All piezometric elevations calculated to date have been near or below the VWP tip installation elevation except for Borehole BH21-12, which has remained at a water pressure head of approximately 0.4 m to 0.6 m.

Groundwater levels typically fluctuate seasonally due to climatic conditions (high in late spring and early summer). There is also potential for perched groundwater to develop within the uncontrolled fill materials and sand/silt soils, particularly during heavy rain events.

5.0 SUPPLEMENTAL SLOPE STABILITY ANALYSIS

5.1 General

The following subsections present a summary of the methodology and results of the supplemental slope stability analysis conducted to re-establish/corroborate the redevelopment setback distances originally determined within Tetra Tech's preliminary geotechnical evaluation. This was conducted in response to the June 2020 slope failure to ensure The City's guidelines for developments located along slopes were still adhered to (i.e., global slope stability factor of safety of 1.5 or greater).

To progress redevelopment approvals, The City asked that interim slope stability analysis be conducted and provided in advance of this document. The interim slope stability results were provided within the 'Milestone No. N#3' deliverable which is attached in **Appendix F** for reference.

These supplemental slope stability analyses build on the interim 'Milestone No. N#3' results as well as include additional assessments for the historical slope failure toe berm area (as designed by Geo-Engineering) and pedestrian asphalt paved walkway, at the request of The City.

The slope stability assessment for the historical failure toe berm area (previously analyzed by Tetra Tech as a 'Back Analysis') first included duplicating the results of Geo-Engineering's 2006 toe berm design (in which a factor of safety of 1.2 was achieved) and amending as appropriate based on the factual data of this subsurface investigation and regular instrumentation monitoring.

The pedestrian asphalt paved walkway results are provided for information purposes only and have not been assessed considering the customary City requirement for developments located along slopes (i.e., global slope stability factor of safety of 1.5 or greater). Noting that the purpose of the analyzed and established construction setback distances is to ensure that the slope stability factor of safety requirement is met in relation to the location of the redevelopment structures.

These supplemental slope stability analyses were conducted using the *Slope/W* component of the *GeoStudio* computer software program (Version 11.2.0).

5.2 Regular Instrumentation Monitoring Results

Since the slope monitoring instruments were installed in May 2021, there have been seven intervals in which readings have been taken for any horizontal displacements and/or elevated adverse pore water pressures that might suggest potential impending slope failures (i.e., June 4, 2021; June 14, 2021; July 5, 2021; August 21, 2021; November 22, 2021; February 25, 2022; June 21, 2022). The results of the 'Milestone N-Regular Monitoring of Slope Inclinometers' that have been collected and provided to date have been considered within the supplemental slope stability analysis discussed herein and have been attached within **Appendix F** for reference (i.e., Milestones No. N#1 through N#7).

In general, the results of Milestones No. N#1 through N#7 portray the following relevant items related to the supplemental slope stability analysis:

- Downslope horizontal displacements of approximately 5 mm within Borehole BH21-12 casing at depths of approximately 3.5 m (fill materials) and 19.5 m (clay) corresponding to approximate elevations of 1072.4 m and 1056.4 m; however, these are not yet of a magnitude to suggest the soils have undergone enough strain to reduce their shear strength to a minimum residual state.
- Calculated Bbar/r_u values from all the VWP readings are below a value of 0.1 which is typically used in slope stability analysis for these types of cohesive based fill materials (based on Tetra Tech's experience with similar materials in similar conditions). The calculated pressures also do not suggest significantly elevated porewater conditions within the native soils at the elevations where VWP tips were installed.
- Visual monitoring suggests the existing observable slope movement slumps, cracks, and settlements have not significantly increased in magnitude over the duration of the monitoring period; however, it is understood The City requests these areas be mitigated, which includes the June 2020 failure area, which is further discussed in **Section 6.2**.

The installed slope monitoring instrumentation should continue to be used as part of a general observational approach methodology to assess the overall stability of the project site northern slopes. Certain circumstances or events at the project site may prompt the collection of additional measurements to confirm stable slope conditions such as, but not necessarily limited to; visually observable slope instabilities, precipitation event which greatly exceeds historical averages, the introduction of surcharge loading above that previously analyzed or imposed, changes in the slope condition/geometry due to future development at the upper or lower areas of the slope, and/or if an arbitrary reading interval suggests increasing adverse conditions. Based on the slope monitoring measurements collected to date (June 21, 2022), Tetra Tech recommends the instruments next be read following a significant rain event sometime in June/July 2023. Once the results of that monitoring interval have been processed and reviewed, Tetra Tech can propose a date for a subsequent instrumentation reading.

5.3 Analysis Section Updates

Based on the fieldwork laboratory testing results (refer to **Section 3.2**), the overall additional subsurface information collected (refer to **Section 4.0**), and the regular slope instrumentation monitoring results collected to date (refer to **Section 5.2**), amendments to the previous slope stability analysis section configurations were required, as detailed in **Table 5.** Note that only the analysis section items that were modified have been detailed below. The locations of the analysis sections and general analyzed areas are presented on **Figure 2**.

Table 5: Analysis Section Update Summary

Preliminary Slope Stability Details*		Supplemental Slope Stability Updates	
Analysis Section	**Previous Section Configuration and Material Properties**	**Analysis Section**	**Updated Section Configuration and Material Properties**
A-A'	<u>Material Boundaries:</u> 1. Existing ground surface based on LiDAR provided by The City (LIDAR_DEM_2018_Midfield_Park). 2. Fill material base at a constant El. 1060.2 m. 3. Clay layer thickness at a constant approximate 2.1 m. 4. Silt till top at a constant El. 1058.1 m. 5. Clay till layer not included. <u>Material Strengths:</u> 6. Clay strength friction angle of 15° with a cohesion of 0 kPa. 7. Clay till layer not included. 8. Silt till cohesion of 0 kPa. <u>Piezometric Groundwater Tables</u> 9. Estimated phreatic surface and r_u=0.1 applied.	A-A'	<u>Material Boundaries:</u> 1. Existing ground surface re-processed and imported given errors in original data reduction. 2. Fill material base shifted to El. 1061.5 m at Borehole BH21-12 and El. 1059.5 m at Borehole BH21-13. 3. Clay layer thickness increased to 7.1 m at Borehole BH21-12 and 3.5 m at Borehole BH21-13. 4. Silt till top decreases from El. 1054.4 m at Borehole BH21-12 to El. 1053.0 m at Borehole BH21-13. 5. Clay till layer included between the fill and clay units with a thickness of 0.0 m at Borehole BH21-12 to a thickness of 3.0 m at Borehole BH21-13. <u>Material Strengths:</u> 6. Clay strength friction angle increased to 25° with a cohesion of 2.5 kPa. Based on the results of the advanced direct shear laboratory testing (refer to **Table 3** and **Appendix C**) and lack of horizontal displacements within the installed SIs suggest peak native clay soil strengths at depth in this area. 7. Clay till strength friction angle of 27° with a cohesion of 2.0 kPa included (no change in previously assigned strength for clay till). 8. Silt till cohesion increased to 2 kPa. Based on the results of the advanced direct shear laboratory testing (refer to **Table 3** and **Appendix C**). <u>Piezometric Groundwater Tables</u> 9. General reduction in estimated phreatic surface based on VWP monitoring results (refer to **Table 4**) and r_u=0.1 unchanged.

B-B'**	<u>Material Boundaries:</u> 1. Existing ground surface based on LiDAR provided by The City along analysis section designated B-B' (LIDAR_DEM_2018_Midfield_Park). 2. Clay till layer thickness at a constant approximate 1.5 m. 3. Clay layer thickness at a constant approximate 7.5 m with top El. 1066.5 m and bottom El. 1059.0 m. 4. Sill till top at a constant El. 1059.0 m and no defined bottom. 5. Sand layer not included. <u>Material Strengths:</u> 6. Clay strength friction angle of 15° with a cohesion of 0 kPa. 7. Silt till cohesion of 0 kPa. 8. Sand layer not included. <u>Piezometric Groundwater Tables</u> 9. Estimated phreatic surface and r_u=0.1 applied.	B1-B1'**	<u>Material Boundaries:</u> 1. Existing ground surface based on LiDAR provided by The City along analysis section previously designated B-B', relabeled to B1-B1'. 2. Clay till layer thickness increased to 5.0 m at Borehole BH21-14. 3. Clay layer thickness reduced at BH21-14 to a constant approximate 2.0 m with top El. 1063.0 m and bottom El. 1061.0 m. 4. Silt till top shifted to El. 1061.0 m at BH21-14 and inclusion of bottom at El. 1058.0 m. 5. Sand layer included at BH21-14 with top El. 1058.0 m. <u>Material Strengths:</u> 6. Clay strength friction angle increased to 25° with a cohesion of 2.5 kPa. Based on the results of the advanced direct shear laboratory testing (refer to **Table 3** and **Appendix C)** and lack of horizontal displacements within the installed SIs suggest peak native clay soil strengths at depth in this area. 7. Silt till cohesion increased to 2 kPa. Based on the results of the advanced direct shear laboratory testing (refer to **Table 3** and **Appendix C**). 8. Sand strength friction angle of 30° with a cohesion of 0 kPa included (no sand layers present in any of previous analysis). <u>Piezometric Groundwater Tables</u> 9. None. Worst case estimated phreatic surface and r_u=0.1 remained given the absence of additional groundwater level information at/near the slope toe.

Table 5: Analysis Section Update Summary

Preliminary Slope Stability Details*		Supplemental Slope Stability Updates	
Analysis Section	**Previous Section Configuration and Material Properties**	**Analysis Section**	**Updated Section Configuration and Material Properties**
B-B'**	Material Boundaries: 1. Existing ground surface based on LiDAR provided by The City along analysis section designated B-B' (LIDAR_DEM_2018_Midfield_Park). 2. Clay till layer thickness at a constant approximate 1.5 m. 3. Clay layer thickness at a constant approximate 7.5 m with top El. 1066.5 m and bottom El. 1059.0 m. 4. Sill till top at a constant El. 1059.0 m and no defined bottom. 5. Sand layer not included. Material Strengths: 6. Clay strength friction angle of 15° with a cohesion of 0 kPa. 7. Silt till cohesion of 0 kPa. 8. Sand layer not included. Piezometric Groundwater Tables 9. Estimated phreatic surface and r_u=0.1 applied.	B2-B2'**	Material Boundaries: 1. Existing ground surface based on LiDAR provided by The City along June 2020 failure designated B2-B2' (new analysis section). Incorporated changes in the surface since LiDAR date resulting from the failure through supplemental survey collected by The City and provided via email dated July 7, 2021 (The City[2]). 2. Clay till layer thickness increased to 5.5 m with top El. 1067.0 m (from El. 1068.0 m). 3. Clay layer removed. 4. Silt till top shifted to El. 1061.5 m at BH21-15 and inclusion of bottom at El. 1060.0 m. Silt till layer removed at BH21-16. 5. Sand layer included with top El. 1060.0 m at BH21-15 and El. 1062.5 m at BH21-16. Material Strengths: 6. Clay layer removed. 7. Silt till cohesion increased to 2 kPa. Based on the results of the advanced direct shear laboratory testing (refer to **Table 3** and **Appendix C**). 8. Sand strength friction angle of 30° with a cohesion of 0 kPa included (no sand layers present in any of previous analysis). Piezometric Groundwater Tables 9. Updated estimated phreatic surface based on VWP monitoring results along B2-B2' (refer to **Table 4**) and r_u=0.1 unchanged.

[2] Dort, Malcolm. Email to Kyle Haugrud. Subject '*FW: Midfield Heights Survey Request – June 2020 Slope Failure Area*'. July 7, 2021.

Table 5: Analysis Section Update Summary

Preliminary Slope Stability Details*		Supplemental Slope Stability Updates	
Analysis Section	**Previous Section Configuration and Material Properties**	**Analysis Section**	**Updated Section Configuration and Material Properties**
Back Analysis	<u>Material Boundaries:</u> 1. Existing ground surface and subsurface boundaries based on Geo-Engineering (M.S.T.) Ltd. 1999 slope stability evaluation. 2. Clay fill not included. 3. Clay layer (residual strength) top at El. 1061.5 m to El. 1059.0 m and no defined bottom. 4. Clay till not included below clay layer (residual strength). <u>Material Strengths:</u> 5. Clay fill not included. 6. Clay till not included below clay layer (residual strength). <u>Piezometric Groundwater Tables</u> 7. Estimated phreatic surface and r_u=0.1 applied.	Toe Berm Design Area (general area identified on **Figure 2**)	<u>Material Boundaries:</u> 1. Existing ground surface and subsurface boundaries updated based on Geo-Engineering (M.S.T.) Ltd. 2006 slope stability evaluation toe berm design inclusive of residual strength clay progressing downslope to the approximate location of the designed shear plane 'key-in'. 2. Clay fill included in areas of 1999 and 2006 toe berm designs. 3. Clay layer (residual strength) thickness reduced to a constant approximate 2.0 m mimicking the existing slope gradient to the shear plan 'key-in'. 4. Clay till included below clay layer (residual strength). <u>Material Strengths:</u> 5. Clay fill strength friction angle of 25° with a cohesion of 0.5 kPa included (no change in previously assigned strength for clay fill). 6. Clay till strength friction angle of 27° with a cohesion of 2.0 kPa included (no change in previously assigned strength for clay till). <u>Piezometric Groundwater Tables</u> 7. Extended estimated phreatic surface downslope and r_u=0.1 unchanged.
C-C'	1. Refer to note '*'.	C-C' (general area identified on **Figure 2**)	1. The original analysis provided within the preliminary geotechnical evaluation for section C-C' takes precedence as no additional information was collected in proximity to warrant an update (nearest subsurface information collected at an offset of approximately 120 m at BH21-17).

Notes: * As per Tetra Tech's 'Preliminary Geotechnical Evaluation and Slope Stability Assessment (Revision 1)' report dated February 7, 2020.
** General area represented by previous analysis Section B-B' was split into two analysis sections, designated Sections B1-B1' and B2-B2', to differentiate/analyze the June 2020 failure separately.

5.4 Material Parameters

The slope stability analysis configurations, stratigraphy, material parameters, and piezometric elevations are as per the initial preliminary geotechnical evaluation analysis with updates based on the results of this subsurface investigation and regular instrumentation monitoring as outlined in **Table 5**.

In general, **Table 6** presents a summary of the soil and pore pressure parameters used in the supplemental slope stability analysis.

Table 6: Soil Parameters

Soil Type	Unit Weight (kN/m^3)	Cohesion (kPa)	Friction Angle (Degrees)	Porewater Coefficient (r_u)*
Clay Fill	19.0	0.5	25	0.1
Clay (Peak)	19.5	2.5	25	0.1
Clay (Residual)	19.5	0.0	15	0.1
Clay Till	19.5	2.0	27	0.1
Silt Till	20.0	2.0	20	0.1
Sand	20.0	0.0	30	0.1

Notes: * r_u reflects an assumed porewater pressure as a fraction of the overburden stress and was only applied to soils located above the piezometric line.

A piezometric line (groundwater table) was incorporated in the analysis based on the highest measured groundwater levels, updated based on the regular monitoring results, and adjusted for seasonal fluctuations (raised a minimum 0.25 m) per The City's '*2011 Stormwater Management & Design Manual (Figure 3-20)*' for groundwater adjustments.

The porewater coefficient (r_u) is defined as the "ratio of excess pore pressure to the total stress," and was applied to the soils located above the piezometric line to simulate porewater pressures that may be present.

5.5 Surcharge Loading

The supplemental slope stability analysis was conducted under the following two surcharge loading cases as previously determined to establish the construction setback distances:

- Case 1: uniform surcharge load of up to 100 kPa applied at a depth of 1.4 m below the ground surface within the property boundaries to simulate potential light foundation loads/lightly-loaded buildings (e.g., one to two-storey wood frame structures with zero to one level below grade).
- Case 2: uniform surcharge load of up to 200 kPa applied at a depth of 1.4 m below the ground surface within the property boundaries to simulate potential heavy foundation loads (e.g., high-rise concrete building structures with two to three levels below grade).

To establish the construction setback distances based on the above predetermined surcharge loading cases, the analysis was conducted via an iterative process which was initialized with the surcharge loads placed at the property limit then progressively moved away from the slope crest until The City's required minimum factor of safety for developments along a slope was achieved (i.e., global slope stability factor of safety ≥1.5).

Note that loads/structures placed at greater depths (i.e., below-grade structures between one and three levels below grade) and/or deep foundation systems will only improve the overall calculated global slope stability factors of safety. The analysis was conducted by placing the surcharge loads at/near the ground surface to simulate worst-case scenarios given the affects of the soil weight in addition to the surcharge loading.

The surcharge 'live loading' of traffic (i.e., pedestrians and potential maintenance vehicles/equipment) along the asphalt paved pedestrian walkway at the project site northern limit was modelled as a uniform surcharge load of up to 5 kPa over the width of the pathway of approximately 2.6 m.

5.6 Analysis Results

A summary of the supplemental slope stability analysis results is presented in **Table 7**. The locations of the analysis sections and general areas in which the analysis results apply are highlighted on **Figure 2**. Excerpts of the typical critical slip surface slope failure paths for each analyzed section/area are provided as **Figures 3 through 6** as indicated below. The locations of the VWPs and measured SI horizontal displacements to date are presented on the cross-sections for reference.

Table 7: Analysis Results

Analysis Section/Area	Surcharge Load Condition (1.4 m below exiting ground surface)	Factor of Safety		Construction Setback from Property Line (m)	Reference Figure
		Calculated	Required		
Cross-Section A-A'	5 kPa (Along 2.6 m Pathway Surface)	1.4	N/A	N/A	Figure 3
	100 kPa	>1.5	≥1.5	25	
	200 kPa	>1.5	≥1.5	40	
Cross-Section B1-B1'	5 kPa (Along 2.6 m Pathway Surface)	1.2	N/A	N/A	Figure 4
	100 kPa	>1.5	≥1.5	30	
	200 kPa	>1.5	≥1.5	55	
Cross-Section B2-B2'	5 kPa (Along 2.6 m Pathway Surface)	1.2	N/A	N/A	Figure 5
	100 kPa	>1.5	≥1.5	30	
	200 kPa	>1.5	≥1.5	55	
Toe Berm Area (Previously 'Back-Analysis')	5 kPa (Along 2.6 m Pathway Surface)	1.2	N/A	N/A	Figure 6
	100 kPa	>1.5	≥1.5	30	
	200 kPa	>1.5	≥1.5	55	
Cross-Section C-C'	5 kPa (Along 2.6 m Pathway Surface)	1.4	N/A	N/A	N/A
	100 kPa	>1.5*	≥1.5	30*	
	200 kPa	>1.5*	≥1.5	55*	

Notes: * As per Tetra Tech's 'Preliminary Geotechnical Evaluation and Slope Stability Assessment (Revision 1)' report dated February 7, 2020. Original analysis takes precedence as no additional information was collected in proximity to warrant an update. The preliminary slope stability assessment report may be referred to for additional details related to the area of Cross-Section C-C'.

In general, the calculated supplemental slope stability analysis factors of safety indicated that the previously designated construction setback distances are valid at the time of this report's preparation (refer to **Table 7**).

6.0 DISCUSSION AND RECOMMENDATIONS

6.1 General

There were several items recommended within Tetra Tech's 'preliminary geotechnical evaluation and slope stability assessment' to improve the condition of the northern slope in terms of stability. These items are listed in **Table 8** along with any corrective actions that may have taken place to address said items to date followed by any suggested further corrective actions.

Table 8: Status of Previous Slope Stability Recommendations

Item	Previous Recommendation*	Status	Further Recommended Actions
Limited Subsurface Information	▪ Conduct additional subsurface investigation at/near the toe of the slope	Completed (as part of this work scope)	▪ N/A
Visually Observable Slope Instabilities	▪ Installation of slope monitoring instruments	Completed (as part of this work scope)	▪ N/A
Development-Specific Slope Stability Analysis	▪ Update slope stability assessment once redevelopment structure loading is known	Carried Forward	▪ Development loading specifics should be reviewed once finalized to ensure continued compliance with The City's slope stability guidelines (i.e., ≥1.5)
Visually Observable Slumps and Tension Cracks	▪ Implement slope stabilization mitigation measures to minimize the potential for retrogressive slope failures	Carried Forward	▪ Refer to **Section 6.2**
Structure Basements	▪ Foundation perimeter drainage systems should be installed around any basements to minimize the potential for increasing porewater pressures in the soils which may lead to instabilities	Carried Forward	▪ Should be addressed during detailed design and construction
Site Drainage	▪ Permanent surface and subsurface drainage systems should be designed to minimize the potential impact of water surcharge on the stability of the slope. Outlets or downspouts and surface runoff should not be diverted towards the slope	Carried Forward	▪ Should be addressed during detailed design and construction
Vegetation	▪ Slope should stay vegetated with shrubs/trees as it typically provides additional slope stability, unless the grades require flattening and/or reinforcement	Carried Forward	▪ Should be addressed during detailed design and construction
Waterbodies	▪ Should not be constructed at the project site without the approval of a geotechnical engineer and confirmation through additional slope stability analysis	Carried Forward	▪ Should be addressed during detailed design and construction

Notes: * As per Tetra Tech's 'Preliminary Geotechnical Evaluation and Slope Stability Assessment (Revision 1)' report dated February 7, 2020.

6.2 Slope Stabilization Measures

It is understood The City desires the existing observable slumps and tension cracks, as identified in the preliminary geotechnical evaluation, as well as the June 2020 failure area be stabilized to reduce the potential for future retrogressive larger failures.

In general, Tetra Tech recommends progressing through the below potential options during the detailed design and analysis reviews when determining which slope stabilization mitigation measure is best suited for each of the identified failure areas.

Potential Option 1. Regrading Slopes

Wherever possible, the preferred slope stabilization mitigation measure is for the failure area to be graded back to a stable, long-term slope. Cut slopes with gradients varying from approximately 3H:1V to 3.5H:1V are likely to provide a suitable factor of safety (dependent on the eventual determined factor of safety requirement) against instability for these localized areas that are prone to slump failures. This mitigation measure could also take advantage of cut/fill balance efficiencies; however, may also require fill beyond the existing slope toe extent within The Winston Golf Club.

Potential Option 2. Engineered Fill Berms

Where the required factor of safety cannot be achieved through regrading the slopes, fill berms in a form of slope toe support can be constructed (most likely out of cohesive clay till and/or granular fill for this project site) to stabilize the existing slopes with an overall final combination of slope gradients varying from approximately 2.0H:1V to 3.5H:1V. Providing such toe supports for the existing slopes are likely to notably improve the factor of safety against instability. This mitigation option may require additional space allocation beyond the existing slope toe extent within The Winston Golf Club.

Potential Option 3. Soil Nail Slopes

Where space or other limitations do not allow for cut and regrading slopes or the construction of a fill toe berm, soil nails may be used to 'anchor' the unstable part of the slope consisting of appropriate sized and depth soil nails combined with mesh, mats, or panels. The design of a soil nail reinforced slope comprises confirming the internal and global stabilities inclusive of determination of the nail configuration spacing and depths. Other typical features of such soil nail slopes include defining, but not necessarily limited to, the following: ultimate grout to soil bond resistance; minimum bar ultimate load capacity; minimum soil nail bore diameter (typically 150 mm); and inclination of soil nails. Note that this mitigation measure minimizes the expected disturbance to the existing slope; however, may be limited by accessibility for construction equipment.

Potential Option 4. Reinforced Slopes

The next preferred option is to regrade/cut back the slopes as flat as possible and reinforce the regraded/cut slope where necessary (e.g., with gradient of approximately 1.5H:1V to 2.5H:1V). Reinforced slope examples may include heavy stone cover or steel mesh cover for flatter sections and/or the installation of geogrid slope reinforcement materials. These types of slope reinforcement typically require additional design features and considerations when compared to the above options such as temporary and permanent drainage systems, bearing surface review and preparation, and increased displacement monitoring during construction.

Potential Option 5. Retaining Structures

When all the above options are not possible, the slope can be stabilized using a conventional cast-in-place concrete retaining wall (cantilever wall), founded on a wide base footing or a deep foundation, and extending vertically as required. The portion of the cut slope above the top of the wall, if any, may need to have a stable gradient, such as 3H:1V. This option poses the advantage of a stable vertical wall without the need for soil nails or anchors but would require structural technical design input from qualified personnel. There would be a considerable disturbed zone behind the retaining wall during the construction period, which should be reinstated after the wall is constructed. This condition similarly applies to a Mechanically Stabilized Earth (MSE) wall, a modular wall or block wall, pile walls with/without soil nails, or gravity wall system, which are also equally feasible. Modular walls may also be tied back using metal tie-backs or geosynthetic tie-backs. Some of these retaining systems could be designed as free-standing cantilever concrete pile walls without the requirement for tie-back anchors or internal bracing depending on their height and surcharge loadings, if any. Relatively higher lateral wall movements would typically be expected for such walls without anchors. Note that this slope stabilization mitigation option would require extensive design and construction work.

Recommended for Midfield Project Site

Tetra Tech recommends utilizing one of the above **Potential Options 1 through 3** for each of the identified surficial slope failure areas as they would be most appropriate based on our current understanding of the project site, collected slope monitoring data, and detailed slope stability analysis to meet The City's requirement. At the time of this report's preparation, Tetra Tech was in the process of further reviewing the suitability of these options for each failure area for input into a detailed design, in consultation with The City, as part of Milestone No. O#1 *Slope Stabilization Detailed Design* as scoped within Tetra Tech's Supplemental Scope and Fee Schedule No. 18-2006-A05-S01-08. Part of Tetra Tech's mitigation option review includes considering any potential constraints and limitations a failure area may pose given equipment accessibility, proximity to property boundaries, locations of existing infrastructure, and the existing vegetation.

7.0 CLOSURE

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

2022-07-06

61732
2022-07-06

Prepared by:
Kyle Haugrud, P.Eng.
Geotechnical Engineer
Engineering Practice
Direct Line: 403.723.1618
kyle.haugrud@tetratech.com

Reviewed by:
Joseph Yonan, Ph.D., P.Eng.
Principal Consultant
Engineering Practice
Direct Line: 403.723.6885
joseph.yonan@tetratech.com

/mh

PERMIT TO PRACTICE
TETRA TECH CANADA INC.

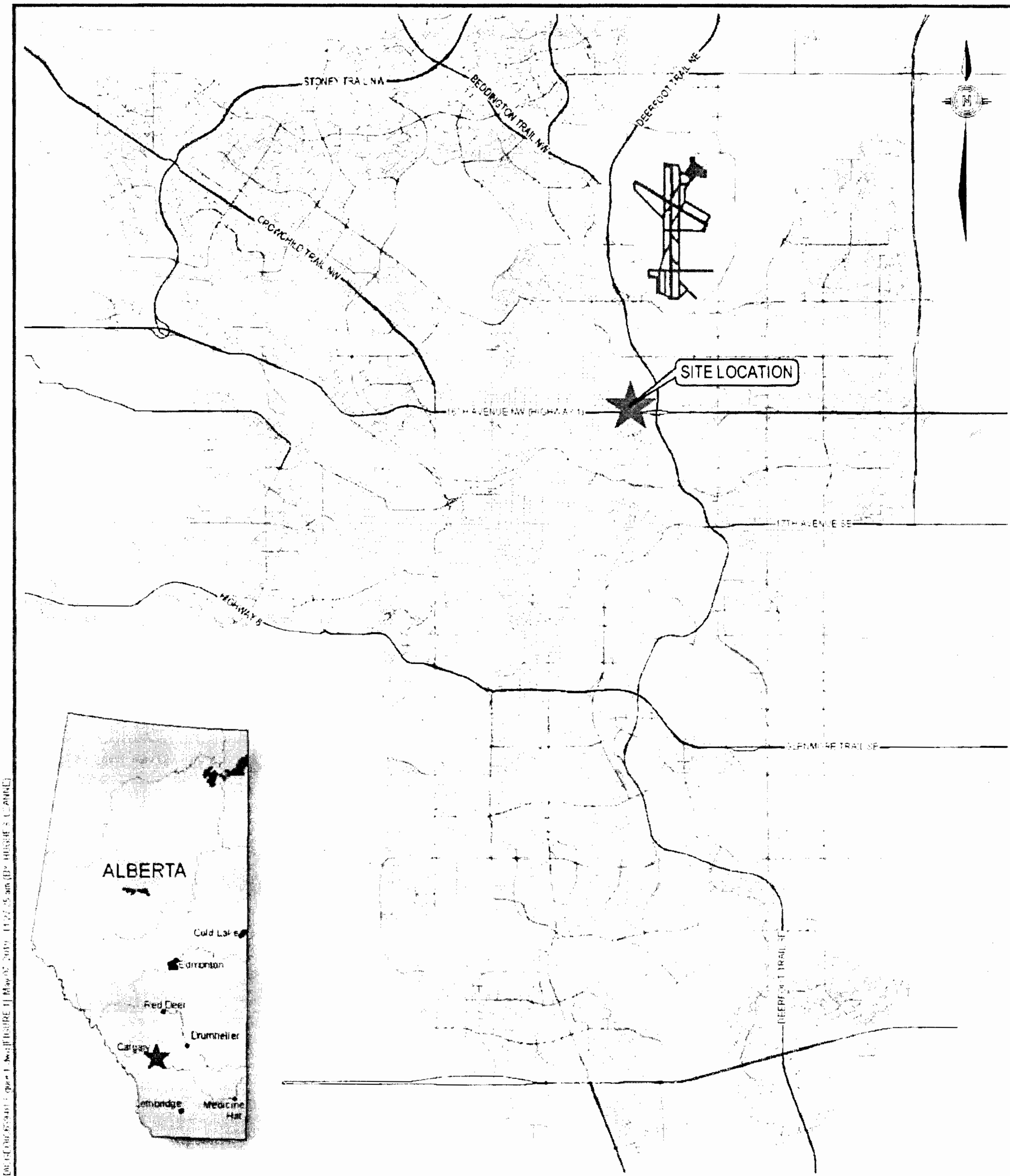
RM SIGNATURE: ____________

RM APEGA ID #: 61732

DATE: 2022-07-06

PERMIT NUMBER: P013774
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

FIGURES



DRAWING PROVIDED BY Department of Natural Resources Canada. All rights reserved.

0 5,000m

Scale 1:150,000 @ 8.5"x11"

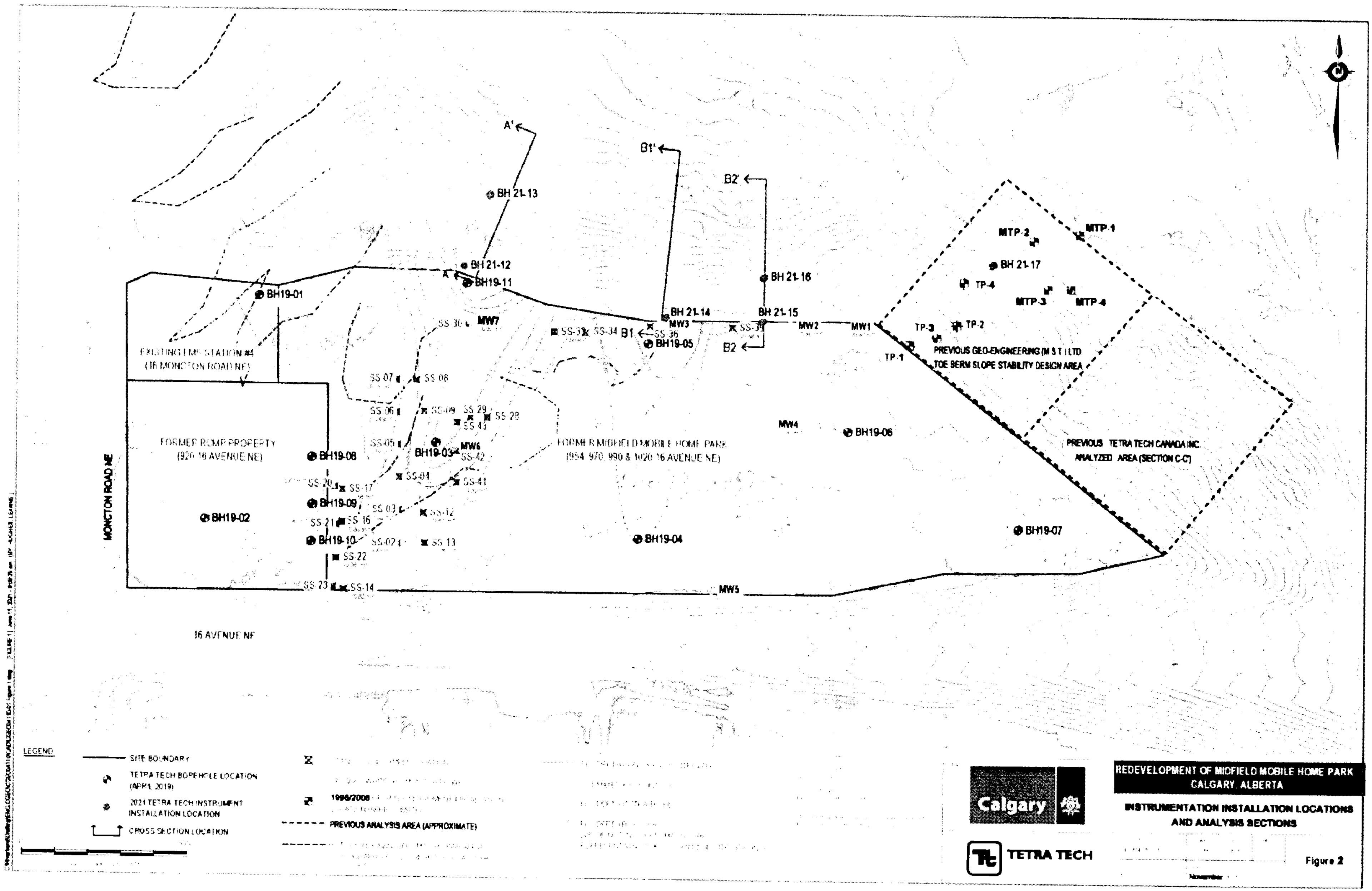
Calgary

TETRA TECH

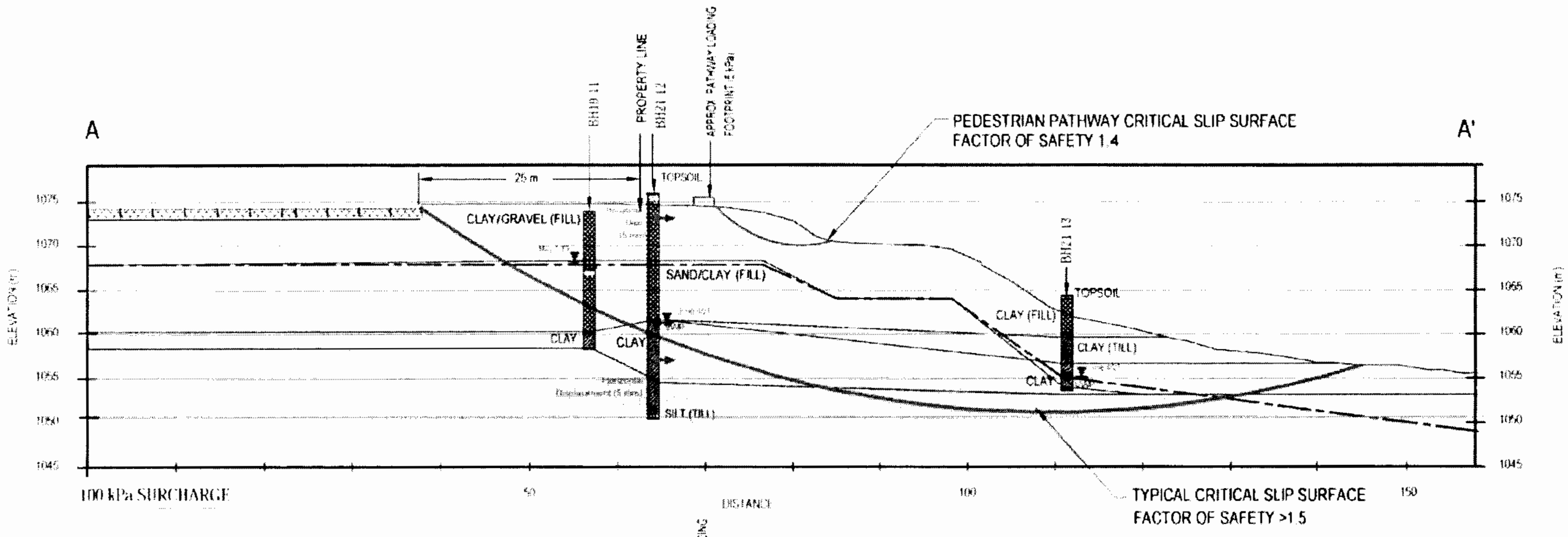
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

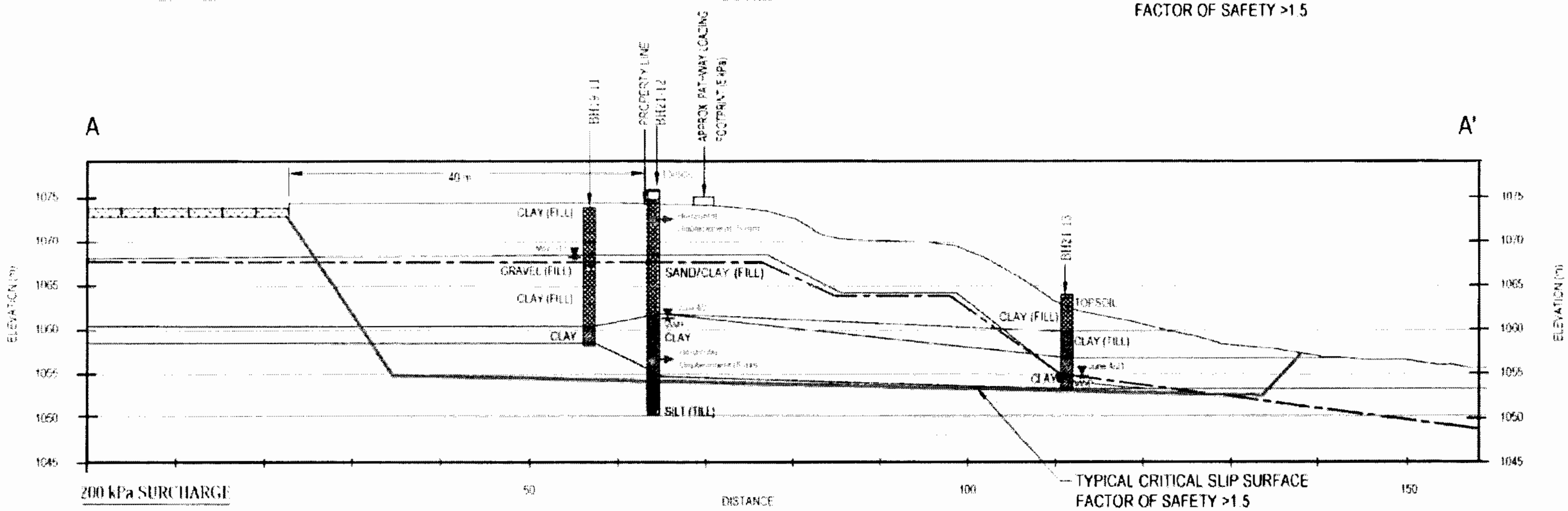
SITE LOCATION PLAN

Figure 1



A'
B1'
B2'
BH 21-13
BH 21-12
BH19-11
A
BH 21-16
BH 21-14
BH 21-15
MW3
MW2
MW1
B1
B2
SS-36
BH19-05
MTP-1
MTP-2
BH 21-17
TP-4
MTP-3
MTP-4
TP-3
TP-2
TP-1
PREVIOUS GEO-ENGINEERING (M.S.T.) LTD.
TOE BERM SLOPE STABILITY DESIGN AREA
PREVIOUS TETRA TECH CANADA INC.
ANALYZED AREA (SECTION C-C')
BH19-01
EXISTING EMS STATION #4
(16 MONCTON ROAD NE)
MW7
SS-30
FORMER RCMP PROPERTY
(920 16 AVENUE NE)
FORMER MIDFIELD MOBILE HOME PARK
(954, 970, 990 & 1020 16 AVENUE NE)
MW4
BH19-06
BH19-08
BH19-03
MW6
BH19-09
BH19-02
BH19-10
BH19-04
BH19-07
MW5
MONCTON ROAD NE
16 AVENUE NE
LEGEND
SITE BOUNDARY
TETRA TECH BOREHOLE LOCATION (APRIL 2019)
2021 TETRA TECH INSTRUMENT INSTALLATION LOCATION
CROSS SECTION LOCATION
PREVIOUS ANALYSIS AREA (APPROXIMATE)
1996/2008
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA
INSTRUMENTATION INSTALLATION LOCATIONS
AND ANALYSIS SECTIONS
Calgary
TETRA TECH
Figure 2





SYMBOL	SOIL TYPE	UNIT WEIGHT (kN/m³)	COHESION (kPa)	PHI (°)	Ru
	CLAY	19.5	2.5	25	
	CLAY (Ru)	19.5	2.5	25	0.1
	CLAY FILL	19	5	25	
	CLAY FILL (Ru)	19	5	25	0.1
	CLAY TILL	19.5	2	27	
	CLAY TILL (Ru)	19.5	2	27	0.1
	SAND	20	0	30	
	SAND (Ru)	20	0	30	0.1
	SILT TILL	20	2	20	
	SILT TILL (Ru)	20	2	20	0.1

1. CROSS SECTION SURFACE BASED ON LIDAR DATA (LIDAR_DEM_2018 MIDFIELD_PARK) PROVIDED BY THE CITY OF CALGARY
2. THE GEOLOGIC AND STRATIGRAPHIC SECTION DETAILS SHOWN ON THIS DRAWING ARE INTERPRETED FROM DISCRETE BOREHOLE LOGS. STRATIGRAPHY IS KNOWN WITH CERTAINTY ONLY AT THE BOREHOLE LOCATIONS. ACTUAL STRATIGRAPHY AND GEOLOGIC CONDITIONS BETWEEN BOREHOLES MAY VARY FROM THAT INDICATED ON THIS DRAWING.
3. SOIL STRATIGRAPHY BASED ON TETRA TECH BOREHOLES BH19-11, BH21-12, AND BH21-13

0 — 25m

Scale: 1:750 @ 8.5"x11"

CLIENT

Calgary

TETRA TECH

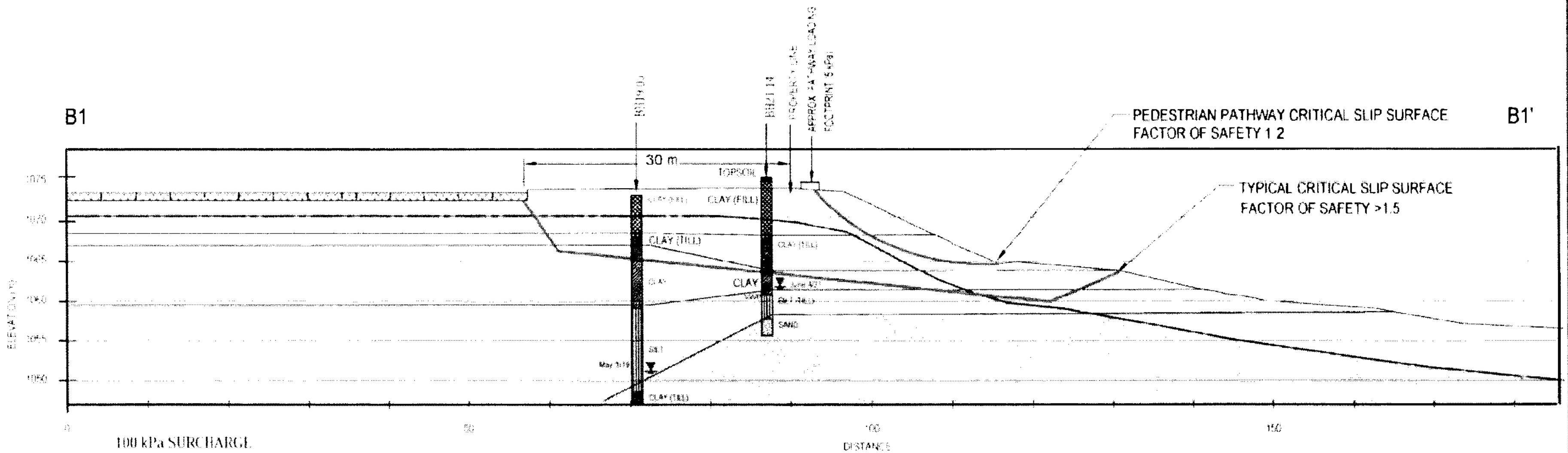
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

SLOPE STABILITY RESULTS

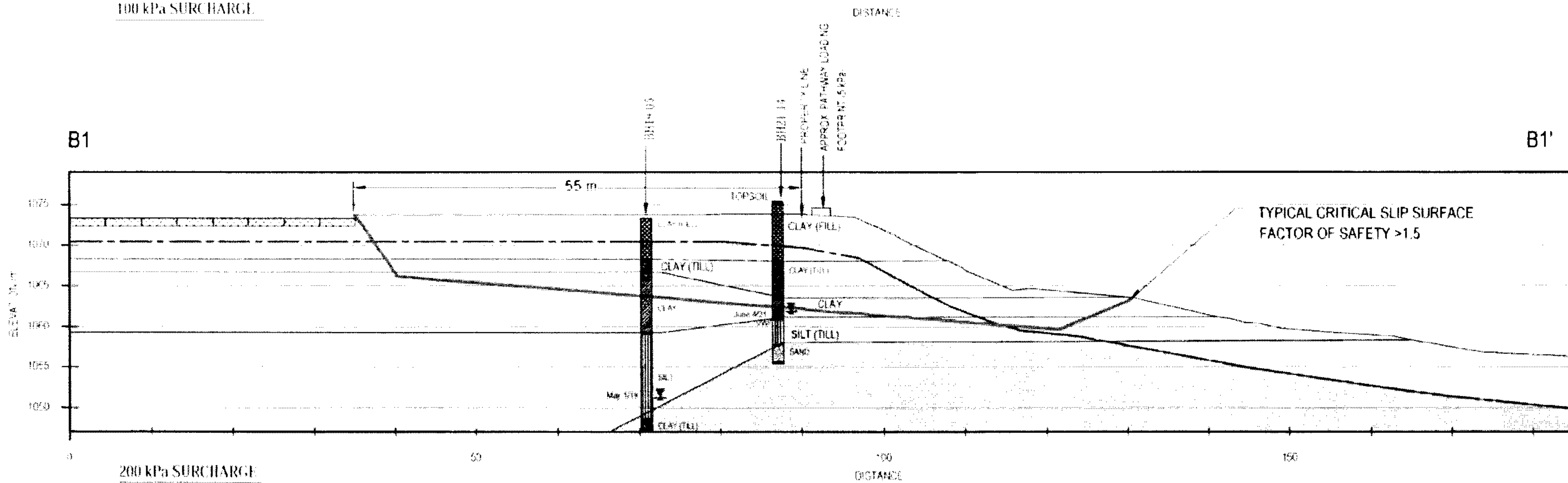
CROSS SECTION A-A'

PROJECT NO.	DWN	CKD	REV
ENG.CGEO04110-01	LCH	KH	0
OFFICE	DATE		
Tt Cal	April 2022		

Figure 3



100 kPa SURCHARGE



200 kPa SURCHARGE

SYMBOL	SOIL TYPE	UNIT WEIGHT (kN/m³)	COHESION (kPa)	PHI (°)	Ru
	CLAY	19.5	2.5	25	
	CLAY (Ru)	19.5	2.5	25	0.1
	CLAY FILL	19	5	25	
	CLAY FILL (Ru)	19	5	25	0.1
	CLAY TILL	19.5	2	27	
	CLAY TILL (Ru)	19.5	2	27	0.1
	SAND	20	0	30	
	SAND (Ru)	20	0	30	0.1
	SILT TILL	20	2	20	
	SILT TILL (Ru)	20	2	20	0.1

1. CROSS SECTION SURFACE BASED ON LIDAR DATA (LIDAR_DEM_2018, MIDFIELD_PARK) PROVIDED BY THE CITY OF CALGARY.
2. THE GEOLOGIC AND STRATIGRAPHIC SECTION DETAILS SHOWN ON THIS DRAWING ARE INTERPRETED FROM DISCRETE BOREHOLE LOGS. STRATIGRAPHY IS KNOWN WITH CERTAINTY ONLY AT THE BOREHOLE LOCATIONS. ACTUAL STRATIGRAPHY AND GEOLOGIC CONDITIONS BETWEEN BOREHOLES MAY VARY FROM THAT INDICATED ON THIS DRAWING.
3. SOIL STRATIGRAPHY BASED ON TETRA TECH BOREHOLES BH19-05 AND BH21-14.

0 25m

Scale 1:750 @ 8.5"x11"

Calgary

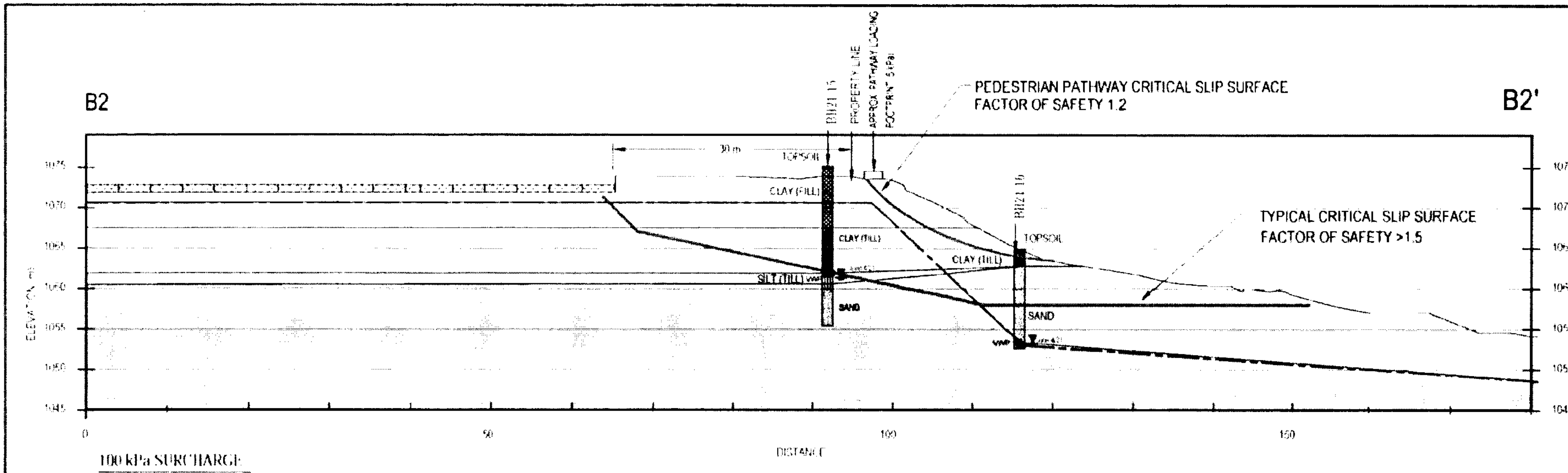
TETRA TECH

REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

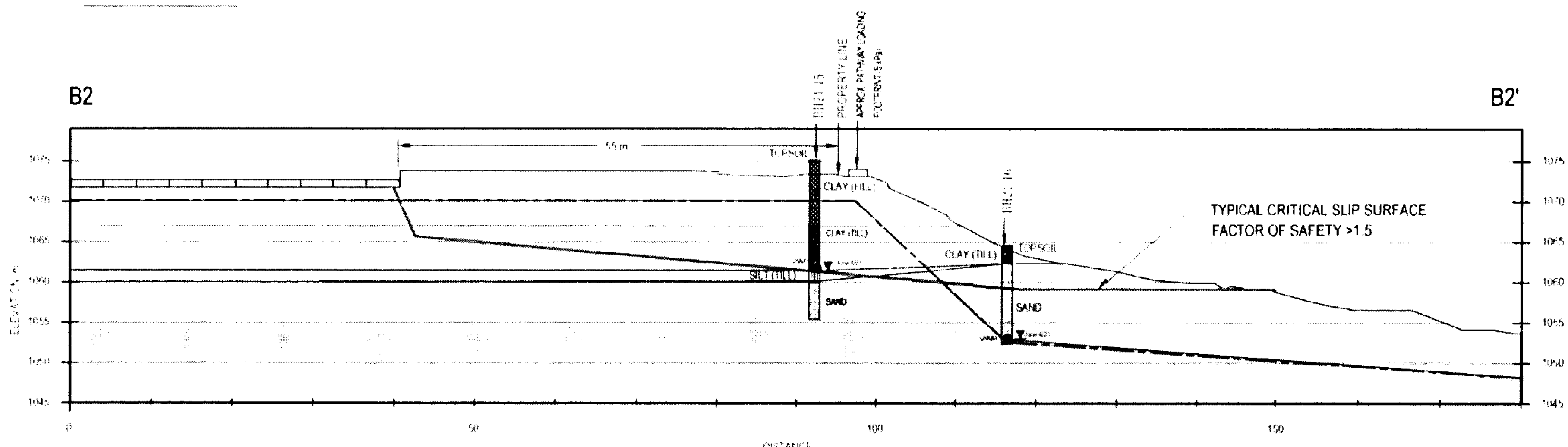
SLOPE STABILITY RESULTS
CROSS SECTION B1-B1'

ENG.CGEO04110-01	LCH	KH	0
TtCal	April 2022		

Figure 4



100 kPa SURCHARGE



200 kPa SURCHARGE

SYMBOL	SOIL TYPE	UNIT WEIGHT (kN/m^3)	COHESION (kPa)	PHI (°)	Ru
	CLAY FILL	19	5	25	
	CLAY FILL (Ru)	19	5	25	0.1
	CLAY TILL	19.5	2	27	
	CLAY TILL (Ru)	19.5	2	27	0.1
	SAND	20	0	30	
	SAND (Ru)	20	0	30	0.1
	SILT TILL	20	2	20	
	SILT TILL (Ru)	20	2	20	0.1

1. CROSS SECTION SURFACE BASED ON LIDAR DATA (LIDAR_DEM_2019_MIDFIELD_PARK) AND SURVEY OF JUNE 2020 FAILURE DATED JULY 7, 2021 AS PROVIDED BY THE CITY OF CALGARY.
2. THE GEOLOGIC AND STRATIGRAPHIC SECTION DETAILS SHOWN ON THIS DRAWING ARE INTERPRETED FROM DISCRETE BOREHOLE LOGS. STRATIGRAPHY IS KNOWN WITH CERTAINTY ONLY AT THE BOREHOLE LOCATIONS. ACTUAL STRATIGRAPHY AND GEOLOGIC CONDITIONS BETWEEN BOREHOLES MAY VARY FROM THAT INDICATED ON THIS DRAWING.
3. SOIL STRATIGRAPHY BASED ON TETRA TECH BOREHOLES BH21-15 AND BH21-16.

0 25m

Scale: 1:750 @ 8.5"x11"

Calgary

TETRA TECH

REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

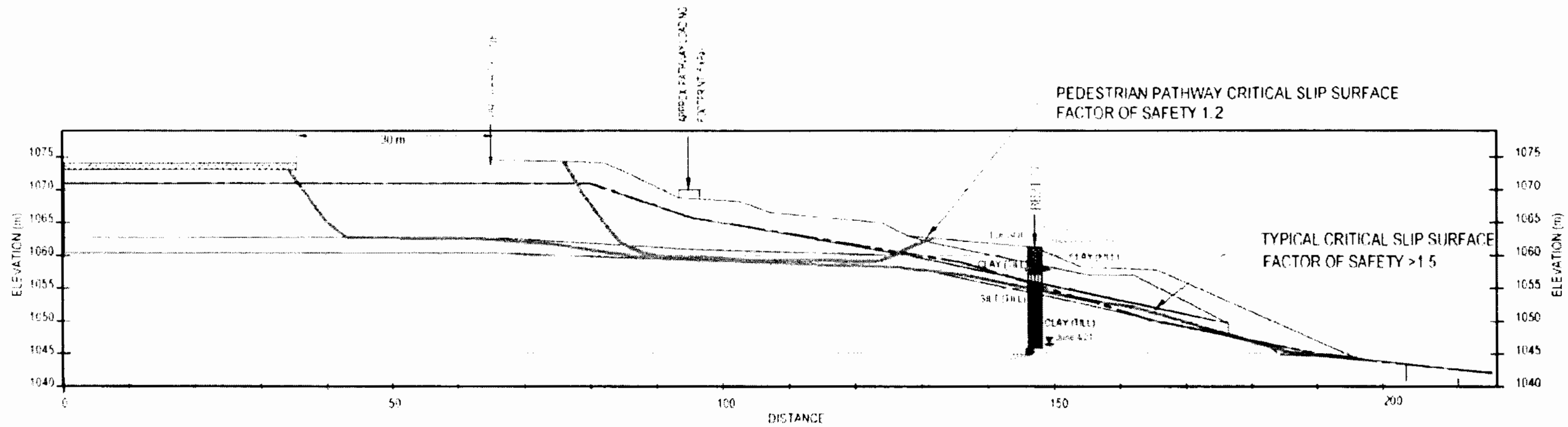
SLOPE STABILITY RESULTS

CROSS SECTION B2-B2'

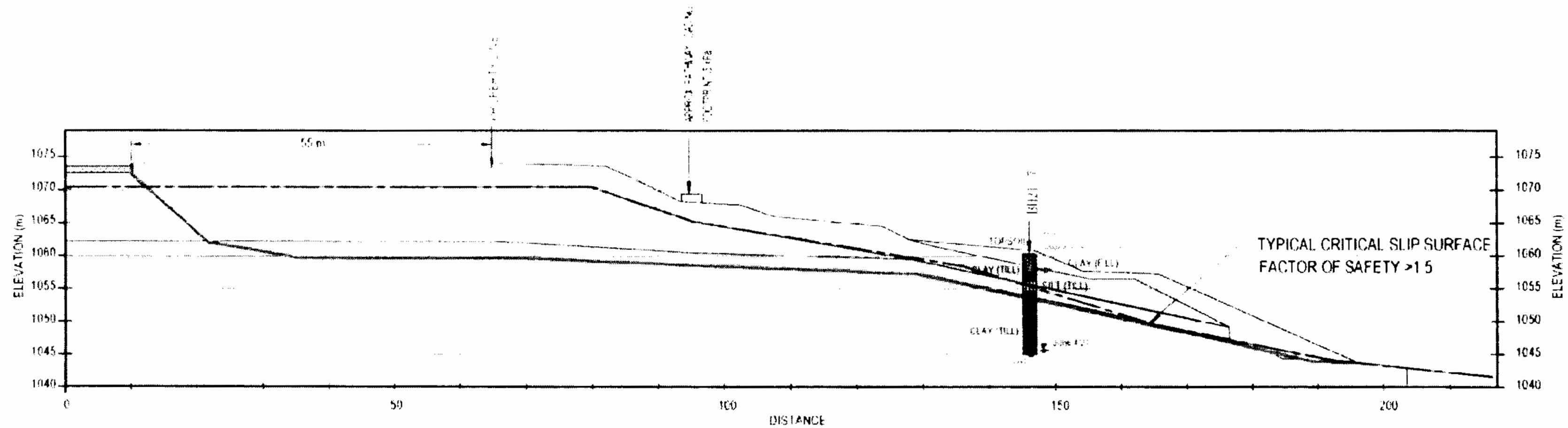
ENG.CGEO04110-01 | LCH | KH | 0

Figure 5

April 2022



100 kPa SURCHARGE



200 kPa SURCHARGE

SYMBOL	SOIL TYPE	UNIT WEIGHT (kN/m³)	COHESION (kPa)	PHI (°)	Ru
	CLAY(RESIDUAL)	19.5	0	15	
	CLAY(Ru) (RES.)	19.5	0	15	0.1
	CLAY FILL	19	5	25	
	CLAY FILL (Ru)	19	5	25	0.1
	CLAY TILL	19.5	2	27	
	CLAY TILL (Ru)	19.5	2	27	0.1
	SAND	20	0	30	
	SAND (Ru)	20	0	30	0.1
	SILT TILL	20	2	20	
	SILT TILL (Ru)	20	2	20	0.1

1. CROSS SECTION SURFACE BASED ON GEO ENGINEERING (M.S.T.) LTD. 2006 SLOPE STABILITY EVALUATION TOE BERM DESIGN.
2. THE GEOLOGIC AND STRATIGRAPHIC SECTION DETAILS SHOWN ON THIS DRAWING ARE INTERPRETED FROM DISCRETE BOREHOLE LOGS. STRATIGRAPHY IS KNOWN WITH CERTAINTY ONLY AT THE BOREHOLE LOCATIONS. ACTUAL STRATIGRAPHY AND GEOLOGIC CONDITIONS BETWEEN BOREHOLES MAY VARY FROM THAT INDICATED ON THIS DRAWING.
3. SOIL STRATIGRAPHY BASED ON GEO ENGINEERING (M.S.T.) LTD. 2006 SLOPE STABILITY EVALUATION TOE BERM DESIGN AND TETRA TECH BOREHOLE BH21-1?.

0 50m

Scale: 1:1,000 @ 8.5"x11"

Calgary

TETRA TECH

REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

SLOPE STABILITY RESULTS
TOE BERM AREA

ENG.CGEO04110-01	LCH	KH	0
Tt Cal	April 2022		

Figure 6

APPENDIX A
MILESTONE M#1 DESKTOP AND SITE REVIEW

TETRA TECH

FIELD REPORT

Project:	Redevelopment of Midfield Mobile Home Park	**Date:**	April 20, 2021
Location:	Moncton Road and 16 Ave NE Calgary, AB	**Tetra Tech Rep(s):**	Ipryl Buiza, E.I.T.
Client:	The City of Calgary		Kyle Haugrud, P.Eng
Weather:	10 C	**Status:**	ISSUED FOR USE
File:	704-ENG.CGEO04110-01 Milestone M#1		

SUBJECT:

Site visit was conducted on April 20, 2021 to determine potential borehole locations for instrumentation installations (Slope Inclinometer [SI] and Vibrating Wire Piezometers [VWP]) and assess the condition of the 70 mm SI casing previously installed within subsurface borehole TP-2. This field report represents the Milestone No. M#1 deliverable as part of extension five of The City of Calgary's (The City) scope and fee schedule No. 18-2006-A05-S01-05 dated April 15, 2021. The supplementary site photographs and accompanying data provided by The City April 15, 2021 via a file sharing portal were reviewed prior to conducting the site visit.

BACKGROUND SITE INFORMATION (DESKTOP REVIEW):

The following was noted prior to conducting the site visit on April 20, 2021 during the background data review

- The existing SI casing within Borehole TP-2 was installed under the direction of Geo-Engineering (M.S.T.) Ltd (Geo-Eng) on November 26, 1998 to a total depth of approximately 15.9 m. Displacement data was not available at the time of this report's preparation however, negligible movement was noted in a slope stability evaluation conducted by Geo-Eng dated December 6, 2006. No additional information on the condition of the SI casing was available post the 2006 evaluation;
- Ponded water typically present in area of June 2020 slope failure during the summer months;
- Water flow visually apparent over asphalt path in area of failure in late June to early July 2020;
- Trench with fabric separator installed in area of failure to a maximum approximate 0.9 m (3 ft) depth in July 2020 to minimize seepage and runoff flows, and
- Additional V-ditch and berm understood to be installed in November 2020 to further reduce water flows to failure area.

SITE OBSERVATIONS:

The following steps were carried out to assess the existing condition of the SI previously installed within TP-2 during the site visit (refer to Figure A)

- A 1.0 m long 25 mm diameter steel rod was attached to the end of a measuring tape and lowered inside the SI casing. The steel rod was able to reach a depth of 15.9 m below the top of SI casing suggesting it had not been previously sheared and was unobstructed to its base
- An SI probe was lowered inside the SI casing and reached the depth of 15.9 m below the top of SI casing. Tightness was noted during the lowering of the SI probe at an approximate depth of 9.1 m (30 ft) below the top of SI casing, and

Tetra Tech Canada Inc.
Tel: Fax:

- The SI was initialized with the SI probe which consisted of two consecutive SI readings to determine a baseline that will be used to measure displacements going forward. Accordingly, the potential proposed SI replacement numbered BH21-18 within the scope fee schedule is currently determined to not be necessary.

Groundwater levels were measured in the installed standpipes that were accessible with the results presented in Table 1 which will be used to adjust/confirm groundwater levels in stability analyses as part of Milestone M#3. The locations of the boreholes below are highlighted with blue text on Figure A for reference. Access to the locations within the fenced project site area was granted by personnel on-site at the time of the site visit.

Table 1: Groundwater Level Reading Results

Borehole Number	Standpipe Depth Below Existing Ground Surface (m)	Ground Elevation at Borehole Location (m)	Depth to Groundwater Below Existing Ground Surface (m)	Groundwater Elevation (m)
BH19-05	25.9	1073.2	22.1	1051.1
BH19-07	24.4	1074.9	Dry	<1050.5
TP-3	12.6	1067.7	Dry	<1055.1
	16.6		15.5	1052.2

A site walkthrough was then conducted to assess potential borehole locations along the stability sections for instrumentation installations. The selected locations are presented on Figure A and photographs of each are provided as Photographs 1 though 6. The borehole locations were surveyed using a hand-held GPS which are presented in Table 2.

DISCUSSION:

As previously discussed, initialization readings were obtained in the existing SI casing installed at Borehole TP-2 (refer to background site information section for additional details). Accordingly, the potential replacement SI at this location is currently deemed not necessary. These initialization readings will be used going forward to measure any displacements.

Given the proximity to the existing slope and pathway, borehole locations BH21-14 and BH21-15 will require complete closure of the pathway during borehole advancement as well as temporary fence removal (which will be reinstalled following completion) for the drilling equipment. The distance between the fence posts is such that the drilling equipment may be able to maneuver into position without post removal; however, in the event one post requires extraction, it will be reinstated with bentonite chips and/or quick mix grout.

Borehole BH21-12 will likely only require proper signage and delineation of the drilling area to divert pathway traffic away from potential hazards. Note that proper signage and working area delineation will be commonplace at each drilling location.

The excess drill cuttings and any additional waste materials will be removed from site upon completion of the fieldwork; accordingly, pedestrian pathways will be clear of any obstructions related to the drilling activities. Additionally, the rubber tracks and weight of the drill rig are such that the asphalt paved pedestrian pathways will remain intact given the minimal disturbance incurred from any required equipment crossings (attempts will be made to minimize movement on asphalt paved areas).

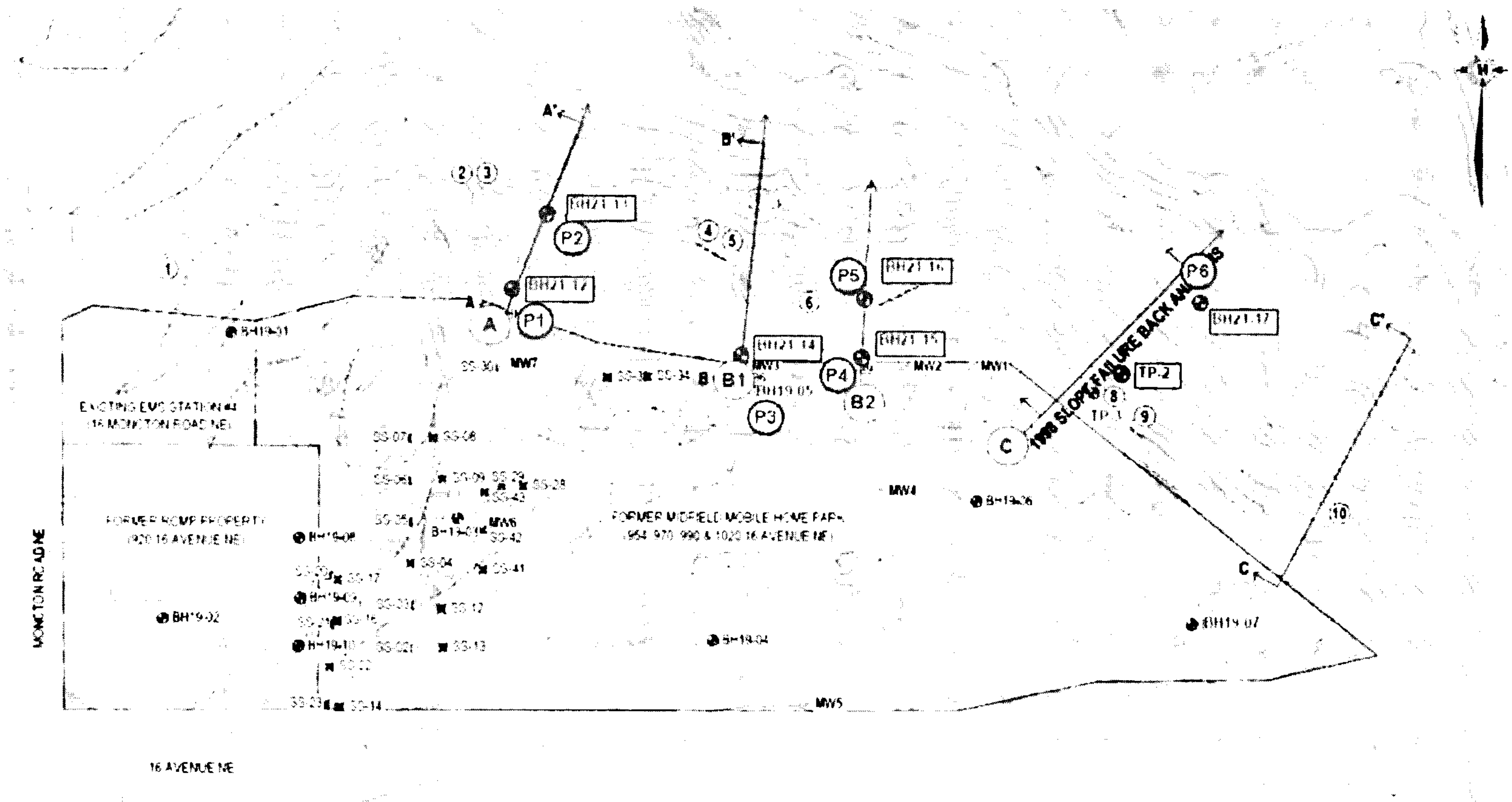
The installation depths of the proposed SI's and VWP's was determined based on the available borehole data and slope stability analyses. Note that these may still be somewhat shifted based on observed subsurface conditions during execution of the fieldwork (i e , base on SI casing to be founded in competent material, VWP to be installed targeting the unit considered to have highest pore pressure response). Excerpts of the stability analysis cross-sections with overlays of the proposed instrumentation locations and depths are presented on the attached Figures 1 and 2. A summary of the updated proposed instrument location details following the data review and site visit is presented in Table 2. Note that the instrument locations will include steel protective casings and padlocks

Table 2: Proposed Borehole Summary

Borehole Number	Northing (m)*	Easting (m)*	Total Slope Inclinometer Depth (m)	Proposed Vibrating Wire Depth (m)	Proposed Borehole Location Photo	Respective Cross-Section and Figure
BH21-12	5661680.88	707422.79	20	14	Photo 1	Section A (Fig 1)
BH21-13	5661728.29	707431.14	10	4	Photo 2	Section A (Fig 1)
BH21-14	5661652.44	707537.83	20	14	Photo 3	Section B1 (Fig 2)
BH21-15	5661653.65	707588.92	20	14	Photo 4	Section B2 (Fig 2)
BH21-16	5661676.31	707590.47	10	4	Photo 5	Section B2 (Fig 2)
BH21-17	5661681.03	707771.61	15**	3	Photo 6	'98 Failure (Fig 1)

Notes: * Coordinates were taken with a hand-held GPS and are based on UTM Zone 11.
** Proposed Borehole BH21-17 should have SI casing bottom anchor installed at least 3.0 m into the bedrock

TETRA TECH



- Proposed Slope Inclinometer Location

Figure A: Midfield Proposed Slope Inclinometer Locations

Photo 1: Midfield looking West – Proposed SI BH21-12 Location

Photo 2: Midfield looking West – Proposed SI BH21-13 Location

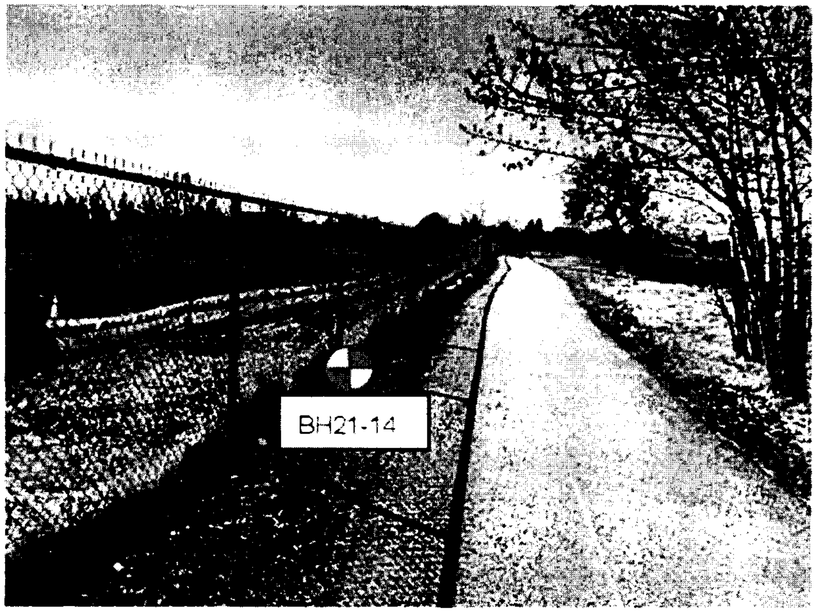


Photo 3: Midfield looking West – Proposed SI BH21-14 Location (Fence Removal Required)

Photo 4: Midfield looking East – Proposed SI BH21-15 Location (Fence Removal Required)

Photo 5 Midfield looking South – Proposed SI BH21-16 Location

Photo 6 Midfield looking South – Proposed SI BH21-17 Location

This field report has been prepared for The City of Calgary and their agents. The City of Calgary shall at all times be entitled to fully use and rely on this field report, including all attachments, drawings, and schedules, for the specific purpose for which the field report was prepared, in each case notwithstanding any provision, disclaimer, or waiver in the field report that reliance is not permitted.

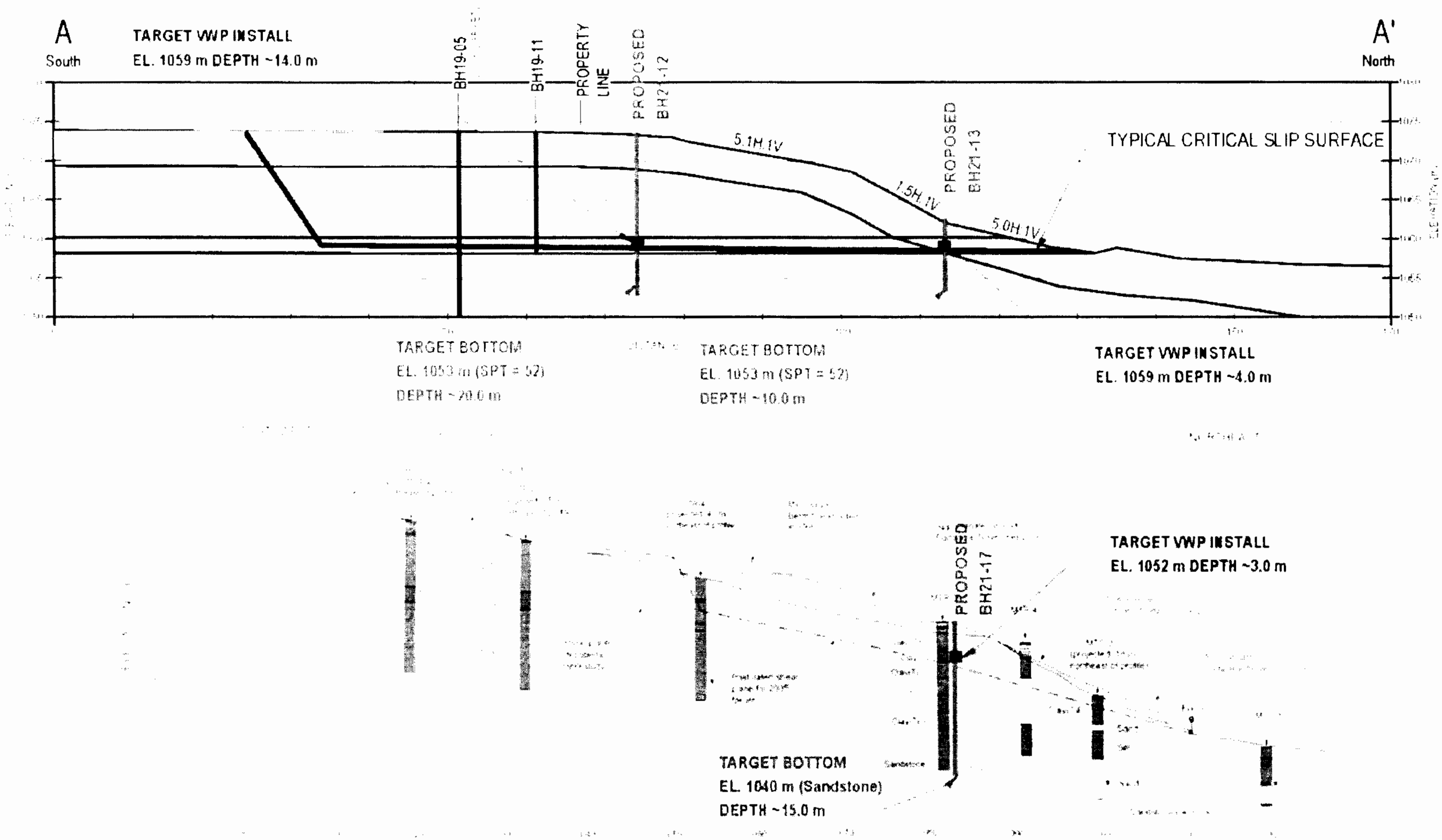
The City of Calgary shall at all times be entitled to provide copies of the field report to City Council, City of Calgary regulatory boards, City of Calgary employees, officers, agents, affiliates, advisors, consultants, parties contracting with The City of Calgary, lenders and assignees and other governmental authorities and regulatory bodies having jurisdiction, each of whom shall also be similarly entitled to fully use and rely on the field report in the same manner and to the same extent as The City of Calgary for the specific purpose for which the field report was prepared.

Respectfully submitted,

704-ENG.CGEO04110-01
704-ENG.CGEO04110-01
704-ENG.CGEO04110-01
Prepared by:
Ipryl Buiza, E.I.T.
Geotechnical Engineer-in-Training
Engineering Practice, Prairie Region
Direct Line: 403.723.1578
Ipryl.buiza@tetratech.com

704-ENG.CGEO04110-01
704-ENG.CGEO04110-01
704-ENG.CGEO04110-01
Reviewed by:
Kyle Haugrud, P.Eng.
Geotechnical Engineer
Engineering Practice
Direct Line: 403.723.1618
kyle.haugrud@tetratech.com

Attachments (2):	Figure 1	Proposed Inclinometer Locations, Cross Sections A and 1998 Failure
	Figure 2	Proposed Inclinometer Locations, Cross Sections B1 and B2



		UNIT WEIGHT (kN/m³)		PHI (°)

0 25m

Scale 1:750 @ 8.5"x11"

Calgary

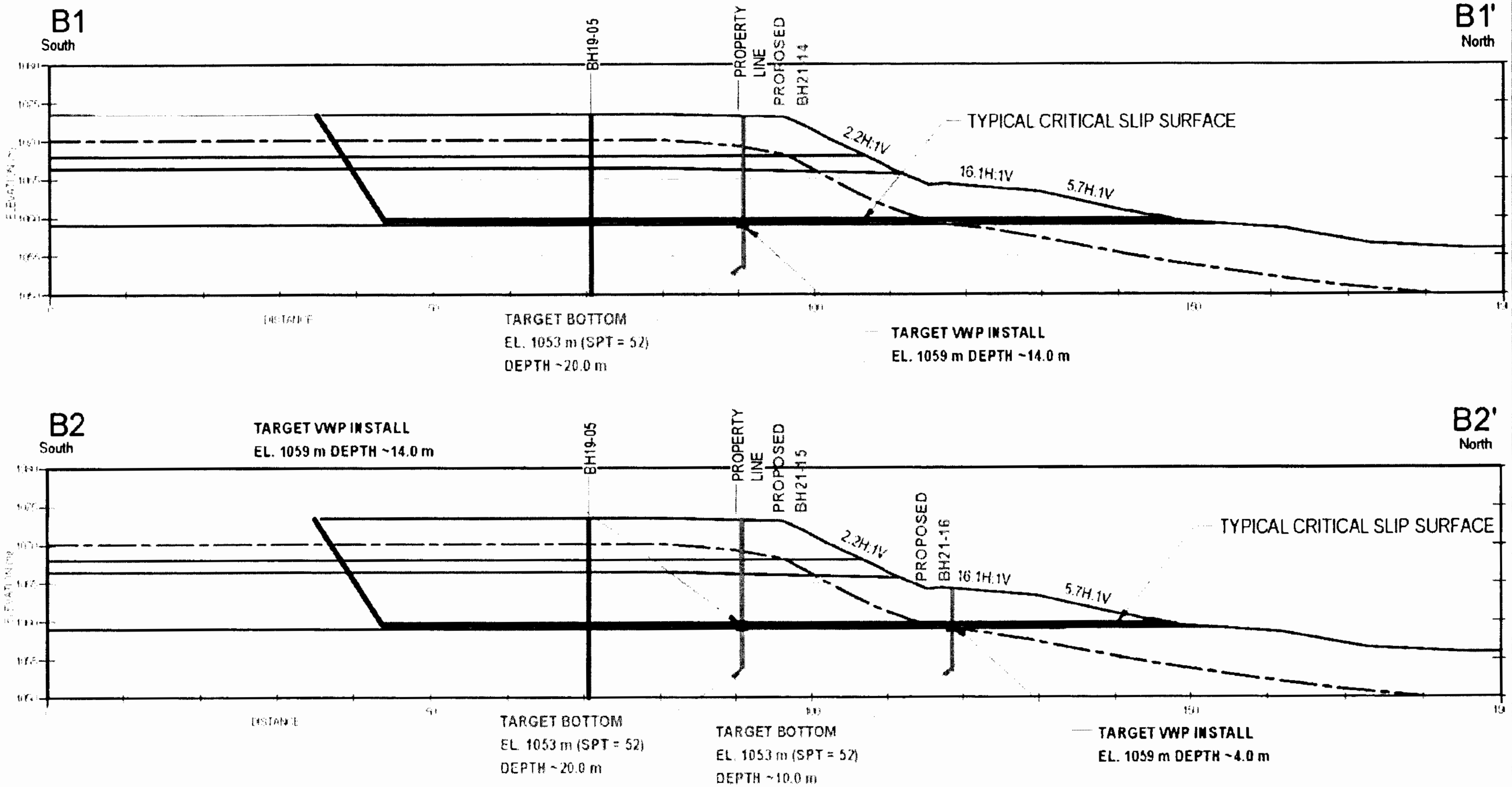
TETRA TECH

REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

PROPOSED INCLINOMETER LOCATIONS CROSS SECTIONS A AND 1998 FAILURE

CGEO04110-01		KH	0
	April 2021		

Figure 1



0 25m

Scale: 1:750 @ 8.5"x11"

Calgary

TETRA TECH

REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

PROPOSED INCLINOMETER LOCATIONS
CROSS SECTIONS B1 AND B2

CGEO04110-01	LCH	KH	0
	April 2021		

Figure 2

APPENDIX B
SOIL DESCRIPTION GUIDELINES AND BOREHOLE LOGS

TERMS USED ON BOREHOLE LOGS

TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (major portion retained on 0.075mm sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as inferred from laboratory or in situ tests.

DESCRIPTIVE TERM	RELATIVE DENSITY	N (blows per 0.3m)
Very Loose	0 TO 20%	0 to 4
Loose	20 TO 40%	4 to 10
Compact	40 TO 75%	10 to 30
Dense	75 TO 90%	30 to 50
Very Dense	90 TO 100%	greater than 50

The number of blows, N, on a 51mm O.D. split spoon sampler of a 63.5kg weight falling 0.76m, required to drive the sampler a distance of 0.3m from 0.15m to 0.45m.

FINE GRAINED SOILS (major portion passing 0.075mm sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as estimated from laboratory or in situ tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH (KPA)
Very Soft	Less than 25
Soft	25 to 50
Firm	50 to 100
Stiff	100 to 200
Very Stiff	200 to 400
Hard	Greater than 400

NOTE: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil.

GENERAL DESCRIPTIVE TERMS

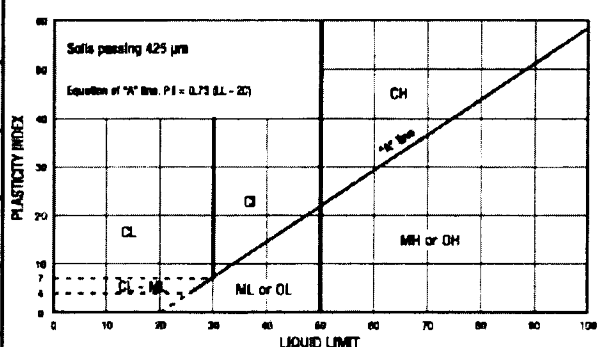
Slickensided - having inclined planes of weakness that are slick and glossy in appearance.
Fissured - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated - composed of thin layers of varying colour and texture.
Interbedded - composed of alternate layers of different soil types.
Calcareous - containing appreciable quantities of calcium carbonate.;
Well graded - having wide range in grain sizes and substantial amounts of intermediate particle sizes.
Poorly graded - predominantly of one grain size, or having a range of sizes with some intermediate size missing.

MODIFIED UNIFIED SOIL CLASSIFICATION

MAJOR DIVISION			GROUP SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA		
COARSE-GRAINED SOILS More than 50% retained on 75 μm sieve*	GRAVELS 50% or more of coarse fraction retained on 4.75 mm sieve	CLEAN GRAVELS	GW	Well-graded gravels and gravel-sand mixtures, little or no fines	Classification on basis of percentage of fines: Less than 5% Pass 75 μm sieve: GW, GP, SW, SP; More than 12% Pass 75 μm sieve: GM, GC, SM, SC; 5% to 12% Pass 75 μm sieve: Borderline Classification requiring use of dual symbols	$C_u = D_{60}/D_{10}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			GP	Poorly graded gravels and gravel-sand mixtures, little or no fines		Not meeting both criteria for GW	
		GRAVELS WITH FINES	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
	SANDS More than 50% of coarse fraction passes 4.75 mm sieve	CLEAN SANDS	SW	Well-graded sands and gravelly sands, little or no fines		$C_u = D_{60}/D_{10}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3	
			SP	Poorly graded sands and gravelly sands, little or no fines		Not meeting both criteria for SW	
		SANDS WITH FINES	SM	Silty sands, sand-silt mixtures		Atterberg limits plot below "A" line or plasticity index less than 4	Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols
			SC	Clayey sands, sand-clay mixtures		Atterberg limits plot above "A" line or plasticity index greater than 7	
FINE-GRAINED SOILS (by behavior) 50% or more passes 75 μm sieve*	SILTS	Liquid limit <50	ML	Inorganic silts, very fine sands, rock flour, silty or clayey fine sands of slight plasticity			
		Liquid limit >50	MH	Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts			
	CLAYS Above "A" line on plasticity chart negligible organic content	Liquid limit <30	CL	Inorganic clays of low plasticity, gravelly clays, sandy clays, silty clays, lean clays			
		Liquid limit 30-50	CI	Inorganic clays of medium plasticity, silty clays			
		Liquid limit >50	CH	Inorganic clays of high plasticity, fat clays			
	ORGANIC SILTS AND CLAYS	Liquid limit <50	OL	Organic silts and organic silty clays of low plasticity			
		Liquid limit >50	OH	Organic clays of medium to high plasticity			
HIGHLY ORGANIC SOILS			PT	Peat and other highly organic soils			

For classification of fine-grained soils and fine fraction of coarse-grained soils.

PLASTICITY CHART



*Based on the material passing the 75 mm sieve
Reference: ASTM Designation D2487, for identification procedure see D2488. USC as modified by PFRA

SOIL COMPONENTS

FRACTION	SIEVE SIZE		DEFINING RANGES OF PERCENTAGE BY MASS OF MINOR COMPONENTS	
	PASSING	RETAINED	PERCENTAGE	DESCRIPTOR
GRAVEL coarse	75 mm	19 mm	>35 %	"and"
GRAVEL fine	19 mm	4.75 mm	21 to 35 %	"y-adjective"
SAND coarse	4.75 mm	2.00 mm	10 to 20 %	"some"
SAND medium	2.00 mm	425 μm		
SAND fine	425 μm	75 μm	>0 to 10 %	"trace"
SILT (non plastic) or CLAY (plastic)	75 μm		as above but by behavior	

OVERSIZE MATERIAL

Rounded or subrounded

COBBLES	75 mm to 300 mm
BOULDERS	> 300 mm

Not rounded

ROCK FRAGMENTS	>75 mm
ROCKS	> 0.76 cubic metre in volume

TETRA TECH

BOREHOLE KEYSHEET

Water Level Measurement

Measured in standpipe, piezometer or well	Inferred

Sample Types

A-Casing	Core	Disturbed, Bag, Grab	HQ Core	Jar
Jar and Bag	NQ Core	No Recovery	Split Spoon/SPT	Tube

Backfill Materials

Asphalt	Bentonite	Cement/ Grout	Drill Cuttings	Grout
Gravel	Sand	Slough	Topsoil Backfill	

Lithology - Graphical Legend[1]

Asphalt	Bedrock	Cobbles/Boulders	Clay	Coal
Concrete	Fill	Gravel	Limestone	Mudstone
Organics	Peat	Sand	Sandstone	Shale
Silt	Siltstone	Till	Topsoil	

1. The graphical legend is an approximation and for visual representation only. Soil strata may comprise a combination of the basic symbols shown above. Particle sizes are not drawn to scale

TETRA TECH

Borehole No: **BH21-12**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.906 m
Calgary, Alberta	3TM: -2759.955157 E; 5659201.831 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit – Moisture Content – Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80	BH SI	BH VWP	Core Photos	Elevation (m)
0	Solid Stem Auger	TOPSOIL - sand, some clay, some silt, trace gravel, damp, dark brown, trace organics										
		SAND (FILL) - some silt, trace clay, trace gravel, fine grained, poorly graded, dark brown										
				B1								1075
1												
		CLAY (FILL) - silty, trace sand, trace gravel, damp to moist, low plastic, brown, trace black streaks, hydrocarbon odour										
				B2		19.8						
2												1074
	Hollow Stem Auger	Switched to Hollow Stem										
3												1073
4												1072
4.57												

Contractor: Mobile Augers and Research	Completion Depth: 25.45 m
Drilling Rig Type: Solid Stem Auger/Hollow Stem	Start Date: May 17, 2021
Logged By: IB	Completion Date: May 17, 2021
Reviewed By:	Page 1 of 6

TETRA TECH

Borehole No: **BH21-12**

Project: Midfield Mobile Home Park Redevelopment	Project No. ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.906 m
Calgary, Alberta	3TM: -2759.955157 E; 5659201.831 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80	BH SI	BH VWP	Core Photos	Elevation (m)
4.57	Hollow Stem Auger											
5												1071
			X	S1	4	41.2	●	■				
6												1070
		- moist to wet, grey										
7												1069
		- wet										
8												1068
9												1067
9.14												

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 25.45 m
Drilling Rig Type: Solid Stem Auger/Hollow Stem	Start Date: May 17, 2021
Logged By: IB	Completion Date: May 17, 2021
Reviewed By:	Page 2 of 6

Borehole No: BH21-12

Calgary	
Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.906 m
Calgary, Alberta	3TM: -2759.955157 E; 5659201.831 N

Columns: Depth (m) | Method | Soil Description | Sample Type | Sample Number | SPT (N) | Moisture Content (%) | Soluble Sulphates (%) 1 2 3 4; Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80 | SPT (N) 20 40 60 80 | BH SI | BH VWP | Core Photos | Elevation (m)

Depth range: 9.14 – 13.7 m. Method: Hollow Stem Auger

Depth (m)	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
~9.8	- some gravel				
10		X	S2	19	13.4
~12.9	- trace wood debris				
13		X	S3	16	8.6

Elevation (m): 1066, 1065, 1064, 1063

TETRA TECH	
Contractor: Mobile Augers and Research	Completion Depth: 25.45 m
Drilling Rig Type: Solid Stem Auger/Hollow Stem	Start Date: May 17, 2021
Logged By: IB	Completion Date: May 17, 2021
Reviewed By:	Page 3 of 6

Borehole No: **BH21-12**

Calgary

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.906 m
Calgary, Alberta	3TM: -2759.955157 E; 5659201.831 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80	BH SI	BH WP	Core Photos	Elevation (m)
13.7	Hollow Stem Auger											
14												1062
		CLAY - silty, some sand, trace gravel, wet, firm, low plastic, brown		SH1								
June 4/21												June 4/21
				S4	7	17.7						1061
15		Vibrating Wire Piezometer [Depth - 15.2 m, Tip Serial No. VW132946] Pre-Installation Reading [Frequency - 2949.2 Hz, Temp - 21.8°C]										
16												1060
17												1059
		- stiff										
				S5	14	27.3						
18												1058
18.28												

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 25.45 m
Drilling Rig Type: Solid Stem Auger/Hollow Stem	Start Date: May 17, 2021
Logged By: IB	Completion Date: May 17, 2021
Reviewed By:	

GEOTECHNICAL ENG-CGEO04110-01.GPJ EBA.GDT 11/5/21

Borehole No: **BH21-12**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.906 m
Calgary, Alberta	3TM: -2759.955157 E; 5659201.831 N

Calgary

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80	BH SI	BH VWP	Core Photos	Elevation (m)
18.28	Hollow Stem Auger											
19												1057
20												1056
			X	S6	14	20.9	●	■				
21												1055
22												1054
22.85												

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 25.45 m
Drilling Rig Type: Solid Stem Auger/Hollow Stem	Start Date: May 17, 2021
Logged By: IB	Completion Date: May 17, 2021
Reviewed By:	

Calgary

Borehole No: BH21-12

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.906 m
Calgary, Alberta	3TM: -2759.955157 E; 5659201.831 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80	BH SI	BH WP	Core Photos	Elevation (m)
22.85 – 25	Hollow Stem Auger											1053, 1052, 1051
25		SILT (TILL) - sandy, some clay, trace gravel, very stiff, wet, low plastic, brown		S7	24	26						
25.45		END OF HOLE AT 25.45 m 85 mm slope inclinometer installed to 24.99 m Vibrating Wire Piezometer serial #132946 installed to 15.24 m Groundwater seepage upon completion. Groundwater measured at 14.67 m on June 4, 2021 Coordinates are based on 3TM grid surveyed to a geodetic benchmark. Note that core photos are provided for visual information purposes only. In the event of discrepancy between log data and photos, log data takes precedence.										1050, 1049
26, 27, 27.43												

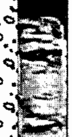
TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 25.45 m
Drilling Rig Type: Solid Stem Auger/Hollow Stem	Start Date: May 17, 2021
Logged By: IB	Completion Date: May 17, 2021
Reviewed By:	Page 6 of 6

Borehole No: BH21-13

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1063.593 m
Calgary, Alberta	3TM: -2744.154862 E; 5659245.503 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80	BH SI	BH VWP	Core Photos	Elevation (m)
0	Solid Stem Auger	TOPSOIL - clay, silty, some sand, trace gravel, damp, dark brown, trace organics										
		CLAY (FILL) - some sand, some silt, some gravel, damp, low plastic, brown with grey and black streaks										
												1063
1												
				B1								
												1062
2												
				S1	11			■				
												1061
		- grey to dark grey, hydrocarbon odour										
3				B2		18.2	●					
												1060
				S2	15			■				
4												
		CLAY (FILL) - sandy, some silt, trace gravel, damp, stiff, low plastic, brown, trace oxides										
4.57												



TETRA TECH		
	Contractor: Mobile Augers and Research	Completion Depth: 10.67 m
	Drilling Rig Type: Solid Stem Auger	Start Date: May 19, 2021
	Logged By: IB	Completion Date: May 19, 2021
	Reviewed By:	Page 1 of 3

Calgary	Borehole No: **BH21-13**	
	Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
	Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1063.593 m
	Calgary, Alberta	3TM: -2744.154862 E; 5659245.503 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit – Moisture Content – Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80	BH SI	BH VWP	Core Photos	Elevation (m)
4.57	Solid Stem Auger			B3		16.6						1059
5				S3	10							1058
6				B4		16.7						1057
7		- loose sand seam, approximately 450 mm		S4	8							
		CLAY: silty, trace sand, trace gravel, damp to moist, stiff, low to medium plastic, brown		B5		25.4						1056
8		Direct Shear Strength [Peak: phi = 31.8°, c = 7.8 kPa] [Residual: phi = 28.9°, c = 5.8 kPa]		SH1								1055
9		- moist to wet		S5	11							
9.14												

TETRA TECH	Contractor: Mobile Augers and Research	Completion Depth: 10.67 m
	Drilling Rig Type: Solid Stem Auger	Start Date: May 19, 2021
	Logged By: IB	Completion Date: May 19, 2021
	Reviewed By:	Page 2 of 3

Borehole No: BH21-13

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1063.593 m
Calgary, Alberta	3TM: -2744.154862 E; 5659245.503 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80	BH SI	BH WWP	Core Photos	Elevation (m)
9.14	Solid Stem Auger	Vibrating Wire Piezometer [Depth - 9.1 m, Tip Serial No. VW132933] Pre-Installation Reading [Frequency - 2953.0 Hz, Temp - 8.8°C]										
		- hard										
10				S6	32	16.8						1054
		END OF HOLE AT 10.67 m 85 mm slope inclinometer installed to 10.36 m Vibrating Wire Piezometer serial #132933 installed to 9.14 m Groundwater seepage upon completion Groundwater measured at 9.12 m on June 4, 2021 Coordinates are based on 3TM grid surveyed to a geodetic benchmark Note that core photos are provided for visual information purposes only. In the event of discrepancy between log data and photos, log data takes precedence										1053
11												1052
12												1051
13												1050
13.71												

June 4/21

Contractor: Mobile Augers and Research	Completion Depth: 10.67 m
Drilling Rig Type: Solid Stem Auger	Start Date: May 19, 2021
Logged By: IB	Completion Date: May 19, 2021
Reviewed By:	Page 3 of 3

TETRA TECH

Calgary

Borehole No: **BH21-14**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.438 m
Calgary, Alberta	3TM: -2637.701253 E; 5659172.068 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) / Plastic Limit – Moisture Content – Liquid Limit	SPT (N) / Pocket Pen. (kPa)	BH SI	BH VWP	Core Photos	Elevation (m)
0	Sonic	TOPSOIL - clay, silty, some sand, trace gravel, damp, dark brown, trace organics										
		CLAY (FILL) - silty, some sand, trace gravel, damp, low plastic, brown										1075
		Unconfined Compressive Strength [Pocket Penetrometer = 275 kPa]		B1								
1		- some gravel, dark brown, trace grey staining, trace oxides										1074
		Unconfined Compressive Strength [Pocket Penetrometer = 450 kPa]		B2								
		- silty, trace gravel, wet, light brown										
2		Unconfined Compressive Strength [Pocket Penetrometer = 0 kPa]		B3		26.2						1073
3												1072
4		- grey Unconfined Compressive Strength [Pocket Penetrometer = 0 kPa]		B4		20.9						1071
4.57												

Soluble Sulphates (%): 1 2 3 4
Plastic Limit / Moisture Content / Liquid Limit: 20 40 60 80
SPT (N): 20 40 60 80
Pocket Pen. (kPa): 100 200 300 400

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 1 of 5

Borehole No: **BH21-14**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.438 m
Calgary, Alberta	3TM: -2637.701253 E; 5659172.068 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit – Moisture Content – Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
4.57	Sonic											
		- sandy, some silt										
5												
		Unconfined Compressive Strength [Pocket Penetrometer = 100 kPa]		B5				▲ 100				
												1070
		- some gravel, trace black staining										
6												
												1069
7												
												1068
		CLAY (TILL) - silty, some sand, trace gravel, trace cobbles, moist, firm, low plastic, grey, trace coal specks										
8		Unconfined Compressive Strength [Pocket Penetrometer = 100 kPa]		B6		18.4	● 18.4	▲ 100				
												1067
9												
9.14												

TETRA TECH		
	Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
	Drilling Rig Type: Sonic	Start Date: May 20, 2021
	Logged By: IB	Completion Date: May 20, 2021
	Reviewed By:	Page 2 of 5

Borehole No: **BH21-14**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.438 m
Calgary, Alberta	3TM: -2637.701253 E; 5659172.068 N

Columns: Depth (m) | Method | Soil Description | Sample Type | Sample Number | SPT (N) | Moisture Content (%) | ■ Soluble Sulphates (%) ■ 1 2 3 4; Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80 | ■ SPT (N) ■ 20 40 60 80; ▲ Pocket Pen. (kPa) ▲ 100 200 300 400 | BH SI | BH VWP | Core Photos | Elevation (m)

Depth at top of page: 9.14

Depth (m)	Method	Soil Description	Sample Number	Moisture Content (%)	Elevation (m)
					1066
10					
					1065
	Sonic	- stiff, low to medium plastic, brown			
11					
		Unconfined Compressive Strength [Pocket Penetrometer = 175 kPa]	B7	17.6	1064
12					
		CLAY - silty, trace to some sand, trace gravel, moist, firm, medium plastic, brown			
					1063
13					
		Material Proportions [Gravel - 1%, Sand - 20%, Silt - 46%, Clay (<2 μm) - 33%] Unconfined Compressive Strength [Pocket Penetrometer = 50 kPa]	B8	30.9	1062
13.71					

June '21

Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 3 of 5

TETRA TECH

Borehole No: **BH21-14**

Calgary

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.438 m
Calgary, Alberta	3TM: -2637.701253 E; 5659172.068 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Suphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
13.7	Sonic	Vibrating Wire Piezometer [Depth - 13.7 m, Tip Serial No VW132926] Pre-installation Reading [Frequency - 2934.2 Hz, Temp - 14.6°C]		B9		30						
14		- high plastic Unconfined Compressive Strength [Pocket Penetrometer = 75 kPa]										
												1061
		SILT [TILL] - some sand, trace to some clay, trace gravel, moist to wet, trace plasticity, brown		B10								
15												
		Direct Shear Strength [Peak phi = 26.3°, c = 18.3 kPa] [Residual phi = 23.0°, c = 11.7 kPa]		SH1								1060
16				B11		26.7						1059
17				B12								1058
		SAND - silty, trace clay, fine grained, poorly graded, moist, dense, brown										
18												
18.28												

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 4 of 5

Borehole No: **BH21-14**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.438 m
Calgary, Alberta	3TM: -2637.701253 E; 5659172.068 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
18.28	Sonic											
				S1	46							1057
19												
				B13		9.4						1056
		END OF HOLE AT 19.81 m 85 mm slope inclinometer installed to 19.51 m. Vibrating Wire Piezometer serial #132926 installed to 13.72 m Groundwater seepage upon completion Groundwater measured at 13.61 m on June 4, 2021 Coordinates are based on 3TM grid surveyed to a geodetic benchmark Note that core photos are provided for visual information purposes only. In the event of discrepancy between log data and photos, log data takes precedence										
20												
												1055
21												
												1054
22												
												1053
22.85												

Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 5 of 5

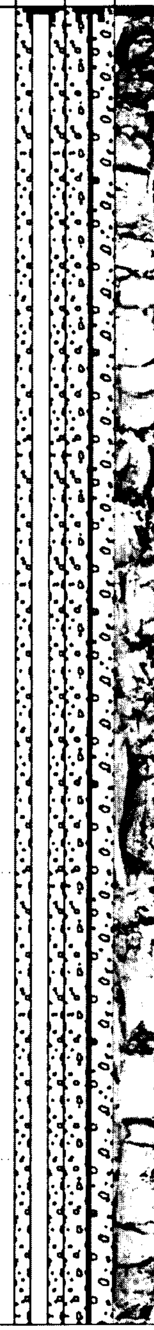
TETRA TECH

Borehole No: **BH21-15**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.212 m
Calgary, Alberta	3TM: -2579.261462 E, 5659170.019 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Elevation (m)
0	Sonic	TOPSOIL - clay, some sand, some silt, trace gravel, damp, dark brown, trace organics					1075
		CLAY (FILL) - some sand, some silt, trace gravel, damp, low plastic, brown					
1		Unconfined Compressive Strength [Pocket Penetrometer = 450 kPa]		B1			1074
2		- sandy Unconfined Compressive Strength [Pocket Penetrometer = 25 kPa]		B2		22.2	1073
		- buried topsoil					
3		- grey, hydrocarbon odour					1072
4		Unconfined Compressive Strength [Pocket Penetrometer = 50 kPa]		B3			1071
4.57							

Graph columns: ■ Soluble Sulphates (%) ■ 1 2 3 4; Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80; ■ SPT (N) ■ 20 40 60 80; ▲ Pocket Pen. (kPa) ▲ 100 200 300 400; BH SI; BH WWP; Core Photos



TETRA TECH	
Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 1 of 5

Borehole No: **BH21-15**

Calgary

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.212 m
Calgary, Alberta	3TM: -2579.261462 E; 5659170.019 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
4.57	Sonic											
5												1070
		- buried organics Unconfined Compressive Strength [Pocket Penetrometer = 100 kPa]		B4		22.1						
6												1069
7		- dark brown, trace roots, organics Unconfined Compressive Strength [Pocket Penetrometer = 200 kPa]		B5		35.2						1068
8		CLAY (TILL) - sandy, silty, trace gravel, damp to moist, firm, grey, hydrocarbon odour Unconfined Compressive Strength [Pocket Penetrometer = 50 kPa]		B6		18.5						1067
9												
9.14												

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 2 of 5

Borehole No: BH21-15

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.212 m
Calgary, Alberta	3TM: -2579.261462 E; 5659170.019 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
9.14												1066
10												1065
11	Sonic											1064
12												1063
13												1062
13.71		Vibrating Wire Piezometer [Depth - 13.7 m; Tip Serial No. VW132945] Pre-Installation Reading [Frequency - 2920.2 Hz; Temp. 17.3°C]										

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 3 of 5

Borehole No: BH21-15

Calgary

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.212 m
Calgary, Alberta	3TM: -2579.261462 E; 5659170.019 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
13.71 – 14	Sonic	SILT (TILL) - trace to some clay, trace sand, trace gravel, moist to wet, stiff, low plastic, brown, trace oxides										June 4/21
		Material Proportions: [Gravel - 1% Sand - 5% Silt - 77% Clay (<2 µm) - 17%]		B7		28.1						1061
15		SAND - silty, trace gravel, fine grained, poorly graded, damp, very dense, brown to grey										1060
16												1059
17				B8		10.1						1058
18 – 18.28												1057

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 4 of 5

Borehole No: **BH21-15**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1075.212 m
Calgary, Alberta	3TM: -2579 261462 E; 5659170 019 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	■Soluble Sulphates (%)■ 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	■SPT (N)■ 20 40 60 80 / ▲Pocket Pen. (kPa)▲ 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
18.28	Sonic			S1	72	16.2						
19				B9		14.1						1056
20		END OF HOLE AT 19.81 m 85 mm slope inclinometer installed to 18.90 m Vibrating Wire Piezometer serial #132945 installed to 13.72 m Groundwater seepage upon completion Groundwater measured at 13.77 m on June 4, 2021 Coordinates are based on 3TM grid surveyed to a geodetic benchmark. Note that core photos are provided for visual information purposes only. In the event of discrepancy between log data and photos, log data takes precedence										1055
21												1054
22												1053
22.85												

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 19.81 m
Drilling Rig Type: Sonic	Start Date: May 20, 2021
Logged By: IB	Completion Date: May 20, 2021
Reviewed By:	Page 5 of 5

Calgary

Borehole No: **BH21-16**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1064.478 m
Calgary, Alberta	3TM: -2578.917229 E; 5659196.791 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit – Moisture Content – Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
0	Solid Stem Auger	TOPSOIL - clay, sandy, silty, trace gravel, dry to damp, dark brown, trace organics										
		CLAY (TILL) - sandy, silty, trace gravel, dry to damp, stiff, low plastic, brown, trace oxides										1064
1		Unconfined Compressive Strength [Pocket Penetrometer = 125 kPa]		B1		15.6						1063
2		SAND - some silt, trace clay, trace gravel, fine grained, poorly graded, damp, compact, brown		S1	12							1062
3				B2		4.2						1061
4				S2	13							1060
4.57												

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 12.19 m
Drilling Rig Type: Solid Stem Auger	Start Date: May 21, 2021
Logged By: IB	Completion Date: May 21, 2021
Reviewed By:	Page 1 of 3

Borehole No: **BH21-16**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1064.478 m
Calgary, Alberta	3TM: -2578.917229 E, 5659196.791 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Elevation (m)
4.57	Solid Stem Auger	Material Proportions [Sand - 78% Silt - 14% Clay (<2 µm) - 8%]		B3		6.6	
5							
				S3	20		1059
6				B4		3.2	1058
7				S4	20		
				B5		2.8	1057
8				S5	27		1056
9							
9.14							

Chart headings: ■ Soluble Sulphates (%) ■ 1 2 3 4; Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80; ■ SPT (N) ■ 20 40 60 80; ▲ Pocket Pen. (kPa) ▲ 100 200 300 400; BH SI; BH VWP; Core Photos

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 12.19 m
Drilling Rig Type: Solid Stem Auger	Start Date: May 21, 2021
Logged By: IB	Completion Date: May 21, 2021
Reviewed By:	Page 2 of 3

GEOTECHNICAL ENG-CGEO04110-01.GPJ EBA.GDT 11/5/21

Borehole No: **BH21-16**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1064.478 m
Calgary, Alberta	3TM: -2578.917229 E; 5659196.791 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)
9.14	Solid Stem Auger					
				B6		5.7
10				S6	20	
		- trace black staining		B7		10.2
11						
		Vibrating Wire Piezometer [Depth - 11.6 m, Tip Serial No. VW132925] Pre-installation Reading [Frequency - 2931.6 Hz, Temp - 12.5°C]		S7	29	
June 4/21						
12						
		END OF HOLE AT 12.19 m 85 mm slope inclinometer installed to 11.58 m. Vibrating Wire Piezometer serial #132925 installed to 11.58 m. Dry upon completion. Groundwater measured at 11.61 m on June 4, 2021. Coordinates are based on 3TM grid surveyed to a geodetic benchmark. Note that core photos are provided for visual information purposes only. In the event of discrepancy between log data and photos, log data takes precedence.				
13						
13.71						

Chart headings: ■ Soluble Sulphates (%) ■ 1 2 3 4; Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80; ■ SPT (N) ■ 20 40 60 80; ▲ Pocket Pen. (kPa) ▲ 100 200 300 400; BH SI; BH VWP; Core Photos; Elevation (m): 1055, 1054, 1053, June 4/21, 1052, 1051

Contractor: Mobile Augers and Research	Completion Depth: 12.19 m
Drilling Rig Type: Solid Stem Auger	Start Date: May 21, 2021
Logged By: IB	Completion Date: May 21, 2021
Reviewed By:	Page 3 of 3

Borehole No: **BH21-17**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1059.85 m
Calgary, Alberta	3TM: -2439.879301 E; 5659205.991 N

Calgary

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Elevation (m)
0	Solid Stem Auger	TOPSOIL - clay, silty, some sand, trace gravel, damp, low plastic, dark brown, trace organics					
		CLAY (FILL) - silty, some sand, trace gravel, damp, low plastic, brown, trace oxides, trace coal specks					1059
1							
		Unconfined Compressive Strength [Pocket Penetrometer = 200 kPa]		B1		16	1058
2				S1	5		
		CLAY (TILL) - silty, trace sand, trace gravel, damp, stiff, medium plastic, brown, trace oxides, trace coal specks					1057
3		Unconfined Compressive Strength [Pocket Penetrometer = 100 kPa]		B2		17.1	
				S2	10		1056
4		SILT (TILL) - sandy, trace to some clay, trace gravel, damp, stiff, brown, trace oxides					
4.57				B3		13.1	

Chart columns: Soluble Sulphates (%) 1 2 3 4; Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80; SPT (N) 20 40 60 80; Pocket Pen. (kPa) 100 200 300 400; BH SI; BH VWP; Core Photos

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 15.24 m
Drilling Rig Type: Solid Stem Auger	Start Date: May 21, 2021
Logged By: IB	Completion Date: May 21, 2021
Reviewed By	

GEOTECHNICAL ENG-CGEO04110-01.GPJ EBA.GDT 11/8/21

Borehole No: **BH21-17**

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG.CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1059.85 m
Calgary, Alberta	3TM: -2439.879301 E; 5659205.991 N

Calgary

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
4.57	Solid Stem Auger											
		- sand seam approximately 150 mm thick										1055
5												
				S3	11							
		CLAY (TILL) - silty, some sand, trace gravel, damp, very stiff, low plastic, brown, trace oxides										1054
6												
		Unconfined Compressive Strength [Pocket Penetrometer = 150 kPa]		B4		15.1						
				S4	21							1053
7												
		Unconfined Compressive Strength [Pocket Penetrometer = 175 kPa]		B5		14.5						1052
8												
		- sandy										
				S5	26							1051
9												
9.14												



TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 15.24 m
Drilling Rig Type: Solid Stem Auger	Start Date: May 21, 2021
Logged By: IB	Completion Date: May 21, 2021
Reviewed By:	Page 2 of 4

Calgary

Borehole No: BH21-17

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1059.85 m
Calgary, Alberta	3TM: -2439.879301 E, 5659205.991 N

Column headings: Depth (m) · Method · Soil Description · Sample Type · Sample Number · SPT (N) · Moisture Content (%) · Soluble Suphates (%) 1 2 3 4 · Plastic Limit / Moisture Content / Liquid Limit 20 40 60 80 · SPT (N) 20 40 60 80 · Pocket Pen. (kPa) 100 200 300 400 · BH SI · BH VWP · Core Photos · Elevation (m)

Method: Solid Stem Auger

Depth (m)	Soil Description	Sample Number	SPT (N)	Moisture Content (%)
9.14	Unconfined Compressive Strength [Pocket Penetrometer = 175 kPa]	B6		
10		S6	18	
	- moist Unconfined Compressive Strength [Pocket Penetrometer = 125 kPa]	B7		14.8
11		S7	25	
12	Unconfined Compressive Strength [Pocket Penetrometer = 200 kPa]	B8		
13		S8	25	
13.7				

Elevation (m): 1050, 1049, 1048, 1047

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 15.24 m
Drilling Rig Type: Solid Stem Auger	Start Date: May 21, 2021
Logged By: IB	Completion Date: May 21, 2021
Reviewed By	Page 3 of 4

Borehole No: **BH21-17**

Calgary

Project: Midfield Mobile Home Park Redevelopment	Project No: ENG CGEO04110-01
Location: Moncton Road NE and 16 Avenue NE	Ground Elev: 1059.85 m
Calgary, Alberta	3TM: -2439.879301 E; 5659205.991 N

Depth (m)	Method	Soil Description	Sample Type	Sample Number	SPT (N)	Moisture Content (%)	Soluble Sulphates (%) 1 2 3 4 / Plastic Limit, Moisture Content, Liquid Limit 20 40 60 80	SPT (N) 20 40 60 80 / Pocket Pen. (kPa) 100 200 300 400	BH SI	BH VWP	Core Photos	Elevation (m)
13.71	Solid Stem Auger	Unconfined Compressive Strength [Pocket Penetrometer = 150 kPa]		S8		14.6						1046
14												
June 4/21		Vibrating Wire Piezometer [Depth - 14.6 m, Tip Serial No. VW132947] Pre-Installation Reading [Frequency - 2944.5 Hz, Temp - 15.2°C]		S9	26							June 4/21
15												1045
		END OF HOLE AT 15.24 m 85 mm slope inclinometer installed to 14.63 m Vibrating Wire Piezometer serial #132947 installed to 14.63 m Dry upon completion Groundwater measured at 14.60 m on June 4, 2021 Coordinates are based on 3TM grid surveyed to a geodetic benchmark Note that core photos are provided for visual information purposes only. In the event of discrepancy between log data and photos, log data takes precedence										1044
16												
17												1043
18												1042
18.29												

TETRA TECH

Contractor: Mobile Augers and Research	Completion Depth: 15.24 m
Drilling Rig Type: Solid Stem Auger	Start Date: May 21, 2021
Logged By: IB	Completion Date: May 21, 2021
Reviewed By:	Page 4 of 4

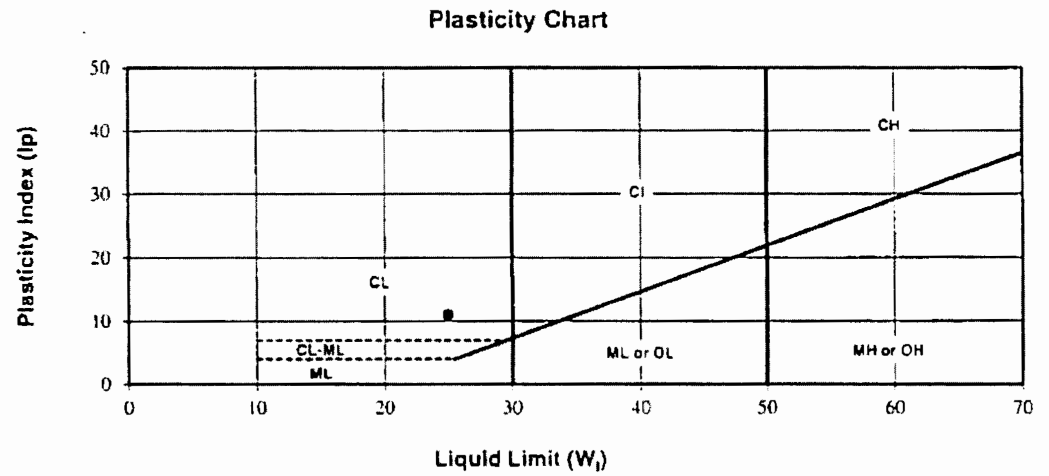
APPENDIX C
LABORATORY TEST RESULTS

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	S4
		Borehole Number:	BH21-12
Project No:	704-ENG.CGEO04110-01	Depth:	14.6-15.1 m
Client:	The City of Calgary	Sampled By:	EB Tested By: AT
Attention:		Date Sampled:	May 17, 2021
Email:		Date Tested:	June 8, 2021

Sample Description: CLAY, silty, sandy, trace gravel



Liquid Limit (W_l):	25	Natural Moisture (%)	17.7
Plastic Limit :	14	Soil Plasticity:	Low
Plasticity Index (Ip) :	11	Mod.USCS Symbol:	CL-ML

Remarks:

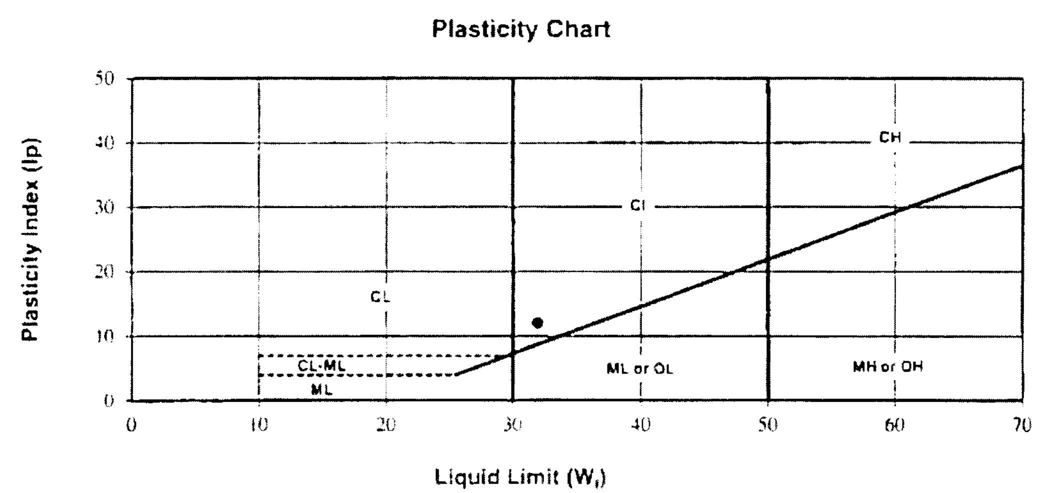
Reviewed By: [signature] P.Eng.

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	B5
		Borehole Number:	BH21-13
Project No:	704-ENG.CGEO04110-01	Depth:	7.5-7.8 m
Client:	The City of Calgary	Sampled By:	EB Tested By: AT
Attention:		Date Sampled:	May 17, 2021
Email:		Date Tested:	June 8, 2021

Sample Description: CLAY, silty, some sand, trace gravel



Liquid Limit (W_l):	32	Natural Moisture (%)	25.4
Plastic Limit :	20	Soil Plasticity:	Medium
Plasticity Index (Ip) :	12	Mod.USCS Symbol:	CI

Remarks:

Reviewed By: [signature] P.Eng.

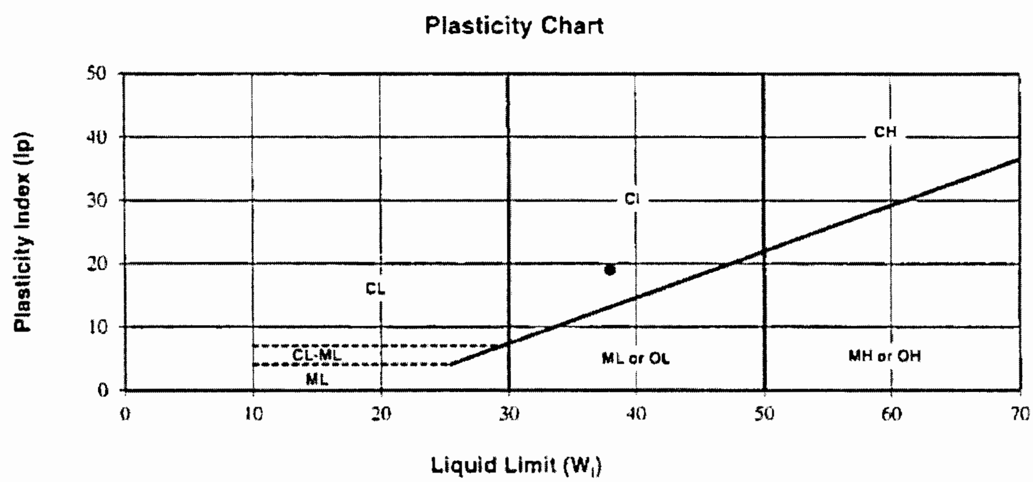
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	B8
		Borehole Number:	BH21-14
Project No:	704-ENG.CGEO04110-01	Depth:	13.1-13.4 m
Client:	The City of Calgary	Sampled By:	EB Tested By: AT
Attention:		Date Sampled:	May 17, 2021
Email:		Date Tested:	June 8, 2021

Sample Description: CLAY, silty, sandy, trace gravel



Liquid Limit (W_l):	38	Natural Moisture (%)	30.9
Plastic Limit :	19	Soil Plasticity:	Medium
Plasticity Index (Ip) :	19	Mod.USCS Symbol:	CI

Remarks:

Reviewed By: [signature] P.Eng.

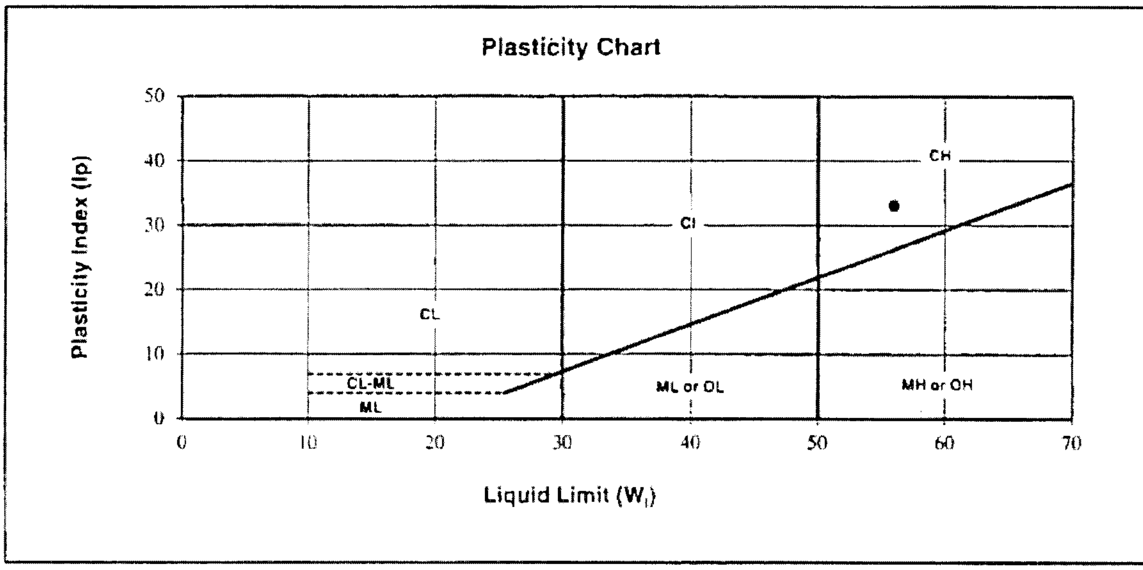
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	B9
		Borehole Number:	BH21-14
Project No:	704-ENG.CGEO04110-01	Depth:	13.7-14 m
Client:	The City of Calgary	Sampled By:	EB Tested By: SS
Attention:		Date Sampled:	May 17, 2021
Email:		Date Tested:	June 8, 2021

Sample Description: CLAY, silty, some sand, trace gravel



Liquid Limit (W_l):	56	Natural Moisture (%)	30.0
Plastic Limit :	23	Soil Plasticity:	High
Plasticity Index (Ip) :	33	Mod.USCS Symbol:	CH

Remarks:

Reviewed By: P.Eng

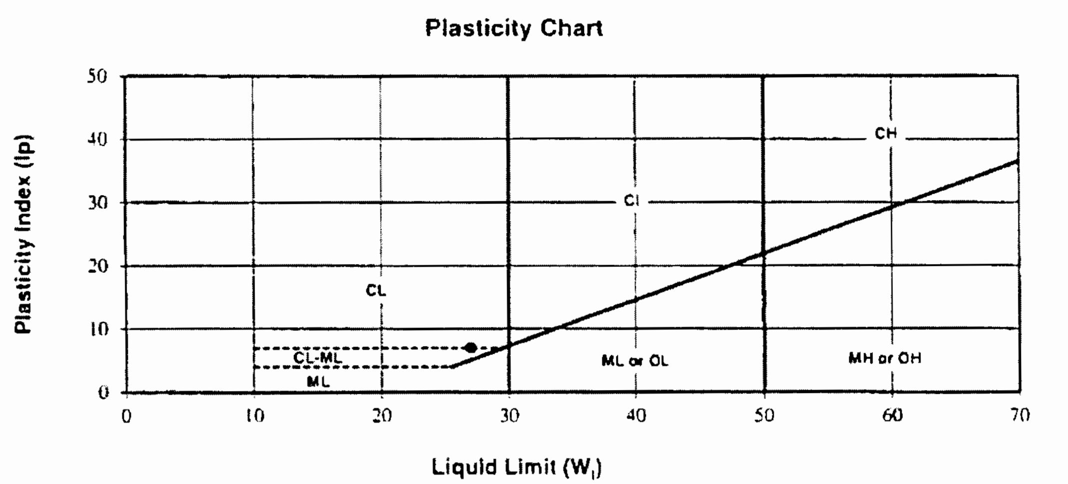
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	B7
		Borehole Number:	BH21-15
Project No:	704-ENG.CGEO04110-01	Depth:	14.3-14.6 m
Client:	The City of Calgary	Sampled By:	EB Tested By: AT
Attention:		Date Sampled:	May 17, 2021
Email:		Date Tested:	June 8, 2021

Sample Description: SILT, some clay, trace sand, trace gravel



Liquid Limit (W$_l$):	27	Natural Moisture (%)	28.1
Plastic Limit :	20	Soil Plasticity:	Low
Plasticity Index (Ip) :	7	Mod.USCS Symbol:	ML

Remarks:

Reviewed By: [signature] P.Eng.

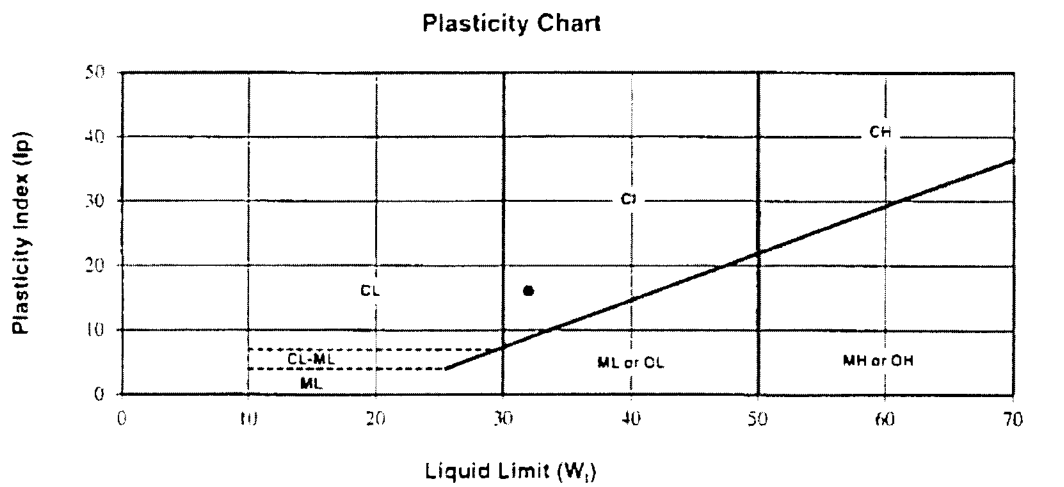
TETRA TECH

ATTERBERG LIMITS TEST REPORT

ASTM D4318

Project:	Midfield Mobile Home Park Redevelopment	Sample Number:	B2
Project No:	704-ENG.CGEO04110-01	Borehole Number:	BH21-17
Client:	The City of Calgary	Depth:	3.0-3.4 m
Attention:		Sampled By:	EB Tested By: SS
Email:		Date Sampled:	May 17, 2021
		Date Tested:	May 21, 2021

Sample Description: CLAY, silty, sandy, trace gravel



Liquid Limit (W_l):	32	Natural Moisture (%)	17.1
Plastic Limit:	16	Soil Plasticity:	Medium
Plasticity Index (Ip):	16	Mod.USCS Symbol:	CI

Remarks:

Reviewed By: [signature] P.Eng

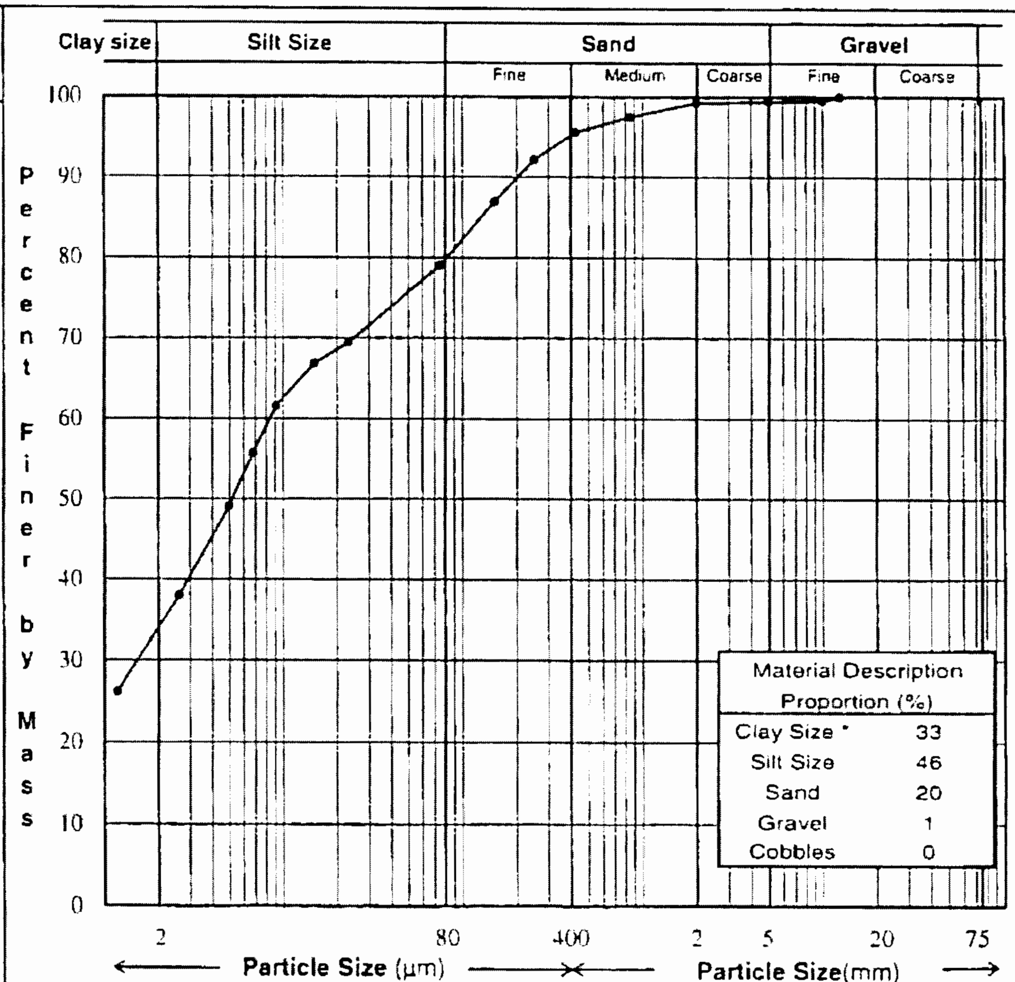
TETRA TECH

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D7928

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	B8
Client:	The City of Calgary	Borehole/ TP:	BH21-14
Project No.:	704-ENG.CGEO04110-01	Depth:	13.1-13.4 m
Location:	Moncton Road NE and 16 Avenue NE, Calgary	Date Tested	June 8, 2021
Description **:	CLAY, silty, sandy, trace gravel	Tested By:	AT

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	100
10 mm	100
5 mm	99
2 mm	99
850 µm	97
425 µm	96
250 µm	92
150 µm	87
75 µm	79
23 µm	69
15 µm	67
9 µm	62
7 µm	56
5 µm	49
3 µm	38
1 µm	26



Material Description	Proportion (%)
Clay Size *	33
Silt Size	46
Sand	20
Gravel	1
Cobbles	0

Remarks: * The description is behaviour based & subject to Tetra Tech Canada description protocols.

** Unless expressly stated, this test was performed by the Air Dry Method

Reviewed By: [signature] P.Eng.

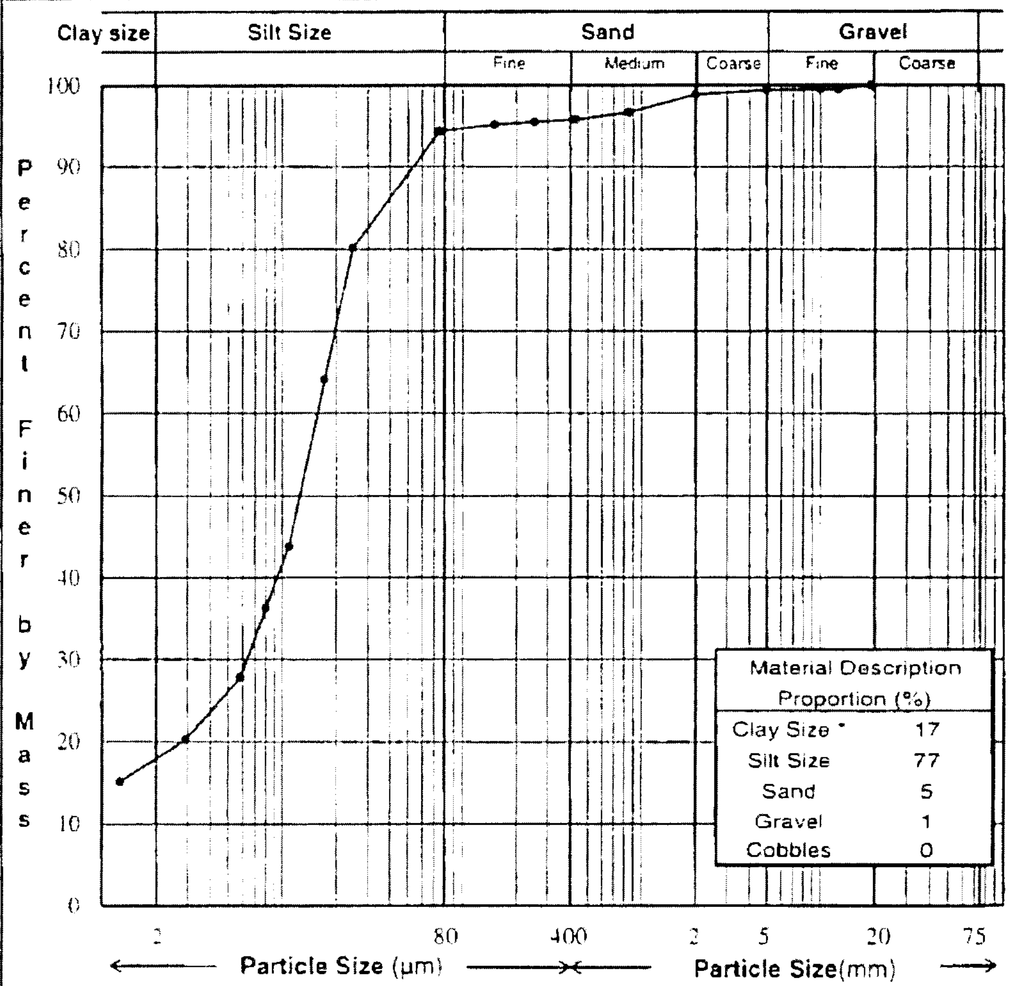
TETRA TECH

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D7928

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	B7
Client:	The City of Calgary	Borehole/ TP:	BH21-15
Project No.:	704-ENG.CGEO04110-01	Depth:	14.3-14.6 m
Location:	Moncton Road NE and 16 Avenue NE, Calgary	Date Tested	June 8, 2021
Description **:	SILT, some clay, trace sand, trace gravel	Tested By:	AT

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	100
13 mm	99
10 mm	99
5 mm	99
2 mm	99
850 µm	97
425 µm	96
250 µm	95
150 µm	95
75 µm	94
25 µm	80
17 µm	64
11 µm	44
8 µm	36
6 µm	28
3 µm	20
1 µm	15



Material Description	Proportion (%)
Clay Size *	17
Silt Size	77
Sand	5
Gravel	1
Cobbles	0

Remarks: * The description is behaviour based & subject to Tetra Tech Canada description protocols.

** Unless expressly stated, this test was performed by the Air Dry Method

Reviewed By: P.Eng.

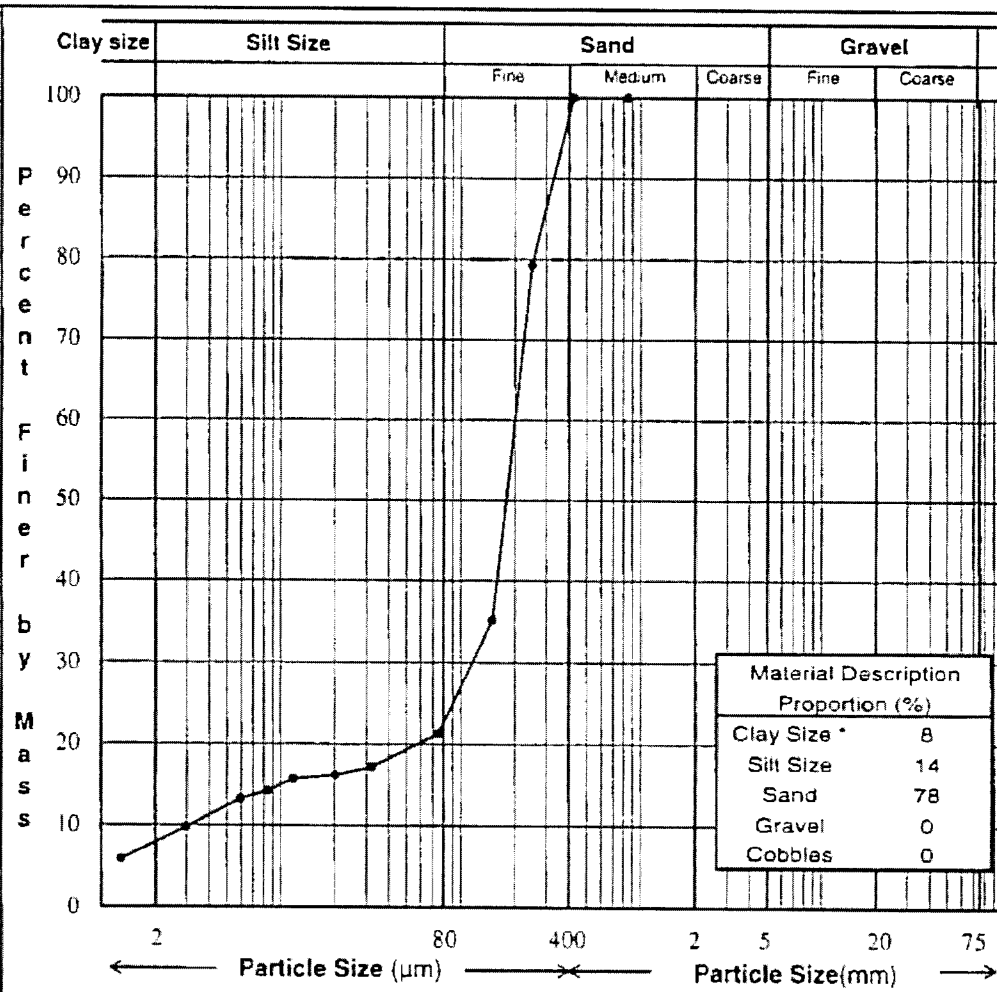
TETRA TECH

PARTICLE SIZE ANALYSIS (Hydrometer) TEST REPORT

ASTM D7928

Project:	Midfield Mobile Home Park Redevelopment	Sample No.:	B3
Client:	The City of Calgary	Borehole/ TP:	BH21-16
Project No.:	704-ENG.CGEO04110-01	Depth:	4.6-4.9 m
Location:	Moncton Road NE and 16 Avenue NE, Calgary	Date Tested	June 8, 2021
Description **:	SAND, some silt, trace clay	Tested By:	AT

Particle Size	Percent Passing
100 mm	
75 mm	
50 mm	
38 mm	
25 mm	
19 mm	
13 mm	
10 mm	
5 mm	
2 mm	
850 µm	100
425 µm	100
250 µm	79
150 µm	35
75 µm	21
32 µm	17
20 µm	16
12 µm	16
8 µm	14
6 µm	13
3 µm	10
1 µm	6



Material Description	Proportion (%)
Clay Size *	8
Silt Size	14
Sand	78
Gravel	0
Cobbles	0

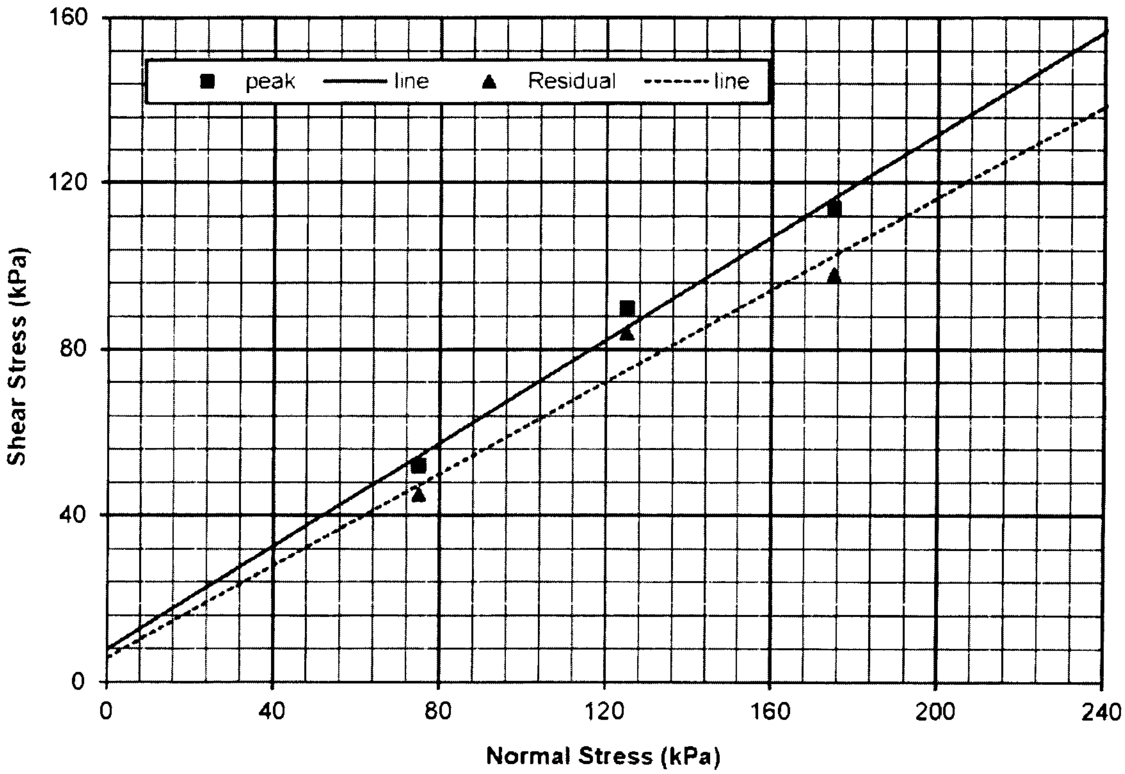
Remarks: * The description is behaviour based & subject to Tetra Tech Canada description protocols.
** Unless expressly stated, this test was performed by the Air Dry Method

Reviewed By: [signature] P.Eng.

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project:	Midfield Mobile Home Park Redevelopment	Test Hole:	BH21-13
Project No.:	ENG.CGEO04110-01	Depth:	N/A
Client:	City of Calgary	Date:	June 23, 2021
Attention:		Tested By:	TD
Email:		Office:	Edmonton



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	7.8	31.8
Residual Strength:	5.8	28.9

Reviewed By: V.O P.Eng

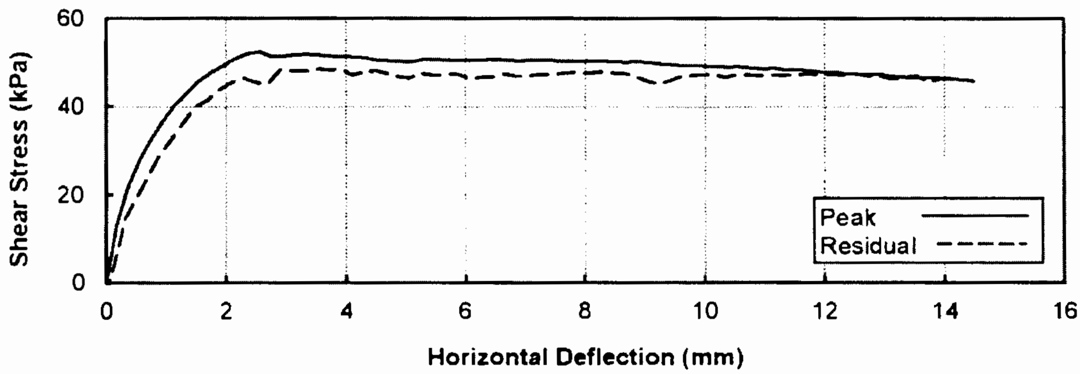
TETRA TECH

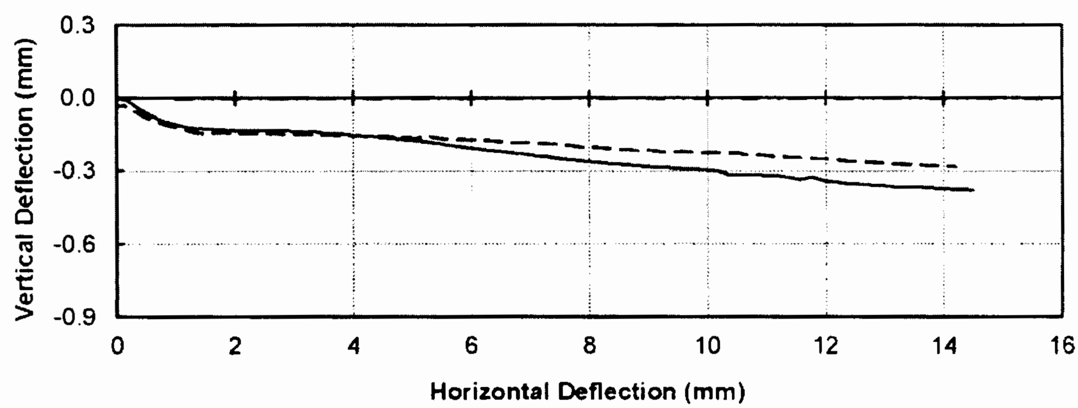
DIRECT SHEAR TEST

ASTM D3080

Project:	Midfield Mobile Home Park Redevelopment	Test Hole No.:	BH21-13
Project No.:	ENG.CGEO04110-01	Depth:	N/A
Client:	City of Calgary	Test No.:	DS-1
Date Tested:	June 23, 2021	Machine:	3
Description:	SILT, clayey, sandy, trace gravel, brown	Preparation:	Undisturbed

			Initial	Final
Normal Stress (kPa) =	75	Moisture Content (%)	21.4	18.9
Peak Stress (kPa) =	52	Wet Density (Mg/m^3)	2.046	1.940
Residual Stress (kPa) =	45	Dry Density (Mg/m^3)	1.685	1.632





Remarks: ______________________________

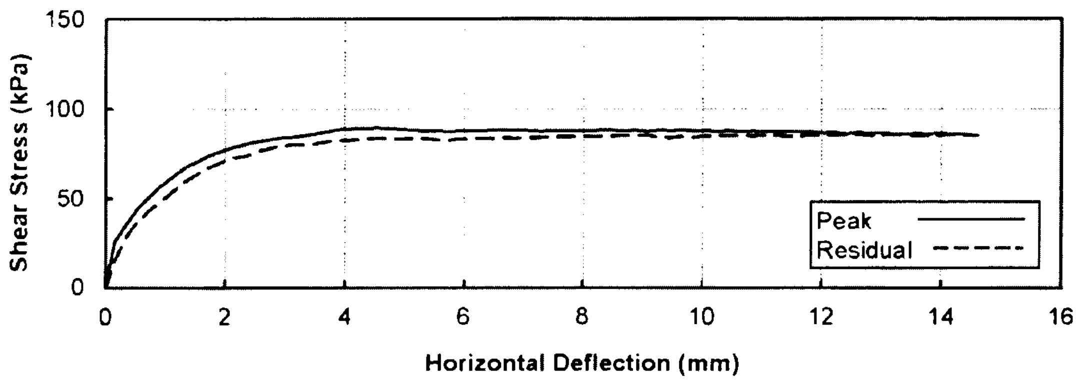
Reviewed By: V·O P.Eng

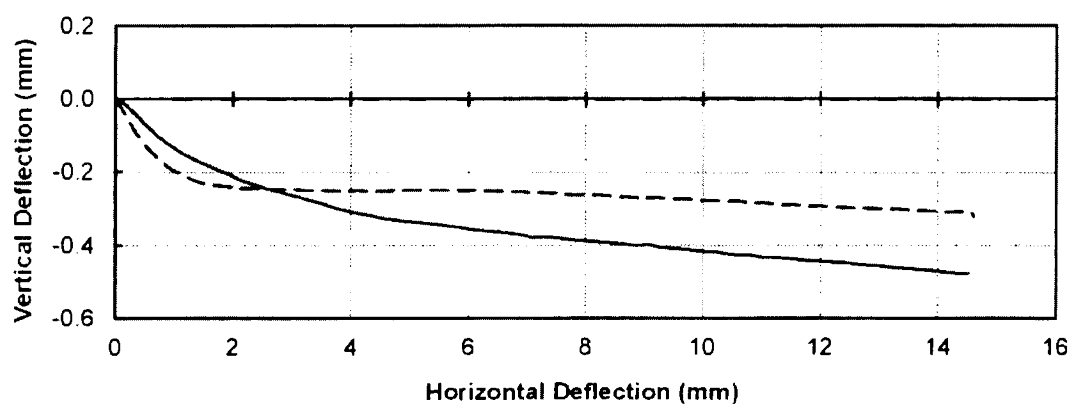
DIRECT SHEAR TEST

ASTM D3080

Project:	Midfield Mobile Home Park Redevelopment	Test Hole No.:	BH21-13
Project No.:	ENG.CGEO04110-01	Depth:	N/A
Client:	City of Calgary	Test No.:	DS-2
Date Tested:	June 23, 2021	Machine:	2
Description:	SILT, clayey, sandy, trace gravel, brown	Preparation:	Undisturbed

			Initial	Final
Normal Stress (kPa) =	125	Moisture Content (%)	24.3	19.0
Peak Stress (kPa) =	90	Wet Density (Mg/m^3)	1.994	1.831
Residual Stress (kPa) =	84	Dry Density (Mg/m^3)	1.604	1.539





Remarks: ____________________

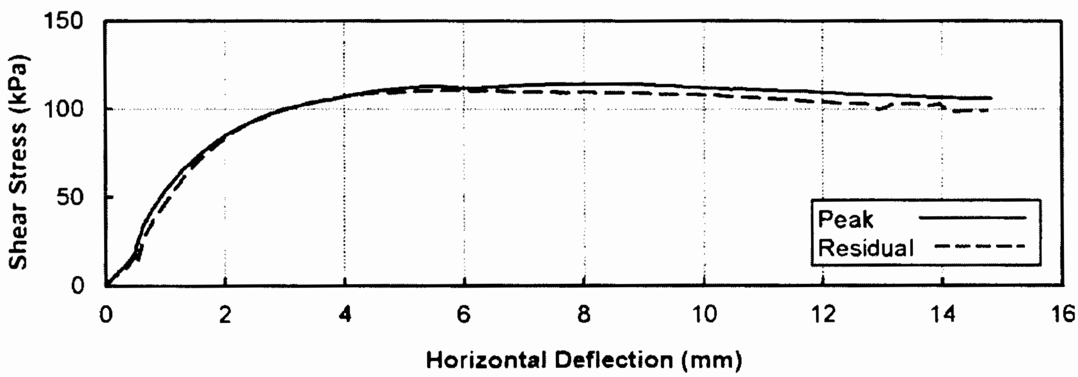
Reviewed By: V·O P Eng

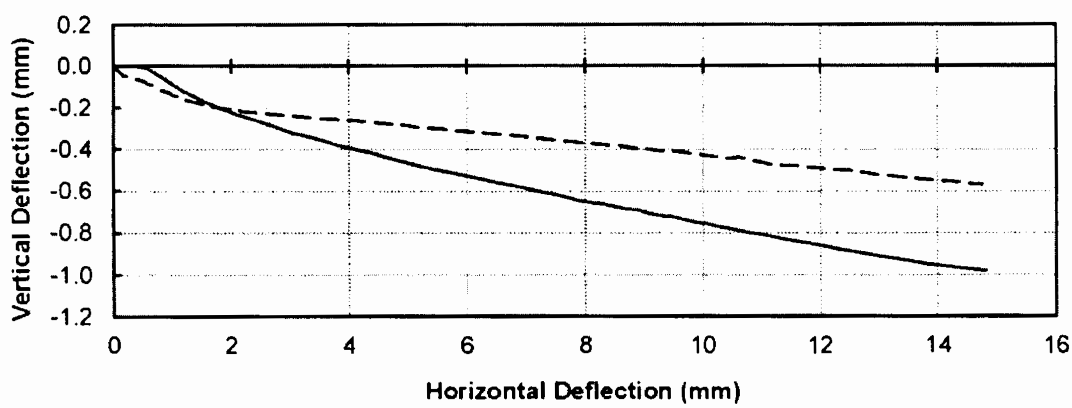
DIRECT SHEAR TEST

ASTM D3080

Project:	Midfield Mobile Home Park Redevelopment	Test Hole No.:	BH21-13
Project No.:	ENG.CGEO04110-01	Depth:	N/A
Client:	City of Calgary	Test No.:	DS-3
Date Tested:	June 23, 2021	Machine:	1
Description:	SILT, clayey, sandy, trace gravel, brown	Preparation:	Undisturbed

			Initial	Final
Normal Stress (kPa) =	175	Moisture Content (%)	25.2	20.6
Peak Stress (kPa) =	114	Wet Density (Mg/m^3)	1.982	1.832
Residual Stress (kPa) =	98	Dry Density (Mg/m^3)	1.584	1.519





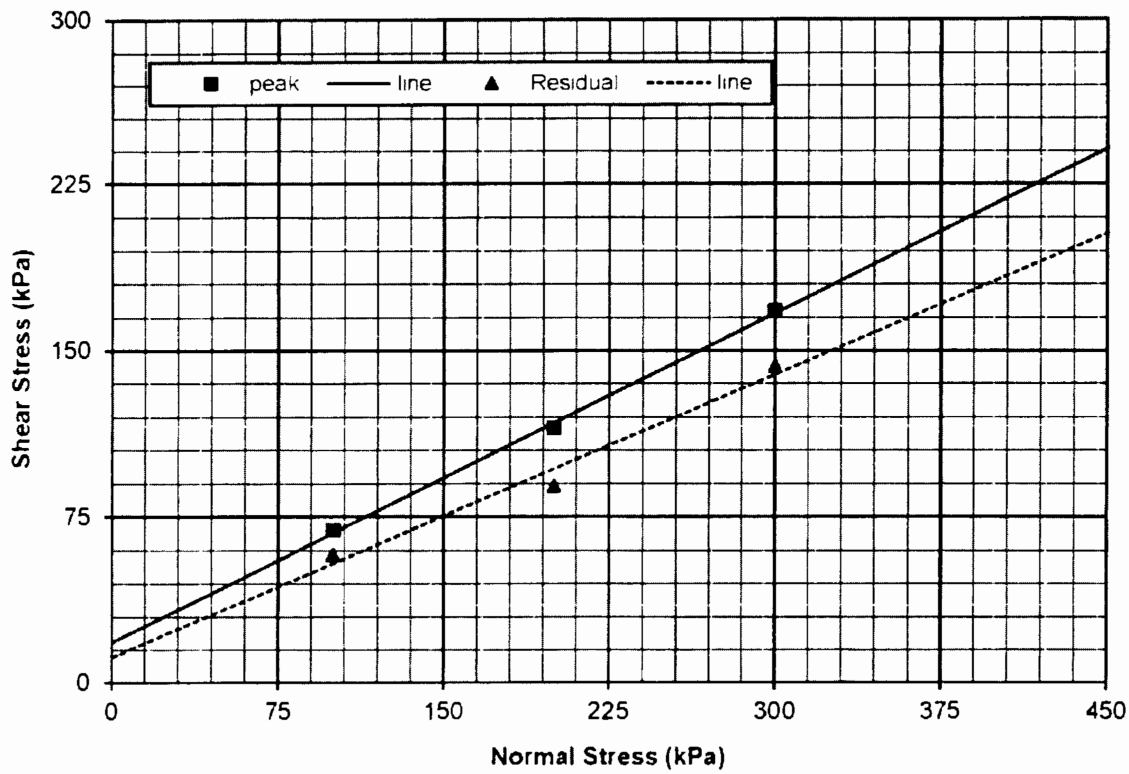
Remarks: ______________________

Reviewed By: V·O P Eng

SUMMARY of DIRECT SHEAR TEST RESULTS

ASTM D3080

Project:	Midfield Mobile Home Park Redevelopment	Test Hole:	BH21-14
Project No.:	ENG.CGEO04110-01	Depth:	N/A
Client:	City of Calgary	Date:	June 28, 2021
Attention:		Tested By:	TD
Email:		Office:	Edmonton



Inferred Shear Strength Parameters :-

	Cohesion Intercept (kPa)	Inferred Angle of Shearing Resistance (Degrees)
Peak Strength:	18.3	26.3
Residual Strength:	11.7	23.0

Reviewed By: V·O P Eng

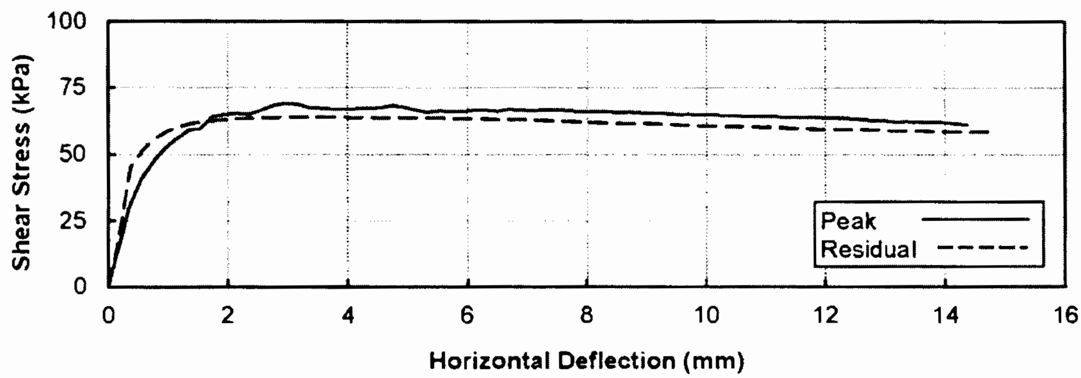
TETRA TECH

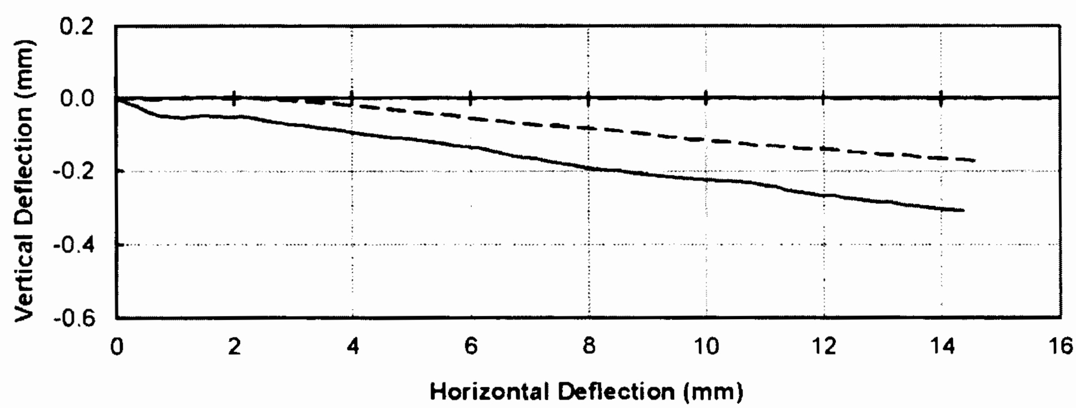
DIRECT SHEAR TEST

ASTM D3080

Project:	Midfield Mobile Home Park Redevelopment	Test Hole No.:	BH21-14
Project No.:	ENG.CGEO04110-01	Depth:	N/A
Client:	City of Calgary	Test No.:	DS-4
Date Tested:	June 28, 2021	Machine:	3
Description:	SILT, clayey, brown	Preparation:	Undisturbed

			Initial	Final
Normal Stress (kPa) = 100		Moisture Content (%)	26.5	23.6
Peak Stress (kPa) = 69		Wet Density (Mg/m^3)	2.037	1.925
Residual Stress (kPa) = 58		Dry Density (Mg/m^3)	1.611	1.557





Remarks: __________________

Reviewed By: V.O P Eng

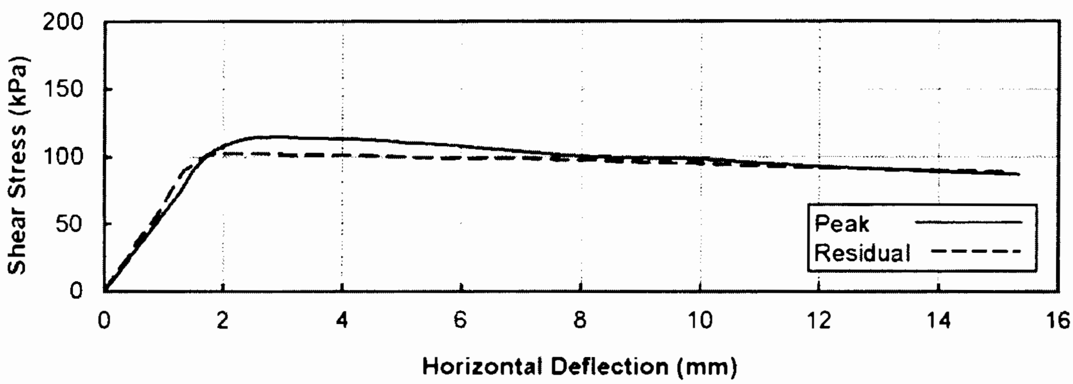
DIRECT SHEAR TEST

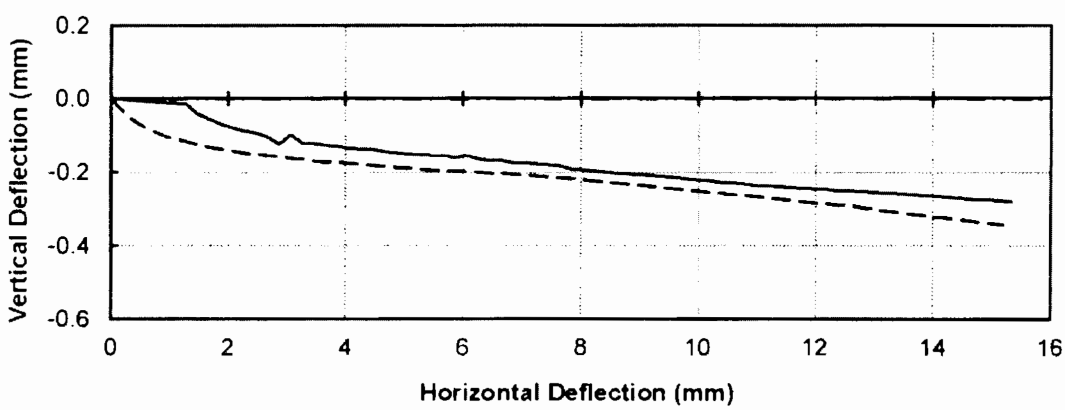
ASTM D3080

Project:	Midfield Mobile Home Park Redevelopment	Test Hole No.:	BH21-14
Project No.:	ENG.CGEO04110-01	Depth:	N/A
Client:	City of Calgary	Test No.:	DS-5
Date Tested:	June 28, 2021	Machine:	2
Description:	SILT, clayey, brown	Preparation:	Undisturbed

Normal Stress (kPa) =	200
Peak Stress (kPa) =	115
Residual Stress (kPa) =	89

	Initial	Final
Moisture Content (%)	32.1	32.7
Wet Density (Mg/m^3)	1.923	1.882
Dry Density (Mg/m^3)	1.456	1.418





Remarks: ____________________

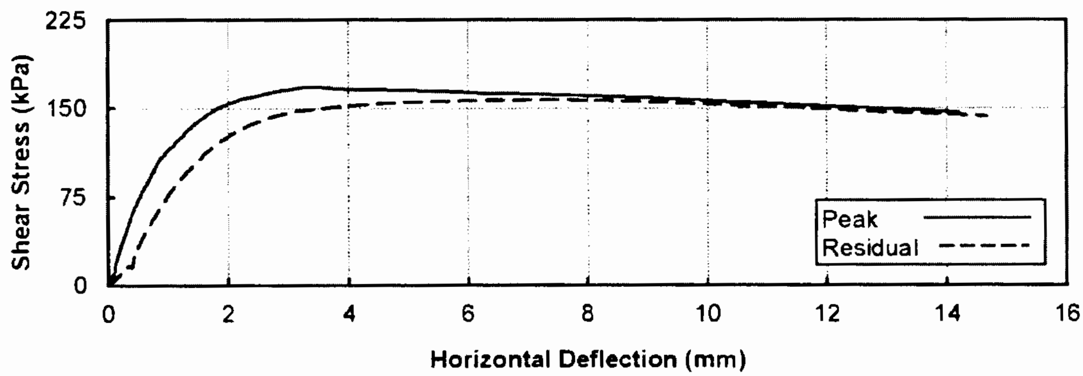
Reviewed By: V.O P.Eng

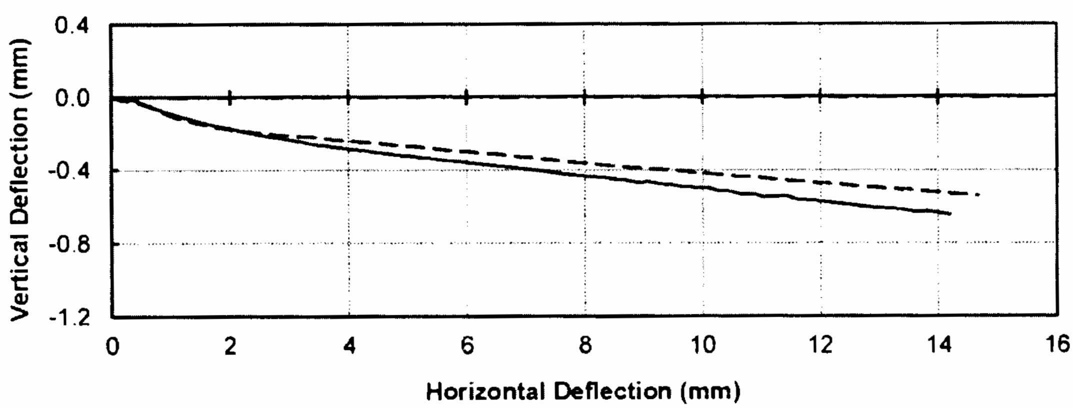
DIRECT SHEAR TEST

ASTM D3080

Project:	Midfield Mobile Home Park Redevelopment	Test Hole No.:	BH21-14
Project No.:	ENG.CGEO04110-01	Depth:	N/A
Client:	City of Calgary	Test No.:	DS-6
Date Tested:	June 28, 2021	Machine:	1
Description:	SILT, clayey, brown	Preparation:	Undisturbed

			Initial	Final
Normal Stress (kPa) =	300	Moisture Content (%)	26.4	24.3
Peak Stress (kPa) =	168	Wet Density (Mg/m^3)	2.000	1.864
Residual Stress (kPa) =	143	Dry Density (Mg/m^3)	1.583	1.500





Remarks: ______________________

Reviewed By: V·O P.Eng

TETRA TECH

APPENDIX D
INSTRUMENTATION MATERIAL SPECIFICATIONS (SI AND VWP)

Inclinometer Casing

Inclinometer Casing

Inclinometer casing is a special purpose, grooved pipe used in inclinometer installations. It is typically installed in boreholes, but can also be embedded in fills, cast into concrete, or attached to structures.

Inclinometer casing provides access for the inclinometer probe, allowing it to obtain subsurface measurements. Grooves inside the casing control the orientation of the probe and provide a surface from which repeatable tilt measurements can be obtained.

Choosing Inclinometer Casing

Although Slope Indicator casing is competitively priced, price should never be the deciding factor in choosing inclinometer casing. The cost of casing is quite small relative to the cost of mobilizing a drill rig, and very small relative to the cost of a failed installation.

This page summarizes the most important factors to consider when choosing casing.

Casing Diameter

The useful life of the casing ends when ground movement pinches or shears the casing, preventing the probe from passing through. Larger diameter casing generally provides longer life.

85mm (3.34") Casing is suitable for landslides and long term monitoring. It is also appropriate for monitoring multiple shear zones or very narrow shear zones, and it is required for the horizontal Digitilt inclinometer probe.

70mm (2.75") Casing is suitable for construction projects. It can also be used for slope stability monitoring when only a moderate degree of deformation is anticipated.

48mm (1.9") Casing is suitable for applications where small deformations are distributed over broad zones. It is generally not installed in soils.

Casing Grooves

Measurement accuracy is directly influenced by the quality of casing grooves. Slope Indicator optimizes casing grooves for the wheels of the Digitilt inclinometer probe, providing a flat surface for the wheels and also the extra width needed when the probe must pass through cross-axis curvature. Groove spiral is also tightly controlled.

Casing Strength

In borehole installations, the annular space around the casing is usually backfilled with grout. The grouting process can generate pressure high enough to cause the casing to collapse. In deep installations, the pressure of grout must be controlled by stage grouting, but in other cases, the casing must be strong enough to withstand the normal pressure of grouting. Slope Indicator uses thick-walled pipe and carefully controls the depth of the grooves.

Sealable Couplings

If casing joints are not adequately sealed, grout can force its way into the casing and later prevent the probe from reaching its intended depth.

Slope Indicator offers several types of couplings and casings, all of which can be sealed easily and consistently. Our newest designs feature O-ring seals, and our older designs feature tight-fitting surfaces that are fused together with solvent cement.

Assembly

Inclinometer casing should be easy to assemble, even with an untrained crew. Slope Indicator's QC casing, which snaps together, is the current leader in quick and easy assembly. Other types of casing are assembled with shear wires or with solvent cement.

Casing Materials

Slope Indicator uses only ABS plastic for its casing for several reasons. ABS plastic retains its shape and flexibility over a wider range of temperatures than PVC plastic. ABS plastic is much easier to handle and seal than fiberglass casing. Finally, ABS plastic is suitable for long term contact with all types of soils, grouts, and ground water, unlike aluminum casing, which is no longer recommended for any application.

Installation Information

Visit the technical support section at www.slopeindicator.com to find recommended grout mixes, ways to counter casing buoyancy, and notes on other installation issues.

QC CASING

QC (Quick Connect) casing features snap-together convenience and strong, flush joints.

Grooves: Grooves are machine broached for excellent control of width, chamfer, depth, straightness, and spiral.

Sealing: O-ring seals prevent entry of grout.

Coupling: Built-in couplings snap together to make a flush joint. Unique locking mechanism engages full inner circumference of casing, providing much stronger joints than other snap-type casings.

Assembly: Press casing sections together until joint snaps closed. The resulting joint is strong, flush, and grout-proof. Solvent cement, rivets, or tape are not required. O-ring lubricant is applied at factory. Extra O-rings and lubricant are supplied with each box of casing.

Best for: General use.

QC Casing 85mm · 3.34"

Casing OD: 85 mm, 3.34 inches.
Casing ID: 73 mm, 2.87 inches.
Collapse Rating: 12.4 bar, 180 psi.
Load Rating: 635 kg, 1400 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3m or 10' section.

QC Casing 70mm · 2.75"

Casing OD: 70 mm, 2.75 inches.
Casing ID: 59 mm, 2.32 inches.
Collapse Rating: 16.5 bar, 240 psi.
Load Rating: 635 kg, 1400 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3m or 10' section.

STANDARD CASING

Slope Indicator's traditional inclinometer casing features high-strength, flush joints and is available in three diameters.

Grooves: Grooves are machine broached for excellent control of width, chamfer, depth, straightness, and spiral.

Sealing: Solvent cement and tape.

Coupling: Precision molded couplings have interference fit for high-strength bonding. Small diameter version has integral couplings.

Assembly: Casing and couplings are glued together with ABS solvent cement, riveted, and wrapped with tape.

Best for: General use. The extra-strong joints are helpful in very deep boreholes and oversize boreholes in which casing is not well supported.

Standard Casing 85mm · 3.34"

Coupling OD: 89 mm, 3.51 inches.
Casing OD: 85 mm, 3.34 inches.
Casing ID: 73 mm, 2.87 inches.
Collapse Rating: 10.6 bar, 155 psi.
Load Rating: 320 kg, 700 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3m or 10' section.

Standard Casing 70mm · 2.75"

Coupling OD: 70 mm, 2.75 inches.
Casing OD: 70 mm, 2.75 inches.
Casing ID: 59 mm, 2.32 inches.
Collapse Rating: 15 bar, 220 psi.
Load Rating: 320 kg, 700 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3 m or 10' section.

Standard Casing 48mm · 1.9"

Casing OD: 48 mm, 1.9 inches.
Casing ID: 38 mm, 1.5 inches.
Collapse Rating: 24 bar, 350 psi.
Load Rating: 320 kg, 700 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3 m or 10' section.

EPIC CASING

EPIC casing is an economical casing that can be cut and coupled at any point along its length.

Grooves: Grooves are formed during extrusion and are less precise than broached grooves.

Sealing: Solvent cement, mastic, and tape.

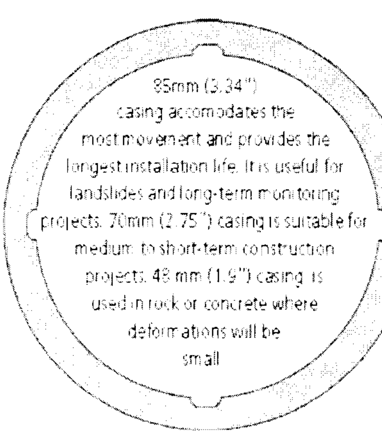
Coupling: Oversize couplings make very strong joints.

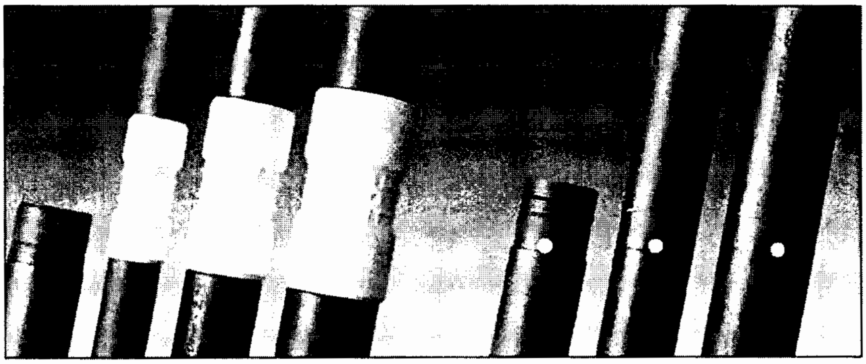
Assembly: Casing and couplings are glued together with ABS solvent cement. The joint must then be sealed with mastic and tape.

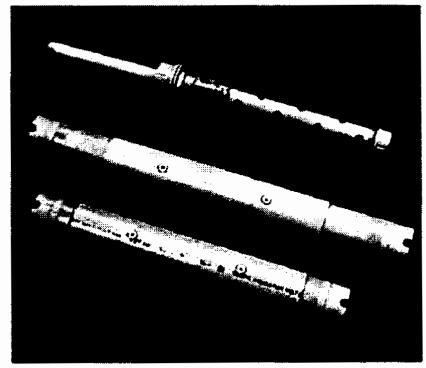
Best for: General use. Some care must be taken to seal the coupling.

EPIC Casing 70mm · 2.75" Only

Coupling OD: 78 mm, 3.07 inches.
Casing OD: 70 mm, 2.75 inches.
Casing ID: 60 mm, 2.32 inches.
Collapse Rating: 15 bar, 220 psi.
Load Rating: 320 kg, 700 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.5° per 3m or 10' section.







CPI CASING

CPI casing features quick assembly and disassembly and is available in 3 diameters.

Grooves: Grooves are machine broached for excellent control of width, chamfer, depth, straightness, and spiral.

Sealing: O-ring seals prevent entry of grout.

Coupling: Oversize couplings and shear wires make high strength joint.

Assembly: Apply grease to O-rings, press coupling onto casing, and insert shear wire.

Best for: Cold weather assembly or temporary installations that involve repeated disassembly.

CPI Casing 85mm · 3.34"

Coupling OD: 94 mm, 3.7 inches.
Casing OD: 85 mm, 3.34 inches.
Casing ID: 73 mm, 2.87 inches.
Collapse Rating: 11 bar, 155 psi.
Load Rating: 635 kg, 1400 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3m or 10' section.

CPI Casing 70mm · 2.75"

Coupling OD: 76 mm, 3 inches.
Casing OD: 70 mm, 2.75 inches.
Casing ID: 59 mm, 2.32 inches.
Collapse Rating: 15 bar, 220 psi.
Load Rating: 400 kg, 900 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3m or 10' section.

CPI Casing 48mm · 1.9"

Coupling OD: 54 mm, 2.12 inches.
Casing OD: 48 mm, 1.9 inches.
Casing ID: 38 mm, 1.5 inches.
Collapse Rating: 24 bar, 350 psi.
Load Rating: 320 kg, 900 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3 m or 10' section.

SHEAR-WIRE CASING

Shear-Wire casing features flush joints that can be assembled easily in cold weather.

Grooves: Grooves are machine broached for excellent control of width, chamfer, depth, straightness, and spiral.

Sealing: O-ring seals prevent entry of grout.

Coupling: Built-in couplings lock together with removable nylon shear wire to make flush joint.

Assembly: Press casing sections together, then insert shear wire. The result is a flush, grout-proof joint. Solvent cement, rivets, and tape are not required. O-ring lubricant is applied at the factory. Extra O-rings, lubricant, and shear wires are supplied with each box of casing.

Best for: Easy assembly in weather that is too cold for solvent cement or snap-together joints. Generally used in water-filled boreholes.

Shear Wire Casing 85mm · 3.34"

Casing OD: 85 mm, 3.34 inches.
Casing ID: 73 mm, 2.87 inches.
Collapse Rating: 12.4 bar, 180 psi.
Load Rating: 225 kg, 500 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3m or 10' section.

Shear Wire Casing 70mm · 2.75"

Casing OD: 70 mm, 2.75 inches.
Casing ID: 59 mm, 2.32 inches.
Collapse Rating: 16.5 bar, 240 psi.
Load Rating: 225 kg, 500 lb.
Temp rating: -29 to 88 °C, -20 to 190 °F.
Spiral: ≤ 0.33° per 3m or 10' section.

GROUT VALVES

Grout valves allow placement of grout backfill in boreholes that cannot accommodate an external grout pipe. The one-way valve is installed in the bottom section of casing. A grout pipe is lowered through the casing to mate with the grout valve and deliver the grout.

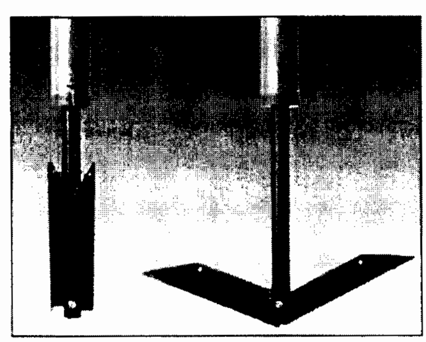
TELESCOPING SECTIONS

Optional telescoping sections accommodate 150 mm (6 inches) of compression or extension. Fully extended, each telescoping section adds 0.76 m (2.5 feet) of length to the casing.

CASING ANCHORS

In its fluid state, grout exerts an uplift force that can push even water-filled casing out of the borehole. Holding the casing down from the top has unfortunate side-effects: the casing goes into compression and snakes from side to side in the borehole. Thus casing curvature is present from the start, and slight variations in the positioning of the probe are more likely to produce reading errors.

The casing anchor, installed in place of the bottom cap, provides a convenient way to counter casing buoyancy and reduces casing curvature, since the casing self-centers in the borehole. The anchor has spring loaded arms that are activated when a pin is pulled. Anchors are available for 70 mm and 85 mm casing.



QC CASING 85MM · 3.34"

Casing Section, 10' (3.05 m)	51150310
Casing Section, 5' (1.52 m)	51150311
Section, Telescoping	51150320
Cap, Bottom	51150330
Cap, Bottom, Heavy Duty	51100520
Grout Valve, Gasket Type	51100830
Cap, Top	51100500
Cap, Locking	51100550
Splice Kit, Male	51150350
Splice Kit, Female	51150351

QC CASING 70mm · 2.75"

Casing Section, 10' (3.05 m)	51150210
Casing Section, 5' (1.52 m)	51150211
Section, Telescoping	51150220
Cap, Bottom	51150230
Cap, Bottom, Heavy Duty	51101520
Grout Valve, Gasket Type	51100820
Cap, Top	51101500
Cap, Locking	51101550
Splice Kit, Male	51150250
Splice Kit, Female	51150251

STANDARD CASING 85mm · 3.34"

Casing Section, 10' (3.05 m)	51100100
Casing Section, 5' (1.52 m)	51100105
Telescoping Section	51106400
Coupling	51100200
Cap, Bottom, Heavy Duty	51100520
Grout Valve, Gasket Type	51100830
Cap	51100500
Cap, Locking	51100550
Pop Rivet AD44H	51103301

STANDARD CASING 70mm · 2.75"

Casing Section, 10' (3.05 m)	51101100
Casing Section, 5' (1.52 m)	51101105
Telescoping Section	51107400
Coupling	51101200
Cap, Bottom, Heavy Duty	51101520
Grout Valve, Gasket Type	51100820
Cap	51101500
Locking Cap with Padlock	51101550
Pop Rivet AD42H	51003303

STANDARD CASING 48mm · 1.9"

Casing Section, 5' (1.52 m)	51102305
Cap	51102500
Locking Cap with Padlock	51102550
Grout Valve, Gasket Type	51104000

EPIC CASING 70mm · 2.75"

Casing Section, 10' (3.05 m)	51111100
Coupling	51111200
Telescoping Coupling	51111400
Cap, Bottom, Heavy Duty	51101520
Grout Valve, Gasket Type	51100820
Cap	51111500
Locking Cap with Padlock	51101550
Pop Rivet AD46H	51003310
Lubricant for Telescoping Coupling	57504000

CPI CASING 85mm · 3.34"

Casing Section, 10' (3.05 m)	57500100
Casing Section, 5' (1.52 m)	57500105
Telescoping Section	57506400
Coupling with 2 Shear Wires	57500200
Cap with Shear Wire	57500500
Cap, Bottom, Heavy Duty	51100520
Grout Valve, Gasket Type	51100830
Cap, Top	51100500
Spare Nylon Shear Wire	57500700
O-Ring Lubricant	57504000

CPI CASING 70mm · 2.75"

Casing Section, 10' (3.05 m)	57501100
Casing Section, 5' (1.52 m)	57501105
Telescoping Section	57507400
Coupling with 2 Shear Wires	57501200
Cap with Shear Wire	57501500
Cap, Bottom, Heavy Duty	51101520
Grout Valve, Gasket Type	51100820
Cap, Top	51101500
Spare Nylon Shear Wire	57501700
O-Ring Lubricant	57504000

CPI CASING 48mm · 1.9"

Casing Section, 5' (1.52 m)	57502105
Coupling with 2 Shear Wires	57502200
Cap with Shear Wire	57502500
Grout Valve, Gasket Type	57503700
Cap, Top	51102500
Spare Nylon Shear Wire	57502700
O-Ring Lubricant	57504000

SHEAR WIRE CASING 85mm · 3.34"

10' (3.05 m) Casing Section	51160310
5' (1.52 m) Casing Section	51160311
Section, Telescoping	51160320
Cap, Bottom	51160330
Cap, Bottom, Heavy Duty	51100520
Grout Valve, Gasket Type	51100830
Cap, Top	51100500
Cap, Locking	51100550

SHEAR WIRE CASING 70mm · 2.75"

Casing Section, 10' (3.05 m)	51160210
Casing Section, 5' (1.52 m)	51160211
Section, Telescoping	51160220
Cap, Bottom	51160230
Cap, Bottom, Heavy Duty	51101520
Grout Valve, Gasket Type	51100820
Cap, Top	51101500
Cap, Locking	51101550

CASING ANCHORS

Casing Anchor, 85 mm (3.34")	51104385
Casing Anchor, 70 mm (2.75")	51104370
Anchor + Grout Valve, 85mm(3.34")	51104485
Anchor + Grout Valve, 70mm(2.75")	51104470

INSTALLATION ACCESSORIES

Mastic Sealing Tape	51003800
Vinyl Tape	51003900
Duct Tape	51004000
ABS Solvent Cement, 1/2 pint	51103401
ABS Solvent Cement, 1 pint	51103402
Pop Rivet Gun	50100202
Casing Clamp	50100200

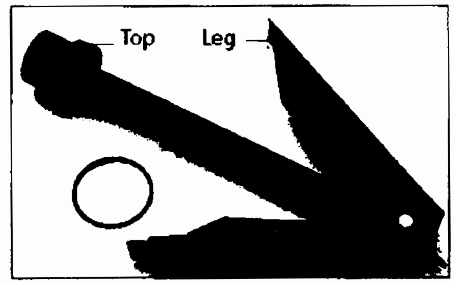
www.slopeindicator.com
solutions@slope.com
DGSI East 2175 West Park Court, Stone Mountain, GA USA 30087 Tel: +1-770-465-7557
DGSI West 12123 Harbour Reach Drive, Mukilteo, WA, USA 98275 Tel: +1-425-493-6200
CE

Installing the Casing Anchor

Casing Anchor Components

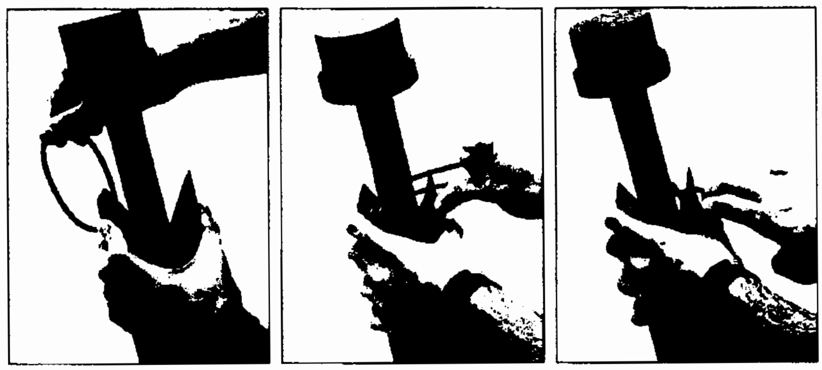
Supplied parts include the anchor, a large O-ring, and four screws.

You must provide ABS cement, tape, and a release cord of appropriate length. We suggest cord that is rated for 250 kg or 500 lb.



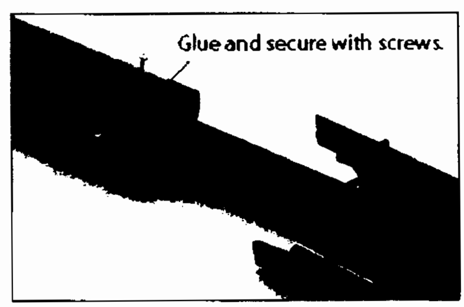
Step 1

1. Hold legs closed. Slip O-ring over one leg.
2. Wrap O-ring behind pipe.
3. Slip O-ring over other leg.



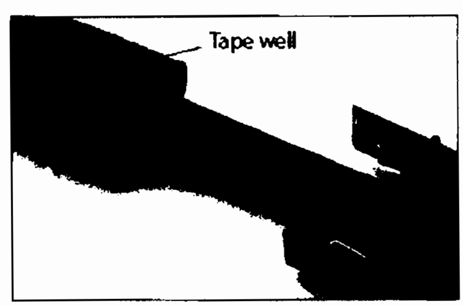
Step 2

1. Cut off end of casing.
2. Glue top of anchor to casing with ABS cement and secure with self-tapping screws.
3. Tape joint well to prevent entry of grout.



Step 3

1. Tie release cord onto O-ring.
2. Devise method for handling release cord as the casing is installed down hole.



Deploying the Anchor

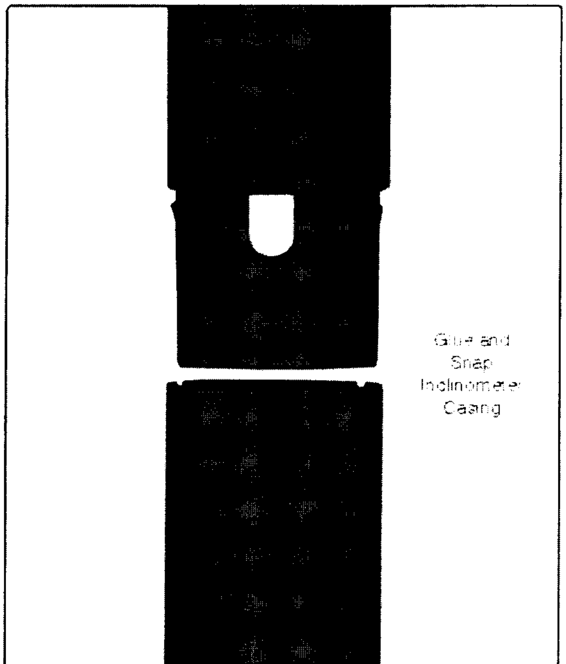
1. Pull drill casing, if any, above elevation of anchor so that anchor is not deployed inside.
2. Pull release cord and retrieve cord and O-ring.
3. Backfill borehole as specified. Check that casing remains anchored.

Monitor
with
Confidence

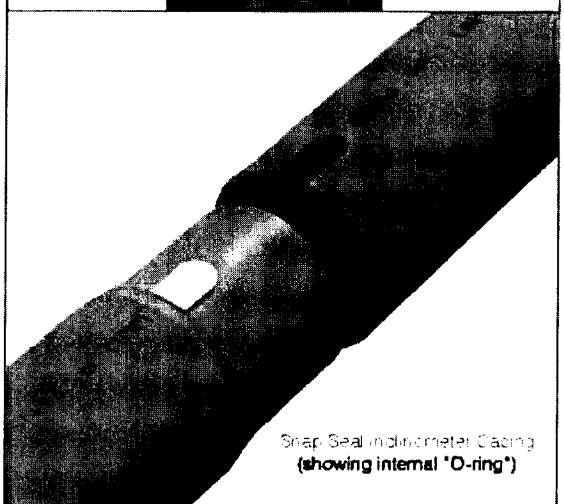
TEL 604 540 1100
info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd
11545 Kingston St.,
Maple Ridge BC V2X 0Z5 Canada

ISO 9001



Glue and Snap Inclinometer Casing



Snap Seal Inclinometer Casing
(showing internal "O-ring")

Standard Bottom Cap

Bottom Cap with Grout Valve

PRODUCT CATEGORY:
INCLINOMETERS + TILT SENSORS

Inclinometer Casing

RST's Inclinometer Casing is engineered to be assembled quickly and accurately for long and short term monitoring in the most adverse field conditions. It is suited to be installed in boreholes, embankments, piles, set into concrete or attached to structures.

The casing serves as an access tube to guide a MEMS-based inclinometer probe in the two orthogonal directions of measurement. Changes in the output of the probe caused by the deformation of the casing, is proportional to the sine of the **angle of inclination of the long sensor axis from vertical. These displacements are** incrementally summed to provide profiles of total displacement versus depth.

Key to quality inclinometer casing is not only the material, but the quality and shape of the grooves. The inclinometer probe utilizes grooves in the casing to control the azimuth of the inclinometer probe.

RST casing is manufactured from non-recycled virgin ABS resin. While more costly than common PVC resin, ABS is preferred due to superior flexibility, stability and low temperature impact resistance. Using recycled resin degrades the performance **of casing. All RST casing is machined to insure the highest quality possible.**

> THIS PRODUCT

Provides alignment and displacement measurements in numerous applications

Available in either "Snap Seal" or "Glue & Snap" coupling styles

> APPLICATIONS

Piers	Landslides and slope stability
Subsidence control	Under large storage tanks
Embankment and dam stability	Bridge pier, abutments deflection
Adjacent to large excavations	

> FEATURES

Aligned and machined guide grooves	**Low spiral ≤ 0.005 Rad/3 m (≤ 0.3 deg./10 ft.)**
Meets or exceeds all applicable standards	Easy assembly
Self-aligning, water and grout tight couplings	**70 mm (2.75 in.) and 85 mm (3.34 in.) OD sizes.**

Compatible with all commercial probe types and in-place inclinometer sensors

Integral coupling reduces assembly induced spiral by 50%
over conventional separate coupling methods

Compatible with inductance, reed switch, magnetic or mechanical settlement monitoring devices

Snap Seal and Glue & Snap integral flush couplings that minimze field installation time.

Low temperature, impact and corrosion resistant ABS plastic

External keys provides visual and tactile confirmation of proper installation

> BENEFITS

- ✓ Increase Safety
- ✓ Increase Productivity
- ✓ High Reliability
- ✓ High Accuracy
- ✓ Upgradable

Available for IMMEDIATE DELIVERY Info on reverse.

Monitor with Confidence

TEL 604 540 1100
info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

Inclinometer Casing

PRODUCT CATEGORY:
INCLINOMETERS + TILT SENSORS

SPECIFICATIONS + ORDERING

CASING SPECS

DESCRIPTION	70 MM (2.75 IN.) OD	85 MM (3.34 IN.) OD
Casing OD (including coupling)	70 mm (2.75 in.)	85 mm (3.34 in.)
Casing ID	59 mm (2.32 in.)	73 mm (2.87 in.)
Casing Length	5 or 10 ft. (1.5 or 3 m)	5 or 10 ft. (1.5 or 3 m)
Casing Weight	1.27 kg/m (.85 lbs/ft.)	1.49 kg/m (1.0 lbs/ft.)
Material	ABS Plastic	
Groove Spiral	**≤ 0.3 deg./10 ft.**	
GLUE & SNAP SPECIFICATIONS - 70 MM		
Load Test	736 kg (1630 lbs.)	
Collapse Test	17.2 bar (250 psi)	

TELESCOPIC SECTION SPECS

DESCRIPTION	70 MM (2.75 IN.) CASING	85 MM (3.34 IN.) CASING
Telescopic Section OD	76.96 mm (3.03 in.)	91.44 mm (3.6 in.)
Compressed Length	457 mm (18 in.)	457 mm (18 in.)
Extended Length	609 mm (24 in.)	609 mm (24 in.)
Range	152 mm (6 in.)	152 mm (6 in.)
Weight	0.77 kg (1.7 lbs.)	0.9 kg (2 lbs.)

SNAP SEAL CASING

Snap Seal is the original O-ring sealed coupling system, which does not require glue, pop rivets, screws, or shear wires. This patented, innovative system allows casing sections to lock together while maintaining precise groove alignment and high collapse **strength. The Snap Seal system is flush** coupled for ease of installation in hollow stem augers and casing advancers.

GLUE + SNAP CASING

Glue & Snap provides the speed and convenience of a snap-together flush coupling combined with the low cost and **high tensile/high torsional strength of a** glue joint. Installation is simply done by applying a bead of glue to the male end, snap casing together and insert down hole.

ORDERING

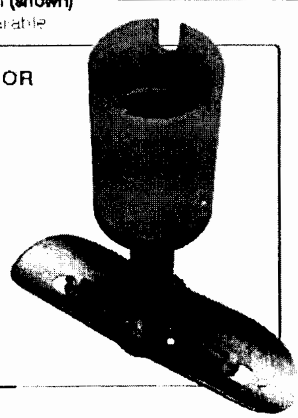
Available for IMMEDIATE DELIVERY

Contact RST for Details

DESCRIPTION	GLUE & SNAP 70 MM (2.75 IN.)	GLUE & SNAP 85 MM (3.34 IN.)	SNAP SEAL 70 MM (2.75 IN.)	SNAP SEAL 85 MM (3.34 IN.)
1.52 m length (5 ft.)	ICGC205	ICGC305	ICSC205	ICSC305
1.50 m length (4.92 ft.)	ICGC205M	ICGC305M	ICSC205M	ICSC305M
3.05 m length (10 ft.)	ICGC210	ICGC310	ICSC210	ICSC310
3 m length (9.84 ft.)	ICGC210M	ICGC310M	ICSC210M	ICSC310M
Top Cap	ICC2TC	ICC3TC	ICC2TC	ICC3TC
Bottom Cap	ICGC2BC	ICGC3BC	ICSC2BC	ICSC3BC
Casing Anchor	ICGC2CA	ICGC3CA	ICSC2CA	ICSC3CA
Casing Anchor with Grout Cap	ICGC2CG	ICGC3CG	ICSC2CG	ICSC3CG
Grout Cap	ICGC2CP	ICGC3CP	ICSC2CP	ICSC3CP
Repair Coupling	ICGC2RC	ICGC3RC	ICSC2RC	ICSC3RC
Alignment Tool for Coupling	IC1002	IC1003	IC1002	IC1003
ABS Solvent Cement (1/2 pint) (NOTE: cannot be air shipped)	IC1020			
Female Grout Adapter 3/4" NPT	IC1200			
Telescopic Section	ICGC2TC	ICGC3TC	ICSC2TC	ICSC3TC

Telescopic Section

Below: A top view of an Inclinometer Casing Anchor **with its arms fully extended. Both Snap Seal (shown)** and Glue & Snap coupling styles are available.



INCLINOMETER CASING ANCHOR

The Inclinometer Casing Anchor prevents buoyant uplift of inclinometer casing during installation. It is affixed to the bottom of the inclinometer casing prior to inserting it into the **drill-rod/borehole. As soon as the** anchor exits the bottom opening of the **drill-rod/borehole, the spring loaded** arms of the anchor are automatically extended to grip the borehole wall.

TELESCOPIC SECTION

When vertical heave or settlement is anticipated to exceed 1-2%, Inclinometer Casing Telescoping Sections must be used to allow axial movement **of the casing while minimizing distortion due to vertical strain. Telescopic sections must be inserted** approximately extended or collapsed to accommodate **the expected settlement/rebound. Settlement sections are available in 70 mm (2.75 in.) and 85 mm (3.34 in.) and each section can accommodate up to 150 mm (6 in.) of compression or heave.**

Monitor with Confidence

TEL 604 540 1100
info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

PRODUCT CATEGORY:
PIEZOMETERS + TRANSDUCERS

Available for **IMMEDIATE DELIVERY** Info on reverse.

VW2100 Standard Vibrating Wire Piezometer

VW2100-HD Heavy Duty Vibrating Wire Piezometer

VW2100-DPC Drive Point Vibrating Wire Piezometer

Vibrating Wire Piezometer

The RST Vibrating Wire Piezometer provides excellent long term accuracy, stability of readings, and reliability under demanding geotechnical conditions. Vibrating Wire Piezometers are the electrical piezometers of choice as the frequency output of VW devices is immune to external electrical noise and able to tolerate wet wiring common in geotechnical applications.

Vibrating Wire Piezometers contain a high tensile steel wire with a fixed anchor at one end and are attached to a diaphragm in contact with water pressure at the other end. The wire is electrically plucked, with the resonant frequency of vibration proportional to the tension in the wire. This frequency induces an alternating current in a coil which is detected by the readout unit, such as the VW2106 Vibrating Wire Readout (see separate brochure), and can then be converted to a pressure. The frequency output is immune to external electrical noise.

The frequency signal is exceptionally immune from cable effects, including length (to several kilometers), splicing, resistance, noise pickup, and moisture. The vibrating wire coil circuit contains no semiconductor devices and has built in ionized gas discharge device protection against transient damage. As a result, the vibrating wire piezometer provides excellent reliability in typical geotechnical situations - i.e. long outdoor cables buried in saturated soil.

The piezometer is equipped with a standard sintered stainless steel porous filter to prevent soil particles from contacting the diaphragm. A thermistor is built into the piezometer body to permit temperature measurement and temperature compensation of the piezometer. Standard construction is all stainless steel. RST vibrating wire piezometers are shipped with extremely tough polyurethane jacketed foil shielded cable for maximum endurance in field conditions.

> APPLICATIONS

[illegible]

> FEATURES

[illegible]

> BENEFITS

Increase Safety

High Accuracy

Monitor
with
Confidence

TEL 604 540 1100
info@rstinstruments.com
www.rstinstruments.com

RST Instruments Ltd.
11545 Kingston St.,
Maple Ridge, BC V2X 0Z5 Canada

ISO 9001

Vibrating Wire Piezometer

PRODUCT CATEGORY:
PIEZOMETERS • TRANSDUCERS

SPECIFICATIONS + ORDERING

SPECIFICATIONS

DESCRIPTION	SPECIFICATION
Over range	2X F.S.
Resolution	0.025% F.S. minimum
Accuracy	0.1% F.S.
Linearity	<0.5% F.S.
Operating Temperature	-20 to 80°C (-4 to 176°F)
Diaphragm Displacement	<0.001 cc at F.S.
Thermal Zero Shift	<0.05% F.S./°C
Materials	Hermetically sealed stainless steel housing
Thermistor Type	NTC 3K Ohms @ 25°C
Thermistor Interchangeability	±0.5°C
Thermistor Resolution	0.1°C
Filter	50 micron sintered filter (high air entry ceramic filter 1 bar available)

VW2100-DPC
Drive point model

ELECTRICAL CABLE SPECS

PART #	DESCRIPTION
EL380004	Two twisted pairs cable with polyurethane jacket
EL380004[illegible]	Two twisted pairs heavy duty cable with [illegible] polyurethane jacket [illegible] for added protection
EL380004K	Two twisted pairs Kevlar® reinforced [illegible] polyurethane jacketed cable for [illegible] installations where the stretch [illegible] cable is [illegible]

Other types of cables (depending on site conditions and atmospheric reference requirements) are available on request. These include vented, PE, PVC, polyurethane and armoured varieties.

OPTIONAL EQUIPMENT

VW2106 Vibrating Wire Readout
Data loggers
Cable splice kits

STOCK LENGTHS!

Available for all VW2100 ranges, contact RST for available lengths and quantities.

Available for IMMEDIATE DELIVERY

Contact RST for Details

ORDERING

PART #	DESCRIPTION	PRESSURE RANGE	DIMENSION
VW2100	Standard model for general applications	0.35, 0.7, 1.0, 2.0, 3.0 MPa	19 mm Ø X [illegible] mm
VW2100-HD	Heavy duty piezometer for direct burial in fills and large dam embankments or for high pressure borehole installations	[illegible] 20 MPa	25.4 mm Ø X 14[illegible] mm
VW2100-DPC	Drive point model with DP thread	[illegible] MPa	31.4 mm Ø X [illegible]
VW2100-DPEW	Drive point model with EW thread	[illegible] MPa	34.9 mm Ø (body) X 304.8 mm
VW2100-L	Low Pressure unvented	70, 175 kPa	25 mm Ø X [illegible]
VW2100-LV	Low Pressure vented	70, 175 kPa	[illegible] mm Ø X [illegible] mm
VW2100-M	Miniature version - 17.5 mm diameter	0.35, 0.7, 1.0, 2.0, 3.0 MPa	17.5 mm Ø X [illegible] mm
VW2100-MM	Micro-miniature version - 11.1 mm diameter	[illegible] MPa	11.1 mm Ø X [illegible]
VW2191	Heavy duty piezometer with bladder for marine environment	0.07, 0.175, 0.35, 0.7, 1.0, 2.0, [illegible] 7.5 MPa	4[illegible] mm Ø X 3[illegible] mm
VW219[illegible]	Heavy duty piezometer with bladder for marine environment with [illegible]	[illegible] 7.5 MPa	4[illegible] mm Ø X [illegible]

VW2191 - Heavy Duty Piezometer with Bladder

APPENDIX E
VIBRATING WIRE PIEZOMETER CALIBRATION SHEETS

BH21-12

Calibration Record

Monitor with Confidence

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:	TETRA TECH CANADA INC.
Sales Order:	227851
Customer ID:	
Model:	VW2100-0.35
Serial Number:	VW132946
Mfg Number:	P132946
Range:	350 kPa
Cable Length:	40 meters
Cable Marking:	625888 m to 625929 m
Cable Type:	EL380004
Cable Colour Code:	Red/Black (Coil) Green/White (Thermistor)
Thermistor Type:	3K

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (%FS)	Calculated Polynomial (kPa)	Polynomial Error (%FS)
0.0	8588	8588	8588	-0.2	-0.05	0.1	0.02
70.0	7942	7943	7942	70.0	-0.01	69.9	-0.03
140.0	7296	7296	7296	140.1	0.04	139.9	-0.01
210.0	6651	6651	6651	210.2	0.07	210.0	0.01
280.0	6007	6008	6007	280.2	0.05	280.1	0.03
350.0	5367	5368	5368	349.7	-0.09	349.9	-0.02
Max Error (%)					0.09		0.03

Linear Calibration Factor: CF = 1.0864e-01 kPa/B unit
Temperature Correction Factor: Tk = -1.3430e-01 kPa/°C rise

Polynomial Gauge Factor:
A = 1.7989e-07 kPa/(B unit)² B = -1.1115e-01 kPa/B unit C = calculate (see below) kPa

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

Shipped Zero Readings:	Date	VW Reading (B Units)	Temperature (°C)	Baro (mbar)
	29 Apr 2021	8580	21.5	1026.2

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: Ora Nygren **Date:** 29/04/2021

Approved: Kailah Toews **Date:** 29/04/2021

BH21-13

Calibration Record

Monitor with Confidence

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:	TETRA TECH CANADA INC.
Sales Order:	227851
Customer ID:	
Model:	VW2100-0.35
Serial Number:	VW132933
Mfg Number:	P132933
Range:	350 kPa
Cable Length:	40 meters
Cable Marking:	947256 m to 947297 m
Cable Type:	EL380004
Cable Colour Code:	Red/Black (Coil) Green/White (Thermistor)
Thermistor Type:	3K

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (%FS)	Calculated Polynomial (kPa)	Polynomial Error (%FS)
0.0	8610	8610	8610	-0.5	-0.14	0.0	0.00
70.0	7947	7948	7948	70.1	0.04	70.0	0.01
140.0	7289	7290	7290	140.3	0.09	139.9	-0.02
210.0	6632	6633	6632	210.4	0.11	210.0	0.00
280.0	5978	5978	5978	280.2	0.05	280.1	0.02
350.0	5328	5329	5328	349.5	-0.15	350.0	-0.01
Max Error (%)					0.15		0.02

Linear Calibration Factor: CF = 1.0664e-01 kPa/B unit
Temperature Correction Factor: Tk = -7.8114e-02 kPa/°C rise

Polynomial Gauge Factor:
A = 3.4406e-07 kPa/(B unit)² B = -1.1144e-01 kPa/B unit C = calculate (see below) kPa

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

Shipped Zero Readings:	Date	VW Reading (B Units)	Temperature (°C)	Baro (mbar)
	29 Apr 2021	8600	21.5	1026.2

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: Ora Nygren **Date:** 29/04/2021

Approved: Kailah Toews **Date:** 29/04/2021

BH21-14

Calibration Record

Monitor with Confidence

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:	TETRA TECH CANADA INC.
Sales Order:	227851
Customer ID:	
Model:	VW2100-0.35
Serial Number:	VW132926
Mfg Number:	P132926
Range:	350 kPa
Cable Length:	40 meters
Cable Marking:	947215 m to 947255 m
Cable Type:	EL380004
Cable Colour Code:	Red/Black (Coil) Green/White (Thermistor)
Thermistor Type:	3K

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (%FS)	Calculated Polynomial (kPa)	Polynomial Error (%FS)
0.0	8515	8516	8515	-0.5	-0.14	0.1	0.02
70.0	7861	7862	7861	70.0	0.01	69.9	-0.03
140.0	7208	7209	7209	140.4	0.10	139.9	-0.02
210.0	6558	6558	6558	210.5	0.14	210.1	0.02
280.0	5911	5912	5911	280.2	0.07	280.1	0.04
350.0	5270	5271	5270	349.3	-0.19	349.9	-0.03
Max Error (%)					0.19		0.04

Linear Calibration Factor: CF = 1.0781e-01 kPa/B unit
Temperature Correction Factor: Tk = -7.1559e-02 kPa/°C rise

Polynomial Gauge Factor:
A = 3.9864e-07 kPa/(B unit)² B = -1.1331e-01 kPa/B unit C = calculate (see below) kPa

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

Shipped Zero Readings:	Date	VW Reading (B Units)	Temperature (°C)	Baro (mbar)
	29 Apr 2021	8498	21.5	1026.2

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: Ora Nygren **Date:** 29/04/2021

Approved: Kailah Toews **Date:** 29/04/2021

BH21-15

Calibration Record

Monitor with Confidence

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:	TETRA TECH CANADA INC.
Sales Order:	227851
Customer ID:	
Model:	VW2100-0.35
Serial Number:	VW132945
Mfg Number:	P132945
Range:	350 kPa
Cable Length:	40 meters
Cable Marking:	868213 m to 868254 m
Cable Type:	EL380004
Cable Colour Code:	Red/Black (Coil) Green/White (Thermistor)
Thermistor Type:	3K

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (%FS)	Calculated Polynomial (kPa)	Polynomial Error (%FS)
0.0	8440	8441	8441	-0.1	-0.01	0.1	0.02
70.0	7792	7793	7792	69.9	-0.02	69.9	-0.03
140.0	7142	7143	7142	140.1	0.02	140.0	-0.01
210.0	6492	6493	6493	210.2	0.05	210.1	0.02
280.0	5844	5844	5844	280.1	0.04	280.1	0.03
350.0	5199	5199	5199	349.8	-0.06	349.9	-0.02
Max Error (%)					0.06		0.03

Linear Calibration Factor: CF = 1.0791e-01 kPa/B unit
Temperature Correction Factor: Tk = -6.0432e-02 kPa/°C rise

Polynomial Gauge Factor:
A = 9.1155e-08 kPa/(B unit)² B = -1.0916e-01 kPa/B unit C = calculate (see below) kPa

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

Shipped Zero Readings:	Date	VW Reading (B Units)	Temperature (°C)	Baro (mbar)
	29 Apr 2021	8422	21.4	1026.2

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: Ora Nygren **Date:** 29/04/2021

Approved: Kailah Toews **Date:** 29/04/2021

BH21-16

Calibration Record

Monitor with Confidence

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:	TETRA TECH CANADA INC.
Sales Order:	227851
Customer ID:	
Model:	VW2100-0.35
Serial Number:	VW132925
Mfg Number:	P132925
Range:	350 kPa
Cable Length:	40 meters
Cable Marking:	868255 m to 868296 m
Cable Type:	EL380004
Cable Colour Code:	Red/Black (Coil) Green/White (Thermistor)
Thermistor Type:	3K

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (%FS)	Calculated Polynomial (kPa)	Polynomial Error (%FS)
0.0	8509	8510	8509	-0.2	-0.05	0.1	0.03
70.0	7884	7885	7885	69.9	-0.03	69.8	-0.05
140.0	7258	7258	7258	140.2	0.05	139.9	-0.02
210.0	6632	6633	6633	210.3	0.09	210.1	0.02
280.0	6010	6010	6010	280.2	0.05	280.1	0.04
350.0	5391	5392	5391	349.6	-0.11	349.9	-0.03
Max Error (%)					0.11		0.05

Linear Calibration Factor: CF = 1.1218e-01 kPa/B unit
Temperature Correction Factor: Tk = -6.9830e-02 kPa/°C rise

Polynomial Gauge Factor:
A = 2.3180e-07 kPa/(B unit)² B = -1.1540e-01 kPa/B unit C = calculate (see below) kPa

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

Shipped Zero Readings:	Date	VW Reading (B Units)	Temperature (°C)	Baro (mbar)
	29 Apr 2021	8491	21.4	1026.2

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: Ora Nygren **Date:** 29/04/2021

Approved: Kailah Toews **Date:** 29/04/2021

B H21-17

Calibration Record

Monitor with Confidence

RST Instruments Ltd., 11545 Kingston St., Maple Ridge, British Columbia, Canada V2X 0Z5
Tel: 604 540 1100 • Fax: 604 540 1005 • Toll Free: 1 800 665 5599 (North America only)
e-mail: info@rstinstruments.com • Website: www.rstinstruments.com

Vibrating Wire Piezometer

Customer:	TETRA TECH CANADA INC.
Sales Order:	227851
Customer ID:	
Model:	VW2100-0.35
Serial Number:	VW132947
Mfg Number:	P132947
Range:	350 kPa
Cable Length:	40 meters
Cable Marking:	625846 m to 625887 m
Cable Type:	EL380004
Cable Colour Code:	Red/Black (Coil) Green/White (Thermistor)
Thermistor Type:	3K

Applied Pressure (kPa)	First Reading (B units)	Second Reading (B units)	Average Reading (B units)	Calculated Linear (kPa)	Linearity Error (%FS)	Calculated Polynomial (kPa)	Polynomial Error (%FS)
0.0	8582	8583	8583	-0.2	-0.07	0.1	0.02
70.0	7946	7947	7946	69.9	-0.02	69.9	-0.04
140.0	7309	7309	7309	140.2	0.06	140.0	-0.01
210.0	6673	6673	6673	210.3	0.10	210.1	0.02
280.0	6040	6040	6040	280.2	0.04	280.1	0.03
350.0	5410	5410	5410	349.6	-0.11	349.9	-0.02
Max Error (%)					0.11		0.04

Linear Calibration Factor: CF = 1.1026e-01 kPa/B unit
Temperature Correction Factor: Tk = -5.1408e-02 kPa/°C rise

Polynomial Gauge Factor:
A = 2.4429e-07 kPa/(B unit)² **B = -1.1368e-01 kPa/B unit** **C = calculate (see below) kPa**

Users must establish site zero readings for calculation purposes
Polynomial $C = -[A(L_0^2) + B(L_0)]$

Pressure is calculated with the following equations:
Linear: $P = CF(L_0 - L) - Tk(T_0 - T) + (S_0 - S)$
Polynomial: $P = A(L^2) + B(L) + C - Tk(T_0 - T) + (S_0 - S)$

L_0, L = initial (installation) and current readings, in B units
T_0, T = initial (installation) and current temperature, in °C
S_0, S = initial (installation) and current barometric pressure readings, in kPa
B units = Hz²/1000 ie: 1700 Hz = 2890 B units

Shipped Zero Readings:	Date	VW Reading (B Units)	Temperature (°C)	Baro (mbar)
	29 Apr 2021	8561	21.5	1026.2

This instrument has been calibrated using standards traceable to the NIST in compliance with ANSI Z540-1

Technician: Ora Nygren **Date:** 29/04/2021

Approved: Kailah Toews **Date:** 29/04/2021

APPENDIX F

MILESTONES NO. N#1-N#7 REGULAR MONITORING OF SLOPE INCLINOMETERS

TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE CONFIDENTIAL

To:	Malcolm Dort, P.Eng., LEED AP (The City of Calgary)	**Date:**	June 23, 2021
From:	Kyle Haugrud, P.Eng. Joseph Yonan, Ph.D., P.Eng.	**Memo No:**	N#1
		File:	704-ENG.CGEO04110-01
Subject:	Regular Slope Monitoring Program Milestone N#1: One Week Interval – June 4, 2021 Redevelopment of Midfield Mobile Home Park Calgary, Alberta		

1.0 INTRODUCTION

This technical memo summarizes the results of the instrumentation measurements (Slope Inclinometers [SI] and Vibrating Wire Piezometers [VWP]) and visual observations collected by Tetra Tech Canada Inc. (Tetra Tech) as part of the regular slope monitoring program for the Redevelopment of Midfield Mobile Home Park project. The project is located northeast of the 16 Avenue NE and Moncton Road NE intersection in northeast Calgary, Alberta.

The details of the SI and VWP installations will be provided within the Milestone No. M#4 *Final Geotechnical Report* which was in progress at the time of this technical memo's preparation.

This technical memo represents the Milestone No. N#1 deliverable (one-week post installation interval) as part of extension five of The City of Calgary's (The City) scope and fee schedule No. 18-2006-A05-S01-05 dated April 15, 2021. This is the first monitoring interval of the currently proposed six monitoring intervals, with the following remaining: two-week interval; four-week interval; three-month interval; six-month interval; and one-year interval. Table 1 summarizes the monitoring intervals as completed to date. Note that if instrumentation exhibits adverse conditions, additional monitoring intervals may be required.

Table 1: Instrumentation Regular Monitoring Summary

Instrument Borehole Number	SI Initialization Date	No. N#1 One-Week Date	No. N#2 Two-Week Date**	No. N#3 Four-Week Date**	No. N#4 Three-Month Date**	No. N#5 Six-Month Date**	No. N#6 One-Year Date**
BH21-12	May 26, 2021	June 4, 2021					
BH21-13							
BH21-14							
BH21-15							
BH21-16							
BH21-17							
TP-2*	Apr 20, 2021						

Notes: * Borehole TP-2 was installed under the direction of Geo-Engineering (M.S.T.) Ltd. on November 26, 1998. Previous displacement data was not available, and the instrument was re-initialized on April 20, 2021.
** Greyed-out cells represent proposed future monitoring intervals yet to be completed.

Tetra Tech Canada Inc.
Suite 110, 140 Quarry Park Blvd SE
Calgary, AB T2C 3G3 CANADA
Tel 403.203.3355 Fax 403.203.3301

2.0 MONITORING AND MEASUREMENT

2.1 General

The key objective of the installed instrumentation (SI and VWP) and visual observations is to sufficiently monitor slope movement and measure pore pressure responses throughout the Midfield project site's northern slope to assess its overall slope stability, and to provide enough warning/time for slope stabilization measures.

The locations of the installed instrumentation are provided on the attached Figure 1. The following subsections summarize the monitoring results completed to date.

2.2 Slope Inclinometer (SI) Summary

A summary of the horizontal displacements within the SI casings measured to date (N#1 one-week) is provided in Table 2.

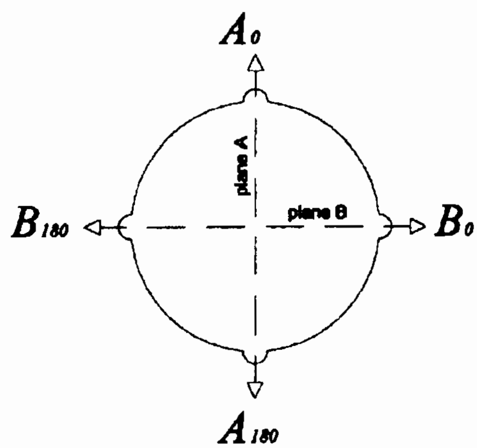
Table 2: Slope Inclinometer (SI) Movement Summary for N#1

SI Borehole No.	Analysis Section / Casing Diameter	SI Depth (m)	Movement						
			Depth (m)	Elev. (m)	Soil Unit	Shear (mm)*		Total (mm)**	
						New	Cumulative	New	Cumulative
BH21-12	A / 85 mm	25.0	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-13	A / 85 mm	10.4	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-14	B1 / 85 mm	19.5	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-15	B2 / 85 mm	18.9	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-16	B2 / 85 mm	11.6	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-17	C / 70 mm	14.6	N/A	N/A	N/A	N/A	N/A	<5	<5
TP-2	C / 70 mm	15.9	N/A	N/A	N/A	N/A	N/A	<5	<5

Notes: * Shear movement is considered observable horizontal movement over a discrete plane.
** Total movement is not considered until over 5 mm is observable (considered 'noise' <5 mm).

Given that this was the first measurement interval and only establishes a baseline for potential fluctuations over a limited period (approximately one week), it is difficult to determine with any certainty if areas of potential movement exist at depth. Each monitoring interval will provide a greater understanding of the existing conditions and any deviations from those conditions. Accordingly, commenting on potential movement planes, or the complete absence of such, will be reserved until at least the second monitoring interval (approximately two weeks following initialization). The SI casing displacement plots are attached in Appendix A for reference.

The displacement plots in Appendix A present two graphs for each SI casing location; this is a result of there being two 'sets' of grooves which control the orientation of the inclinometer probe reader. Attempts are made during installation to ensure one set of grooves is properly aligned with the direction of expected movement (i.e., downslope, typically A_0-A_{180}); however, shifts in the casing's orientation are typical prior to the grout completely curing. Therefore, both groove sets are read from the bottom of the SI casing to the top and should be reviewed in tandem for a comprehensive representation of the casing condition. Schematic 1 presents a top view of an SI casing depicting the general groove orientation.



Schematic 1: SI Casing Groove Orientation

2.3 Vibrating Wire Piezometer (VWP) Summary

A summary of the porewater pressure response calculated from the VWP measurements to date (N#1 one-week) is provided in Table 3.

Table 3: Vibrating Wire Piezometer (VWP) Pore Pressure Summary for N#1

VWP Borehole No.	Analysis Section	VWP Tip Depth (m)	VWP Tip Elev. (m)	Soil Unit	Date	Measured Piezometric Elev. (m)*	Calculated Bbar/r_u*
BH21-12	A (Crest)	15.2	1060.7	Clay	June 4, 2021	1061.2	N/A
BH21-13	A (Toe)	9.1	1054.5	Clay	June 4, 2021	1054.5	N/A
BH21-14	B1 (Crest)	13.7	1061.7	Clay	June 4, 2021	1061.8	N/A
BH21-15	B2 (Crest)	13.7	1061.5	Clay	June 4, 2021	1061.5	N/A
BH21-16	B2 (Toe)	11.6	1052.9	Sand	June 4, 2021	1052.9	N/A
BH21-17	C (Mid)	14.6	1045.2	Clay	June 4, 2021	1045.3	N/A

Note: * Piezometric elevations have yet to stabilize. Bbar/r_u to be calculated during N#2 (two-week interval).

Given that the VWPs were attached to the side of the SI casing and fully grouted in-place, the one-week interval has not provided enough time for the piezometric elevation envelope to stabilize at the tip location. Accordingly, commenting on potential elevated pore pressures at depth, or the complete absence of such, will be reserved until at least the second monitoring interval (approximately two weeks following initialization). The measured piezometric elevation can then be translated into a Bbar/r_u groundwater pressure parameter (if applicable) to be used in slope stability analyses. Over time, the piezometric elevations can be plotted to determine any potential porewater pressure trends within the soil/bedrock.

2.4 Visual Observations

During the collection of the instrumentation data, the slope and general project area (inclusive of the erosion and sediment control berm) is also visually observed for any potential signs of movement along the existing ground surface (e.g., slumping, cracking, settlements).

Visual observations of the erosion and sediment control berm (located in the northern portion of the project site along the pedestrian pathway) suggest it is functioning properly and containing any potential surface water run-off from further eroding the June 2020 slope failure area. It is also understood that additional maintenance of the control berm was scheduled for Monday June 14, 2021.

Visual observations of the general project area slope presented no immediate ground surface indicator of potential slope movement or failure as supported by the lack of slumping, cracking, or new depressions.

3.0 COMMENTARY

In general, the Milestone No. N#1 one-week monitoring interval results suggest the following:

- Not enough monitoring results to comment on immediate concern to overall slope stability as supported by the initial SI and VWP measurements.
- The erosion and sediment control berm appears to be functioning properly and containing any potential surface water run-off from further eroding the June 2020 slope failure area.
- No immediate ground surface sign of potential slope failure as supported by the lack of visually observation movement along the slope crest or at the mid/toe of slope instrumentation locations (e.g., slumping, cracking, settlements).

The above will be further developed following the measurements taken as part of the Milestone No. N#2 Two-week monitoring interval.

4.0 LIMITATIONS OF TECHNICAL MEMO

This technical memo has been prepared for The City of Calgary and their agents. The City of Calgary shall at all times be entitled to fully use and rely on this technical memo, including all attachments, drawings, and schedules, for the specific purpose for which the technical report was prepared, in each case notwithstanding any provision, disclaimer, or waiver in the technical memo that reliance is not permitted. This technical memo is subject to the terms and conditions of the Master Consulting Terms and Conditions executed between The City of Calgary and Tetra Tech Canada Inc.

The City of Calgary shall at all times be entitled to provide copies of the technical memo to City Council, City of Calgary regulatory boards, City of Calgary employees, officers, agents, affiliates, advisors, consultants, parties contracting with The City of Calgary, lenders and assignees and other governmental authorities and regulatory bodies having jurisdiction, each of whom shall also be similarly entitled to fully use and rely on the technical memo in the same manner and to the same extent as The City of Calgary for the specific purpose for which the technical memo was prepared.

5.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

2021-06-24

Prepared by:
Kyle Haugrud, P.Eng.
Geotechnical Engineer
Engineering Practice
Direct Line: 403.723.1618
kyle.haugrud@tetratech.com

Reviewed by:
Joseph Yonan, Ph.D., P.Eng.
Principal Consultant
Engineering Practice
Direct Line: 403.723.6885
joseph.yonan@tetratech.com

/mh

PERMIT TO PRACTICE
TETRA TECH CANADA INC.

RM SIGNATURE ____________

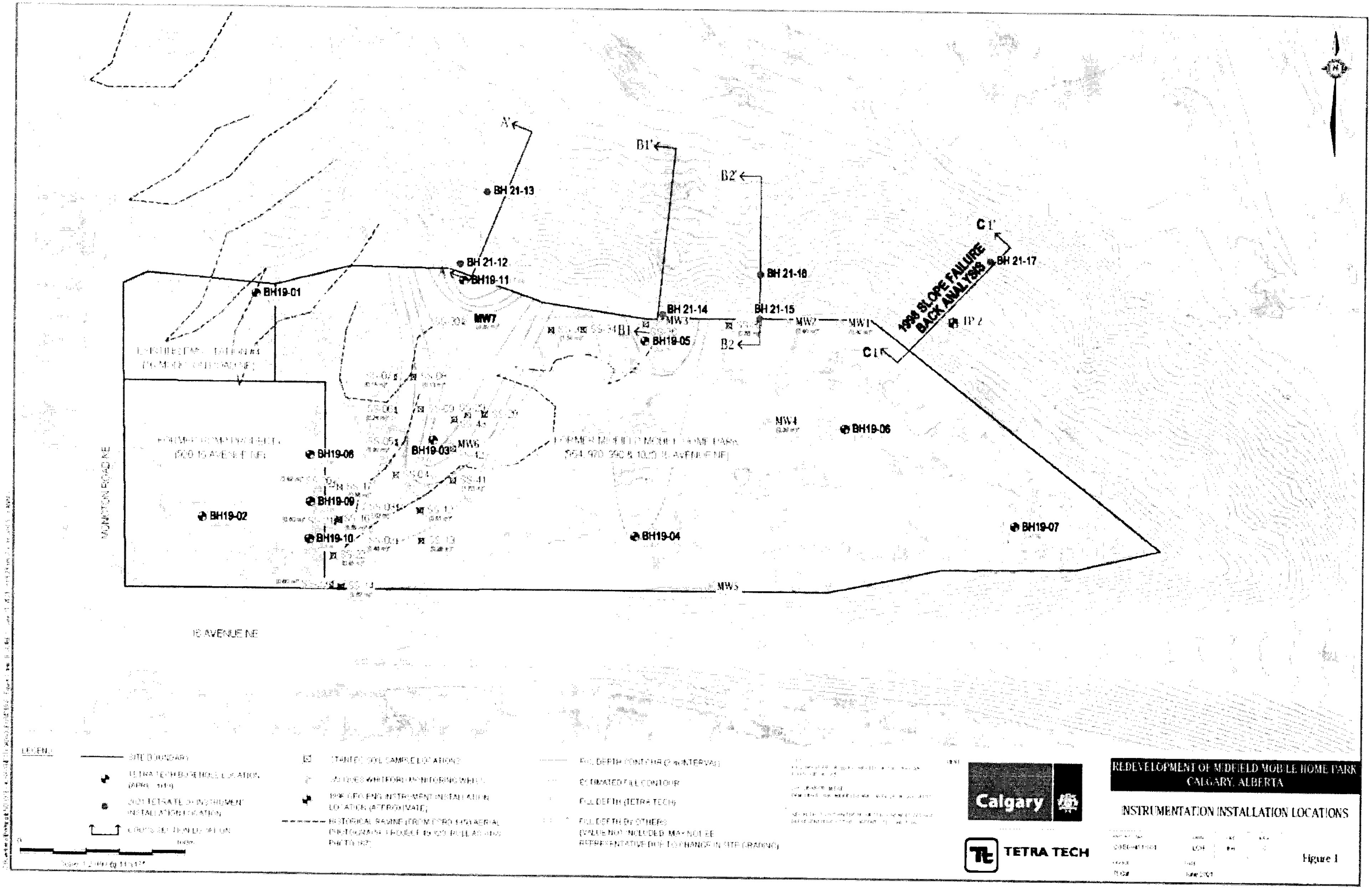
RM APEGA ID # 74722

DATE June 24 2021

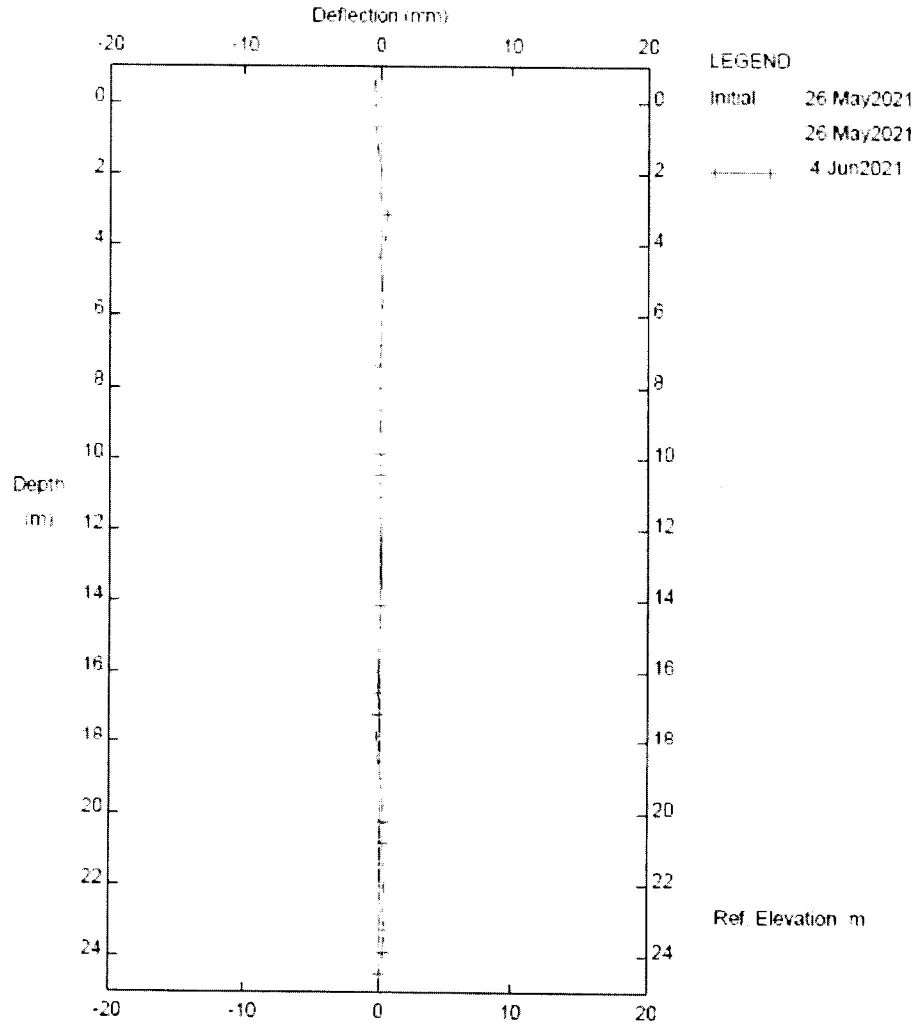
PERMIT NUMBER: P013774
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Attachments: Figure 1: Instrument Installation Locations
Appendix A – Slope Inclinometer Measurements

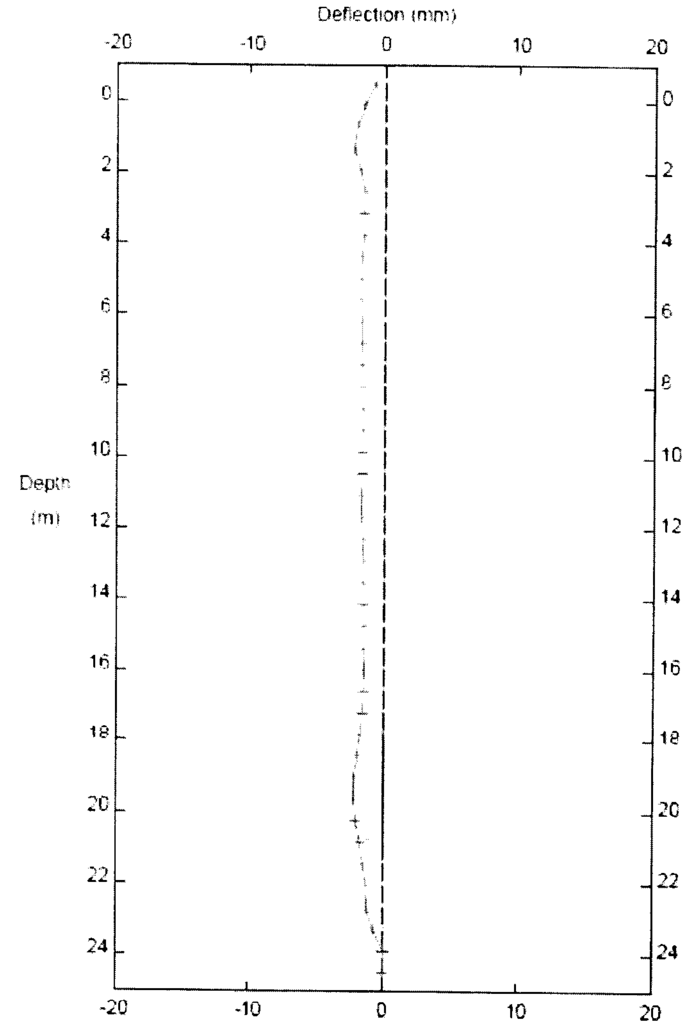
FIGURES


A'
B1'
B2'
C1'
BH 21-13
BH 21-12
A
BH19-11
BH19-01
BH 21-14
MW3
B1
BH19-05
BH 21-15
B2
BH 21-16
MW2
MW1
C1
1998 SLOPE FAILURE
BACK ANALYSIS
BH 21-17
MW7
MW6
BH19-03
MW4
BH19-06
BH19-08
BH19-09
BH19-02
BH19-10
BH19-04
BH19-07
MW5
MONTON ROAD NE
16 AVENUE NE
FORMER MIDFIELD MOBILE HOME PARK
LEGEND
SITE BOUNDARY
Calgary
TETRA TECH
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA
INSTRUMENTATION INSTALLATION LOCATIONS
Figure 1

APPENDIX A
SLOPE INCLINOMETER MEASUREMENTS



Cumulative Deflection
Direction A



Cumulative Deflection
Direction B

Midfield Heights, Inclinometer BH21-12

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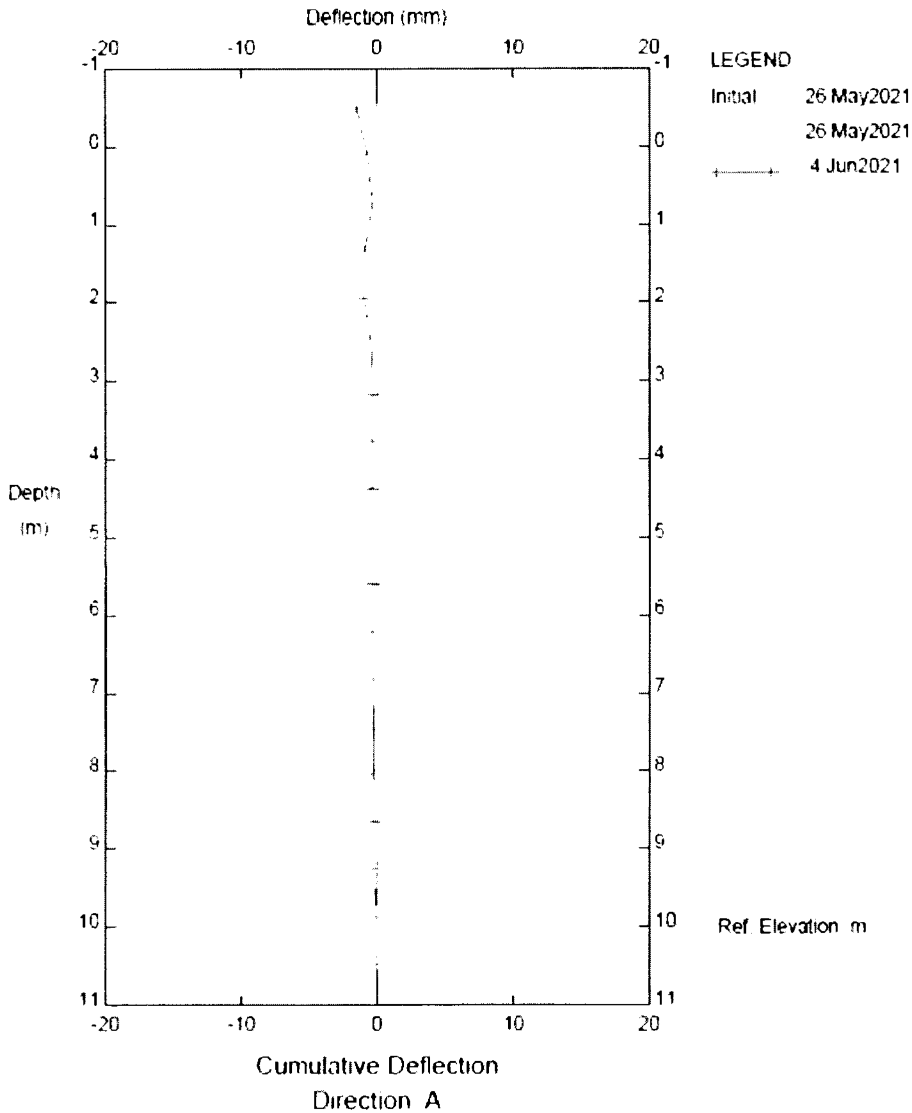
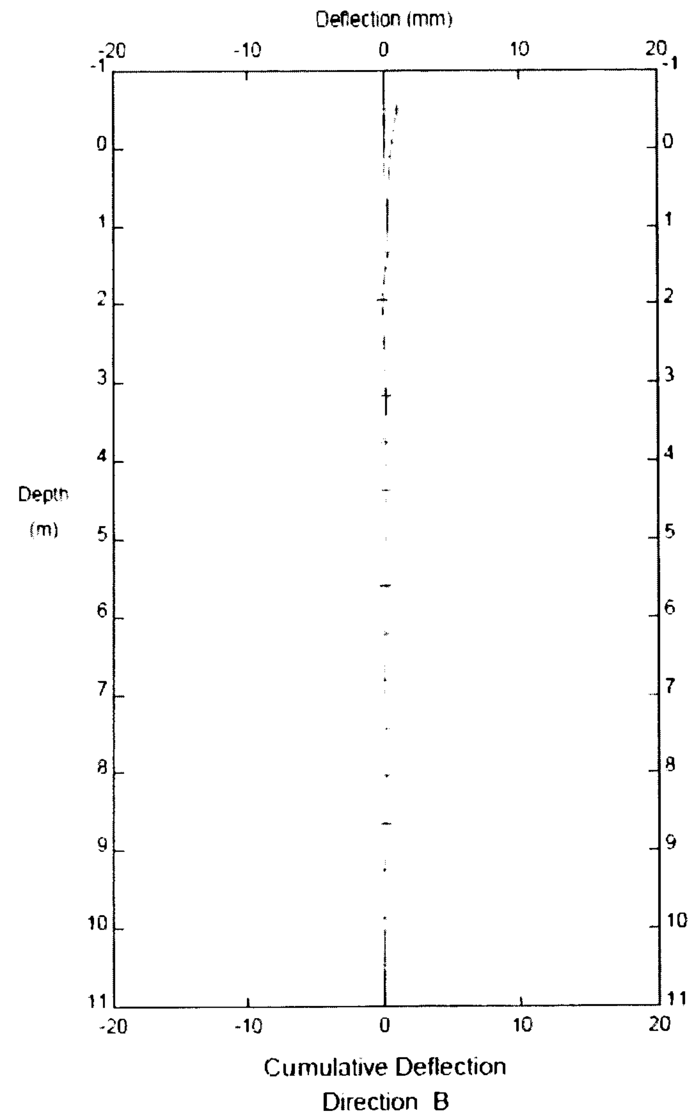
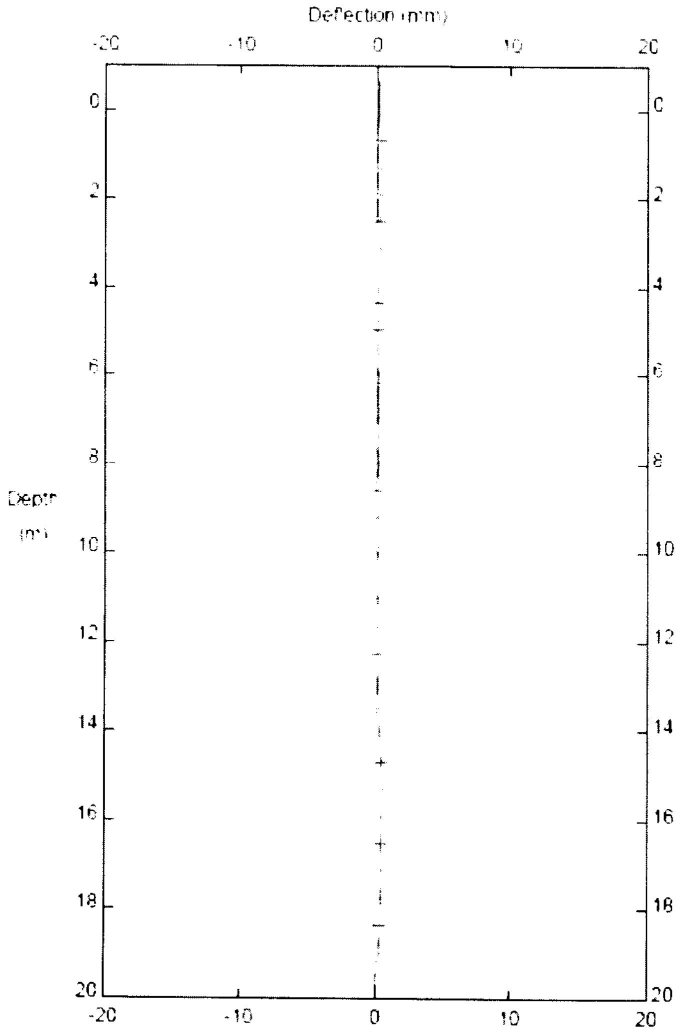




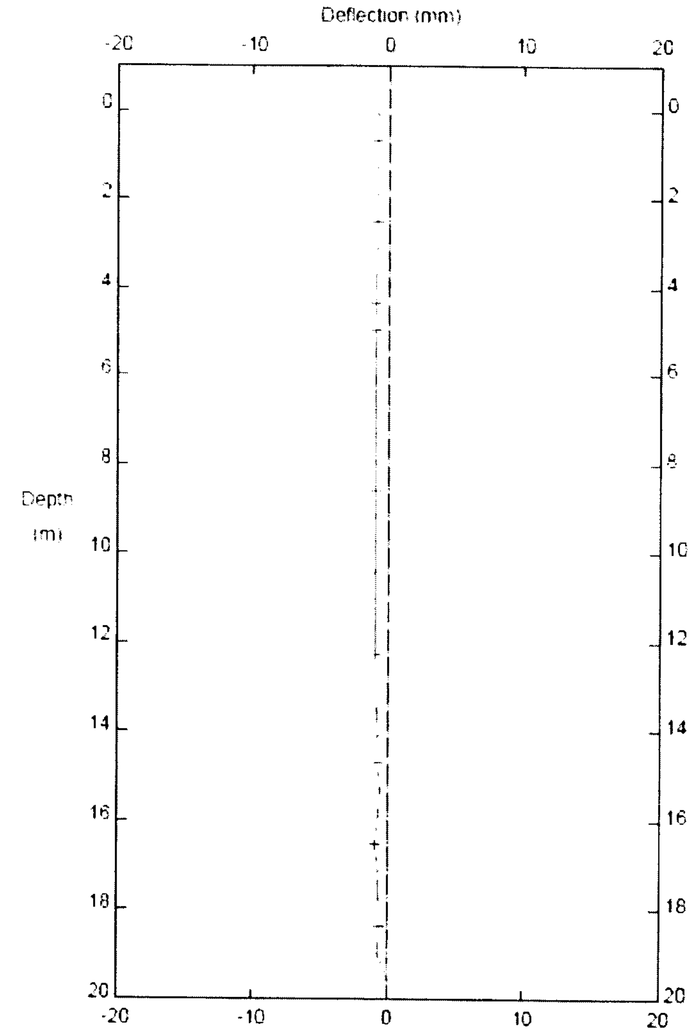
Midfield Heights, Inclinometer BH21-13



Cumulative Deflection
Direction A

LEGEND
Initial 26 May2021
26 May2021
4 Jun2021

Ref Elevation m



Cumulative Deflection
Direction B

Midfield Heights, Inclinometer BH21-14

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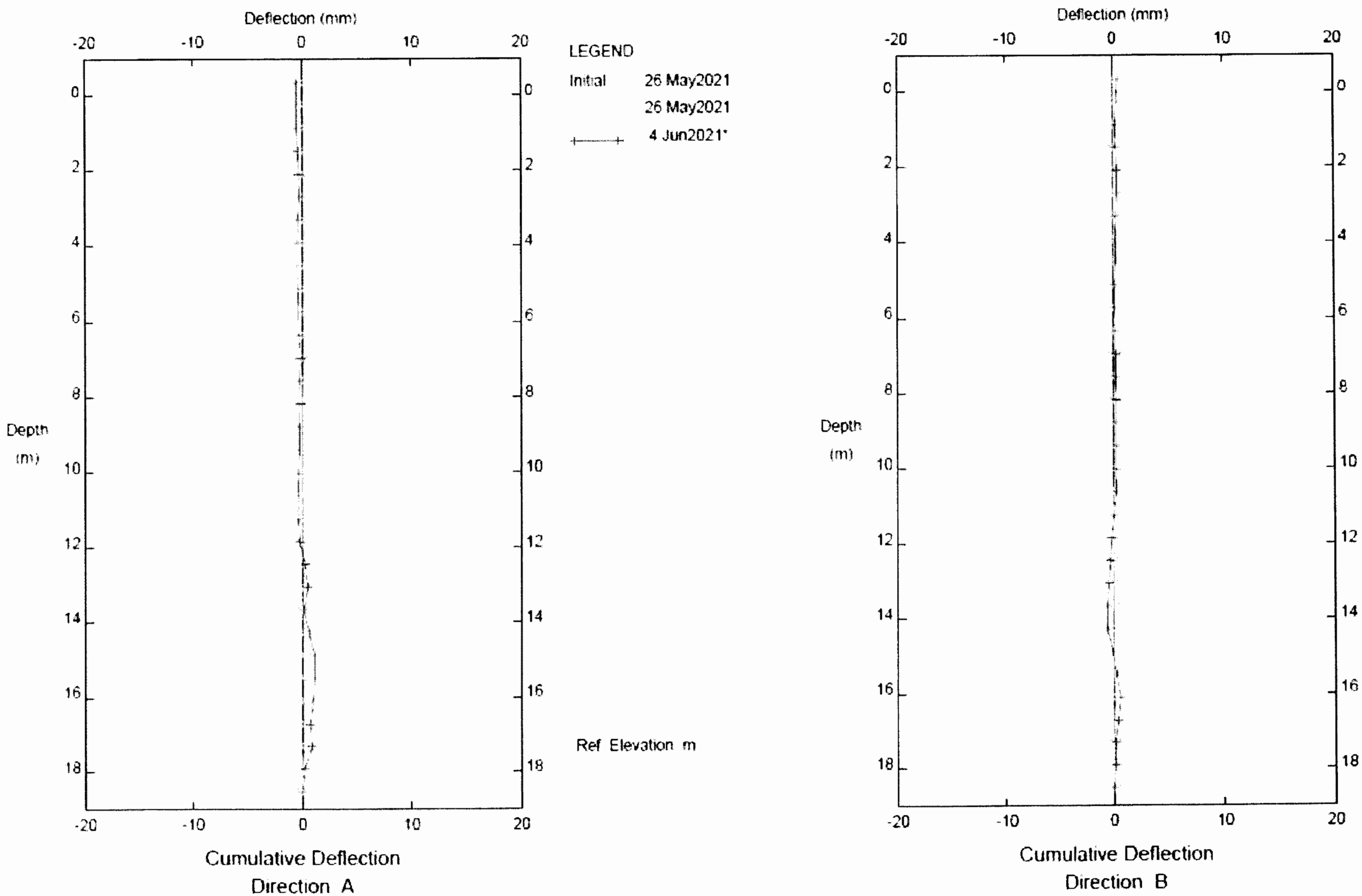
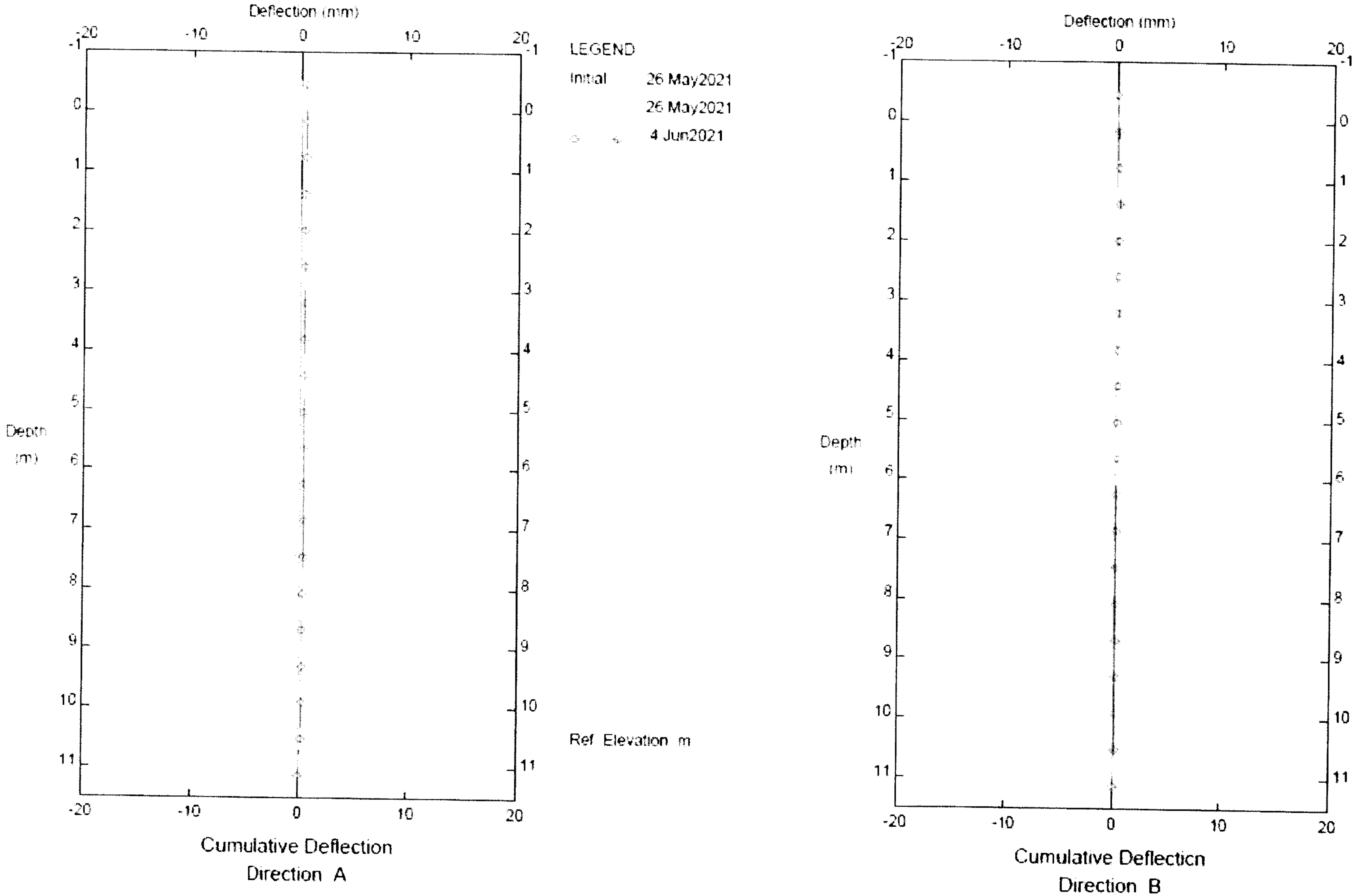
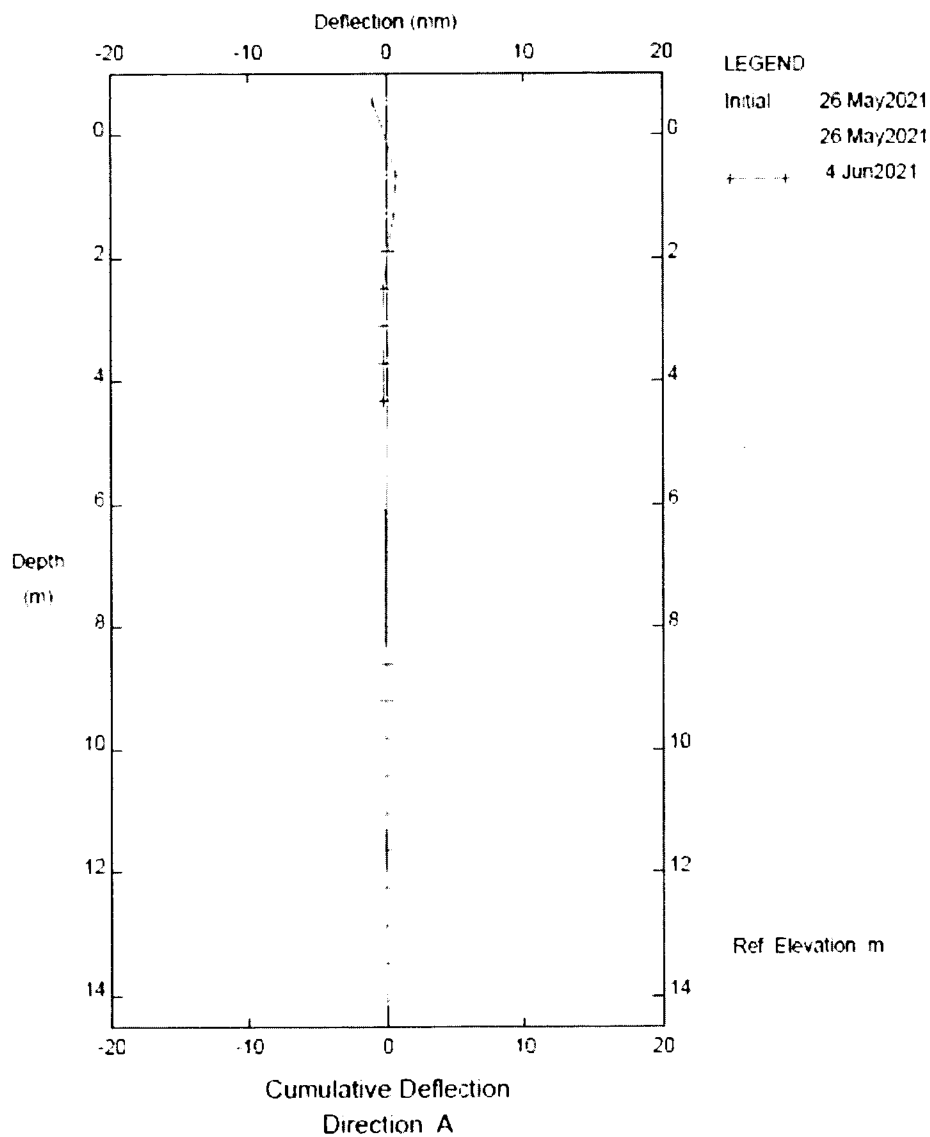


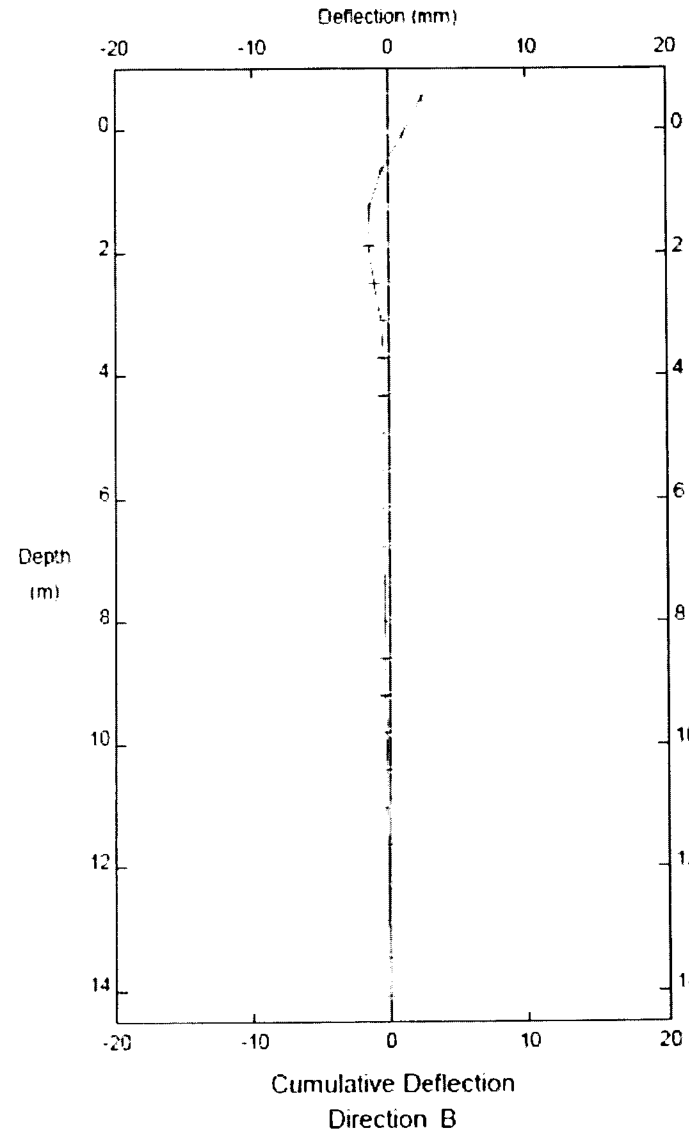
Midfield Heights, Inclincmeter BH21-15



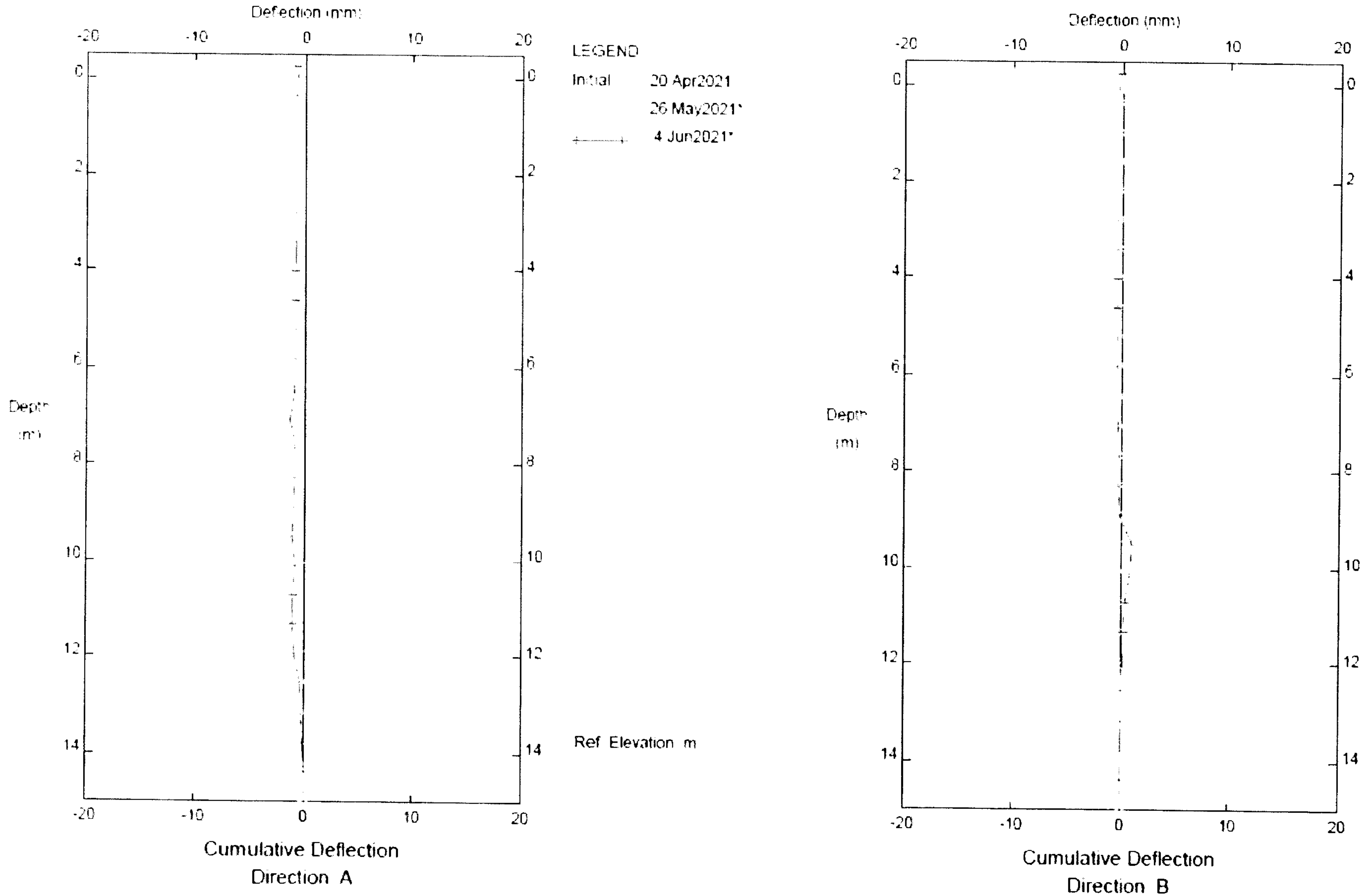
Midfield Heights, Inclinometer BH21-16

TETRA TECH





Midfield Heights, Inclinometer BH21-17



Midfield Heights, Inclinometer TP-2

TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE CONFIDENTIAL

To:	Malcolm Dort, P.Eng., LEED AP (The City of Calgary)	**Date:**	July 12, 2021
From:	Kyle Haugrud, P.Eng. Joseph Yonan, Ph.D., P.Eng.	**Memo No:**	N#2
		File:	704-ENG.CGEO04110-01
Subject:	Regular Slope Monitoring Program Milestone N#2: Two Week Interval – June 14, 2021 Redevelopment of Midfield Mobile Home Park Calgary, Alberta		

1.0 INTRODUCTION

This technical memo summarizes the results of the instrumentation measurements (Slope Inclinometers [SI] and Vibrating Wire Piezometers [VWP]) and visual observations collected by Tetra Tech Canada Inc. (Tetra Tech) as part of the regular slope monitoring program for the Redevelopment of Midfield Mobile Home Park project. The project is located northeast of the 16 Avenue NE and Moncton Road NE intersection in northeast Calgary, Alberta.

The details of the SI and VWP installations will be provided within the Milestone No. M#4 *Final Geotechnical Report* which was in progress at the time of this technical memo's preparation.

This technical memo represents the Milestone No. N#2 deliverable (two-week post installation interval) as part of extension five of The City of Calgary's (The City) scope and fee schedule No. 18-2006-A05-S01-05 dated April 15, 2021. This is the second monitoring interval of the currently proposed six monitoring intervals, with the following remaining: four-week interval; three-month interval; six-month interval; and one-year interval. Table 1 summarizes the monitoring intervals as completed to date. Note that if instrumentation exhibits adverse conditions, additional monitoring intervals may be required.

Table 1: Instrumentation Regular Monitoring Summary

Instrument Borehole Number	SI Initialization Date	No. N#1 One-Week Date	No. N#2 Two-Week Date**	No. N#3 Four-Week Date**	No. N#4 Three-Month Date**	No. N#5 Six-Month Date**	No. N#6 One-Year Date**
BH21-12	May 26, 2021	June 4, 2021	June 14, 2021				
BH21-13							
BH21-14							
BH21-15							
BH21-16							
BH21-17							
TP-2*	Apr 20, 2021						

Notes: * Borehole TP-2 was installed under the direction of Geo-Engineering (M.S.T.) Ltd. on November 26, 1998. Previous displacement data was not available, and the instrument was re-initialized on April 20, 2021.
** Greyed-out cells represent proposed future monitoring intervals yet to be completed.

Tetra Tech Canada Inc.
Suite 110, 140 Quarry Park Blvd SE
Calgary, AB T2C 3G3 CANADA
Tel 403.203.3355 Fax 403.203.3301

2.0 MONITORING AND MEASUREMENT

2.1 General

The key objective of the installed instrumentation (SI and VWP) and visual observations is to sufficiently monitor slope movement and measure pore pressure responses throughout the Midfield project site's northern slope to assess its overall slope stability, and to provide enough warning/time for slope stabilization measures.

The locations of the installed instrumentation are provided on the attached Figure 1. The following subsections summarize the monitoring results completed to date.

2.2 Slope Inclinometer (SI) Summary

A summary of the horizontal displacements within the SI casings measured to date (N#1 and N#2 two-week) is provided in Table 2.

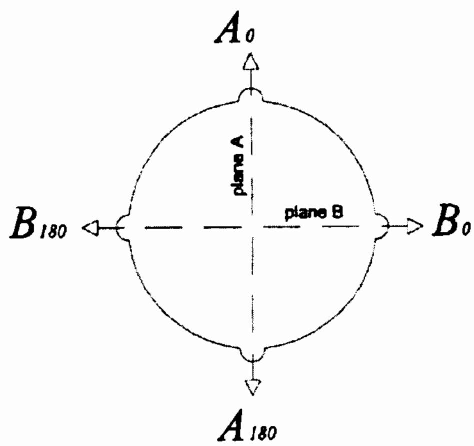
Table 2: Slope Inclinometer (SI) Movement Summary to Date

SI Borehole No.	Analysis Section / Casing Diameter	SI Depth (m)	Movement						
			Depth (m)	Elev. (m)	Soil Unit	Shear (mm)*		Total (mm)**	
						New	Cumulative	New	Cumulative
BH21-12	A / 85 mm	25.0	19.5	1056.4	Clay	N/A	N/A	<5	<5
BH21-13	A / 85 mm	10.4	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-14	B1 / 85 mm	19.5	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-15	B2 / 85 mm	18.9	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-16	B2 / 85 mm	11.6	N/A	N/A	N/A	N/A	N/A	<5	<5
BH21-17	C1 / 70 mm	14.6	N/A	N/A	N/A	N/A	N/A	<5	<5
TP-2	C1 / 70 mm	15.9	N/A	N/A	N/A	N/A	N/A	<5	<5

Notes: * Shear movement is considered observable horizontal movement over a discrete plane.
** Total movement is not considered until over 5 mm is observable (considered 'noise' <5 mm).

The SI casing displacement plots are attached in Appendix A for reference. As presented in Appendix A, most of the N#2 (two-week) deflection plots dated June 14, 2021 are comparable to the previous N#1 (one-week) interval dated June 4, 2021, except for BH21-12. From a depth range of approximately 18.0 m to 21.0 m (approximate El. 1054.9 m to El. 1057.9 m) within BH21-12 there appears to be a gentle propagation of cumulative deflection over time. The total displacement magnitude over this depth range of approximately 3 mm is still below the considered 'noise' threshold (5 mm) and is not an immediate stability concern at this time; however, it warrants mentioning and increased attention during future monitoring intervals. The next monitoring N#3 four-week interval will provide a greater understanding of this potential movement zone.

The displacement plots in Appendix A present two graphs for each SI casing location; this is a result of there being two 'sets' of grooves which control the orientation of the inclinometer probe reader. Attempts are made during installation to ensure one set of grooves is properly aligned with the direction of expected movement (i.e., downslope, typically A_0-A_{180}); however, shifts in the casing's orientation are typical prior to the grout completely curing. Therefore, both groove sets are read from the bottom of the SI casing to the top and should be reviewed in tandem for a comprehensive representation of the casing condition. Schematic 1 presents a top view of an SI casing depicting the general groove orientation.



Schematic 1: SI Casing Groove Orientation

2.3 Vibrating Wire Piezometer (VWP) Summary

A summary of the porewater pressure response calculated from the VWP measurements to date (N#1 and N#2 two-week) is provided in Table 3.

Table 3: Vibrating Wire Piezometer (VWP) Pore Pressure Summary to Date

VWP Borehole No.	Analysis Section	VWP Tip Depth (m)	VWP Tip Elev. (m)	Soil Unit	Date	Measured Piezometric Elev. (m)	Water Pressure Head (m)	Calculated Bbar/r_u*
BH21-12	A (Crest)	15.2	1060.7	Clay	June 4, 2021	1061.2		
					June 14, 2021	1061.2	0.6	<0.1
BH21-13	A (Toe)	9.1	1054.5	Clay	June 4, 2021	1054.5		
					June 14, 2021	<1054.5	<0.1	<0.1
BH21-14	B1 (Crest)	13.7	1061.7	Clay	June 4, 2021	1061.8		
					June 14, 2021	1061.8	0.1	<0.1
BH21-15	B2 (Crest)	13.7	1061.5	Clay	June 4, 2021	1061.5		
					June 14, 2021	<1061.5	<0.1	<0.1
BH21-16	B2 (Toe)	11.6	1052.9	Sand	June 4, 2021	1052.9		
					June 14, 2021	<1052.9	<0.1	<0.1
BH21-17	C1 (Mid)	14.6	1045.2	Clay	June 4, 2021	1045.3		
					June 14, 2021	<1045.2	<0.1	<0.1

Note * Water pressure head and Bbar/r_u not calculated during N#1 (one-week interval); all current (as of June 14, 2021) Bbar/r_u calculated pressures are under 0.1

All piezometric elevations were near or below the VWP tip installation elevation except for BH21-12, which exhibited a water pressure head of approximately 0.6 m. The resulting calculated Bbar/r_u groundwater pressure parameters are all below a value of 0.1 typically used in stability analyses for fill (based on Tetra Tech experience of similar materials in similar conditions) and do not suggest significant elevated porewater conditions within potential native soils at the tip elevation.

2.4 Visual Observations

During the collection of the instrumentation data, the slope and general project area (inclusive of the erosion and sediment control berm [ESCB]) were also visually observed for any potential signs of movement along the existing ground surface (e.g., slumping, cracking, settlements).

As mentioned within the Milestone N#1 one-week monitoring interval technical memo, maintenance of the ESCB was scheduled and consequently conducted on June 14, 2021 prior to Tetra Tech's Milestone N#2 site visit. Visual observations following the maintenance suggest an additional approximate 0.3 m (1 ft) was removed from the trench base and placed along its crest given recent erosion and slumping from rainfall events. Minimal ponded water was visually observed in finite segments of the ESCB approximately at a 0.8 m depth from the existing ground surface: understandably so, given the lack of precipitation following the Milestone N#1 monitoring interval. Overall, the ESCB appeared to be functioning properly and contained any potential surface water run-off from further eroding the June 2020 slope failure area over the N#2 monitoring interval.

Visual observations of the general project area slope presented no immediate ground surface indicator of potential slope movement or failure as supported by the lack of slumping, cracking, or new depressions.

3.0 COMMENTARY

In general, the Milestone No. N#2 two-week monitoring interval results suggest the following:

- The SI monitoring measurement results for the two-week interval are comparable to the one-week interval and there is no immediate concern to overall slope stability; however, propagation of cumulative displacement within BH21-12, although minimal, warrants mentioning and increased attention during future monitoring intervals.
- The VWP calculated Bbar/r_u groundwater pressure parameters are all below a value of 0.1 typically used in stability analyses for fill and do not suggest significant elevated porewater conditions within potential native soils at the tip elevation at this time.
- The ESCB had undergone additional maintenance, appeared to be functioning properly, and contained any potential surface water run-off from further eroding the June 2020 slope failure area over the N#2 monitoring interval.
- There was no immediate ground surface sign of potential slope failure as supported by the lack of visually observed movement along the slope crest or at the mid/toe of slope instrumentation locations (e.g., slumping, cracking, settlements).

The above will be further developed following the measurements taken as part of the Milestone No. N#3 four-week monitoring interval.

4.0 LIMITATIONS OF TECHNICAL MEMO

This technical memo has been prepared for The City of Calgary and their agents. The City of Calgary shall at all times be entitled to fully use and rely on this technical memo, including all attachments, drawings, and schedules, for the specific purpose for which the technical report was prepared, in each case notwithstanding any provision, disclaimer, or waiver in the technical memo that reliance is not permitted. This technical memo is subject to the terms and conditions of the Master Consulting Terms and Conditions executed between The City of Calgary and Tetra Tech Canada Inc.

The City of Calgary shall at all times be entitled to provide copies of the technical memo to City Council, City of Calgary regulatory boards, City of Calgary employees, officers, agents, affiliates, advisors, consultants, parties contracting with The City of Calgary, lenders and assignees and other governmental authorities and regulatory bodies having jurisdiction, each of whom shall also be similarly entitled to fully use and rely on the technical memo in the same manner and to the same extent as The City of Calgary for the specific purpose for which the technical memo was prepared.

5.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

2021-07-12

Prepared by:
Kyle Haugrud, P.Eng.
Geotechnical Engineer
Engineering Practice
Direct Line: 403.723.1618
kyle.haugrud@tetratech.com

Reviewed by:
Joseph Yonan, Ph.D., P.Eng.
Principal Consultant
Engineering Practice
Direct Line: 403.723.6885
joseph.yonan@tetratech.com

/mh

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TETRA TECH CANADA INC.

RM SIGNATURE ____________

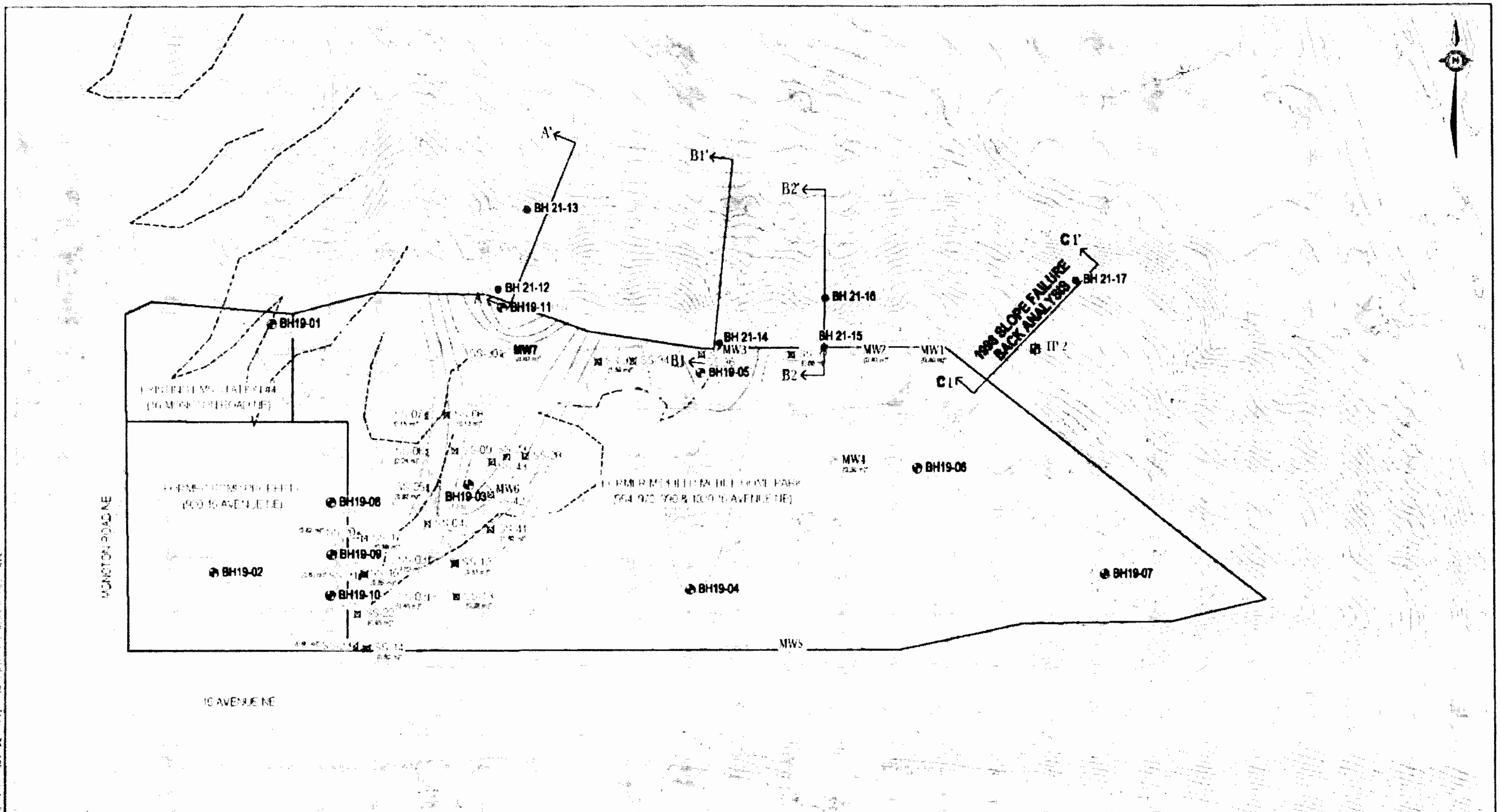
RM APEGA ID # 74722

DATE July 13 2021

PERMIT NUMBER: P013774
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

Attachments: Figure 1: Instrument Installation Locations
Appendix A – Slope Inclinometer Measurements

FIGURES



Calgary

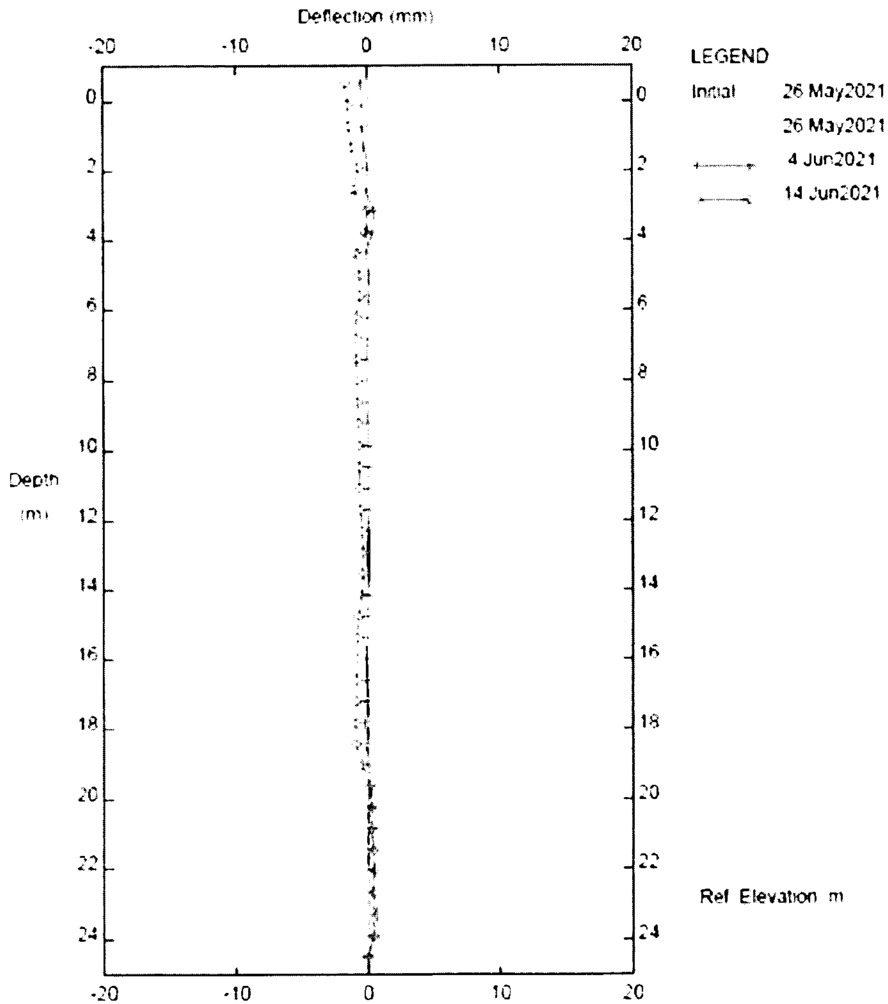
TETRA TECH

REDEVELOPMENT OF MEDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

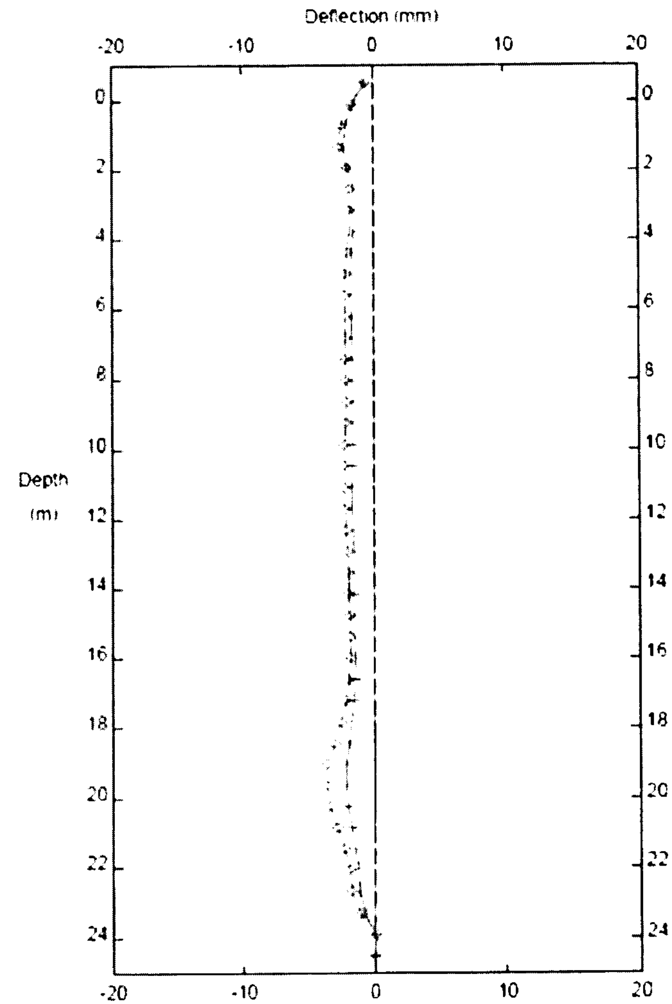
INSTRUMENTATION INSTALLATION LOCATIONS

Figure 1

APPENDIX A
SLOPE INCLINOMETER MEASUREMENTS

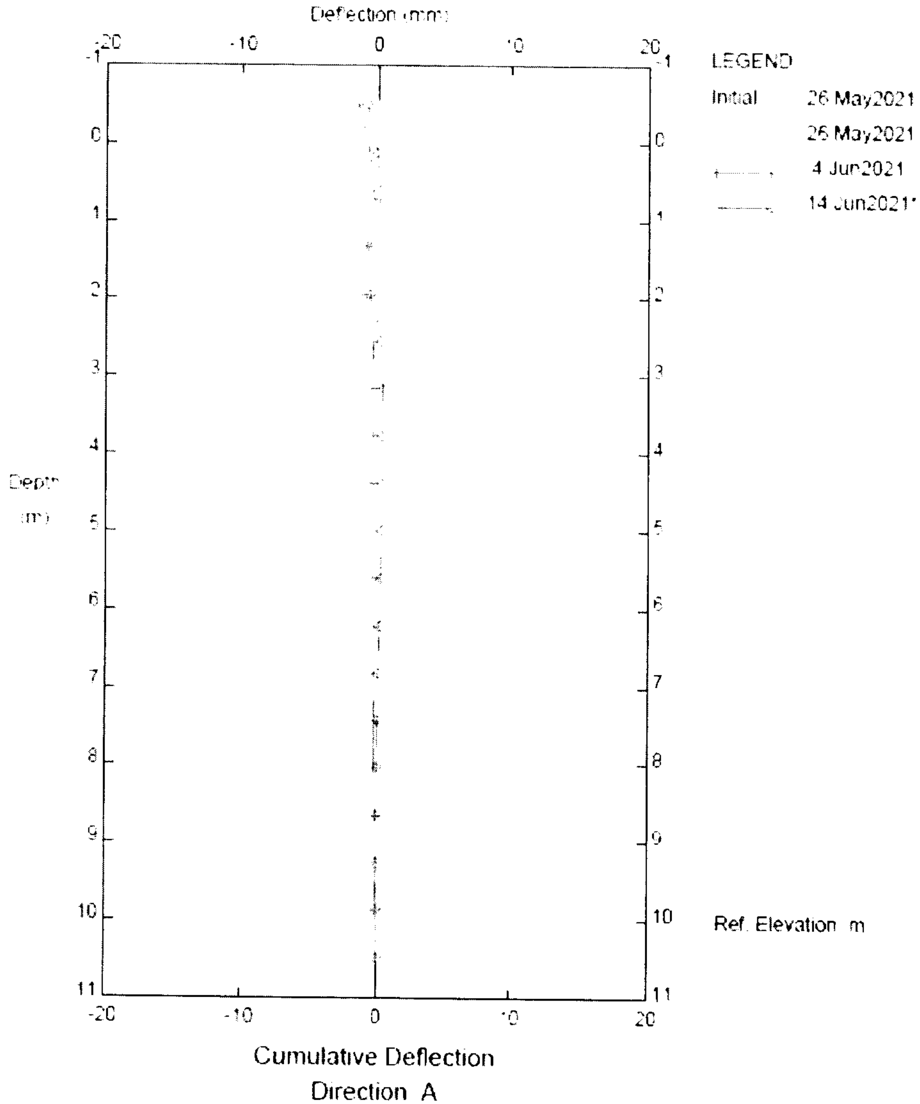


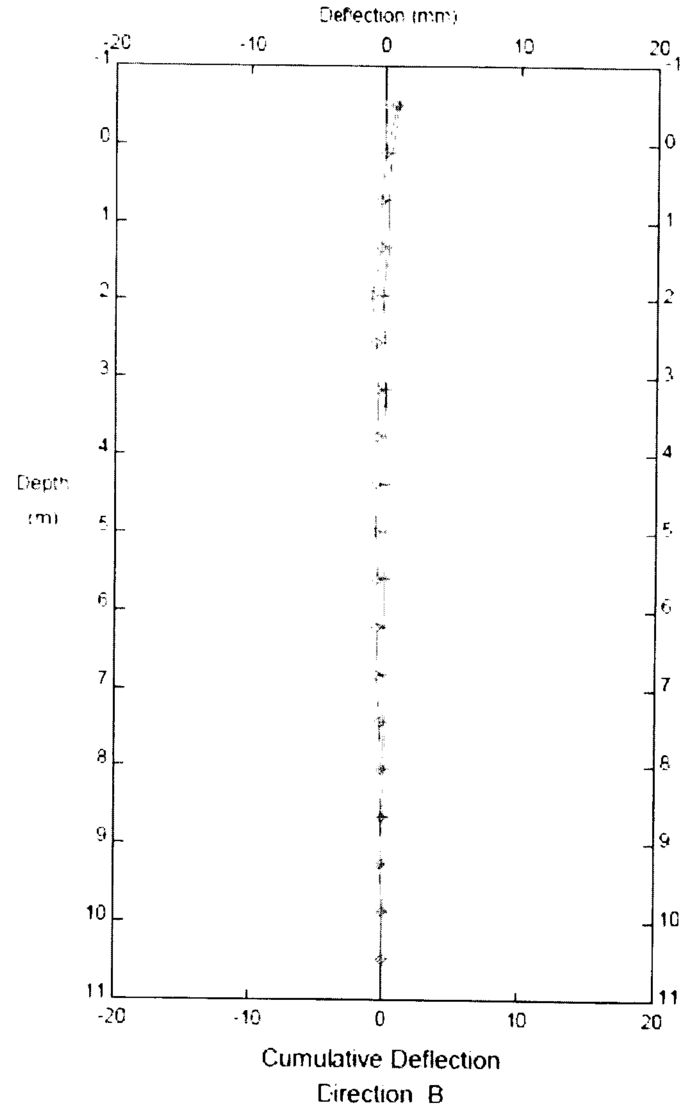
Cumulative Deflection
Direction A



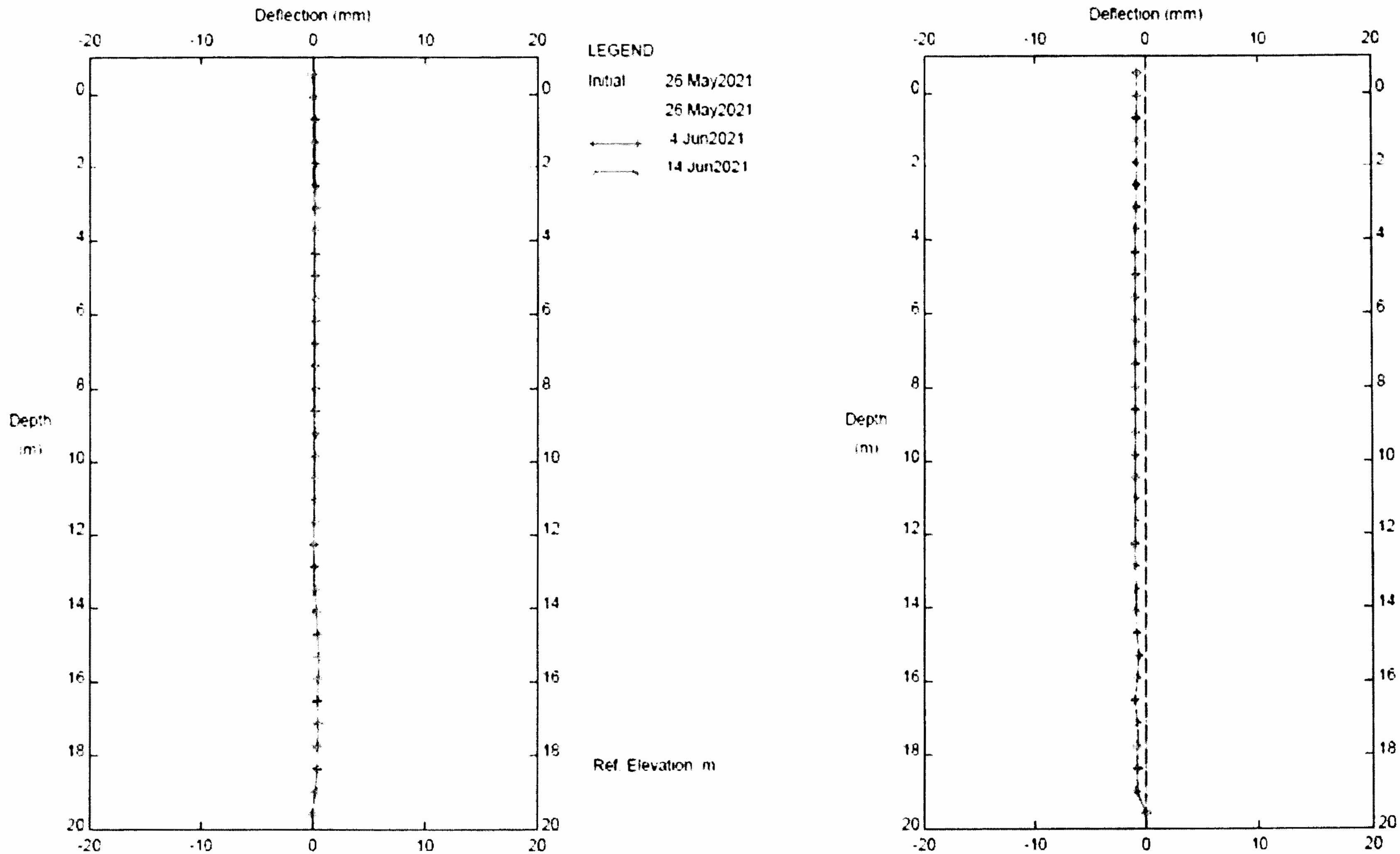
Cumulative Deflection
Direction B

Midfield Heights, Inclinometer BH21-12





Midfield Heights, Inclinometer BH21-13



Cumulative Deflection
Direction A

Cumulative Deflection
Direction B

Midfield Heights, Inclinometer BH21-14

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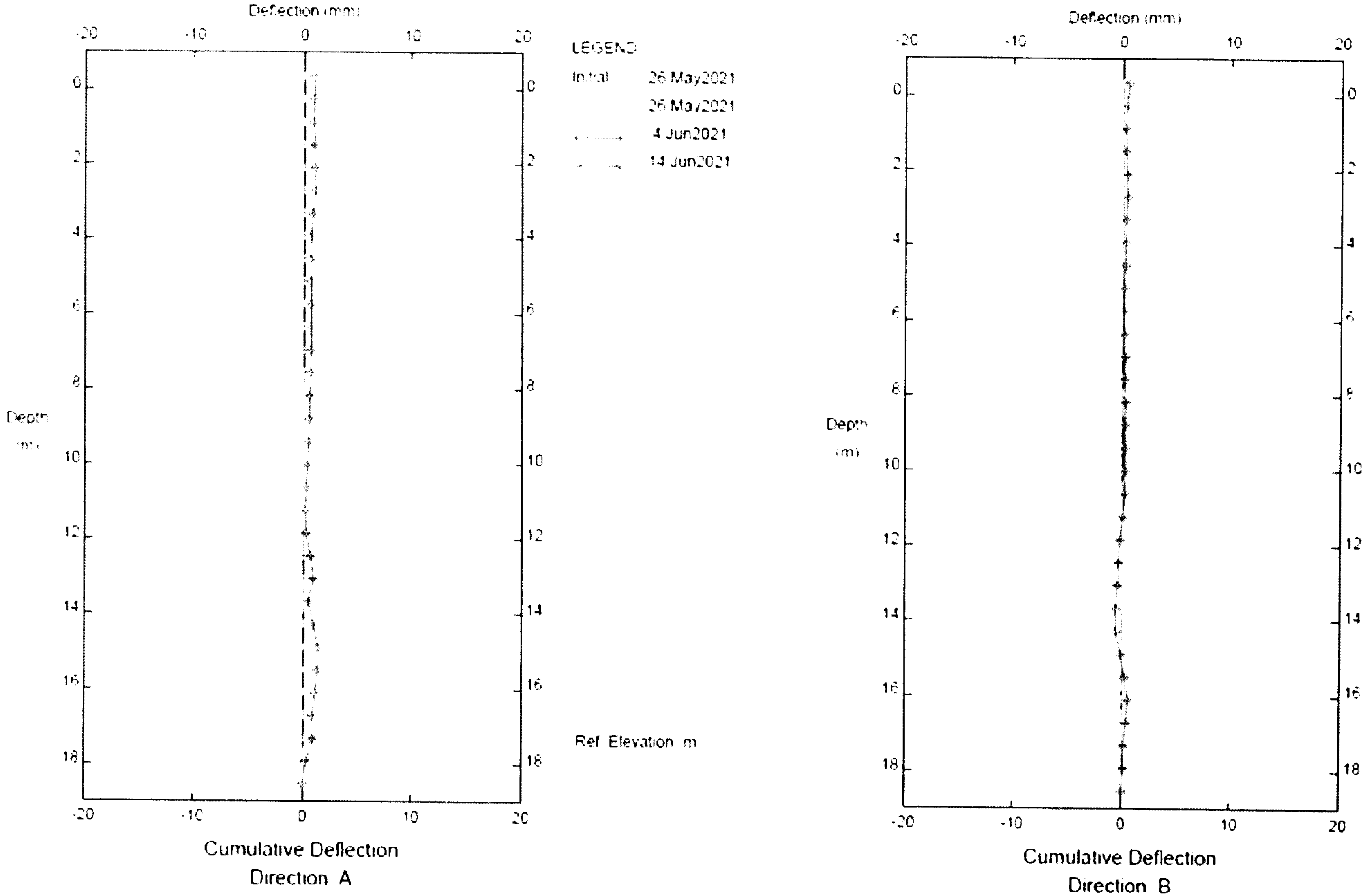

Midfield Heights, Inclinometer BH21-15

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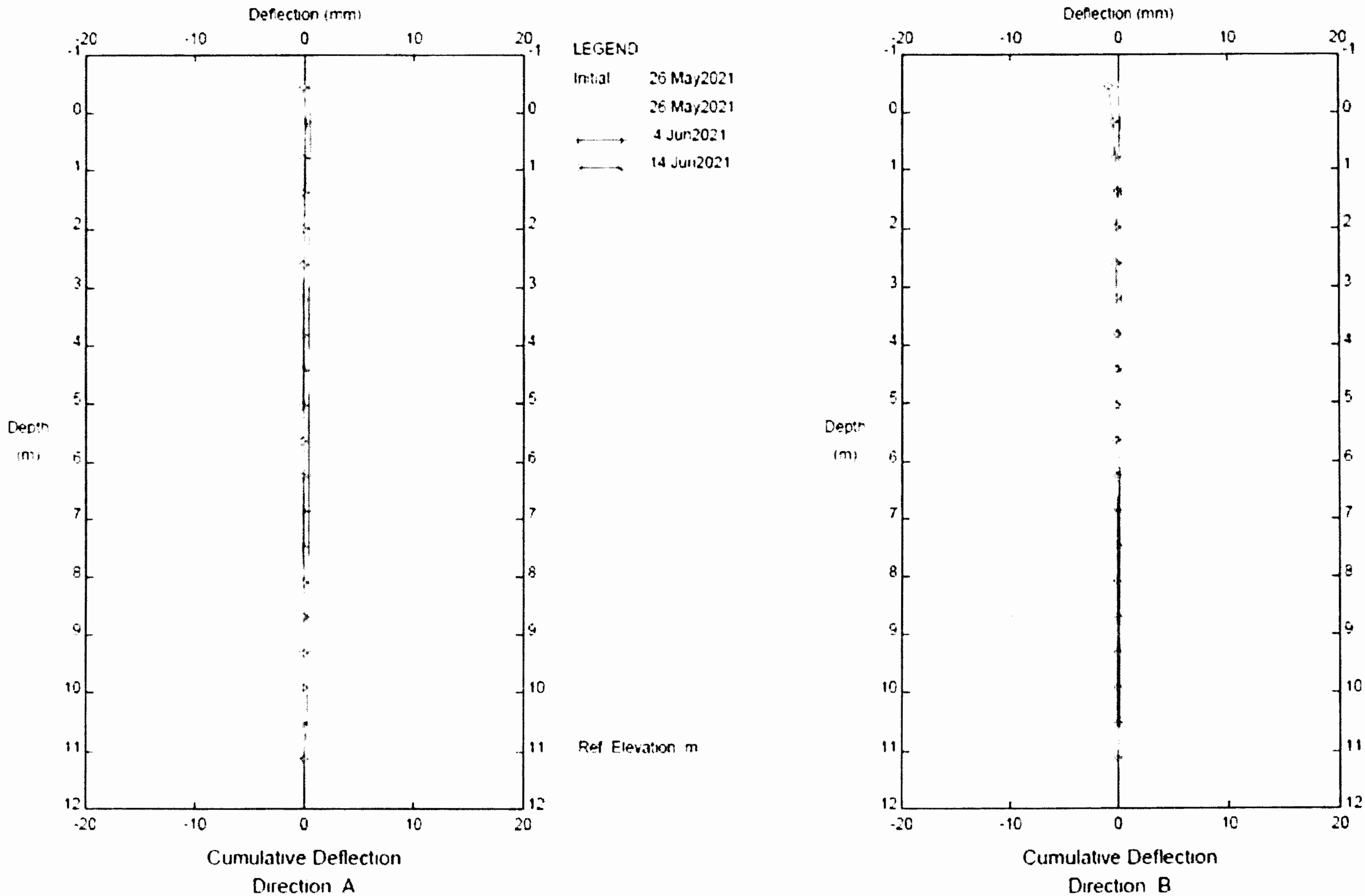
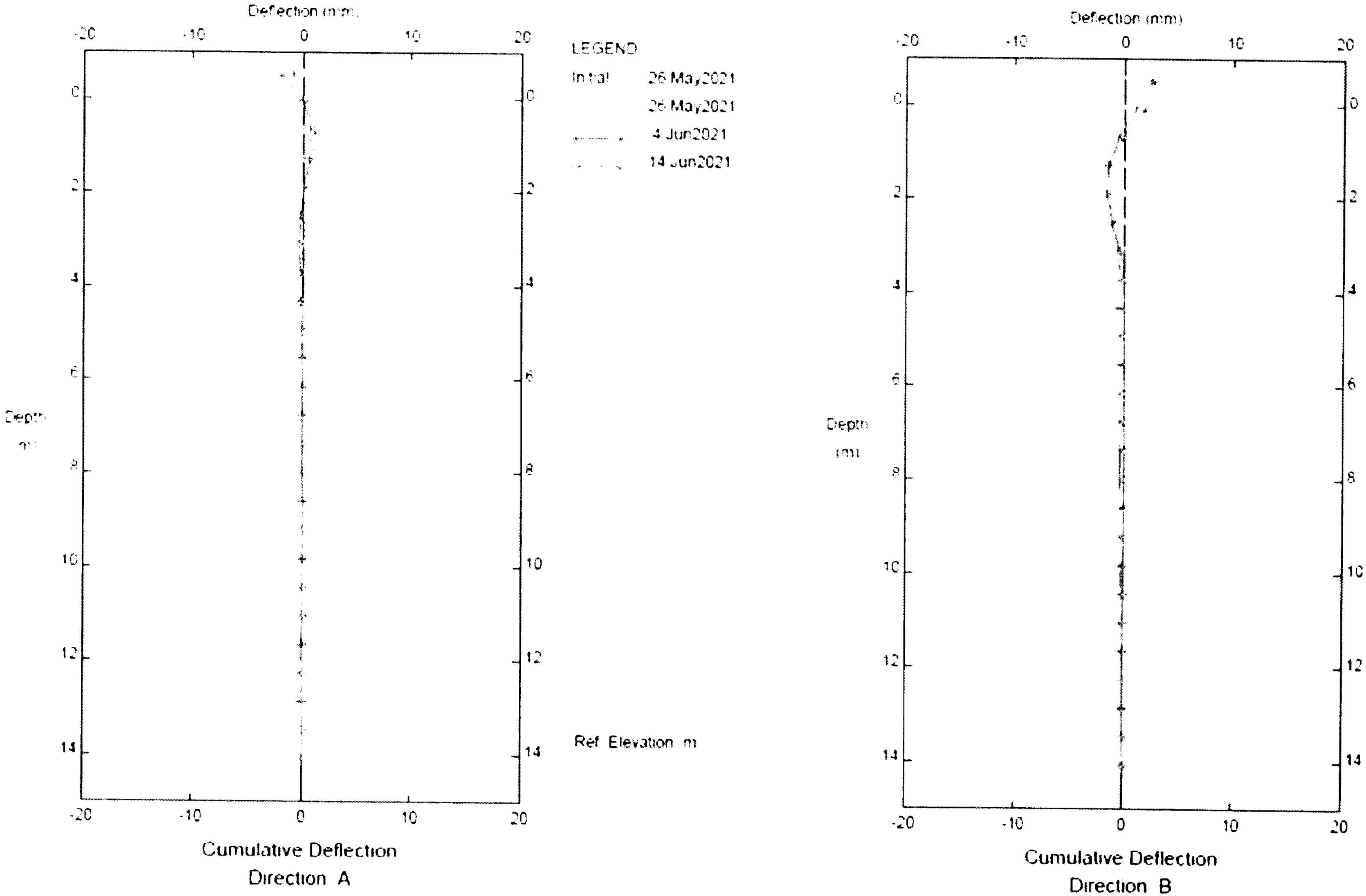


Midfield Heights, Inclinometer BH21-16



Midfield Heights, Inclinometer BH21-17

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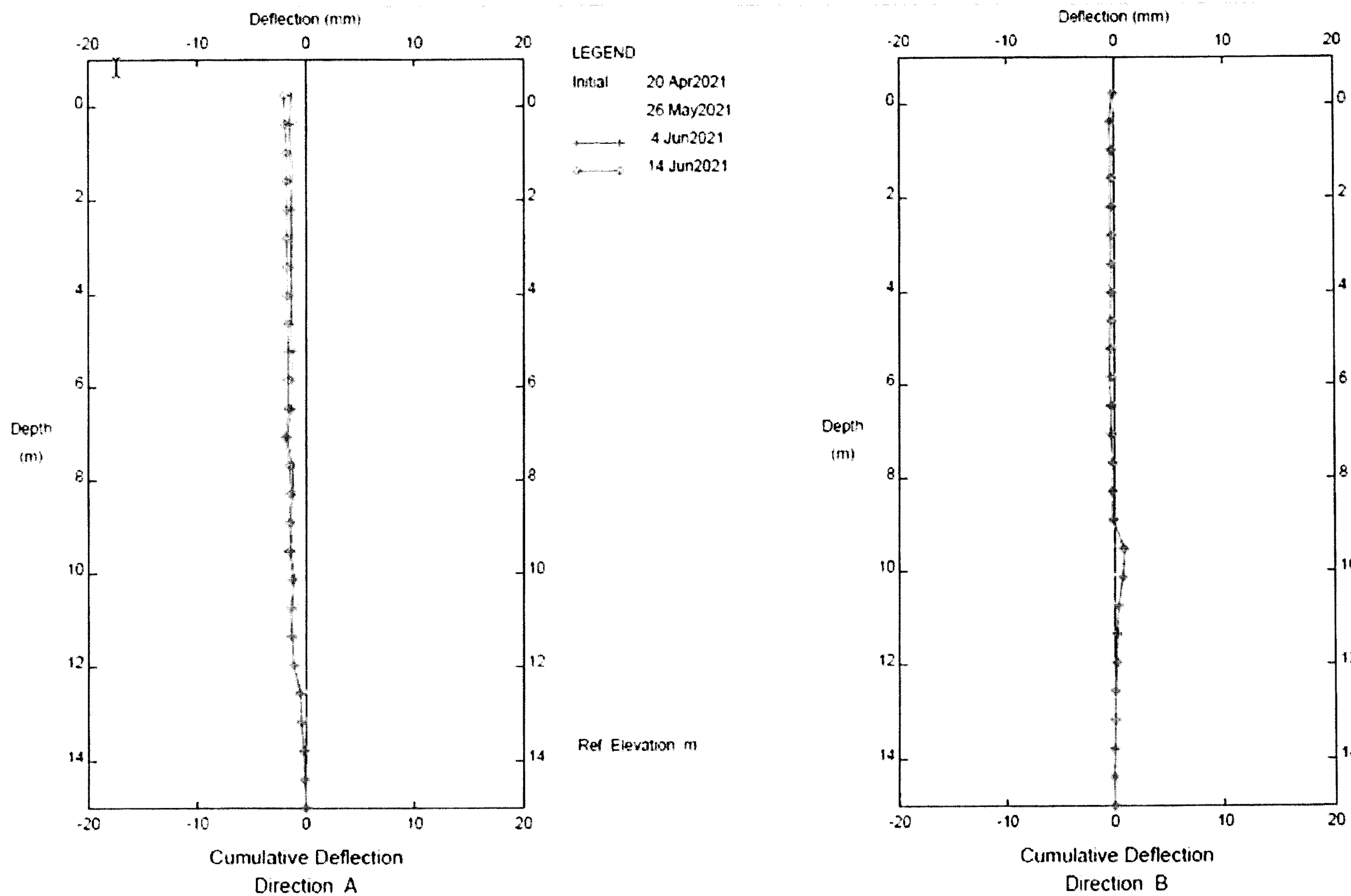


Midfield Heights, Inclinometer TP-2

TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE. CONFIDENTIAL

To:	Malcolm Dort, P.Eng., LEED AP (The City of Calgary)	**Date:**	August 10, 2021
From:	Kyle Haugrud, P.Eng. Joseph Yonan, Ph.D., P.Eng.	**Memo No:**	N#3
		File:	704-ENG.CGEO04110-01
Subject:	Regular Slope Monitoring Program and Interim Preliminary Slope Stability Analysis Milestone N#3: Four-Week Interval – July 5, 2021 Redevelopment of Midfield Mobile Home Park Calgary, Alberta		

1.0 INTRODUCTION

This technical memo summarizes the results of the instrumentation measurements (Slope Inclinometers [SI] and Vibrating Wire Piezometers [VWP]), visual observations, and interim preliminary slope stability analyses conducted by Tetra Tech Canada Inc. (Tetra Tech) as part of the regular slope monitoring program for the Redevelopment of Midfield Mobile Home Park project. The project is located northeast of the 16 Avenue NE and Moncton Road NE intersection in northeast Calgary, Alberta.

The details of the SI and VWP installations will be provided within the Milestone No. M#4 *Final Geotechnical Report*, which was in progress at the time of this technical memo's preparation.

To progress development approvals, The City of Calgary (The City) requested that interim preliminary slope stability analyses for the instrumentation section lines (refer to Figure 1) be conducted to verify that the setback distances previously provided within Tetra Tech's *Geotechnical Evaluation Report* (Tetra Tech[1] [referred to herein as 'Geo Eval']) still satisfy the required 1.5 factor of safety. The justification for additional stability analyses was driven by a surficial slope failure that occurred in June 2020 following the provision of the setbacks, which prompted The City to request a reassessment of the existing slope stability condition, noting that no previous slope stability instrumentation monitoring data was available. Tetra Tech has amended the applicable setback distance analysis sections, inclusive of a newly developed analysis section along the slope failure (designated Section B2), incorporating the recently acquired additional subsurface information and instrumentation monitoring data collected to date. The results of the interim preliminary slope stability analyses are presented herein. Note that these results are preliminary in nature and may not be identical to the ultimate results provided in the future M#4 *Final Geotechnical Report* deliverable; however, for the intent of progressing development approvals, these provided results may be relied upon. The setback distances will be further confirmed within the M#4 deliverable as well as validated through the ongoing regular slope monitoring program intervals.

This technical memo represents the Milestone No. N#3 deliverable (four-week post-installation interval) as part of extension five of The City's Scope and Fee Schedule No. 18-2006-A05-S01-05 dated April 15, 2021. This is the third monitoring interval of the currently proposed six monitoring intervals, with the following remaining: three-month interval; six-month interval; and one-year interval. Table 1 summarizes the monitoring intervals as completed to date. Note that if instrumentation results suggest adverse conditions, additional monitoring intervals may be required.

[1] Tetra Tech Canada Inc. 2020. ***Preliminary Geotechnical Evaluation and Slope Stability Assessment (Revision 1), Redevelopment of Midfield Mobile Home Park, Former RCMP Property, and EMS Station #4, Moncton Road NE and 16 Avenue NE,*** Calgary, Alberta, File No. 704-ENG.CGEO03639-01, dated February 7, 2020.

Tetra Tech Canada Inc.
Suite 110, 140 Quarry Park Blvd SE
Calgary, AB T2C 3G3 CANADA
Tel 403.203.3355 Fax 403.203.3301

Table 1: Instrumentation Regular Monitoring Summary

Instrument Borehole Number	SI Initialization Date	No. N#1 One-Week Date	No. N#2 Two-Week Date	No. N#3 Four-Week Date	No. N#4 Three-Month Date**	No. N#5 Six-Month Date**	No. N#6 One-Year Date**
BH21-12	May 26, 2021	June 4, 2021	June 14, 2021	July 5, 2021			
BH21-13							
BH21-14							
BH21-15							
BH21-16							
BH21-17							
TP-2*	April 20, 2021						

Notes: * Borehole TP-2 was installed under the direction of Geo-Engineering (M.S.T.) Ltd. on November 26, 1998. Previous displacement data was not available, and the instrument was re-initialized on April 20, 2021.
** Greyed-out cells represent proposed future monitoring intervals yet to be completed.

It is important to note that the instrument readings for this N#3 interval (four-weeks post installation) were collected following a heavy rainfall event that occurred between July 2, 2021, and July 4, 2021, which resulted in approximately 37.1 mm of precipitation (Environment and Climate Change Canada[2]). Typical normal precipitation amounts for Calgary over the entire month of July are approximately 66.6 mm.

2.0 MONITORING AND MEASUREMENT

2.1 General

The key objective of the installed instrumentation (SI and VWP) and visual observations is to sufficiently monitor slope movement and measure pore pressure responses throughout the Midfield project site's northern slope to assess its overall slope stability and to provide enough warning/time for slope stabilization/mitigation measures.

The locations of the installed instrumentation are provided on the attached Figure 1. The following subsections summarize the monitoring results completed to date.

2.2 Slope Inclinometer Summary

A summary of the horizontal displacements within the SI casings measured to date (N#1 through N#3 four-week) is provided in Table 2.

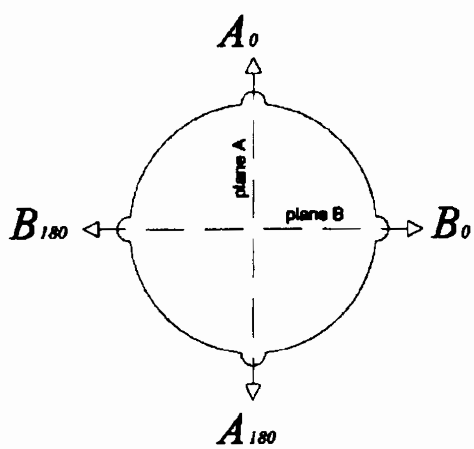
[2] Weather Dashboard for Calgary. 'Total Precipitation – Daily Data for Calgary on July 2 to 4, 2021'. Accessed July 5, 2021. https://calgary.weatherstats.ca/charts/precipitation-daily.html

Table 2: Slope Inclinometer Movement Summary to Date

SI Borehole No.	Analysis Section / Casing Diameter	SI Depth (m)	Movement*						
			Depth (m)	Elev. (m)	Soil Unit	Shear (mm)**		Total (mm)***	
						New	Cumulative	New	Cumulative
BH21-12	A / 85 mm	25.0	19.5	1056.4	Clay	-	-	-	<5
BH21-13	A / 85 mm	10.4	-	-	-	-	-	-	-
BH21-14	B1 / 85 mm	19.5	-	-	-	-	-	-	-
BH21-15	B2 / 85 mm	18.9	-	-	-	-	-	-	-
BH21-16	B2 / 85 mm	11.6	-	-	-	-	-	-	-
BH21-17	C1 / 70 mm	14.6	-	-	-	-	-	-	-
TP-2	C1 / 70 mm	15.9	-	-	-	-	-	-	-

Notes: * '-' indicates no notable movement is apparent at any specific depth.
** Shear movement is considered observable horizontal movement over a discrete plane.
*** Total movement is not considered until over 5 mm is observable (considered 'noise' <5 mm).

The SI casing displacement plots are attached in Appendix A for reference, which present two graphs for each SI casing location; this is a result of there being two 'sets' of grooves that control the orientation of the inclinometer probe reader. Attempts are made during installation to ensure one set of grooves is properly aligned with the direction of expected movement (i.e., downslope, typically A_0-A_{180}); however, shifts in the casing's orientation are typical prior to the grout completely curing. Therefore, both groove sets are read from the bottom of the SI casing to the top and should be reviewed in tandem for a comprehensive representation of the casing condition. Schematic 1 presents a top view of an SI casing depicting the general groove orientation.



Schematic 1: SI Casing Groove Orientation

Each SI casing displacement plot displays the A_0 direction in degrees relative to directly downslope (clockwise equalling a positive angle and counterclockwise equalling a negative angle). These 'skew' angle values range from approximately 2° (BH21-15) to 14° (BH21-17).

As presented in Appendix A, the N#3 (four-week) deflection plots dated July 5, 2021, are comparable to the previous N#2 (two-week) interval dated June 14, 2021. The deflection previously noted within BH21-12 from a depth range of approximately 18.0 m to 21.0 m (approximate El. 1054.9 m to El. 1057.9 m) had not noticeably increased from the total displacement magnitude of approximately 3 mm and is still below the considered 'noise' threshold (5 mm).

In addition, the displacement is within the B_0-B_{180} plane parallel with the slope crest as opposed to perpendicular (i.e., downslope). It is possible this displacement is at the backfill-native soil interface and a by-product of disturbing the area during the drilling and installation activities.

2.3 Vibrating Wire Piezometer Summary

A summary of the porewater pressure response calculated from the VWP measurements to date (N#1 through N#3 four-week) is provided in Table 3.

Table 3: Vibrating Wire Piezometer Pore Pressure Summary to Date

VWP Borehole No.	Analysis Section	VWP Tip Depth (m)	VWP Tip Elev. (m)	Soil Unit	Date	Measured Piezometric Elev. (m)	Water Pressure Head (m)	Calculated Bbar/r_u*
BH21-12	A (Crest)	15.2	1060.7	Clay	June 4, 2021	1061.2		
					June 14, 2021	1061.2	0.6	<0.1
					July 5, 2021	1061.3	0.6	<0.1
BH21-13	A (Toe)	9.1	1054.5	Clay	June 4, 2021	1054.5		
					June 14, 2021	<1054.5	<0.1	<0.1
					July 5, 2021	<1054.5	<0.1	<0.1
BH21-14	B1 (Crest)	13.7	1061.7	Clay	June 4, 2021	1061.8		
					June 14, 2021	1061.8	0.1	<0.1
					July 5, 2021	1061.8	0.1	<0.1
BH21-15	B2 (Crest)	13.7	1061.5	Clay	June 4, 2021	1061.5		
					June 14, 2021	<1061.5	<0.1	<0.1
					July 5, 2021	1061.5	<0.1	<0.1
BH21-16	B2 (Toe)	11.6	1052.9	Sand	June 4, 2021	1052.9		
					June 14, 2021	<1052.9	<0.1	<0.1
					July 5, 2021	<1052.9	<0.1	<0.1
BH21-17	C1 (Mid)	14.6	1045.2	Clay	June 4, 2021	1045.3		
					June 14, 2021	<1045.2	<0.1	<0.1
					July 5, 2021	<1045.2	<0.1	<0.1

Note: * Water pressure head and Bbar/r_u not calculated during N#1 (one-week interval); all current (as of July 5, 2021) Bbar/r_u calculated pressures are under 0.1.

All piezometric elevations were comparable to the previous readings and were near or below the VWP tip installation elevation except for BH21-12, which still exhibited a water pressure head of approximately 0.6 m. The resulting calculated Bbar/r_u groundwater pressure parameters were all still below a value of 0.1 typically used in stability analyses for fill (based on Tetra Tech experience of similar materials in similar conditions). The water pressure heads also do not suggest significant elevated porewater conditions within potential native soils at the tip elevation.

2.4 Visual Observations

During the collection of the instrumentation data, the slope and general project area (inclusive of the erosion and sediment control berm [ESCB]) were also visually observed for any potential signs of movement along the existing ground surface (e.g., slumping, cracking, settlements).

Following the heavy rainfall event, Mr. Sean Kim, P.Tech.(Eng.), of The City, observed the condition of the ESCB on July 3, 2021. Mr. Kim stated there was a decent amount of ponded water but no observable issues with the berm or signs of surface water flowing over the pathway.

During the collection of the instrumentation data on July 5, 2021, Tetra Tech observed ponded water within the ESCB approximately at 0.3 m from the berm crest. Photograph 1 depicts the condition of the ESCB at the time of Tetra Tech's field visit.

<u>Photograph 1:</u> ESCB Condition on July 5, 2021

Overall, the ESCB appeared to be functioning properly and contained any potential surface water runoff from further eroding the June 2020 surficial slope failure area over the N#3 monitoring interval.

Visual observations of the general project area slope at the existing ground surface presented no indicator of immediate potential slope movement or failure as supported by the lack of slumping, cracking, or new depressions.

3.0 INTERIM PRELIMINARY SLOPE STABILITY ANALYSIS RESULTS

3.1 General

The key objective of the interim preliminary slope stability analyses was to verify that the previously provided setback distances still satisfy the 1.5 factor of safety requirement at a minimum (refer to 'Geo Eval').

The interim preliminary slope stability analyses were conducted using the *Slope/W* component of the *GeoStudio* computer program (Version 11.2.0). The overall slope stability analysis configurations, stratigraphy, material parameters, piezometric elevations, and surcharge loads were as per the original analyses provided in the 'Geo Eval' except for the general adjustments discussed in Section 3.2.

The results of the interim slope stability analyses presented in the following subsections are preliminary in nature and may not be identical to the ultimate results provided in the M#4 *Final Geotechnical Report* deliverable; however, they may still be relied upon for the intent of setback distance approvals until the issuance of the M#4, as well as corroborated through favourable instrumentation monitoring data.

The original analysis provided within the 'Geo Eval' for Section C-C' (refer to Figure 1) should take precedence as no additional information was gathered in close enough proximity to warrant an update (nearest Borehole BH21-17 advanced at a 120 m offset).

The toe berm design slope stability analyses and subsequent construction previously completed by Geo-Engineering (M.S.T.) Ltd. for the '1998 Slope Failure' area (Geo-Engineering[3,4]) should take precedence until instrumentation monitoring data evaluation is complete

3.2 Analysis Section Adjustments

The general updates made to the analysis sections based on the additional subsurface and monitoring data, for the purpose of setback distance approval, include the following:

- Section A-A':
  - Updated existing ground surface profile based on LiDAR provided by The City (previously improperly reduced).
  - Reduced fill material depth (shifted from approximately El. 1060.0 m to 1061.5 m).
  - Increased native clay friction angle (phi) based on advanced direct shear testing results from 15° to 25° and inclusion of a 2.5 kPa cohesion. The lack of horizontal displacements within the installed SIs suggests potential peak native soil strengths; however, instrumentation data is currently limited, and thus analyses were also conducted assuming residual strength (as per 'Geo Eval') in the event future displacements are measured.
  - Increased native clay thickness from approximately 2.0 m to 7.0 m resulting in greater depth to silt till material from approximate El. 1058.0 m to El. 1054.5 m.
  - Included native clay till unit with a thickness of approximately 3.5 m between the fill materials and native clay based on observation made during fieldwork at section toe Borehole BH21-13.
  - Revised the silt till cohesion parameter (originally 0 kPa) based on direct shear test results on a Shelby Tube sample taken within the unit.
- Section B1-B1':
  - Relabelled from Section B-B' to Section B1-B1' given the additional analysis section along the June 2020 slope failure (designated Section B2-B2').
  - Increased the thickness of the clay till unit from approximately 1.5 m to 5.0 m thereby reducing the thickness of the underlying clay from approximately 7.0 m to 2.0 m. Clay material parameters were also modified as per analysis Section A-A'.
  - Raised the elevation of the silt till from approximately El. 1059.0 m to El. 1061.0 m.
  - Included a sand unit underlying the silt till at an elevation of approximately El. 1058.0 m with a friction angle (phi) of 28° and a cohesion of 0 kPa.

[3] Geo-Engineering (M.S.T.) Ltd. 2006. *Midfield Mobile Home Park, Slope Stability Evaluation*. File No. G4058, dated December 6, 2006.

[4] Geo-Engineering (M.S.T.) Ltd. 2007. Issued for Construction Drawing Package Titled *Slope Stability Construction, IFC Drawings*. Drawing Nos. 4267-1 through 4267-4, dated January 26, 2007.

- Section B2-B2' (Section B1-B1' used as a base):
  - Updated existing ground surface profile based on survey collected by The City following the June 2020 failure and provided via email on July 7, 2021.
  - Increased the thickness of the clay till unit from approximately 1.5 m to 5.5 m and removed the previous underlying clay unit while shifting the silt till from approximately El. 1059.0 m to 1061.5 m with a thickness of approximately 1.5 m.
  - Included a sand unit underlying the silt till at an elevation of approximately El. 1060.0 m with a friction angle (phi) of 28° and a cohesion of 0 kPa.

3.3 Interim Slope Stability Analysis Results

A summary of the interim preliminary slope stability analysis results together with the original analysis results is presented in Table 4. Figure excerpts of the typical critical slip surface failure paths for each analyzed section are provided in Appendix B for reference.

Table 4: Interim Preliminary Slope Stability Analysis Results

Cross-Section	Surcharge Load Condition (1.4 m below exiting ground surface)	Factor of Safety		Minimum Setback Distance from North Property Line (m)	
		As per Original Analysis*	As per Updated Interim Analysis**	As per Original Analysis*	As per Updated Interim Analysis**
A-A'	100 kPa	> 1.5	> 1.5	25	25
	200 kPa	> 1.5	> 1.5	40	40
B1-B1' (B-B')	100 kPa	> 1.5	> 1.5	30	30
	200 kPa	> 1.5	> 1.5	55	55
B2-B2'	100 kPa	-	> 1.5	-	30
	200 kPa	> 1.5	> 1.5	-	55

Notes: * Original analysis as detailed in the Tetra Tech 'Geo Eval' report.
** The lack of horizontal displacements within the installed SIs suggest potential peak native soil strengths; however, instrumentation data is currently limited, and thus analyses were also conducted assuming residual strength (as per 'Geo Eval') for the clay unit in the event future displacements are measured, which also resulted in a Factor of Safety >1.5.

4.0 COMMENTARY

In general, the Milestone No. N#3 four-week monitoring interval results and interim preliminary slope stability analyses suggest the following:

- The SI monitoring measurement results for the four-week interval are comparable to the two-week interval; accordingly, there is no immediate concern to overall slope stability. The cumulative displacement previously measured within BH21-12 had not propagated further as it remained at approximately 3 mm.
- The VWP calculated Bbar/r_u groundwater pressure parameters are all below a value of 0.1 typically used in stability analyses for fill (inclusive of the analyses presented herein). The water pressure heads also do not currently suggest significant elevated porewater conditions within potential native soils at the tip elevation.

- The ESCB appeared to be functioning properly and contained any potential surface water runoff from further eroding the June 2020 surficial slope failure area over the N#3 monitoring interval.
- There was no immediate sign of potential slope failure at the existing ground surface as supported by the lack of visually observed movement along the slope crest or at the mid/toe of slope instrumentation locations (e.g., slumping, cracking, settlements).
- The interim preliminary slope stability analyses incorporated the additional subsurface information collected during the instrumentation installation program as well as considered the instrument measurements collected to date. In general, the calculated slope stability factors of safety indicated that the previously designated setback distances are considered valid at the time of this report's preparation (refer to Table 4). Note that these results are preliminary in nature and may not be identical to the ultimate results provided in the M#4 *Final Geotechnical Report* deliverable. The setback distances will be further confirmed within the M#4 deliverable as well as validated through the ongoing regular slope monitoring program intervals. Additional analyses would also be necessary if the instrumentation started displaying adverse conditions.

The above will be further developed following the measurements taken as part of the Milestone No. N#4 three-month monitoring interval.

5.0 LIMITATIONS OF TECHNICAL MEMO

This report has been prepared for The City of Calgary and their agents. The City of Calgary shall at all times be entitled to fully use and rely on this report, including all attachments, drawings, and schedules, for the specific purpose for which the report was prepared, in each case notwithstanding any provision, disclaimer, or waiver in the report that reliance is not permitted.

The City of Calgary shall at all times be entitled to provide copies of the report to City Council, City of Calgary regulatory boards, City of Calgary employees, officers, agents, affiliates, advisors, consultants, parties contracting with The City of Calgary, lenders and assignees and other governmental authorities and regulatory bodies having jurisdiction, each of whom shall also be similarly entitled to fully use and rely on the report in the same manner and to the same extent as The City of Calgary for the specific purpose for which the report was prepared.

6.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

2021-08-10

Prepared by:
Kyle Haugrud, P.Eng.
Geotechnical Engineer
Engineering Practice
Direct Line: 403.723.1618
kyle.haugrud@tetratech.com

Reviewed by:
Joseph Yonan, Ph.D., P.Eng.
Principal Consultant
Engineering Practice
Direct Line: 403.723.6885
joseph.yonan@tetratech.com

/blw

Attachments: Figure 1 – Instrument Installation Locations
Appendix A – Slope Inclinometer Measurements
Appendix B – Interim Preliminary Slope Stability Analysis Results

PERMIT TO PRACTICE
TETRA TECH CANADA INC.

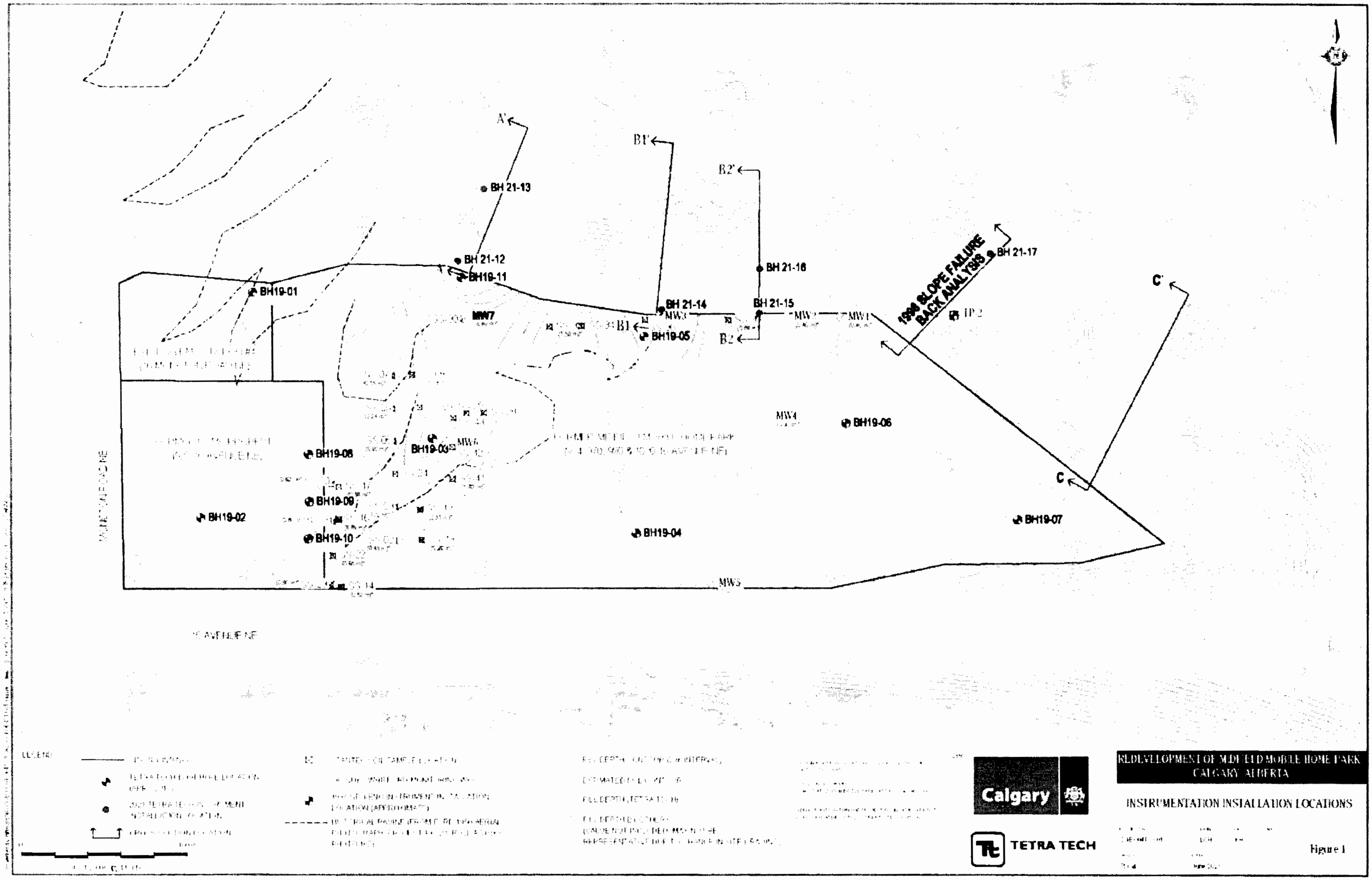
RM SIGNATURE: ____________

RM APEGA ID #: 74722

DATE: August 10 2021

PERMIT NUMBER: P013774
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

FIGURES


A'
B1'
B2'
BH 21-13
BH 21-12
BH19-11
BH19-01
1998 SLOPE FAILURE
BACK ANALYSIS
BH 21-17
C'
BH 21-16
BH 21-14
BH 21-15
MW3
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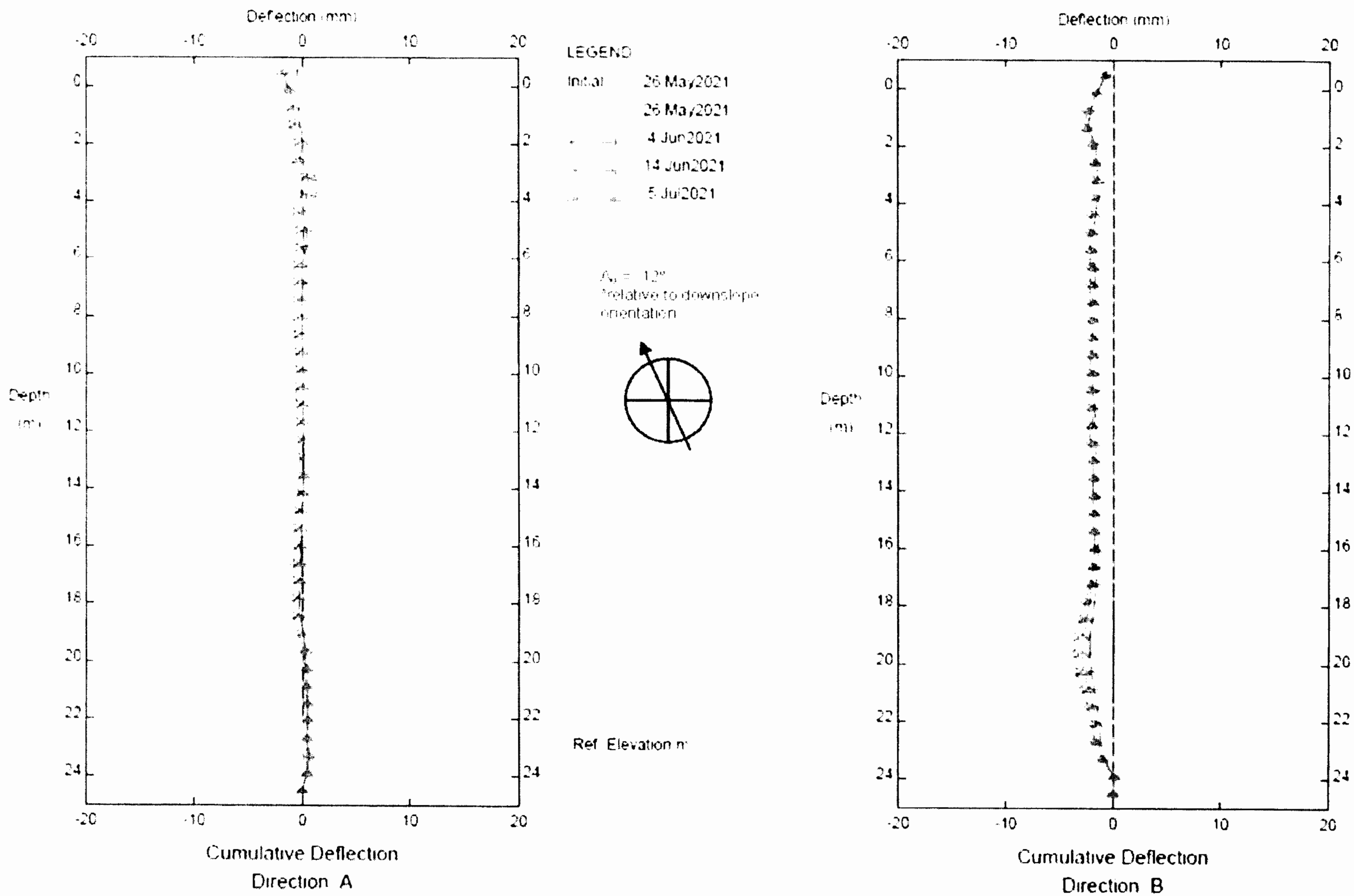
INSTRUMENTATION INSTALLATION LOCATIONS
Figure 1

APPENDIX A
SLOPE INCLINOMETER MEASUREMENTS



Midfield Heights, Inclinometer BH21-12

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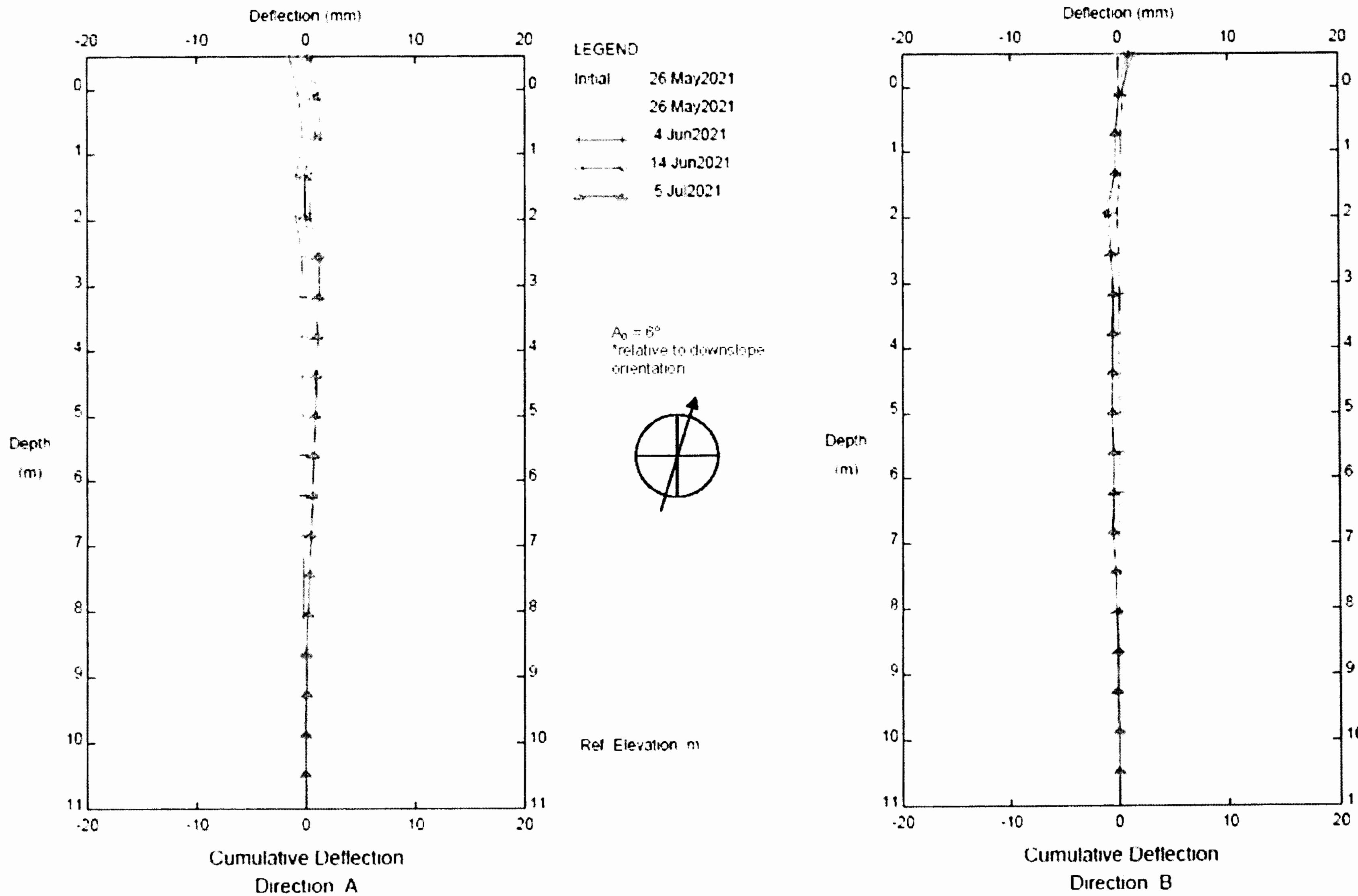
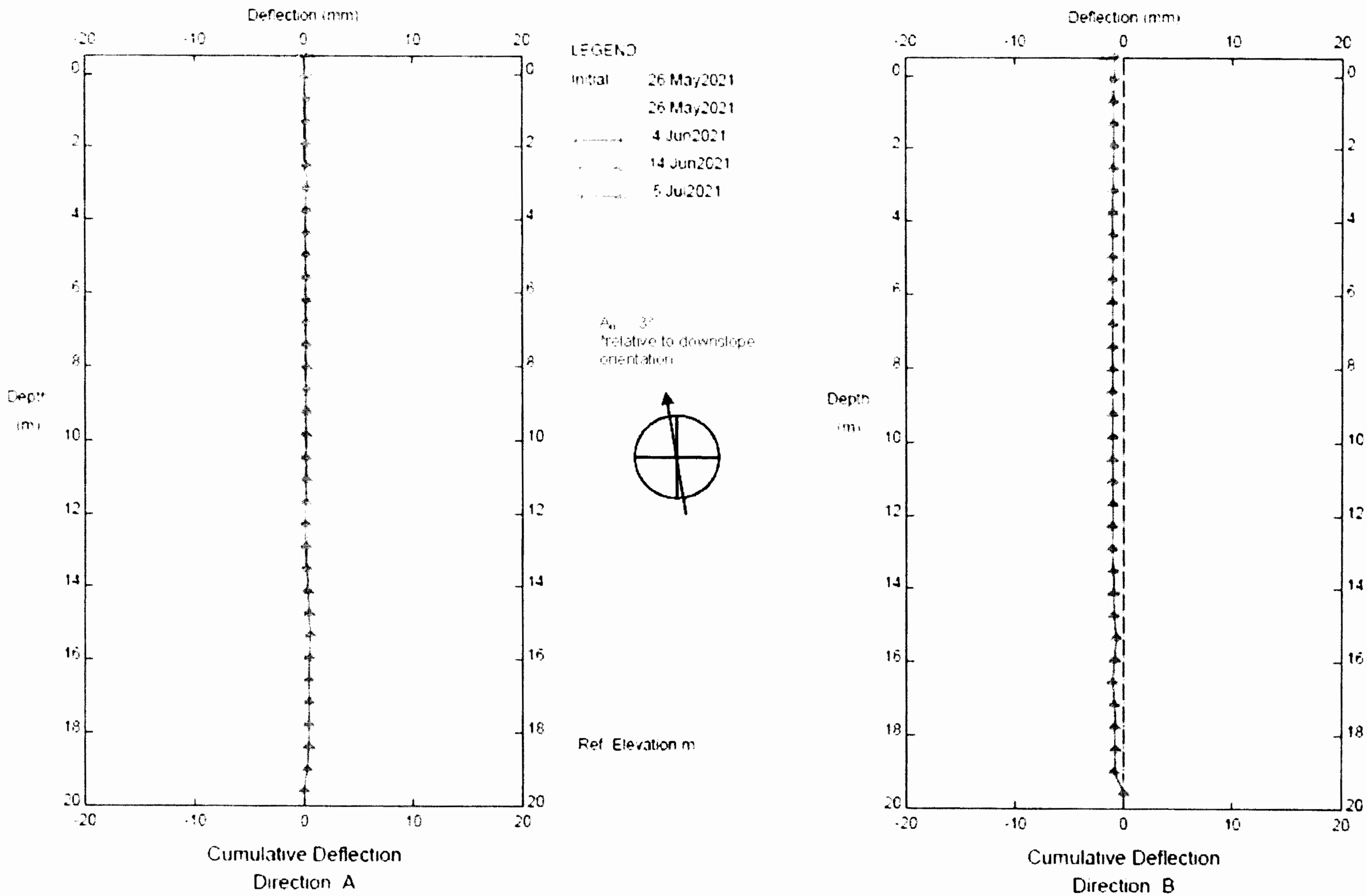


Midfield Heights, Inclinometer BH21-13



Midfield Heights, Inclinometer BH21-14

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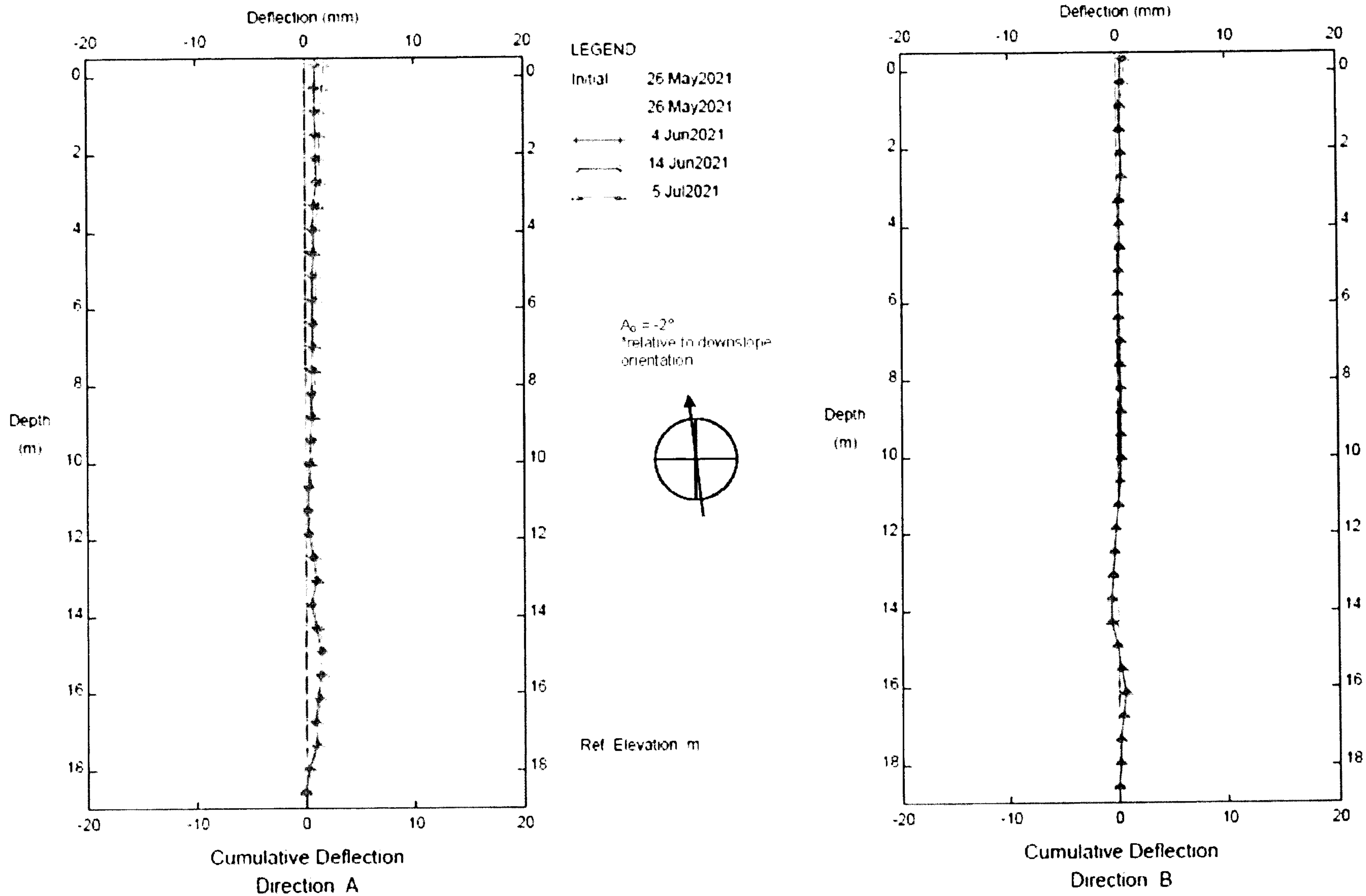
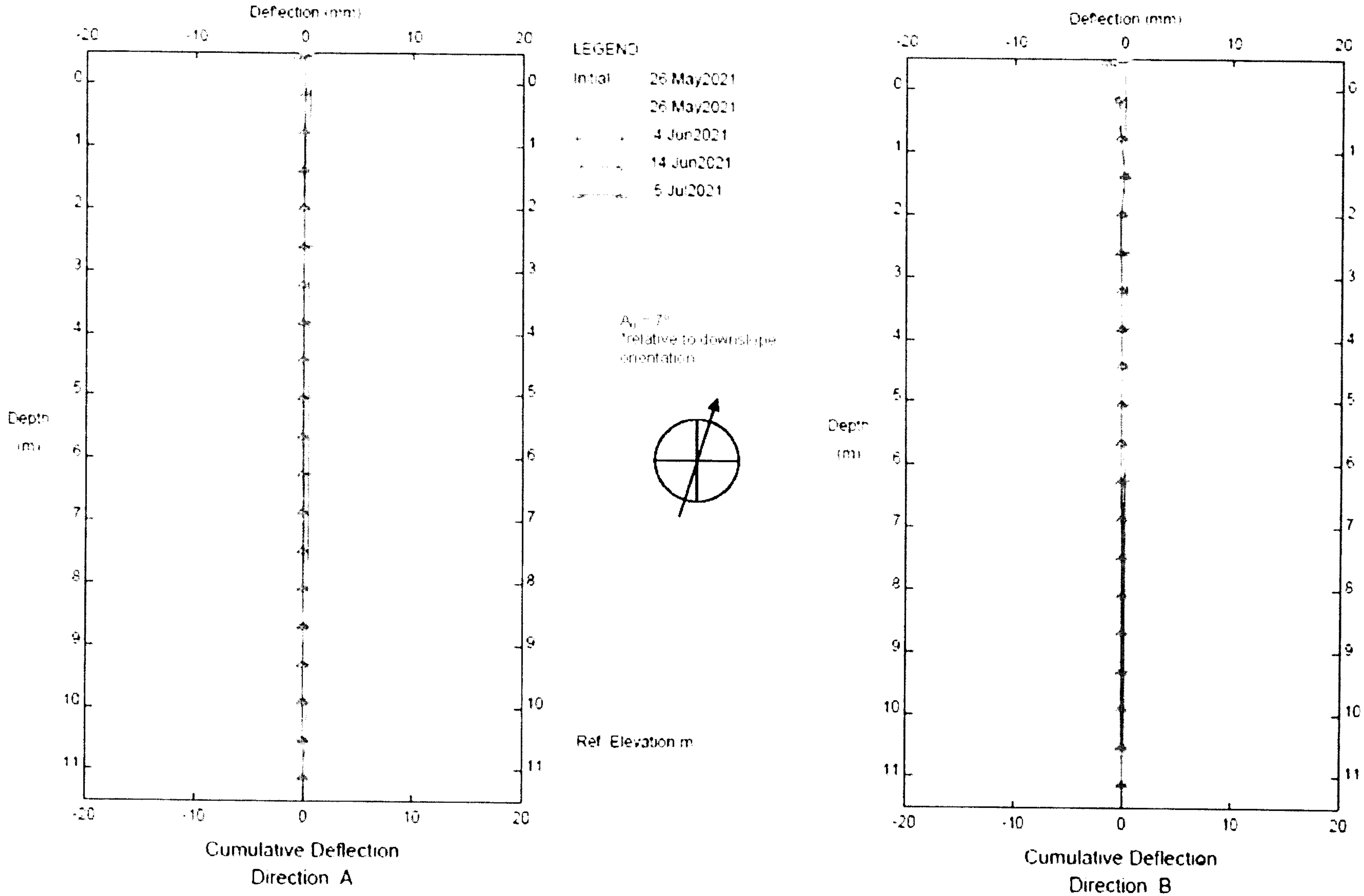


Midfield Heights, Inclinometer BH21-15



Midfield Heights, Inclinometer BH21-16

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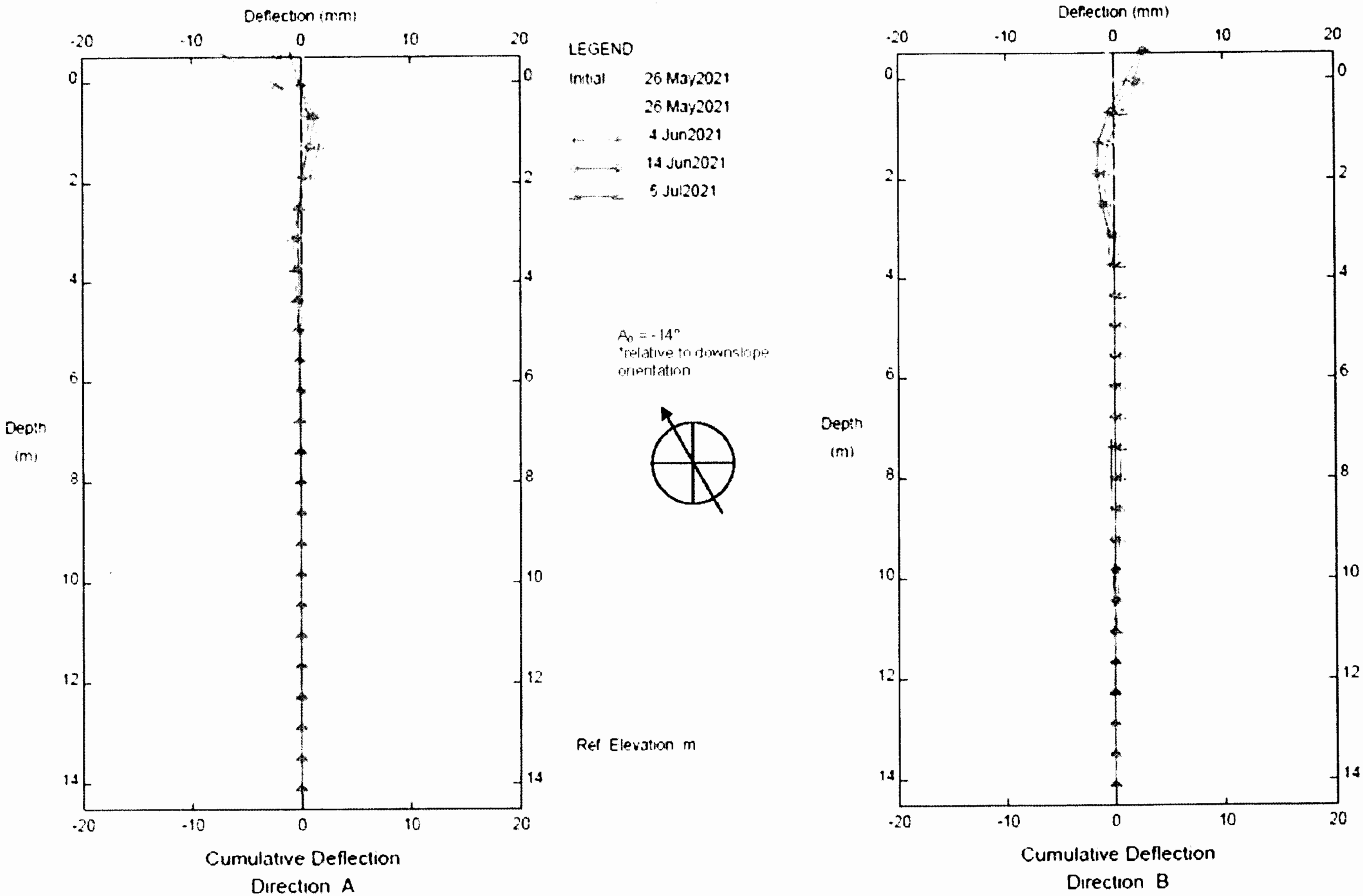
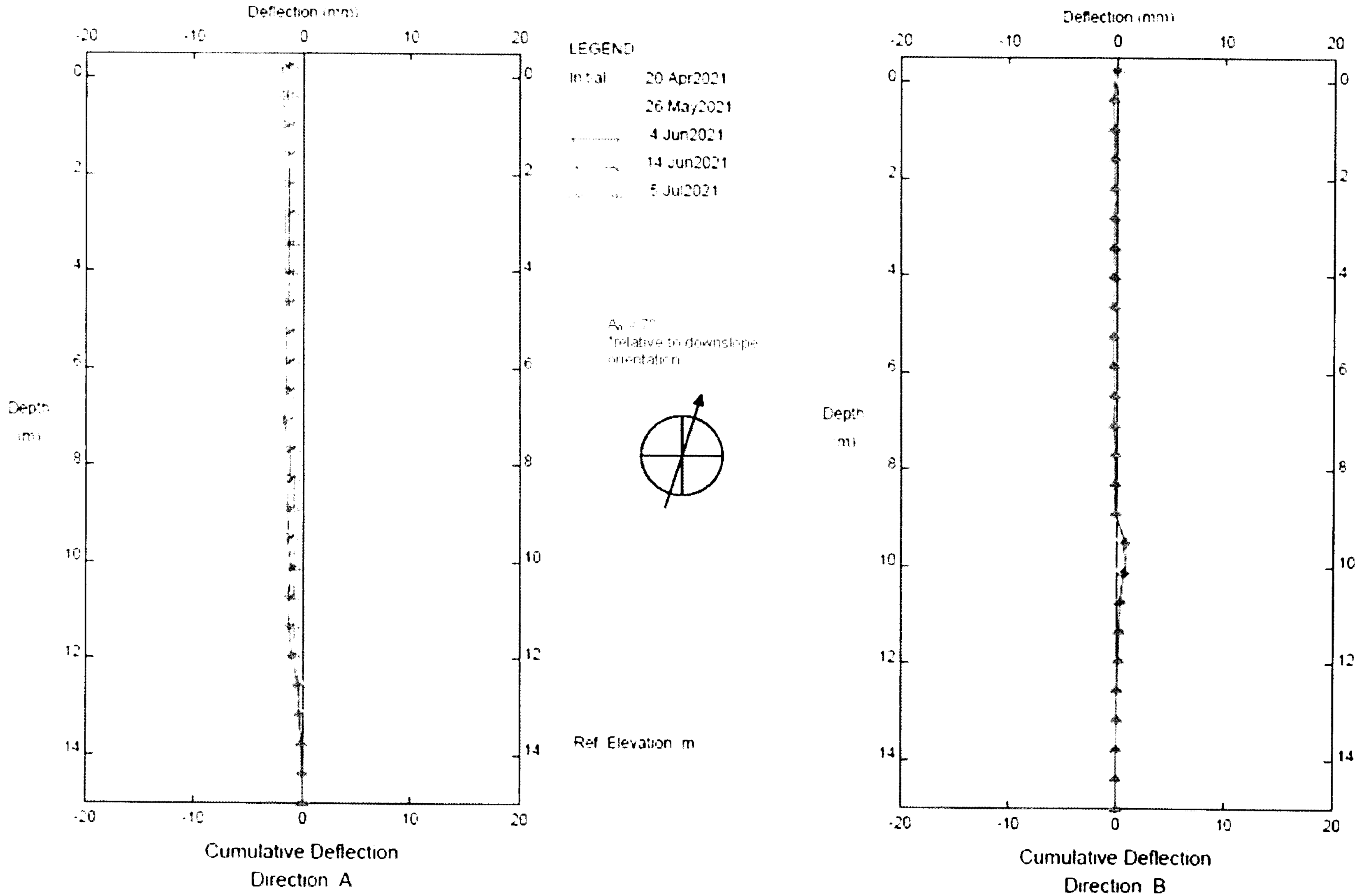


Midfield Heights, Inclinometer BH21-17



Midfield Heights, Inclinometer TP-2

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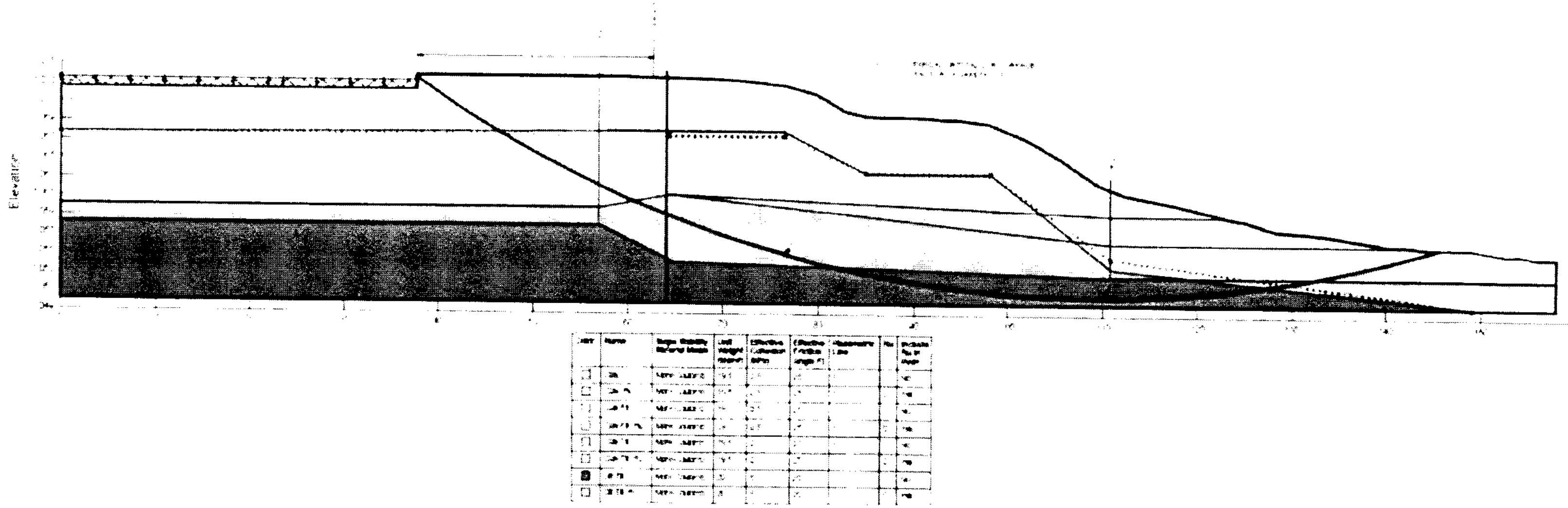
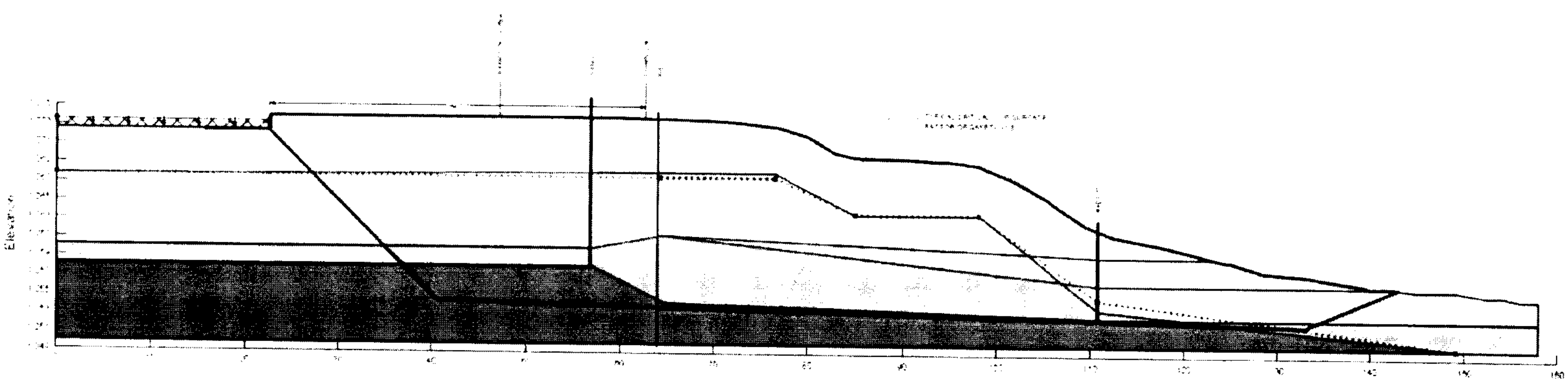
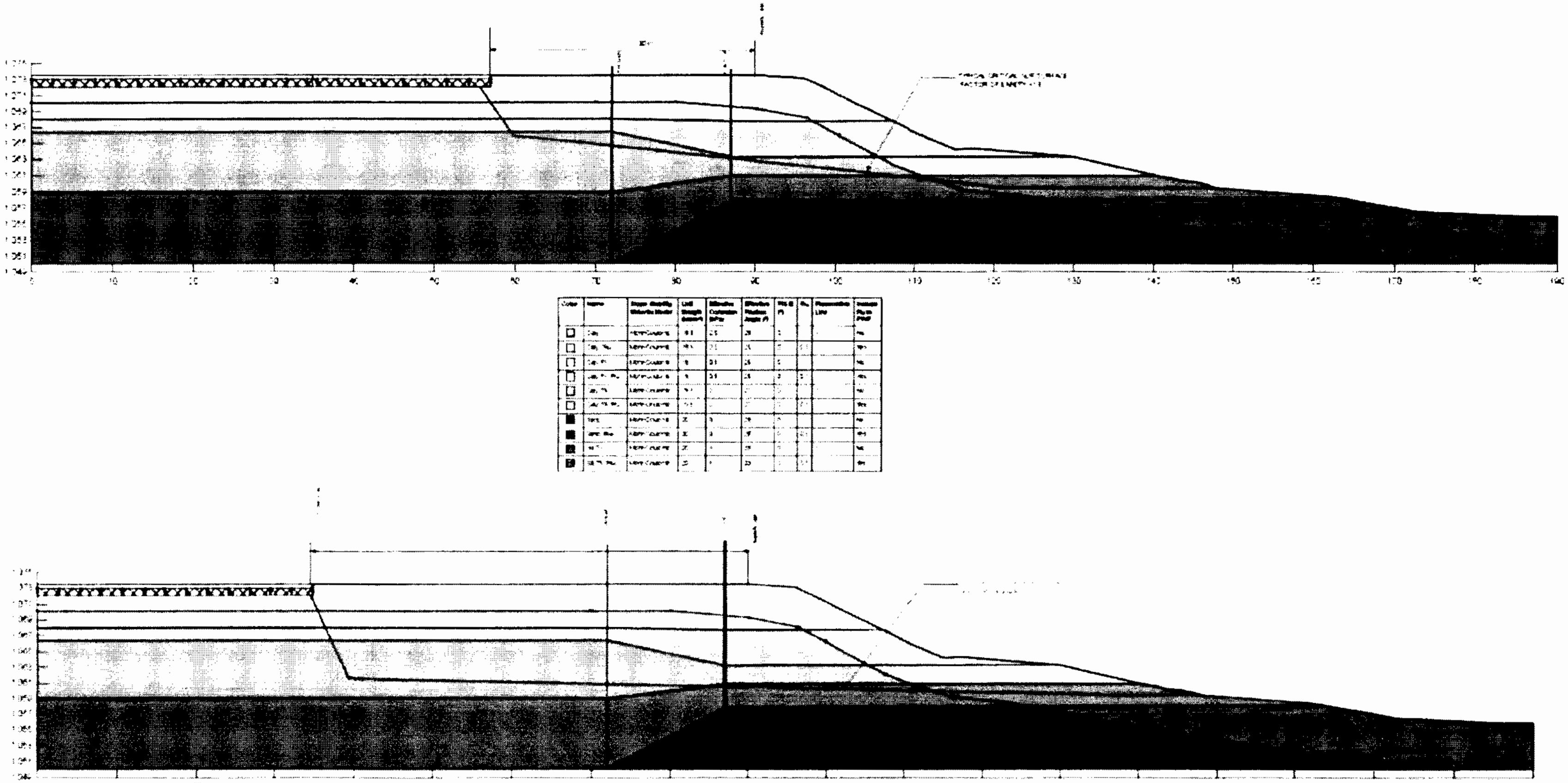
APPENDIX B
INTERIM PRELIMINARY SLOPE STABILITY ANALYSIS RESULTS





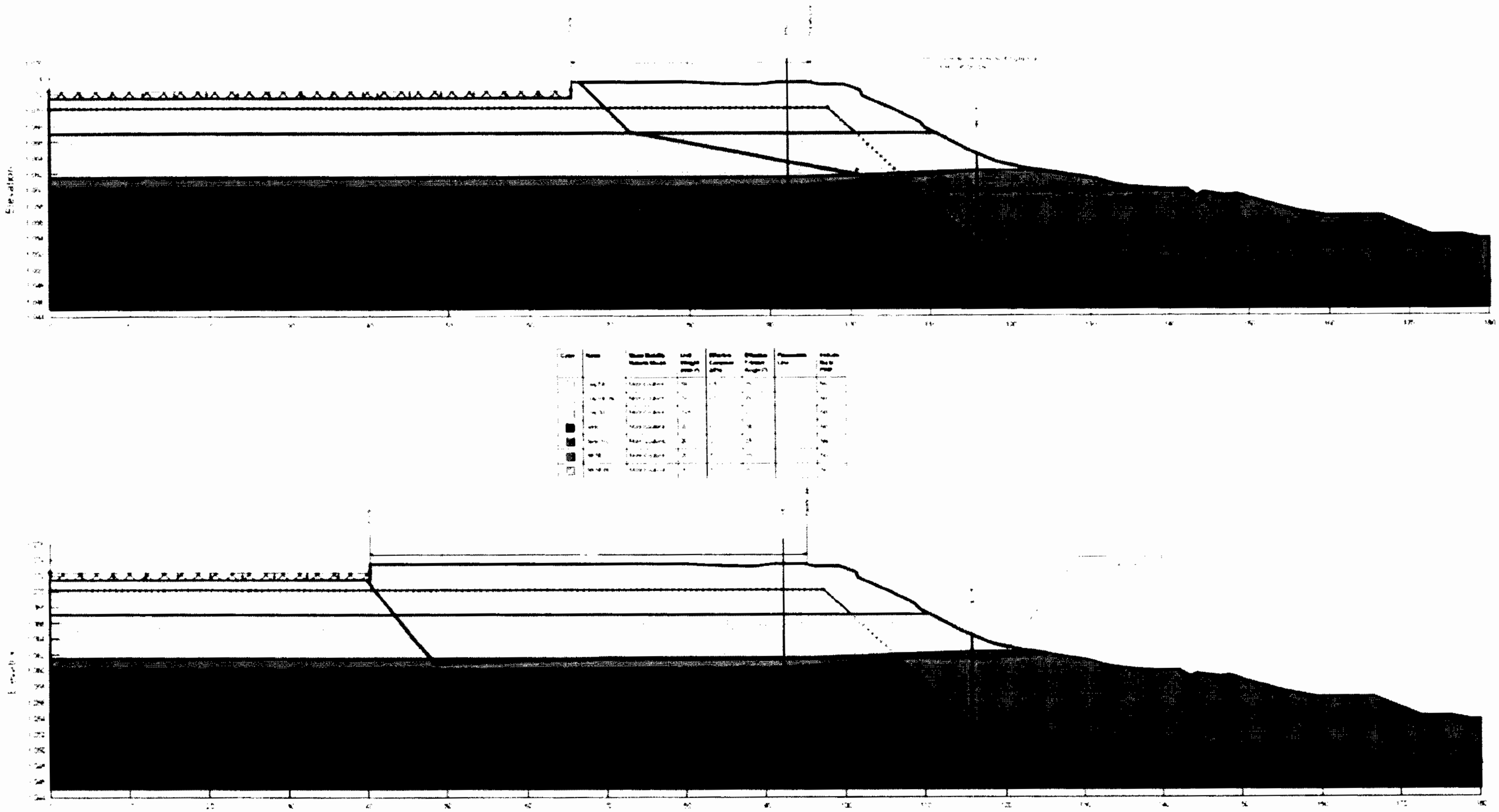
Schematic B-1: Section A-A' (100 kPa and 200 kPa)

TETRA TECH



Schematic B-2: Section B1-B1' (100 kPa and 200 kPa)

TETRA TECH



Schematic B-3: Section B2-B2' (100 kPa and 200 kPa)

TETRA TECH

TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE. CONFIDENTIAL

To:	Malcolm Dort, P.Eng., LEED AP (The City of Calgary)	**Date:**	September 15, 2021
From:	Kyle Haugrud, P.Eng. Joseph Yonan, Ph.D., P.Eng.	**Memo No:**	N#4
		File:	704-ENG.CGEO04110-01
Subject:	Regular Slope Monitoring Program Milestone N#4: Three-Month Interval – August 21, 2021 Redevelopment of Midfield Mobile Home Park Calgary, Alberta		

1.0 INTRODUCTION

This technical memo summarizes the results of the instrumentation measurements (Slope Inclinometers [SI] and Vibrating Wire Piezometers [VWP]) and visual observations conducted by Tetra Tech Canada Inc. (Tetra Tech) as part of the regular slope monitoring program for the Redevelopment of Midfield Mobile Home Park project for The City of Calgary (The City). The project is located northeast of the 16 Avenue NE and Moncton Road NE intersection in northeast Calgary, Alberta.

The details of the SI and VWP installations as well as updated stability analyses will be provided within the Milestone No. M#4 *Final Geotechnical Report*, which was in progress at the time of this technical memo's preparation.

At the request of The City, an interim preliminary slope stability assessment for the instrumentation section lines was conducted to verify that the setback distances initially provided still satisfied the required 1.5 factor of safety based on the supplementary subsurface information and instrumentation monitoring data collected. The results of the interim preliminary slope stability analyses were provided within the Milestone No. N#3 technical memo (four-week interval), which considered instrument measurements up to July 5, 2021 (Tetra Tech[1]). The results of this regular monitoring interval as they pertain to the interim slope stability analyses is further discussed in Section 3.0.

This technical memo represents the Milestone No. N#4 deliverable (three-month post-installation interval) as part of extension five of The City's Scope and Fee Schedule No. 18-2006-A05-S01-05 dated April 15, 2021. This is the fourth monitoring interval of the currently proposed six monitoring intervals, with the following remaining: six-month interval and one-year interval. Table 1 summarizes the monitoring intervals as completed to date. Note that if instrumentation results suggest adverse conditions, additional monitoring intervals may be required.

[1] Tetra Tech Canada Inc. 2021. ***Regular Slope Monitoring Program and Interim Preliminary Slope Stability Analysis, Milestone N#3: Four-Week Interval – July 5, 2021, Redevelopment of Midfield Mobile Home Park, Calgary, Alberta.*** File No. 704-ENG.CGEO04110-01, dated August 10, 2021.

Tetra Tech Canada Inc.
Suite 110, 140 Quarry Park Blvd SE
Calgary, AB T2C 3G3 CANADA
Tel 403.203.3355 Fax 403.203.3301

Table 1: Instrumentation Regular Monitoring Summary

Instrument Borehole Number	SI Initialization Date	No. N#1 One-Week Date	No. N#2 Two-Week Date	No. N#3 Four-Week Date	No. N#4 Three-Month Date	No. N#5 Six-Month Date**	No. N#6 One-Year Date**
BH21-12	May 26, 2021	June 4, 2021	June 14, 2021	July 5, 2021	August 21, 2021		
BH21-13							
BH21-14							
BH21-15							
BH21-16							
BH21-17							
TP-2*	April 20, 2021						

Notes: * Borehole TP-2 was installed under the direction of Geo-Engineering (M.S.T.) Ltd. on November 26, 1998. Previous displacement data was not available, and the instrument was re-initialized on April 20, 2021. ** Greyed-out cells represent proposed future monitoring intervals yet to be completed.

2.0 MONITORING AND MEASUREMENT

2.1 General

The key objective of the installed instrumentation (SI and VWP) and visual observations is to sufficiently monitor slope movement and measure pore pressure responses throughout the Midfield project site's northern slope to assess its overall slope stability and to provide enough warning/time for potential slope stabilization/mitigation measures to be employed.

The locations of the installed instrumentation are provided on the attached Figure 1. The following subsections summarize the monitoring results completed to date.

2.2 Slope Inclinometer Summary

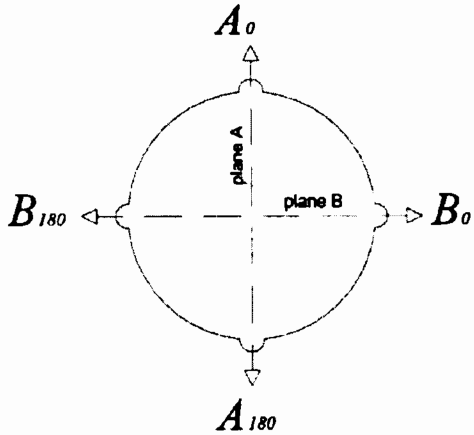
A summary of the horizontal displacements within the SI casings measured to date (N#1 through N#4 three-month) is provided in Table 2.

Table 2: Slope Inclinometer Movement Summary to Date

SI Borehole No.	Analysis Section / Casing Diameter	SI Depth (m)	Movement*						
			Depth (m)	Elev. (m)	Soil Unit	Shear (mm)**		Total (mm)***	
						New	Cumulative	New	Cumulative
BH21-12	A / 85 mm	25.0	19.5	1056.4	Clay	-	-	1	5
			3.5	1072.4	Fill	-	-	1	<5
BH21-13	A / 85 mm	10.4	-	-	-	-	-	-	-
BH21-14	B1 / 85 mm	19.5	-	-	-	-	-	-	-
BH21-15	B2 / 85 mm	18.9	-	-	-	-	-	-	-
BH21-16	B2 / 85 mm	11.6	-	-	-	-	-	-	-
BH21-17	C1 / 70 mm	14.6	-	-	-	-	-	-	-
TP-2	C1 / 70 mm	15.9	-	-	-	-	-	-	-

Notes: * '-' indicates no notable movement is apparent at any specific depth. ** Shear movement is considered observable horizontal movement over a discrete plane. *** Total movement is not considered until over 5 mm is observable (considered 'noise' <5 mm).

The SI casing displacement plots are attached in Appendix A for reference, which present two graphs for each SI casing location; this is a result of there being two 'sets' of grooves that control the orientation of the inclinometer probe reader. Attempts are made during installation to ensure one set of grooves is properly aligned with the direction of expected movement (i.e., downslope, typically A_0-A_{180}); however, shifts in the casing's orientation are typical prior to the grout completely curing. Therefore, both groove sets are read from the bottom of the SI casing to the top and should be reviewed in tandem for a comprehensive representation of the casing condition. Schematic 1 presents a top view of an SI casing depicting the general groove orientation.



<u>Schematic 1:</u> SI Casing Groove Orientation

Each SI casing displacement plot displays the A_0 direction in degrees relative to directly downslope (clockwise equalling a positive angle and counter-clockwise equalling a negative angle). These 'skew' angle values range from approximately 2° (BH21-15) to 14° (BH21-17).

As presented in Appendix A, the N#4 (three-month) deflection plots dated August 21, 2021, are comparable to the previous N#3 (four-week) interval dated July 5, 2021, except for Borehole BH21-12. The deflection previously noted within Borehole BH21-12 from a depth range of approximately 18.0 m to 21.0 m (approximate El. 1054.9 m to El. 1057.9 m) had a slight measurable increase in displacement to a total magnitude of approximately 5 mm, which is equivalent to the considered 'noise' threshold (5 mm). However, the displacement is within the B_0-B_{180} plane parallel with the slope crest as opposed to perpendicular (i.e., downslope). It is possible this displacement is near the backfill-native soil interface and a by-product of disturbing the area during the drilling/installation activities or may also be a potential groundwater drainage path. Additionally, cumulative displacement has become discernible at a depth range of approximately 2.5 m to 4.5 m (approximate El. 1073.4 m to El. 1071.4 m) within the fill materials. Although this displacement is within the 'noise' threshold, it should be noted and have increased attention during future readings. Whether these displacements within Borehole BH21-12 will continue to propagate or not will become more apparent during the next monitoring N#5 six-month interval.

Borehole BH21-17 also appears to have propagating deflections over the previous few monitoring intervals; however, this movement is at/directly underlying the existing ground surface and is potentially an outcome of not being entirely rigid following installation and/or tampering from the public given its proximity to a trail. The measured deflection near the topsoil/fill interface (approximately 0.2 m depth) is still within the 'noise' threshold (5 mm).

2.3 Vibrating Wire Piezometer Summary

A summary of the porewater pressure response calculated from the VWP measurements to date (N#1 through N#4 three-month) is provided in Table 3.

Table 3: Vibrating Wire Piezometer Pore Pressure Summary to Date

VWP Borehole No.	Analysis Section	VWP Tip Depth (m)	VWP Tip Elev. (m)	Soil Unit	Date	Measured Piezometric Elev. (m)	Water Pressure Head (m)	Calculated Bbar/r_u*
BH21-12	A (Crest)	15.2	1060.7	Clay	June 4, 2021	1061.2		
					June 14, 2021	1061.2	0.6	<0.1
					July 5, 2021	1061.3	0.6	<0.1
					August 21, 2021	1061.2	0.6	<0.1
BH21-13	A (Toe)	9.1	1054.5	Clay	June 4, 2021	1054.5		
					June 14, 2021	<1054.5	<0.1	<0.1
					July 5, 2021	<1054.5	<0.1	<0.1
					August 21, 2021	<1054.5	<0.1	<0.1
BH21-14	B1 (Crest)	13.7	1061.7	Clay	June 4, 2021	1061.8		
					June 14, 2021	1061.8	0.1	<0.1
					July 5, 2021	1061.8	0.1	<0.1
					August 21, 2021	1061.8	<0.1	<0.1
BH21-15	B2 (Crest)	13.7	1061.5	Clay	June 4, 2021	1061.5		
					June 14, 2021	<1061.5	<0.1	<0.1
					July 5, 2021	1061.5	<0.1	<0.1
					August 21, 2021	1061.6	0.1	<0.1
BH21-16	B2 (Toe)	11.6	1052.9	Sand	June 4, 2021	1052.9		
					June 14, 2021	<1052.9	<0.1	<0.1
					July 5, 2021	<1052.9	<0.1	<0.1
					August 21, 2021	<1052.9	<0.1	<0.1
BH21-17	C1 (Mid)	14.6	1045.2	Clay	June 4, 2021	1045.3		
					June 14, 2021	<1045.2	<0.1	<0.1
					July 5, 2021	<1045.2	<0.1	<0.1
					August 21, 2021	<1045.2	<0.1	<0.1

Note: * Water pressure head and Bbar/r_u not calculated during N#1 (one-week interval); all current (as of August 21, 2021) Bbar/r_u calculated pressures are under 0.1.

All piezometric elevations were comparable to the previous readings and were near or below the VWP tip installation elevation except for Borehole BH21-12, which still exhibited a water pressure head of approximately 0.6 m. The resulting calculated Bbar/r_u groundwater pressure parameters were all still below a value of 0.1 typically used in stability analyses for fill (based on Tetra Tech's experience with similar materials in similar conditions). The water pressure heads also do not suggest significant elevated porewater conditions within potential native soils at the tip elevation.

2.4 Visual Observations

During the collection of the instrumentation data, the slope and general project area (inclusive of the erosion and sediment control berm [ESCB]) were also visually observed for any potential signs of movement along the existing ground surface (e.g., slumping, cracking, settlements).

During the collection of the instrumentation data on August 21, 2021, Tetra Tech observed ponded water within the ESCB ditches at depths of approximately 0.2 m. Photograph 1 depicts the condition of the ESCB at the time of Tetra Tech's field visit.

Photograph 1: ESCB Condition on August 21, 2021

Overall, the ESCB appeared to be functioning properly and contained any potential surface water runoff from further eroding the June 2020 surficial slope failure area over the N#4 monitoring interval.

Visual observations of the general project area slope at the existing ground surface presented no indicator of immediate potential slope movement or failure as supported by the lack of slumping, cracking, or new depressions. Photograph 2 depicts the condition of the slope crest along the area of the June 2020 surficial slope failure at the time of Tetra Tech's field visit. Note that the observable cracks within the asphalt bike path were present prior to the instrumentation installation fieldwork program and the cracks have not noticeably increased in size over the regular monitoring period to date.

Photograph 2: Slope Crest Condition on August 21, 2021

3.0 COMMENTARY

In general, the Milestone No. N#4 three-month monitoring interval results suggest the following:

- The SI monitoring measurement results for the three-month interval are comparable to the four-week interval; accordingly, there is no immediate concern to overall slope stability. The cumulative displacement previously measured within Borehole BH21-12 had a slight increase to an overall approximate movement of 5 mm parallel to the slope crest direction as well as a further minimal displacement at an approximate average depth of 3.5 m (<5 mm). Additionally, the measured displacement at the top of Borehole BH21-17 is largely within/above the topsoil material and is likely caused by overland disturbance as opposed to subsurface movements. All displacements discussed should be further reviewed during the next monitoring interval.
- The VWP calculated Bbar/r_u groundwater pressure parameters are all below a value of 0.1 typically used in stability analyses for fill (inclusive of the analyses presented herein). The water pressure heads also do not currently suggest significant elevated porewater conditions within potential native soils at the tip elevation.
- The instrumentation monitoring results over the N#4 (three-month) interval do not constitute an update to the interim slope stability analyses provided within the N#3 (four-week) interval deliverable; accordingly, the provided setbacks should still be considered valid.
- The ESCB appeared to be functioning properly and contained any potential surface water runoff from further eroding the June 2020 surficial slope failure area over the N#4 monitoring interval.
- There was no immediate sign of potential slope failure at the existing ground surface as supported by the lack of visually observed movement along the slope crest or at the mid/toe of slope instrumentation locations (e.g., slumping, cracking, settlements).

The above will be further developed following the measurements taken as part of the Milestone No. N#5 six-month monitoring interval.

4.0 LIMITATIONS OF TECHNICAL MEMO

This report has been prepared for The City of Calgary and their agents. The City of Calgary shall at all times be entitled to fully use and rely on this report, including all attachments, drawings, and schedules, for the specific purpose for which the report was prepared, in each case notwithstanding any provision, disclaimer, or waiver in the report that reliance is not permitted.

The City of Calgary shall at all times be entitled to provide copies of the report to City Council, City of Calgary regulatory boards, City of Calgary employees, officers, agents, affiliates, advisors, consultants, parties contracting with The City of Calgary, lenders and assignees and other governmental authorities and regulatory bodies having jurisdiction, each of whom shall also be similarly entitled to fully use and rely on the report in the same manner and to the same extent as The City of Calgary for the specific purpose for which the report was prepared.

5.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

2021-09-16

Prepared by:
Kyle Haugrud, P.Eng.
Geotechnical Engineer
Engineering Practice
Direct Line: 403.723.1618
kyle.haugrud@tetratech.com

Reviewed by:
Joseph Yonan, Ph.D., P.Eng.
Principal Consultant
Engineering Practice
Direct Line: 403.723.6885
joseph.yonan@tetratech.com

/mh

Attachments: Figure 1 – Instrument Installation Locations
Appendix A – Slope Inclinometer Measurements

PERMIT TO PRACTICE
TETRA TECH CANADA INC.

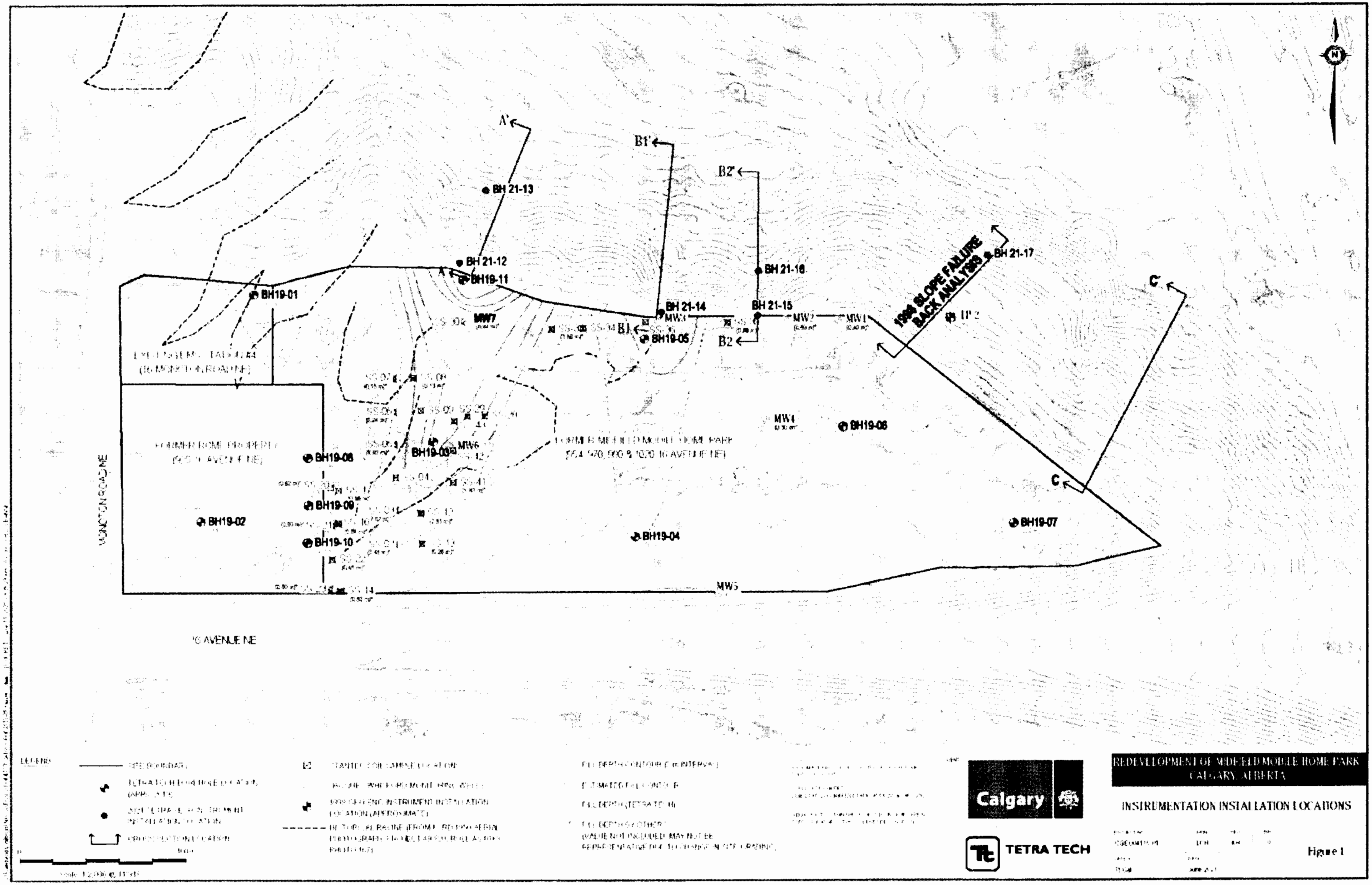
RM SIGNATURE: ______________________

RM APEGA ID #: 74722

DATE: September 16 2021

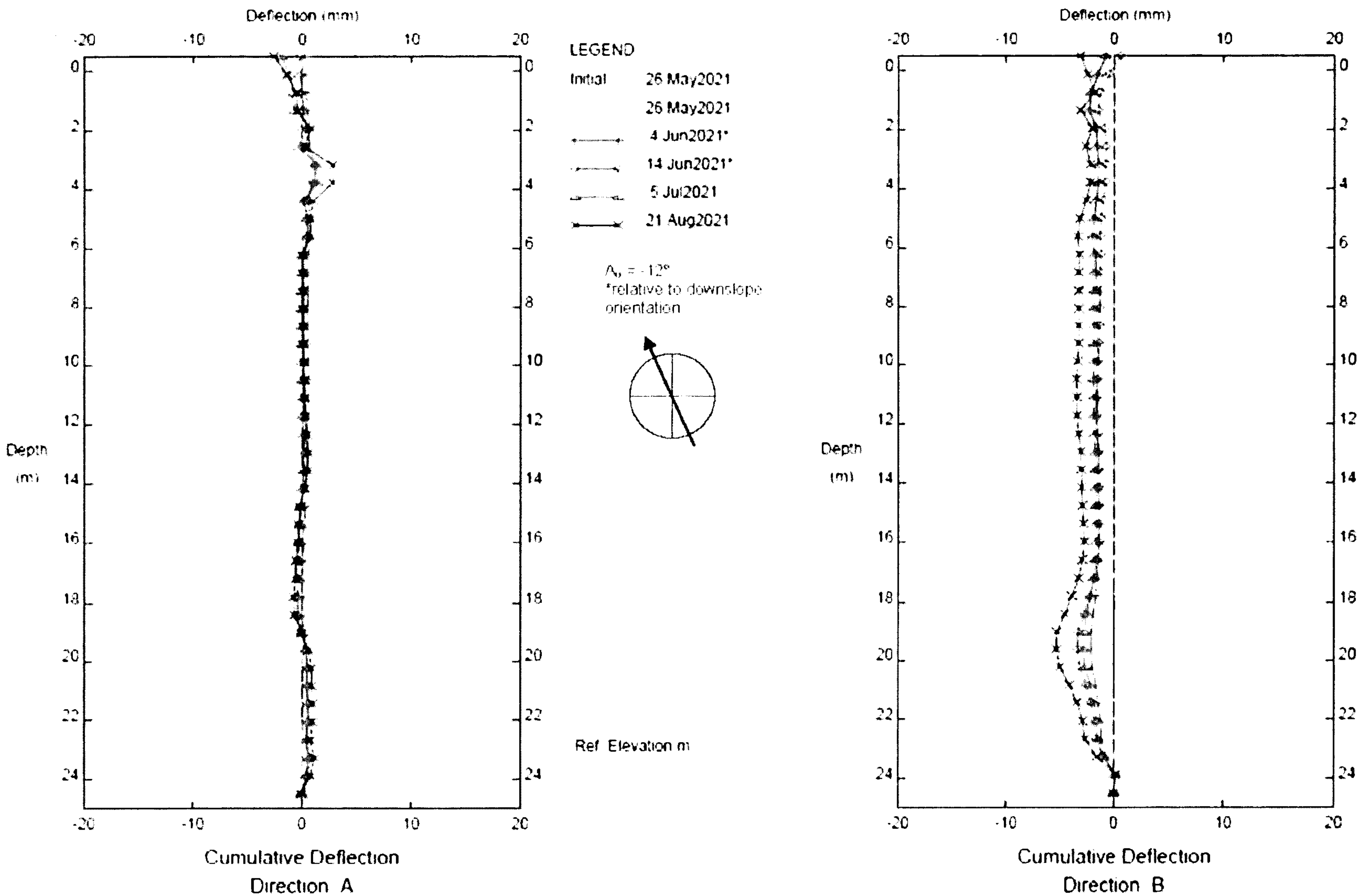
PERMIT NUMBER: P013774
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

FIGURES

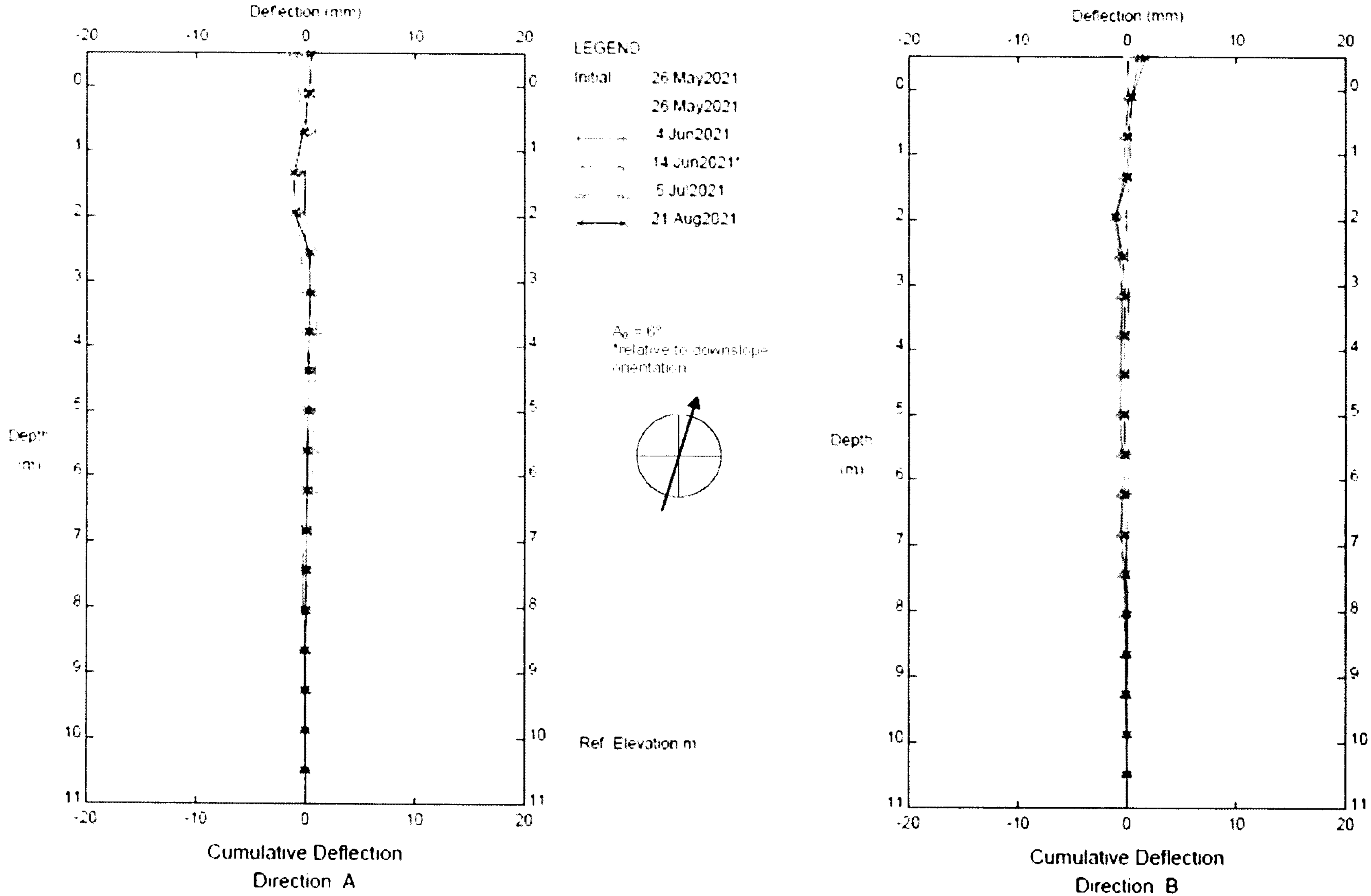


A'
B1'
B2'
C'
BH 21-13
BH 21-12
BH19-11
BH19-01
BH 21-14
MW3
BH 21-15
BH 21-16
MW2
MW1
1988 SLOPE FAILURE BACK ANALYSIS
BH 21-17
BH19-05
B1
B2
MW7
MW6
BH19-03
BH19-08
BH19-09
BH19-10
BH19-02
MW4
BH19-06
BH19-04
BH19-07
C
MW5
MONCTON ROAD NE
16 AVENUE NE
FORMER HOME PROPERTY
FORMER MIDFIELD MOBILE HOME PARK
LEGEND
Calgary
TETRA TECH
REDEVELOPMENT OF MIDFIELD MOBILE HOME PARK
CALGARY, ALBERTA
INSTRUMENTATION INSTALLATION LOCATIONS
Figure 1

APPENDIX A
SLOPE INCLINOMETER MEASUREMENTS

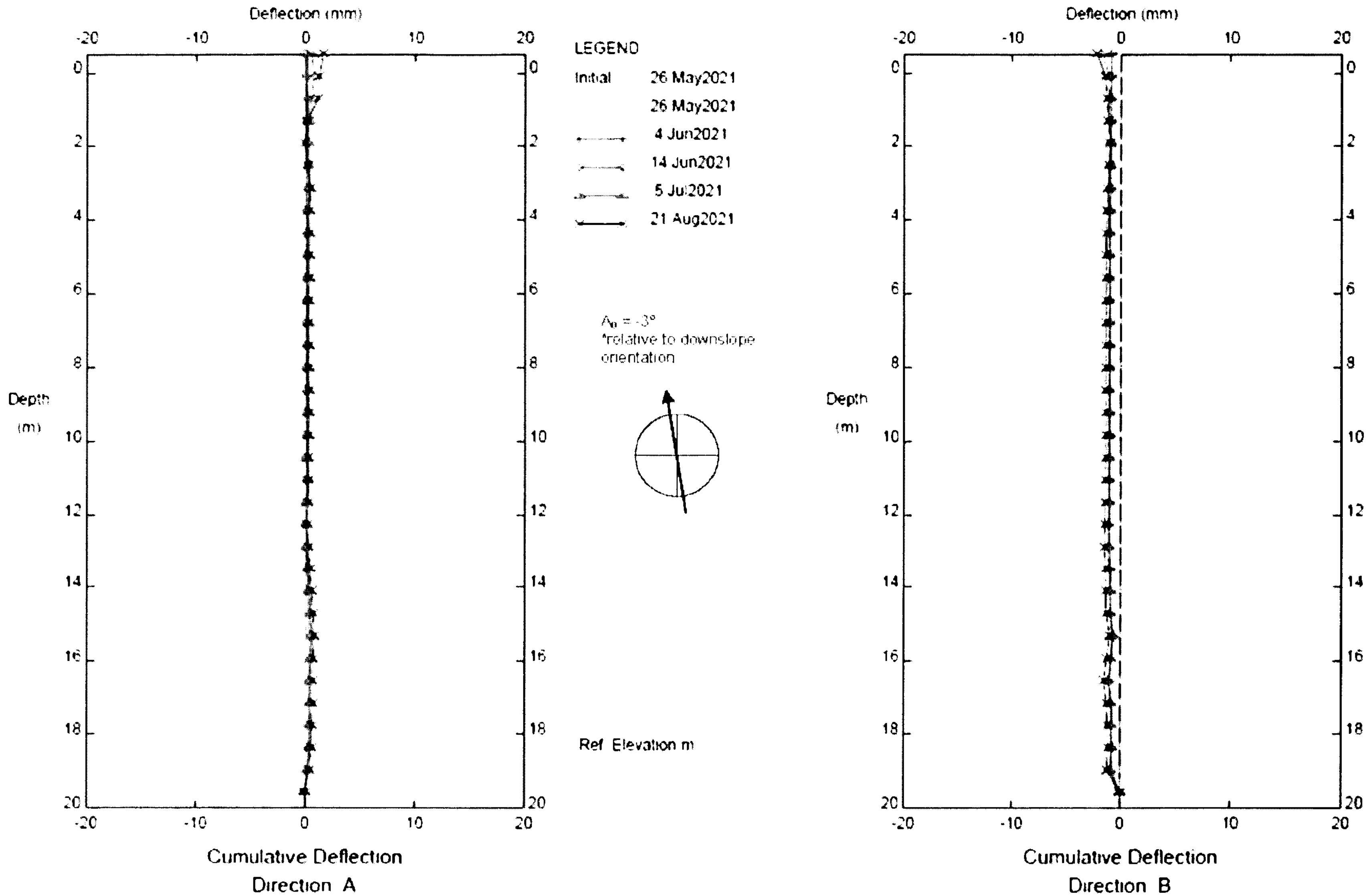


Midfield Heights, Inclinometer BH21-12



Midfield Heights, Inclinometer BH21-13

TETRA TECH



Midfield Heights, Inclinometer BH21-14

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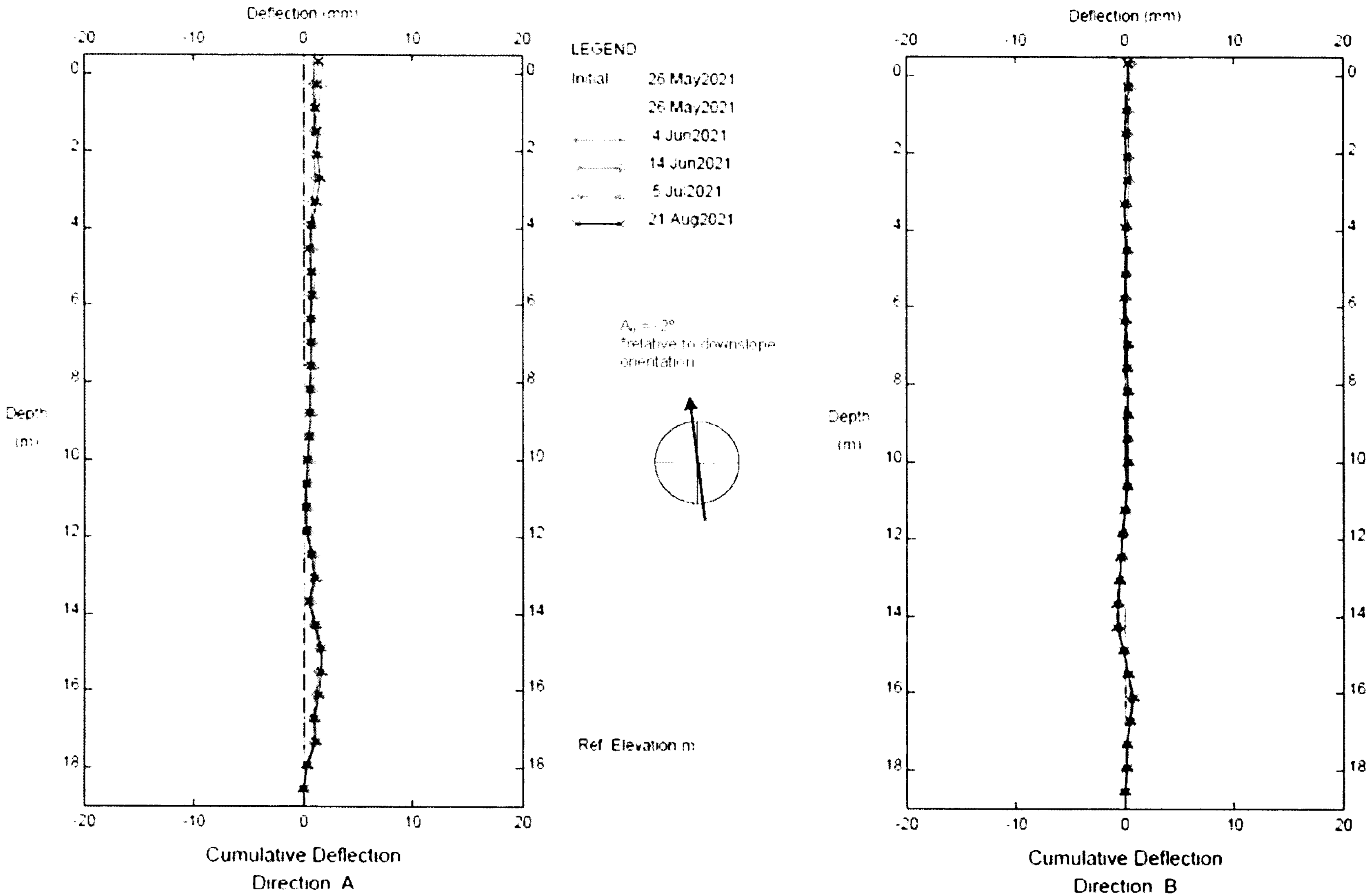

Midfield Heights, Inclinometer BH21-15

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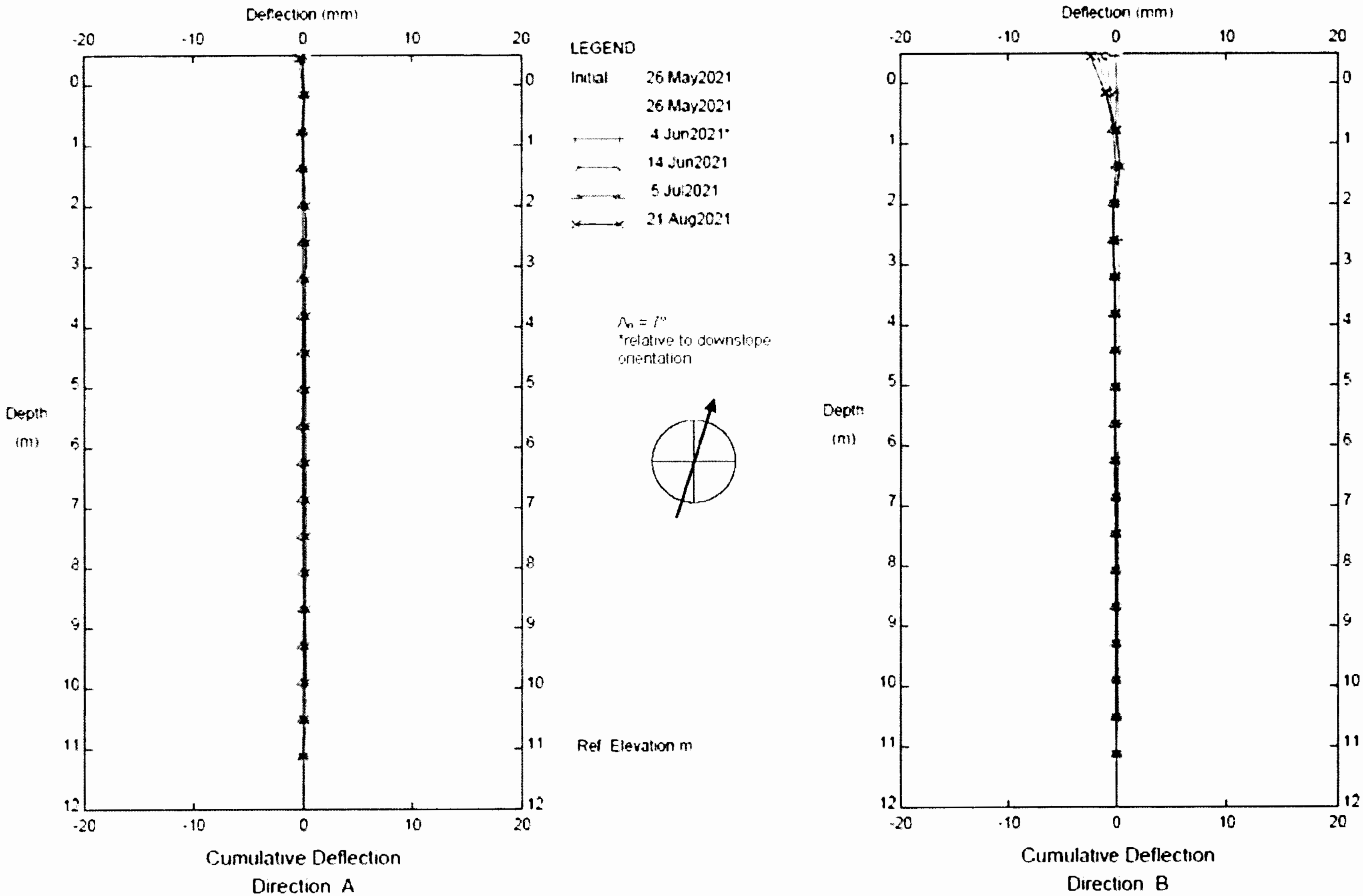
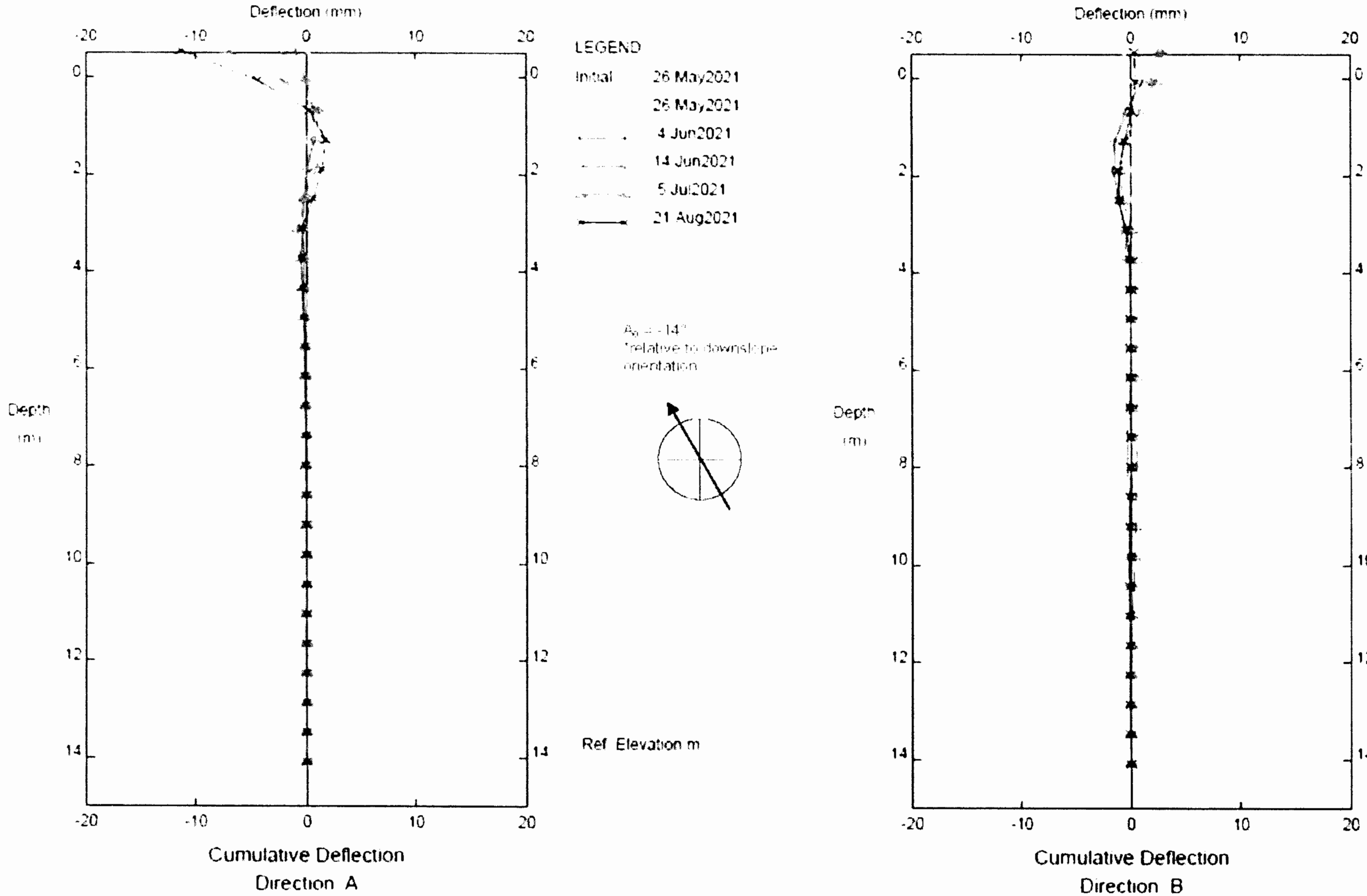
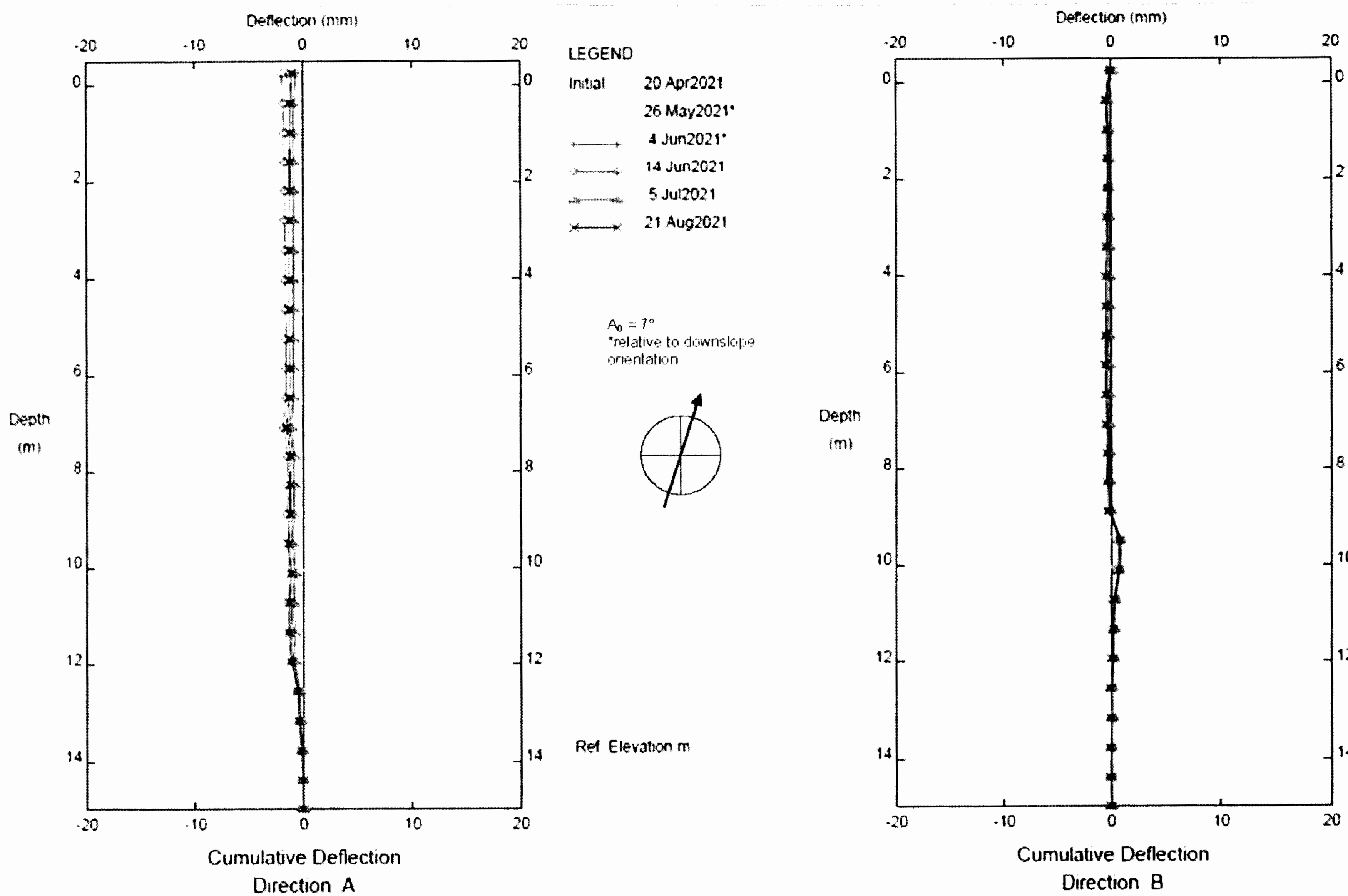


Midfield Heights, Inclinometer BH21-16



Midfield Heights, Inclinometer BH21-17



Midfield Heights, Inclinometer TP-2

TETRA TECH

TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE: CONFIDENTIAL

To:	Malcolm Dort, P.Eng., LEED AP (The City of Calgary)	**Date:**	December 6, 2021
From:	Kyle Haugrud, P.Eng. Joseph Yonan, Ph.D., P.Eng.	**Memo No:**	N#5
		File:	704-ENG.CGEO04110-01
Subject:	Regular Slope Monitoring Program Milestone N#5: Six-Month Interval – November 22, 2021 Redevelopment of Midfield Mobile Home Park Calgary, Alberta		

1.0 INTRODUCTION

This technical memo summarizes the results of the instrumentation measurements (Slope Inclinometers [SI] and Vibrating Wire Piezometers [VWP]) and visual observations conducted by Tetra Tech Canada Inc. (Tetra Tech) as part of the regular slope monitoring program for the Redevelopment of Midfield Mobile Home Park project for The City of Calgary (The City). The project is located northeast of the 16 Avenue NE and Moncton Road NE intersection in northeast Calgary, Alberta.

The details of the SI and VWP installations as well as updated stability analyses will be provided within the Milestone No. M#4 *Final Geotechnical Report,* which was in progress at the time of this technical memo's preparation with the intent of incorporating these regular monitoring results into the analyses.

At the request of The City, an interim preliminary slope stability assessment for the instrumentation section lines was conducted to verify that the setback distances initially provided still satisfied the required 1.5 factor of safety based on the supplementary subsurface information and instrumentation monitoring data collected. The results of the interim preliminary slope stability analyses were provided within the Milestone No. N#3 technical memo (four-week interval), which considered instrument measurements up to July 5, 2021 (Tetra Tech[1]). The results of this regular monitoring interval as they pertain to the interim slope stability analyses is further discussed in Section 3.0.

This technical memo represents the Milestone No. N#5 deliverable (six-month post-installation interval) as part of extension five of The City's Scope and Fee Schedule No. 18-2006-A05-S01-05 dated April 15, 2021. This is the fifth monitoring interval of the currently proposed six monitoring intervals, with one interval remaining at the one-year mark. Table 1 summarizes the monitoring intervals as completed to date. Note that if instrumentation results suggest adverse conditions, additional monitoring intervals may be required.

[1] Tetra Tech Canada Inc. 2021. *Regular Slope Monitoring Program and Interim Preliminary Slope Stability Analysis, Milestone N#3: Four-Week Interval – July 5, 2021, Redevelopment of Midfield Mobile Home Park, Calgary, Alberta.* File No. 704-ENG.CGEO04110-01, dated August 10, 2021.

Tetra Tech Canada Inc.
Suite 110, 140 Quarry Park Blvd SE
Calgary, AB T2C 3G3 CANADA
Tel 403.203.3355 Fax 403.203.3301

Table 1: Instrumentation Regular Monitoring Summary

Instrument Borehole Number	SI Initialization Date	No. N#1 One-Week Date	No. N#2 Two-Week Date	No. N#3 Four-Week Date	No. N#4 Three-Month Date	No. N#5 Six-Month Date	No. N#6 One-Year Date**
BH21-12	May 26, 2021	June 4, 2021	June 14, 2021	July 5, 2021	August 21, 2021	November 22, 2021	
BH21-13							
BH21-14							
BH21-15							
BH21-16							
BH21-17							
TP-2*	April 20, 2021						

Notes: * Borehole TP-2 was installed under the direction of Geo-Engineering (M.S.T.) Ltd. on November 26, 1998. Previous displacement data was not available, and the instrument was re-initialized on April 20, 2021.
** Greyed-out cells represent proposed future monitoring intervals yet to be completed.

2.0 MONITORING AND MEASUREMENT

2.1 General

The key objective of the installed instrumentation (SI and VWP) and visual observations is to sufficiently monitor any slope movements and/or adverse pore pressure responses throughout the Midfield project site's northern slope. These results are utilized to assess the overall slope stability and act as precursors to potential slope failures that may be preventively stabilized/mitigated.

The locations of the installed instrumentation are provided on the attached Figure 1. The following subsections summarize the monitoring results completed to date.

2.2 Slope Inclinometer Summary

A summary of the horizontal displacements within the SI casings measured to date (N#1 through N#5 six-month) is provided in Table 2.

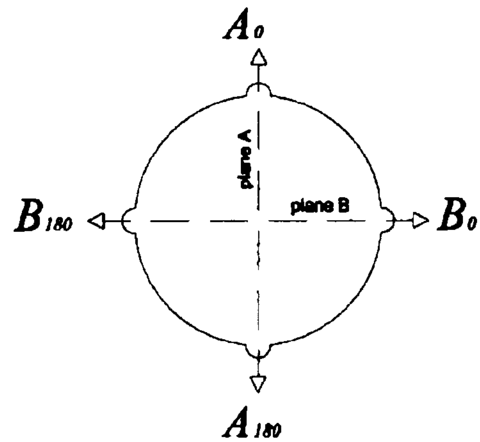
Table 2: Slope Inclinometer Movement Summary to Date

SI Borehole No.	Analysis Section / Casing Diameter	SI Depth (m)	Movement*						
			Depth (m)	Elev. (m)	Soil Unit	Shear (mm)**		Total (mm)***	
						New	Cumulative	New	Cumulative
BH21-12	A / 85 mm	25.0	3.5	1072.4	Fill	-	-	2	5
			19.5	1056.4	Clay	-	-	0	5
BH21-13	A / 85 mm	10.4	-	-	-	-	-	-	-
BH21-14	B1 / 85 mm	19.5	-	-	-	-	-	-	-
BH21-15	B2 / 85 mm	18.9	-	-	-	-	-	-	-
BH21-16	B2 / 85 mm	11.6	-	-	-	-	-	-	-
BH21-17	C1 / 70 mm	14.6	2.0	1057.9	Fill	-	-	1	<5
TP-2	C1 / 70 mm	15.9	-	-	-	-	-	-	-

Notes: * '-' indicates no notable movement is apparent at any specific depth. ** Shear movement is considered observable horizontal movement over a discrete plane. *** Total movement is not considered until over 5 mm is observable (considered 'noise' <5 mm).

TETRA TECH

The SI casing displacement plots are attached in Appendix A for reference, which present two graphs for each SI casing location; this is a result of there being two 'sets' of grooves that control the orientation of the inclinometer probe reader. Attempts are made during installation to ensure one set of grooves is properly aligned with the direction of expected movement (i.e., downslope, typically designated A_0-A_{180}); however, shifts in the casing's orientation are typical prior to the grout completely curing. Accordingly, both groove sets are read from the bottom of the SI casing to the top and should be reviewed in tandem for a comprehensive representation of the casing condition. Schematic 1 presents a top view of an SI casing depicting the general groove orientation.



<u>Schematic 1:</u> SI Casing Groove Orientation

Each SI casing displacement plot in Appendix A displays the A_0 direction in degrees relative to directly downslope (clockwise equalling a positive angle and counter-clockwise equalling a negative angle). These 'skew' angle values range from approximately 2° (BH21-15) to 14° (BH21-17).

When comparing the N#5 (six-month) deflection plots dated November 22, 2021, to the previous N#4 (three-month) interval dated August 21, 2021, the following can be distinguished related to measured displacements:

- Borehole BH21-12 from a depth range of approximately 2.5 m to 4.5 m (approximate El. 1073.4 m to El. 1071.4 m) within fill materials had an approximate 2 mm of new movement for a cumulative total of roughly 5 mm. Over a six-month period, this amount of displacement is minor; however, this area should continue to be observed closely during future monitoring intervals in the event the rate of movement begins to increase.
- Borehole BH21-12 from a depth range of approximately 18.0 m to 21.0 m (approximate El. 1057.9 m to El. 1054.9 m) within native clay had no discernable additional displacement and remained at roughly 5 mm total (within B_0-B_{180} plane). This gives credence to the possibility of the displacement occurring near the backfill-native interface because of installation disturbance and/or groundwater drainage (as there has been minimal precipitation after the previous monitoring interval). This displacement area should be further assessed during the next monitoring interval scheduled during the spring rainy season (end of May/early June 2022).
- Borehole BH12-17 from a depth range of approximately 1.0 m to 2.0 m (approximate El. 1058.9 m to El. 1057.9 m) within fill materials had a slight observable increase in displacement for a total of roughly 2 mm. Given the large variance of measured deflection in the opposite direction at the existing ground surface (-11 mm), it is still suggested this is an outcome of the protective casing not being entirely rigid following installation and/or tampering from the public.

- All other borehole locations and depths had no additional discernable horizontal displacements over the three-month period from N#4 to N#5.

2.3 Vibrating Wire Piezometer Summary

A summary of the porewater pressure response calculated from the VWP measurements to date (N#1 through N#5 six-month) is provided in Table 3. Note that additional pore pressure readings were obtained between N#4 and N#5 on October 19, 2021, during Tetra Tech's site visit to bail water from the top of the SI casings to avoid blockage from freezing.

Table 3: Vibrating Wire Piezometer Pore Pressure Summary to Date

VWP Borehole No.	Analysis Section	VWP Tip Depth (m)	VWP Tip Elev. (m)	Soil Unit	Date	Measured Piezometric Elev. (m)	Water Pressure Head (m)	Calculated Bbar/r_u*
BH21-12	A (Crest)	15.2	1060.7	Clay	June 4, 2021	1061.2		
					June 14, 2021	1061.2	0.6	<0.1
					July 5, 2021	1061.3	0.6	<0.1
					August 21, 2021	1061.2	0.6	<0.1
					October 19, 2021	1061.2	0.5	<0.1
					November 22, 2021	1061.2	0.5	<0.1
BH21-13	A (Toe)	9.1	1054.5	Clay	June 4, 2021	1054.5		
					June 14, 2021	<1054.5	<0.1	<0.1
					July 5, 2021	<1054.5	<0.1	<0.1
					August 21, 2021	<1054.5	<0.1	<0.1
					October 19, 2021	<1054.5	<0.1	<0.1
					November 22, 2021	<1054.5	<0.1	<0.1
BH21-14	B1 (Crest)	13.7	1061.7	Clay	June 4, 2021	1061.8		
					June 14, 2021	1061.8	0.1	<0.1
					July 5, 2021	1061.8	0.1	<0.1
					August 21, 2021	1061.8	<0.1	<0.1
					October 19, 2021	1061.8	<0.1	<0.1
					November 22, 2021	1061.8	<0.1	<0.1
BH21-15	B2 (Crest)	13.7	1061.5	Clay	June 4, 2021	1061.5		
					June 14, 2021	<1061.5	<0.1	<0.1
					July 5, 2021	1061.5	<0.1	<0.1
					August 21, 2021	1061.6	0.1	<0.1
					October 19, 2021	<1061.5	<0.1	<0.1
					November 22, 2021	<1061.5	<0.1	<0.1

Table 3: Vibrating Wire Piezometer Pore Pressure Summary to Date

VWP Borehole No.	Analysis Section	VWP Tip Depth (m)	VWP Tip Elev. (m)	Soil Unit	Date	Measured Piezometric Elev. (m)	Water Pressure Head (m)	Calculated Bbar/r_u*
BH21-16	B2 (Toe)	11.6	1052.9	Sand	June 4, 2021	1052.9		
					June 14, 2021	<1052.9	<0.1	<0.1
					July 5, 2021	<1052.9	<0.1	<0.1
					August 21, 2021	<1052.9	<0.1	<0.1
					October 19, 2021	1052.9	<0.1	<0.1
					November 22, 2021	<1052.9	<0.1	<0.1
BH21-17	C1 (Mid)	14.6	1045.2	Clay	June 4, 2021	1045.3		
					June 14, 2021	<1045.2	<0.1	<0.1
					July 5, 2021	<1045.2	<0.1	<0.1
					August 21, 2021	<1045.2	<0.1	<0.1
					October 19, 2021	<1045.2	<0.1	<0.1
					November 22, 2021	<1045.2	<0.1	<0.1

Note: * Water pressure head and Bbar/r_u not calculated during N#1 (one-week interval); all current (as of November 22, 2021) Bbar/r_u calculated pressures are under 0.1.

All piezometric elevations were comparable to the previous readings and were near or below the VWP tip installation elevation except for Borehole BH21-12, which still exhibited a water pressure head of approximately 0.5 m. The resulting calculated Bbar/r_u groundwater pressure parameters were all still below a value of 0.1 typically used in slope stability analyses for fill (based on Tetra Tech's experience with similar materials in similar conditions). The water pressure heads also do not suggest significant elevated porewater conditions within potential native soils at the tip elevation.

2.4 Visual Observations

During the collection of the instrumentation data, the slope and general project area were also visually observed for any potential signs of movement along the existing ground surface (e.g., slumping, cracking, settlements).

During the collection of the instrumentation data on November 22, 2021, Tetra Tech observed no ponded water within the Erosion and Sediment Control Berm (ESCB) as well as an excavation (within a red fenced area) and material stockpiles directly south of the ESCB on the west side of the project site. Given temperatures now typically reach below zero, it is understood backfilling of the project site is on hold until the spring; accordingly, the existing excavation and stockpiles are assumed to remain over winter. Photograph 1 depicts the condition described above at the time of Tetra Tech's field visit.

Photograph 1: General Site Condition on November 22, 2021

Overall, the material stockpiles are at an offset from the slope crest such that the surcharge weight is not expected to adversely affect its stability. Additionally, there are no constraints associated with the open excavation in relation to the stability of the slope at this time.

Visual observations of the general project area slope at the existing ground surface presented no indicator of immediate potential slope movement or failure as supported by the lack of slumping, cracking, or new depressions. Photograph 2 depicts the condition of the crest between the June 2020 surficial slope failure and Borehole BH21-12, where displacement has been observed near the existing ground surface (depth of approximately 3.5 m). Note that the depicted cracks within the asphalt bike path were present prior to instrumentation installation and have not noticeably increased in size over the regular monitoring periods to date; however, the cracks substantiate the measured shallow displacement in the nearby instrument.

Photograph 2: Slope Crest Condition on November 22, 2021

3.0 COMMENTARY

In general, the Milestone No. N#5 six-month monitoring interval results suggest the following:

- The SI monitoring measurement results for the six-month interval are comparable to the previous three-month interval; accordingly, there is no immediate concern to overall slope stability. The cumulative displacement previously measured within Borehole BH21-12 at the shallow depth of approximately 3.5 m had a slight increase to an overall approximate movement of 5 mm. The deeper displacement within Borehole BH21-12 at approximately 19.5 m had no measurable increase from the previous reading and remained at a cumulative total of approximately 5 mm. Additionally, the shallow measured displacement at Borehole BH21-17 had a slight increase, though is still considered to have been caused by overland disturbance given the variance of movement at the ground surface. All displacements discussed should be further reviewed during the next monitoring interval.
- The VWP calculated Bbar/r_u groundwater pressure parameters are all below a value of 0.1 typically used in stability analyses for fill. The water pressure heads also do not currently suggest significant elevated porewater conditions within potential native soils at the tip elevation.
- Overall, the instrumentation monitoring results for the N#5 (six-month) interval do not constitute an update to the interim slope stability analyses provided within the N#3 (four-week) interval deliverable; accordingly, the provided setbacks should still be considered valid.
- There was no sign of immediate potential slope failure as supported by the lack of measured displacement within the SIs as well as the absence of visually observable slumping, cracking, and/or settlements at the existing ground surface.

The above will be reassessed following the measurements taken as part of the Milestone No. N#6 one-year monitoring interval.

4.0 LIMITATIONS OF TECHNICAL MEMO

This report has been prepared for The City of Calgary and their agents. The City of Calgary shall at all times be entitled to fully use and rely on this report, including all attachments, drawings, and schedules, for the specific purpose for which the report was prepared, in each case notwithstanding any provision, disclaimer, or waiver in the report that reliance is not permitted.

The City of Calgary shall at all times be entitled to provide copies of the report to City Council, City of Calgary regulatory boards, City of Calgary employees, officers, agents, affiliates, advisors, consultants, parties contracting with The City of Calgary, lenders and assignees and other governmental authorities and regulatory bodies having jurisdiction, each of whom shall also be similarly entitled to fully use and rely on the report in the same manner and to the same extent as The City of Calgary for the specific purpose for which the report was prepared.

5.0 CLOSURE

We trust this technical memo meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech Canada Inc.

2021-12-06

Prepared by:
Kyle Haugrud, P.Eng.
Geotechnical Engineer
Engineering Practice
Direct Line: 403.723.1618
kyle.haugrud@tetratech.com

Reviewed by:
Joseph Yonan, Ph.D., P.Eng.
Principal Consultant
Engineering Practice
Direct Line: 403.723.6885
joseph.yonan@tetratech.com

/mh

Attachments: Figure 1 – Instrument Installation Locations
Appendix A – Slope Inclinometer Measurements

PERMIT TO PRACTICE
TETRA TECH CANADA INC.

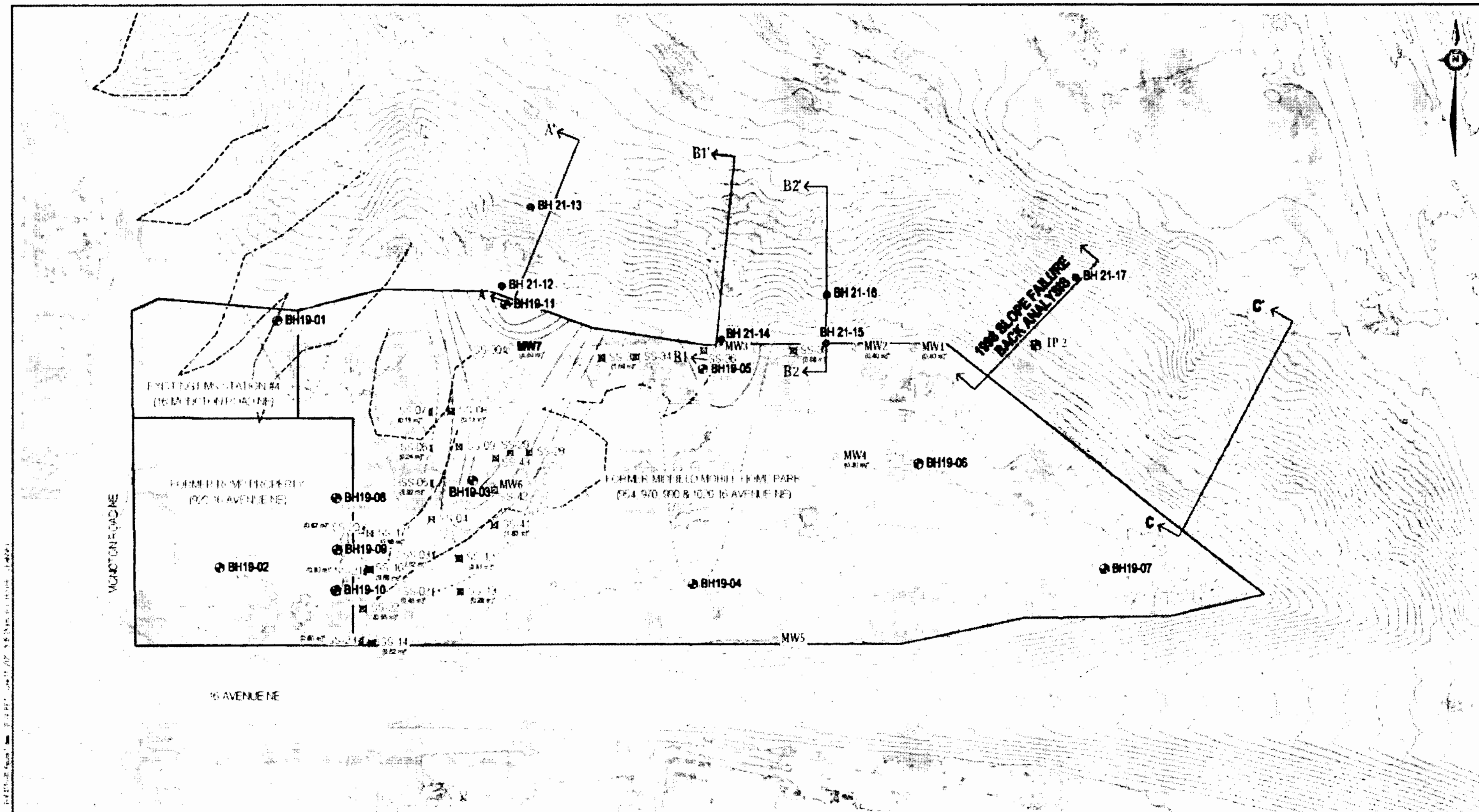
RM SIGNATURE: ____________________

RM APEGA ID #: 74722

DATE: December 6 2021

PERMIT NUMBER: P013774
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

FIGURES

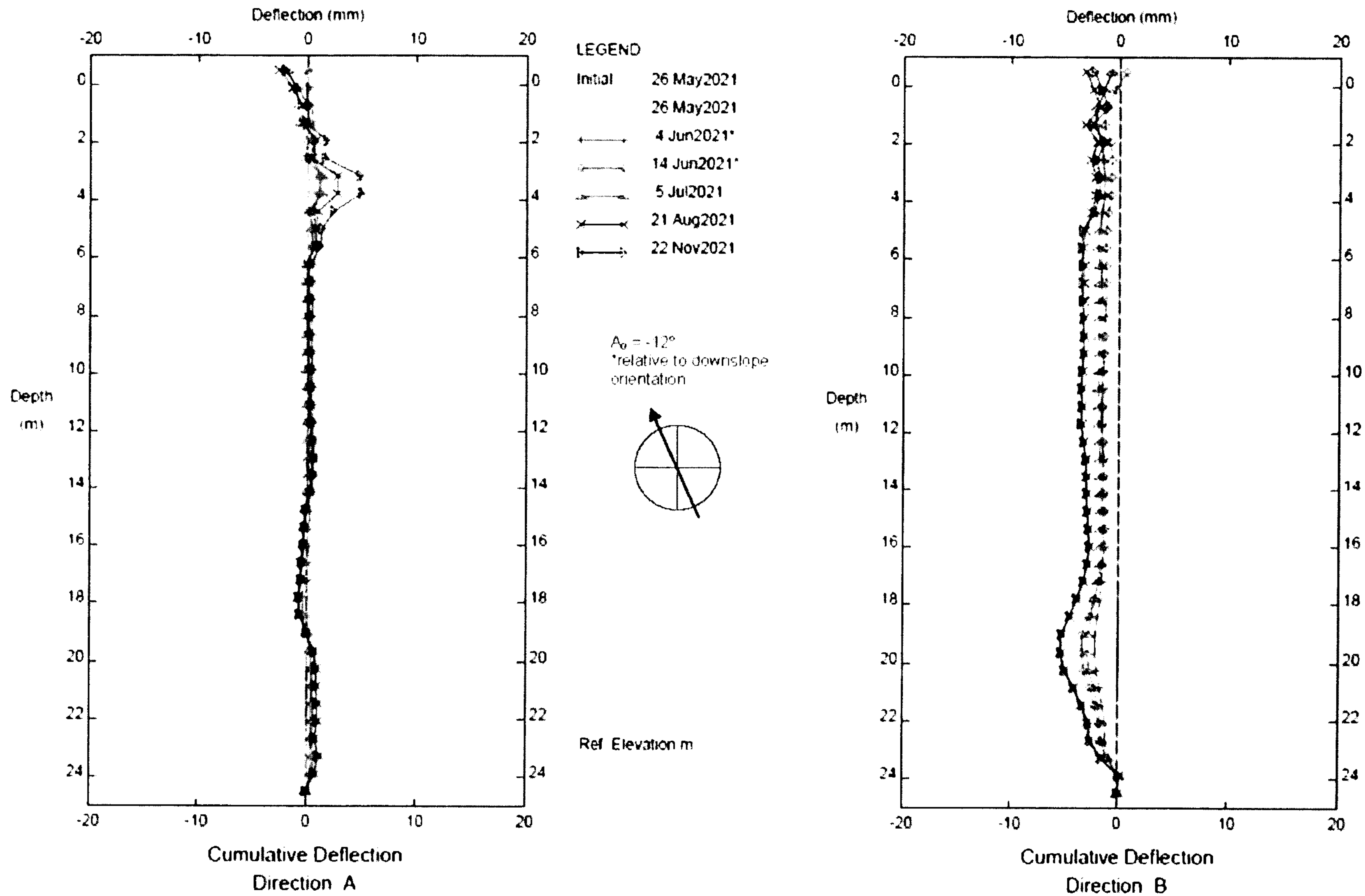


REDEVELOPMENT OF MEDFIELD MOBILE HOME PARK
CALGARY, ALBERTA

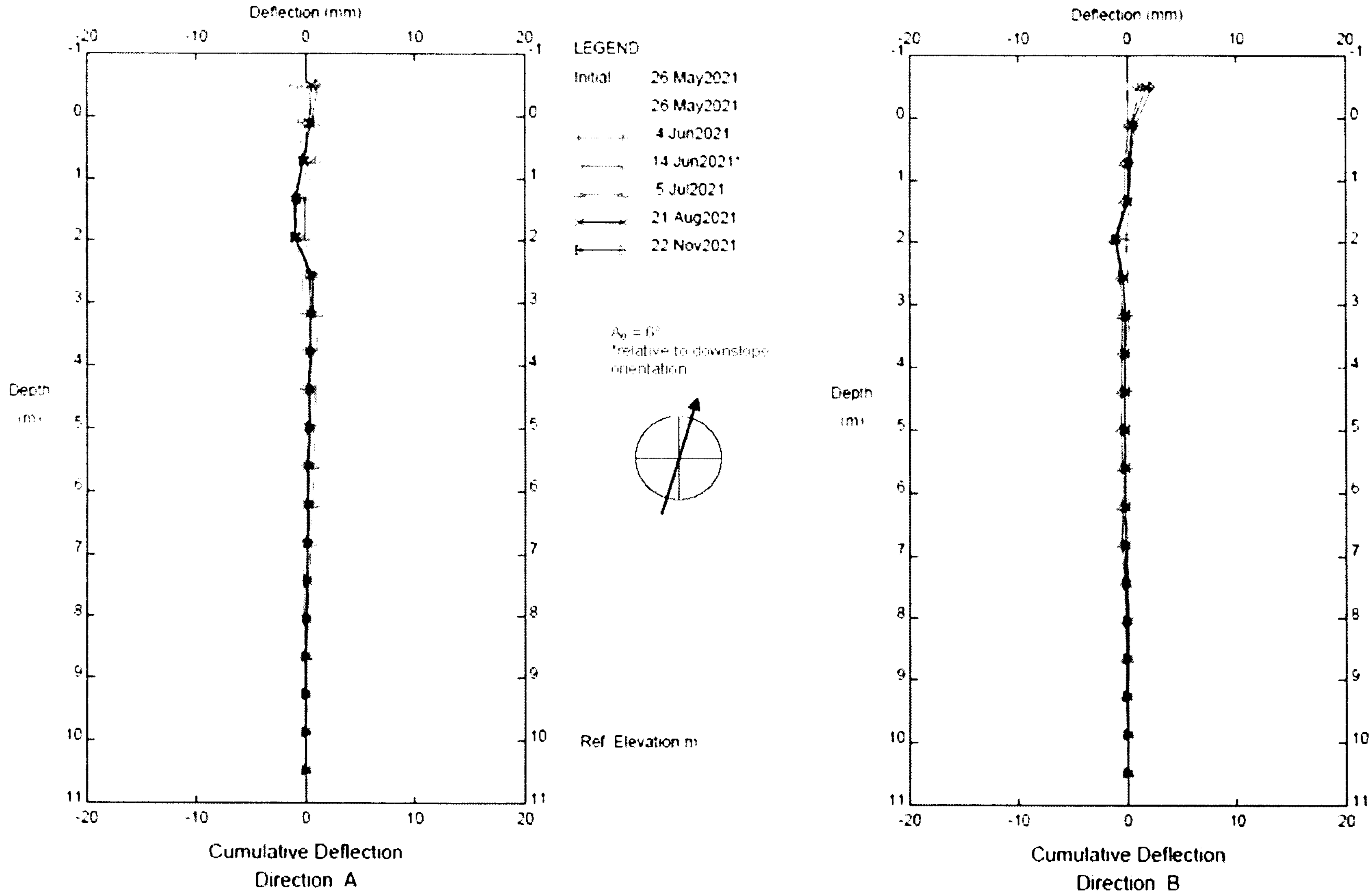
INSTRUMENTATION INSTALLATION LOCATIONS

Figure 1

APPENDIX A
SLOPE INCLINOMETER MEASUREMENTS



Midfield Heights, Inclinometer BH21-12



Midfield Heights, Inclinometer BH21-13

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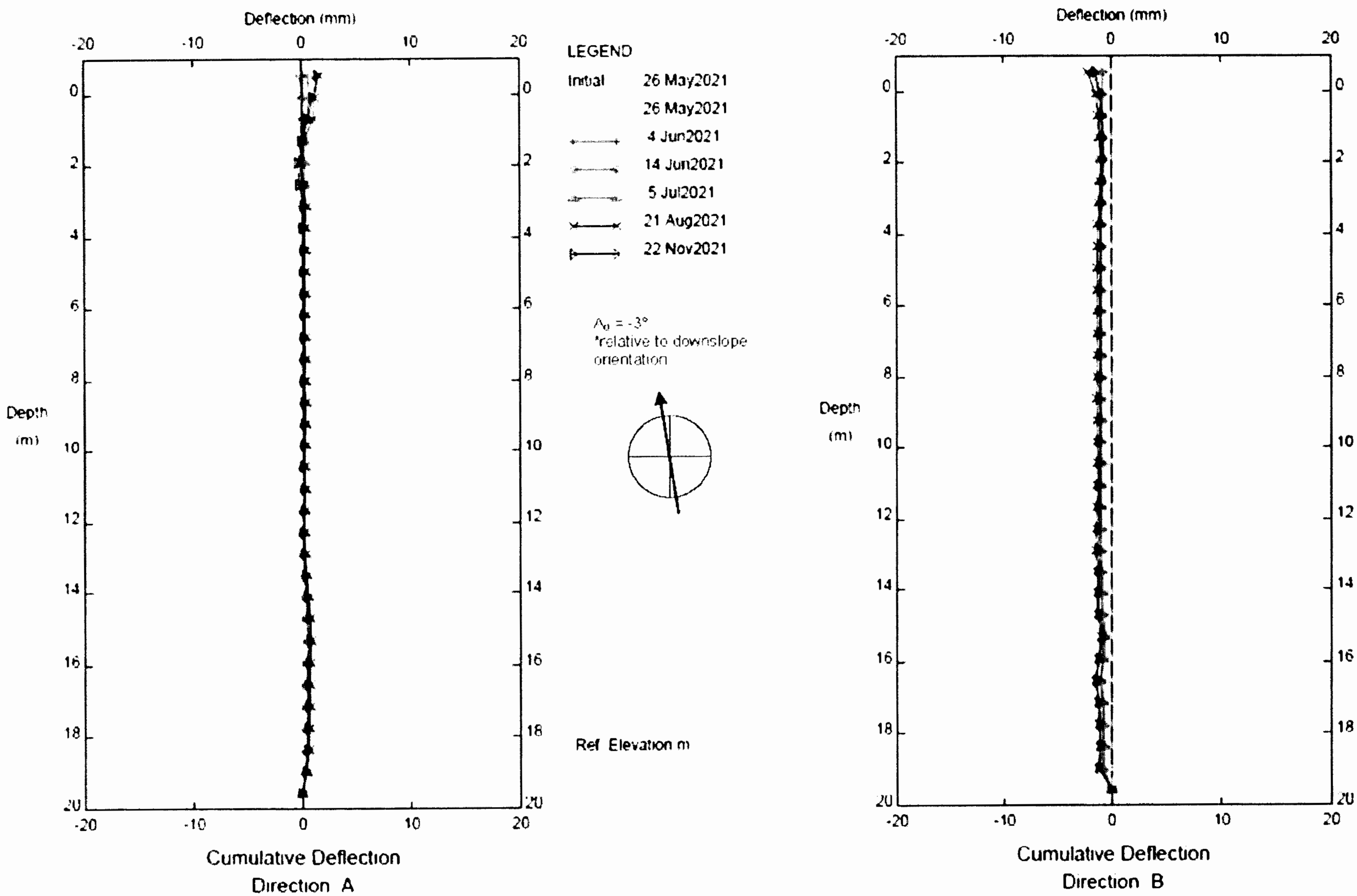

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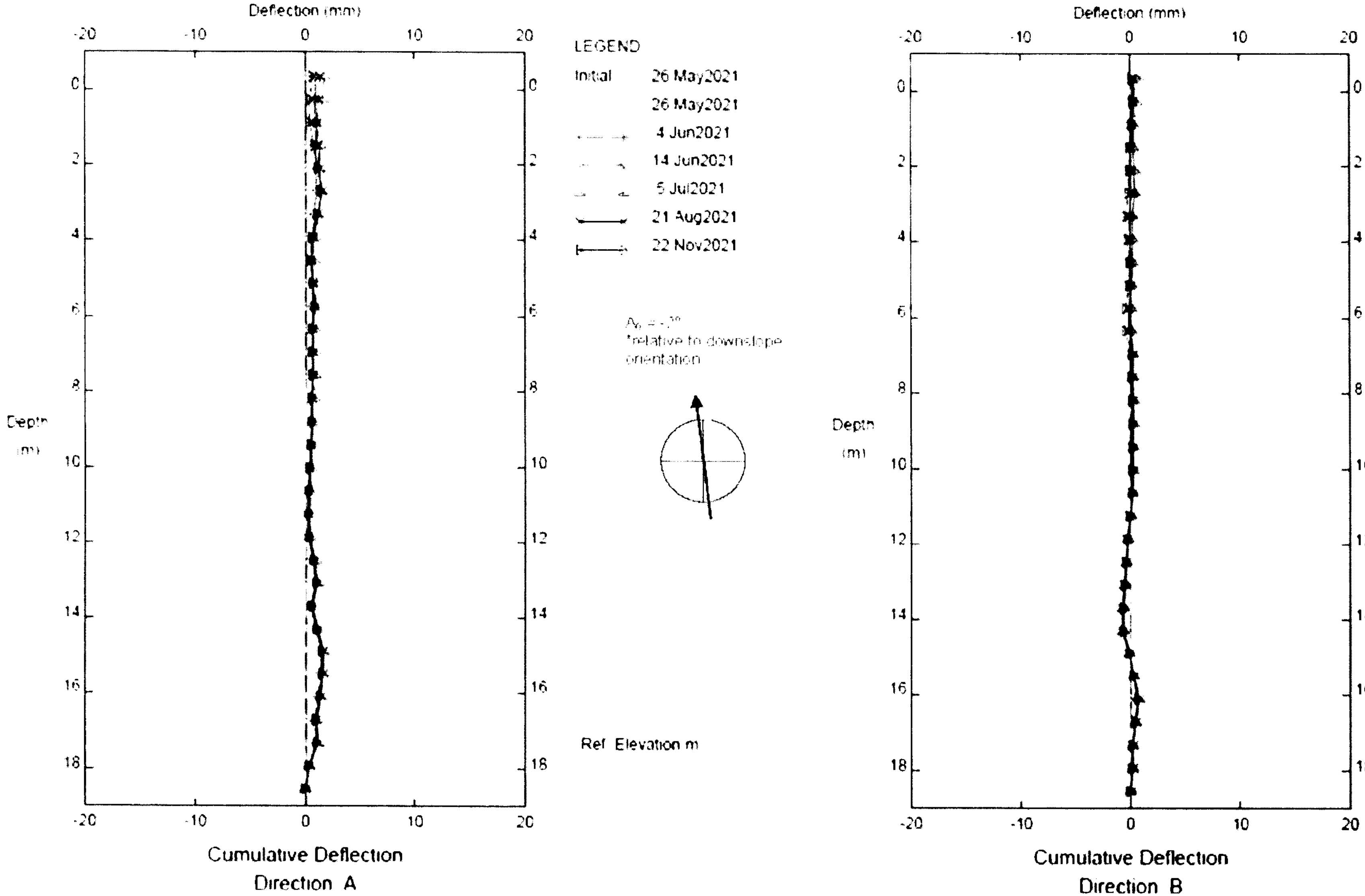
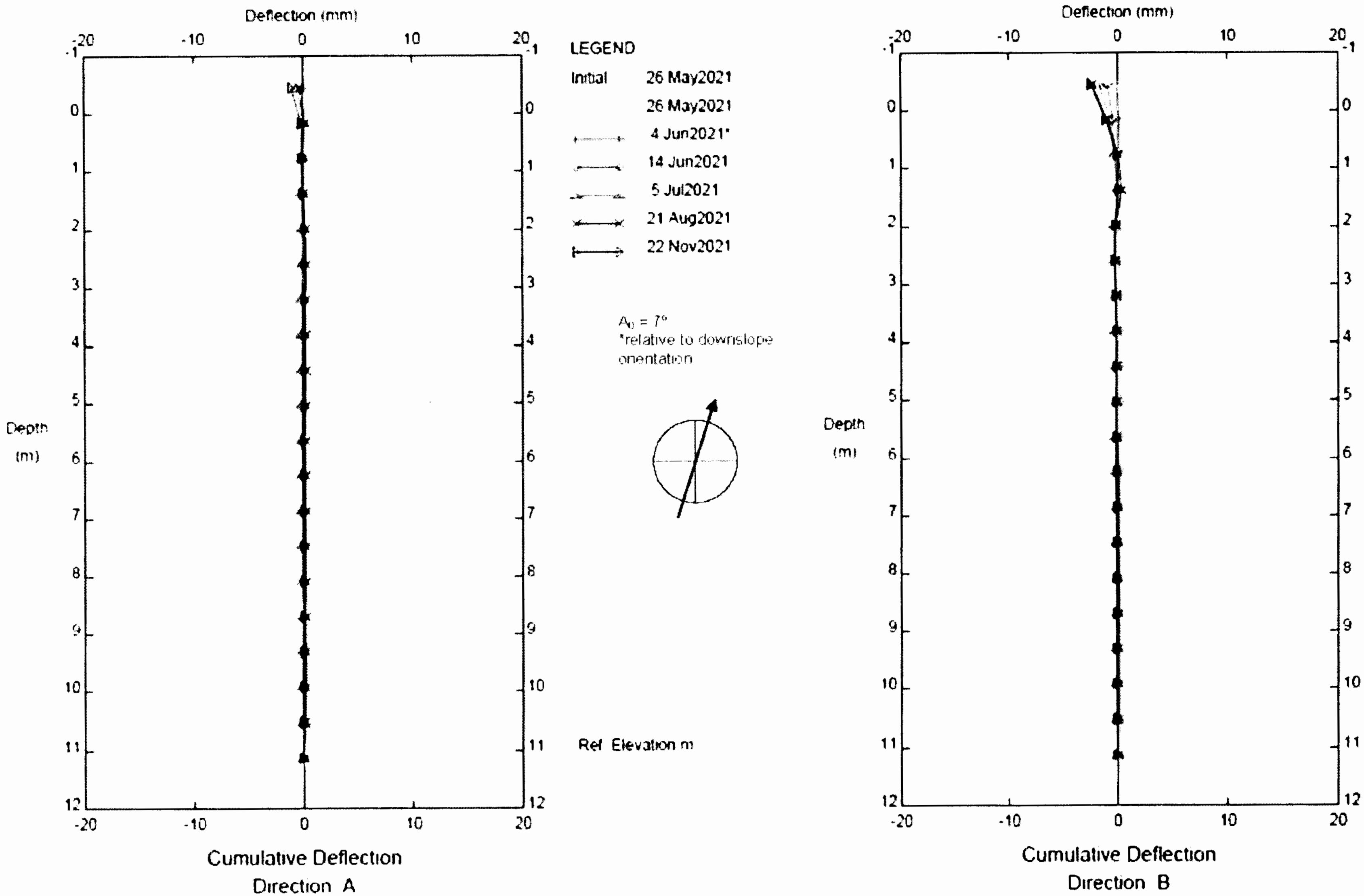
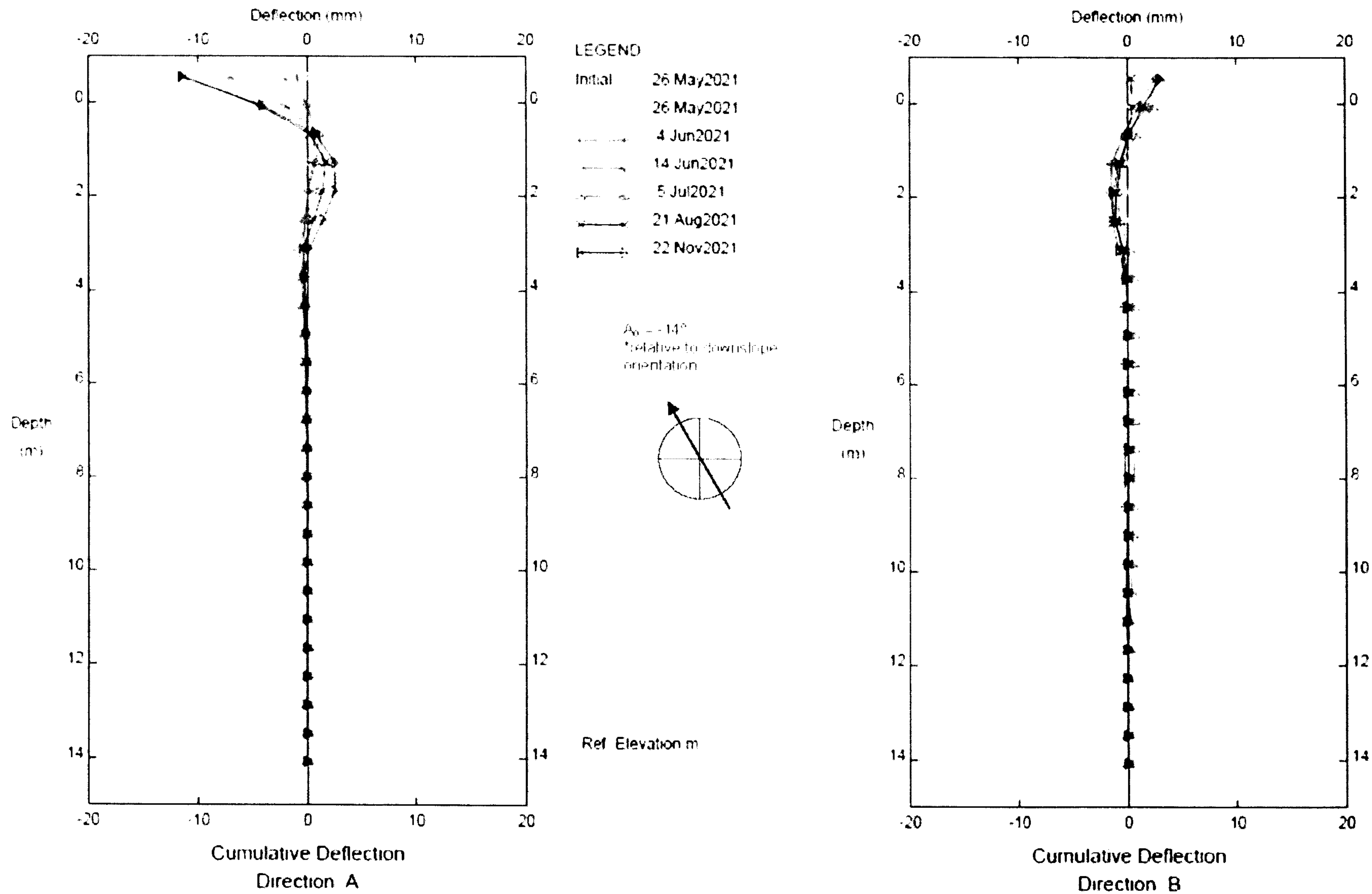


Midfield Heights, Inclinometer BH21-15

TETRA TECH

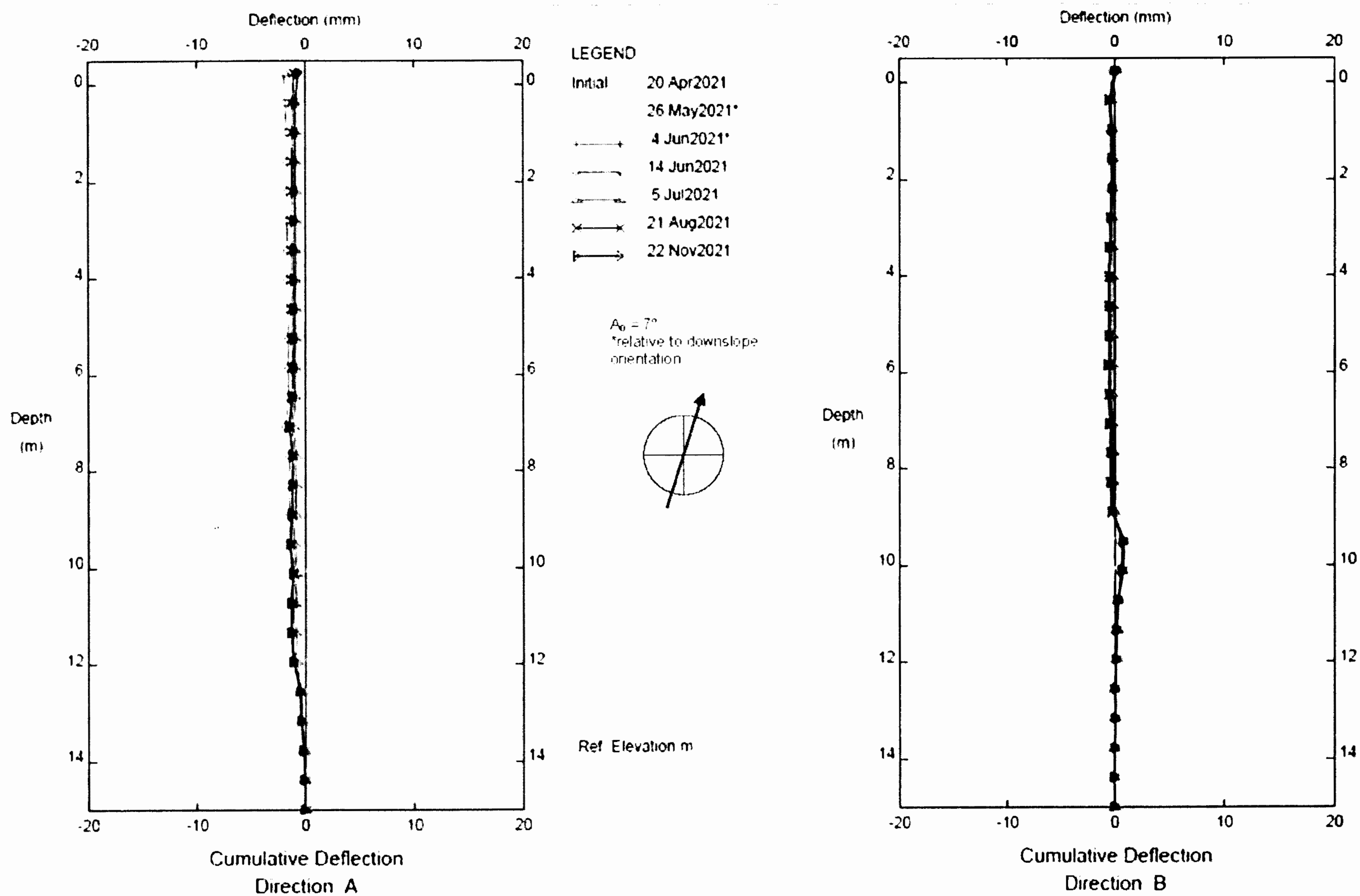


Midfield Heights, Inclinometer BH21-16



Midfield Heights, Inclinometer BH21-17

TETRA TECH



Midfield Heights, Inclinometer TP-2

TETRA TECH

TETRA TECH

TECHNICAL MEMO

ISSUED FOR USE CONFIDENTIAL

To:	Malcolm Dort, P.Eng., LEED AP (The City of Calgary)	**Date:**	March 9, 2022
From:	Kyle Haugrud, P.Eng. Joseph Yonan, Ph.D., P.Eng.	**Memo No:**	N#6
		File:	704-ENG.CGEO04110-01
Subject:	Regular Slope Monitoring Program Milestone N#6: Nine-Month Interval – February 25, 2022 Redevelopment of Midfield Mobile Home Park Calgary, Alberta		

1.0 INTRODUCTION

This technical memo summarizes the results of the instrumentation measurements (Slope Inclinometers [SI] and Vibrating Wire Piezometers [VWP]) and site visual observations conducted by Tetra Tech Canada Inc. (Tetra Tech) as part of the regular slope monitoring program for the Redevelopment of Midfield Mobile Home Park project for The City of Calgary (The City). The project is located northeast of the 16 Avenue NE and Moncton Road NE intersection in northeast Calgary, Alberta.

The details of the SI and VWP installations as well as updated slope stability analyses will be provided within the Milestone No. M#4 *Final Geotechnical Report*, which was in progress at the time of this technical memo's preparation with the intent of incorporating these regular monitoring results into the slope stability analyses.

At the request of The City, an interim preliminary slope stability assessment for the instrumentation section lines was conducted to verify that the setback distances initially provided still satisfied the required 1.5 factor of safety based on the supplementary subsurface information and instrumentation monitoring data collected to that point. The results of the interim preliminary slope stability analyses were provided within the Milestone No. N#3 technical memo (four-week interval), which considered instrument measurements up to July 5, 2021 (Tetra Tech[1]). The results of this regular monitoring interval as they pertain to the interim slope stability analyses is further discussed in Section 3.0.

This technical memo represents the Milestone No. N#6 deliverable (nine-month post-installation interval) as part of the fifth (5) extension of The City's Scope and Fee Schedule No. 18-2006-A05-S01-05 dated April 15, 2021. Note that this milestone was originally planned as a twelve-month post-installation interval; however, given funding restrictions resulting in an accelerated construction schedule, the geotechnical detailed design for any slope stability mitigation measures is required mid-July 2022. To meet this deadline, the Milestone No. N#6 interval was brought forward to provide an up-to-date representation of the existing conditions for use in the development of the geotechnical detailed design. An additional monitoring interval (Milestone No. N#7) was being incorporated into the eighth (8) extension (Fee Schedule No. 18-2006-A05-S01-08), which was being developed at the time of this technical memo's preparation. Confirmation to conduct the Milestone No. N#6 at nine months post-installation (instead of twelve months) was received from The City via email correspondence dated February 9, 2022 (Dort[2]). The twelve-month interval (now Milestone No. N#7) scheduled for the beginning of June 2022 will act as a final review prior to construction in mid-August.

[1] Tetra Tech Canada Inc. 2021. ***Regular Slope Monitoring Program and Interim Preliminary Slope Stability Analysis, Milestone N#3: Four-Week Interval – July 5, 2021, Redevelopment of Midfield Mobile Home Park, Calgary, Alberta***. File No. 704-ENG.CGEO04110-01, dated August 10, 2021.

[2] Dort, Malcolm. Email to Kyle Haugrud. Subject '*RE: Midfield – DRAFT Supplemental Scope & Fee Sched #8 – Clarifications*'. February 9, 2022.

Tetra Tech Canada Inc.
Suite 110 140 Quarry Park Blvd SE
Calgary, AB T2C 3G3 CANADA
Tel 403.203.3355 Fax 403.203.3301

Table 1 summarizes the monitoring intervals as completed to date. Note that if instrumentation results suggest adverse conditions, additional monitoring intervals may be required.

Table 1: Instrumentation Regular Monitoring Summary

<table>
<tr><th>ID</th><th>SI Initialize Date</th><th>No. N#1 One-Week Date</th><th>No. N#2 Two-Week Date</th><th>No. N#3 Four-Week Date</th><th>No. N#4 Three-Month Date</th><th>No. N#5 Six-Month Date</th><th>No. N#6 Nine-Month Date**</th><th>No. N#7 Twelve-Month Date***</th></tr>
<tr><td>BH21-12</td><td rowspan="6">May 26, 2021</td><td rowspan="7">June 4, 2021</td><td rowspan="7">June 14, 2021</td><td rowspan="7">July 5, 2021</td><td rowspan="7">August 21, 2021</td><td rowspan="7">November 22, 2021</td><td rowspan="7">February 25, 2022</td><td rowspan="7"></td></tr>
<tr><td>BH21-13</td></tr>
<tr><td>BH21-14</td></tr>
<tr><td>BH21-15</td></tr>
<tr><td>BH21-16</td></tr>
<tr><td>BH21-17</td></tr>
<tr><td>TP-2*</td><td>April 20, 2021</td></tr>
</table>

Notes: * Borehole TP-2 was installed under the direction of Geo-Engineering (M.S.T.) Ltd. on November 26, 1998. Previous displacement data was not available, and the instrument was re-initialized on April 20, 2021.

** Additional monitoring interval included at nine-month post-installation at the request of The City.

*** Greyed-out cells represent proposed future monitoring intervals yet to be completed.

2.0 MONITORING AND MEASUREMENT

2.1 General

The key objective of the installed instrumentation (SI and VWP) and site visual observations is to sufficiently monitor any slope movements and/or adverse pore pressure responses throughout the Midfield project site's northern slope. These results are utilized to assess the overall slope stability and act as precursors to potential slope failures that may be preventatively stabilized/mitigated.

The locations of the installed instrumentation are provided on the attached Figure 1. The following subsections summarize the monitoring results completed to date.

2.2 Slope Inclinometer Summary

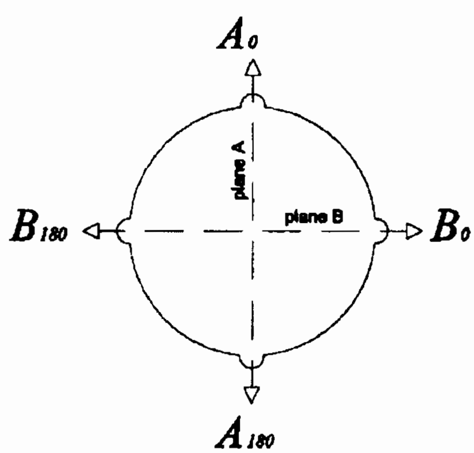
A summary of the horizontal displacements within the SI casings measured to date (N#1 through N#6) is provided in Table 2.

Table 2: Slope Inclinometer Movement Summary to Date

SI Borehole No.	Analysis Section / Casing Diameter	SI Depth (m)	Movement*						
			Depth (m)	Elev. (m)	Soil Unit	Shear (mm)**		Total (mm)***	
						New	Cumulative	New	Cumulative
BH21-12	A / 85 mm	25.0	3.5	1072.4	Fill	-	-	0	5
			19.5	1056.4	Clay	-	-	0	5
BH21-13	A / 85 mm	10.4	-	-	-	-	-	-	-
BH21-14	B1 / 85 mm	19.5	-	-	-	-	-	-	-
BH21-15	B2 / 85 mm	18.9	-	-	-	-	-	-	-
BH21-16	B2 / 85 mm	11.6	-	-	-	-	-	-	-
BH21-17	C1 / 70 mm	14.6	2.0	1057.9	Fill	-	-	0	<5
TP-2	C1 / 70 mm	15.9	-	-	-	-	-	-	-

Notes: * '-' indicates no notable movement is apparent at any depth. 'New' indicates discernable change from previous monitoring interval.
** Shear movement is considered observable horizontal movement over a discrete plane.
*** Total movement is not considered until over 5 mm is observable (considered 'noise' <5 mm).

The SI casing displacement plots are attached in Appendix A for reference, which present two graphs for each SI casing location; this is a result of there being two 'sets' of grooves that control the orientation of the inclinometer probe reader. Attempts are made during installation to ensure one set of grooves is properly aligned with the direction of expected movement (i.e., downslope, typically designated A_0-A_{180}); however, shifts in the casing's orientation are typical prior to grout curing. Accordingly, both groove sets are read from the bottom of the SI casing to the top and should be reviewed in tandem for a comprehensive representation of the casing condition. Schematic 1 presents a top view of an SI casing depicting the general groove orientation.



Schematic 1: SI Casing Groove Orientation

Each SI casing displacement plot in Appendix A displays the A_0 direction in degrees relative to downslope or perpendicular to the slope crest (clockwise equalling a positive angle and counter-clockwise equalling a negative angle). These 'skew' angle values range from approximately 2° (BH21-15) to 14° (BH21-17).

When comparing the N#6 (nine-month) deflection plots dated February 25, 2022, to the previous N#5 (six-month) interval dated November 22, 2021, the following can be distinguished related to measured displacements:

- Borehole BH21-12 previous movements from depth intervals of approximately 2.5 m to 4.5 m (El. 1073.4 m to El. 1071.4 m) within fill materials and approximately 18.0 m to 21.0 m (El. 1057.9 m to El. 1054.9 m) within native clay had no new discernable displacements and both remained at approximately 5 mm total. These displacement areas should be further assessed during the next monitoring interval scheduled during the spring rainy season (end of May/early June 2022).
- Borehole BH12-17 previous movement from a depth range of approximately 1.0 m to 2.0 m (El. 1058.9 m to El. 1057.9 m) within fill materials had no new discernable displacement and remained at a total of approximately 2 mm. The large variance of measured deflection in the A_0-A_{180} direction at the existing ground surface slightly decreased from approximately -11 mm to -9 mm; accordingly, it is still suggested this movement is an outcome of the protective casing not being completely rigid during grout curing and/or tampering from public.
- All other borehole locations and depths had no discernable horizontal displacements over the three-month period from N#5 to N#6.

2.3 Vibrating Wire Piezometer Summary

A summary of the porewater pressure response calculated from the VWP measurements to date (N#1 through N#6) is provided in Table 3.

Table 3: Vibrating Wire Piezometer Pore Pressure Summary to Date

VWP Borehole No.	Analysis Section	VWP Tip Depth (m)	VWP Tip Elev. (m)	Soil Unit	Date	Measured Piezometric Elev. (m)	Water Pressure Head (m)	Calculated Bbar/r_u*
BH21-12	A (Crest)	15.2	1060.7	Clay	June 4, 2021	1061.2		
					June 14, 2021	1061.2	0.6	<0.1
					July 5, 2021	1061.3	0.6	<0.1
					August 21, 2021	1061.2	0.6	<0.1
					October 19, 2021	1061.2	0.5	<0.1
					November 22, 2021	1061.2	0.5	<0.1
					February 25, 2022	1061.1	0.5	<0.1
BH21-13	A (Toe)	9.1	1054.5	Clay	June 4, 2021	1054.5		
					June 14, 2021	<1054.5	<0.1	<0.1
					July 5, 2021	<1054.5	<0.1	<0.1
					August 21, 2021	<1054.5	<0.1	<0.1
					October 19, 2021	<1054.5	<0.1	<0.1
					November 22, 2021	<1054.5	<0.1	<0.1
					February 25, 2022	<1054.5	<0.1	<0.1

Table 3: Vibrating Wire Piezometer Pore Pressure Summary to Date

VWP Borehole No.	Analysis Section	VWP Tip Depth (m)	VWP Tip Elev. (m)	Soil Unit	Date	Measured Piezometric Elev. (m)	Water Pressure Head (m)	Calculated Bbar/r_u*
BH21-14	B1 (Crest)	13.7	1061.7	Clay	June 4, 2021	1061.8		
					June 14, 2021	1061.8	0.1	<0.1
					July 5, 2021	1061.8	0.1	<0.1
					August 21, 2021	1061.8	<0.1	<0.1
					October 19, 2021	1061.8	0.1	<0.1
					November 22, 2021	1061.8	0.1	<0.1
					February 25, 2022	1061.8	<0.1	<0.1
BH21-15	B2 (Crest)	13.7	1061.5	Clay	June 4, 2021	1061.5		
					June 14, 2021	<1061.5	<0.1	<0.1
					July 5, 2021	<1061.5	<0.1	<0.1
					August 21, 2021	1061.6	0.1	<0.1
					October 19, 2021	<1061.5	<0.1	<0.1
					November 22, 2021	<1061.5	<0.1	<0.1
					February 25, 2022	1061.5	<0.1	<0.1
BH21-16	B2 (Toe)	11.6	1052.9	Sand	June 4, 2021	1052.9		
					June 14, 2021	<1052.9	<0.1	<0.1
					July 5, 2021	<1052.9	<0.1	<0.1
					August 21, 2021	<1052.9	<0.1	<0.1
					October 19, 2021	1052.9	<0.1	<0.1
					November 22, 2021	<1052.9	<0.1	<0.1
					February 25, 2022	<1052.9	<0.1	<0.1
BH21-17	C1 (Mid)	14.6	1045.2	Clay	June 4, 2021	1045.3		
					June 14, 2021	1045.2	<0.1	<0.1
					July 5, 2021	<1045.2	<0.1	<0.1
					August 21, 2021	<1045.2	<0.1	<0.1
					October 19, 2021	<1045.2	<0.1	<0.1
					November 22, 2021	<1045.2	<0.1	<0.1
					February 25, 2022	1045.3	<0.1	<0.1

Note: * Water pressure head and Bbar/r_u not calculated during N#1 (one-week interval); all current (as of February 25, 2022) Bbar/r_u calculated pressures are under 0.1.

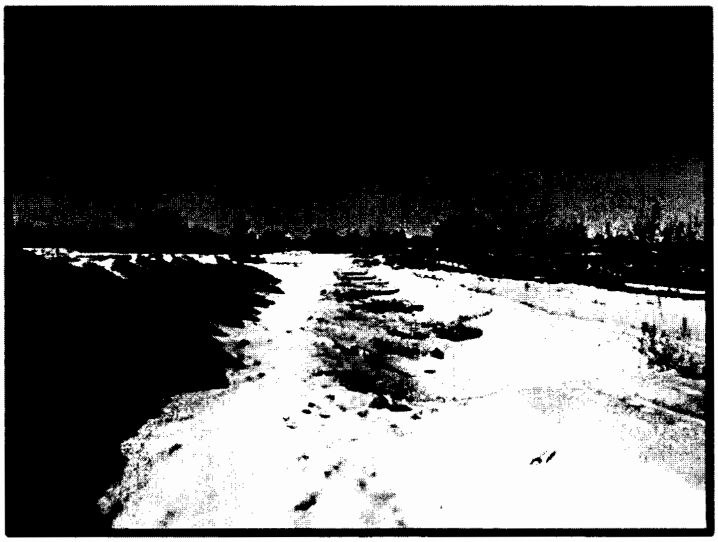
All piezometric elevations were comparable to the previous readings and were near or below the VWP tip installation elevation except for Borehole BH21-12, which remained at a water pressure head of approximately 0.5 m to 0.6 m. The resulting calculated Bbar/r_u groundwater pressure parameters were all still below a value of 0.1, typically used in slope stability analyses for fill (based on Tetra Tech's experience with similar materials in similar conditions). The water pressure heads also do not suggest significant elevated porewater conditions within potential native soils at the tip elevation.

2.4 Visual Observations

During the collection of the instrumentation data, the slope and general project area were also visually observed for any potential signs of new movement along the existing ground surface (e g , slumping, cracking, settlements)

Note that during the collection of the instrumentation data on February 25, 2022, snow coverage limited effective visual observations at the existing ground surface.

In general, the site conditions inclusive of the Erosion and Sediment Control Berm (ESCB) as well as the existing open excavation and material stockpiles directly south of the ESCB on the west side of the project site appeared unchanged from the previous monitoring interval. It is understood that backfilling of the project site is on hold until the spring. Photograph 1 depicts the general site condition around the ESCB at the time of Tetra Tech's field visit.



Photograph 1: General Site Condition on February 25, 2022

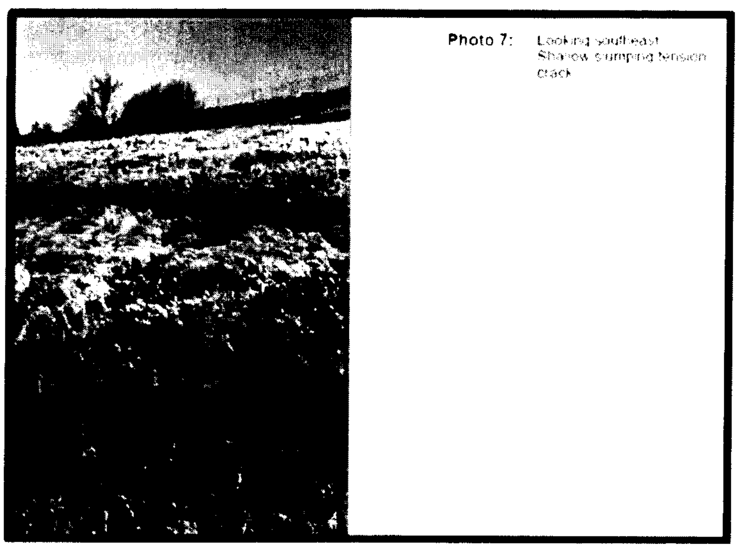
Visual observations of the general project area slope at the existing ground surface, though limited given snow coverage, presented no indicator of immediate potential slope movement or failure (i.e., no visual slumping, cracking, or new depressions)

Although the primary objective of the visual observations is to highlight areas of potential new or increasing displacements (thereby generally excluding commentary on now stable known slumps), previously existing tension cracking/slumping situated directly west of the 1998 slope failure toe berm area was identified by The City as a concern. Photograph 2 depicts the area of concern as communicated by The City via email (Dort[3]).

[3] Dort, Malcolm. Email to Kyle Haugrud Subject '*FW: Midfield Heights Geotechnical Reports*' February 15, 2022

<u>Photograph 2</u>: Existing Slump Identified by The City as Viewed February 25, 2022

The area depicted above was first observed and documented by Tetra Tech during the site reconnaissance conducted on April 24, 2019, as part of the preliminary geotechnical evaluation (Tetra Tech[4]). Photograph 3 is an excerpt from the preliminary evaluation report depicting this area of concern. Although the entire extent of this existing slump was not precisely portrayed by a 'Tension Cracks/Slumping' icon on 'Figure 3' within the same document, the intention has always been to review this area along with all other previously identified historical slumps during execution of the slope stabilization measure geotechnical detailed design.



<u>Photograph 3</u>: Existing Slump Identified by The City as Viewed April 24, 2019

[4] Tetra Tech Canada Inc. 2020. *Preliminary Geotechnical Evaluation and Slope Stability Assessment (Revision 1), Redevelopment of Midfield Mobile Home Park, Former RCMP Property, and EMS Station #4, Moncton Road NE and 16 Avenue NE, Calgary, Alberta.* File No. 704-ENG CGEO03639-01, dated February 7, 2020.