



THURBER ENGINEERING LTD.

July 28, 2022

File No.: 32121

Alberta Transportation
Provincial Building
9621-96 Avenue
Peace River, Alberta
T8S 1T4

Attention: Mr. Max Shannon

**ALBERTA TRANSPORTATION GRMP (CON0022164)
PEACE REGION (PEACE RIVER DISTRICT)
INSTRUMENTATION MONITORING RESULTS – SPRING 2022**

SECTION C

**SITE PH070: HWY 2:60, PEACE RIVER EAST HILL
RETAINING WALL SITE (km 33.84)**

Dear Mr. Shannon:

This report provides the results of the annual geotechnical instrumentation monitoring for the above-mentioned site as part of Alberta Transportation's Geohazard Risk Management Program for Peace Region – Peace River District (CON0022164).

It is a condition of this letter report that Thurber's performance of its professional services will be subject to the attached Statement of Limitations and Conditions.

1. FIELD PROGRAM AND INSTRUMENTATION STATUS

From August 2016 to October 2017, a 135 m long reinforced concrete tied-back tangent pile wall and a 41 m long reinforced concrete cantilever wall were constructed at the Hwy 2:60 Peace River East Hill Retaining Wall site (km 33.84) to mitigate the landslide affecting the highway. Four new slope inclinometers (SI-P40, SI-P58, SI-P90 and SI-P116) were installed in selected piles in the new pile walls. One shape accelerometer array (SAA-P74) and thirty vibrating wire strain gauges were installed in pile P74 of the tied back pile wall. Sixteen vibrating wire load cells were installed on selected anchors to monitor changes in anchor loads over time. The SAA, strain gauges and load cells were wired to a Campbell Scientific CR6 datalogger.

In addition to the instruments installed during construction, there are four SIs (SI13-3, SI14-2, SI14-3, and SI14-4), eight pneumatic piezometers (PN13-2A, PN13-3A, PN13-3B, PN14-2A, PN14-2B, PN14-3A, PN14-3B, and PN14-4A) and one standpipe piezometer (SP14-1) which were installed prior to construction.

The SIs, pneumatic piezometers, and standpipe piezometer were read on June 13, 2022, by Mr. Niraj Regmi, G.I.T. and Mr. Jayden Del Cid, both of Thurber Engineering Ltd.



The SIs were read using two RST Digital Inclinator probes with 2 ft. wheelbases and RST Pocket PC readouts. Inclinator reading depths were defined as per cable markings with respect to the top of the inclinometer casing. The pneumatic piezometers were read using an RST C108 pneumatic piezometer reader. The standpipe was read using a Heron dipmeter.

During previous readings cycles, the CR6 datalogger was downloaded manually at the site to a field laptop. Prior to the spring of 2022 readings, several upgrades were completed by Thurber to the datalogger station to allow for automated readings of the pile wall instruments. The updates included the installation of a new dual battery enclosure, replacing the single 12-volt battery powering the logger with two new batteries, and installation of a modem to allow remote connection to the datalogger. A computer was set up at Thurber's Edmonton office to automatically download the data once per day. The data from the automated readings for the East Hill CR6 datalogger is included in this report.

As of the current readings, three of the thirty strain gauges installed in pile P74 are no longer functional.

2. DATA PRESENTATION

2.1 General

SI plots for A and B directions are included in Appendix A. Where movement has been recorded the resultant plot (X direction, if applicable) and rate of movement have also been provided. Piezometer and load cell reading plots are also included in Appendix A.

Slope inclinometer, SAA, load cell, vibrating wire strain gauge, and piezometer reading summary tables are provided below. These tables also include instruments deleted from the GRMP program, for reference.

2.2 Zones of Movement

Zones of new movement were not observed in the SIs or SAA since the previous readings in the spring of 2021.

Zones of movements are summarized in Tables PH070-1 for the SIs and PH070-2 for the SAA. These tables also provide a historical account of the total movement, the depth of movement and the maximum rate of movement that has occurred in the SIs and the SAA since initialization.



**TABLE PH070-1
 SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 SLOPE INCLINOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: June 13, 2022

INSTRUMENT #	DATE INITIALIZED	TOTAL CUMULATIVE RESULTANT MOVEMENT AT NOTED DEPTH SINCE INITIAL READING (mm)	MAXIMUM RATE OF MOVEMENT (mm/yr)	CURRENT STATUS	DATE OF PREVIOUS READING	INCREMENTAL MOVEMENT SINCE PREVIOUS READING (mm)	RATE OF MOVEMENT (mm/yr)	CHANGE IN RATE OF MOVEMENT SINCE PREVIOUS READING (mm/yr)
SI10-1	March 4, 2010	53.4 mm over 0 m to 3.0 m depth in 173° direction	52.1 mm/yr. in September 2013	Removed during construction	September 15, 2016	N/A	N/A	N/A
		13.1 mm over 3.6 m to 6.6 m depth in 173° direction	3.8 mm/yr. in May 2015			N/A	N/A	N/A
		3.8 mm over 26.2 m to 28.0 m depth in 173° direction	3.3 mm/yr. in May 2010			N/A	N/A	N/A
SI10-2	March 4, 2010	27.5 mm over 4.1 m to 5.9 m depth in 330° direction	54.7 mm/yr. in September 2010	Sheared at ~6.1 m depth	June 1, 2011	N/A	N/A	N/A
		1.8 mm over 24.2 m to 26.0 m depth in 250° direction	4.4 mm/yr. in May 2010			N/A	N/A	N/A
SI13-2	August 4, 2013	33.3 over 15.5 m to 19.1 m depth in 17° direction	16.5 in September 2015	Removed during construction	June 2, 2016	N/A	N/A	N/A
SI13-3	August 4, 2013	No discernible movement	No discernible movement	Operational	July 7, 2021	N/A	N/A	N/A

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.



**TABLE PH070-1 – CONTINUED...
 SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 SLOPE INCLINOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: June 13, 2022

INSTRUMENT #	DATE INITIALIZED	TOTAL CUMULATIVE RESULTANT MOVEMENT AT NOTED DEPTH SINCE INITIAL READING (mm)	MAXIMUM RATE OF MOVEMENT (mm/yr)	CURRENT STATUS	DATE OF PREVIOUS READING	INCREMENTAL MOVEMENT SINCE PREVIOUS READING (mm)	RATE OF MOVEMENT (mm/yr)	CHANGE IN RATE OF MOVEMENT SINCE PREVIOUS READING (mm/yr)
SI14-2	December 16, 2014	6.5 mm over 2.8 m to 5.8 m depth in 185° direction	24.7 mm/yr in December 2014	Operational	July 7, 2021	No discernible movement	N/A	-0.1
		12.8 mm over 17.4 m to 21.0 m depth in 185° direction	18.9 mm/yr in December 2014			1.7	1.8	0.9
		8.5 mm over 24.7 m to 27.1 m depth in 185° direction	4.2 mm/yr in May 2015			1.3	1.4	1.1
SI14-3	December 16, 2014	19.9 mm over 3.3 m to 9.4 m depth in 171° direction	85.8 mm/yr in December 2014	Operational	July 7, 2021	0.8	0.9	0.4
SI14-4	December 20, 2014	44.7 mm over 17.3 m to 19.7 m depth in 171° direction	18.1 mm/yr in September 2016	Operational	July 7, 2021	4.0	4.2	1.3

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.



**TABLE PH070-1 – CONTINUED...
 SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 SLOPE INCLINOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: June 13, 2022

INSTRUMENT #	DATE INITIALIZED	TOTAL CUMULATIVE RESULTANT MOVEMENT AT NOTED DEPTH SINCE INITIAL READING (mm)	MAXIMUM RATE OF MOVEMENT (mm/yr.)	CURRENT STATUS	DATE OF PREVIOUS READING	INCREMENTAL MOVEMENT SINCE PREVIOUS READING (mm)	RATE OF MOVEMENT (mm/yr.)	CHANGE IN RATE OF MOVEMENT SINCE PREVIOUS READING (mm/yr.)
SI-P40	October 19, 2016	0.9 mm over 2.4 m to 19.5 m depth in 188° direction	-39.8 mm/yr. on April 4, 2017	Operational	July 7, 2021	2.1	2.2	1.2
		-3.0 mm over 0 m to 19.5 m depth in 188° direction	-57.3 mm/yr. on April 4, 2017			2.7	2.9	3.5
SI-P58	October 18, 2016	-7.5 mm over 2.4 m to 23.7 m depth in 209° direction	-70.8 mm/yr. on June 24, 2017	Operational	July 7, 2021	No discernible movement	N/A	-5.3
		-9.2 mm over 0.5 m to 23.7 m depth in 209° direction	-65.7 mm/yr. on June 24, 2017			No discernible movement	N/A	-3.8
SI-P90	October 18, 2016	-12.3 mm over 1.9 m to 23.3 m depth in 174° direction	-76.0 mm/yr. on April 8, 2017	Operational	July 7, 2021	No discernible movement	N/A	1.1
		-15.4 mm over 0.1 m to 23.3m depth in 174° direction	-97.5 mm/yr. on April 8, 2017			0.1	0.1	3.2
SI-P116	November 25, 2016	6.4 mm over 1.6 m to 18.1 m depth in 209° direction	24.6 mm/yr. on October 4, 2017	Operational	July 7, 2021	0.9	0.9	-1.5
		7.2 mm over 0.4 m to 18.1 m depth in 209° direction	27.1 mm/yr. on October 4, 2017			1.2	1.2	-0.8



**TABLE PH070-2
 SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 SHAPE ACCELEROMETER ARRAY INSTRUMENTATION READING SUMMARY**

Date Monitored: June 13, 2022

INSTRUMENT #	DATE INITIALIZED	TOTAL CUMULATIVE RESULTANT MOVEMENT AT NOTED DEPTH SINCE INITIAL READING (mm)	CURRENT STATUS	DATE OF PREVIOUS READING*	INCREMENTAL MOVEMENT SINCE PREVIOUS READING (mm)	AVERAGE RATE OF MOVEMENT SINCE PREVIOUS READING (mm/yr.)	CHANGE IN AVERAGE RATE OF MOVEMENT SINCE PREVIOUS READING (mm/yr.)
SAA-P74	January 31, 2017	-2.9 over 2.0 m to 31.0 m depth in 194° direction	Operational	July 7, 2021	1.1	1.1	-0.9
		-7.5 over 1.0 m to 31.0 m depth in 194° direction			0.6	0.6	-0.9

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.

* SAA readings are taken once per day and collected to datalogger. Movement rates are an average rate compared to the previous readings in Spring 2021



**TABLE PH070-3
 SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 VIBRATING WIRE STRAIN GAUGE INSTRUMENTATION READING SUMMARY**

Date Monitored: June 13, 2022

DEPTH FROM TOP OF PILE P74 (m)	GAUGE #	TOTAL MICROSTRAIN (µε)	CHANGE IN MICROSTRAIN SINCE PREVIOUS READINGS* (µε)	MEASURED TEMPERATURE (°c)	GAUGE #	TOTAL MICROSTRAIN (µε)	CHANGE IN MICROSTRAIN SINCE PREVIOUS READINGS* (µε)	MEASURED TEMPERATURE (°c)
UPSLOPE PILE FACE					DOWNSLOPE PILE FACE			
0.2	29	-108.3	4.6	14.5	28	-78.1	-1.1	17.4
2.4	8	-14.1	6.8	12.1	3	-2.3	-1.2	13.9
4.2	5	<i>Not functioning</i>	<i>N/A</i>	<i>N/A</i>	22	36.6	4.0	8.2
6.2	14	-167.7	-13.0	6.8	12	16.9	4.7	6.7
8.2	13	-147.6	-9.3	7.3	7	9.9	-7.3	7.1
10.2	4	-150.2	-9.9	7.9	25	18.6	12.1	7.9
12.2	1	-143.7	-7.7	8.4	11	-3.9	6.8	8.3
14.2	15	-126.2	-5.9	8.6	16	26.4	9.0	8.5
16.2	9	-120.4	-6.4	8.6	21	2.2	4.1	8.6
18.2	27	-85.7	-3.8	8.6	23	14.6	0.9	8.6
20.2	6	-105.3	-2.0	8.5	20	-62.3	-6.0	8.5
22.2	30	-46.6	2.8	8.4	19	<i>Not functioning</i>	<i>N/A</i>	8.5
24.2	2	-38.6	<i>N/A</i>	8.4	24	-122.2	-9.4	8.4
26.2	26	-39.7	-4.4	8.3	17	-107.9	-6.1	8.3
28.2	10	-66.5	-2.1	8.2	18	<i>Not functioning</i>	<i>N/A</i>	8.3

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.

* Previous readings on September 5, 2020



**TABLE PH070-4
 SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 PNEUMATIC PIEZOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: June 13, 2022

INSTRUMENT #	DATE INITIALIZED	TIP DEPTH (m)	GROUND ELEV. (m)	CURRENT STATUS	HIGHEST MEASURED WATER LEVEL BGS (m)	MEASURED PORE PRESSURE (kPa)	CURRENT WATER LEVEL BGS (m)	PREVIOUS WATER LEVEL BGS (m)	CHANGE IN WATER LEVEL SINCE PREVIOUS READING (m)
PN10-1 (33089)	Feb. 21, 2010	9.1	-	Removed during construction	8.06 on May 20, 2015	N/A	N/A	8.94 (Sep. 15, 2016)	N/A
PN10-2 (33091)	Feb. 21, 2010	19.0	-	Damaged/ Sheared	11.62 on May 20, 2015	N/A	N/A	17.46 (Sep. 27, 2017)	N/A
PN13-2A (35449)	August 4, 2013	6.1	490.6	Operational	4.35 on August 4, 2013	8.5	5.23	5.59	0.36
PN13-2B (35446)	August 4, 2013	26.7	490.6	Removed during construction	16.92 m on May 20, 2015	N/A	N/A	18.11 (June 2, 2016)	N/A
PN13-3A (35451)	August 4, 2013	9.1	486.4	Operational	7.27 on August 4, 2013	1.9	8.91	8.81	-0.10
PN13-3B (35444)	August 4, 2013	18.3	486.4	Operational	13.40 On May 20, 2017	37.8	14.45	14.78	0.33
PN14-2A (35757)	November 23, 2014	13.0	490.5	Operational	11.95 on May 20, 2015	3.1	12.68	12.66	-0.02
PN14-2B (35867)	November 23, 2014	28.0	490.5	Operational	19.14 on November 23, 2014	63.6	21.51	21.92	0.41
PN14-3A (35759)	November 23, 2014	13.0	490.9	Operational	11.59 on May 20, 2015	4.2	12.57	12.36	-0.21
PN14-3B (35866)	November 23, 2014	25.0	490.9	Operational	23.17 on November 23, 2014	3.9	24.60	24.60	0.00

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.



TABLE PH070-4 – CONTINUED...
SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
PNEUMATIC PIEZOMETER INSTRUMENTATION READING SUMMARY

Date Monitored: June 13, 2022

INSTRUMENT #	DATE INITIALIZED	TIP DEPTH (m)	GROUND ELEV. (m)	CURRENT STATUS	HIGHEST MEASURED WATER LEVEL BGS (m)	MEASURED PORE PRESSURE (kPa)	CURRENT WATER LEVEL BGS (m)	PREVIOUS WATER LEVEL BGS (m)	CHANGE IN WATER LEVEL SINCE PREVIOUS READING (m)
PN14-4A (35758)	November 23, 2014	10.5	486.5	Operational	9.02 on November 23, 2014	2.3	10.27	10.26	-0.01
PN14-4B (35865)	November 23, 2014	28.0	486.5	Not functioning	13.94 on November 23, 2014	N/A	N/A	27.82 (Sep. 29, 2019)	N/A

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.



**TABLE PH070-5
 SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 STANDPIPE PIEZOMETER INSTRUMENTATION READING SUMMARY**

Date Monitored: June 13, 2022

INSTRUMENT #	DATE INITIALIZED	TIP DEPTH (m)	GROUND ELEV. (m)	CURRENT STATUS	MAXIMUM GROUNDWATER LEVEL (m)	MEASURED GROUNDWATER DEPTH (m)	PREVIOUS READING (m)	CHANGE IN GROUNDWATER LEVEL SINCE PREVIOUS READING (m)
SP13-1	August 4, 2013	14.9	490.8	<i>Blocked at 0.9 m below top of casing</i>	1.18 on June 2, 2016	N/A	N/A	N/A
SP14-1	November 23, 2014	15.5	490.2	Operational	3.81 on September 15, 2016	3.21	3.76	0.55

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.



**TABLE PH070-6
 SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 VIBRATING WIRE LOAD CELL INSTRUMENTATION READING SUMMARY**

Date Monitored: June 13, 2022

ANCHOR NUMBER	LOAD CELL SERIAL #	SLS DESIGN LOAD / LOCK-OFF LOAD (kN)	MAXIMUM RECORDED LOAD (kN)	RECORDED LOAD ⁽¹⁾ (JUNE 13, 2022) (kN)	PREVIOUS RECORDED LOAD ⁽¹⁾ (JULY 7, 2021) (kN)	CHANGE IN LOAD SINCE PREVIOUS READING (kN)
G39WL	VC1977	253/253	242.18 on June 10, 2022	241.69	233.17	8.52
G40WU	VC1975	331/331	322.30 on June 3, 2022	321.52	315.00	6.52
G58WU	VC1972	366/358	375.01 on June 2, 2022	374.82	370.31	4.51
G59WL	VC1973	325/308	269.36 on June 3, 2022	268.42	268.37	0.05
G80WU	VC1969	246/331	307.89 on October 2, 2017	300.74	300.45	0.29
G80WL	VC1970	293/337	314.86 on January 3, 2018	313.68	311.37	2.31
G102WU	VC1974	366/358	343.61 on October 2, 2017	339.46	339.11	0.35
G102WL	VC1976	325/308	343.70 on April 7, 2017	316.83	316.12	0.71
G118PU	VC1980	320/257	217.20 on June 24, 2017	206.91	207.00	-0.09
G134PU	VC1979	288/229	222.80 on May 27, 2017	206.86	204.70	2.16
G150PU	VC1978	288/229	236.60 on May 28, 2017	218.56	218.41	0.15

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.

(1) Load cell data is recorded daily with datalogger on site. See Figures PH070-5 to PH070-8 in Appendix A for combined historical instrument readings.



TABLE PH070-6– CONTINUED...
SPRING 2022 – HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
VIBRATING WIRE LOAD CELL INSTRUMENTATION READING SUMMARY

Date Monitored: June 13, 2022

ANCHOR NUMBER	LOAD CELL SERIAL #	DESIGN LOAD / LOCK-OFF LOAD (kN)	MAXIMUM RECORDED LOAD (kN)	RECORDED LOAD ⁽¹⁾ (JUNE 13, 2022) (kN)	PREVIOUS RECORDED LOAD ⁽¹⁾ (JULY 7, 2022) (kN)	CHANGE IN LOAD SINCE PREVIOUS READING (kN)
G167PM	VC1971	302/175	179.15 on July 8, 2017	170.62	167.71	2.91
G190PL	VC1968	302/105	125.19 on June 4, 2022	125.19	124.16	1.03
G182PL ⁽²⁾	VC2023	302/0	13.96 on September 26, 2017	13.46	13.49	-0.03
G188PL ⁽²⁾	VC2024	302/0	16.38 on September 4, 2020	15.77	15.64	0.13
G202PL ⁽²⁾	VC2025	302/0	11.32 on November 9, 2019	11.13	10.72	0.41

Drawings 32121-PH070-1 and 32121-PH070-2 in Appendix A provide a sketch of the approximate locations of the monitoring instrumentation for this site.

- (1) Load cell data is recorded daily with datalogger on site. See Figures PH070-5 to PH070-8 in Appendix A for combined historical instrument readings.
- (2) Stiff anchors left with slack in the anchor nut during construction.



3. INTERPRETATION OF MONITORING RESULTS

Slope inclinometer SI14-2, located upslope of the new pile wall, showed no discernible movement over 2.8 m to 5.8 m depth, a rate of movement of 1.8 mm/yr over 17.4 m to 21.0 m depth, and a rate of movement of 1.4 mm/yr over 24.7 m to 27.1 m depth since the spring of 2021 readings. Slope inclinometer SI14-3, also located upslope of the new pile wall, showed a rate of movement of 0.9 mm/yr over 3.3 m to 9.4 m depth since the spring of 2021 readings.

SI13-3, located downslope of the new pile wall, continued to show no discernible movement. Based on the instrument readings and observations on site, it is believed that SI13-3 is not installed deep enough to intercept the shear surface of the landslide. SI14-4, also located downslope of the pile wall, showed a rate of movement of 4.2 mm/yr over 17.3 m to 19.7 m depth since the spring of 2021 readings.

Zones of movement in the piles were defined over the length of the pile and over the combined length of the pile and waler.

SI-P40, installed in Pile 40, showed a rate of movement of 2.2 mm/yr in the downslope direction over the length of the pile and a rate of movement of 2.9 mm/yr in the downslope direction over the combined length of the pile and waler since the spring of 2021 readings. Pile 40 has shown a total cumulative pile head movement of 0.9 mm in the downslope direction and a total cumulative movement of 3.0 mm in the upslope direction over the combined length of the pile and waler.

SI-P58, installed in Pile 58, showed no discernible downslope movement over either the length of the pile or over the combined length of the pile and waler since the spring of 2021 readings. The cumulative pile head movement was 7.5 mm in the uphill direction and the cumulative movement at the top of the water was 9.2 mm in the uphill direction.

SI-P90, installed in Pile 90, showed no discernible movement in the downslope direction over the length of the pile and a rate of movement of 0.1 mm/yr in the downslope direction over the combined length of the pile and waler since the spring of 2021 readings. Pile 90 has shown a total cumulative pile head movement of 12.3 mm in the upslope direction and a total cumulative movement of 15.4 mm in the upslope direction over the combined length of the pile and waler.

SI-P116, installed in Pile 116, showed a rate of movement of 0.9 mm/yr over the length of the pile and a rate of movement of 1.2 mm/yr over the combined length of the pile and waler since the spring of 2021 readings. Pile 116 has shown a total cumulative pile head movement of 6.4 mm in the downslope direction and a total cumulative movement of 7.2 mm in the downslope direction over the combined length of the pile and waler.

SAA-P74, installed in pile P74 of the pile wall, showed an average rate of movement of 1.1 mm/yr in the downslope direction over the length of the pile and an average rate of movement of 0.6 mm/yr over the combined length of the pile and waler in the downslope direction since the spring of 2021 readings. SAA-P74 has shown a total cumulative pile head movement of 2.9 mm in the upslope direction and a total cumulative movement of 7.5 mm in the upslope direction over the combined length of the pile and waler.



The strain gauge readings are summarized in Table PH070-3 and plotted on Figures PH070-1 and PH070-2 included in Appendix A. In general, the strain gauges showed small increases in negative (compressive) strain on the upslope pile face, while the strain gauges on the downslope pile face showed small increases in positive (tension) stress. The maximum change in microstrain since the previous readings was $-13.0 \mu\epsilon$.

Pneumatic piezometers PN13-2A, PN13-3B and PN14-2B showed increases in groundwater level of 0.36 m, 0.33 m, and 0.41 m, respectively, since the spring of 2021 readings. PN13-3A, PN14-2A, PN14-3A and PN14-4A showed decreases in groundwater level of 0.10 m, 0.02 m, 0.21 m, and 0.01 m, respectively. The current groundwater readings in PN13-3A, PN13-3A and PN14-4A were the lowest levels measured in the respective instruments since initialization. PN14-3B showed no change in groundwater level compared to the spring of 2021 readings.

Standpipe piezometer SP14-1 showed an increase in groundwater level of 0.55 m since the spring of 2021 readings.

The pneumatic and standpipe piezometer readings are summarized in Tables PH070-4 and PH070-5, and are plotted on Figures PH070-3 (by elevation) and PH070-4 (by depth) in Appendix A.

The majority of the load cells showed an increase in measured load compared to the spring of 2021 readings, ranging from 0.05 kN in VC1973 (anchor G59WL) to 8.52 kN in VC1875 (anchor G40WU). Load cells VC1980 (anchor G118PU) and VC2023 (G182PL) showed decreases in measured load of 0.09 kN and 0.03 kN, respectively, since the spring of 2021 readings. Load cells VC1977 (anchor G39WL), VC1975 (anchor G40WU) VC1972 (anchor G58WU) and VC1973 (anchor G59WL) registered all-time high loads during a period between June 2-10, 2022.

Overall, the load cells show a trend of relatively stable loads. Anchors G39WL and G40WU in Wall Section 2 currently show a trend of gradually increasing load, although these loads are still below the SLS design loads. Anchor G190PL, in the bottom (fifth) row of anchors in Wall Section 4, also shows a trend of slowly increasing load, however the design of the wall assumes that the anchors installed through the piles in this wall section will pick up load over time. Some of the load cells have also shown somewhat higher load values during the winter months, similar to what has been observed in other tied-back pile walls of similar configuration.

Load cells VC2023, VC2024, and VC2025 were installed on stiff anchors (G182PL, G188PL and G202PL', respectively) that were left with some slack to allow the piles to deform before the anchors pick up load. These anchors are located in wall Design Section 4. These load cells were connected to the datalogger on September 27, 2017. These load cells indicate current loads ranging from 11.13 kN to 15.77 kN, and these anchors have not shown significant changes in the loads since the end of construction, suggesting that there may still be some slack at the nut in these anchors.

The load cells on G80WU and G80WL in Design Section 4 are showing loads that are 54.74 kN and 20.68 kN above SLS design load, respectively. However, these anchors were intentionally locked off at a higher load than the SLS load during construction, with the expectation that they



would slacken over time. It should also be noted that anchor G58WU, in Wall Section 3A, is currently showing a load that is 8.82 kN above its SLS design load.

The load cell readings are summarized in Table PH070-6 above and plotted on Figures PH070-5 to 8, in Appendix A.

4. RECOMMENDATIONS

4.1 Future Work

The instruments should be read again in the spring of 2023.

It is recommended that the readings be used to complete a pile wall system performance review to compare the measured responses to the expected design values, especially for Design Section 4 to confirm that the performance is within expected limits.

Since the new movements noted in SI14-2 are below the tips of the pile wall, special attention should be paid when reviewing future readings to check for potential increases in the rate of movement. Although the movement to date had been very small, the road surface should also be visually monitored at this location to check for any subsidence or new cracks.

4.2 Instrumentation Repairs

No repairs are required at this time.



5. CLOSURE

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

Yours very truly,
Thurber Engineering Ltd.
Tarek Abdelaziz, Ph.D., P. Eng.
Principal | Senior Geotechnical Engineer

Bruce Nestor, P.Eng.
Geotechnical Engineer
/jf

Attachments:

- Statement of Limitations and Conditions
- Appendix A
 - Field Inspector's report
 - Site Plans Showing Approximate Instrument Locations (Drawings No. 32121-PH070-1 and 32121-PH070-2)
 - SI Reading Plots
 - SAA Reading Plots
 - Figure PH070-1 (Downslope Strain Gauge Values)
 - Figure PH070-2 (Upslope Strain Gauge Values)
 - Figure PH070-3 (Piezometric Elevations)
 - Figure PH070-4 (Piezometric Depths)
 - Figure PH070-5 (Section 2 Load cells)
 - Figure PH070-6 (Section 3A Load Cells)
 - Figure PH070-7 (Section 3B Load Cells)
 - Figure PH070-8 (Section 4 Load Cells)



STATEMENT OF LIMITATIONS AND CONDITIONS

1. STANDARD OF CARE

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

2. COMPLETE REPORT

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

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

3. BASIS OF REPORT

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

4. USE OF THE REPORT

The information and opinions expressed in the Report, or any document forming part of the Report, are for the sole benefit of the Client. NO OTHER PARTY MAY USE OR RELY UPON THE REPORT OR ANY PORTION THEREOF WITHOUT THURBER'S WRITTEN CONSENT AND SUCH USE SHALL BE ON SUCH TERMS AND CONDITIONS AS THURBER MAY EXPRESSLY APPROVE. Ownership in and copyright for the contents of the Report belong to Thurber. Any use which a third party makes of the Report, is the sole responsibility of such third party. Thurber accepts no responsibility whatsoever for damages suffered by any third party resulting from use of the Report without Thurber's express written permission.

5. INTERPRETATION OF THE REPORT

- a) Nature and Exactness of Soil and Contaminant Description: Classification and identification of soils, rocks, geological units, contaminant materials and quantities have been based on investigations performed in accordance with the standards set out in Paragraph 1. Classification and identification of these factors are judgmental in nature. Comprehensive sampling and testing programs implemented with the appropriate equipment by experienced personnel may fail to locate some conditions. All investigations utilizing the standards of Paragraph 1 will involve an inherent risk that some conditions will not be detected and all documents or records summarizing such investigations will be based on assumptions of what exists between the actual points sampled. Actual conditions may vary significantly between the points investigated and the Client and all other persons making use of such documents or records with our express written consent should be aware of this risk and the Report is delivered subject to the express condition that such risk is accepted by the Client and such other persons. Some conditions are subject to change over time and those making use of the Report should be aware of this possibility and understand that the Report only presents the conditions at the sampled points at the time of sampling. If special concerns exist, or the Client has special considerations or requirements, the Client should disclose them so that additional or special investigations may be undertaken which would not otherwise be within the scope of investigations made for the purposes of the Report.
- b) Reliance on Provided Information: The evaluation and conclusions contained in the Report have been prepared on the basis of conditions in evidence at the time of site inspections and on the basis of information provided to Thurber. Thurber has relied in good faith upon representations, information and instructions provided by the Client and others concerning the site. Accordingly, Thurber does not accept responsibility for any deficiency, misstatement or inaccuracy contained in the Report as a result of misstatements, omissions, misrepresentations, or fraudulent acts of the Client or other persons providing information relied on by Thurber. Thurber is entitled to rely on such representations, information and instructions and is not required to carry out investigations to determine the truth or accuracy of such representations, information and instructions.
- c) Design Services: The Report may form part of design and construction documents for information purposes even though it may have been issued prior to final design being completed. Thurber should be retained to review final design, project plans and related documents prior to construction to confirm that they are consistent with the intent of the Report. Any differences that may exist between the Report's recommendations and the final design detailed in the contract documents should be reported to Thurber immediately so that Thurber can address potential conflicts.
- d) Construction Services: During construction Thurber should be retained to provide field reviews. Field reviews consist of performing sufficient and timely observations of encountered conditions in order to confirm and document that the site conditions do not materially differ from those interpreted conditions considered in the preparation of the report. Adequate field reviews are necessary for Thurber to provide letters of assurance, in accordance with the requirements of many regulatory authorities.

6. RELEASE OF POLLUTANTS OR HAZARDOUS SUBSTANCES

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

7. INDEPENDENT JUDGEMENTS OF CLIENT

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



**ALBERTA TRANSPORTATION GRMP (CON0022164)
PEACE REGION (PEACE RIVER DISTRICT)
INSTRUMENTATION MONITORING RESULTS**

SPRING 2022

**APPENDIX A
DATA PRESENTATION**

**SITE PH070: HWY 2:60, PEACE RIVER EAST HILL
RETAINING WALL SITE (km 33.84)**

**ALBERTA TRANSPORTATION
PEACE REGION (PEACE RIVER DISTRICT)
INSTRUMENTATION MONITORING FIELD SUMMARY (PH070)
SPRING 2022**

Location: East Hill Retaining Wall Site (HWY 2:60 C1 33.840) File Number: 32121 Probe: RST set 5R & 8R Cable: RST set 5R & 8R	Readout: Extension: 2.75" Temp: 13 Read by: NKR/JD
--	---

SLOPE INCLINOMETER (SI) READINGS

SI#	GPS Location (UTM 11)		Date	Stickup (m)	Depth from top of Casing (ft)	Magn. North A+ Groove	Current Bottom Depth Readings				Probe/ Reel #	Remarks
	Easting (m)	Northing (m)					A+	A-	B+	B-		
SI13-3	485285	6230649	13-Jun-22	1.32	66 to 2	170	-1101	1122	-1453	1433	5R/5R	
SI14-2	485222	6230662	13-Jun-22	1.21	98 to 2	160	436	-412	43	-71	5R/5R	
SI14-3	485260	6230664	13-Jun-22	1.23	98 to 2	150	-420	433	526	532	5R/5R	
SI14-4	485261	6230648	13-Jun-22	0.70	102 to 2	175	939	-989	602	-614	5R/5R	Use Dummy Probe for spring readings
SI-P40	485240	6230661	13-Jun-22	0.94	66 to 2	212	-158	169	205	-198	8R/8R	Pile Wall
SI-P58	485263	6230633	13-Jun-22	1.00	80 to 2	131	-1844	1858	-728	732	8R/8R	Pile Wall
SI-P90	485312	6230668	13-Jun-22	0.80	78 to 2	143	-343	358	322	-315	8R/8R	Pile Wall
SI-P116	485348	6230622	13-Jun-22	1.12	62 to 2	203	227	-220	-895	902	8R/8R	Pile Wall

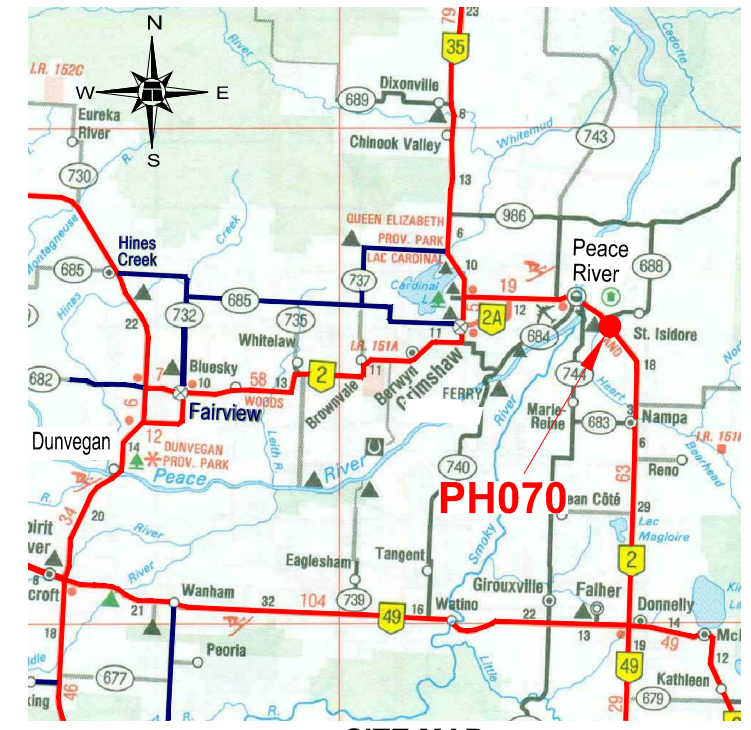
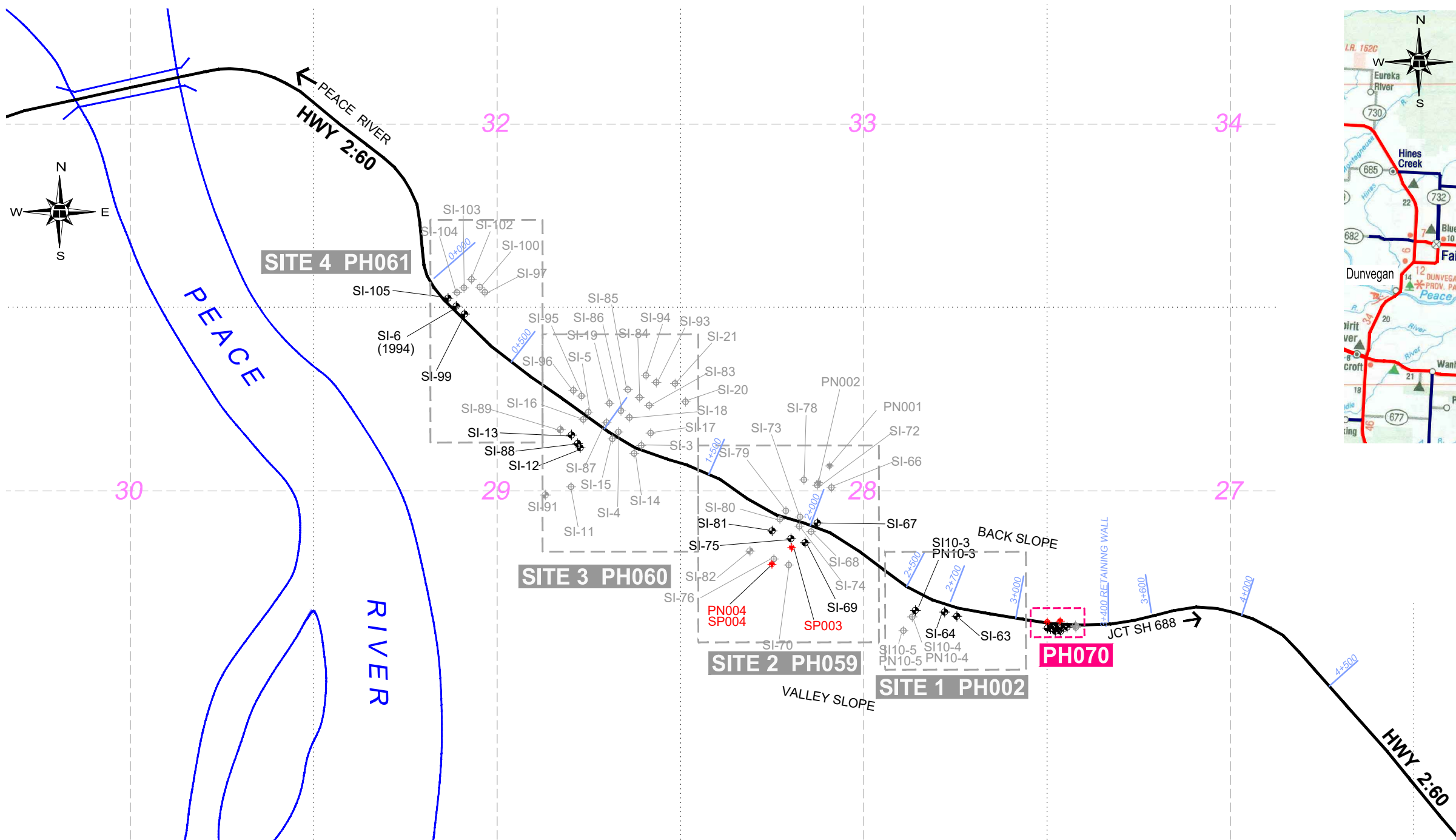
PNEUMATIC PIEZOMETER (PN) READINGS

PN#	GPS Location (UTM 11)		Date	Reading (kPa)	Identification Number
	Easting (m)	Northing (m)			
PN13-2A	485283.33	6230665.34	13-Jun-22	8.5	35449
PN13-3A	485284.52	6230648.64	13-Jun-22	1.9	35451
PN13-3B	485284.52	6230648.64	13-Jun-22	37.8	35444
PN14-2A	485221.85	6230662.44	13-Jun-22	3.1	35757
PN14-2B	485221.85	6230662.44	13-Jun-22	63.6	35867
PN14-3A	485260.48	6230664.41	13-Jun-22	4.2	35759
PN14-3B	485260.48	6230664.41	13-Jun-22	3.9	35866
PN14-4A	485260.79	6230648.07	13-Jun-22	2.3	35758

STANDPIPE PIEZOMETER (SP) READINGS

SP#	GPS Location (UTM 11)		Date	Stick-up (m)	Reading below top of casing (m)	Bottom Pipe Depth (below top of casing (m))
	Easting (m)	Northing (m)				
SP14-1	485221.459	6230689.704	13-Jun-22	1.00	4.21	15.45

Datalogger is connected to a modem and does not need to be downloaded
SI14-04 Bottom of probe sits at 101 ft



SITE MAP
NOT TO SCALE

LEGEND :

- SLOPE INCLINOMETER
(currently using)
- SP STANDPIPE PIEZOMETER
- PN PNEUMATIC PIEZOMETER
- SLOPE INCLINOMETER
(not in use)
- PNEUMATIC PIEZOMETER
(not in use)

SITE PLAN
1:20,000 (APPROX.)

PEACE REGION (PEACE RIVER DISTRICT)

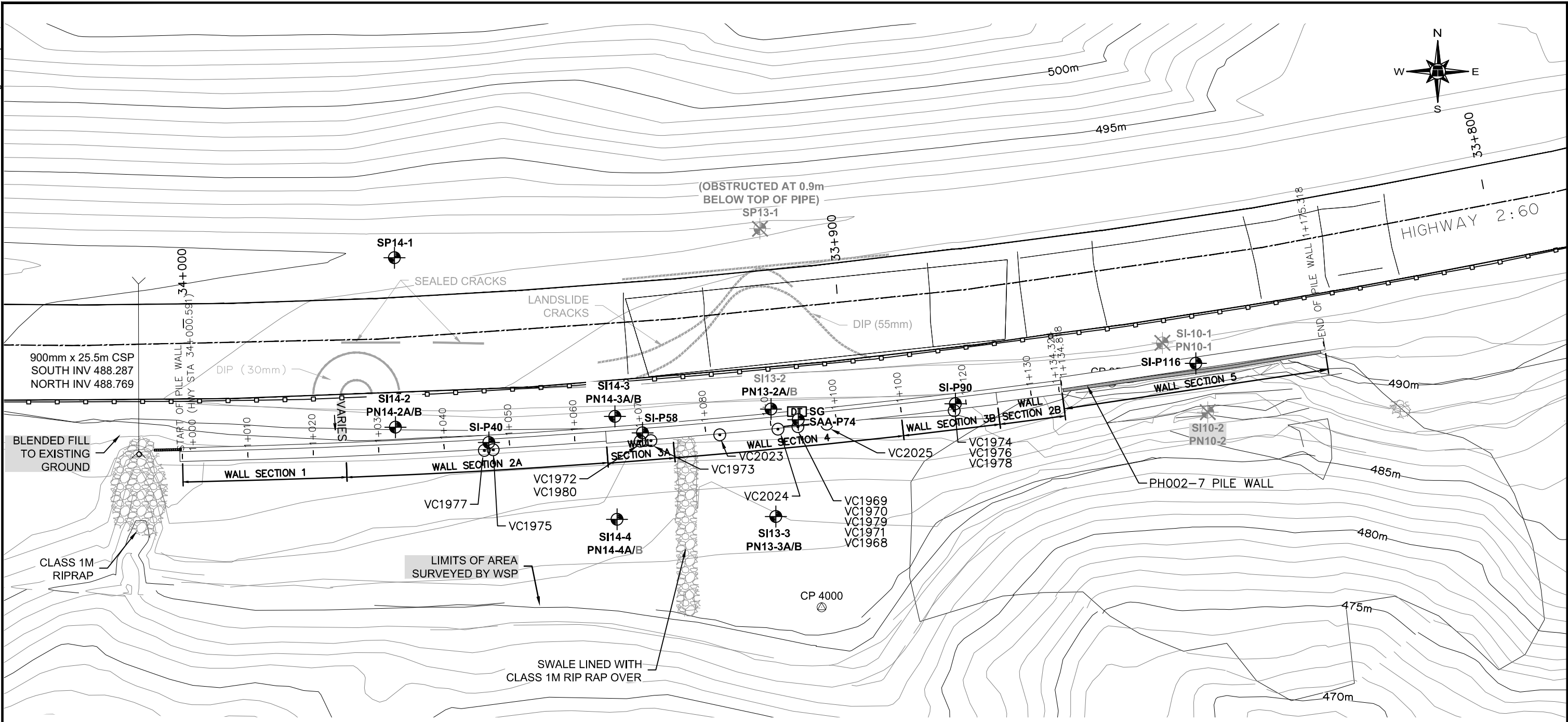
PH070: PEACE RIVER EAST HILL INSTRUMENTATION READINGS












DWG No. 32121-PH070-1

DRAWN BY	ML
DESIGNED BY	BWN
APPROVED BY	DWP
SCALE	AS SHOWN
DATE	SEPTEMBER 2021
FILE No.	32121

THURBER ENGINEERING LTD.


H:\32000\32121 AT GRMP Peace River District 2021-2025\CAD\2021 INSTRUMENT\32121-PH070-2.dwg - 2 - Sep. 08. 2021



- LEGEND**
-  INSTRUMENT LOCATION
 -  DAMAGED / NON - OPERATIONAL INSTRUMENT LOCATION
 -  VIBRATING WIRE LOAD CELL LOCATION
 -  DATALOGGER
 -  SLOPE INCLINOMETER
 -  PNEUMATIC PIEZOMETER
 -  TEST HOLE
 -  VIBRATING WIRE LOAD CELL
 -  CONTROL POINT
 -  GUARD RAIL
 -  STRAIN GAUGES

NOTES
 LOAD CELLS, SHAPE ACCELEROMETER ARRAY, AND STRAIN GAUGES ARE CONNECTED TO A CAMPBELL SCIENTIFIC CR6 DATALOGGER (SERIAL # 4301)






PEACE REGION (PEACE RIVER DISTRICT)

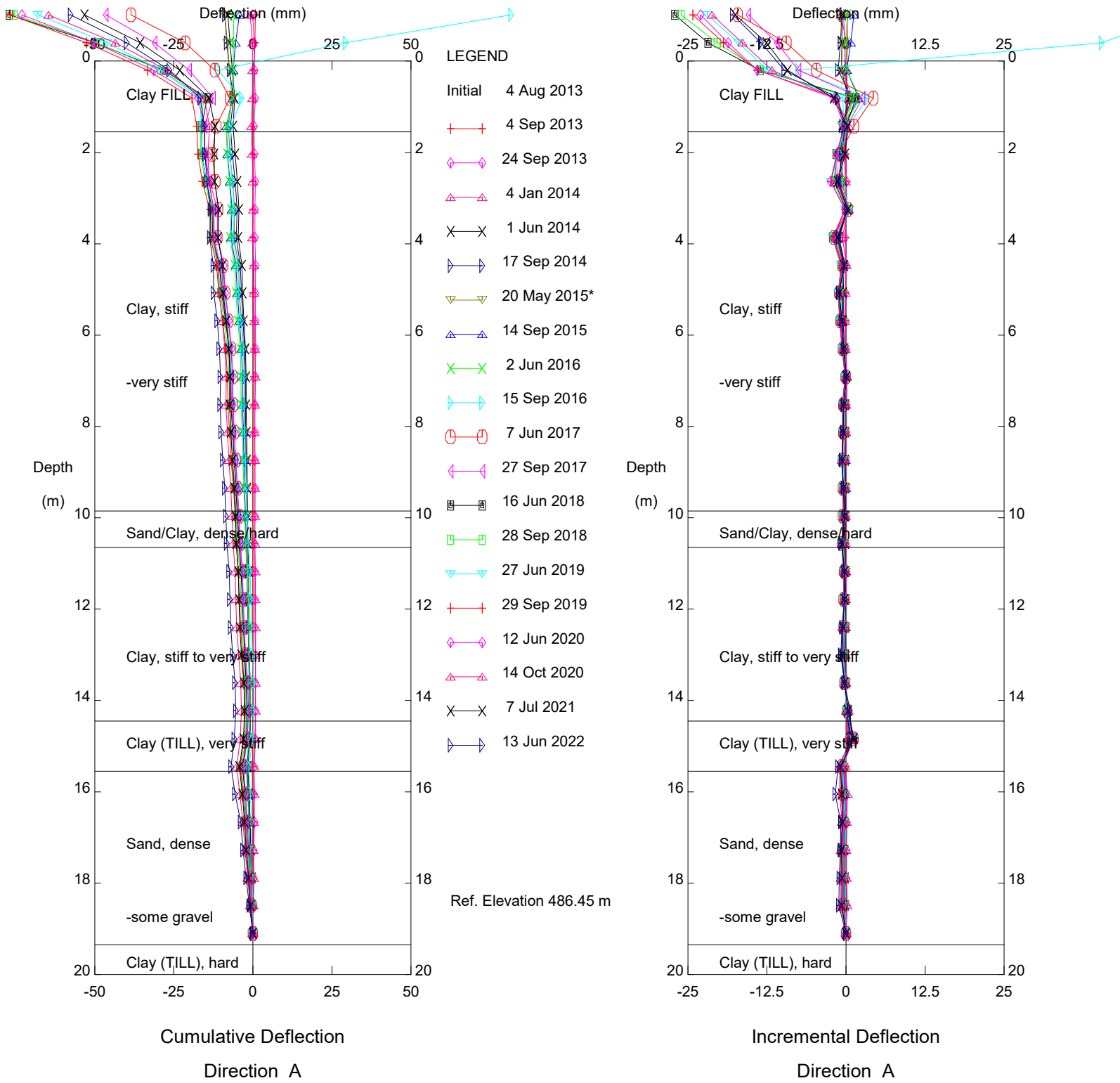
**PH070: HWY 2:60 PEACE RIVER EAST HILL
 RETAINING WALL SITE (km 33.84)
 INSTRUMENTATION READINGS**

DWG No. 32121-PH070-2

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APPROVED BY	DWP
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DATE	SEPTEMBER 2021
FILE No.	32121



THURBER ENGINEERING LTD.

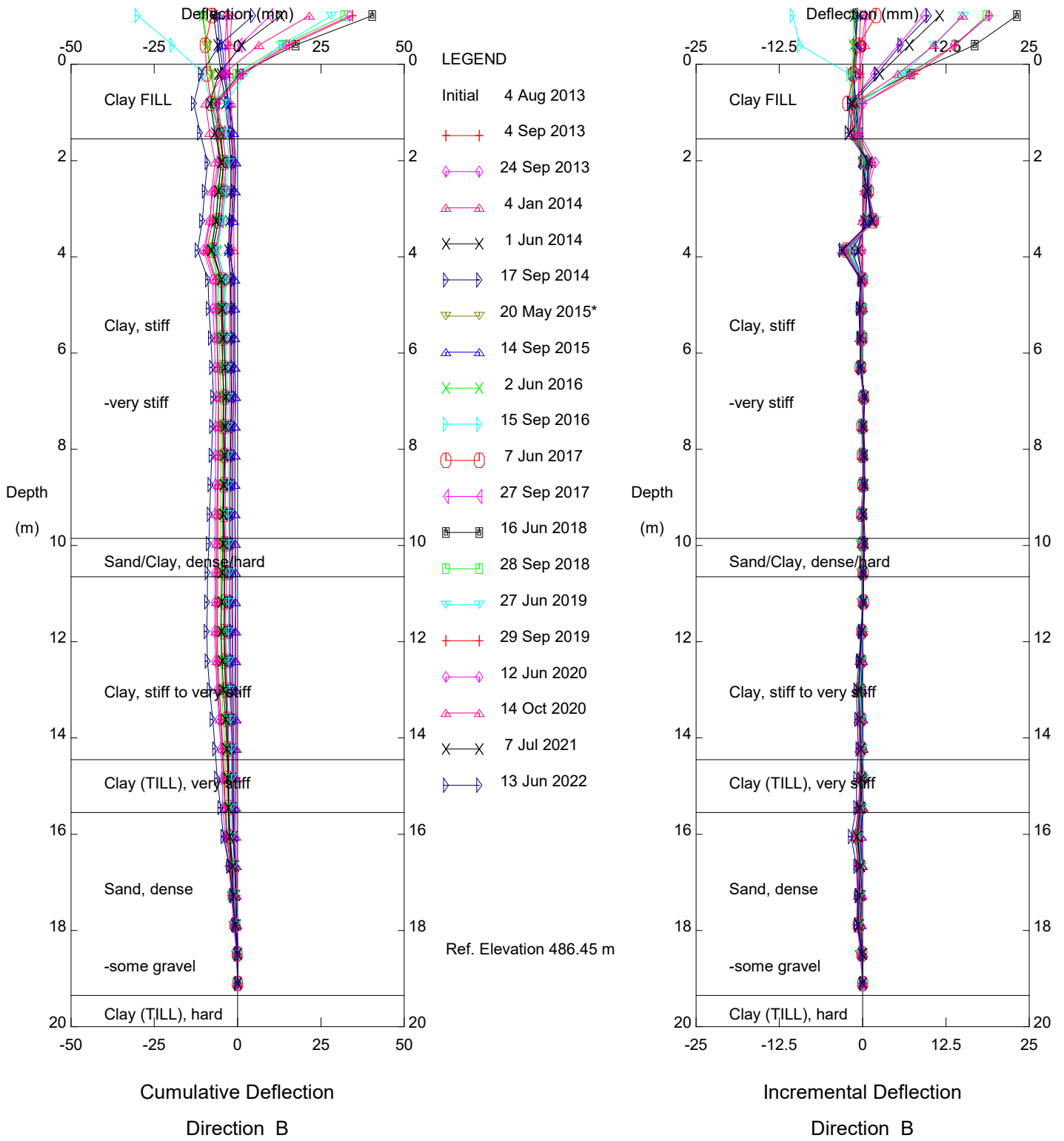


Peace River East Hill PH070, Inclinometer SI13-3

Alberta Transportation

Sets marked * include zero shift and/or rotation corrections.

Thurber Engineering Ltd.

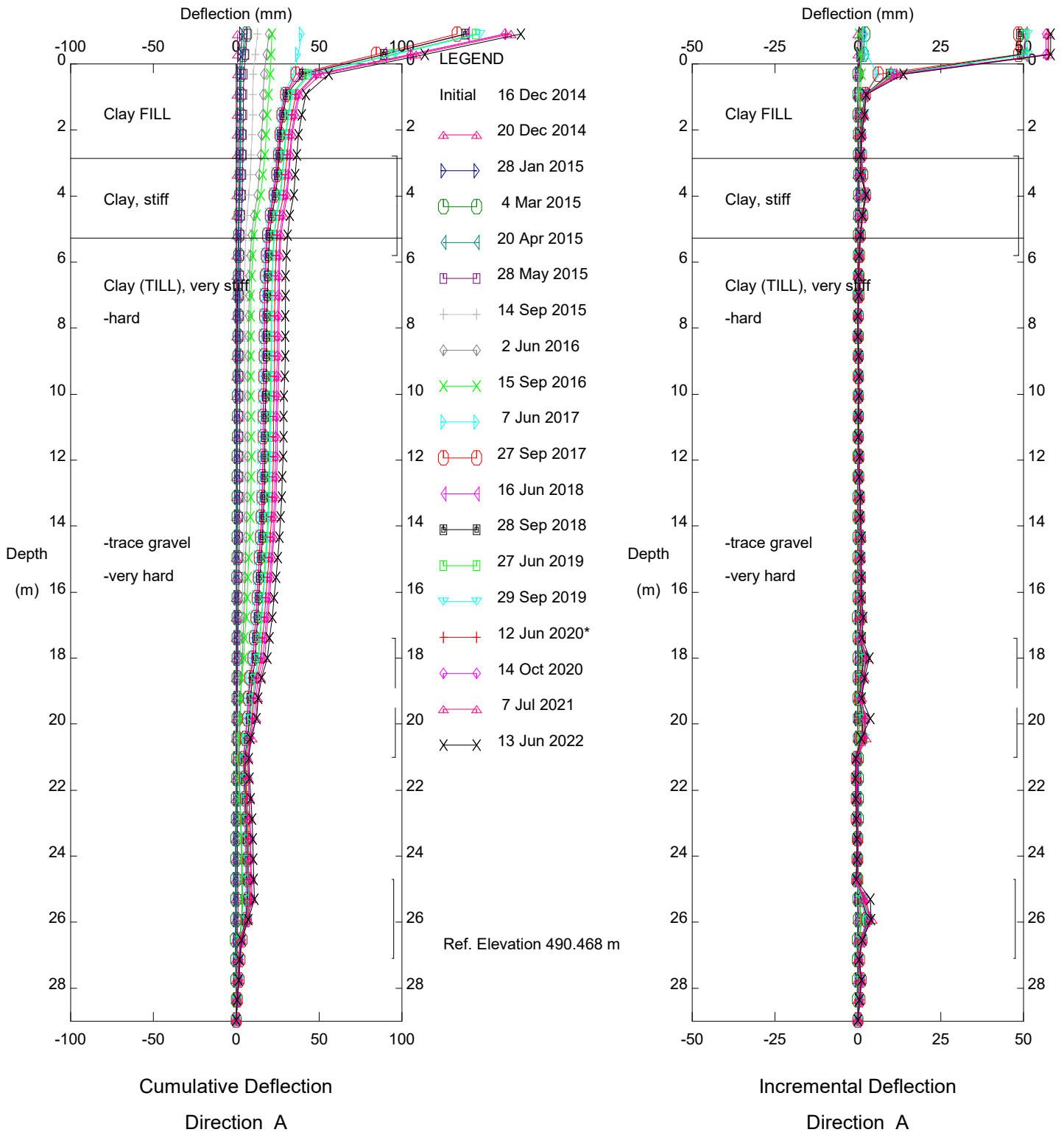


Peace River East Hill PH070, Inclinometer SI13-3

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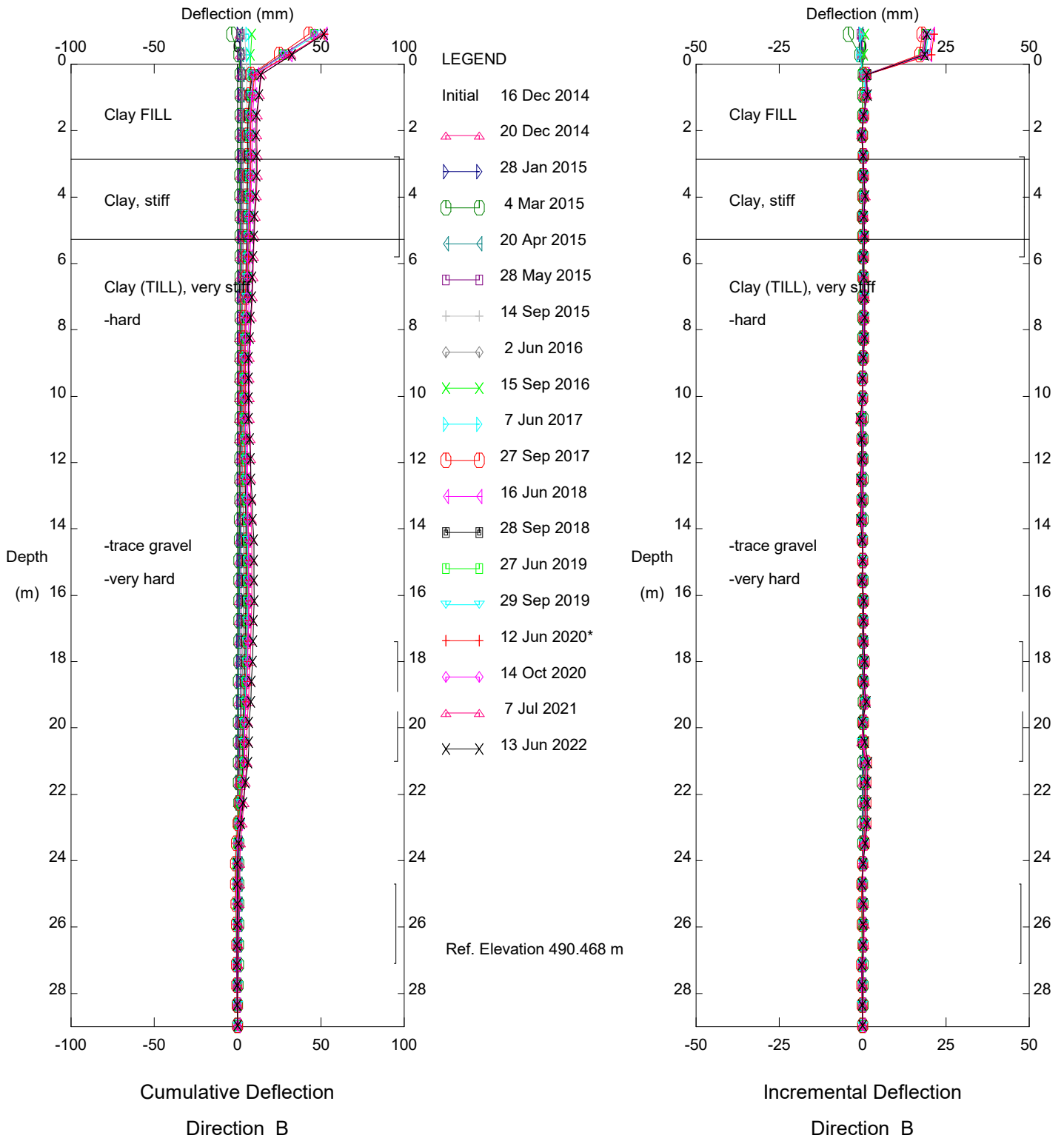
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Peace River East Hill PH070, Inclinometer SI14-2

Alberta Transportation

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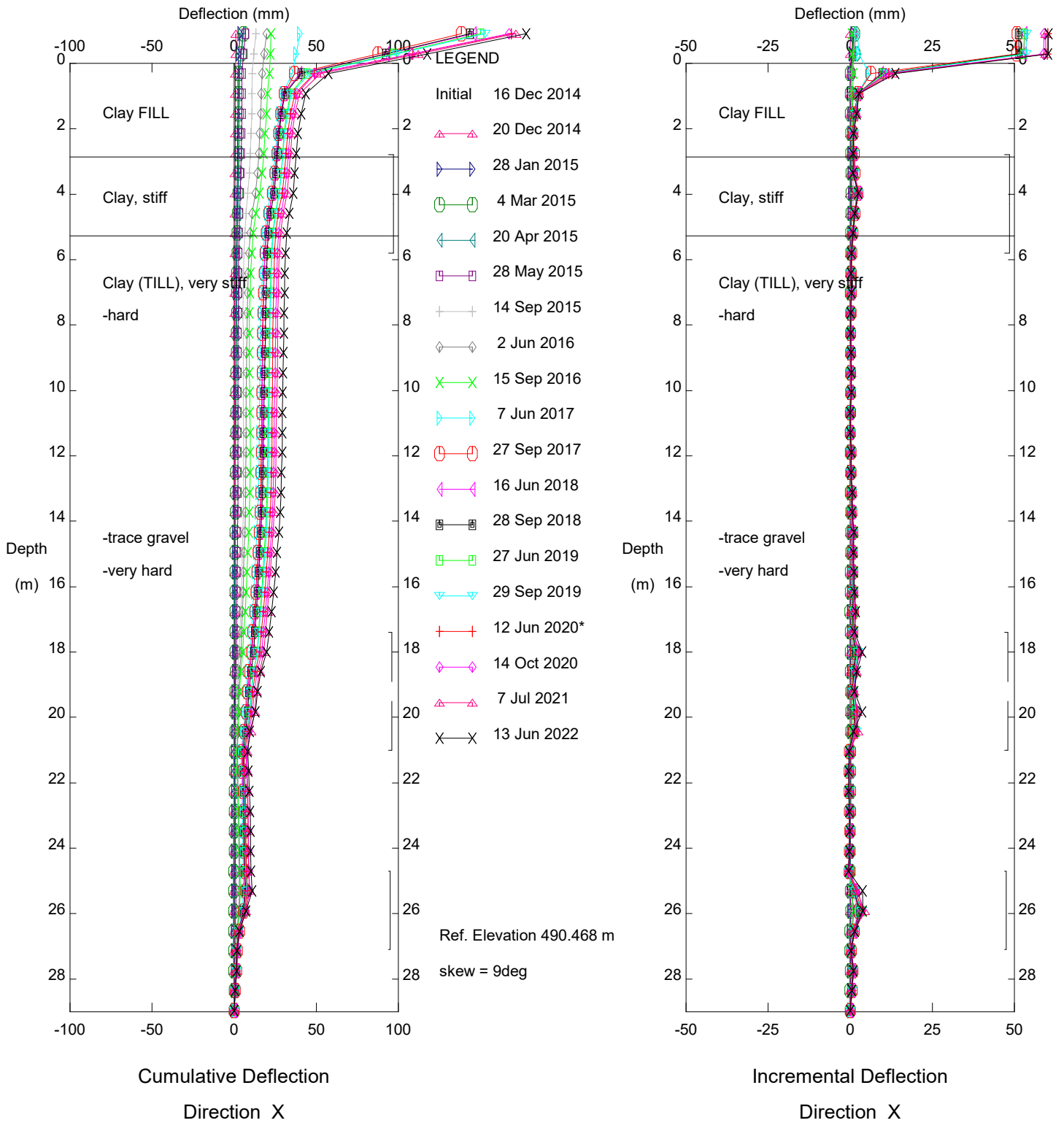


Peace River East Hill PH070, Inclinometer SI14-2

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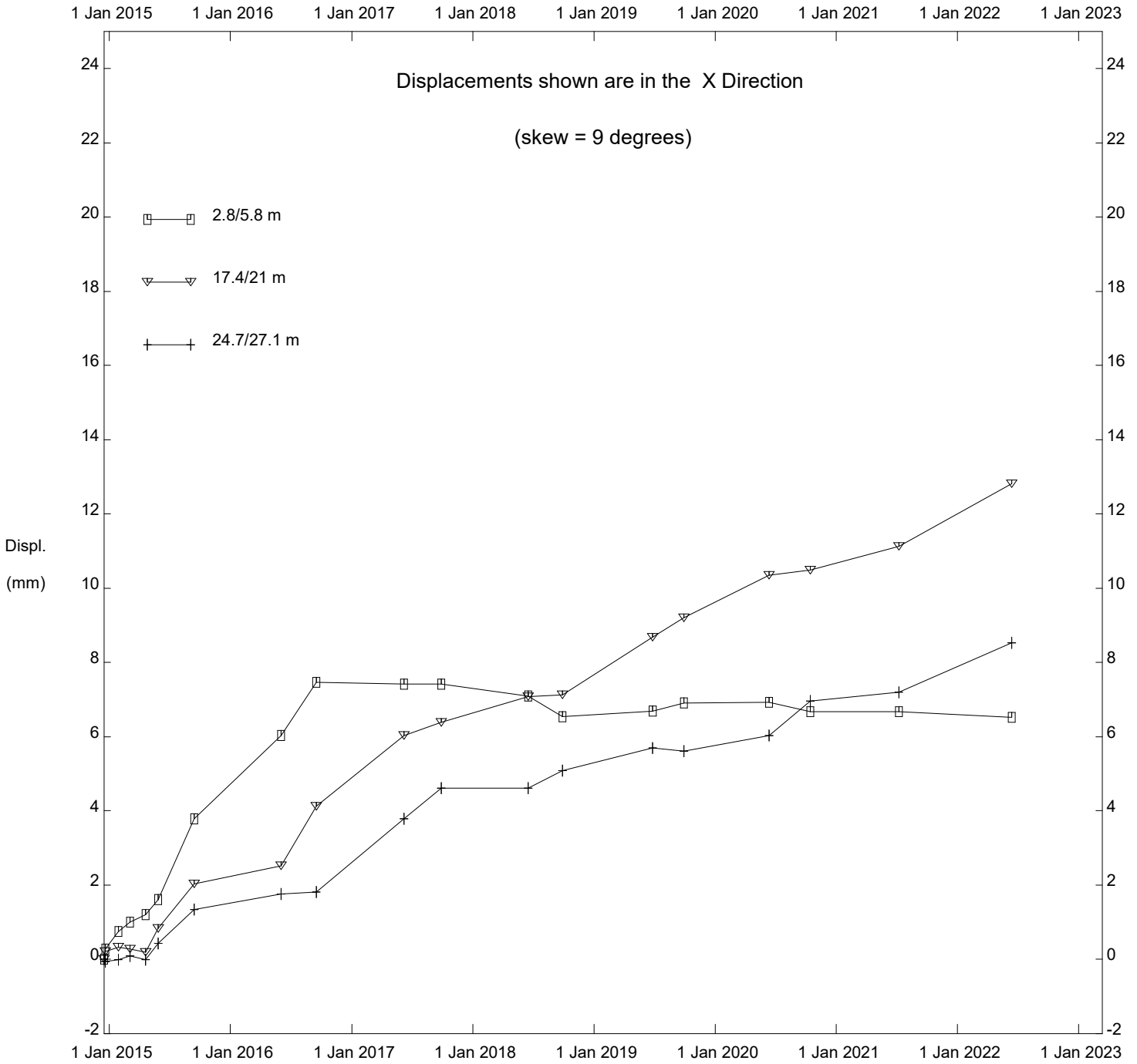


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Alberta Transportation

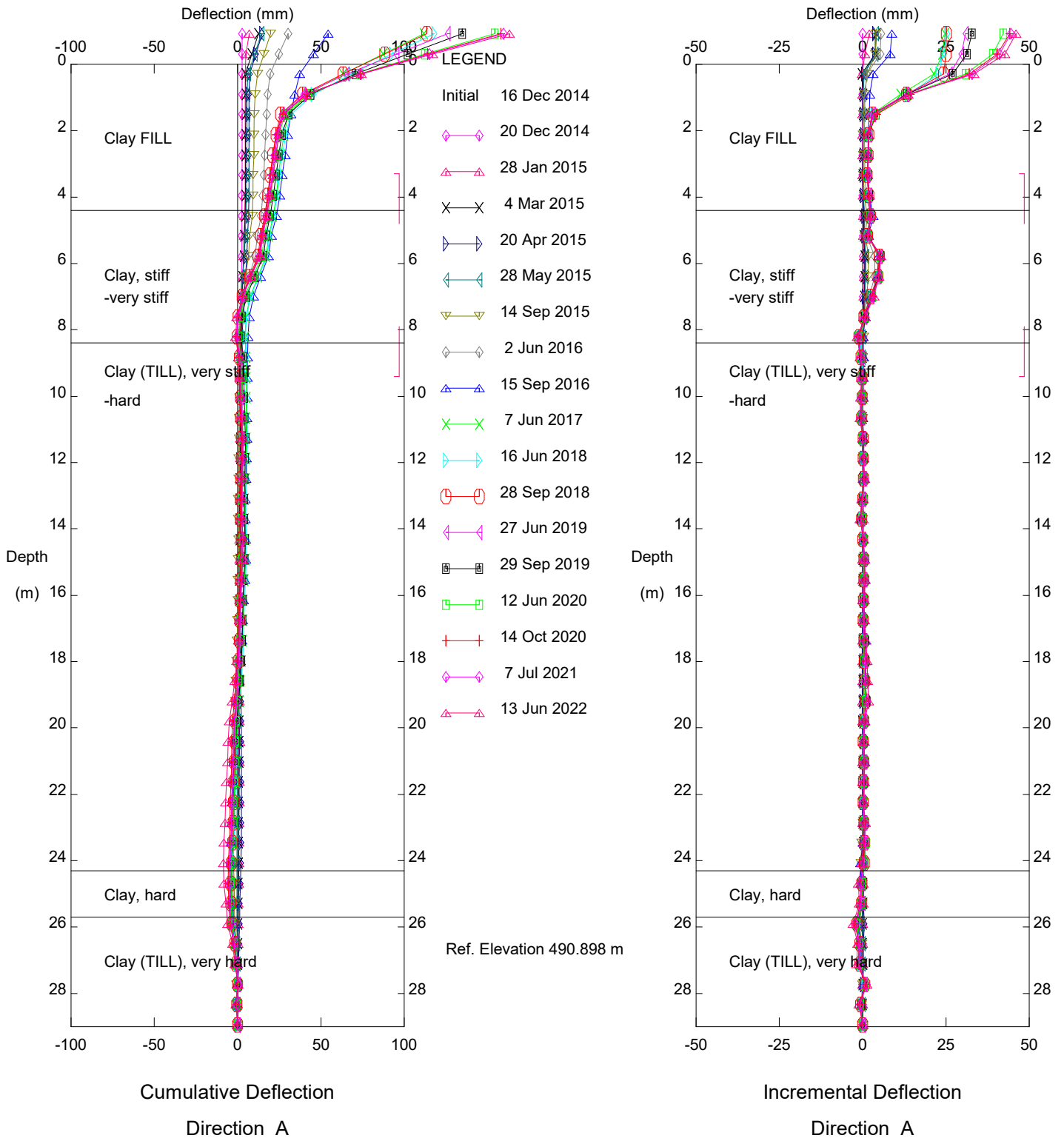
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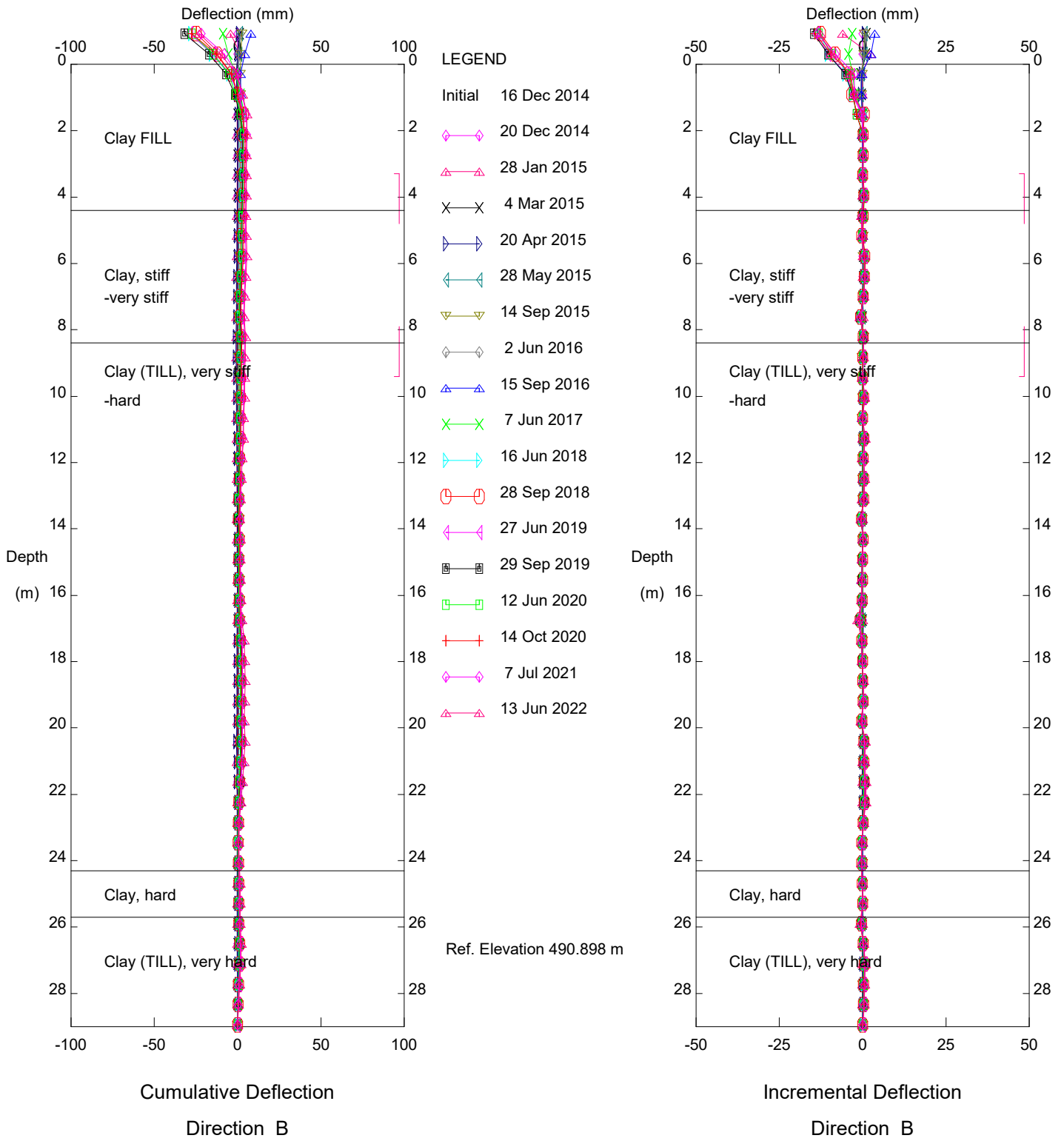
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Alberta Transportation



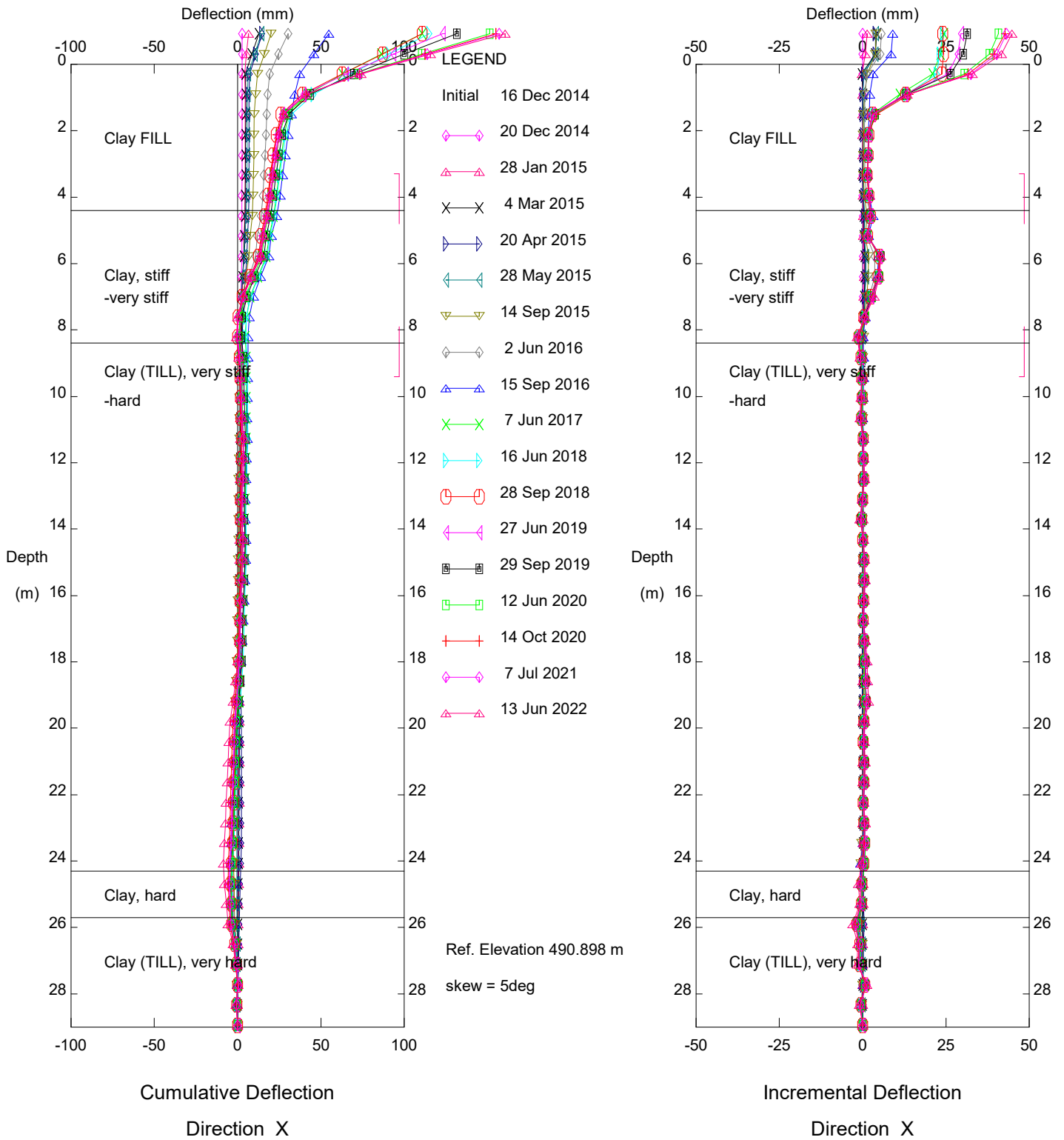
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Alberta Transportation



Peace River East Hill PH070, Inclinator SI14-3

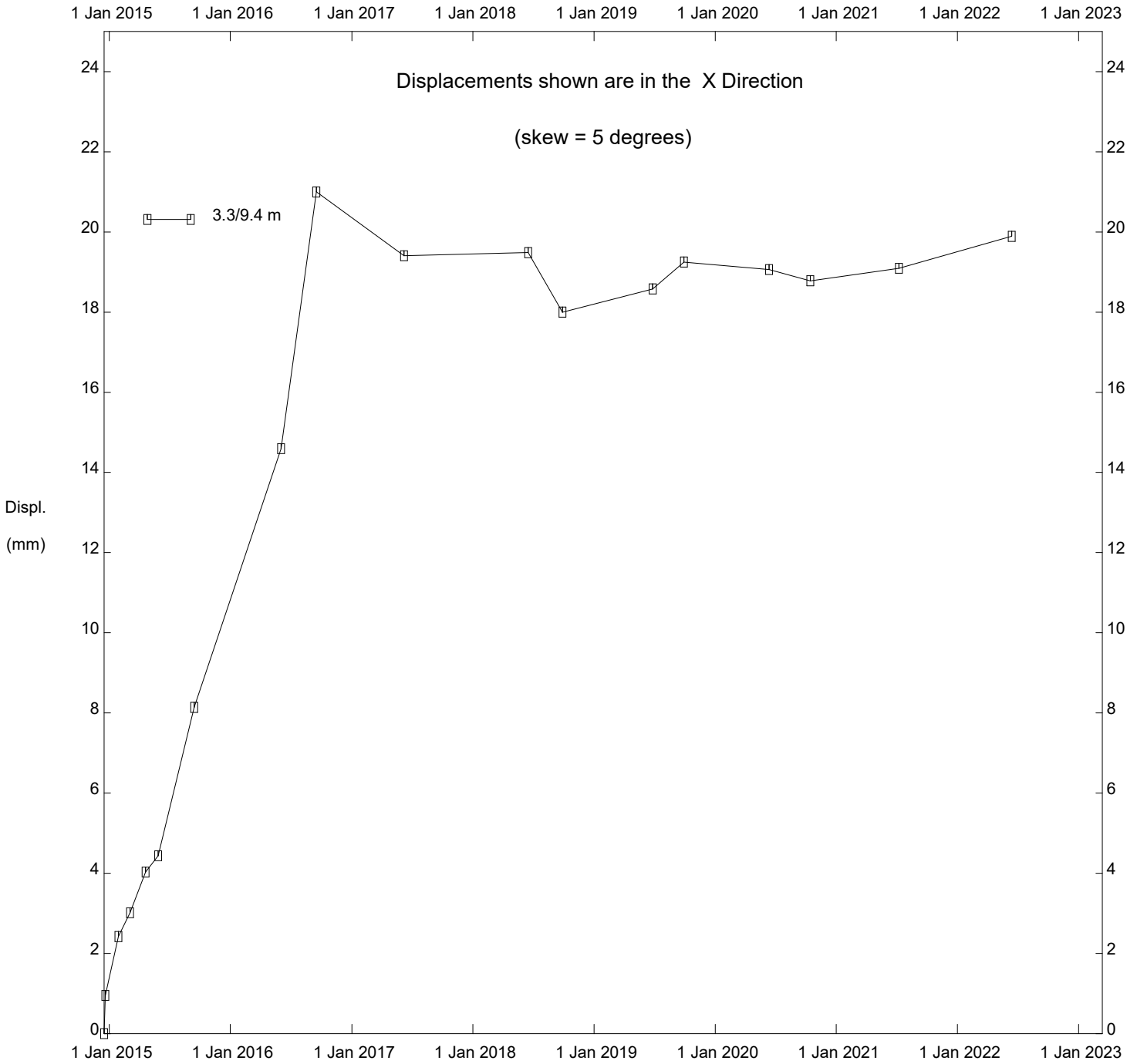
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Peace River East Hill PH070, Inclinometer SI14-3

Alberta Transportation

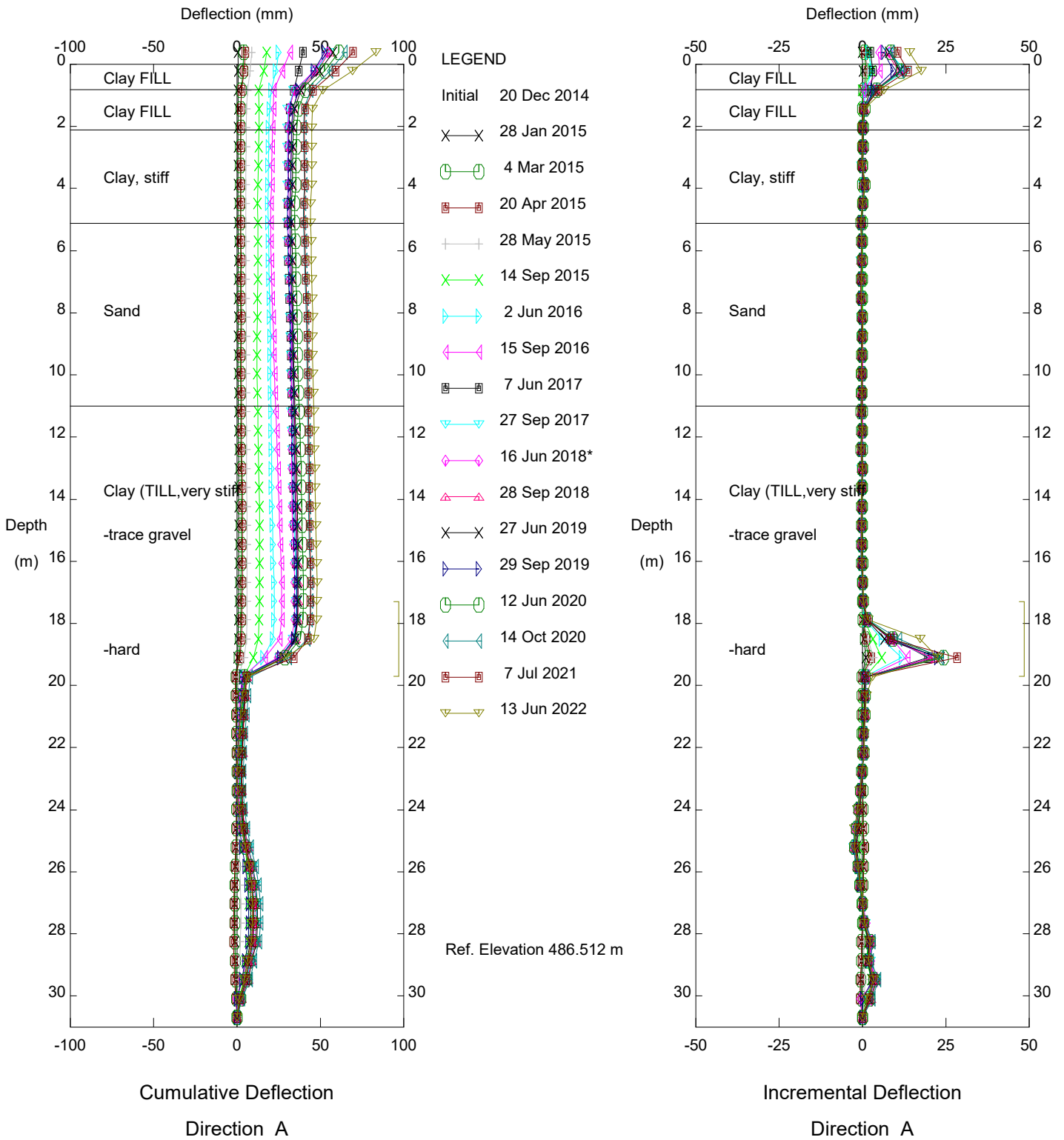
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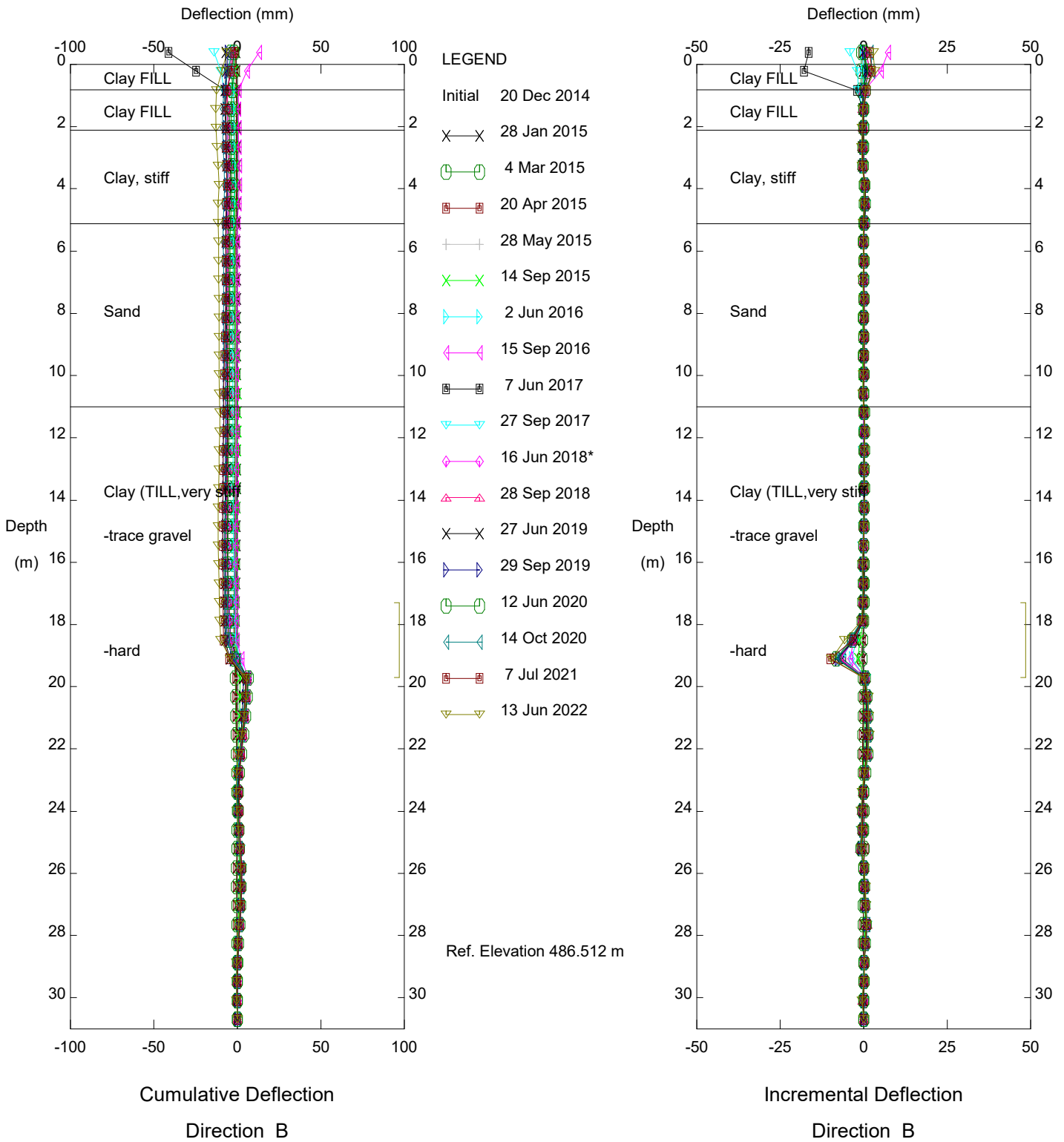
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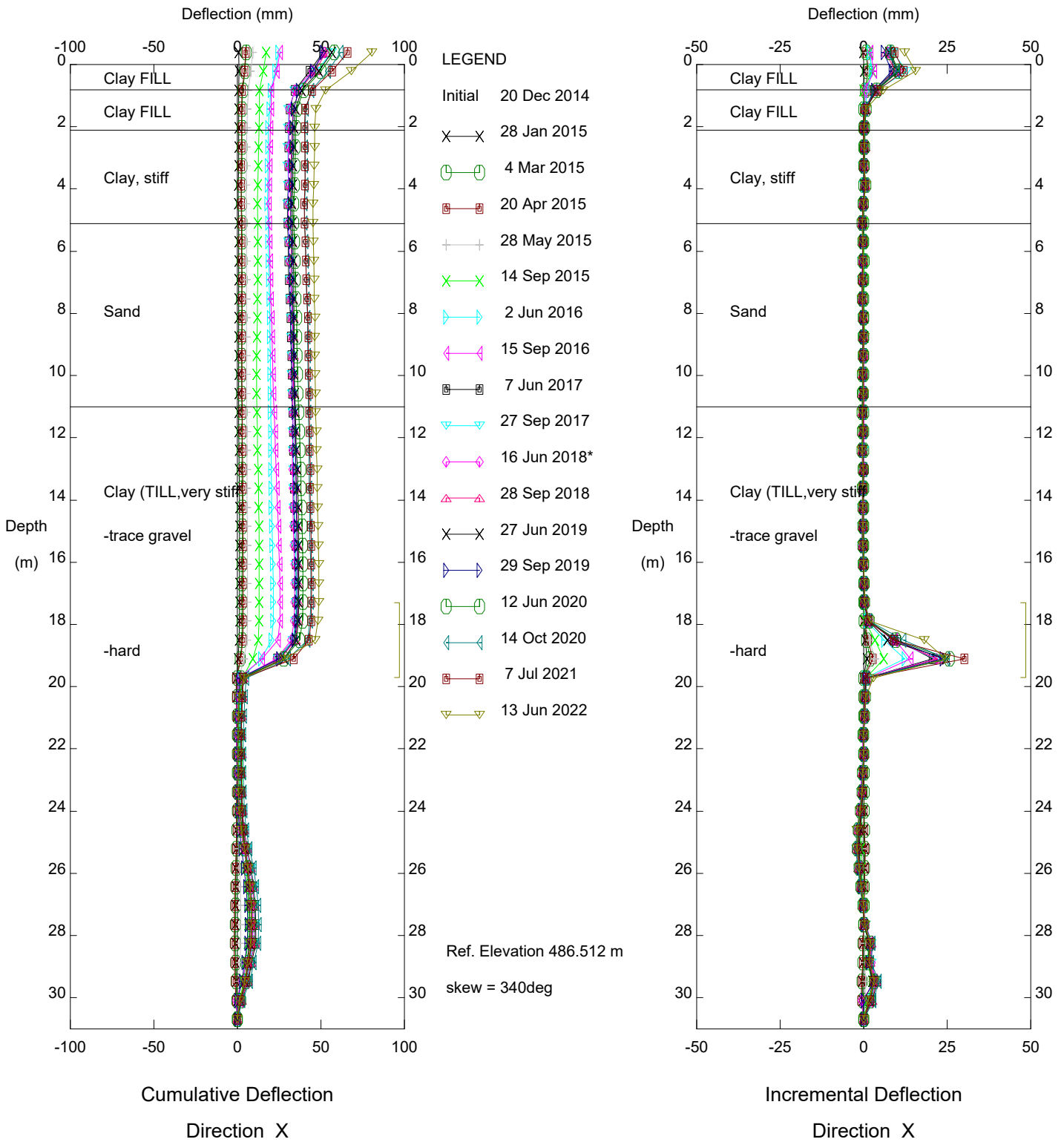


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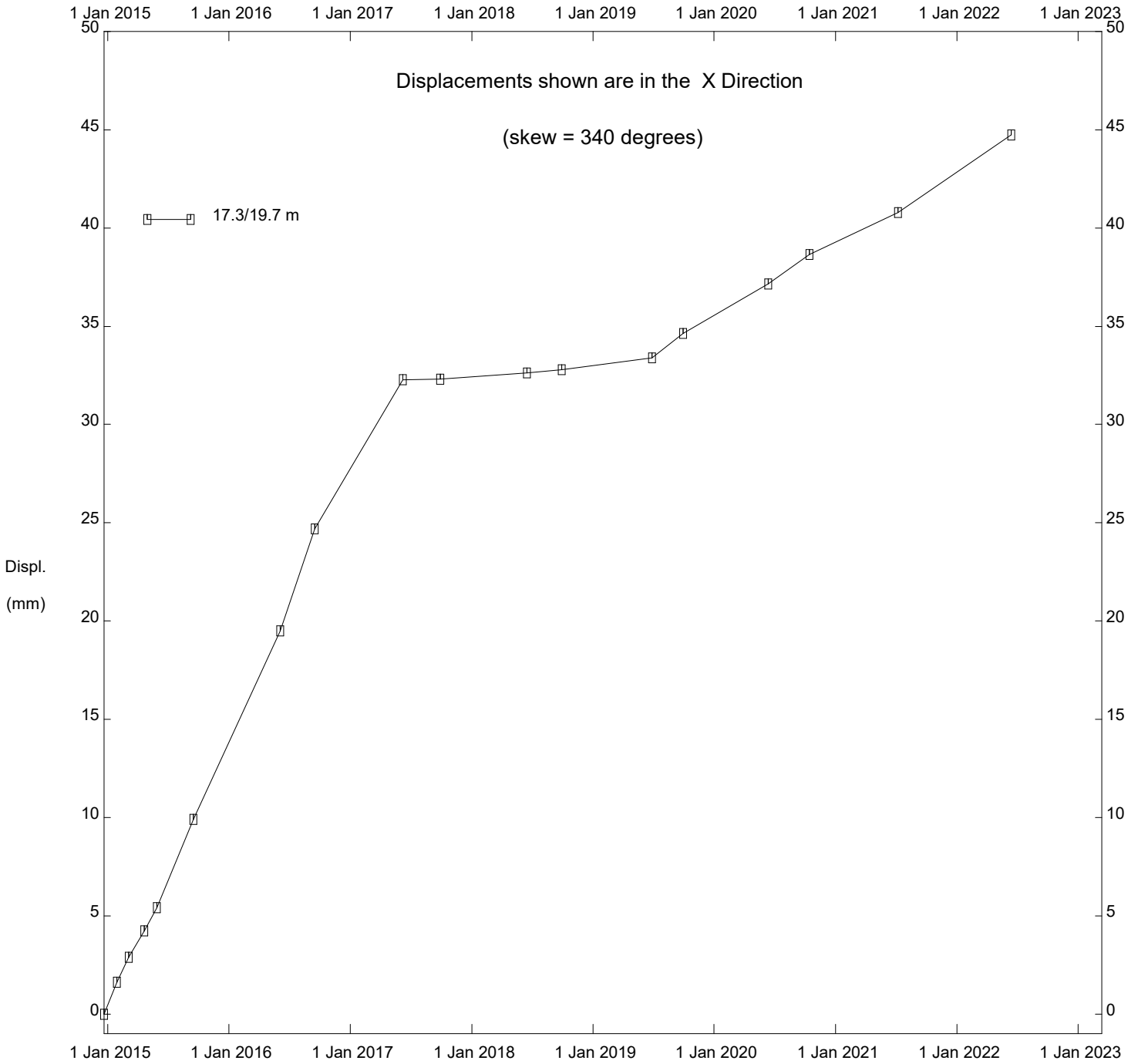


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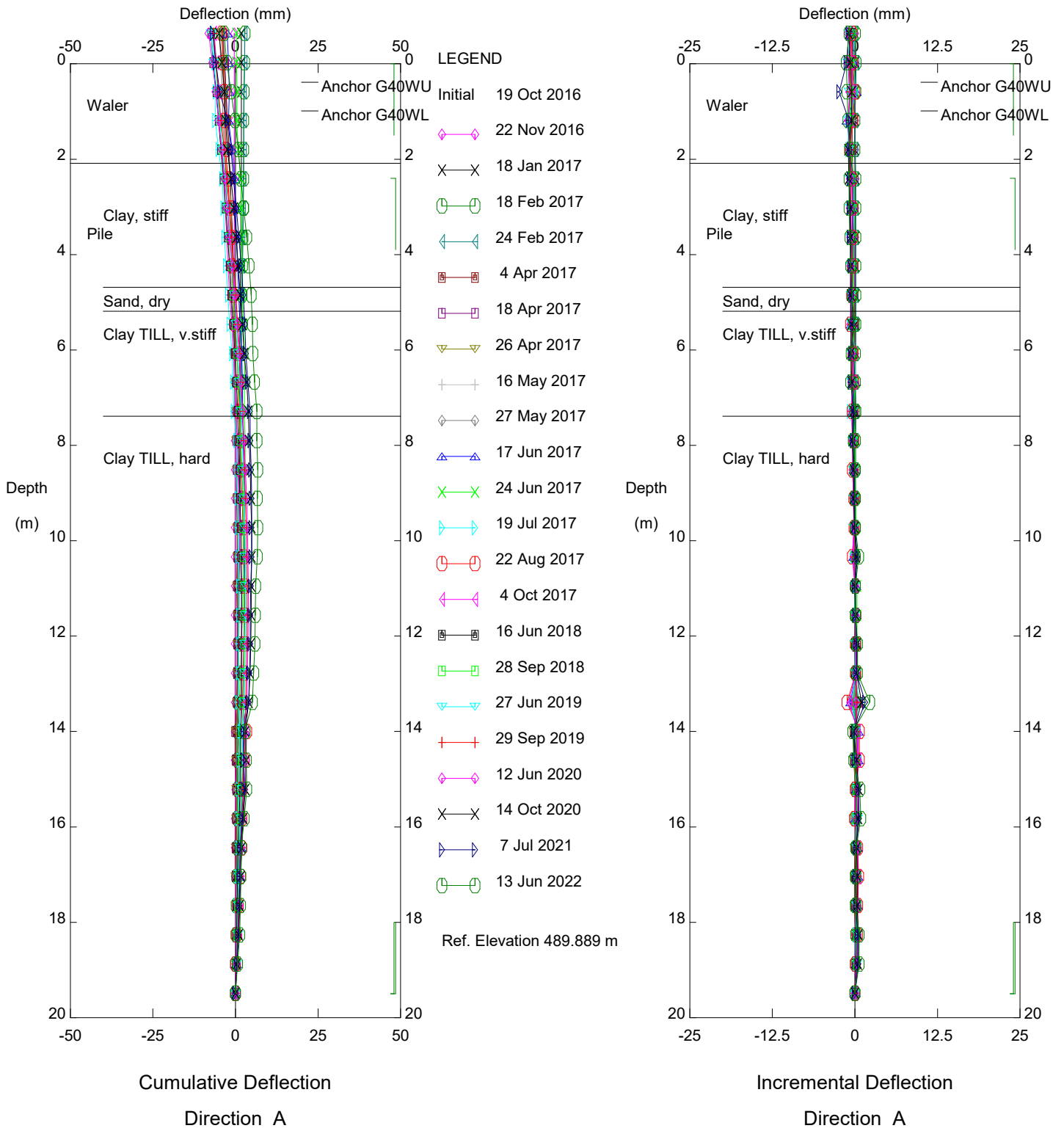
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Alberta Transportation

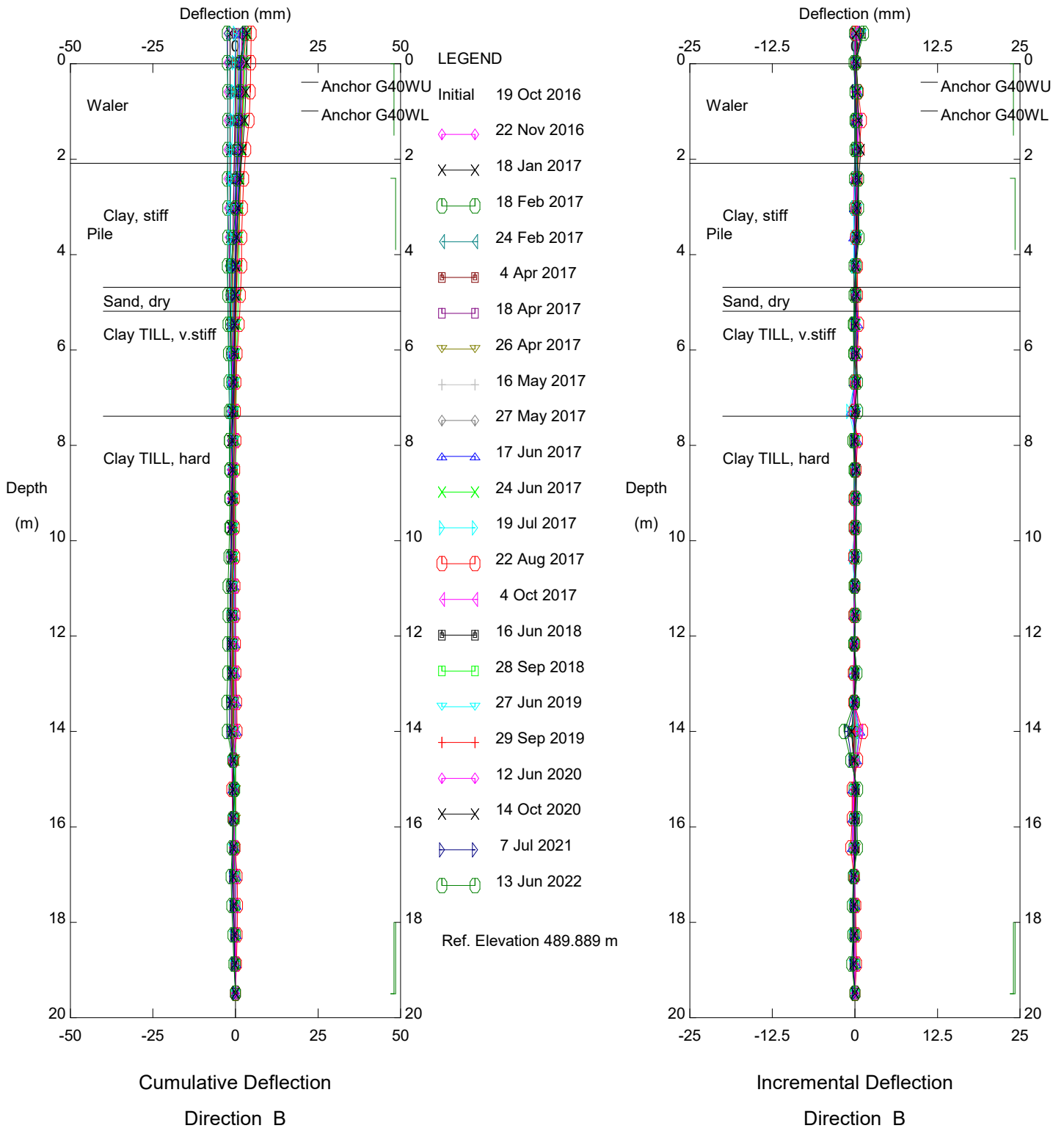
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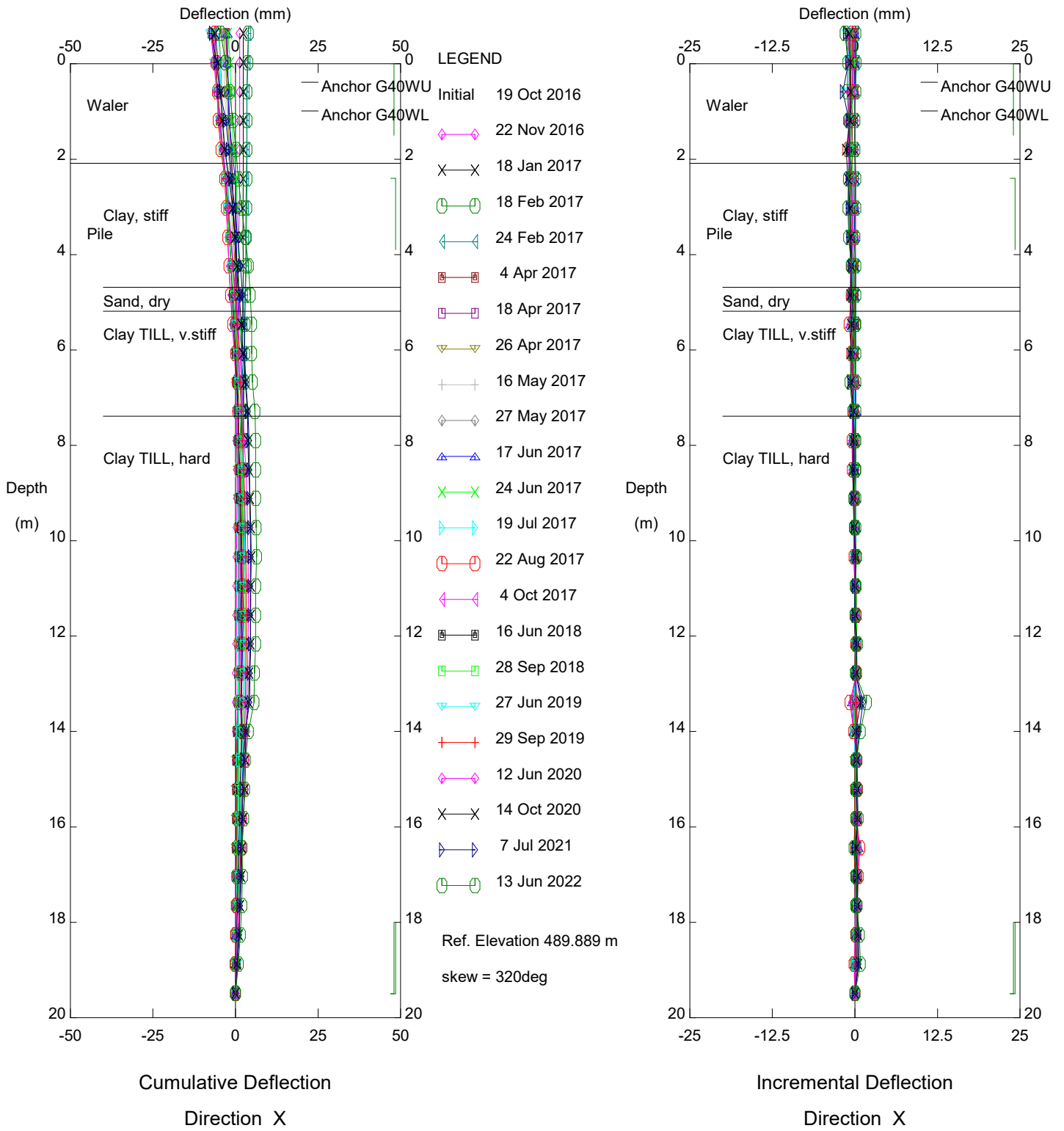
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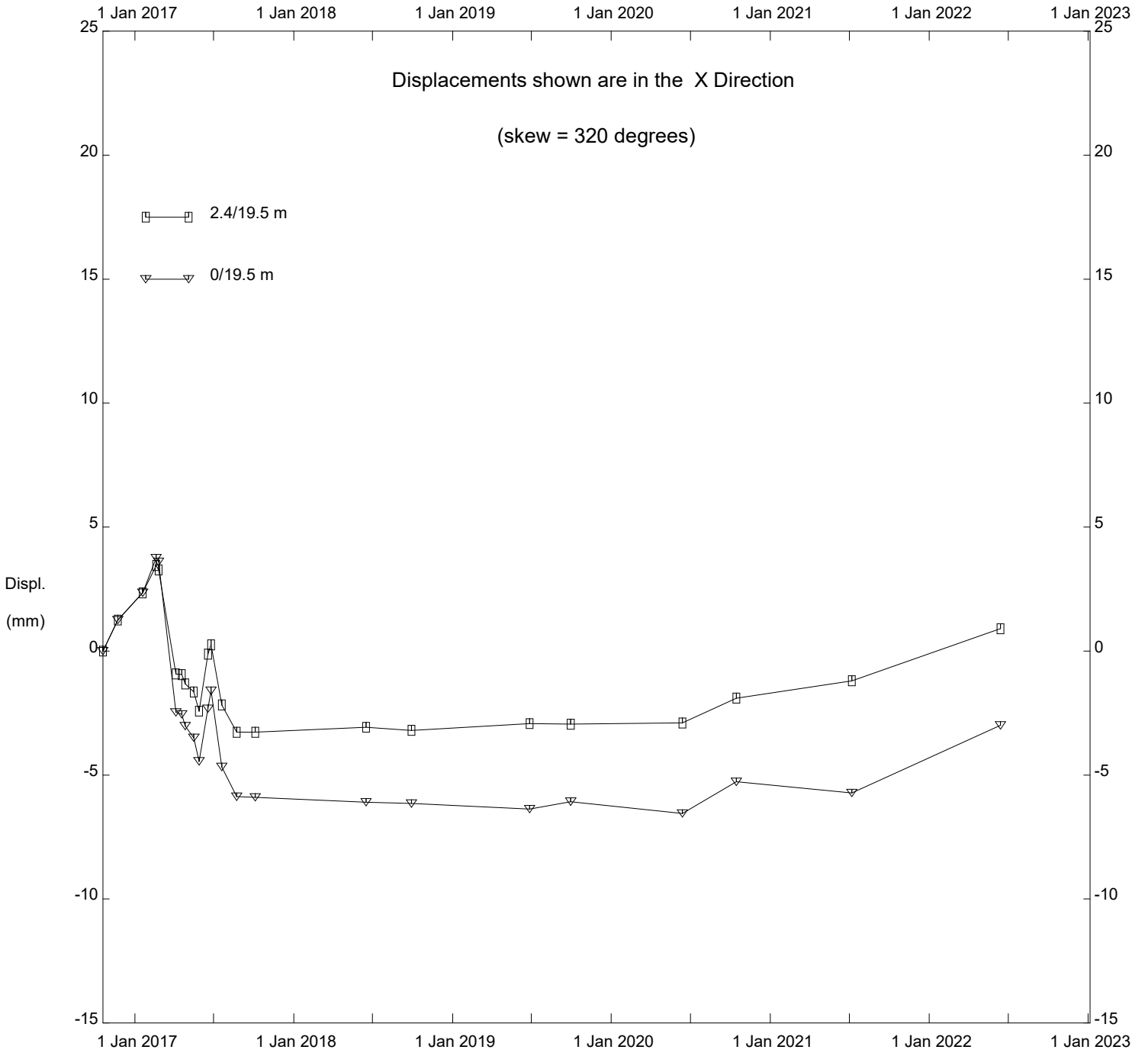
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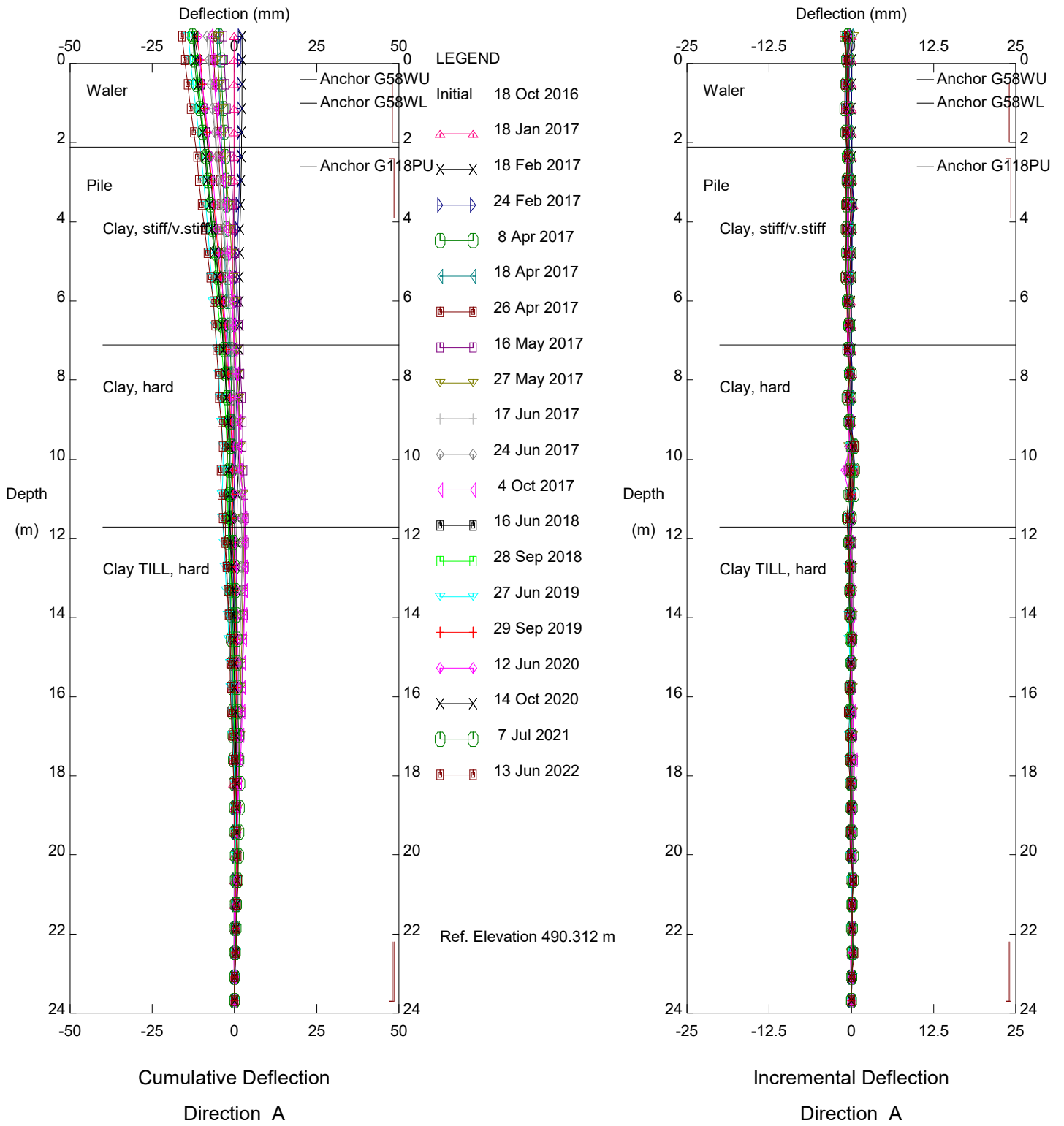
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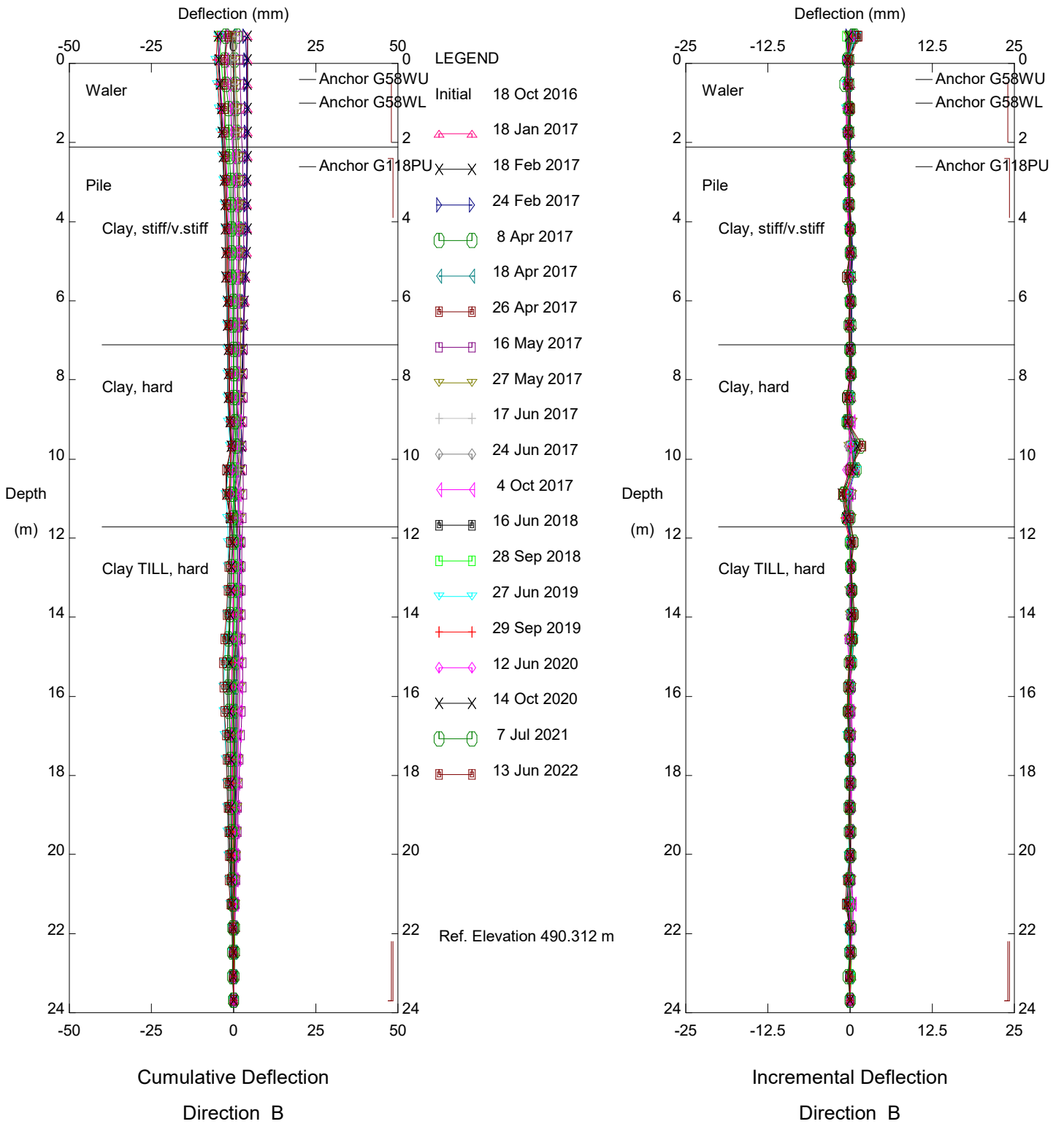
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Peace River East Hill PH070, Inclinometer P58

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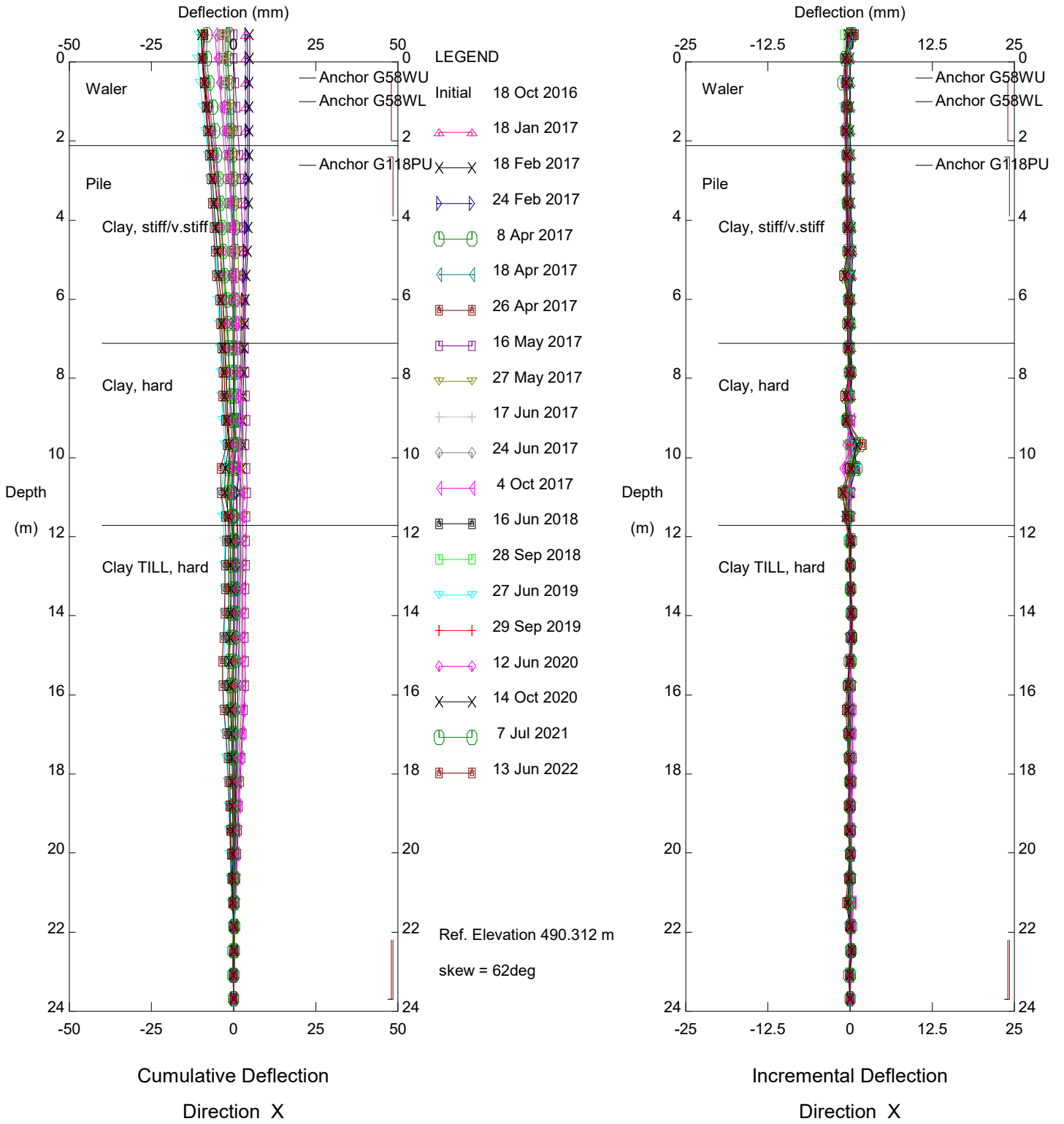
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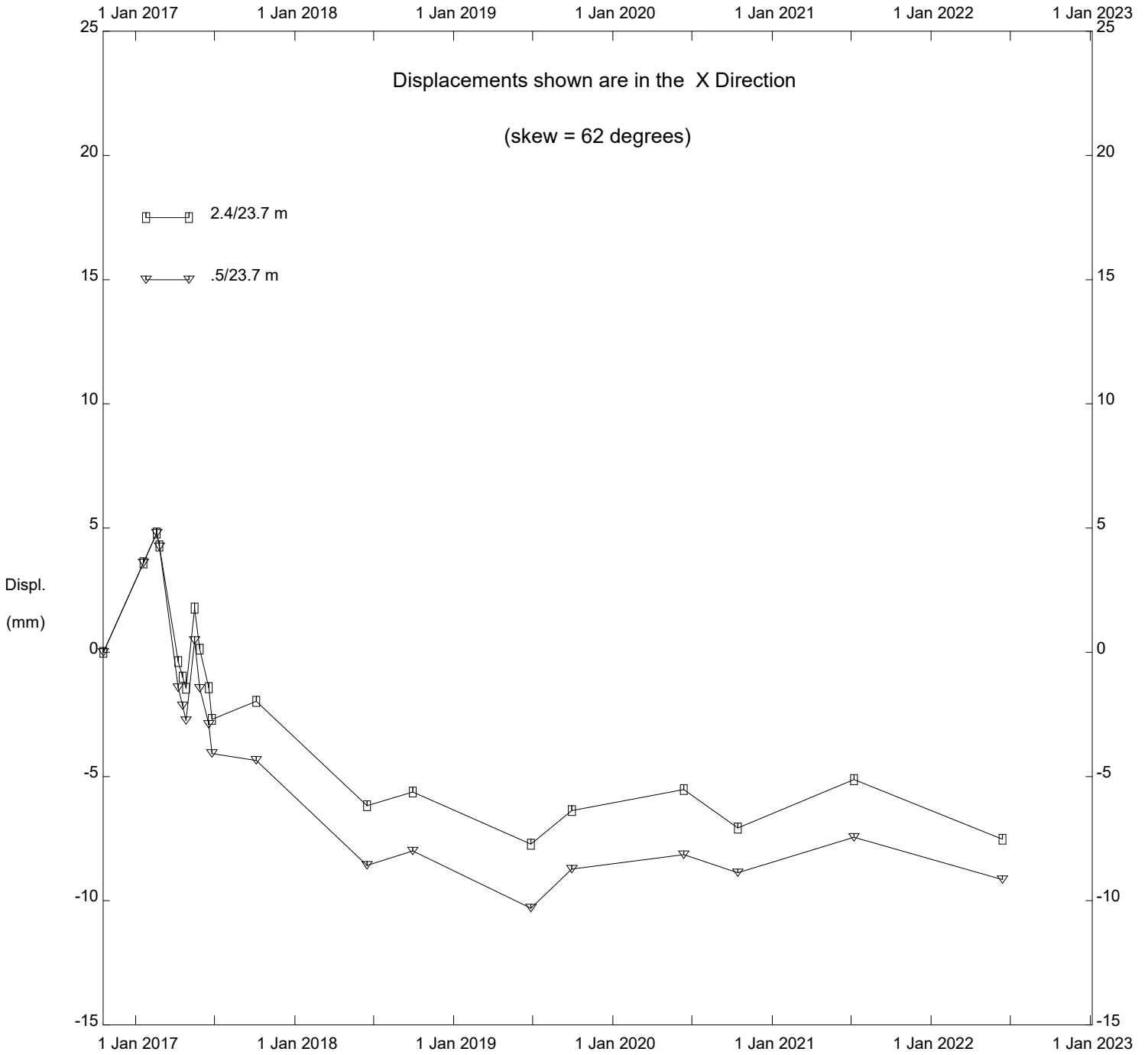
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Peace River East Hill PH070, Inclinometer P58

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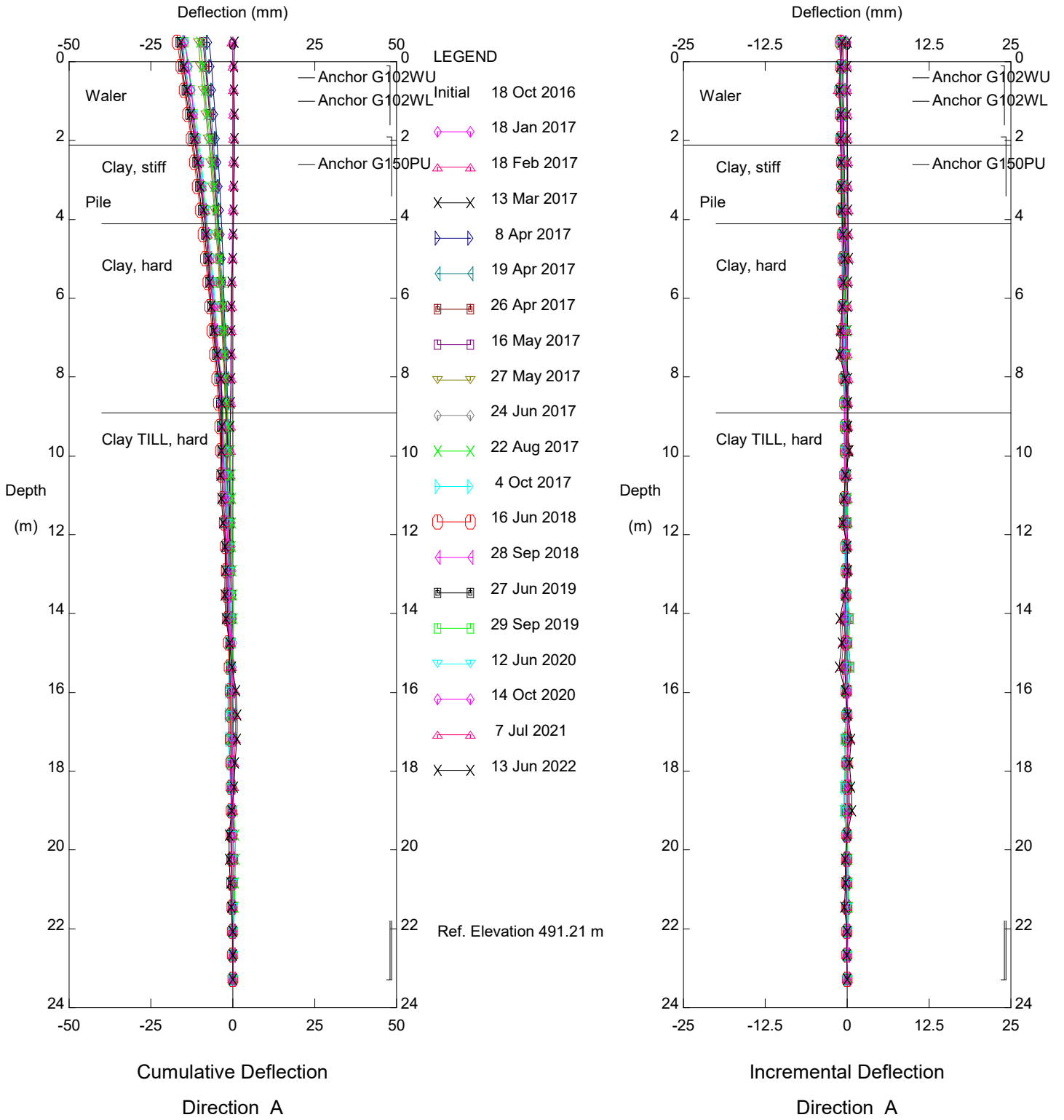
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Peace River East Hill PH070, Inclinator P58

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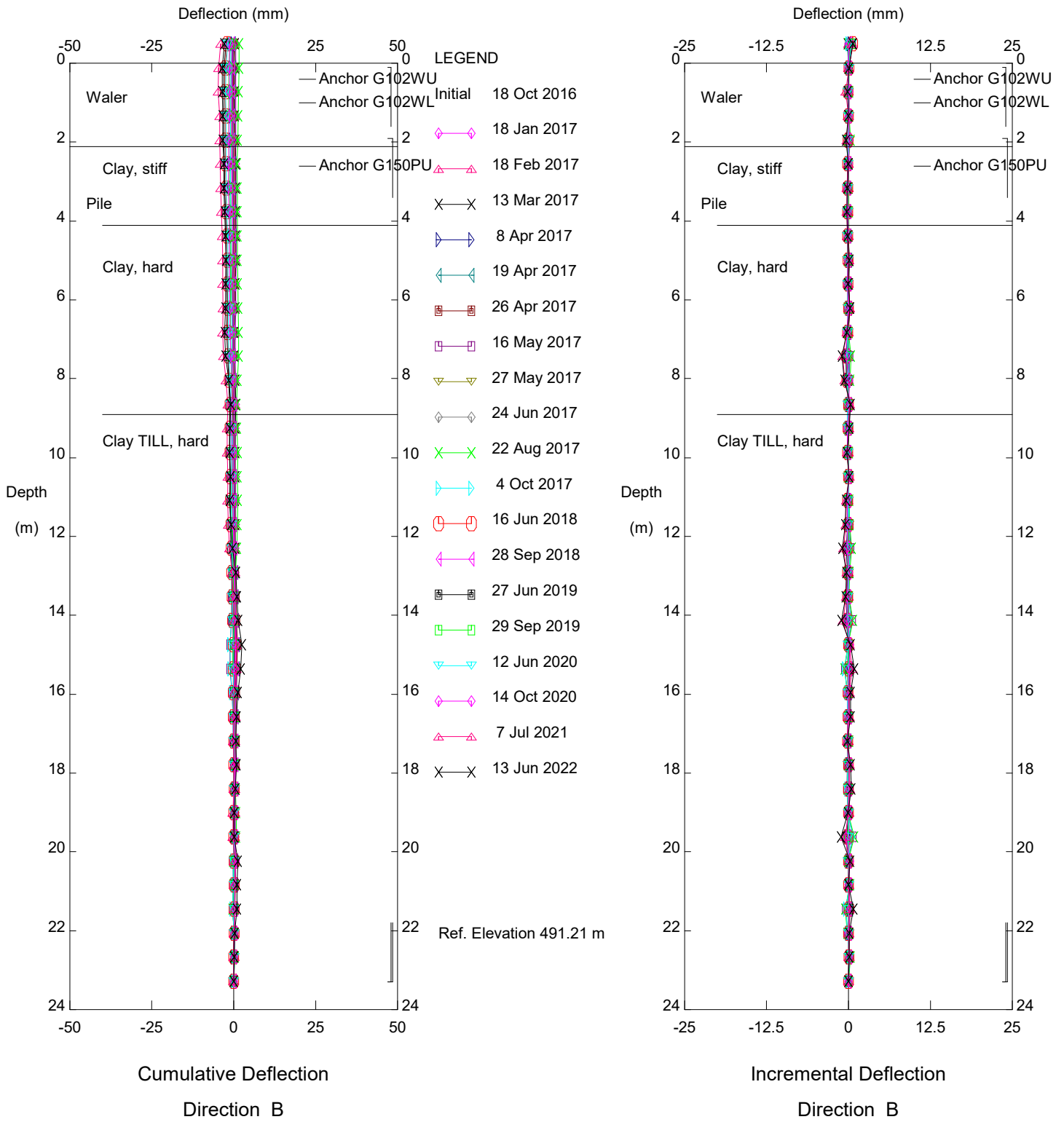
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Peace River East Hill PH070, Inclinometer P90

Alberta Transportation

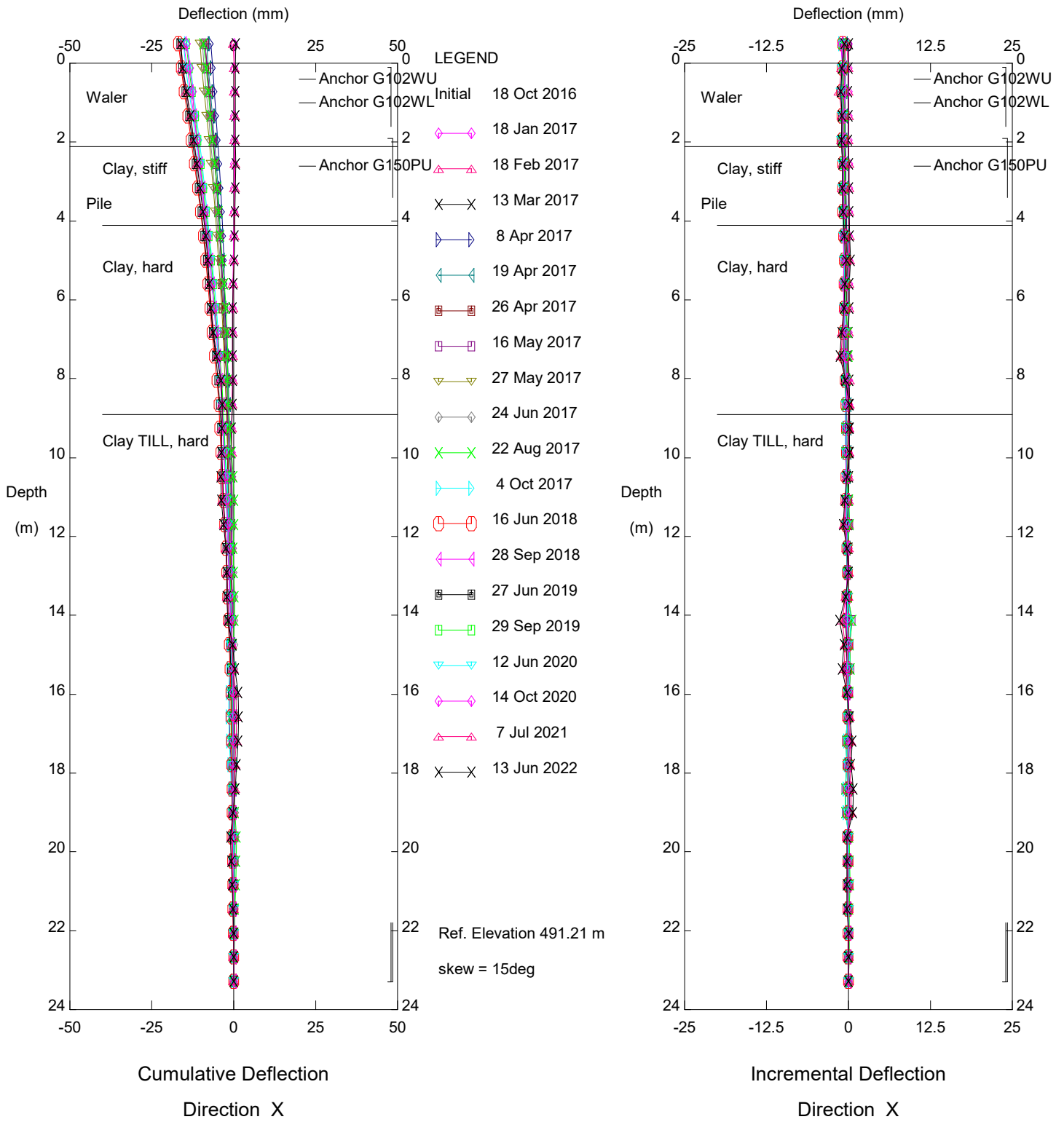
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Peace River East Hill PH070, Inclinometer P90

Alberta Transportation

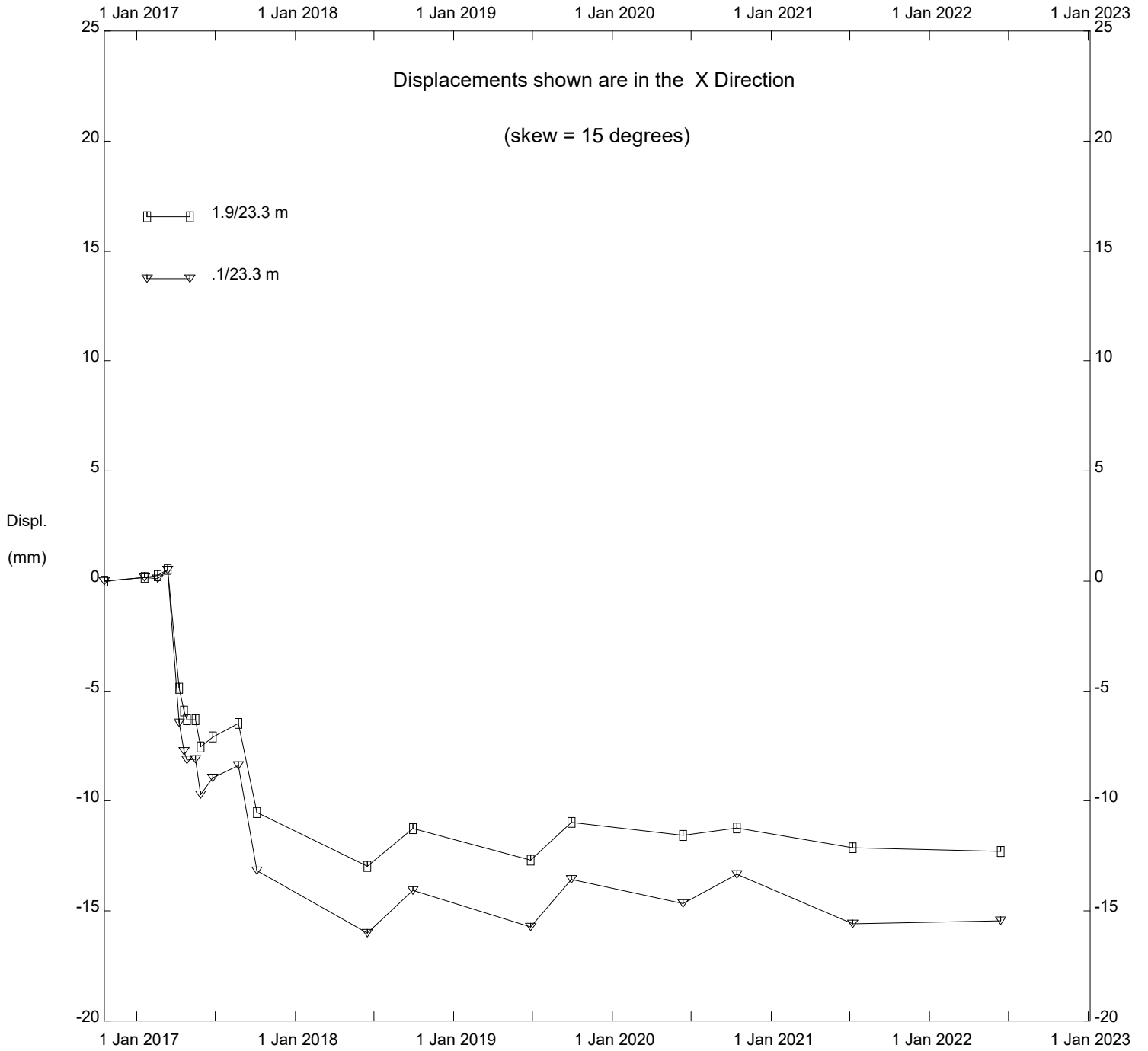
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Peace River East Hill PH070, Inclinometer P90

Alberta Transportation

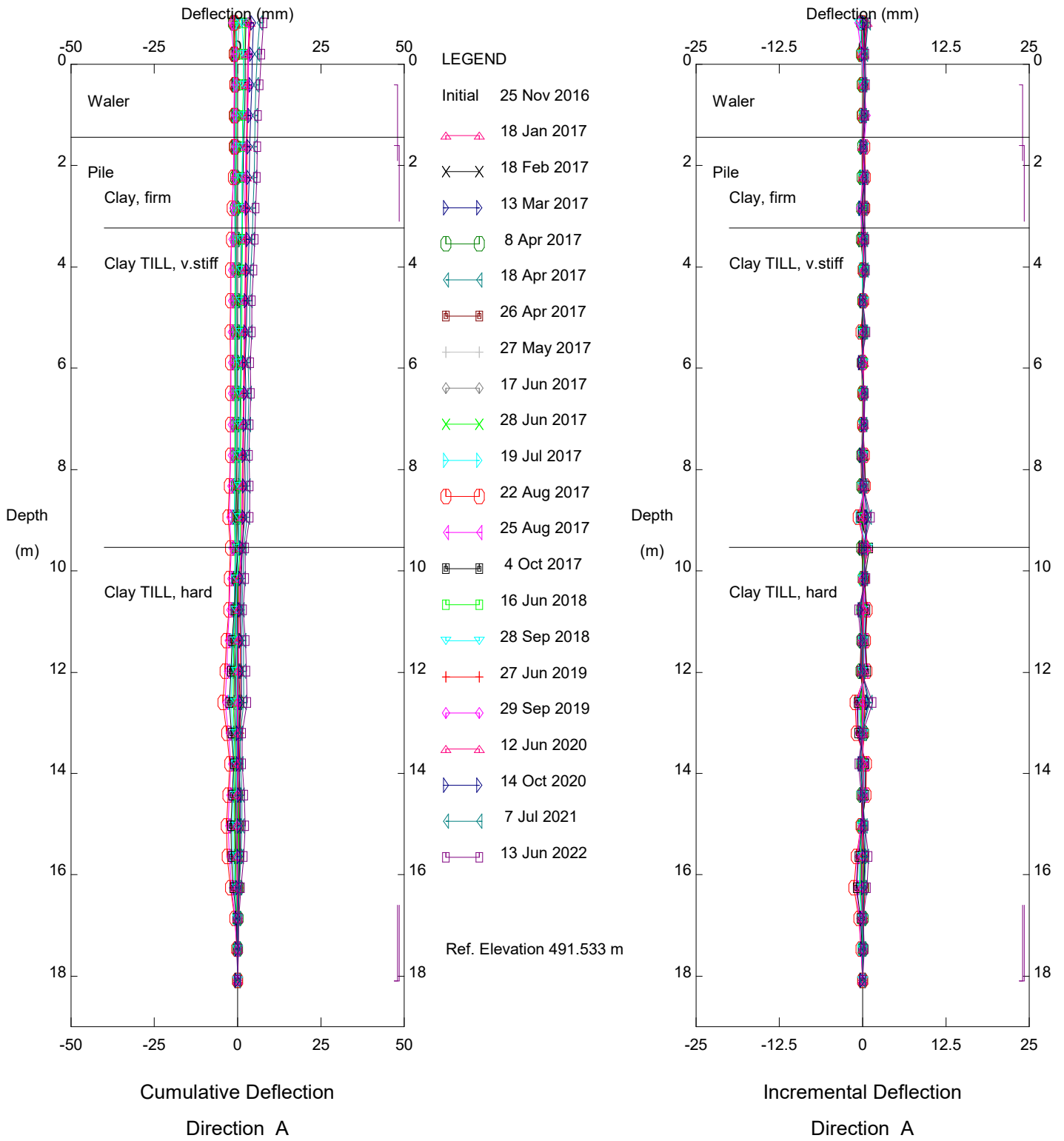
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Peace River East Hill PH070, Inclinator P90

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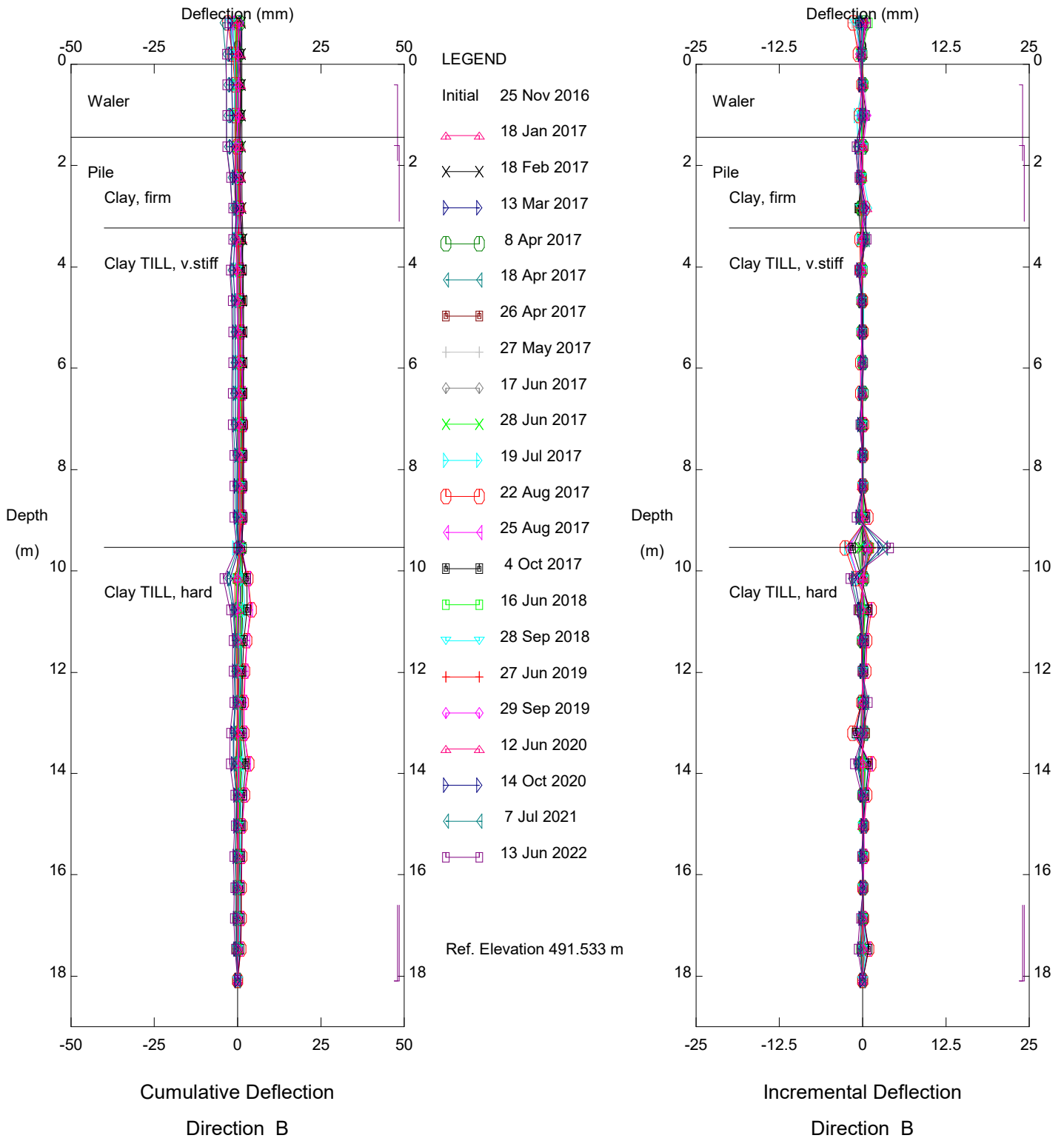
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Peace River East Hill PH070, Inclinometer P116

Alberta Transportation

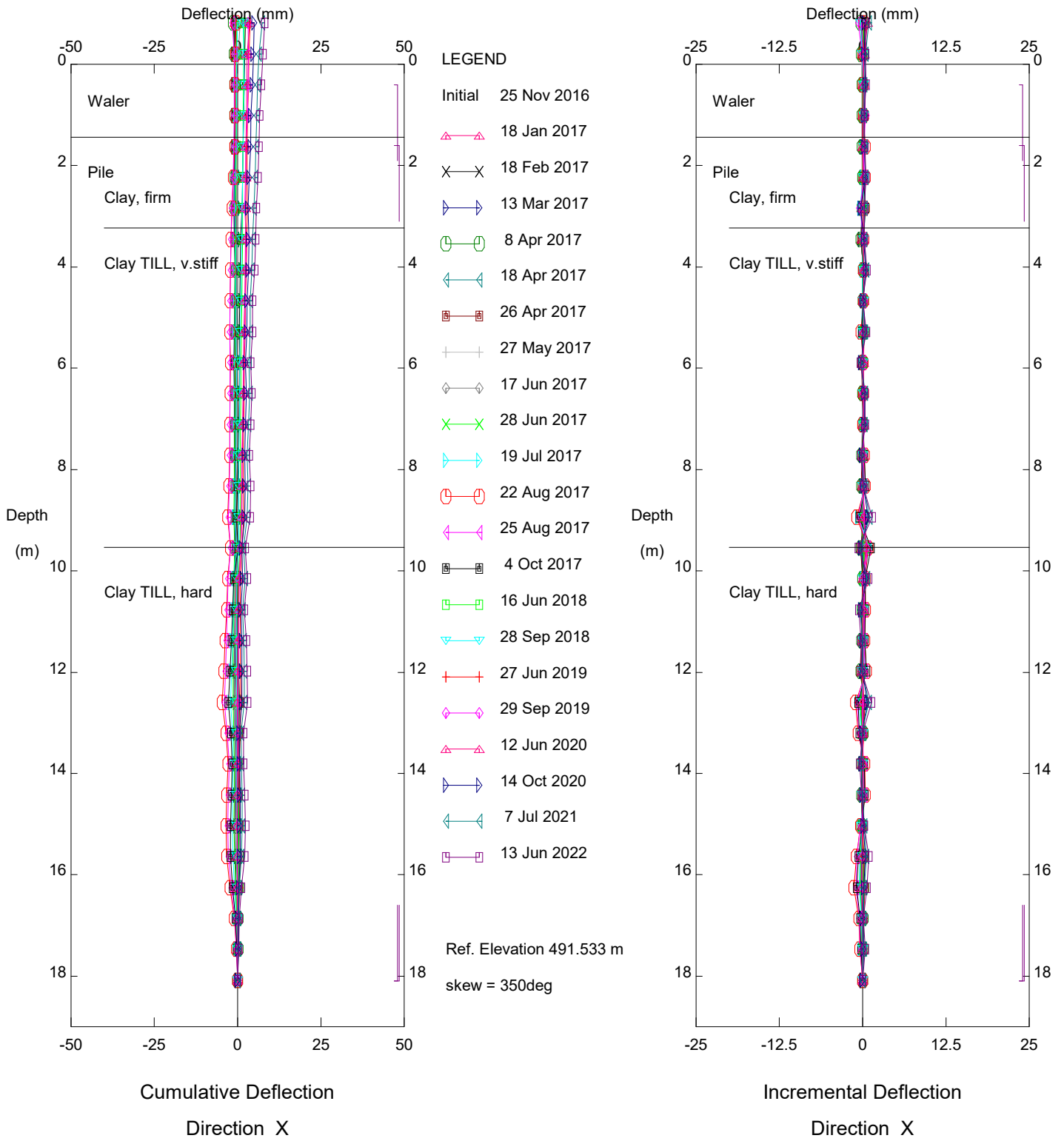
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Peace River East Hill PH070, Inclinator P116

Alberta Transportation

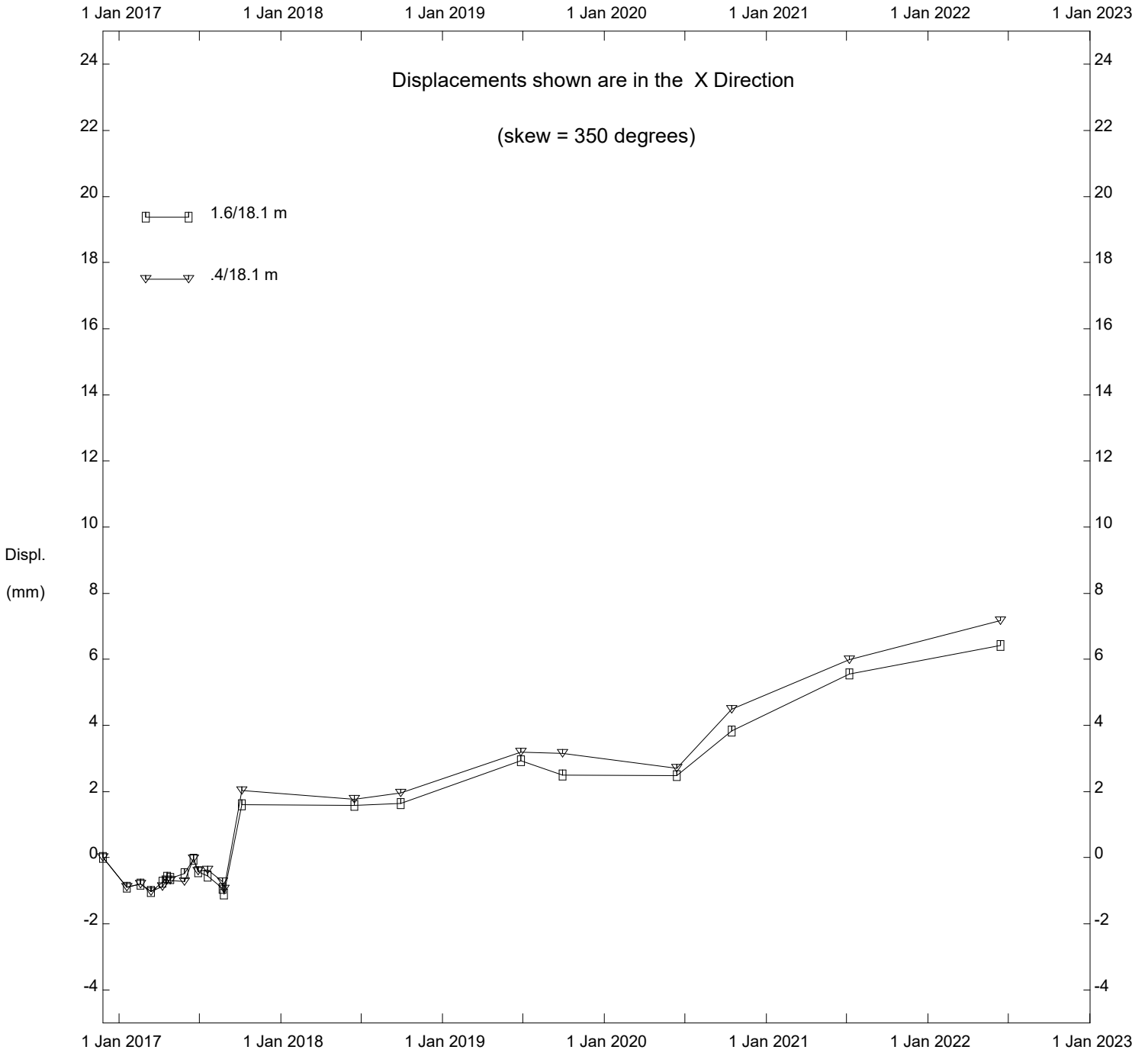
Thurber Engineering Ltd.



Peace River East Hill PH070, Inclinometer P116

Alberta Transportation

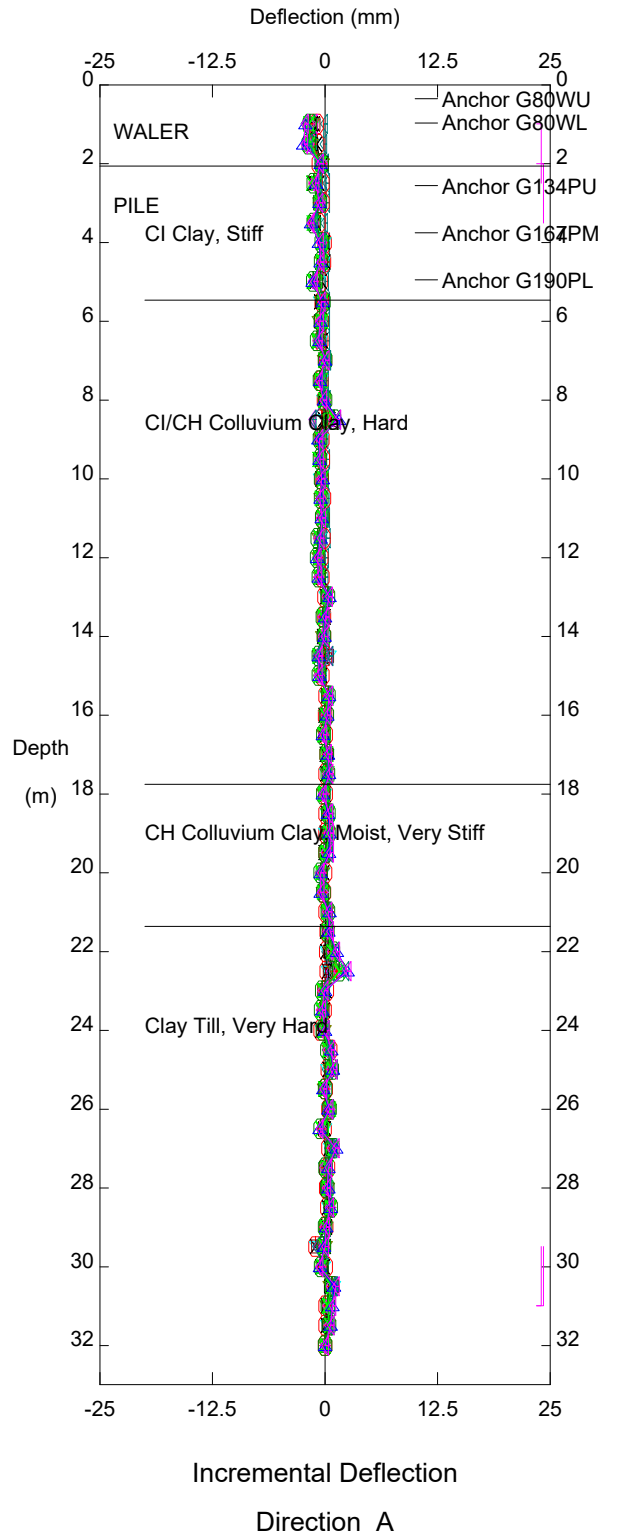
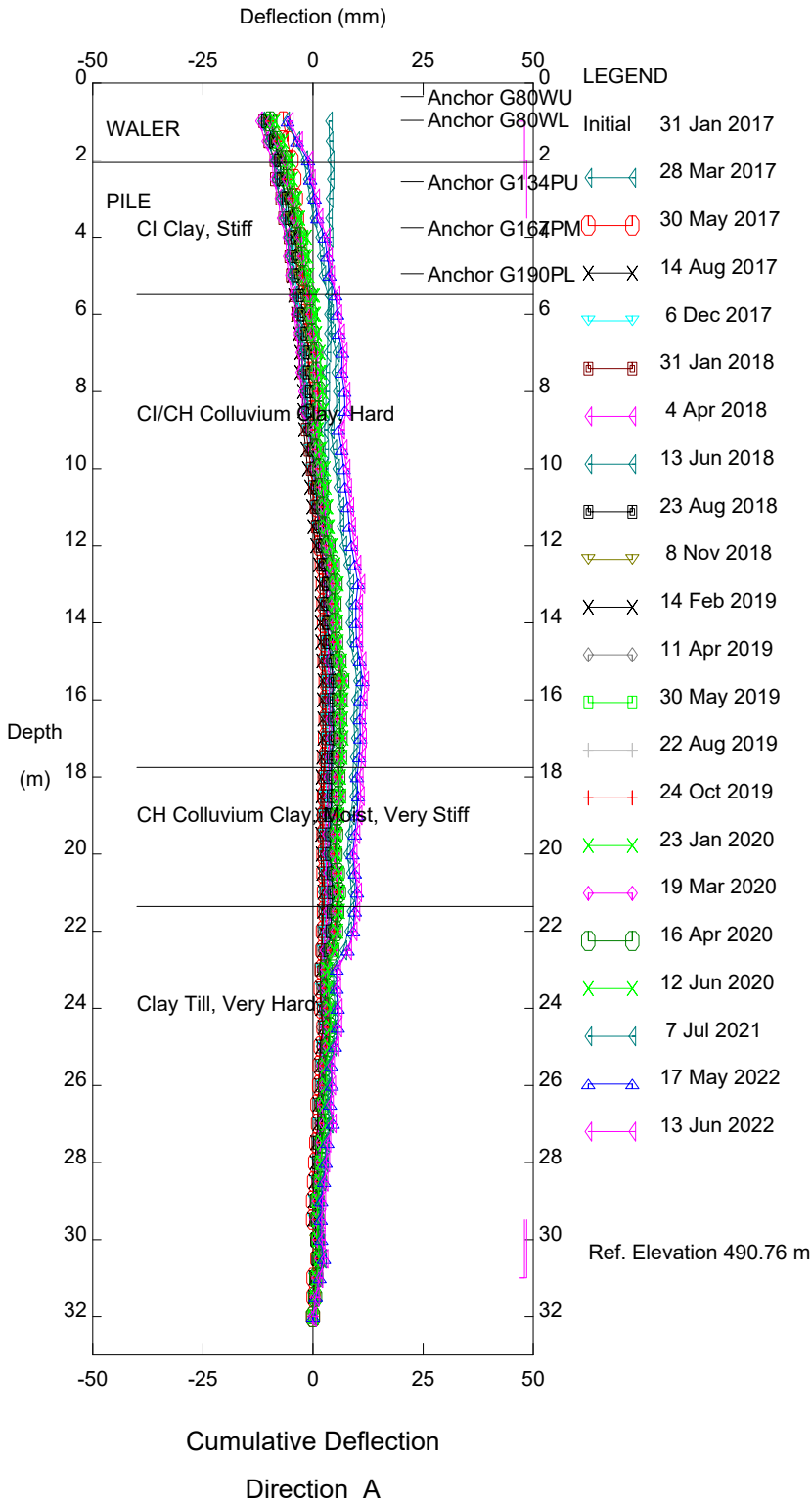
Thurber Engineering Ltd.



Peace River East Hill PH070, Inclinator P116

Alberta Transportation

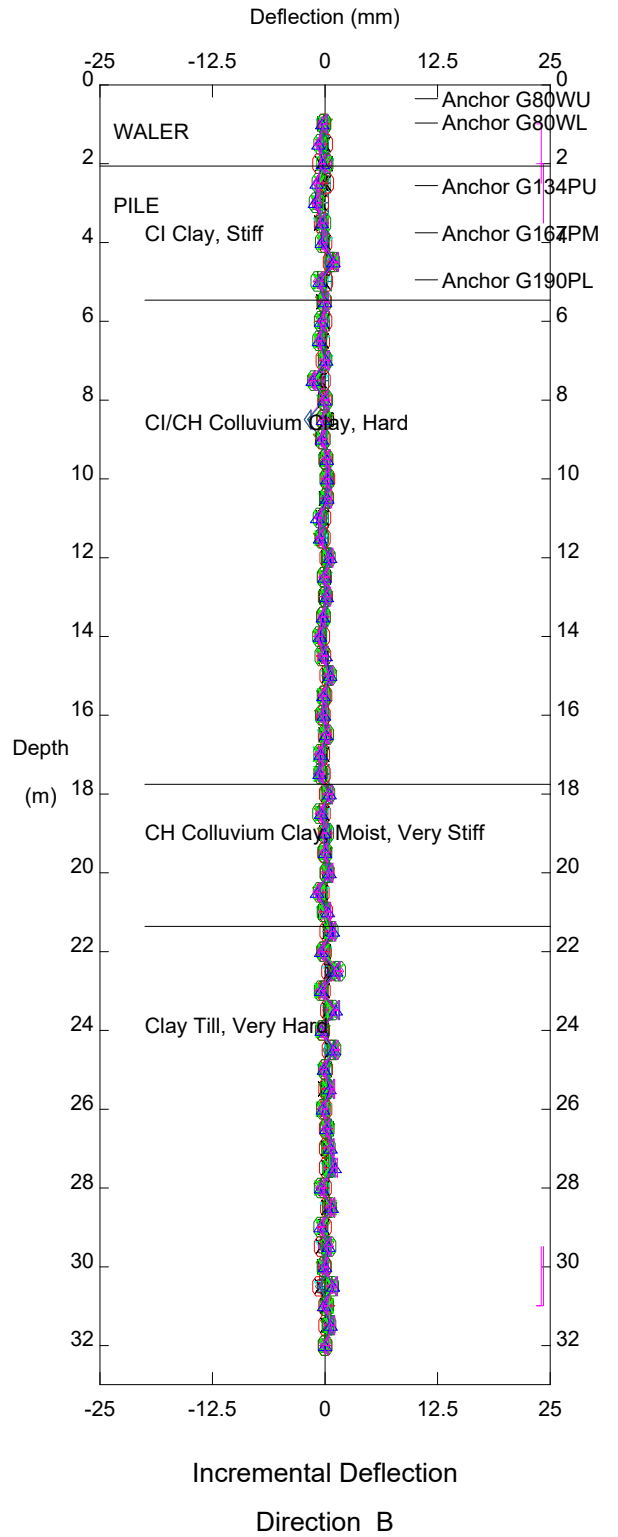
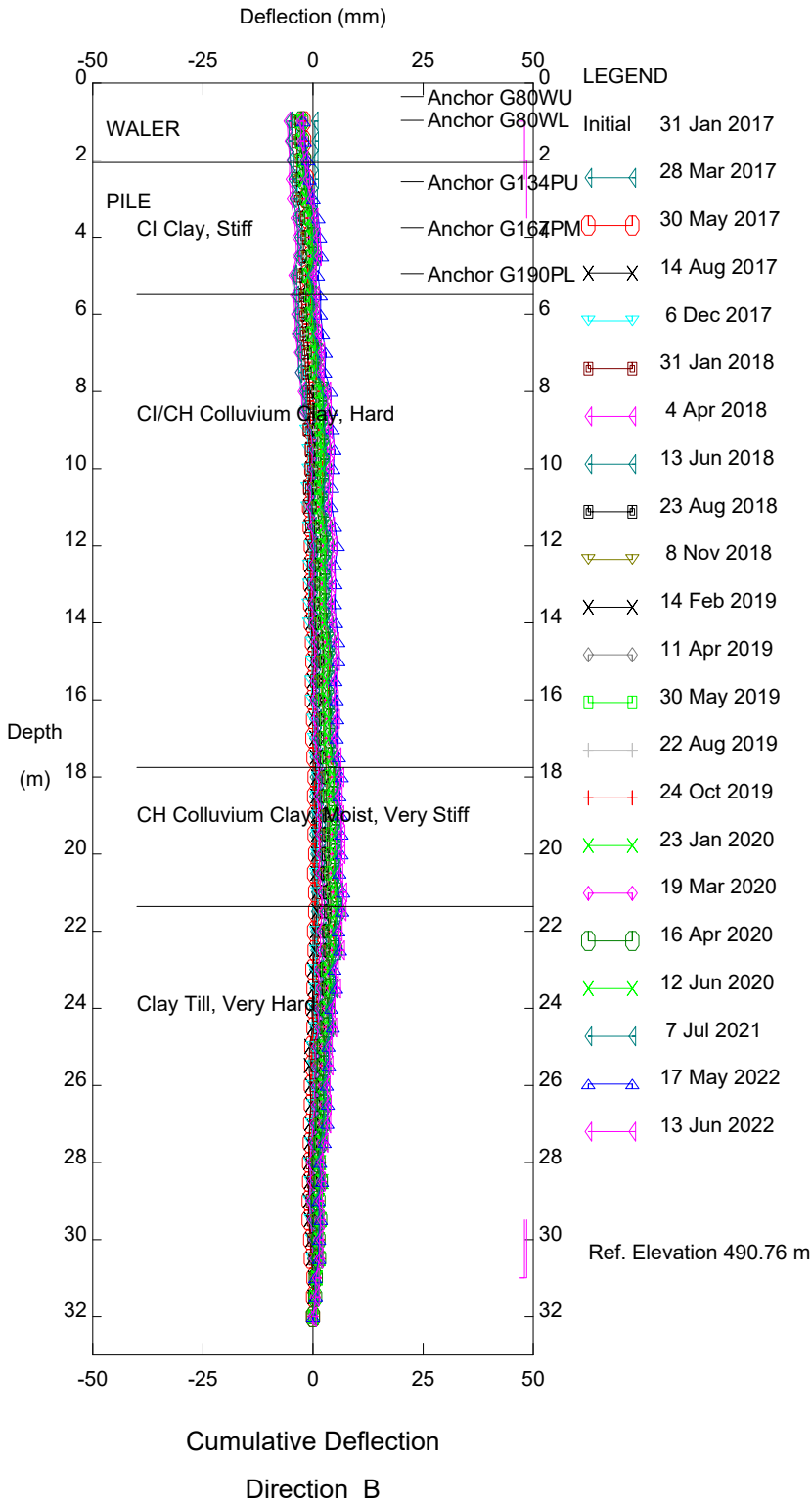
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PH070 Hwy 2:60 East Hill, Inclinometer SAA-P74

Alberta Transportation

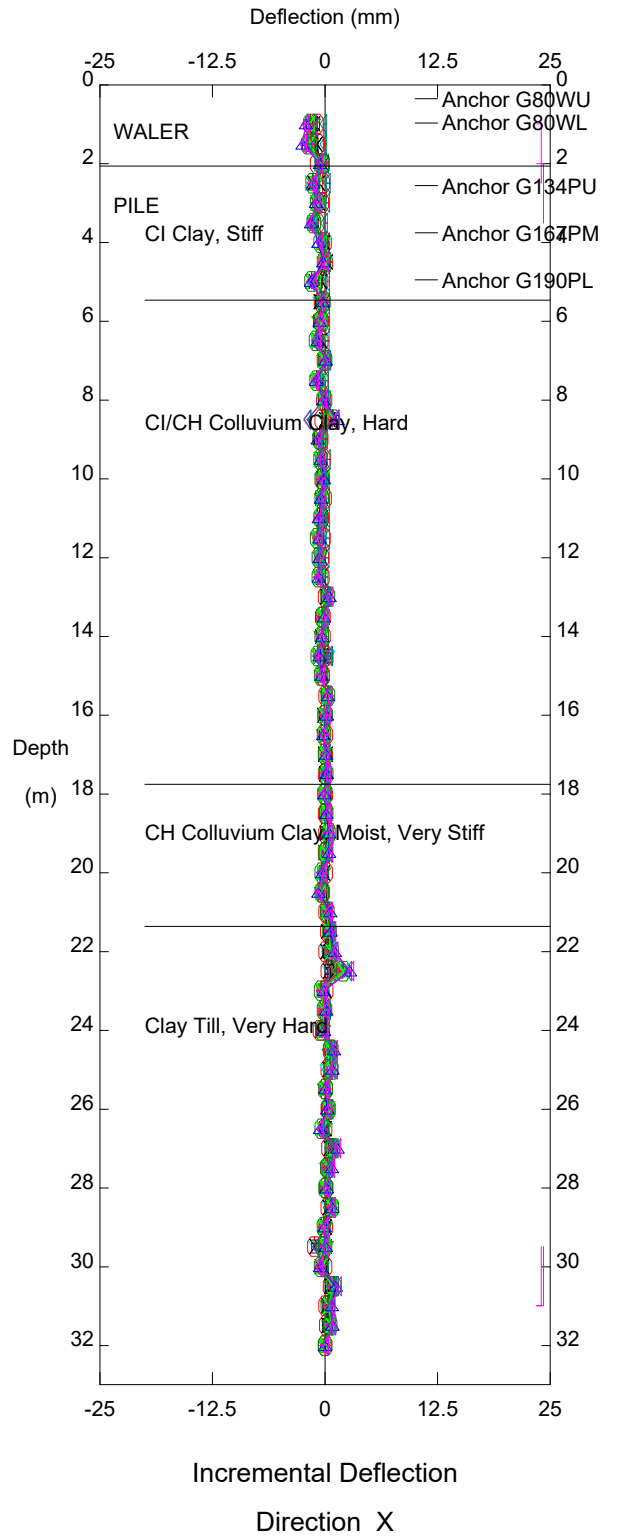
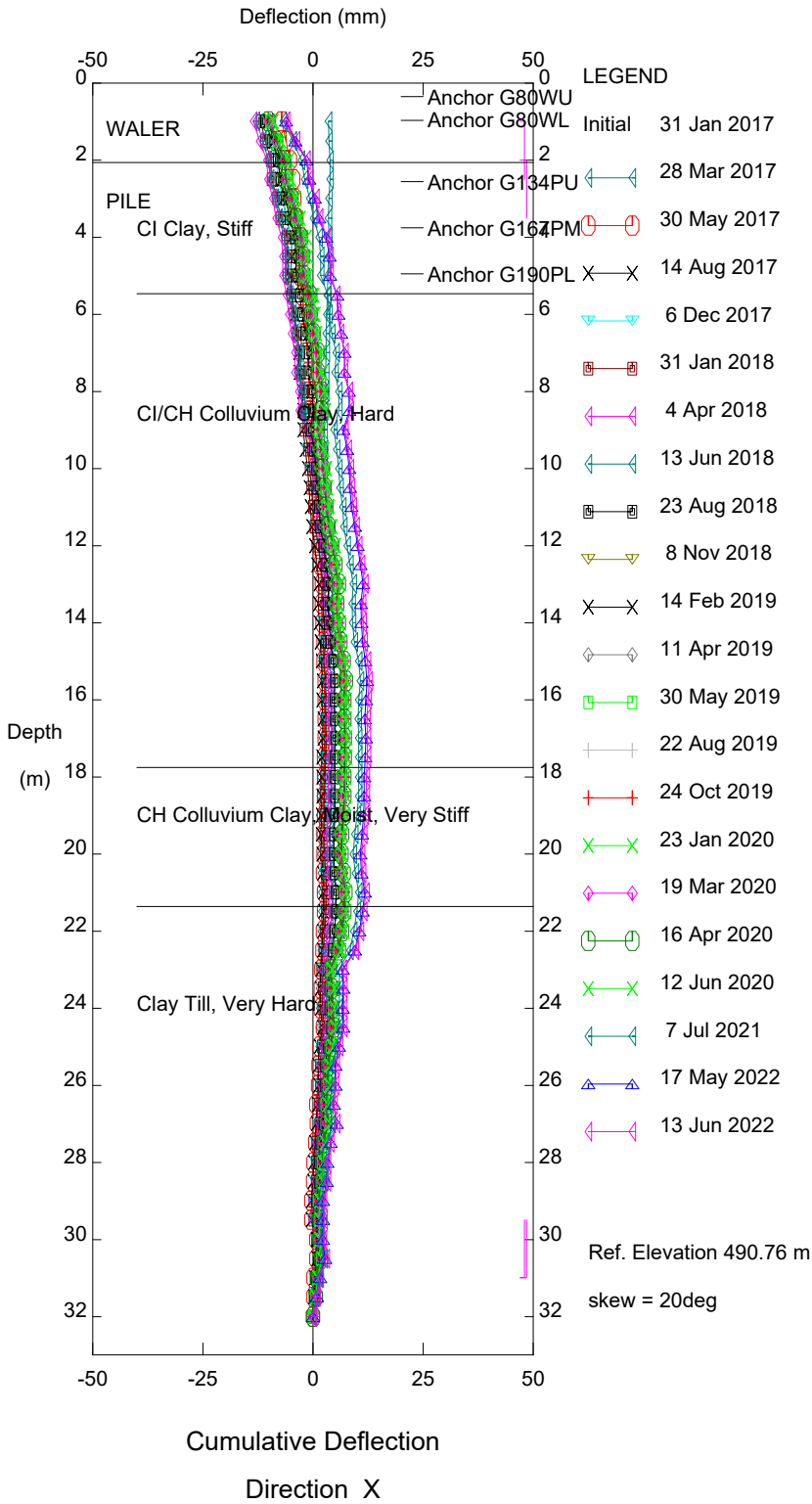
Thurber Engineering Ltd



PH070 Hwy 2:60 East Hill, Inclinometer SAA-P74

Alberta Transportation

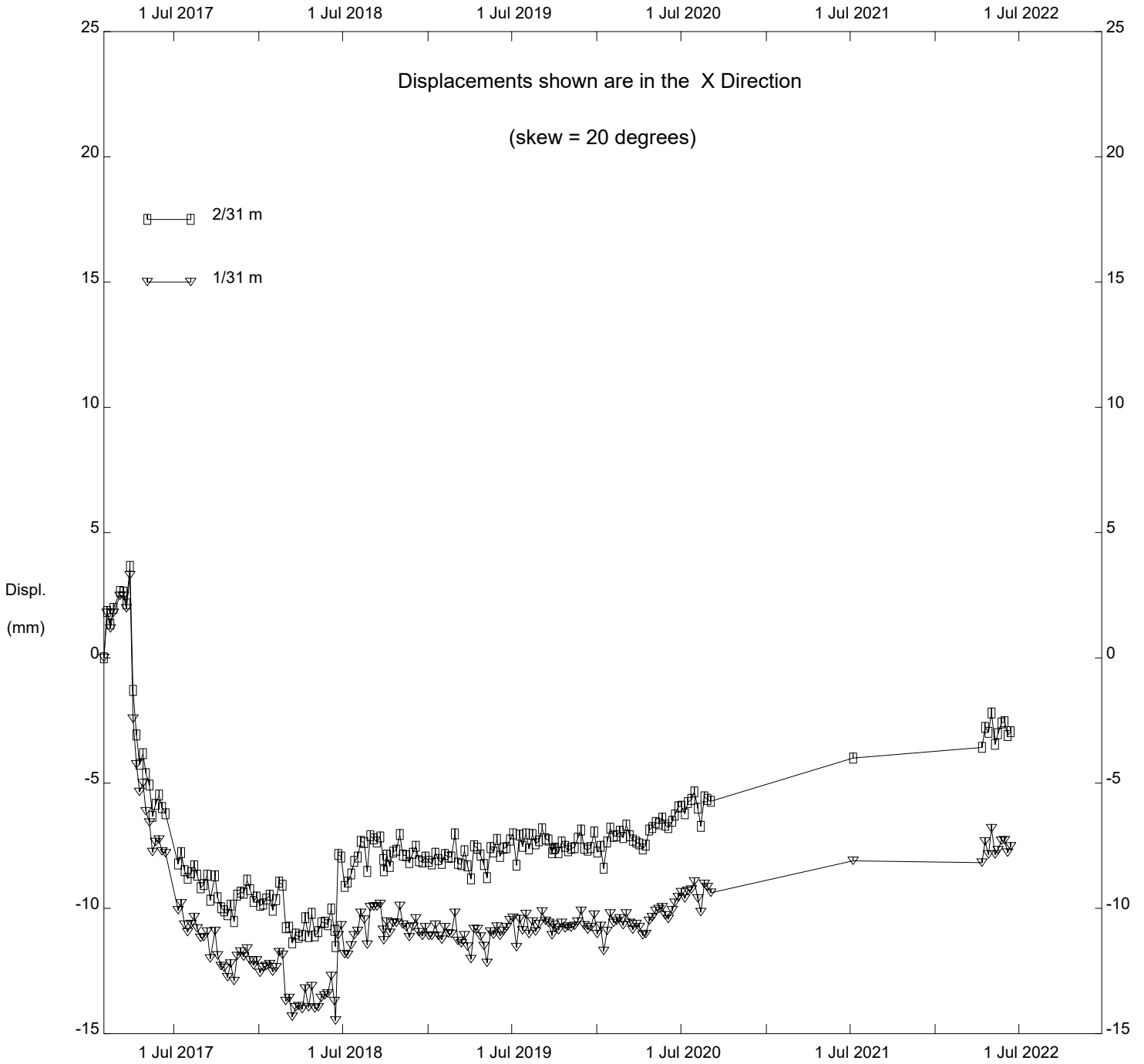
Thurber Engineering Ltd



PH070 Hwy 2:60 East Hill, Inclinometer SAA-P74

Alberta Transportation

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PH070 Hwy 2:60 East Hill, Inclinator SAA-P74

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FIGURE PH070-1
HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
PILE P74 DOWNSLOPE SIDE STRAIN GAUGE VALUES VS DEPTH

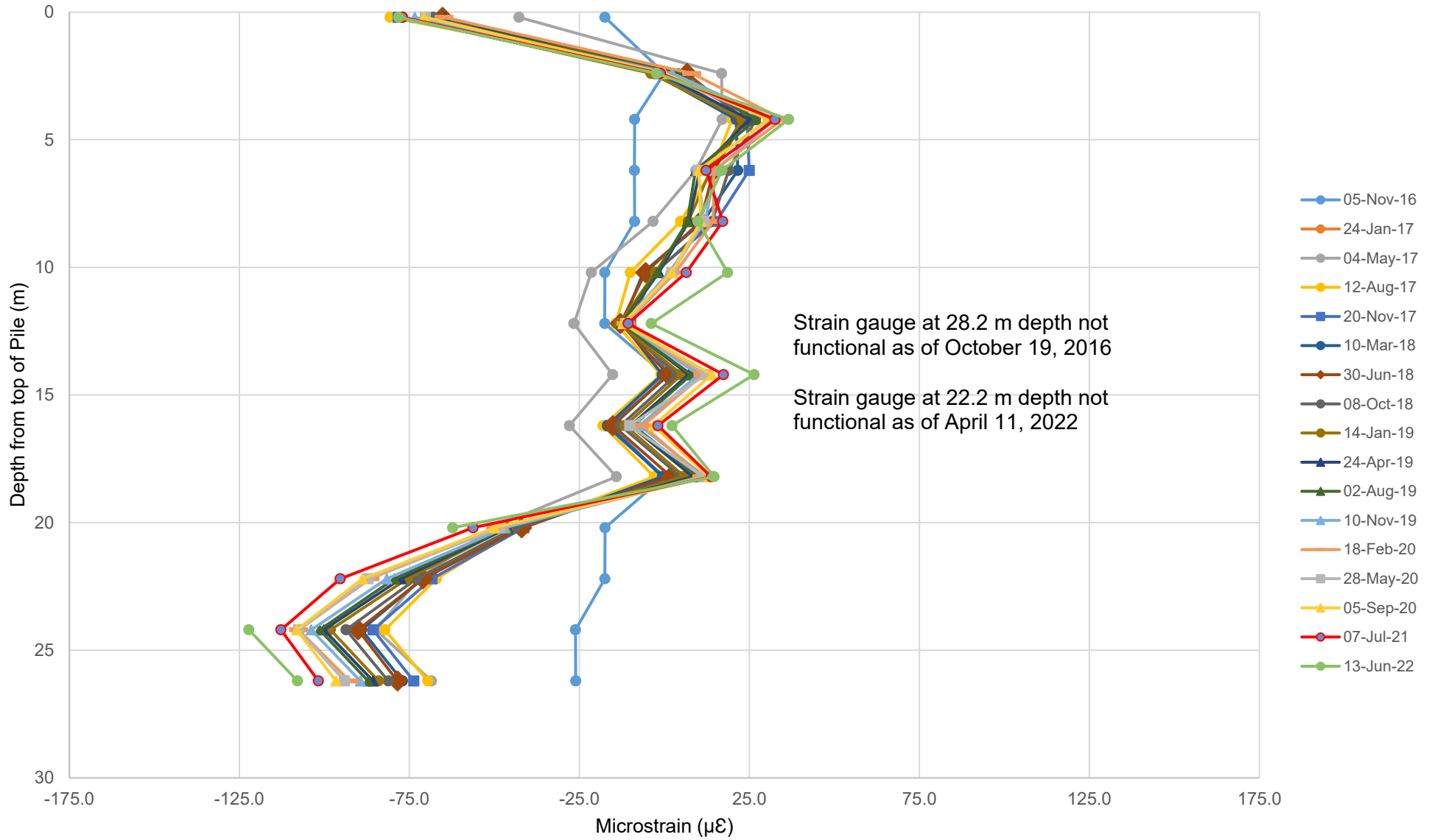


FIGURE PH070-2
HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
PILE P74 UPSLOPE SIDE STRAIN GAUGE VALUES VS DEPTH

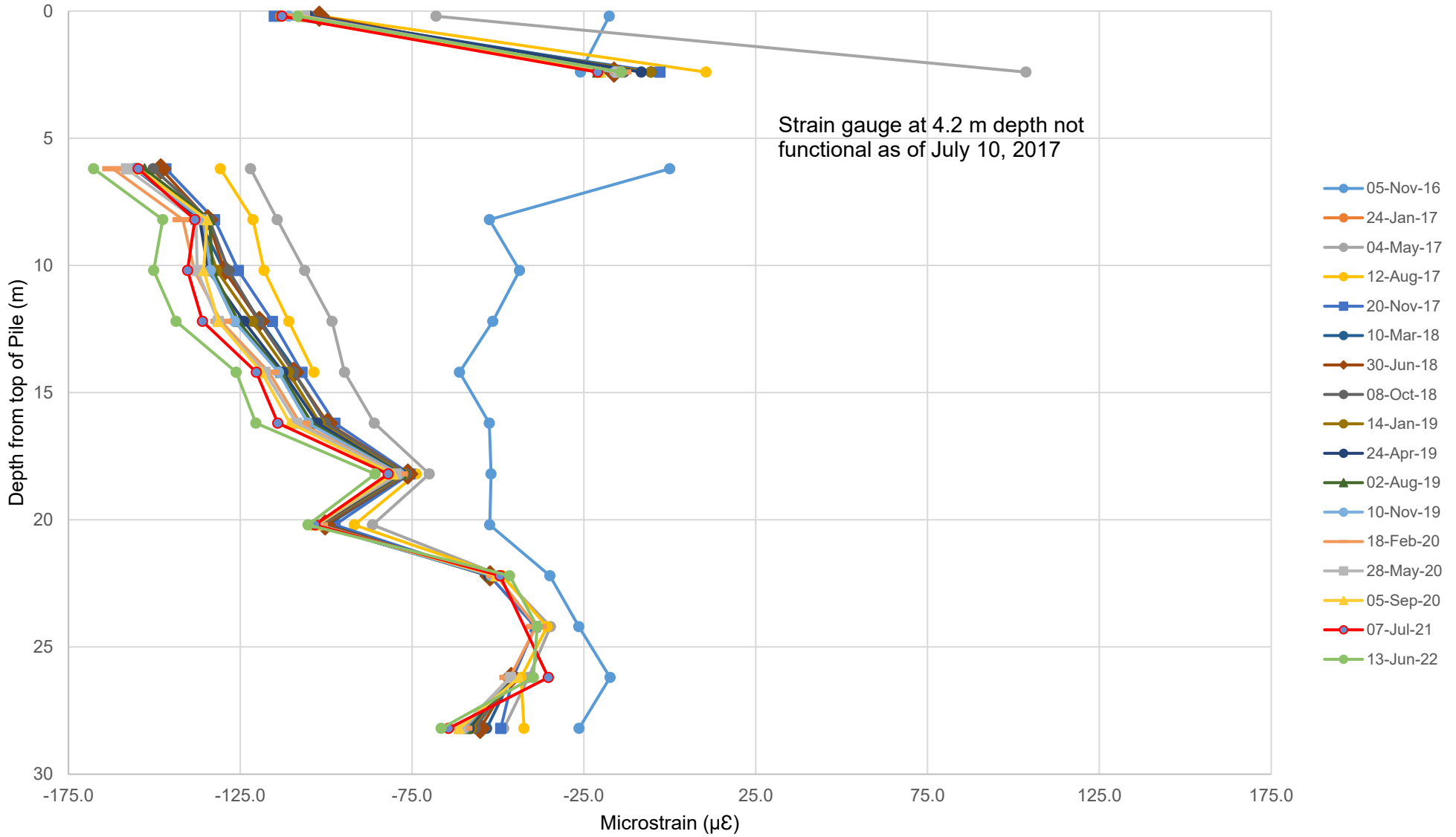
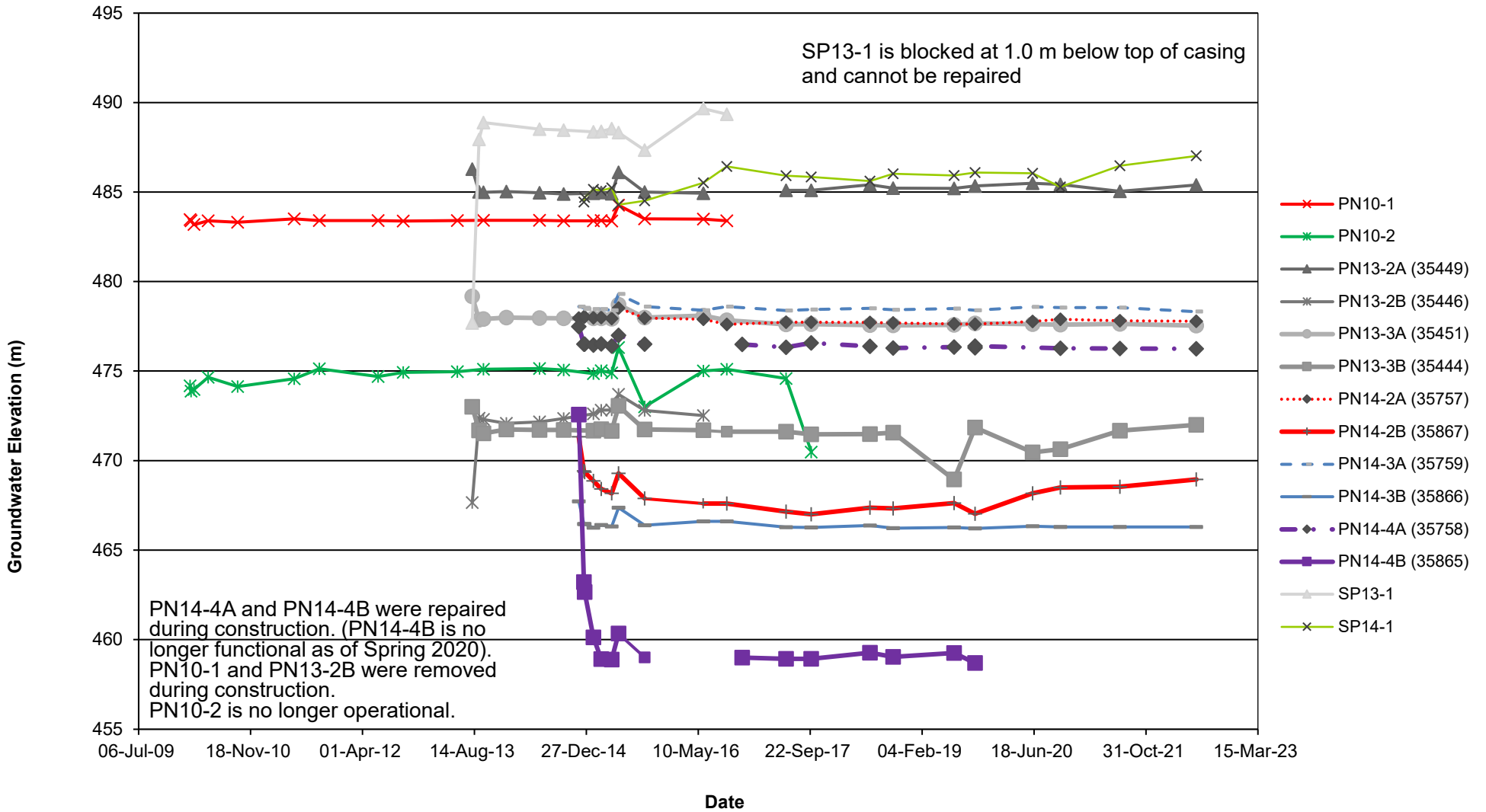
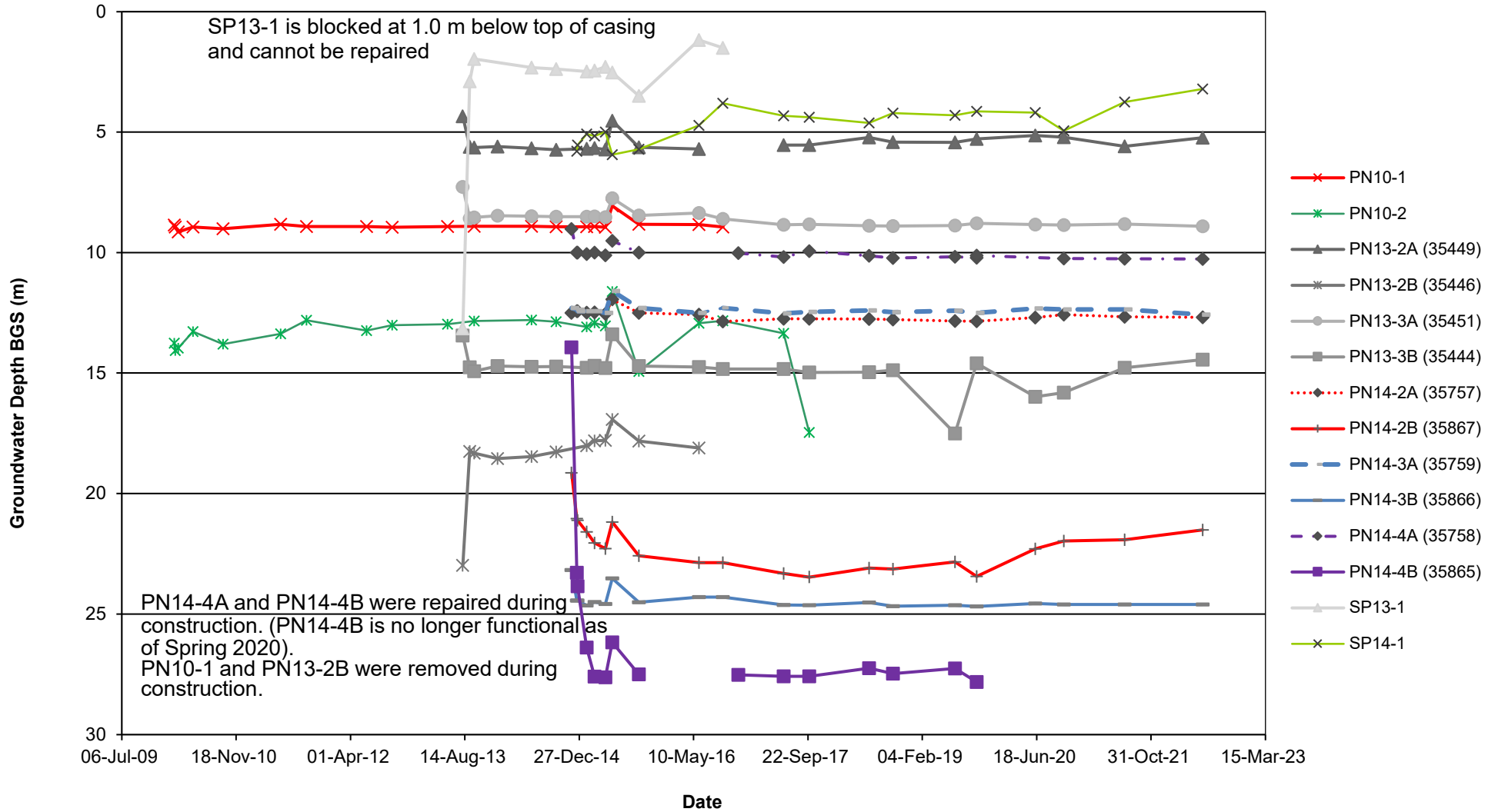


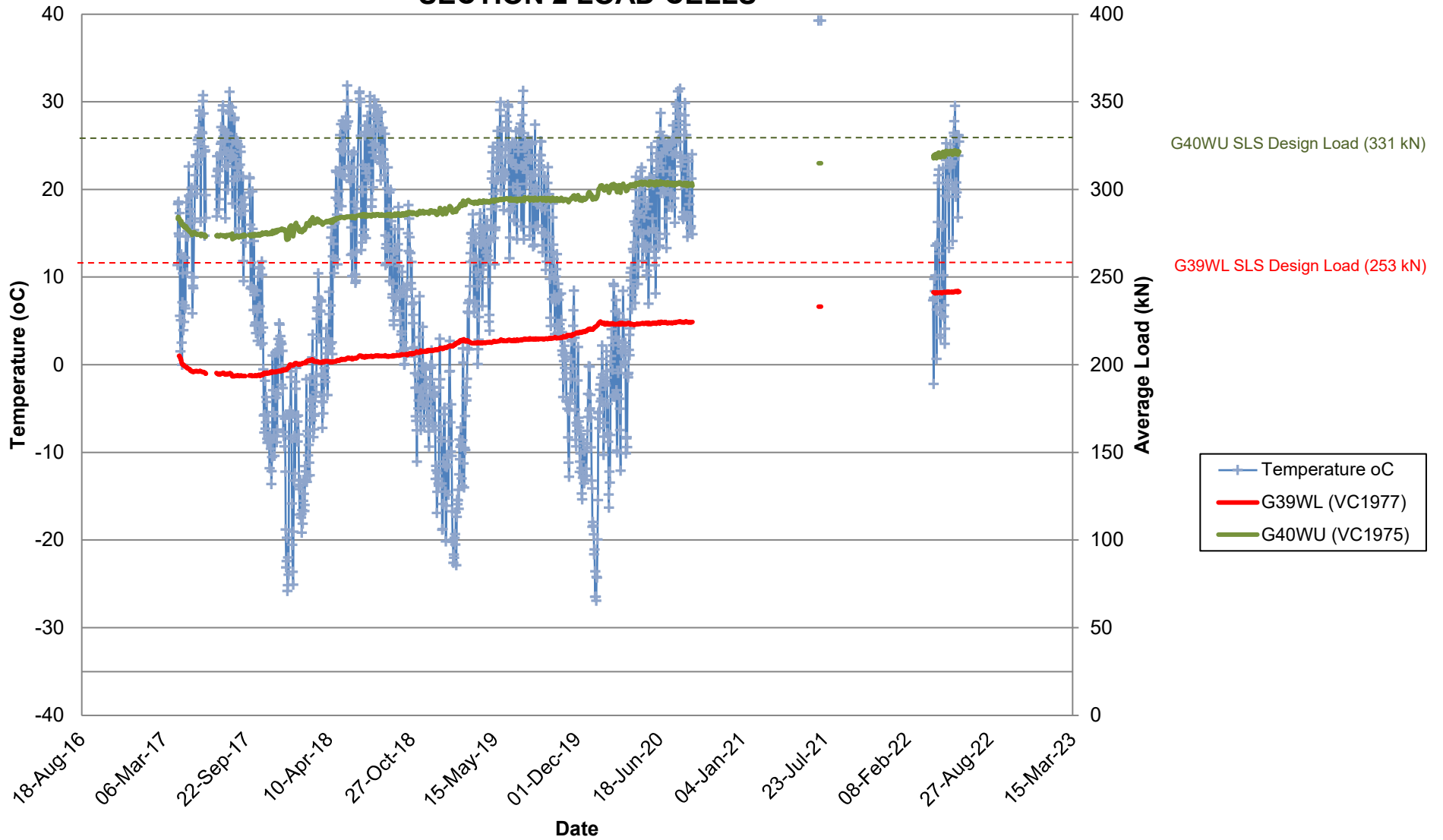
FIGURE PH070-3 HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84) PIEZOMETRIC ELEVATIONS



**FIGURE PH070-4
HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
PIEZOMETRIC DEPTHS**



**FIGURE PH070-5
HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
SECTION 2 LOAD CELLS**



**FIGURE PH070-6
 HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
 SECTION 3A LOAD CELLS**

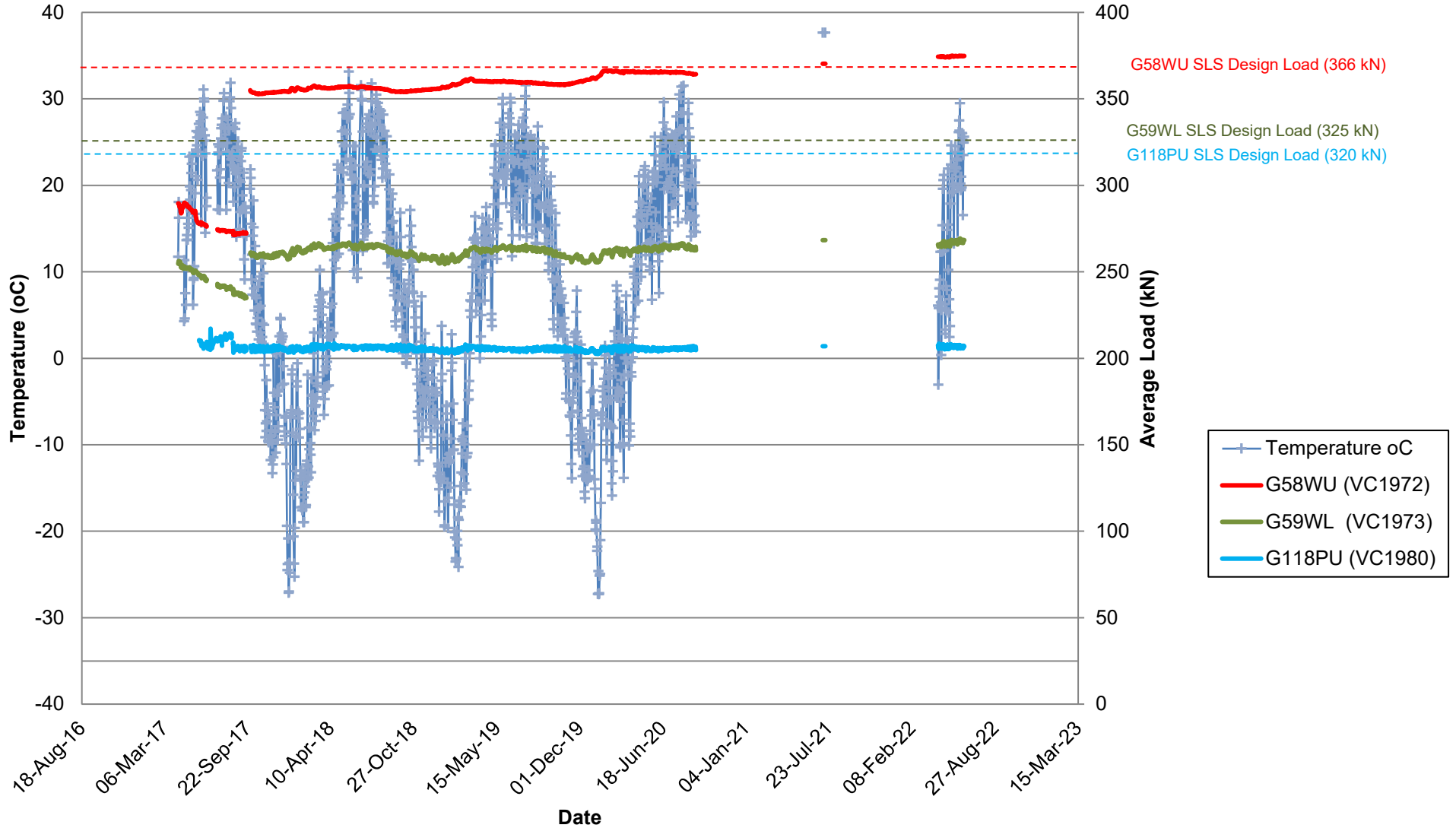


FIGURE PH070-7
HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
SECTION 3B LOAD CELLS

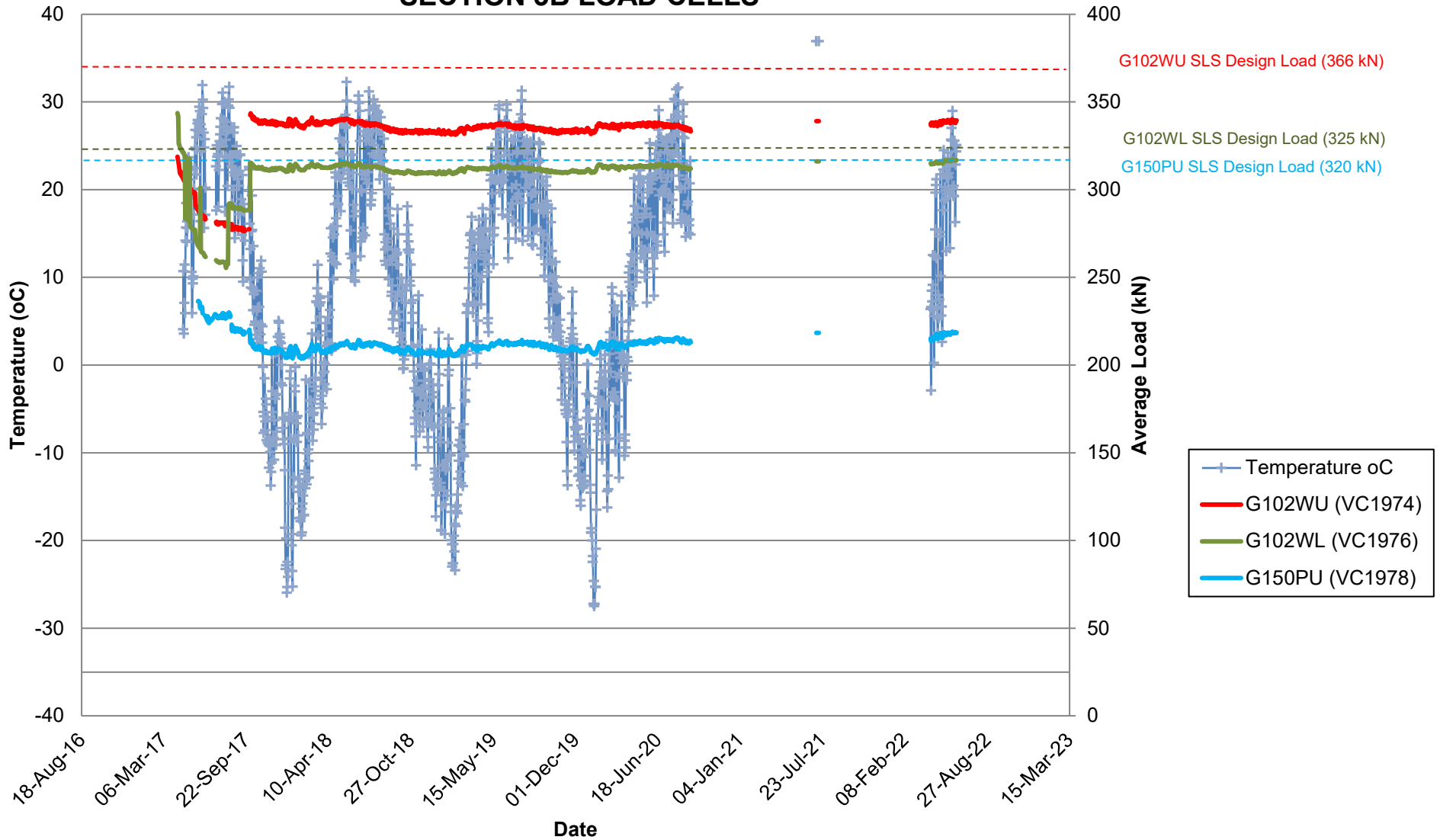


FIGURE PH070-8
HWY 2:60 PEACE RIVER EAST HILL RETAINING WALL SITE (km 33.84)
SECTION 4 LOAD CELLS

