November 30, 2022

Alberta Transportation
2nd Floor, 803 Manning Road N.E.
Calgary, Alberta
T2E 7M8

Alex Frotten, P.Eng.
Construction Engineer – Delivery Services Division (Southern Region)

Dear Mr. Frotten:

CON0022161 Southern Region GRMP Instrumentation Monitoring
Site S054; H22:10, km 37.817 Longview Bridge
Section C – 2022 Fall Readings

1 GENERAL

One shape array accelerometer (SAA) (SAA17-02) was read at the S054 site in Southern Region on September 21, 2022, by Mr. Gabriel Bonot, E.I.T. of Klohn Crippen Berger Ltd. (KCB). This instrument was read as part of the Southern Region Geohazard Risk Management Program (GRMP). The site is located on Hwy 22:10 km 37.817, at the north abutment of the Highwood River Bridge (BF1741), approximately 1 km south of Longview, Alberta. The approximate site coordinates are 5600426 N, 696051 E (UTM Zone 11, NAD 83). A site plan is presented in Figure 1.

The geohazard at the S054 site consists of surface-runoff and riverbank erosion and slope instabilities in the north bank of the Highwood River. The undermining of a gabion wall at the toe of the slope occurred during a flood event in 2013. Surface-runoff erosion appears to be removing lateral earth support from one of the bridge piers (Pier 1A) and its foundation. Rotational movement in the pile cap of Pier 1A to the southwest was reported by the previous consultant. Pier 1A is reported to be founded on 24 piles embedded to a depth of approximately 3.7 m.

The north abutment height is approximately 22 m and the north riverbank slope from the south side of Pier 1A to the top of the gabion wall was estimated to be approximately 1.2H:1V. Immediately downslope of the south side of Pier 1A, tension cracking approximately 12 m to 15 m in length has been observed during previous site inspections.

In 2016 and 2017, geotechnical site investigations were completed at the S054 site by previous consultants to support design and construction work. In 2017, one SAA and three vibrating wire piezometers (VWPs) were installed to monitor movement and groundwater conditions, respectively. In general, the encountered stratigraphy is as follows: medium-plastic clay, overlying silty gravel, overlying sedimentary bedrock (sandstone, siltstone, and claystone).

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1.1 Instrumentation

KCB has been reading the instruments at this site since 2020. Between 2016 and 2020, instruments were read by Thurber Engineering Ltd. (Thurber) on behalf of ISL Engineering and Land Services Ltd. (ISL Engineering) as part of a slope stability monitoring project. Instrumentation installation details are tabulated in Table 1.1. Instrument locations are shown in Figure 1.

SAA17-02 (Serial No. 147741) is 31 m deep and located below the bridge deck at the crest of the north riverbank, in the southeast corner of Pier 1A. SAA17-02 is connected to a data-logger system consisting of a CR800 data logger, SSA232 connection cable, Microhard Bullet-LTE gateway telemetry system (no sim card), and an antenna. However, there is no long-term power supply for the data-logger system (KCB has replaced the battery three times since 2020), so the instrument is read manually using a USB-Serial cable and Campbell Scientific LoggerNet software.

SAA17-02 is protected by an above-ground casing protector that contains the data-logger system.

Table 1.1 Instrument Installation Details

Instrument No.	Instrument Type	Date Installed	UTM Coordinates[1] (m)		Stick Up (m)	Depth (mbgs[1])	Condition
			Northing	Easting			
SAA17-02	SAA	Mar. 2017	5600431	696051	N/A	29.8	Operable
~~VW16-01A~~	~~VWP~~	~~May 2016~~	~~5600472~~	~~696087~~	~~N/A~~	~~27.4~~	~~Inoperable[3]~~
~~VW16-01B~~	~~VWP~~	~~May 2016~~	~~5600472~~	~~696087~~	~~N/A~~	~~17.4~~	~~Inoperable[3]~~
~~VW16-01C~~	~~VWP~~	~~May 2016~~	~~5600472~~	~~696087~~	~~N/A~~	~~7.3~~	~~Inoperable[3]~~

Notes:
[1] Coordinates reported by the previous consultants were confirmed by KCB with a handheld GPS (accuracy of ± 5 m).
[2] Meters below ground surface (mbgs). Bottom reading depth for SI and tip depth for VWPs.
[3] Flush-mounted casing protector for VW16-01A/B/C paved over in 2021 and instruments no longer readable.

2 INTERPRETATION

2.1 General

Prior to October 31, 2017, the instruments were monitored by Thurber. No previous instrumentation reports were available to KCB for review.

For the SAA, the cumulative displacement, incremental displacement, displacement-time data was plotted in the A-direction (i.e., the direction of the A0-grooves) and the X-direction (i.e., the direction of maximum movement obtained at a skew angle from the A0-grooves). SAA17-02 has a skew angle of 85° measured clockwise from the direction of the A0-grooves.

The pile-cap thickness has not been measured by KCB. However, based on the ground surface elevation of 1202.1 m for a nearby test hole (reported by the previous consultant) the tip of the pile is estimated to be at an approximate elevation of 1198.0 m (an approximate depth of 4.2 m below ground surface).

The SAA data plots are included in Appendix I, and a summary of the SAA data is provided in Table 2.1.

2.2 Zones of Movement

There are three zones of distributed movement being recorded in SAA17-02, which include:

- a shallow zone from ground surface to an approximate depth of 2.5 m below ground surface, in the medium plastic clay; and
- a deeper zone from an approximate depth of 17.0 m to 21.5 m below ground surface, at the base of the sandstone/siltstone unit and into the underlying claystone; and
- the deepest zone from an approximate depth of 22.0 m below ground surface to near the base of the instrument, from the base of the identified claystone unit to a lower unidentified unit.

2.3 Interpretation of Monitoring Results

Since December 2020, a negligible rate of movement (less than 2 mm/year) has been recorded in SAA17-02. Overall, based on the September 2022 data obtained from this instrument:

- in the upper monitoring zone approximately 7 mm of distributed movement has been recorded in the medium plastic clay, with the majority of the movement occurring shortly after installation.
- In the middle monitoring zone approximately 8 mm of distributed movement has been recorded from near the base of the sandstone/siltstone until to the base of the claystone unit, with the majority of the movement occurring shortly after installation.
- In the lower monitoring zone approximately 3.5 mm of distributed movement has been recorded from near the base of the claystone unit to the base of the instrument, with the majority of the movement occurring shortly after installation.

Table 2.1 Shape Array Accelerometer Readings Summary

Instrument ID	Date				Recorded Reading Frequency (Last reading date)	Ground Surface Elevation (m)	Depth of Movement (mbgs[1])	Direction of Movement, Skew Angle[2]	Movement (mm)		Rate of Movement (mm/year)		
	Initialized	Previous Maximum Cumulative Movement Recorded	Previous Reading	Most Recent Reading					Maximum Cumulative	Incremental Since Previous Maximum Cumulative	Previous Maximum	Most Recent Reading	Change from Previous Reading
SAA17-02	Mar. 24, 2017	May 21, 2021	Jun. 21, 2021	Sep. 21, 2022	Every 12-hours (Apr. 11, 2022)	1202.1	0.0 – 2.5	X-Direction, 85°	6.6	-0.1	107.0	13.3	1.1
		Feb. 17, 2022					17.0 – 21.5		7.9	-0.2	431.6	7.1	16.4
		Feb. 10, 2022					22.0 – 30.0		3.9	-0.2	31.4	-16.8	-28.0

Note:
[1] Meters below ground surface (mbgs).
[2] Skew angle of X-direction measured clockwise from A-direction.

3 RECOMMENDATIONS

3.1 Future Work

All operable instruments should continue to be read twice per year (spring and fall).

KCB recommends that a topographic survey of the north riverbank is carried out, and that two new boreholes are drilled, one east and one west of the north bridge abutment. The west borehole should include installation of a new SI and the east borehole should include installation of new VWPs to replace the ones that were paved over in 2021 (if they cannot be recovered).

3.2 Instrument Repairs and Maintenance

As previously discussed with AT, a comprehensive slope stability and bridge deck monitoring plan should be developed for this site, including upgrading SAA17-02 with a long-term solution, including a new battery and a permanent power supply (e.g., installation of a solar panel and mount).

4 CLOSURE

This report is an instrument of service of Klohn Crippen Berger (KCB). The report has been prepared for the exclusive use of Alberta Transportation (Client) for the specific application to the Southern Region Geohazard Risk Management Program (Contract No. CON0022161), and it may not be relied upon by any other party without KCB's written consent.

KCB has prepared this report in a manner consistent with the level of care, skill and diligence ordinarily provided by members of the same profession for projects of a similar nature at the time and place the services were rendered. KCB makes no warranty, express or implied.

Use of or reliance upon this instrument of service by the Client is subject to the following conditions:

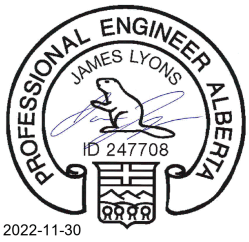
1. The report is to be read in full, with sections or parts of the report relied upon in the context of the whole report.
2. The observations, findings and conclusions in this report are based on observed factual data and conditions that existed at the time of the work and should not be relied upon to precisely represent conditions at any other time.
3. The report is based on information provided to KCB by the Client or by other parties on behalf of the client (Client-supplied information). KCB has not verified the correctness or accuracy of such information and makes no representations regarding its correctness or accuracy. KCB shall not be responsible to the Client for the consequences of any error or omission contained in Client-supplied information.
4. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

5. This report is electronically signed and sealed and its electronic form is considered the original. A printed version of the original can be relied upon as a true copy when supplied by the author or when printed from its original electronic file.

Please contact the undersigned if you have any questions or comments regarding this report.

Yours truly,

KLOHN CRIPPEN BERGER LTD.



2022-11-30

James Lyons, P.Eng.
Civil Engineer

Reviewed by: Chris Gräpel, M.Eng., P.Eng.
Senior Civil Engineer, Associate

Cc: Peter Roy, P.Eng.
Civil Engineer, Project Manager

JL:bb

PERMIT TO PRACTICE
KLOHN CRIPPEN BERGER LTD.
RM SIGNATURE: _____
RM APEGA ID #: 187607
DATE: 30 Nov. 2022
PERMIT NUMBER: P009196
The Association of Professional Engineers and Geoscientists of Alberta (APEGA)

ATTACHMENTS

Figure	
Appendix I	Instrumentation Plots
Appendix II	ISL – Historic Ground Slope Profiles

FIGURE

Legend

- Shape Array Accelerometer
- Vibrating Wire Piezometer
- Bridge Pier Location
- Flow Direction

0 100 Metres

NOTES:
1. HORIZONTAL DATUM: NAD83
2. GRID ZONE: UTM ZONE 11N
3. IMAGE SOURCE: 2022 MICROSOFT CORPORATION, 2022 MAXAR CNES, DISTRIBUTION AIRBUS DS
4. INSTRUMENT AND BRIDGE PIER LOCATIONS ARE APPROXIMATE

CLIENT: Alberta

Klohn Crippen Berger

PROJECT: SOUTHERN REGION GEOHAZARD RISK MANAGEMENT PROGRAM

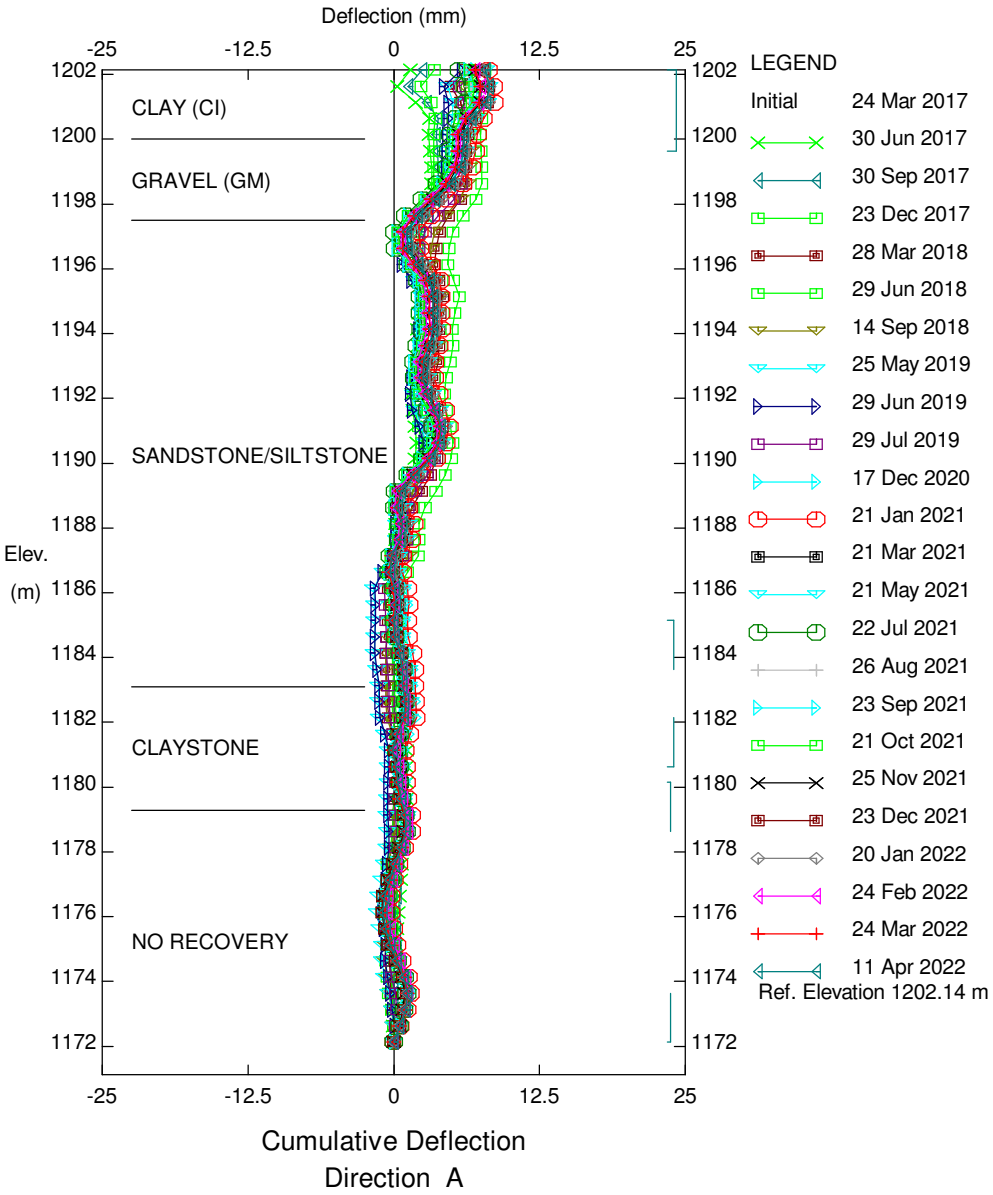
TITLE: Site Plan
S054 - Longview Bridge
Hwy 22:10, km 37.817

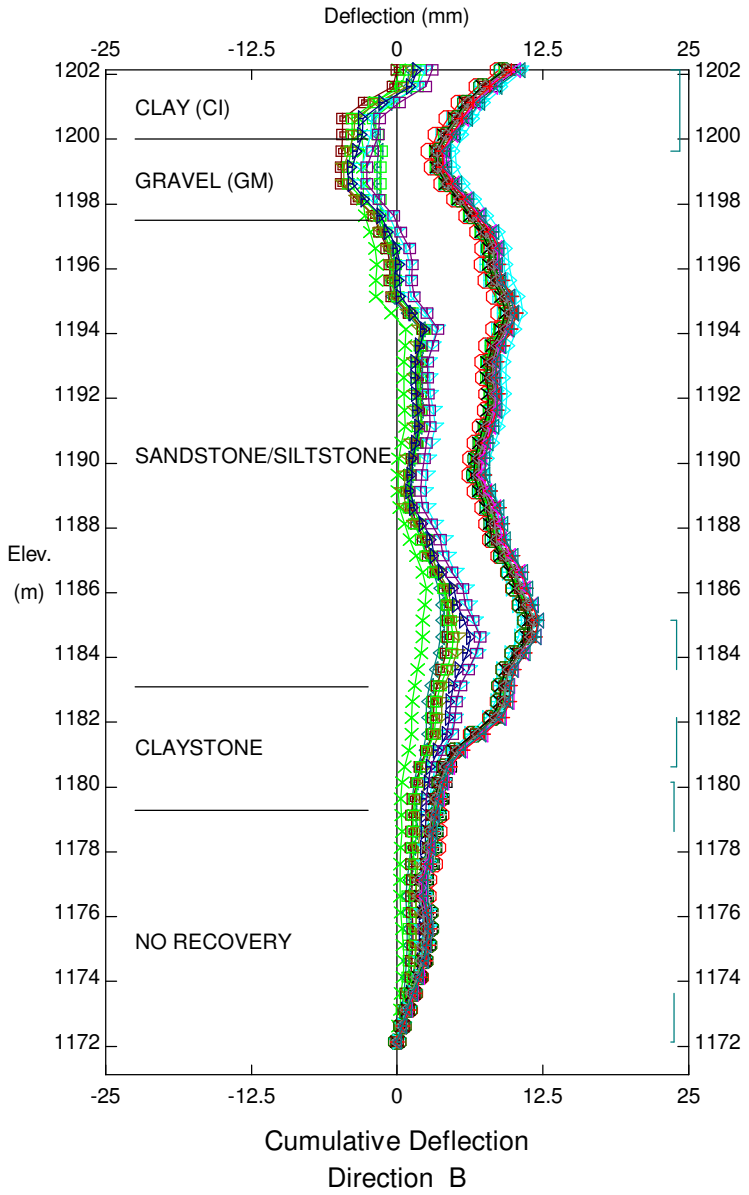
SCALE	PROJECT No.	FIG No.
1:2,000	A05115A03	1

APPENDIX I

Instrumentation Plots

Klohn Crippen Berger - Calgary





LEGEND

Initial	24 Mar 2017
	30 Jun 2017
	30 Sep 2017
	23 Dec 2017
	28 Mar 2018
	29 Jun 2018
	14 Sep 2018
	25 May 2019
	29 Jun 2019
	29 Jul 2019
	17 Dec 2020
	21 Jan 2021
	21 Mar 2021
	21 May 2021
	22 Jul 2021
	26 Aug 2021
	23 Sep 2021
	21 Oct 2021
	25 Nov 2021
	23 Dec 2021
	20 Jan 2022
	24 Feb 2022
	24 Mar 2022
	11 Apr 2022

Ref. Elevation 1202.14 m

S054; H22:10 Longview Bridge, Inclinometer SAA17-02

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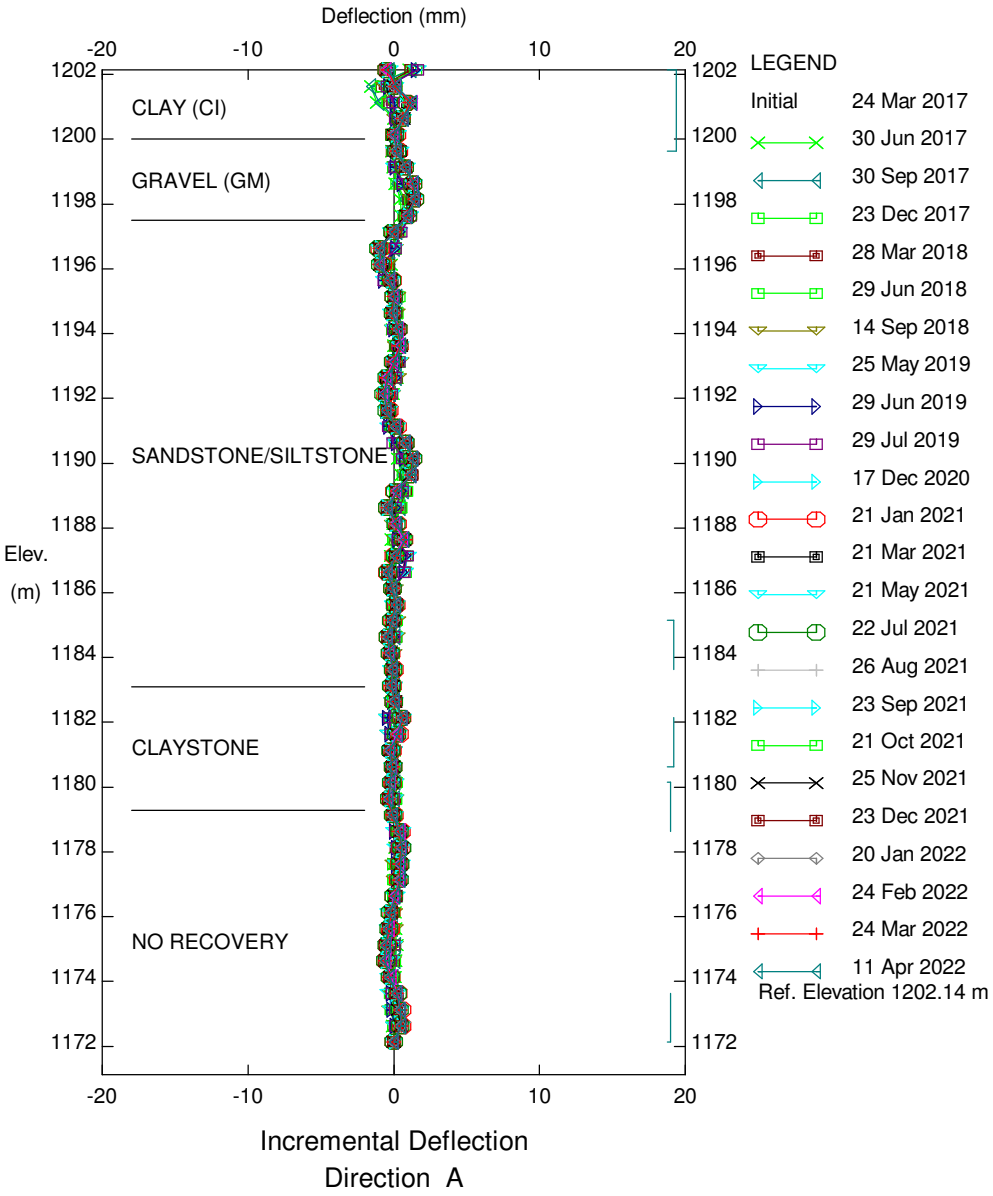

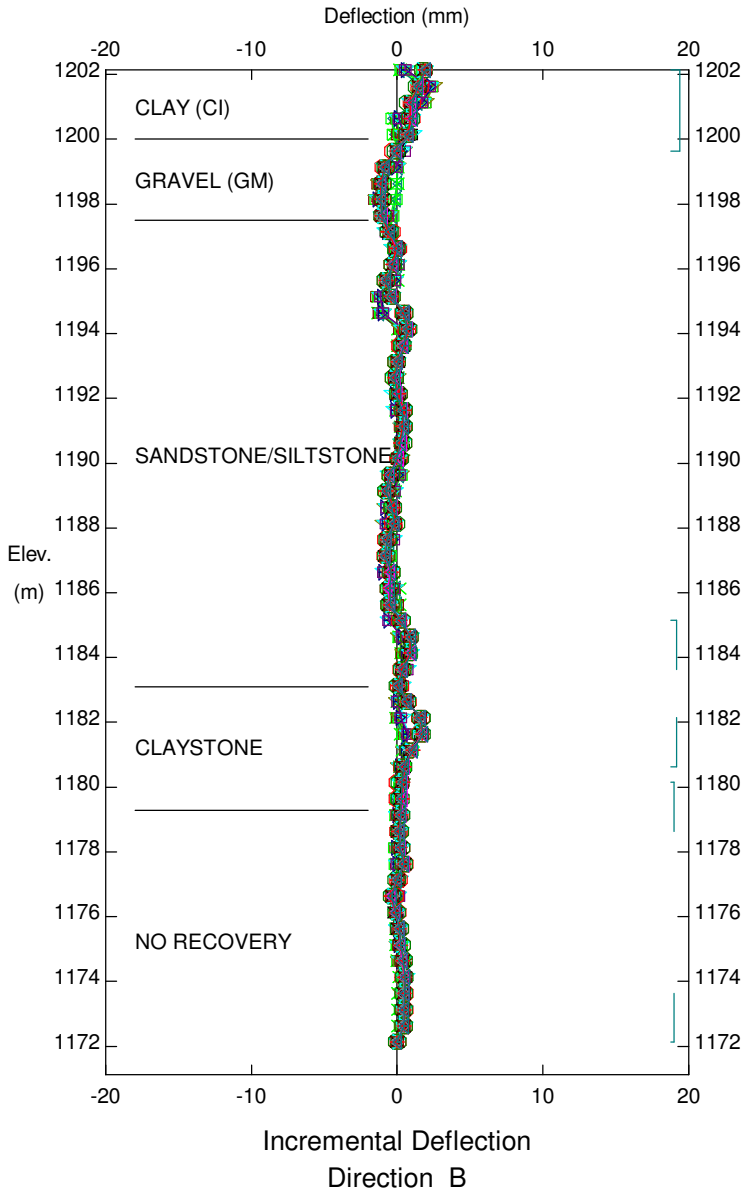

S054; H22:10 Longview Bridge, Inclinometer SAA17-02

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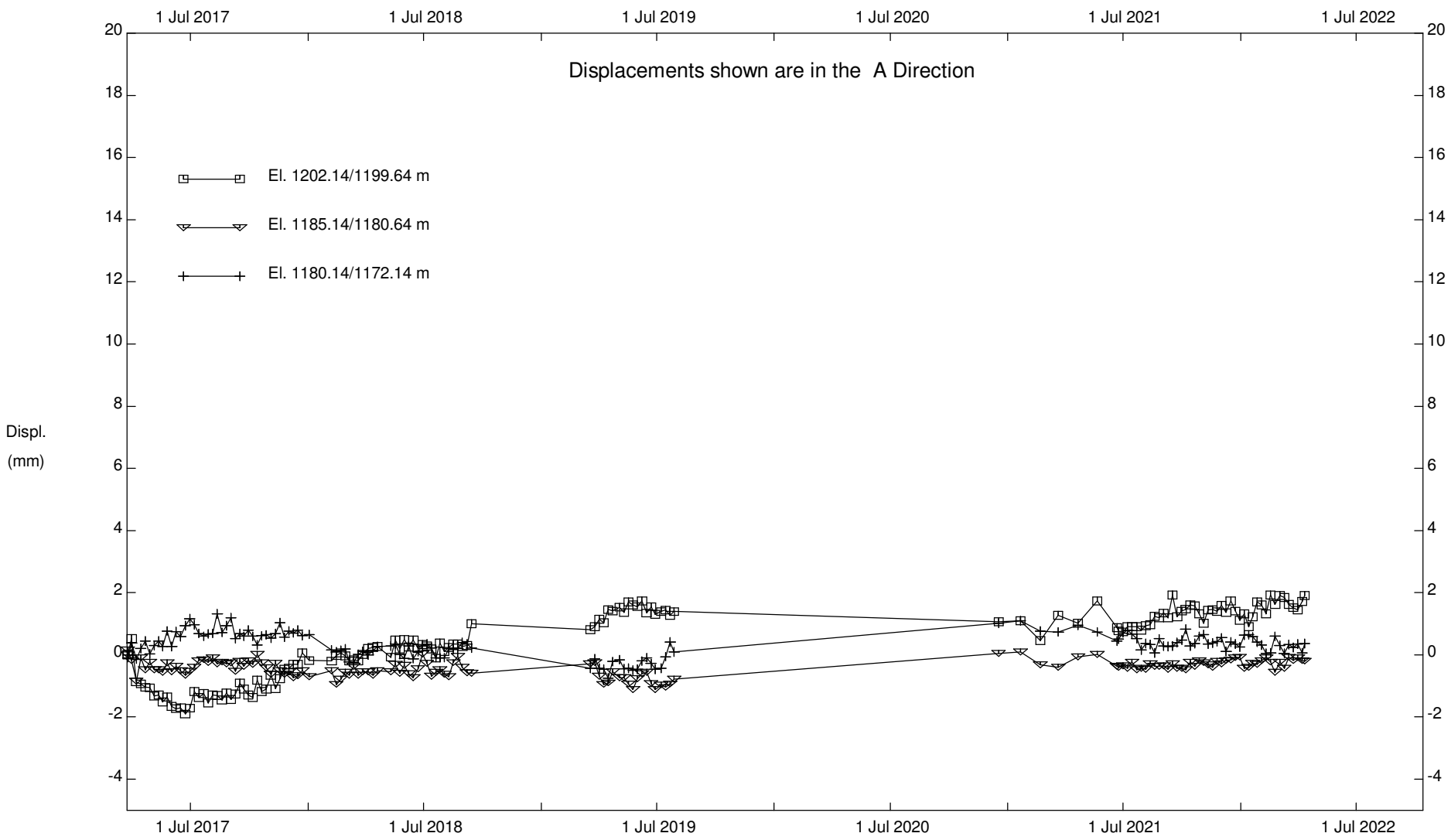

S054; H22:10 Longview Bridge, Inclinometer SAA17-02

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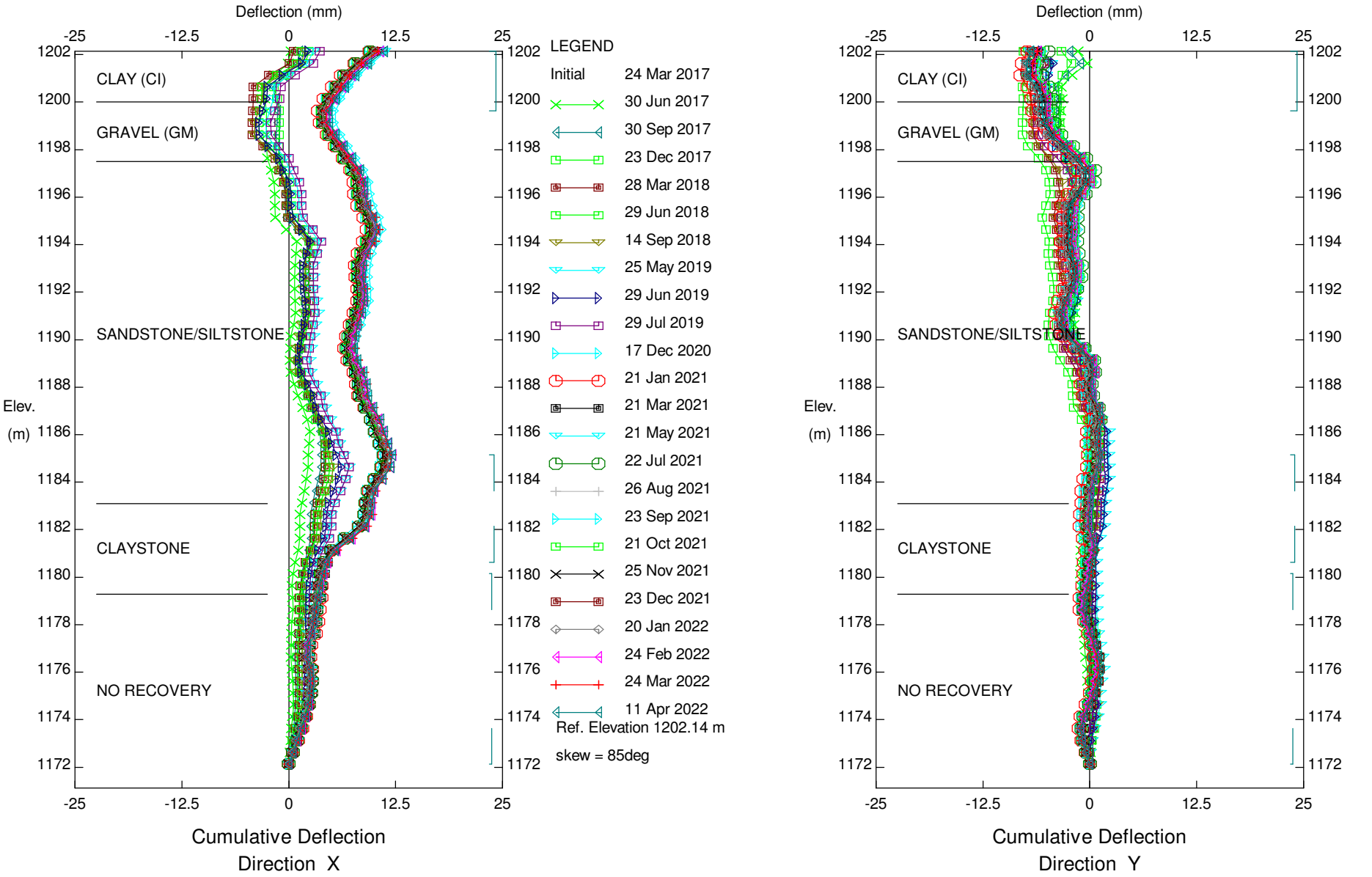

S054; H22:10 Longview Bridge, Inclinometer SAA17-02

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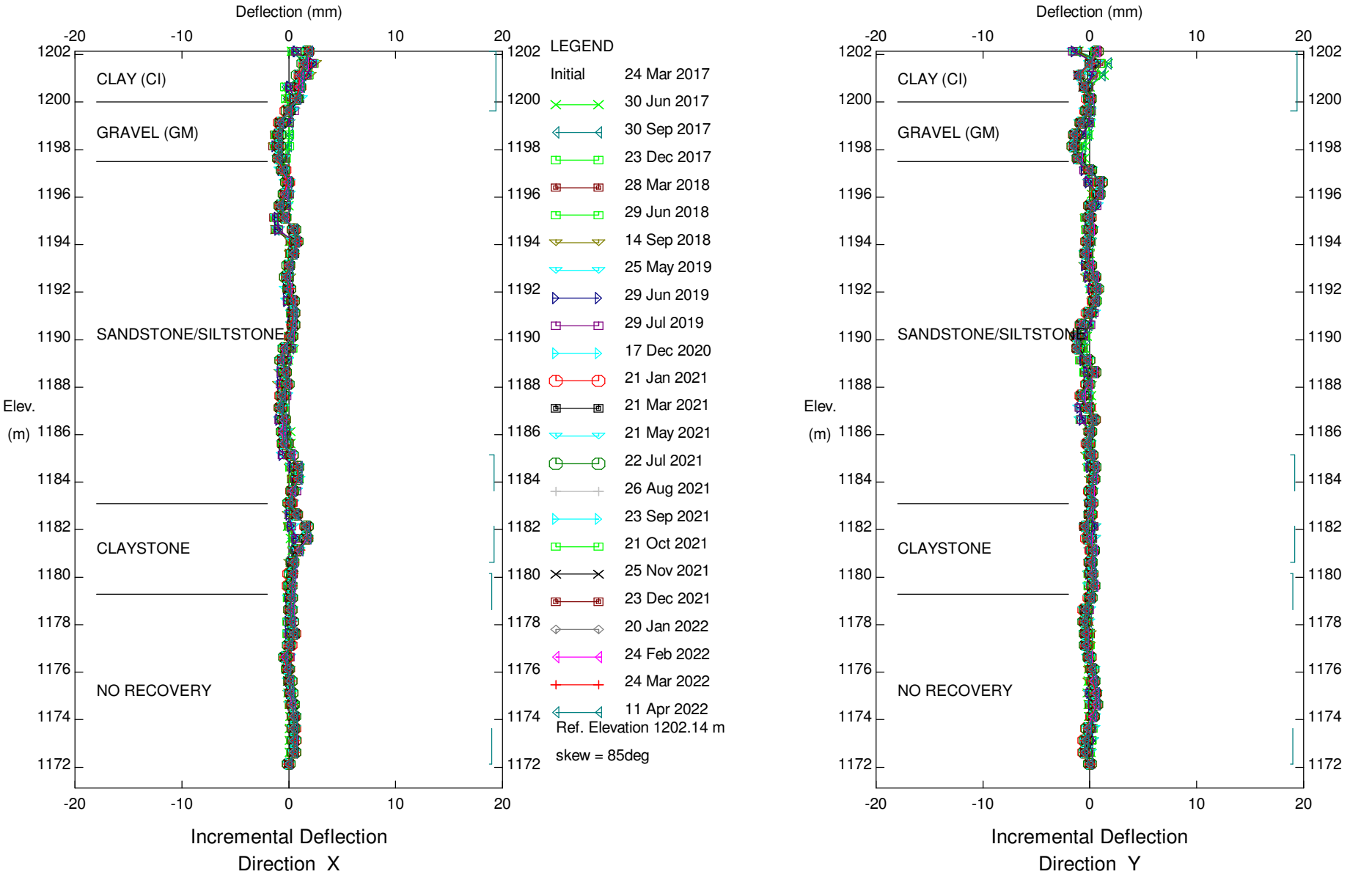

S054; H22:10 Longview Bridge, Inclinometer SAA17-02

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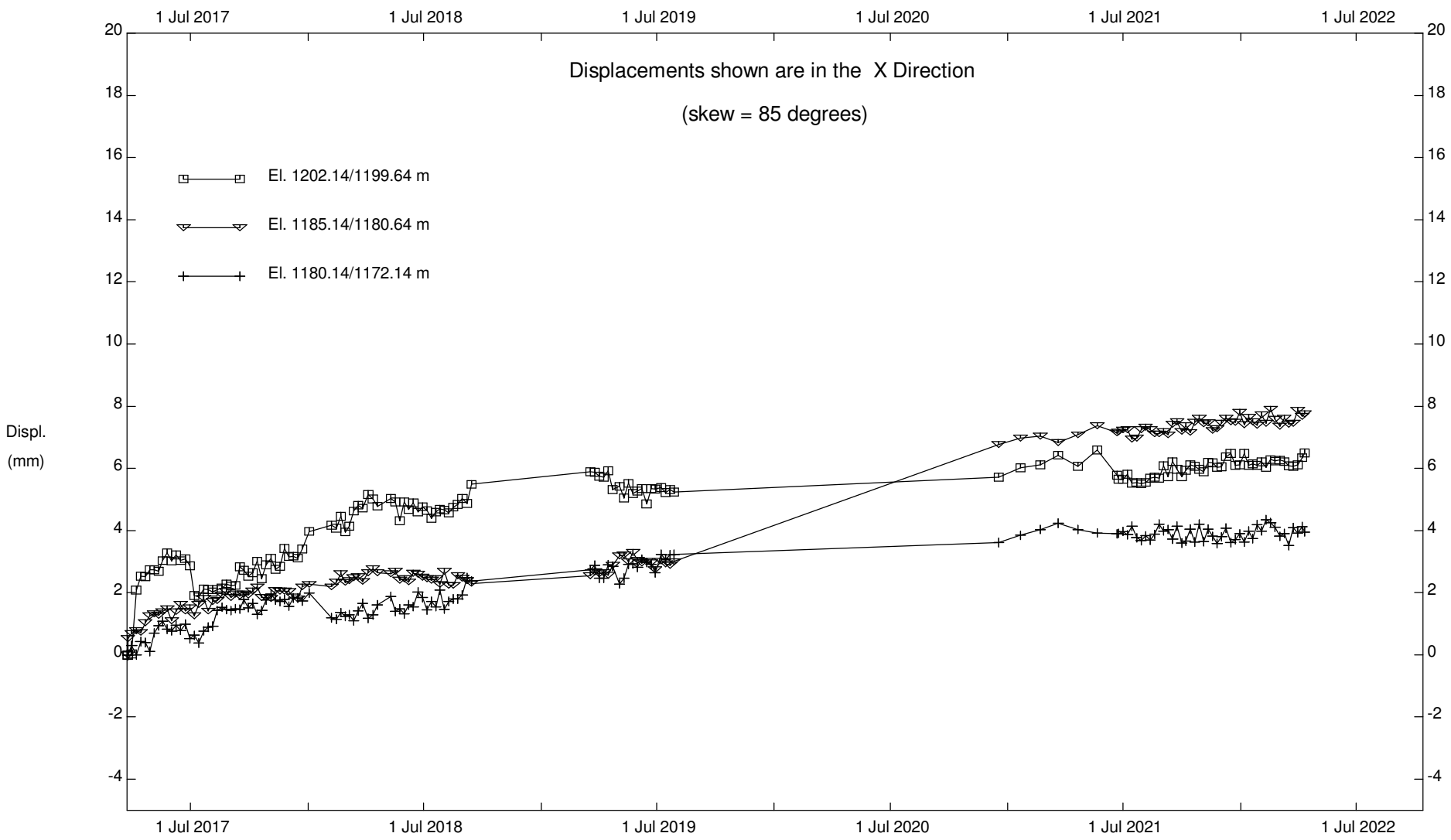

S054; H22:10 Longview Bridge, Inclinometer SAA17-02

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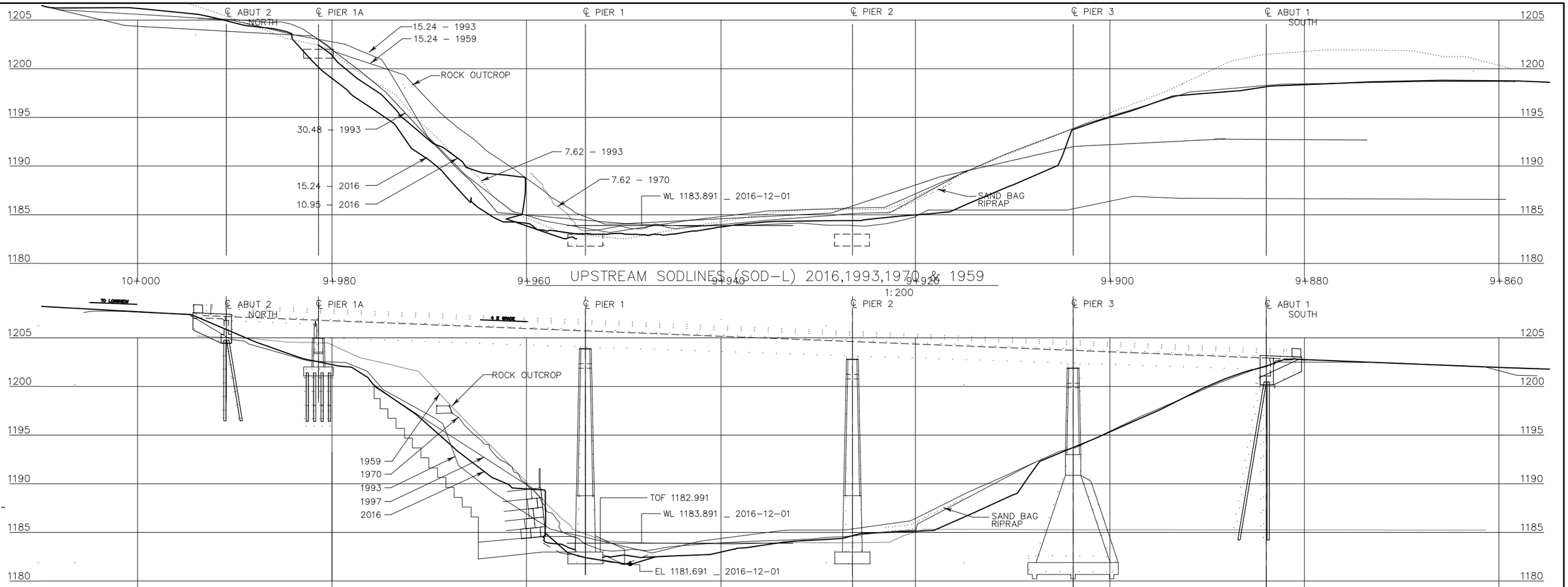
APPENDIX II

ISL – Historic Ground Slope Profiles

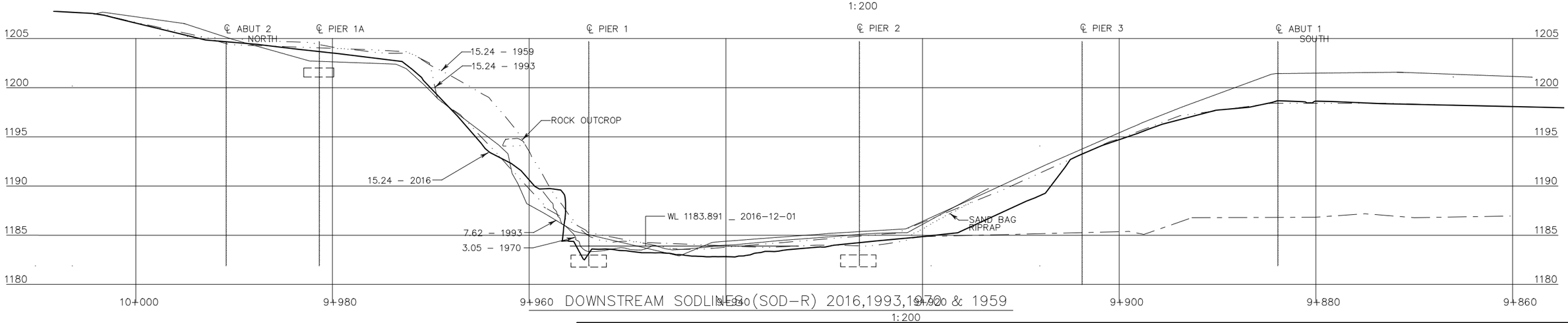


UPSTREAM SODLINES (SOD–L) 2016,1993,1970 & 1959

1: 200

CENTRELINE 2016,1993,1970 & 1959

1: 200



DOWNSTREAM SODLINES (SOD–R) 2016,1993,1970 & 1959

1: 200

CONSULTANT: ISL Engineering and Land Services

JOB No. 26760

DESIGNER

DATE DESIGN_DATE

CHECKER

DATE REVIEW_DATE

REV	DATE	REVISION	BY
5	?	?	?
4	?	?	?
3	?	?	?
2	?	?	?
1	?	?	?

Alberta Transportation

HIGHWOOD RIVER BRIDGE
ON HWY 22, 1 Km S OF LONGVIEW
SLOPE STABILIZATION REPORT
GROUND LINES 1959 TO 2016

DATE	LOCATION	SITE	CONTRACT	HIGHWAY	SHEET	DRAWING
2016-12-16	NE17-18-2-5	BF 1741	CONTRACT	HWY 22	? OF ?	SK-4

DRAWING | HIGHWAY | CONTRACT | DESCRIPTION | PHOTO | DATE | BY | SURVEYED | DEPARTMENT BAR CODE

Doug Savage / Dec. 16, 16 / M:\26700\26760_BF1741_HeadslopeStabalization\02_CAD\20_Drafting\26760_Gound_Lines_Over_Years.dwg