

January 10, 2022

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

**Ed Szmata**  
**Construction Technologist**

Dear Mr. Szmata:

**CON0022166 Peace Region (Grande Prairie District – South) GRMP Instrumentation Monitoring Site GP016; H666:02; km 34.837 Slide 2 km West of Hwy 40 and Hwy 666 Junction Section C – 2021 Spring Readings**

## **1 GENERAL**

Four slope inclinometers (SIs) (SI-1, SI-2, SI-13, and SI-41), one vibrating wire piezometer (VWP) (VW14-55A), four pneumatic piezometers (PNs) (PN-51A, PN-51B, PN-52A, and PN-52B), and two standpipe piezometers (SPs) (SP14-51 and SP14-54) were read at the GP016 site in the Peace Region (Grande Prairie District – South) (GP South) on June 27, 2021 by Mr. James Lyons, E.I.T. and Ms. Amy Miller, E.I.T. of Klohn Crippen Berger Ltd. (KCB). These instruments were read as part of the GP South geohazard-risk-management program (GRMP). The site is located on Hwy 666:02, km 34.837, 2 km west of Hwy 40 and Hwy 666 junction. The site coordinates are 6103361 N, 383749 E (UTM zone 11, NAD 83). A site plan is presented in Figure 1.

The geohazard at the GP016 site consists of three landslides along the south slope of the Wapiti River Valley.

### **1.1 Instrumentation**

Instrumentation installation details are tabulated in Table 1.1. Instrument locations are shown in Figure 1.

Six SIs (SI-1, SI-2, SI-13, SI-41, SI-52, and SI-53) and seven PNs (PN-13A, PN-13B, PN-51A, PN-51B, PN-51C, PN-52A, and PN-52B) were installed between 1989 and 2003. In 2014, two additional PNs (PN14-51 and PN14-52), two SPs (SP14-51 and SP14-52), and three VWPs (VW14-51, VW14-52, and VW14-55A) were installed. The SIs and piezometers were installed to monitor depth of movement and groundwater conditions, respectively. The instruments are protected with above-ground casing protectors.

A number of the instruments are currently inoperable. SI-52 and SI-53 are sheared at 18.9 m and 4.9 m, respectively. PN-13A and PN-13B were missing caps so readings could not be obtained. PN-51C, PN14-51, PN14-52, VW14-51, and VW14-53 are all also inoperable.

The SIs were read using an RST Digitilt MEMS Inclinometer System with a metric inclinometer probe with a 0.5 m wheelbase. Prior to the Spring 2021 monitoring program, the readings were obtained using an imperial RST Digital Inclinometer probe with a 2 ft wheelbase and an RST Pocket PC readout.

The operational VWP was read using an RST VW2106 vibrating wire readout, which is the same equipment that was used during the fall 2020 instrumentation readings.

The operational PNs were read using an RST C109 pneumatic piezometer readout and the SPs were read using an RST Water Level Meter. Previously, the PNs and SPs were read using an RST C108 pneumatic piezometer readout and a Heron dipmeter, respectively.

**Table 1.1 Instrumentation Installation Details**

Instrument ID	Instrument Type	Date Installed	Coordinates <sup>1</sup> (m)		Ground Surface Elevation (m)	Stick Up (m)	Depth Below Ground Surface (m)	Condition
			Northing	Easting				
SI-1	SI	Feb. 19, 1997	6102779	383232	Unknown	0.8	60.0	Operational
SI-2	SI	Feb. 19, 1997	6102793	383286	Unknown	0.8	60.0	Operational
SI-13	SI	Jun. 19, 1989	6103089	383338	Unknown	0.8	23.5	Operational
SI-41	SI	May 9, 1995	6103295	383734	Unknown	1.1	20.5	Operational
SI-52	SI	Dec. 6, 2003	Unknown	Unknown	Unknown	Unknown	Unknown	Inoperable <sup>2</sup>
SI-53	SI	Dec. 6, 2003	Unknown	Unknown	Unknown	Unknown	Unknown	Inoperable <sup>3</sup>
PN-13A	PN	Jun. 6, 2001	6103088	383338	595	N/A	4.6	Inoperable <sup>4</sup>
PN-13B	PN	Jun. 6, 2001	6103088	383338	595	N/A	18.3	Inoperable <sup>4</sup>
PN-51A	PN	Dec. 6, 2003	6103441	383704	554	N/A	7.6	Operational
PN-51B	PN	Dec. 6, 2003	6103441	383704	554	N/A	10.7	Operational
PN-51C	PN	Dec. 6, 2003	6103441	383704	554	N/A	18.0	Inoperable
PN-52A	PN	Dec. 6, 2003	6103499	383723	549	N/A	4.9	Operational
PN-52B	PN	Dec. 6, 2003	6103499	383723	549	N/A	17.4	Operational
PN14-51	PN	Oct. 8, 2014	6102924	382899	630	N/A	15.2	Inoperable
PN14-52	PN	Oct. 11, 2014	6102955	382905	624	N/A	14.0	Inoperable
VW14-51	VWP	Oct. 8, 2014	Unknown	Unknown	621	N/A	30.5	Inoperable
VW14-53	VWP	Oct. 16, 2014	Unknown	Unknown	617	N/A	15.2	Inoperable
VW14-55A	VWP	Oct. 18, 2014	6102966	382935	622	N/A	12.2	Operational
SP14-51	SP	Oct. 21, 2014	6102924	382899	631	0.9	6.5	Operational
SP14-54	SP	Oct. 23, 2014	6102932	382934	627	0.8	6.4	Operational

**Notes:**

<sup>1</sup> Installation details were provided by AT and the previous consultant. Ground surface elevations were not provided for the SIs, so the ground surface elevation from adjacent instruments/piezometer tips if provided.

<sup>2</sup> SI-52 is sheared at 18.9 mbgs.

<sup>3</sup> SI-53 is sheared at 4.9 mbgs.

<sup>4</sup> PN-13A and PN-13B were missing caps, so readings could not be taken in spring 2021. These instruments may be repairable.

## 2 INTERPRETATION

### 2.1 General

For the SIs, the cumulative displacement, incremental displacement, and displacement-time data was plotted in the A-direction (i.e., the direction of the A0-groove) and where applicable, the X-direction (i.e., the direction of maximum movement obtained at a skew angle from the A0-grooves). SI-13 and SI-41 have skew angles of 210° and 351°, respectively, measured clockwise from the direction of the A0-grooves. The A0-grooves for SI-1 and SI-2 are aligned with the expected direction of movement during installation.

For the operable piezometers, the equivalent water level data was plotted relative to ground surface elevation and each instrument's tip elevation.

The SI and piezometer plots are included in Appendix I, and a summary of the SI, PN, VWP, and SP data is provided in Table 2.1 through

Table 2.4, respectively.

**Table 2.1 Slope Inclinometer Reading Summary**

Instrument ID	Date Initialized	Date of Previous Reading	Date Previous Maximum Cumulative Movement Recorded	Date of Most Recent Reading	Ground Surface Elevation (m)	Depth of Movement (mbgs <sup>1</sup> )	Maximum Cumulative Movement Recorded (mm)	Incremental Movement Recorded Since Previous Maximum Cumulative Movement Recorded (mm)	Rate of Movement (mm/year)		
									Previous Maximum	Current	Change from Previous Reading
SI-1	Feb. 19, 1997	Oct. 9, 2020	N/A	Jun. 27, 2021	668.6	N/A – no discernible movement has been recorded					
SI-2	Feb. 19, 1997	Oct. 9, 2020		Jun. 27, 2021	668.5						
SI-13	Jun. 19, 1989	Oct. 9, 2020	Oct. 9, 2020	Jun. 27, 2021	594.6	1.5 – 4.9	178.7	5.4	28.8	7.4	-21.4
SI-41	May 9, 1995	Oct. 9, 2020	Oct. 9, 2020	Jun. 27, 2021	570.1	0.5 – 2.5	56.3	0.9	2.4	1.2	-0.2

**Notes:**  
<sup>1</sup>Meters below ground surface (mbgs).

**Table 2.2 Pneumatic Piezometer Reading Summary**

Instrument ID	Date Installed	Date of Previous reading	Date of Most Recent Reading	Ground Surface Elevation (m)	Tip Depth (mbgs <sup>1</sup> )	Previous Water Level (mbgs <sup>1</sup> )	Current Water Level (mbgs <sup>1</sup> )	Change from Previous Reading (m)
PN-51A	Dec. 6, 2003	Oct. 9, 2020	Jun. 27, 2021	554	7.6	5.5	1.3	4.2
PN-51B	Dec. 6, 2003	Oct. 9, 2020	Jun. 27, 2021	554	10.7	5.6	5.8	-0.2
PN-52A	Dec. 6, 2003	Oct. 9, 2020	Jun. 27, 2021	549	4.9	4.8	-2.3	7.1
PN-52B	Dec. 6, 2003	Oct. 9, 2020	Jun. 27, 2021	549	17.4	15.6	14.7	0.9

**Notes:**  
<sup>1</sup>Meters below ground surface (mbgs).

**Table 2.3 Vibrating Wire Piezometer Reading Summary**

Instrument ID	Date Installed	Date of Previous reading	Date of Most Recent Reading	Ground Surface Elevation (m)	Tip Depth (mbgs <sup>1</sup> )	Previous Water Level (mbgs <sup>1</sup> )	Current Water Level (mbgs <sup>1</sup> )	Change from Previous Reading (m)
VW14-55A	Oct. 18, 2014	Oct. 9, 2020	Jun. 27, 2021	622	12.2	6.3	6.0	0.3

**Notes:**  
<sup>1</sup>Meters below ground surface (mbgs).

**Table 2.4 Standpipe Piezometer Reading Summary**

Instrument ID	Date Installed	Date of Previous reading	Date of Most Recent Reading	Ground Surface Elevation (m)	Tip Depth (mbgs <sup>1</sup> )	Previous Water Level (mbgs <sup>1</sup> )	Current Water Level (mbgs <sup>1</sup> )	Change from Previous Reading (m)
SP14-51	Oct. 21, 2014	Oct. 9, 2020	Jun. 27, 2021	631	6.5	2.5	2.4	0.1
SP14-54	Oct. 23, 2014	Oct. 9, 2020	Jun. 27, 2021	627	6.4	5.2	5.1	0.1

**Notes:**  
<sup>1</sup>Meters below ground surface (mbgs).

KCB reviewed the instrumentation data provided by the previous consultant and removed corrections applied to the historical SI data based on our experience. The instrumentation data obtained by KCB is generally consistent with the data obtained by the previous consultant, except for:

- For SI-2, the previous consultant was copying the bottom 8 readings (4 m) for each subsequent reading instead of using the data obtained in the field. Without this correction, there is a “kick-out” at the base of the instrument when compared to the previous readings. However, with the replacement readings, KCB’s reading is consistent with the previous readings. The SI plots with and without this correction are included in Appendix II.

The SI data plots presented herein include data for readings taken with both the previous consultants’ and KCB’s equipment.

## 2.2 Zones of Movement

There are no zones of discernible movement in SI-1 and SI-2 at the valley crest of Site 1 above the highway.

SI-13 downslope of the highway in Site 1 is recording a zone of discrete movement from approximately El. 588.5 m to El 593.0 m (1.5 mbgs to 5.0 mbgs).

SI-41 upslope of the highway at Site 2 is recording a zone of discrete movement from approximately El. 567.0 m to El 569.5 m (0.5 mbgs to 2.5 mbgs).

## 2.3 Interpretation of Monitoring Results

The metric readings taken by KCB for SI-1 and SI-2 in 2021 do not line up well with the imperial probe readings taken by the previous consultant (i.e., readings taken before June 2021). These instruments may be re-initialized using the June 2021 reading as the new baseline reading.

Between installation in 1989 and 2012, the movement rate for SI-13 was approximately 5 mm/year. After 2012, the rate of movement slowed to approximately 3 mm/year up until 2017. Since 2017, the movement rate increased to upwards of 25 mm/year to 28 mm/year (recorded in October 2019 and October 2020, respectively).

Since regular readings began in 2007, the movement rate for SI-41 has been on average less than approximately 1 mm/year. The pavement distress being experienced at Site 2 is not being recorded in SI-41.

There was no significant water level change recorded by SP14-51 and SP14-51 (0.1 m increases) or VW14-55A (0.3 m increase) between October 2020 and June 2021.

Between October 2020 and June 2021, PN-51A, PN-52A, and PN-52B recorded water level increases of 4.2 m, 7.1 m, and 0.9 m, respectively. PN-51B recorded a water level decrease of 0.2 m. It is unclear of the sudden large increases recorded by PN-51A and PN-52B, as these instruments typically

do not vary significantly between readings. The sudden increase may be attributed to changing pneumatic readout boxes in June 2021 or ageing of the pneumatic piezometers.

### **3 RECOMMENDATIONS**

#### **3.1 Future Work**

All operational instruments should continue to be read once per year (spring).

In the spring of 2022, KCB will confirm the instrument coordinates and ground surface elevations with a handheld GPS (accuracy of  $\pm 5$  m), and where applicable, sticks up and reading depths with a tape measure, and azimuths of the SI A0-grooves with a compass.

The site should continue to be inspected by the Maintenance Contract Inspector (MCI) and as part of the GP South GRMP Section B inspections.

#### **3.2 Instrument Repairs**

The caps of PN-13A and PN-13B should be replaced.

## 4 CLOSING

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 Peace Region Geohazard Risk Management Program (Contract No. CON0022166) 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. KCB should be consulted regarding the interpretation or application of the findings and recommendations in the report.

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

Yours truly,

**KLOHN CRIPPEN BERGER LTD.**



James Lyons, E.I.T.  
Civil Engineer

Chris Gräpel, M.Eng., P.Eng.  
Senior Civil Engineer, Associate

JL:bb

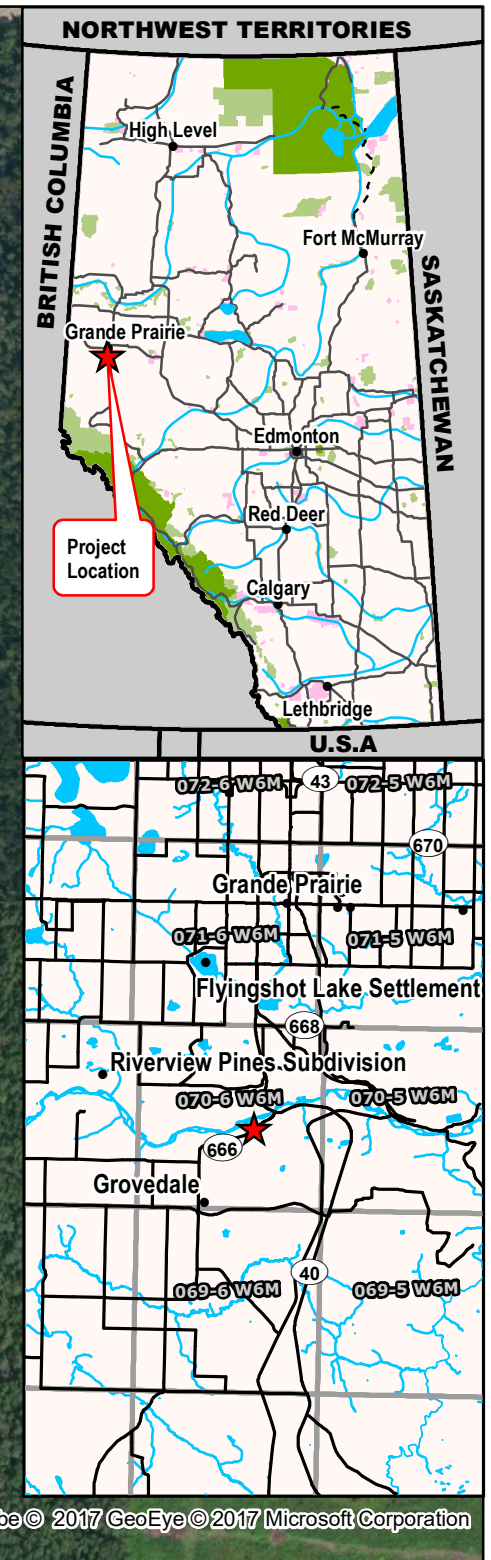
### ATTACHMENTS

Figure  
Appendix I      Instrumentation Plots

## FIGURE

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- Legend**
- ◆ Pneumatic Piezometer (PN)
  - Slope Inclinator (SI)
  - ⊕ Standpipe Piezometer (SP)
  - ⊗ Vibrating Wire Piezometer (VW)
  - Flow Direction
  - >—< Culvert
  - ▭ Site Extent



**NOTES:**  
 1. HORIZONTAL DATUM: NAD83  
 2. GRID ZONE: UTM Zone 11N  
 3. IMAGE SOURCE: ESRI Basemap

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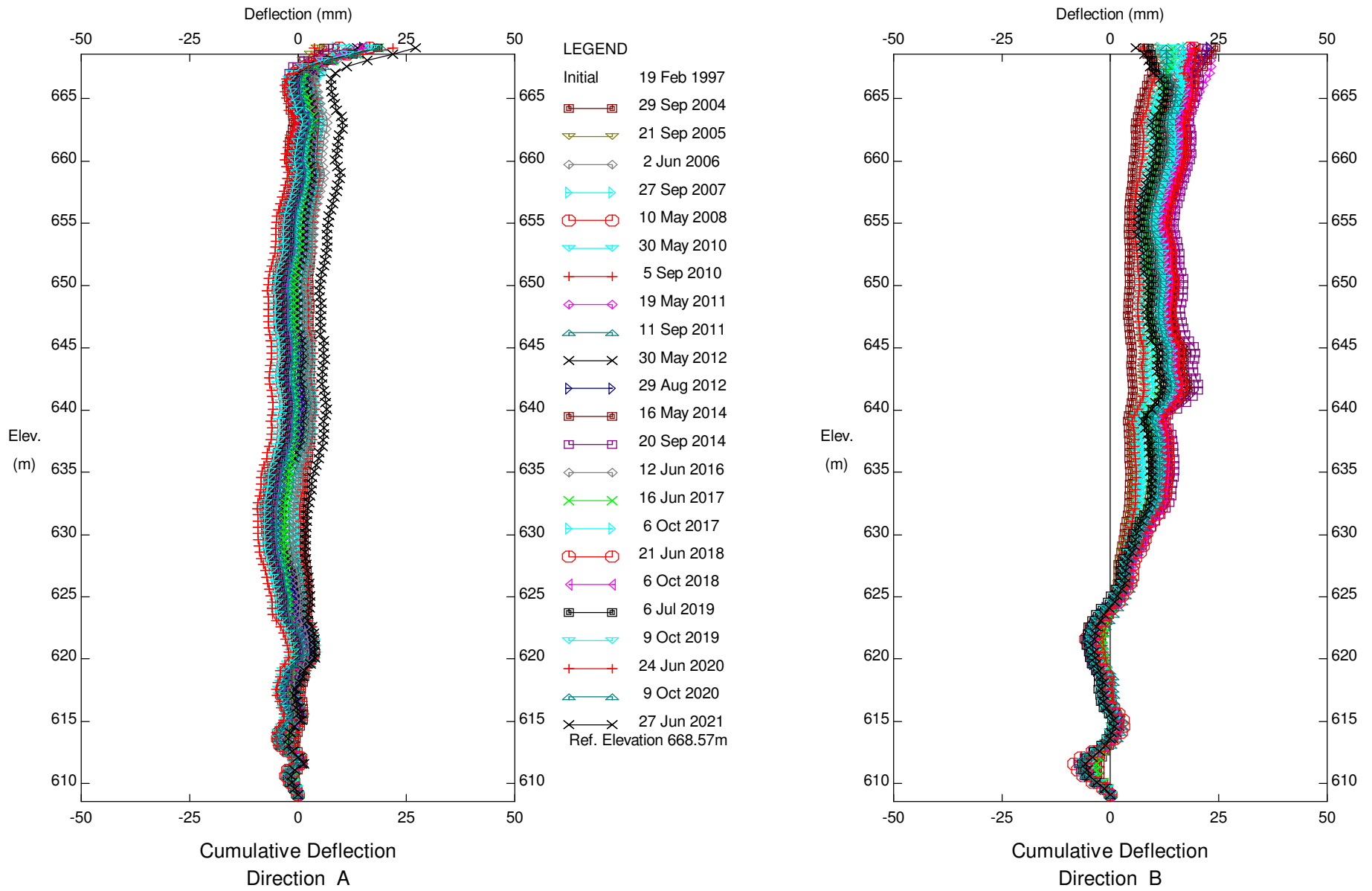
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<b>SCALE</b>	1:5,000	<b>FIG No.</b>
<b>PROJECT No.</b>	A05116A01	<b>FIG No.</b>
		1

## APPENDIX I

### Instrumentation Plots

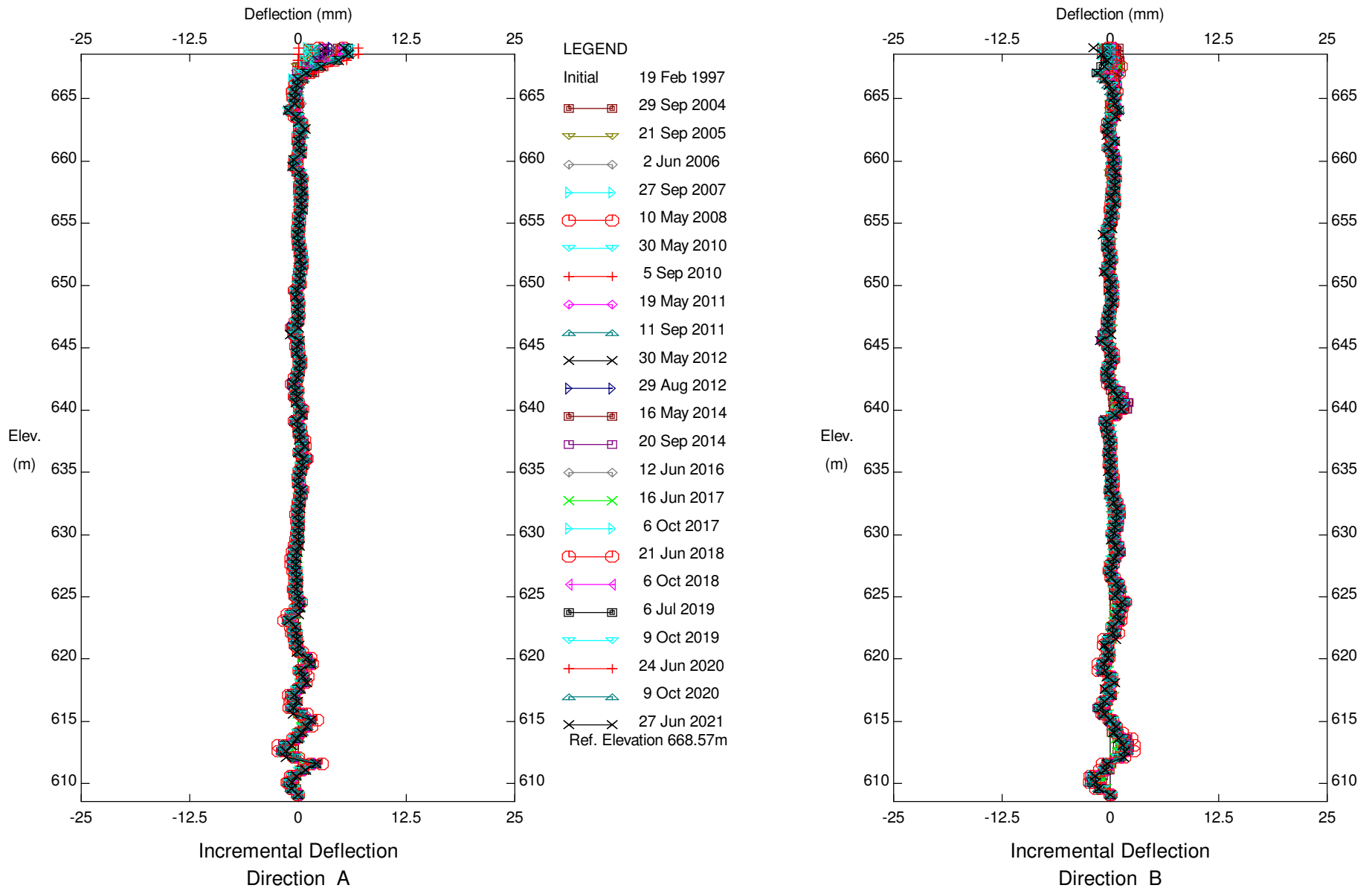
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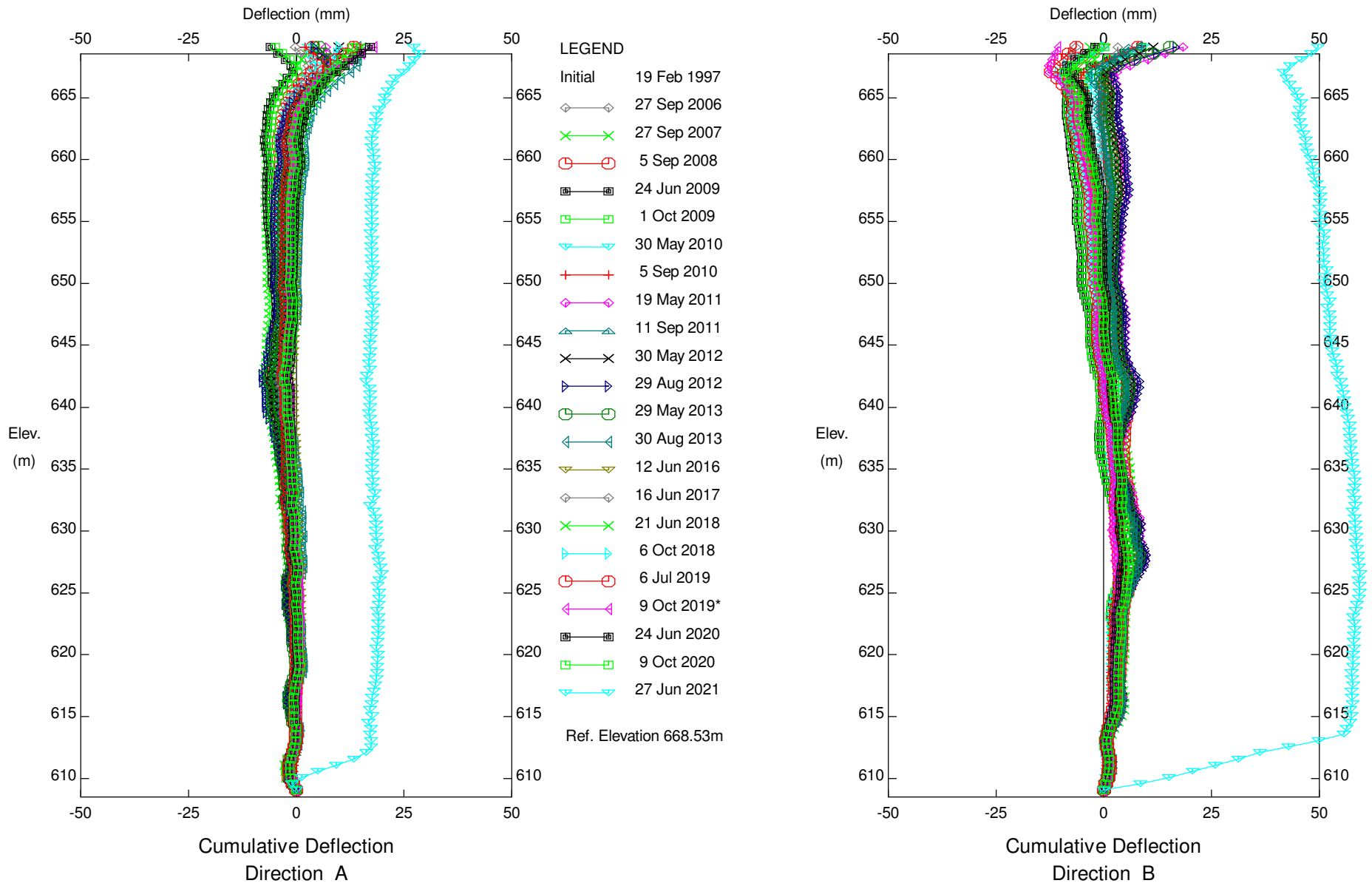
GP016; H666:02 Slide 2 km West of Hwy 40, Inclinometer SI-1  
Alberta Transportation

# Klohn Crippen Berger - Calgary



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 Alberta Transportation

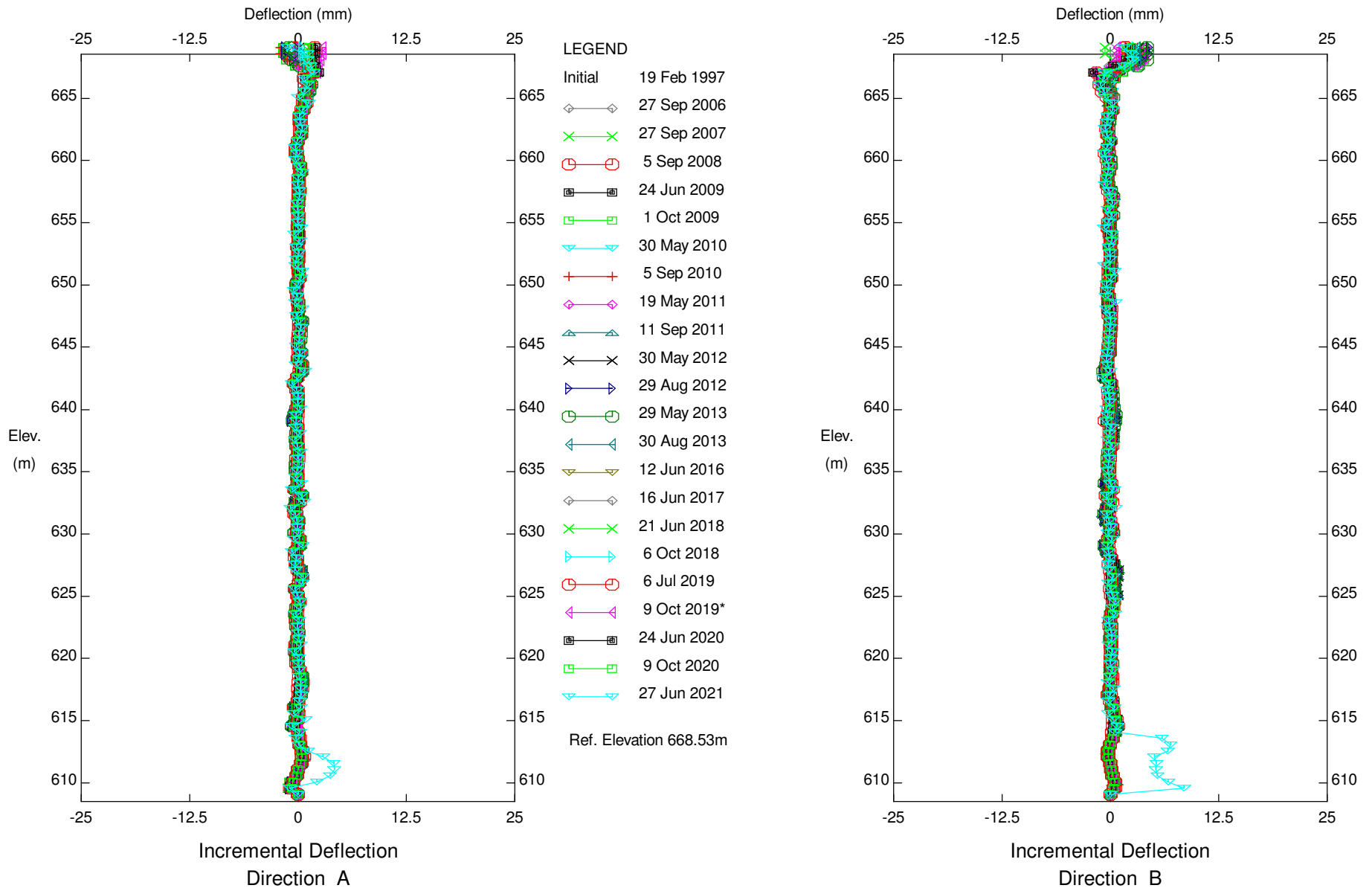
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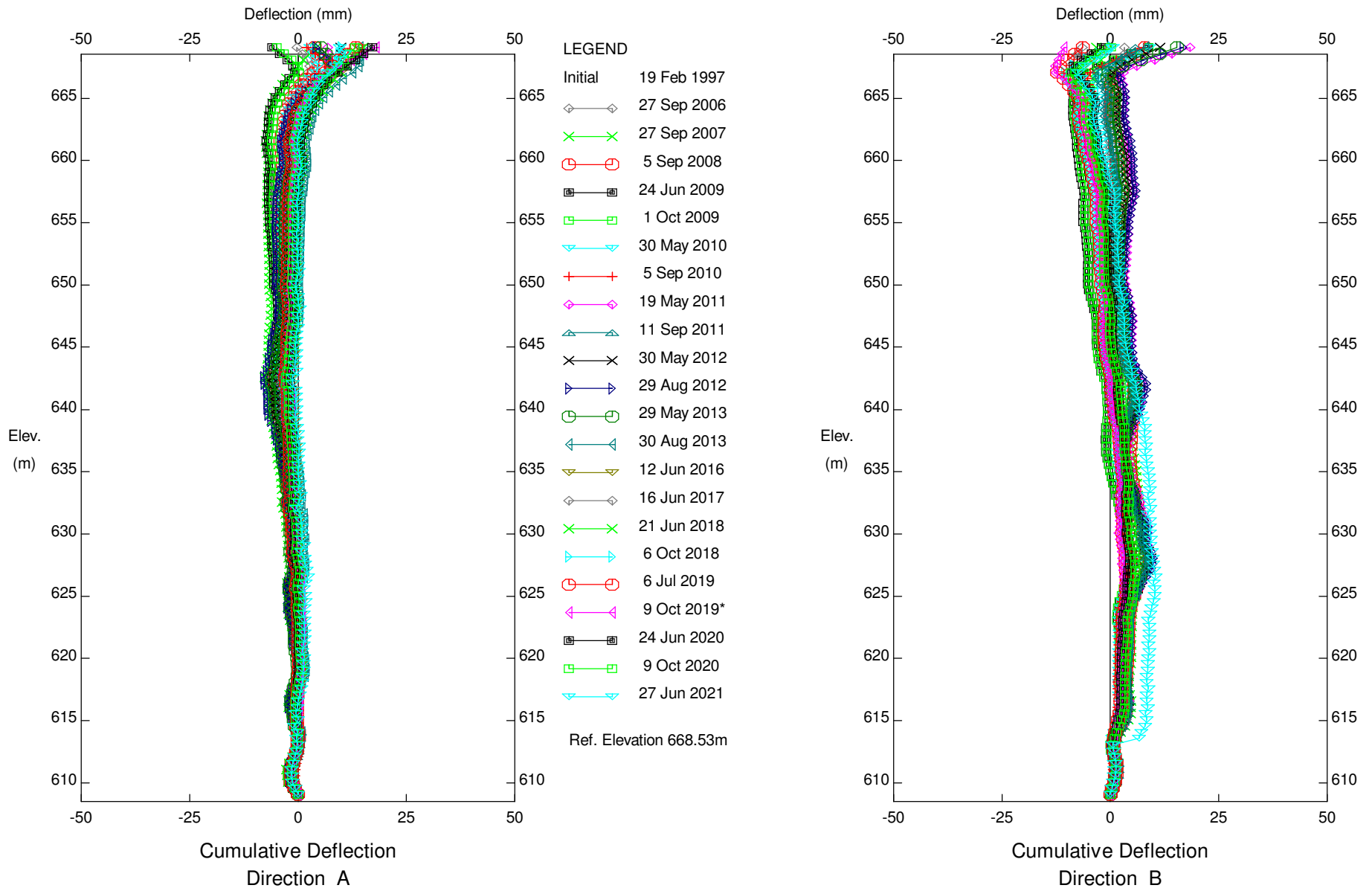
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 Alberta Transportation

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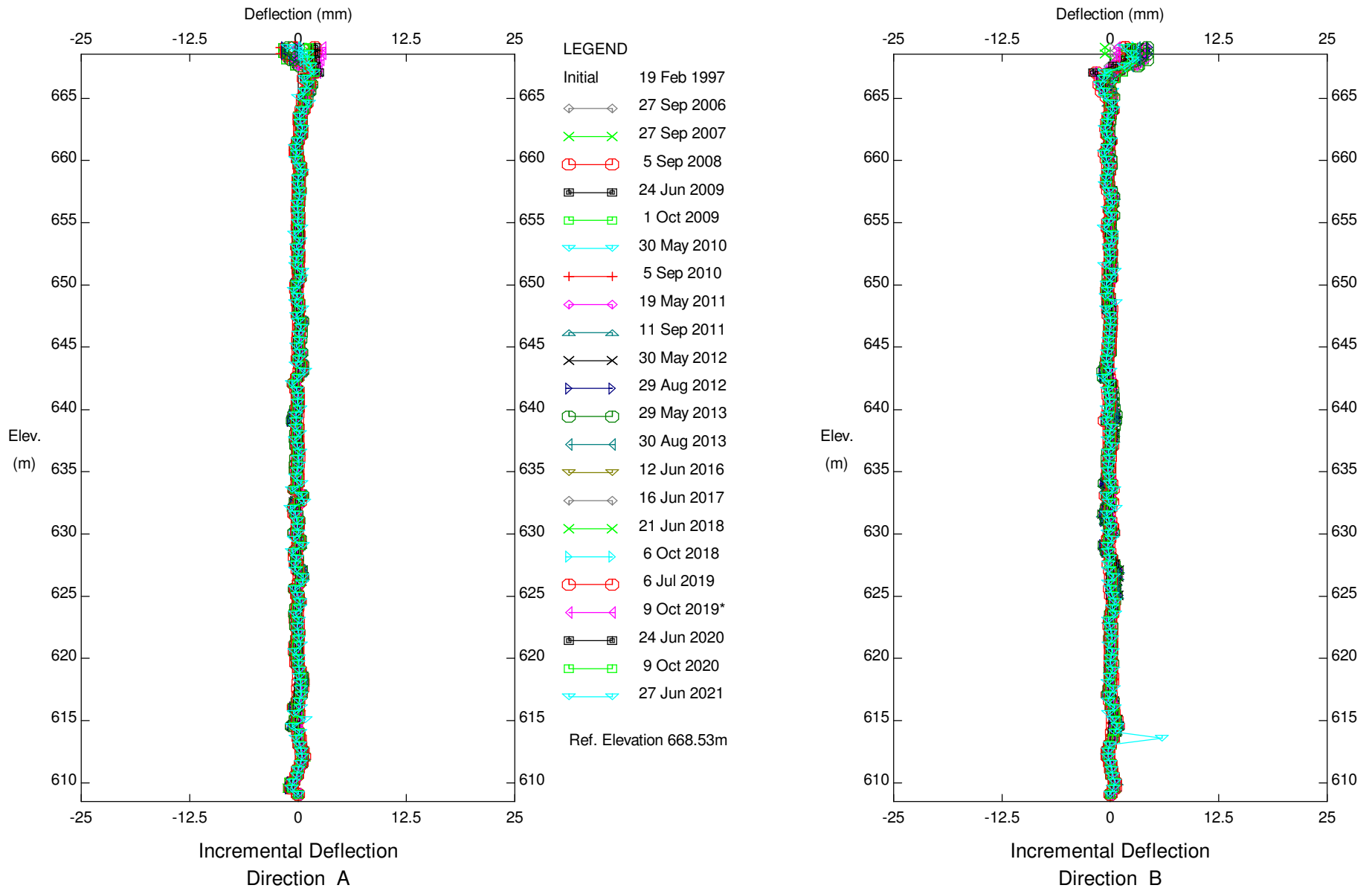
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Alberta Transportation

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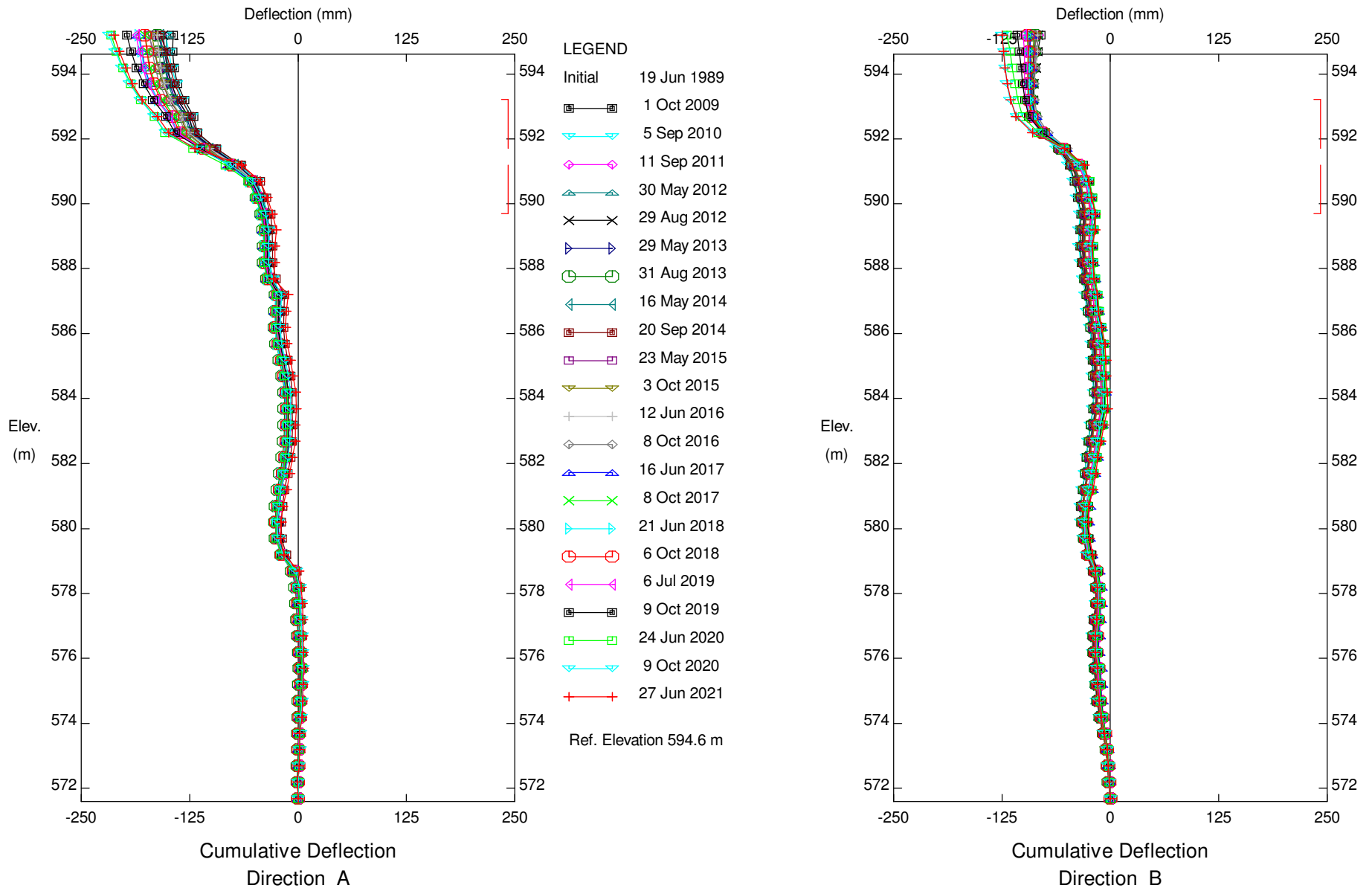


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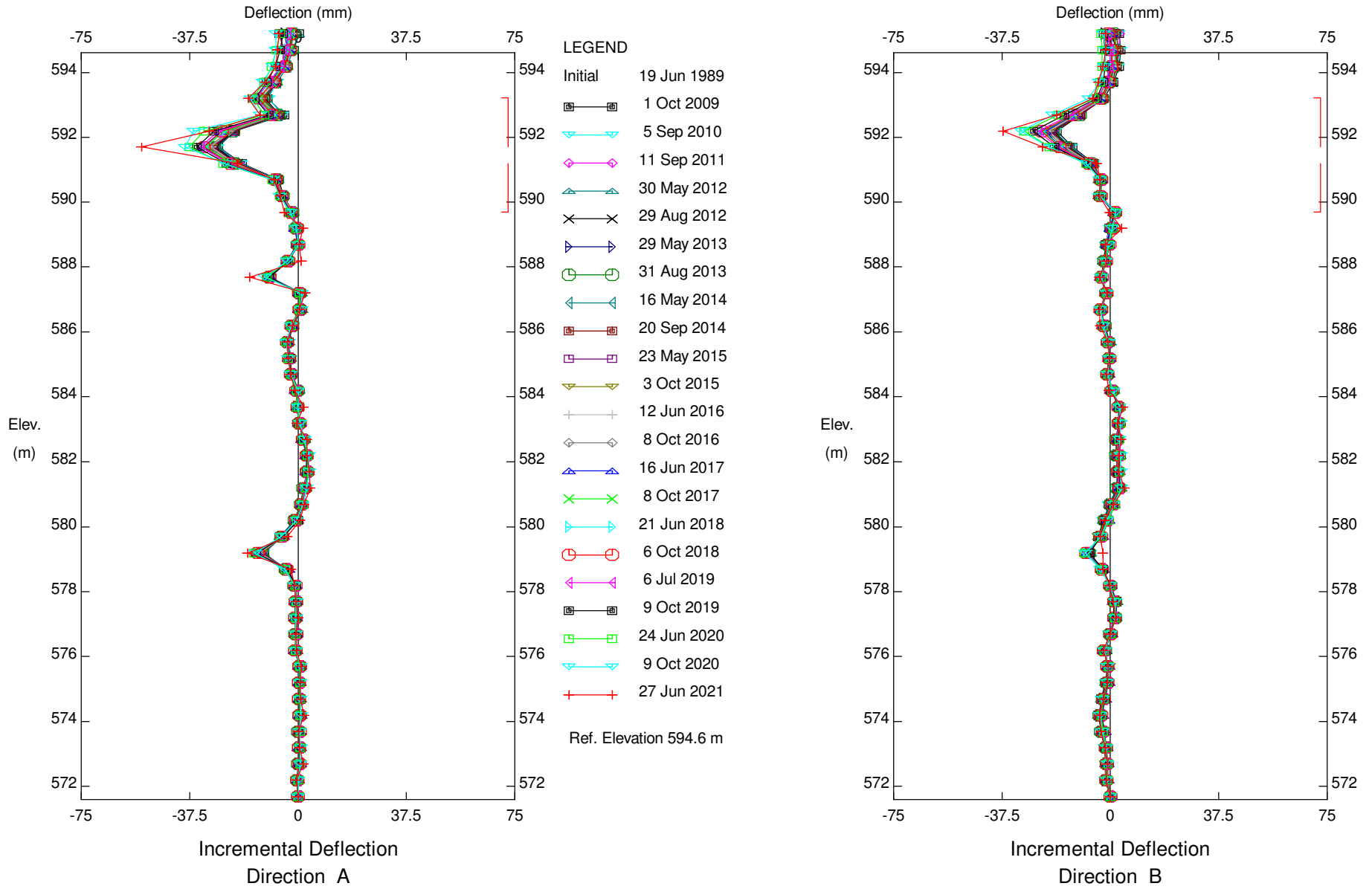


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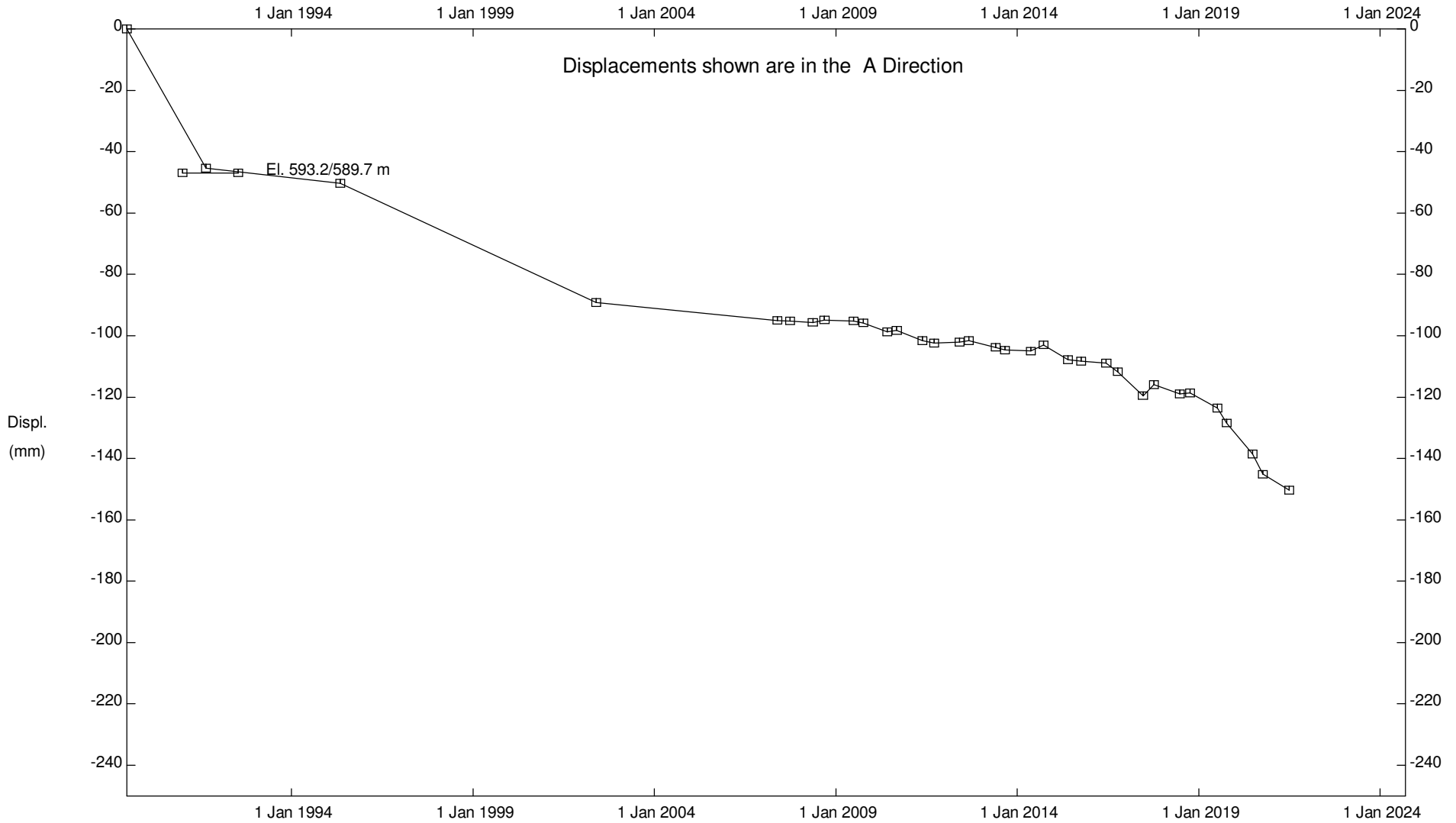


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Alberta Transportation

### Klohn Crippen Berger - Calgary



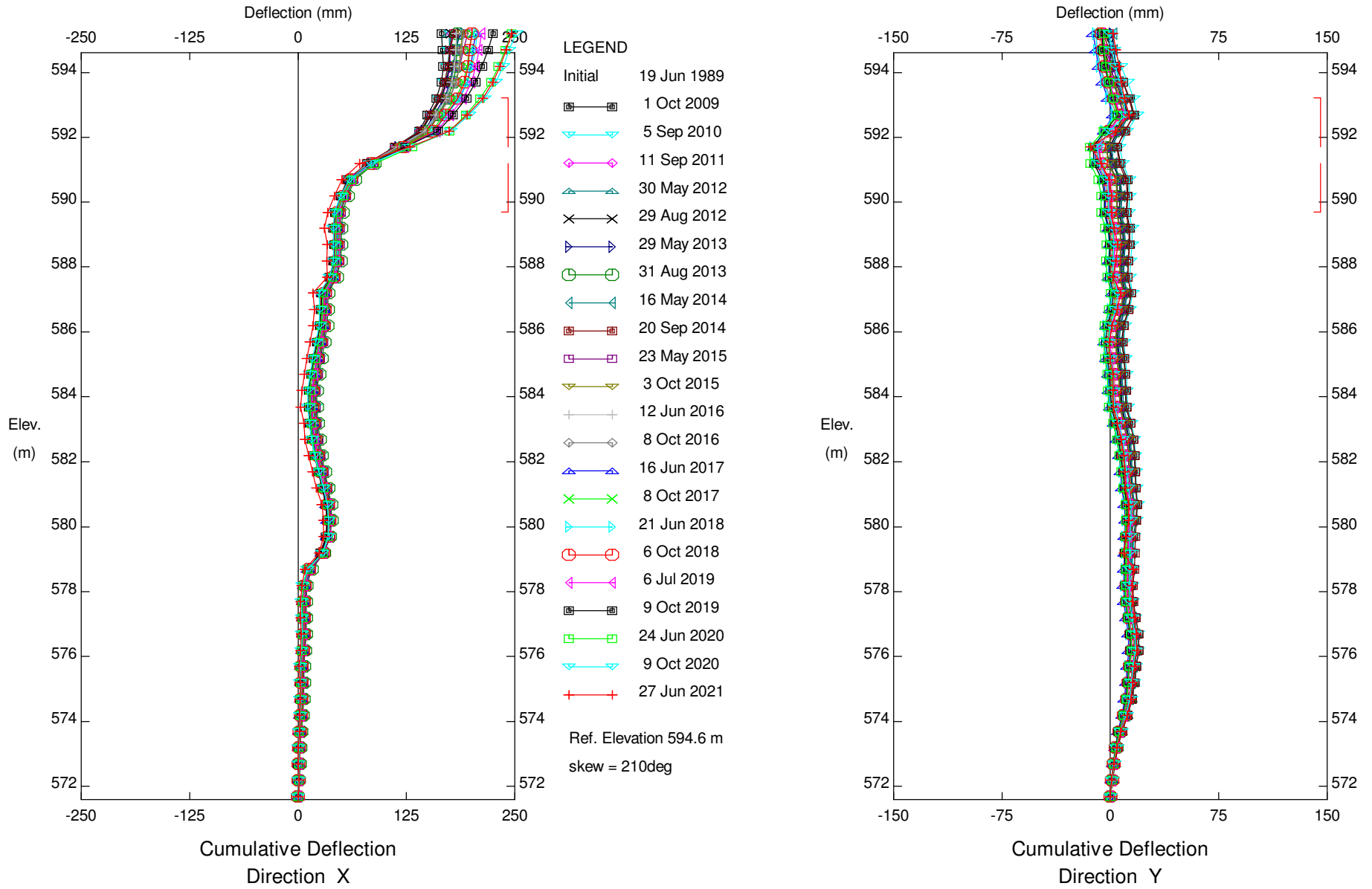
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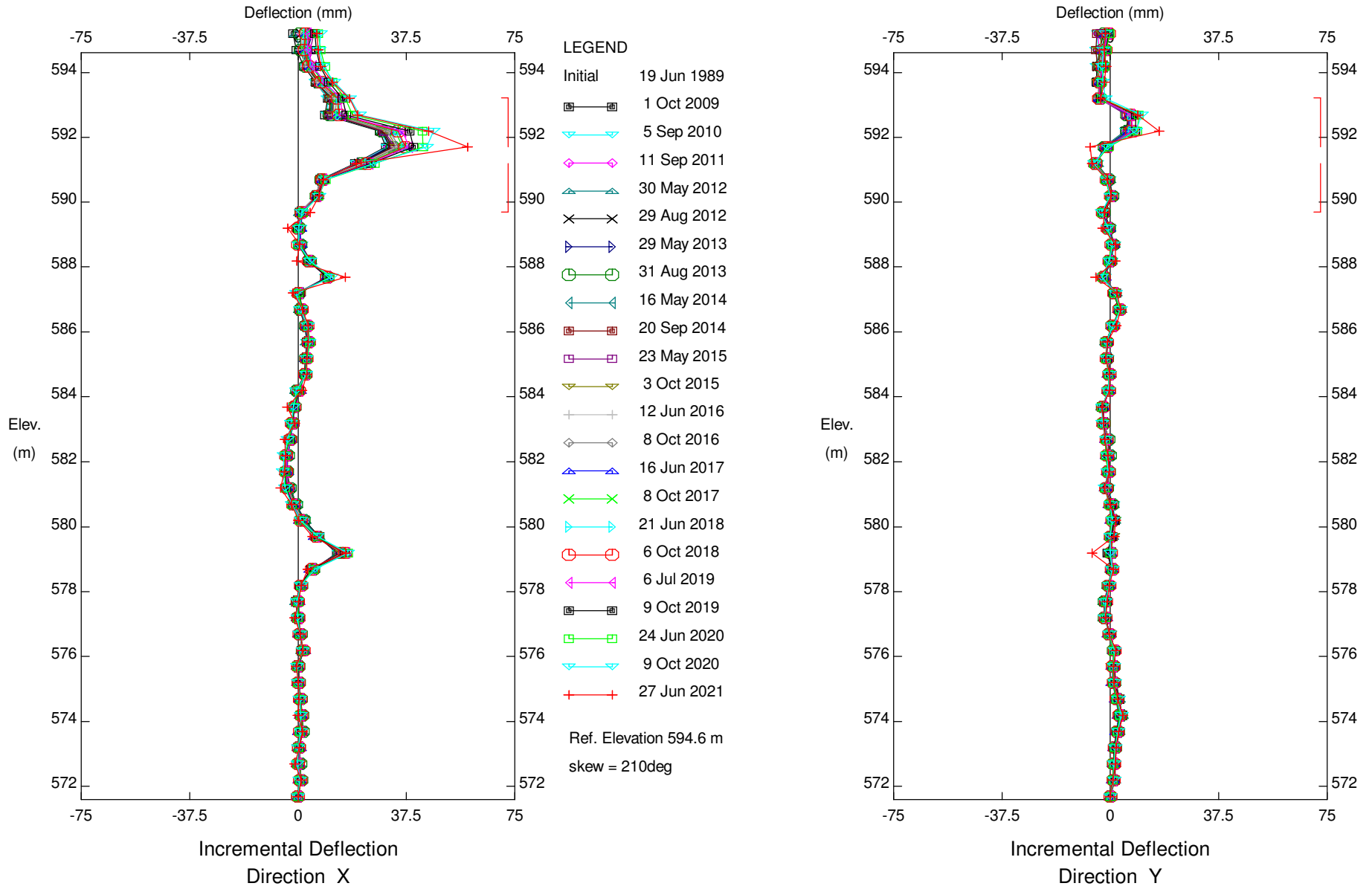
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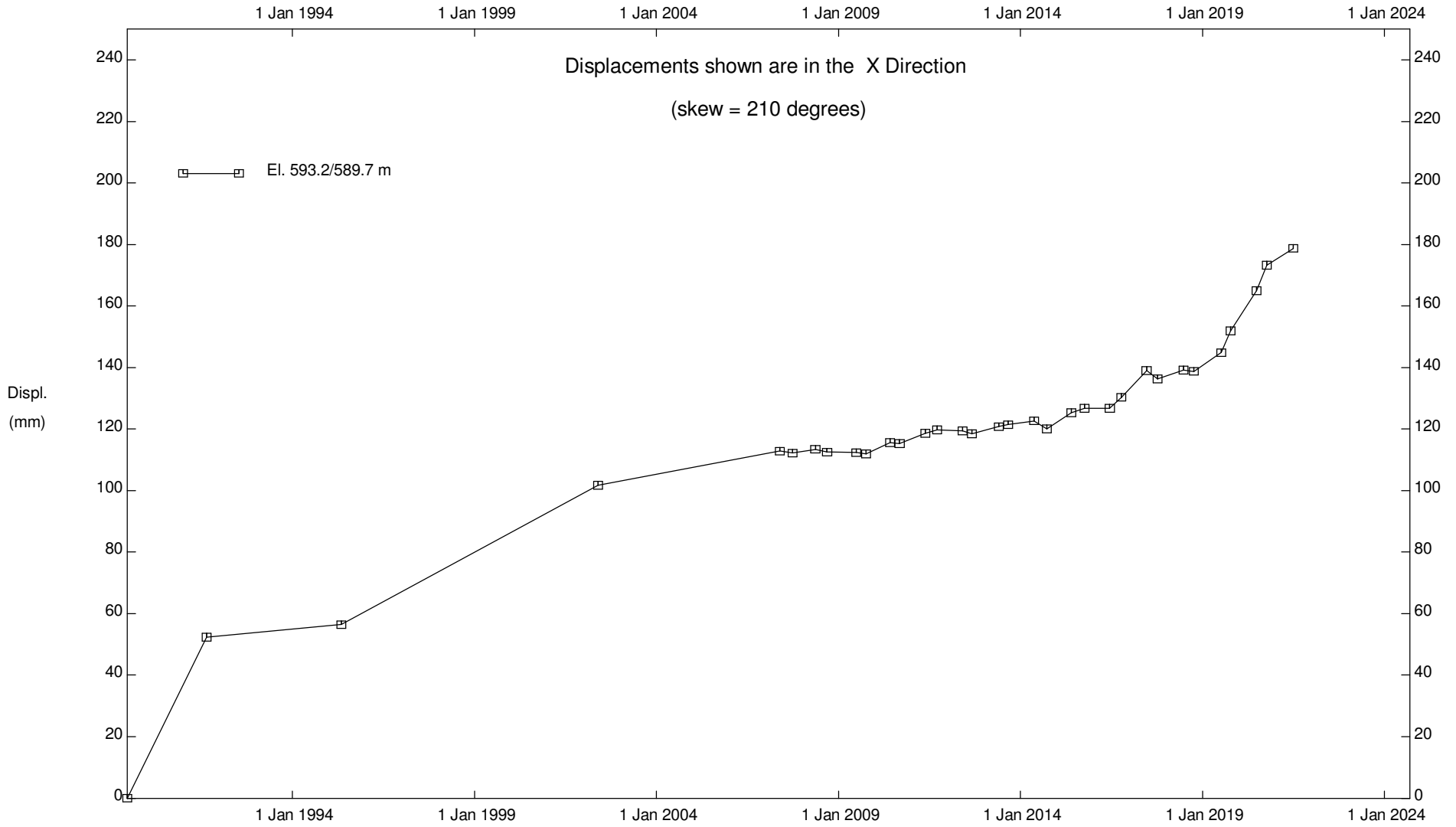
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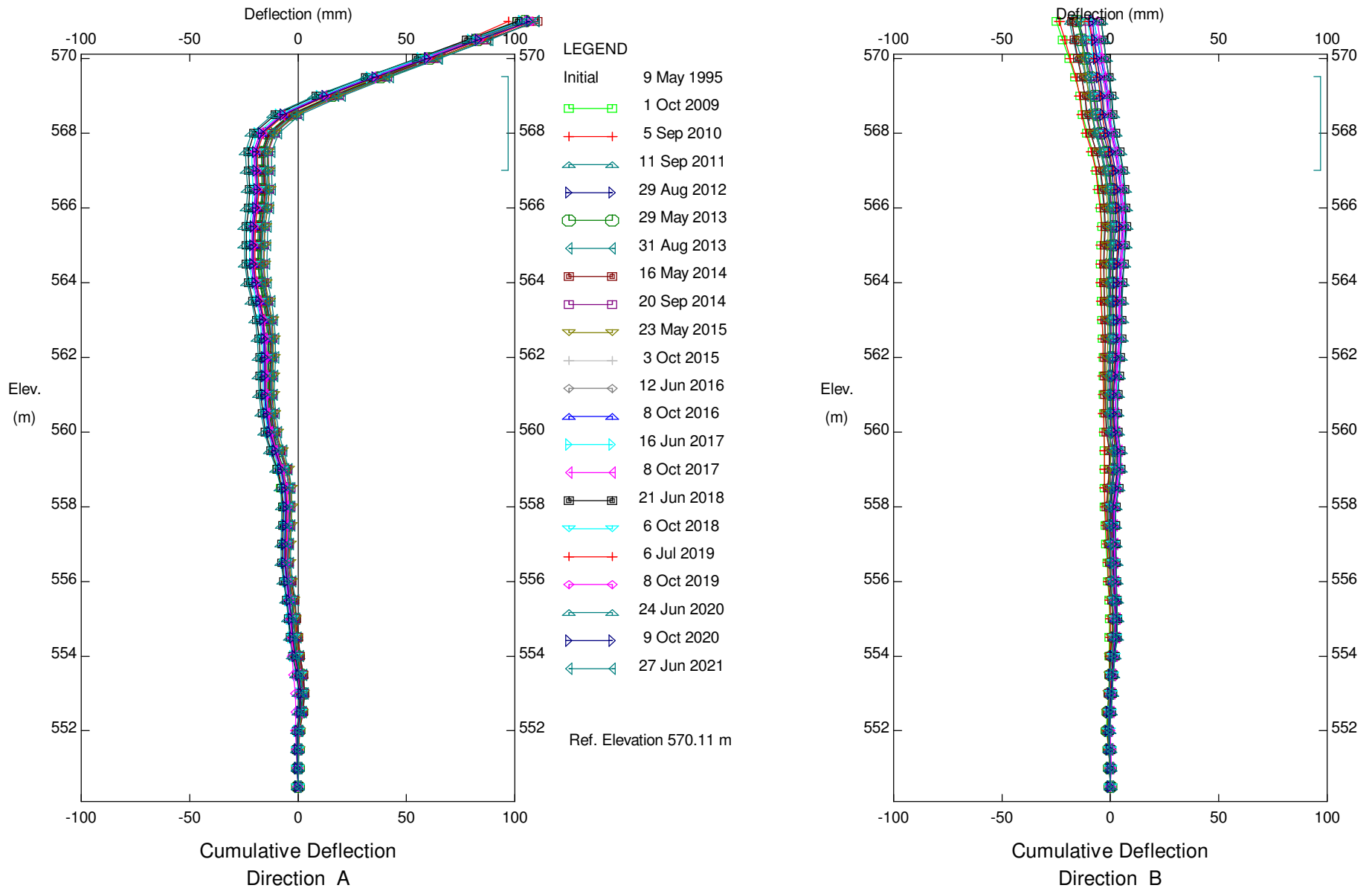
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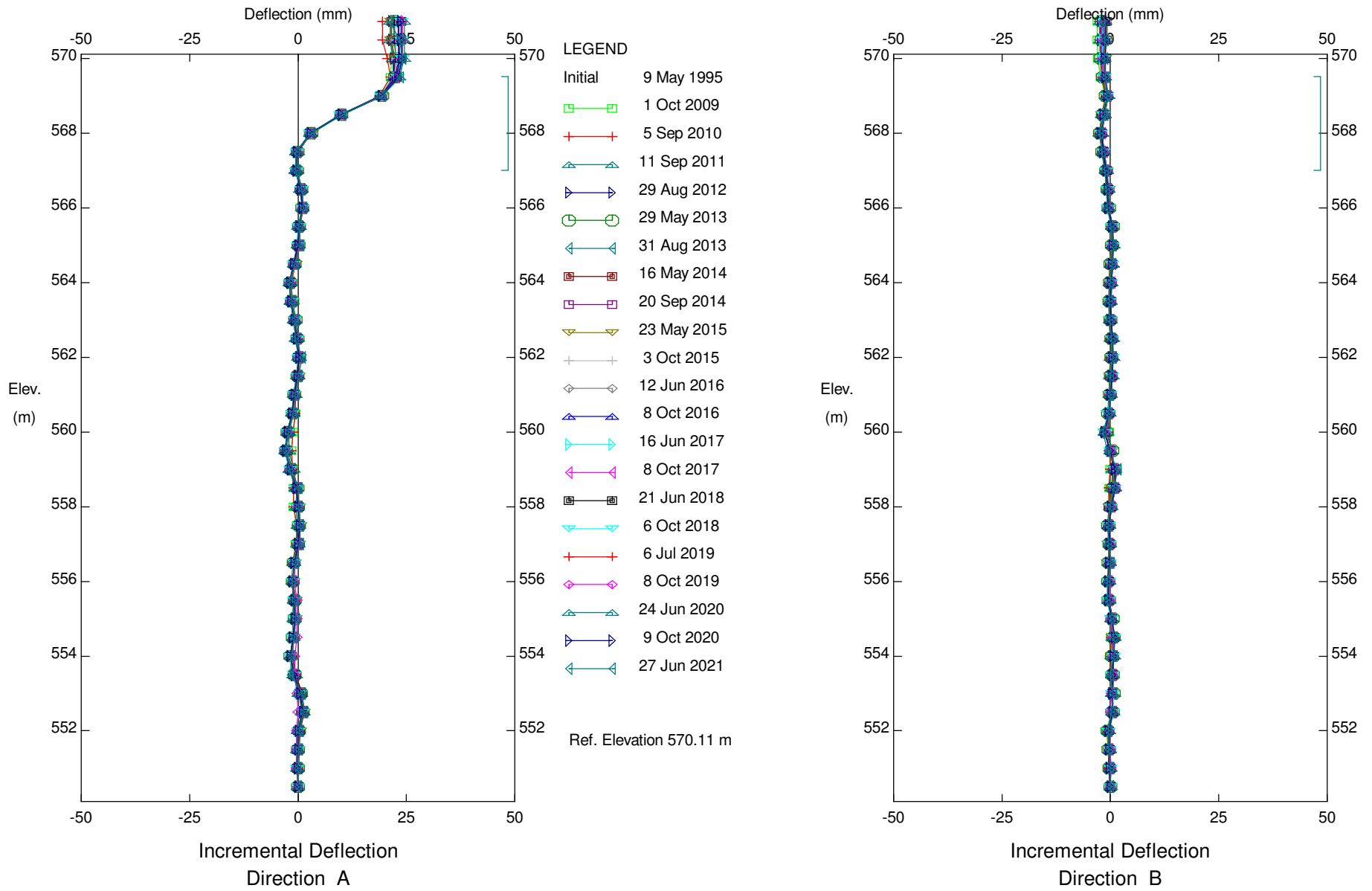
Alberta Transportation

### Klohn Crippen Berger - Calgary



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 Alberta Transportation

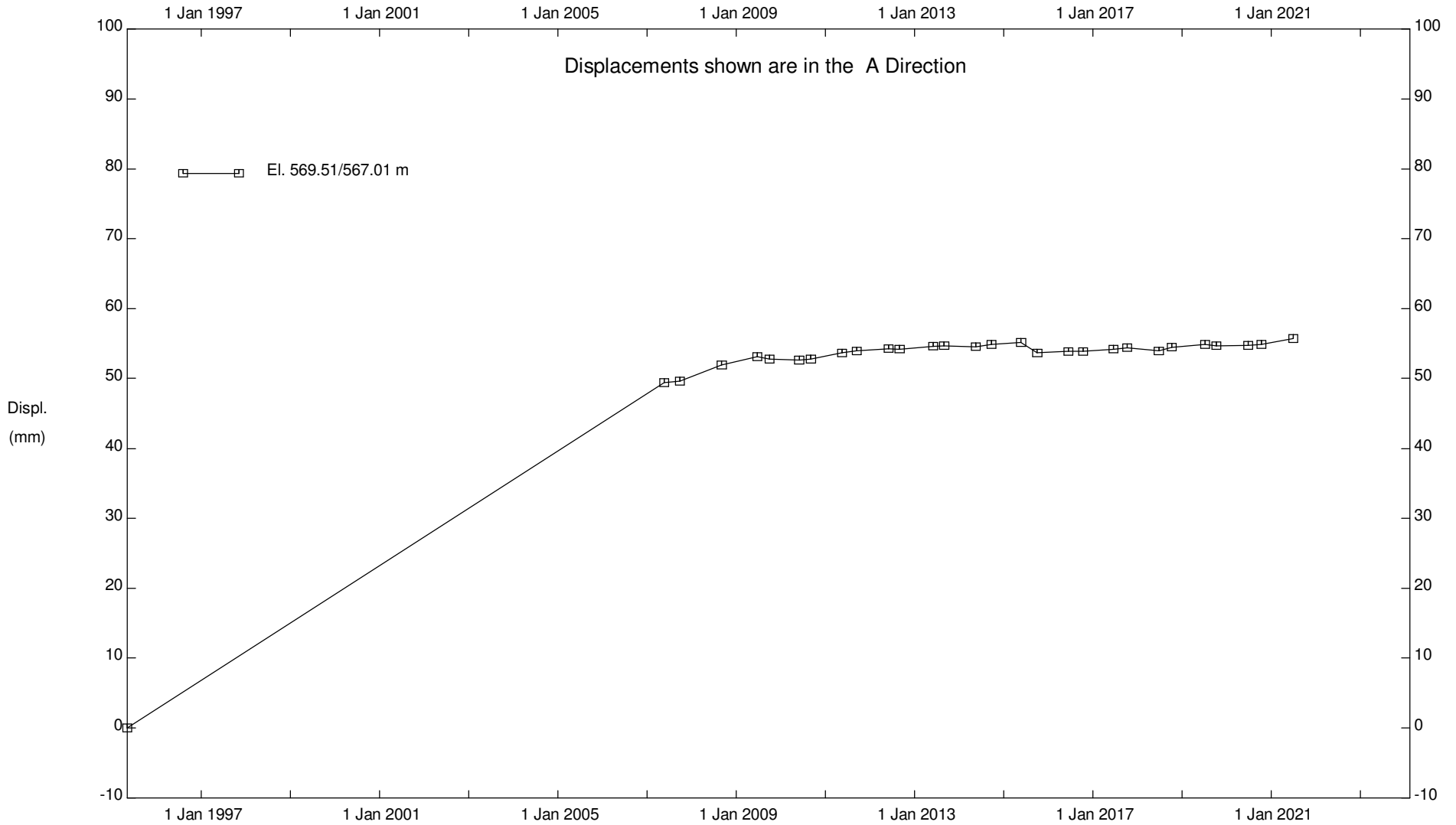
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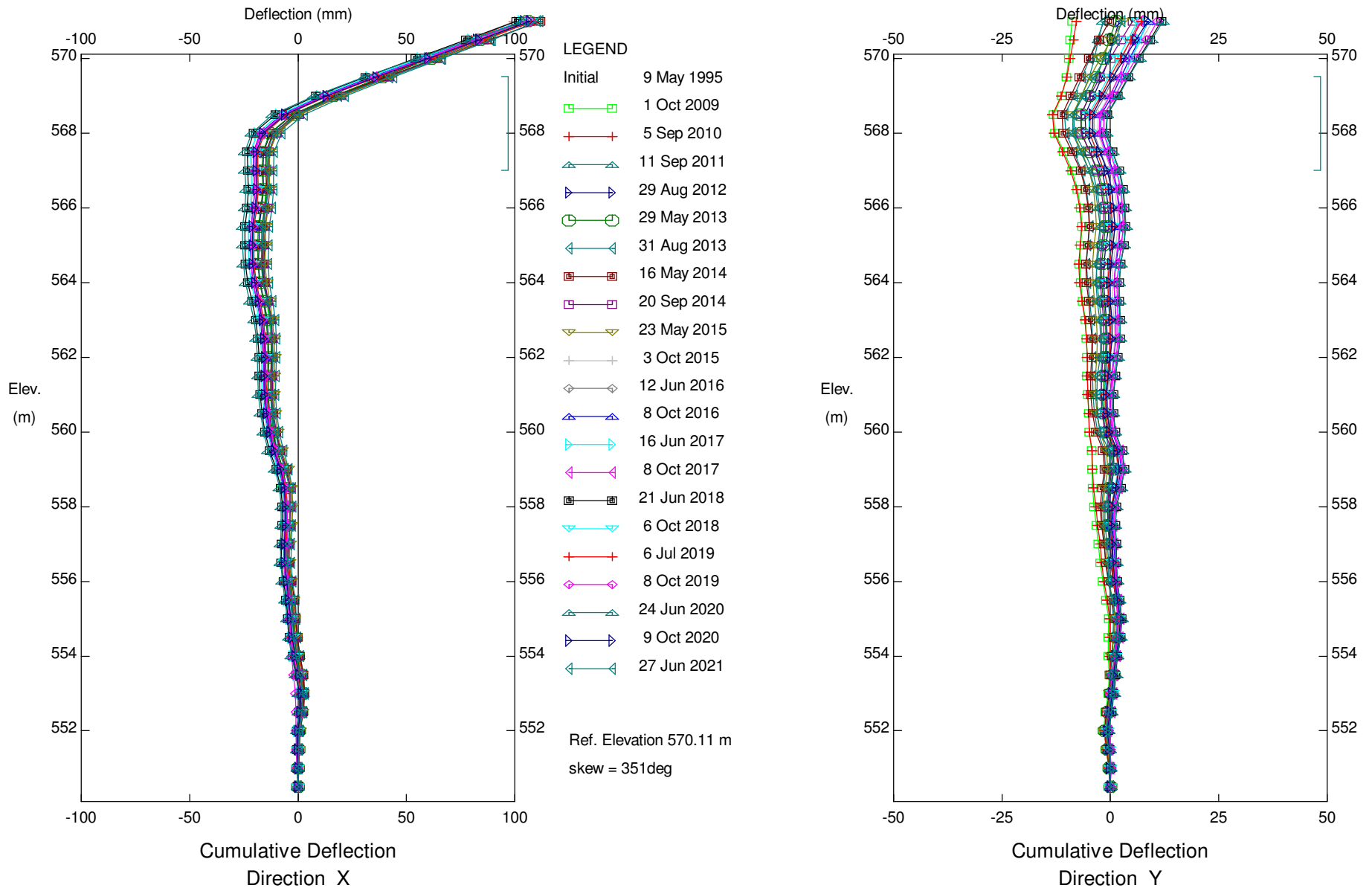
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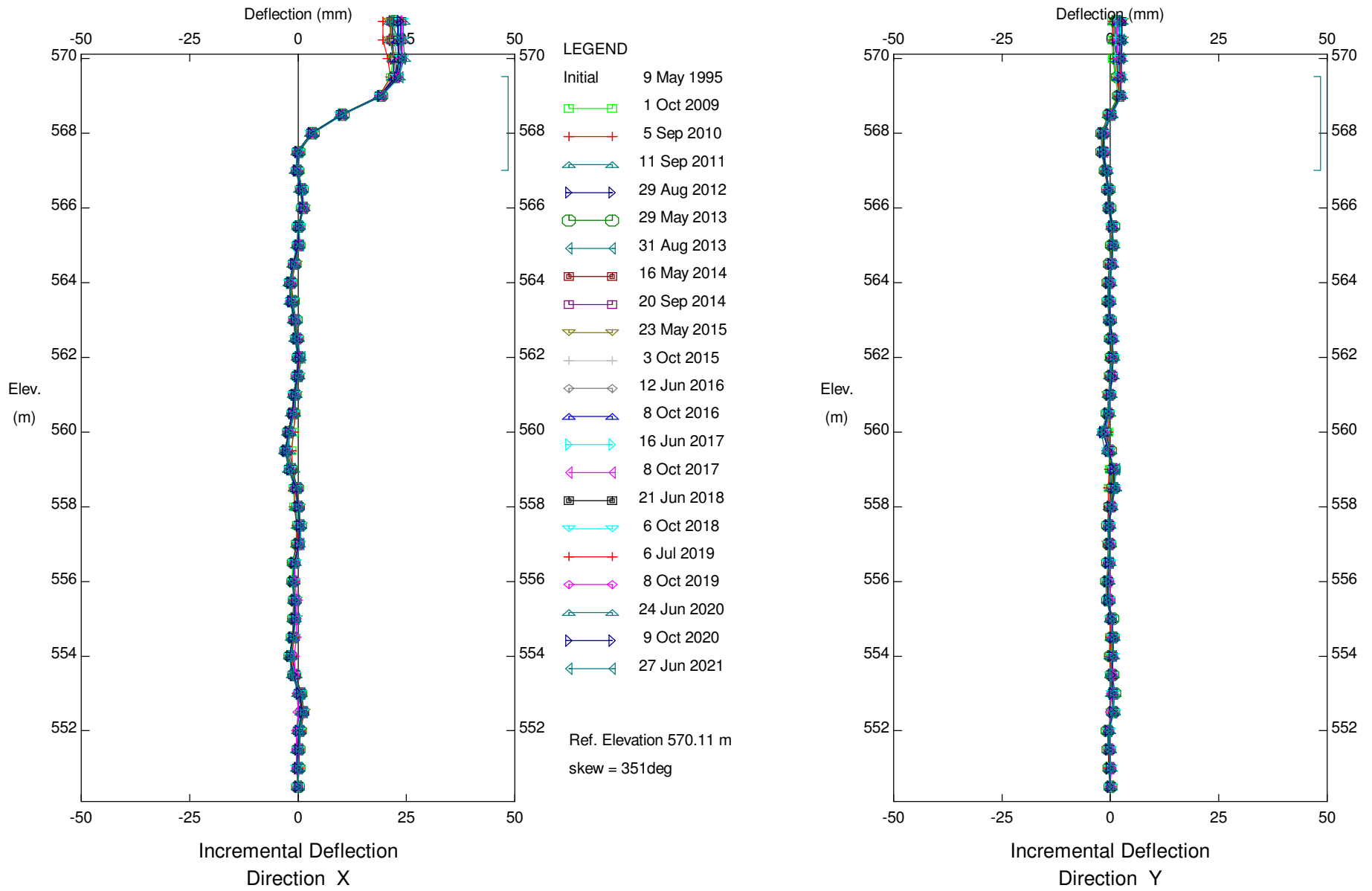
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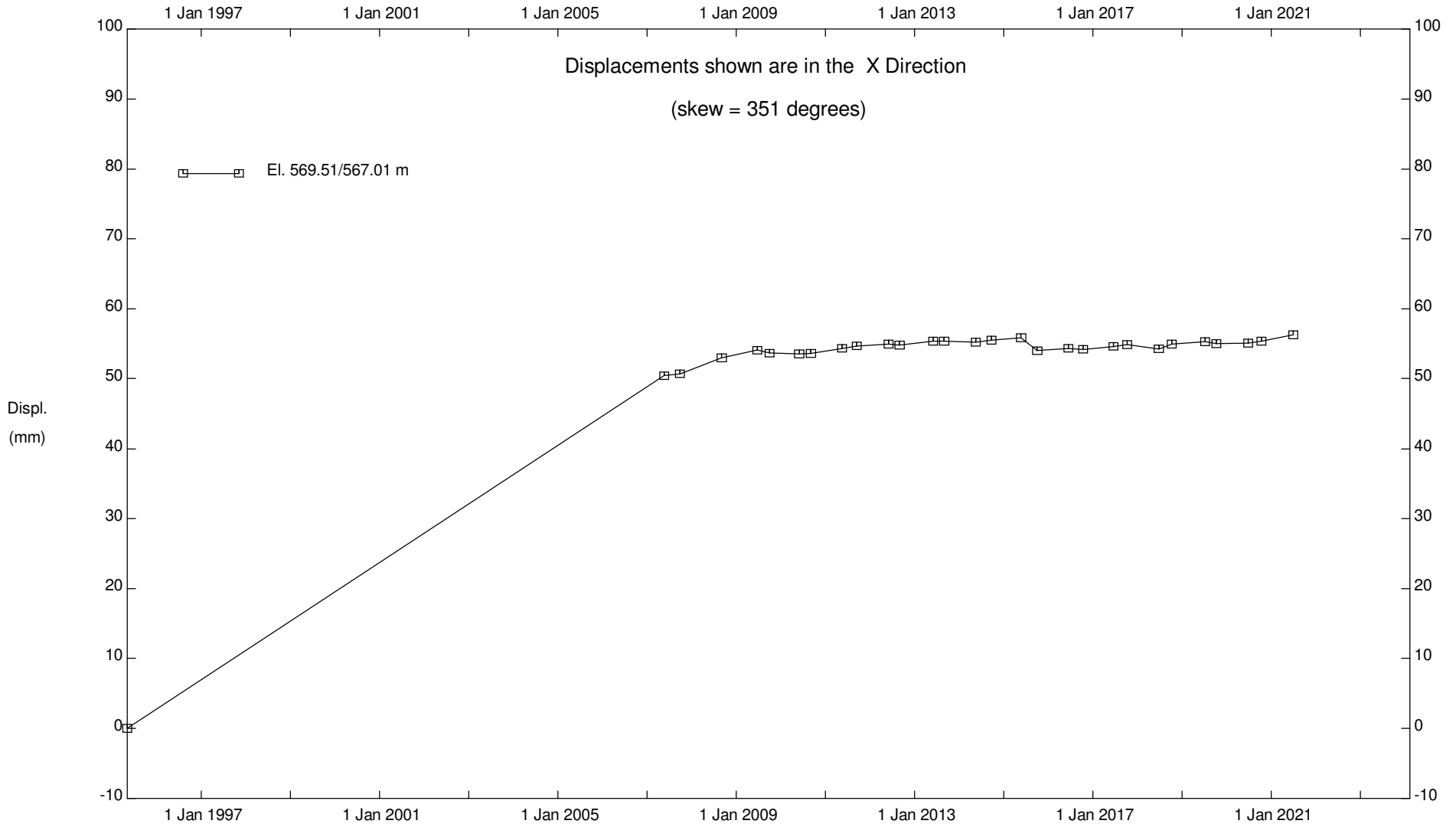
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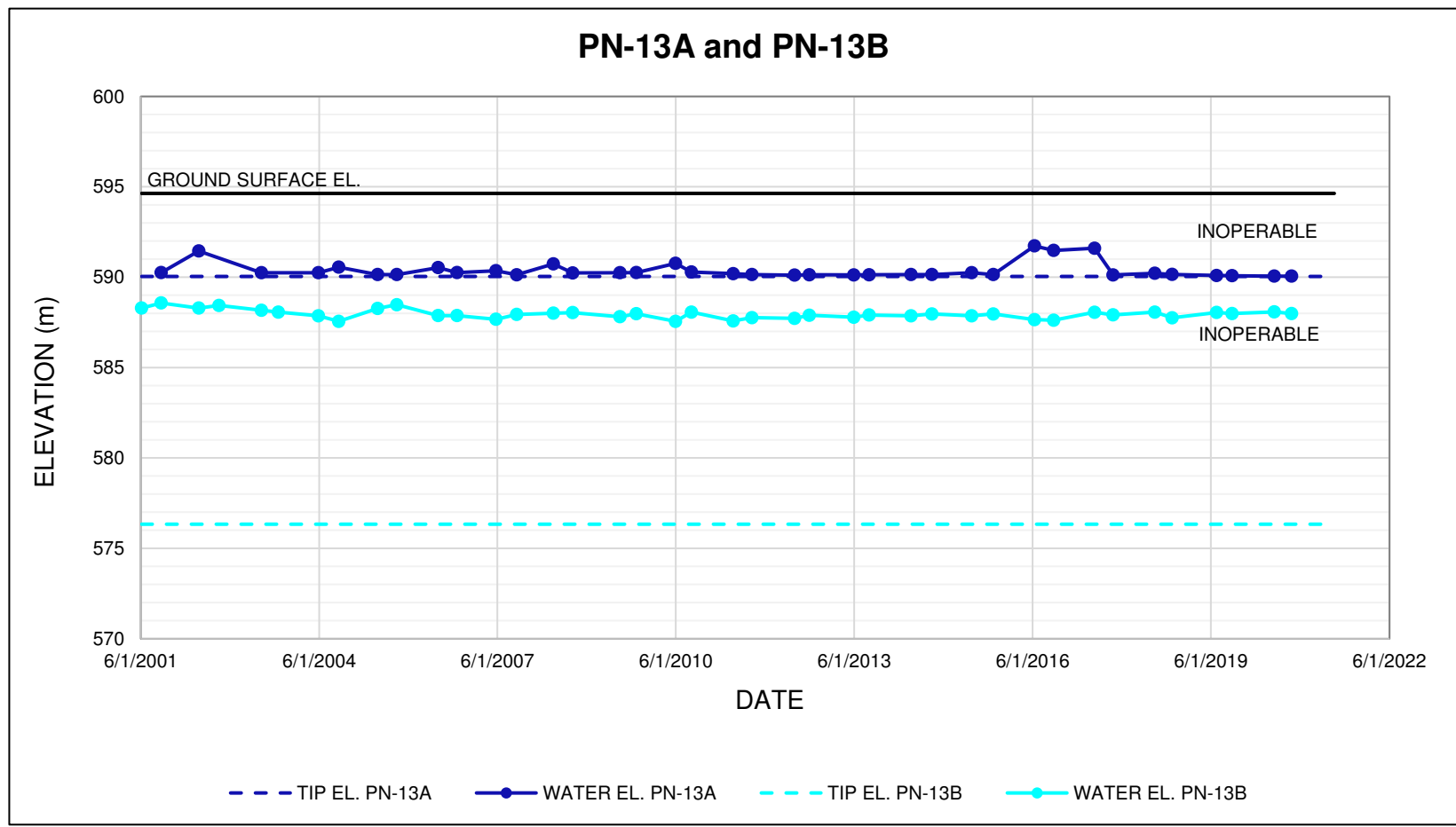
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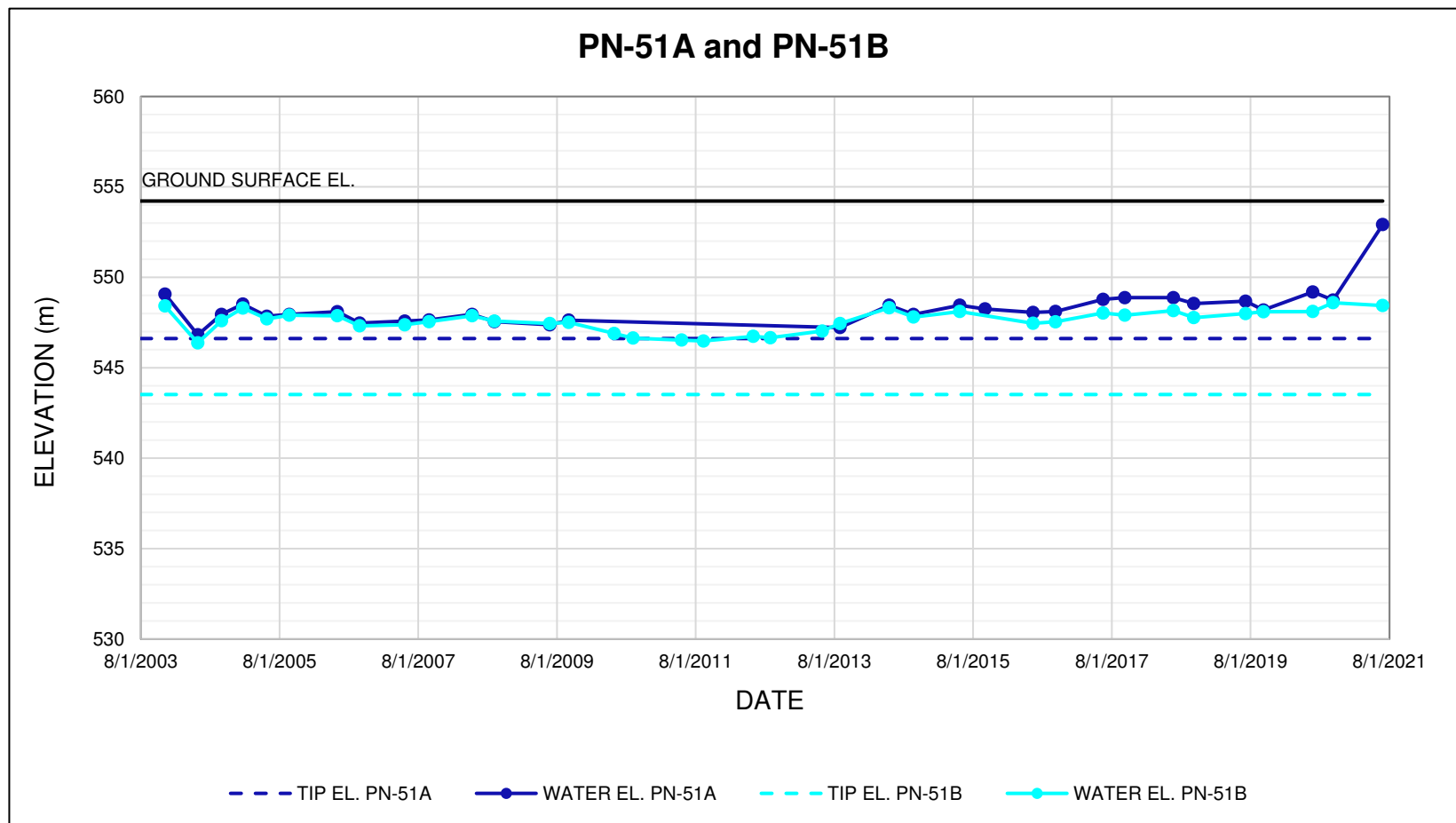
Alberta Transportation



**Notes:**



1. Piezometer data obtained before the spring 2021 reading on June 27, 2021 was provided to KCB by Alberta Transportation (AT) on June 25, 2021.

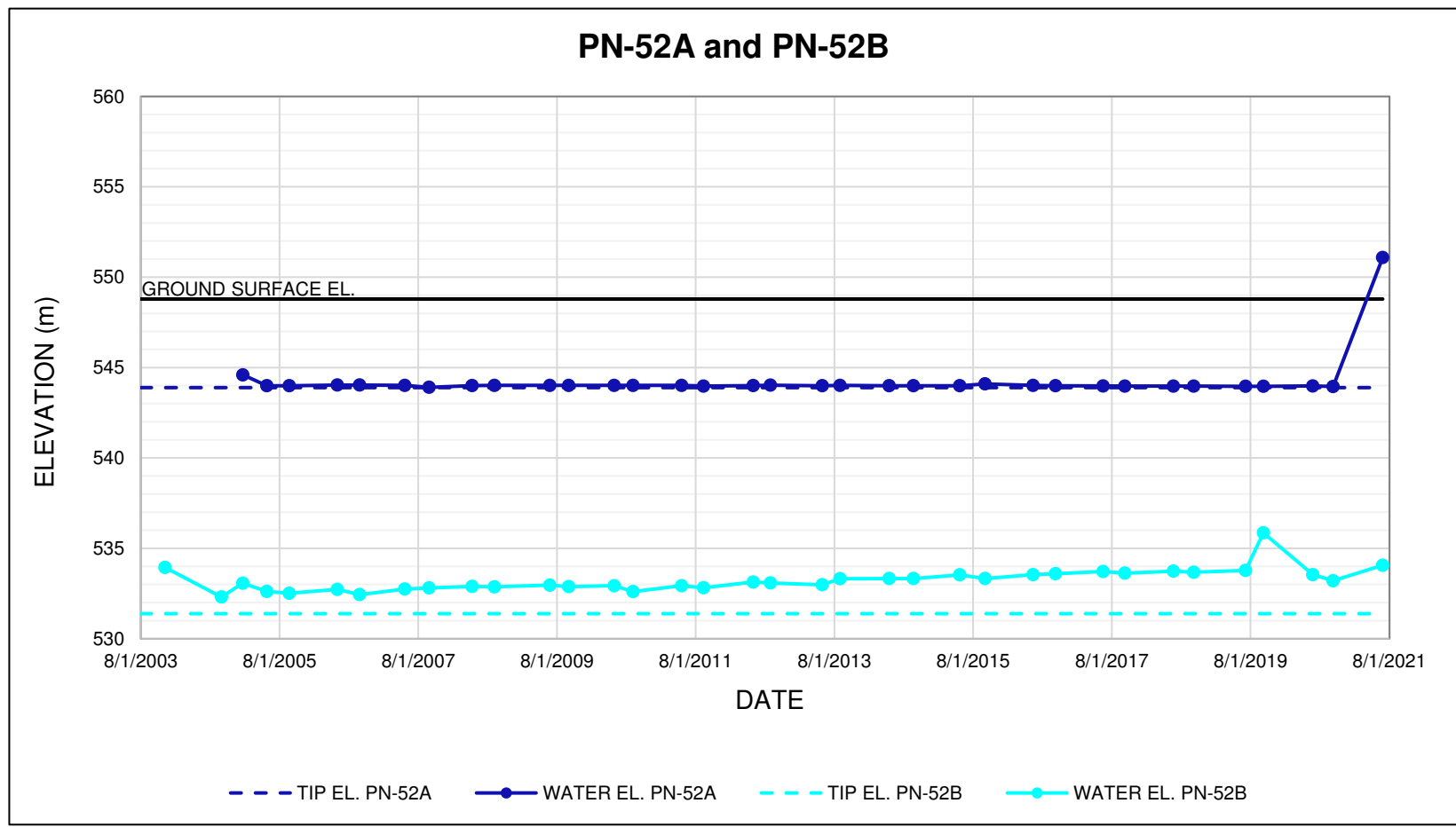
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	SCALE	PROJECT No. A05116A01
		FIG No.



**Notes:**



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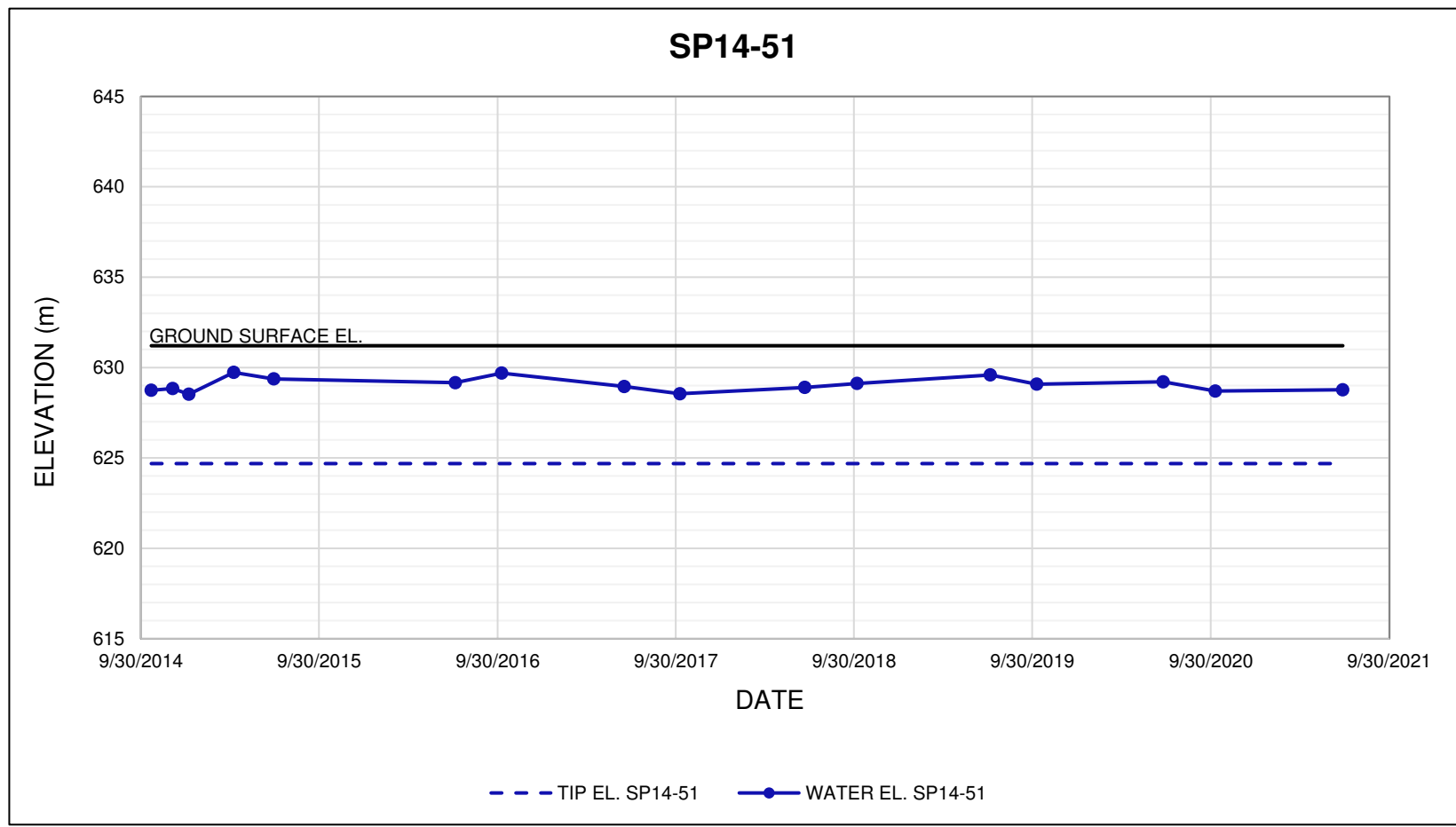
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		TITLE	
		Piezometer Data GP016 - 2 km West of Hwy 40 Hwy 666:02, km 34.837	
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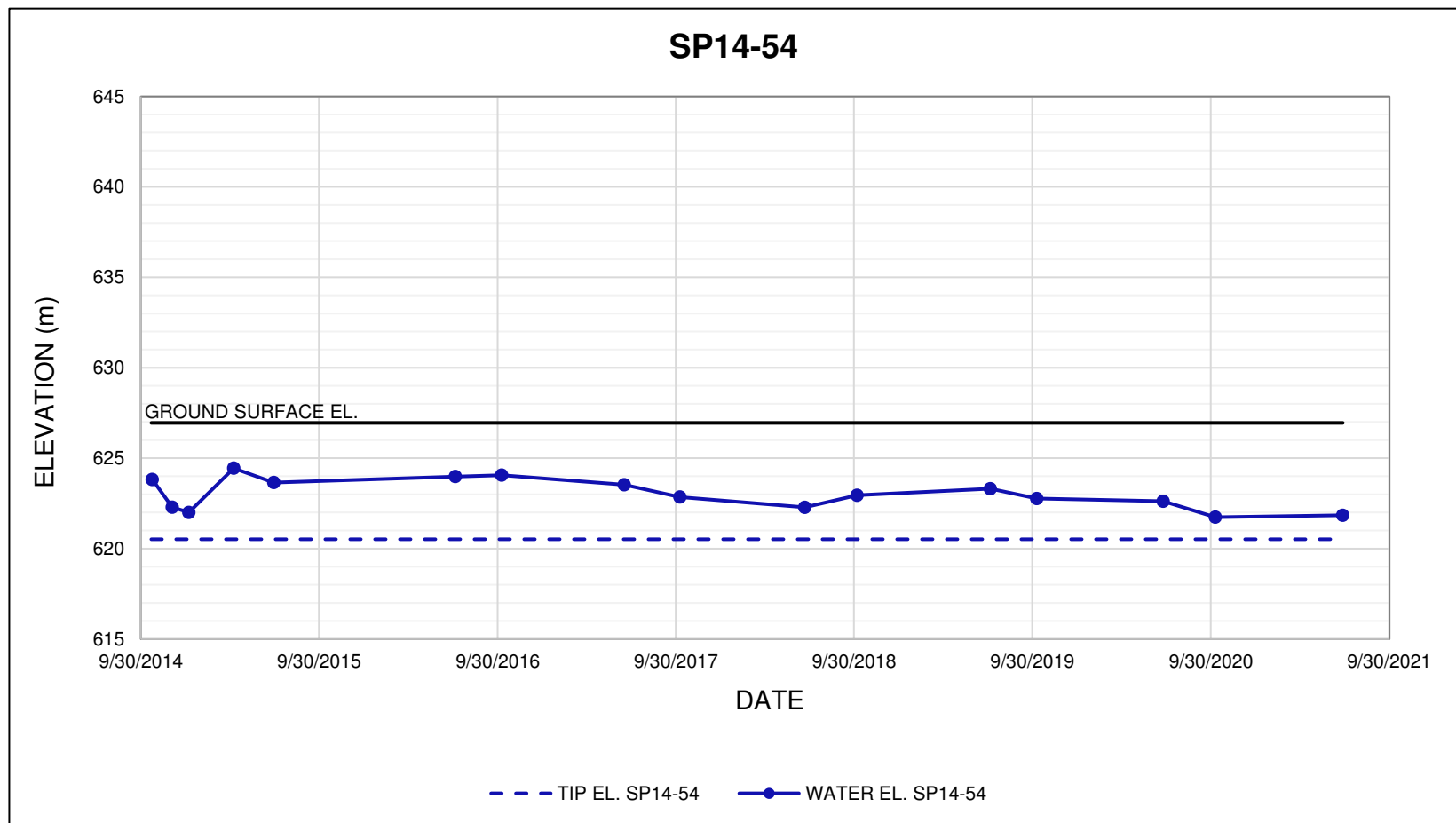


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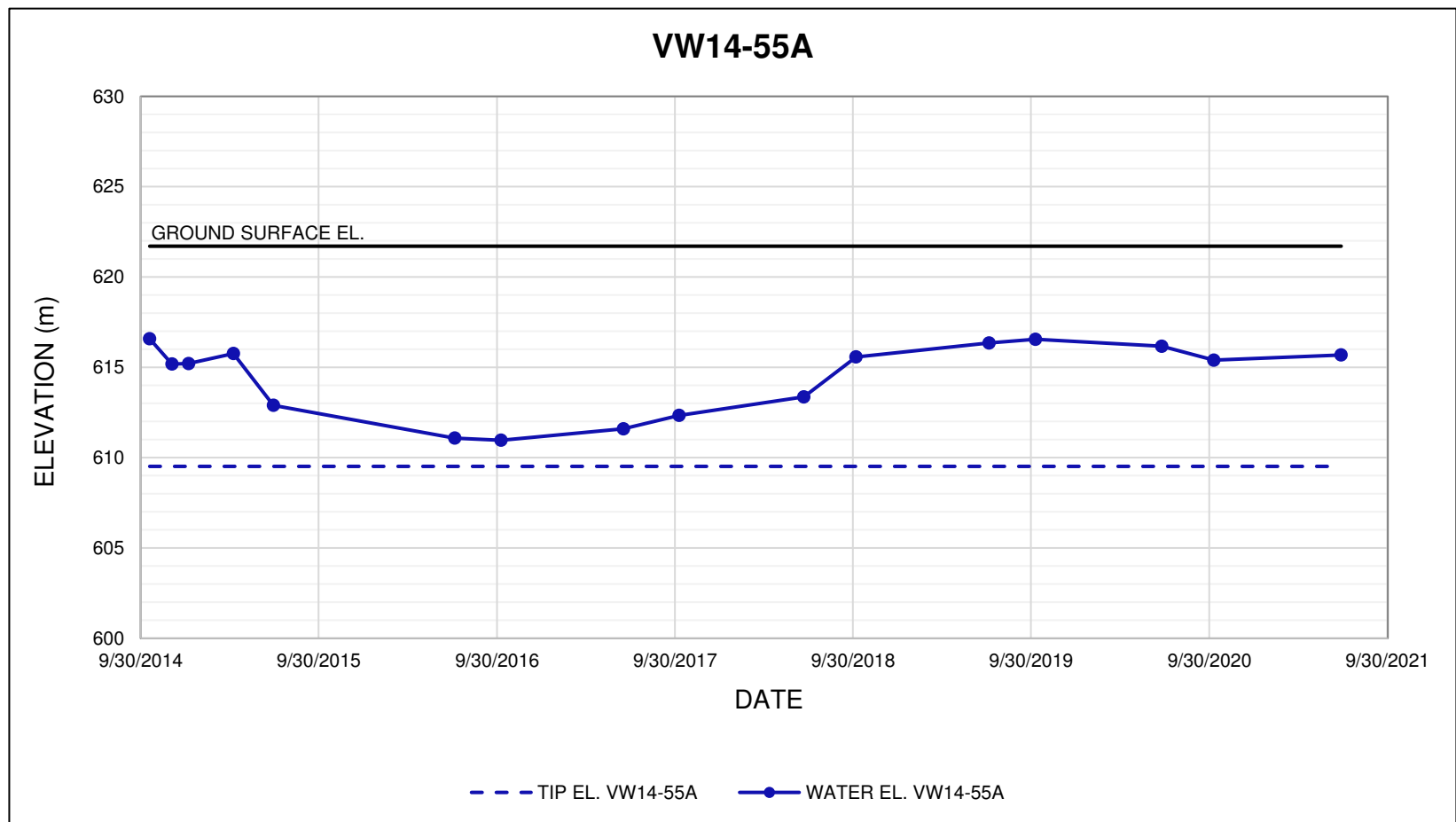




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	TITLE Piezometer Data GP016 - 2 km West of Hwy 40 Hwy 666:02, km 34.837	
	SCALE	FIG No.
	PROJECT No.	A05116A01



**Notes:**

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