



Work Area: SMM
Work Type: I&M
Originator Company: GEOCISA UK

C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer:

Monitoring Close-Out Report: Automated Total Station ATS 52 and 3D Targets read by ATS 52.

CRL Document Number: C435-BFK-C2-RGN-M123-51644

Supplier Document Number: N/A

Contract MDL reference C13.012

1. Contractor Document Submittal History:

Revision:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
1.0	18-05-2016	[Redacted]	[Redacted]	[Redacted]	For acceptance
2.0	16-08-2016	[Redacted]	[Redacted]	[Redacted]	For acceptance

2a. Stakeholder Review Required? YES NO

Stakeholder submission required: LU RfL Purpose of submission: For no objection
 NR LO For information
 DLR Other: _____

This document has been reviewed by the following individual for coordination, compliance, integration and acceptance and is acceptable for transmission to the above stakeholder for the above stated purpose.

Sign: _____ Role: _____ Name: _____ Date: _____

Sign: _____ Role: _____ Name: _____ Date: _____

2b. Review by Stakeholder (if required):

Stakeholder Organisation	Job Title	Name	Signature	Date	Acceptance
					<input type="checkbox"/>
					<input type="checkbox"/>
					<input type="checkbox"/>

3. Acceptance by Crossrail:

03/11/2016

Contents

A. INTRODUCTION	3
B. INSTRUMENTS	3
B.1 DESCRIPTION OF THE INSTRUMENTS	3
B.2 LOCATION OF THE INSTRUMENTS	5
C. MOVEMENTS	5
C.1 MOVEMENTS RESULTING FROM CONSTRUCTION ACTIVITIES	5
C.1.1 Relevant Crossrail (BFK) Works	5
C.1.2 Resulting Movements	6
C.2 TRIGGER/DEFAULT ALERTS BREACHES	7
C.3 SIGNIFICANT ISSUES WITH THE INSTRUMENTATION	7
C.4 RESIDUAL RISKS	7
D. CONCLUSIONS	8
APPENDIX A: DRAWINGS/PHOTOMONTAGES	
APPENDIX B: GRAPHS.	

A. INTRODUCTION

In line with the C122 – M&W Specification KX10 – Instrumentation & Monitoring C122-OVE-Z4-RSP-CR001-00007 Sections KX10.2113 and KX10.2114 (final and close-out reports), this close out report aims to address the following points in relation to the instrumentation defined in Section B.

- Identify movements observed by the relevant instruments;
- Relate these movements to construction activities, where applicable.
- Identify trigger breaches that may have occurred.
- Demonstrate that the rate of change of the data is either in line with the required rate or such that residual risks are minimal.
- Identify any such residual risks should there be considered to be any.
- Based on the above points, this close out reports will provide justification for the decommissioning of the instruments.

B. INSTRUMENTS

B.1 Description of the Instruments

This Close-Out Report relates the prisms read by ATS52. See Table 1 below with the details of the prisms read by ATS52

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C435-RP05201	47-53 CHARTERHOUSE STREET	81948,0408	36473,1575	114.2085
C435-RP05202	47-53 CHARTERHOUSE STREET	81948,2808	36476,2638	108.4046
C435-RP05203	47-53 CHARTERHOUSE STREET	81948,2848	36476,2653	109.8519
C435-RP05204	47-53 CHARTERHOUSE STREET	81949,4687	36466,895	119.3579
C435-RP05205	47-53 CHARTERHOUSE STREET	81949,4939	36466,8435	122.1479
C435-RP05206	47-53 CHARTERHOUSE STREET	81953,5351	36447,1393	118.4834
C435-RP05207	47-53 CHARTERHOUSE STREET	81953,5072	36447,0443	121.5738
C435-RP05208	47-53 CHARTERHOUSE STREET	81951,4489	36457,1802	118.7936
C435-RP05209	47-53 CHARTERHOUSE STREET	81951,4081	36457,298	122.2356
C435-RP05210	47-53 CHARTERHOUSE STREET	81949.4639	36466.8930	128.2565
C435-RP05211	47-53 CHARTERHOUSE STREET	81949.4892	36466.8412	122.2427
C435-RP05212	47-53 CHARTERHOUSE STREET	81953.5300	36447.1377	115.5819
C435-RP05213	47-53 CHARTERHOUSE STREET	81953.5018	36447.0423	115.6538
C435-RP05214	47-53 CHARTERHOUSE STREET	81951.4489	36457.1802	115.6589
C430-RP19001	CAXTON SLAB	81904.064	36452.78	111.8249
C430-RP19002	CAXTON SLAB	81915.318	36458.07	112.7691
C430-RP19003	CAXTON SLAB	81926.033	36462.82	113.2143
C430-RP19004	CAXTON SLAB	81935.919	36467.623	113.2457
C430-RP19005	CAXTON SLAB	81946.522	36472.695	113.1691
C430-RP80101	INTEGRATED TICKET HALL	81934.750	36535.047	121.5958
C430-RP80102	INTEGRATED TICKET HALL	81936.041	36532.429	121.5948
C430-RP80103	INTEGRATED TICKET HALL	81938.568	36527.294	121.5847
C430-RP80104	INTEGRATED TICKET HALL	81941.156	36522.034	121.5934
C430-RP80105	INTEGRATED TICKET HALL	81944.088	36516.090	121.5837
C430-RP80106	INTEGRATED TICKET HALL	81946.907	36510.335	121.5901
C430-RP80107	INTEGRATED TICKET HALL	81949.826	36504.400	121.5776

Sensor	Location	Easting (m)	Northing (m)	Elevation (mATD)
C430-RP80109	INTEGRATED TICKET HALL	81955.216	36493.455	121.5943
C430-RP80110	INTEGRATED TICKET HALL	81957.896	36488.011	121.5812
C430-RP80111	INTEGRATED TICKET HALL	81960.462	36489.135	121.9796
C430-RP80112	INTEGRATED TICKET HALL	81937.654	36537.040	121.9555
C430-RP80113	INTEGRATED TICKET HALL	81965.286	36550.674	121.9701
C430-RP80114	INTEGRATED TICKET HALL	81967.094	36541.428	121.9835
C430-RP80115	INTEGRATED TICKET HALL	81968.872	36537.844	121.9754
C430-RP80116	INTEGRATED TICKET HALL	81967.685	36536.207	121.9742
C430-RP80117	INTEGRATED TICKET HALL	81968.831	36533.914	121.9799
C430-RP80118	INTEGRATED TICKET HALL	81970.641	36530.225	121.9654
C430-RP80119	INTEGRATED TICKET HALL	81972.012	36527.453	121.9633
C430-RP80120	INTEGRATED TICKET HALL	81974.914	36521.562	121.9628
C430-RP80121	INTEGRATED TICKET HALL	81981.754	36498.899	121.871
C430-RP80122	INTEGRATED TICKET HALL	81980.833	36509.548	121.97
C430-RP80123	INTEGRATED TICKET HALL	81979.198	36514.164	121.998
C430-RP80124	INTEGRATED TICKET HALL	81954.514	36545.402	121.9253

Table 1: Details of the prisms read by ATS52

The location of prisms read by ATS52 which is installed on 20 Farringdon Road, are shown in the following documents:

Drawings:

- C122-OVE-C2-DDA-CR001_Z-31531: Asset Protection I&M Ground Surface and In-Ground Farringdon Station C435
- C122-OVE-C2-DDA-CR001_Z-31532: Asset Protection I&M Buildings Farringdon Station C435

Installation Reports:

- C435-BFK-C2-RGN-M123-50024 Installation Report: Automated Total Station Installation at 20 Farringdon Road (ATS 52)
- C435-BFK-C2-RGN-M123-51009 Installation Report of 3D Targets read by ATSs 51, 52, 53 and 54.
- C430-LOS-C-RGN-M123-50019 Installation Report – Assets Protection Outside Site Boundaries - WTH
- C430-LOS-C-RGN-M123-50015 Installation Report – Assets Protection Inside Site Boundaries

B.2 Location of the Instruments

Prisms associated with ATS52 are located on the plan below highlighted in yellow.

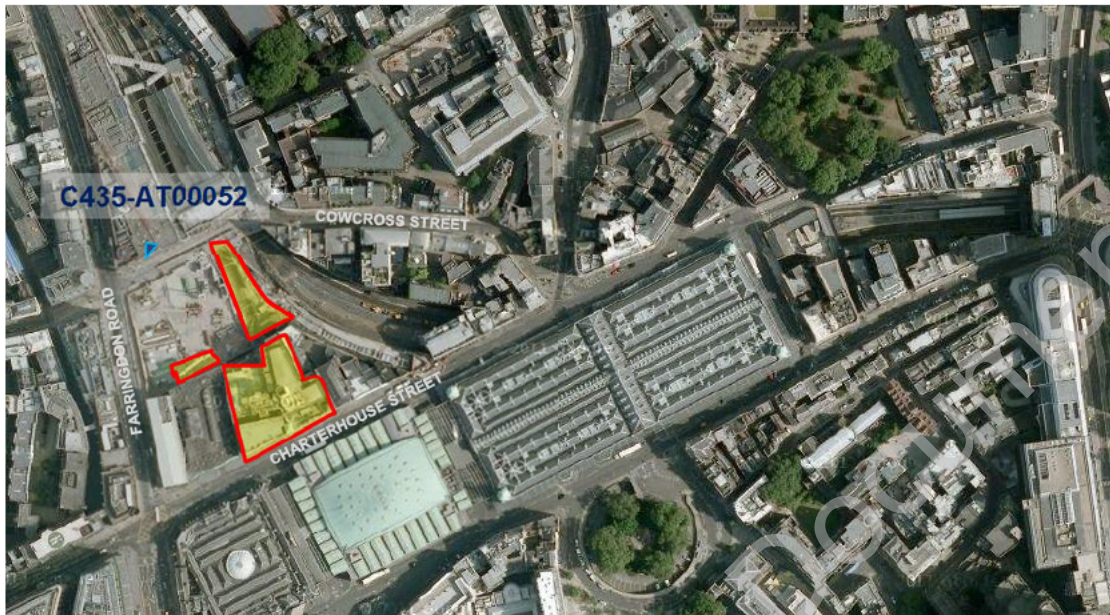


Figure 1 – Plan showing the Location prisms read by ATS 52.

C. MOVEMENTS

C.1 Movements Resulting from Construction Activities

C.1.1 Relevant Crossrail (BFK) Works

The construction activities that may have affected the above instruments are related only to Crossrail C300, C430 and C435 tunnelling and excavation works. See below table for dates.

ACTIVITY	START DATE	END DATE
PL1	18/06/2013	21/06/2013
Butcher's Ramp Shaft TAM Installation	25/06/2013	23/08/2013
CP1	06/07/2013	22/07/2013
Butcher's Ramp Shaft Pre-Treatment works	29/07/2013	16/08/2013
WB TBM passage	08/09/2016	19/09/2016
EB TBM passage	14/12/2013	09/01/2014
STW3	25/01/2014	28/01/2014
PTW enlargement	19/02/2014	12/04/2014
WTH – SHW3 excavation	17/03/2014	10/10/2014
STW1	29/03/2014	24/04/2014
WTH – SHW2 Level -8 excavation	11/04/2014	09/05/2014
PTE enlargement	04/05/2014	08/06/2014
VA1	23/11/2014	13/01/2015
ES1	14/03/2015	12/04/2015

ACTIVITY	START DATE	END DATE
PL2	29/04/2015	24/05/2015

Table 2 – Construction Activities that may have effected readings from ATS 52.

C.1.2 Resulting Movements

- **47-53 Charterhouse Street:**

Monitoring data for these prisms is presented in Appendix B.

- Compensation grouting from Butcher's Ramp caused maximum 6mm of heave in August 2013
- WB TBM passage caused around 6mm settlement in the area on 10-09-2013.
- EB TBM caused 3mm maximum of settlement on 14-12-2013
- PL1 and CP1 excavation caused around 3mm settlement in the area from 18-06-2013 to 22-07-2013.
- Compensation grouting caused 6mm of heave in March 2014.
- Compensation grouting caused 10mm of heave in May 2014
- 4mm of settlement was recorded PTE enlargement from 04-05-2014 to 08-06-2014.
- ES1 caused maximum 2mm of settlement between 14-03-2015 and 12-04-2015.
- PL2 construction caused 20mm maximum of settlement on from 29-04-2015 to 24-05-2015.
- Compensation grouting carried out on May 2015 caused 12mm of heave.
- Maximum longitudinal displacement at the end of the works: -8.3mm.
- Maximum transversal displacement at the end of the works: 6.1mm.
- Maximum elevation movement at the end of the works: -16mm.

- **Caxton Slab:**

Monitoring data for these prisms is presented in Appendix B.

- WB TBM passage caused 7mm settlement on 10-09-2013
- EB TBM caused 2mm of settlement on 14-12-2013.
- Maximum longitudinal displacement at the end of the works: -2.4mm.
- Maximum transversal displacement at the end of the works: 7.1mm.
- Maximum elevation movement at the end of the works: -14.5mm.

- **Integrated Ticket Hall:**

Monitoring data for these prisms is presented in Appendix B.

- WB TBM passage caused a settlement around 2mm on 10-09-2013
- EB TBM caused 2mm maximum of settlement on 14-12-2013.
- VA1 excavation caused 4mm of settlement between 23-11-2014 and 13-01-2015
- PL2 construction caused 3mm of settlement from 29-04-2015 to 24-05-2015.
- Maximum longitudinal displacement at the end of the works: -2.3mm.
- Maximum transversal displacement at the end of the works: 12.8mm.
- Maximum elevation movement at the end of the works: -8mm.

C.2 Trigger/Default Alerts Breaches

The Instrumentation and Monitoring Plan: Farringdon Station Ground Movement and Asset Protection C122-OVE-C2-RGN-M123-50013 outlines the triggers associated with the works.

The table below shows the breached default alerts.

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
47-53 CHARTERHOUSE STREET	C435-RP05201	AUTOMATIC RP	Settlement	08/07/2013 05:00	-1.9	Clear	Clear
	C435-RP05202	AUTOMATIC RP	Settlement	31/07/2015 08:00	-17.1	Default Alert	Default Alert
	C435-RP05203	AUTOMATIC RP	Settlement	04/08/2015 08:00	-17	Default Alert	Default Alert
	C435-RP05204	AUTOMATIC RP	Settlement	03/12/2015 16:00	-11.1	Default Alert	Default Alert
	C435-RP05205	AUTOMATIC RP	Settlement	10/12/2015 20:00	-12.8	Default Alert	Default Alert
	C435-RP05206	AUTOMATIC RP	Settlement	10/12/2015 13:00	-3.8	Clear	Clear
	C435-RP05207	AUTOMATIC RP	Settlement	10/12/2015 20:00	-7.3	Clear	Clear
	C435-RP05208	AUTOMATIC RP	Settlement	07/04/2014 22:47	-5	Clear	Clear
	C435-RP05209	AUTOMATIC RP	Settlement	10/12/2015 20:00	-54	Default Alert	Default Alert
	C435-RP05210	AUTOMATIC RP	Settlement	10/12/2015 20:00	-5.1	Clear	Clear
	C435-RP05211	AUTOMATIC RP	Settlement	10/12/2015 20:40	-9.2	Clear	Clear
	C435-RP05212	AUTOMATIC RP	Settlement	08/10/2015 05:00	-10.5	Default Alert	Default Alert
	C435-RP05213	AUTOMATIC RP	Settlement	06/10/2015 09:00	-12.1	Default Alert	Default Alert
	C435-RP05214	AUTOMATIC RP	Settlement	18/11/2015 12:00	-12.7	Default Alert	Default Alert
	CAXTON SLAB	C430-RP19001	AUTOMATIC RP	Settlement	26/11/2015 20:00	8.4	Clear
C430-RP19002		AUTOMATIC RP	Settlement	25/11/2015 16:00	-5.4	Clear	Clear
C430-RP19003		AUTOMATIC RP	Settlement	27/11/2015 00:00	-5.1	Clear	Clear
C430-RP19004		AUTOMATIC RP	Settlement	27/11/2015 12:00	-15.1	Default Alert	Default Alert
C430-RP19005		AUTOMATIC RP	Settlement	23/05/2015 08:00	-17.4	Default Alert	Default Alert
INTEGRATED TICKET HALL	C430-RP80101	AUTOMATIC RP	Settlement	10/12/2015 16:00	-1.1	Clear	Clear
	C430-RP80102	AUTOMATIC RP	Settlement	10/12/2015 20:00	-2.3	Clear	Clear
	C430-RP80103	AUTOMATIC RP	Settlement	10/12/2015 20:00	-1.8	Clear	Clear
	C430-RP80104	AUTOMATIC RP	Settlement	10/12/2015 16:00	-6.4	Clear	Clear
	C430-RP80105	AUTOMATIC RP	Settlement	10/12/2015 20:00	-5.6	Clear	Clear
	C430-RP80106	AUTOMATIC RP	Settlement	10/12/2015 20:00	-3	Clear	Clear
	C430-RP80107	AUTOMATIC RP	Settlement	10/12/2015 20:00	-2.8	Clear	Clear
	C430-RP80108	AUTOMATIC RP	Settlement	10/12/2015 16:00	-2.5	Clear	Clear
	C430-RP80109	AUTOMATIC RP	Settlement	10/12/2015 04:00	0.2	Clear	Clear
	C430-RP80110	AUTOMATIC RP	Settlement	10/12/2015 16:00	-0.8	Clear	Clear
	C430-RP80111	AUTOMATIC RP	Settlement	03/11/2013 02:00	-3.3	Clear	Clear
	C430-RP80112	AUTOMATIC RP	Settlement	10/12/2015 20:00	-3.6	Clear	Clear
	C430-RP80113	AUTOMATIC RP	Settlement	10/12/2015 20:00	-5.1	Clear	Clear
	C430-RP80114	AUTOMATIC RP	Settlement	11/02/2014 08:00	-1.5	Clear	Clear
	C430-RP80115	AUTOMATIC RP	Settlement	27/03/2015 04:00	-6.5	Clear	Clear
	C430-RP80116	AUTOMATIC RP	Settlement	22/04/2015 04:00	-3.4	Clear	Clear
	C430-RP80117	AUTOMATIC RP	Settlement	10/12/2015 20:00	-3.3	Clear	Clear
	C430-RP80118	AUTOMATIC RP	Settlement	10/12/2015 20:00	-4.4	Clear	Clear
	C430-RP80119	AUTOMATIC RP	Settlement	06/03/2015 18:00	-5.3	Clear	Clear
	C430-RP80120	AUTOMATIC RP	Settlement	10/12/2015 20:00	-5	Clear	Clear
	C430-RP80121	AUTOMATIC RP	Settlement			-	-
	C430-RP80122	AUTOMATIC RP	Settlement	07/04/2014 03:00	-2	Clear	Clear
	C430-RP80123	AUTOMATIC RP	Settlement			-	-
	C430-RP80124	AUTOMATIC RP	Settlement	10/12/2015 20:00	3.1	Clear	Clear

Table 3 – Default Alerts breached by the prisms read by ATS52.

C.3 Significant issues with the Instrumentation

Because of facade lining issues, prism C435-RP05209 installed in the 47-53 Charterhouse Street building got loose getting worse with time, showing an anomalous trend of movement from installation.

Prisms installed on the Caxton Slab structure show discontinuous readings along their life due to the line of sight from the ATS 52 has being temporary getting blocked because of vegetation growing in the area and operative cranes working in the WTH shaft. Also, Prisms C430-RP19001 and 19005 were damaged and reinstalled in November 2013. Prism C430-RP19005 was knocked and damaged on 23rd of May 2015 when last reading was recorded.

Prisms C430-RP80121 and 80123 were never read by C435 because of the lack of line of sight from any ATS.

C.4 Residual Risks

No risks remain.

D. CONCLUSIONS

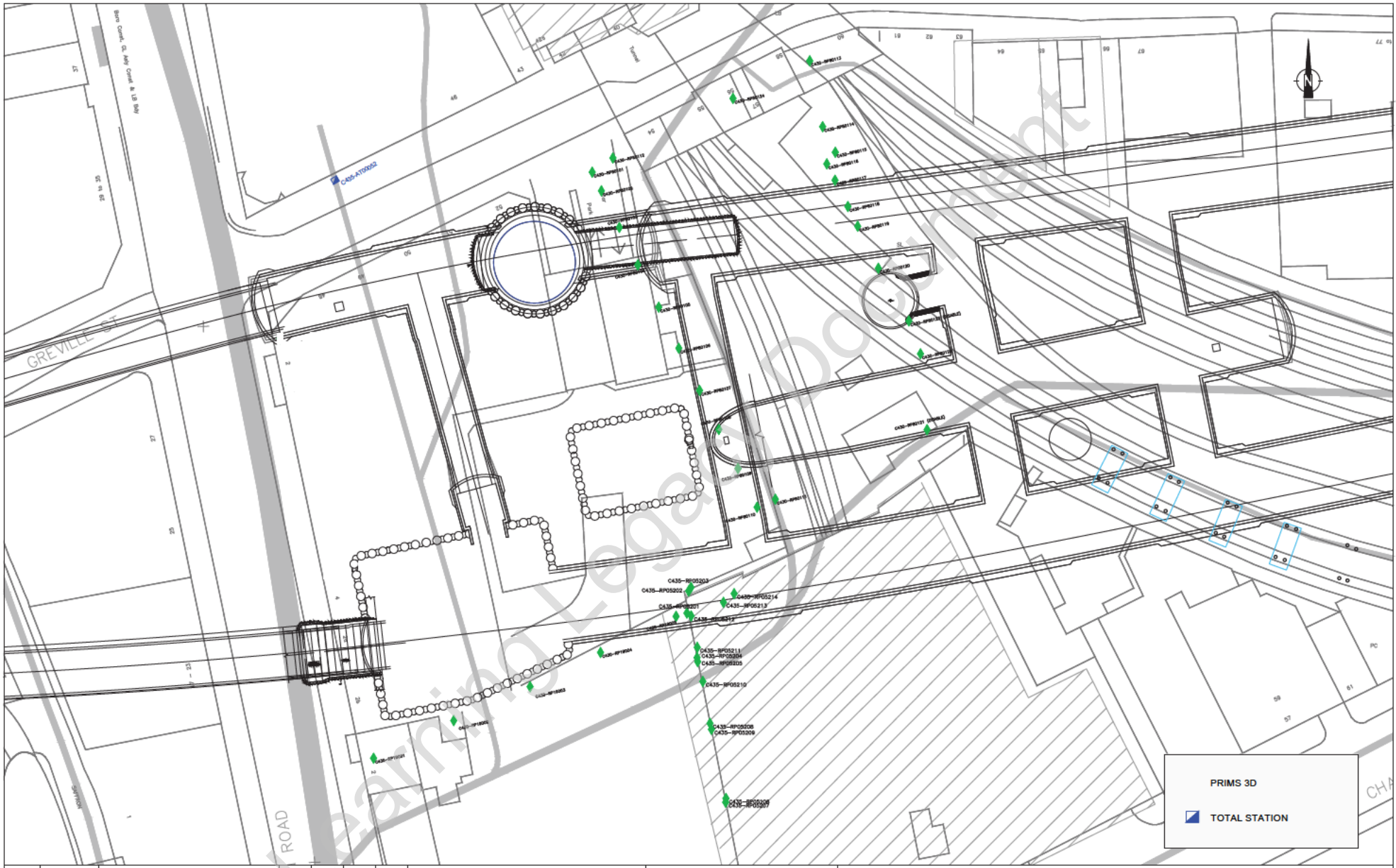
No triggers breached, monitoring stable. No residual risks remain. Long term monitoring to be completed by Crossrail.

As per C435-PMI-00549 the Long Term Monitoring has been ceased in this area and subsequently all monitoring associated is no longer undertaken by BFK. The last measurement carried out for these devices on 10/12/2015.

Learning Legacy Document

APPENDIX A: DRAWINGS

Learning Legacy Document



PRIMS 3D

TOTAL STATION

Rev.	Date	Description	By	Chkd	App	Auth
1	20-05-2013					

Notes:

Geocisa UK
 C/ Los Llanos de Jerez 10 12
 28923 MADRID
 www.geocisa.com

BFK
 here! Forward. Car

Scale: @ A3

Contract: C435 18M FARRINGTON
 Originator: GEOCISA
 Location: CROSSRAIL GENERAL
 Title: 3D PRIMS ATS52
 Drg No: C435-BFK-C2-DRW-M123-50045

By: [Redacted]
 Chk: [Redacted]
 App: [Redacted]
 Auth: **Geocisa**

\$ppby\$

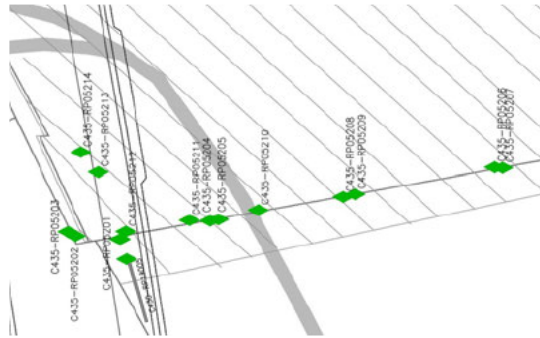
APPENDIX B: GRAPHS

Learning Legacy Document

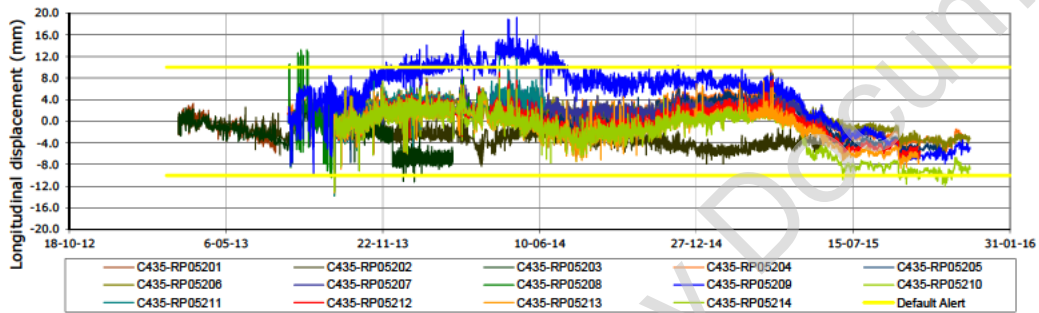


GEOCISA UK

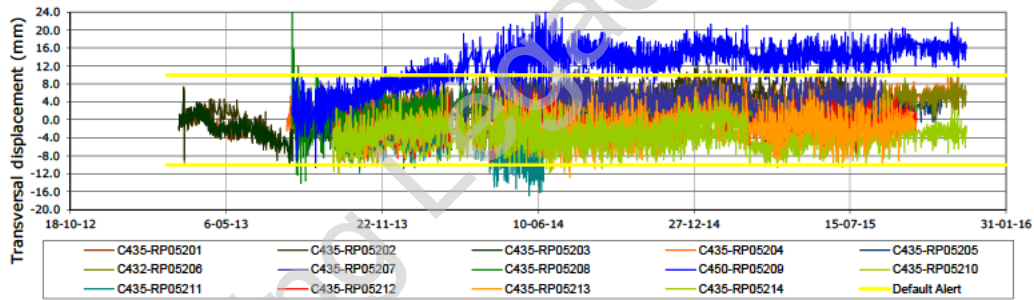
REPORT Automatic Prisms
AREA Farringdon Station
DEVICE 3D Target



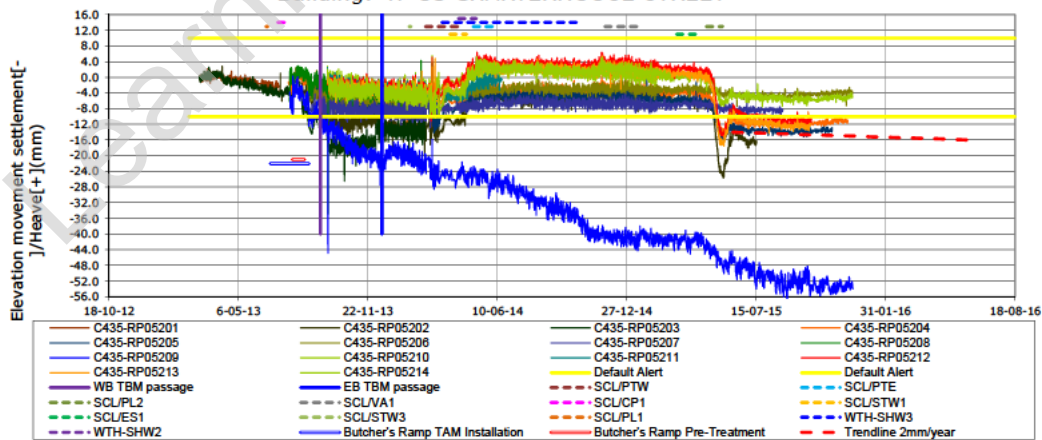
Building: 47-53 CHARTERHOUSE STREET



Building: 47-53 CHARTERHOUSE STREET



Building: 47-53 CHARTERHOUSE STREET



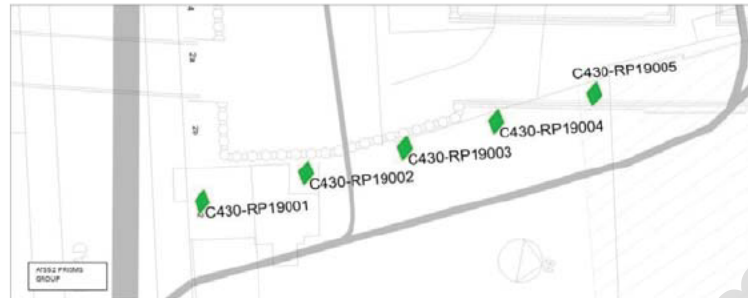
REMARKS

Because of facade lining issues, prism C435-RP05209 installed in the 47-53 Charterhouse Street building got loose getting worse with time, showing an anomalous trend of movement from installation.

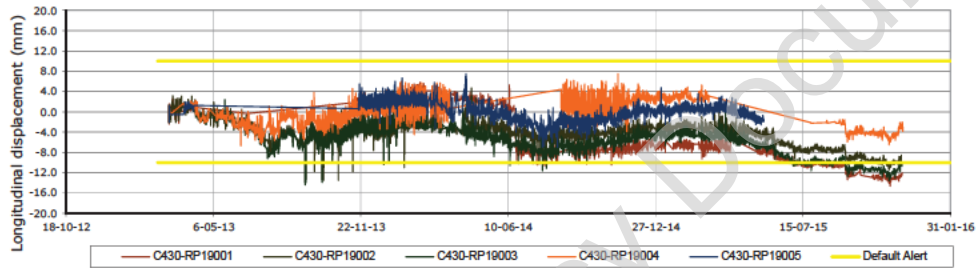


GEOCISA UK

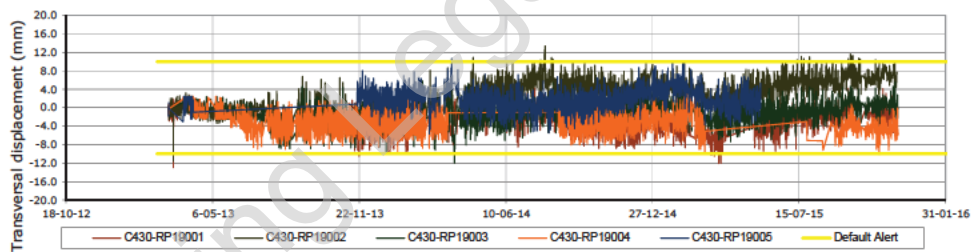
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



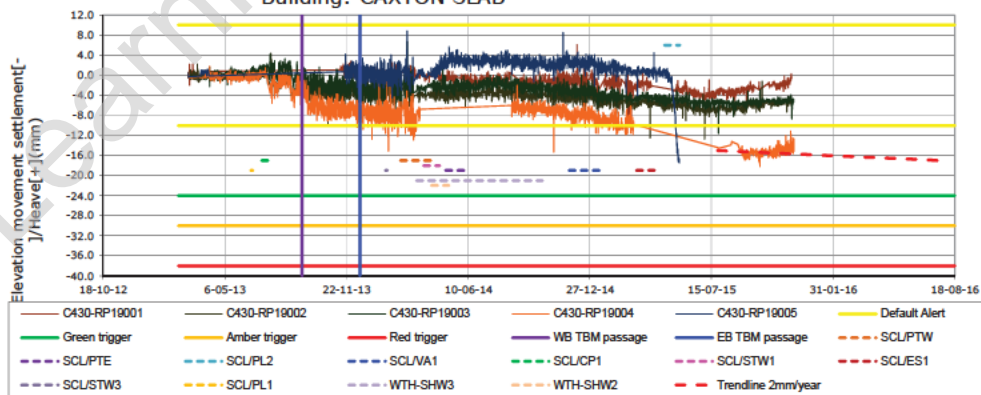
Building: CAXTON SLAB



Building: CAXTON SLAB



Building: CAXTON SLAB



REMARKS:

12-11-2013: Prism C430-RP19001 has been reinstalled.
 18-11-2013: Prism C430-RP19005 has been reinstalled.

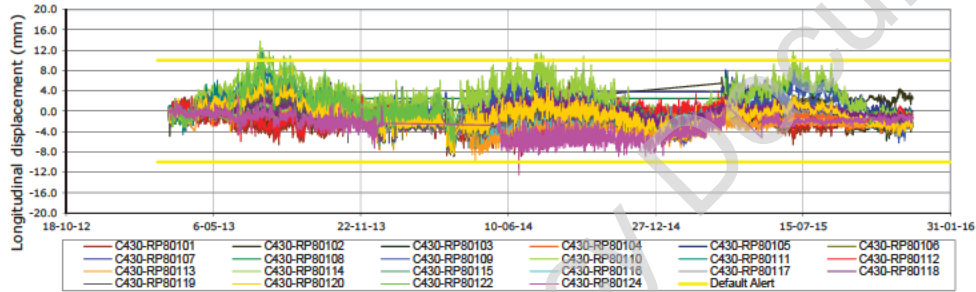


GEOCISA UK

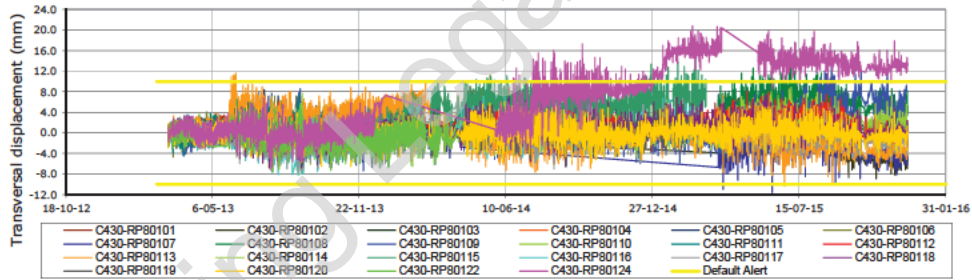
REPORT Automatic Prisms
 AREA Farringdon Station
 DEVICE 3D Target



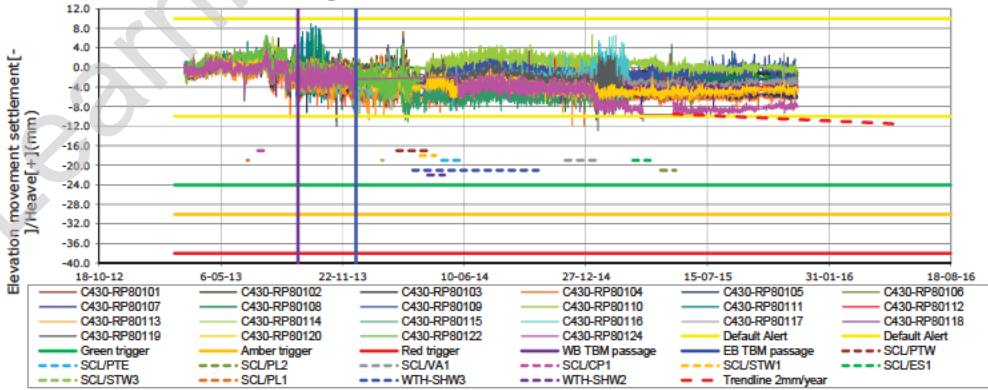
Building: INTEGRATED TICKET HALL



Building: INTEGRATED TICKET HALL



Building: INTEGRATED TICKET HALL



REMARKS:

[Empty box for remarks]

APPENDIX C: GLOSSARY

- ATS Automatic Total Station.
- ETH Eastern Ticket Hall.
- WB Westbound.
- TBM Tunnel Boring Machine.
- EB Eastbound.
- PTW Platform Tunnel West
- PTE Platform Tunnel East
- CP Cross passages.
- CH Concourse Hall.
- VA Ventilation Adit
- STE Stub Tunnel East
- STW Stub Tunnel West
- RTE Running Tunnel East.
- ES Escalator

Learning Legacy Document