



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

C435 Farringdon Main Station

CRL Lead reviewer: [Redacted]
CRL Reviewer: [Redacted]

Monitoring Close-Out Report: Automated Total Station ATS 20 and 3D Targets read by ATS 20.

CRL Document Number: C435-BFK-C2-RGN-M123-51631

Supplier Document Number: N/A

Contract MDL reference C13.012

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2a. Stakeholder Review Required? YES NO

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

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"/>

compliance with their contractual obligations and does not constitute ds or materials developed or selected by the designer/supplier.

3. Acceptance by Crossrail:

[Redacted] eer
09/03/2016

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Learning Legacy Document

A. INTRODUCTION

In line with the C122 – M&W Specification KX10 – Instrumentation & Monitoring C122-OVE-Z4-RSP-CR001-00007, 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 Smithfield East Market corridor, consisting of 3D Targets read by ATS 20 and 1No. Automated Total Station (ATS 20) located at East Smithfield Market Car Park. See table 1 below with details.

ATS 20 CODE	LOCATION	COORDINATES	
		X (m)	Y (m)
C435-AT00020	East Smithfield Market Car Park	82225.89	36461.85

PRISM CODE	LOCATION	COORDINATES	
		X (m)	Y (m)
C435-RP02001	EAST MARKET – CAR PARK	82216.4241	36451.8031
C435-RP02002	EAST MARKET – CAR PARK	82212.0355	36460.4013
C435-RP02003	EAST MARKET – CAR PARK	82206.6	36471.1803
C435-RP02004	EAST MARKET – CAR PARK	82202.633	36479.6928
C435-RP02005	EAST MARKET – CAR PARK	82207.1611	36491.2929
C435-RP02006	EAST MARKET – CAR PARK	82213.1472	36494.7002
C435-RP02007	EAST MARKET – CAR PARK	82216.8719	36487.4099
C435-RP02008	EAST MARKET – CAR PARK	82221.1037	36479.0748
C435-RP02009	EAST MARKET – CAR PARK	82225.0948	36473.1948
C435-RP02010	EAST MARKET – CAR PARK	82228.2749	36467.2823
C435-RP02011	EAST MARKET – CAR PARK	82229.3278	36464.4199
C435-RP02012	EAST MARKET – CAR PARK	82232.1423	36461.0094
C435-RP02013	EAST MARKET – CAR PARK	82239.5995	36464.7921
C435-RP02014	EAST MARKET – CAR PARK	82237.699	36468.8957
C435-RP02015	EAST MARKET – CAR PARK	82235.8041	36471.8162
C435-RP02016	EAST MARKET – CAR PARK	82234.9491	36474.3292
C435-RP02017	EAST MARKET – CAR PARK	82229.8624	36483.4939
C435-RP02018	EAST MARKET – CAR PARK	82226.1666	36491.4533
C435-RP02019	EAST MARKET – CAR PARK	82221.0669	36499.7406
C435-RP02020	EAST MARKET – CAR PARK	82229.9138	36503.1914

C435-RP02021	EAST MARKET – CAR PARK	82235.0363	36496.0226
C435-RP02022	EAST MARKET – CAR PARK	82241.4754	36481.5194
C435-RP02023	EAST MARKET – CAR PARK	82245.8734	36472.9459
C435-RP02024	EAST MARKET – CAR PARK	82247.7812	36468.387
C435-RP02025	EAST MARKET – CAR PARK	82263.9086	36477.0056
C435-RP02026	EAST MARKET – CAR PARK	82270.5416	36485.2673
C435-RP02027	EAST MARKET – CAR PARK	82254.5898	36495.6635
C435-RP02028	EAST MARKET – CAR PARK	82250.9461	36504.026
C435-RP02029	EAST MARKET – CAR PARK	82271.9362	36481.2269
C435-RP02030	EAST MARKET – CAR PARK	82270.5417	36485.2673
C435-RP02031	EAST MARKET – CAR PARK	82260.6571	36483.7562
C435-RP02032	EAST MARKET – CAR PARK	82256.8342	36512.2759

Table 1: Details 3D Targets read by ATS 20 and ATS 20.

At the moment, this area monitored by these prisms should be in a Long Term basis with readings every three months, but per C435-PMI-00549 Long Term has being ceased in this area, being the last measure carried out for these devices on 13/12/2015.

These prisms read by ATS 20 and the ATS 20 itself 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-M123-50019 Installation Report: Automated Total Station Installation at Smithfield Market Car Park (ATS 20)
- C435-BFK-C2-RGN-M123-50065 Installation Report of 3D Targets read by ATS 20

B.2 Location of the Instruments

As you can see from the Figure 1 below, the instruments described in Section B.1 are located at Smithfield East Market. A drawing showing the location of these devices can be found in the Appendix A.

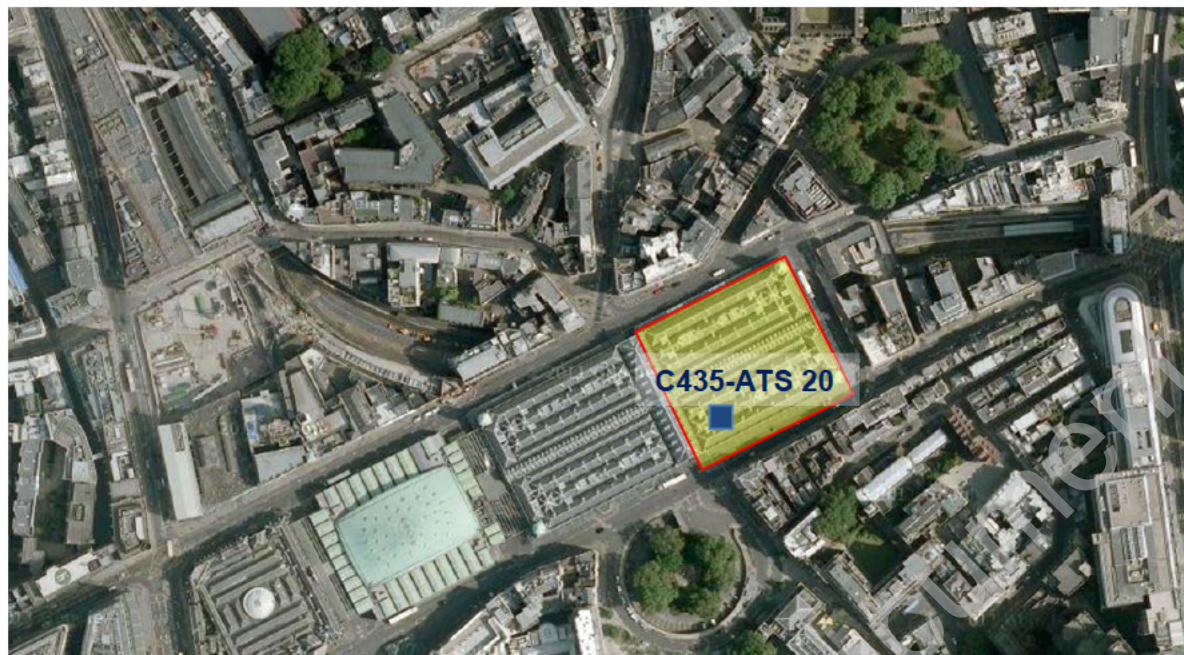


Figure 1 – Map showing the Location of ATS 20 and 3D Targets read by ATS 20.

C. MOVEMENTS

C.1 Movements Resulting from Construction Activities

C.1.1 Relevant Crossrail (BFK) Works

The construction activities associated with these instruments are related to Crossrail tunnelling works. In all cases, these comprise of the passage of a TBMs (C300) and a platform tunnel enlargement.

ACTIVITY	START DATE	END DATE
Moorgate Spur Shaft No. 1 TAM Installation	08/07/2013	20/08/2013
Moorgate Spur Shaft No. 1 Pre-Treatment works	19/08/2013	15/09/2013
Moorgate Spur Shaft No. 2 TAM Installation	01/05/2013	16/07/2013
Moorgate Spur Shaft No. 2 Pre-Treatment works	29/07/2013	02/09/2013
WB TBM passage	30/09/2013	07/10/2013
SCL-PTW enlargement	24/07/2014	06/10/2014
EB TBM passage	16/01/2014	23/01/2014
SCL-PTE enlargement	17/08/2014	18/01/2015
SCL-RTE2	18/10/2014	11/11/2014
SCL-CP6	12/11/2104	22/11/2014
SCL-CP7	23/02/2015	26/02/2015
SCL-CH2E	15/01/2015	05/03/2015
SCL-CH2 Phase2	15/05/2015	28/05/2015
SCL-ES2	04/06/2015	21/09/2015
ETH-Excavation works	26/04/2013	29/08/2014

C.1.2 Resulting Movements

- Smithfield East Market Car Park:

The monitoring data for these prisms is presented in Appendix B.

This Smithfield East Market building where the prisms are installed was affected by WB and EB TBMs, SCL PTE and PTW enlargements, RTE2, CP6, CP7, CH2E, CH2 Phase2 and ES2 tunnels. Also, this building has been affected by Compensation Grouting works carried out from Moorgate Spur Shafts No.1 and No.2 and ETH both Trapezoidal and 2 Storey Basement shafts excavation works.

During the WB TBM passage, the movement recorded by these devices was about 4mm settlement, increasing around 3mm more because of the EB TBM passage.

During the PTW stage, a settlement of 3mm was captured by these 3D Targets.

The CH2 passage caused until 2-3mm of settlement in the area.

In the last instance, this building was affected by ES2 Excavation works, recording around 4mm settlement still ongoing when the last reading on 13/12/2015 was taken.

No significant movement was recorded during SCL PTE, RTE2, CP6, CP7 passage or ETH excavation works in this building.

About Compensation Grouting works, until 14mm heave was captured during Moorgate Spur Shaft No.1 TAM Installation and 4mm heave when the Pre-Treatment works were carried out from Moorgate Spur Shaft No.1. Additional 2-3mm heave was achieved before the EB TBM passage.

C.2 Trigger 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.

In this case, part of the building is in Moorgate Spur Shafts No.1 and No.2. ZOI, so the trigger values associated to this building are:

- DEFAULT ALERT (in any direction): 10mm

No triggers have been defined for the Automated Total Stations (ATS).

C435-BFK-C2-RGN-M123-51631

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
PARKING EAST MARKET	C435-RP02001	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.5	Clear	Clear
	C435-RP02002	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.1	Clear	Clear
	C435-RP02003	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.5	Clear	Clear
	C435-RP02004	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.2	Clear	Clear
	C435-RP02005	AUTOMATIC RP	Settlement	13/12/2015 13:00	-1	Clear	Clear
	C435-RP02006	AUTOMATIC RP	Settlement	13/12/2015 13:00	-1.2	Clear	Clear
	C435-RP02007	AUTOMATIC RP	Settlement	13/12/2015 13:00	1.6	Clear	Clear
	C435-RP02008	AUTOMATIC RP	Settlement	13/12/2015 13:00	1.7	Clear	Clear
	C435-RP02009	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.8	Clear	Clear
	C435-RP02010	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.4	Clear	Clear
	C435-RP02011	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.3	Clear	Clear
	C435-RP02012	AUTOMATIC RP	Settlement	13/12/2015 13:00	-0.2	Clear	Clear
	C435-RP02013	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.1	Clear	Clear
	C435-RP02014	AUTOMATIC RP	Settlement	13/12/2015 13:00	1.3	Clear	Clear
	C435-RP02015	AUTOMATIC RP	Settlement	13/12/2015 13:00	1.3	Clear	Clear
	C435-RP02016	AUTOMATIC RP	Settlement	13/12/2015 13:00	0.9	Clear	Clear
	C435-RP02017	AUTOMATIC RP	Settlement	13/12/2015 13:00	2.5	Clear	Clear
	C435-RP02018	AUTOMATIC RP	Settlement	13/12/2015 13:00	2.3	Default Alert	Clear
	C435-RP02019	AUTOMATIC RP	Settlement	13/12/2015 13:00	-1.7	Clear	Clear
	C435-RP02020	AUTOMATIC RP	Settlement	13/12/2015 13:00	-1.8	Clear	Clear
	C435-RP02021	AUTOMATIC RP	Settlement	13/12/2015 13:00	3.2	Default Alert	Clear
	C435-RP02022	AUTOMATIC RP	Settlement	13/12/2015 13:00	2.2	Clear	Clear
	C435-RP02023	AUTOMATIC RP	Settlement	13/12/2015 13:00	1.1	Clear	Clear
	C435-RP02024	AUTOMATIC RP	Settlement	13/12/2015 13:00	-0.1	Clear	Clear
	C435-RP02025	AUTOMATIC RP	Settlement	13/12/2015 13:00	-2.7	Clear	Clear
	C435-RP02026	AUTOMATIC RP	Settlement	13/12/2015 13:00	-4.7	Clear	Clear
	C435-RP02027	AUTOMATIC RP	Settlement	13/12/2015 13:00	-1.6	Default Alert	Clear
	C435-RP02028	AUTOMATIC RP	Settlement	13/12/2015 13:00	-3.2	Default Alert	Clear
	C435-RP02029	AUTOMATIC RP	Settlement	13/12/2015 13:00	-5.2	Clear	Clear
	C435-RP02030	AUTOMATIC RP	Settlement	13/12/2015 13:00	-4.7	Clear	Clear
	C435-RP02031	AUTOMATIC RP	Settlement	13/12/2015 13:00	-1.8	Clear	Clear
	C435-RP02032	AUTOMATIC RP	Settlement	01/05/2013 09:00	1.4	Clear	Clear

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C435-BFK-C2-RGN-M123-51631

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
PARKING EAST MARKET	C435-RP02001	AUTOMATIC RP	Transversal	13/12/2015 13:00	1.1	Clear	Clear
	C435-RP02002	AUTOMATIC RP	Transversal	13/12/2015 13:00	1.1	Clear	Clear
	C435-RP02003	AUTOMATIC RP	Transversal	13/12/2015 13:00	1.4	Clear	Clear
	C435-RP02004	AUTOMATIC RP	Transversal	13/12/2015 13:00	0.7	Clear	Clear
	C435-RP02005	AUTOMATIC RP	Transversal	13/12/2015 13:00	0.2	Clear	Clear
	C435-RP02006	AUTOMATIC RP	Transversal	13/12/2015 13:00	-0.2	Clear	Clear
	C435-RP02007	AUTOMATIC RP	Transversal	13/12/2015 13:00	-0.7	Clear	Clear
	C435-RP02008	AUTOMATIC RP	Transversal	13/12/2015 13:00	-0.4	Clear	Clear
	C435-RP02009	AUTOMATIC RP	Transversal	13/12/2015 13:00	-1.3	Clear	Clear
	C435-RP02010	AUTOMATIC RP	Transversal	13/12/2015 13:00	-1.8	Clear	Clear
	C435-RP02011	AUTOMATIC RP	Transversal	13/12/2015 13:00	-1.8	Clear	Clear
	C435-RP02012	AUTOMATIC RP	Transversal	13/12/2015 13:00	-1.2	Clear	Clear
	C435-RP02013	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2	Clear	Clear
	C435-RP02014	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2.1	Clear	Clear
	C435-RP02015	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2.3	Clear	Clear
	C435-RP02016	AUTOMATIC RP	Transversal	13/12/2015 13:00	-1.7	Clear	Clear
	C435-RP02017	AUTOMATIC RP	Transversal	13/12/2015 13:00	-1.7	Clear	Clear
	C435-RP02018	AUTOMATIC RP	Transversal	13/12/2015 13:00	-1.2	Clear	Clear
	C435-RP02019	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2.5	Clear	Clear
	C435-RP02020	AUTOMATIC RP	Transversal	13/12/2015 13:00	-4	Clear	Clear
	C435-RP02021	AUTOMATIC RP	Transversal	13/12/2015 13:00	-1.5	Clear	Clear
	C435-RP02022	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2.3	Clear	Clear
	C435-RP02023	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2.4	Clear	Clear
	C435-RP02024	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2.1	Clear	Clear
	C435-RP02025	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2.4	Clear	Clear
	C435-RP02026	AUTOMATIC RP	Transversal	13/12/2015 13:00	-3.7	Clear	Clear
	C435-RP02027	AUTOMATIC RP	Transversal	13/12/2015 13:00	-2.9	Clear	Clear
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	C435-RP02029	AUTOMATIC RP	Transversal	13/12/2015 13:00	-3	Clear	Clear
	C435-RP02030	AUTOMATIC RP	Transversal	13/12/2015 13:00	-3.4	Clear	Clear
	C435-RP02031	AUTOMATIC RP	Transversal	13/12/2015 13:00	-3.1	Clear	Clear
	C435-RP02032	AUTOMATIC RP	Transversal	01/05/2013 09:00	-0.9	Clear	Clear

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C435-BFK-C2-RGN-M123-51631

MONITORING GROUP (Location)	POINT ID	TYPE	DIRECTION	DATE OF LAST READING	LAST READING VALUE (mm)	TRIGGER LEVEL	
						WORST HISTORICAL STATUS	CURRENT STATUS
PARKING EAST MARKET	C435-RP02001	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	0.9	Clear	Clear
	C435-RP02002	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	1.3	Clear	Clear
	C435-RP02003	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	2.5	Clear	Clear
	C435-RP02004	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	3.2	Clear	Clear
	C435-RP02005	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	3.6	Clear	Clear
	C435-RP02006	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	4.6	Clear	Clear
	C435-RP02007	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	4.8	Clear	Clear
	C435-RP02008	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	3.6	Clear	Clear
	C435-RP02009	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	2.8	Clear	Clear
	C435-RP02010	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	2	Clear	Clear
	C435-RP02011	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	1	Clear	Clear
	C435-RP02012	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	-0.2	Clear	Clear
	C435-RP02013	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	1.1	Clear	Clear
	C435-RP02014	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	1.4	Clear	Clear
	C435-RP02015	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	2	Clear	Clear
	C435-RP02016	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	2.6	Clear	Clear
	C435-RP02017	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	4.5	Clear	Clear
	C435-RP02018	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	4.7	Clear	Clear
	C435-RP02019	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	4.7	Clear	Clear
	C435-RP02020	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	4.9	Clear	Clear
	C435-RP02021	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	4.6	Clear	Clear
	C435-RP02022	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	3	Clear	Clear
	C435-RP02023	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	2.2	Clear	Clear
	C435-RP02024	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	1.6	Clear	Clear
	C435-RP02025	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	2.8	Clear	Clear
	C435-RP02026	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	3.5	Clear	Clear
	C435-RP02027	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	4.5	Clear	Clear
	C435-RP02028	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	5.1	Clear	Clear
	C435-RP02029	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	3.1	Clear	Clear
	C435-RP02030	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	3.6	Clear	Clear
	C435-RP02031	AUTOMATIC RP	Longitudinal	13/12/2015 13:00	3.3	Clear	Clear
	C435-RP02032	AUTOMATIC RP	Longitudinal	01/05/2013 09:00	0.1	Clear	Clear

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C.3 Significant issues with the Instrumentation

3D Target C435-RP02032 was installed and read until 01/05/2013 when it was covered by a net, being the visual from ATS 20 blocked from then onwards.

C.4 Residual Risks

Residual settlement still ongoing when last reading was taken on 13/12/2015.

D. CONCLUSIONS

Following the TBMs passages, SCL and ETH excavation works, as well as the Compensation Grouting works undertaken in this area, the maximum movement recorded by these 3D Targets read by ATS20 has been a settlement of 7mm.

On the other hand, the maximum horizontal movement in longitudinal and transversal directions has being of +5mm and -4mm for these 3D Targets, having been potentially affected by the temperature fluctuation recorded from the ATS 20 along these years. More than 4mm movement was recorded in transversal direction during Moorgate Spur Shaft No.1 TAM installation stage.

At the moment, this area monitored by these prisms should be in a Long Term basis with readings every three months, but per C435-PMI-00549 Long Term has being ceased in this area, being the last measure carried out for these devices on 13/12/2015.

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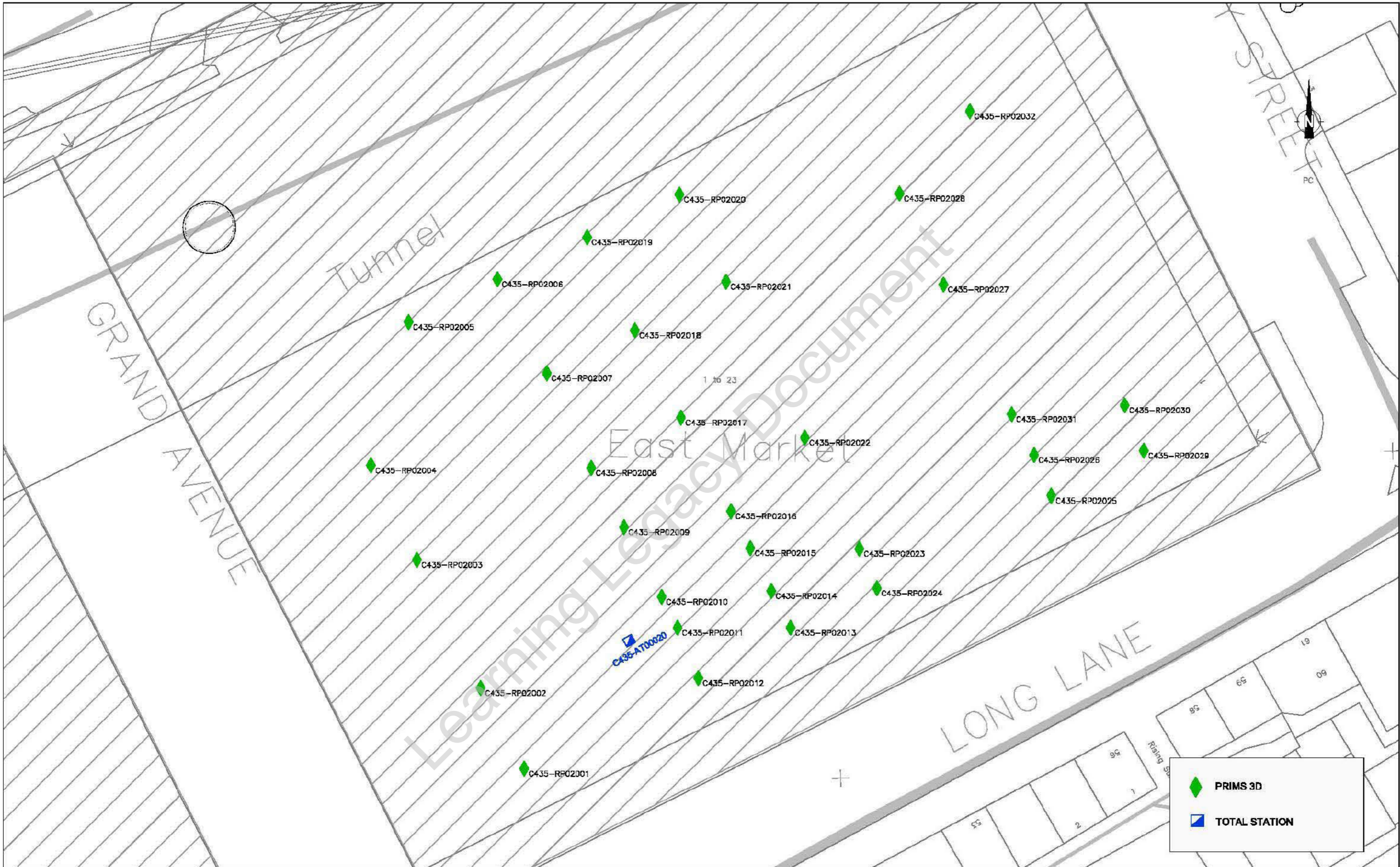
Close-Out Report – Automated Total Station ATS 20 and 3D
Targets read by ATS 20



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Appendix A: Drawing / Photomontage




 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
 28823- MADRID
 www.geocisa.com


Contract : C435 I&M FARRINGTON
 Originator : GEOCISA
 Location : CROSSRAIL GENERAL
 Title :
 3D PRIMS ATS20
 Drg No : C435-BFK-C2-RGN-M123-50065-IR-RP-ATS20
 Rev :
 Sult :
 Auth : 

\$pby\$



Close-Out Report – Automated Total Station ATS 20 and 3D
Targets read by ATS 20

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Appendix B: Graphs

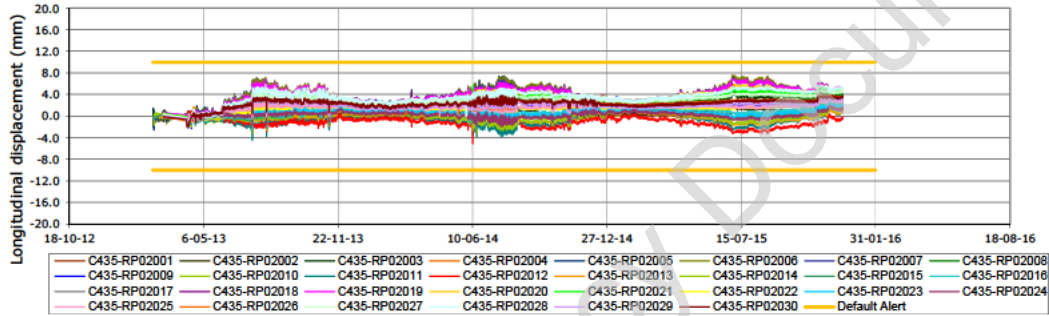


GEOCISA UK

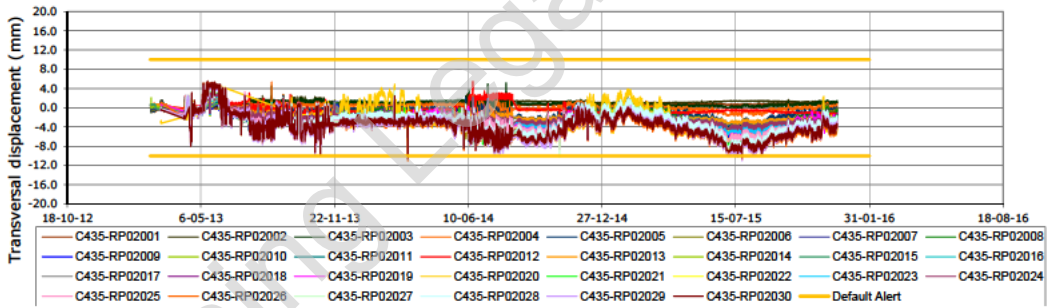
REPORT Automatic Prisms
AREA Farringdon Station
DEVICE 3D Target



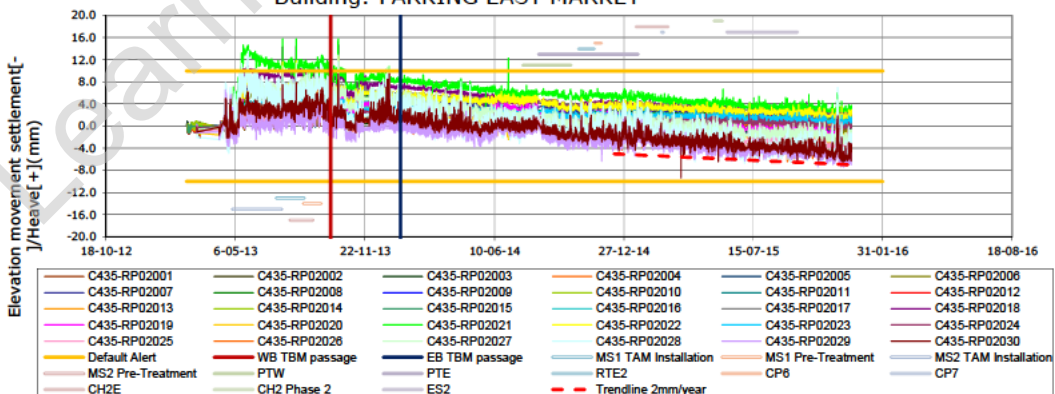
Building: PARKING EAST MARKET



Building: PARKING EAST MARKET



Building: PARKING EAST MARKET



REMARKS

[Empty box for remarks]