



### C305– Eastern Running Tunnels

## I&M Close out report for Rod Extensometers Blackwall Way (Drive Y)

CRL Document Number: C305-DSJ-C2-RGN-CRG03-50327

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Revision:	Date:	Prepared by:	Checked by:	Approved by:	Reason for Issue:
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#### 2a. Stakeholder Review Required? YES NO

Stakeholder submission required LU  RIL  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"/>

#### 3. Acceptance by Crossrail:

Crossrail Review and Acceptance Decal			
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<input type="checkbox"/>	Code 4	Received for information only Receipt is confirmed	
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[Redacted Signature]	[Redacted Name]	[Redacted Position]	25/11/15
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I&M Close out report for Rod Extensometers Blackwall Way (Drive Y)

*C305 Crossrail Eastern Running Tunnels*

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Revision:	Date:	Prepared by:	Checked by:	Engineering Approved by:
2.0	09-11-15	[REDACTED]	[REDACTED]	[REDACTED]
		[REDACTED]	[REDACTED]	[REDACTED]

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## **1. CLOSE OUT REPORT PURPOSE**

As stated in the specification: C122-OVE-Z4-RSP-CR001-00007 Rev 7.0, the purpose of this close-out report is to summarize the data from the instrumentation included in this document and to relate the recorded movements to the construction activities which produce any observed changes. For construction activities it is intended excavation of the C305 twin bored tunnels and dewatering of cross passages; impacts from cross passage excavation or from other CRL contracts are not included in this report.

The long term readings have been used to demonstrate that the subsequent movement has reached an acceptably stable rate within the accuracy of the system in order to decommission and/or that C305 works are no longer impacting the area concerned.

As stated in the specifications the settlement rate of 2 mm/yr has been defined. Where this is not achieved this report seeks agreement from all parties that the rate is acceptably low enough to cease monitoring and decommission.

The settlement rate of monitoring locations, covered by this close-out report, had generally reached the specified rate of 2mm/year post TBM works but they are located in an area affected by dewatering works associated with cross passage construction. Monitoring of instruments close to the dewatering works is included in this report to provide evidence that settlement due to the dewatering works has now reached the specified rate. Therefore by inference, instruments located in the vicinity of the dewatering would have also reached the specified rate.

## **2. LOCATION OF THE WORKS**

The instrumentation included within this report is situated within Area 4, Limmo Shaft to Canary Wharf Station, along project chainage 84000 to 83700. The boreholes were situated adjacent to Blackwall Way in an area of light industrial and commercial use.

See Appendix A for the instrument location.

### 3. DOCUMENTATION SUMMARY

CROSSRAIL NUMBER	DOCUMENT NAME	REASON FOR ISSUE	TYPE AND NUMBER OF INSTRUMENTATION INSTALLED
C305-DSJ-C2-GMS-CRG03-50016	'C305 I&M Boreholes Rod Extensometers 84000-83700'	Main Method statement	5 Rod Extensometers
C305-DSJ-C2-CCN-CRG03-50015	SNC To Change Location of Boreholes in Reuters	Relocation of one rod extensometer	-
C305-DSJ-C2-CCN-CRG03-50005	SNC Additional Borehole to the 5 Blackwall Boreholes	Additional piezometer borehole	1 piezometer with two sensors
C305-DSJ-C2-CCN-CRG03-50019	SNC Design change of the chamber of the IBIS extensometer	Extensometer head too deep to be accessed. Larger chamber required.	-
C305-DSJ-C2-RGN-CRG03-50203	Installation Report For I&M MS 'Boreholes: Rod Extensometers 84000-83700, C305-DSJ-C2-GMS-CR03-50016'	Installation report	-

### 4. SUMMARY OF INSTALLED INSTRUMENTATION ON SITE

The total number instruments installed, as per the method statement and short notice changes (SNC) was:

- 5 Rod extensometers
- 1 Piezometer with two sensors

The average commissioning readings included in Appendix B have been used to calculate the relative movements provided in the graphs of this report. See Appendix B for further information of the installed instrumentation, including borehole logs.

### 5. CONSTRUCTION ACTIVITY

#### TBM PASSAGE

DRIVE Y	RINGS	PROJECT CHAINAGE	DATES
Eastbound	545 – 685	83958 – 83777	18/04/2013 to 24/04/2013
Westbound	570 – 682	83985 - 83761	05/05/2013 to 24/05/2013

Stoppage period

Eastbound Drive-Y

No stoppage

Westbound Drive-Z

Ring 680 (Project chainage - 83770)

20/05/2013 to 24/05/2013

The periods of TBM passage and stoppage are related to the rings located close to the instrumentation included in this close out report.

**DEWATERING**

Cross passage 13      26<sup>th</sup> November 2013 to 3<sup>rd</sup> August 2015  
 Cross passage 14      16<sup>th</sup> December 2013 to 17<sup>th</sup> January 2014  
                                  28<sup>th</sup> July 2014 to 27<sup>th</sup> July 2015  
 Limmo                    4<sup>th</sup> November 2013 (still on)  
 Canary Wharf        It is understood that Canary Wharf dewatering systems were switched on throughout the monitoring period

**6. METHODOLOGY**

To determine the settlement rate the following methodology has been used. A Linear Regression has been applied for a defined period using long term readings after TBM construction. This uses the following formula.

$$b = \frac{\sum_{i=1}^n (X_i - \bar{X}_i) \cdot (Y_i - \bar{Y}_i)}{\sum_{i=1}^n (X_i - \bar{X}_i)^2}$$

Where:

B =gradient or slope

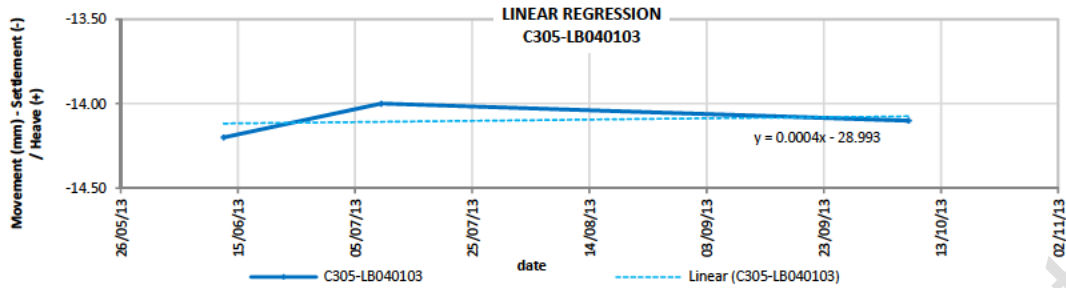
X (independent variable) = date

Y (dependent variable) = vertical movement

From this, the settlement rate per day can be calculated and rate per year determined (negative value is for settlement, positive is for heave). For these values, the percentage at or below 2 mm/yr will be used to determine the trend of the section/area being considered. Also for comparison, values at or below 3mm/year are presented to highlight that the rate is close to achieving the 2 mm/yr. Note the percentages of settlement rate presented in the sections below refer to values rounded to the nearest integer.

One example of this calculation can be seen below for one socket and its projection.

	Registered movement (mm)			RATE mm/year
	12/06/2013	09/07/2013	07/10/2013	
C305-LB040103	-14.20	-14.00	-14.10	0.146



**CALCULATION - C305-LB040103**

$X_i$	$Y_i$	$X_i - \bar{X}_i$	$Y_i - \bar{Y}_i$	$(X_i - \bar{X}_i)^2$	$(X_i - \bar{X}_i) \cdot (Y_i - \bar{Y}_i)$
12/06/2013	-14.2	-47.94	-0.10	2298.67	4.794
09/07/2013	-14	-21.03	0.10	442.17	-2.103
07/10/2013	-14.1	68.97	0.00	4757.17	0.000

$\bar{X}_i$	41485.53	
$\bar{Y}_i$	-14.10	
$\sum_{i=1}^n (X_i - \bar{X}_i)^2$	7498.00	(2)
$\sum_{i=1}^n (X_i - \bar{X}_i) \cdot (Y_i - \bar{Y}_i)$	2.692	(1)
m (SLOPE)	(1)/(2)	0.0004
Rate (mm/year)	m * 365	0.146

**7. SUMMARY OF THE DATA**

The methodology described for sockets in section 6 is applied here for rod extensometers sensors.

Note: For the following data plots #N/A refers to instances where readings were not taken for that sensor (e.g. damaged sensor, not access, etc).

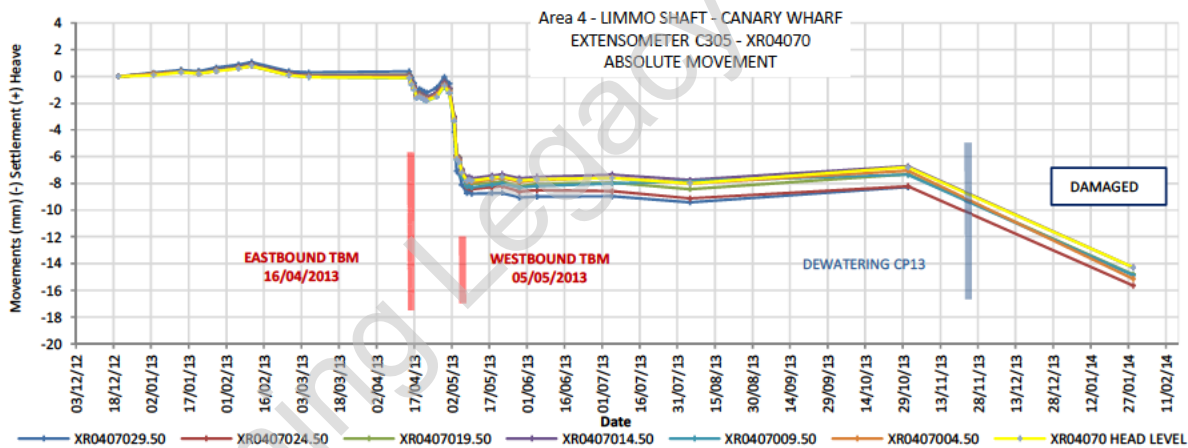
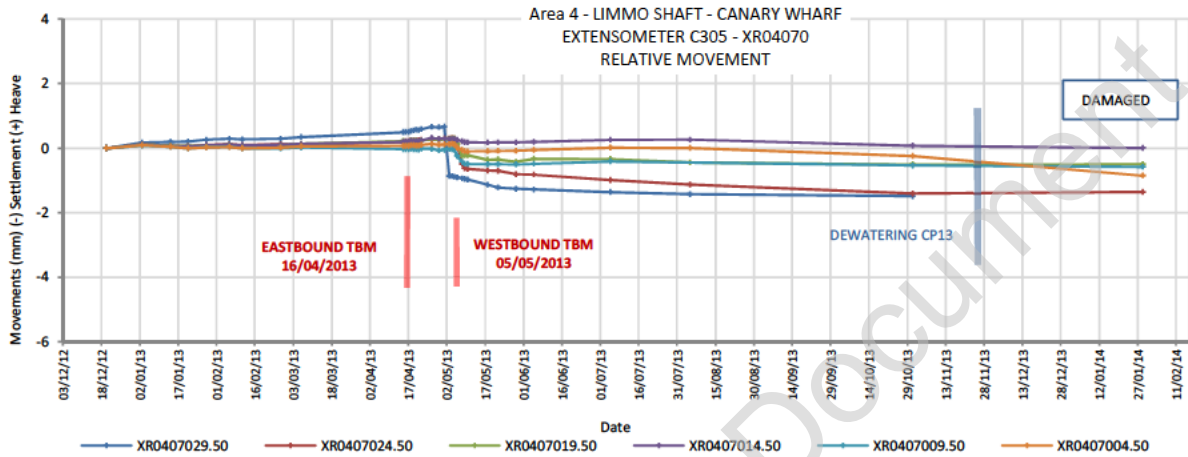
**ROD EXTENSOMETERS**

- Instrument Type: Rod extensometers
- Quantity: 5

For every rod extensometer two graphs are displayed, showing relative and absolute movements. The relative movement graph represents the movement of the rod extensometers without taking into account the head level elevation whereas in the absolute movement the levelling of the head level has been introduced, adding the value to the relative movement of the rods.

C305-XR04070

The rod extensometer in the graph below is located in Reuters. It was damaged and decommissioned in September 2014.



As can be seen in the graph above there is an absolute settlement of -2 mm during the Eastbound TBM transit and a +2mm heave after it. During the Westbound TBM transit a settlement of -8 mm can be observed.

The effect of the dewatering in the Cross Passage 13 can be observed in the graphic above. In order to differentiate the movement due to the TBM transit from the dewatering and evaluate whether the rate of change in the data has reached an acceptably small rate, the three readings before the dewatering were used to calculate the annual projection.

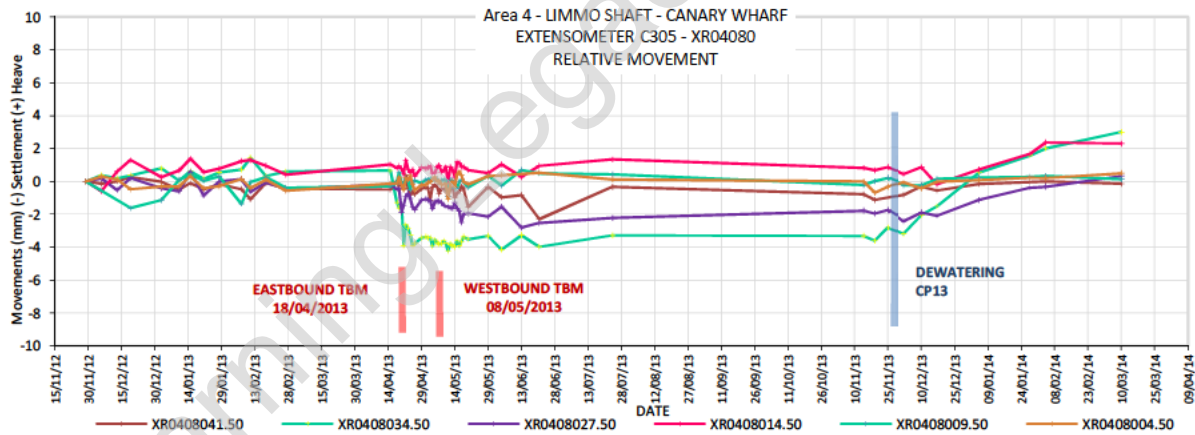
The table below shows the calculated annual settlement rate.

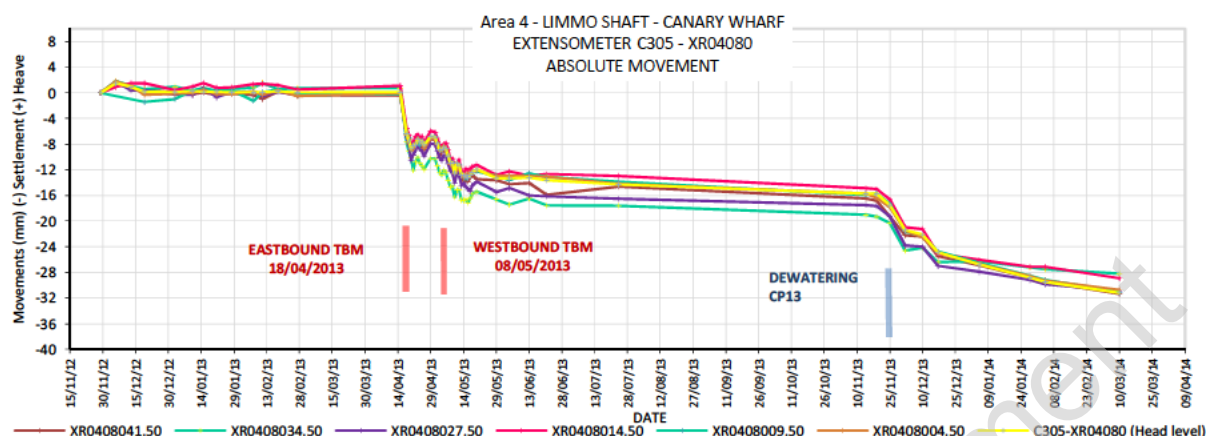


	Registered Movement (mm)			Rate (mm/year)
	05/07/2013	05/08/2013	31/10/2013	
HEAD LEVEL	105.7209	105.7205	105.7217	3.030
XR0407029.50	102.55	102.61	102.67	0.354
XR0407024.50	103.03	103.17	103.45	1.270
XR0407019.50	103.66	103.76	103.82	0.445
XR0407014.50	102.39	102.39	102.58	0.606
XR0407004.50	101.95	101.96	102.21	0.861
	05/06/2013	05/07/2013	31/10/2013	
XR0407009.50	127.527041	127.450511	127.580612	0.209
	Rate less than -2.5 mm/year		% less 2 mm/ year	100.00%
	Rate greater than -3.5 mm/year		% less 3 mm/ year	100.00%

The percentage of rod sensors with a settlement rate less than 2 mm/year is 100%. See section 8 Summary of movements related to dewatering activities.

C305-XR04080





As can be seen in the graph above, extensometer C305-XR04080 shows an absolute settlement of -12 mm during the Eastbound TBM transit and an additional -5 mm settlement from the Westbound TBM transit.

The effect of the dewatering in the Cross Passage 13 can be observed in the graphic above. In order to differentiate the movement due to the TBM transit from the dewatering and evaluate whether the rate of change in the data has reached an acceptably small rate, the three readings before the dewatering were used to calculate the annual projection.

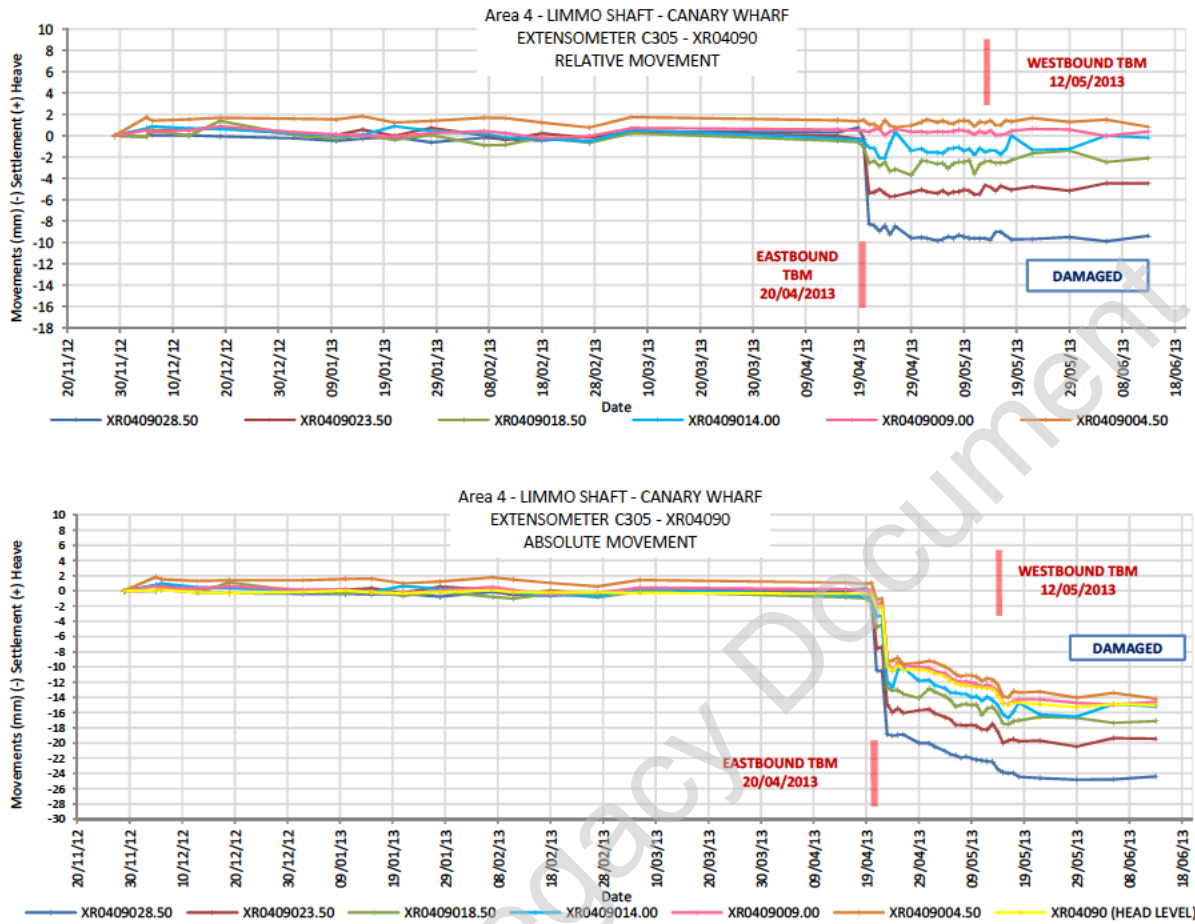
The table below shows the calculated annual settlement rate.

	Registered Movement (mm)			Rate (mm/year)
	24/07/2013	14/11/2013	19/11/2013	
HEAD LEVEL (m)	104.4376	104.4362	104.4362	-4.418
XR0408029.50	46.89	47.34	47.68	1.991
XR0408024.50	13.58	13.61	13.9	0.582
XR0408019.50	23.72	23.28	23.45	-1.103
XR0408014.50	43.77	44.29	44.44	1.893
XR0408009.50	50.12	50.77	50.54	1.665
XR0408004.50	50.54	50.67	51.35	1.553
	Rate less than -2.5 mm/year		% less 2 mm/year	85.71%
	Rate greater than -3.5 mm/year		% less 3 mm/year	85.71%

The percentage of rod sensors with a settlement rate less than 2 mm/year is 85.71% and less than 3 mm/year is 85.71%. See section 8 Summary of movements related to dewatering activities.

#### C305-XR04090

The extensometer C305-XR04090 was decommissioned in July 2013. No further readings after 13/06/2013.

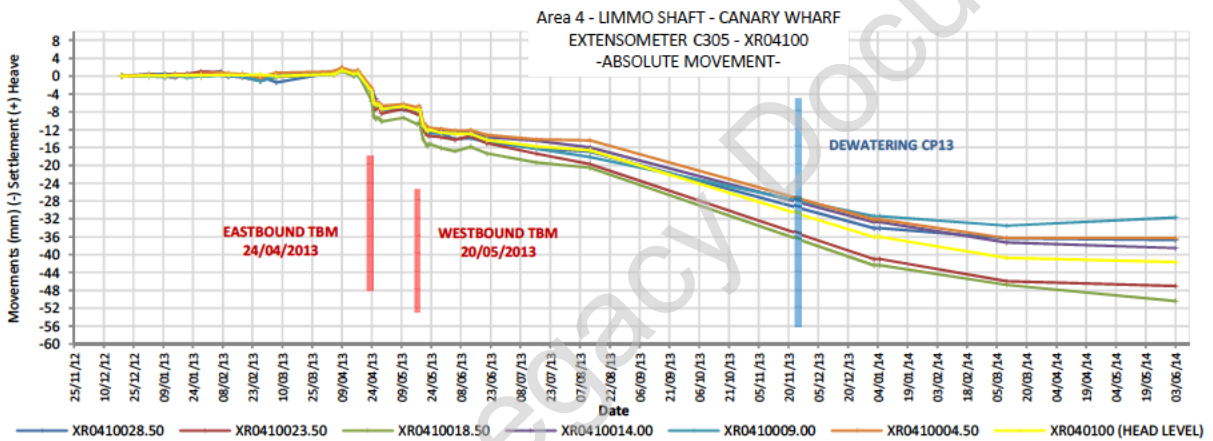
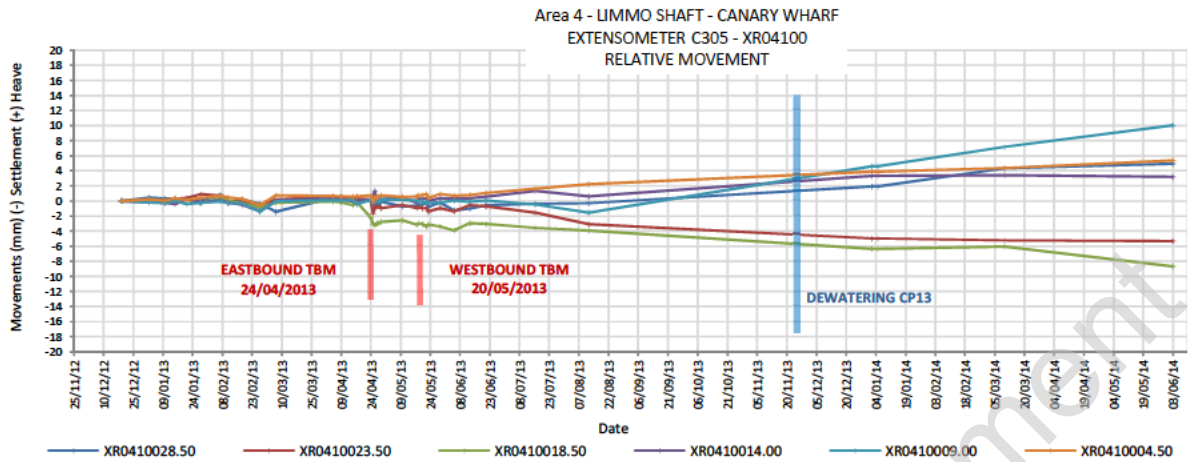


As can be seen in the graph above the extensometer C305-XR04090 shows an absolute settlement of 19mm during the Eastbound TBM transit and additional 5 mm settlement until the Westbound TBM transit.

Due to the damage suffered by the instrument, and the following decommission, it was not possible to acquire measures for a sufficient period to find a representative settlement rate of the area.

#### C305-XR04100

As can be seen in the graph below, extensometer C305-XR04100 shows an absolute settlement of -10 mm during the Eastbound TBM transit and an additional -6 mm settlement from the Westbound TBM transit.



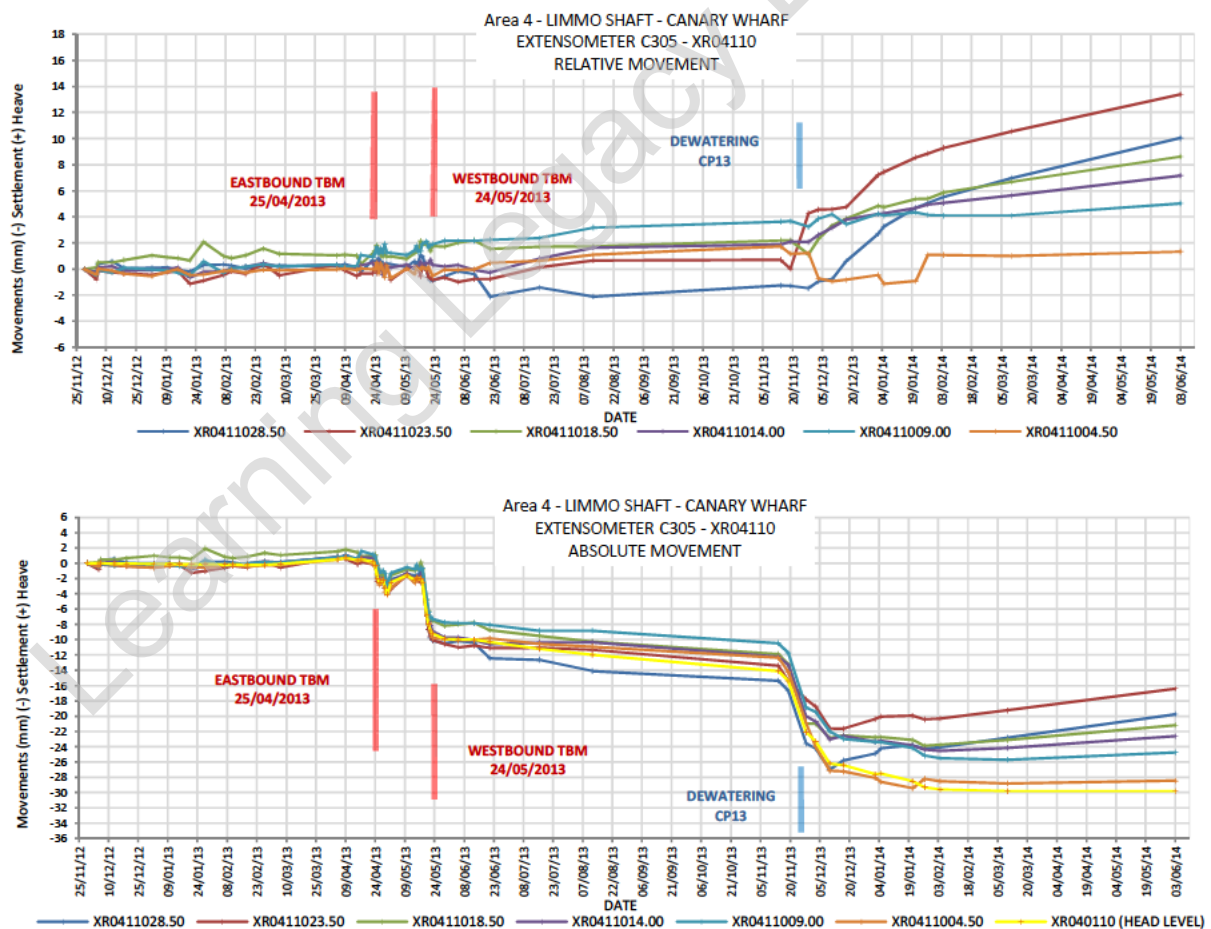
The effect of the dewatering in the Cross Passage 13 can be observed in the graphic above. Head level shows a settlement of -20mm due to these works. In order to differentiate the movement due to the TBM transit from the dewatering and evaluate whether the rate of change in the data has reached an acceptably small rate, there were used three readings to calculate the annual projection before dewatering started.

The table below shows the calculated annual settlement rate.

	Registered Movement (mm)			Rate (mm/year)
	22/05/2013	05/06/2013	13/06/2013	
HEAD LEVEL	103.1078	103.1072	103.1072	-10.5968
XR0410029.50	44.35	45.39	45.14	14.688
XR0410024.50	62.27	62.67	61.85	-5.004
XR0410019.50	62.17	62.67	61.72	-5.151
XR0410014.50	49.26	49.26	49.28	0.294
XR0410009.50	54.39	54.17	54.32	-1.678
XR0410004.50	41.58	41.82	41.73	2.914
	Rate less than -2.5 mm/year		% less 2 mm/year	57.14%
	Rate greater than -3.5 mm/year		% less 3 mm/year	57.14%

The percentage of rod sensors with a settlement rate less than 2 mm/year is 57.14% and less than 3 mm/year is 57.14%. See section 8 Summary of movements related to dewatering activities.

C305-XR04110



As can be seen in the graph above the extensometer C305-XR04110 shows an absolute settlement of -4 mm during the Eastbound TBM transit and a +2mm heave after it. During the Westbound TBM transit a settlement of -8 mm can be observed.

The effect of the dewatering in the Cross Passage 13 can be observed in the graphic above. Head level shows a settlement of -16 mm due to these works. In order to differentiate the movement due to the TBM transit from the dewatering and evaluate whether the rate of change in the data has reached an acceptably small rate, three readings before the dewatering were used to calculate the annual projection.

The table below shows the calculated annual settlement rate.

	Registered Movement (mm)			Rate (mm/year)
	16/07/2013	12/08/2013	14/11/2013	
HEAD LEVEL	101.8466	101.8458	101.8437	-8.5935
XR0411027.50	48.46	49.14	48.29	-1.238
XR0411022.50	47.48	46.97	46.91	-1.333
XR0411018.00	36.90	36.88	36.42	-1.536
XR0411013.50	34.86	34.02	33.78	-2.653
XR0411008.50	36.10	35.30	34.84	-3.277
XR0411004.00	40.71	40.26	39.61	-3.112
	Rate less than -2.5 mm/year		% less 2 mm/year	42.86%
	Rate greater than -3.5 mm/year		% less 3 mm/year	85.71%

The percentage of rod sensors with a settlement rate less than 2 mm/year is 42.86% and less than 3 mm/year is 85.71%. See section 8 Summary of movements related to dewatering activities.

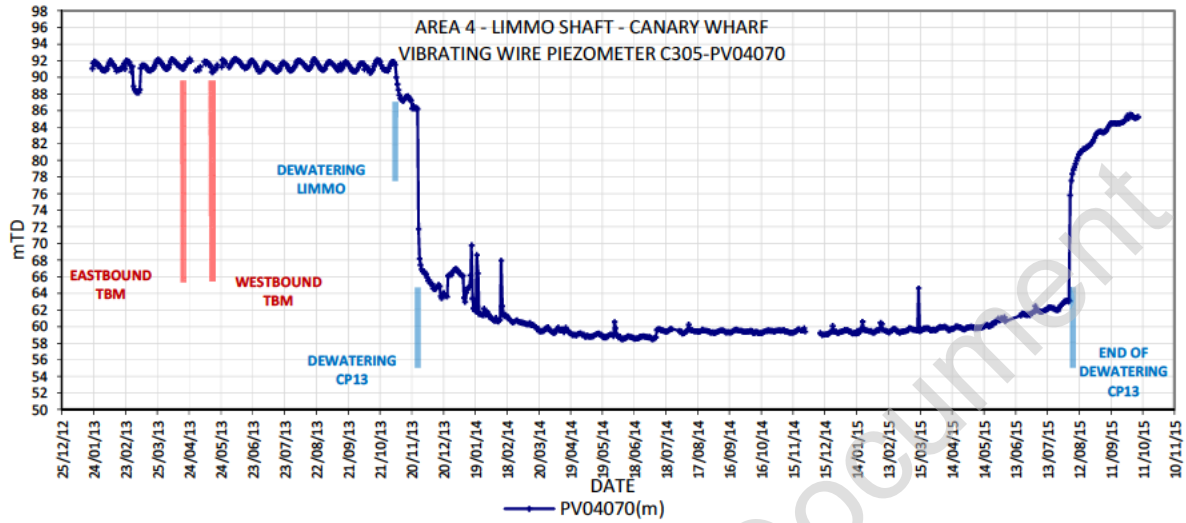
#### VIBRATING WIRE PIEZOMETERS

- Instrument Type: Vibrating wire piezometer
- Quantity: 1 piezometer with two sensors

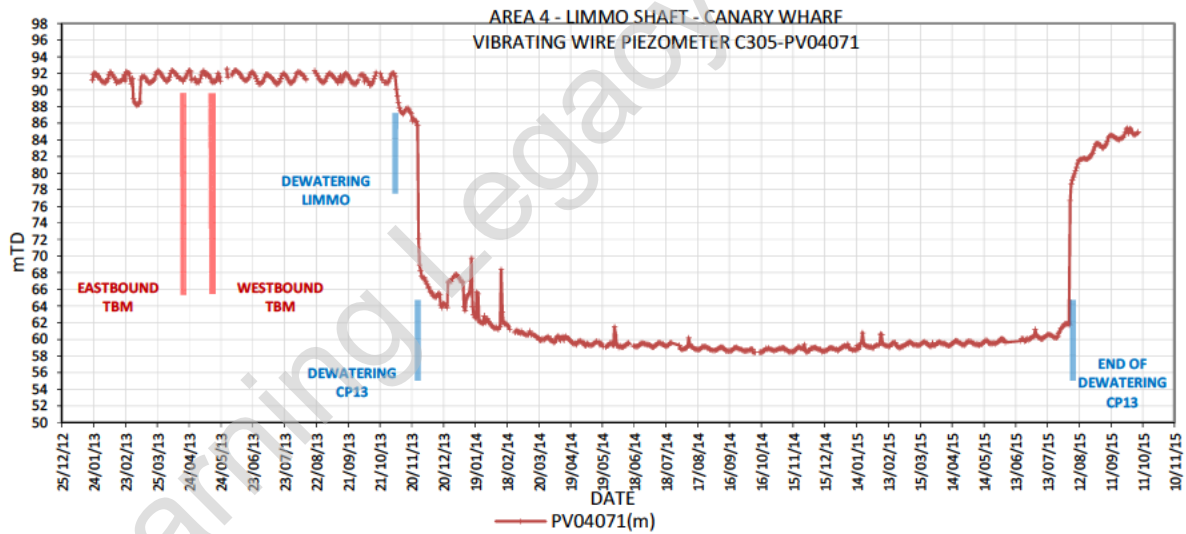
There are two sensors in the same borehole situated at different depths. Sensor C305-PV04070 is at a depth of 49 m below ground level (bgl) whereas sensor C305-PV04071 is at 55 m bgl.

The response zone of each sensor is located into Chalk, as per borehole log included in Appendix B.

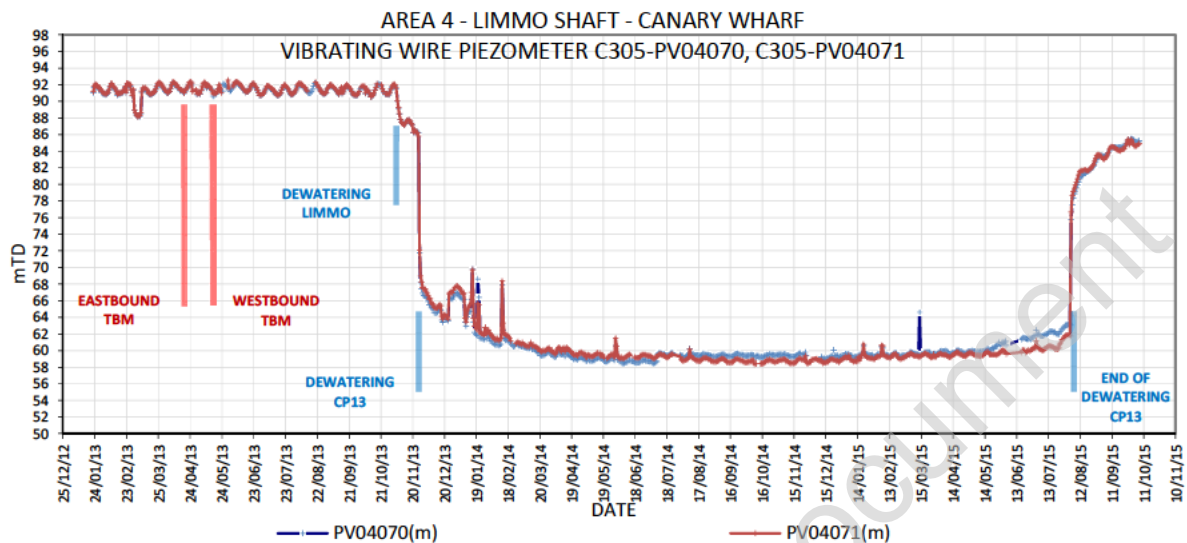
C305-PV04070



C305-PV04071



COMBINED CHART C305-PV04070 & C305-PV04071



The combined graph above shows the same ground water level for both sensors.

It is noted the monitored aquifer is not affected by the TBM excavation, while a significant change is recorded for each dewatering phase. This can be outlined as follows:

- A drop approximately 4m due to dewatering at Limmo being switched on;
- A further drop of approximately 22m due to dewatering at CP13 being switched on;
- An additional slow decrease of approximately 8m until April 2014, when the readings reached a steady regime;
- A rapid first stage recovery due to dewatering at CP13 being switched off.

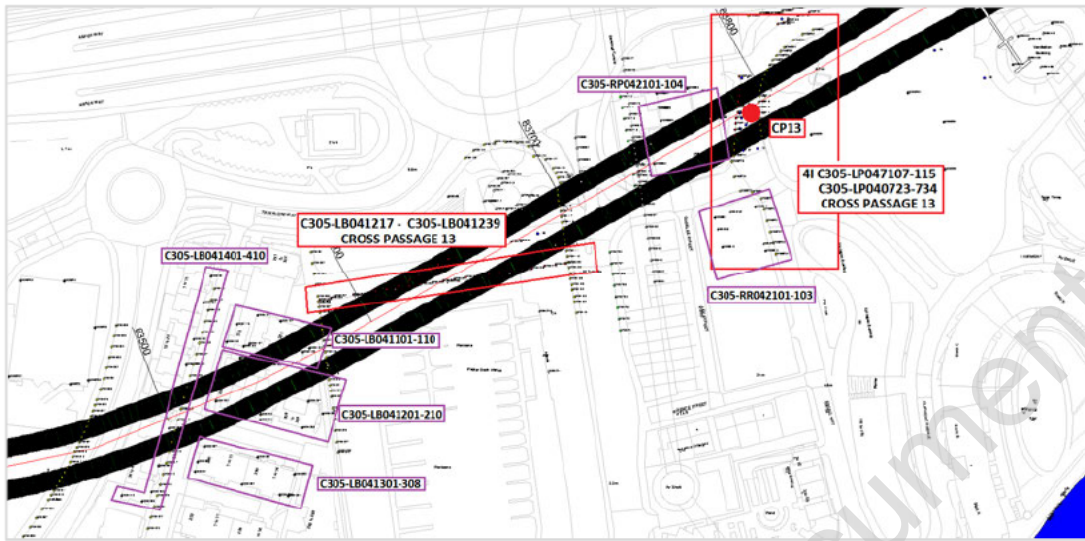
**8. SUMMARY OF MOVEMENTS RELATED TO DEWATERING ACTIVITIES**

The effect of dewatering systems being switched on is clearly illustrated in the graphs presented in section 7 above.

Monitoring data from one transect installed to monitor the dewatering activities have been included in this report. This graph presents over a year collection of data and shows that the current rate of change is acceptably small, proving that ground movement post dewatering works have sufficiently stabilized to allow decommissioning of the instruments covered in this report. This section is indicated below:

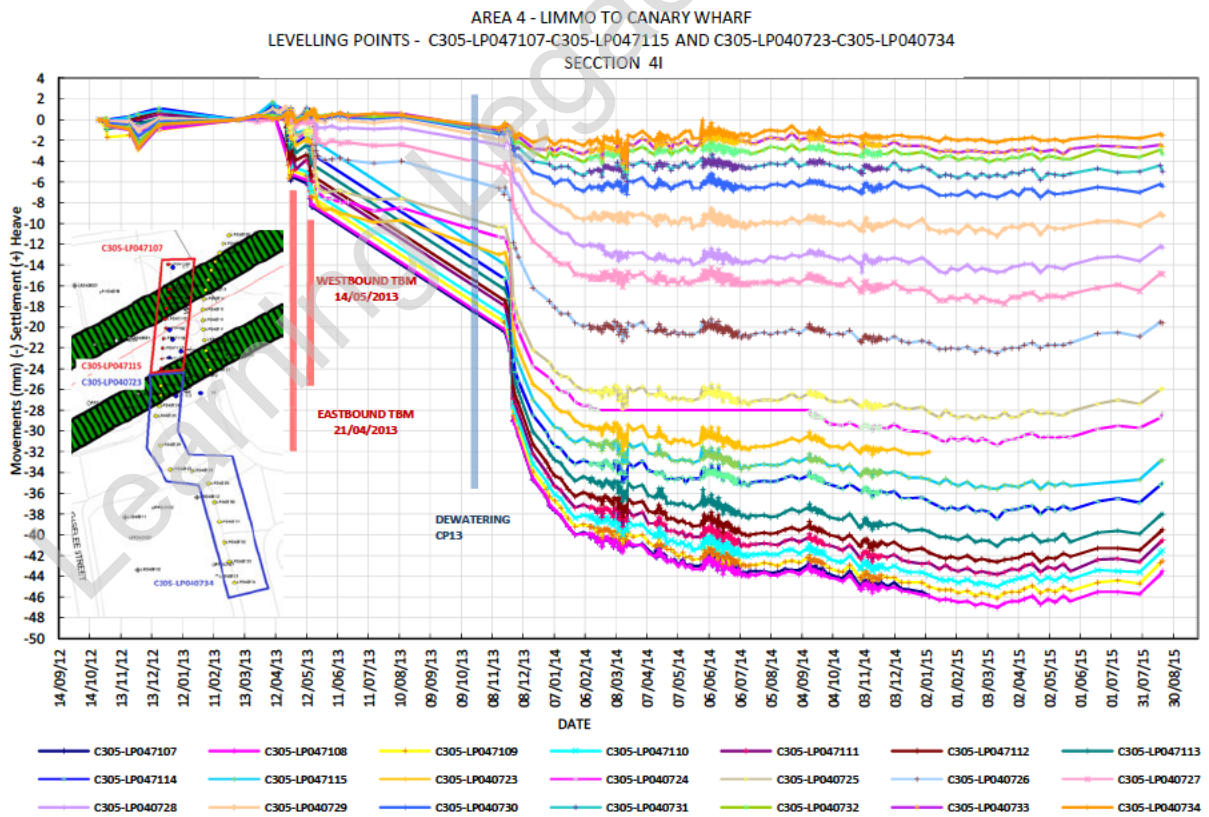
- The transect 4I (C305-LP047107-C305-LP047115 and C305-LP040723-C305-LP040734) is not covered by this close out report. It is included in the Specific Action Plan Y015 – Cross Passage 13 Ground Movement (C305-DSJ-C2-STP-CRG03-50043) and their data will be summarized in their relevant Close-Out Report (C305-DSJ-C2-RGN-CRG03-50374).





Location of transect 4I and Cross Passage 13

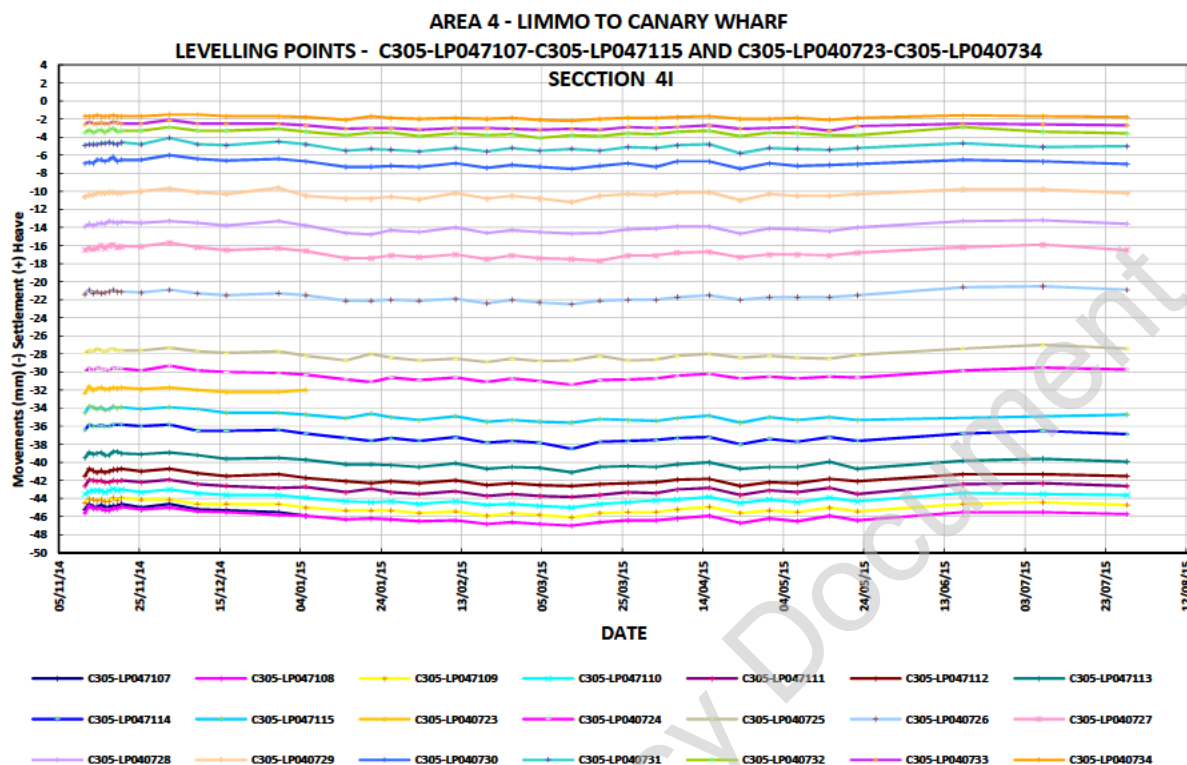
**Transect 4I (C305-LP047107-C305-LP047115 AND C305-LP040723-C305-LP040734) (Cross Passage 13)**



	Registered movement (mm)		Rate (mm/year)		
C305-LP047107			-		
C305-LP047108			-1.679		
C305-LP047109			-1.679		
C305-LP047110			-1.533		
C305-LP047111			-1.533		
C305-LP047112			-1.716		
C305-LP047113			-2.154		
C305-LP047114			-2.336		
C305-LP047115			-2.373		
C305-LP040723	READINGS FROM 31/10/2014 TO 28/07/2015 WERE TAKEN FROM THE GRAPH ILLUSTRATED BELOW		-		
C305-LP040724			-1.095		
C305-LP040725			-0.621		
C305-LP040726			-0.402		
C305-LP040727			-1.059		
C305-LP040728			-0.694		
C305-LP040729			-0.110		
C305-LP040730			-0.767		
C305-LP040731			-0.840		
C305-LP040732			-0.548		
C305-LP040733			-0.767		
C305-LP040734			-0.365		
			Rate less than -2.5 mm/year	% less 2 mm/ year	100.00%
			Rate greater than -3.5 mm/year	% less 3 mm/ year	100.00%

These levelling points reach an annual rate less than 2mm/year for the 100%.

The graph and the table below show the data from October 2014 to July 2015 and the annual rate calculated for each levelling points.



The graphs and tables of settlement rate for the transects above show that settlement rate due to dewatering works is less than 2 mm/year. As the instruments in this report are located between these two transects, it is concluded that they will behave in a similar manner and hence their settlement rate will be less than 2 mm/year rate.

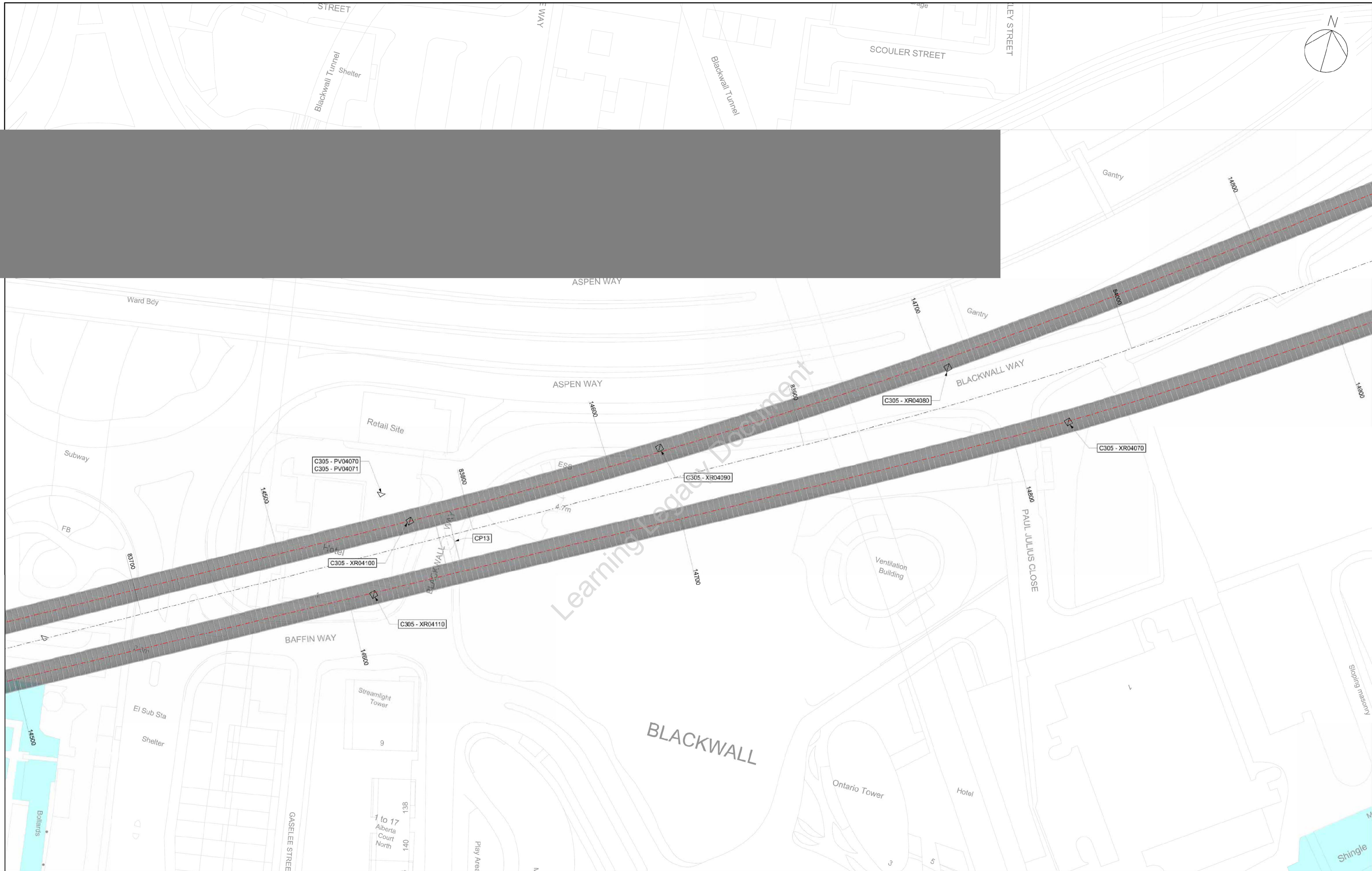
## 9. SUMMARY STATEMENT

It has been agreed between the Project Manager, the Designer, the Contractor and the Sub Contractor that the instrumentation covered herein, for monitoring ground movement effects of Crossrail works, including long term effects, but which have been subsequently affected by dewatering of cross passages, stations or shafts, prior to the achievement of 12 months 'post-TBM' long term monitoring, can be closed out for decommissioning as the following criteria has been met:

- Local monitoring of the effects of dewatering, directly around the Cross passage 13, shows that ground movement has stabilized to an acceptable rate (<2 mm/year) for a period of at least three months.

Learning Legacy Document

**APPENDIX A: INSTRUMENT LOCATION**

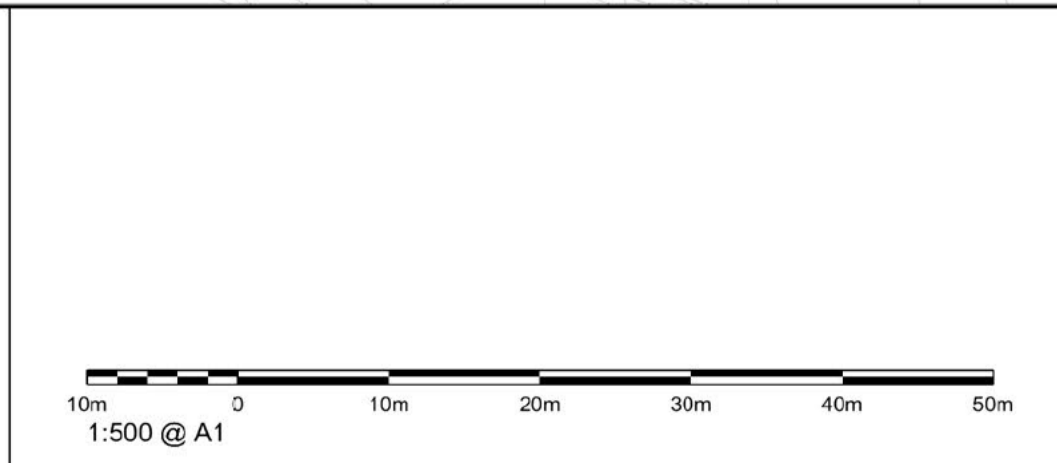


Rev.	Date	Description	By	Chkd	App	Auth
P01	09/03/2015	First Issue	MD	AH	RC	-
P02	13/06/2015	---	MD	RC	RC	-
P03	23/10/2015	---	MD	MD	MD	-
P04	09/11/2015	---	MD	SD	SD	-

Notes

- ◊ Rod Extensometer
- ▽ Vibrating Wire Piezometer

Learning Legacy Document



<p>Crossrail Limited 25 Canada Square Canary Wharf London E14 5LQ</p> <p>© Crossrail www.crossrail.co.uk</p>	<p>Contract: Tunnels East - Drive Y LIM to FAR &amp; Drive Z SGJ to PML &amp; Drive G</p> <p>Originator: Dragados Sisk Joint Venture</p> <p>Location: Crossrail Tunnels - Drive Y (Limmo Peninsula to Farringdon Stn)</p>	<p>By: M.DAVIS</p> <p>CHK: S.DIRIKWE</p> <p>App: S.DIRIKWE</p> <p>Auth: ...</p>	
	<p>Title: Instrumentation &amp; Monitoring Installation Report for I&amp;M MS</p> <p>Boreholes: Rod Extensometers (84000-83700)</p> <p>C305-DSJ-C2-RGN-CRG03-50202</p>	<p>Scale: 1:500 @ A1</p>	<p>Rev: P04</p>
	<p>Drawing and CAD file No.: C305-DSJ-C2-DDA-CRT00_ST006_Z-08095</p>	<p>Sutability: S4</p>	<p>Fit for authorisation</p>
	<p>RESTRICTED</p>		

**APPENDIX B: SUMMARY OF INSTRUMENTATION INSTALLED ON SITE AND  
BOREHOLE LOGS**

Learning Legacy Document

## IRS Installation Record Sheets

Sensor Type	Monitoring ID	Installation Date	Status	Sensor location – GPS reading (m)			Depth (m bgl)
				Easting X	Northings Y	Elevation Z (m ATD)	
Rod Extensometer with	<b>C305-XR04070</b>	16/11/2012	Installed	88925.684	35205.29	104.656	30.0
Rod Extensometer	<b>C305-XR04080</b>	05/11/2012	Installed	88887.501	35211.331	104.529	30.0
Rod Extensometer	<b>C305-XR04090</b>	02/11/2012	Installed	88812.373	35166.439	103.015	29.0
Rod Extensometer	<b>C305-XR04100</b>	26/10/2012	Installed	88747.545	35126.596	102.322	30.0
Rod Extensometer	<b>C305-XR04110</b>	13/11/2012	Installed	88742.952	35103.105	101.97	28.0
Piezometer – Casing	<b>C305-PV04070</b>	25/10/2012	Installed	88737.278	35132.046	102.666	49.0
Piezometer - Sensor	<b>C305-PV04070</b>	22/01/2013	Installed	88737.278	35132.046	102.666	49.0
Piezometer – Casing	<b>C305-PV04071</b>	25/10/2012	Installed	88737.278	35132.046	102.666	57.0
Piezometer - Sensor	<b>C305-PV04071</b>	21/01/2013	Installed	88737.278	35132.046	102.666	55.5

Notes: Depth is referred to the borehole and meters below ground level.

Coordinates for sensor location (Easting, Northings and elevation) are GPS readings. Commissioning readings are levelling readings.

All elevations or levels presented in this document are metres above tunnel datum (mATD)

## COMMISSIONING READINGS ROD EXTENSOMETERS

		20/12/2012	20/12/2012	20/12/2012	Baseline	Units
Rod Extensometer with displacement transducers	Head Level	105.728	105.729	105.729	105.729	m
	XR0407029.50	101.18	101.19	101.18	101.18	mm
	XR0407024.50	102.05	102.04	102.04	102.04	mm
	XR0407019.50	103.32	103.32	103.32	103.32	mm
	XR0407014.50	102.64	102.66	102.65	102.65	mm
	XR0407009.50	127.03	127.05	127.05	127.04	mm
	XR0407004.50	101.97	101.96	101.97	101.97	mm

## COMMISSIONING READINGS ROD EXTENSOMETERS

			29/11/2012	29/11/2012	29/11/2012	Baseline	Units
Rod Extensometer	C305-XR04080	Head Level	104.452	104.453	104.451	104.452	m
		XR0408029.50	46.55	46.57	46.56	46.56	mm
		XR0408024.50	10.30	10.30	10.30	10.3	mm
		XR0408019.50	21.51	21.50	21.50	21.5	mm
		XR0408014.50	45.12	45.10	45.11	45.11	mm
		XR0408009.50	50.54	50.56	50.55	50.55	mm
		XR0408004.50	50.66	50.67	50.65	50.66	mm
			29/11/2012	29/11/2012	29/11/2012	Baseline	Units
Rod Extensometer	C305-XR04090	Head Level	103.342	103.343	103.343	103.343	m
		XR0409028.50	45.74	45.72	45.73	45.73	mm
		XR0409023.50	45.22	45.21	45.23	45.22	mm
		XR0409018.50	42.67	42.65	42.66	42.66	mm
		XR0409014.00	41.91	41.90	41.91	41.91	mm
		XR0409009.00	49.72	49.73	49.74	49.73	mm
		XR0409004.50	46.95	46.94	46.93	46.94	mm
			19/12/2012	19/12/2012	19/12/2012	Baseline	Units
Rod Extensometer	C305-XR04100	Head Level	103.121	103.120	103.121	103.121	m
		XR0410029.50	44.15	44.15	44.15	44.15	mm
		XR0410024.50	61.30	61.32	61.31	61.31	mm
		XR0410019.50	58.78	58.77	58.77	58.77	mm
		XR0410014.50	49.61	49.62	49.63	49.62	mm
		XR0410009.50	54.24	54.23	54.22	54.23	mm
		XR0410004.50	42.52	42.50	42.51	42.51	mm
			29/11/2012	29/11/2012	29/11/2012	Baseline	Units
Rod Extensometer	C305-XR04110	Head Level	101.857	101.858	101.858	101.858	m
		XR0411027.50	47.03	47.02	47.04	47.03	mm
		XR0411022.50	47.62	47.62	47.62	47.62	mm



## COMMISSIONING READINGS ROD EXTENSOMETERS

Monitoring ID	22/01/2013	22/01/2013	22/01/2013	Baseline	Units		
Rod Extensometer	C305-XR04110	XR0411018.00	38.63	38.62	38.61	38.62	mm
		XR0411013.50	35.68	35.66	35.66	35.67	mm
		XR0411008.50	38.47	38.46	38.47	38.47	mm
		XR0411004.00	41.35	41.34	41.33	41.34	mm

Note: Head level is the level survey point (levelling point) fixed to the top of the reference head.

## COMMISSIONING READINGS VIBRATING WIRE PIEZOMETERS

Sensor Type	Monitoring ID	22/01/2013	22/01/2013	22/01/2013	Baseline	Units
Vibrating Wire Piezometer	C305-PV04070	91.07	91.06	91.08	91.07	m
Vibrating Wire Piezometer	C305-PV04071	90.97	90.99	90.98	90.98	m

BOREHOLE NUMBER: PV04070

AREA: BLACKWALL WAY

STARTING DATE: 16/10/2012

ENDING DATE: 24/10/2012

EQUIPMENT: DANDO 2000

METHOD: CABLE PERCUSSION

INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION	INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION
	0.0	0.00 - 3.50		30.0	30.00 - 47.00
	1	Made Ground		31	Thanet Sand
	2			32	
	3			33	
	4	3.50 - 6.50		34	
	5.0	Alluvium		35.0	
	6			36	
	7	6.50 - 9.60		37	
	8	River Terrace Deposits		38	
	9			39	
	10.0	9.60 - 25.00		40.0	
	11	London Clay		41	
	12			42	
	13			43	
	14			44	
	15.0			45.0	
	16			46	
	17			47	
	18			48	47.00 - 60.00
	19		C305-PV04070	49	Chalk
	20.0			50.0	
	21			51	
	22			52	
	23			53	
	24			54	
	25.0	25.00 - 30.00	C305-PV04071	55.0	
	26	Lambeth Group		56	
	27			57	
	28			58	
	29			59	60.00
	30.0			60.0	Borehole end

All units are expressed in metres

BOREHOLE NUMBER: XR04070

AREA: BLACKWALL WAY

STARTING DATE: 08/11/2012

ENDING DATE: 22/11/2012

EQUIPMENT: DANDO 2000

METHOD: CABLE PERCUSSION

INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION	INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION
	0.0	0.00 - 4.20		30.0	
	1	Made Ground		31	
	2			32	
	3			33	
C305-XR0407004.50	4	4.20 - 8.60		34	
	5.0	Alluvium		35.0	
	6			36	
	7			37	
	8			38	
C305-XR0407009.50	9	8.60 - 13.10		39	
	10.0	River Terrace Deposits		40.0	
	11			41	
	12			42	
	13	13.10 - 20.10		43	
C305-XR0407014.50	14	London Clay		44	
	15.0			45.0	
	16			46	
	17			47	
	18			48	
C305-XR0407019.50	19			49	
	20.0	20.10 - 29.90		50.0	
	21	Lambeth Group		51	
	22			52	
	23			53	
C305-XR0407024.50	24			54	
	25.0			55.0	
	26			56	
	27			57	
	28			58	
C305-XR0407029.50	29	29.90		59	
	30.0	Borehole end		60.0	

All units are expressed in metres

BOREHOLE NUMBER: XR04080

AREA: BLACKWALL WAY

STARTING DATE: 30/10/2012

ENDING DATE: 02/11/2012

EQUIPMENT: DANDO 2000

METHOD: CABLE PERCUSSION

INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION	INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION
	0.0	0.00 - 3.70		30.0	
	1	Made Ground		31	
	2			32	
	3			33	
C305-XR0408004.50	4	3.70 - 7.80		34	
	5.0	Alluvium		35.0	
	6			36	
	7			37	
	8	7.80 - 13.20		38	
C305-XR0408009.50	9	River Terrace Deposits		39	
	10.0			40.0	
	11			41	
	12			42	
	13	13.20 - 19.60		43	
C305-XR0408014.50	14	London Clay		44	
	15.0			45.0	
	16			46	
	17			47	
	18			48	
C305-XR0408019.50	19			49	
	20.0	19.60 - 30.00		50.0	
	21	Lambeth Group		51	
	22			52	
	23			53	
C305-XR0408024.50	24			54	
	25.0			55.0	
	26			56	
	27			57	
	28			58	
C305-XR0408029.50	29	30.00		59	
	30.0	Borehole end		60.0	

All units are expressed in metres

BOREHOLE NUMBER: XR04090

AREA: BLACKWALL WAY

STARTING DATE: 29/10/2012

ENDING DATE: 02/11/2012

EQUIPMENT: DANDO 2000

METHOD: CABLE PERCUSSION

INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION	INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION
	0.0	0.00 - 4.15		30.0	
	1	Made Ground		31	
	2			32	
	3			33	
C305-XR0409004.50	4	4.15 - 6.60		34	
	5.0	Alluvium		35.0	
	6			36	
	7	6.60 - 10.05		37	
	8	River Terrace Deposits		38	
C305-XR0408009.00	9			39	
	10.0	10.05 - 16.30		40.0	
	11	London Clay		41	
	12			42	
	13			43	
C305-XR0408014.00	14			44	
	15.0			45.0	
	16	16.30 - 26.80		46	
	17	Lambeth Group		47	
C305-XR0408018.50	18			48	
	19			49	
	20.0			50.0	
	21			51	
	22			52	
C305-XR0408023.50	23			53	
	24			54	
	25.0			55.0	
	26	26.80 - 29.00		56	
	27	Thanet Sand		57	
C305-XR0408028.50	28			58	
	29	30.00		59	
	30.0	Borehole end		60.0	

All units are expressed in metres

BOREHOLE NUMBER: XR04100

AREA: BLACKWALL WAY

STARTING DATE: 18/10/2012

ENDING DATE: 07/11/2012

EQUIPMENT: DANDO 2000

METHOD: CABLE PERCUSSION

INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION	INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION
	0.0	0.00 - 3.80		30.0	
	1	Made Ground		31	
	2			32	
	3			33	
C305-XR041.0004.50	4	3.80 - 5.30		34	
	5.0	Alluvium		35.0	
	6	5.30 - 9.60		36	
	7	River Terrace Deposits		37	
	8			38	
C305-XR041.0009.50	9			39	
	10.0	9.60 - 14.50		40.0	
	11	London Clay		41	
	12			42	
	13			43	
C305-XR041.0014.50	14			44	
	15.0			45.0	
	16	14.50 - 24.10		46	
	17	Lambeth Group		47	
	18			48	
C305-XR041.0019.50	19			49	
	20.0			50.0	
	21			51	
	22			52	
	23			53	
C305-XR041.0024.50	24	24.10 - 30.00		54	
	25.0	Thanet Sand		55.0	
	26			56	
	27			57	
	28			58	
C305-XR041.0029.50	29	30.00		59	
	30.0	Borehole end		60.0	

All units are expressed in metres

BOREHOLE NUMBER: XR4110

AREA: BLACKWALL WAY

STARTING DATE: 07/11/2012

ENDING DATE: 19/11/2012

EQUIPMENT: DANDO 2000

METHOD: CABLE PERCUSSION

INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION	INSTALLED INSTRUMENTS	DEPTH	DESCRIPTION
	0.0	0.00 - 3.30		30.0	
	1	Made Ground		31	
	2			32	
	3	3.30 - 5.00		33	
XR0411004.00	4	Alluvium		34	
	5.0	5.00 - 10.55		35.0	
	6	River Terrace Deposits		36	
	7			37	
XR0411008.50	8			38	
	9			39	
	10.0	10.55 - 15.20		40.0	
	11	London Clay		41	
	12			42	
XR0411013.50	13			43	
	14			44	
	15.0	15.20 - 24.50		45.0	
	16	Lambeth Group		46	
	17			47	
XR0411018.00	18			48	
	19			49	
	20.0			50.0	
	21			51	
XR0411022.50	22			52	
	23			53	
	24	24.50 - 28.00		54	
	25.0	Thanet Sand		55.0	
	26			56	
XR0411027.50	27	28.00		57	
	28	Borehole end		58	
	29			59	
	30.0			60.0	

All units are expressed in metres