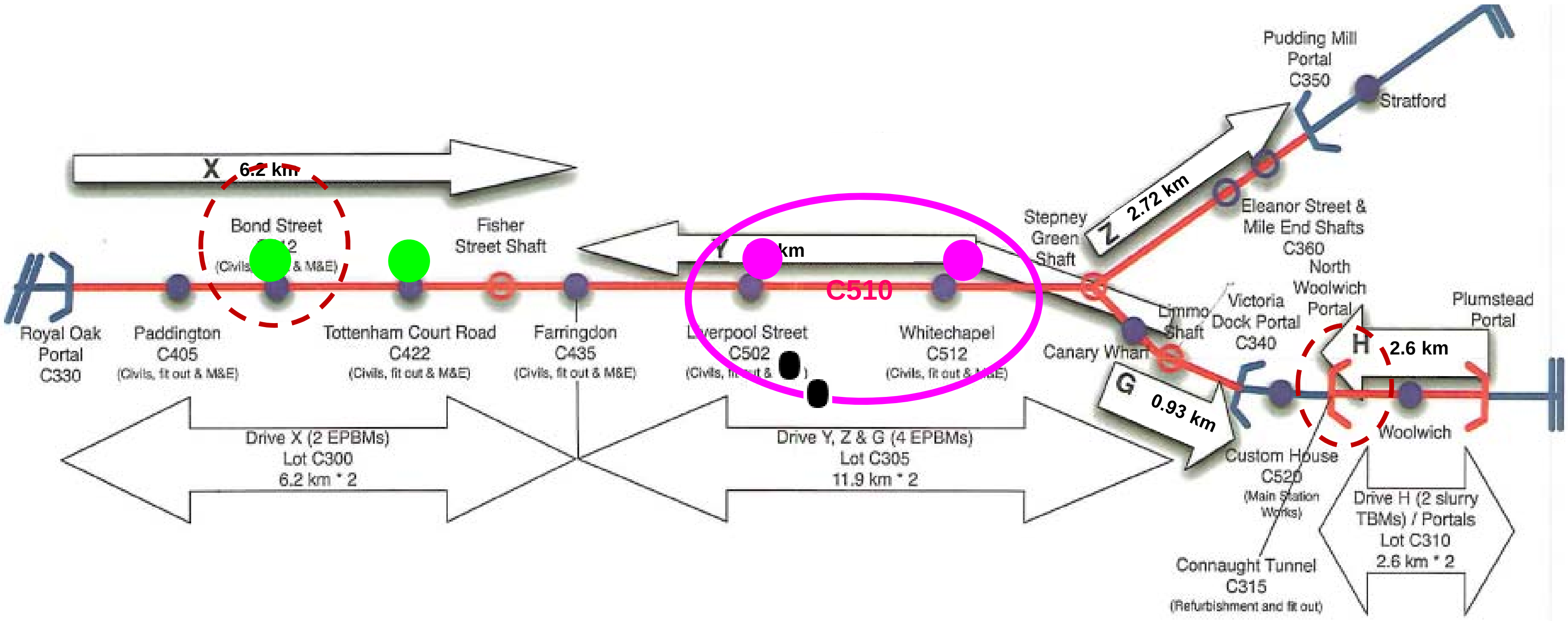
CLUB TRAVAUX SOUTERRAINS

19 septembre 2014

Crossrail C510 - Overview

Crossrail

- **£13 billion total value**
- **> 200 buildings to protect by compensation grouting - many historic and/or important**
- **Across the project > £100 million of compensation grouting, >£ 60 million in instrumentation & monitoring**

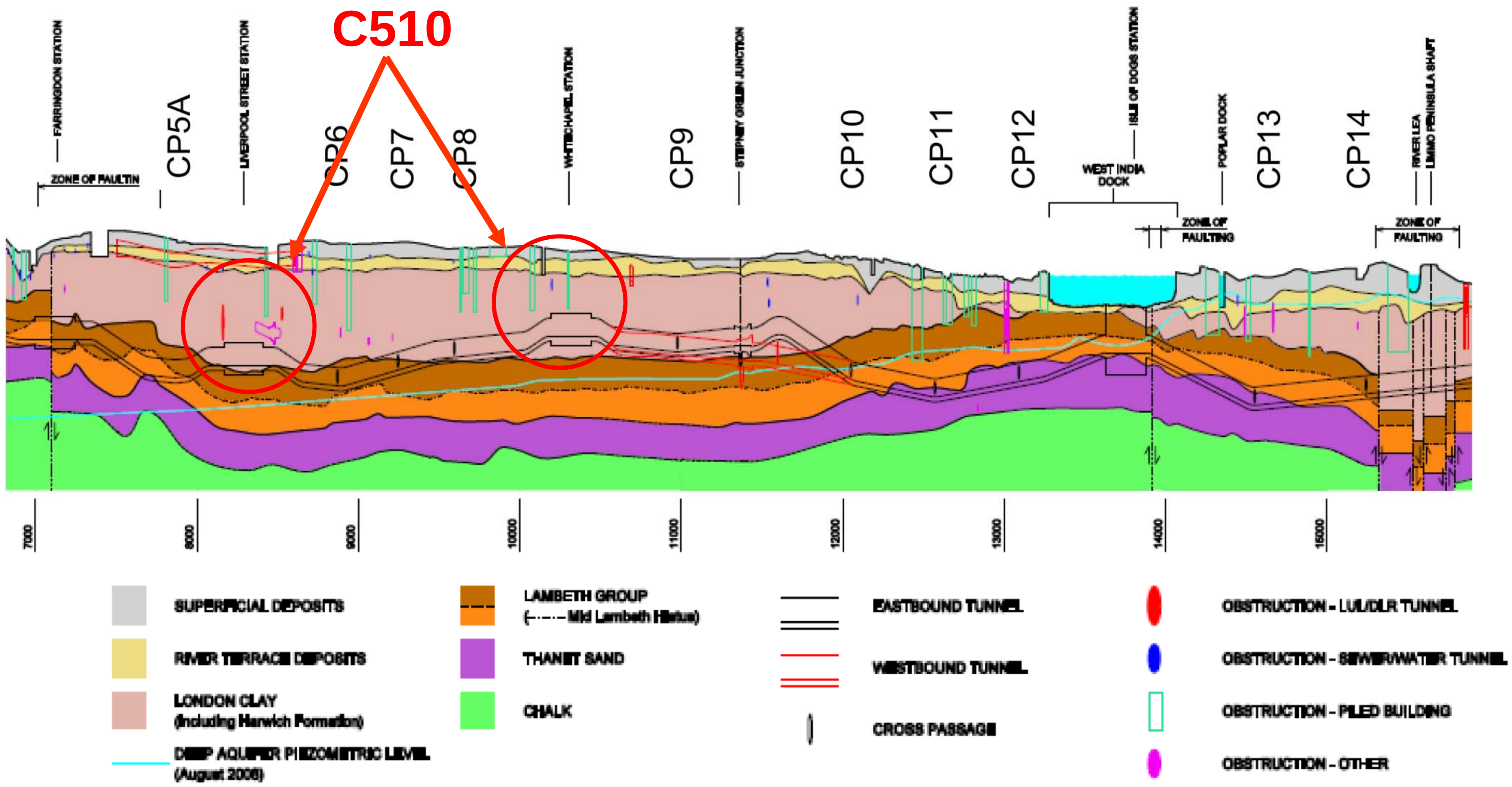


Crossrail C510 - £25+ million compensation grouting
Crossrail C315 - £ 2 million ground consolidation
Bond Street St. Upgrade - £ 6 million compensation grouting

Crossrail - Core Technical Challenges

- Settlement control for key structures and utilities
- Application of complex and detailed Crossrail specifications
- Structures with mixed foundations, diverse sensitivity, complex structural history
- Prestigious & historic structures, influential stakeholders
- Victorian era utilities and infrastructure 120-150 yrs
- Impact of compensation grouting on underground infrastructure and utilities
- Management of different specifications for buildings, LUL tunnels, utilities
- Assessment of potential settlement and damage
- Project scale and industry resource

Crossrail Project Geology



Scope of Full Works - Crossrail C510 - Value > £300m

Scope of Settlement Mitigation Works - Value > £35m

- **Liverpool Street Station Tunnels**
- Temporary access shaft
- 750m Platform tunnels
- 830m Cross passages and adits
- 4 No. Grout Locations
- Extensive monitoring
- Depressurisation in most tunnels
- Compensation, permeation grouting, pipe arch

Excavation Vol.= 134,000 m3

Concrete Vol. = 57,000 m3

- **Whitechapel Station Tunnels**
- Temporary access shaft
- 640m Platform tunnels
- 355m Cross passages and adits
- 1 no Grout shaft
- Depressurisation in most tunnels
- Compensation grouting, Permeation grouting, pipe arch
- Crossover tunnels

Excavation Vol.= 130,000 m3

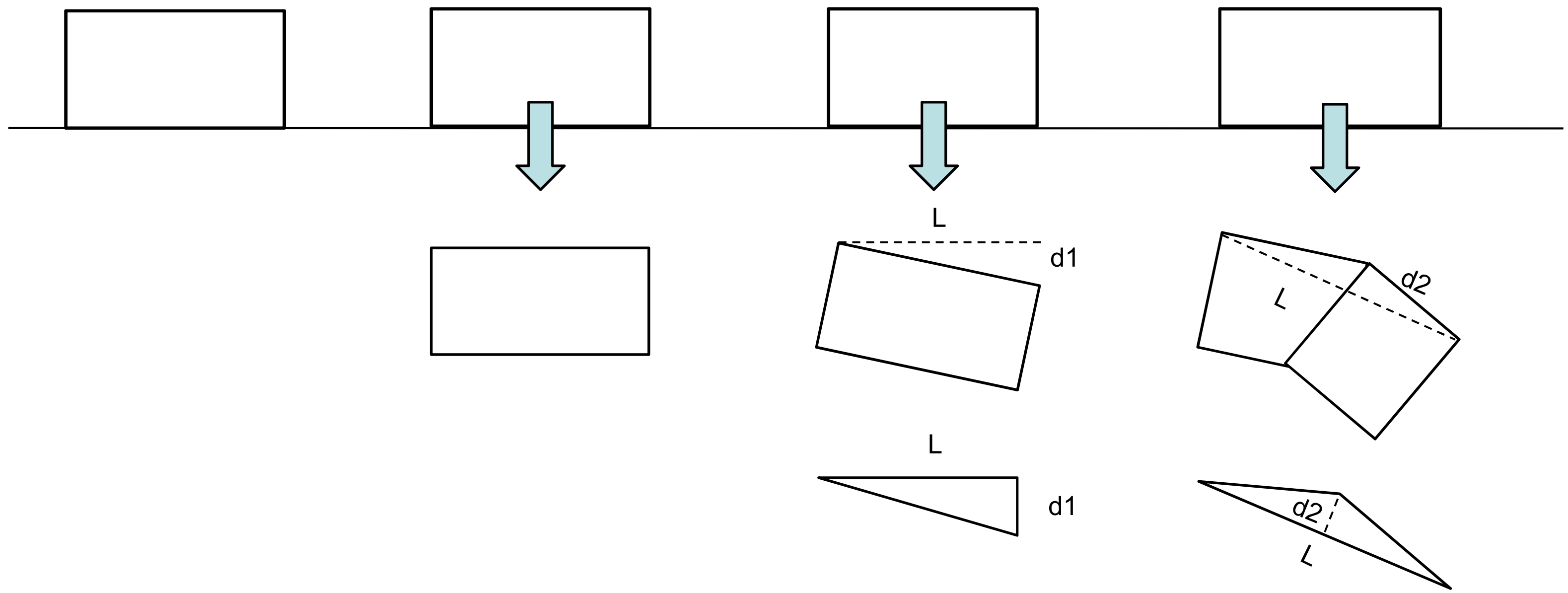
Concrete Vol. = 62,000 m3

Compensation Grouting

Design Considerations - Specified Performance Criteria

Current UK approach (Crossrail)

Crossrail - Settlement Control Criteria - Surface structures



No Displacement

No Issues

Even Settlement

No Issues for structure
But beware Utilities

Limits set in mm or defined by limits set for utilities

Differential Displacement

May be critical
Depends on condition of structure and type of construction

Limits have been set in range 1/500 to 1/3000. CRL limit is =1/1000 for settlement, 1/2000 and 5mm max. for heave

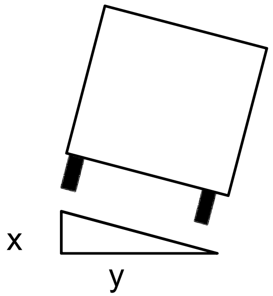
Deflection Ratio

Often much more critical
Requires more detailed information on structure

CRL limit is set at 1/2000
ie 0.5 x diff. settlement

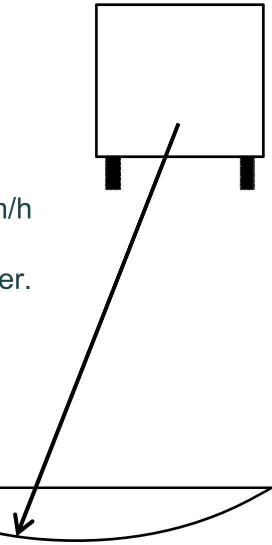
Crossrail - Settlement Control Criteria - Infrastructure

Cross-Track Displacement

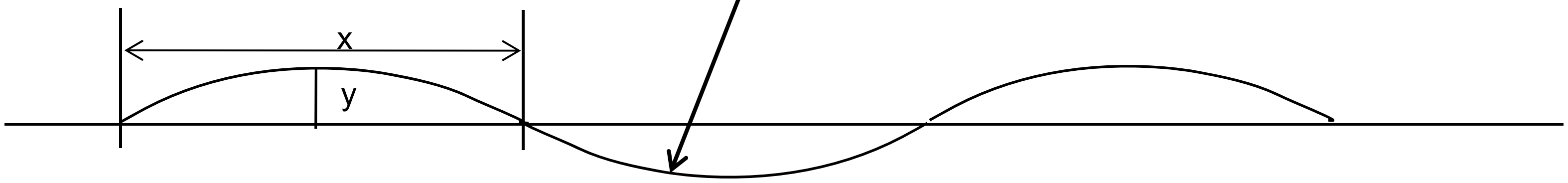


Limits set to avoid speed restriction and/or risk of derailment .
Typical value in UK for full guage railway, with running speeds < 45km/h = 5mm. Limits will vary for different track speeds, curvatures, and camber.

Longitudinal Chord Displacement

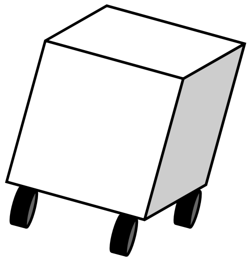


Limits set to avoid speed restriction, passenger discomfort, and/ or risk of derailment .
Typically the operator will set limiting values for the vertical displacement along a fixed chord length, and /or a radius of curvature. Limits will vary for different track speeds.

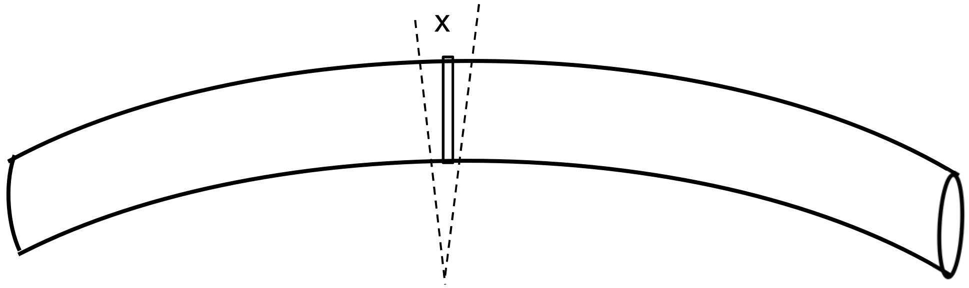


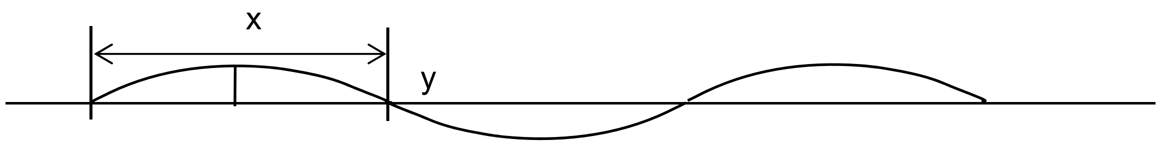
Compound Displacement

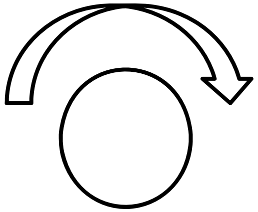
Set limits may be very onerous for compound displacements , particularly on high speed curves.



Crossrail - Settlement Control Criteria - Utilities



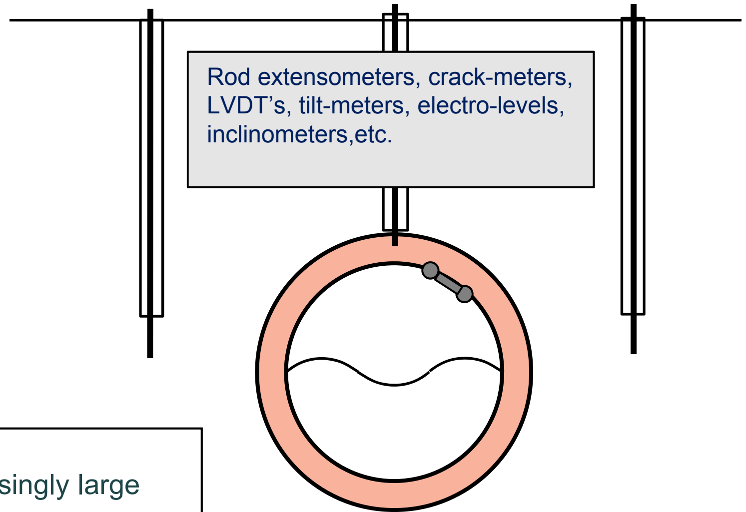




For flanged / jointed structures, consideration of joint rotation can have a significant impact in reducing the degree of predicted strain.

Displacement Limits may be defined in different ways eg

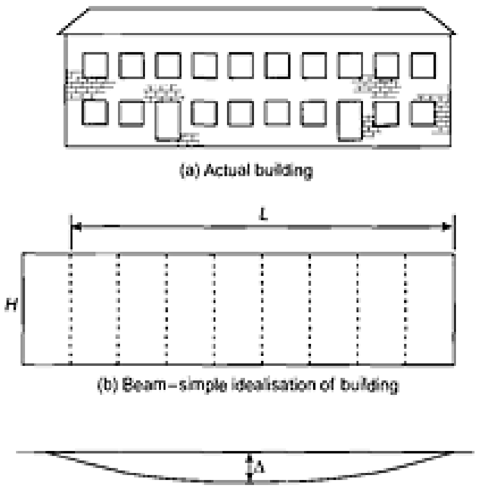
- as a physical chord displacement
- as a deflection
- increasingly, as a value of limiting strain, verified by physical displacement monitoring, in situ strain guages, or soil displacement monitoring, all to avoid physical damage of lining for brick or masonary structures
- to protect joints in the case of flanged cast iron pipes or jointed GRP conduits



New optic fibre strain monitoring systems may play and increasingly large role in future for asset monitoring and managing asset maintenance.

These are being considered for use by several infrastructure and utility companies on the basis of providing safe, remote access, and low maintenance

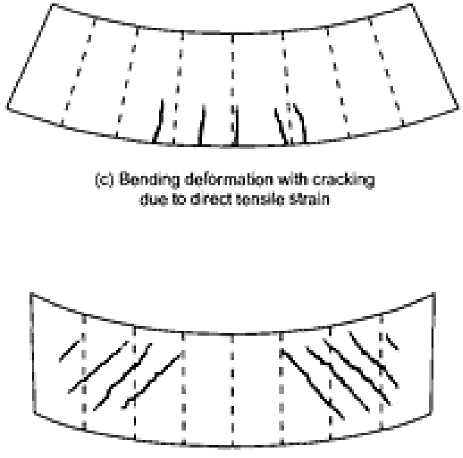
Crossrail - Settlement Control Criteria - Structural Damage



(a) Actual building

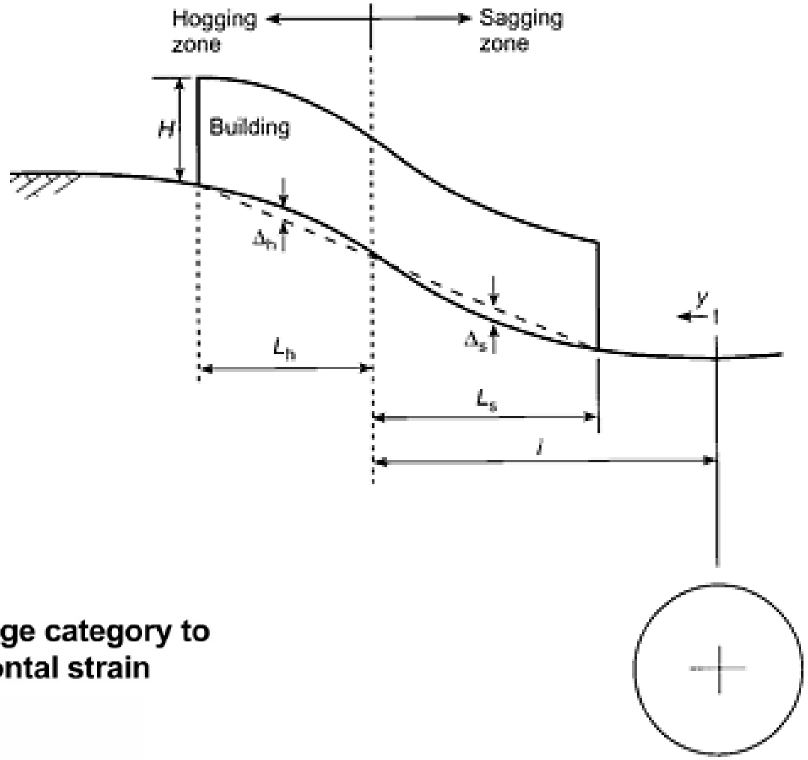
(b) Beam–simple idealisation of building

Deflected shape of soffit of beam

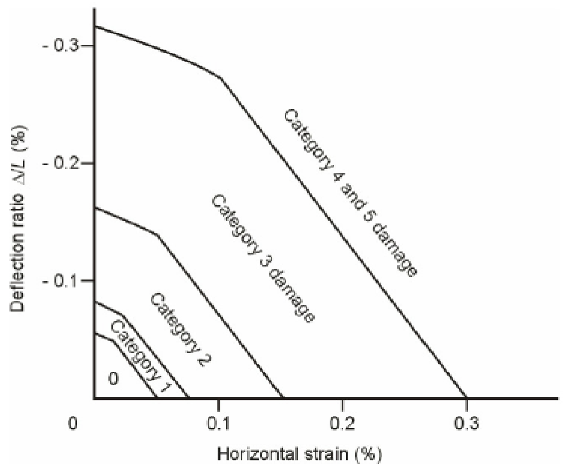


(c) Bending deformation with cracking due to direct tensile strain

(d) Shear deformation with cracking due to diagonal tensile strain



Relationship of building damage category to deflection ratio and horizontal strain



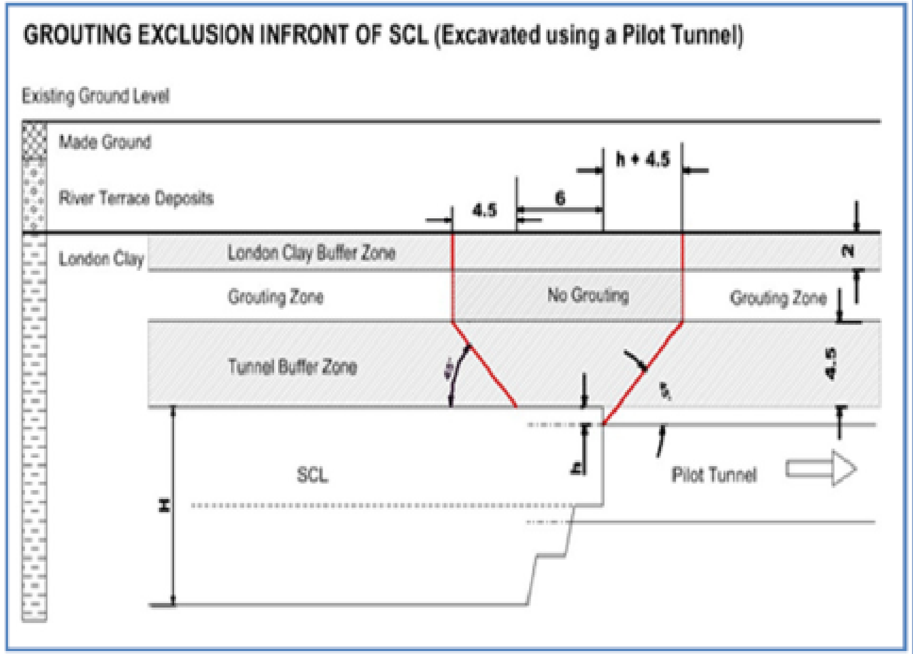
Burland (1995); Mair,Taylor and Burland (1996)

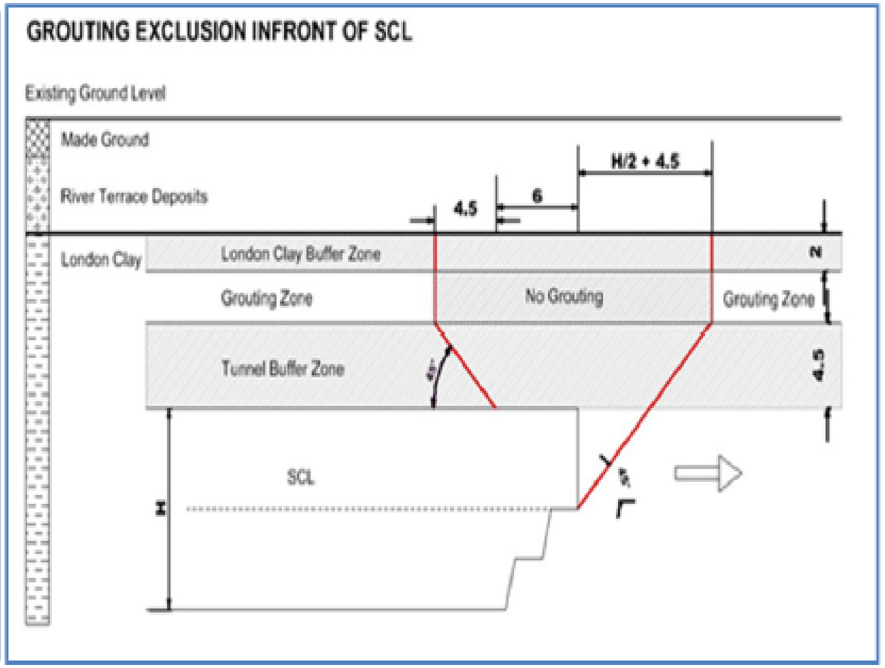
Extract from Building Research Establishment report on Building Damage Classification, after Burland et al. (1977)

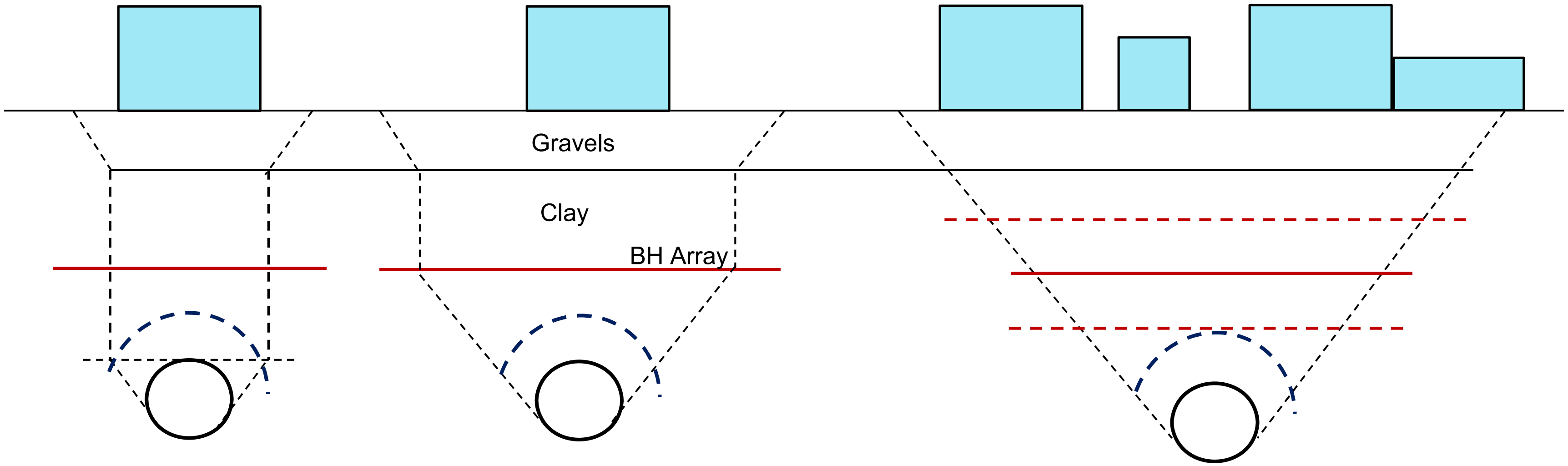
Compensation Grouting

Design Considerations - Geometry

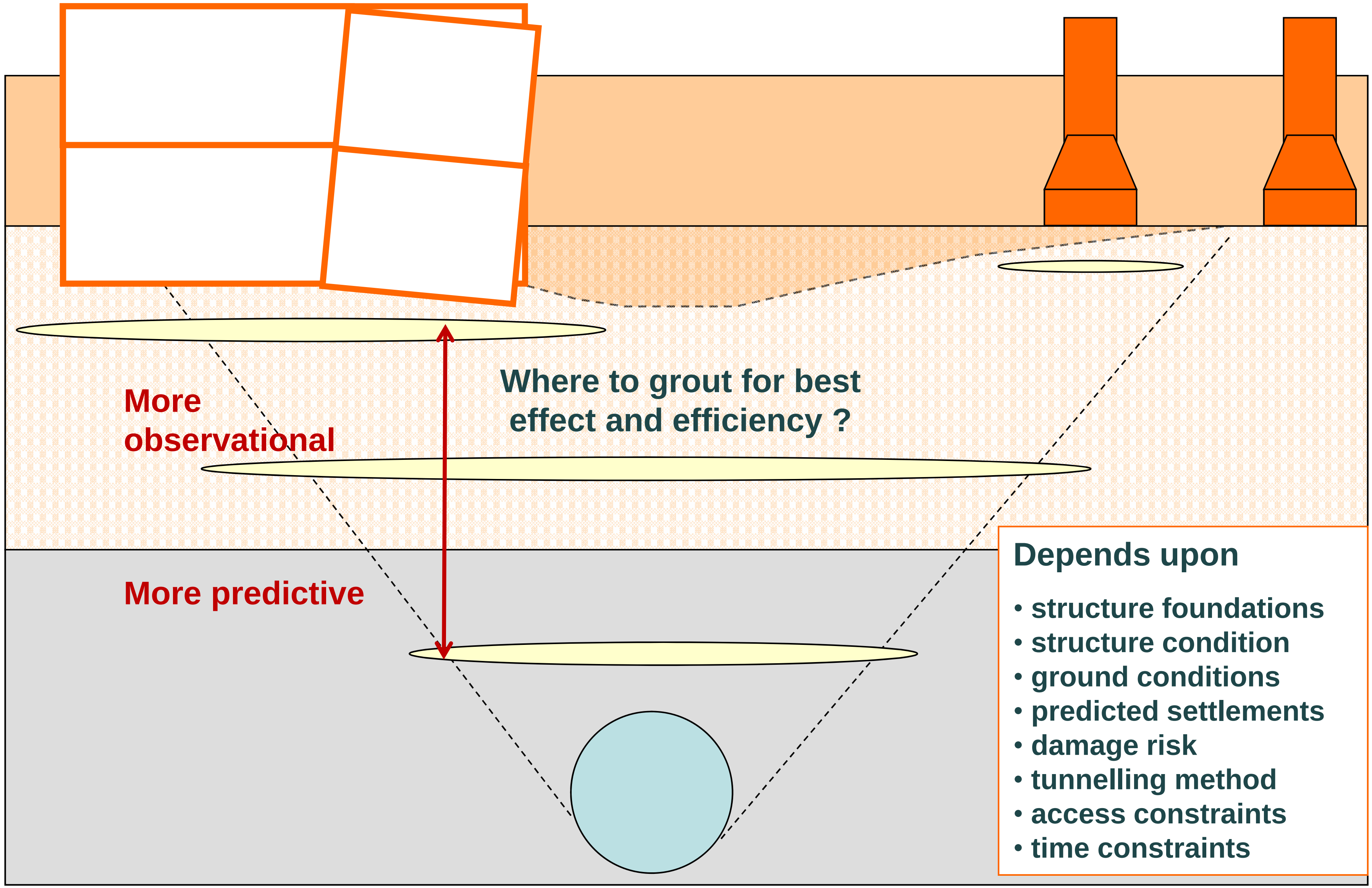
Crossrail C510 - Protection of SCL Linings - Managing Exclusion Zones



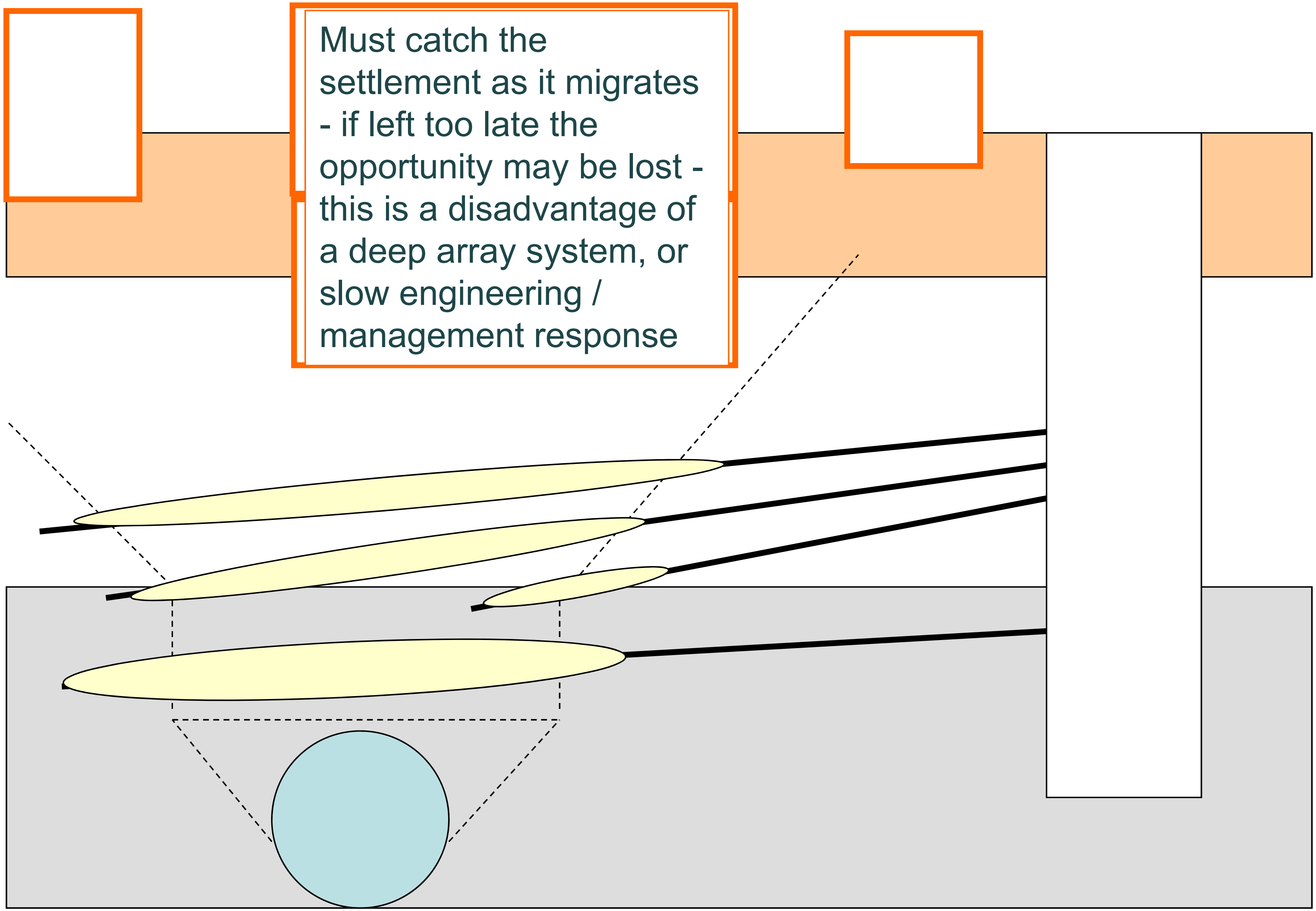




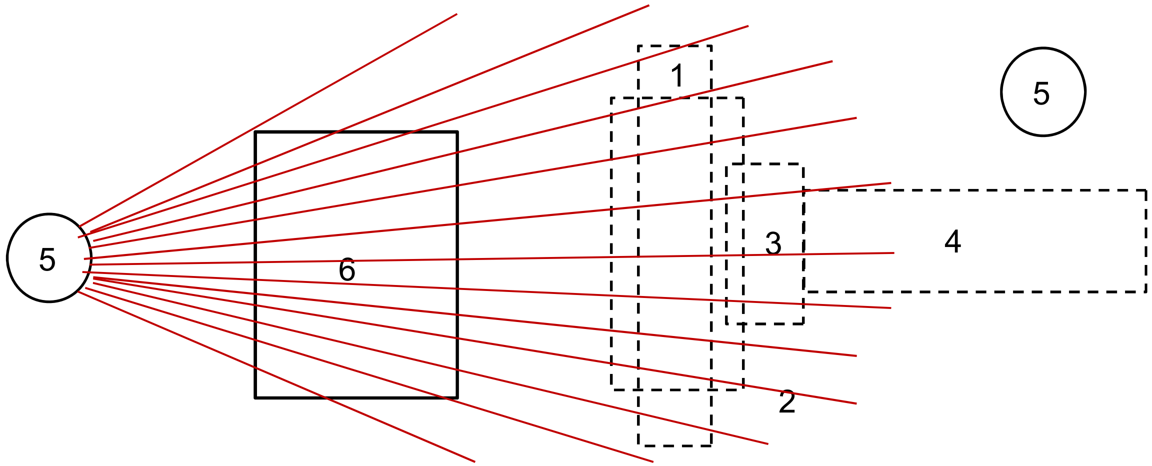
Compensation Grouting - Premise

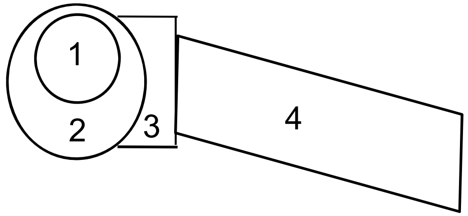


Compensation - the importance of location and timing

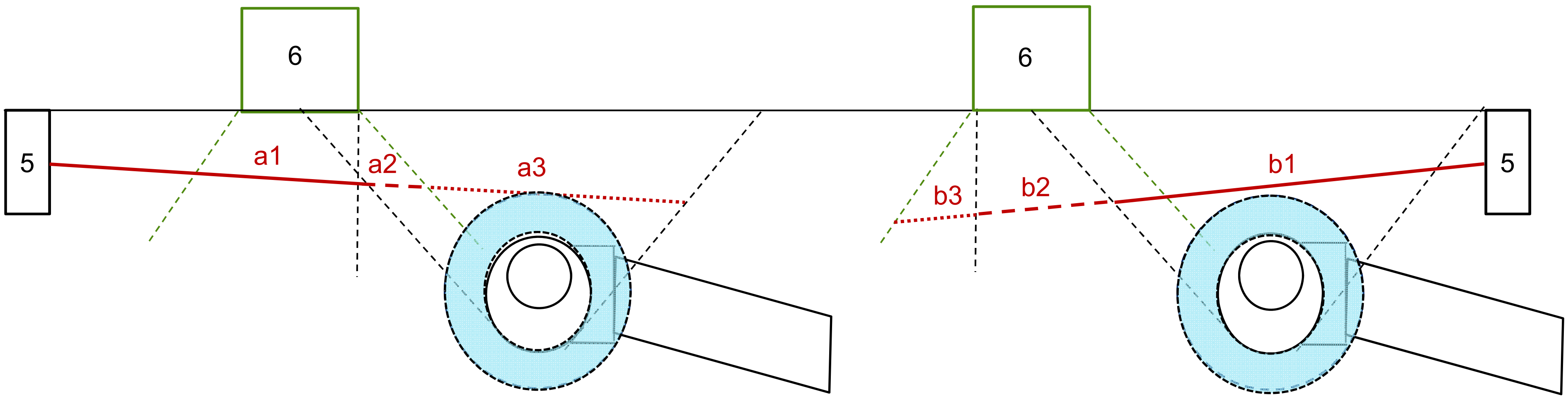


Compensation - selection of grouting zone

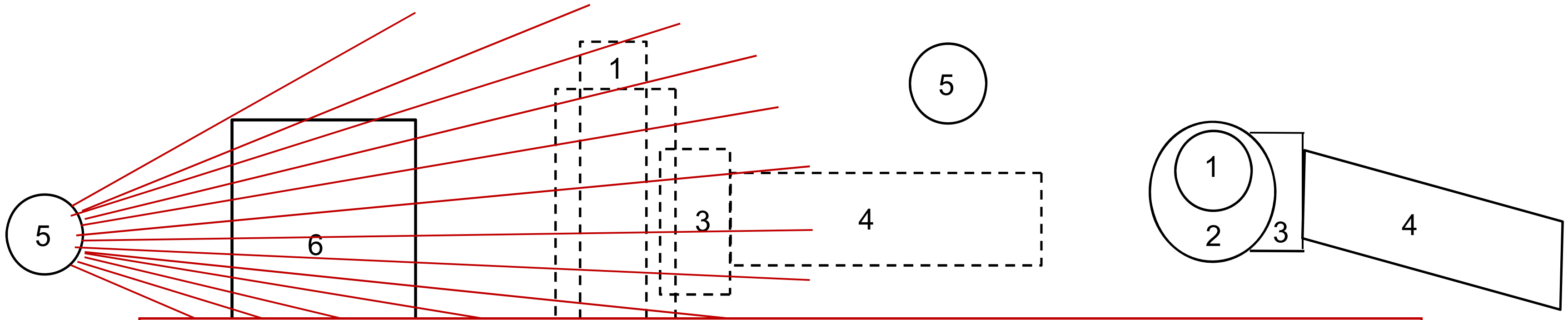




1. - Pilot Tunnel
2. - Enlargement
3. - Break Out
4. - Escalator
5. - Possible grout shaft
6. - Building requiring protection



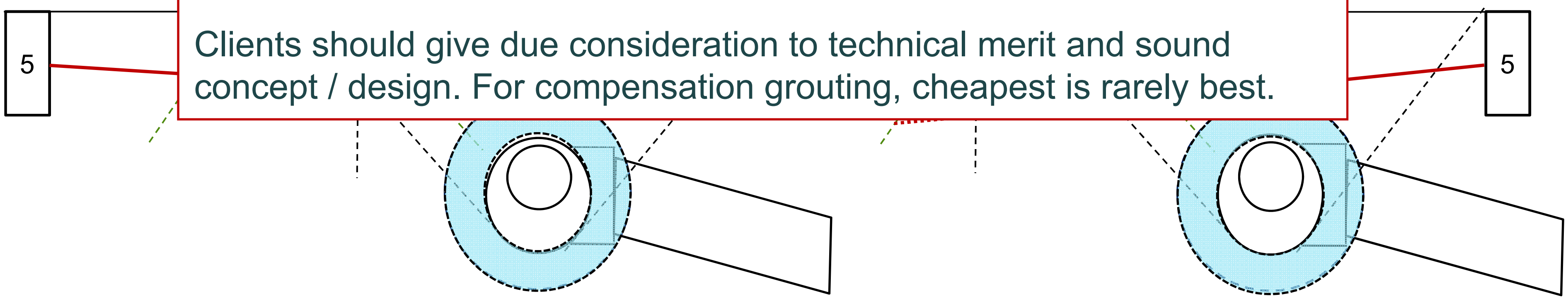
Compensation - selection of grouting zone



The engineering decision is often easier than commercial decision when bidding competitively - the parties should try to bid a basic conforming design & address the coverage during the OCI period.

However, this issue of coverage is vital - it is too late to extend the arrays once settlements begin to develop - designers must fight to get this issue fully addressed at design and planning stage.

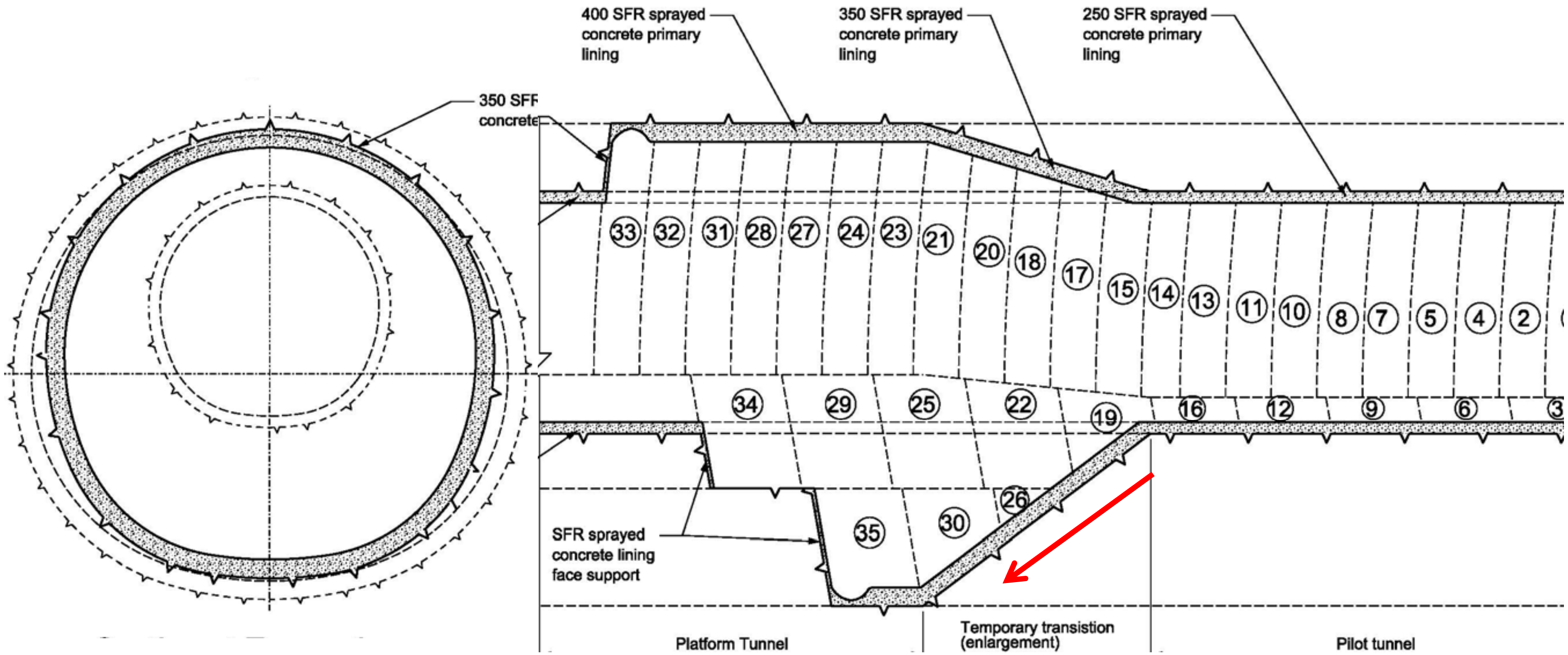
Clients should give due consideration to technical merit and sound concept / design. For compensation grouting, cheapest is rarely best.



Crossrail C510 - Excavation Methods

Excavation - Enlargement pilot to platform tunnel

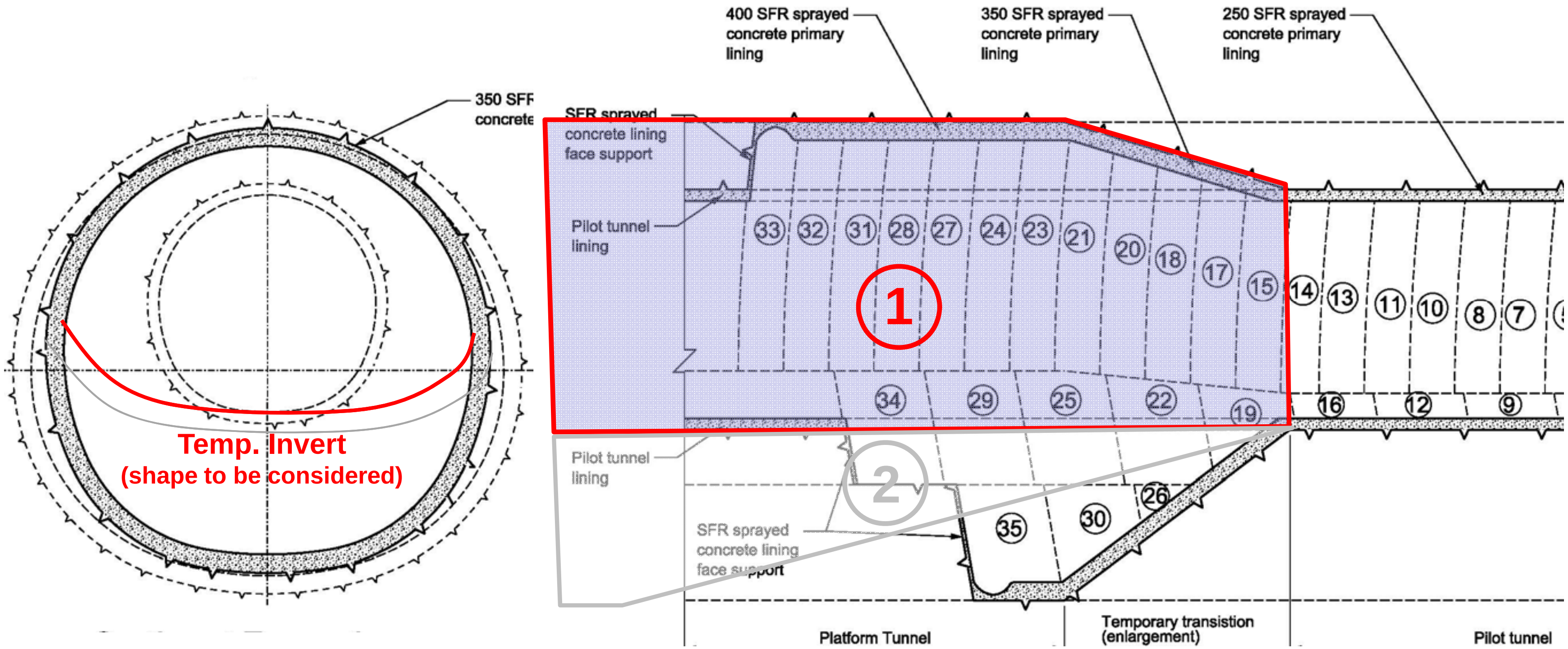
- Safetey – ca. 58% Declined Tunnel (3,5 m in 6m)



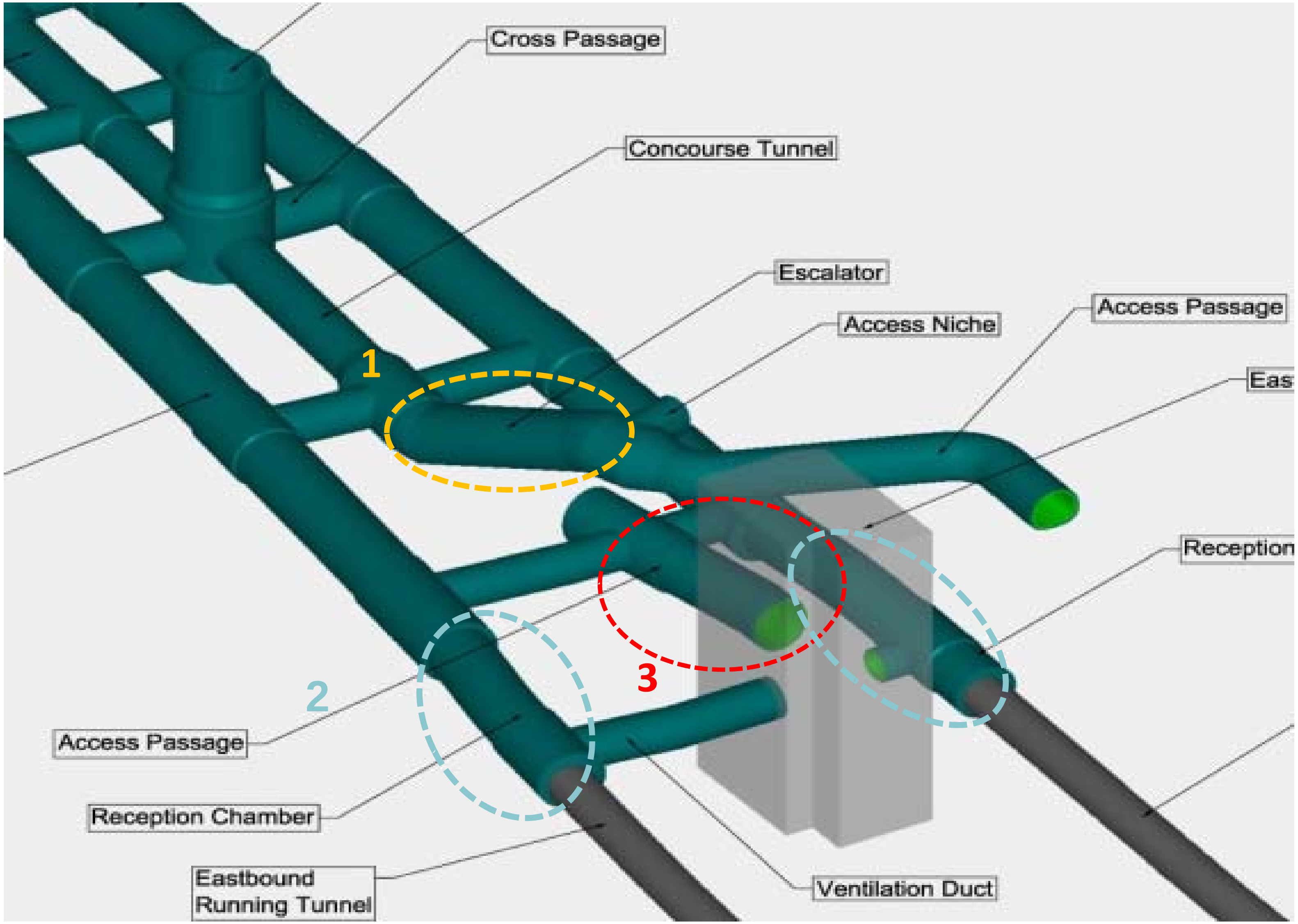
Excavation - Enlargement pilot to platform tunnel

1) Top Heading with temp. invert

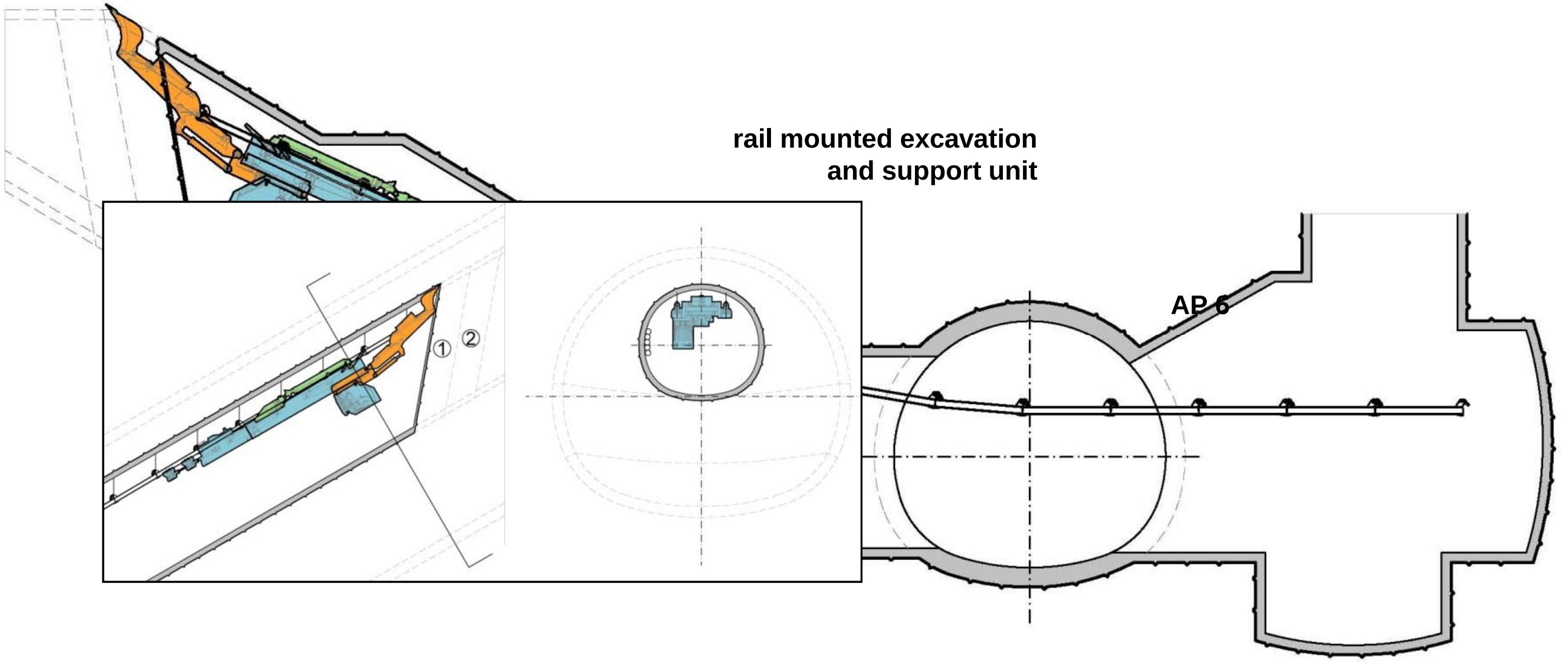
2) Enlargement of bench & invert

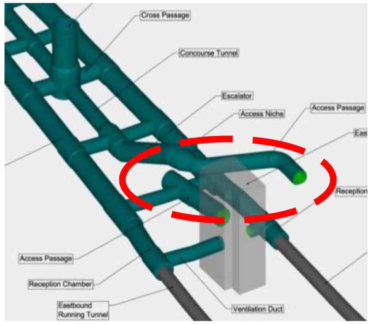


Liverpool Station Site - Up-slope Excavation of ES2 Escalator Tunnel



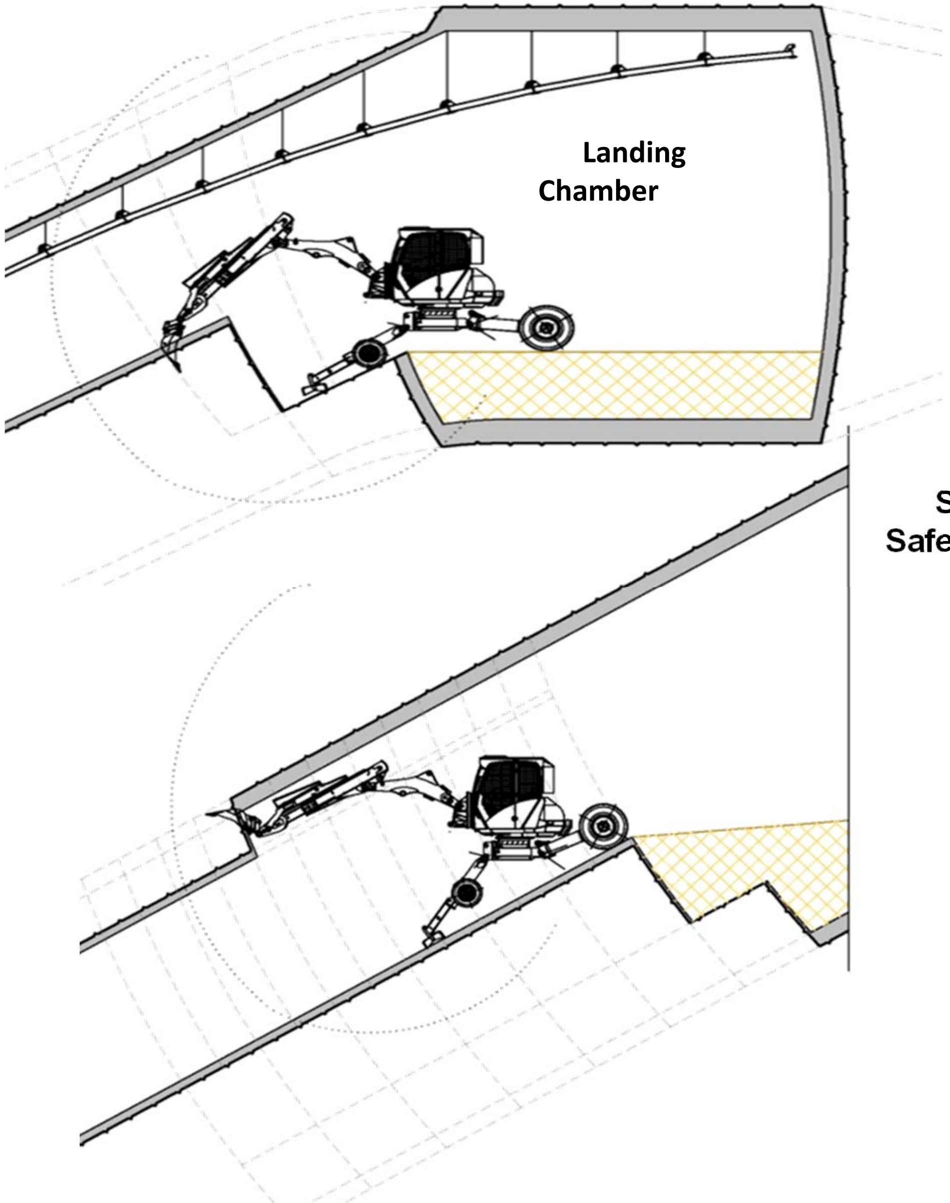
Up-slope Excavation of ES2 Escalator Tunnel

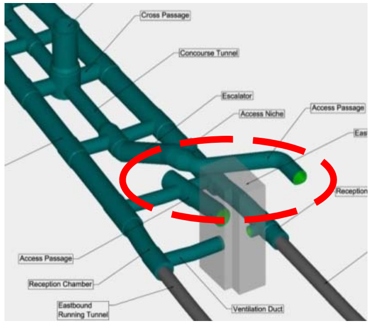


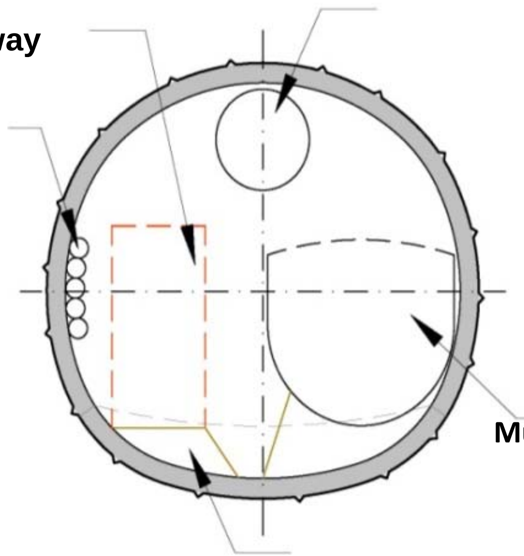


Up-slope Excavation of ES2 Escalator Tunnel

Alternative Down-slope Excavation of Escalator Tunnel

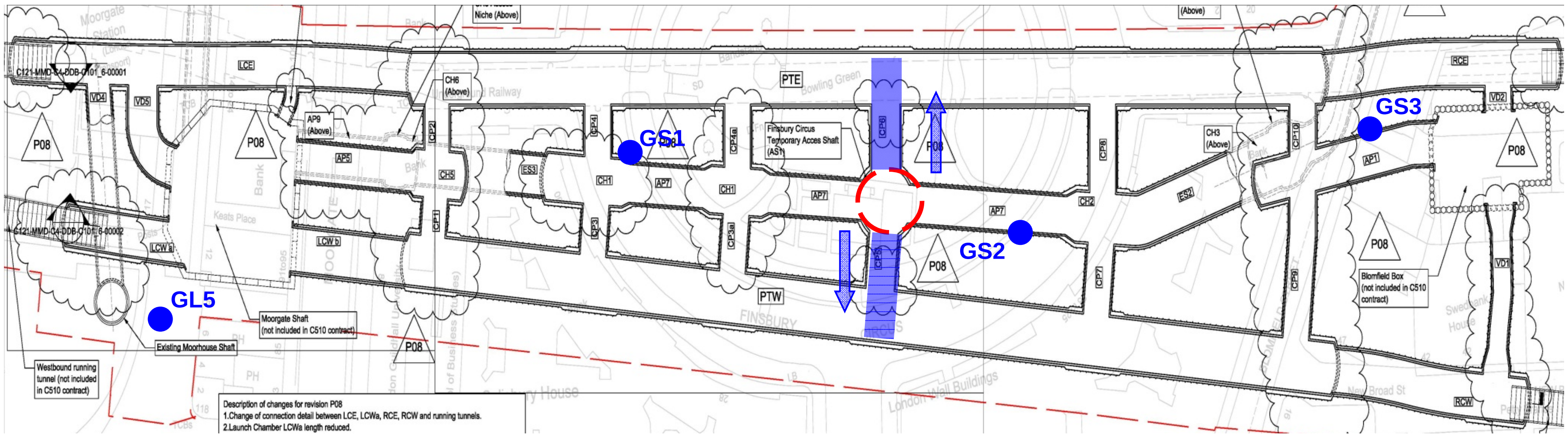






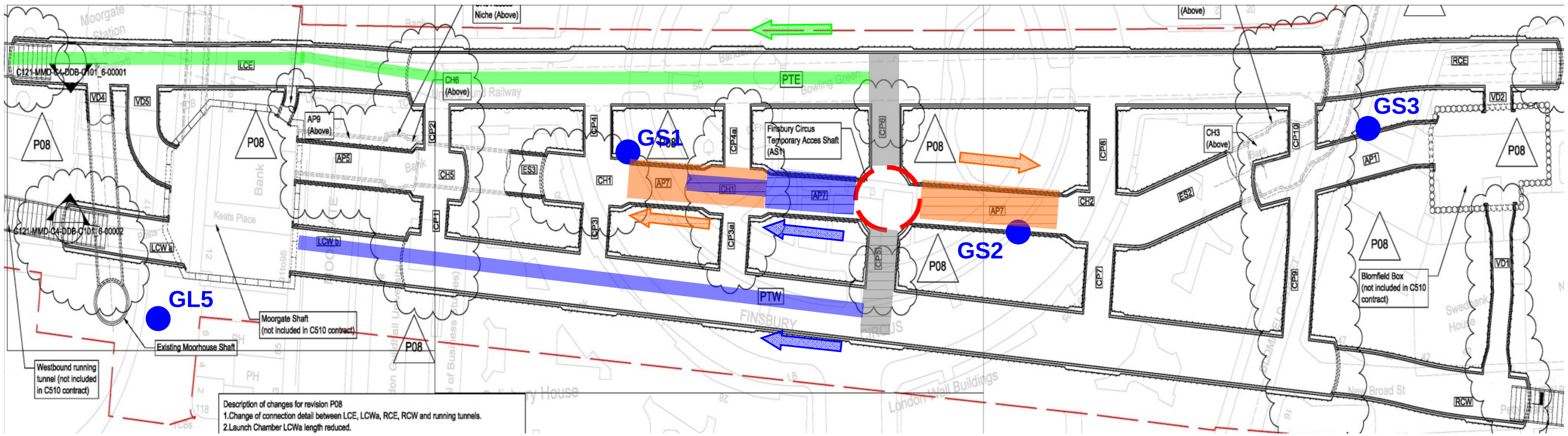
Early Development of Broadgate Link

C510 Liverpool Street Station Excavation Sequence
Base Bid not including TPO2



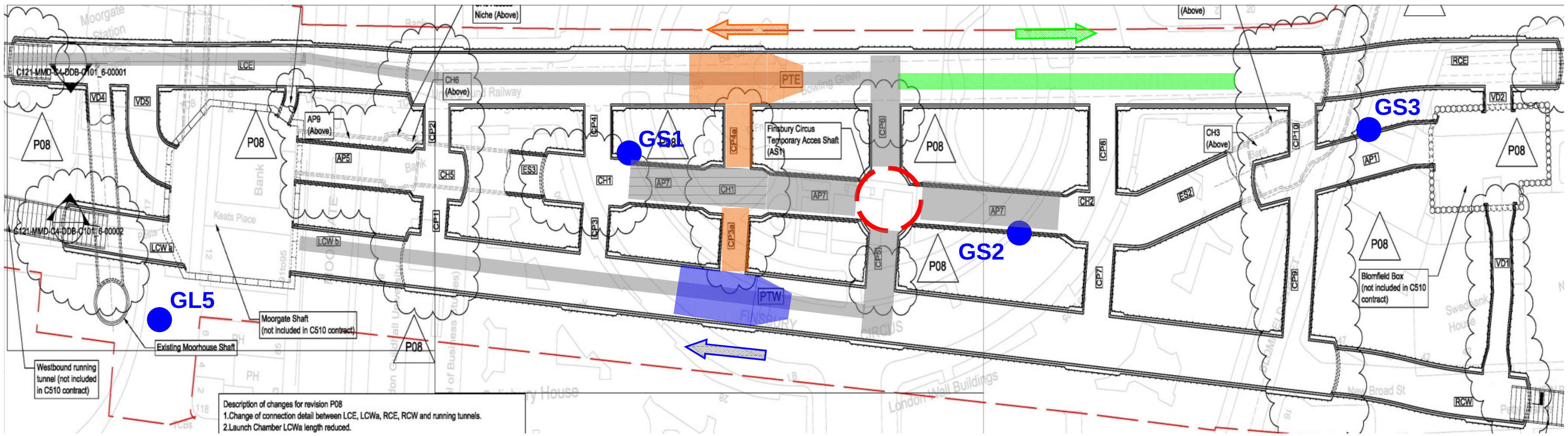
Team 1
SCL Shaft CP5 / CP6

C510 Liverpool Street Station Excavation Sequence
Base Bid not including TPO2



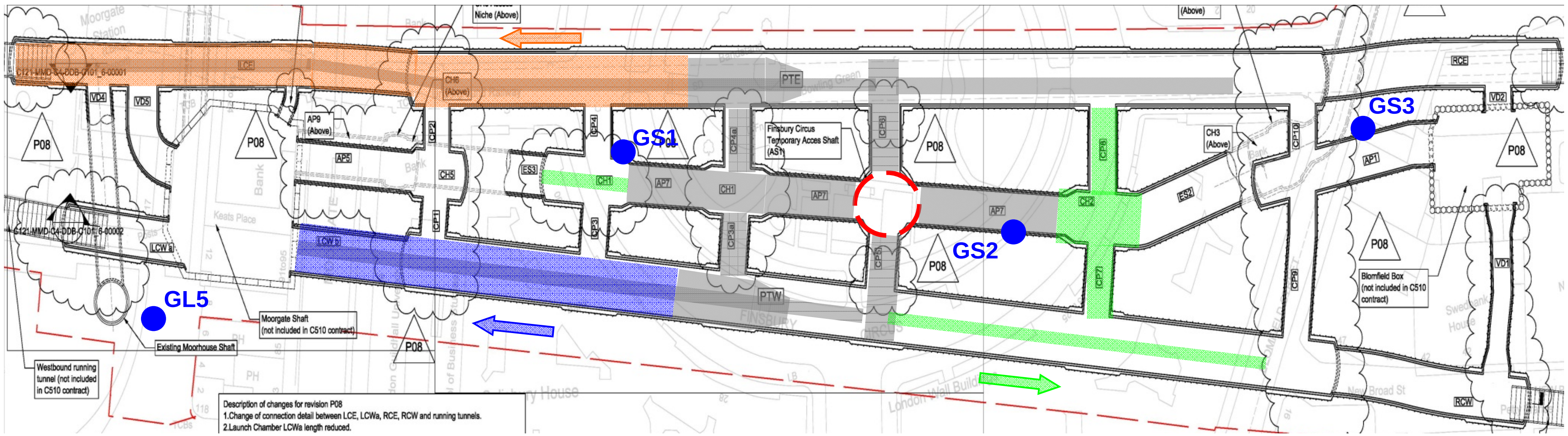
Team 1	Team 2	Team 3
AP7 West-1 CH1-1 pilot PTW pilot West incl depressurisation	AP7 East CH1-1 enlarge AP7 West-2	PTE pilot West incl depressurisation

C510 Liverpool Street Station Excavation Sequence
Base Bid not including TPO2



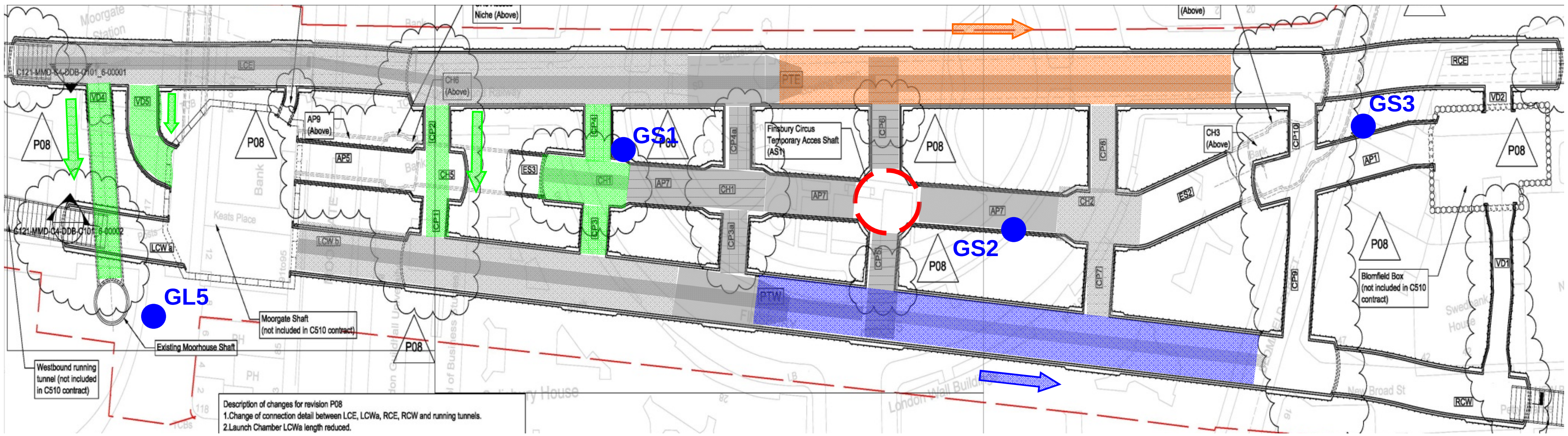
Team 1	Team 2	Team 3
PTW Transition	PTE Transition CP3a / CP3b	PTE pilot East incl depressurisation

C510 Liverpool Street Station Excavation Sequence
Base Bid not including TPO2



Team 1	Team 2	Team 3
PTW Enlarge West	PTE Enlarge West	PTW pilot East incl depressurisation CH1-2 pilot CH2 pilot and enlargement CP7 / CP8

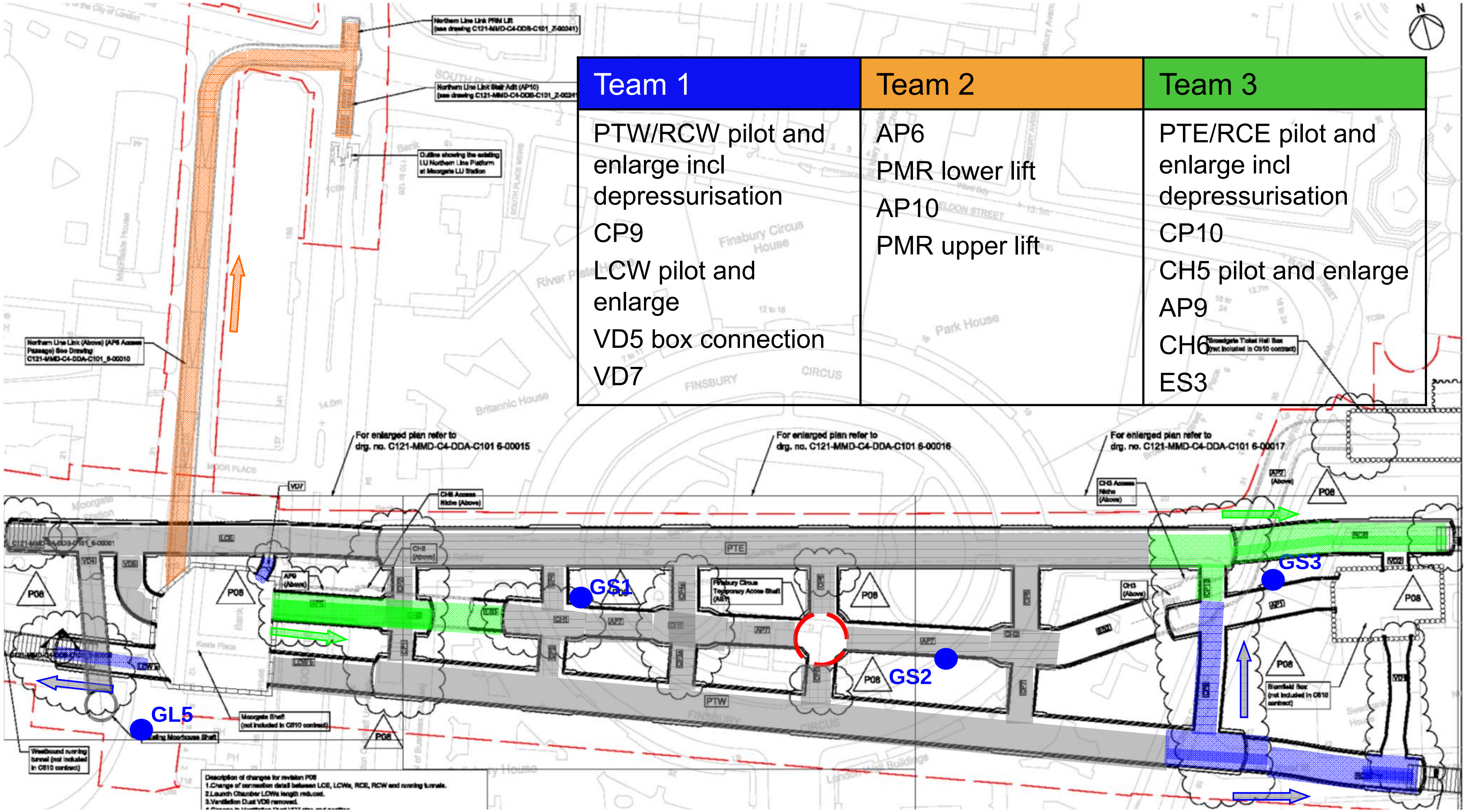
C510 Liverpool Street Station Excavation Sequence
Base Bid not including TPO2



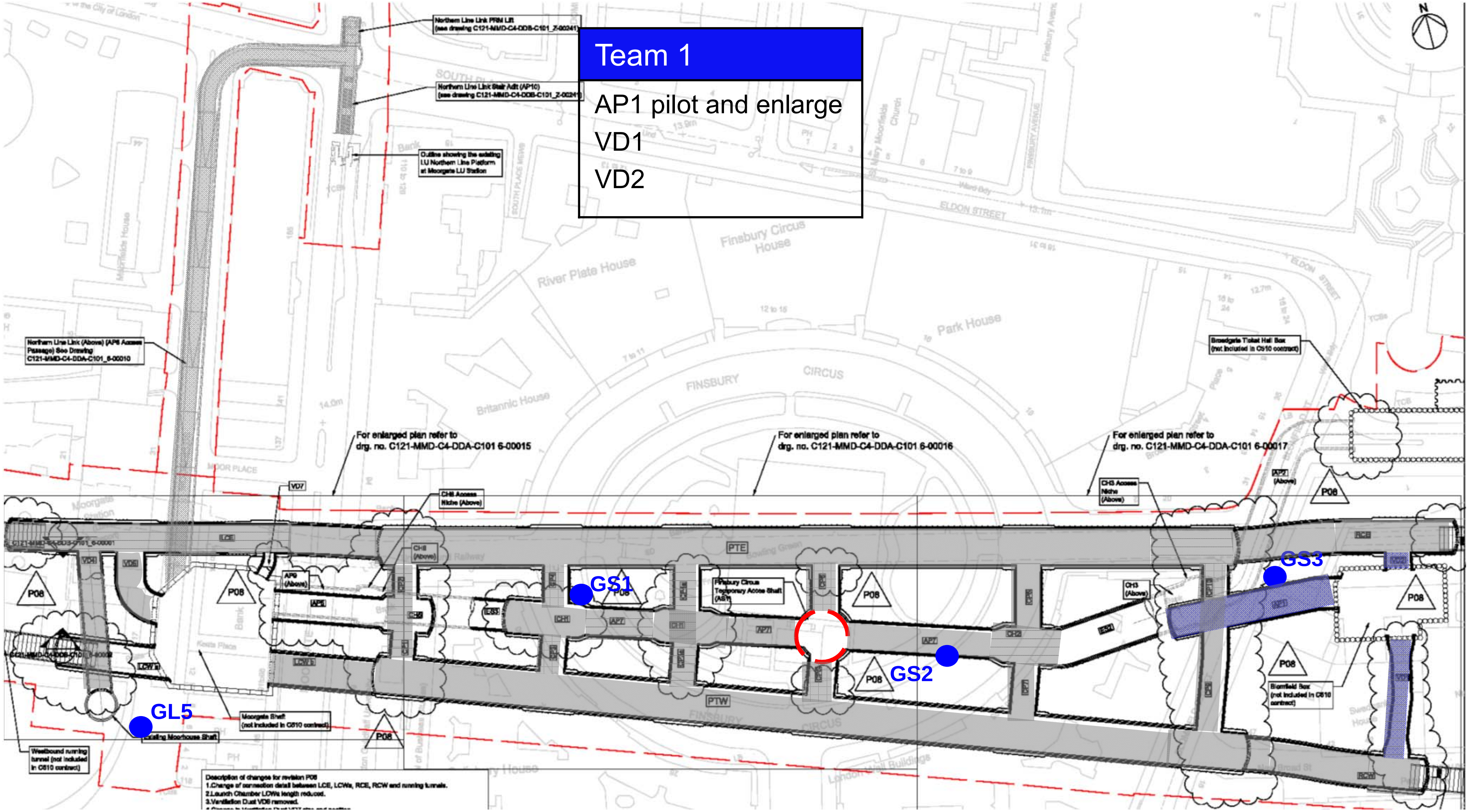
Team 1	Team 2	Team 3
PTW Enlarge East	PTE Enlarge East	Ch1-2 enlargement CP 3 / 4 CP 1 / 2 VD5 VD4

C510 Liverpool Street Station Excavation Sequence
Base Bid not including TPO2

Team 1	Team 2	Team 3
PTW/RCW pilot and enlarge incl depressurisation CP9 LCW pilot and enlarge VD5 box connection VD7	AP6 PMR lower lift AP10 PMR upper lift	PTE/RCE pilot and enlarge incl depressurisation CP10 CH5 pilot and enlarge AP9 CH6 ES3

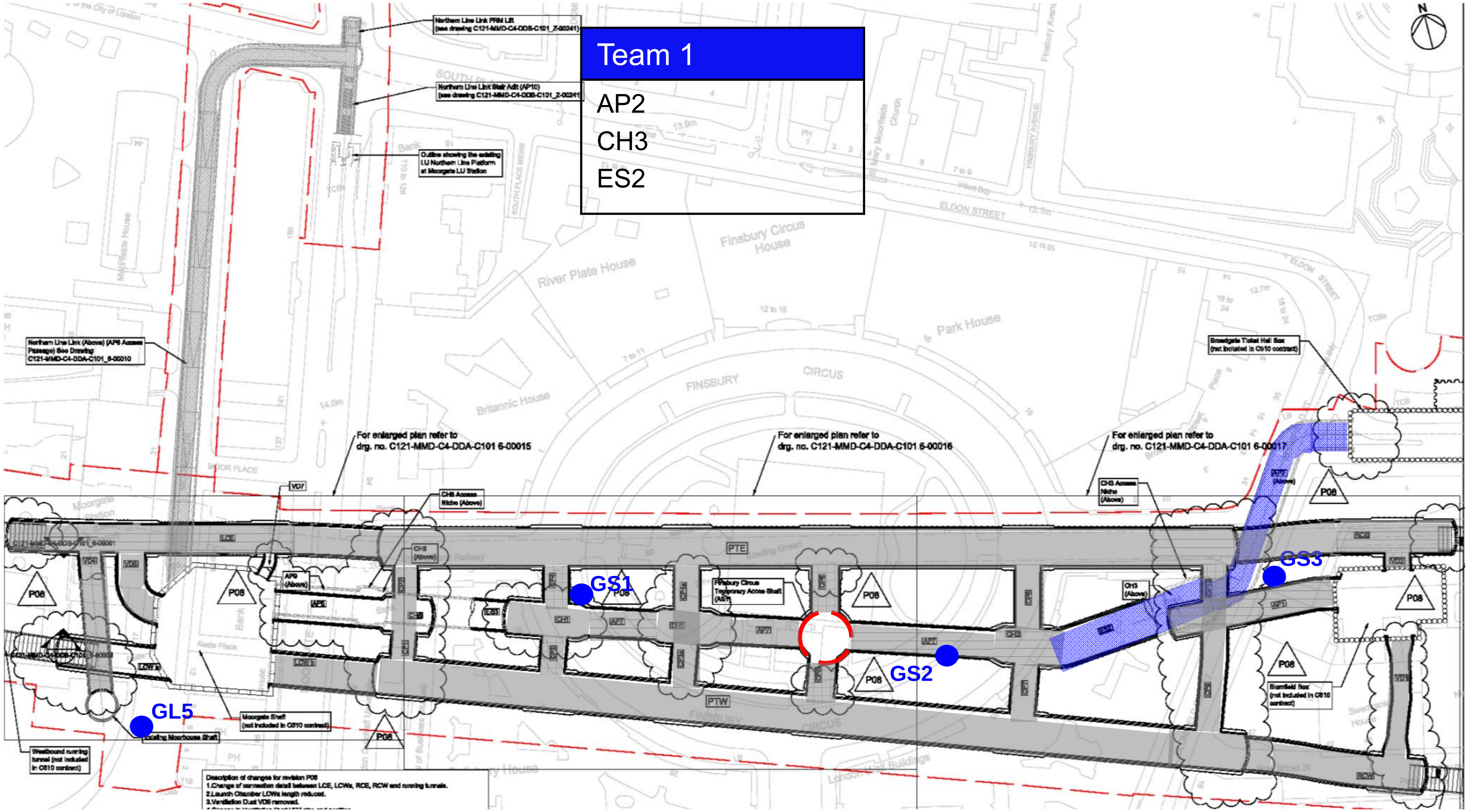


C510 Liverpool Street Station Excavation Sequence
Base Bid not including TPO2



Team 1
AP1 pilot and enlarge
VD1
VD2

C510 Liverpool Street Station Excavation Sequence
Base Bid not including TPO2



Compensation Grouting

Design Considerations - An example of an approach for predictive grouting using COGNAC

Objective

Try to re-compact ground as close as possible in both time and space to the source of relaxation, to try to prevent the majority of this relaxation migrating to the foundation level of the structures above.

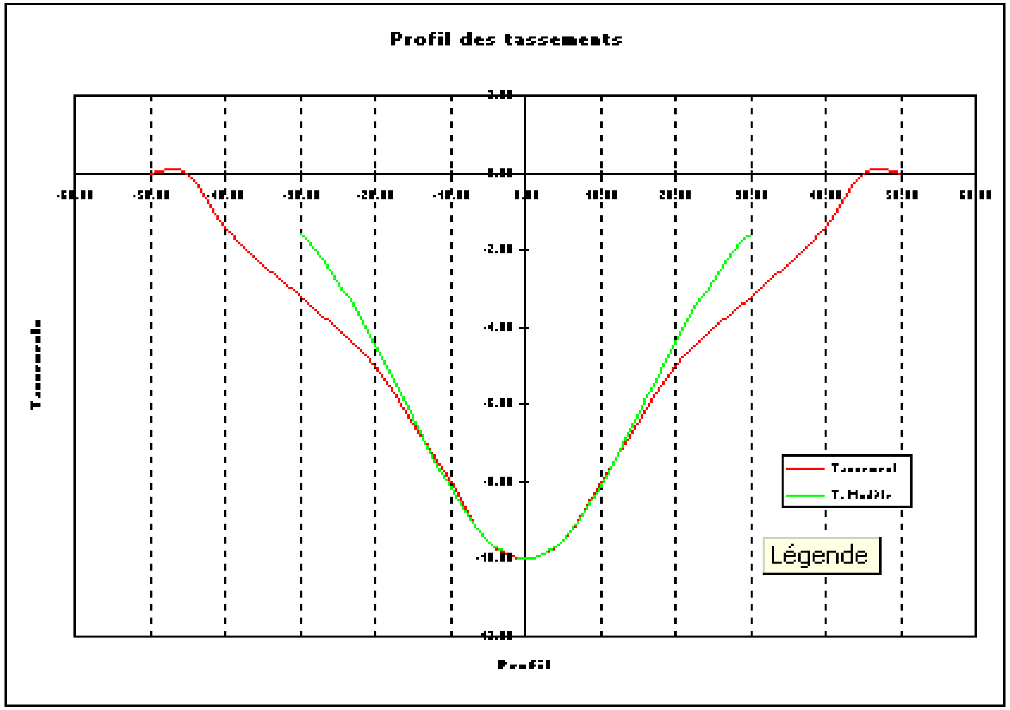
Compensation Grouting - example of basis of predictive design

Zone de saisie

coeff	Y m	Tassement mm
0	-50.00	0.00
0	-45.00	0.00
0	-40.00	-1.40
0	-35.00	-2.40
0	-30.00	-3.20
0	-25.00	-4.00
0	-20.00	-5.00
0	-15.00	-6.50
0	-10.00	-8.00
1	-5.00	-9.50
30	0.00	-10.00
1	5.00	-9.50
0	10.00	-8.00
0	15.00	-6.50
0	20.00	-5.00
0	25.00	-4.00
0	30.00	-3.20
0	35.00	-2.40
0	40.00	-1.40
0	45.00	0.00
0	50	0.00

Z0	32.1	m
RAYON	7	m
LONGUEUR ANNEAU	2	m

ZONE GRAPHIQUE

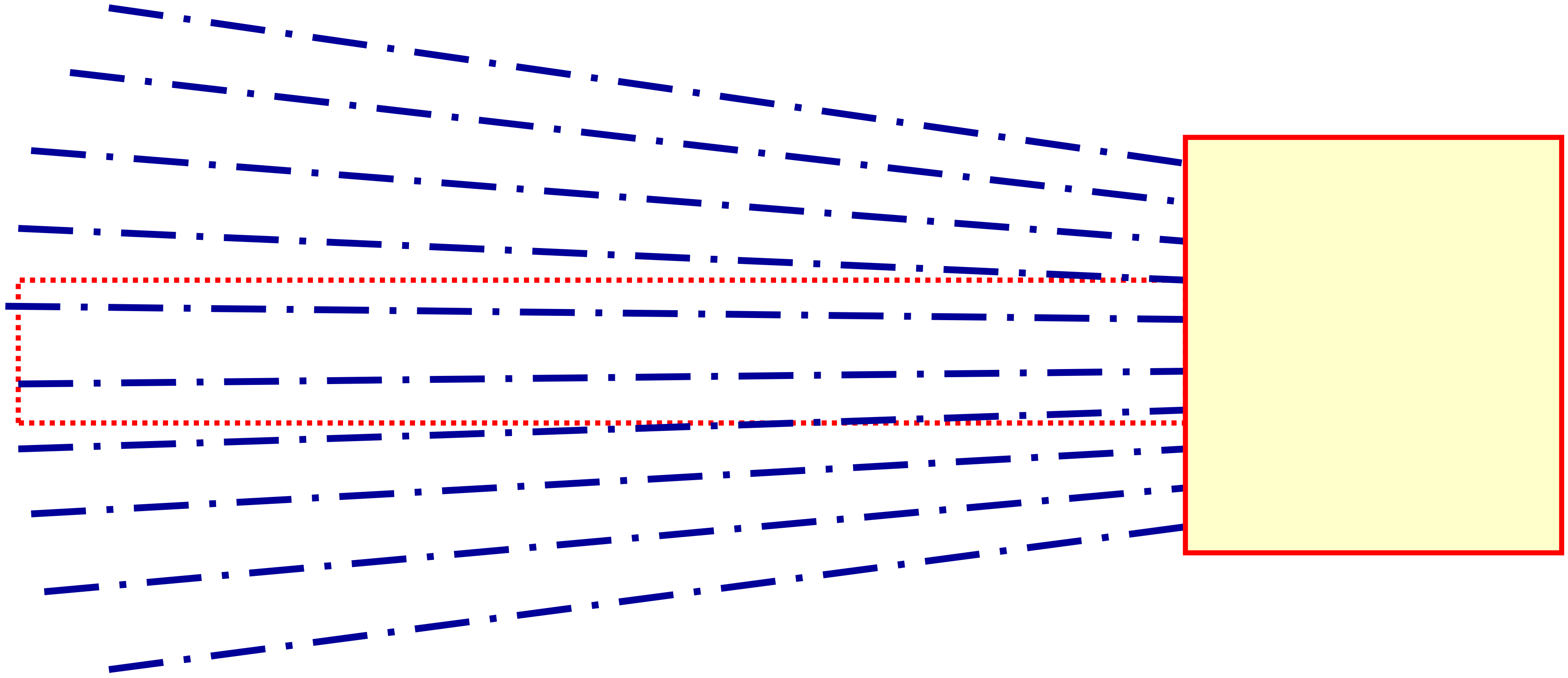


ZONE RESULTATS

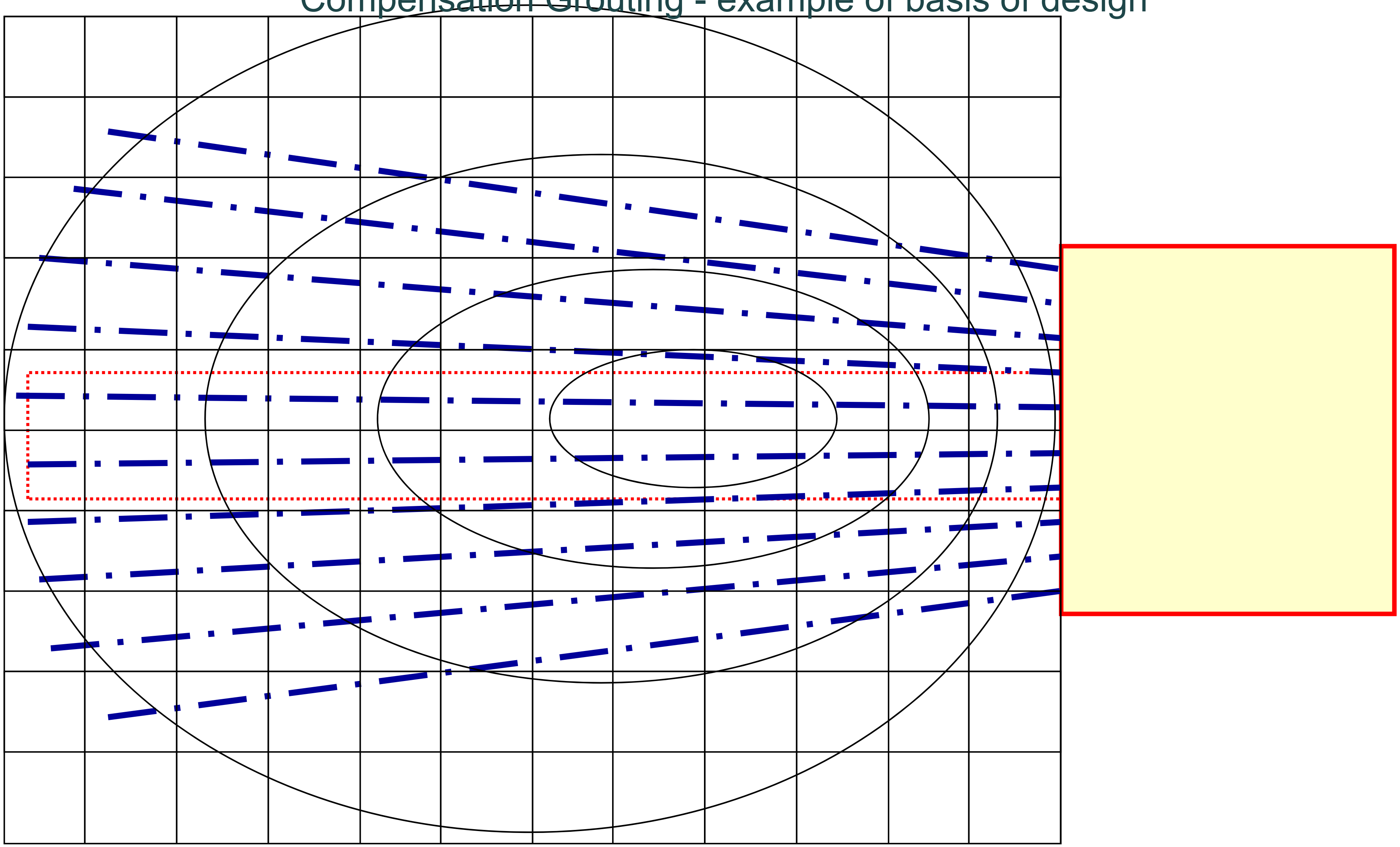
Wmax	10	mm
Iy	15.6108	m
Ky	0.48632	
VolLoss	25%	%
Wu	0.51111	mm

We must start with the same soil parameters and settlement trough monitoring as the tunnel designers

Compensation Grouting - example of basis of design

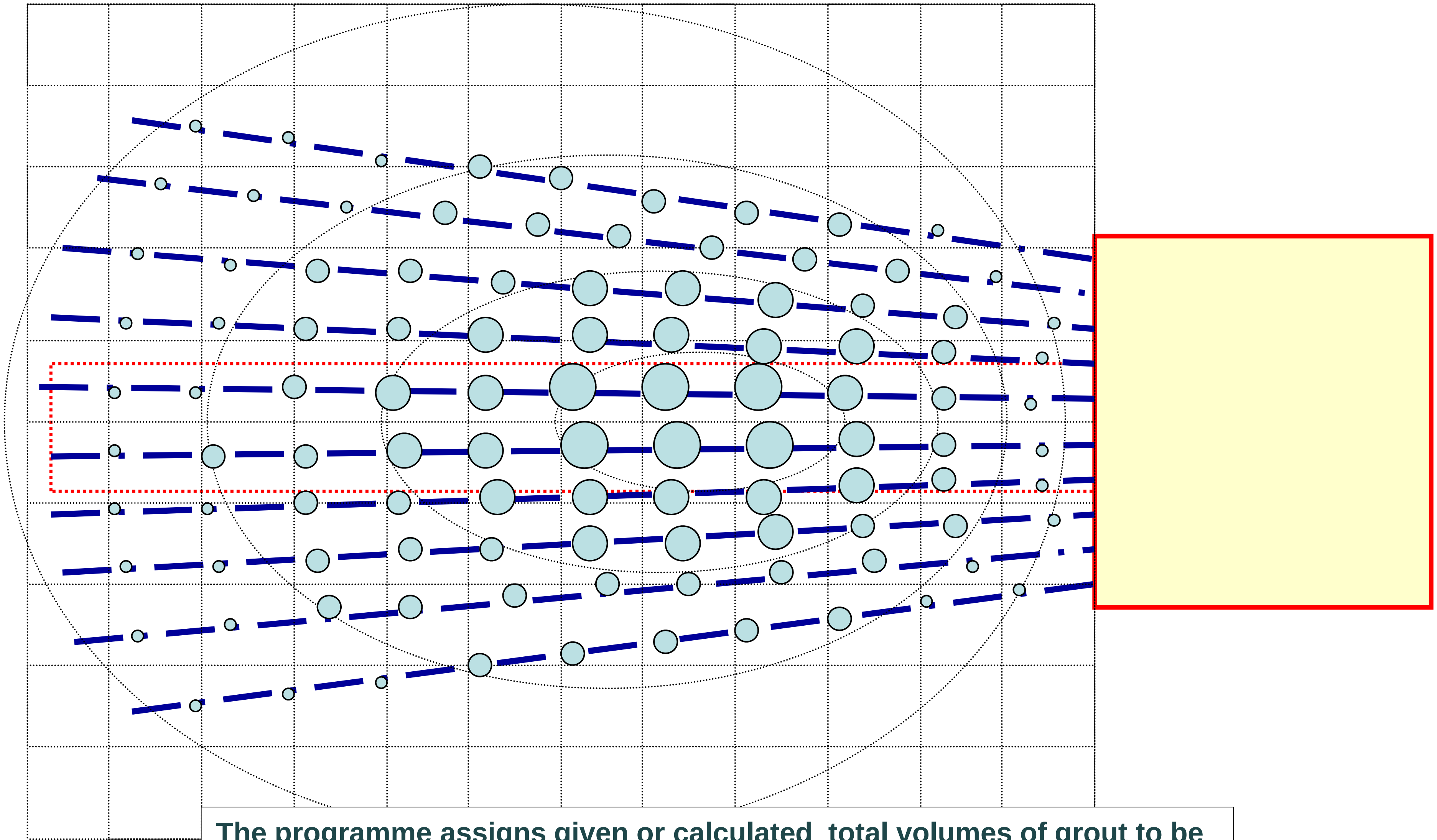


Compensation Grouting - example of basis of design



The programme takes the tunnel geometry, predicted settlement profile, and as-built borehole layout, and overlays a reference grid as a basis for design of injection programmes

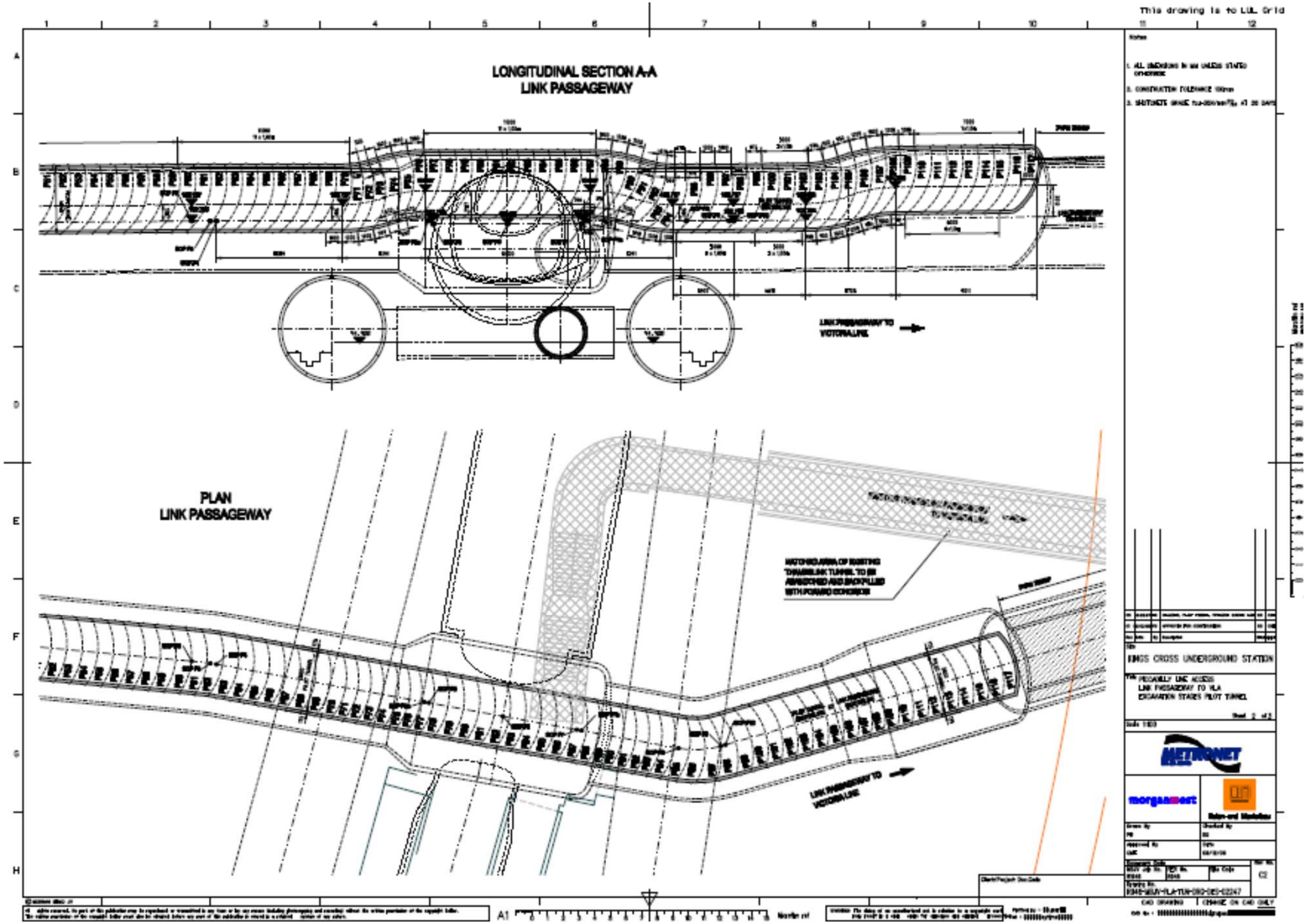
Compensation Grouting - example of basis of design



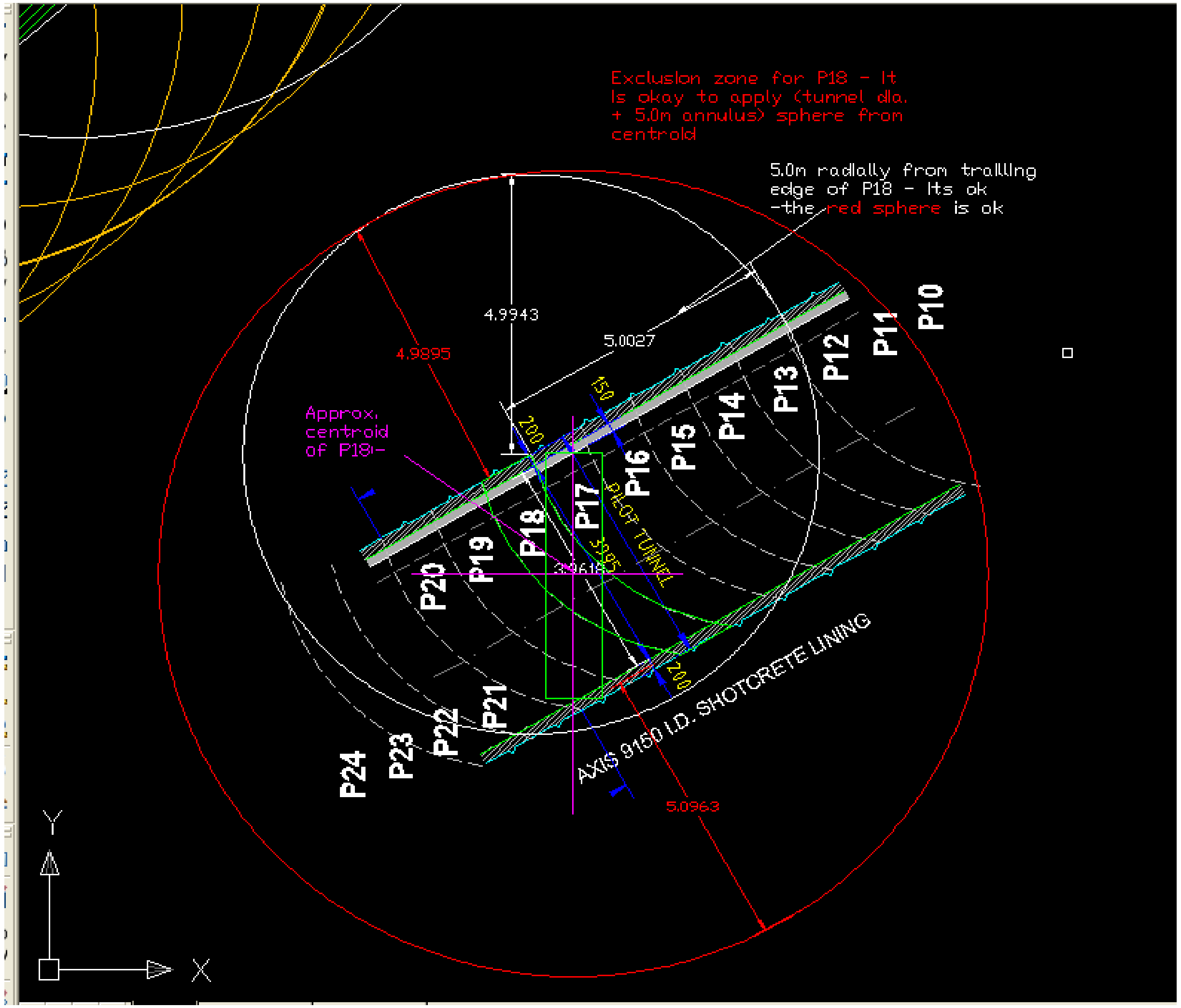
The programme assigns given or calculated total volumes of grout to be injected within each individual cell, for each phase of tunnel excavation.

Grout volumes derived from excavation volume, assumed face loss, GEC

Compensation Grouting - example of basis of design



Compensation Grouting - example of basis of design



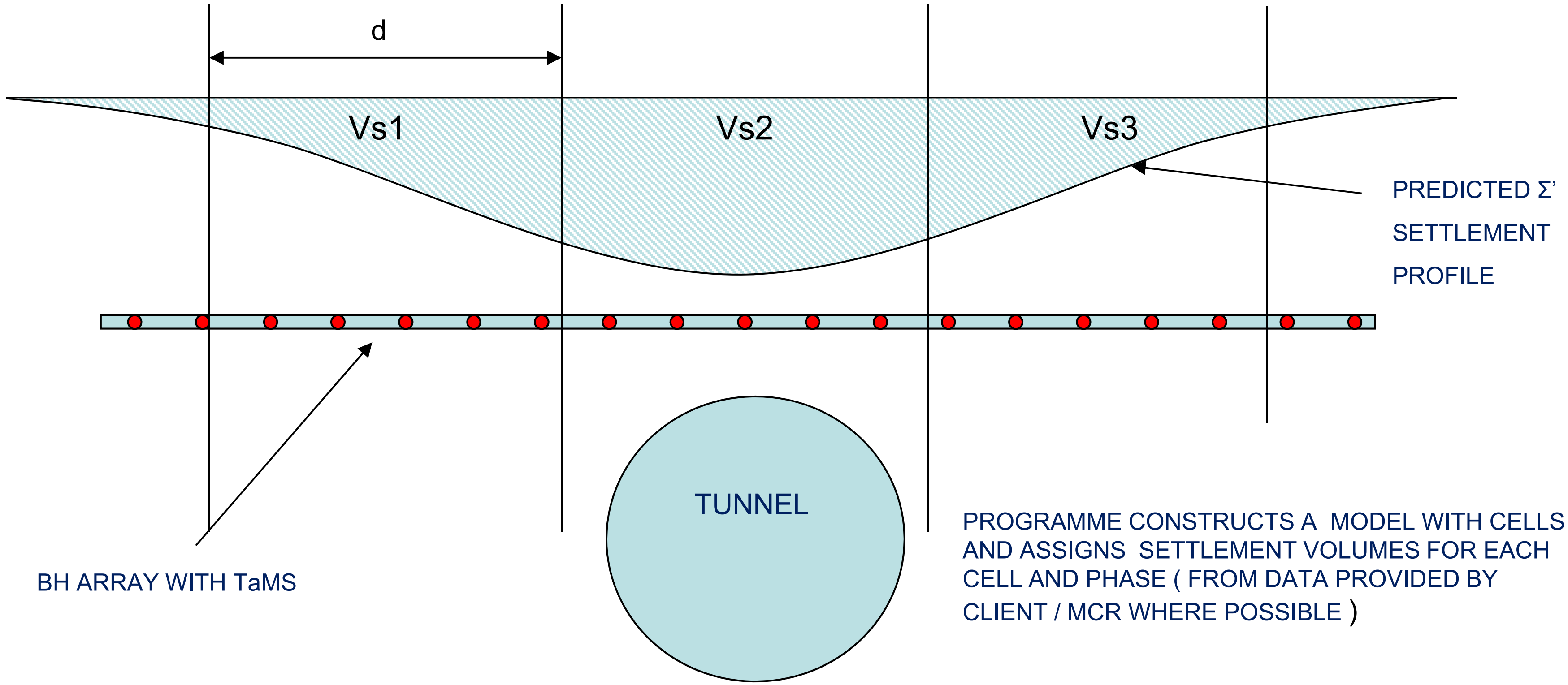
Creation of equivalent volume with common xyz location of centre of element

Application of same soil parameters, face loss assumptions, and settlement formulae as the client and the tunnelling designers

Automatic production of

- Surface volume loss for each 1m excavation element of each phase of tunnelling
- Application of GEC - the grouting efficiency co-eff., to calculate grout volume for each 1m element
- Grouting programme with grout distribution based upon surface settlement profile

Compensation Grouting - example of basis of design



IF THE CLIENT CAN NOT PROVIDE SETTLEMENT VOLUME, THE PROGRAMME WILL CALCULATE A THEORETICAL VOLUME BASED ON THE TOTAL SETTLEMENT.

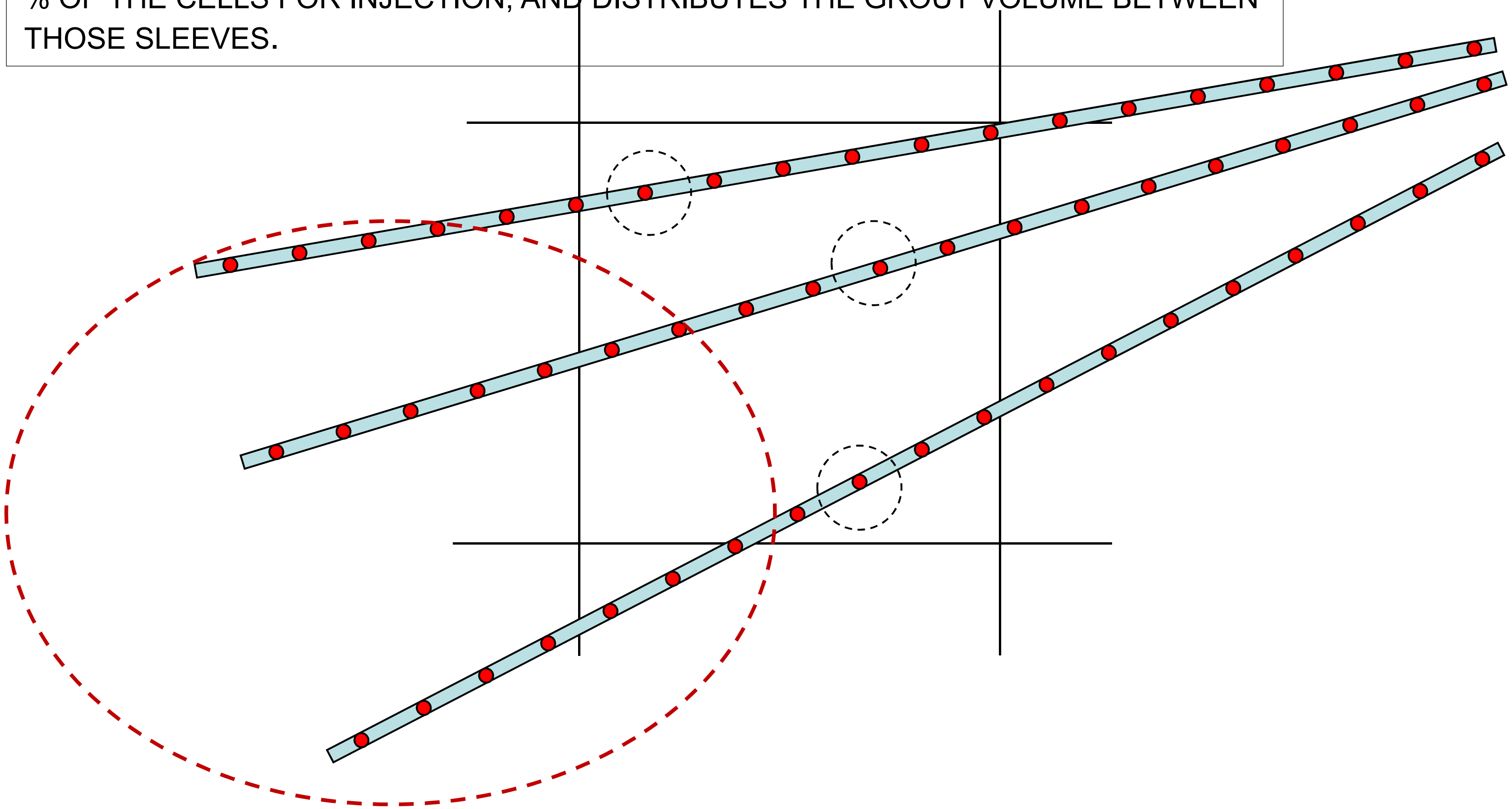
Vs = PREDICTED SETTLEMENT VOLUME PER CELL

d = AN ARBITRARY VALUE FOR THE 'CELL' DIMENSIONS APPROPRIATE TO THE WORKS

THE GROUT INJECTION VOLUME Vmax = Vs x EFFICIENCY CO-EFFICIENT (generally 3 - 5 for London Clay)

Compensation Grouting - example of basis of design

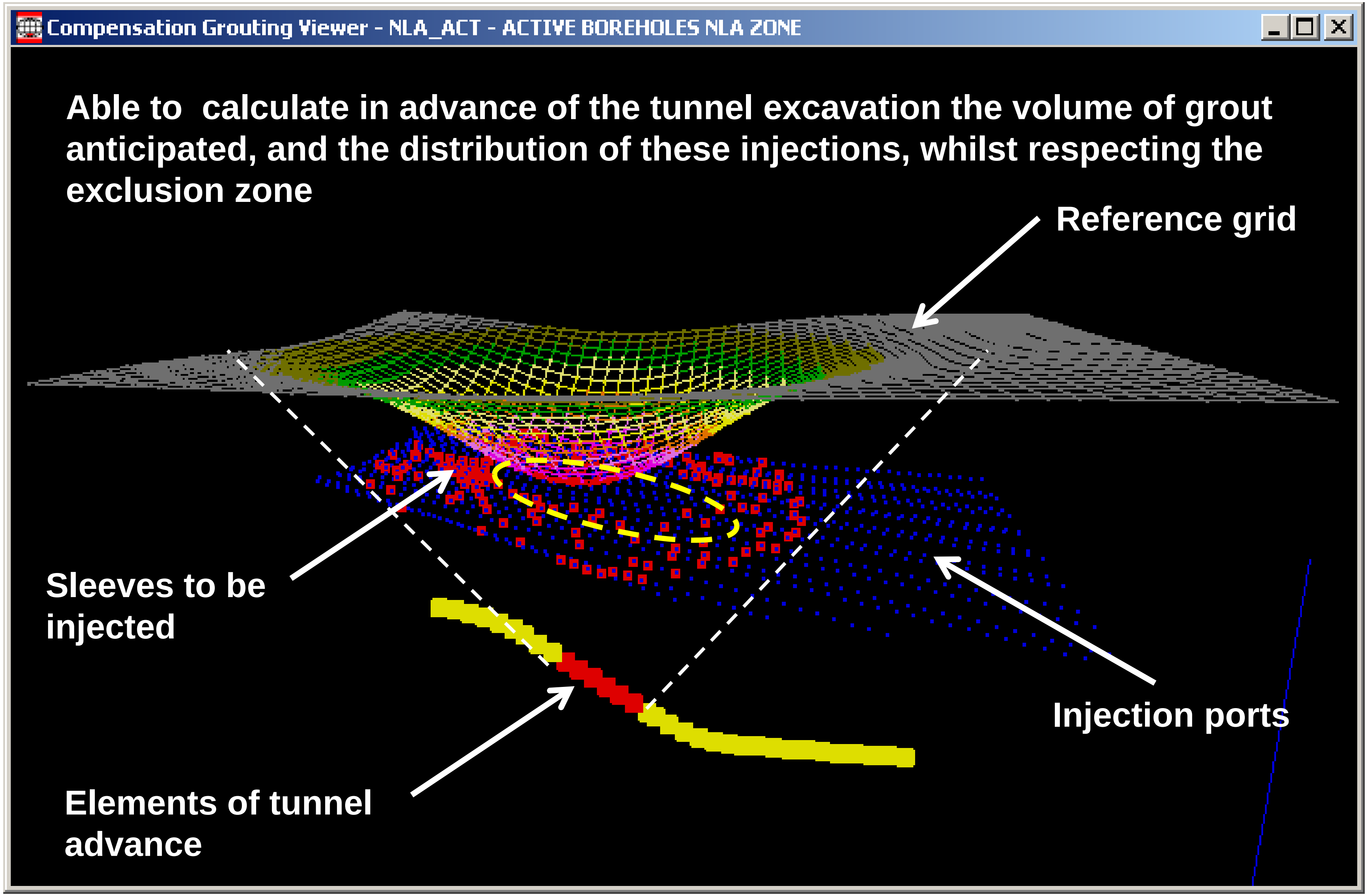
VOLUME Vs AND Vmax IS CALCULATED FOR EACH CELL AND COGNAC ALLOCATES A % OF THE CELLS FOR INJECTION, AND DISTRIBUTES THE GROUT VOLUME BETWEEN THOSE SLEEVES.



A PRACTICAL MINIMUM FIGURE Vmin IS SET FOR EACH INJECTION (e.g. 20-25*lts*) AND A Vmax IS SET FOR EACH INJECTION, GENERALLY ≤ 50*lts*.

INJECTION RANGE WOULD THEREFORE BE 25-50*lts*, AND THE PROGRAMME SELECTS A NUMBER OF BOREHOLES NECESSARY FOR VOLUME TO BE INJECTED.

Compensation Grouting - example of basis of design



Compensation Grouting - example of basis of design

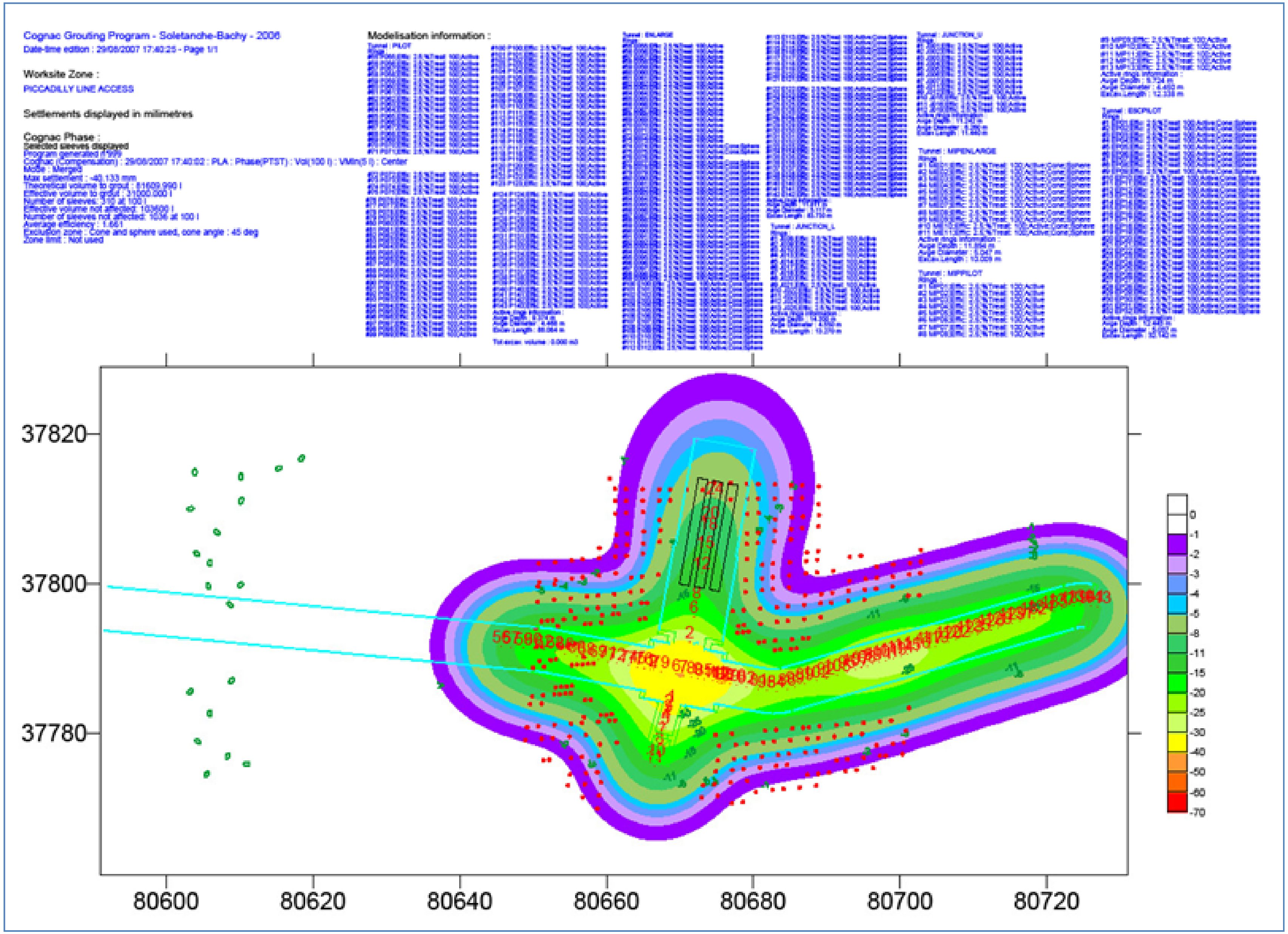
Grid cells : Site Tunnel NATM

SITE	Row	Column	Efficiency	ThVLoss	ThSettlement	ThGroutVolume	XCenter	YCenter
NATM	8	12	5	37.017	-5.923	185.087	-14.326	-275.505
NATM	8	13	5	39.721	-6.355	198.607	-13.655	-273.097
NATM	9	1	5	48.3	-7.728	241.501	-24.116	-301.325
NATM	9	2	5	41.81	-6.69	209.049	-23.445	-298.917
NATM	9	3	5	35.961	-5.754	179.803	-22.774	-296.508
NATM	9	4	5	31.185	-4.99	155.925	-22.102	-294.1
NATM	9	5	5	27.842	-4.455	139.209	-21.431	-291.692
NATM	9	6	5	26.162	-4.186	130.81	-20.76	-289.284
NATM	9	7	5	26.209	-4.193	131.045	-20.089	-286.875
NATM	9	8	5	27.863	-4.458	139.315	-19.418	-284.467
NATM	9	9	5	30.83	-4.933	154.15	-18.747	-282.059
NATM	9	10	5	34.676	-5.548	173.378	-18.076	-279.651
NATM	9	11	5	38.877	-6.22	194.385	-17.405	-277.242
NATM	9	12	5	42.885	-6.862	214.424	-16.734	-274.834

107 / 300 | By Row

Close

Compensation Grouting - example of basis of design



Compensation Grouting - example of basis of design

Date-time edition : 25/02/2007 14:24:08 - Page 1/1

Worksite Zone :

NORTHERN LINE ACCESS

Settlements displayed in milimetres

Cognac Phase :

Program generated n°999
Cognac (Compensation) : 25/02/2007 14:23:54 : NLA : Phase(NT03) : Vol(20 l) : VMin(5 l) : Random
Mode : Merged
Max settlement : -4.985 mm
Theoretical volume to grout : 1319.446 l
Effective volume to grout : 440.000 l
Number of sleeves: 22 at 20 l
Effective volume not affected: 1580 l
Number of sleeves not affected: 79 at 20 l
Average efficiency : 1.143
Exclusion zone : Cone and sphere used, cone angle : 45 deg
Zone limit : Not used

Modelisation information :

Tunnel : PILOT
Active rings :
P01 n°1 ; Effic: 2.5 ; %Treat: 100 ; WFace
P02 n°2 ; Effic: 2.5 ; %Treat: 100 ; WFace
P03 n°3 ; Effic: 2.5 ; %Treat: 100 ; WFace
P04 n°4 ; Effic: 2.5 ; %Treat: 100 ; WFace
P05 n°5 ; Effic: 2.5 ; %Treat: 100 ; WFace
P06 n°6 ; Effic: 2.5 ; %Treat: 100 ; WFace
P07 n°7 ; Effic: 2.5 ; %Treat: 100 ; WFace
P08 n°8 ; Effic: 2.5 ; %Treat: 100 ; WFace
P09 n°9 ; Effic: 2.5 ; %Treat: 100 ; WFace
Avge Depth : 8.754 m
Avge Diameter : 1.487 m
Excav.Length : 8.052 m

Tot excav. volume : 39.868 m3

Excavation volume	= 39.868m3
Est'd face loss	= 1.4%
39.868m3 x 1.4%	= 0.558m3
Efficiency Factor	= 2.5
Theo. Volume of grout	= 1329.446 lts
Actual Volume available	
Outside exclusion zone	= 440 lts
Retained volume	= 1889 lts

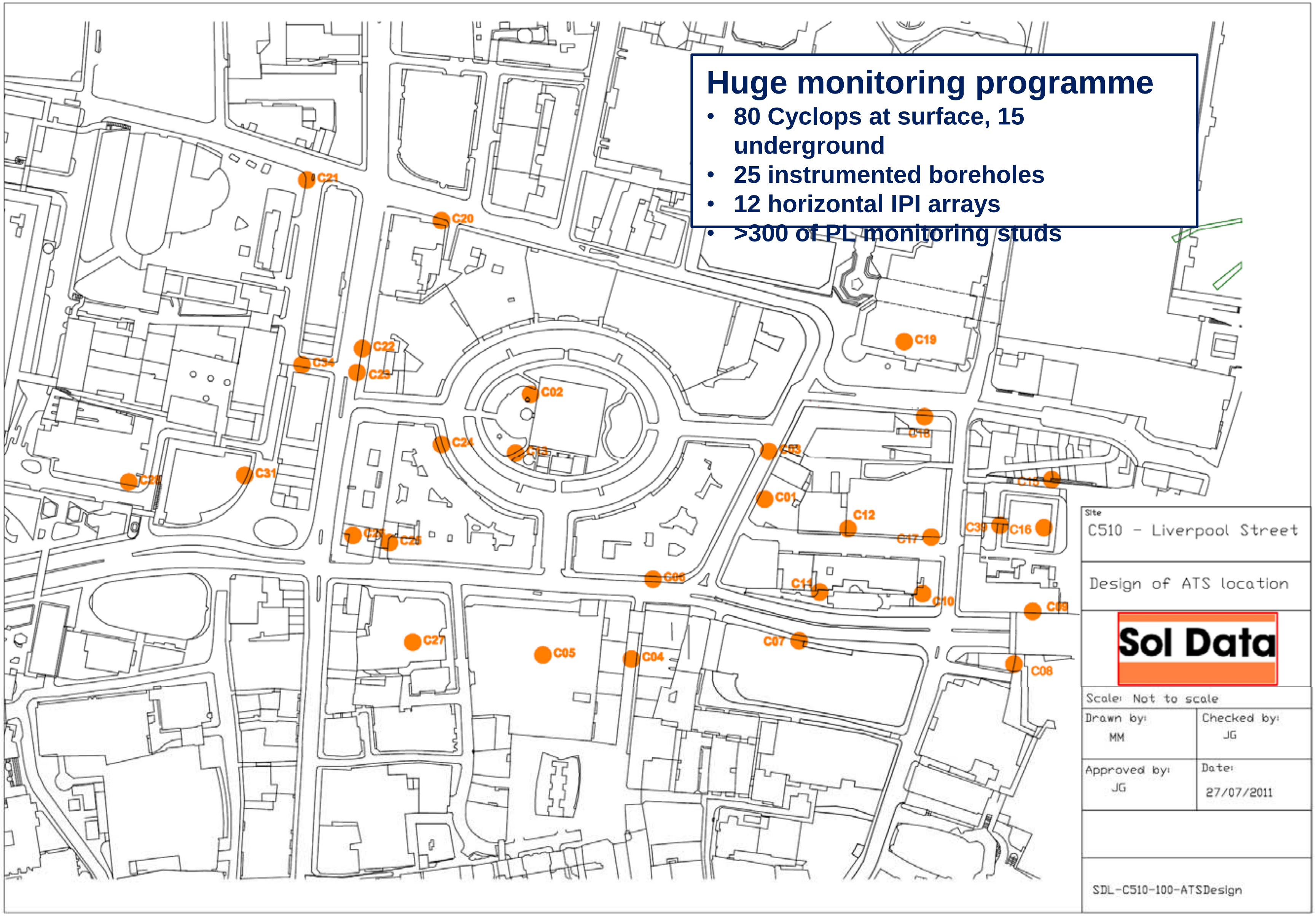
As the settlement develops, the programme prepares Injection programmes in phases according to the volume of settlement predicted for each phase, and the rate of progress . The model is refined daily on the basis of settlement and injection data

Crossrail C510 - Liverpool Street Station

Crossrail Liverpool St Station

Huge monitoring programme

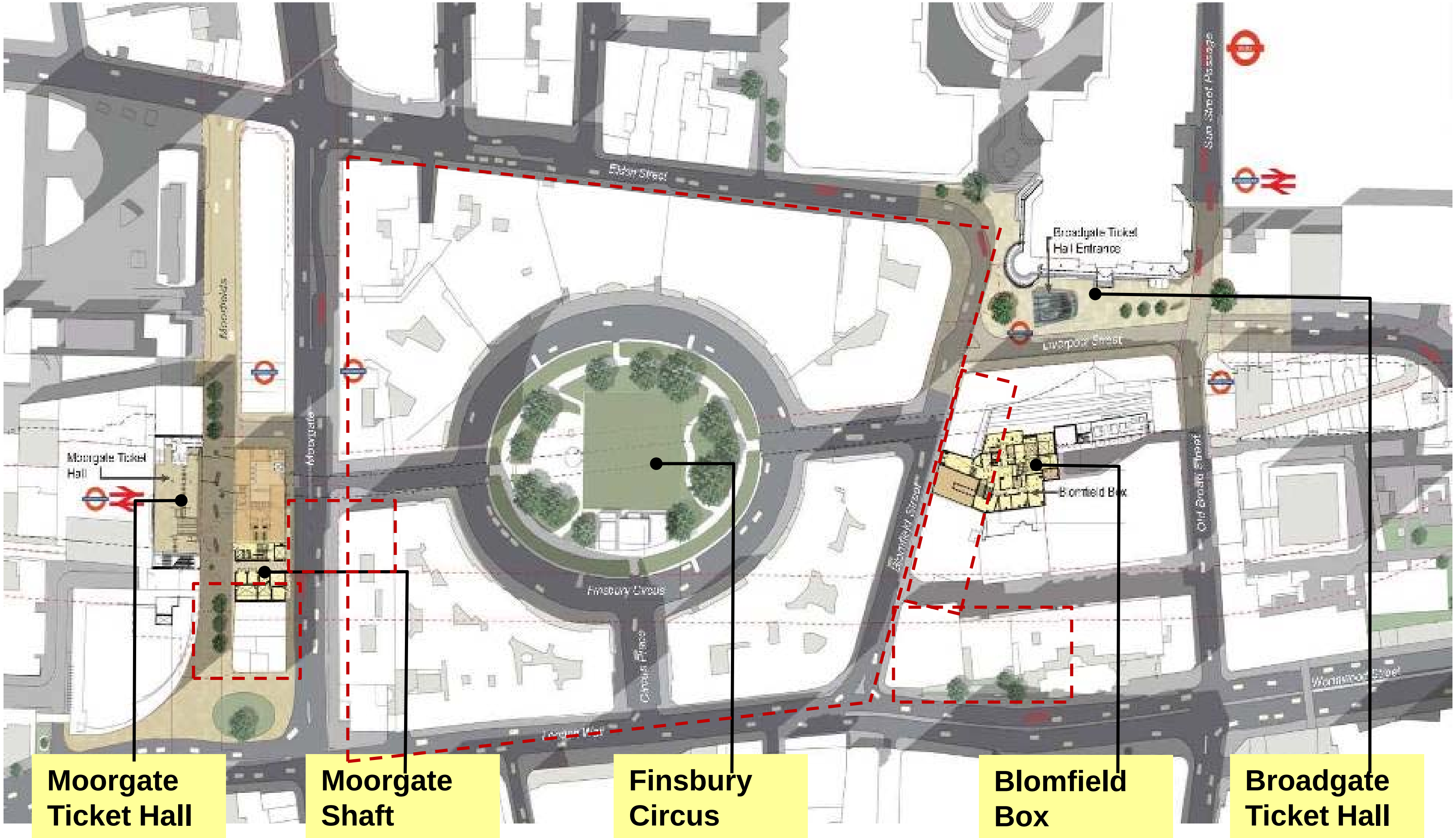
- 80 Cyclops at surface, 15 underground
- 25 instrumented boreholes
- 12 horizontal IPI arrays
- >300 of PL monitoring studs



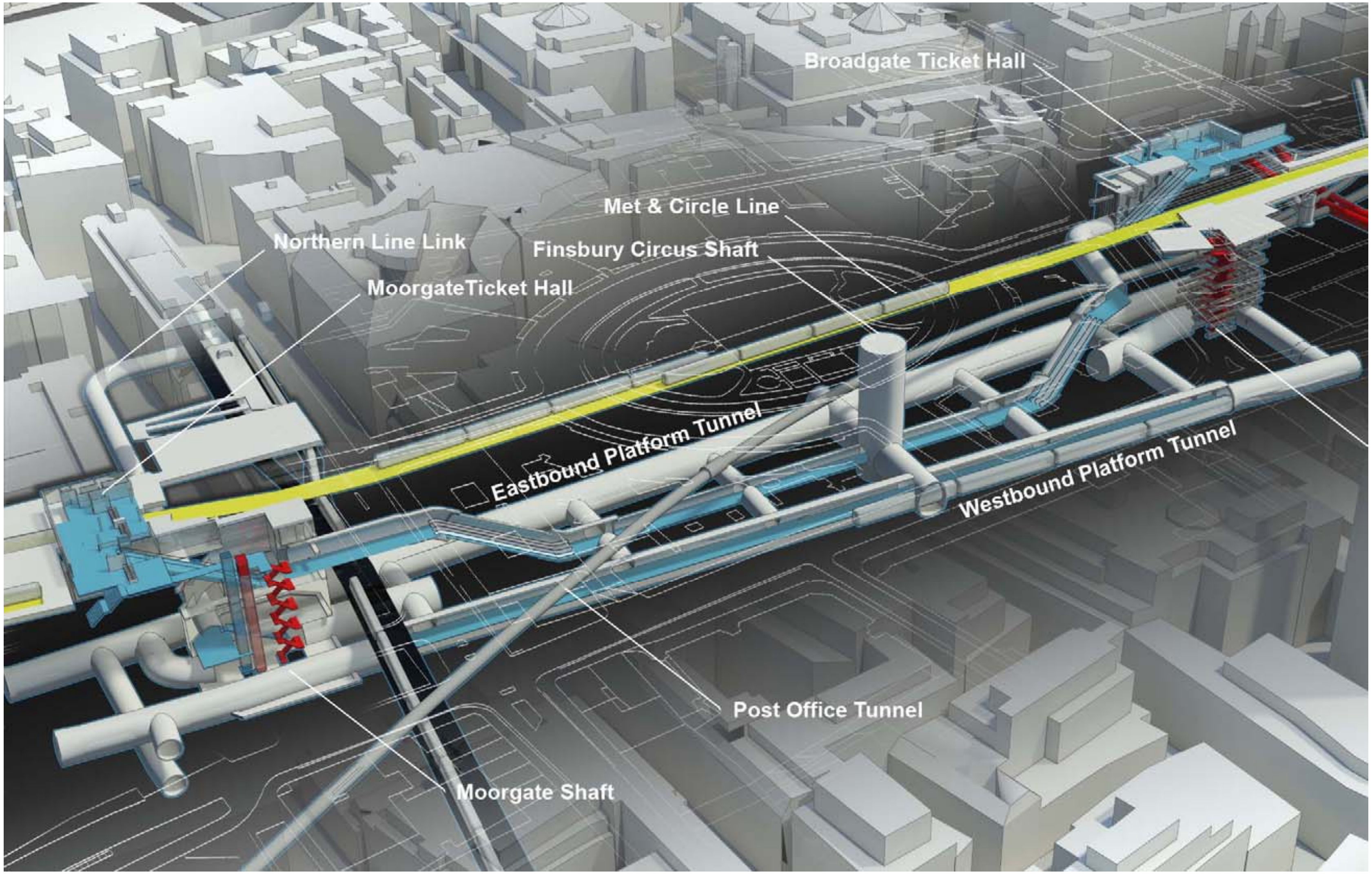
Crossrail Liverpool St Station

Very large listed structures, mixed foundations, high loads, limited access, influential owners - example : Finsbury Circus

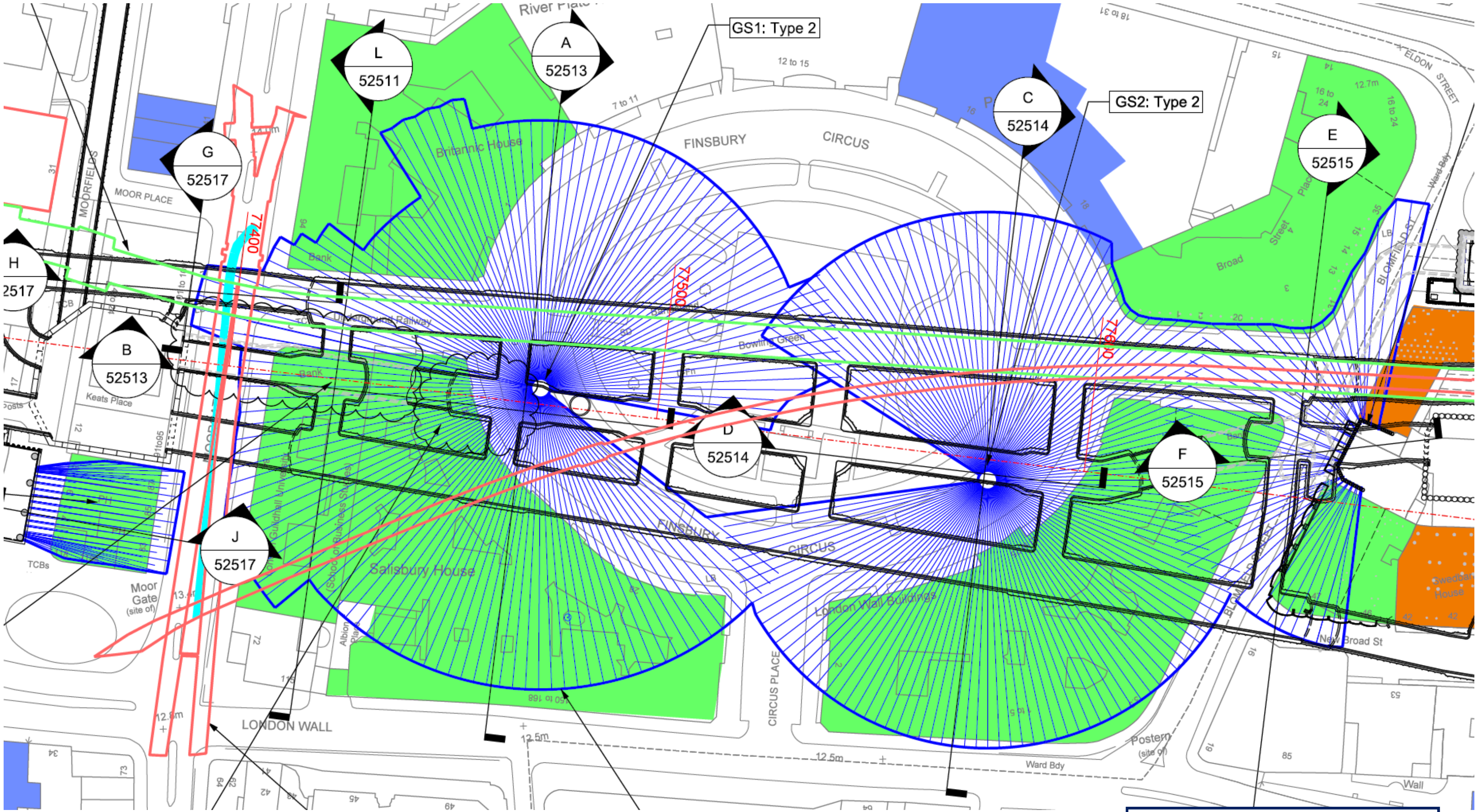
Liverpool Street Station



Crossrail Liverpool St Station



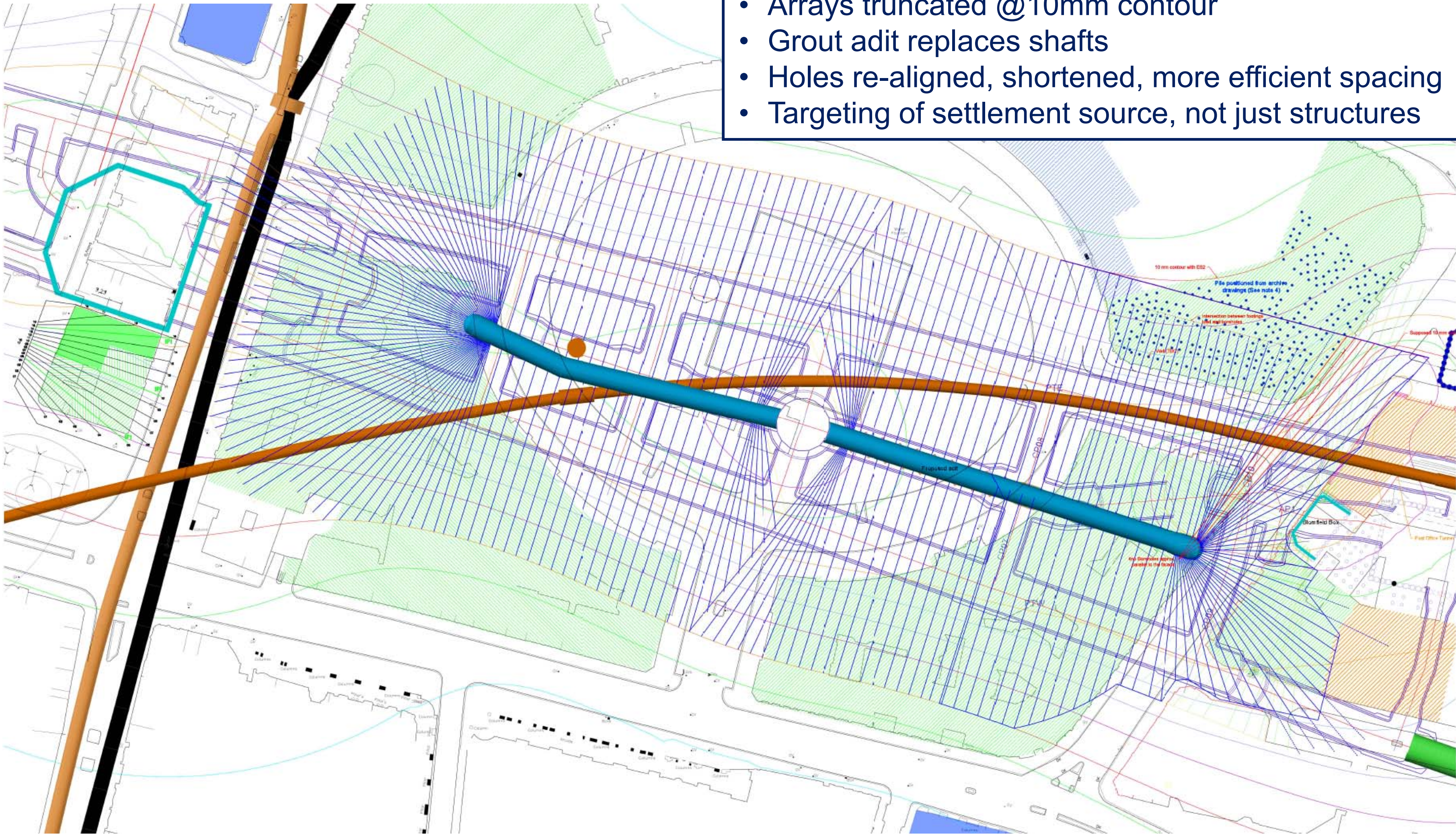
Crossrail Liverpool St Station



Original design

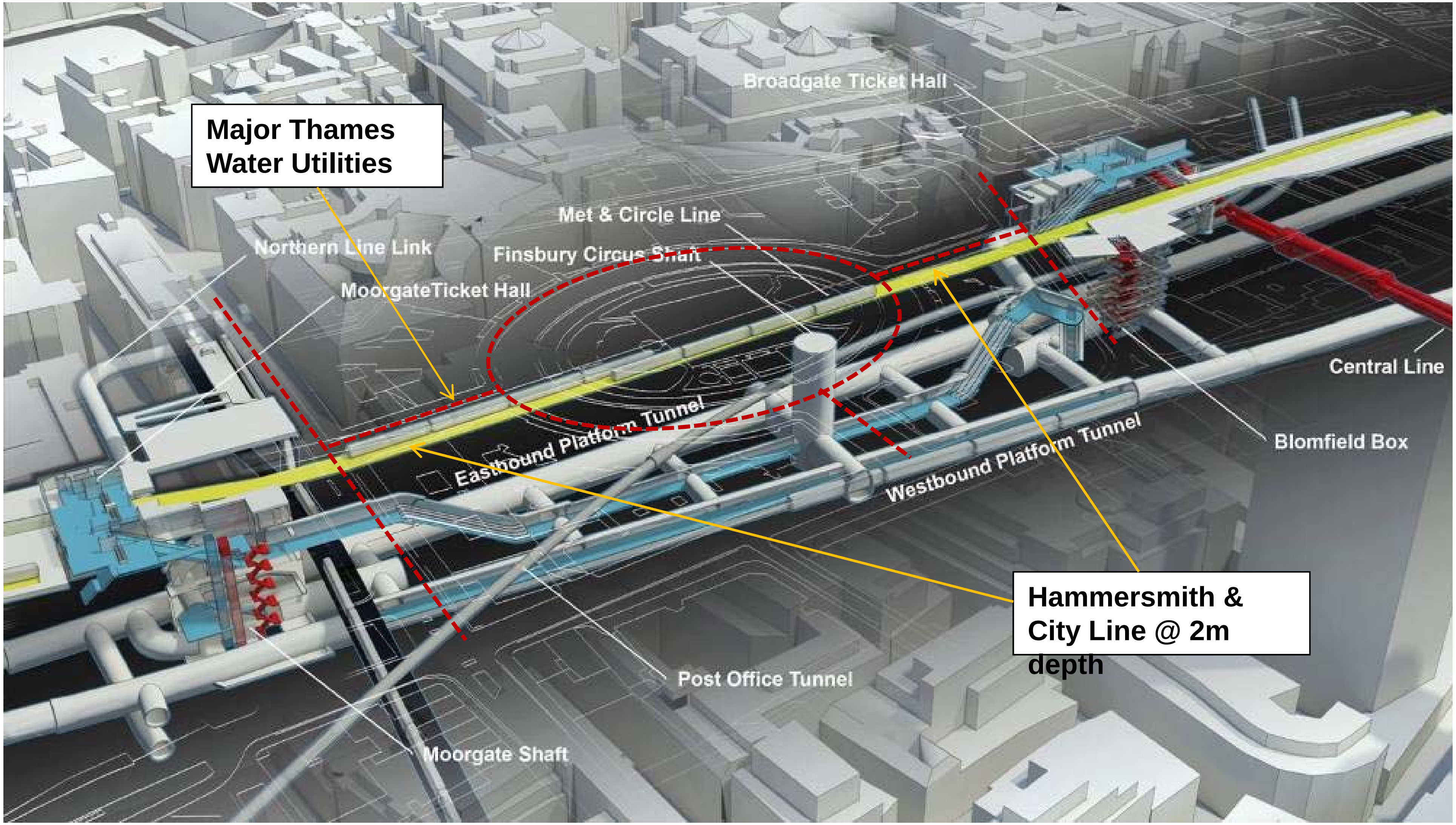
Crossrail Liverpool St Station

- Arrays truncated @10mm contour
- Grout adit replaces shafts
- Holes re-aligned, shortened, more efficient spacing
- Targeting of settlement source, not just structures

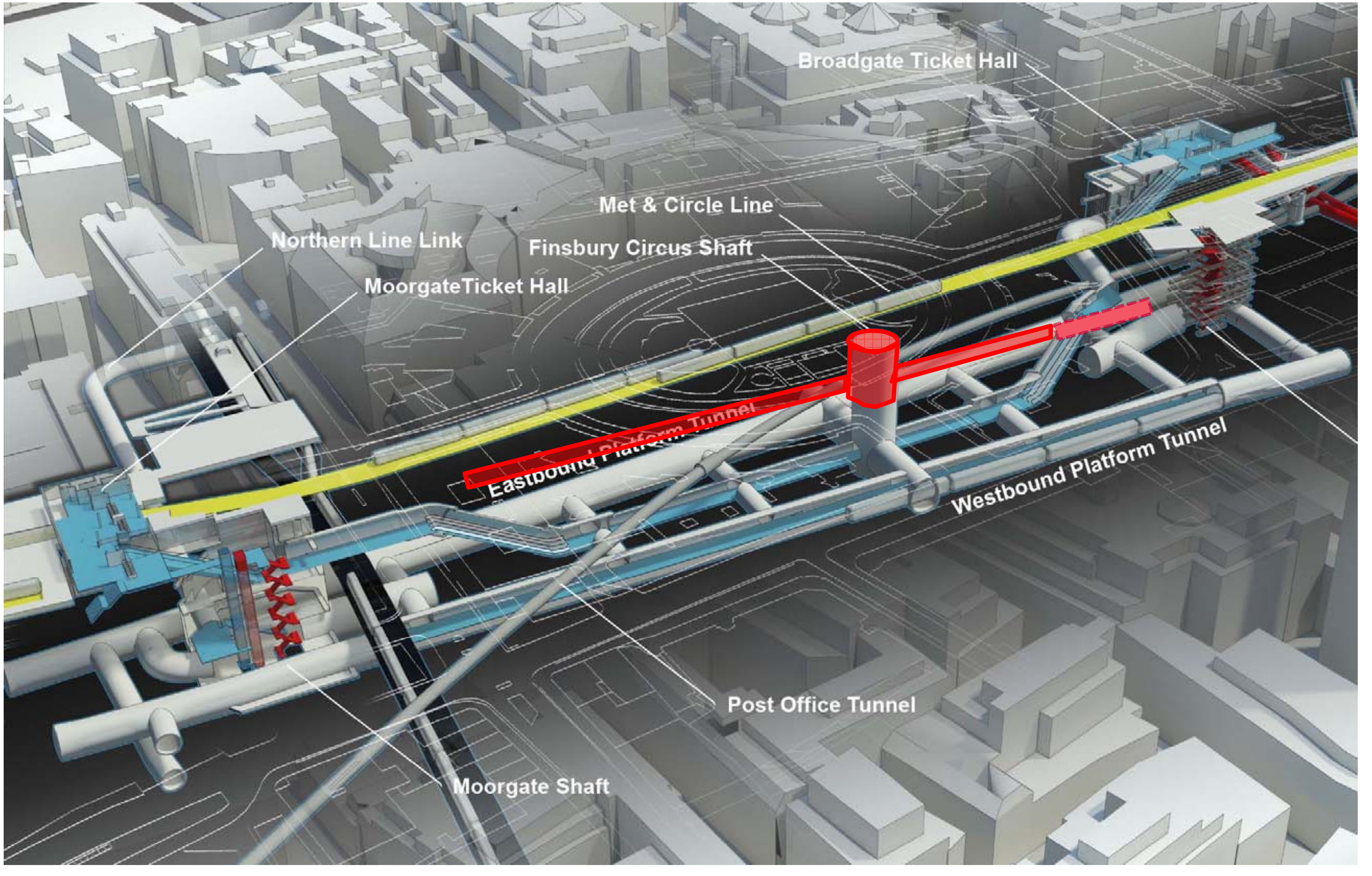


Optimised design

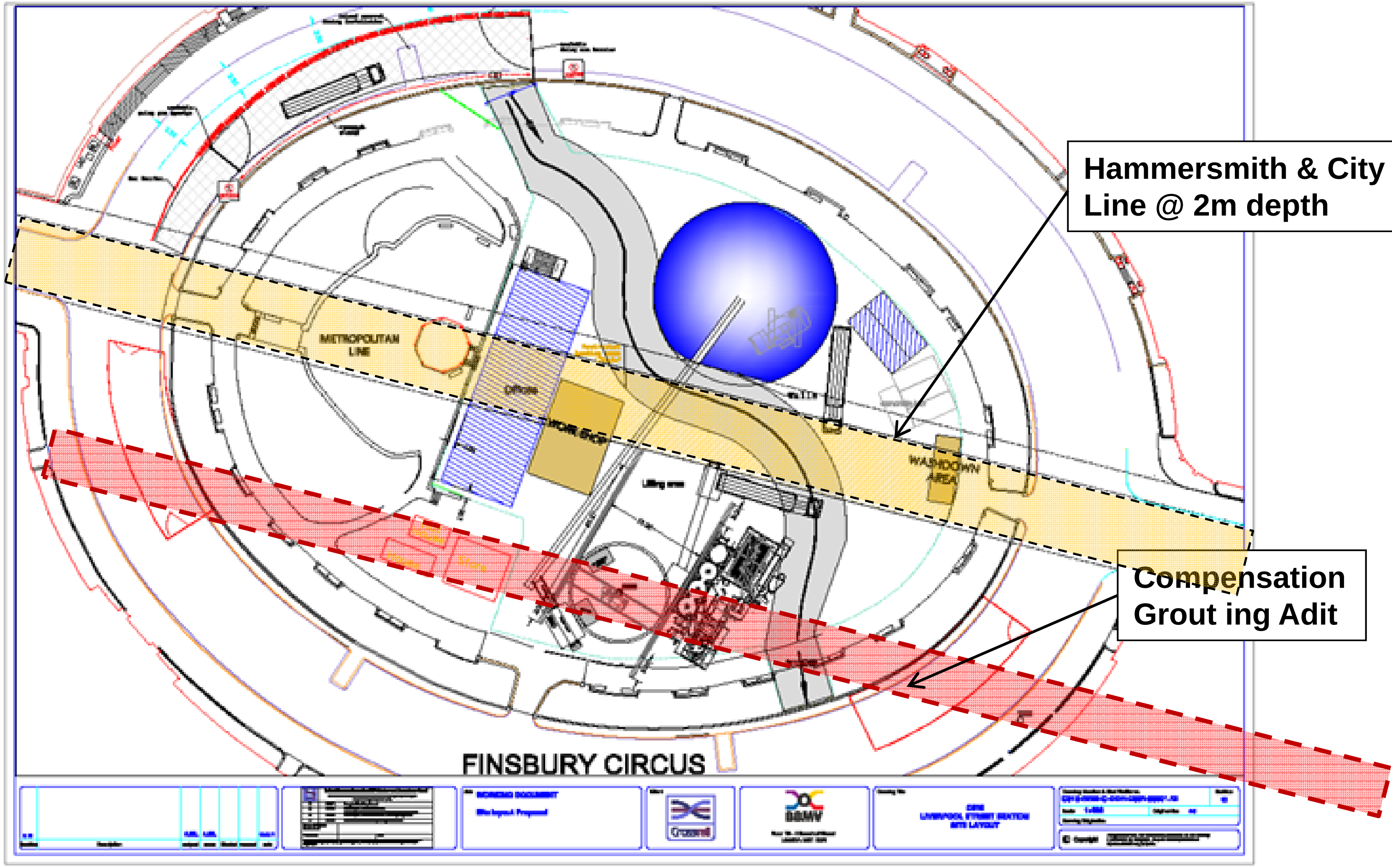
Liverpool St Station



Crossrail Liverpool St Station

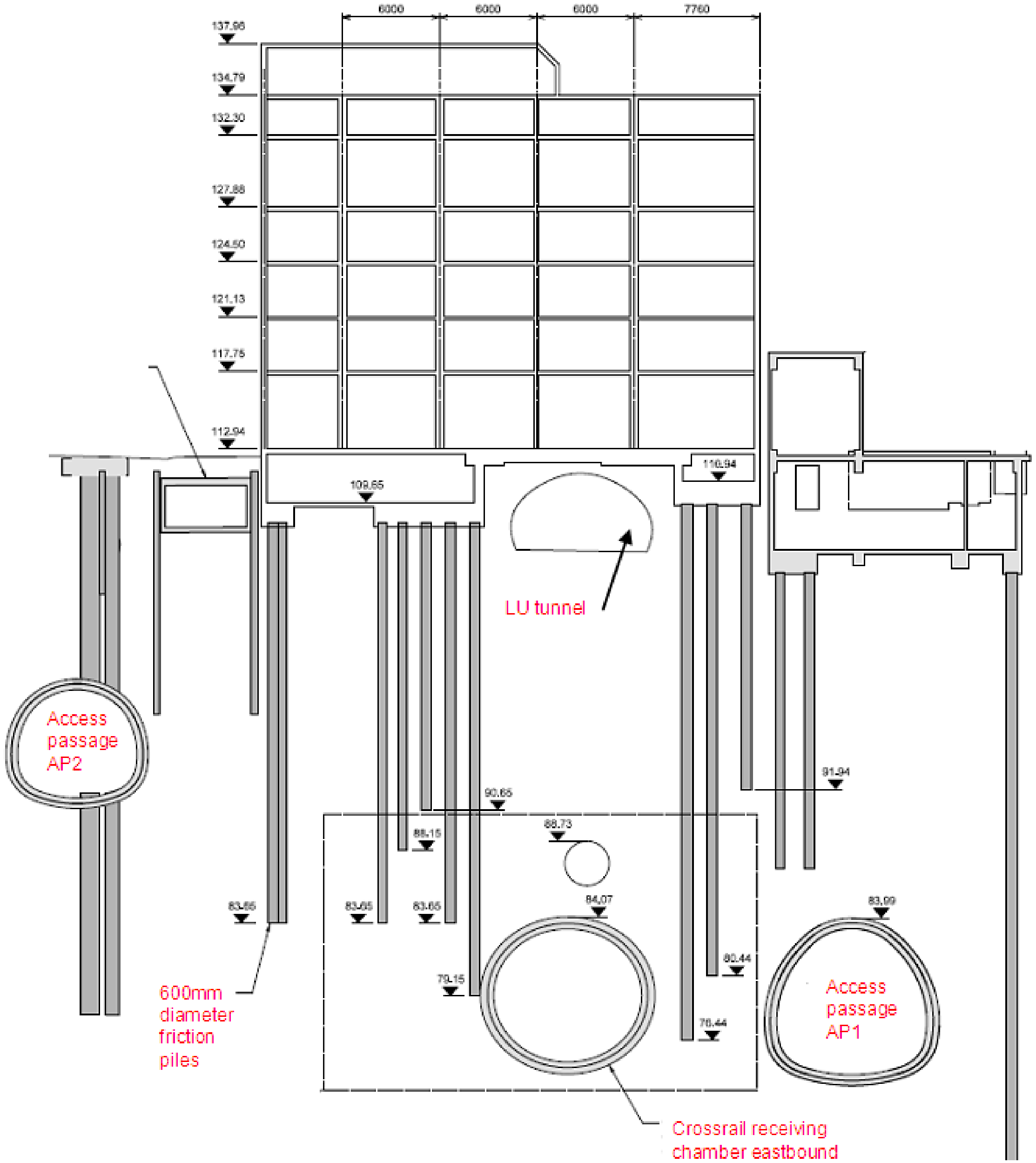


Finsbury Circus Site Layout

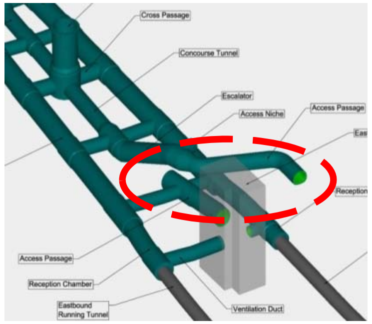


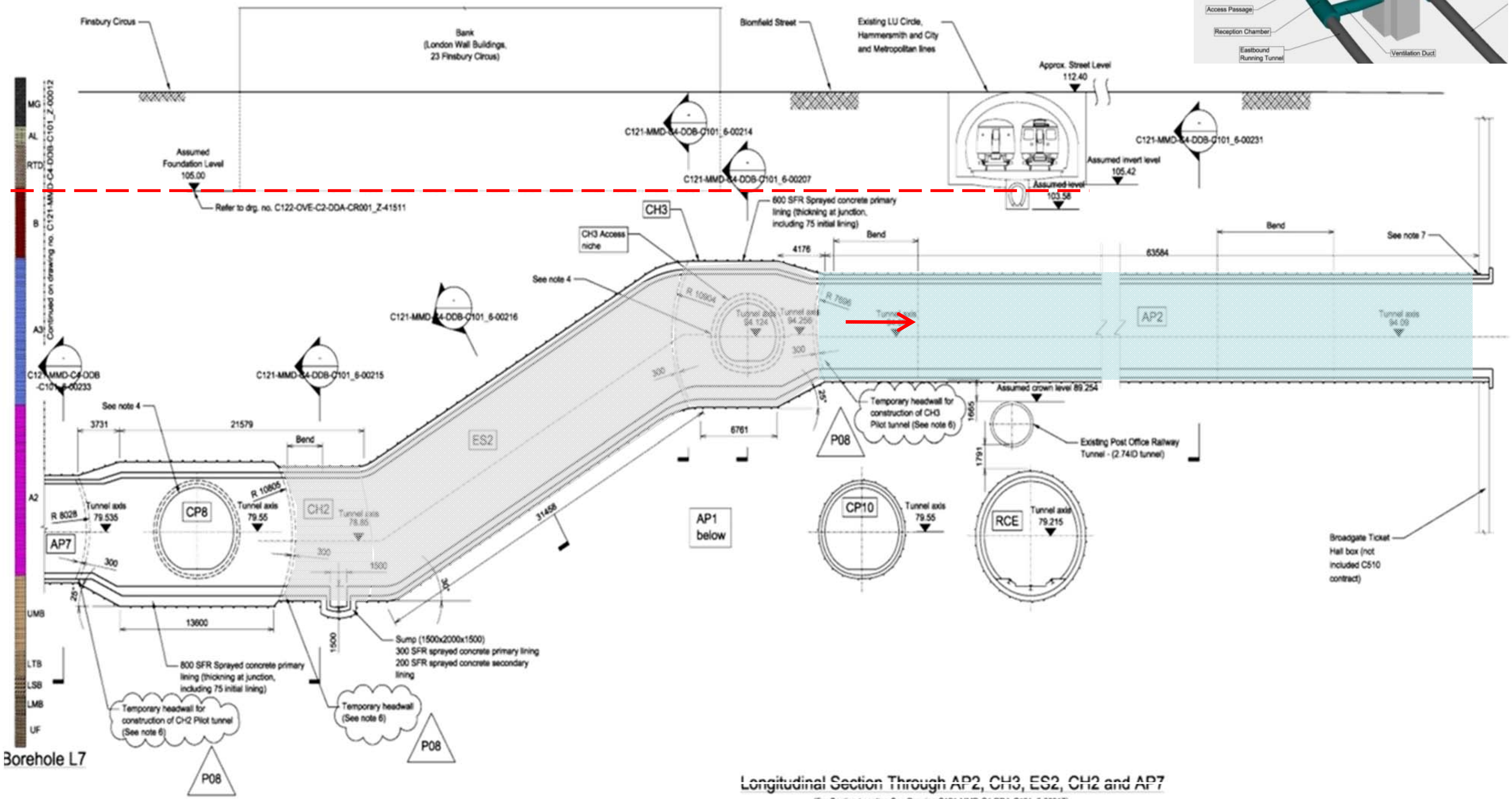
Crossrail C510 - 1 to 5 Broad St. Place

1-5 Broad St Place



1-5 Broad St Place

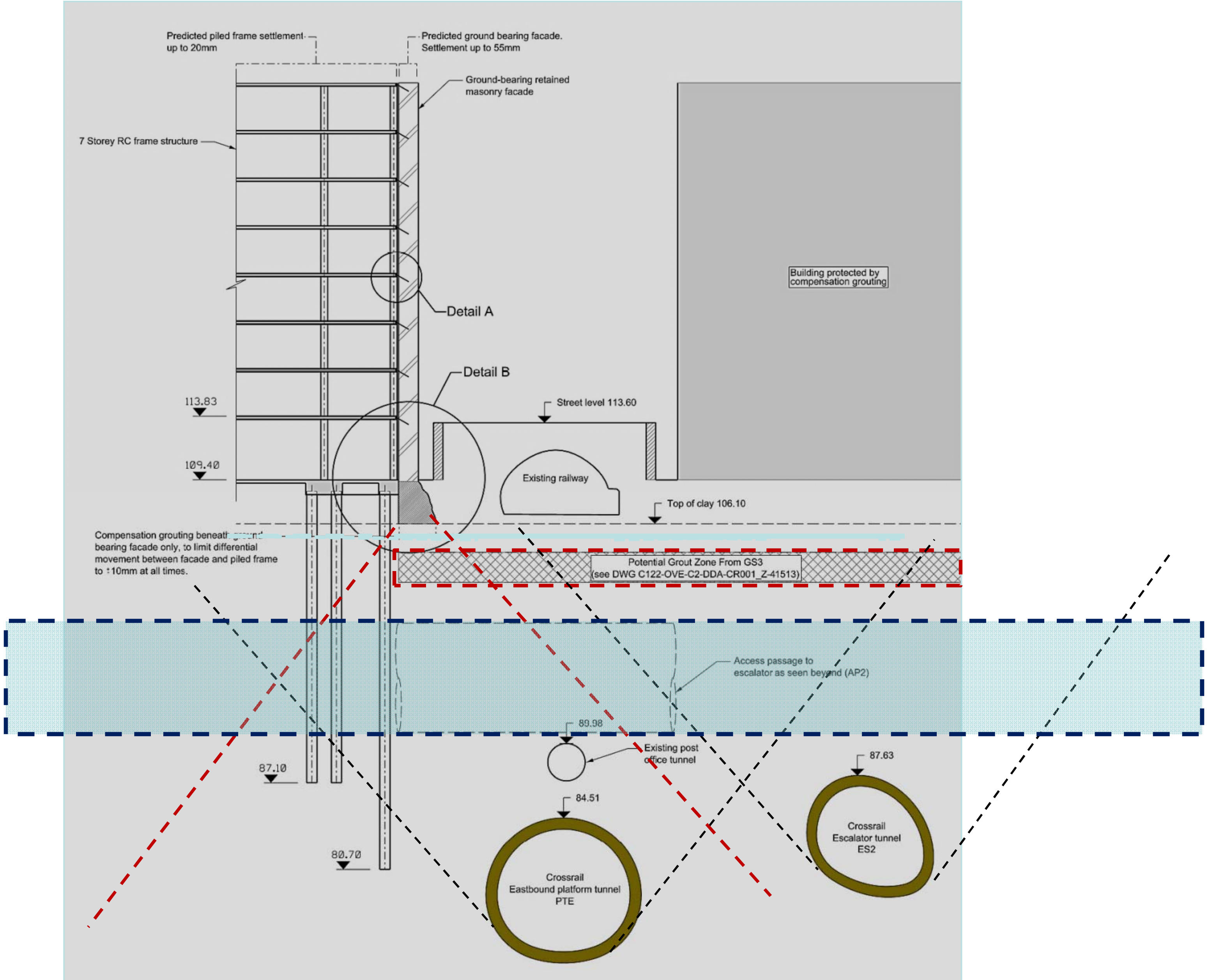




Longitudinal Section Through AP2, CH3, ES2, CH2 and AP7

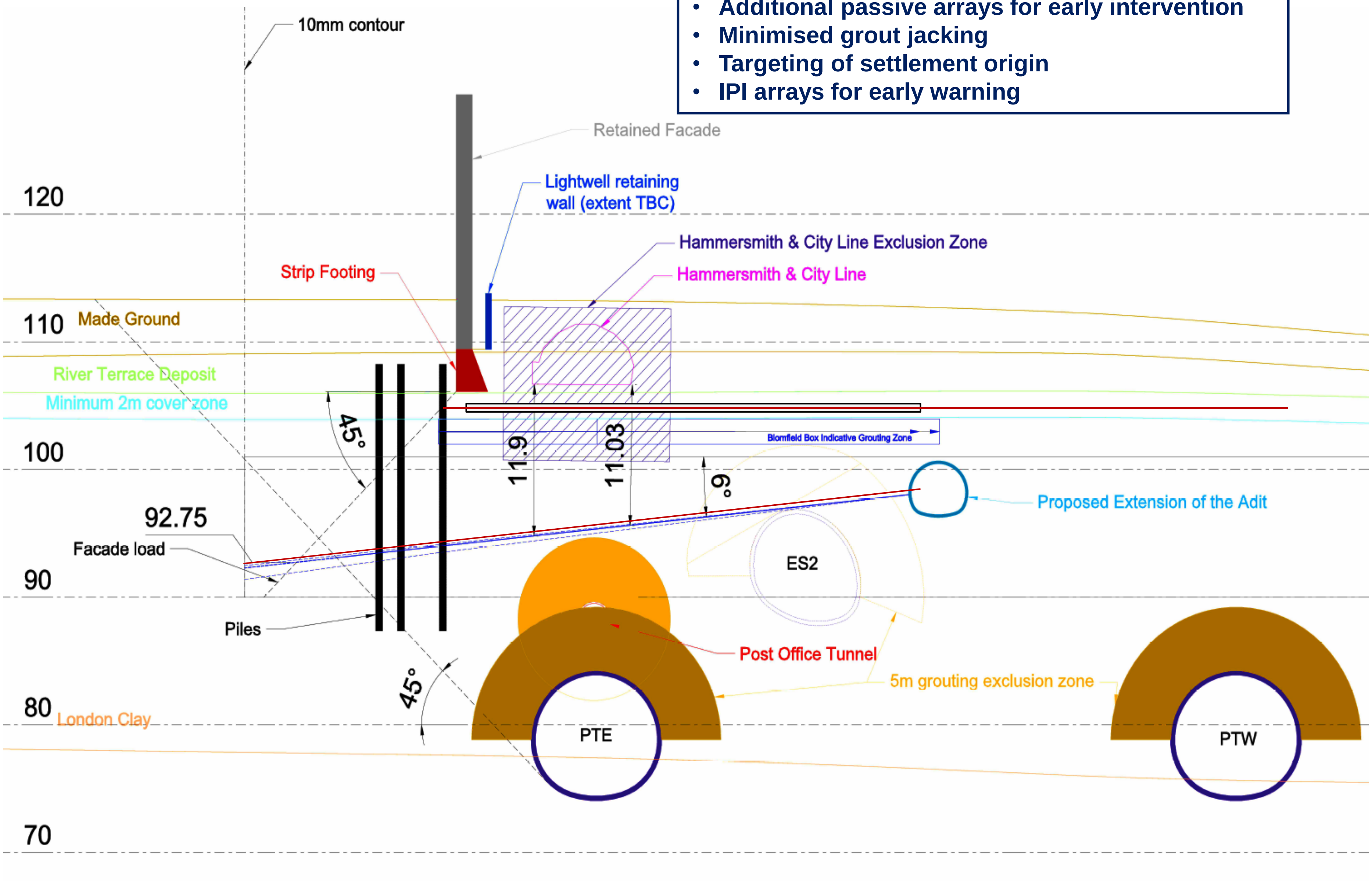
1) Early Development of Broadgate Link: Phase 3

Crossrail Liverpool St Station

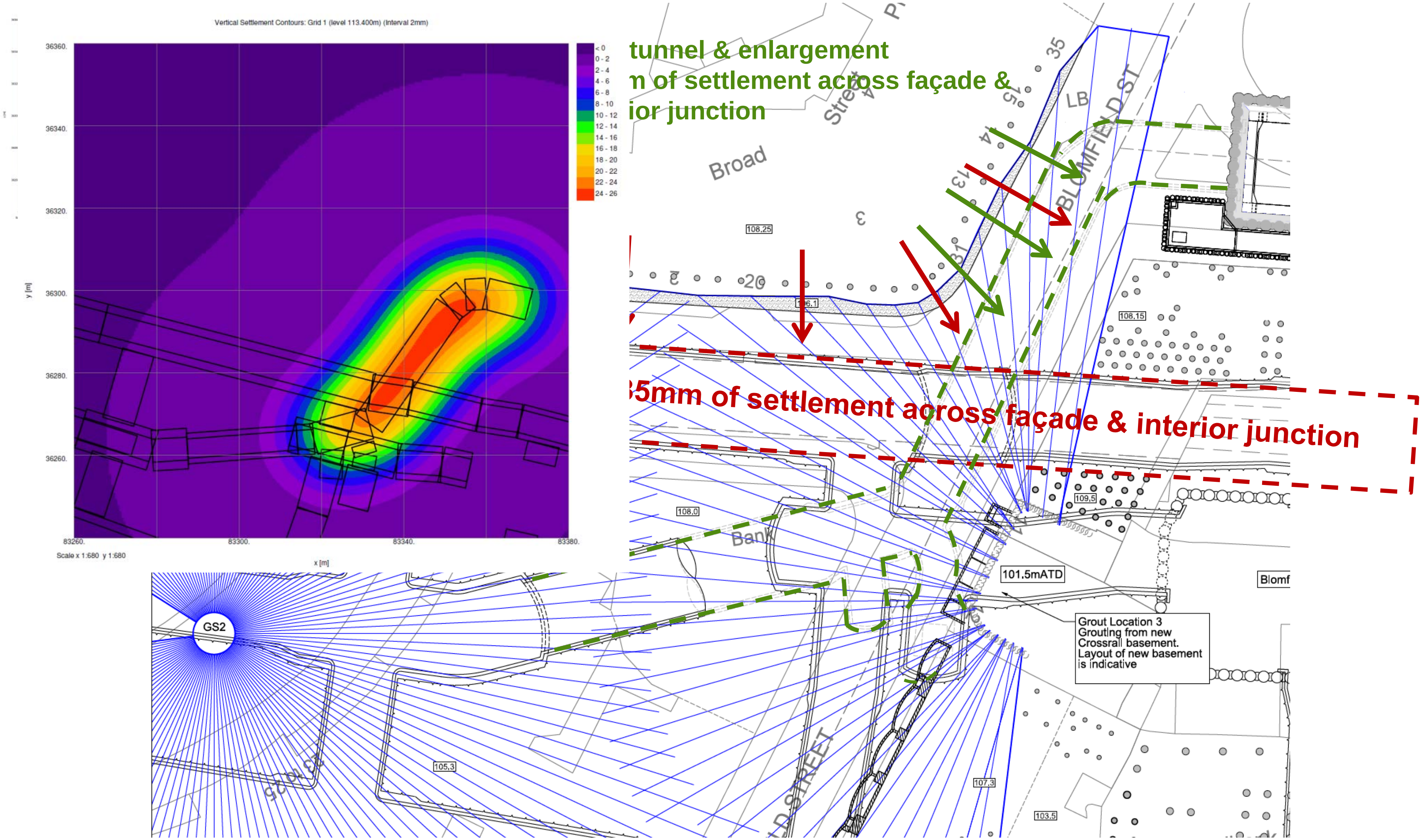


1-5 Broad St Place

- **Additional passive arrays for early intervention**
- **Minimised grout jacking**
- **Targeting of settlement origin**
- **IPI arrays for early warning**

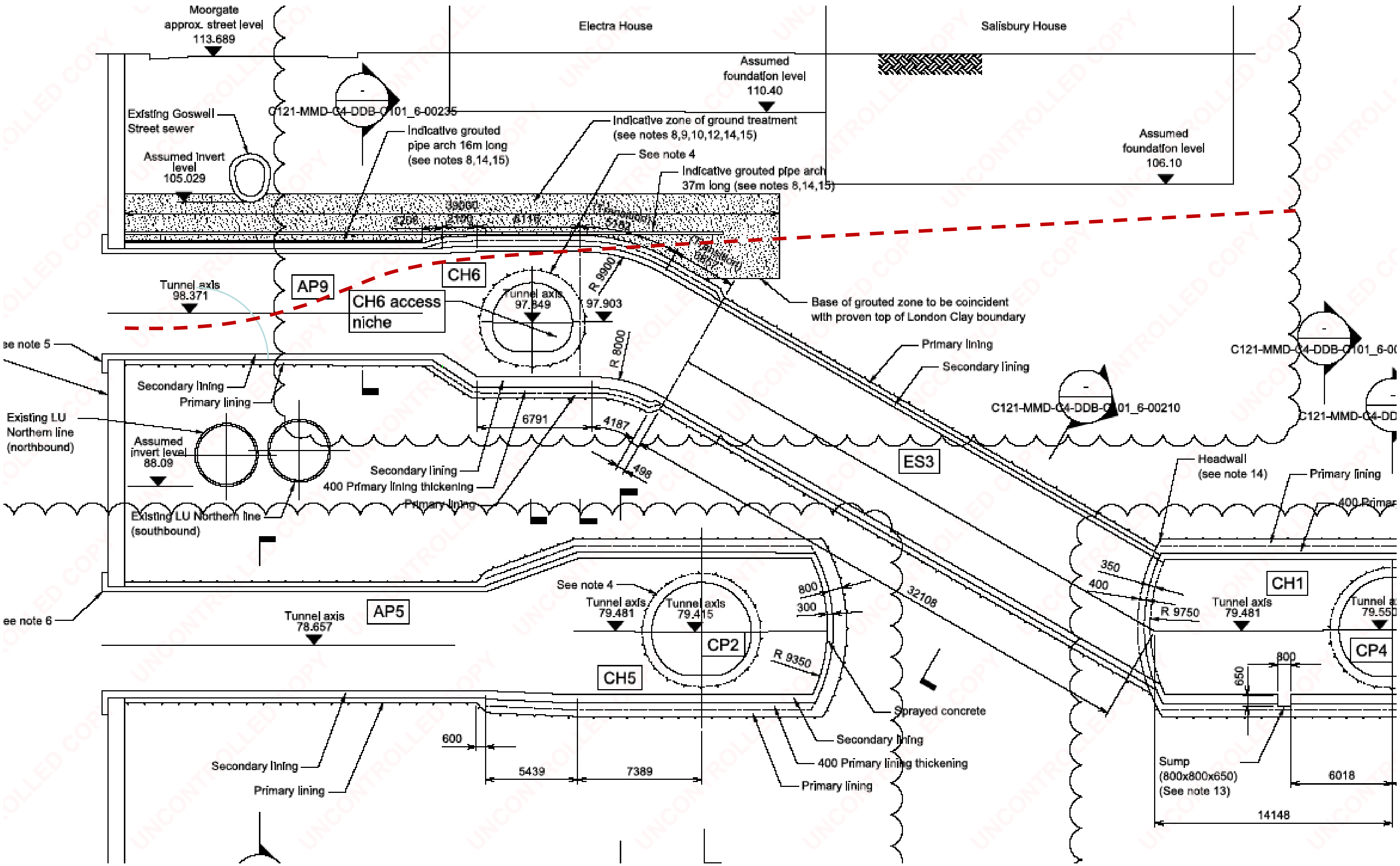


1-5 Broad St Place

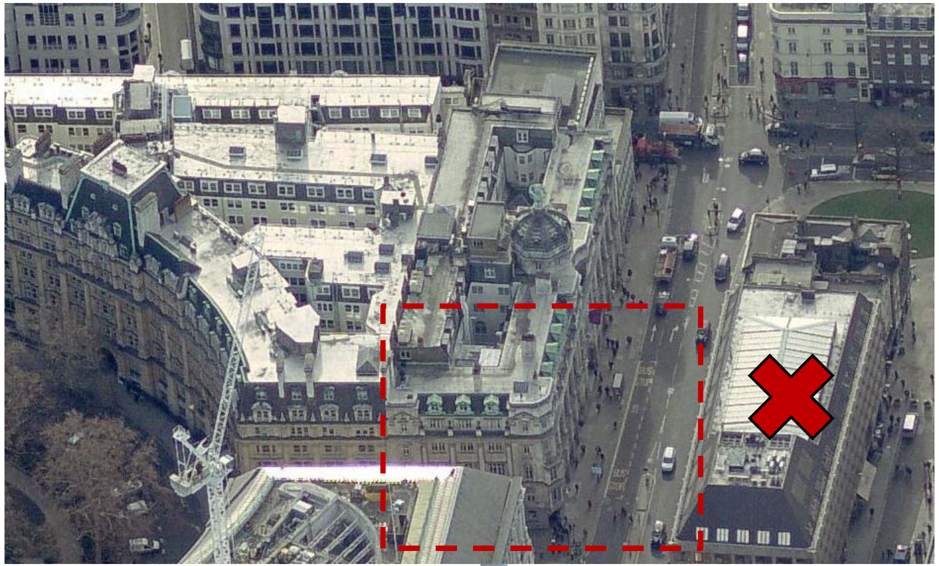


Crossrail C510 - Electra House

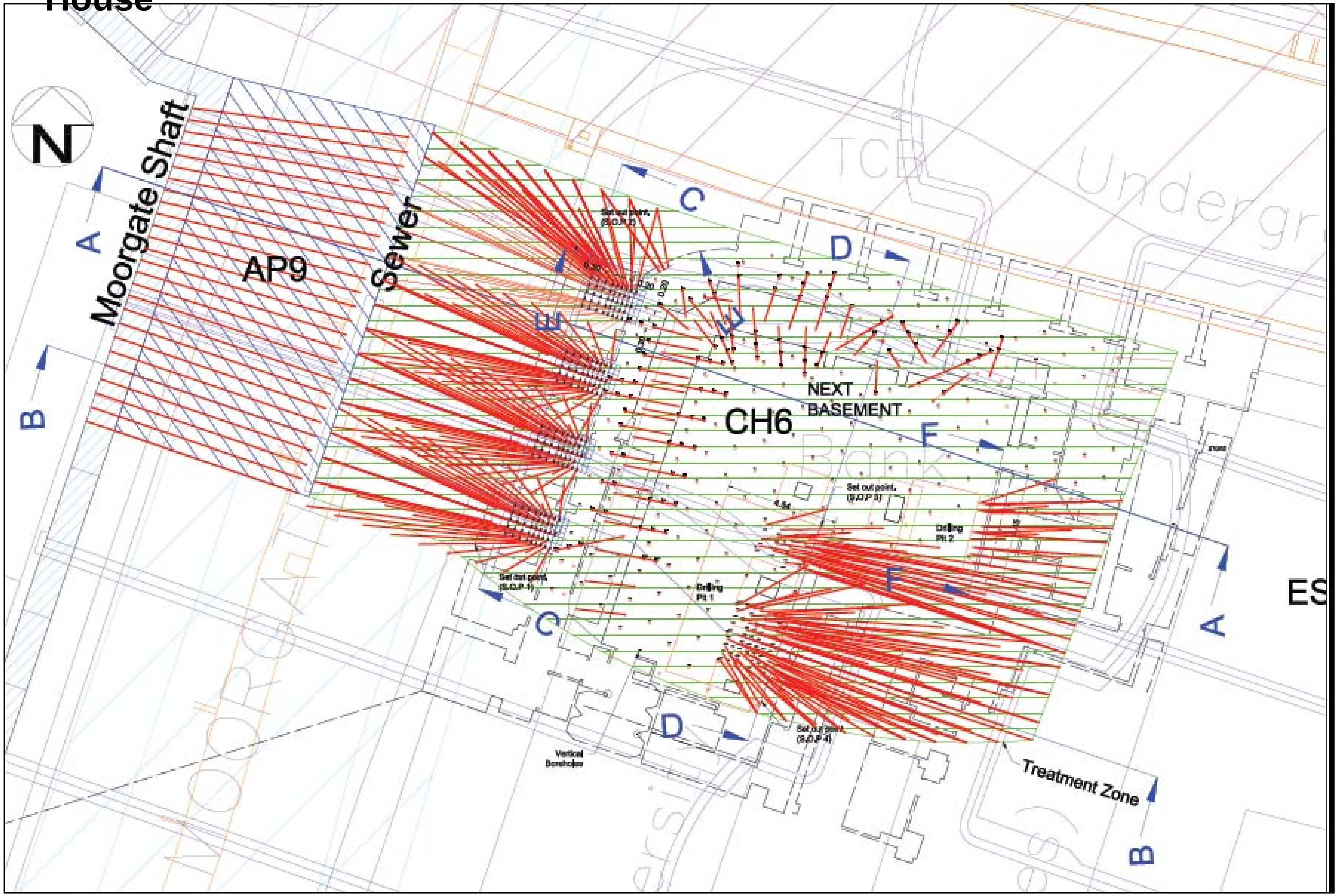
Electra House



Electra House

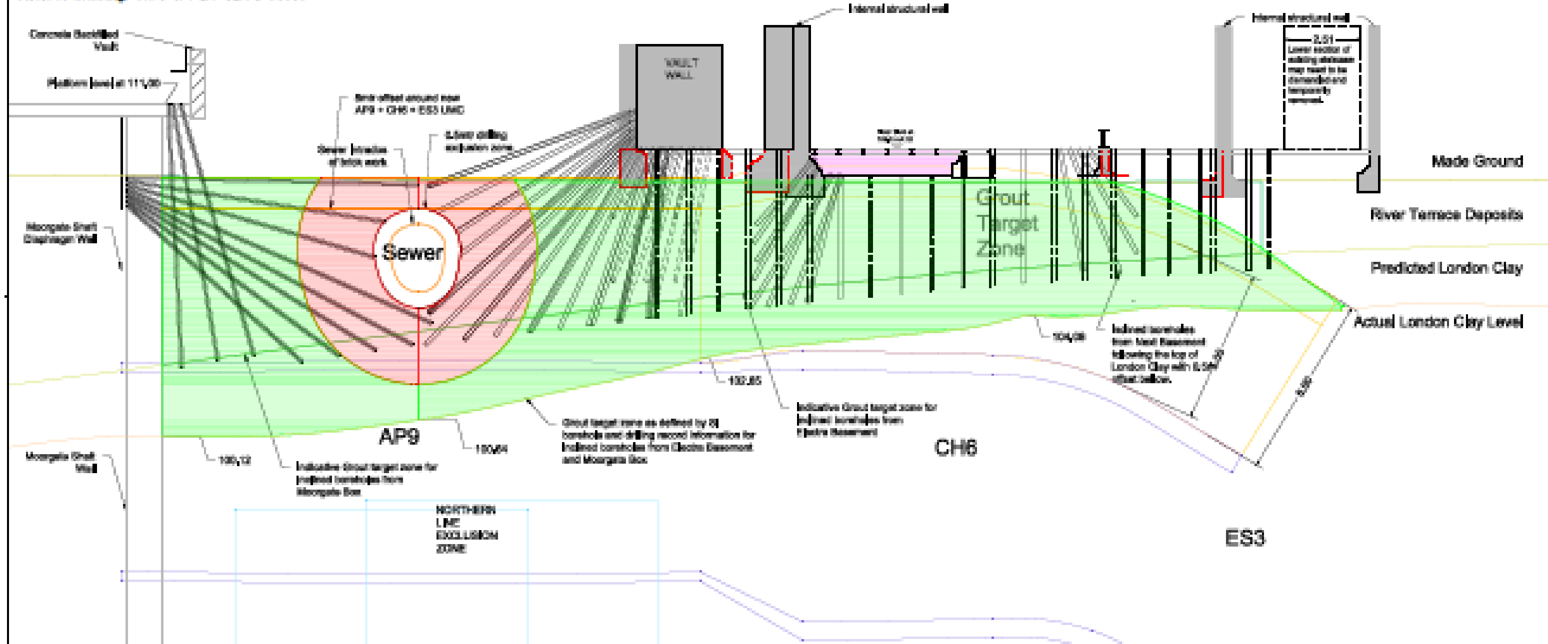


Electra House



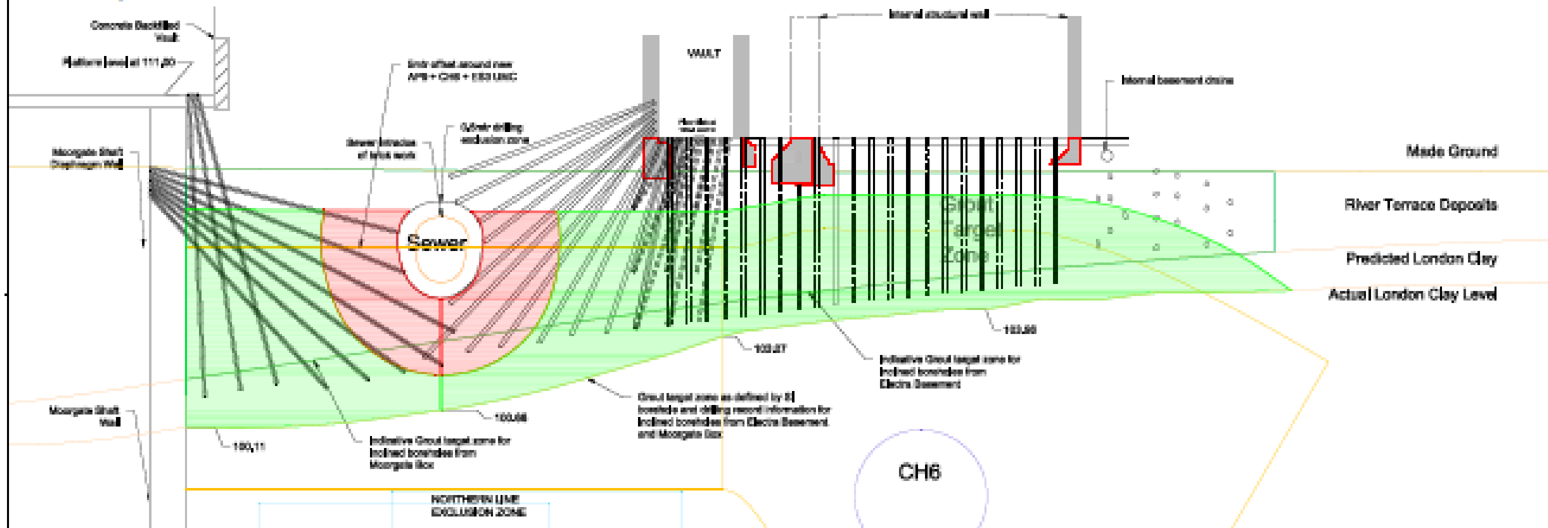
Section E:E

Refer to drawing: UnPS-CFT-LIV-GEN-D-50909



Section F:F

Refer to drawing: UnPS-CFT-LIV-GEN-D-50909

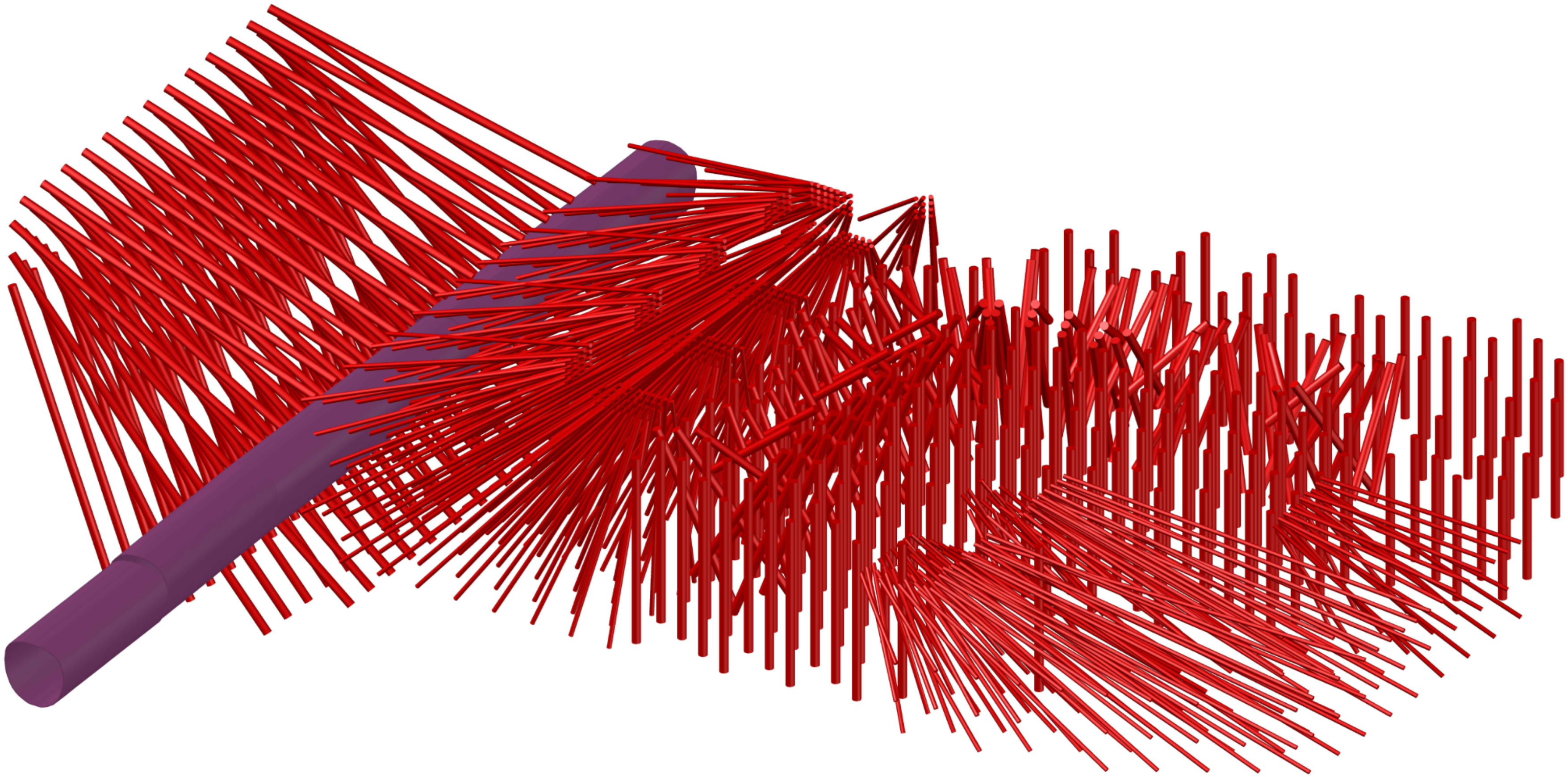


Notes:

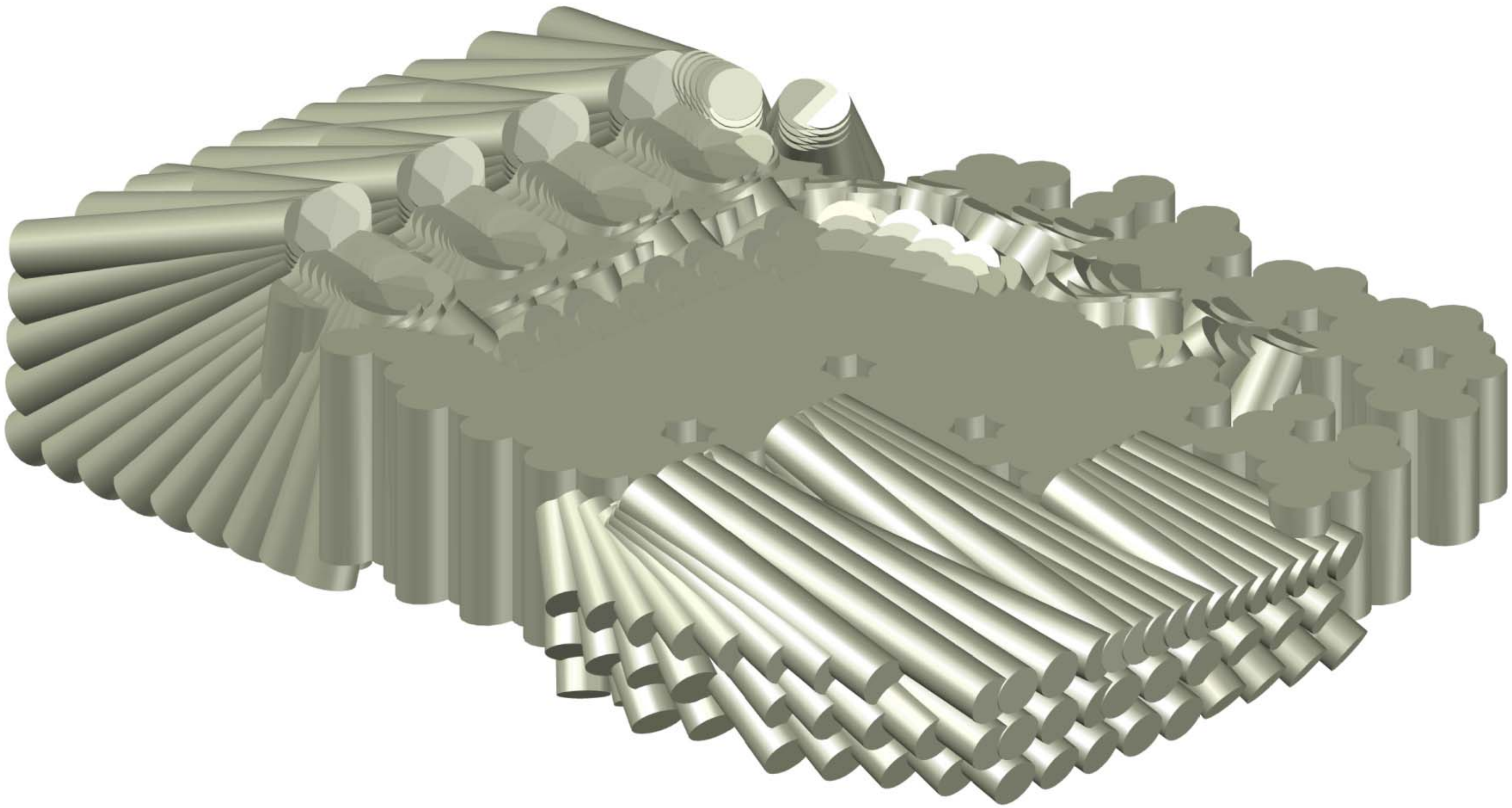
1. All dimensions are in meters.
2. All levels are in mATD. Set out to ±25mm.
3. All angles are in degrees. Rig set-up to ±0.2 degree decimal.
4. TAM positions to be confirmed by as built survey.
5. TAM final arrangement subject to minor change, depending upon what is revealed by the excavation of drill pits/reduced level dig.
6. Boreholes illustrated in solid lines are in section and those illustrated in dashed lines are out of section.
7. Drawing based on CRL1-XRL-G-DMA-CR099-00041 and plan of NEXT shop layout received 23.11.2012
8. Access ramp not previously illustrated, but is considered to be the only practical means of allowing access to each drill pit.

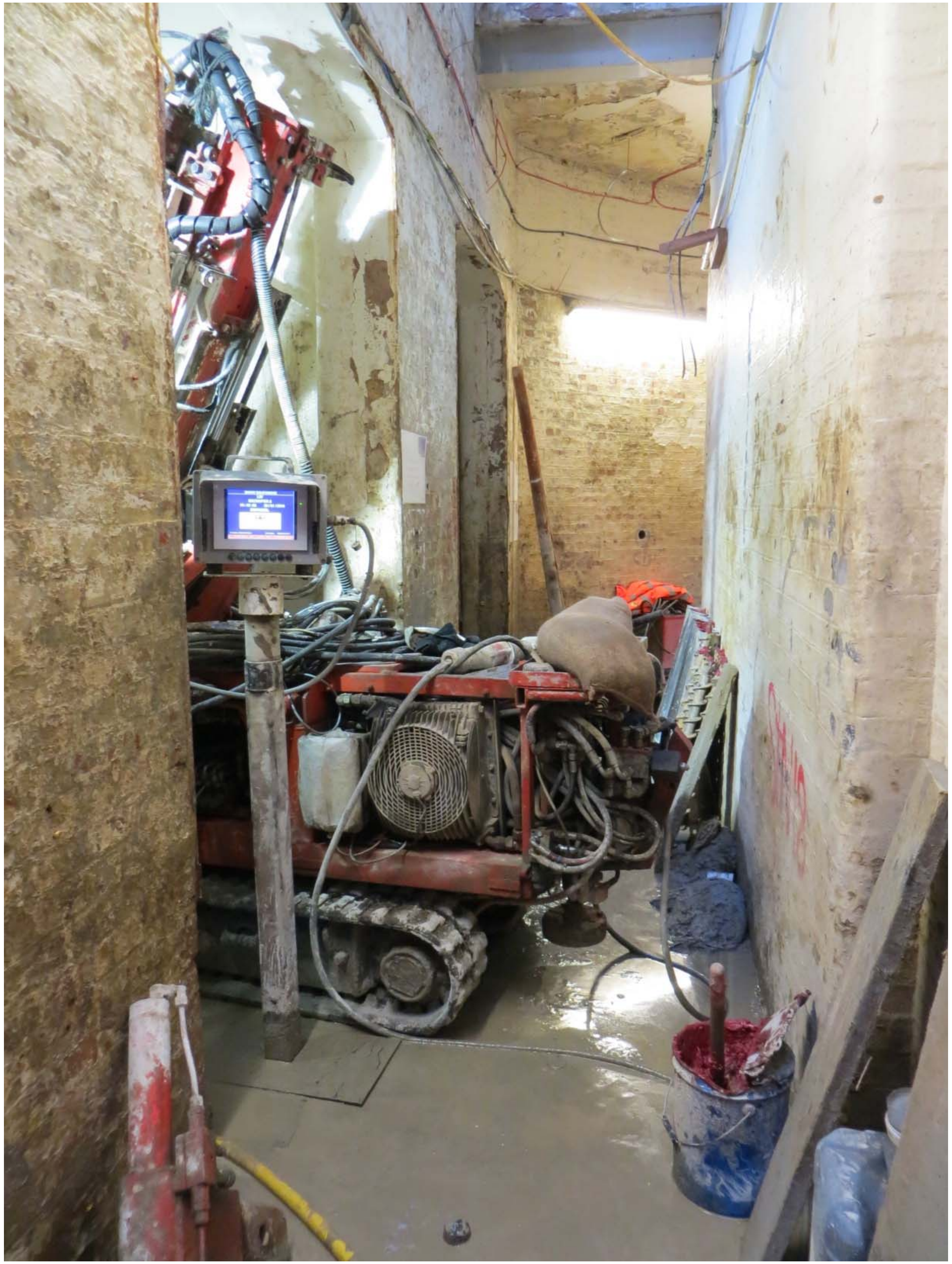
ISSUED FOR INFORMATION

Electra House

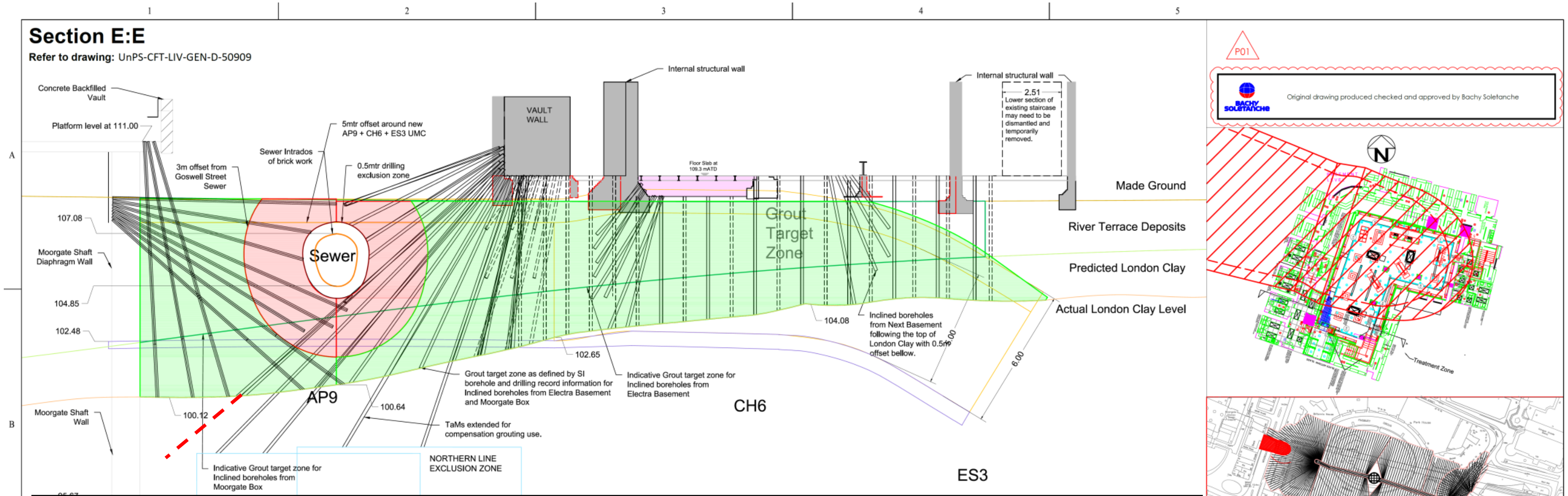


Electra House

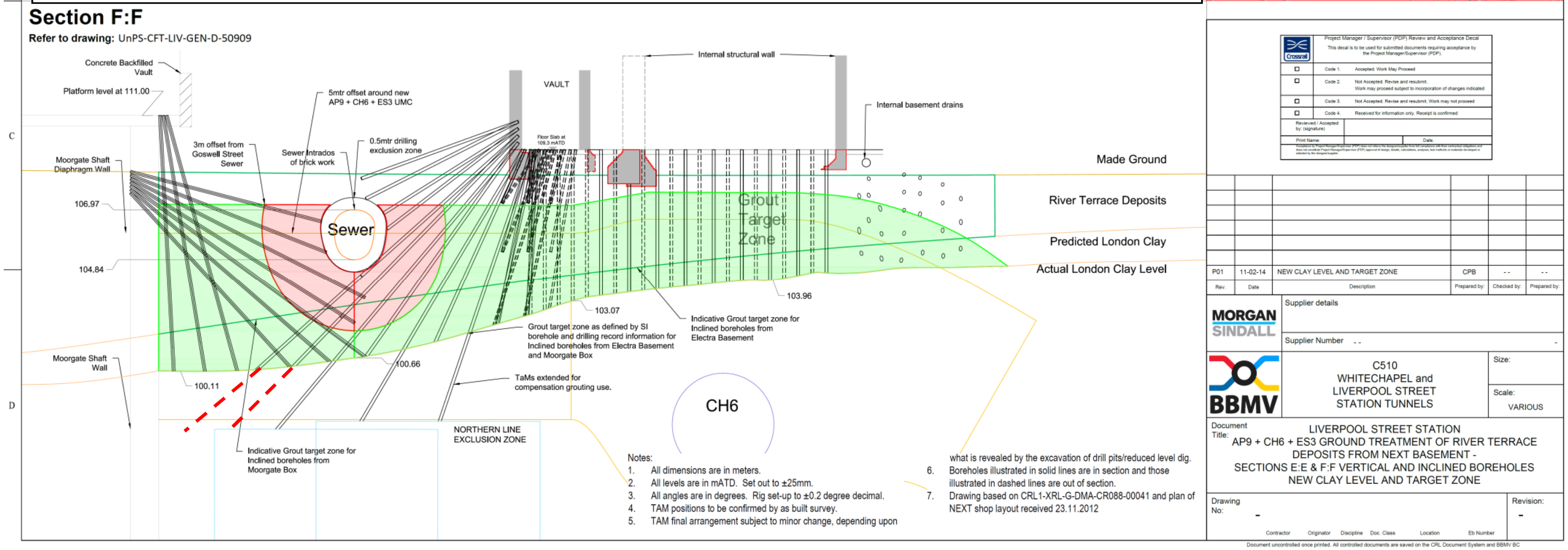




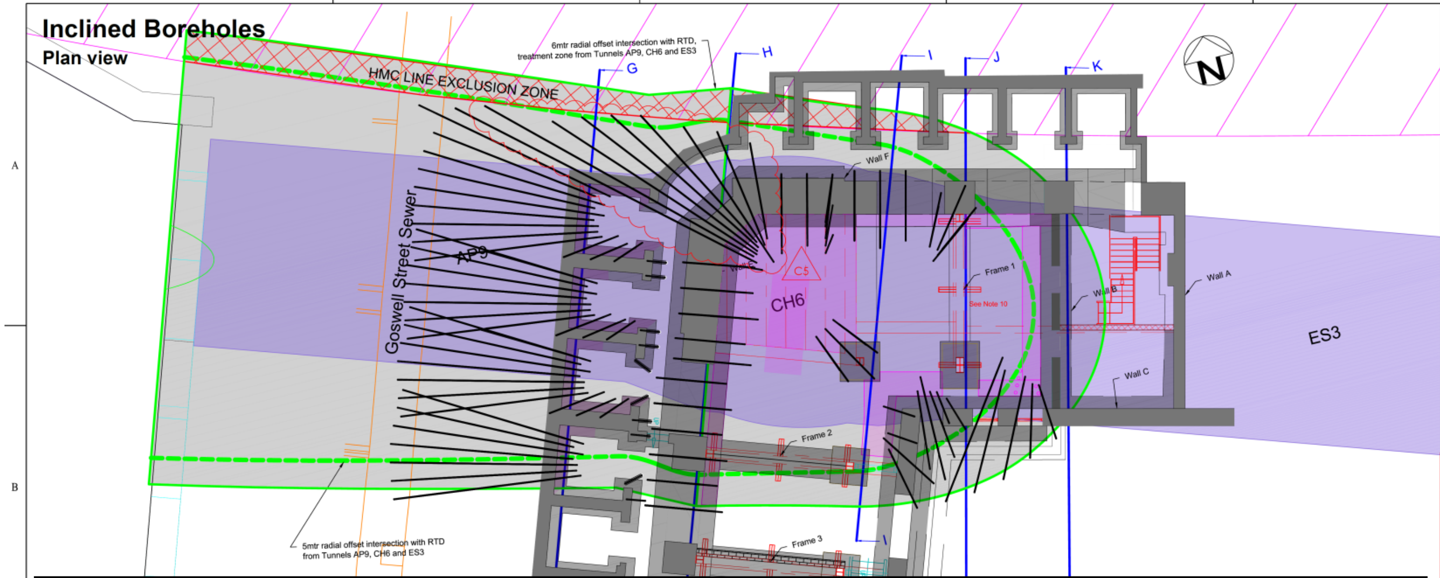

BACHY SOLETANCHE
LV
ENPASOL

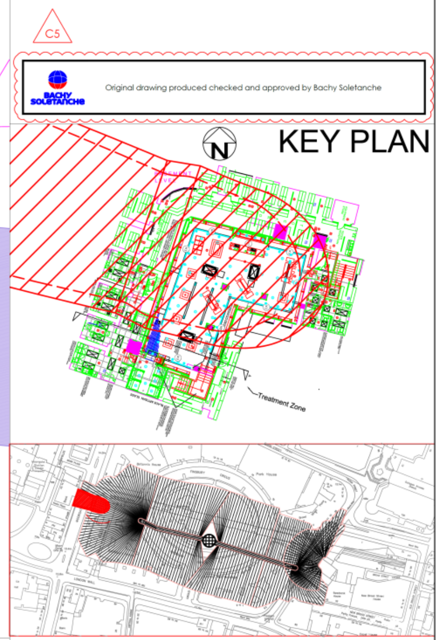


Electra House - revised design of borehole layout



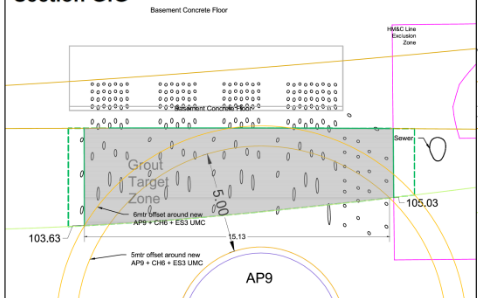
Inclined Boreholes
Plan view



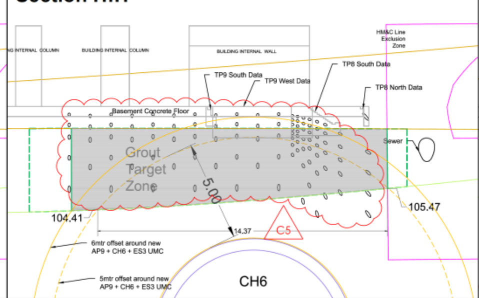


Electra House - revised design of ground treatment

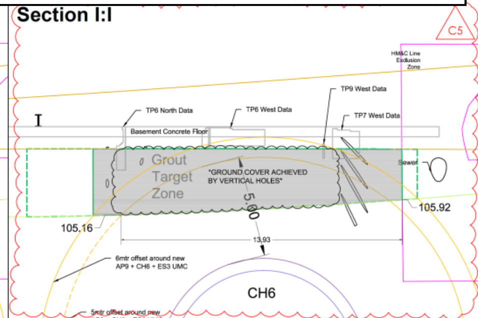
Section G:G



Section H:H



Section I:I



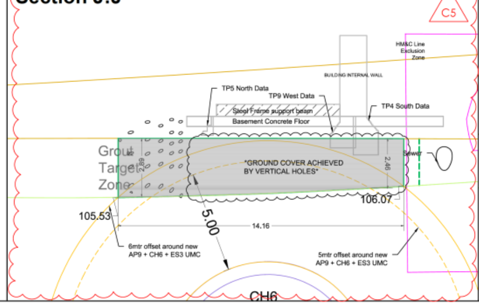
KEY:

Revised ground treatment zone

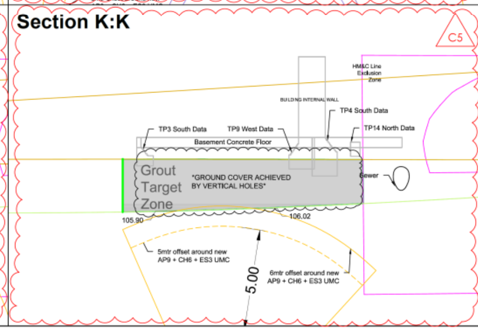
Notes:

1. All dimensions are in meters.
2. All levels are in mATD. Set out to ±25mm.
3. All angles are in degrees. Rig set-up to ±0.2 degree decimal.
4. TAM positions to be confirmed by as built survey.
5. TAM final arrangement subject to minor change, depending upon what is revealed by the excavation of drill pits/reduced level dig.
6. Boreholes illustrated in solid lines are in section and those illustrated in dashed lines are out of section.
7. Drawing based on CRL1-XRL-G-DMA-CR088-00041 and plan of NEXT shop layout received 23.11.2012
8. Access ramp not previously illustrated, but is considered to be the only practical means of allowing access to each drill pit.
9. 5mtr radial coverage of grouted zone from tunnel profile deemed sufficient for tunnel stability, per discussions on 10/07/13 grout block extents reduction meeting. BBMV however select 6m radial coverage in order to ensure performance requirements are fully met within 5m zone.

Section J:J



Section K:K



Rev.	Date	Description	Prepared by:	Checked by:	Prepared by:
C5	27-11-13	REVISED SECTIONS H:H, I:I, J:J, K:K	CPB	RA/BS	
C4	15-10-13	REVISED TREATMENT ZONE SECTION K:K ADDED EXCAVATION PIT - WALL B	CPB	RA/BS	SG
C3	12-09-13	CHANGED TO SUIT COMMENTS	CPB	RA/BS	SG

MORGAN SINDALL

Supplier details

Supplier Number UnPS-CFT-LIV-GEN-D-50898 C4

BBMV

C510
WHITECHAPEL and
LIVERPOOL STREET
STATION TUNNELS

Size:

Scale:

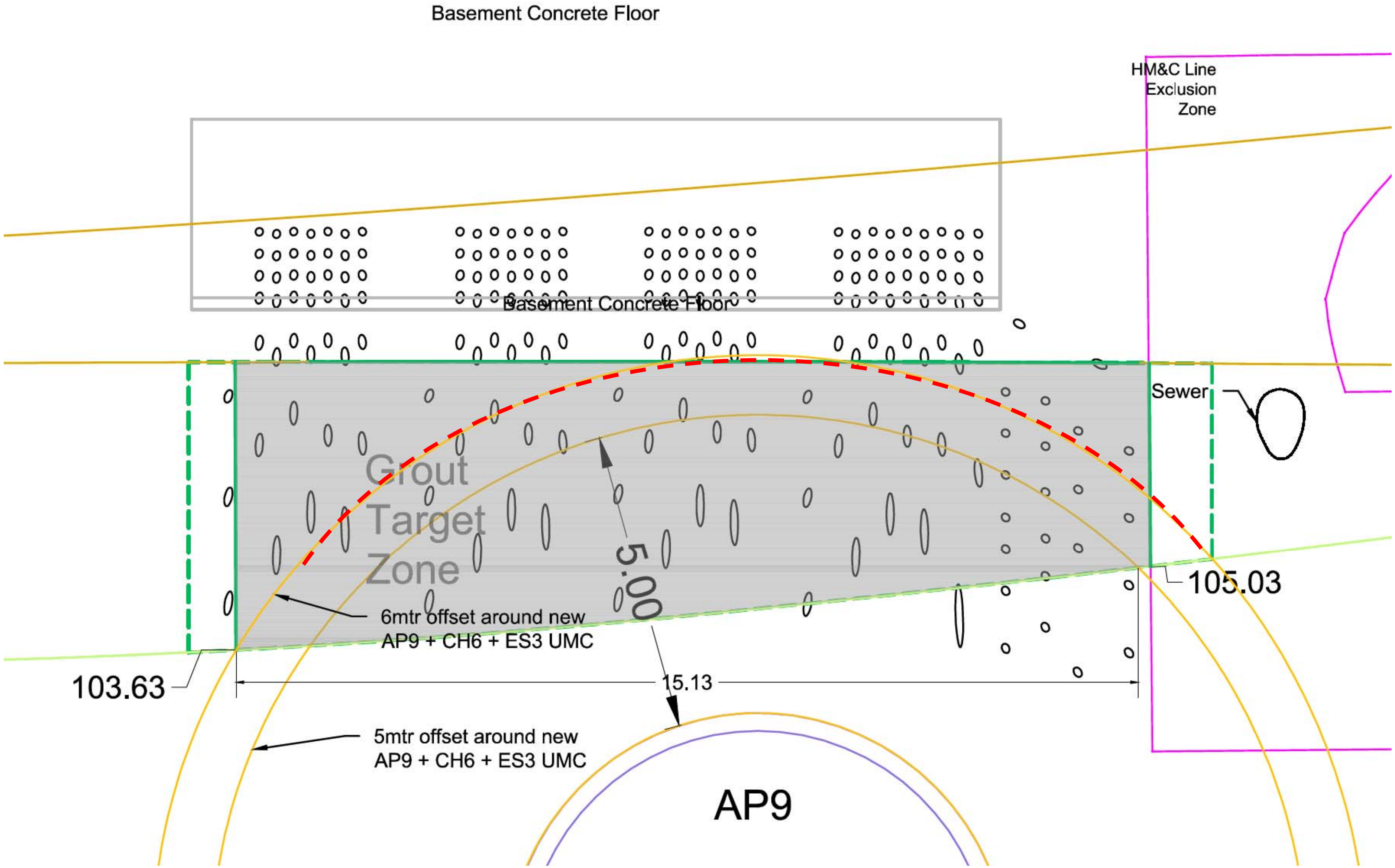
Document Title: LIVERPOOL STREET STATION
AP9 + CH6 + ES3 GROUND TREATMENT OF RIVER TERRACE DEPOSITS FROM NEXT BASEMENT - SECTIONS G:G, H:H, I:I, J:J & K:K (INCLINED BOREHOLES ONLY)

Drawing No: -

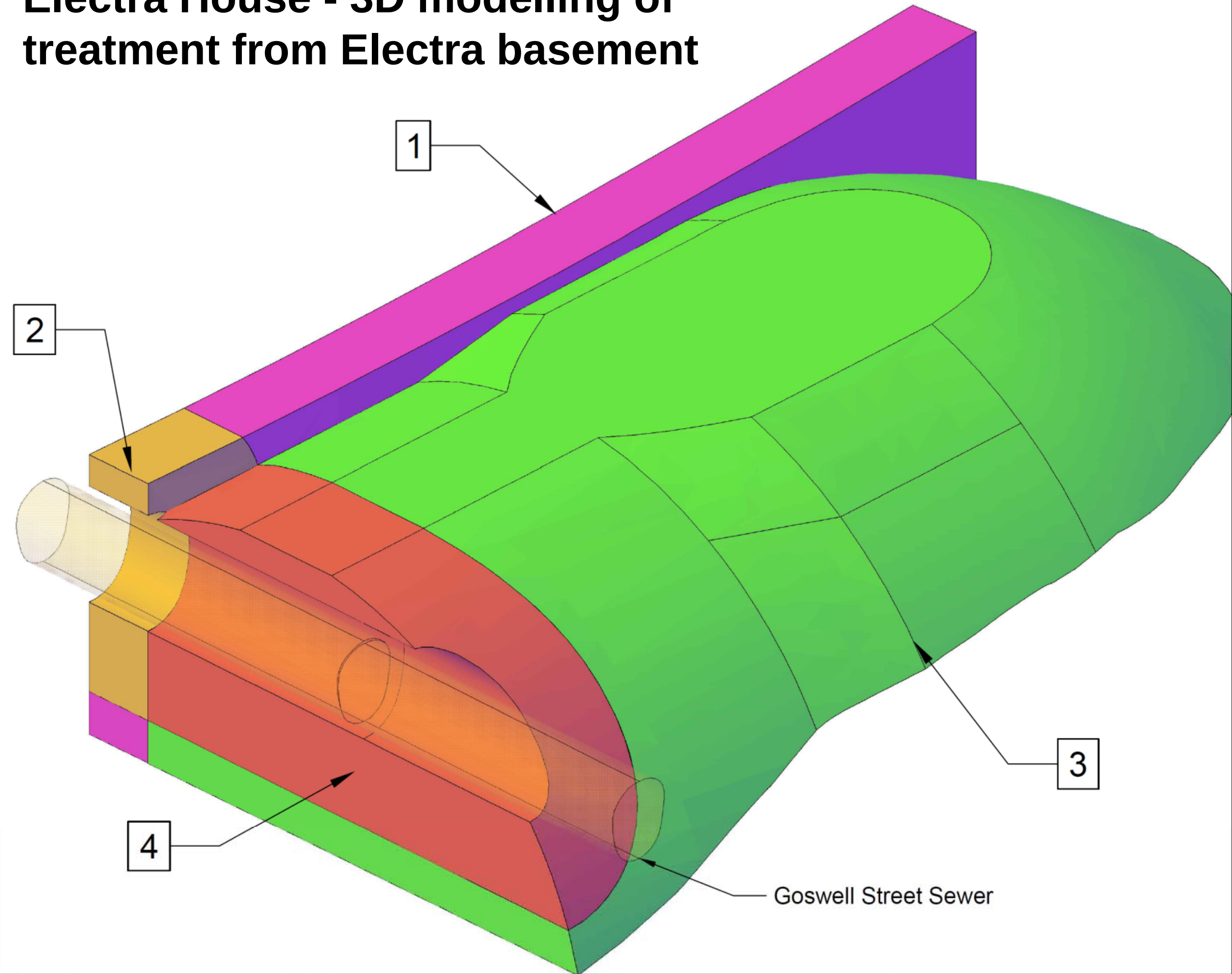
Revision: -

Contractor Originator Discipline Doc. Class Location Eb Number

Electra House - Transverse section detail at Moorgate headwall

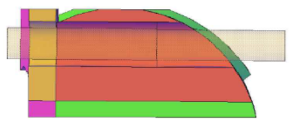


Electra House - 3D modelling of treatment from Electra basement



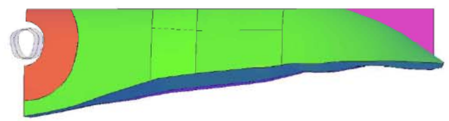
	Name/Area	Volume (m³)
1	HMC Grout Curtain	284.6
2	HMC Curtain within 3m of Goswell Street Sewer	36.4
3	6m CRL Tunnel offset	1406.8
4	6m CRL Tunnel offset within 3m of Goswell Street Sewer	206.7
	Total Vol. :	1934.5

Front View



Left View

Right View



Rev	Date	Description	By	Chkd	App
P01	30.01.14	FOR INFORMATION	CB	IA	--

Notes

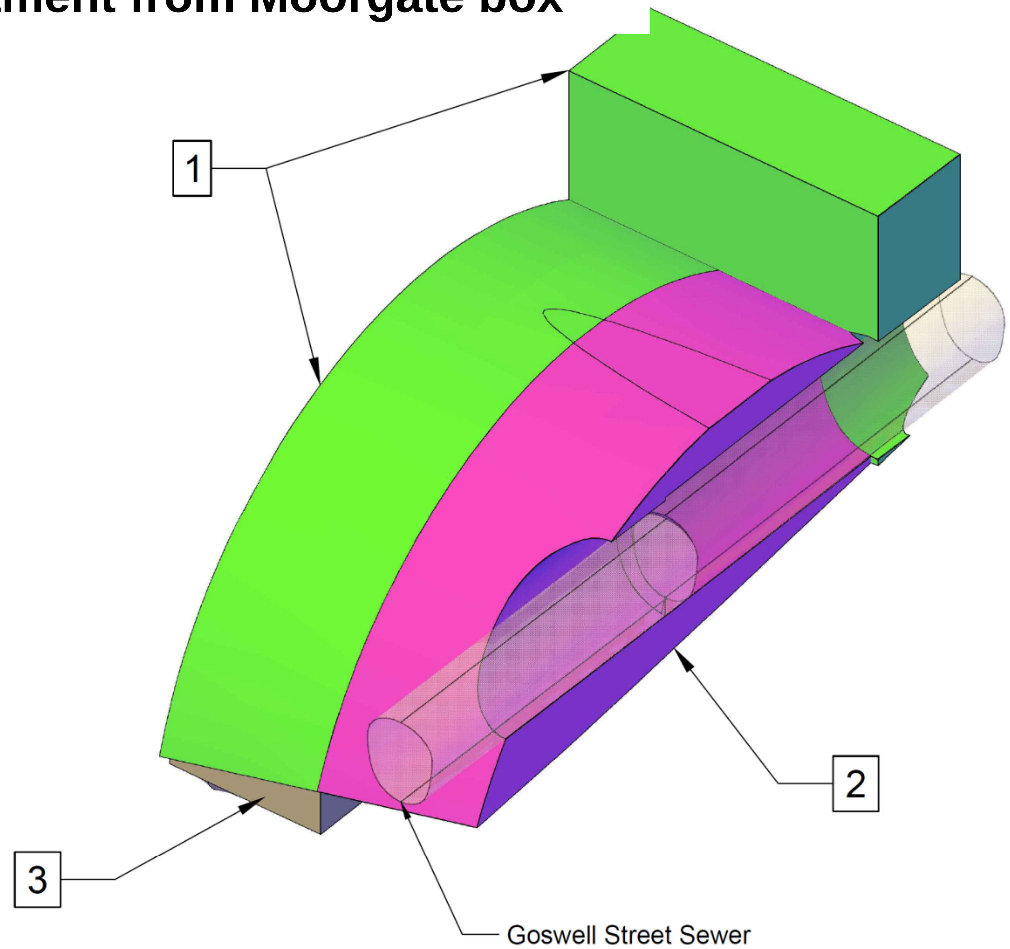
1. All dimensions are in millimeters

Key Plan

BBMV
Second Floor Reception
Royalmail Delivery Office
206 Whitechapel Road
London. E1 1AA
© BBMV
www.bbmv.co.uk

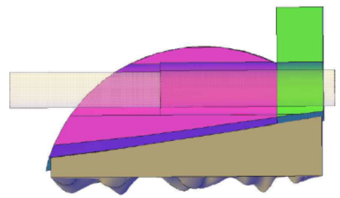
Contract : WHI & LIV Station Tunnels
Originator : BBMV Joint Venture C510 (PBA)
Location : Liverpool Street C510
Title : NEXT BASEMENT
PERMEATION GROUTING
GROUND TO TREAT - DEEPER CLAY LEVEL
By : C.BRODIE
Chk : I.ACREMAN
App :
Scale : 1:XXX @ A3
Drawing No : C510 - BBM - C - XXXX - XXXX -XXXXX (Contract, Originator, Discipline, Doc Class, Location, Dwg Number)
Revision P01

Electra House - 3D modelling of treatment from Moorgate box

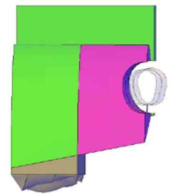


	Name/Area	Volume (m³)
1	HMC Curtain with Stage 1 Grouting	443.4
2	Stage 2 Grouting	211.3
3	New deeper Clay interface level extra volume to grout.	157.0
	Total Vol. :	811.7

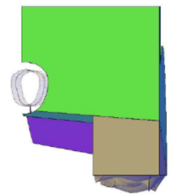
Front View



Left View



Right View



Rev	Date	Description	By	Chkd	App
P01	16.12.13	FOR INFORMATION	CB	IA	--

Notes
1. All dimensions are in millimeters

Key Plan

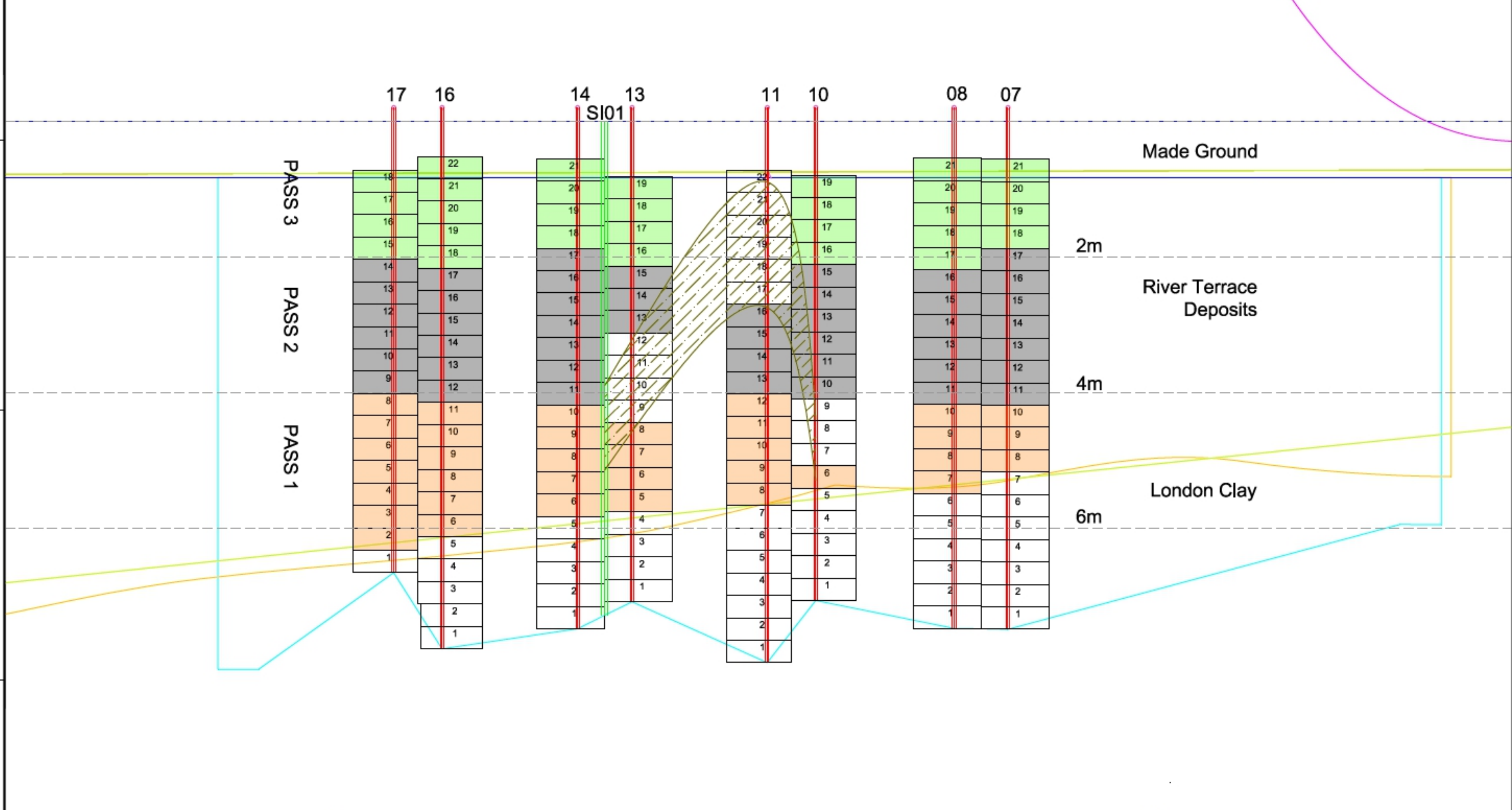
BBMV
Second Floor Reception
Royalmail Delivery Office
206 Whitechapel Road
London. E1 1AA

www.bbmv.co.uk

Contract : WHI & LIV Station Tunnels
Originator : BBMV Joint Venture C510 (PBA)
Location : Liverpool Street C510
Title : MOORGATE BOX PERMEATION GROUTING GROUND TO TREAT
By : C.BRODIE
Chk : I.ACREMAN
App :
Scale : 1:XXX @ A3
Drawing No : C510 - BBM - C - XXXX - XXXX -XXXXX (Contract, Originator, Discipline, Doc Class, Location, Dwg Number)
Revision P01

FAN A

Electra House - HCL grouted cut-off wall - injection phase detail



Rev	Date	Description	By	Chkd	App
P01	17-02-14	FOR INFORMATION	CB	BS	--

Notes

1. All dimensions are in millimeters

Key Plan

KEY:

CLAY LENSE IN RTD

BBMV

Contract: WHI & LIV Station Tunnels

Originator: BBMV Joint Venture C510 (PBA)

Location: NEXT BASEMENT

Title: NEXT BASEMENT DRILLING
VERTICAL TAMS
FAN A - BOREHOLES 01-17 WITH SLEEVES

By: C.BRODIE

Chk: B.SADLER

App: - -

Scale: 1:XXX @ A3

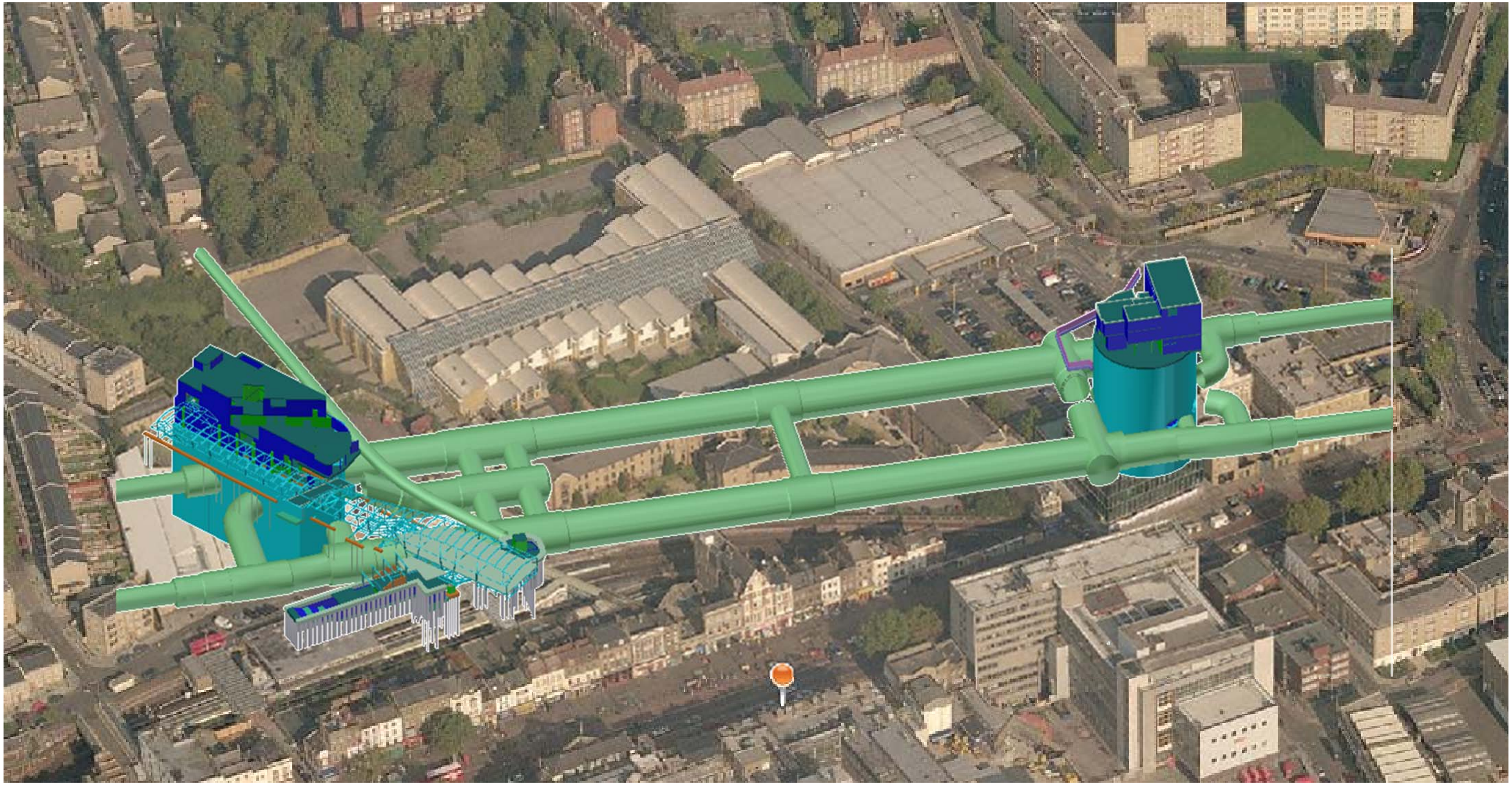
Drawing No: C510 - BBM - C - XXXX - XXXX -XXXXX

Revision: P01

Crossrail C510 - Whitechapel Station

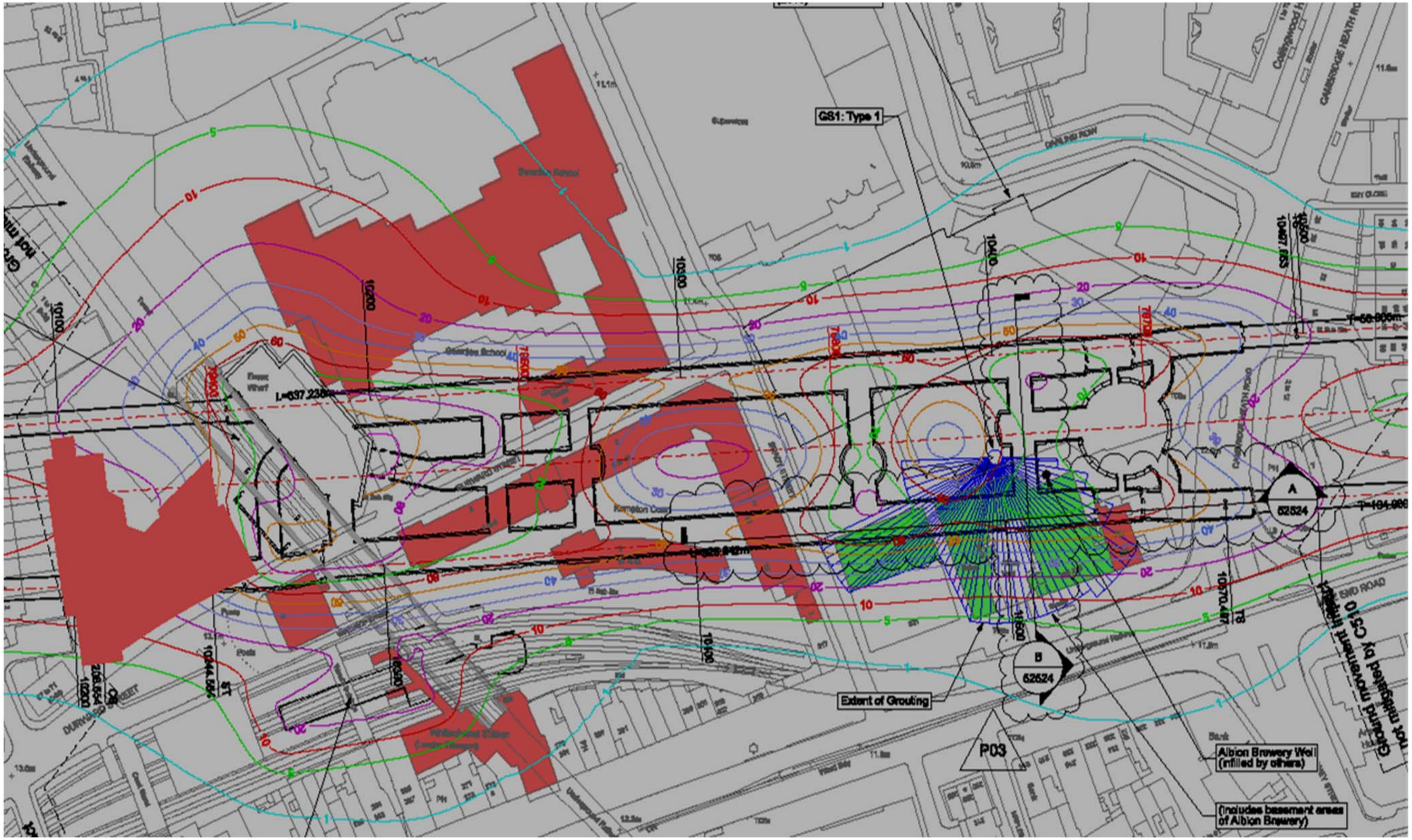
Whitechapel Station Site

Whitechapel Station Site

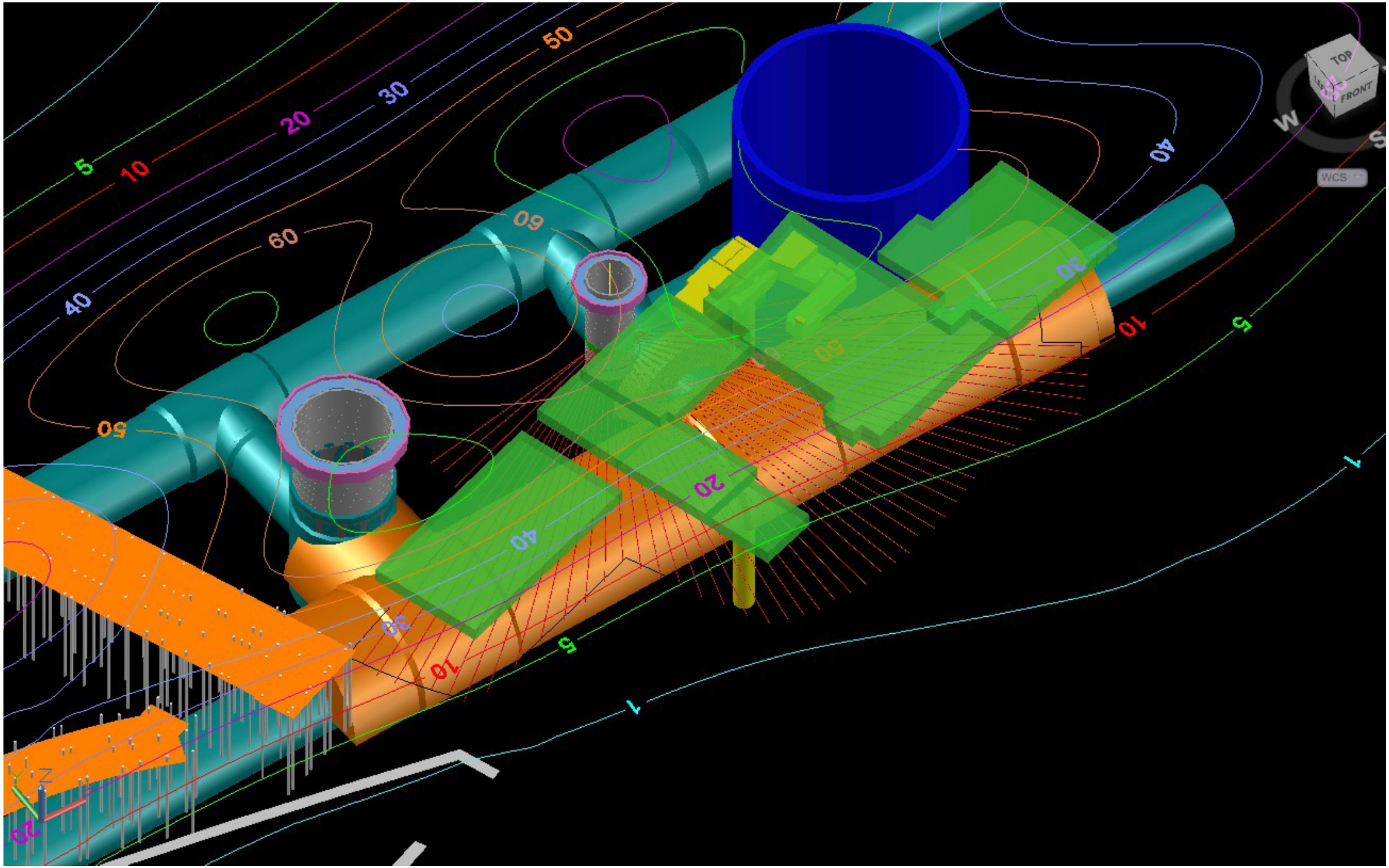


Whitechapel Station - Key Buildings

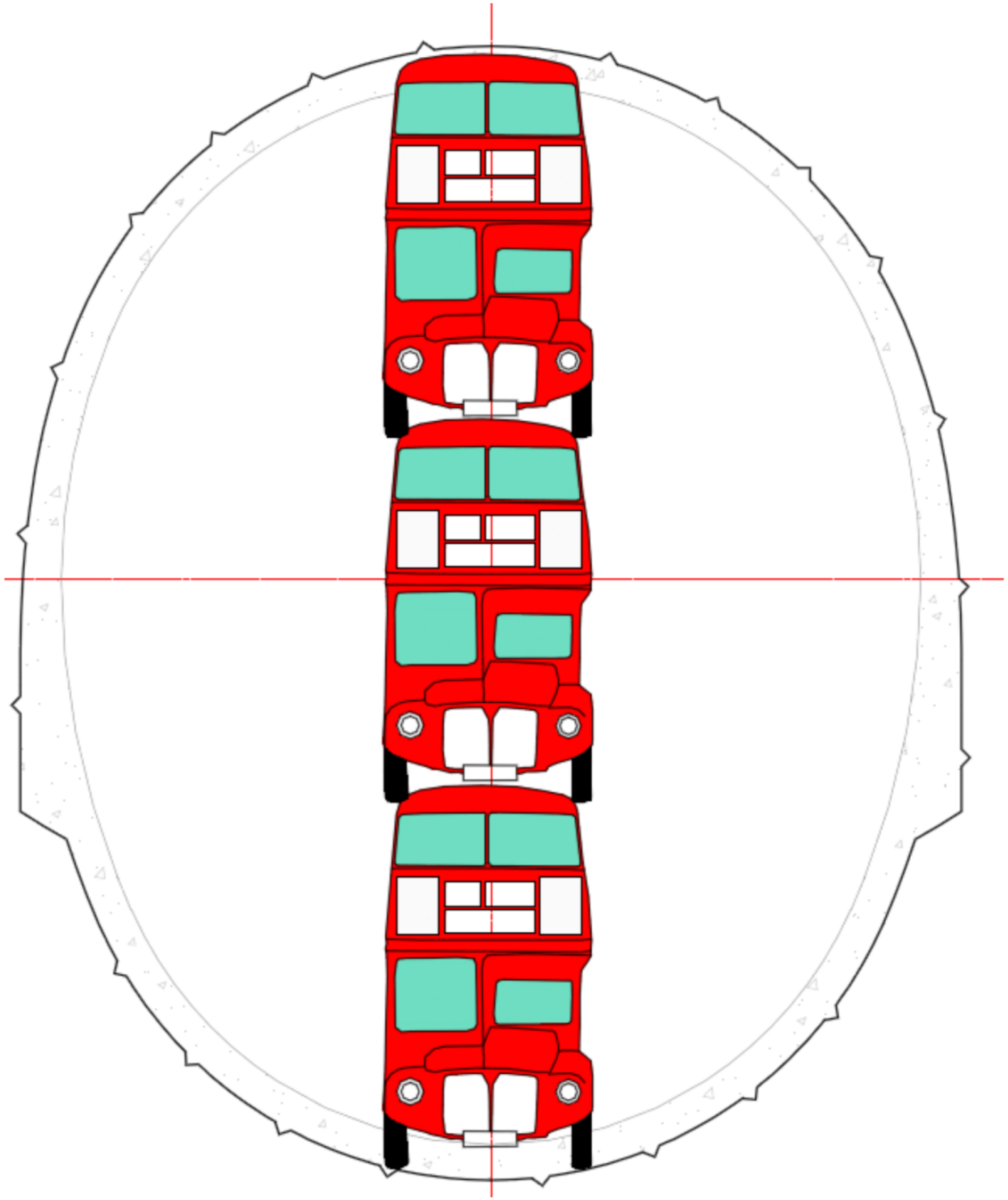
Whitechapel Station Settlement Mitigation



Whitechapel Station - Compensation Grouting Array



Whitechapel Station - Break-out chamber



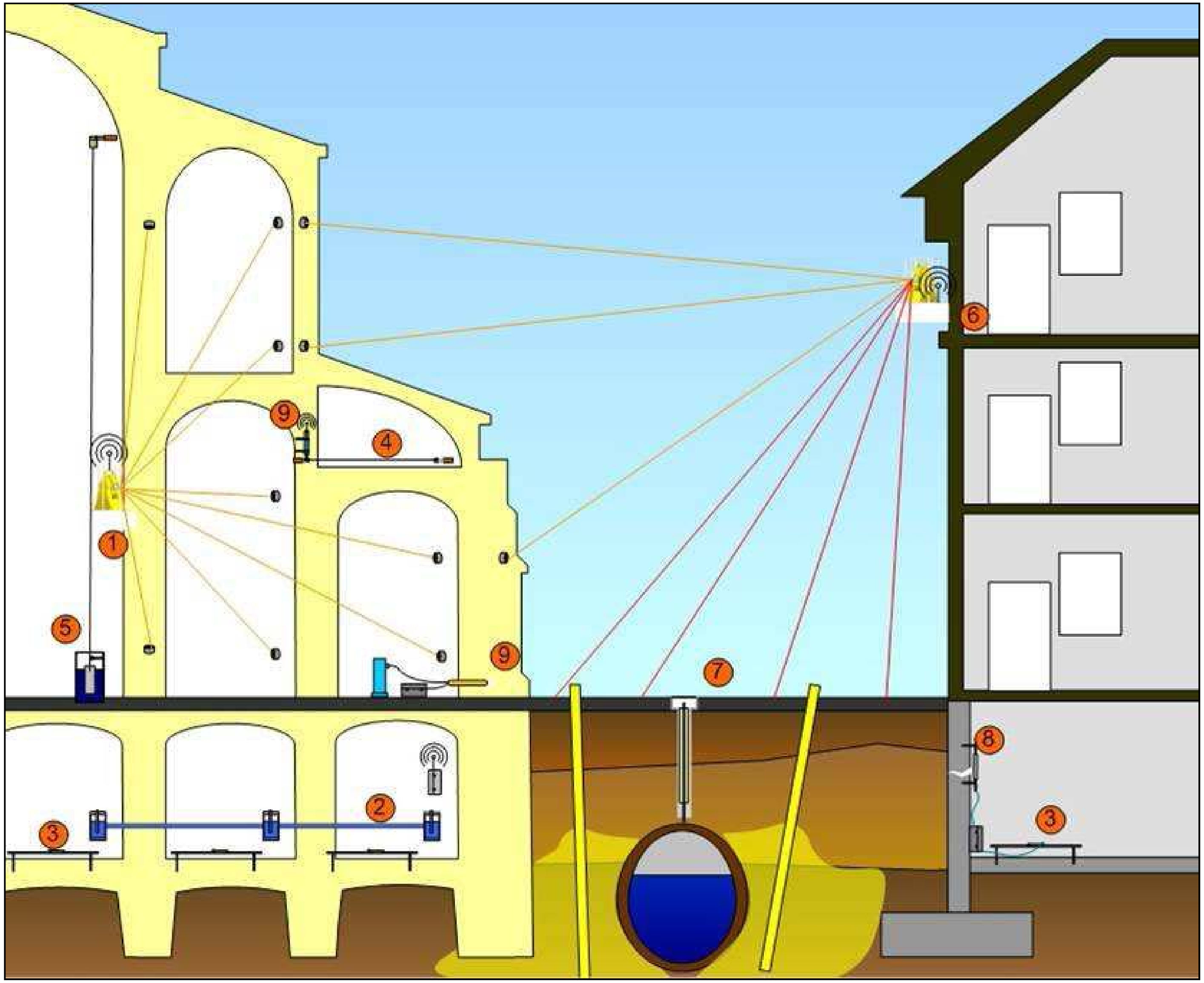
Process control

Settlement monitoring for key structures

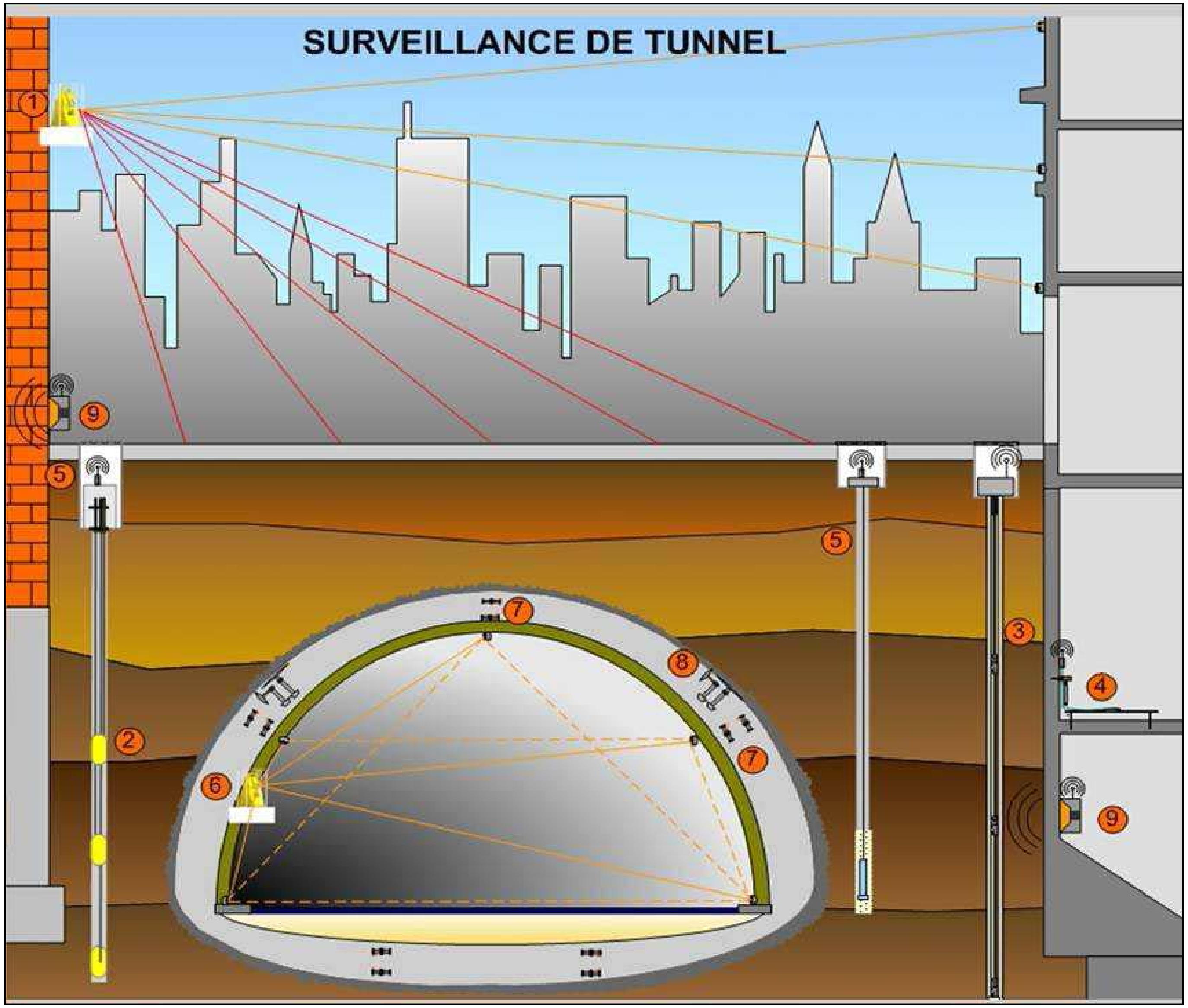
Challenges

- Provide adequate frequency of monitoring to allow for active compensation grouting
- Integrate data from several sources, including grouting
- Display data in a format compliant with specified criteria - differential settlement, deflection
- Display/analyse historic project-wide data
- Provide remote and multi-user access to data

Compensation Grouting - settlement control for key structures & utilities



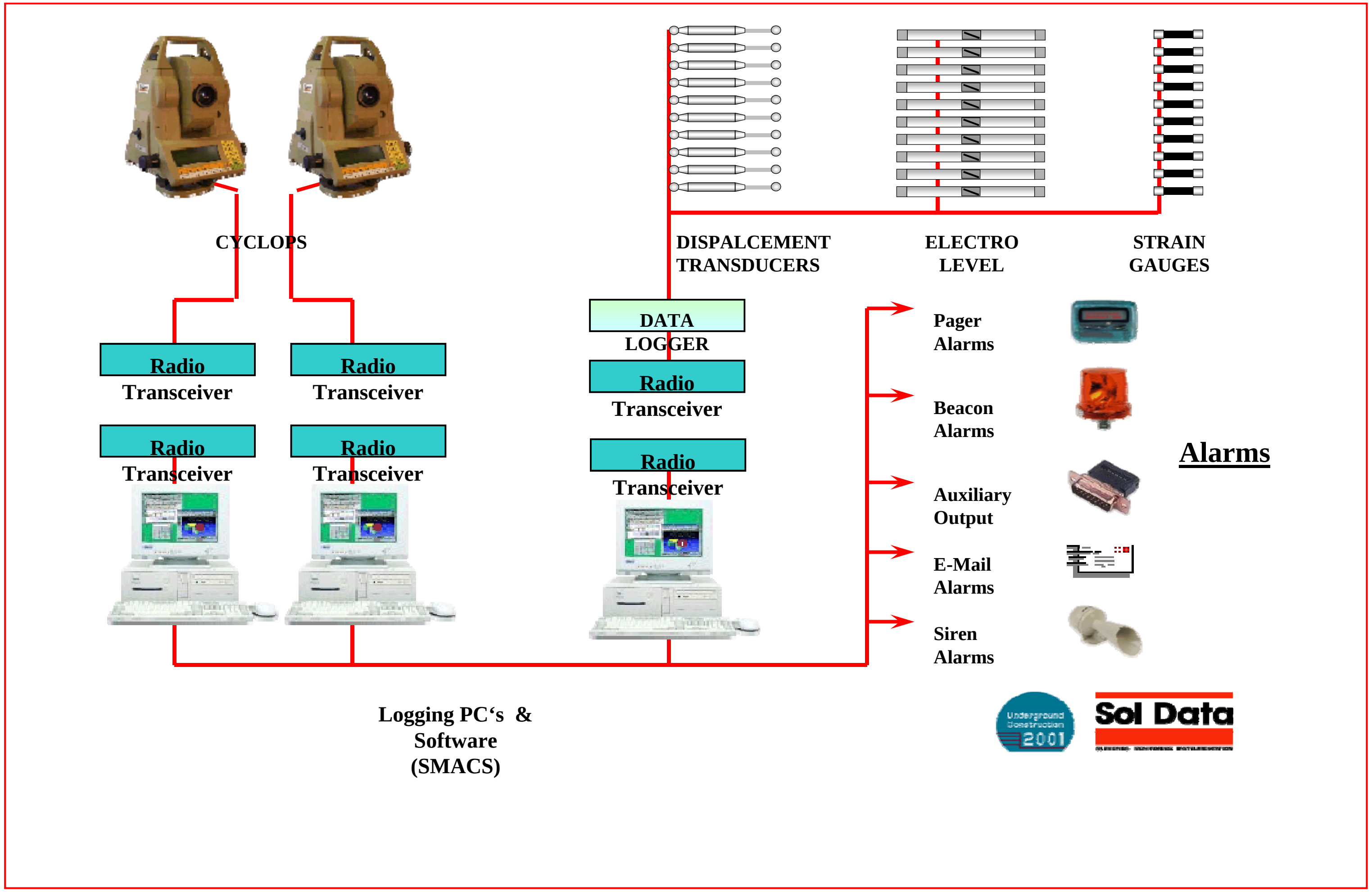
Compensation Grouting - settlement control for key structures & utilities



Process control - Settlement control for key structures

THE CENTRAL ROLE OF REAL TIME DATA ACQUISITION & PRESENTATION

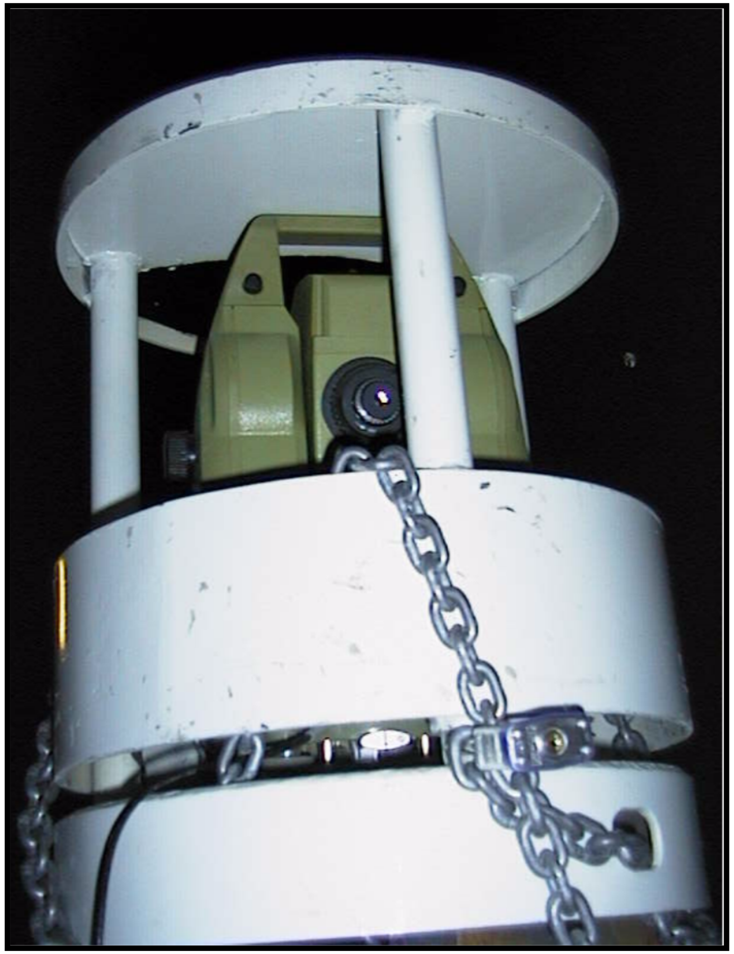
FOR STRUCTURAL / GEOTECHNICAL MONITORING



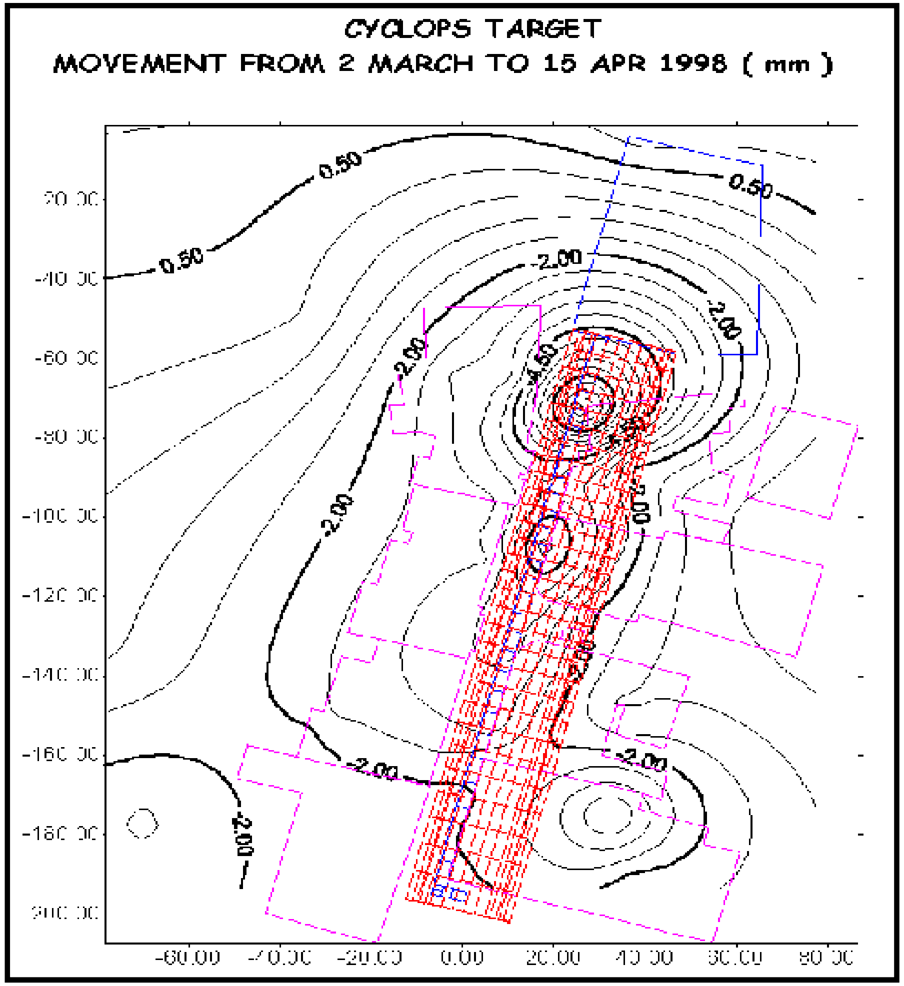
Process control - Settlement control for key structures

Automatic survey of displacements in semi-real time

Motorised Total Station

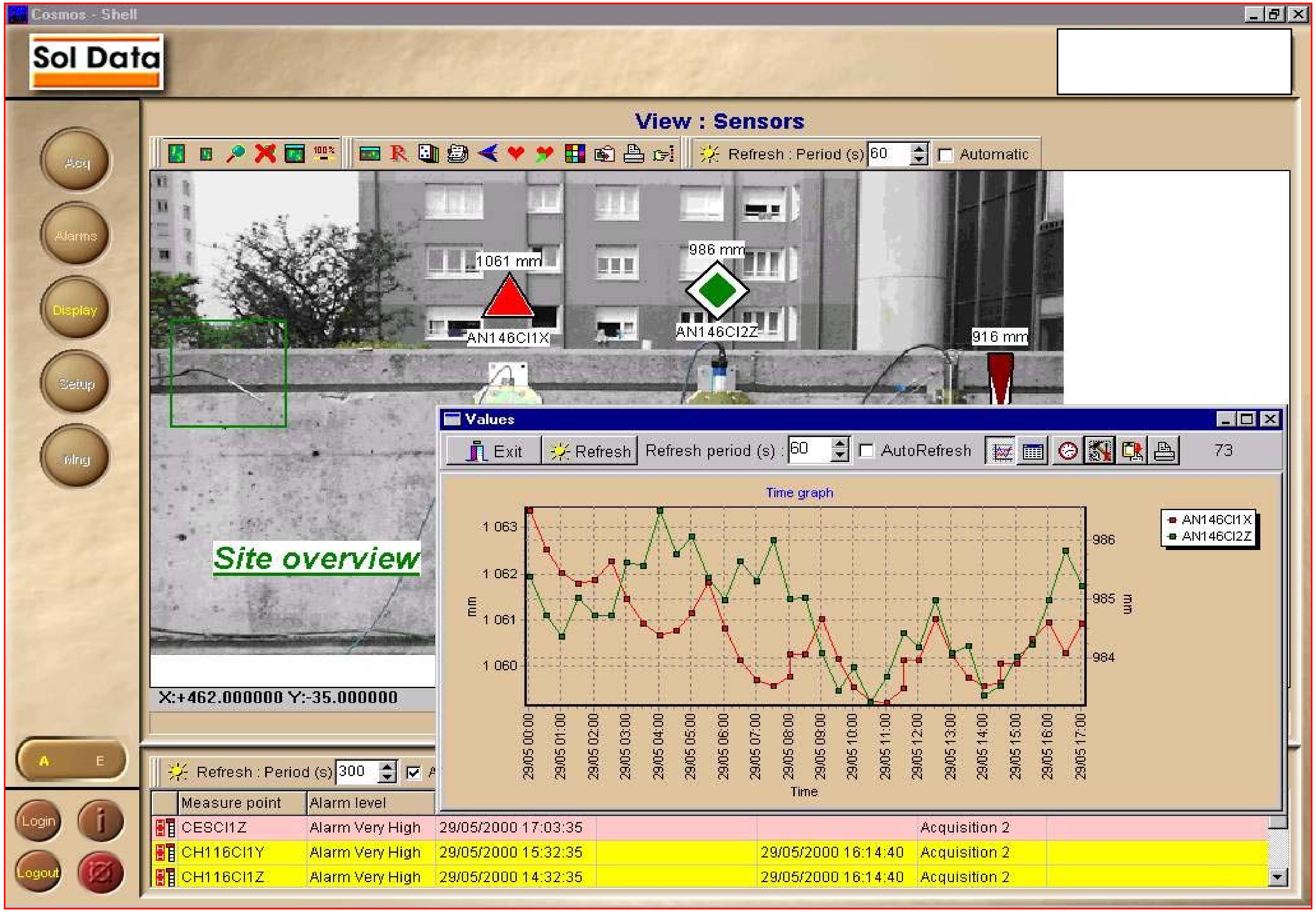


Settlement Contours



Process control - Settlement control for key structures

GEOSCOPE WEB - Example of remote monitoring via Internet

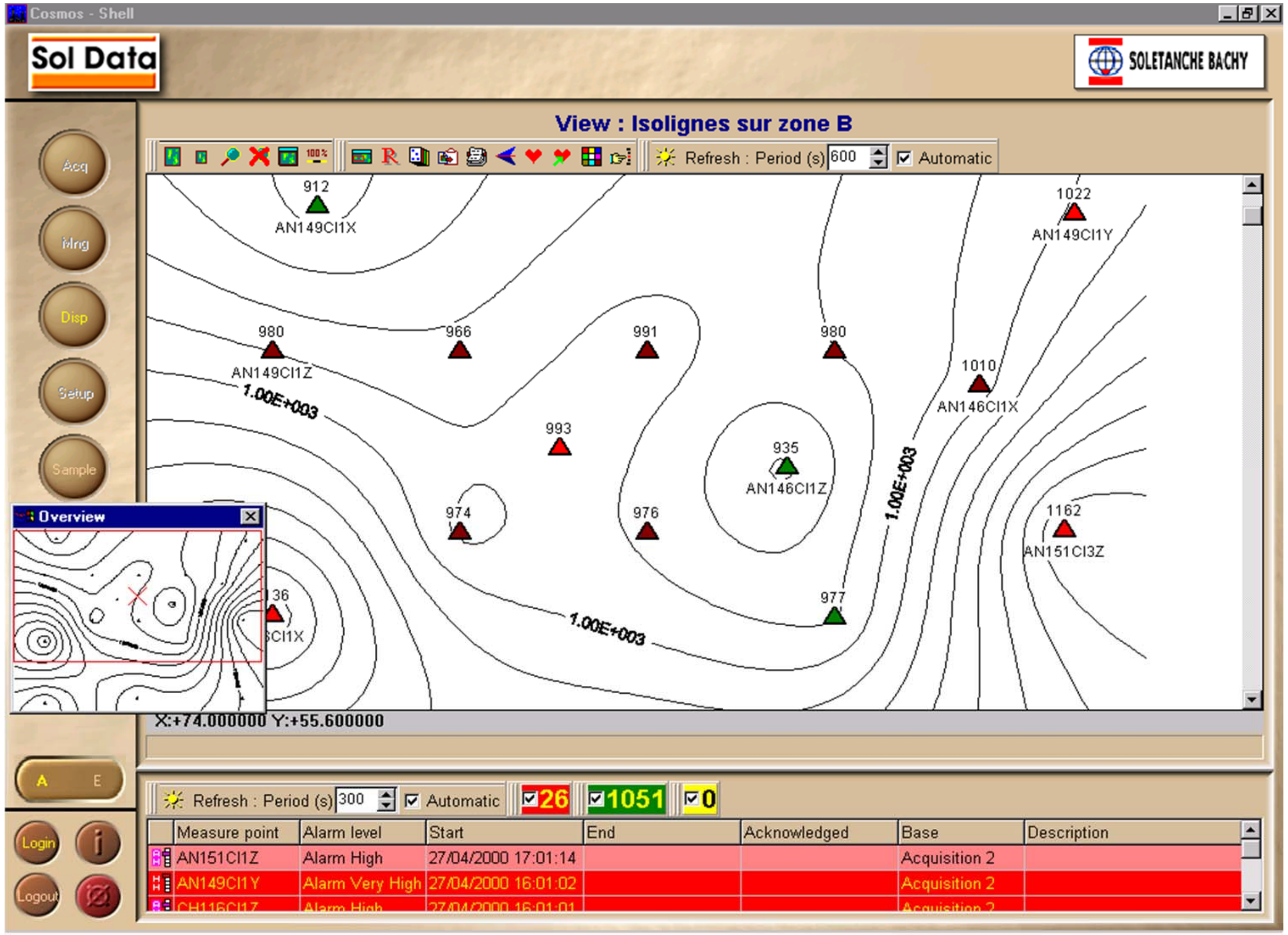


Process control - Settlement control for key structures

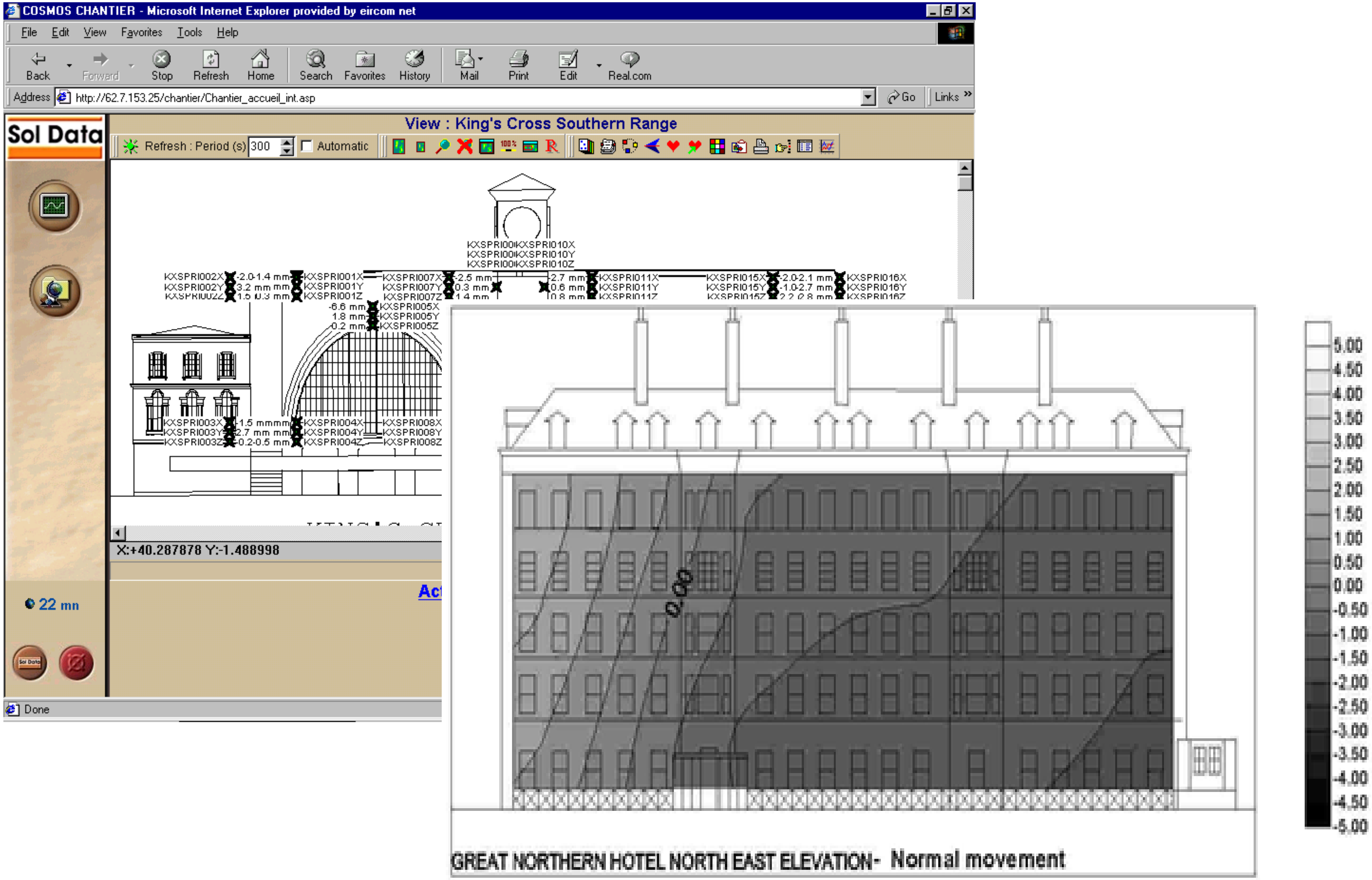
GEOSCOPE WEB - Settlement contours

THE CENTRAL ROLE OF REAL TIME DATA ACQUISITION &

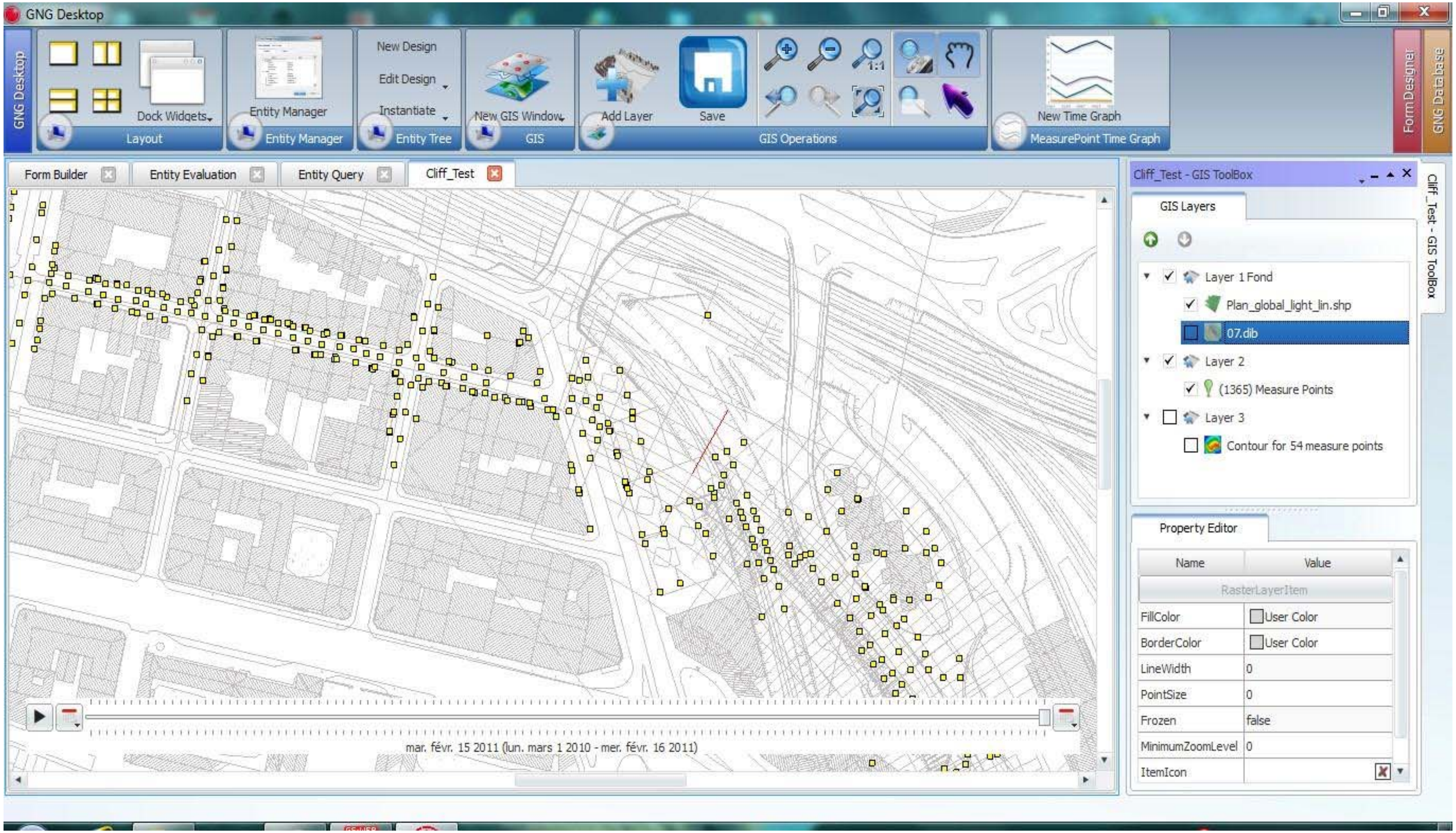
PRESENTATION FOR STRUCTURAL / GEOTECHNICAL MONITORING



Process control - Settlement control for key structures

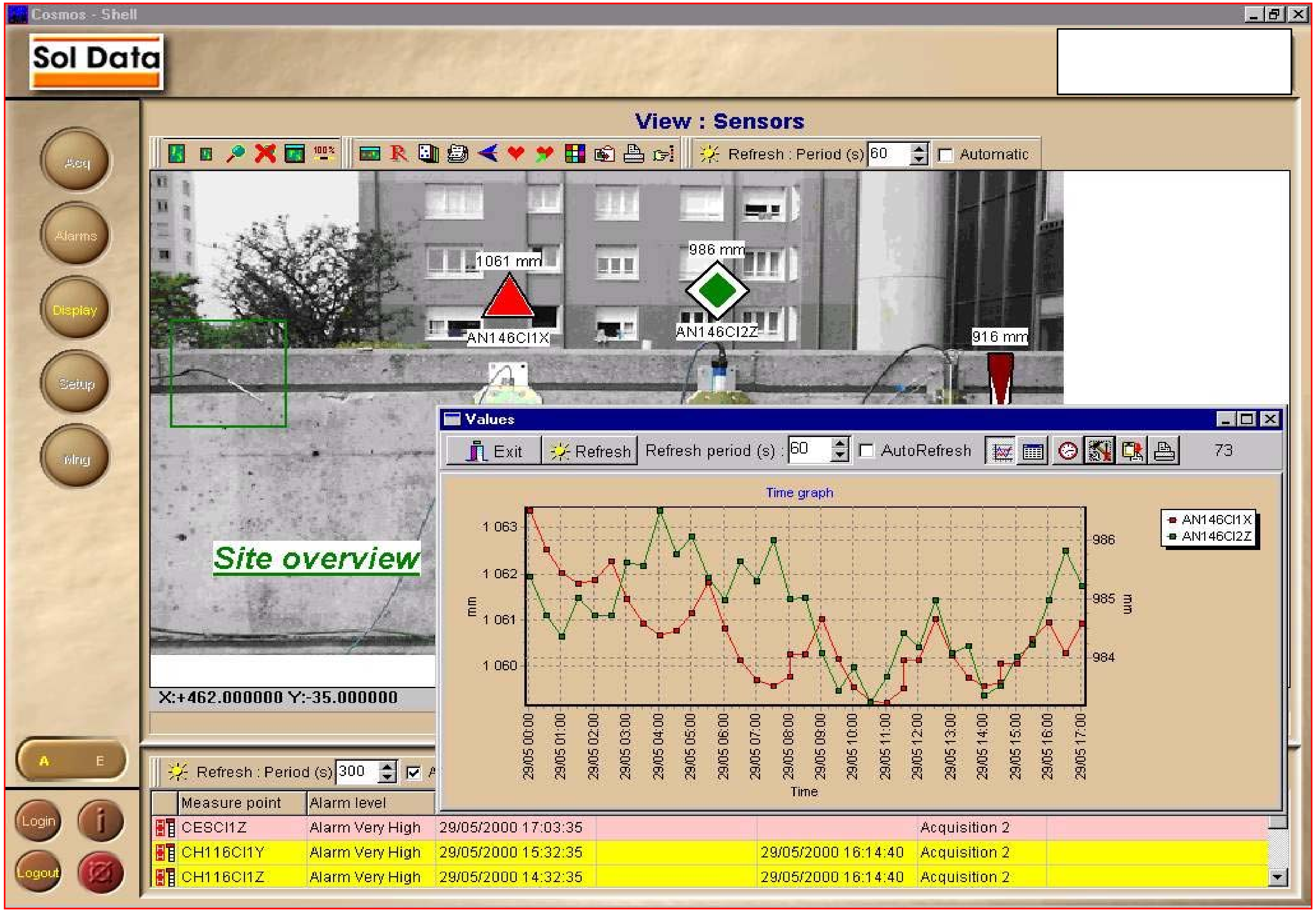


Process control - Settlement control for key structures



Process control - Settlement control for key structures

GEOSCOPE WEB - Example of remote monitoring via Internet

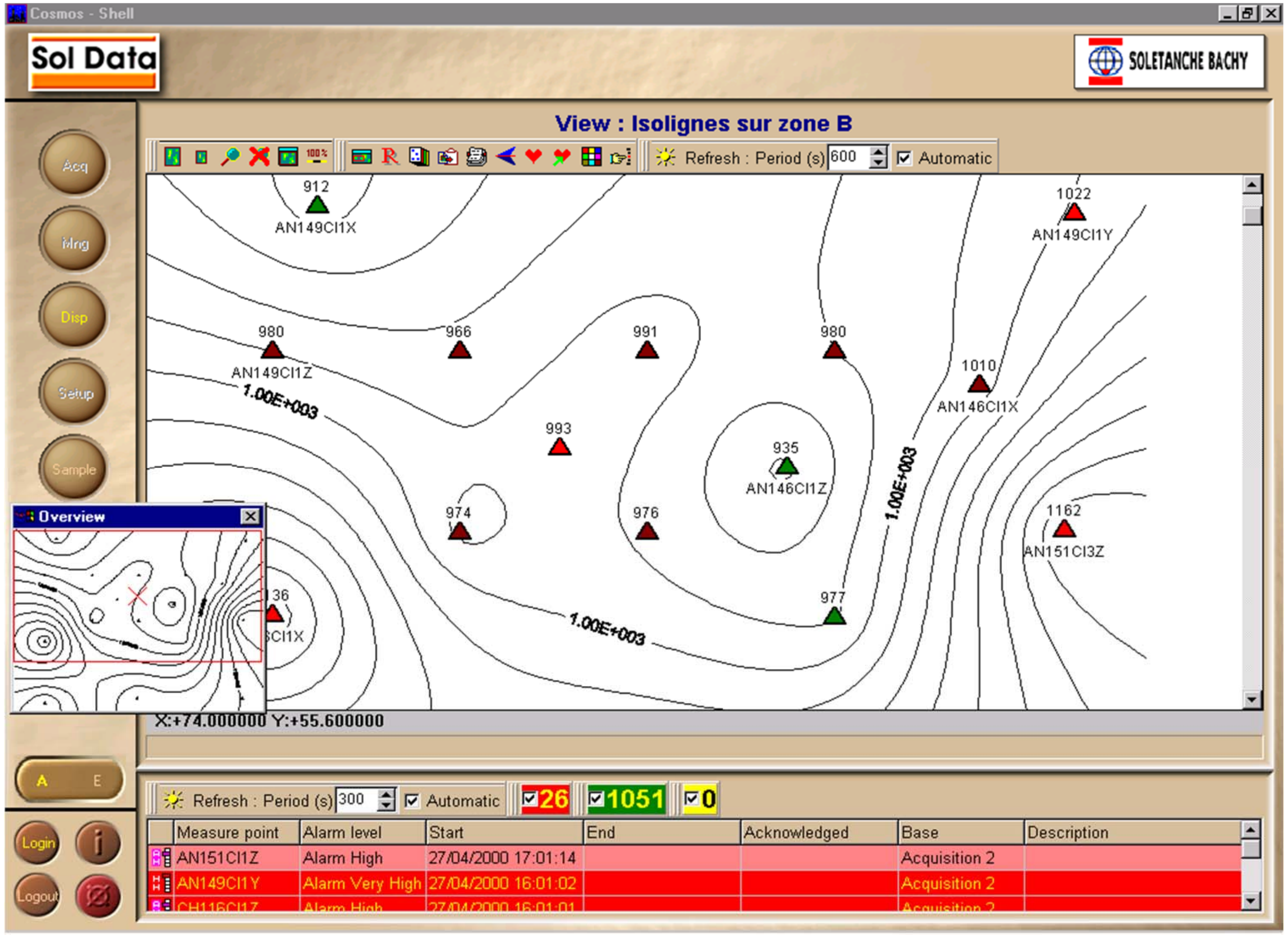


Process control - Settlement control for key structures

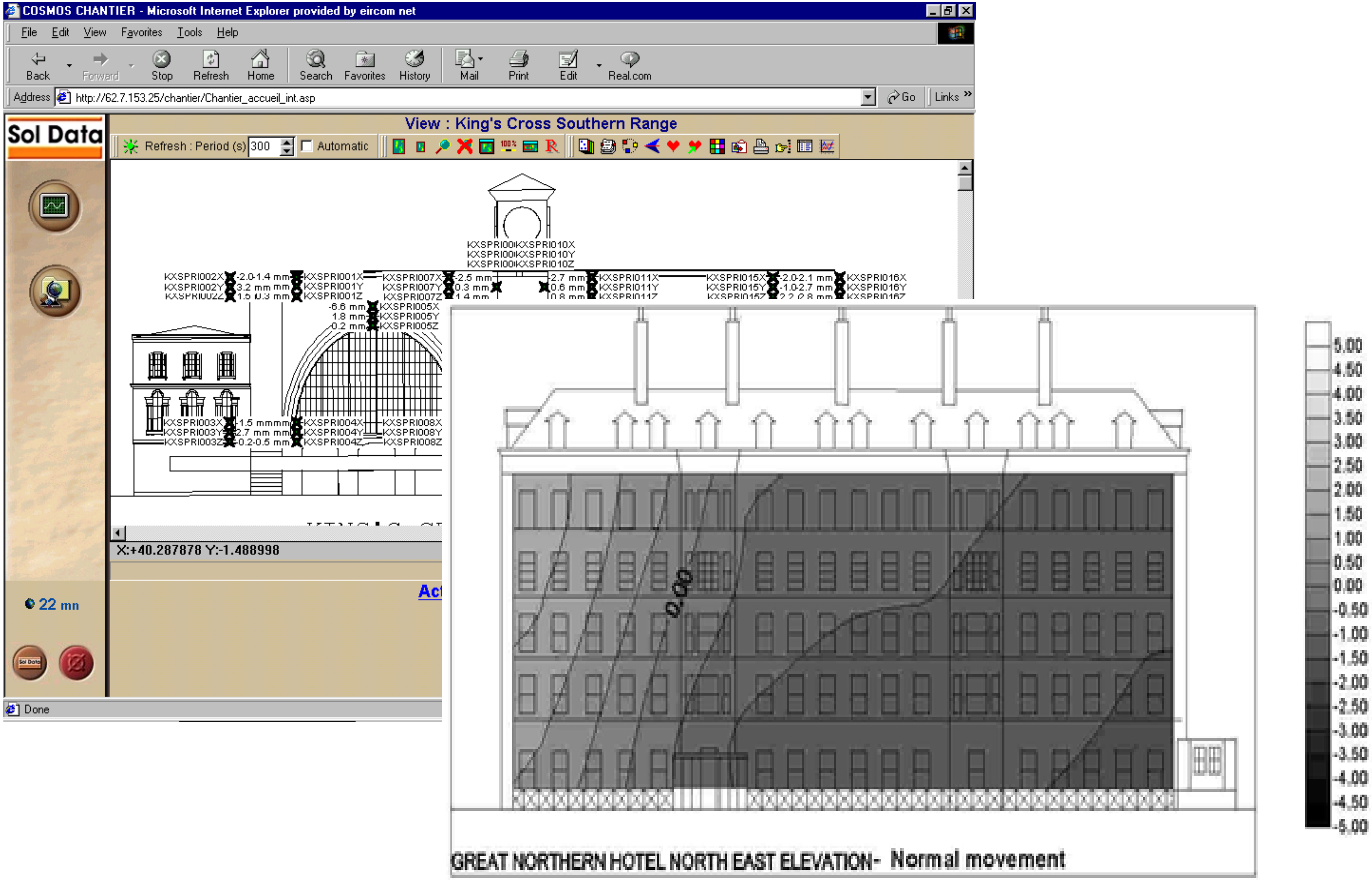
GEOSCOPE WEB - Settlement contours

THE CENTRAL ROLE OF REAL TIME DATA ACQUISITION &

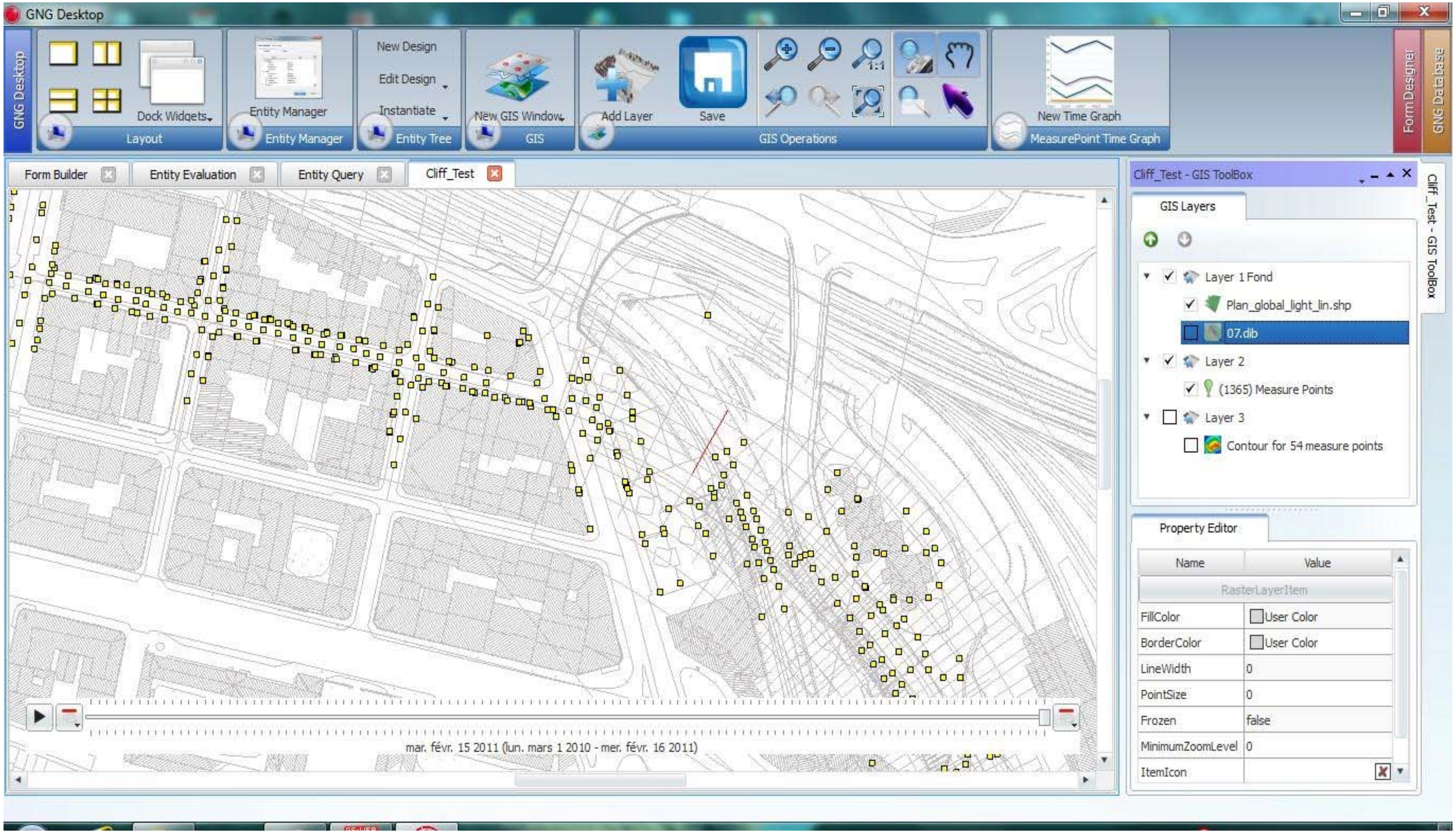
PRESENTATION FOR STRUCTURAL / GEOTECHNICAL MONITORING



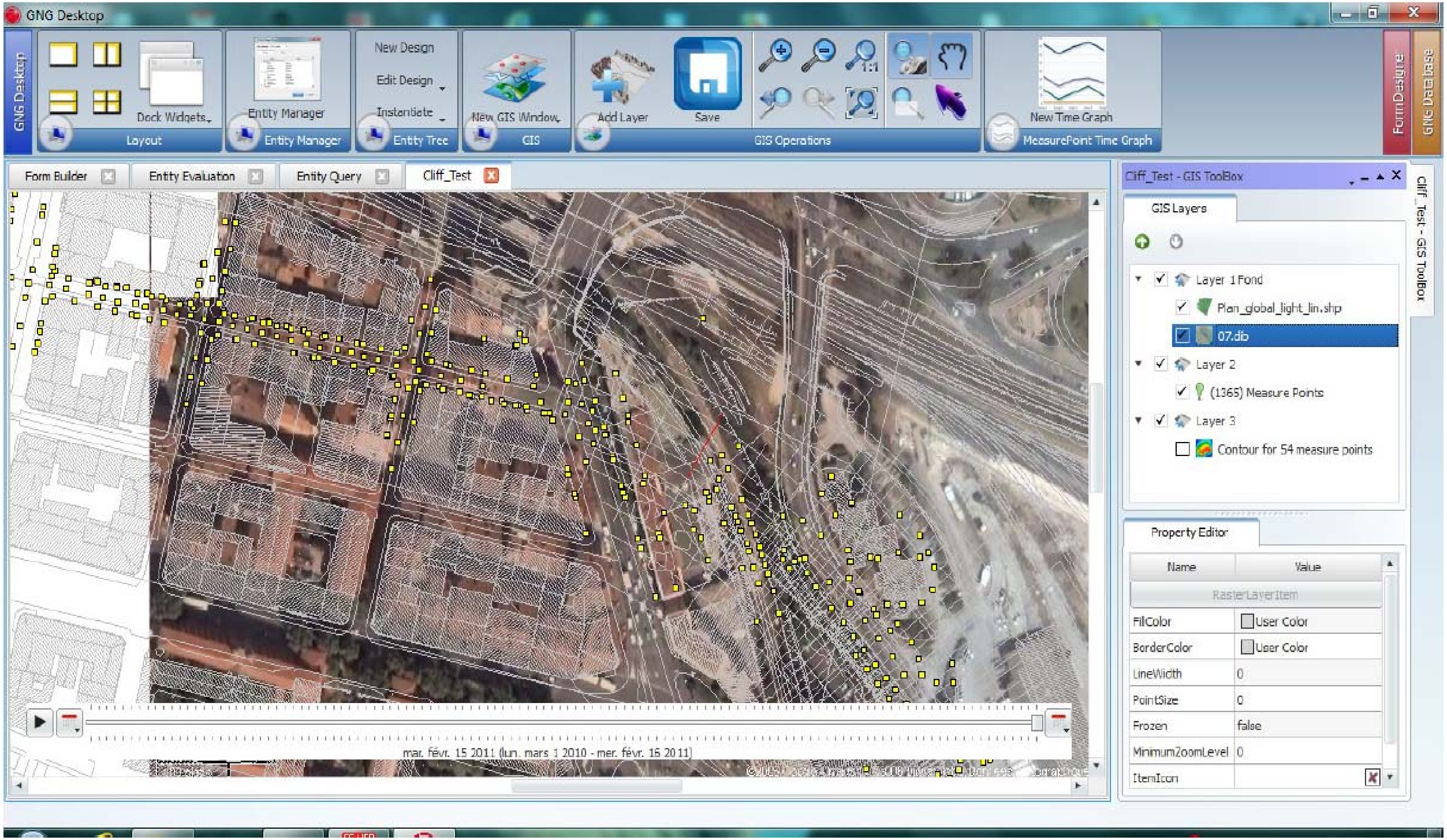
Process control - Settlement control for key structures



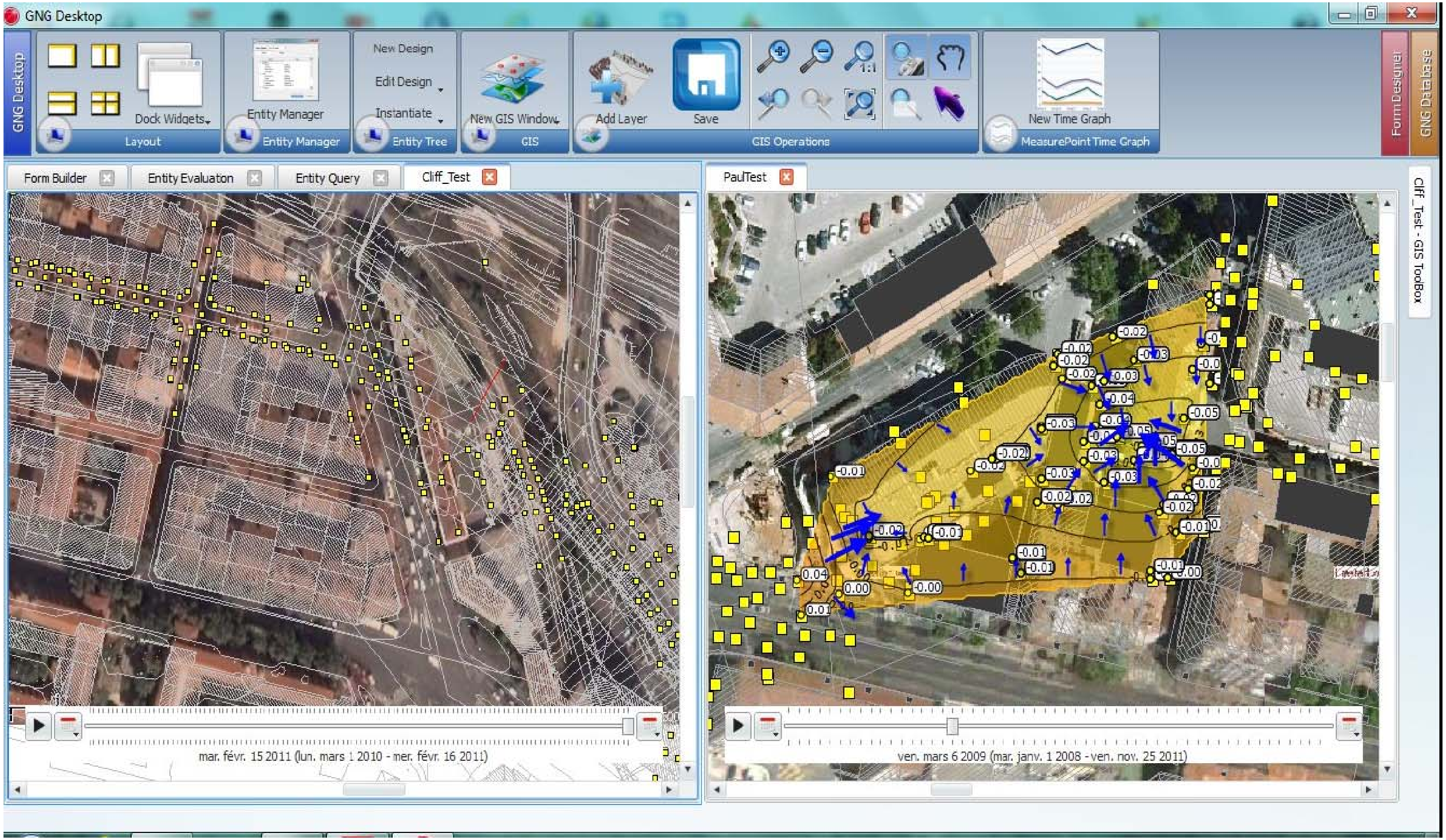
Process control - Settlement control for key structures



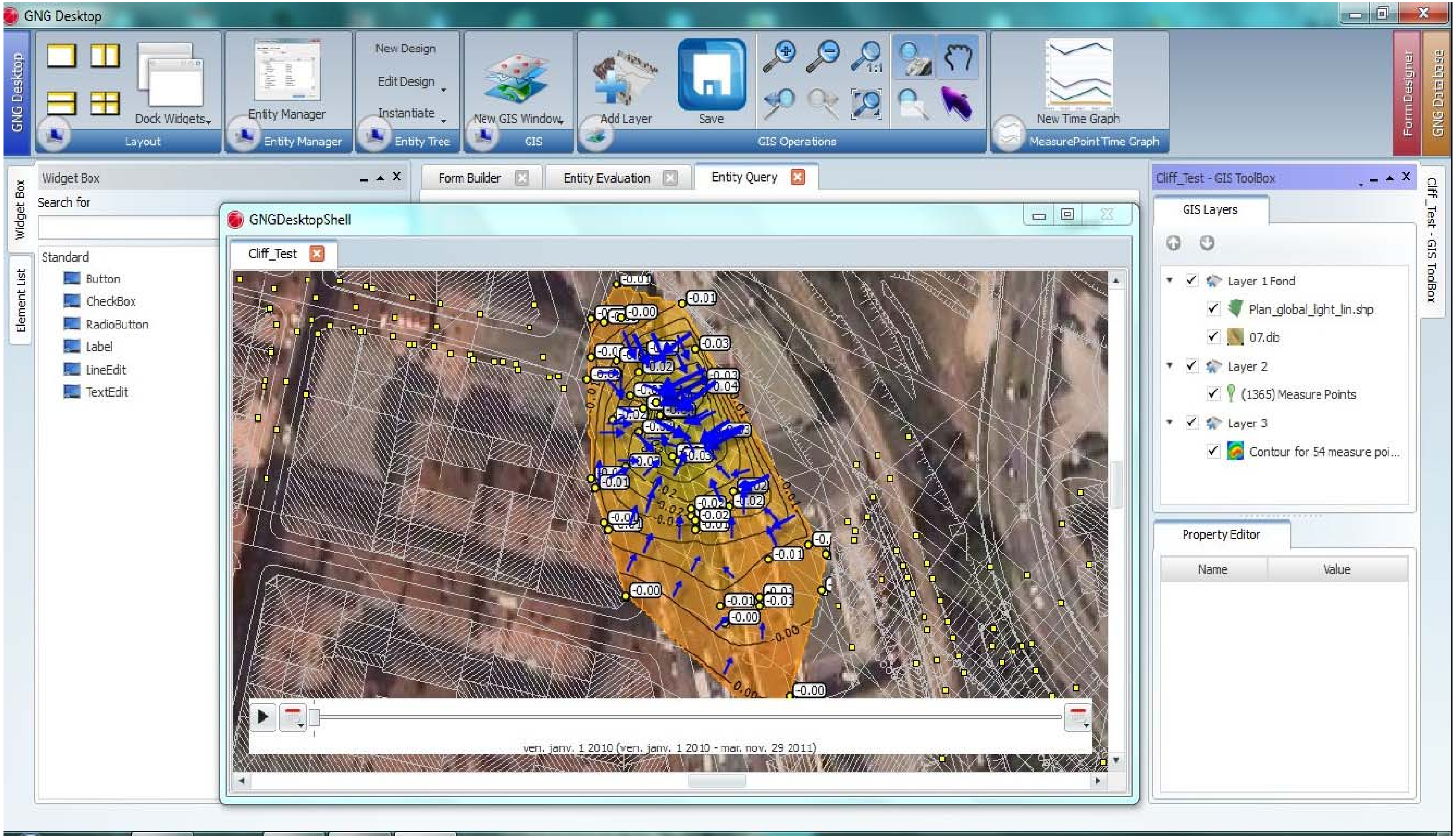
Process control - Settlement control for key structures



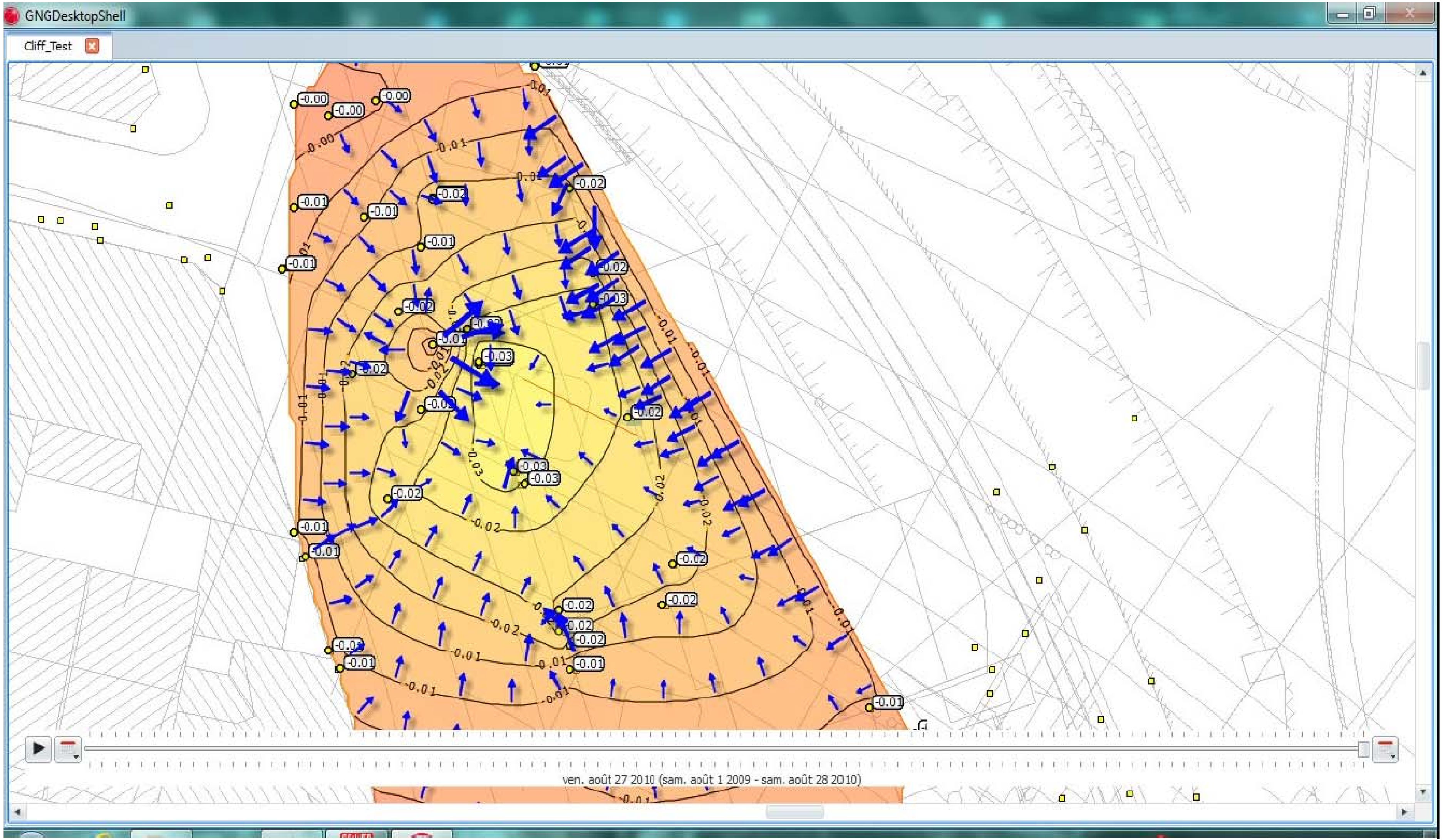
Process control - Settlement control for key structures



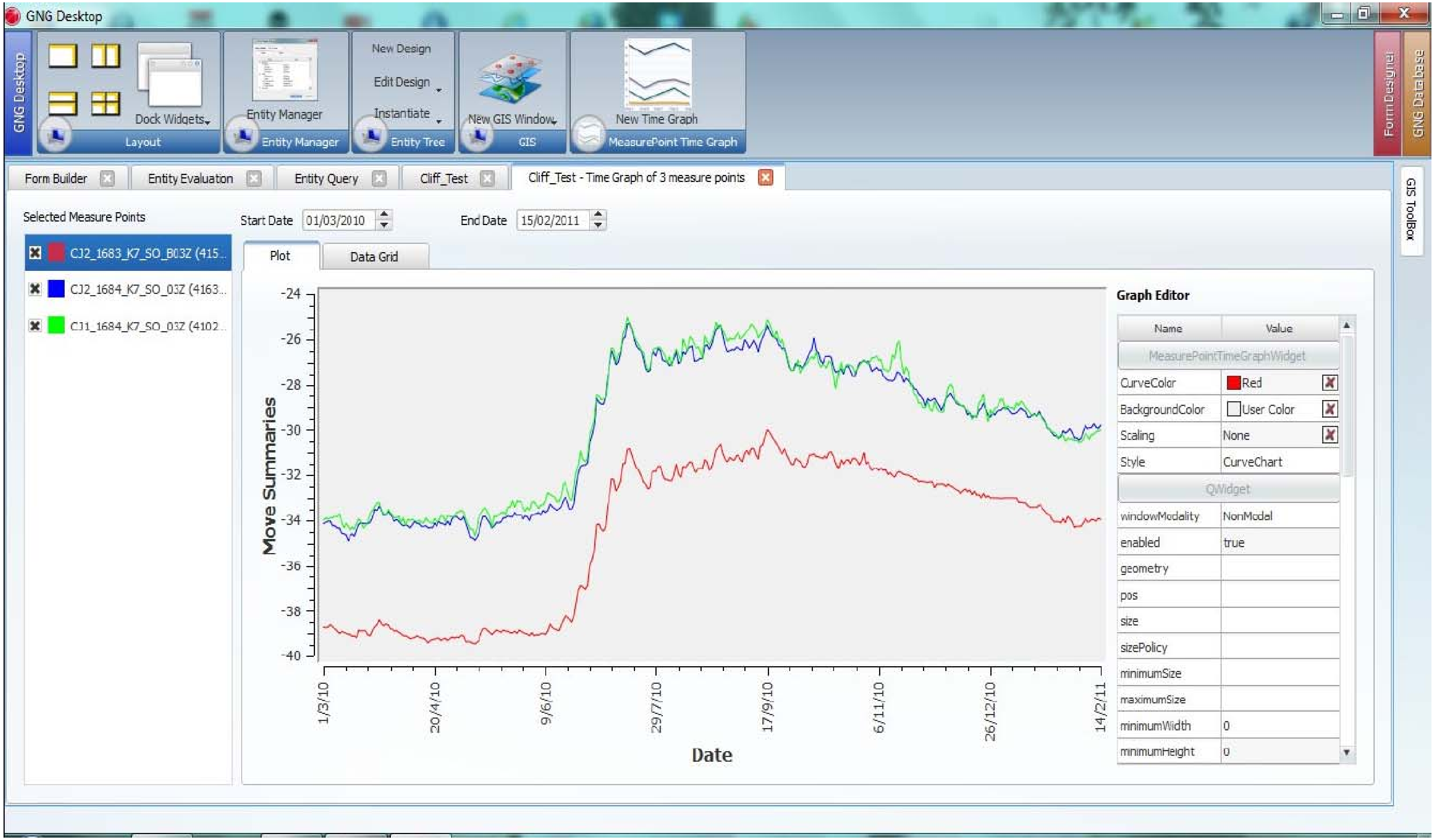
Process control - Settlement control for key structures



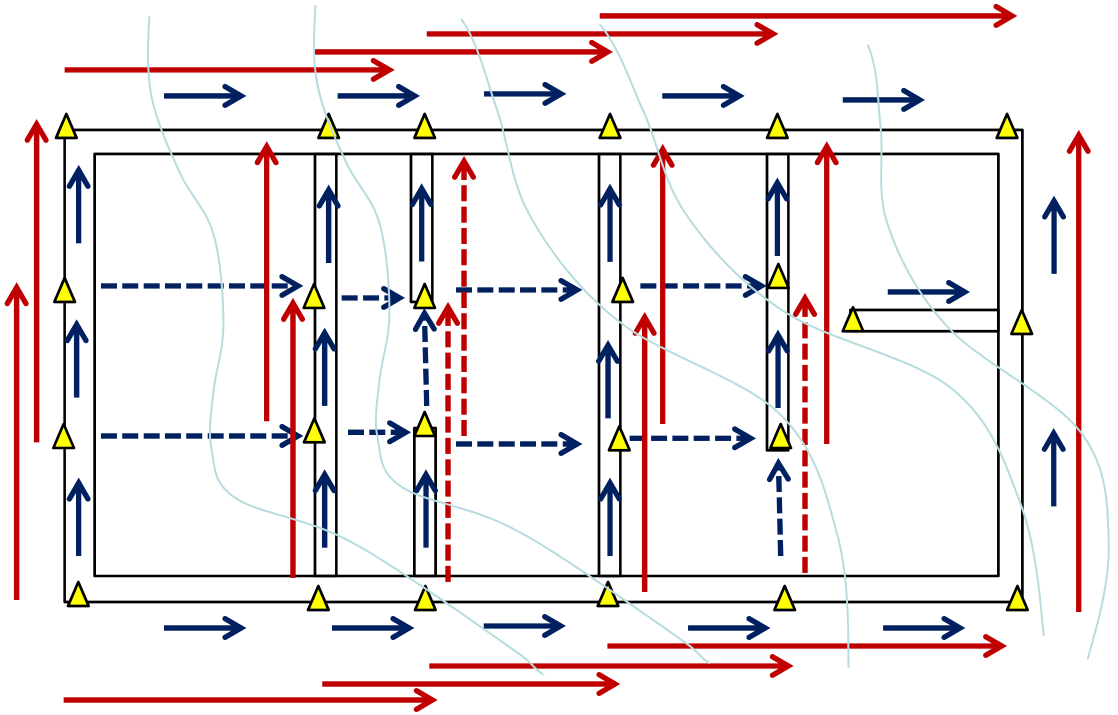
Process control - Settlement control for key structures



Process control - Settlement control for key structures



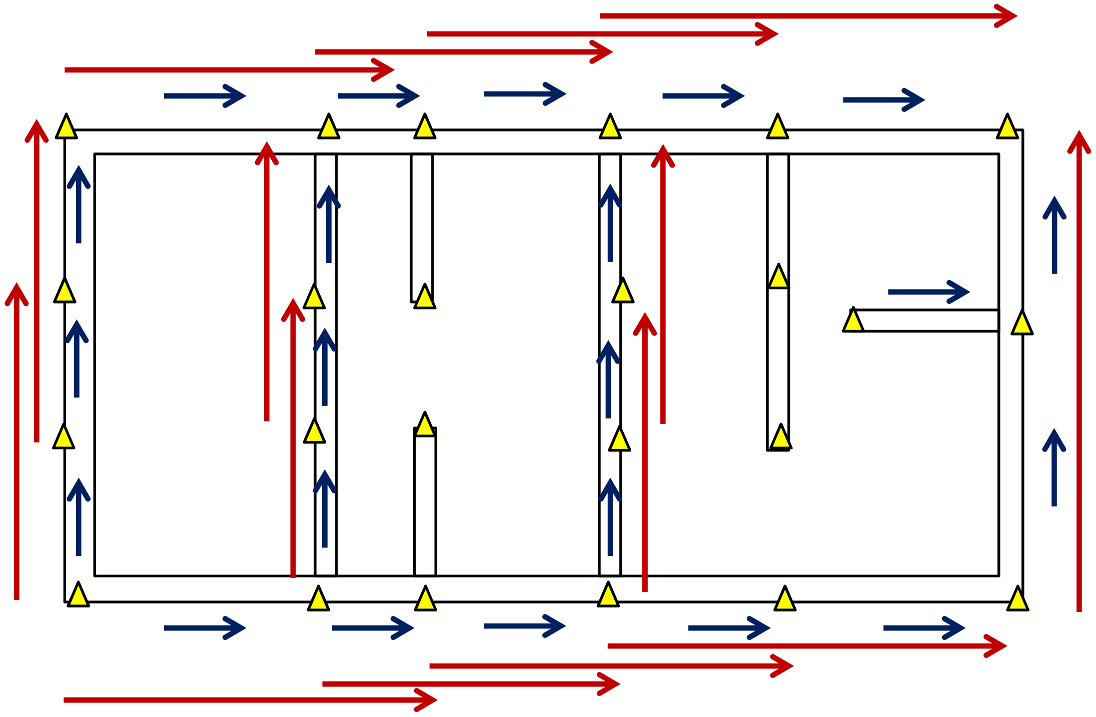
Process control - Settlement control for key structures



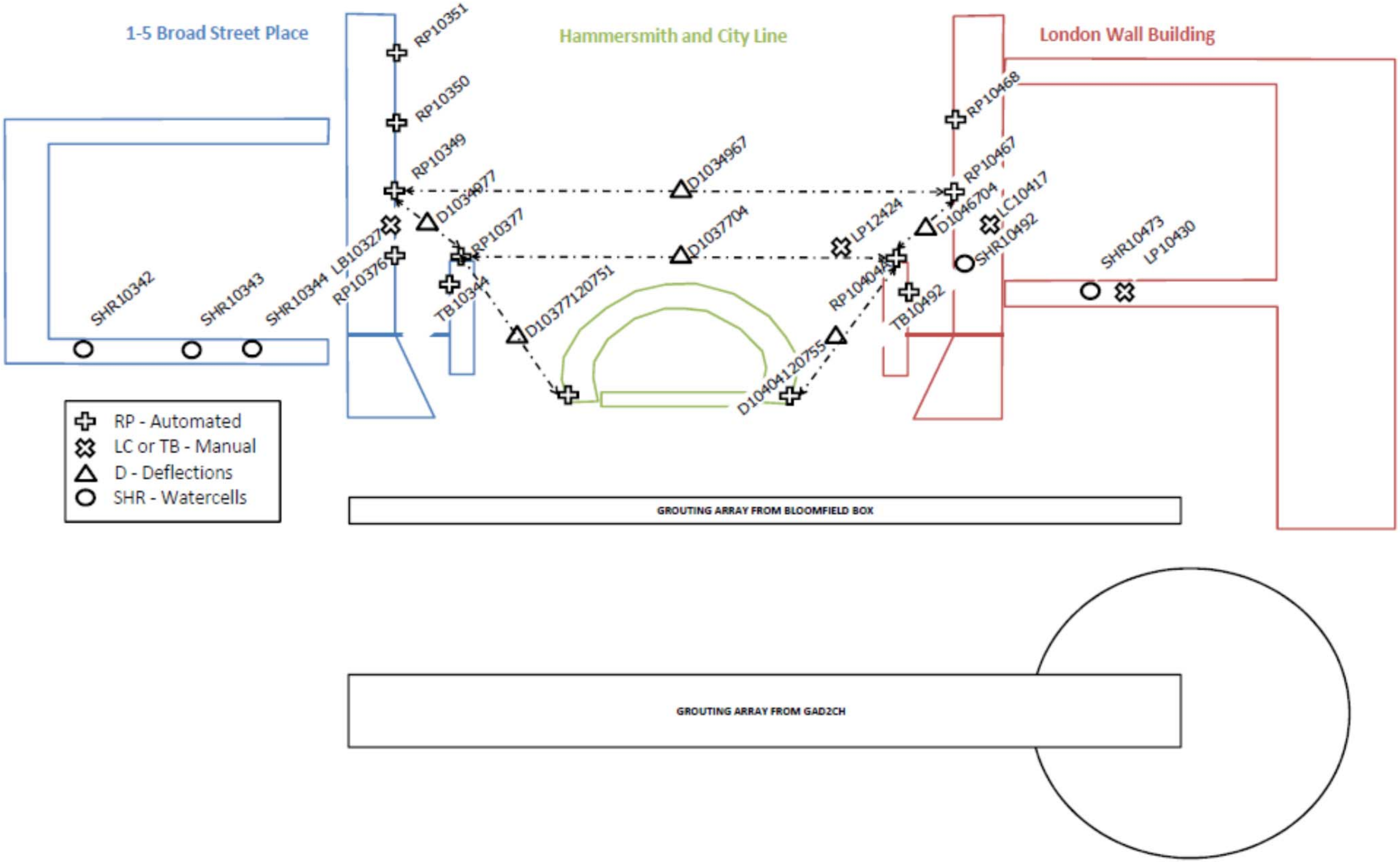
Be sure of what you are monitoring- significant elements only

- Specification requires monitoring of differential settlement between any 2 adjacent points, & deflection across any 3
- If taken literally this is too much information, and can be misleading, The specification must be applied sensibly
- We must select and agree key structural elements to be monitored
- We must advise the client what we need in order to manage the works, and ensure provision is made for this
- To achieve all this properly requires
  a) a measured survey, b) a structural survey, c) a settlement prediction, and d) a building damage assessment

Process control - Settlement control for key structures



- We must pare back the instrumentation, eliminating unnecessary detail
  It is necessary
- to identify the key structural elements,
- to install appropriate survey points and instruments
- to define whether data needs to be real-time, semi real-time, or periodic,
- to decide how to present and distribute the data

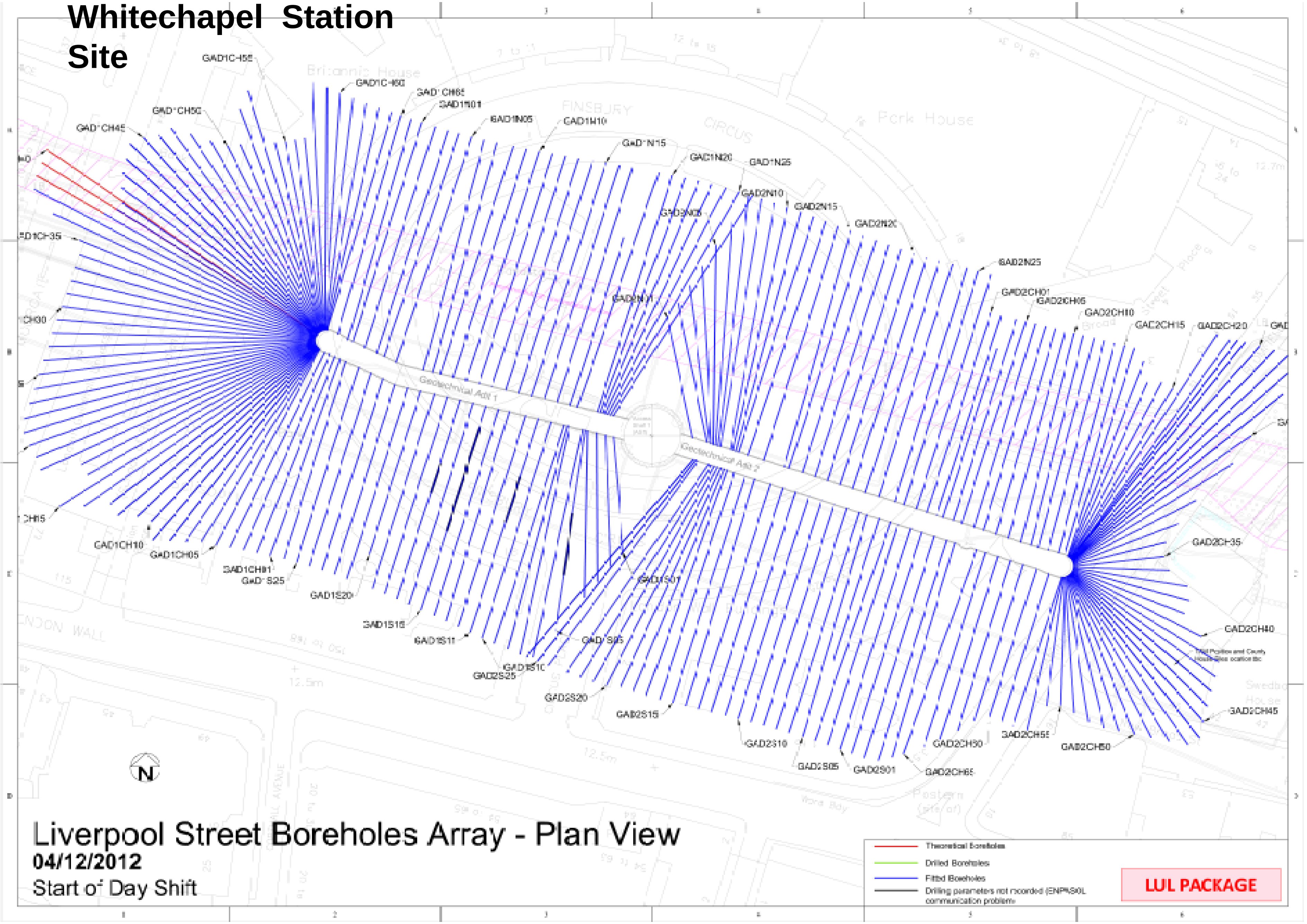


1-5 Broad Street Place
Hammersmith and City Line
London Wall Building
RP10351
RP10350
RP10349
D1034977
LB10327
RP10376
RP10377
TB10344
SHR10342
SHR10343
SHR10344
D10377120751
D1034967
D1037704
LP12424
RP10404
D10404120755
TB10492
D1046704
RP10467
RP10468
LC10417
SHR10492
SHR10473
LP10430
RP - Automated
LC or TB - Manual
D - Deflections
SHR - Watercells
GROUTING ARRAY FROM BLOOMFIELD BOX
GROUTING ARRAY FROM GAD2CH

Daily Report Pack for all-party SRG Meeting

CTC Pack 1

Whitechapel Station Site



CROSSRAIL C510 - WHITECHAPEL & LIVERPOOL STREET STATION TUNNELS

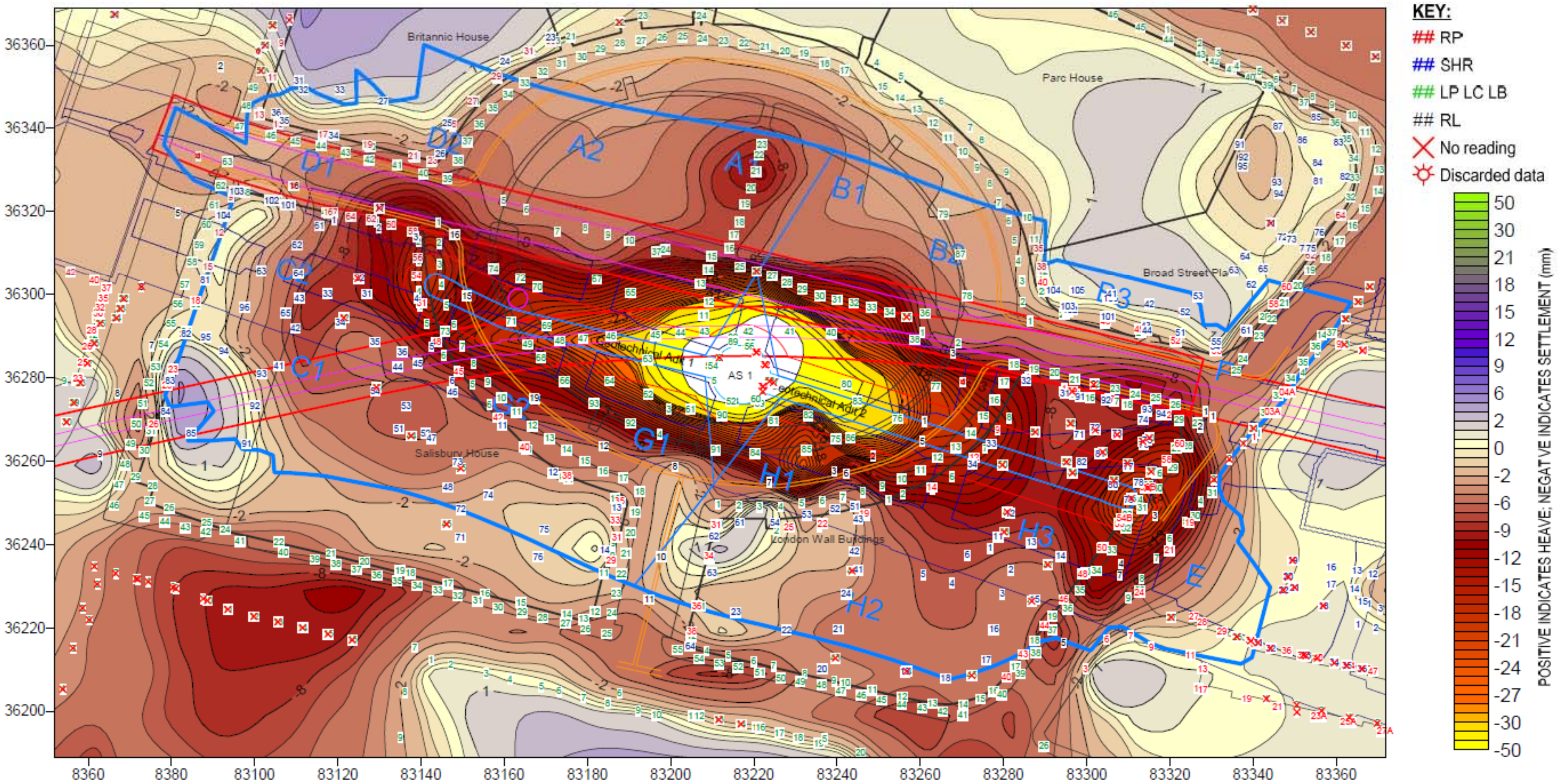
LIVERPOOL STREET - Geotechnical Adits

ABSOLUTE REPORT SURFACE & BASEMENT MONITORING INSTRUMENTATION.

WHOLE SITE

BASIS OF CONTOURS:
For Automatic monitoring: NIGHTSHIFT OF 04/12/12 (19:00 to 07:00 HRS ending next day)
For Manual monitoring: DAYSHIFT OF 04/12/12 ending at 19:00 HRS
KRIGING METHOD USED TO ESTABLISH CONTOURS.

VOLUME:
CUT: 19226 L
FILL: 305530 L



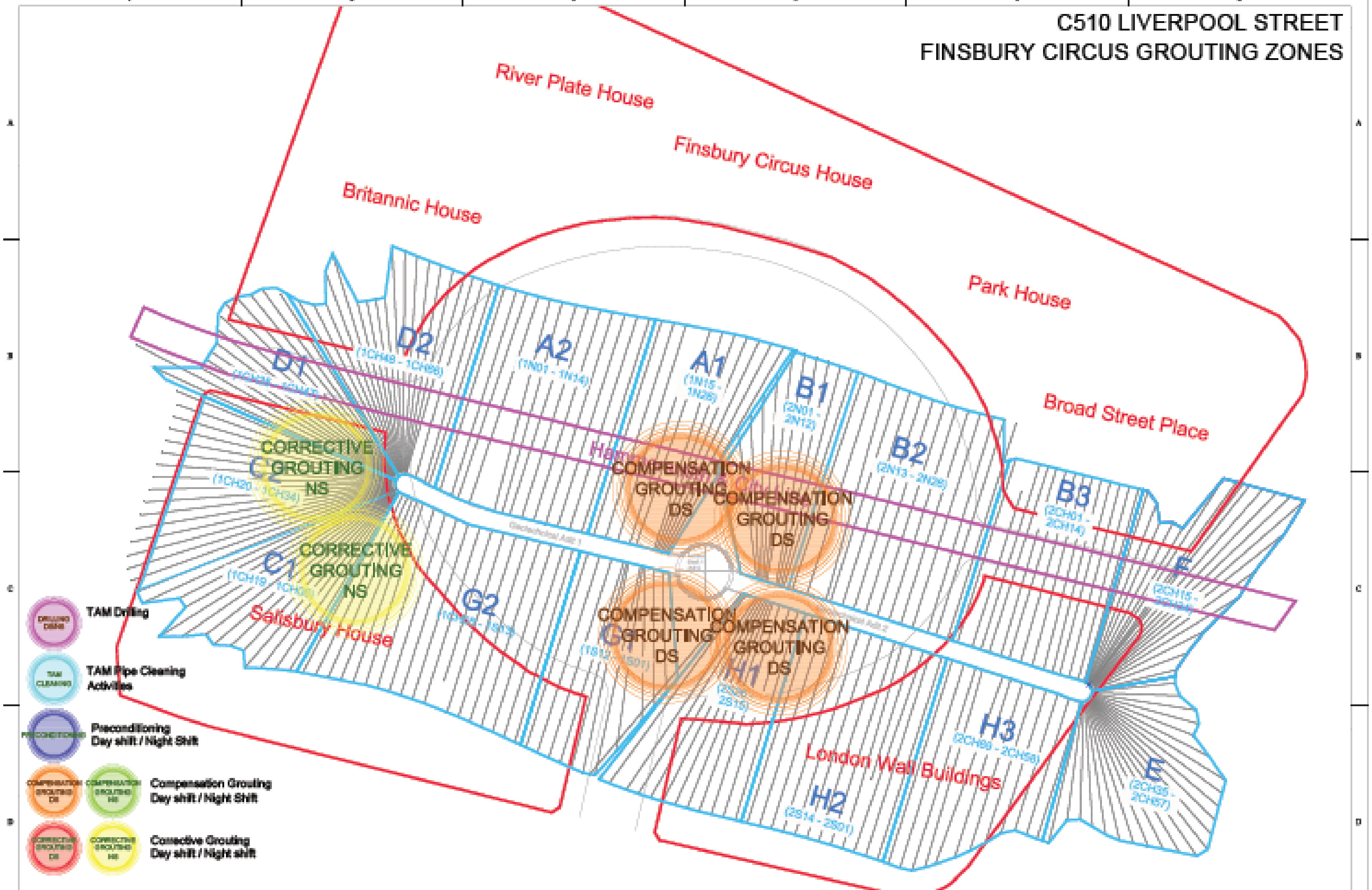
File Reference: 20121205-LIV_ABSOLUTE_[WHOLE SITE].srf

Created By: ISA - Checked By: NRA

Printed: 2012-12-05

CTC Pack 2

C510 LIVERPOOL STREET
FINSBURY CIRCUS GROUTING ZONES



06/12/2012
Proposed programme for next day and night shift if approved in SRG meeting.

LUL PACKAGE

CROSSRAIL C510 - WHITECHAPEL & LIVERPOOL STREET STATION TUNNELS

LIVERPOOL STREET - Geotechnical Adits

SHIFT REPORT SURFACE & BASEMENT MONITORING INSTRUMENTATION.

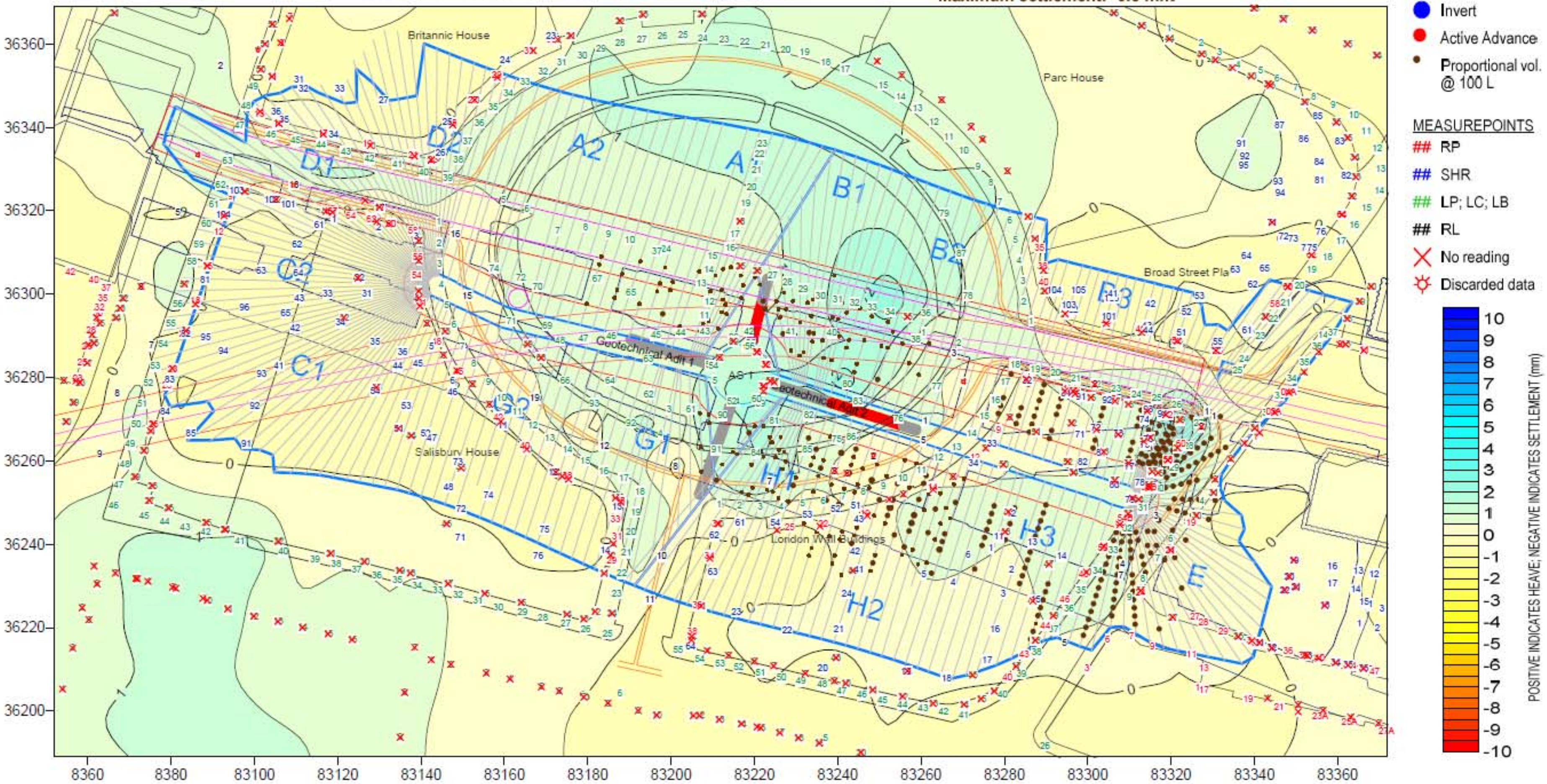
WHOLE SITE

BASIS OF CONTOURS:
NIGHTSHIFT OF 04/12/12 MINUS NIGHTSHIFT OF 03/12/12
I.E. MEDIAN OF 04/12/12 19:00HRS TO 05/12/12 07:00HRS minus
MEDIAN OF 03/12/12 19:00HRS TO 04/12/12 07:00HRS.

KRIGING METHOD USED TO ESTABLISH CONTOURS.

VOLUME
CUT: 24086 L
FILL: 2711 L

Grouted Volumes for the 04/12/2012 (DS-NS): 16,188 L
ACG-AP7_P_E_150: 3,278 L
ACG-CP6: 2,226 L
PRG11-GJ46,48: 10,684 L
Maximum heave: 2.8 mm
Maximum settlement: -0.5 mm



Crossrail

CROSSRAIL C510 - Whitechapel and Liverpool Street Station Tunnels

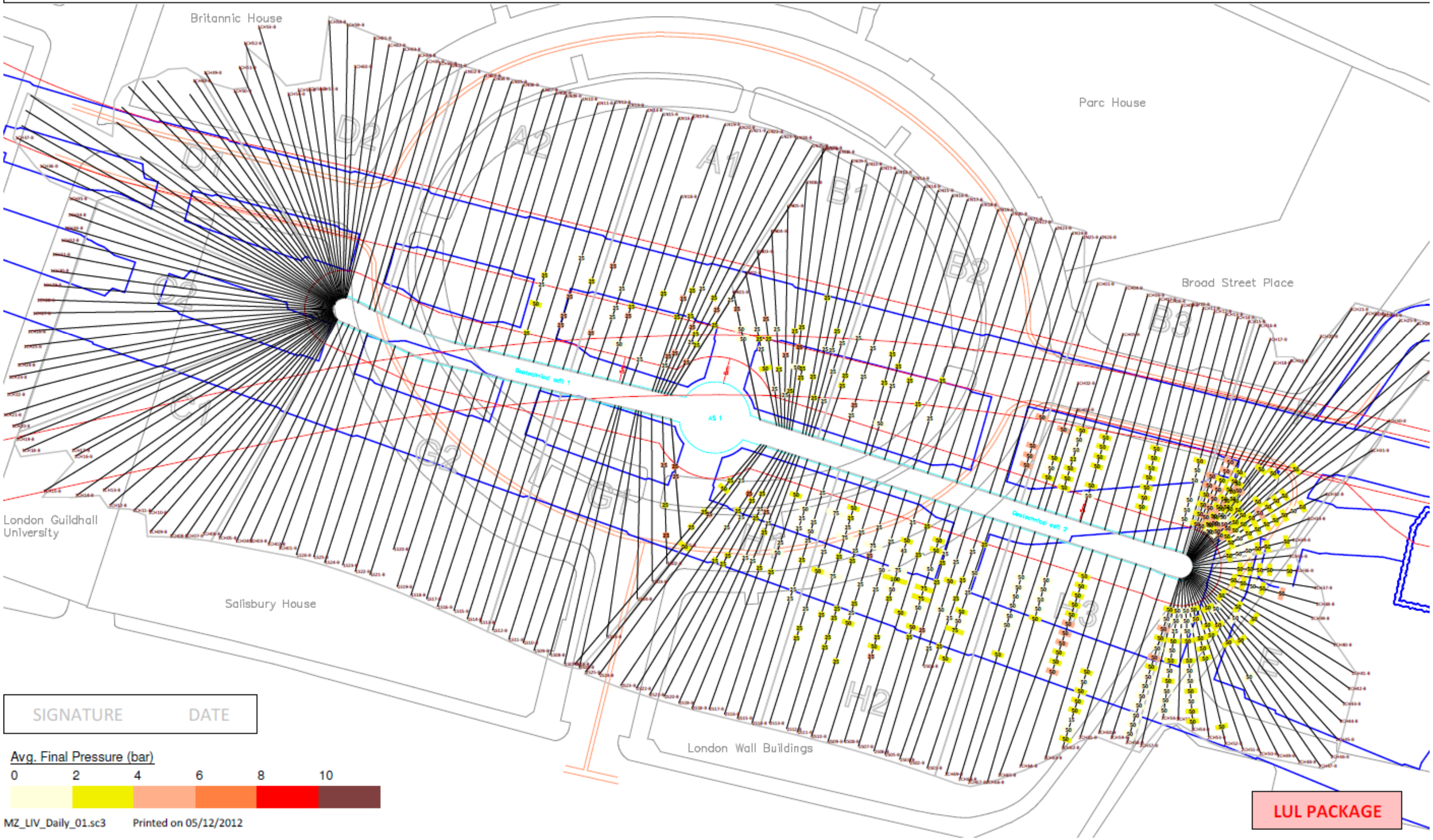
BBMV

LIVERPOOL STREET
ZONES: LIV1, LIV2, LIV4

DAILY REPORT,

from 08:21:24, 04/12/2012 to 05:49:48, 05/12/2012
total grouted volume: 16,187.45 (litres) 398 Sleeves

First Phase: AP7_P_E/0019-0024_150, Last Phase: GJ48 PRG11 [GJ45 to GJ48]



MZ_LIV_Daily_01.sc3 Printed on 05/12/2012

LUL PACKAGE

CROSSRAIL C510 - WHITECHAPEL & LIVERPOOL STREET STATION TUNNELS

LIVERPOOL STREET - Geotechnical Adits

CUMULATIVE REPORT

WHOLE SITE

Historic Active Compensation Grouting from 19/10/2012

SURFACE & BASEMENT MONITORING INSTRUMENTATION.

BASIS OF CONTOURS:
NIGHTSHIFT OF 04/12/12 MINUS NIGHTSHIFT OF 19/10/12
I.E. MEDIAN OF 04/12/12 19:00HRS TO 05/12/12 07:00HRS minus
MEDIAN OF 19/10/12 19:00HRS TO 20/10/12 07:00HRS.

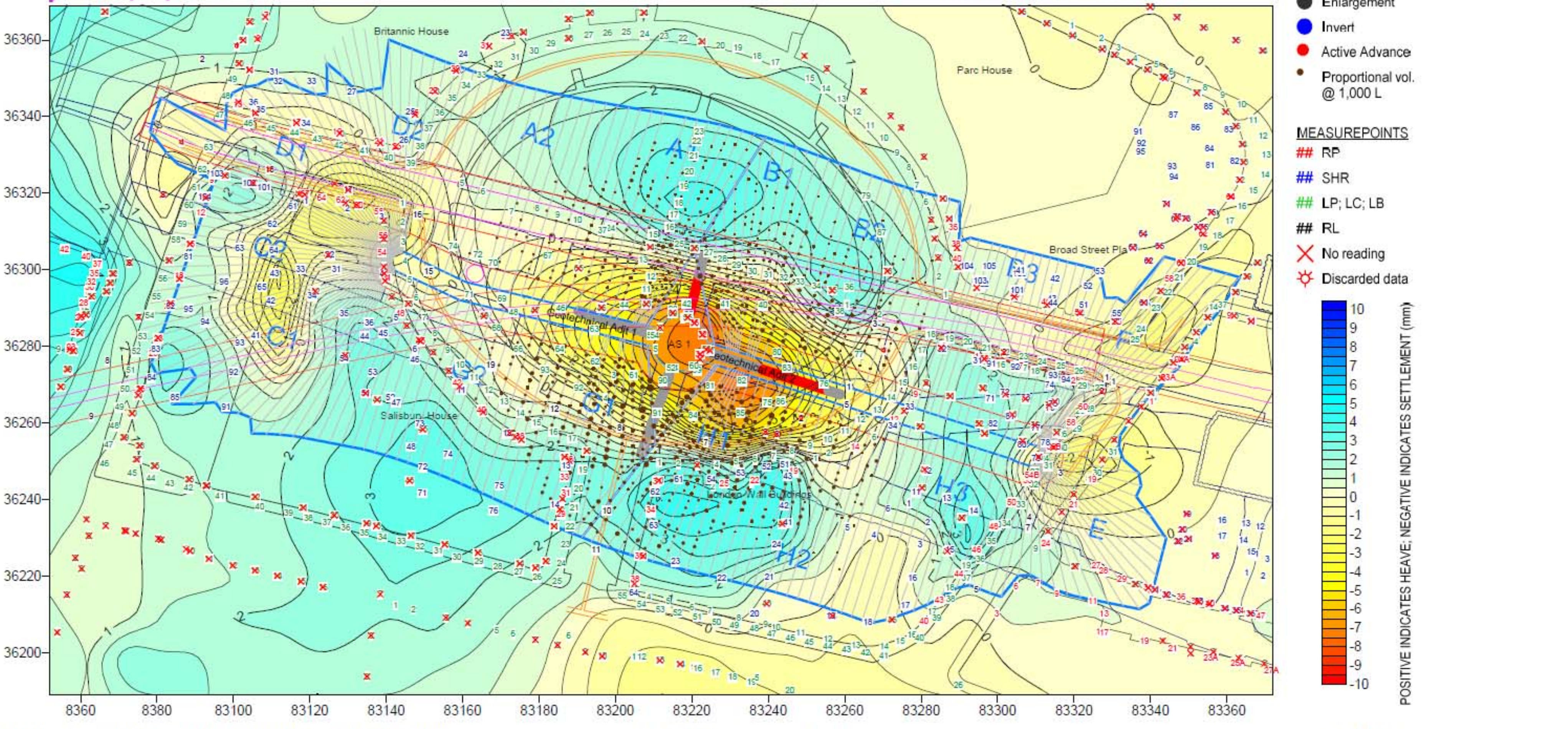
KRIGING METHOD USED TO ESTABLISH CONTOURS.

VOLUME:
CUT: 59364 L
FILL: 18876 L

Grouted volume (cumul) : 148,261.43 L

Maximum heave: 4.7 mm
Maximum settlement: -7.5mm

BBMV



File Reference: 20121205-20121019-LIV_CUMUL_[WHOLE SITE Tunnel_HISTO].srf   Created By: ISA - Checked By: NRA   Printed: 2012-12-05

CROSSRAIL C510 - WHITECHAPEL & LIVERPOOL STREET STATION TUNNELS

LIVERPOOL STREET - Geotechnical Adits

CUMULATIVE REPORT

WHOLE SITE

CORRECTIVE GROUTING PRG11
GJ46-GJ48

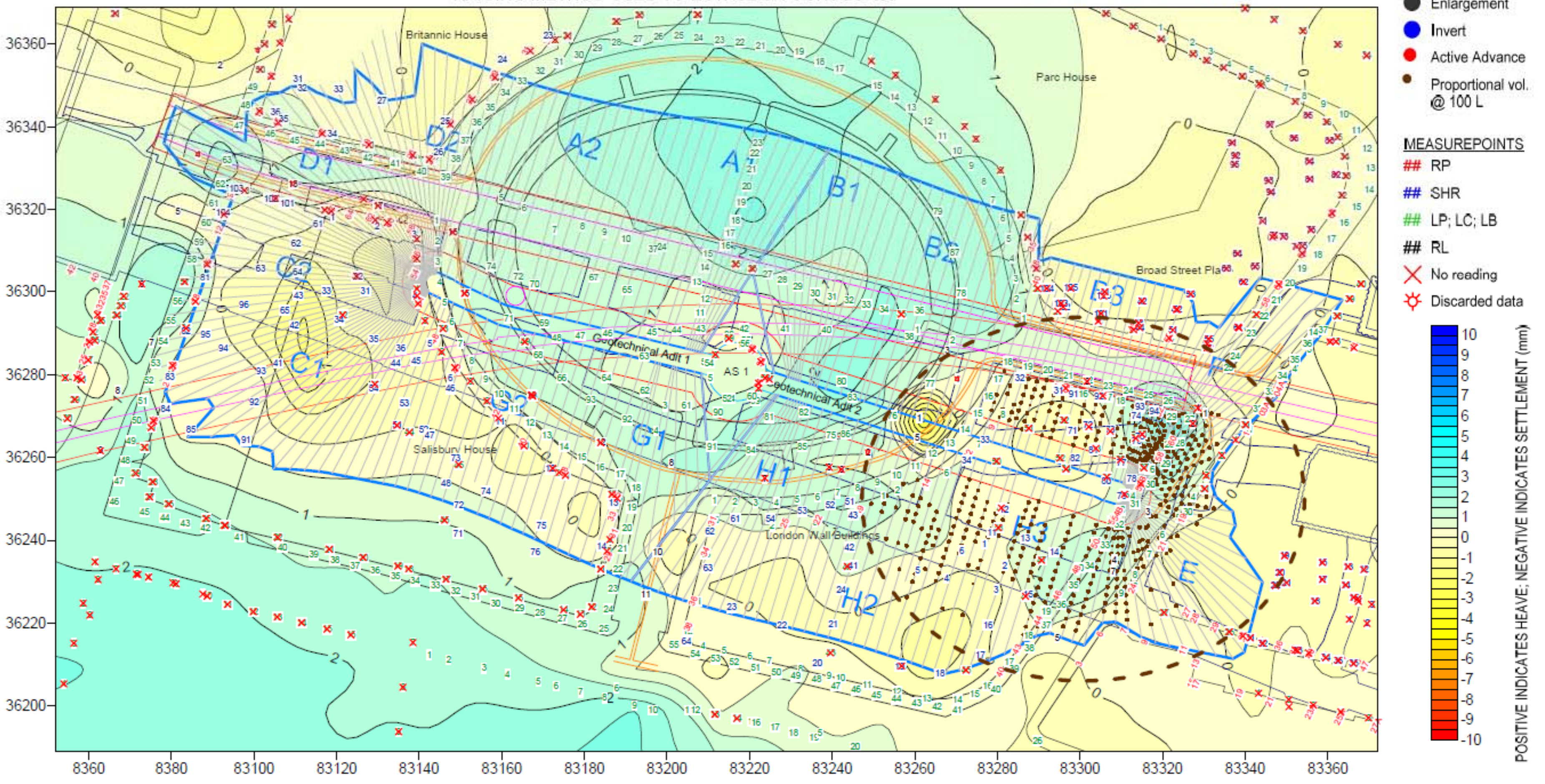
SURFACE & BASEMENT MONITORING INSTRUMENTATION.

BASIS OF CONTOURS:
NIGHTSHIFT OF 04/12/12 MINUS NIGHTSHIFT OF 26/11/12
I.E. MEDIAN OF 04/12/12 19:00HRS TO 05/12/12 07:00HRS minus
MEDIAN OF 26/11/12 19:00HRS TO 27/11/12 07:00HRS.

KRIGING METHOD USED TO ESTABLISH CONTOURS.

VOLUME:
CUT: 46545 L
FILL: 2611 L

PRG 11 - Cumul Grouted Vol : 23,142.17 L
Maximum heave: 3 mm
Maximum settlement: -3 mm



File Reference: 20121205-20121127-LIV_CUMUL_[WHOLE SITE PRG11].srf

Created By: ISA - Checked By: NRA

Printed: 2012-12-05

CTC Pack

CROSSRAIL C510 - Whitechapel and Liverpool Street Station Tunnels

Crossrail

BBMV

LIVERPOOL STREET

ZONES: LIV1, LIV2

CUMULATIVE REPORT, from 08:33:32, 24/10/2012 to 18:49:43, 04/12/2012

total grouted volume: 148,261.43 (litres) 947 Sleeves

First Phase: AP7_P_E/0001-0006, Last Phase: CP6_P/0015-0019_075

SIGNATURE DATE

Avg. Final Pressure (bar)

0 2 4 6 8 10

MZ_LIV_Cumul_01.sc3 Printed on 05/12/2012

LUL PACKAGE

CTC Pack

CROSSRAIL C510 - Whitechapel and Liverpool Street Station Tunnels

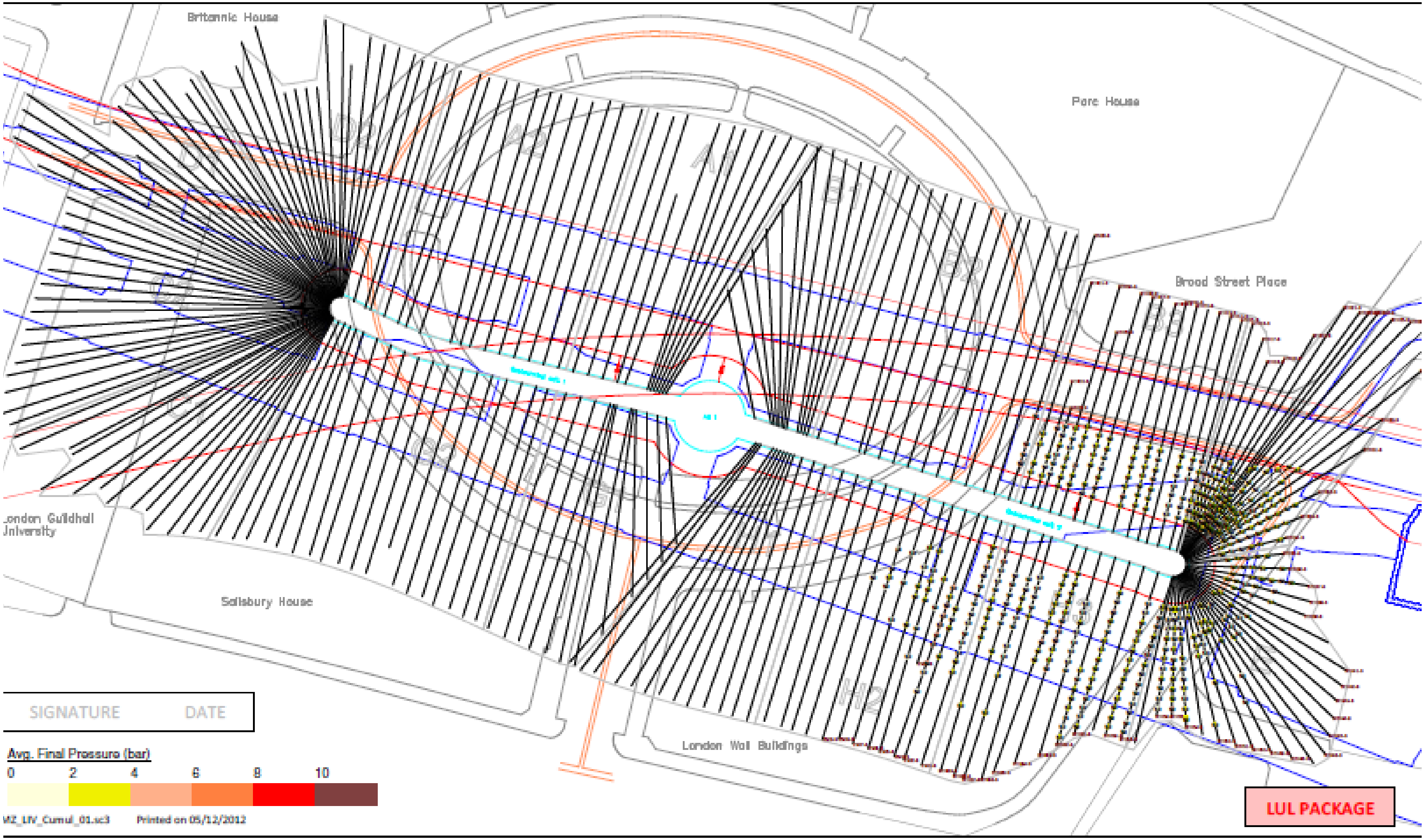
LIVERPOOL STREET

ZONES: LIV1, LIV4

CUMULATIVE REPORT, from 09:12:29, 28/11/2012 to 05:49:48, 05/12/2012

total grouted volume: 23,142.17 (litres) 467 Sleeves

First Phase: GJ45 PRG11 [GJ45 to GJ48], Last Phase: GJ48 PRG11 [GJ45 to GJ48]



SIGNATURE DATE

Avg. Final Pressure (bar)

0 2 4 6 8 10

WZ_LIV_Cumul_01.sc3 Printed on 05/12/2012

LUL PACKAGE

CTC Pack 10

CROSSRAIL C510 - Whitechapel and Liverpool Street Station Tunnels

BBMV

GROUT I.T.

Grouting Report

Site : *LIVERPOOL STREET*

Zones: LIV1_H2, LIV2_B1, LIV4_E

Printed on: 05/12/2012

From: 08:21:24, 04/12/2012 To: 05:47:49, 05/12/2012

Zone: LIV1 *Area: G1*

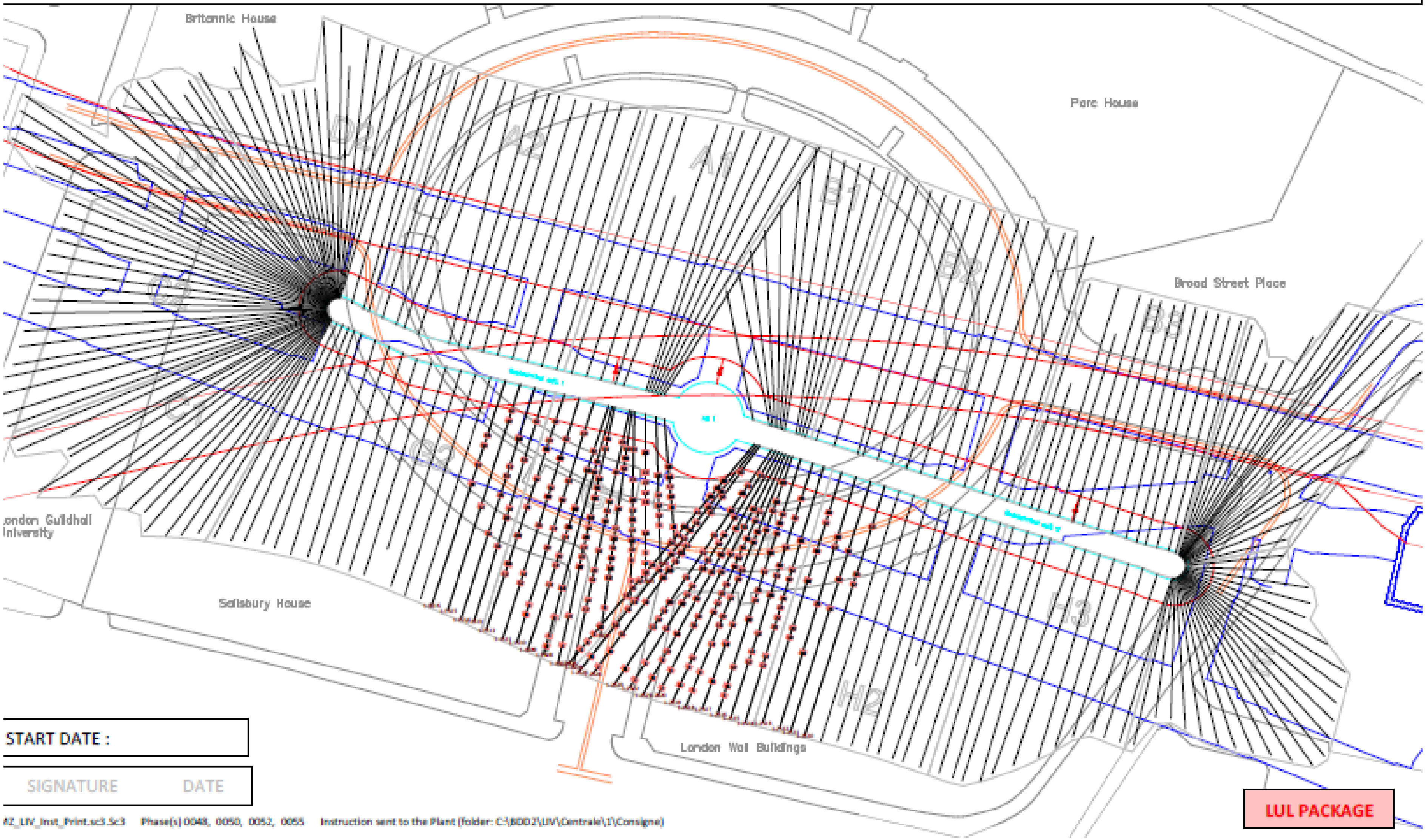
Area	Hole	Sleeve	Phase	Start Time	End Time	Grouted Volume (litre)	Final Pres. (bar)	Av. Final Pres. (bar)	Av. Flow (l/h)	Stop Comment
G1	1S01	14	AP7_P_E/0019-0024_150	04/12/2012 08:21	08:24	25.0	4.9	4.5	96	Maximum Volume
G1	1S01	16	AP7_P_E/0025-0030_150	04/12/2012 08:32	08:37	25.0	6.9	7.0	102	Maximum Volume
G1	1S02	6	AP7_P_E/0019-0024_150	04/12/2012 08:54	09:11	25.0	4.4	6.3	48	Maximum Volume
G1	1S02	12	AP7_P_E/0019-0024_150	04/12/2012 09:29	09:31	25.0	2.8	2.9	72	Maximum Volume
G1	1S02	20	AP7_P_E/0019-0024_150	04/12/2012 09:43	09:46	25.0	5.4	5.6	101	Maximum Volume

Total Grouted Volume for Area: G1 0.125 m3

CTC Pack 11

CROSSRAIL C510 - Whitechapel and Liverpool Street Station Tunnels

LIVERPOOL STREET
ZONES: LIV1
04/12/2012
Instruction Phase(s): CP5_P/0001-0006_150, CP5_P/0007-0012_150, CP5_P/0013-0018_150, CP5_P/0024-0027_125   Phase(s) ID: 0048, 005(
Max. Volume: 25.00 L   Max Pressure: 8.00 bar   361 Sleeves.



START DATE :

SIGNATURE   DATE

LUL PACKAGE

Design – selection of zones for Corrective Grouting

CROSSRAIL C510 - WHITECHAPEL & LIVERPOOL STREET STATION TUNNELS

Programme 06

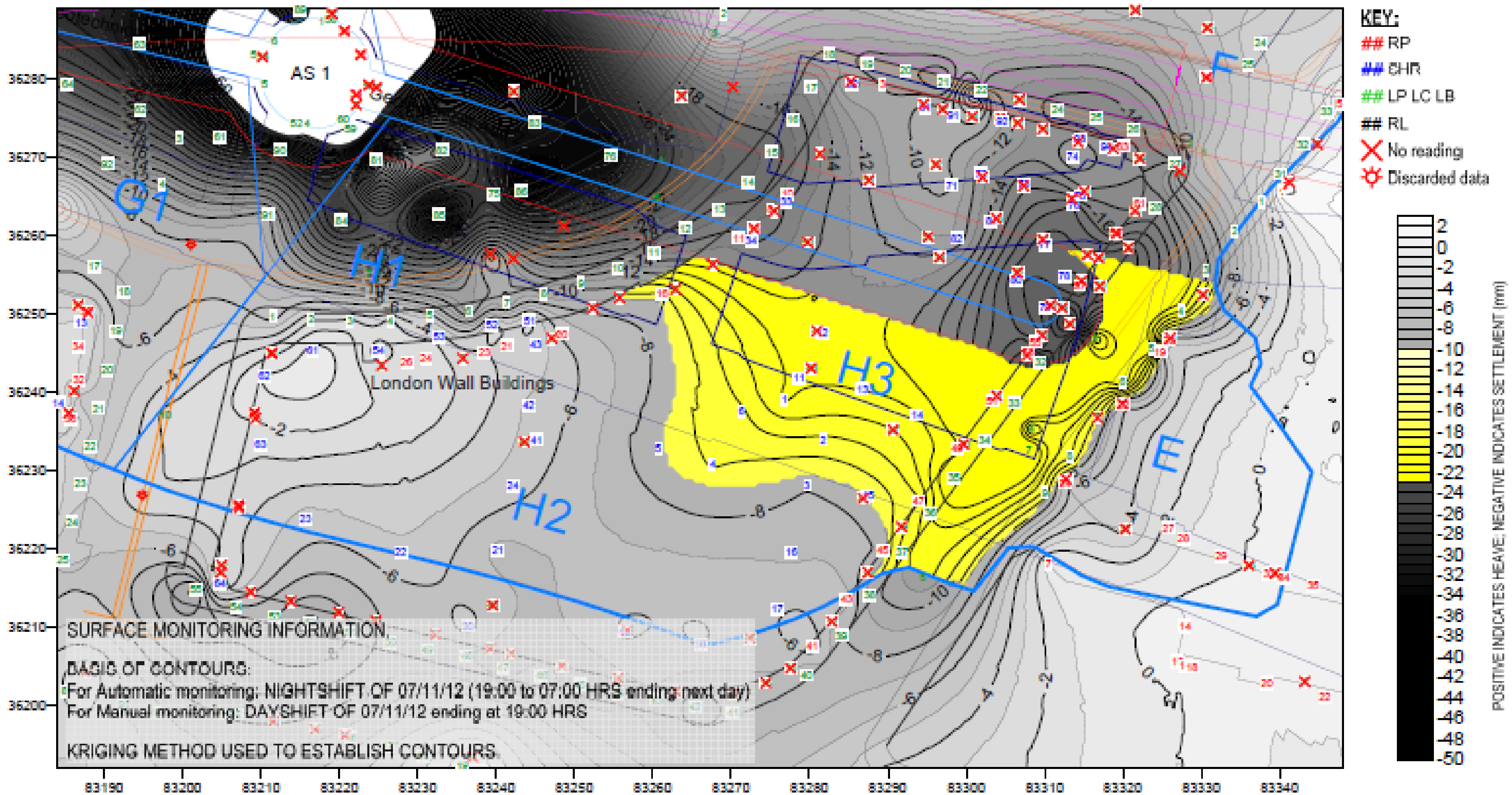
Proposed Programme for Corrective Grouting

LIVERPOOL STREET

LONDON WALL

Programme 06 to give absolute settlement an incremental heave of +5mm in highlighted region
PHASES GJ25, GJ26, GJ27, GJ28

Programme 06 to start 08/11/2012 Night Shift



File Reference: 20121108-LIV_ABSOLUTE_[WHOLE SITE].srf

Created By: NRA - Checked By: ALE

Printed: 2012-11-08

Crossrail

CROSSRAIL C510 - Whitechapel and Liverpool Street Station Tunnels

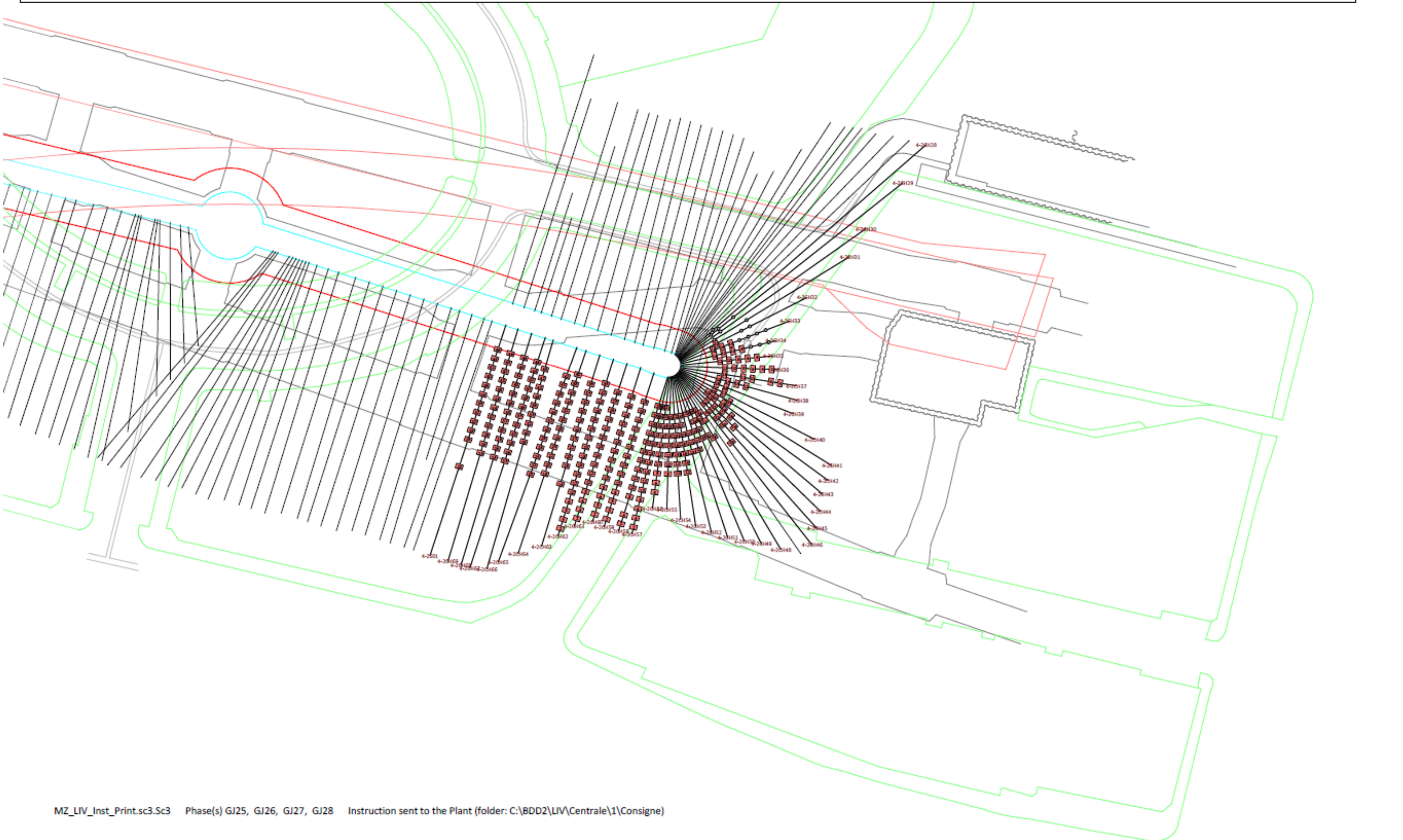
BBMV

LIVERPOOL STREET
ZONES: LIV4

09/11/2012

Instruction Phase(s): Corrective grouting 25, Corrective grouting 26, Corrective grouting 27, Corrective grouting 28

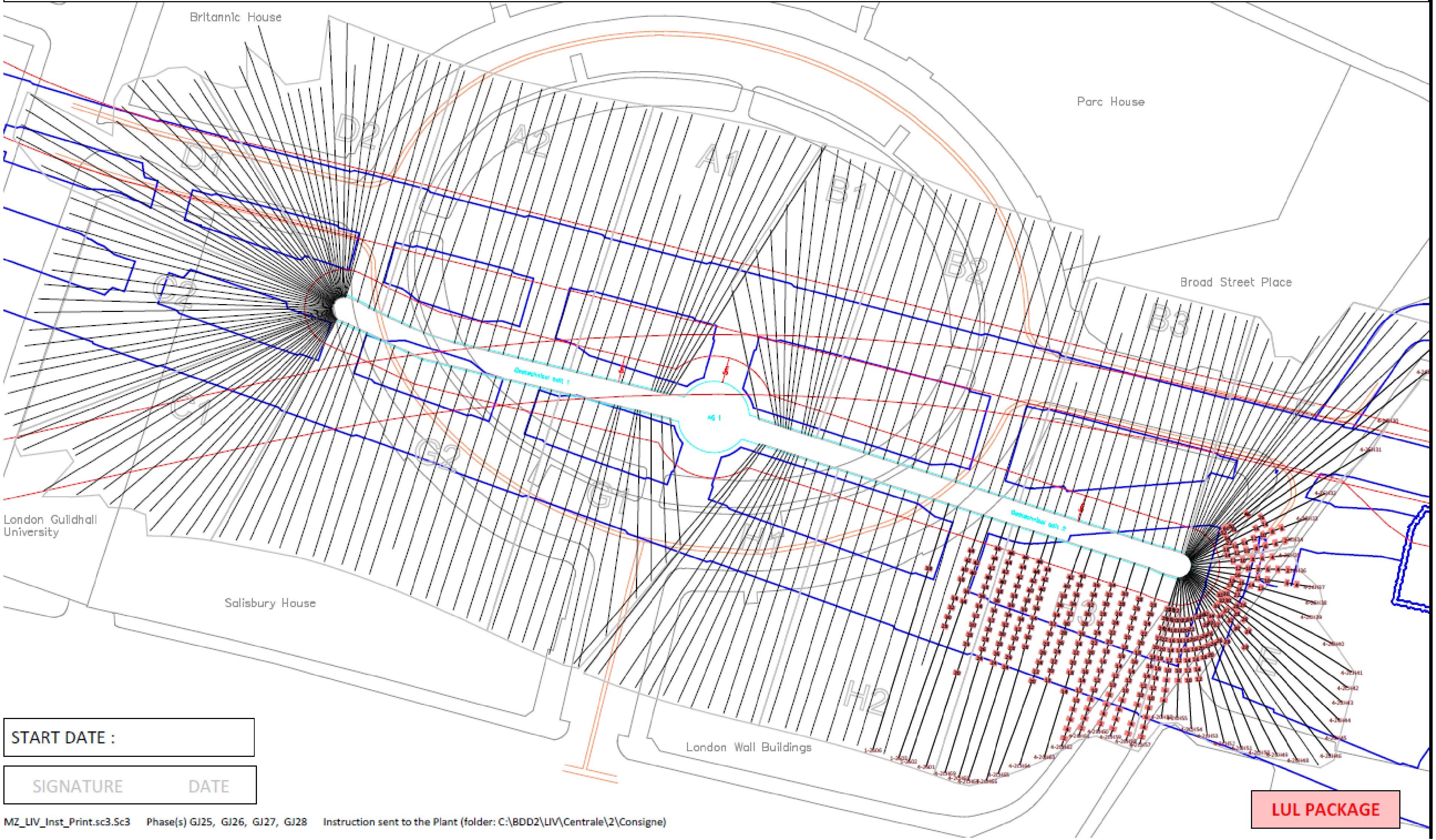
Max. Volume: 50.00 L   Max Pressure: 8.00 bar   273 Sleeves.



MZ_LIV_Inst_Print.sc3.Sc3   Phase(s) GJ25, GJ26, GJ27, GJ28   Instruction sent to the Plant (folder: C:\BDD2\LIV\Centrale\1\Consigne)

CROSSRAIL C510 - Whitechapel and Liverpool Street Station Tunnels

LIVERPOOL STREET
ZONES: LIV1, LIV4
05/12/2012
Instruction Phase(s): GJ25 PRG06 [GJ25 to GJ28], GJ26 PRG06 [GJ25 to GJ28], GJ27 PRG06 [GJ25 to GJ28], GJ28 PRG06 [GJ25 to GJ28] Phase(
Max. Volume: 50.00 L Max Pressure: 8.00 bar 302 Sleeves.



START DATE :

SIGNATURE DATE

LUL PACKAGE

MZ_LIV_Inst_Print.sc3.Sc3 Phase(s) GJ25, GJ26, GJ27, GJ28 Instruction sent to the Plant (folder: C:\BDD2\LIV\Centrale\2\Consigne)

CROSSRAIL C510 - WHITECHAPEL & LIVERPOOL STREET STATION TUNNELS

LIVERPOOL STREET - Geotechnical Adits

Crossrail

BBMV

CUMUL REPORT

WHOLE SITE

CORRECTIVE GROUTING
GJ25 - GJ27

SURFACE & BASEMENT MONITORING INSTRUMENTATION.

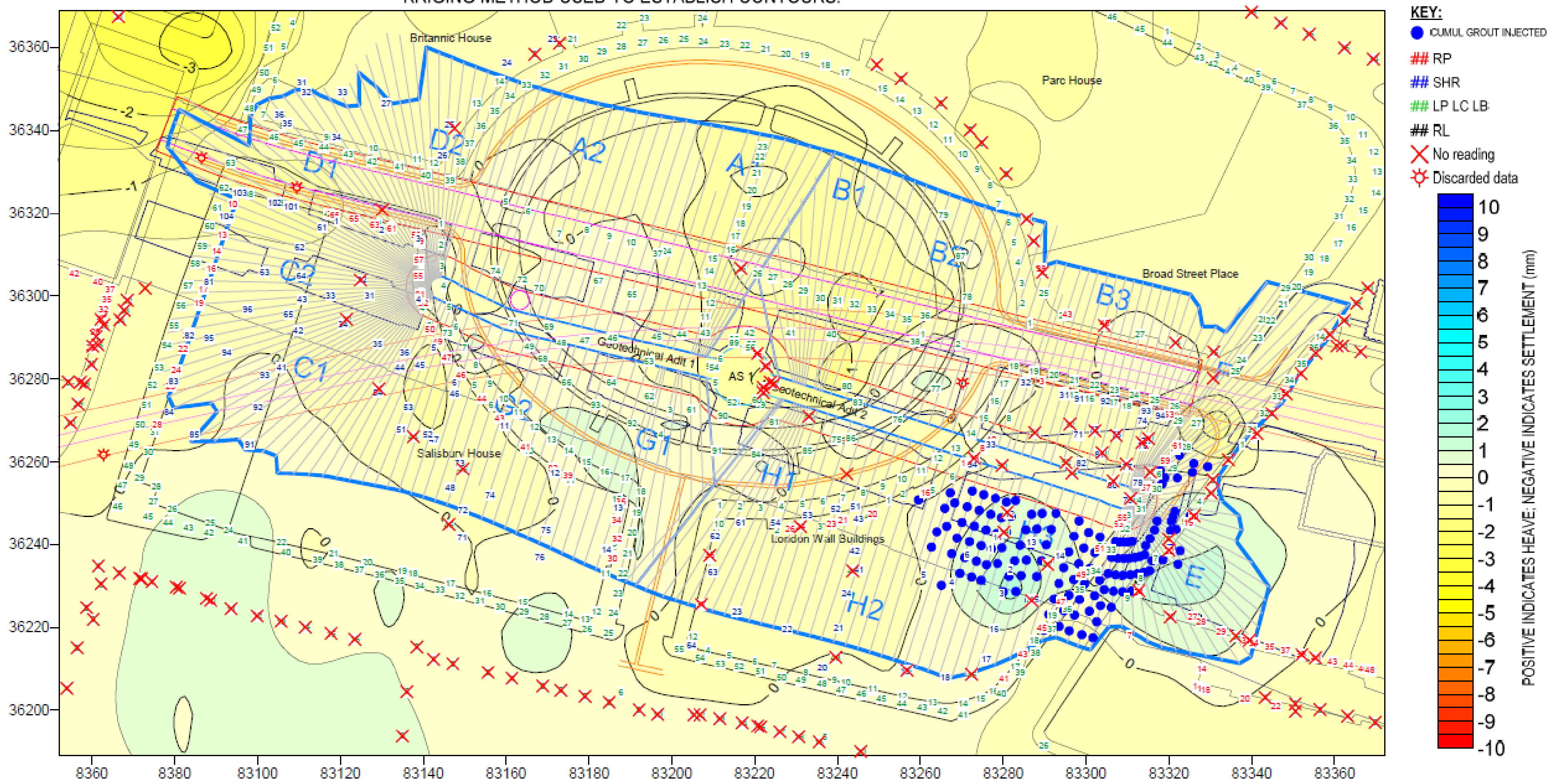
BASIS OF CONTOURS:
NIGHTSHIFT OF 08/11/12 MINUS NIGHTSHIFT OF 07/11/12
I.E. MEDIAN OF 08/11/12 19:00HRS TO 09/11/12 07:00HRS minus
MEDIAN OF 07/11/12 19:00HRS TO 08/11/12 07:00HRS.

KRIGING METHOD USED TO ESTABLISH CONTOURS.

Grouted Volume for Cumul: 6521.43 L

VOLUME:
CUT: 6929 L
FILL: 14035 L

Maximum heave: 1.8mm



File Reference: 20121109-20121107-LIV_CUMUL_[WHOLE SITE GJ].srf

Created By: DMA - Checked By: NRA

Printed: 2012-11-09

CROSSRAIL C510 - WHITECHAPEL & LIVERPOOL STREET STATION TUNNELS

LIVERPOOL STREET - Geotechnical Adits

CUMUL REPORT

WHOLE SITE

CORRECTIVE GROUTING PRG6
GJ26 - GJ27

SURFACE & BASEMENT MONITORING INSTRUMENTATION.

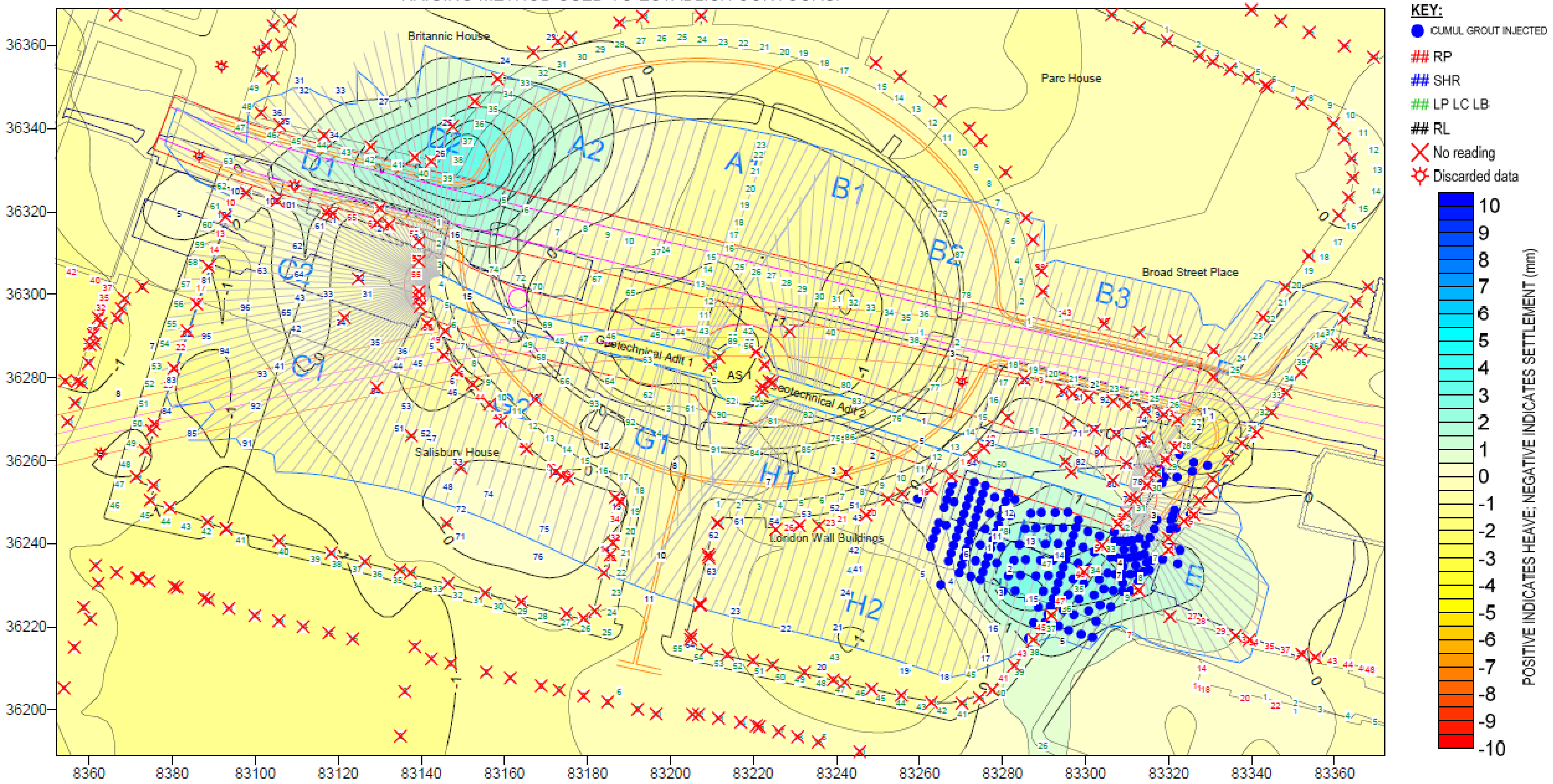
BASIS OF CONTOURS:
NIGHTSHIFT OF 11/11/12 MINUS NIGHTSHIFT OF 07/11/12
I.E. MEDIAN OF 11/11/12 19:00HRS TO 12/11/12 07:00HRS minus
MEDIAN OF 07/11/12 19:00HRS TO 08/11/12 07:00HRS.

KRIGING METHOD USED TO ESTABLISH CONTOURS.

Grouted Volume for Cumul: 8972 L

VOLUME:
CUT: 8877 L
FILL: 24245 L

Maximum heave: 3.4 mm



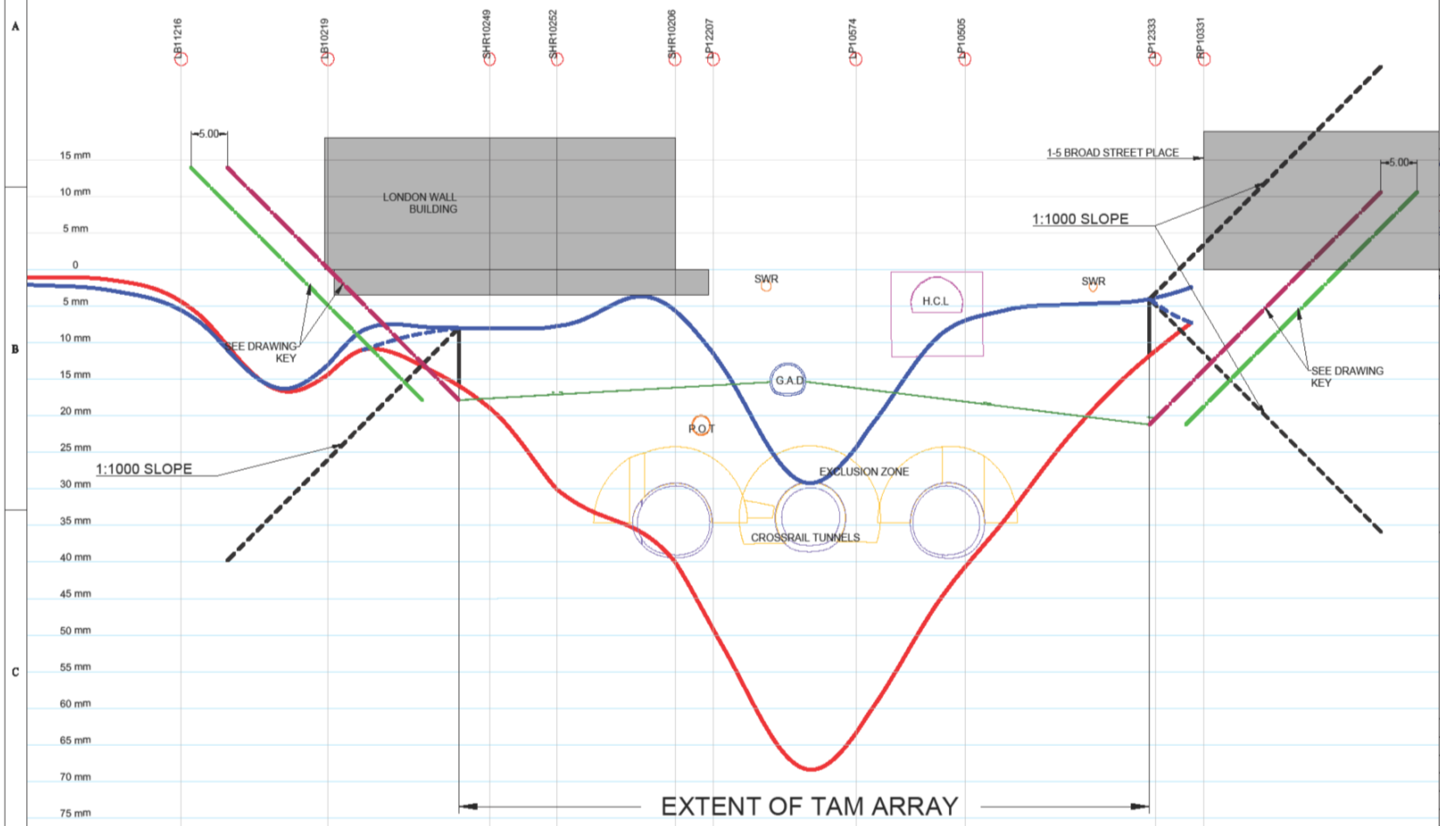
File Reference: 20121112-20121107-LIV_CUMUL_[WHOLE SITE GJ].srf

Created By: DMA - Checked By: ARC

Printed: 2012-11-12

SALISBURY HOUSE BUILDING TRAVERSE SECTION

SECTION PS04 THROUGH SALISBURY HOUSE BUILDING



SETTLEMENT LEGEND

- 10.10.2013 ABSOLUTE SETTLEMENT
- THEORETICAL GROUND LEVEL FEATHERING CONTOUR
- ABSOLUTE + PREDICTED REMAINING SETTLEMENT

DRAWING LEGEND

- SWR - SEWER
- H.C.L - HAMMERSMITH AND CITY LINE
- P.O.T - POST OFFICE TUNNEL
- CROSSRAIL TUNNELS
- EXCLUSION ZONES
- LEVELS SCALE AT 1000:1
- LP####/SHR###/RP### - MONITORING POINTS
- N.L.T - NORTHERN LINE TUNNELS
- WORST CASE 5MTR COVERAGE FROM TAMS
- BEST CASE 5MTR COVERAGE FROM TAMS

	Project Manager / Supervisor (PDP) Review and Acceptance Decal This decal is to be used for submitted documents requiring acceptance by the Project Manager/Supervisor (PDP).	
☐	Code 1.	Accepted. Work May Proceed
☐	Code 2.	Not Accepted. Revise and resubmit. Work may proceed subject to incorporation of changes indicated
☐	Code 3.	Not Accepted. Revise and resubmit. Work may not proceed
☐	Code 4.	Received for information only. Receipt is confirmed
Reviewed / Accepted by: (signature)		
Print Name:		Date.

Rev.	Date	Description	Prepared by:	Checked by:	Prepared by:
P01	11/11/13	TRAVERSE SECTION ABSOLUTE/PREDICTED+ABSOLUTE	CPB	CTK	-

Supplier details

Supplier Number

BBMV

C510
WHITECHAPEL and
LIVERPOOL STREET
STATION TUNNELS

Size:

Scale:

Document Title:

LIVERPOOL STREET STATION
TRAVERSE SECTIONS
SECTION PS04 THROUGH SALISBURY HOUSE BUILDING

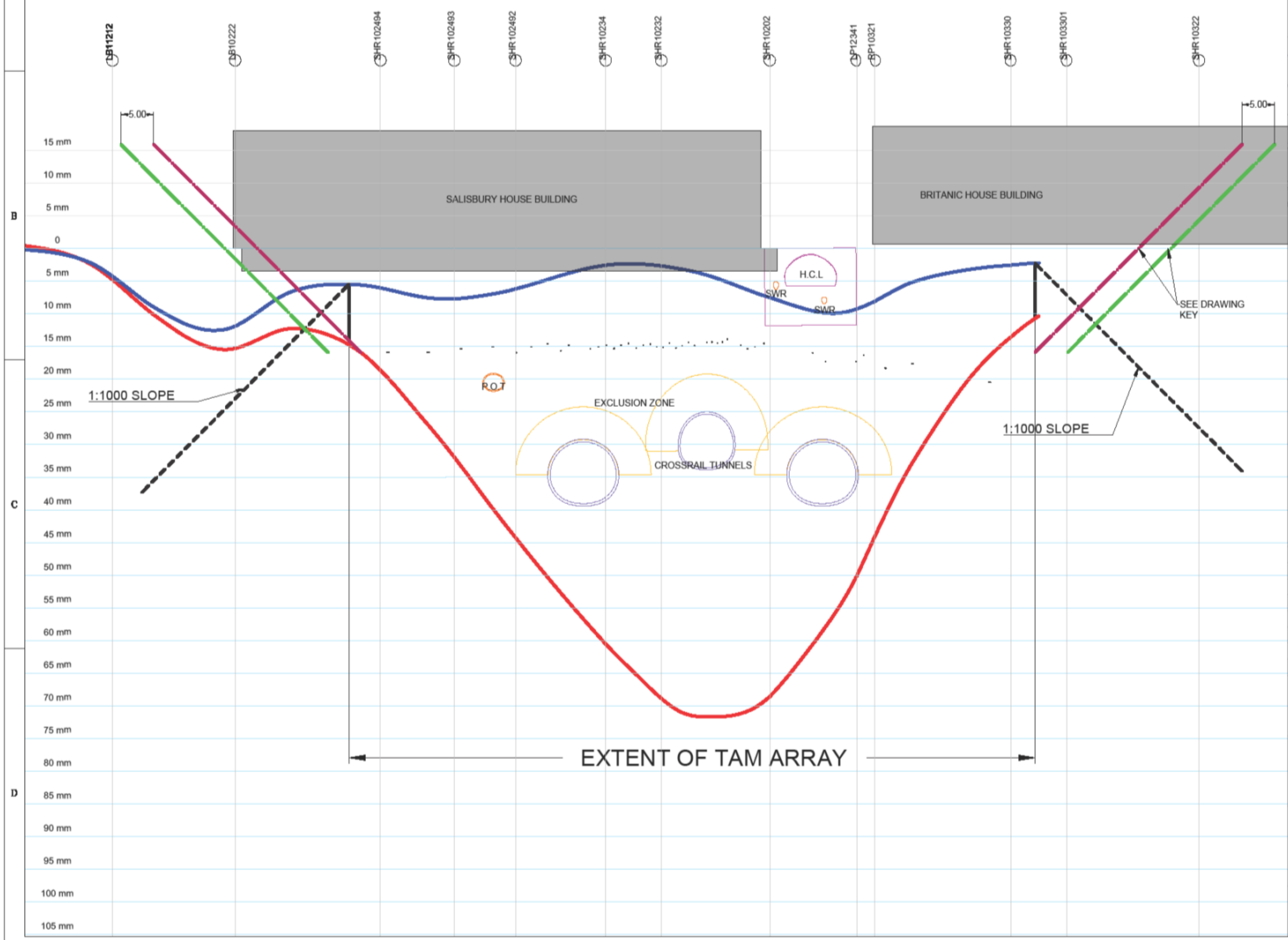
Drawing No:

Contractor | Originator | Discipline | Doc. Class | Location | Eb Number

Revision:

SALISBURY HOUSE BUILDING TRAVERSE SECTION

SECTION PS06 THROUGH SALISBURY HOUSE BUILDING



SETTLEMENT LEGEND

- 10.10.2013 ABSOLUTE SETTLEMENT
- THEORETICAL GROUND LEVEL FEATHERING CONTOUR
- ABSOLUTE + PREDICTED REMAINING SETTLEMENT

DRAWING LEGEND

- SWR - SEWER
- H.C.L - HAMMERSMITH AND CITY LINE
- P.O.T - POST OFFICE TUNNEL
- CROSSRAIL TUNNELS
- EXCLUSION ZONES
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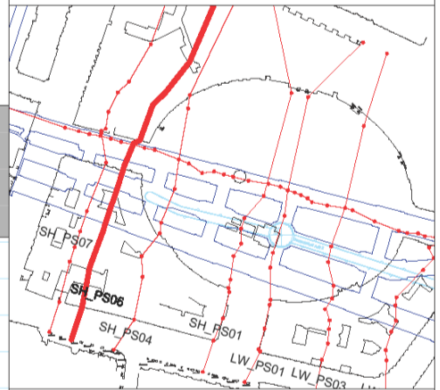
- N.L.T - NORTHERN LINE TUNNELS
- WORST CASE 5MTR COVERAGE FROM TAMS
- BEST CASE 5MTR COVERAGE FROM TAMS



Project Manager / Supervisor (PDP) Review and Acceptance Decal

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Print Name: Date:

Rev.	Date	Description	Prepared by:	Checked by:	Prepared by:
P01	11/11/13	TRAVERSE SECTION ABSOLUTE/PREDICTED+ABSOLUTE	CPB	CTK	-

Supplier details

Supplier Number

BBMV

C510
WHITECHAPEL and
LIVERPOOL STREET
STATION TUNNELS

Size:

Scale:

Document Title:

LIVERPOOL STREET STATION
TRAVERSE SECTIONS
SECTION PS06 THROUGH SALISBURY HOUSE BUILDING

Drawing No:

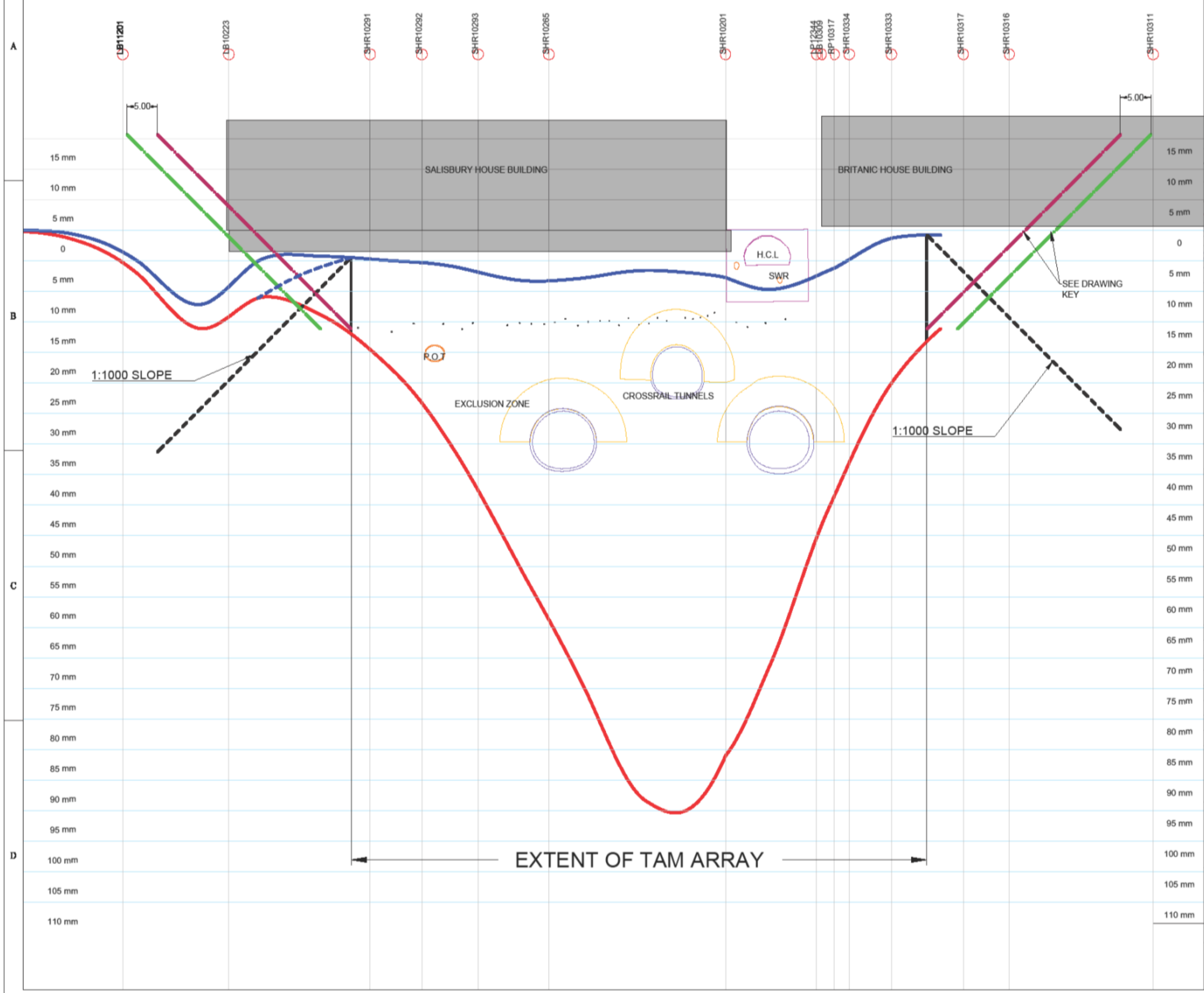
Contractor Originator Discipline Doc. Class Location Eb Number

Revision:

Document uncontrolled once printed. All controlled documents are saved on the CRL Document System and BBMV BC

SALISBURY HOUSE BUILDING TRAVERSE SECTION

SECTION PS07 THROUGH SALISBURY HOUSE BUILDING



SETTLEMENT LEGEND

- 10.10.2013 ABSOLUTE SETTLEMENT
- THEORETICAL GROUND LEVEL FEATHERING CONTOUR
- ABSOLUTE + PREDICTED REMAINING SETTLEMENT

DRAWING LEGEND

- SWR - SEWER
- H.C.L - HAMMERSMITH AND CITY LINE
- P.O.T - POST OFFICE TUNNEL
- CROSSRAIL TUNNELS
- EXCLUSION ZONES
- LEVELS SCALE AT 1000:1
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P01	11/11/13	TRAVERSE SECTION ABSOLUTE/PREDICTED+ABSOLUTE	CPB	CTK	-

Supplier details

Supplier Number

BBMV

C510
WHITECHAPEL and
LIVERPOOL STREET
STATION TUNNELS

Size:

Scale:

Document Title:

LIVERPOOL STREET STATION
TRAVERSE SECTIONS
SECTION PS07 THROUGH SALISBURY HOUSE BUILDING

Drawing No:

Contractor Originator Discipline Doc. Class Location Eb Number

Revision:

Contract C510 Drilling Task					
Liverpool St					
Location	No of holes	Drill m	Avge	Grouting Type	Installation
Liv St Adit E	121	5632	46.5	Compensation	88.9mm dia steel TaM x 4mm wall
Liv St Adit W	118	6210	52.6	Compensation	88.9mm dia steel TaM x 4mm wall
Moorgate box	168	1559	9.3	Permeation	50mm PVC TaM for permeation
				Pipe roofing	114mm, 7mm wall Heavy Duty TaM
Blomfield box	48	1823		Compensation	88.9mm dia steel TaM x 4mm wall, 114mm, 7mm
			38.0		wall Heavy Duty TaM below Metro
Electra House	695	4930	7.1	Permeation	50mm PVC TaM
Sub total Liv St	1150	20154	17.5		
Contract C510 Drilling Task					
Whitechapel					
Location	No of holes	Drill m	Avge	Grouting Type	Installation
W'chapel shaft	64	2149	33.6	Compensation	88.9mm dia steel TaM x 4mm wall
Total @ 15Sep14	1214	22303	18.4		

C510 Injection Quantities

A. Compensation grouting

GROUT QUANTITIES (m3)

	PRE-CON	ACG	CORRECTIVE	GRAND TOTAL
LIV	286	2322	3380	5988
WHI	66	162	225	452

Quantity still to inject - Approx 1000m3 for escalators
- Approx 2000m3 for long-term settlement

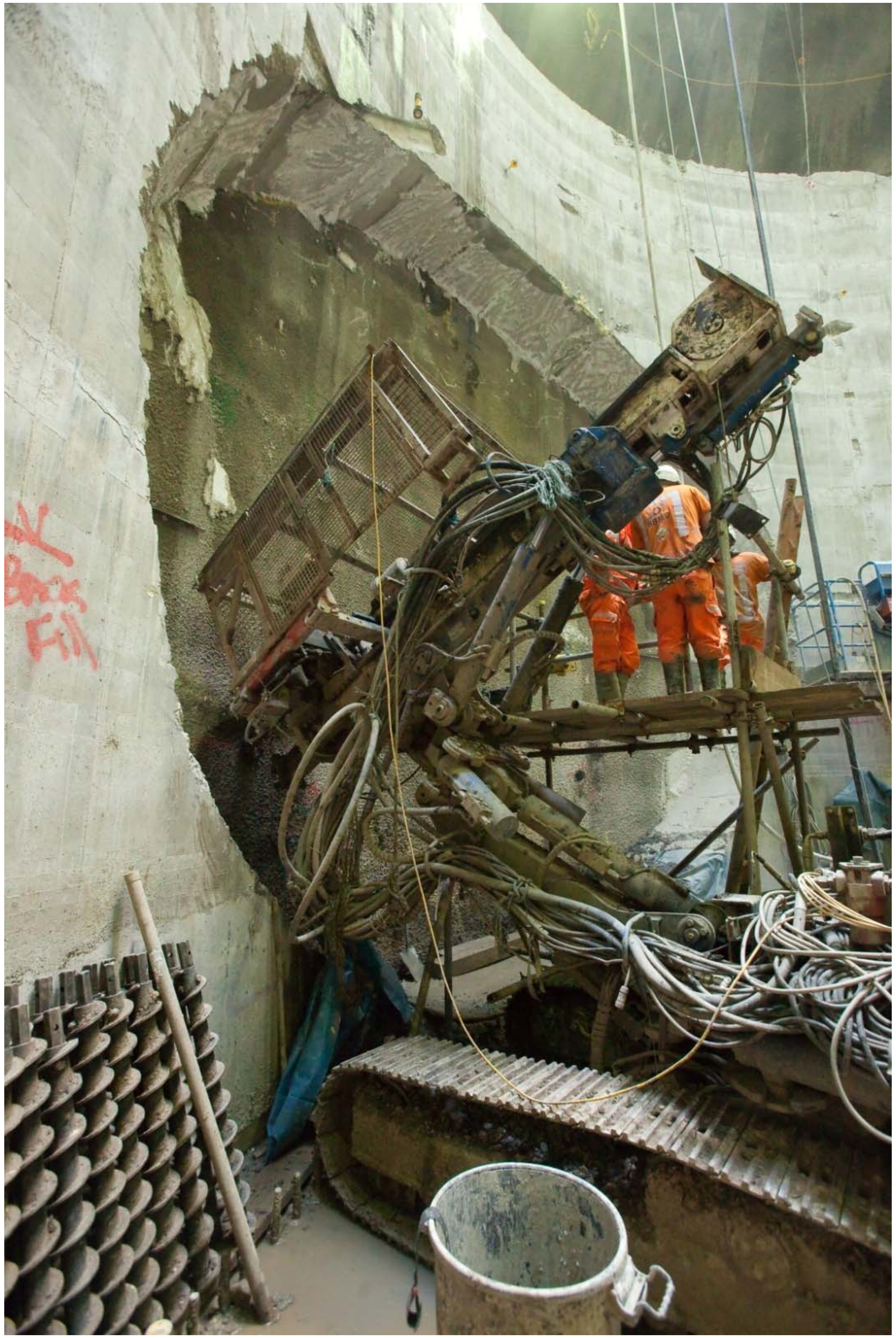
B. Permeation Grouting

Volume injected to date - Approx. 1000m3 Microsol

Quantity still to inject - Approx 400m3 for escalators

Crossrail C510 - Liverpool St. - Photos

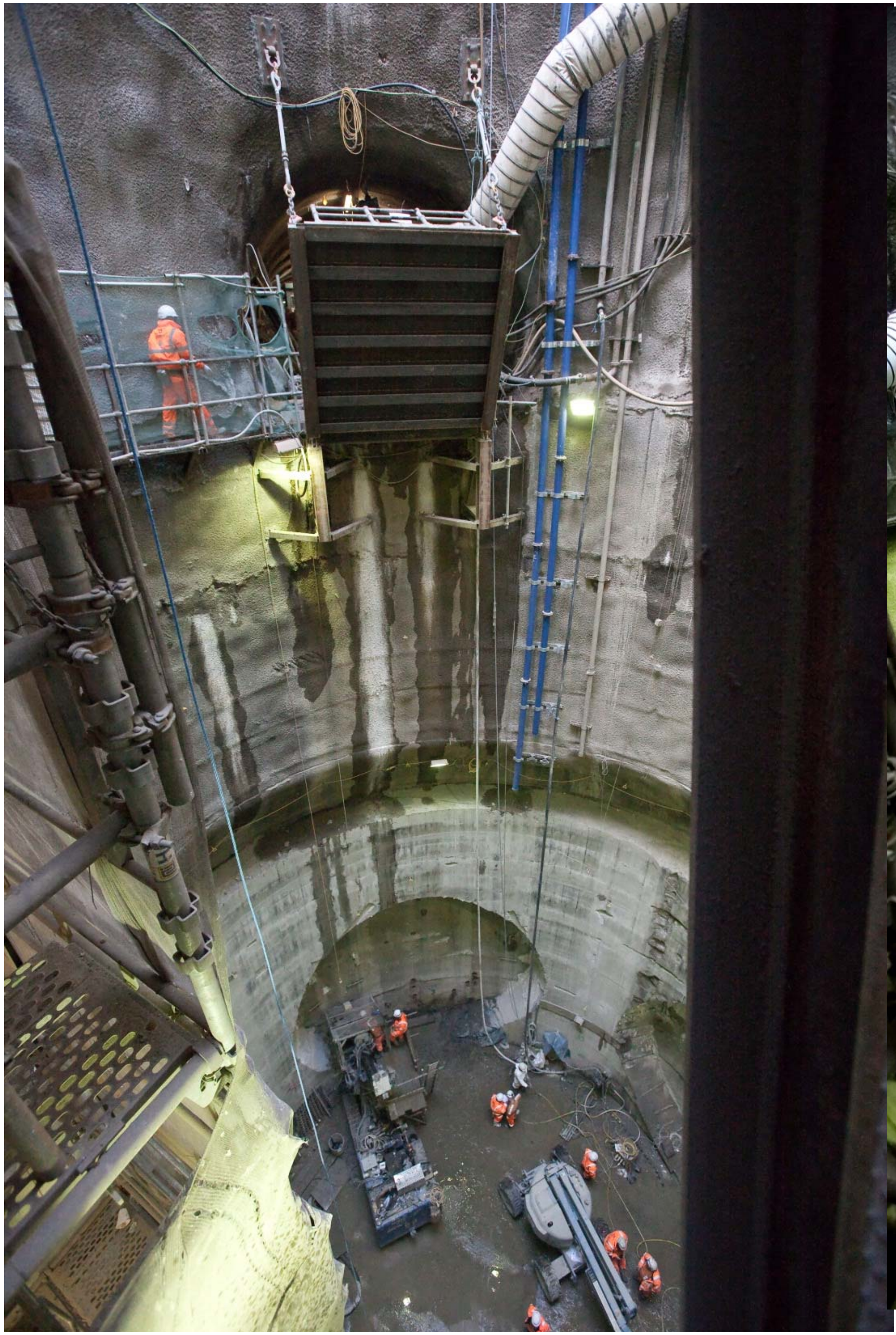

BBMV LIV
WATER TREATMENT PLANT
19.06.12
TANGENTIAL SEPARATOR
HOLDING TANK + WATER TANK
CENTRIFUGE + FLOC' MIXING UNIT
SKIP
PSD


Back Fill


HUTTE
Genie
WP02
IC Power
4x4


HBR 502- 2


TEC

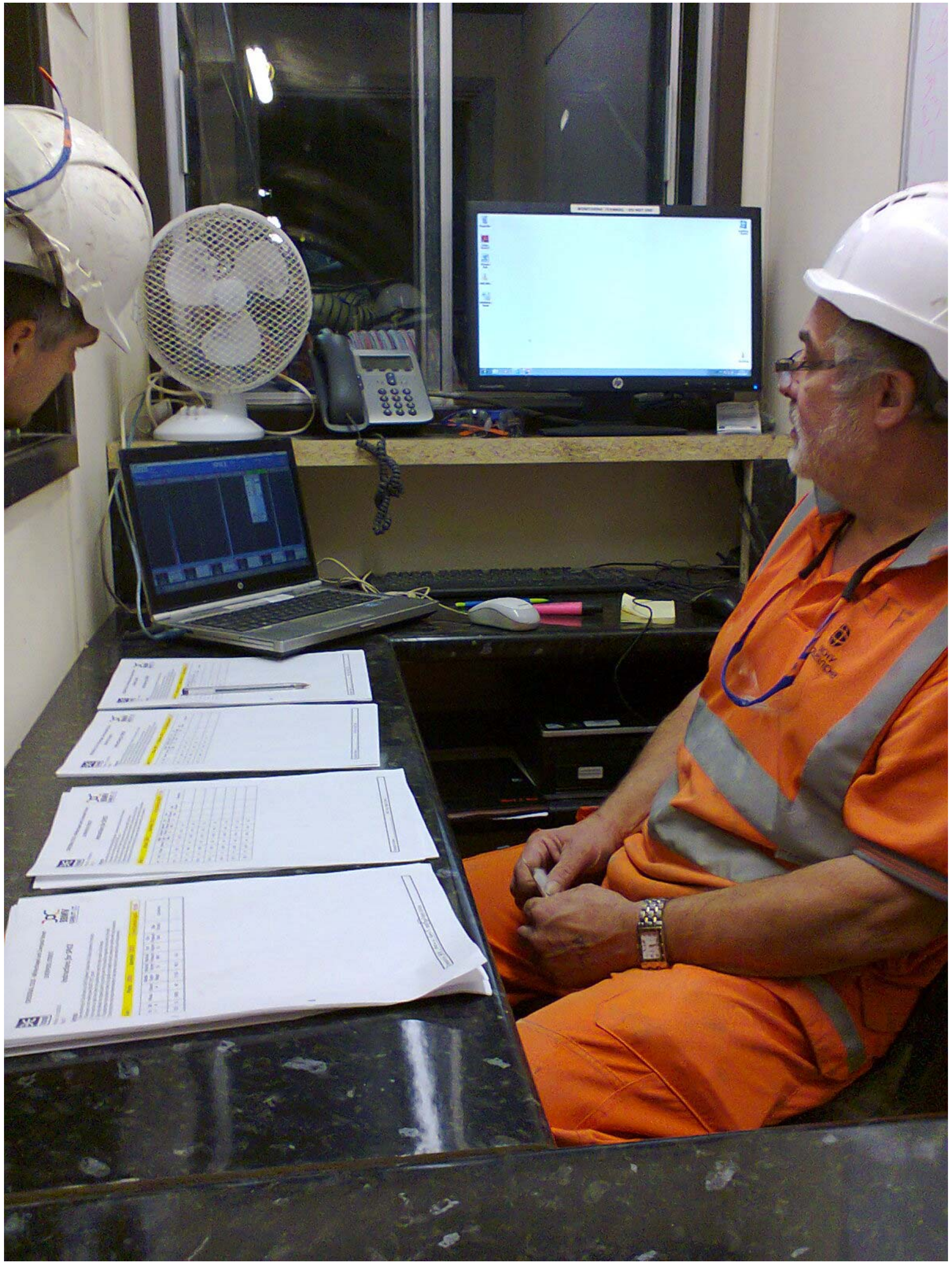


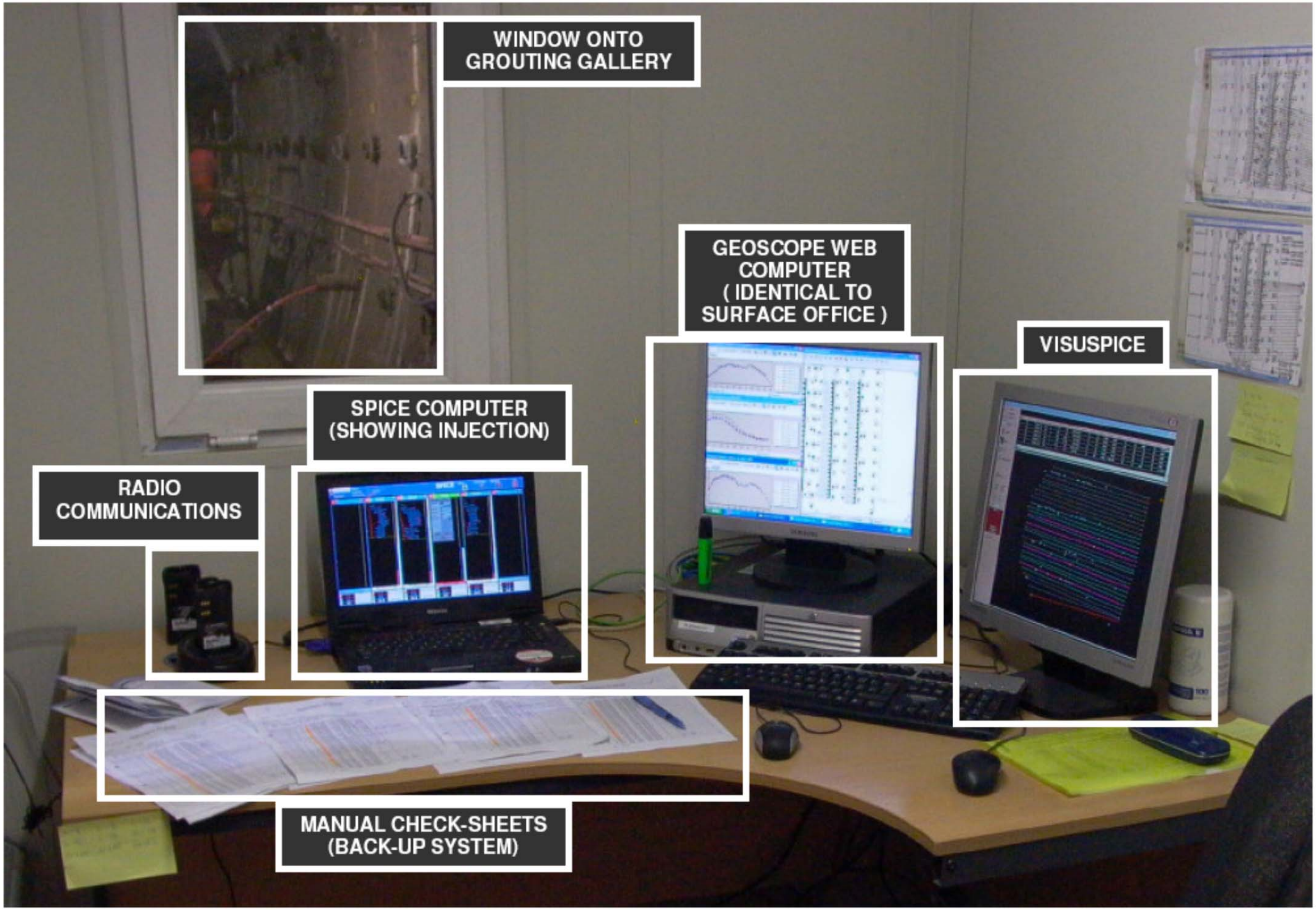


GAD2CH15
GAD2CH25
B3
(2CH01 - 2CH14)
F
(2CH15 - 2CH34)
Broad Street
GAD2CH35
E
GAD2CH40


Fax: 02761/63852
2

Steel TAMs

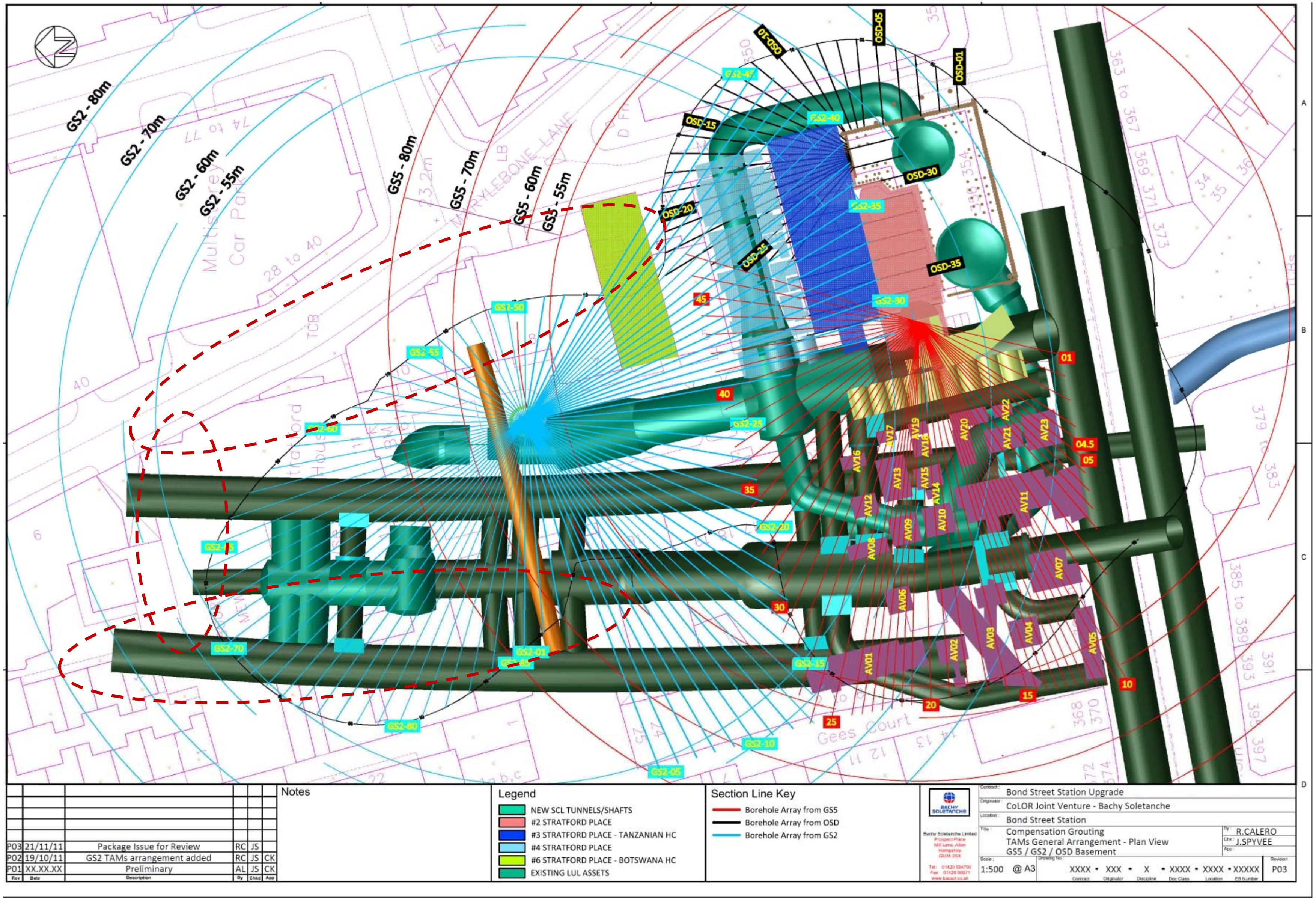



WINDOW ONTO
GROUTING GALLERY
GEOSCOPE WEB
COMPUTER
(IDENTICAL TO
SURFACE OFFICE)
VISUSPICE
SPICE COMPUTER
(SHOWING INJECTION)
RADIO
COMMUNICATIONS
MANUAL CHECK-SHEETS
(BACK-UP SYSTEM)

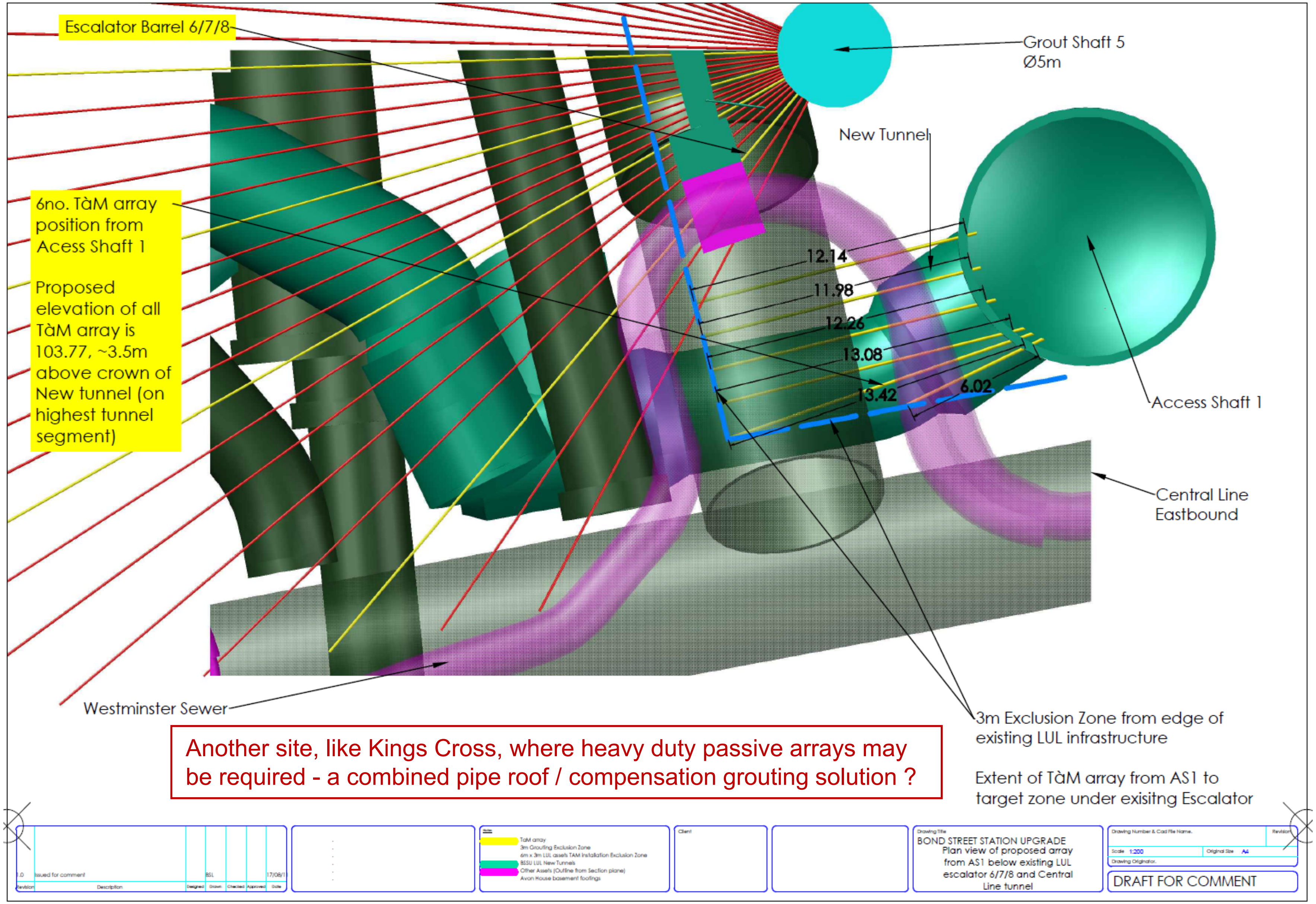
Bond Street Station - Overview

FIGURE 1 – DRILLING ARRAYS GS5

Crossrail Bond St Station

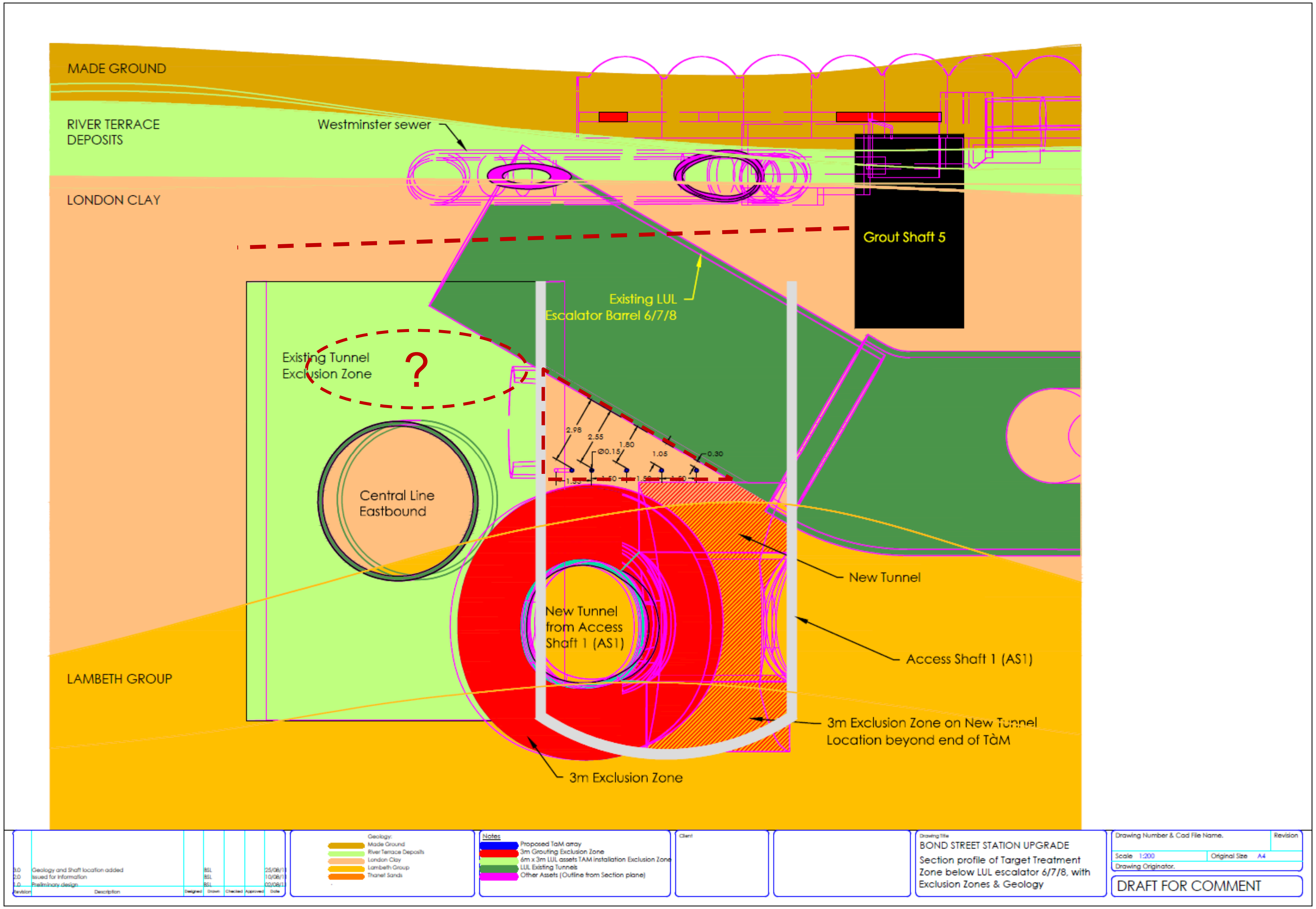


Crossrail Bond St Station

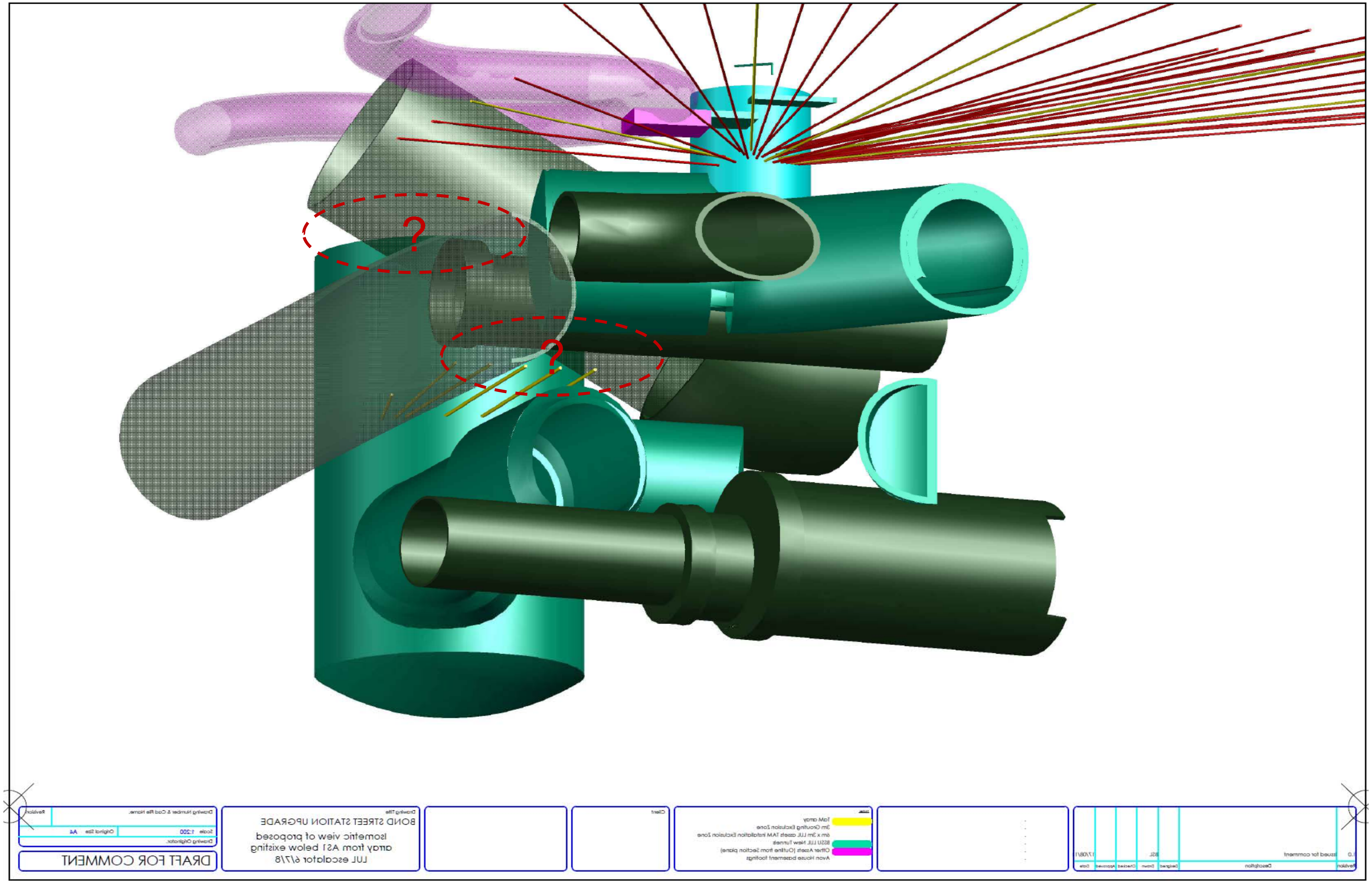


Another site, like Kings Cross, where heavy duty passive arrays may be required - a combined pipe roof / compensation grouting solution ?

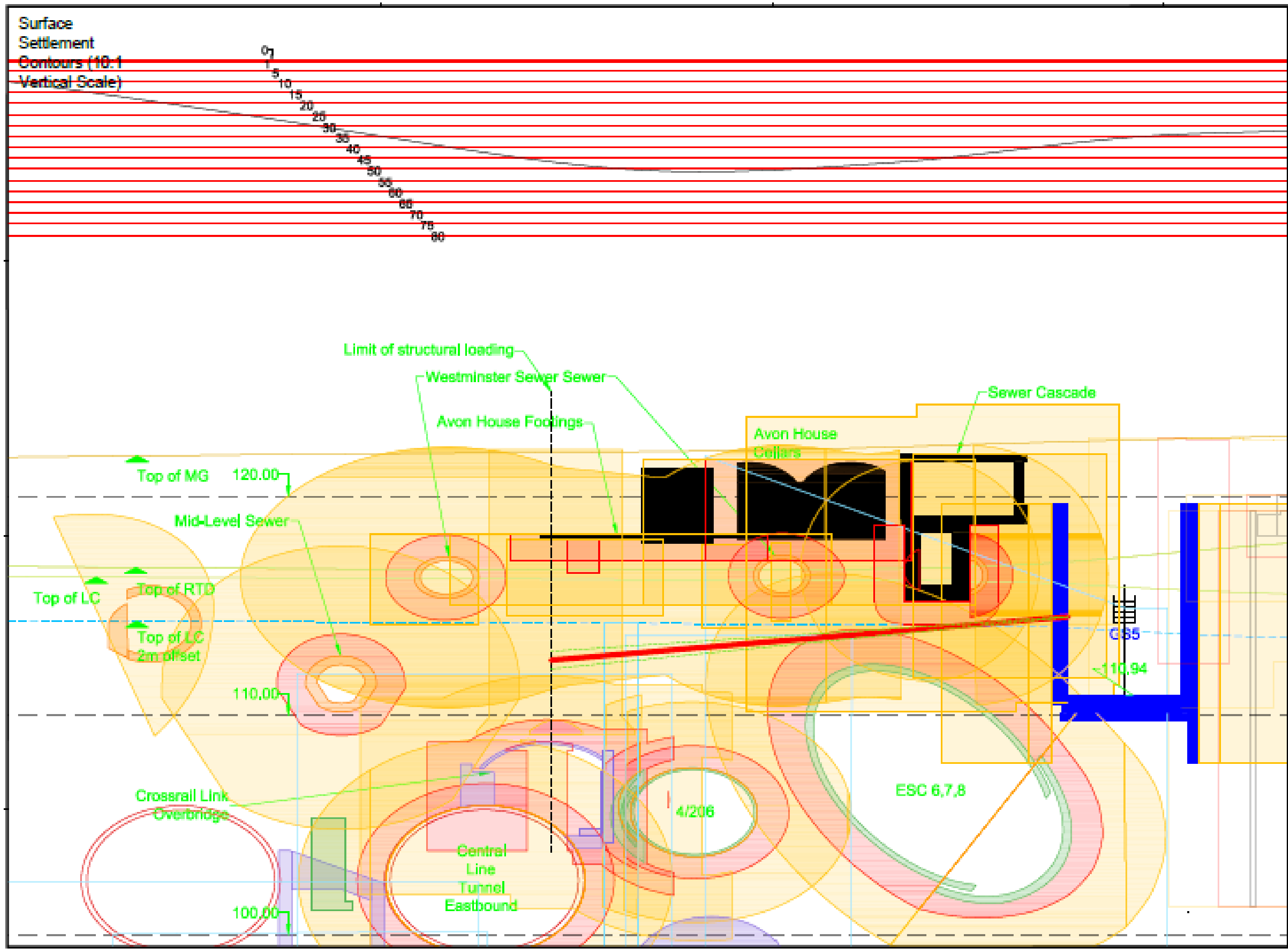
Crossrail Bond St Station



Crossrail Bond St Station



Crossrail Bond St Station



Notes:

1. All Dimensions in Meters (m).

2. Dimensions are not to be scaled from drawings.

3. For Ground Treatment target zone refer to drawing: CoLOR-BND-0799-DWG-TCG-000724 Rev 2 dated 7th June 2013.

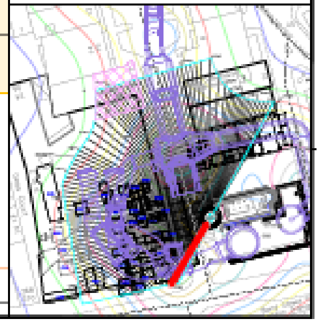
4. Settlement contours taken from drawing: BSU-CLO-99-Z-M2-Z-0903 received 04/10/2012.

5. All Levels are in mLUD

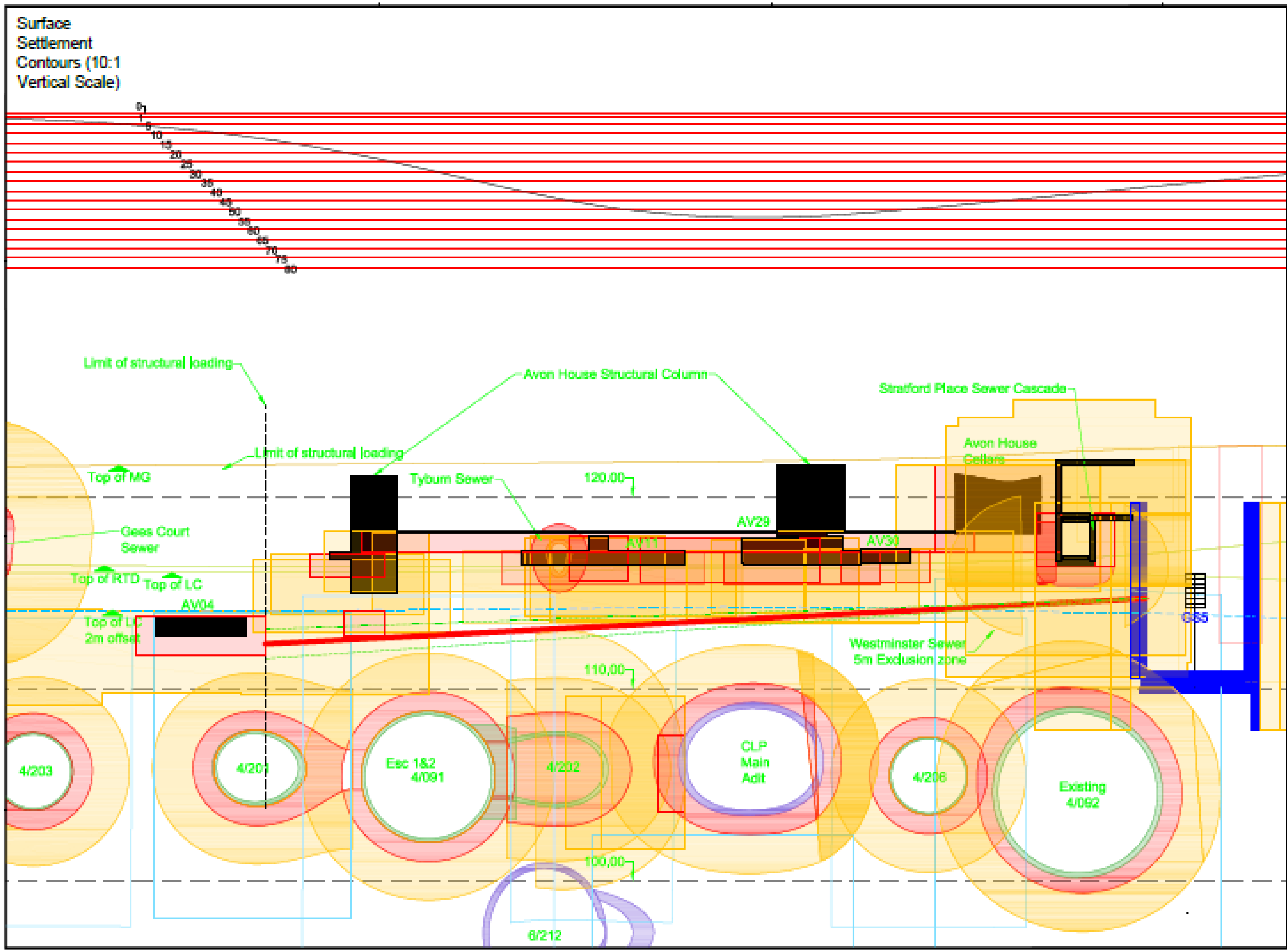
6. Where grouting is carried out within 5m of a Grout Shaft, this shall be done on an observational basis.

7. If TaMs are to be operated within 5m of any foundation a risk assessment is required in accordance with the Compensation Grouting Performance Specification.

Key:
TAM
TAM Tolerance Envelope
1 Mtr No Drilling Zone
No Grouting Zone
London Clay 2mtr Zone
LU Rectangular Concession Zone



Crossrail Bond St Station



Notes:

1. All Dimensions in Meters (m).

2. Dimensions are not to be scaled from drawings.

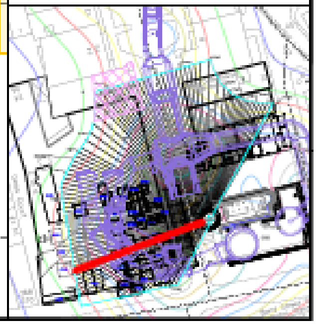
3. For Ground Treatment target zone refer to drawing: C0LOR-BND-8799-DWG-TCG-000724 Rev 2 dated 7th June 2013.

4. Settlement contours taken from drawing: BSU-CLO-99-Z-M2-Z-6903 received 04/10/2012.

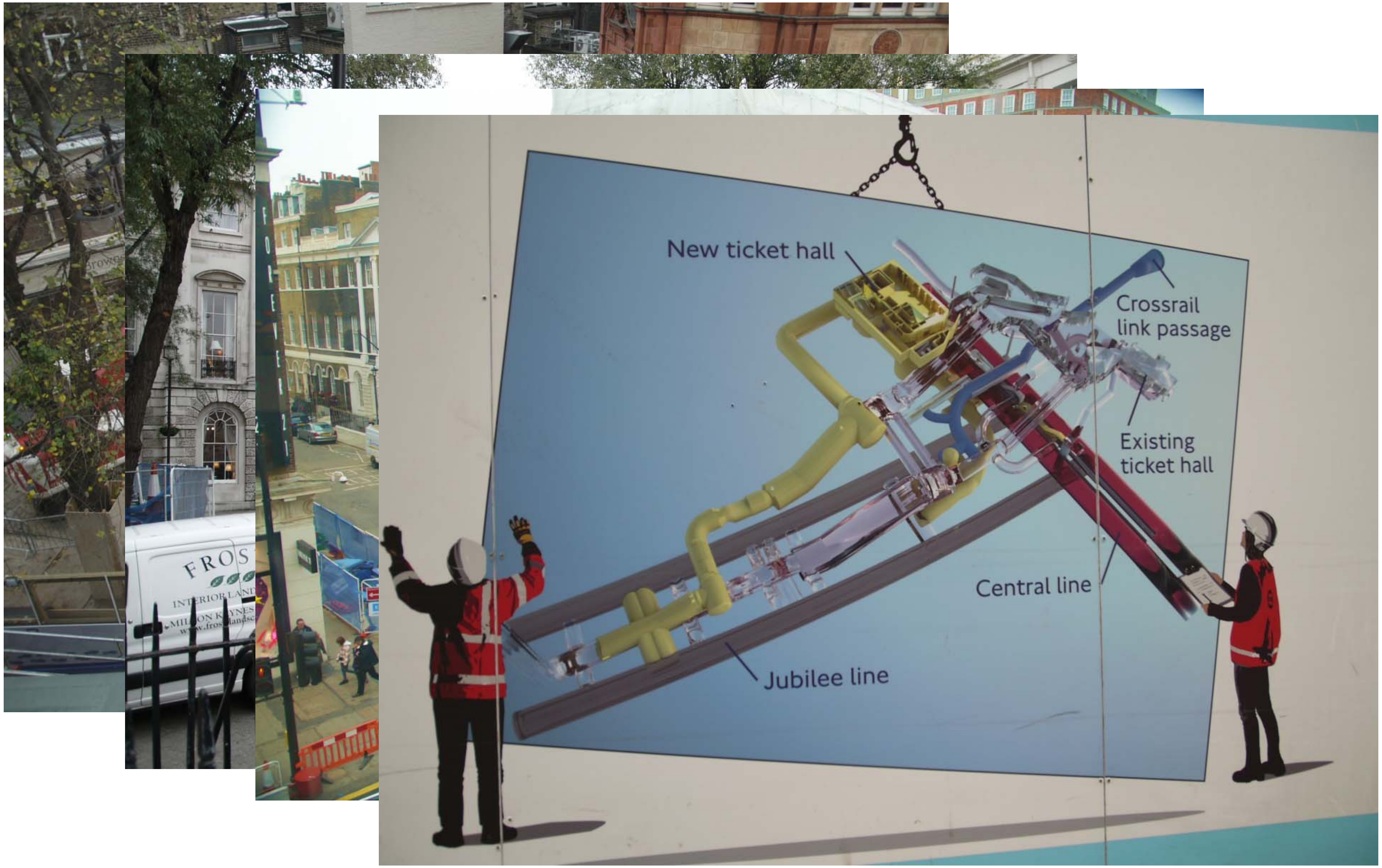
5. All Levels are in mLUD

6. Where grouting is carried out within 5m of a Grout Shaft, this shall be done on an observational basis.

7. If TaMs are to be operated within 5m of any foundation a risk assessment is required in accordance with the Compensation Grouting Performance Specification.

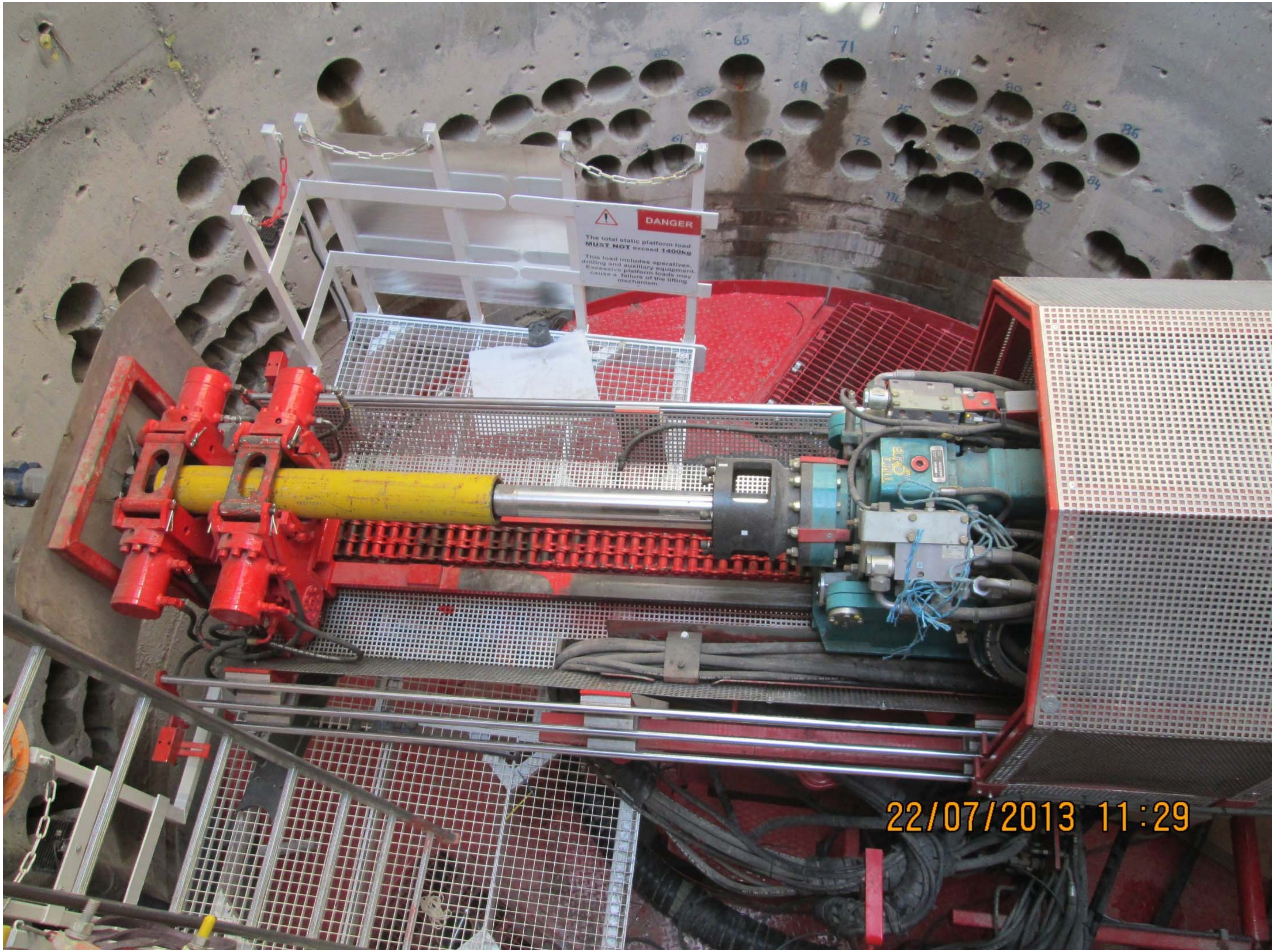


Crossrail Bond St Station




BACHY
SOLETANCHE
DAVLAV


19/07/2013 11:17

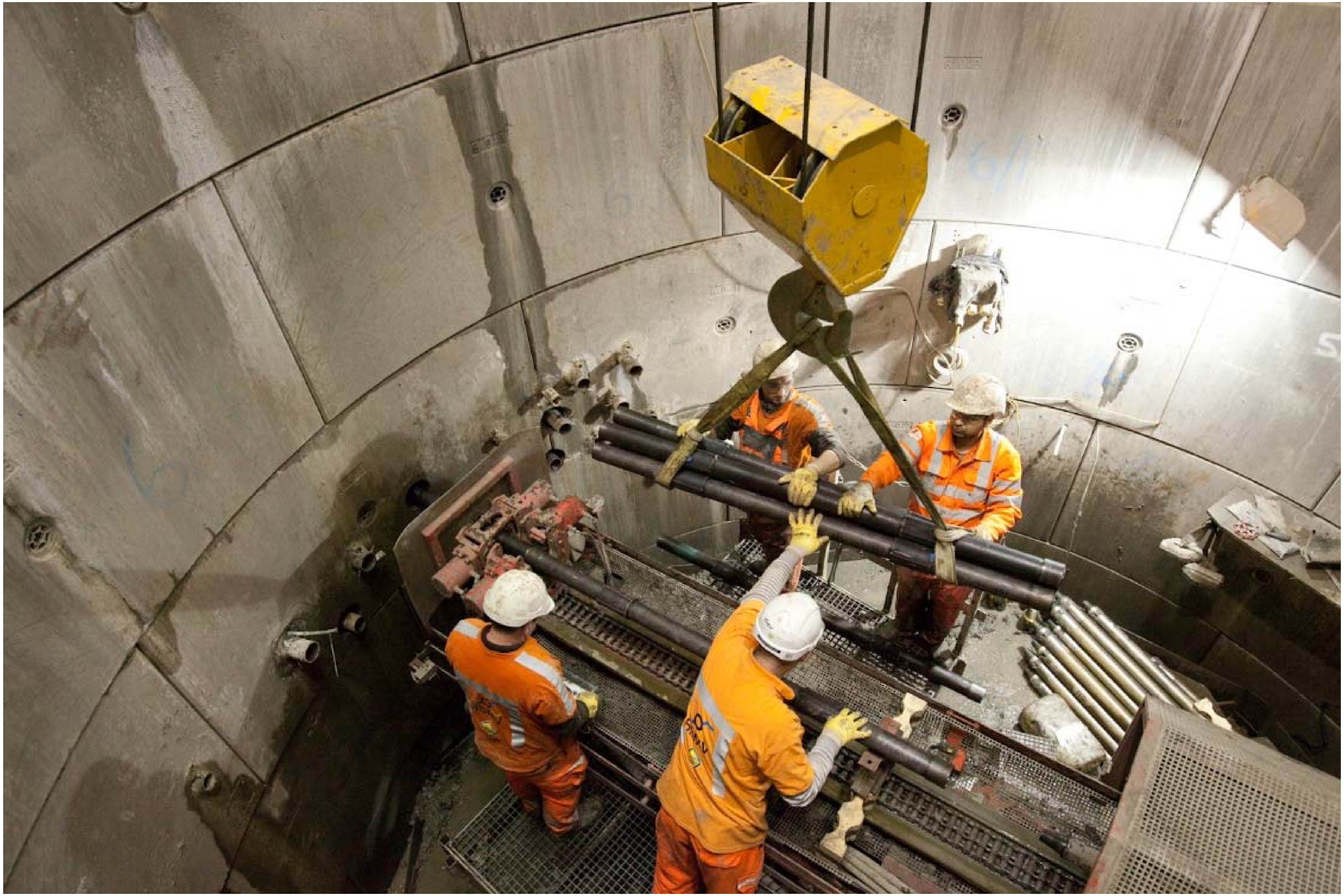

DANGER
The total static platform load MUST NOT exceed 1400kg
This load includes operatives, drilling and auxiliary equipment. Excessive platform loads may cause a failure of the lifting mechanism
22/07/2013 11:29


25/07/2013 12:27

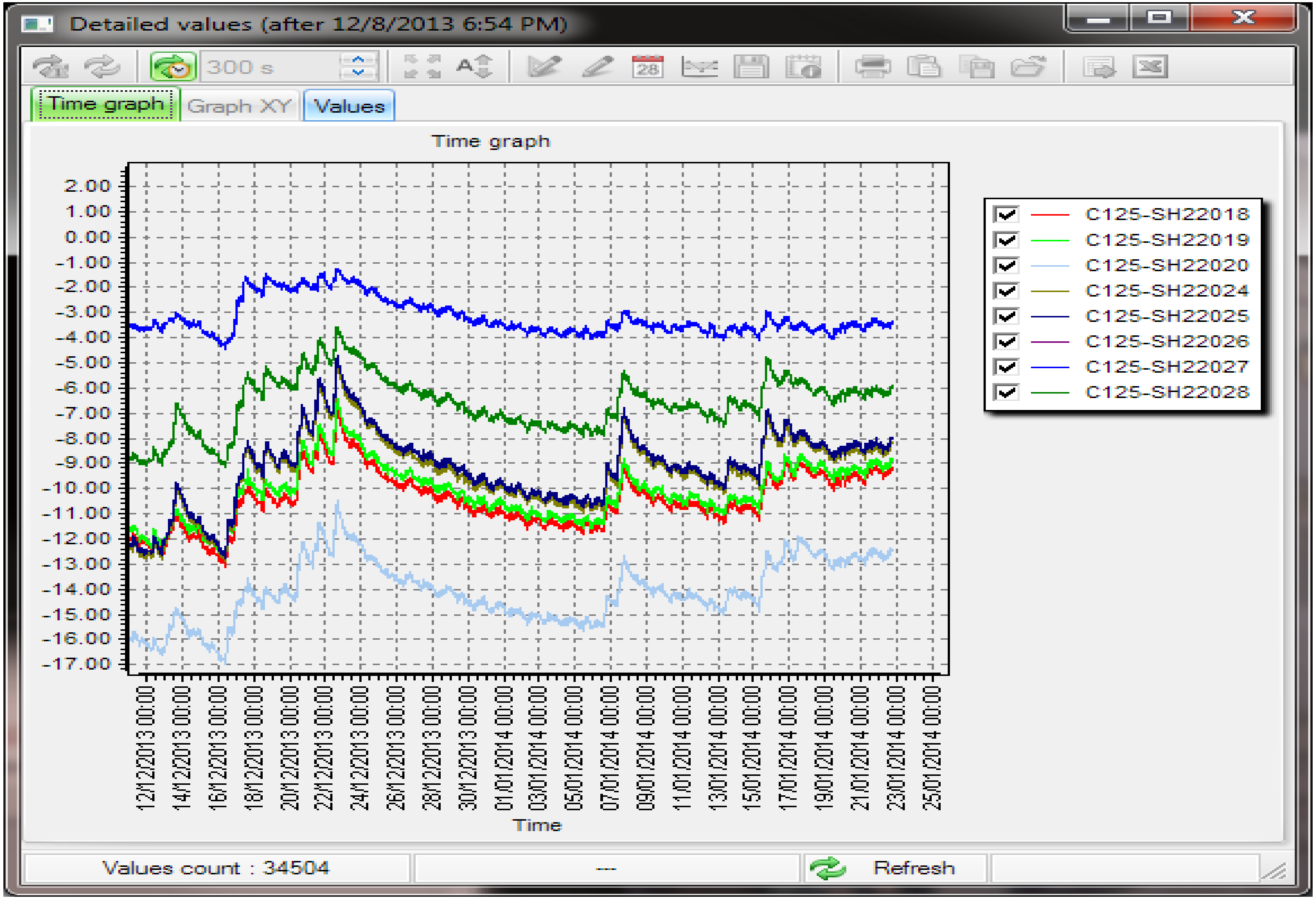

25/07/2013 14:46


DRILL U71 Depth : 4105 cm
Pressure Fluid
5 bar
Pressure Push
3 bar
Pressure Torque
19 bar
Speed Rotation
0 tr/min
Flow Fluid
98 l/mn
Volume
3131 l
Reached Depth : 4105 cm
13 : 51 : 12 06 / 08 / 2013
06/08/2013 13:29


25/07/2013 20:14




tecniwell
TEC
03/07/2013 09:01



Detailed values (after 12/8/2013 6:54 PM)
300 s
Time graph
Graph XY
Values
Time graph
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1.00
0.00
-1.00
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-3.00
-4.00
-5.00
-6.00
-7.00
-8.00
-9.00
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C125-SH22027
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Refresh


BAR