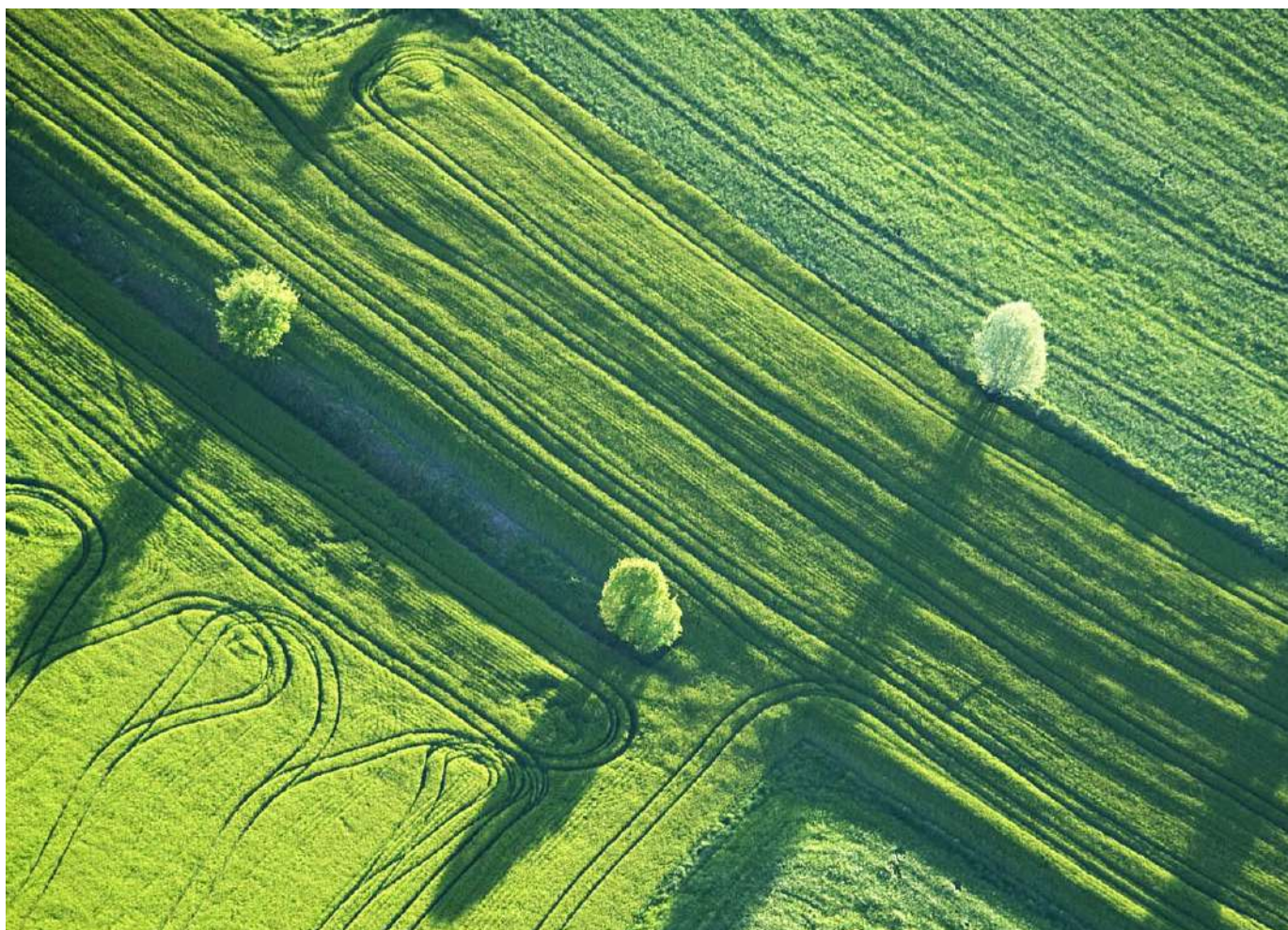




EOS Inc. Limited

Gateway 36 Phase 2A.1

Ground Treatment Validation Report - Units 1, 2 and 3

322638-R08 (01)

RSK GENERAL NOTES

Project No.: 322638

Title: Ground Treatment Validation Report - Units 1, 2 and 3: Gateway 36 Phase 2A.1

Client: EOS Inc. limited

Date: June 2022

Office: RSK Environment Limited, Spring Lodge, 172 Chester Road, Helsby, Chester, WA6 0AR. Tel 01928 726006

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Rev 01	June 2022	JM Planning comments	Sion Roberts	See above

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Where field investigations have been carried out, these have been restricted to a level of detail required to achieve the stated objectives of the work.

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1 INTRODUCTION

1.1 Commissioning

RSK Environment Limited (RSK) was commissioned by EOS Inc. Limited (the Client) to carry out a Ground Treatment Validation Report for the ground treatment of development Units 1, 2 and 3 (this area is also referred to as Phase 2A.1) of the land at Gateway 36, Rockingham, Barnsley.

A planning application (reference: 2019/1573) for the proposed development was submitted on 23 December 2019 to Barnsley Metropolitan Borough Council (BMBC) with outline planning permission granted on 10 August 2020. This validation report has been prepared to support discharge of Planning Condition 24 '*...Following implementation and completion of the approved remediation scheme, a verification report shall be submitted to and approved in writing by the Local Planning Authority to confirm completion of the remediation scheme in accordance with approved details*' and, to support discharge of Planning Condition 47 to prepare '*...a validation report to certify the remediation works, highlighted within RSK report (ref 322638-R02).*'

The site in question is being developed for commercial use.

1.2 Definition of roles

EOS Inc. Ltd - Client.

RPP – the Employer's Agent and Quantity Surveyor for the ground treatment works and building works.

RSK – the geotechnical and environmental consultants having completed the assessment of the site ground conditions, modelled expected settlements, produced the performance requirements for the ground treatment works and designed and provided a specification for the ground treatment works. RSK supervised the installation of settlement monitoring infrastructure, supervised the ground treatment works and are providing this validation report on the ground treatment.

Howards Civil Engineering (HCE) – Contractor responsible for the cut and fill operations, surcharge placement and removal and installation of settlement monitoring infrastructure (hydraulic profile gauge (HPG) loops).

JPG – are the civil and structural engineer appointed by the client to oversee the construction phase of the development which will follow-on from the ground treatment works. JPG produced the earthworks specification and designed the development platforms with associated cut/fill plans.

Harris Partnership – Architect.

FPCR – Ecologist.

TEP – Arboricultural Consultant.

1.3 Background

In order to allow the proposed development a scheme of cut / fill earthworks has been completed by HCE to establish the development platforms across the Phase 2 Gateway 36 site as designed by JPG (NB these earthworks include the Phase 2A.1 area, which is the subject of this report, together with surrounding land parcels which comprise the complete Phase 2 development area). The wider Phase 2A area lies within a previous surface coal mine and is underlain by opencast backfill material.

Owing to the history of the site and the nature of the backfill a risk of load-induced settlement was highlighted within RSK's previous reporting (see Section 1.6) and an instrumented load test was constructed and monitored on the neighbouring Phase 3 land parcel in 2015 - 2016. The data obtained from the load test was then used along with the site investigation information from Phase 2A to model the anticipated settlements from development and earthworks loads. This modelling identified that settlements would exceed acceptable levels for the development of the site and a ground treatment strategy (by surcharge pre-loading) was devised to induce settlement prior to construction, reducing anticipated residual settlements to acceptable levels for proposed development.

The earthworks included excavation of these materials from more elevated locations and controlled redeposition of the material in low-lying areas to meet an engineering specification provided by JPG to create sensibly level development plateaus.

This report aims to validate the ground treatment works completed by HCE, which were designed by RSK to sufficiently improve the opencast backfill soils beneath the original ground level for Units (or Plots) 1, 2 and 3 in Phase 2A.1 to facilitate development. In order to achieve this monitoring instrumentation was installed in advance of the treatment works and monitoring results were collected by RSK. RSK also maintained full time supervision of the HCE earthworks and construction of the surcharge mounds.

The ground treatment and requirements for monitoring infrastructure was first set out in the Ground Treatment Specification (RSK report reference: 322638 R03 (02)), included as Appendix A of this report.

The installed monitoring infrastructure across the wider Phase 2 site include; permanent ground markers (PGM's), hydrostatic profile gauge (HPG) settlement loops laid in shallow trenches across the site surface and down hole magnetic extensometers.

These methods were chosen to provide settlement data across a range of depths and ground conditions in order to confirm that the required settlement had been induced by the earthworks and surcharge treatment.

1.4 Objectives of ground treatment

The objective of the ground treatment is to improve the opencast backfill material underlying the Phase 2A.1 area to a standard capable of supporting the proposed commercial development.

By combining the surcharge ground treatment as set out within the RSK Ground Treatment Specification with the controlled placement and validation of engineered fill in accordance with the JPG Earthworks Specification, the performance requirements can be achieved as set out below.

(a) Performance requirements beneath building footprints

The performance requirements are to be achieved at a level 450mm below the finished earthworks level.

- allowable ground bearing pressure: 100kN/m² beneath building foundations
- anticipated weight of loaded building for settlement calculation purposes: imposed load up to 35kN/m². The imposed load will vary over time and across the footprint of the building depending on the amount of goods being stored within the building
- CBR: a minimum CBR at top of formation level of 3% or 5% where granular fill is utilised (based on 600mm diameter plate tests)
- maximum residual ground movement: 25mm (to be reviewed following receipt of calculated ground movement from RSK)
- maximum differential movement: 1 in 500.

(b) Performance requirements for external areas, car parks and roads

The performance requirements are to be achieved at the top of the formation level.

- CBR: a CBR at top of formation level of 3% or 5% where granular fill is utilised (based on 600mm diameter plate tests)
- allowable ground bearing pressure: 50kN/m²
- anticipated weight for settlement calculation purposes: Transient load of 5kN/m². The imposed load will vary over time and across the hard-standing areas depending on the amount of goods being stored / vehicles in attendance
- maximum residual movement: 50mm (to be reviewed following receipt of calculated ground movement from RSK)
- maximum differential movement: 1 in 200.

1.5 Scope of works

The scope of this validation report is to:

- provide as built information for the monitoring infrastructure installed
- collate and present the monitoring data obtained
- interpret the monitoring data and confirm whether the surcharging has successfully treated the opencast backfill materials.

1.6 Previous reports

Several reports have been completed for the wider Phase 2 site relating to ground investigations undertaken to inform the development and support the planning application. These are summarised in RSK report 322638 R03 (02).

The pertinent previous reports in relation to design and specification for the ground treatment and the specification for the earthworks for Phase 2A include:

- RSK Environment Ltd, Ground Treatment Specification – Development Platforms, Report reference 322638 R03 (02), September 2020
- JPG, Site Specification – Earthworks, Phase 2 Rockingham, Report reference: 4652-JPG-XX-XX-SP-G-0401-S1-P02, May 2020.

The latest site investigation report covering the Phase 2A Units 1, 2 and 3 is:

- RSK Environment Ltd, RSK Environment Ltd, Ground Treatment Specification – Development Platforms, Report reference 322638 R02 (01), May 2020.

2 SITE DETAILS

2.1 Site location

The site is located at Rockingham, Hoyland, South Yorkshire, at National Grid reference 434810, 401210, as shown on Figure 1.

2.2 Site description

The wider site is being developed for commercial purposes, comprising several light industrial units with associated roads and infrastructure. A planning application was submitted to Barnsley Metropolitan Borough Council (BMBC) for the proposed development and outline planning permission was granted on 10 August 2020 (reference: 2019/1573).

The proposed development work for the site divides it into three areas termed 'Phases 2A, 2B and 3'. Phase 2A lies to the immediate south of the Dearne Valley Parkway (Parkway) with 2A.1 representing the first development phase of area 2A, with Phase 2B located adjacent and further to the south. Phase 3 is located to the north of the Parkway between two existing commercial developments; Shortwood Business Park to the east, and Rockingham 1 (a Harworth development plot) to the west. The Phase 2 site was originally on a sloping hillside with the lower elevations to the north and west however the earthworks has now provided level plateaus for development. Units 1, 2 and 3 which are the focus of this report are located within Phase 2A.1, in the north-eastern portion of the Phase 2 site.

The site was historically subject to extensive opencast mining operations, including beneath Units 1, 2 and 3, from the 1990's. Restoration of the wider site was completed by 2002. For the Phase 2 site the opencast backfill is understood not to have been placed as an engineered material, based on the results of the site investigation and historical records, although compacted backfill is indicated to be present beneath the Parkway.

2.3 Development plans

A number of iterations of the development masterplan have been produced throughout the project to reflect changing design and market priorities.

The most significant alterations in relation to the Phase 2A.1 area are the changes between the masterplan at the time of production of the ground treatment specification and current masterplan. The principal change in this period is the reduction from 4 buildings to 3 buildings on the northern plateau of the Phase 2A.1 development area. There is now no Unit 4 in the current masterplan. There were also slight modifications to the building positions for Units 1, 2 and 3 although these were of a minor nature.

The proposed layout of the site both at the time of production of the ground treatment specification and at the time of preparing this report are provided in Appendix B.

2.4 Alterations to ground treatment design

Owing to the changed layout of the proposed built development at the site the following changes were made to the preliminary ground treatment design and the ground treatment specification set out in 322638 R03 (02):

- additional surcharge to Unit 1
- additional surcharge to Unit 2
- relocated surcharge for Unit 3.

The updated design for the ground treatment works is presented in Appendix C.

3 WORKS UNDERTAKEN

3.1 Site supervision

An RSK engineer carried out full-time supervision of the works in order to; oversee installation of settlement monitoring infrastructure; periodically obtain readings from installed monitoring equipment; inspect formations prior to placement works; inspect the materials used for the placement; inspect the compaction works for placement of engineered fill and associated testing; inspection of surcharge treatment works; general inspection and supervision; and raising any identified issues in relation to non-compliance with the specifications (both the JPG earthworks specification and RSK ground treatment specification).

3.2 Chronology

The works undertaken on site relevant to Units 1, 2 and 3 on Phase 2A.1 are summarised in chronological order in **Table 1** below:

Table 1: Units 1, 2 and 3 Chronology

Site activity undertaken	Commencement date	Completed date
Site preparation (tree stump and vegetation removal)	28.09.20	16.10.20
Topsoil strip	19.10.20	02.11.20
Cut to level	30.10.20	07.05.21
Placing engineered fill Units 1, 2 and 3	06.11.20	08.07.21
Installation of HPG loops	30.11.20	14.12.20
HPG measurement	22.11.20	23.02.22
Installation of PGM ground markers	23.04.21 (12.11.21)	05.07.21 (17.11.21)
PGM measurement	23.04.21	*03.02.22
Surcharge construction Unit 1	15.04.21 (30.11.21)	13.05.21 (14.12.21)
Surcharge construction Unit 2	15.04.21 (30.11.21)	13.05.21 (14.12.21)
Surcharge construction Unit 3	05.08.21	26.08.21
Surcharge removal Unit 1	05.08.21 (02.02.22)	26.08.21 (18.02.22)
Surcharge removal Unit 2	05.08.21 (07.02.22)	26.08.21 (18.02.22)
Surcharge removal Unit 3	30.11.21	14.12.21
<p>Note: () The surcharge treatment was expanded from the footprint set out in the ground treatment specification to capture the altered building layouts within the latest masterplan. The figures in brackets represent the treatment of these additional areas.</p> <p>*measurements ongoing however this is the last date available for inclusion within this report</p>		

3.3 Installation of monitoring infrastructure

3.3.1 Hydrostatic profile gauge loops

Hydrostatic profiles gauge loop (HPG3) was installed by HCE under RSK supervision with construction works completed by 14 December 2020, prior to the placement of earthworks fill material. HPG3 extends beneath Unit 3.

A trench (~500mm in depth) was dug from the existing ground level beneath fill areas into the opencast backfill in an arcuate pattern extending from the toe of the engineered fill into the site. The position of each trench was captured by GPS with the locations displayed on Figure 2.

Pipework was laid into this trench with a gravel surround bedding material. The pipe was to act as a conduit for the hydrostatic profile gauge sensor, allowing it to traverse beneath the site whilst filling operations progressed, and later during surcharge construction.

By running the probe across the site original surface data was captured to demonstrate the settlement in relation to the different loadings imposed by the increasing height of engineered fill (constructed with a 1:3 batter) and surcharge (1:2 batter) from the datum point.

HPG4 and HPG5 were later constructed into the engineered fill of the final platform level beneath Unit 1 and HPG6 beneath Unit 3 using the same methodology as HPG3. These were installed in order to provide measurement points beneath the building footprint for settlement induced by surcharging only.

The results of the monitoring are discussed in Section 4.1.

3.3.2 Permanent ground markers

Ground anchor PGM's were installed across the site on completion of the cut/fill earthworks and in advance of the construction of the surcharge mounds.

24 PGM's were initially installed across Units 1, 2 and 3 of which 12 are within the boundaries of Units 1 and 2.

An additional 22 PGM's were added prior to the construction of the additional surcharges applied to Units 1 and 2.

Markers were installed in ~100mm deep hand dug pits. A sand blinding was added for protection and to aid visibility after removal of the surcharge mound.

On removal of the surcharge mounds the PGM's were monitored in order to provide total settlement figures across the footprint of the plots which also allows for cross-checking of the settlement recorded by the HPG.

The location of each marker was captured by GPS and each are displayed on Figure 2.

The results of the monitoring are discussed in Section 4.2.

3.4 Earthworks

3.4.1 Site preparation

In order to prepare the Phase 2 site for the earthworks approximately 8Ha of semi-mature broadleaf woodland was cut down to ground level under supervision of the site ecological (FPCR) and arboriculture team (TEP).

The remainder of the stumps and roots were removed along with other vegetation and topsoil by HCE between 28 September and 16 October 2020.

Site land drainage was maintained where possible in order to manage surface water flows during the redevelopment works.

3.4.2 Earthworks operations

The Phase 2 earthworks began with a topsoil strip on 19 October 2020 and were completed 2 July 2021.

The total cut and fill is demonstrated by the JPG design figures and the as built land form provided by HCE, included as Appendix D.

3.4.3 Contractor compliance testing

HCE appointed Fairhurst as their environmental and geotechnical consultant in order to oversee compliance with the specifications, most particularly the requirements of the engineered fill.

Initial compliance testing of the engineered fill was carried out on a test pad within Phase 2. The first layers of placed engineered fill returned mixed results (a broad range of in situ density values and moisture contents) when utilising the specified nuclear density gauge measurements. Fairhurst proposed that this may be due to the variable coal content and suggested that sand replacement test may be a more reliable measure of the density of the engineered fill. This was agreed by RSK and the method altered to include sand replacement tests.

A summary of the compliance testing carried out on the engineered fill is provided within the earthworks validation report produced by Fairhurst on behalf of HCE. This is provided in Appendix E.

3.4.4 Surcharge construction

The first surcharge mound began construction over Units 1 and 2 on 15 April 2021 and was completed on the 14 May 2021.

Materials were sourced from the stockpiled 'topsoil' and subsoil stripped from the original site surface as well as colliery spoil and clay from the site cutting operations. In total the surcharge volume amounted to ~50,275m³.

This same material was then moved from Units 1 and 2 to form the surcharge treatment mound for Unit 3 between 27 July 2021 and 26 August 2021.

After completion of the Unit 3 treatment it was identified that the full coverage of treatment was not achieved for Units 1 and 2 under the latest masterplan. The surcharge soils were

then moved to form two treatment mounds over those areas identified as not having received full treatment.

The formation of the Unit 1 and Unit 2 additional treatment surcharge mounds was completed on the 14 December 2021 and the surcharge materials were fully removed from Unit 1 and Unit 2 to be used for future treatment on the remainder of the Gateway 36 site on 18 February 2022.

As built drawings for the surcharge mounds are provided in Figure 3.

3.5 Monitoring methodology

3.5.1 Hydrostatic profile gauge loops

Initial (baseline) readings were obtained for the HPG loops immediately after installation and then subsequent visits were carried out, typically on a weekly basis. Readings were obtained at 5m intervals along the loops by drawing the probe through the installed pipework.

Each reading was referenced to datum points comprising PGM's secured at each end of the monitoring loop. The elevation of these PGM's were periodically captured and updated using precise levelling techniques so that the HPG readings, which are relative to the datum PGM's, were not being significantly influenced by ground movement at the datum points.

Results were captured periodically (weekly) throughout the works, with each round of monitoring subject to a check run to ensure accuracy.

3.5.2 PGM ground markers

The location of each PGM was recorded by GPS at installation and their elevation captured by precise levelling to an accuracy of +/-2mm.

Upon removal of the surcharge mounds the PGM's were found using the coordinates and excavated with their elevations again captured using precise levelling to an accuracy of +/-2mm.

Monitoring of the PGM's continued after removal using precise levelling techniques, where possible, in order to try and capture any rebound in ground levels after surcharge removal.

4 MONITORING RESULTS

4.1 Hydrostatic profile gauge loops

The results of the HPG monitoring are presented in graphical and table form within Appendix F.

It should be noted that monitoring points along each loop will have been subject to different thicknesses of engineered fill and surcharge and results will therefore vary from point-to-point. The results show the change in levels of the installation during the course of the earthworks and ground treatment such that correlations can be made as to the cause of ground movements. These are interpreted and discussed below.

4.1.1 HPG3

The rate of settlement was as expected, showing a sharp increase on loading from the completion of placement of engineered fill over the monitoring loop, captured by the 27 April 2021 monitoring round, with a range of total settlements of 154mm at P75 and 44mm at P51 recorded. Gradual settlement continued under the earthwork loads with a maximum of 221mm recorded by the 8 July 2021.

Additional load from the construction of the surcharge mound was applied between 5 and 26 August 2021 which led to a maximum recorded settlement of 276mm on 23 September 2021, after which time little additional settlement was recorded.

The surcharge over HPG3 began to be removed on 30 November 2021 and was completed by 14 December 2021. No further HPG readings could be obtained after the 18 November 2021 covering this period due to damage of the monitoring infrastructure. It was not therefore possible to record any response to unloading for HPG3, however readings were collected from the overlying HPG6 and are discussed in Section 4.1.4.

The result of the surcharge was as expected based upon the completed modelling with sufficient settlement induced to create a stable platform for development.

4.1.2 HPG4

The majority of settlement recorded at HPG4 was achieved by completion of the surcharge construction with the first monitoring round undertaken on 13 May 2021 recording an average settlement of 98mm.

The average and maximum settlements show little movement after complete loading for the ~2 months that the surcharge was in place, ranging from 81mm to 98mm and 105mm and 130mm, respectively.

The unloading of the surcharge was carried out between 5 and 26 August 2021 during which data was captured by 4 monitoring rounds. The maximum settlement reduction was from 126mm to 88mm in this period with the average settlement of those monitoring points that were beneath the surcharge reduced from 96mm to 70mm. These values are in line with the predicted rebound of up to 25%.

HPG4 also captured the loading of the 4m high Unit 1 Additional Surcharge Mound, the extents of which are displayed on Figure 2 in relation to the monitoring loop. The average

settlements of those monitoring points loaded increased from 59mm to 88mm, between 14 December 2021 and the monitoring round on 10 February 2022.

Unloading of the additional surcharge resulted in a rebound of ~10mm, approximately 10% of the total settlements recorded.

The result of the surcharge was as expected based upon the completed modelling with sufficient settlement induced to create a stable platform for development.

4.1.3 HPG5

The engineered fill induced considerable settlement on the HPG5 loop, with an average settlement recorded across P48 to P81 of 146mm between 27 April and 13 May 2021. Between this same date range surcharge construction began over P6 to P45 reaching a height of 1.7m at the time of monitoring. The surcharge loading caused initial settlements of 94mm to be recorded beneath its crest. The magnitude and rate of settlement to this point were as expected.

The surcharge was completed to its full height for the 27 May 2021 monitoring round, however this had little impact on the settlement recorded with average settlement only increasing by 1mm and the maximum recorded settlement increasing by 8mm.

There was no further significant movement recorded until the removal of the surcharge between 5 and 26 August 2021 which caused relative heave, averaging 13mm, which was approximately 10% of the total settlement induced.

HPG5 also captured the loading of the 4m high Unit 1 Additional Surcharge Mound which induced approximately 10mm to 40mm of additional settlement to the monitoring points beneath its crest between its completion on 14 December 2021 and the monitoring round on 3 February 2022.

The unloading of the additional surcharge resulted in a rebound of ~5-10mm, similar to the ~10% rebound recorded after surcharging of other areas discussed above.

The result of the surcharge was as expected based upon the completed modelling with sufficient settlement induced to create a stable platform for development.

4.1.4 HPG6

The rate of settlement was as expected, showing a steady increase during the surcharge construction over the monitoring loop, captured by the 4 monitoring rounds undertaken during construction between 22 July and 19 August 2021. By the completion of the surcharge mound up to 81mm of settlement had been recorded at P30, with the average settlement across the 11 monitoring points recorded as 48mm.

This was followed by a period with slower rates of settlement, which reduced with time. The maximum total settlement reached 102mm before unloading began.

Attempts to capture the rebound of the ground on unloading were unsuccessful as the monitoring loop was disturbed during unloading.

The result of the surcharge was as expected based upon the completed modelling with sufficient settlement induced to create a stable platform for development.

4.2 PGM ground markers

The results of the PGM surveys are presented in Appendix G in graphical and table form.

The post treatment elevations recorded vary widely, with significant variations at neighbouring locations. These results indicate that the PGMs have been disturbed during the surcharge removal works and unfortunately cannot provide useful monitoring results.

The other monitoring technique employed (the HPG loop monitoring) has demonstrated settlement as would be expected with the increased load from placement of engineered fill and surcharge.

5 CONCLUSIONS

The slope of the original ground has required areas of cut together with varying thicknesses of engineered fill to provide the development platform in the Phase 2A area. In addition considering the variability in made ground thickness and bedrock depths created by the past opencast mining the ground conditions and settlement characteristics of the area are complex.

The monitoring undertaken has demonstrated significant settlements as a result of the earthworks loads and loads applied by the surcharge ground treatment. Good correlations can be seen between the modelled estimates of ground settlement and those recorded by the HPGs, taking into consideration the variation of induced load from changes in thickness of engineered fill and surcharge treatment. The PGM measurements have evidently been subject to disturbance, proved much less reliable and have not provided the desired supporting data. This is likely due to the operation of heavy site plant in the process of uncovering the PGM's.

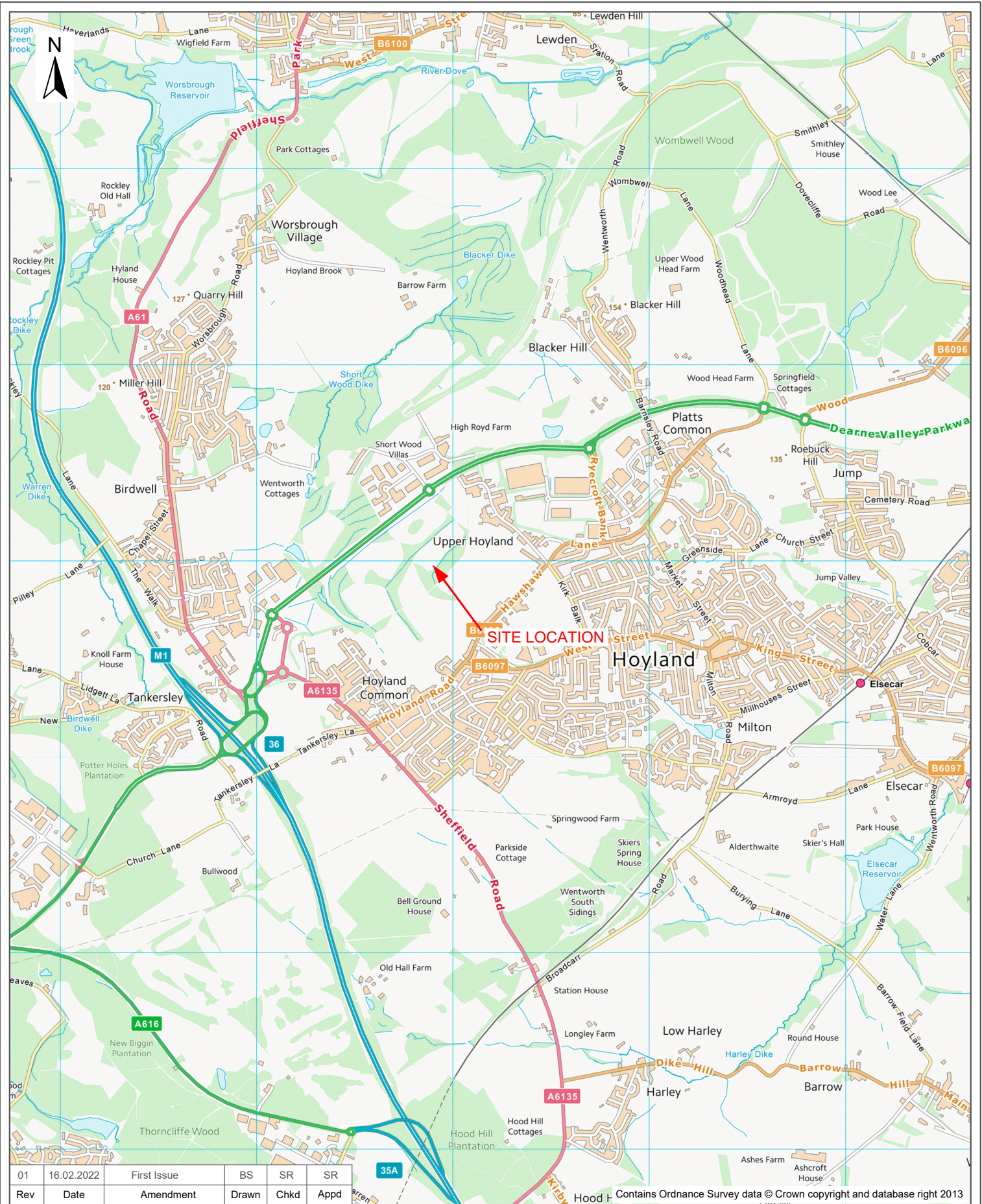
The recorded settlements occurred within the anticipated timescales, with the majority occurring during or shortly after loading and then continuing at a decreasing rate with time until levelling off before the removal of the surcharge mounds.

Each of the HPG monitoring loops recorded sufficient total induced settlements to confirm that the ground treatment to Units 1, 2 and 3 of the Gateway 36 Phase 2A.1 site has been successfully completed.

FIGURES



FIGURE 1 SITE LOCATION PLAN

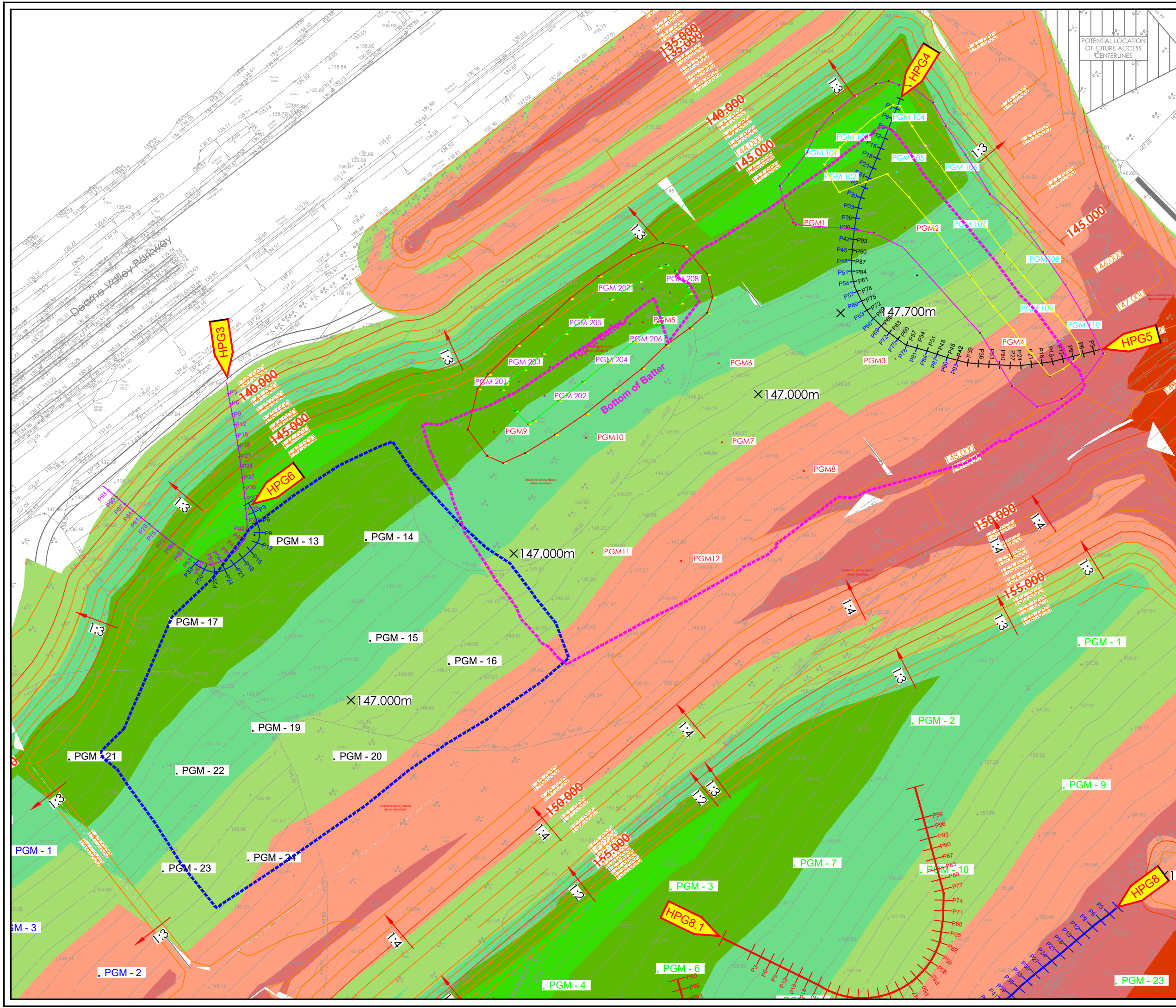


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Rev	Date	Amendment	Drawn	Chkd	Appd

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<div><div><div>Spring Lodge 172 Chester Road Helsby WA6 0AR</div><div>Tel: +44(0)1794 329276 Email: info@rsk.co.uk Web: www.rsk.co.uk</div></div></div>				Client			
				EOS Inc Limited			
				Project Name			
				Gateway 36 Development Site			
				Description			
				Site Location Plan			
Dimension	Size	Scale	Geolocation	Project ID	Drawing no.	Rev	File name
m	A4	1:25,000	435898,400980	322638	DFR014-1	01	322638-SITE LOCATION PLAN-REV01

FIGURE 2 PHASE 2 SETTLEMENT MONITORING INFRASTRUCTURE



LEGEND

Hydrostatic profile gauge (HPG) monitoring loops installed before placement of engineered fill.

Hydrostatic profile gauge (HPG) monitoring loops installed at platform level.

Permanent ground markers (PGMs) placed at near-surface platform level prior to surcharge ground treatment, 23.04.2021

Permanent ground markers (PGMs) placed at near-surface platform level 05.07.2021

Permanent ground markers (PGMs) placed at near-surface platform level 12.11.2021

Permanent ground markers (PGMs) placed at near-surface platform level 17.11.2021

Phase 2 Units 1 & 2, 3m high
Inclusive dates of complete surcharge' (13.05.21 - 05.08.21)

Phase 2 Unit 3, 5m high
Inclusive dates of complete surcharge' (26.08.21 - 30.11.21)

Phase 2 Unit 1 Additional, 4m high
Inclusive dates of complete surcharge (30.11.21 - 02.02.22)

Phase 2 Unit 2 Additional, 4m high
Inclusive dates of complete surcharge (30.11.21 - 07.02.22)

Cut/Fill Depth By Colour Banding			
Number	Minimum Elevation	Maximum Elevation	Colour
1	-12.00	-10.00	Red
2	-10.00	-8.00	Red
3	-8.00	-6.00	Red
4	-6.00	-4.00	Red
5	-4.00	-2.00	Red
6	-2.00	0.00	Red
7	0.00	2.00	Green
8	2.00	4.00	Green
9	4.00	6.00	Green
10	6.00	8.00	Green
11	8.00	10.00	Green
12	10.00	12.00	Green

Note-Cut and fill baseplan taken from JPG Drawing Ref: 4652-2-JPG-SW-00-M2-C-1201_Phase_2_Cut_Fill_Analysis

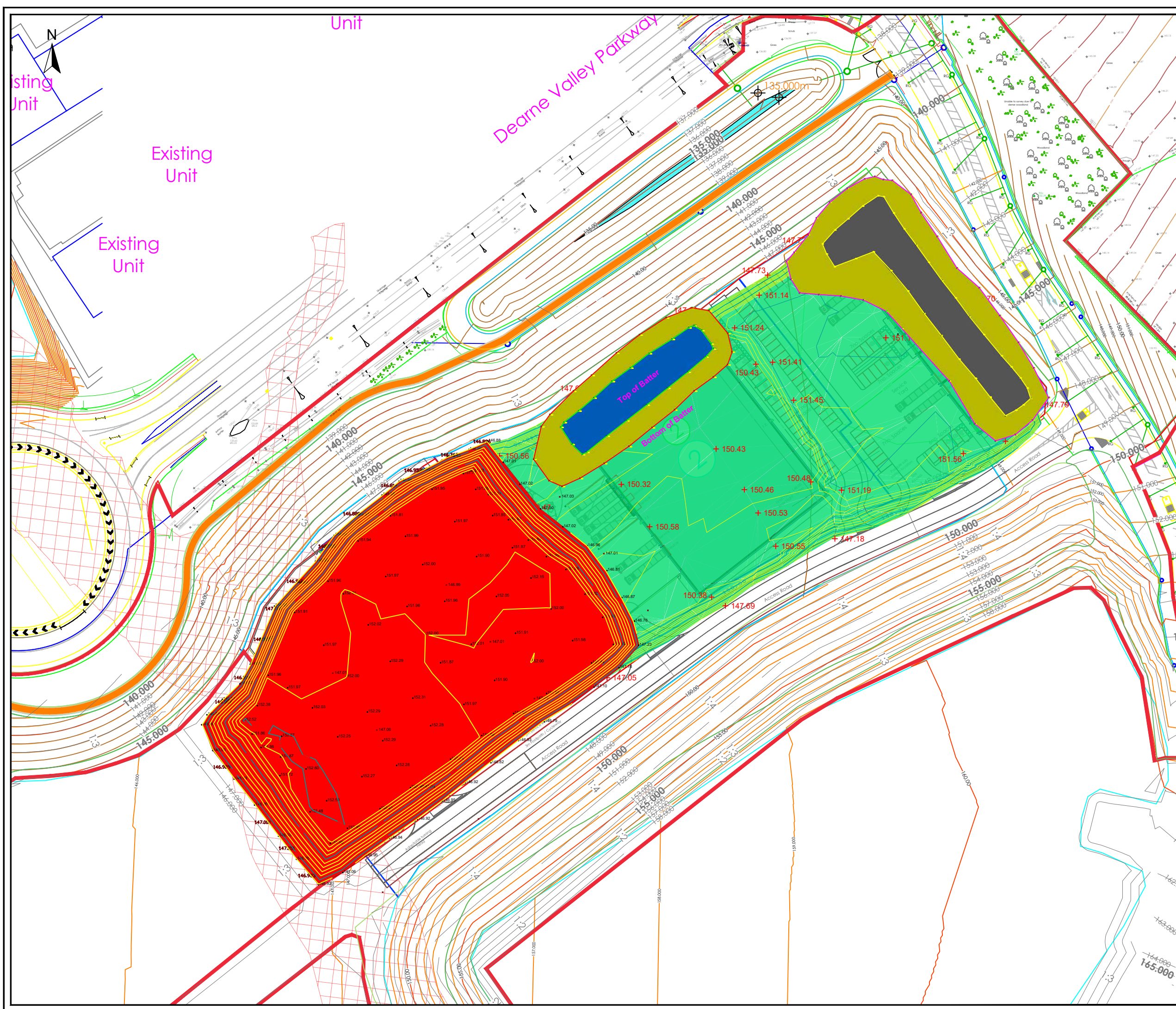
01	11.03.22	First Issue	BS	AC	AC
Rev	Date	Amendment	Drawn	Chkd	Appd

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Client			EOS INC LIMITED		
Project Name			GATEWAY 36 DEVELOPMENT SITE – PHASE 2		
Description			Phase 2 Units 1, 2 and 3 Settlement Monitoring Infrastructure		
Project ID		Figure		Revision	
322638		DRF019		01	
File name					
322638-Phase 2 Units 1, 2 and 3 Settlement Monitoring Infrastructure-REV01					
Dimensions		Scale		Size	
m		NTS		A3	

FIGURE 3 AS BUILT SURCHARGE MOUNDS



- LEGEND**
-  Phase 2 Units 1 & 2, 3m high
Inclusive dates of complete
surcharge' (13.05.21 - 05.08.21)
 -  Phase 2 Unit 3, 5m high
Inclusive dates of complete
surcharge' (26.08.21 - 30.11.21)
 -  Phase 2 Unit 1 Additional, 4m high
Inclusive dates of complete
surcharge (30.11.21 - 02.02.22)
 -  Phase 2 Unit 2 Additional, 4m high
Inclusive dates of complete surcharge
(30.11.21 - 07.02.22)

Note-Notes: Surcharges are located based upon the survey received from Howards Civil Engineering Limited

01	07.03.22	First Issue	BS	AC	AC
Rev	Date	Amendment	Drawn	Chkd	Appd



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Client			EOS INC LIMITED		
Project Name			GATEWAY 36 DEVELOPMENT SITE		
Description			As Built Surcharge Mounds		
Project ID	Figure	Revision			
322638	03	01			
File name					
322638-As Built Surcharge Mounds-REV03					
Dimensions	Scale	Size			
m	NTS	A3			

APPENDICES

APPENDIX A

RSK GROUND TREATMENT SPECIFICATION



EOS Inc Limited

J36 Rockingham Phase 2 and 3

Ground Treatment Specification – Development Platforms

322638 R03 (02)

SEPTEMBER 2020

DOCUMENT CONTROL SHEET

PROJECT NAME **J36 Rockingham Phase 2 and 3**

REPORT TITLE **Ground Treatment Specification – Development Platforms**

REPORT REFERENCE **322638-R03 (02)**

Version	Date	Prepared by:	Checked by:	Approved by:
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FIGURES

Figure 1	Ground Treatment Areas including required Surcharge Construction
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1 INTRODUCTION

1.1 General

The site includes Phase 2 and 3 of the J36 Rockingham development site, near Barnsley. It is currently proposed to develop the site with ten warehouse buildings with associated service yards, car parks and infrastructure.

The site is located within the former Rockingham opencast coal mine, situated approximately 1km north east of Junction 36 of the M1 motorway. The Phase 2 area lies to the south and Phase 3 to the north of the Dearne Valley Parkway (A6195).

This document (or any subsequent revision) provides detail on the ground treatment requirements for the development platforms as currently indicated on the latest masterplan. . This document will form part of the contract documents for the ground works, which will include a ground treatment specification for the Phase 2 and 3 development platforms (this document) a ground treatment specification for the adoptable roads and roundabout (produced by RSK) and an earthworks specification for the same area (by JPG) The ground works and subsequent building works will be managed by Joint Contracts Tribunal (JCT) contracts.

1.2 Definition of Roles

Harworth Group are the client for the ground treatment works.

The funder for the project will require agreement of the appointment documents with all parties prior to their appointment.

RPP – will be the Employer's Agent and Quantity Surveyor for the ground treatment works and building works.

RSK – are the geotechnical and environmental consultants and have been responsible for the assessment of the site ground conditions and the production of the performance requirements for the ground treatment works. They will also be responsible for supervising the earthworks and ground treatment works, carrying out independent testing and providing validation that all works are in compliance with the specifications and performance requirements following completion.

Contractor – is responsible for the ground treatment works which will include cut and fill operations, surcharge placement and clearance works to the final cut surface prior to handover of the site (as specified by JPG). The contractor will also be responsible for undertaking any validation testing required by the client, RSK or JPG. The contractor will be required to place the surcharge mounds detailed in this document. The client will be responsible for the settlement attributable to the surcharge mounds detailed within this document and the removal of these mounds only. For the avoidance of doubt the contractor is responsible for the performance of the development platforms and all other works.

JPG – are the civil and structural engineer appointed by the client to oversee the construction phase of the development which will follow-on from the Ground Treatment works. JPG have produced the earthworks specification and designed the development platforms with associated cut/fill plans.

Harris Partnership – Architect.

1.3 Site History

The site has a long history of both deep underground mining (from the Rockingham colliery) and more recent opencast coal mining (RJ Budge Rockingham opencast in the 1990's) with the most recent operations including backfilling and restoration in the late 1990's. The site has been assessed by RSK Environment Ltd (RSK) since 2013. The ground conditions underlying the wider site are complex, as they include areas of historic open cast mining (1960's), recent opencast mining (1990's), and unexcavated areas. Opencast backfill materials are present across the site, which overlie Coal Measures bedrock.

1.4 Proposed development

The site is proposed for development with ten commercial units; two in the Phase 3 area (Units 1 and 2) and nine in the Phase 2 area (Units 1 to 8). In addition, access roads will be required into both development areas.

At this stage it is expected that development will proceed in the Phase 2 area and then into the Phase 3 area however there is an opportunity to progress the work on both Phases 2 and 3 simultaneously if deemed viable by the Contractor. The anticipated sequence is as follows:

- Works for the access road off the existing roundabout will be carried out during the Phase 2 works
- Phase 2 Units 1 to 4
- Works for the access road and new roundabout will be carried out during the Phase 2/3 works
- Phase 3 Unit 1
- Phase 2 Unit 5
- Phase 3 Unit 2
- Phase 2 Unit 6
- Phase 2 Unit 7
- Phase 2 Unit 8

The surcharge mound for Units 1 to 4 will be left in situ and subsequently made available for re-use to surcharge other Phase 2 units; similarly, for Phase 3 on completion of the works a surcharge mound for Unit 1 will be left in situ for subsequent re-use.

For Phase 2 Units 5 – 8 and Phase 3 Unit 2 only earthworks to provide the development platform are included in the current package of work detailed within this document. For these latter plots ground treatment by surcharging is currently outside the scope of works for which this document is being prepared. Ground treatment beneath the roads and roundabout is within the Contractor scope of work and is detailed in a separate specification (RSK report reference 322638 R07).

2 SITE INFORMATION

This section lists all Site Information which is available.

2.1 Drawings

Harris Partnership Drawings

Title	Reference	Revision
Proposed Masterplan	12006-1-110	L

JPG Drawings

Title	Reference	Revision
Proposed Earthwork Levels	4652-2-JPG-SW-00-DR-C-1200-S4	P013
Cut Fill Analysis	4652-2-JPG-SW-00-DR-C-1201-S4	P014
Phase 3 Proposed Earthwork Levels	4652-2-JPG-SW-00-DR-C-1202-S4	P07
Phase 3 Cut Fill Analysis	4652-2-JPG-SW-00-DR-C-1203-S4	P07
Topsoil Strategy	4652-2-JPG-SW-00-DR-C-1212-S4	P03

Note: Please contact JPG for the latest revision of the above-referenced drawings. Where these differ to the revision referenced please seek confirmation from RSK of any required alterations.

RSK Drawings

Title	Reference	Revision
Ground Treatment Areas Including Required Surcharge Construction	Figure 1	C
Indicative Monitoring Infrastructure Locations – Phase 3	Figure 2a	01
Indicative Monitoring Infrastructure Locations – Phase 2	Figure 2b	01

2.2 Site investigation information and reports

RSK have completed site investigation work including borehole and trial pit investigation and monitoring of surface ground markers across both development Phases together with a large-scale loading test in the Phase 3 area.

Details of the site investigation work completed to date can be found in the latest versions of the reports referenced below:

- RSK Report Reference 321393 – R3 (01), dated April 2015: Geo-environmental Site Assessment: Rockingham 2 East.
- RSK Report Reference 321393 – R4 (01), dated April 2015: Geo-environmental Site Assessment: Rockingham 3.
- RSK Report Reference 321393 – R6 (01), dated April 2015: Geo-environmental Site Assessment: Rockingham 2 West.
- RSK Report Reference 322494-R1 (00), dated February 2019; Preliminary Risk Assessment and Coal Mining Risk Assessment: J36 Phase 2, Rockingham.
- RSK Report Reference 322638 R02 (01), dated May 2020; Phase 2 Geo-environmental and Geotechnical Site Investigation : J36 Phase 2, and Phase 3 Rockingham.

JPG have prepared the Earthworks Specification documents referenced below for the cut and fill earthworks element of the preparatory works. These provide details on the requirements for cut and fill earthworks to provide development platform areas.

- Site Specification – Earthworks, Phase 2 Rockingham Reference: 4652-JPG-XX-XX-SP-G-0401-S1-P02, May 2020.
- Site Specification – Earthworks, Phase 3 Rockingham Reference: 4652-JPG-XX-XX-SP-G-0402-S1-P02, May 2020.

This Ground Treatment Specification outlines the requirements for ground treatment works which are required for Phase 2 Units 1, 2, 3 and 4, Phase 2 roundabout treatment area and Phase 3 Unit 1 and access road to improve the current ground conditions to a standard capable of adequately supporting the proposed commercial development units.

3 GROUND TREATMENT WORKS

In the Table below the ground treatment requirements for the tender are summarised.

All areas	<ul style="list-style-type: none"> Cut and fill earthworks (in accordance with JPG specification and drawings)
Phase 2 Units 1-4 and Phase 3 Unit 1	<ul style="list-style-type: none"> Surcharge of development platforms (buildings, external and perimeter areas) as detailed on Figure 1
New roundabout and Phase 3 access	<ul style="list-style-type: none"> Detailed within RSK report reference 322638 R07

The ground treatment requirements are detailed in the following sections.

3.1 Ground treatment required

The outline design for the ground treatment works are set out below. The cut and fill earthworks are to be completed to the JPG specification and surcharge treatment shall be carried out in accordance with this specification.

In order to provide development platforms suitable for the proposed buildings, access roads, associated service yards and ancillary areas, cut and fill works are required as detailed in the JPG Earthworks Specification. Performance requirements for these works are detailed in the JPG specification and Section 5 of this document.

In conjunction with the cut and fill works, ground improvement works are also required to improve the engineering properties of the opencast backfill and in particular the near surface materials in order that the performance requirements for the remediated site can be met. It is anticipated that the placement of engineered fill, where required, will be completed before surcharge treatment works are undertaken.

The performance of the ground treatment works will be recorded by RSK using monitoring equipment installed in advance of the main site operations. Three stages of equipment installation will be required. The first of these will be carried out by RSK before the main Contractor mobilises to site and the position of these installations (magnetic extensometers installed in deep boreholes) will have to be protected and maintained by the Contractor to enable monitoring during and on completion of the earthworks and surcharge treatment. The second stage will follow vegetation removal and topsoil strip, when the Contractor will install the required monitoring infrastructure as detailed in Section 6. The third stage continues from the second after the completion of the cut and fill works to finalise installation of the monitoring equipment detailed in Section 6. The installation of monitoring infrastructure and all earthworks and ground treatment will be supervised by RSK.

After the initial stage of installation works (pre Contract), the following works will be carried out:

(a) Vegetation clearance

In accordance with JPG Earthworks Specification.

(b) Surface Strip

Strip of 'topsoil' and organic subsoil in accordance with JPG Earthworks Specification and Topsoil Strategy.

(c) Install monitoring infrastructure

The contractor will install monitoring infrastructure under instruction from RSK. The location and timing of works will vary across the site and will be dependent on the Contractors programme. Details are provided in Section 6 and an indicative layout (which will be subject to change and is dependent on the Contractors programme) is included in Figures 2a and 2b.

(d) Carry out Cut and Fill Works

In accordance with JPG Earthworks Specification and drawings.

(e) Surcharge Treatment

In areas where engineered fill has to be placed to achieve the development level, surcharge works can only take place once infill operations have achieved the required levels for each given treatment area. In areas where materials are to be cut, such materials will have already contributed to surcharging the underlying development platform and consequently the sequencing of operations need careful consideration to minimise double or multiple handling – e.g. in an area where 4m is to be cut but the surcharge height is to be 5m then placement of 1m of surcharge over the original levels should be considered.

Based on the current masterplan for the site produced by the Harris Partnership, there is a requirement for surcharge areas over each of the ten development units prior to construction however for this contract the Contractor is only required to place the surcharge mounds for Phase 2 Units 1,2,3 and Unit 4 and Phase 3 Unit 1 (see Figure 1)

The treatment to the Phase 3 access road and new roundabout treatment area is detailed separately in RSK report reference 322638 R07.

If the Contractor has chosen to delay cutting to the final earthworks levels in order to reduce the required surcharge height they would also be required to remove the surcharges to a location chosen by the client on completion of the treatment works such that the underlying material could be cut to level and the material used for fill elsewhere on the site. Outside of this scenario, removal or moving of the surcharge mounds to other areas of the site would constitute a variation and should be priced at that time if requested by RPP/the client.

Where buildings are closely spaced a single surcharge mound can be used for multiple units and this is required for Phase 2 Units 1 to 4 as detailed on Figure 1.

3.2 Materials for use as Surcharge

Materials to be used as surcharge treatment can include the 'topsoil' material stripped from the site as well as subsoil and the underlying opencast backfill materials (although at this stage it is expected that sufficient volumes of 'topsoil', subsoil and stripped material will be present for all the surcharge works). The opencast backfill materials can only be used if they are surplus to the earthworks requirements or if they are only used temporarily and are subsequently used as engineered fill to create the final development landform as detailed in the JPG Earthwork Specification and drawings, by completion of the contract.

If different materials are used, they should be segregated. This includes segregation of 'topsoil' and subsoil as well as opencast backfill in order to preserve the 'topsoil' for re-use. Where 'topsoil' is used within the same surcharge mound as other materials the 'topsoil' will need to remain accessible (e.g. at the top of the pile).

If soils become mixed then they are unlikely to be suitable for subsequent use in landscape areas or engineered fill and the Contractor may be required to remove the mixed material from site and replace it with chemically and geotechnically suitable fill/landscaping materials at the discretion of the client.

All materials to be used as surcharge will be tested by the Contractor to confirm the in-situ density in advance of construction at a rate of 1 test per 10,000m³.

It is proposed that each treatment area is surcharged in turn with Phase 2 Units 1 to 4 being treated in the first instance and forming the requirement of these works.

If the Contractor identifies an opportunity to treat a greater area of the site simultaneously, whilst still meeting the required deadlines, this should be presented to RSK/ RPP.

It is expected that the volume of materials from the Phase 2 surface scrape and 'topsoil' will be sufficient to surcharge Units 1 to 4 as a minimum and that the surface scrape, 'topsoil' and existing load test mound will be sufficient to surcharge Phase 3 Unit 1 as a minimum.

3.3 Surcharge Heights

A 3m surcharge height, above final earthworks levels for each given area, will be required over Phase 2 Units 1 to 4, increasing to 3.5m if organic rich 'topsoil'/subsoil or soils with a density of less than 1,500 kg/m³ are utilised.

A 5m height of surcharge, above final earthworks levels, will be required over all remaining Units and the new roundabout treatment area, increasing to 6m if organic rich 'topsoil'/subsoil or soils with a density of less than 1,500 kg/m³ are utilised.

If an accelerated programme was required consideration could be given to increasing the surcharge height to induce the required settlement in a shorter time.

All surcharge heights will be measured relative to the final earthworks levels, as defined on the latest revision of JPG's Proposed Earthwork Levels.

3.4 Outline Methodology

Following the vegetation removal and 'topsoil'/subsoil strip, the plan area where surcharge materials are to be placed will be subject to proof rolling following the specification defined in the JPG earthworks strategy. Any soft spots will be removed and replaced.

For areas where infill is required this would be completed in accordance with the JPG Earthwork Specification.

The Contractor will then install the required monitoring infrastructure and provide notice and access to RSK as detailed in Section 6 (NB installation will be required at different times across the site, subject to the Contractors programme, and some works can only take place once some areas are cut to final level).

After site clearance, enabling earthworks and initial installation works the following sequence will be completed, or an alternative as devised by the Contractor which has been agreed by RSK and RPP/ the client:

- 1 The first areas of the works (Phase 2 Units 1 to 4 and Phase 3 Unit 1,)will be set out by the Contractor to establish the area of placement (Figure 1) which indicates the top surface of the surcharge. The surcharge heights will be as detailed in the Surcharge Heights (Section 3.3) above. A 1:2 batter is proposed initially however the Contractor will need to review the stability of the material and determine an appropriate angle of repose. In determining side slopes consideration shall be given by the Contractor to potential slope stability issues, containing material and water run-off down side-slopes and, where relevant, proximity of services.
- 2 Arisings from areas of cut, including the existing load test mound (present in the Phase 3 area), soil removed with surface 'topsoil' scrape and any other agreed borrow pit areas (if used) will be brought to each area of surcharge placement in dumper trucks and appropriate plant will be used to level out and track over/compact the deposited materials and form the surcharge mounds.

- 3 The 'topsoil' and subsoil should be segregated from one another as well as being and segregated off from any opencast backfill materials (if they are being used for surcharge). It is suggested that in the Phase 2 area a significant volume of topsoil and surface scrape materials will be made available at an early stage, which could be used for the surcharge for Phase 2 Units 1 to 4 after completion of the cut and fill in this area. Similarly, on Phase 3 such materials and the existing load test mound can be used as surcharge Unit 1 after completion of the cut and fill.
- 4 As placement works progress a gently sloping ramp will be required at the edge of the surcharge area to allow access onto the top working surface by dumper trucks. This may require more regular tracking and compaction than the wider treatment area. The Contractor is required to consider an appropriate angle for the side slopes to maintain their stability and working practices should be continually reviewed to ensure the safety of all parties.
- 5 As construction of the surcharge treatment mounds progresses the Contractor will be responsible for ensuring the protection and integrity of all monitoring infrastructure (including both the previously installed magnetic extensometers and subsequent hydraulic profile loops). If any equipment is made inoperable by the works this would have to be replaced by the Contractor at his cost. If replacement was required works would have to locally cease until full reinstatement was completed and this could cause delays to the programme.
- 6 As placement works progress attention should be provided to side slopes to ensure safe working slopes which should be locally compacted by tracking plant or with the bucket of an excavator. Again, consideration should be given to the working practices employed to ensure safety of plant and operators.
- 7 Placement works should progress until the surcharge has achieved the required elevation above the proposed final development platform levels. At this stage the final surface should be compacted and sealed to minimise the potential for rainwater entry. The final mound as constructed should then be surveyed (as-built), and details provided to RSK in CAD format.
- 8 The surcharge mound will then remain in place until such time as the engineer (RSK) deems sufficient settlement to have been induced. At this stage it is considered likely that this will take approximately 3 months however dependant on the results of the settlement monitoring for each surcharge successful treatment may be achieved sooner or later.
- 9 Though not forming part of this contract, once treatment is deemed complete the surcharge mounds can be moved to the next area or progressively rolled across a treatment area, in order to achieve the required coverage. The above process would then be repeated until all Units have been treated.

3.5 Programme

The Contractor shall programme their works such that the surcharges over Phase 2 Units 1-4 and, Phase 3 Unit 1 are placed to allow sufficient treatment time ahead of construction.

3.6 Alternative Schemes of Treatment

The works set out in Sections 3.1 to 3.5 above have been designed to improve the ground conditions to a level suitable to support the proposed building development for Phase 2 Units 1 to 4 and Phase 3 Unit 1. This design is based on the results of a long-term loading test and detailed geotechnical settlement modelling of the proposed development platform.

It is possible that alternative schemes of treatment may be suitable for the prevailing ground conditions and in the case of the access road may be deemed more practical. If the Contractor considers other methods feasible, they can only be considered if their efficacy can be demonstrated by appropriate completion testing and they

are fully warranted by the Contractor. Alternatives may be considered if they are provided in addition to a compliant tender bid based upon the scope set out in this document and must be supported by an appropriate level of detail, together with an outline of time and cost savings and verification testing and warranty provision.

4 MATERIALS MANAGEMENT

All materials used for surcharge treatment and for cut and fill earthworks will be handled by the Contractor with due care in order to preserve their suitability for re-use on site. All movements of materials will have to follow the protocols set-out in a Materials Management Plan (MMP) which is currently under preparation and a template of which is included within the tender documents.

The MMP document will be written to allow re-use of suitable materials generated on site from the surface strip and cut operations to be used as engineered fill and as surcharge materials. It will require segregation of different material types, geotechnical and contamination testing by the contractor to demonstrate suitability of use (see Section 6) and will allow limited treatment of as dug materials to make them suitable for re-use. This may include crushing of oversized material and the option of conditioning of materials with lime or cement to reduce moisture content and/or improve handling characteristics.

In order to be reused the material will need to be chemically and geotechnically suitable for use on site. All environmental incidents must be reported to RSK (e.g. spills of hydraulic oil) and any resultant remedial requirements are the responsibility of the Contractor.

In order to remain geotechnically suitable the materials will need to be managed by the contractor to minimise water entry. Movement of materials in wet weather is not advised and all stockpiles and surcharge mounds should be sealed to prevent water ingress.

5 PERFORMANCE REQUIREMENTS

This section sets out the performance requirements for the finished surface on completion of the earthworks and after ground treatment only where this is indicated to be required.

(a) Performance requirements beneath building footprints

The performance requirements are to be achieved at a level 450mm below the finished earthworks level.

- Allowable Ground Bearing Pressure: 100kN/m² beneath building foundations.
- Anticipated weight of loaded building for settlement calculation purposes: Imposed Load up to 35kN/m². The imposed load will vary over time and across the footprint of the building depending on the amount of goods being stored within the building.
- CBR: A minimum CBR at top of formation level of 3% or 5% where granular fill is utilised (based on 600mm diameter plate tests).
- Maximum Residual Ground Movement: 25mm (to be reviewed following receipt of calculated ground movement from RSK).
- Maximum Differential Movement: 1 in 500.

(b) Performance requirements for external areas, car parks and roads

The performance requirements are to be achieved at the top of the formation level.

- CBR: A CBR at top of formation level of 3% or 5% where granular fill is utilised (based on 600mm diameter plate tests).
- Allowable Ground Bearing Pressure: 50kN/m².
- Anticipated weight for settlement calculation purposes: Transient load of 5kN/m². The imposed load will vary over time and across the hard-standing areas depending on the amount of goods being stored / vehicles in attendance.
- Maximum Residual Movement: 50mm (to be reviewed following receipt of calculated ground movement from RSK).
- Maximum Differential Movement: 1 in 200.

Note that in areas where engineered fill is to be placed in order to achieve the specified CBR, a near optimum moisture content will need to be achieved during compaction. In certain areas and dependant on how the materials have been handled there may be a requirement for a drying method (e.g. air drying or lime stabilisation) of the fill material to achieve near optimum moisture content.

In areas of cut inspection and proof rolling would be required in order to meet the performance requirements. At this stage any loose, soft or deleterious materials would need to be removed and replaced with suitable fill.

Any such actions to treat out of specification materials (i.e. drying or lime stabilisation, or material replacement) should be agreed by RSK/RPP prior to the works being carried out.

6 MONITORING INFRASTRUCTURE AND TESTING REQUIREMENTS

6.1 Installations prior to Contractor Mobilisation (First Stage)

Extensometer Boreholes

In advance of the Contractor mobilising to site RSK will install 3 no. earthwork monitoring boreholes across the site. The indicative locations for these boreholes are included on Figures 2a and 2b. These boreholes must be protected during the earthworks programme. Access must be maintained for RSK to conduct monitoring works and collaboration with RSK is required as engineered fill and/or surcharge is placed to extend the monitoring pipework as ground levels are raised.

The contractor should provide adequate protection to these boreholes such that their works will not damage the pipework. It is understood that disturbance of the ground surface adjacent to the boreholes will be unavoidable during the earthworks scheme however this will not impact the majority of the data points so long as the pipework is protected. RSK's suggestion for a practical method of protection is to install an additional 2m height of pipework above ground level such that the installations are visible to large plant. This extension should be marked with cones, hazard tape or flagged to further aid visibility. All operators should receive a briefing on the importance of protecting, and the locations of the extensometer boreholes before commencing work. If the Contractor wishes to adopt alternative or additional protective measures these should be agreed with RSK/Harworth Estates in advance,

As the earthworks progress and levels rise extensions to the pipework for these monitoring positions will be applied by RSK. The supervising engineer should be informed by the Contractor when ground levels are within 1m of the top of the pipes.

Once the earthworks and monitoring is complete the pipework will be grouted by RSK.

6.2 Installations during the Contract (Stage 2)

Monitoring Infrastructure

In order to allow confirmatory and performance monitoring of the ground settlement resultant from the surcharge treatment additional infrastructure will have to be installed and monitored. The Contractor will be required to install this infrastructure under RSK supervision and RSK will undertake the monitoring. The Contractor will allow safe access to RSK and any third-party staff to undertake monitoring and supervise installation, which may require the Contractor to cease working in particular areas during monitoring visits.

Settlement Monitoring Loops

The Contractor is required to provide plant and materials to install monitoring tubing in a number of shallow excavations and to subsequently protect monitoring infrastructure which is outlined below:

- Excavation of a series of trenches totalling approximately 1400m in length, 500mm deep and 300/450mm wide. Indicative locations are provided on Figures 2a and 2b. The trenches will be required at different times as the works progress dependant on the Contractor's programme. Access will be required to the end positions of each loop and these areas should be made (by the Contractor) free draining and safely accessible.
- The contractor will need to provide pipework (MDPE water pipe, 50mm ID, such as Wavin MDPE Pipe Blue 50mm x 100m or similar, any joints internally flush coupled) and a suitable pipe bedding material (e.g. building sand) to sufficiently bed and protect the pipe as the trench is backfilled also ensuring that excess surface water ingress is prevented. Each backfilled excavation will form a settlement monitoring loop.

RSK should be consulted before any of the above materials are purchased in order to confirm their suitability for the intended purpose.

Figure 2a and 2b differentiates the loops by colour based on the time of installation. Some can be installed in advance of filling operations and others can only be installed after some areas have been cut – NB these are indicative and final positions will be dependent on the Contractors programme. The Contractor will need to ensure plant and materials are available at the required time and must give RSK reasonable notice prior to dates of installation.

Permanent ground Markers (PGMs)

When building areas are brought to platform level, but in advance of surcharge treatment, the Contractor will install surface mounted ground anchor PGM's. These should be installed at a slightly reduced level in shallow hand dug pits and their precise elevation and co-ordinates recorded prior to covering with coloured sand (or similar to facilitate subsequent inspection and monitoring on removal of surcharge). The indicative number and positions of PGMs are presented in Figures 2a and 2b.

The PGMs need to be robust as they will have to withstand the construction process required to place and subsequently remove the surcharge before completion monitoring can be carried out. The design of the PGMs will have to be agree with RSK. Previously we have used bespoke monitoring pins using 10 to 15mm diameter steel bar, protruding from and set-in concrete monoliths 200mm square and 300mm deep.

The Contractor will agree with RSK practical positions for the PGMs and the measures necessary to protect them during the early stages of surcharge placement (this may include for example the temporary placement of concrete sewer rings or similar, until surrounding levels are raised).

PGM's will also be required at either end of each settlement monitoring loop and must be similarly protected.

In addition, RSK will install PGM's at the ground surface in areas of cut once final levels are achieved. Once these PGM's are installed plant movements should cease in the vicinity of the PGM's. RSK will work with the Contractor in positioning these PGM's such that access is maintained to all remaining work areas though some restriction to haul routes should be expected. The Contractor would be responsible for making sure the PGM's are not damaged or disturbed as a result of their operations.

Groundwater inundation tests

At selected locations groundwater inundation tests will be required. These will be constructed by the Contractor but all equipment will be installed and monitored by RSK. Tests will be required at three locations, one in Phase 3 and two in Phase 2, some indicative locations are shown on Figures 2a and 2b.

At each test location the contractor will excavate a test pit of minimum dimensions 1m depth, 1m width and 6m length. This will then be backfilled with coarse gravel around three evenly spaced, vertically orientated, slotted standpipes (of 150mm diameter) NB all materials to be provided by the Contractor. RSK will then install monitoring pins, the position and spacing of which will be dependent on the test location. Once these are installed and levelled the Contractor will then carry out the water inundation stage (being mindful not to disturb any of the monitoring equipment). This will require a steady supply of potable water to be available to be brought to the test area (either by hose or tanker) and discharged into the test pit via the vertical standpipes. The volume of water required will be dependent on infiltration rate, but it is expected that continuous soakage will be required for a minimum of 2 working days. On completion of the soakage stage the Contractor will place temporary fencing around the test area and make sure that his subsequent site operations are conducted away from the test area. RSK will continue monitoring which will reduce in frequency but be required for up to 3 months.

It is possible that the three inundation tests will be carried out separately at different times or possibly concurrently. This would be dependent on the Contractors programme.

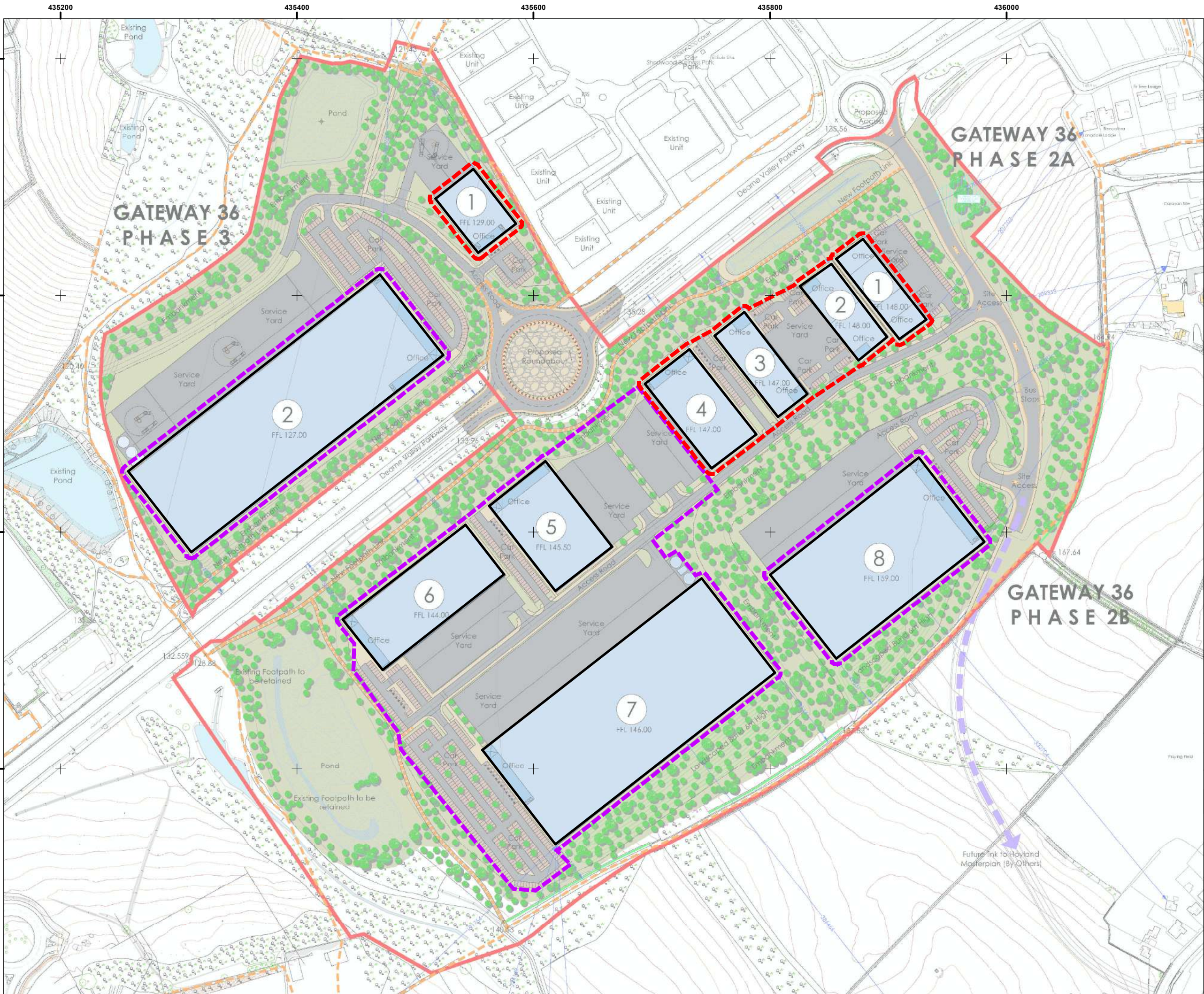
6.3 Testing Requirements

The Contractor will be required to carry out testing of materials to be used in the earthworks as outlined in the JPG Earthworks specification documents. Although not expected to be required, any materials to be brought onto the site to achieve final levels will have to be tested in advance to demonstrate their geotechnical suitability; their engineering material classification; and that they are chemically inert (and suitable for use). If any materials are to be taken off site the Contractor will be responsible for appropriate testing to ensure the materials can be accepted by the receiving off-site facility.

If any modification of on-site materials are required then additional testing would be necessary – the scope of such testing would be agreed with RSK in advance. This would include gradings for any materials subject to crushing and contamination testing (largely pH value but also total sulphate and dissolved metals) for lime or cement stabilised soils and monitoring of pH in any water courses or ponds.

The Materials Management Plan outlines a required testing frequency for those soils retained or placed in the landscaped areas of the development.

FIGURES



Legend:

- Proposed Building Footprints
- Top of surcharge treatment mound to be constructed prior to construction (outside the Contractors current scope of works). Area to achieve the heights specified in RSK report reference 322638 R03 (03) relative to post earthworks ground levels
- Top of surcharge treatment mound to be constructed by the Contractors within the current scope of works. Area to achieve the heights specified in RSK report reference 322638 R03 (03) relative to post earthworks ground levels

Notes:
Surcharge mounds are to be constructed in accordance with the requirements set out in RSK report reference 322638 R03 (03). This report details the required heights of surcharge for each of the treatment areas.

Top of surcharge extent to cover the whole building footprint.
Where required consider the use of concrete blocks, excavated boulders or other measures to create a stable and safe slope within the perimeter of the site.

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

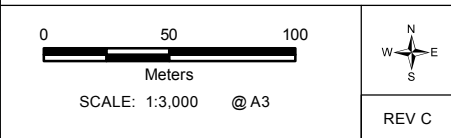


Rev	Date	Description	Drm	Chk	App
C	02/09/2020	Surcharge Updated	AJ	AC	AC
B	19/08/2020	Second Draft	DR	AC	AC

Rockingham Infrastructure



TITLE: 322638 R03 (03) - Figure 1:
Indicative Ground Treatment Areas
Including Required Surcharge
Construction





- Legend:**
- Possible Indundation Test Site
 - Permanent Ground Markers Installed at Final Level Beneath Surcharge
 - Extensometer Borehole Installations
 - Monitoring loop – constructed after completion of cut/fill but in advance of surcharging
 - Monitoring loop – constructed before overlying cut/fill
 - Building Footprints



Rev	Date	Description	Drm	Chk	App
01	02/09/2020	Base Updated	AJ	AC	AC
00	13/05/2020	First Draft	DR	AC	AC

Rockingham Infrastructure

TITLE:

322638 R03 (03) - Figure 2a:
Indicative Monitoring Infrastructure
Locations

0322638 R03 (03) - Figure 2a:
Indicative Monitoring Infrastructure
Locations

0

30

60

Meters

SCALE: 1:2,000 @ A3

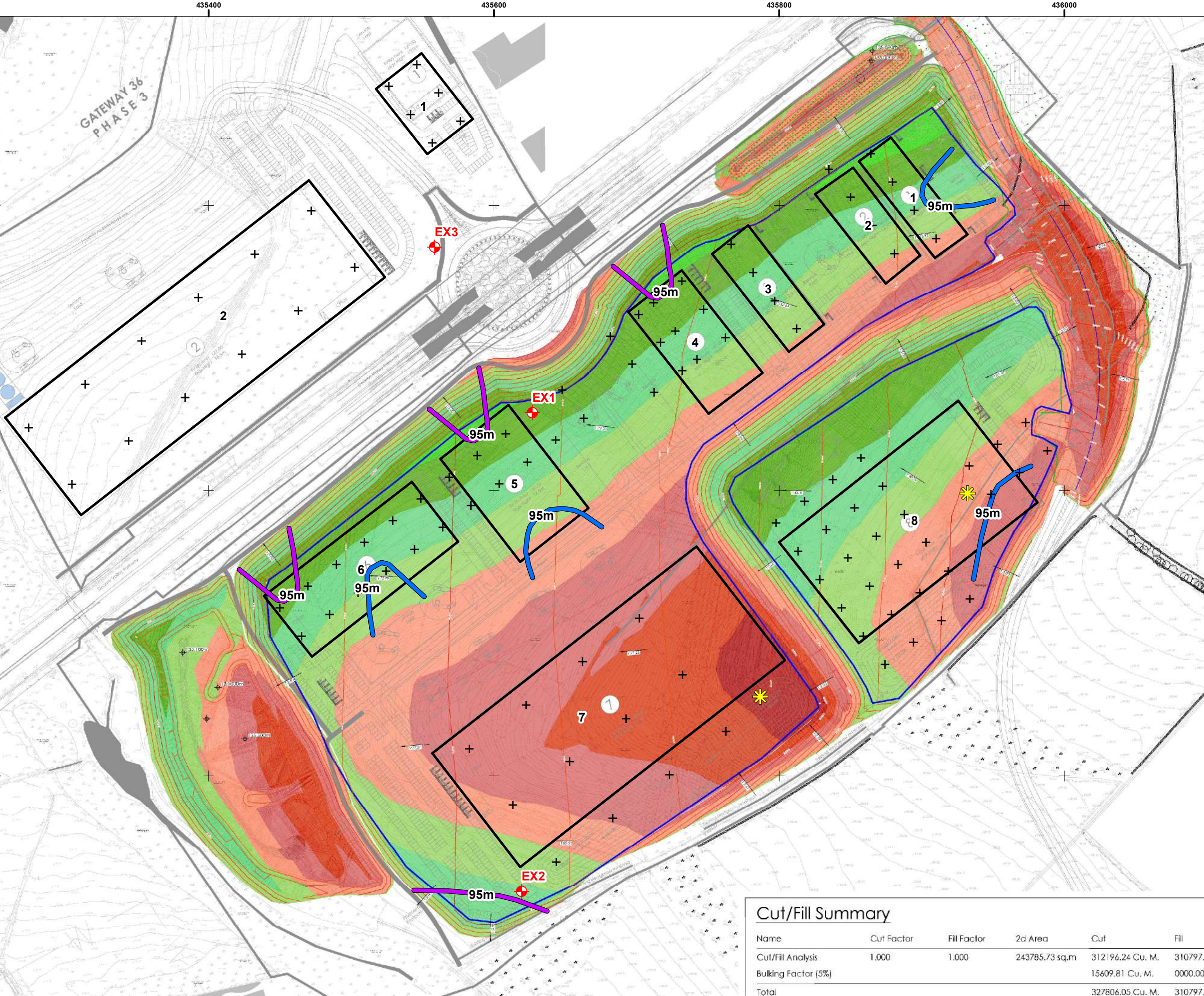
N

W

E

S

REV 01



- Legend:**
- Possible Indundation Test Site
 - Permanent Ground Markers Installed at Final Level Beneath Surcharge
 - Extensometer Borehole Installations
 - Monitoring loop – constructed after completion of cut/fill but in advance of surcharging
 - Monitoring loop – constructed before overlying cut/fill
 - Building Footprints

Coordinate System: British National Grid
Projection: Transverse Mercator
Datum: OSGB 1936
Units: Meter

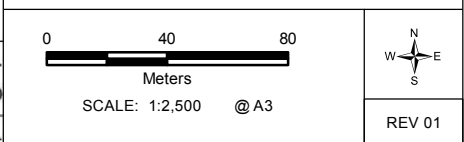


Rev	Date	Description	Drm	Chk	App
01	03/09/2020	Base Updated	AJ	AC	AC
00	13/05/2020	First Draft	DR	AC	AC

Rockingham Infrastructure



TITLE: 322638 R03 (03) - Figure 2b:
Indicative Monitoring Infrastructure
Locations



Cut/Fill Summary					
Name	Cut Factor	Fill Factor	2d Area	Cut	Fill
Cut/Fill Analysis	1.000	1.000	243785.73 sq.m	312196.24 Cu. M.	310797.15 Cu. M.
Bulking Factor (5%)				15609.81 Cu. M.	0000.00 Cu. M.
Total				327806.05 Cu. M.	310797.15 Cu. M.