APPENDIX I

STABILITY RISK ASSESSMENT (SRA) (REPORT REFERENCE BRE/WL/SE/1729/01/SRA)

AN APPLICATION FOR AN ENVIRONMENTAL PERMIT TO AUTHORISE THE DEPOSITION OF WASTE ON LAND AS A RECOVERY ACTIVITY FOR THE RESTORATION OF WILLINGTON LOCK QUARRY, ST NEOTS ROAD, BEDFORD TO AGRICULTURE AND NATURE CONSERVATION

APPENDIX I

STABILITY RISK ASSESSMENT (SRA)

Report reference: BRE/WL/SE/1729/01/SRA
October 2021

Technical advisers on environmental issues

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INTRODUCTION

1.1. Report Context

i) MJCA is commissioned by Breedon Trading Limited (Breedon) to prepare a Stability Risk Assessment (SRA) as part of an application for a bespoke Environmental Permit (EP) for the deposition of inert waste on land as a recovery activity in order to restore Willington Lock Quarry, St Neots Road, near Bedford (the site) to agriculture and nature conservation. The site will be restored with imported inert waste materials and on site soils and overburden.

ii) The structure of this SRA is based on a template produced by the Environment Agency entitled "Stability Risk Assessment Report Version 1" dated March 2010 (Reference 1). The SRA presents relevant aspects of the site setting and the proposed recovery design. A risk screening stage identifies which potential stability risks need further assessment. The further assessment methodology is explained and the geotechnical parameters and target factors of safety used are described. From the stability assessment it is concluded that the side slope attenuation layer achieves an acceptable factor of safety.

Site Description

iii) The SRA is based on the conceptual model presented in the Environmental Setting and Site Design (ESSD) report which is provided at Appendix F to the application report. Details presented in the ESSD include:

- the site location,
- the environmental setting of the site,
- the site geology, hydrology and hydrogeology,
- the history of the site,
- the recovery site design,
- the potential contamination migration pathways and receptors, and
- the waste acceptance procedures to verify that waste material permitted under the site recovery permit only will be accepted at the site.

Site location

iv) The site is centred approximately on National Grid Reference (NGR) TL 125 505 approximately 760m east north east of Willington and 830m south west of Great Barford. The eastern extent of Bedford is located approximately 3km west of the site. The closest property to the site is Old Mills Cottage which is located approximately 220m east north east of the site. The River Great Ouse flows from south west to north east along the north western boundary of the site. The site location is shown on Figure SRA 1. There is a high pressure gas main aligned east to west which passes beneath the site and bisects it into a northern and a southern part.

Topography

v) Topography survey data for the site and the immediate surrounds provided by Breedon is presented on Figure SRA 2. The site lies to the east of the previously extracted and restored areas of the Willington Quarry Complex. Prior to the extraction of mineral at the site ground levels were generally level ranging in elevation from approximately 18.5m Above Ordnance Datum (AOD) to 22.5mAOD and fall gently towards the river to the north at a maximum approximate slope gradient of 1v:100h. The site is bisected by a raised cycle path on a former railway embankment approximately 1.3m high running in an east to west direction across the centre of the site under which lies the high pressure gas main.

Geology

vi) A detailed description of the geology at the site is presented in the ESSD report. In summary, the geology of the site comprises clayey soils overlying superficial sand and gravel deposits overlying Oxford Clay.

vii) Based on the British Geological Survey geological mapping the superficial deposits across the site comprise river terrace deposits and alluvium of the Ouse Valley Formation. Boreholes drilled in the vicinity of the site encountered superficial deposits comprising generally a silty or gravelly sand to a depth of approximately 4m.

viii) The superficial deposits are underlain by clay of the Peterborough Member of the Oxford Clay Formation. Information published by the British Geological Survey record the Oxford Clay as being between 21m to 24m thick in the region. The BGS website records the thickness of the Oxford Clay Formation at approximately 25.5m in a borehole located approximately 2.6km from the site.

Hydrogeology

ix) A detailed description of the hydrogeology at and in the vicinity of the site is provided in the ESSD report.

x) The alluvium and river terrace deposits at the site are water bearing and are designated as a Secondary A aquifer containing permeable layers capable of supporting water supplies at a local rather than strategic level. The Oxford Clay Formation is designated as unproductive strata with low permeability that has negligible significance for water supply or river base flow. Based on information provided by the Environment Agency the site is not located within a groundwater Source Protection Zone (SPZ).

General Site Design

xi) The site comprises 4 phases which will be worked progressively to recover the sand and gravel resources. Phases 1 and 2 are located in the southern area of the site and Phases 3 and 4 are located in the northern area of the site. The design of the quarry slopes and the proposed construction of the attenuation layer and subsequent infilling operations at the site are consistent generally with the operations undertaken at the neighbouring Dairy Farm and Willington Plant sites. The proposed extracted profile is shown on Figure SRA 3.

xii) Figure SRA 3 shows the gas pipeline removed. However, it is understood that Breedon consider that it is highly unlikely that the gas pipeline will be removed or relocated, although ultimately this is a decision which will be taken by Cadent who operate the pipeline. For the purpose of the SRA it is assumed that the gas pipeline will be removed and if it is not removed a revised extraction profile will be provided once the required stand offs and excavation profiles along the pipeline route can be confirmed.

Quarry Base Design

xiii) The elevation of the majority of the base ranges between approximately 15.0mAOD and 16.6mAOD and is generally flat with slight undulations at a maximum gradient of approximately 1v:300h. The southern corner of the site is locally steeper and falls from a maximum of 20.4m AOD in the south at an approximate gradient of 1v:15h. The base of the extraction will comprise the Oxford Clay Formation. Based on information from the British Geological Survey the Oxford Clay Formation is estimated to have a thickness in excess of 20m.

xiv) Groundwater in the vicinity of the site is recorded in the sand and gravel deposits overlying the Oxford Clay and will be dewatered as necessary to facilitate the excavation and recovery operations. Dewatering will continue from the mineral extraction operations such that wastes will not be deposited directly into water. Groundwater has not been encountered in the Oxford Clay strata underlying the site.

Quarry Side Slope Design

xv) As shown on the extracted profile drawing (Figure SRA 3) the final excavated slopes will be between 1.5m and 6m high with slope gradients of 1v:2h. The side slopes will comprise in situ silty to gravelly sand. The excavations and slopes will be the subject of a separate ongoing geotechnical assessment as required by the Quarries Regulations 1999.

Attenuation layer

xvi) The side slopes of the excavation will comprise superficial sand and gravel deposits and on this basis are likely to have a hydraulic conductivity greater than 1.0×10^{-7}m/s. As explained in the Hydrogeological Risk Assessment (HRA) presented at Appendix G of the ESSD, notwithstanding that it is concluded that there will be no unacceptable impacts on groundwater or surface water quality it is proposed on a precautionary basis to construct an attenuation layer round the perimeter of the site adjacent to the sidewalls of the excavation.

xvii) As the base of the quarry comprises Oxford Clay consisting of low permeability clay deposits, it is considered that an attenuation layer equivalent to 1m of in situ material with a hydraulic conductivity no greater than 1×10^{-7} m/s is present and it is not necessary to construct a basal attenuation layer.

xviii) The side slope attenuation layer will be constructed to a height of up to 6m and to a minimum thickness of 1m perpendicular to the face of the slope. Slopes will be constructed to achieve a maximum gradient no steeper than 1v:2h. A schematic diagram showing the construction design for the side slope attenuation layer is presented on Figure SRA 4.

xix) The procedures for the selection, placement, and compaction of the materials used to form the side slope attenuation layer will be agreed with the Environment Agency through the preparation and approval of a Construction Quality Assurance (CQA) Plan in accordance with Environment Agency guidance to achieve a hydraulic conductivity of no greater than 1 x 10^{-7} m/s and a shear strength of no less than 40kPa.

xx) Filling against the side slope attenuation layer will commence shortly after the construction of each lift of the side slope attenuation layer. Dewatering will continue during the construction of the side slope attenuation layer and during waste placement as necessary.

Restored Slope Design

xxi) It is estimated that approximately 447,000m^3 of inert restoration materials will be placed in the excavated void. The site will be restored to agricultural and nature conservation. The proposed restoration profile is shown on the drawing at Appendix SRA A.

1.2. Conceptual Stability Site Model (CSSM)

i) The principles of the site design as presented above have been used to define the individual slopes and materials which comprise each of the elements considered in the stability risk assessment.

1.2.1 Basal Sub-Grade Model

i) The base of the excavation will be generally flat with typical maximum gradients of 1v:300h and local maximum gradient of 1v:15h in the southern corner of the basal area. The base is at an elevation of approximately 15.0mAOD to 20.4mAOD and comprise in situ low permeability Oxford Clay which has a thickness in excess of 20m. Groundwater is not present within the Oxford Clay.

1.2.2 Side Slope Sub-Grade Model

i) The side slopes will comprise the in situ overburden and sand and gravel deposits. The side slopes will be excavated at gradients of up to approximately 1v:2h and to a maximum depth of approximately 6m. Groundwater is present within the sand and gravel deposits and the deposits will be dewatered to facilitate mineral extraction and infilling. Site excavations and slopes will be subject to ongoing geotechnical assessment as required by the Quarries Regulations 1999.

1.2.3 Basal Attenuation Layer Model

i) As the in situ Oxford Clay Formation forms the base of the site it is considered that no artificially constructed basal attenuation layer is necessary.

1.2.4 Side Slope Attenuation Layer Model

i) A side slope attenuation layer will be constructed prior to the deposition of inert restoration materials. Dewatering will continue during the construction of the attenuation layer to maintain groundwater levels below the base of the construction works. The side slope attenuation layer will be constructed in lifts of up to 6m in height with internal slope gradients no steeper than 1v:2h and to a minimum thickness of 1m perpendicular to the side slopes of the excavation.

ii) The attenuation layer will be constructed using carefully selected imported inert restoration materials or suitable site derived materials. The materials will be selected, placed and compacted to achieve a minimum undrained shear strength of 40kPa and a hydraulic conductivity of no greater than $1x10^{-7}m/s$.

1.2.5 Waste Mass Model

i) The inert materials will be placed generally in horizontal layers so that no significant internal waste slopes are formed during the recovery operations. The southern section of the site (Phase 1 and 2) will be worked first in an east to west direction followed by the northern section of the site (Phases 3 and 4) in an east to west direction. The upper surface of the waste mass will consist of placed suitable imported inert restoration materials with on site soils and overburden used to form the restored landform.

ii) Dewatering of the site will continue throughout the infilling operations to maintain groundwater levels below the base of the inert materials until the level of material placement is above natural groundwater level.

1.2.6 Capping System and Restoration Model

i) No capping system is proposed. The final restoration will consist of placed suitable imported inert restoration materials and on site soils and overburden to form the restored landform. The restored profile will be largely flat with localised areas of maximum gradients of approximately 1v:15h.

2 STABILITY RISK ASSESSMENT

2.1 Risk Screening

i) A risk screening of the CSSM is presented in this section of the SRA. The risk screening considers each element of the CSSM and assesses whether the component of each element needs further detailed assessment.

2.1.1 Basal Sub-Grade Screening

i) The basal sub-grade is formed in the natural in situ Oxford Clay. The basal profile will be generally flat with gradients of no greater than 1v:15h (less than 4 degrees) falling gently from east to west. Groundwater is not present within the Oxford Clay. The excavations at the site are the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999. As a result it is unnecessary to undertake separate quantitative assessments of the basal sub-grade.

2.1.2 Side Slope Sub-Grade Screening

i) The side slopes excavations will be the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999. As a result it is unnecessary to undertake separate quantitative assessments of the side slope sub-grade.

2.1.3 Basal Attenuation Layer Screening

i) No basal artificially constructed attenuation layer is proposed.

2.1.4 Side Slope Attenuation Layer Screening

i) As each lift of the side slope attenuation layer will be constructed to a slope gradient of up to 1v:2h and up to a height of 6m it is appropriate to undertake a quantitative analysis of the short term stability of the side slope attenuation layer to verify that a suitable factor of safety against slope failure is achieved.

ii) As in the long term the side slope attenuation layer will be supported by waste placed against it, it is unnecessary to assess further the long term stability of the side slope attenuation layer.

2.1.5 Waste Mass Screening

i) As the internal temporary waste slopes formed during the waste placement will be generally horizontal with no significant slopes constructed and as dewatering will continue during the restoration works to maintain groundwater levels at a depth sufficient to pose no significant risk it is unnecessary to undertake quantitative assessments of the waste mass.

2.1.6 Capping System and Restoration Screening

i) No capping system is proposed.

ii) As the restored landform will have slope gradients no greater than approximately 1v:15h (less than 4 degrees) it is considered unnecessary to undertake quantitative slope stability assessments of the site restoration.

2.2 Life Cycle Phases

i) The site will be excavated and infilled progressively. The critical phase in relation to stability will be during the construction of the side slope attenuation layer and the placement of supporting inert waste against the side slope attenuation layer, during which the areas of excavation and infilling will need to be dewatered until the waste level has reached a level above the natural groundwater level.

2.3 Data Summary

i) The data used in the stability analysis and the data sources are presented in Table SRA 1.

2.4 Justification for Modelling Approach and Software

i) Based on the results of the risk screening a quantitative SRA has been undertaken to assess the short term stability of the side slope attenuation layer. All other elements have been assessed qualitatively in the risk screening as not needing further assessment.

ii) The stability risk assessment analyses have been undertaken in general accordance with conventional British Standard methodologies using global factors of safety rather than incorporating partial factors into the individual parameters describing the slopes, strengths and forces.

iii) Analysis of stability against rotational failure of the side slope attenuation layer is undertaken using the two dimensional limit equilibrium programme SLOPE/W. Slopes are analysed using the Spencer method. The Spencer method has been selected as it is one of the more mathematically robust limit equilibrium methods and considers the shear and the normal inter-slice forces together with moment and force equilibrium (Reference 2). It is considered that this method is more appropriate than simpler methods such as Bishop's Simplified Method or Janbu's Simplified Method.

2.5 Justification for Geotechnical Parameters Selected for Analysis

2.5.1 Parameters Selected for Basal Sub-Grade Analysis

i) No quantitative assessment of the basal sub-grade is necessary.

2.5.2 Parameters Selected for Side Slope Sub-Grade Analysis

i) No quantitative assessment of the side slope sub-grade is necessary.

2.5.3 Parameters Selected for Basal Attenuation Layer Analysis

i) No basal attenuation layer is proposed as detailed in Section 1.2.3.

2.5.4 Parameters Selected for Side Slope Attenuation Layer Analysis

ii) The model represents the construction of the side slope attenuation layer against the excavated slope gradient shown on the worked out model such that:

a. The base of the site is a horizontal surface formed of Oxford Clay.

b. The side slope of the site has a slope gradient of 1v:2h, a height of 6m and is formed of superficial sand and gravel deposits.

c. The side slope attenuation layer has a slope gradient of 1v:2h and a height of 6m and is modelled with horizontal thicknesses of both 2.25m (to represent the minimum horizontal thickness necessary to maintain a minimum 1m perpendicular thickness) and a horizontal thickness of 4m to represent a possible increase in the horizontal thickness of the side slope attenuation layer to accommodate construction plant if the side slope attenuation layer were to be constructed in horizontal layers.

d. Elevated groundwater levels and pressures are not included as dewatering will continue during the construction of the side slope attenuation layer and during infilling until the level of the waste is above the natural groundwater level.

ii) The values for the geotechnical parameters used are based on specified values, site specific information and parameters published in Hoek and Bray (Reference 3).

a. As the side slope attenuation layer will be constructed from selected imported inert waste material or site derived material that will be placed and compacted to achieve a minimum undrained shear strength of 40kPa, a shear strength of 40kPa is used to represent the side slope attenuation layer material in the model. A unit weight of 17 kN/m^3 is used in the modelling based on the lowest values provided for stiff glacial clay by Hoek and Bray.

b. The superficial sand and gravel deposits of the side slope subgrade are modelled as having an angle of friction of 26.5°, an apparent cohesion of 0kPa and a unit weight of 19kN/m^3. These values for the strength parameters are equivalent to the minimum needed for a drained granular material which has an angle of repose of 1v:2h. As stated in the description of the conceptual model the side slopes at the site which will form the subgrade are excavated in sand and gravel deposits at gradients of approximately 1v:2h. The unit weight of the sand and gravel is based on values provided for sand and gravel of mixed grain size by Hoek and Bray (Reference 3).

c. The Oxford Clay bedrock underlying the superficial deposits is modelled as impenetrable bedrock.

2.5.5 Parameters Selected for Waste Mass Analysis

i) No quantitative assessments of the waste mass is necessary.

2.5.6 Parameters Selected for Capping System and Restoration Analysis

i) No capping system is proposed as detailed in Section 1.2.6.

ii) No quantitative assessments of the site restoration is necessary.

2.6 Selection of Appropriate Factors of Safety

2.6.1 Factor of Safety for Basal Sub-Grade

i) Analysis of the stability of the basal sub grade is not necessary as detailed in Section 2.1.1.

2.6.2 Factor of Safety for Side Slope Sub-Grade

i) Analysis of the stability of the side slope sub grade is not necessary as detailed in Section 2.1.2.

2.6.3 Factor of Safety for Basal attenuation layer

i) Analysis of the stability of a basal attenuation layer is not necessary as detailed in Section 2.1.3.

2.6.4 Factor of Safety for Side Slope Attenuation Layer

i) A factor of safety of 1.3 has been selected for the assessment of the side slope attenuation layer as during a failure event of the side slope attenuation layer the failure will be contained within the site boundary, can be monitored and remediated, and would not extend outwards towards nearby buildings and infrastructure. This is consistent with Environment Agency guidance (Reference 4) and British Standards BS6031:2009 (Reference 5).

2.6.5 Factor of Safety for Waste Mass

i) Analysis of the waste mass is not necessary as detailed in Section 2.1.5.

2.6.6 Factor of Safety for Capping System and Restoration

i) Analysis of the capping system and restoration is not necessary is detailed in Section 2.1.6.

2.7 Analysis

i) This sub-section provides the results of the quantitative analysis where identified as needed as part of the risk screening.

2.7.1 Basal Sub-Grade Analysis

i) No analysis has been conducted on the basal sub-grade.

2.7.2 Side Slope Sub-Grade Analysis

i) No analysis has been conducted on the side slope sub-grade.

2.7.3 Basal Attenuation Layer Analysis

i) No analysis has been conducted on the basal liner.

2.7.4 Side Slope Attenuation Layer Analysis

i) The stability analysis of the 6m high side slope attenuation layer with a horizontal thickness of 2.25m with a slope gradient of 1v:2h onto the underlying Oxford Clay Formation yields a factor of safety of 1.628 which is above the target factor of safety of 1.3 and is therefore considered stable. The SLOPE/W plot of the assessment is presented at Appendix SRA B.

ii) The stability analysis of the 6m high side slope attenuation layer with a horizontal thickness of 4m with a slope gradient of 1v:2h onto the underlying Oxford Clay Formation yields a factor of safety of 1.907 which is above the target factor of safety of 1.3 and is therefore considered stable. The SLOPE/W plot of the assessment is presented at Appendix SRA B.

iii) Given the conservative selection of parameters, low risk due to slope failure and high factors of safety determined in the analysis of the two construction scenarios no further sensitivity analysis has been undertaken.

2.7.5 Waste Mass Analysis

i) No analysis has been conducted on the waste mass.

2.7.6 Capping System and Restoration Analysis

i) No analysis has been conducted on the capping system and restoration.

2.8 Assessment

2.8.1 Basal Sub-Grade Assessment

i) Due to the shallow basal slopes, thickness of basal Oxford Clay and lack of groundwater within the Oxford Clay it is considered that the basal sub-grade is stable and that there is no potential for basal heave at the site.

2.8.2 Side Slope Sub-Grade Assessment

i) The side slopes excavations at the site will be the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999. As a result it is unnecessary to undertake separate assessments of the side slope sub-grade.

2.8.3 Basal Attenuation Layer Assessment

i) No basal attenuation layer is proposed.

2.8.4 Side Slope Attenuation Layer Assessment

i) The stability of the side slope attenuation layer has been analysed in the short term and the resulting lowest factor of the scenarios assessed is 1.628 which is above the target factor of safety of 1.3 and is therefore considered stable.

ii) In the long term the side slope attenuation layer will be supported by waste materials placed against it and therefore is considered stable.

2.8.5 Waste Mass Assessment

i) As the internal temporary and final waste slopes will be generally horizontal and dewatering will continue during recovery operations to maintain groundwater levels below the level of waste, the waste mass is considered stable.

2.8.6 Capping System and Restoration Assessment

i) No capping system is proposed.

ii) As the restored landform will have slope gradients no greater than approximately 1v:15h (less than 4 degrees) it is considered that the restoration will be stable.

3 MONITORING

3.1 The risk based monitoring scheme

i) The results of the SRA show that all elements of the proposed site design, where assessed, are stable and where analysed achieve appropriate factors of safety.

ii) A weekly visual inspection of the exposed subgrade, side slope attenuation layer and the waste mass for signs of settlement or instability is appropriate for monitoring at the site during the operation of the site. The results of the weekly inspections will be recorded in the site diary during the operation of the site. In the unlikely event that areas of concern are identified from the weekly inspection further assessment and remediation will be carried out as necessary.

iii) It will be necessary to monitor and control groundwater at the site during the extraction and filling works so that groundwater is dewatered in the sand and gravel deposits overlying the base of the quarry until waste placement has reached a level above the natural groundwater level. A programme of groundwater monitoring is presented as part of Table ESSD 3 of the ESSD.

3.1.1 Basal Sub-Grade Monitoring

i) The basal sub-grade will be the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999.

3.1.2 Side Slopes Sub-Grade Monitoring

i) The side slopes excavations at the site will be the subject of ongoing geotechnical assessment as required by the Quarries Regulations 1999.

3.1.3 Basal Attenuation Layer Monitoring

i) No basal attenuation layer is necessary.

3.1.4 Side Slope Attenuation Layer Monitoring

i) The construction of the attenuation layer will be the subject of Construction Quality Assurance (CQA) to verify that it is constructed with maximum slope gradients of 1v:2h and to a minimum perpendicular thickness of 1m and from materials which achieve a hydraulic conductivity of no greater than 1×10^{-7} m/s and a shear strength of no less than 40kPa. Prior to the construction of the side slope attenuation layer a CQA Plan shall be prepared and agreed in accordance with Environment Agency guidance**Error! Bookmark not defined.**.

ii) Placement of waste will commence shortly after construction of the attenuation layer to provide support to the side slope attenuation layer.

iii) Any areas of exposed side slope attenuation layer will be monitored for signs of instability by the weekly visual inspections as detailed above. Inspections of the side slope attenuation layer will not be needed or possible once the side slope attenuation layer has been covered and supported by waste.

3.1.5 Waste Mass Monitoring

i) During the operational period the waste mass will be monitored for signs of settlement or instability by the weekly visual inspections as detailed above.

3.1.6 Capping System and Restoration Monitoring

i) No capping system is necessary.

ii) The restoration will be monitored for signs of settlement or instability by weekly visual inspections as detailed above.

REFERENCES

1. https://www.gov.uk/guidance/waste-recovery-engineering-create-a-construction-quality-plan
2. Slope Stability Modelling with Slope/W 2007 Version. An Engineering Methodology. Fourth Edition, February 2010. GEO-SLOPE International Ltd.
3. Hoek and Bray “Rock Slope Engineering: Third Edition” 1981.
4. Environment Agency “Stability of Landfill Lining Systems: Report No. 2 Guidance” R&D Technical Report P1-385/TR2.
5. British Standard BS6031 – 2009, Code of practice for Earthworks.

TABLES

Table SRA 1

Geotechnical parameters used in the stability modelling

Material	Unit weight	Undrained parameters (short term)	Drained parameters (long term)
Side slope attenuation layer constructed from selected inert waste or site derived material	γ = 17 kN/m^3 (1)	C_u = 40 kPa (2)	Not required
In situ sand and gravel deposits	γ = 19 kN/m^3 (1)	Not required	Ø' = 26.5° (3) c' = 0 kPa (3)
Oxford Clay	Modelled as impenetrable bedrock		

Notes:

γ Unit weight

Ø' Friction angle

c' Apparent cohesion

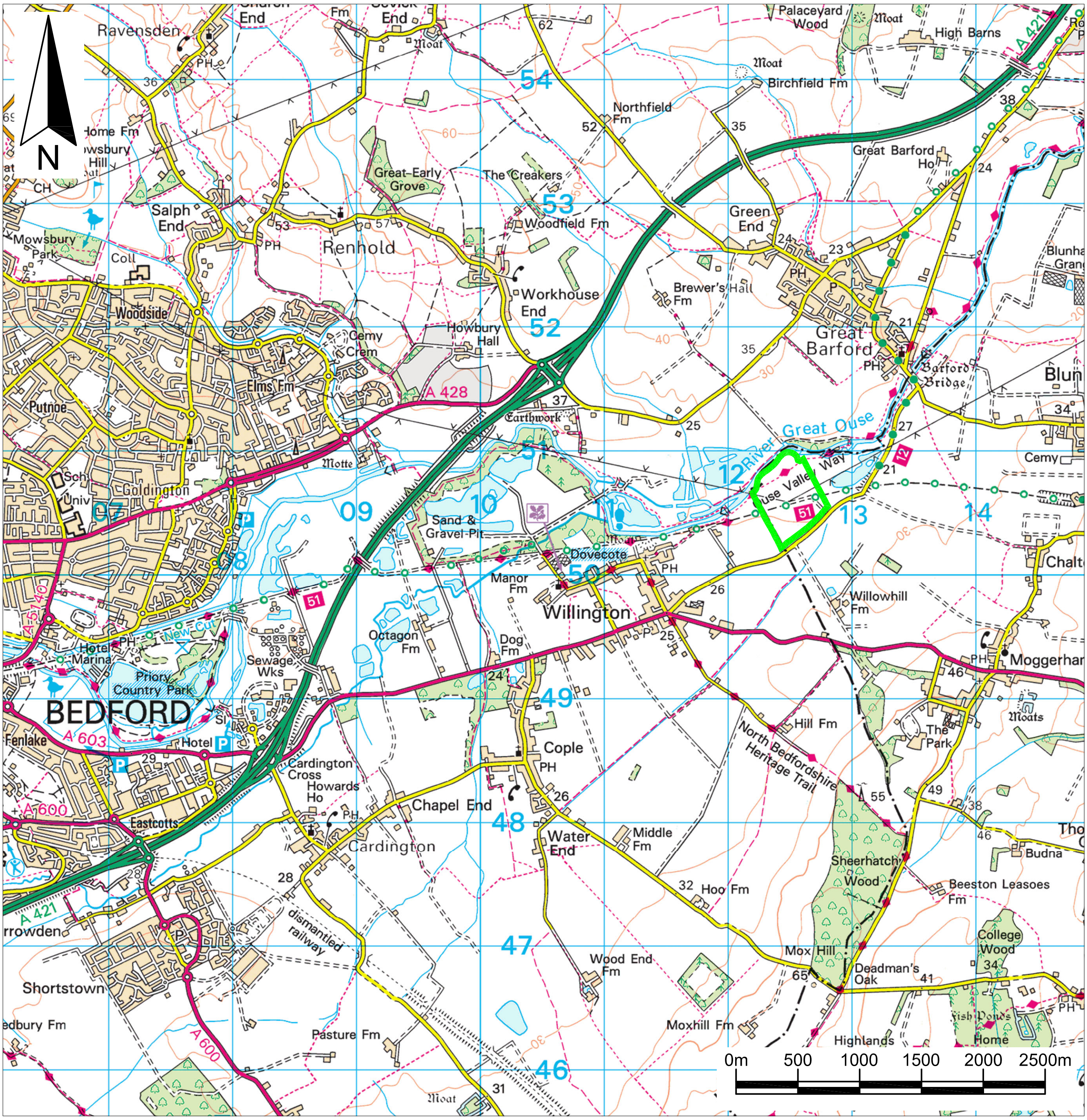
C_u Undrained shear strength

(1) Value based on conservative estimates taken from Hoek and Bray, "Rock Slope Engineering", 1981.

(2) Value based on minimum specified undrained shear strength.

(3) Value is conservatively based on minimum friction angle needed to achieve the 1v:2h excavated sand and gravel faces at the site.

FIGURES



Key / Notes

Approximate boundary of the site the subject of the Environmental Permit application

Rev	Status	Drn	App	Chk	Date
	Final	KR	JCR	GT	23/04/21

Site
WILLINGTON LOCK

Client
BREEDON

Title
The site location

Figure SRA 1

Scale
1:50,000@A4

Drawing Ref
BRE/WL/11-20/22066

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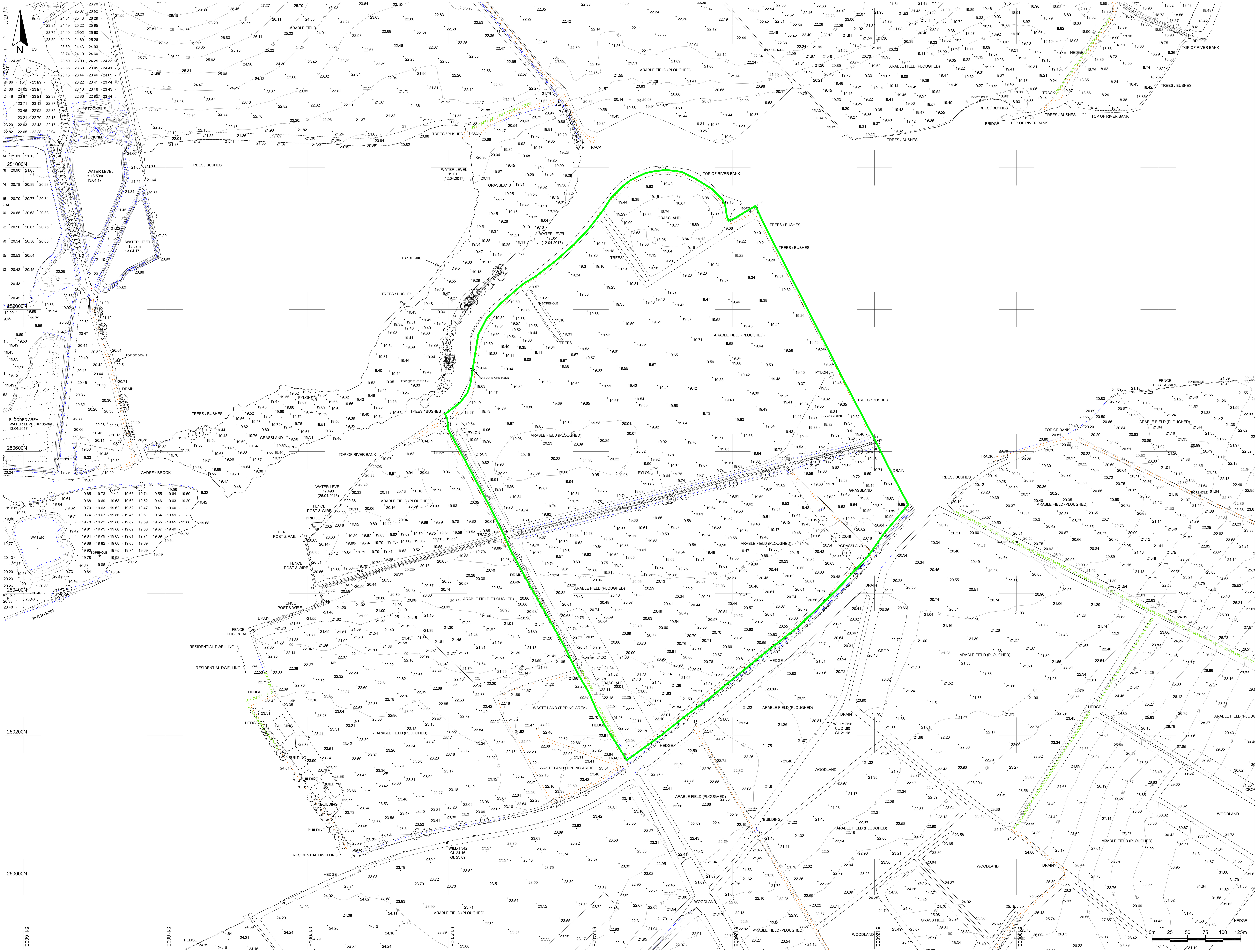

Key / Notes

- Approximate boundary of the site the subject of the Environmental Permit application
- Bottom of bank
- Building
- Contours (mAOD)
- Fence
- Hedge
- Kerb
- 18.75 Levels (mAOD)
- Top of bank
- Track
- Water

Note:
Based of model reference "W009 2020-01-28 WILLINGTON LOCK.LSS" provided by Breedon on 5 February 2020

Rev	Status	Drn	App	Chk	Date
	Final	KR	JCR	GT	23/04/21

Site: WILLINGTON LOCK

Client: BREEDON

Title: Topographical survey of the site

Figure SRA 2

Scale: 1:2,500@A1

Drawing Ref: BRE/WL/11-20/22067

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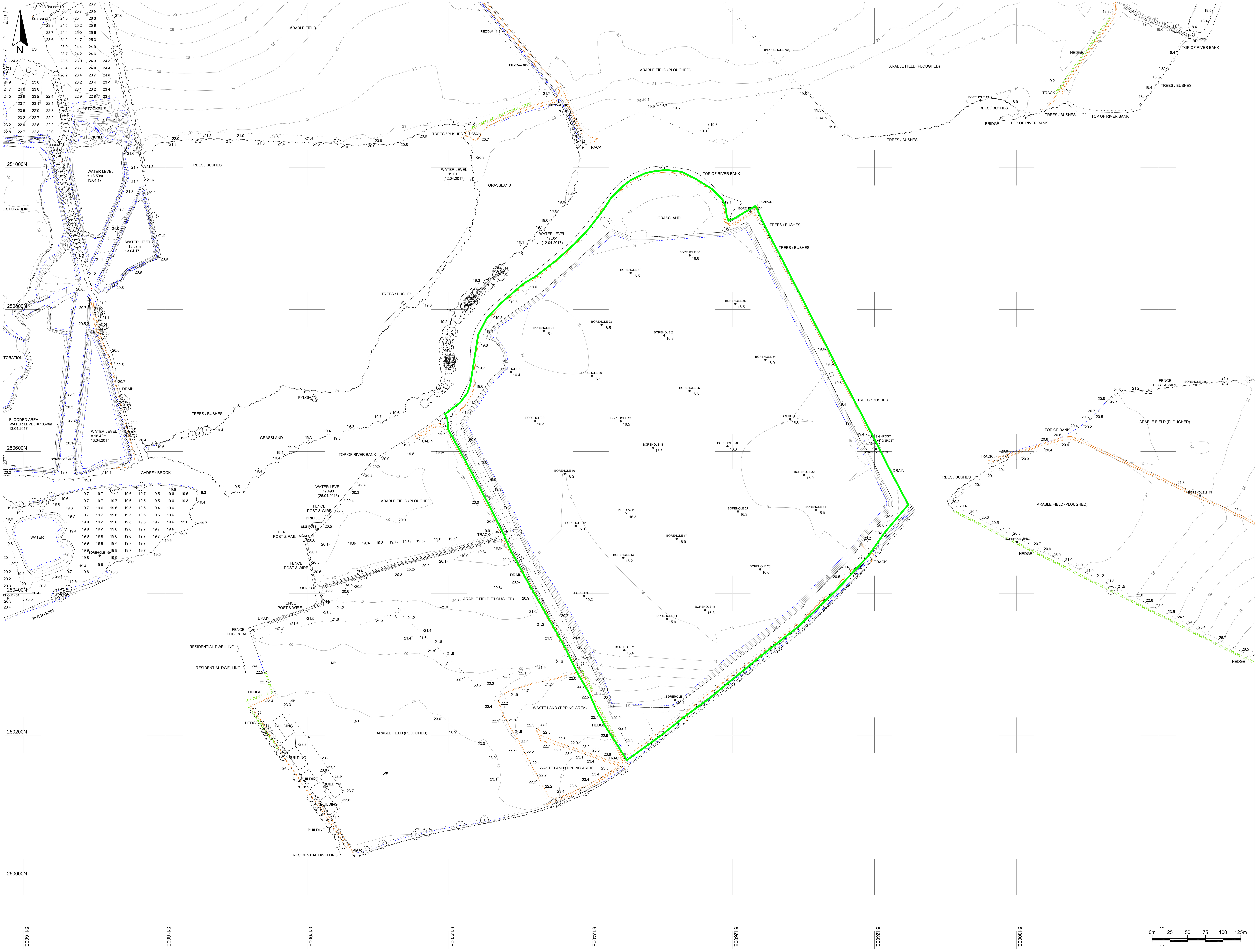

Key / Notes

- Approximate boundary of the site the subject of the Environmental Permit application
- Bottom of bank
- Building
- Contours (mAOD)
- Fence
- Hedge
- Kerb
- 18.75 Levels (mAOD)
- Top of bank
- Track
- Water

Note:
Based on model reference "WILLINTON LOCK MAX DIG.LSS" provided by Breedon on 12 February 2018

Rev	Status	Drn	App	Chk	Date
	Final	KR	JCR	GT	23/04/21

Site
WILLINGTON LOCK

Client
BREEDON

Title
Proposed extracted profile

Figure SRA 3

Scale
1:2,500@A1

Drawing Ref
BRE/WL/11-20/22068

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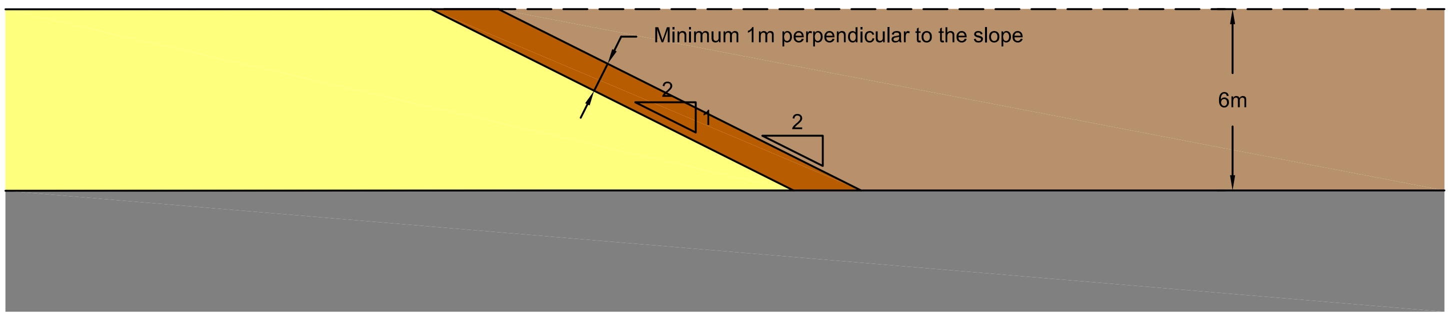

0m 2.5 5 7.5 10 12.5m

Key / Notes

- Sand and gravel
- Oxford Clay
- Attenuation layer
- Inert waste

Rev	Status	Drn	App	Chk	Date
	Final	KR	JCR	GT	23/04/21

Site
WILLINGTON LOCK

Client
BREEDON

Title
Schematic drawing of the construction of the attenuation layer

Figure SRA 4

Scale
1:250@A4

Drawing Ref
BRE/WL/11-20/22069

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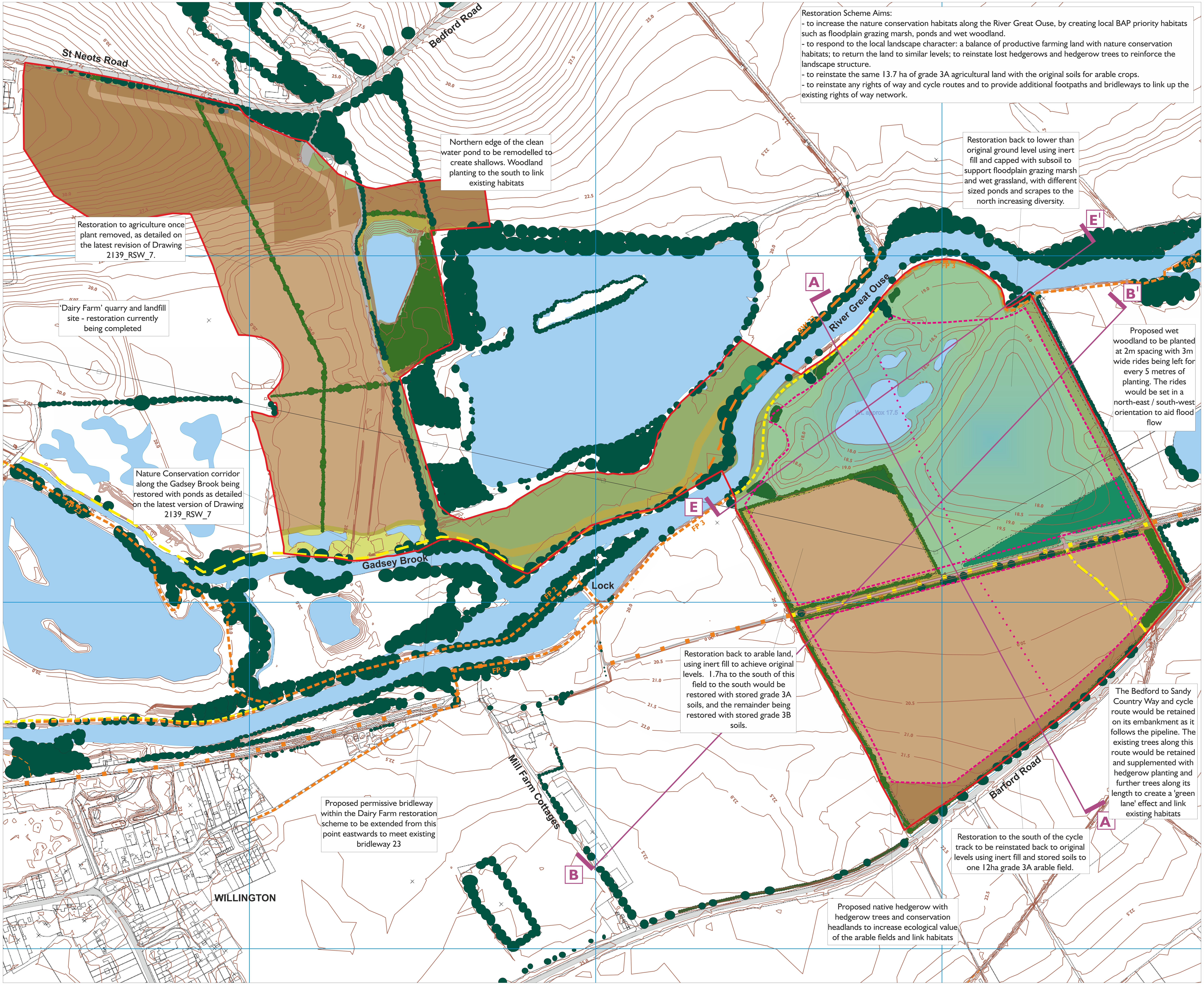
APPENDICES

APPENDIX A

DRAWING SHOWING THE RESTORED PROFILE



Legend

- Site boundary
- Limit of extraction
- Phase boundary
- Cross Section
- Existing trees, woodland and hedges
- Existing water bodies
- Existing arable
- Existing grassland
- Existing track
- Existing footpath
- Existing Bridleway
- Existing cycle route
- Proposed broadleaved native woodland
- Proposed wet woodland
- Proposed hedgerow
- Proposed fence
- Proposed water body
- Proposed arable
- Proposed wet grassland
- Proposed conservation grassland / headland
- Proposed scrub
- Proposed track
- Proposed footpath (PROW)
- Proposed bridleway (PROW)
- Proposed permissive bridleway
- Proposed cycle route
- 20.0 Proposed contour (m aOD)

Rev A: GEA/KB 270318 amendments following post submission comments

INFORMATION

CLIENT

BREEDON

ESP — Chartered Surveyors, Chartered Landscape Architects, Environmental Consultants, Health and Safety Consultants

The Creative Industries Centre, Glaisher Drive, Wolverhampton, WV10 9TG. Tel: 01902 771311

PROJECT: Willington Lock

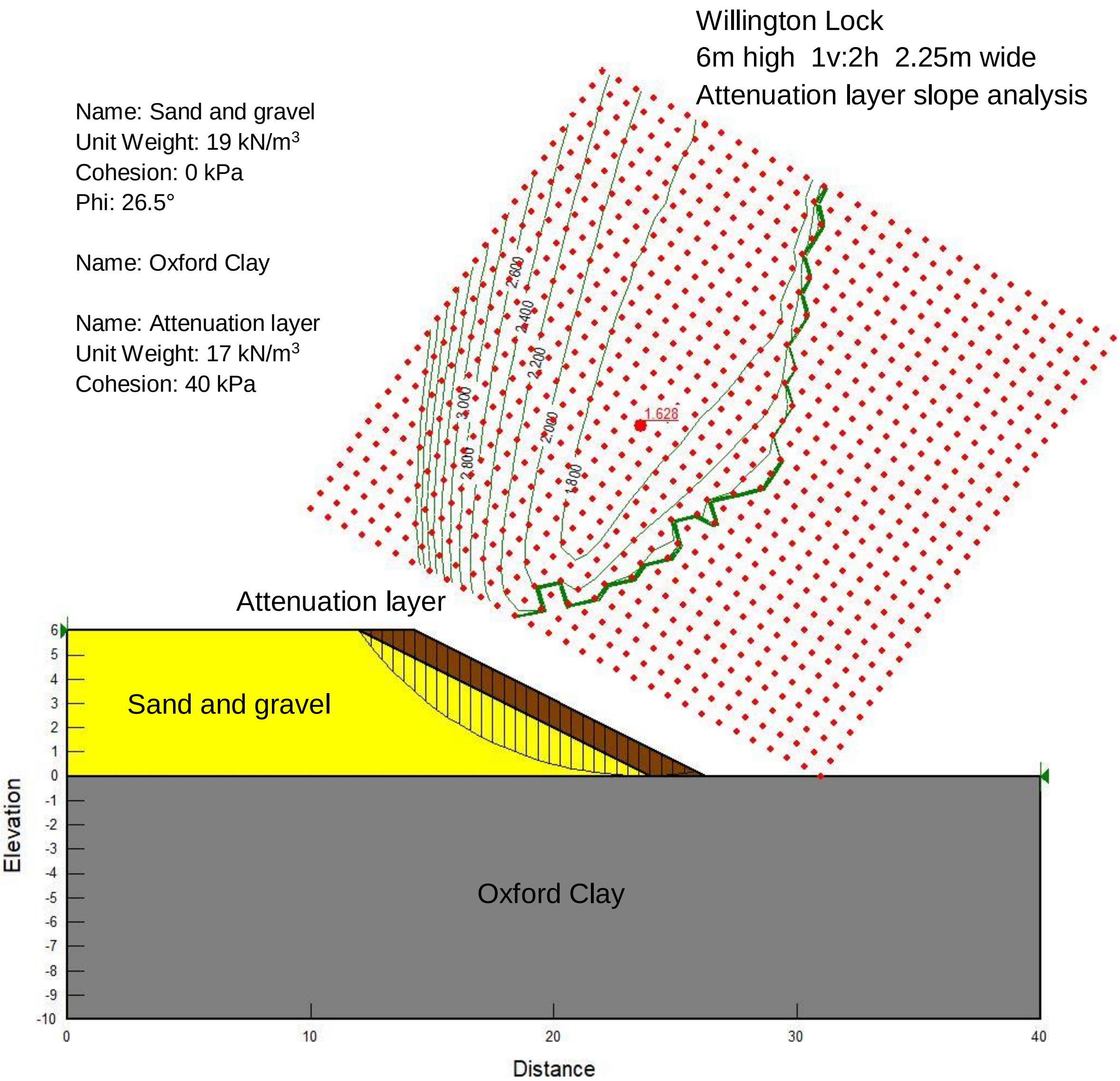
TITLE: **Restoration Strategy (pipeline retained)**

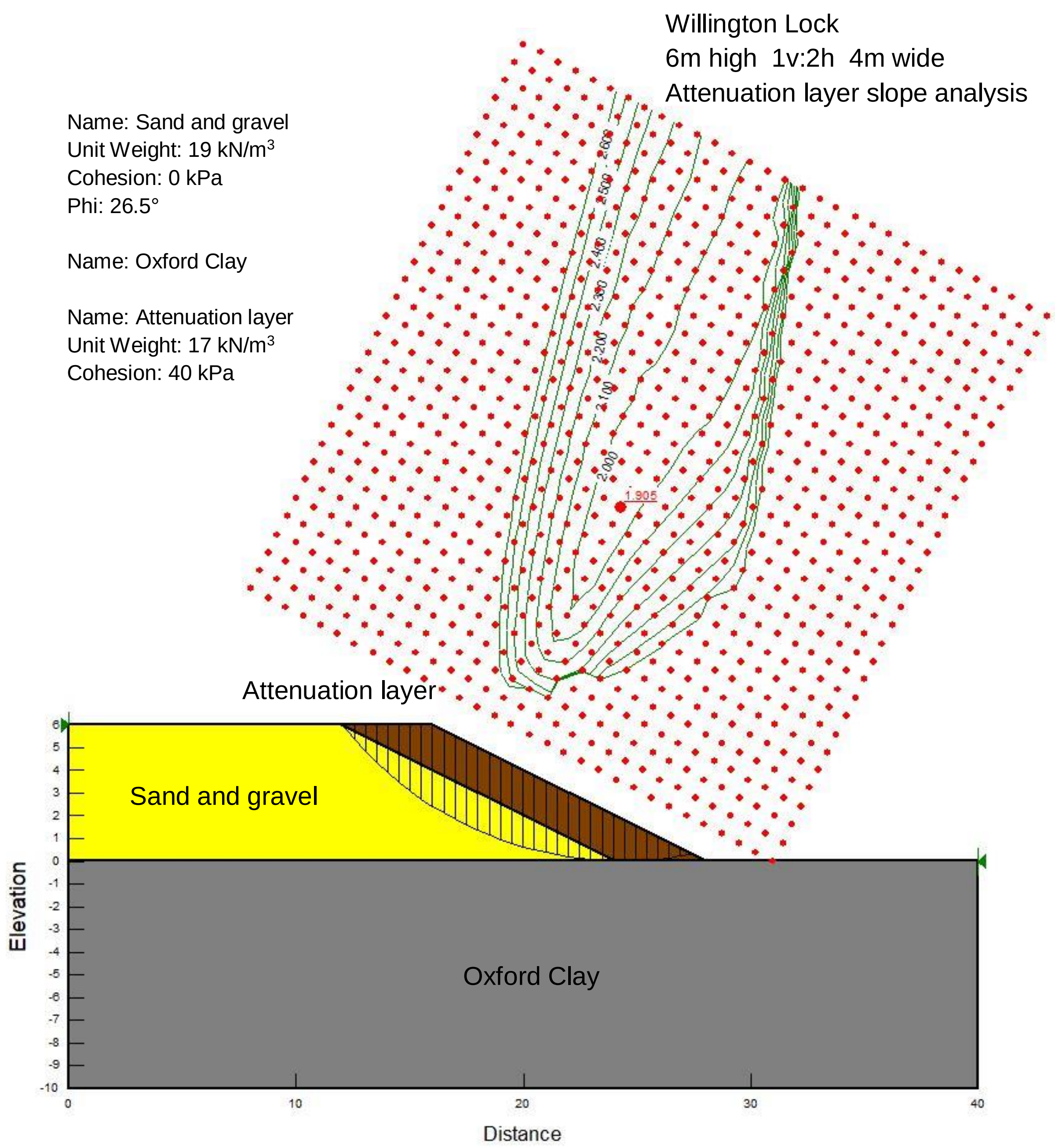
SCALE	DRAWN BY	DATE
1:2500@ A1	GA/TW	Oct 2017

DRAWING NUMBER	REV
W16_LAN_022	A

APPENDIX B

RESULTS OF THE STABILITY MODELLING


Willington Lock
6m high 1v:2h 2.25m wide
Attenuation layer slope analysis
Name: Sand and gravel
Unit Weight: 19 kN/m3
Cohesion: 0 kPa
Phi: 26.5°
Name: Oxford Clay
Name: Attenuation layer
Unit Weight: 17 kN/m3
Cohesion: 40 kPa
1.628
Attenuation layer
Sand and gravel
Oxford Clay
Elevation
Distance



Willington Lock
6m high 1v:2h 4m wide
Attenuation layer slope analysis
Name: Sand and gravel
Unit Weight: 19 kN/m3
Cohesion: 0 kPa
Phi: 26.5°
Name: Oxford Clay
Name: Attenuation layer
Unit Weight: 17 kN/m3
Cohesion: 40 kPa
2.600
2.500
2.400
2.300
2.200
2.100
2.000
1.905
Attenuation layer
Sand and gravel
Oxford Clay
Elevation
Distance