Geotechnical Design Report

Radlett, SRFI Area 2

March 2023

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Waterman Group's IMS (BS EN ISO 9001: 2015, BS EN ISO 14001: 2015 and BS EN ISO 45001:2018)

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Comments

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1. Introduction

1.1 Scopes and Objectives

Segro UK (the Client) has instructed Waterman Infrastructure & Environment Limited (Waterman) to prepare a Geotechnical Design Report (GDR) for a site hereafter referred to as Area 2 (the Site), located at North Orbital Road, Upper Colne Valley, Hertfordshire, AL2 2ET.

This GDR has been prepared following the guidelines of BS EN 1997-1:2004 *'Eurocode 7: Geotechnical Design – Part 1: General Rules'* [2] and in accordance with the requirements of specific design codes and standards (i.e Code of Practice for earth retaining structures (BS 8002:2015), Code of practice for foundations (BS 8004:2015) listed in Section 4.1.

The scope of the current Geotechnical Design Report (GDR) focuses on Area 2 specifically and is summarised as:

- Review of available Ground Investigation (GI).
- Production of ground models and characteristic soil parameters for the geotechnical design works.
- Geotechnical design recommendations.
- Proposals for preliminary slope stability assessment and ground movement analysis.
- Provide an updated Geotechnical Risk Register

1.2 Limitations and Constraints

The assessment was undertaken in accordance with the scope agreed between Waterman and Segro UK I line with bespoke terms of appointment.

The benefit of this report is made to Segro UK.

The information contained in this report is based on a review of available historical, geological, and hydrogeological sources, previous ground investigation reports, and consultation with the regulatory authorities.

Waterman has endeavoured to assess all information provided to them during this investigation but makes no guarantees or warranties as to the accuracy or completeness of this information.

The conclusions resulting from this study are not necessarily indicative of future conditions or operating practices at or adjacent to the Site.

1.3 Existing Conditions and Proposed Development

Area 2 is centred at National Grid coordinates TL 16114 03242 and comprises an area of grassed land currently disused and closed-off to the public. The Site is 26ha and is irregular in shape – roughly rectangular becoming a point at the northwest corner (Figure 1).

The Site is bordered to the south by the M25 and to the west by the Midland Main Line (MML), with Area 1 of the Development beyond. The east of the site is bordered by undeveloped land while the north of the Site is defined by the eastern boundary curving westwards to meet the MML.

Ground levels generally fall from west (72 to 74mAOD) to east (68 to 70mAOD). This coincides with the railway embankment which is typically around 2.0m to 3.0m above current Site levels.

Two small ditches bisect the Site centrally from west to east, and then travel south adjacent to the eastern

Site boundary. Vegetation is locally relatively dense, particularly adjacent to the ditches and around the Site boundary.

The Site comprises part of a larger development area the Client intends to develop as a Strategic Rail Freight Interchange (SRFI). This will comprise an intermodal rail terminal and a rail and road served large distribution facility comprising several large warehouses to be situated in Area 1. Areas 3 to 8 include additional works and landscaping to provide publicly accessible open land and a community forest. Figure Ref: RAD-WAT-A2EX-XX-PL-I-0001 (Appendix A) shows the current Site (Area 2) in relation to the different development phases (Areas 1 to 8).

To achieve the rail connection to Area 1 a new rail chord will be constructed that leaves the MML crossing Area 2 in a northerly direction before sweeping westwards beneath the MML at the north end of Area 1 to terminate at a new freight intermodal terminal in Area 1.

As well as constructing the new rail chord two large landscaping bunds (to 80mAOD) will be constructed, one positioned in the north of Area 2 between the MML and the new rail chord and the second larger landscaping bund to the south and east of the rail chord and extending to the south of Area 2. An annotated figure (Ref: RAD-WAT-A2EX-XX-PL-I-0002) detailing the main features of the development relevant to Area 2 is presented in Appendix A.

Historically Area 2 has been subject to land filling, with municipal waste landfills operating at the Site. The approximate footprint of the landfilled areas as encountered by completed ground investigations is shown in Appendix A (Ref: RAD-WAT-A2EX-XX-DP-I-0005).

To facilitate construction of the rail chord, landfill material will be removed and replaced with engineered fill. Given the proximity of the northern landscaping bund to the MML and the new rail chord removal of landfill waste from beneath some of this feature may also be required to ensure the landscaping bund is not constructed on landfill material and therefore is not at increased risk of settlement or failure. Removal of landfill waste beneath part of the north of the larger landscaping bund to the south of the rail chord may also be required.

The area where landfill waste will be removed is to be confirmed and will be influenced by the evolving design of the rail chord and landscaping bunds.

Figure 1: Current Site layout (source: Google Maps)

2. Existing Information

2.1 Ground Conditions Report

A review of Ground Conditions Report (Ref: RAD-WAT-A2EX-XX-RP-I-0003), relating to geotechnical engineering design, has been carried out. This report details the findings of GI carried out by Geotechnical Engineering Limited (GEL) between August 2022 and September 2022 (with post investigation monitoring and groundwater sampling undertaken between October 2022 and December 2022).

2.1.1 Summary of Ground Conditions

Boreholes WBH101, WBH102, WBH103, WBH106, WBH107, WBH108, WBH109, WBH110, WBH111, WBH112, WBH114, WBH115, WBH116, WBH117, WBH118, WBH119, WBH121, WBH124, WBH125, WBH126, WBH127, WBH129, WBH130 of ground investigation undertaken by GEL are the most relevant to the present study. The ground investigation location plan is provided in Appendix A (Ref: RAD-WAT-A2EX-XX-DP-I-0004). The borehole logs indicate the presence of Topsoil, Made Ground – General Fill, Made Ground – Landfill Capping, Made Ground – Landfill, Made Ground – Basal Clay Layer, Kesgrave Catchment Subgroup, and Lewes Nodular Chalk and Seaford Chalk Formations. Where landfill wasn't encountered, the Made Ground – General Fill was directly underlain by the Kesgrave Catchment Subgroup.

Assumptions in relation to strata thickness and soil material description are presented in Table 1 for Landfill areas and Table 2 for non-landfilled areas.

Table 1: Summary of encountered geological strata in landfilled areas

Strata	Thickness Range (Minimum – Max)	Description
Topsoil	0.1m – 0.4m	Grass over greyish brown/dark brown/brown slightly gravelly slightly sandy clayey silt with frequent rootlets, and occasional roots (up to 170mm diameter) and rare fragments (60x60mm) of textile. Gravel is subangular to rounded fine to coarse flint, brick, and rare concrete and chalk. Occasional pockets (up to 300mm) of stiff brown clay.
Made Ground – General Fill	0.1m – 1.85m	Soft brown/dark brown slightly gravelly slightly sandy clayey silt or slightly sandy gravelly silty clay with frequent roots (up to 250mm diameter) and rootlets. Gravel is angular to rounded fine to coarse flint, brick and concrete and rare chalk. Occasional fragments of plastic, textiles, glass, wood, and ceramic. Orangish brown/brown slightly gravelly clayey medium and coarse sand with occasional fragments of plastic. Gravel is angular to rounded fine to coarse flint and rare crystalline, chalk, brick and concrete.
Made Ground – Landfill Capping	0.1m – 2.5m	Stiff brown mottled greyish brown/orangish brown slightly sandy slightly gravelly silty clay. Gravel is subangular to rounded fine to coarse flint and rare brick, concrete, and chalk.
Made Ground – Landfill	0.2m – 5.7m	Domestic waste comprising glass, plastic, polystyrene, ceramic, metal, cables, textiles, paper, sponges, tin, newspaper (dated 1980), fragments of paper, cardboard, and book (1979) in a dark greyish brown and black sandy gravelly clay matrix.

Strata	Thickness Range (Minimum – Max)	Description
		Construction-type waste including fragments of brick and masonry, concrete, and tarmacadam. Other fragments of wood, rubber, black and white plastic sheeting, electrical wires, ripped nylon sheet, wood chippings, rope, clumps of straw.
Made Ground – Basal Clay Layer	0.25m – 3.0m	Soft to stiff orangish brown/brown slightly gravelly silty clay with rare fragments of wood and plastic. Gravel is subangular to rounded fine to coarse flint, chalk and rare brick. Soft to firm greenish brown and dark brown grey slightly gravelly sandy clay with rare pockets of firm orangish brown mottled bluish grey clay. Rare fragments of metal, plastic, and wood. Gravel is angular to rounded fine to coarse flint and brick.
Kesgrave Catchment Subgroup	0.8m – 9.0m	Firm to stiff orangish brown and dark brown slightly gravelly sandy clay with rare pockets (up to 80x100m) of firm orangish brown mottled bluish grey clay. Gravel is angular to rounded fine to coarse flint.
	0.6m – 4.6m	Overlying very dense brown, light brown and greenish brown slightly clayey sandy angular to rounded fine to coarse flint gravel.
Chalk	0.85m – 12.1m	Structureless white mottled light grey/yellow white slightly sandy slightly gravelly silt or silty sandy gravel with a low subangular and subrounded flint and cobble content. Gravel is angular to subrounded fine to coarse weak chalk and flint (CIRIA Grade Dc and Dm).
	>11.95m (total thickness not proven)	Becoming extremely to very weak medium locally high density white mottled grey with rare black specs chalk rarely stained orangish brown. Rare bivalve shell fragments. Frequent rounded dark grey/black cobble sized flints recovered between 0.05m and 0.5m thick (CIRIA Grade A3/B3).

Table 2: Summary of encountered geological strata in non-landfilled areas

Strata	Typical Thickness (Minimum – Max)	Description
Topsoil	0.05m – 0.6m	Grass over greyish brown/dark brown/brown slightly gravelly sandy silt with frequent rootlets and occasional roots (up to 600mm diameter). Gravel is angular to rounded fine and medium flint, brick and rare glass, chalk, and concrete.
Made Ground – General Fill	0.2m – 2.95m	Silty very sandy gravel or slightly gravelly sandy silt with fragments of fine to coarse clinker, brick, flint, concrete and rare tarmacadam, coal, ash, ceramic, and glass gravel. Occasional medium subangular brick cobble content, roots (up to 90mm diameter) and rootlets.

Strata	Typical Thickness (Minimum – Max)	Description
		Firm to stiff sandy gravelly clay or clayey sandy gravel. Gravel is subangular to subrounded fine to coarse flint, brick, and chalk. Occasional fragments of clinker, plastic, and concrete.
Kesgrave Catchment Subgroup	3.0m – 8.2m	Firm becoming stiff orangish brown mottled light grey/dark grey, slightly sandy slightly gravelly clay. Gravel is angular to rounded fine to coarse flint and rare chalk. Occasional thin horizons (>0.5m thick) of reddish brown locally mottled grey slightly gravelly sandy clay with frequent black staining and rare remnant rootlets. Gravel is angular to rounded fine to coarse flint. Orangish brown very clayey very sandy angular to rounded fine to coarse flint gravel.
	1.8m – 13.8m	Loose to very dense yellowish brown slightly gravelly fine and medium sand. Gravel is angular to rounded fine and medium flint and quartz. Becoming medium to very dense yellowish brown sandy subangular to rounded flint gravel with a low subrounded flint cobble content.
Chalk	0.9m – 10.3m	Interbedded very soft to soft off white/brown white/yellow white slightly sandy gravelly silt and silty sandy gravel with a low subangular and subrounded flint and chalk cobble content. Gravel is angular to subrounded fine to coarse weak chalk and flint (CIRIA Grade Dc and Dm).
	>16.05m (total thickness not proven)	Becoming extremely weak medium density white with rare black specs chalk rarely stained orangish brown. Rare bivalve shell fragments. Frequent rinded dark grey/black cobble sized flints recovered between 0.05m and 0.3m thick (predominantly CIRIA Grade B4/B3).

2.1.2 Hydrogeology

Groundwater levels were recorded within Area 2 during GEL GI . The relevant boreholes are WBH103, WBH108, WBH109, WBH12, WBH112, WBH116, WBH117, and WBH124. These recorded groundwater levels varying from 0.4-2.55m bgl (69.86 – 73.55 m AOD).

According to the Environment Agency online dataset, the hydrogeological properties of the deposits underlying the Site are classified as per .

Table 3: Summary of Hydrogeological properties of the main geological strata

Stratum	EA Classification	Hydrogeological Significance
Made Ground	Not classified	Likely to be sufficiently permeable to allow the migration of surface water to underlying strata.
Landfill	Not classified	Likely to be sufficiently permeable to allow the migration of surface water to underlying strata.

Stratum	EA Classification	Hydrogeological Significance
Kesgrave Catchment Subgroup	Secondary A Aquifer	Permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers.
Lewes Nodular Chalk Formation and Seaford Chalk Formation	Principal Aquifer	Layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage.

The Site is situated within groundwater Source Protection Zone (SPZ) 1 (Inner Zone) and SPZ2 (Outer Zone), relating to an abstraction point 1km to the south/southwest. The landfill areas within the Site are known to be clay lined, reducing the potential for the ingress of groundwater from the Site.

The Lewes Nodular Chalk Formation and Seaford Chalk Formation is characterised as a Principal Aquifer. This is related to layers of rock that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. The GEL GI encountered between 0.85m and 12.1m of structureless chalk overlying structureless chalk.

The superficial Kesgrave deposits are characterised as a Secondary A Aquifer, which normally applies to permeable layers (intergranular flow) capable of supporting water supplies at a local, rather than strategic scale, and in some cases forming an important source of base flow to rivers.

The Environment Agency's flood map indicates the site is not located within an indicative fluvial floodplain (located in Flood Zone 1).

The Environment Agency's surface water flood map indicates most of the site is at very low risk of surface water flooding, with small areas of low to high-risk concentrated along the Site's south-eastern boundary, and otherwise found dotted sporadically across the Site.

3. Ground Model and Geotechnical Parameters

The ground model and soil parameters have been based upon information provided in the Waterman Ground Conditions Report (RAD-WAT-A2EX-XX-RP-I-0003).

Ground investigation data interpretations and graphs, based on which soil parameters were derived, are presented in Appendix B. Due to the variable ground level across the Site, a groundwater level of 1m bgl is considered for geotechnical design purposes.

3.1 Material Parameters for Design

The ground model and characteristic material parameters summarised in Table 4 should be used in the geotechnical design.

Table 4: Ground model and characteristic material parameters for design

	Elevation at Top of Stratum	Bulk Unit Weight	Undrained Shear Strength	Drained Shear Strength		K_0	Young's Modulus (undrained)	Young's Modulus (Drained)
	(mAOD)	γ_b (kN/m3)	c_u (kN/m^2)	c' (kN/m^2)	φ°		Eu (MN/m^2)	E' (MN/m^2)
Made Ground – granular	+76.2	18.0	80.0	0.0	29	0.52	32	25.6
Landfill - Clay	+74.7	18.0	50.0	1.0	26	0.56	20	16
Landfill		17.0	45.0	0.5	24	0.59	18	14.4
Clay Basal		18.0	70.0	1.0	26	0.56	28	22.4
Kesgrave Catchment Subgroup	+68.2	17.0	-	0.0		0.44	-	50
Lewes Nodular Chalk Formation and Seaford Chalk Formation	+62.0	20.0	68.0+21.4z	5.0	30	0.50	27+8.5z	21.6+6.8z

Notes

[1] z refers to depth below top of the Lewes Nodular Chalk Formation and Seaford Chalk Formation.

[2] The short-term total stress (undrained) stiffness for cohesive strata has been obtained by correlation with the undrained shear strength data for the anticipated range of strain in the respective analytical models. The long-term effective stress (drained) stiffness for cohesive strata has been taken as 80% of the total stress (undrained) stiffness, following principles of elasticity theory (assuming a Poisson's Ratio of 0.2).

[3] Angle of shearing resistance for granular soils has been based on the correlation φ=30°+A+B+C (BS 8002:2015), where A depends on the particles angularity, B depends on the grading and C depends on the SPT results or an SPT correlation based on Peck et. al 1974 suggested relationship.

[4] Clay Cap, Clay Basal, and Weathered Chalk stiffness profiles indicated are based on the relationship EU=400CU for foundations. The use of this correlation is considered conservative in view of the general nature of the soil-structure interaction analysis and the strain levels expected to develop in the proximity of various geotechnical works.

[4] Stiffness estimation for granular soils has been based on the correlation E'=1*SPT N (MPa).

[5] Groundwater assumed at +75.2m AOD (1m bgl).
[6] Landfill material is not a standard geotechnical material. The above parameters have been interpreted from laboratory test results. Given the nonstandard, extremely heterogeneous nature of landfill material, caution shall be exercised when using these parameters. Extensive and robust sensitivity checks of the landfill material properties is required detail design as well as applying appropriate factors of safety.

Undrained behaviour has been assumed for all strata, excluding the Made Ground and Kesgrave Catchment Subgroup, during short term loading/unloading stages. The long-term behaviour of the cohesive strata is modelled by introducing drained condition properties to the soil layers.

4. Geotechnical Design

4.1 Design Standards

As it is discussed in Section 1.3, this report aims to provide geotechnical design considerations for the construction of the landscaping bunds within Area 2. For the proposal scheme, geotechnical design recommendations are provided for the rail chord cut and fill and landscaping, as well as for shallow and deep land bearing and stability.

The current geotechnical considerations shall be in general accordance with the following Design Standards and Specifications:

- BS EN 1997-1:2004 'Eurocode 7: Geotechnical Design – Part 1 General Rules';
- BS 8004:2015 Code of practice for foundations;
- BS 8002:2015 Code of practice for earth retaining structures;
- BS 6031 2009 Code of practice for earthworks;
- CIRIA R143 (1995) The Standard Penetration Test (SPT): Methods and Use;
- CIRIA C760, Guidance on Embedded Retaining Wall Design;
- UK National Annex to Eurocode 7: Geotechnical design – Part 1: General Rules (NA+A1:2014 to BS EN 1997-1:2004+A:2013);
- The Construction (Design & Management) Regulations 2015.

4.2 Preliminary Slope Stability and Ground Movement Assessments

A preliminary slope stability check has been undertaken to determine the stability of the bunds in areas of cut and fill along the route of the proposed rail chord. This is to be completed using Plaxis 2D 2022 software and is to represent a worst-case section for the planned works. A 2D finite element (FE) soil-structure interaction plane strain analysis has been carried out in order to evaluate the ground movements induced by construction stages and proposed loadings. This will also assess the stability of the bund slopes in close proximity to the rail chord cut and fill, by obtaining a Factor of Safety (FoS) and applying it to the Eurocode 7 design requirement of FoS>1.25. FoS results with a value greater than 1.25 are considered stable and satisfy the EC7 requirement, while values of less than 1 indicate risk of immediate failure. The cases with values between 1 and 1.25 are considered stable, but do not meet the EC7 design requirement.

Differential settlement for the bunds will be discussed as part of the ensuing landscape design report. This will involve the modelling of multiple sections in Plaxis 2D representing areas with and without underlying landfill, and comparison of settlements between each area.

The Indicative Railway Works Corridor Plan & Long Section will be used to determine the geometry of the chosen section (Ref: RAD-WAT-A2EX-XX-DS-C-0001), shown in Figure 2 and Appendix A. An initial 50m excavation corridor, centred on the rail chord, will be considered for the analysis. This is to account for the removal of landfill material located beneath the rail chord, which will then be replaced with Engineered Fill. The fence boundary of the rail chord will mark the required width of the Engineered Fill at ground level, with an approximate 1(v) in 3(h) slope required from here down to competent rock. It must be noted that temporary works during the cut and fill stages are yet to be established, and have therefore been assumed for the purpose of this analysis.

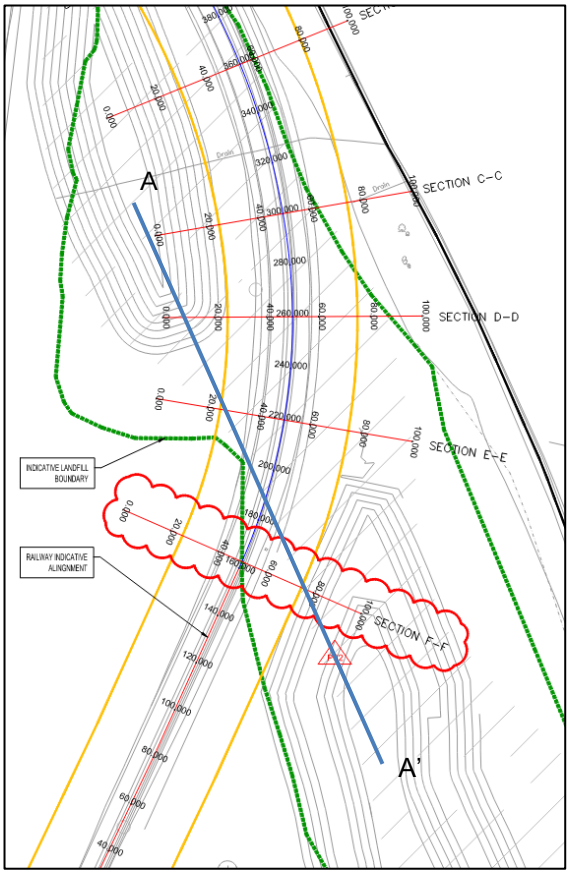

Figure 2: Plan of 50m excavation corridor (yellow lines) in relation to landscaping bunds, extent of landfill (green line), and preliminary section line used in analysis (blue line, A – A')

The modelled construction stages will represent the proposed works, consisting of:

- Initial stage: Existing ground conditions;
- Cut stage: Excavation of landfill material within 50m corridor;
- Fill stage: Replacement of excavated material with Engineered Fill;
- Bund construction stage: Bunds are constructed in 1m layers, with consolidation after each layer is applied;
- Loading stage: Assumed line loadings are applied for the rail chord (20 kN/m/m) and at the top of the bunds (10 kN/mm);
- Short-term FoS stage: A FoS analysis to assess short-term slope stability;
- Consolidation stage: A final consolidation is run following the application of the loadings, allowing pore water pressure to dissipate;
- Long-term (drained) stage: Geotechnical properties amended to drained conditions for long-term analysis; and
- Long-term FoS stage: A FoS analysis to assess long-term slope stability.

The Layout of the model is displayed in Figure 3.

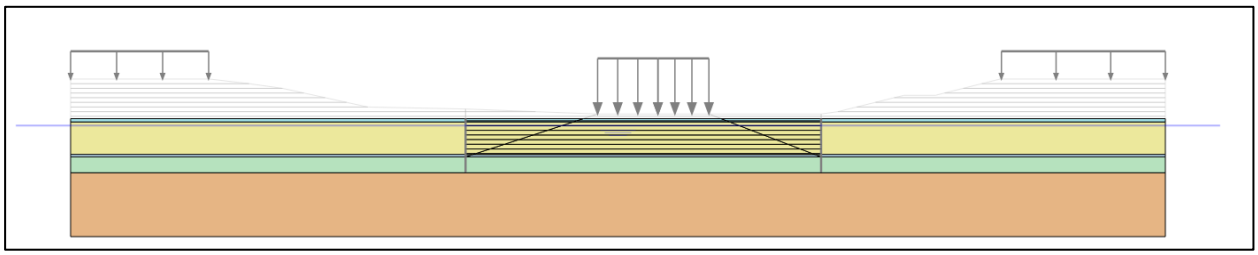

Figure 3: Layout of the initial stage of Plaxis 2D model

Soil layers have been modelled using linear elastic perfectly plastic (Mohr-Coulomb failure criterion) constitutive model. The undrained behaviour of has been modelled with effective properties stiffness and undrained shear strength. Long term conditions are achieved by performing a final consolidation analysis in which all excess pore water pressures generated during the previous construction stages are dissipated and ground water equilibrium is achieved. Soil stratigraphy and geotechnical parameters have been taken from Table 4. The strength parameters of the Engineered Fill have been assumed as φ'=35° and c'=0 kN/m^2, while the parameters used for the bund material have been taken from the existing Landfill parameters in Table 4.

The results from this preliminary model indicate long-term settlement of up to 200mm for both landscaping bunds (Figure 4). Both short-term and long-term FoS>1.25 was achieved when assessing slope stability. The geotechnical parameters of the Landfill represent the minimum requirements for the bund material to ensure slope stability, as these were the parameters used for the bunds in the Plaxis model.

The majority of the material will comprise topsoil and subsoil sourced from Area 1 as well as some recovered material from the landfill waste removed to accommodate the rail chord in Area 2 see draft cut and fill plan (T30253 - Dwgs & Specs - Pck I - 018844-CA-0-GF-DR-S-422-P01).

To date modelling has been carried out assuming the material used to construct the bunds meets minimum requirements. Detailed design will consider the findings of the proposed 2023 GI to be carried out in Area 1, which will include areas to be subject to cut to provide material to construct bunds in Area 2.

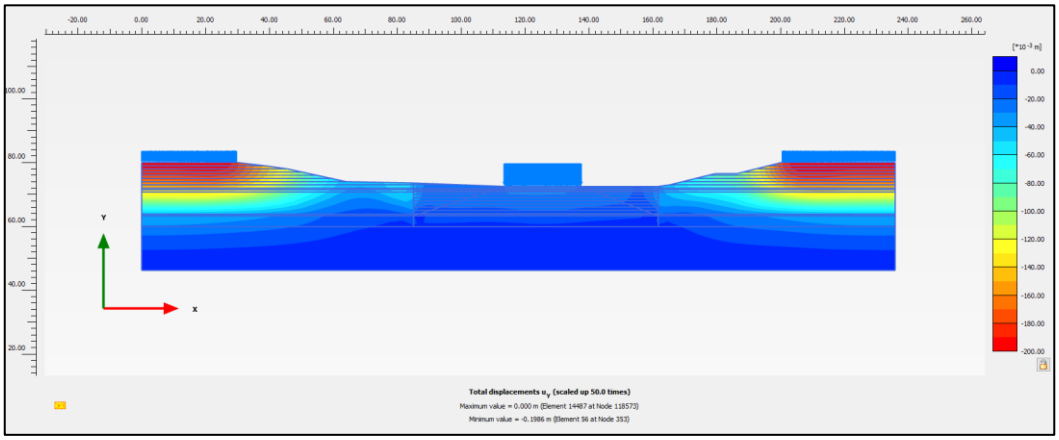

Figure 4: Total vertical displacements - Long-term (drained) stage

Further analysis and sensitivity checks will be undertaken as part of the subsequent landscape design, where sections with no underlying landfill will be modelled, and compared with the results from sections where landfill is present.

4.3 Ground Movement Monitoring Plan

The scope of supervision and monitoring will be prepared by Waterman in the subsequent detailed landscape design report. In outline, the following requirements should be satisfied:

- Confirmation that groundwater and ground conditions are as expected, as detailed within this GDR.
- In conjunction with the above, settlement monitoring will be required to confirm that total and differential settlements are within acceptable limits (Trigger levels will be specified following the slope stability assessment).
- Monitoring shall be undertaken in accordance with the Manual of Contract Documents for Highways Works and in accordance with the Construction Specification.

4.4 Aggressive Chemical Environment for Concrete Classification

It is recommended that all concrete used in the proposed development shall designed in accordance with the appropriate Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classifications as given in BRE SD1 (2005).

For these classifications, it is presumed that groundwater is mobile within all strata, excluding the Chalk which will be considered static.

The Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classifications are summarised in Table 5 below according to laboratory findings from GEL's ground investigation:

Table 5: Design Class for concrete summary

Stratum	DS Class	ACEC Class
Made Ground	DS-2	AC-2
Landfill/Clay	DS-3	AC-3
Kesgrave Catchment Subgroup	DS-1	AC-1
Chalk Formations	DS-1	AC-1s

Chemical testing undertaken is for preliminary design only. A DS-3 – AC-3 design concrete class is recommended for and foundations.

4.5 Groundwater and Stability of Excavations

The route of the rail chord through Area 2 will require substantial cut and fill. In areas of Landfill, this will involve excavation down to the top of the Kesgrave Catchment Subgroup or Chalk Formations, with potential excavations of up to 8m bgl in places.

If there are any retaining structures, they shall be designed according to BS EN 1997-1:2004 'Eurocode 7: Geotechnical Design – Part 1 General Rules, BS EN 1992-1-1:2004 'Eurocode 2: Design of Concrete Structures – Part 1, BS EN 1993-1-1:2004 'Eurocode 3: Design of Steel Structures', BS 8002:2015 Code

of practice for earth retaining structures and CIRIA C760, Guidance on Embedded Retaining Wall Design.

Groundwater inflow to excavations may promote instability and temporary works measures should include an allowance for groundwater control.

It is recommended that:

- in line with BS:6031 (2009), all excavations shall be examined daily by a competent person to ensure that they remain safe;
- where the sides cannot be graded back to a safe angle, as approved by a competent and experienced person, their continued stability shall not be taken for granted;
- The stability of all excavations requiring man entry, regardless of depth, must be assessed by a competent person and provided with a suitably designed shoring support system as required;
- for excavations below groundwater level, groundwater control in the form of excavation of sumps and pumping to agreed discharge points may be required.

The stability of the retaining structures will need to satisfy both temporary and permanent design requirements.

It is recommended that:

- the effects of the short term and long-term unloading (excavation) and subsequent re-loading (construction) may need to be assessed and monitored on site.

Given the fact that groundwater level is assumed to be 1m bgl, any proposed excavation is anticipated at deeper level than the groundwater level; as per BS:8102 (2009), the groundwater is considered to be ‘High’. The presence of water-bearing strata within or immediately below the deep excavation requires dewatering both to allow excavation in the dry (should this be a requirement of the construction methodology) and to control pore pressures to prevent base heave, therefore foundations should be designed for uplift.

Appropriate dewatering measures employed should be in accordance with relevant guidance such as CIRIA Report C750, Groundwater control: design and practice, second edition (2016).

5. Conclusions

The following potential geotechnical engineering observations have been identified for the Site:

- The borehole logs indicate the presence of Topsoil, Made Ground, Kesgrave Catchment Subgroup (gravel), and Lewes Nodular Chalk and Seaford Chalk Formations. Landfill material was also identified in certain boreholes, positioned below the Made Ground and above the Kesgrave Catchment Subgroup or Chalk, and consisting of general landfill material with a clay liner at its top and base.
- A preliminary ground movement analysis section close to railway chord indicate 200mm of settlement below the bunds. More analysis sections and sensitivity checks subject to different landfill material parameters will be discussed in the detail design of landscaping bunds.
- When assessing slope stability of the bunds, the FoS exceeded 1.25 for both short and long-term conditions. FoS results with a value greater than 1.25 are considered stable and satisfy the EC7 requirement, while values of less than 1 indicate risk of immediate failure. The cases with values between 1 and 1.25 are considered stable, but do not meet the EC7 design requirement.

6. Recommendations

The findings and recommendations in this report are indicative/preliminary and will need to be reviewed at detailed design stage.

- Entering excavations should be carried out in accordance with the Confined Space Entry Regulations 1997;
- A serviceability / settlement assessment should be undertaken as part of the final design;
- The Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classifications are recommended to be DS-2 – AC-2 for Made Ground, DS-3 – AC-3 for Landfill/Clay, DS-1 – AC-1 for Kesgrave Catchment Subgroup, and DS1 – AC-1s for the Chalk Formations;
- Additional design CBRs should be confirmed during construction, by undertaking in-situ CBR testing after proof-rolling of formation. If soft spots are encountered during construction, they should be compacted or replaced with the engineering fill to achieve the required CBR;
- If there are any retaining structures, they shall be designed according to BS EN 1997-1:2004 'Eurocode 7: Geotechnical Design – Part 1 General Rules, BS EN 1992-1-1:2004 'Eurocode 2: Design of Concrete Structures – Part 1, BS EN 1993-1-1:2004 'Eurocode 3: Design of Steel Structures', BS 8002:2015 Code of practice for earth retaining structures and CIRIA C760, Guidance on Embedded Retaining Wall Design;
- Appropriate dewatering measures employed should be in accordance with relevant guidance such as CIRIA Report C750, Groundwater control: design and practice, second edition (2016);
- Further slope stability checks and ground movement analyses to be conducted during the landscape detail design stage; and
- Monitoring specifications to be provided following the detailed landscape design.

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APPENDICES

A. Site Plans

Source: Capita Lovejoy

waterman

Strategic Rail Freight Interchange Site Boundary

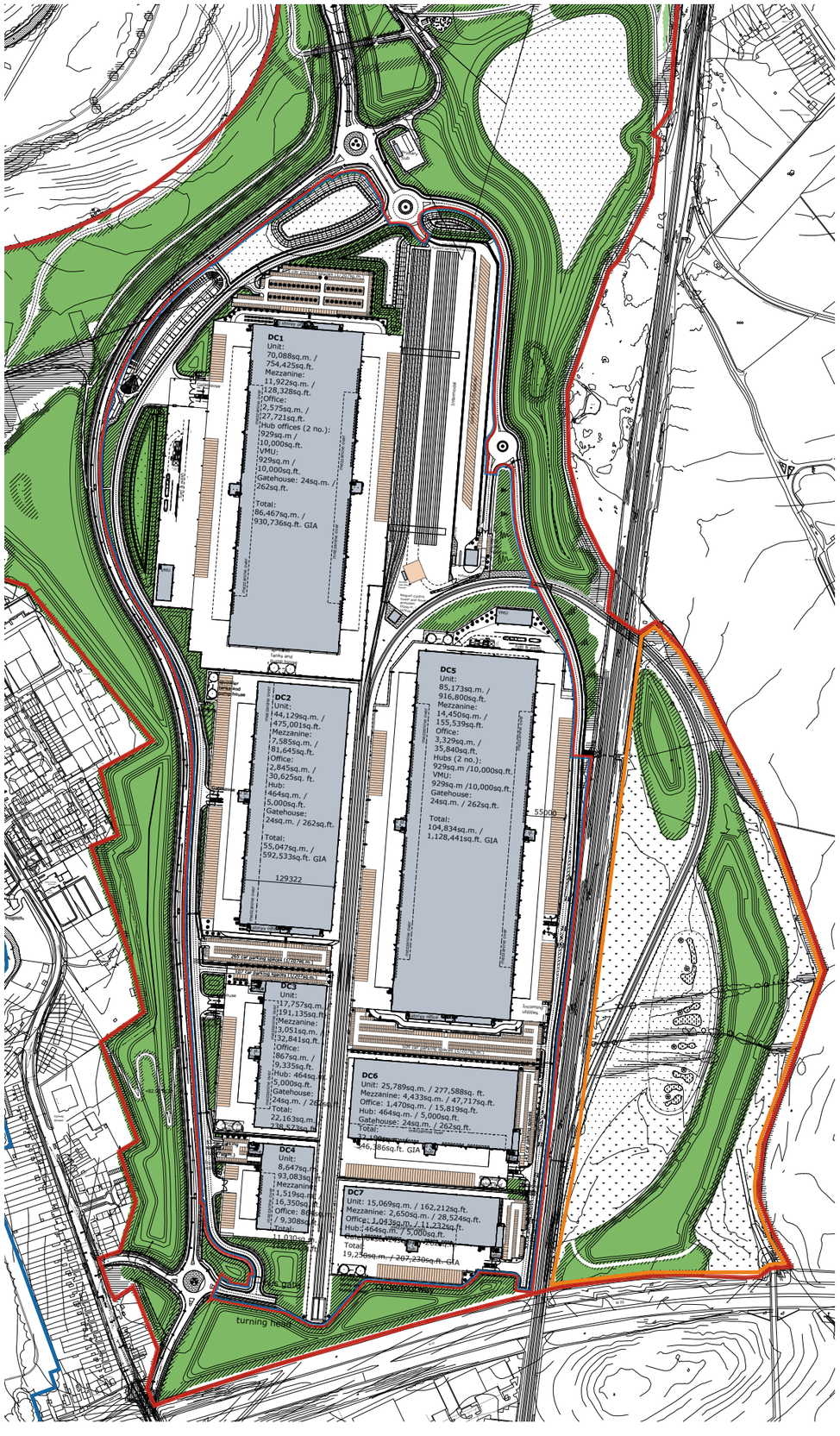
Country Park Boundary

6 Land Parcel

N

Project Details	WIE18710-100: Radlett
Figure Title	A3 - Different Development Phases (Area 1 to 8) of the SRFI
Figure Ref	RAD-WAT-A2EX-XX-PL-I-0001
Date	December 2022
File Location	\\s-lncs\wiel\projects\wie8710\100\graphics\gi\issued figures

www.watermangroup.com



INFRASTRUCTURE SITE APPLICATION BOUNDARY

ASSOCIATED DEVELOPMENT AND COUNTRY PARK AREAS

AREA 2

AREAS SCHEDULE
Logistics Park Buildings
(excluding Railport):
330,971sq.m. /
3,562,820sq.ft. GIA

Ancillary Railport buildings:
694sq.m. /
7,465sq. ft. GIA

TOTAL:
331,665sq.m. /
3,570,285sq.ft. GIA

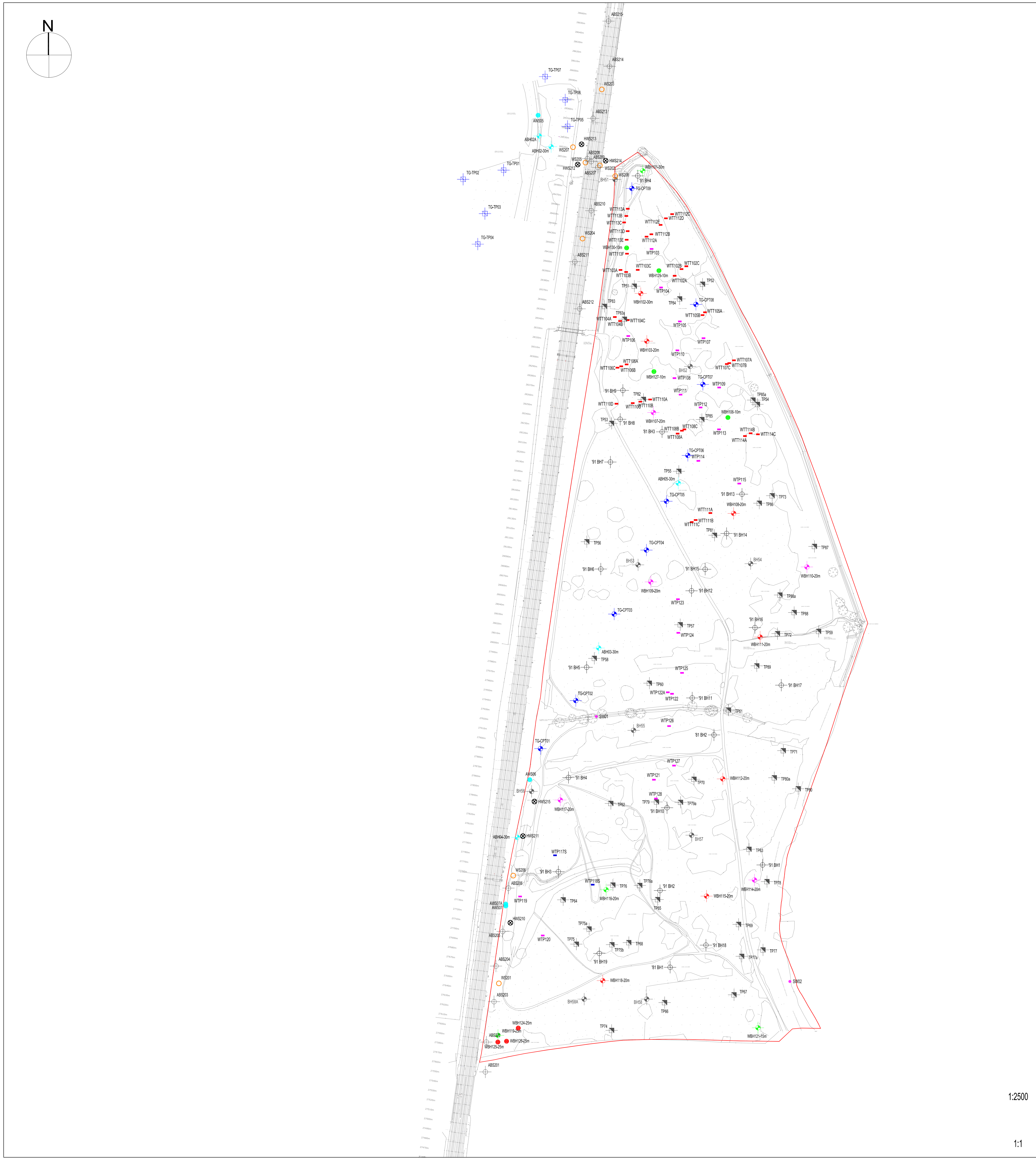
PARKING
1602 car parking spaces total
(1/207sq.m.) (including railport)

617 trailer spaces total
(1/538sq.m.) (including railport)

N

Project Details	WIE18710-100: Radlett
Figure Title	A4 - Proposed Development Layout
Figure Ref	RAD-WAT-A2EX-XX-PL-I-0002
Date	December 2022
File Location	\\s-lncs\wiel\projects\wie8710\100\graphics\gi\issued figures

Source: Stephen George & Partners LLP



KEY:

- 2016 BOREHOLE LOCATION
- 2016 TRIAL PIT LOCATION
- ARUP BOREHOLE
- ARUP WINDOW SAMPLE
- AUTOMATIC BALLAST SAMPLER
- WINDOWLESS SAMPLER
- HANDHELD WINDOWLESS SAMPLER
- TG CPTS
- TG TPS
- WATERMAN GEOTECHNICAL LANDSCAPE LOADINGS
- WATERMAN GROUNDWATER MONITORING WELL RELOCATION DUE TO PROPOSED INFRASTRUCTURE
- WATERMAN GROUNDWATER MONITORING WELL NETWORK ADDITION
- WATERMAN ASSESSMENT OF LANDFILL AT DEPTH
- BOREHOLE FOR PUMPING TEST COMPLETION
- SURFACE WATER SAMPLE
- WATERMAN TRIAL PITS (3.5m x 1.5m)
- WATERMAN TRIAL PIT WITH BRE365 SOAKAWAY TEST
- LANDFILL DELINEATION TRIAL PIT
- 1981 EXPLORATORY HOLE LOCATIONS
- 1991 EXPLORATORY HOLE LOCATIONS

1:2500 0 20m 40m 60m 80m 100m 120m 140m 160m 180m 200m 220m 240m

1:1 0 10 20 30 40 50 60 70 80 90 100

Pickfords Wharf, Clink Street, London SE1 9DG t 020 7928 7888 f 03333 444 501

GENERAL NOTES

APPROXIMATE SITE BOUNDARY

Status		Date	Description	By	Chk
P01	S0	16.12.22	PRELIMINARY ISSUE	DC	FA

Amendments

Project

RADLETT

Title

A5 GROUND INVESTIGATION LOCATION PLAN

Client

-

Waterman

Pickfords Wharf Clink Street London SE1 9DG

t 020 7928 7888

mail@watermangroup.com www.watermangroup.com

Status

PRELIMINARY

Designed By BG	Director FA	Waterman Ref WIE18710-100
Drawn By DC	Date DECEMBER 2022	Scales @ A2 1:2500

Project - Originator - Volume - Level - Type - Role - Number: RAD-WAT-A2EX-XX-DP-I-0004

Revision: P01

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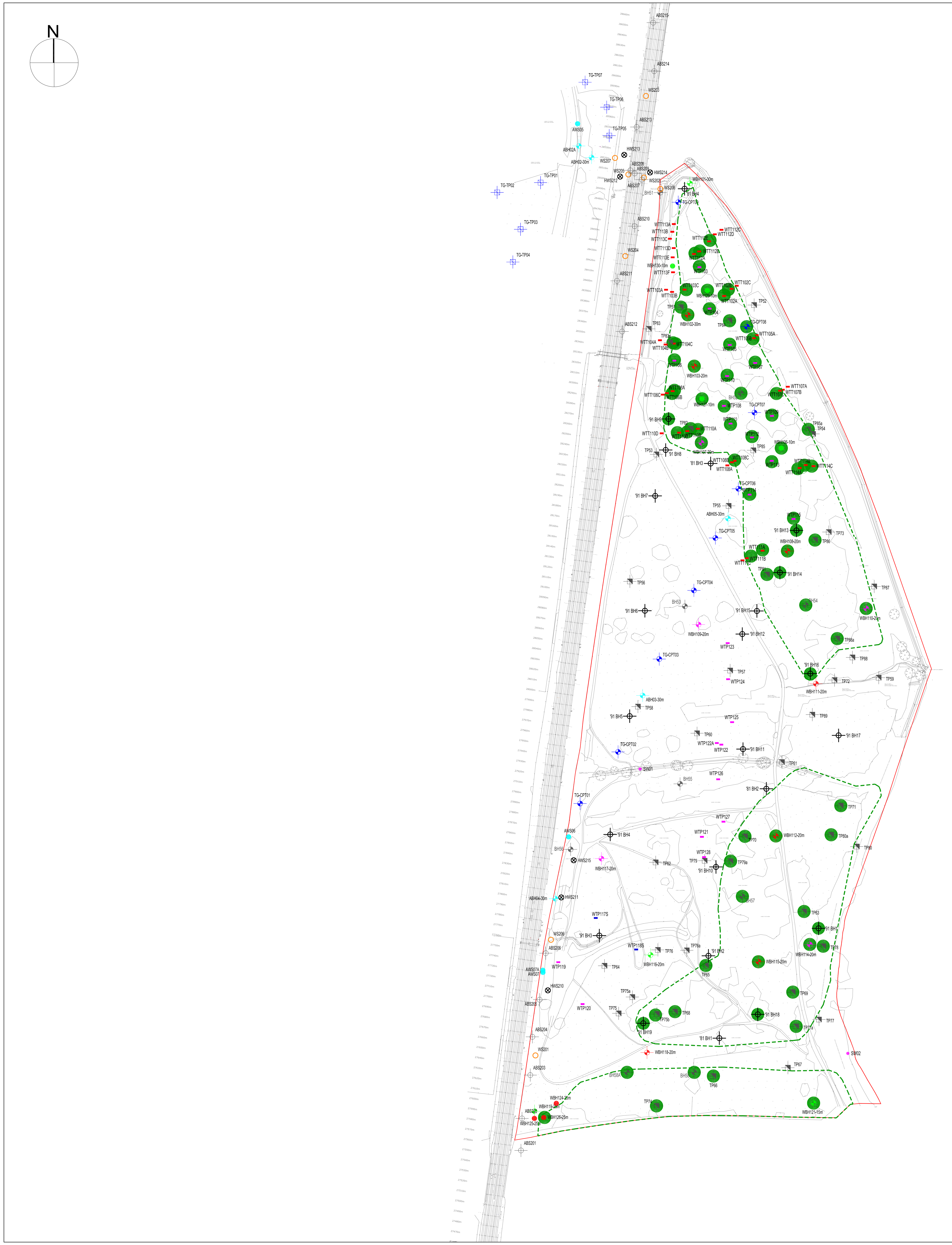
21054-Radlett-P-1 DRAFT, A2-Wat-BS-S



KEY:

- 2016 BOREHOLE LOCATION
- 2016 TRIAL PIT LOCATION
- ARUP BOREHOLE
- ARUP WINDOW SAMPLE
- AUTOMATIC BALLAST SAMPLER
- WINDOWLESS SAMPLER
- HANDHELD WINDOWLESS SAMPLER
- TG CPTS
- TG TPS
- WATERMAN GEOTECHNICAL LANDSCAPE LOADINGS
- WATERMAN GROUNDWATER MONITORING WELL RELOCATION DUE TO PROPOSED INFRASTRUCTURE
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- WATERMAN TRIAL PITS (3.5m x 1.5m)
- WATERMAN TRIAL PIT WITH BRE365 SOAKAWAY TEST
- LANDFILL DELINEATION TRIAL PIT
- 1981 EXPLORATORY HOLE LOCATIONS
- 1991 EXPLORATORY HOLE LOCATIONS
- APPROXIMATE EXTENT OF LANDFILL
- LANDFILL MATERIAL IDENTIFIED

1:2500 | 0 | 20m | 40m | 60m | 80m | 100m | 120m | 140m | 160m | 180m | 200m | 220m | 240m

1:1 | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100

This drawing should not be scaled. Dimensions to be verified on site.
Any discrepancies should be referred to the Engineer prior to work being put in hand.

GENERAL NOTES

APPROXIMATE SITE BOUNDARY

Status		Date	Description	By	Chk
P01	S0	16.12.22	PRELIMINARY ISSUE	DC	FA

Amendments

Project

RADLETT

Title

A6 APPROXIMATE LANDFILL FOOTPRINT AS CONFIRMED BY GROUND INVESTIGATION

Client

-

Waterman

Pickfords Wharf Clink Street London SE1 9DG
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mail@watermangroup.com www.watermangroup.com

Status

PRELIMINARY

Designed By	BG	Director	FA	Waterman Ref	WIE18710-100
Drawn By	DC	Date	DECEMBER 2022	Scales @ A2	1:2500

Project - Originator - Volume - Level - Type - Role - Number: RAD-WAT-A2EX-XX-DP-I-0005

Revision: P01

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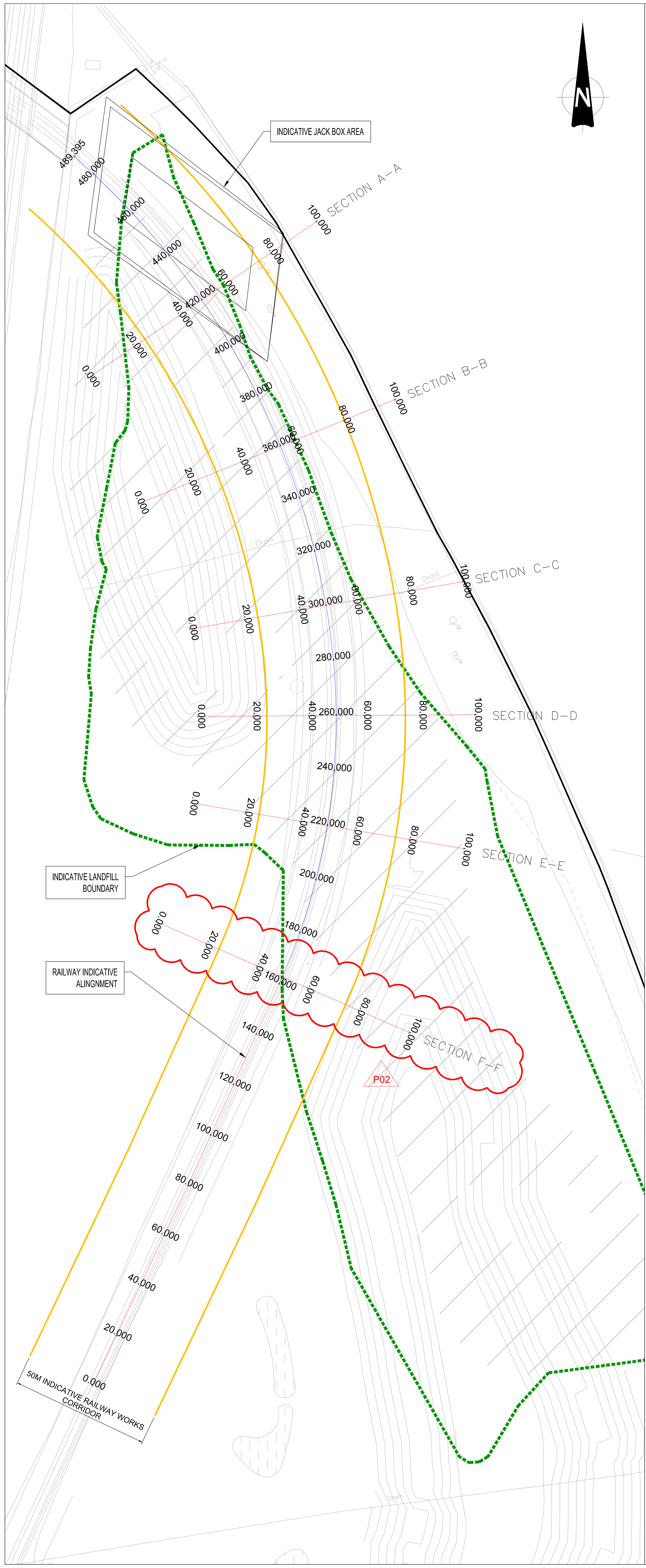
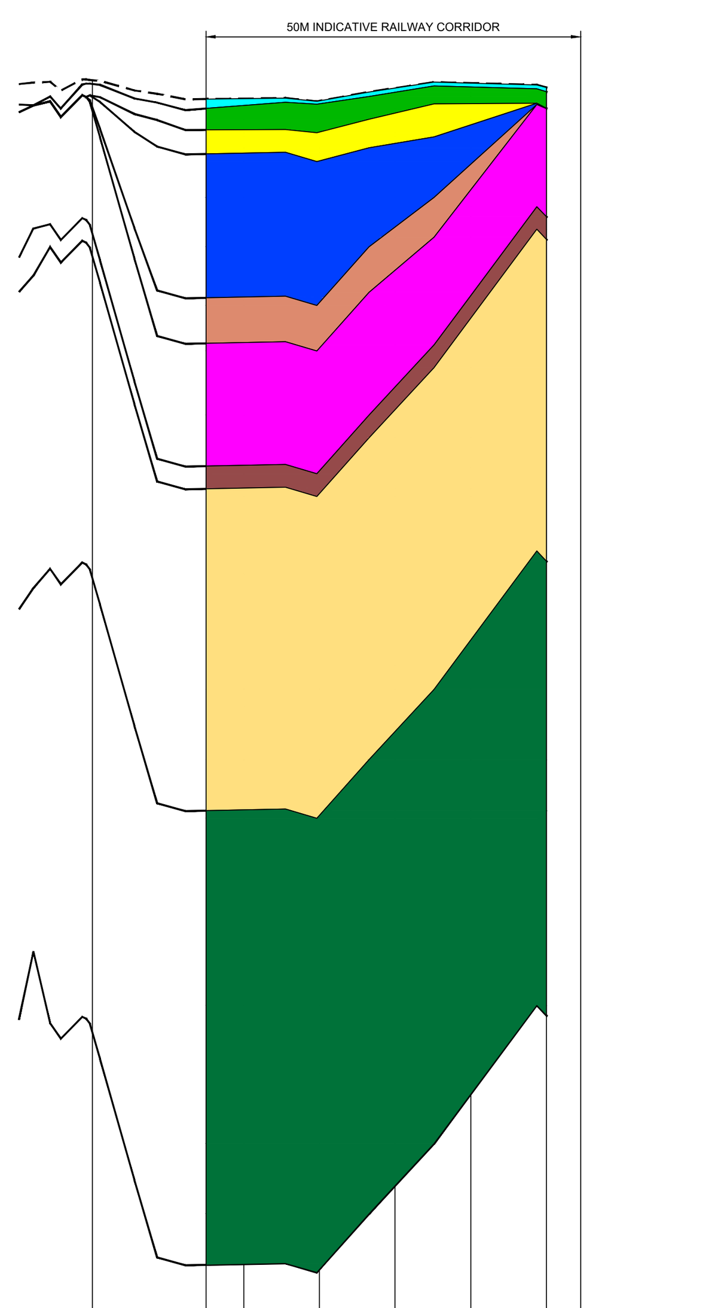
21054-Radlett-P-1 DRAFT, A2-Wat-BS-S





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H1 TOPSOIL-TOP LEVELS		72.765	72.348	72.279	72.217	72.557	72.687	72.572			
H2 MADE GROUND-TOP LEVELS		72.664	72.095	72.093	72.138	72.445	72.587	72.456			
H5 CAPPING LINER-TOP LEVELS		72.350	71.607	71.456	71.396	71.894	72.144	72.020			
H6 LANDFILL-TOP LEVELS		72.314	70.929	70.834	70.632	71.091	71.581	72.019			
H7 LANDFILL LINER-TOP LEVELS		72.031	67.129	67.034	66.893	68.882	70.539	72.015			
H8 CLAY SUPERFICIAL-TOP LEVELS		71.941	65.929	65.834	65.693	67.742	69.863	72.014			
H9 SAND AND GRAVEL SUPERFICIAL-TOP LEVELS		68.694	62.682	62.587	62.446	64.657	67.073	69.156			
H10 STRUCTURELESS CHALK-TOP LEVELS		68.095	62.083	61.988	61.847	64.058	66.474	68.557			
H11 STRUCTURED CHALK-TOP LEVELS		59.595	53.583	53.488	53.347	55.558	57.974	60.057			
H11 STRUCTURED CHALK-BASE LEVELS		47.595	41.583	41.488	41.347	43.558	45.974	48.057			

Datum: 40.00 mAOD

SECTION A-A
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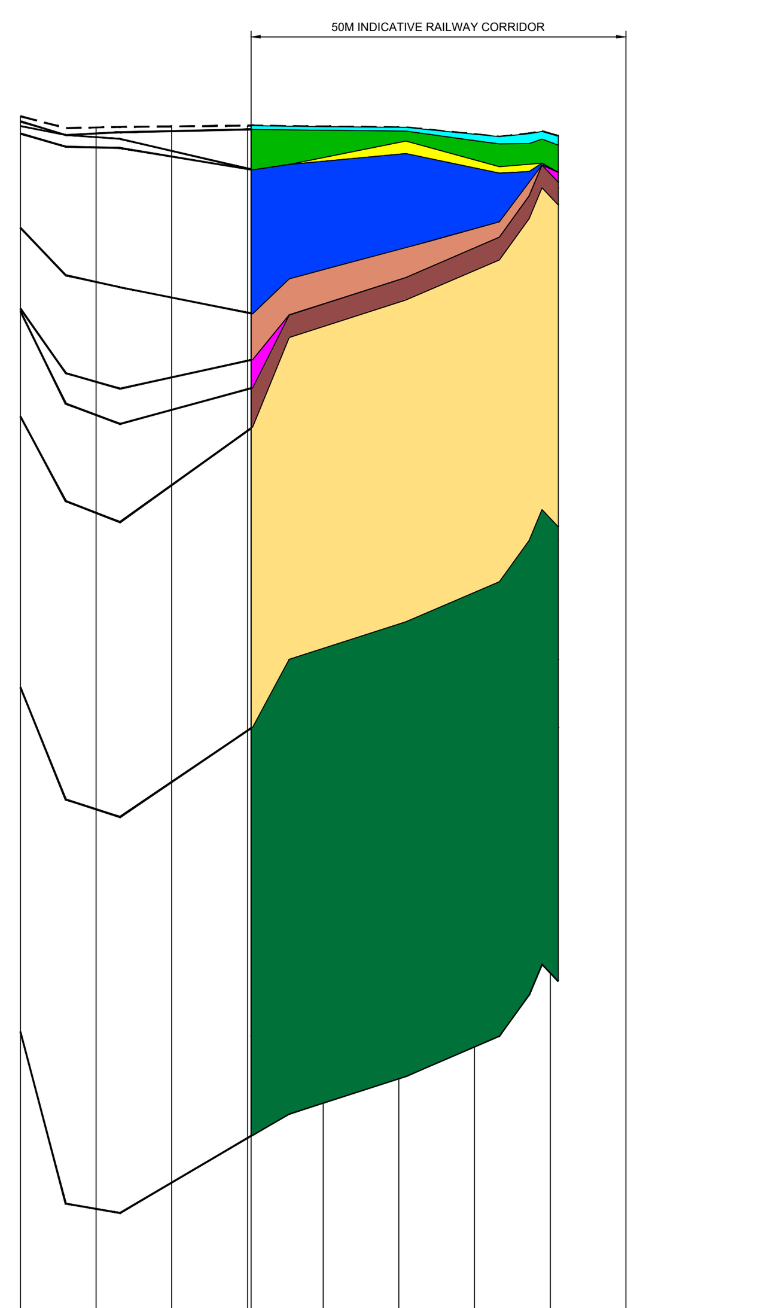

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H1 TOPSOIL-TOP LEVELS	71.811	71.516	71.543	71.564	71.540	71.519	71.339	71.349			
H2 MADE GROUND-TOP LEVELS	71.675	71.357	71.418	71.462	71.440	71.419	71.166	71.125			
H5 CAPPING LINER-TOP LEVELS	71.554	71.260	70.895	70.427	70.715	71.115	70.656	70.449			
H6 LANDFILL-TOP LEVELS	71.357	70.989	70.747	70.417	70.619	70.807	70.445	70.448			
H7 LANDFILL LINER-TOP LEVELS	68.867	67.435	67.021	66.622	67.756	68.290	68.842	70.421			
H8 CLAY SUPERFICIAL-TOP LEVELS	66.731	64.796	64.916	65.350	66.852	67.495	68.336	70.420			
H9 SAND AND GRAVEL SUPERFICIAL-TOP LEVELS	66.661	63.920	64.057	64.597	66.851	67.494	68.335	70.289			
H10 STRUCTURELESS CHALK-TOP LEVELS	63.884	61.333	62.071	63.505	66.252	66.895	67.736	69.690			
H11 STRUCTURED CHALK-TOP LEVELS	56.731	53.503	54.227	55.580	57.752	58.395	59.236	61.190			
H11 STRUCTURED CHALK-BASE LEVELS	47.634	42.946	43.642	44.819	45.752	46.395	47.236	49.190			

Datum: 40.00 mAOD

SECTION B-B
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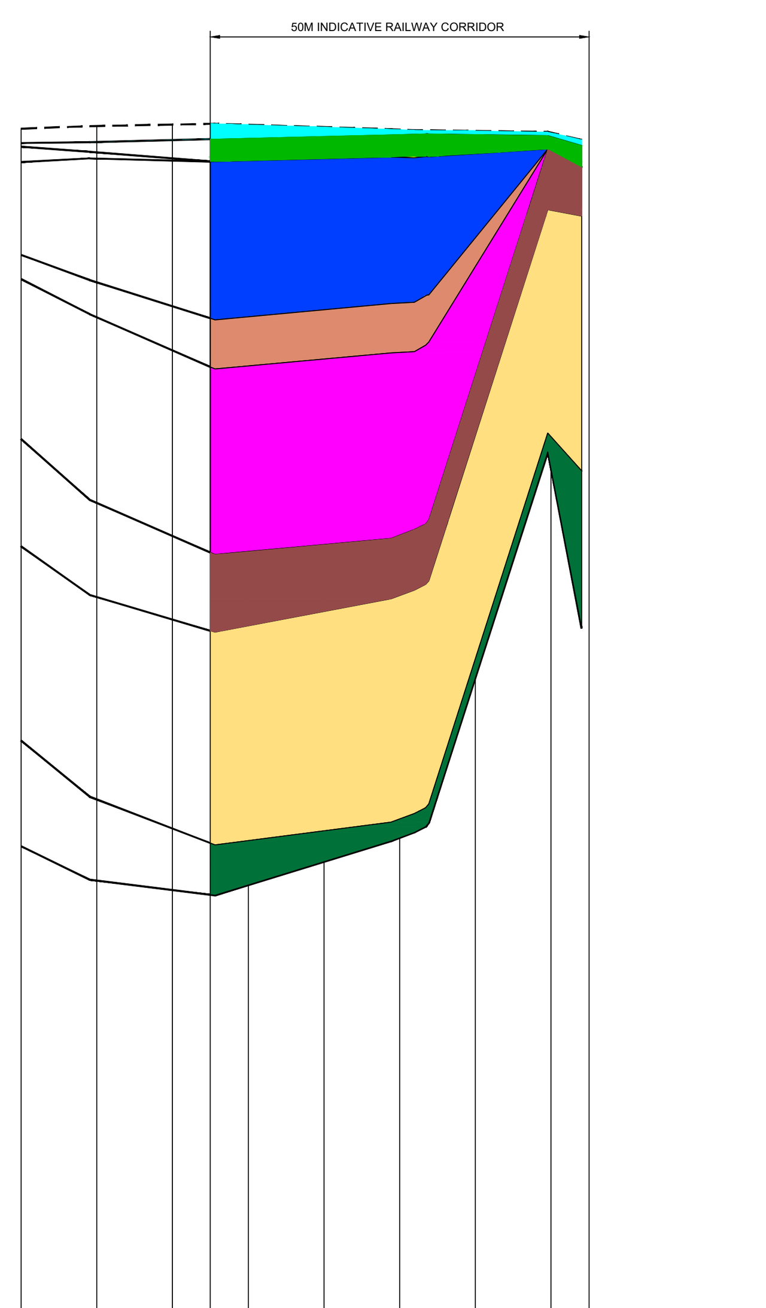

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H1 TOPSOIL-TOP LEVELS	71.484	71.554	71.591	71.585	71.524	71.461	71.423	71.376			
H2 MADE GROUND-TOP LEVELS	71.106	71.130	71.181	71.229	71.276	71.324	71.323	71.272			
H5 CAPPING LINER-TOP LEVELS	71.009	70.857	70.700	70.634	70.685	70.741	70.822	70.897			
H6 LANDFILL-TOP LEVELS	70.602	70.694	70.641	70.633	70.684	70.723	70.821	70.896			
H7 LANDFILL LINER-TOP LEVELS	68.150	67.427	66.791	66.513	66.698	66.873	68.602	70.895			
H8 CLAY SUPERFICIAL-TOP LEVELS	67.511	66.501	65.625	65.213	65.398	65.573	67.843	70.894			
H9 SAND AND GRAVEL SUPERFICIAL-TOP LEVELS	63.290	61.601	60.725	60.313	60.498	60.748	64.981	70.893			
H10 STRUCTURELESS CHALK-TOP LEVELS	60.451	59.112	58.518	58.350	58.728	59.149	63.382	69.325			
H11 STRUCTURED CHALK-TOP LEVELS	55.321	53.765	52.996	52.676	52.934	53.249	57.482	63.345			
H11 STRUCTURED CHALK-BASE LEVELS	52.531	51.621	51.373	51.502	52.118	52.749	56.982	62.495			

Datum: 40.00 mAOD

SECTION C-C
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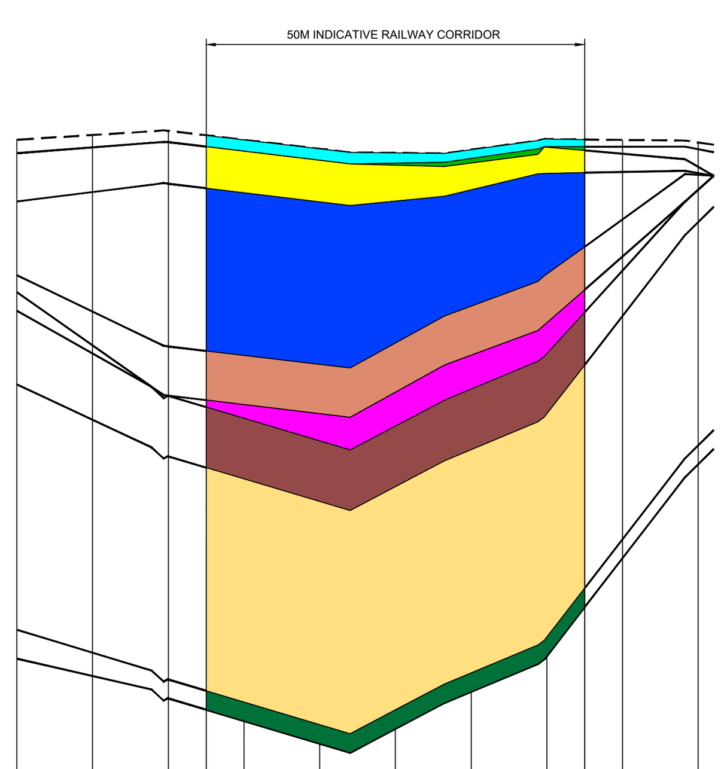

CHAINAGE	00.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
H1 TOPSOIL-TOP LEVELS	71.350	71.476	71.588	71.350	71.112	71.004	71.087	71.368	71.347	71.279	
H2 MADE GROUND-TOP LEVELS	70.998	71.151	71.288	71.049	70.810	70.733	70.854	71.165	71.167	71.101	
H5 CAPPING LINER-TOP LEVELS	70.997	71.150	71.287	71.048	70.809	70.680	70.736	71.158	70.981	70.635	
H6 LANDFILL-TOP LEVELS	69.721	69.968	70.188	69.949	69.710	69.730	70.024	70.462	70.498	70.469	
H7 LANDFILL LINER-TOP LEVELS	67.771	66.807	65.888	65.649	65.410	65.976	66.953	67.799	69.247	70.423	
H8 CLAY SUPERFICIAL-TOP LEVELS	67.327	65.918	64.588	64.349	64.110	64.676	65.653	66.508	68.267	70.031	
H9 SAND AND GRAVEL SUPERFICIAL-TOP LEVELS	66.833	65.701	64.585	63.987	63.389	63.780	64.757	65.691	67.896	70.030	
H10 STRUCTURELESS CHALK-TOP LEVELS	64.886	63.950	62.986	62.388	61.790	62.181	63.158	64.104	66.692	69.174	
H11 STRUCTURED CHALK-TOP LEVELS	58.402	57.793	57.086	56.488	55.890	56.281	57.258	58.204	60.792	63.274	
H11 STRUCTURED CHALK-BASE LEVELS	57.637	57.177	56.586	55.988	55.390	55.781	56.758	57.704	60.292	62.774	

Datum: 40.00 mAOD

SECTION D-D
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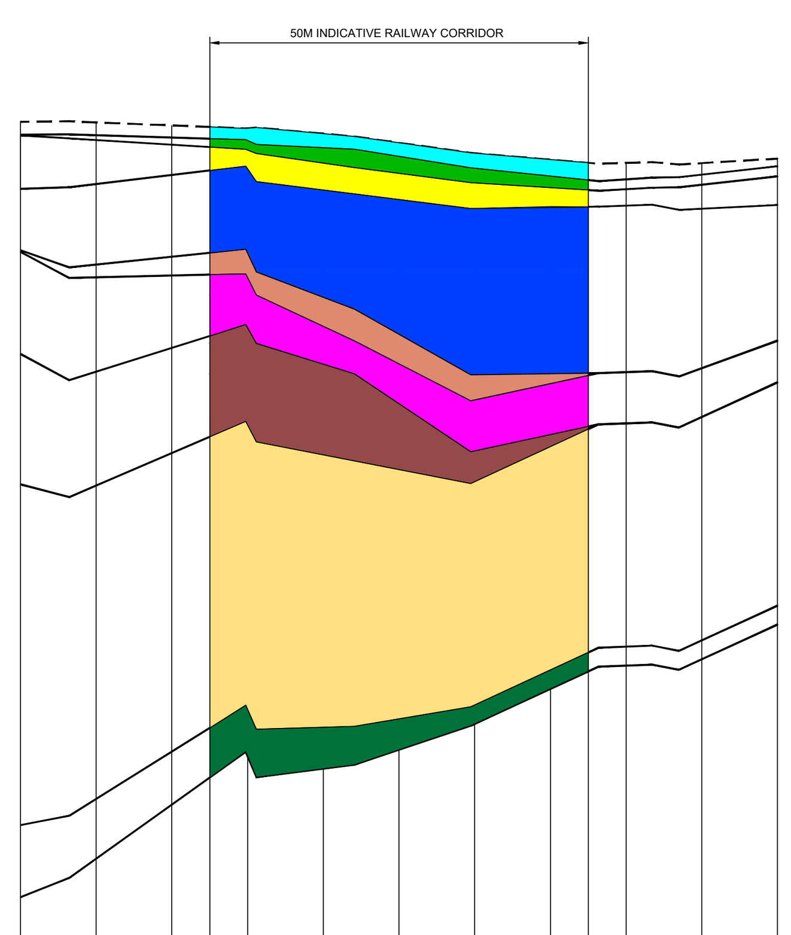

CHAINAGE	00.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
H1 TOPSOIL-TOP LEVELS	71.826	71.811	71.730	71.655	71.512	71.272	70.996	70.828	70.741	70.735	70.854
H2 MADE GROUND-TOP LEVELS	71.486	71.475	71.413	71.331	71.142	70.913	70.598	70.389	70.304	70.432	70.652
H5 CAPPING LINER-TOP LEVELS	71.470	71.346	71.222	71.084	70.736	70.464	70.210	70.085	70.046	70.164	70.385
H6 LANDFILL-TOP LEVELS	70.052	70.182	70.420	70.587	70.026	69.775	69.540	69.567	69.611	69.530	69.628
H7 LANDFILL LINER-TOP LEVELS	68.433	68.052	68.258	68.361	67.186	66.208	65.140	65.167	65.211	65.318	66.042
H8 CLAY SUPERFICIAL-TOP LEVELS	68.394	67.717	67.765	67.718	66.420	65.431	64.480	64.910	65.210	65.317	66.041
H9 SAND AND GRAVEL SUPERFICIAL-TOP LEVELS	65.695	65.225	65.853	66.385	65.423	64.377	63.131	63.561	63.861	64.026	64.942
H10 STRUCTURELESS CHALK-TOP LEVELS	62.251	62.214	63.073	63.824	63.043	62.654	62.320	63.245	63.860	64.025	64.941
H11 STRUCTURED CHALK-TOP LEVELS	53.245	53.937	55.187	56.304	55.829	56.053	56.420	57.345	57.960	58.125	59.041
H11 STRUCTURED CHALK-BASE LEVELS	51.338	52.360	53.787	55.070	54.734	55.235	55.920	56.845	57.460	57.625	58.541

Datum: 40.00 mAOD

SECTION E-E
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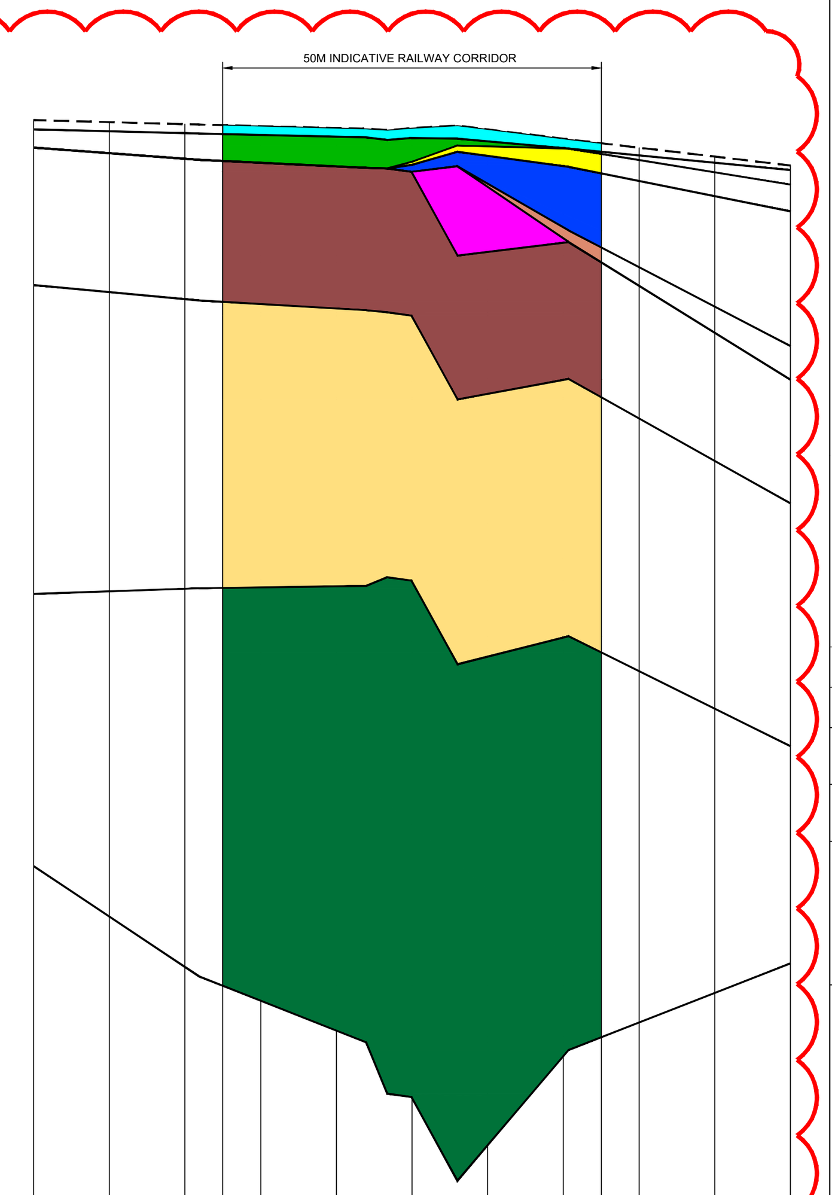


CHAINAGE	00.00	10.00	20.00	30.00	40.00	50.00	60.00	70.00	80.00	90.00	100.00
H1 TOPSOIL-TOP LEVELS	72.536	72.482	72.427	72.376	72.326	72.323	72.291	72.041	71.805	71.571	71.336
H2 MADE GROUND-TOP LEVELS	72.289	72.239	72.188	72.141	72.094	72.059	71.975	71.798	71.604	71.409	71.215
H5 CAPPING LINER-TOP LEVELS	71.812	71.664	71.516	71.409	71.312	71.435	71.842	71.788	71.481	71.155	70.829
H6 LANDFILL-TOP LEVELS	71.811	71.663	71.515	71.408	71.311	71.355	71.591	71.320	70.927	70.524	70.122
H7 LANDFILL LINER-TOP LEVELS	71.810	71.662	71.514	71.407	71.310	71.170	70.855	69.700	68.649	67.607	66.565
H8 CLAY SUPERFICIAL-TOP LEVELS	71.809	71.661	71.513	71.406	71.309	71.169	70.771	69.407	68.156	66.914	65.672
H9 SAND AND GRAVEL SUPERFICIAL-TOP LEVELS	71.808	71.660	71.512	71.405	71.308	71.141	69.051	69.293	68.155	66.913	65.671
H10 STRUCTURELESS CHALK-TOP LEVELS	68.174	67.990	67.805	67.675	67.557	67.341	65.301	65.669	64.651	63.529	62.407
H11 STRUCTURED CHALK-TOP LEVELS	68.174	67.990	67.805	67.675	67.557	67.341	65.301	65.669	64.651	63.529	62.407
H11 STRUCTURED CHALK-BASE LEVELS	52.819	51.487	50.155	49.264	48.472	46.691	45.445	47.799	48.689	49.469	50.249

Datum: 40.00 mAOD

SECTION F-F
SCALE: H 1:1000,V 1:200. DATUM: 40.000

P02

1:1000 0 10m 20m 30m 40m 50m 60m 70m 80m 90m 100m
1:1 0 10 20 30 40 50 60 70 80 90 100

Key:

- H1 Topsoil
- H2 Made Ground
- H5 Landfill Capping Liner
- H6 Landfill
- H7 Landfill Basal Liner
- H8 Clay Superficial
- H9 Sand and Gravel Superficial
- H10 Structureless Chalk
- H11 Structured Chalk

Notes:

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
2. This drawing is to be read in conjunction with all relevant architects, engineers and specialists drawings and specifications.
3. All dimensions in millimetres unless noted otherwise. All levels in metres unless noted otherwise.
4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. Quantities are calculated considering an indicative 50m railway corridor within the indicative Landfill Boundary.
6. Soil horizons have been modeled based on the information shown in the document RAD-WAT-A2EX-XX-SH-C-0002

Rev	Date	Description	By
P02	21.02.23	SECTION F–F ADDED	ZT
P01	09.02.23	DRAFT	ZT

Amendments

Project
RADLETT

Title
INDICATIVE RAILWAY WORKS CORRIDOR PLAN & CROSS SECTIONS

Client
SEGRO UK

waterman
mail@watermangroup.com www.watermangroup.com

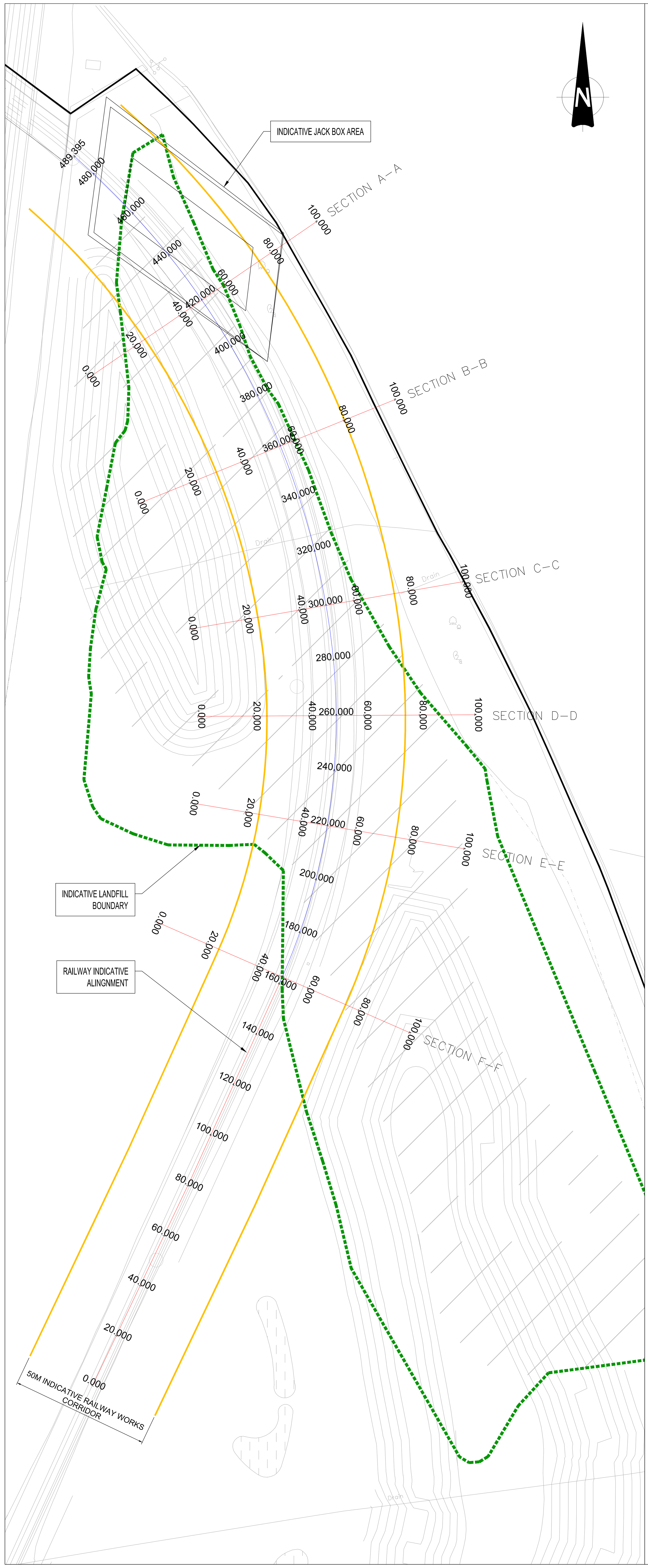
Suitability: WORK IN PROGRESS S0

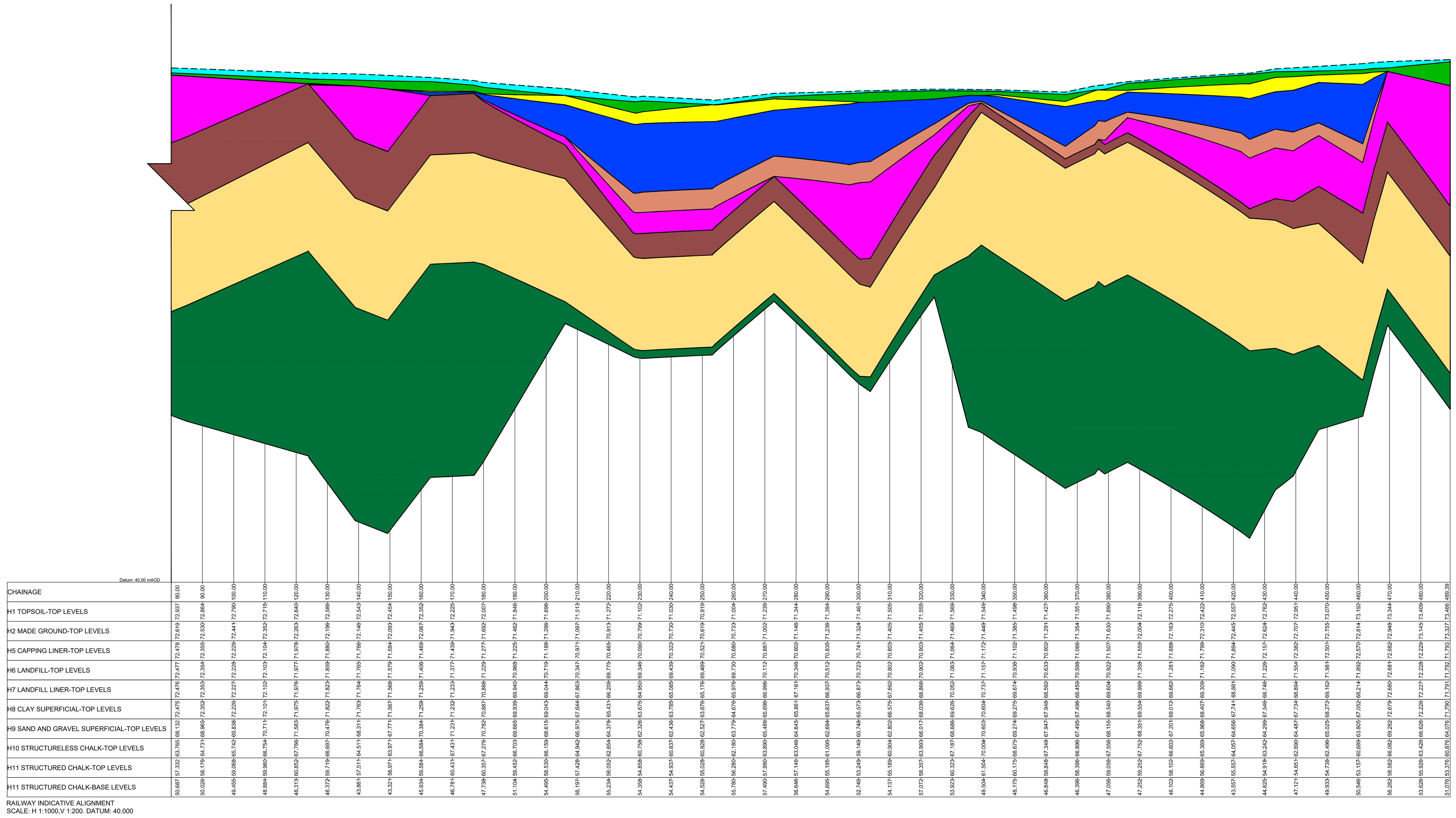
Designed By	ZT	Checked By	FA	Waterman Ref	WIE18710
Drawn By	ZT	Date	21/02/23	Scales @ A1	1:1000

Project - Originator - Volume - Level - Type - Role - Number: RAD-WAT-A2EX-XX-DS-C-0001

Revision: P02

File Path





1:1000 0 10m 20m 30m 40m 50m 60m 70m 80m 90m 100m

1:1 0 10 20 30 40 50 60 70 80 90 100

Key:

- H1 Topsoil
- H2 Made Ground
- H5 Landfill Capping Liner
- H6 Landfill
- H7 Landfill Basal Liner
- H8 Clay Superficial
- H9 Sand and Gravel Superficial
- H10 Structureless Chalk
- H11 Structured Chalk

Notes:

1. Do not scale this drawing. All dimensions must be checked/ verified on site. If in doubt ask.
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4. Any discrepancies noted on site are to be reported to the engineer immediately.
5. Quantities are calculated considering an indicative 50m railway corridor within the indicative Landfill Boundary.
6. Soil horizons have been modeled based on the information shown in the document RAD-WAT-A2EX-XX-SH-C-0002

Rev	Date	Description	By
P01	21.02.23	DRAFT	ZT

Amendments

Project

RADLETT

Title

INDICATIVE RAILWAY WORKS CORRIDOR PLAN & LONG SECTION

Client

SEGRO UK

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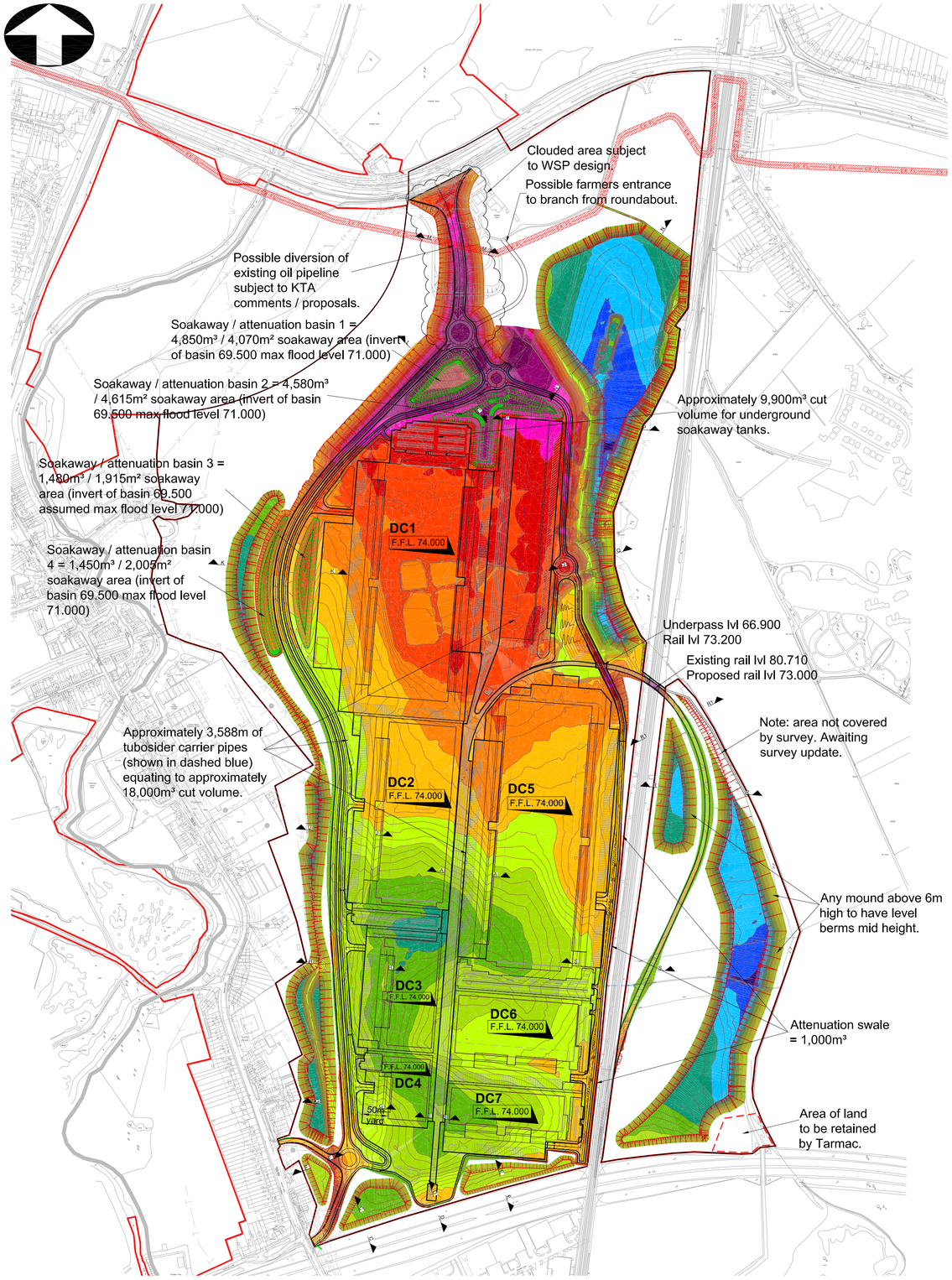
Suitability: WORK IN PROGRESS S0

Designed By	ZT	Checked By	FA	Waterman Ref	WIE18710
Drawn By	ZT	Date	21/02/23	Scales @ A1	1:1000

Project - Originator - Volume - Level - Type - Role - Number: RAD-WAT-A2EX-XX-DS-C-0002

Revision: P01

File Path



Existing Topsoil Site Strip:

238,750m³

For details refer to drawing 018844-420.

Note:

For assumed minimum construction depths and areas refer to drawing 018844-423.

Earthwork quantities to underside of imported sub-base:

Cut and fill volumes required to achieve formation level are: (bulking factor of 1.025 applied to CUT)

Access roads:		
Cut volume	=	396,150m³
Fill volume	=	26,200m³
NET (cut/surplus)	=	369,950m³
Warehouse units (smaller units):		
Cut volume	=	0m³
Fill volume	=	222,850m³
NET (fill/required)	=	222,850m³
Warehouse units (large units):		
Cut volume	=	391,950m³
Fill volume	=	164,100m³
NET (cut/surplus)	=	227,850m³
Heavy duty service yards:		
Cut volume	=	433,350m³
Fill volume	=	36,300m³
NET (cut/surplus)	=	397,050m³
Service yards and car parks:		
Cut volume	=	323,000m³
Fill volume	=	290,900m³
NET (cut/surplus)	=	32,100m³
Train tracks:		
Cut volume	=	129,600m³
Fill volume	=	49,850m³
NET (cut/surplus)	=	79,750m³
Landscaping:		
Cut volume	=	874,500m³
Fill volume	=	1,790,200m³
NET (fill/required)	=	915,700m³
TOTAL:		
Cut volume	=	2,548,550m³
Fill volume	=	2,580,400m³
Total (fill/required)	=	**31,850m³**

Summary:

Allowing for the following:
9,900m³ underground attenuation tank below DC1 car park
18,000m³ for carrier pipes running across site
1,000m³ for swale running along Eastern internal road
Total cut from above = 28,900m³
Remaining fill to come from surplus airsings from drainage and services, therefore cut and fill balance achieved.

SURFACE ELEVATION DATA

NUMBER	MINIMUM ELEVATION	MAXIMUM ELEVATION	COLOR
1	-18.00	-16.00	
2	-16.00	-14.00	
3	-14.00	-12.00	
4	-12.00	-10.00	
5	-10.00	-8.00	
6	-8.00	-6.00	
7	-6.00	-4.00	
8	-4.00	-2.00	
9	-2.00	0.00	
10	0.00	2.00	
11	2.00	4.00	
12	4.00	6.00	
13	6.00	8.00	
14	8.00	10.00	
15	10.00	12.00	
16	12.00	14.00	

Note:
Surface elevation isopachytes (colours) shown on plan and key are calculated from existing survey information to proposed formation levels.

Drawings:

Topographical survey - SEP drawing ref. S10885-T rev -.
Architects layout plan - SGP drawing ref. 15-857 K017-Option 10 Planning.

For visual reference only. Does not reflect the latest proposed development

WORK IN PROGRESS
For information Only

The findings on the drawing are subject to a full detail Geotechnical site investigation report and assessment.

THIS DRAWING IS FOR INFORMATION PURPOSES ONLY AND THE MAIN CONTRACTOR MUST CARRY OUT HIS OWN CUT AND FILL ANALYSIS TO SATISFY HIMSELF AS TO THE ACCURACY OF THE CUT AND FILL VOLUMES.

THE LEVELS AND VOLUMES ON THIS DRAWING ARE PRELIMINARY ONLY AND NOT TO BE USED FOR CONSTRUCTION PURPOSES.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

Refer to the relevant Construction (Design and Management) documentation where applicable.

It is assumed that all works on this drawing will be carried out by a competent contractor, working where appropriate to an approved method statement.

NOTES:

1. Earthworks volumes are calculated from existing survey to proposed formation levels and exclude arisings from excavations for drainage and foundations.
2. Cut and fill isopachytes shown on this drawing are calculated from existing survey information to proposed formation levels. As such, they include existing construction thicknesses unless noted otherwise. They do not include the proposed new construction thicknesses and do not include a bulking factor.
3. Cut and fill exercise allows for a bulking factor of 1.025 to cut volume only.
4. The cut and fill isopachytes and volumes assume that all cut material are suitable to be re-used as fill material.
5. The topsoil thicknesses and volumes shown on this drawing are assumed and to be confirmed on site.
6. Additional testing of head deposits is required to certain areas of the site and a volume of material may need to be stabilised prior to reuse as fill material.
7. All earthworks are to be undertaken in conjunction with Capita NBS Specification. Full method statement to be provided for approval by the Engineer prior to any work commencing on site.
8. All cut and fill quantities are preliminary and are to be verified by quantity surveyor for cost estimating purposes.

Rev	Date	By	Description	Rev' check
P01	01.07.16	NDH	SOAKAWAY NO. 4 AND CARRIER DRAINS ADDED TO CALCULATIONS AND EASTERN MOUND AMENDED TO SUIT BALANCE.	NRB

Drawing status
PRELIMINARY

Client
heliosslough

Project
RADLETT SRFI
HERTFORDSHIRE

Drawing
EARTHWORKS ANALYSIS
CUT AND FILL VOLUMES

Scale @ A1	Drawn	Checked
1:5000	NDH	NRB
Project No.	**Date**	**Office**
SS/018844	June 2016	WATFORD

Drawing Identifier (BS1192:2007 / Avanti Compliant)

project	origin	zone	level	file type	role	number	revision
018844	-CA-	0	- GF -	DR	- S -	422	- P01

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B. Ground Investigation Data Interpretation – Graphs

waterman	SPT N Value
Project ID: **WIE18710**	Project Title: **Ground Conditions Report**
Client: **Segro**	Location: **Radlett, SRFI Area 2**

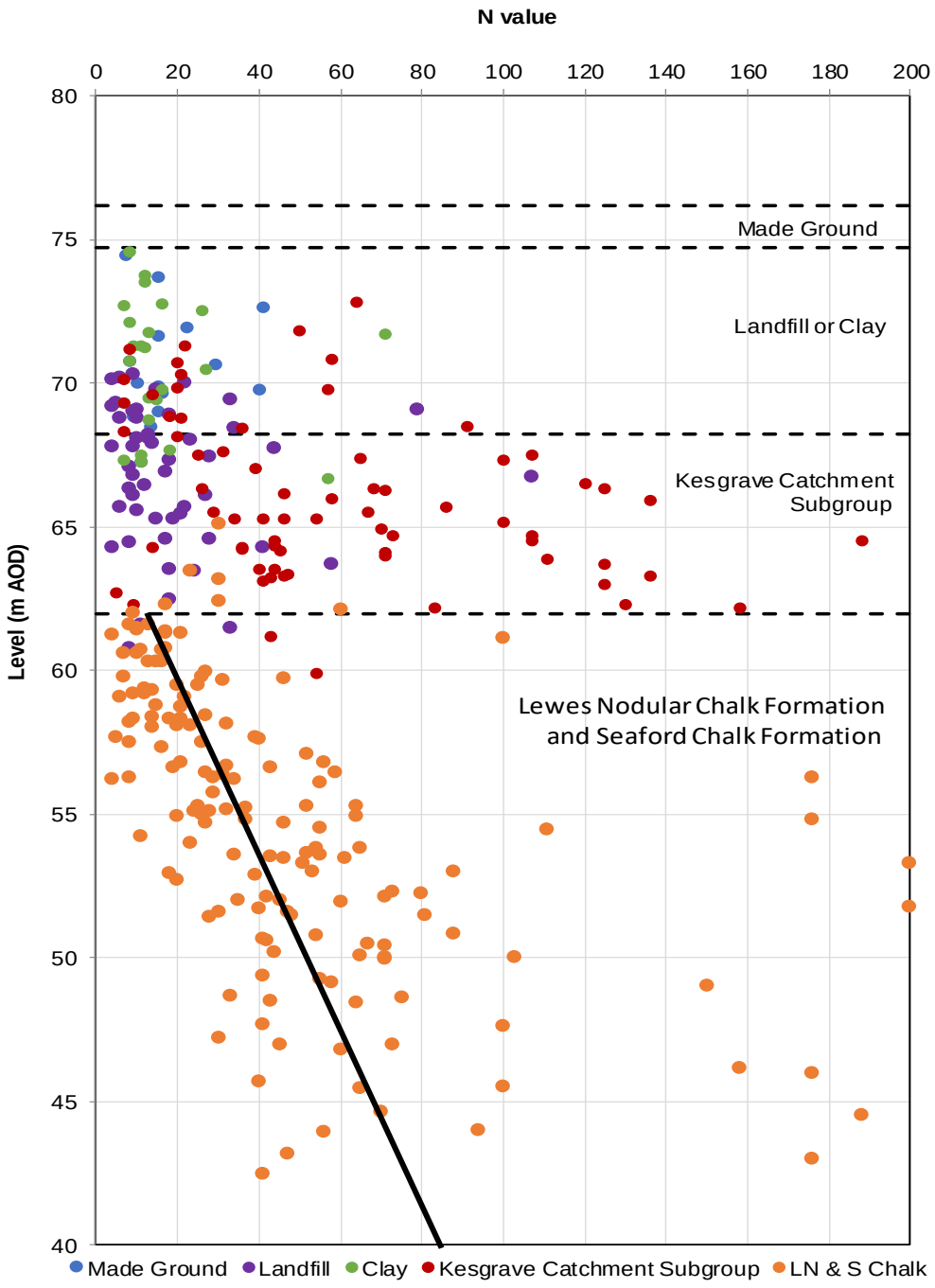

Figure G1: **SPT value versus level (all strata)**

waterman	Unit Weight		
Project ID:	**WIE18710**	Project Title:	**Ground Conditions Report**
Client:	**Segro**	Location:	**Radlett, SRFI Area 2**

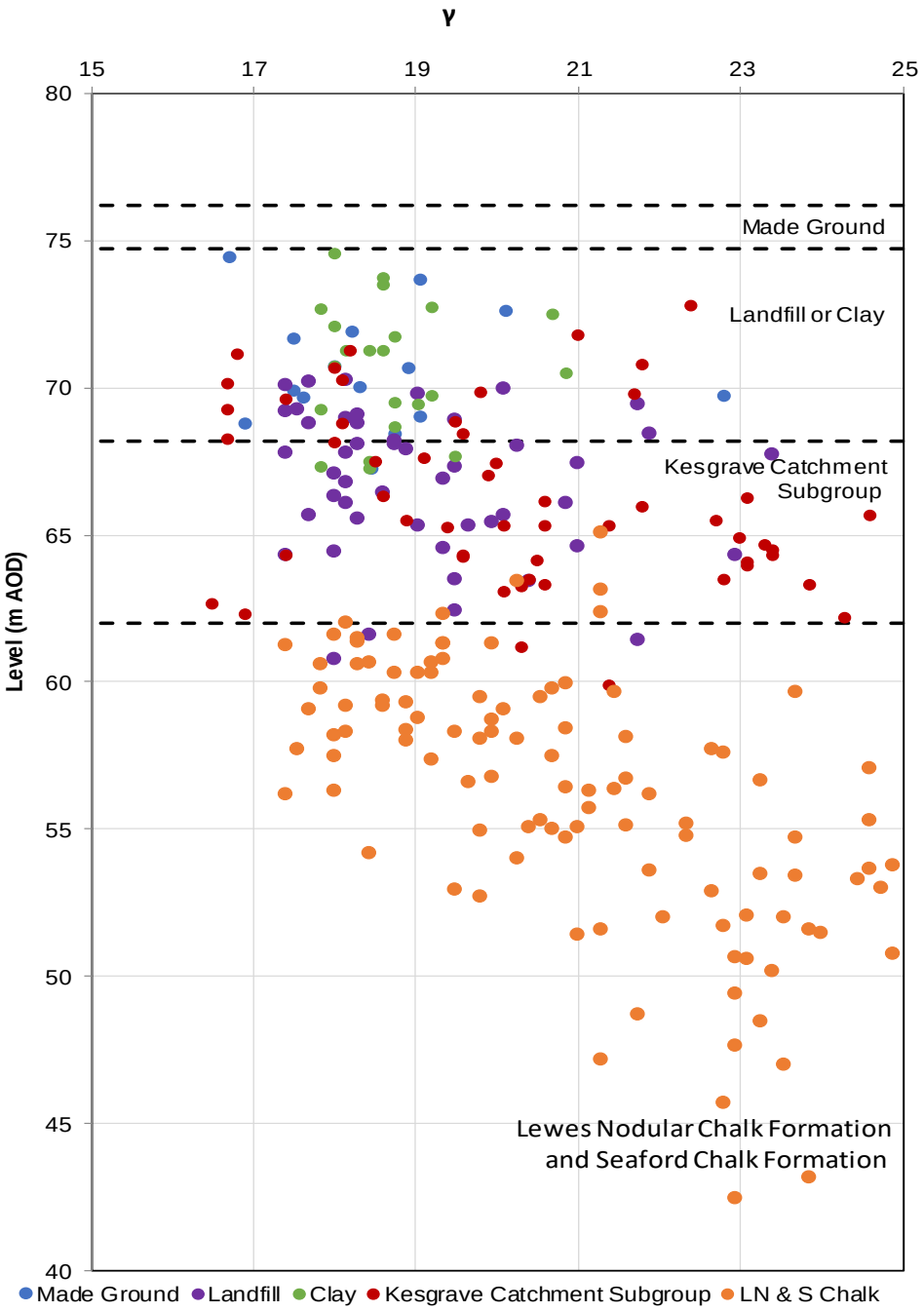

Figure G2: **Unit weight versus level (all strata)**

waterman	Undrained Shear Strength		
Project ID:	**WIE18710**	Project Title:	**Ground Conditions Report**
Client:	**Segro**	Location:	**Radlett, SRFI Area 2**

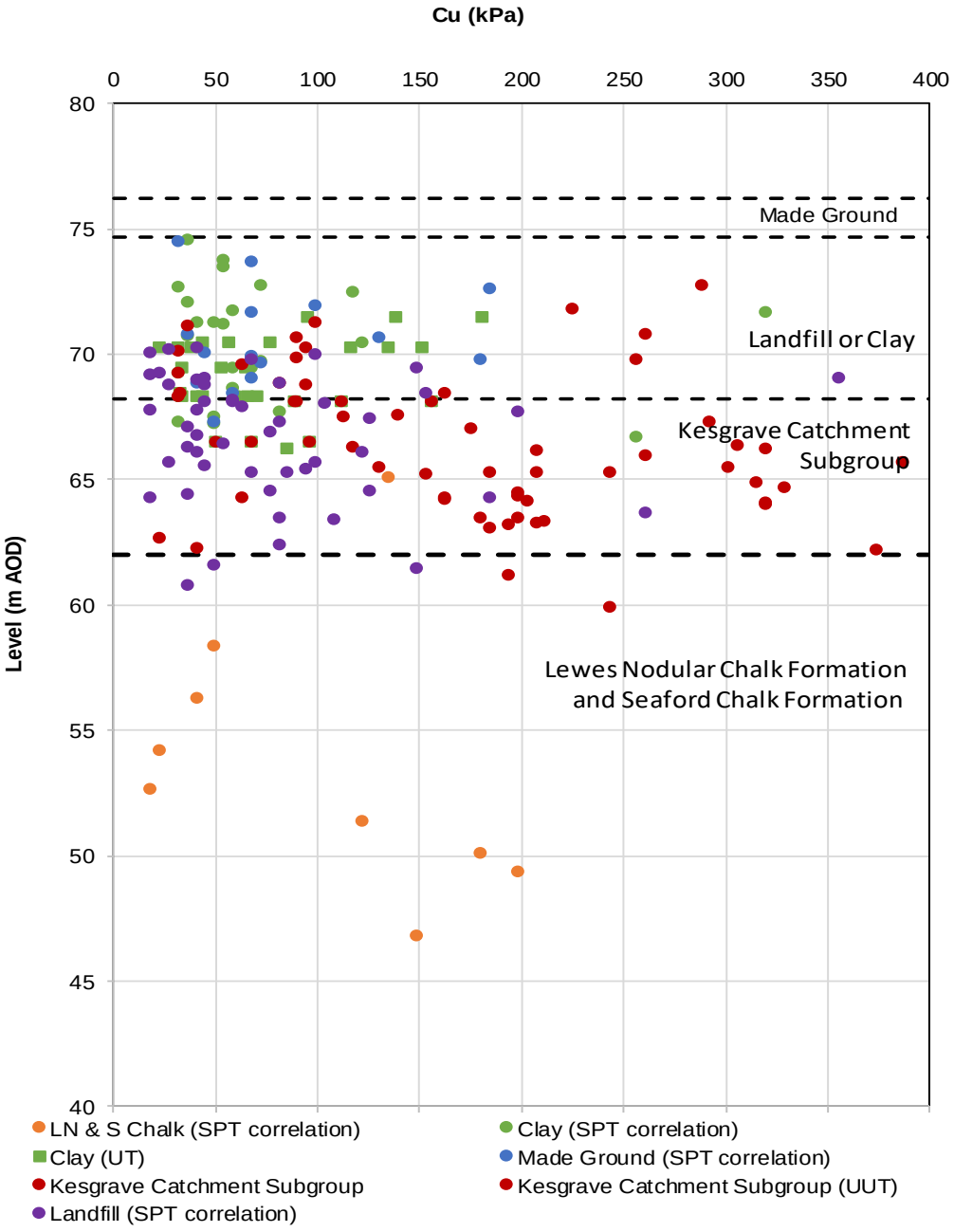

Figure G3: **Undrained shear strength versus level (cohesive strata)**

waterman	Internal angle of friction	
Project ID:	**WIE18710**	Project Title: **Ground Conditions Report**
Client:	**Segro**	Location: **Radlett, SRFI Area 2**

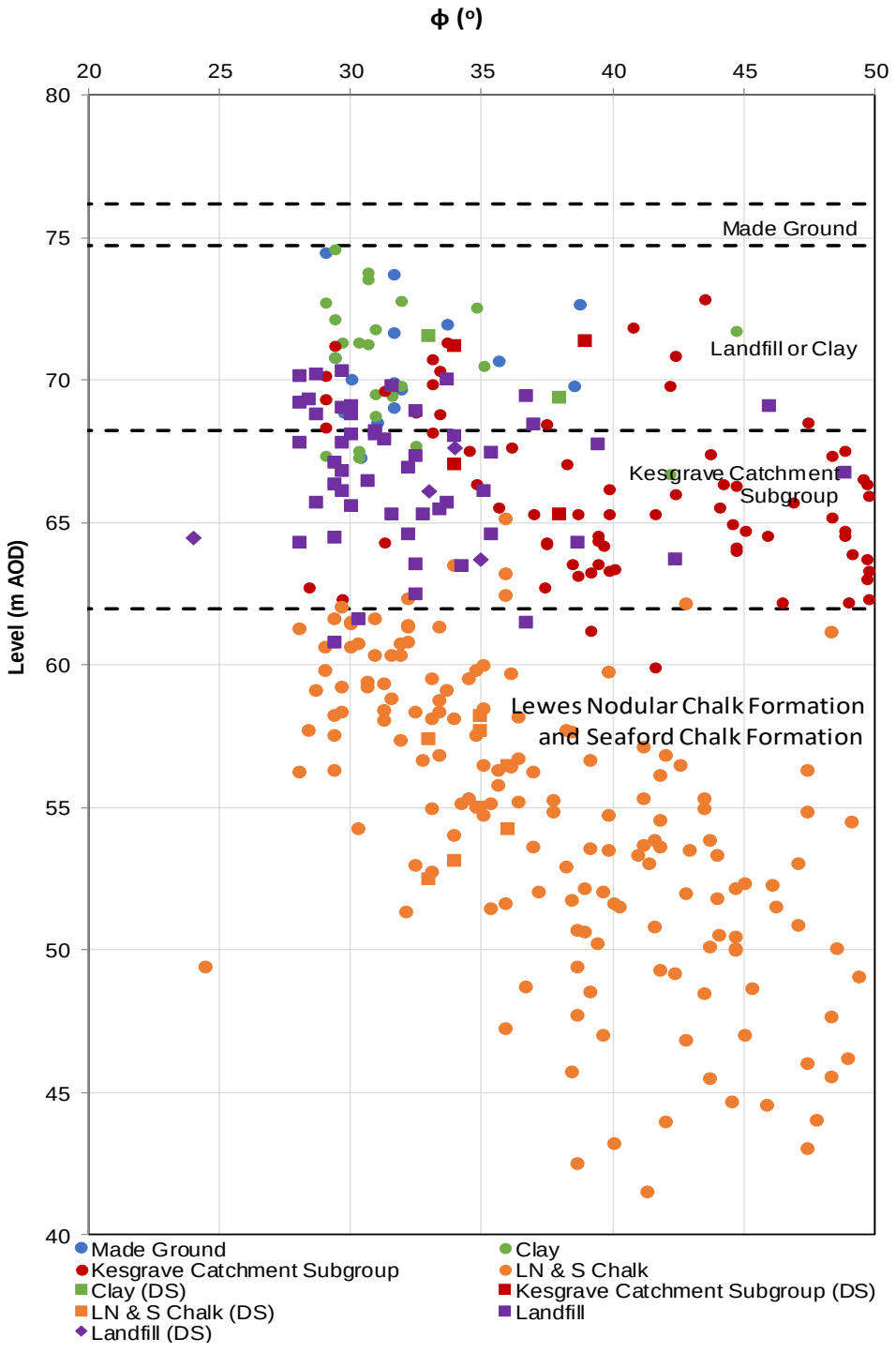

Figure G4: **Angle of shearing resistance versus level (all strata)**

waterman		A Line Plot	
Project ID:	**WIE18710**	Project Title:	**Ground Conditions Report**
Client:	**Segro**	Location:	**Radlett, SRFI Area 2**

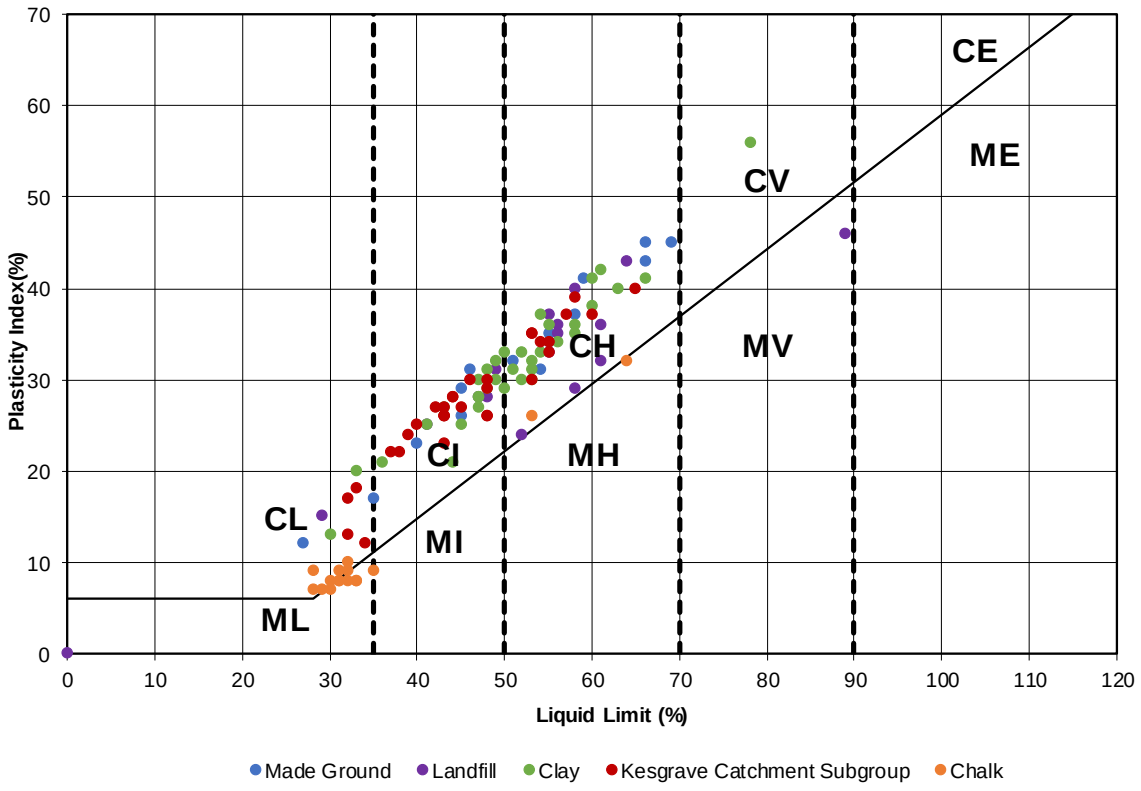

Figure G6: A-Line plot for all strata

C. Geotechnical Risk Register

Likelihood		Severity				
		1	2	3	4	5
		Minor	Moderate	Serious	Major	Catastrophic
1	Extremely unlikely	1	2	3	4	5
2	Unlikely	2	4	6	8	10
3	Likely	3	6	9	12	15
4	Extremely likely	4	8	12	16	20
5	Almost certain	5	10	15	20	25

Potential severity of harm occurring		
1	Minor	Minor damage or loss – (No human injury)
2	Moderate	Moderate damage or loss – (Slight injury or illness)
3	Serious	Substantial damage or loss – (Serious injury or illness)
4	Major	Major damage or loss – (Fatal injury or illness)
5	Catastrophic	Catastrophic damage or loss – (multiple fatalities)

Risk Classification	
Low (1 – 8)	Ensure assumed control measures are maintained and reviewed as necessary
Medium (9 – 19)	Additional control measures needed to reduce risk rating to a level that is equivalent to a test of 'reasonably required' for.
High (20 – 25)	Activity not permitted. Hazard to be avoided or risk to be reduced to tolerate level.

Risk ID	Hazard	Consequence	Likelihood	Severity	Risk	Mitigation	Likelihood	Severity	Residual Risk
1	Contamination in Made Ground and shallow soils from on-site and adjacent off-site land uses of landfill	Impact on the design of landscaping bunds and rail chord	3	3	9	A watching brief for contamination should be undertaken during the works. Should contamination be identified and the material in question is not required to be excavated as part of the works, then risk assessment should be undertaken to identify the most appropriate action going forward. Where imported topsoil/subsoil is required, this should be certified as clean and undergo chemical analysis to demonstrate it is protective of human health and suitable for use in a residential setting.	2	2	4
2	Variable composition of Made Ground with low bearing capacity for slope stability.	Not adequate strength to support slopes in landscape bund and rail chord construction.	4	2	8	Embankment would require suitable place and compacted granular Engineering Fill, with a minimum shearing resistance to be calculated in slope stability/ground movement analysis.	1	3	3
3	Low CBR values from laboratory test results (less than 2%).	Low CBR values lead to unsuitable foundation layer for the design of rail chord.	2	2	4	It is recommended that additional design CBRs should be confirmed during construction, by undertaking in-situ CBR	1	2	2

						testing after proof-rolling of formation. If soft spots are encountered during construction, they should be compacted or replaced with the engineering fill to achieve the required CBR.			
4	Design Sulphate (DS) and Aggressive Chemical Environment for Concrete (ACEC) classifications for Landfill/Clay - Class DS-3 and AC-3	Highly corrosive environment for concrete design	4	4	16	Piled foundations and deep concrete structures to take into account the chemical reaction with the soil and consider a protection layer.	2	2	4
5	Pile capacities not as anticipated due to weak / fractured zones in the founding layer.	Instability/failure of structures due to bearing capacity failure	3	5	15	Final design of the piles should be carried out in accordance with the individual existing GI information related to each location. Pile testing is required to assess the pile capacities on site and validate the final design.	2	4	8
6	Potential existence of soft made ground material on site	Cause of excessive ground settlements or differential settlements to proposed rail chord and landscape bunds.	4	4	16	Necessary ground improvement (eg: excavate and replace) for the soft spots identified on site	2	3	6
7	High groundwater table	High risk of flooding and accumulation of excessive pore water pressure.	4	2	8	Flood risk assessment to be conducted and appropriated drainage system may need to be designed to control water level	2	2	4
8	Poorly backfilled/reinstated longitudinal service tranches and leaking pipework.	Water ingress into excavations causing instability/failure.	4	4	16	Ensure appropriate specification documentation provided to site personnel to	1	4	4

		emphasise the need to mitigate the risk. Works to be supervised by an appropriate qualified geotechnical professional.	

waterman

UK and Ireland Office Locations