9 Ground Conditions and Contamination

Preface

This preface highlights the new and amended information that has been included within this chapter since the 2023 ES.

- **Section 9.3: Methodology - Table 9.2:** Consultation Responses are updated with comments made by relevant stakeholders on the 2023 ES and how they have been addressed in the updated chapter.
- **Section 9.4: Baseline Conditions -** The Baseline Condition data has been updated to include the Grand Union Canal (GUC), as well as the most up to date surface water sampling data from Broadwater Lake progressed by the Environment Agency. All other baseline data remains as per the previous ES Chapter.
- **Sections 9.6 and 9.7:** Assessment of Effects - The assessment has been updated to include the revised Proposed Development drawings and plans, notably the significantly reduced extent of dredging and land reclamation in Chapter 4: Alternatives. An updated assessment of risks to the Proposed Development associated with ground gas is provided in response to comments made on the 2023 ES by LBH and Environment Agency.
- **Appendix 9.6: Lake Bed Sediment Sampling -** This new appendix provides information on lake sediment sampling from the currently proposed dredging areas within the Eastern Channel of Broadwater Lake. Lake bed samples have also been collected to determine the type of materials present across Broadwater Lake.
- **Appendix 9.7: Lake Bed Photos -** This new Appendix provides images from a submarine survey which was undertaken of the lake by Greengage in September and October 2024, and March 2025 to provide visual evidence of the materials and ground conditions present across the lake bed).
- **Appendix 9.8: Relevant EA Correspondence** – This new Appendix provides copies of the correspondence with the Environment Agency following submission of the 2023 Scheme of relevance to the assessment including written responses and meeting minutes.
- **Appendix 9.9: Relevant EA Correspondence** – This new Appendix provides a review of updated Groundsure Desk Study Searches undertaken in August 2025.
- The assessment of effects on surface water and groundwater quality is now covered entirely in Chapter 8: Water Resources and Flood Risk.

9.1 Introduction

9.1.1 This chapter of the ES was prepared by Hydrogeo Ltd and presents an assessment of the likely significant effects of the Proposed Development in relation to potential, existing and historic ground contamination. The Proposed Development also consists of areas of land reclamation that need to be considered in regard to land stability, ground contamination and ground gas risks.

9.1.2 Mitigation measures are identified, where appropriate, to avoid, reduce or offset any significant adverse effects identified and / or enhance likely beneficial effects. The nature and significance of the likely residual effects are reported.

9.1.3 The chapter has been informed the following appendices:

- Appendix 9.1: Relevant Planning Policy;
- Appendix 9.2: Geo-Integrity Phase I Geo-environmental Assessment and Site Walkover September 2023 ('Phase 1 Geo-environmental Assessment');
- Appendix 9.3: Geo-Integrity Phase II Geo-Environmental Site Investigation. September 2023. ('Phase II Site Investigation');
- Appendix 9.4: Drawing 1 Landfill Locations Within The Study Area;
- Appendix 9.5: Preliminary Explosive Ordnance Risk Assessment;
- Appendix 9.6: Lake Bed Sediment Sampling;
- Appendix 9.7: Lake Bed Photos;
- Appendix 9.8: Relevant Environment Agency Correspondence; and
- Appendix 9.9: Review of Updated Groundsure Desk Study Searches.

9.1.4 This chapter considers groundwater and surface water in so much as they interact with land contamination. The effects on groundwater, hydrogeology and water quality are assessed further in Chapter 8: Water Resources and Flood Risk.

Competence

9.1.5 This assessment has been overseen and approved by Mike Willis and Chris Betts. Mike has over 20 years' experience in the geo-environmental industry specialising in contaminated land, site investigation, risk assessment and remediation. Mike is a Director at Hydrogeo Ltd, and a Fellow of the Geological Society (FGS). Chris is a Chartered Geologist and has expertise in undertaking Geological and Hydrogeological Assessments for a wide range of developments. The team are well experienced in advising waste management, water resource, energy schemes, minerals, commercial, industrial and residential developments.

9.1.6 This work has been prepared by Scott Greaves. Scott has five years of experience undertaking geo-environmental projects. Scott has a master's degree in Applied Environmental Geology (Cardiff University) and is a Fellow of the British Geological Society (FGS).

9.2 Legislation, Planning Policy and Guidance

9.2.1 There are several regimes that regulate land and groundwater contamination in the UK, including those related to environmental protection, planning and development control, waste management and pollution control and prevention.

Legislation Context

9.2.2 The following legislation is relevant to the Proposed Development:

- Environment Act 2021[1];
- Natural Environment and Rural Communities (NERC) Act (2006)[2];
- The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017[3];
- Groundwater (England and Wales) Regulations 2009[4];
- The Flood Risk Regulations 2009 ('Floods Directive')[5];
- Nitrates Directive (91/676/EEC) ('Nitrates Directive')[6] ;
- Flood and Water Management Act 2010[7];
- Water Resources Act 1991 (WRA)[8];
- The Asbestos (Licensing) (Amendment) Regulations 1998[9];
- The Building Regulations 2010[10];
- The Construction (Design and Management) Regulations 2015[11];
- The Contaminated Land (England) (Amendment) Regulations 2012[12];
- The Contaminated Lane (England) Regulations 2006[13];
- The Control of Asbestos Regulations 2012[14];
- The Private Water Supplies (England) Regulations 2016[15];
- The Water Supply (Water Quality) Regulations 201610[16];
- Health and Safety at Work Act 1974[17];
- The Environmental Damage (Prevention and Remediation) (England) Regulations 2015[18];
- The Environmental Permitting (England and Wales) Regulations 2016[19];
- Part 2A of the Environmental Protection Act 1990[20];
- Pollution Prevention and Control Act 1999[19];
- Land Drainage Act 1994[21]; and
- The Climate Change Act 2008 (2050 Target Amendment) Order 2019[22].

Planning Policy Context

9.2.3 The following national, regional and local planning policy is relevant to the Proposed Development. Further details of the planning policy context, including the National Planning Policy Framework (NPPF) is included as Appendix 9.1: Relevant Planning Policy.

National

- National Planning Policy Framework (February 2025[23].

Regional

- The London Plan (March 2021)[24].

Local

- London Borough of Hillingdon Local Plan Part 1 – Strategic Policies (LPP1) (adopted November 2012)[25].
- London Borough of Hillingdon Local Plan Part 2 – Development Management Policies (LPP2) (adopted January 2020)[26].

Guidance

9.2.4 The following guidance is relevant to the Proposed Development in regard to potential ground contamination:

- British Standard (BS) 10175:2011+A2:2017 Investigation of Potentially Contaminated Sites, Code of Practice[27].
- BS ISO 18400-104 Soil quality – Sampling – Strategies[28].
- BS ISO 21365 Conceptual Site Models[29].
- BS 3882:2015 Top-soil[30].
- BS 8576:2013 Guidance of investigations for ground gas – permanent gases and Volatile Organic Compounds[31].
- BS ISO 15176:2019 Soil quality – Guidance on characterisation of excavated soil and other materials intended for re-use[32].
- EA Land Contamination Risk Management (LCRM) (October 2020, Updated April 2021)[33].
- Association of Ground Investigation Specialists (AGS) (2006). Guidelines for Good Practice in Site Investigation. Issue 2[34].
- Building Research Establishment (BRE) (2005). Concrete in aggressive ground. BRE Special Digest 1, Third Edition[35].
- BRE (2023). BR 211 Radon: Guidance on protective measures for new buildings[36].
- British Plastic Federation (BPF) Pipes Group (2018). Designing Drains and Sewers for Brownfield Sites: Guidance Notes[37].
- BSI, (2010) BS 6031:2009 Code of practice for earthworks (incorporating corrigendum No.1)[38].
- BSI (2013). BS EN 1997-1:2004+A1:2013 Eurocode 7: Geotechnical design. Part 1 General rules (incorporating corrigendum February 2009)[39].
- BSI (2017). BS 10175:2011+A2:2017 Investigation of potentially contaminated sites - code of practice[40].
- BSI (2019). BS 8485:2015+A1:2019. Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings[41].
- BSI (2020). BS 5930:2015+A1:2020 Code of practice for ground investigations[42].
- BSI (2020) BS EN ISO 21365:2020 Soil quality – Conceptual site models for potentially contaminated sites[43].
- CIRIA (2001). C552 Contaminated land risk assessment – a guide to good practice[44].
- CIRIA (2007). C665 Assessing risks posed by hazardous ground gases to buildings[45].

- CIRIA (2009). C681 Unexploded Ordnance (UXO), A guide for the construction industry[46].
- Contaminated Land: Applications in Real Environments (CL:AIRE) (2011). The Definition of Waste: Development Industry Code of Practice, Version 2[47].
- CL:AIRE (2017). Research Bulletin 17, A Pragmatic Approach to Ground Gas Risk Assessment[48].
- CL:AIRE (2020). Professional Guidance: Comparing Soil Contamination Data with a Critical Concentration[49].
- Department for Environment, Food and Rural Affairs (DEFRA) (2012). Environmental Protection Act 1990: Part 2A, Contaminated Land Statutory Guidance[50].
- DEFRA (2014). SP1010: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Document[51].
- EA (EA) (2001). National Groundwater & Contaminated Land Centre report NC/99/73. Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention[52].
- EA (2006). Guidance on the design and installation of groundwater quality monitoring points53.
- EA (2014). Land Contamination: remedial targets methodology[54].
- EA (2015). Contaminated land exposure assessment (CLEA) tool[55].
- EA (2021). Land contamination risk management (LCRM)[56].

9.3 Assessment Methodology

Consultation

Pre-Application Consultation

9.3.1 Table 9.1 summarises key comments raised by consultees of relevance to this assessment during pre-application meetings, scoping and in response to the 2023 Scheme and how the assessment has responded to them.

9.3.2 Following submission of the planning application in 2023, the Applicant held further meetings with the EA and Arup as LBH's advisors on ground conditions and contaminated land matters which informed the revised proposals and updated assessment.

Table 9.1: Consultation Response Summary

Consultee and Comment	Response
London Borough of Hillingdon (Arup as advisors to LBH) Contaminated Land – Pre-Application Document Review – 26 July 2023	
Geo Integrity Draft Phase II Site Investigation Report	Arup, as advisors to LBH were provided with a draft version of the Phase II Site Investigation Report for comment in September 2023.

Consultee and Comment	Response
The draft report focuses solely on the Peninsula in the south east. An updated Geoenvironmental report with a red line boundary and associated assessment which matches the planning application site boundary should be produced. The update report should consider the latest development proposals, including the new pontoons, camping ground, extension to the Peninsula and construction of new islands. The draft report does not mention these activities; therefore, Arup does not agree with the conclusion in Section 6.3 that "*no further works or remedial measures are necessary prior to development.*" A robust ground gas risk assessment should be carried out as part of the further Geoenvironmental assessment, The draft report only makes mention of an offsite landfill; there is no mention of the on-site landfill (historic and unregistered). Considering the risk from these landfills on and off-Site, taking ground gas samples from three locations on four occasions over the course of 20 days is not considered sufficient. The updated report should provide a clear drawing of the location of the unregistered landfill as provided by the EA, compared to the development proposals. An updated human health risk assessment should be carried out as part of the above mentioned updated Geoenvironmental report, in light of the latest development proposals (including camping ground). Arup notes that whilst there are several gaps in the draft report in relation to the reuse of dredged material (no sediment samples having been taken as part of the assessment), the potential for dredging to release contamination, and the potential for the construction of pontoons / structures on land the create pathways via foundations and piling, these aspects are covered in detail in the draft	A Phase I Geoenvironmental Assessment and Phase II Site Investigation Report were submitted with the planning application in 2023 (Appendix 9.2: Phase 1 Geo-environmental Assessment and Appendix 9.3: Geo-Integrity Phase II Geo-Environmental Site Investigation September 2023). Existing ground gas monitoring boreholes are to be retained during the enabling and construction phases of Proposed Development, and will be monitored at regular frequencies prior to, during and following the enabling and construction phases, particularly during times of large scale works (piling, foundation excavations etc.). These boreholes are also to be maintained across the operational Proposed Development for ongoing ground gas monitoring at the Site where deemed to be required. An updated Human Health Risk Assessment and Ground Gas Risk Assessment is included in paragraphs 9.6.7 to 9.6.14 and 9.7.10 to 9.7.16 of this chapter.

Consultee and Comment	Response
Hydrogeo groundwater risk assessment report.	
Local Authority Contaminated Land Officer – Pre-application Email correspondence – July 2023	
Parts of the Site redline boundary, as shown on the submitted Tarmac Plan (Drawing No: B310-00027-1 dated 08/06/2022) encloses an EA registered landfill, and also an extensive area situated within 250m radius of a further historic landfill site situated to the north east. The Site is within the 250 meters extents of landfill gas buffer zones, which are indicating potential risk/s from any migrating landfill gas, particularly if gas production is active and in sufficient quantities at the on-Site EA registered site and / or the other nearby former landfill site. Furthermore, earlier development/s, including associated carpark areas etc. may have introduced quantities of made ground materials which would require additional consideration, especially in the location of proposed change/s of use which may involve introduction of receptors having increased sensitivity in comparison with previous and current land use/s. Areas of the Proposed Development Site may be on land that is affected by unacceptable contamination, thereby requiring an appropriate phased investigation process incorporating suitable risk assessments to be conducted. It is considered that the Local Planning Authority will likely impose contaminated land conditions and in the case of a full application it would be recommended that standard contaminated land planning conditions are assigned to the Proposed Development if planning consent is awarded.	The Phase II Geo-Environmental Site Investigation Report includes ground gas monitoring data obtained during the period 09/03/2023 – 29/03/2023. The Phase II Site Investigation has encountered made ground materials which have been included and screened / risk assessed within this chapter. Correspondence with LBH has indicated the inclusion of standard contaminated land conditions that are to be progressed during the planning process. These conditions are likely to include additional Phased Site Investigation Works. Historic regulated off-Site landfill has been considered within this assessment, and measures have been identified and set out to avoid any risks to receptors as part of the construction and operation of the Proposed Development.
EA – Pre-Application Meeting 30 June 2023	

Consultee and Comment	Response
Waste (including ash / burnt waste) was deposited outside of the regulated landfill identified to be present in the south east of the Peninsula. If any physical disturbance to this material is proposed, including removal of concrete, channels for pipework, foundation then this would be considered waste recovery / waste disposal. The priority is to minimise the amount of disturbance of this waste mass.	The Applicant met with the EA prior to submission of the 2023 Scheme to discuss the proposals and approach to the assessment. The revised proposals for the Proposed Development involves minimal disturbance to the existing Peninsula. Only parking spaces and upgrades to an existing internal access road will be located within the limits of the mapped regulated historic landfill, resulting in very limited earthworks requirements. Minimal built development t is located within the mapped limits of the regulated historic landfill. The planned structures include a shelter and a bike shelter / storage area. The Applicant is aware of the importance of the current concrete hardstanding coverage across the Site and only a small area would be removed as described in Chapter 6: Construction. Ground disturbance is required to facilitate the Proposed Development in some areas to allow for essential construction of access roads / tracks, service infrastructure (water, gas, electricity, drainage etc). Where excavation arisings are generated, these are to be screened and where required tested to inform suitability for re-use. Where unsuitable, verified clean imported materials may be used to backfill service runs.
EA Planning Advice Letter – Ref: NE/2023/135833 – Dated 26 September 2023	
The EA have reviewed Draft Phase II Ground Investigation Report and the Draft Groundwater Risk Assessment and raised a number of comments, on waste, permitting, groundwater, surface water and flood risk.	Draft reports were provided to the EA for comment prior to submission of the planning application. These reports were updated to address a number of the comments raised by the EA and Appendix 9.3 provides the Phase II Site Investigation. The Groundwater Risk Assessment Report is provided as Appendix 8.3.
EA – Meeting Comments from meeting held 28 September 2023	
The EA raised comments in regard to their review of submitted reports, including the Draft	The Applicant held a meeting to discuss the comments on Draft reports. These comments

Consultee and Comment	Response
Phase II Site Investigation Report and the DRAFT Groundwater Risk Assessment. The EA noted that further works are required as the Proposed Development progresses. The EA suggested that the EA National Permitting Team is contacted to open discussion in regard to permit requirements for the proposed works.	raised by the EA within their letter dated 26 September 2023 have been addressed. The project team recognise that further works will be required as a condition of planning together with continued regulatory discussions with the EA, LBH and Affinity Water ahead of the progression of further intrusive site investigation and monitoring works.

EIA Scoping Opinion

9.3.3 A request for a Scoping Opinion was submitted by the Applicant to LBH on 23 February 2023. An EIA Scoping Report (the 'Scoping Report') accompanied the request (Appendix 3.2: EIA Scoping Report (February 2023) and scoping correspondence). A Scoping Opinion was issued by the LBH on 19 May 2023 (Appendix3.3: LBH EIA Scoping Opinion) which included comments from statutory consultees. Table 9.2 summarises key comments raised by consultees of relevance to the assessment of ground conditions and contamination by the EIA Scoping Opinion and how the assessment has responded to them.

Table 9.2: EIA Scoping Opinion Response

Consultee and Comment	Response
LBH – Comments made by Arup as advisors to LBH (30 March 2023)	
Section 7.23 [of the Scoping Report] refers to human health receptors during operation. Considering the nature of the Proposed Development (including camping ground), the assessment should also consider the ingestion of contaminated soils.	The EIA has considered the risks posed to human health receptors, including the potential for ingestion of contaminated soils across the development and operational phases of the Proposed Development.
The assessment should consider not only aquifer designations, but also water abstractions (SPZ1) and nearby surface watercourses (River Colne) as sensitive receptors, for the construction and operational stages. The potential for dredging activities to release contamination and for the construction of pontoons and other large structures on land to create pathways (via foundations / piling) should be included in the assessment.	The assessment considers risks posed to all ground and surface water receptors. A standalone groundwater risk assessment is provided in Appendix 8.3. Chapter 8: Water Resources and Flood Risk also considers the potential effects on surface water and groundwater receptors. The potential risks associated with dredging are discussed in Chapter 8: Water Resources and Flood Risk.
New structures are listed under 'key receptors' in section 7.25, but not within the earlier assessment scope. Contaminant impacts on all	The EIA has addressed the risks posed to built receptors, including concrete classification and

Consultee and Comment	Response
building materials in contact with the ground should be included as part of the assessment.	upgraded barrier water supply pipes due to presence of made ground materials.
Ecological receptors are listed under 'key receptors' in section 7.25, but not within the earlier assessment scope. Contaminant impacts on ecological receptors as a result of ground and groundwater contamination should be included as part of the assessment.	Contaminant impacts on ecological receptors as a result of ground conditions and groundwater contamination are assessed within this chapter. An assessment of the associated effects on ecological receptors is provided in Chapter 7: Biodiversity and its associated appendices.
The following guidance should be referred to and followed within the ES: BS10175:2011+A2:2017 Investigation of potentially contaminated sites Code of Practice.	The Phase II Site Investigation (Appendix 9.3) was undertaken in line with this guidance, and all future site investigation works will be progressed in line with this guidance.
The scoping report includes a desk study report undertaken in November 2022 by Geo-Integrity. An appropriate and comprehensive desk study report and preliminary risk assessment is required to supplement this, based on the latest development proposals. The current desk study does not make reference to the proposed new pontoon structures, camping ground, extension to the Peninsula and islands, and localised dredging. It also mentions that an intrusive ground investigation (GI) is proposed to be undertaken. The details of this GI should be agreed in advance with the EA and LB Hillingdon contaminated land officer. The GI should aim to provide comprehensive coverage of the Site, based on the latest Proposed Development. Surface water and soil waste classification testing should also be undertaken as part of the GI.	An appropriate and comprehensive desk study and preliminary risk assessment is provided in Appendix 9.2. Site investigation at the Site was restricted across the Peninsula by dense vegetation limiting access for plant and operators. Site investigation works were progressed, and the results are presented in the Phase II Site Investigation (Appendix 9.3). WAC Testing has been progressed on several soil samples across the Site. It is also proposed that surface water quality is to be monitored frequently during the enabling and construction phases through capture of surface water samples. The reports were updated as of September 2023 to reflect the submitted plans and land uses.
An assessment of all likely significant environmental effects referring to construction and operation stages of the Proposed Development is required. The ES assessment should clearly set out the likely significant effects in relation to each stage of development and each identified receptor, considering human health, controlled waters, ground gases, building materials and ecological receptors.	Ecological receptors have been assessed within this chapter. Greater detail and assessment of the ecological receptors and assessments are included within Chapter 7: Biodiversity and its associated appendices.

Consultee and Comment	Response
The EA and LB Hillingdon contaminated land officer should be consulted during the preparation of the ES. The ES should include an environmental search request obtained from LB Hillingdon.	The EA and LB Hillingdon contaminated land officer were consulted throughout preparation of the ES. The Groundsure data set included in Appendix 9.1 includes records held by Local Planning Authorities including LBH. An updated Groundsure data set has been acquired and is provide in Appendix 9.9.
EA – Contamination (30 March 2023)	
Developers should ensure that all contaminated materials are adequately characterised both chemically and physically in line with British Standards BS EN 14899:2005, and that the permitting status of any proposed treatment or disposal activity is clear. Contaminated soil that is (or must be) disposed of is waste. Therefore, its handling, transport, treatment, and disposal are subject to waste management legislation. The Proposed Development is on the Broadwater Plant Site historic landfill. The physical disturbance of the waste mass may pose unacceptable risk to the environment and human health. Any import or alteration of the landform or piling within waste should be regarded as a waste activity and requires an environmental permit.	Details of contaminated soils stockpiling, handling, re-use and / or disposal will be addressed within Environmental Permits for the works as deemed necessary. The Environmental Permits are expected to consist of Part A permits which control activities with a range of environmental impacts for example to land and water. Environmental Permit applications will be supported by additional site investigation in advance of enabling and construction works the Site. Minimal ground disturbance is proposed within the mapped extents of the historic landfill site. Proposed carparking areas, the upgrading of an existing internal access track, a shelter area, and a bike storage shed are the only proposed works in the area. Provision for Remediation Strategy and Verification reports are detailed within this chapter. A Detailed Quantitative Risk Assessment (DQRA) is to be progressed to determine site-specific end use / re-use criteria for any excavated soils and materials, following the capture of additional Site Investigation data during which can be used to inform the enabling and construction phases of work. The Environmental Permits will likely include the Waste Framework Directive (EPR Schedule 9 – Waste operations and materials facilities), the

Consultee and Comment	Response
	Landfill Directive (EPR Schedule 10 – Landfill), Mining Waste Directive (EPR Schedule 20 – Mining waste operations) and Groundwater activities (EPR Schedule 22 – Groundwater activities).
Environment Agency - Waste (30 March 2023)	
Developers should ensure that all contaminated materials are adequately characterised both chemically and physically, and that the permitting status of any proposed on-site operations are clear. If in doubt, the EA should be contacted for advice at an early stage to avoid any delays. We recommend that developers should refer to: ▪ The position statement on the Definition of Waste: Development Industry Code of Practice; ▪ The waste management page on gov.uk; and ▪ All material deposited within the historic landfill remains controlled waste and must comply with waste legislation. Any import or alteration of the landform or piling within waste should be regarded as a waste activity and requires an environmental permit.	A number of Waste Assessment Criteria (WAC) Soils Tests have already been completed at the Site as part of the Phase II Site Investigation (Appendix 9.3). Dredged materials from Broadwater Lake are proposed to be used in the small area of land reclamation at the Peninsula. As evidenced in Chapter 6: Construction minimal importation of materials will be required across the Proposed Development. Where import is required, the materials will be addressed within the remediation strategy, with subsequent remediation verification to prove any imported materials are clean and suitable for use. The Applicant recognises that any import or alteration of the landform or piling within waste would be regarded as a waste activity and requires an environmental permit. The works would be subject to environmental permits as appropriate and as stated above. Remediation Strategy and Remediation Verification following additional site investigation works will be undertaken. Further details are provided in this chapter. All waste arisings during construction would be subject to waste legislation and management controls set out in the Outline CEMP (Appendix 6.1).

Post Application Consultation

9.3.4 Table 9.3 presents comments raised by consultees in response to the 2023 ES and 2023 Scheme and how the Proposed Development and assessment has responded to them.

Table 9.3: 2023 Scheme Consultation Responses

Consultee and Comment	Response
EA. Ref: NE/2023/136465/01 – 12 January 2024	
The Proposed Development will require a permit under the Environmental Permitting Regulations (England and Wales) 2016. We do not have enough information to know if the development can meet our requirements to prevent, minimise and / or control pollution. We therefore recommend that planning permission is refused. To reduce the risks to people and the environment and obtain a permit, the suitability of the location with respect to the protection of groundwater will need to be considered, the design and / or layout of the buildings may need to change and include abatement technology to reduce the impact of the development beyond Best Available Techniques (BAT). In particular, mitigation is likely to be required to control Air Quality impacts, surface water runoff and the squeezing out of leachate from the underlying landfill, therefore may require a leachate extraction and treatment plant incorporated into the development to protect groundwater. We recommend that the applicant considers parallel tracking the planning and permit applications as this can help identify and resolve any issues at the earliest opportunity. Parallel tracking can also prevent the need for post-permission amendments to the planning application. We would welcome a joint discussion with the applicant and planning authority to discuss this further.	The Applicant recognises that Proposed Development will require a permit under the Environmental Permitting Regulations (England and Wales) 2016 and intends to pursue parallel tracking of the planning and permit applications to help identify and resolve any issues at the earliest opportunity. The Applicant has begun engaging with the EA permitting team. A groundwater risk assessment is provided in Appendix 8.3 and presents the mitigation required to reduce risks to the groundwater. Mitigation measures are also described in this chapter. Following review of all data currently available, it is not considered that a leachate extraction and treatment plant would be required as part of the Proposed Development. The site investigation data and submarine photo survey, have both generally encountered inert waste materials, which are likely to generate minimal leachate requiring extracting and treatment.

9.3.5 The Applicant and consultant team engaged further with the EA and LBH (and Arup as their advisors) to discuss the revised proposals and matters raised in their consultation responses. Table 9.4 provides a summary of this engagement. Relevant correspondence is provided in Appendix 9.8.

Table 9.4: Summary of Post-2023 Scheme Engagement

Consultee	Key Matters and Relevant Correspondence
EA. Ref: NE/2024/137219/02– 31 October 2024	
Land reclamation and Dredging We are pleased to see a significant reduction in land reclamation [and therefore reduced proposed reuse of material] and dredging in the updated proposal. **Parallel Tracking** We understand that you are in the process of, or have already requested, the national permitting service pre-application advice, following our meeting. If the permitting regime requires any change of design, we anticipate that you will address this through normal planning routes. **Waste – Definition of Waste** It is positive to hear that site investigation works (lake bed sediment sampling) are being undertaken. We'd like to remind you that material is defined as a waste where the producer or holder discards it, intends to discard it, or is required to discard it. Based upon the submitted information, 12,746m2 of material is going to be removed with dredging and / or island cutting. We appreciate this is a reduction in dredged materials since the previous submission. The plans show only 8,290m2 will be reused to create the new land, shelf and buffer. That leaves approximately 4,500m2 to be disposed of. We request further details to be submitted as part of any planning application regarding what is intended to be done with the remaining material, and this disposal will require a permit.	There will be no import of fill materials to facilitate the land reclamation or island formation. All material will be obtained from the dredging of the lakebed as described previously. Cut and fill volumes are as follows: ▪ Lake dredging in Eastern Channel – cut volume 7,094m^3; ▪ Loss of islands – total cut volume 5,652m^3; and ▪ Land reclamation – total fill volume 8,290m^3. The excess cut material (approx. 4,500m^2) will be retained and re-used on site following being subject to testing and screening against relevant re-use criteria. It is not planned for any waste materials to be disposed of off-site. However, if this is required, materials will be subject to Waste Acceptance Criteria (WAC) testing and permitting rules prior to disposal at an off-site suitably regulated waste facility.
LBH (Arup as advisors to LBH) – Email on 27 January 2025	
We have reviewed the proposed analysis suites for the sediment sampling set out below and are broadly in agreement. For the purposes of waste classification, we would also recommend that this includes hexavalent chromium.	This recommendation was included in the Lake Bed Sediment Sampling provided in Appendix 9.6.

Consultee	Key Matters and Relevant Correspondence
LBH (Arup as advisors to LBH) – Email on 16 July 2025	
We highlighted the need for additional GI and more comprehensive risk assessment previously. We understand the challenges in terms of the planned ES submission and the possible timing of the additional GI. Therefore, we will be advising the case officer that specific contaminated land conditions are placed on the development.	The Applicant welcomes the placement of specific contaminated land conditions. An updated ground gas risk assessment has been progressed and is included within this chapter. Additionally, further site investigation is proposed in September 2025 which is to include the advancement, installation and monitoring of several ground gas monitoring wells across the Proposed Development footprint. Site Investigation works proposals are to be presented to the key stakeholders for review and discussion prior to commencement.

Summary of Assessment Scope

9.3.6 As outlined within the EIA Scoping Report (Appendix 3.2), and as agreed with LBH via the EIA Scoping Opinion (Appendix 3.3), the scope of the works within this chapter is to set out the likely significant effects in relation to each stage of development and each identified receptor, considering human health, controlled waters, ground gases, building materials and ecological receptors. The scope also includes an assessment of risks related to migration of ground gases the potential area of unlicensed landfilling located to the west of the land Peninsula in response to comments from the EA.

Construction Phase

9.3.7 The following elements are considered to have the potential to give rise to likely effects during construction of the Proposed Development and have therefore been considered within this assessment:

Human Health

- Potential for generation of contaminated dusts, including asbestos fibres (if soils are allowed to dry and are trafficked / disturbed to air); and
- Potential for direct contact with contaminated soils.

Ground Gas

- Lateral migration of ground gas from the former on-Site landfill and landfill within the immediate vicinity of the Study Area consequent of ground changes, human health asphyxiant and explosive risk. Anecdotal evidence provided by the EA also indicates the potential of an unregistered historic landfill to the immediate west of the Peninsula, which may also provide a source of lateral ground gas migration.

Operational Phase (Completed Development)

9.3.8 The following elements are considered to have the potential to give rise to likely effects during the operational phase of the Proposed Development, and have therefore been considered within this assessment, as per the EIA Scoping Report:

Human Health

- Potential for generation of contaminated dusts if soils are allowed to dry and are then trafficked.
- Potential for direct contact with contaminated soils.

Ground Gases

- Lateral migration of ground gas from the former on-Site landfill and landfill within the immediate vicinity of the Study Area consequent of ground changes, human health asphyxiant and explosive risk. Anecdotal evidence provided by the EA also indicates the potential of an unregistered historic landfill to the immediate west of the Peninsula, which may also provide a source of lateral ground gas migration.

Geotechnical – Land Stability

- Settlement – potential damage to future structures / infrastructure from land stability issues;
- Low Bearing Capacities – potential damage to future structures / infrastructure;
- Presence of ‘quicksand’ areas across the wider Application Site Boundary; and
- Risks / Hazards – potential risks / hazards due to structures, presence of quicksand, unexploded ordnance etc.

Non-Significant Effects

9.3.9 All other ground condition and contamination effects were scoped out of further assessment within this ES. See Section 3 of the EIA Scoping Report (Appendix 3.2) for further details and justification.

9.3.10 There are no Local Geological Sites (LGS) located on-Site or within the vicinity of the Site, therefore assessment of Local Geological Sites has been scoped out of this chapter.

Study Area

9.3.11 The study area considered as part of this ES is the application Site and the immediate surrounding land use. The Site boundary is shown on Figure 9.1.

9.3.12 The study area is defined for this chapter as the land in the immediate vicinity of the Site (i.e. within 250m) and which has the potential to be a contaminant source or receptor and there is a potential pathway for migration, which may impact upon the Site.

9.3.13 The inclusion of this 250m buffer is based on the guidance ‘Guidance for the Safe Development of Housing on Land Affected by Contamination’ (EA, 200859). This buffer is considered reasonable in the context of this Proposed Development scheme taking into account the distance over which contaminants can migrate, and the sensitivity of the Study Area.

9.3.14 The Site boundary is presented in Figure 9.1. The study area consists of the application Site and the surrounding land within 250m of the boundary.

Figure 9.1: Site Boundary and Study Area

Establishing Baseline Conditions

9.3.15 Baseline conditions across the Study Area have been established through records provided by the Applicant, LBH and the EA during consultation and the progression of the following works:

Phase I Geo-Environmental Assessment (Including Unexploded Ordnance) – Geo-Integrity Updated in September 2023

9.3.16 Including a site walkover survey as part of the Phase I Desk Geo-environmental Report in October 2022, review of publicly available data, desk study and historic Ordnance Survey Maps. A review of available British Geological Survey (BGS) data including the BGS Online GeoIndex and BGS Sheet Maps TQ08NW (1:10,000), TQ09SW (1:10,000) and BGS Sheet

Map 255 – Beaconsfield (1:50,000 – 2005) have been used to determine the geological baseline conditions underlying the Site area.

9.3.17 The Phase I Geo-Environmental Assessment provided an Unexploded Ordnance Survey Risk Assessment, with reference to an online UXO Risk Map provided by Zetica, and further assessment provided by Impartial Assessment Ltd on 11 September 2023.

9.3.18 Updated Groundsure Desk Study Searches were undertaken in August 2025 and are provided in Appendix 9.9. There were no material changes compared to the data presented in the Phase I Desk Geo-environmental Report in October 2022 which is considered to remain valid.

Phase II Site Investigation (Including Groundwater, Ground Gas and Land Stability) – Geo-Integrity April 2023 – Updated September 2023

9.3.19 An intrusive Phase II Site Investigation was progressed across the Peninsula by Geo-Integrity between 15 and 28 February 2023. The Site Investigation consisted of the progression of 9no. cable percussive boreholes, to a maximum depth of 15m, 3no. machine excavated 3no. machine excavated infiltration pits (SA1 – SA3) and 14no. machine excavated trial pits (TP1 – TP14). The Phase II Site Investigation also consisted of a number of plate-loaded California Bearing Ration (CBR) Tests. All site investigation positions were progressed across accessible areas of the Site Peninsula at the time (October 2022).

9.3.20 Initial phase of Site investigation works were focused on the November 2023 proposed building and development layout. The SI allowed for determination of ground and ground chemical condition andfor a risk assessment to be progressed accounting for human health and environmental receptors.

9.3.21 As part of the Phase II Site Investigation, disturbed soil samples were captured across a range of depths within the Trial Pits and boreholes for subsequent laboratory inspection and testing at a UKAS and MCERTS accredited facility. The samples provide baseline chemical soil data across the Peninsula.

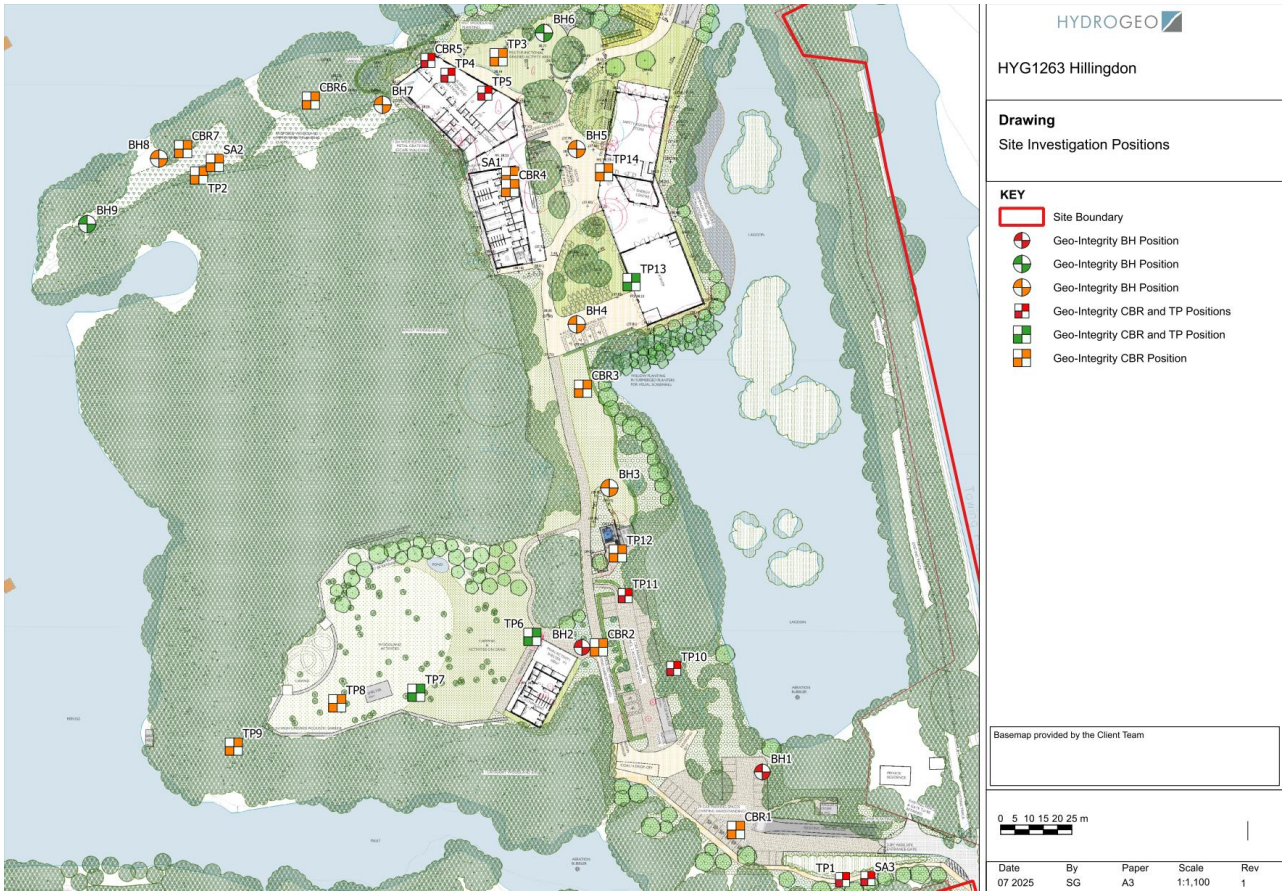
9.3.22 A made ground sample from TP14 (0.60m depth) was collected and tested for PCB congers immediately adjacent to the existing on-site electricity sub-station. Laboratory analysis did not identify any measurable PCB concentrations above the Laboratory Limit of Detection (LoD).

9.3.23 Select borehole positions (BH3, BH6 & BH9) were installed as groundwater and ground gas monitoring positions to allow for ongoing monitoring of gas and groundwater conditions across the Peninsula.

9.3.24 Groundwater monitoring was progressed between 09/03/2023 and 29/03/2023, with ground gas monitoring progressed over the same period. In total 3no. groundwater samples were captured from the installed groundwater monitoring well positions (BH3, BH6 and BH9), with the samples dispatched to an MCERTS and UKAS accredited laboratory facility for chemical analysis.

9.3.25 Seven Plate Loaded CBR Tests (CBR 1 – CBR 7) were progressed as part of the Phase II Site Investigation. Soil samples were also captured for geotechnical laboratory testing purposes which provide baseline geotechnical conditions and data sets across the Peninsula to address land stability.

Figure 9.2: 2023 Site Investigation Position Locations



Broadwater Lake Sediment Sampling

March 2023

9.3.26 Johns Associates captured 20 no. sediment samples on 20 March 2023 from across the base of Broadwater Lake for chemical analysis at a UKAS and MCERTS accredited laboratory facility. The sampling provides a baseline condition of the ground conditions at the base of the lake and chemical nature of the lake sediment. Figure 9.3 presents the locations of the Broadwater Lake sediment samples taken in March 2023.

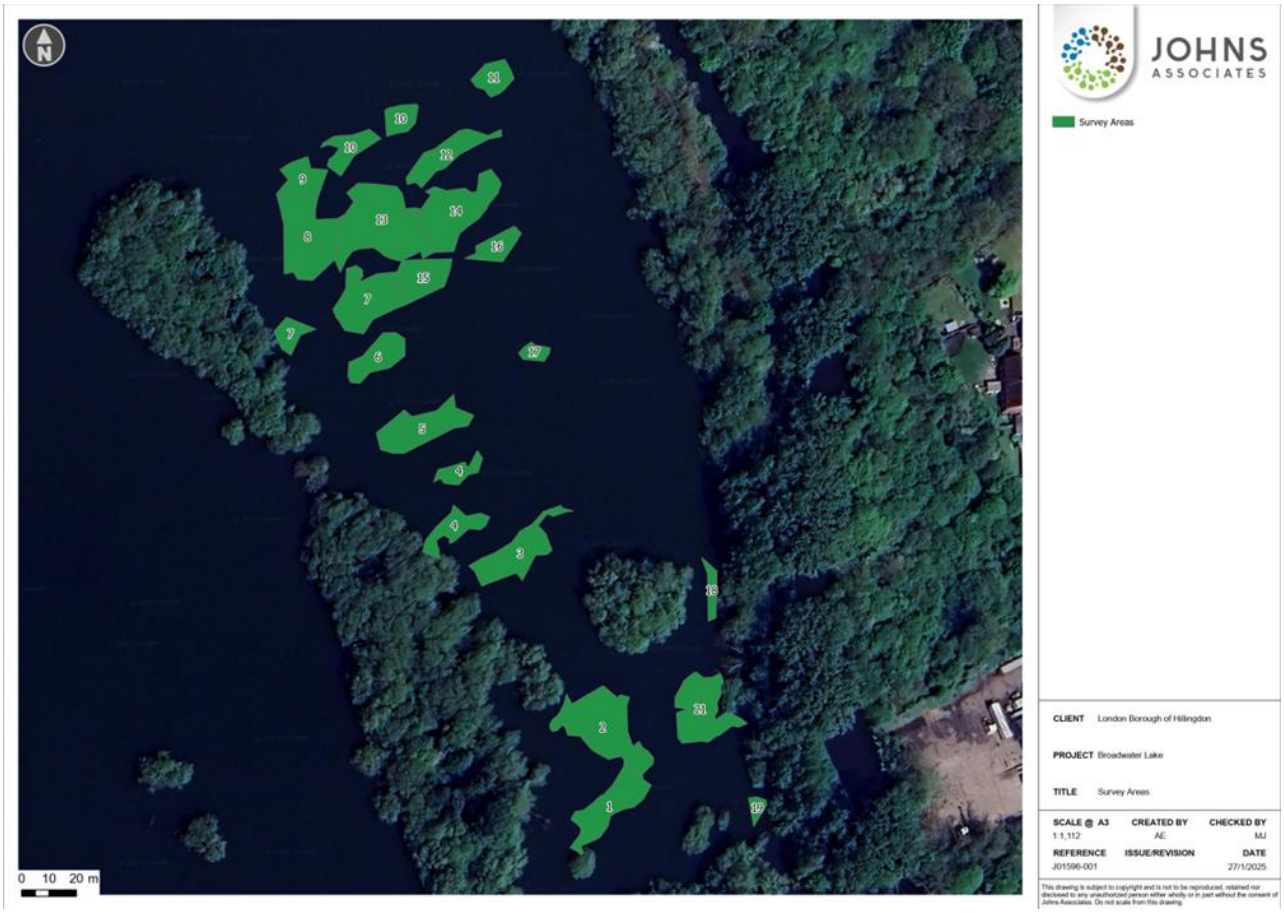
9.3.27 A review of the Lake Sediment Results has been included within Chapter 8**:** Water Resources and Flood Risk.

Figure 9.3: Broadwater Lake Sediment Sampling Plan (March 2023)

March 2025

9.3.28 Additional sediment samples were collected in Mach 2025 at 20no. locations across Broadwater Lake, with the samples issued to an accredited laboratory facility for testing against a suite of chemical determinants. Locations of the sediment samples taken in March 2025 are shown on Figure 9.4.

Figure 9.4: Broadwater Lake Sediment Sample Plan (March 2025)



9.3.29 The suite of chemical determinants included:

- Asbestos Screen;
- Toxic metals, including Chromium, Copper, Zinc, Lead, Iron, Cadmium, Mercury, Manganese, Nickel, Selenium;
- pH;
- Organic Matter;
- Fluoride;
- Polyaromatic Hydrocarbons (PAHs);
- Total Petroleum Hydrocarbons (TPHs);
- Available phosphorus;
- Available potassium;
- Available magnesium;
- Conductivity;
- Organic matter loss on ignition;

- Total phosphorus;
- Total potassium;
- Total magnesium;
- Total calcium;
- Total sodium;
- Total carbon;
- Total sulphur.

9.3.30 The 20no. lake sediment samples have been screened against Generic Assessment Criteria (GAC) consisting of the following:

- Category 4 Screening Levels (C4SLs) – Human health screening criteria produced using the CLEA model, used to assess the risk posed to human health by the deposited sediment. 'Residential – Without produce' concentrations have been used.
- EA Ecological Soils Screening Values (SSVs) – Produced by the EA in 2017, the SSVs are used for screening waste and waste derived materials to be used as soil improvers on agricultural land. The values assess the hazard posed by 19 substances to soil fauna, flora and ecosystems. These values asses the suitability of the materials for agricultural spreading, taking into account background concentrations which have been sourced from the NSIV survey.
- Sewage Sludge on Farmland – Potentially Toxic Elements (PTEs) – the sediment has also been screened using the same values which are applied to sewage sludge spreading on agricultural land.
- NSIV Survey Normal Background Concentrations – These values represent the normal background concentration of substances in the local area. Background concentrations are primarily the result of the material's parent geology.

9.3.31 Potentially toxic elements tested for within the lake sediment samples include copper, zinc, nickel, zinc, cadmium. Lead, chromium, mercury, molybdenum, selenium, arsenic, fluoride, TPHs and PAHs.

9.3.32 Screening of the laboratory chemical data concentrations against the Generic Assessment Criteria (GAC) has not indicated any exceeding concentrations within the lake bed sediment.

Surface Water Quality Database

9.3.33 The Department for Environment Food and Rural Affairs (Defra) hold an online database which indicates the presence of a surface water quality monitoring point at Broadwater Lake (Monitoring ID: TH-PGWL0196). The database consists of 8 no. samples of surface water from Broadwater Lake over the period October 2019 – June 2025 and provides a limited baseline to the surface water quality within Broadwater Lake.

9.3.34 The chemical determinants tested for by the EA include colour (filtered), conductivity, alkalinity, phosphorus, chlorophyll, nitrogen, orthophosphate, and nitrogen.

9.3.35 Additionally, LBH has also collected surface water samples from Broadwater Lake at 7 no. Locations from 12 November 2024 – 10 June 2025. The sampling is proposed to continue

on a monthly basis. The LBH monitoring includes a microbiology and chemical suite of analysis.

Existing Off-site Residential Use

9.3.36 The Site is surrounded by some isolated residential developments, particularly to the north east (Harefield) and east (South Harefield) and the south west (Denham Green). Of the existing off-site residential land uses, only parts of Harefield, and South Harefield are located within the defined study area (250m of the Site boundary) as presented on Figure 9.1.

Initial and Refined Conceptual Site Model

9.3.37 Based on guidance in LCRM, a tiered approach is taken with regards to the risk assessment process. Appendix 9.2: Phase I Geo-Environmental Assessment includes a preliminary Ground Model representing expected below ground conditions at the Site and an Initial Conceptual Site Model (ICSM), which identifies potential contaminant linkages.

9.3.38 In order to develop the ICSM, a review of current and historical land use in the study area is undertaken to identify potential sources of contamination. The end use of the Site and the preliminary Ground Model are then reviewed to identify potential receptors and pathways linking the sources to those receptors, known as the Source-Pathway-Receptor approach. A potential contaminant linkage is identified where the source, pathway and receptor are all present.

9.3.39 The Phase II Ground Investigation (Appendix 9.3) was undertaken based on the findings of the Phase I Desk Study, with the objective of refining and updating the preliminary Ground Model and the ICSM based on site-specific data to produce a Ground Model and the Conceptual Site Model (CSM). A CSM is defined in BSI (2020)45 as the synthesis of all information about a potentially contaminated site relevant to the task in hand with interpretation as necessary and recognition of uncertainties. The CSM comprises all relevant information, including:

- Past and present uses;
- Intended future uses;
- The geological, geomorphological, hydrogeological and hydrological settings, soil, sediments, and air (indoor air and the atmosphere) of the Site and surrounding area;
- The properties of the potential contaminants (e.g. volatility solubility, toxicity) and their sources, including distribution of contamination (i.e. depth and area), potential migration pathways (natural and anthropogenic features such as sewer lines) and transport mechanisms;
- Potential receptors of the contamination;
- Possibilities of new exposure pathways and new receptors associated with the construction and completion of a new development; and
- Foreseeable events (e.g. potentials for flooding (rivers, sea, groundwater), rising groundwater levels, extreme weather conditions, change of use, etc.).

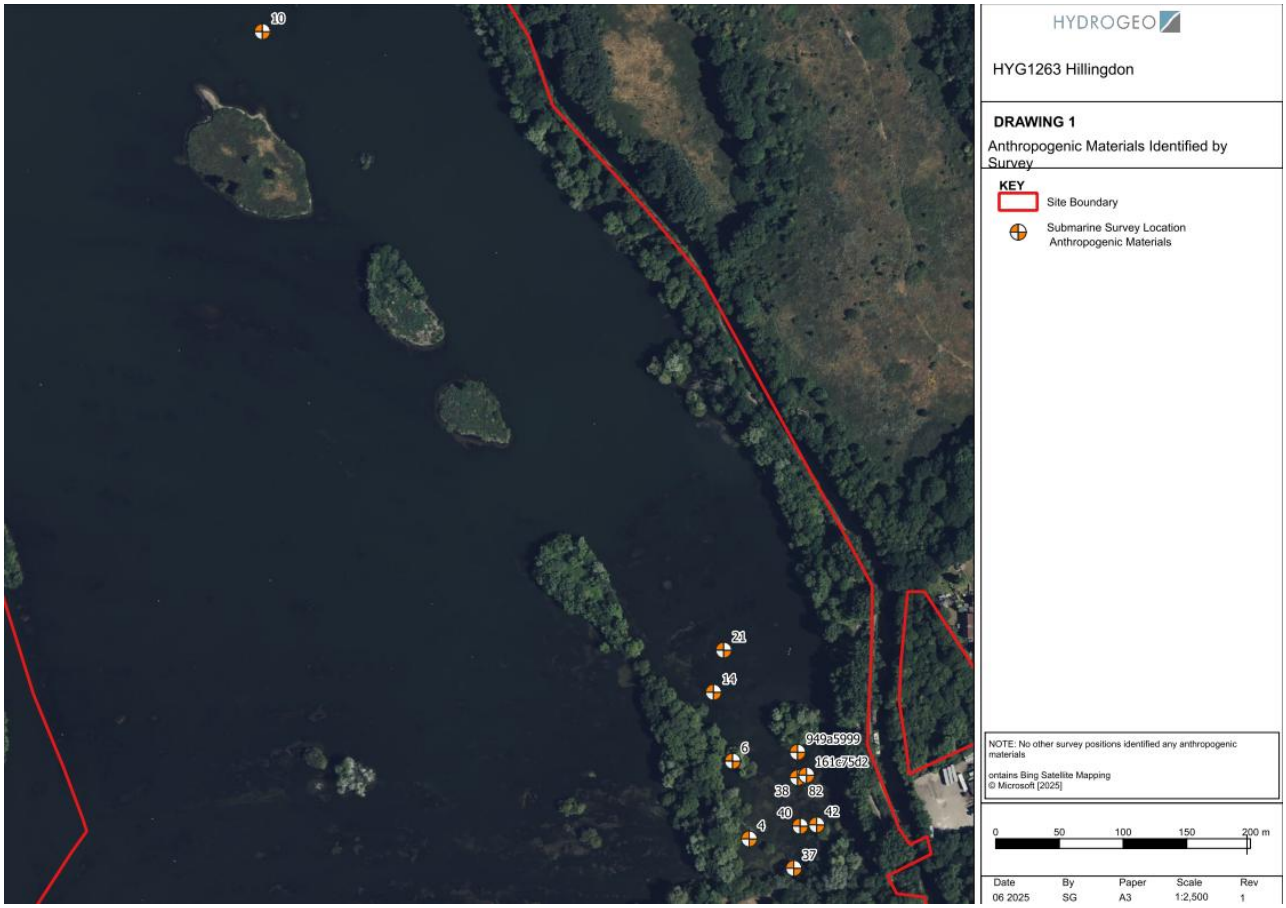
Broadwater Lake Submarine Survey (September and October 2024, and March 2025)

9.3.40 A submarine survey was undertaken by Greengage to provide further information on features across the lake bed. The submarine survey was progressed across several dates in September and October 2024, and March 2025, with a total of 113no. positions being surveyed. The survey provided camera footage of the lake bed sediment, as well as a number of comments and general observations.

9.3.41 Following review, 12no. individual survey positions (4, 6,10, 14, 21, 37, 38, 40, 42, 82, 161c75d2 & 949a5999)) have identified the presence of anthropogenic materials at the bed of Broadwater Lake. The anthropogenic materials identified include metal structures, metal shuttering, metal grate, bricks, and small to large concrete blocks.

9.3.42 Figure 9.3 provides the lake bed survey positions where anthropogenic materials have been identified by the survey.

Figure 9.3: Submarine Survey Locations - Anthropogenic Material



Broadwater Lake Ground Investigation (July 2023)

9.3.43 Miles Water Engineering (MWE) undertook ground investigation on 28 June 2023 at several locations around the lake to gather lake sediment samples. Samples were collected from shallow areas of the lake.

9.3.44 In total 6no. investigation positions were completed. At each location, one investigation was undertaken with a handheld auger, and another with a core sampler. In total 12no. lake sediment samples were collected.

9.3.45 Lake samples were allowed to dry naturally to remove excess moisture for at least one week. After this period the samples were reviewed to confirm results.

9.3.46 The lake bed sediment samples collected all remained consisted with each other and showed there to be a thin layer of stone and boulders at the surface of the lakebed of around 0.1m in thickness. Underlying this is a band of silty clay 0.2m thick. At the base of the investigation positions was very stiff clay.

Assessing Likely Significant Effects

9.3.47 The approach adopted for the land contamination risk assessment (potential impacts) would be based on guidance document LCRM[57] and CIRIA C552[58.] These key guidance documents provide a technical framework for the application of a risk management process. The risk assessment applies the principles given in the NHBC and EA report R&D Publication 66[59], which provides guidance on the development and application of the consequence and probability matrix for contaminated land risk assessment.

9.3.48 The land contamination impact assessment is based on the change of risk between the baseline and the different phases of the Proposed Development (i.e., construction and completed development). The calculated increase or decrease in risk identifies the significance of effect, however professional judgement would be used in instances where a receptor is not present during every phase of the Proposed Development.

9.3.49 The risk assessments have also been used to inform the design of the Proposed Development and any remedial or geotechnical measures that may be required.

9.3.50 The first stage of the assessment is risk estimation, which is undertaking the Source-Pathway-Receptor approach to identify potentially complete contaminant linkages. As discussed, a source, pathway and receptor must all be present in order for a contamination linkage to be complete. Where one or more of the elements are absent, i.e., there is no pathway linking the source to the receptor or no source of contamination has been identified where a pathway and receptor are present, there is no complete contaminant linkage.

9.3.51 The second stage of the assessment is risk evaluation, which is a qualitative method of interpreting the output from the risk estimation stage and involves the classification of the following to attribute a risk factor for each complete contaminant linkage:

- Magnitude of the probability (likelihood) of the risk occurring (Table 9.7); and
- Magnitude of the potential consequence (severity) of risk occurring (Table 9.4).

9.3.52 As stated in CIRIA C552, it is important that this classification is only applied where there is a possibility of a contaminant linkage existing.

9.3.53 The risk evaluation, based on the above guidance is represented in the form of a consequence and probability matrix to establish the level of risk (Table 9.3). For the purpose of this assessment, risk levels of moderate, high and very high are considered significant, whereas low and very low risks are considered insignificant.

Table 9.3: Classification of Probability

Classification	Definition of the probability of harm / pollution occurring
High likelihood	There is a contaminant linkage and an event that either appears very likely in the short team and almost inevitable over the long term, or there is evidence at the receptor of harm or pollution.
Likely	There is a contaminant linkage, and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that and event is not inevitable, but possible in the short team and likely over the long term.
Low likelihood	There is a contaminant linkage, and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period such event would take place and is less likely in the shorter term.
Unlikely	There is a contaminant linkage, but circumstances are such that it is improbable that an event would occur even in the very long term.

Table 9.4: Classification of Consequence

Classification	Definition of consequence
Human health impacts from chemicals in the ground	
Severe	Short-term (acute) effects likely to result in significant harm e.g. high concentration of cyanide on the surface of an informal recreational area.
Medium	Long-term (chronic) effects likely to result in significant harm e.g. high concentration of contaminants close to the surface of a development site.
Mild	Harm but probably not significant harm unless particularly sensitive individual within the receptor group. May be aesthetic / olfactory impacts.
Minor	No measurable effects.
Site worker impacts from chemicals in the ground	
Severe	Risk assessment required to determine required personal protective equipment (PPE)
Medium	Risk assessment required to determine required personal protective equipment (PPE)
Mild	Risk assessment required to determine required personal protective equipment (PPE)
Minor	No measurable effects, but simple personal protective equipment (PPE) required
Human health impact from ground gases such as radon and landfill gas where exceedance of a risk-based trigger indicates the potential for harm	

Classification	Definition of consequence
Severe	Pollution linkage identified over a large area.
Medium	Pollution linkage identified in limited areas.
Mild	Pollution linkage uncertain.
Minor	Plausible pollution linkage not established.
Controlled Waters impacts from chemicals in the ground	
Severe	Pollution of highly sensitive water resources (Principal aquifer within a groundwater Source Protection Zone 1, potable water supply or rivers). Discharge of a List I or List II substance to Controlled Waters or major spillage. Substances leaching from contaminated soil causing receiving waters to exceed surface water and groundwater quality indicators (EQS / DWS) over a large area or resulting in a change in water quality grade for the river reach.
Medium	Pollution of sensitive water resources (Principal aquifer outside of a groundwater Source Protection Zone (inner and outer), Secondary A aquifer, industrial groundwater abstraction, irrigation supply or rivers / streams). Substances leaching from contaminated soil cause receiving waters to exceed surface water and groundwater quality indicators (EQS / DWS) in limited areas, insufficient to result in a change in the water quality grade of the river reach.
Mild	Pollution of non-sensitive water bodies (Secondary A or Secondary B aquifer) or non-classified groundwater or minor ditches. Substances leaching from contaminated soil cause receiving waters to slightly exceed surface water and groundwater quality indicators (EQS / DWS), insufficient to result in a change in the water quality grade of the river reach or pollution of a surface water course without a quality classification.
Minor	No measurable effects. Substances leaching from contaminated soil do not cause receiving waters to exceed surface water and groundwater quality indicators (EQS / DWS).
Ecosystems impacts from chemicals in the ground	
Severe	Short-term risk to a particular ecosystem or organism forming part of that ecosystem in a designated protected area, e.g. by contamination spillage. Irreversible damage to a protected area of international significance (e.g. Ramsar site).
Medium	Death of species in a particular ecosystem in a designated protected area, e.g. by contamination spillage. Substantial damage to a protected area of national significance (e.g. Site of Special Scientific Interest).

Classification	Definition of consequence
Mild	Minor change in a particular ecosystem in a designated protected area, but not significant harm. Damage to a locally important area.
Minor	No measurable effects. Limited harm to ecosystems of low sensitivity such as sites of local importance.
New planting impacts from chemicals in the ground	
Severe	Complete and rapid die-back of landscaped areas.
Medium	Stressed or dead plants in landscaped areas.
Mild	Damage to plants in landscaped areas, e.g., stunted growth, discoloration.
Minor	No measurable effects.
Damage to building products form chemicals in the ground (e.g. sulphate attack of concrete, organic solvent decay of plastics)	
Severe	Maximum soil concentration exceeds industry accepted trigger value over a large area.
Medium	Maximum soil concentration exceeds industry accepted trigger value in limited areas.
Mild	Maximum soil concentration slightly exceeds industry accepted trigger value in limited areas.
Minor	Maximum soil concentration less than industry accepted trigger value.
Damage to buildings from flammable ground gas	
Severe	Catastrophic damage, e.g. gas explosion causing collapse.
Medium	Damage renders unsafe to occupy.
Mild	Damage to sensitive buildings etc.
Minor	No measurable effects.

Table 9.5: Risk Level Estimation

Probability	Consequence			
	Severe	Medium	Mild	Minor
High likelihood	Very High	High	Moderate	Low

Probability	Consequence			
	Severe	Medium	Mild	Minor
Likely	High	Moderate	Low	Low
Low likelihood	Moderate	Low	Low	Very Low
Unlikely	Low	Low	Very Low	Very Low

Construction

9.3.54 Details of the construction programme for the Proposed Development are covered in greater detail within Chapter 6: Construction and are summarised in the following paragraphs.

9.3.55 The indicative delivery programme for the Proposed Development is estimated to be approximately 16 months. Enabling works are anticipated to commence second quarter ('Q2') of 2026 and with completion of works by the start of 2028 subject to securing planning permission and other consents and licenses.

9.3.56 The overall construction of the Proposed Development is programmed to take place continuously over the 16 month period, albeit at different levels of intensity. Careful consideration of the spatial phasing and timing has been at the heart of the programme development due to the ecological sensitivity factors with the presence of sensitive ecological receptors present within the Site and the surrounds.

9.3.57 A phased approach is to be undertaken in order to ensure an enabling works package which minimises ecological effect. As noted above, consideration has been given to the best time periods to undertake the works given the sensitive ecological receptors at the Site. Further information on the timing and likely duration of construction work is provided in Chapter 6: Construction.

9.3.58 The construction phase will also include the requirement for Horizontal Direction Drilling (HDD) under the Grand Union Canal to allow for the services connection for the Proposed Development, including electricity, telecoms and data, foul and surface water drainage, and potable water. HDD works will connect the Proposed Development to the electricity sub-station to the east of the Site and other utilities connection.

Completed Development

9.3.59 The assessment of the completed, operational Development is based upon the description of Development provided in Chapter 5: Description of the Development and supporting plans provided in Appendix 5.1. This includes reasonable worst-case assumptions about the nature and location of land-based activities uses within the Site.

9.3.60 The assessment approach undertaken for Ground Conditions and Contamination during the Completed Development is the same as the approach for the construction phase but is based on receptors present once the Proposed Development is complete.

9.3.61 The temporal scope used in the assessment of the completed, operational effects is the lifetime of the Proposed Development.

Determining Effect Significance

Sensitivity of Receptor

9.3.62 The sensitivity of the receptors is a matter of professional judgement. In this chapter, the sensitivity is taken to be the likelihood that one of the sensitive receptors is impacted.

Table 9.6: Receptor Sensitivity Descriptors

Value (Sensitivity)	Descriptor
High	The receptor has low ability to absorb change without fundamentally altering its present character / health, is of high environmental value, or is of national importance, e.g., human health, highly sensitive water resources (Principal aquifer within a groundwater Source Protection Zone, potable water supply or rivers), protected area of international or national significance (e.g. SSSI).
Medium	The receptor has capacity to absorb change without significantly altering its present character / health, has some environmental value, or is of regional importance, e.g., sensitive water resources (Principal aquifer outside of a groundwater Source Protection Zone (inner and outer), Secondary A aquifer, industrial groundwater abstraction, irrigation supply or rivers / streams), protected areas of locally importance.
Low	The receptor is tolerant of change without detriment to its character / health, is low environmental value, or local importance, e.g. non-sensitive water bodies (secondary aquifer) or non-classified groundwater or minor ditches, planting and landscaping.
Negligible	The receptor is resistant to change and is of little environmental value e.g. buildings and infrastructure.

Magnitude of Impact

9.3.63 The magnitude of impacts is judged on the consequences of the impact. In terms of contamination, for example, this would be the degree of exceedance of the assessment criteria and whether this takes place locally or across large areas of the Site. Professional judgement is used to estimate the likely degree of exceedance based on experience from other, similar sites.

Table 9.7: Magnitude of Impact Descriptors

Impact Magnitude	Descriptor
High	Total loss of major alterations to one of more of the key elements, features or characteristics of the baseline. The post-development situation will be fundamentally different. Acute or genotoxic risks to human health, catastrophic damage to buildings, major pollution to highly sensitive controlled waters (e.g. significant spill).
Medium	Partial loss or alteration to one of more of the key elements or characteristics of the baseline. The post-development situation will be partially changed.

Impact Magnitude	Descriptor
	Chronic risks to human health, pollution of sensitive controlled waters, significant effects on sensitive ecosystems or species, rapid die-back of landscaped areas, significant damage to buildings or infrastructure rendering them unsafe for use.
Low	Minor loss or alteration to one or more of the key elements, features or characteristics of the baseline. Post-development, the change will be discernible, but the underlying situation will remain similar to the baseline. Nuisance from odours, pollution of non-sensitive waters, minor damage to landscaping (stressed plants, stunted growth), buildings or infrastructure (not sufficient to render unsafe).
Negligible	Very minor loss or alteration to one of more of the key elements, features or characteristics of the baseline, such that post-development, the change will be barely discernible, approximating to the “no change” situation. No reversible effect to human health, limited harm to non-sensitive ecosystems or species, aesthetic changes (discoloration of plant life or concrete).

Assessing Significance

9.3.64 The significance of a potential impact is based on the combination of the magnitude and sensitivity of that impact as given in the matrix in Chapter 3: EIA Methodology. Note that the degree of ‘significance’ is not the same as the legal definition of ‘significant harm’ as defined by the Environmental Protection Act 1990.

9.3.65 The significance of an environmental effect is determined by the interaction of the magnitude and sensitivity, whereby the impacts can be beneficial or adverse. The Effects Significance Matrix is set out in Table 9.8.

Table 9.8: Effects Significance Matrix

Magnitude	Sensitivity			
	High	Medium	Low	Negligible
High	Major adverse / beneficial	Major adverse / beneficial	Moderate adverse / beneficial	Moderate adverse / beneficial
Medium	Moderate - Major adverse / beneficial	Moderate adverse / beneficial	Moderate – minor adverse / beneficial	Minor adverse / beneficial
Low	Moderate adverse / beneficial	Moderate – minor adverse / beneficial	Minor adverse / beneficial	No adverse / beneficial
Negligible	Minor adverse / beneficial	Minor adverse / beneficial	No adverse / beneficial	No adverse / beneficial

Assumptions and Limitations

9.3.66 The Risk Assessment has assumed peak enabling and construction phase works, as well as peak operational phase works to provide a 'worst case' scenario. Peak construction works are likely to comprise enabling works, and the main construction and Peninsula works.

9.3.67 The Geo-Integrity Site Investigation has been considered 'Preliminary' due to inaccessibility of some site areas. It is recognised by the Applicant that following the planning application decision, additional site investigation will be required. The scope of these site investigations will be agreed with LBH, the EA, the Local Authority CLO and Affinity Water and Natural England as appropriate.

9.3.68 These works would be progressed in accordance with suitably worded planning conditions.

9.3.69 The Phase II Site Investigation sampling locations were restricted to accessible areas of the Site. Therefore, spatial coverage of some Site areas (where densely wooded / vegetated) was not possible, and therefore no data has been captured at this stage. Areas that were inaccessible during the Site Investigation works, including the BSC area are to be investigated to inform the enabling works phase of development where access will be made.

9.4 Baseline Conditions

Geological Conditions

Artificial Geology

9.4.1 The Site is mapped as underlain by undivided worked ground. This is as a result of the Broadwater Lake being formed through the surface excavation for sands and gravels historically.

9.4.2 There are also areas across the Peninsula which are mapped as infilled ground. These areas have been confirmed across the Peninsula by Phase II Site Investigation which has identified anthropogenic materials present in made ground soils.

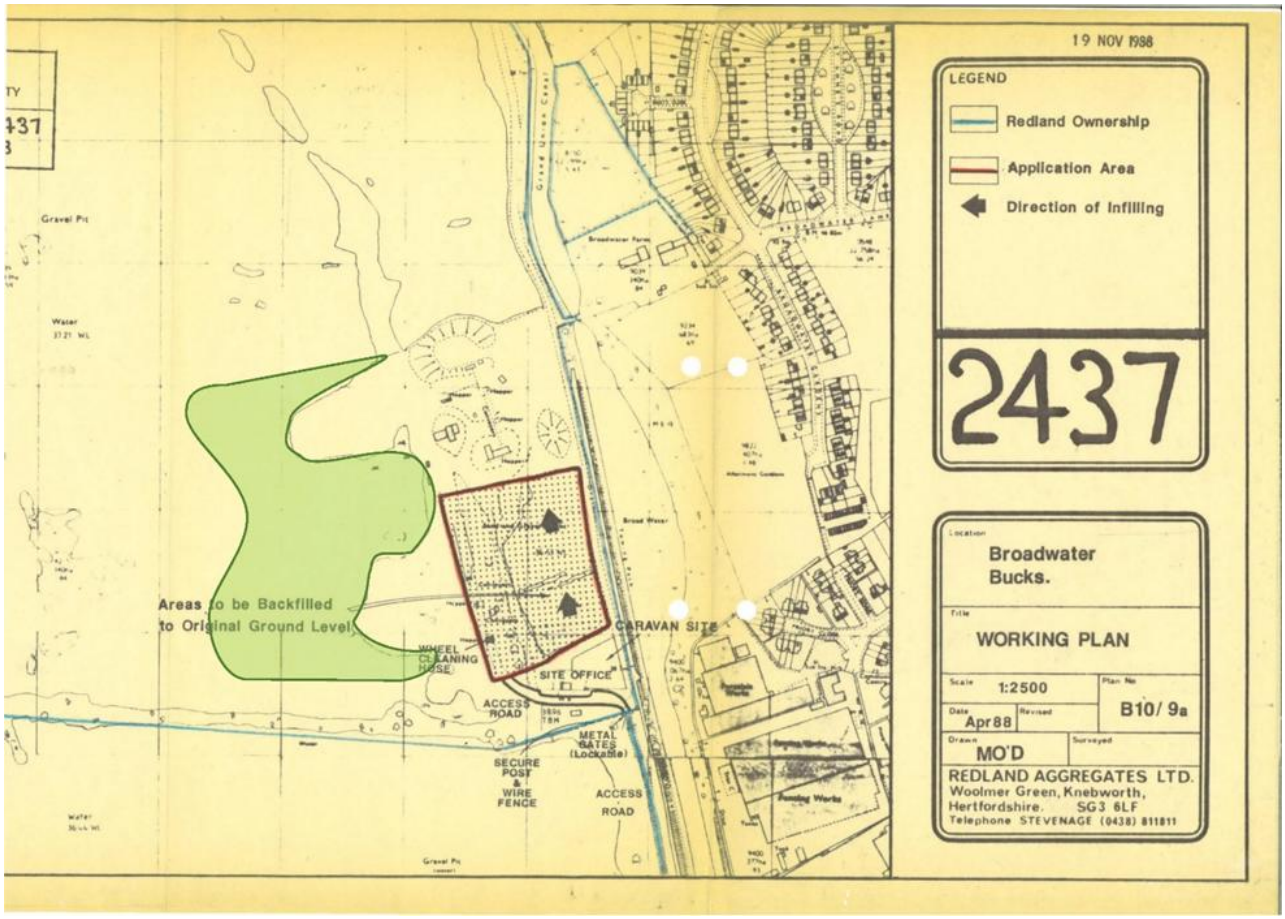
9.4.3 EA records indicate that the lagoon and a portion of the Peninsula has previously been used as a licensed landfill, operating from 1993 to 2004 by Lafarge Aggregates Limited. The extent of the licensed landfill area is shown on Figure 9.3.

9.4.4 Additionally, EA records indicate the presence of an historic landfill underlying the area of Mitchel's Meadows, located off-site, but within the 250m study area. The landfill is mapped approximately 30m east of the Site boundary and Grand Union Canal.

9.4.5 A drawing showing the position of the on-Site and off-Site landfills located within the Study Area (250m buffer) is included as Appendix 9.4.

9.4.6 Following a consultation meeting on 30 June 2023, a historic plan has been provided to the Applicant by the EA (Figure 9.3) which shows the extent of the historic landfilling area (red boundary) with an additional area of infilling which was anecdotally suggested by the EA Officer and is highlighted in green.

Figure 9.5: Historic Landfill Plan (provided by EA)



Note: Area of licenced landfill shown in Red. Area of suspected unregistered landfill shown in Green (as advised by EA)

9.4.7 The Phase II Site Investigation has confirmed that the made ground thickness across the Peninsula reaches a maximum of 3.45m within BH4 (shown on Figure 9.2).

9.4.8 The Phase I and Phase II Reports both indicate that a significant portion of the Site Peninsula is underlain by concrete hardstanding.

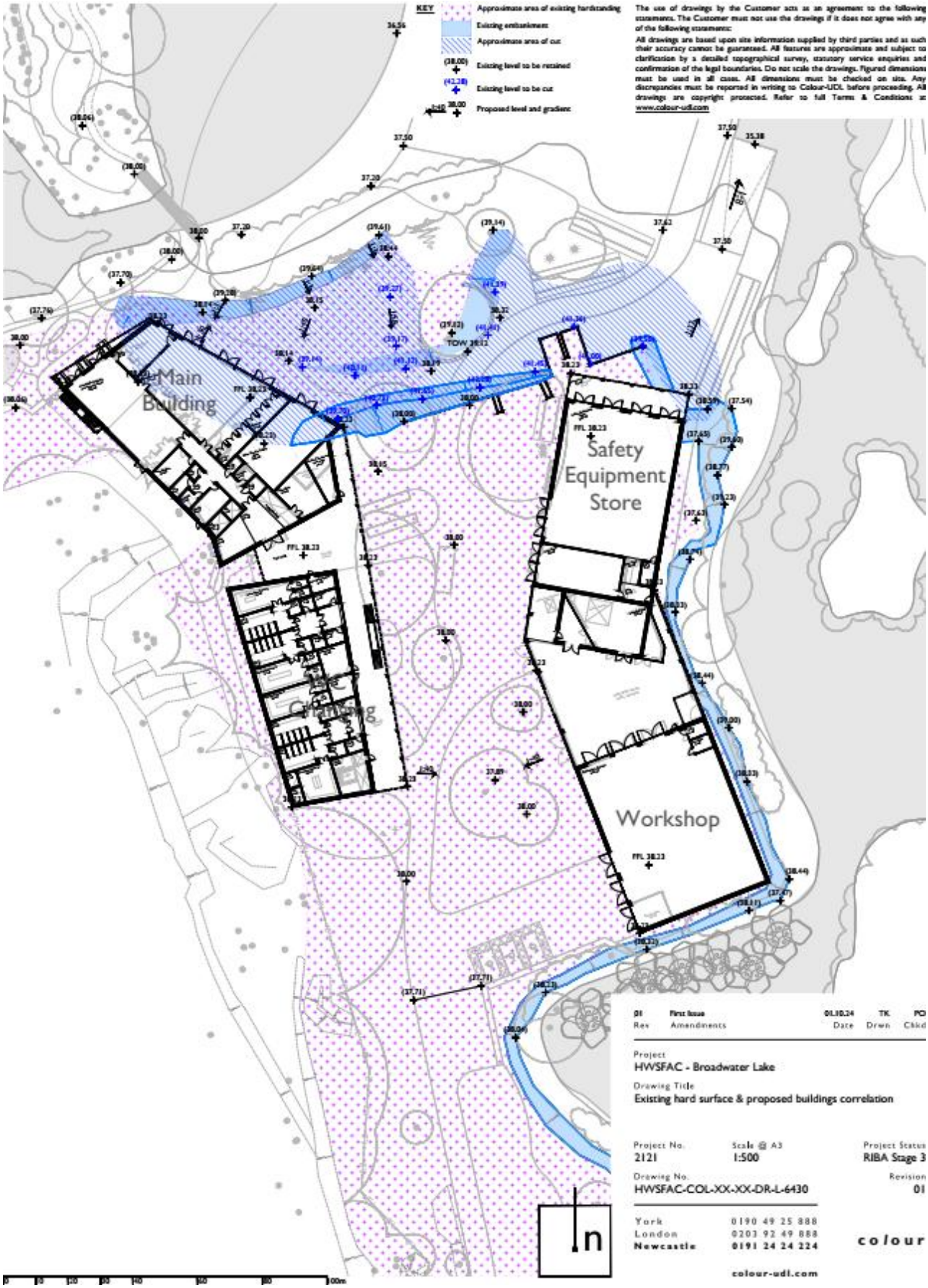
9.4.9 Intrusive investigation positions (including boreholes and trial pits) have encountered inert landfilled materials underlying the majority of the Site Peninsula area. The materials generally consist of inert landfill materials including brick, brick debris, concrete debris, and coal fragments. The made ground attains a maximum thickness of 3.45m within BH4. Although the total depth in a number of positions was not proven with exploratory position being completed within the made ground.

9.4.10 In places, the Phase II Site Investigation has encountered materials comprising ash, slag, rubber, hydrocarbon stained soils and hydrocarbon odours. These materials may not be considered inert fill material by current standards.

9.4.11 Within the made ground deposits, an isolated ‘hotspot’ of hydrocarbon contamination has been encountered. This is discussed further in the ‘Ground Chemical Conditions’ section below.

9.4.12 Figure 9.6 shows the extent of the hardstanding surfacing across the Peninsula.

Figure 9.6: Hardstanding Surfacing Coverage (Peninsula)



Superficial Geology

9.4.13 The Site is mapped as being underlain by Alluvium and Shepperton Gravel Member superficial deposits.

9.4.14 The BGS describe the Alluvium as '*Ground associated with the nearby River Colne and consists of interbedded clays, silts, sands and gravels, associated with flooding events and meandering of the river across the valley floor.*'

9.4.15 The BGS describe the Shepperton Gravel Member as '*generally consisting of sand and gravel, locally with lenses of silt, clay or peat*.'

9.4.16 It is likely that the majority of the shallow Shepperton Gravel Member has been excavated from the lake areas, with mainly the deeper gravels and the higher silt / clay content materials (Alluvium) left in-situ at the base of Broadwater Lake and immediately underlying the lake.

Bedrock Geology

9.4.17 BGS Maps show the Site as underlain by the Seaford Chalk and Newhaven Chalk Formation (Undifferentiated).

9.4.18 The Seaford Chalk Formation is described by the BGS as '*Firm white chalk with conspicuous semi-continuous nodular and tabular flint seams. Hardgrounds and thin marls are known from the lowest beds. Some flint nodules are large to very large.*'

9.4.19 The BGS describes the Newhaven Chalk Formation as '*Soft to medium hard, smooth white chalks with numerous marl seams and flint bands*.'

9.4.20 Underlying the made ground deposits is a low permeability 'silty clay' alluvium. The Shepperton Gravel Member immediately underlies the alluvium deposits. The Seaford Chalk underlies the Site area at depth.

Groundwater

9.4.21 The Aquifer Designation Map (Bedrock) shows that the Site is designated as underlain by a Principal Aquifer (previously known as 'Major Aquifers'). Principal Aquifers have a geology of high intergranular and / or fracture permeability, usually providing a high level of water storage and may support water supply / river base flow on a strategic scale.

9.4.22 The Superficial Drift Aquifer Designation Map shows the Site being designated as a Secondary A Aquifer. Secondary A aquifers comprise permeable layers that can support local water supplies and may form an important source of base flow to rivers.

9.4.23 The underlying groundwater within the Mid-Colne Valley is known to be in hydraulic continuity with the overlying surface water features present across the base of the valley, including Broadwater Lake, and the River Colne.

9.4.24 The Site is situated across two Source Protection Zones (SPZ): Type 1 (Inner Catchment, or SPZ1) which have a 50-day travel time of pollutant to source; and Type 2 (Outer Catchment, or SPZ2) which have a 400-day travel time of pollutant to source.

9.4.25 Broadwater Lake is located over, and likely is in continuity with the Mid-Chilterns Chalk Groundwater Body (Water Framework Directive (WFD) Ref GB40601G601200). Its most recent (2019) Overall Rating is Poor, Chemical rating is Poor and Quantity rating is Poor. Objectives include achieving 'Good' classification for Chemical classification by 2027.

9.4.26 There are two active abstraction licences on-Site associated with Gravel Pit A and B, held by Tarmac Aggregates Ltd and associated with mineral washing activity on the raised area of ground in the south east of Broadwater Lake. An additional abstraction is present within 250m of the study area, the Harleyford Aggregates Ltd borehole, located at NGR: 504860, 188840, approximately 240m south of the Site Peninsula.

9.4.27 Additional details in regard to the Groundwater baseline conditions are presented in Chapter 8: Water Resources and Flood Risk.

9.4.28 The Groundsure Enviro-Geo Insight report (included in Appendix 9.2) details the groundwater vulnerability of the Site and surrounding area. This assesses the vulnerability of groundwater to a pollutant discharged at ground level based on the hydrological, geological, hydrogeological and soil properties within a 1km grid square. The Groundsure report shows that features found within the Site include:

- Principal Bedrock Aquifer – High Vulnerability (Combined Classification: Productive Bedrock Aquifer, Productive Superficial Aquifer);
- Secondary Superficial Aquifer – High Vulnerability (Combined Classification: Productive Bedrock Aquifer, Productive Superficial Aquifer); and
- Principal Bedrock Aquifer – Medium Vulnerability (Combined Classification: Productive Bedrock Aquifer, Productive Superficial Aquifer).

9.4.29 High vulnerability is described as: areas able to easily transmit pollution to groundwater. They are likely to be characterised by high leaching soils and the absence of low permeability superficial deposits. Medium vulnerability is described as: intermediate between high and low vulnerability (where low vulnerability is defined as areas that provide the greatest protection from pollution, likely to be characterised by low-leaching soils and / or the presence of superficial deposits characterised by a low permeability).

Surface Water

9.4.30 The majority of the Site comprises a waterbody (Broadwater Lake) within the River Colne floodplain. Formed as a result of gravel extraction, Broadwater Lake is one of over 60 such waterbodies throughout the wider Mid-Colne Valley that together form a complex of wetland features and as such, many of these are likely to be in hydrological continuity with one another.

9.4.31 Broadwater Lake is bordered to the west and north by the River Colne (Main River), and the Grand Union Canal is located to the east. Other former gravel pits / sand pits are situated immediately to the north and south, with a narrow terrestrial perimeter forming the lake / river shore and canal embankment. The Peninsula is located adjacent to the south east corner of the lake and is currently characterised by wet woodland, broadleaved woodland and standing water.

9.4.32 A review of the 1865 County Series Ordnance Survey (OS) map shows the Site as part of an area referred to as Harefield Moor and of a series of field parcels separated by ditches

and sluices, with the River Colne to the west and the Grand Union Canal to the east. The 1974 – 1976 OS 1:10,000 maps show the first phase of sand and gravel extraction extending across some two thirds of the Site. By 2001, the OS 1:10,000 map shows the majority of the Site (Broadwater Lake area) having been worked for sand and gravel (now completed), flooded and the lake being present, together with 30 islands of varying sizes.

9.4.33 The Grand Union Canal (GUC) was completed in 1805. Linking London and the Midlands and stretches for 4 miles within the Colne Valley. The GUC is likely lined with low permeability material over part of its length, particularly where the groundwater level fluctuates significantly, although it is recognised that several sections are unlined. It is also understood that some sections of the canal were constructed in the former channels of the River Colne. Internet based resources indicate that the depth of the Grand Union Canal within the Colne Valley is approximately 1.68m. This is to be confirmed during further site investigation works proposed to inform the HDD to form site service connections.

9.4.34 Additional details in regard to the surface water features are included within Chapter 8: Water Resources and Flood Risk.

Current and Historical Land Use

9.4.35 The Site is currently utilised by Broadwater Sailing Club, which features associated car parking facilities and access tracks on the northern lake shore.

9.4.36 As part of the Phase I Geo-Environmental Assessment, a site walkover was undertaken to determine the current land uses and the associated potential contamination sources relating to the current Site use. The site walkover identified no significant contamination sources relating to the current land use of the Site.

9.4.37 The Site has historically been utilised for surface mineral extraction (sands and gravels) as well as the on-Site processing of these minerals. The site walkover identified remnants of this historic site use, including a weighbridge, hoppers, conveyor gantries, concrete bunds and electricity substation which all pose a potential point sources for historical contamination.

9.4.38 Reviewed datasets also indicate that areas of the Peninsula have been utilised for historic licensed landfilling, as well as potential areas of unregulated landfilling. These landfilling areas are shown on Figure 9.3.

Other Regulatory Data

9.4.39 Additional regulatory datasets have been reviewed as part of the Phase I Geo-Environmental Assessment and include:

- 6no. waste exemptions within the Study Area (off-Site but within 250m Study Area);
- 1no. historic licensed pollutant release (Part A(2)/B) - off-Site but within 250m Study Area;
- 13no. licensed discharges to controlled waters within 250m Study Area (including 1no. on-Site record – pertaining to historic sewage effluent);
- 5no. historic pollution event records (all records located off-Site but within 250m Study Area). Events pertaining to pollutants including smoke, construction and demolition materials and waste, unidentified oils and dust; and

- There are no other notable regulatory datasets with inventories pertaining to records on-Site or within the 250m Study Area.

Mining / Mineral Resources

9.4.40 The Phase I Geo-Environmental Assessment identifies the following information relevant to mining and mineral resources:

- 10no. records of BritPits, including one on-site record (Nine others within 250m Study Area) – records pertaining to surface mineral workings;
- There are 29no. records pertaining to surface workings on-Site, this number includes duplicated records as the data is retrieved from historic OS Maps. The surface workings include, gravel pits, Grand Union Canal, cement lime brick and tile works, and an unspecified wharf; and
- 4no. records of historic mineral planning areas on-Site relating to Broadwater Farm and Harefield pits, all of which appear to be operated from 1948 to 1969. There are also 7no. records pertaining to mineral planning areas within the 250m Study Area.

Geo-conservation Resources

9.4.41 Online records in regard to Regionally Important Geomorphological Sites (RIGS) indicates that there are no RIG Sites located within the 250m Study Area.

9.4.42 Harefield Pit is a Geological SSSI Unit within the Study Area. Harefield Pit is assigned SSSI status as it provides a key section in the London Basin for a sequence through the Upper Chalk, Reading Beds and London Clay.

Ground Chemical Conditions

9.4.43 The Phase II Site Investigation captured a number of soil samples from a range of depths within the exploratory borehole and trial pit positions, with full details and laboratory certificates provided in Appendix 9.3.

9.4.44 The Phase II Site Investigation indicates the presence of a hydrocarbon contamination ‘hotspot’ on the Peninsula, with the trial pit logs indicating visual and olfactory evidence of hydrocarbons at TP4 and CBR5.

9.4.45 Laboratory chemical analysis of the soil samples indicates measurable concentrations. These were screened against ‘Commercial’ and also ‘Residential with produce’ Safe for Use Levels (S4ULs), which identified a number of exceeding TPH and PAH concentrations.

9.4.46 Elevated concentrations of PAHs when compared against ‘Residential with produce’ criteria were identified in 4no. made ground samples, with 3no. samples having elevated concentrations of TPHs, including Aliphatic TPH >C10- C12 and >C12 – C16.

9.4.47 Laboratory analysis indicated measurable concentrations of some heavy metals and select PAHs; however concentrations were not in exceedance of GAC.

9.4.48 No asbestos was identified within the laboratory screening of 12no. made ground soil samples.

9.4.49 Other potential contamination sources were encountered within the infilled / made ground including ash, slag, coal and anthropogenic materials such as brick, rubber and glass.

9.4.50 In places, it appears that made ground soil classification has been used where the encountered description appears to be more consistent with reworked ground, with inclusions of gravels of quartz and flint, rather than any significant anthropogenic inclusions.

Broadwater Lake Sediment Chemical Conditions

9.4.51 Screening of the 40no. Broadwater Lake sediment samples against human health S4ULs indicated 1no. exceedance for arsenic concentrations, and a number of other exceedances of the Ecological Soil Screening Values (SSVs) for zinc, nickel and cadmium.

9.4.52 The results of the Broadwater Lake sediment screening are included in Appendix 9.6 of this ES chapter.

Unexploded Ordnance

9.4.53 A Preliminary UXO Risk Assessment was undertaken by Impartial Assessments Ltd in September 2023 (Appendix 9.5). This identifies there is a potentially elevated likelihood of Explosive Ordnance being encountered during the construction works for the Proposed Development.

9.4.54 German Air Force earmarked an airfield 700m away for attack. In the event, there was an elevated local bombing density (at least 10 bombs landed within 200m of the Site, including one on-site). The Grand Union Canal was a WW2 fortified defence line which indicates army activities, potentially involving live ammunition.

9.4.55 Post-war sand / gravel extraction may not have extended down to the maximum bomb penetration depth and in any event did not affect the entire Site area. UXBs could therefore remain buried on-site.

9.4.56 A Stage 2 detailed risk assessment would be undertaken prior to the commencement of construction to further assess the potential risk of UXO.

Ground Gas Conditions

9.4.57 Part of the Peninsula is mapped as shown in Figure 9.4 as within an EA licensed landfill, as well as being within the 250m ground gas buffer zone for other nearby off-Site former landfills.

9.4.58 Correspondence with the EA indicates the potential presence of unregistered landfilling activity to the west of the Peninsula as highlighted in green on Figure 9.5.

9.4.59 Organic materials including coal and wood have also been encountered during the Phase II Site Investigation which may lead to ground gas generation.

9.4.60 3no. borehole positions (BH3, BH6 and BH9) as groundwater and ground gas monitoring positions for subsequent monitoring visits. In total, 4no. ground gas monitoring visits were progressed between 09/03/2023 and 29/03/2023.

9.4.61 Methane was recorded between below detection limits and 0.6%, carbon dioxide between 0.1% and 0.8% and oxygen between 0.6% and 19.3%. Peak flow was recorded at 0.27l/h. The worst case gas screening value (GSV) was calculated at 0.00216.

9.4.62 The Gas Screening Value (GSV) of 0.00216 is representative of a Characteristic Situation 1 (CS1) due to no significantly elevated levels, as per CIRIA C665 and BS8485:2015 Guidance.

9.4.63 The Site is located within an area where <1% of the properties exceed the action level of 200Bq per cubic meter for radon gas, and therefore no radon protection measures are necessary in the construction of any proposed buildings.

Groundwater Conditions

9.4.64 A qualitative Groundwater Risk Assessment has been undertaken which covers the groundwater environment, the risks posed to the groundwater environment by the Proposed Development, and where required mitigation measures to reduce / offset the potential risks associated with the Proposed Development. This is included as Appendix 8.3.

9.4.65 Groundwater samples captured during the Phase II Site Investigation were screened against Freshwater Environmental Quality Standards (EQS) and UK Drinking Water Standards (UK DWS). The groundwater samples were captured from BH3, BH6 and BH9 from depths of 2.20m below ground level (mbgl), 0.94mbgl and 2.36mbgl, respectively.

9.4.66 The screening of groundwater samples indicated several marginal exceedances of heavy metals, including copper (1no. exceedance), manganese (3no. exceedances) and nickel (2no. exceedances).

9.4.67 All other screened chemical determinants were present at below their respective GAC concentration, or below the Laboratory Level of Detection (LoD).

9.4.68 Groundwater level monitoring indicated the presence of groundwater levels beneath the Peninsula at between 38.56mAOD (BH3) and 38.82mAOD (BH6).

9.4.69 Based on the groundwater levels within BH3, and BH6, the groundwater flow direction beneath the Site is to the south, in the general direction of flow within the River Colne.

9.4.70 Further details in regard to the groundwater environment and conditions are included in Chapter 8: Water Resources and Flood Risk.

Ecology

9.4.71 Broadwater Lake forms part of the Mid-Colne Valley Site of Special Scientific Interest (SSSI) and SINC. Broadwater Lake is designated as a Natural England Nature Reserve for its bird populations including great crested grebe, cormorant, gadwall, shoveler, tufted duck, pochard, wigeon, goldeneye, smew, ruddy duck and coot. The Site also provides a number of habitats including standing water and woodland.

9.4.72 Ecological baseline information is present within Chapter 7: Biodiversity, within the Mitigation Enhancement Management Plan.

Future Baseline

9.4.73 If the Proposed Development does not proceed, it is envisaged that the Site will remain in its existing use, and baseline conditions will go marginally unchanged. There may be potential for the current concrete hardstanding across the Site to deteriorate over the long term if the Site is undeveloped and left unmanaged, which may create preferential pathways and increase the volume of rainfall and surface water infiltration in the underlying filled material and made ground.

9.4.74 The only committed future developments within the Study Area which may potentially change the land quality baseline of the Site is the HS2 development. Due to the locality of the HS2 development, it is not thought that it is likely to impact upon the baseline conditions of the Site's ground contamination baseline.

Summary of Receptors and Sensitivity

9.4.75 Table 9.9 provides a summary of the identified existing receptors and their associated sensitivity, as well as the future receptors once the Proposed Development is complete and operational.

Table 9.9: Summary of Receptor Sensitivity

Receptor	Sensitivity (Value)
Construction	
Human Health – Construction workers, existing off-site residential uses	Low to High
Ecology - Mid-Colne Valley SSSI and SINC	High
Built Receptors – Foundations and services	Low
Completed Development	
Human Health – Site end users and existing residential uses	High
Ecology – Mid-Colne Valley SSSI and SINC	High
Built Receptors – Foundations and services	Low

9.5 Embedded Mitigation (Scheme Design and Management)

Construction

9.5.1 The Proposed Development has been designed to avoid potential risks from contamination and ground gas to receptors during construction. Since the 2023 Scheme, the following revisions have been made to the proposals:

- Significantly reduced extent and volume of dredging and excavation work in the lake (now confined to the Eastern Channel, a single island removal instead of two islands);

- Significantly reduced area of land reclamation at the Peninsula from approximately 16,000m^2 to 8,000m^2 and avoidance of areas of historic landfill; and
- Reduced building footprint for all buildings and buildings have been positioned on the areas of existing hardstanding to avoid the creation of new pathways.

9.5.2 Based on the Proposed Development Proposals, there are no notable construction works located within 8m of the River Colne located along the western site boundary.

9.5.3 A range of other measures will be in place during the demolition and construction phase in order to minimise and manage potential impacts from the Proposed Development. It is expected that these measures would be subject to controls through the CEMP, other conditions attached to the planning permission, and relevant waste, water and environmental protection / permitting legislative regimes. These measures are set out below:

- **Pre-demolition asbestos survey** – asbestos surveys of remnant site buildings and structures will be undertaken on any structures that are to be removed as part of the Proposed Development to identify Asbestos Containing Materials (ACM) requiring regulated removal off-Site by specialist licensed contractors. This is required for compliance with relevant legislative regimes.
- **Environmental Permits** - Permits will be required to cover the works associated with the Proposed Development and are likely to include, Waste Framework Directive (EPR Schedule 9 – Waste operations and materials facilities), the Landfill Directive (EPR Schedule 10 – Landfill), Mining Waste Directive (EPR Schedule 20 – Mining waste operations) and Groundwater activities (EPR Schedule 22 – Groundwater activities). Following discussion and receipt of comments from the EA, Parallel Tracking of both the permit applications and the planning application will be progressed, so as to avoid any delays during the construction phases of the Proposed Development.
- **Outline CEMP –** The Outline CEMP (Appendix 6.1) includes the following measures which would be implemented to mitigate the potential risks posed to human health, groundwater, surface water, built environment and ecology:
  - General good construction working practices would be implemented such as dust suppression, including potentially contaminated dusts, (damping down), perimeter fencing around excavations, covering stockpiled materials;
  - Appropriate stockpile segregation, locations and containment measures would be implemented to minimise the exposure of surface water and groundwater from potentially impacted runoff;
  - A discovery strategy for managing and dealing with unexpected / unforeseen contamination that may be encountered during construction phase works. This may require additional site investigation, sampling risk assessment and remediation to ensure the protection of the identified receptors;
  - All construction workers would be required to wear PPE such as gloves, goggles and face mask (where appropriate) to prevent dermal contact, inhalation or ingestion. Appropriate site hygiene facilities will be put in place and the presence of contaminants, and the associated risks will be explained to ground workers before they begin work;

- Fuel storage on-Site would be carried out under best practice i.e., integrally bunded containers. Plant refuelling would be carried out using best practice techniques and any spills to be controlled with spill kit. Fuel storage should, where possible, be located sufficiently away from any surface water features, ditches and drains which may provide a preferential pathway for migration of leaks / spills;
- Management of water that collects on Site or within excavations would be implemented;
- Appropriate management plan for polluting substances that are being brought on Site and used as part of the construction process would be implemented. This is to include any site won materials (i.e. Broadwater Lake sediment / BSC demolition materials) that are proposed to be re-used in land reclamation;
- Appropriate management plan for sediments in surface water runoff generated in construction area and laydowns would be implemented;
- Appropriate management plan of accidental leakage and / or spillage incidents of oils / hazardous substances would be implemented; and
- Incorporation of hydrocarbon interceptors into the Site drainage system at high risk areas, such as parking, unloading and refuelling areas, to remove hydrocarbons and oils from surface water prior to discharge would be implemented.

- **Geotechnical Measures (Land Stability)** – The presence of highly variable and potentially compressible made ground deposits underlying the Peninsula are to be identified during enabling works phases, prior to the commencement of construction phase works. Remedial measures to address land stability will include temporary works and likely ground improvement (shoring of excavations, dig and replace, piling mats etc). Mitigation for compressible and unstable ground will be designed in accordance with guidance presented in CIRIA C572 BRE FB75 and BS 6031:2009.
- **Piling Method Statement -** CFA piling methods are likely to be appropriate for use during the piling of building foundations to limit the potential for the mobilisation of shallow contamination within made ground soils into underlying natural strata and the groundwater. Shallow foundations are considered unsuitable for settlement sensitive structures due to unacceptable total and differential settlements under applied foundations loadings. Shallow reinforced raft foundations may be considered for small, low-bearing structures where a small amount of settlement can be tolerated, while keeping differential settlement to a minimum. For the implementation of shallow foundations (where feasible) the identified construction measures set out in Appendix 9.3 are to be followed. Piling method statements will be provided at detailed design stage
- **HDD** - Based on industry experience, detailed design and skilled execution by a suitably qualified and competent HDD contractor, the risks from HDD drilling will be minimised. A Breakout Management Plan will be put in place by the appointed HDD contractor to assess the risks posed by potential breakout of drilling fluid (bentonite). The Breakout Management Plan will incorporate drilling suspension protocols, breakout containment strategies, fluid removal and clean-up procedures, and incident recording and reporting. No refuelling of plant machinery associated with the HDD process will occur within the vicinity of any watercourse, including the Grand Union Canal or the Eastern Channel. These measures are secured through the Outline CEMP.

- **Dredging** - Dredging works will be progressed within a turbidity curtain to restrict the potential for wider scale migration of sediments, turbidity and suspended solids across other parts of Broadwater Lake.

9.5.4 It is envisaged that planning conditions will be assigned to the Proposed Development as part of the planning application process, which will likely highlight the requirement for additional investigation, site specific risk assessment, a remediation strategy, remediation verification works, and reporting based on the historical uses of the Site.

Completed Development

9.5.5 As set out in paragraph 9.5.1, the proposals at the Peninsula have been designed to minimise potential contamination risks associated with the completed Proposed Development, e.g. by avoiding landfilled areas, retaining hardstanding, positioning structures on hardstanding areas. Other measures set out below will be included within the detailed design to mitigate the risks posed by the Proposed Development across its operational lifespan to the identified sensitive receptors:

- **Clean cover systems** – These will be installed to a minimum 600mm thickness in the camping area on the Peninsula and may be reduced to a minimum of 400mm in less sensitive areas based upon proposed land use[1] with details to be agreed with LBH. The clean cover system will comprise verified clean material which is suitable for the proposed use and could include on-site derived tested verified materials or imported material. Sampling numbers based on material types are to be confirmed at detailed design stage once the finalised materials volumes are known;
- **'No dig or hard to dig' layers** – These are to be incorporated where made ground materials have been determined safe for retention and re-use at depth within public open space areas. These layers may consist of a colour geotextile membrane, or a hard to dig compacted stone layer to minimise the likelihood of future disturbance or risk of accidental exposure through digging of soil; and
- **Surface water drainage control** – Hard surfaces such as car parking, access roads and building roofs which will incorporate drainage control measures and further restrict the infiltration of rainwater and surface water directly to ground. These measures are secured through the Drainage Strategy set out in Appendix 8.2.

9.6 Assessment of Effects - Construction Stage

Human Health – Construction / Enabling Workers, Existing Residents

9.6.1 The sources of potential effects to human health receptors during the enabling works, demolition and construction phase include the identified made ground associated with historical landfilling and mineral extraction / processing, and the potential for ground gas generation by this historic landfilling / infilling of ground.

9.6.2 Ground gas risks have been identified as a result of the presence of on-Site, mapped, historic landfilling activity, as well as the potential presence, as highlighted by the EA of an

[1] More sensitive areas include camping and soft landscaped areas. Less sensitive areas include parking and access roads.

unregistered landfilling area at Broadwater Lake, located west of the existing Peninsula. An assessment of effects in regard to ground gas and vapours is provided below.

9.6.3 Pathways for the identified sources of contamination during the enabling and construction phase include ingestion, inhalation and dermal contact with made ground / infilled ground materials during construction works (including HDD requirements). Inhalation of hazardous ground gases and vapours, following the lateral migration from historic on-Site and off-Site landfill areas. There is likely to be a Low to Moderate Risk posed by the made ground soils to existing residents and construction workers respectively, prior to the implementation of additional mitigation measures.

9.6.4 The length of direct exposure is limited to the duration of works (temporary) in which construction workers are directly involved, and therefore the effect is considered short-term. Any health effects from the potentially contaminated soil could have a low impact. The magnitude of the potential impact upon human health receptors has been considered as ranging from Low (on-site workers) to Negligible (Existing off-site residents) determined in line with Table 9.7, as there may be a discernible change as a result of nuisance from dusts / odours, and a very minor, barely discernible change to the baseline for existing off-Site residents.

9.6.5 The sensitivity of existing residents and construction workers ranges from low to high, where ranging amounts of ground disturbance occurs, and where distances of pathways increase.

9.6.6 The significance of the effect on the human health receptors during the construction phase have been determined as Minor Adverse to Negligible (not significant).

Ground Gas / Vapours

9.6.7 Identified sources of potential ground gas / vapour which may pose a potential gas / vapour risk to the Proposed Development include an on-site EA licensed landfill on the Peninsula and another potential on-Site area of unlicensed landfilling (west of the Peninsula) as shown on Figure 9.3. An off-site EA licensed landfill is also located within the Study Area (250m from the Site). This off-Site landfill is located immediately north east of the Grand Union Canal. The off-Site EA landfills are shown in Appendix 9.4.

9.6.8 Other identified sources of ground gas / vapour include made ground deposits underlying the Peninsula, including organics such as coal and wood, as well as noted localised hydrocarbon odours and staining within made ground.

9.6.9 The Phase II Site Investigation has characterised the Site as CS1 due to no significantly elevated ground gas levels, as per CIRIA C665 and BS8485:2015 Guidance. The guidance considers the gas characteristic scenario 1 as Low Risk.

9.6.10 Pathways for migration of potential ground gases / vapours include presence of granular soils underlying the Site and the creation of preferential short circuit pathways through cutting / reducing Site levels or forming of foundations.

Human Receptors

9.6.11 The identified source, pathway, receptor linkage may result in temporary Moderate Risks posed to the receptors during peak construction work phases, prior to the implementation of additional mitigation measures.

9.6.12 Receptors of migrating ground gases / vapours during the enabling and construction works phases include construction works (Human Health) and ecological receptors already occupying the Site. The sensitivity of the identified receptors has been determined High.

9.6.13 The length of direct exposure is limited to the duration of works (temporary) in which receptors are at risk, and therefore the effect is considered short-term. Any potential effects from the ground gas and vapours could have a Medium impact magnitude. The medium impact magnitude has been justified with reference to Table 9.7, where a potential alteration to one or more of the key characteristics of the baseline may occur during the construction phase.

9.6.14 The significance of the effect of ground gases / vapours has been determined as Moderate Adverse (significant) prior to the implementation of additional mitigation measures.

Built Environment

9.6.15 Built receptors include the proposed foundation solutions (piled, concrete structures, as well as sub-surface services including water supply pipes.

9.6.16 Identified sources of potential contaminants which may pose a risk to the identified built receptors include, presence of made ground / infilled ground across the Site, which includes hydrocarbon hotspot and identified exceeding leachable contaminant concentrations, and elevated measurable concentration of TPHs, VOCs and SVOCs. The presence of an area of landfilling across the Site Peninsula, as well as a landfill within 250m of the Site**.** These are therefore potential sources of risk posed to the built environment.

9.6.17 Pathways for the identified contamination sources consist of chemical attack and degradation, as well as the creation of preferential pathways for lateral migration of contaminants.

9.6.18 Sub-surface concrete structures are likely to be in direct contact with made / infilled ground.

9.6.19 Sub-surface services, including water supply pipes are also likely to be in partial contact with made ground / infilled ground which has identified measurable concentrations of TPHs, VOCs and SVOCs.

9.6.20 The sensitivity of the built receptors has been considered as Low as the Site is to require a potable supply of water and will consist of several concrete sub-surface structures (piled foundations). The impact magnitude has been determined with reference to Table 9.7, where the impact magnitude upon built receptors during the construction phase has been considered negligible, with a potential very minor loss and / or alteration to the key elements of the baseline.

9.6.21 The identified source, pathway receptor linkage may result in long term Moderate to Low Risk posed to the built receptors prior to the implementation of additional mitigation measures.

9.6.22 The magnitude of effect has been considered low as the risks are not thought to render any built receptors ‘unsafe’. The significance of the effect on the Built Environment receptors has been determined as Negligible (not significant) prior to the implementation of additional mitigation measures.

Geotechnical Risks – Settlement, Low Bearing Capacities and other risks / hazards

9.6.23 The Phase II Site Investigation has considered geotechnical design for the Proposed Development, including a general assessment of ground conditions, assessment of excavations and foundation solution assessment. The findings of this investigation have informed the assessment below.

9.6.24 Ground conditions across the Peninsula will be problematic for shallow foundations and it is likely that alternative foundations such as piles will be required for the Proposed Development. Shallow foundation solutions will be unsuitable for the settlement sensitive structures (Site buildings) to unacceptable total and differential settlements under applied foundations loadings.

9.6.25 At this stage, a specialist dredging contractor has not been appointed to undertake the works. Geotechnical risks associated with land reclamation; the re-use of material and construction would be further assessed as part of detailed Construction Method Statements which would be approved by LBH. The team are also in liaison with the EA National Permitting Team regards the necessary permits required in order to progress works as outlined.

9.6.26 Land reclamation is expected to be being delivered through the use of a long-reach excavator on a suitably sized pontoon. Lake bed materials (mostly gravels) will be placed into a receiving barge. This secondary barge would transit down the lake, along a pre-agreed route where the sediment can then be unloaded by excavator.

9.6.27 As gravels build up, it will find a natural submerged angle of repose. This can be enhanced and made more efficient through formation of post ‘fence’ to create boundaries and shapes that the materials can be placed into.

9.6.28 In order to create suitable conditions to commence construction at the reclaimed area of the Peninsula, a combination of dynamic compaction and vibro-compaction is likely to be required, to be confirmed by a specialist dredging contractor.

9.6.29 Chapter 6: Construction confirms that the Main Building will be founded on piled construction likely using Continuous Flight Auger (CFA), in line with the Phase II Site Investigation Report recommendations.

9.6.30 No construction works, or associated facilities are located close to the area of mapped sinking sands (quicksand). The sinking sands are to be fenced off, clearly signposted and left devoid of any storage / use across the entire enabling and construction phase of works.

9.6.31 The magnitude of impact has been considered in line with Table 9.7 where it is believed that there is potential for partial alteration to one or more of the characteristics of the baseline.

9.6.32 Prior to the implementation of the additional mitigation measures, a Moderate Risk is considered. The magnitude of impact has been considered Medium, with the receptor sensitivity Low. Resulting in a Minor Adverse to Moderate Adverse (Not significant to significant)

Ecological Receptors

9.6.33 Identified ecological receptors in regard to the Proposed Development include priority and notable habitats (woodland), protected species including badgers, bats and birds, as well as terrestrial plant species. A list of the identified ecological receptors is included within Chapter 7: Biodiversity (Baseline Conditions).

9.6.34 The identified pathways for risks to sensitive ecological receptors include, construction impacts from dredging and other in-lake works, surface-water run-off into Broadwater Lake and the River Colne, and plant root uptake of bioavailable metal concentrations within made / infilled ground across the Peninsula.

9.6.35 The identified ecological receptors at the Site have been considered High sensitivity, as most of the Site is within the Mid-Colne Valley SSSI.

9.6.36 The source-pathway-receptor linkage poses a temporary Moderate Risk, as the linkage will be enhanced during construction phases prior to the implementation of additional mitigation measures. The low magnitude of impact has been considered based upon a potential for minor loss and / or alteration to one or more of the key elements of the baseline ecological conditions across the Site, including minor damage to existing landscaping (plants / trees / grasses etc.).

9.6.37 The magnitude of the impact upon the ecological receptors has been considered Low. The significance of the effect has been determined as Moderate Adverse (Significant), due to the high sensitivity of the receptor, prior to the implementation of additional mitigation measures.

9.6.38 A full assessment of the effects of the Proposed Development on ecological receptors is provided in Chapter 7: Biodiversity.

Additional Mitigation, Monitoring and Residual Effects

9.6.39 The implementation of the following additional mitigation measures will address the risks posed to the identified receptors by the construction works:

- Engage and continue liaison with the EA, the Local Authority CLO (Arup acting as CLO on behalf of LBH) and Affinity Water prior to, during and following the progression of the following proposed works;
- Additional Intrusive Site Investigation as required to support the Proposed Development prior to enabling and construction phases (SI to inform these works phases);
- Site Monitoring – Including Groundwater, Surface Water and ground gas during construction and operational phases;
- Environmental Permits;
- Quantitative Risk Assessment to determine suitable for reuse targets for site soils generated during cut enabling works activities;
- Piling Risk Assessment;
- Remediation Strategy;
- Materials Management Plan;

- Remediation Verification Watching Brief
- Remediation Verification Report; and
- Early project liaison with the EA National Permitting Service in regard to the requirements for environmental permits for the site-based works.

9.6.40 The above aspects are discussed further below.

Human Health – Construction Workers

9.6.41 A Remediation Strategy would detail all enabling and construction earth works activities such as any cut and fill works, requirements for on-going monitoring, the decommissioning of redundant historic boreholes and material re-use. It is recommended that a watching brief be in place during the enabling and breakout / grubbing up of any historic concrete structures where required (especially historic bunds / retaining walls) across the Site.

9.6.42 Materials generated during the reduction to levels across the north eastern area of the Peninsula should be sorted and segregated. Where ground conditions are encountered that differ significantly from those identified within the Phase II Site Investigation or subsequent additional site investigation works construction works should be paused in that area, and suitably qualified geo-environmental personnel informed to assist with progress.

9.6.43 The Geo-Integrity Gas Monitoring has not identified any exceeding concentrations of ground gases / vapours associated with the historic landfill, and the Site has been characterised by Geo-Integrity as CS1. However, the recommendation is based on 3 no. ground gas monitoring boreholes which are sparsely distributed across Site. A further review of the potential for both on and off-Site ground gas generation and impacts will be discussed with the regulatory authorities. Additional groundwater and ground gas monitoring will be progressed, particularly in areas of future site building construction, and around significant groundworks which may be likely to alter the ground gas regime at the Site.

9.6.44 A Remediation Strategy (RS) will be prepared and will present mitigation and monitoring measures required to ensure that the Site is suitable for the proposed end uses. A subsequent Remediation Verification Report will be prepared to present evidence and verify that the works set out within the RS have been completed. A discovery strategy may form part of the RS which will detail the works and remedial measures required where any unforeseen grossly contaminated soils or groundwater are encountered. Where the discovery strategy identifies grossly contaminated soils which are unable to meet re-use criteria, these materials are to be removed from the Site by a suitably licensed waste carrier to an appropriately licensed waste facility.

9.6.45 With the implementation of these additional mitigation measures, the risk posed to human health receptors during construction phase works can be considered Low Risk. The residual effect to human health receptors during construction of the Proposed Development will be Negligible to Minor Adverse (not significant).

Built Environment

9.6.46 It is recommended that the mitigation measures indicated within the Geo-Integrity Site Investigation Report (set out below) are adopted during construction phase works.

9.6.47 Upgraded barrier pipe for new potable drinking water supplies will be used across the Proposed Development.

9.6.48 A Site-specific Piling Risk Assessment will be progressed to address the specific risks associated with piled foundation solutions across the Proposed Development. Piling is to be progressed in line with EA Guidance 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention.

9.6.49 Piling Risk Assessment – This will be progressed at detailed design stage to identify the risks posed by piling at the Site, and mitigation measures included to offset any potential risks and protect sensitive identified receptors.

9.6.50 With the implementation of the above detailed secondary mitigation measures the risks posed to built receptors during construction phase works is Low Risk. The residual effect on the identified built environment receptors following implementation of the mitigation measures is Negligible to Minor Adverse (not significant)

Ground Gases / Vapours

9.6.51 Gas monitoring has not identified any exceeding concentrations of ground gases / vapours associate with the historic on-Site licensed landfill or the off-Site licensed landfill, and the Site has been characterised as CS1 (Low Risk).

9.6.52 Additional site investigation works progressed across the Site, would include additional ground gas monitoring positions, particularly in areas surrounding proposed building construction. These works are to be progressed prior to the enabling and construction phases to inform the Proposed Development.

9.6.53 Continuous ground gas monitoring would take place prior to the construction works. It is proposed that gas clams are installed within the borehole so as time-series ground gas data can be captured, particularly across the footprints of Proposed Development buildings.

9.6.54 Gas Characterisation Situations (CS) refers to a classification system used to determine the level of protection required for a building or development against potentially hazardous gases like methane and carbon dioxide.

9.6.55 In some Gas Characterisation Situations, there may be a requirement for additional ground gas mitigation measures to be adopted within the Proposed Development buildings. These mitigation measures could include the incorporation of an upgraded damp proof membrane across the proposed building footprints to a gas barrier in line with BS 8485:2015 +A1 2019, and requirement for sub-floor ventilation.

9.6.56 If required, additional details of gas membrane requirement, subsequent installation and validation would be included within a report package for the Site inclusive of a Remediation Strategy and Remediation Verification Plan and Report.

9.6.57 Given the nature of works to be progressed at Site, which will involve changing site levels through cut and fill activities existing boreholes (BH3, BH6 and BH9) will be retained along with any additional monitoring boreholes and continue ground gas monitoring.

9.6.58 When excavation and removal of the identified contamination hotspot takes place a suitably qualified consultant shall be in attendance. A Photo Ionisation Detector may be used as a

mitigation measure to detect any elevated levels of Volatile Organic Compounds (VOCs) and Semi-Volatile Organic Compounds (SVOCs). The localised hotspot can be chased out removed and verification samples collected to demonstrate effective removal. These works would be detailed within the Remediation Strategy with targets reflective of both site end users and controlled waters.

9.6.59 No excavations should be entered by site personnel, regardless of depth without monitoring and controlled risk assessments and method statements being adhered to in order to minimise any asphyxiation risk to site workers.

9.6.60 With the implementation of these additional mitigation measures, the risk posed to the identified receptors by ground gases / vapours can be mitigated and considered Low Risk. The residual effects from ground gases / vapours following the implementation of the mitigation measures is Negligible – Minor Adverse (not significant).

Geotechnical Risks

9.6.61 A Site-specific Piling Risk Assessment should be formulated and support the Proposed Development, and a Specialist Piling Contractor will be engaged at an early planning stage to assess the Site.

9.6.62 The Construction Method Statement details mitigation measures required to address the potential geotechnical risks associated with the Proposed Development, as below. These works will be further progressed and refined by the project team as the project progresses.

9.6.63 Following placement and compaction of the dredged lake bed sediment for the Peninsula land reclamation, additional geotechnical testing should be progressed across the reclaimed portion of land, including, but not limited to CBR testing and CPT testing to verify the compaction, in line with BS 1377-2:2033 and classified in accordance with BS 5930:2015.

9.6.64 Once compaction and testing are complete, the ground should be levelled and further compacted using a vibratory roller weighing a minimum of 5 tonnes, achieving a minimum bearing capacity of 85kPa.

9.6.65 Additional details on mitigation measures understood at this stage of the works are included within the construction method statement. The construction method statement will be continuously updated as the Proposed Development progresses.

9.6.66 Care should be taken to ensure that washing away of concrete does not take place which could weaken piles. It is therefore recommended that a suitably qualified geotechnical engineer is present on-Site during the piling works for a watching brief.

9.6.67 The quicksand area to the south of the Peninsula is to be fenced off and secured and would not be subject to any development during the lifetime of the Proposed Development.

9.6.68 Following the implementation of additional mitigation measures, the residual effect of construction on geotechnical receptors has been considered as Negligible (not significant) .

Ecological Receptors

9.6.69 A detailed ecological impact assessment, including baseline surveys, design evolution and inclusions of embedded mitigation, compensation and enhancement measures, and assessment of residual effects has been completed.

9.6.70 These documents include mitigation measures during the construction phase, which include measures such as ecologist site visits and checks prior to commencement of construction and prior to disturbance by demolition works and thereafter visits every 3 months once construction is progressing.

9.6.71 Implementation of turbidity curtains / barriers within the lake-based construction works will minimise the risks associated, and spatial extent of increased turbidity, reduced dissolved oxygen and release of potential contaminants stored within lake sediment.

9.6.72 Following the implementation of the mitigation measures, the significance of the residual effect on ecological receptors has been considered as Negligible (not significant)

9.6.73 Further discussion of the required mitigation measures are included within Chapter 7: Biodiversity.

9.7 Assessment of Effects - Completed Development

Human Health – Site End Users

9.7.1 Reclaimed land proposed at the Peninsula is proposed to be constructed using lakebed sediment only which has been tested and proven to pose a low risk to human health receptors when compared against GAC. Lake bed sediment has already been sampled and screened against GAC at 40no. individual locations across Broadwater Lake, with no exceeding concentrations present. It is therefore considered that the reclaimed land will pose a Low Risk to site end users during the operational phase of the Proposed Development.

9.7.2 The proposed camping area on the Peninsula is considered as High sensitivity due to the proposed nature of its use. The Site Investigation positions across the proposed camping area (BH2, TP6 – TP9) all encountered Made Ground / infilled ground conditions, with only a partial concrete hardstanding cover.

9.7.3 Other site surfaces include internal road access and associated car parking spaces which will likely consist of concrete / tarmacadam surfaces. This surface therefore breaks the pathway between site end-users and potential contact and / or ingestion associated with contaminants present within the underlying made ground.

9.7.4 Contact and / or ingestion of made ground materials following the completed development is restricted through the use of proven clean and imported clean cover soil materials across public open space, and soft landscaping areas of the Site. Future disturbance of made ground soils will also be restricted by the incorporation of hard to dig / no dig layers, which may consist of a hard compacted layer separating the proven clean materials with the underlying made ground, or a coloured geotextile material. Both measures are included within the embedded mitigation measures for the Proposed Development.

9.7.5 It is considered that the underlying made ground / infilled ground underlying the Site Peninsula presents a Moderate Risk to site end users and will require mitigating through the implementation of remedial measures. The magnitude of impacts on human health receptors is considered negligible, where very minor loss or alteration to the baseline could occur.

9.7.6 There are currently no permanent human health receptors (residents) on-site. Operations on-site, including BSC and use of Broadwater Lake for fishing use the Site for short periods. Based on the implementation of embedded mitigation measures as described in Section 9.6.56 onward. the significance of the effect on human health receptors is considered Negligible (not significant)

Built Environment

9.7.7 With the implementation of the mitigation measures identified within the construction phase of works, including correct concrete class use, the built environment receptors during the operational phase of Proposed Development are at a Low Risk from contact with made ground / infilled ground.

9.7.8 It is likely that access tracks and road surfaces will be formed using compacted gravel with the implementation of controlled drainage to capture and divert surface waters. The operational phase impact magnitude on the identified built receptors has been considered negligible, where minor alteration to one or more of the key features of the baseline is possible, approximate to a 'no negative change' scenario.

9.7.9 The significance of the effect on Built Receptors during the operational phase of the Proposed Development has been determined as Negligible to Minor Adverse (not significant) prior to the implementation of additional mitigation measures for operation, determined based upon a low magnitude and medium sensitivity.

Ground Gases and Vapours

9.7.10 The Proposed Development does not consist of any sub-surface structures such as basements which would be at an increased risk from ground gases and vapours. The risk is therefore reduced to Moderate Risk as opposed to if the buildings were constructed with sub-surface structures which would be High Risk.

9.7.11 The Proposed Development consists of 3no. proposed building structures. Two of the large building structures are located on the northern portion of the Peninsula and include the Main Building (including toilets and changing facilities, administrative offices, accommodation for seasonal staff), with other two buildings comprising an Equipment Store and energy centre separated by a yard. A third smaller building structure is located further south on the existing Peninsula and includes toilets and changing as well as an activity shelter.

9.7.12 The 2no. larger buildings consist of structures built over footprint areas of approximately 1,600m^2 each, and are considered 'large'. Whereas the smaller building to the south of the Peninsula only covers an area of approximately 300m^2 and is considerably smaller. Cabins are proposed for occupancy within the larger buildings, and therefore these buildings are more sensitive to potential ground gas and vapour risks when compared to the small activities shed at the southern area of the Peninsula.

9.7.13 At their closest point, the Proposed Development structures are approximately 10m away from the mapped landfill extents at the Peninsula, with features such as internal access roads and car parking spaces located within the mapped extents of the landfill.

9.7.14 There is a known EA registered landfill on-Site across the eastern portion of the Peninsula. The Site is also located within a 250m ground gas buffer zone of an off-Site EA registered landfill. However, ground gas monitoring results from the Phase II Site Investigation have indicated a gas characteristic situation 1 (CS1) – indicating a Low Risk and further investigation and monitoring is prosed prior to development. The EA has also highlighted the potential for the presence of an unregistered landfill located immediately west of the current Broadwater Lake island Peninsula. The nature of waste is believed to be reworked natural or imported inert building and construction arisings. In the absence of site based information it is considered unregistered landfill arisings may pose a potential high risk to the Proposed Development. However additional site investigation is proposed in order to inform development proposals

9.7.15 The impact magnitude on the identified receptors susceptible to ground gases has been considered negligible, where minor alteration to one or more of the key features of the baseline is possible, approximate to a 'no negative change' scenario.

9.7.16 The significance of the effect on receptors of ground gases / vapours Minor (not significant) prior to the implementation of additional mitigation measures.

Geotechnical Risks

9.7.17 In line with standard practice, foundations and finished surfaces will be visually inspected regularly to identify any impacts from potential settlement and other land stability risks. Where impacts have been identified (differential settlement, cracks etc) a suitably qualified geotechnical engineer will be instructed to inform on how to proceed.

9.7.18 The area of sinking sands (quicksand) located to the south of the Site, is to remain devoid of any storage and infrastructure. Public access to this area would be prohibited by secure fencing with clear signposting indicating the presence of sinking sands.

9.7.19 Considering the detailed design, and implementation of embedded mitigation measures to address potential geotechnical risks, Negligible (not significant) effects has been considered.

Ecological Receptors

9.7.20 With embedded mitigation measures, including the use of clean cover soil systems, and additional tree and shrub planting, the identified ecological receptors are considered to be at a low risk during the operational lifespan of the Proposed Development.

9.7.21 The sensitivity of the ecological receptors are considered high, with the magnitude of effects considered negligible. The significance of the effect is Negligible (not significant). Operational phase impact magnitude is Negligible, where minor alteration of the baseline is possible.

9.8 Additional Mitigation, Monitoring and Residual Effects

Human Health – Site End Users and Existing Residents

9.8.1 The human health risks are largely avoided through the design of the Proposed Development and mitigation measures during the construction phase (including additional targeted regulatory approved Site Investigation, Risk Assessment, Remediation Strategy, Remediation Verification, CL:AIRE Materials Management Plan, Earthworks Assessment), there should be no unacceptable risk posed to site end users (Camping) in relation to made ground / infilled ground across the camping area.

9.8.2 It is therefore considered that the operation phase of Proposed Development poses a long term Low Risk to site end users, and that no additional operation phase mitigation measures are required to offset any moderate risks. The residual effect to the identified human health receptors during site operation is Negligible (not significant)

Built Environment

9.8.3 Where necessary, foundations and other structures should be inspected regularly to ensure safety. tarmacadam / concrete hardstanding surfaces will also be routinely inspected and maintained, to ensure that no obvious signs of wear and damage are present which could result in preferential pathways through the hardstanding and into the underlying made ground / infilled ground.

9.8.4 Access tracks and road surfaces will be formed using compacted gravel with the implementation of controlled drainage to capture and divert surface waters.

9.8.5 The residual effect of the Proposed Development on the built environment receptors are Negligible (not significant) Ground Gas / Vapours

9.8.6 Due to the presence of on-Site and off-Site historic landfill, it is proposed that further SI works are progressed prior to the enabling / construction works phases, with the findings used to inform the enabling and construction works, as well as further risk assessment. Selected positions are to be installed as ground gas monitoring positions, particularly those in areas of proposed buildings. The existing ground gas monitoring boreholes are to remain in-situ across the Peninsula for use also during the monitoring works.

9.8.7 Where ground gas was to be detected within the on-site boreholes, an evaluation of remedial options, and subsequent remediation strategy would be required. The Remediation Strategy would detail required mitigation measures in line with CIRIA C665 *Assessing Risks Posed by Hazardous Ground Gases to Buildings*. Typical scope for gas protective measures is determined in relation to the Gas Characteristic Situation, and may include any of the following:

- Reinforced concrete cast in-situ floor slab;
- All joints and penetrations sealed;
- In-ground venting wells or barriers;
- Gas proof membrane;
- Underfloor venting or pressurisation in combination with the above points.

9.8.8 The residual effect of the Proposed Development in regard to ground gas and vapours is Negligible (not significant).

9.8.9 Following the completion of additional site investigation, monitoring and agreement on any mitigation, where this is required, it is proposed that all ground gas and groundwater monitoring boreholes are decommissioned.

Geotechnical Risks

9.8.10 Where necessary, foundations and other structures should be inspected regularly to ensure safety, and that no land instability issues are occurring, including differential settlement.

9.8.11 It is unlikely that any additional mitigation measures are required to be implemented and the residual effect would remain no adverse / beneficial effect.

Ecological Receptors

9.8.12 It should be ensured that suitably sized planting cells are present for all planted species of plant, shrub and tree. On-going flora and fauna species surveys across the Site and monitoring of newly installed / enhanced habitats (on-land and in the lake) are to be undertaken at the Site with further details to be agreed as part of the detailed MEMP. Some habitat areas will require the restriction or reduction of public access to limit the potential impacts upon the areas by site users. This would be secured through the detailed MEMP where appropriate.

9.8.13 The Drainage Strategy secures the ongoing management of SuDS drainage devices across the operational lifespan of the Proposed Development. The residual effects upon the identified ecological receptors remain Negligible (not significant)

9.9 Cumulative Effects

9.9.1 No approved developments have been identified which are of scale that are likely to lead to the cumulative effects in combination with either the construction or operation of the Proposed Development.

Table 9.10: Summary of Effects, Mitigation and Residual Effects

Potential Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Construction						
Dermal contact / dust and vapour inhalation / direct ingestion of contaminated soil.	Human Health (Construction workers) - Low to High	On-site	Low	Negligible to Minor Adverse	Adherence to health and safety regime as secured by Outline CEMP. Additional soil characterisation informed by additional Site Investigation (scope to be confirmed with EA and LBH), which will inform additional risk assessment at the Peninsula, particularly across areas where SI was previously unable to access. Remediation Strategy and Remediation Verification reports.	Negligible to Minor Adverse (not significant)
Inhalation of contaminated dusts and / or gases	Human Health – Existing Residents - High	Within study area (250m of Site boundary)	Negligible	Negligible to Minor Adverse	Adherence to good construction practice as defined by detailed CEMP(s), informed by ground investigation. EA approval will be gained for sensitive works.	Negligible to Minor Adverse (not significant)
Ground Gas	Human Health – High	On-site	Medium	Moderate Adverse	Additional SI following clearance of previously inaccessible areas of the Peninsula will provide additional ground gas monitoring wells, for proposed future	Negligible to Minor Adverse (not significant)

Potential Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Aggressive ground conditions	Built Environment – Low	On-site	Low	Negligible	and ongoing monitoring of ground gases and vapours associated with historic landfilling and other surrounding operations.	
Settlement, low bearing capacities and other risks / hazards	Geotechnical Receptors – Low	On-site	Medium	Minor Adverse – Moderate Adverse	Geotechnical testing following phases of compaction of Peninsula reclamation prior to building construction. Detailed design of foundations solutions for all proposed structures.	Negligible (not significant)
Impeded health of growth of flora and fauna	Ecology – High	On-site	Low	Moderate Adverse	Clean cover clay soil systems are to be implemented across the Peninsula, particularly in proposed zones of planting and seeding. Adherence to measures set out in detailed CEMP and MEMP during construction.	Negligible (not significant)
Completed Development						
Contact with contaminated soils, dusts and vapours	Site end users – High	On-site and within 250m study area.	Negligible	Negligible	Use of concrete hardstanding / compacted gravel surfaces, as well as the use of clean cover soils and no-dig layers will act as a pathway break between human health and potentially impacted soil contact.	Negligible (not significant)

Potential Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Aggressive attack on sub-surface structures and geotechnical receptors (Geotechnical Risks)	Built Environment – Low	On-site	Negligible	Negligible	Additional SI is to inform further risk assessment of soils across the Peninsula. The scope of works is to be discussed and confirmed with the EA and CLO. The findings of the SI and additional risk assessment will then inform more detailed design in regard to confirmation of sub-surface materials (barrier pipe, concrete class etc). Use of concrete class and barrier pipe will be captured and verified within Remediation Strategy and Remediation verification works.	Negligible (not significant)
Impeded health and growth of flora and fauna	Built Environment – Low	On-site	Negligible	Minor beneficial	Ecological monitoring is proposed at regular intervals as secured through the MEMP. Sensitive habitat areas will have restricted public access to prevent potential impacts.	Negligible (not significant)

Potential Effect	Receptor (Sensitivity)	Geographic & Temporal Scale	Magnitude of Impact	Significance of Effect	Additional Mitigation and Monitoring	Significance of Residual Effect
Ground gas / Vapours	Built Environment – Low	On-site	Negligible	Minor to moderate adverse	Following implementation of additional monitoring positions and on-going future ground gas / vapour monitoring precise mitigation measures can be determined, captured and verified within remediation strategy and remediation verification reports, with subsequent sign off from the EA and CLO. It may be prudent for the Completed Development to consider the use of upgraded damp proof membranes to gas protection measures. These measures would be secured and further detailed within a Remediation Strategy and Remediation Verification Report.	Minor Adverse (not significant)

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