Appendix 8.3

GROUNDWATER RISK ASSESSMENT

HYDROGEO

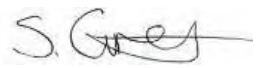
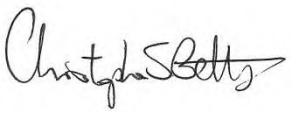
Groundwater Risk Assessment

Broadwater Lake – Hillingdon Water Sports Facility and Activity Centre.

On behalf of

Johns Associates

Quality Management

Prepared by:	Scott Greaves BSc MSc FGS	
Reviewed by:	Chris Betts BSc MSc FGS CGeol	
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Date:	September 2023	
Revision:	FINAL	
Project Number:	HYG1120	
Document Reference:	HYG1120 R 2300921 SG Groundwater Risk Assessment.docx	
Document File Path:	C:\Users\Scott\mike willis\Mike Willis - Projects\HYG1120 Outdoor Activity Centre, London Borough of Hillingdon\Reports\Groundwater Risk Assessment\Final\HYG1120 R 2300921 SG Groundwater Risk Assessment.docx	

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1 Introduction

1.1 Background

Hydrogeo Limited (Hydrogeo) have been commissioned by Johns Associates (The Client) to undertake a Groundwater Risk Assessment for the works associated with the Proposed Development of the London Borough of Hillingdon Water Sports Facility and Activity Centre.

This report has been progressed as a standalone document which will inform the Environmental Impact Assessment. The report addresses, further potential effects as a result of the proposed development and will be important within design considerations. The Groundwater Risk Assessment will accompany a number of additional standalone documents in support of the proposed planning application with London Borough of Hillingdon for the development of Hillingdon Water Sports Facility and Activity Centre.

a new Water Sports Facility and Activity Centre.

This Groundwater Risk Assessment provides a review of the geological, hydrological and hydrogeological conditions of the site and surrounding area, and provides a Hydrogeological Conceptual Model used to assess the potential risks posed to the groundwater dependent environment as a result of works associated with the proposed development.

The Environment Agency's (EA) approach to groundwater protection guidance note F1 – Non-landfill waste activities indicates the EA's position statement in regard to sites within Source Protection Zone 1 – Inner Catchment.

The position statement from the Environment Agency is as follows, *Inside SPZ1 the Environment Agency will only object to proposals for new development of non-landfill waste operations where it believes the operation poses an intrinsic hazard to groundwater. For example, deposit of waste for recovery activities. The Environment Agency will oppose such new developments via the development planning system".*

"For any other non-landfill waste operations that are proposed in SPZ1, when considering any environmental permit application, the Environment Agency will usually require a detailed risk assessment, and mitigation measures to be put in place to manage all risks

to groundwater. Accordingly, the Environment Agency will raise concerns when responding to any planning application consultation, as to whether a permit could be granted. In sensitive groundwater locations, the Environment Agency will therefore strongly encourage parallel tracked environmental permit applications with planning applications".

1.2 Data Sources & Third-Party Information

In completing this assessment, Hydrogeo has utilised the following information:

- British Geological Survey (BGS) data;
- BGS borehole records;
- BGS 1:50,000 Geology Map - Sheet 255, Soil and Drift – Beaconsfield, England & Wales (2005);
- BGS The physical properties of major aquifer in England and Wales. Technical Report WD/97/34 (1997);
- Aquifer Vulnerability Map 39 – DEFRA Magic Map Online Viewer.
- BGS 1:100,000 Hydrogeological Map – 14, Maidenhead (1984);
- BGS Memoir – Geology of the Beaconsfield District – 2005;
- Geo-Integrity Phase I Geo-environmental Assessment and Site Walkover – November 2022);
- Geo-Integrity Phase II Geo-environmental Site Investigation (April 2023);
- UK Water Projects 2015-2016 Virtual Ed. Mid River Colne & Lakes investigating the impacts of Affinity Water's groundwater abstraction on the Mid River Colne and Lakes (Matthew Rickard).
- CL:AIRE Petroleum Hydrocarbons in Groundwater: Guidance on assessing petroleum hydrocarbons using existing hydrogeological risk assessment methodologies (2017);

2 Site Setting and Development Description

2.1 Introduction

The Hillingdon Water Sports Facility and Activity Centre is being built as a replacement for HOAC which is being lost as a result of HS2. The Site is located at Broadwater Lake, Moorhall Road, Harefield, Uxbridge UB9 6PE, as a result of HS2 Rail Works.

Broadwater Lake is a large body of water with a number of small islands bordered by trees and scrub. Broadwater Sailing Club located at the northern end and a private road provides access from Moorhall Road to the south. Two bungalows are situated south of Broadwater Lake and provide accommodation for site wardens. A Site Location Plan is provided as Figure 2-1, with the indicative planning application red line boundary included as Figure 2-2.

Figure 2-1 Site Location Plan

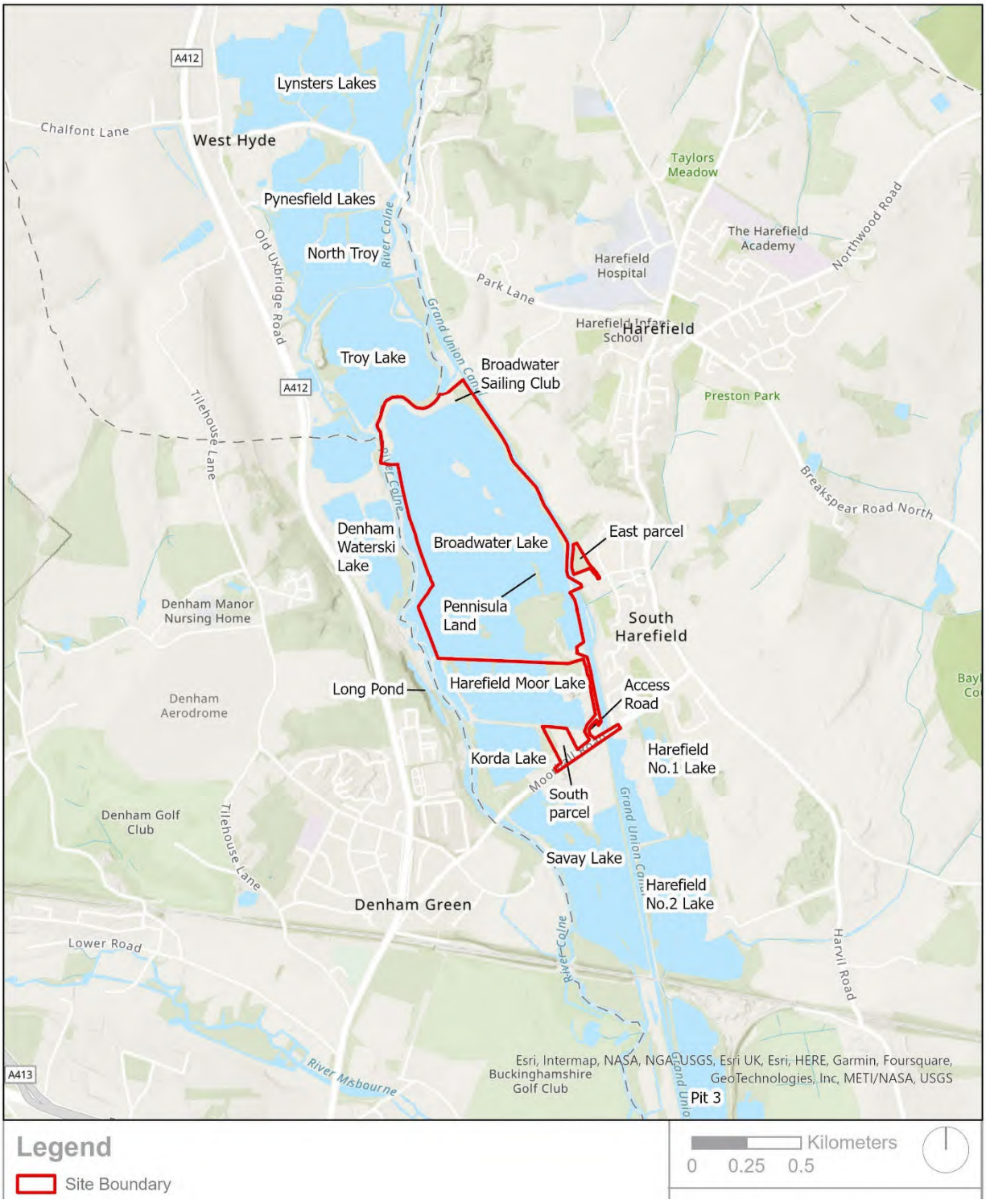
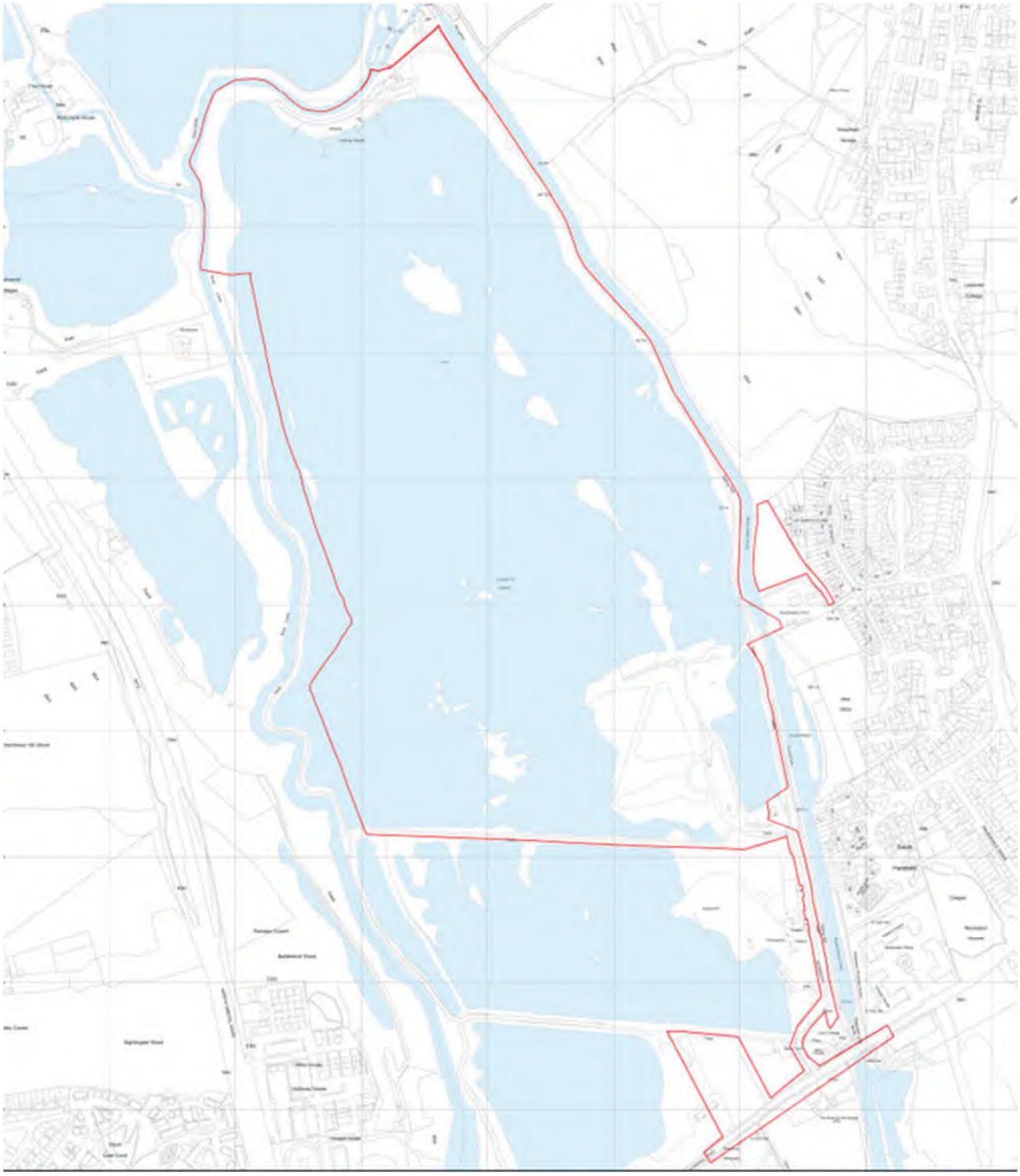


Figure 2-2 Indicative Planning Application Boundary



2.2 Proposed Development Description

The Development will provide a new water sports facility and activities centre that will be a new base for HOAC, Broadwater Sailing Club and Hillingdon Rowing Club. The facilities will be fenced off from the surrounding uses around the Site. The centre is to be used year-round by the public and private members of the BSC, which is to be relocated from the northern part of the lake, and their existing clubhouse demolished.

The Development will also involve physical works to Broadwater Lake, including localised dredging to facilitate sailing uses, the creation of new habitats such as islands and an area of land reclamation. The Applicant is also committed to the long-term management of Broadwater Lake to preserve and enhance its wildlife interest.

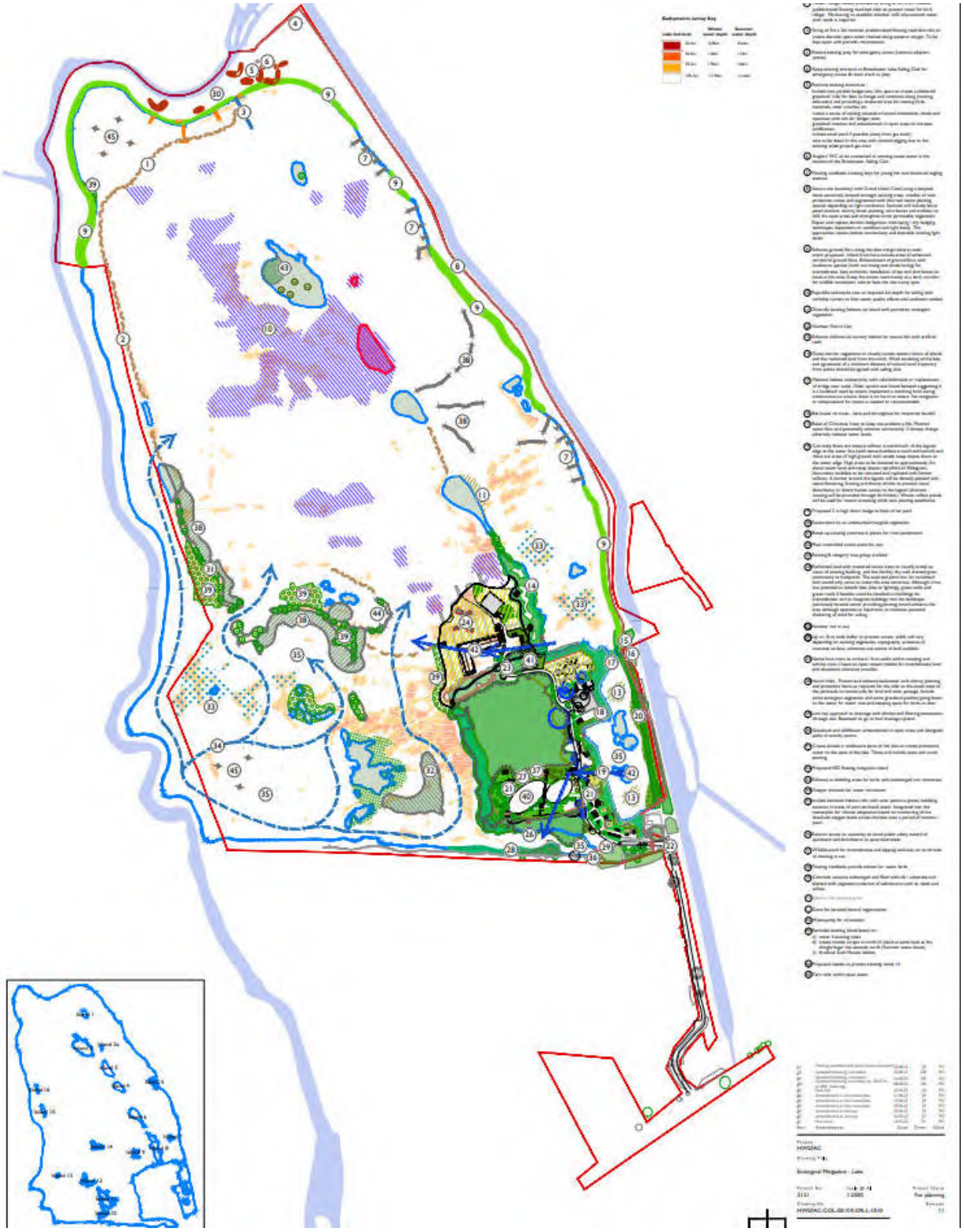
The key construction details of the Development will include:

- Enabling Works – Site Access Road;
- Enabling Works – In-lake works;
- Phase 1a – Deployment of floating reedbeds to create initial protected areas;
- Phase 1b – Deployment of floating reedbeds in accessible locations;
- Phase 2 – Place caissons in preparation for island formation;
- Phase 3a – Removal of islands & reprofiling of island 2 to create muddy pond and artificial sand martin colony;
- Phase 3b – Fill caissons;
- Phase 3c – Fill – Island formation;
- Phase 4a – Enabling dredge to clear way for main dredge;
- Phase 4b – Main dredge of lake;
- Phase 4c – Peninsula extension / land reclamation;
- Construction – Main Works and Peninsula;
- Construction – Canal Bridge;
- Future Ecological Enhancements.

Localised dredging of the lake will be required to increase the lake depth in order to facilitate sailing from the launch locations

Creation of new islands and other modification to lakeside habitats.

Figure 2-3 Proposed Development Masterplan



3 Environmental Setting

3.1 Geology

Geological information has been gathered from the BGS Geological Map of Beaconsfield, Sheet 255 (Solid and Drift) 1:50,000 Scale, and online BGS mapping resources. A superficial geology map of the Site has been included as Drawing 1, with the bedrock geology shown in Drawing 2.

Artificial Geology

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

There are also areas across the site which are mapped as infilled ground. These areas have been proven by the Geo-Integrity Site Investigation which has identified inert anthropogenic materials present in made ground soils.

The Site investigation has confirmed that the made ground thickness reaches a maximum of 3.45m within BH4.

Superficial Geology

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

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'.*

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

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

The BGS Maps the site as underlain by the Seaford Chalk and Newhaven Chalk Formation (Undifferentiated).

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'.*

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

BGS Borehole Logs

The BGS GeoIndex indicates several historical borehole records available within the site area and surrounding vicinity. A summary of the closest / most representative borehole logs have been included within Table 3-1.

Table 3-1 BGS GeoIndex Borehole Details

Borehole Details	Ground Conditions
Reference:TQ08NW641 Name: Affinity Water Broadwater Denham BH 5 NGR:504700, 189600 Depth (m):80m	• Ground level to 0.3m – Topsoil • 0.3m to 0.5m – silty CLAY • 0.5m to 1m – Blue CLAY • 1m to 1.8m – PEATY Soil • 1.8m to 3.5m – Sand and Gravel; • 3.5m to 80m – CHALK and flints. Groundwater strike at 1.8mbgl, with Rest Water Level at 1.1mbgl.
Reference:TQ08NW640 Name: Affinity Water Broadwater Denham BH 3 NGR:504100, 189300 Depth (m): 57	• Ground level to 1.2m – Topsoil • 1.2m to 6m – Sand and Gravel • 6m to 6.3m – GRAVEL and Chalk • 6.3m to 57m – CHALK and flints Groundwater strike at 1.2mbgl, RWL at 1.2mbgl.
Reference: TQ08NW129 Name: Northmoor Near Denham Bucks NGR:503950, 189810 Depth (m):91.44	• Ground level to 0.61m – Topsoil; • 0.61m to 8.53m – Sand and Gravel • 8.53m to 30.48m – CHALK and flints • 30.48m to 59.44m – Sticky CHALK and flint • 59.44m to 74.1m – Sticky CHALK • 74.1m to 76.81m – Hard CHALK • 76.81m to 91.44m – Sticky CHALK Rest Water Level at 1.06mbgl.

Site Investigation Boreholes

A number of Site Investigation cable percussive boreholes have been progressed across the Development Site, these have been discussed in detail within Section 4 of this Groundwater Risk Assessment.

3.2 Hydrogeology

The Site is located within a Source Protection Zone (SPZ 1 – Inner Catchment). Source Protection Zones (SPZs) are designated areas around a water well or groundwater abstraction borehole. The inner catchment is typically the zone 50 day travel time of pollutants.

Aquifer Classification

The Aquifer classifications in the UK are as follows:

- Principal Aquifer: These are layers of rock or drift deposits that have high intergranular and/or fracture permeability - meaning they usually provide a high level of water storage. They may support water supply and/or river base flow on a strategic scale. In most cases, principal aquifers are aquifers previously designated as major aquifer.
- Secondary Aquifer: These include a wide range of rock layers or drift deposits with an equally wide range of water permeability and storage. Secondary aquifers are subdivided into two types:
    - Secondary A: permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers;
    - Secondary B: predominantly lower permeability layers which may store and yield limited amounts of groundwater due to localised features such as fissures, thin permeable horizons and weathering. These are generally the water-bearing parts of the former non-aquifers;
- Secondary Undifferentiated: has been assigned in cases where it has not been possible to attribute either category A or B to a rock type. In most cases, this means that the layer in question has previously been designated as both minor and non-aquifer in different locations due to the variable characteristics of the rock type;
- It is believed that the underlying aquifers (Superficial and bedrock are in partial continuity with each other;
- The partial continuity between groundwater and surface water levels were indicated by broadly similar measured groundwater and lake level within the UK Water Projects 2015-2016 Report;
- The groundwater flow in the superficial deposits is likely to be down the river valley and potentially flow through some of lakes where the gravel has been excavated

- The UK Water Projects Report indicates that the lake water level rises exceeded the rises expected following rainfall events, and therefore influenced by groundwater levels.

Superficial Deposits

The Superficial deposits underlying the Development site area are designated by the Environment Agency as 'Secondary A Aquifers'. This designation covers the Alluvium and Shepperton Gravel deposits.

Bedrock Geology

The Chalk geology underlying the Site is designated by the Environment Agency (EA) as a 'Principal Aquifer'.

BGS Hydrogeology Map

The Site is mapped by the BGS within Map 14, Cambridge – Maidenhead 1:100,000 Hydrogeological Sheet Map.

The Hydrogeology map covering the Development indicates that the site is located between the +30mAOD and +40mAOD contours of the potentiometric surface of the underlying Chalk. The Site is located at an approximate topographic level of between 36mAOD and 43mAOD, indicating that the potentiometric groundwater surface of the Chalk aquifer is within a minimum of 3m below ground level.

The Site is also mapped as located between the 0mAOD and -25mAOD contours representing the base of the Upper Chalk.

The regional groundwater flow direction based upon the contours of the potentiometric surface of the underlying chalk indicate a flow direction to the southeast.

3.3 Groundwater Levels

All desk based data reviewed, including historical borehole logs and the hydrogeology map indicates the presence of shallow groundwater within 2m below ground level.

Historic borehole records indicate the presence of groundwater strikes at 1.2mbgl and 1.8mbgl respectively, with a single, minor groundwater level rise to rest from 1.8mbgl to 1.2mbgl.

The Geo-Integrity Phase I Report indicates that the Site is located in a High Risk Groundwater Flooding area. The Client Team have indicated to Hydrogeo that there are no proposed sub-surface structures within the proposed development plans. The potential

impacts to groundwater needs to be carefully considered during any deeper piling activities for building foundation solutions.

Groundwater Levels – Site Investigation and Monitoring

Groundwater levels were encountered during the Geo-integrity Site Investigation works in the majority of exploratory positions, with groundwater strikes recorded during the drilling works between 1mbgl and 4.9mbgl, with rest water levels between 1.2mbgl and 4.6mbgl.

Subsequent groundwater monitoring progressed between 9th March 2023 and 29th March 2023 within the standpipes installed at BH3, BH6 and BH9 recorded groundwater levels between 0.75m and 2.39m.

Spot heights were captured by Geo-integrity using GPS to determine the groundwater level in relation to Ordnance Datum. Due to the excessive tree cover, and the resulting inaccuracies of the GPS system BH9 groundwater levels in mAOD have not been presented. Table 3-2 presents the groundwater monitoring level from BH3 and BH6.

Table 3-2 Groundwater Monitoring Levels

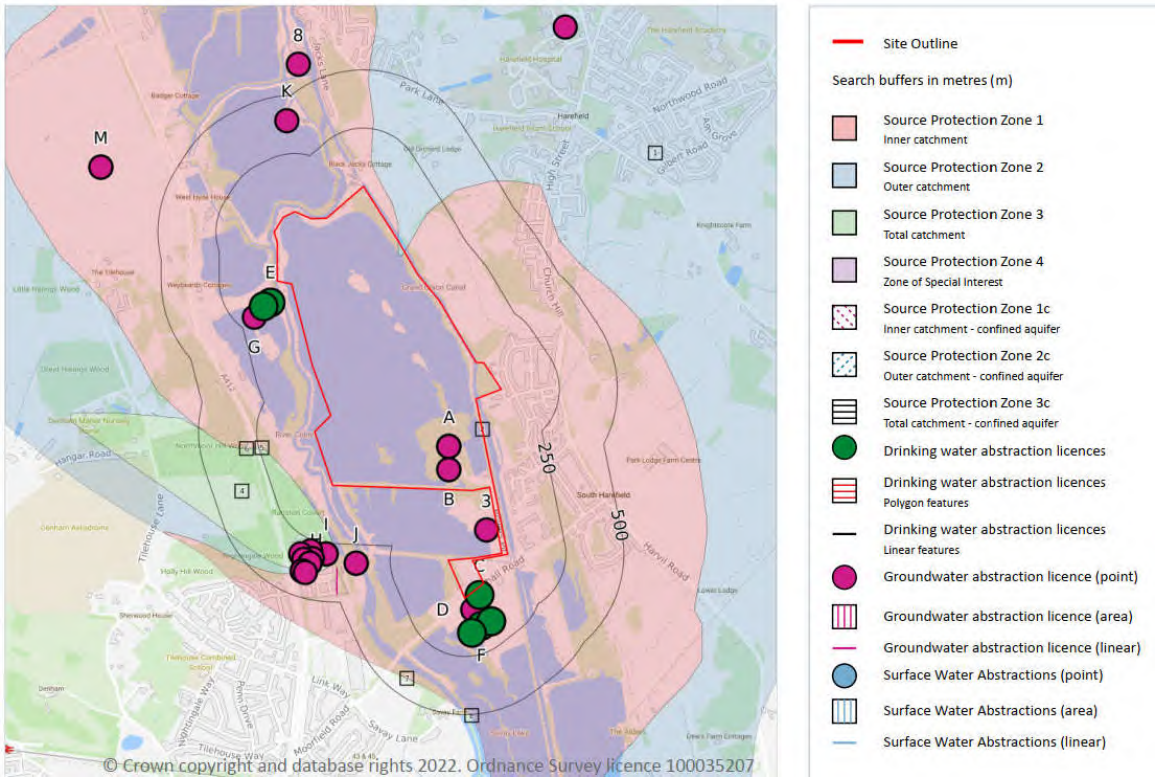
Borehole ID	**Groundwater Levels (mAOD)**		
	09/03/2023	15/03/2023	29/03/2023
BH3	38.56	38.65	38.65
BH6	38.67	38.82	38.82

From the Geo-integrity groundwater monitoring rounds, the groundwater flow direction has been determined to the south, which corresponds to the direction of the River Colne.

3.4 Licensed Abstractions

There are a number of licensed groundwater abstractions mapped on-site and within the immediate vicinity. The abstractions are shown spatially within Figure 3-1.

Figure 3-1 Licensed Abstractions



The 2no. on-site abstraction licenses pertain to the historical mineral extraction and concrete production operations across the site, with the Client Team providing Hydrogeo with the Environment Agency documentation. The available information confirms that the original license was granted in March 1966, with another license granted in May 2006.

The original 1966 abstraction license covered abstraction from 2no. points (Point A and B) for flow rates of 37.89l/s and 4.92l/s respectively. The abstraction points were located at National Grid References: TQ 0470 8910 and TQ 0470 8920 respectively. The Client Team note that they have been unable to identify any boreholes across the proposed development site area at the time of reporting.

Affinity Water is licensed to abstract 88Ml/d from the underlying Chalk aquifer as part of the Blackford Group license which includes 9 abstraction boreholes in this area, however, not all are currently operational. The Blackford and Northmoor boreholes located in the immediate site vicinity abstract up to 37 Ml/day.

The BGS Geoindex indicates that Affinity Water Broadwater BH3 Denham is located approximately 500m west of the proposed development site.

The closest licensed surface water abstraction to the Development is 1156m south at Buckinghamshire Golf Club for top up and make up water for irrigation.

3.5 Private Water Supplies

At the time of reporting Hydrogeo has made an enquiry with London Borough of Hillingdon (LBH) for details in regard to private water supplies within the site vicinity. The enquiry was made under the Freedom of Information Act. Hydrogeo are currently awaiting a response form the Local Authority.

The Client Team has indicated that a number of historic and active abstraction boreholes are present on site, including the current sailing club which utilise a borehole for wash water for boats and domestic purposes. The borehole at the sailing club is not used as a potable water supply.

3.6 Hydrology

The planning application is to be supported by a number of standalone reports relating to the hydrology of the area and proposed development, including:

- Water Framework Directive (WFD) Assessment;
- Drainage Strategy
- Lake Management Plan.
- Flood risk, Drainage and Sequential Assessment (Weetwood, September 2023)

A Flood Risk, Drainage and Sequential Assessment has been prepared by Weetwood (September 2023) under separate cover to this Groundwater Risk Assessment to act as a stand along report to inform planning.

The majority of the Site comprises a water body (Broadwater Lake) within the River Colne floodplain that extends over circa 80ha. Formed as a result of gravel extraction, it 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.

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 located immediately to the north and south, with a narrow terrestrial perimeter forming the lake/river shore and canal embankment. A larger area of land is located adjacent to the south east corner of the lake and is currently characterised by wet woodland, broadleaved woodland and standing water (‘the peninsula’).

Broadwater Lake is a surface water body (Lake) under the Water Framework Directive (WFD) reference GB30641907. It is located adjacent to the River Colne (Confluence with Chess to the River Thames) WFD reference GB106039023090 and the Grand Union Canal, a Canal under the WFD reference GB70610252. Broadwater Lake is associated with the Thames Basin River Basin District. The most recent data from the Environment Agency (EA) from 2019 shows that their overall WFD rating is Moderate, Chemical rating is Fail and Ecology rating is Moderate. The chemical failure rating is as a result of perfluorooctane Sulphonate (PFOS), and polybrominated diphenyl ethers (PBDE).

Broadwater Lake is located over, and likely is in continuity with the Mid-Chilterns Chalk Groundwater Body reference GB40601G601200. Its most recent (2019) Overall Rating is Poor, Chemical rating is Poor and Quantity rating is Poor.

Data provided by Groundsure and from the EA (flood map for planning) identify that Broadwater Lake and land within 50m is at High risk of fluvial flooding (with the exception of the raised peninsula in the south-east corner of the lake). Most of the lake within Site is in Flood Zone 3. The peninsula is typically in Flood Zone 1 and the access to Moorhall Road is in Flood Zone 2.

Recent water quality sampling (for microbial and certain water quality parameters relating to use for water sport activity) taken from the south east lake margins by GEA Ltd in 2022 show that the results were generally found to meet the EC Bathing Water Directive (76/160/EEC and 2006/7/EC), with the exception of the concentration of Entercocci within the sample collected from Location No 1, which was classified as 'Poor (fail)'. None of the samples were found to contain salmonella, and all six samples were found to meet the requirements of the EC Bathing Water Directive (76/160/EEC and 2006/7/EC), with the exception of the concentration of Entercocci within the sample collected from Location No 1, which was classified as 'Poor (fail)'. All six samples were found to meet the World Health Organisation (WHO) guidance values with respect to blue-green algae (cyanobateria). The concentration of Clostridium perfringens recorded in one sample is considered to be elevated with respect to the adopted threshold for faecal coliforms, of 200 colony-forming units per 100ml.

The Environment Agency and the Department for Environment and Rural Affairs (DEFRA) Online Water Quality Archive indicates a sampling location within Broadwater Lake, at National Grid Reference (NGR): 504591, 189093. 6No. Samples have been collected 30th October 2019 – 26th April 2022, with 8No. Chemical determinants measured (colour, conductivity, alkalinity, phosphorus, chlorophyll, nitrogen, orthophosphate and nitrogen total oxidised).

3.7 Environmental Designations

Figure 3-2 shows the locations of the environmental sensitivities in relation to the Site.

The Site is set within the landscape context of the Colne Valley Regional Park, which is a mosaic of farmland, woodland and water with 200 km of rivers, canals and over 60 lakes.

The entire Site forms a component part of the Mid Colne Valley SSSI, designated for breeding and over-wintering water birds. A number of nationally and regionally important statutory designated wildlife sites are present within 2km, as detailed in Chapter 5. The site is also designated as a Site of Importance for Nature Conservation (SINC) of Metropolitan importance.

Part of the Site is within the Broadwater Lake Nature Reserve managed by Hertsmere and Middlesex Wildlife Trust, and Northmoor Hill Wood Local Nature Reserve is located approximately 300m west of the Site boundary.

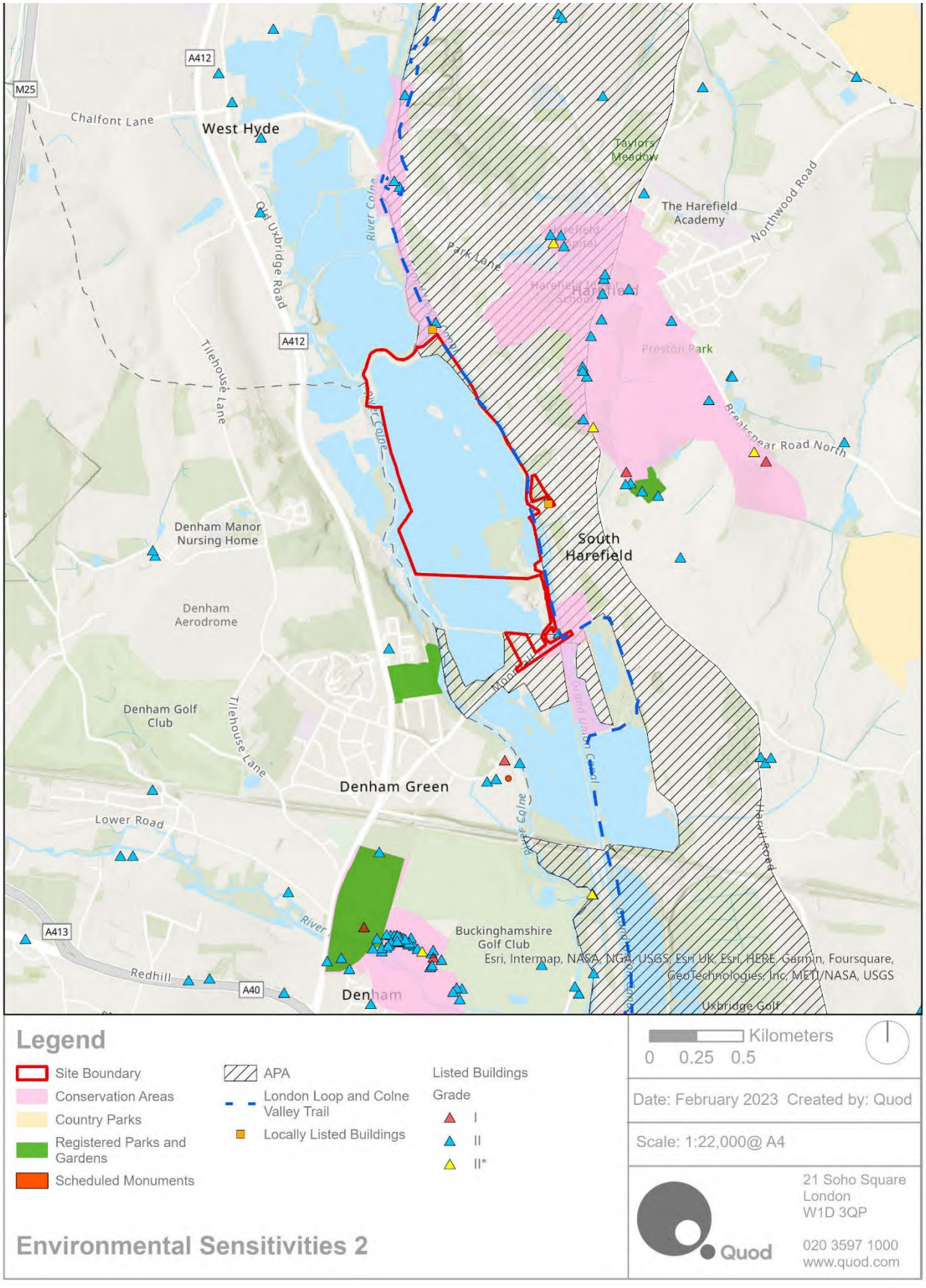
Priority habitat is present onsite and in the adjacent surrounds, comprising deciduous woodland. Parts of the woodland adjacent to the west of the Site are designated as Ancient Woodland.

The Site is adjacent to the Widewater Lock Conservation Area (CA) in the south-east and Black Jacks and Copper Mill Lock (CA) in the north-east. The Site is also 250m from the Harefield Village CA in the east. Broadwater Park Registered Park and Garden is located approximately 400m southwest of the Site boundary.

The Site is located adjacent to an Archaeological Priority Area (APA) in the east designated within the LBH Local Plan.

Broadwater Lake is designated by the Environment Agency (EA) as a Groundwater Dependent Terrestrial Ecosystem.

Figure 3-2 Environmental Sensitivities



4 Site Investigation – Land Based

4.1 Introduction

A Site investigation has been carried out by Geo-integrity following the progression of an earlier Phase I Geo-environmental Study and Site Walkover which indicated the requirement for additional site works.

4.2 Site Investigation

The Geo-integrity Site Investigation was progressed over the course of 10-days 15th – 28th February 2023.

The site works consisted of the advancement of:

- 9no. cable percussive boreholes BH1 – BH9 (maximum 15mbgl);
- 3no. machine excavated infiltration pits (SA1 – SA3);
- 14no. machine excavated trial pits (TP1 – TP14).

Selected cable percussive boreholes (BH3, BH6 and BH9) were installed as groundwater / ground gas monitoring positions for subsequent groundwater and ground gas monitoring rounds. The positions of all intrusive investigations are presented within Figure 4-1, which shows the positions of the intrusive investigations overlain onto the Proposed Development Plan.

Figure 4-1 Site Investigation Positions

4.3 Encountered Ground Conditions

The ground conditions encountered across the site have been summarised based upon the findings within the Geo-integrity Site Investigation Report.

Concrete Hardstanding

Concrete hardstanding was encountered across the majority of the eastern portion of Site Peninsula, the extent of which has been indicated in Figure 4-2produced as part of the works to support the planning application.

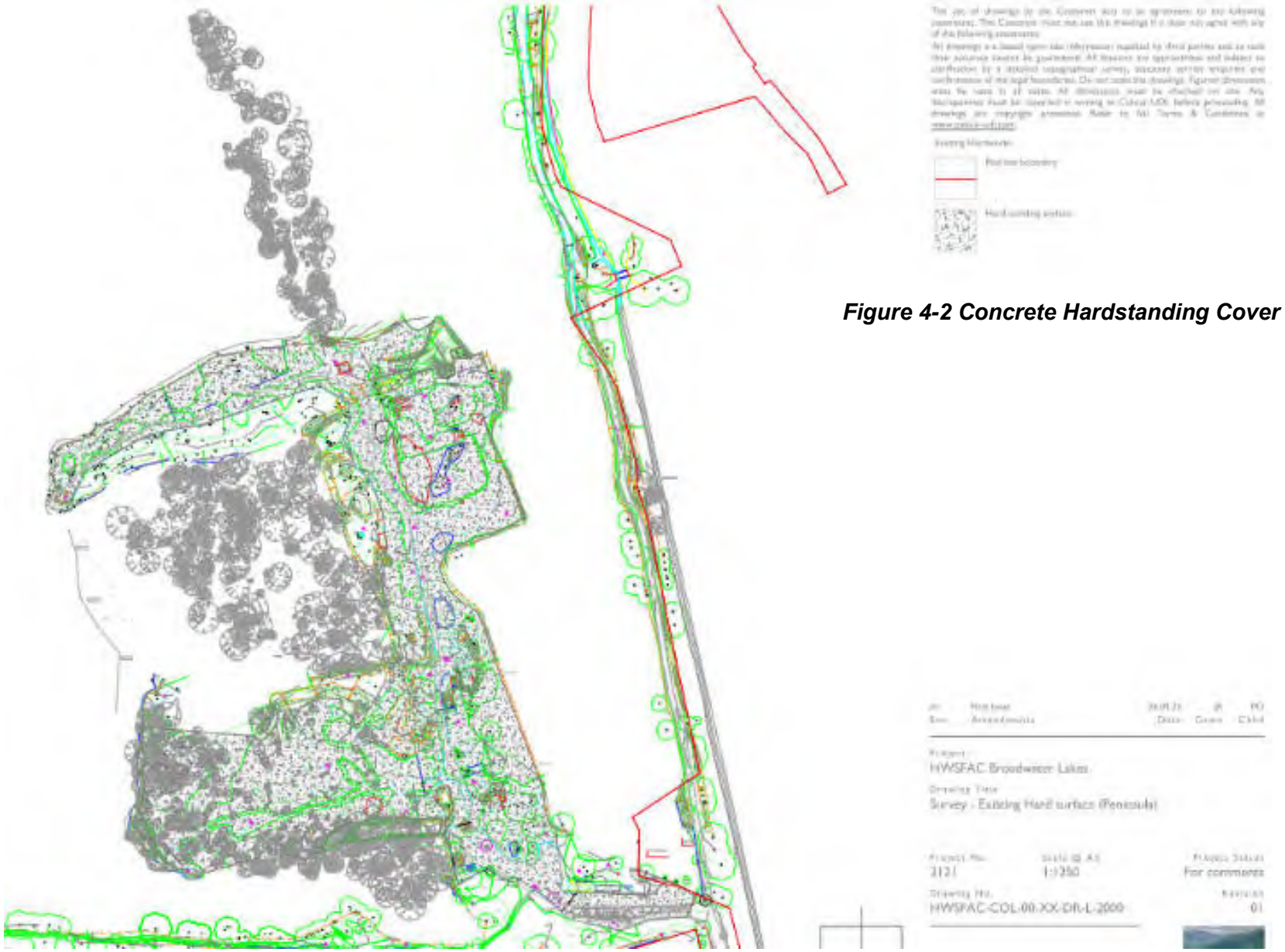


Figure 4-2 Concrete Hardstanding Cover

Made Ground / Reworked Ground

Made Ground was encountered across the extensive areas of the Site Peninsula from ground level and underlying the concrete hardstanding to locally maximum depths of 3.45mbgl along the eastern portion of the site. Generally, the made ground thickness was encountered to depths between 1mbgl – 2mbgl.

The Made Ground was generally encountered as loose, orange / brown silty, sandy gravel, with inclusions of cobble and boulder size fragments of concrete, ash, slag, slate, rubber and glass.

Reworked soils were located along the northern boundary thickening westward. The ground conditions consisted of natural gravels to depths ranging between 2.45mbgl and 3.25mbgl which have been interpreted by Geo-integrity as reflecting the historic infilling process from 2001.

Alluvium

A consistent layer of alluvium deposits was present across the entire site area, at depths ranging 1.3mbgl to 4.50mbgl. The alluvium deposits were encountered as very soft, dark brown, grey, black highly organic, silty, slightly gravelly clay with peat and plant debris. Gravels were encountered as fine to coarse of flint.

Shepperton Gravel Member

Encountered within the deeper site investigation positions (BH1 – BH9) and (TP11- TP14) from depths ranging 0.5mbgl – 4.5mbgl to 6.1mbgl and 8mbgl.

Hydrogeo believe that this shallower identified gravel horizon is likely reworked gravels, as all other gravels encountered are recorded at greater depths below ground level.

The material encountered consisted of a medium dense to dense, dark grey, orange, brown, sandy gravel, gravels being fine to coarse, sub-angular to sub-rounded flint and quartz.

Chalk

Encountered only within the cable percussive boreholes (BH1 – BH9) at depths of 4.5mbgl to in excess of 19.55mbgl, encountered as structureless off-white chalk comprising both gravelly silt and silty gravel.

Table 4-1 summarises the ground conditions encountered underlying the Site.

Table 4-1 Summary of Encountered Ground Conditions

Depth (mbgl)	Strata
Ground level (0mbgl)	Concrete Hardstanding
Ground Level to maximum 3.45mbgl	Made Ground – silty, sandy gravel with inclusions of cobbles and boulders of concrete, ash, slag and slate.
1.3mbgl – 4.50mbgl	Alluvium – very soft, dark brown, grey, black, highly organic, silty, slightly gravelly clay with peat and plant debris.
0.5mbgl – 4.5mbgl & 6.1mbgl – 8.1mbgl	Shepperton Gravel Member – medium dense to dense, dark grey, orange / brown sandy gravel. Gravels being fine to coarse, sub-angular to sub-rounded of flint and quartz.
4.5mbgl – 19.55mbgl (Maximum depth advanced)	Chalk – Off-white structureless chalk, comprising both gravelly silt and silty gravel.

4.4 Encountered Contamination and Chemical Testing

Geo-integrity noted some evidence of contamination which were identified locally within the made ground soils during the site investigation. Hydrocarbon staining and odour was noted within 2no. Trial Pits, TP4 and CBR5 positioned adjacent to an historic concrete bund situated at the north of the site.

In addition, some anthropogenic materials were encountered within the Made Ground such as brick, concrete, ash slag and slate.

Laboratory Chemical Testing

Geo-integrity scheduled 13no. soil samples for chemical analysis at an MCERTS and UKAS accredited laboratory facility for a varied suite of chemical testing including:

- Metals and inorganic substances;
- Speciated PAHs;
- Benzene, toluene, ethylbenzene and xylene (BTEX);
- TPHs;
- Made ground tested for WAC Suite and asbestos.
- Volatile and Semi-volatile organic compounds (SVOC's and VOCs).

3no. groundwater samples were also captured and scheduled for testing for a suite in accordance with environmental quality standards (EQS), including:

- Heavy metals;
- TPHs;
- PAHs;
- Dissolved Organic Carbon (DOC);
- pH
- Essential minerals – calcium, potassium, magnesium, sodium.

Soil Screening Results

No asbestos was indicated within any of the 12no. made ground samples.

Geo-Integrity have screened laboratory soil results against 'commercial end-use criteria targets' for aromatic and aliphatic compounds, as well as TPH compounds did not determine any exceedances of the General Assessment Criteria (GAC).

Leachate and Groundwater Sample Screening Results

Leachate tests were progressed on 2no. made ground samples captured from TP1 and TP2 and 0.5mbgl. The screening of the leachate results indicated marginally elevated levels of chromium, copper, nickel, lead and zinc when compared to the EQS values for freshwater, however when compared to UK Drinking Water Standards (UKDWS) none were significantly elevated.

Groundwater samples taken from BH3, BH6 and BH9 were tested and indicated marginally elevated concentrations of heavy metals including copper, manganese and nickel as indicated in Table 4-2.

All other chemical determinants were present at concentrations below either the Laboratory Level of Detection (LoD) or the respective Screening Criteria (Environmental Quality Standard)

Table 4-2 Summary of Groundwater Screening Exceedances

Heavy Metal	Recorded Value Range (µg/l)	Number of Exceedances	EQS Freshwater (µg/l)	UK DWS (µg/l)
Copper	<0.5 – 1.80	1	1(bioavailable)	2000
Manganese	150 - 760	3	123(bioavailable)	50
Nickel	3.2 – 4.8	2	4(bioavailable)	20

5 Site Investigation – Broadwater Lake

5.1 Introduction

Lake sediment samples have been captured across Broadwater Lake and issued to an accredited laboratory facility for testing against a suite of chemical determinants. Locations of the captured sediment samples are presented in Appendix C of this report.

The samples were captured across Broadwater Lake by Johns Associates, and were captured to support this Groundwater Risk Assessment, as well as to inform other parts of the planning application process including dredging, ground contamination and water quality.

The proposed dredging works include the dredging of lake bed materials to make deeper lake areas within the sailing corridor. The dredged lake bed materials are then proposed to be retained on-site in the formation of new lake islands, shallow lake areas and land reclamation for the Site Peninsula.

From review of the Ordnance Survey Map of the lake area, no obvious inflows or outflows of water occur.

In total Johns Associates captured 20no. samples from across Broadwater Lake, with all samples tested for a range of chemical determinants including:

- Soil pH;
- Available phosphorus;
- Available potassium;
- Available magnesium;
- Potentially Toxic Elements – including copper, zinc, nickel, zinc, cadmium. Lead, chromium, mercury, molybdenum, selenium, arsenic, fluoride
- Conductivity;
- Organic matter loss on ignition;
- Total phosphorus;
- Total potassium;
- Total magnesium;
- Total calcium;
- Total sodium;
- Total carbon;

- Total sulphur.

5.2 Lake Sediment Screening

The 20no. lake sediment samples have been screened against General 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.

- Environment Agency 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.

5.3 Chemical Testing Results

Laboratory certificates are attached as Appendix A, with the soil screening spreadsheet attached as Appendix B.

Potentially Toxic Elements (PTE)

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

Screening of the laboratory chemical concentrations against the C4SL screening criteria did not identify any exceeding concentrations of potentially toxic elements across all 20no. lake sediment samples.

Screening of the potentially toxic element concentrations against the Environment Agency (EA) Ecological Soils Screening Values (SSVs) has indicated a number of exceeding concentrations for cadmium, nickel and zinc.

All other chemical determinants screened against the Environment Agency SSVs remain below the SSV concentration criteria.

The soil chemical laboratory results included as Appendix A present the findings of the screening against the maximum permissible concentrations of the PTEs in arable/grassland soil. These screening values are derived from DEFRAs Code of Practice for Agricultural Use of Sewage Sludge.

The development proposal is to retain and reuse the dredged lake sediment within the boundaries of the lake, initially below water levels, and then eventually to build up small island features, and reclaim land on the Site Peninsula.

6 Conceptual Hydrogeological Model

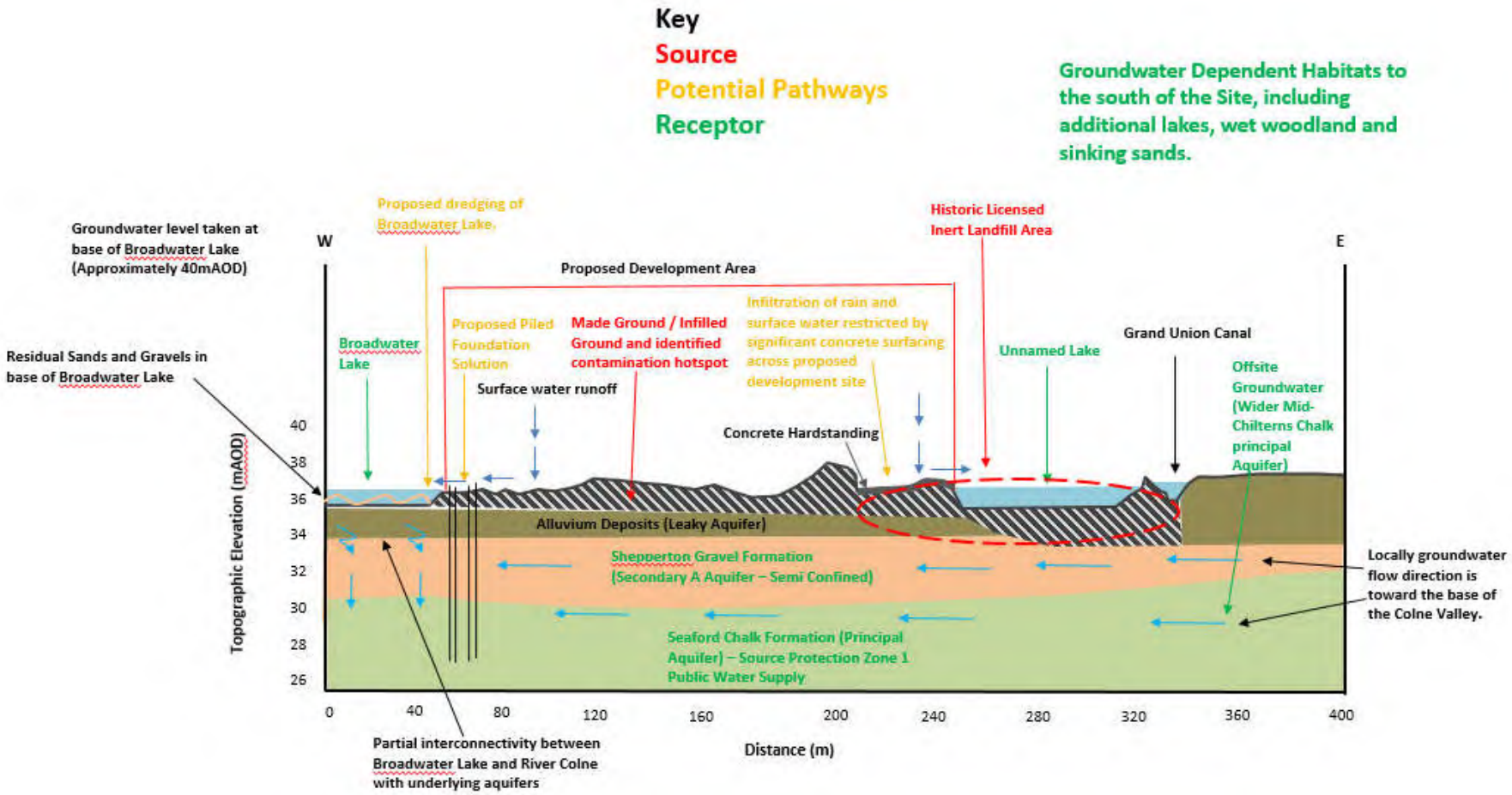
A regional Conceptual Hydrogeological Model is included as Drawing 3 of this report, with Figure 6-1 presenting a Conceptual Hydrogeological Model of the proposed development site, including the identified sources, pathways and receptors. Figure 6-1 presents a conceptual hydrogeological model of the proposed development.

6.1 Conceptual Hydrogeological Model

- The site is underlain by a thickness of concrete hardstanding, beneath which are made ground and reworked ground conditions. The concrete hardstanding is presently acting as a capping layer above the inert landfill made ground, and therefore limiting infiltration of rainwater and surface water.
- The underlying Chalk is designated as a Principal Aquifer, and is extensively used for groundwater abstraction, including a significant quantity of public supply. The Chalk aquifer is a dual permeability aquifer which is characterised by very low flow rates through the rock matrix and much higher rates of flow through fissures.
- The Chalk is likely to be heterogeneous with the principal mechanism of groundwater flow to occur through a network of interconnected fractures and solution enlarged voids.
- Geophysical data available from different boreholes within the chalk of the Colne Valley indicates the presence of 3no. distinct fissure horizons at 14m-16mbgl, 26mbgl – 32mbgl and 48mbgl – 52mbgl.
- The majority of groundwater movement within the chalk is likely to be within the top 50m of the saturated zone, and layering is likely, with some horizons more permeable than others.
- BGS data indicates that transmissivity values within major valleys (Thames and Colne) in the Chalk in the Chilterns is high, typically in the range of 1500m^2/d to 3000m^2/day.
- Leakage form the overlying sands and gravels into the chalk aquifer may be part of the reason for high transmissivity values.
- Groundwater levels within the chalk bedrock may be influenced by the proximity to the Affinity Water abstraction boreholes, and the associated pumping rate of these. This may increase the downward leakage of water into the underlying aquifers.
- The groundwater is thought to only be in partial hydraulic continuity with surface water features due to the superficial gravels becoming very silty towards the base, and the upper surface of the Chalk can often be weathered to a clay like '*putty*

chalk'. This *putty chalk'* is noted as locally reducing permeability, especially where the base of the sands and gravels is indicated to have increased silt content.

Figure 6-1 Proposed Development Hydrogeological Conceptual Model

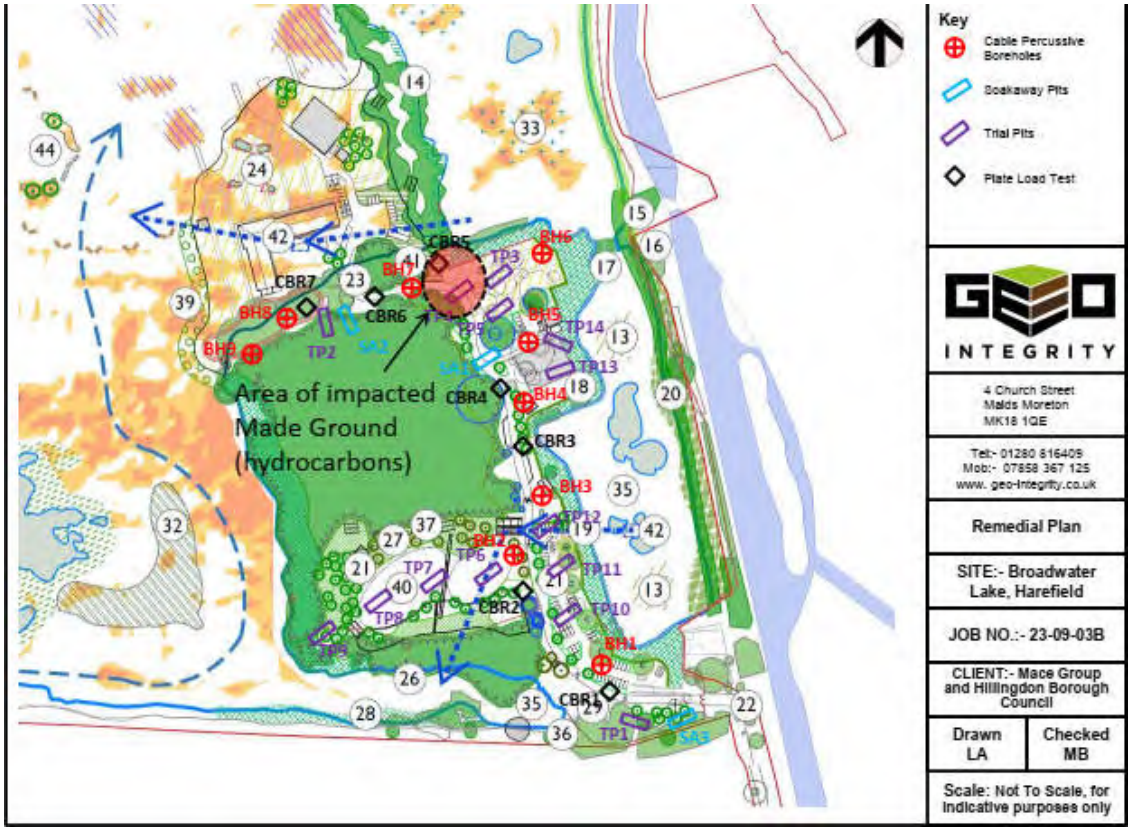


6.2 Sources

Following progression of land based Site Investigation and Broadwater Lake Site Investigation, a number of potential sources of contamination that may pose a risk to groundwater have been identified.

- Made ground has been encountered across the majority of the Geo-Integrity Site investigation positions to a maximum depth of 3.45mbgl. The made ground materials appear to consist of inert waste, consisting of brick, ash, coal, concrete debris etc, and is likely associated with the historic landfill on-site identified within the Geo-Integrity Phase I Report. The identified inert landfill reference: TE1/L/LAF001 was operated by Lafarge Aggregates Limited from 1993, with the license surrendered it June 2004.
- It is noted within the Phase II Geo-Integrity Investigation that inert landfill waste materials appear beyond the mapped boundaries of the historic licensed inert landfill.
- An identified 'hotspot' of malodours and visually impacted hydrocarbon stained made ground around the area of TP4 and CBR5, as well as the presence of marginally elevated heavy metal leachability concentrations has been identified within the Geo-Integrity site investigation. The position of the identified contamination hotspot is shown in Figure 6-2 below.
- Groundwater samples during the Geo-Integrity land based site investigation has identified marginally elevated existing concentrations of nickel, copper and manganese when screened against the UK Drinking Water Standards and their associated Environmental Quality Standards (EQS) as in Table 4-2.
- Laboratory analysis of Broadwater Lake sediment samples has identified measurable concentrations of heavy metals, however when these were screened against residential end use targets, no exceeding concentrations were found. Screening of the sediment samples against Environment Agency (EA) Ecological Soil Screening Values (SSVs) has identified several marginal exceedances for zinc, nickel and cadmium.

Figure 6-2 Location of Geo-Integrity Identified Hotspot



6.3 Pathways

Pathways for the migration of potential contamination have been identified based upon proposed site development plans, construction plans and existing site condition reports including the Geo-Integrity Phase I and Phase II reports.

- It is believed that some of the proposed development structures will require piled foundation solutions, which may present a short-circuit pathway for the migration of near-surface contaminants present within the made ground to greater depths into the underlying groundwater, superficial and chalk aquifers.
- The piling process will likely result in the interconnectivity of the overlying superficial aquifer (sands and gravels) with the underlying chalk aquifer. It is believed that the surface water environment and shallow groundwater environment is already in partial continuity with the groundwater within the chalk bedrock.
- Formation of service ducts will generate made ground, potential for the retention and reuse of this material will need to be considered within appropriate areas within the development. The service ducts and channels may encounter shallow groundwater conditions. Site investigation has encountered groundwater at shallow depths (0.75mbgl at BH9). The channels may provide preferential short circuit pathways for potential contaminants into the underlying groundwater environment.
- Construction works may create additional pathways through the removal of existing concrete hardstanding. This will likely increase the volume of rainfall and surface water infiltration into the made ground, and increase the potential for leachate generation and migration (vertical and lateral).The proposed dredging scheme may also result in additional interconnection between the Broadwater Lake and the underlying groundwater if any deeper dredging works are proposed in exceedance of the initial 2m.
- The Client Team has provided Hydrogeo with Reclaimed Land Peninsula Outline Construction Method Plan which proposes the use of sheet piling into the underlying chalk to allow for the reclamation of some of the Broadwater Lake area as land. Broadwater Lake is underlain by naturally occurring materials. During construction of the reclaimed land it is proposed to use only the dredged lake sediments.

6.4 Receptors

The identified receptors of potential contamination have been identified from all reports and available data to Hydrogeo.

The identified receptors are as follows:

- Secondary A Superficial Aquifer;
- Broadwater Lake surface water;
- River Colne;
- Principal bedrock Chalk Aquifer;
- Affinity Water Public Borehole Supply (Source Protection Zone 1 – Inner catchment);

7 Risk Assessment and Mitigation Measures

Made Ground and Contamination Hotspot

Made Ground conditions have been identified across the majority of the proposed development site, with the made ground encountered consisting of mostly inert landfill material including brick, concrete, flints, ash and rubber. The Geo-Integrity Phase I Report has indicated an area of inert landfilled ground, as shown by 1 in Figure 7-1.

Details provided in the Geo-Integrity Phase I Report indicated the landfill as an historic inert landfill, operated by Lafarge Aggregates Ltd from 1993 to 2004, under Waste Permit Reference: TE1/L/LAF001.

Figure 7-1 Area of Mapped Historic Inert Landfill

The identified contamination 'hotspot' encountered within the Geo-Integrity Phase II Site Investigation works in the area of TP4 and CBR5 consisted of malodours and visually impacted made ground conditions with hydrocarbon staining to a maximum depth of 2mbgl. The hotspot position is presented in Figure 6.2 which is included within the Geo-Integrity Site investigation Report.

Laboratory analysis of 2no. soil samples from TP4 (0.75mbgl & 2mbgl) indicates elevated concentrations of Aliphatic hydrocarbon compounds within the C12 – C16, C16 – C21 and C21-C35.

The extent of the contamination hotspot area is shown within the Impacted Made Ground Plan of the Geo-Integrity Phase II Site Investigation Report.

It appears that the contamination hotspot is located beneath the proposed access road area, and extends onto the proposed boat yard areas.

The identified hydrocarbons are included in Table 5.1 of the CL:AIRE Petroleum Hydrocarbons in Groundwater (2017) document which shows the determinants partition coefficient, solubility and mobility. Relevant sections of Table 5.1 of the CL:AIRE document has been reproduced as Table 7-1. Hydrocarbons present are described generally as having low mobility in groundwater.

Table 7-1 Mobility of Hydrocarbon Fractions in Groundwater

Carbon band range	Partition coefficient, K_{oc}		Aqueous Solubility		Overall relative mobility in groundwater
	Value (l/kg)	Potential sorption ranking	Value (l/kg)	Potential mobility ranking	
Aliphatic >C12 – C16	5x10^6	Very Low	7.6x10^-4	Very Low	Very Low
Aliphatic >C16 – C21	6.3x10^8	Very Low	3x10^-6	Very Low	Very Low
Aliphatic >C21 – C36	Not Included				

As indicated in Table 7-1 the identified hydrocarbon chains have very low mobility rankings within groundwater, and are therefore not considered to pose a significant risk to the underlying groundwater.

Groundwater samples captured during the Geo-Integrity Site Investigation did not indicate the presence of measureable concentrations of TPH compounds, with all associated TPH bands beneath the Laboratory Level of Detection (LoD).

Piling

It is believed that some of the proposed building structures will require a piled foundation solution, with piles bearing into the underlying chalk bedrock. This will result in piles being bored through shallow made ground soils, into the underlying superficial deposits and forming within the chalk bedrock.

The piling process may pose a potential risk of creating short-circuit pathways for near-surface made ground contaminants into the underlying aquifers.

The sheet piling to allow for the reclamation of land for the peninsula is proposed to be advanced through clean naturally occurring materials underlying Broadwater Lake. The sheet pile is proposed to terminate within the underlying chalk geology.

To reclaim the land for peninsula construction it is proposed that dredged material from Broadwater lake are used, some areas of the lake bed sediment have already been sampled for laboratory analysis. However, it is recognised that additional samples within the proposed dredging area will need to be collected and analysed prior to the progression of the works.

Dredging

Dredging of Broadwater Lake is proposed to allow for the formation of deeper sailing channels and the creation of new island shallows. The dredging works is proposed to be progressed under an Environment Agency (EA) Environmental Permit, and where possible a waste exemption (using one mechanical movement).

In total 20no. samples of Broadwater Lake sediment have been captured by Johns Associates. Screening of the laboratory chemical results has indicated no exceedances of human health criteria – residential land use targets (used as these are more stringent than Public Open Space Criteria).

All lake sediment materials are naturally occurring sand, silt and gravel, as it appears that no landfilling operations have occurred across Broadwater Lake, only at the smaller lake to the east, and the parcel of land proposed for development.

Proposed Development

The proposed development consists of considerable coverage of low permeability surfaces including tarmacadam and concrete for road surfacing and car parking / boat storage. This will restrict the volume of surface and rainfall infiltration into the made ground.

The proposed development consists of a maintenance / servicing building for boats which is likely to include the storage of potentially contaminative materials, fuels, oils chemicals and grease which have the potential to migrate into the made ground and underlying geology following leaks / spills.

Construction phase works including plant machinery refuelling and on-site storage of fuels / oils, break out and grubbing up of existing concrete surfacing may also present potential risks to the groundwater environment.

7.1 Recommendations and Mitigation Measures

Made Ground and Contamination Hotspot

The identified made ground soils have been encountered as containing inert materials including concrete, brick, flints etc, to a maximum depth of 3.45mbgl. Leachate testing of 2no. made ground samples has identified marginal exceedances of chromium, copper, nickel, lead and zinc.

The historic licensed inert landfill area as indicated in Figure 7-1 is shown to extend partially onto the proposed development site (Site Peninsula). Site Investigation positions in this area have indicated a thickness of concrete hardstanding which is effectively capping and restricting the infiltration of rainwater and surface water into the underlying inert waste. This therefore restricts leachate generation and potential for vertical and lateral migration.

It is recommended, where possible that this concrete hardstanding is left intact during development.

The identified hydrocarbons within the Geo-Integrity Site Investigation includes C10-C12 and C12 – C16 chains. Guidance within the CL:AIRE petroleum hydrocarbons in groundwater indicates that these hydrocarbon chain lengths have a very low partition coefficient and a very low mobility in groundwater.

Low mobility in groundwater is also evidenced by the groundwater samples captured by Geo-Integrity which indicates concentrations of all TPH compounds at concentrations below the Laboratory Level of Detection (LoD).

Due to the locality of the contamination hotspot, underlying a proposed road area and boat storage yard, the infiltration of rainfall and surface water to this position will be restricted, therefore limiting the potential for leachate generation and migration.

The Geo-Integrity Site Investigation positions in the vicinity of the made ground and contamination hotspot all encounter a significant thickness of low permeability silty clay which isolates the overlying made ground from the underlying superficial sands and gravels and chalk geology, restricting the vertical migration of potential contaminants.

Lake Management Plan (Appendix 8.10 of the Environmental Statement)

A Preliminary for Planning Lake Management Plan has been produced by the Client Team and is reported as Appendix 8.10 of the Environmental Statement.

The Lake Management Plan sets out integrated / embedded mitigation measures that are to be implemented during the enabling and construction works phases. The mitigation measures identified to manage and mitigate the risks posed to the groundwater environment include, but are not limited to the following measures:

- Implementation of a Construction Environmental Management Plan (CEMP);
- Use of bunded refuelling facilities, with secondary containment measures;
- No excavation of any areas associated with former regulated or potential unregulated waste activities. No removal of any concrete cover over these locations. Provision of a suitably designed/specified impermeable barrier over these areas (e.g., clay) and appropriate overlying clean cover to prevent new pathways to terrestrial areas including connected groundwater.
- No reduction in groundwater quantity available for abstraction due to continuity between Broadwater Lake and aquifer, but a localised improvement in surface water quality. Implementation in accordance with all legal and permitting requirements.

Proposed Monitoring – Groundwater

A suitable groundwater monitoring programme covering the enabling, construction and operational phases of the Proposed Development will be developed and implemented as a planning condition. The monitoring will involve, but are not restricted to the following:

- Pre-construction Re-assessment: Before the construction begins, a comprehensive re-assessment of the site's hydrogeological conditions should be conducted. This assessment should include a review of available geological and hydrogeological data, site-specific groundwater flow characteristics, and the identification of nearby water sources such as wells or surface water bodies (Addressed within the Groundwater Risk Assessment).

- Baseline Monitoring: Baseline monitoring involves collecting data on groundwater levels, water quality, and flow rates in the vicinity of the construction site before any work begins. This provides a reference point for comparison during and after construction.
- Installation of Monitoring Wells: Depending on the site conditions, it may be necessary to install monitoring wells strategically around the construction area. These wells should be properly designed, constructed, and equipped with appropriate instruments to measure groundwater levels and quality accurately.
- Continuous Monitoring: During construction, continuous monitoring of groundwater conditions is essential. This typically involves installing automatic monitoring equipment that provides real-time data on groundwater levels, flow rates, and water quality. Automated alarms can be set up to alert project personnel if any predetermined thresholds are exceeded.
- Regular Sampling and Analysis: Periodic sampling of groundwater should be conducted at designated intervals to assess changes in water quality throughout the construction process. The samples will be analysed in a laboratory to detect any potential contamination or changes in groundwater chemistry.
- Construction Activity Tracking: It is important to document construction activities that may have a potential impact on groundwater, such as excavation, dewatering, or underground utility installation. Keeping a detailed record of these activities will help correlate any changes in groundwater conditions with specific construction actions.
- Response and Mitigation Measures: If the monitoring program detects any adverse impacts on groundwater, appropriate response and mitigation measures will be implemented promptly. These will include adjusting construction techniques, altering dewatering methods, or implementing additional pollution control measures.
- Post-construction Monitoring: Once construction is completed, post-construction monitoring will be conducted to evaluate the effectiveness of any mitigation measures and ensure that groundwater conditions return to pre-construction levels.
- Documentation and Reporting: A comprehensive record of the monitoring program, including data collected, analysis reports, and any mitigation measures taken, will be maintained. This documentation is critical for regulatory compliance, future reference, and potential legal requirements.

Piling

It would be prudent for the Client Team to consider the commission of a site-specific Piling Risk Assessment. The Environment Agency have published technical guidance regarding the assessment of risks associated with, and preventing pollution from piling and penetrative ground improvement methods. The guidance outlines a process to allow designers to select an appropriate piling method and any mitigation and monitoring measures required.

The project team will engage with a piling contractor at an early stage of the construction phase works so that all potential piling specific risks can be addressed, and where required mitigated without significantly affecting the project timescale.

Dredging

It is believed that dredging of lake sediment materials will take place within a turbidity curtain to initially contain the spread of suspended particles (turbidity).

The placement of dredged materials within island edges will be contained within a geotextile with pockets and posts, installed using operator and long reach excavator, and within sheet piles for the land reclamation of the peninsula.

Dredging is only taking place across certain areas of the Broadwater Lake where increased depths are required to allow for sailing corridors. Depths of dredging are indicated at a maximum of 2m depth. From all the information and data provided to Hydrogeo and reviewed in preparation of this report, it appears that the alluvium deposits will remain intact during the dredging process, and that no further interconnectivity between the groundwater and Broadwater Lake will be created.

Where interconnectivity does occur, it is likely to be across limited areas, which are unlikely to significantly affect the present condition of the underlying groundwater.

Other Construction Considerations

A Construction Environmental Management Plan (CEMP) should be put in place to consider any potential risks associated with construction works on-site, i.e. temporary on-site storage and refuelling of site plant.

The CEMP should also consider the management of surface waters and surface water runoff during construction periods to ensure no potentially impacted surface waters enter Broadwater Lake, or the River Colne.

Affinity Water Public Water Boreholes

Affinity Water have been identified as a key stakeholder due to proximity of a PWS groundwater borehole and sensitivity of the groundwater environment.

Affinity Water have been consulted at the pre-planning application stage, and provided with a draft version of this groundwater risk assessment, and draft versions of the Phase I Geo-environmental Assessment, and Phase II Site investigation reports for review and comment.

Dialogue is to be continued with Affinity Water throughout the enabling, construction and operational phases of development.

An Affinity Groundwater Abstraction borehole is located approximately 500m west of the proposed development Site. This borehole is advanced to a maximum depth of 57mbgl, and abstracts groundwater from the Principal Chalk Aquifer.

8 Conclusions

8.1 Conclusions

Hydrogeo Limited (Hydrogeo) has been commissioned by Quod (The Client) to undertake a Groundwater Risk Assessment for the Proposed Development of Hillingdon Water Sports Facility and Activity Centre.

Outdoor Activity Centre at Broadwater Lake. The current outdoor activity centre is to be relocated as a result of construction works associated with the High Speed 2 Rail Scheme.

The hydrogeological conceptual model has been characterised based upon previous reports progressed by Geo-Integrity, including a Phase I Geo-environmental Desk Study and Site Walkover, as well as the subsequent Phase II Site Investigation Report. Additional details have been captured from BGS maps and data.

The underlying chalk bedrock is designated by the Environment Agency as a 'Principal Aquifer', and the site is located within a Source Protection Zone I – Inner catchment, relating to a public water supply abstraction borehole.

The Geo-Integrity Phase II Site Investigation progressed 9no. boreholes, 14no. trial pits, and several other CBR and Soakaway test positons, which have been used to inform the geological and hydrogeological conditions underlying the site within this Groundwater Risk Assessment. The Site Investigation has identified a hotspot of hydrocarbon malodours and visually impacted made ground materials.

The groundwater beneath the site is expected to be partly in hydraulic continuity with the surface water features in the area, including Broadwater Lake itself, and the River Colne. The Groundwater flow direction is believed to be toward the base of the valley (toward Broadwater Lake). This direction may be influenced during periods of extensive pumping at the Affinity Public Supply Boreholes.

Made Ground and Contamination Hotspot

Laboratory analysis of 3no. soil samples from the identified hotspot area has indicated exceeding concentrations of Aliphatic >C10-12 and Aliphatic C12 – C16 TPH compounds, to a maximum depth of 2mbgl.

Using CL:AIRE Guidance 'Petroleum Hydrocarbons in Groundwater', these TPH Hydrocarbons have very low partition coefficient, a very low potential mobility ranking and an overall very low relative mobility in groundwater.

The low mobility is further evidenced by 3no. groundwater samples which indicates concentrations of all TPH chain determinants at concentrations below their respective laboratory Level of Detection (LoD).

Leachability testing of 2no. made ground samples did not identify any exceedances of the UK Drinking Water Standards (UKDWS),and is therefore not thought to pose a significant potential risk to the underlying aquifers.

A significant thickness of low permeability silty clay has been encountered which isolates the overlying made ground from the underlying superficial sands and gravels and chalk geology, restricting the vertical migration of potential contaminants.

The area of historic licensed inert landfill that extends partially onto the development site has been encountered as covered by a thickness of concrete hardstanding within the Geo-Integrity Site Investigation positions. This concrete layer is effectively acting as a capping layer and restricting the infiltration of rainwater and surface water into the underlying inert material.

Dredging

Screening of 20no. Broadwater Lake sediment samples against stringent human health criteria did not indicate any exceeding concentrations, and it is not thought that this material poses a significant risk to the underlying groundwater and aquifers.

Proposed dredging requirements indicate that the maximum depth of dredging is to be between 1.5m – 2m beneath the existing lake base. Based on the conceptual model and geology of the site, dredging to this depth is not likely to significantly increase the continuity of the groundwater and Broadwater Lake as underlying low permeability silts and clays of the Alluvium depots will remain intact.

Proposed Development

A Construction Environmental Management Plan (CEMP) should be put in place to consider any potential risks associated with construction works on-site, i.e temporary on-site storage and refuelling of site plant.

The CEMP should also consider the management of surface waters and surface water runoff during construction periods to ensure no potentially impacted surface waters enter Broadwater Lake.

8.2 Recommendations

It is recommended that a specific Piling Risk Assessment is progressed to inform the construction process. The Piling Risk Assessment should detail the specific piling methodologies, risks associated with the piling operations, and mitigation measures required to inform the Development.

Where possible, the concrete hardstanding cover should be left in-situ across the site to restrict the infiltration of rainwater / surface water into the made ground and therefore reduce the likelihood of leachate generation and lateral / vertical migration. The concrete hardstanding is currently covering the underlying historic licensed inert landfill area.

This report is issued to the Contaminated Land Officer at the Local Authority and the Environment Agency for review.

Discussions should be opened with Affinity Water at an early stage to gauge their potential concerns in regard to the works and to discuss any mitigation measures.

The Construction Environment Management Plan (CEMP) should address any potential risks posed by construction to the groundwater environment including the storage and refuelling of site plant vehicles and the management of surface water runoff during construction.

Construction phase works including construction of service trenches and ducts, as well as piling are likely to generate materials (arisings). Therefore it may be considered prudent to develop a remediation strategy which sets out control measures and explores where possible suitable retention and re-use areas for the generated materials in and across the proposed development site.

If any additional contamination ‘hotspots’ are identified a discovery strategy should be put in place and agreed with the local authority.

Drawings

Drawing 1- 3

Geology Maps

HYDROGEO

HYG1120- London Borough of Hillingdon

DRAWING 1 Superficial Geology

KEY

Site Boundary

GBR BGS 1:50k Superficial deposits

- Alluvium
- Shepperton Gravel Member
- Gerrards Cross Gravel
- Winter Hill Gravel

N

0 125 250 375 500 m

Date	By	Paper	Scale	Rev
05 2023	SG	A3	1:7,500	1

HYDROGEO

HYG1120 - London Borough of Hillingdon

DRAWING 2 Bedrock Geology Map

KEY

Site Boundary

GBR BGS 1:50k Bedrock

London Clay Formation

Lambeth Group

Seaford Chalk Formation

0 125 250 375 500 m

N

Date	By	Paper	Scale	Rev
05 2023	SG	A3	1:10,000	1

HYDROGEO

HYG1120 - London Borough of Hillingdon

DRAWING 3 Artificial Geology

KEY

Site Boundary

GBR BGS 1:50k Artificial ground

Worked Ground

Infilled Ground

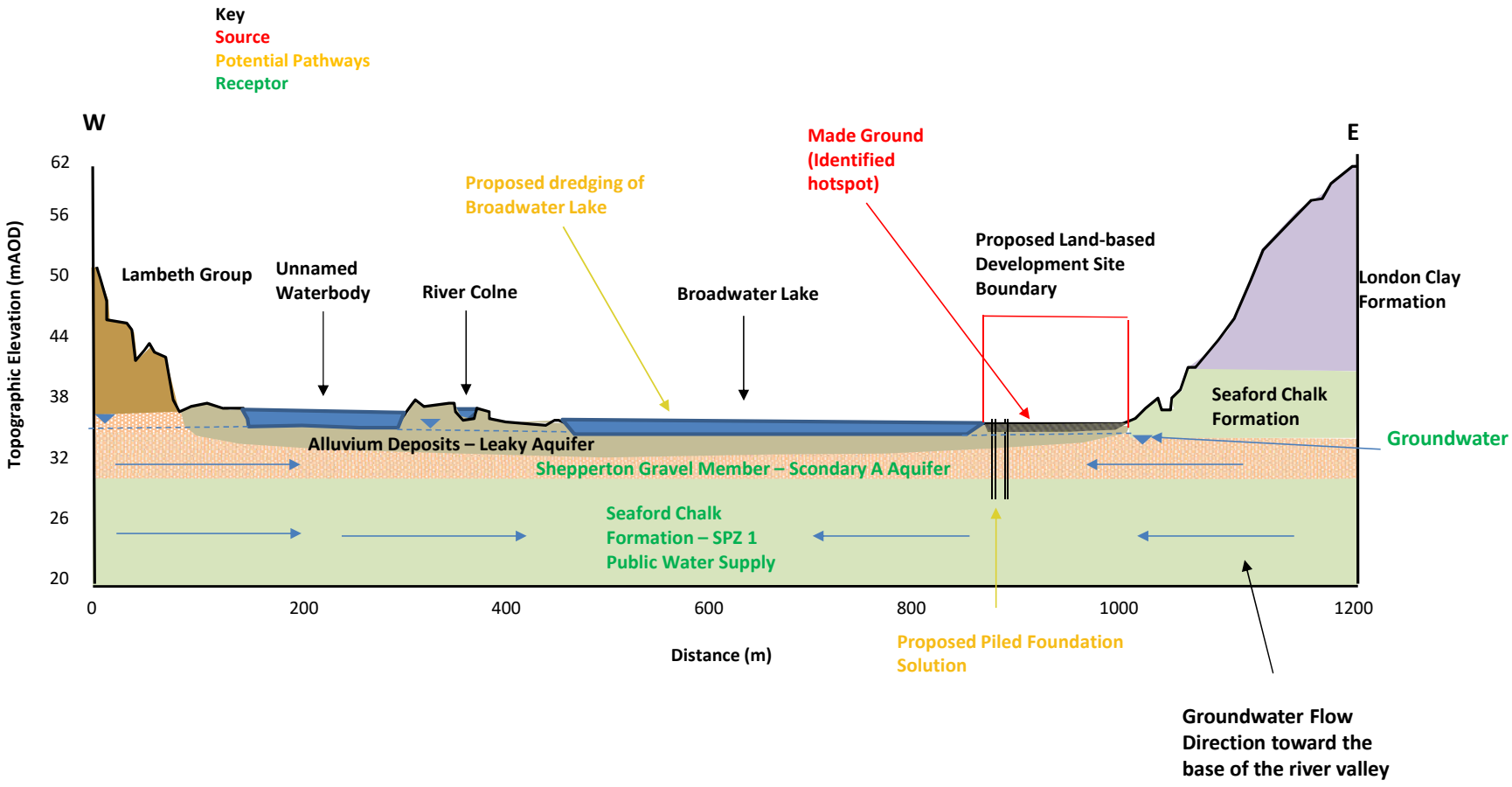
N

0 125 250 375 500 m

Date	By	Paper	Scale	Rev
05 2023	SG	A3	1:7,500	1

Drawing 4

Regional Conceptual Site Model



DRAWING 4 – Regional Hydrogeological Conceptual Site Model

Client: London Borough of Hillingdon

Project: Outdoor Activity Centre Ref: HYG1120

Date: 05 2023 Drawn By: SG Checked: MW

HYDROGEO Telephone:01873 856813 Email:mike@hydrogeo.co.uk Web:www.hydrogeo.co.uk

Appendices

Appendix A

Laboratory Lake Sediment Results

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 1

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

W184

Please quote above code for all enquiries

JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

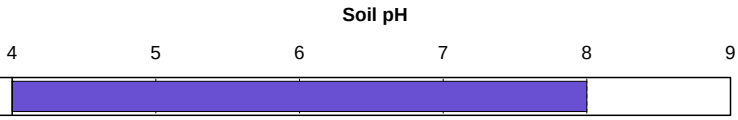
Date Received	11-APR-2023
Date Reported	28-APR-2023

Laboratory References

Report Number	66761
Sample Number	623553

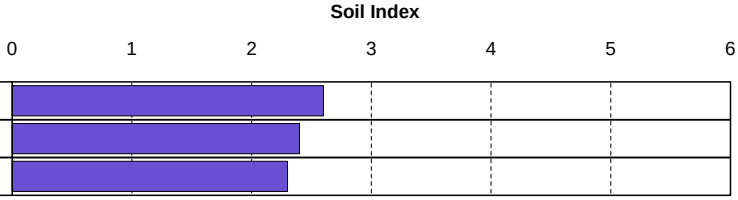
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



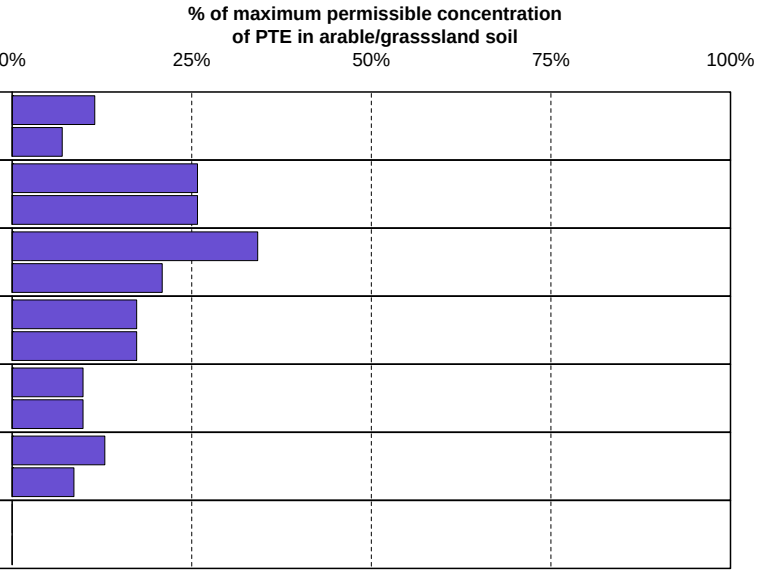
Determinand	Result
Soil pH	8.0

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	22.4	2
Available Potassium	170	2-
Available Magnesium	69.6	2

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	23.0	Arable	200
		Grassland	330
Total Zinc	77.4	Arable	300
		Grassland	300
Total Nickel	37.6	Arable	110
		Grassland	180
Total Cadmium	0.52	Arable	3
		Grassland	3
Total Lead	29.6	Arable	300
		Grassland	300
Total Chromium	51.6	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

(2) Concentration of Potentially Toxic Elements (PTE, commonly referred to as 'heavy metals') are in mg/kg dry soil. The maximum and the percentage of this maximum permissible concentration of PTE in soil are derived from the values in Defra's Code of Practice for Agricultural Use of Sewage Sludge (England & Wales) 1996. If applying organic manures to this soil it is important to ensure the soil is managed with a pH no less than 5.0, and that the PTE maximum values are not exceeded following the application. For soil where the pH value is less than 5.2, a FACTS Qualified Adviser should be consulted. Further details are provided in the Sludge Code.

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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 1

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

W184

Please quote above code for all enquiries

JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	28-APR-2023

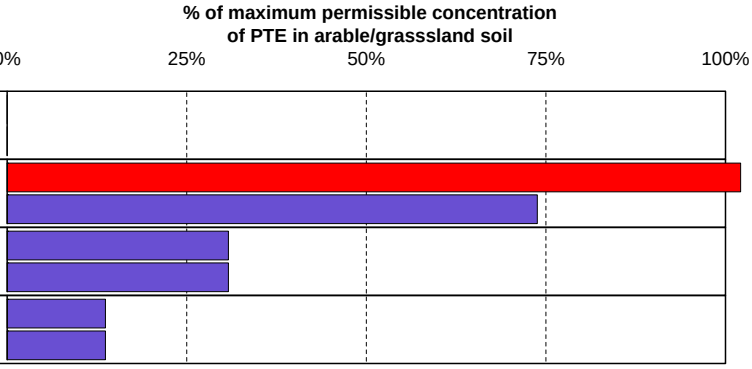
Laboratory References

Report Number	66761
Sample Number	623553

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	3.69	Arable	3
		Grassland	5
Total Arsenic	15.4	Arable	50
		Grassland	50
Fluoride	68.4	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 1

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NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	28-APR-2023

Laboratory References

Report Number	66761
Sample Number	623553

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2248
Organic Matter LOI	% w/w	4.6
Total Nitrogen	% w/w	0.127
Total Phosphorus	mg/kg	999
Total Potassium	mg/kg	1778
Total Magnesium	mg/kg	2434
Total Calcium	mg/kg	39913
Total Sodium	mg/kg	174
Total Carbon	% w/w	2.71
Total Sulphur	mg/kg	2003

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 2

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	28-APR-2023

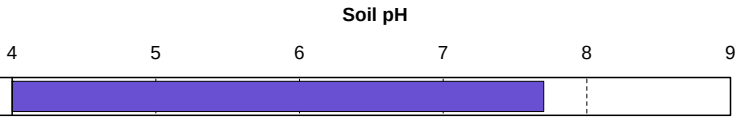
Laboratory References

Report Number	66761
Sample Number	623554

ANALYTICAL RESULTS *on 'dry matter' basis.*

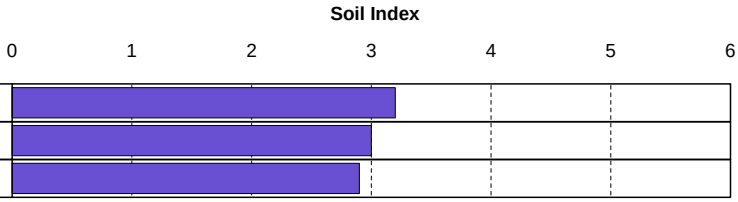
pH (1)

Determinand	Result
Soil pH	7.7



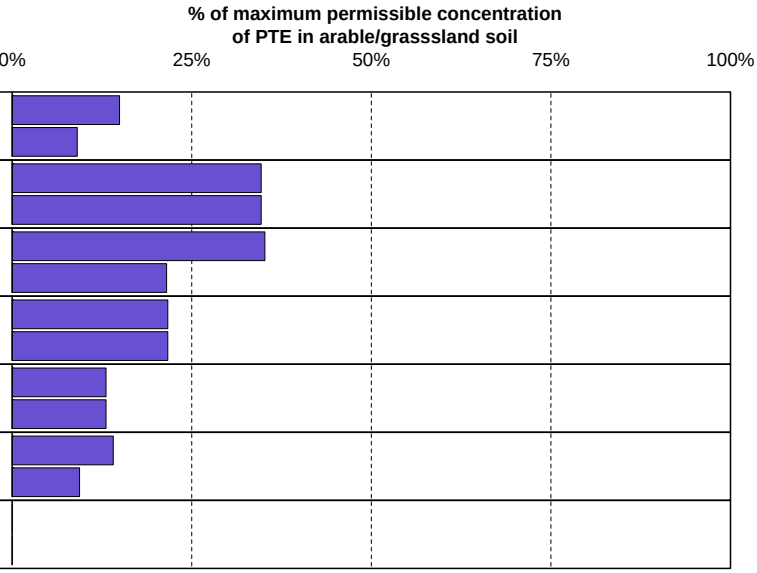
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	30.8	3
Available Potassium	247	3
Available Magnesium	96.6	2



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	29.9	Arable	200
		Grassland	330
Total Zinc	104	Arable	300
		Grassland	300
Total Nickel	38.7	Arable	110
		Grassland	180
Total Cadmium	0.65	Arable	3
		Grassland	3
Total Lead	39.2	Arable	300
		Grassland	300
Total Chromium	56.3	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 2

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	28-APR-2023

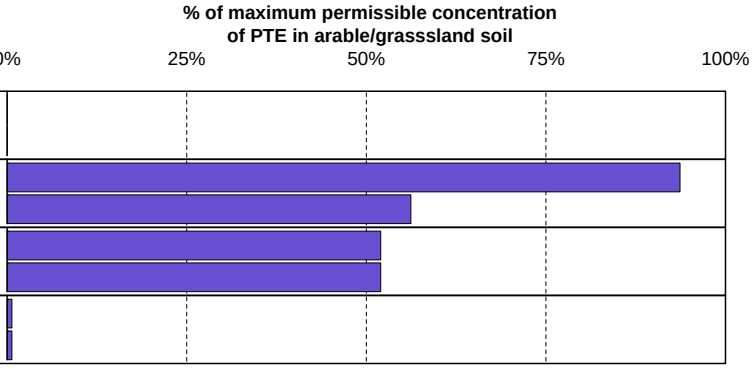
Laboratory References

Report Number	66761
Sample Number	623554

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	2.81	Arable	3
		Grassland	5
Total Arsenic	26.0	Arable	50
		Grassland	50
Fluoride	3.3	Arable	500
		Grassland	500



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Released by *Myles Nicholson* Date *28/04/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 2

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UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	28-APR-2023

Laboratory References

Report Number	66761
Sample Number	623554

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2147
Organic Matter LOI	% w/w	6.8
Total Nitrogen	% w/w	0.219
Total Phosphorus	mg/kg	1435
Total Potassium	mg/kg	2371
Total Magnesium	mg/kg	3277
Total Calcium	mg/kg	82839
Total Sodium	mg/kg	230
Total Carbon	% w/w	4.34
Total Sulphur	mg/kg	2044

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 3

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

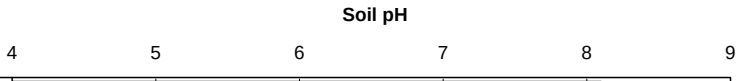
Date Received	11-APR-2023
Date Reported	16-MAY-2023

Laboratory References

Report Number	66762
Sample Number	623555

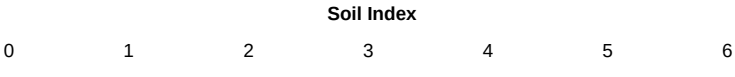
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



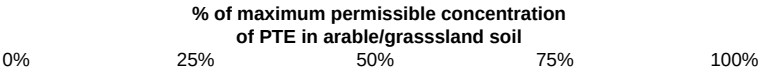
Determinand	Result
Soil pH	8.1

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	18.8	2
Available Potassium	122	2-
Available Magnesium	46.9	1

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	18.5	Arable	200
		Grassland	330
Total Zinc	64.9	Arable	300
		Grassland	300
Total Nickel	29.7	Arable	110
		Grassland	180
Total Cadmium	0.37	Arable	3
		Grassland	3
Total Lead	21.2	Arable	300
		Grassland	300
Total Chromium	37.8	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

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Released by ..... *Myles Nicholson* ..... Date ..... *16/05/23* .....

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 3

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UNIT 4 WADDINGTON HOUSE
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NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	16-MAY-2023

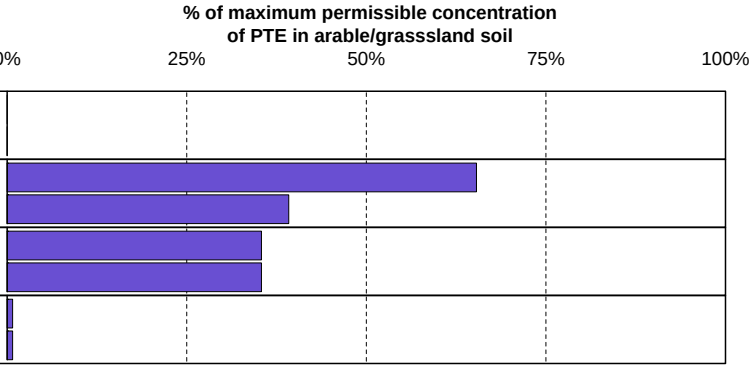
Laboratory References

Report Number	66762
Sample Number	623555

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.96	Arable	3
		Grassland	5
Total Arsenic	17.7	Arable	50
		Grassland	50
Fluoride	3.8	Arable	500
		Grassland	500



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Released by *Myles Nicholson* Date *16/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 3

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LLANOVER BUSINESS CENTRE
LLANOVER
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	16-MAY-2023

Laboratory References

Report Number	66762
Sample Number	623555

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2090
Organic Matter LOI	% w/w	3.3
Total Nitrogen	% w/w	0.097
Total Phosphorus	mg/kg	902
Total Potassium	mg/kg	1623
Total Magnesium	mg/kg	2168
Total Calcium	mg/kg	91670
Total Sodium	mg/kg	173
Total Carbon	% w/w	3.60
Total Sulphur	mg/kg	1161

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 4

HYDROGEO LTD
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LLANOVER
ABERGAVENNY
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	16-MAY-2023

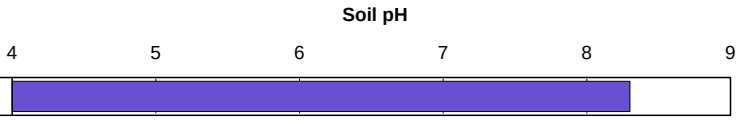
Laboratory References

Report Number	66762
Sample Number	623556

ANALYTICAL RESULTS *on 'dry matter' basis.*

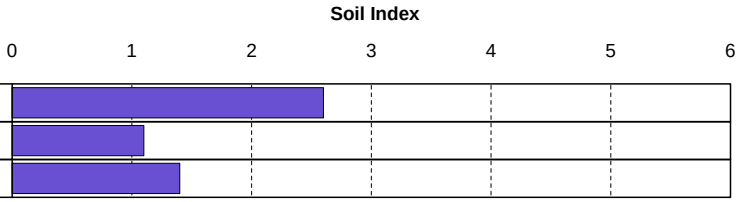
pH (1)

Determinand	Result
Soil pH	8.3



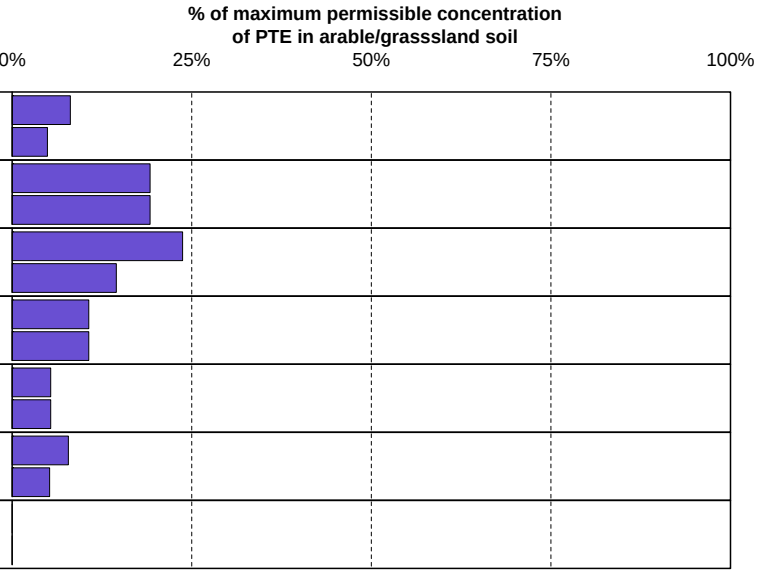
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	21.8	2
Available Potassium	71.7	1
Available Magnesium	37.8	1



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	16.2	Arable	200
		Grassland	330
Total Zinc	57.6	Arable	300
		Grassland	300
Total Nickel	26.1	Arable	110
		Grassland	180
Total Cadmium	0.32	Arable	3
		Grassland	3
Total Lead	16.1	Arable	300
		Grassland	300
Total Chromium	31.3	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 4

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LLANOVER BUSINESS CENTRE
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	16-MAY-2023

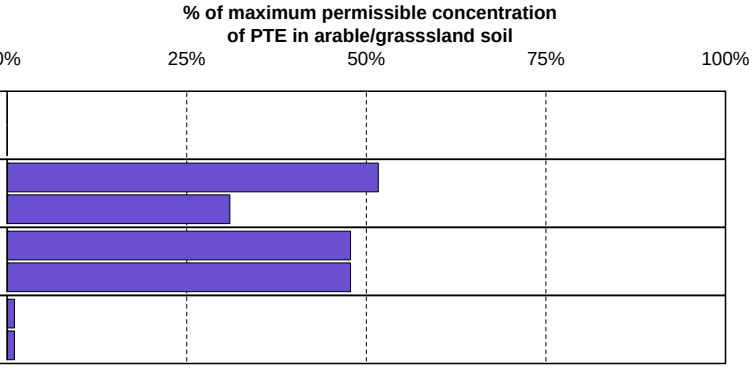
Laboratory References

Report Number	66762
Sample Number	623556

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.55	Arable	3
		Grassland	5
Total Arsenic	23.9	Arable	50
		Grassland	50
Fluoride	5.1	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 4

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	16-MAY-2023

Laboratory References

Report Number	66762
Sample Number	623556

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2144
Organic Matter LOI	% w/w	2.5
Total Nitrogen	% w/w	0.071
Total Phosphorus	mg/kg	815
Total Potassium	mg/kg	1435
Total Magnesium	mg/kg	1944
Total Calcium	mg/kg	74280
Total Sodium	mg/kg	147
Total Carbon	% w/w	3.28
Total Sulphur	mg/kg	562

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 5

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NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

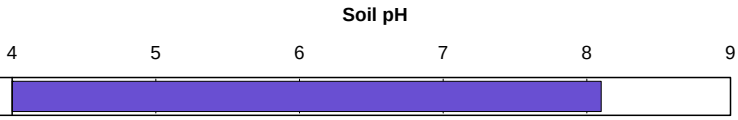
Laboratory References

Report Number	66763
Sample Number	623557

ANALYTICAL RESULTS *on 'dry matter' basis.*

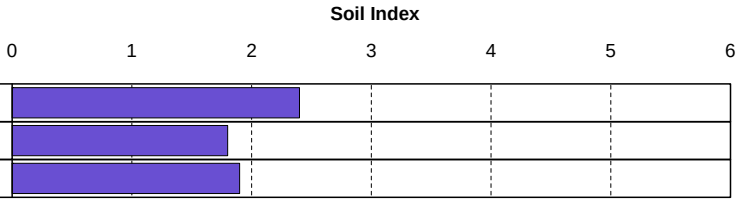
pH (1)

Determinand	Result
Soil pH	8.1



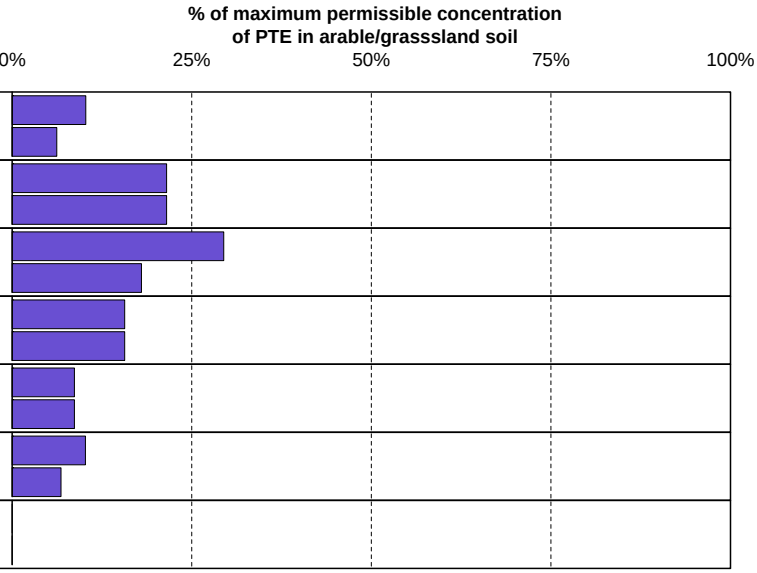
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	20.2	2
Available Potassium	111	1
Available Magnesium	49.5	1



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	20.5	Arable	200
		Grassland	330
Total Zinc	64.5	Arable	300
		Grassland	300
Total Nickel	32.4	Arable	110
		Grassland	180
Total Cadmium	0.47	Arable	3
		Grassland	3
Total Lead	26.0	Arable	300
		Grassland	300
Total Chromium	40.8	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 5

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

W184

Please quote above code for all enquiries

JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

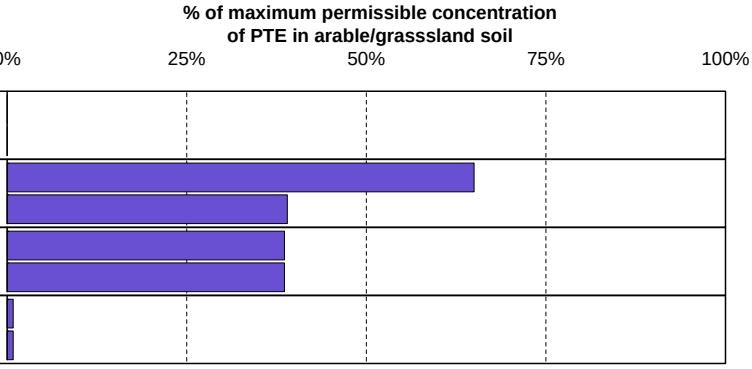
Laboratory References

Report Number	66763
Sample Number	623557

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.95	Arable	3
		Grassland	5
Total Arsenic	19.3	Arable	50
		Grassland	50
Fluoride	4.2	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 5

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66763
Sample Number	623557

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2169
Organic Matter LOI	% w/w	4.9
Total Nitrogen	% w/w	0.155
Total Phosphorus	mg/kg	891
Total Potassium	mg/kg	1761
Total Magnesium	mg/kg	2311
Total Calcium	mg/kg	62983
Total Sodium	mg/kg	175
Total Carbon	% w/w	3.93
Total Sulphur	mg/kg	1633

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 6

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

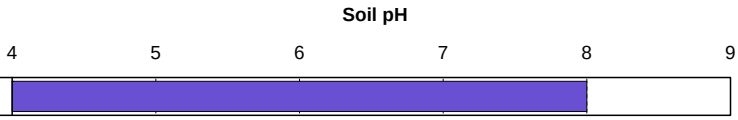
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66763
Sample Number	623558

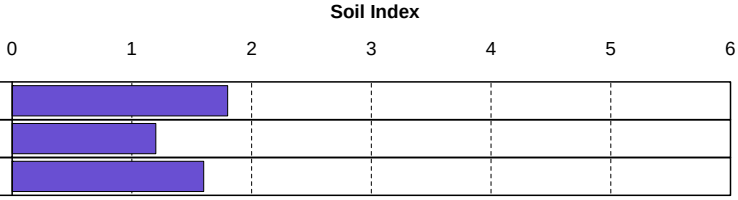
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



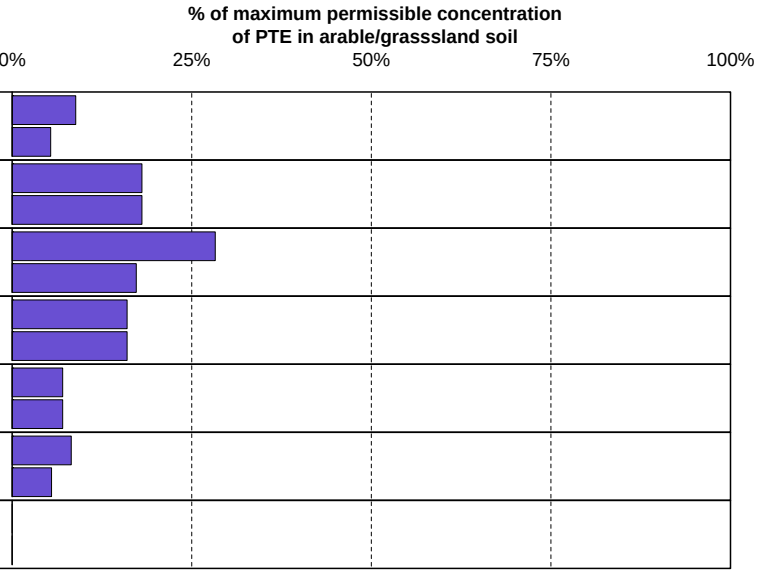
Determinand	Result
Soil pH	8.0

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	14.8	1
Available Potassium	76.6	1
Available Magnesium	42.2	1

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	17.7	Arable	200
		Grassland	330
Total Zinc	54.2	Arable	300
		Grassland	300
Total Nickel	31.1	Arable	110
		Grassland	180
Total Cadmium	0.48	Arable	3
		Grassland	3
Total Lead	21.1	Arable	300
		Grassland	300
Total Chromium	32.9	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 6

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
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NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

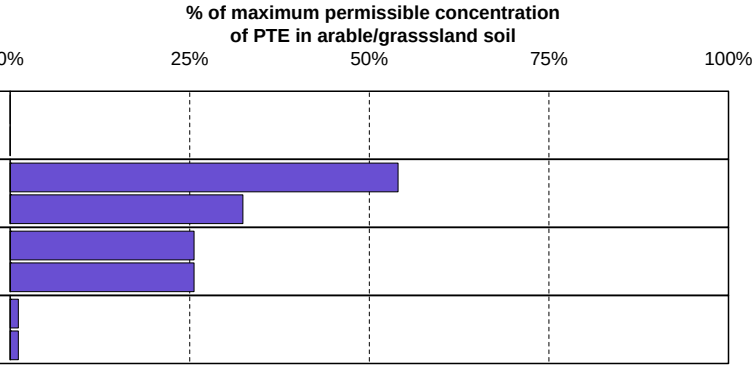
Laboratory References

Report Number	66763
Sample Number	623558

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.62	Arable	3
		Grassland	5
Total Arsenic	12.8	Arable	50
		Grassland	50
Fluoride	5.7	Arable	500
		Grassland	500



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Released by *Daniel Petty* Date *02/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 6

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UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66763
Sample Number	623558

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2186
Organic Matter LOI	% w/w	4.6
Total Nitrogen	% w/w	0.157
Total Phosphorus	mg/kg	761
Total Potassium	mg/kg	1513
Total Magnesium	mg/kg	1996
Total Calcium	mg/kg	71156
Total Sodium	mg/kg	152
Total Carbon	% w/w	4.06
Total Sulphur	mg/kg	1981

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 7

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

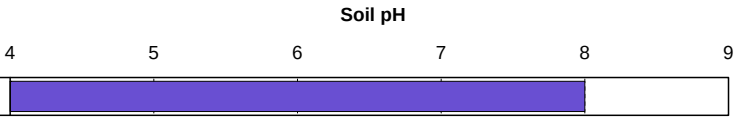
Laboratory References

Report Number	66764
Sample Number	623559

ANALYTICAL RESULTS *on 'dry matter' basis.*

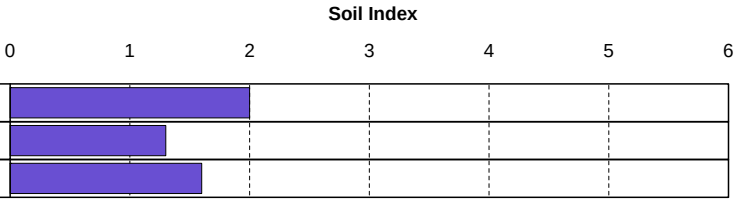
pH (1)

Determinand	Result
Soil pH	8.0



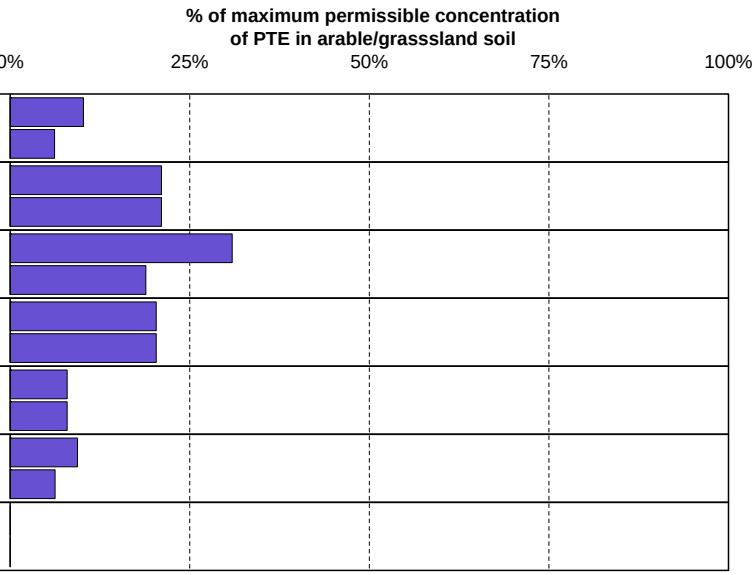
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	16.4	2
Available Potassium	82.2	1
Available Magnesium	41.2	1



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	20.4	Arable	200
		Grassland	330
Total Zinc	63.2	Arable	300
		Grassland	300
Total Nickel	34.0	Arable	110
		Grassland	180
Total Cadmium	0.61	Arable	3
		Grassland	3
Total Lead	23.8	Arable	300
		Grassland	300
Total Chromium	37.5	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 7

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UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
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NP7 9HA

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Please quote above code for all enquiries

JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

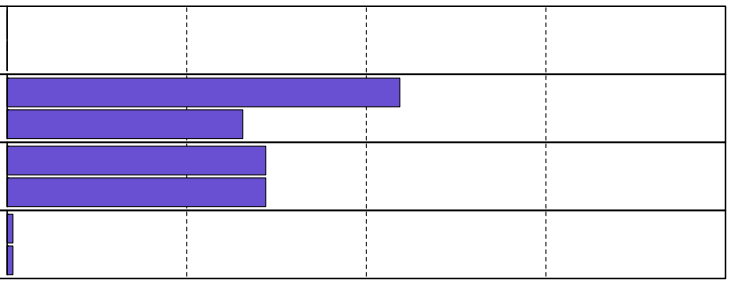
Laboratory References

Report Number	66764
Sample Number	623559

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.64	Arable	3
		Grassland	5
Total Arsenic	18.0	Arable	50
		Grassland	50
Fluoride	4.0	Arable	500
		Grassland	500



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Released by *Daniel Petty* Date *02/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 7

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66764
Sample Number	623559

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2177
Organic Matter LOI	% w/w	5.2
Total Nitrogen	% w/w	0.184
Total Phosphorus	mg/kg	851
Total Potassium	mg/kg	1786
Total Magnesium	mg/kg	2219
Total Calcium	mg/kg	71128
Total Sodium	mg/kg	175
Total Carbon	% w/w	4.36
Total Sulphur	mg/kg	2429

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 8

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ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

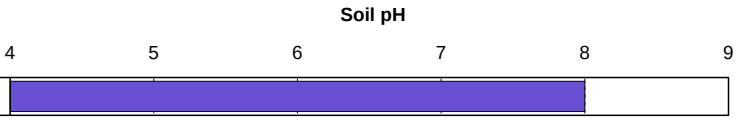
Laboratory References

Report Number	66764
Sample Number	623560

ANALYTICAL RESULTS *on 'dry matter' basis.*

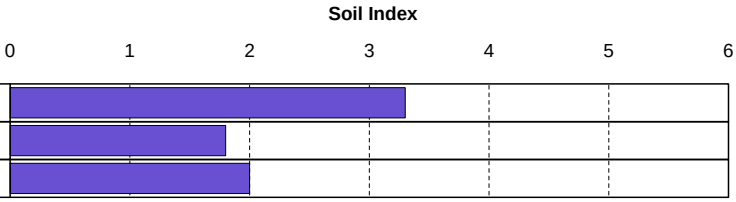
pH (1)

Determinand	Result
Soil pH	8.0



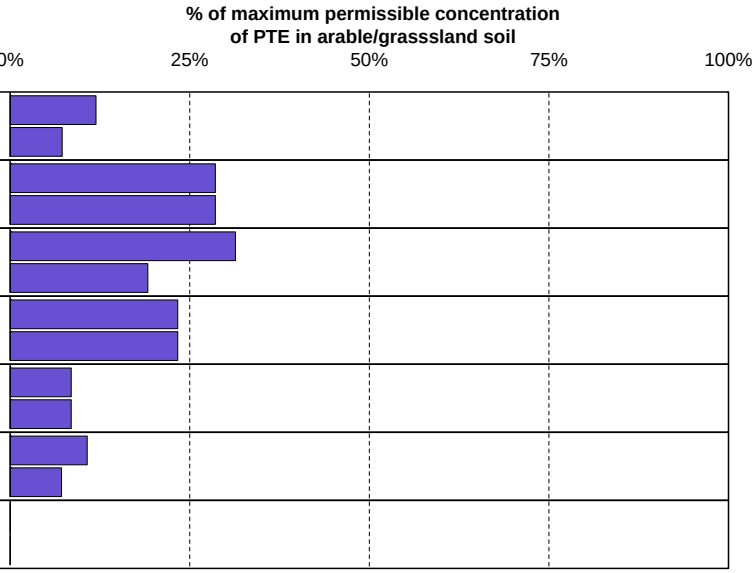
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	31.8	3
Available Potassium	111	1
Available Magnesium	55.2	2



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	23.9	Arable	200
		Grassland	330
Total Zinc	85.7	Arable	300
		Grassland	300
Total Nickel	34.5	Arable	110
		Grassland	180
Total Cadmium	0.70	Arable	3
		Grassland	3
Total Lead	25.5	Arable	300
		Grassland	300
Total Chromium	42.9	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 8

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ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

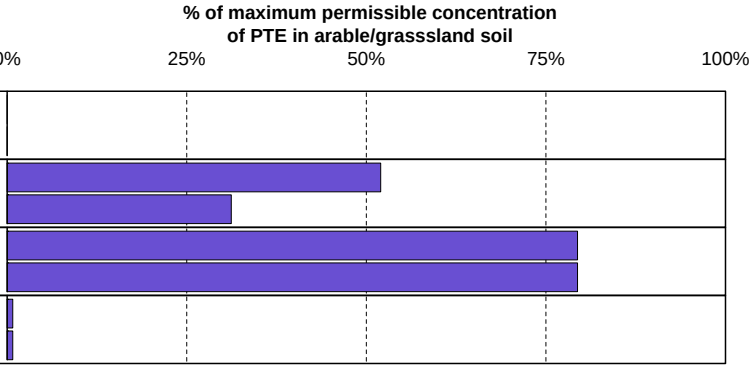
Laboratory References

Report Number	66764
Sample Number	623560

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.56	Arable	3
		Grassland	5
Total Arsenic	39.7	Arable	50
		Grassland	50
Fluoride	3.9	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 8

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66764
Sample Number	623560

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2132
Organic Matter LOI	% w/w	3.8
Total Nitrogen	% w/w	0.116
Total Phosphorus	mg/kg	1289
Total Potassium	mg/kg	1882
Total Magnesium	mg/kg	2367
Total Calcium	mg/kg	62089
Total Sodium	mg/kg	182
Total Carbon	% w/w	3.11
Total Sulphur	mg/kg	1354

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 9

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

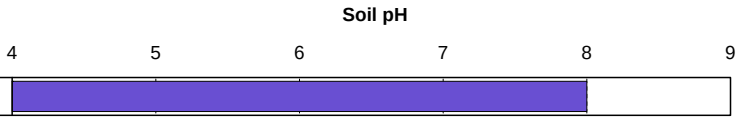
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66765
Sample Number	623561

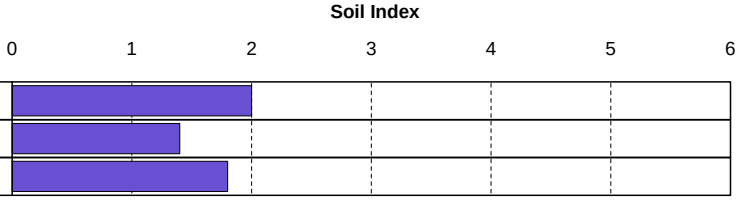
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



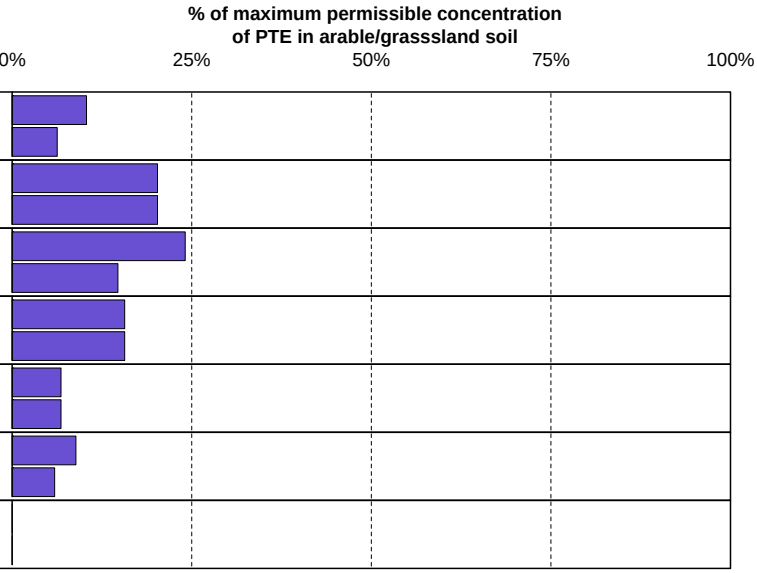
Determinand	Result
Soil pH	8.0

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	16.4	2
Available Potassium	85.8	1
Available Magnesium	45.9	1

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	20.7	Arable	200
		Grassland	330
Total Zinc	60.7	Arable	300
		Grassland	300
Total Nickel	26.5	Arable	110
		Grassland	180
Total Cadmium	0.47	Arable	3
		Grassland	3
Total Lead	20.4	Arable	300
		Grassland	300
Total Chromium	35.5	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

(2) Concentration of Potentially Toxic Elements (PTE, commonly referred to as 'heavy metals') are in mg/kg dry soil. The maximum and the percentage of this maximum permissible concentration of PTE in soil are derived from the values in Defra's Code of Practice for Agricultural Use of Sewage Sludge (England & Wales) 1996. If applying organic manures to this soil it is important to ensure the soil is managed with a pH no less than 5.0, and that the PTE maximum values are not exceeded following the application. For soil where the pH value is less than 5.2, a FACTS Qualified Adviser should be consulted. Further details are provided in the Sludge Code.

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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 9

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

W184

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

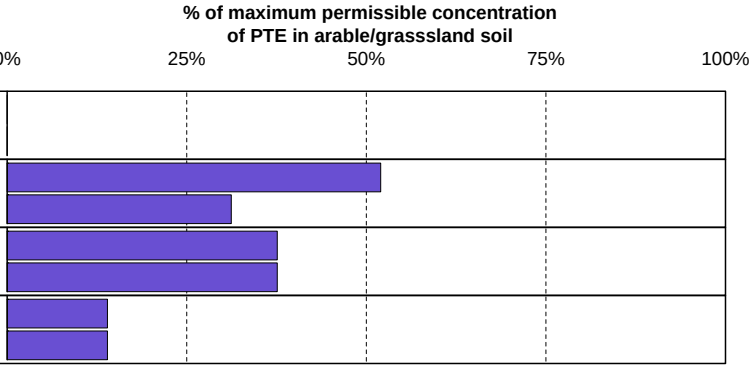
Laboratory References

Report Number	66765
Sample Number	623561

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.56	Arable	3
		Grassland	5
Total Arsenic	18.8	Arable	50
		Grassland	50
Fluoride	69.8	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 9

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66765
Sample Number	623561

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2173
Organic Matter LOI	% w/w	5.8
Total Nitrogen	% w/w	0.186
Total Phosphorus	mg/kg	753
Total Potassium	mg/kg	1606
Total Magnesium	mg/kg	2148
Total Calcium	mg/kg	34813
Total Sodium	mg/kg	156
Total Carbon	% w/w	3.53
Total Sulphur	mg/kg	1344

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 10

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GREEN TREE HOUSE

SOIL

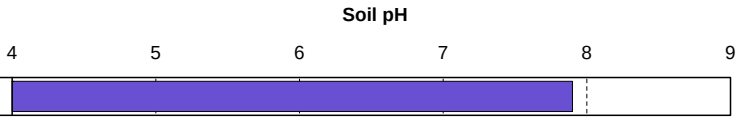
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66765
Sample Number	623562

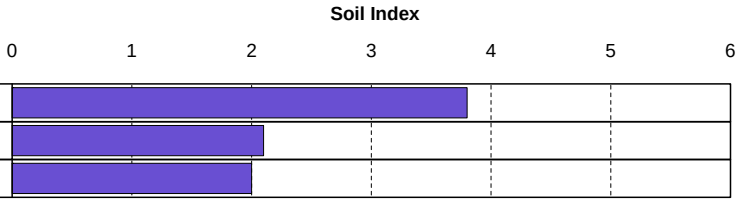
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



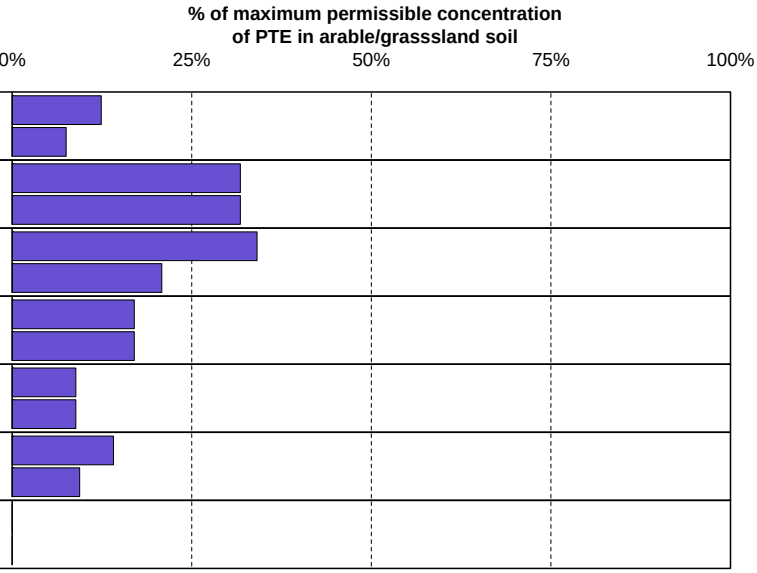
Determinand	Result
Soil pH	7.9

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	41.6	3
Available Potassium	136	2-
Available Magnesium	51.5	2

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	24.8	Arable	200
		Grassland	330
Total Zinc	95.3	Arable	300
		Grassland	300
Total Nickel	37.5	Arable	110
		Grassland	180
Total Cadmium	0.51	Arable	3
		Grassland	3
Total Lead	26.6	Arable	300
		Grassland	300
Total Chromium	56.4	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

(2) Concentration of Potentially Toxic Elements (PTE, commonly referred to as 'heavy metals') are in mg/kg dry soil. The maximum and the percentage of this maximum permissible concentration of PTE in soil are derived from the values in Defra's Code of Practice for Agricultural Use of Sewage Sludge (England & Wales) 1996. If applying organic manures to this soil it is important to ensure the soil is managed with a pH no less than 5.0, and that the PTE maximum values are not exceeded following the application. For soil where the pH value is less than 5.2, a FACTS Qualified Adviser should be consulted. Further details are provided in the Sludge Code.

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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 10

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NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

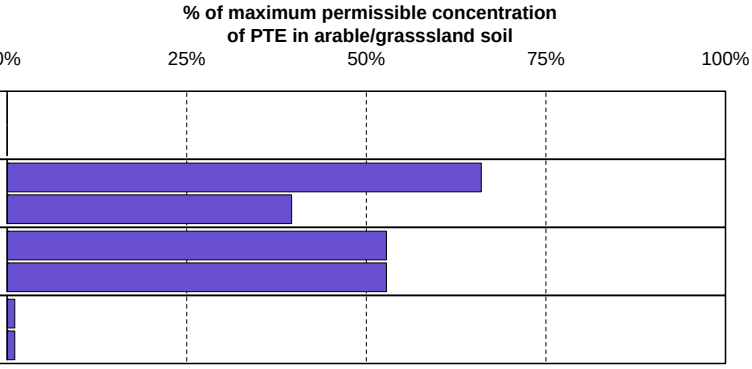
Laboratory References

Report Number	66765
Sample Number	623562

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.98	Arable	3
		Grassland	5
Total Arsenic	26.4	Arable	50
		Grassland	50
Fluoride	5.3	Arable	500
		Grassland	500



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Released by *Daniel Petty* Date *02/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 10

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LLANOVER BUSINESS CENTRE
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66765
Sample Number	623562

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2241
Organic Matter LOI	% w/w	4.1
Total Nitrogen	% w/w	0.144
Total Phosphorus	mg/kg	1499
Total Potassium	mg/kg	2521
Total Magnesium	mg/kg	3263
Total Calcium	mg/kg	50962
Total Sodium	mg/kg	174
Total Carbon	% w/w	2.75
Total Sulphur	mg/kg	2367

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 11

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

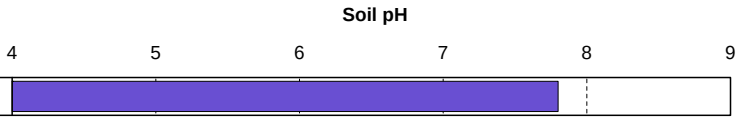
Laboratory References

Report Number	66766
Sample Number	623563

ANALYTICAL RESULTS *on 'dry matter' basis.*

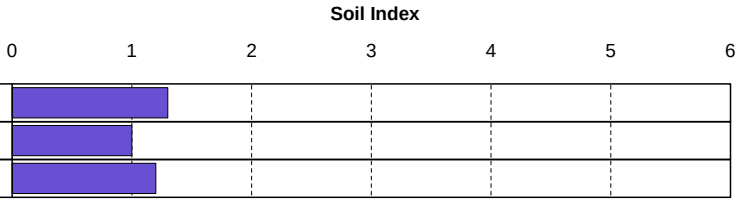
pH (1)

Determinand	Result
Soil pH	7.8



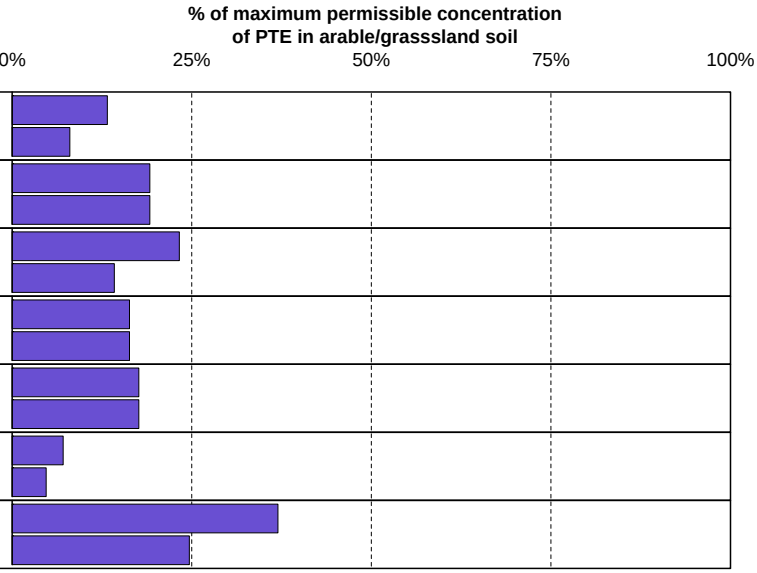
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	12.4	1
Available Potassium	63.7	1
Available Magnesium	33.2	1



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	26.5	Arable	200
		Grassland	330
Total Zinc	57.5	Arable	300
		Grassland	300
Total Nickel	25.6	Arable	110
		Grassland	180
Total Cadmium	0.49	Arable	3
		Grassland	3
Total Lead	52.9	Arable	300
		Grassland	300
Total Chromium	28.4	Arable	400
		Grassland	600
Total Mercury	0.37	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 11

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NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

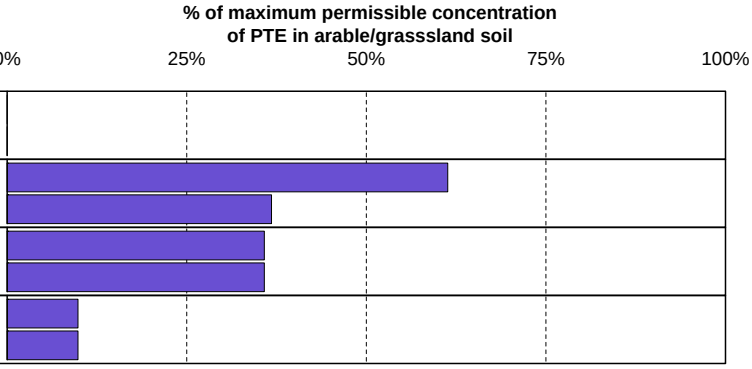
Laboratory References

Report Number	66766
Sample Number	623563

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.84	Arable	3
		Grassland	5
Total Arsenic	17.9	Arable	50
		Grassland	50
Fluoride	49.3	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 11

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66766
Sample Number	623563

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2183
Organic Matter LOI	% w/w	8.6
Total Nitrogen	% w/w	0.295
Total Phosphorus	mg/kg	730
Total Potassium	mg/kg	1120
Total Magnesium	mg/kg	1636
Total Calcium	mg/kg	35370
Total Sodium	mg/kg	129
Total Carbon	% w/w	4.82
Total Sulphur	mg/kg	2056

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 12

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LLANOVER BUSINESS CENTRE
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ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

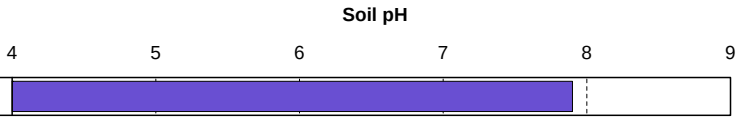
Laboratory References

Report Number	66766
Sample Number	623564

ANALYTICAL RESULTS *on 'dry matter' basis.*

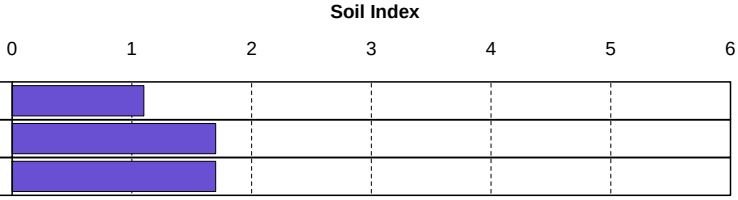
pH (1)

Determinand	Result
Soil pH	7.9



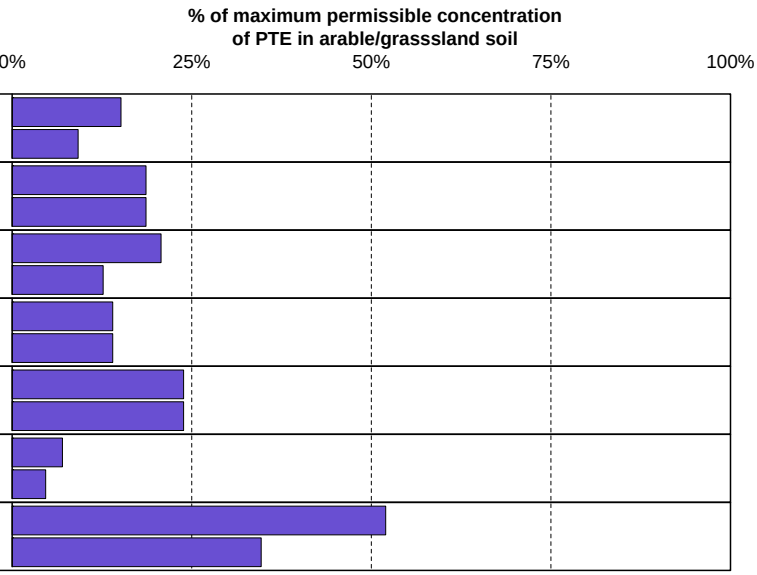
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	10.6	1
Available Potassium	106	1
Available Magnesium	45.2	1



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	30.3	Arable	200
		Grassland	330
Total Zinc	55.9	Arable	300
		Grassland	300
Total Nickel	22.8	Arable	110
		Grassland	180
Total Cadmium	0.42	Arable	3
		Grassland	3
Total Lead	71.6	Arable	300
		Grassland	300
Total Chromium	28.0	Arable	400
		Grassland	600
Total Mercury	0.52	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 12

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NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

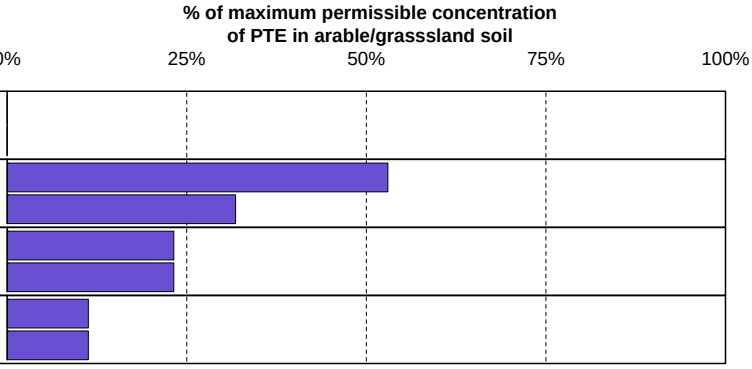
Laboratory References

Report Number	66766
Sample Number	623564

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.59	Arable	3
		Grassland	5
Total Arsenic	11.6	Arable	50
		Grassland	50
Fluoride	56.5	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 12

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GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66766
Sample Number	623564

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2167
Organic Matter LOI	% w/w	7.9
Total Nitrogen	% w/w	0.304
Total Phosphorus	mg/kg	573
Total Potassium	mg/kg	1138
Total Magnesium	mg/kg	2016
Total Calcium	mg/kg	29251
Total Sodium	mg/kg	143
Total Carbon	% w/w	4.27
Total Sulphur	mg/kg	1121

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 13

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LLANOVER BUSINESS CENTRE
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ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

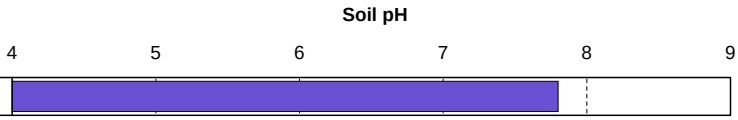
Laboratory References

Report Number	66767
Sample Number	623565

ANALYTICAL RESULTS *on 'dry matter' basis.*

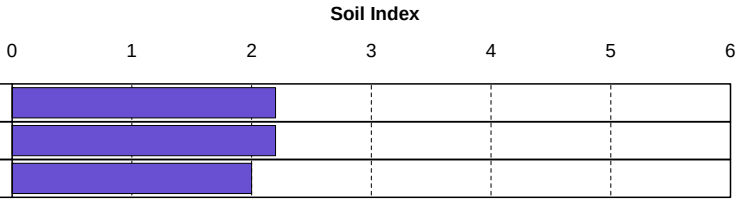
pH (1)

Determinand	Result
Soil pH	7.8



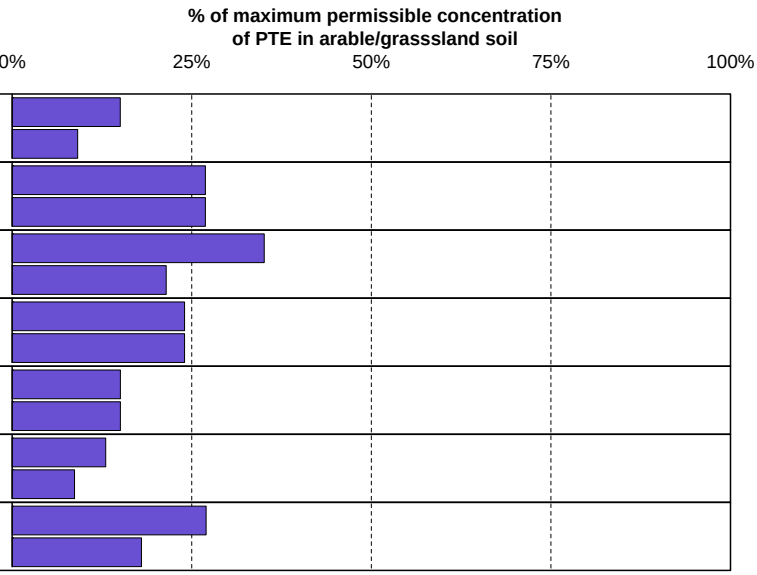
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	18.2	2
Available Potassium	147	2-
Available Magnesium	52.7	2



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	30.1	Arable	200
		Grassland	330
Total Zinc	80.7	Arable	300
		Grassland	300
Total Nickel	38.6	Arable	110
		Grassland	180
Total Cadmium	0.72	Arable	3
		Grassland	3
Total Lead	45.2	Arable	300
		Grassland	300
Total Chromium	52.1	Arable	400
		Grassland	600
Total Mercury	0.27	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 13

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

W184

Please quote above code for all enquiries

JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

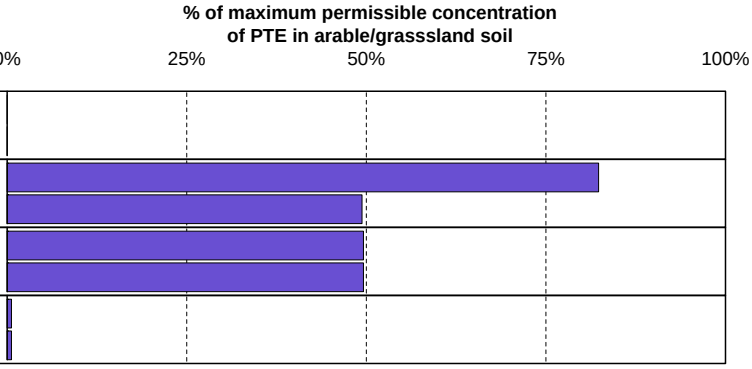
Laboratory References

Report Number	66767
Sample Number	623565

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	2.47	Arable	3
		Grassland	5
Total Arsenic	24.8	Arable	50
		Grassland	50
Fluoride	3.0	Arable	500
		Grassland	500



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Released by *Daniel Petty* Date *02/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 13

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ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66767
Sample Number	623565

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2265
Organic Matter LOI	% w/w	8.4
Total Nitrogen	% w/w	0.311
Total Phosphorus	mg/kg	1252
Total Potassium	mg/kg	1913
Total Magnesium	mg/kg	2451
Total Calcium	mg/kg	65755
Total Sodium	mg/kg	218
Total Carbon	% w/w	5.80
Total Sulphur	mg/kg	2546

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 14

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

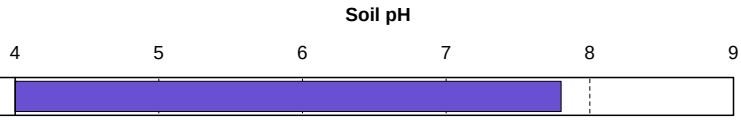
Laboratory References

Report Number	66767
Sample Number	623566

ANALYTICAL RESULTS *on 'dry matter' basis.*

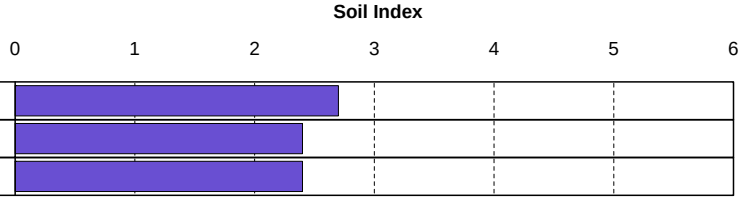
pH (1)

Determinand	Result
Soil pH	7.8



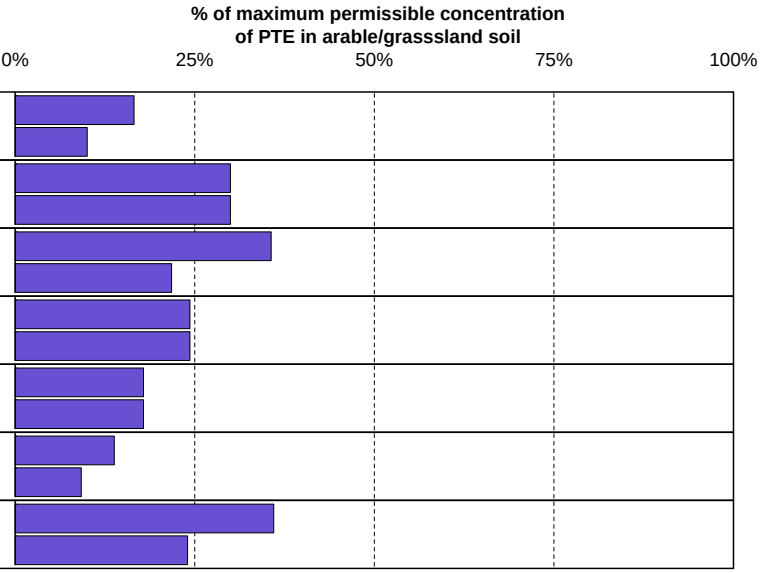
Soil Nutrients (1)

Determinand	Result mg/litre	Soil Index
Available Phosphorus	22.6	2
Available Potassium	173	2-
Available Magnesium	72.3	2



Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	33.1	Arable	200
		Grassland	330
Total Zinc	89.9	Arable	300
		Grassland	300
Total Nickel	39.2	Arable	110
		Grassland	180
Total Cadmium	0.73	Arable	3
		Grassland	3
Total Lead	53.6	Arable	300
		Grassland	300
Total Chromium	55.2	Arable	400
		Grassland	600
Total Mercury	0.36	Arable	1
		Grassland	1.5



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 14

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ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

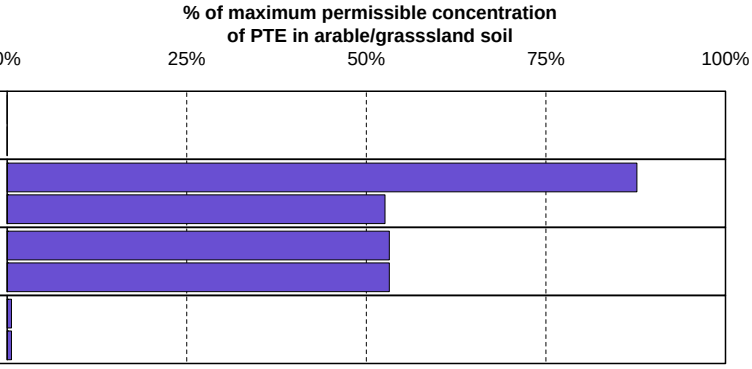
Laboratory References

Report Number	66767
Sample Number	623566

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	2.63	Arable	3
		Grassland	5
Total Arsenic	26.6	Arable	50
		Grassland	50
Fluoride	3.0	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 14

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66767
Sample Number	623566

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2295
Organic Matter LOI	% w/w	10.3
Total Nitrogen	% w/w	0.359
Total Phosphorus	mg/kg	1355
Total Potassium	mg/kg	2214
Total Magnesium	mg/kg	2679
Total Calcium	mg/kg	66043
Total Sodium	mg/kg	227
Total Carbon	% w/w	6.23
Total Sulphur	mg/kg	3445

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 15

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

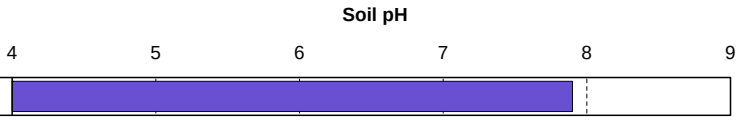
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66768
Sample Number	623567

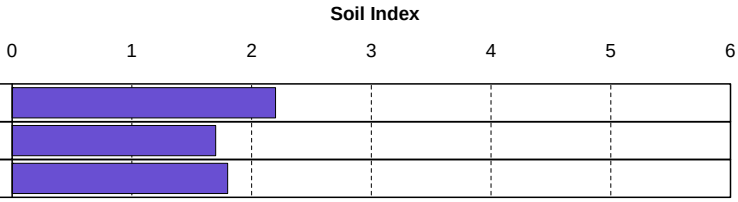
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



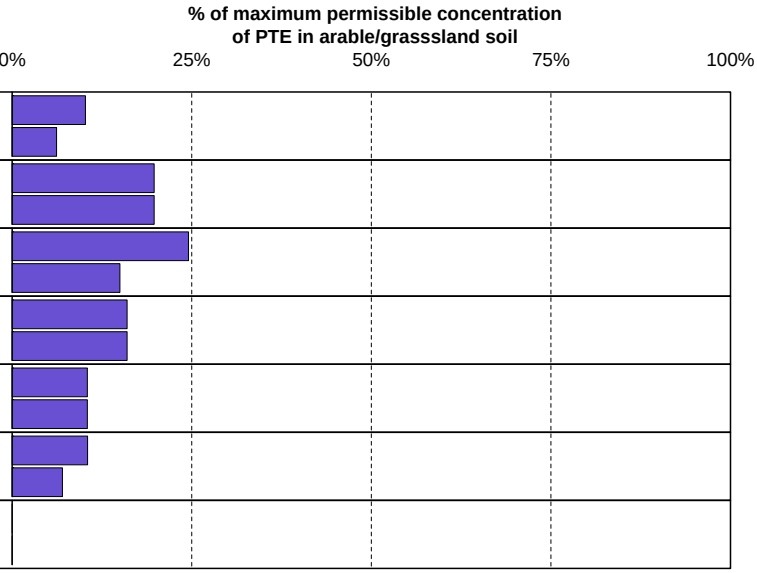
Determinand	Result
Soil pH	7.9

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	18.2	2
Available Potassium	108	1
Available Magnesium	45.5	1

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	20.4	Arable	200
		Grassland	330
Total Zinc	59.3	Arable	300
		Grassland	300
Total Nickel	27.0	Arable	110
		Grassland	180
Total Cadmium	0.48	Arable	3
		Grassland	3
Total Lead	31.4	Arable	300
		Grassland	300
Total Chromium	42.0	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5

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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 15

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LLANOVER
ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

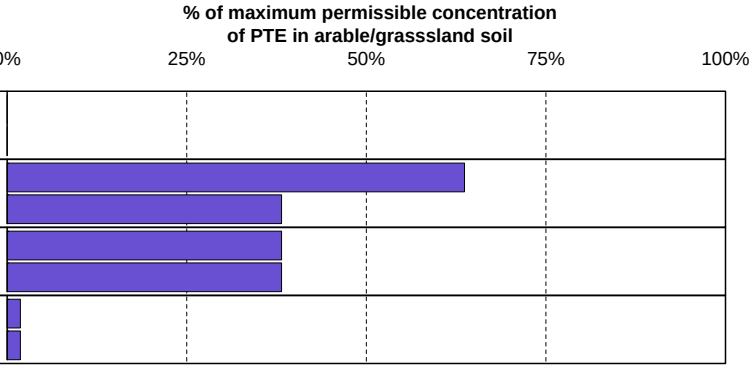
Laboratory References

Report Number	66768
Sample Number	623567

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	1.91	Arable	3
		Grassland	5
Total Arsenic	19.1	Arable	50
		Grassland	50
Fluoride	9.2	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 15

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GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66768
Sample Number	623567

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2248
Organic Matter LOI	% w/w	6.8
Total Nitrogen	% w/w	0.296
Total Phosphorus	mg/kg	921
Total Potassium	mg/kg	1407
Total Magnesium	mg/kg	1720
Total Calcium	mg/kg	46636
Total Sodium	mg/kg	154
Total Carbon	% w/w	4.20
Total Sulphur	mg/kg	2607

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 16

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

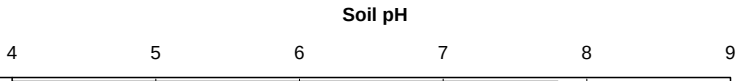
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66768
Sample Number	623568

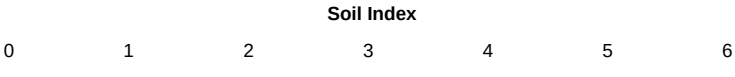
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



Determinand	Result
Soil pH	7.8

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	18.4	2
Available Potassium	125	2-
Available Magnesium	47.1	1

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	22.3	Arable	200
		Grassland	330
Total Zinc	59.6	Arable	300
		Grassland	300
Total Nickel	27.4	Arable	110
		Grassland	180
Total Cadmium	0.49	Arable	3
		Grassland	3
Total Lead	31.6	Arable	300
		Grassland	300
Total Chromium	37.0	Arable	400
		Grassland	600
Total Mercury	0.21	Arable	1
		Grassland	1.5

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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 16

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ABERGAVENNY
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

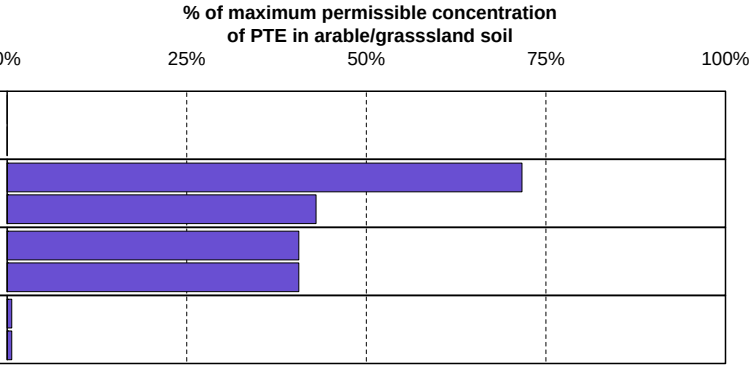
Laboratory References

Report Number	66768
Sample Number	623568

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	2.15	Arable	3
		Grassland	5
Total Arsenic	20.3	Arable	50
		Grassland	50
Fluoride	3.2	Arable	500
		Grassland	500



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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 16

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66768
Sample Number	623568

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2275
Organic Matter LOI	% w/w	8.4
Total Nitrogen	% w/w	0.382
Total Phosphorus	mg/kg	869
Total Potassium	mg/kg	1529
Total Magnesium	mg/kg	1974
Total Calcium	mg/kg	72259
Total Sodium	mg/kg	215
Total Carbon	% w/w	6.47
Total Sulphur	mg/kg	3895

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 17

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GREEN TREE HOUSE

SOIL

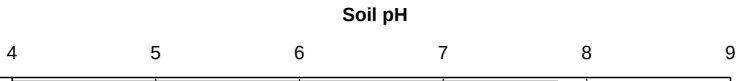
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66769
Sample Number	623569

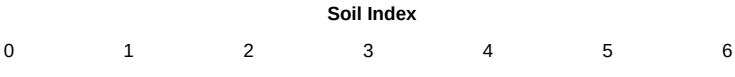
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



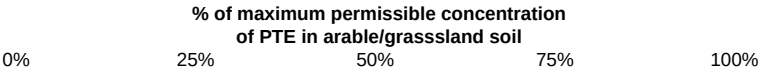
Determinand	Result
Soil pH	7.8

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	19.0	2
Available Potassium	140	2-
Available Magnesium	60.8	2

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	23.4	Arable	200
		Grassland	330
Total Zinc	69.0	Arable	300
		Grassland	300
Total Nickel	30.6	Arable	110
		Grassland	180
Total Cadmium	0.61	Arable	3
		Grassland	3
Total Lead	30.9	Arable	300
		Grassland	300
Total Chromium	45.2	Arable	400
		Grassland	600
Total Mercury	<0.2	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

(2) Concentration of Potentially Toxic Elements (PTE, commonly referred to as 'heavy metals') are in mg/kg dry soil. The maximum and the percentage of this maximum permissible concentration of PTE in soil are derived from the values in Defra's Code of Practice for Agricultural Use of Sewage Sludge (England & Wales) 1996. If applying organic manures to this soil it is important to ensure the soil is managed with a pH no less than 5.0, and that the PTE maximum values are not exceeded following the application. For soil where the pH value is less than 5.2, a FACTS Qualified Adviser should be consulted. Further details are provided in the Sludge Code.

Released by ..... *Daniel Petty* ..... Date ..... *02/05/23* .....

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 17

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

W184

Please quote above code for all enquiries

JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

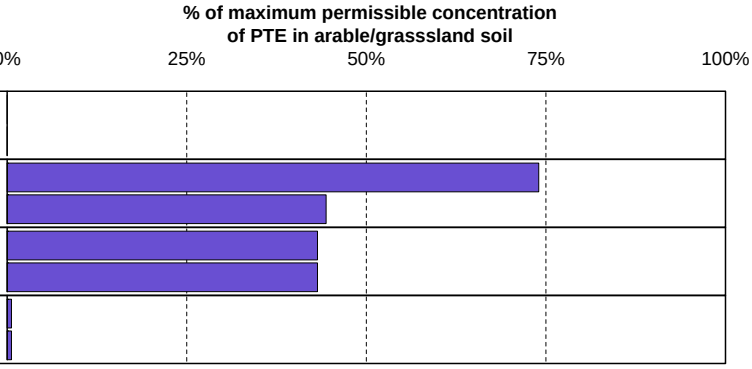
Laboratory References

Report Number	66769
Sample Number	623569

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	2.22	Arable	3
		Grassland	5
Total Arsenic	21.6	Arable	50
		Grassland	50
Fluoride	3.0	Arable	500
		Grassland	500



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(2) Concentration of Potentially Toxic Elements (PTE, commonly referred to as 'heavy metals') are in mg/kg dry soil. The maximum and the percentage of this maximum permissible concentration of PTE in soil are derived from the values in Defra's Code of Practice for Agricultural Use of Sewage Sludge (England & Wales) 1996. If applying organic manures to this soil it is important to ensure the soil is managed with a pH no less than 5.0, and that the PTE maximum values are not exceeded following the application. For soil where the pH value is less than 5.2, a FACTS Qualified Adviser should be consulted. Further details are provided in the Sludge Code.

Released by *Daniel Petty* Date *02/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 17

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GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66769
Sample Number	623569

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2270
Organic Matter LOI	% w/w	8.6
Total Nitrogen	% w/w	0.366
Total Phosphorus	mg/kg	983
Total Potassium	mg/kg	1787
Total Magnesium	mg/kg	2456
Total Calcium	mg/kg	60733
Total Sodium	mg/kg	192
Total Carbon	% w/w	5.93
Total Sulphur	mg/kg	3561

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 18

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ABERGAVENNY
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

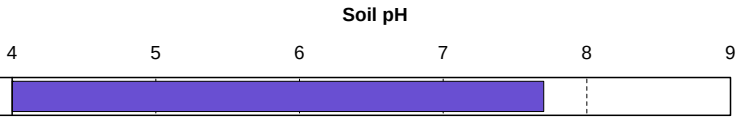
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66769
Sample Number	623570

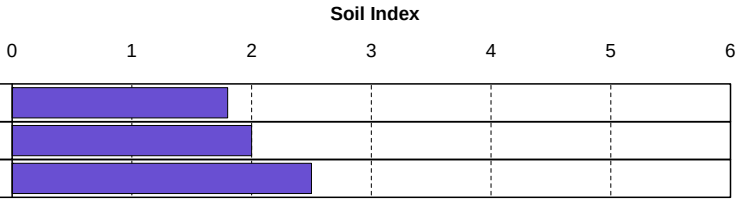
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



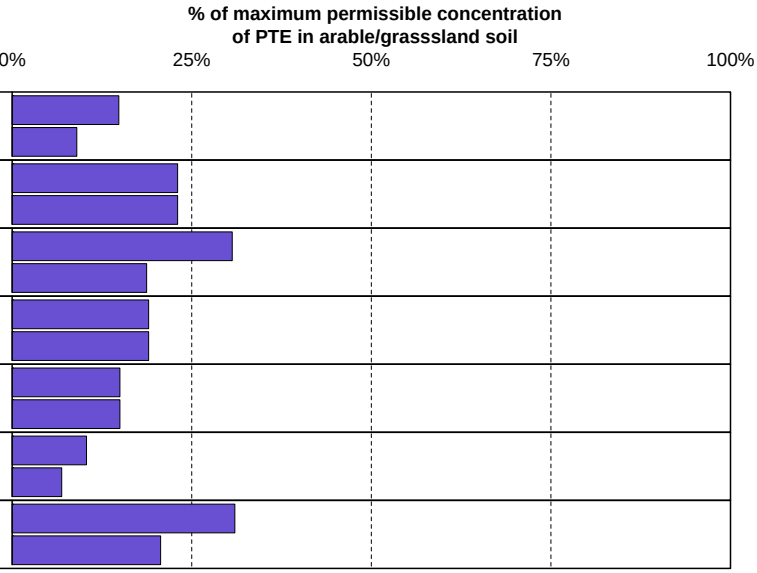
Determinand	Result
Soil pH	7.7

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	15.4	1
Available Potassium	123	2-
Available Magnesium	80.3	2

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	29.7	Arable	200
		Grassland	330
Total Zinc	69.1	Arable	300
		Grassland	300
Total Nickel	33.7	Arable	110
		Grassland	180
Total Cadmium	0.57	Arable	3
		Grassland	3
Total Lead	45.0	Arable	300
		Grassland	300
Total Chromium	41.4	Arable	400
		Grassland	600
Total Mercury	0.31	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

(2) Concentration of Potentially Toxic Elements (PTE, commonly referred to as 'heavy metals') are in mg/kg dry soil. The maximum and the percentage of this maximum permissible concentration of PTE in soil are derived from the values in Defra's Code of Practice for Agricultural Use of Sewage Sludge (England & Wales) 1996. If applying organic manures to this soil it is important to ensure the soil is managed with a pH no less than 5.0, and that the PTE maximum values are not exceeded following the application. For soil where the pH value is less than 5.2, a FACTS Qualified Adviser should be consulted. Further details are provided in the Sludge Code.

Released by *Daniel Petty* Date *02/05/23*

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NRM, Coopers Bridge, Braziers Lane, Bracknell, Berkshire RG42 6NS

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 18

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
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NP7 9HA

W184

Please quote above code for all enquiries

JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

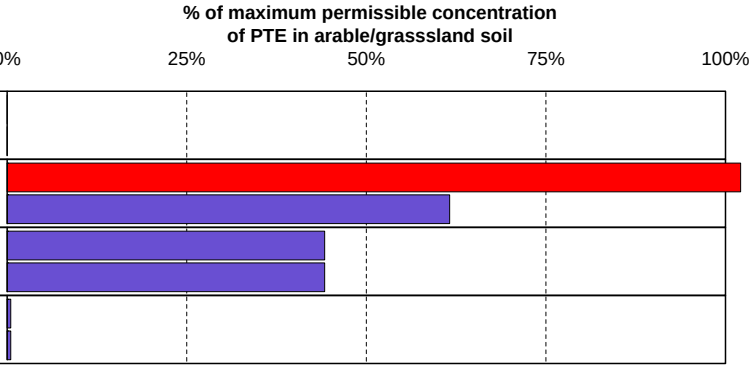
Laboratory References

Report Number	66769
Sample Number	623570

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	3.08	Arable	3
		Grassland	5
Total Arsenic	22.1	Arable	50
		Grassland	50
Fluoride	2.5	Arable	500
		Grassland	500



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Released by *Daniel Petty* Date *02/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 18

HYDROGEO LTD
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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66769
Sample Number	623570

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2339
Organic Matter LOI	% w/w	14.4
Total Nitrogen	% w/w	0.602
Total Phosphorus	mg/kg	840
Total Potassium	mg/kg	1791
Total Magnesium	mg/kg	2462
Total Calcium	mg/kg	70175
Total Sodium	mg/kg	238
Total Carbon	% w/w	10.3
Total Sulphur	mg/kg	5405

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 19

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LLANOVER BUSINESS CENTRE
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ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

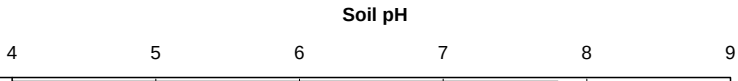
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66770
Sample Number	623571

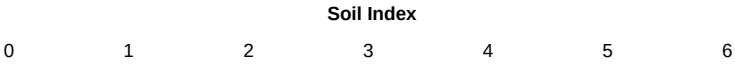
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



Determinand	Result
Soil pH	7.8

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	21.0	2
Available Potassium	143	2-
Available Magnesium	78.2	2

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Copper	31.5	Arable	200
		Grassland	330
Total Zinc	87.5	Arable	300
		Grassland	300
Total Nickel	40.6	Arable	110
		Grassland	180
Total Cadmium	0.66	Arable	3
		Grassland	3
Total Lead	40.0	Arable	300
		Grassland	300
Total Chromium	49.4	Arable	400
		Grassland	600
Total Mercury	0.21	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

(2) Concentration of Potentially Toxic Elements (PTE, commonly referred to as 'heavy metals') are in mg/kg dry soil. The maximum and the percentage of this maximum permissible concentration of PTE in soil are derived from the values in Defra's Code of Practice for Agricultural Use of Sewage Sludge (England & Wales) 1996. If applying organic manures to this soil it is important to ensure the soil is managed with a pH no less than 5.0, and that the PTE maximum values are not exceeded following the application. For soil where the pH value is less than 5.2, a FACTS Qualified Adviser should be consulted. Further details are provided in the Sludge Code.

Released by ..... *Daniel Petty* ..... Date ..... *02/05/23* .....

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 19

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

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Please quote above code for all enquiries

JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

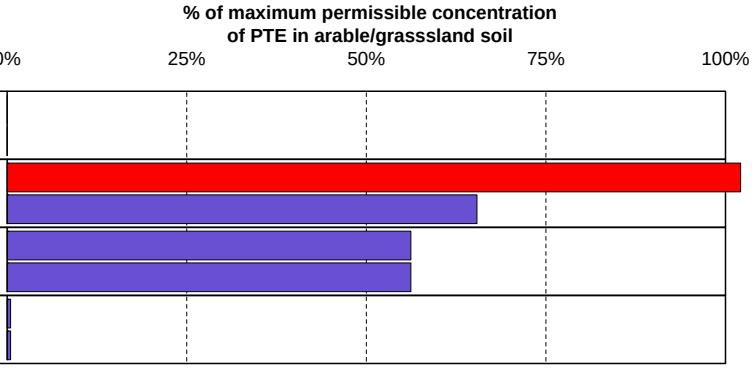
Laboratory References

Report Number	66770
Sample Number	623571

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	3.27	Arable	3
		Grassland	5
Total Arsenic	28.1	Arable	50
		Grassland	50
Fluoride	2.4	Arable	500
		Grassland	500



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Released by *Daniel Petty* Date *02/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 19

HYDROGEO LTD
UNIT 4 WADDINGTON HOUSE
LLANOVER BUSINESS CENTRE
LLANOVER
ABERGAVENNY
NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66770
Sample Number	623571

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2267
Organic Matter LOI	% w/w	12.0
Total Nitrogen	% w/w	0.488
Total Phosphorus	mg/kg	1074
Total Potassium	mg/kg	2192
Total Magnesium	mg/kg	3071
Total Calcium	mg/kg	70782
Total Sodium	mg/kg	228
Total Carbon	% w/w	7.82
Total Sulphur	mg/kg	3159

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 20

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NP7 9HA

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

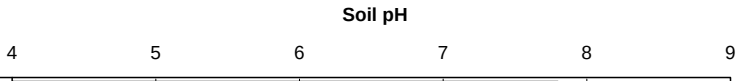
Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66770
Sample Number	623572

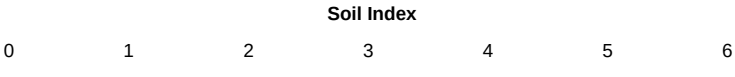
ANALYTICAL RESULTS *on 'dry matter' basis.*

pH (1)



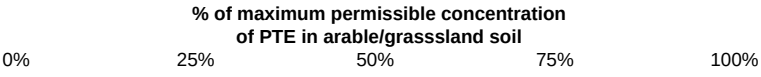
Determinand	Result
Soil pH	7.8

Soil Nutrients (1)



Determinand	Result mg/litre	Soil Index
Available Phosphorus	21.0	2
Available Potassium	182	2+
Available Magnesium	97.3	2

Potentially Toxic Elements (2)



Determinand	Result mg/kg		Maximum mg/kg
Total Copper	33.9	Arable	200
		Grassland	330
Total Zinc	101	Arable	300
		Grassland	300
Total Nickel	43.3	Arable	110
		Grassland	180
Total Cadmium	0.69	Arable	3
		Grassland	3
Total Lead	43.7	Arable	300
		Grassland	300
Total Chromium	58.5	Arable	400
		Grassland	600
Total Mercury	0.20	Arable	1
		Grassland	1.5

(1) Recommendations for liming and fertiliser should be obtained from Defra's Fertiliser Manual (RB209). The analytical methods used are as described in Defra's RB427.

(2) Concentration of Potentially Toxic Elements (PTE, commonly referred to as 'heavy metals') are in mg/kg dry soil. The maximum and the percentage of this maximum permissible concentration of PTE in soil are derived from the values in Defra's Code of Practice for Agricultural Use of Sewage Sludge (England & Wales) 1996. If applying organic manures to this soil it is important to ensure the soil is managed with a pH no less than 5.0, and that the PTE maximum values are not exceeded following the application. For soil where the pH value is less than 5.2, a FACTS Qualified Adviser should be consulted. Further details are provided in the Sludge Code.

Released by *Daniel Petty* Date *02/05/23*

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SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 20

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JOHNS ASSOCIATES LTD
GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

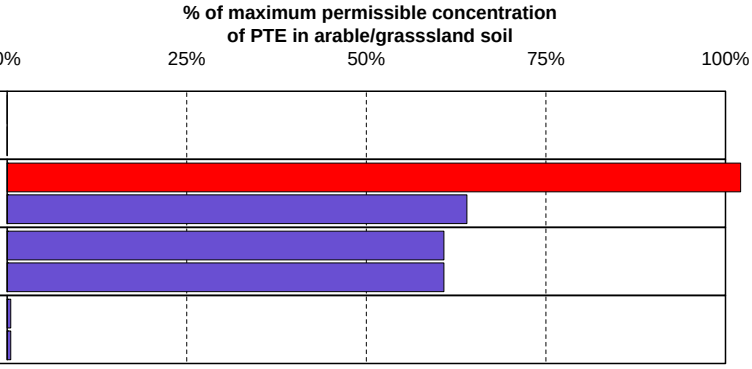
Laboratory References

Report Number	66770
Sample Number	623572

ANALYTICAL RESULTS *on 'dry matter' basis.*

Potentially Toxic Elements (2)

Determinand	Result mg/kg		Maximum mg/kg
Total Molybdenum	<1	Arable	4
		Grassland	4
Total Selenium	3.20	Arable	3
		Grassland	5
Total Arsenic	30.4	Arable	50
		Grassland	50
Fluoride	2.5	Arable	500
		Grassland	500



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Released by *Daniel Petty* Date *02/05/23*

SOIL CHEMICAL ANALYSIS REPORT FOR FIELD - BROADWATERLAKE 20

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GREEN TREE HOUSE

SOIL

Date Received	11-APR-2023
Date Reported	02-MAY-2023

Laboratory References

Report Number	66770
Sample Number	623572

ANALYTICAL RESULTS *on 'dry matter' basis.*

Determinand	Units	Result
Conductivity Sat CaSO4	uS/cm	2328
Organic Matter LOI	% w/w	10.0
Total Nitrogen	% w/w	0.377
Total Phosphorus	mg/kg	1222
Total Potassium	mg/kg	2590
Total Magnesium	mg/kg	3520
Total Calcium	mg/kg	60303
Total Sodium	mg/kg	265
Total Carbon	% w/w	5.74
Total Sulphur	mg/kg	1756

Appendix B

Broadwater Lake Sediment Screening Results (Electronic)

Determinants	Units	Broadwater Lake 1	Broadwater Lake 2	Broadwater Lake 3	Broadwater Lake 4	Broadwater Lake 5
pH	pH units	8	7	8.1	8.3	8.1
Phosphorus	mg/l	22.4	30.8	18.8	21.8	20.2
Potassium	mg/l	170	247	122	72	111
Magnesium	mg/l	70	97	47	38	77
Copper	mg/kg	23	29.9	18.5	16.2	20.5
Zinc	mg/kg	77.4	104	64.9	57.6	64.5
Nickel	mg/kg	37.6	38.7	29.7	26.1	32.4
Cadmium	mg/kg	0.52	0.65	0.37	0.32	0.47
Lead	mg/kg	29.6	39.2	21.2	16.1	26
Chromium	mg/kg	21.6	56.3	37.8	31.3	40.8
Mercury	mg/kg	<0.2	<0.2	<0.2	<0.2	<0.2
Molybdenum	mg/kg	<1	<1	<1	<1	<1
Selenium	mg/kg	3.69	2.81	1.96	1.55	1.95
Arsenic	mg/kg	15.4	26	17.7	23.9	19.3
Fluoride	mg/kg	68.4	3.3	3.8	5.1	4.2
Conductivity	uS/cm	2248	2147	2090	2144	2169
Organic Matter	% w/w	4.6	6.8	3.3	2.5	4.9
Total Nitrogen	% w/w	0.127	0.219	0.097	0.071	0.155
Total phosphorus	mg/kg	999	1435	902	815	891
Total Potassium	mg/kg	1778	2371	1623	1435	1761
Total Magnesium	mg/kg	2434	3277	2168	1944	2311
Total Calcium	mg/kg	39913	82839	91670	74280	62983
Stotal Sodium	mg/kg	174	230	173	147	175
Total Carbon	% w/w	2.71	4.34	3.6	3.28	3.93
Total Sulphur	mg/kg	2003	2044	1161	562	1633

All lab results have been screened against the following criteria:

Suitable 4 Use Levels (S4ULs) – Human health screening criteria produced using the CLEA model, used to assess the risk posed to human health by the depos

Environment Agency Ecological Soils Screening Values (SSVs) – Produced by the EA in 2017, the SSVs are used for screening waste and waste derived materia

Sewage Sludge on Farmland – Potentially Toxic Elements (PTEs) – the sediment has also been screened using the same values which are applied to sewage s

Exceedance of Suitable 4 Use Levels (S4ULs) - Residential - Without Produce

Exceedance of Environment Agency Ecological Soils Screening Values (SSVs)

Exceedance of potentially Toxic Elements (PTE) - Sewage sludge on farmland

Broadwater Lake 6	Broadwater Lake 7	Broadwater Lake 8	Broadwater Lake 9	Broadwater Lake 10	Broadwater Lake 11	Broadwater Lake 12
8	8	8	8	7.9	7.8	7.9
14.8	16.4	31.8	16.4	41.6	12.4	10.6
77	82	111	86	136	64	106
42	41	55	46	52	33	45
17.7	20.4	23.9	20.7	24.8	26.5	30.3
54.2	63.2	85.7	60.7	95.3	57.5	55.9
31.1	34	34.5	26.5	37.5	25.6	22.8
0.48	0.61	0.7	0.47	0.51	0.49	0.42
21.1	23.8	25.5	20.4	26.6	52.9	71.6
32.9	37.5	42.9	35.5	56.4	28.4	28
<0.2	<0.2	<0.2	<0.2	<0.2	0.37	0.52
<1	<1	<1	<1	<1	<1	<1
1.62	1.64	1.56	1.56	1.98	1.84	1.59
12.8	18	39.7	18.8	26.4	17.9	11.6
5.7	4	3.9	69.8	5.3	49.3	56.5
2186	2177	2132	2173	2241	2183	2167
4.6	5.2	3.8	5.8	4.1	8.6	7.9
0.157	0.184	0.116	0.186	0.144	0.295	0.304
761	851	1289	753	1499	730	573
1513	1786	1882	1606	2521	1120	1138
1996	2219	2367	2148	3263	1636	2016
71156	71128	62089	34813	50962	35370	29251
152	175	182	156	174	129	143
4.06	4.36	3.11	3.53	2.75	4.82	4.27
1981	2429	1354	1344	2367	2056	1121

ited sediment. These values determine the suitability of materials kept as bank-side retention. 'Residential – Without produce' values have been selected as they provide the
als 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
ludge spreading on agricultural land.

Broadwater Lake 13	Broadwater Lake 14	Broadwater Lake 15	Broadwater Lake 16	Broadwater Lake 17	Broadwater Lake 18
7.8	7.8	7.9	7.8	7.8	7.7
18.2	22.6	18.2	18.4	19	15.4
147	173	108	125	140	123
53	72	46	47	61	680
30.1	33.1	20.4	22.3	23.4	29.7
80.7	89.9	59.3	59.6	69	69.1
38.6	39.2	27	27.4	30.6	33.7
0.72	0.73	0.48	0.49	0.61	0.57
45.2	56.6	31.4	31.6	30.9	45
52.1	55.2	42	37	45.2	41.4
0.27	0.36	<0.2	0.21	<0.2	0.31
<1	<1	<1	<1	<1	<1
2.47	2.63	1.91	2.15	2.22	3.08
24.8	26.6	19.1	20.3	21.6	22.1
3	3	9.2	3.2	3	2.5
2265	2295	2248	2275	2270	2339
8.4	10.3	6.8	8.4	8.6	14.4
0.311	0.359	0.296	0.382	0.366	0.602
1252	1355	921	869	983	840
1913	2214	1407	1529	1787	1791
2451	2679	1720	1974	2456	2462
65755	66043	46636	72259	60733	70175
218	227	154	215	192	238
5.8	6.23	4.2	6.47	5.93	10.3
2546	3445	2607	3895	3561	5405

most conservative screening criteria.

of the materials for agricultural spreading, taking into account background concentrations which have been sourced from the NSIV survey.

Broadwater Lake 19	Broadwater Lake 20
7.8	7.8
21	21
143	182
78	97
31.5	33.9
87.5	101
40.6	43.3
0.66	0.69
40	43.7
49.4	58.5
0.21	0.2
<1	<1
3.27	3.2
28.1	30.4
2.4	2.5
2267	2328
12	10
0.488	0.377
1074	1222
2192	2590
3071	3520
70782	60303
228	265
7.82	5.74
3159	1756

GENERIC ASSESSMENT CRITERIA (GAC) FOR HUMAN HEALTH
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HYDROGEO Groundwater and Environment

Compound	SGV (EA) mg/kg	S4UL (LQM/CIEH 2014) mg/kg			C4SL Phase 1 (DEFRA) mg/kg	C4SL Phase 2 (CLAIRE) mg/kg		
		1% SOM	2.5% SOM	6% SOM		1% SOM	2.5% SOM	6% SOM
Metals								
Inorganic Arsenic	32	40	40	40	40			
Beryllium	-	1.7	1.7	1.7	-			
Boron	-	11000	11000	11000	-			
Cadmium	10	85	85	85	150			
Chromium III	-	910	910	910	-			
Chromium VI	-	6	6	6	21			
Copper	-	7100	7100	7100	-			
Elemental Mercury - Hg4	1	1.2	1.2	1.2	-			
Inorganic Mercury - Hg2+	170	56	56	56	-			
Methyl Mercury - Hg+4	11	15	15	15	-			
Nickel	130	180	180	180	-			
Selenium	350	430	430	430	-			
Vanadium	-	1200	1200	1200	-			
Zinc	-	40000	40000	40000	-			
Lead	-	-	-	-	310			
Total Petroleum Hydrocarbons (TPH)								
BTEX								
Benzene	0.33	0.38	0.7	1.4	3.3			
Toluene	610	880	1900	3900	-			
Ethylbenzene	350	83	190	440	-			
O-Xylene	250	88	210	480	-			
M-Xylene	240	82	190	450	-			
P-Xylene	230	79	180	430	-			
Aliphatics								
Aliphatics >C5-C6	-	42	78	160	-			
Aliphatics >C6-C8	-	100	230	530	-			
Aliphatics >C8-C10	-	27	65	150	-			
Aliphatics >C10-C12	-	130	330	770	-			
Aliphatics >C12-C16	-	1100	2400	4400	-			
Aliphatics >C16-C35	-	65000	92000	110000	-			
Aliphatics >C35-C44	-	65000	92000	110000	-			
Aromatics								
Aromatics >EC5-EC7	-	370	690	1400	-			
Aromatics >EC7-EC8	-	860	1800	3900	-			
Aromatics >EC8-EC10	-	47	110	270	-			
Aromatics >EC10-EC12	-	250	590	1200	-			
Aromatics >EC12-EC16	-	1800	2300	2500	-			
Aromatics >EC16-EC21	-	1900	1900	1900	-			
Aromatics >EC21-EC35	-	1900	1900	1900	-			
Aromatics >EC35-EC44	-	1900	1900	1900	-			
Aliphatics + Aromatics EC >44-70	-	1900	1900	1900	-			
Poly Aromatic Hydrocarbons (PAH)								
Acenaphthene	-	3000	4700	6000	-			
Acenaphthylene	-	2900	4600	6000	-			
Anthracene	-	31000	35000	37000	-			
Benz(a)anthracene	-	11	14	15	-			
Benzo(a)pyrene	-	3.2	3.2	3.2	5.3			
Benzo(b)fluoranthene	-	3.9	4	4	-			
Benzo(ghi)perylene	-	360	360	360	-			
Benzo(k)fluoranthene	-	110	110	110	-			
Chrysene	-	30	31	32	-			
Dibenzo(ah)athracene	-	0.31	0.32	0.32	-			
Fluoranthene	-	1500	1600	1600	-			
Fluorene	-	2800	3800	4500	-			
Indeno (1,2,3-cd) pyrene	-	45	46	46	-			
Naphthalene	-	2.3	5.6	13	-			
Phenanthrene	-	1300	1500	1500	-			
Pyrene	-	3700	3800	3800	-			

Coal Tar (Bap as surrogate marker)	-	1.2	1.2	1.2	-			
Chloroalkanes and Alkenes								
1,2 - Dichloroethane	-	0.0092	0.013	0.023	-	0.16	0.24	0.41
1,1,1 - Trichloroethane	-	9	18	40	-			
1,1,2,2 - Tetrachloroethane	-	3.9	8	17	-			
1,1,1,2 - Tetrachloroethane	-	1.5	3.5	8.2	-			
Tetrachloroethene (PCE)	-	0.18	0.4	0.92	-	0.32	0.71	1.6
Tetrachlormethane	-	0.026	0.056	0.13	-			
Trichloroethene (TCE)	-	0.017	0.036	0.08	-	0.0097	0.020	0.045
Trichloromethane (Chloroform)	-	1.2	2.1	4.2	-			
Chloroethene (vinyl Chloride)	-	0.00077	0.001	0.0015	-	0.015	0.019	0.029
Explosives								
2,4,6 - Trinitrotoluene	-	65	66	66	-			
HMX	-	6700	6700	6700	-			
RDX	-	13000	13000	13000	-			
Pesticides								
Aldrin	-	7.3	7.4	7.5	-			
Dieldrin	-	7	7.3	7.4	-			
Atrazine	-	610	620	620	-			
Dichlorvos	-	6.4	6.5	6.6	-			
Alpha-Endosulfan	-	160	280	410	-			
Alpha-Hexachlorocyclohexanes	-	6.9	9.2	11	-			
Beta-Hexachlorocyclohexanes	-	3.7	3.8	3.8	-			
Gamma-Hexachlorocyclohexanes	-	2.9	3.3	3.5	-			
Chlorobenzenes								
Chlorobenzene	-	0.46	1	2.4	-			
1,2-Dichlorobenzene	-	24	57	130	-			
1,3-Dichlorobenzene	-	0.44	1.1	2.5	-			
1,4-Dichlorobenzene	-	61	150	350	-			
1,2,3-Trichlorobenzene	-	1.5	3.6	8.6	-			
1,2,4-Trichlorobenzene		2.6	6.4	15	-			
1,3,5-Trichlorobenzene	-	0.33	0.81	1.9	-			
1,2,3,4-Tetrachlorobenzene	-	24	56	120	-			
1,2,3,5-Tetrachlorobenzene	-	0.75	1.9	4.3	-			
1,2,4,5-Tetrachlorobenzene	-	0.73	1.7	3.5	-			
Pentachlorobenzene	-	19	30	38	-			
Hexachlorobenzene	-	4.1	5.7	6.7	-			
Phenol And Chlorophenols								
Phenol	420	750	1300	2300	-			
Chlorophenols	-	94	150	210	-			
Pentachlorophenol	-	27	29	31	-			
Other								
Carbon Disulhide	-	0.14	0.29	0.62	-			
Hexachloro-1,3-butadiene	-	0.32	0.78	1.8	-			

Table 4.1 SSVs for common trace elements and persistent organic pollutants

Substance	SSV (mg per kg DW)	Added risk	Site-specific adjustment	Driver
Trace elements				
Antimony	37	No	No	Direct toxicity
Cadmium	0.6	No	No	Direct toxicity
Cobalt	4.2	No	Yes	Direct toxicity
Copper	35.1	No	Yes	Direct toxicity
Molybdenum	5.1	No	Yes	Direct toxicity
Nickel	28.2	No	Yes	Direct toxicity
Silver	0.3	No	Yes	Direct toxicity
Vanadium	2.0	Yes	No	Direct toxicity
Zinc	35.6	Yes	Yes	Direct toxicity
Organic pollutants				
Benzo[a]pyrene	0.15	No	Yes	Direct toxicity
Bis(2-ethylhexyl) phthalate	13	No	No	Direct toxicity
Hexachlorobenzene	0.002	No	Yes	Secondary poisoning
Pentachlorophenol	0.6	No	Yes	Direct toxicity
Perfluorooctanoic acid	0.019	No	No	Secondary poisoning
Perfluorooctane sulfonate	0.013	No	No	Secondary poisoning
Polychlorinated alkanes (medium chain)	2.2	No	Yes	Secondary poisoning
Triclosan	0.13	No	Yes	Direct toxicity
Tris(2-chloroethyl) phosphate	1.1	No	Yes	Direct toxicity
Tris(2-chloro-1-methylethyl) phosphate	1.8	No	Yes	Direct toxicity

Appendix C

Broadwater Lake Sediment Sampling Locations

Broadwater Lake. Overlying lake bed soft sediment sampling locations 20th March 2023

Appendix C

Broadwater Lake Sediment Sampling Locations

Broadwater Lake. Overlying lake bed soft sediment sampling locations 20th March 2023