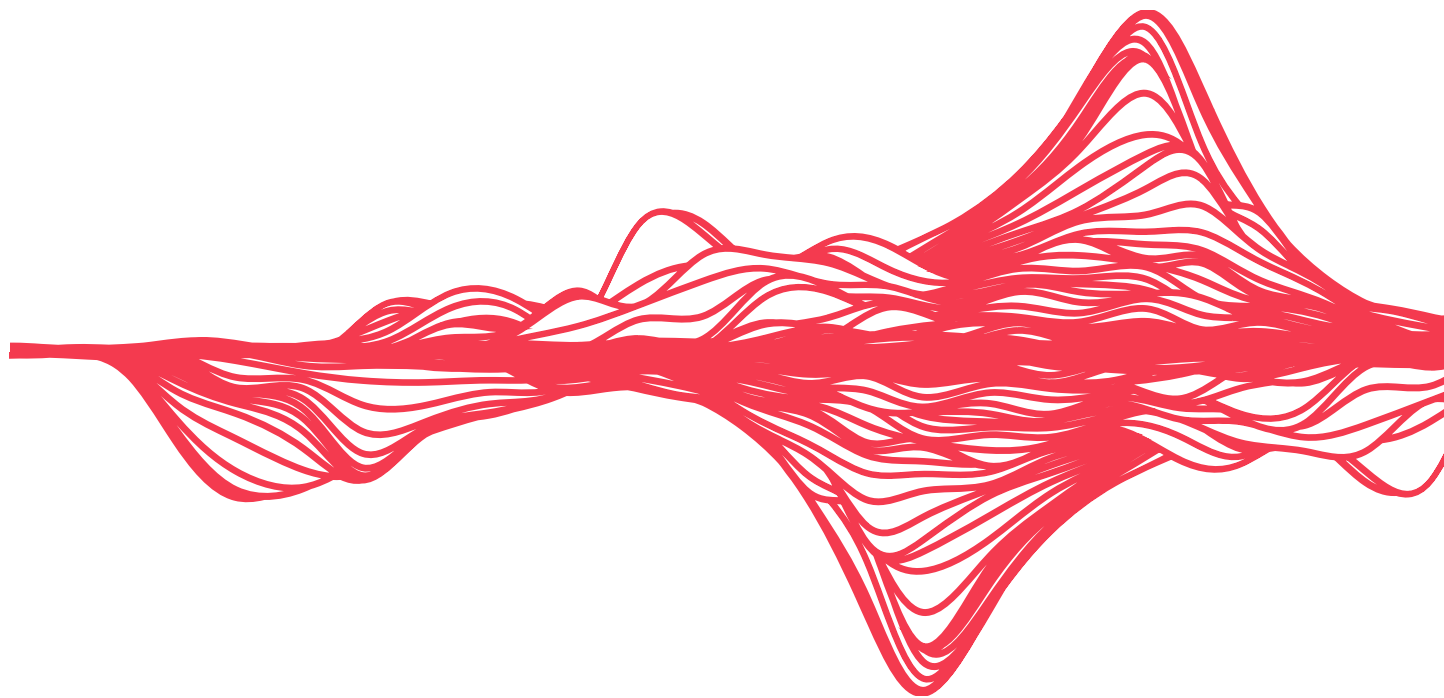


CADENT GAS LIMITED

Outline Remediation Strategy

Brick Kiln Street, Hinckley

Document no. Rev 0: 415001-00017_00402_Rev 0



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1. Introduction

Worley Consulting has been appointed by Cadent Gas Limited (Cadent) to prepare a Remediation Options Appraisal and Outline Strategy for Brick Kiln Street, Hinckley, LE10 0NA (the 'Site') in support of their Outline planning application (reference: 24/00610/OUT). The application relates to the proposed erection of 195 dwellings with private gardens and areas of public open space. The site location is shown on Figure 1.

The assessment has been undertaken in general accordance with the processes and procedures for investigating and assessing land contamination, as outlined in Land Contamination: Risk Management (LCRM), published by the Environment Agency (updated 2025); and other relevant industry best practice.

1.1 Background

Cadent is seeking outline planning consent for the future residential development of the former gas works site. Following completion of an initial Phase 1 assessment and consultation, Hinckley and Bosworth Council Pollution Officer and the Environment Agency advised that the planning submission should be supported by completion of a Phase 2 site investigation, Detailed Quantitative Risk Assessment (DQRA) and an Outline Remediation Strategy for the site. The Phase 2 was completed between March and June 2025, with the DQRA prepared in June and July 2025.

This outline strategy document draws on the information obtained as part of these works and, as such, the document should be read with reference to the following reports:

- Worley Consulting, December 2024, Phase 1 Desk Study – Brick Kiln Street, Hinckley, 41500-00017_004: Rev A;
- Worley Consulting, May 2025, Environmental Assessment - Phase 2 Factual Site Investigation – Brick Kiln Street, Hinckley, 41500-00017_00401: Rev A;
- Worley Consulting, June 2025, Environmental Assessment - Interpretative Phase 2 Site Investigation – Brick Kiln Street, Hinckley, 41500-00017_00401_I: Rev A; and
- Worley Consulting, July 2025, Controlled Waters Detailed Quantitative Risk Assessment – Brick Kiln Street, Hinckley, 41500-00017_00402_DQRA_Draft.

The site comprises three separate land parcel areas as detailed below and shown on Figures 2A and 2B:

- **Area A** (former car park in the north);
- **Area B** (majority of the site to the south of Area A); and
- **Area C** (smaller area of former car parking to the east).

The historical layout of the site and the previous site investigation locations are illustrated on Figure 3.

1.2 Report Objectives

The objectives of this Outline Strategy are to:

1. Provide the context for the anticipated risk mitigation works required to manage historical contamination sources at the site;
2. Provide an overview of the site conceptual model of risk based on the findings of the Phase 2 assessment and DQRA, and summarise the potentially significant contaminant linkages that will need to be addressed as part of site redevelopment;
3. Review possible risk mitigation approaches and remediation options that could be adopted to manage the identified potential risks;
4. Shortlist viable remediation options for the site based on the proposed site redevelopment;
5. Prepare an outline strategy based around the shortlisted options that should be considered by a future developer to render the site suitable for a residential development; and
6. Support the Outline Planning Application for development submitted by Cadent.

1.3 Limitations

This Outline Remediation Strategy has been written with the assumption that the site will be remediated to a residential end-use, as detailed in the Outline Planning Application. The conclusions within this report are based on the findings of the site investigations and the condition of the site at the time of writing.

The assessment of the ground conditions within this report is based upon the findings of the boreholes, window sampling or trial pitting that have been undertaken to interpret the ground conditions. Ground conditions, however, frequently vary between exploratory locations and no site investigation, however detailed, can inspect each and every section of a site and therefore changes in the physical and chemical nature of the ground cannot be discounted.

Intrusive works were constrained by a number of issues including widespread concrete floors and foundations of the former buildings and utility services.

The proposed development and site layout is currently in outline form. The implemented strategy will need to be aligned to a specific development plan. As such, refinement of the strategy, followed by detailed remediation/risk mitigation design will be required once a plan has been agreed. Likely additional works are detailed within this Outline Strategy.

2. Site Information

2.1 Site Description

Table 1 Site Description

Site Information	
Site Address	Cadent Gas, Brick Kiln Street, Hinckley, LE10 0NA
National Grid Reference	442126, 293683
Site Area	5.95 hectares (Ha)
Site Setting	The surrounding land uses are mixed commercial / industrial and residential.
Site Ownership	Cadent Gas Ltd.
Site Access	The site can be accessed through double palisade gates off Brick Kiln Street in the east of Area B. There is also vehicular site access through locked double gates via Trinity Vicarage Road (within the northeast of Area B). A pedestrian entrance to Area A was also noted in the western corner of Area A, via the neighbouring Gymnastics Centre.
Site Boundaries	The site boundary predominantly comprises 2m high metal palisade fencing in the south and west, and wooden fencing along the north and western boundaries. The boundary was assessed to be in good condition. The site is considered to be secure due to fencing and onsite security in the form of CCTV.
Adjoining / Nearby Land Use	Adjacent land uses in relation to the site comprise the following: • North and northeast: Residential properties and Park Play Area • Southeast: Lidl supermarket and associated car park, The Meeting Centre, and a vacant plot of land beyond this. A radio mast is present between Area B and C • South: Coventry Road, residential properties, and Granville Road Park • West: Clarendon Park, residential properties and Hinckley Gymnastics Club
Site Topography and Elevation	Two significant changes in topography falling to the north are present between Area B and A, and between Block 3 and Block 4, characterised by vegetated embankments. Area A is generally flat with an elevation of 108 m Above Ordnance Datum (m AOD), it is topographically lower than Area B which lies at an elevation of around 111 m AOD.

A hydraulic containment system was constructed by Biogenie (formerly Celtic) in 2009 to treat dissolved and free-phase contamination in groundwater at the south-western boundary of the site, and to mitigate off-site migration. The key components of the system are summarised below:

- Ten abstraction wells with a total maximum capacity of >30m³/hr coupled with pneumatic pumps;
- Eight groundwater re-injection borehole wells;
- Seven additional Dense Non-aqueous Phase Liquids (DNAPL) delineation/ recovery wells and nine DNAPL recovery pumps;
- Four groundwater elevation monitoring boreholes;
- An oil water separator, oil storage tank and aqueous granular activated carbon vessels;

- A groundwater aeration system; and,
- Semi-automatic control system with telemetry and fault detection.

The most recent progress report (Q4 2024) noted that approximately 1,578 kg calculated dissolved phase hydrocarbon mass, 12,184 kg DNAPL and 1,793 kg LNAPL product has been recovered via the hydraulic containment system since the start of the project. A significant proportion (78.3%) of the total mass recovered was attributable to DNAPL.

It is understood that the current system is operated under a Bespoke Waste License issued by the Environment Agency. The system also operates under an abstraction license which permits the reinjection of treated water to ground.

The system is currently operational and is reducing the off-site migration of NAPLs and dissolved phase contamination in the Wolston Sands and Gravels aquifer.

2.2 Summary of Ground Conditions

Reference should be made to the reports detailed in Section 1.1 for detailed information on the site setting, history, geology, hydrogeology and hydrology. A brief summary of ground conditions, as identified in the recent investigation is provided below.

2.2.1 Made Ground

Made ground was deepest within Area B (generally between 0.8 and 2.6 m bgl outside of structures). This was the area primarily occupied by the former gas works structures, and it is suspected that areas of the site were raised resulting in the significant level changes towards the north of Area B. Various former features, including historical infilled gasholder tanks, were encountered across Area B resulting in significantly deeper areas of made ground (up to 9.45 m bgl) and various obstructions extending into the underlying superficial deposits.

Within Area A, made ground was generally shallower, comprising sandy gravel to between 0.5 and 1 m bgl. No significant former features are considered to be present within Area A, however, the site was potentially used historically as a coke tip.

Within Area C, again, made ground was generally shallower, comprising slightly silty slightly gravelly sand and slightly silty slightly sandy gravel to between 0.4 and 1.4 m bgl.

2.2.2 Superficial Deposits

The superficial deposits appear to be variable across the site, in part due to the significant level changes, but also due to the variability presented by lowland glaciation deposits. Two retaining walls/banks are present within the north of Area B; one towards former Block 4 and one towards Area A.

The highest ground elevation within the site is to the east; Area C. Here, Oadby Till was encountered below the made ground. The Oadby Till Member comprised slightly sandy slightly gravelly clay and is classified as a Secondary Undifferentiated Aquifer, however due to its fine-grained nature, no groundwater flow is expected to occur and the till will likely act as a confining layer above the underlying sands.

The Wolston Sand and Gravel Formation was encountered below the Oadby Member within Area C. The formation extends across Area B and the eastern edge of Area A, where it lies directly below the made ground in the centre and the south of the site, before extending below clay in the east of Area B.

The Wolston Sand and Gravel Member is classified as a Secondary A Aquifer, and monitoring visits recorded groundwater present within the strata across the site.

The Bosworth Clay Member, designated as unproductive strata, is recorded extending across the entire site and is present beneath the sands and gravels. In Area A, the clay is encountered directly below the made ground.

2.2.3 Bedrock

Bedrock was not encountered during any intrusive investigation at the site. The bedrock beneath the site is reported to comprise the Mercia Mudstone Formation which is described by the British Geological Survey (BGS) as 'red gypsiferous mudstone of the Triassic, with siltstone and sandstone bands, dipping gently to the southwest'

The Mercia Mudstone is classified as a Secondary B Aquifer.

2.2.4 Hydrology

The nearest surface water feature is the Battling Brook, which is located approximately 100 m north of the site and flows to the southwest.

Sketchley Brook is located approximately 700 m south of the site and flows to the southwest, similar to the Battling Brook.

2.2.5 Groundwater

It is inferred that groundwater flow is predominantly within the Wolston Sand and Gravels, with minimal flow within the other predominantly cohesive deposits. Based on the site geology and groundwater levels recorded within wells during monitoring visits, the following conclusions are currently drawn:

- **Area A** - Groundwater flow appears to reflect that of previous findings in that it is generally north-westerly. Groundwater is likely to be contained within the sand and silt layers of the Bosworth Clay deposits, with some perched flow within the made ground. Drainage systems installed within Area A are also likely to capture groundwater.
- **Area B** - Groundwater flow within is likely to be towards the west, potentially becoming southwest in the south of Area B and northwest in the north of Area B. Groundwater flow is predominantly contained within the Wolston Sand and Gravels, though groundwater has been recorded within the variable Oadby Member located overlying the Wolston Sand in the centre of the site, where it may flow through more granular layers. Groundwater is shallow in the north of the site, towards the spring line, and whilst some groundwater may be reaching Area C, it is believed a large part is influenced by drainage systems towards the north.

Towards the west, the groundwater flows off-site to the neighbouring residential development. A hydraulic containment system is currently operating to reduce flow of NAPL offsite and treat dissolved phase; the operation of which may locally influence the groundwater regime.

- **Area C** - Oadby Till was encountered below the made ground in the east of the area and is classified a Secondary Undifferentiated Aquifer, however due to its fine-grained cohesive nature, no significant groundwater flow is expected to occur and the till will likely act as a confining layer above the underlying sands. Groundwater was encountered within the underlying Wolston Sand and Gravels.
- **Off-site** - Whilst flow may be west, south-west towards the Sketchley Brook, the Wolston Sand and Gravels do not appear to be laterally continuous, with the unit thinning to the south-west and disappearing before reaching the brook. This suggests that groundwater within the sands is unlikely to flow directly into the brook via groundwater flow; however, there is the potential for entry via drainage and streams that drain the unit.

Given the complex groundwater regime, Area A is considered to have a different groundwater conceptual model to Areas B and C.

Schematic cross sections produced for the Interpretative Phase 2 report are provided as Figure 4.

3. Conceptual Model of Risk

The inferred contamination sources, possible migration pathways and receptors are summarised in Sections 3.1 to 3.3. Plausible contaminant linkages that will likely require mitigation to render the site suitable for residential development are summarised in Section 3.4.

3.1 Contaminant Sources

The primary sources of contamination are located in Area B; the former gasworks process area. The main sources in this area are the former gas holder bases/tanks and surrounding soils which extend to depth into natural soils. Impacted soils and tar-related contamination are present in these areas. Tar-related contamination is also associated with other former structures, including the condensers, scrubbers, tanks, purifiers, etc.

The investigation suggests that the integrity of the gasholder tanks and former below ground features may have been compromised when placing the foundations of the former building blocks onsite, resulting in impact to surrounding soils.

Made Ground across the broader site contains elevated concentrations of hydrocarbons, sulphate, metals and other inorganic contaminants (eg total cyanide). Again, concentrations are highest in Area B, but hotspots and broader areas of impact are also noted in Made Ground in both Areas A and C.

Saturated soils containing NAPL and impacted shallow groundwater (NAPL and dissolved phase) across Area B are secondary sources of hydrocarbons. Free phase and high dissolved phase concentrations are currently being recovered from the hydraulic containment system along the southern-western boundary.

Dissolved phase concentrations recorded in water samples from wells installed in Area B are indicative of free phase being present in the surrounding soils. The ongoing recovery of NAPL from the containment system indicates the continued presence of a upgradient source of mobile free phase contamination.

There are inferred to be four broad source types which will have an impact on the applicability and viability of potential remediation techniques. These are summarised below and illustrated on Figure 5.

All Areas

- **Source type S1** -Inorganic contaminants (eg. metals, asbestos, sulphate, cyanide, etc.) and lower levels of organic impact in unsaturated shallow made ground, typically present in the upper 2 m of Areas A and C and outside of the primary source areas (S2 and S3) in Area B;

Area B

- **Source type S2** - Impacted made ground characterised by significant hydrocarbon impact; primarily tar, either as NAPL-impact or contamination of soils. The main sources are identified on Figure 5 as S2a – S2e. These soils are present within and outside of historical

structures and extend to depths of greater than 6 m at some locations. Made ground soils are saturated at depth. Other hotspots, historical structures and areas of contamination are also likely to be present between these key source areas. Contaminants of concern include naphthalene, benzene, toluene, ethylbenzene and xylenes (BTEX), ammoniacal nitrogen as N and NH₄, and TPH aromatic C10-C12 and C12-C16;

- **Source type S3** - Impacted natural saturated sands and gravels and groundwater characterised by mobile and residual phase NAPL, extending to depths of 9+ m. Given the complexity of the geology and presence of structures, it is difficult to currently fully delineate this source, but there are broadly inferred to be two key areas of impact (although these potentially overlap):
 - S3a - a shallower area of NAPL impact associated with S2c sources; and
 - S3b - a deeper zone of NAPL associated with the deeper holder/tank bases.
- **Source type S4** - Dissolved phase organic (eg. naphthalene, BTEX, etc.) contamination and ammoniacal nitrogen in groundwater in the sand and gravel aquifer (Area B). High concentrations of ammoniacal nitrogen have been recorded across Area B, which is particularly recalcitrant and more difficult to treat than organic hydrocarbons.

3.2 Pathways

The following plausible pathways have been identified.

Human Health

- Physical contact pathways such as direct contact, ingestion and inhalation of dusts and fibres;
- Vapour generation and migration through soils, into buildings with subsequent inhalation; and
- Diffusion through water mains and consumption

Controlled Waters

- Leakage of impacted perched/ contained water and/or NAPL from below-ground former gasworks structures to the soils and underlying aquifer;
- Leaching/dissolution from soil or NAPL and vertical migration into groundwater;
- Migration of NAPL into the underlying aquifer; and
- Migration of NAPL and/or dissolved phase contamination within shallow groundwater in the sands and gravels towards Sketchley Brook.

3.3 Receptors

The following receptors were identified following completion of the investigation and risk assessments (human health and controlled waters).

Human Health

- Users of residential houses with private gardens;
- Users of public open spaces;
- Off-site residential properties;

It is understood that some remediation of the land to the west was completed prior to residential development. However, groundwater from the Cadent site flows off-site and beneath the residential development. The hydraulic containment system is currently operating and reduces the flow of NAPL and dissolved phase off-site. It is also understood that some residential properties down-hydraulic gradient of Area B were fitted with vapour barriers. This receptor is not considered further in this report.

- Off-site commercial workers;
- Off-site public open space (park) users;

Controlled Waters

- **Sketchley Brook.** Although uncertain due to the currently active pumping system and local geology, groundwater flow in the south of the site may be towards the direction of the Sketchley Brook within the Wolston Sand and Gravels. The Wolston Sand and Gravels are not laterally continuous (the BGS mapping indicates that they disappear circa 400 m southwest of the site) and groundwater in the sands is unlikely to flow directly into the Brook; however, there is the potential for entry via drainage and streams that drain the unit.
- **Secondary A Aquifer.** Associated with the Wolston Sand and Gravels: Resource potential (abstraction for drinking water purposes and supplying surface waters). Whilst the overlying Oadby Formation may provide some protection from contaminants within the made ground, this is noted to contain sandy bands and hydrocarbon impact has been observed. Towards the south, the Wolston Sand and Gravel formation appears to directly underlie the made ground, forming a direct pathway for leaching of contaminants.
- **Abstractions.** The site is not located within a Source Protection Zone or in a drinking water safeguard zone for either groundwater or surface water (Defra, 2025). No potable groundwater abstractions were reported to exist within 500 m of the site (Landmark, 2024). Therefore, a current abstraction is not considered a potential receptor within the conceptual site model. However, the Wolston Sands and Gravels are classified as a Secondary A Aquifer, so should be treated as having the potential for use as a drinking water abstraction resource. Therefore, potential for future consumptive use of groundwater within the Wolston Sands and Gravels is considered to be a viable receptor.

3.4 Summary of Potentially Significant Contaminant Linkages

Contaminant linkages that are inferred to pose a potentially significant risk given the proposed future development are summarised in Table 3-1.

A schematic conceptual site model is provided as Figure 6.

Table 3-1: Potentially Significant Contaminant Linkages

Link No.	Source Contaminants	Pathways	Receptor
Human Health			
H1	S1 Areas A & C - General made ground (eg. arsenic and lead)	Physical contact pathways such as direct contact, ingestion and inhalation of dusts	Future site Users and off-site residents/public
H2		Vapour inhalation (Area A only) ¹	Future site Users
H3		Diffusion through water mains	
H4	S1 Areas B - General made ground (hydrocarbons, metals and cyanide)	Physical contact pathways such as direct contact, ingestion and inhalation of dusts. Diffusion through water mains.	Future site Users
H5		Vapour inhalation	Future site Users
H6		Diffusion through water mains	
H7	S1 Areas A, B & C - Asbestos Containing Materials (ACM) in soil	Ingestion and inhalation	Future site Users and off-site residents/public
H8	S2 Area B: Historical gas works structures containing hydrocarbons and other gas works-related contamination (see Section 3.1)	Physical contact pathways such as direct contact, ingestion and inhalation of dusts Diffusion through water mains.	Future site Users and off-site residents/public
H9		Vapour inhalation	
H10		Diffusion through water mains	Future site Users
H11	S3 & S4 Area B - NAPL and dissolved phase contaminants in shallow groundwater in sands and gravels	Vapour inhalation	Future site Users ³
H12			
Controlled Waters			
C1	S1 - General made ground, primarily Area B	Leaching/dissolution from soils or NAPL	Wolston Sands and Gravels
C2			Sketchley Brook
C3	S2 Area B: Historical gas works structures containing hydrocarbons and other gas works-related contamination	Leaching/dissolution from soil or NAPL	Wolston Sands and Gravels
C4		Leakage from structures	
C5		Migration of NAPL into groundwater	
C6		Migration of NAPL and/or dissolved phase contamination within shallow groundwater in the sands and gravels	Sketchley Brook
C7	S3 & S4 Area B - NAPL and dissolved phase contaminants in shallow groundwater in sands and gravels	Migration of NAPL and/or dissolved phase contamination within shallow groundwater in the sands and gravels	Wolston Sands and Gravels
C8			Sketchley Brook

Notes:

1. Associated with one vapour exceedance recorded in VW25-04
2. No asbestos currently detected in samples from Areas A and C, but present in Area B
3. Currently assumed risks to off-site residents mitigated by vapour barriers in buildings and the hydraulic containment system.

4. Risk Mitigation Options Appraisal

Potentially significant risks from onsite sources to future human health and controlled waters receptors have been identified at the site. Therefore, an evaluation of the feasible risk mitigation options has been undertaken to help determine the most appropriate risk mitigation strategy for the site.

4.1 Remediation Objectives

The primary objective of the options appraisal is to determine the likely optimal approach for managing potentially unacceptable risks to human health and controlled waters from identified onsite sources for a proposed residential development.

4.2 Methodology

In line with LCRM guidance, the following steps will be followed in the remediation options appraisal for the site:

- Step 1: Identify feasible remediation options.** The feasibility appraisal process considers various factors including; applicability and matrix properties, technical feasibility, site constraints, and contaminant properties.
- Step 2: Detailed evaluation of the feasible remediation options.** To determine which is the most suitable for addressing each of the identified relevant contaminant linkages. Evaluation criteria will be used to appraise each of the feasible remediation options. These criteria will assess the limitations, advantages and disadvantages of each option. Criteria include cost, timescales, practicability, effectiveness and durability.
- The process will establish which options are likely to be most suitable – either singularly or in combination.
- Step 3: Select/Shortlist final remediation options.** Selecting only one option may not be practical or sufficient, i.e. there may be more than one for different types of relevant contaminant linkage. The final option may be single, multiple or combined.

4.3 Constraints

Given the nature of the contamination and the site setting, there are a number of constraints that warrant consideration when undertaking an options appraisal for remediation of the identified sources. These are summarised in Table 4-1.

Table 4-1: Site Specific Remediation Constraints

Constraint	Discussion
Site setting	The site is located in a mixed residential and commercial setting. Remediation works have the potential to cause disturbance and nuisance issues such as dust and odours, vehicle movements, noise, etc. A large retaining wall forms the boundary in the south-western site area and there are other significant level changes across the site.
Geology / Hydrogeology / Hydrology	Key constraints to remediation relating to the site's ground conditions include: • Large areas of surface concrete and large foundations and in-ground structures; • Heterogeneity of made ground; • Shallow groundwater onsite and contained water within structures (eg. Gas holder tanks). • Heterogeneity of superficial deposits. Previous investigation findings determined there are two distinct units within the superficial deposits: granular sands and gravels overlying cohesive slightly gravelly clay deposits. • NAPL contamination in deeper units including mobile free product; • Deep soil and groundwater impact close to the site boundary, and • A number of spring lines have been identified to cross the site. It is understood that these are currently picked up by the drainage network.
Existing Systems	An operational hydraulic containment system is present in the south-western site area. This will need to be considered as part of any risk mitigation strategy for the site.
Offsite Sources	Contamination was present adjacent to the site along the south-western boundary. It is understood (from documents available on the council planning portal relating to the development) that areas along this boundary (off-site) were remediated prior to construction of the houses.
Utility services	Live services are present on-site

4.4 Identification of Feasible Risk Mitigation Options

The main approaches to reduce and/or control unacceptable risks include:

1. Removal and/or treatment of the contaminant source;
2. Isolation of the source and/or breaking or removal of the migration pathways; or,
3. Removal, protection or isolation of the receptor.

The potential remediation techniques have been classified as follows:

- **Civil Engineering Methods:** These seek to physically break the pathway or protect/isolate a receptor in a contaminant linkage thereby managing the risk e.g., cut-off walls, hydraulic barriers, cover systems, barrier pipe for water mains.
- **Biological Methods:** The elimination, attenuation or transformation of polluting or contaminating substances using biological processes e.g., bio-sparging, natural attenuation.
- **Chemical Methods:** The transformation, destruction or concentration of contaminants mediated by chemical reagents e.g., chemical oxidation.
- **Physical Methods:** Excavation, separation and /or concentration of contaminants by exploiting differences in physico-chemical properties of the contaminant and the

contaminated soil or groundwater e.g., off-site disposal, dual phase soil vapour extraction (SVE), air sparging and permeable reactive barriers (PRB)

- **Stabilisation and Solidification (S/S) Methods:** Mixing of a binding reagent into the contaminated media to prevent or limit (immobilize) release of contaminants e.g., hydraulic binders.
- **Thermal Processes:** Seek to destroy or concentrate contaminants by heating the soil or groundwater e.g., thermal desorption.

4.5 High Level Review of Risk Mitigation Options

In line with Environment Agency guidance, the identification of the most suitable remediation option(s) has been evaluated using a set of qualifying criteria. The criteria used for evaluating and selecting the best practicable technique for remediation of the identified sources are outlined in Table 4-2 below.

Table 4-2: Criteria for Best Practicable Technique for Remediation

Criteria	Factors considered
Effectiveness	Achievement of the standard of remediation (within a remediation package or remediation scheme)
	Time taken for the standard of remediation to be achieved
Reasonableness	Cost of remediation is justified by the benefit of breaking any pollutant linkage and/or mitigating the effect of any significant harm or pollution of controlled water that has already occurred
Practicability	Technical constraints (e.g., availability of power or materials)
	Site constraints (e.g., area and access)
	Time constraints
	Regulatory constraints (e.g., need to obtain a permit, licence, or operate within the conditions of that permit or licence)
	Interaction with any other works already proposed, in progress, or completed
	Adverse environmental impacts
Durability	The period of time over which the effectiveness of remediation will need to be maintained
Other	Track record
	Technological and scientific advances
	Implementation in accordance with good practice and quality assurance procedures

The factors have been reviewed for the various risk mitigation options, with scores assigned based on whether the technology reviewed is considered to suitable for use at the site. Where a score of zero is assigned, for one or more of the categories above, the technology is not considered suitable for use at the site.

The technologies with the highest scores will be carried forward in the selection of the preferred remediation option(s) for the site.

Options for soil and groundwater/saturated zone risk management have been treated separately, where practicable, in the following sections.

4.5.1 Risk Management - Soils

Table 4.3 reviews the applicability and viability of the various risk mitigation options.

Table 4-3: Risk Mitigation Options Appraisal for Shallow Unsaturated Soil Sources (Including made ground in Former Structures)

Treatment Option				Risk Driver	Contaminants of Concern	Viable Treatment Technology Based on:								Discussion of Viability and Efficacy	
Reference	Type	Remediation Technique	Detail			Contaminant Properties	Matrix Properties	Site Constraints	Sustainability	Durability	Cost	Timeframe	Total Score*		
Measures Incorporated into Development Plan															
1	Pathway break / Receptor isolation	Cover & capping/barrier systems (shallow / lateral)	Placement of cover soils and/or membranes and capillary break layers to break the physical contact pathways between contamination and site users	Human Health	Metals and other inorganics, asbestos, organic contaminants	2	2	2	2	1	2	2	13	Tried and tested and cost effective solutions for managing risks to human health that can be incorporated into the development plan and designs. Solutions do not manage the source of contamination that remains in the ground and do not manage potential risks to controlled waters. Options viable and considered further.	
2		Use of barrier pipe for water mains	Use of appropriate materials for water mains to prevent diffusion of contamination into potable water supplies	Human Health		2	2	2	2	1	2	2	13		
3		Vapour barriers / Ventilation systems in buildings	Installation of vapour barriers and/or adequate ventilation in buildings to limit vapour migration into houses and subsequent inhalation	Human Health	Volatile organics (eg. Benzene, naphthalene, etc.)	2	2	2	2	1	2	2	13		
Civil Engineering Methods															
4	Ex-situ [source treatment]	Excavation and Disposal	Excavation: Physical excavation of soils above the water table with associated disposal or off-site treatment and subsequent replacement with site-won or imported materials.	Human Health and Controlled waters	VOCs PAHs TPHs Ammonium / Ammonia	2	2	1	1	2	1	2	11	- Can potentially manage risks to both receptor groups. - Materials can be sampled, visually sorted, and assessed to full extent. - Designated soils can be excavated and replaced with suitable material, where feasible. - Provides certainty that primary source materials have been removed. - The site area can facilitate onsite (temporary) storage and possible treatment of materials, if feasible. However, consideration will need to be given to issues such as odour and dust nuisance to neighbours. - High costs associated with handling and transporting large volumes of material. - Sustainability issues in relation to landfilling of excavated materials and import of 'clean' backfill materials if on site treatment not feasible. Option potentially viable and considered further.	
Biological Methods															
5	Ex-situ [source treatment]	Biological methods including biopiles, bioventing, landfarming / windrow turning, slurry phase	Introduction of air or biological agents to enhance the natural degradation of contaminants in the source	Human Health and Controlled waters	VOCs SVOCs	1	1	1	1	2	1	1	8	Effective for volatile organic contaminants e.g. benzene which degrade readily. Inorganic contaminants i.e. ammonium are however more recalcitrant contaminants which take longer to degrade and attenuate naturally.	

Treatment Option				Risk Driver	Contaminants of Concern	Viable Treatment Technology Based on:								Discussion of Viability and Efficacy	
Reference	Type	Remediation Technique	Detail			Contaminant Properties	Matrix Properties	Site Constraints	Sustainability	Durability	Cost	Timeframe	Total Score*		
		biotreatment	area											- Typically requires longer timeframes for implementation (e.g. months to years) which will delay development. - The site area can facilitate onsite (temporary) storage and possible treatment of materials, if feasible. However, consideration will need to be given to issues such as odour and dust nuisance to neighbours. - Less effective on soils with high moisture content. As such, wet weather conditions, along with low temperatures, is likely to impede remediation effectiveness. - Less effective on clay rich soils. Option deemed potentially appropriate for some types of material but will have time implications in relation to development.	
Chemical Methods															
3	In-situ [source treatment]	Chemical Oxidation	Injection of appropriate reagents (e.g. oxidants) to destroy contaminants.	Human Health and Controlled waters	VOCs SVOCs	1	0	1	1	2	0	2	0	- Reactions are fast and can result in complete degradation. - Application to a wide range of organic contaminants. - Low waste generation. - Not likely to be effective for use in the shallow unsaturated zone due to presence of structures, concrete and heterogeneous made ground material - Requirement for handling large quantities of hazardous oxidizing chemicals due to the oxidant demand of the target organic chemicals and the unproductive oxidant consumption of the formation. - Repeat phases of treatment would be required to understand whether treatment was likely to be successful. - Likely to be more expensive relative to other solutions for this media. Option not deemed viable for shallow sources.	
4	In-situ [source treatment]	Soil Flushing	Introduction of water and potentially the addition of agents (e.g. surfactant, cosolvent, acid, or base) to re-mobilise residual phase or trapped contaminants with subsequent multiphase extraction.	Human Health and Controlled waters	VOCs PAHs TPHs Ammonium / Ammonia	2	1	0	0	2	0	0	0	- Not likely to be as effective for use in the shallow unsaturated zone due to presence of structures, concrete and heterogeneous made ground material - Effectiveness requires adequate distribution of the additives through the vadose zone and achieving contact with the contaminated soils. Lithologies comprised of fine-grained material, interbedded lenses of more permeable and less permeable materials can be expected to be more difficult to treat than those containing sandy, relatively homogeneous soils. - The flushing solution injection and collection systems must be designed and operated to limit the spread of contaminants to clean areas. - The flushing solution should be recovered, treated, and recycled. Treatment can be costly and time consuming. - Bench-scale laboratory testing should be performed to identify a flushing solution and concentration to optimise removal of site-specific contaminants of concern. Option not deemed viable.	
Stabilisation and Solidification (s/s) Methods															
5	In-situ or ex-treatment [source	Hydraulic binders (e.g. cement)	Stabilisation and Solidification / grouting: Injection of binders and mixing with soils to bind	Human Health and Controlled	VOCs PAHs TPHs	2	1	1	1	1	1	2	9	- Can be applied as an ex-situ or insitu technique. - Does not destroy or remove contaminants, but 'binds' contamination in matrix. - Can result in future building constraints depending on the nature of the treated material produced and futur	

Treatment Option				Risk Driver	Contaminants of Concern	Viable Treatment Technology Based on:								Discussion of Viability and Efficacy	
Reference	Type	Remediation Technique	Detail			Contaminant Properties	Matrix Properties	Site Constraints	Sustainability	Durability	Cost	Timeframe	Total Score*		
	treatment]		and immobilise contamination.	waters	Ammonium / Ammonia									development plans and foundation solutions - Reagent delivery and effective mixing can be difficult to achieve at depth - effective in situ mixing may be difficult, particularly at deeper depths or within highly variable ground conditions. - The presence of in-ground structures could limit the successful application of hydraulic binders. - May require elevated proportion of binders to achieve required objectives making the process expensive. - Potential issue with bulking factor (expansion). - Could be difficult to verify and require background monitoring to check leaching is not occurring. - Treatability studies are required. - In-situ reagent delivery and effective mixing are more difficult than for ex situ applications. Options potentially viable and considered further.	
Thermal Methods															
6	In-situ and ex-situ thermal [source treatment]	Thermal desorption and/or volatilisation/ remobilization of contaminants	Use of electrical energy or radiation to enhance the mobility of organic contaminants in the unsaturated zone which can facilitate their recovery and treatment.	Human Health and Controlled waters	Soil VOCs SVOCs	1	1	1	1	2	0	2	0	- All thermal remediation methods rely on heating the soils/subsurface to enhance removal or destruction of contaminants (primarily volatile contaminants) from the solid matrix. Thermal desorption soil treatment usually undertaken as an ex-stu technique, but can be undertaken in-situ and at depth. - Increased volatility or mobility of contaminants, resulting in enhanced contaminant recovery, is the most common style of application and thus thermal methods are categorised as a removal technology. - Where undertaken in-situ, it is imperative that any mobilised contaminants are subsequently captured. Air emissions may need to be regulated to eliminate possible harm to the public and the environment. Air treatment and permitting will increase project costs. - Thermal remediation methods offer an advantage over chemical and biological approaches, in that direct contact and reaction of a reagent or microbial activity with a contaminant is not necessary. However, in ground obstructions can cause operating difficulties. - Performance in extracting certain contaminants varies depending upon the maximum temperature achieved in the process selected. - High energy inputs required. - Higher initial capital costs than other remedial technologies and utility costs may be high. - Soil that is tight or has high moisture content has a reduced permeability to air, hindering the operation of thermally enhanced SVE and requiring more energy input to increase vacuum and temperature. - Less effective for soil that has a high organic content that has a high sorption capacity of VOCs, which results in reduced removal rates. Option not deemed suitable.	

Notes: Scores have been assigned based on the following rating: 0 – Technically unsuitable or technique otherwise not viable; 1 – Likely to be suitable; 2 – Suitable; * Where a score of 0 has been assigned for 1 or more categories the total score is assigned as 0 indicating that the technique is deemed not suitable for use.

The following options for managing potential risks posed by shallow soils in the unsaturated zone are potentially viable and are taken forward for further appraisal.

1. Cover and capping systems;
2. Use of Barrier pipe for potable water mains;
3. Installation of vapour protection measures in future buildings;
4. Excavation of soils and management. This could potentially include off-site disposal or treatment or some form of on-site treatment such as bioremediation or stabilisation.

Options 1 – 3 are cost effective solutions for managing risks to human health but will not manage the potential risks to controlled waters. As such, they are not options that can be considered for use in isolation where controlled waters risk are present at the site.

4.5.2 Risk Management - Groundwater

Table 4.4 reviews the applicability and viability of the various risk mitigation options. This includes the management of NAPL and soils in the saturated zone.

Table 4-4: Risk Mitigation Options Appraisal for Groundwater/Saturated Soil Sources

Treatment Option				Risk Driver	Applicability		Viable Treatment Technology Based on:								Discussion of Viability and Efficacy
Reference	Type	Remediation Technique	Detail		Media	Contaminants of Concern	Contaminant Properties	Matrix Properties	Site Constraints	Sustainability	Durability	Cost	Timeframe	Total Score*	
Civil Engineering Methods															
1	In-situ [pathway management]	Containment – hydraulic barrier	Abstraction of groundwater/NAPL to prevent off-site migration of NAPL and/or dissolved phase contamination.	Controlled waters & potentially human health (offsite)	Water/ NAPL	VOCs PAHs TPHs Ammonium / Ammonia	2	2	2	1	1	1	1	10	- Hydraulic containment system currently operational. The system is understood to be reducing dissolved phase concentrations migrating offsite and removing NAPL, although it appears likely that the system is not currently containing contamination within the site boundary. - Extraction of groundwater will locally impact the groundwater regime. - The option does not tackle the upgradient sources and/or residual NAPL source and will have to operate for many years if no additional source remediation is undertaken. - Reduction of the residual source terms would rely on dissolution. - Extracted groundwater requires treatment to enable discharge back into the aquifer. A system currently operational with demonstrable recovery of NAPL and treatment of dissolved phase
2	In-situ [pathway management]	Containment – In-ground barrier (<i>Low Permeability Cut Off Wall</i>)	Installation of a barrier across the plume on the downgradient site boundary to prevent migration of NAPL/dissolved phase. Barrier could comprise clay, membrane or sheet piling.	Controlled waters & potentially human health (offsite)	Water / NAPL	VOCs PAHs TPHs Ammonium / Ammonia	2	2	0	1	1	1	1	0	- Would, in theory, be installed on the downgradient boundary; to prevent off-site flow of NAPL/groundwater. - Groundwater levels will increase behind the barrier and may flow around it to the north and south. Significant uncertainties on the local impact to the groundwater regime. Upgradient control (abstraction and treatment of groundwater) likely to be required. - Lateral migration around the barrier could result in an increase in the plume width and the migration of contamination into currently unimpacted areas. Containment system already operational in likely location and unlikely to add anything to status quo. Option not deemed to offer a significantly better solution than that already in place
Biological Methods															
3	In-situ [source treatment]	Natural Attenuation (enhanced)	Introduction of air, oxygen, biological or other agents to enhance the natural degradation of contaminants in the source area	Controlled waters & potentially human health (offsite)	Water	VOCs SVOCs	0	1	2	0	2	1	0	0	- This is potentially a viable solution for organic contaminants e.g. benzene which degrade readily. Inorganic contaminants i.e. ammonium are however more recalcitrant contaminants which take longer to degrade and attenuate naturally. - This technique is primarily applied to dissolved phase contaminants in groundwater and relies on natural processes that mitigate NAPL constituents over time. As such, it requires long term regular monitoring of the site (e.g. quarterly over a 5 year period) to demonstrate natural attenuation is occurring. Impact on NAPL would be minimal. - Could have implications for off-site residents causing increased volatilisation and generation of soil vapours.

Treatment Option				Risk Driver	Applicability		Viable Treatment Technology Based on:								Discussion of Viability and Efficacy
Reference	Type	Remediation Technique	Detail		Media	Contaminants of Concern	Contaminant Properties	Matrix Properties	Site Constraints	Sustainability	Durability	Cost	Timeframe	Total Score*	
															Option not deemed viable in isolation. Could be considered if NAPL is remediated as initial phase. Potential vapour risks would need to be considered.
Chemical Methods															
4	In-situ [source treatment]	Chemical Oxidation	Injection of appropriate reagents (e.g. oxidants) to destroy contaminants.	Controlled waters & potentially human health (offsite)	Water	VOC PAHs TPHs	1	1	1	1	1	1	2	8	- Applicable to a wide range of organic contaminants. - To treat residual NAPL large volumes of reagent would be required, and it would be necessary to get the oxidant in contact with the NAPL. Most appropriate for dissolved phase treatment after NAPL treatment. - Can be applied through soil mixing techniques. - Repeat phases of treatment would potentially be required to understand whether treatment was likely to be successful. - Reagents may accelerate dissolution of NAPL, however, dissolved phase contamination may then migrate off-site into previously unimpacted areas if not captured/treated. Also potential risk of vapour generation and migration. - Requires drilling of a large number of holes which will be hindered by shallow subsurface structures Options potentially viable and considered further.
5	In-situ [source treatment]	Solvent/surfactant enhanced recovery			NAPL	VOC PAHs TPHs	2	1	1	1	2	1	1	9	- Relies on solvents increasing the mobility of NAPLs (and remobilising residual phase NAPLs resulting in enhanced contaminant recovery. - In combination with total fluids recovery, the use of solvents would increase recoverability. The mobilised NAPL could then be recovered and dissolved phase treated. - It is imperative that any mobilised NAPL is subsequently captured. To ensure capture, the technique might need to be combined with a downgradient hydraulic containment system (pump and treat). Option is potentially viable but presents potentially significant risks if mobilised NAPL is not captured.
Stabilisation and Solidification (s/s) Methods															
6	In-situ treatment [source treatment]	Hydraulic binders (e.g. cement)	Stabilisation and Solidification / grouting: Injection of binders and mixing with soils to bind and immobilise contamination.	Human Health and Controlled waters		VOCs PAHs TPHs Ammonium / Ammonia	2	2	1	1	1	1	2	10	- Does not destroy or remove contaminants, but 'binds' contamination in matrix. - Can result in future building constraints depending on the nature of the treated material produced and future development plans and foundation solutions - Reagent delivery and effective mixing can be difficult to achieve at depth - effective in situ mixing may be difficult, particularly at deeper depths or within highly variable ground conditions.

Treatment Option				Risk Driver	Applicability		Viable Treatment Technology Based on:								Discussion of Viability and Efficacy
Reference	Type	Remediation Technique	Detail		Media	Contaminants of Concern	Contaminant Properties	Matrix Properties	Site Constraints	Sustainability	Durability	Cost	Timeframe	Total Score*	
															- The presence of in-ground structures could limit the successful application of hydraulic binders. These would potentially be removed as part of S1 and S2 treatment works - May require elevated proportion of binders to achieve required objectives making the process expensive. - Could be difficult to verify and require background monitoring to check leaching is not occurring. Treatability studies are required. Options potentially viable and considered further.
Physical Methods															
7	Ex-situ physical [source treatment]	Multiphase Recovery with ex-situ treatment	Total fluids extraction (TFE)	Controlled waters & potentially human health (offsite)	NAPL/ Water	VOCs PAHs TPHs Ammonium / Ammonia	2	2	2	2	1	1	1	11	- Well understood and relatively simple treatment options to implement. Proven track record and NAPL and dissolved phase recovery currently underway as part of the operational containment system. - Large volumes of groundwater are recovered – currently an on-site treatment and reinjection system is operational. - Only treats residual NAPL through dissolution, so long time frames required to remove residual NAPL. Options viable and considered further.
8	Ex-situ physical [source treatment]	Multi-phase Recovery with ex-situ treatment	Dual Phase Extraction (DPE)	Controlled waters & potentially human health (offsite)	NAPL/ Water	VOCs	0	2	2	1	1	1	1	0	- Drilling and installation of soil vapour wells will be costly. Radius of influence for soil vapour wells may be small due to ground conditions. - Limited mass transfer into vapour phase limits the benefits of vacuum application. - The soil vapour extraction will not provide additional contaminant removal benefit because of the low to no mass transfer into vapour phase based on the low volatility of the majority of the contaminants present. Option not deemed viable.
9	In-situ physical [pathway management]	Air Sparging	Installation of a well network along the downgradient site boundary and injection of air or oxygen to encourage degradation of dissolved phase contamination.	Dissolved phase plume (only)	Water	VOCs	0	2	2	1	1	1	1	0	- Possibly feasible to install along the downgradient boundary dependent upon radius of influence (ROI) of sparge wells. - Can be highly cost effective particularly for high volatility contamination. - Should only be applied to unconfined aquifers where injected air can freely reach the unsaturated zone and be subsequently collected. - Need to ensure a uniform airflow to avoid spreading of contaminant plume. - Not suitable for the treatment of inorganic contaminants. - Not very effective for low volatility contaminants present in coal tars. - The sparge curtain will not manage the residual NAPL source and may have to operate indefinitely. - Could have implications for off-site residents causing increased volatilisation and generation of soil vapours.

Treatment Option				Risk Driver	Applicability		Viable Treatment Technology Based on:								Discussion of Viability and Efficacy
Reference	Type	Remediation Technique	Detail		Media	Contaminants of Concern	Contaminant Properties	Matrix Properties	Site Constraints	Sustainability	Durability	Cost	Timeframe	Total Score*	
															Option not deemed to offer a viable or durable solution while NAPL present. Poses potentially significant risks off-site.
10	In-situ physical [pathway management]	Permeable Reactive Barriers (PRBs)	Installation of a barrier comprising chemicals or reagents that can intercept the mass flux from the NAPL zone by in-situ treatment with a reactive medium placed in a trench or injected.		Typically Water	VOCs PAHs TPHs Ammonium / Ammonia	2	2	1	1	1	1	1	9	- Proven technology on similar sites. Some products offer potential treatment for NAPLs - Installed on downgradient boundary – system currently operational in this area - Reagents would possibly need to be replenished and, as with sparging (above), the barrier may not manage the mobile/residual NAPL sources onsite and will have to operate indefinitely. - The barrier would need to be placed downgradient of any NAPL to prevent NAPL impact on the reagents. - PRBs more challenging for treating ammonium. Staged treatment required. Option potentially viable solution and to be considered further.
Thermal Methods															
11	In-situ thermal [source treatment]	Steam / heat injection	Use of thermal energy to enhance the mobility of organic contaminants in the saturated zone which can facilitate their recovery and treatment.		Water NAPI inc. residual	VOCs SVOCs	2	1	1	1	2	1	1	9	- All thermal remediation methods rely on heating the subsurface to enhance removal or destruction of contaminants (primarily volatile contaminants) from the aqueous phases. Increased volatility or mobility of contaminants, resulting in enhanced contaminant recovery, is the most common style of application and thus thermal methods are categorised as a removal technology. Elevated temperatures, however, can also result in enhanced biodegradation and hydrolysis. - Thermal remediation methods offer an advantage over chemical and biological approaches, in that direct contact and reaction of a reagent or microbial activity with a NAPL or dissolved solute is not necessary. - In combination with total fluids recovery, the use of steam would create a steam front that drives NAPL from targeted source areas into recovery wells. The mobilised NAPL could then be recovered and dissolved phase treated. Thermal enhancement using conductive or electrical resistance and/or heat injection may also be viable. - It is imperative that any mobilised NAPL is subsequently captured. To ensure capture, the technique might need to be combined with a downgradient hydraulic containment system (pump and treat). - High energy inputs required. It is difficult to achieve heat retention in the ground. Higher initial capital costs than other remedial technologies and utility costs may be high. Costs for this option are likely to be prohibitive. Option is potentially viable but presents potentially significant risks if mobilised NAPL is not captured.

Notes: Scores have been assigned based on the following rating: 0 – Technically unsuitable or technique otherwise not viable; 1 – Likely to be suitable; 2 – Suitable; * Where a score of 0 has been assigned for 1 or more categories the total score is assigned as 0 indicating that the technique is deemed not suitable for use.

The following options for managing potential risks posed by groundwater and/or NAPL in the saturated zone are potentially viable and are taken forward for further appraisal. These include options capable of treating the source zones in the saturated zone and those capable of breaking the migration pathway off-site.

1. Hydraulic containment and permeable reactive barriers;
2. In-situ S/S;
3. Chemical oxidation;
4. Dual and/or multiphase abstraction; and
5. Thermal and/or solvent enhanced recovery.

Options 1, 2 and 4 offer potential solutions for managing ammonia in groundwater, but a staged approach is typically required to convert it to a byproduct less harmful to the environment. As such, treatment systems are likely to be more complex and expensive. Treatment of dissolved phase organics is typically more straightforward.

4.6 Evaluation of Shortlisted Options

Table 4.5 below assesses which potentially significant linkages the shortlisted risk mitigation techniques address.

Table 4-5: Risk Mitigations Options and Potentially Significant Linkages

Link No.	Potential Contaminant Linkage		Shortlisted Options which Address Linkage							
	Source Contaminants	Migration Pathway	Cover /Cap systems	Barrier pipe	Vapour barriers	Excavate/treat unsaturated soils	Hydraulic containment/PRB	Chemical oxidation	DPH / MPE	Thermal / Surfactant
	Human Health									
H1/H4	Areas A, B (outside primary source areas) & C - general made ground eg. hydrocarbons and cyanide (Area B only), arsenic and lead (S1)	Physical contact pathways such as direct contact, ingestion and inhalation of dusts	✓			✓				
H2/H5		Vapour inhalation (limited in Area A, not a significant linkage in Area C) ¹			✓	✓				
H3/H6		Diffusion through water mains and consumption		✓		✓				
H7	Areas A, B & C - Asbestos Containing Materials (ACM) in soil (S1)	Ingestion and inhalation	✓			✓				
H8	Area B: Historical gas works structures containing hydrocarbons and other gas works-related contamination (see	Physical contact pathways such as direct contact, ingestion and inhalation of dusts	✓			✓				
H9		Vapour inhalation in proposed houses			✓	✓				

Link No.	Potential Contaminant Linkage		Shortlisted Options which Address Linkage							
	Source Contaminants	Migration Pathway	Cover /Cap systems	Barrier pipe	Vapour barriers	Excavate/treat unsaturated soils	Hydraulic containment/PRB	Chemical oxidation	DPH / MPE	Thermal / Surfactant
H10	Section 3.1) (S2)	Diffusion through water mains and consumption		✓		✓				
H11	Area B - NAPL and dissolved phase	Vapour inhalation in proposed houses			✓			✓	✓	✓
H12	contaminants in shallow groundwater in sands and gravels (S3, S4)	Offsite groundwater migration and vapour generation					✓	✓	✓	✓
	Controlled Waters									
C1/C2	General made ground, primarily Area B (S1)	Leaching/dissolution from soils or NAPL				✓	✓			
C3-C6	Area B: Historical gas works structures containing hydrocarbons and other gas works-related contamination (S2)	Leaching/dissolution from soil or NAPL				✓	✓	✓		
		Leakage from structures				✓	✓	✓	✓	
		Migration of NAPL into groundwater					✓	✓	✓	✓
		Migration of NAPL and/or dissolved phase contamination within shallow groundwater in the sands and gravels					✓	✓	✓	✓
C7/C8	Area B - NAPL and dissolved phase contaminants in shallow groundwater in sands and gravels (S3, S4)	Migration of NAPL and/or dissolved phase contamination within shallow groundwater in the sands and gravels					✓	✓	✓	✓

It is clear from the table that a combination of techniques is likely to be required to mitigate all the identified linkages and, as such, further consideration is given to the source terms in the following sections.

4.6.1 Source Type S1– Contamination in General Made Ground

The site investigation and risk assessment have identified sporadic and isolated 'hotspots' of metal and ACM contamination in made ground in Areas A and C which pose a potential risk to human health. There are likely to be other hotspots in these areas, but the evidence suggests that contamination is not widespread or laterally continuous. These sources have been interpreted as posing a moderate to high risk to future site users. They do not pose an unacceptable risk to controlled waters. Given the disparate nature of contaminants, excavation and treatment, although viable, is unlikely to be a sustainable solution. Large scale excavation and material management will generate potential risks to site workers, adjacent receptors and the general public during works.

Mitigation measures designed into the final development scheme are inferred to provide a sustainable solution for managing the potential risks to future site users in these areas. These should include, where necessary:

- Soil cover systems (with marker layers and capillary breaks, as required) in proposed unsurfaced areas (gardens, landscaped areas and open spaces). Proposed hardstanding (car parks, roads, buildings etc.) will provide a barrier between site users and underlying residual made ground.
- Use of appropriate barrier pipe for water mains
- Installation of vapour protection measures into future residential buildings, where required.

Elevated PAHs and metals are more widespread in general made ground outside of former gas works structures in Area B. Although shallow contamination is more widespread in this area, given the extent of impact, wholesale excavation and treatment/disposal to manage human health risks will not be sustainable when compared to risk mitigation measures incorporated into the development. As such, it is recommended that the same approach is adopted for managing the source term S1 in Area B.

Instances of elevated total cyanide, sulphate and TPH C10-16 (with respect to controlled waters Site Specific Assessment Criteria (SSAC)) are also apparent in some soils (eg. associated with the former refuse tip and gas holder base no.3). These are not deemed to be the primary risk drivers at the site, but the requirement for further appraisal should be considered as part of detailed design, sustainability appraisal and engagement with stakeholders (see Section 5).

4.6.2 Source Type S2 – Contamination Associated with Former Structures (Area B)

Source S2 encompasses the former gas works structures and associated contamination. The contaminants of concern are primarily associated with hydrocarbons, and more specifically tar. Individual sources comprise free (mobile and residual) phase NAPL and heavily tar-impacted made ground. This material is both within and outside of structures.

These sources pose a potentially unacceptable risk to future site users and controlled waters. The risk mitigation measures adopted for S1 would manage risks to human health associated with S2, but additional remediation works would be required to manage risks to controlled waters. S2 sources are more significant and pose a greater potential risk, but are more constrained than those associated with general made ground. These sources are also likely to present greater constraints to future development and greater risks during development. Given these factors, a different remedial approach is warranted.

It is inferred that excavation followed by treatment and/or off-site disposal is the most appropriate option for S2. Treatment, either on or off site, offers a more sustainable outcome, particularly if soils can be treated and re-used on-site. This reduces disposal to landfill, transport to landfill or treatment centre and importation of material for backfilling excavations.

Viable treatment techniques identified by this options appraisal include ex-situ stabilisation and/or bioremediation, but this will require detailed assessment and benchscale trials to confirm suitability to achieve the remediation criteria and the appropriate reagent mixes, etc.

Bioremediation would require significantly longer timescales and is unlikely to be suitable for the most contaminated material.

4.6.3 Source Types S3 to S4 – Contamination Associated with NAPLs and dissolved phase in the saturated zone (Area B)

It is likely that remediation of these two source terms will be combined in some extent.

The options appraisal has demonstrated that the risks to controlled waters can be mitigated by source treatment and/or pathway management. Risks are currently being mitigated via pathway management and the hydraulic containment system. This approach could continue, but would be required to operate for decades as it does not treat the upgradient source.

Based on the current evidence, the source of NAPL in the aquifer in the south-western corner of the site (S3b) is inferred to be associated with historical leakage from gas holder tanks A and B.

Source remediation could remove the requirement to operate the containment system, or at least reduce the length of time it would need to operate. NAPL-impacted natural soils and free phase NAPLs below the water table will effectively be treated as one source and are considered to be more of a groundwater issue than a soil one. Groundwater remediation criteria will drive the nature and extent of remediation works in the saturated zone.

Remediation options deemed viable at this stage are:

1. Hydraulic containment and permeable reactive barriers;
2. In-situ S/S;
3. Chemical oxidation;
4. Dual and/or multiphase abstraction; and
5. Thermal and/or solvent enhanced recovery.

Hydraulic containment has been demonstrated to be viable for treating NAPL and organic contamination to some extent in that there is currently an operational system. The current efficacy of the system and degree of risk reduction it provides are however unclear.

Options 2 and 3 will have a shorter time frame in that following completion of treatment, NAPL and impacted shallow soils will be bound or remediated and should have a positive impact on groundwater quality. The viability of these options will be dependent on ground conditions and the quantity and extent of NAPL around the primary source areas (S2). Detailed assessment and remediation trials will be required to assess these options further.

Multiphase NAPL and dissolved phase extraction will recover mobile NAPL, but will only manage residual NAPL through dissolution, which will take a considerable time. At present, NAPL is being recovered from wells along the site boundary, so the option is viable.

Thermal and solvent enhanced recovery will support recovery of residual NAPL, but it is imperative that any mobilised NAPL is captured and abstracted before it migrates off-site. Increased migration offsite would increase risks to off-site residents and controlled waters.

Given the short distances between the source and the boundary and the setting and sensitivity of the adjacent site, it is likely that the potential risks associated with these options outweighs the benefits that could be achieved.

Given the above, it is interpreted that a combination of source treatment through NAPL extraction and/or stabilisation or chemical oxidation, and ongoing hydraulic containment is the most appropriate approach. The containment system would need to operate until the remediation of the source has reduced groundwater concentrations to acceptable levels. If this cannot be achieved, consideration will need to be given to operating the system for longer.

The potential risks of vapour migration from the deeper sources will need re-assessment. Source remediation should reduce the potential risk posed by vapours generated by NAPL and dissolved phase, but it is possible vapour protection measures may need to be considered in areas where residual contamination remains. The requirement for these measures will also be dependent on the final development plan.

The treatment of ammonia/ammonium at the high concentrations observed in groundwater is more complex than treatment of organics. It is also a Non-hazardous contaminant. Reducing concentrations through remediation is likely to be difficult and costly. As such, a more detailed assessment of the costs and benefits of ammonium should be considered as part of detailed design works. The assessment will depend to some extent on what other groundwater treatment options are taken forward to detailed design.

5. Outline Risk Mitigation Strategy

5.1 Introduction

The Risk Mitigation Options Appraisal has identified a shortlist of potentially viable risk mitigation approaches and remediation options. Given the output of the appraisal it is evident that a phased approach is the most appropriate sustainable way to manage risks and render the site suitable for the proposed residential development.

The following sections outlines the various phases of work that will likely be required. The final strategy will be dependent on the agreed final development plan (location of buildings, foundation solutions, sensitivity of overlying land-use, etc.) and any remediation trials/tests conducted. The final strategy should also consider the costs and benefits of undertaking the work to ensure that the final scheme is sustainable.

5.2 Strategy Phases

The following phases of work are likely to form the basis of the final risk remediation strategy.

Table 5-1: Outline Risk Mitigation Strategy

Phase	Objective	Work Elements
Phase 1	Remediation of primary source areas in Area B	a. Potential remediation trials/tests for ex-situ soil treatment options (eg. benchscale for S&S) b. Development of a detailed remediation design c. Implementation of works
Phase 2	Remediation of sources in saturated zone – Area B	a. Detailed evaluation of remediation options and remediation trials for saturated soils and groundwater remediation b. Sustainability appraisal to consider the costs and benefits of remediation c. Development of a detailed remediation design d. Implementation of source treatment, as appropriate based on the findings of a. and b. above e. Post works risk assessment It is likely that the first elements of this phase would be completed during Phase 1. Excavation of the source areas is likely to provide further information to support the design of Phase 2.
Phase 3	Implementation of risk mitigation measures in Areas A, B and C	These will include, as appropriate: a. Cover systems in unsurfaced areas b. Vapour protection measures in buildings c. Use of appropriate barrier pipe for water mains
Phase 4	Review of the current hydraulic containment system	This work element will be closely associated with Phase 2. The containment system will, in all likelihood, need to operate until at least completion of the remediation works. The requirement for longer term operation will be dependent on the outcome of phase

Phase	Objective	Work Elements
		2 and discussions with the council and Environment Agency.
Phase 5	Completion of a verification report and close out of any planning conditions	Given the nature of the works, it may be possible and practical to adopt a phased approach to works verification. Review of any post remediation risks.
Phase 6	Post remediation monitoring	There may be a requirement to undertake post remediation monitoring of groundwater to confirm the remediation objectives have been met.

5.3 Phase 1 – Primary Source Treatment Area B

Phase 1 works will include, but is not limited to:

- Utility service clearance and site establishment;
- Removal of concrete foundations and floors across source areas;
- Dewatering of contained structures (eg. former gas holder tanks, etc.), where necessary. Water will require treatment and testing before discharge to sewer. Discharge concentrations and rates will need to be agreed with the local water company;
- Excavation of gross contamination and removal of subsurface structures, where practicable. Excavation to extend to the base of contamination or groundwater. Where contamination extends below the water table, further excavation may be possible with localised dewatering. The risks, costs and benefits of this will need to be assessed;
- Excavation should extend out from the primary impacted structures identified by the site investigations until gross contamination has been removed. Verification sampling of the excavation faces (and the base, if possible) should be undertaken for comparison against remediation criteria;
- Once gross sources have been excavated, it may be prudent to excavate trial trenches out from the excavated areas to enable additional verification sampling and to identify other hotspots and/or sub-surface structures that require removal. This will likely largely fall within the S2 source zone (see Figure 5);
- On- or off-site treatment or off-site disposal of soils to an appropriately licenced landfill/treatment centre. Hard, inert materials can likely be retained on site for recovery, testing and use as recycled aggregate in excavations;
- The requirement for the installation of barriers in the base or sides of the excavations should be considered if there is potential for recontamination of the excavation;
- Backfilling and compaction of the excavation with suitable treated, site-won or imported material;
- Preparation and submission of a materials management in accordance with the CL:AIRE Definition of Waste Code of Practice (CL:AIRE, 2011) for reuse of material, as required. Material removed from site should be handled in accordance with the Waste Regulations and Duty of Care Code of Practice using a registered waste carrier;
- Environmental monitoring and control of dusts, fibres and emissions. This should include air quality, noise and vibration, as required;

- Control of site waters and run-off; and
- Traffic management;

Careful stockpile management will be required to ensure the appropriate segregation and sentencing of materials and the control of potential risks to human health given the sensitive site setting.

Leachate and runoff from stockpiles should be collected and disposed of appropriately. Stockpiles should be constructed in accordance with the following:

- Individual stockpiles should, as far as is reasonably practicable, be composed of materials displaying a high degree of homogeneity, both in terms of geotechnical and chemical characteristics;
- Each stockpile should be given a unique identifying number/reference and shall be clearly labelled with that reference. Each label should include the date the stockpile was started, details of the source location, a description of the material, the date the stockpile was sampled and its current status;
- The contractor should survey the location of each stockpile and present this data as a drawing, on a weekly basis during the site works;
- Excavated soils and treated/processed soils should be regarded as contaminated or potentially contaminated until re-classified based on the chemical and/or geotechnical data obtained;
- Stockpiles of excavated material should be located only on hard standing or within a lined bund, or areas identified for remediation, unless agreed otherwise; and,
- The contractor should manage stockpiles of materials arising from the excavations to prevent nuisance impacts and any spreading of contamination, including all necessary environmental controls, such as run-off control and dust control.

5.4 Phase 2

As with Phase 1 works, pre-design trials and assessment will be required to determine the nature and extent of any remediation works for deeper contaminant sources. The final design should be based on the outcomes of these pilot works, risk assessment refinement, completion of a Sustainability Appraisal and discussions with the Environment Agency. These works should also review and consider the potential risks posed by the secondary sources such as sulphate and cyanide.

This element of work should also consider the efficacy and operation of the existing hydraulic containment system. When assessing options for the system, consideration will need to be given to potential risks to off-site residents down-hydraulic gradient of the site. Risks to these receptors are currently managed to some extent by operation of the system.

5.5 Phase 3

The nature and extent of risk mitigation measures incorporated into the development will be dependent of the final agreed site layout.

For instance, deeper cover layers will be required in private garden areas. A thickness of 600 mm is typically adopted for gardens, but this will need to be agreed as part of the final design. Reduced thickness cover layers will likely be appropriate in open space and landscaped areas, although the nature of the proposed planting will need to be taken into consideration.

A geotextile separator/visual warning layer should be placed between the underlying material and imported soils. Imported soils should be as specified in BS 3882:2015 for topsoil and BS8601:2013 for subsoil.

Cover materials will not be required under hard landscaped areas, roads, buildings, etc.

Limited excavation should be undertaken to understand the potential source of benzene vapour in the vicinity of VW25-04. If a source of volatile contamination is encountered it should be remediated.

The requirement for measures in Area B will be dependent on the final design implemented as part of Phase 1 and any residual potential risks that remain.

5.6 Mitigation of Risks to Site Workers

Site workers should be made aware of the potential risks from subsurface contamination and should adopt health and safety procedures appropriate for working in contaminated ground. Guidance is given in the Health and Safety Executive (HSE) document 'Protection of Workers and the General Public during the Redevelopment of Contaminated Land (HS (G) 66).

Before site operations are commenced, the necessary COSHH Assessments, Method Statements and Health and Safety Plans should be completed and issued by the contractor in accordance with the CDM Regulations.

With regard to potential contamination, as a minimum, mitigation measures should include:

- Toolbox talks detailing the potential for contamination to be encountered and instruction in what contamination may look like in soils and site waters and the actions to be taken if suspected;
- The issue of protective footwear, gloves, glasses, hard hat and coveralls;
- Hand washing prior to eating,
- No eating or smoking in work areas; and
- Provision of welfare facilities away from areas where contamination is present.

Workers should be trained in asbestos awareness. Where asbestos in soils is identified then further works-specific risk assessments method statements, including the use of appropriate PPE, will need to be implemented.

5.7 Mitigation of Risks to the General Public, Adjacent Site Users and the Environment

Measures should be adopted to limit the generation of dusts, noise, vapours and odours. These should be detailed in the Construction Phase H,S&E Plan and should include measures such as dust suppression and covering of odorous/vapour generating soils.

Wagons carrying soils to and from site should be sheeted and measures should be adopted to keep local roads free of dust, soils and other site materials. The movement of vehicles on-site should be controlled to avoid spread of contamination.

5.8 Unexpected Contamination

Given the historical use of the site, it is likely that, as yet unidentified contamination, will be encountered during the remediation and development works.

The machine operators and on-site personal should be made aware that unexpected contamination may be encountered and observe the ground during excavation/ground disturbance. Any indications of stained, unusually coloured or odorous soils or liquids, hydrocarbons and potential ACM should be reported and works in that area cease until further assessment has been undertaken.

Access to the impacted area should be restricted until the nature of the material and the potential risks it poses are understood. If suspected ACM or volatile contamination is encountered it should be covered immediately to prevent the disbursement of fibres or vapours into air.

The suitably qualified person shall advise on the most appropriate course of action, including any sampling required, to manage any risks posed by the contamination. This may include the use of additional personal protective equipment and/or enhanced protection methods. The characterisation of the material, the subsequent decision making process and outcomes should be detailed in the Verification report.

5.9 Works Verification

Records of operations relating to the works should be maintained on site and included in Verification report. The records should include, but are not limited to:

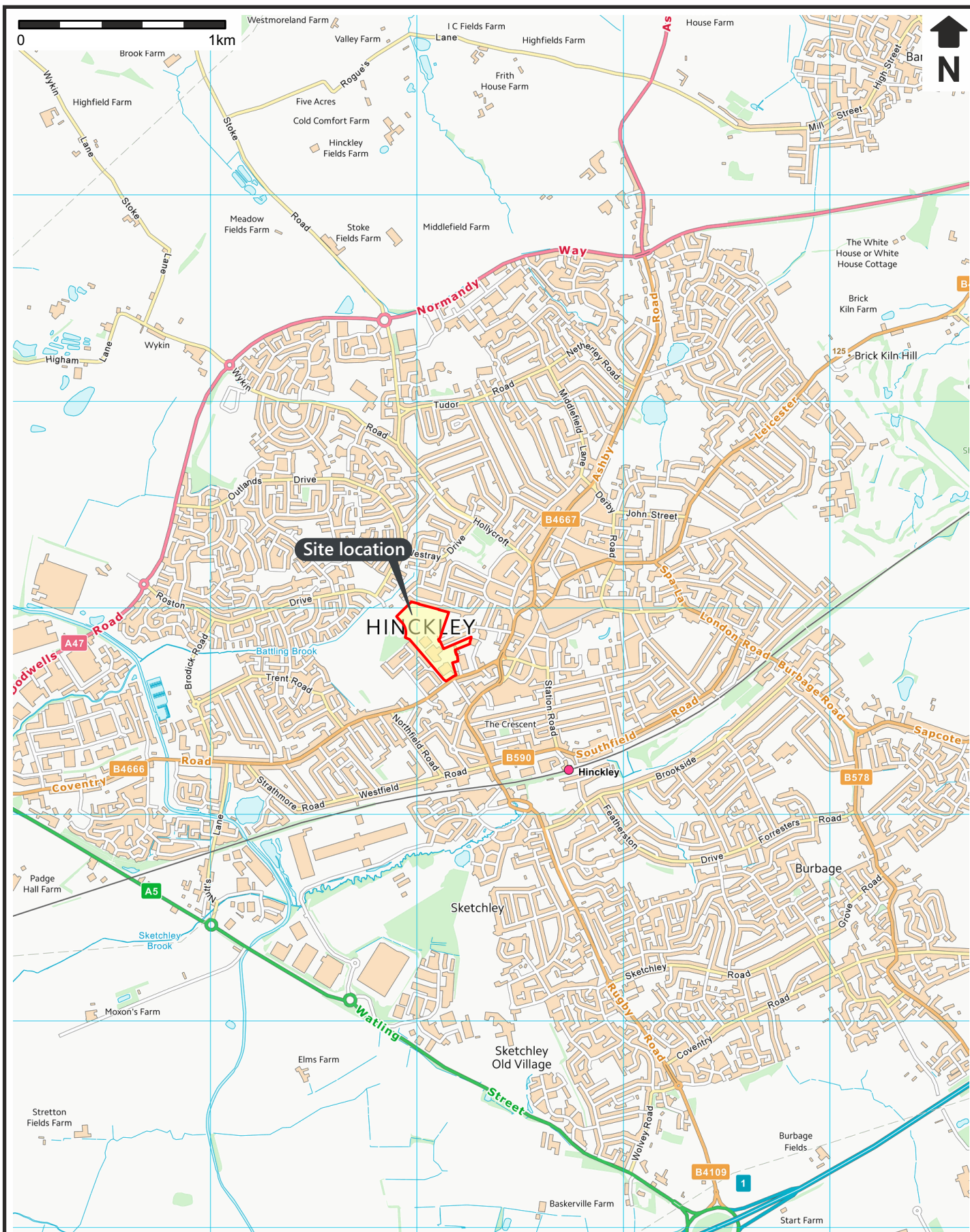
- A daily record of site activities;
- Health and safety records including inductions, and any incidents or accidents reported;
- Details of the areas excavated;
- Soil and water analytical test results and material sentencing;
- Technique-specific sampling and analytical data to verify treatment (eg. Tank test results for S&S);
- Stockpile plans, records and details of where any re-used material has been placed;
- Verification records and report from the independent third party relating to the installation of gas/vapour membranes;

- A photographic record of works
- Confirmation of cover soil depths, membranes, etc.;
- Excavation plans for remediation excavation extents and locations of all validation samples;
- As-built drawings detailing:
 - Initial site conditions;
 - Formation levels (include top and base of excavations);
 - Remnant structures/pipe work, if encountered;
 - All verification sample locations; and,
 - Final site conditions.
- Records of volumes of water pumped from excavations and disposal records;
- Wagon movements on- and off-site and duty of care and waste disposal documentation;
- Volumes of surplus material removed from site, site-won material, treated soils and imported fill;
- Details of variations to the final remediation strategy; and
- Details of quality control and assurance procedures adopted and identify whereabouts of records
- Environmental monitoring records including:
 - Reasons and periods of monitoring activities;
 - Environmental monitor test results;
 - Analytes, frequency of monitoring, duration, who requested the work and who receives and acts on the data should be reported; and,
 - Summary of environmental incidents (including complaints), emergencies and what mitigating actions were adopted.
- Relevant correspondence with the Council and Environment Agency.
- Residual risk assessment and clarification of the effectiveness of the remediation for the site end-use.

6. References

Author/Publisher	Date	Title
Worley Consulting	December 2024	Phase 1 Desk Study – Brick Kiln Street, Hinckley, 41500-00017_004: Rev A
	May 2025	Environmental Assessment - Phase 2 Factual Site Investigation – Brick Kiln Street, Hinckley, 41500-00017_00401: Rev A
	June 2025	Environmental Assessment - Interpretative Phase 2 Site Investigation – Brick Kiln Street, Hinckley, 41500-00017_00401_I: Rev A
	July 2025	Controlled Waters Detailed Quantitative Risk Assessment – Brick Kiln Street, Hinckley, 41500-00017_00402_DQRA

Figures



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PROJECT: 00402
BRICK KILN STREET, HINCKLEY

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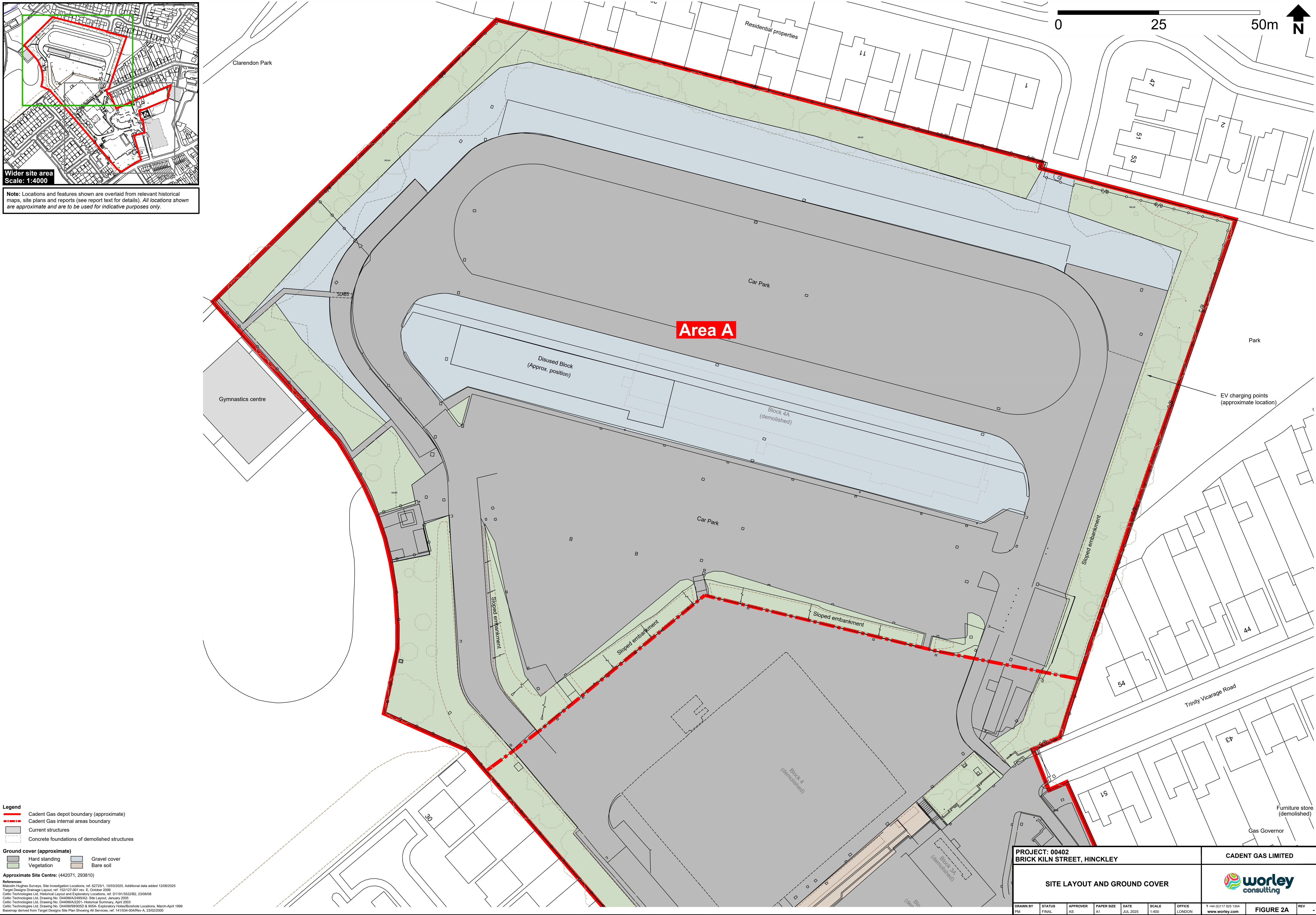
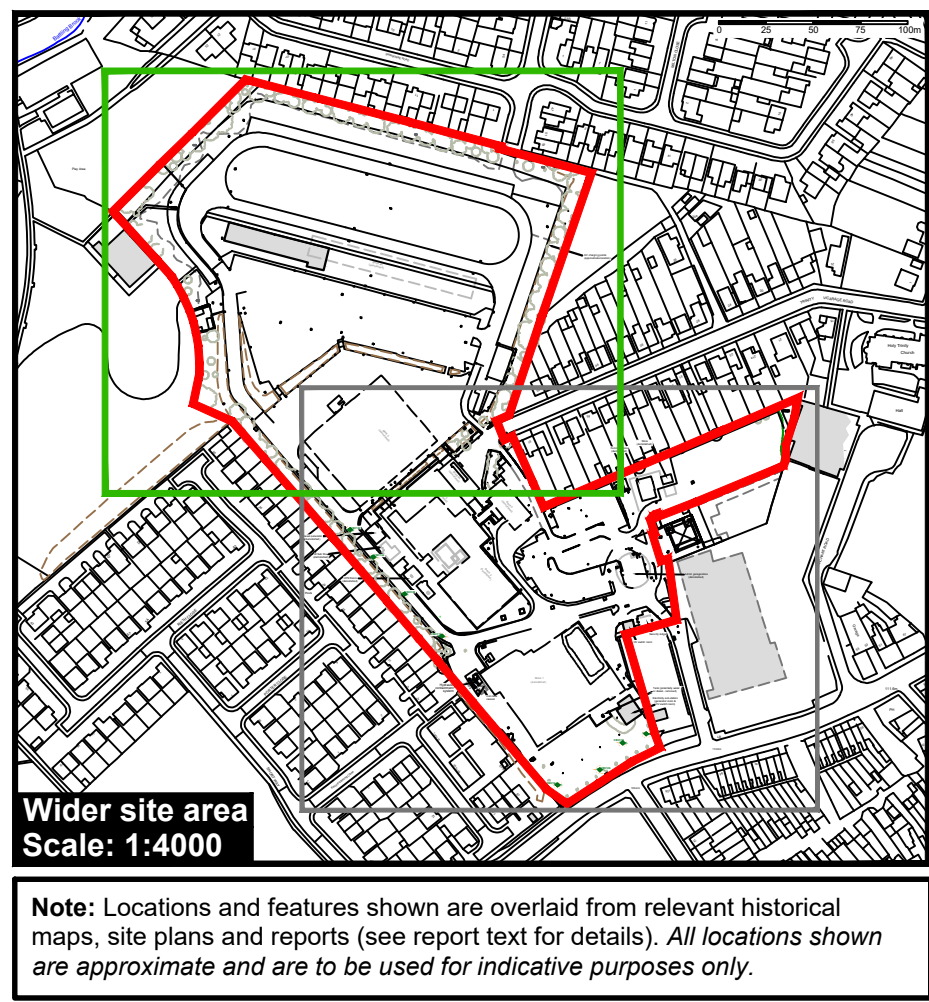
SITE LOCATION PLAN



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- Legend**
- Cadent Gas depot boundary (approximate)
 - - - Cadent Gas internal areas boundary
 - Current structures
 - - - Concrete foundations of demolished structures

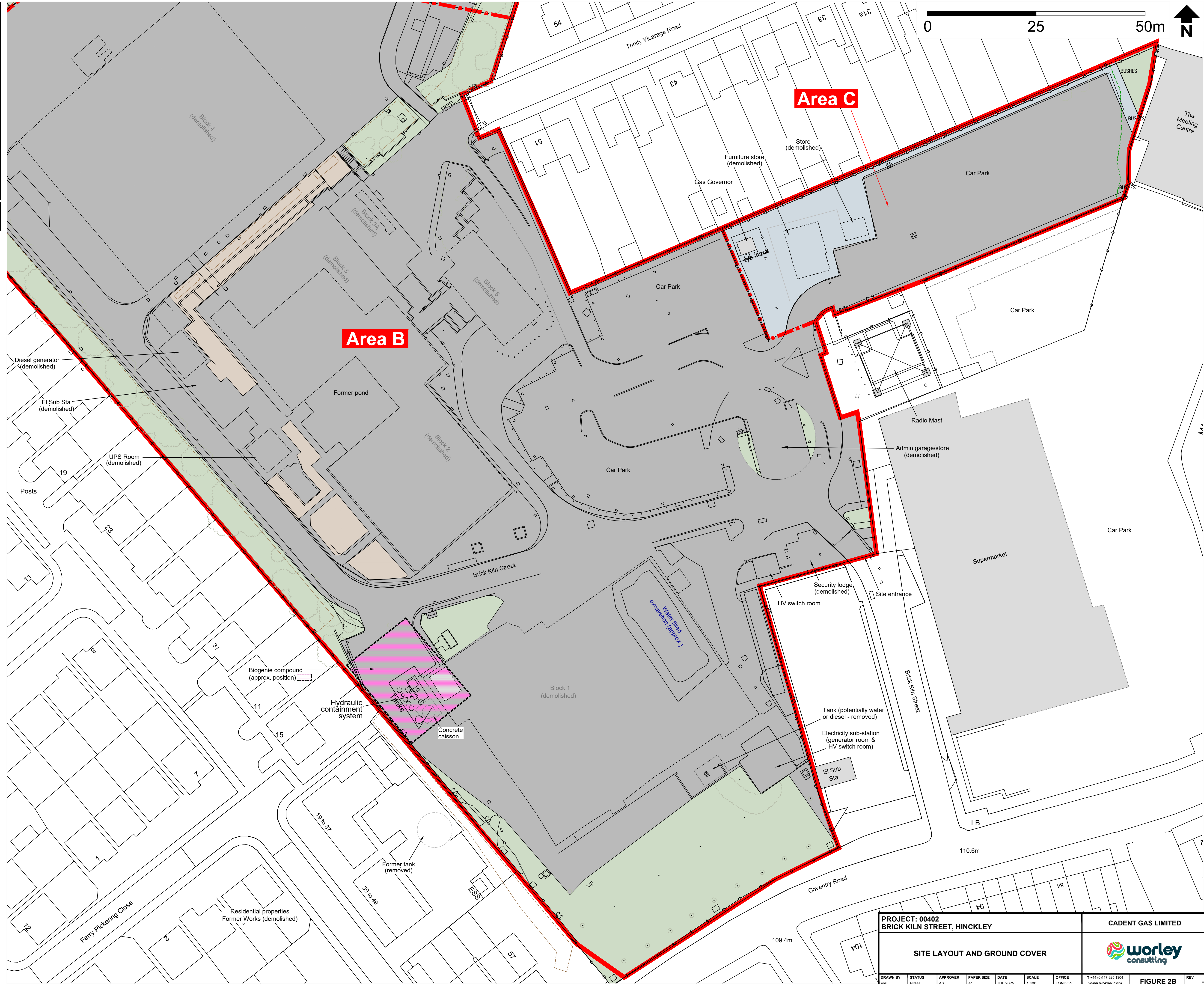
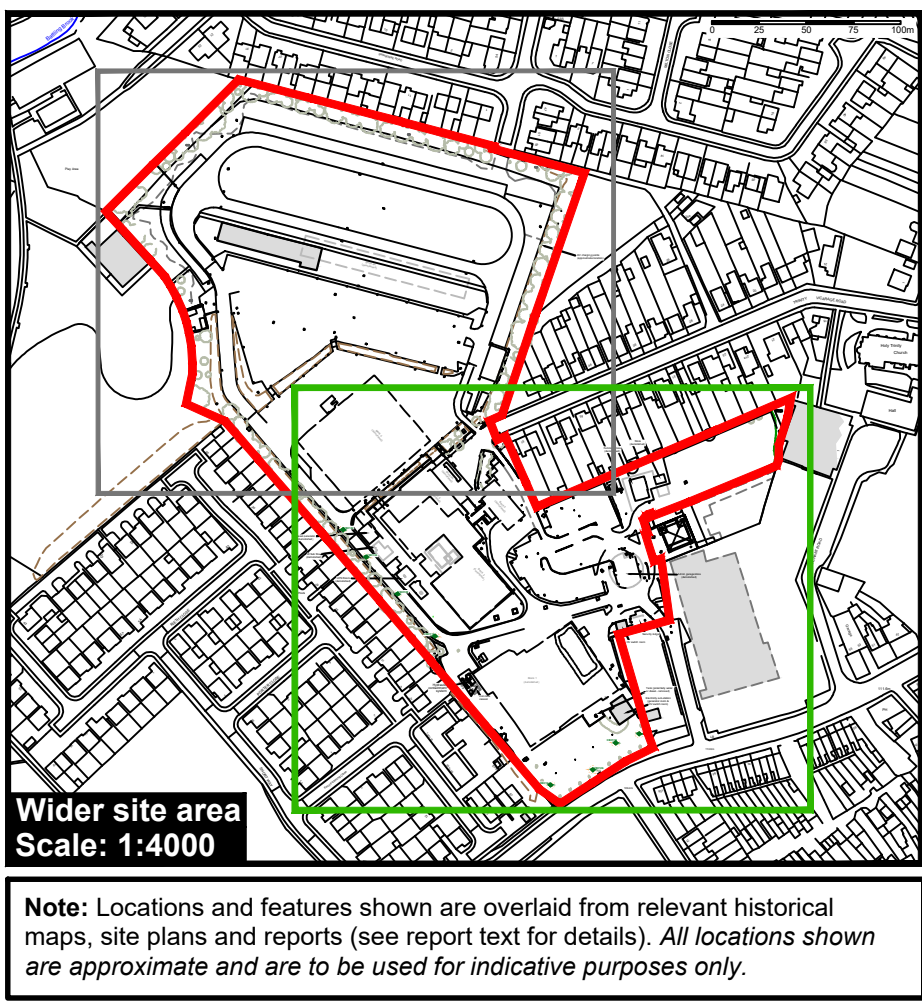
- Ground cover (approximate)**
- Hard standing
 - Vegetation
 - Gravel cover
 - Bare soil

Approximate Site Centre: (442071, 293810)

References:

- Malcolm Hughes Surveys, Site Investigation Locations, ref. 827251, 10/03/2025, Additional data added 12/06/2025
- Target Designs Drainage Layout, ref. 152127-001 rev. E, October 2006
- Celtic Technologies Ltd, Historical Layout and Exploratory Locations, ref. D1191052082, 23/06/08
- Celtic Technologies Ltd, Drawing No. D440MA2650A2, Site Layout, January 2005
- Celtic Technologies Ltd, Drawing No. D440MA2201, Historical Summary, April 2003
- Celtic Technologies Ltd, Drawing No. D440MA090502 & 0504, Exploratory Holes/Borehole Locations, March-April 1999
- Base map derived from Target Designs Site Plan Showing All Services, ref. 141034-004/Rev A, 23/02/2000

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SITE LAYOUT AND GROUND COVER							
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FIGURE 2A						REV	-



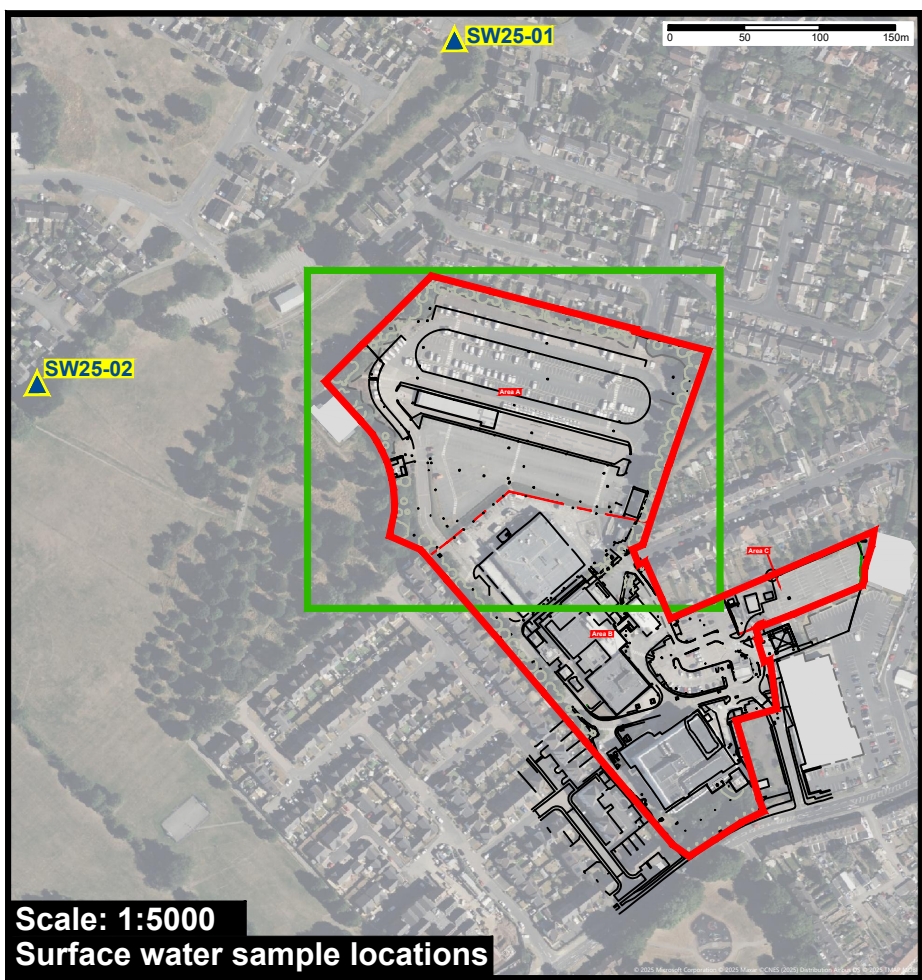
- Legend**
- Cadent Gas depot boundary (approximate)
 - - - Cadent Gas internal areas boundary
 - Current structures
 - Concrete foundations of demolished structures
- Ground cover (approximate)**
- Hard standing
 - Vegetation
 - Gravel cover
 - Bare soil

Approximate Site Centre: (442071, 293810)

References:

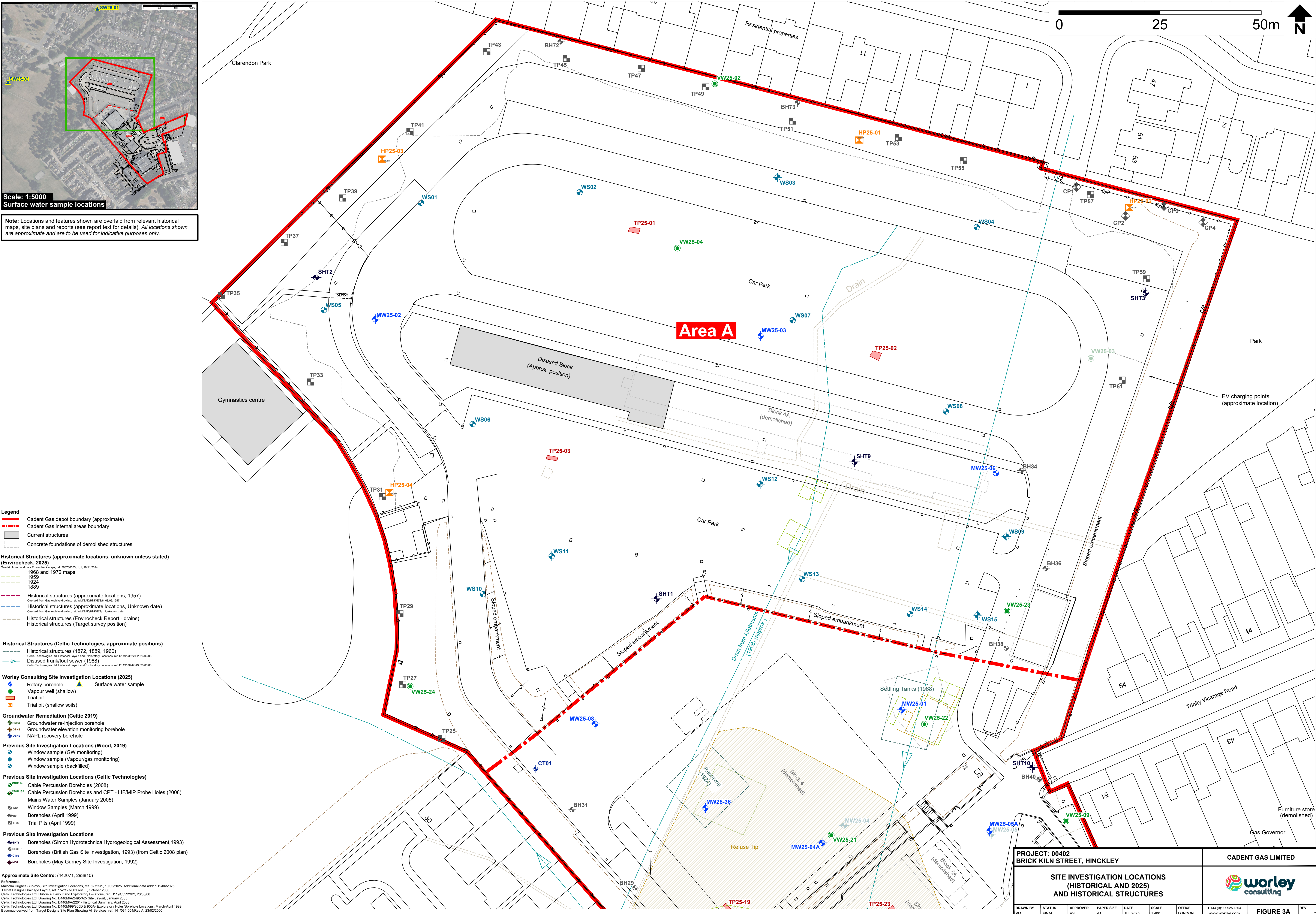
- Malcolm Hughes Surveys, Site Investigation Locations, ref. 82725/1, 10/03/2025, Additional data added 12/06/2025
- Target Designs Drainage Layout, ref. 152127-001 rev. E, October 2006
- Celtic Technologies Ltd, Historical Layout and Exploratory Locations, ref. D1191/052/082, 23/06/08
- Celtic Technologies Ltd, Drawing No. D440MA/2650/02, Site Layout, January 2005
- Celtic Technologies Ltd, Drawing No. D440MA/2201, Historical Summary, April 2003
- Celtic Technologies Ltd, Drawing No. D440MA/090/002 & 0004, Exploratory Holes/Borehole Locations, March-April 1999
- Base map derived from Target Designs Site Plan Showing All Services, ref. 141034-004/Rev A, 23/02/2000

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SITE LAYOUT AND GROUND COVER						 worley consulting		
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Scale: 1:5000
Surface water sample locations

Note: Locations and features shown are overlaid from relevant historical maps, site plans and reports (see report text for details). All locations shown are approximate and are to be used for indicative purposes only.



- Legend**
- Cadent Gas depot boundary (approximate)
 - - - Cadent Gas internal areas boundary
 - ▭ Current structures
 - - - Concrete foundations of demolished structures

Historical Structures (approximate locations, unknown unless stated) (Envirocheck, 2025)

- Overlaid from Landmark Ordnance Survey, ref. 30379003, 1, 1, 18/11/2024
- 1959 and 1972 maps
 - 1959
 - 1924
 - 1989
 - Historical structures (approximate locations, 1957)
Overlaid from Gas Archive drawing, ref. WMEADHMK/EE1, 06/03/1957
 - Historical structures (approximate locations, Unknown date)
Overlaid from Gas Archive drawing, ref. WMEADHMK/EE1, Unknown date
 - Historical structures (Envirocheck Report - drains)
 - Historical structures (Target survey position)

Historical Structures (Celtic Technologies, approximate positions)

- Historical structures (1872, 1889, 1960)
Celtic Technologies Ltd. Historical Layout and Exploratory Locations, ref. D11913622/82, 23/06/08
- Disused trunk/foul sewer (1968)
Celtic Technologies Ltd. Historical Layout and Exploratory Locations, ref. D11913447/03, 23/06/08

Worley Consulting Site Investigation Locations (2025)

- ⊕ Rotary borehole
- ⬆ Surface water sample
- ⬆ Vapour well (shallow)
- ⬆ Trial pit
- ⬆ Trial pit (shallow soils)

Groundwater Remediation (Celtic 2019)

- ⊕ Groundwater re-injection borehole
- ⊕ Groundwater elevation monitoring borehole
- ⊕ NAPL recovery borehole

Previous Site Investigation Locations (Wood, 2019)

- ⊕ Window sample (GW monitoring)
- ⊕ Window sample (Vapour/gas monitoring)
- ⊕ Window sample (backfilled)

Previous Site Investigation Locations (Celtic Technologies)

- ⊕ Cable Percussion Boreholes (2008)
- ⊕ Cable Percussion Boreholes and CPT - LIF/MIP Probe Holes (2008)
- ⊕ Mains Water Samples (January 2005)
- ⊕ Window Samples (March 1999)
- ⊕ Boreholes (April 1999)
- ⊕ Trial Pits (April 1999)

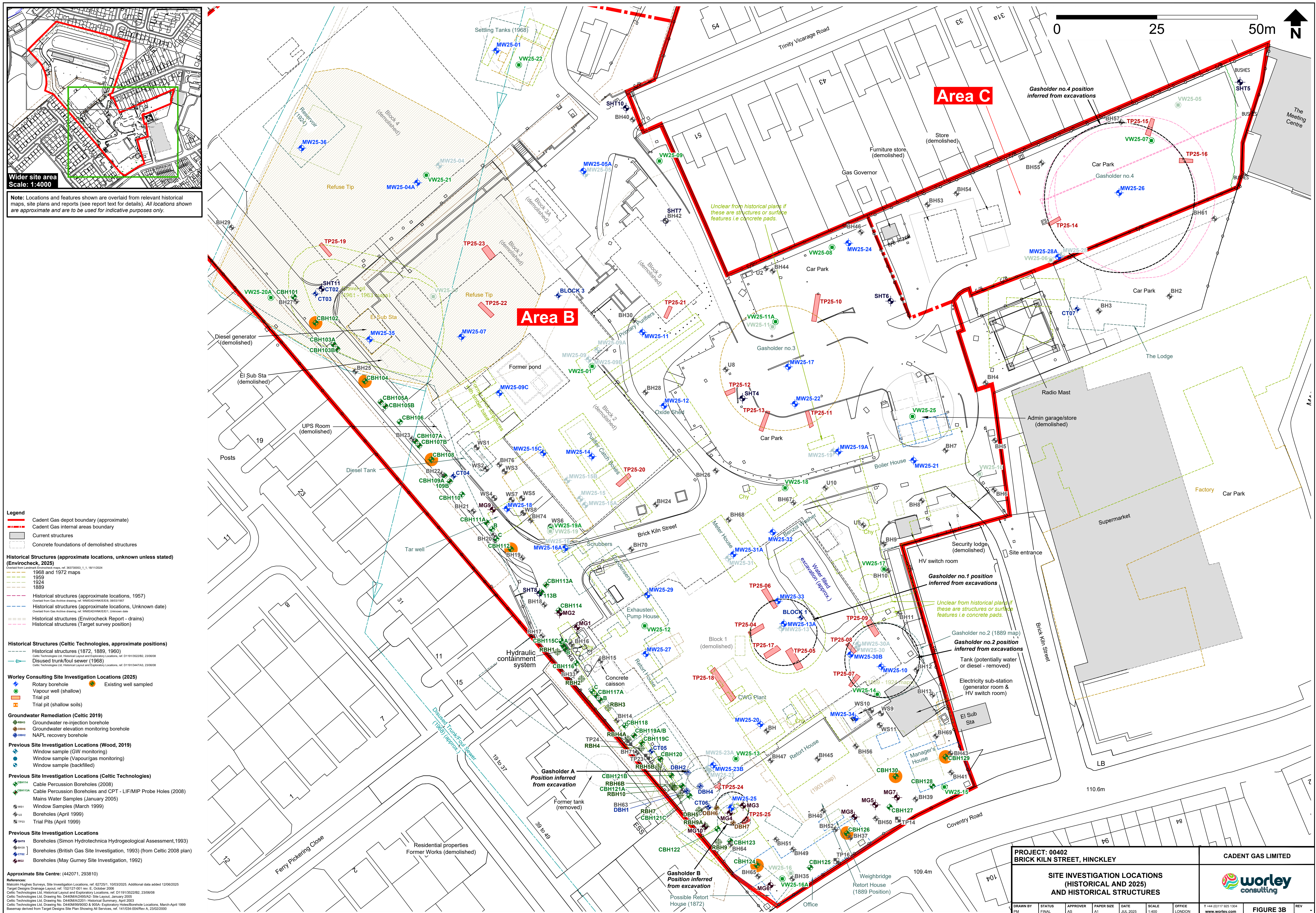
Previous Site Investigation Locations

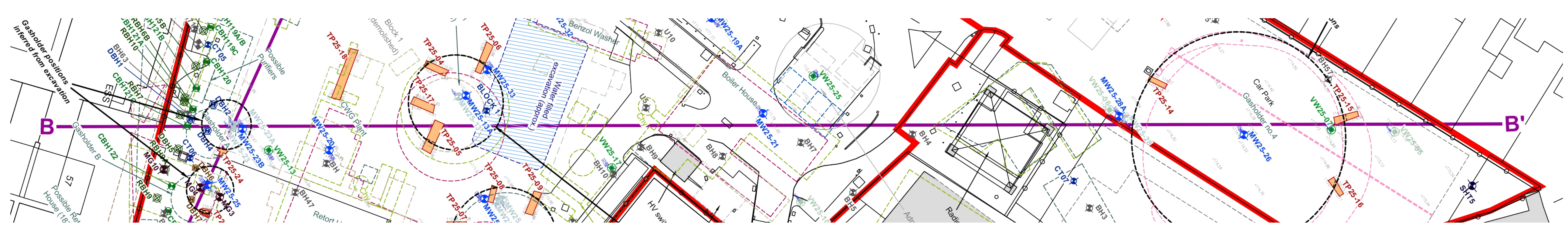
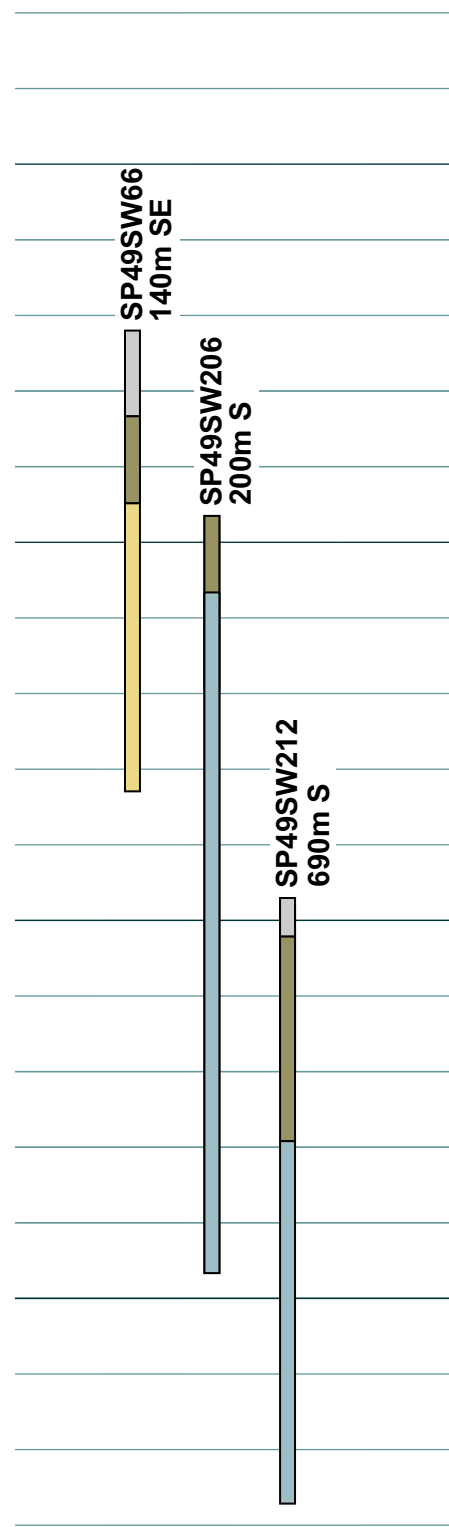
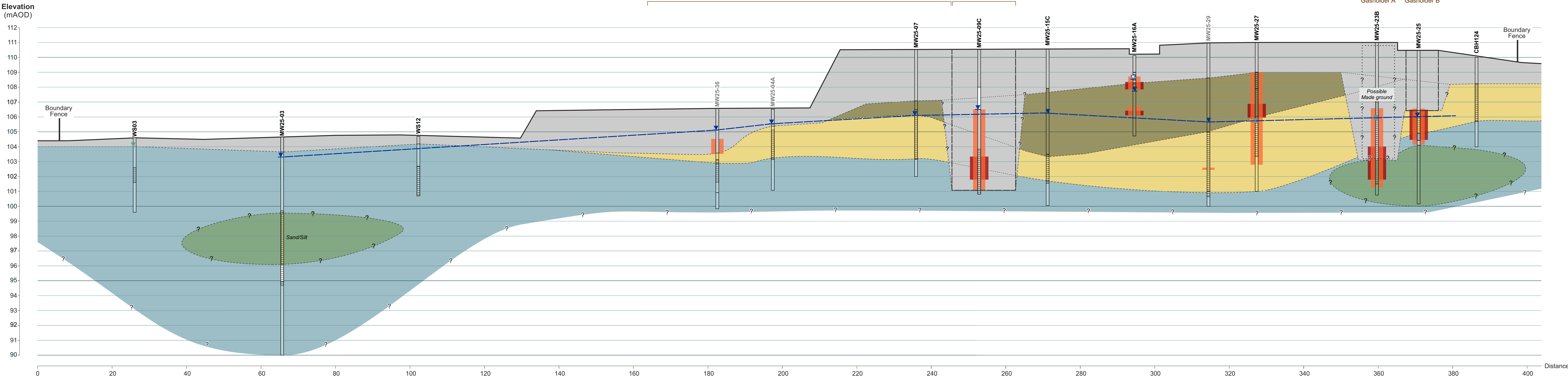
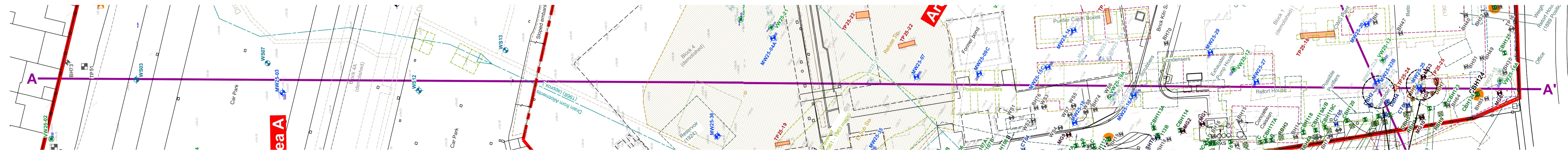
- ⊕ Boreholes (Simon Hydrotechnica Hydrogeological Assessment, 1993)
- ⊕ Boreholes (British Gas Site Investigation, 1993) (from Celtic 2008 plan)
- ⊕ Boreholes (May Gurney Site Investigation, 1992)

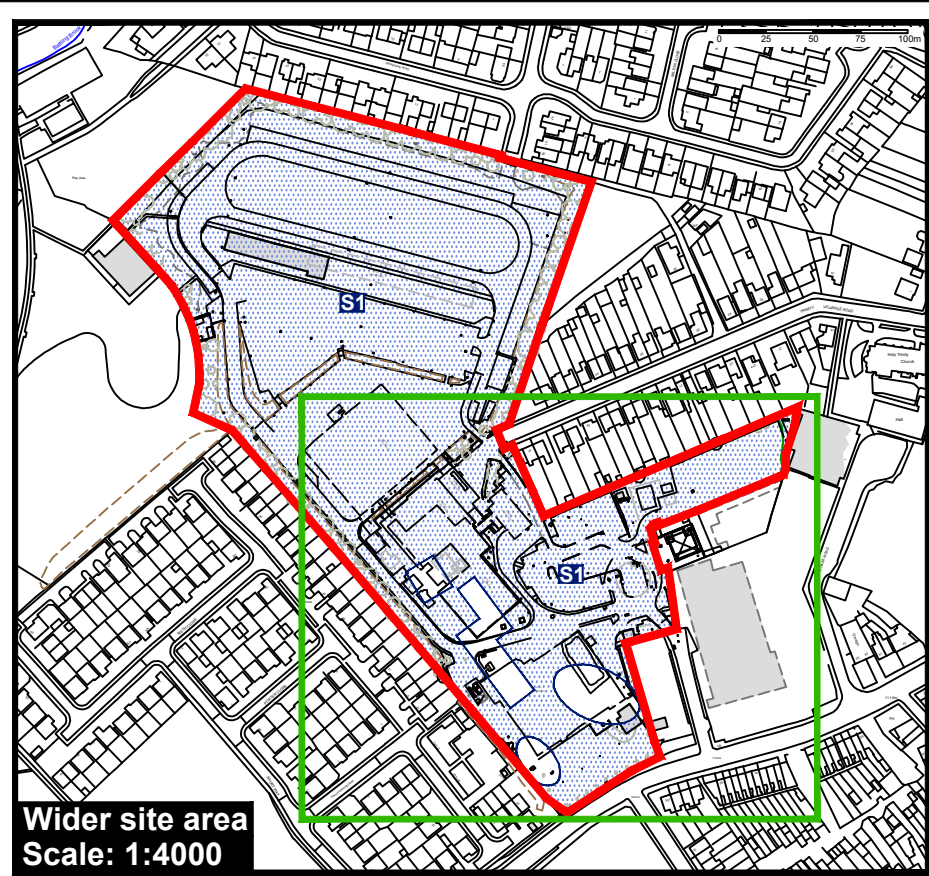
Approximate Site Centre: (442071, 293810)

References:
Malcolm Hughes Surveys, Site Investigation Locations, ref. 62725/1, 10/03/2025. Additional data added 12/06/2025
Target Designs Drainage Layout, ref. 152/127-001 rev. E, October 2006
Celtic Technologies Ltd. Historical Layout and Exploratory Locations, ref. D11913622/82, 23/06/08
Celtic Technologies Ltd. Drawing No. D440MA/2495/A2- Site Layout, January 2005
Celtic Technologies Ltd. Drawing No. D440MA/2271- Historical Summary, April 2003
Celtic Technologies Ltd. Drawing No. D440M/95/00D & 905A- Exploratory Notes/Borehole Locations, March-April 1999
Basemap derived from Target Designs Site Plan Showing All Services, ref. 141034-004/Rev A, 23/02/2000

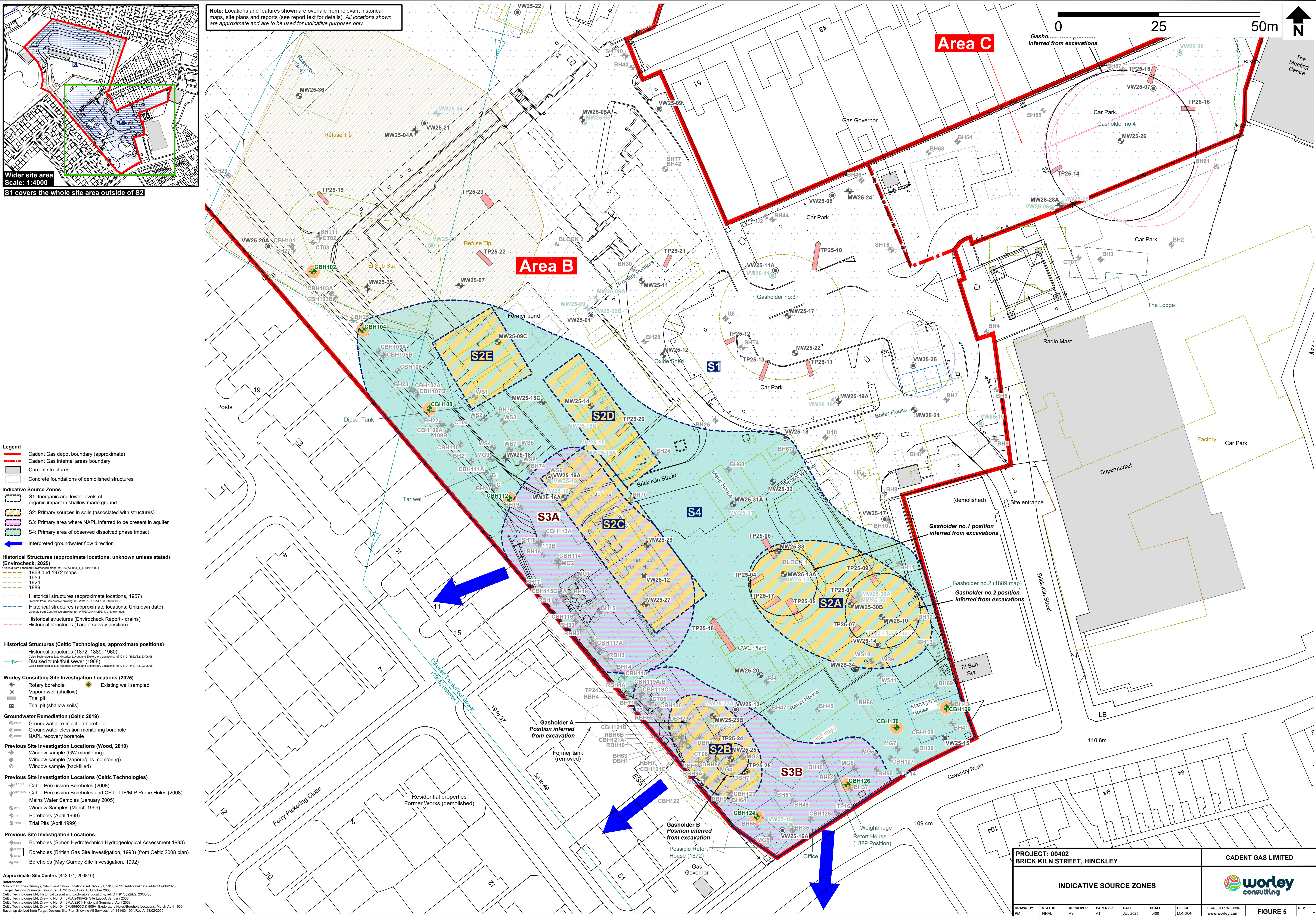
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SITE INVESTIGATION LOCATIONS (HISTORICAL AND 2025) AND HISTORICAL STRUCTURES							
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FIGURE 3A						REV	-







Wider site area
Scale: 1:4000
S1 covers the whole site area outside of S2

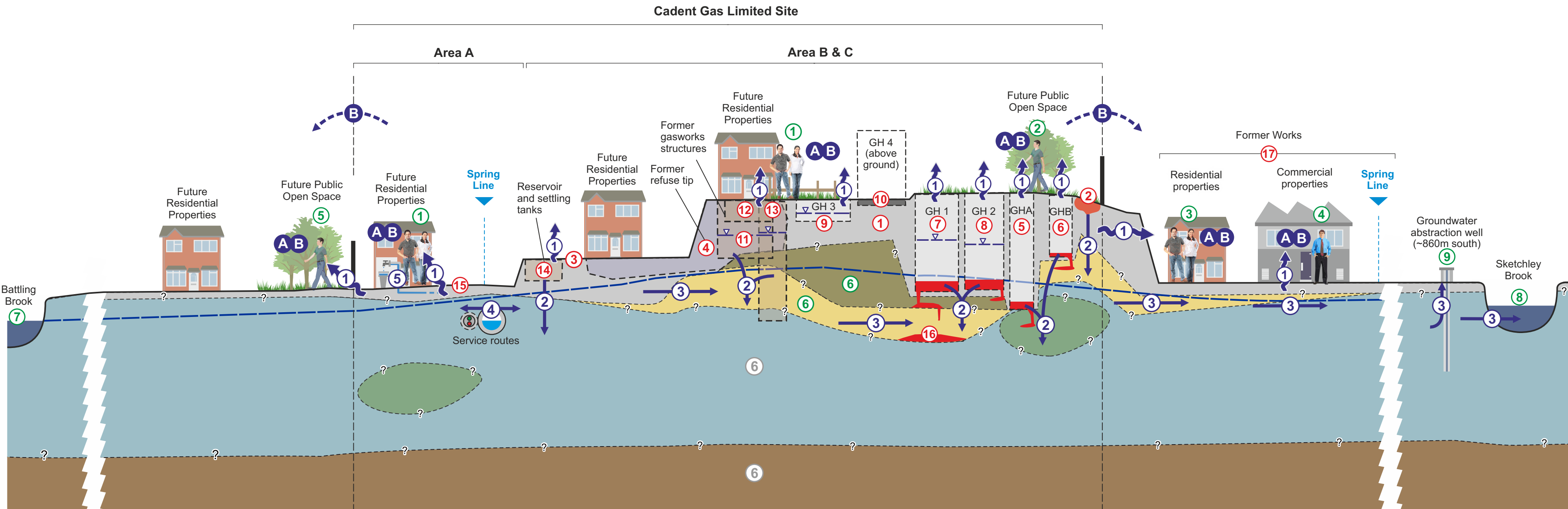


- Legend**
- Cadent Gas depot boundary (approximate)
 - Cadent Gas internal areas boundary
 - Current structures
 - Concrete foundations of demolished structures
- Indicative Source Zones**
- S1: Inorganic and lower levels of organic impact in shallow made ground
 - S2: Primary sources in soils (associated with structures)
 - S3: Primary area where NAPL inferred to be present in aquifer
 - S4: Primary area of observed dissolved phase impact
 - Interpreted groundwater flow direction
- Historical Structures (approximate locations, unknown unless stated) (Envirocheck, 2025)**
- 1968 and 1972 maps
 - 1959
 - 1924
 - 1889
 - Historical structures (approximate locations, 1957)
 - Historical structures (approximate locations, Unknown date)
 - Historical structures (Envirocheck Report - drains)
 - Historical structures (Target survey position)
- Historical Structures (Celtic Technologies, approximate positions)**
- Historical structures (1872, 1889, 1960)
 - Disused trunk/foul sewer (1968)
- Worley Consulting Site Investigation Locations (2025)**
- Rotary borehole
 - Existing well sampled
 - Vapour well (shallow)
 - Trial pit
 - Trial pit (shallow soils)
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- Groundwater re-injection borehole
 - Groundwater elevation monitoring borehole
 - NAPL recovery borehole
- Previous Site Investigation Locations (Wood, 2019)**
- Window sample (GW monitoring)
 - Window sample (Vapour/gas monitoring)
 - Window sample (backfilled)
- Previous Site Investigation Locations (Celtic Technologies)**
- Cable Percussion Boreholes (2008)
 - Cable Percussion Boreholes and CPT - LIF/MIP Probe Holes (2008)
 - Mains Water Samples (January 2005)
 - Window Samples (March 1999)
 - Boreholes (April 1999)
 - Trial Pits (April 1999)
- Previous Site Investigation Locations**
- Boreholes (Simon Hydrotechnica Hydrogeological Assessment, 1993)
 - Boreholes (British Gas Site Investigation, 1993) (from Celtic 2008 plan)
 - Boreholes (May Gurney Site Investigation, 1992)
- Approximate Site Centre: (442071, 293810)**
- References:**
- Malcolm Hughes Surveys, Site Investigation Locations, ref. 62725/1, 10/03/2025. Additional data added 12/08/2025
 - Target Designs Drainage Layout, ref. 152/127-001 rev. E, October 2006
 - Celtic Technologies Ltd. Historical Layout and Exploratory Locations, ref. D11910622/82, 23/06/08
 - Celtic Technologies Ltd. Drawing No. D440M/A249/A2, Site Layout, January 2005
 - Celtic Technologies Ltd. Drawing No. D440M/A22/1 - Historical Summary, April 2003
 - Celtic Technologies Ltd. Drawing No. D440M/95/002 & 905A - Exploratory Notes/Borehole Locations, March-April 1999
 - Basemap derived from Target Designs Site Plan Showing All Services, ref. 141034-004/Rev A, 23/02/2000

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INDICATIVE SOURCE ZONES							
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				FIGURE 5			

North

South



Legend

- Made ground
- Oadby Member
- Wolston Sand and Gravel
- Bosworth Clay Member (Clay)
- Bosworth Clay Member (Silt)
- Mercia Mudstone Formation
- Perched water level
- Inferred groundwater level (June 2025)
- Free product noted in the form of globules or pockets of tar
- Contaminant pathways

Sources

- General Made Ground in Area B (not including hotspots of free product), including areas of former predominantly above ground features
- Hotspots of free-phase product within made ground west of former Blocks 1,2 & 3 (including vicinity of cast iron square tar tank)
- Asbestos in soils
- Former refuse tip, and infilled gravel pit
- Infilled Gasholder A - sub-surface structure
- Infilled Gasholder B - sub-surface structure
- Infilled Gasholder 1 - sub-surface structure, including perched waters
- Infilled Gasholder 2 - sub-surface structure, including perched waters
- Infilled Gasholder 3 - sub-surface structure, including perched waters
- Made Ground within Area C (including Gasholder 4 - above ground structure)
- Purifiers in Area B
- Scrubbers and Condensers in Area B
- Former brick structures with timber base in Area B
- Reservoir and settling tanks in Area B
- Made Ground within Area A (former coke tip)
- NAPL and contaminated groundwater (dissolved phase) in Sand and Gravels
- Offsite sources (Former Dye Works/ Hosiery Factory, Printing & Packaging Works)

Pathways (Migration)

- Migration of vapour/gas
- Leaching/dissolution from impacted soil/NAPL
- Migration in groundwater
- Migration via service routes (site drainage/sewers)
- Diffusion through drinking water pipes

Pathways (Exposure)

- A Direct contact (dermal, ingestion, vapour/gas inhalation)
- B Inhalation/direct contact via offsite migration (groundwater, wind-blown)

Receptors

- Future site users – residential with private gardens (allowing for ingestion of vegetables)
- Future site users – public open space (attenuation ponds and landscaped areas)
- Off-site residential properties (surrounding the site)
- Off-site commercial workers (primarily to the southeast)
- Off-site public open space (park) users (Clarendon Park in the northeast and Granville Road Park in the south)
- Groundwater - the Secondary A Aquifer associated with the Wolston Sand & Gravel Member and the Secondary B Aquifer associated with the Oadby Member. The Mercia Mudstone Formation and the Bosworth Clay Member are designated unproductive and not considered as receptors.
- Surface Water: Battling Brook
- Surface Water: Sketchley Brook
- Groundwater extraction well - located approximately 860 m south of site for general farming and domestic use

PROJECT: 00402 BRICK KILN STREET, HINCKLEY								CADENT GAS LIMITED		
CONCEPTUAL SITE MODEL								worley consulting		
DRAWN BY PM	STATUS FINAL	APPROVER AS	PAPER SIZE A2	DATE JUL 2025	SCALE N/A	OFFICE LONDON	T +44 (0)117 925 1304 www.worley.com	FIGURE 6	REV -	

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