



Geo-Environmental Assessment

Dyson Road, Edmonton

Presented to Lifestory Group Limited

Issued: June 2020

Delta-Simons Project No. 20-0337.01



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Report Details

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Specialising in Environment, Health & Safety and Sustainability, Delta-Simons provide support and advice within the property development, asset management, corporate and industrial markets. Operating from ten locations - Lincoln, Birmingham, Bristol, Dublin, Leeds, London, Manchester, Newcastle, Norwich and Nottingham - we employ over 100 environmental professionals, bringing experience from across the private consultancy and public sector markets.

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Executive Summary

Brief	Delta-Simons Environmental Consultants Limited ('Delta-Simons') was instructed by Lifestory Group Limited (the 'Client') to undertake a Geo-Environmental Assessment for land off Dyson Road, Edmonton, N17 0RU (hereafter referred to as the 'Site'). The purpose of this assessment is to identify the potential for land contamination issues to be present at the Site in the context a continued commercial end use.
Site Setting	The site has undergone several periods of demolition and construction and was previously a chocolate manufacturing and footwear manufacturing factory. In more recent times the Site has been used as part of a vehicle recycling centre and is currently occupied by a car sale office and yard. Several buildings currently remain on site, including a long single story building along the northern perimeter, currently used as a car body works and spraying workshop. A two story building with single story warehouse occupies the north east of the Site and is currently utilised as offices and an indoor car showroom. Currently the site is covered in concrete hardstanding. A series of disconnected underground tanks are located in the south east corner of the Site, previously used for oil and waste fuel storage. A review of historical reports indicates that four large ASTs were located in the south east of the Site, and during the removal of the ASTs a small spill of diesel is indicated to have occurred. The Kempton Park Gravels beneath the Site are classified as a Secondary A Aquifer which is underlain by the London Clay Formation which is classified as an Unproductive Stratum. The deeper strata is anticipated to comprise the Lambeth Group and chalk at depth with the Site also indicated to lie within a Source Protection Zone II which is considered to correspond to the deeper chalk aquifer.
Ground Conditions	Ground conditions were found to comprise a variable thickness of granular Made Ground to 1.0m bgl bearing onto soft clays of the Enfield Silt Formation to 2.0m bgl which in turn are underlain by the Kempton Park Gravels to 5.0m bgl. The underlying solid strata was found to comprise the London Clay Formation to 13.4m bgl which is considered to protect the deeper deposits of the Lambeth Group proven to the 15m bgl. During the investigation, localised evidence of hydrocarbon contamination was identified in the shallow soils in the centre of the Site with localised staining also observed in the south east. Groundwater was found to be present at depths between 1.93 and 2.18m bgl in the Kempton Park Gravel and between 2.16 and 8.96m bgl in the Lambeth Group. Groundwater in the shallow aquifer is indicated to flow in a southerly direction.
Land Contamination Assessment	<u>Human Health</u> No significantly elevated contaminants were identified within the shallow soils with the exception of ACMs (amosite and chrysotile fibres) in the Made Ground at two locations. <u>Controlled Waters</u> Elevated contaminant concentrations were not recorded in the deeper Lambeth Group however marginally elevated heavy metals and ammonium were recorded in the Kempton Park Aquifer along with two areas of elevated medium and long chain aliphatic and aromatic hydrocarbons and PAHs in the centre and south east however free phase product was not identified. <u>Ground Gas</u> Preliminary ground gas monitoring indicates the Site can be provisionally classified as CS2

	<u>Contamination Assessment</u> Whilst elevated TPH concentrations have been recorded in the centre and south east of the Site, these are both likely to correspond to lubricant releases and are considered to have a low mobility. Given the generally commercial / industrial nature of the surrounding area, the risk of statutory and third party action is considered to be low, however there is considered to be a low/moderate risk of remedial works should the site be taken forward for development.
Geotechnical Assessment	The depth and distribution of Made Ground and the variable Enfield Silt Member across the site will likely preclude the use of traditional spread foundations and ground bearing floor slabs. Pad foundations taken into the top of the Kempton Park Gravel are likely to provide bearing capacities up to 300 kPa subject to groundwater levels. Where higher working loads are required then a piled foundation solution may need to be adopted. Lightly loaded ground bearing floor slabs may be suitable following proof rolling and inspection for soft spots. Where higher loads are required then a suspended floor slab may need to be considered. The construction of soakaways are unlikely to be suitable given the limited thickness of unsaturated zone at the site and areas of localised organic contamination. Buried concrete may need to be designed to resist DSS – AC2 within the Kempton Park Gravel and DS54- AC4 in the London Clay Formation depending on foundation solution.
Recommendations	Based on the findings of the investigation, it is recommended that the existing USTs be decommissioned if they are not actively in use. Where boreholes are no longer required for future monitoring purposes, it is recommended that these positions are decommissioned in accordance with EA guidance for decommission of boreholes to prevent the creation of pathways into the deeper aquifer. The on site H&S file should be updated to include the findings of this investigation. Routine inspection and maintenance of existing drainage and interceptors given the observed poor state of surface drainage during the Site Walkover.
This is intended as a summary only. Further detail and the limitations of the assessment are provided within the main body of the Report.	

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1.0 Introduction

1.1 Appointment

Delta-Simons Environmental Consultants Limited ("Delta-Simons") was instructed by Lifestory Group Limited (the "Client") to prepare a Geo-Environmental Assessment for Land located at Dyson Road, Edmonton (the "Site").

1.2 Context & Purpose

The aim of the study was to complete a geo-environmental assessment of the proposed development area in order to support the proposed divestment of the Site and to address concerns of future potential purchasers. The investigation has obtained information regarding ground conditions, from which risks to end-users, the environment and structures have been assessed, with mitigation measures suggested where necessary.

The investigation has also gathered geotechnical information to inform comment on the preliminary design of foundations and infrastructure. The report provides recommendations for further work (where appropriate) based on the findings of the investigation.

1.3 Scope of Works

The scope of the investigation and layout of this report has been designed with consideration of guidance on Land Contamination: Risk Management pages of the [GOV.UK](https://www.gov.uk) web pages, the relevant requirements of the National Planning Policy Framework 2019 (NPPF) (paragraphs 170 & 178-180)¹ and the Planning Practice Guidance (Land Affected by Contamination)².

The project was carried out to an agreed brief as set out in Delta-Simons' proposal dated 19th March 2020 (ref.20-0337.01). The scope of works is outlined in Section 3.2.1.

1.4 Existing Information

The following information has been made available to Delta-Simons for review:

- ▲ Pre-Purchase Site Appraisal (letter report), 173-175 Willoughby Lane, reference GB/380, dated December 2016
- ▲ Asbestos Survey (Demolition Survey) Report by Life Environmental Sciences Ltd on behalf of Anthology, dated 9th February 2017. Ref: B-64194
- ▲ ASTs and USTs survey by Oakley Soils and Concrete Engineering LTD on behalf of Anthology, dated 15th of December 2016. Ref: BBB/78

1.5 Limitations

The assessment is limited to the issues agreed within the proposal for the works. Notes on limitations associated with this assessment are provided in Appendix A. In addition, there are the following specific limitations that apply to this assessment:

- ▲ It was not possible to locate boreholes within the current building footprints and eastern extremity of the Site, due to occupation by the tenant;
- ▲ It was not possible to inspect the entire surface of the Site for evidence of potential contamination or associated features due to the presence of multiple parked cars;
- ▲ The investigation undertaken was preliminary in nature and was not designed to fulfil planning requirements.

¹ https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779764/NPPF_Feb_2019_web.pdf

² <https://www.gov.uk/guidance/land-affected-by-contamination>

2.0 Site Details

2.1 Site Setting

A summary of the current Site status, environmental setting and key historical features is presented below.

Co-ordinates	Centred approximately at National Grid Reference 534770, 191740	Elevation	10.7 – 10.9 m AOD
		Area	1.0 Ha
Site Location	The Site is located in Tottenham, North London, approximately 0.6 km from Meridian Water Train Station and 13 km to the north of the city of London. A Site location map is provided as Figure 1. The property adjacent to the west of the Site is currently utilised as a vehicle breakers yard, while to the north the Site is bounded by residential properties. Dyson Road bounds the Site to the east with vehicle servicing facilities beyond. The south of the Site is bound by Brantwood Road with warehousing beyond.		
Current Site Use	The Site currently comprises a generally level parcel of land, currently utilised as a car dealership. The east of the Site incorporates two buildings utilised as a showroom and office space. Running parallel across the north of the Site is a building which is used for car spraying and bodyworks. A car wash is located in the south western corner of the Site.		
Proposed Development	No specific development plans have been provided for the Site, and it is understood that the site is to be divested for continued commercial use.		
Site Reconnaissance	Delta Simons conducted a Site visit on the 13th May 2020. Pertinent information that was observed at the Site is summarised as follows. ▲ The Site is generally level and covered with concrete hardstanding, noted to be in good condition. Several large retaining walls constructed from reclaimed railway sleepers were present around the western and southern boundaries of the Site and centrally. ▲ A large raised concrete plinth was also noted in the central area of the Site, likely housing former compacting equipment. ▲ A long single story building runs the length of the northern site boundary. Parts of the building were noted to be in disrepair while other parts of the building were utilised as an auto body works and paint spraying workshop. Several large barrels and drums were noted within the buildings, along with materials used for car spraying and bodyworks. ▲ Two large buildings are present in the north east of the Site. one building was utilised as a car showroom and the other as offices, relating to the car garage. ▲ A car wash area was present in the south west of the Site, with water appearing to drain into on Site drainage. ▲ The majority of the Site was used for car storage with limited access routes present. ▲ Five underground tanks were noted in the south east of the Site, cars were parked on top of the access chambers and it was not possible to assess the current state or visually check for signs of spills. ▲ Drains throughout the Site were noted to be blocked with several drains noted to have a sheen on the surface. ▲ Interceptor chambers were noted in the east and north of the Site.		

	▲ The central area of the Site contained an area that was confined on all sides by reclaimed railway sleepers and on inspection was noted to contain old car parts within. Photographs from the Site Walkover are included as Appendix B.
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2.2 Environmental Setting

Published Geology	From current British Geological Survey (BGS) data, the Site is indicated to be underlain by superficial deposits of the Enfield Silt Member comprising clay, silt and sand. Deposits of the Kempton Park Gravel Member are likely to be present below, comprising sand and gravel. The London Clay Formation underlays these deposits. Borehole records in close proximity to the Site and located on the Site indicate that underlying the London Clay Formation, the Lambeth Group, Thanet Sands and Chalk Formation are located at depth. Borehole TQ39SW207 drilled in 1935 for Jameson's Chocolates Ltd, located 10m to the west of the Site indicates the following geological succession to be present: ▲ Made Ground and the Enfield Silt Member to depths of 1.2 m bgl ▲ Sand and Gravel to 4 m bgl ▲ Clay and Sandy clay to 12 m bgl ▲ Mottled clay to 15.5 m bgl ▲ Yellow sand to 19 m bgl ▲ Grey sand to 24 m bgl ▲ Sandy gravelly clay to 30 m bgl ▲ Green sand to 36 m bgl ▲ Chalk at 91 m bgl Three shallow trial pits were also completed within the Site boundary (TQ39SW670/671 and 673). Made Ground deposits were typically found to shallow depths of 0.6m bgl with associated hydrocarbon odours bearing onto broadly similar geology as identified and proven to 2.1m bgl.
Hydrogeology	According to current Environment Agency (EA) data, the superficial deposits are classified as Unproductive Strata. The underlain Kempton Park Gravel is classified as Secondary A Aquifer. The underlying Chalk is classified as a Principal Aquifer. The Site is located within a Source Protection Zone II (SPZ) and 96 m west of a SPZ I, and are likely to relate to groundwater abstraction within the Principal Chalk Aquifer. There are six groundwater abstraction licenses within 500m of the Site,. The nearest is located 22m to the west corresponding to a now revoked/ lapsed license permitted to abstraction groundwater for industrial processing associated with a former factory at the Site. A further three licenses are associated with the abstraction of groundwater for remediation purposes to the north east of the site (200-300m) with the remaining two licenses corresponding to an abstraction permit for laundry use 463m to the south east. The nearest potable abstraction point is located approximately 770m to the north east for mineral water bottling operated by Coca Cola and Schweppes which is permitted to abstract up to 360m3 of water per day. A former abstraction well is indicated to be present 20m to the west of the Site and is assumed that this is no longer active.

	There is one revoked listing discharge Consent for treated sewage effluent water into land/soakaway for 308m east of the Site. There are two listings for pollution incidents to controlled waters within 250 m of the Site comprising a Category 2 – Significant Incident, located 87 m north east of the Site relating to oils and a separate Category 3 – Minor Incident, located 183 m east of the site relating to oils. The nature of the receiving water was not specified. Groundwater was not encountered within any of the trial pits completed at the Site with groundwater within the deeper chalk aquifer indicated to have a resting water level of approximately 34m bgl. Whilst not encountered, groundwater is expected to be present in the Kempton Park Gravels and is likely to flow in an easterly direction towards the River Lee Navigation.
Hydrology	The nearest surface water feature is Pymmes Brook located 291m to the east. Banbury and Lockwood reservoirs are located approximately 500m to the east. According to the Envirocheck® Report, there are no surface water abstractions located within 500 m of the Sites. The Site is indicated to lie within a Flood Zone 2. There are no discharges to surface water within 500m of the Site. The nearest Substantiated Pollution Incident comprised the release of oils 145 m west in 2018, which was classified as a Category 1 ‘Major Incident’
Coal Mining	Reference to the Coal Authority on-line viewer indicates that the Site is not within a Coal Mining Reporting Area and is not within a Development High Risk Area. Consequently, a Coal Mining Risk Assessment (CMRA) is unlikely to be required under the planning regime.
Radon Gas	Information contained within the Landmark Report indicates that the Site lies within an area where less than 1% of homes are above the National Radiological Protection Board (NRPB) recommended “action level” for radon. BRE211 (2015) indicates that no radon protective measures are necessary in the construction of new buildings at the Site.
Ecological Receptors	It is understood from information provided within the Envirocheck® Report, there are no statutory ecological receptors located within 500m of the Site.
Heritage Interest	According to Historic England.org.uk, there are no area of heritage interest located within 500m of the Site.
Environmental Sensitivity	Whilst the Site is located over a Secondary A Aquifer and Principal aquifer at depth which is likely to benefit from protection by the overlying London Clay Formation, given the current nature of the Site and surrounding area comprising commercial/industrial land uses , nature of recent remediation works and pollution incidents, the Site is considered to be located within an area of Low to Moderate environmental sensitivity.

2.3 Historical Use of the Site & Surrounding Area

Approach	The historical development of the Site and surrounding area has been assessed through a review of available historical OS maps and Google Earth historical satellite imagery. A summary of the key historical Site uses and developments in the surrounding area is presented below. Copies of pertinent historical maps are included as Appendix B.
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Historical Features On-Site	The earliest available mapping (1867) indicates that the Site was occupied by Whitebraid Hill Farm with a small pond in the north east (and no longer visible by 1914). By 1935 two buildings appear on Site: a chocolate factory is located in the north of Site and a footwear factory in the south with an access road intersecting the northern and southern factories. By 1956 'tanks' are labelled in the centre of the Site immediately to the north of the access road. This is followed in 1960 by the presence of a tank on the midpoint of the western Site boundary. The Site remained in this configuration until 2006 where the central and western part of the northern factory was demolished.. The southern factory was demolished by 2009 with the site utilised as a car recycling/dismantling centre.
Historical Features Off-Site	The earliest available mapping from 1868 indicates the surrounding area to be a combination of undeveloped agricultural land and farms. Dysons Road, intersects the north of the Site. 1873 mapping also indicates Tottenham and Edmonton gas works approximately 200m east of the Site. By 1914 a number of residential properties are located to the north of the Site. By 1935 the surrounding area has become more developed and a number of factories and residential properties surround the Site, in addition to this approximately 100 m east of the Site allotment gardens and a sports ground are present. Key industries surrounding the Site from 1935 mapping include, a Footwear manufactory, Marbolex products factory, Radio works, Gas works and a dresses factory. Further Industrial buildings begin to appear around the Site from 1935 mapping onwards, with factories including warehouses, metal plate works, electrical cable works and furniture works. A subway station appears around 200m north east of the Site in 1990 mapping associates with the great eastern railway. Between 1974 and 1990 the Gas works to the east of the Site appears to have been demolished with only gas holders and small infrastructure remaining on Site. Historically, the area off-Site has been utilised as agricultural/farmland. It then went through a transition period with the gradual appearance of industrial and residential buildings. There is a divide between the north and south areas surrounding the site with the north area being predominantly residential and the south side predominantly industrial use.

2.4 Environmental Database Review

Approach	The Landmark Envirocheck® Report provides a database of environmental information held by various statutory bodies including the EA, Local Authority (LA), Health & Safety Executive (HSE) and HPA amongst others. A full copy of the Envirocheck® Report is provided in Appendix D and the most relevant information is summarised below.
Features On-Site	A revoked licensed waste management facility listing is attributed to the Site for Brantwood Auto Recycling Limited associated with vehicle dismantling the license was revoked in 2015 Two contemporary trade directory, 3 commercial services points of interest, 1 Public infrastructure points of interest, 2 manufacturing and production points of interest entries are listed for the site associated to Brantwood Auto Recycling and Brantwood Metal Recycling.
Potentially Contaminative Features Off-Site	Pertinent entries included within the Landmark Envirocheck® Report located within 100m from the Site include several industrial and trading estates, three licenced waste management facilities, two landfill areas (~800m to the north east), garage services, recycling centres, car body repairs, pet food and animal feeds, MOT testing centres, electrical goods manufacturers, metal workers, car painters, and brewers. There is also an infilled pond to the north of the Site. Within the wider area there are three waste transfer sites within 500m east and southeast of the Site

Potential Sources of Contamination	The review has identified the following potential sources of contamination: ▲ Made Ground (on and off Site) – heavy metals, pH, hydrocarbon fractions, PAHs, inorganic contaminants, SVOCs, VOCs, asbestos, carbon dioxide and methane; ▲ Tanks (on and off Site) – hydrocarbon fractions, PAHs, SVOC and VOCs; ▲ Gas works (off Site) – ammonia, phenol, cyanide, long chain hydrocarbons, VOCs and SVOCS
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2.5 Planning Review/Regulatory Enquiries

Part 2A of the Environmental Protection Act (EPA) 1990	A records search has been requested from the London Borough of Haringey to ascertain the current environmental status of the Site and whether it has been identified as requiring inspection under Part 2A of the Environmental Protection Act 1990, as part of the Council's Contaminated Land Inspection Strategy. The following statement received from Haringey applies to the Site. <i>"From our contaminated land record, the site is not on our list of prioritised sites under Part IIA of the Environmental Protection Act 1990. However, the site was identified as an unspecified factory works of medium risk from our contaminated land site prioritisation record. Our record also shows that the site is within a very close proximity of other potential contaminated land sites identified as electrical substation, unspecified surface or underground tanks as well as for gas manufacture. and distribution of high risk."</i> Copies of correspondence with the EHO are included as Appendix E.
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2.6 Previous Reports

List of Reports	The following reports were made available to Delta Simons: ▲ Asbestos Survey (Demolition Survey) Report by Life Environmental Sciences LTD on behalf of Anthology, dated 9th February 2017. Ref: B-64194 ▲ ASTs and USTs survey by Oakley Soils and Concrete Engineering Ltd on behalf of Anthology, dated 15th of December 2016. Ref: BBB/78 ▲ Soil Condition Desktop Report by GB Card & Partners dated 2nd December 2016. Ref: GB/380
Report Summary Asbestos Survey Report: Life Environmental Sciences 2017	An asbestos survey was undertaken by Life Environmental Sciences in 2017, the survey indicated that asbestos has been identified within the remaining buildings on Site. Asbestos was encountered within several locations including door panels , ceilings, and insulators to electrical cupboards. As the report commissioned was for demolition purposes it was recommended that all asbestos was removed prior to demolition. The report also states that several areas of the buildings were not able to be accessed during the Survey and as such it is assumed that asbestos containing materials were present.
Report Summary AST & UST Survey, Oakley Soils and Concrete Engineering LTD, 2016	Oakley Soils and Concrete Engineering LTD, carried out a survey of underground storage tanks and above ground storage tanks located at the Site and a series of photographs were provided documenting the removal of AST's . Four AST's were located on the eastern side of the Site, in two locations indicated to hold white and red diesel. Based on visual estimates the tanks may have held between 4,000 and 7,500 litres. No secondary bunding appears to have been in place and

	during the removal of the tanks, a localised spill appears to have occurred from around AST3 in the south. The survey also identified five UST's to be present in the south east of the Site which were indicated to have received waste petrol, oil and diesel. The status and contents of the tanks is unknown but UST 1 was indicated to hold waste oil, UST 2 was noted to have a slight solvent odour, UST3 and 5 were unknown and UST 3 indicated to hold waste petrol. The capacity of the tanks was not indicated on the provided drawing with the base of tanks at ~3m bgl.
Report Summary Soil Condition Desktop Report by GB Card & Partners 2016.	GB Card & Partners were instructed to complete a Pre-Purchase Site Appraisal of the Site known as 173 – 175 Willoughby Lane, Tottenham, in relation to the potential development for high rise residential purposes.. Preliminary considerations and recommendations identified within the report included: ▲ The report considered that there was the potential for contamination to be present associated with fuel storage, on site breakers activities and also the potential for upfilling the site with historical gas works waste (including coal tar and iron cyanide) ▲ Specialist decommissioning and removal of all underground tanks and associated pipework. ▲ An intrusive ground investigation to better define and understand ground conditions and the potential contaminative nature of the Site. ▲ Monitoring of soil gas generation / vapour to confirm potential gas protection measures. ▲ Monitoring of groundwater to determine potential impact to nearby receptors. ▲ A UXO assessment.

2.7 Preliminary Conceptual Site Model

A summary of the preliminary Conceptual Site Model is presented below.

Source(s)	Pathways	Receptors	Justification and Mitigation	Preliminary Risk Rating
Potential on-Site Made Ground Deposits. Potential contaminants of concern based on the Sites history include Asbestos, PAHs, Petroleum Hydrocarbons, Gas works waste including cyanide	Direct Ingestion and inhalation of soil bound contaminants.	Current and Future Site users and maintenance workers.	Made Ground deposits are known to be present on Site from previous investigations. Risks posed to current and future users are considered to be low given the presence of hardstanding across the Site, preventing exposure to the underlying soils.	Low to Moderate Risk
	Inhalation of organic vapours		Risks by ground gas and vapours cannot be discounted however no significant hazards have been identified during the operation of the Site and areas of maintenance are expected to have high air exchange preventing the accumulation of potentially hazardous ground gases/ vapour.	
	Migration of ground gas vapours into on Site buildings.		There is considered to be a plausible pollutant linkage between the potentially limited Made Ground and the underlying aquifers (Secondary A aquifer of the Kempton Park Gravel)	
	Leaching of contamination into groundwater	Underlying aquifers. Kempton Park Gravel (Secondary A and Chalk Group – Principle aquifer)		
Historical Fuel USTs and anecdotal evidence of spills.	Direct Ingestion and inhalation of soil bound contaminants.	Maintenance workers.	Due to the built nature of the Site, which is predominantly covered in hardstanding, it is considered unlikely that site users will come into contact with contaminated soils.	Low to Moderate Risk
	Inhalation of organic vapours		The presence of multiple historic and more recent above ground tanks along with the underground storage tanks in the south east combined with the recorded spill may pose a risk to the underlying shallow Secondary A Aquifer.	
	Migration of ground gas vapours into on Site buildings.	Current and Future Site users and maintenance workers.	Ground investigation and subsequent water analysis will need to be undertaken to confirm the presence and	

	Leaching of contamination into groundwater	Underlying aquifers. Kempton Park Gravel (Secondary A and Chalk Group – Principle aquifer)	types of contamination. The risk posed to off-Site third party land should be assessed.	
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3.0 Site Investigation

3.1 Intrusive Investigation

Delta-Simons carried out intrusive investigation work between the 26th May to 3rd June 2020 to assess the potential linkages identified in the outline conceptual model (see Section 2.2 above) and to provide preliminary geotechnical information.

3.1.1 Health & Safety Considerations

Partial Service plans for the site were provided by the client; and service drawings were acquired from utilities providers. A utilities clearance specialist attended the site on 26th May to trace services on and around the site prior to excavation of exploratory hole locations. As a further precaution for the avoidance of buried services, each position was scanned with a CAT (cable avoidance tool) by the supervising engineer.

An initial assessment of the Site identified a moderate potential risk in relation to Unexploded Ordnance (UXO) and so a specific detailed UXO study was obtained from 1st Line Defence. The report identified the following precautionary measures which were applied for the works:

- ▲ Specialist staff induction;
- ▲ Full time site attendance from a UXO specialist during intrusive works;

Future Contractors should undertake their own assessment of UXO risk in relation to their specific proposed scope of works.

3.2 Scope of Ground Investigation and Rationale

3.2.1 Scope

The ground investigation comprised the following items:

- ▲ Supervision of all works by a Delta-Simons Geo-Environmental engineer. All intrusive locations were logged to BS5930:2015 Code of Practice for Site Investigations;
- ▲ Drilling of 10 shallow boreholes holes (DS101 to DS110) using a combination of sonic and dynamic sampling techniques to a maximum depth of 5.0 m bgl with insitu SPTs; and
- ▲ Drilling of three deep Boreholes (BH101 to BH103 inclusive) using sonic drilling techniques to a maximum depth of 15.0 m bgl with insitu SPTs and collection of U100 samples;

Although the assessment did not encounter major limitations, the following specific limitations apply:

- ▲ DS103, was terminated due to the presence of visual and olfactory evidence of contamination preventing the continuation of drilling.
- ▲ During the first round of ground gas monitoring DS101 was blocked due to the presence of concrete on which was subsequently cleared prior to the second monitoring visit.

3.2.2 Rationale

Location	Rationale	Key Contaminants of Concern
BH103, DS108, DS109, DS110	Targeting the eastern area of the Site where AST's (DS108) were previously located and where five USTs are currently located (BH103, DS109 and DS110). BH103 also targets deeper geological strata to determine the contaminative status of deeper groundwater.	Hydrocarbons, PAH, VOCs and SVOCs
DS105, DS106,	Target former above storage tanks in the west (DS105) and centre (DS106)	Hydrocarbons, PAH, VOCs and SVOCs
DS101 to DS104 , DS107, DS109	Targeting boundaries and to ensure a wide coverage across the Site.	Hydrocarbons, PAH, Asbestos, potential gas works waste

Location	Rationale	Key Contaminants of Concern
BH101 – BH102	Targeting deeper strata, to determine the contaminative status of deeper groundwater bodies (Lambeth Group).	Hydrocarbons, PAH

3.3 Ground Investigation Factual Data

The investigation locations were surveyed in by the appointed surveying contractor to an accuracy of approximately +/- 0.1m. An intrusive exploratory hole location plan is presented as Figure 2.

Delta-Simons engineer verified borehole logs are presented as Appendix F, the SPT Calibration Certificates, in accordance with *BS EN ISO 22476-3:2005 (incorporating corrigendum No. 1 2007), Geotechnical investigation and testing - Field testing - Part 3: Standard penetration test for SPT trip hammers* are provided in Appendix F.

3.4 In-Situ Testing and Sampling

SPT tests were undertaken in all boreholes at 1.00 m intervals until 5.00 m bgl, then every 1.5 m bgl thereafter. The results of these tests are presented in the borehole logs included as Appendix F. Corrected SPT values are shown in Figure 3. PID Screening was also undertaken on select samples, results are recorded on Borehole logs included as Appendix F.

Sampling comprised disturbed tub and jar samples as detailed on the borehole logs.

3.5 Geotechnical Laboratory Testing

A selection of soil samples were submitted to the UKAS accredited laboratory for a range of geotechnical testing, the results of which are included in Appendix G.

The programme of geotechnical testing undertaken on samples obtained from the natural soils is presented within the table below. The purpose of the laboratory testing was to assess the classification properties of the soils encountered in order to inform the outline geotechnical design advice.

Analysis	No. Tested	Rationale
Moisture content	17	To enable geotechnical assessment of cohesive soils
Plastic and liquid limits	17	To enable geotechnical assessment of cohesive soils
Particle size distribution	2	To enable geotechnical assessment of granular soils
Undrained Triaxial Shear Strength	2	To enable geotechnical assessment of cohesive soils
Oedometer Consolidation	3	To enable geotechnical assessment of cohesive soils

3.6 Environmental Sampling, In-Situ Testing and Laboratory Analysis

Soils collected for laboratory analysis were placed in a variety of containers appropriate to the anticipated testing suite. Samples were stored in accordance with Delta-Simons' quality procedures to maintain sample integrity and preservation and to minimise the chance of cross contamination. Records of the samples taken as part of the site investigation works, including their depths and location, are included within the exploratory hole records in Appendix D.

Groundwater samples were collected from nine boreholes (on 8th and 9th June and one sample was collected on the 15th June 2020. The groundwater samples were collected using low-flow sampling techniques using a peristaltic pump and dedicated suitable tubing

Samples analysed for environmental purposes were placed in chilled cool boxes on site and transported to the laboratory for analysis on completion of the site investigation works/groundwater sampling visit.

The rationale for chemical analysis is presented in the table below and the results of the chemical laboratory testing are included in Appendix H and I.

Analytes	No. of Samples Tested		Rationale
	Soil	Ground-water	
Asbestos	33	-	Common potential contaminant - Analysed in all samples of Made Ground.
pH, As, Cd, Cu, Cr, Hg, Pb, Ni, Zn, speciated Polycyclic Aromatic Hydrocarbons (PAH)	33	10	Potential contaminants of concern, common to many sites.
Total Petroleum Hydrocarbons, Criteria Working Group Method (TPHCWG), Benzene, Toluene, Ethylbenzene and Xylene (BTEX)	33	10	Specific analysis to target identified hydrocarbon sources and to target areas of concern
TPH C10-C40 Screen	3		Specific analysis to target identified hydrocarbon sources and to target areas of concern
Volatile and Semi-Volatile Organic Compounds (VOC and SVOC)	17	8	Targeting specific identified areas of concern in preliminary CSM and observations of potential contamination during fieldworks.
sulphate, Total Sulphur, water soluble sulphate and acid soluble sulphate	43	10	To assess potential for chemical attack on buried concrete.
Speciated Phenols	14	6	Potential contaminants of concern, common where suspected gas works materials may have been imported onto site
Free Cyanide and Total Cyanide	14	6	Potential contaminants of concern, common where suspected gas works materials may have been imported onto site
Ammonium		8	

3.7 Monitoring Programme

Two rounds of groundwater level and ground gas monitoring were undertaken on newly installed wells (BH101 to BH103 and DS101 to DS110 inclusive) between on the 8th and 15th June 2020. Measurements of the depth to groundwater within the monitoring wells were taken using an electronic dip meter. The groundwater level monitoring sheets are included as Appendix J.

To characterise the ground gas regime at the site, an infrared gas meter was used to measure gas flow, concentrations of carbon dioxide (CO₂), methane (CH₄) and oxygen (O₂) in percentage by volume. Initial and steady state concentrations were recorded. The atmospheric pressure before and during monitoring, together with the weather conditions, was recorded. All monitoring results obtained to date together with the temporal conditions are contained within Appendix J.

4.0 Ground Summary

4.1 Introduction

The sections below summarise the ground and groundwater conditions encountered during the site investigation.

4.2 Ground Model

A summary of the observed ground conditions at the Site is provided below.

Summary of Observed Ground Conditions				
Strata	Typical Strata Description	Depth Range of Strata Base (m)	Maximum Proven Thickness (m)	Comments
Made Ground	Concrete over: brownish black gravelly sand. Gravel is angular to subangular fine to coarse of flint, brick, concrete and clinker, frequent ash, plastic, glass fragments throughout.	0.7 – 1.0	1.0	Plastic membrane located beneath concrete Geotextile and plastic mesh membrane located beneath made ground. Concrete was recorded to a maximum depth of 0.3 m bgl
Enfield Silt Member	Soft brown slightly gravelly clay. Gravel is angular to subangular fine to medium of flint.	1.3 – 1.9	1.0 m	Encountered across the entire site
Kempton Park Gravel Formation	Medium dense brownish orange sand and gravel. Gravel is angular to subrounded fine to coarse of flint. Sand is fine to coarse.	3.9 – 5.3	3.8 m	Base not proven at DS101, DS102, DS103 and DS106.
London Clay Formation	Stiff grey clay with frequent micro selenite. Over Greenish grey sand over greenish grey gravelly sand encountered at the base of the stratum.	11.2 – 13.4	8.9	Base proven at BH101, BH102 and BH103
Lambeth Group	Stiff grey, mottled red, orange, blue clay. Soft white silty sand was encountered within BH101 at 14.5 m bgl.	15.0 m bgl	1.6 m	Base not proven

4.3 Visual and Olfactory Evidence of Contamination - Soils

Visual and olfactory evidence of contamination was encountered during the investigation. The below table indicates the depth and location of contamination encountered.

Location	Depth / Strata	Visual or Olfactory Evidence
DS101	Kempton Park Gravel – 1.3 – 1.6 m bgl	Slight hydrocarbon odour
DS101	Kempton Park Gravel – 1.4 – 2.8m bgl	Strong hydrocarbon odour
DS103	Kempton Park Gravel: 1.5 – 4 m bgl	Strong hydrocarbon odour and black staining in soils and groundwater,

DS104	Made Ground: 0.25 – 0.7 m bgl Enfield Silt Member: 0.7 – 1.6 m bgl Kempton Park Gravel Member: 1.6 – 2.7 m bgl	Strong hydrocarbon odour and slight sheen noted on soils.
DS105	Made Ground – 0.22 – 0.7m bgl	Hydrocarbon odour
DS106	Kempton Park Gravel: 1.4 – 1.6 m bgl	Hydrocarbon odour and associated black staining.
BH101	Kempton Park Gravel 1.3 -1.6m bgl	Slight hydrocarbon odour

4.4 Groundwater

4.4.1 Levels During Monitoring Programme

Groundwater levels were monitored on a total of two occasions on the 8th June 2020 and 15th June 2020. Monitoring data and LNAPL measurements are provided in Appendix J and summarised in the table below.

Exploratory Hole	Response Zone		Water level during monitoring Max to Min Range		LNAPL Y/N	Stratum
	m bgl	m AOD	m bgl	m AOD.		
BH101	11 - 14	-3.1 - -0.1	5.10 - 5.11	5.72 - 5.72	N	London Clay Formation / Lambeth Group
BH102	12 - 14	-3.1 - -1.1	2.16 - 2.23	8.65 - 8.58	N	London Clay Formation / Lambeth Group
BH103	11 - 14	-3.1 - -0.1	4.29 - 8.96	6.53 - 1.86	N	Kempton Park Gravel
DS101	1 - 5	5.8 - 9.8	1.99 - 1.99	8.85 - 8.85	N	Kempton Park Gravel
DS102	1 - 5	5.7 - 9.7	1.93 - 2.02	8.83 - 8.74	N	Kempton Park Gravel
DS103	1 - 4	6.9 - 9.9	1.7 - 1.7	9.22 - 9.22	N	Kempton Park Gravel
DS104	1 - 5	5.8 - 9.8	1.97 - 2.01	8.90 - 8.86	N	Kempton Park Gravel
DS105	1 - 5	5.8 - 9.8	2.1 - 2.11	8.76 - 8.75	N	Kempton Park Gravel
DS106	1 - 5	5.8 - 9.8	1.96 - 1.96	8.87 - 8.87	N	Kempton Park Gravel
DS107	1 - 5	5.8 - 9.8	2.13 - 2.18	8.67 - 8.62	N	Kempton Park Gravel
DS108	1 - 5	5.8 - 9.8	2.1 - 2.12	8.71 - 8.69	N	Kempton Park Gravel
DS109	1 - 5	5.8 - 9.8	2.1 - 2.18	8.70 - 8.62	N	Kempton Park Gravel
DS110	1 - 5	5.8 - 9.8	2.09 - 2.17	8.74 - 8.66	N	Kempton Park Gravel

The results of groundwater monitoring have identified two groundwater bodies to present at the Site. A body of water is present within the Kempton Park Gravel and typically has been monitored at depths between 1.93 and 2.18m bgl (8.83 and 8.67 m AOD). Localised shallow water was recorded at DS103 at 1.7m bgl however this is not considered to be representative of the true groundwater level and is considered to be reflective of water that has accumulated within the end cap. A deeper groundwater body was also identified at the base of the London Clay Formation/Lambeth Group and noted to be sub artesian in nature. Located approximately at 11 m bgl within the green grey sands and gravels at the base of the London Clay Formation before the interface between the London Clay Formation and the stiff Clays of the Lambeth Group. Groundwater within this stratum has been monitored at depths between 2.16 and 8.96 m bgl (5.73 – 8.65 m AOD)

Groundwater elevations within the Kempton Park Gravel have been plotted for the second round of groundwater monitoring on the 15th June 2020 and are presented as Figure 4. The plots indicate that groundwater within the Kempton Park Gravel Member flows in a southerly direction.

Due to the variation in levels at the base of the London Clay formation and within the Lambeth Group it was not possible to plot and infer groundwater flow through this aquifer.

Groundwater within the Lambeth/ base of the London Clay Formation was noted to equilibrate at differing depths to the overlying Kempton Park Gravel Formation and when considering the sub artesian nature of the groundwater at the base of the London Clay and top of the Lambeth Group, this aquifer is unlikely to be in hydrological continuity with the overlying Aquifer. Based on the thickness and consistency of the London Clay Formation, this strata is considered to offer protection against the vertical migration of contamination into the deeper more sensitive aquifers.

4.5 Visual and Olfactory Evidence of Contamination - Groundwater

Olfactory evidence of gross contamination was observed during the post investigation groundwater monitoring in DS104 and DS101.

- ▲ DS101 – Strong hydrocarbon odour in groundwater sample
- ▲ DS104 – Strong hydrocarbon odour and slight sheen noted on groundwater sample

4.6 Material Properties

The table below summarises the factual material properties based upon the results of in-situ and laboratory test data and where appropriate provides derived geotechnical parameters.

Parameter	Made Ground	Enfield Silt Member (Cohesive)	Kempton Park Gravel (Granular)	London Clay Formation (Cohesive)	Lambeth Group (Cohesive)
Moisture Content - w	-	18%	-	17 % - 37 %	23 %
Liquid Limit - w _L	-	44 %	-	30 % - 81 %	29 %
Plastic Limit - w _P	-	27 %	-	20 % - 30 %	19 %
Plasticity Index - IP	-	17 %	-	10 – 51 %	10 %
Bulk Unit Weight - γ	-	-	-	19.3 – 20.01	
Uncorrected SPT N Value	5 - 45	5 – 21	6 – 50	9 - 31	26 - 50
Corrected ¹ SPT (N ₆₀)	6 - 54	6 – 26	7 – 57	10 – 42	35 – 68
Undrained Shear Strength ^{2,3} - cu	-	-	-	18 - 119 -	
Notes:					
1. SPT N values corrected for energy delivered to drive rods utilising the determined energy ratio (Er): N ₆₀ = (Er x N)/60 after BS EN ISO 22476-3:2005 [Ref. 5]					
2. From laboratory test results					
Correlation by Stroud....					

4.7 Geochemical Testing

Geochemical analysis was undertaken on 33 soil samples of Made Ground Enfield Silt Member and Kempton Park Gravel, and 10 samples of London Clay Formation and Lambeth Group, tested for selective contaminants (BRE Special Digest 1:2005 (3rd Edition), Concrete in Aggressive Ground, the results of which are summarised in the table below.

Tests	No. of Tests	Minimum	Maximum
Soil - pH	33	7.3	11.10
Soil - Total Sulphur	10	0.22%	2.27%
Soil – Acid Soluble Sulphate	10	0.06%	0.17%
Soil - Water Soluble Sulphate	33	0.01 g/L	2.0 g/L
Water – pH	10	6.8	9.2
Water - Sulphate	10	31 mg/l	145 mg/l

4.8 Ground Gas Data

Gas monitoring results are presented in Appendix J and are summarised in the table below, a total of 2 rounds of gas monitoring was undertaken over a period of 2 weeks.

Barometric pressures ranged from 1012mB (visit) to 1020mB (visit 1).

Exploratory Hole	Steady Gas Concentration (%v/v)						Steady Flow Rate (l/hr)		Response Zone (m bgl)		Stratum	Flooded?
	Methane		Carbon Dioxide		Oxygen							
	Min	Max	Min	Max	Min	Max	Min	Max	From	To		
BH101	<0.1	0.3	<0.1	0.2	18.4	18.9	<0.1	<0.1	11	14	London Clay / Lambeth Group	Y
BH102	<0.1	0.2	<0.1	<0.1	20.4	21	<0.1	<0.1	12	14	London Clay /Lambeth Group	Y
BH103	<0.1	0.2	<0.1	0.2	18.2	20.1	<0.1	<0.1	11	14	London Clay / Lambeth Group	Y
DS101	0.1	0.2	<0.1	<0.1	5.2	9.6	<0.1	<0.1	1	5	Kempton Park Gravel	N
DS102	<0.1	0.1	<0.1	<0.1	18.8	20.2	<0.1	<0.1	1	5	Kempton Park Gravel	N
DS103	5	5.7	<0.1	<0.1	0.5	0.8	<0.1	<0.1	1	4	Kempton Park Gravel	N
DS104	0.2	10.9	0.5	4.6	3.6	10.4	<0.1	<0.1	1	5	Kempton Park Gravel	N
DS105	<0.1	1.2	1.1	1.6	1.5	8.9	<0.1	<0.1	1	5	Kempton Park Gravel	N
DS106	0.1	2.8	0.2	0.7	13.8	20.5	<0.1	<0.1	1	5	Kempton Park Gravel	N
DS107	6.6	19.7	0.1	0.8	3.8	4.4	<0.1	0.2	1	5	Kempton Park Gravel	N
DS108	<0.1	0.2	<0.1	<0.1	15.8	17.7	<0.1	<0.1	1	5	Kempton Park Gravel	N
DS109	<0.1	0.5	0.1	0.5	2.8	19.5	<0.1	<0.1	1	5	Kempton Park Gravel	N
DS110	0.2	0.2	1.5	2.1	5.3	8.7	<0.1	<0.1	1	5	Kempton Park Gravel	N

5.0 Geotechnical Assessment

5.1 Summary of Development Proposals

At this stage no development been proposed at the Site.

Ground conditions at the Site have broadly been found to comprise Made ground to 1.0 m bgl. bearing onto soft strata of the Enfield Silt Member to depths of 1.9 m bgl. The underlying strata has been found to comprise the medium dense Kempton Park Gravels to depths of 5.3 m bgl, bearing onto the London Clay Formation to depths between 12.3 m bgl., which is in turn underlain by, deposits of the Lambeth Group encountered as sands over very Stiff Clay to depths of 15.0 m bgl. Groundwater within the Kempton Park Gravel Member has been recorded at depths between 1.9 – 2.1 m bgl

5.2 Foundations

5.2.1 Spread Foundations

The Made Ground encountered across the Site is considered to be too unpredictable, variable, weak and compressible in its existing condition for conventional shallow foundations at the Site. The Clay of the Enfield Silt Member are also considered to be unsuitable as a founding stratum due to the low shear strength of the soils.

Based on the site investigation undertaken pad foundations are considered to be suitable for the majority of the Site, founded at a minimum depth of 2m bgl within the top of the Kempton Park Gravel. An allowable bearing capacity of 300kPa limited to 25mm settlement and subject to groundwater levels is likely to be suitable.

5.2.2 Volume Change Potential

Given the granular nature of the shallow soils and absence of any vegetation combined with a relatively shallow groundwater, soils are unlikely to be susceptible to moisture induced volume change.

5.2.3 Piling

Alternative foundation solutions may comprise the use of vibro or controlled modulus columns which depending on the warranties provided by a specialist ground improvement contractor are likely to provide bearing capacities up to 150kN/m².

Where higher loads require support, then deeper foundations solution comprising piles transferring loads into the Kempton Park Gravel, London Clay and deeper Lambeth Group should be adopted. Where feasible, foundations should be limited to the London Clay Formation to minimise the potential for contamination to migrate into the deeper aquifer.

It should be noted that underground features associated with the existing USTs will need to be removed as part of any redevelopment of the site and would need to be replaced with compacted engineered fill which should be placed in accordance with a specification derived to support the future development.

5.2.4 Floor Slabs

Lightly loaded ground bearing floor slabs are likely to be suitable at the Site. Where higher floor slab loadings are required then either a suspended floor slab or the use of ground improvement techniques may need to be considered and should be assessed in the context of a future development, if required.

5.3 Chemical Attack on Buried Concrete

For the purpose of this assessment, parameters used for the assessment of buried concrete in chemical aggressive ground conditions has been split into two anticipating foundation strata comprising:

- ▲ Made Ground, Enfield Silt Member and Kempton Park Gravels.
- ▲ London Clay, and Lambeth Group.

Given the presence of potentially pyritic materials such as ash and clinker within the Made Ground, a conservative approach has been adopted when assessing the shallow soils in accordance with the recommendations presented in BRE Special Digest 1, 'Concrete in Aggressive Ground' 2005'. Buried foundations taken solely into the Made Ground and Kempton Park Gravels should be designed to resist DS2 – AC2 chemically aggressive ground conditions.

In accordance with the recommendations of BRE Special Digest 1, 'Concrete in Aggressive Ground' 2005, the conditions of the soils at the Site for piled foundations taken into the London Clay Formation and Lambeth Group would therefore be classified as Design Sulphate Class DS-5 and ACEC Class AC-5 for soils and groundwater, however when considering that piled foundations will not expose pyritic soils to oxidising conditions then the class can be reduced to DS4- AC4 conditions.

6.0 Generic Quantitative Risk Assessment

6.1 Introduction

The presence of hazardous substances in or on a site is generally only of concern if an actual or potential unacceptable risk exists. Legislation and guidance on the assessment of contaminated sites, consistent with UK best practice, acknowledges the need for a tiered risk-based approach. A Preliminary Risk Assessment is presented in Section 2.2. This section represents a Generic Quantitative Risk Assessment (GQRA) being a comparison of site contaminant levels against Generic Assessment Criteria.

6.2 Human Health GQRA

The assessment of risks in relation to human health has been undertaken using Generic Assessment Criteria (GAC) as detailed within the appropriate tables. Risks from soil, groundwater and Non-Aqueous Phase Liquids (NAPL) have been considered. The GAC are predominantly based on long term (chronic) risk to health. However, in the limited circumstances where short-term (acute) risks are more pronounced, these GAC have been utilised to ensure a thorough and conservative initial assessment is undertaken.

The end use scenario adopted for the assessment is for a commercial end use, considered appropriate based on a continued commercial use for the Site.

6.2.1 Risks from Soil Sources

Based on the proposed use of the Site for commercial use, the soil and groundwater chemical data has been compared against a commercial end use GAC for 1% soil organic matter (SOM) content.

The laboratory results for contaminants exceeding detection limit compared to their respective GAC are presented in the table below.

The primary exposure pathways considered in the risk assessment are as follows:

- ▲ Ingestion of soil and indoor dust and/or oral background exposure;
- ▲ Inhalation of dust (background and indoor);
- ▲ Direct dermal contact; and
- ▲ Inhalation of vapour (background and indoor).

Contaminant	No. Samples	Max Conc. (mg/kg)	GAC (mg/kg)	GAC Source	No. Exceed GAC	Volatile	Location of Exceedances (depth) = Concentration (mg/kg)	Area of Site of Exceedance
Asbestos	33		Detected	DS	5	N	DS109 (0.40m) – Amosite fibres, DS109 (1.70m) – Chrysotile fibres, BH103 (0.80m) Chrysotile fibres, DS103 (0.50m) Chrysotile fibres, DS106 (0.50m) Chrysotile Fibres	Localised to one area in the north and one area in the south
Metals and metalloids								
Arsenic	33	36	640	LQM	0	N		
Cadmium	33	32	190	LQM	0	N		
Chromium (total)	33	580	8600	LQM	0			
Chromium VI	33	1.3	33	LQM	0	N		
Copper	33	460	68000	LQM	0	N		
Lead	33	680	2300	C4SL	0	N		
Mercury	33	0.8	1100	LQM	0	Y		
Nickel	33	100	980	LQM	0	N		
Zinc	33	40000	730000	LQM	0	N		
Polyaromatic Hydrocarbons								
Naphthalene	33	1.2	190	LQM	0	Y		
Acenaphthylene	33	0.3	83000	LQM	0	Y		
Acenaphthene	33	1.1	84000	LQM	0	Y		
Fluorene	33	1.6	63000	LQM	0	Y		
Phenanthrene	33	12	22000	LQM	0	N		
Anthracene	33	3.2	520000	LQM	0	N		
Fluoranthene	33	14	23000	LQM	0	N		
Pyrene	33	12	54000	LQM	0	N		
Benzo[a]anthracene	33	7.5	170	LQM	0	N		
Chrysene	33	4.3	350	LQM	0	N		
Benzo[b]fluoranthene	33	5.2	44	LQM	0	N		

Contaminant	No. Samples	Max Conc. (mg/kg)	GAC (mg/kg)	GAC Source	No. Exceed GAC	Volatile	Location of Exceedances (depth) = Concentration (mg/kg)	Area of Site of Exceedance
Benzo[k]fluoranthene	33	3.7	1200	LQM	0	N		
Benzo[a]pyrene	33	5.3	35	LQM	0	N		
Indeno(1,2,3-c,d)pyrene	33	3.3	500	LQM	0	N		
Dibenz(a,h)anthracene	33	1	3.5	LQM	0	N		
Benzo[g,h,i]perylene	33	3.7	3900	LQM	0	N		
Total Petroleum Hydrocarbons								
Aliphatic TPH >C6-8	32	0.18	7800	LQM	0	Y		
Aliphatic TPH >C8-10	32	1.1	2000	LQM	0	Y		
Aliphatic TPH >C10-C12	32	39	9700	LQM	0	Y		
Aliphatic TPH >C12-C16	32	430	59000	LQM	0	N		
Aliphatic TPH >C16-C21	32	1500	1600000	LQM	0	N		
Aliphatic TPH >C21-C35	32	13000	1600000	LQM	0	N		
Aromatic TPH >C7-8	32	1.6	56000	LQM	0	Y		
Aromatic TPH >C8-10	32	6.4	3500	LQM	0	Y		
Aromatic TPH >C10-C12	32	19	16000	LQM	0	Y		
Aromatic TPH >C12-C16	32	120	36000	LQM	0	Y		
Aromatic TPH >C16-C21	32	410	28000	LQM	0	N		
Aromatic TPH >C21-C35	32	2700	28000	LQM	0	N		
Total Petroleum Hydrocarbons	32	18161	5000	DS	4	Y	DS103 (0.50m- 6,424) DS103 (2.50 – 18,161) DS106 (1.50 – 5141.9) DS104 (0.40 – 13,094)	Centre/north of Site
Other Organic Contamination (including VOC and SVOC results)								
Toluene	32	1.6	56000	LQM	0	Y		
Ethylbenzene	32	0.54	5700	LQM	0	Y		
p & m-Xylene	32	2.4	5900	LQM	0	Y		
o-Xylene	32	1.1	6600	LQM	0	Y		

Contaminant	No. Samples	Max Conc. (mg/kg)	GAC (mg/kg)	GAC Source	No. Exceed GAC	Volatile	Location of Exceedances (depth) = Concentration (mg/kg)	Area of Site of Exceedance
Isopropylbenzene	17	0.07	1400	LQM	0	Y		
N-Propylbenzene	17	0.14	4100	EIC	0	Y		
1,3,5-Trimethylbenzene	17	0.45	NO GAC					
1,2,4-Trimethylbenzene	17	1.6	42	EIC	0	Y		
Sec-Butylbenzene	17	0.03	NO GAC					
p-Isopropyltoluene	17	0.022	NO GAC					
Butylbenzene	17	0.014	NO GAC					
1,2,4-Trichlorobenzene	17	0.3	220	LQM		Y		
Hexachlorobutadiene	17	4	31	LQM		Y		
1,3-Dichlorobenzene	17	0.2	30	LQM		Y		
1,4-Dichlorobenzene	17	0.2	4400	LQM		Y		
Phenol	17	2	440	LQM		Y		
2,4-Dichlorophenol	17	4	3500	LQM		N		
2,4,6-Trichlorophenol	17	2	3500	LQM		N		
Bis(2-Chloroethyl)Ether	17	1	NO GAC					
4-Methylphenol	17	0.3	160000	EIC		N		
Bis(2-Chloroisopropyl)Ether	17	2	NO GAC					
2-Nitrophenol	17	2	NO GAC					
2-Methylnaphthalene	17	2.8	NO GAC					
Dimethylphthalate	17	2	NO GAC					
Dibenzofuran	17	4	150000	EIC		N		
Dibutyl Phthalate	17	2	150000	EIC		N		
Notes: Shaded = Maximum concentration exceeds GAC C4SL = Category 4 Screening Levels (C4SLs) published by DEFRA. DS = In-house GAC derived by Delta-Simons Environmental Consultants Ltd, 2018.								

Contaminant	No. Samples	Max Conc. (mg/kg)	GAC (mg/kg)	GAC Source	No. Exceed GAC	Volatile	Location of Exceedances (depth) = Concentration (mg/kg)	Area of Site of Exceedance
EIC = Guidance values produced by the Environmental Industries Commission (EIC), the Associated of Geotechnical and Geoenvironmental Specialists (AGS) and Contaminated Land: Application in Real Environments (CL:AIRE) in December 2009. LQM = Land Quality Management/CIEH S4UIs for Human Health Risk Assessment, 2014. AGAC = Acute Generic Assessment Criteria published by the Society of Brownfield Risk Assessment (SoBRA) 2019 No GAC = No Generic Assessment Criteria value available for compound.								

Widespread significant contamination of the soils has not been identified at the Site based on the Site remaining in a commercial end use. Although recordable concentrations of heavy metals, Petroleum Hydrocarbons and PAHs have been identified they remain below relevant Generic Assessment Criteria based on a commercial end use scenario.

Localised exceedances of Delta Simons derived GAC for Total Petroleum Hydrocarbons have been identified in the shallow soils (Made Ground, Enfield and Kempton Park Gravel) at DS103, Kempton Park Gravel at DS106 and the Made Ground at DS104. The screening criteria, whilst not directly correlating to risks to human health are considered to be an indicator of potential product with the soil based on soil co-solubilities and is discussed in section 6.2.3 below. It should also be noted that a break down of TPH fractions indicate that the majority of elevated TPH concentrations are located within the longer chain aliphatic hydrocarbon range which are typically less mobile and also less volatile. A maximum concentration of total TPH (18,161mg/kg) has been recorded within the deeper Kempton Park Gravels at DS103 with similar concentrations of 13,094mg/kg recorded within the Made Ground at DS104, predominantly comprising long chain aliphatic compounds.

Asbestos screening identified ACMs consisting of chrysotile and amosite fibres in five samples located at three locations, typically within the Made Ground. ACMs were also detected within the Enfield Silt Member and Kempton Park Gravel at DS103 and given the naturally occurring state of these soils, it is considered that the results of the screening are not representative of these materials and are likely to correspond to materials from the overlying borehole that have fallen in during the borehole construction. It should also be noted that all areas of the Site are covered by hardstanding and hence there is currently no exposure pathway for site operatives.

The soil analysis results are considered further in the Conceptual Site Model (CSM) presented in Section 8.0 with regard to potential contaminant linkages.

6.2.2 Risks from Groundwater Sources

Based on the current use of the Site for light industrial use, the soil and groundwater chemical data has been compared against a commercial/industrial end use GAC to assess risks from groundwater sources to indoor air and subsequent vapour inhalation indoors.

None of the site-specific contaminants of concern were recorded at concentrations in excess of their detection limits/respective GAC.

The water analysis results are considered further in the Conceptual Site Model (CSM) presented in Section 8.0 with regard to potential contaminant linkages.

6.2.3 Risks from Non-Aqueous Phase Liquids (NAPL)

Soil and groundwater exposure models used in generating Generic Assessment Criteria do not account for the potential for NAPL to represent a source of risk to human health, principally due to the production of vapours. Whilst it is possible to calculate theoretical soil saturation limits, in reality, due to co-solubility effects, these are not an appropriate indicator of the presence of NAPL. In order to assess the presence of NAPL, for petroleum hydrocarbons, an assessment criterion of 5,000 mg/kg has been applied based on professional experience.

Soil and groundwater exposure models used in generating Generic Assessment Criteria do not account for the potential for NAPL to represent a source of risk to human health, principally due to the production of vapours. Whilst it is possible to calculate theoretical soil saturation limits, in reality, due to co-solubility effects, these are not an appropriate indicator of the presence of NAPL. In order to assess the presence of NAPL, for petroleum hydrocarbons, an assessment criterion of 5,000 mg/kg has been applied based on professional experience.

The following has been identified in relation to NAPL at the Site:

- ▲ A black liquid was noted from water arising from DS103 and DS104
- ▲ Concentrations of Total Petroleum Hydrocarbons in excess of 5,000 mg/kg were recorded within the Made ground at DS103 and DS104 and also within the deeper Enfield Silt Member and Kempton Park Gravel at DS103 and DS106;
- ▲ No NAPL was identified during groundwater monitoring works, however a slight sheen was noted in groundwater sampled from DS104.

- ▲ The results of groundwater testing and interpretation from the laboratories has indicated that TPH concentrations within the centre of the Site are likely to correspond to lubrication oil.

Whilst elevated TPH concentrations and localised product has been identified in the soils, the results of laboratory chemical testing have indicated that contaminants within the groundwater are likely to have been derived from the overlying soils and are considered to correspond to lubricating oils which are not considered to be highly volatile. A review of the speciation of TPH concentrations has also indicated that TPH concentrations are broadly located with the longer chain aliphatic range and hence are unlikely to be volatile. Given that the area of identified hydrocarbon impact are away from occupied areas, the Site is covered by a layer of concrete and the nature of the contaminants themselves, the risks posed to human health via vapour inhalation is considered to be low.

6.3 Controlled Waters/Water Environment GQRA

6.3.1 Groundwater Results

The approach adopted to assessing risks to Controlled Waters/Water Environment is based principally on considering the concentrations of contaminants identified within the groundwater samples obtained in comparison to relevant GAC.

Given the 'prevent and limit' approach of the Water Framework Directive (2000/60/EC) and the identified receptors, a range of Water Quality Standards (WQS) have been applied as Generic Assessment Criteria (GAC), these include Water Framework Directive standards and thresholds (WFD), the UK Drinking Water Quality Standards (DWQS), WHO Guidelines for Drinking Water Quality or SEPA resource protection values which have been used as initial conservative GAC to assess whether groundwater contamination requires further assessment or discussion in terms of the risks to controlled waters. Where specific water quality standards are not available, Delta-Simons has adopted surrogate values based on professional judgement (DS GAC).

For the purposes of this assessment, the shallow aquifer within the Kempton Park Gravels and the wider aquifer/ connecting surface water features are considered to represent the most sensitive controlled water, given that the underlying Lambeth/ Thanet / Chalk Aquifer and associated SPZII are located at significant depths and are likely to be protected by the overlying London Clay Formation.

Therefore, where screening criteria for WFD and DWQS GAC exist for the same contaminant, WFD GAC have been adopted for the purposes of this assessment for the shallow aquifer and DWQS have been adopted for water samples within the deeper aquifer.

Groundwater contaminant concentrations that exceed the applied GAC are then considered in the context of the Site's environmental setting as to whether further qualitative or quantitative assessment is required as described in subsequent sections. Laboratory results above relevant detection limits are summarised in the table below with a comparison to the GAC applied.

6.3.2 Kempton Park Gravel – Secondary A Assessment

Contaminant	No. Samples	Max Conc. (µg/l)	GAC (µg/l)	GAC Source	No. Exceed GAC	Location of Exceedances (depth)	Area of Site of Exceedance
Metals and Metalloids							
Arsenic	8	12.7	50	WFD	0		
Cadmium	8	0.12	0.08	WFD	3	DS106 – 0.11 µg/l DS107 – 0.12 µg/l	Centre and south
Chromium	8	0.9	4.7	WFD	0		
Copper	8	27	1	WFD	6	DS101 = 1.2 µg/l DS102 = 3.9 µg/l DS105 = 3.4 µg/l DS107 = 4.1 µg/l DS108 = 27 µg/l DS109 = 2.8 µg/l	Site wide
Lead	8	2	2.54	WFD	0		
Nickel	8	39	8.48	WFD	5	DS101 = 16 µg/l DS104 = 9.4 µg/l DS106 = 39 µg/l DS109 = 8.7 µg/l DS107 = 16 µg/l	Site wide
Zinc	8	6.1	8	WFD			
Inorganics							
Ammonium as NH ₄	8	3200	500	DWQS	4	DS101= 941 µg/l DS104 = 1200 µg/l DS106 = 3200 µg/l DS108 = 1100 µg/l	Centre and north
Cyanide	5	10	1	EQS	5	DS101, DS104, DS105, DS106 and DS107 LOD of 10µg/l exceeds criteria	Site Wide
Polyaromatic Hydrocarbons							
Naphthalene	8	1.3	2.4	WFD	0		

Contaminant	No. Samples	Max Conc. (µg/l)	GAC (µg/l)	GAC Source	No. Exceed GAC	Location of Exceedances (depth)	Area of Site of Exceedance
Acenaphthene	8	0.45	GAC	GAC	0		
Fluorene	8	1.8	GAC	GAC	0		
Phenanthrene	8	4.24	GAC	GAC	0		
Anthracene	8	0.92	0.194	WFD	1	DS104 = 0.92 µg/l	Central east
Fluoranthene	8	1.91	0.12	WFD	2	DS104 = 1.91 µg/l DS108 = 0.81 µg/l	Central east
Pyrene	8	2.5	GAC	GAC	0		
Benzo[a]anthracene	8	1.22	GAC	GAC	0		
Chrysene	8	0.95	GAC	GAC	0		
Benzo[b]fluoranthene	8	0.42	0.058	WFD	1	DS108 = 0.29	east
Benzo[k]fluoranthene	8	0.17	0.017	WFD	1	DS108 = 0.42	East
Benzo[a]pyrene	8	0.29	0.27	WFD	1	DS108 = 0.17	East
Total EPA 16 PAH's	8	14.9	0.1	DWQS	8	DS104 = 14.9 µg/l DS108 = 5.07 µg/l DS101, DS102, DS105, DS106, DS107, DS109 – LOD of 0.16 µg/l exceeds criteria	Central east
Petroleum Hydrocarbons							
Aliphatic TPH >C10-12	8	12	300	WHO	0		
Aliphatic TPH >C12-16	8	180	300	WHO	0		
Aliphatic TPH >C16-C21	8	590	300	WHO	1	DS104 = 590 µg/l	Central
Aliphatic TPH >C21-C35	8	5500	300	WHO	2	DS104 = 5500 µg/l DS108 = 2600 µg/l	Central east
Aromatic TPH >C8-10	8	14	20	WFD	0		
Aromatic TPH >C10-C12	8	100	90	WHO	1	DS101 = 100 µg/l	north
Aromatic TPH >C12-C16	8	280	90	WHO	2	DS101 = 280 µg/l DS104 = 170 µg/l	Central and north
Aromatic TPH >C16-C21	8	270	90	WHO	3	DS101 = 220 µg/l	Central east

Contaminant	No. Samples	Max Conc. (µg/l)	GAC (µg/l)	GAC Source	No. Exceed GAC	Location of Exceedances (depth)	Area of Site of Exceedance
						DS104 = 270 µg/l DS108 = 110 µg/l	
Aromatic TPH >C21-C35	8	1200	90	WHO	3	DS101 = 110 µg/l DS104 = 1,200 µg/l DS108 = 830 µg/l	Central east
Total Petroleum Hydrocarbons	8	15958	300	WHO	3	DS101 = 1655 µg/l DS104 = 15958 µg/l DS108 = 7627 µg/l	Central east
Other Organic Contamination (including VOC and SVOC results)							
1,3,5-Trimethylbenzene	8	2.4	GAC	GAC			
1,2,4-Trimethylbenzene	8	8.5	GAC	GAC			
Isophorone	8	4.2	GAC	GAC			
o-xylene	8	2.7	GAC	GAC			
Notes: Shaded = Maximum concentration exceeds GAC. GAC = No GAC available for individual compounds DWQS 2016 = The Water Supply (Water Quality) Regulations 2016 [UK Drinking Water Standards] WHO 2003 = WHO background documents to Guidelines for Drinking Water Quality, 2003. WFD = Water framework Directive WHO 2003* = The WHO guidance states that the use of the lowest guidance value for aliphatic hydrocarbons (300 µg/l) for comparison to the total TPH concentration in groundwater will provide a conservative level of protection. WHO 2017 = WHO Guidelines for Drinking Water Quality (4 th Edition), 2017.							

6.3.3 Lambeth Group – Secondary A Assessment

Contaminant	No. Samples	Max Conc. (µg/l)	GAC (µg/l)	GAC Source	No. Exceed GAC	Location of Exceedances (depth)	Area of Site of Exceedance
Metals and Metalloids							
Arsenic	2	2.46	10	DWQS	0		
Cadmium	2	0.08	5	DWQS	0		
Chromium	2	4.7	50	DWQS	0		
Copper	2	8.5	2000	DWQS	0		
Lead	2	6.3	10	DWQS	0		
Nickel	2	9.6	20	DWQS	0		
Zinc	2	8.7	5000	DWQS	0		
Notes: Shaded = Maximum concentration exceeds GAC. GAC = No GAC available for individual compounds DWQS 2016 = The Water Supply (Water Quality) Regulations 2016 [UK Drinking Water Standards] WHO 2003 = WHO background documents to Guidelines for Drinking Water Quality, 2003. WFD = Water framework Directive WHO 2003* = The WHO guidance states that the use of the lowest guidance value for aliphatic hydrocarbons (300 µg/l) for comparison to the total TPH concentration in groundwater will provide a conservative level of protection. WHO 2017 = WHO Guidelines for Drinking Water Quality (4th Edition), 2017.							

The results of groundwater laboratory analysis have identified marginally elevated heavy metals and Ammonium (NH_4) to be present across the entire Site within the Kempton Park Gravels. The analysis has also identified elevated TPH fractions comprising medium and long chain aliphatic and aromatic hydrocarbon fractions to be present in the north around DS101 and DS104 and also at DS108, with elevated PAH compound predominantly recorded at DS108.

A plot of TPH fractions C16-21 Aliphatic, C21-35 Aliphatic, C16-21 Aromatic and C21-35 aromatic fractions are presented as Figure 5. The plot indicates TPH fractions to be concentrated around DS104 and DS108, with DS108 noticed to be located down hydraulic gradient. At this stage it is unclear if both locations form part of a single plume or two separate source areas, given that the split of TPH fractions are broadly similar.

It is also noted that the area around DS104 has been historically utilised for the crushing and recycling of cars with a suspected shear located in this area. The results of laboratory analysis has also indicated that the distribution of TPH fractions within the groundwater at DS104 are likely to be reflective of lubricants and it is plausible that leaks from the shears may have locally impacted the soils and groundwater.

As part of the review of available information, a spill indicated to comprise diesel was recorded around DS108 and it is plausible that this spill may have comprised lubricants which may result in the second hotspot around this location.

The remainder of contaminants assessed within the Kempton Park Gravels were found to have concentrations below their respective screening criteria.

Two groundwater samples were obtained from the deeper Lambeth Group with samples targeted to assess the nature of contaminants at the Site boundary and also in proximity to the USTs in the south east of the Site. The results of the laboratory analysis have not identified any exceedances when considered in the context of UK Drinking Water Standards and no evidence of contaminants exceedances within the shallow aquifer have been identified deeper aquifer, indicating the aquifers to be isolated from each other.

The groundwater analysis results are considered further in the CSM presented in Section 8.0 with regard to potential contaminant linkages.

7.0 Preliminary Ground Gas Risk Assessment

7.1 Ground Gas Conceptual Site Model

7.1.1 Sources

Historically the site has been subjected to a number of commercial/industrial land uses, including phases of demolition and the results of the ground investigation have identified a laterally continuous layer of Made Ground across the Site.

The Made Ground generally comprises gravelly sand and sand and clay mixtures. The gravel content included brick, coal, ash and clinker. Occasional plastic and metal fragments were also recorded and given the absence of large volumes putrescible and organic materials is unlikely to represent a significant source of ground gas.

Beneath the Made Ground, the Enfield Silt member was identified to a maximum of 1.9 m bgl and Kempton Park Gravel was identified to a maximum depth of 5.3 m bgl

Other potential on Site sources of ground gas/ vapour include areas of hydrocarbon impacted soils, fuel storage and the five USTs located in the south east corner of the Site.

7.1.2 Receptors

The principal receptors under consideration are current and future Site users along with any maintenance staff.

7.1.3 Pathways

The underlying geology is likely to be of variable permeability with respect to ground gases. The Made Ground is heterogeneous and this deposit along with the Kempton Park Gravel are likely to allow preferential migration however the overlying Enfield Silt Member may in part mitigate the migration of ground gas/ vapours between both strata given its cohesive nature.

The most significant pathways with respect to users of the Site relate to the potential for gases to enter buildings. At present, no gas protections measures were identified during the Site walkover however areas of maintenance are expected to have high air exchange preventing accumulation of potentially hazardous ground gases.

7.2 Duration & Extent of Monitoring

During the two monitoring periods, gas concentrations have been recorded in a total of 13 monitoring positions. The locations of the monitoring wells are highlighted on Figure 2 and indicate representative coverage across the whole study area. Several monitoring wells have been positioned in the area where contamination was visually identified in the centre of the Site

Barometric pressures during the gas monitoring period ranged from 1012mB (visit) to 1020mB (visit 1) with pressure falling during the second event.

It was not possible to monitor groundwater elevations at DS101 during the initial monitoring event due to the well being stuck in place

7.3 Ground Gas Risk Assessment

7.3.1 Background

Based on the proposed continuing commercial end use, the following documents have been consulted when assessing the gas regime at the site:

- ▲ British Standards Institute (BSI, 2015): Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings, BS:8485.

The presence of a source of hazardous gas within the ground does not necessarily indicate a risk will be present. Consideration of recorded gas flows together with source concentrations can allow an initial assessment to be

made of the potential both for generation and subsequent migration of gas. A Characteristic Situation (CS) is derived from an assessment of the ground gas data and forms the basis of determining mitigation measures.

7.3.2 Gas Screening Value (GSV)

The Gas Screening Value (gas concentration as a fraction x maximum recorded flow) is used to provide an initial assessment of risks to future site users. The GSVs calculated for the monitoring wells are presented in the following table.

Location	Maximum Methane (%v/v)	Maximum Carbon Dioxide (%v/v)	Maximum Flow Rate (l/hr)	GSV/Characteristic Situation				Flooded well (Frequency)
				Methane		Carbon Dioxide		
				GSV	CS	GSV	CS	
BH101	0.1	0.2	<0.1	0.0001	1	0.0002	1	2 of 2
BH102	0.1	<0.1	<0.1	0.0001	1	0.0001	1	2 of 2
BH103	<0.1	0.2	<0.1	0.0001	1	0.0002	1	2 of 2
DS101	0.2	<0.1	<0.1	0.0002	1	0.0001	1	0 of 1
DS102	0.1	<0.1	<0.1	0.0001	1	0.0001	1	0 of 2
DS103	5.7	<0.1	<0.1	0.0057	2	0.0001	1	0 of 2
DS104	10.8	4.6	<0.1	0.0108	2	0.0046	1	0 of 2
DS105	1.2	1.6	<0.1	0.0012	2	0.0016	1	0 of 2
DS106	2.8	0.7	<0.1	0.0028	2	0.0007	1	0 of 2
DS107	19.6	0.8	0.2	0.0392	2	0.0016	1	0 of 2
DS108	0.1	<0.1	<0.1	0.0001	1	0.0001	1	0 of 2
DS109	0.5	0.5	<0.1	0.0005	1	0.0005	1	0 of 2
DS110	0.2	2.1	<0.1	0.0002	1	0.0021	1	0 of 2
Notes:	CS1+ = Calculated GSV is CS1; however, peak methane exceeds 1%v/v and/or peak carbon dioxide exceeds 5%v/v, therefore, consider increase in CS value.							

The results of the gas monitoring have identified elevated levels of methane at DS103, DS104, DS105, DS106, and DS107, with response zones located within the Made Ground and Kempton Park Gravel.

Elevated methane concentrations were typically encountered in areas where evidence of hydrocarbon staining had been noted however no significant VOCs other than 25ppm at DS103 have been recorded during either monitoring event, and it is unlikely that gas monitoring equipment is suffering from interference from recorded hydrocarbon contamination. It should also be noted that elevated methane was recorded at DS107 in the west of the Site and may be representative of an off site source given the absence of significant contamination at this location.

Carbon dioxide concentrations were generally noted to be low (<5%) across the Site with localised areas of depleted oxygen. No detectable flow rates were monitoring during either event with the exception of 0.2 l/hr which was recorded at DS107 during the first monitoring event only.

Based on the initial findings of the investigation, the gassing regime at the Site is considered to correspond to a CS2 gassing regime. Whilst no specific gas protection measures were noted during the walkover, existing properties and maintenance areas are likely to have sufficiently high air exchange that no specific remedial works are likely to be required within the existing development based on a continued commercial use.

7.4 Radon

The Site is located within an area where radon protective measures are not required.

7.5 Organic Vapours

The results of soil screening during the ground investigation did not identify any significantly elevated VOC concentrations with the exception of the following locations:

Location	Depth m bgl	PID Reading ppm
DS106	2.5	49.8
DS106	3.5	171.3

Significant evidence of contamination was noted at DS106 during the investigation nor have elevated VOCs been noted during gas monitoring and are not considered to pose a significant risk to occupants of the Site.

8.0 Revised Conceptual Site Model

A revised CSM is presented in the table below, and has been formulated taking into account all of the available data from the Delta-Simons intrusive investigation, suitable for a Site with a proposed commercial end-use. Based on the finding of the investigation, the majority of potential sources have been discounted given their absence as part of the quantitative investigation. Where sources have been identified or uncertainties remain, these are discussed in the conceptual Site Model below

Source	Pathways	Receptors	Mitigation
Localised asbestos containing materials in the Made Ground at DS103 and DS109	Inhalation of fibres	Current and future occupants of the property and maintenance workers.	The Site is currently capped with hardstanding which will act to substantially constrain exposure to contaminated soil thus reducing the likelihood of asbestos fibres being liberated and inhaled. Risks posed to current and future site users are considered to be Low. ACMs are likely to pose a risk to maintenance staff however as with most brownfield sites, these contaminants would expected to be present. It is recommended that the findings of this investigation be retained on site within the H&S file and referred to, prior to undertaking intrusive works. Risks to maintenance workers cannot however be reduced to an acceptable level by reference to the H&S file and the adoption of appropriate control measures including the use of appropriate PPE and damping down of work spaces.

Hydrocarbon impacted soils and groundwater. Two sources areas centred around DS103 and DS104 and to a lesser extent around DS108	Migration of hydrocarbon fractions and PAHs from the soils into the groundwater	Secondary A Aquifer – Kempton Park Gravel and third party land	Hydrocarbon impacted soils have been identified around DS103 in close proximity to a former shears along with similar impacts to groundwater albeit no product has been identified in the groundwater other than a sheen. It is therefore considered that there is a pollutant linkage between the identified soil source and wider impact within the Kempton Park Gravel. Elevated TPH and PAHs have also been identified around DS108 in the south east near to the former above ground storage tanks, however it is unclear if the recorded concentrations originate from a separate incident or are an extension of the existing plume at DS103/DS104. The results of laboratory testing have indicated the elevated contaminants to comprise long chain hydrocarbon fractions with laboratory analysis indicating compounds likely to be reflective of lubrication oils. Groundwater is also indicated to flow in a southerly direction across the Site. Given the nature of the lubrication oils and TPH fractions, these contaminants are generally considered to have a low mobility and hence any associated plume is expected to be relatively static. It should also be noted that the surrounding area is predominantly commercial in nature to the south and west of the Site (Down hydraulic gradient) and when considered in the context of the gas works to the north east where remedial works have been undertaken, the underlying Secondary A Aquifer is considered to have a low/moderate environmental sensitivity. Given the low environmental sensitivity of the underlying aquifer, absence of free phase product and low mobility of the identified contaminants, the risks posed to third party land and the wider Secondary A Aquifer are considered to be low set in the context of a continued commercial end use and industrial nature of the surrounding area.
	Direct contact, ingestion and inhalation of impacted particulates	Maintenance workers	Should any below ground works be required it is recommended that maintenance workers should be made aware of the presence of hydrocarbon impacted soils and groundwater and that appropriate working methods and PPE are adopted as part of the proposed works.
Elevated methane concentrations (preliminary characterisation as CS2)	Vertical and lateral migration and accumulation of gas in enclosed spaces	Current and future occupants of the property and maintenance workers	The source of elevated methane have not been fully characterised and are likely to correspond to a combination of on and off site sources. The site is currently utilised for car storage and vehicle maintenance and given continued high air exchange within existing buildings risks posed by the presence of methane, especially in the absence of associated flow rates are likely to be low and no further mitigation is likely to be required given the existing use of the Site.

9.0 Conclusions & Recommendations

Contamination Risks Associated with Ownership (Current Use)	There is considered to be a Low risk of enforcement action by the regulatory authorities under Part 2A of the Environmental Protection Act, the Water Resources Act or the Environmental Damage Regulations, whilst the Site remains in its current commercial use. The potential for legal action by surrounding landowners / Third Parties based on the potential for contamination to migrate off-Site (ongoing or historically) is considered to be Low given the general mobility of the contaminants identified at the Site.
Potential Contaminated Land Development Risks	Localised soil and groundwater organic contamination along with ACMs in the Made Ground and a marginally elevated gassing regime have been identified as part of this assessment, however free phase product was not identified in any of the monitoring wells. Should the Site be redeveloped in the future then it is likely that the local authorities would require further ground investigation, assessment and modelling of identified contaminants set in the context of the proposed development. Construction related mitigation measures comprising the use of gas protection systems and provision of clean capping layers may be required however these are likely to be required as part of a typical brownfield development and are not expected to constitute a significant abnormal. Based on the finding of the investigation it is considered that there is a low/moderate risk of significant remediation works be required to support a development at the Site.
Plausible Geotechnical Development Risks	Shallow soils (Made Ground and Enfield Silt Member) are unlikely to provide a suitable strata for the construction of foundations, however strip foundations taken into the top of the Kempton Park Gravels are expected to provide bearing capacities up to 300kPa, subject to groundwater levels. Where higher loads are required then a piled foundation solutions may need to be adopted. Lightly loaded ground bearing floor slabs may be suitable following proof rolling and inspection for soft spots. Where higher loads are required then a suspended floor slab may need to be considered. The construction of soakaways is unlikely to be suitable given the limited thickness of unsaturated zone at the site and areas of localised organic contamination. Buried concrete may need to be designed to resist DSS – AC2 within the Kempton Park Gravel and DS54- AC4 in the London Clay Formation depending on foundation solution.
Recommendations	Based on the findings of the investigation, it is recommended that the existing USTs be decommissioned if they are not actively in use. Where boreholes are no longer required for future monitoring purposes, it is recommended that these positions are decommissioned in accordance with EA guidance for decommission of boreholes to prevent the creation of pathways into the deeper aquifer. The on site H&S file should be updated to include the findings of this investigation.

	Routine inspection and maintenance of existing drainage and interceptors given the observed poor state of surface drainage during the Site Walkover.
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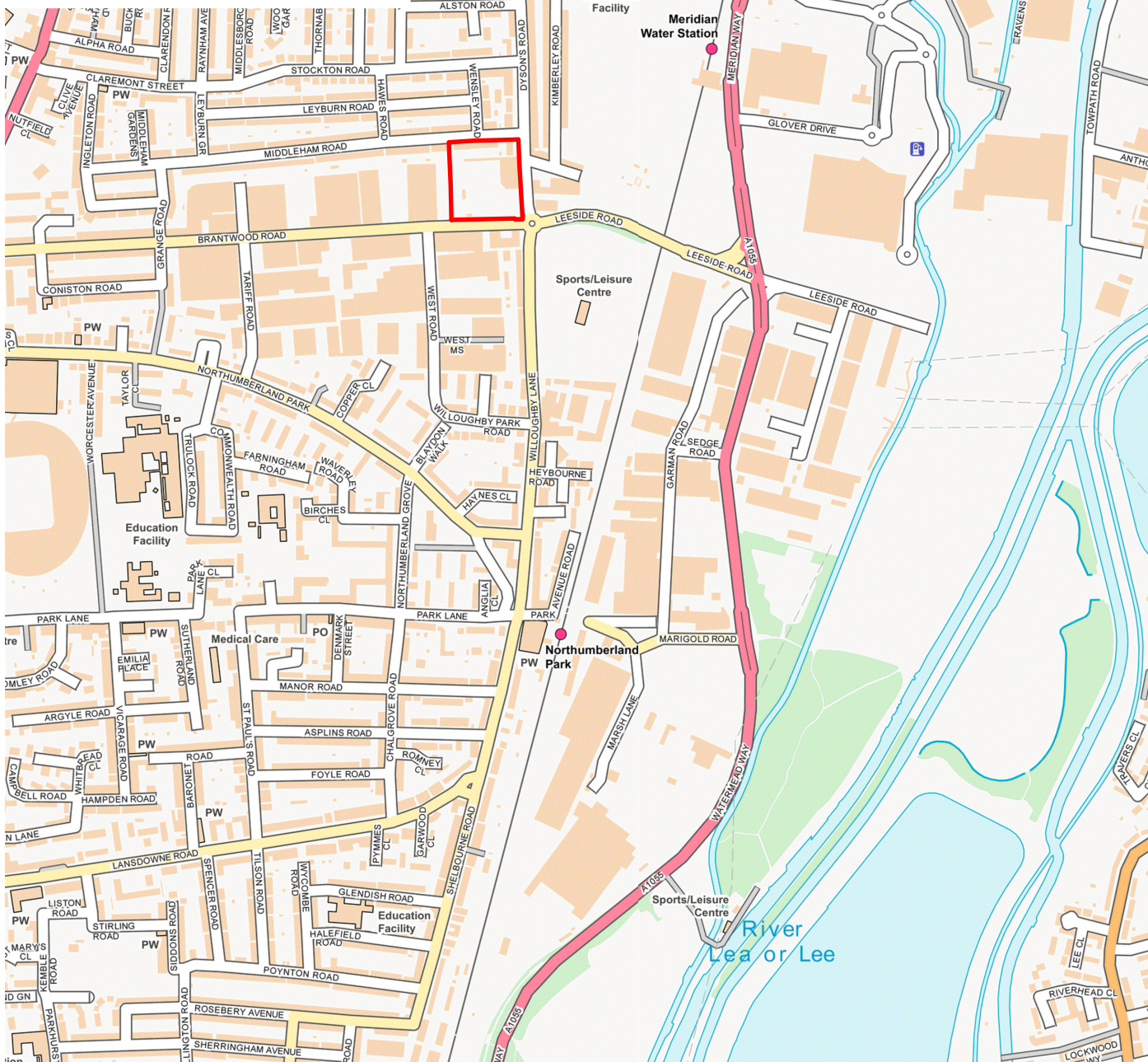
Figure 1 – Site Location Map



LEGEND



Site Boundary



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Figure 2 – Exploratory Hole Location Plan



LEGEND

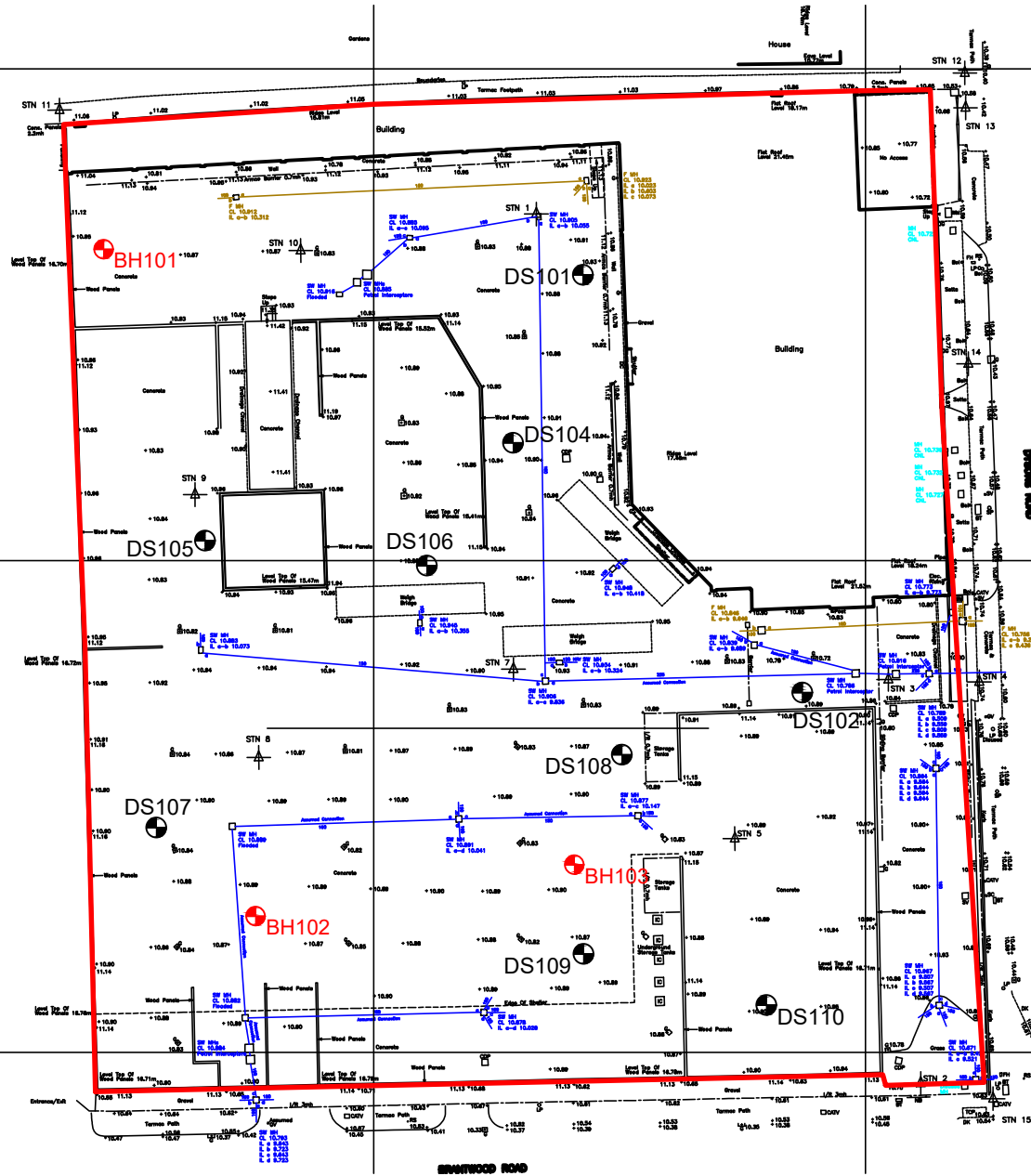
Site Boundary

DSx

Dynamic Sampler

BHx

Borehole



Scale	1:100
North Arrow	True North
Site Plan Provided by Client	

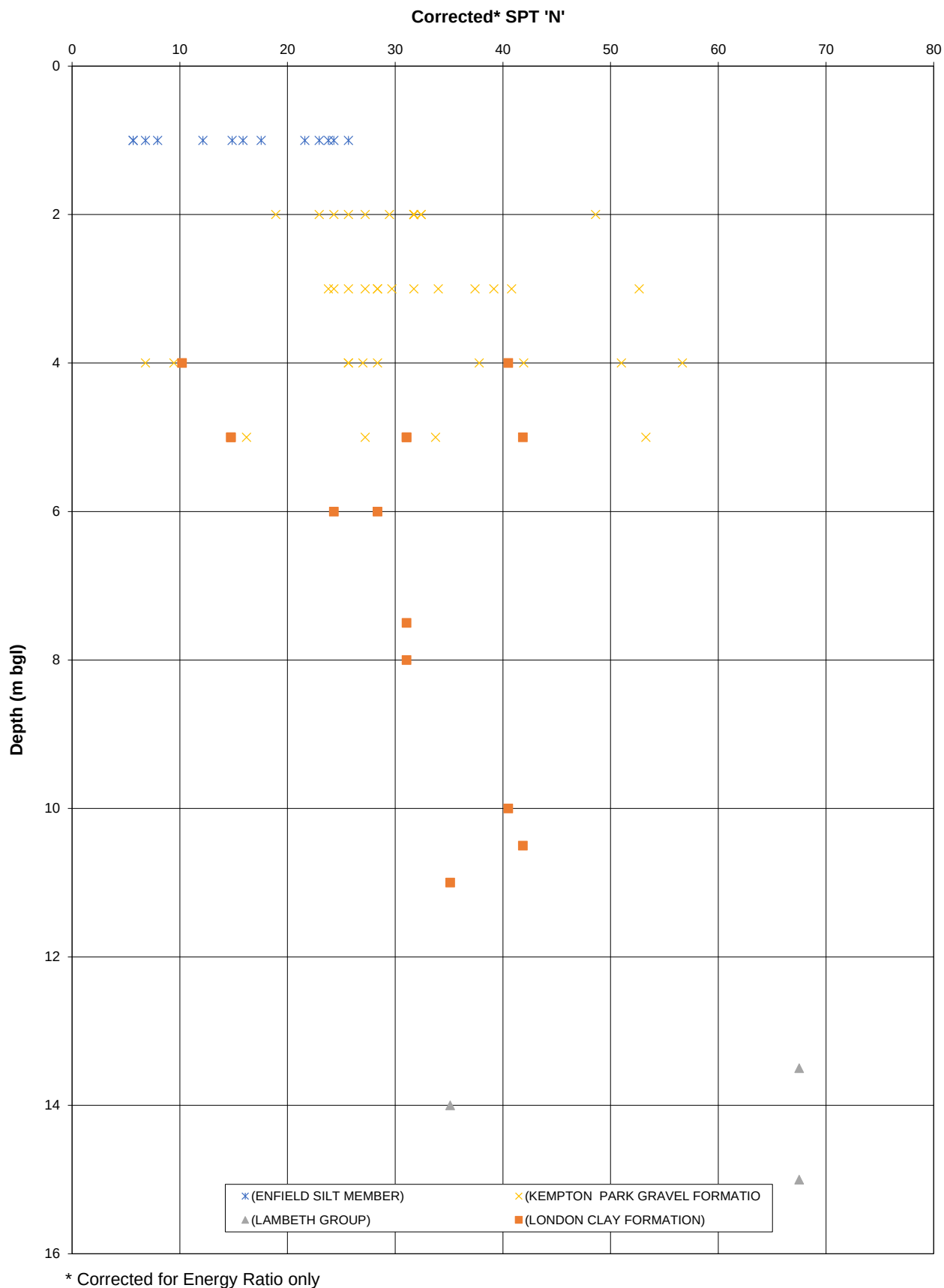
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TITLE:
Exploratory Hole Location Plan
Dyson Road
Edmonton

DRAWN BY: KE	SCALE: Not to Scale	PROJECT NO: 20-337.01
CHECKED BY: DJ	REVISION: 1	FIGURE NO: 2
DATE: 25 June 2020		

Figure 3 – Corrected SPT Results



* Corrected for Energy Ratio only



LEGEND

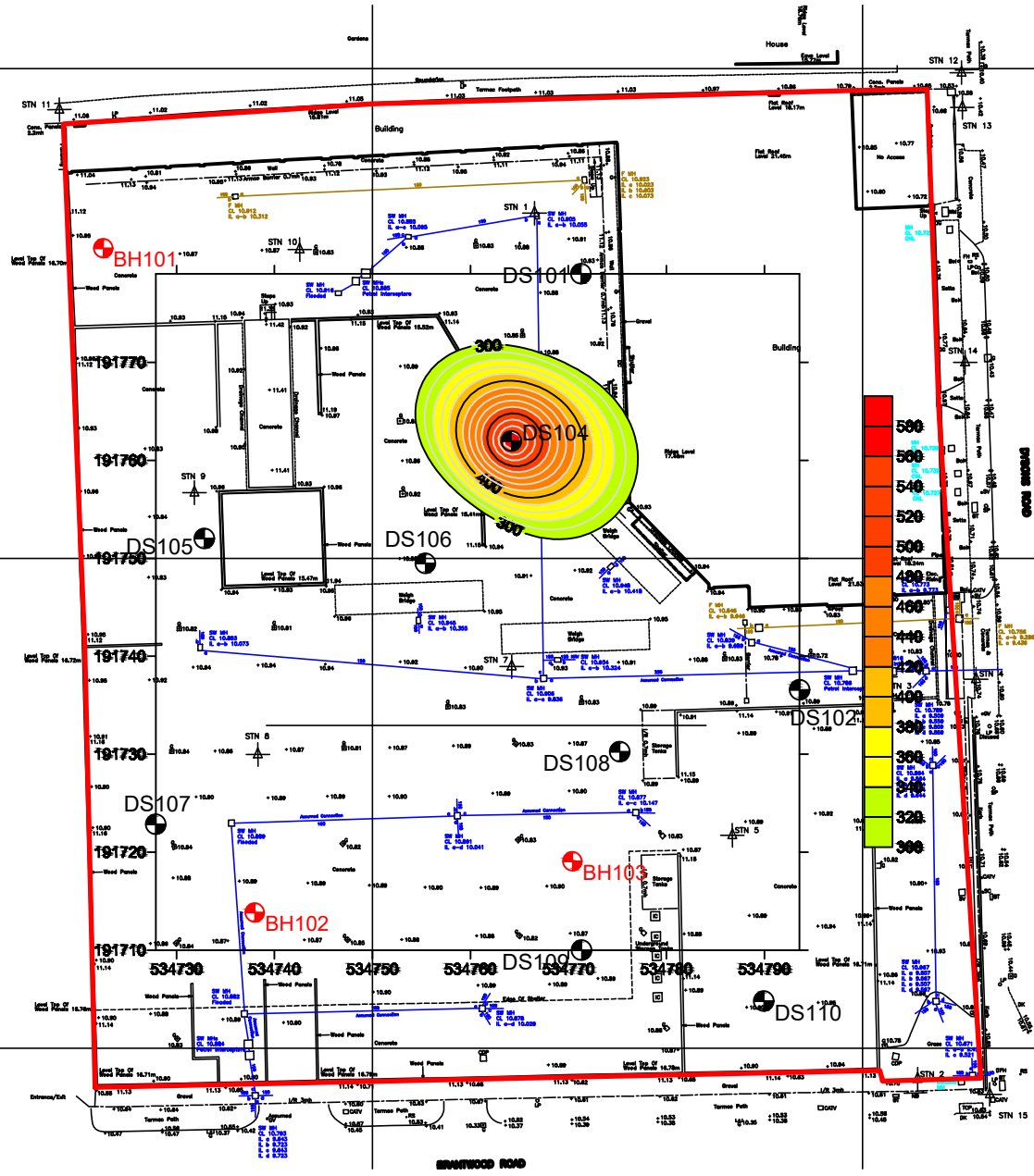
Site Boundary

DSx

Dynamic Sampler

BHx

Borehole



Site Plan Provided by Client

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TITLE:
C16-21 Ali
Dyson Road
Edmonton

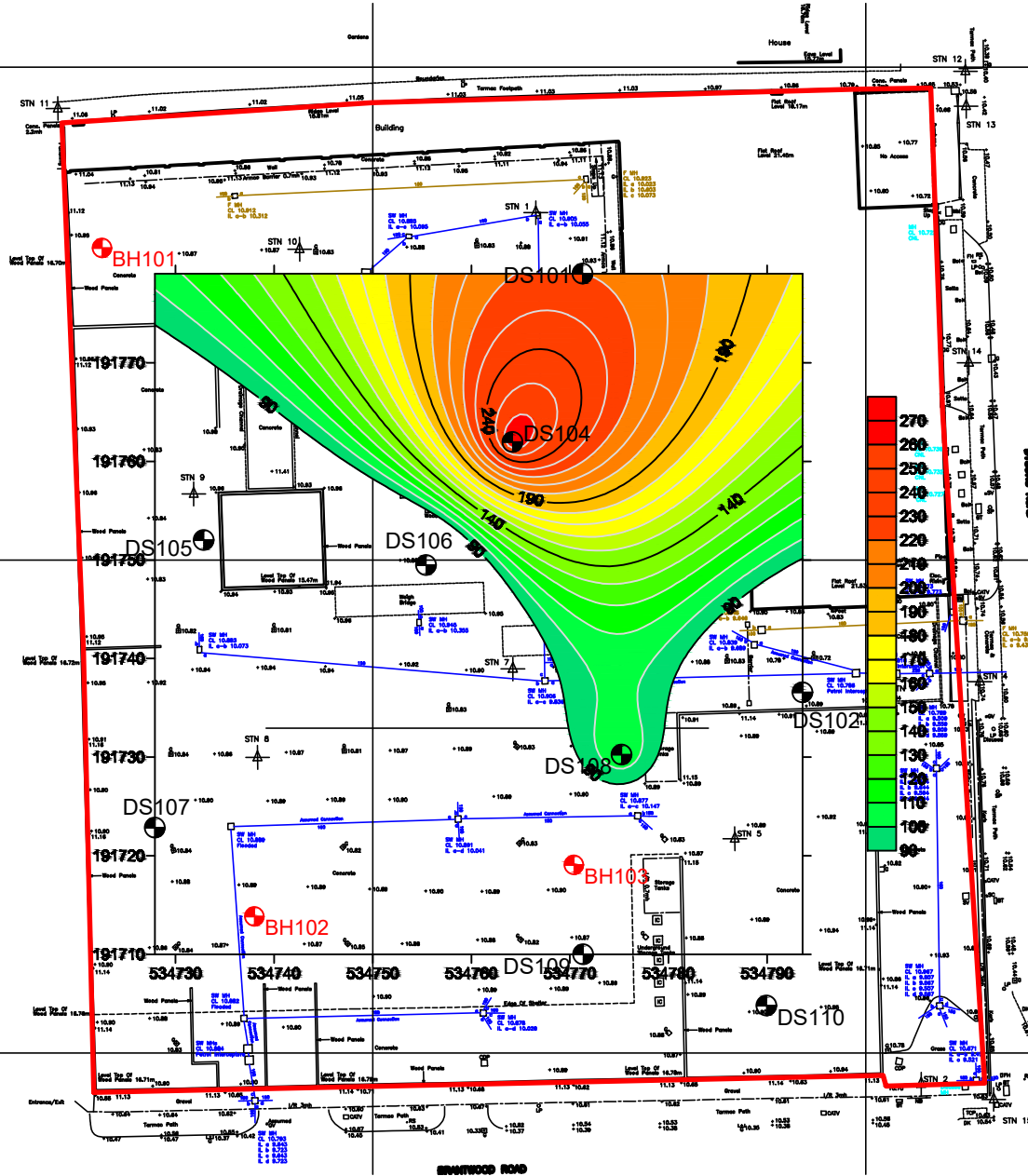
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CHECKED BY:	DJ	REVISION:	1
DATE:	25 June 2020		

PROJECT NO:	20-337.01
FIGURE NO:	3a



LEGEND

- Site Boundary
- DSx Dynamic Sampler
- BHx Borehole



Site Plan Provided by Client

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LEGEND

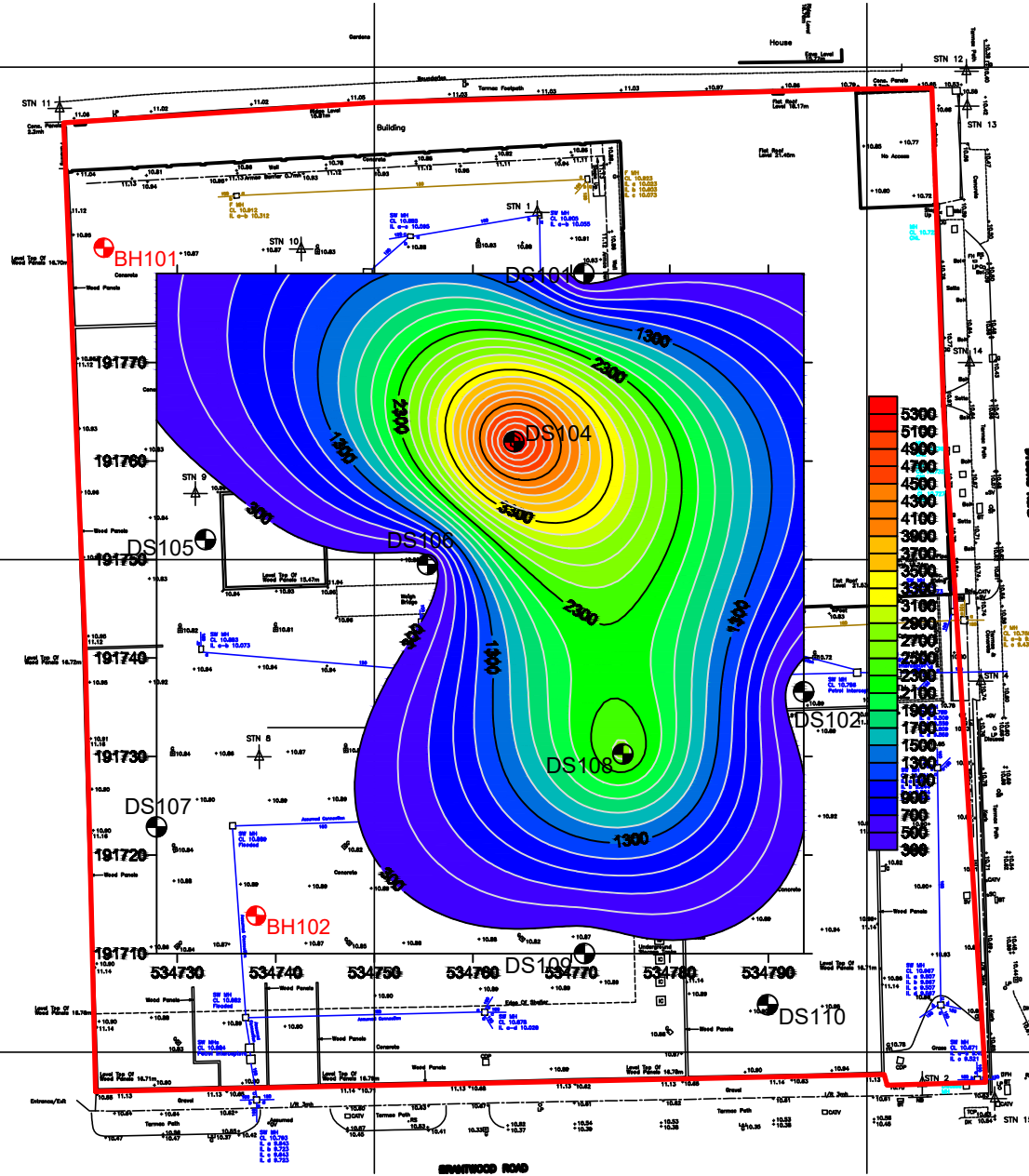
Site Boundary

DSx

Dynamic Sampler

BHx

Borehole



Scale	1:1000
North Arrow	True North
Site Plan Provided by Client	

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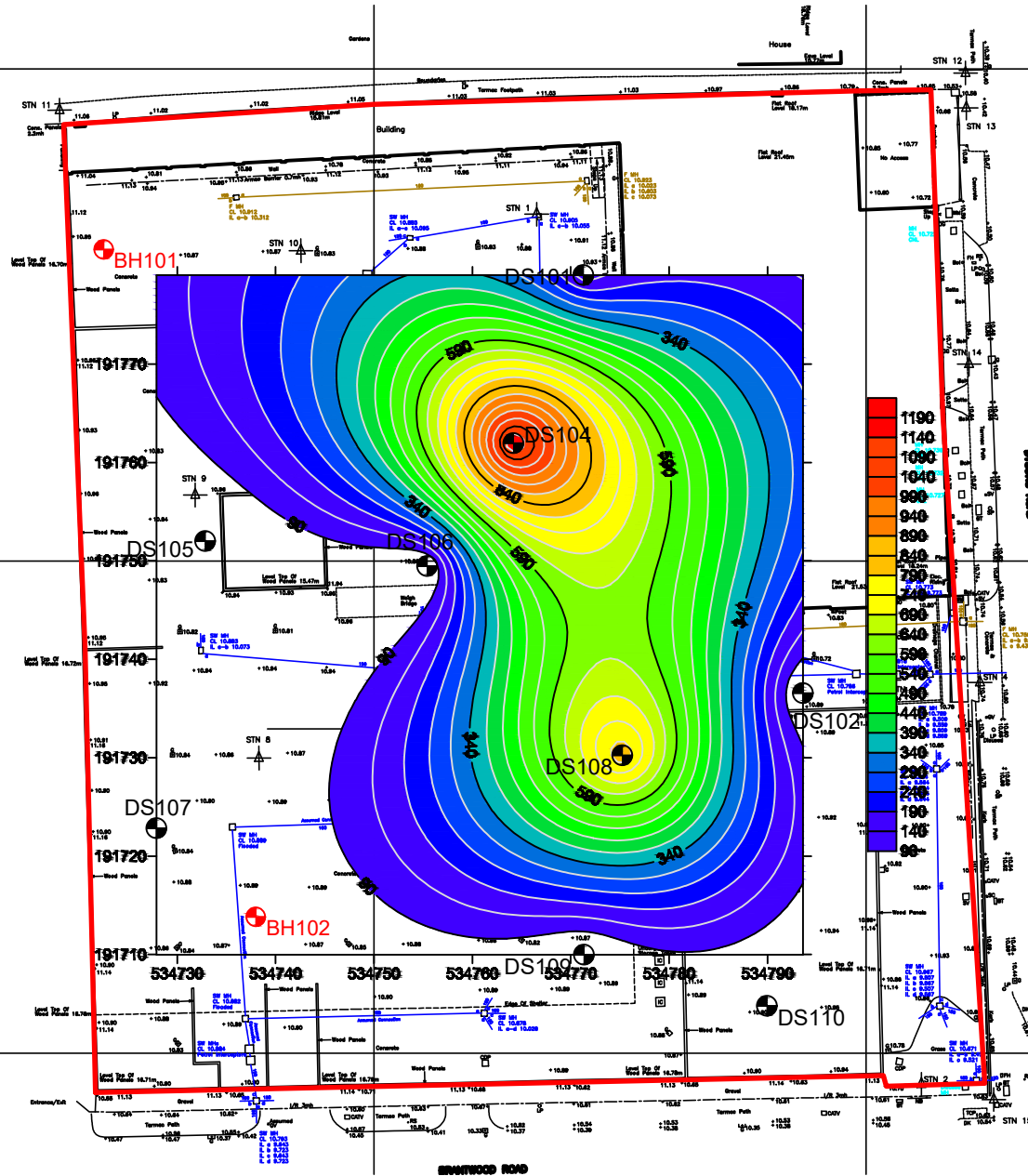


LEGEND

Site Boundary

DSx Dynamic Sampler

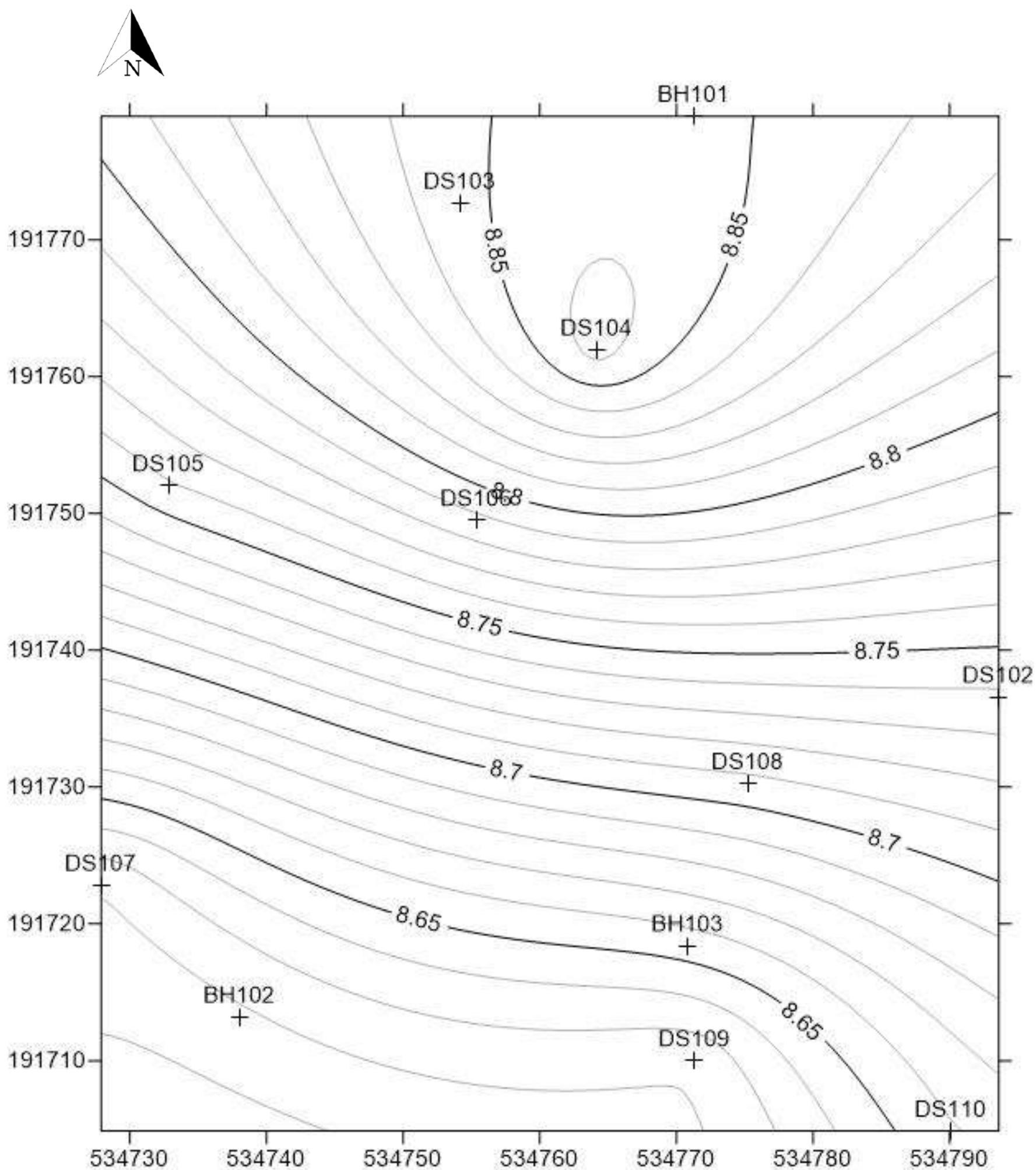
BHx Borehole



Site Plan Provided by Client

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Figure 4 – Interpolated Groundwater Plots



Appendix A – Limitations

Limitations

The recommendations contained in this Report represent Delta-Simons professional opinions, based upon the information listed in the Report, exercising the duty of care required of an experienced Environmental Consultant. Delta-Simons does not warrant or guarantee that the Site is free of hazardous or potentially hazardous materials or conditions.

Due to the evolving regulatory climate specific to Per Fluoro Alkyl Substances (PFAS), the scope of works is not intended to be conclusive as it relates to the identification of any PFAS related issues. While Delta-Simons may advise its Client if Delta-Simons becomes aware of the use of PFAS at the subject property, Delta-Simons makes no representation nor accepts any liability that any or all PFAS issues have been identified and/or revealed to its client through its scope of work, as presented herein.

Delta-Simons obtained, reviewed and evaluated information in preparing this Report from the Client and others. Delta-Simons conclusions, opinions and recommendations has been determined using this information. Delta-Simons does not warrant the accuracy of the information provided to it and will not be responsible for any opinions which Delta-Simons has expressed, or conclusions which it has reached in reliance upon information which is subsequently proven to be inaccurate.

This Report was prepared by Delta-Simons for the sole and exclusive use of the Client and for the specific purpose for which Delta-Simons was instructed. Nothing contained in this Report shall be construed to give any rights or benefits to anyone other than the Client and Delta-Simons, and all duties and responsibilities undertaken are for the sole and exclusive benefit of the Client and not for the benefit of any other party. In particular, Delta-Simons does not intend, without its written consent, for this Report to be disseminated to anyone other than the Client or to be used or relied upon by anyone other than the Client. Use of the Report by any other person is unauthorised and such use is at the sole risk of the user. Anyone using or relying upon this Report, other than the Client, agrees by virtue of its use to indemnify and hold harmless Delta-Simons from and against all claims, losses and damages (of whatsoever nature and howsoever or whensoever arising), arising out of or resulting from the performance of the work by the Consultant.

Appendix B – Site Photographs

Site Photographs



Photograph 1 – cars parked over 5 underground storage tanks, (disconnected)



Photograph 2 – Reclaimed railway sleepers, used as retaining walls around Site



Photograph 3 – Raised concrete plinth in the centre of the Site. Assumed to formerly house compactor.



Photograph 4 – Central inaccessible compound, with evidence of Sites former use with waste car parts present.



Photograph 5 – Car wash located in south west corner of the Site. waste water, draining to pre existing on Site drainage



Photograph 6 – Northern Building used for storage, compressed gas pump visible.



Photograph 7 – waste chemical containers stored within northern building.



Photograph 8 – Car spraying unit, located within northern building



Photograph 9 – car showroom and offices located within western site buildings



Photograph 10 – Drainage with potential petroleum product on surface.

Appendix C – Historical Maps

Historical Mapping Legends

Ordnance Survey County Series 1:10,560

	Gravel Pit		Sand Pit		Other Pits
	Quarry		Shingle		Orchard
	Osiers		Reeds		Marsh
	Mixed Wood		Deciduous		Brushwood
	Fir		Furze		Rough Pasture
	Arrow denotes flow of water		Trigonometrical Station		
	Site of Antiquities		Bench Mark		
	Pump, Guide Post, Signal Post		Well, Spring, Boundary Post		
	Surface Level				
	Sketched Contour		Instrumental Contour		
	Main Roads		Minor Roads		
	Sunken Road		Raised Road		
	Road over Railway		Railway over River		
	Railway over Road		Level Crossing		
	Road over River or Canal		Road over Stream		
	Road over Stream				
	County Boundary (Geographical)				
	County & Civil Parish Boundary				
	Administrative County & Civil Parish Boundary				
	County Borough Boundary (England)				
	County Burgh Boundary (Scotland)				
	Rural District Boundary				
	Civil Parish Boundary				

Ordnance Survey Plan 1:10,000

	Chalk Pit, Clay Pit or Quarry		Gravel Pit
	Sand Pit		Disused Pit or Quarry
	Refuse or Slag Heap		Lake, Loch or Pond
	Dunes		Boulders
	Coniferous Trees		Non-Coniferous Trees
	Orchard		Scrub
	Bracken		Heath
	Marsh		Reeds
	Building		Glasshouse
	Sloping Masonry		Pylon
	Cutting		Embankment
	Road Under		Road Over
	Level Crossing		Foot Bridge
	Standard Gauge Multiple Track		Standard Gauge Single Track
	Siding, Tramway or Mineral Line		Narrow Gauge
	Geographical County		Administrative County, County Borough or County of City
	Municipal Borough, Urban or Rural District, Burgh or District Council		Borough, Burgh or County Constituency
	Civil Parish		
	Boundary Post or Stone		Police Station
	Church		Post Office
	Club House		Public Convenience
	Fire Engine Station		Public House
	Foot Bridge		Signal Box
	Fountain		Spring
	Guide Post		Telephone Call Box
	Mile Post		Telephone Call Post
	Mile Stone		Well

1:10,000 Raster Mapping

	Gravel Pit		Refuse tip or slag heap
	Rock		Rock (scattered)
	Boulders		Boulders (scattered)
	Shingle		Mud
	Sand		Sand Pit
	Slopes		Top of cliff
	General detail		Underground detail
	Overhead detail		Narrow gauge railway
	Multi-track railway		Single track railway
	County boundary (England only)		Civil, parish or community boundary
	District, Unitary, Metropolitan, London Borough boundary		Constituency boundary
	Area of wooded vegetation		Non-coniferous trees
	Non-coniferous trees (scattered)		Coniferous trees
	Coniferous trees (scattered)		Positioned tree
	Orchard		Coppice or Osiers
	Rough Grassland		Heath
	Scrub		Marsh, Salt Marsh or Reeds
	Water feature		Flow arrows
	Mean high water (springs)		Mean low water (springs)
	Telephone line (where shown)		Electricity transmission line (with poles)
	Bench mark (where shown)		Triangulation station
	Point feature (e.g. Guide Post or Mile Stone)		Pylon, flare stack or lighting tower
	Site of (antiquity)		Glasshouse
	General Building		Important Building

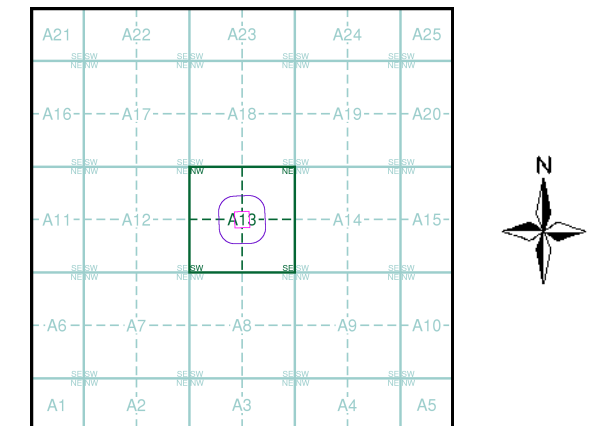
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Historical Mapping & Photography included:

Mapping Type	Scale	Date	Pg
Middlesex	1:10,560	1868 - 1873	3
Middlesex	1:10,560	1872 - 1879	4
Middlesex	1:10,560	1872	5
Essex	1:10,560	1876	6
London	1:10,560	1896	7
Essex	1:10,560	1898	8
Essex	1:10,560	1920	9
Essex	1:10,560	1938	10
Historical Aerial Photography	1:10,560	1945 - 1950	11
Ordnance Survey Plan	1:10,000	1952	12
Ordnance Survey Plan	1:10,000	1966 - 1968	13
Ordnance Survey Plan	1:10,000	1975 - 1976	14
Ordnance Survey Plan	1:10,000	1983	15
London	1:25,000	1985	16
Ordnance Survey Plan	1:10,000	1990 - 1992	17
10K Raster Mapping	1:10,000	1999	18
10K Raster Mapping	1:10,000	2006	19
VectorMap Local	1:10,000	2020	20

Historical Map - Slice A



Order Details

Order Number: 242179315_1_1
Customer Ref: 20-0337.01
National Grid Reference: 534770, 191740
Slice: A
Site Area (Ha): 1.
Search Buffer (m): 1000

Site Details

Dyson Road, Edmonton, N17 0RU

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Russian Military Mapping Legends

1:5,000 and 1:10,000 mapping

a. Not drawn to scale b. Drawn to scale

Government and Administrative Buildings

Military and Industrial Buildings

Military and Communication Areas

Subway Entrance

Fireproof Building

Prominent Fireproof Building

Non-fireproof Building

Non-fireproof Building (non-dwelling)

Factory, mill, and flour mill, with chimneys

Factory, mill, and flour mill, without chimneys

Power Station, drawn to scale

Hydroelectric Power Station

Radio Station, drawn to scale

Telephone Station, drawn to scale

Abandoned Open-pit Mine or Quarry

Open-pit Salt Mine

Pit

Oil Deposit or Well

Oil Seepage

Tailings Pile

Fuel Storage Tanks

Natural Gas Tank

Bench Mark

Drill Hole

Burial Mound

Triangulation Point on Burial Mound

Single-track Railroad

Double-track Railroad

Railroad and Station Building

Coniferous Forest

Deciduous Forest

Mixed Forest

Lawns

Citrus Orchard

Wet Ground

Scattered Vegetation

243.8 Values for prominent elevations
186.0 Numbers for spot elevations, depth soundings, contour lines, etc.
0.2 Velocity of the current, width of river bed, depth of river
180/12 Fractional terms: length and capacity of bridges; depth of fords and condition of the river bottom; height of forest and the diameter of trees

Russian Alphabet (For reference and phonetic interpretation of map text)

А а (A)	З з (Z)	П п (P)	Ч ч (CH)
Б б (B)	И и (I)	Р р (R)	Ш ш (SH)
В в (V)	Й й (Y)	С с (S)	Щ щ (SHCH)
Г г (G)	К к (K)	Т т (T)	Ъ (-)
Д д (D)	Л л (L)	У у (U)	Ы (Y)
Е е (E)	М м (M)	Ф ф (F)	Ь (')
Ё ё (YO)	Н н (N)	Х х (KH)	Э э (E)
Ж ж (ZH)	О о (O)	Ц ц (TS)	Ю ю (YU or IU)
			Я я (YA or IA)

1:25,000 mapping

a. Not drawn to scale b. Drawn to scale

Government and Administrative Buildings

Military and Industrial Buildings

Military and Communication Areas

Subway Entrance

Partly Demolished Buildings

Demolished Buildings

Built-Up Area with Fireproof Buildings Predominant

Built-Up Area with Non-Fireproof Buildings Predominant

Individual Fireproof Building

Prominent Industrial Building

Individual Dwelling, Fireproof

Ruins of an Individual Dwelling

Factory or Mill Chimney

Factory or Mill with Chimney

Factory or Mill without Chimney

Mine or Open Pit Mine

Operating Shaft or Mine

Non-Operating Shaft or Mine

Salt Mine

Tailings Pile

Pit

Stone Quarry

Gas Pump or Service Station

Fuel Storage or Natural Gas Tank

Oil or Natural Gas Derrick

Small Hydroelectric Power Station

Power Station

Transformer Station

Cemetery

Burial Mound (height in metres)

Triangulation Point on Burial Mound

Triangulation Point

Bench Mark

Bench Mark (monumented)

Telegraph Office

Telephone Station

Radio Station

Radio Tower

Airfield or Seaplane Base

Landing Strip

Cut, Fill, Km Post, Plantings

Telegraph/Telephone Lines

Main Highway

Highway under Construction

Improved Dirt Road (former truck road)

Small Bridge, Pipe (Culvert), Tunnel

Double-track Railroad with First Class Station

Dismantled Railroad

Railroad Under Construction

Shore Embankment

River or Ditch with Embankment

Water Gauge

Water Level Mark

Well

Water Reservoir or Rain Water Pit

Spring

Isobath with value

Heavy (Index) Contour Line

Contour Line and Value

Half Contour Line

Spot Elevation Value

Coniferous

Deciduous

Mixed

Scrub

Key to Numbers on Mapping

TQ39_London

No.	Description
113	Factories (Machinery And Rubber Goods)

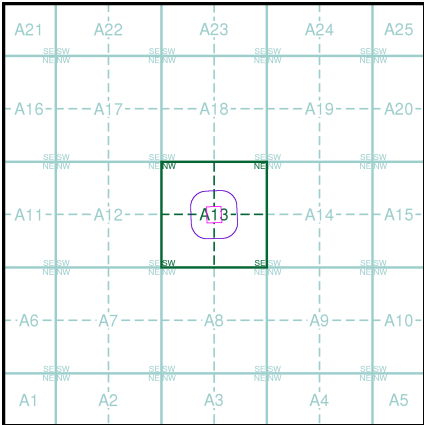
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10K Raster Mapping	1:10,000	2006	19
VectorMap Local	1:10,000	2020	20

Russian Map - Slice A



Order Details

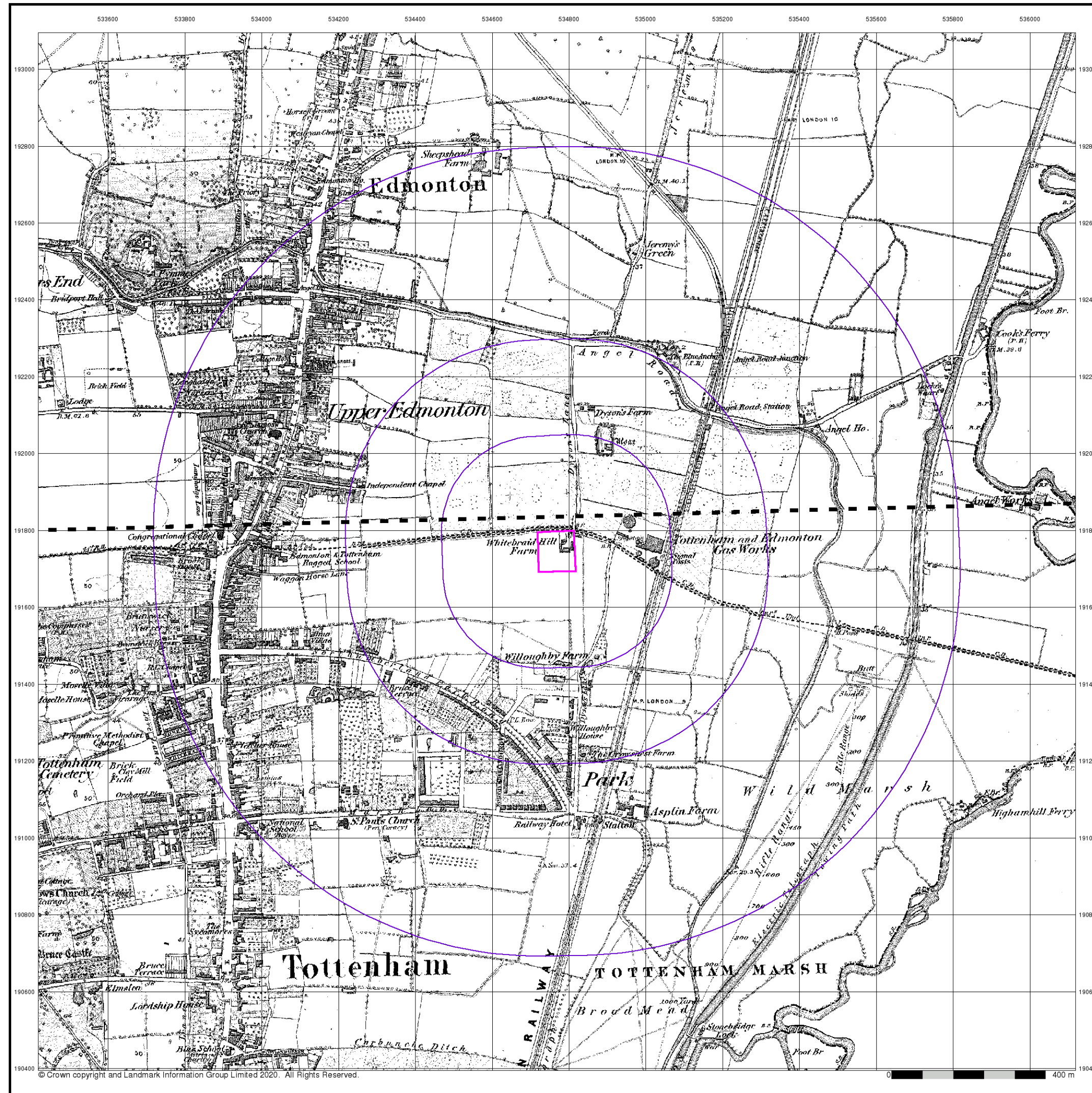
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Site Area (Ha): 1.
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Middlesex

Published 1868 - 1873

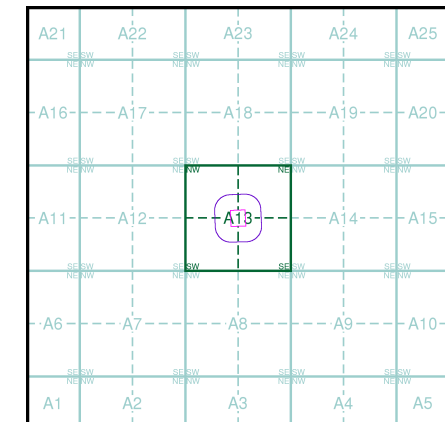
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The historical maps shown were reproduced from maps predominantly held at the scale adopted for England, Wales and Scotland in the 1840's. In 1854 the 1:2,500 scale was adopted for mapping urban areas; these maps were used to update the 1:10,560 maps. The published date given therefore is often some years later than the surveyed date. Before 1938, all OS maps were based on the Cassini Projection, with independent surveys of a single county or group of counties, giving rise to significant inaccuracies in outlying areas. In the late 1940's, a Provisional Edition was produced, which updated the 1:10,560 mapping from a number of sources. The maps appear unfinished - with all military camps and other strategic sites removed. These maps were initially overprinted with the National Grid. In 1970, the first 1:10,000 maps were produced using the Transverse Mercator Projection. The revision process continued until recently, with new editions appearing every 10 years or so for urban areas.

Map Name(s) and Date(s)

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1868
1:10,560
01200
1873
1:10,560

Historical Map - Slice A



Order Details

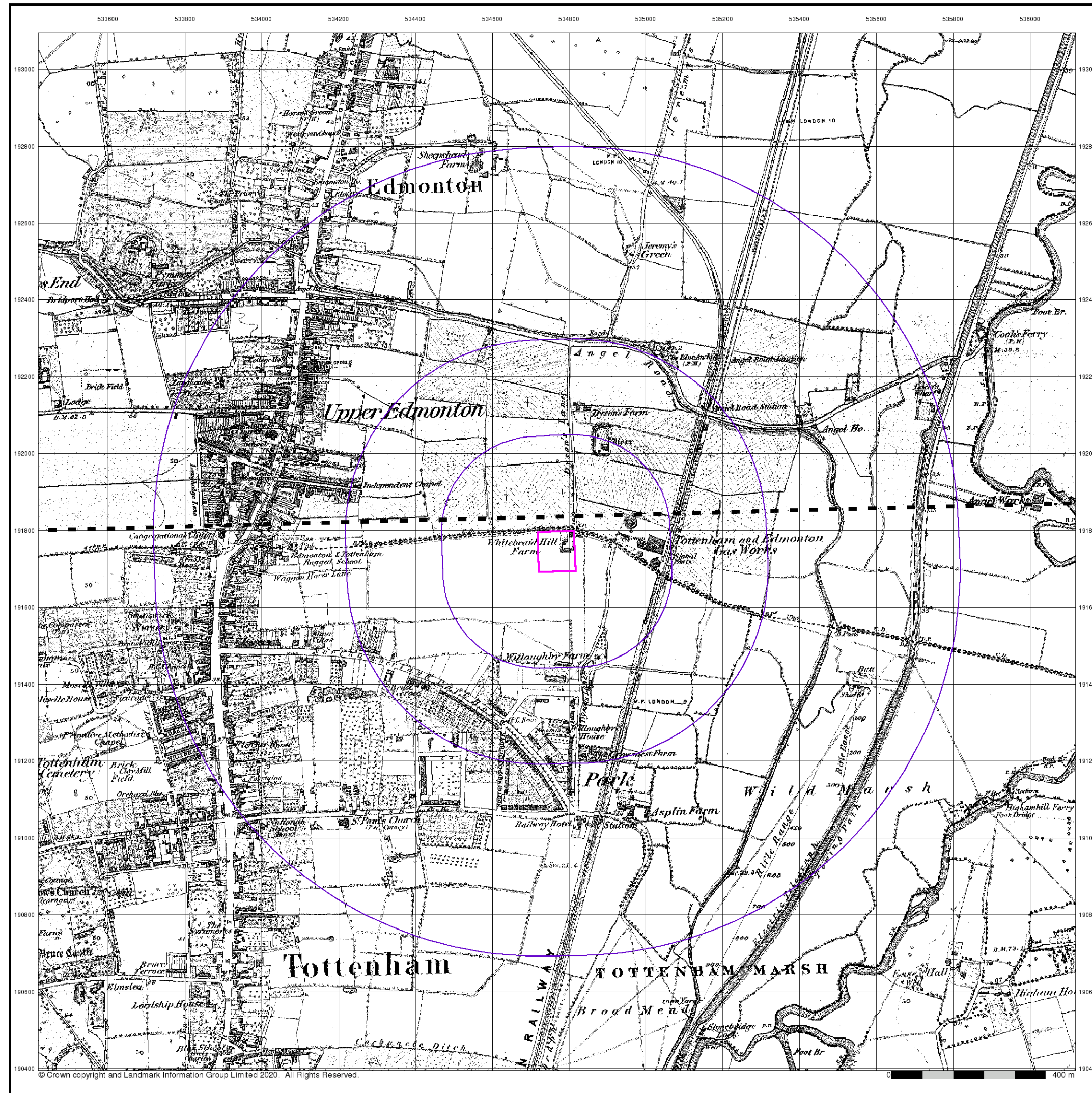
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Middlesex

Published 1872 - 1879

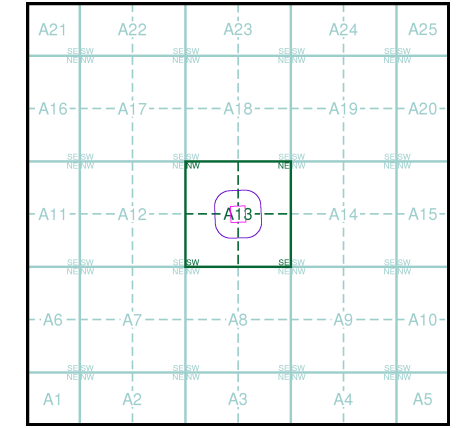
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Map Name(s) and Date(s)

00700
1872
1:10,560
01200
1879
1:10,560

Historical Map - Slice A



Order Details

Order Number: 242179315_1_1
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0 400 m

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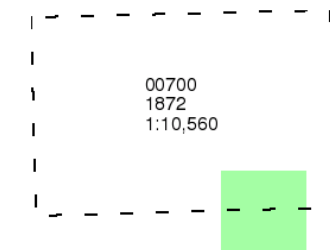
Middlesex

Published 1872

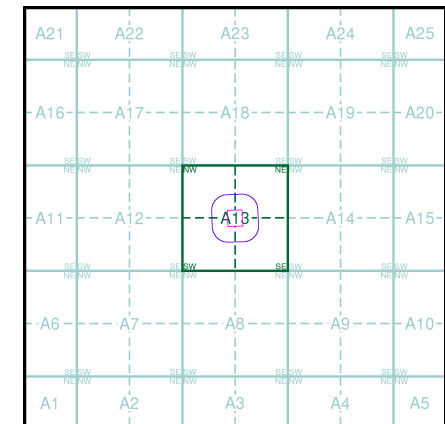
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Historical Map - Slice A



Order Details

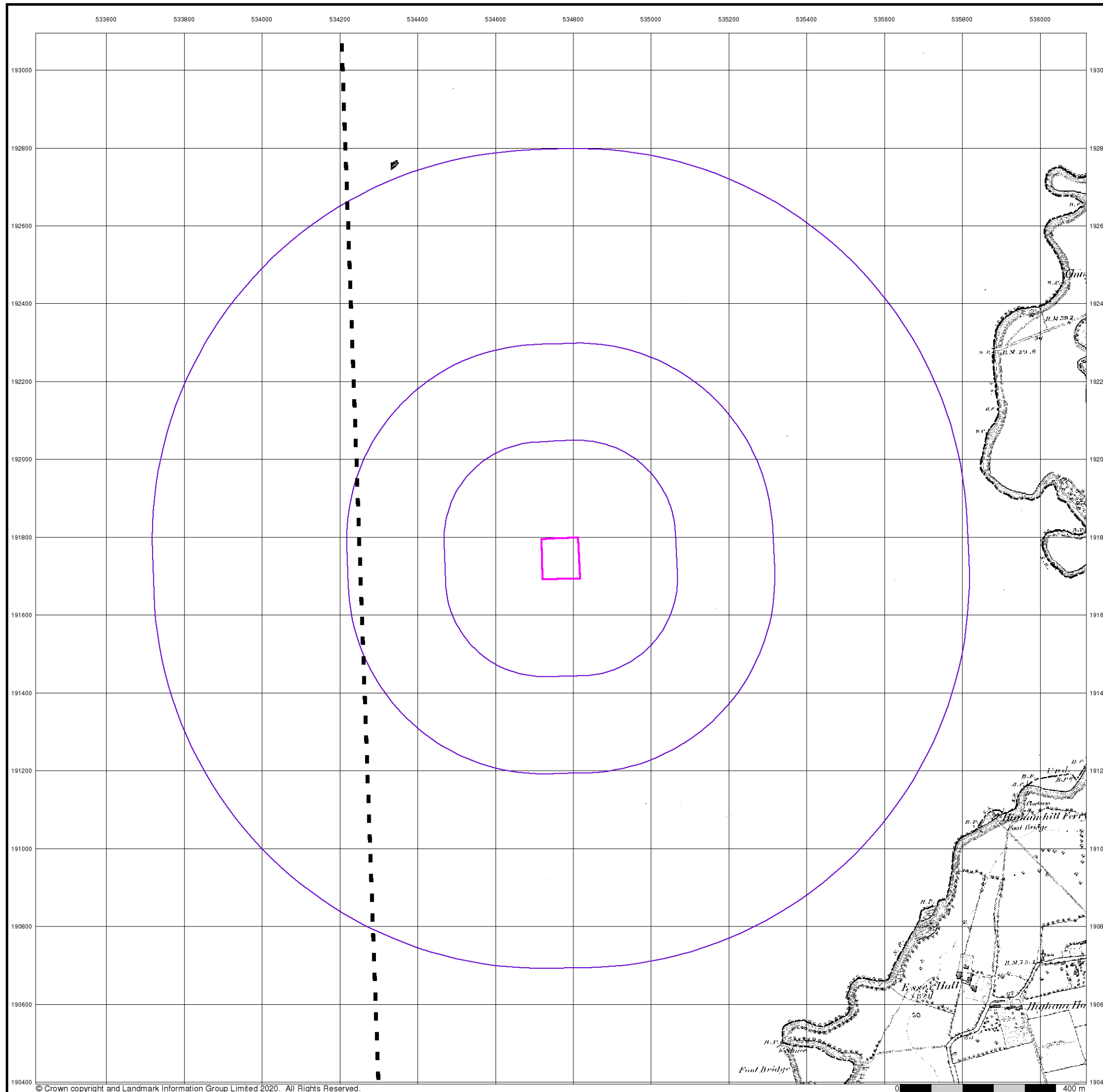
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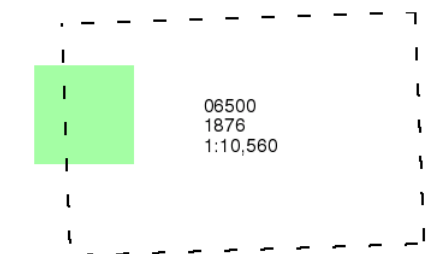
Essex

Published 1876

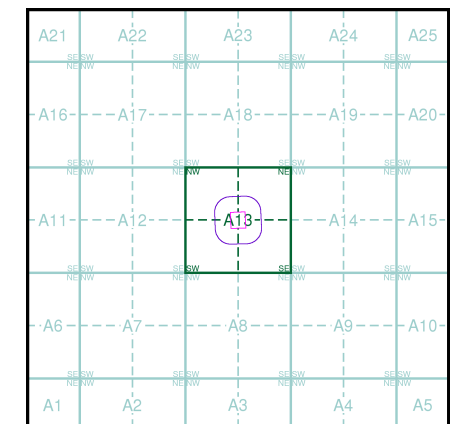
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