Phase I & II Geo-Environmental Assessment:

Land Adjacent 59-61
Broadway
Crowland
Lincolnshire
PE6 0BH

Prepared for:

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LAND ADJACENT 59-61 BROADWAY, CROWLAND

NON TECHNICAL SUMMARY

This report presents the findings of a combined Phase I Desk Study and Phase II intrusive Geo-Environmental Assessment undertaken to determine ground conditions and establish if there are any environmental risks associated with the site and its development. Pertinent findings and conclusions may be summarised as follows:

- A number of previous investigations have been carried out at this site in the past, however the purpose of this Phase I Desk Study was to document all previous work and provide an up to date conceptual site model in advance of the proposed site redevelopment.
- The property was a petrol station since the 1970's and the underground fuel storage tanks were removed in 2003. Currently all former infrastructure, buildings and hardstanding has been stripped from the area prior to forthcoming redevelopment works and this report highlighted potential risks associated with the nature and quality of shallow soils within proposed garden areas and also the potential for organic contaminant vapours to migrate into any proposed and neighbouring dwellings causing risks to current / future residents.
- Six hand auger boreholes were formed during the Phase II intrusive investigation and ground conditions were found to comprise a combination of made ground materials and natural silty sandy gravelly clays. Samples of these materials sent to the lab for analysis found no unacceptable risks to any future residents although it has been considered prudent to recommend a suitable growing medium for plants within any areas of soft landscaping / gardens around the location of sample point HA4.
- Vapour resistant membranes will need to be installed within the footprint of Plots 1-4 to control the risks of volatiles migrating into the proposed dwellings. In order to reduce the risk of water supply pipework being impacted by ground contamination, the use of barrier pipework is recommended.
- After examination of groundwater samples, the findings of the previous QRA produced by EPS are still considered appropriate, as the samples obtained from neighbouring property boreholes are not considered to be impacted by site derived contamination, and therefore no remediation of groundwater is considered necessary for the site.

The above points represent a simplified summary of the findings of this assessment and should not form the basis for key decisions for the proposed development. A thorough review of the details is contained within the following report, or get in touch and we'll talk you through it.

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Where ground investigations have been conducted, these have been limited to the level of detail required for the site in order to achieve the objectives of the investigation.

The report has been written, reviewed and authorised by the persons listed above. It has also undergone EPS' quality management inspection. Should you require any further assistance regarding the information provided within the report, please do not hesitate to contact us.

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1 INTRODUCTION

In April 2015, Environmental Protection Strategies Ltd (EPS) was commissioned by Mr Ian Ladds to complete a combined Phase I and II Geo-Environmental Assessment for Land Adjacent 59-61, Broadway, Crowland, Lincolnshire, PE6 0BH (the 'site'); see Figure 1.

This report presents the findings, conclusions, and recommendations of a Phase I Desk Study and subsequent Phase II intrusive investigation undertaken for the site in connection with the current development proposals related to South Holland District Council planning application number: H02-0147-15 and Environment Agency reference number: AN/2015/121235/01/-L01.

Development proposals include construction of five residential dwellings with associated access road, vehicle parking and domestic garden areas.

1.1 Background and Previous Reports

Prior to the development of this report, several phases of investigations have been carried out but only three have been documented as follows:

- *Site Investigation Report – Former Broadway PFS, Crowland, Lincolnshire, PE6 0BH* (Applied Geology, Ref.: AG1031-08 – November 2008)
- *Supplementary Sampling Report – Former Broadway PFS, Crowland, Lincolnshire, PE6 0BH* (EPS Ltd, Ref.: UK14.1470 – 14th January 2014)
- *Quantitative Risk Assessment – Former Broadway PFS, Crowland, Lincolnshire, PE6 0BH* (EPS Ltd, Ref: UK14.1470 – 23rd October 2014).

A brief summary of the work known to have been carried out is summarised below, however it is also recommended that the reader review the above reports prior to considering this document.

Previous Undocumented Investigations:

In 2000, the firm PEB Robson excavated three trial pits at the site to inspect the ground conditions and confirm the design and location of the on-site underground tanks. Subsequently, in 2001, Ground Engineering attended the site and drilled five boreholes to determine the conditions of the underlying soils at the site.

In June 2003, JP Chick &Partners attended the site to supervise the excavation and removal of underground tanks, which comprised several relatively small underground tanks used to store either petrol, diesel or waste oils at the northern end of the site. The excavations were reinstated with inert materials. JP Chick also excavated four trial pits in the surrounding area to determine the condition of the surrounding soils and groundwater but it is not clear what the results of this investigation were.

Applied Geology Report - November 2008

The report passed to EPS for review consists of a number of site plans with various notes appended to each to summarise various findings. Very little detail is included, however it appears Applied Geology attended the site in March 2008 to excavate several trial pits across the site and to install six on-site groundwater monitoring wells (BHA-F). In May 2008, Ground Engineering then installed one additional deeper ground monitoring well at the site (BH1A) and JP Chick & Partners Ltd subsequently undertook some groundwater testing of the seven on-site monitoring wells in June 2008. The results of the groundwater sampling identified elevated concentrations of hydrocarbons in several monitoring wells across the site, in particular BH1A situated in the central area of the site where up to 2mm of liquid hydrocarbon was found.

The monitoring wells were subsequently tested again in November 2008 by Applied Geology which indicated that the elevated concentrations of hydrocarbons were still present in the groundwater underlying the site, with the concentration of Total Petroleum Hydrocarbons detected in monitoring well BHA at a concentration of 72mg/l.

A very brief summary of some remediation activities, proposed for completion by Celtic Technologies Ltd, was also included in the report, which involved excavation of up to 3250m^3 (6688 tonnes) of contaminated soil from the majority of the northern half of the property for subsequent off-site disposal. It is not clear if this work was ever completed.

EPS Supplementary Sampling Report – January 2014

The supplementary sampling investigation consisted of the precision sampling of the seven existing groundwater monitoring wells at the site for subsequent laboratory analysis. In addition, seven trial pits were also excavated across the property to confirm the ground conditions and to determine if any of the former underground fuel storage tanks were still present at the site.

EPS did not find any remaining underground tanks and confirmed that ground conditions consisted predominantly of made ground overlying natural ground of Abbey Sands and Gravels and then Oxford Clay respectively; the last of which extended to beyond a depth of 3.0m. Groundwater was measured within the monitoring wells at depths of approximately 1.0m below the ground surface.

EPS found black and grey staining in the saturated subsurface soil in several of the trial pits it excavated, with some occasional hydrocarbon odours also evident. Evidence of dissolved hydrocarbon was found in the water samples that were submitted to the laboratory and these were found to exceed relevant basic screening criteria for some hydrocarbon compounds, (including benzene and xylene) at a few of the sampling locations. However, the concentrations identified were significantly lower than those identified during the last groundwater sampling in 2008.

EPS recommended that a detailed site-specific risk assessment for contaminants in groundwater was carried out to determine whether any remedial action would be necessary to protect the surrounding groundwater resources in the area.

Whilst no soil samples were collected for laboratory analysis, the report did make recommendations for future sampling and outlined work that may be necessary during the proposed development to protect the health of future site users from the presence of any hydrocarbon contaminants in the subsurface. These provisions included installation of a hydrocarbon-resistant membrane and drinking water pipework within proposed dwellings at the intended development to break linkages associated with direct and indirect contact with contaminated soil, as well as inhalation of vapours from soil into indoor air.

EPS Quantitative Risk Assessment – October 2014

A Quantitative Risk Assessment was produced by EPS in October 2014 in order to quantify as far as possible the risks to groundwater resources in the surrounding area and determine if existing concentrations in groundwater required control or reduction.

Benzene and Aromatic Hydrocarbons C8-C10 were chosen as the risk drivers for the site with remedial targets being derived for both at 2.8mg/l and 0.465mg/l respectively. On site concentrations did not exceed these thresholds and groundwater samples obtained from off-site neighbouring boreholes substantiated conservatism within the modelling process as contaminants of concern were not identified above minimum laboratory detection limits and the distance the closest off-site borehole is situated from the most significant hydrocarbon impacts coincides with the adopted compliance distance (50m).

It was concluded that the delivery of a groundwater remediation scheme, on the basis of reducing risks to controlled waters, could not pass a test of 'reasonableness' in terms of wider economic and environmental benefits which could sensibly be achieved.

It was reiterated that control measures outlined in previous reports to control the potential risks to human health would still need to be carried out and validated to ensure that the proposed residential development does not pose an unacceptable risk to future site residents.

1.2 Objectives

The objectives of this investigation were as follows:

a) To compile a Conceptual Site Model (CSM) for the purpose of evaluating the potential risks the site may pose to human and environmental receptors, both currently and in future.
b) To investigate potential contaminant linkages identified by the CSM by means of investigating and collecting samples of shallow soils for laboratory analyses.
c) Confirm the findings of the Quantitative Risk Assessment by undertaking another round of groundwater monitoring.
d) To determine the potential risks posed by the site and make recommendations for any further work that may be required and to ensure safe development in accordance with the *Model Procedures for the Management of Land Contamination* - Contaminated Land Report 11.

1.3 Scope of Work

The brief for these works was to perform an exploratory Geo-Environmental assessment of the site in accordance with the principles and requirements of DEFRA Circular 01/2006, BS10175 – '*Investigation of Potentially Contaminated Sites*', and therefore included the following:

Desk Study:

- Collection of site records.
- Study of existing geological, hydrogeological and historic maps of the area.
- Examination of environmental databases.
- Development of conceptual model and contaminant linkage assessment.

Site Work:

- Site walkover, inspection of any visual evidence of contamination at the site, obtaining photographic records.
- Health and safety briefing / site supervision.
- Drilling of hand auger boreholes to a maximum depth of 0.6m below ground level (bgl) at six locations.
- Continual logging of ground conditions including inspection of samples for visual and olfactory contamination, and laboratory analysis of selected soil samples.
- Obtain groundwater samples from existing boreholes both on and off-site.

Reporting:

- Data collection and interpretation.
- Reporting.

The findings of these investigations and their conclusions are presented in the following sections.

1.4 Limitations and Constraints

The purpose of this report is to present the findings of a soil and water sampling investigation conducted at the location(s) specified. When examining the data collected from the investigations made during the assessment, Environmental Protection Strategies Ltd (EPS) makes the following statements:

No investigation method is capable of completely identifying all ground conditions that might be present in the soil or groundwater under a site. Where outlined in our report, we have examined the ground beneath a site by constructing a number of boreholes and / or trial pits to recover soil and / or groundwater samples. The locations of these excavations and sampling points are considered to be representative of the condition of the whole site subsurface however, ground conditions are naturally variable and it may be possible that the ground conditions encountered may differ to those encountered during the investigation.

The investigation was carried out to assess the significance of contamination resulting from the use of the site as identified in this report. Unless EPS has otherwise indicated, no assessment of potential impact of any other previous uses has been made.

No visible evidence of Japanese Knotweed was identified during the site walkover, however this plant can be difficult to identify in the early stages of growth and therefore it is not always possible to identify its presence at certain times of the year. For this reason EPS cannot confirm that Japanese Knotweed rhizomes do not exist and it is recommended that if it is suspected that this species or other similarly invasive plants are present at the site, a specialist contractor should be commissioned to make a detailed assessment.

2 GEO-ENVIRONMENTAL SETTING

The following section provides a summary of the information collected in relation to the site location and history.

2.1 Site Description

Detail	Description
Location	The site is located within Crowland, approximately 13km south of Spalding, Lincolnshire.
Grid Reference	523899, 309924
Topographic Elevation	Approximately 5m Above Ordnance Datum (AOD).
Topographic Gradient	Local topography is relatively flat.
Description of Site	During a site walkover survey on 26th May 2015, the area was found to be an active construction site which had been cleared of former structures and hardstanding with stockpiles of excavated materials along the western boundary.
Surrounding Land Use	The site is bound by Broadway to the north beyond which is South View Primary School. The eastern, southern and western boundaries are bound by residential properties and associated domestic garden areas.

A plan showing the site location is provided as Figure 1, the current site layout is detailed on Figure 2 and an aerial photograph is included as Figure 3. Selected site photographs are included as Appendix A, an indicative proposed development plan as Appendix B and relevant extracts of a Landmark Envirocheck report are included as Appendix C.

2.2 Environmental Setting

Detail		Description
Geology	Geological maps of the area show that underlying superficial geology comprises Abbey Sand and Gravels with bedrock geology being described as the Oxford Clay Formation. Previous site specific ground investigation work has indicated a variable thickness of made ground materials underlain by Abbey Sand and Gravels and the Oxford Clay Formation at approximately 2.5m below ground level (m bgl). The sites geological context is presented within Appendix D.	
Geological Hazards	**Hazard**	**On Site Risk**
	Mining	No Hazard
	Collapsible Ground	Very Low
	Compressible Ground	No Hazard
	Ground Dissolution	No Hazard
	Running Sand	Very Low
	Landslide	Very Low
	Shrinking / Swelling Clay	No Hazard

Detail	Description
Radon	The BGS and Health Protection Agency (HPA) report entitled '*Indicative Atlas of Radon in England and Wales*' (November 2007) shows the site to lie within a 1km grid section where the percentage of homes above the radon action level is between 0% and 1%. The joint Building Research Establishment Ltd (BRE) report entitled '*Radon: Guidance on Protective Measures for New Buildings* - 2007' reports that the site does not lie within an area where basic radon protection methods will need to be employed.
Hydrogeology	Groundwater vulnerability maps for the area show that the Abbey Sands and Gravels are classified as a Secondary A Aquifer while the underlying Oxford Clay Formation is classified as Unproductive Strata. Two groundwater abstraction licenses are listed within 1km, the closest of which is a revoked license located 611m southwest and is described as a groundwater fed reservoir for general agricultural use. Two private groundwater abstraction boreholes are located in neighbouring properties to the west which are understood to be used for small scale irrigation purposes, the closest of the two is located approximately 20m west, (in relation to the western site boundary). As established through previous site investigations, depth to groundwater is known to range from approximately 0.9-1.1m below ground level (m bgl). It was also noted that the site has a very flat groundwater surface within the ground although from examining laboratory data and interpretation of the contaminant distribution an inferred groundwater flow direction to the west / southwest has been established. The site does not lie within a Source Protection Zone (SPZ) for groundwater abstraction.
Hydrology	The closest surface watercourse is an unnamed man-made drainage channel 134m south. Three surface water abstractions are listed within 1km with the closest relating to an abstraction 638m west for spray irrigation purposes.
Landfill & Waste	A single historic landfill site is located within 1km which received household waste approximately 575m west at a location named Corporation Bank.
Industrial Land Use	The Envirocheck report lists 21 inactive and 15 active commercial / industrial land uses within 500m. The most pertinent of which includes an inactive domestic cleaning services approximately 55m northeast, an active boatbuilders and repairers 120m west and an inactive paint & varnish stripping business 130m north. The site is also listed as being an obsolete fuel station called Broadway Service Station.
Sensitive Land Use	A surface water Nitrate Vulnerable Zone is located approximately 35m northwest where surface water is identified as being at risk from nitrates leaching from agricultural land.

2.3 Site History

A summary of historical map data from 1886 to 2015 is provided below and copies of relevant historic maps during the investigation are included in this report as Appendix F.

- Initial records from 1886 indicate a single structure to be located in the north eastern corner of the site which is presumed to be a residential property while the rest of the area is anticipated to be undeveloped agricultural land. The site is bound by New Road to the north, small residential properties to the east and agricultural land to the south and west.
- By 1904 a further structure is evident in the north western corner adjacent New Road. The majority of the area to the south remains undeveloped.
- A 1:2,500 scale historic map from 1975 shows the site to be redeveloped as a Garage / Petrol Filling Station (PFS) with centralised access off Broadway (previously New Road) to the north, main commercial structure to the west and a row of what appears to be individual lock up garages along the western boundary. Land immediately to the west has been developed with five individual small structures of unknown use. Former agricultural land to the south has been developed as residential properties with associated domestic garden areas.
- By 1995 adjacent land to the west has been developed as a detached residential property with associated private driveway and domestic garden area.
- By 2006 land immediately west has been split into two residential properties while the site remains largely unchanged.
- A 1:10,000 scale map from 2015 shows the site to be cleared of any structures and the former Garage / PFS appears to have been demolished.

3 CONCEPTUAL MODEL

The following section provides a review of the contaminant linkages that may be active at the site through examination of the potential sources that may be present as a result of historic and / or current site activities and where potential interaction between these sources and the identified human / environmental receptors may occur.

3.1 Source Characterisation

The following potential contaminant sources have been identified at the site and in the surrounding area:

Potential Source	Source Description	Principal Contaminants of Concern
Historic / Current Site Use	Potential shallow made ground materials associated with the sites historical use as a garage and former historical structures to the north.	Metals, PAH, ACM, TPH
Historic Site Use	Sites former use as Broadway Service Station which is understood to have comprised underground fuel storage and dispensing infrastructure.	EPH, VPH, BTEX, MTBE
Historic / Current Surrounding Land Use	Surrounding commercial land use including inactive domestic cleaning services 55m northeast, active boatbuilders and repairers 120m west and inactive paint and varnish stripping business 130m north.	TPH, VOC, SVOC, PAH, Metals
Historic Surrounding Land Use	Historic landfill approximately 575m west	Landfill Gas (CO_2, CH_4)

Notes: PAH Polycyclic Aromatic Hydrocarbons; ACM Asbestos Containing Material; TPH Total Petroleum Hydrocarbons; EPH Extractable Petroleum Hydrocarbons; VPH Volatile Petroleum Hydrocarbons; VOC Volatile Organic Compounds; SVOC Semi-Volatile Organic Compounds; CO_2 Carbon Dioxide; CH_4 Methane

3.2 Potential Receptors

A framework for the assessment of risks arising from the presence of contamination in soils has been produced by the Environment Agency and the Department for the Environment, Food and Rural Affairs (DEFRA) and is presented with the report '*Using Science to Create A Better Place: Updated Technical Background to the CLEA Model* – Science Report SC050021/SR3'. This guidance document defines a series of standard land-uses, which form a basis for the development of a Conceptual Site Model.

It is understood that the site is to be developed as residential properties within associated car parking areas and domestic gardens. Therefore the land use, (in accordance with Science Report SC050021/SR3) has been considered as:

- Residential

In view of the environmental setting, current and potential future land use of the site and surrounding area, the potential receptors for any contaminant impact are discussed in the table on the following page.

Receptor	Site Specific Description
Human	Construction workers through the development and future site users have the potential to be at risk of exposure to potential contaminants of concern within shallow soils by direct contact.
Groundwater	The Abbey Sands & Gravels are classified by the EA as a Secondary A Aquifer and two private groundwater abstraction boreholes are located in the neighbouring properties to the west. Groundwater should therefore be considered as a sensitive receptor to site derived contaminants of concern.
Surface Water Bodies	Given that the nearest surface water course is a man-made drainage channel approximately 135m south, surface water courses have not been considered as a sensitive receptor to site derived contaminants of concern.
Flora and Fauna	The proposed development includes the provision of domestic garden areas and potential soft landscaped areas. Some of the identified contaminants of concern are known to be phytotoxic and as such the potential for this impact should be considered.
Buildings & Infrastructure	The identified contaminants of concern have the potential to adversely affect buried site infrastructure such as water supply pipes.
Adjacent Land	Given that surrounding land use is predominantly residential, adjacent land and subsequent site users should be considered as sensitive to site derived contaminants of concern.

3.3 Potential Pathways

Where contaminants may be present in soil, there are a number of potential pathways that enable human receptors to come into contact with or be exposed to them. The most direct pathways, considered under current UK legislation, can be summarised as follows:

- Direct ingestion of contaminated soil
- Ingestion of household dust
- Ingestion of contaminated vegetables
- Ingestion of soil attached to vegetables
- Dermal contact with contaminated soil
- Dermal contact with household dust
- Inhalation of fugitive soil dust
- Inhalation of fugitive household dust
- Inhalation of vapours outside
- Inhalation of vapours inside

Clearly, not all of these potential pathways apply for every standard land-use; the simplest example for exclusions being a commercial / industrial site which is covered by concrete hardstanding. The concrete precludes the direct exposure of humans working at the site to any contaminated soils.

However in addition to direct exposure pathways, a number of physical transport mechanisms / pathways may also exist at a site that allow remote or less accessible contaminants in soil or groundwater to reach human or environmental receptors both at a site and beyond the site boundary. These include the physical transport mechanisms listed on the following page:

- Downward and lateral movement of contaminants in soil either by gravity or through being 'leached' by percolating rainwater
- Lateral migration of contaminants dissolved in groundwater.
- Direct seepage or leaching of contaminants from soil into subsurface drains or supply pipework.
- Volatilisation of contaminants from groundwater or unsaturated soils into buildings or outdoor air.

Through examination of the standard land use and environmental setting at each site, the presence of pathways and transport mechanisms described above must be considered when assessing whether a contaminant linkage may plausibly be active, and therefore be included in the conceptual site model.

3.4 Summary of Contaminant Linkages

Considering the site use and environmental setting, and the proposed land use; the plausible contaminant linkages that require further investigation are summarised in the following table:

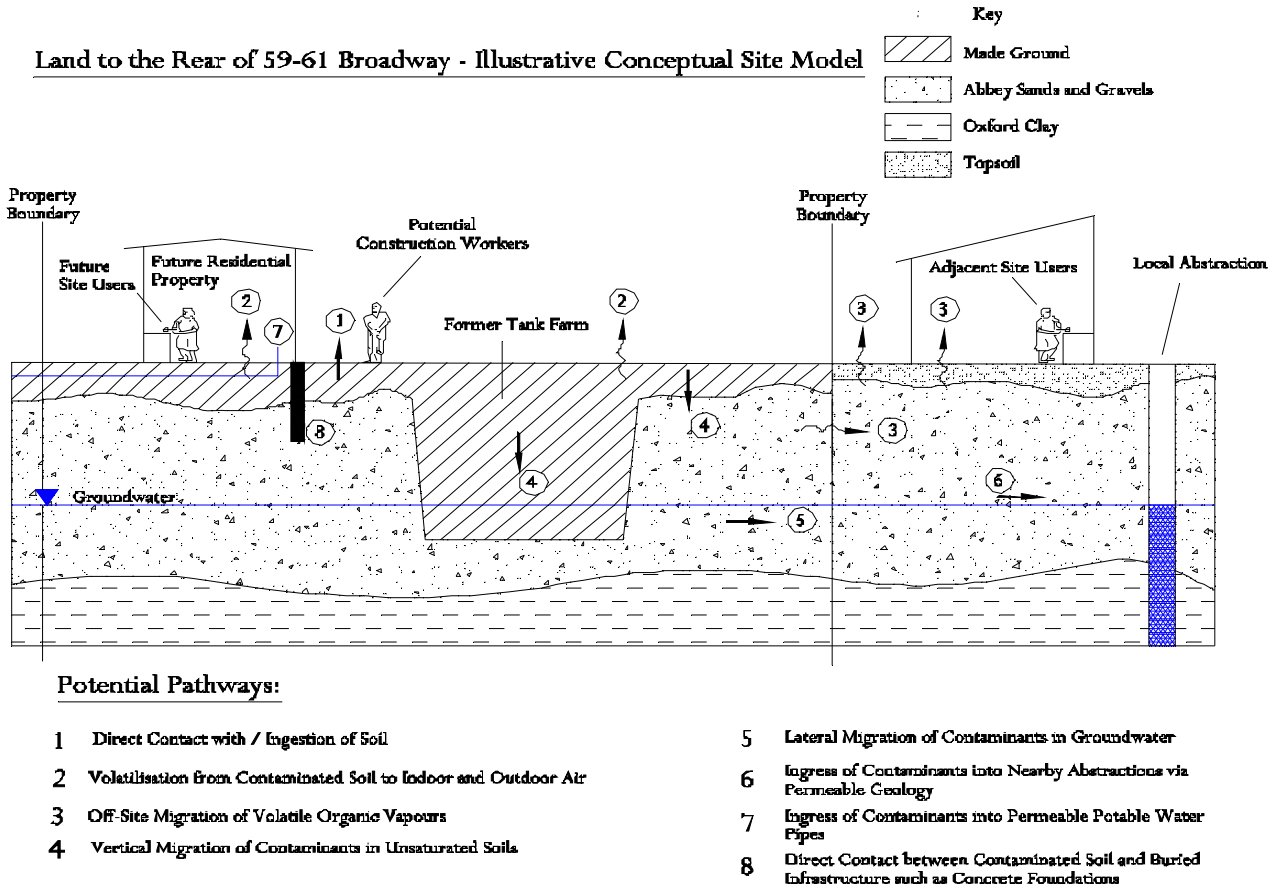
Source	Pathway	Receptor
Contaminated soil	Direct contact and inadvertent ingestion by eating or smoking with dirty hands, inhalation of fugitive dusts.	Future site users & construction workers during redevelopment
	Direct uptake and / or adherence of contaminated soil to vegetation and subsequent ingestion.	Future site users
	Direct uptake via root systems.	Plants
	Vertical migration through permeable geology and into underlying groundwater.	Groundwater
	Ingress / diffusion through permeable potable water supply pipes.	Site users
Contaminated soil / groundwater	Volatilisation of organic compounds to indoor and outdoor air.	Site users
	Off-site migration of organic vapours	Adjacent Site Users

The following comments are made with respect to contaminant linkages which have been considered through development of the conceptual model, but have not been concluded as 'plausible' – i.e. through which a significant possibility of significant harm could occur to an identified receptor:

- The migration of ground gas through unsaturated geology and into indoor and outdoor air has not been considered as plausible due to the distance which the identified historical landfill is located from site (approximately 575m west).
- An inactive domestic cleaning services was identified approximately 55m northeast along with other commercial land uses within 150m. Given the distance of these commercial activities and small scale domestic nature of the cleaning services, a risk of contaminants migrating onto site and causing an unacceptable risk to human receptors is not considered as plausible.

3.5 Conceptual Site Model

The following diagram provides a schematic representation of the conceptual site model, which includes a summary of the plausible contaminant linkages:



4 SUMMARY OF INTRUSIVE INVESTIGATIONS

The intrusive investigation was undertaken on 26th May 2015 in accordance with EPS standard operating procedures, copies of which will be made available on request. A summary of the investigation is presented in the following sections:

4.1 Borehole Locations

Borehole locations were selected through consideration of the potential contaminant linkages identified through the Phase I Desk Study, the proposed development layout and operational health & safety considerations.

A total of six hand auger boreholes (HA101 & HA2-HA6) were drilled during the intrusive investigation in order to assess the nature and quality of underlying soils to depths of up to 0.6m below ground level (m bgl).

The overall objective in terms of borehole locations was to provide an appropriate lateral and vertical coverage of the site to determine the underlying shallow ground conditions and identify potential contamination which may be present.

An objective of this additional phase of site investigation was to complete another round of groundwater monitoring on existing on and off-site boreholes. Through the recent demolition / site clearance works a number of monitoring wells have been damaged and subsequently infilled. BH1A is the only remaining monitoring well on-site and a hand auger standpipe installed off-site (HA1) was found to be infilled to 1.305m bgl whereby no groundwater sample could be obtained.

A detailed layout plan showing the locations of the boreholes formed during the investigation and existing boreholes installed during previous ground investigation work is presented as Figure 4.

4.2 Soil Sampling

Each borehole was logged for ground conditions encountered and inspected for any physical evidence of contamination such as soil staining, odour and the presence of separate phase liquids.

Shallow soil samples were obtained from each location and submitted for laboratory analysis to assess the nature and quality of underlying soils.

4.3 Groundwater Sampling

Groundwater samples were obtained from monitoring wells BH1A, BH1 & BH2.

Groundwater samples were obtained using the 'low flow' sampling technique in accordance with EPS standard operating procedures. Groundwater was monitored for dissolved oxygen, redox, pH and temperature before sampling at the three standpipe locations.

4.4 Environmental Laboratory Analysis

All samples obtained for analysis of identified contaminants of concern were submitted to Jones Environmental of Flintshire, who hold appropriate UKAS / MCERT accreditation for the required testing. Samples were transported in laboratory supplied containers and delivered to the laboratory by approved courier.

5 FINDINGS OF THE INVESTIGATION

This section of the report provides a summary of the findings of the various aspects of the most recent intrusive investigation.

5.1 Ground Conditions

A total of six boreholes were formed at the site and the ground conditions encountered are briefly summarised as follows:

Geological Strata	Maximum Depth to Base of Strata(m bgl)	Strata Thickness (m)
Made Ground /Topsoil	>0.6	0.2 - >0.6
Abbey Sand and Gravels	>0.6	>0.4

5.1.1 Made Ground / Topsoil

Made ground was encountered in hand auger borehole locations (HA101 & HA2 - HA5) as orangey brown silty sandy gravelly clay with brick fragments and clinker material. Dark brown silty sandy topsoil with recently active roots was encountered from 0.0-0.3m within HA6.

5.1.2 Abbey Sand and Gravels

The Abbey Sand and Gravels were generally observed as orangey brown, slightly sandy silty gravelly clay beneath made ground materials within HA2 & HA4 – HA6. At all other locations made ground was not penetrated.

5.1.3 Groundwater

Groundwater was not encountered at any hand auger borehole location. Depth to groundwater measured in existing monitoring wells is included in the following table.

Borehole ID	Depth to Groundwater (m bgl)
BH1A	1.730
BH1	1.223
BH2	1.325
HA1	DRY at 1.305

5.1.4 Site Specific Borehole Records

Site specific borehole logs are included as Appendix G and give descriptions and depths of strata encountered.

5.2 Physical Evidence of Contamination

Other than made ground materials, no visible or olfactory evidence of contamination, such as hydrocarbon odours / staining or putrefiable materials were encountered within shallow soils at any hand auger borehole location. During the purging process prior to groundwater sampling, a strong hydrocarbon odour was noted in groundwater recovered from BH1A.

5.3 Laboratory Analysis

5.3.1 Chemical Analysis-Soils

A laboratory analysis testing schedule is presented as Table 1 and all environmental sample results obtained from the laboratory are included as Appendix H. The key results of laboratory testing on environmental soil samples are summarised as follows:

Contaminant	No. of Samples	No of Detections	Range of Detections (mg/kg)		Highest Location & Depth (m bgl)
			Min	Max	
Arsenic	6	6	16.6	31.0	HA101 / 0.1-0.6
Cadmium	6	3	0.2	0.5	HA4 / 0.2-0.6 HA6 / 0.1-0.6
Chromium	6	6	50.0	63.5	HA2 / 0.1-0.6 HA6 / 0.1-0.6
Chromium (6^+)	6	0	-	-	-
Copper	6	6	17	62	HA101 / 0.1-0.6
Mercury	6	2	0.2	1.0	HA101 / 0.1-0.6
Nickel	6	6	14.0	29.3	HA4 / 0.2-0.6
Lead	6	6	30	214	HA4/ 0.2-0.6
Selenium	6	4	-	1	HA101 / 0.1-0.6 HA2 / 0.1-0.6 HA3 / 0.1-0.6 HA4 / 0.2-0.6
Zinc	6	6	113	565	HA4 / 0.2-0.6
Benzo[a]pyrene	6	6	0.49	5.84	HA4 / 0.2-0.6
PAH (Total of 16)	6	6	4.8	63.9	HA4 / 0.2-0.6
ACM	6	0	-	-	-
Cyanide (Total)	6	2	0.6	6.0	HA101 / 0.1-0.6
Phenols (Total)	6	0	-	-	-
Soil Organic Matter (SOM) (%)	6	6	0.8	14.0	HA101 / 0.1-0.6
Benzene	6	0	-	-	-
Toluene	6	0	-	-	-
Ethylbenzene	6	0	-	-	-
Xylenes	6	0	-	-	-
MTBE	6	0	-	-	-

Contaminant	No. of Samples	No of Detections	Range of Detections (mg/kg)		Highest Location & Depth (m bgl)
			Min	Max	
TPHCWG (Total)	6	6	45	449	HA3 / 0.1-0.6

Notes:
- = Contaminant not found above laboratory detection limits
PAH = Polycyclic Aromatic Hydrocarbons
ACM = Asbestos Containing Material
MTBE = Methyl-tert-butyl-ether
TPHCWG = Total Petroleum Hydrocarbons Criteria Working Group

- The most significant concentrations of PAH compounds were identified within HA2-HA4.
- TPH impacts have been analysed as predominantly aromatic compounds ranging from C16-C35. BTEX compounds and MTBE were not analysed above Method Detection Limits (MDL). An Extractable Petroleum Hydrocarbon (EPH) Interpretation Report produced by Jones Environmental has identified the impacts as PAH's with HA3 & HA4 also being noted as possible lubricating oil & possible tarmac / bitumen related impacts.

5.3.2 Chemical Analysis-Groundwater

A laboratory analysis testing schedule is presented as Table 1 and all environmental sample results obtained from the laboratory are included as Appendix H.

Groundwater Parameter data is included within Table 2.

The key results of laboratory testing on groundwater samples is summarised as follows:

Contaminant	No. of Samples	No of Detections	Range of Detections (mg/l)		Highest Location
			Min	Max	
Total Aliphatics	3	2	0.14	3.131	BH1A
Total Aromatics	3	3	0.033	2.549	BH1A
MTBE	3	0	-	-	-
Benzene	3	1	-	1.905	BH1A
Toluene	3	1	-	0.043	BH1A
Ethylbenzene	3	1	-	0.080	BH1A
Xylenes	3	1	-	0.110	BH1A

Notes:
- = Contaminant not found above laboratory detection limits
MTBE = Methly-Tert-Butyl-Ether

- The greatest hydrocarbon impacts have been analysed within BH1A where compounds were identified as aliphatic hydrocarbons C5-C10 and aromatic hydrocarbons C5-C21.
- Within the private domestic borehole, BH1, low level impacts were observed as aliphatic C10-C16 and aromatic C10-C12. Within the second private domestic borehole, BH2, low level impacts have been analysed as aromatic C10-C16.

- MTBE was not identified above MDL in any sample and BTEX compounds were not identified above MDL in BH1 or BH2.
- BTEX compounds have been found above MDL within BH1A, the most notable impact of which is Benzene at a concentration of 1.905mg/l.

6 GENERIC QUALITATIVE RISK ASSESSMENT

The following section summarises the method used to measure the risk to human health and / or environmental receptors in the area by contaminants in soil and / or groundwater, and it identifies any results found by this investigation which warrant further consideration.

6.1 Generic Screening

6.1.1 Generic Screening - Soils

In order to screen laboratory data for concentrations of contaminant in soil with potential to cause harm to human health at a residential setting, (seen as a conservative representation of the site based on the likely child / young adult receptor), UK Soil Guideline Values (SGVs) and an In-House Generic Assessment Criteria (GACs) for contaminants in soil have been used. The technical framework used to derive the assessment criteria and the documents in which they are published are summarised as follows:

- *EA Science Reports* (SC050021/SR2, SC050021/SR3, and SC050021/SR7)
- *EA Soil Guideline Value Science Reports*
- *Suitable For Use Levels (S4ULs) for Human Health Risk Assessment* – LQM and CIEH (2015).
- *Soil Generic Assessment Criteria for Human Health Risk Assessment* - EIC/AGS/CL:AIRE (2010)

Category 4 Screening Levels (C4SLs) released in December 2013 by The Department for the Environment, Food and Rural Affairs (DEFRA), (Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010) provide generic suitable for use screening values for concentrations of Lead for a variety of land uses.

For concentrations of Lead in soil, EPS has used DEFRAs C4SL as an appropriate guide for professional judgement with respect to reasonable 'low risk' levels in the context of this site and its suitability for use.

A summary of the screening criteria and the methodology used to derive them is included in Appendix I.

6.2 Assessment of Soil Results

Screening Criteria representative of minimal risk to human receptors at a residential setting were exceeded for the concentration of Lead within two samples and various PAH compounds across four samples. The exceedances and the relevant screening criteria are summarised in the following table. Given the relative spread of PAH compounds detected above method detection limits, Benzo[a]pyrene (BaP) has been taken as the risk driver for PAH compounds with respect to human health and as such no assessment of other PAH compounds has been made.

Contaminant	Low Risk Screening Criteria (mg/kg)	Number of Exceedances	Highest Concentration (mg/kg) & Location
Lead	200	2	214 / HA4 (0.2-0.6m)
Benzo[a]pyrene	2.2	3	5.84 / HA4 (0.2-0.6m)

No other exceedances have been identified above minimal risk screening criteria representative of minimal risk to human receptors at a residential setting.

6.3 'Low Risk' Assessment of Soil Concentrations

The Phase II intrusive investigation has identified concentrations of Lead and the PAH compound Benzo[a]pyrene (BaP) above residential 'minimal risk' screening criteria. The screening criteria adopted for Lead (200mg/kg) is already considered to be representative of 'low risk' and therefore no additional assessment of this contaminant of concern has been undertaken.

Category 4 Screening Levels (C4SLs) released in December 2013 by The Department for Environment, Food and Rural Affairs (DEFRA), (see *Development of Category 4 Screening Levels for assessment of land affected by contamination - SP1010 Appendix E – BAP)* provide screening values for concentrations of BaP for a variety of land uses. The C4SL screening value representative of 'low risk' for BaP at a residential setting, with home grown produce, is 5.0mg/kg. This 'low risk' screening value has been exceeded by the concentration of BaP (5.84mg/kg) at sampling location HA4 (0.2-0.6m).

6.4 Assessment & Discussion of Groundwater Results

TPH impacts during the most recent groundwater sampling regime have shown to be elevated above concentrations analysed during the February & April 2014 monitoring events. It is understood that groundworks have been undertaken in the area of the historical tank farm which provides reason that concentrations of contaminants of concern within the groundwater sample obtained from BH1A might be artificially elevated by recent ground disturbance. The concentrations of TPH identified within BH1 and BH2 are not considered to be site derived given the petrol range impact on site, (including BTEX compounds) and different characteristics off-site (C10-C16 and no BTEX compounds). These low level impacts off-site could potentially be attributed to other sources of pollution such as fertilisers used for agricultural / horticultural use, particularly given the TPH impacts fall within the Naphthalene range. It is also noted that BH1 and BH2 are uncapped boreholes; one located within a garden work shed containing gardening machinery and equipment and another within an outdoor shelter, where contaminants of concern could potentially enter and impact the underlying groundwater from surface sources.

Results obtained from BH1A have been screened against the Tier 3 groundwater remedial targets derived in the controlled waters Quantitative Risk Assessment (QRA). For aromatic hydrocarbon C8-C10 the remedial target of 0.465mg/l was not exceeded with an on-site concentration of 0.212mg/l. For Benzene the remedial target of 2.8mg/l was not exceeded with an on-site concentration of 1.905mg/l.

7 CONCLUSIONS & RECOMMENDATIONS

7.1 Human Health

The Phase I (Desk Study) identified a number of plausible contaminant linkages associated with potential risks posed to human receptors.

The most recent Phase II intrusive investigation of shallow soils identified ground conditions to comprise made ground materials underlain by silty sandy gravelly clay. Other than fine brick fragments and rare ash & clinker materials within made ground, no physical evidence of contamination, such as hydrocarbon odour or staining, was identified.

Making Garden Areas Safe for Development:

The adopted screening criteria representative of 'low risk' at a residential setting have been marginally exceeded for the concentration of Benzo[a]pyrene at HA4 and Lead at HA101 & HA4. Given the marginal exceedances of 'low risk' screening criteria, an unacceptable risk to future site users is not considered plausible. However, where areas of soft landscaping / domestic gardens are proposed, it is recommended that clean material be imported for use in these areas which should be supported by appropriate chemical analysis, to ensure a suitable growing medium for any plants. Alternatively areas of soft landscaping at HA4 could be converted into areas of impermeable hardstanding such as asphalt or paving.

An isolated area of groundwater hydrocarbon contamination has previously been identified to the north and some of the contaminants of concern are known to be phytotoxic so it may also be prudent to consider the use of deep planters for any new trees / deep-rooted shrubs within this area.

Protecting Site Users from Vapour

As outlined in previous reports an isolated area of hydrocarbon impacted groundwater is located to the north of site. To prevent any ingress of hydrocarbon vapours into the proposed residential buildings from groundwater, a proprietary gas and vapour resistant membrane will need to be installed into the ground floor footprint of Plots 1-4 in order to resist the passage of volatile vapours into the living space above. Photographic evidence and certification of any vapour membranes installed will also be required.

A vapour resistant membrane is not considered as necessary for Plot 5 given its distance from the primary source area (approximately 50m) and contaminant degradation modelling within the previous QRA report inferred that Benzene concentrations will drop below laboratory detection limits by 35m in distance.

For neighbouring properties the risk of migrating volatile vapours is expected to be low considering samples obtained from BH1 and BH2 contained no BTEX compounds and only relatively low concentrations of diesel range aromatic hydrocarbons. Although a groundwater sample could not be obtained from HA1, previous analysis in April 2014 suggests that BTEX compounds, which are considered as the risk drivers for migrating / volatilising contaminants of concern, are unlikely to be present beneath the residential properties to the west.

The nearest down gradient off-site residential dwelling is located approximately 20m west of BH1A (BH1A being considered as the source area of hydrocarbon impacted groundwater). The Remedial Target Worksheets indicate that at a distance of 20m, with degradation occurring in all phases, the concentration of Benzene is likely to drop to 0.0348mg/l, which is not considered to pose an unacceptable risk to human receptors especially given that the model is a conservative representation of site conditions. For reference, the Remedial Target Worksheets for Benzene are included as Appendix J.

Control of Other Risks:

In order to address remaining contaminant linkages identified by EPS investigations, the following additional precautionary measures are recommended:-

a) All construction workers operating at the site should be advised of the potential for contact with hydrocarbon products which could still be stored at the site and the potential for exposure to made ground in the subsurface at the site. Appropriate health and safety precautions should also be adopted during any excavation works to avoid exposure to soils. Reference should be made to the following HSE document: *Protection of Workers and the General Public during Development of Contaminated Land*.
b) Should any palpable evidence of unexpected contamination be encountered during the redevelopment work, it should be reported to EPS so that an inspection can be made and appropriate sampling and assessment work carried out. A method statement for encountering any unexpected contamination is included as Appendix K of this report.
c) In order to reduce potential risks from linkages associated with ingress of contaminants to underground water supply pipework, aluminium barrier pipework meeting Water Industry Standard 4-32-19 and associated fittings can be used subject to agreement with the local water company. If other pipework is preferable, more detailed testing may be required in accordance with UK Water Industry Research Report 10/WM/03/21 - "*Guidance For The Selection Of Water Supply Pipes To Be Used In Brownfield Sites*" (2010).

A summary of the approach outlined in CLR11, marking the work completed by EPS to date, is presented as a flow diagram in Figure 4 of this report.

7.2 Controlled Waters

While concentrations of TPH and BTEX compounds have been found to increase within BH1A when compared to monitoring in February 2014, the remedial targets derived through the previous QRA have not been exceeded. Furthermore, the impacts identified within off-site boreholes BH1 and BH2 are not currently considered to be attributed to the on-site historical unleaded petrol source.

Ultimately the lack of petrol range organics in groundwater samples obtained from the off-site boreholes confirms the applicability of the modelling process as contaminant degradation and site conditions prevent widespread contaminant migration off-site. The previous QRA concluded that remediation / control measures were not warranted for Land to the Rear of 59-61 Broadway due to the need for 'reasonableness' and lack of any health, environmental or economic benefits which would arise from such action. This conclusion is still considered appropriate given the limited resource value beneath the site and that off-site extractions are not being impacted by site derived contaminants of concern.

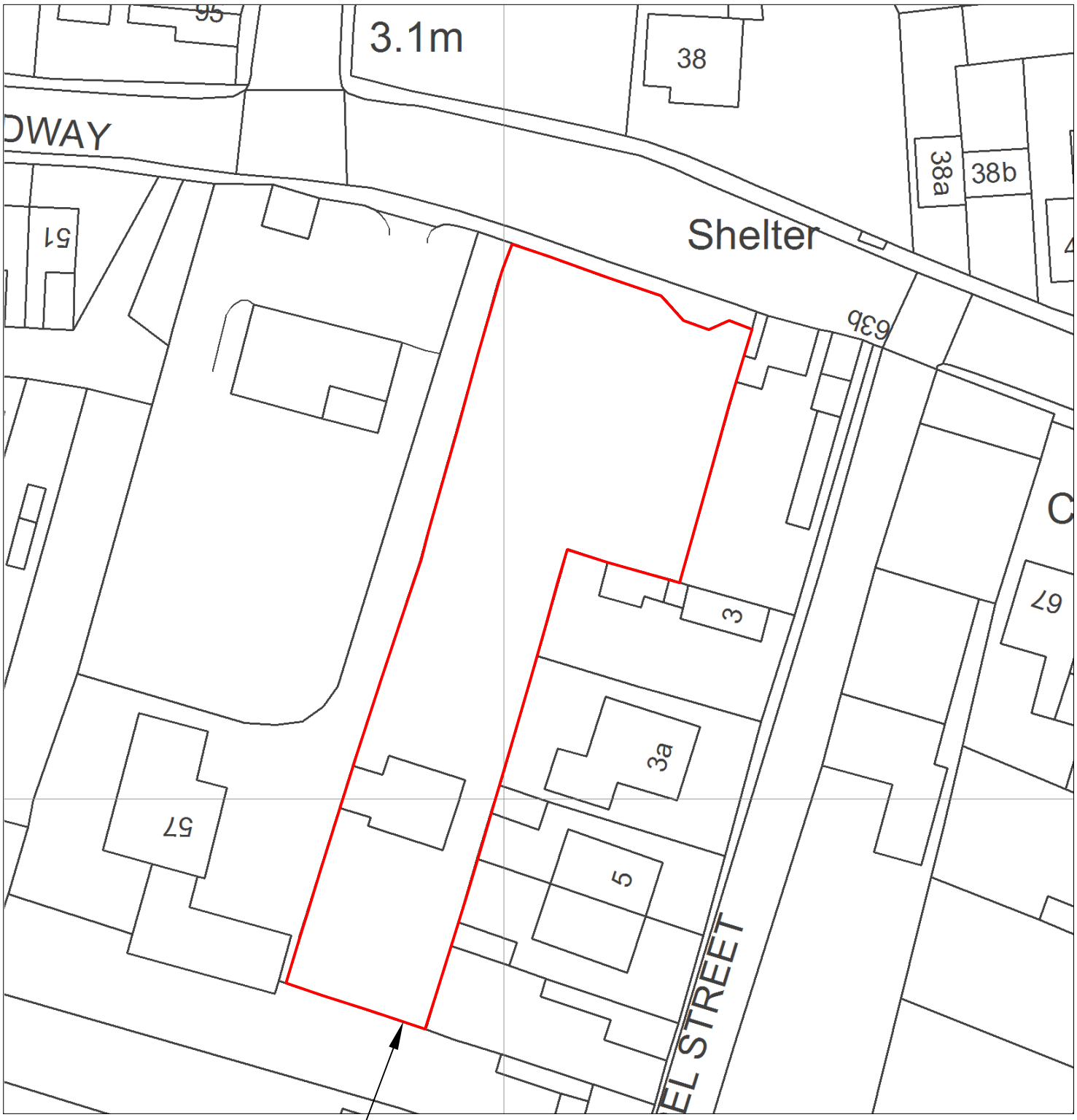
It is recommended that this report is forwarded to the planning department of South Holland District Council for their review and comment from statutory consultees.

FIGURES



Crown Copyright. All rights reserved.
Licence Number: 100054115

Title:	**Site Location Plan**
Project:	Former Broadway PFS, Crowland
Client:	Mr Ian Ladds
Fig No:	**1**
Scale:	Not to Scale
Drawn By:	TJ
Approved By:	WE
Job No:	UK14.1470
Dwg No:	Ladds/Broadway/0214/01
Date:	February 2014



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Title: Current Site Layout Plan

Project: Former Broadway PFS, Crowland

Client: Mr Ian Ladds

Fig No: 2

Scale: NTS

Drawn By: KH | Approved By: WE

Job No: UK14.1470

Dwg No: Ladds/Broadway/0615/02

Date: June 2015

N



Approximate Site Boundary

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eps

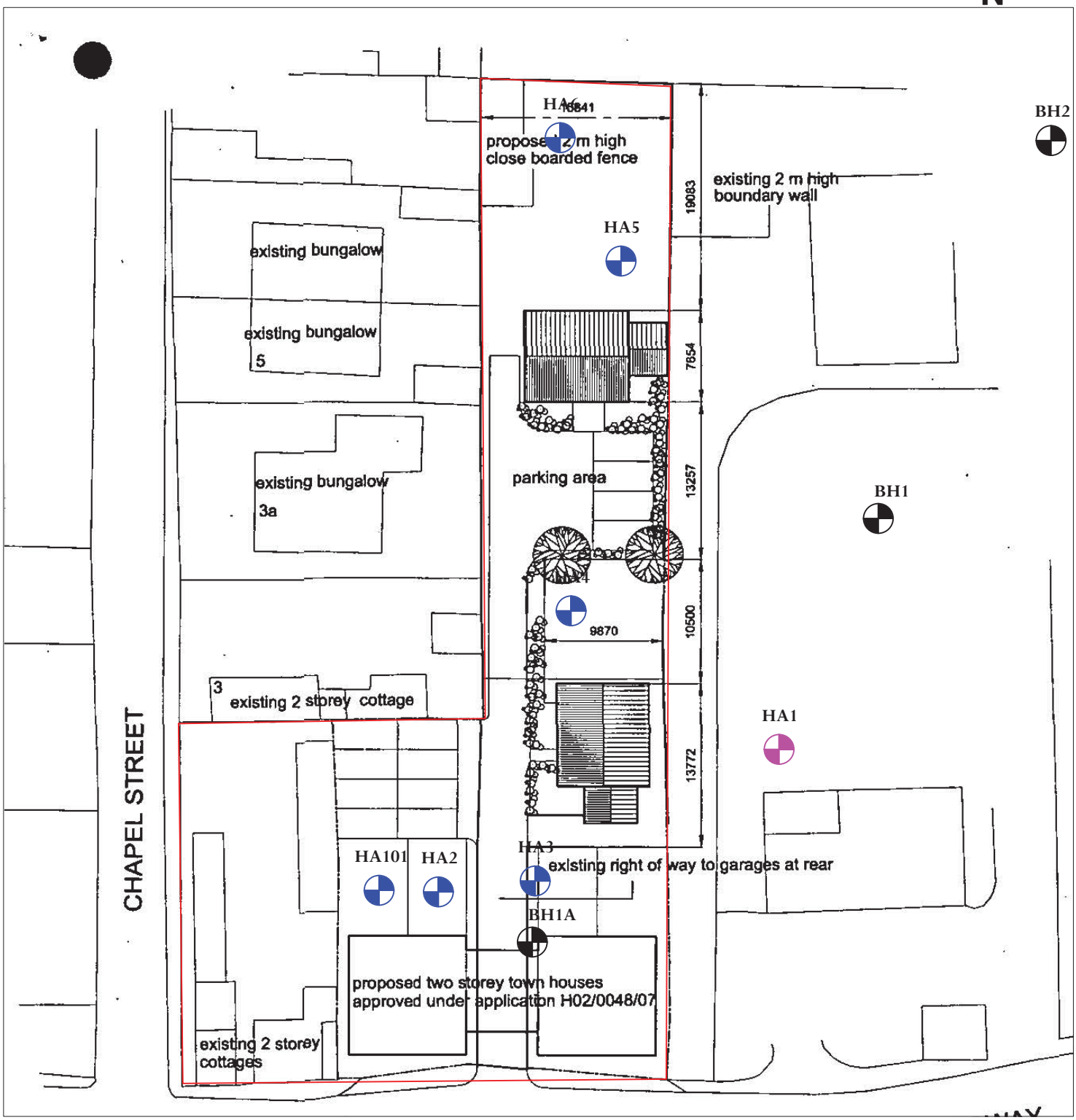
Title: Aerial Photograph

Project: Former Broadway PFS, Crowland

Client: Mr Ian Ladds

Fig No: 3

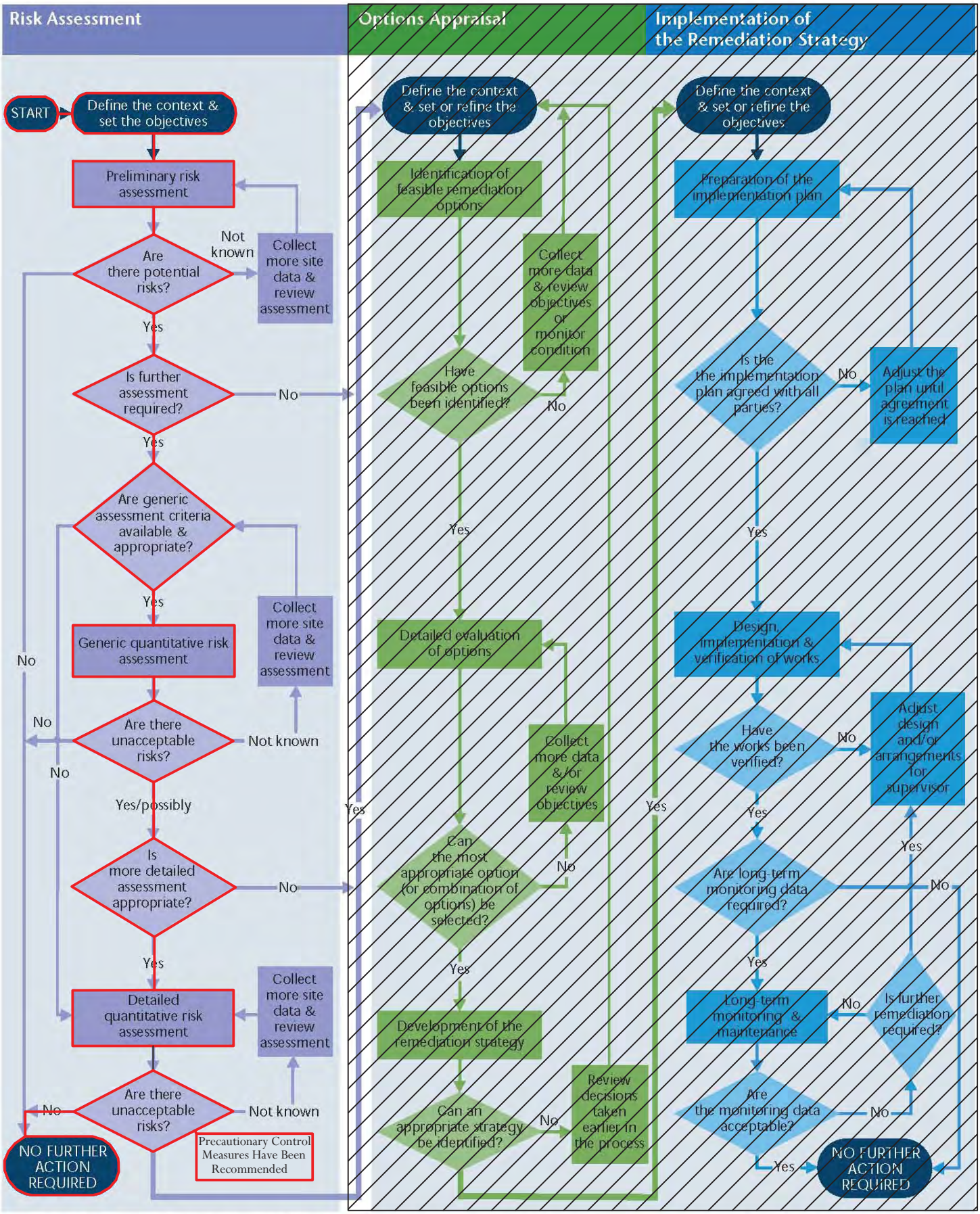
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Drawn By:	KH
Approved By:	WE
Job No:	UK14.1470
Dwg No:	Ladds/Broadway/0615/03
Date:	June 2015



Key:

- Hand Auger Location
- Temporary Standpipe
- Existing Monitoring Well / Extraction Borehole

Title:	**Hand Auger Borehole Location Plan and Existing Monitoring Wells**		
Project:	Former Broadway PFS, Crowland	Scale:	NTS
		Drawn By: RS	Approved By: WE
Client:	Mr Ian Ladds	Job No:	UK14.1470
Fig No:	4	Dwg No:	Ladds/Broadway/0615/04
		Date:	June 2015



Assessment Pathway for Site

Title:	**Site Context - CLR11**		
Project:	Former Broadway PFS, Crowland	Scale:	n/a
		Drawn By: RS	Approved By: GL
Client:	Mr Ian Ladds	Job No:	UK14.1470
Fig No:	**5**	Dwg No:	Ladds/Broadway/0515/05
		Date:	June 2015

TABLES

Table 1 – Laboratory Testing Schedule

Sample ID	Sample Depth (m bgl)	EPS Mini Suite	EPS TPH Suite
HA101 (Soil)	0.1-0.6	1	1
HA2 (Soil)	0.1-0.6	1	1
HA3 (Soil)	0.1-0.6	1	1
HA4 (Soil)	0.2-0.6	1	1
HA5 (Soil)	0.1-0.4	1	1
HA6 (Soil)	0.1-0.6	1	1
BH1A (Groundwater)	n/a	-	1
BH1 (Groundwater)	n/a	-	1
BH2 (Groundwater)	n/a	-	1

Notes:

m bgl	meters below ground level
1	Sample Taken
-	Sample Not Taken
EPS Mini Suite	pH, Cyanide, Sulphate, Metals (Including Lead),PAH's, Phenols, Asbestos
EPS TPH Suite	TPHCWG, BTEX, MTBE

Table 2 – Groundwater Monitoring Data (26/05/2015)

Borehole No.	Dissolved Oxygen (ppm)	pH	Redox Potential (mV)	Temperature (°C)	Depth to Groundwater (m bgl)	Notes
BH1	0.47	6.94	-25.4	11.8	1.223	
BH2	0.52	6.96	-80.1	10.8	1.325	
BH1A	0.62	7.00	-30.7	12.7	1.730	Strong hydrocarbon odour while purging

Samples obtained during dry, sunny, hot weather.

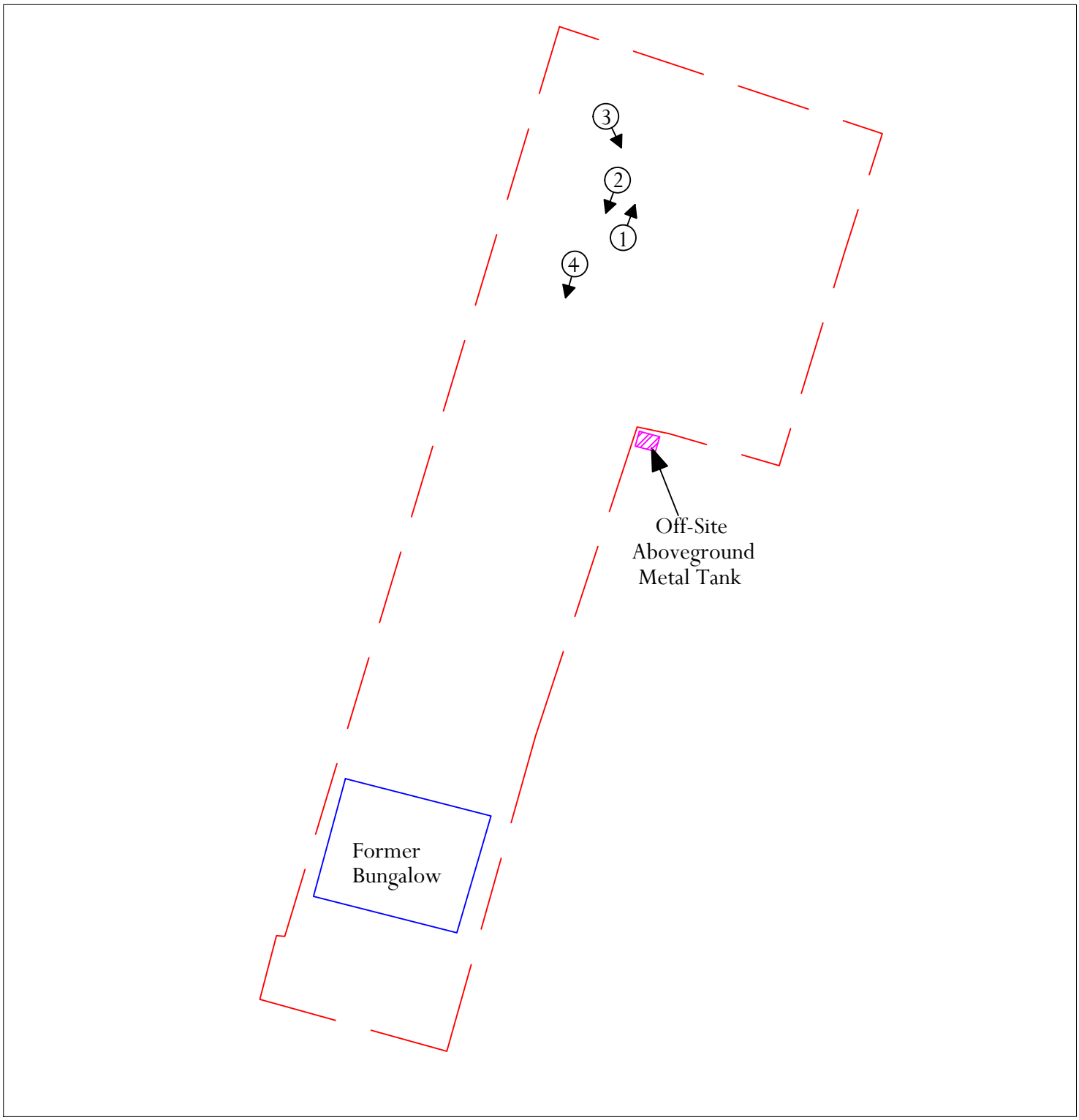
Notes

mbgl	Meters below ground level
mV	Millivolts
ppm	Parts Per Million
-	Data not collected due to physical signs of contamination

APPENDICES

APPENDIX A

Selected Site Photographs



Key

1 → Approximate Photograph Locations & Directions

— — Approximate Site Boundary

Title: **Photograph Location Plan**

Project: Former Broadway PFS, Crowland

Client: Mr Ian Ladds

Appendix: **A**

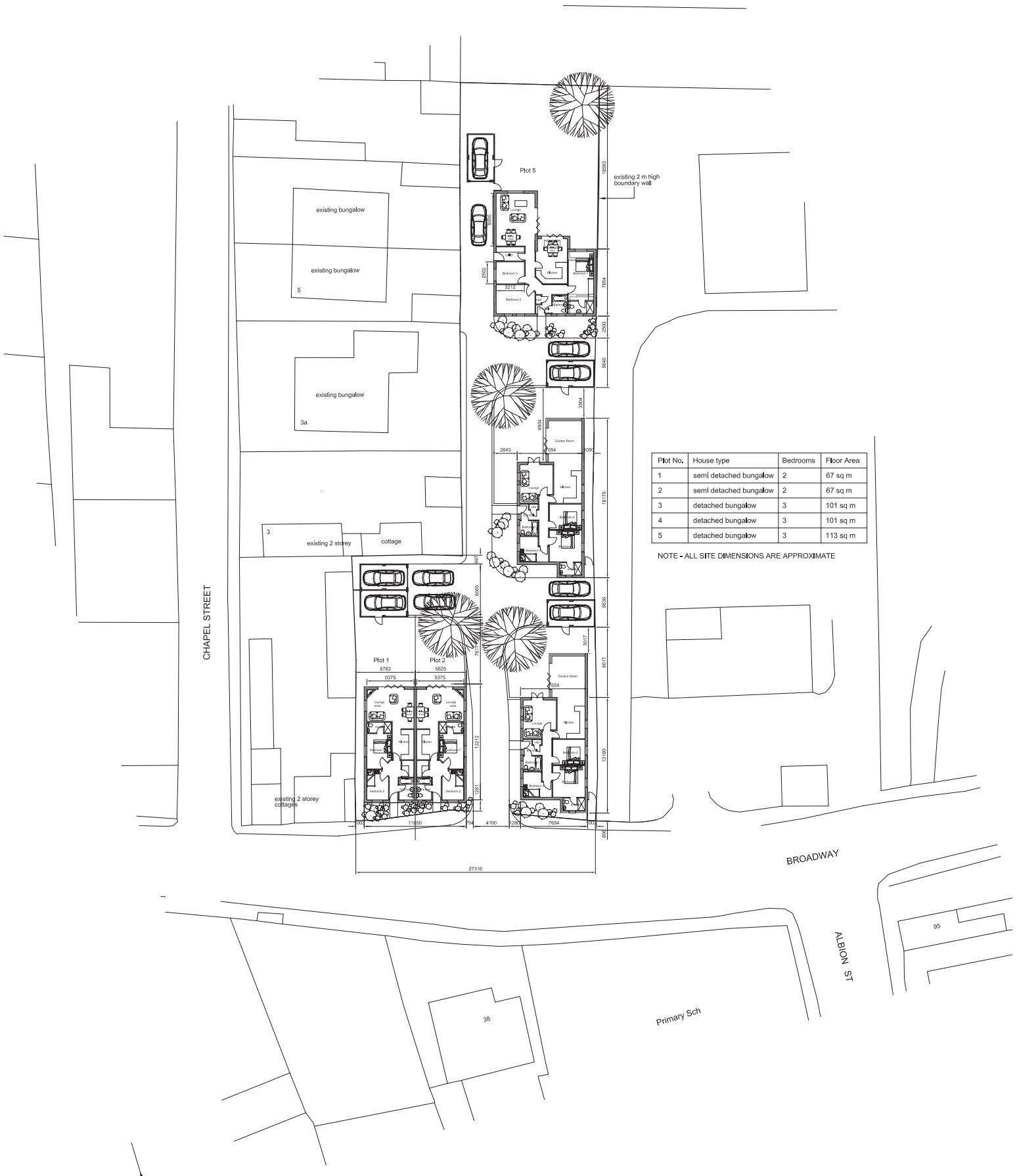
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Drawn By:	RS	Approved By:	WE
Job No:	UK14.1470		
Dwg No:	Ladds/Broadway/0615/AppA		
Date:	June 2015		

Photo 1: Photograph facing approximately north towards an access point off Broadway.	Photo 2: Photograph facing approximately south showing stockpiles excavated materials. Please note BH1A is located under the orange cone.
	
Photo 3: Photograph facing southeast.	Photo 4: Photograph facing approximately south towards the southern section of the site.
	

APPENDIX B

Proposed Development Plan

Do not scale directly from this drawing. All discrepancies are to be brought to the attention of the Practice.
The copyright to this drawing is owned by Trevor A Clay RIBA Ltd.



Plot No.	House type	Bedrooms	Floor Area
1	semi detached bungalow	2	67 sq m
2	semi detached bungalow	2	67 sq m
3	detached bungalow	3	101 sq m
4	detached bungalow	3	101 sq m
5	detached bungalow	3	113 sq m

NOTE - ALL SITE DIMENSIONS ARE APPROXIMATE

North (Indicative)

Revision	Date	Drawn	Description

Client Wilcox Group Ltd

Project Residential Development at Rear of 59-61 Broadway, Crowland

Drawing Feasibility Layout

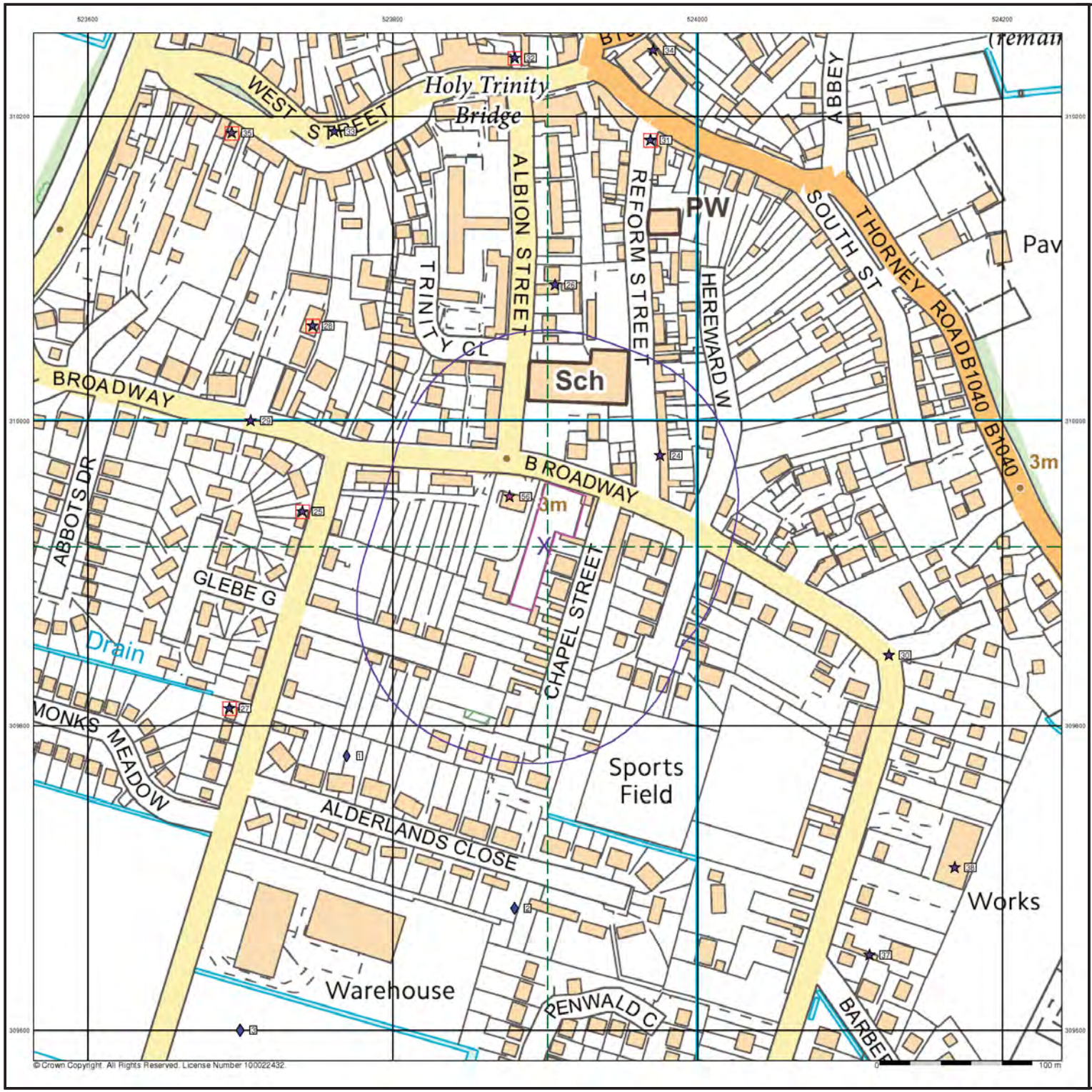
Scale 1:200 Drawn AWM Checked TAC Date 21/07/2014

Drawing No. 14/387/PA/003

Trevor A Clay RIBA Ltd, 14 Old Fendike Road, Weston Hills, Spalding, Lincs. PE126DD
01406 380027 07778 597975 trevor@tacarchitects.co.uk www.tacarchitects.co.uk

APPENDIX C

Surrounding Land Use



General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Map ID

Several of Type at Location

Agency and Hydrological

- Contaminated Land Register Entry or Notice (Location)
- Contaminated Land Register Entry or Notice
- Discharge Consent
- Enforcement or Prohibition Notice
- Integrated Pollution Control
- Integrated Pollution Prevention Control
- Local Authority Integrated Pollution Prevention and Control
- Local Authority Pollution Prevention and Control
- Local Authority Pollution Prevention and Control Enforcement
- Pollution Incident to Controlled Waters
- Prosecution Relating to Authorised Processes
- Prosecution Relating to Controlled Waters
- Registered Radioactive Substance
- River Network or Water Feature
- River Quality Sampling Point
- Substantiated Pollution Incident Register
- Water Abstraction
- Water Industry Act Referral

Waste

- BGS Recorded Landfill Site (Location)
- BGS Recorded Landfill Site
- EA Historic Landfill (Buffered Point)
- EA Historic Landfill (Polygon)
- Integrated Pollution Control Registered Waste Site
- Licensed Waste Management Facility (Landfill Boundary)
- Licensed Waste Management Facility (Location)
- Local Authority Recorded Landfill Site (Location)
- Local Authority Recorded Landfill Site
- Registered Landfill Site
- Registered Landfill Site (Location)
- Registered Landfill Site (Point Buffered to 100m)
- Registered Landfill Site (Point Buffered to 250m)
- Registered Waste Transfer Site (Location)
- Registered Waste Transfer Site
- Registered Waste Treatment or Disposal Site (Location)
- Registered Waste Treatment or Disposal Site

Geological

- BGS Recorded Mineral Site

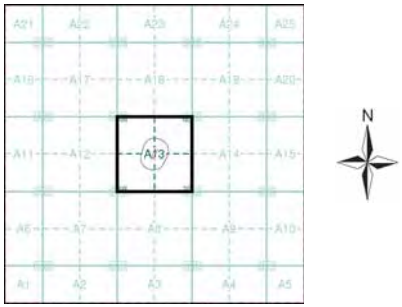
Hazardous Substances

- COMAH Site
- Explosive Site
- NIHHS Site
- Planning Hazardous Substance Consent
- Planning Hazardous Substance Enforcement

Industrial Land Use

- Contemporary Trade Directory Entry
- Fuel Station Entry

Site Sensitivity Map - Segment A13



Order Details

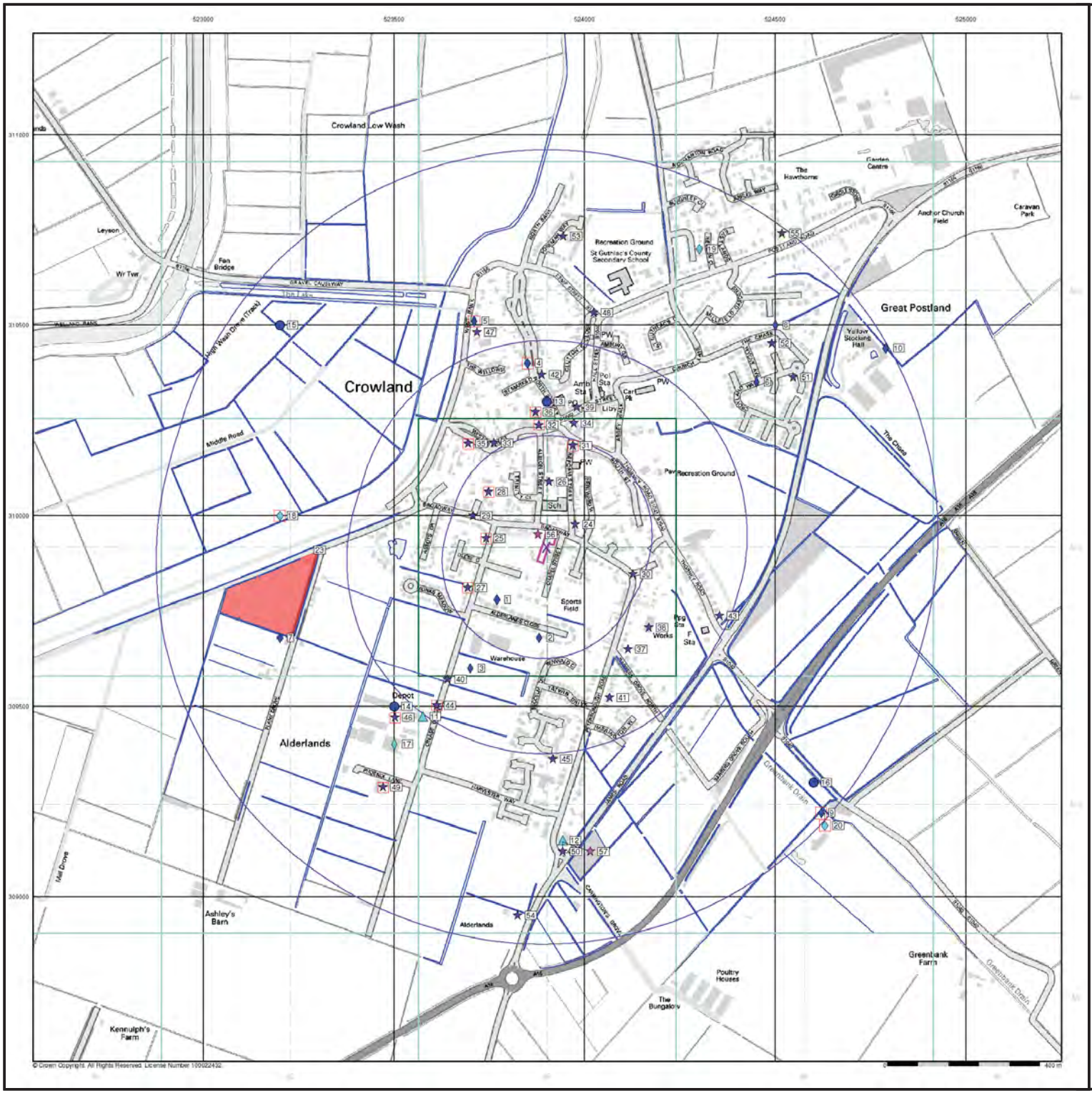
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Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17

Site Details

Site at 523900, 309920

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Map ID

Several of Type at Location

Agency and Hydrological

- Contaminated Land Register Entry or Notice (Location)
- Contaminated Land Register Entry or Notice
- Discharge Consent
- Enforcement or Prohibition Notice
- Integrated Pollution Control
- Integrated Pollution Prevention Control
- Local Authority Integrated Pollution Prevention and Control
- Local Authority Pollution Prevention and Control
- Local Authority Pollution Prevention and Control Enforcement
- Pollution Incident to Controlled Waters
- Prosecution Relating to Authorised Processes
- Prosecution Relating to Controlled Waters
- Registered Radioactive Substance
- River Network or Water Feature
- River Quality Sampling Point
- Substantiated Pollution Incident Register
- Water Abstraction
- Water Industry Act Referral

Waste

- BGS Recorded Landfill Site (Location)
- BGS Recorded Landfill Site
- EA Historic Landfill (Buffered Point)
- EA Historic Landfill (Polygon)
- Integrated Pollution Control Registered Waste Site
- Licensed Waste Management Facility (Landfill Boundary)
- Licensed Waste Management Facility (Location)
- Local Authority Recorded Landfill Site (Location)
- Local Authority Recorded Landfill Site
- Registered Landfill Site
- Registered Landfill Site (Location)
- Registered Landfill Site (Point Buffered to 100m)
- Registered Landfill Site (Point Buffered to 250m)
- Registered Waste Transfer Site (Location)
- Registered Waste Transfer Site
- Registered Waste Treatment or Disposal Site (Location)
- Registered Waste Treatment or Disposal Site

Geological

- BGS Recorded Mineral Site

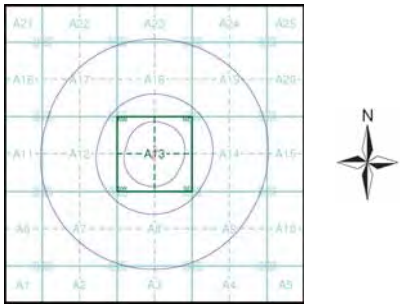
Hazardous Substances

- COMAH Site
- Explosive Site
- NIHHS Site
- Planning Hazardous Substance Consent
- Planning Hazardous Substance Enforcement

Industrial Land Use

- Contemporary Trade Directory Entry
- Fuel Station Entry

Site Sensitivity Map - Slice A



Order Details

Order Number:	68231479_1_1
Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

Site Details

Site at 523900, 309920

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

APPENDIX D

Geological Context

Geology 1:50,000 Maps Legends

Superficial Geology

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	ALV	Alluvium	Clay, Silt, Sand and Gravel	Flandrian - Flandrian
	TFD	Tidal Flat Deposits	Sand and Silt	Holocene - Holocene
	ABSG	Abbey Sand and Gravel	Sand and Gravel	Devensian - Devensian
	MRCG	March Gravels Member	Sand and Gravel	Ipswichian - Ipswichian
	PEAT	Peat	Peat [Unlithified Deposits Coding Scheme]	Quaternary - Quaternary
	TFD1	Tidal Flat Deposits, 1	Clay and Silt	Quaternary - Quaternary
	TFD1	Tidal Flat Deposits, 1	Sand and Silt	Quaternary - Quaternary
	RTD1	River Terrace Deposits, 1	Sand and Gravel	Quaternary - Quaternary

Bedrock and Faults

Map Colour	Lex Code	Rock Name	Rock Type	Min and Max Age
	OXC	Oxford Clay Formation	Mudstone	Oxfordian - Callovian

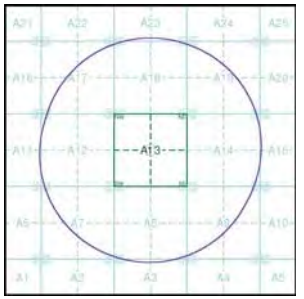
Geology 1:50,000 Maps

This report contains geological map extracts taken from the BGS Digital Geological map of Great Britain at 1:50,000 scale and is designed for users carrying out preliminary site assessments who require geological maps for the area around the site. This mapping may be more up to date than previously published paper maps.
The various geological layers - artificial and landslip deposits, superficial geology and solid (bedrock) geology are displayed in separate maps, but superimposed on the final 'Combined Surface Geology' map. All map legends feature on this page. Not all layers have complete nationwide coverage, so availability of data for relevant map sheets is indicated below.

Geology 1:50,000 Maps Coverage

Map ID:	**1**
Map Sheet No:	**158**
Map Name:	**Peterborough**
Map Date:	**1984**
Bedrock Geology:	**Available**
Superficial Geology:	**Available**
Artificial Geology:	**Available**
Faults:	**Not Supplied**
Landslip:	**Not Available**
Rock Segments:	**Not Supplied**

Geology 1:50,000 Maps - Slice A



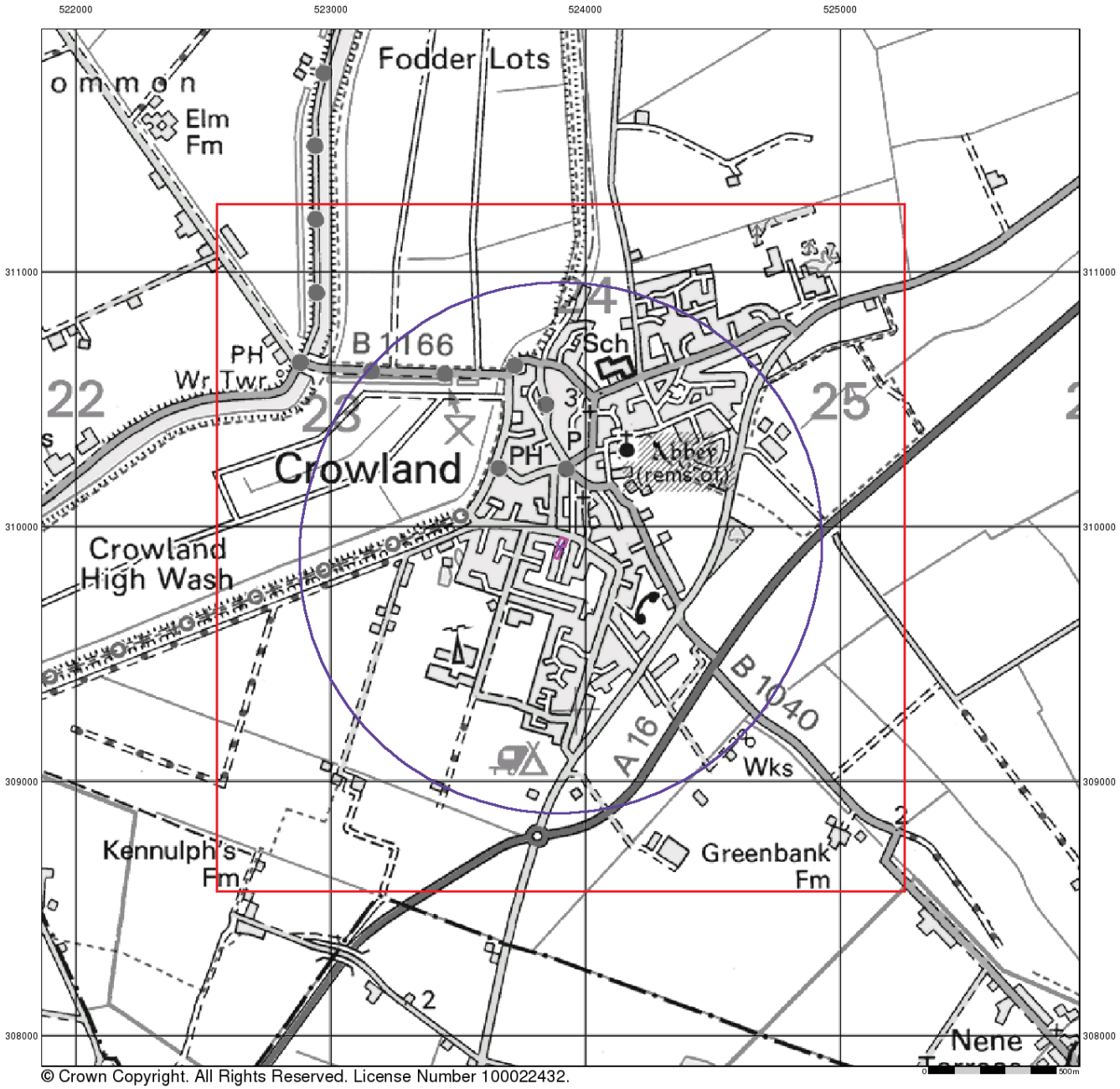
Order Details:

Order Number:	68231479_1_1
Customer Reference:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

Site Details:

Site at 523900, 309920

Landmark Information Group
Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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Artificial Ground and Landslip

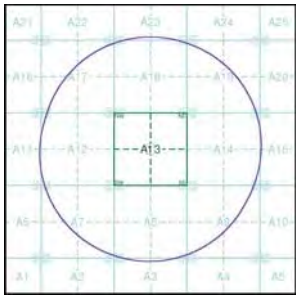
Artificial ground is a term used by BGS for those areas where the ground surface has been significantly modified by human activity. Information about previously developed ground is especially important, as it is often associated with potentially contaminated material, unpredictable engineering conditions and unstable ground.

Artificial ground includes:

- Made ground - man-made deposits such as embankments and spoil heaps on the natural ground surface.
- Worked ground - areas where the ground has been cut away such as quarries and road cuttings.
- Infilled ground - areas where the ground has been cut away then wholly or partially backfilled.
- Landscaped ground - areas where the surface has been reshaped.
- Disturbed ground - areas of ill-defined shallow or near surface mineral workings where it is impracticable to map made and worked ground separately.

Mass movement (landslip) deposits on BGS geological maps are primarily superficial deposits that have moved down slope under gravity to form landslips. These affect bedrock, other superficial deposits and artificial ground. The dataset also includes foundered strata, where the ground has collapsed due to subsidence.

Artificial Ground and Landslip Map - Slice A



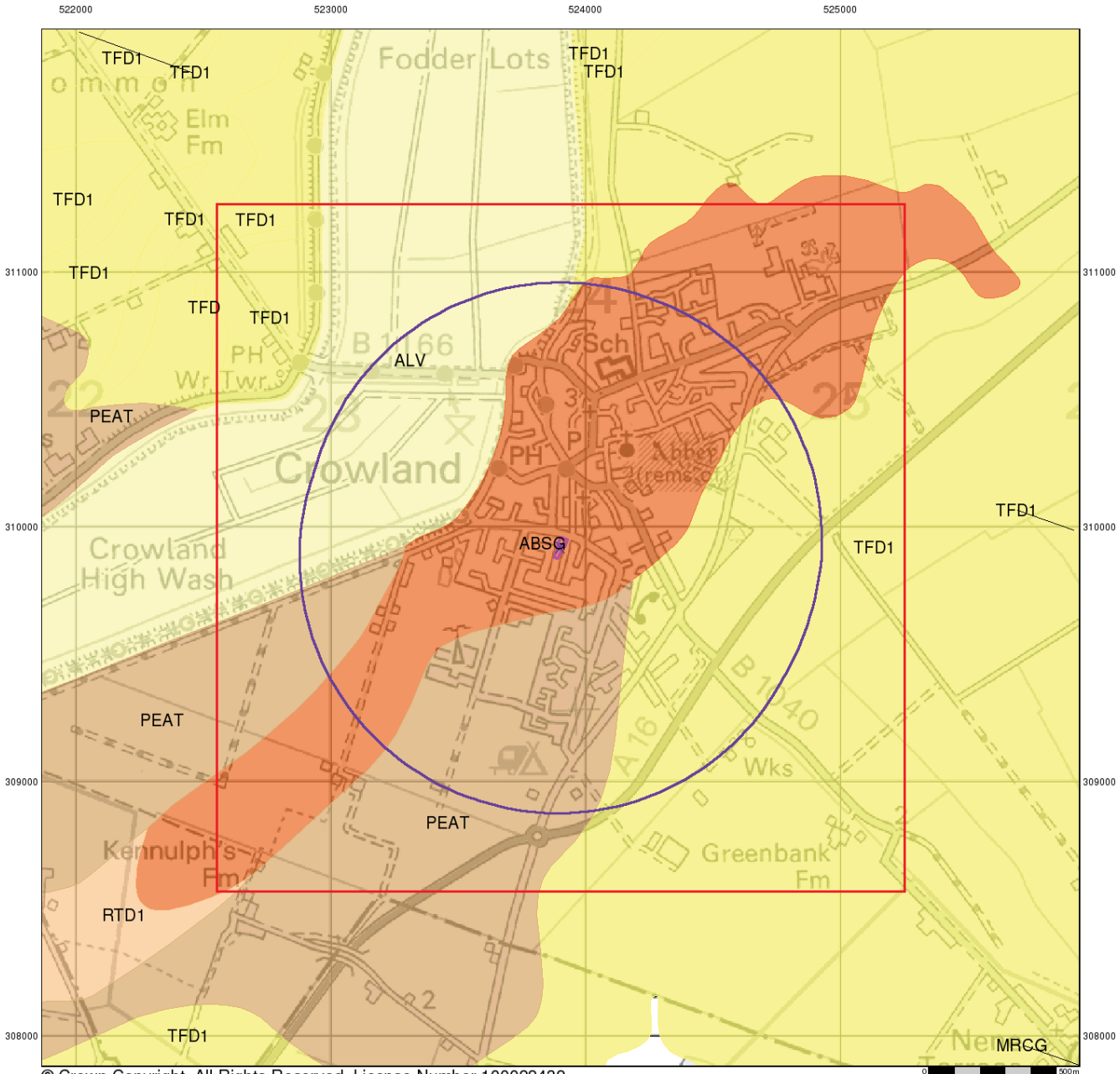
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Customer Reference:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

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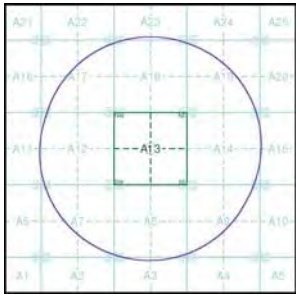
Superficial Geology

Superficial Deposits are the youngest geological deposits formed during the most recent period of geological time, the Quaternary, which extends back about 1.8 million years from the present.

They rest on older deposits or rocks referred to as Bedrock. This dataset contains Superficial deposits that are of natural origin and 'in place'. Other superficial strata may be held in the Mass Movement dataset where they have been moved, or in the Artificial Ground dataset where they are of man-made origin.

Most of these Superficial deposits are unconsolidated sediments such as gravel, sand, silt and clay, and onshore they form relatively thin, often discontinuous patches or larger spreads.

Superficial Geology Map - Slice A



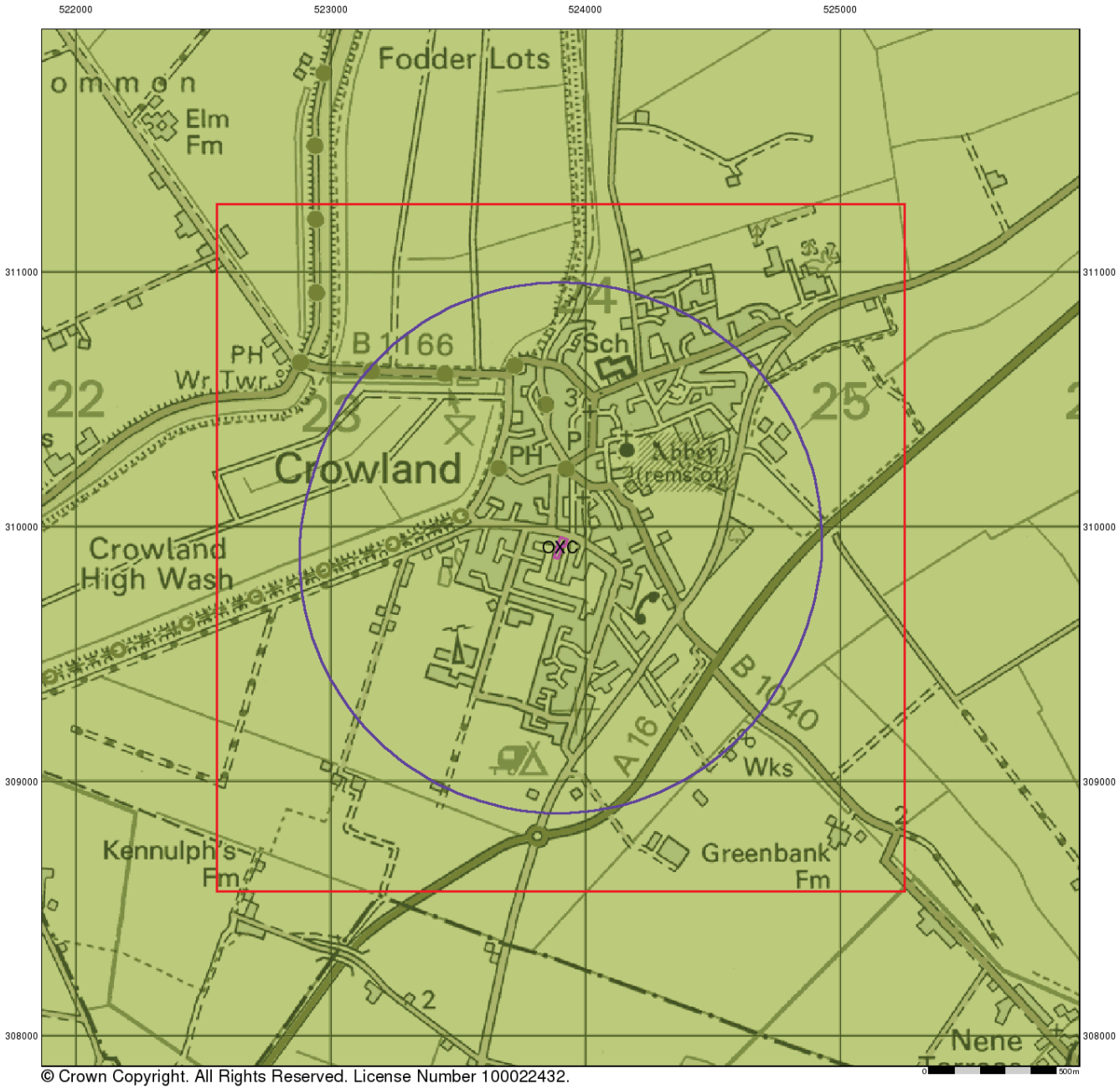
Order Details:

Order Number:	68231479_1_1
Customer Reference:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
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Bedrock and Faults

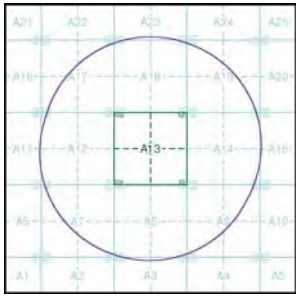
Bedrock geology is a term used for the main mass of rocks forming the Earth and are present everywhere, whether exposed at the surface in outcrops or concealed beneath superficial deposits or water.

The bedrock has formed over vast lengths of geological time ranging from ancient and highly altered rocks of the Proterozoic, some 2500 million years ago, or older, up to the relatively young Pliocene, 1.8 million years ago.

The bedrock geology includes many lithologies, often classified into three types based on origin: igneous, metamorphic and sedimentary.

The BGS Faults and Rock Segments dataset includes geological faults (e.g. normal, thrust), and thin beds mapped as lines (e.g. coal seam, gypsum bed). Some of these are linked to other particular 1:50,000 Geology datasets, for example, coal seams are part of the bedrock sequence, most faults and mineral veins primarily affect the bedrock but cut across the strata and post date its deposition.

Bedrock and Faults Map - Slice A



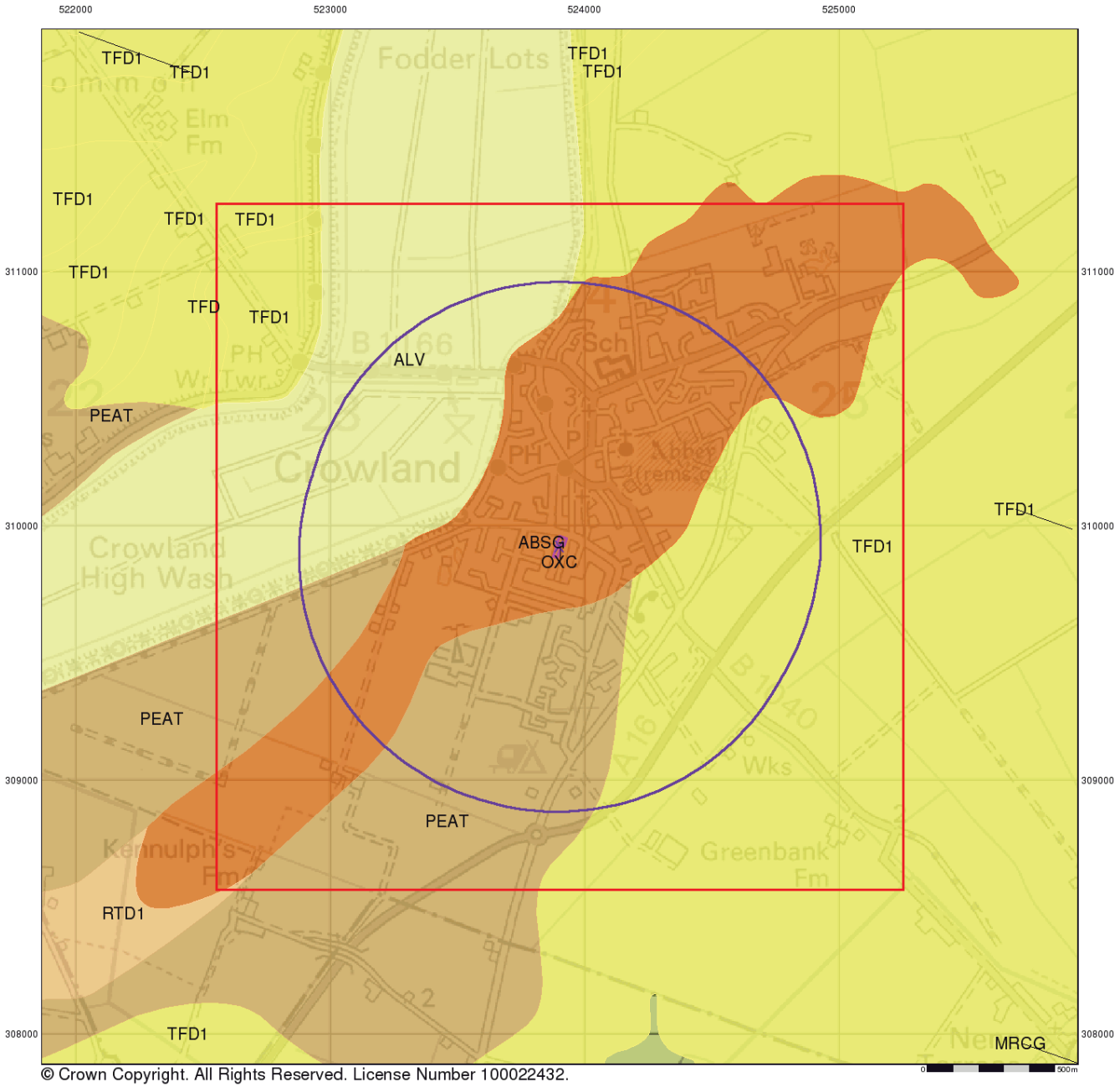
Order Details:

Order Number:	68231479_1_1
Customer Reference:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

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Combined Surface Geology

The Combined Surface Geology map combines all the previous maps into one combined geological overview of your site.

Please consult the legends to the previous maps to interpret the Combined "Surface Geology" map.

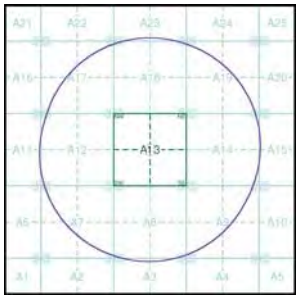
Additional Information

More information on 1:50,000 Geological mapping and explanations of rock classifications can be found on the BGS website. Using the LEX Codes in this report, further descriptions of rock types can be obtained by interrogating the 'BGS Lexicon of Named Rock Units'. This database can be accessed by following the 'Information and Data' link on the BGS website.

Contact

British Geological Survey
Kingsley Dunham Centre
Keyworth
Nottingham
NG12 5GG
Telephone: 0115 936 3143
Fax: 0115 936 3276
email: enquiries@bgs.ac.uk
website: www.bgs.ac.uk

Combined Geology Map - Slice A



Order Details:

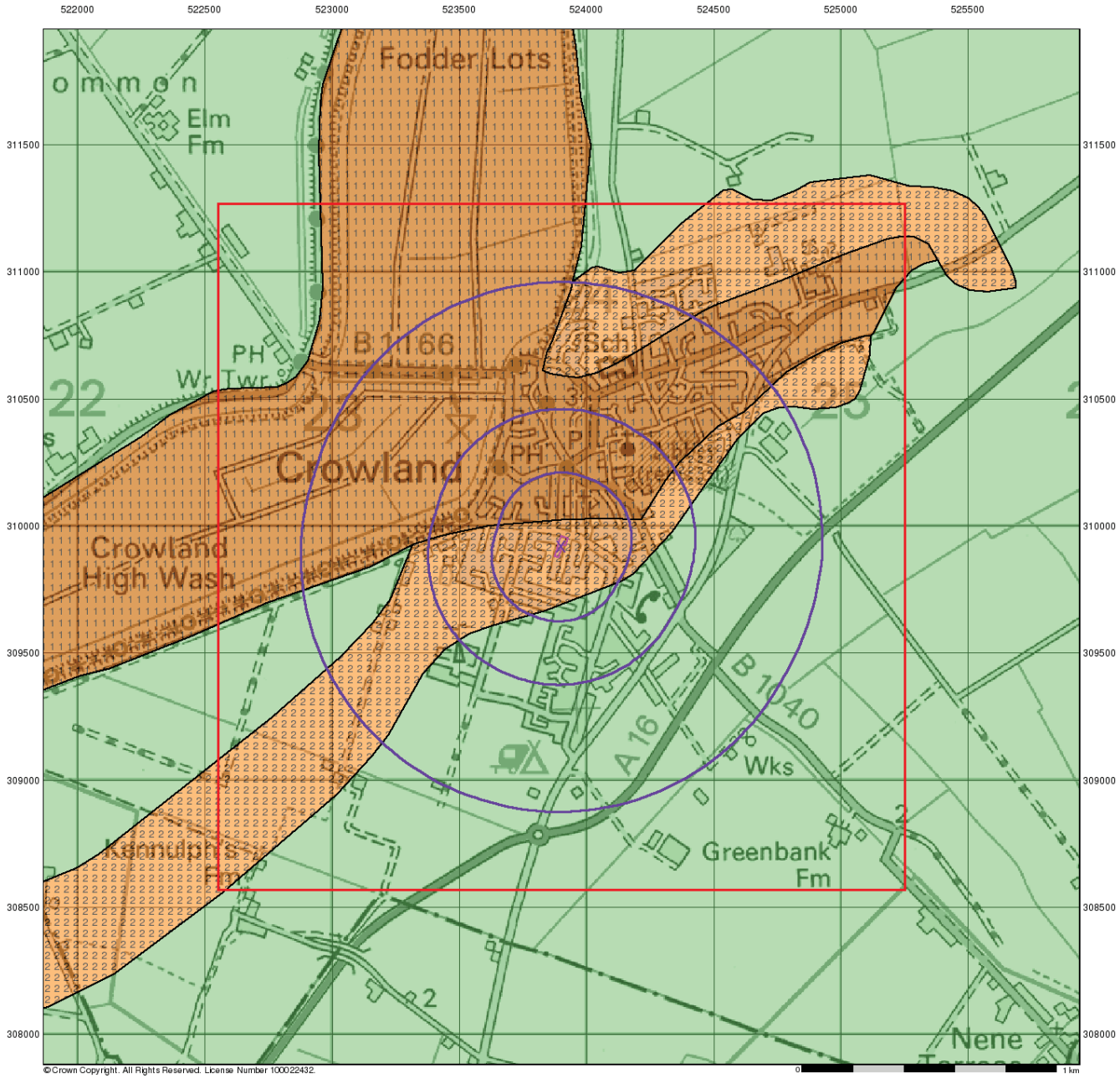
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Customer Reference:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

Site Details:

Site at 523900, 309920

APPENDIX E

Groundwater Vulnerability and Flood Maps



Groundwater Vulnerability

General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes	Soil Classes
Major Aquifer (Highly Permeable)	High (H) 1, 2, 3, U
	Intermediate (I) 1, 2
	Low
Minor Aquifer (Variably Permeable)	High (H) 1, 2, 3, U
	Intermediate (I) 1, 2
	Low
Non Aquifer (Negligibly Permeable)	
Water or Sea	
Drift Deposit	

Site Sensitivity Context Map - Slice A



Order Details

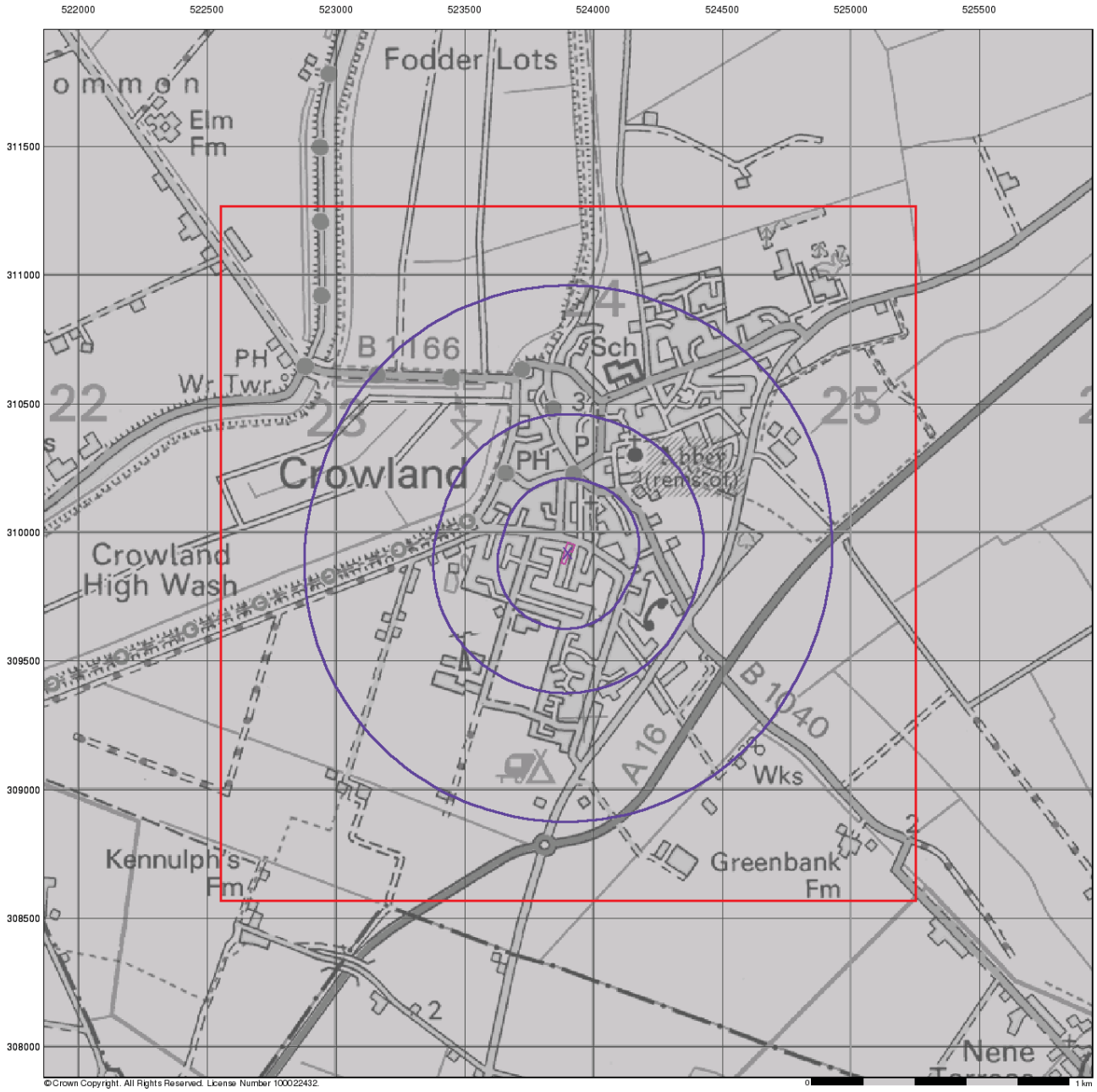
Order Number:	68231479_1_1
Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

Site Details

Site at 523900, 309920

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Web: www.envirocheck.co.uk



Bedrock Aquifer Designation

General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown

Site Sensitivity Context Map - Slice A



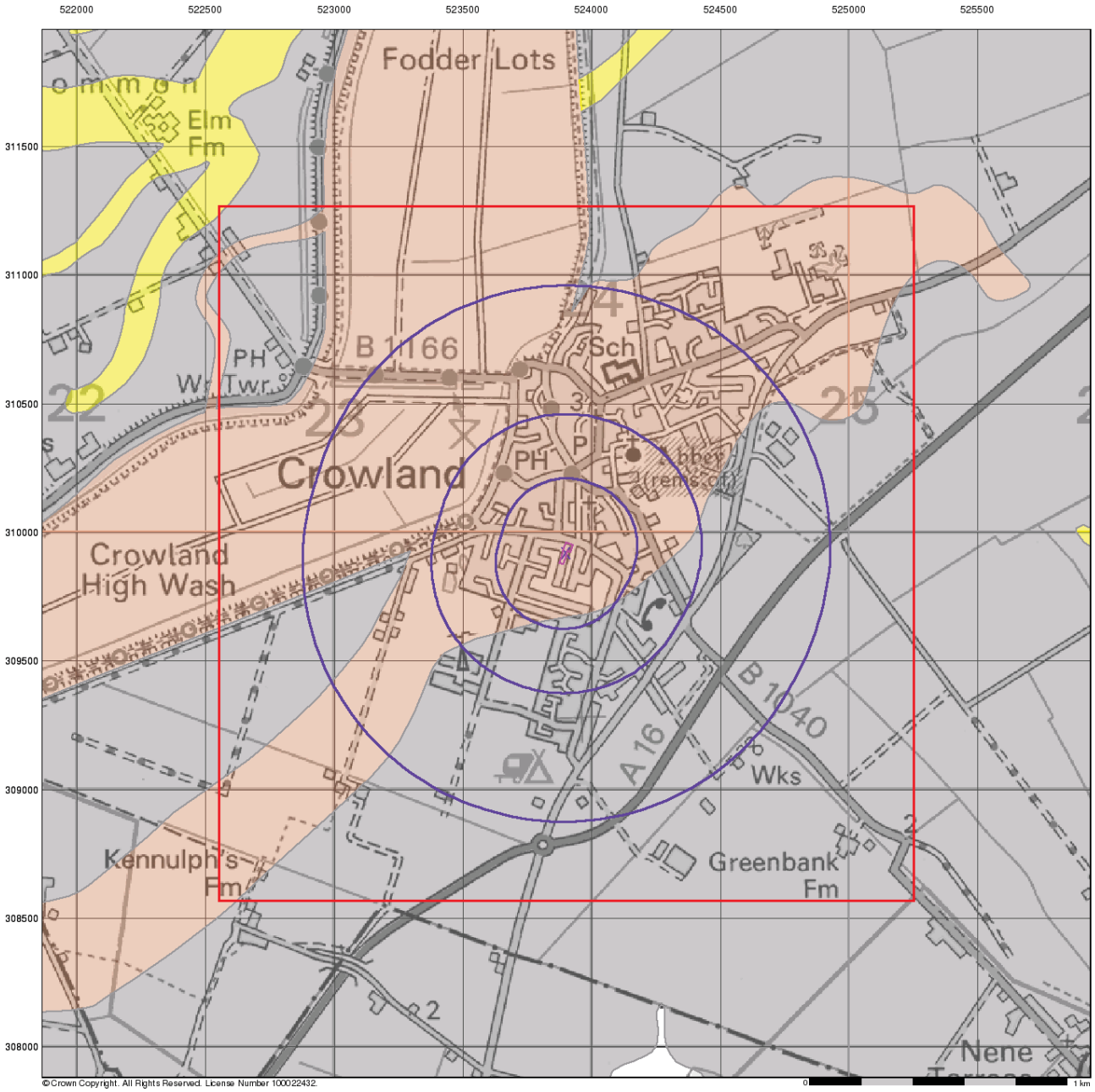
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Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

Site Details

Site at 523900, 309920

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Superficial Aquifer Designation

General

Specified Site | Specified Buffer(s) | Bearing Reference Point | Slice | Map ID

Agency and Hydrological

Geological Classes

- Principal Aquifer
- Secondary A Aquifer
- Secondary B Aquifer
- Secondary Undifferentiated
- Unproductive Strata
- Unknown

Site Sensitivity Context Map - Slice A



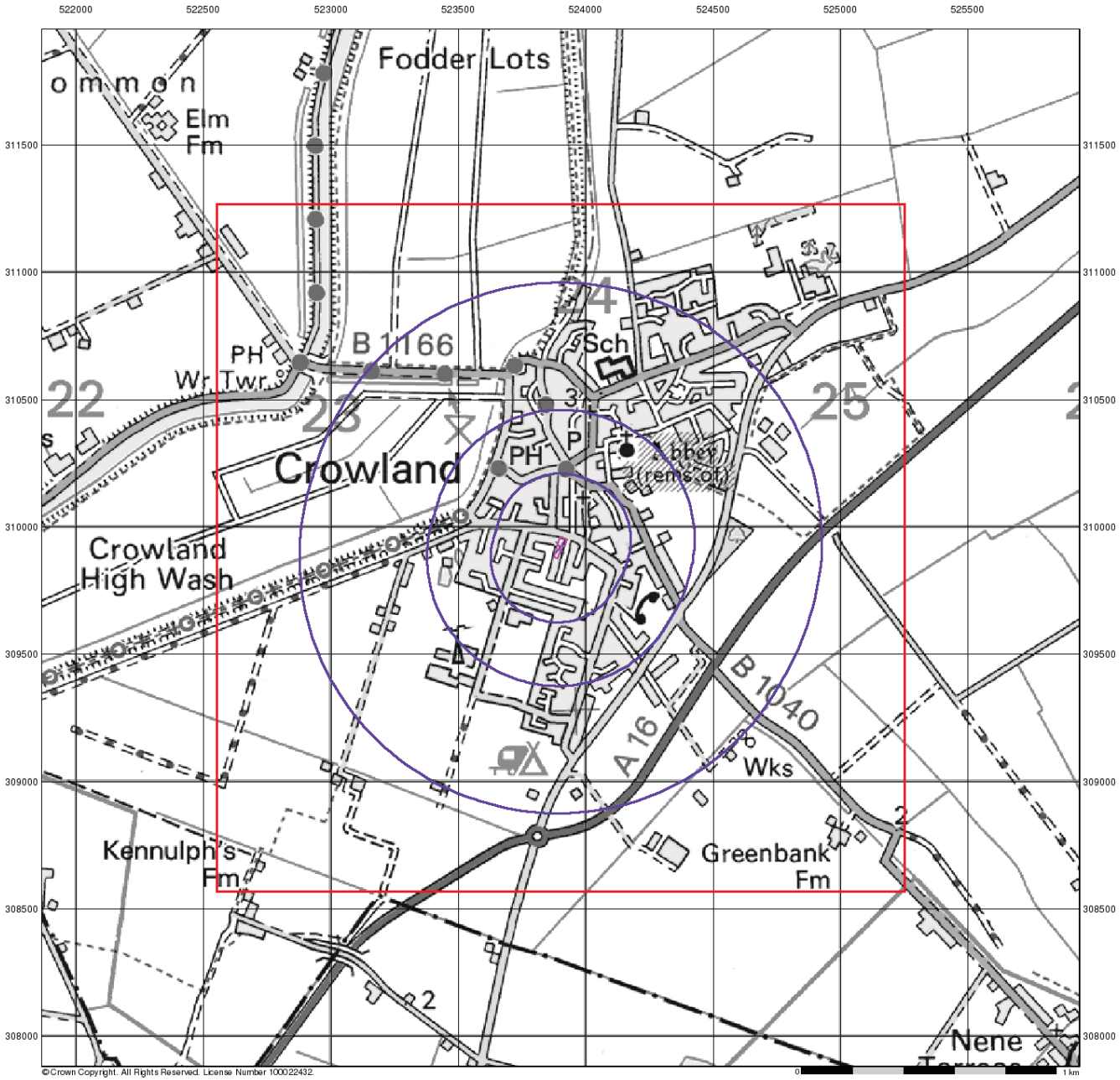
Order Details

Order Number:	68231479_1_1
Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

Site Details

Site at 523900, 309920

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Source Protection Zones

General

Specified Site | Specified Buffer(s) | Bearing Reference Point

Slice | Map ID

Agency and Hydrological

- Inner zone (Zone 1)
- Inner zone - subsurface activity only (Zone 1c)
- Outer zone (Zone 2)
- Outer zone - subsurface activity only (Zone 2c)
- Total catchment (Zone 3)
- Total catchment - subsurface activity only (Zone 3c)
- Special interest (Zone 4)
- Source Protection Zone Borehole

Site Sensitivity Context Map - Slice A



Order Details

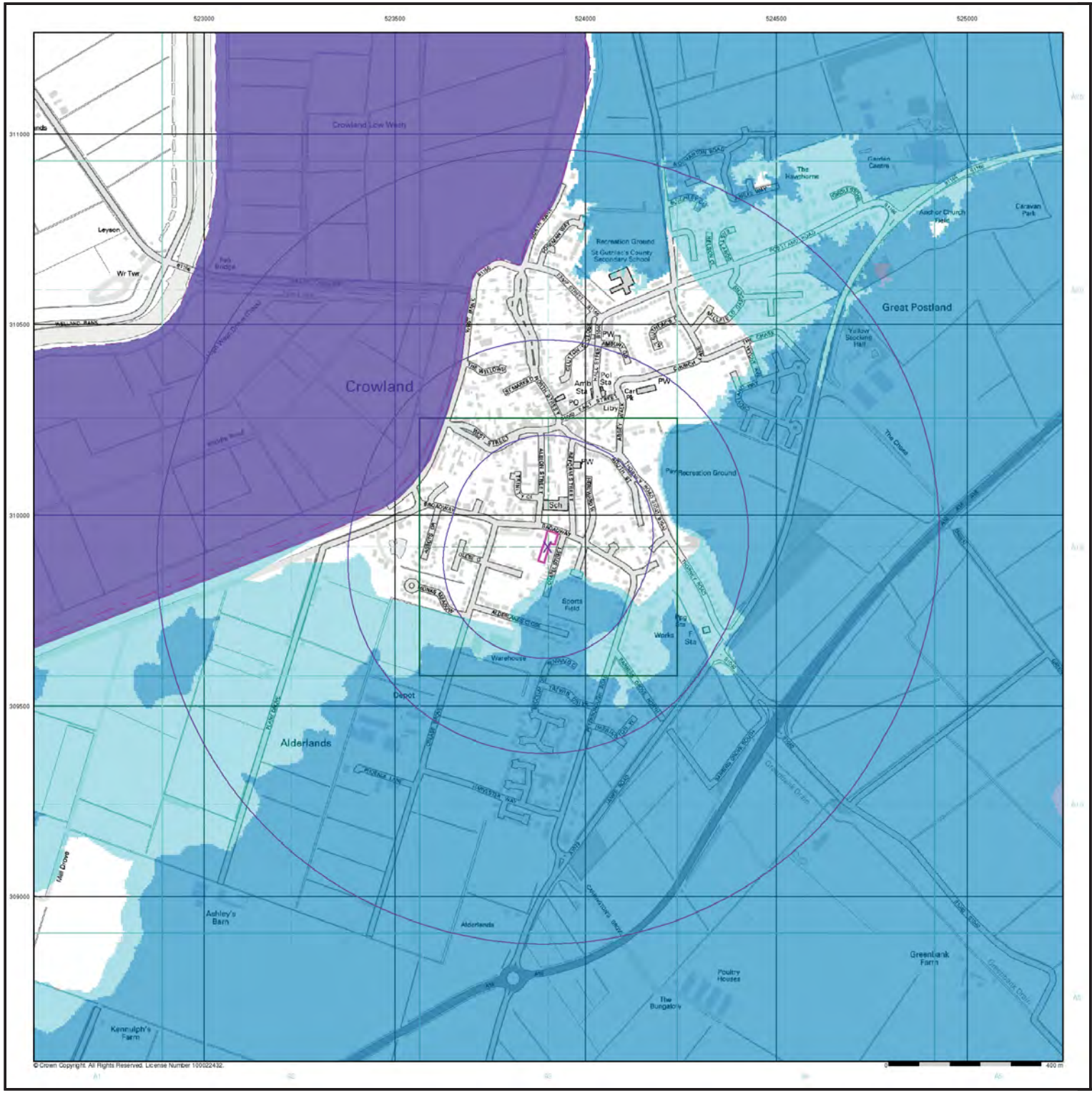
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Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

Site Details

Site at 523900, 309920

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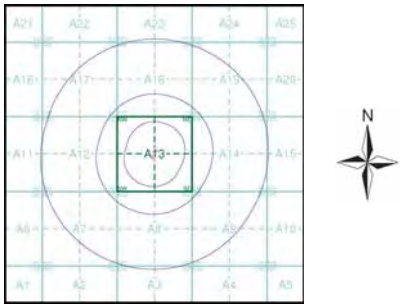
General

- Specified Site
- Specified Buffer(s)
- X Bearing Reference Point

Agency and Hydrological (Flood)

- Extreme Flooding from Rivers or Sea without Defences (Zone 2)
- Flooding from Rivers or Sea without Defences (Zone 3)
- Area Benefiting from Flood Defence
- Flood Water Storage Areas
- Flood Defence

Flood Map - Slice A



Order Details

Order Number:	68231479_1_1
Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
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Site Details

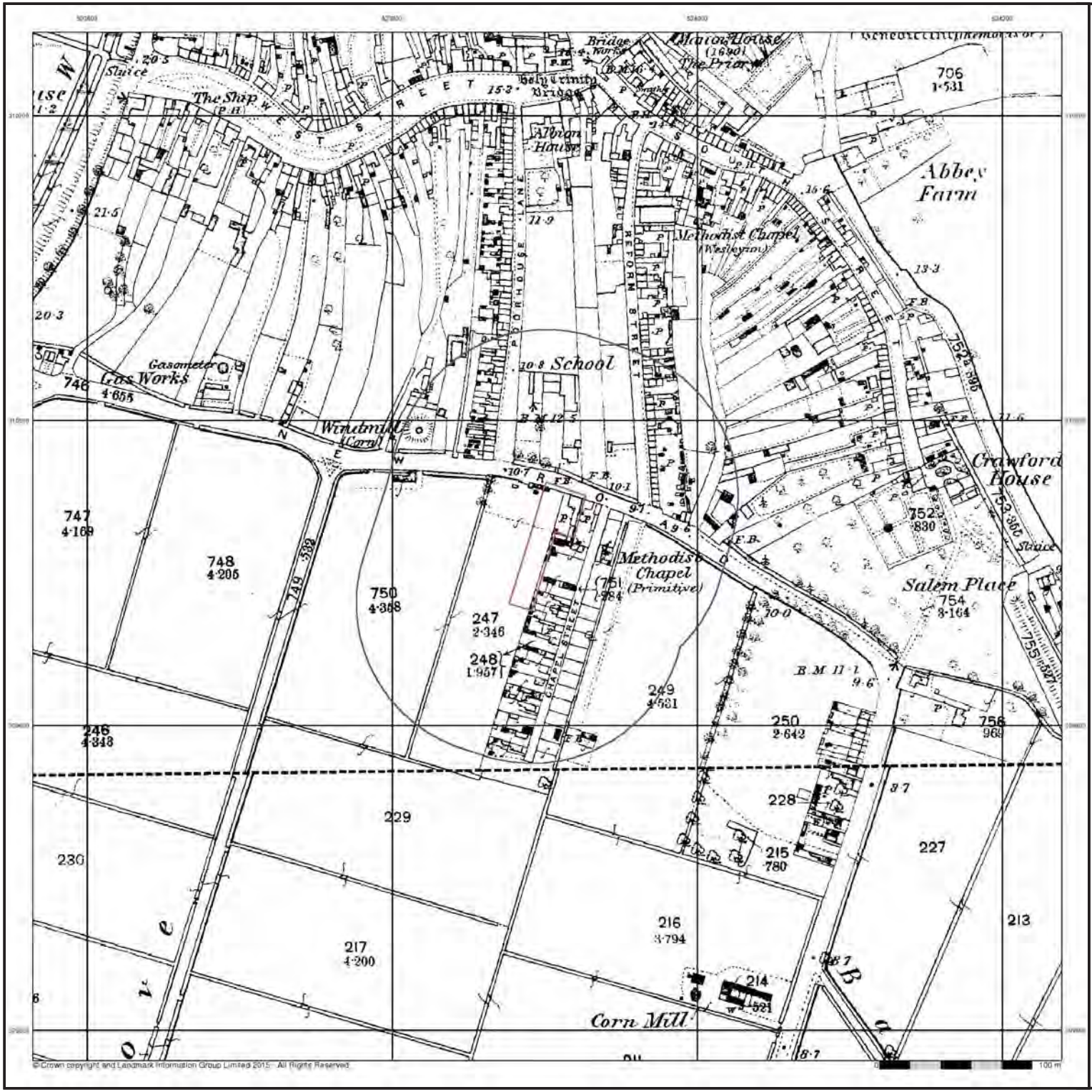
Site at 523900, 309920

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APPENDIX F

A Selection of Historic Maps



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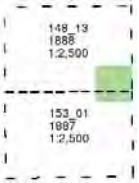
Lincolnshire

Published 1887 - 1888

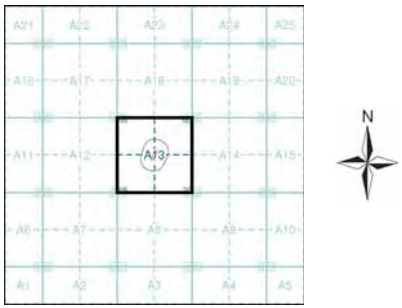
Source map scale - 1:2,500

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number:	68231479_1_1
Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	100

Site Details

Site at 523900, 309920

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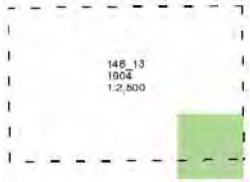
Lincolnshire

Published 1904

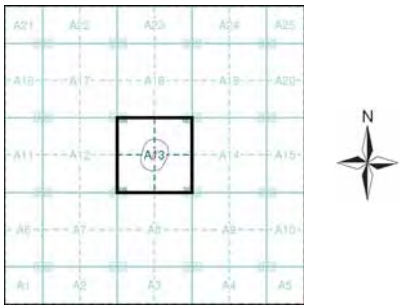
Source map scale - 1:2,500

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

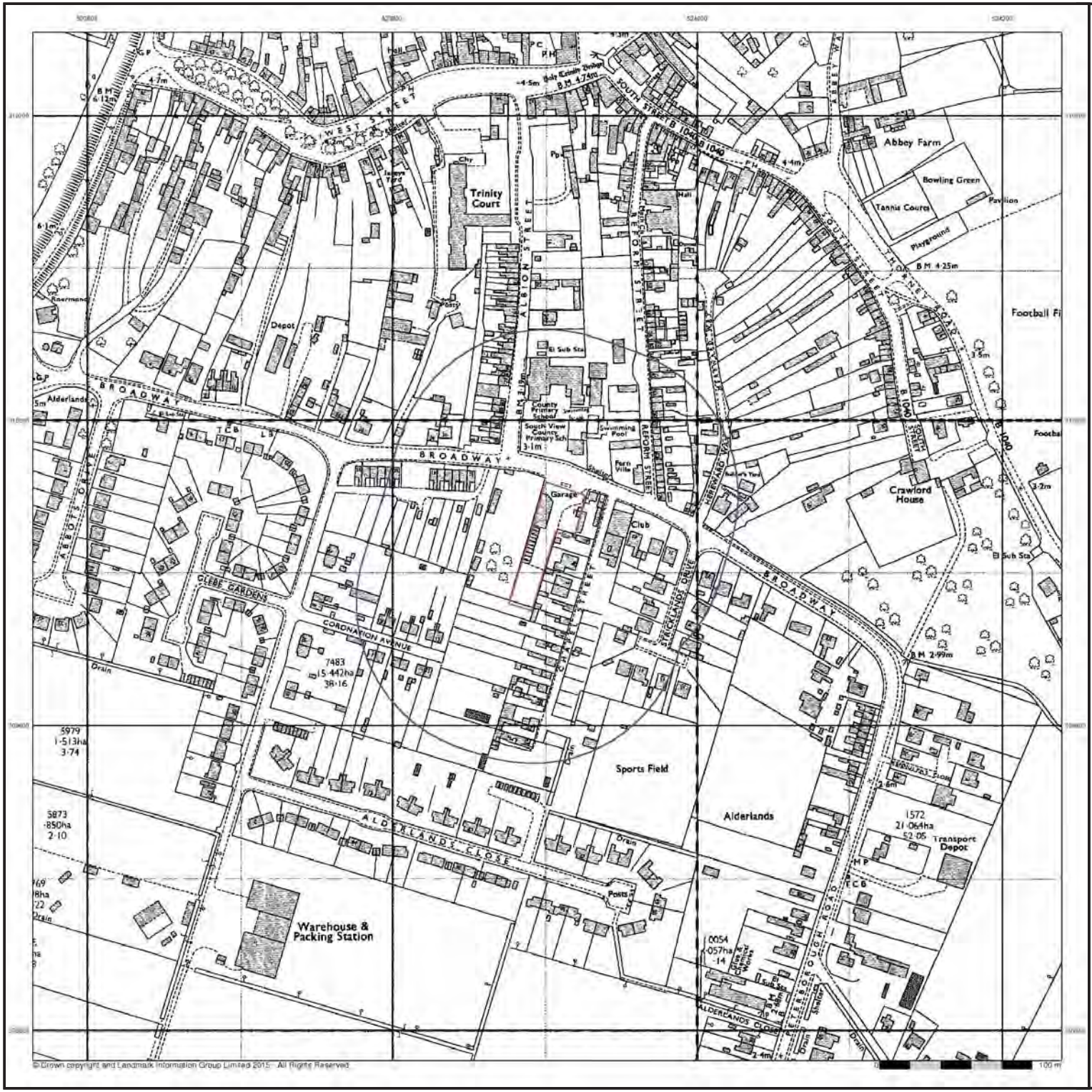
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Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	100

Site Details

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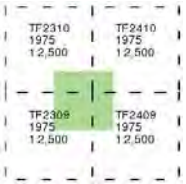
Ordnance Survey Plan

Published 1975

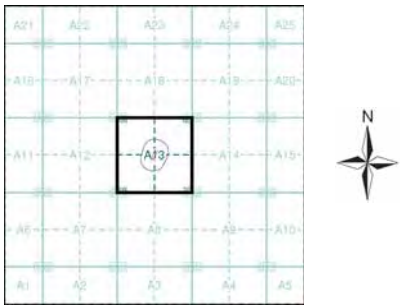
Source map scale - 1:2,500

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 and by 1896 it covered the whole of what were considered to be the cultivated parts of Great Britain. The published date given below 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.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

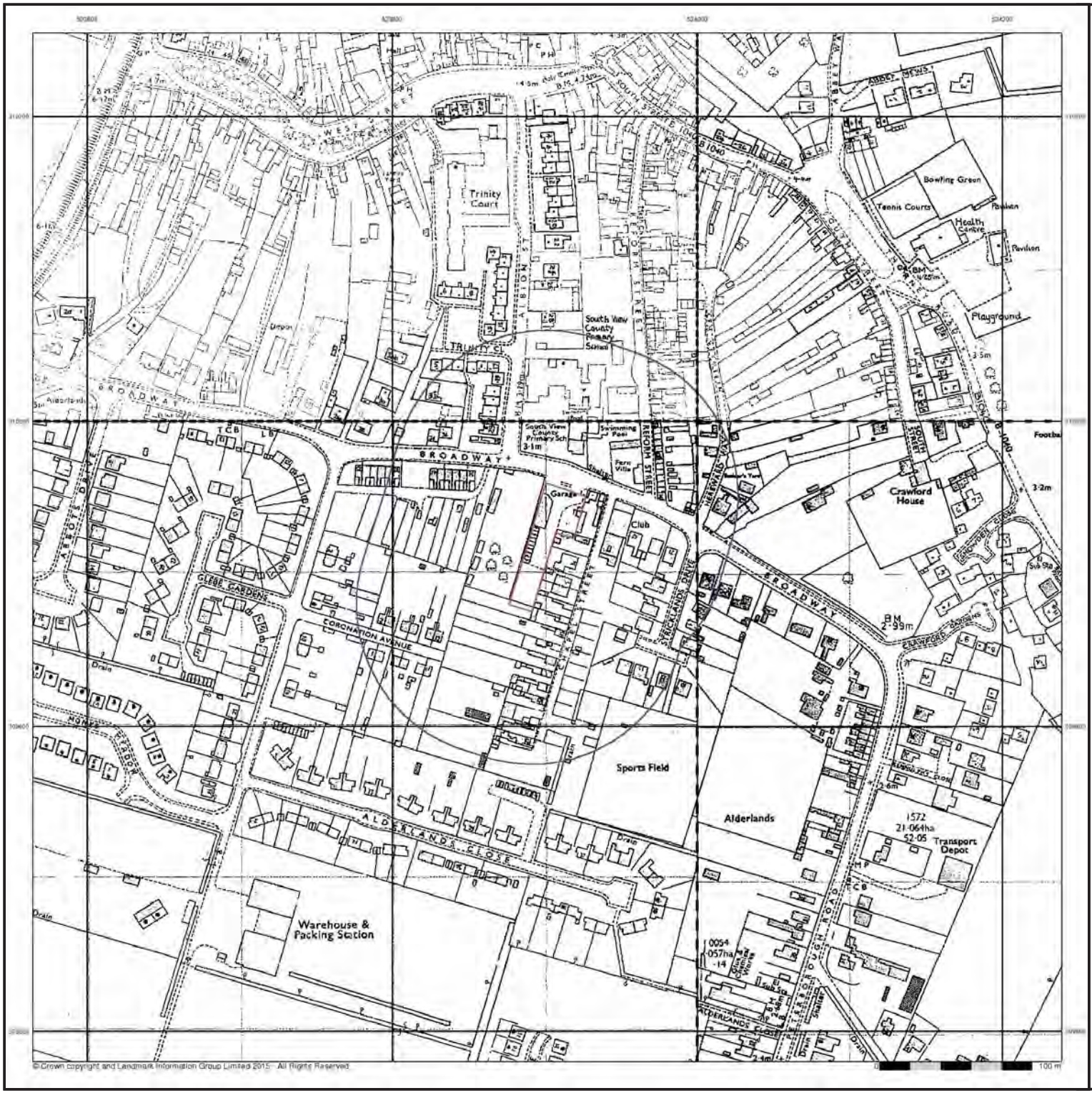
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Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	100

Site Details

Site at 523900, 309920

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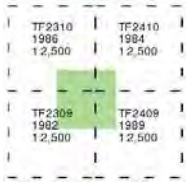
Additional SIMs

Published 1982 - 1989

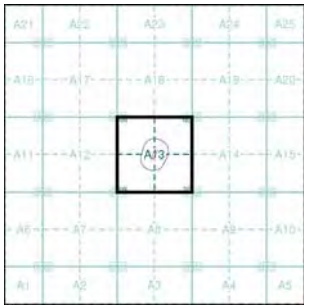
Source map scale - 1:2,500

The SIM cards (Ordnance Survey's `Survey of Information on Microfilm') are further, minor editions of mapping which were produced and published in between the main editions as an area was updated. They date from 1947 to 1994, and contain detailed information on buildings, roads and land-use. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

Order Number:	68231479_1_1
Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
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Site Area (Ha):	0.17
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Site Details

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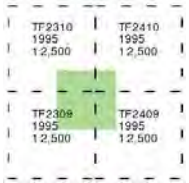
Large-Scale National Grid Data

Published 1995

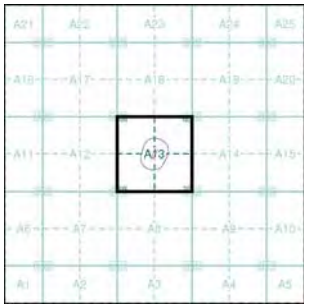
Source map scale - 1:2,500

'Large Scale National Grid Data' superseded SIM cards (Ordnance Survey's 'Survey of Information on Microfilm') in 1992, and continued to be produced until 1999. These maps were the fore-runners of digital mapping and so provide detailed information on houses and roads, but tend to show less topographic features such as vegetation. These maps were produced at both 1:2,500 and 1:1,250 scales.

Map Name(s) and Date(s)



Historical Map - Segment A13



Order Details

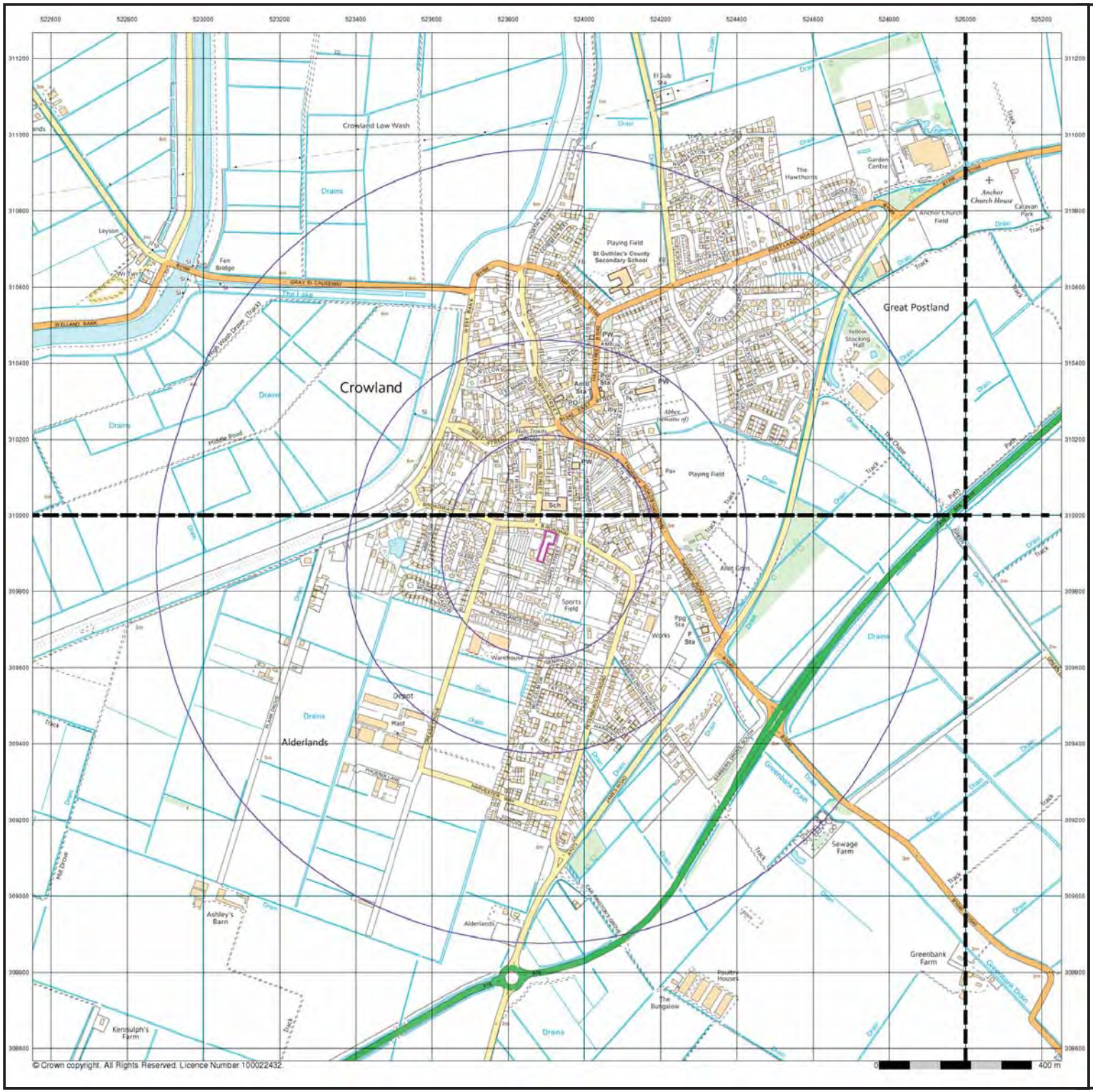
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Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	100

Site Details

Site at 523900, 309920

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk



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VectorMap Local

Published 2015

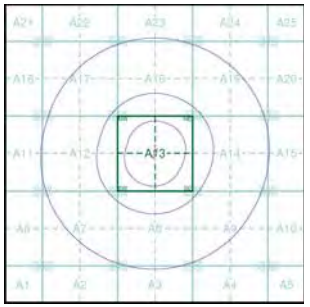
Source map scale - 1:10,000

VectorMap Local (Raster) is Ordnance Survey's highest detailed 'backdrop' mapping product. These maps are produced from OS's VectorMap Local, a simple vector dataset at a nominal scale of 1:10,000, covering the whole of Great Britain, that has been designed for creating graphical mapping. OS VectorMap Local is derived from large-scale information surveyed at 1:1250 scale (covering major towns and cities),1:2500 scale (smaller towns, villages and developed rural areas), and 1:10 000 scale (mountain, moorland and river estuary areas).

Map Name(s) and Date(s)

TF21SW 2015 Variable	TF21SE 2015 Variable
TF20NW 2015 Variable	TF20NE 2015 Variable

Historical Map - Slice A



Order Details

Order Number:	68231479_1_1
Customer Ref:	UK14.1470
National Grid Reference:	523900, 309920
Slice:	A
Site Area (Ha):	0.17
Search Buffer (m):	1000

Site Details

Site at 523900, 309920

Landmark Information Group

Tel: 0844 844 9952
Fax: 0844 844 9951
Web: www.envirocheck.co.uk

APPENDIX G

Site Specific Borehole Logs

Environmental Protection Strategies
Tel: 01954 710666
email: info@epstrategies.co.uk
www.epstrategies.co.uk

Borehole No
HA101
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
Former Broadway PFS	UK14.1470		HA
Location: Crowland , Lincolnshire, PE6 OBH		Level: -	Scale 1:25
Client: Mr Ian Ladds		Dates: 26/05/2015	Logged By RS

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			MADE GROUND: Brown silty sandy gravelly clay with bricks, glass, ash and clinker
					0.60			MADE GROUND: Orangey brown silty sandy gravelly clay with fine brick fragments and clinker material
								End of Borehole at 0.60 m
			Type	Results				

1
2
3
4

Remarks:

AGS

Environmental Protection Strategies
Tel: 01954 710666
email: info@epstrategies.co.uk
www.epstrategies.co.uk

Borehole No
HA2
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
Former Broadway PFS	UK14.1470		HA
Location: Crowland , Lincolnshire, PE6 OBH		Level: -	Scale 1:25
Client: Mr Ian Ladds		Dates: 26/05/2015	Logged By RS

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Brown slightly silty slightly sandy gravelly clay with fine brick fragments and rare clinker material
					0.45			Orangey brown slightly sandy silty CLAY
					0.60			End of Borehole at 0.60 m
			Type	Results				

Remarks:

AGS

Environmental Protection Strategies
Tel: 01954 710666
email: info@epstrategies.co.uk
www.epstrategies.co.uk

Borehole No
HA3
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
Former Broadway PFS	UK14.1470		HA
Location: Crowland , Lincolnshire, PE6 OBH		Level: -	Scale 1:25
Client: Mr Ian Ladds		Dates: 26/05/2015	Logged By RS

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.60			MADE GROUND: Brown slightly silty sandy gravelly clay with brick fragments Rare concrete fragments End of Borehole at 0.60 m

1
2
3
4

Remarks:

Environmental Protection Strategies
Tel: 01954 710666
email: info@epstrategies.co.uk
www.epstrategies.co.uk

Borehole No
HA4
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
Former Broadway PFS	UK14.1470		HA
Location: Crowland , Lincolnshire, PE6 OBH		Level: -	Scale 1:25
Client: Mr Ian Ladds		Dates: 26/05/2015	Logged By RS

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
					0.20			MADE GROUND: Orangey brown silty sandy clay with rare clinker and rare fine brick fragments
					0.60			Brown silty slightly sandy CLAY
								End of Borehole at 0.60 m
			Type	Results				

Remarks:

AGS

Environmental Protection Strategies
Tel: 01954 710666
email: info@epstrategies.co.uk
www.epstrategies.co.uk

Borehole No
HA5
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
Former Broadway PFS	UK14.1470		HA
Location: Crowland , Lincolnshire, PE6 OBH		Level: -	Scale 1:25
Client: Mr Ian Ladds		Dates: 26/05/2015	Logged By RS

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
								MADE GROUND: Brown slightly sandy slightly silty very gravelly clay with ash and recently active roots
					0.40			Brown slightly sandy silty gravelly CLAY
					0.60			End of Borehole at 0.60 m
			Type	Results				

1
2
3
4

Remarks:

AGS

Environmental Protection Strategies
Tel: 01954 710666
email: info@epstrategies.co.uk
www.epstrategies.co.uk

Borehole No
HA6
Sheet 1 of 1

Project Name	Project No.	Co-ords: -	Hole Type
Former Broadway PFS	UK14.1470		HA
Location: Crowland , Lincolnshire, PE6 OBH		Level: -	Scale 1:25
Client: Mr Ian Ladds		Dates: 26/05/2015	Logged By RS

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
								Dark brown silty sandy TOPSOIL with recently active roots
					0.30			Orangey brown slightly gravelly slightly silty sandy CLAY
					0.60			End of Borehole at 0.60 m
			Type	Results				

Remarks:

AGS

APPENDIX H

Laboratory Data – Environmental

Jones Environmental Laboratory

Registered Address : Unit 3 Deeside Point, Zone 3, Deeside Industrial Park, Deeside, CH5 2UA. UK

Unit 3 Deeside Point
Zone 3
Deeside Industrial Park
Deeside
CH5 2UA

Tel: +44 (0) 1244 833780
Fax: +44 (0) 1244 833781

EPS Ltd
7B Caxton House
Broad Street
Cambourne
Cambridgeshire
CB23 6JN

Attention :	Ross Smith
Date :	5th June, 2015
Your reference :	UK14.1470
Our reference :	Test Report 15/7986 Batch 1
Location :	Crowlands
Date samples received :	29th May, 2015
Status :	Final report
Issue :	2

Nine samples were received for analysis on 29th May, 2015 of which nine were scheduled for analysis. Please find attached our Test Report which should be read with notes at the end of the report and should include all sections if reproduced. Interpretations and opinions are outside the scope of any accreditation, and all results relate only to samples supplied.
All analysis is carried out on as received samples and reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected.

Compiled By:

Bruce Leslie
Project Co-ordinator

Bob Millward BSc FRSC
Principal Chemist

Client Name: EPS Ltd
Reference: UK14.1470
Location: Crowlands
Contact: Ross Smith
JE Job No.: 15/7986

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-2	3-4	5-6	7-8	9-10	11-12					LOD/LOR	Units	Method No.
Sample ID	HA101	HA2	HA3	HA4	HA5	HA6							
Depth	0.1-0.6	0.1-0.6	0.1-0.6	0.2-0.6	0.1-0.4	0.1-0.6							
COC No / misc													
Containers	J	J	J	J	J	J							
Sample Date	26/05/2015	26/05/2015	26/05/2015	26/05/2015	26/05/2015	26/05/2015							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1							
Date of Receipt	29/05/2015	29/05/2015	29/05/2015	29/05/2015	29/05/2015	29/05/2015							
Arsenic #M	31.0	19.5	20.5	28.3	16.6	20.6					<0.5	mg/kg	TM30/PM15
Cadmium #M	<0.1	<0.1	<0.1	0.5	0.2	0.5					<0.1	mg/kg	TM30/PM15
Chromium #M	50.0	63.5	56.9	62.0	61.5	63.5					<0.5	mg/kg	TM30/PM15
Copper #M	62	20	17	59	47	30					<1	mg/kg	TM30/PM15
Lead #M	201	65	59	214	30	101					<5	mg/kg	TM30/PM15
Mercury #M	1.0	<0.1	<0.1	0.2	<0.1	<0.1					<0.1	mg/kg	TM30/PM15
Nickel #M	28.9	25.1	17.9	29.3	14.0	24.8					<0.7	mg/kg	TM30/PM15
Selenium #M	1	1	1	1	<1	<1					<1	mg/kg	TM30/PM15
Total Sulphate #M	1130	1343	1237	1144	334	801					<50	mg/kg	TM50/PM15
Zinc #M	238	113	132	565	135	442					<5	mg/kg	TM30/PM15
PAH MS													
Naphthalene #M	0.08	0.05	0.05	0.09	<0.04	<0.04					<0.04	mg/kg	TM4/PM8
Acenaphthylene	0.25	0.30	0.21	0.51	0.07	0.06					<0.03	mg/kg	TM4/PM8
Acenaphthene #M	<0.05	0.08	<0.05	0.37	<0.05	<0.05					<0.05	mg/kg	TM4/PM8
Fluorene #M	0.10	0.06	<0.04	0.33	<0.04	<0.04					<0.04	mg/kg	TM4/PM8
Phenanthrene #M	1.90	1.62	0.49	5.18	0.28	0.31					<0.03	mg/kg	TM4/PM8
Anthracene #	0.62	0.65	0.31	1.43	0.12	0.10					<0.04	mg/kg	TM4/PM8
Fluoranthene #M	3.10	6.07	2.64	12.09	0.92	0.81					<0.03	mg/kg	TM4/PM8
Pyrene #	2.47	5.41	2.49	10.17	0.79	0.74					<0.03	mg/kg	TM4/PM8
Benzo(a)anthracene #	2.52	3.11	1.66	5.24	0.70	0.49					<0.06	mg/kg	TM4/PM8
Chrysene #M	2.04	2.91	1.60	5.41	0.61	0.44					<0.02	mg/kg	TM4/PM8
Benzo(bk)fluoranthene #M	3.80	5.77	4.06	9.81	1.20	0.85					<0.07	mg/kg	TM4/PM8
Benzo(a)pyrene #	2.00	3.51	2.83	5.84	0.62	0.49					<0.04	mg/kg	TM4/PM8
Indeno(123cd)pyrene #M	1.14	2.11	2.15	3.87	0.45	0.25					<0.04	mg/kg	TM4/PM8
Dibenzo(ah)anthracene #	0.26	0.29	0.18	0.32	0.07	<0.04					<0.04	mg/kg	TM4/PM8
Benzo(ghi)perylene #	0.92	1.69	1.84	3.27	0.37	0.25					<0.04	mg/kg	TM4/PM8
PAH 16 Total	21.2	33.6	20.5	63.9	6.2	4.8					<0.6	mg/kg	TM4/PM8
Benzo(b)fluoranthene	2.74	4.15	2.92	7.06	0.86	0.61					<0.05	mg/kg	TM4/PM8
Benzo(k)fluoranthene	1.06	1.62	1.14	2.75	0.34	0.24					<0.02	mg/kg	TM4/PM8
PAH Surrogate % Recovery	83	103	98	117	115	112					<0	%	TM4/PM8
TPH CWG													
Aliphatics													
>C5-C6 #M	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					<0.1	mg/kg	TM36/PM12
>C6-C8 #M	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					<0.1	mg/kg	TM36/PM12
>C8-C10	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					<0.1	mg/kg	TM36/PM12
>C10-C12 #M	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2					<0.2	mg/kg	TM5/PM16
>C12-C16 #M	<4	<4	<4	<4	<4	<4					<4	mg/kg	TM5/PM16
>C16-C21 #M	<7	<7	17	<7	<7	<7					<7	mg/kg	TM5/PM16
>C21-C35 #M	<7	22	89	28	11	<7					<7	mg/kg	TM5/PM16
Total aliphatics C5-35	<19	22	106	28	<19	<19					<19	mg/kg	TM5/TM36/PM12/PM16

Client Name: EPS Ltd
Reference: UK14.1470
Location: Crowlands
Contact: Ross Smith
JE Job No.: 15/7986

Report : Solid

Solids: V=60g VOC jar, J=250g glass jar, T=plastic tub

Please see attached notes for all abbreviations and acronyms

J E Sample No.	1-2	3-4	5-6	7-8	9-10	11-12					LOD/LOR	Units	Method No.
Sample ID	HA101	HA2	HA3	HA4	HA5	HA6							
Depth	0.1-0.6	0.1-0.6	0.1-0.6	0.2-0.6	0.1-0.4	0.1-0.6							
COC No / misc													
Containers	J	J	J	J	J	J							
Sample Date	26/05/2015	26/05/2015	26/05/2015	26/05/2015	26/05/2015	26/05/2015							
Sample Type	Soil	Soil	Soil	Soil	Soil	Soil							
Batch Number	1	1	1	1	1	1							
Date of Receipt	29/05/2015	29/05/2015	29/05/2015	29/05/2015	29/05/2015	29/05/2015							
TPH CWG													
Aromatics													
>C5-EC7	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					<0.1	mg/kg	TM36/PM12
>EC7-EC8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					<0.1	mg/kg	TM36/PM12
>EC8-EC10 #M	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1					<0.1	mg/kg	TM36/PM12
>EC10-EC12	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2					<0.2	mg/kg	TM5/PM16
>EC12-EC16	<4	<4	<4	<4	<4	<4					<4	mg/kg	TM5/PM16
>EC16-EC21	<7	22	42	71	58	<7					<7	mg/kg	TM5/PM16
>EC21-EC35	86	149	301	265	210	45					<7	mg/kg	TM5/PM16
Total aromatics C5-35	86	171	343	336	268	45					<19	mg/kg	TM5/TM36/PM12/PM16
Total aliphatics and aromatics(C5-35)	86	193	449	364	268	45					<38	mg/kg	TM5/TM36/PM12/PM16
MTBE #	<5	<5	<5	<5	<5	<5					<5	ug/kg	TM31/PM12
Benzene #	<5	<5	<5	<5	<5	<5					<5	ug/kg	TM31/PM12
Toluene #	<5	<5	<5	<5	<5	<5					<5	ug/kg	TM31/PM12
Ethylbenzene #	<5	<5	<5	<5	<5	<5					<5	ug/kg	TM31/PM12
m/p-Xylene #	<5	<5	<5	<5	<5	<5					<5	ug/kg	TM31/PM12
o-Xylene #	<5	<5	<5	<5	<5	<5					<5	ug/kg	TM31/PM12
Total Phenols HPLC	<0.15	<0.15	<0.15	<0.15	<0.15	<0.15					<0.15	mg/kg	TM26/PM21
Natural Moisture Content	32.7	25.2	15.3	27.1	5.0	16.0					<0.1	%	PM4/PM0
Hexavalent Chromium #	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3					<0.3	mg/kg	TM38/PM20
Sulphate as SO4 (2:1 Ext) #M	0.0744	0.1444	0.2454	0.0447	0.0104	0.0293					<0.0015	g/l	TM38/PM20
Chromium III	50.0	63.5	56.9	62.0	61.5	63.5					<0.5	mg/kg	NONE/NONE
Total Cyanide #M	6.0	<0.5	<0.5	<0.5	<0.5	0.6					<0.5	mg/kg	TM89/PM45
Organic Matter	14.0	3.4	2.2	8.1	0.8	4.1					<0.2	%	TM21/PM24
pH #M	8.09	8.14	8.02	7.78	8.31	8.05					<0.01	pH units	TM73/PM11
Sample Type	Clay	Clay	Clay	Clay	Clay	Clay						None	PM13/PM0
Sample Colour	Dark Brown	Medium Brown	Dark Brown	Dark Brown	Medium Brown	Dark Brown						None	PM13/PM0
Other Items	sand and stones	sand and stones	sand and stones	sand and stones	sand and stones	sand and stones						None	PM13/PM0

Client Name: EPS Ltd
Reference: UK14.1470
Location: Crowlands
Contact: Ross Smith
JE Job No.: 15/7986

Report : Liquid

Liquids/products: V=40ml vial, G=glass bottle, P=plastic bottle
H=H_2SO_4, Z=ZnAc, N=NaOH, HN=$HN0_3$

Please see attached notes for all abbreviations and acronyms

J E Sample No.	13-14	15-16	17-18								LOD/LOR	Units	Method No.
Sample ID	BH1A	BH1	BH2										
Depth													
COC No / misc													
Containers	V G	V G	V G										
Sample Date	26/05/2015	26/05/2015	26/05/2015										
Sample Type	Ground Water	Ground Water	Ground Water										
Batch Number	1	1	1										
Date of Receipt	29/05/2015	29/05/2015	29/05/2015										
TPH CWG													
Aliphatics													
>C5-C6 #	1810	<5	<5								<5	ug/l	TM36/PM12
>C6-C8 #	1146	<5	<5								<5	ug/l	TM36/PM12
>C8-C10 #	175	<5	<5								<5	ug/l	TM36/PM12
>C10-C12 #	<5	80	<5								<5	ug/l	TM5/PM30
>C12-C16 #	<10	60	<10								<10	ug/l	TM5/PM30
>C16-C21 #	<10	<10	<10								<10	ug/l	TM5/PM30
>C21-C35 #	<10	<10	<10								<10	ug/l	TM5/PM30
Total aliphatics C5-35 #	3131	140	<10								<10	ug/l	TM5/TM36/PM30
Aromatics													
>C5-EC7 #	1905	<5	<5								<5	ug/l	TM36/PM12
>EC7-EC8 #	43	<5	<5								<5	ug/l	TM36/PM12
>EC8-EC10 #	212	<5	<5								<5	ug/l	TM36/PM12
>EC10-EC12 #	159	33	106								<5	ug/l	TM5/PM30
>EC12-EC16 #	180	<10	100								<10	ug/l	TM5/PM30
>EC16-EC21 #	50	<10	<10								<10	ug/l	TM5/PM30
>EC21-EC35 #	<10	<10	<10								<10	ug/l	TM5/PM30
Total aromatics C5-35 #	2549	33	206								<10	ug/l	TM5/PM30
Total aliphatics and aromatics(C5-35) #	5680	173	206								<10	ug/l	TM5/TM36/PM30
MTBE #	<5	<5	<5								<5	ug/l	TM36/PM12
Benzene #	1905	<5	<5								<5	ug/l	TM36/PM12
Toluene #	43	<5	<5								<5	ug/l	TM36/PM12
Ethylbenzene #	80	<5	<5								<5	ug/l	TM36/PM12
m/p-Xylene #	110	<5	<5								<5	ug/l	TM36/PM12
o-Xylene #	21	<5	<5								<5	ug/l	TM36/PM12

Client Name: EPS Ltd **Matrix : Solid**
Reference: UK14.1470
Location: Crowlands
Contact: Ross Smith

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	EPH Interpretation
15/7986	1	HA101	0.1-0.6	1-2	PAH's
15/7986	1	HA2	0.1-0.6	3-4	PAH's
15/7986	1	HA3	0.1-0.6	5-6	PAH's, Possible lubricating oil & Possible tarmac/bitumen
15/7986	1	HA4	0.2-0.6	7-8	PAH's, Possible lubricating oil & Possible tarmac/bitumen
15/7986	1	HA5	0.1-0.4	9-10	PAH's
15/7986	1	HA6	0.1-0.6	11-12	PAH's

Client Name: EPS Ltd

Matrix : Liquid

Reference: UK14.1470

Location: Crowlands

Contact: Ross Smith

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	EPH Interpretation
15/7986	1	BH1A		13-14	Dissolved phase aromatics
15/7986	1	BH1		15-16	Dissolved phase compounds
15/7986	1	BH2		17-18	Dissolved phase aromatics

Client Name: EPS Ltd
Reference: UK14.1470
Location: Crowlands
Contact: Ross Smith

Note:

Analysis was carried out in accordance with our documented in-house methods PM042 and TM065 and HSG 248 by Stereo and Polarised Light Microscopy using Dispersion Staining Techniques and is covered by our UKAS accreditation. Samples are retained for not less than 6 months from the date of analysis unless specifically requested.

Opinions lie outside the scope of our UKAS accreditation.

Where the sample is not taken by a Jones Environmental Laboratory consultant, Jones Environmental Laboratory cannot be responsible for inaccurate or unrepresentative sampling.

If asbestos fibres are reported at trace levels there will not be enough fibres to quantify and will be less than 0.001%.

Signed on behalf of Jones Environmental Laboratory:



Ryan Butterworth
Asbestos Team Leader

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Date Of Analysis	Analysis	Result
15/7986	1	HA101	0.1-0.6	1	01/06/2015	**Mass of Dry Sample**	40.8 (g)
					01/06/2015	**General Description (Bulk Analysis)**	Soil/Stones/Brick/Veg
					01/06/2015	**Asbestos Containing Material**	None
					01/06/2015	**Asbestos Containing Material (2)**	None
					01/06/2015	**Asbestos Screen**	NAD
					01/06/2015	**Asbestos Screen (2)**	NAD
					01/06/2015	**Asbestos Level**	NAD
15/7986	1	HA2	0.1-0.6	3	01/06/2015	**Mass of Dry Sample**	46.1 (g)
					01/06/2015	**General Description (Bulk Analysis)**	Soil/Stones/Brick/Veg
					01/06/2015	**Asbestos Containing Material**	None
					01/06/2015	**Asbestos Containing Material (2)**	None
					01/06/2015	**Asbestos Screen**	NAD
					01/06/2015	**Asbestos Screen (2)**	NAD
					01/06/2015	**Asbestos Level**	NAD
15/7986	1	HA3	0.1-0.6	5	01/06/2015	**Mass of Dry Sample**	49.2 (g)
					01/06/2015	**General Description (Bulk Analysis)**	Soil/Stones/Brick/Veg
					01/06/2015	**Asbestos Containing Material**	None
					01/06/2015	**Asbestos Containing Material (2)**	None
					01/06/2015	**Asbestos Screen**	NAD
					01/06/2015	**Asbestos Screen (2)**	NAD
					01/06/2015	**Asbestos Level**	NAD
15/7986	1	HA4	0.2-0.6	7	01/06/2015	**Mass of Dry Sample**	46.8 (g)
					01/06/2015	**General Description (Bulk Analysis)**	Soil/Stones/Brick
					01/06/2015	**Asbestos Containing Material**	None
					01/06/2015	**Asbestos Containing Material (2)**	None
					01/06/2015	**Asbestos Screen**	NAD
					01/06/2015	**Asbestos Screen (2)**	NAD
					01/06/2015	**Asbestos Level**	NAD
15/7986	1	HA5	0.1-0.4	9	01/06/2015	**Mass of Dry Sample**	51.4 (g)
					01/06/2015	**General Description (Bulk Analysis)**	Soil/Stones/Veg
					01/06/2015	**Asbestos Containing Material**	None
					01/06/2015	**Asbestos Containing Material (2)**	None
					01/06/2015	**Asbestos Screen**	NAD
					01/06/2015	**Asbestos Screen (2)**	NAD
					01/06/2015	**Asbestos Level**	NAD

Client Name: EPS Ltd
Reference: UK14.1470
Location: Crowlands
Contact: Ross Smith

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Date Of Analysis	Analysis	Result
15/7986	1	HA6	0.1-0.6	11	01/06/2015	**Mass of Dry Sample**	49.3 (g)
					01/06/2015	**General Description (Bulk Analysis)**	Soil/Stones/Veg
					01/06/2015	**Asbestos Containing Material**	None
					01/06/2015	**Asbestos Containing Material (2)**	None
					01/06/2015	**Asbestos Screen**	NAD
					01/06/2015	**Asbestos Screen (2)**	NAD
					01/06/2015	**Asbestos Level**	NAD

Client Name: EPS Ltd
Reference: UK14.1470
Location: Crowlands
Contact: Ross Smith

J E Job No.	Batch	Sample ID	Depth	J E Sample No.	Analysis	Reason
No deviating sample report results for job 15/7986						

Please note that only samples that are deviating are mentioned in this report. If no samples are listed it is because none were deviating.
Only analyses which are accredited are recorded as deviating if set criteria are not met.

Please include all sections of this report if it is reproduced

NOTES TO ACCOMPANY ALL SCHEDULES AND REPORTS

JE Job No.: 15/7986

SOILS

Please note we are only MCERTS accredited (UK soils only) for sand, loam and clay and any other matrix is outside our scope of accreditation.

Where an MCERTS report has been requested, you will be notified within 48 hours of any samples that have been identified as being outside our MCERTS scope. As validation has been performed on clay, sand and loam, only samples that are predominantly these matrices, or combinations of them will be within our MCERTS scope. If samples are not one of a combination of the above matrices they will not be marked as MCERTS accredited.

It is assumed that you have taken representative samples on site and require analysis on a representative subsample. Stones will generally be included unless we are requested to remove them.

All samples will be discarded one month after the date of reporting, unless we are instructed to the contrary.

If you have not already done so, please send us a purchase order if this is required by your company.

Where appropriate please make sure that our detection limits are suitable for your needs, if they are not, please notify us immediately.

All analysis is reported on a dry weight basis unless stated otherwise. Results are not surrogate corrected. Samples are dried at 35°C ±5°C unless otherwise stated. Moisture content for CEN Leachate tests are dried at 105°C ±5°C.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

Where a CEN 10:1 ZERO Headspace VOC test has been carried out, a 10:1 ratio of water to wet (as received) soil has been used.

% Asbestos in Asbestos Containing Materials (ACMs) is determined by reference to HSG 264 The Survey Guide - Appendix 2 : ACMs in buildings listed in order of ease of fibre release.

WATERS

Please note we are not a UK Drinking Water Inspectorate (DWI) Approved Laboratory .

ISO17025 (UKAS) accreditation applies to surface water and groundwater and one other matrix which is analysis specific, any other liquids are outside our scope of accreditation.

As surface waters require different sample preparation to groundwaters the laboratory must be informed of the water type when submitting samples.

Where Mineral Oil or Fats, Oils and Grease is quoted, this refers to Total Aliphatics C10-C40.

DEVIATING SAMPLES

Samples must be received in a condition appropriate to the requested analyses. All samples should be submitted to the laboratory in suitable containers with sufficient ice packs to sustain an appropriate temperature for the requested analysis. If this is not the case you will be informed and any test results that may be compromised highlighted on your deviating samples report.

SURROGATES

Surrogate compounds are added during the preparation process to monitor recovery of analytes. However low recovery in soils is often due to peat, clay or other organic rich matrices. For waters this can be due to oxidants, surfactants, organic rich sediments or remediation fluids. Acceptable limits for most organic methods are 70 - 130% and for VOCs are 50 - 150%. When surrogate recoveries are outside the performance criteria but the associated AQC passes this is assumed to be due to matrix effect. Results are not surrogate corrected.

DILUTIONS

A dilution suffix indicates a dilution has been performed and the reported result takes this into account. No further calculation is required.

NOTE

Data is only reported if the laboratory is confident that the data is a true reflection of the samples analysed. Data is only reported as accredited when all the requirements of our Quality System have been met. In certain circumstances where all the requirements of the Quality System have not been met, for instance if the associated AQC has failed, the reason is fully investigated and documented. The sample data is then evaluated alongside the other quality control checks performed during analysis to determine its suitability. Following this evaluation, provided the sample results have not been effected, the data is reported but accreditation is removed. It is a UKAS requirement for data not reported as accredited to be considered indicative only, but this does not mean the data is not valid.
Where possible, and if requested, samples will be re-extracted and a revised report issued with accredited results. Please do not hesitate to contact the laboratory if further details are required of the circumstances which have led to the removal of accreditation.

ABBREVIATIONS and ACRONYMS USED

#	ISO17025 (UKAS) accredited - UK.
B	Indicates analyte found in associated method blank.
DR	Dilution required.
M	MCERTS accredited.
NA	Not applicable
NAD	No Asbestos Detected.
ND	None Detected (usually refers to VOC and/SVOC TICs).
NDP	No Determination Possible
SS	Calibrated against a single substance
SV	Surrogate recovery outside performance criteria. This may be due to a matrix effect.
W	Results expressed on as received basis.
+	AQC failure, accreditation has been removed from this result, if appropriate, see 'Note' on previous page.
++	Result outside calibration range, results should be considered as indicative only and are not accredited.
*	Analysis subcontracted to a Jones Environmental approved laboratory.
AD	Samples are dried at 35°C ±5°C
CO	Suspected carry over
LOD/LOR	Limit of Detection (Limit of Reporting) in line with ISO 17025 and MCERTS
ME	Matrix Effect
NFD	No Fibres Detected
BS	AQC Sample
LB	Blank Sample
N	Client Sample
TB	Trip Blank Sample
OC	Outside Calibration Range

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All solid results are expressed on a dry weight basis unless stated otherwise.

JE Job No: 15/7986

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465 and BS1377.	PM0	No preparation is required.				
PM4	Gravimetric measurement of Natural Moisture Content and % Moisture Content at either 35°C or 105°C. Calculation based on ISO 11465 and BS1377.	PM0	No preparation is required.			AR	Yes
TM4	Modified USEPA 8270 method for the solvent extraction and determination of 16 PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.			AR	Yes
TM4	Modified USEPA 8270 method for the solvent extraction and determination of 16 PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes		AR	Yes
TM4	Modified USEPA 8270 method for the solvent extraction and determination of 16 PAHs by GC-MS.	PM8	End over end extraction of solid samples for organic analysis. The solvent mix varies depending on analysis required.	Yes	Yes	AR	Yes
TM5	Modified USEPA 8015B method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) with carbon banding within the range C8-C40 GC-FID.	PM16	Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.			AR	Yes
TM5	Modified USEPA 8015B method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) with carbon banding within the range C8-C40 GC-FID.	PM16	Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.	Yes	Yes	AR	Yes
TM5	Modified USEPA 8015B method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) with carbon banding within the range C8-C40 GC-FID.	PM16	Fractionation into aliphatic and aromatic fractions using a Rapid Trace SPE.			AR	
TM5	Modified USEPA 8015B method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) with carbon banding within the range C8-C40 GC-FID.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.				
TM5	Modified USEPA 8015B method for the determination of solvent Extractable Petroleum Hydrocarbons (EPH) with carbon banding within the range C8-C40 GC-FID.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			

Please include all sections of this report if it is reproduced

JE Job No: 15/7986

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM5/TM36	TM005: Modified USEPA 8015B. Determination of solvent Extractable Petroleum Hydrocarbons (EPH) including column fractionation in the carbon range of C10-35 into aliphatic and aromatic fractions by GC-FID. TM036: Modified USEPA 8015B. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C5-10 by headspace GC-FID.	PM12/PM16	CWG GC-FID			AR	Yes
TM5/TM36	TM005: Modified USEPA 8015B. Determination of solvent Extractable Petroleum Hydrocarbons (EPH) including column fractionation in the carbon range of C10-35 into aliphatic and aromatic fractions by GC-FID. TM036: Modified USEPA 8015B. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C5-10 by headspace GC-FID.	PM30	Water samples are extracted with solvent using a magnetic stirrer to create a vortex.	Yes			
PM13	A visual examination of the solid sample is carried out to ascertain sample make up, colour and any other inclusions. This is not a geotechnical description.	PM0	No preparation is required.			AR	
TM21	Modified USEPA 415.1. Determination of Total Organic Carbon or Total Carbon by combustion in an Eltra TOC furnace/analyser in the presence of oxygen. The CO2 generated is quantified using infra-red detection.	PM24	Dried and ground solid samples are washed with hydrochloric acid, then rinsed with deionised water to remove the mineral carbon before TOC analysis.			AD	Yes
TM26	Determination of phenols by Reversed Phased High Performance Liquid Chromatography and Electro-Chemical Detection.	PM21	As received solid or water samples are extracted in Methanol: Sodium Hydroxide (0.1M NaOH) (60:40) by orbital shaker.			AR	Yes
TM30	Determination of Trace Metal elements by ICP-OES (Inductively Coupled Plasma - Optical Emission Spectrometry). Modified US EPA Method 200.7	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes	Yes	AD	Yes
TM31	Modified USEPA 8015B. Determination of Methyltertbutylether, Benzene, Toluene, Ethylbenzene and Xylene by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes
TM31	Modified USEPA 8015B. Determination of Methyltertbutylether, Benzene, Toluene, Ethylbenzene and Xylene by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.	Yes		AR	Yes
TM36	Modified US EPA method 8015B. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.	Yes			
TM36	Modified US EPA method 8015B. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.			AR	Yes

JE Job No: 15/7986

Test Method No.	Description	Prep Method No. (if appropriate)	Description	ISO 17025 (UKAS)	MCERTS (UK soils only)	Analysis done on As Received (AR) or Dried (AD)	Reported on dry weight basis
TM36	Modified US EPA method 8015B. Determination of Gasoline Range Organics (GRO) in the carbon chain range of C4-12 by headspace GC-FID.	PM12	Modified US EPA method 5021. Preparation of solid and liquid samples for GC headspace analysis.	Yes	Yes	AR	Yes
TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	PM20	Extraction of dried and ground samples with deionised water in a 2:1 water to solid ratio for anions. Extraction of as received samples with deionised water in a 2:1 water to solid ratio for ammoniacal nitrogen. Samples are extracted using an orbital shaker.	Yes	Yes	AD	Yes
TM38	Soluble Ion analysis using the Thermo Aquakem Photometric Automatic Analyser. Modified US EPA methods 325.2, 375.4, 365.2, 353.1, 354.1	PM20	Extraction of dried and ground samples with deionised water in a 2:1 water to solid ratio for anions. Extraction of as received samples with deionised water in a 2:1 water to solid ratio for ammoniacal nitrogen. Samples are extracted using an orbital shaker.	Yes		AR	Yes
TM50	Acid soluble sulphate analysed by ICP-OES	PM15	Acid digestion of dried and ground solid samples using Aqua Regia refluxed at 112.5 °C. Samples containing asbestos are not dried and ground.	Yes	Yes	AD	Yes
TM65	Asbestos Bulk Identification method based on HSG 248.	PM42	Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.			AR	
TM65	Asbestos Bulk Identification method based on HSG 248.	PM42	Solid samples undergo a thorough visual inspection for asbestos fibres prior to asbestos identification using TM065.	Yes		AR	
TM73	Modified US EPA methods 150.1 and 9045D. Determination of pH by Metrohm automated probe analyser.	PM11	Extraction of as received solid samples using one part solid to 2.5 parts deionised water.	Yes	Yes	AR	No
TM89	Modified USEPA method OIA-1667. Determination of cyanide by Flow Injection Analyser.	PM45	As received solid samples are extracted with 1M NaOH by orbital shaker for Cyanide and Thiocyanate analysis.	Yes	Yes	AR	Yes
NONE	No Method Code	NONE	No Method Code			AR	Yes

APPENDIX I

Generic Screening Criteria

EPS Generic Quantitative Risk Assessment

Minimal Risk Generic Screening Criteria - Residential Land Use

Contaminant	Soil Targets			Groundwater Targets	
	Human Health	Controlled Waters		Controlled Waters	
		LGwRP	HGwRP	LGwRP	HGwRP
Unit	**mg/kg**			**ug/l**	
Arsenic	37	n/c	n/c	50	10
Cadmium	11	n/c	n/c	5	5
Chromium III	910	n/c	n/c	250	50
Chromium VI	6	n/c	n/c	n/c	n/c
Copper	2400	n/c	n/c	28	28
Mercury (elemental)	1.2	n/c	n/c	1	1
Nickel	180	n/c	n/c	200	50
Lead	NA	n/c	n/c	250	10
Selenium	250	n/c	n/c	10	10
Zinc	3700	n/c	n/c	500	500
Benzene	0.087	0.252	0.008	30	1
Toluene	130	1.17	1.17	50	50
Ethylbenzene	47	15.0	10.0	300	200
Xylene (para)	56	0.885	0.885	30	30
MTBE#	49	0.138	0.0276	75	15
Benzo(a)Pyrene	2.2	10	1.44	0.7	0.1
Naphthalene	2.3	0.934	0.02	10	0.1
Dibenz(ah)anthracene	0.24	n/c	n/c	n/c	n/c
Aliphatic C5-C6	42	5.27	1.05	50	10
Aliphatic C6-C8	100	23.2	4.64	50	10
Aliphatic C8-C10	27	175	35.1	50	10
Aliphatic C10-C12	130(48)*	1380	276	50	10
Aliphatic C12-C16	1100(8.48)**	27500	5490	50	10
Aliphatic C16-C35	65000 (8.48)**	3.46E+06	6.91E+05	50	10
Aromatic C8-C10	34	8.74	1.75	50	10
Aromatic C10-C12	74	13.8	2.76	50	10
Aromatic C12-C16	140	27.5	5.5	50	10
Aromatic C16-C21	260	86.9	17.4	50	10
Aromatic C21-C35	1100	690	138	50	10

Notes:
LGwRP - Low Groundwater Resource Potential HGwRP - High Groundwater Resource Potential
f = Oral, dermal and inhalation exposure compared with oral HCV N/C = Not Calculated
* = S4UL exceeds vapour saturation limit (in brackets) ** = S4UL exceeds solubility saturation limit (in brackets)

Soil Targets

Targets for Human Health have been taken from *S4ULs 'Suitable For Use Levels for Human Health Risk Assessment' – LQM and CIEH (2014)* derived using standard sandy loam soil with 1% SOM, except (#) = *EIC/AGS/CL:AIRE GAC 'Soil Generic Assessment Criteria' (2010)* . For sites where ground conditions differ significantly from sandy loam or site-specific SOM and pH are available, the generic human health targets may be revised.

Targets for Controlled waters have been derived using EA Remedial Targets Worksheet (v3.1) - using standard Sandy Loam ground conditions as described in Science Report SC050021/SR3, assuming no degradation for a 10m compliance distance with criteria of EQS or UKDWS for LGwRP and HGwRP respectively (see notes for GW targets).

Groundwater Targets

For LGwRP, targets have been taken as Freshwater EQS where available. For Ethylbenzene and BaP the WHO Health limit has been used and for MTBE and individual TPH fractions a 5 times multiplier of taste threshold and UKDWS has been taken repectively.
For HGwRP, targets have been taken as UKDWS where available, with the exception of Copper and Zinc where the EQS is lower than the DWS and therefore the EQS has been used as the groundwater target. For Ethlylbenzene the upper WHO ATO limit has been used. For Toluene and Xylene, the WHO ATO limit is higher than the EQS and so the lower value has been taken. For MTBE the taste threshold has been taken.

Work carried out to calculate generic screening criteria for concentrations of contaminant in groundwater with respect of risks to Human Health has generally found that criteria far exceed (by at least 2 orders of magnitude) those listed for the protection of either LGwRP and HGwRP receptors. On this basis, the above Groundwater criteria are also considered protective of human health and further evaluation of these risks should be considered alongside any detailed quantitative risk assessments carried out for groundwater on a site specific basis.

EPS Generic Quantitative Risk Assessment

Low Risk Generic Screening Criteria - All Land Uses

Contaminant	Soil Targets					
	Residential		Allotments	Commercial	Public Open Spaces	
	With Home Grown Produce	Without Home Grown Produce			Residential	Parks
Unit	**mg/kg**					
Arsenic	37	40	49	640	79	168
Benzene	0.87	3.3	0.18	98	140	230
Benzo(a)pyrene	5	5.3	5.7	76	10	21
Cadmium	26	149	4.9	410	220	880
Chromium (VI)	21	21	170	49	23	250
Lead	200	310	80	2330	630	1300

Notes:

Targets for Human Health have been taken from available Category 4 Screening Levels (C4SLs) for assessment of land affected by contamination issued by DEFRA in December 2013.

APPENDIX J

Remedial Target Worksheets - Benzene

Hydrogeological risk assessment for land contamination

Remedial Targets Worksheet , Release 3.1

Date of Workbook Issue: February 2006

This worksheet has been produced in combination with the document 'Remedial Targets Methodology: Hydrogeological risk assessment for land contamination (Environment Agency 2006).

Users of this worksheet should always refer to the User Manual to the Remedial Targets Methodology and to relevant guidance on UK legislation and policy, in order to understand how this procedure should be applied in an appropriate context.

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The calculation of equations in this worksheet has been independently checked by Entec (UK) Ltd on behalf of the Environment Agency.

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IMPORTANT: To enable MS Excel worksheet, click Tools, Add -Ins, Analysis Tool Pak and Analysis Tool Pak-VBA (to calculate error functions).

Details to be completed for each assessment				
Site Name:	Broadway PFS			
Site Address:	Crowland			
Completed by:	Ross Smith			
Date:	15-Jun-15		Version:	1.01
Contaminant	Benzene			
Target Concentration (C_T)	0.001	mg/l	Origin of C_T:	Resource Protection Value

This worksheet can be used to determine remedial targets for soils (Worksheets Level 1 Soil, Level 2 and Level 3 Soil) or to determine remedial targets for groundwater (Level 3 Groundwater). For Level 3, parameter values must be entered separately dependent on whether the assessment is for soil or groundwater. For soil, remedial targets are calculated as either mg/kg (for comparision with soil measurements) or mg/l (for comparison with leaching tests or pore water concentrations).
Site details entered on this page are automatically copied to Level 1, 2 and 3 Worksheets.
Worksheet options are identified by brown background and employ a pull-down menus. Data entry are identified as blue background.
Data origin / justification should be noted in cells coloured yellow and fully documented in subsequent reports.
Data carried forward from an earlier worksheet are identified by a light green background
It is recommended that a copy of the original worksheet is saved (all data fields in the original copy are blank).

The spreadsheet also includes a porosity calculation worksheet, a soil impact calculation worksheet and a worksheet that performs some simple hydrogeological calculations.

Remedial Targets Worksheet , Release 3.1

Level 1 - Soil

Select the method of calculating the soil water Partition Co-efficient by using the pull down menu below

Calculate for non-polar organic chemicals

Contaminant		**Benzene**		
Target concentration	C_T	**0.001**	**mg/l**	

Input Parameters	**Variable**	**Value**	**Unit**	**Source of parameter value**
Standard entry				
Water filled soil porosity	θ_W	2.40E-01	fraction	Literature value from CLEA Science report 3 (sand)
Air filled soil porosity	θa	3.00E-01	fraction	Literature value from CLEA Science report 3 (sand)
Bulk density of soil zone material	ρ	1.78E+00	g/cm^3	***Median of Consim files***
Henry's Law constant	H	2.25E-01	dimensionless	***TPHCWG***
Entry if specify partition coefficient (option)				
Soil water partition coefficient	Kd		l/kg	
Entry for non-polar organic chemicals (option)				
Fraction of organic carbon (in soil)	foc	1.00E-03	fraction	Arbitrary low value in absence of site data
Organic carbon partition coefficient	Koc	6.76E+01	l/kg	***TPHCWG***
Entry for ionic organic chemicals (option)				
Sorption coefficient for neutral species	$K_{oc,n}$		l/kg	
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg	
pH value	pH		pH units	
Acid dissociation constant	pKa			
Fraction of organic carbon (in soil)	foc		fraction	

Soil water partition coefficient used in Level Assessment	**Kd**	**6.76E-02**	**l/kg**	***Calculated value***

This sheet calculates the Level 1 remedial target for soils(mg/kg) based on a selected target concentration and theoretical calculation of soil water partitioning. Three options are included for determining the partition coefficient.

The measured soil concentration as mg/kg should be compared with the Level 1 remedial target to determine the need for further action.

Level 1 Remedial Target

Level 1 Remedial Target	**2.40E-04**	**mg/kg**	**(for comparison with soil analyses)**
	or		
	0.001	**mg/l**	**(for comparison with leachate test results)**

Site being assessed:	Broadway PFS
Completed by:	Ross Smith
Date:	15-Jun-15
Version:	1.01

Remedial Targets Worksheet , Release 3.1

Level 2 - Soil

Contaminant		**Benzene**		from Level 1	This sheet calculates the Level 2 remedial target for soils (mg/kg) or for pore water (mg/l).
Target concentration	C_T	**0.001**	**mg/l**	from Level 1	

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 2 remedial target to determine the need for further action. Equations presented in 'Hydrogeological risk assessment for land contamiantion' (Environment Agency 2006)

Input Parameters

	Variable	Value	Unit	Source of parameter value	
Standard entry					
Infiltration	Inf	4.99E-04	m/d	**dstanding - 30% of mean for 1981-2011 daily rainfall fo**	
Area of contaminant source	A	2.00E+01	m^2	**Assume source measures 4m by 5m**	Not used in calculation
Entry for groundwater flow below site					
Length of contaminant source in direction of groundwater flow	L	4.00E+00	m	**Assume tank lies perpendicular to gw flow**	
Saturated aquifer thickness	da	3.50E+00	m	**Observed**	
Hydraulic Conductivity of aquifer in which dilution occurs	K	1.61E+00	m/d	**Average of site data**	
Hydraulic gradient of water table	i	1.63E-03	fraction	**Mean of site data**	
Width of contaminant source perpendicular to groundwater flow	w	5.00E+00	m	**Assume tank lies perpendicular to gw flow**	Not used in calculation
Background concentration of contaminant in groundwater beneath site	Cu	0.00E+00	mg/l	**Assumed upgradient to be non-detect**	
Define mixing zone depth by specifying or calculating depth (using pull down list)		**Calculate**			
Enter mixing zone thickness	Mz		m		
Calculated mixing zone thickness	Mz	1.11E+00	m		

Calculated Parameters

Dilution Factor	**DF**	**2.45E+00**		
Level 2 Remedial Target		**2.45E-03**	**mg/l**	**For comparison with measured pore water concentration. This assumes Level 1 Remedial Target is based on Target Concentrat**
		or		
		5.89E-04	**mg/kg**	**For comparison with measured soil concentration. This assumes Level 1 Remedial Target calculated from soil-water**

Additional option

Calculation of impact on receptor

Concentration of contaminant in contaminated discharge (entering receptor)	Cc	0.00E+00	mg/l	
Calculated concentration within receptor (dilution only)		0.00E+00	mg/l	0

Site being assessed:	Broadway PFS
Completed by:	Ross Smith
Date:	15-Jun-15
Version:	1.01

Remedial Targets Worksheet , Release 3.1

Level 3 - Soil

See Note

Input Parameters

	Variable	Value	Unit	Source
Contaminant		Benzene		from Level 1
Target Concentration	C_T	0.001	mg/l	from Level 1
Dilution Factor	DF	2.45E+00		from Level 2

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in R&D Pub. 20

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to dissolved pollutants only**

	Variable	Value	Unit	Source of parameter value
Enter source concentration		Soil concentration as mg/kg		
Enter soil concentration		1	mg/kg	
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+02	days	*Maximum anaerobic half life*
Calculated decay rate	λ	1.39E-03	$days^{-1}$	calculated
Width of plume in aquifer at source	Sz	5.00E+00	m	from Level 2
Plume thickness in aquifer at source	Sy	1.11E+00	m	from Level 2
Bulk density of aquifer materials	ρ	1.78E+00	g/cm^3	*Median from Consim*
Effective porosity of aquifer	n	4.00E-01	fraction	*Median from Consim*
Hydraulic gradient	i	2.74E-03	fraction	from Level 2 (adjusted)
Hydraulic conductivity of saturated aquifer	K	1.61E+00	m/d	from Level 2
Distance to compliance point	x	5.00E+01	m	*Based on GP3 to protect gw resource*
Distance (lateral) to compliance point perpendicular to flow direction	z		m	
Distance (depth) to compliance point perpendicular to flow direction	y		m	
Time since pollutant entered groundwater	t	1.00E+100	days	*time variant options only*
Parameters values determined from options				
Partition coefficient	Kd	1.76E-01	l/kg	*see options*
Longitudinal dispersivity	ax	5.000	m	*see options*
Transverse dispersivity	az	0.500	m	*see options*
Vertical dispersivity	ay	0.050	m	*see options*

Parameter values should be checked against Level 1 and 2

Calculated Parameters

	Variable		
Groundwater flow velocity	v	1.10E-02	m/d
Retardation factor	Rf	1.78E+00	fraction
Decay rate used	λ	7.78E-04	d^{-1}
Hydraulic gradient used in aquifer flow down-gradient	i	2.74E-03	fraction
Rate of contaminant flow due to retardation	u	6.19E-03	m/d
Ratio of Compliance Point to Source Concentration	C_{ED}/C_0	1.32E-03	fraction
Attenuation factor (C_0/C_{ED})	**AF**	**7.55E+02**	**fraction**
Calculated soil leachate concentration	Co	4.16E+00	mg/l

Remedial Targets

Level 3 Remedial Target	**1.85E+00**	**mg/l**	For comparison with measured pore water concentration.
Ogata Banks	**or**		This assumes Level 1 Remedial Target is based on Target Concentration.
	4.45E-01	**mg/kg**	For comparison with measured soil concentration. This
Distance to compliance point	**50**	**m**	assumes Level 1 Remedial Target calculated from soil-water
			partitioning equation.
Ratio of Compliance Point to Source Concentration	**C_{ED}/C_0** **1.32E-03**	**fraction**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99

Enter method of defining partition co-efficient (using pull down list)

Calculate for non-polar organic chemicals

Entry if specify partition coefficient (option)

Soil water partition coefficient — Kd — l/kg

Entry for non-polar organic chemicals (option)

Fraction of organic carbon in aquifer	foc	2.60E-03	fraction
Organic carbon partition coefficient	Koc	6.76E+01	l/kg

Entry for ionic organic chemicals (option)

Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
Acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	1.76E-01	l/kg

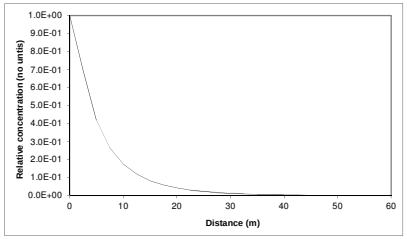
Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	**ax**	0.00E+00	5.00E+00	2.98E+00	m
Transverse dispersivity	**az**	0.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	**ay**	0.00E+00	5.00E-02	2.98E-02	m

Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed

Note
This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O_2, NO_3, SO_4 etc than the separate Corona Solution spreadsheet should be used



Note: 'Relative concentration' is the ratio of calculated concentation at a given position compared to the source compliance. The calculations assume plume disperses from the top of the aquifer. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

This sheet calculates the Level 3 remedial target for soils(mg/kg) or for pore water (mg/l), based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.By setting a long travel time (e.g. 9E99) it will give the steady state solution, which should always be used when calculating remedial targets.

The measured soil concentration as mg/kg or pore water concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.9E+99.

Site being assessed:	Broadway PFS
Completed by:	Ross Smith
Date:	########
Version:	1.01

Calculated (relative) concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Relative concentration (No units)	Concentration mg/l
0	1.0E+00	4.16E+00
2.5	6.93E-01	2.88E+00
5.0	4.20E-01	1.75E+00
7.5	2.65E-01	1.10E+00
10.0	1.74E-01	7.26E-01
12.5	1.18E-01	4.93E-01
15.0	8.23E-02	3.42E-01
17.5	5.83E-02	2.42E-01
20.0	4.18E-02	1.74E-01
22.5	3.03E-02	1.26E-01
25.0	2.22E-02	9.25E-02
27.5	1.64E-02	6.83E-02
30.0	1.22E-02	5.08E-02
32.5	9.12E-03	3.79E-02
35.0	6.85E-03	2.85E-02
37.5	5.17E-03	2.15E-02
40.0	3.91E-03	1.63E-02
42.5	2.97E-03	1.24E-02
45.0	2.26E-03	9.42E-03
47.5	1.73E-03	7.19E-03
50.0	1.32E-03	5.51E-03

R&D Publication 20 Remedial Targets Worksheet, Release 3.1

Level 3 - Groundwater

See Note

Input Parameters (using pull down menu)

	Variable	Value	Unit	Source
Contaminant		Benzene		from Level 1
Target Concentration	C_T	1.00E-03	mg/l	from Level 1

Select analytical solution (click on brown cell below, then on pull-down menu)

Ogata Banks — Equations in R&D Pub. 20

Approach for simulating vertical dispersion: **Simulate vertical dispersion in 1 direction**

Select nature of decay rate (click on brown cell below, then on pull-down menu)

Approach for simulating degradation of pollutants: **Apply degradation rate to pollutants in all phases**

				Source of parameter value
Initial contaminant concentration in groundwater at plume core	C_0	1.91E+00	mg/l	***Max Site Conc***
Half life for degradation of contaminant in water	$t_{1/2}$	5.00E+02	days	***Max anaerobic half life***
Calculated decay rate	λ	1.39E-03	$days^{-1}$	
Width of plume in aquifer at source (perpendicular to flow)	Sz	5.00E+00	m	***Assume tank is perpendicular to flow***
Plume thickness at source	Sy	3.00E+00	m	***Assume full depth of former tank farm***
Saturated aquifer thickness	da	3.50E+00	m	***Max observed saturated thickness***
Bulk density of aquifer materials	ρ	1.78E+00	g/cm^3	***Median from Consim***
Effective porosity of aquifer	n	4.00E-01	fraction	***Median from Consim***
Hydraulic gradient	i	1.63E-03	fraction	***Field Data***
Hydraulic conductivity of aquifer	K	1.61E+00	m/d	***Average of site data***
Distance to compliance point	x	5.00E+01	m	***GP3 protective of groundwater resou***
Distance (lateral) to compliance point perpendicular to flow direction	z	0.00E+00	m	***EA Recommended Value***
Distance (depth) to compliance point perpendicular to flow direction	y	0.00E+00	m	***EA Recommended Value***
Time since pollutant entered groundwater	t	1.00E+100	days	***time variant options only***
Parameters values determined from options				
Partition coefficient	Kd	6.76E-02	l/kg	***see options***
Longitudinal dispersivity	ax	5.00E+00	m	***see options***
Transverse dispersivity	az	5.00E-01	m	***see options***
Vertical dispersivity	ay	5.00E-02	m	***see options***

Calculated Parameters

	Variable		
Groundwater flow velocity	v	6.53E-03	m/d
Retardation factor	Rf	1.30E+00	fraction
Decay rate used	λ	1.39E-03	d^{-1}
Rate of contaminant flow due to retardation	u	5.02E-03	m/d
Contaminant concentration at distance x, assuming one-way vertical dispersion	C_{ED}	1.82E-04	mg/l
Attenuation factor (one way vertical dispersion, CO/CED)	**AF**	**1.05E+04**	

Remedial Targets

Remedial Target Ogata Banks		**1.05E+01**	**mg/l**	For comparison with measured groundwater concentration.
Distance to compliance point		**50**	**m**	
Concentration of contaminant at compliance point after	C_{ED}/C_0	**1.82E-04** **1.0E+100**	**mg/l** **days**	Ogata Banks

Care should be used when calculating remedial targets using the time variant options as this may result in an overestimate of the remedial target.
The recommended value for time when calculating the remedial target is 9.9E+99.

Select Method for deriving Partition Co-efficient (using pull down menu)

Calculate for non-polar organic chemicals

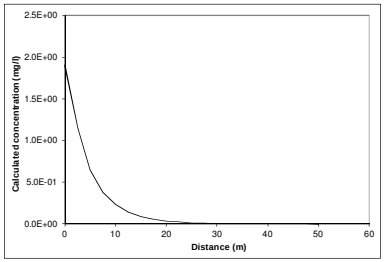
Entry if specify partition coefficient (option)			
Soil water partition coefficient	Kd		l/kg
Entry for non-polar organic chemicals (option)			
Fraction of organic carbon in aquifer	foc	1.00E-03	fraction
Organic carbon partition coefficient	Koc	6.76E+01	l/kg
Entry for ionic organic chemicals (option)			
Sorption coefficient for related species	$K_{oc,n}$		l/kg
Sorption coefficient for ionised species	$K_{oc,i}$		l/kg
pH value	pH		
acid dissociation constant	pKa		
Fraction of organic carbon in aquifer	foc		fraction
Soil water partition coefficient	Kd	6.76E-02	l/kg

Define dispersivity (click brown cell and use pull down list)

Dispersivities 10%, 1%, 0.1% of pathway length

		Enter value	Calc value	Xu & Eckstein	
Longitudinal dispersivity	ax	1.00E+01	5.00E+00	2.98E+00	m
Transverse dispersivity	az	1.00E+00	5.00E-01	2.98E-01	m
Vertical dispersivity	ay	9.90E-98	5.00E-02	2.98E-02	

For calculated value, assumes ax = 0.1 *x, az = 0.01 * x, ay = 0.001 * x
Xu & Eckstein (1995) report ax = $0.83(\log_{10}x)^{2.414}$; az = ax/10, ay = ax/100 are assumed



Note graph assumes plume disperses vertically in one direction only. An alternative solution assuming the centre of the plume is located at the mid-depth of the aquifer is presented in the calculation sheets.

Note

This sheet calculates the Level 3 remedial target for groundwater, based on the distance to the receptor or compliance located down hydraulic gradient of the source Three solution methods are included, the preferred option is Ogata Banks.

By setting a long travel time it will give the steady state solution, which should be used to calculate remedial targets.

The measured groundwater concentration should be compared with the Level 3 remedial target to determine the need for further action.

Note if contaminant is not subject to first order degradation, then set half life as 9.0E+99.

This worksheet should be used if pollutant transport and degradation is best described by a first order reaction. If degradation is best desribed by an electron limited degradation such as oxidation by O2, NO3, SO4 etc than the separate Corona Solution spreadsheet should be used

Site being assessed:	Broadway PFS
Completed by:	Ross Smith
Date:	15/06/2015
Version:	1.01

Calculated concentrations for distance-concentration graph

Ogata Banks
From calculation sheet

Distance	Concentration
	mg/l
0	1.9E+00
2.5	1.14E+00
5.0	6.45E-01
7.5	3.79E-01
10.0	2.29E-01
12.5	1.41E-01
15.0	8.78E-02
17.5	5.51E-02
20.0	3.48E-02
22.5	2.21E-02
25.0	1.41E-02
27.5	9.03E-03
30.0	5.80E-03
32.5	3.73E-03
35.0	2.41E-03
37.5	1.56E-03
40.0	1.01E-03
42.5	6.57E-04
45.0	4.28E-04
47.5	2.79E-04
50.0	1.82E-04

APPENDIX K

Example Method Statement for Construction Workers Encountering Unexpected Contamination

METHOD STATEMENT

ACTIONS TO BE TAKEN IN THE EVENT OF DISCOVERING UNEXPECTED CONTAMINATION DURING INTRUSIVE GROUNDWORKS

If at any point during intrusive groundworks at a site, evidence of unforeseen contamination is encountered in the form of significant noxious odours, discolouration, or instability within soils or sheen / discolouration in groundwater, the following actions will be taken:

- Intrusive works in the immediate area of the impacted ground will be suspended and the continuation of work in other areas of the site will be considered within the context of the site specific health & safety plan.
- Environmental Protection Strategies Ltd (EPS) will be contacted and appraised of the situation so that arrangements can be made to characterise the impact and determine what action may be necessary in addition to the scheduled site works. Where possible / health & safety plan permits, digital photographs of the impacted ground will be taken and emailed to EPS at the address below to assist in the initial assessment.
- It may well be necessary for EPS to attend site to undertake visual inspection and obtain samples for field and/or laboratory analysis, although the actions taken will be dependent on the nature of what is encountered.
- In cases where EPS consider the unforeseen contamination likely to pose a significant risk of significant harm to adjacent site users or local environmental receptors, the local authority and the Environment Agency will be informed of the situation and the actions being taken.
- Once appropriate action has been agreed and undertaken a written summary will be produced by EPS for submission to the Local Authority (and where relevant, the Environment Agency) in accordance with planning requirements. The submission will include details of work undertaken, analytical results of investigative and validation samples obtained and conclusions and recommendations for any further actions considered necessary.
- Where regulatory bodies have been involved, site works should only recommence following their agreement and in all cases should only recommence when the site manager considers it safe to do so within the context of the site specific health & safety plan.

EPS Contact Details:

Principal Contact	Giles Lock	Director	Tel: 0781 253 9656
Secondary Contact	Will Evans	Director	Tel: 0781 253 9655

Email: info@epstrategies.co.uk (automatically forwarded to both of the above and office based personnel)