

**Supplementary Sampling Report
Former Broadway PFS
Crowland
Lincolnshire
PE6 0BH**

Prepared for:

**Mr Ian Ladds
Church Farm
Church Street
Northborough
Peterborough
PE6 9BN**

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Author: **Reviewed / Authorised:**



Thomas Jones
Senior Consultant



Will Evans
Director



Your specialists on the ground

7B Caxton House
Broad Street
Cambourne
Cambridge CB23 6JN

T +44 (0) 1954 710666
F +44 (0) 1954 710677
E info@epstrategies.co.uk
W www.epstrategies.co.uk

FORMER BROADWAY PFS, CROWLAND

NON TECHNICAL SUMMARY

This report presents the findings of a Phase II Ground Investigation which was undertaken to identify the presence, nature and extent of contaminants arising from potential sources of contamination at the site, and to make appropriate recommendations for foundation design. Pertinent findings and conclusions are summarised as follows:

- This investigation included the sampling of seven existing groundwater monitoring wells and submission of the groundwater samples for laboratory analysis. Seven trial pits were also excavated across the site to inspect ground conditions and to identify if any of the former underground fuel storage tanks were still present at the site.
- The ground was found to comprise predominantly of sandy Made Ground with fragments of brick and concrete, underlain by natural ground of Abbey Sands and Gravels and then Oxford Clay beyond a depth of 3.0m below the surface. Groundwater was measured within the monitoring wells at depths of around 1m below the surface.
- No underground tanks were identified by the trial pits, however some black and grey staining in the soils below 1m depth was noted in several of the trial pits, with some occasional hydrocarbon odour and the water that seeped into some of the trial pits showed evidence of hydrocarbon contamination (odour).
- In the groundwater samples tested, relevant risk screening criteria were exceeded for a number of hydrocarbon contaminants including Benzene and Xylene compounds at a few of the sampling locations, however, the concentrations identified are generally significantly lower than those identified during the last groundwater sampling in 2008.
- EPS has recommended that a detailed site-specific assessment of the risk posed to surrounding controlled waters be undertaken to confirm whether any remedial action to improve the quality of the groundwater is required. Also, shallow soil samples should be collected from unsaturated soils to determine if it is necessary to protect the health of future site users although some control measures have been recommended in the absence of these data.

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 contained within the following report, or discussion with EPS is recommended.

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1 INTRODUCTION

In February 2014, Environmental Protection Strategies Ltd (EPS) was commissioned by Mr Ian Ladds to complete supplementary groundwater sampling at the Former Broadway PFS, Crowland, Lincolnshire, PE6 0BH ('the site'); see Figure 1. Selected site photographs are included as Appendix A.

This report presents a summary of the environmental assessment reports previously undertaken at the site and the findings of the supplementary sampling undertaken by EPS in February 2014.

Pre-application proposals for the site include the redevelopment of the site as residential properties. An indicative proposed development plan is included as Appendix B.

1.1 Objectives

The objectives of this investigation were as follows:

- a) To determine the current condition of the groundwater and soils at the site, particularly in comparison to the last groundwater testing undertaken in November 2008
- b) To determine the potential risks posed by the site and make recommendations for any further work that may be required, to ensure safe development in accordance with the Model Procedures for the Management of Land Contamination - Contaminated Land Report 11.

1.2 Scope of Work

To perform an exploratory assessment of the site in accordance with the principles and requirements of DEFRA Circular 01/2006, BS10175 – 'Investigation of Potentially Contaminated Sites', the following tasks were undertaken:

Site Work:

- Site walkover, inspection of any visual evidence of contamination at the site, obtaining photographic records.
- Health and safety briefing / site supervision.
- Sampling of groundwater from seven existing on-site groundwater monitoring wells and submission of groundwater samples for laboratory testing.
- Excavation of trial pits to a maximum depth of 3.0m below ground level (bgl) at seven locations across the site at selected locations.
- Continual logging of ground conditions including inspection of samples for any visual and olfactory contamination.

Reporting:

- Data collection and interpretation.
- Reporting.

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

1.3 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 the contaminants 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 localised ground controls could influence the spread of contaminants within the site subsurface. For this reason it is possible that samples collected during the investigation may not represent the conditions across the entire site.

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.

Whilst it is recognised that information contained within this report may assist relevant and suitably qualified professionals, this report does not provide a geotechnical appraisal of ground conditions with respect to suitability of foundations or future structures nor does it intend to identify a need for any associated geotechnical ground improvement works.

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.

If third parties have been contracted / consulted during compilation of this report, the validity of any data they may have supplied, and which are included in the report, have been assessed as far as possible by EPS, however, EPS cannot guarantee the validity of these data.

The report has been prepared for the client(s) listed on the report title page and has been subject to standard internal EPS review procedures. EPS accepts no liability or responsibility for use of, or reliance upon, this report and / or the information contained within it by third parties.

No part of this report, or references to it, may be included in published documents of any kind without approval from EPS.

This report and its contents, together with any supporting correspondence or other documentation, remain the property of Environmental Protection Strategies Ltd until paid for in full.

2 SUMMARY OF PREVIOUS REPORTS

Several intrusive investigations have been undertaken at the site between 2000 and 2008. Unfortunately, only a summary of the previous reports assembled by Applied Geology has been available to review for this report. A summary of the available information is provided below:

- The previous reports issued for the site indicate that several relatively small underground tanks, used to store either petrol, diesel or waste oils, were previously present in the northern end and central area of the site. These tanks were associated with the site's historic use as a petrol filling station and are believed to have been decommissioned and removed from the site in June 2003.
- In 2000, 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. 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 the underground tanks at the site with the excavations in-filled with inert materials. JP Chick also excavated four trial pits in the surrounding soils to determine the condition of the surrounding soils. Samples of the groundwater encountered within three of the trial pits and two existing groundwater boreholes located on residential properties directly west of the site were also sent for laboratory testing.
- In March 2008, Applied Geology attended the site to excavate several trial pits across the site and to install six on-site groundwater monitoring wells (BHA-F). In May 2008, Ground Engineering installed one additional deeper ground monitoring well at the site (BH1A). JP Chick & Partners Ltd subsequently undertook some groundwater testing of the seven on-site monitoring wells in June 2008 which identified elevated concentrations of hydrocarbons in several monitoring wells across the site, in particular BH1A situated in the central area of the site.
- The monitoring wells were subsequently tested again in November 2008 by Applied Geology, the results of 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.

Copies of the available reviewed sections of the previous reports regarding the site are presented as Appendix C of this report.

3 SUMMARY OF INTRUSIVE INVESTIGATIONS

The intrusive investigation was undertaken on the 7th February 2014 in accordance with EPS standard operating procedures, copies of which will be made available on request. A summary of the fieldworks is presented in the following sections:

3.1 Trial Pit Locations

Trial pit locations were selected through the findings of the previous reports as summarised in Section 2.2 above, the current locations of the on-site groundwater monitoring wells and the location of existing on-site buried utilities.

A total of seven trial pits (TP1-7) were excavated in order to assess the nature and quality of underlying soils to depths of up to 3.0m below ground level (bgl) using a motorised excavator. The overall objective in terms of trial pit location was to determine the current condition of the ground underlying the site.

The trial pits were excavated in accordance with standard EPS drilling methodologies, and subcontractors were supervised at all times by an EPS engineer. A detailed plan showing the locations of the trial pits excavated during the investigation is presented as Figure 2.

3.2 Soil Sampling

Each trial pit 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. The objectives for the trial pit work were to determine if any buried tanks remained at the site and to check that unsaturated made ground materials used to reinstate the site after the previous tanks were removed, were not grossly contaminated. EPS was not instructed to collect soil samples for laboratory testing during this investigation.

3.3 Groundwater Sampling

Groundwater samples were obtained from seven on-site groundwater monitoring wells (BHA-F & BH1A) which were installed during previous intrusive investigations undertaken at the site. A detailed plan showing the locations of the monitoring wells sampled during the investigation is presented as Figure 2.

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.

3.4 Organic Vapour & Soil Gas Monitoring

The presence of organic vapours within soil samples collected by EPS was monitored at site by placing soil samples into sealed bags, the 'headspace' in the bag was then pierced using the tip of a Photo-ionisation Detector (PID) to measure the concentration of total organic volatiles.

3.5 Laboratory Analysis

All groundwater samples obtained for analysis of identified contaminants of concern were submitted to Chemtest Ltd of Newmarket, who hold appropriate UKAS / MCERT accreditation for the required testing. Samples were transported in laboratory supplied containers and delivered to the laboratory by an EPS engineer.

Copies of chain of custody documentation are held by EPS and will be made available on request.

4 FINDINGS

This section of the report provides a summary of the findings of the various aspects of the ground investigation.

4.1 Site Description

The site is currently a disused area of predominantly undeveloped land which is surrounded to the south, east and west by residential properties. Directly to the north is a road, Broadway, from which the site is accessed, while an off-site metal aboveground storage tank was observed adjacent to the eastern edge of the site. It is unknown if this tank is currently in use, but it is believed likely to have at some point used to store domestic heating oil (Kerosene).

The surface of the site is comprised predominantly of open ground, which appears from the surface to be made ground with a few small plants growing across the surface. A small stretch of asphalt hardstanding leading from the entrance of the site is situated in the north-eastern corner. Located at the southern end of the site is the concrete frame of a row of garages, a small disused bungalow and the remains of a small caravan. Located in one of the garages was a pile of concrete roof sheets. Seven groundwater monitoring wells with metal covers were located across the site.

No visible signs of underground utilities or underground / aboveground tanks were observed at the site, however, based upon the previous reports undertaken at the site and anecdotal evidence from the site owner, it is believed that the site has been historically used as a petrol station and a few underground tanks were removed from the site in 2003.

4.2 Ground Conditions

A total of seven trial pits were excavated across the site and the ground conditions encountered during these works may be briefly summarised as follows:

TP2-4, TP6

Max Depth to Base of Strata(m bgl)	Strata Thickness Range (m)	General Description of Geology
1.0	0.4 - 1.0	MADE GROUND: Fine to coarse sand and gravels with fragments of brick and occasional concrete fragments.
2.6	1.6 – 2.0	Orange-brown or black-stained fine to coarse SAND and GRAVEL (Abbey Sand and Gravels).
>3.0	>0.4 - >0.6	Grey silty CLAY (Oxford Clay).

TP1 & TP5

Max Depth to Base of Strata(m bgl)	Strata Thickness (m)	General Description of Geology
2.5	2.4-2.5	MADE GROUND: Fine to coarse sand and gravels with fragments of brick and occasional concrete fragments.
>3.0	>0.5 - >0.6	Grey silty CLAY (Oxford Clay)

TP7

Max Depth to Base of Strata(m bgl)	Strata Thickness (m)	General Description of Geology
1.2	1.2	MADE GROUND: Fine to coarse sand and gravels.
2.5	1.3	Black sandy gravelly organic CLAY
>2.6	>0.1	Grey silty CLAY (Oxford Clay)

4.2.1 Made Ground

Made ground comprised of fine to coarse sand and gravels with some fragments of brick and concrete occasionally present. This was encountered across the near surface of the site, extending to depths ranging between 0.4m (TP2 & TP4) up to a maximum depth of 2.5m (TP1). The layer of made ground was particularly thicker in trial pits TP1 and TP5, which were excavated at the believed former locations of the underground tanks at the site.

4.2.2 Abbey Sand and Gravels

Natural ground comprised of fine to coarse sand and gravels were encountered underlying the made ground across the majority of the site, except for in trial pits TP1, TP5 and TP7. The sands and gravels extended up to a maximum depth of 2.6m (TP3) and were either orange brown in colour or black stained, presumably caused by the hydrocarbon contamination identified in the groundwater at the site.

4.2.3 Oxford Clay

Grey silty clay, believed to be the Oxford Clay, was encountered within all trial pits except TP6 at depths ranging between 2.4m and 2.6m.

Site specific trial pit logs are included as Appendix D.

4.3 Physical Evidence of Contamination and Field Analyses

No evidence of residual underground fuel tanks or associated pipework were encountered during the trial pit investigation. Inspection of the shallow unsaturated made ground found materials that were visually free of hydrocarbon contamination but, as described in Section 4.2.1 above, fragments of brick and concrete were noted. Black and grey staining of the soils was noted in trial pits TP1-3 and TP5 from between 1m and 3m below ground level (bgl), with slightly odorous contaminated groundwater observed flowing into trial pits TP1-3, TP5 and TP7.

Headspace analysis by PID reported relatively low concentrations of organic vapour across the site for some tested soil samples which ranged between 6ppmV (TP7 1.0-2.0m) up to a maximum of 98ppmV (TP2 2.0-3.0m). Results of headspace testing are included as Table 2.

4.4 Groundwater

Groundwater was encountered within all of the onsite trial pits except TP6, with varying volumes of groundwater seepage entering the sides of the trial pits at depths ranging between 2.2m to 2.5m bgl.

Groundwater was encountered within all of the on-site monitoring wells at depths ranging between 0.929m (BHD) and 1.100m (BHA). Based on the elevations of the monitoring wells, groundwater is believed to flow in a generally south westerly direction although the slight change in groundwater elevations indicates that groundwater flow may be variable at the site depending upon several factors, which may include rainfall, influence from neighbouring abstractions when used to water the gardens and, potentially, local land drainage.

Groundwater monitoring data are included as Table 3.

4.5 Laboratory Analysis - Groundwater

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

The significant results of laboratory testing of groundwater samples are summarised as follows:

Contaminant	No. of Samples	No of Detections	Range of Detections (µg/l)		Highest Location
			Min	Max	
TPH	7	4	34	1000	BH1A
Benzene	7	4	40	560	BH1A
Toluene	7	3	6.5	28	BH1A
Ethyl-Benzene	7	2	6.4	120	BHD
Xylenes	7	3	15.5	64	BHD
MTBE	7	3	11	24	BH1A

Note: - = Contaminant not found above laboratory detection limits

- Detectable concentrations of TPH were encountered within groundwater samples obtained from four sampling locations ranging from 34µg/l (BHF) to 1000µg/l (BH1A).
- The TPH compounds detected in monitoring wells BHC, BHF and BH1A were comprised predominantly of hydrocarbons ranging between carbon groups C5 to C8, while the hydrocarbons identified at monitoring well BHD ranged predominantly between carbon groups C8 to C12.
- Detectable concentrations of Benzene were identified in four of the groundwater samples obtained from the site, ranging from 40µg/l (BHD) to 560µg/l (BH1A).
- Detectable concentrations of Toluene were identified in three of the groundwater samples obtained from the site, ranging from 6.5µg/l (BHD) to 28µg/l (BH1A).
- Detectable concentrations of Xylenes were identified in three of the groundwater samples obtained from the site, ranging from 15.5µg/l (BHC) to 64µg/l (BHD).
- Detectable concentrations of MTBE were detected in the groundwater samples obtained from three sampling locations, ranging from 11µg/l (BHC) to 24µg/l (BH1A). In the only other groundwater sample obtained from the site where hydrocarbon contamination was also identified (BHD); no detectable concentration of MTBE was present.

No detectable concentrations of TPH, BTEX or MTBE compounds were detected in the groundwater samples obtained from monitoring wells BHA, BHB and BHE

5 TIER 1 QUALITATIVE RISK ASSESSMENT

5.1 Tier 1 Screening – Generic Assessment Criteria (GAC)

In order to screen laboratory data for concentrations of contaminants in soil with potential to cause harm to human health at a residential setting, UK Soil Guideline Values (SGVs) and 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
- Generic Assessment Criteria for Human Health Risk Assessment – LQM and CIEH 2nd edition (2009).

For concentrations of Lead in soil, there are currently no published human health screening criteria available and EPS has used the previously withdrawn SGV for lead as an appropriate guide for professional judgement with respect to reasonable ‘minimal risk’ levels in the context of this site.

In addition to screening the concentrations of contaminant in soil for risks to human health, EPS has also screened the concentrations for potential to cause harm to water resources. The criteria used for this process were derived by EPS using the following technical guidance:

- Environment Agency Remedial Targets Methodology: Hydrogeological Risk Assessment for Land Contamination.

EPS has also screened the reported groundwater concentrations at an initial Tier 1 level for potential to cause harm to controlled waters within the local area. The criteria used for this process has been taken as follows:

Resource Sensitivity of Area	Basis of Tier 1 Criteria
High Groundwater Resource Potential (HGwRP) - Principal aquifers	UK Drinking Water Standards (UKDWS)
Low Groundwater Resource Potential (LGwRP) - Secondary aquifers not being abstracted and Un-productive groundwater strata	UK Environmental Quality Standards (EQS)

Tier 1 Risk Screening criteria for Low Groundwater Resource Potential have been adopted for this site given the presence of the underlying secondary aquifer which is abstracted locally by neighbouring properties for garden irrigation.

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

5.2 Assessment of Soil Results

The EPS brief for investigation of soil quality at the site during this investigation was to determine if any obvious hydrocarbon contamination was present within unsaturated soils and it was not instructed to carry out soil sampling. For this reason it is not possible to measure the potential risk to human health of groundwater from any potential contaminants within made up ground.

Although no palpable evidence of hydrocarbon contamination from petrol or diesel was identified in soil located above the level of groundwater during the investigation, (approximately 1m bgl), made up ground did contain fragments of brick and concrete, which may be indicative of other potential contaminants. Whilst routine protection measures could be advised for construction workers on the assumption that soils do contain contaminants, further assessment should be carried out to determine if plausible pollutant linkages relating to the health of future site residents will be needed.

5.3 Assessment of Groundwater Results

The results of the screening process for on-site human receptors show that Generic Assessment Criteria, representative of minimal risk values for controlled waters were exceeded for aromatic hydrocarbon compounds ranging between C8 to C12 at sampling location BHD. The concentrations of aromatic hydrocarbons ranging between C5-C7 and C10-C16 also exceeded the relevant Tier 1 screening criteria values at sampling location BH1A.

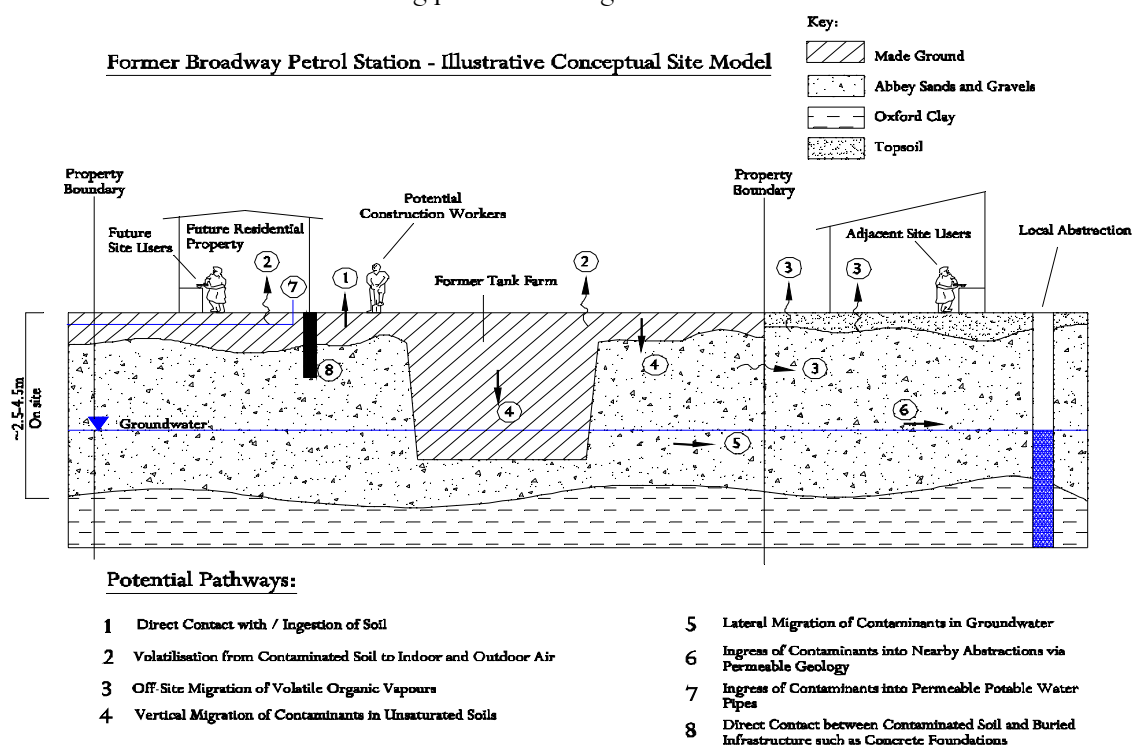
The concentration of Benzene detected at sampling locations BHC, BHD, BHF and BH1A exceeded the relevant Tier 1 screening criteria values, as did the concentration of Xylene compounds identified at BHD and BH1A. No other exceedances of the relevant screening values by contaminants of concern were identified at the site.

6 REVISED CONCEPTUAL MODEL

On the basis of the findings in this and previous investigations at the site, the following pollutant linkages are considered as warranting further action or control measures to ensure they do not become active as a result of the proposed development:

Source	Pathway	Receptor
Contaminated Soil	Ingestion of soil through direct contact, eating or smoking with dirty hands	Construction workers & site users
Contaminated Soil	Direct Contact, inadvertent ingestion and inhalation of fugitive dusts	Site users
Contaminated Soil	Direct contact	Buried infrastructure
Contaminated Soil	Permeation of organic compounds into potable water supply.	Site users
Contaminated Soil / Groundwater	Volatilisation of contaminants to indoor and outdoor air.	Site users & adjacent site users
Contaminated groundwater	Lateral migration through permeable geology	Groundwater resources

The following diagram provides a schematic representation of the conceptual site model, which includes detail of the above remaining pollutant linkages:



7 CONCLUSIONS & RECOMMENDATIONS

The supplementary groundwater sampling has identified that the hydrocarbon contamination has decreased notably across nearly the entire site since the previous groundwater sampling undertaken in November 2008, but it is still present at concentrations which could pose a potential risk to water resources in the surrounding area.

On this basis EPS recommends carrying out a more detailed site-specific assessment of the risk posed to surrounding controlled waters to confirm whether remedial actions are required to reduce the dissolved contaminant impacts.

In terms of the risk to human health, areas of in-filled ground have been identified across the site where former underground tanks were believed to have been present but subsequently removed and the excavations reinstated. Whilst EPS found no evidence of obvious hydrocarbon contamination in unsaturated soils, it is feasible that the fill used to reinstate the area after the tanks were removed does contain contaminants that would make the ground unsuitable for use in context with the proposed residential development on the property.

It is therefore also feasible that some of the potential pollutant linkages associated with human health such as those relating to construction workers involved with redevelopment work, vapours emanating from contaminants dissolved in groundwater, and diffusion of contaminants into potable water supplies in buried drinking water pipes could be dealt with by means of precautionary control measures in the absence of supporting data. However, without data to rely upon it is not clear if all of these would be necessary, or if they go far enough to control risks. For example, the depth and construction of any clean topsoil cover system in proposed areas of soft landscaping or residential gardens needed to protect the long term health of future residents should only be determined by means of shallow soil sampling.

On this basis, EPS recommends that shallow soil samples are collected from proposed garden areas at the site and submitted to a laboratory for analysis of metals, TPH and PAH compounds. Depending upon the results of these investigations, it may then be necessary to include the following controls during development of the property to break potential linkages associated with risks to human health:

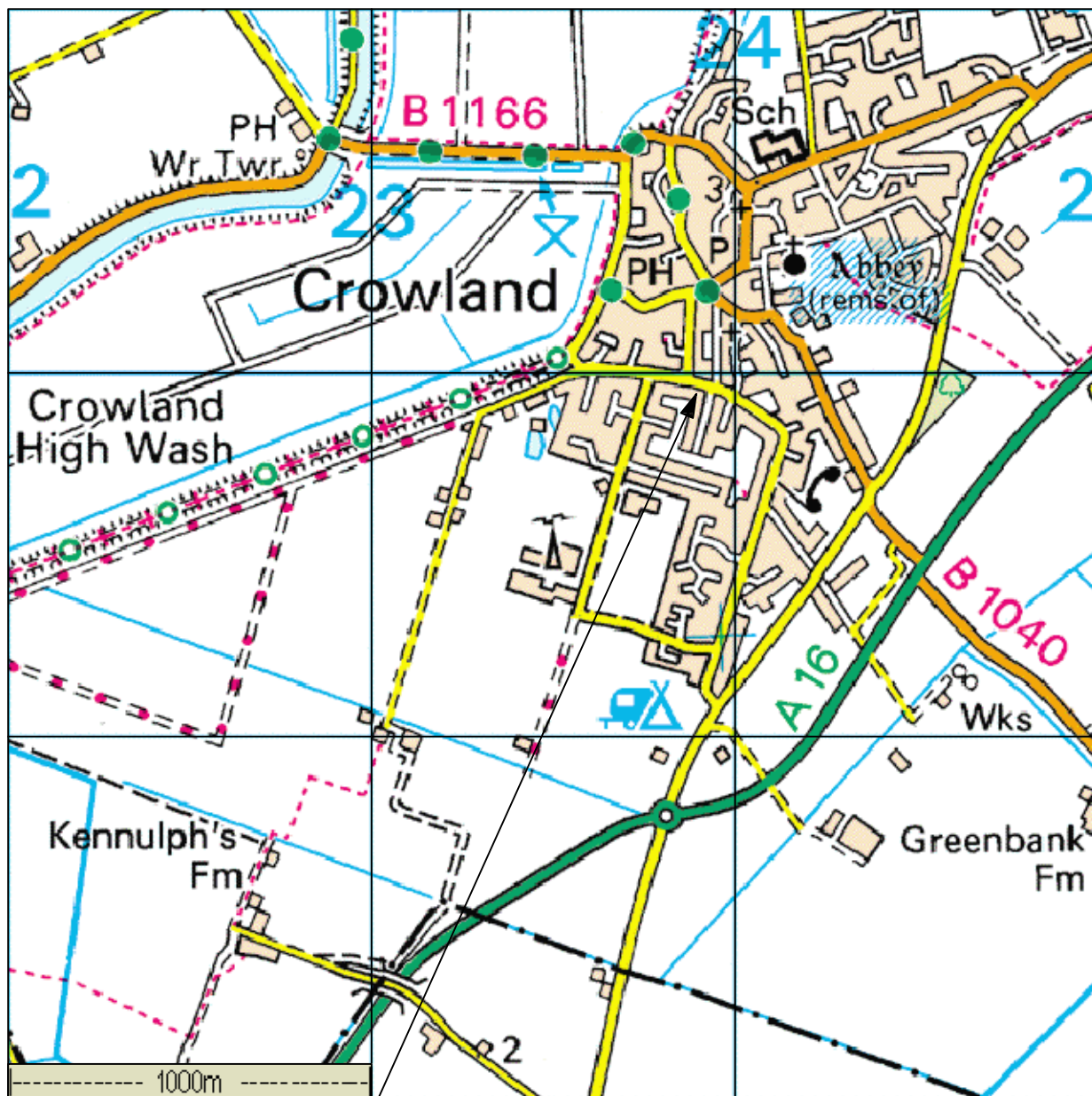
- a) To prevent any ingress of hydrocarbon vapours into the proposed residential buildings from groundwater, a proprietary gas and vapour resistant membrane will need to be installed into the ground floor footprint of all buildings in order to resist the passage of volatile vapours into the living space above.
- b) In order to reduce potential risks associated with ingress of contaminants to underground water supply pipework, aluminium barrier pipework meeting Water Industry Standard 4-32-19, and associated fittings may need to 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).

- c) All construction workers operating at the site should be advised of the potential for contact with 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*.
- d) Any palpable evidence of unexpected contamination or underground tanks encountered during exposure of shallow soils beneath the site during redevelopment work should be reported to EPS so that an inspection can be made and appropriate sampling and assessment work carried out.

A specification for the type of vapour resistant membrane that may be required is attached as Appendix G of this document. Any membrane should be installed in accordance with manufacturer's instructions by suitably qualified and experienced personnel and subsequent integrity testing should be conducted by a third-party.

After any remedial works are carried out, they will need to be validated to demonstrate to regulators under planning that the work has been done to an appropriate standard. The validation work will include collection of soil samples from any garden areas, photographic evidence and certification of any vapour membrane installation work, which will need to be documented in a report for submission to the local Council on completion of the development.

FIGURES



Approximate Site Location

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Title: Site Location Plan

Project: Former Broadway PFS, Crowland

Client: Mr Ian Ladds

Fig No: 1

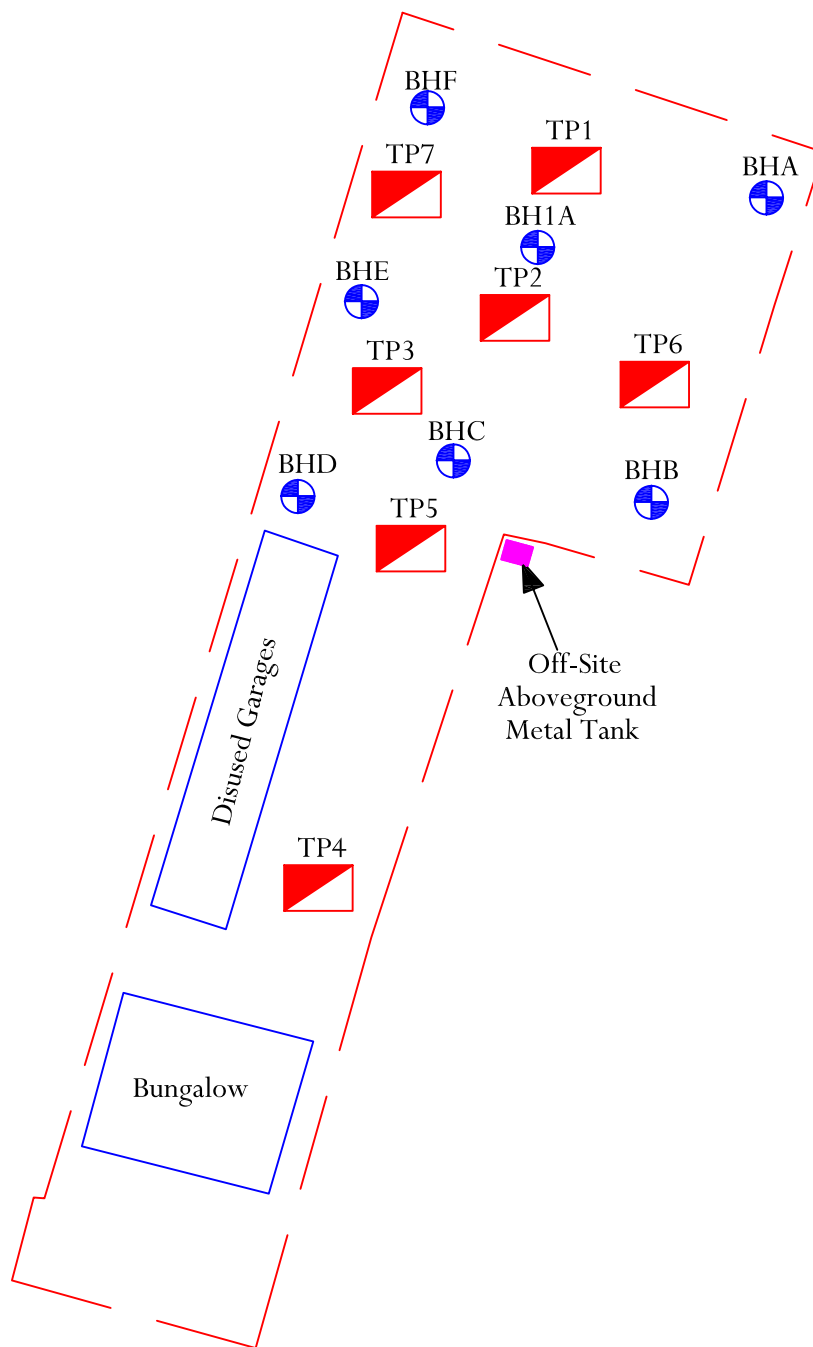
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Job No: UK14.1470

Dwg No: Ladds/Broadway/0214/01

Date: February 2014



Key



Approximate Groundwater
Monitoring Well Location



Approximate Trial Pit
Location



Approximate Site Boundary



Title: Groundwater Monitoring Well & Trial Pit Location Plan

Project: Former Broadway PFS, Crowland

Client: Mr Ian Ladds

Fig No: 2

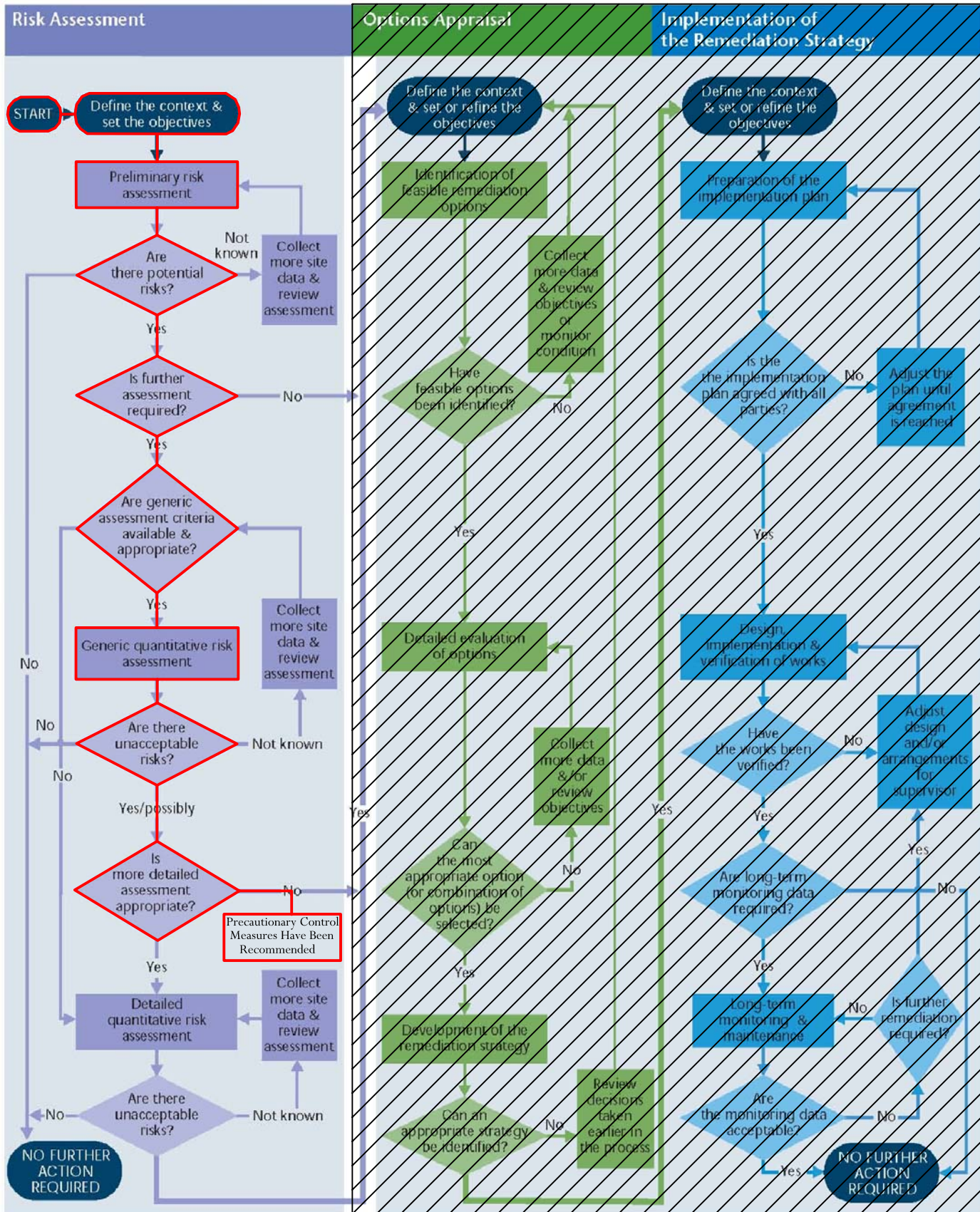
Scale: Not to Scale

Drawn By: TJ **Approved By:** WE

Job No: UK14.1470

Dwg No: Ladds/Broadway/0214/02

Date: February 2014



Assessment Pathway for Site



Title: Site Context - CLR11

Project: Former Broadway PFS, Crowland

Client: Mr Ian Ladds

Fig No: 3

Scale: n/a

Drawn By: TJ

Approved By: WE

Job No: UK14.1470

Dwg No: Ladds/Broadway/0214/3

Date: February 2014

TABLES

Table 1 – Laboratory Testing Schedule

Sample ID	Sample Depth (mbgl)	TPH	BTEX & MTBE
BHA (water)	n/a	1	1
BHB (water)	n/a	1	1
BHC (water)	n/a	1	1
BHD (water)	n/a	1	1
BHE (water)	n/a	1	1
BHF (water)	n/a	1	1
BH1A (water)	n/a	1	1

Notes

TPH	Total Petroleum Hydrocarbons
BTEX	Benzene, Toluene, Ethylbenzene & Xylenes
MTBE	Methyl Tert-Butyl Ether
1	Sample Taken
-	Sample Not Analysed

Table 2 – Headspace Analysis by PID

TP1		TP2	
Depth	ppmV	Depth	ppmV
0.5-1.0	<0.1	0.5-1.0	<0.1
1.0-2.0	28	1.0-2.0	42
2.0-3.0	85	2.0-3.0	98

TP3		TP4	
Depth	ppmV	Depth	ppmV
0.5-1.0	<0.1	0.5-1.0	<0.1
1.0-2.0	27	1.0-2.0	<0.1
2.0-3.0	83	2.0-3.0	<0.1

TP5		TP6	
Depth	ppmV	Depth	ppmV
0.5-1.0	<0.1	0.5-1.0	<0.1
1.0-2.0	12	1.0-2.0	<0.1
2.0-3.0	35	2.0-2.5	<0.1

TP7	
Depth	ppmV
0.5-1.0	<0.1
1.0-2.0	6
2.0-2.6	45

Notes

ppmV Parts Per Million Vapour
All depths metres below ground level.

Table 3 – Groundwater Monitoring Data

Borehole No.	Depth to Floating Product (mbgl)	Depth to Groundwater (mbgl)	Redox Potential (mV)	Dissolved Oxygen (mg/l)	pH	Temperature (°C)
BHA	n/a	1.1	4.04	4.04	6.73	8.26
BHB	n/a	0.991	46.20	1.44	6.08	9.66
BHC	n/a	1.089	-132.50	0.00	6.36	9.24
BHD	n/a	0.929	-115.40	0.00	6.16	9.18
BHE	n/a	0.965	77.10	4.11	6.09	8.59
BHF	n/a	1.22	-143.80	0.00	6.43	10.21
BH1A	n/a	1.088	-116.20	0.00	6.19	9.94

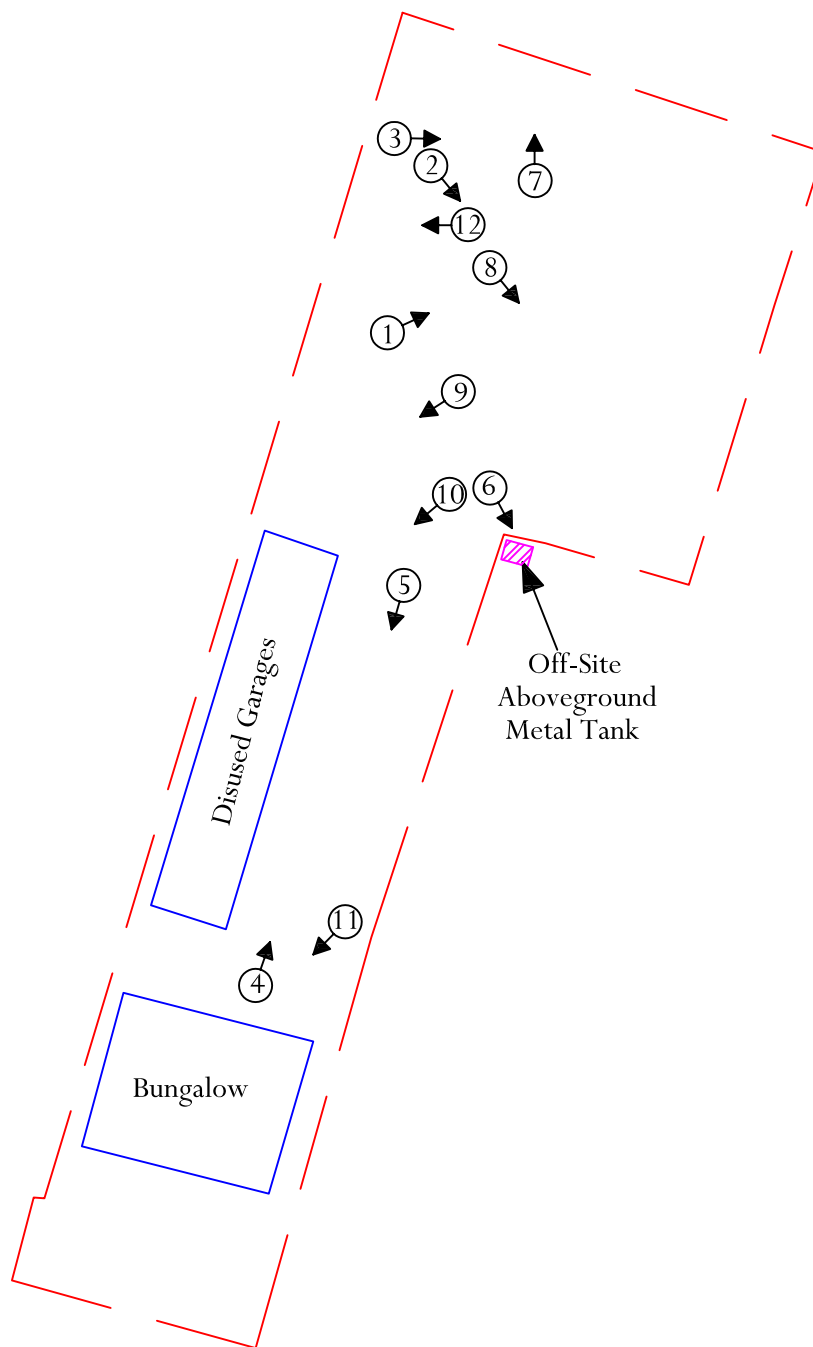
Notes

mbgl	Meters below ground level
mV	Millivolts
mg/l	Milligrams per litre
-	no data collected
n/a	Floating product not encountered

APPENDICES

APPENDIX A

Selected Site Photographs



Key



Approximate Photograph
Locations & Directions



Approximate Site Boundary



Title: Photograph Location Plan

Project: Former Broadway PFS, Crowland

Client: Mr Ian Ladds

Appendix No: A

Scale: Not to Scale

Drawn By: TJ **Approved By:** WE

Job No: UK14.1470

Dwg No: Ladds/Broadway/0214/A

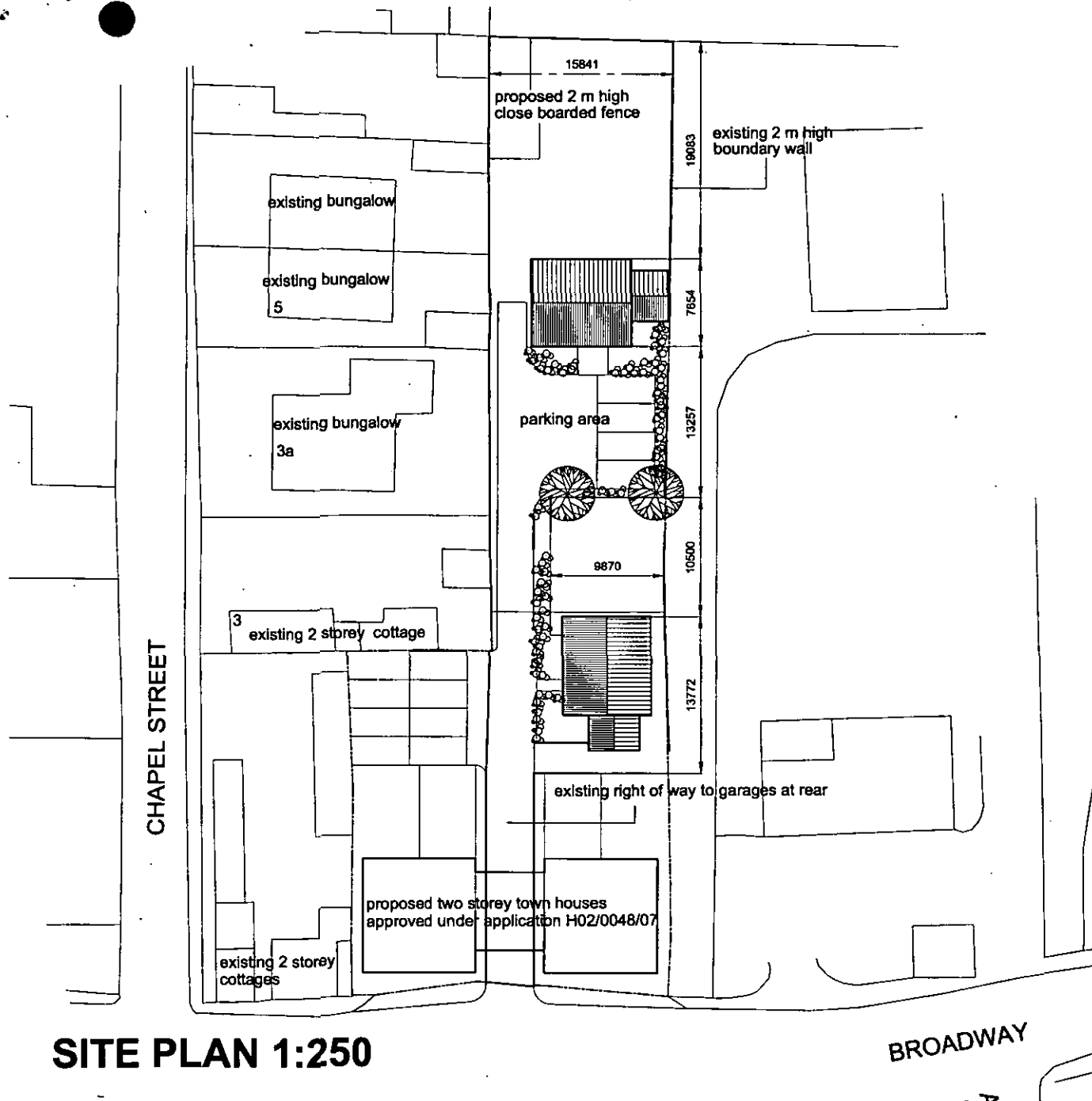
Date: February 2014

Photo 1: View looking northeast across the northern edge of the site	Photo 2: View looking southeast across the north-eastern corner of the site.
	
Photo 3: View looking east along the northern edge of the site.	Photo 4: View looking northeast across the site from the southern end.
	
Photo 5: View looking south-west across the southern end of the site.	Photo 6: View looking southeast across the location of the off-site aboveground storage tank located adjacent to the eastern edge of the site.
	

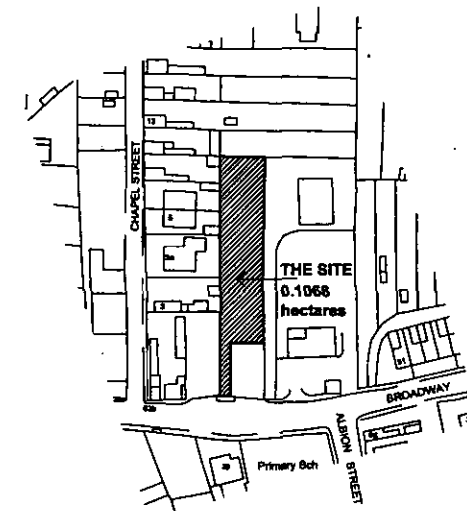
Photo 7: View looking into trial pit TP1.	Photo 8: View looking into trial pit TP2.
	
Photo 9: View looking into trial pit TP3.	Photo 10: View looking into trial pit TP5
	
Photo 11: View looking into trial pit TP4.	Photo 12: View looking into trial pit TP7.
	

APPENDIX B

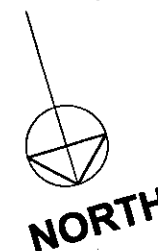
Proposed Development Plan



SITE PLAN 1:250



LOCATION PLAN 1:1250



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Scale 1:250 (1" = 31' 6")			
Date 22/04/2008			
Drawn T.A. CLAY			
Title PROPOSED RESIDENTIAL DEVELOPMENT AT REAR OF 59 TO 61 BROADWAY, CROWLAND FOR MR. P. LEO SITE AND LOCATION PLANS			
Drawing Number 00/084/PA/007			Sheet A

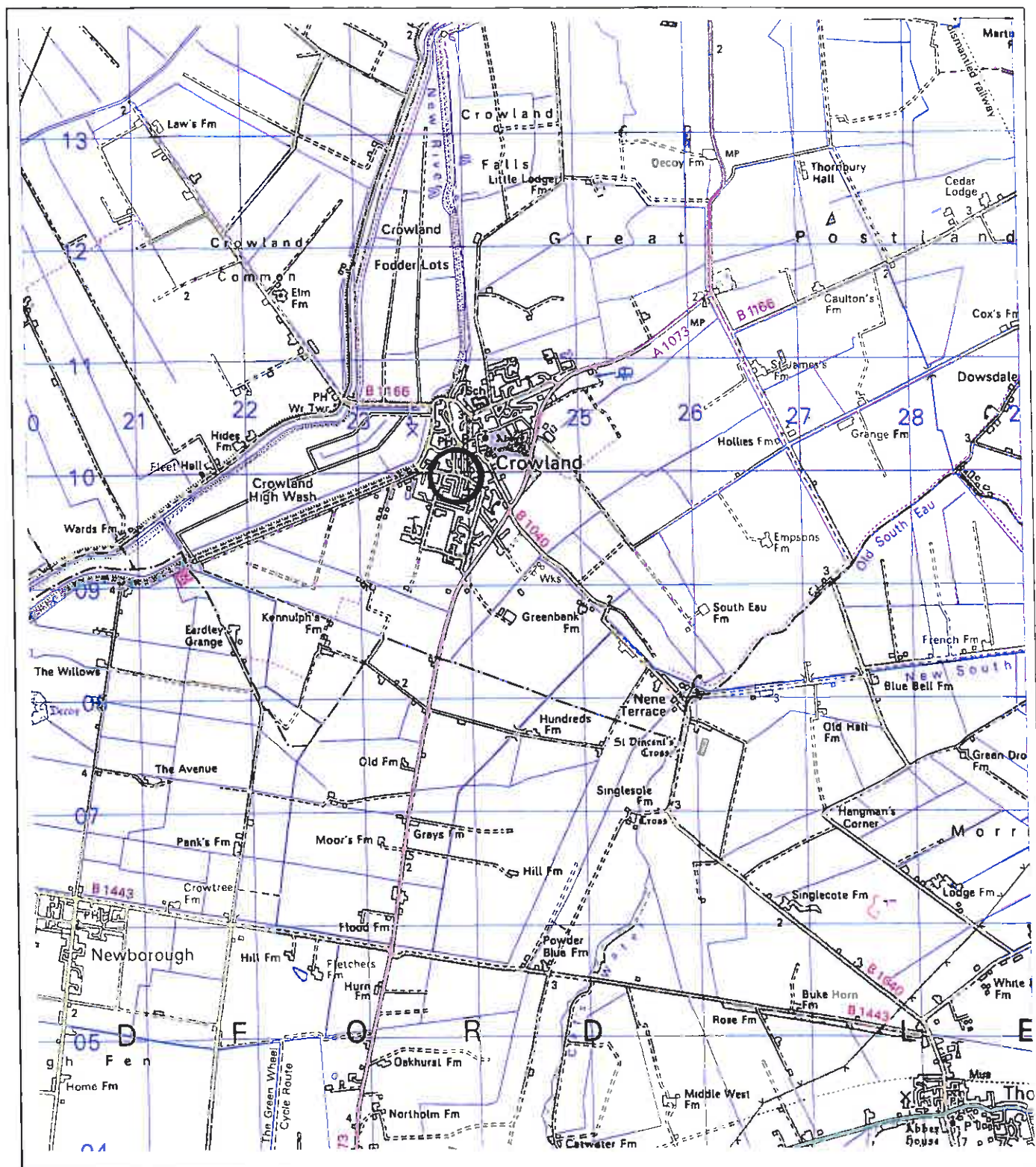
APPENDIX C

Previous Site Investigation Report Summary

Site Location Plan
Proposed Development Plans
Topographic Survey
Site Investigation Summary Plans
Monitoring Results
Remediation Extent and Volume Calculation

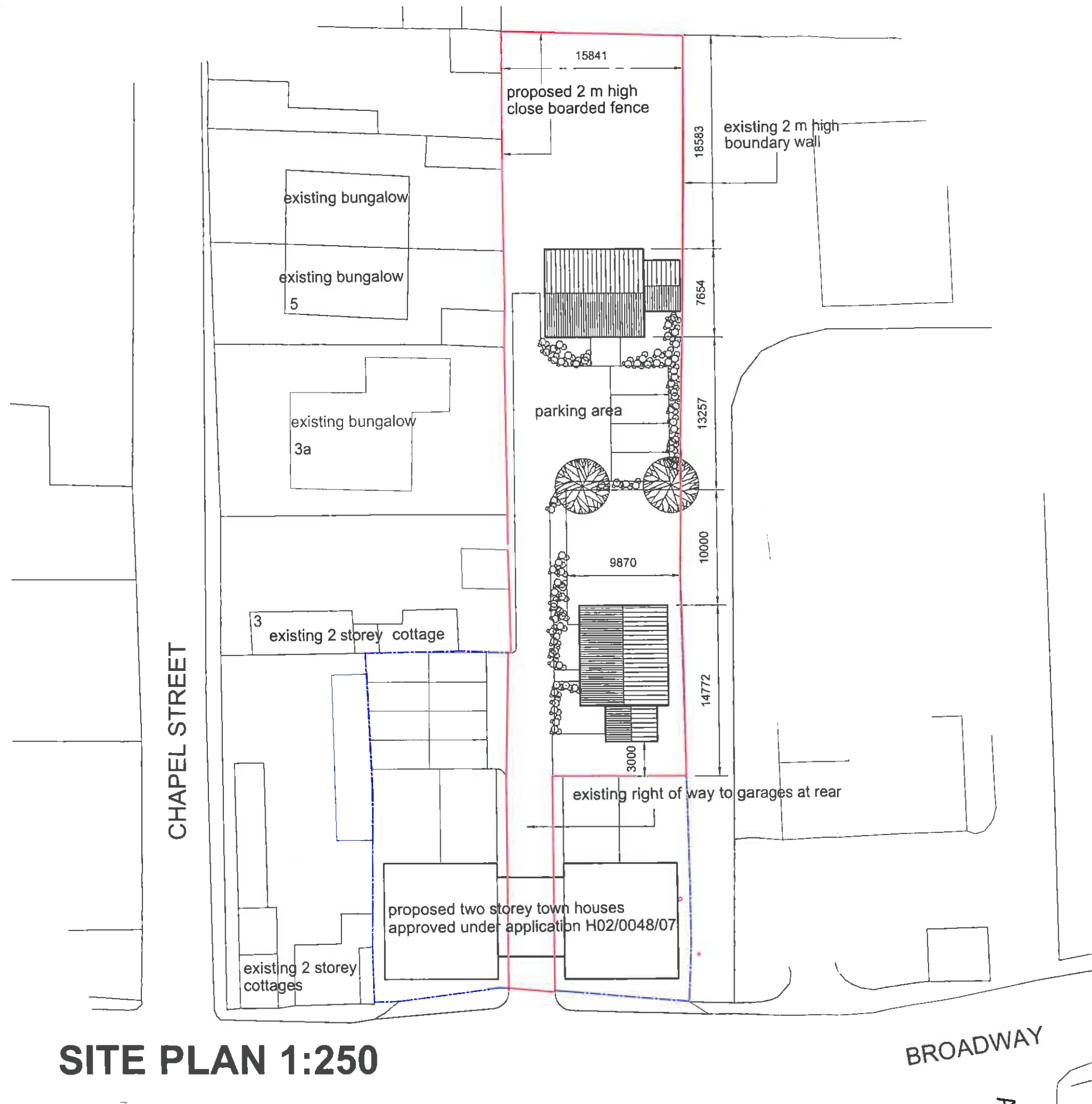
DATASHEET

Project No: **AG1031**

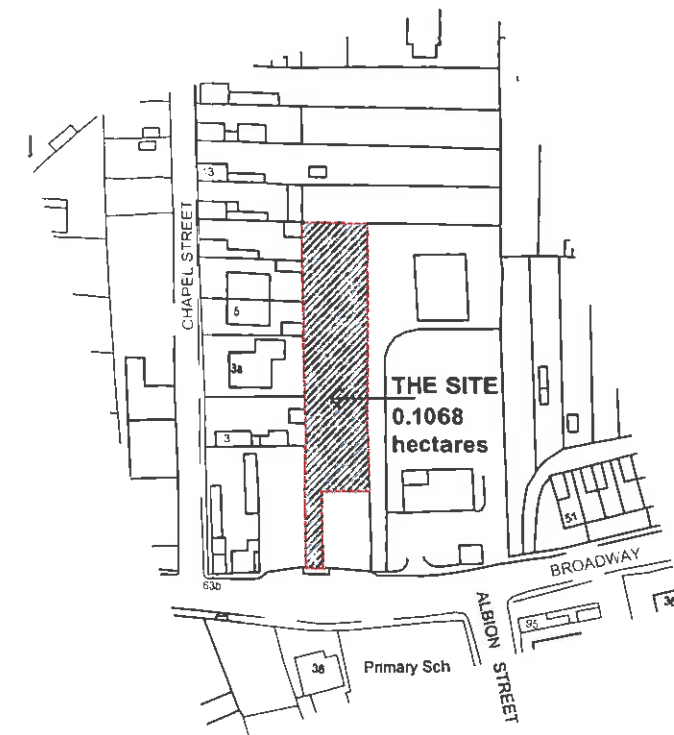


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SITE PLAN 1:250



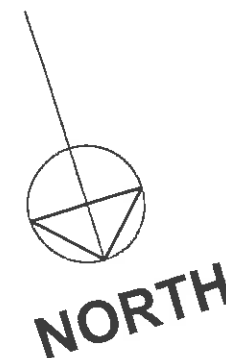
LOCATION PLAN 1:1250



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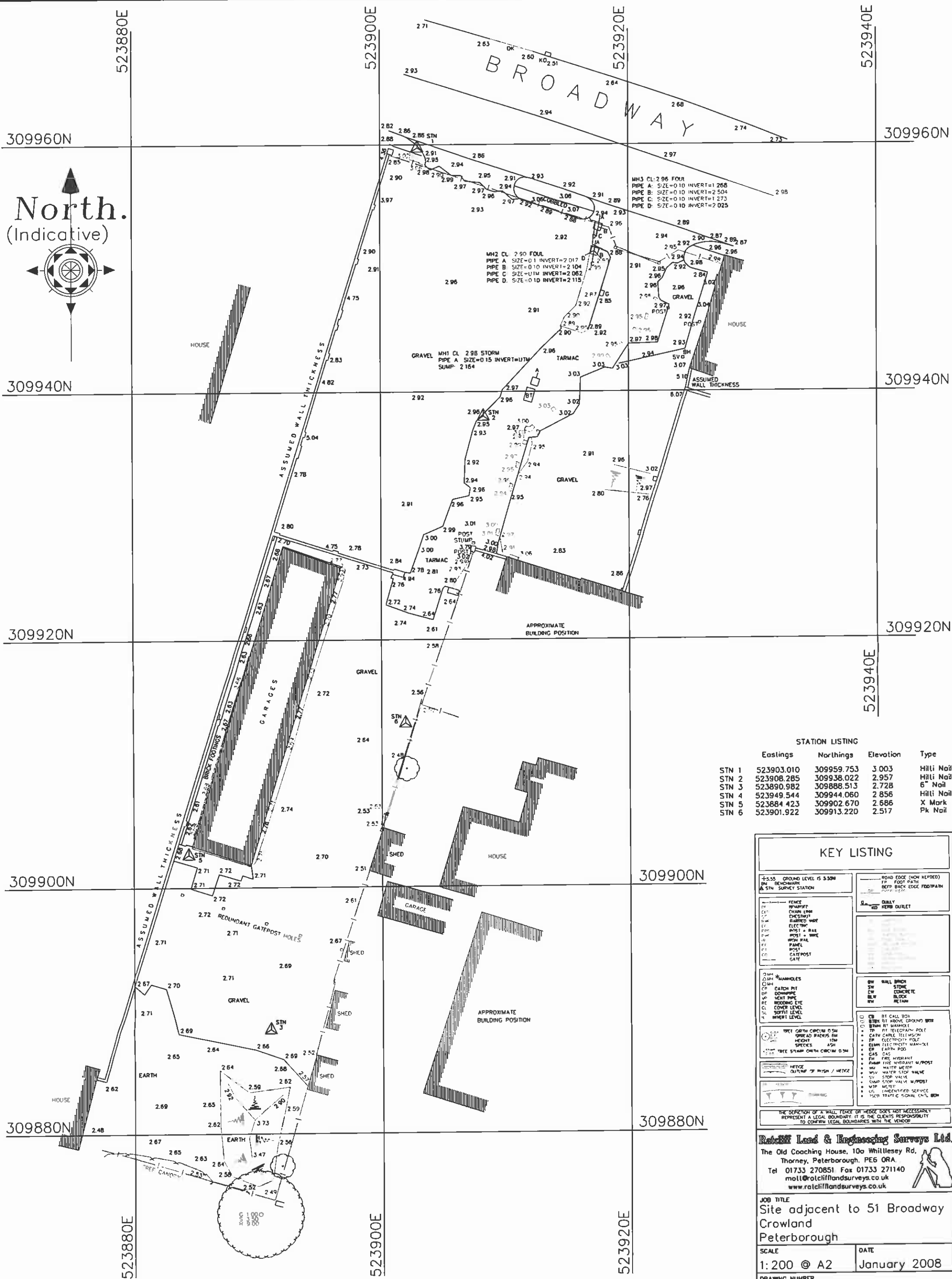
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REVISIONS: A - 20 June 07 - bungalows raised as agreed with Planning Authority B - 20 June 07 - bungalows raised again as agreed with Planning Authority C - 10 June 08 - red and blue lines shown to support the two Planning Applications			
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H02/0048/07			
Scale: 1:250/1250	Sheet Size: A2	Date: 22/MARCH/06	Drawn by: T.A.CLAY
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Drawing Number: 00/064/PA/007			Rev: C



The data used for the computation of horizontal and vertical control for this survey was recorded using our survey grade GPS receivers. This data was provided by Leica Geosystems Smartnet RTK Correction Service.

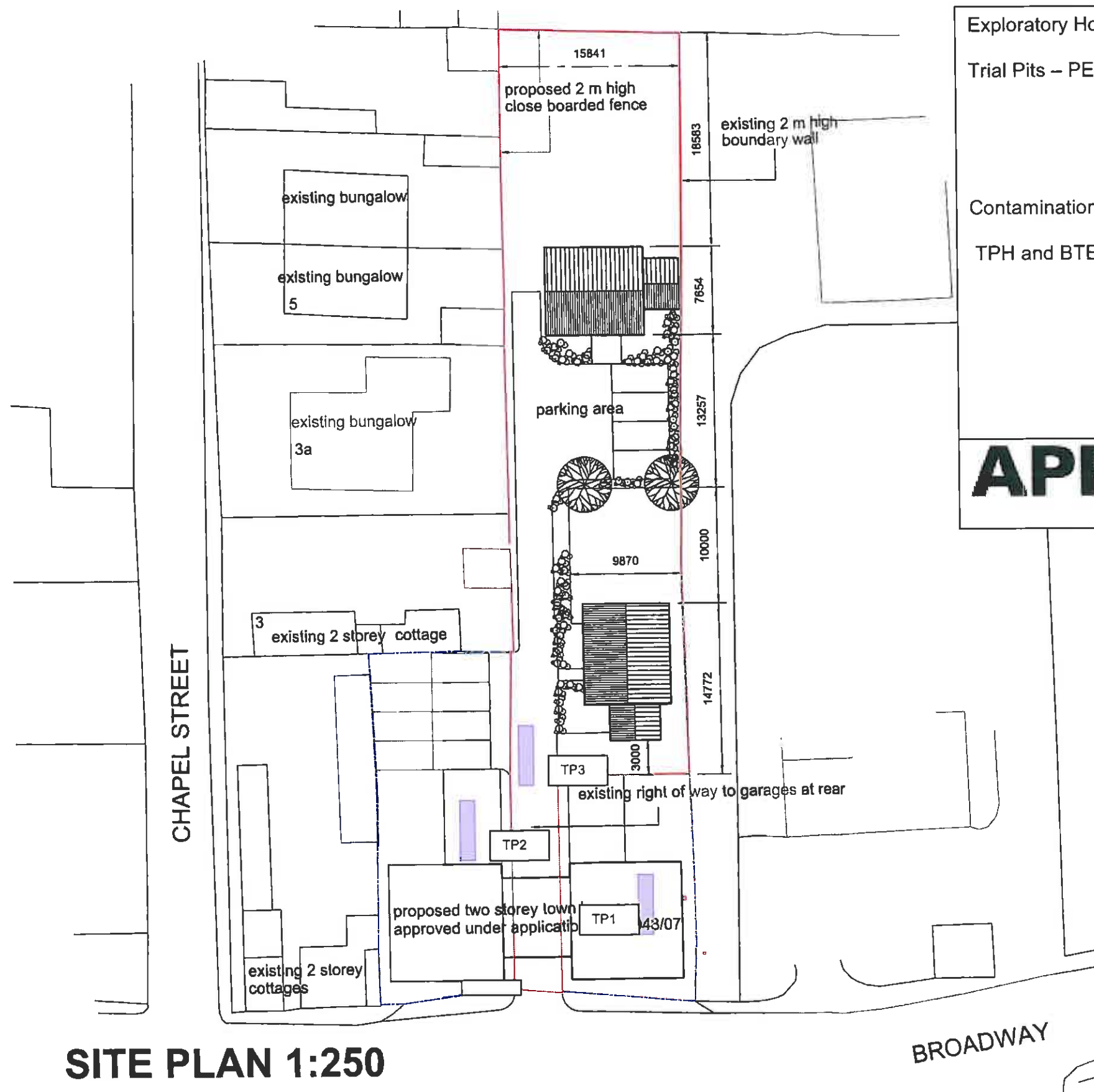
STATION LISTING				
	Eastings	Northings	Elevation	Type
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STN 2	523908.285	309938.022	2.957	Hilti Nail
STN 3	523890.982	309888.513	2.728	6" Nail
STN 4	523949.544	309944.060	2.856	Hilti Nail
STN 5	523884.423	309902.670	2.686	X Mark
STN 6	523901.922	309913.220	2.517	Pk Nail

[illegible]

Ratcliff Land & Engineering Surveys Ltd
The Old Coaching House, 10a Whillsey Rd,
Thorney, Peterborough, PE6 0RA
Tel 01733 270851 Fax 01733 271140
mol@ratclifflandsurveys.co.uk
www.ratclifflandsurveys.co.uk

JOB TITLE Site adjacent to 51 Broadway Crowland Peterborough	
SCALE 1:200 @ A2	DATE January 2008
DRAWING NUMBER 3136-1	
CLIENT Trevor Clay	

SITE PLAN 1:250



Exploratory Hole Location Plan

Trial Pits – PEB Robson 2000 –

Contamination Summary

TPH and BTEX encountered within TP2 at 2.0m bgl and TP3 at 1.00m bgl

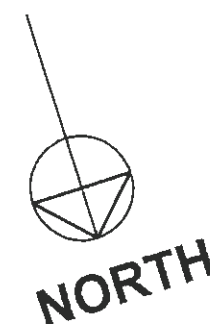
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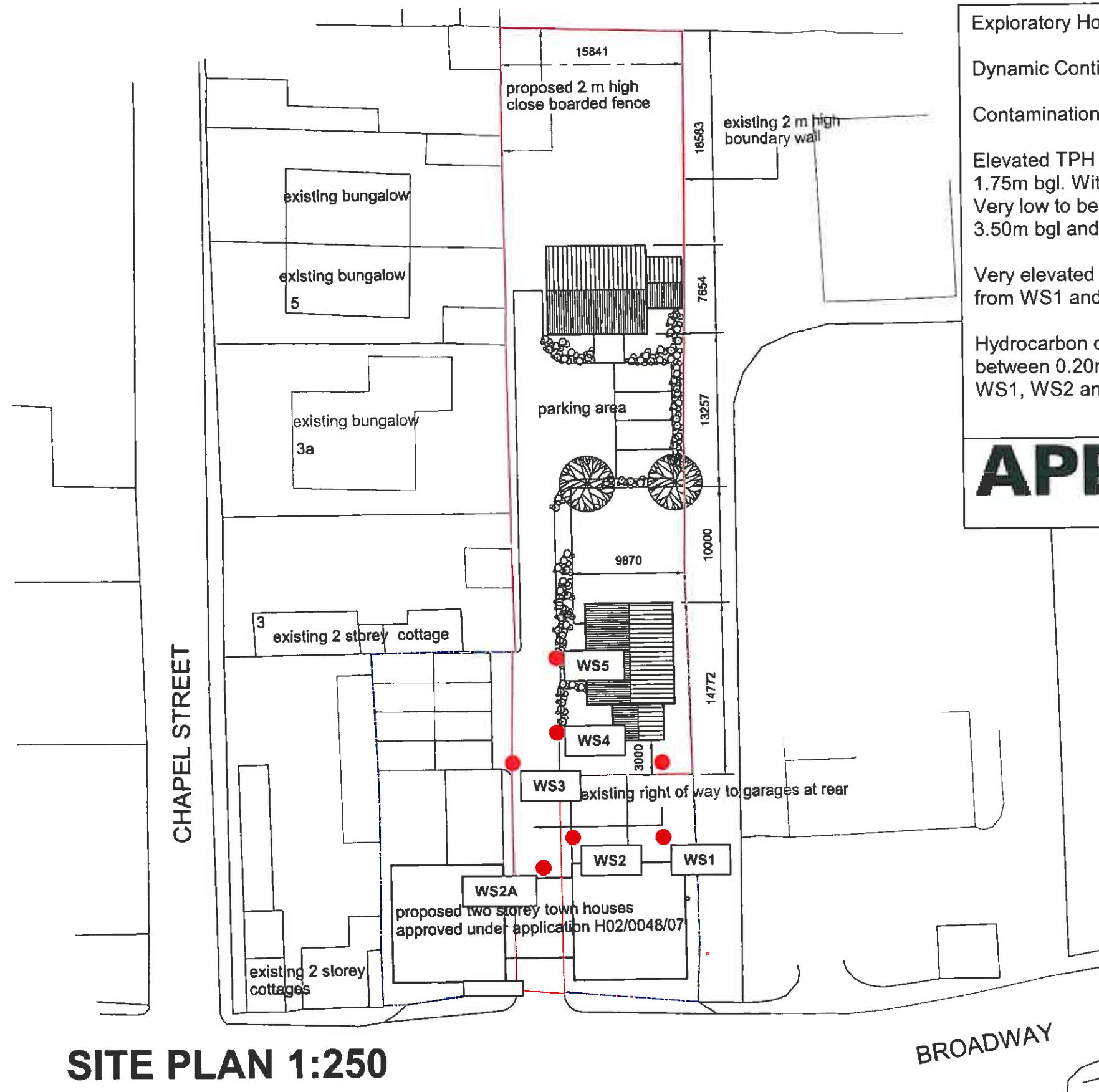


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Notes: A - 1:250 Scale 1:1 - bungalows plotted as agreed with Planning Authority B - 1:250 Scale 1:1 - bungalows plotted as agreed with Planning Authority C - 1:250 Scale 1:1 - bungalows plotted as agreed with Planning Authority			
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HMRC Approval Number			
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Drawing Number 00/064/PA/007			Rev. C

SITE PLAN 1:250



Exploratory Hole Location Plan - Ground Engineering Report 2001

Dynamic Continuous Boreholes 2001 - ●

Contamination Summary -

Elevated TPH encountered within WS1 at 1.55m bgl and 2.80m bgl and WS2 at 1.75m bgl. With slight TPH concentrations within WS3 and WS6

Very low to below laboratory detection limits within WS1 at 3.60m bgl, WS5 at 3.50m bgl and WS6 at 2.75m bgl.

Very elevated hydrocarbon concentrations were recorded within groundwater from WS1 and elevated BTEX concentrations within groundwater from WS5.

Hydrocarbon odours were noted on the exploratory hole records from depths of between 0.20m and 1.10m to depths of between 3.00m and 3.40m bgl within WS1, WS2 and WS5.

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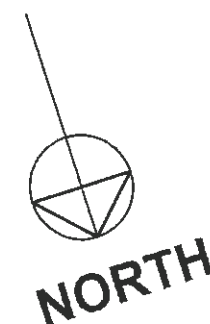
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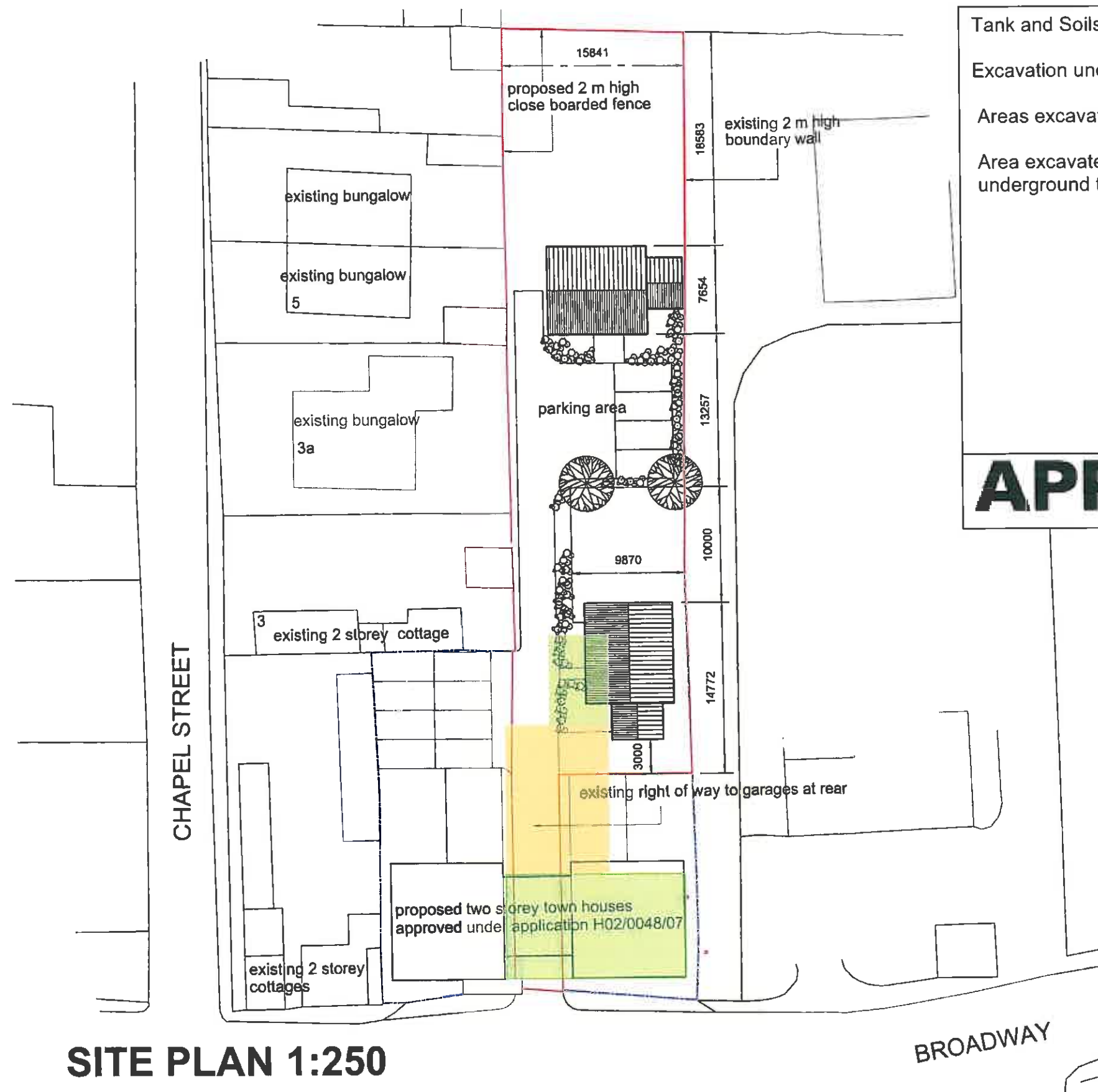
A - 20 June 07 - boundaries based on agreed planning authority B - 20 June 07 - boundaries based on agreed planning authority C - 20 June 07 - not yet agreed with planning authority			
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Local Authority Approval Number:			
HWS Approval Number:			
Scale	Sheet No.	Date	Drawn
1:250/1:250	A2	22/MARCH/08	T.A. CLAY
Title: PROPOSED RESIDENTIAL DEVELOPMENT AT REAR OF 59 TO 61 BROADWAY, CROWLAND, FOR MR P. LEO SITE AND LOCATION PLANS			
Drawn by	Rev.		
00/064/PA/007			C

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SITE PLAN 1:250



Tank and Soils Excavation Plan - 2003

Excavation undertake under supervision of JP Chick & Partners

Areas excavated and removed

Area excavated to locate possible further underground tanks and soils replaced

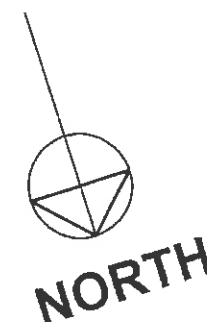
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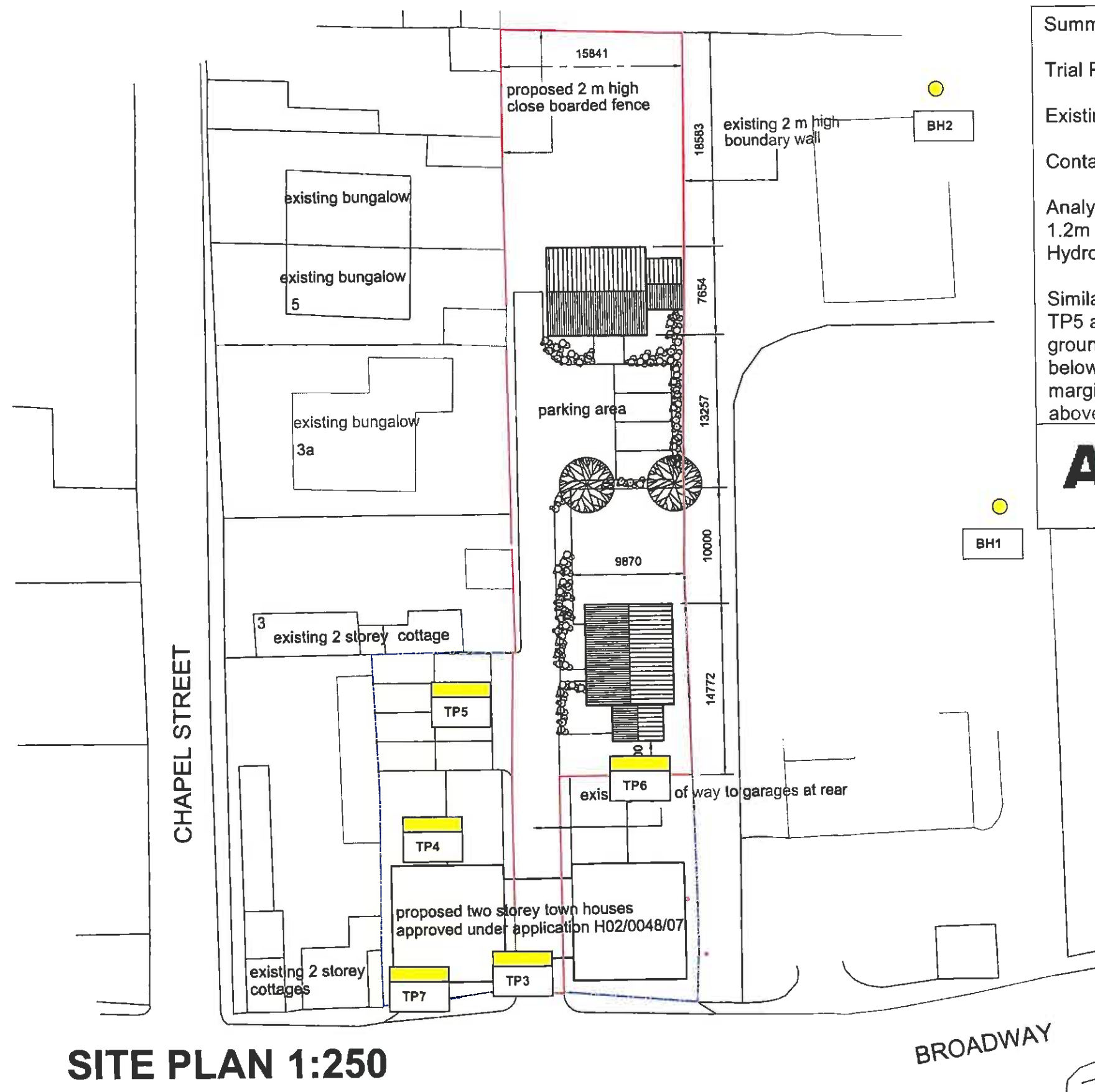
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Local Authority Approval Number			
NEBC Approval Number			
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The PROPOSED RESIDENTIAL DEVELOPMENT AT REAR OF 59 TO 61 BROADWAY, CROWLAND FOR MR P LEO SITE AND LOCATION PLANS			
Drawing No. 00/064/PA/007			Rev C



SITE PLAN 1:250

Summary Exploratory Hole Location Plan – JP Chick Report 2003

Trial Pits

Existing Groundwater Boreholes ●

Contamination Summary

Analysis of Soil samples from TP 4, 5, 6 & 7 from depths of between 1.2m and 2.2m bgl recorded concentrations of BTEX and Hydrocarbons below laboratory detection limits.

Similarly groundwater analysis of samples from BH1, BH2 and TP4, TP5 and TP7 recorded levels below laboratory detection limits. A groundwater sample from TP6 also generally recorded concentrations below laboratory detection with levels of benzene and Total TPH marginally above laboratory detection. The TPH level recorded was above the UK drinking Water Standard.

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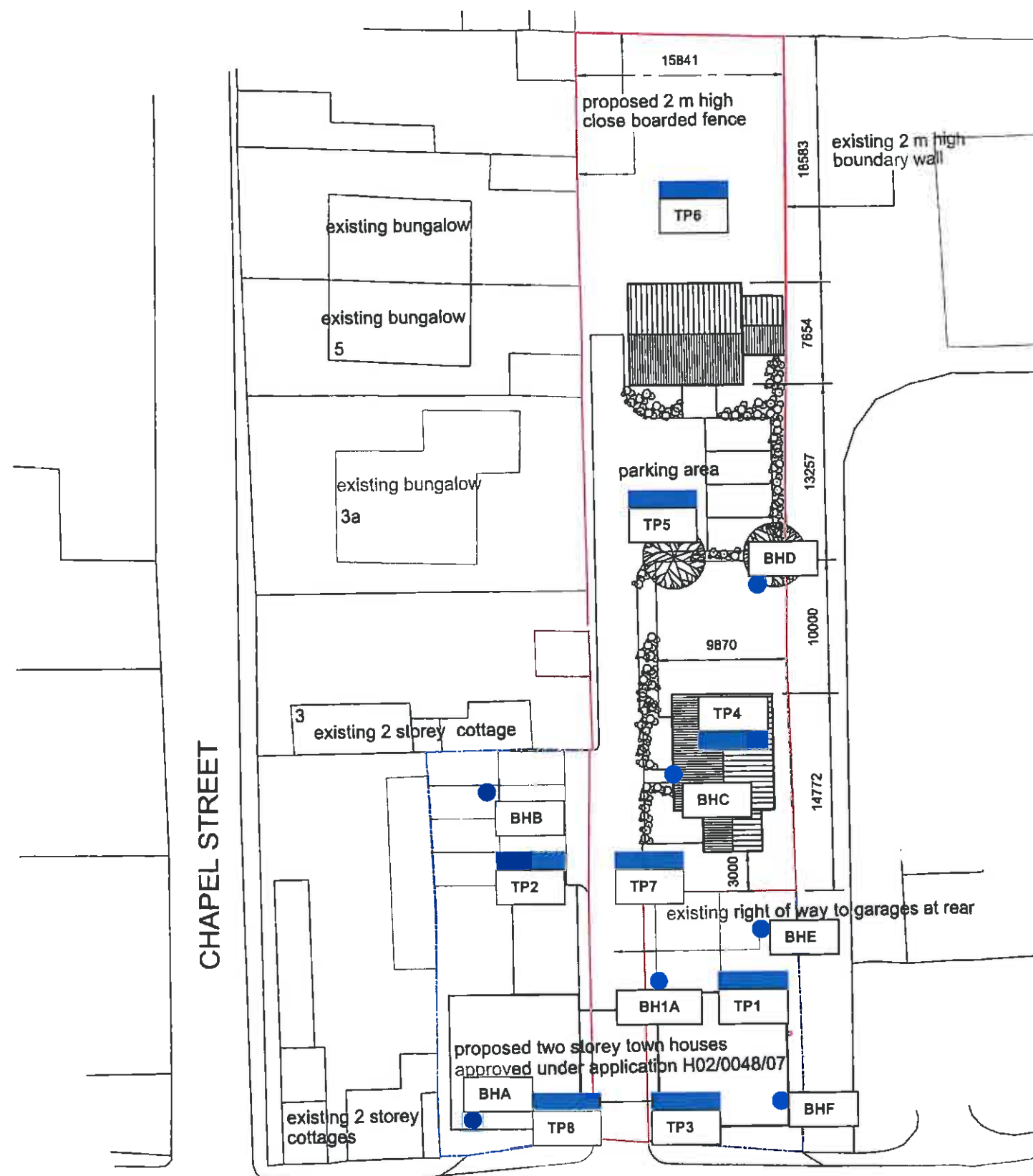
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Revision: A - 28 June 07 - final plan submitted to Planning Authority B - 22 June 07 - final plan submitted to Planning Authority C - 18 June 07 - final plan submitted to Planning Authority			
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Local Authority Approval Number: N/A			
MDC Approval Number: N/A			
Scale: 1:250/1:250	Sheet No.: A2	Date: 22/MARCH/08	Drawn by: T.A. CLAY
Title: PROPOSED RESIDENTIAL DEVELOPMENT AT REAR OF 59 TO 61 BROADWAY, CROWLAND FOR MR P. LEO SITE AND LOCATION PLANS			
Drawing No. / Project No.: 00/064/PA/007			Rev. / Date: C

SITE PLAN 1:250



Summary Exploratory Hole Location Plan – 2008

Trial Pits - 2008

Dynamic Continuous Sampling Boreholes - 2008

Contamination Summary

The Trial Pits and BH 1A were undertaken to assist with foundation design and therefore contamination testing was not undertaken upon the soil samples. Strong hydrocarbon odours were encountered within the Made Ground and underlying gravel deposits from depths of between 0.05m bgl and 1.70m bgl and to depths of between 0.90m bgl and 4.60m bgl, within Borehole 1A and Trial Pits TP1, 3, 4, 5, 7 and 8.

Subsequently additional boreholes were drilled and monitoring probes installed, hydrocarbon odours were recorded within boreholes B, D, E from depths of between 0.10m and 2.30m bgl to depths of between 3.10m bgl and 4.00m bgl.

The sampling and analysis of groundwater samples on two occasions during June 2008 revealed elevated concentrations of TPH and BTEX compounds within Boreholes C, E and F on the first occasion and within A, B, C, E, F and 1A on the second occasion.

Soil gas monitoring undertaken on the 14th November 2008 revealed volatile organic vapours within Boreholes 1A, C, D, E, F and free product (2mm) within BH1A.

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NEBC Approval Number			
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PROPOSED RESIDENTIAL DEVELOPMENT AT REAR OF 59 TO 61 BROADWAY, CROWLAND FOR MR P. LEO SITE AND LOCATION PLANS			
Drawing No. 00/064/PA/007			Rev. C

MONITORING VISIT	
Project No:	AG1031-08
Site Name:	Broadway, Crowland
Nat Grd Ref/Address:	
Date/Time of Monitoring:	14th November 2008 (a.m)
Monitoring Personnel:	Rod Langley
Air Temperature (°C):	14 deg.C
Atmos Oxygen (%vol):	20.90%
Barometric Pressure (rising or falling):	1024mb rising
Wind Speed & Direction:	0-10 mph SE
Weather:	Fine
Ground Conditions (vegetation stress, visual contamination):	

Instrument Used	GF60	GF430	LMSXI	Mini Rae	Thermo	Thermo II	Other
Serial Number	3096	10072		1321			
Specifications and Accuracy	LMSXI G3 - CH4 - 0-100% Accuracy +/- 0.2% @ 5% 1.0% @30% 3.0% @ 100% Response 20 secs LEL 0 - 100% Accuracy +/- 4% of LEL Response 30 secs CO2 0-100% 0.1% @10% 3.0% @50% 3% @ 100% Response 20 Secs O2 0-25% Accuracy +/- 0.5% Response 20 secs Atmos Pressure 800 to 1200 mbar +/- 1mbar Temp -10 - +40°C Flow Range 0.1- 20 l/hr Flow Resolution 0.1 l/hr Borehole Pressure -10 to +80 mbar						
Mini Rae Range Resolution & Response 0-99ppm - 0.1ppm 2 sec 100-1999ppm 1.0ppm 2 sec 2000-10000 ppm 1.0 ppm 2 sec Accuracy - 0-2000 ppm +/- 2ppm or 10% >2000ppm +/- 20% reading (For Isobutylene 100ppm) Temp - 0-45°C	GFM 430 - CH4 - 0-100% Accuracy 0.2% @ 5% 1.0% @30% 3.0% @ 100% Response 20 secs LEL 0-100% Accuracy +/- 4% of LEL Response 40Secs CO2 0-100% 0.1% @10% 3.0% @40% 3% @ 100% response 20 Secs O2 0-25% Accuracy 0.5% Response 20 secs Atmos Pressure - 800 to 1200 mbar +/- 1mbar Temp -10 - 40°C Flow Range +30/-30 l/hr Flow Resolution 0.1 l/hr Borehole Pressure +100/-1000 Pa				Thermo I & II Range 0.1 - 2500 ppm (isobutylene) Resolution 0.1ppm at 0 - 99ppm, 1ppm above 99ppm Accuracy +/- 10% of actual concentration (10-120 % of span concentration) Response < 4sec Temp 0- 45°C		GF60 Flowmeter Flow - +80/-81 l/hr +/- 2% Vol - +9999/-999ml +/- 2% BH Pres +300/-30 Pa +/- 2% Atmos Pres 900-1100 mb +/- 5 mb Test Time 0-999 sec
Other General Notes	Calibration records held in equipment register						

Monitoring point reference	Co-ordinates O S BNG	Flow Range (litres/hr over 3 mins)				Differential Pressure (pa)	Methane % v/v		Methane % LEL		Carbon dioxide % v/v		Oxygen % v/v		VOC (ppm)	LNAPL	Water Level (mbgl)	DNAPL	Depth of Well (m)	Diameter of installation
		Max	Min	Avg	Volume (ml)		Peak	Steady	Peak	Steady	Peak	Steady	Min	Steady						
1A	TF 23905-09958	1.7	-1.6	0.0	4.0	-5 to 5	63.4	63.4	>>>>	>>>>	1.8	1.8	16.2	16.2	174.0	1.373	1.38	N/D	6.86	50mm
A	TF 23922-09956	1.2	-1.2	0.0	9.0	-4 to 3	0.0	0.0	0.0	0.0	0.0	0.0	20.9	20.9	0.0	N/D	1.50	N/D	3.51	50mm
B	TF 23916-09937	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	20.9	20.9	0.0	N/D	1.24	N/D	3.75	50mm
C	TF 23900-09940	0.5	-0.6	0.0	-7.5	-2 to 2	0.0	0.0	0.0	0.0	0.6	0.6	20.1	20.1	0.9	N/D	1.41	N/D	3.73	50mm
D	TF 23894-09941	0.2	-1.6	-0.1	-28.0	-5 to 0	0.0	0.0	0.0	0.0	0.0	0.0	20.9	20.9	5.1	N/D	1.16	N/D	3.61	50mm
E	TF 23891-09954	0.0	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	3.7	3.7	16.9	16.9	6.8	N/D	1.23	N/D	3.64	50mm
F	TF 23901-09966	1.0	-0.8	0.1	22.0	-2 to 3	0.0	0.0	0.0	0.0	0.9	0.9	20.0	20.0	1.9	N/D	1.41	N/D	3.82	50mm



Project No:

AG1031-08

Date of Monitoring:

14th November 2008

Project:

Broadway, Crowland

Phase of Monitoring:

1

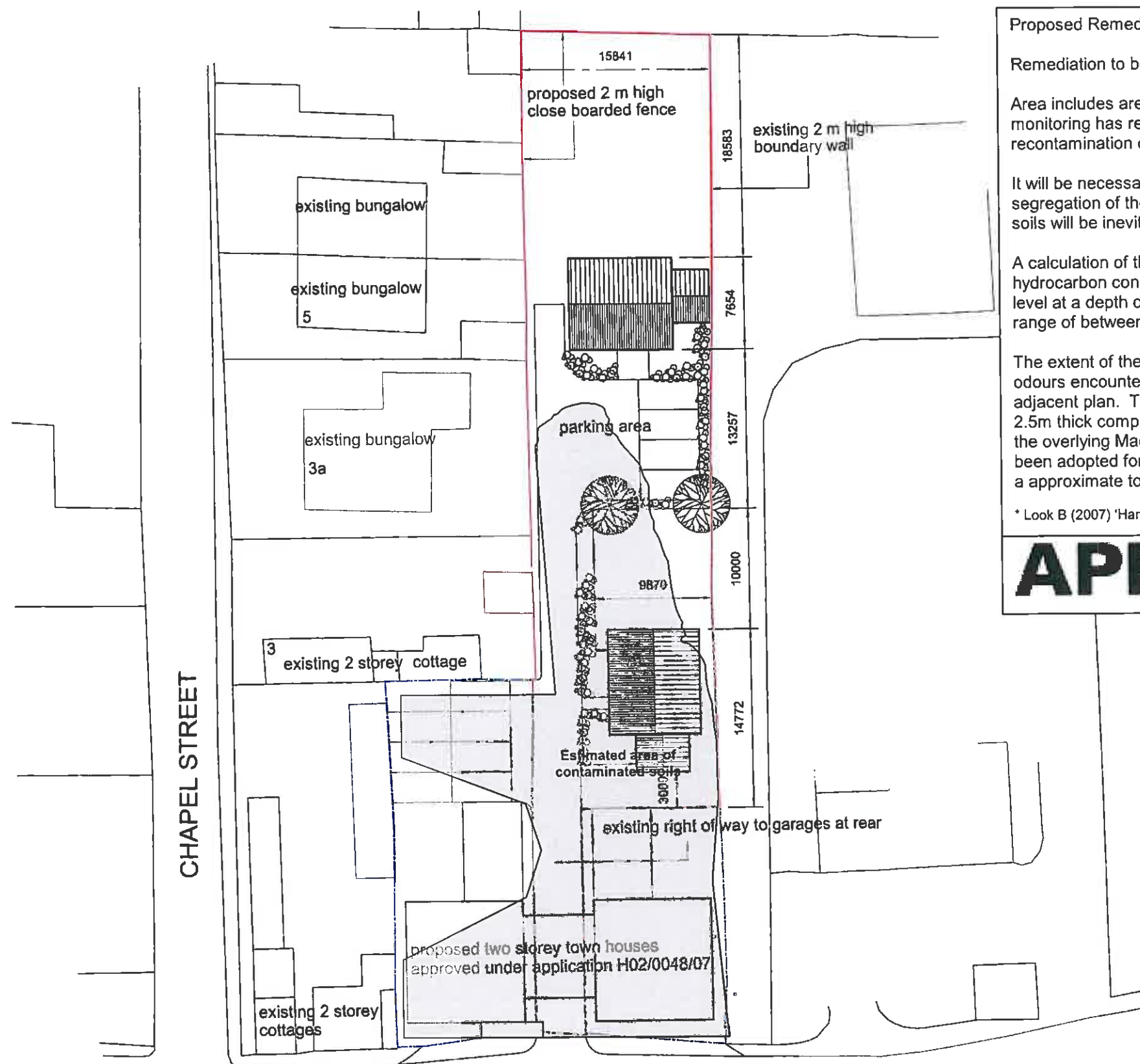
Monitor Point Reference	Co-ordinates O.S. BNG	pH	ORP mV	EC µs	TDS ppm
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A	TF 23922-09956	7.6	40.0	1043	522
B	TF 23916-09937	7.3	51.0	931	465
C	TF 23900-09940	7.7	-54.0	801	400
D	TF 23894-09941	7.5	60.0	901	449
E	TF 23891-09954	7.3	59.0	1671	837
F	TF 23901-09966	7.5	-61.0	1294	645

Meteorological Data

Ambient Temperature:	14 deg.C
Instrument Used	In-situ test kit
Monitored by:	Rod langley



SITE PLAN 1:250



Proposed Remediation Areas Plan - 2008

Remediation to be undertaken by Celtic Technologies Limited.

Area includes areas previously excavated and infilled with 'inert' fill during 2003 as groundwater monitoring has revealed significant recontamination of the groundwater in this area suggesting recontamination of soils within the previously remediation areas.

It will be necessary to excavate the overlying 'clean' soils in order to reach the underlying soils, segregation of the soils will be undertaken although some excavation and intermixing of clean soils will be inevitable.

A calculation of the soil volume has been made based upon the average depth and thickness of hydrocarbon contamination recorded. Contamination has been recorded from just below ground level at a depth of 0.10m bgl to a maximum recorded depth of 4.60m bgl with thickness in the range of between 0.90m and 4.0m.

The extent of the contamination based upon the laboratory analysis of soils, groundwater and odours encountered during the various investigations has been approximated and plotted on the adjacent plan. The area of contamination has been estimated to cover 1300m² and typically be 2.5m thick comprising the depth of gravels overlying the oxford clay with some contamination of the overlying Made Ground. This equates to 3250m³ of soil. A density of 1.9 tonnes.m⁻³* has been adopted for the mixed Made ground and Sand and Gravel contaminated soils to calculate a approximate tonnage of contaminated soils of 6688 tonnes.

* Look B (2007) 'Handbook of Geotechnical Investigation and Design Tables' Taylor & Francis, London.

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Notes

- A - 100 June 07 - bungalows marked as agreed with Planning Authority
- B - 100 June 07 - bungalows marked as agreed with Planning Authority
- C - 100 June 07 - not yet approved but agreed to be agreed with Planning Authority

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This drawing should be used in conjunction with the approved plans and approved details.
All points shall be subject to the surveying of Trevor A Clay RIBA Ltd.

Local Authority Approval Number

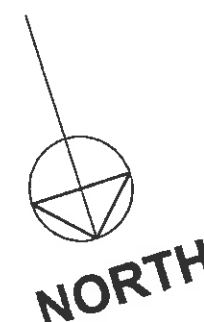
NEBC Approval Number

Sheet	Drawn	Date	Drawn
1.250/1250	A2	22/MARCH/08	T.A. CLAY

PROPOSED RESIDENTIAL
DEVELOPMENT AT REAR OF 59 TO 61
BROADWAY, CROWLAND FOR MR P LEO
SITE AND LOCATION PLANS

Drawing Number	Rev.
00/064/PA/007	C

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APPENDIX D

Site Specific Trial Pit Logs





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

Borehole No

TP2

Sheet 1 of 1

Project Name
Former Broadway PFS

Project No.
UK14.1470

Co-ords: -

Hole Type
TP

Location: Crowland, Lincolnshire, PE6 OBH

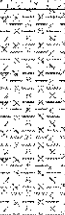
Level: -

Scale
1:20

Client: Mr Ian Ladds

Dates: 07/02/2014

Logged By
TJ

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.40			MADE GROUND: yellow-brown fine to coarse sand and gravels with some occasional brick fragments.	
								Black stained SAND and GRAVEL. Some slight hydrocarbon odours between 2.3m to 2.4m.	1
					2.40			Grey silty CLAY with some slight staining and hydrocarbon odours between 2.4m and 2.5m.	2
					3.00			End of Borehole at 3.00 m	3
			Type	Results					

Remarks: Groundwater seepage encountered at 2.2m.





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Borehole No

TP3

Sheet 1 of 1

Project Name
Former Broadway PFS

Project No.
UK14.1470

Co-ords: -

Hole Type
TP

Location: Crowland, Lincolnshire, PE6 OBH

Level: -

Scale
1:20

Client: Mr Ian Ladds

Dates: 07/02/2014

Logged By
TJ

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.00			MADE GROUND: Brown fine to coarse sand and gravel with occasional brick fragments.	1
					1.50			Black stained fine to coarse SAND and GRAVEL.	
					2.60			Orange-brown fine to coarse SAND and GRAVEL	2
					3.00			Grey silty CLAY	
								End of Borehole at 3.00 m	3
			Type	Results					

Remarks: Groundwater seepage encountered at 2.5m.





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Borehole No

TP4

Sheet 1 of 1

Project Name
Former Broadway PFS

Project No.
UK14.1470

Co-ords: -

Hole Type
TP

Location: Crowland, Lincolnshire, PE6 OBH

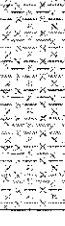
Level: -

Scale
1:20

Client: Mr Ian Ladds

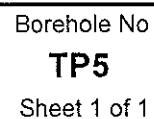
Dates: 07/02/2014

Logged By
TJ

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					0.40			MADE GROUND: Yellow-brown fine to coarse sand and gravel.	
					1.40			Black sandy gravelly organic CLAY	1
					2.40			Orange-brown fine to coarse SAND and GRAVEL	2
					3.00			Grey silty CLAY	
								End of Borehole at 3.00 m	3
			Type	Results					

Remarks: Groundwater seepage encountered at 2.5m.





Hole Type
TP

Scale
1:20

Logged By
TJ

Remarks: Groundwater seepage encountered at 2.3m.



Project Name
Former Broadway PFS

Project No.
UK14.1470

Co-ords: -

Hole Type	TP
-----------	----

Location: Crowland , Lincolnshire, PE6 OBH

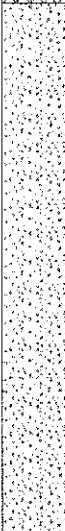
Level: -

Scale
1:20

Client: Mr Ian Ladds

Dates: 07/02/2014

Logged By
TJ

Well	Water Strikes	Samples & in Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description
		Depth (m)	Type	Results				
					1.00			MADE GROUND: Brown fine to coarse sand and gravel with some occasional brick fragments.
								Alternating layers of orange brown and black SAND and GRAVEL
								End of Borehole at 2.50 m

Remarks: No groundwater encountered



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Borehole No

TP7

Sheet 1 of 1

Project Name
Former Broadway PFS

Project No.
UK14.1470

Co-ords: -

Hole Type
TP

Location: Crowland, Lincolnshire, PE6 OBH

Level: -

Scale
1:20

Client: Mr Ian Ladds

Dates: 07/02/2014

Logged By
TJ

Well	Water Strikes	Samples & In Situ Testing			Depth (m)	Level (m AOD)	Legend	Stratum Description	
		Depth (m)	Type	Results					
					1.20			MADE GROUND: Pale brown fine to coarse sand and gravel.	1
								Black sandy gravelly organic CLAY	2
					2.50			Grey silty CLAY	
					2.60			End of Borehole at 2.60 m	3
			Type	Results					

Remarks: Groundwater seepage encountered at 2.4m.



APPENDIX E

Formal Laboratory Reports

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 11 February 2014

Report Date
19 February 2014

FAO T Jones / S Smith

UK14.1470 - Former Broadway PFS, Crowland

Login Batch No

Chemtest LIMS ID

Sample ID

Sample No

Sampling Date

Depth

Matrix

SOP↓ Determinand↓

CAS No↓

Units↓

*

251088

					AJ81814	AJ81815	AJ81816	AJ81817	AJ81818	AJ81819
					BH A	BH B	BH C	BH D	BH E	BH F
					7/2/2014	7/2/2014	7/2/2014	7/2/2014	7/2/2014	7/2/2014
					WATER	WATER	WATER	WATER	WATER	WATER
1675	TPH aliphatic >C5-C6		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C6-C8		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C8-C10		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C10-C12		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C12-C16		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C16-C21		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C21-C35		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aliphatic >C35-C44		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C5-C7		µg l ⁻¹	N	< 0.1	< 0.1	49	32	< 0.1	32
	TPH aromatic >C7-C8		µg l ⁻¹	N	< 0.1	< 0.1	5.1	46	< 0.1	1.5
	TPH aromatic >C8-C10		µg l ⁻¹	N	< 0.1	< 0.1	49	270	< 0.1	< 0.1
	TPH aromatic >C10-C12		µg l ⁻¹	N	< 0.1	< 0.1	25	94	< 0.1	< 0.1
	TPH aromatic >C12-C16		µg l ⁻¹	N	< 0.1	< 0.1	13	< 0.1	< 0.1	< 0.1
	TPH aromatic >C16-C21		µg l ⁻¹	N	< 0.1	< 0.1	0.61	< 0.1	< 0.1	< 0.1
	TPH aromatic >C21-C35		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	TPH aromatic >C35-C44		µg l ⁻¹	N	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1	< 0.1
	Total Petroleum Hydrocarbons		µg l ⁻¹	N	< 10	< 10	140	440	< 10	34
	Total Aliphatic Hydrocarbons		µg l ⁻¹	N	< 5	< 5	< 5	< 5	< 5	< 5
	Total Aromatic Hydrocarbons		µg l ⁻¹	N	< 5	< 5	140	440	< 5	34
1760	Methyl tert-butylether	1634044	µg l ⁻¹	N	<1.0	<1.0	11	<1.0	<1.0	16
	Benzene	71432	µg l ⁻¹	U	<1.0	<1.0	71	40	<1.0	69
	Toluene	108883	µg l ⁻¹	U	<1.0	<1.0	9.5	6.5	<1.0	<1.0
	Ethylbenzene	100414	µg l ⁻¹	U	<1.0	<1.0	6.4	120	<1.0	<1.0
	m- & p-Xylene	1330207	µg l ⁻¹	U	<1.0	<1.0	11	14	<1.0	<1.0

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 11 February 2014

Report Date
19 February 2014

FAO T Jones / S Smith

UK14.1470 - Former Broadway PFS, Crowland

Login Batch No

Chemtest LIMS ID

Sample ID

Sample No

Sampling Date

Depth

Matrix

SOP↓ Determinand↓

CAS No↓

Units↓

*

251088

AJ81820

BH 1A

7/2/2014

WATER

1675	TPH aliphatic >C5-C6		µg l ⁻¹	N	< 0.1
	TPH aliphatic >C6-C8		µg l ⁻¹	N	< 0.1
	TPH aliphatic >C8-C10		µg l ⁻¹	N	< 0.1
	TPH aliphatic >C10-C12		µg l ⁻¹	N	< 0.1
	TPH aliphatic >C12-C16		µg l ⁻¹	N	< 0.1
	TPH aliphatic >C16-C21		µg l ⁻¹	N	< 0.1
	TPH aliphatic >C21-C35		µg l ⁻¹	N	< 0.1
	TPH aliphatic >C35-C44		µg l ⁻¹	N	< 0.1
	TPH aromatic >C5-C7		µg l ⁻¹	N	640
	TPH aromatic >C7-C8		µg l ⁻¹	N	38
	TPH aromatic >C8-C10		µg l ⁻¹	N	190
	TPH aromatic >C10-C12		µg l ⁻¹	N	95
	TPH aromatic >C12-C16		µg l ⁻¹	N	58
	TPH aromatic >C16-C21		µg l ⁻¹	N	22
	TPH aromatic >C21-C35		µg l ⁻¹	N	1.4
	TPH aromatic >C35-C44		µg l ⁻¹	N	< 0.1
	Total Petroleum Hydrocarbons		µg l ⁻¹	N	1000
	Total Aliphatic Hydrocarbons		µg l ⁻¹	N	< 5
	Total Aromatic Hydrocarbons		µg l ⁻¹	N	1000
1760	Methyl tert-butylether	1634044	µg l ⁻¹	N	24
	Benzene	71432	µg l ⁻¹	U	560
	Toluene	108883	µg l ⁻¹	U	28
	Ethylbenzene	100414	µg l ⁻¹	U	<1.0
	m- & p-Xylene	1330207	µg l ⁻¹	U	49

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 11 February 2014

UK14.1470 - Former Broadway PFS, Crowland

Report Date
19 February 2014

251088					
AJ81814	AJ81815	AJ81816	AJ81817	AJ81818	AJ81819
BH A	BH B	BH C	BH D	BH E	BH F
7/2/2014	7/2/2014	7/2/2014	7/2/2014	7/2/2014	7/2/2014
WATER	WATER	WATER	WATER	WATER	WATER
1760 p-Xylene	95476	µg l ⁻¹	U	<1.0	<1.0
				4.5	50
				<1.0	<1.0

Environmental Protection Strategies Ltd
Unit 7B Caxton House
Broad Street
Cambourne, Cambs
CB23 6JN

FAO T Jones / S Smith

LABORATORY TEST REPORT

Results of analysis of 7 samples
received 11 February 2014

UK14.1470 - Former Broadway PFS, Crowland



Report Date
19 February 2014

					251088
					AJ81820
					BH 1A
					7/2/2014
					WATER
1760	o-Xylene	95476	µg l ⁻¹	U	14

APPENDIX F

Tier I Screening Criteria

EPS Tier 1 Qualitative Risk Assessment

Generic Assessment Criteria - Residential Land Use

Contaminant	Tier 1 Soil Targets			Tier 1 Groundwater Targets	
	Human Health	Controlled Waters		Controlled Waters	
		LGwRP	HGwRP	LGwRP	HGwRP
Unit	mg/kg			ug/l	
Arsenic	32	n/c	n/c	50	10
Cadmium	10	n/c	n/c	5	5
Chromium	3000	n/c	n/c	250	50
Chromium VI	4.3	n/c	n/c	n/c	n/c
Copper	2330	n/c	n/c	28	28
Mercury	170	n/c	n/c	1	1
Nickel	130	n/c	n/c	200	50
Lead	450	n/c	n/c	250	10
Selenium	350	n/c	n/c	10	10
Zinc	3750	n/c	n/c	500	500
Benzene	0.33	0.252	0.008	30	1
Toluene	6.10E+02	1.17	1.17	50	50
Ethylbenzene	3.50E+02	15.0	10.0	300	200
Xylene	2.30E+02	0.885	0.885	30	30
MTBE	-	0.138	0.0276	75	15
Benzo(a)Pyrene	8.30E-01	10	1.44	0.7	0.1
Napthalene	1.50E+00	0.934	0.02	10	0.1
Dibenz(ah)anthracene	7.60E-01	n/c	n/c	n/c	n/c
Aliphatic C5-C6	3.00E+01	5.27	1.05	50	10
Aliphatic C6-C8	7.30E+01	23.2	4.64	50	10
Aliphatic C8-C10	1.90E+01	175	35.1	50	10
Aliphatic C10-C12	9.30E+01	1380	276	50	10
Aliphatic C12-C16	7.40E+02	27500	5490	50	10
Aliphatic C16-C35	4.50E+04	3.46E+06	6.91E+05	50	10
Aromatic C8-C10	2.70E+01	8.74	1.75	50	10
Aromatic C10-C12	6.90E+01	13.8	2.76	50	10
Aromatic C12-C16	1.40E+02	27.5	5.5	50	10
Aromatic C16-C21	2.50E+02	86.9	17.4	50	10
Aromatic C21-C35	8.90E+02	690	138	50	10

Notes:

LGwRP - Low Groundwater Resource Potential
 HGwRP - High Groundwater Resource Potential
 >SOL - GAC exceeds solubility saturation limit
 n/c - not calculated

Tier 1 Soil Targets

Targets for Human Health have been taken from available Soil Guideline Values (SGVs), derived using standard sandy loam soil with 6% SOM. For contaminants where SGVs are not currently available, GACs from LQM & CIEH 'Generic Assessment Criteria for Human Health Risk Assessment - 2nd edition (2009)' derived using standard sandy loam soil with 1% SOM were used as alternatives. For sites where ground conditions differ significantly from sandy loam or site-specific SOM and pH are available, the Tier 1 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 Tier 1 GW targets)

Tier 1 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 respectively.

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 Ethylbenzene 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.

APPENDIX G

Example Vapour Resistant Membrane Specification

RTEC. 4 GAS BARRIER

- Reinforced LDPE membrane including aluminium foil.
- Very low gas transmission.
- Exceeds D.P.M standards.
- Gas Barrier for Methane, Carbon Dioxide, Hydro Carbons and Radon.
- Weldable with conventional hot air equipment.

Composition

Scrim reinforced polyethylene and aluminium

Nominal Weight/unit area	370grams/m2
Minimum Thickness	0.40mm
Tensile Strength	10.5kN/m (BS4415 Pt 2)
Methane Permeability	<0.001ml/m2/Day
Moisture Transmission	<0.01g/m2/Day
Radon improvement factor	500-1
Roll size	2m x 50m

Suggested Specification: The gas membrane shall be [RTEC.4 Gas Barrier] loose laid to prepared substrate. The membrane shall contain Aluminium foil encapsulated in polyethylene and be reinforced with polyester scrim, minimum thickness 0.40mm, methane transmission less than 0.001ml/m2/day.