



**REMEDIATION STRATEGY HERITAGE
COURT, LLANGOLLEN RD, ACREFAIR**

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Prepared for:

Gower Homes Ltd

Prepared by J Thorburn

GroundSolve Ltd

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This report has been prepared by GroundSolve Ltd with all reasonable care and diligence, within the best practice and guidance current at the time of issue within the proposed redline boundary and proposed Site end use as presented by the Client.

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1 INTRODUCTION

GroundSolve Ltd was commissioned by Gower Homes Ltd to undertake a Remediation Strategy and Verification Plan for a new residential housing estate Heritage Court, Llangollen Rd, Acrefair, North Wales (the "Site").

This report has been devised to generally comply with the relevant principles and requirements of a range of guidance including:

- Welsh Local Government Assoc- Development of Land Affected By Contamination Guide for Developers 2017
- Welsh Land Contamination Working Group (WLGA) - Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems
- Part IIA of the Environment Protection Act, 1990
- BS5930:2015+A1:2020: "Code of practice for site investigations"
- BS10175: 2011 +A2:2017 "Investigation of Potentially Contaminated Sites - Code of Practice"
- The Building Regulations 2010. Part C (HM Government 2013)

1.1 Proposed Development

The proposed development comprises the construction of 22 three and four bedroom residential properties with associated gardens, roads and services.

It is understood that the Principal Contractor for the development is Gower Homes Ltd.

Planning Application number P/2021/0793.



Figure 1: Extract of Development Plan 21-DES-002 C Site plan.

1.2 Objectives

The objective of this document is to present details of the remedial measures required based on the findings of ground investigations. This report presents how the remediation of the site will be undertaken and sets out how the works will be validated. In addition, this document explains how the works will be permitted under current regulatory regimes. The remediation will ensure that upon completion of the proposed development, the ground and conditions at the site can be shown to be appropriate for its intended use, and that it will not pose unacceptable contamination risks to identified receptors.

The findings and conclusions of the risk assessments have been set out and recommendations given for the proposed end use.

This report provides a Remediation Strategy and Verification Plan in relation to the identified contaminant sources, together with further details of how the developer will deal with encountering unexpected contamination, should this occur.

This document is a working document and may need to be updated, in agreement with the relevant regulatory bodies, at any stage during development dependent on the conditions encountered. This version of this document is to be issued to regulators for approval (i.e., Wrexham County Borough Council).

Additional investigation work is proposed to further delineate potentially contaminated soils and allow a less onerous remediation strategy to be employed. However, at the time of writing this work has not yet been undertaken due to access issues. As such a worst case scenario will be assumed and this report revised once further information is available.

1.3 Previous Investigations

The following reports have already been undertaken and will be summarised in Section 3:

- Phase II Assessment, South Site (Former Engineering Works), Acrefair, Wrexham – carried out by WSP (Reference 9460(2), dated July 2011. which encompassed the current site of interest within a larger parcel of land.
- Coal Mining Risk Assessment Report undertaken by Earth Environmental & Geotechnical Ltd (Reference: A3341/17, August 2017)
- Phase 1 Preliminary Risk Assessment undertaken by Earth Environmental & Geotechnical Ltd (Ref: A3341/19, dated 17th December 2019)
- Phase 2 Ground Investigation undertaken by Earth Environmental & Geotechnical Ltd (Ref: A3341/20/SI/V2, dated 9th September 2020)
- A Soil Contamination Delineation Letter Report undertaken by Earth Environmental & Geotechnical Ltd (Ref: A3341/21, dated 24th June 2020)

1.4 Limitations

This report has been prepared for the sole use of Gower Homes Ltd. No other third party may rely upon or reproduce the contents of this report without the written approval of GroundSolve Ltd. If any unauthorised third party comes into possession of this report, they rely on it entirely at their own risk.

2 SITE DETAILS AND DESCRIPTION

Table 2.1 Current Site Overview.

Site name	Heritage Court, Llangollen Rd, Acrefair
Site address	Llangollen Rd, Acrefair, closest postcode LL14 3HW
National Grid Reference (NGR)	328138, 343231
Approximate Site area	The area of the site is 1.12 ha.
Site shape	The site is irregular in shape with maximum dimensions of approximately 150m north-south and 155m east-west.
Current land use on the Site	The site is currently a disused parcel of land with the majority covered in asphalt hardstanding. Patches of trees and shrubs can be seen spread across the site, especially surrounding a concrete slab in the south of the site. A steep slope covered in mature trees is present along the eastern site boundary. The old kilns/furnaces are set into the eastern tree lined embankment.
Surrounding land uses	To the northwest of the site is Llangollen Road (A539) with residential properties and vacant land beyond, to the north east is a bowling green, to the east is a steep slope with residential properties beyond and to the south is a vacant plot of land
General topography and ground levels	Topographical survey suggests site slopes from generally from north to south varying between 53mOD on the northern boundary to 48.5m OD on the southern boundary. There is a steep overgrown slope along the eastern boundary ranging from 50m OD to 61m OD.

3 PREVIOUS INVESTIGATIONS

Phase II Assessment Report WSP (Reference 9460(2), dated July 2011

The Phase 2 investigation report carried out by WSP dated July 2011, encompassed the current site of interest within a larger parcel of land further to the south.

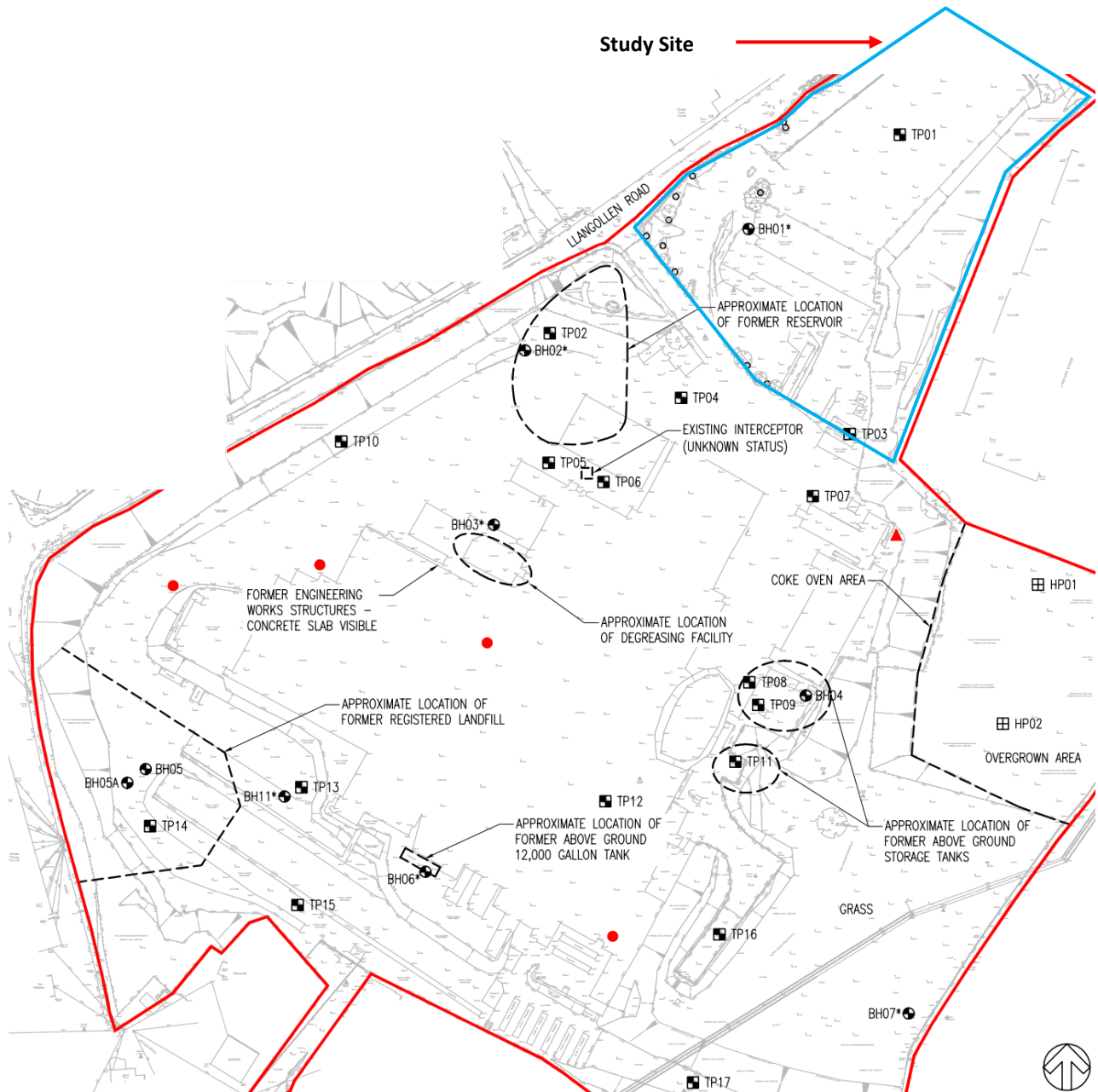


Figure 2: Extract of Exploratory Hole Location Plan .

The phase 2 investigation include 1No. cable percussion borehole and 2No. machine excavated trial pits within the study site.

A brief history of the overall site (including study site) was noted as follows:

In the late Nineteenth Century, the site formed part of an iron works and was occupied by buildings and infrastructure including coke ovens and railway sidings. A reservoir or lagoon located half way along the northwestern site boundary formed part of the original iron works and was infilled between 1962 and 1968. By the end of the Nineteenth Century the iron works had been replaced by an engineering works, which remained on site until recent demolition. A spoil heap (likely to comprise coal mining and iron foundry waste) was present in the southwestern corner of the site from the time of the iron works, and although apparently regraded, remains in the same position at the time of the investigation (April 2011).

The site investigation encountered Made Ground ranging from 0.3m to 6.5m. The Made Ground typically comprised various proportions of intermixed ash, clinker and gravel/cobble sized fragments of slag, burnt shale, ironstone, burnt ironstone, burnt shale, coal, sandstone, mudstone and brick. The deepest Made Ground (6.5m) was encountered in the former infilled pond/lagoon and comprised intermixed ash and clinker. The infilled pond is located 50m to the southwest of the site, however at approx 3.0m lower than the study site.

BH01 and TP01 encountered weathered mudstone from 0.3m proven to 4.0m and 1.5m respectively. TP03 encountered asphalt over clinker made ground to 2.0m overlying brown slightly gravelly clay to 2.5m.

Groundwater was not encountered during the investigation however subsequent groundwater monitoring recorded groundwater in two monitoring wells at depths of between 1.4m bgl and 3.6m bgl.

Regarding contamination observations, the Made Ground was observed to contain variable amounts of ash, which can be a source of heavy metals and PAHs.

Chemical testing recorded elevated concentrations above the relevant GACs for arsenic, Chromium, Naphthalene and Benzo-a-pyrene. None of the exceedances were from the exploratory holes present on the study site.

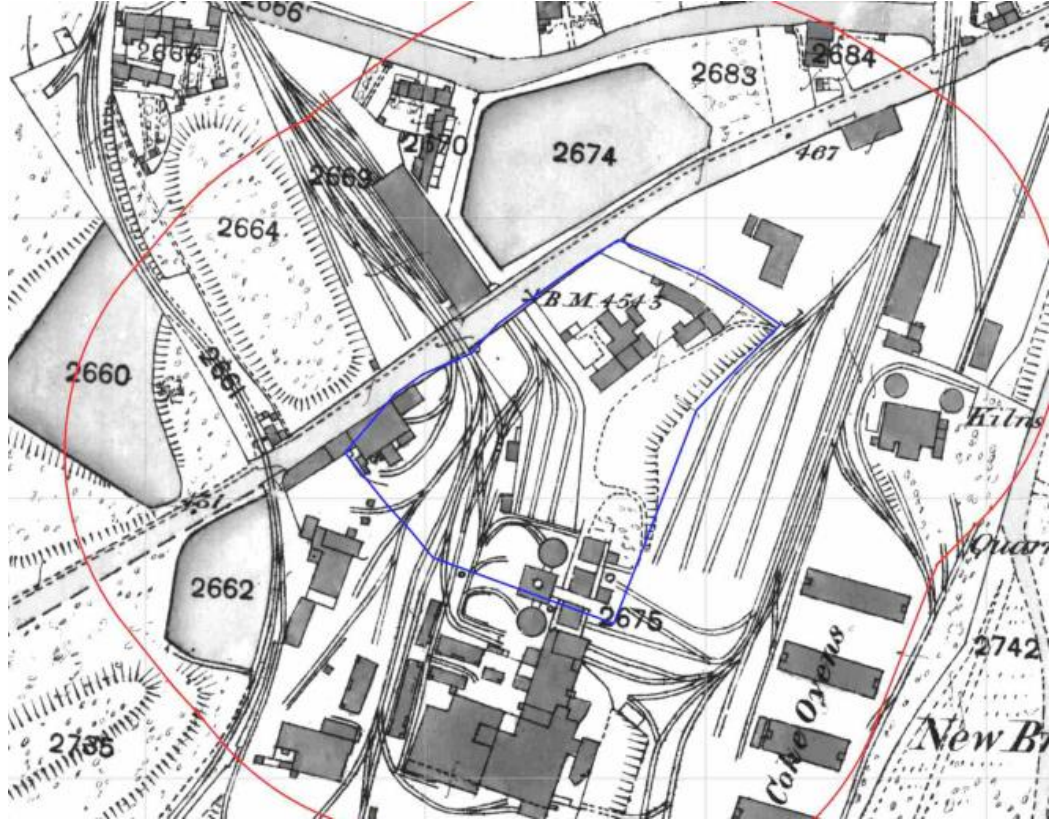
Further investigation was recommended.

Phase 1 Preliminary Risk Assessment Earth Environmental & Geotechnical Ltd (Ref. A3341/19, dated 17th December 2019)

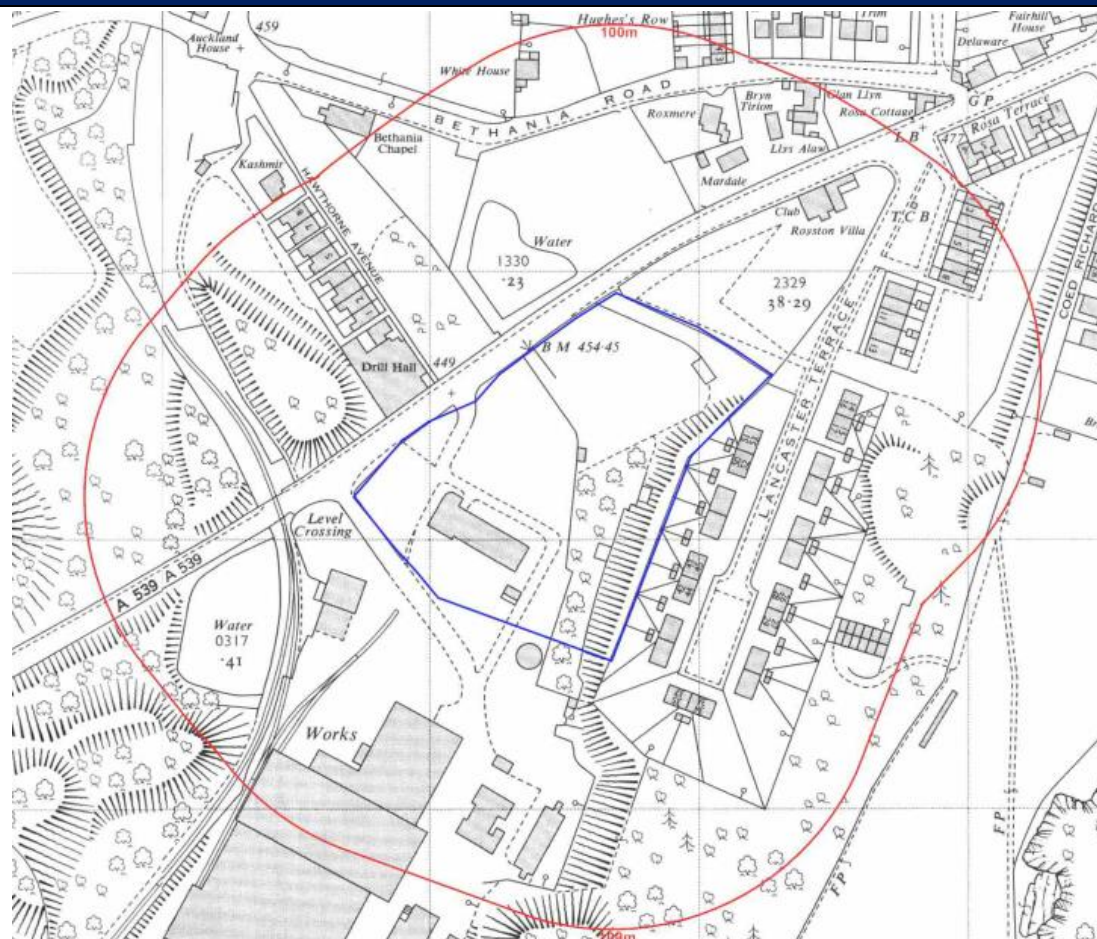
The phase 1 report identified potential contamination sources from previous land use.

In summary, from the site history, review of historical maps and site walkover survey, there was identified a low risk of potential sources of contaminants being present at the site. Any Made Ground was anticipated to be relatively thin.

Table 3.1 Summary of main findings from the Phase 1 Report.

Summary of main findings from the Phase 1 Report	
Site History	 The earliest mapping (1873) shows the presence of railway tracks and sidings running though the centre of the site connecting works to the north and south. Along the southern section of the site there is a works, potentially connected to be New British Iron Works. There are also associated buildings in the north and west. There is an embankment along the eastern boundary. Offsite, there are three reservoirs / ponds relating to the works. There are other railway sidings along eastern boundary with a series of Coke Ovens further to the east.

Summary of main findings from the Phase 1 Report



The New British Iron Works were removed by 1899 along with the majority of associated railway lines and sidings. The previous buildings were removed within the north and southern parts of the site. By 1960s, new rectangular buildings were now present in the southern part of the site. The remaining parts of the site were used for vehicle parking.

The Acrefair engineering works and Air Products Engineering facility occupied to the south of the site. The former reservoirs / ponds were infilled by 1962.

The site generally has remained unchanged until recently when the previous buildings were demolished.

Geological Setting

Made ground – present on the site variable in thickness, deepest in southern part of site.
Superficial deposits – Till (Diamicton), Devensian.
Bedrock – Pennine Lower Coal Measures Formation comprising mudstone, coal seams, siltstone and sandstone), Carboniferous.
Two coal seams outcrop through the site.

Mining

The site is located in a coal mining Development High Risk Area by the Coal Authority. There are 3no. associated coal seams and 1no. ironstone coal seam potentially underlying the site. There is a mine shaft present along the eastern boundary.

Summary of main findings from the Phase 1 Report

	The site is not in an area affected by historic brine or salt extraction. In an area where possible historical mining of bedded iron ore. Potential for difficult ground conditions are unlikely or localised and are at a level where they need not be considered
Radon	The site is located in a Radon Affected Area as between 3 and 5% of properties are above the Action Level. Basic Radon protection measures will therefore be necessary.
Hydrogeology	Superficial deposits (Glacial Till) – Secondary Undifferentiated Aquifer. Bedrock(Pennine Lower Coal Measure) – Secondary A Aquifer. There are no Groundwater Abstraction Licence, Potable Abstractions or Surface Water Abstraction Licence points within 1000m of the site. The site is not located within 500m of a Source Protection Zone or Source Protection Zone within a confined aquifer
Hydrology	There are no surface water features identified within 250m of the site.
Waste	There are no records for current Environment Agency landfill records within 1km of the site There are 9no. records of historic Environment Agency landfill sites within 1.5km of the site. The closest record refers to a site located 17m to the northwest of the site (former infilled works reservoir. The site received inert, industrial waste between 1950 and 1960.
Contamination Sources	Made Ground from various phases of on-site development and railway land Made Ground is present on site known to comprise ash/clinker/ coal. Thickness of Made Ground varies from 0.3m to 2.0m. Asbestos containing materials (ACM) from former structures Ground gas associated with deep made ground, and infilled features from railway land Contaminants may therefore include heavy metals, polycyclic aromatic hydrocarbons (PAH), total petroleum hydrocarbons (TPH), BTEX compounds, Volatile Organic Compounds (VOC), Polychlorinated Biphenyls (PCB), asbestos and ground gases (Carbon dioxide and methane).

Phase 2 Ground Investigation undertaken by Earth Environmental & Geotechnical Ltd (Ref: A3341/20/SI/V2, dated 9th September 2020)

The investigation included:

- 6 No. Rotary boreholes (RH01-06) to a maximum depth of 30.0mbgl,
- 4No Gas monitoring wells installed
- 12 No. machine excavated Trial Pits to maximum depth of 3.15mbgl ,
- Sampling for chemical and geotechnical testing of soils,
- Description of the ground encountered in accordance with BS5930:2015 + A1:2020, Code of Practice for Site Investigations.

The sequence of strata encountered beneath the site was as follows:

- Made Ground – Variable Made Ground was encountered in all the exploratory holes, comprising:
 - Asphalt hardstanding.
 - Gravels with varying sand and cobble content (containing brick, slag, glass, timber, clinker, concrete, metal, pottery fragments, carbonaceous fragments, sandstone and mudstone.
- Clay was encountered in all the exploratory holes. The clay is thought to be a completely weathered mudstone that becomes less weathered with depth. This lithology was recovered as:
 - Sandy gravelly clay (containing gravel of mudstone and carbonaceous fragments).
 - Clayey mudstone was encountered in the rotary boreholes.
- Mudstone was encountered in all of the rotary boreholes as:
 - Mudstone with occasional siltstone and sandstone bands.
- Sandstone was also encountered in all of the rotary boreholes as:
 - Sandstone with mudstone bands and strong sandstone bands.
- Coal was encountered in RH1 and RH3 and was found to be intact and separated by a thin layer of black shale.

Contamination analysis

15 soil samples were taken from depths of between 0.30m and 1.20mbgl. These samples were tested for a broad range of contaminants in line with the identified potential sources noted in the Preliminary Risk Assessment.

Table 3.2 Testing undertaken.

Suites and Contaminants	No. Samples	Location and Depth		Justification
Metals / metalloids, pH, water soluble sulphate, speciated Poly Aromatic Hydrocarbons, TPH, Soil Organic Matter and asbestos screen.	15	TP01 (0.75) TP01 (1.20) TP02 (0.80) TP03 (0.30) TP03 (1.00) TP04 (0.50) TP05 (0.40) TP06 (0.30)	TP06 (0.90) TP07 (0.20) TP08 (0.70) TP09 (0.50) TP10 (0.40) TP11 (0.60) TP12 (1.00)	A suite with a broad selection of contaminants tested as no significant evidence of contamination was identified (with the exception of occasional ash and coal).

Tier I Human Health Soil Risk Assessment

The assessment of contamination was carried out in accordance with the overall guidance presented in Land Contamination: Risk Management (LCRM). This involved the identification and evaluation of the hazards presented by the concentrations of contaminants and followed by an evaluation of the risks which are associated with these hazards (CLR11).

Elevated concentrations of contaminants of concern, with respect to the long-term protection of human health, have been identified across the site when compared to residential end use (with plant uptake) assessment criteria.

Table 3.3 Summary of Exceedances.

Contaminant	Location
Lead	TP1 – 1.2m
Inorganic Mercury	TP2 – 1.2m
TPH	TP6 – 1.2m
PAH	TP2 – 1.2m, TP6 – 0.3m, TP7 – 0.2m, TP11 – 0.6m

Assessment for the Protection of Controlled Waters

The assessment of contamination was carried out in accordance with the overall guidance presented in Land Contamination Controlled Waters.

The total concentrations detected within soil samples are predominantly relatively marginal in human health terms and do not indicate particularly high concentrations which would be indicative of a significant source of groundwater contamination. The ground conditions encountered on site have been proven to be low permeability Glacial Till overlying weathered Mudstone. Overall it is assessed that there is a low possibility of a contaminant linkage between and the underlying groundwater in the Secondary A Aquifer.

Groundsolve believes that the site does not pose a significant risk to Controlled Water because:

- the site is underlain by non-productive strata;
- the shallow groundwaters at and in the vicinity of the site are not abstracted for human consumption;
- the nearest surface water is greater than 250m from the site; and

Permanent Ground Gases

The site is located within a Radon Affected Area as defined by the Health Protection Agency, as between 3% and 5% of properties are above the Action Level of exposure and therefore basic radon protection measures will be necessary for any new properties.

There are no significant on site ground gas sources. Made Ground has been encountered in the range between 0.3m to 1.95m with a typical thickness of 1.25m. The Made Ground generally comprises clayey gravel including varying amounts of clinker, brick, mudstone, concrete, plastic, timber, metal and occasional layers of reworked firm brown clay. Total Organic Carbon (TOC) concentrations range between 0.8% to 9.7% with an average of 4.2%.

Measured Gas Concentrations

Four rounds of gas monitoring were carried out during the Phase 2 Investigation in the four gas monitoring wells. The highest flow rates, methane, and carbon dioxide concentrations to date, together with the lowest oxygen levels (i.e., a combination of the worst-case temporal conditions recorded) from the monitoring visits are summarised in the table below:

Table 3.4: Summary of Ground Gas Monitoring

Borehole	Response Zone mbgl	No. of monitoring occasions	Steady State Flow (l/hr)	Methane (%v/v)	Carbon Dioxide (%v/v)	Oxygen (% v/v)	Water Level mbgl	Atmospheric pressure readings mb
RH01	1.0-5.0	4	0.1	0.0-0.2	0.1-0.2	21.2	1.0	983-1012
RH02	1.0-5.0	4	0.1	<0.1	4.6 - 7.0	10.9-16.5	1.9	983-1012
RH04	1.0-5.0	4	0.1	<0.1	3.4-6.2	16.6-18.7	1.5	983-1012
RH05	1.0-5.0	4	0.1	<0.1	5.9-7.8	7.3-10.7	1.5	983-1012

Ground Gas Assessment

In accordance with current guidance on the assessment of ground gases with this approach and the above measured ground gas levels, it is considered that the worst-case temporal conditions may not have been measured during the monitoring period. However, it is anticipated that the worst-case temporal conditions will not be significantly worse than those presented in **Table 7.4** above. The gas flow rates measured across the whole of the site at all of the monitoring visits was less than the instrument detection limit of 0.1 l/hr. From Table 8.5 of CIRIA C665 the worst-case Characteristic Situation for the site are as follows:

Table 7.5 Characteristic Gas Situations

Borehole Number	Steady State Flow	CH ₄			CO ₂		
	l/h	% v/v	GSV (l/hr)	Characteristic Situation	% v/v	GSV (l/hr)	Characteristic Situation
RH01	0.1	0.2	0.0002	CS1	0.2	0.0002	CS1
RH02	0.1	0.1	0.0001	CS1	7.0	0.0070	CS1
RH04	0.1	0.1	0.0001	CS1	6.2	0.0062	CS1
RH05	0.1	0.1	0.0001	CS1	7.8	0.0078	CS1

Based on the Ground Gas Assessment it can be seen that the carbon dioxide conditions at the site are the main risk driver regarding the gas conditions. Table 7.5 above indicates that site has recorded CS1 conditions. However, due to the Carbon Dioxide concentrations have been recorded consistently above 5.0% within three of the four monitoring wells, it is recommended that that Characteristic Situation 2 gas protection measures are adopted for the development in line with BS8485:2015+A1:2019.

A Soil Contamination Delineation Letter Report undertaken by Earth Environmental & Geotechnical Ltd (Ref: A3341/21, dated 24th June 2020)

The purpose of the investigation was to assess the presence and likely extent of any potential environmental hazards (soil contamination) associated with previously identified hotspots within proposed garden areas.

The investigation included:

- 25 No. window sample boreholes to a maximum depth of 1.5mbgl,
- Sampling for chemical testing of soils,
- Description of the ground encountered in accordance with BS5930:2015 + A1:2020, Code of Practice for Site Investigations.

The sequence of strata encountered beneath the site was as follows:

- Made Ground – Variable Made Ground was encountered in all the exploratory holes ranging from 0.1m to >1.5m.
- Clay was encountered in areas below the Made Ground. The clay is thought to be a completely weathered mudstone that becomes less weathered with depth.

Contamination analysis

25 soil samples were taken from depths of between 0.30m and 1.20mbgl. These samples were tested for a broad range of contaminants in line with the identified potential sources noted in the Preliminary Risk Assessment.

Chemical analyses were carried out on twenty-five soil samples and were submitted for the following suite of determinants:

Lead, speciated Polyaromatic Hydrocarbons (PAH) and Speciated Petroleum Hydrocarbons (TPH).

Tier I Human Health Soil Risk Assessment

The assessment of contamination was carried out in accordance with the overall guidance presented in Land Contamination: Risk Management (LCRM). This involved the identification and evaluation of the hazards presented by the concentrations of contaminants and followed by an evaluation of the risks which are associated with these hazards (CLR11).

Elevated concentrations of contaminants of concern, with respect to the long-term protection of human health, have been identified across the site when compared to residential end use (with plant uptake) assessment criteria.

Table 3.5 Summary of Exceedances.

Contaminant		Location
Toxic Metals	Lead	WS0201 (0.80m), WS0203 (0.80m), WS0605 (0.30)
PAH	Dibenz(a,h)anthracene	WS0202 (0.80m), WS0601 (0.30m), WS0602 (0.30m), WS0704 (0.20m) and WS1103 (0.60m)
	Benzo(b)fluoranthene	WS0601 (0.30m), WS0602 (0.30m), WS0704 (0.20m) and WS1103 (0.60m)
	Benzo(a)pyrene	WS0601 (0.30m) and WS0704 (0.20m)

Conclusions

Based on the results of chemical testing from both the original and follow-up site investigation, exceedances in contaminants have been found at twelve sampling locations. The contamination is considered to be associated with clinker and ash in the Made Ground soil matrix. Due to the nature of the heterogeneous Made Ground, the exceedances are unlikely to be hot spots and typical of the general Made Ground.

Therefore, in order to break potential pollutant linkages to future residential end users, it is recommended that garden areas across the site should have a clean soil cover of 600mm thickness.

4 REMEDIATION STRATEGY

4.1 Enabling Works

The review of the previous investigations has shown that no assessment of the eastern boundary has been carried out. This area is currently restricted in accessibility due to the steep slope and dense vegetation. After the redevelopment, this area will remain a soft landscaped area as recommended by the ecological assessment for the site. Access to the general public will be restricted.

Further work is proposed at the start of the enabling works to help assess the contamination risk from the shallow soils within the eastern soft landscaped area. It is proposed that 6No. shallow hand excavated trial pits (HD01 to HD06) will be carried out within this area. It is proposed that a minimum of 6No. samples will be recovered for chemical testing. The testing suites will include Toxic Metal, PAH, TPH and asbestos. The results of the chemical testing will be assessed for suitability for residential public open space landuse.



Figure 3: Extract of Proposed Development Plan. Edge Architects NW Ltd Drawing 21-DES-001-02D – March 2022

4.2 Summary of Risk Assessments within development area

The review of the previous investigations has shown that main development site has recorded elevated concentrations of certain contaminants (Lead, Mercury, TPH, PAHs) potentially connected with the clinker/ ash material present within the Made Ground.

Carbon dioxide concentrations have also been recorded consistently above 5.0%. It has been recommended that CS2 protection measures are used within the construction of the new development.

The contamination at the site was assessed using the contaminant-pathway-receptor linkage approach. Following the site investigation, the plausible contaminant sources identified were updated and are detailed in **Table 4.1** below.

Table 4.1 – Summary of Contaminant Linkages

Receptor Group	Pollution Source	
	Hotspots	Pervasive
Human Health	The presence of Lead/ PAHs	None
Plant Life	No unacceptable contamination.	None
Controlled Waters	No unacceptable contamination.	
Water Supply Pipe Material Assessment	No special precautions required, use of PE pipe is deemed permissible	
Human health / property (from ground gases)	Radon risk is medium 3-5% of estimated properties affected. Basic radon protective measures are required. Gas Situation 2 protection measures are also required for this site.	

4.3 General Observations and Requirements

The risk assessments have concluded that remediation measures are required to address risks to human health only, resulting from contamination in the existing shallow Made Ground.

The remedial actions required for the soft landscaped areas are:

- Made Ground can be left in-situ below building floor slabs and future permanent hard standing (e.g., parking areas, roads, footpaths), excluding service runs and areas where future excavation might be anticipated (assuming all geotechnical requirements are met).
- Remediation is only required for below areas of soft landscaping where Made Ground is present to enable provision of uncontaminated cover soils in areas of garden/soft landscaping (minimum of 600 mm);

- Provision of a clean cover system in soft landscaping. A 600 mm thick cover of 'clean and inert' capping is proposed (comprising 450 mm subsoil and 150 mm topsoil).
- This clean cover will also be required where private gardens and larger front gardens on the residential development include decking, patio and hardstanding, unless otherwise approved by the local authority as it is reasonable to anticipate that a future residents may wish to alter, plant or create a soft landscape in their garden.

Dust

During the construction works there will be a low risk from dust to on site workers and people occupying adjacent properties. Appropriate risk assessments should be carried out by the contractor to allow appropriate controls for the mitigation of risk to health of construction workers to be put in place. This risk can be controlled to within acceptable limits by:

- Method statement for site activities including control of dust generation;
- having adequate site hygiene facilities allowing staff to keep a good level of personal hygiene;
- only permitting smoking or eating on site in appropriate pre-designated areas.
- the method statement shall have a contingency plan which should be implemented if the presence of asbestos is suspected in groundworks; and

Given the low level heavy metals (principally lead) and PAHs together with the proximity of residential receptors in the environs of the site and construction workers, control of fugitive dust will be required. As a minimum it is anticipated the works will be undertaken in accordance with BRE best practise guidance and that the following measures will be introduced to assist with control of dust generation during the groundworks phase of the works:

- access roads and any stockpiles created during groundworks should be regularly damped down with water;
- vehicles used to transport materials/wastes and aggregates should be enclosed or tarpaulined;
- vehicle movements and speed should be kept to a minimum within the site ;
- dust generating equipment should be located to minimise potential nuisance impacts to receptors as far as practicable; and
- minimising drop heights of all loading and unloading activities that involve the transfer of soils and demolition materials.

Main Earthworks

The proposed redevelopment will result in the provision of buildings, hardstanding (including roadways and pavements) and landscaped areas. Areas of buildings and hardstanding will be sufficient to break potential pollutant linkages relating to human health from the limited areas of Made Ground encountered on the site.

Made Ground is currently present within all proposed soft landscaped areas, therefore the following procedures should be applied:

- Removal of Made Ground **as required** to accommodate 600mm thick clean cover system ;
- Stockpiling of made ground, separately from all other materials, prior to appropriate disposal or reuse at depth;
- Placement of clean cover system, comprising min. 150mm topsoil and 450mm subsoil within any areas of Made Ground

Imported topsoil and subsoil will be required to be analysed for a suitable suite of contaminants in relation to human health (in addition to topsoil being compliant with BS3882:2015). Further details regarding sampling frequency and analysis are presented in Section 4.4.

The proposed development may be carried out in phases, therefore verification of the soft landscaped areas may be required to be carried out in phases.

4.4 Unexpected Contamination

Whilst significant gross contamination is not anticipated, the proposed redevelopment could encounter previously unrecorded hotspots of contaminants. These will be assessed and mitigated in accordance with current good practice.

A 'watching brief' is to be maintained by the Principal Contractor during all earthworks at the site. This will enable any previously unidentified contamination on the site to be dealt with in an appropriate manner. Should any unusual ground conditions, visual or olfactory evidence of contamination (including asbestos containing material) be encountered at the site, GSL and the Local Authority should be informed and further assessment may be required.

If unexpected contamination is encountered, then the procedures set out in **Appendix B** should be implemented.

4.5 Clean Cover System

A clean cover system, 600 mm in thickness, shall be installed in all garden and soft-landscaped areas, typically 450mm subsoil and 150mm topsoil. Where patios or decking is present, a 600mm thick capping layer will still apply, however some of the thickness may comprise the patio and any underlying imported stone/gravel structural make-up used in the patio construction.

None of the garden areas have yet been constructed, and therefore the same remedial measures will be carried out for all plots, whether currently developed or not. Some of the patio areas are currently in situ, these will need to be taken up and levels reduced further, to ensure that a full 600mm thick clean cover layer is present beneath finished levels.

The council will require that all imported clean cover soils are suitable, and that there is appropriate sampling and testing of this soil, and a verification report is produced. Reference should be made to the Welsh Land Contamination Working Group (WLGA) document - Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems’.

For the garden and soft landscaped areas to all plots:

- Cover systems, 600 mm in thickness, are to extend across the whole garden area, regardless of the proposed surface cover (this includes any patio areas, decking and any areas of artificial lawn).
- Clean cover in garden and soft landscaping area to comprise a minimum thickness of 150 mm of topsoil over a 450 mm thick subsoil.
- Should extensions be proposed to properties which are known to have cover systems, it is essential that the cover system is maintained, and soils at depth are not moved to the surface, compromising the cover system. It is recommended that the presence of a cover system at the property is conveyed to new house owners within the sale pack for their awareness, as permitted development rights allow some forms of extensions for which planning permission is not required.
- No soils are to be imported to site until information on their source, the results of any soil analysis, and an assessment of their suitability for use. This is to ensure that soils used as part of the proposed development are suitable for use, and contaminated soil is not brought on and used within developments.

For the new soft landscaped areas overlying Made Ground:

- Clean cover in new soft landscaped areas overlying Made Ground to comprise a minimum thickness of 150 mm of topsoil over a 450 mm thick subsoil.
- Existing topsoil / subsoil from southern areas may be reused within new soft landscaped areas. Verification testing will be required.

- If imported material is required, the soils must have information on their source, the results of any soil analysis, and an assessment of their suitability for use. This is to ensure that soils used as part of the proposed development are suitable for use, and contaminated soil is not brought on and used within developments.
- Sampling of topsoil and subsoil shall be minimum of 3 samples per source, with sampling density in line with **Table 4.2** and results meeting the requirements of the relevant assessment criteria.

The Welsh Land Contamination Working Group (WLG) document *Requirements for the Chemical Testing of Imported Materials for Various End Uses and Validation of Cover Systems* suggests the minimum frequency for developments with 20-30 plots should be 1 sample (separate topsoil and subsoil) every 3 plots meeting the requirements of Table 4.2. The proposed development comprises 22 Plots with the additional of a large communal landscaped area in the centre of the site. It is therefore anticipated there will be a **minimum** of 8No. topsoil and 8No. subsoil samples from the proposed soft landscaped areas. If plots are to be completed in stages, there will be a minimum of 3 samples for each material.

The proposed testing suite for verification testing of the topsoil and subsoil will include the following:

Table 4.2 – Acceptance Criteria for imported material (Topsoil and Subsoil)

Analyte	Soil Re-Use and Importation Criteria		Analyte	Soil Re-Use and Importation Criteria	
	mg/kg	Reference		mg/kg	Reference
Metals			BTEX		
Arsenic (total)	37	S4UL	Benzene	0.087	S4UL
Cadmium (total)	11	S4UL	Toluene	130	S4UL
Chromium (total)	520	HWT	Ethyl Benzene	47	S4UL
Chromium (hexavalent)	6	S4UL	Xylene – O	60	S4UL
Copper (total)	200	BS3882	Xylene – M or P	56	S4UL
Lead (total)	200	C4SL			
Mercury (total inorganic)	40	S4UL	Petroleum Hydrocarbons[§]		
Nickel (total)	130	S4UL	Aliphatic > EC5 - EC6	42	S4UL
Selenium	250	S4UL	Aliphatic > EC6 - EC8	100	S4UL
Vanadium	410	S4UL	Aliphatic > EC8 - EC10	27	S4UL
Zinc (total)	2,009**	HWT	Aliphatic > EC10 - EC12	130	S4UL
			Aliphatic > EC12 - EC16	1000**	HWT
Inorganic			Aliphatic > EC16 - EC21	1000**	HWT
Sulphate	2400***	-	Aliphatic > EC21 - EC35	1000**	HWT
Phenol	120	S4UL			
			Aromatic > EC5 - EC7	70	S4UL
PAH[§]			Aromatic > EC7 - EC8	130	S4UL
Naphthalene	2.3	S4UL	Aromatic > EC8 - EC10	34	S4UL
Acenaphthylene	170	S4UL	Aromatic > EC10 - EC12	74	S4UL
Acenaphthene	210	S4UL	Aromatic > EC12 - EC16	140	S4UL
Fluorene	170	S4UL	Aromatic > EC16 - EC21	260	S4UL
Phenanthrene	95	S4UL	Aromatic > EC21 - EC35	1000**	HWT
Anthracene	2400	S4UL	Aromatic > EC35-44	1000**	HWT
Fluoranthene	280	S4UL	Aromatic > EC44-EC77	1000**	HWT
Pyrene	620	S4UL	Asbestos	Not detected (<0.001%) for topsoil and subsoil	Lab LoD
Benz(a)anthracene	7.2	S4UL			

Analyte	Soil Re-Use and Importation Criteria		Analyte	Soil Re-Use and Importation Criteria	
	mg/kg	Reference		mg/kg	Reference
Chrysene	15	S4UL			
Benzo(b)fluoranthene	2.6	S4UL			
Benzo(k)fluoranthene	77	S4UL			
Benzo(a)pyrene	2.2	S4UL			
Indeno(123cd)pyrene	27	S4UL			
Benzo(ghi)perylene	320	S4UL			
Dibenzo(ah)anthracene	0.24	S4UL			

4.6 Re-Use of Soils

It is proposed that any existing made ground onsite will not be reused unless placed at a minimum of 600mm below surface level within soft landscaped areas. The location of any Made Ground will be recorded and the thickness of cover system above will be validated within the verification report. The Made Ground will be stockpiled prior to any reuse or until removal off site to appropriate landfill.

4.7 Waste Characterisation and Classification

Excess soil will be sent to a suitable landfill site. A summary of current relatively complex guidance on categorising waste from earthworks is presented in **Appendix C**. A two-phase approach is required comprising comprises:

- Waste Characterisation; and,
- Waste Classification (Waste Acceptance Criteria).

Waste Characterisation

The results of the total concentrations from the chemical testing on soil samples have been assessed to determine whether or not they are hazardous in terms of waste classification. The results of this assessment indicate that none of the materials encountered during the investigation can be classified as hazardous.

Waste Classification

In order to determine whether soils can be sent to a licensed landfill for disposal further testing is required comprising landfill Waste Acceptance Criteria (WAC) analysis for both total concentrations for certain chemicals and for leachate analysis. No WAC testing was carried out as part of the previous investigations. While WAC testing is not required for non-hazardous waste unless it is to be deposited in an inert landfill, it may be requested by the landfill operator. WAC testing can be carried out to confirm the landfill waste classification and if any pre-treatment is required.

4.8 Gas Risk Assessment

The results from the previous site investigations have shown concentrations of carbon dioxide to represent Characteristic Situation 2 (CS2) conditions to be present on site. It is therefore recommended that Characteristic Situation 2 gas protection measures are adopted for all buildings with enclosed spaces for the development in line with BS8485:2015+A1:2019.

Basic Radon protection is also required for the proposed developments.

From BS8485:2015 + A1:2019, Table 3, the new developments can be classed as a Building Type A (Private, residential) and from Table 4 of this standard, a Score of 3.5 points of protection will be required for Characteristic Situation 2 ground gas conditions. The standard does not provide set requirements, but it provides a menu of different options which in combination can be used to provide an appropriate Score as set out in Table 4 of this standard.

It is understood that the proposed protection measures include the following:

- Floor Slab:
 - Cast in situ ground-bearing floor slab (with only nominal mesh reinforcement) – Score 0.5; or
- Passive sub floor dispersal layer
 - Good performance– Score 1.5;
Media used to provide the dispersal layer are:
 - No-fines gravel layer
- Gas resistant membrane – Score 2.0:
 - Visqueen Gas Barrier – suitable for Co2 and Radon protection
 - verified in accordance with CIRIA C735.

The Principal Contractor must ensure that the gas membrane is suitably protected from damage by follow on trades.

5 VERIFICATION PLAN

5.1 General

All stages of the remediation works should be verified independently by suitably qualified and experienced personnel. Verification reports should be prepared for each stage. Verification will be required in two stages:

- Initial earthworks/remediation
- Any of Made Ground material will be stockpiled separately prior to removal to landfill or reuse on site
- Verification of imported subsoil and topsoil within soft landscaped areas overlying Made Ground,

On completion a copy of the Verification Reports should be sent to the Local Authority Environmental Health Officer for their approval so that planning conditions can be discharged. A copy of the report should be sent to the NHBC, local authority building control officer or other similar authority for their approval. Where such organisations are involved in the development process, it is advised that approval be sought to any remediation works from these organisations prior to the commencement of development.

It is important that the information provided to show that remediation was carried out is provided for each area where remediation was required. Where remediation was required at individual areas of a development then it is particularly important to make sure that information is provided for each of those individual areas. It is not sufficient to provide information that simply provides general information about the remediation work that was carried out.

5.2 Verification of Earthworks/Remediation

The verification works/ report should include:

- A description of the works, sample location plan, test results, photographs, interpretation;
- Contractor's documentation (e.g., method statements, plant data sheets etc.);
- Manufacturer's/ supplier's product documentation (e.g., compliance certificates & delivery notes;
- Records of all imported / onsite topsoil, subsoil and soil conditioning material for the site complete with laboratory test certificates demonstrating that the material is suitable for use (if appropriate);
- Verification Engineer's daily logs;
- Photographic Records;
- As-built Drawings;
- Description of how the use of materials links with the Remediation Strategy;
- Reference to site investigation data and risk assessments;

- Record of quantity of materials used;
- Details of any unexpected contamination encountered and how it was dealt with;
- In order that regulatory compliance can be confirmed, a copy of all site licences, consents, Waste Transfer Notes and imported material consignment notes shall be included.

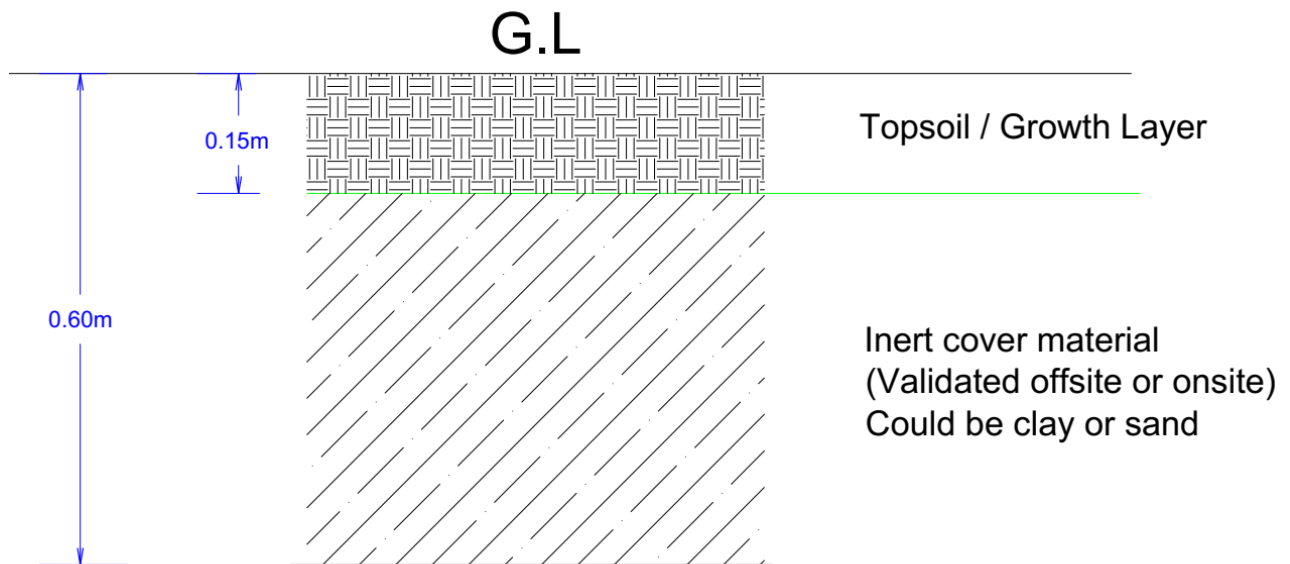


Figure 4: Schematic drawing showing typical cover system construction within garden and soft landscaped areas

5.3 Imported Subsoil and Topsoil

Imported soils will be tested to ensure suitability, GroundSolve propose the following soil validation strategy:

Pre-Placement of Soils

- Imported material (for both sub-soil and topsoil), as detailed above, and compared to appropriate assessment criteria (**Table 4.2**).
- Verification photographs from the proposed garden and soft landscaped areas before the placement of the cover system

Post Placement of Soils

- Place sub-soil and topsoil to a minimum thickness of 600 mm in garden areas, which includes a suitable thickness of topsoil as a growing medium.
- Method of Validating Capping Thickness:
 1. Engineer to verify thickness of capping layer via hand dug exploratory holes from 1 in every 3 plots, plus the soft landscaped area from both topsoil and subsoil.

2. Engineer to digitally photograph every residential garden area and soft landscaped area post capping.
 3. All data to form part of a Validation Report which must include prints of all digital photographs titled with plot number, front or rear garden, or location of soft landscaped area.
- Submit a validation report confirming the works have been undertaken in accordance with this agreed strategy.

5.4 Gas General Verification

Verification is required in accordance with CIRIA C735. Verification is defined within CIRIA C735 as:

The process of demonstrating that risk has been reduced to meet remediation criteria and objectives based on a quantitative assessment of remediation performance.

Following the installation of each component that contributes to the gas protection score, verification is required, in accordance with BS8485 and CIRIA document C735 'Good Practice on the Testing and Verification of Protection Systems for Buildings Against Hazardous Ground Gases' (2014).

BS8485 states that "The installation and verification report should present an accurate description of the measures actually applied and present the evidence gathered to confirm that installed measures are suitable for purpose.

The risk based approach identified within CIRIA C735 guides the verification plan to consider the following:

- Site specific gas regime
- No. of plots
- Complexity of the design and installation
- Qualifications and experience of the workforce (Construction Skills level 2 NVQ diploma)

The site is considered as the following:

- Well characterised as CS2 - Green
- Proposed residential development is small/medium - orange
- The foundations and gas protections measures are relatively simple - green
- Gas protection measures will be installed by combination of general builders with the membrane installed by a specialist contractor, which have extensive experience at installing gas protection systems - orange

The factors above have shown a range of 'green' to orange as identified in Figure 3.1 of CIRIA C735. Therefore, the role of the independent verification of the gas protection measures is would be likely to have a relatively light touch.

All aspects of the ground gas mitigation measures will be checked and validated. No membrane will be validated and signed off by independent verifier until a minimum acceptable standard has been achieved, whereby ensuring the membrane installation is suitably managed to achieve maximum confidence to the suitability of the installed materials.

Verification/validation of gas membrane installation should confirm:

- inspection of the products being used (membrane, tape, propriety top hats etc.) to ensure they are as specified
- laps are sufficient in length with edges, seams, service penetrations all sealed.
- the membrane spans across the cavity wall.

Any defects identified in any of the points above will be recorded on the verification pro-forma with photographic records, together with corrective actions and subsequent verification checks.

The visit details will be presented in a verification report including photographic evidence for submission to the Planning Authority to complete the discharge of relative planning conditions.

6 REGULATORY REQUIREMENTS

6.1 Remediation

Any proposals to remediate or develop the site should be agreed with the relevant authorities (e.g., local authority environmental health officer) to obtain Planning Permission prior to commencement of the works and should be agreed with the NHBC, or similar, or with the local authority building control officer prior to commencement of the works.

6.2 Health and Safety

The works should be undertaken in compliance with all relevant regulations, guidance and legislation. As outlined within the HSE publication "Successful Health and Safety Management – HSG65" this report should inform your

development of safe systems of work and information as an input into the safety management system. The contents of this report may be used to supplement the contents of the Health and Safety File as required under the Construction Design and Management (CDM) Regulations 2015. All risk control measures should be in accordance with the guidelines laid down within the Management of Health and Safety at Work Regulations 1999.

In accordance with the Construction Design and Management (CDM) Regulations 2015, GroundSolve has acted in the role of Principal Contractor and as Principal Designer for the works as described in this report. With issue of this report, GroundSolve has discharged and completed all contractual and legal requirements for these positions, and we have no further involvement with the project. The Principal Contractor is responsible for obtaining any necessary approvals from regulatory bodies and third parties to fully implement the works.

7 REFERENCES

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- BS5930:2015+A12020 Code of practice for ground investigations BSI
- BS8485 2015 Code of Practice for the design of protective measures for methane and carbon dioxide ground gases in new buildings. British Standards
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- SoBRA (2017) Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater – Version 1.0.
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- Coal Authority Interactive Map Viewer, <http://mapapps2.bgs.ac.uk/coalauthority/home.html>
- BGS Geology of Britain Viewer <http://mapapps.bgs.ac.uk/geologyofbritain/home.html>

8 DEFINITIONS

AOD	Above Ordnance Datum
bgl	Below ground level
BGS	British Geological Survey
BRE	Building Research Establishment
CBR	California Bearing Ratio (test)
COMAH	Control of Major Accident Hazards (regulations)
DQRA	Detailed Quantitative Risk Assessment
DWS	Drinking Water Standard
EQS	Environmental Quality Standard
GAC	Generic Assessment Criterion
GQA	General Quality Assessment (Environment Agency)
GQRA	Generic Quantitative Risk Assessment
GSV	Gas Screening Value
HCV	Health Criteria Value
IPPC	Integrated Pollution Prevention and Control (regulations)
NGR	National Grid Reference
NIHHS	Notification of Installations Handling Hazardous Substances (regulations)
OS	Ordnance Survey
ppm	Parts per million
ppmv	Parts per million by volume
SAC	Special Area of Conservation
SPZ	Source Protection Zone (see Error! Reference source not found.)
SSAC	Site-Specific Assessment Criterion
SSSI	Site of Special Scientific Interest

APPENDIX A - DRAWINGS



SITE PLAN

EDGE
ARCHITECTS

RIBA
Chartered Practice

EDGE Architects NW Ltd.
Studio 55:20
North Wales Business Park, Abergelle
Conwy, LL22 8LJ

CLIENT:

Gower Homes Ltd

ADDRESS:

Former Air Products site, Llangollen Road,
Acrefair LL14 3HW

PROJECT:

Proposed residential development

DRAWING No:

DATE: MARCH 2022

21-DES-001-02 C

SCALE: 1:500 @ A3

APPENDIX B - UNFORESEEN GROUND CONTAMINATION

Unforeseen Ground Contamination

There is the potential for areas of previously unexpected contamination to be present, as is the case with any “brownfield” site. Any significant quantities of asbestos, significant ashy soils, unusual, brightly coloured or significantly oily or odorous material should be considered in this category. If unexpected contamination is found the following procedures should be adhered to:

1. All site works at the position of the suspected contamination will cease.
2. A suitably trained geo-environmental specialist should assess the visual and olfactory observations of the condition of the ground and the extent of contamination, and the Client and the Local Authority should be informed of the discovery. Should the contamination be likely to affect controlled waters the Environment Agency shall also be informed.
3. The suspected contaminated material will be investigated and tested appropriately in accordance with the assessed risks. The investigation works will be carried out in the presence of a suitably qualified geo-environmental engineer. The investigation works shall commence to recover samples for testing and, using visual and olfactory observations of the condition of the ground, delineate the area over which contaminated materials are present.
4. The unexpected, contaminated material will either be left in situ or be stockpiled whilst testing is carried out and suitable assessments completed to determine whether the material can be re-used on site or requires to be disposed as appropriate.
5. Where the material is left in situ awaiting results it will be reburied or covered with plastic sheeting.
6. Where the potentially contaminated material is to be temporarily stockpiled it will either be placed either on a prepared surface of clayey Alluvium, or on 2000-gauge Visqueen sheeting (or other impermeable surface) and covered to prevent dust and odour emissions.
7. Any areas where unexpected visual or olfactory ground contamination will be surveyed, a photographic record kept, and testing results incorporated into the Verification Report.
8. A photographic recorded will be made of relevant observations.
9. The testing suite will be determined by the independent geo-environmental specialist on the basis of visual and olfactory observations.
10. Test results will be compared against current assessment criteria suitable for the future use of the area of the site affected.
11. The results of the investigation and testing of any suspect unexpected contamination will be used to determine the relevant actions. After consultation with the Local Authority and if necessary the Environment Agency, materials should either be:
 - re-used in areas where test results indicate that it meets compliance targets so it can be reused without treatment; or
 - treatment of material on site to meet compliance targets so it can be reused; or

- removal from site to a treatment centre or to a suitably licensed landfill or permitted treatment facility.

12. Verification Report will be produced for the work.

Asbestos

Asbestos cement products and asbestos fibres have not been encountered in the soils at the site but based on the age of the Made Ground material containing asbestos could be expected to be encountered. If non-notifiable asbestos (e.g., chrysotile asbestos cement board) is encountered in excavations then it will be dealt with in accordance with the Control of Asbestos Regulations 2012 (CAR 2012) and the HSE's ACoP for asbestos (2013). Finding non-notifiable asbestos is a very common occurrence on brownfield sites and is a relatively low risk activity and can be dealt with as a matter of routine. Therefore, it is not proposed that the Council will be notified but an appropriate record will be kept of confirmatory testing and disposal. This will be included in remediation verification reports.

If suspect notifiable asbestos is encountered then the Council and the HSE will be notified. An appropriate action plan will be agreed with the Council and the HSE in accordance with CAR 2012. The action plan will include the preparation of the Risk Assessment and Plan of Work in accordance with CAR and other statutory requirements including:

- Site mobilisation;
- Excavation methodology;
- Handling, movement and storage on-site of excavation arisings;
- Any processing of excavation arisings containing ACMs;
- Movement and placement of arisings to final destination;
- Placing of cover system over soils with and ACMs remaining on-site;
- Off-site disposal of ACMs;
- Licences;
- PPE & RPE; and,
- Dust and fibre monitoring.

Potential mitigation measures that would be required include:

- Ensuring works are carried out by suitably trained and experienced personnel with working with asbestos;
- Site investigation and risk assessment;
- Removal or treatment of asbestos hotspots;
- Use of PPE and RPE by construction workers; and,

- Compliance monitoring.

Unexpected Tanks

No buried underground fuel storage tanks have been encountered during the site investigation works; however, there remains a low risk that tanks are present on-site. Should an underground tank be encountered, operations should cease in the area. Additionally, there may be pipework associated with these tanks which could have oily residues. The following procedures are to be adhered to if tanks and pipework are identified:

1. All site works at the position of the tanks/pipework should stop.
2. A description of the tank should be made by the geo-environmental engineer including; condition and surround, along with visual and olfactory observations should any contents in the tank be apparent. A photographic record will also be made of relevant observations.
3. The tank's position and depth should be determined and marked on a plan of the site.
4. The independent geo-environmental engineer will inform Client and the Local Authority.
5. During the presence of the independent geo-environmental engineer, investigation works should be undertaken to obtain samples of any liquid or sludge contents and to establish dimensions of the tank.
6. Testing will be determined on the basis of visual and olfactory observations by independent geo-environmental engineer.
7. Test results will be compared against current assessment criteria and proposals for disposal of any contents determined in agreement with the appropriate Regulatory Parties.
8. Emptying the tank and disposal of contents to a suitable licenced disposal facility.
9. Degassing and removal of the tank by a suitably qualified contractor will be required, and a Naked Flame Certificate should be provided.
10. Once the tank has been emptied in accordance with the above proposals, it is to be removed for disposal to a licensed waste management facility. Copies of the relevant waste consignment notes are to be kept and included in the Verification Report.
11. Excavation and remediation of any contaminated soils around the tank will be carried out.
12. Samples of the base and sides of the resultant hole will be sampled and supervised by the independent geo-environmental engineer to confirm whether risks to human health or controlled waters.

APPENDIX C - GUIDANCE FOR CLASSIFICATION OF SOIL FOR OFF SITE DISPOSAL AT A LANDFILL SITE

Guidance for Classification of Soil for Off Site Disposal at a Landfill Site

Many site developments create a portion of excess soils and Made Ground which if not re-usable, are required to be disposed off-site at a suitably licensed landfill site. The regulations and associated guidance published by the Environment Agency is relatively complex and lengthy. This guidance provides a summary of the following documents which should be referred to when assessing soil (and common constituents found within Made Ground on remediation sites) for off-site disposal:

- Guidance for Waste destined for disposal in landfills: Interpretation of the Waste Acceptance Requirements of the Landfill (England and Wales) Regulations 2002 (as amended) (EA, 2004);
- Guidance on Sampling and Testing of Wastes to Meet Landfill Waste Acceptance Procedures (EA, April 2005);
- WM3 - Hazardous Waste: Interpretation of the Definition and Classification of Hazardous Wastes (EA, May 2015);
- European Regulation No 1272/2008 on Classification, Labelling and Packaging of substances 2015 (CLP 2015);
- Guidance on Waste Destined for Disposal in Landfill (EA, June 2006);
- Treatment of Non-hazardous wastes for Landfill (EA, February 2007).

It is important to distinguish between the waste classification system and the designation of materials as “suitable for use” on site. A material may be retained on site for an appropriate end use if that end-use is clearly designated and that a site-specific risk assessment ensures that it does not pose a risk to human health or controlled waters. However, if this material is excavated and sent for disposal, the material is then subject to waste management regulations and the two systems cannot be directly correlated. It is therefore important to note that classifying a material as hazardous (should it be excavated and become a waste) does not necessarily indicate that it might not be suitable to be kept on site for re-use. Separate guidance in the form of a Code of Practice (CL:AIRE Version 2, 2011) has been developed jointly between the development industry and the Environment Agency to provide best practice when assessing whether materials are wastes or not, and for determining when waste can cease to be waste for a particular use.

In accordance with the current waste regulations (or Landfill Directive, as they are more commonly known), from 30th October 2007 all waste materials produced from construction sites have to be pre-treated prior to disposal. Pre-treatment includes waste minimisation, recovery (e.g., separation of demolition waste to be used as hardcore) and separation of materials into different waste categories (e.g., separate inert waste from hazardous waste etc). Mixing of different waste types shall be avoided and intentional mixing of inert materials with hazardous waste to ‘dilute it’ and hence change its waste classification, is illegal.

The current waste regulations (based on the EU landfill directive) introduced a two-tier classification system for waste materials, defining them as either being hazardous or non-hazardous. Landfills are licensed to take wastes based on a three-tier classification system with the non-hazardous waste divided into two sub-categories:

- Non-Hazardous - inert;
- Non-Hazardous - non-hazardous;
- Hazardous.

Waste materials are categorised with a six-figure numeric code in the European Waste Catalogue. Commonly found construction and demolition wastes including excavated soil from contaminated sites and Made Ground with their waste codes are summarised below (this is not a comprehensive list):

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 01 01 Concrete	Concrete, possibly with reinforcement (from Construction & Demolition)	✓		
17 01 02 Bricks		✓		
17 01 06* Mixtures of concrete, bricks, tiles & ceramics containing dangerous substances	These are not normally considered hazardous but if they are contaminated (e.g., by asbestos) then could be hazardous – see comment above			✓
17 01 07 Mixtures of concrete, bricks, tiles & ceramics other than those in 17 01 06	This is mixed inerts c.f. 17 09 04	✓		
17 05 03* soils and stones containing dangerous substances				✓
17 05 04 soils and stones other than those mentioned in 17 05 03	Soil and stones only (excluding top soil, peat, soil and stones from contaminated sites)	✓		
17 06 05* Construction materials containing asbestos	e.g., corrugated asbestos sheeting			✓
17 08 02 Gypsum-based construction materials other than those mentioned in 17 08 01	Plaster & plasterboard (although specific disposal requirements are required for high sulphate waste – see EA guidance ‘Understanding the Landfill Directive’ version 1.0 March 2010.		✓	
17 09 01* Construction & demolition wastes containing mercury				✓
17 09 02* Construction & demolition wastes containing PCBs	Waste with more than 50 mg/kg of PCB’s are hazardous			✓

Waste Code	What is it?	Likely Waste Category–		
		Inert Waste	Non-Hazardous	Hazardous Waste
17 09 03* Other mixed construction & demolition wastes containing dangerous substances	Broad range of potentially (see notes below – if asterix the waste is hazardous) hazardous wastes			✓
17 09 04 Mixed construction & demolition wastes other than those mentioned in 17 09 01, 17 09 02 & 17 09 03	Mixed inerts with soil, tarmac, cables, vegetation, plaster, etc. (this waste can only be considered inert if it passes the waste acceptance criteria identified in the regulations).	✓	✓	

Note: all wastes with an asterix code are hazardous regardless of whether they are mirror or absolute entries in the EWC list the decision to with regard to composition must come before applying the code for mirror entries.

Some materials are classified as Inert Waste based in its origin (e.g., 17 01 01 Concrete, or glass) without any requirement for laboratory chemical analysis.

However, most soils will require laboratory testing to confirm whether they are classified as Hazardous Waste. The protocol for assessing these materials and the appropriate threshold values is complicated and are set out in the Environment Agency’s “Technical Guidance WM3 Hazardous Waste – Interpretation of the Definition and Classification of Hazardous Waste” (2015). If the test results for the waste indicates that it is not hazardous then further analysis of the waste is required to determine whether it is Inert Waste. If the waste does not meet the criteria for either Hazardous or Inert, then it is by default classified as Non-hazardous Waste.

As an alternative location to landfills for off-site disposal of inert and non-hazardous waste, there are a number of sites which have Waste Permit Exemptions that can accept certain categories of inert and non-hazardous wastes. Additionally, some quarries can accept certain types of wastes to be used for quarry restoration material. For both alternatives to disposal at landfill sites the material still requires chemical testing as these sites have site specific acceptance criteria for wastes. It should also be noted that these types of sites do not incur landfill tax which in the 2022/23 tax year is £3.25 for inactive waste (inert and some types of non-hazardous waste) and £102.20/Tonne for active waste (some types of non-hazardous waste and hazardous waste). For 2024/25 the corresponding rates will be £3.30 and £103.70/Tonne. Note that the Inland Revenue uses a different classification scheme for waste for tax purposes to the European Waste Classification scheme.

Waste Categorisation

The process of determining the category of wastes is a three-stage process:

- Stage 1 – is the waste either Hazardous or Inert by definition without the requirement for chemical analysis (if it is then Stages 2 and 3 are not required);
- Stage 2 - Waste characterisation;
- Stage 3 - WAC classification.

Waste characterisation determines if a waste is hazardous or not. Excavated soil is characterised using a system based on the contaminants present and their hazardous properties. The system uses total concentrations of the contaminants. Thresholds (as a percentage of the waste) have been set for the various hazardous properties.

Fourteen hazardous properties together with other scenarios where material could cause a hazard have been defined:

- Hazardous properties: explosive, oxidising, highly flammable/flammable, irritant, harmful, toxic, carcinogenic, corrosive, infectious, toxic for reproduction, mutagenic and ecotoxic;
- Substances which can release toxic/very toxic gases in contact with water, acid or air;
- Substances which, after disposal, can yield another substance, e.g., a leachate, which possesses any of the above hazardous properties.

Some of the hazardous properties are sub-divided e.g., there are three categories of carcinogenic, mutagenic and toxic for reproduction substances. The hazardous properties were originally defined in the European Hazardous Waste Directive 91/689/EC. Should a waste contain a contaminant with one or more of the listed hazardous properties at a concentration equal to or above the threshold value for the particular property, then the waste is hazardous. The hazardous properties of a wide range of chemicals are sourced from CLP 2015.

There are many reasons why waste soil is classified as being hazardous, but the majority of reasons can be divided into the following four groups:

- Hydrocarbons – this is probably the most common reason for the hazardous classification of soils. For most soils hydrocarbon analysis will be required for both Polycyclic Aromatic Hydrocarbons (PAH) and speciated Petroleum Hydrocarbons (PHCs) but depending on the site's history other groups of organic contaminants may also be included in any analysis suite for soil samples;
- Metals – Particularly sites from former metal processing or mining sites and also some types of ash have metal concentrations that are sufficiently high to characterise materials requiring disposal as hazardous waste.
- Asbestos;
- Anions – e.g., sulphate in plasterboard (there are special disposal requirements for high sulphate waste and specific WAC requirements); it is possible that sulphate salts of metals and semi-metals could make the waste hazardous – the sulphate concentration could possibly be significant under H12, H13 and H14.

The characterisation of wastes with significant metal concentrations involves some processing of the analysis data. The chemical analysis results for inorganic substances are generally reported as total concentrations e.g., total lead, total arsenic, total sulphate etc. However, CLP 2015 deals with the hazardous properties of actual compounds e.g., lead sulphate, arsenic pentoxide, nickel carbonate. Therefore, the total metal results have to be converted into assessed chemical analysis results for the compound most likely to be present in the soil samples. For example, if the sample contains high total lead concentrations and high sulphate concentrations, then the lead is likely to be present

in the soil as lead sulphate. The most likely compounds can often be determined from a desk study or previous site uses. If the site has been derelict for a number of years, consideration should be given as to whether water soluble compounds should or should not be chosen, as rainfall could have removed them from the soil (this does not apply if the soil has been taken from below under a concrete slab etc). Chemical knowledge and common sense needs to be used in choosing a suitable compound.

If no data is available, then a worst-case scenario has to be assumed and the most hazardous compound likely to be present has to be chosen. For example, metal chromates (lead chromate, nickel chromate) are often the most hazardous compounds formed by many metals, but if the chromium concentrations in the soil are low, chromates are unlikely to be present. It should also be noted that for many of the hazard categories, the cumulative hazard from different compounds is added (e.g., add the concentrations of the copper, lead and zinc compounds together to assess the Hazard Category H14 Ecotoxicity).

If the results of the above assessment determine that the waste is hazardous, it must then be analysed for the Waste Acceptance Criteria (WAC) analysis contained within appropriate Environmental Permitting Regulations (this comprises mainly leachate but also analysis for TOC and Loss on ignition). WAC limit values have been set for the listed determinands. If any of the determinands exceed their limit value, the waste must be pre-treated to reduce concentrations to below the limit values before the waste may be disposed of at a landfill site licensed to take hazardous waste.

For waste classified as not being hazardous, then there are two options available. Currently, waste correctly characterised as not being hazardous may be disposed of without WAC testing to a non-hazardous landfill. Alternatively, WAC testing for Inert Waste can be carried out (this is similar to the list for hazardous waste with the addition of PAH's, BTEX and Mineral Oil). If the results pass the Inert WAC criteria it can be disposed of at an Inert Waste Landfill. If any of the WAC test results exceed the Inert WAC criteria the waste has to be disposed at a non- hazardous landfill. There are WAC limits for non-hazardous waste set for pH and TOC. If these two criteria are not met then the waste must be pre-treated to so that it meets the criteria before it can be disposed.

If materials fail the WAC criteria it may be possible to pre-treat the waste on-site or be taken to a soil treatment centre for pre-treatment to reduce the soil's hazardous properties (e.g., by bioremediation of hydrocarbons).

It should be noted that in order to dispose of Hazardous Waste, the site must register as a producer of Hazardous Waste with the Environment Agency. When disposing of waste materials to landfill sites the appropriate Duty of Care Waste Transfer procedures must be followed.

Landfilled Waste Decision Tree

