



Geotechnical &
Environmental
Consultants

Dam Gate
Holbeach

**Remediation Method Statement
For
Ashwood Homes**



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Project No: D38108		Date: 18th August 2020	
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Comments			

1.0 INTRODUCTION

1.1 Introduction

GeoDyne Limited has been appointed by the Client, Ashwood Homes, to prepare a Remediation Method Statement (RMS) relating to the site at Dam Gate, Holbeach. A site location plan (Figure No. D38108/R1) is included in Appendix I.

The RMS has been prepared taking due consideration of the following previous report:

- GeoDyne Limited report '*Dam Gate, Holbeach – Combined Phase I Desk Study and Phase II Exploratory Investigation*', produced for Ashwood Homes, Reference D38108, dated 30th September 2019.

We would recommend that the above referenced report is read in conjunction with this RMS.

1.2 Project Understanding

We understand that it is proposed to redevelop the site with low-rise residential properties to include private gardens, as indicated on the proposed site layout drawing contained within Appendix II. This understanding has formed the basis of our report.

Where our understanding is incorrect, it may be necessary to review our assessment to ensure that it continues to apply.

1.3 Project Overview

The above referenced report was forwarded to South Holland District Council (SHDC) as part of the planning consultation process in relation to the discharge of the planning conditions relating to contamination. Following this submission, an email was received from SHDC detailing comments dated 5th August 2020 from the Environmental Protection Officer in relation to our report.

With respect to remediation, the comments state '*The report recommends remediation and/ or further site investigation, and either option is acceptable*'. In relation to ground gas issues at the site, the comments state '*The report currently recommends either installation of ground gas protection measures to CS2 or further monitoring to delineate the area of which these may be required. Either option is acceptable*'.

A copy of the comments from SHDC is presented in Appendix III.

We have produced this RMS based on our current understanding of the Clients preferred options with respect to both remediation and ground gas protection measures, to provide the Site Manager with a document for control of the remediation and validation works at the site.

1.4 Details of Remediation Method Statement (RMS)

This RMS details the necessary remediation and validation measures required at the site and represents a stand-alone report to act as a working document for use by the Contractor carrying out the remediation works; the Client including the construction phase Site Manager; and the Supervising Engineer in order to control / manage the remediation activities and the validation works.

The responsibilities of the Supervising Engineer (GeoDyne) are restricted to monitoring the works of the Contractor in terms of compliance with this Remediation Method Statement, carrying out validation testing, liaison with Regulators and reporting.

The Supervising Engineer has no responsibility for the direct instruction of the Contractor, or measurement and administration of the contract. The Supervising Engineer will report to the Client who will issue all instructions to the Contractor.

This document also states the level of inspection and Site Acceptance Criteria considered appropriate by GeoDyne for assessment of any soils which are proposed to be imported to site for use within the development.

1.5 Limitations

This report has been produced specifically to address remediation and validation issues at the site. For a detailed review of the sites history, geology and environmental setting, and recommendations relating to all other matters, reference should be made to the previous report detailed in Section 1.1.

The recommendations made in this report are limited to those that can be made based on the findings of the investigation works previously undertaken at the site. Where comments are made based on information obtained from third parties, GeoDyne Limited assumes that all third party information is true and correct. No independent action has been undertaken to validate the findings of third parties unless specifically stated.

The RMS has been prepared in accordance with our understanding of current best practice. However, new information or legislation, or changes to best practice may necessitate revision of the report after the date of its issue.

GeoDyne Limited has prepared this report for the sole use and reliance of the Client, Ashwood Homes, in accordance with our standard Conditions & Limitations provided in Appendix V. This report may not be used or relied upon by any unauthorised third party without the explicit written agreement of GeoDyne Limited. Reliance may not be placed on our report until all invoices associated with the project have been paid.

2.0 SITE SUMMARY

2.1 Site Description

At the time of our previous Phase I and II works in July and August 2019, the site comprised an undeveloped grassed field which incorporated numerous mature trees and a pond.

Drainage ditches were present either completely or partially along the western, southern and eastern site boundaries. Scar-like features (potentially representative of a culvert) were visible on the ground surface in the southeast and centre of the site.

2.2 Summary of Site History

Historically, the site has largely remained as an undeveloped grassed field. However, two presumed agriculture related buildings were present along the eastern edge of the site which became present circa 1960s which appear to have become absent circa 2006. A number of ponds and drains were present on-site that have become absent and are presumed infilled and / or culverted. According to the historical maps, the western site area comprised a golf course from circa 1980s.

2.3 Summary of Geological & Environmental Setting

A full description of the sites geological and environmental setting has been provided in the previous report and the salient issues are summarised in Table 1.

TABLE 1 – SUMMARY OF GEOLOGICAL & ENVIRONMENTAL SETTING	
Geology	The site is indicated to be underlain by drift deposits comprising Tidal Flat Deposits. Bedrock of the Ampthill Clay Formation is indicated to underlie the drift deposits beneath the majority of the site, although in the western extremity of the site, bedrock comprising the West Walton Formation is indicated to underlie the drift deposits.
Hydrogeology	The drift deposits and underlying bedrock are both classified as Unproductive Strata. The site is not shown to lie within a Source Protection Zone (SPZ), as designated by the Environment Agency. There are no water abstractions on site or within close proximity to the site.
Hydrology	A pond is present in the central south of the site. Drains are also present around the site and partially around the western, southern and eastern site boundaries. Numerous Inland Rivers within the surrounding site area, predominantly to the east, west and south of the site. Four underground (potentially culverted) Inland Rivers from between 81m and 217m to the southwest of the site.

2.4 Summary of Ground Conditions

Made Ground (including Made Ground topsoil) was encountered in localised areas of the site. In four of the exploratory holes, the Made Ground comprised topsoil over reworked natural clay / silt strata to depths of up to 0.90m begl. In two exploratory holes, the Made Ground was encountered to depths of 1.40m and 2.20m begl and comprised a clay / silt which included peat in addition to fragments of brick, glass bottles and pieces of plastic, metal and wood.

Where Made Ground was absent, natural TOPSOIL was encountered at the surface in the exploratory holes to an average depth of approximately 0.30m begl.

Underlying the Made Ground or natural topsoil, the Natural Strata initially comprised firm (locally stiff) silty sandy CLAY and / or firm sandy very clayey SILT. These soils were typically encountered to depths of between 1.40m and 2.70m begl and were noted to locally become softer with depth.

With the exception of the eastern extremity of the site, very soft CLAY was encountered underlying the near surface Clay and Silt. In the majority of the exploratory holes, the very soft Clay was noted to be peaty.

2.5 Contamination Assessment Findings

Human Health

Contamination testing was carried out on selected samples of the Made Ground (including topsoil), natural Topsoil and the underlying Natural Strata.

The results of the contamination assessment of the Made Ground revealed a concentration of lead within one sample (TP14) and a concentration of dibenzo(ah)anthracene in one sample (TP5) to be elevated above Tier 1 human health screening criteria based on a residential with plant uptake end-use. The Made Ground was found to incorporate man-made materials including brick, glass, plastic, metal and wood.

The natural Topsoil and Natural Strata may generally be considered to be uncontaminated for the proposed residential with plant uptake end-use.

Controlled Waters

Although there are exceedances of lead and PAH (dibenzo(ah)anthracene) above the Tier 1 human health screening criteria within the Made Ground there was no obvious visual or olfactory evidence of chemical soil contamination within the underlying Natural Strata. Therefore, taking into account the nature of the soils and the contaminants identified, there are considered to be no specific risks posed to Controlled Waters by the findings of the laboratory analysis undertaken.

2.6 Summary of Ground Gas Assessment

The ground gas monitoring carried out at the site has identified a maximum methane concentration of 0.7% v/v and a maximum carbon dioxide concentration of 6.8% v/v. Measurable steady flow rates were not recorded during the monitoring visits.

Based on the findings of the ground gas monitoring undertaken to date and the development proposals with buildings that may be designated as Building Type A, the site may be classified as Characteristic Situation CS2 in accordance with BS 8485:2015+A1:2019. In view of this, gas protection measures are required to be incorporated within the proposed new buildings to be constructed at the site.

The Combined Report noted 'the site has been classified as Characteristic Situation (CS2) based on carbon dioxide concentrations exceeding 5% by volume in one of the five gas monitoring standpipes, i.e. up to 6.8% by volume. In view of this, consideration should therefore be given to undertaking further gas monitoring at the site (including from additional gas monitoring installations and falling periods of rapidly falling atmospheric pressure) in order to obtain a more robust dataset and better characterise the ground gas regime at the site. It is considered possible that the findings of such further monitoring may potentially result in a reduction in the area of the site / number of properties requiring gas protection measures'.

We understand at this stage that the Client does not intend to carry out further monitoring and assessment of the ground gas regime and that it is currently proposed to install ground gas precautions compliant with the requirements of CS2 within all proposed dwellings at the site.

3.0 CONCEPTUAL SITE MODEL

3.1 Introduction

GeoDyne's conceptual site model (CSM) of possible CPR pollutant linkages based on the findings of the Phase II Exploratory Investigation works (reproduced from our Combined Report referenced in Section 1.1) is provided in Table 2.

In preparing this CSM, it has been assumed that construction personnel involved with the redevelopment of the site (typically short term (acute) exposure) will adopt all necessary personal protective equipment (PPE and RPE etc.) and conform to all appropriate health and safety requirements, including their site-specific Risk Assessments and Method Statements (RAMS). Site workers have therefore not been included within the following table, as the adoption of these appropriate mitigation measures will result in an overall low risk of exposure to the CPR linkages identified.

**TABLE 2 – RISK ASSESSMENT SUMMARY TABLE
PHASE II EXPLORATORY INVESTIGATION**

Potential Contaminant Source [C]	Potential Pathway(s) [P]	Potential Receptor [R]	Probability of CPR Linkage	Consequence of CPR Linkage	Risk Level	Comments / Justification
General Made Ground & Near Surface Soils	Direct contact, ingestion or inhalation of fugitive dust	End users	Likely	Medium	Moderate	<p>Phase II Exploratory Investigation works have revealed an elevated concentration of lead and an elevated concentration of dibenzo(ah)anthracene within the localised Made Ground. The natural Topsoil and the Natural Strata may be regarded as uncontaminated.</p> <p>Further delineation of the localised Made Ground at the site should be undertaken and subjected to supplementary chemical analysis.</p> <p>Subject to the results of the supplementary analysis it may become necessary to undertake localised source removal works or provide localised remedial capping to proposed gardens or areas of soft landscape.</p>
	Direct contact, ingestion or inhalation of fugitive dust	Site personnel	Likely	Medium	Moderate	<p>Phase II Exploratory Investigation works have revealed an elevated concentration of lead and an elevated concentration of dibenzo(ah)anthracene within the localised Made Ground. The natural Topsoil and the Natural Strata may be regarded as uncontaminated.</p> <p>We would recommend that site personnel use appropriate PPE and welfare facilities in accordance with normal working practices.</p>
	Plant uptake	End users	Likely	Medium	Moderate	<p>Phase II Exploratory Investigation works have revealed an elevated concentration of lead and an elevated concentration of dibenzo(ah)anthracene within the localised Made Ground. The natural Topsoil and the Natural Strata may be regarded as uncontaminated.</p> <p>Further delineation of the localised Made Ground at the site should be undertaken and subjected to supplementary chemical analysis.</p> <p>Subject to the results of the supplementary analysis it may become necessary to undertake localised source removal works or provide localised remedial capping to proposed gardens or areas of soft landscape.</p>
	Vertical and lateral migration	Neighbouring properties	Unlikely	Mild	Negligible	<p>No significant sources of potential mobile hydrocarbon contamination have been identified on site and there was no obvious visual or olfactory evidence of any significant contamination (i.e. hydrocarbon impacted soils, for example).</p>

**TABLE 2 – RISK ASSESSMENT SUMMARY TABLE
PHASE II EXPLORATORY INVESTIGATION**

Potential Contaminant Source [C]	Potential Pathway(s) [P]	Potential Receptor [R]	Probability of CPR Linkage	Consequence of CPR Linkage	Risk Level	Comments / Justification
	Leaching of Contaminants through unsaturated zone and/or vertical and lateral migration	Controlled Waters	Unlikely	Mild	Negligible	The soil test results are not sufficiently elevated to represent a significant risk to Controlled Waters. No significant sources of potential mobile hydrocarbon contamination have been identified on site and there was no obvious visual or olfactory evidence of any significant contamination (i.e. hydrocarbon impacted soils, for example). A consistent groundwater level was not encountered in the exploratory holes. The ground conditions revealed during the Phase II investigation works have confirmed the presence of typically low permeability typically cohesive soils beneath the site, which would act to minimise any vertical migration of leachate to groundwater.
	Direct contact or contact with vapours	Plastic buildings products (i.e. water supply pipes) and buried concrete	Unlikely	Mild	Negligible	No sources of potentially mobile hydrocarbon contamination have been identified on site. Design Class DS-1/ACEC Class AC-1. (BRE Spec. Digest 1:2005).
	Vertical and lateral migration of ground gases to indoor air	End users of new buildings (asphyxiation) or new buildings (damage via explosion)	Low Likelihood	Severe	Moderate	Based on the ground gas monitoring undertaken to date, the site may be classified as Characteristic Situation 'CS2' in accordance with BS8485:2015. Phase II Exploratory Investigation works revealed the presence of localised Made Ground across the site at depths of up to 2.20m begl. Further gas monitoring and risk assessment may reduce or negate the requirement for gas protection measures.
Off-Site Made Ground	Vertical and lateral migration of ground gases to indoor air	End users of new buildings (asphyxiation) or new buildings (damage via explosion)	Low Likelihood	Severe	Moderate	Based on the ground gas monitoring undertaken to date, the site may be classified as Characteristic Situation 'CS2' in accordance with BS8485:2015. Further gas monitoring and risk assessment may reduce or negate the requirement for gas protection measures.

3.2 Requirement for Remediation

Taking account the findings of the contamination assessment works undertaken for the site (as detailed within the previous report listed in Section 1.1), together with the CSM, the following remedial options were recommended for the site:

Proposed Areas of Soft Landscape / Gardens

OPTION 1 – Existing Made Ground to remain in-situ. Provision of a remedial capping layer to proposed areas of soft landscape / gardens where the Made Ground is exposed.

OPTION 2 – Existing Made Ground to be removed from site to expose the underlying uncontaminated Natural Strata, followed by placement of suitably clean topsoil. This would require delineation works to determine the extent of the contaminated soils.

Following the issue of our report referenced in Section 1.1, it is understood that the Client has elected to adopt Option 1 for the site. However, this is subject to change should the Client elect to carry out further Made Ground delineation works in the future.

Ground Gas Precautions

Ground gas protection measures (compliant with CS2, BS 8485:2015 +A1:2019) should be provided to the proposed dwellings at the site. Alternatively, consideration may be given to undertaking further monitoring at the site which may negate the need for protection measures or possibly reduce the area of the site / number of properties requiring gas protection measures.

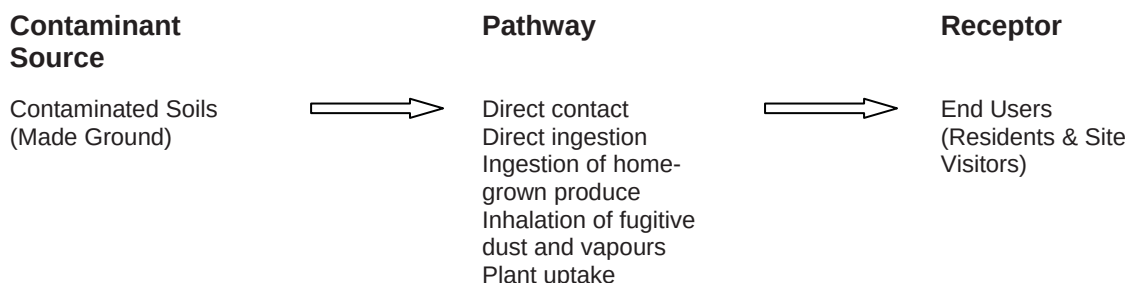
We understand at this stage that the Client has elected to include CS2 ground gas precautions within all proposed dwellings at the site.

3.3 Remediation Objectives

The remediation objectives detailed in the Remediation Strategy (Section 4.0) are required in order to break the significant contaminant linkages identified in the above CSM.

Remedial Capping Layer

The remediation objective of the proposed encapsulation of the Made Ground in soft landscaped areas is to break the following plausible pollutant linkage:

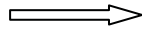


Gas Protection Measures

The remediation objective of the proposed gas protection measures is to break the following plausible pollutant linkage:

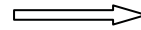
**Contaminant
Source**

Ground gases
(including carbon dioxide
and methane)



Pathway

Vertical and lateral
migration of ground
gases to indoor air



Receptor

End users of new
buildings (asphyxiation)
or new buildings
(damage via explosion)

4.0 REMEDIATION STRATEGY – PROTECTION OF HUMAN HEALTH

4.1 Introduction

In accordance with the findings of our previous works at the site and our understanding of the development proposals, the following remedial strategy is considered appropriate for the site from a human health protection perspective.

Remediation and validation works are to be undertaken in accordance with the following guidance document:

- Yorkshire and Lincolnshire Pollution Advisory Group (YALPAG) document entitled '*Verification Requirements for Cover Systems – Technical Guidance for Developers, Landowners and Consultants*', Version 3.4 – November 2017.

4.2 Pre-Start Site Meeting

Once the Client has selected their preferred Contractor(s), it is recommended that a pre-start meeting is arranged between the Site Manager and GeoDyne (as a minimum), to outline the remedial requirements during the construction phase of the development.

4.3 Ground Gas Issues

4.3.1 Summary

Based on the results of the ground gas monitoring undertaken (in relation to methane and carbon dioxide), and the development proposals, the site has been classified as Characteristic Situation CS2, in accordance with Table 4 of BS8485:2015 +A1:2019 '*Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*'.

Taking account of the current development proposals to construct low-rise residential properties at the site, the proposed structures are considered to be classified as Building Type A in accordance with Table 3 of BS8485.

On the basis of Characteristic Situation CS2 and the development proposals with buildings designated as Building Type A and in accordance with Table 4 of BS8485, the minimum gas protection score for the site is 3.5 points.

Appropriate precautions should therefore be included within the design of the proposed buildings to accommodate the requirements of this classification, as detailed in Section 4.3.2 below.

4.3.2 Ground Gas Protection Measures

The following mitigation measures are considered appropriate for the site (assuming an Engineer designed strip foundation, refer to Combined Report referenced in Section 1.1 for foundation solutions) to achieve the required level of protection to dwellings:

- Suspended floors (i.e. beam and block) – 0 Points.

- Provision of a clear ventilated void and periscopic air-brick ventilation and sub-floor cross ventilation – 1.5 Points (Good Performance Clear Void Dispersal Layer). To achieve a Very Good Performance Clear Void Dispersal Layer (2.5 points) in accordance with BS8485, the number of side vents (i.e. air-bricks) for a small to medium width buildings (up to 15m) should be 1500mm²/m run of wall on at least two sides, the minimum clear void space should be 100mm and there should be four or five times the area of the side vents provided to the internal obstructions (i.e. beams) to provide sub-floor cross ventilation.
- Provision of a well installed and verified low permeability proprietary gas resistant membrane (2 Points).
- The membrane should be suitably lapped and sealed and should be extended across wall cavities and lapped with cavity trays to effectively exclude ground gases from the footprint of the proposed buildings. The membrane should be inspected by third party in accordance with the requirements of CIRIA C735 '*Good practice on the testing and verification of protection systems for buildings against hazardous ground gas*' (2014).
- The membrane must be suitably robust to withstand the construction process and should be suitably protected following installation and inspection to minimise damage during construction.
- Service penetrations through the membrane should be kept to a minimum and should be suitably sealed to the membrane. Where the service penetrations (typically 150mm pipes) are to be used as ducting for smaller service pipes (e.g. water, electricity or gas supply etc.) an appropriate method of sealing the smaller pipes within the ducting should be adopted (such as closed cell expanding foam), to minimise the risk of the ducting acting as a conduit for ground gases to enter the dwellings.

The foregoing precautions would score 3.5 Points (based on a Good Performance Clear Void Dispersal Layer) in accordance with BS8485:2015 +A1:2019 and are therefore considered appropriate for the site.

Alternative floor slab design and gas protection measures that give a minimum protection level of 3.5 points may be considered in accordance with BS8485:2015 +A1:2019 and subject to Local Authority approval.

In accordance with BS8485, for dwellings where a raft foundation is considered appropriate, the requirement for a minimum protection level of 3.5 points may be achieved by ensuring that the raft is well reinforced (to control cracking) and is designed with minimal penetrations. This would score 1.5 points, which in conjunction with an appropriate well installed and verified membrane (as detailed above) would achieve the minimum gas protection score.

Where the proposed dwellings are to benefit from a Buildmark warranty (i.e. NHBC, or similar) we would recommend liaison with the warranty provider with respect to the floor slab design and ground gas protection measures to ensure that the proposals fully satisfy their requirements.

4.3.3 Ground Gas Protection Measures Verification

In order to accord with Table 7 of BS8485 where a gas resistant membrane is proposed as part of gas protection measures, the membrane should be installed, inspected and validated by a third party in accordance with the requirements of CIRIA C735 '*Good practice on the testing and verification of protection systems for buildings against hazardous ground gas*' (2014), for the gas protection points associated with installation of a gas resistant membrane to apply.

We would recommend that the membrane specified for the proposed dwellings is installed by a suitably qualified specialist contractor in a quality controlled / quality assured (QA/QC) manner.

The membrane must be suitably robust to withstand the construction process and should be suitably protected following installation and inspection to minimise damage during construction.

Verification of the membrane should include a third party visual inspection of the installed membrane, as a minimum, and may require integrity testing such as air lancing of the joints, dependent on the qualifications of the installer and the characteristic situation of the site. Otherwise a score of zero is awarded for the membrane and therefore the installed solution would fail to comply with BS 8485.

Once the design of ground gas precautions for the site have been finalised, we would recommend the following information included within a site specific Verification Plan, to be prepared in accordance with CIRIA guidance (C735), to assist with verification of the gas protection measures.

- Drawings showing the proposed membrane installation details, inclusive of how membrane penetrations (i.e. service pipes, stanchions etc.), door entries and corners will be sealed. The drawings should also confirm the floor slab design.
- Technical specification data for the gas resistant membrane(s) to be installed at the site, together with Local Authority approval for its use.
- Method Statement for the installation of the membrane, prepared by the membrane installers.
- Details of the membrane installers relevant experience / qualifications.

Following installation, the ground gas protection measures should be visually inspected (as far as practicable) to ensure they are in accordance with the appropriate installation drawings and that the membranes are suitably installed and free from damage and defects.

The inspections should be carried out in accordance with good practice and should include the following as a minimum (further details will be provided within the Verification Plan).

- Obtain photographic records of the membrane during the installation process.
- Visual inspection of the joints / welds in the membrane to assess the continuity of the membrane throughout the structure. Integrity testing should be undertaken, as appropriate.
- Visual inspection of the seals around penetrations through the membranes (i.e. service pipes, stanchions etc.). Integrity testing should be undertaken, as appropriate.
- Records of all materials used on site will be obtained during our inspection.
- Records of any deviation from the 'Construction' drawings and photographic evidence of any changes to the installation detail will be obtained.
- Records of any non-compliances (i.e. punctures/tears to the membrane, defective joints/seals etc.) and corrective action taken to rectify the defective areas will be obtained.

Following satisfactory installation of the membrane and satisfactory repair to any defective / damaged areas of the membrane, the membrane will be considered to 'Pass' the verification process. Validation report(s) relating to the membrane installation may be prepared on a rolling basis, to suit the requirements of the Client for completion / 'sign-off' purposes). Validation works should be undertaken at the earliest opportunity following installation, to minimise the potential for delays in construction etc.

The Client should note that following inspection, the membranes should be appropriately protected during construction to minimise damage. The protection may comprise the provision of loose laid boarding over the membrane, or implementation of an exclusion zone preventing other Contractors access into the plots prior to pouring of the floor. Any damage to the membrane will compromise the efficacy of the membrane and should be appropriately repaired.

4.4 Remedial Capping Layer

4.4.1 Summary

We understand at this stage, that the Made Ground is to remain in-situ following development. On this basis we would recommend the provision of a remedial capping layer to proposed areas of soft landscape where the Made Ground is exposed taking account of the lead and PAH (dibenzo(ah)anthracene) contamination within the Made Ground.

Where Natural Strata is exposed at formation level, the provision of remedial capping is considered to not be necessary although a nominal thickness of suitably clean topsoil should be placed in gardens / soft landscaped areas, to act as a growing media for plants.

4.4.2 Formation Inspection

Remedial capping is only considered to be necessary in areas where Made Ground is present at formation level. Therefore, in order to confirm the requirement for remedial capping the formation level should be inspected by an Engineer from GeoDyne (or an alternatively suitably competent and experienced Engineer). Photographic evidence of the formation level of each and every plot should be obtained by the inspecting Engineer for in-house records and inclusion within the Validation Report, as appropriate.

Where Made Ground is present at formation level, any potentially sharp deleterious material (i.e. glass shards, oversized fragments of brick and concrete etc.) at formation level should be removed.

4.4.3 Capping Thickness

The recommended remedial capping thicknesses are detailed in Table 3.

TABLE 3 – REMEDIAL CAPPING PROPOSALS			
Land Use	Subsoil (m)	Topsoil (m)	Total (m)
Rear Gardens	0.45	0.15	0.60
Front Gardens	0.15	0.15	0.30
Public Open Space	0.15	0.15	0.30

Please note that, subject to finished levels at the site, it may be necessary to locally reduce levels within areas of soft landscape (i.e. remove some of the existing Made Ground) to accommodate an appropriate thickness of remedial capping.

Should all of the Made Ground be removed during this process (i.e. where there is less than 0.60m thickness of Made Ground in rear gardens or 0.30m of Made Ground in front gardens / public open space) to expose underlying Natural Strata, removal of material may stop and, following formation inspection, a nominal thickness of topsoil may be provided.

We would note that based on the proposed site layout shown on the drawing in Appendix II, the front gardens of the proposed dwellings are relatively small in size; furthermore, the front gardens may also incorporate shallow buried services. Therefore, it may not be possible to achieve the full recommended depth of remedial capping within these areas. However, it is considered that any gravel surround to the buried services and concrete haunching to edging stones would act as a hard to dig layer within the completed gardens. Photographic evidence of front garden construction should be obtained by the Site Manager/attending Engineer for inclusion in a validation report.

Where applicable, the capping soil may comprise entirely of topsoil if preferred. It may be necessary to increase the thicknesses of topsoil / growing medium likely to be required around tree roots and to suit the planting regime, subject to confirmation by an arborist.

4.4.4 Capping Materials

The Natural Strata may be regarded as suitable for re-use within proposed gardens as subsoil within the remedial capping or to raise levels (as appropriate), similarly the existing natural Topsoil may be retained on site for use within gardens / areas of public open.

Where it is proposed to re-use the natural topsoil and Natural Strata suitable control measures should be implemented to segregate the overlying contaminated Made Ground soils.

There is likely to be a requirement to import topsoil and potentially subsoil to the site for use within the remedial capping layer. It will be necessary to test the topsoil and subsoil at source to ensure it is suitably clean (prior to importation) in accordance with CLEA/generic guidance. The topsoil should also ideally conform to BS3882: 2015 '*Specification for topsoil*', with respect to the presence of foreign objects, and ideally nutrient levels etc.

The Site Acceptance Criteria (SAC) for the donor soils are detailed in Table 4 (Section 4.4.5). The results of the chemical analysis on topsoil and/or subsoil proposed for importation should be forwarded to the Local Authority (Environmental Protection Officer) for approval (prior to importation).

4.4.5 Validation Protocol

The recommended remediation protocol for use by the Site Manager and GeoDyne (in the form of a decision tree), which defines the key stages of the remediation and validation processes areas is presented in Appendix IV.

Inspections of the remediation works will be undertaken on a rolling basis as necessary. Validation works will include:

- Obtaining photographic records to demonstrate compliance with the RMS.
- Inspection of the formation layer (including photographic records) to assess the presence Made Ground and confirm the capping requirements, and to assess the absence of potentially sharp deleterious materials, where Made Ground remains in-situ.
- Review of laboratory test certificates for donor topsoil / subsoil prior to importation to site and undertake potential additional chemical analysis (if necessary / appropriate). Laboratory test certificates are to be supplied to the Local Authority Environmental Protection Officer for comment / approval prior to the importation of materials to site.
- Inspection of validation holes within garden areas. Validation holes are typically advanced using a spade/auger, however, the Groundworkers may elect to create a preformed hole within the capping layer whereby a validation hole may be formed using a section of 150mm diameter drainpipe (or similar) of a minimum length of 0.60m, stood vertically at formation level. The drainpipe should be centrally located within the garden /public open space area. An appropriate thickness of remedial capping (i.e. 0.60m – rear gardens or 0.30m front gardens / public open space) should be placed around the drainpipe and across the remainder of garden / soft landscape. The drainpipe will be removed during validation works, to enable the depth of the validation hole to be measured and the hole sides and base to be inspected/photographed. Following validation, the hole should be backfilled with suitably clean topsoil.
- Validation testing for the remedial capping / topsoil thickness should be:
 - o Rear Gardens – 1 No. hole per plot.
 - o Front Gardens – 1 No. hole per every other plot.
 - o Public Open Space – 1 No. hole per area.

- Preparation of a validation report to confirm that the remediation objectives (as set out in the RMS) have been met.

4.4.6 Site Acceptance Criteria

It will be necessary for the Local Authority Environmental Protection Officer to review the suggested Site Acceptance Criteria (SAC) detailed in Table 4, which would be used when assessing the suitability of any materials proposed for importation (i.e. topsoil and subsoil, as appropriate etc.).

The SAC in Table 4 have been derived for a residential end-use with home grown produce (i.e. private gardens).

The following SAC are proposed for assessment of the laboratory results relating to the topsoil (and subsoil) proposed to be imported to site:

TABLE 4 – PROPOSED SITE ACCEPTANCE CRITERIA (RESIDENTIAL END-USE WITH PLANT UPTAKE)	
Determinand	Tier 1 SAC (mg/kg)
Metals	
Arsenic	37 S4UL
Cadmium	11 S4UL
Chromium III	910 S4UL
Chromium VI	6 S4UL
Lead	200 C4SL
Inorganic Mercury	40 S4UL
Selenium	250 S4UL
Nickel	130 S4UL
Copper	2400 S4UL
Zinc	3700 S4UL
PAHs	
Acenaphthene	210 S4UL
Acenaphthylene	170 S4UL
Anthracene	2400 S4UL
Benz(a)anthracene	7.2 S4UL
Benzo(a)pyrene	2.2 S4UL
Benzo(b)fluoranthene	2.6 S4UL
Benzo(ghi)perylene	320 S4UL
Benzo(k)fluoranthene	77 S4UL
Chrysene	15 S4UL
Dibenzo(ah)anthracene	0.24 S4UL
Fluoranthene	280 S4UL
Fluorene	170 S4UL
Indeno(123-cd)pyrene	27 S4UL
Naphthalene	2.3 S4UL
Phenanthrene	95 S4UL
Pyrene	620 S4UL
Asbestos	
Asbestos	Absence
Key S4UL – CIEH/LQM Suitable 4 Use Levels (2015). Copyright Land Quality Management Limited. All rights reserved. C4SL - value for Lead taken from DEFRA publication SP1010.	
Note SAC values for metals derived from S4UL values assume 6% Soil Organic Matter. SAC values for PAHs derived from S4UL values assume 1% SOM in the first instance (where appropriate, S4UL values for 2.5% or 6% SOM may be considered for the assessment of donor soils).	

Topsoil and subsoil samples should be tested at the donor site for the metals, PAHs and asbestos detailed in the above table (this may be undertaken by a Consultant under instruction from the Client or directly by the Supplier).

Please note that where donor materials are sourced from an unknown or potentially contaminated source (i.e. 'brownfield' sites) it may also be necessary to test the materials for additional determinands (i.e. speciated Total Petroleum Hydrocarbons, pesticides etc.), as well having the appropriate permits in place to allow transport of the material.

4.4.7 Pre-Importation Testing Methodology

In accordance with the requirements of the YALPAG document for a greenfield source, it is recommended that the donor topsoil / subsoil should be sampled and analysed at a minimum density of 1 No. sample per 250m³ or 3 No. samples per source site / stockpile (whichever is the greater) to ensure that the results are representative and provide sufficient confidence that the soils will be acceptable in the proposed residential context.

If soils are proposed to be imported from an unknown or potentially contaminated source, then an increased testing frequency of a minimum of 1 No. sample per 100m³ or 6 No. samples per source (whichever is the greater) would be necessary, along with laboratory analysis for additional determinands to those contained in Table 4 (depending upon the source).

In the first instance, the results of the testing will be compared directly to the SAC (Table 4). If the individual values are less than the SAC the source shall be considered suitable for use at the site.

If the individual values are greater than the SAC, the supervising Engineer may elect to calculate the 95th percentile Upper Confidence Level (UCL) Mean Value of the topsoil samples, which would then be compared to the appropriate SAC to determine whether the soil is 'clean' and suitable for use at the site.

Should the UCL Mean Value of the topsoil / subsoil samples be in excess of the SAC, further samples may be obtained to enlarge the dataset prior to reassessment and a final decision being reached. Alternatively, the Client may elect to reject the donor site and select an alternative donor site.

4.5 Segregation of Materials

It is imperative that any 'clean' materials (i.e. any imported chemically suitable capping materials, e.g. topsoil and subsoil) are kept separate from 'contaminated' arisings generated at the site (including retained Made Ground materials).

Any cross contamination may result in the necessity to remove all affected materials from the site. Appropriate measures should therefore be adopted by the chosen Contractor.

These measures should include the following:

- The Contractor shall take all necessary measures during excavation and loading into lorries or skips to prevent any spillages of contaminants onto the adjacent ground, in order to prevent the cross contamination of the surrounding soils.
- All vehicles are to be appropriately sheeted and 'clean', prior to leaving site. The Contractor shall take all reasonable and applicable measures to prevent the escape of material during transportation.
- It may be necessary to temporarily stockpile contaminated soils prior to removal from site. If circumstances arise where temporarily stockpiling is required, contaminated soils should be placed onto suitable polythene sheeting to prevent cross contamination from occurring.

- During the importation and placement of the remedial capping soils, all imported capping soils should be placed directly into areas of proposed gardens. If required, imported capping soils should be temporarily stockpiled onto suitable polythene sheeting (if suitable surface hardstanding is not present) to prevent cross contamination with the existing Made Ground from occurring prior to placement.

4.6 Off-Site Disposal & Waste Classification

The chemical testing regime for off-site disposal (if required) is different to the chemical testing required to assess the suitability of the soils for retention on site and the risks to human health. Therefore, a separate contamination assessment may be required to classify the soils for off-site disposal with testing criteria to assess whether the soil is hazardous, non-hazardous or inert waste.

The receiving landfill may require additional specialist laboratory testing to further characterise the material proposed for disposal against Waste Acceptance Criteria (WAC). We would recommend early consultation between the Contractor and the receiving landfill to determine any specific laboratory testing requirements. These may potentially include bespoke WAC leachate testing.

Individuals / companies removing soils from the site are bound by a **duty of care**; as such this should only be undertaken by an **authorised person**. All waste movements should be accompanied by a **waste transfer note and Environment Agency waste consignment notes**.

4.7 Utilities

Prior to development of the site, we would recommend that a copy of this report and the previous report listed in Section 1.1 are supplied to utility companies, and that their recommendations relating to appropriate supply pipes are adhered to.

4.8 Licences, Permits, Registrations, Plans & Approvals

The Contractor / Developer is responsible for, and must ensure that, all necessary licenses, permits, plans, registrations and approvals are in place prior to commencing with the earthworks at the site.

These will include any Materials Management Plans (MMPs), Site Waste Management Plans (SWMPs) and/or Environmental Permits / Exemptions as necessary to enable the completion of the proposed works.

4.9 Unforeseen Circumstances

Any areas of potentially contaminated soils encountered during site construction works must be brought to the attention of GeoDyne, to ensure that our recommendations continue to apply. Any potentially contaminated soils should be left in-situ and subjected to further assessment, to potentially include further chemical testing and risk assessment.

The following procedure should be adhered to if any areas of previously unidentified suspected contamination are encountered during the redevelopment of the site:

- i. Suspected contaminated material will remain in-situ.
- ii. GeoDyne to be notified, and will inform the Local Authority.
- iii. GeoDyne will undertake a visual assessment of the possible contamination, followed by appropriate sampling/testing.
- iv. If necessary, contamination will then be treated or removed from site and the Environmental Protection Officer informed accordingly. All necessary remediation works should be validated by testing in accordance with an approved strategy.

4.10 Construction Workers

Site workers should adopt suitable good practice for example PPE (i.e. boots, gloves, overalls etc.) together with dust suppression (as necessary). Furthermore, hygiene facilities should be provided in accordance with general health and safety guidelines.

The Contractor should undertake a suitable Risk Assessment to confirm the appropriate level of PPE / RPE necessary for their activities.

A copy of all reports relating to the site (by GeoDyne) should be included within the site health and safety file and site workers should be made fully aware of the sites setting.

4.11 Site Managers Site Diary

It is the responsibility of the Site Manager to keep a site diary to record the progress of remediation works. This should include, but not be limited to:

- Photographic and written records of remediation works, with specific attention paid to unforeseen circumstances.
- Records of any remedial measures that cannot be dug up / sampled and validated at a later date.
- Records of all movements of waste materials, including consignment notes etc.

4.12 Communication

We would recommend that regular communication is maintained between GeoDyne and the Site Manager throughout the development / remediation works.

It will be the responsibility of the Site Manager to inform GeoDyne when the gas resistant membranes have been installed (prior to covering, such as by the placement of a concrete screed), together with when the formation level and remedial capping is ready for inspection and validation.

4.13 Statutory Consultation

We would recommend that a copy of our Remediation Method Statement is issued to the Local Authority Environmental Protection Officer for review / comment and approval, at the earliest opportunity, prior to commencing with any remedial activity.

Where the proposed dwellings are to benefit from a buildmark warranty (i.e. NHBC, or similar) the warranty provider will require written approval of the RMS from the Local Authority in order to satisfy their Land Quality Conditions.

5.0 CONCLUSIONS

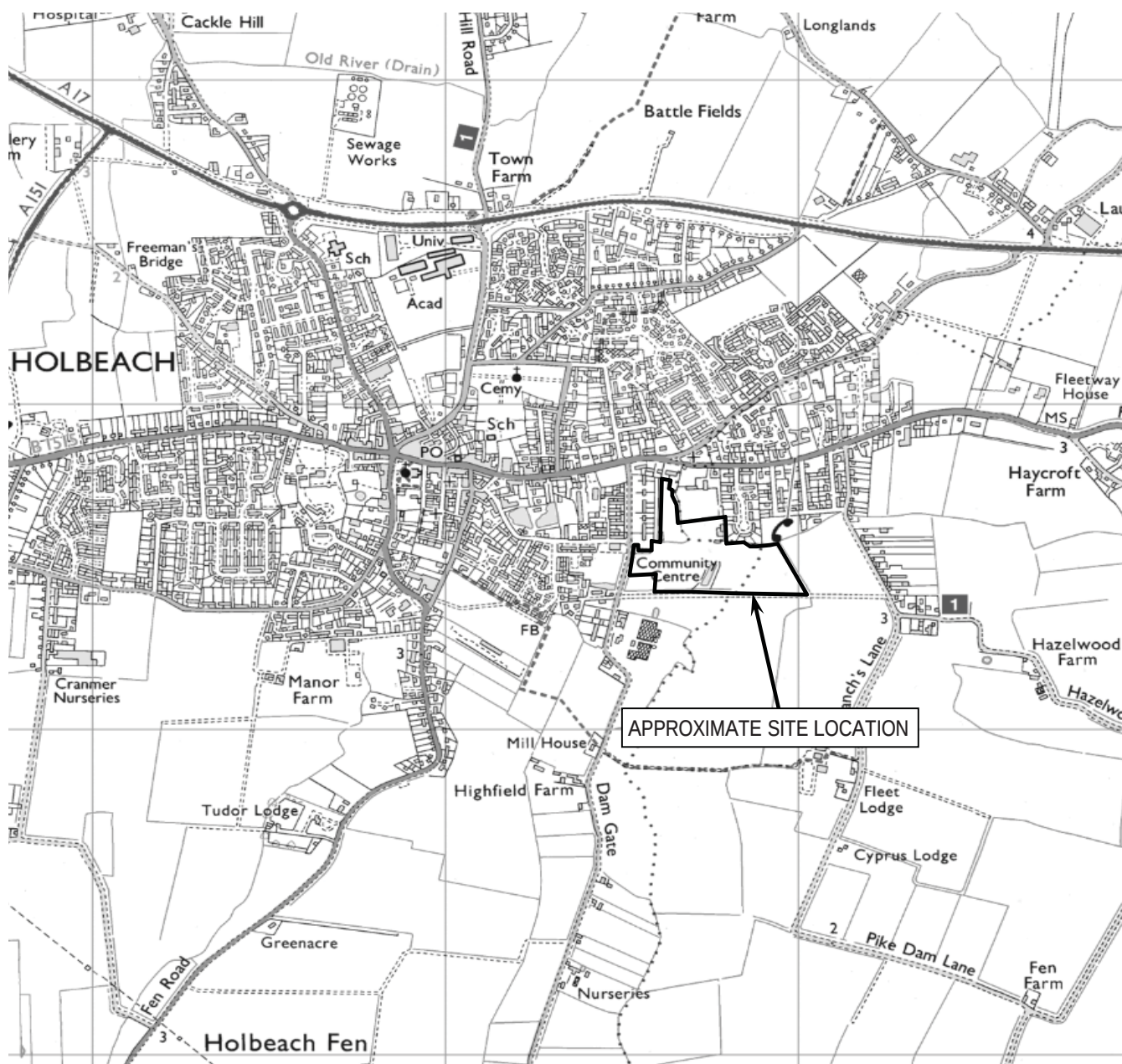
To the best of our knowledge, this RMS has been prepared to be compliant with the requirements of the Local Authority Planning Department.

Written approval of this report should be obtained from the Local Authority Environmental Protection Officer prior to implementation of the recommendations.

This RMS presents methodologies and procedures which, when implemented, are considered to be appropriate to enable the future development of the site without creating unacceptable risk to end-users.

APPENDIX I

**Site Location Plan
(Figure No. D38108/R1)**

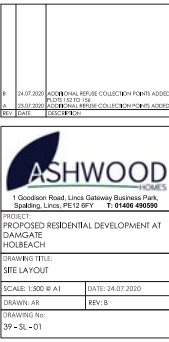


Do Not Scale

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Project No.	D38108	Drawn	CEH	
Client	Ashwood Homes	Checked	PK	
Project	Dam Gate Holbeach	Approved	PK	
		Scale	NTS	
		Date Drawn	11/08/2020	
Title	Site Location Plan	Rev.		
		Figure No.	D38108/R1	

APPENDIX II
Proposed Site Layout



APPENDIX III

Local Authority Correspondence

Online Comment

Application H09-0523-20
Location Land off Damgate Holbeach Spalding
Proposal Details of Conditions 3, 4, 5, 6, 7, 8, 9, 10, 11, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22 and 23 H09-0332-16

Name Sue Armour
Address Environmental Protection Officer SHDC PE11 2XE

Date Submitted 05-08-20
For/Against Comments

I have reviewed the GeoDyne Limited report 'Dam Gate Holbeach Combined Phase I Desk Study and Phase II Exploratory Investigation' Project No: D38108 Date: 30th September 2019 and am in general agreement with the findings.

I therefore recommend discharge of parts i & ii of condition 3 of H09-0332-16, with parts iii & iv remaining outstanding.

The report recommends remediation and/ or further site investigation, and either option is acceptable.

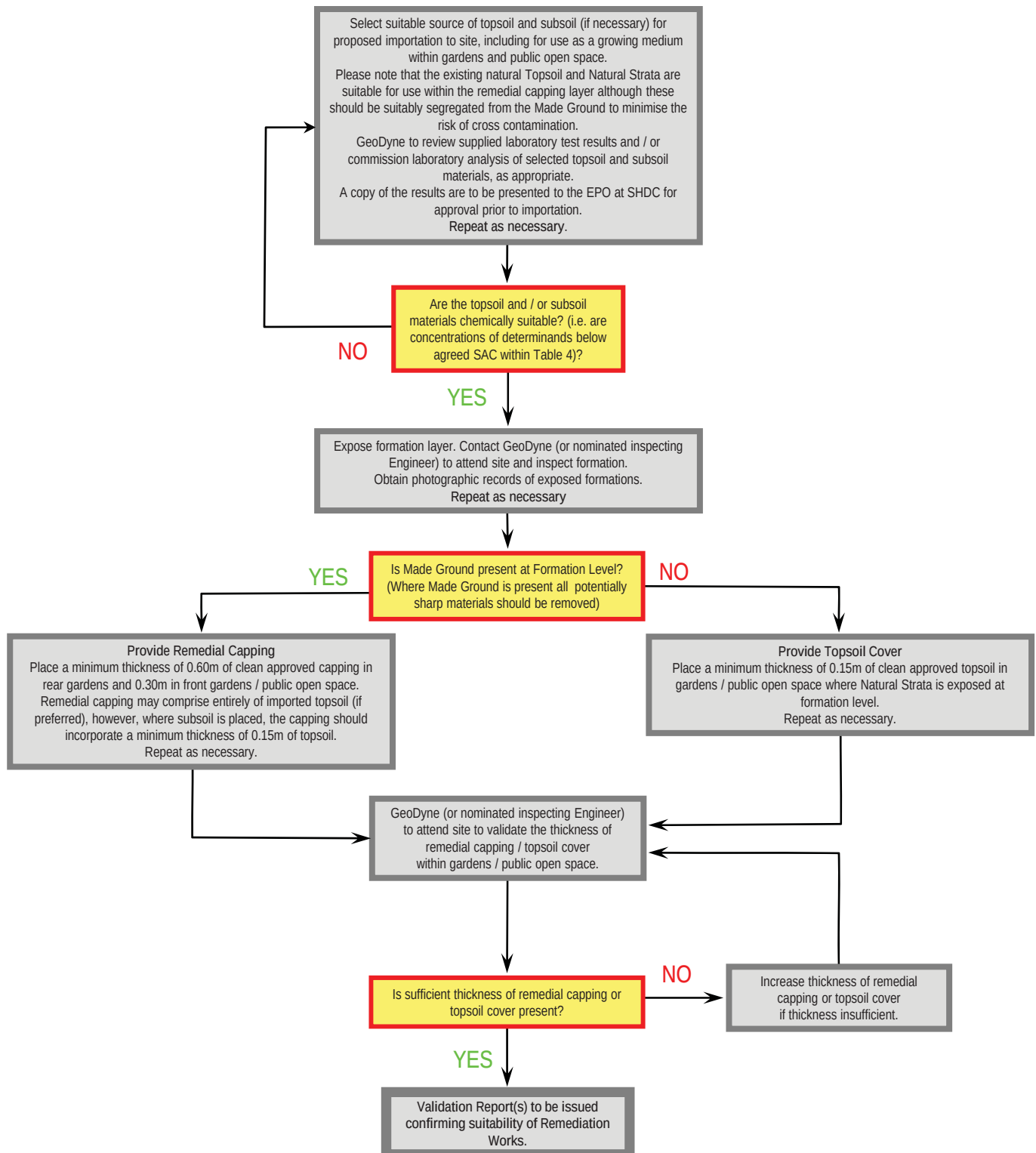
The report currently recommends either installation of ground gas protection measures to CS2 or further monitoring to delineate the area of which these may be required. Either option is acceptable.

I look forward to receipt of a remediation method statement, containing detailed proposals for both items, in due course.

APPENDIX IV

Remediation Validation Protocol

Client	Ashwood Homes
Project No.	D38108
Site	Dam Gate, Holbeach
Date	August 2020
Comments	Remediation Validation Protocol – Proposed Gardens and Soft Landscaped Areas



APPENDIX V

Conditions & Limitations

Conditions & Limitations

Phase I Desk Studies

1. Works undertaken to provide the basis of the Phase I Desk Study report comprise a review of information available from a number of sources/parties (potentially also including the Client) together with a walk over of the site (where applicable and included within the quotation). The opinions given in the Phase I Desk Study are based on the information available from third parties/sources that has been obtained within the available timeframe. GeoDyne Limited assumes all third party information to be true and correct and therefore cannot accept liability for the accuracy of such information supplied.
2. Should additional information become available that may affect the comments and opinions made within the Phase I Desk Study, GeoDyne Limited reserves the right to review such information and make modifications to comments/opinions as appropriate.
3. It should be borne in mind that a Phase I Desk Study collates available information to generate a conceptual model of the site. The actual geotechnical and environmental considerations can only be fully quantified by intrusive investigation works to confirm the accuracy of the conceptual site model.

Phase II Intrusive Investigations

1. Our quotation assumes that access to the site will be arranged by others at no cost to ourselves.
2. We have assumed that free access is available throughout to the entire site and that works can be undertaken during a single mobilisation. Where restricted access is encountered, or where additional unscheduled mobilisations are required, additional costs may be incurred to the client.
3. We have assumed that all available information relating to buried services will be supplied by the Client at no cost to ourselves. No responsibility will be accepted for damage to underground services that have not been brought to our prior attention by the Client.
4. All excavations/boreholes will be backfilled with compacted arisings upon completion, with any excess arisings left proud of ground levels. Excess arisings will not be removed from the site unless specifically requested by the Client. Where we are requested to remove excess arisings, all associated costs will be passed to the Client.
5. We will attempt to leave the site in a clean and tidy state, however, it must be understood that some disturbance of the site is unavoidable during intrusive works.
6. Exploratory holes are positioned approximately on site by GeoDyne Limited. Should the client require precise locations of all exploratory points, additional fees will be incurred. It must be borne in mind that backfilled trial pits can create 'soft spots', therefore, should the Client wish to designate 'no dig' zones, for example under the footprint of proposed structures, these must be brought to our attention prior to commencement of works.
7. Groundwater observations relate to conditions encountered at the time of investigation. It must be understood that groundwater levels may vary as a result of recent climatic conditions or seasonal variation.
8. Trial pits and boreholes examine only a small proportion of the total site area. No liability can be accepted for conditions not revealed in exploratory holes, particularly between positions. All extrapolations of available data are given in good faith.

Payment

1. Payment terms are strictly 28 days from the invoice date.
2. Prior to commencement of works, we require receipt of formal written instruction from the party accepting full financial responsibility for the work. In the absence of such an instruction, we would expect the instructing Consulting Engineers/Architects to accept full financial responsibility for the works.
3. Receipt of instruction to commence work shall be taken as acceptance and compliance of the foregoing conditions.

Liability

1. GeoDyne Limited offer £5,000,000.00 Professional Indemnity Insurance (in aggregate over the year). This shall be the limit of our liability for works undertaken. No individual liability shall be implied to, or accepted by, any employee for works undertaken for and on the behalf of GeoDyne Limited.