Geo-Environmental

REMEDIATION STRATEGY & VERIFICATION PLAN

for the land at

57 THE QUEENSWAY, BOGNOR REGIS,

WEST SUSSEX PO21 1QN

on behalf of

HJP SURVEYORS

Report:	**REMEDIATION STRATEGY & VERIFICATION PLAN**
Site:	**57 THE QUEENSWAY, BOGNOR REGIS, WEST SUSSEX PO21 1QN**
Client:	**HJP SURVEYORS**
Date:	**03/03/2025**
Reference:	**GE22978/RSVP/MAR25**
Version:	**1.0**
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AMENDMENT RECORD

Revision ref.	Date	Reasons for amendment	Author	Reviewed By	Authorised by
1.0	03/03/2025	First issue	LL	SA	SA

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1.0 INTRODUCTION

1.1 General

Following a third party desk study and intrusive investigation undertaken on site, Geo-Environmental Services Limited ('Geo-Environmental') was appointed by JHP Surveyors ('the Client') to formulate a Remediation Strategy and Verification Plan in relation to the proposed development on land at 57 The Queensway, Bognor Regis, PO21 1QN herein referred to as 'the site' (see Figure 1).

The site has been the subject of a Phase 1 desk based and Phase 2 intrusive investigation by a third party as detailed below:

- Phase 1 and 2 Geoenvironmental and Geotechnical Assessment, undertaken by Your Environment on behalf of HJP Ltd, reference YEX2909, dated February 2023;

The remedial strategy and verification plan has been developed to reflect the findings from a review of the third party assessment as detailed in the report detailed above and a site walkover undertaken on 13th February 2025 by an Engineer from Geo-Environmental.

Based on the findings of the investigation it is considered that remediation works would be required with respect to: soil contamination identified within the shallow soils encountered across the site; the presence of ground gas identified within areas across the site; and the removal of the infrastructure associated with the site's use as a former Petrol Filling Station, i.e. an underground storage tanks (USTs), interceptors, pipework, service runs and associated infrastructure.

It should be noted that third party report reviewed and referenced herein is assumed to factually correct and no liability is taken for any omissions or inaccuracies within the report and associated data. It is also assumed that the Client has reliance on the third party report.

1.2 Objectives

The Remediation Strategy & Verification Plan (RSVP) sets out the proposed remedial works to be undertaken on the subject site to support its development for a proposed residential end use with communal soft landscaping.

1.3 Planning Permission

It is understood from the Client that pre-planning application discussions have taken place with the Council regarding development for the site, but that a formal application is still to be submitted.

While planning conditions have not yet been applied to any planning permission for the site it should also be noted that the lack of planning conditions or specific wording applied to the development, in relation to contamination or discharge of such planning conditions does not remove the developer's responsibility to deal with contamination identified in line with current guidance, regulations and duty of care.

This Remediation Strategy and Verification Plan has been prepared to inform the feasibility assessment of the site and to support any future planning submission.

2.0 BACKGROUND

This Remediation Strategy & Verification Plan (RSVP) has been developed from the findings of the assessments:

- Phase 1 and 2 Geoenvironmental and Geotechnical Assessment, undertaken by Your Environment on behalf of HJP Ltd, reference YEX2909, dated February 2023;
- Site walkover undertaken by an Engineer from Geo-Environmental on 13th February 2025.

A brief overview of salient findings of the third party report is presented in Section 2.1 below. For further information, the individual report should be referred to directly. Details from the updated site walkover are presented in Section 2.2 and site photographs presented in Appendix A.

2.1 Overview

Your Environment - Phase 1 and 2 Geoenvironmental and Geotechnical Assessment (YEX2909, dated February 2023)

The site was reported to have comprised a garage from 1968 more recently being utilised as a hand car wash premises with a canopy in the east and building in the northern part of the site. The River Terrace Deposits beneath the site were reported to comprise a Secondary A Aquifer. The closest surface water was reported to comprise the English Channel c. 500m south of the site.

An enquiry was made by Your Environment to the Petroleum Licensing Officer with respect to the presence of tanks on site. The response was received on 10th January 2023 confirming that the former Queensway Filling Station located on the site comprised 5no. underground fuel tanks (USTs), which were decommissioned in 1999 by infilling with concrete slurry. However, it is not known whether these tanks have since been removed or what volumes they held.

The site works were undertaken on 20th June 2022 and comprised:
- 4No. windowless sampler boreholes (WS01-WS04) to a maximum depth of 4.0m bgl and installation of monitoring wells within WS01, WS02 and WS04);
- 6No. return spot gas and groundwater monitoring visits;
- Groundwater sampling during return gas and groundwater monitoring.

The geology beneath the site was mapped as likely to comprise Superficial deposits of the River Terrace Deposits over solid geology of the London Clay Formation.

Ground conditions encountered were reported to comprised:
- Macadam – 100mm thick at all locations.
- Made Ground – extending to a maximum depth of 1.0m bgl and comprising blackish grey sandy cobbly GRAVEL with brick and concrete in WS01 and WS02. WS03 comprised blackish brown clayey gravelly SAND with frequent brick fragments and WS04 comprised brown sandy gravelly CLAY with occasional chalk, coal, flint and brick.
- Natural Cohesive Soils – Firm sandy gravelly clay to depth of at least 3.0m bgl.
- Natural Granular Soils - Encountered beneath the natural cohesive soils in WS04 and comprised clayey gravelly SAND with flint gravel, which was proven to the base of the boreholes 4.0m bgl.

The nature of the Made Ground reported at shallow depth is such that is would not be suitable for use within the top 450mm of communal landscaping or top 600mm of private gardens if proposed.

Groundwater was not reported during the intrusive investigation. Return monitoring undertaken on six occasions between 26th September 2022 and 19th January 2023 recoded the following range of water levels within the monitoring wells:

- WS01 – between 1.54m and 1.80m bgl (with water level not recorded on 21st November 2022)
- WS02 – 1.07m and 1.36m bgl
- WS04 – 0.70m and 1.33m bgl (with water level not recorded on 21st November 2022 and 19th January 2023)

Where water levels were not recorded it is not clear if the wells were not dipped or if the wells were recorded as dry to the base of the installation.

During the investigation a hydrocarbon odour was reported within all boreholes in the natural granular and cohesive soils at depths ranging from 1.0m bgl to 4.0m bgl with black discolouration of the soils also reported in WS02 at 1.0m bgl.

Twelve soil samples were subject to geochemical analysis for a range of substances including TPH, PAH, heavy metals and metalloids, soil organic matter, BTEX and MTBE, sulphate and screening for the presence of asbestos. The results were assessed against a residential land use with consumption of homegrown produce. No exceedances above the respective screening criteria were reported with the exception of the following:

- Aromatic C16-C21 which reported a maximum concentration of 409mg/kg compared to a LQM/CIEH GAC (1% SOM) of 260mg/kg within WS04 at 3.5m bgl
- Aromatic C21-C35 which reported a maximum concentration of 1788mg/kg compared to a LQM/CIEH GAC (1% SOM) of 1100mg/kg within WS02 at 3.0m bgl.

The asbestos screening reportedly returned a negative result for the presence of asbestos from all samples analysed.

Two water samples were tested for geochemical analysis for a range of substances including TPH, PAH, heavy metals and metalloids, BTEX and MTBE, pH, electrical conductivity, TOC, and total hardness, phenols, total cyanide, and sulphate. The results were assessed against The Water Supply (Water Quality) Regulations: 2016 (WSR), Water Framework Directive (WFD) (Standards and Classification) Directions England and Wales 2015 (including EQS) and World Health Organisation (WHO) Standards.

Groundwater exceedances were reported for:

- Barium in WS01 and WS04 at 54µg/l and 124µg/l – both concentrations significantly exceeded the DWS (WHO GAC) of 0.7 µg/l.
- Mercury in WS04 at 0.12µg/l – marginal exceedance of the EQS of 0.07 µg/l.
- Nickel in WS01 at 157µg/l and WS04 at 18µg/l – WS01 concentration significantly exceeded the EQS with WS01 also significantly exceeding the DWS of 2.0 µg/l.
- Zinc in WS01 at 23µg/l – marginal exceedance of the EQS 12.9 µg/l.

There were no EQS or DWS exceedances reported from the screening undertaken on the respective PAH or TPH CWG bands. In addition, BTEX and MTBE were reported to be below the LOD within the analysis undertaken.

It was reported unlikely that a continuous water body was presented beneath the site due to the cohesive nature of the soil identified. It was reported that the enabling works for the site would result in betterment of the site in terms of the removal of USTs, stripping of Made Ground together with the construction of formal drainage infrastructure such that the site was considered unlikely to represent a significant risk to surface water receptors.

The report highlighted that the superficial deposits were noted to comprise a Secondary A Aquifer (River Terrace Deposits) over solid geology of the London Clay Formation being Unproductive Strata. It was considered that the presence of a continuous shallow groundwater body within the superficial deposits was unlikely within the superficial deposits.

Six return spot ground gas monitoring standpipes (WS01, WS02 and WS04) were installed by Your Environment. Return monitoring was completed on six occasions between September 2022 and January 2023.

The spot monitoring undertaken detected methane up to 1.8%, carbon dioxide up to 7.4% and oxygen in the range 6.4% to 21.0%. Hydrogen sulphide was not detected and carbon monoxide was detected up to 5ppm. Positive borehole flow rates of up to 0.2l/hr were recorded during the monitoring. Your Environment recommended that gas protection measures in line with CS2 should be installed. In addition, the report stated:

'Additionally, the presence of potential hydrocarbon vapours needs to be considered. Although recorded at concentrations below the GAC, the presence of toluene, ethylbenzene, xylenes, MTBE, naphthalene and lighter end TPH bands were all detected within soils. The historic use of the site as a garage and petrol filling station is significant and that hydrocarbon odours were noted in the soils during the advancement of the boreholes. Concentrations of dissolved BTEX, MTBE, TPH bands and naphthalene were all below the level of detection of the laboratory. Therefore, provision of a gas resistant membrane should additionally include hydrocarbon vapour resistance.'

The findings of the ground gas assessment undertaken are detailed in Section 8 of this RSVP.

2.2 Site Walkover

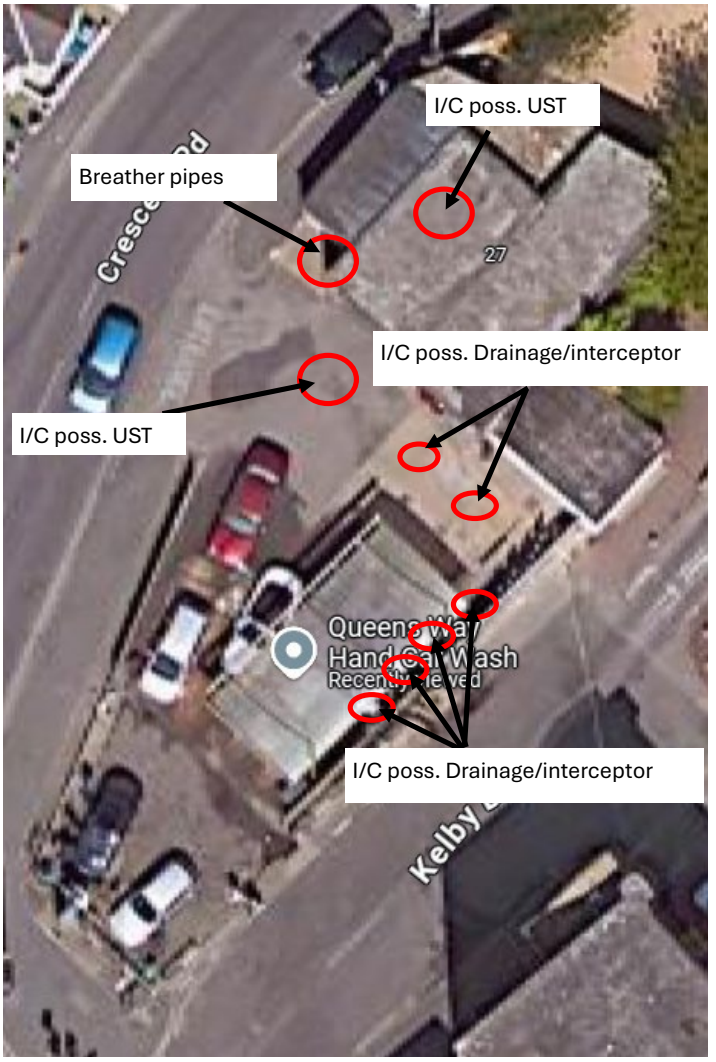
At the time of the site walkover on 13th February 2025, the site was in use as a hand car wash, with the surfacing comprising hardstanding.

Breather pipes were present in the north of the site adjacent to the current buildings, with inspection covers present within the building and in front of the building suggesting the possible presence of USTs remaining on site (albeit these are understood to have been decommissioned).

In the north east of the site in front of the current building further smaller inspection covers were noted to be present, suggesting the possible presence of interceptors or drainage. A series of 4-5 inspection covers were located along the eastern boundary of the site running in a linear pattern, suggesting the possible presence of interceptors or drainage.

Anecdotal evidence from the hand car wash operator suggested that any USTs present are considered to be located within the north of the site, with site drainage and interceptor systems located along the east of the site. The car wash operators stated that he had lifted the inspection covers across the site to ascertain this and to improve current site drainage.

A plan showing the identified features is overleaf:



2.3 Proposed Site Use

The proposed development is understood to comprise the erection of a 3No storey residential development block with associated access, parking and landscaping following demolition and site preparation.

2.4 Conceptual Site Model

Assessment of the investigation findings have identified physically unsuitable soils (general Made Ground) and elevated levels of Aromatic C16-C21 and Aromatic C21-C35 TPH within the underlying natural soils on site which were considered to require intervention (remediation) to mitigate the risk of harm, together with the presence USTs, oil interceptors and associated infrastructure which will require removal, and elevated carbon dioxide across the site and the potential for hydrocarbon vapours, current assessment of which has identified a requirement for gas protection measures.

Remediation works are proposed to break the identified plausible contamination linkages associated with the following elements:

- Unsuitable Made Ground soils containing anthropogenic materials (and/or non-mobile chemical contamination) located at shallow depth within areas of proposed communal and/or private gardens.

This would be undertaken one of two ways depending on finished formation levels:

1) Reduced dig (i.e. excavation/stripping of upper soil layers) of Made Ground to sufficient depth to accommodate the clean soil cover system or remove the full depth of Made Ground. Where Made Ground beneath the site is fully removed back to natural soils, validation visual inspection of the underlying natural soils will be required to confirm the removal of the Made Ground in order to demonstrate that a cover system is no longer required in these areas. Where site levels are to be raised, a cover system can be installed directly over the current Made Ground levels.
2) The installation of a cover system in proposed gardens and areas of soft landscaping to break the source pathway receptor contamination linkage. Should any reduced dig remove the Made Ground entirely in some locations, a cover system would not be required in these locations, subject to validation to verify the Made Ground removal. Where significant fill is proposed to raise site levels, and the fill comprises natural soils, this would also serve to break the source pathway receptor linkage.

- Installation of a gas protection measures, in line with CIRIA/BS CS2 to protect against elevated concentrations of carbon dioxide identified through monitoring undertaken to date and to allow for the provision of a hydrocarbon resistance membrane.
- Provision for barrier pipe with respect to proposed water supply pipes, due to TPH exceedances identified. Potable water supply pipework will need to be installed in dedicated service runs below any Made Ground and backfilled with clean aggregate. Requirements should be confirmed with the water company provider.
- If/where it is proposed to retain and re-use the excavated soils where suitable for use (without treatment) across the wider site. These works would need to be undertaken in line with a Materials Management Plan (MMP), subject to the appropriate documentation (including agreement of the RSVP), Qualified Person (QP as defined in DoWCoP) independent review and declaration and agreement of the Regulators.
- Material re-use is subject to the requirements of this RSVP and no materials are to be re-used until a Materials Management Plan is in place and the required QP Declaration has been submitted to and accepted by CL:AIRE which subsequently notifies the Environment Agency (EA). Re-use of any Made Ground or materials containing contaminants outside of these protocols would be considered an illegal waste process and subject to potential legal action and financial penalties applied by the regulators to the developer and/or groundworks contractor. Please note that soils containing mobile contaminants would not be acceptable for re-use on site.

Fuel Storage Tank (UST, interceptors and associated infrastructure)

1) Removal of the underground storage tank (UST) and/or interceptor and associated pipework and infrastructure.
2) Excavation and disposal (with/without prior treatment subject to space and time constraints and requirement for re-use of materials) of any hydrocarbon impacted soils and/ or groundwater identified beneath/in the vicinity of the former UST and interceptor (if identified), together with validation sampling at the base and sides of both tank excavations.
3) If excavated soils containing any mobile contaminants are to be stored on site prior to their removal, they will need to be placed on impermeable sheeting, within a bunded area and covered with impermeable sheeting to prevent the spread of any mobile contaminants. It is preferable for excavated soils from any tank excavations to be relocate directly into wagons for removal without additional stockpiling so as to avoid double handling of contaminated materials, stockpile controls and the like.

4) Backfill of the tank and/or interceptor/infrastructure excavations with suitable subsoil and/or engineered fill, followed by the completion of soft landscaped areas (where required in relation to the proposed development) with the placement of Topsoil, a minimum depth of 150mm.

The aim of the remediation is not necessarily to remove all unsuitable material identified on site but to reduce the identified risk to an acceptable level with respect to human health and the built environment and to provide a betterment in relation to the site to minimise any ongoing risk with respect to potential mobile contamination.

3.0 REMOVAL OF UNDERGROUND STORAGE TANK, INTERCEPTORS, DRAINAGE RUNS AND ASSOCIATED INFRASTRUCTURE

The removal of the underground storage tanks, oil interceptors, drainage runs and associated infrastructure should be carried out in accordance with the following, as a minimum:

- An area to place the tank/interceptor and any excavated soils should be prepared before removing the tank/interceptor or commencing excavations. Ideally this should be on an area of hardstanding, where possible. An earth bund should be formed, lined with thick plastic sheeting, so as to contain any hydrocarbon contamination.
- Before excavation, the contents of the tank(s)/interceptor(s) should be confirmed. If the contents are liquid, the product should be pumped out and disposed of by a specialist contractor and 'chain of custody' documentation retained for inclusion within the validation report. If the contents are solid, e.g. sand, the contents should be excavated before exhuming the tank. The tank should be cleaned, de-gassed and certificated by a specialist contractor before removal. **It must be noted that under no circumstances should hot works be utilised as part of the tank removal or deconstruction process, in order to break open the tank demolition shears (or similar equipment) or similar cold methods must be utilised.**
- Excavation should commence and the empty tank should be carefully removed in one piece and placed onto the pre-prepared bund or lorry for site removal.
- Any obviously contaminated soils should be excavated and placed directly into the pre-prepared bunded area.
- The void should be visually inspected by a Geo-Environmental Engineer and the sides and base of the excavation sampled for laboratory analysis to determine the extent (if any) of residual contamination.
- Vapour monitoring (Head Space Analysis) should be undertaken on samples of soils obtained from the base and sides of the excavation in order to determine the presence of VOC vapours and lighter fraction hydrocarbon compounds.
- If any groundwater is identified within the excavation this should also be visually inspected by the Geo-Environmental Engineer for the presence of free product and sampled for laboratory analysis. The presence of free product may require additional investigation to 'chase out' a smear zone of impacted soils.
- Soils removed from the excavation will require testing for waste classification purposes to be removed from site.
- The excavation should be cordoned off until receipt of the laboratory results, unless it is deemed unsafe for the excavation to remain open.
- Depending on the results of the laboratory analysis, additional soil may need to be removed from the excavation.
- If the results show the remaining soils within the excavation to be suitable for use (in terms of risk to human health and groundwater), the excavation will be backfilled with suitable materials for the proposed development in this area.
- Should it be necessary to place the materials into a bund which cannot be created on an area of existing hardstanding (i.e. is constructed directly on the ground) then validation sampling will also be necessary beneath the bund following its removal in order to demonstrate that any contaminants have been contained through the works.

The steps detailed above must be undertaken during dry weather and with a Geo-Environmental Engineer in attendance. The following information will be required to be recorded and retained for inclusion within the validation report:

- Tank/interceptor size and condition;

- Any observations regarding the condition of the surrounding soils and with respect to contamination and nature of surround (i.e. concrete encased);
- Waste transfer notes will be retained for the following:
    - Disposal of tank;
    - Disposal of associated pipework;
    - Disposal of tank contents if present;
    - Disposal of concrete/ brick surrounding materials, if present;
    - Disposal of impacted soils.

- In the event that soils are treated and re-used as opposed to disposed of, this must be undertaken under an appropriate permit, and validated in line with agreed criteria under the permit, with details provided for inclusion in the validation report. The Contractor shall be responsible for any permit application, management of permitted works and surrender (where relevant) of any such permit.

4.0 SOILS

The ground conditions on the site have been established through third party assessment. Nevertheless,, a discovery strategy must be in place on site during any site clearance of development works. Should further or unexpected contamination be identified this should be followed.

Ground conditions encountered were reported to comprised:

- Macadam – 100mm thick at all locations;
- Made Ground – extending to a maximum depth of 1.0m bgl and comprising blackish grey sandy cobbly GRAVEL with brick and concrete in WS01 and WS02. WS03 comprised blackish brown clayey gravelly SAND with frequent brick fragments and WS04 comprised brown sandy gravelly CLAY with occasional chalk, coal, flint and brick;
- Natural Cohesive Soils – Firm sandy gravelly clay to depth of at least 3.0m bgl;
- Natural Granular Soils - Encountered beneath the natural cohesive soils in WS04 and comprised clayey gravelly SAND with flint gravel, which was proven to the base of the boreholes 4.0m bgl.

Twelve soil samples were tested for geochemical analysis for a range of substances to include TPH, PAH, heavy metals and metalloids, Soil organic matter, BTEX and MTBE, sulphate and screening for the presence of asbestos. The results of which were assessed against a residential land use with consumption of homegrown produce. No exceedances above the respective screening criteria were reported with the exception of the following:

- Aromatic C16-C21 which reported a maximum concentration of 409mg/kg compared to a LQM/CIEH GAC (1% SOM) of 260mg/kg within WS04 at 3.5m bgl
- Aromatic C21-C35 which reported a maximum concentration of 1788mg/kg compared to a LQM/CIEH GAC (1% SOM) of 1100mg/kg within WS02 at 3.0m bgl.

The asbestos screening reportedly returned a negative result for the presence of asbestos from all samples analysed.

It should be noted that the top 600mm of gardens and 450mm of communal soft landscaping should also be free from anthropogenic Made Ground and visual contaminants (brick, concrete, glass, plastics, etc). The composition of the shallow Made Ground soils in the exploratory holes, is such that it would not be suitable for re-use in areas where soft landscaping is proposed and thus any remedial action should be applied across the portions of the site where Made Ground is present and soft landscaping is proposed.

Asbestos was not detected within any of the samples tested. Nonetheless, this should not be taken as confirmation of the absence of asbestos in other locations such as discrete burial, entrained within building fabric and concrete, or as aggregate beneath concrete or tarmac slabs. Due caution will be required in this respect and the discovery strategy must be enacted if any such discovery is encountered during demolition, clearance or development.

Given the extent of Made Ground soils within exploratory holes across the site, it was considered likely to be impractical to consider wholesale excavation and removal of Made Ground. As such, a suitable soil cover system is required to be installed over Made Ground soils where soils remain in situ, in garden areas and/or areas of proposed communal soft landscaping.

- In areas of proposed private gardens the cover system should comprise 0.60m thick soil cover system and would comprise 150mm of clean Topsoil underlain by clean subsoil laid over a high vis deter-to-dig geomembrane laid over the Made Ground to form a physical marker layer .

- In areas of proposed communal soft landscaping the cover should comprise 0.45m thick soil cover system and would comprise 150mm of clean Topsoil underlain by clean subsoil laid over a high vis deter-to-dig geomembrane laid over the Made Ground to form a physical marker layer.

The requirement for a cover system is likely to influence development levels and thus may require the raising of roads and floor levels accordingly, or a reduced dig to facilitate the installation of the cover system.

Based on the above, it is considered that remedial action would be warranted to protect end users of a residential development across the site where Made Ground or hydrocarbon impacted soils were recorded.

4.1 Site Workers

It is the responsibility of the Principal Contractor and their appointed sub-contractors to implement and manage safe systems of work, prepare their own risk assessments in accordance with Health and Safety legislation in order to protect persons in their employ, as well as mitigate the risk of harm to others due to works in their control. Special consideration should be given to the provisions of the Construction (Design & Management) Regulations 2015, Health and Safety at Work Act and the Control of Substances Hazardous to Human Health regulations to protect the safety of persons in their employment. Additional guidance can be sought from the CIRIA publications entitled "A Guide for Safe Working on Contaminated Sites" and “Environmental Good Practice on site guide (fourth edition)”.

In addition to the safe systems of works to be implemented alongside appropriate risk assessments and method statements, all site personnel shall benefit from on-site hygiene facilities including wash area, toilets and drying room.

Separate canteen area and welfare facilities should be provided. All eating and drinking should be restricted to the canteen area and only once site personnel have removed outer PPE and washed exposed skin.

In the event of dry spells, or where the exposed surface becomes dry, regular damping down of the surface of the site will be required to prevent the release of soil dust which could impact on site operatives or migrate off-site, thereby mitigating both off-site exposure and nuisance for neighbours.

4.2 End Users

A contamination assessment has identified physical contaminants within the general Made Ground across the site and chemical contaminants within the deeper natural soils on site.

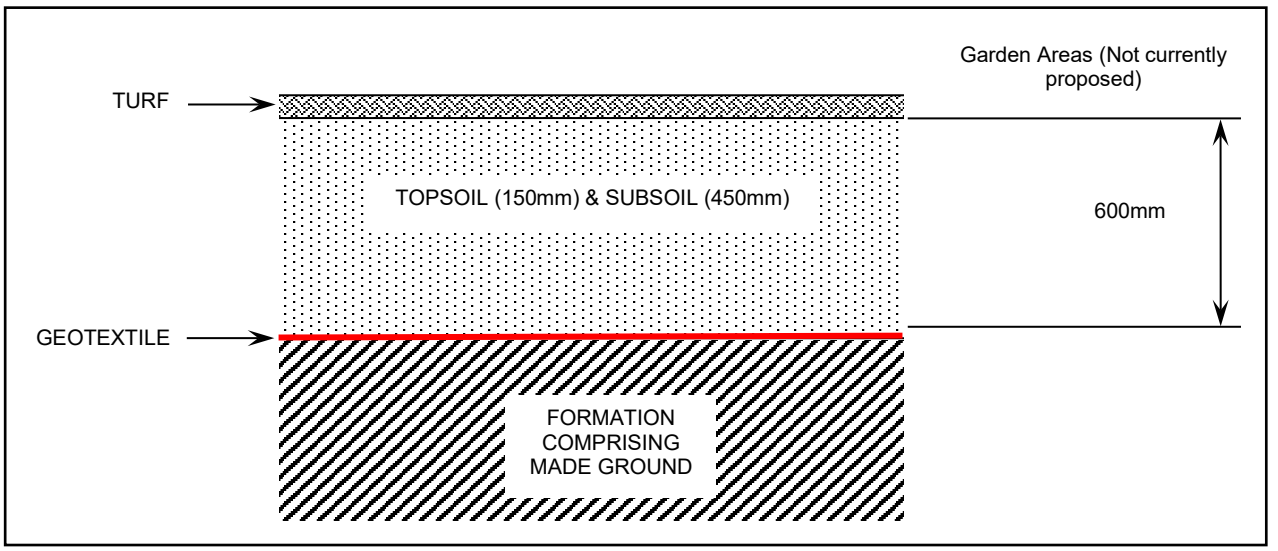
Given the nature of the physical contaminants identified within these soils, the Made Ground soils will either be removed entirely back to natural ground, or a soil cover system will be installed within proposed garden and landscaped areas (subject to final development levels). Where significant fill is proposed to raise site levels, and the fill comprises natural soils, this would also serve to break the source pathway receptor contamination linkage. Where impacted soils are completely removed back to natural soils, this would require independent validation by Geo-Environmental.

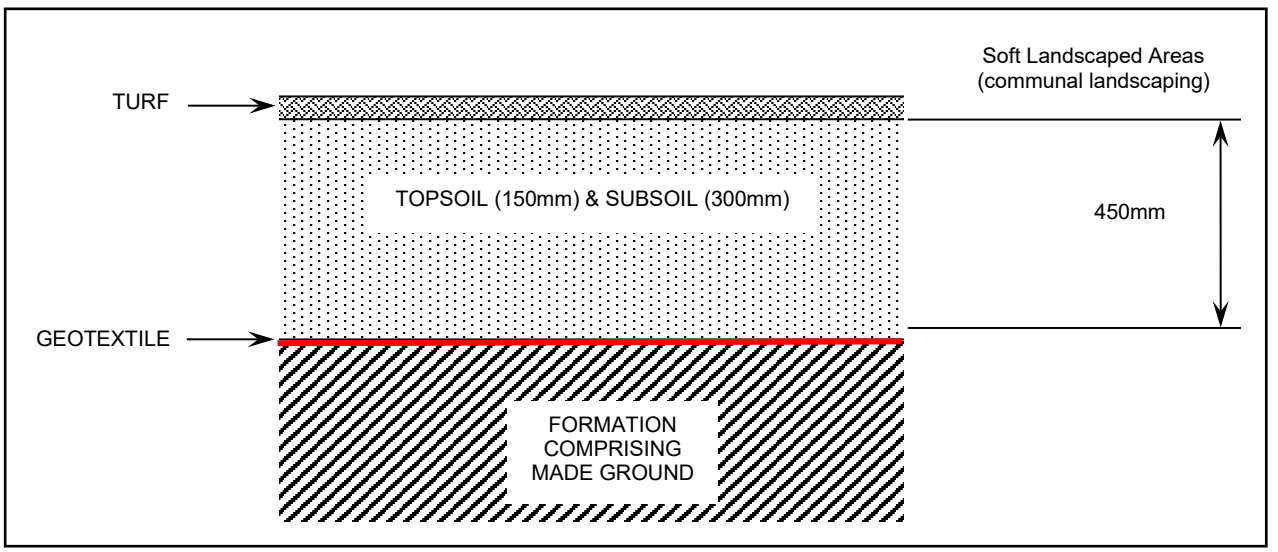
At this stage, it is understood that the site is proposed to be developed for residential land use with communal landscaping. However, mitigation measures are also included to comprise any areas of private gardens should proposals change. Where a cover system is installed the cover system must comprise certifiably ‘clean’ Topsoil and subsoil. Both aspects of the cover system must be chemically and physically suitable for the proposed end use. A soil cover system with a minimum soil cover thickness of 600mm would be required in proposed gardens

and 450mm in areas of communal soft landscaping underlain by a high vis deter to dig geotextile. The upper 150mm of a cover system should comprise Topsoil.

Where the cover system is placed directly over Made Ground the cover systems will incorporate a high visibility, deter-to-dig geotextile, e.g. Alert® deter to dig membrane or similar, to provide a visible separation between the cover soils and the underlying Made Ground. Any soils imported onto the site should be verified free from contamination with chemical testing undertaken to confirm their suitability for use within gardens and areas of soft landscaping.

An example of the recommended cover systems for use in areas of private gardens and areas of communal soft landscaping are provided below:





Any soils imported onto the site will need to be verified free from contamination (chemical and physical) with chemical testing undertaken to confirm their suitability for use within areas of soft landscaping. Soil importation is discussed further in Section 5.0.

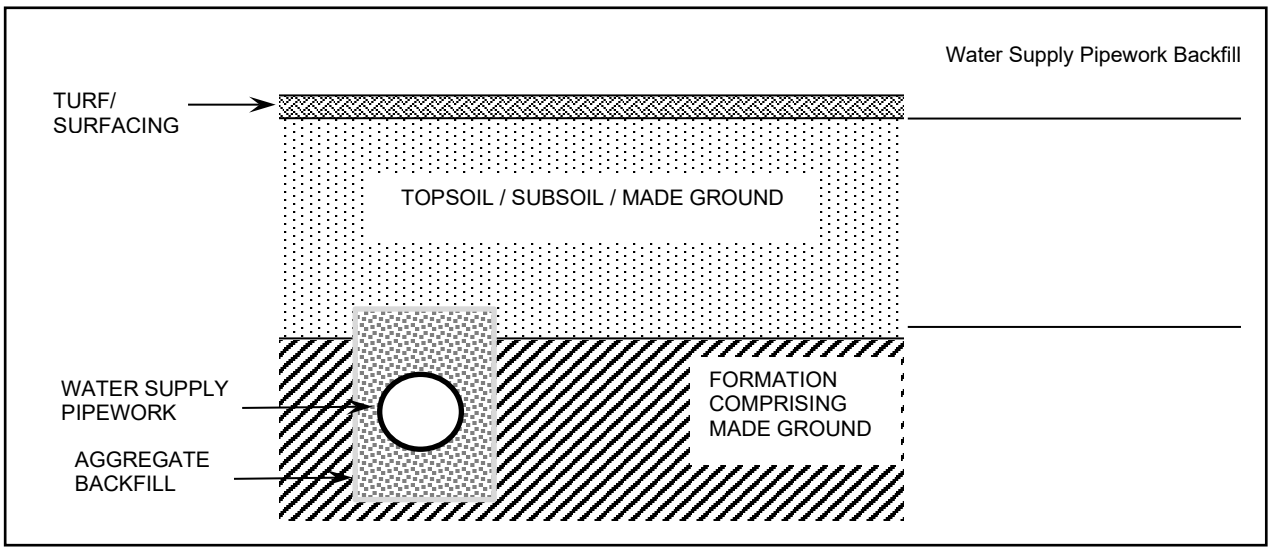
Where contaminated/physically unsuitable soils are located in an area of permanent hard cover, e.g. building footprint, road, car park, driveway or the like, then the hard cover would break the contamination linkage and remediation would not be required in terms of the risk to human health, however limited works may be required in these areas to provide a suitable working platform for development to proceed and in relation to any longer term maintenance for any service runs located in this area.

4.3 Built Environment

The analysis undertaken has identified exceedances in the threshold concentrations for PE pipe with respect to proposed water supply pipes. The exceedances related to TPH Aromatic C16-C21 within WS04 at 3.5m bgl and Aromatic C21-C35 within WS02 at 3.0m bgl. However, the nature of the former land use of the site is such that other pockets of mobile contamination may be present associated with the former tanks, interceptors and associated pipework and infrastructure.

As such, the utility company should be consulted in order to confirm their specific requirements in this respect, at this time subject to further confirmation and given the former land use of the site, it is considered that specific protection measures are likely to be required and provision should be made for the use of barrier pipe for potable water supply.

Potable water supply pipework will be installed in dedicated service runs where located within any Made Ground and backfilled with clean aggregate. This will require validation works to ensure backfill has been undertaken correctly.



Even where services are located within underlying clean natural soils, as a matter of good practice and to maximise the protection to maintenance workers, it is recommended that clean, granular backfill is used in service runs and that marker tapes are used for all buried services.

Documentary evidence of the liaison undertaken with the water utility company and records of the installation of the agreed type of supply pipework should be provided for inclusion within the Verification Report.

4.4 Inspection/Validation

Verification of remediation measures shall be required through regular inspection at key stages of the works to include:

- Excavation/removal of soils from a reduced dig (where required) and subsequent validation of removal;
- Inspection and validation testing of the exposed formation where Made Ground soils are completely removed, such that a cover system would not be required;
- The placement of a cover system or level raising, including verification of any additional subsoil and/or Topsoil to allow for the installation of the capping system required in garden and landscaped areas;
- Evidence of installation of potable water supply pipework in dedicated service runs;
- Verification of gas protection measures at key stages of construction works;
- Verification of the removal of the underground storage tank/s (UST), oil interceptors, and associated pipework and drainage runs and inspection soils, disposal certificates and verification.

Details of these works would be presented within a verification report for the site.

5.0 DEFINITION OF WASTE CODE OF PRACTISE

5.1 Re-use of Soils

Should there be a requirement to re-use materials on site and/or import materials (from another development site) to the site this will need to be undertaken under a Materials Management Plan (MMP) for the site. Which would requirement agreement of the RSVP and principal of re-use with the regulators (Local Authority and Environment Agency).

Made Ground has currently been identified across the site containing anthropogenic contamination that would require remediation in the form of a reduce dig and removal of Made Ground back to natural soils or the installation of a cover system in relation to areas of proposed soft landscaping and private gardens. In addition hydrocarbon has been identified at depth within investigation positions, although it is not noted to have mobilised to groundwater beneath the site.

It may be possible to re-use soils comprising Made Ground and/or containing contaminants in areas where the risk of re-use is acceptable in terms of the proposed development, but this re-use would be subject to the agreement of re-use and agreement of this Remedial Strategy and Verification Plan (RSVP) with the Local Authority Environmental Health Officer and the Environment Agency) beneath a suitable capping layer, where it can be demonstrated that there is a requirement for such materials and where the risk is acceptable, i.e. the source, pathway, receptor (SPR) linkage has been severed, there is a certainty of use and no more that the required volume will be used. Any proposed re-use will be detailed within a separate Materials Management Plan (MMP) for the site.

Any works on site should include a contingency plan for any unexpected contamination encountered during the development and as assessment of the suitability of materials for re-use in line with the Definition of Waste Code of Practice (DOWCOP). Soil impacted by mobile contamination on site would not be suitable for re-use and excavation and off site disposal and/or treatment.

In accordance with CL:AIRE Code of Practice (2011) materials are only considered waste if ‘they are discarded, intended to be discarded or required to be discarded by the holder’. Current guidance recommends the retention and re-use of site won soils where there is a need for the materials and where the risk is acceptable

The Code of Practice therefore allows soils to be re-used on site where the following criteria are met:

- Pollution of the environment and harm to human health is prevented, or not increased in reusing the excavated materials;
- The materials are suitable for use (without any further processing);
- There is certainty of use; and
- The quantity that is absolutely necessary (and no more) is used.

Where materials do not meet the required criteria, it may be possible to treat them under an environmental permit so that they may be re-used on site.

In accordance with the Definition of Waste Code of Practice, the re-use and importation of material will need to be fully documented and included within the Verification Report produced on completion of the works.

Should excess clean naturally occurring materials be identified on site, it may be possible for these to be re-used on other sites through the CL:AIRE register of materials, as opposed to these materials being considered waste.

5.2 Imported Soils

Subsoil and Topsoil shall not be imported to site without prior acceptance of provenance and chemical suitability. Import suitability criteria are presented in Appendix A. Where materials are to be imported on to the site for use as subsoil and Topsoil, these shall be derived from one of two sources, i.e. natural or processed. Where natural sourcing is proposed, the provenance of the material shall be determined by confirmation of the source site's history to confirm no previous potentially contaminative use, coupled with analysis of soils at a minimum rate of 3No. samples per source site (up to 250m^3) and 1 sample per 250m^3 thereafter. Where topsoil or subsoil are derived from a manufactured source, testing would be undertaken at a rate of 1 sample per 50m^3 up to 10No. samples and then at one sample per 150m^3 thereafter if the source and initial sample results remain consistent. Use of an additional source would require repetition of this stepped sampling frequency. With regard to physical and nutritional composition, a minimum testing regime of 1 sample per 250m^3 is recommended for either source.

6.0 EXCAVATION AND STOCKPILING OF MATERIAL (FUEL STORAGE TANKS)

6.1 Excavation Process

For the area where excavation works are proposed to remove the underground storage tanks, interceptors, storage tank, associated pipework or infrastructure, and any hydrocarbon impacted soils, this shall commence where the highest contaminant concentrations were encountered progressing laterally towards uncontaminated faces. Once lateral removal has been completed, the excavation shall be progressed vertically. This approach will minimise the potential for cross contamination or the creation of migration pathways.

During the excavation works soils will be visually assessed by a Geo-Environmental Engineer and screened with a Photo Ionisation Detector (PID) to assess the presence of Volatile Organic Compounds (VOCs), to help target validation sampling. Where validation analysis indicates that the concentrations of concern remain, the area surrounding the failure sample shall be subject to further excavation and re-validation.

Excavations would be limited where it is not reasonably practicable to do so in a safe manner, such as:

- Instability to the adjacent roadways, buildings, walls or site boundaries;
- Close proximity of adjacent services, particularly foul sewers and high voltage cables.
- Ingress of water that cannot be dealt with by normal pumping equipment.

Where it is not possible to fully excavate all mobile contamination, impacted soils/groundwater within the excavations due to the limitations noted above, the use of in-situ oxidation (e.g. ISCO treatment) of the shallow groundwater will be utilised to further breakdown the mobile contaminants identified where application is appropriate.

6.2 Stockpiling of Soils

All stockpiles of contaminated soil, where required, shall be constructed no larger than 250m^3 and no higher than 1.8m. Stockpiles shall be placed on stable and level ground, and where possible areas of hardstanding, with a perimeter bund overlain by a polythene liner for run-off control. The liner will extend across the full base area of the stockpile. The stockpile shall either be covered by a second polythene (or similar) sheet, or otherwise sealed to prevent the ingress of rainfall into the stockpile and the release of dust and fibres. This upper sheet shall be weighted down or otherwise secured to the stockpile.

Prior to placement of material the stockpile bund will be inspected to ensure that it is impermeable and as such will be sufficient to retain surface runoff during the period of storage. Should water be noted to be building up within the bund, it will be pumped out of the bund and disposed of under the appropriate duty of care.

On completion of on-site remediation works and removal of the stockpiles, the bund and liner materials will be removed to enable development of this portion of the site to continue. At this stage, the exposed ground will be inspected to confirm/validate that no leakage/cross contamination has occurred from the stockpile. Any such new impact would be dealt with under the Discovery Strategy set out in Section 9 of this report.

6.3 Validation Sampling from Excavations

Where the underground storage tank and associated pipework, oil interceptors and associated infrastructure have been identified, on-site screening shall be undertaken using organoleptic evidence of contamination supported with a Photo Ionisation Detector (PID) calibrated to a standard Isobutylene 100ppm gas. Given that olfactory senses can become desensitised to organic contaminants, PID screening shall take precedence. On-site screening

shall be undertaken as required by the specific conditions encountered. On completion of the excavation works, validation samples shall be taken from the base and sides of the excavation.

Validation sampling shall be undertaken in relation to the area excavated. As a guide, for small areas, a sample shall be taken from each face and two from the base. Sampling frequency may be varied by Geo-Environmental's Site Representative to account for variation in the soils exposed.

7.0 CONTROLLED WATERS

The site superficial deposits (River Terrace Deposits) are classified a Secondary 'A' Aquifer. The 'bedrock' strata (London Clay Formation) are classified as Unproductive Strata. The site is understood to be located outside any Source Protection Zone.

Two water samples were subjected to geochemical analysis for a range of substances to include TPH, PAH, heavy metals and metalloids, BTEX and MTBE, pH, electrical conductivity, TOC, and total hardness, phenols, total cyanide, and sulphate. The results of which were assessed against The Water Supply (Water Quality) Regulations: 2016 (WSR), Water Framework Directive (WFD) (Standards and Classification) Directions England and Wales 2015 (including EQS) and World Health Organisation (WHO) Standards.

Groundwater exceedances were reported for:

- Barium in WS01 and WS04 at between 54µg/l and 124µg/l – both concentrations significantly exceeded the DWS (WHO GAC) of 0.7 µg/l.
- Mercury in WS04 at 0.12µg/l – marginal exceedance of the EQS of 0.07 µg/l.
- Nickel in WS01 at 157µg/l and WS04 at 18µg/l – WS01 concentration significantly exceeded the EQS with WS01 also significantly exceeding the DWS of 2.0 µg/l.
- Zinc in WS01 at 23µg/l – marginal exceedance of the EQS 12.9 µg/l.

While elevated metals have been identified within the groundwater analysed beneath the site it is noted that elevated metals were not reported within the soils analysis on site to date.

There were no EQS or DWS exceedances reported from the screening undertaken on the respective PAH or TPH CWG bands. In addition, BTEX and MTBE were reported to be below the LOD within the analysis undertaken.

It was reported unlikely that a continuous water body was presented beneath the site due to the cohesive nature of the soil identified. It was reported that the enabling works for the site would results in betterment of the site in terms of the removal of USTs, stripping of Made Ground together with the construction of formal drainage infrastructure such that the site was considered unlikely to represent a significant risk to surface water receptors.

While significant gross soil impact or significant mobile contaminants were not recorded during the intrusive investigations and testing to date, the nature of the site and presence of USTs, interceptors and associated pipework and infrastructure on site are such that areas of mobile contamination or grossly impacted soils may be encountered on site during site clearance works, which if encountered should be dealt with under the discovery strategy.

Based on the ground conditions encountered within investigation works undertaken to date, coupled with the chemical results and proposed excavation and removal of the UST, interceptors, pipework, infrastructure and associated grossly impacted soils which would provide a betterment over existing conditions on site, no specific remedial works are considered necessary to protect groundwater from on-site soil contamination concentrations identified at this stage.

Should impacted groundwater/free product be encountered as part of the excavation and removal of this tank/interceptor structures and associated infrastructure this should be pumped out and disposed of under the appropriate duty of care and should be dealt with under the discover strategy presented in Section 9.0.

7.1 Monitoring Well Decommissioning

Where gas and groundwater monitoring wells have been installed on the site as part of the ground investigation works these should be decommissioned in line with best practice and in line with Environment Agency Guidance prior to or as they become redundant on site and prior to any development works where they are situated on site. The decommissioning should comprise the removal of the well and backfilling of the location with bentonite, in order to ensure that a pollution pathway does not remain on the site and these works should be documents within the validation report for the site.

8.0 GROUND GASES

8.1 Bulk Ground Gases

Six return spot ground gas monitoring standpipes (WS01, WS02 and WS04) were installed by Your Environment. Return monitoring on six occasions between September 2022 and January 2023.

The spot monitoring undertaken detected methane up to 1.8%, carbon dioxide up to 7.4% and oxygen in the range 6.4% to 21.0%. Hydrogen sulphide was not detected and carbon monoxide was detected up to 5ppm. Positive borehole flow rates of up to 0.2l/hr were recorded during the monitoring.

A gas screening value (GSV) was calculated by Your Environment for both methane and carbon dioxide in accordance with the recommendations contained with C665. To calculate a GSV for the site, the worst case, i.e. the highest concentration value, of recorded methane and carbon dioxide, have been used. A value of 1.8% v/v has been used for methane and a value of 74% has been used for carbon dioxide. The highest representative borehole flow rate recorded was 0.2l/hr.

Using these worst-case values, a GSV of 0.0036l/hr has been calculated for methane and a GSV of 0.0148l/hr has been calculated for carbon dioxide for the site. This would classify the site as representative of Characteristic Situation 1 (BS and CIRIA). However, the limiting 'threshold' concentration for carbon dioxide for a Characteristic Situation 1 gassing regime has been exceeded within the monitoring undertaken. Therefore, consideration was given to classification of the site as Characteristic Situation 2 gassing regime site based on ground conditions, site history, the sources of ground gases identified and monitoring results.

Your Environment recommended that gas protection measures in line with CS2 should be installed. In addition, the report stated.

'Additionally, the presence of potential hydrocarbon vapours needs to be considered. Although recorded at concentrations below the GAC, the presence of toluene, ethylbenzene, xylenes, MTBE, naphthalene and lighter end TPH bands were all detected within soils. The historic use of the site as a garage and petrol filling station is significant and that hydrocarbon odours were noted in the soils during the advancement of the boreholes. Concentrations of dissolved BTEX, MTBE, TPH bands and naphthalene were all below the level of detection of the laboratory. Therefore, provision of a gas resistant membrane should additionally include hydrocarbon vapour resistance.'

Recommendations on acceptable gas concentrations recorded in the ground beneath or adjacent to buildings are given in a variety of publications. For the purpose of this assessment, the results have been evaluated in terms of British Standard BS8485, '*Code of practice for the design of protective measures for methane and carbon dioxide ground gases for new buildings*' (2019); CIRIA C665, '*Assessing risks posed by hazardous ground gases to buildings*' (2007) and NHBC report NF94 '*Hazardous Ground Gas – an essential guide for house builders*' (2023).

As such, it is considered that the gassing regime within the site would be Characteristic Situation 2 (CS2) based on the monitoring carried out to date and the presence of an organic contamination associated within the site former use and presence of USTs, interceptors and hydrocarbon impacted soils at depth. It may be possible to downgrade the classification however this would require a period of further monitoring post site clearance and removal of the USTs, interceptors, associated pipework and infrastructure to allow for consideration of any residual risk.

Where the site has been characterised as CS2 the following gas protection measures would comprise typical measures required within a proposed residential development as a guide, however detailed design must be based on BS8485 Scoring:

- Suspended ground floor slabs;
- Passively ventilated sub-floor void via air bricks (minimum 150mm clear void height across the footprint) with sufficient ventilation to allow at least one complete volume change in any given 24hr period. Air bricks will need to be positioned above external ground level in the outer skin such that they have a clear and uninterrupted flow of air across them. This has a direct bearing of construction and external levels where level thresholds are required;
- Cross ventilation through sleeper walls to prevent the formation of low flow zones within the sub-floor void;
- Installation of a gas and hydrocarbon resistant membrane (suitable for protection against both methane and carbon dioxide) laid across the floor with all joints and service penetrations sealed to form a single integral membrane with taped or welded joints. All joints should comprise a minimum 150mm overlap. It is recommended that membrane installation is undertaken by a suitability competent (e.g. NVQ qualified) installer;
- Minimum penetration of the slab by services and sealing of all penetrations and joints using 'top hats' or bespoke/site formed top hat seals;
- Use of an appropriate gas resistant DPC across the cavity with lap on the inner skin wall to facilitate joining to the floor membrane.
- Inspection and verification of installed measures.

Detailed design is required to be undertaken in line with the BS8485 scoring requirement for protection measures.

In accordance with NHBC policy, recycled plastics will not be acceptable as part of the gas protection measures. Use of recycled plastics would result in plots being failed during validation and at CML stage.

If any of the proposed houses have an integral garage, or a detached garage which could be converted for 'non-garage' use, e.g. residential, home gym, home office or the like, the gas protection measures should also be installed in the garage.

BS8485 Scoring Assessment

Ground gas protection would need to comply with BS8485 which provides a scoring system based on gassing regime, end use and mitigation measures. Gas protection cannot be based solely on one form of protection, but requires a 'layered' approach whereby if one measure fails, protection is maintained because of other measures already included in the construction stage.

For a CS2 gassing regime, BS8485 requires a minimum score of 3.5 to be provided by the protection/mitigation measures. It is considered that the proposed development relates to Type B (small managed buildings), i.e. residential including tenanted and/or maintained by a landlord.

Table 5 of BS8485 assigns a score of 1.0 for a cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations with 'good' performance. Whilst a score of 1.5 might apply for 'very good' performance it would also require sufficient reinforcement to prevent cracking and must also have 'minimal' penetrations. The latter can be difficult to achieve. Either way, the proposed floor slab does not attain sufficient scoring under BS8485 to be considered acceptable as the sole form of gas protection.

Table 6 of BS8485 assigns a score of 0.5 for a pressure relief pathway e.g low fines gravel or with a thin geocomposite blanket or strips terminating in a gravel trench external to the building) or 1.5 to passively ventilated sub-floor void, e.g. sub-floor void ventilated to air bricks, polystyrene void formers and vent conduits.

Table 7 of BS8485 assigns a score of 2.0 to a gas barrier membrane (as defined in BS8485). Here again, a membrane alone does not attain sufficient scoring either alone. However, a combined scoring for the floor, sub floor void an and membrane (assuming a score of 2) provide a score of >3.5 and so does meet the minimum requirement of BS8485.

It is therefore considered necessary for ground gas protection to include a cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab (to achieve a minimum score of 1.0), passively vented sub floor void (to achieve a minimum score of 1.5) and gas barrier membrane (to achieve a minimum score of 2). Membrane installation should be undertaken by a specialist competent installer. All protection measures will require inspection and verification.

Proposed construction details have not been provided for review at this stage.

Membrane installation should be undertaken by a specialist competent installer. All protection measures will require inspection and verification.

8.2 Construction Method

The gas protection measures are to be installed by either a specialist installer or an alternative suitably qualified contractor and will be subject to their own installation quality checking.

Good practice requires any surface onto which a membrane will be laid to have been checked and cleared of obstructions, sharp items or the like which might cause damage to the membrane. Any defects in the membrane once installed are to be repaired.

Whilst the membrane strips laid across/through walls will be laid at the relevant stage of brickwork, the main floor membranes can be installed at a later stage of construction, should this be deemed appropriate for the proposed construction program. Installation of floor insulation and screed must occur immediately following installation and inspection/verification of the floor membrane in order to protect the membrane during later stages of construction. If floor construction is delayed, protection matting must be laid over the membrane to prevent accidental damage.

In accordance with BS84845, the proposed structures across the site comprise Type B for which a gas protection score of 3.5 is required based on the site's gassing regime (CS2). Table 8.1 summarises the scores applicable to the construction as set out above and demonstrates that the protection measures to be incorporated in the construction of buildings on this site meet the minimum score required.

Element	Score
Cast in situ monolithic reinforced ground bearing raft or reinforced cast in situ suspended floor slab with minimal penetrations with 'good' performance	1.0
Pressure pressure relief pathway or passively ventilated sub-floor void	0.5 - 1.5
Gas resistant membrane	2.0
Total	3.5 - 4.5

Table 8.1 BS8485 gas protection measures score

Proposed construction details have not been provided for review at this stage.

8.3 Inspection/Validation

Verification of remediation measures shall be required through regular inspection at key stages of the works to include:

- Inspection and verification of gas protection and gas mitigation measures at key stages of construction.

It is likely that verification will be undertaken in phases in line with the construction programme. It should be noted that phasing of remediation and verification with build programme may not align with any 'first occupation' planning conditions and it is recommended that agreement is sought from the Local Planning Authority for how any such discrepancy can be managed.

The verification process is set out in Table 10.1

Details of these works would be presented within a verification report for the site.

8.4 Radon

UK Health Security Agency (UKHSA) and British Geological Survey (BGS) updated the UK maps of Radon in December 2022 (see www.ukradon.org), i.e. after production of the desk study report for the site. The new mapping is based on updated geological mapping and additional measurements from indoor surveys by UKHSA. The new mapping replaces the previous mapping which was based on 2012 data and came into effect from 1st December 2022.

Examination of the radon mapping provided at www.ukradon.org indicates that site lies within an area where 1-3% of homes are estimated to be above the action level as detailed in the Your Environment Reported dated February 2023. Based on this, no radon protection measures would be required for new buildings or extensions at the site.

9.0 DISCOVERY STRATEGY

Whilst an intrusive investigation has been undertaken on the site, it remains possible that unexpected soil ground and/or groundwater conditions may be encountered during the process of construction.

Should previously undiscovered contamination or unforeseen ground conditions be encountered during construction, this must be reported to the site manager immediately in order that the consultant is notified. Where deemed necessary and instructed, the consultant shall attend the site to inspect the discovery and provide recommendations on the further actions required, if any. Where necessary the regulatory authority shall be informed. Post any additional investigation or laboratory testing the results and any proposed remedial measures shall be reported to the regulatory authority or other appropriate organisation for consent, before proceeding or implementing the remedial measures.

A copy of the discovery strategy must be lodged on site, and provisions made to ensure that all workers are made aware of their responsibility to observe, report, and act on any potentially suspicious, abnormal unforeseen or contaminated soils ground and/or groundwater conditions they may encounter.

Depending on the type, nature and extent of any such 'discovery', it may be necessary to halt works in that location until such time as the assessment has been completed. This shall be reviewed on a 'discovery' specific basis and in conjunction with regulatory consultation with the client, other technical personnel and/or regulatory/appraisal organisations.

As a general guide, where such unexpected conditions are encountered the following approach is required as a minimum:

- All discoveries are to be reported to the Site Manager immediately and works at that location are to halt until further notice;
- The Site Manager is to report any such discoveries to the Client and the Consultant;
- Following notification from the Site Manager, the Consultant shall discuss the discovery with the Local Authority and/or other relevant parties and if considered necessary, arrange to meet an Officer on site to view the discovery;
- The Consultant shall attend the site to record the location, extent and nature of the discovery and implement an appropriate sampling and analysis regime, taking due account of the type and nature of the discovery, known and probable land uses in that area of the site;
- Where remedial action is required, regulatory consultation and approval will be sought;
- A record will be produced by the Consultant and held on site (with copies held by the Consultant, Client and Local Authority/other relevant organisation), detailing the discovery, assessment works undertaken, findings thereof, confirmation either of no action required or detailing the remedial action taken and validation thereof.

The process is shown below.

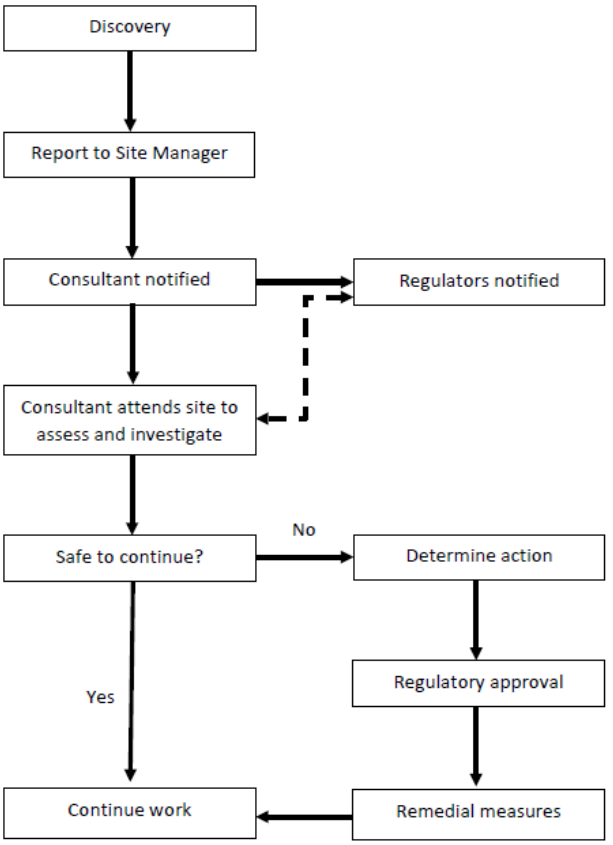


Chart 1 Discovery Strategy Process

A copy of this strategy will be lodged on site, and provisions made to ensure that all workers are made aware of their responsibility to observe, report, and act on any potentially suspicious or contaminated materials they may encounter.

10.0 VERIFICATION

Verification is required to be undertaken throughout the course of the remediation works, together with tracking and placement of any works/movement/re-use of soils undertaken in line with a Materials Management Plan (if required) alongside the RSVP. The Verification Report will be submitted to the Client, NHBC and Local Authority for formal approval and to the Environment Agency if requested as part of any works completed under the Definition of Waste Code of Practice.

The Verification Report will refer to the works as set out within this remediation strategy and verification plan and as required by any relevant planning conditions. The report will include records from site inspections including:

- Locations where the Made Ground was excavated and confirmation of either placement location on site or disposal from site, and any subsequent validation inspections undertaken.
- Details of cover system installations and validation of thicknesses and specification (including subsoil element if required as part of any cut and fill works onsite in areas where remediation is required).
- Confirmation of removal of the UST/interceptors, associated pipework, infrastructure and impacted soils, disposal certificated and associated verification.
- An audit trail for any imported subsoil and Topsoil, including source, provenance, analytical results, placement location and thickness (should subsoil and/or topsoil be imported).
- Evidence of installation of potable water supply pipework in dedicated service runs.
- Documentary evidence confirming the installed water supply pipework including agreement from the water utility company.
- Details of the validation of gas and hydrocarbon vapour membrane installation.
- Details of any discovery made under the Discovery Strategy on site and subsequent works undertaken in relation to these discoveries.

A summary of verification proposals is presented in Table 10.1 below.

The Contractor will be required to deploy a competent person to manage the works and ensure that relevant records are kept in relation to the disposal of any waste soils and pre-important compliance testing for any imported soils. In addition, the remedial works will be inspected and validated on behalf of the Client by Geo-Environmental in order to present independent verification.

It should be noted that to enable the required validation works to be undertaken and reported within a verification report on completion of the works, the client is required to keep the consultant updated on the progress of works on site and to notify them when various stages have been reached such that validation inspections can be carried out as required. Geo-Environmental takes no responsibility for failure to be notified that works are ready for inspection at the required key stages of the works as detailed herein.

Reference	Principal requirements	Design or construction related	Site visit required by Qualified Geo-Environmental Engineer	Supporting documentation
1.0 Verification general principles	Geo-Environmental will be supervising remedial works for the site at 57 The Queenway, Bognor Regis, West Sussex PO21. These works require the installation of cover systems and/or reduced dig within proposed gardens/communal landscaping, removal of a UST(s)/interceptor(s) and associated pipework(s), infrastructure and grossly impacted soils and installation of gas protection measures to CS2 across part of the site. The aforementioned work is in line with the approach adopted for site investigation and risk assessment and previously undertaken by third parties, in respect of the proposed development.	Design and Construction	**Yes –** See below	Details of construction programme to be provided by client/contractor.
2.0 Reduced dig of Made Ground	Excavation of Made Ground, where required by development levels.	Construction	**Yes – 5 days' notice required**	Regular visits to site required to confirm works being undertaken. Where Made Ground is removed back to natural ground, visual inspection of the exposed natural formation level will be required.
3.0 Soil cover system	Cover systems to be constructed by the ground workers as detailed in Section 4.2 and inspected by Geo-Environmental.	Construction	**Yes - 5 days' notice required**	Provenance of imported soils used to complete cover system must be verified by the groundworks contractor prior to importation or placement of the soils. Placement of soils to be observed/inspected by Geo- Environmental. Thickness and construction of cover system to be verified by Geo-Environmental. If soils are to be imported to site, pre-import analysis is required to be provided from the source site for review and compliance/suitability assessment prior to importation. Validation samples to be taken and

Reference	Principal requirements	Design or construction related	Site visit required by Qualified Geo-Environmental Engineer	Supporting documentation
				chemical test results presented in the report. Thickness and construction of cover system to be verified by Geo-Environmental.
4.0 Removal of USTs and associated pipework and infrastructure	Removal of tanks/interceptors and associated pipework and infrastructure undertaken by ground workers supervised and validated by the Environmental Consultant.	Demolition	**Yes - 5 days' notice required**	PID used for on-site screening purposes and validation samples to be taken at base and sides of excavation and chemical test results presented in the validation report.
5.0 Hydrocarbon soil (grossly impacted) removal, if encountered in relation to tank/interceptor removal	Excavation works to be undertaken by ground workers and supervised and validated by the Environmental Consultant	Construction	**Yes - 5 days' notice required**	PID used for on-site screening purposes and validation samples to be taken at base and sides of excavation and chemical test results presented in the report.
6.0 Gas Protection to houses and garages where applicable	Gas and Vapour Protection Measures to be included within the proposed development, to protect against Carbon Dioxide and hydrocarbons identified beneath the site.	Design and Construction	**Yes - 5 days' notice required**	Regular visits to site required to confirm works being undertaken and to validate the various stages of installation across the site.
7.0 Potable Water Supply Pipework	Water utility company requirements to be confirmed and aggregate backfill of water supply pipe runs to be constructed by the groundworkers at detailed in Section 4.3 and records to be provided to Geo-Environmental.	Construction	**No**	Site records and photographs to be provided by the groundworkers, or independent inspection by Geo-Environmental. Confirmation of Water utility company requirements to be presented in validation report.

Reference	Principal requirements	Design or construction related	Site visit required by Qualified Geo-Environmental Engineer	Supporting documentation
8.0 Waste Management/Soil re-use Management	Any waste soils arisings from the reduced dig in the area of Made Ground and any other waste soils will be disposed of appropriately. Waste tickets for the removal of arisings should be compiled for submission as part of the verification report for each phase of the development. The waste tickets will be required to demonstrate that the approximate amount of material being removed is equal to the summed volume on the waste tickets. Where soils are to be re-used on site under the Definition of Waste Code of Practice under a Materials Management Plan for the site records of daily soil movements (volumes)/stockpiling and re-use of materials must be kept.	Design and Construction	**No (unless further waste classification and WAC testing required where 5 days' notice required)**	Chemical test results (waste classification and WAC) Waste tickets Records of material movements on site to be provided for inclusion in the validation report. (Assumed to be recorded by ground workers, if not then independent inspections will be required).
9.0 Imported Soils	In-situ testing of any soils imported onto site for placement in gardens or landscaped areas will be carried out after placement in line with the frequencies detailed in Section 5.0 with comparison of results to assessment criteria for residential end use.	Construction	**Yes**	Pre-import certification verifying the chemical quality of the Topsoil and subsoil to be provided to Geo-Environmental for review prior to Importation.

Table 10.1 Details of verification visits required on site

FIGURES

Project:	57 The Queensway, Bognor Regis, West Sussex PO21			**Title**	Site Location Plan
Client:	HJP Surveyors			**Geo-Environmental Services Ltd**	
Ref No:	GE22978	**Revision:**	0	**Unit 7 Danworth Farm, Cuckfield Road**	
Drawn:	LL	**Date:**	22/02/2025	**Hurstpierpoint, West Sussex BN6 9GL**	
Figure:	1	**Scale:**	Not To Scale	**+44(0)1273 832972 www.gesl.net**	

Geo-Environmental

N

Project:	57 The Queensway, Bognor Regis, West Sussex PO21			**Title**	Site Walkover Plan (February 2025)
Client:	HJP Surveyors			**Geo-Environmental Services Ltd**	
Ref No:	GE22978	**Revision:**	0	**Unit 7 Danworth Farm, Cuckfield Road**	
Drawn:	LL	**Date:**	22/02/2025	**Hurstpierpoint, West Sussex BN6 9GL**	
Figure:	2	**Scale:**	Not To Scale	**+44(0)1273 832972 www.gesl.net**	

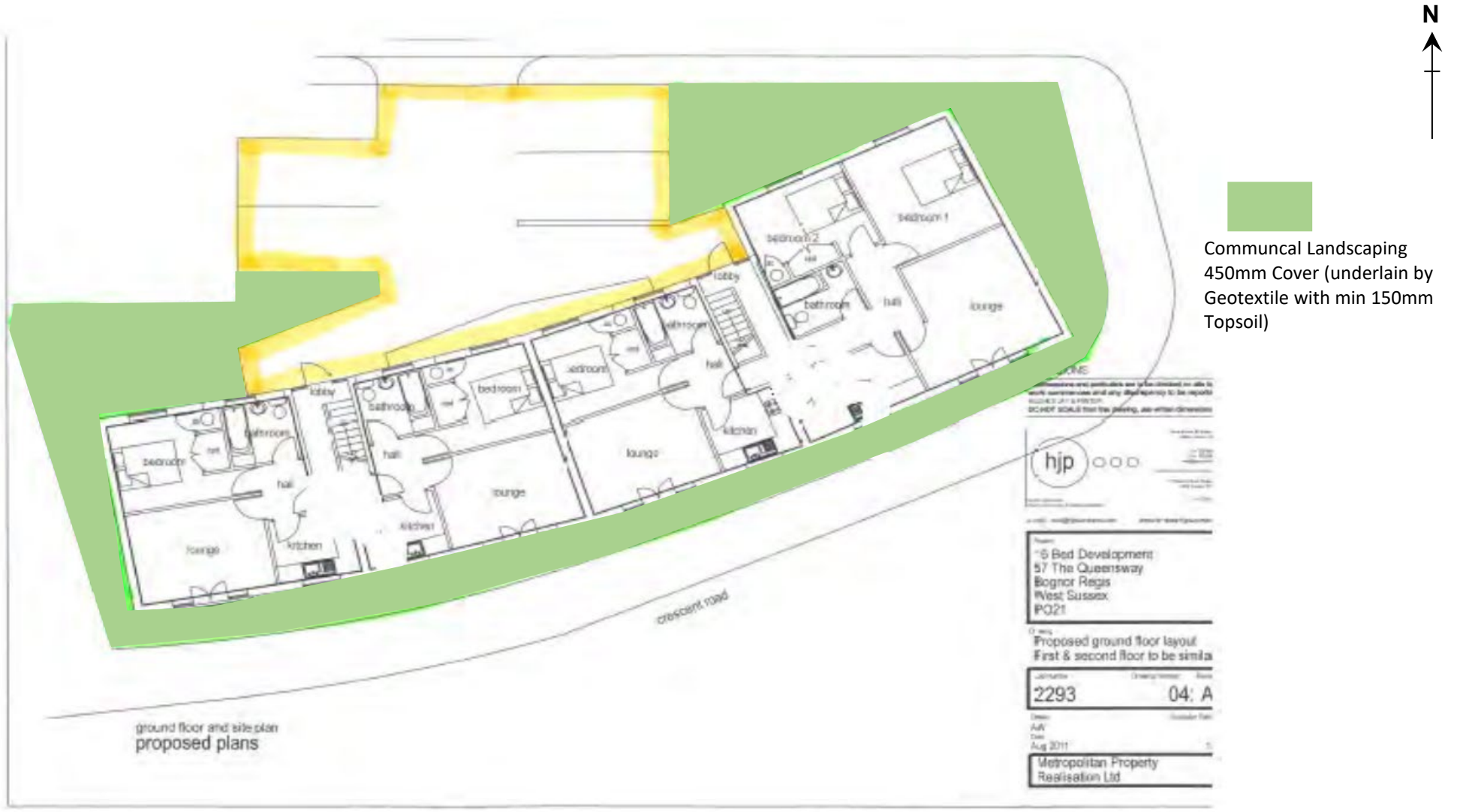
Geo-Environmental

Project:	57 The Queensway, Bognor Regis, West Sussex PO21			**Title**	Site Development Plan
Client:	HJP Surveyors			**Geo-Environmental Services Ltd**	
Ref No:	GE22978	**Revision:**	0	**Unit 7 Danworth Farm, Cuckfield Road**	
Drawn:	LL	**Date:**	22/02/2025	**Hurstpierpoint, West Sussex BN6 9GL**	
Figure:	3	**Scale:**	Not To Scale	**+44(0)1273 832972 www.gesl.net**	

Geo-Environmental

Project:	57 The Queensway, Bognor Regis, West Sussex PO21			**Title**	Gas Protection Measures
Client:	HJP Surveyors			**Geo-Environmental Services Ltd**	
Ref No:	GE22978	**Revision:**	1	**Unit 7 Danworth Farm, Cuckfield Road**	
Drawn:	LL	**Date:**	22/02/2025	**Hurstpierpoint, West Sussex BN6 9GL**	
Figure:	4	**Scale:**	Not To Scale	**+44(0)1273 832972 www.gesl.net**	

Geo-Environmental



Project:	57 The Queensway, Bognor Regis, West Sussex PO21			**Title**	Proposed Soil Cover System Areas
Client:	HJP Surveyors			**Geo-Environmental Services Ltd**	
Ref No:	GE22978	**Revision:**	0	**Unit 7 Danworth Farm, Cuckfield Road**	
Drawn:	LL	**Date:**	22/02/2025	**Hurstpierpoint, West Sussex BN6 9GL**	
Figure:	5	**Scale:**	Not To Scale	**+44(0)1273 832972 www.gesl.net**	

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APPENDIX A

Site Photographs

Plate 1 View of the site's current use as a hand car wash

Plate 2 View of the buildings in the northern portion of the site

Plate 3 View south across the site

Plate 4 View of breather pipes located adjacent to the buildings in the north of the site

Plate 5 Inspection chamber located inside the building in the north of the site, possibly indication of presence of UST

Plate 6 View of inspection chamber in north of site, possible presence of UST

Plate 7 Inspection covers in front of buildings location on site, possible interceptors

Plate 8 View of the inspection covers present on site

Plate 9 View of cover located in front of buildings in north of site

Plate 10 View of inspection covers located along the eastern site boundary, likely presence of drainage/interceptors

Plate 11 View of inspection cover located along eastern site boundary

Plate 12 View of the inspection covers along eastern boundary

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APPENDIX B

Imported Soil Specification

IMPORTED SOIL SPECIFICATION

for the land at

57 THE QUEENSWAY, BOGNOR REGIS,

WEST SUSSEX PO21 1QN

on behalf of

HJP SURVEYORS

Report:	**IMPORTED SOIL SPECIFICATION**
Site:	**57 THE QUEENSWAY, BOGNOR REGIS, WEST SUSSEX PO21 1QN**
Client:	**HJP SURVEYORS**
Date:	**03/03/2025**
Reference:	**GE22978/ISS/MAR25**
Revision:	**1.0**
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	SHAUN ARMITAGE BSc (Hons), FGS **PRINCIPAL ENGINEER**

Geo-Environmental Services Limited
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AMENDMENT RECORD

Revision ref.	Date	Reasons for amendment	Author's initials	Reviewer's initials	Approver's initials
1.0	03/03/2025	First issue	LL	SA	SA

CONTENTS

1.0 Introduction

This document sets out the requirements for imported subsoil and Topsoil materials for any project undergoing redevelopment or other works where capping work is required in line with a residential with plant up take land use.

Within the specification reference has been made to Topsoil and subsoil. Topsoil relates to the top layer of natural soil that can support healthy vegetation growth. Subsoil relates to the layer of soil immediately below the topsoil to the depth of the underlying broken rock or geological parent material.

The specification considers the chemical, nutritional and physical properties of soils that are to be imported onto site in order to ensure materials used are suitable for their intended use and do not introduce any new hazard or pollutant linkage on to the site.

Where there is any discrepancy between this specification and BS3882:2015 or BS8601:2013, the latter documents shall take precedence unless otherwise formally confirmed by the relevant regulator.

2.0 Chemical Composition

The chemical criteria listed below are based on the published Category 4 Screening Levels (C4SLs) by DEFRA and/or the relevant Suitable for Use Levels (S4ULs) published by LQM, for a residential end use with plant uptake. From time to time these values may change in line with regulatory or UK policy changes. Such changes will require revision and re-issue of this document.

Where C4SLs or S4ULs are published for a range of Soil Organic Matter (SOM) values, these ranges and their respective SOM values have been presented and would be considered when assessing compliance with this Specification. Where additional guidance comes in which supersedes that information presented herein, this will be assessed at the time when considering acceptability of materials being imported to site.

2.1 Method of Analysis

Samples should be analysed using UKAS or MCERTS accredited laboratories. For TPH analysis sample preparation must not include air drying.

2.1.1 Poly Aromatic Hydrocarbon (PAH)

The PAH analysis must include the EPA priority 16.

2.1.2 Total Petroleum Hydrocarbons (TPH)

The analysis for TPH should be undertaken on the ‘as received’ sample and not be subject to any pre-treatment and shall include aliphatic and aromatic carbon banding split.

2.2 Topsoil (0-300mm depth)

Tables 1, 1a, 1b and 1c provide a list of the maximum acceptable concentrations for a range of determinands for imported Topsoil.

Determinand	Maximum concentration (mg/kg) SOM 6%
Inorganic	
Arsenic (total)	37
Boron (water soluble)	290
Cadmium (total)	11
Chromium (total)	130
Copper (total)	2400
Cyanide (total)	250
Lead (total)	200
Mercury (total inorganic)	40
Nickel (total)	180
pH	5.5 – 8.5
Selenium (total)	250
Zinc (total)	3700
Asbestos	Absent
Organic	
Phenols (total)	110
Poly Aromatic Hydrocarbon (speciated)	See Table 1a
Total Petroleum Hydrocarbon (speciated)	See Table 1b

Table 1 Chemical Specification for Topsoil

Determinand	Maximum Concentration (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Acenaphthene	210	510	1100
Acenaphthylene	170	420	920
Anthracene	2400	5400	11000
Benz(a)anthracene	7.2	11	13
Benzo(a)pyrene	4.95*	4.95*	4.95*
Benzo(b)fluoranthene	2.6	3.3	3.7
Benzo(ghi)perylene	320	340	350
Benzo(k)fluoranthene	77	93	100
Chrysene	15	22	27
Dibenz(ah)anthracene	0.24	0.28	0.30
Fluoranthene	280	560	890
Fluorene	170	400	860
Indeno(1,2,3CD)pyrene	27	36	41
Naphthalene	2.3	5.6	13.0
Phenanthrene	95	220	440
Pyrene	620	1200	2000

*C4SL

Table 1a Topsoil Specification for Speciated PAH

Determinand	Maximum Concentration (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Aliphatic			
EC 5-6	42	78	160
EC >6-8	100	230	530
EC >8-10	27	65	150
EC >10-12	130	330	760

Determinand	Maximum Concentration (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
EC >12-16	1100	2400	4300
EC >16-35	65000	92000	110000
EC >35-44	65000	92000	110000
Aromatic			
EC 5-7 (benzene)	70	140	300
EC >7-8 (toluene)	130	290	660
EC >8-10	34	83	190
EC >10-12	74	180	380
EC >12-16	140	330	660
EC >16-21	260	540	930
EC >21-35	1100	1500	1700
EC >35-44	1100	1500	1700

Table 1b Topsoil Specification for Speciated TPH

Determinand	Phytotoxicity GAC (mg/kg)		
	pH <6.0	pH 6.0-7.0	pH >7.0
Zinc	200	200	300
Copper	100	135	200
Nickel	60	75	110

Table 1c Topsoil Specification for phytotoxicity

2.3 Subsoil (150-1000mm depth)

Tables 2, 2a, 2b and 2c provide a list of the maximum acceptable concentrations for a range of determinands for imported subsoil.

Determinand	Maximum concentration (mg/kg) SOM 6%
Inorganic	
Arsenic (total)	37
Boron (water soluble)	290
Cadmium (total)	11
Chromium (total)	130
Copper (total)	2400
Cyanide (total)	250
Lead (total)	200
Mercury (total inorganic)	40
Nickel (total)	180
pH	5.5 – 8.5
Selenium (total)	250
Zinc (total)	3700
Asbestos	Absent
Organic	
Phenols (total)	110
Poly Aromatic Hydrocarbon (speciated)	See Table 2a
Total Petroleum Hydrocarbon (speciated)	See Table 2b

Table 2 Chemical Specification for Subsoil

Determinand	Maximum Concentration (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Acenaphthene	210	510	1100
Acenaphthylene	170	420	920
Anthracene	2400	5400	11000
Benz(a)anthracene	7.2	11	13
Benzo(a)pyrene	4.95*	4.95*	4.95*
Benzo(b)fluoranthene	2.6	3.3	3.7
Benzo(ghi)perylene	320	340	350
Benzo(k)fluoranthene	77	93	100
Chrysene	15	22	27
Dibenz(ah)anthracene	0.24	0.28	0.30
Fluoranthene	280	560	890
Fluorene	170	400	860
Indeno(1,2,3CD)pyrene	27	36	41
Naphthalene	2.3	5.6	13.0
Phenanthrene	95	220	440
Pyrene	620	1200	2000

*C4SL

Table 2a Subsoil Specification for Speciated PAH

Determinand	Maximum Concentration (mg/kg)		
	1% SOM	2.5% SOM	6% SOM
Aliphatic			
EC 5-6	42	78	160
EC >6-8	100	230	530
EC >8-10	27	65	150
EC >10-12	130	330	760
EC >12-16	1100	2400	4300
EC >16-35	65000	92000	110000
EC >35-44	65000	92000	110000
Aromatic			
EC 5-7 (benzene)	70	140	300
EC >7-8 (toluene)	130	290	660
EC >8-10	34	83	190
EC >10-12	74	180	380
EC >12-16	140	330	660
EC >16-21	260	540	930
EC >21-35	1100	1500	1700
EC >35-44	1100	1500	1700

Table 2b Subsoil Specification for Speciated TPH

Determinand	Phytotoxicity GAC (mg/kg)		
	pH <6.0	pH 6.0-7.0	pH >7.0
Zinc	200	200	300
Copper	100	135	200
Nickel	60	75	110

Table 2c Subsoil Specification for phytotoxicity

3.0 Nutritional Composition

The nutritional criteria listed below are based on BS3882:2015 for Topsoil and BS8601:2013 for subsoil. In the absence of published criteria, current guidance and best practice has been applied to derive appropriate criteria.

3.1 Topsoil & Subsoil

Table 3 details the minimum acceptable concentrations for imported topsoil and subsoil. The nutrient concentrations set out in Table 3 for Topsoil are based on those set out in BS3882:2015 which states *"Multipurpose topsoil is the grade suited to most situations where topsoil is required; however, there can be situations where specific purpose topsoil is required"*. In the event that an alternative specific Topsoil grade is required, i.e. acidic; calcareous; low fertility; low fertility acidic; or low fertility calcareous, the compliance criteria set out in BS3882:2015 shall be applicable in place of those set out in Table 3 below.

Topsoil/Subsoil	Parameter	Concentration
Topsoil (multipurpose grade only)	Phosphorous	16 – 140 mg/l
	Potassium	121 – 1500 mg/l
	Magnesium	51 – 600 mg/l
	Nitrogen	0.15 % m/m
	Carbon:nitrogen ratio	<20:1
Subsoil	Exchangeable sodium percentage (ESP)	<15% Need not measure if soil electrical conductivity <2 800 µS/cm
	Electrical conductivity	Value measured and recorded

Table 3 Nutritional Specification for Topsoil and Subsoil

Where the nutritional values for subsoil are not strictly in accordance with Table 3 but comply with the current British Standards, then these soils may also be deemed to be acceptable for importation.

4.0 Physical Composition

The physical criteria listed below are based on BS3882:2015 Specification for Topsoil. In the absence of published criteria, current guidance and best practice has been applied to derive appropriate criteria.

4.1 Topsoil

Table 4 details the physical suitability requirements for imported Topsoil and subsoil. Table 4 sets out acceptability criteria from BS3882:2015 for multipurpose Topsoil. In the event that an alternative specific Topsoil grade is required, i.e. acidic; calcareous; low fertility; low fertility acidic; or low fertility calcareous, the compliance criteria set out in BS3882:2015 shall be applicable in place of those set out in Table 4 below.

Topsoil/Subsoil	Parameter	Specification requirements
Topsoil (multipurpose Topsoil only)	Textural Classification	Sandy clay loam, sandy loam, loamy sand, sandy silt loam (as defined in BS3882:2015, Figure 1)
	Loss on Ignition	3 - 20% (for 5-20% clay soil) 5 - 20% (for 20-35% clay soil)
	Maximum Stone content:	>2mm = 30% >20mm = 10% >50mm = 0%
Subsoil	Textural Classification	Refer to BS8601:2013 Figure 1

Topsoil/Subsoil	Parameter	Specification requirements
	Loss on Ignition	2%
	Maximum Stone content:	>2mm = 40% >20mm = 20% >75mm = 0%

NB: Topsoil and Subsoil must be free from glass, brick fragments, plastic, metal, asbestos and other deleterious materials.

Table 4 Physical Specification for Topsoil & Subsoil

5.0 Source Requirements

5.1 Topsoil and Subsoil

The following will be required to be provided with all soils imported to site:

- A site plan detailing the location and address of the source site, including grid reference.
- Location description of source material, including historic and current site uses.
- Sample analysis results of material at source, including details of laboratory, date of sampling, date samples received by laboratory etc.

5.2 Manufactured soils

Where natural soils are unavailable manufactured soils may be utilised, and the following should be provided:

- Details of the soil manufacturing process, including criteria for received soils, quality control procedure and validation protocol.
- Soils should be tested at a minimum ratio of one sample per 50m^3.

6.0 Testing Rates and Compliance

Sampling shall be undertaken in accordance with BS3882:2015 and BS8601:2013.

6.1 Topsoil

Where natural sourcing is proposed, the provenance of the material shall be determined by analysis of the soils at a minimum rate of 3No. samples per source site (up to 250m^3) and 1 sample per 250m^3 thereafter. Imported soil should be sampled once it has been laid on the site to support the analysis provided by the source supplier.

Where Topsoil is derived from a manufactured source, testing would be undertaken at a rate of 1 sample per 50m^3, with a minimum of 3No. tests for any given potential source material (or production batch).

6.2 Subsoil

Where the source of the material is known validation sampling should be undertaken at a minimum rate of 3 samples per source (up to 250m^3) and 1 sample per 250m^3 thereafter. Imported soil should be sampled once it has been laid on the site to support the analysis provided by the source supplier.

Where subsoil is derived from a manufactured source, testing would be undertaken at a rate of 1 sample per 50m^3, with a minimum of 3No. tests for any given potential source material (or production batch)

Where the source of the material is not known the validation sampling should be undertaken in-line with the testing rates as set out for cover systems to ensure the materials are suitable for their intended use. Further guidance on minimum testing under this scenario is presented in Section 6.3 below.

6.3 Cover Systems

Where a cover system/ capping layer is proposed as part of the required remedial measures, sampling frequency will follow the guidance set out by the NHBC in their guidance for clean cover systems (2010), outlined below:

- Sites with more than 30 plots testing should be conducted at a rate of one plot in four;
- Sites with between 20 – 30 plots testing should be conducted at a rate of one plot in three;
- Sites with between 5 -20 plots testing should be conducted at a rate of one plot in two;
- Sites with fewer than 5 plots testing should be conducted in every plot.

Where larger sites are broken down into smaller areas in terms of validation the higher rates of validation frequency may be required to allow earlier signoff by the Regulators/Warranty Providers in relation to these specific areas of the wider development.

6.4 Sample failure

In the event that a sample fails to meet the specified criteria for any parameter the Environmental Consultant should be contacted for advice on the suitability of the materials.

Further testing may be required to provide reassurance that the exceedances are not representative of the soil and to provide clarification whether the soil is suitable for importation and/or proposed use.

6.5 Timing

Sampling and analysis undertaken by a manufactured topsoil supplier shall be no earlier than two weeks from the date of import, any results which are older than two weeks will be deemed not to be representative of the soils to be imported and rejected. Results showing consistency of batching may be requested to demonstrate consistency of the physical, chemical and nutritional composition of the material.

Imported soil suppliers and groundwork contractors are required to take reasonably practicable measures to ensure that compliance with this Specification does not hinder formal completion of individual plots or developments.

6.6 General Compliance

All analytical suites shall correspond with the chemical, nutritional and physical compliance criteria (as set out in Tables 1 to 4). The soil supplier shall ensure that the analytical limits of detection are equal or lower than the compliance values presented within this Specification. Where either testing suites or limits of detection do not comply with this Specification, the entire set of results shall be rejected.