

## Remediation Strategy

Sladen Mill, Littleborough



**SOIL AND  
STRUCTURES**

Report Status

|                |                                     |
|----------------|-------------------------------------|
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Appendices Drawings > Generic Assessment Criteria (residential with home-grown produce)

**Peer review:** To support continuity throughout regulatory approval process, this Report has been reviewed by Tim Booth of T J Booth Associates.

**Printing:** This Report is intended to be read electronically on a >20 inch monitor or printed landscape, as double-sided A3. Font sizes have been selected that means it should remain legible printed landscape, as double-side A4.

**Units:** Throughout this Report chemical concentrations or target concentrations are reported in: parts per million (ppm) milligrams per kilogram (mg/kg) for solids; and, parts per billion (ppb) micrograms per litre (ug/l) for liquids.

Appointment

Soil and Structures Ltd were instructed by Mere Development Group (*the Client*) in June 2024 to prepare a Remediation Strategy (*the Report*) to support the re-development of a parcel of land formerly occupied by Sladen Mill, Littleborough (*the Site*).

Development proposals include for construction of 25 no. dwellings and associated hardstanding, including access roads, and soft landscaping areas under reserved matters planning application ref. 21/00950/REM pursuant to outline permission ref. 15/0125/OUT.

Reliance on the advice presented herein rests solely with the Client.

Scope and Context

The Remediation Strategy offers advice on risk mitigation measures or ‘remedial actions’ that are required to bring the site up to a condition that would be deemed ‘suitable for use’.

The legal context of this advice is rooted within national planning policy guidance (the National Planning Policy Framework) that is governed by planning law (various acts).

In this context, the Site would be deemed ‘suitable for use’ if residual risk is reduced to acceptably low levels for: two historical hazards; potentially harmful material and potentially polluting material; and, one geological hazard; radon gas.

Other ground-related hazards, e.g. shrink-swell clays, sub-structures, ground dissolution, are beyond the scope of this Report. It is noted that ground-related hazards are all inter-related and therefore commentary relating to other potential hazards, e.g. slope stability or sub-structures, is included within this Report. Ultimately, all ground-related reports and design documents need to be coordinated to

Background to this Report

This Report is preceded by various existing ground-related reports prepared by others. All available background data, including these reports, are annexed to this Report (included as a separate document available on request).

References

The Remediation Strategy has been written with reference to various sources of information including; design drawings (appended); and, existing ground-related report referenced above (not appended; readers of this Report assumed have access to it).

Reference is also made to the ‘Engineer’ within this Report that relates to the appointed design engineer (structural and/or civil) who is most likely to be the main point of contact within the design team.

1.0 The Site and Proposed Development

1.1 The Site

**Location and size:** The Site (the planning boundary) comprises a parcel of land approximately 1.30 ha in area located 175 m north of Halifax Road, Littleborough, Lancashire (Figure 1).

**Access:** The main body of the Site is accessed on foot and by vehicle via a fenced entrance in the south-eastern corner and the upper level of the Site openly accessible on foot and by vehicle midway down the eastern boundary.

**Topography:** is characterised by two distinct areas with general westerly and north-westerly fall in levels (within the Castle Brook valley): i) the 'main body' of the Site that lies between 165 and 174 mAOD; and, ii) the 'upper level' that is present midway along the eastern boundary of the Site that lies between 176.5 and 177 mAOD.

**Utilities:** Below ground utilities are expected to be present beneath the Site with evidence of overhead lines on Site.

**Existing structures:** At the point of issue various structures were noted on Site including: a masonry structure and electrical sub-station on the western edge of the Site; sandstone retaining walls in varied conditions along the eastern edge of the Site and locally to the bridge in the southern portion of the Site; and, localised areas of residual concrete hardstanding.

1.2 The Proposed Development

**Development proposals:** Development proposals (Figure 2) include for construction of 25 no. dwellings and associated hardstanding, including access roads, and soft landscaping areas.

① **Development works and risk:** An appreciation of the construction processes is essential for development-related risk assessments given the groundworks stand to meaningfully alter the level of risk, e.g. unstable slopes being removed by earthworks, or unsuitable material being exposed as part of the works.

To enable this development, the following groundworks are likely to be required, N.B. listing is outline only.

- > **Preparation:** at the point of inspection Site clearance and preparation appears to have been partially completed with remaining works including: demolition of the remaining structures (detailed above); and, removal of remaining hardstanding surfaces.
- > **Earthworks (cut and fill):** Are expected to be required to suit development levels with the existing Made Ground deposits not anticipated to be suitable for re-use as a general fill in its current condition.
- > **Utility Excavations:** Excavation of any drainage and other utility alignments.
- > **Foundations:** Subject to the selected foundation solution, construction of sub-structures (foundations).
- > **Surfacing:** Formation soft landscaping and hardstanding surfaces.

① **Risk profile of the proposed development for Human Health and 'Controlled Waters'**<sup>1</sup>: The proposed development would see a former industrial site that has been subject to multiple uses (land associated with coal mining, woollen mill, cotton raising and finishing mill, and more recently the manufacture of uPVC products) developed for a residential use.

This change of use represents a shift from a land use with low sensitivity and high pollution potential (various industrial uses) to a high sensitivity and low pollution potential (residential). On this basis alone, the requirement for risk management (remedial works) would be anticipated. The existing ground-related reporting including Soil and Structure's "Controlled Waters Risk Assessment" confirmed that remedial works were required to reduce the risk presented to human health and Controlled Waters. This Report details the nature and extent of this work.

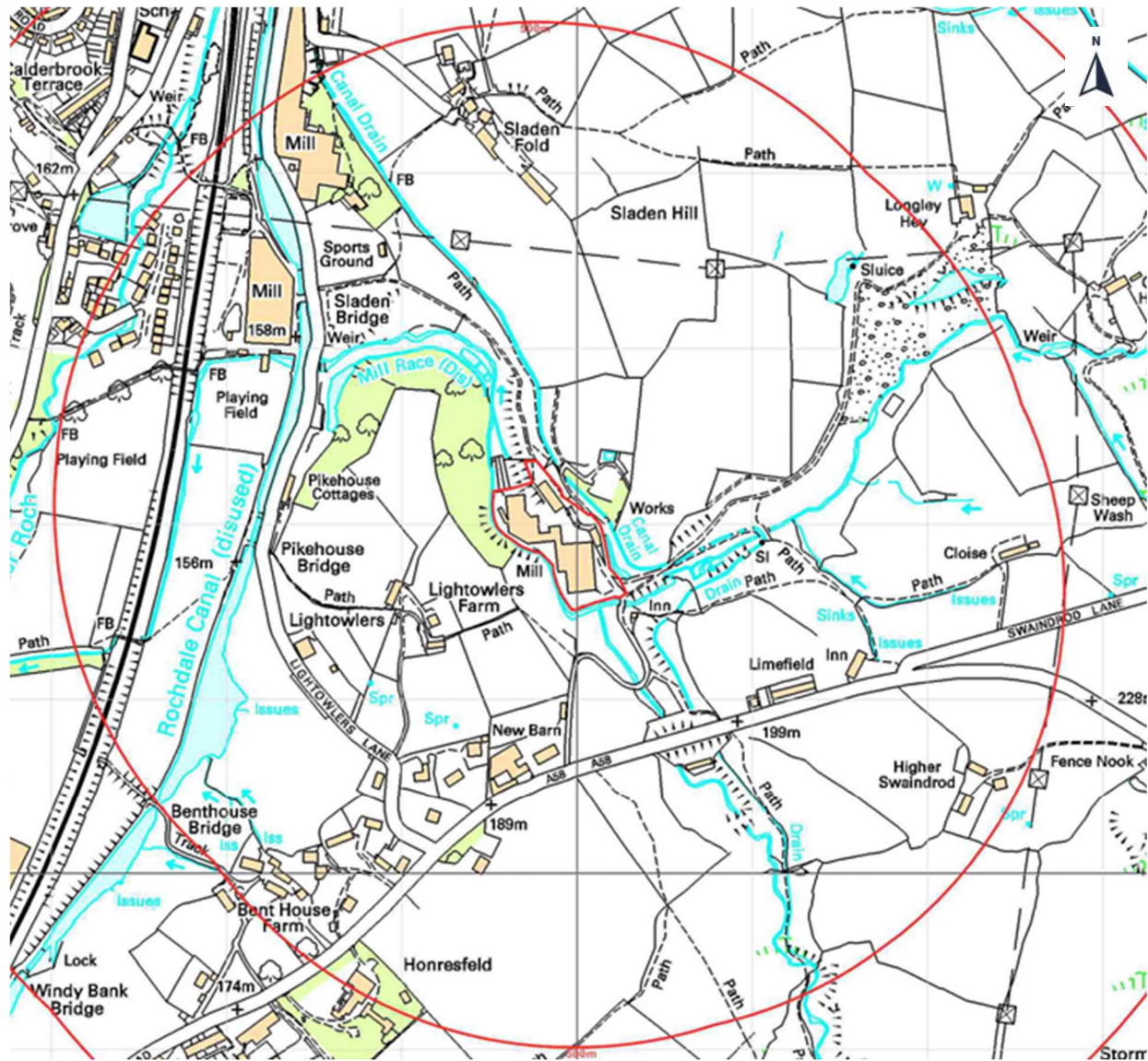


Figure 1: Location Plan

- > Site approximately centred on 394983 417383
- > Central red line = outline planning application boundary; outer red line = 500 m buffer

<sup>1</sup> [Water Resources Act 1991 \(legislation.gov.uk\)](https://www.legislation.gov.uk/ukpga/1991/29)



**Figure 2 – Development Plan**  
> Extract from appended drawing

2.0 Risk Assessments

The following table presents a summary of the risk assessments for three, ground-related hazards specific to the contaminated land planning regime. More in-depth analysis and assessment is presented with earlier ground-related reporting referenced within the introduction. The recommended remedial actions are also illustrated conceptually on the Ground Models presented within Section 3.0.

| Hazard                                                                            | If the hazard has been identified, what is the nature of the hazard? |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | If the risk presented by this hazard is not acceptably low, what remedial action (risk reduction) is recommended? |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-----------------------------------------------------------------------------------|----------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Contamination (on-site)                                                           | →                                                                    | <p>Chemical testing of the Made Ground soils on Site (the <i>source</i>) revealed the presence of various chemical compounds at concentrations that, without remedial action, stand to present an unacceptable risk to end users of the Site and any visitors (the <i>receptors</i>) through various general <i>pathways</i>, e.g. direct contact with this material, tracking back dust into homes, as well as more <i>specific pathways</i> such as vapour intrusion in areas where material with the potential to generate vapour has been detected.</p> <p>Whilst chemical concentrations vary across the Site, the Made Ground soils have been extensively disturbed through the action of previous demolition works and are therefore considered to represent an ‘averaged area’. It is however noted that discrete areas of the Site do include evidence of free-phase hydrocarbons (Made Ground locally to TH2, TH7 and TH18) that could be treated as ‘<i>hot spots</i>’ of potentially harmful material for which targeted remedial action is recommended.</p> <p>The presence of asbestos fibres has been detected in the Made Ground soils across multiple locations. All Made Ground soils should be treated as potential Asbestos Containing Soils (ACSSs) with suitable risk mitigation measures recommended for both the construction works and permanent, developed condition of the Site.</p>                                                                                                                                                                  | →                                                                                                                 | <p><b>Made Ground (general): Recommended risk mitigation:</b> Provision of a suitably thick, clean capping to all proposed areas of soft landscaping to serve as a physical barrier between the Made Ground soils and end users of the Site. It is noted that, in the absence of suitable soil forming material on the Site, the provision of clean capping is also required to serve as a physically suitable growing medium.</p> <p><b>Made Ground (locally to TH2, TH7 and TH18): Recommended risk mitigation:</b> Excavation, delineation and either; i) two stage sump-pumping of hydrocarbon impacted groundwater is recommended to reduce the overall mass of free-phase hydrocarbons accounting for the anticipated ‘lag’ effects, i.e. following the first phase of pumping, hydrocarbons otherwise sorbed onto soil particles will have a tendency to mobilise/dissolve into groundwater; or, ii) in-situ stabilisation through solidification/stabilisation. In addition, as a precautionary measure, the provision of vapour resistant membrane (upgrade to ground gas protection recommended below) is recommended to all proposed dwellings within 10 m of the final delineated zone.</p> |
| Contamination (off-site; including transport of pollutants from off-site sources) | →                                                                    | <p>Spring points are present on the eastern boundary of the Site. At least one of these springs has been confirmed to contain elevated concentrations of PFAS compounds, three times above the UK Drinking Water Standard) and therefore is serving as a <i>source</i> of both potentially harmful and polluting material (PFAS). Without remedial action this spring waters stand to present an unacceptable risk to various <i>receptors</i> including: end users of the Site and any visitors through direct contact; groundwater beneath the Site through infiltration; and surface water (Castle Brook) through surface run-off (that appears to be the primary pathway for the transport of this material).</p> <p>It is noted that, at this stage, the spring water has only been tested for PFAS compounds noting that the recommended remedial action is unlikely to vary even if other chemicals are recorded at unacceptably high concentrations within this water.</p> <p>No other off-Site sources of potentially harmful material have been identified however, for completeness, it is noted that the adjoining land continues to be used for aggregate storage and manufacture and therefore wind-blown dust associated with these activities potentially represents a pathway for potentially harmful or polluting material to affect the Site. Investigation and assessment of this potential pathway is beyond the scope of this Report and nonetheless, it is assumed that any dust-generating activities are conducted within the scope of any permits.</p> | →                                                                                                                 | <p><b>Spring water: Recommended risk mitigation:</b> Provision of a dedicated, below ground toe-drain along the full length of the retaining wall planned along the full length of the eastern edge of the lower level of the Site to intercept all spring / seepage points and direct the spring water away from the Site’s soils, groundwater and proposed dwelling and direct the resultant water through granular activated carbon filters.</p> <p>It is noted that, management of the spring water will be required notwithstanding the risk of harm this water presents with the spring water liable to flood the proposed dwellings if not suitably managed.</p> <p>In the source of this potentially harmful material very likely lying off-Site, in addition to the risk mitigation works recommended herein, consideration may wish to be given to further investigation of plausible sources of the PFAS given, at present, the spring water appears to be adversely impacting soil and groundwater quality on the Site.</p>                                                                                                                                                                 |
| Pollution (waters)                                                                | →                                                                    | <p>Chemical testing of the groundwater across Site (the <i>source</i>) revealed chemical compounds at concentrations that, without risk mitigation, stand to present an unacceptable risk to Controlled Water receptors (the <i>receptors</i>) through lateral and vertical mitigation (the <i>pathways</i>).</p> <p>Whilst chemical concentrations vary across the Site, the groundwater quality could be described as ‘generally degraded’ and is therefore considered to represent an ‘averaged area’. It is however noted that discrete areas of the Site do include evidence of free-phase hydrocarbons (groundwater locally to TH2, TH7 and TH18) that are treated as ‘hot spots’ of potentially polluting material for which targeted risk mitigation is recommended. It is also noted that the chemical concentrations of fuel and oil range hydrocarbons in the soils and groundwater within these locations was found to be relatively ‘low’ despite evidence of free-product existing.</p> <p>The chemicals of concern are broad ranging with concentrations of toxic metals, inorganics and hydrocarbon compounds recorded above Environmental Quality Standards (annual average) with select compounds</p> <p>The Controlled Water receptors identified include: Castle Brook (surface watercourse) west of the Site; and, groundwater below the Site.</p>                                                                                                                                                                                                          | →                                                                                                                 | <p><b>Groundwater (general): Recommended risk mitigation:</b> Provision of a dedicated, below ground toe-drain along the full length of the engineered slope planned along the Site’s western boundary (bordering Castle Brook) to intercept groundwater flows migrating through the Site and direct the resultant water through granular activated carbon filters.</p> <p><b>Groundwater (locally to TH2, TH7 and TH18): Recommended risk mitigation:</b> Excavation, delineation and either; i) two stage sump-pumping of hydrocarbon impacted groundwater to reduce the overall mass of free-phase hydrocarbons accounting for the anticipated ‘lag’ effects, i.e. following the first phase of pumping, hydrocarbons otherwise sorbed onto soil particles will have a tendency to mobilise/dissolve into groundwater; or, ii) in-situ stabilisation through solidification/stabilisation.</p>                                                                                                                                                                                                                                                                                                       |
| Ground gas (all types)                                                            | →                                                                    | <p>Plausible sources of ground gas were discussed within the “<i>Phase 2 Site Investigation &amp; Risk Assessment – Phase 3 Remediation Statement</i>” report prepared by T J Booth &amp; Associated dated February 2024 (Revision 5) and, apart from radon, assessed to have very low ground gas generation potential.</p> <p>The Site is located within an area where between 5 and 10 % of dwellings are predicted to be above the ‘Action Level’ for radon that, as currently set, represents half of a person’s annual average radiation dose.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | →                                                                                                                 | <p><b>Radon: Recommended risk mitigation:</b> Precautionary provision of ‘full radon protection measures’ in line with BRE 211 is recommended to offer protection against the ingress of all ground gases (including radon). Note: vapour barriers recommended to select properties as detailed above under ‘Contamination (on-Site)’.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

2.1 Other commentary relate to ground-related risk assessments

Risk assessments are 'live' documents and the levels of risk may change if and where new information is presented, e.g. if and where unforeseen material is encountered in the ground.

Risk drivers are defined as:

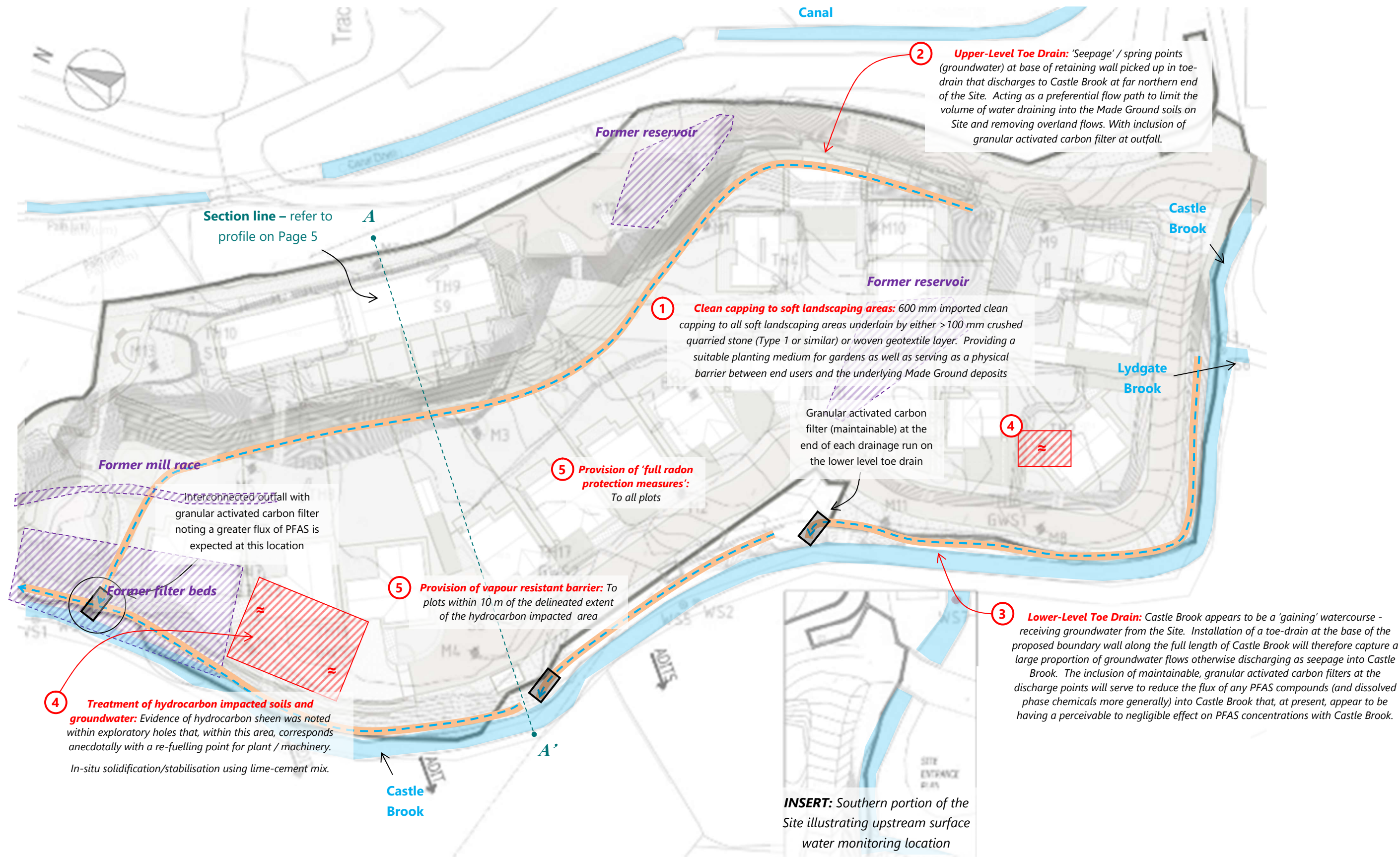
⚠ For soils: asbestos (asbestos containing soils; ACS)

⚠ For groundwater / spring water: PFAS, PAH, phenols and sulphate for groundwater (and spring water).

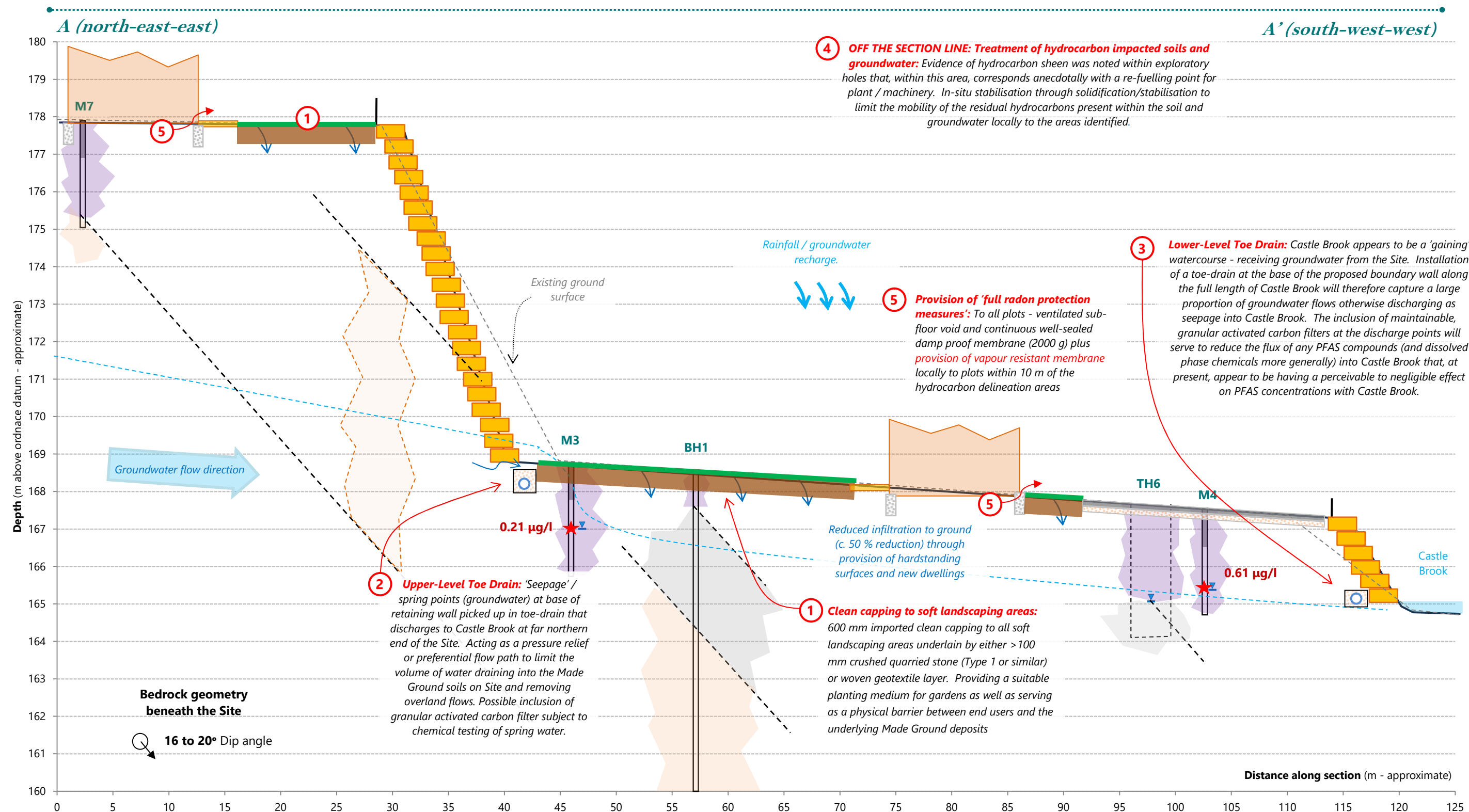
It should be borne in mind that other chemicals are present within the soils and groundwater at concentrations that pose an unacceptable risk to human health and Controlled Waters however, these are considered to be secondary to the risks posed by the risk drivers identified above.

Inherent risk reduction is incorporated as part of the development proposals, such as, a net increase in impermeable areas by around 50 % that will both serve as a physical barrier to the underlying Made Ground soils as well as reduce the rate of infiltration, a key factor in the fate and transport of groundwater-based chemicals.

3.0 Ground Model – Endline (Post-Development Condition) – Plan (presenting an overview of the Remedial Actions)



3.0 Ground Model – Endline (Post-Development Condition) – Profile (aligned with dip direction of bedrock; presenting an overview of the Remedial Actions)



Illustrative / conceptual only – do not scale from drawing – note compressed horizontal axis

4.0 Remedial Works

Remedial action has been recommended to reduce the residual risk presented by ground-related hazards to acceptable low levels, as tabled in Section 2.0.

Five remedial actions are recommended with more in-depth commentary presented within this Section.

1 Remedial Action 1 – Clean capping to soft landscaping areas

The objective of this remedial action is to prevent end users of the Site being exposed to any residual Made Ground that is physically and chemically unsuitable for use as a soil forming material within soft landscaping areas on Site.

This remedial action can be achieved through: the provision of a suitable thickness of ‘clean capping’ to any areas where the Made Ground is present beneath soft-landscaping areas.

This remedial action has been selected given there is a requirement for importing soil-forming material to soft landscaping areas regardless of the requirement for remedial action.

- > **Function:** A clean capping or ‘cover system’ is designed to serve as a dedicated barrier between potentially harmful material (residual Made Ground) and end users (residents and visitors).
- > **Extent:** The clean capping is only required if and where residual Made Ground (non-natural soils) are present beneath planned soft landscaping areas. In this scenario, this is expected to apply to all soft landscaping areas.

If it can be demonstrated, through plot-by-plot inspection, that the sub-grade is free from Made Ground and comprised of natural soil, there would be no requirement for a dedicated clean capping to be provided and the soft landscaping design can be architect led.

- > **Thickness (Table 1):** The recommended thicknesses and composition are set out within Table 1 below.

This thickness aligns with the likely usage of the soft landscaping areas, current guidance<sup>2</sup> and the level of risk present on Site. If and where evidence of material that differs from that described herein, i.e. stained soils, that could present a greater risk of harm then deeper thicknesses of capping may be required.

It is noted that such an occurrence would be an ‘unexpected encounter’ for which a pre-agreed response plan would need to be agreed with the local planning authority (as detailed within Section 3.2)

The inclusion of a no-fines, crushed stone layer of at least 75 mm thickness is intended to serve as:

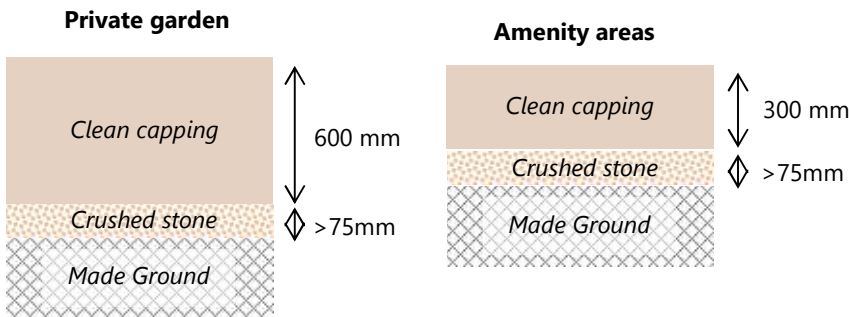
- i) A visual demarcation (that is not a plastic geotextile) acting as a ‘no-dig’ layer, limiting the potential for end uses of the Site to excavate through the capping into the underlying Made Ground soils; and,
- ii) A capillary break layer, limiting the potential for any upwards, vertical migration of soil or groundwater-based chemicals.

For tree and shrub planting areas, the advice of the landscape architect should be sought however, in general, at least 600 mm of soil is likely to be required.

Table 1: Clean capping design

| Soft Landscaping Area | Clean Capping Component and Thickness |         |                                | Total Depth Required |
|-----------------------|---------------------------------------|---------|--------------------------------|----------------------|
|                       | Topsoil                               | Subsoil | Other                          |                      |
| Private garden areas  | Min. 150 mm*                          | 450 mm  | >75mm ‘no fines’ crushed stone | 700 mm               |
| Amenity areas         | Min. 150 mm*                          | 150 mm  | >75mm ‘no fines’ crushed stone | 400 mm               |

\* In general, the provision of topsoil thicknesses greater than 300 mm is liable to induce a collapse of the soil structure (compression or collapse)



- > **Material sourcing:** Topsoil and other imported soils should be sourced from a reputable supplier who can confirm the source of the material as well as its chemical and physical properties prior to being imported onto Site.
- > **Quality:** The soft landscaping soils’ quality should be verified for suitability against both; the relevant British Standards, e.g. BS3882:2015 for topsoil and BS8601:2013 for subsoil, and Local Planning Authority (LPA) guidance<sup>3</sup>.

The LPA guidance is hyperlinked below and reference should be made to Section 6.0 for the specific frequencies and suites of testing that are required for imported soils.

The frequency and suite of testing varies depending on the nature of the source, e.g. Greenfield or manufactured.

Imported soils shall therefore be defined as ‘suitable for use’ if the verification testing falls within the Generic Assessment Criteria that are appended.

<sup>2</sup> Cover Systems for Land Regeneration - Thickness of cover systems for Contaminated Land BRE/AGS/NHBC: 2004 (under review)

<sup>3</sup> [Contaminated Land \ Manchester City Council](#)

2 Remedial Action 2 – Upper-level toe drain

The objective of this remedial action is to: i) limit pollution loading of the Site’s soils and groundwater; and, ii) limit the flux of PFAS and other potential pollutants into Castle Brook.

This remedial action can be achieved through: the provision of an upper level toe-drain at the base of the upper embankment, to collect spring water and other seepages from the upper level embankment with in-line Granular Activated Carbon (GACarbon) filter at the outfall.

This remedial action has been selected given: i) it is the only viable means to reduce pollution loading to the Site soils and groundwater from the spring water source(s), ii) there is a requirement for a toe-drain to manage surface water flooding regardless of the requirement for remedial action; and, iii) the inclusion of the GACarbon filter demonstrates pollution control measures on water that requires management as part of the development works the quality of which cannot be controlled by the developer (off-Site source).

Based on the estimated flow rates, it is recommended that the toe drain comprises:

- > A perforated 150 mm diameter pipe with an invert level at least 150 mm below the base of the embankment’s lowest level formed within a trench that is wrapped in geo-textile and filled with suitable granular, drainage medium with;
- > Falls of no less than 1 in 200 within the pipework to maintain flows;
- > A 150mm thick clay lining to the western edge of the trench to limit losses from the pipe; and,
- > A solid 150 mm diameter pipe connection over the last 1000 mm fall in levels to allow for sufficient head to develop with the Granular Activated Carbon filter at the outfall (Figure 3 and Figure 4).

① The final design of the pipework should be made in direct consultation with the project’s drainage / civil engineer.

Once intercepted, the spring-water will be diverted away from the Site, that otherwise is considered likely to represent a significant flux of PFAS (and other chemicals) into the Site soils and groundwater. Notwithstanding this, there will remain a requirement to limit potential pollution of Castle Brook through the inclusion of some pre-treatment to the outfall water.

Pollution loading within the spring-water is expected to vary seasonally with the main control being rainfall rates and groundwater levels. It is therefore recommended that the GACarbon filter at the outfall is designed on a modular, ‘in-principle’ basis allowing for the performance to be optimised through the construction process.

In practice, this would entail a two-stage process.

- > Stage 1 of Granular Activated Carbon filter deployment: installation of a single filter module the performance of which is tested against reasonable predictions of the filter’s short-term performance.

The filter module is conceptually illustrated within Figure 3 and is designed as a passive, gravity filter system (driven by the head of water within the solid 150 mm diameter pipe) with no mechanical parts for ease of maintenance / serviceability.

Inlet waters (spring water or, for the lower-level toe drain, groundwater) will enter the filter and rise upwards under hydraulic pressure through the GACarbon filter medium at a rate that can be controlled by the density of the filter medium

① The final design of the filter should be made in direct consultation with the project’s drainage / civil engineer as well as the GACarbon supplier

The performance of the filter which will again need to be validated through a programme of ‘upstream’ and ‘downstream’ monitoring.

At this stage, it is recommended that monitoring at 2 to 4 week and 12 to 16 week intervals (post-installation) is conducted with sampling and testing for key chemicals of concern.

Key chemicals of concern include: PFAS, PAHs and phenols.

These compounds have been selected based on their presence within groundwater beneath the Site (noting that soil-based concentrations of PAHs and phenols were ‘low’ suggesting the spring water is also transporting other chemicals onto Siet) and, with respect to PFAS, based on its confirmed presence within the spring-water.

At this stage, if and where PFAS, PAH and phenol concentrations can be reduced by a half of their ‘upstream’ concentration then single filter module is likely to be considered ‘suitable for use’.

① Direct consultation with the Environment Agency should be maintained, particularly with respect to the performance of the filter.

Subject to the performance of a single filter module being confirmed, contingency allowance for ‘upgrading’ the system is recommended as detailed below.

- > Stage 2 of Granular Activated Carbon filter deployment: installation of up to two additional GACarbon filter modules in series (three in total) the performance of which will again need to be validated through a programme of ‘upstream’ and ‘downstream’ monitoring.

At this stage, it is recommended that monitoring at 2 to 4 week and 12 to 16 week intervals (post-installation) is conducted with sampling and testing for the same chemicals of concern: PFAS, PAHs and phenols.

3 Remedial Action 3 – Lower-level toe drain

The objective of this remedial action is to limit the flux of PFAS and other potential pollutants, that are present in the groundwater beneath the Site, flowing into Castle Brook.

This remedial action can be achieved through: the provision of three lower level toe-drains at the base of the lower embankment, to collect groundwater seepage flows otherwise migrating from the Site into Castle Brook in-line Granular Activated Carbon (GACarbon) filter at the outfall.

This remedial action has been selected given: i) it is a viable means to reduce pollution loading to Castle Brook from on-Site sources that are expected to diminish with time, ii) there is a requirement for a toe-drain as part of the boundary treatment to the western edge of the Site; and, iii) the inclusion of the GACarbon filter demonstrates pollution control measures on water that requires management as part of the development works the quality of which can be controlled by the developer (on-Site sources of PFAS and other chemicals of concern but, based on the available lines of evidence, likely originated from locations beyond the developer's control (off-Site sources).

Based on the estimate flow rates it is recommended that the toe drain is designed in the same manner as the upper-level toe drain with two exceptions:

- > The requirement for a clay liner on the western edge is not considered necessary; and,;
- > The solid 150 mm diameter pipe connection is installed to allow for 500 mm fall in levels to allow for sufficient head to develop with the Granular Activated Carbon filter at the outfall (Figure 5).

⑩ The final design of the pipework should be made in direct consultation with the project's drainage / civil engineer.

Following installation of the upper-level toe drain, pollution loading within the groundwater beneath the Site is expected decrease with the springs on the upper level of the Site identified as key sources of PFAS pollution entering the Site's soils and groundwater. It is therefore recommended that the GACarbon filter at the outfall is designed on a modular, 'in-principle' basis allowing for the performance to be optimised through the construction process.

A smaller 'head' (or column of GACarbon) is recommended within the lower-level toe drain purely on a practical basis to optimise the extent to which groundwater flows can be effectively 'captured' by the drain.

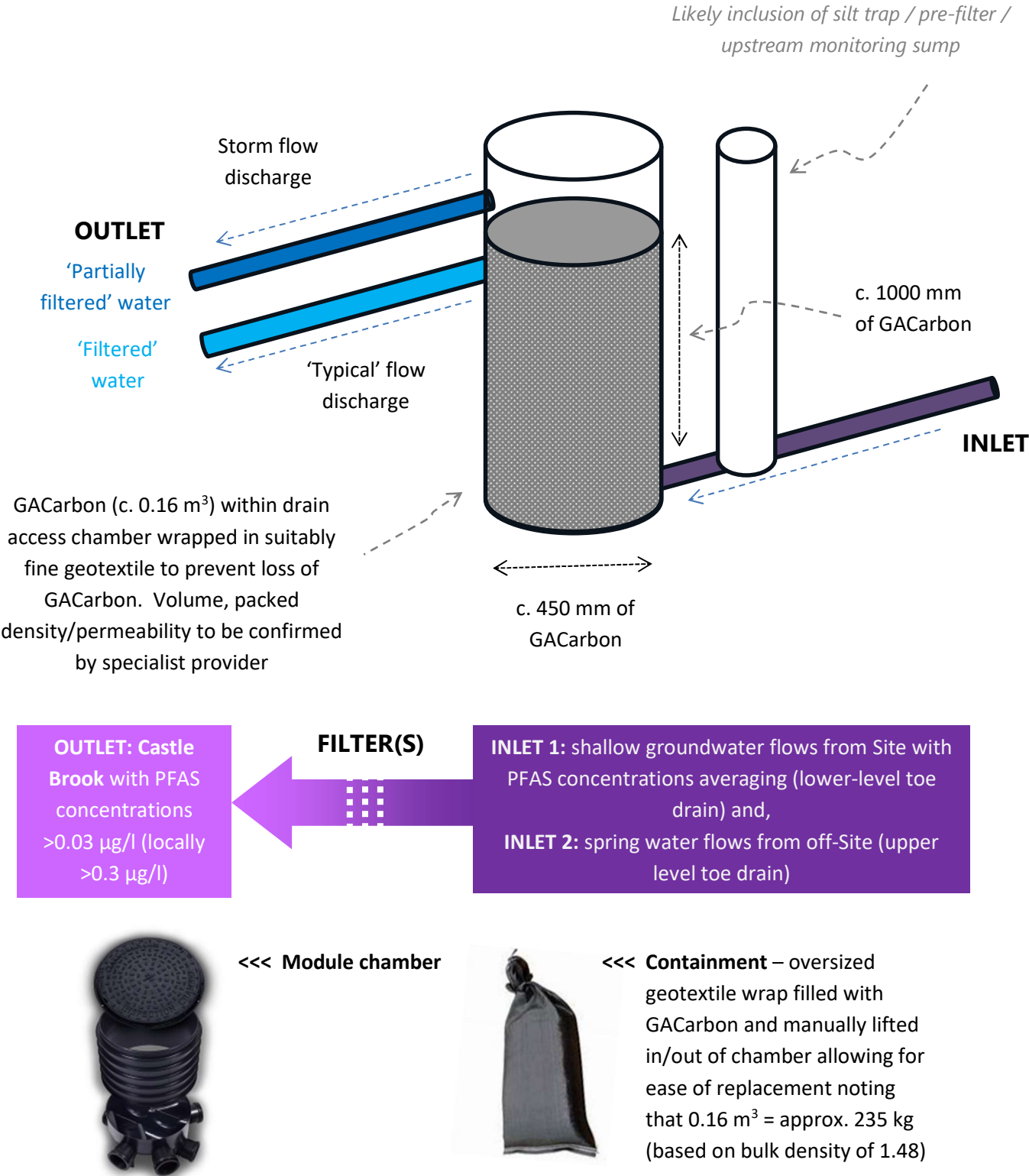
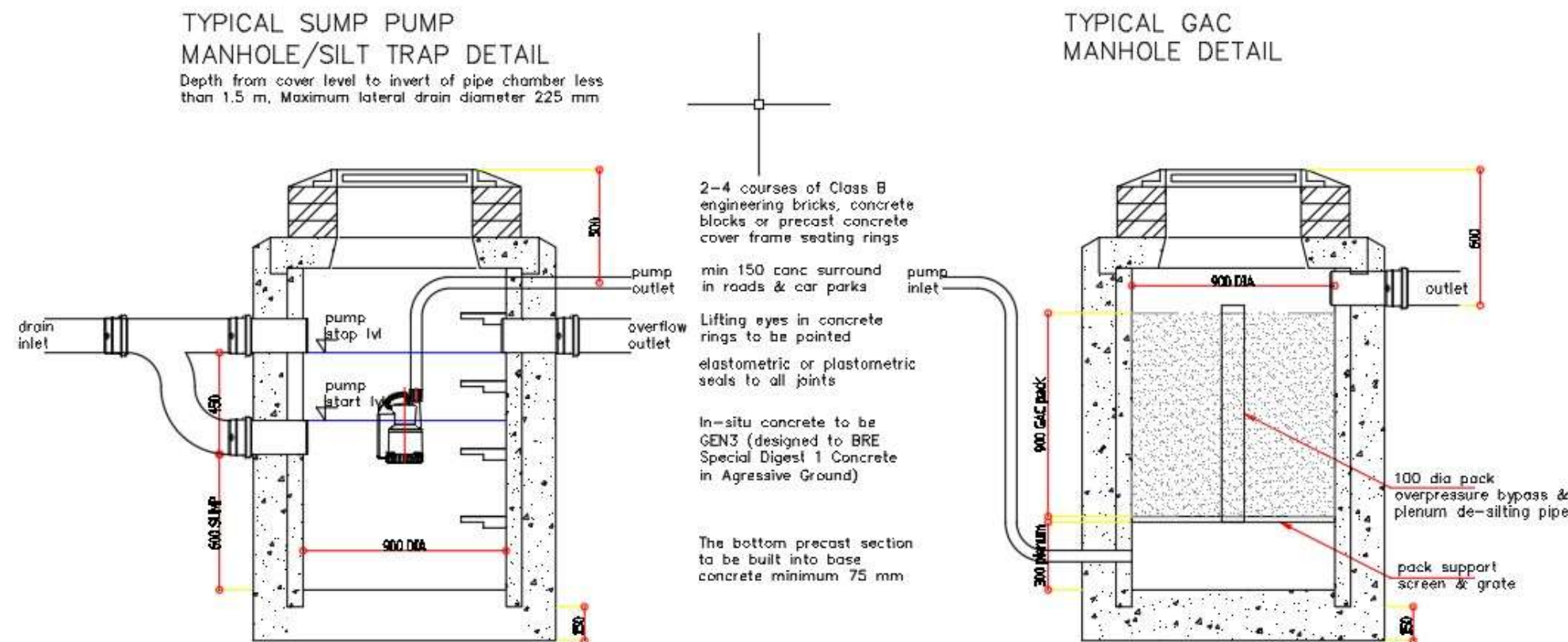
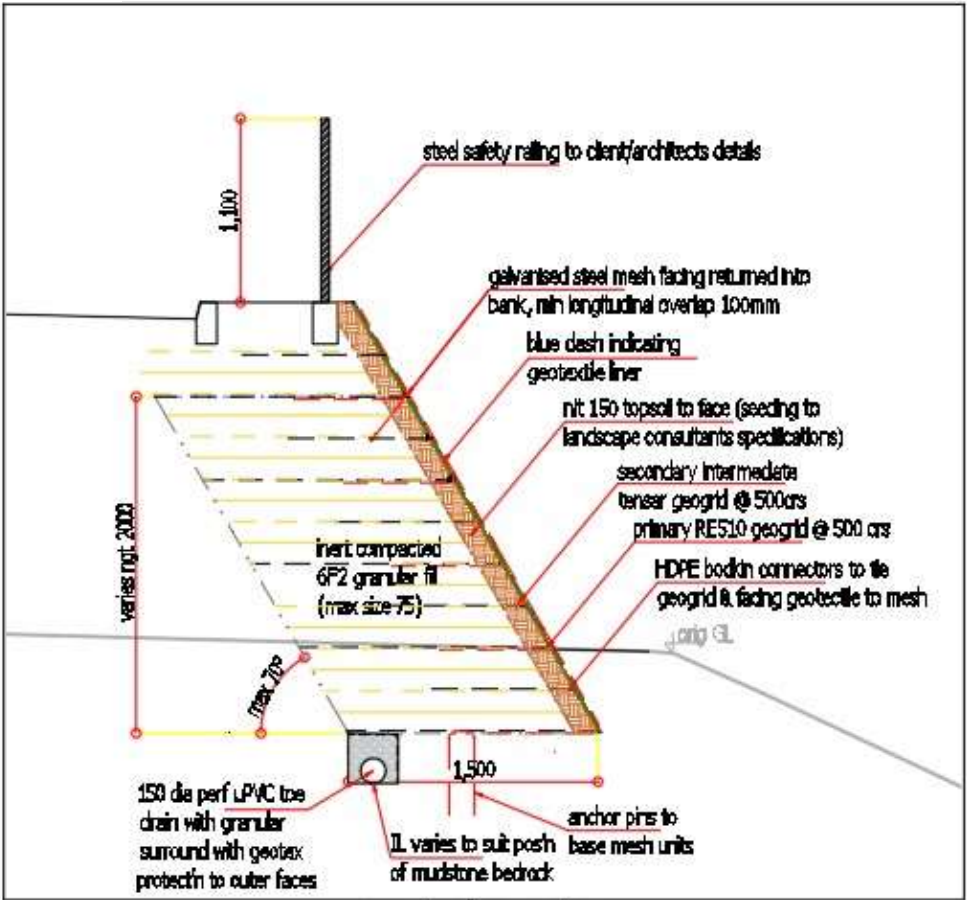


Figure 3 – Conceptual illustration of Granular Activated Carbon filter module  
> Referencing PFAS as one chemical of concern noting others are present in the inlet water  
> Examples of filter components illustrated bottom right



**Figure 4** – Work-in-progress detailed design drawings for 'silt trap' and Granular Activated Carbon filter modules  
> Extract from appended drawing



**Figure 5** – Work-in-progress detailed design drawings lower level toe-drain position within the green-slope construction  
> Extract from appended drawing

**4 Remedial Action 4 – Treatment of hydrocarbon impacted soils and groundwater**

The objective of this remedial action is to reduce the pollution potential of hydrocarbon impacted soils and groundwater present in localised 'hotspot' areas of the Site.

A secondary objective is to reduce the potential (and therefore the risk) for vapours to be generated beneath the proposed dwellings with some crossover with Remedial Action 5 detailed below.

This remedial action can be achieved through: in-situ solidification/stabilisation using a lime-cement mix.

This option has been selected based on the overall, low concentrations of hydrocarbons present within the soils and groundwater in these locations and the ability of solidification / stabilisation to effectively entrain both soil and water-based chemicals.

The action of mixing lime-cement with the soils will serve to have a three-fold affect of: i) initial exothermic effects resulting in a very short period of increased volatilisation of any volatile hydrocarbons within the soil and groundwater; ii) use of free water within the soil as part of the chemical reaction that in turn will result in; iii) podsolisation (chemical entrainment) of chemicals present with the soils and groundwater limiting their leachability.

Whilst not directly degrading the chemicals of concern (source removal) the action of stabilising the soils will limit the mobility of all chemical species resulting in either the near-permanent entrainment of the chemicals within the treated soil mass or else, 'slowing the flow' of potential pollutants, through limiting the leachability/mobility of the chemicals that, for hydrocarbon compounds will result in longer residency times in the ground and an increased likelihood of natural degradation.

The use of lime-cement is recommended given the variably graded nature of the Made Ground deposits that lend themselves to the use of a broader based or mixed soil additive.

It is recommended that the areas where evidence of 'free-phase' hydrocarbons are encountered that:

- > A conservative estimate of the extent of hydrocarbon impacted soils is marked out;
- > The soils are excavated vertically in a sequential manner, under the same controls in place for general earthworks, to a depth at which evidence of hydrocarbon staining is present;
- > When evidence of stained soils/groundwater are encountered, the excavation is progressed to a natural soil formation using a riddling bucket with lime-cement dosing to achieve between 1 to 2 % <sup>vol</sup>/<sub>vol</sub> of the total soil mass).

The lime : cement ratios should be between 90 : 10 to 80 : 20 dry-weight.

The use of continuous Photoionisation Detection during the works is recommended to support validation of the extent of the delineation (how far the hydrocarbon impacted soils and groundwater extends).

It is recommended that this work is supervised by a suitably qualified and experienced environmental engineer / engineering geologist.

5 Remedial Action 5 – Provision of ‘full radon protection measures’ to all new dwellings

The objective of this remedial action is to reduce the potential (and therefore the risk) for radon gas to enter the proposed dwellings.

As noted above under Remedial Action 4, secondary objective is to reduce the potential (and therefore the risk) for vapours to enter select dwellings.

This remedial action can be achieved through: the provision of ‘full radon protection measures’ to all dwellings with incorporation of a vapour barrier to select properties.

This option has been selected based a precautionary approach towards ground gases (all types) and vapours allowing for two forms of protection to the properties (sub-floor ventilation and gas/vapour resistant barriers).

This approach offers conservative, low-cost risk management of gases and vapours for which accurate assessment of risk is both costly and unreliable.

The action of providing “full radon protection” (in accordance with BRE 211 {2015}) to be provided to the new dwellings will offer inherent, effective protection against all ground gases.

The action of providing vapour barriers (hydrocarbon resistant) to the properties within 10 m of the delineated extent of hydrocarbon impacted soils will offer additional protection to these properties from any residual volatile hydrocarbons present within the ground.

This option has been selected based on the overall, low concentrations of hydrocarbons present within the soils and groundwater in these locations and the ability of solidification / stabilisation to effectively entrain both soil and water-based chemicals.

The ventilation should be:

- > 150 mm clear void installed front-to-back or side-to-side but NOT on all elevations. Installing on all elevations will create ‘dead-zones’ under the slab otherwise with the ventilation working off pressure differentials and not direct wind flows.
- > The installation of a minimum three (3) air bricks at no greater than 1500 mm centres along the front and back elevations of the properties is recommended.
- > The internal sleeper walls need to be ventilated too (missing blocks) to allow free flow of air across full length of the plot.

The membrane should be:

- > A minimum 1200 gauge is required with the recommended upgrade to 2000 gauge membrane to limit the potential of the barrier being damaged/punctured by follow-on trades; and,
- > Well-sealed, e.g. double-jointed and service penetrations sealed, such that it can act as an effectively ‘air tight’ barrier to the movement of any radon gas up into the habitable spaces.

The membrane within properties 10 m away from the confirmed extent of the hydrocarbon delineation zone should be:

- > A hydrocarbon and Volatile Organic Compound resistant membrane (as defined by CIRIA C748:2014)

- > Well-sealed, e.g. double-jointed and service penetrations sealed, such that it can act as an effectively ‘air tight’ barrier to the movement of any radon gas up into the habitable spaces.

The ventilation is the first and main line of defence, but the barrier needs to be well installed as modern houses have high levels of air tightness that can result in an increased likely of gases being ‘sucked’ into habitable spaces across the pressure gradient difference.

4.1 Response plan for ‘Unforeseen Contamination’

If and where any material is revealed on Site that is suspected as being unsuitable, i.e. potentially harmful, then the advice of the Engineer or the author of this Report should be sought.

Examples of ‘unforeseen contamination’ could include visibly stained or odorous soils. If and where soils are encountered that differ physically or in colour from those detailed and illustrated herein then it is also recommended that the advice of the Engineer or the author of this Report is sought.

The Engineer should in turn notify Rochdale Borough Council’s Contaminated Land Team of the encounter (and the Environment Agency where it concerns groundwater).

If and where the unforeseen contamination requires remedial action that differs from the actions detailed herein, then a revised Remediation Strategy should be submitted to Rochdale Borough Council’s Contaminated Land Team and agreed in advance of any work on or around the potentially contaminated material recommencing.

4.2 Other Actions

New water supply pipes are expected to be formed into Made Ground sub-soils that include chemicals that may pose a risk of fouling to the water supply pipes.

As a minimum requirement, it is recommended that water supply pipes are constructed using ‘barrier pipe’ (PE/AL/PE) that that all trenches are confirmed to be free from any potentially polluting material, e.g. stained or odorous soils.

## 5.0 Validation Plan

This section sets out the lines of evidence required to demonstrate, or validate, how the recommended remedial works achieve their stated aim.

On completion of the development works (including the required remedial action) a Validation Report should be prepared and submitted to the Local Planning Authority for approval.

### 1 Remedial Action 1 – Clean capping to soft landscaping areas

The following lines of evidence should be sought to demonstrate Made Ground deposits are covered by a suitable thickness of 'clean capping':

#### > For the clean capping thickness:

- Hand excavated trial pits on a plot-by-plot basis or one per every 50 m<sup>2</sup> of soft landscaping illustrating (through photographic evidence) how, the required thickness of clean capping has been provided over the Made Ground.

Guidance on the requirement for photographic evidence can be found in Local Planning Authority guidance<sup>4</sup>.

Hand pits should be taken down onto the 'no-dig' stone layer but no deeper to maintain the integrity of this layer and limit mixing with the underlying Made Ground deposits.

- Relative comparisons of reduced and final level surveys are not considered suitable however photographic evidence of the reduced level surface, prior to clean capping placement can be used to supplement the validation works.

#### > For the clean capping quality:

- As detailed within Section 4.0 Remedial Action 1, the chemical suitability of soil forming materials should be confirmed in line with local planning authority guidance.

### 2 Remedial Action 2 – Upper level toe drain

The following lines of evidence should be sought to demonstrate the upper level toe-drain and associated infrastructure have been installed correctly and are functioning at an acceptable level:

#### > For the toe-drain construction:

- Photographic evidence of the drain being installed to the agreed specification as outlined within Section 4.0 Remedial Action 2.

#### > For the Granular Activated Carbon filter:

- Photographic evidence of the filter being installed to the agreed specification as outlined within Section 4.0 Remedial Action 2.
- At the point of installation: Upstream sampling of water quality within the drain for PFAS compounds; PAHs, phenol (total monohydric) and sulphate.
- After 2 to 4 weeks: Upstream and downstream, sampling of water quality within the drain for; PFAS compounds, PAHs and phenol (total monohydric).

- After 12 to 16 weeks: Upstream and downstream, sampling of water quality within the drain for; PFAS compounds, PAHs and phenol (total monohydric).

The performance of the filter shall be assessed on a trial-and-error basis with the overall objective of achieving a 'betterment' in water quality at the downstream outfall. In practice, the filter is seeking to achieve a short to mid term reduction in all chemicals of concern by around 50 %, i.e. if and where PFOA is measured at 0.3 ug/l upstream of the filter, the objective is to achieve a reduction to 0.15 ug/l at the downstream outfall.

If and where less than 25 % reduction in concentrations occurs at either sampling event, then allowance for a secondary filter should be made.

This requirement should be determined in direct consultation with the Environment Agency.

For the upper toe drain, given the source of PFAS (and likely other chemicals) has been determined to lie off Site, ultimate responsibility for the management of these potential pollutants lies with third parties, yet to be identified. Notwithstanding this, in managing these waters, the Client will take on some responsibility towards its quality and potential risk these pollutants pose to Controlled Waters.

Confirming the extent of this responsibility is recommended and beyond the scope of this Report.

The installation of the filter to the upper level toe drain is recommended on an in-principle basis to demonstrate duty of care towards this water that, at present, is freely draining across and into the Site soils and directly discharging into Castle Brook with the only controls on PFAS (and other chemicals) concentrations being dilution and natural retention/retardation.

### 3 Remedial Action 3 – Lower level toe drains

The following lines of evidence should be sought to demonstrate the lower level toe-drains and associated infrastructure have been installed correctly and are functioning at an acceptable level:

#### > For the toe-drains' construction:

- Photographic evidence of the drains being installed to the agreed specification as outlined within Section 4.0 Remedial Action 3.

#### > For the Granular Activated Carbon filter:

- Photographic evidence of the filter being installed to the agreed specification as outlined within Section 4.0 Remedial Action 2.
- At the point of installation: Upstream sampling of water quality within the drain for PFAS compounds; PAHs, phenol (total monohydric) and sulphate.
- After 2 to 4 weeks: Upstream and downstream, sampling of water quality within the drain for; PFAS compounds, PAHs and phenol (total monohydric).
- After 12 to 16 weeks: Upstream and downstream, sampling of water quality within the drain for; PFAS compounds, PAHs and phenol (total monohydric).

The performance of the filter shall be assessed on a trial-and-error basis with the overall objective of achieving a 'betterment' in water quality at the downstream outfall. In practice, the filter is seeking to achieve a short to mid term reduction in all chemicals of concern by around 50 %, i.e. if and where PFOA is measured at 0.3 ug/l upstream of the filter, the objective is to achieve a reduction to 0.15 ug/l at the downstream outfall.

<sup>4</sup> [Contaminated Land | Manchester City Council](#)

If and where less than 25 % reduction in concentrations occurs at either sampling event, then allowance for a secondary filter should be made.

For the lower level toe drain, given the source of PFAS (and likely other chemicals) has been determined to lie on Site, ultimate responsibility for the management of these potential pollutants lies with the Client and therefore, the performance of these filters needs to be measured to a stricter standard than the upper level toe drain.

Again, the requirement for additional filter modules and the exact metrics by which they are measured should be agreed in direct consultation with the Environment Agency.

4 Remedial Action 4 – Treatment of hydrocarbon impacted soils and groundwater

The following lines of evidence should be sought to demonstrate that the hydrocarbon impacted soils and groundwater have been treated as recommended:

> For the extent of the works:

Photographic diary of the works prepared by the suitably qualified supervisor of the works illustrating through visual inspection and PID ‘sniff-tests’ the extent of hydrocarbon impacted soils has been chased out entirely.

> For the solidification/stabilisation works:

Photographic diary of the works prepared by the suitably qualified supervisor of the works confirming mix ratios for the lime : cement.

5 Remedial Action 5 – Provision of ‘full radon protection measures’ and vapour barriers to select properties

The following lines of evidence should be sought to demonstrate this ground gas protection measures have been installed as recommended:

> For the gas protection design:

Detailed design drawings are appended.

> For the ground gas / vapour protection installation:

The installation of ground gas protection shall be completed by the Client, an experienced house-building contractor.

This approach is considered appropriate for this development type (low-rise residential developments with ventilated void) under current good practice guidance<sup>5</sup>.

For radon gas, the inspection and verification of protection measures is commonly not a regulated activity despite the higher background threat this gas presents compared to other gases.

It is therefore recommended that:

- For properties where radon gas protection is installed: that the provision of suitable radon protection measures is verified by an independent consultant or qualified and experienced installer for at least 3 plots.
- For properties where vapour protection is required: that the provision of suitable vapour protection measures is verified by an independent consultant or qualified and experienced installer for all affected plots (to be confirmed following completion of Remedial Action 4.

The appointed ‘verifier’ shall be the Author of this Report who is a *competent, experienced and suitably trained* individual with specific experience of detailed quantitative risk assessment (for ground gas) and inspection and sign-off of ground gas protection (various designs) for over 1000 properties.

Signed inspection report shall be prepared by the ‘verifier’, confirming that the agreed gas protection has been installed correctly in line with the design and current guidance<sup>5,6</sup>.

Any non-conformances, e.g. inadequate sealing of service penetrations or multiple punctures, shall be immediately identified by the ‘verifier’ and, where not able to be rectified adequately on the inspection visit, an additional visit scheduled to demonstrate that appropriate steps have been taken to address the non-conformance.

① **Follow-on trades** should be made aware that any damage to the membrane is unacceptable and stands to compromise the gas protection.

5.1 Unforeseen material

If and where potentially harmful or polluting material is unexpectedly encountered in the ground, then confirmation of the pre-agreed response plan having been completed satisfactorily should be included within the Validation Report.

5.2 Other Actions

Provision of suitable pipe material should be confirmed through either photographic evidence or order sheets.

<sup>5</sup> NHBC publication ‘NHBC Foundation – Hazardous ground gas – an essential guide for housebuilders’ April 2013

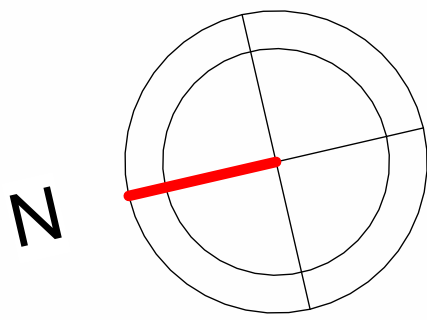
Schedule of Accommodation:

| Plot | Accommodation   | sqm | sqft |
|------|-----------------|-----|------|
| 1    | 3 Bedroom House | 96  | 1032 |
| 2    | 3 Bedroom House | 96  | 1032 |
| 3    | 3 Bedroom House | 96  | 1032 |
| 4    | 3 Bedroom House | 96  | 1032 |
| 5    | 3 Bedroom House | 96  | 1032 |
| 6    | 3 Bedroom House | 96  | 1032 |
| 7    | 3 Bedroom House | 96  | 1032 |
| 8    | 3 Bedroom House | 96  | 1032 |
| 9    | 4 Bedroom House | 138 | 1484 |
| 10   | 4 Bedroom House | 138 | 1484 |
| 11   | 4 Bedroom House | 218 | 2346 |
| 12   | 4 Bedroom House | 162 | 1744 |
| 13   | 4 Bedroom House | 130 | 1398 |
| 14   | 4 Bedroom House | 130 | 1398 |
| 15   | 4 Bedroom House | 130 | 1398 |
| 16   | 4 Bedroom House | 160 | 1722 |
| 17   | 4 Bedroom House | 180 | 1937 |
| 18   | 5 Bedroom House | 182 | 1959 |
| 19   | 5 Bedroom House | 182 | 1959 |
| 20   | 5 Bedroom House | 182 | 1959 |
| 21   | 3 Bedroom House | 103 | 1108 |
| 22   | 3 Bedroom House | 103 | 1108 |
| 23   | 5 Bedroom House | 260 | 2800 |
| 24   | 5 Bedroom House | 260 | 2800 |
| 25   | 5 Bedroom House | 278 | 3000 |

See landscaping plan for full detail for green space



Visual Scale - 1:300



materials palette

rainwater goods to be black gutters, downpipes and waste pipes  
fascias where applicable to be s/w painted black  
doors: composite high security front and rear entrance doors. Garage doors to be aluminium in finish to match main entrance doors

- Hedge with 1000mm metal wired fence separating rear gardens

Low level hedge to front garden

Grass

Green space

Tegula Pavious/sets Vehicle Use

Tegula Pavious/sets (Pedestrian use Contrasting)

Tarmac Driveways/parking

Tarmac Road

Stone Wall - varies

Timber fence

-1800mm to plot perimeter  
-1500mm division to gardens( where hedging not proposed)

600mmx600mm Pavers

Tegula Pavious/sets public footpath

Pond

nicol thomas

| Rev | Date     | Description                            |
|-----|----------|----------------------------------------|
| N   | 02.12.22 | pond changed to engineers drawing      |
| O   | 06.12.22 | Revised to EA comments                 |
| P   | 05.01.23 | structural detail information included |
| Q   | 17.01.23 | wall length increased                  |
| R   | 19.01.23 | Wall decreased                         |
| S   | 24.01.23 | Tim Booth revisions                    |
| T   | 13.02.23 | Patio area updated                     |

nicol thomas  
architects project managers construction cost consultants CDM co-ordinators  
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|                           |                            |            |       |
|---------------------------|----------------------------|------------|-------|
| Client                    | Mainly Mere                |            |       |
| Job                       | Sladen Mill, Littleborough |            |       |
| Drawing title Site Layout |                            |            |       |
| Project number            | M4856                      | (PL)02     | Rev T |
| Scale                     | As indicated @ A1          |            |       |
| Date                      | 01/30/23                   |            |       |
| Drawn by                  | KS                         | Checked by | GRF   |

13.02.23

**Material Suitability**  
Chemical Screening

## SOIL AND STRUCTURES

| Notes on Generic Assessment Criteria                                       |
|----------------------------------------------------------------------------|
| 1. Assumes sandy loam soil (default soil type)                             |
| 2. Assumes 6% SOM                                                          |
| 3. Assumes small terraced house                                            |
| 4. S4UL = Suitable 4 Use Levels (LQM/CIEH) - <i>minimal risk</i>           |
| 5. C4SL = Category 4 Screening Levels (DEFRA) - <i>acceptably low risk</i> |
| 6. Bold GACs derived from SGV report input parameters in CLEA v1.071       |

| Material Description |
|----------------------|
| Lab Sample Number    |
| Sample Reference     |
| Sample Number        |
| Depth (m)            |
| Date Sampled         |
| Time Taken           |

| Topsoil (imported) | Topsoil (imported) | Topsoil (imported) | Topsoil (imported) | Topsoil (imported) |
|--------------------|--------------------|--------------------|--------------------|--------------------|
|                    |                    |                    |                    |                    |
|                    |                    |                    |                    |                    |
|                    |                    |                    |                    |                    |
|                    |                    |                    |                    |                    |
|                    |                    |                    |                    |                    |

### Generic Assessment Criteria

|                         |                         |
|-------------------------|-------------------------|
| Exceeds by more than x2 | Exceeds by less than x2 |
|-------------------------|-------------------------|

| Analytical Parameter (Soil Analysis) | Units | Detection | Accred? |
|--------------------------------------|-------|-----------|---------|
| Stone Content                        | %     | 0.1       | NONE    |
| Moisture Content                     | %     | N/A       | NONE    |
| Total mass of sample received        | kg    | 0.001     | NONE    |

|                |
|----------------|
| Not applicable |
| Not applicable |
| Not applicable |

|                  |      |     |           |
|------------------|------|-----|-----------|
| Asbestos in Soil | Type | N/A | ISO 17025 |
|                  |      |     |           |

| Type             |
|------------------|
| Detected or not? |
| Analyst          |

| General Inorganics                                                      |          |         |        |
|-------------------------------------------------------------------------|----------|---------|--------|
| pH - Automated                                                          | pH Units | N/A     | MCERTS |
| Water Soluble Sulphate as SO <sub>4</sub> 16hr extraction (2:1)         | mg/kg    | 2.5     | MCERTS |
| Water Soluble SO <sub>4</sub> 16hr extraction (2:1 Leachate Equivalent) | g/l      | 0.00125 | MCERTS |
| Water Soluble SO <sub>4</sub> 16hr extraction (2:1 Leachate Equivalent) | mg/l     | 1.25    | MCERTS |
| Organic Matter                                                          | %        | 0.1     | MCERTS |

|                      |
|----------------------|
| Review when <5 or >9 |
| Not applicable       |
| Not applicable       |
| Not applicable       |
| GSV variable         |

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| Speciated PAHs         |       |      |        |
|------------------------|-------|------|--------|
| Naphthalene            | mg/kg | 0.05 | MCEBTS |
| Acenaphthylene         | mg/kg | 0.05 | MCEBTS |
| Acenaphthene           | mg/kg | 0.05 | MCEBTS |
| Fluorene               | mg/kg | 0.05 | MCEBTS |
| Anthracene             | mg/kg | 0.05 | MCEBTS |
| Anthracene             | mg/kg | 0.05 | MCEBTS |
| Fluoranthene           | mg/kg | 0.05 | MCEBTS |
| Pyrene                 | mg/kg | 0.05 | MCEBTS |
| Benzo(a)anthracene     | mg/kg | 0.05 | MCEBTS |
| Chrysene               | mg/kg | 0.05 | MCEBTS |
| Benzo(b)fluoranthene   | mg/kg | 0.05 | MCEBTS |
| Benzo(k)fluoranthene   | mg/kg | 0.05 | MCEBTS |
| Benzo(a)pyrene         | mg/kg | 0.05 | MCEBTS |
| Indeno(1,2,3-cd)pyrene | mg/kg | 0.05 | MCEBTS |
| Dibenz(a,h)anthracene  | mg/kg | 0.05 | MCEBTS |
| Benzo(g,h,i)perylene   | mg/kg | 0.05 | MCEBTS |
| Coronene               | mg/kg | 0.05 | NOH    |

| SAUL | CASL             |
|------|------------------|
| >    | Surrogate Marker |
| >    | Surrogate Marker |
| >    | Surrogate Marker |
| >    | Surrogate Marker |
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| >    | Surrogate Marker |
| >    | 5                |
| >    | Surrogate Marker |
| >    | Surrogate Marker |
|      | -                |

[illegible]

|                             |       |     |        |
|-----------------------------|-------|-----|--------|
| <b>Total PAH</b>            |       |     |        |
| Speciated Total EPA-16 PAHs | mg/kg | 0.8 | MCERTS |

|               |
|---------------|
| Not available |
|---------------|

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| Phenols            |       |   |        |
|--------------------|-------|---|--------|
| Total - Monohydric | mg/kg | 1 | MCERTS |

|      |      |
|------|------|
| S4UL | C45L |
| 420  | <    |

|  |  |  |  |  |
|--|--|--|--|--|
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|--|--|--|--|--|

| Heavy Metals / Metalloids         |       |     |        |
|-----------------------------------|-------|-----|--------|
| Arsenic (aqua regia extractable)  | mg/kg | 1   | MCERTS |
| Boron (water soluble)             | mg/kg | 0.2 | MCERTS |
| Cadmium (aqua regia extractable)  | mg/kg | 0.2 | MCERTS |
| Chromium (hexavalent)             | mg/kg | 1.2 | MCERTS |
| Chromium (aqua regia extractable) | mg/kg | 1   | MCERTS |
| Copper (aqua regia extractable)   | mg/kg | 1   | MCERTS |
| Lead (aqua regia extractable)     | mg/kg | 1   | MCERTS |
| Mercury (aqua regia extractable)  | mg/kg | 0.3 | MCERTS |
| Nickel (aqua regia extractable)   | mg/kg | 1   | MCERTS |
| Selenium (aqua regia extractable) | mg/kg | 1   | MCERTS |
| Zinc (aqua regia extractable)     | mg/kg | 1   | MCERTS |

| S4UL | C45L |
|------|------|
| >    | 37   |
| 290  | <    |
| >    | 22   |
| 21   | <    |
| 910  | <    |
| 2400 | <    |
| >    | 200  |
| 1    | <    |
| 130  | <    |
| 350  | <    |
| 3700 | <    |

[illegible]

| Monoaromatics & Oxygenates         |       |   |        |
|------------------------------------|-------|---|--------|
| Benzene                            | µg/kg | 1 | MCERTS |
| Toluene                            | µg/kg | 1 | MCERTS |
| Ethylbenzene                       | µg/kg | 1 | MCERTS |
| p & m-xylene                       | µg/kg | 1 | MCERTS |
| o-xylene                           | µg/kg | 1 | MCERTS |
| MTBE (Methyl Tertiary Butyl Ether) | µg/kg | 1 | MCERTS |

| S4UL | C4SL |
|------|------|
| »    | 0.87 |
| 610  | «    |
| 350  | «    |
| 230  | «    |
| 230  | «    |
|      |      |

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| Petroleum Hydrocarbons          |       |       |        |
|---------------------------------|-------|-------|--------|
| TPH-CWG >Aliphatic >EC5 - EC6   | mg/kg | 0.001 | MCERTS |
| TPH-CWG >Aliphatic >EC6 - EC8   | mg/kg | 0.001 | MCERTS |
| TPH-CWG >Aliphatic >EC8 - EC10  | mg/kg | 0.001 | MCERTS |
| TPH-CWG >Aliphatic >EC10 - EC12 | mg/kg | 1     | MCERTS |
| TPH-CWG >Aliphatic >EC12 - EC16 | mg/kg | 2     | MCERTS |
| TPH-CWG >Aliphatic >EC16 - EC21 | mg/kg | 8     | MCERTS |
| TPH-CWG >Aliphatic >EC21 - EC35 | mg/kg | 8     | MCERTS |
| TPH-CWG >Aliphatic (EC5 - EC35) | mg/kg | 10    | MCERTS |

|       |   |
|-------|---|
| 160   | € |
| 530   | € |
| 150   | € |
| 760   | € |
| 4300  | € |
| 11000 | € |
|       | € |
|       |   |

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|                                 |       |       |        |
|---------------------------------|-------|-------|--------|
| TPH-CWG - Aromatic >EC5 - EC7   | mg/kg | 0.001 | MCERTS |
| TPH-CWG - Aromatic >EC7 - EC8   | mg/kg | 0.001 | MCERTS |
| TPH-CWG - Aromatic >EC8 - EC10  | mg/kg | 0.001 | MCERTS |
| TPH-CWG - Aromatic >EC10 - EC12 | mg/kg | 1     | MCERTS |
| TPH-CWG - Aromatic >EC12 - EC16 | mg/kg | 2     | MCERTS |
| TPH-CWG - Aromatic >EC16 - EC21 | mg/kg | 10    | MCERTS |
| TPH-CWG - Aromatic >EC21 - EC35 | mg/kg | 10    | MCERTS |
| TPH-CWG - Aromatic (EC5 - EC35) | mg/kg | 10    | MCERTS |

|      |   |
|------|---|
| 300  | ← |
| 660  | ← |
| 190  | ← |
| 380  | ← |
| 660  | ← |
| 930  | ← |
| 1700 | ← |
|      |   |

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