



e3p

Remediation and Enabling Works Strategy
Land at Greenbooth Road and Edenfield Road, Norden

Reference:16-465-R4-1
Date: September 2023



REMEDIATION AND ENABLING WORKS STRATEGY

Land at Greenbooth Road and Edenfield Road
Norden
Rochdale
OL12 7TD

Prepared for:

Stonebond.

Report Ref: 16-465-R4-1
Date Issued: September 2023



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EXECUTIVE SUMMARY

Site Address	Land at Greenbooth Road and Edenfield Road, Norden, Rochdale OL12 7TD
National Grid Reference	E 385812, N 414724
Site Area	2.62 Ha.
Background	E3P has been instructed by Stonebond Properties Ltd to develop a remediation and enabling works strategy for the proposed residential development at the site located to the north of Greenbooth Road and Edenfield Road, Norden, Rochdale. Stonebond Properties Ltd intends to construct a low-rise residential development comprising 49 residential dwellings with associated gardens, estate roads, infrastructure, and a connecting bridge. Drawing 16-465-002 (Appendix III) identifies the proposed development layout. The E3P Remediation and Enabling Earthworks Strategy has been produced in due consideration of the geoenvironmental site investigation and contaminated land assessments previously undertaken by E3P (16-465-R2-23, dated August 2023), Encia Consulting and LK Consult.

CONTAMINATED LAND RISK ASSESSMENT

Human Health Risk Assessment	The Tier 2 human health risk assessment identified concentrations of heavy metals, asbestos, non-volatile PAHs, naphthalene, petroleum hydrocarbons, VOCs and SVOCs that would present unacceptable degrees of theoretical risk to the identified receptors associated with direct exposure pathways. The majority of the identified elevated concentrations have primary exposure pathways related to dermal contact and ingestion of soils, inhalation of particulate and consumption of homegrown vegetables; with naphthalene, petroleum hydrocarbons, VOCs and SVOCs having a primary exposure pathway related to volatilisation to indoor air risk. The risk to chronic human health associated with the elevated concentrations of inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed private rear gardens, front gardens, areas of soft landscaping and public open space (POS) to remove any potential for direct exposure to impacted soils. Asbestos in the form of chrysotile and amosite has been identified within localised areas in Made Ground deposits in the southern part of Sheppard Mill area (WS124 and WS18), the historical landfill in the eastern section of Tack Lea Works area (HP05) and the central section of Tack Lea Works (TP114 and TP116). Asbestos bulk fragments, in the form of hard cement were also identified in WS124, HP05 and WS10; and asbestos sheeting/board debris within HP05. Visual signs of ACM were encountered during the ground investigations in HP05. Impacted soils should be managed according to the asbestos risk mitigation conceptual site model.
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**Human Health Risk
Assessment
(continued)**

It is noted that the presence of asbestos sheeting and boarding will require a different remedial approach to those proposed within the asbestos risk mitigation conceptual site model (i.e., hand picking of visible bulk asbestos fragments). Where asbestos sheeting and boarding has previously been identified, any proposed earthworks within those areas may be required to be undertaken under license. In addition, any off-site disposal of materials from these areas would be considered hazardous unless the asbestos bulk fragments are pre-removed via hand picking techniques.

Elevated concentrations of mercury have been identified within two locations within the Tack Lea Works area (WS111 at 0.60 m bgl and WS9 at 0.50 m bgl); and one location within the Sheppard Mill area (WS25 at 0.70 m bgl). During remediation and enabling works, speciated mercury analysis should be completed at the locations WS111, WS9 and WS25 to assess whether elemental mercury is present which may pose a risk to future site users through vapour inhalation. If elemental mercury is identified, it may be necessary to delineate and excavate the soils as a hotspot and place them in an area of low sensitivity such as beneath areas of public open space or removed from site. Alternatively, if it is proven that there is no elemental mercury, a clean cover system will be sufficient.

The elevated concentrations of naphthalene, TPH, and trichloroethene (TCE) identified within the Tack Lea Works area (TP116 and WS12) are considered to be localised occurrences and therefore these locations can be treated as localised hotspots. During a process of cut/fill enabling works, a hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on-site in an area of no future sensitivity.

However, elevated concentrations of naphthalene, TPH, VOCs and SVOCs have been identified throughout the Shepherd Mill area, and these do not appear to be localised hotspots. A Tier 3 vapour risk assessment is required in the Sheppard Mill area to assess the level of risk to the future site users by volatilisation to indoor air.

The SVOCs identified in WS107 and TP116 within the Tack Lea Works area are not considered to pose a risk to future site users given the marginal concentrations.

Furthermore, with regards to the elevated volatile contaminants (naphthalene, TPH, VOCs and SVOCs) identified in the Tack Lea Works area and the Sheppard Mill area, vapour resistant membranes may be required to be installed during the build phase for any proposed buildings situated within the immediate vicinity of the contamination hotspot / impacted soils. A Detailed Quantitative Risk Assessment (DQRA) may also be required to determine if any risks to human health and controlled water receptors remains following the hotspot removal.

Chemical analysis of the natural subsoil deposits has indicated these soils to be acceptable for use within the proposed garden areas; however, further chemical validation samples will be required to confirm this. No suitable source of natural topsoil deposits has been identified on-site.



Controlled Waters Risk Assessment	The ICSM developed within the context of the site setting has determined that the surface water features (Naden Brook, Woodhouse Lane Brook and the culverted water courses and springs) are the critical receptors at risk from a viable pollutant pathway, which would be the lateral migration of potentially mobile phase-soluble contaminants. The presence of low permeability cohesive drift deposits across the site affords protection from vertical migration to the underlying Secondary A bedrock aquifer. As such, this receptor is considered to be at a low risk . Though the risk to the underlying bedrock Secondary A aquifer is considered to be low, the risk to the surface water receptors is considered to be high, due to the presence of impacted soils within close proximity of surface water features, and the presence of high permeability strata in areas beneath the site. Widespread naphthalene and TPH contamination has been identified in the soil analysis, with the majority of the impact noted within the Sheppard Mill area of the site. Thus, the source of the contaminants cannot be attributed to one area or point source and the majority of the contamination is considered present on a site wide basis. During the remediation and enabling works phase, the removal of the hardstanding currently present across the site may induce infiltration and potential mobilisation of contaminants present within the soils and groundwater directly into the surface water receptors. However, the areas of low permeability clay soils will act to inhibit migration. The supplementary controlled waters risk assessment completed by E3P has not identified any significant impact within the groundwater or surface water samples. The data suggests that there is no complete pollutant linkage and the identified contamination within the soils is not likely to be mobile. It will be necessary to instigate a watching brief during Remediation and Enabling Works to ensure that it can be demonstrated that all material that remains in-situ is suitable for retention. Surface water sampling is also recommended throughout the Remediation and Enabling Works to ensure that the water quality of the surface water features is not altered.
Ground Gas	Ground gas monitoring suggests that the site can be predominantly classified as CS1. However, CS2 measures are recommended for the whole site due to the presence of the historical landfill (eastern section of the Tack Lea Works area). Elevated concentrations of volatile contaminants (naphthalene, TPHs, VOCs, SVOCs, and mercury) have been identified within the Made Ground on-site, which present a potential volatilisation to indoor air risk. Elevated concentrations of volatile contaminants in the Tack Lea Works area are considered to be localised occurrences and therefore these locations can be treated as hotspots. However, elevated concentrations of volatile contaminants have been identified throughout the Shepherd Mill area and these do not appear to be localised hotspots.



Ground Gas (continued)	Further assessment, in the form of a Tier 3 vapour risk assessment is required in the Sheppard Mill area to assess the level of risk to the future site users by volatilisation to indoor air. Subject to the findings of the vapour risk assessment, vapour resistant membranes may be required. Design and validation of gas and vapour mitigation measures will be detailed within a specific build phase mitigation strategy.
Coal Mining and Historical Workings	No risk from coal mining is present, and no further measures are required.
Invasive Plants	Invasive species have not been identified to date. However, the remediation contractor should review all ecological reports and undertake their own surveys to confirm the presence of any invasive plant species and the requirement for treatment and eradication as part of their works.
Potable Water Supply	This will need to be confirmed following the completion of a UKWIR risk assessment. Post-remediation and enabling works ground conditions may be different from those identified during this ground investigation.

GEOTECHNICAL ASSESSMENT

Relict Sub-Structures	Extensive relict substructures, infrastructure and materials deemed geotechnically deleterious are identified. All such materials will require removal from beneath proposed structures and infrastructure to the depths and extents as defined within this specification.
Adverse Ground Conditions	All potentially infilled ponds and historical features where deleterious/putrescible material is identified should be located and subject to the necessary remediation works. There is the potential for a quarry high wall to be present in the location of the former sandstone quarry in the north of the site, however this was not identified during the ground investigation.
Proposed Foundations	Given the significant topographical variances on the site, prior to the detailed design of a suitable foundation solutions, a programme of remediation and enabling works will be required to remove the extensive buried obstructions and cut/fill the site in order to create proposed development platform levels suitable for residential development. Following the removal of obstructions and subsequent engineering of soils to a specific performance specification, proposed plots could be constructed utilising vibro stone columns to support a suitably reinforced spread footing. Where tree influence is present and clays prone to volumetric instability, an alternative foundation solution may need to be adopted to deepen the foundation or the cohesive stratum may be removed and replaced with a granular material. The depth of the granular infill will be plot specific and require calculation on receipt of development levels. The use of vibro stone columns will also be dependent on the removal of clays that have a shear strength of $<30\text{kN/m}^2$. This specifically applies to Plots 41-44, where soft clays with a shear strength of $<30\text{ kN/m}^2$ were encountered between 1.10 m and 2.20 m bgl in TP115.



Proposed Foundations (continued)	Where plots are in close proximity to slopes or the existing retaining walls, the proposed loadings may need to be transferred beneath the influencing depth of the retainer or slope to ensure no unacceptable loading is induced that would cause a geotechnical failure. Consideration should also be given to the historical landfill located in the eastern section of Tack Lea Works, as well as the potential presence of a quarry high wall associated with the historical sandstone quarry in the north of Tack Lea Works area. Where plots span such a feature, socketed piles into the bedrock will be required to reduce the risk of differential settlement. Therefore, upon completion of these enabling works, it is anticipated that the final foundation solution will be a combination of: ✳ Vibro Stone Columns (VSC) that will ensure a uniform ABP in the order of 100kN/m² for the construction of a doubly reinforced strip footing at ~600mm below remediated ground level (1050 mm below FFL); ✳ Shallow strip foundations, where viable, bearing on localised areas of firm to very stiff clays, medium dense sands and shallow bedrock; ✳ Mass trench fill, where viable, bearing on localised areas of firm to very stiff clays, medium dense sands and shallow bedrock; ✳ Piled foundations may be required where deep Made Ground and soft clays have been encountered; and for plots which span the historical sandstone quarry and associated high wall in the north-western section of the Tack Lea Works area; and ✳ Raft foundations may be required where obstructions cannot be removed. Foundation depths within the conjectured influence of former, existing or proposed trees will need to be deepened to ensure that structural loading bears within the underlying target founding stratum, which cannot be subject to volumetric instability associated with fluctuation in moisture content.
Highways and Infrastructure	All proposed adopted roads will be constructed in accordance with the geotechnical engineering requirements as defined within the MCHW Series 600. Specific engineering and compaction of materials will be completed in strict accordance with the geotechnical specification contained within this report. All materials outside of structural/infrastructure development will be engineered and compacted to ensure consolidation associated with self-weight settlement is limited to < 50 mm in accordance with the E3P specification.
Waste Soils	Materials present from with the historical landfill will need to be processed utilising the relevant treatment permits in order for the soils to reach end of waste status. The permit will need to be submitted to the National Permitting Team for approval. If excavation is proposed in the landfill area, a specific waste management and recovery strategy will be required. Materials from outside the area of the former landfill can be re-used in accordance with CL:AIRE Definition of Waste code of practice.



REMEDIATION AND ENABLING WORKS

Objectives	The remediation and enabling works will be delivered in a manner that will seek to ensure that the site is prepared to deliver the optimum foundation solution for the proposed structures, infrastructure and highways. The geotechnical foundation zoning plan and structural engineer's drawings should be referenced to determine the proposed foundation solution.
Remediation and Enabling Works	The site remediation and enabling works strategy provides a comprehensive specification for the regeneration of the land to negate identified pollutant linkages and construct a development platform that will be geotechnically suitable for the proposed end use. The salient features of the remediation and enabling works strategy are summarised as follows: ✳ Implementing all works in strict accordance with UK Environmental Permitting and local planning authority requirements. ✳ Watching brief and sampling beneath the former building footprint during remediation works. ✳ Investigation of the former landfill area. ✳ Tier 3 vapour risk assessment for volatile compounds. ✳ Controlled removal of all trees and vegetation. ✳ Removal and treatment of all invasive plant species (as required) in accordance with specialist contractor method statement, validation and independent certification. ✳ Further assessment of mercury. ✳ Segregation of organic topsoil deemed unsuitable for use within a residential garden and placement in an area of no sensitivity or removal from site in accordance with UK waste management legislation. ✳ Decommission of all interceptors, tanks and active drainage infrastructure in accordance with contractor method statement and ensuring no environmental impact. ✳ Management of asbestos containing materials. ✳ Excavation, validation and treatment of the identified hotspots. ✳ Identification, delineation and removal of organic materials within infilled ponds and reservoirs. ✳ Settlement analysis of deep fill in landfill/lagoon areas, or, ✳ Full depth 'turn-over' of the former landfill/lagoons, removal of putrescible and deleterious elements prior to the replacement and re-engineering of the material during backfill. ✳ Removal of all structures, relict foundations and buried features in their entirety. ✳ Removal of all materials considered geotechnically deleterious. ✳ Excavation and processing of Made Ground in a controlled manner with the sorting, processing and segregation of identified deleterious materials to geotechnical specification.



Remediation and Enabling Works (continued)	✳ Validation sampling and leachate testing to confirm material retained on-site poses no unacceptable risk to the residential end users, controlled waters or wider environ. ✳ Importation of suitable material (if required) to achieve the required development levels. ✳ Replacement of material in accordance with the E3P enabling specification and engineering requirements.
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BUILD PHASE REQUIREMENTS

Summary of Build-Phase Mitigation Requirements	The developer's works will also include the completion of the following additional elements: ✳ Provision of a 600 mm cover system using certified material underlain by a geotextile membrane with appropriate validation within proposed rear garden areas, comprising 450 mm subsoil (potentially site won natural drift deposits) overlain by 150 mm topsoil; and, ✳ Provision of a 300 mm clean cover system using certified material with appropriate validation within front gardens deemed to be functional landscaping; comprising 150 mm subsoil (potentially site won natural drift deposits) overlain by 150 mm topsoil; ✳ Provision of a 300 mm cover system using certified material with appropriate validation within proposed areas of soft landscaping and public open space; comprising 150 mm subsoil (potentially site won natural drift deposits) overlain by 150 mm topsoil; ✳ Construction of dwellings with appropriate gas mitigation to be compliant with CS2/Amber 1. ✳ Provisional allowance for the construction of VOC resistant membranes. ✳ Construction of appropriate potable water supply infrastructure. Design and validation of gas and vapour mitigation measures will be detailed within a specific build phase mitigation strategy.
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DRAWING LIST

16-465-001 – Site Location Plan
16-465-002 – Proposed Development Plan
16-465-003 – Site Features Plan
16-465-004 – Historical Features Plan
16-465-005 – Exploratory Hole Location Plan
16-465-006 – Depth of Made Ground Plan
16-465-008 – Depth of Founding Strata Plan
16-465-009 – Concept Foundation Zoning Plan
16-465-010 – Conceptual Site Model
16-465-012 – Depth of Bedrock Plan
16-465-015 – Development Constraints Plan
16-465-024 – Ground Gas Plan
16-465-027 – Contamination Issues Plan – TPH
16-465-028 – Contamination Issues Plan – VOCs
16-465-029 – Contamination Issues Plan – SVOCs
16-465-030 – Contamination Issues Plan – Heavy Metals
16-465-031 – Contamination Issues Plan – Naphthalene
16-465-032 – Contamination Issues Plan – Non-Volatile PAHs
16-465-033 – Contamination Issues Plan – Asbestos
16-465-034 – Contamination Issues Plan – Leachate
16-465-035 – Contamination Issues Plan – Groundwater
16-465-036 – Contamination Issues Plan – Surface Water
16-465-037 – Controlled Waters Conceptual Site Model
16-465-040 – Groundwater Flow Plan



1. INTRODUCTION

1.1. BACKGROUND

E3P has been instructed by Stonebond Properties Ltd to develop a remediation and enabling works strategy for the proposed residential development at the site located to the north of Greenbooth Road and Edenfield Road, Norden, Rochdale.

1.2. REPORT OBJECTIVES

The objectives of this report are to:

- ✿ Prepare an overview of contaminated land remediation requirements;
- ✿ Evaluate feasible remedial technologies;
- ✿ Assess the most-appropriate earthworks solution to ensure the delivery of the optimum development platform;
- ✿ Define validation criteria to demonstrate the successful implementation of a site remediation and enabling works plan;
- ✿ Specify geotechnical engineering performance requirements; and
- ✿ Ensure the safe, cost effective and regulatory compliant redevelopment of the site.

1.3. SCOPE OF WORKS

The development of the risk management strategy for the subject site includes the following tasks:

- ✿ Identification of the relevant pollutant linkages;
- ✿ Review of site characteristics;
- ✿ Identification of geotechnical constraints;
- ✿ Development of remedial objectives;
- ✿ Selection of appropriate remedial technology; and
- ✿ Development of remedial strategy.

1.4. PREVIOUS WORKS

The following phases of geoenvironmental investigations have previously been carried out at the site:

- ✿ **Encia Consulting Limited** – Geoenvironmental Appraisal – Land at Greenbooth Road, Norden (Report Ref: 7112/1 June 2006)
- ✿ **LK Consult** – Geoenvironmental Risk Assessment – Land at Greenbooth Road, Norden (Report Ref: CL602-LKC 20 1618-01, September 2020)
- ✿ **E3P** – Phase I Geoenvironmental Site Assessment Land at Greenbooth Road and Edenfield Road, Norden (Report Ref: 16-465-R1-1, December 2022)



 **E3P** – Phase II Geoenvironmental Site Assessment Land at Greenbooth Road and Edenfield, Road, Norden. (Report Ref 16-465-R2-3, August 2023).

To inform the assessment of the potential risk to contaminated land within the context of the proposed residential development and to inform the preparation of the remediation strategy, the pertinent points from the above reports are summarised within Section 2.

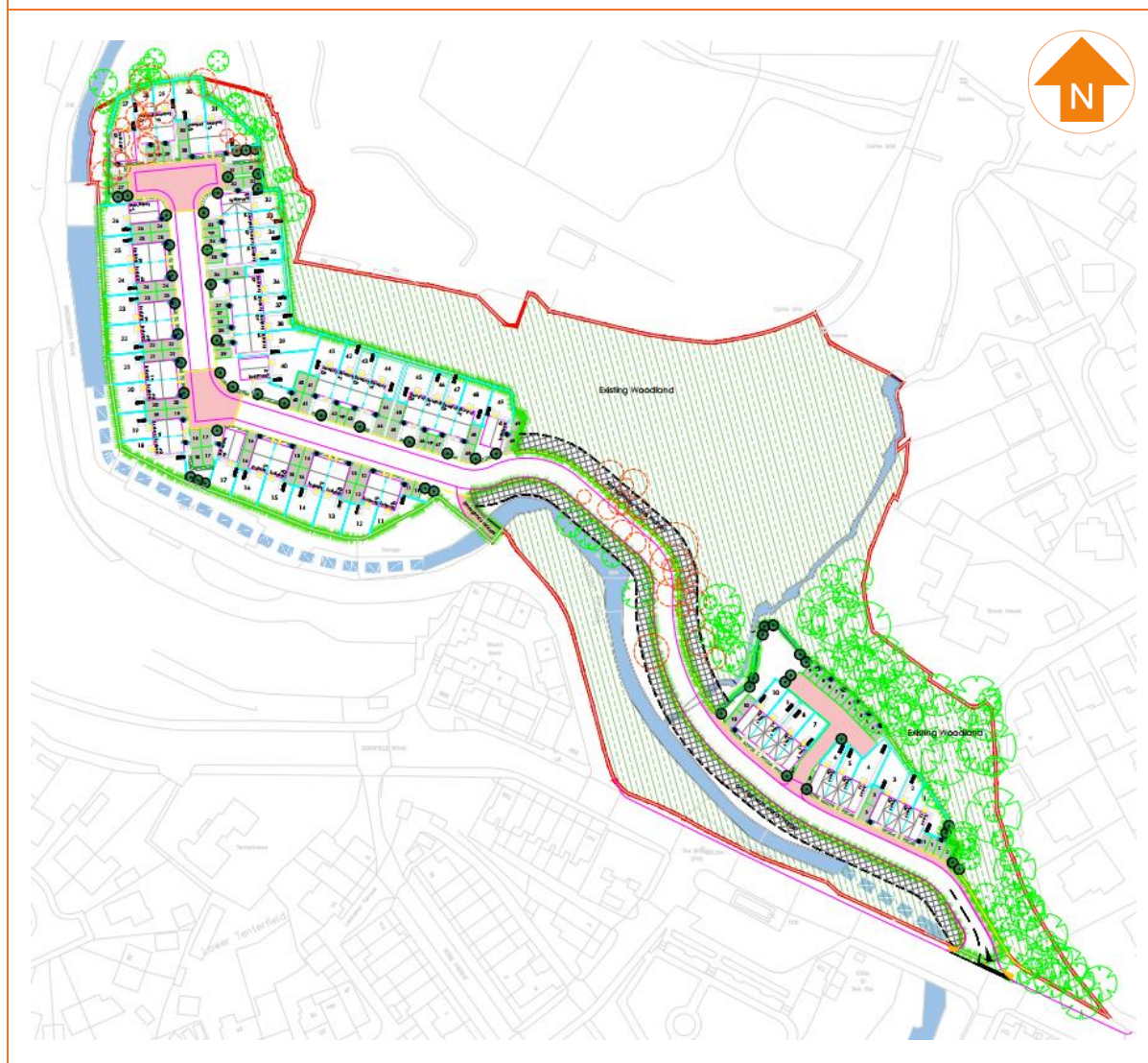
For the avoidance of any doubt, the E3P Geoenvironmental Site Investigation Report should be read both as a precursor to and in conjunction with this document.

1.5. REDEVELOPMENT PLAN

Stonebond Properties Ltd intends to construct a low-rise residential development comprising 49 residential dwellings with associated gardens, estate roads, infrastructure, and a connecting bridge. Drawing 16-465-002 (Appendix III) identifies the proposed development layout.

A snapshot of the proposed development layout is indicated in Figure 1.1.

FIGURE 1.1 SNAPSHOT OF PROPOSED DEVELOPMENT



1.6. SUMMARY OF PARTIES INVOLVED

Function/interest	Name of Party
Local Planning Authority	Rochdale Metropolitan Borough Council
Developer	Stonebond Properties Ltd
Geoenvironmental Consultant	E3P
Main Contractor	TBC
Remediation/Enabling Works Contractor	TBC
Human Health Regulator	Rochdale Metropolitan Borough Council
Controlled Waters and Waste Regulator	Environment Agency
Highways Adoption Authority	Rochdale Metropolitan Borough Council

1.7. REGULATORY CORRESPONDENCE

Stonebond Properties Ltd are in the process of submitting a detailed planning application to the local planning authority for the proposed redevelopment of the site for low-rise residential housing with associated adopted estate roads and infrastructure.

It is presumed that as part of the planning approval process, the planning authority will undertake consultation with the pertinent statutory consultees, which will include:

- ✿ Environmental health/contaminated land officer at the local authority (or external adviser);
- ✿ Environment Agency planning liaison; and
- ✿ The Coal Authority.

1.8. SITE DETAILS

Site Address	Land at Greenbooth Road and Edenfield Road, Norden, Rochdale, OL12 7TD
National Grid Reference	E 385812, N 414724
Site Area	2.62 Ha

All acronyms used within this report are defined in the glossary presented in Appendix II.

A site location plan is presented in Appendix III as Drawing 16-465-001.



1.9. SITE SUMMARY

TABLE 1.1 SITE DESCRIPTION AND SETTING

Occupancy/Use	The subject site is an irregularly shaped disused parcel of land located to the north of Greenbooth Road and Edenfield Road, Norden Rochdale. Hardstanding comprises over half the land cover, but the site can be split into two distinct areas: the former Tack Lea Works (Woodhouse Mills) area occupying the northern and central portions of the site and the former Shepherd Mill area in the east and south-eastern part of the site. The site is predominantly old industrial land with five structures present in the centre of the Tack Lea Works area. The structures comprised an old boiler house, a coal hopper, a vehicle spray workshop, a coal bunker, and a gas substation. Concrete and brick-lined structures, believed to be historical filter tanks and reservoirs are also present within an area of semi-mature woodland in the eastern section of the Tack Lea Works area. No structures were identified within the Shepherd Mill area. An earthen bund approximately 1 m in width and height is located to the immediate west of the old boiler house and bisects the Tack Lea Works area from northeast to southwest. Naden Brook enters from the northwest and generally flows in a south/southeast direction, adjacent to the site's western and southern boundary along Greenbooth Road. Woodhouse Lane Brook enters the site from the north and flows south separating the Tack Lea Works area and Shepherd Mill area before entering Naden Brook. The south of the site has been artificially raised and levelled where previous industrial mills were located	
Environmental Setting	Drift Geology	Till – Devensian (Diamicton)
	Bedrock Geology	Rough Rock - SANDSTONE.
	Hydrogeology	Secondary undifferentiated superficial aquifer with a Secondary A bedrock aquifer recorded. The site is not located within a groundwater source protection zone. No active groundwater abstraction points identified within a 1 km radius. The nearest active surface water abstraction point is located 498 m northwest of site (United Utilities) – located upstream of site.
	Hydrology	Woodhouse Lane Brook bisects the site in the centre and runs from north to south before entering Naden Brook. Naden Brook is located along the western and southern boundaries of the site. Naden Brook is classified by the EA as a Statutory Main River.



Environmental Setting (continued)	Hydrology (continued)	Anecdotal evidence indicates the presence of a culverted watercourse beneath the former mill building on the Tack Lea Works area, which arises from a spring beneath the former mill building and discharges into Naden Brook. A second spring and stone lined well is anticipated to be present in the basement area of the former dye house on the Tack Lea Works area. A second culverted watercourse is also anticipated to be present beneath the former mill building on the Shepherd Mill area, which discharges into Woodhouse Lane Brook. Due to the local topography, any shallow groundwater will likely flow in a south-easterly direction, following the topographical gradient towards Naden Brook and Woodhouse Lane Brook.
	Flood Risk	Predominantly located within a currently defined "Flood Risk Zone 1". However, sections of the western and southern boundaries of the site are located within "Flood Risk Zones 2 and 3" and as such are considered to be affected by river flooding. There is a high potential for surface water flooding to occur at the site, with the highest risk areas being located in the southern sections of the site. The site is at risk of flooding from reservoirs in the area (i.e., from Greenbooth Reservoir located approximately 430 m to the north). There is a low to the negligible potential for groundwater flooding to occur at the site.
	Subsidence Hazard	No hazard identified in data searches.
Site History	Earliest mapping (circa 1851) shows the site comprised industrial land with numerous buildings (Woodhouse Mill and Shepherd Mill) associated with bleaching, fulling, dyeing and finishing mills. Several reservoirs are present in the centre and east of the site, and a sandstone quarry is present in the northwest. Wooded areas are present in the centre and southeast of the site. From 1890, additional structures and reservoirs have been erected in the centre of the site along Naden Brook. The sandstone quarry is no longer present (replaced by woodland), and a pond is located in the northwest. Additional structures are also present to the northwest of Shepherd Mill. Wooded areas have also expanded to include the central and northern parts of the site. From 1910, additional structures and tanks are present in the northwest of the site (in the location of the former sandstone quarry). Filter tanks have also been developed in the northeast within an area of woodland in the centre along Naden Brook.	



Site History (continued)	From 1929, unnamed structures in the northwest and filter tanks in the northeast have expanded. The unnamed structure to the northwest of Shepherd Mill has been demolished and replaced with a larger structure. From 1961, unnamed structures in the northwest and south along Naden Brook have been expanded further. The pond in the northwest and a number of reservoirs in the centre are no longer present, with new structures erected over the presumed infilled reservoirs. From 1974, structures in the northwest have been expanded and several filter tanks are located in the centre within the wooded area. Filter tanks in the wooded area in the northeast and reservoirs in the east have been removed, with part of Shepherd Mill demolished. A tank is located to the southeast of Shepherd Mill. From 1990, structures in the northwest and Sheppard Mill in the southeast have been expanded. From 2003, Woodhouse Mill, Shepherd Mill, unnamed structures in the centre bordering Naden Brook and the tank southeast of Sheppard Mill are no longer present. From 2012 to the present, only five structures remain in the Tack Lea Works area. Extensive hardstanding is present across the north-western and south-eastern sections of the site and extensive vegetation/tree cover is present across the central and northern sections of the site.
Landfill Sites and Ground Gases	There is one licenced historical landfill located on-site in the eastern section of the Tack Lea Works area and west of Woodhouse Lane Brook within an area of semi-mature woodland. The landfill site was listed as formerly receiving inert and industrial wastes between 1987 and 1991. Several infilled ponds/reservoirs are located in the Tack Lea Works area in the north-western section and beneath the old boiler house and coal bunker. Two infilled reservoirs are located in the southern section of the Shepherd Mill Area. A historical sandstone quarry (presumed infilled) is located in the north-western section of the Tack Lea Works area. The site has also undergone extensive historical development and ground working. The Made Ground associated with these historical land uses together with recorded landfill may produce hazardous ground gases such as methane and carbon dioxide
Radon	A BGS Radon Report was purchased for the site, which indicated that the northeast and northwest of the site is situated in an area where 1–3% of homes are above the "Action Level" and the rest of the site is situated in an area where 0–1% of homes are above the "Action Level". Therefore, full radon protective measures are not necessary for the construction of new dwellings or extensions.

1.10. SUMMARY OF REPORTED GROUND CONDITIONS

E3P has prepared a detailed Site Investigation Report (Ref: 16-465-R2-3, dated August 2023). The summary of reported ground conditions is given in Table 1.2.



TABLE 1.2 SUMMARY OF GROUND CONDITIONS

Made Ground	Made Ground deposits were encountered within all exploratory hole locations to depths ranging between 0.00 m and 5.80 m bgl. However, in 23 locations in the Tack Lea Works area and 13 locations in the Sheppard Mill area, the full thickness of Made Ground could not be proven due to significant concrete and brick obstructions and basement features, which are indicative of relict foundations from the former buildings. The five hand pit locations within the eastern section of the Tack Lea Works area were all terminated within Made Ground. Obstructions identified during the ground investigation are shown on the Development Constraints Plan, presented as Drawing 16-465-015 in Appendix III. In all locations except WS101 and WS103 (central section of the Tack Lea Works area), concrete was encountered to a maximum proven depth of 0.68 m bgl (WS104). The concrete often contained rebar. In WS101 and WS103, dark brown clay with occasional rootlets (reworked topsoil) was encountered. In the majority of locations, the concrete was underlain by brown sandy gravel with gravels of sandstone, mudstone, limestone, concrete, and brick. In two locations in the Tack Lea Works area (TP118, and TP120) and one location in the Sheppard Mill area (TP121) a brown gravelly sand was encountered. In five locations in the Tack Lea Works area (WS101, WS102, WS103, WS107 and WSS14) and three locations in the Sheppard Mill area (WS119, WS122 and WS124) a brown gravelly clay was encountered underneath the sandy gravel. In one location within the Tack Lea Works area (TP113), a dark brown blackish slightly clayey slightly gravelly silt and a white sandy silt was encountered. Frequent fragments of ceramic, glass, wood, and metal were encountered within the Made Ground. Ash was also encountered in one location within the Tack Lea Works area (WS115) and one location in the Sheppard Mill area (WS123). Intact empty plastic bottles of fabric softener were also encountered in one location within the Tack Lea Works area (TP114). In the Tack Lea Works area, Made Ground deposits were generally encountered between 1.00 m and 2.00 m bgl, with shallower deposits (< 1.00 m bgl) located along the northern boundary (i.e. closer to the valley edge). Deeper Made Ground deposits, ranging between 2.00 m and 5.80 m bgl, were encountered in the northwest part of the site (associated with the infilled sandstone quarry), the central part of the site (associated with infilled reservoirs) and the eastern part of the site (associated with the filter tanks, reservoirs and historical landfill). In the Sheppard Mill area, Made Ground deposits were generally encountered between 2.00 m and 5.10 m bgl, with shallower deposits (< 1.00 m bgl) located along the northern boundary (i.e. closer to the valley edge). The deepest Made Ground deposits were encountered along the southern boundary associated with the former buildings and infilled reservoirs.
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Topsoil	No topsoil that would be deemed suitable for reuse has been identified within any of the exploratory hole locations.
Drift	Drift deposits were encountered within twenty-nine exploratory hole locations between depths of 0.50 m and 15.00 m bgl. Both granular and cohesive drift deposits were encountered, which generally comprised a loose to dense brown clayey to sandy GRAVEL overlying a brown gravelly CLAY with gravels of mudstone and sandstone. The strength of CLAY varied from soft to very stiff. Drift deposits were noted to be shallower (between 1.00 m and 2.50 m thick) along the northern parts of the Tack Lea Works area and Sheppard Mill area (i.e. closer to the valley edge). Deeper drift deposits (between 7.70 m and 11.00 m thick) were noted to be present along the western and southern boundaries of the Tack Lea Works area and the southern boundary of the Sheppard Mill area (i.e. towards the centre of the valley). In seven locations across the Tack Lea Works area (TP130, WS102, WS103, WS105, WS107, WS111 and WS114) and two locations within the Sheppard Mill area (WS119 and WS120), a loose to dense brown clayey GRAVEL was encountered with gravels of sandstone and mudstone. In four locations located across the Tack Lea Works area (WS114, TP130, CP101 and CP102) and two locations located across the Sheppard Mill area (WS120 and CP103), a loose to dense brown sandy GRAVEL was encountered. In two locations located along the northern and southern boundaries of the Tack Lea Works area (RB101 and RB103), and two locations located along the southern boundary of the Sheppard Mill Area (TB104 and RB105), a brown fine to medium SAND & GRAVEL was encountered. In TP103 (south-western boundary of the Tack Lea Works area), a brown gravelly SAND was encountered with gravels of sandstone and mudstone.
Bedrock	The solid bedrock geology was encountered within five exploratory hole locations. Shallow bedrock was encountered between 1.60 m and 2.90 m bgl along the northern part of the Tack Lea Works area (i.e. closer to the valley edge). Along the southern boundaries of the Tack Lea Works area and Sheppard Mill area (i.e. towards the centre of the valley), deep bedrock was encountered between 11.60 m and 13.80 m bgl. The bedrock generally comprised of a greyish brown SANDSTONE. Outcrops of bedrock were also noted to be present in the northwest part of the Tack Lea works area and along the northern boundaries of the Tack Lea Works area and Sheppard Mill area. In the Encia Consulting 2006 Report, shallow bedrock of sandstone was encountered in the central and western sections of the Tack Lea Works area at depths typically <2.00 m bgl. To the east of the former Tack Lea Mill Buildings and in the Sheppard Mill area, bedrock was found to be deeper and was encountered at depths ranging between 4.30 m and 5.00 m bgl. To the north of the Tack Lea Works area and Sheppard Mill area, bedrock can be seen outcropping in the valley and hillsides.



Groundwater	Perched groundwater was encountered during the ground investigation in one location in the Tack Lea Works area at 1.50 m bgl. Groundwater was encountered between 1.40–3.90 m bgl during the ground investigation, with deep groundwater encountered in one location within the Sheppard Mill area at 12.10 m bgl. During the monitoring, groundwater levels were recorded between 0.59 m and 4.89 m bgl.
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2. E3P CONTAMINATION RISK ASSESSMENT

2.1. BACKGROUND

E3P has completed a Tier 2 Qualitative Contaminated Land Risk Assessment to determine the potential risk to human health, controlled waters and the wider environ. This assessment is documented in full within the E3P Geoenvironmental Site Assessment report and, for clarity, is summarised in the following sections of this document.

2.2. HUMAN HEALTH RISK SUMMARY

The E3P Tier 2 Qualitative Human Health Risk Assessment identified concentrations of the following determinants at or above the screening criteria for the assessment of no unacceptable degree of risk to human health:

- ✳ **Arsenic** (WS110 at 0.50m bgl and TP113 0.90 m bgl).
- ✳ **Lead** (Bund01, WS101 at 0.80 m bgl, WS110 at 0.50 m bgl, TP113 at 0.90 m bgl, TP115 0.80 m bgl, TP116 1.20 m bgl, TP122 1.00 m bgl and TP126 0.90 m bgl).
- ✳ **Mercury** (WS111 0.60 m bgl).
- ✳ **Asbestos** (Chrysotile and Amosite) HP05 at 0.10 m bgl, TP114 at 1.00 bgl, TP116 at 1.20 m bgl, and WS124 at 3.40 m bgl).
- ✳ **Naphthalene** (WS117 at 3.20 m bgl, WS122 at 3.20 m bgl, TP122 at 1.00 m bgl, TP123 at 0.80 m bgl and TP126 at 0.90 m bgl).
- ✳ **Phenanthrene** (TP123 at 0.80 m bgl).
- ✳ **Benzo(a)anthracene** (WS117 at 3.20 m bgl, TP122 at 1.00 m bgl, TP123 at 0.80 m bgl and TP126 at 0.90 m bgl).
- ✳ **Chrysene** (TP122 at 1.00 m bgl and TP123 at 0.80 m bgl).
- ✳ **Benzo(b)fluoranthene** (WS117 at 3.20m bgl, TP115 at 0.80 m bgl, TP116 at 1.20 m bgl, TP122 at 1.00 m bgl, TP123 at 0.80 m bgl, and TP126 at 0.90 m bgl).
- ✳ **Benzo(a)pyrene** (Bund01, WS117 at 3.20 m bgl, TP115 at 0.80 m bgl, TP116 at 1.20 m bgl, TP122 at 1.00 m bgl, TP123 at 0.80 m bgl and TP126 at 0.90 m bgl).
- ✳ **Dibenzo(a,h)anthracene** (Bund01, WS117 at 3.20 m bgl, TP115 at 0.80 m bgl, TP116 at 1.20 m bgl, TP122 at 1.00 m bgl, TP123 at 0.80 m bgl and TP126 at 0.90 m bgl).
- ✳ **TPH C12 – C16 (aromatic)** (WS122 at 3.20 m bgl and TP122 at 1.00 m bgl).
- ✳ **TPH C16 – C21 (aromatic)** (WS122 at 3.20 m bgl, TP116 at 1.20 m bgl, and TP122 at 1.00 m bgl).



VOCs (including ethylbenzene, p & m-xylene, o-xylene, isopropylbenzene, n-propylbenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, sec-butylbenzene and p-isopropyltoluene) have been identified above the limit of detection within TP122 and WS122 in the Shepherd Mill area.

SVOCs (including aniline, phenol, 1,3-dichlorobenzene, 2-methylphenol, 4-methylphenol, 2,4 - dimethylphenol, 2-methylnaphthalene, dibenzofuran, carbazole, dibutyl phthalate and anthraquinone) have been identified above the limit of detection within the central section of the Tack Lea Works area (WS107 and TP116) and the Shepherd Mill area (WS117, WS122, WS124, TP122, TP123, TP124 and TP126).

PCB analysis on a sample taken from TP118 which is located in the vicinity of the former electricity substation in the Tack Lea Works area showed no exceedances.

Encia Consulting identified the following exceedances of the GAC within the subject site boundary:

- ✳ **Lead** (HP7 0.25 m bgl, WS5 0.70 m bgl, WS9 0.50 m bgl, WS10 0.40 m bgl, WS25 0.70 m bgl);
- ✳ **Mercury** (WS9 0.50 m bgl, WS25 0.70 m bgl);
- ✳ **Asbestos** (Amosite Fibres - WS18 D2 0.60-0.70 m bgl);
- ✳ **Naphthalene** (WS12 0.70 m bgl, WS19 0.90 m bgl, WS19 D6 3.70 m bgl, WS21 0.50 m bgl, WS22 0.70 m bgl, WS19 0.40 m bgl, WS19 0.80 m bgl, WS25 0.50 m bgl);
- ✳ **Non-volatile PAHs:** BH10 1.00 m bgl, WS10 0.40 m bgl, WS12 0.70 m bgl, WS17A D1, WS12 0.80 m bgl, WS19 0.90 m bgl, WS20 D1 0.60 m bgl, WS22 0.70 m bgl, WS19 0.40 m bgl, WS24 A 0.30 m bgl);
- ✳ **TPH C16-C21 Aromatic** (BH10 1.00 m bgl, WS19 0.40 m bgl);
- ✳ **TPH C21-C35 Aromatic** (WS19 0.40 m bgl);
- ✳ **Trichloroethene (TCE)** (WS12 0.80 m bgl); and
- ✳ **1,2,4-Trimethylbenzene** (WS19 0.40 m bgl).

Elevated trichloroethene (TCE) was recorded in WS12 at 0.80 m bgl. Tetrachloroethene (PCE) was recorded above the limit of detection, however the concentration does not exceed the residential GAC.

Elevated 1,2,4-Trimethylbenzene was recorded in WS19 at 0.40 m bgl. Additional VOCs including benzene, toluene, ethylbenzene, m/p-xylene, styrene, o-xylene, isopropylbenzene, propylbenzene, 1,2,4 trimethylbenzene, 4-isopropyltoluene, 1,3,5 trimethylbenzene, sec-butylbenzene, n-butylbenzene were recorded above the limit of detection in WS19 at 0.40 m bgl, WS19 0.80 m bgl and WS25 0.50 m bgl.

SVOCs including 2-methylnaphthalene, carbazole and dibenzofuran were recorded in WS19 at 0.40 m bgl, WS19 at 0.80 m bgl and WS25 at 0.50 m bgl.

Potential visible asbestos was noted in WS10 as likely chrysotile cement.

Contamination Issues Plans for heavy metals, asbestos, non-volatile PAHs, Naphthalene, TPHs, VOCs and SVOCs in soils are presented as Drawings 16-465-027 to 16-465-033 in Appendix III.



HUMAN HEALTH RISK ASSESSMENT AND MITIGATION

The majority of the identified elevated concentrations have primary exposure pathways related to dermal contact and ingestion of soils, inhalation of particulate and consumption of homegrown vegetables; with naphthalene, petroleum hydrocarbons, VOCs and SVOCs having a primary exposure pathway related to volatilisation to indoor air risk.

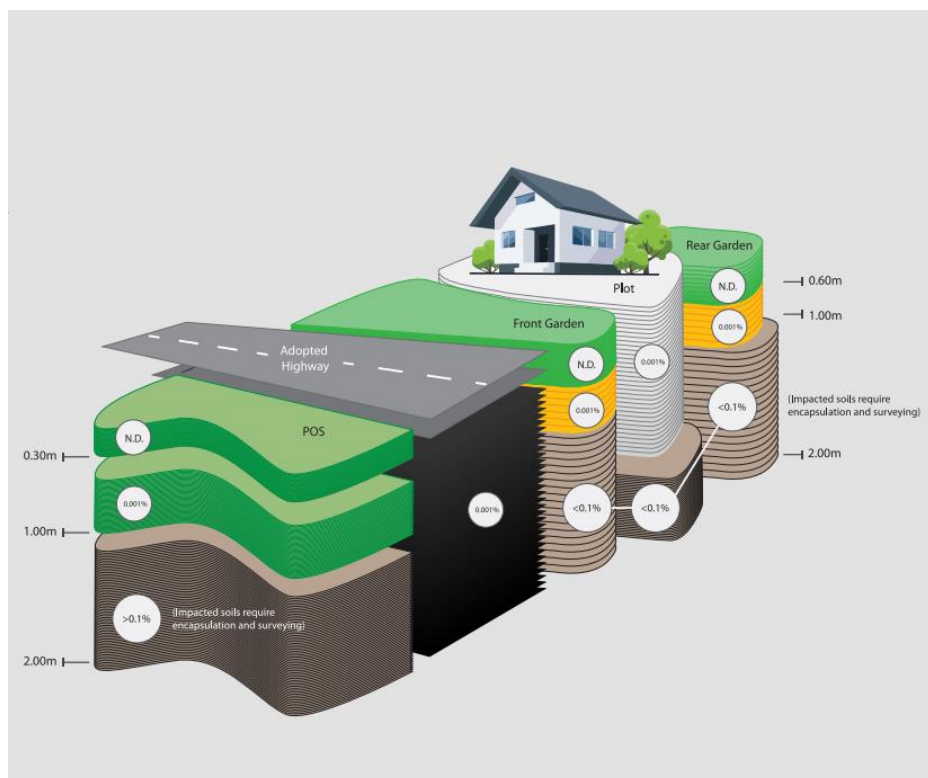
The risk to chronic human health associated with the elevated concentrations of inorganic heavy metals and non-volatile PAH compounds can be mitigated through the installation of a suitable cover system in all proposed private rear gardens, front gardens, areas of soft landscaping and public open space to remove any potential for direct exposure to impacted soils.

Asbestos in the form of chrysotile and amosite has been identified within localised areas in Made Ground deposits in the southern part of Sheppard Mill area (WS124 and WS18), the historical landfill in the eastern section of Tack Lea Works area (HP05) and the central section of Tack Lea Works (TP114 and TP116).

Asbestos bulk fragments, in the form of hard cement were also identified in WS124, HP05 and WS10; and asbestos sheeting/board debris within HP05. Visual signs of ACM were encountered during the ground investigations in HP05.

Impacted soils should be managed according to the asbestos risk mitigation conceptual site model shown in Figure 2.1.

FIGURE 2.1 ASBESTOS CONCEPTUAL SITE MODEL



It is noted that the presence of asbestos sheeting and boarding will require a different remedial approach to those proposed within Figure 4.8 (i.e., hand picking of visible bulk asbestos fragments). Where asbestos sheeting and boarding has previously been identified, any proposed earthworks within those areas may be required to be undertaken under license. In addition, any off-site disposal of materials from these areas would be considered hazardous unless the asbestos bulk fragments are pre-removed via hand picking techniques.

Elevated concentrations of mercury have been identified within two locations within the Tack Lea Works area (WS111 at 0.60 m bgl and WS9 at 0.50 m bgl); and one location within the Sheppard Mill area (WS25 at 0.70 m bgl). Mercury occurs in three different forms; elemental mercury, inorganic mercury and methyl mercury. Inorganic and methyl mercury have an exposure pathway of dermal contact and ingestion, whereas elemental mercury could present a potential volatilisation to indoor air risk.

During remediation and enabling works, speciated mercury analysis should be completed at the locations WS111, WS9 and WS25 to assess whether elemental mercury is present which may pose a risk to future site users through vapour inhalation. If elemental mercury is identified, it may be necessary to delineate and excavate the soils as a hotspot and place them in an area of low sensitivity such as beneath areas of public open space or removed from site. Alternatively, if it is proven that there is no elemental mercury, a clean cover system will be sufficient.

The elevated concentrations of naphthalene, TPH, and trichloroethene (TCE) identified within the Tack Lea Works area (TP116 and WS12) are considered to be localised occurrences and therefore these locations can be treated as localised hotspots. During a process of cut/fill enabling works, a hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on-site in an area of no future sensitivity.

However, elevated concentrations of naphthalene, TPH, VOCs and SVOCs have been identified throughout the Shepherd Mill area and these do not appear to be localised hotspots. A Tier 3 vapour risk assessment is required in the Sheppard Mill area to assess the level of risk to the future site users by volatilisation to indoor air.

The SVOCs identified in WS107 and TP116 within the Tack Lea Works area are not considered to pose a risk to future site users given the marginal concentrations.

Furthermore, with regards to the elevated volatile contaminants (naphthalene, TPH, VOCs and SVOCs) identified in the Tack Lea Works area and the Sheppard Mill area, vapour resistant membranes may be required to be installed during the build phase for any proposed buildings situated within the immediate vicinity of the contamination hotspot / impacted soils. A Detailed Quantitative Risk Assessment (DQRA) may also be required to determine if any risks to human health and controlled water receptors remains following the hotspot removal.

Chemical analysis of the natural subsoil deposits has indicated these soils to be acceptable for use within the proposed garden areas; however, further chemical validation samples will be required to confirm this.

No suitable source of natural topsoil deposits has been identified on-site.

All proposed rear garden areas within the development are to be installed with a 600 mm chemically suitable cover system underlain by a geotextile membrane, which will ensure that future site users will be at no unacceptable risk from the identified contaminant exceedances. A 300 mm clean cover system will be required within front gardens, areas of soft landscaping and POS.

It is concluded that the site will be suitable for the proposed residential end use subject to the completion of the supplementary assessments and the following build-phase mitigation items:

- 🔧 Completion of a Tier 3 vapour risk assessment for volatile compounds;



- ✳ Management of soils to ensure that all materials impacted by asbestos fibres are placed in areas of low sensitivity during the site enabling works;
- ✳ Use of potable water supply infrastructure that will be compliant with United Kingdom Water Infrastructure Risk (UKWIR) assessment criteria;
- ✳ Construction of all dwellings with ground gas mitigation measures that conform to CS2/Amber 1 requirements of BS 8485;
- ✳ Provisional allowance for the construction of VOC resistant membranes;
- ✳ Construction of a 600 mm clean cover system underlain by a geotextile membrane to rear gardens in accordance with the detailed methodologies herein;
- ✳ Construction of a 300 mm clean cover system within front gardens deemed to be functional landscaping in accordance with the detailed methodologies herein; and
- ✳ Construction of a 300 mm clean cover system to all areas of soft landscaping and POS in accordance with the detailed methodologies herein.



2.3. CONTROLLED WATERS CONTAMINATION RISK SUMMARY

A Tier 2 Controlled Water Risk Assessment was completed by E3P as part of the E3P Geoenvironmental Site Assessment, the findings of which are summarised as follows:

The Tier 2 Controlled Waters Risk Assessment identified exceedances of the EQS for the following compounds:

- ✳ **Cadmium** (Surface Water – Naden Brook U);
- ✳ **Chromium (VI)** (Leachate – TP108 at 0.70 m);
- ✳ **Chromium (III)** (Leachate – TP108 at 0.70 m);
- ✳ **Copper** (Leachate – TP108 at 0.70 m, TP115 at 0.80 m, TP126 at 0.90 m, RB105 at 11.60 m, ; Groundwater - CP101, CP103, RB101, RB102, RB103, RB105, Surface Water - Woodhouse Lane U + D and Naden Brook U, M and D, Spring);
- ✳ **Cyanide** (Leachate – TP115 at 0.80 m, RB105 at 11.60 m);
- ✳ **Lead** (Leachate – TP115 at 0.80 m and TP126 at 0.90 m);
- ✳ **Nickel** (Groundwater - RB102, Surface Water – Naden Brook U)
- ✳ **Zinc** (Leachate – TP126 at 0.90 m; Surface Water - Woodhouse Lane U, Naden Brook D Groundwater – RB105);
- ✳ **pH** (Leachate – TP108 at 0.70 m and TP115 at 0.80 m);
- ✳ **Anthracene** (Surface Water - Woodhouse Lane D);
- ✳ **Benzo(b)fluoranthene** (Surface Water - Woodhouse Lane D);
- ✳ **Benzo(k)fluoranthene** (Surface Water - Woodhouse Lane D);
- ✳ **Benzo(a)pyrene** (Surface Water - Woodhouse Lane D);
- ✳ **Fluoranthene** (Groundwater - CP103; Surface Water - Woodhouse Lane D); and
- ✳ **TPH C10-C12 Aromatic** (Leachate – RB105 at 11.60 m).

Encia Consulting identified the following exceedances of the EQS within the subject site boundary:

- ✳ **Chromium (III)** (Leachate – BH2 at 0.50 m, WS8 at 0.40 m, WS9 at 0.50 m and WS11 at 0.60 m; Groundwater – BH10, BH12, WS4, WS5, WS12 and WS19; Surface Water – W1, W3, W4 and W5);
- ✳ **Copper** (Leachate – BH2 at 0.50 m, HP1 at 0.50 m, WS6 at 1.00 m, WS8 at 0.40 m, WS9 at 0.50 m, WS11 at 0.60 m, WS12 at 0.70 m, WS17A at 4.80 m, WS19 at 0.90 m, WS20 at 0.60 m, WS21 at 0.50 m and WS25 at 0.70 m; Groundwater – BH10 and WS12; Surface Water – W1, W3, W4);
- ✳ **Lead** (Leachate – HP1 at 0.50 m, WS4 at 0.50 m, WS6 at 1.00 m, WS11 at 0.60 m, WS19 at 0.90 m, WS20 at 0.60 m and WS25 at 0.70 m);
- ✳ **Nickel** (Leachate – WS21 at 0.50 m);



- ✳ **Zinc** (Leachate – BH2 at 0.50 m, HP1 at 0.50m, WS4 at 0.50 m, WS8 at 0.40 m, WS9 at 0.50 m, WS11 at 0.60 m, WS12 at 0.70 m, WS19 at 0.90 m and WS20 at 0.60m; Groundwater – BH10, BH12, WS4, WS5, WS12 and WS19; Surface Water – W1, W3, W4 and W5);
- ✳ **Naphthalene** (Leachate – WS21 at 0.50 m; Groundwater – WS19);
- ✳ **Anthracene** (Leachate – WS19 at 0.90 m, WS21 at 0.50m and WS25 at 0.70 m; Groundwater – BH12 and WS19);
- ✳ **Benzo(b)fluoranthene** (Leachate – WS21 at 0.50 m; Groundwater – BH12, WS4 and WS12; Surface Water – W4);
- ✳ **Benzo(k)fluoranthene** (Leachate – WS21 at 0.50 m; Groundwater – BH12, WS4 and WS12; Surface Water – W4);
- ✳ **Benzo(a)pyrene** (Leachate – WS21 at 0.50 m; Groundwater – BH12, WS4 and WS12; Surface Water – W4);
- ✳ **Indeno(123cd)pyrene** (Leachate – WS21 at 0.50 m; Groundwater – BH12, WS4 and WS12; Surface Water – W4);
- ✳ **Fluoranthene** (Leachate – WS4 at 0.50 m, WS8 at 0.40 m, WS9 at 0.50 m, WS12 at 0.70 m, WS17A at 4.80 m, WS19 at 0.90 m, WS20 at 0.60 m, WS21 at 0.50 m and WS25 at 0.70 m; Groundwater – BH10, BH12, WS4, WS12 and WS19; Surface Water – W4);
- ✳ **m&p-xylene** (Groundwater – WS19);
- ✳ **o-xylene** (Groundwater – BH12 and WS19);
- ✳ **TPH Aromatics C8-C10, C10-C12, C12-C16, C16-C21 and C21-C35** (Groundwater – BH12 and WS19);
- ✳ **TPH Aliphatic C8-C10** (Groundwater – BH12) (*Screened against DWS in absence of EQS value*);
- ✳ **TPH Aliphatic C10-C12** (Groundwater – BH12 and WS19) (*Screened against DWS in absence of EQS value*); and,
- ✳ **TPH Aliphatic C12-C16** (Groundwater – BH12) (*Screened against DWS in absence of EQS value*).

Note – Leachate sample WS21 underwent 25 times dilution and Water sample WS19 underwent 200 times dilution for PAH analysis.

No significant concentrations of VOCs or SVOCs were identified within samples submitted for analysis.

PFAS/PFOS testing on groundwater and surface water samples had no detections above the laboratory LOD.

Conclusions & Recommendations

Though the risk to the underlying bedrock Secondary A aquifer is considered to be low, the risk to the surface water receptors is considered to be high, due to the presence of impacted soils within close proximity of surface water features, and the presence of high permeability strata in areas beneath the site which would afford the lateral and vertical migration of contaminants.

The groundwater flow plan (Drawing 16-465-040, Appendix III) suggests that groundwater is flowing towards the central sector of the site from the north and southeast.



Widespread naphthalene and TPH contamination has been identified in the soil analysis, with the majority of the impact noted within the Sheppard Mill area of the site. Thus, the source of the contaminants cannot be attributed to one area or point source and the majority of the contamination is considered present on a site wide basis.

During the remediation and enabling works phase, the removal of the hardstanding currently present across the site may induce infiltration and potential mobilisation of contaminants present within the soils and groundwater directly into the surface water receptors. However, the areas of low permeability clay soils will act to inhibit migration.

The supplementary controlled waters risk assessment completed by E3P has not identified any significant impact within the groundwater or surface water samples. The data suggests that there is no complete pollutant linkage and the identified contamination within the soils is not likely to be mobile.

It will be necessary to instigate a watching brief during Remediation and Enabling Works to ensure that it can be demonstrated that all material that remains in-situ is suitable for retention.

Surface water sampling is also recommended throughout the Remediation and Enabling Works to ensure that the water quality of the surface water features is not altered.

2.4. GROUND GAS

Ground gas has been assessed by E3P as part of the E3P Geoenvironmental Site Assessment. The assessment was completed in accordance with the methodology outlined with the CIRIA publication C665, utilising the results of the ground gas monitoring surveys to calculate a tentative gas screening value (GSV). The determined Characteristic Situation for each standpipe for each visit is presented in Table 2.1.

TABLE 2.1 GAS RISK PROFILE AND LOCATION

WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH ₄ (%V/V)	MAX CH ₄ Q _{hg} (l/hr)	MAX CO ₂ (%V/V)	MAX CO ₂ Q _{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
WS101	29/11/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	2.80	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	2.77	0.1	0.1	0.0001	0.2	0.0002	CS1	Green
	06/02/2023	2.78	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/02/2023	2.79	0.1	0.1	0.0001	0.2	0.0002	CS1	Green
	06/03/2023	2.78	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	2.76	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS105	29/11/2022	1.70	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	1.88	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	1.79	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	1.22	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	1.05	0.1	0.1	0.0001	0.7	0.0007	CS1	Green
	06/02/2023	1.07	0.1	0.1	0.0001	0.7	0.0007	CS1	Green
	22/02/2023	1.05	0.1	0.1	0.0001	0.6	0.0006	CS1	Green
	06/03/2023	1.08	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	1.03	0.1	0.1	0.0001	0.1	0.0001	CS1	Green



WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH ₄ (%V/V)	MAX CH ₄ Q _{hg} (l/hr)	MAX CO ₂ (%V/V)	MAX CO ₂ Q _{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
WS107	29/11/2022	1.30	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	1.40	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	1.35	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	1.11	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	1.32	0.1	0.1	0.0001	0.2	0.0002	CS1	Green
	06/02/2023	1.29	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/02/2023	1.34	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	06/03/2023	1.26	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	1.30	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS108	29/11/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	06/02/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/02/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	06/03/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS111	29/11/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	1.62	0.1	0.1	0.0001	0.4	0.0004	CS1	Green
	06/02/2023	1.15	0.1	0.1	0.0001	0.2	0.0002	CS1	Green
	22/02/2023	1.20	0.1	0.1	0.0001	0.1	0.0003	CS1	Green
	06/03/2023	1.18	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	1.09	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS114	29/11/2022	DRY	2.6	0.1	0.0001	0.1	0.0026	CS1	Green
	12/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	DRY	0.1	0.1	0.0001	0.2	0.0002	CS1	Green
	06/02/2023	2.60	0.1	0.1	0.0001	0.3	0.0003	CS1	Green
	22/02/2023	2.57	0.1	0.1	0.0001	0.4	0.0004	CS1	Green
	06/03/2023	2.60	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	2.61	0.1	0.1	0.0001	0.1	0.0001	CS1	Green



WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH ₄ (%V/V)	MAX CH ₄ Q _{hg} (l/hr)	MAX CO ₂ (%V/V)	MAX CO ₂ Q _{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
WS115	29/11/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	06/02/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/02/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	06/03/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS117	29/11/2022	2.35	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	2.48	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	2.38	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	2.54	0.1	0.1	0.0001	0.9	0.0009	CS1	Green
	06/02/2023	2.14	0.1	0.1	0.0001	1.2	0.0012	CS1	Green
	22/02/2023	2.18	0.1	0.1	0.0001	1.4	0.0014	CS1	Green
	06/03/2023	2.23	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	1.88	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS122	29/11/2022	2.80	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	2.90	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	2.86	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	2.35	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	2.09	0.1	0.1	0.0001	0.7	0.0007	CS1	Green
	06/02/2023	2.14	0.1	0.1	0.0001	0.8	0.0008	CS1	Green
	22/02/2023	2.03	0.1	0.1	0.0001	0.7	0.0007	CS1	Green
	06/03/2023	2.01	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	1.63	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
WS123	29/11/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	DRY	0.1	0.1	0.0001	1.5	0.0015	CS1	Green
	30/12/2022	DRY	0.1	0.1	0.0001	1.2	0.0012	CS1	Green
	20/01/2023	DRY	0.1	0.1	0.0001	0.6	0.0006	CS1	Green
	06/02/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/02/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	06/03/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	DRY	0.1	0.1	0.0001	0.1	0.0001	CS1	Green



WELL	DATE	DEPTH TO WATER (m bgl)	MAX FLOW (l/hr)	MAX CH ₄ (%V/V)	MAX CH ₄ Q _{hg} (l/hr)	MAX CO ₂ (%V/V)	MAX CO ₂ Q _{hg} (l/hr)	CHARACTERISTIC SITUATION	NHBC TRAFFIC LIGHT
CP101	29/11/2022	1.65	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	12/12/2022	1.80	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	22/12/2022	1.63	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	30/12/2022	2.12	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/01/2023	1.16	0.1	0.1	0.0001	0.8	0.0008	CS1	Green
	06/02/2023	1.32	0.1	0.1	0.0001	0.7	0.0007	CS1	Green
	22/02/2023	1.16	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	06/03/2023	1.18	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
	20/03/2023	1.11	0.1	0.1	0.0001	0.1	0.0001	CS1	Green
CP103	29/11/2022	2.00	0.1	0.1	0.0003	0.1	0.0003	Flooded	
	12/12/2022	2.20	0.1	0.1	0.0000	0.1	0.0001	Flooded	
	22/12/2022	2.15	0.1	0.1	0.0000	0.1	0.0001	Flooded	
	30/12/2022	1.87	0.1	0.1	0.0001	0.1	0.0001	Flooded	
	20/01/2023	2.20	0.1	0.1	0.0001	0.9	0.0009	Flooded	
	06/02/2023	2.15	0.1	0.1	0.0001	0.9	0.0009	Flooded	
	22/02/2023	2.21	0.1	0.1	0.0001	0.1	0.0001	Flooded	
	06/03/2023	2.16	0.1	0.1	0.0001	0.1	0.0001	Flooded	
	20/03/2023	2.57	0.1	0.1	0.0001	0.1	0.0001	Flooded	

E3P have assessed the previous variables and come to the following conclusions:

- ⚙ Throughout the monitoring period, flow rates were recorded to be 0.1 l/hr (limit of detection of the analyser).
- ⚙ The maximum methane value recorded within the monitoring wells was 0.1% v/v (limit of detection of the analyser).
- ⚙ Carbon dioxide concentrations were recorded at concentrations ranging from 0.1% v/v to 1.5% v/v (WS123).
- ⚙ Made Ground has been encountered across the site to a maximum proven depth of 5.80 m bgl.
- ⚙ Drift deposits comprising glacial till of SAND and CLAY have been encountered across the site at depths ranging between 0.50 – 15.00 m bgl.
- ⚙ Ground gas monitoring suggests that the site can be predominantly classified as CS1. However, given the presence of the historical landfill located in the eastern section of the Tack Lea Works area, it is recommended that CS2 protection measures should be implemented as a minimum across the site until such time that further assessment can be completed once full access to the historical landfill is available.

Elevated concentrations of naphthalene, VOCs and SVOCs within the northern sector of the site are considered to be localised occurrences and therefore these locations can be treated as hotspots. However, elevated concentrations of naphthalene, TPH, VOCs and SVOCs have been identified throughout the Shepherd Mill area of the site (southern sector) and these do not appear to be localised hotspots.



Further assessment, in the form of a Tier 3 vapour risk assessment is required across the site to assess the level of risk to the future site users by volatilisation to indoor air. Subject to the findings of the vapour risk assessment, vapour resistant membranes may be required.

It is recommended that the full ground gas assessment and recommended protection measures (if applicable) are agreed with the local authority prior to their adoption on site. Furthermore, all protection measures adopted should be validated by a suitably qualified engineer.

2.5. POTABLE WATER SUPPLY INFRASTRUCTURE

A contaminant risk assessment completed in accordance with the UKWIR assessment framework identified elevated concentrations of potentially volatile/soluble hydrocarbon compounds and it will be necessary to delineate the impacted soils where present at locations that could potentially impact the potable water infrastructure should be suitable to remediation with robust validation testing.

If unacceptable concentrations remain post-remediation, then potable water infrastructure should be constructed in accordance with a suitably robust risk assessment and design compliant with UKWIR.



3. SITE REMEDIATION AND ENABLING WORKS

3.1. REMEDIATION OPTIONS APPRAISAL

A remediation options appraisal has been completed in accordance with the principals as set out within Environment Agency publication Land Contamination: Risk Management (LC:RM)(updated July 2023).

The LC:RM requires that the following tiered assessments are followed to ensure sufficiently detailed and robust appraisal of remediation options to inform the selection of the preferred approach and utilisation of the correct technologies to promote safe and sustainable land remediation:

- ✿ Identification of feasible remediation technologies;
- ✿ Detailed evaluation of viable options; and,
- ✿ Selection of appropriate remediation option.

3.2. DETERMINATION OF SUFFICIENCY OF INFORMATION

Prior to the commencement of the tiered assessment of remediation options, it is a requirement to assess the sufficiency of available information and validity of the risk-based assessment on which the remediation options appraisal is based.

Based on the works completed to date, it is considered that there has been sufficient investigation to provide a robust data set in which the site can be designed and in regards to potential contaminative sources in order to produce a site wide conceptual site model with the exception of the identified areas that were previously inaccessible. Furthermore, intrusive works were at a high frequency in the vicinity of the proposed development area.

Following clearance of vegetation and the demolition of existing buildings, a supplementary phase of site investigation will be completed to confirm the ground conditions in this area and any areas of possible contamination which may be a risk to the development or future end users as agreed with the LPA. Any future works completed are anticipated to solely be for confirmatory purposes. In the event that further risks are presented, a remedial methodology will be appraised and presented to the LPA.

3.3. REQUIREMENT FOR REGULATORY CONTROL

The LC:RM requires that due consideration be given to the following key issues which will impact the appropriate selection of suitable remediation options.

- ✿ Requirement for regulatory permits;
- ✿ Noise restrictions; and
- ✿ Weather conditions.

The proposed remediation works will require a detailed framework in terms of the Environmental Permit that will be used to recover the waste materials from within a registered landfill to enable the remediation process to ensure that 'end of life' waste status has been achieved.

Due to the complexity of the Environmental Permit Process, this will be addressed as a standalone report that advises on the appropriate use of permits and their correct application for the recovery and re-use of waste in this specific instance. A specific waste management strategy will be developed in collaboration with the specialist contractor.



Outside of the landfill areas, the works are relatively more straight forward and while they may still be covered by a specific Environmental Permit, it is considered that the processes as outlined below will be applicable to the project.

The processing of recycled aggregates will be completed using LAPC Part B licensed plant with the appropriate deployment notification to the local authority prior to commencement of works. All materials that are recovered as recycled aggregate will be compliant with the requirements of the WRAP protocol and the E3P validation testing requirements and as such would not be deemed to be a waste material.

Operations as outlined within the remediation enabling works rationale summarised in this report may be subject to regulation using the appropriate environmental permit, standard rules exemption and materials management plan, to be created in accordance with version 2 of the CL:AIRE Definition of Waste: Code of Practice (DoW CoP). It is considered the remediation and enabling works can be completed by using a CL:AIRE materials management plan.

It is noted that if material is to be imported utilising the CL:AIRE DoW CoP from an alternative development site, then only chemically certified, clean, naturally occurring material can be transferred.

The MMP will be created with due consideration of all proposed remediation and enabling works operations prescribed within this document and will be undertaken by a qualified person with a signed declaration submitted to the EA prior to reuse of materials on the site.

The importation of material for use within the proposed construction of a development platform will be subject to the compliance with the E3P protocol for the importation of materials as set out within the specification for material import included within Appendix V of this report.

It is considered that a suitable environmental permit can be obtained for the recovery, processing and re-use of material that is no longer considered to be a waste and therefore this is not a limiting factor in the selection of the remediation option.

Noise Restrictions

Numerous sensitive receptors are identified in the form of residential dwellings to the periphery of the area that will be subject to remediation works.

Weather Conditions

Given the size and scale and variable remediation works required, it will be possible to ensure that the programme allows for a differentiation in operations to ensure works can proceed in areas depending on the prevailing weather for a specific period of time.

3.4. CONTAMINANTS OF CONCERN (COC)

3.4.1. METALS, PAH, NON-VOLATILE HYDROCARBON (PETROLEUM RANGE) COMPOUNDS

The human health risk drivers for the carcinogenic PAHs and metal CoC are:

-  Direct contact with the soil source by future on-site residents; and
-  Ingestion of impacted soils by future on-site residents.



Therefore, a cover system is considered to be an appropriate remediation technique to address these impacts, as the installation of a cover system to unsurfaced areas of the site will sever the pathway of contact for human health receptors. A cover system is not considered to be required in future hardstanding areas or beneath buildings, as it can reasonably be assumed that the presence of a hardstanding will prevent direct contact.

3.4.2. ASBESTOS

Asbestos in the form of chrysotile hard/cement was identified within the Made Ground in WS124 at 3.40 m bgl (south of Sheppard Mill area) and HP05 at 0.10 m bgl (historical landfill in the eastern section of Tack Lea Works area). Asbestos in the form of chrysotile sheeting/board debris and loose fibrous debris was also identified in HP05 at 0.10 m bgl. Chrysotile and Amosite loose fibres were identified in TP114 at 1.00 m bgl and TP116 at 1.20 m bgl (central section of Tack Lea Works area).

Quantification testing was undertaken with the highest concentration recorded in WS124 at 0.705%. The remaining samples had concentrations of 0.002% (TP116), 0.011% (TP114) and 0.036% (HP05).

Visual signs of ACM were encountered during the ground investigation in HP05.

Encia Consulting identified amosite in WS18 D2 at 0.60 – 0.70 m bgl. Potential visible asbestos was noted in WS10 as likely chrysotile cement.

It should be assumed that asbestos fibres are present throughout the Made Ground on-site. The risk to chronic human health associated with the elevated concentrations of loose chrysotile and fibres (<0.001%) can be mitigated through the installation of a suitable cover system in all proposed landscaping and hardstanding to remove any potential for direct exposure to impacted soils.

Where asbestos is identified at concentrations above <0.001%, a hotspot excavation will be required, and the impacted Made Ground will require placement >1.00m beneath an area of low sensitivity such as public open space in accordance with the E3P conceptual site model (Figure 2.1).

If any visible pieces of asbestos-containing material are identified during the site remediation and enabling work, this material must be dealt with in strict accordance with the Control of Asbestos Regulations (CAR) 2012, UK Waste Management Legislation and the Environmental Protection Act 1994. Asbestos in air monitoring in accordance with HSG248 may be required to confirm that no asbestos fibres have been generated from the enabling works activities.

Should off-site disposal be required, then additional asbestos quantification and waste classification testing should be undertaken to ensure that it is classified correctly and disposed at a suitably licensed facility.

3.4.3. NAPHTHALENE

Table 3.1 displays the locations where naphthalene exceeds the GAC and the relevant zone the exploratory hole is located in.



TABLE 3.1 SUMMARY OF NAPHTHALENE EXCEEDANCES

ZONE	LOCATION
Shepherd Mill Area	WS117 3.20 m bgl
	WS122 3.20 m bgl
	TP122 1.00 m bgl
	TP123 0.80 m bgl
	TP126 0.90 m bgl
	WS19 0.40 m, 0.80 m, 0.90 m, 3.70 m bgl
	WS21 0.50 m bgl
	WS22 0.70 m bgl
	WS25 0.50 m bgl
Tack Lea Works	WS12 0.70 m bgl

3.4.4. TPH C12-C21 (AROMATIC)

Table 3.2 displays the locations where aromatic TPH C12-C21 exceeds the GAC and the relevant zone the exploratory hole is located in.

TABLE 3.2 SUMMARY OF TPH C12-C21 AROMATIC EXCEEDANCES

ZONE	LOCATION
Shepherd Mill Area	WS122 3.20 m bgl
	TP122 1.00 m bgl
	BH10 1.00 m bgl
	WS19 0.40 m bgl
Tack Lea Works	TP116 1.20 m bgl

3.4.5. MERCURY

Elevated concentrations of mercury have been identified within two locations within the Tack Lea Works area (WS111 at 0.60 m bgl and WS9 at 0.50 m bgl); and one location within the Sheppard Mill area (WS25 at 0.70 m bgl). Mercury occurs in three different forms; elemental mercury, inorganic mercury and methyl mercury. Inorganic and methyl mercury have an exposure pathway of dermal contact and ingestion, whereas elemental mercury could present a potential volatilisation to indoor air risk.

3.4.6. SVOC AND VOC

VOCs (including ethylbenzene, p & m-xylene, o-xylene, isopropylbenzene, n-propylbenzene, 1,3,5-trimethylbenzene, 1,2,4-trimethylbenzene, sec-butylbenzene and p-isopropyltoluene) have been identified above the limit of detection within TP122 and WS122 in the Shepherd Mill area.

SVOCs (including aniline, phenol, 1,3-dichlorobenzene, 2-methylphenol, 4-methylphenol, 2,4 - dimethylphenol, 2-methylnaphthalene, dibenzofuran, carbazole, dibutyl phthalate and anthraquinone) have been identified above the limit of detection within the central section of the Tack Lea Works area (WS107 and TP116) and the Shepherd Mill area (WS117, WS122, WS124, TP122, TP123, TP124 and TP126).

Elevated trichloroethene (TCE) was recorded in Encia Consulting WS12 at 0.80 m bgl. Tetrachloroethene (PCE) was recorded above the limit of detection, however the concentration does not exceed the residential GAC.

Elevated 1,2,4-Trimethylbenzene was recorded in WS19 at 0.40 m bgl. Additional VOCs including benzene, toluene, ethylbenzene, m/p-xylene, styrene, o-xylene, isopropylbenzene, propylbenzene, 1,2,4 trimethylbenzene, 4-isopropyltoluene, 1,3,5 trimethylbenzene, sec-butylbenzene, n-butylbenzene were recorded above the limit of detection in WS19 at 0.40 m bgl, WS19 0.80 m bgl and WS25 0.50 m bgl.



SVOCs (including 2-methylnaphthalene, carbazole, dibenzofuran) were also recorded in Encia Consulting WS19 and WS25.

3.4.7. DISCUSSION OF VOLATILE CONTAMINANTS

Volatile TPHs, naphthalene, SVOCs, VOC and mercury present a potential volatilisation to indoor air risk.

The elevated concentrations of naphthalene, TPH, and trichloroethene (TCE) identified within the Tack Lea Works area (TP116 and WS12) are considered to be localised occurrences and therefore these locations can be treated as localised hotspots. During a process of cut/fill enabling works, a hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on-site in an area of no future sensitivity.

However, elevated concentrations of naphthalene, TPH, VOCs and SVOCs have been identified throughout the Shepherd Mill area and these do not appear to be localised hotspots. A Tier 3 vapour risk assessment is required in the Sheppard Mill area to assess the level of risk to the future site users by volatilisation to indoor air.

The SVOCs identified in WS107 and TP116 within the Tack Lea Works area are not considered to pose a risk to future site users given the marginal concentrations.

In addition to the above, in regard to the elevated concentrations of mercury identified, it is also recommended that speciation is completed in order to determine the type of mercury and if it does indeed present a vapour risk. Further risk assessment should be completed to determine its placement on-site, and should it be volatile a hotspot removal should be undertaken to delineate the extent of impact and soils should be chemically validated to assess chemical suitability for retention on-site in an area of no future sensitivity.

3.5. IDENTIFICATION OF FEASIBLE REMEDIATION OPTIONS

3.5.1. OBJECTIVES

The remediation works must be completed in a safe and sustainable manner that ensures that the post remediation condition of the site poses no unacceptable risk to controlled waters or the wider environs. The developed Conceptual Site Model must ensure no complete pollutant linkage to ensure successful implementation.

The remediation works must be completed in a manner that promotes sustainable re-use of material in a manner that minimises waste and maximises retention of material on-site.

The works should be designed and implemented in a manner that ensure no risk to an identified receptor during the works in terms of odour, air quality or noise impact.

Works should be designed, planned and implemented in a manner that ensures full compliance with all pertinent waste management and environmental permit legislation.

3.5.2. AVAILABLE TECHNOLOGIES

Potential remedial technologies that can be applied in order to remediate the identified contaminants of concern are summarised in Table 3.3. The remedial techniques considered would potentially break any source-pathway-receptor linkages, thereby reducing the risk to human health from vapour inhalation to acceptable levels.



TABLE 3.3 SOIL REMEDIATION TECHNOLOGIES

REMEDIAL TECHNOLOGY	CLASSIFICATION	APPLICATION	MEDIUM	LINKAGE ELEMENT AFFECTED
Capping	Containment	In situ	Soil	Pathway interruption
Electro-remediation	Physical	In situ / ex situ	Soil	Removes source
Soil washing	Physical	Ex situ	Soil	Source management
Soil vapour extraction	Physical	In situ	Soil	Removes source
Ex-situ bioremediation	Biological	Ex situ	Soil	Removes source
Thermal desorption	Thermal	Ex situ	Soil	Removes source
Vitrification	Thermal	In situ	Soil	Removes source / breaks pathway
Stabilisation / Solidification	Chemical	In situ / ex Situ	Soil	Pathway Interruption
Excavation and offsite disposal	Civil Engineering	Ex situ	Soil / groundwater	Removes source
Enhanced Bioremediation	Chemical / Biological / Natural attenuation	In situ	Soil / groundwater	Removes source / breaks pathway
Monitored Natural Attenuation	Natural attenuation	In situ	Soil / groundwater	Pathway interruption / eventual removal of source
Vacuum Enhanced Recovery	Physical / Chemical	In situ	Soil / groundwater	Removes source / breaks pathway
Air sparging / Biosparging	Physical / Biological	In situ	Soil / groundwater	Removes source / Pathway interruption
In situ oxidation	Chemical	In situ	Soil / groundwater	Removes source / Pathway interruption



3.5.3. SELECTION OF TECHNOLOGY OPTIONS

Several remedial technologies have been considered in addressing the contaminant linkages of concern identified at the site, as summarised in Table 3.4.

In order to assess which of these technologies are most viable for this particular project, each technology has been reviewed on the basis of applicability, permissibility, cost, timescale and acceptability (including sustainability).

A combination of remediation solutions and technologies will be required to address and treat the numerous contamination issues identified on this site.

Aspects of sustainable remediation are also included within the review element of applicability.

Sustainable remediation is, 'the practise of demonstrating, in terms of environmental, economic and social indicators, that the benefit of undertaking remediation is greater than its impact and that the optimum remediation solution is selected through the use of a balanced decision-making process', (as defined within 'A Framework for Assessing the Sustainability of Soils and Groundwater Remediation', produced by Sustainable Remediation Forum UK, dated March 2010).



TABLE 3.4 ASSESSMENT OF REMEDIATION TECHNOLOGIES APPLICABILITY

REMEDIAL TECHNOLOGY	APPLICABILITY	REGULATORY APPROVAL / PERMITRY	COST	TIME-FRAME	SCORE	SUITABILITY COMMENT
Capping	5	5	5	5	20	Essential remediation solution to remove direct exposure pathways.
Electro-remediation	1	1	1	1	4	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Soil washing	1	1	1	1	4	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Soil vapour extraction	1	1	1	1	4	Landfill to be remediated by excavation for geotechnical purposes meaning such a solution is limited in terms of viability.
Ex-situ bioremediation	4	4	3	3	14	Considered viable to treat soils to ensure residual concentrations pose reduced risk in terms of vapour inhalation and migration in dissolved phase to controlled waters.
Thermal desorption	1	2	2	2	7	Limited application due to nature and depth of material and ability to achieve required results.
Vitrification	1	1	1	1	4	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Stabilisation / Solidification	4	4	4	4	16	The additional of stabilisation and binding agents will limit volatilisation and impede migration. Considered viable.
Excavation and offsite disposal	5	5	1	5	16	Limited by cost being prohibitive. Small quantities of material that cannot be treated will be removed. Likely to form one aspect of the remediation approach.



REMEDIAL TECHNOLOGY	APPLICABILITY	REGULATORY APPROVAL / PERMITRY	COST	TIME-FRAME	SCORE	SUITABILITY COMMENT
Enhanced Bioremediation	4	4	1	3	12	Considered viable to treat soils to ensure residual concentrations pose reduced risk in terms of vapour inhalation and migration in dissolved phase to controlled waters.
Monitored Natural Attenuation	4	3	5	1	13	Likely to form one aspect of the remediation solution. Long term monitoring to demonstrate residual impact poses no significant and ongoing risk.
Vacuum Enhanced Recovery	1	1	1	1	4	Technique unlikely to treat identified contaminants of concern in an efficient manner.
Air sparging / Biosparging	1	1	1	1	4	Technique unlikely to treat identified contaminants of concern in an efficient manner.
In situ oxidation	1	3	3	3	10	Technique unlikely to treat identified contaminants of concern in an efficient manner.



3.6. SUMMARY OF PREFERRED REMEDIATION OPTIONS

Based on the options appraisal, it is considered that the following combination of remediation technologies provides the most sustainable, viable and economic solutions that will ultimately result in the successful remediation for the site:

- ✳ Construction of low permeability **capping system** to ensure no direct exposure pathway to future receptors;
- ✳ Construction of dwellings with **specialist membranes** and mitigation measures to ensure no ingress of volatile phase hazardous compounds into a dwelling;
- ✳ **Ex-situ bioremediation** of materials and treatment on-site in accordance with a Mobile Treatment License (MTL) by a specialist contractor;
- ✳ **Solidification and stabilisation** to bind compounds within the soil matrix to reduce volatilisation and migration into the dissolved phase. Works to be completed by a specialist contractor in accordance with a MTL / EP;
- ✳ **Off-site removal** of hazardous materials which cannot be treated will be required, this operation needs to be limited to materials that cannot be treated on-site to promote sustainability and ensure viable regeneration.

3.7. OVERVIEW OF WORKS

Prior to the commencement of works on-site, the contractor must establish all necessary plant, equipment and site welfare facilities as is necessary to complete the contract within the agreed timescales to the rationale as outlined in the following subsections.

For the avoidance of any doubt, the proposed operations as set out herein document the required performance objectives and validation sampling protocols; however, the specific methods of work deployed to ensure the remediation objectives are achieved in a compliant manner on-site will be the responsibility of the appointed contractor.

RE-1 – Watching Brief and Further Sampling

Site investigation has not been possible within the current footprint of the buildings on-site, and former landfill area. Further sampling and a watching brief will be required within these areas in order to determine the chemical and geotechnical properties of the underlying ground and to determine the soils suitability for use.

Chemical samples of the Made Ground should be undertaken and scheduled for a full suite of analysis to include asbestos identification, heavy metals, speciated PAH, SVOCs, VOCs and TPH.

If any as yet unidentified contamination is identified, this will be the subject of further investigation including laboratory analysis and subsequent assessment of risk within the context of the agreed parameters. Where a theoretical risk to either human health, controlled waters or the wider environs is identified, appropriate remediation works are to be instigated by the placement of clean cover systems to break the pathway or delineation and source removal where required.

Further ground gas monitoring will also be required in the landfill area to determine the requirement for ground gas protection measures.



Given the identified volatile compounds throughout the southern sector of the site (Shepherd Mill area), a Tier 3 vapour risk assessment is recommended to assess the level of risk to the future site users by volatilisation to indoor air.

RE-2 – Pre-Commencement Regulatory Compliance

Prior to commencement of any works on-site, all reports relating to the assessment of risk to contaminated land should be submitted to the regulatory authorities to gain written approval.

All relevant Standard Rules Permits should be registered with the EA.

The LAPC Part B Notification for deployment of mobile crushing plant should be implemented prior to the establishment of equipment on-site.

If the proposed volume of soils to be reused (excluding crushed materials) exceeds the parameters of the Standard Rules Permit, a CL:AIRE Materials Management Plan (MMP)-qualified declaration should be made by the contractor, having obtained full written approval for the remediation strategy from the LPA and Environment Agency.

It is anticipated there will be a requirement to treat materials on-site including hydrocarbon impacted soil. The appointed contractor must notify the EA of their intention to for the deployment of the appropriate Environmental Permit for the specified operation or complete minor works in accordance with the EA RPS.

RE-3 – Environment and Nuisance Control

Management of all works is required so as to ensure that no environmental nuisance is created through dust emissions, noise or vibration levels.

All works are to be completed in a manner so as not to create any structural risk to the adjacent highways.

Temporary works are to be implemented as necessary to support excavations throughout the duration of the works.

In the event that a complaint is made in respect of dust emissions, noise or vibration levels, remedial measures and a programme of ongoing monitoring should be agreed with the local authority and implemented on-site.

RE-4 – Monitoring of Surface Water

Surface water samples were obtained as part of the site investigation which did not identify any significant impact.

Additional surface water samples should be collected prior to commencement and throughout the duration of the Remediation & Enabling Works to demonstrate that the site poses no risk to surface waters associated with the development works.

Measures will be established to prevent surface water runoff from or into targeted excavation and treatment areas by sealing of existing manholes, bunding treatment areas and restricting excavations to facilitate daily re-instatement and deferring works in periods of poor/wet weather.



In the unlikely event of a pollution incident, works will cease until appropriate measures can be put in place to stop and prevent further impact to the watercourse, these may include forming further temporary bunds, interception trenches and deployment of additional pumps and treatment plant or targeted disposal options.

Surface water samples will require testing in line with the schedule present within Table 3.6.

RE-5 – Risk to Infrastructure and Main River

Site works should be completed in a manner that ensures no risk of disturbance to the adjacent infrastructure.

Naden Brook is located along the western and southern boundaries of the site. Naden Brook is classified by the EA as a Statutory Main River.

All works to be completed within the main river channel will require the appropriate EA permit, this should be obtained prior to the commencement of any activities (including demolition). It should be noted that works to the main river channel may be restricted during certain times of the year.

RE-6 – Identification, Isolation and Treatment of Invasive Plants

The remediation contractor must satisfy themselves with respect to the extent of all species deemed invasive prior to the commencement of works on-site. The contractor shall employ a suitably qualified expert to investigate the presence of invasive plant species on or adjacent to the site. If invasive plant species are identified, these will be treated in strict accordance with an approved method statement to be submitted to the supervising consultant for review prior to the instigation of any works.

Where invasive plant species are identified at the site boundary, a suitable barrier shall be installed to prevent any future reinfestation of the subject site.

Upon completion of the eradication of all invasive species, a validation report should be prepared documenting all identified invasive plant species, their location and the treatment methodology. Where materials are removed from site, all waste transfer notes/duty of care certificates should be included within the validation statement.

RE-7 – Site Clearance Operations

Post-demolition general site clearance and provision of welfare, offices and site security are to be determined as per the contract requirements.

Vegetation should be removed in a controlled manner with full compliance with any ecological mitigation measures that are required for the works. Any such measures are outside the scope of this report.

All vegetation should either be stockpiled at a pre-agreed location or alternatively removed from site in accordance with waste permitting regulations.

All root networks are to be removed in accordance with the requirements of the NHBC/LABC.



RE-8 – Delineation, Excavation and Treatment of Identified Asbestos Impact

Asbestos in the form of chrysotile hard/cement was identified within the Made Ground in WS124 at 3.40 m bgl (south of Sheppard Mill area) and HP05 at 0.10 m bgl (historical landfill in the eastern section of Tack Lea Works area). Asbestos in the form of chrysotile sheeting/board debris and loose fibrous debris was also identified in HP05 at 0.10 m bgl. Chrysotile and Amosite loose fibres were identified in TP114 at 1.00 m bgl and TP116 at 1.20 m bgl (central section of Tack Lea Works area).

Quantification testing was undertaken with the highest concentration recorded in WS124 at 0.705%. The remaining samples had concentrations of 0.002% (TP116), 0.011% (TP114) and 0.036% (HP05).

Visual signs of ACM were encountered during the ground investigation in HP05.

Encia Consulting identified amosite in WS18 D2 at 0.60 – 0.70 m bgl. Potential visible asbestos was noted in WS10 as likely chrysotile cement.

The E3P Developed Conceptual Site Model demonstrates a suitable method for management of soils to negate any future risk.

The contractor must ensure that all personnel working on-site are trained in the identification of ACM and the risks associated with impacted soils.

Where any visual evidence of ACM is identified, these materials should be carefully segregated and removed from the soil matrices (if/where possible).

Validation sampling of the processed Made Ground should be completed to demonstrate compliance with the developed conceptual site model.

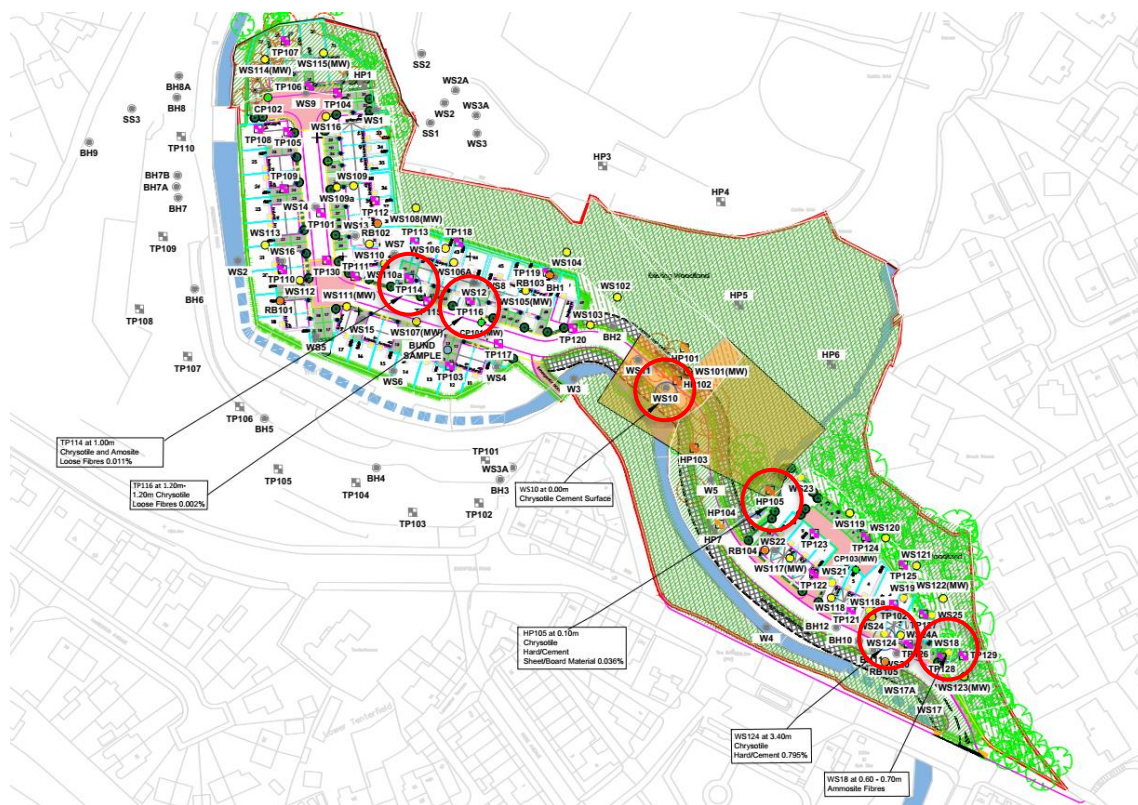
This process should be completed under strict controls to be devised and employed by the nominated contractor to ensure no potential for fibre release into ambient air.

If necessary, reassurance air testing in accordance with the requirements of HSG248 should be completed during the operation to move the soils to demonstrate the deployment of the required control procedures and safe working methods.

The location of the identified asbestos is shown in Figure 3.1.



FIGURE 3.1 LOCATION OF IDENTIFIED ASBESTOS



RE-9 – Delineation, Excavation, Treatment and Disposal of Impacted Material – Hotspots

The elevated concentrations of naphthalene, TPH, and trichloroethene (TCE) identified within the Tack Lea Works area (TP116 and WS12) are considered to be localised occurrences and therefore these locations can be treated as localised hotspots. During a process of cut/fill enabling works, a hotspot removal should be undertaken where these soils may be chemically validated to assess chemical suitability for retention on-site in an area of no future sensitivity.

However, elevated concentrations of naphthalene, TPH, VOCs and SVOCs have been identified throughout the Shepherd Mill area and these do not appear to be localised hotspots. A Tier 3 vapour risk assessment is required in the Sheppard Mill area to assess the level of risk to the future site users by volatilisation to indoor air.

The SVOCs identified in WS107 and TP116 within the Tack Lea Works area are not considered to pose a risk to future site users given the marginal concentrations.

When considering the prior land use, as yet unidentified potentially volatile/soluble phase compounds cannot be discounted. The proposed remediation works will include the full depth turnover of all Made Ground under the supervision of an independent geoenvironmental consultant from E3P.



In the likely event that any as yet unidentified contaminant is identified, this will be the subject of further investigation including laboratory analysis and subsequent assessment of risk within the context of the agreed parameters. Where a theoretical risk to either human health, controlled waters or the wider environs is identified, appropriate remediation works are to be instigated.

Material deemed to be impacted through either visual or olfactory observations or as a result of notable PID readings (> 50 ppm) will be excavated and stockpiled on an impermeable membrane. The membrane will be placed upon a clay containment bund and covered to negate the risk of soils leaching and dispersal of any odours and/or vapours. This material will then be subject to detailed laboratory analysis to determine the suitability for reuse or the requirements for off-site disposal.

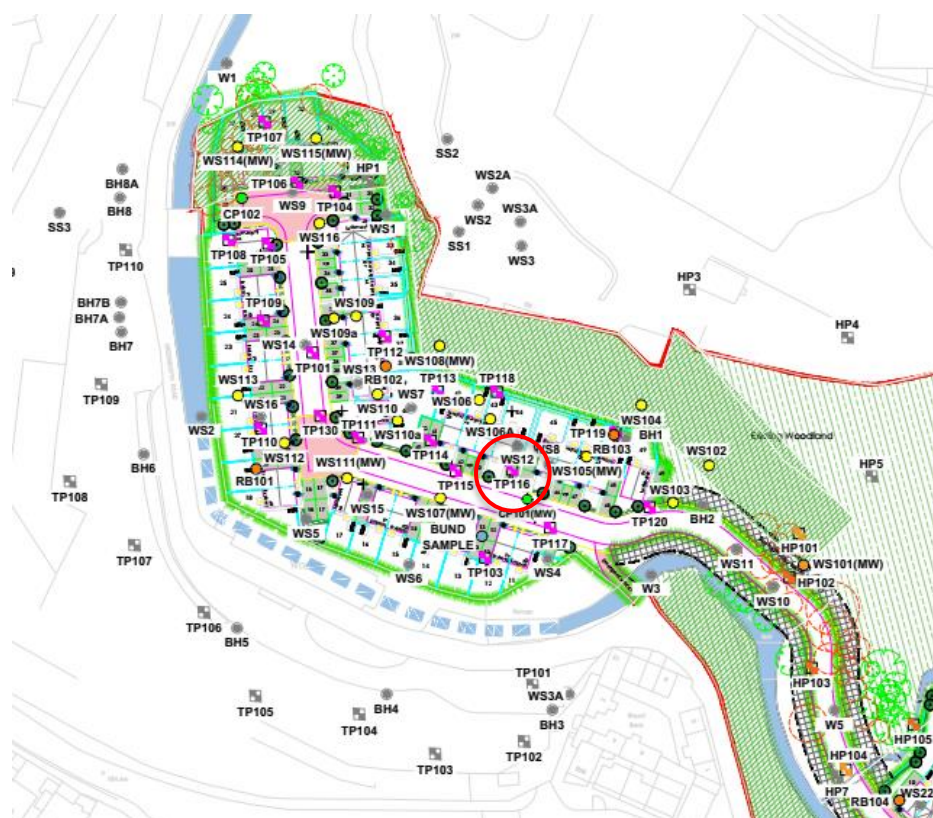
Upon completion of the delineation and excavation, the sides and base of the resulting void(s) where impacted material is present will be chemically validated to confirm that no impacted materials remain in situ.

Validation samples will be collected at 10 linear metre centres from the side and base of the excavation.

The results of this validation testing will be directly compared to the site-specific remediation targets (as defined within Appendix III of this report) to demonstrate that no unacceptable level of risk to human health, controlled waters or the wider environment remains.

The location of the identified hotspots within the northern sector of the site are shown in Figure 3.2.

FIGURE 3.2 LOCATION OF IDENTIFIED HOTSPOTS



RE-10 – Further Assessment of Mercury

Elevated total mercury has been identified within the Made Ground deposits in WS111 at 0.60 m bgl.

Encia also identified elevated concentrations of mercury in WS9 at 0.50 m bgl and WS25 at 0.70 m bgl.

During remediation and enabling works, further samples should be submitted for speciated mercury analysis to assess whether elemental mercury is present which may pose a risk to future site users through vapour inhalation. If elemental mercury is identified, it may be necessary to delineate and excavate the soils as localised hotspots and place in an area of low sensitivity such as POS. Alternatively, if it is proven that there is no elemental mercury, a clean cover system will be sufficient.

The location of known mercury impacted soils are shown in Figure 3.3.

FIGURE 3.3 LOCATION OF ELEVATED TOTAL MERCURY



RE-11 – Excavation, Breaking and Processing of All Above- and Below-Ground Structures

Obstructions, relict foundations and infrastructure (apart from live services) are to be removed from the areas of proposed residential development, to include plot footprints, rear gardens, private driveways, adopted highway and utilities infrastructure (road box) in their entirety.



Artificially hard materials should be broken out and crushed. Stockpiles will be made, validation testing undertaken, and site-won material reused on-site where required. Materials will be processed as per the specifications provided in Section 5 using licensed plant.

The E3P drawings denote the extent of known historic features with obstructions; however, it will be the contractor's responsibility to remove all obstructions.

Obstructions encountered within the near-surface soils will be chased to their full depth and removed; if not possible, the obstruction must be surveyed with the location communicated to E3P, the client and the developer.

Where natural soils are present at a relatively shallow depth, extreme care should be taken to ensure that the natural cohesive deposits remain undisturbed with a full reduced-level survey to be completed to map the depth of filled/processed material.

RE-12 – Delineation, Excavation and Treatment of Infilled Historical Ponds and Reservoirs

Prior to the commencement of the main earthworks (where possible), all known former infilled ponds and reservoirs should be clearly identified and demarked and investigated to assess the nature of materials and extent of any deleterious elements.

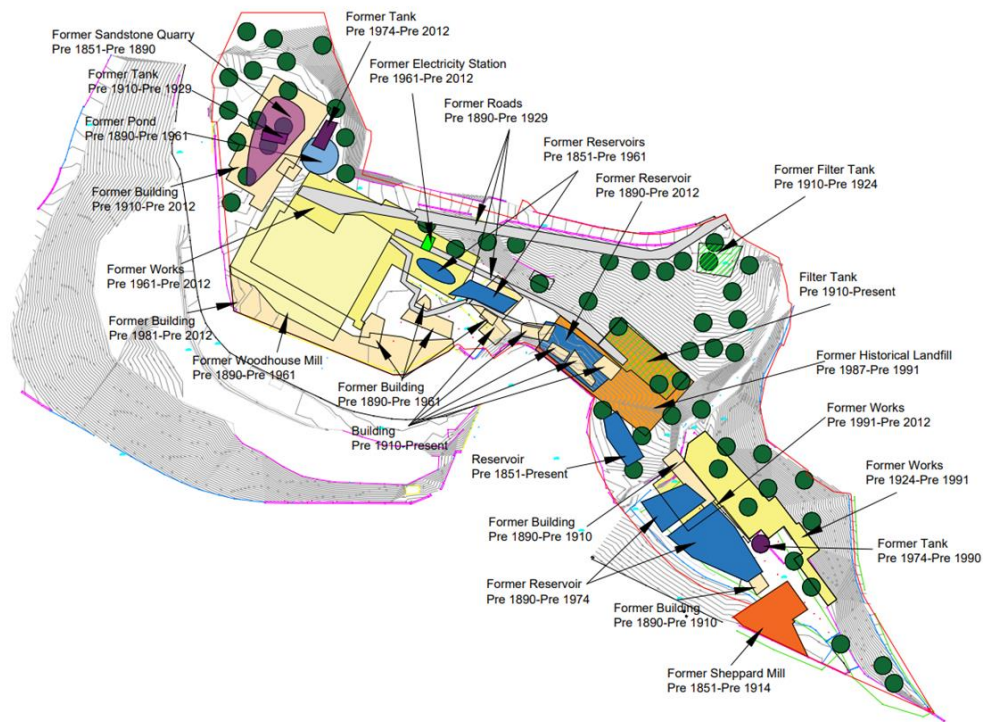
The location of known historic infilled ponds and reservoirs are identified within the E3P Historical Features Plan (Drawing 16-465-003) in Appendix III and in Figure 3.4.

All materials that are deemed to be organic – and thus exhibiting unsatisfactory geotechnical properties – must be removed, with the resulting excavation to be backfilled with materials deemed compliant with the E3P Geotechnical Performance Specification with appropriate compaction for the intended land use.

A suitably qualified geotechnical engineer will need to monitor the works and confirm when all unsuitable material has been excavated and removed from beneath any proposed structure or infrastructure.



FIGURE 3.4 LOCATION OF IDENTIFIED PONDS AND RESERVOIRS



RE-13 – Removal of Deleterious Material

All potentially deleterious materials will be delineated, stockpiled and removed from site by the contractor to a licensed waste facility. Prior to the commencement of the main works, the contractor, under the supervision of E3P, will undertake to complete further confirmatory ground investigations to satisfy themselves with regards to the extent of any buried anthropogenic deleterious materials that are unsuitable for retention within a low-rise residential development.

RE-14 – Investigation and Removal of Historic USTs

During the remediation and enabling works, further investigation within the areas of historically mapped tanks will be required to confirm the presence and the exact location of any underground storage tanks (USTs). The contents of any such tanks are unknown and no evidence is present to suggest decommissioning.

It is proposed to break out all hardstanding around the tanks and inspect their integrity. If the tank is found to be intact, hydraulic shears should be utilised to open the tank along the top and peel back the steel, thus rendering the tank an open vessel and no longer a tank form. The tanks should be checked for vapours using a lower explosive limit (LEL) meter. If they are deemed to be free of vapours, a 24-hour certificate will be issued, during which time the tanks should be rendered unusable (by cold cutting). Should the tanks contain any residual liquids, this should then be uplifted by the vacuum tanker or a surface-mounted pump (peristaltic or double-diaphragm).



Any tank backfill material will be broken up and removed from the tank structure by excavator until the tank is sufficiently light to be lifted and emptied. All oversize materials will be stockpiled and checked for hydrocarbon impact pending chemical validation analysis. It is likely the material present inside the tanks will require disposal off-site, in accordance with UK waste management legislation.

The sides and bases of excavations will need to be chemically validated to ensure that soils are below the site-specific remedial validation criteria for the protection of human health and controlled waters. All waste transfer certificates will be required to be retained and included within the remediation validation report.

The location of the historic tanks is shown in Figure 3.5.

FIGURE 3.5 LOCATION OF HISTORIC TANKS



RE-15 – Remediation of Historical Landfill Area

A historical landfill is located on-site in the eastern section of the Tack Lea Works area and west of Woodhouse Lane Brook within an area of semi-mature woodland (as shown in Figure 3.6). The landfill site was listed as formerly receiving inert and industrial wastes between 1987 and 1991.

Given the potential for unknown sources of yet unidentified contamination and the unproven and unquantifiable geotechnical properties of this material, the site remediation works will require a complete / full depth 'turn over' within this sector.

All deleterious and potentially putrescible materials will require segregation and removal and where necessary off-site disposal to a suitably licensed facility.



Any as yet unidentified visual or olfactory evidence of potential contamination source/impact will be reported to the supervising engineer. The remediation contractor will instigate appropriate laboratory testing to determine the exact chemical composition of any such impact to inform a suitable assessment of risk and, where necessary implement remedial action.

The material within the landfill, could be considered to be a waste albeit the landfill is not the subject of any active Waste Management License or Environmental Permit (according to EA Public Records). The material within the landfill is considered to be compliant with the specification as set out within the CL:AIRE DoW CoP and as such can be recovered and re-used in sustainable construction practises. It should be noted that materials that are considered to be outside the CL:AIRE CoP must be treated as a waste and thus cannot be re-used.

Once sorted and processed, suitable material will be replaced in strict accordance with the E3P Geotechnical Engineering Specification with appropriate validation testing to demonstrate compliance.

FIGURE 3.6 LOCATION OF HISTORICAL LANDFILL



RE-16 – Cut-And-Filling of Made Ground to Development Levels

The Made Ground is noted to be present to substantial depth in some areas of the site (> 5 m). It is considered that it will be possible to utilise vibro stone columns (VSC) within areas of segregated and placed granular Made Ground to treat the currently unknown potential for differential settlement and ensure a uniform safe allowable bearing pressure (ABP) in the order of 125 kN/m².

Where the proposed enabling works levels require the current landform to be cut, extreme care should be taken so as not to disturb the underlying stratum prior to the placement of the appropriate platform, in compliance with the E3P Geotechnical Specification.

Where the development levels require material to be filled, site derived Made Ground must be sorted in a controlled manner prior to replacement, in accordance with the requirements of this specification for the intended land use.

The maximum dry density must be determined in laboratory conditions utilising UKAS-accredited testing prior to the commencement of filling and compaction works. In-situ density testing is required to demonstrate compliance with the E3P Geotechnical Performance Specification.

RE-17 – Placement and Compaction of Uppill Material to Facilitate Ground Improvement by VSC

Where plots are to be prepared in a manner that will facilitate ground improvement by vibro-stone column, materials must be either compliant with the specified grading requirements for a nominally placed and tracked granular aggregate, or alternatively they should be engineered to a defined geotechnical standard.

Materials compliant with VSC grading for granular backfill: granular matrix are to be graded with all particles < 125 mm with no more than 10% fines (0.63 micron).

Materials to be placed in layers to ensure a CBR < 7% to mitigate the requirement for pre-boring.

Non-compliant material requiring engineering to geotechnical design: material is to be placed and engineered in accordance with the correct method for the Series 600 classification (1, 2 or 6) with moisture contents to be controlled within acceptable design limits. In-situ density to be confirmed to be > 95% of the laboratory determined maximum (2.5 kg) with < 5% air void ratio.

RE-18 – Construction of Temporary Working Platform

Where plots are to be prepared in a manner that will facilitate ground improvement by vibro-stone column, a temporary working platform will be constructed.

The specific design for such a platform should be obtained from E3P; however, as a minimum this will comprise:

-  Proof rolling of the subgrade to ensure a California bearing ratio (CBR) > 3%; and
-  Placement of 300 mm of certified 6F2 to be rolled and compacted to ensure a CBR > 6%.



RE-19 – Replacement of Materials, Geotechnical Engineering Requirements

Material is to be backfilled in strict compliance with the E3P Geotechnical Engineering Specification as presented in detail within Section 6 of this report, which generally requires the reinstatement and compaction criteria presented in Table 3.5.

TABLE 3.5 GEOTECHNICAL ENGINEERING WORKS SCHEDULE

Land Use	Construction Requirement	Requirement
Footprint of Proposed Structure (2 m on All Elevations)	Pile Foundation	Backfill using general method compaction to CBR of 5%.
	Vibro-Stone Column	Particle size distribution (PSD confirmed as < 125 mm with no more than 10% fines (0.63 micron). Or Compaction to achieve > 95% of the laboratory determined maximum dry density (DD) with < 5% air void ratio. CBR < 7% in all upfill. CBR > 6% with suitable pile mat. PSD testing of backfill material at 1 sample per 2000 m ³ to confirm.
	Traditional Spread Foundation	Ensure no disturbance of natural soil at shallow depth.
Highways	Adopted Estate Road/Drainage	Manual of Contract Documents for Highways Works (MCHW) Series 600 ensuring CBR > 5% in subgrade (engineered fill).
Driveways	Private Drives and Car Parking	Method compaction to CBR > 5%.
Gardens and Public Open Space	N/A	Method compaction to ensure no settlement.

RE-20 – Preparation of Ground for Vibro-Stone Columns Within Tree Influence

Where trees are present, or within their total zone of influence, the contractor must ensure that all cohesive soils are removed to the required depth with the subsequent replacement with a granular blanket to fully mitigate the potential for volumetric instability in the clay soils.

The zone of tree influence will be indicated within the foundation zoning plan and all resultant excavations and subsequent backfilling must be inspected and approved by E3P.

The depth of the granular blanket required will be determined prior to the commencement of the works and in full agreement of the client, but will nominally be equal to or in excess of 2.5 × foundation width.



RE-21 – Importation of Bulk Fill

Where there is a net shortfall of material required to achieve the proposed ground levels, it will be necessary to import natural inert soils and aggregate as per the engineering requirements (Section 5).

Imported material must be certified as suitable for use in strict accordance with the E3P chemical and geotechnical performance criteria (See Section 6) and in conjunction with the required duty of care notes and waste transfer exemption.

If recycled aggregates are imported, then laboratory testing should be completed to demonstrate compliance with the Waste and Resources Action Programme (WRAP) protocol.

Where inert soils are imported, laboratory testing should be completed in accordance with the requirements of the pertinent environmental permit (i.e. U1 Standard Rules) or CL:AIRE MMP for the reuse of clean, naturally occurring soils.

RE-22 – Preparation of Garden for Cover System

As part of the land remediation works, garden areas will be prepared in a manner that will facilitate the placement of the clean cover system during the development phase of the works. The preparation of the areas requiring clean cover is critical in ensuring delivery of the site in a manner that will ensure no risk to the proposed end users.

Where Made Ground is deemed unsuitable for retention in a garden, the area will be subject to a reduced-level dig to remove unsuitable material to a minimum depth of 600 mm below finished garden level or verified natural stratum (whichever is the shallower).

A provision of a 300 mm cover system using certified material with appropriate validation within front gardens, proposed areas of soft landscaping and public open space will also be required.

Excavated soil will be stockpiled pending the results of the appropriate validation testing (to be completed in accordance with this specification) prior to reuse in an area of no sensitivity or, where necessary, this material will be removed from site in accordance with UK waste management legislation.

The placement of certified subsoil and topsoil will be completed as part of the developer works/build-phase mitigation plan. All rear garden areas where a cover system is required will be subject to plot-specific independent validation. Trial holes within front garden areas will be undertaken at 1 every ten plots, given that these are deemed as functional landscaping, to validate the correct installation of 300 mm cover.

Areas of soft landscaping and POS will have a minimum of 1 trial hole per landscaped area, with additional trial holes undertaken every 1 per 50 m², given that 300 mm cover systems are required in these areas.



RE-23 – Provision of Subsoil

The natural drift deposits (predominantly cohesive soils) are deemed suitable for use within the upper 600 mm of clean cover to residential rear gardens and upper 300 mm of clean cover to front gardens, areas of soft landscaping and POS. It is therefore deemed viable to reuse materials that are cut as part of the wider earthworks or through a soil inversion (regulated by an MMP) to generate the required volumes of material.

The gardens and landscaped areas will require depth validation to satisfy the requirement of the Council of Mortgage Lenders (CML) in order to demonstrate that the appropriate thickness has been provided as a growing medium.

Where a shortfall of material is available at the site there will be a requirement to import chemically suitable to the site. This will require validation sampling prior to placement within landscaping areas to confirm the suitability for the proposed use and confirm that impact has not occurred during transport.

Subsoil will require testing in line with the schedule present within Section 3.8 and Table 3.6.

RE-24 – Provision of Topsoil

No material that would be deemed suitable for use as topsoil is present on-site and as such there will be a requirement to import suitable material for use within the proposed development.

Topsoil will require testing in line with the schedule present within Section 3.8 and Table 3.6.

The gardens and landscaped areas will require depth validation to satisfy the requirements of the CML in order to demonstrate that the appropriate thickness has been provided.

RE-25 – Independent Validation: Watching Brief

Given the site history and potential contamination sources identified within the ICSM, a degree of uncertainty remains with regard to the potential for as yet unidentified contamination impact within the near-surface soils and groundwater.

It will therefore be necessary to instigate the site-wide remediation and enabling works under the supervision of a suitably qualified and independent specialist. The specialist is required to attend site as and when appropriate to monitor works, record ground conditions and fully investigate all potential sources of as yet unidentified contamination.

RE-26 – Waste Soils Surplus to Requirements

In the event that a surplus of excavation material is present on-site, this, in most cases, will be deemed to be a waste in accordance with the Waste Framework Directive (Article 3(1) Waste Framework Directive 2008/98/EE). The waste producer – but ultimately, the landowner – is responsible for the compliant disposal of such materials.



A formal waste classification assessment must be undertaken, irrespective of any future options or considerations for those materials that will be removed from site. Waste classification should only be made following the Environment Agency *Technical Guidance WM3 – Guidance on the Classification and Assessment of Waste*.

To remove the surplus material from site it will either need to be sent to a disposal site (landfill), to a permitted treatment facility or, dependent on the waste classification assessment, it may be suitable for use on a permitted land improvement or restoration operation.

Subject to suitability, these soils can be transferred to the receiving site, subject to an approved permit or materials management plan following guidance in the CL:AIRE *Definition of Waste: Code of Practice*.

RE-27 – Validation of Materials for Potable Water Supply Infrastructure

Elevated TPH compounds were recorded when compared to PE pipeline thresholds at anticipated pipeline depth across the site (0.75-1.35m). Following remediation of the site validation sampling should be completed at 10 m chainage at depths of 0.75 m and 1.50 m within the locality of the potable supply pipes, with samples analysed for all pertinent volatile and semi-volatile hydrocarbons and, where necessary, chlorinated/halogenated compounds.

Upon successful remediation of all impacted materials, the post-remediation validation testing will be reviewed by a qualified person to inform an updated UKWIR assessment to be reviewed and approved by the statutory adoption authority.

If unacceptable concentrations remain following remediation, then potable water infrastructure should be constructed in accordance with a suitably robust risk assessment and design compliant with UKWIR.

Initial assessment determines barrier pipe will be required for this site.

RE-28 – Investigation of Retaining Wall Footings

Prior to the works commencing it is recommended that investigation into the footings of the existing retaining wall be carried out to identify how far footings encroach onto site, which may affect any proposed foundations of the residential development.

It is also recommended that a structural defects survey is undertaken on retaining structures to ensure that the remediation and enabling works do not negatively impact the structure.

All works must be designed and supervised by the project Structural Engineer.

RE-29 – Remedial Verification Report

Collation of information relating to site clearance, chemical testing, remedial works, remedial verification, material movements and waste transfer documentation is required, where appropriate.

Complete remedial validation is to be reported in line with regulatory guidance. This will include a detailed risk assessment. The report will be submitted to the local authority for approval following completion.



3.8. VALIDATION SAMPLING PROTOCOL

In accordance with the current requirements of the regulatory authorities, validation samples will be collected from all materials that are to be subject to movement under the protocols outlined within this remediation and enabling works strategy, or for materials to be imported onto site to facilitate the proposed residential development.

Soil samples destined for chemical analysis will be collected at regular intervals in appropriate sampling containers. All samples will subsequently be stored in cooled boxes prior to submission to a UKAS/MCERTS accredited laboratory.

All samples will be collected using appropriate personal protective equipment (PPE) and sampling equipment, which will be cleaned at each sampling location.

A detailed copy of E3P Ltd sampling methodology, QA procedures and laboratory chain of custody forms will be documented within the site records and presented with the final validation report for the site.

Where material is found to contain concentrations of potential contaminants at levels in excess of the site-specific screening criteria (as detailed within Appendix IV), E3P will undertake further assessment and recommendations on the appropriate use for the material in question, which may involve the disposal of such materials off-site to a suitable waste management facility.

The sampling frequency for materials to be managed under the remediation strategy is presented within Table 3.6.

TABLE 3.6 SPECIFICATION OF CHEMICAL VALIDATION LABORATORY ANALYSIS

MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
Site-Generated		
Site-Generated 6F2	1 Sample per 1000 m ³	A/B/C/D
Site-Won MADE GROUND General Backfill	1 Sample per 250 m ³ where visual and/or olfactory impact is identified	G
Site-Won MADE GROUND General Backfill	1 Sample per 1000 m ³	A/B/C/D
Site-Won MADE GROUND General Backfill	1 Sample per 2000 m ³	I
Site-Won Natural Backfill	1 Sample per 2000 m ³	A/B/C/D
Site-Generated Subsoil (450 mm Garden Cover)	1 Sample per 250 m ³	A/B/C/D
Site-Generated Topsoil Cover (150 mm Garden Cover)	1 Sample per 50 m ³	A/B/C/D
Hotspot Validation Samples	1 Sample per 10 m of linear excavation to base and sidewall	E/G
Surface Water Samples	Throughout the works	A/B/D/E



MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
Imported		
6F2	1 Sample per 1000 m ³	A/B/C/D
Subsoil Greenfield Source (450 mm Garden Cover)	1 Sample per 200 m ³	A/B/C/D
Subsoil Brownfield Source (450 mm Garden Cover)	1 Sample per 50 m ³	A/B/C/D
Topsoil Greenfield Source (150 mm Garden Cover)	1 Sample per 200 m ³	A/B/C/D
Topsoil Brownfield Source (150 mm Garden Cover)	1 Sample per 50 m ³	A/B/C/D
General Engineering Fill (Class 1 and 2 Soil)	1 Sample per 1000 m ³	A/B/C/D

Notes

Suites of Analysis:

- A. Speciated PAH.
- B. Speciated TPH (C5-C35).
- C. Asbestos (ID).
- D. CLEA Inorganic Heavy Metals.
- E. Speciated PAH, Banded TPH and SVOCs, VOCs.
- F. SVOC/Speciated TPH.
- G. On-Site Screening for VOC Using Calibrated PID.
- H. Leachate 2:1 Speciated PAH and Banded TPH.
- I. Leachate Analysis of Inorganic Heavy Metals, TPH, Sulphate and PAH.

All analysis prescribed above to be completed by UKAS-accredited laboratory.

3.9. REMEDIATION CONTRACTORS SITE MANAGEMENT AND RESPONSIBILITY

The appointed remediation contractor will take full and overarching responsibility for all methods of work required to complete the site remediation and enabling operations to ensure the delivery of the site and the completion of the objectives in a safe, legislatively compliant manner that ensures no pollution to the subject site or the wider environs.

For individual remediation operations as set out within this performance specification, the contractor will provide site-specific methods of work for individual operations pertaining to the removal and treatment of contaminated liquids and soils. For each and every operation as set out herein, the contractor will provide a written methodology of works to be supplied to the supervising geoenvironmental engineer prior to the instigation of operations on-site.

The site manager will be responsible for documentation of each day's activities with a full recorded schedule of works completed and corresponding site-specific method statements that have been utilised to ensure the completion of the task to the required standard.



4. MATERIALS MANAGEMENT AND LEGISLATIVE COMPLIANCE

The processing of recycled aggregates will be completed using LAPC Part B licensed plant with the appropriate deployment notification to the local authority prior to commencement of works. All materials that are recovered as recycled aggregate will be compliant with the requirements of the WRAP protocol and the E3P validation testing requirements and as such would not be deemed to be a waste material.

A U1 Exemption will be registered for the site, which allows the reuse of up to 5000 T of prescribed material within construction, with up to 25,000 T of material permissible to be reused in the construction of roads. It should be noted that only 1000 T of material described as sand, stones or clay soil classified as waste can be reused with a U1.

A T5 Exemption, allowing for the screening and recovery of up to 5000 T of permissible material for subsequent reuse in construction will also be registered.

All materials that are recovered under the WRAP protocol, U1 or T5 exemptions must be analysed to demonstrate that they are both chemically and structurally suitable for use within the context of the development.

The relevant LAPC, U1, T5 and WRAP licences, exemptions and protocols provide the legislative framework for material compliance during the site remediation and enabling works to be completed by the specialist contractor under the supervision of E3P.

Where necessary, operations as outlined within the remediation enabling works rationale summarised in this report may be subject to regulation using the appropriate environmental permit, standard rules exemption and materials management plan, to be created in accordance with version 2 of the CL:AIRE *Definition of Waste: Code of Practice (DoW CoP)*.

It is noted that if material is to be imported utilising the CL:AIRE DoW CoP from an alternative development site, then only chemically certified, clean, naturally occurring material can be transferred.

If required, the MMP will be created with due consideration of all proposed remediation and enabling works operations prescribed within this document and will be undertaken by a qualified person with a signed declaration submitted to the EA prior to reuse of materials on the site.

The importation of material for use within the proposed construction of a development platform will be subject to the compliance with the E3P protocol for the importation of materials as set out within the specification for material import included within Appendix IV of this report.



5. ENVIRONMENTAL MONITORING AND VALIDATION

5.1. SITE MANAGEMENT

The tracking of materials will be based on the following hierarchy:

- ✚ The principal contractor will have the responsibility for setting out areas of the site on the basis of the contract specification.
- ✚ Operatives will have instructions only to excavate and to emplace materials in specified areas as assigned by the site manager/foreman.
- ✚ The site manager (employed by the principal contractor) will issue daily instructions to drivers regarding the placement of materials sourced from specific stockpiles or areas, ensuring that appropriate documentary evidence is collected that details which materials are going where and why.
- ✚ An E3P consultant, who will be in attendance as required, will:
 - Inspect the excavation areas and certify that the correct materials are being excavated;
 - Conduct spot checks on loaded vehicles to ensure compliance with this remediation strategy; and
 - Ensure that any loads that fail visual, olfactory or spot checks either remain on the vehicle or, if unloaded, are excavated and set aside. This material will be treated according to the recommendations of the E3P site engineer.
- ✚ E3P will conduct an audit of waste consignment notes. All material imported and removed from site will have duty of care/consignment notes, copies of which will be retained on-site by the site manager.
- ✚ Materials directly reusable will be incorporated into the earthworks, subject to operational conditions and phasing of excavations, in which case they will be stockpiled prior to final placement.

5.2. COMPLETION

Following the completion of the remediation works, a report will be compiled by the environmental consultant detailing all site enabling works undertaken, waste consignment notes, and all site investigations, laboratory test certificates and validation testing undertaken.

A certificate of completion of earthworks should be included within the report which should then be issued to the local authority for their approval.

E3P considers that with the adoption of the above best practices the site can be safely redeveloped. The site enabling works process and presence of any residual contamination (if this is the case) should be recorded for future reference by landowners/occupiers. Future development at the site where this may result in penetration of new areas of hardstanding should be subject to no-less-stringent measures with respect to assessment and, where appropriate, monitoring, than those set out herein.



5.3. MITIGATION OF RISK FROM SOILS WITH ASBESTOS FIBRES

5.3.1. PRE-COMMENCEMENT WORKS

Prior to the commencement of works the following requirements must be satisfied:

- ✳ Induction of all people that will be involved with the proposed site works; and
- ✳ All methodologies must be agreed upon by all parties involved.

5.3.2. CONTROL, MONITORING AND REPORTING OF GENERAL AERIAL EMISSIONS FROM DUSTS AND PARTICULATES

DAMPING DOWN OF SOILS – MITIGATE PARTICULATE (DUST) EMISSION

During excavation, as outlined within the detailed working methodologies, soils will be regularly damped down using water to control the generation of dust (this may also comprise precipitation). The contractor will determine the best form of dust suppression to be used when a detailed programme has been issued.

If any previously unidentified asbestos-containing materials are identified, these should be dealt with in strict accordance with the *Control of Asbestos Regulations* (2012) and industry best practice as detailed in CIRIA 733.

GENERAL CONTROL OF DUST

The following control measures should be utilised to ensure that dust levels are kept to a minimum at all times:

- ✳ Where necessary, haul road, work areas and stockpiles will be damped down with water spray.
- ✳ The application of water to haul roads, work areas and stockpiles should be closely monitored by the resident engineer to ensure that soils are not saturated and, therefore, that the potential for water run-off is appropriately mitigated.
- ✳ Once completed, any stockpiles will be sealed by compacting at the surface.
- ✳ Vehicle speeds and movements on-site will be kept to a minimum (< 5 mph) during civil excavation works to reduce the potential to generate dust.



PERSONAL PROTECTIVE EQUIPMENT (PPE)

In accordance with the HSE *Guidance Note em6: Asbestos Essentials, Personal protective equipment (including RPE)*, E3P recommend that all site operatives present within the work area where potential asbestos-impacted soils are being excavated are supplied with the following personal protective equipment:

Overalls:

- ✳ Disposable overalls.
 - Type 5 (BS EN ISO 13982-1) are suitable.
 - Cotton overalls hold dust and need specialist laundering.
- ✳ Waterproof overalls for outdoor work.
- ✳ Use oversized overalls - this will help to prevent ripping at the seams.
- ✳ If the cuffs are loose, seal them with tape.
- ✳ Avoid wearing a long-sleeved shirt as these are difficult to cover properly.
- ✳ Wear the overall legs over footwear as tucking them in lets dust into footwear.
- ✳ Wear the hood over the RPE straps.

Failure to utilise and correctly employ PPE will result in immediate cessation of works. Works will not be permitted to recommence until the individual has undergone further training in the use of PPE or the individual is removed from the works area.

At this current time, with the levels of ACM identified within the soils, the above-listed PPE is not considered to be required for all site personnel during the entire management of these soils.

When handling asbestos-impacted soils during the enabling works, asbestos monitoring works should be conducted in accordance with, but not limited to, the following HSE legislation and guidance:

- ✳ *Health & Safety at Work Act 1974;*
- ✳ *The Control of Asbestos Regulations 2012;*
- ✳ CL:AIRE, 2016. *Control of Asbestos Regulations 2012 - Interpretation for Managing and Working with Asbestos in Soil and Construction and Demolition Materials: Industry guidance;*
- ✳ *Approved Code of Practice L143 Work with materials containing asbestos;*
- ✳ *Management of Health and Safety at Work Regulations 1999;*
- ✳ *HSE Guidance Note HSG248 Asbestos, the analysts guide to sampling and analysis;*
- ✳ *HSE Guidance Note HSG247 Asbestos: The licensed contractors' guide;* and
- ✳ *CIRIA 733 Asbestos in soil and made ground: a guide to understanding and managing risks.*



If required, air monitoring in accordance with HSG248 will be undertaken intermittently throughout the duration of the works at a frequency to be determined by the contractor, entirely dependent on whether asbestos-impacted soils are being handled at any given time. In general terms, during any one monitoring period, ten standard monitoring pumps will be run throughout the day, for the appropriate time period to achieve the required limit of detection. These slides will be analysed immediately by the on-site UKAS-accredited laboratory.

Once any monitoring has been analysed by the on-site UKAS-accredited laboratory, the results will be delivered to the resident engineer who will then follow the correct site procedure. The results will then be included within the verification report.



6. GEOTECHNICAL ENGINEERING SPECIFICATION

6.1. E3P GEOTECHNICAL ENGINEERING SPECIFICATION

The overarching philosophy of the site enabling works will be the delivery of the following:

-  Preparation of plot footprint (+ 2 m on all elevations) to be suitable for ground improvement by vibro-stone column or a piled foundation, where depth of stiff clay/medium-dense sands exceeds 1.5 m from proposed finished floor level (FFL).
-  Preparation of plots to be suitable for construction with shallow spread foundation where firm to stiff clay and medium-dense sands are present at a depth < 1.5 m from proposed FFL across the complete plot.
-  Engineer all areas of proposed adopted road and private drive to be compliant with the E3P Geotechnical Specification with CBR and elevation defined by the client.

In the event that it is not possible to prepare the site in a manner that will achieve the required foundation solution, the supervising engineer and client should be contacted at the first available opportunity.

The contractor should employ a suitably experienced engineer to be present on-site during these earthwork operations to ensure soil suitability, placement, compaction and testing is undertaken in accordance with this specification and to ensure that any unforeseen circumstances, such as adverse weather, do not compromise the earthworks process.

Works should be halted during periods of intermittent or prolonged rainfall to ensure the materials are not placed in a manner that would result in softening of either the formation or the newly placed material. It will be the contractor's responsibility to determine appropriate weather conditions and determine the suitability of works.

Particular attention must be given to variable weather conditions when re-engineering clay soils as a moisture content fluctuation ($\pm 2\%$) of the tolerable limit will result in an unacceptable degree of compaction loss.

6.2. LOCALLY WON FILL MATERIAL

It is proposed to upfill and level the site with material won from the development area. It is expected that the majority of the soils won from the processing of demolition material will be granular and cohesive soil matrices.

Due to climatic weather conditions and variance in long-term differential settlement associated with even well-compacted granular soils, and the need to facilitate future re-engineering using vibro-replacement stone columns to support a shallow reinforced strip foundation, it is essential that the cut-and-fill process is well controlled, and materials are placed/compacted in accordance with this specification.

Where site-won materials are to be used as fill to achieve the required development platform, they must be compacted to ensure in-situ densities that are in excess of 95% of the maximum dry density, as determined using a 4.5 kg laboratory Proctor test.

Materials should only be compacted when the actual moisture content is within 2% ($\pm$) of the optimum for the soil matrices as determined by laboratory bench testing.



6.3. CLASSIFICATION OF FILL MATERIAL

This specification should be read in conjunction with the following:

-  The Manual of Contract Documents for Highway Works, Volume 1, Specification for Highway Works, Series 600, Earthworks as amended in February 2016; and
-  BS 1377-1:2016 Methods of test for soils for civil engineering purposes. General requirements and sample preparation

6.3.1. GENERAL CLASSIFICATION

The contractor should ensure that all earthworks materials comply with Clause 601 of the *Specification for Highway Works* and shall fall into one of the following general classifications as defined in Table 6/1 of the *Specification for Highway Works*.

-  General granular fill (Class 1);
-  General cohesive fill (Class 2), excluding Class 2A and 2E; or
-  Selected granular fill (Class 6).

6.3.2. PRE-COMMENCEMENT EARTHWORKS TESTING FREQUENCY / PERFORMANCE

To determine the geotechnical classifications of any material to be placed and compacted in layers, representative samples will be taken at a frequency of **1 per 2,000m³** and submitted for particle size distributions (PSDs). Maximum Dry Density and Natural and Optimum Moisture Content determinations.

To determine the geotechnical classifications of any cohesive material to be placed and compacted in layers, representative samples will be taken (following removal of any inclusions of oversize material, metal, timber, plastic, etc.) at a frequency of **1 per 1,000m³** and submitted for liquid and plastic limits, plasticity index and natural moisture content determinations. Organic matter determinations shall be prescribed at the discretion of the supervising consultant, dependent on visual observations.

Representative samples of all proposed backfill shall be taken at a frequency of **1 per 3000m³ (minimum 3nr)** and submitted for Dry Density / Optimum Moisture Content analysis using either a 4.5Kg or 2.5kg rammer to determine the optimum moisture content and maximum dry density for the engineering of structural fill.

For an unaltered fill material to be deemed suitable for use, the natural moisture content must be within 2% (+/-) of the optimum to achieve the required maximum dry density. Where the laboratory test indicates that the soil parameters are outside this requirements, stabilising agents should be added to assess suitability for use to the contractors own design.



TABLE 6.1 E3P EARTHWORKS GEOTECHNICAL COMPACTION SPECIFICATION

SOIL/MATERIAL TYPE	CLASS	DESCRIPTION	COMPACTION EQUIPMENT	LAYER THICKNESS	ROLLER PASSES
Granular Fill (Sand and Gravel Matrices)	1 A	Sandy Gravel with some cobbles	> 5000 kg vibrating roller	225 mm	4
	1 B	Sand or Gravel of same grading size	> 5000 kg vibrating roller	250 mm	10
	1 C	Coarse gravels with many cobbles	> 5000 kg vibrating roller	400 mm	5
Cohesive Fill (Clay with Minor Sand and Gravel Component)	2 A	Wet Clay	> 1000 kg vibrating tamping roller (sheep foot only)	100–225 mm	3
	2 B	Dry Clay	> 5000 kg vibrating roller or 1400 kg tamping (trench roller)	225 mm or 125 mm	4 or 12
	2 C	Gravelly Clay	> 5000 kg vibrating roller or 1400 kg tamping (trench roller)	225 mm or 125 mm	4 or 12
	2 D	Silty/Sandy Clay	> 5000 kg vibrating roller or 1400 kg tamping (trench roller)	225 mm or 125 mm	4 or 12
Recycled Aggregate Crush (< 125 mm Well Graded)	6F2	Any combination of inert hard materials, other colliery spoil, or rock with substantial amounts of clay-like component	> 5000 kg vibrating roller	250 mm	6



6.3.3. USE OF FILL MATERIALS

In addition to any grading requirement, the maximum particle size of any fill material shall be no more than two-thirds of the compacted layer thickness except that cobbles having an equivalent diameter of more than 150 mm shall not be deposited within the restored surface level unless directed otherwise by the engineer. Un-burnt colliery spoil, pulverised fuel ash or furnace bottom ash shall not be used as a fill material.

6.4. GENERAL REQUIREMENTS

The contractor shall employ only plant and working methods that are suited to the materials to be handled and traversed. The contractor shall be responsible for maintaining the nature of the acceptable material so that when it is placed and compacted it remains acceptable in accordance with the contract.

For the purposes of this contract, the proposed earthworks requirements have been split into distinct end use categories, with the corresponding requirements for the earthworks specification assigned to individual areas.

TABLE 6.2 COMPACTION/BACKFILL REQUIREMENTS

LAND USE REQUIREMENT	COMPACTION METHODOLOGY AND GENERAL PERFORMANCE CRITERIA
Traditional Spread Foundation	Ensure no disturbance of natural soil at shallow depth.
Re-Engineering of Soils Using Vibro-Replacement Stone Column (VRSC)	Materials to be placed in a controlled manner to facilitate the construction of vibro-replacement stone columns (VRSC). to limit differential settlement and increase net Allowable Bearing Pressure (ABP) These works are to be completed within the building structure footprint and +2 m of all elevations. Material must be 90% granular in composition with less than 10% fines (which are classified as materials < 0.6 microns in size). CBR <7% on all upfill layers. No material greater than 125 mm in size is permitted, with 90% of the soils placed conforming to grading < 90 mm. Material is to be placed when actual moisture content is within tolerable limits of the optimum, with specific attention to soils that are notably wetter than the optimum. Material to be placed in a manner so as to ensure a minimum CBR of 5% at formation to facilitate machine movement and piling mat construction. Where site-won materials are used to upfill, levels must be compacted to an “end product” performance specification where the in-situ density exceeds 95% of the maximum (determined by laboratory conditions).



	Where rock is present at a shallow depth, the remediation contractor will ensure the substratum is prepared to ensure that a minimum of 1000 mm of appropriately graded granular material is present to the underside of the proposed doubly reinforced concrete strip foundation. The substratum must be prepared to ensure a vibro-stone column treatment depth is not less than 80% of the immediate adjacent profile.
Piled Foundation	All plot footprint (+ 2 m) must be free of any deleterious elements, tree roots and obstructions > 150 mm. Where upfill is proposed, material is to be placed using method compaction specification to achieve a CBR as required by the developer for piling mat construction. Piling mat is to be placed and constructed in accordance with the approved geotechnical engineer's temporary works design.
Adopted Highways (+ 2 m from Back of Footpath)	<i>Method Compaction – MCHW Specification For Highway Works Series 600</i> is to be followed, with in-situ validation testing to meet requirement of adoptions authority. A CBR > 5% is required at subgrade formation (prior to placement of capping).
Estate Roads	<i>Method Compaction – MCHW Specification For Highway Works Series 600</i> is to be followed to achieve a CBR > 5%.
Gardens, POS and Other External Areas	Material is to be placed in layers not exceeding 300 mm and must be rolled using dedicated plant (no earth moving equipment) and in general compliance with the requirements of <i>MCHW Specification For Highway Works Series 600</i>.

Acceptability shall be determined in accordance with Table 6/1 of the *Specification for Highway Works*.

Laboratory testing for the purposes of determining acceptability and compaction requirements will be conducted by the engineer.

Haulage of material to embankments or other areas of fill shall proceed only with sufficient spreading and compaction. Plant is operating at the place of deposition to ensure compliance with Clause 612 of the *Specification for Highway Works*.

No excavated acceptable material or unacceptable material required to be processed, other than surplus to the requirements of the contract, shall be removed from the site.

Where the excavation reveals a combination of acceptable and unacceptable materials, the contractor shall carry out the excavation in such a manner that the acceptable materials are excavated separately for use in the permanent works without contamination by the unacceptable materials. Unless otherwise described in the contract, classes of fill material required to be deposited separately shall be excavated separately without contamination by other classes of material.

The contractor shall make their own arrangements for the stockpiling of acceptable material, and unacceptable material to be processed, and for the provision of site for this purpose.



The contractor shall ensure that they do not adversely affect the stability of excavations or fills by their methods of stockpiling materials, use of plant or siting of temporary buildings or structures.

Topsoil shall, wherever practicable, be used immediately after its stripping and, if not, shall be stored in stockpiles of heights not exceeding 2 m. Topsoil shall not be stockpiled for more than two years. Topsoil shall not be unnecessarily trafficked, either before stripping or when in a stockpile. Stockpiles shall not be surcharged, or otherwise loaded and multiple handling shall be kept to a minimum.

Excavations requiring backfilling shall remain open only for the minimum period necessary.

The contractor shall keep earthworks free of water, including:

- ✿ Arranging the rapid removal of water:
 - shed on to the earthworks; and
 - entering the earthworks from any source;
- ✿ Provide, where necessary, temporary watercourses, drains, pumping and the like;
- ✿ Discharge accumulated water and groundwater into the permanent outfalls of the drainage system where practicable; and
- ✿ Provide adequate means for trapping silt on temporary systems discharging into permanent drainage systems.

The contractor shall carry out and maintain groundwater lowering or other treatment as required.

Where materials are designated either Class U1B or Class U2 (according to the *Specification for Highway Works*), the contractor shall carry out any special requirements for their handling. Where such materials are encountered during the progress of the works, the contractor shall make all necessary arrangements for their safe handling and disposal after consultation with the appropriate environmental authority.

6.4.1. CONSTRUCTION OF FILLS – HIGHWAYS

All fills shall be constructed:

- ✿ In the locations as shown in the contract drawings to the lines and levels stated therein;
- ✿ Of classes of material complying with this specification;
- ✿ By deposition, as soon as practicable after excavation, in layers to meet the compaction requirements as required for each class of material as specified; and
- ✿ To the requirements of this clause and any other requirements for fill in this specification.

Before commencing work on any area of fill, the contractor shall ensure that:

- ✿ The base is sound and stable by excavating and removing any topsoil as soft subsoil;
- ✿ Base layers are not exposed until the fill layer is ready for placement; and
- ✿ Uncompacted material on the side slopes of previously backfilled zones shall be removed and benches of between 1.0 m and 1.5 m height cut in compacted fill immediately prior to deposition of the new fill to ensure that the new backfill placed against the slope is properly integrated.



Whenever fill is to be placed on surfaces inclined at 1 vertical to 7 horizontal or steeper, the surface shall be benched immediately prior to deposition of the fill in order to achieve horizontal basal surfaces. The benches shall be between 1.0 m and 1.5 m in height.

Areas of fill shall, unless otherwise permitted by the engineer, be constructed evenly over their fullest possible extent and the contractor shall carefully control and direct construction plant and other vehicular traffic uniformly over the area of compacted fill. The minimum plan dimensions of any one panel of backfilling shall be properly integrated with areas of previous backfilling. Damage by construction plant and other vehicular traffic shall be made good by the contractor with material having the same characteristics and strength as the material had before it was damaged.

Temporary slopes within compacted and uncompacted backfill shall be formed at gradients that ensure stability.

6.4.2. CONSTRUCTION OF FILLS – ADOPTED HIGHWAYS, ESTATE ROADS AND CAR PARK

The contractor shall carry out compaction upon the materials that require to be compacted, as soon as practicable after deposition.

Compaction shall be either method as required for the classes of fill in Table 6/1 that require to be compacted.

The contractor shall obtain permission from the overseeing organisation before carrying out compaction requirements as listed in Table 6/1 for the class of material being compacted.

Method compaction shall be undertaken using the plant and methods appropriate to the compaction requirements as listed in Table 6/1 for the class of material being compacted.

Earthmoving plant shall not be accepted as compaction equipment nor shall the use of a lighter category of plant to provide any preliminary compaction to assist the use of heavier plant be taken into account when assessing the amount of compaction required for any layer.

If more than one class of material is being used in such a way that it is not practicable to define the areas in which each class occurs, the contractor shall compact with plant operating as if only the material which required the greater compaction effort is being compacted.

If the results of field tests show densities that indicate the state of the compaction to be inadequate, then if this is due to failure of the contractor to comply with requirements of the contract, the contractor shall carry out such further work as is required to comply with the contract.

Refer to Clause 612/10 of the *MCHW Specification for Highway Works* for definition of plant to be used in accordance with these specified works.

The contractor will be responsible for assessing the class of fill in accordance with Table 6/1 of the *Specification for Highway Works*. Table 6/4 of the *Specification for Highway Works* should then be employed to assess the method of compaction to be employed. The test results and method statements shall be submitted to the consulting engineers for approval.

6.4.3. UNACCEPTABLE MATERIAL

The contractor is solely responsible for ensuring full and detailed analysis of all reported ground conditions and areas of risk in terms of the potential for unacceptable material to be present within the proposed earthworks. Limitations in the available information should be highlighted to the supervising engineer prior to the commencement of earthworks. The contractor is to make full and unequivocal



arrangements to investigate the potential presence for unsuitable materials within the earthworks and construction of highway fill. All unsuitable materials are to be identified for removal in accordance with this specification.

Unacceptable material Class U1A shall be:

Material which does not comply with the permitted constituents and material properties of MCHW Table 6/1 and contract specific Appendix 6/1 for acceptable material; and;

Material, or constituents of materials, composed of the following unless otherwise described in contract specific Appendix 6/1:

- ✿ Peat, materials from swamps, marshes and bogs;
- ✿ Logs, stumps and perishable material;
- ✿ Materials in a frozen condition;
- ✿ Clay having a liquid limit determined in accordance with BS 1377: Part 2, exceeding 90 or plasticity index determined in accordance with BS 1377: Part 2, exceeding 65; and,
- ✿ Material susceptible to spontaneous combustion except unburnt colliery spoil complying with sub-Clause 15 of this Clause;(ii)unacceptable material.

Unacceptable material Class U1B shall be:

Contaminated materials, including controlled wastes (as defined in the Environmental Protection Act 1990 Part IIA) whose level of contamination is above that given either in contract specific Appendix 6/14 or in contract specific Appendix 6/15, but excluding all hazardous wastes (as Volume 1 Series 600 Specification for Highway Works Earthworks W2 Amendment – February 2016 defined in the Hazardous Waste (England and Wales) Regulations 2005) and radioactive wastes (as defined in the Radioactive Substances Act 1993).3(02/16).

Unacceptable material Class U2 shall be:(i) hazardous waste (as defined in the Hazardous Waste (England and Wales) Regulations 2005) and radioactive waste (as defined in the Radioactive Substances Act 1993).4(02/16).

Where required in contract, unacceptable material (other than Class U2) shall be processed by mechanical, chemical or other means to render the material acceptable for use in the permanent works in accordance with the requirements of Table 6/1 and contract specific MCHW Appendix 6/1.

6.5. EARTHWORKS MATERIAL TESTS

Prior testing of the potential sources of fill shall be undertaken by the contractor and submitted to the consulting engineers for approval. This testing shall include, but not necessarily be limited to, the compaction and backfill requirements detailed in Table 6.3.



TABLE 6.3 COMPACTION/BACKFILL REQUIREMENTS

LAND USE	COMPACTION METHODOLOGY and GENERAL PERFORMANCE CRITERIA				
Liquid and Plastic Limits	BS 1377: Part 2				
Grading	BS 1377: Part 2				
Uniformity Coefficient	Calculated from grading curve				
Moisture Content Multi-point moisture condition value (MCV) (to assess optimum moisture content).	BS 1377: Part 2				
Organic Matter (Maximum 2.5% Total Organic Content)	BS 1377: Part 3				
Water Soluble Sulphate	TRL Report 447 Test No 1				
Total Sulphate Content	TRL Report 447 Test No 4				
Earthwork In-situ Tests Subsequent to the filling and compaction of the material, a series of in-situ tests shall be undertaken to confirm the success of the compaction process. This testing shall include, but necessarily be limited to, the following: <table><tr><td>Test</td><td>Test Method</td></tr><tr><td>Plate Load Tests (Equivalent CBR of 5%)</td><td>BS 1377: Part 9</td></tr></table>	Test	Test Method	Plate Load Tests (Equivalent CBR of 5%)	BS 1377: Part 9	Clause 632 (BS 1377: Part 4)
Test	Test Method				
Plate Load Tests (Equivalent CBR of 5%)	BS 1377: Part 9				
Disposal of Materials The contractor shall be responsible for the safe disposal of any excess of unsuitable material found on the site.					
Proctor Compaction Testing	BS 1377: Part 4				

6.6. SPECIFICATION FOR GROUND IMPROVEMENT BY VIBRO-STONE COLUMN

The over-arching method and specification for the placement and compaction of non-compliant material where the fine constituent (< 0.63 micron) exceeds the standard requirements for ground improvement by VSC is given in Table 6.4 & 6.5.

TABLE 6.4 OVERVIEW OF WORKS OPERATIONS

Step 1	Carefully segregate materials excavated during civil engineering works (on-site and import) into the following soil types: ☛ Sand/granular soils; ☛ Dry sandy clay; ☛ Wet clay soil; and ☛ Silt. Ensure all stockpiles are sealed to minimise water ingress in approved locations.
---------------	---



Step 2	Analyse bulk sample from each (site-won or imported) soil matrix as per the requirements of the E3P specification for: ☞ Dry density/optimum moisture content (Procter); and ☞ Particle size grading coefficient.
Step 3	On-site observations in conjunction with particle size distribution (PSD) grading will confirm the classification of material and thus the corresponding method for compaction.
Step 4	The dry density/moisture content testing should be used to ensure that the material is within $\pm 3\%$ of the optimum to ensure compaction can be achieved.
Step 5	The classified material should be placed and compacted in accordance with the corresponding method for the material under conditions where the moisture content is within the tolerable limits. CBR <7%.
Step 6	Once placed and compacted, the required validation testing should be completed at formation to demonstrate compliance. The testing will include: ☞ In-situ density and air void ratio; ☞ Moisture condition value; and ☞ Undrained shear strength.

TABLE 6.5 COMPACTION AND VALIDATION OF NON-STANDARD MATERIAL BACKFILL TO VSC

REQUIRED PARAMETERS	THE COMPACTION MUST ACHIEVE THE FOLLOWING MATERIAL PARAMETERS:	
Verification Testing and Report	Bulk Density (ρ)	95% of the maximum dry density and must be within 3% of the optimum moisture content.
	All materials used for upfilling must be durable and inert.	
	In order to verify that the aforementioned material parameters have been attained, representative sampling and testing must be undertaken. All testing will be in accordance with BS EN ISO 17892-1:2014 and BS EN ISO 17892-2:2014. All testing is to be undertaken by a laboratory with the relevant UKAS accreditation. The following tests are required:	
	In-situ Density (ρ)	Approved methods of in-situ testing (i.e. calibrated nuclear density probe (NDP), sand replacement test).
	Moisture Content	Moisture content test.
	In-situ density testing on every 500 m ³ and in each layer of upfill well-spread over site within and around the proposed structures' footprint.	
	Testing must be from a range of depths throughout the treated fill. A minimum of six samples must be taken and tested.	



	A drawing depicting the location of each sample and test point must be provided along with a list of each point and the relevant test/sample depth. A list of all geotechnical testing results for each sample and test must be provided along with the relevant test certificates. If the soils are not suitable, due to the moisture content being higher than the optimum moisture content, then lime modification may also be required. The above is given strictly on the basis that it does not conflict with other elements of the project-specific requirements.
--	--

6.7. CURRENT AND PROPOSED SITE TOPOGRAPHY AND SLOPE INTERACTION

The current and proposed site topography, changes in elevation and any existing or new slopes are beyond the scope of this specification. Where any earth slopes exceed a design gradient of 1(v) in 3(h) either on-site or within the conjectured zone of structural influence, extreme care should be taken with a full and detailed geotechnical slope analysis to inform the retained design solution.



7. RECORD-KEEPING AND VERIFICATION

7.1. RECORD-KEEPING

During the course of the remediation and site enabling works, the on-site E3P consultant will undertake the following record-keeping protocols:

- ✳ Detailed daily site diary including material movements;
- ✳ Sampling register, testing results, photographs, details of locations of hydrocarbon-impacted soils (drawings), details of hotspot removals, details of consignment notes of any hydrocarbon-impacted material that is required to be disposed of off-site; and
- ✳ Detailed surveys (volumes).

Record-keeping on-site, in particular movements and analysis of specific material types, will be in the form of site diaries and a remediation excavation record. This record will remain on-site and will be completed by the E3P on-site engineer during the course of the remediation and site enabling works.

7.2. VERIFICATION

The records listed above will then be compiled into a validation report produced by E3P on completion of the remediation and site enabling works, clearly referencing the origin of the materials used and testing carried out to confirm its suitability for use, where required. E3P will also prepare an as-built development drawing clearly detailing the materials present on-site to be cross referenced with the supporting validation documentation.

The validation report will include the following:

- ✳ Remediation strategy (including copies of confirmation from regulatory authorities agreeing criteria);
- ✳ Detailed surveys of all excavations and production of as-built drawings for the earthworks;
- ✳ Copy of consignment notes relating to the movement of wastes to a licensed waste management facility;
- ✳ Detailed drawings showing all sampling locations for both chemical and geotechnical testing;
- ✳ Chemical test results;
- ✳ Geotechnical test results;
- ✳ Details of qualified persons signed declaration; and
- ✳ Monitoring results if undertaken (e.g. asbestos in air, gas water).



8. CONTINGENCY PLAN

8.1. PREVIOUSLY UNIDENTIFIED CONTAMINANTS

Should significantly impacted material be encountered during the development, then it will be excavated and stockpiled on an impermeable material and sampled and tested for an appropriate range of determinants.

Once the laboratory analysis of the material is available, an assessment will be undertaken to determine whether it can be retained on-site as part of the material management plan or whether it should be disposed of off-site.

Depending on the nature of any such impact, it may be necessary to undertake validation testing of the excavation faces in order to demonstrate that no such materials are left in situ.



9. SECOND PHASE MITIGATION AND MANAGEMENT – BUILD PHASE

This document details the construction works that are required to ensure full compliance with the remediation Strategy, Regulatory Authorities, Building Control & Warranty Providers;

The following should be implemented during the build phase of the development:

- ✳ Laboratory testing of the imported topsoil;
- ✳ Chemical validation of any additional subsoil imported for use within gardens;
- ✳ Placement of the 600 mm clean cover system underlain by a geotextile membrane within rear garden areas;
- ✳ Construction of a 300 mm clean cover system within front gardens deemed to be functional landscaping;
- ✳ Construction of a 300 mm clean cover system within areas of soft landscaping and POS.
- ✳ Installation and validation of ground gas protection measures; and
- ✳ Installation of vapour resistant membranes (if required following further assessment).

The validation protocols are presented within the E3P Remediation and Enabling Works Strategy and are presented below.

9.1. PLACEMENT OF COVER SYSTEM

The Remediation and Enabling Works Strategy for the site, with respect to human health of the future site users includes the provision of a chemically suitable clean material to be installed in all rear gardens, front gardens, areas of soft landscaping and public open space; the construction of the clean cover / placement of clean material shall consist of:

Rear Gardens:

- ✳ Geotextile membrane;
- ✳ 450 mm subsoil; and
- ✳ 150 mm topsoil.

Front gardens, soft landscaping and areas of POS:

- ✳ 150 mm subsoil; and,
- ✳ 150 mm topsoil.

In accordance with the current requirements of the regulatory authorities, validation samples will be collected from all materials that are to be imported or re-used on-site to confirm the proposed development will pose no unacceptable risk to human health or the wider environ.

Subsoil and topsoil shall be free of any deleterious materials, such as buildings materials, timber, plastics, etc and conform to the requirements of BS 3882:2007.

Testing requirements for top-soil and sub-soil are presented in Table 9.1.



TABLE 9.1 SPECIFICATION FOR SOIL TESTING

MATERIAL USE	TESTING FREQUENCY	SUITE OF ANALYSIS
Subsoil Greenfield Source (450 mm Garden Cover)	1 Sample per 200 m ³	A/B/C/D
Subsoil Brownfield Source (450 mm Garden Cover)	1 Sample per 50 m ³	A/B/C/D
Topsoil Greenfield Source (150 mm Garden Cover)	1 Sample per 200 m ³	A/B/C/D
Topsoil Brownfield Source (150 mm Garden Cover)	1 Sample per 50 m ³	A/B/C/D
General Engineering Fill (Class 1 and 2 Soil)	1 Sample per 1000 m ³	A/B/C/D

Notes

Suites of Analysis:

- A. Speciated PAH.
- B. Speciated TPH (C5-C35).
- C. Asbestos (ID).
- D. CLEA Inorganic Heavy Metals.

9.1.1. PROCEDURE FOR PLACEMENT OF CHEMICALLY SUITABLE COVER SYSTEM

The placement of 600 mm of clean material in rear gardens and 300 mm of clean material in front gardens, areas of soft landscaping and POS will be undertaken during the build phase works of the project.

Rear gardens need a geotextile membrane to be installed before been backfilled with 450 mm chemically validated subsoil, with 150 mm topsoil overlaying this. Topsoil is required to be confirmed as chemically suitable prior to placement. Where sub-soil is not placed during Remediation & Enabling works, E3P will be required to return to site and undertake independent validation of the correct placement of sub-soil.

Front gardens, areas of soft landscaping and POS need to be backfilled with 150 mm chemically validated subsoil, with 150 mm topsoil overlaying this.

The placement of subsoil and corresponding validation will be documented within the Garden Validation Letters (to be issued on completion of the contractor's works).

If proposed utilities are to be placed within the cover system, the clean cover should be placed prior to installation of these utilities.

If natural drift deposits are encountered, excavation can cease here.

E3P will collect photographic evidence of the placement of 150 mm of certified topsoil and 450 mm of subsoil in rear gardens on completion of construction works. This element will also be checked by the Building Control Officer as part of the site completion prior to issuing of a CML certificate.

The garden validation procedure is detailed in Table 9.2.



TABLE 9.2 GARDEN VALIDATION PROCEEDURE

PROCEDURE	METHOD
Chemical Validation	Imported sub-soils and topsoil will need to be chemically analysed to confirm suitability for use with the proposed cover system prior to installation and completion of the garden systems. E3P will issue an email to the appropriate party with an assessment of the chemical suitability of both sub soils and topsoils. If acceptable the materials can be installed to the required depth at which time the plot will be deemed complete following a validation procedure by a suitability qualified E3P engineer.
Trial Holes	Trial holes are deemed necessary for all plots given that the 600 mm cover system will need to be placed on each plot rear garden during the build phase. Photographs should reveal the underlying geotextile membrane. Trial holes within front garden areas will be undertaken at 1 every ten plots, given that these are deemed as functional landscaping, to validate the correct installation of 300 mm cover. Areas of soft landscaping and POS will have a minimum of 1 trial hole per landscaped area, with additional trial holes undertaken every 1 per 50 m2, given that 300 mm cover systems are required in these areas.
Validation	Photographic evidence will be taken by E3P of the topsoil placement demonstrating the depth of topsoil and practical completion of works are required for each and every plot. For plots where sub-soil depths require validation by E3P during the build phase, photographs will be taken and collated by E3P.
Validation Certificate	Once the photographs of the placement of topsoil (over the clean material) have been provided, E3P will issue a plot specific validation certificate to demonstrate that the required subsoil and topsoil has been placed in the required garden plots along with the chemical analysis.
Completion Report	Upon completion of all gardens and landscaped areas within the development, a Completion Report will be issued providing the confirmation that all remediation requirements have been achieved.

Plate 1 provides an example of a garden validation photographs that will be required for each plot.



PLATE 1 **EXAMPLE PLOT COVER SYSTEM VALIDATION**

Plot No: 70		
Depth of Strata (m bgl)	0.00-0.15	Validated TOPSOIL
	0.15-0.60	Validated SUBSOIL
Depth of Cover System Materials		Depth of Cover System Materials
		
Depth of Cover System at Ground Level		Depth of Cover System in Relation to Plot
		

9.3. GROUND GAS PROTECTION MEASURES

Ground gas monitoring suggests that the site can be predominantly classified as CS1/Green. However, CS2/Amber 1 measures are recommended for the whole site due to the presence of the historical landfill (eastern section of the Tack Lea Works area). Specialist mitigation measures will need to be constructed in accordance with BS8485 (2015)+A1(2019).

Vapour resistant membranes may be required depending on the residual risk which will be assessed through a vapour monitoring programme.

Design and validation of gas and vapour mitigation measures will be detailed within a specific build phase mitigation strategy.

9.4. POTABLE WATER SUPPLY – CONTAMINANT ASSESSMENT CRITERIA

Table 9.3 provides a summary of the threshold concentrations that must not be exceeded within remediated ground at pipeline depth in order to PE pipe works to be acceptable for the proposed development.

TABLE 9.3 PIPELINE SELECTION PE THRESHOLD CONCENTRATIONS

Contaminant Group	PE-threshold
Total VOC	0.5
Total BTEX And MTBE	0.1
Total SVOCs (Excluding PAH and those substances marked with an *)	2
EC5-EC10 Aliphatic and Aromatic Hydrocarbons	2
EC10-EC16- Aliphatic and Aromatic Hydrocarbons	10
EC16-EC40 Aliphatic and Aromatic Hydrocarbons	500
Phenols (From SVOC Analysis)*	2
Cresols and Chlorinated Phenols (From SVOC Analysis)	2
Ethers*	0.5
Nitrobenzene*	0.5
Ketones*	0.5
Aldehydes*	0.5
Amines	Fail

Upon completion of the remedial works a full UKWIR Risk Assessment should be undertaken.

END OF REPORT



APPENDIX I

LIMITATIONS

1. This report and its findings should be considered in relation to the terms of reference and objectives agreed between E3P and the Client as indicated in Section 1.2.
2. For the work, reliance has been placed on publicly available data obtained from the sources identified. The information is not necessarily exhaustive and further information relevant to the site may be available from other sources. When using the information it has been assumed it is correct. No attempt has been made to verify the information.
3. This report has been produced in accordance with current UK policy and legislative requirements for land and groundwater contamination which are enforced by the local authority and the Environment Agency. Liabilities associated with land contamination are complex and requires advice from legal professionals.
4. During the site walkover, reasonable effort has been made to obtain an overview of the site conditions. However, during the site walkover, no attempt has been made to enter areas of the site that are unsafe or present a risk to health and safety, are locked, barricaded, overgrown, or the location of the area has not been made known or accessible.
5. Access considerations, the presence of services and the activities being carried out on the site limited the locations where sampling locations could be installed and the techniques that could be used.
6. Site sensitivity assessments have been made based on available information at the time of writing and are ultimately for the decision of the regulatory authorities.
7. Where mention has been made to the identification of Japanese Knotweed and other invasive plant species and asbestos or asbestos-containing materials, this is for indicative purposes only and do not constitute or replace full and proper surveys.
8. The executive summary, conclusions and recommendations sections of the report provide an overview and guidance only and should not be specifically relied upon without considering the context of the report in full.
9. E3P cannot be held responsible for any use of the report or its contents for any purpose other than that for which it was prepared. The copyright in this report and other plans and documents prepared by E3P is owned by them and no such plans or documents may be reproduced, published or adapted without written consent. Complete copies of this may, however, be made and distributed by the client as is expected in dealing with matters related to its commission. Should the client pass copies of the report to other parties for information, the whole report should be copied, but no professional liability or warranties shall be extended to other parties by E3P in this connection without their explicit written agreement there to by E3P.
10. New information, revised practices or changes in legislation may necessitate the re-interpretation of the report, in whole or in part.



APPENDIX II

GLOSSARY

TERMS

ACM	Asbestos-containing material	MMP	Materials management plan
ADS	Acoustic design statement	ND	Not detected
AST	Above-ground storage tank	NDP	Nuclear density probe
BGS	British Geological Survey	NMP	Noise management plan
BSI	British Standards Institute	NPSE	Noise policy statement for England
BTEX	Benzene, toluene, ethylbenzene, xylenes	NR	Not recorded
CA	Coal Authority	PAH	Polycyclic aromatic hydrocarbon
CBR	California bearing ratio	PCB	Polychlorinated biphenyl
CIEH	Chartered Institute of Environmental Health	PI	Plasticity index
CIRIA	Construction Industry Research Association	PID	Photo ionisation detector
CLEA	Contaminated land exposure assessment	POS	Public open space
CML	Council of Mortgage Lenders	PPE	Personnel protective equipment
CoC	Contaminants of concern	ProPG	Professional practice guidance
CSM	Conceptual site model	QA	Quality assurance
DNAPL	Dense non-aqueous phase liquid (chlorinated solvents, PCB)	SGV	Soil guideline value
DWS	Drinking water standard	SPH	Separate-phase hydrocarbon
EA	Environment Agency	SPT	Standard penetration test
EQS	Environmental quality standard	SVOC	Semi-volatile organic compound
FFL	Finished floor level	TPH	Total and speciated petroleum hydrocarbon
GAC	General assessment criteria	TPH CWG	Total Petroleum Hydrocarbon (Criteria Working Group)
GL	Ground level	UKWIR	United Kingdom Water Infrastructure Risk
GSV	Gas screening value	UST	Underground storage tank
HCV	Health criteria value	VCC	Vibro-concrete column
ICSM	Initial conceptual site model	VOC	Volatile organic compound
LEL	Lower explosive limit	VRSC	Vibro-replacement stone columns
LMRL	Lower method reporting limit	VSC	Vibro-stone columns
LNAPL	Light non-aqueous phase liquid (petrol, diesel, kerosene)	WHO	World Health Organisation
MCV	Moisture condition value	WRAP	Waste and Resources Action Programme
MIBK	Methyl isobutyl ketone	WTE	Water table elevation
m	Metres	ppm	Parts per million



Land at Greenbooth Road and Edenfield Road, Norden
Remediation and Enabling Works Strategy
September 2023

km	Kilometres	mg/m³	Milligram per metre cubed
% v/v	Percent volume in air	m bgl	Metres below ground level
mb	Millibars (atmospheric pressure)	m bcl	Metre below cover level
l/hr	Litres per hour	m AOD	Metres above ordnance datum (sea level)
µg/l	Micrograms per litre (parts per billion)	kN/m²	Kilonewtons per metre squared
ppb	Parts per billion	µm	Micrometre
mg/kg	Milligrams per kilogram (parts per million)	SSRT	Site Specific Remediation Target
PSD	Particle Size Distribution	DD	Dry Density
CL:AIRE	Contaminated Land: Applications in Real Environments	Mc	Moisture Content
ρ	Bulk Density	GPR	Ground Penetrating Radar
NDP	Nuclear Density Probe	FFL	Finished Floor Level
LEL	Lower Explosive Limit	UKWIR	UK Water Industry Research
CIRIA	Construction Industry Research and Information Association	LOD	Limit of Detection

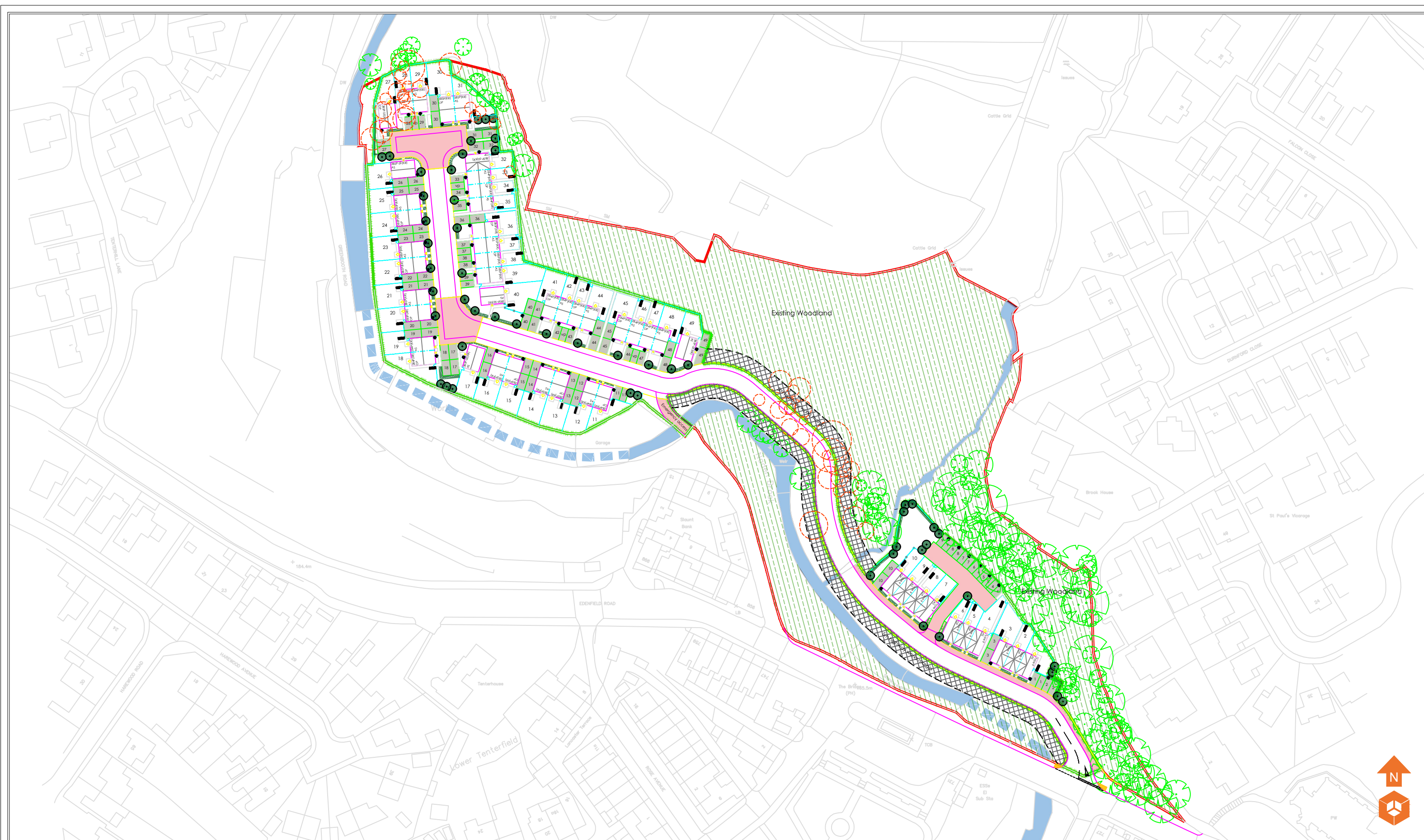


APPENDIX III

DRAWINGS

DRAWING 16-465-001 – SITE LOCATION PLAN





Notes:				
P1	REVC	16.06.2023	OW	MW
P1	REVB	20.03.2023	EB	RJW
P1	REVA	17.11.2022	OW	MD
Phase	Issue	Date	Drawn	Checked

Client:	Stonebond Properties Ltd
Job Title:	Land at Greenbooth Road and Edenfield Road, Norden

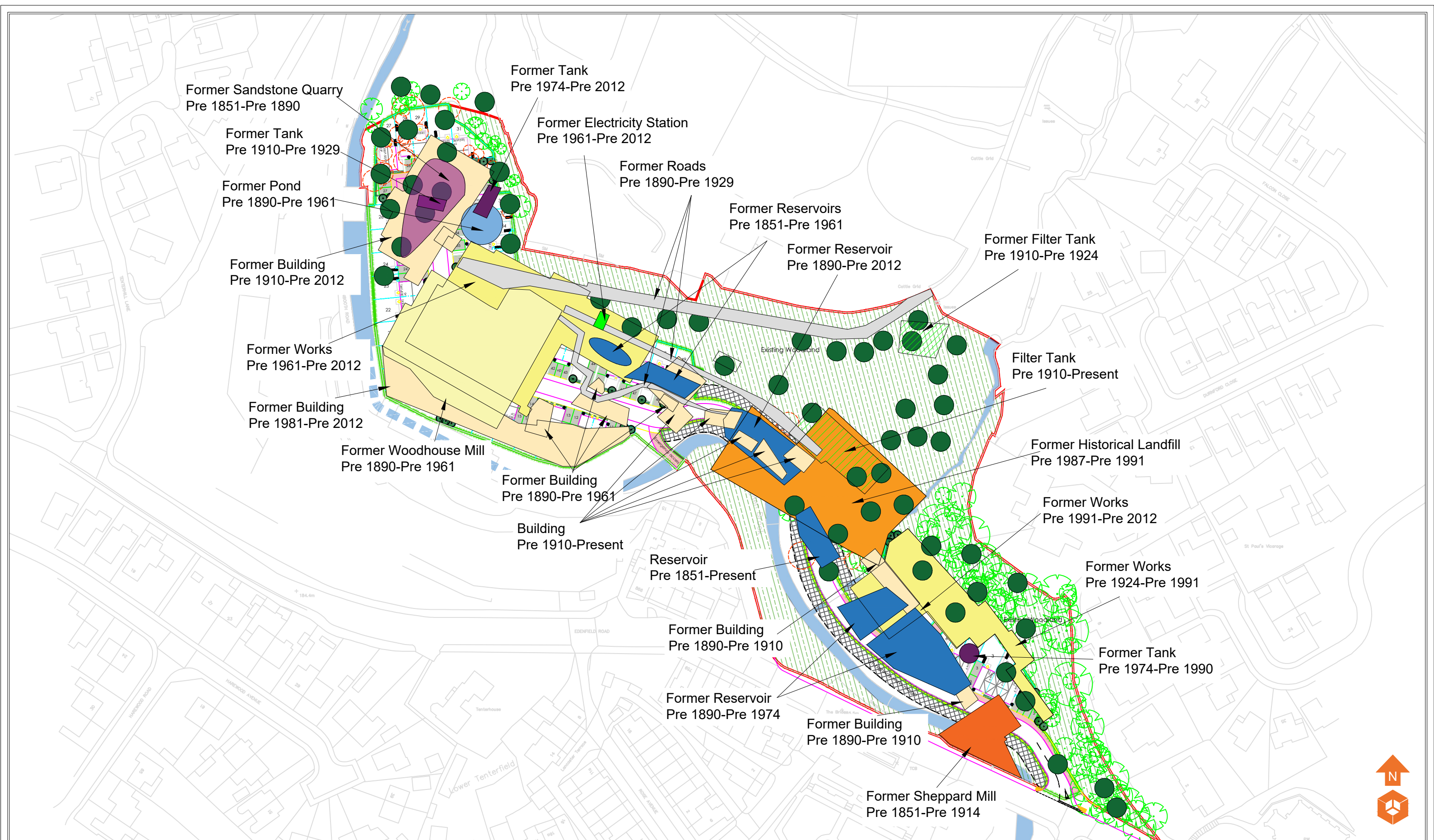
Job No:	16-465
Drawing No:	002

Date:	16.06.2023
Scale:	NTS@ A3
Drawing Title:	Proposed Development Plan



Environmental Engineering
Partnership Ltd
Taylor Road, Trafford Park
Urmston, Manchester, M41 7JQ
Tel: 0161 707 9612
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Website: www.e3p.co.uk

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Historical Features

Former Buildings	Former Filter Tanks
Former Woodhouse Mill	Former Sandstone Quarry
Works	Former Electricity Station
Former Water	Former Tanks
Former Ponds	Former Historical Landfill
Former Reservoir	
Former Sheppard's Mill	
Former Roads	
Former Vegetation	

Notes:

P1	REVG	04.07.2023	EB	MW
P1	REVF	06.06.2023	OW	MW
P1	REVE	11.04.2023	LM	MW
P1	REVD	14.12.2022	OW	MW
P1	REVC	12.12.2022	OW	MW
P1	REVB	05.12.2022	EB	HM
P1	REVA	31.10.2022	OW	MD
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd

Job Title:

Land at Greenbooth Road and Edenfield Road, Norden

Job No:

16-465

Drawing No:

003

Drawing Title:

Historical Features Plan

Date:

04.07.2023

Scale:

NTS @ A3

e3p

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Site Features

- Access Points
- Hard Standing
- Structures
- Surface Water Features
- Site Boundary
- Slope Direction
- Retaining Walls
- Access Bridge
- Spring
- Filter Tanks
- Gas Substation
- Vegetation
- Earth Bank
- Rock Outcrop
- Filter Tank
- Chimney Flue
- Chimney

Notes:

P1	REVI	05.07.2023	EB	MW
P1	REVH	04.07.2023	EB	MW
P1	REVG	06.06.2023	OW	MW
P1	REVF	15.05.2023	OW	MW
P1	REVE	17.04.2023	LM	MW
P1	REVD	11.04.2023	LM	MW
P1	REVC	14.12.2022	OW	MW
P1	REVB	17.11.2022	OW	MD
P1	REVA	28.10.2022	OW	MD
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond
Properties Ltd

Job Title:

Land at Greenbooth Road and
Edenfield Road, Norden

Job No:

16-465

Drawing No:

004

Drawing Title:

Site Features Plan

Date:

05.07.2023

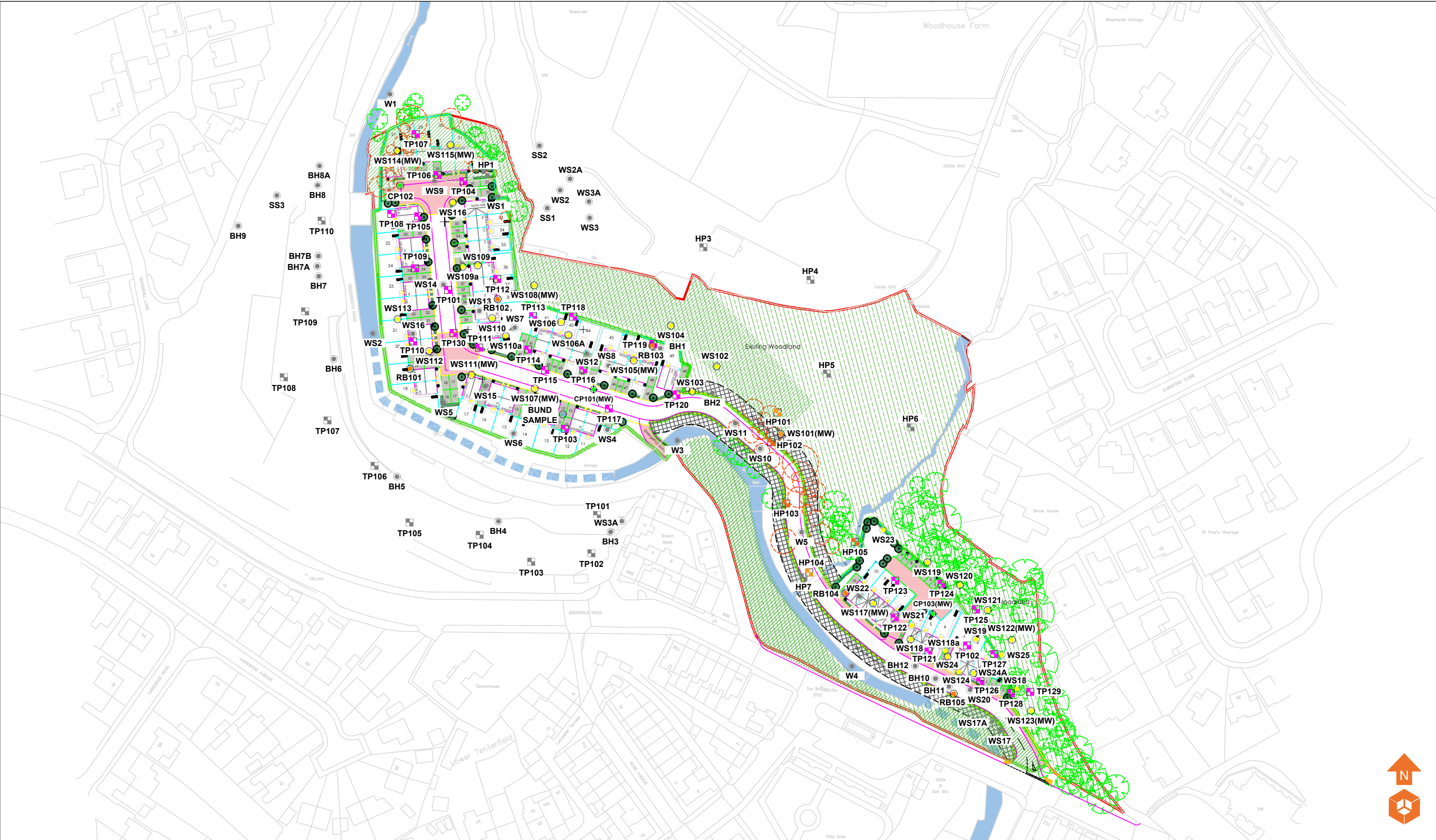
Scale:

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Location Symbols	
	Approximate Window Sample Probehole Location
	Approximate Trial Pit Location
	Approximate Cable Percussive Borehole Location
	Approximate Hand Dug Pit Location
	Bund Sample Location
	Approximate Hand Dug Pit Location (Enica - April 2006)
	Approximate Trial Pit Location (Enica - April 2006)
	Approximate Window Sample Probehole Location (Enica - April 2006)
	Approximate Borehole Location (Enica - April 2006)

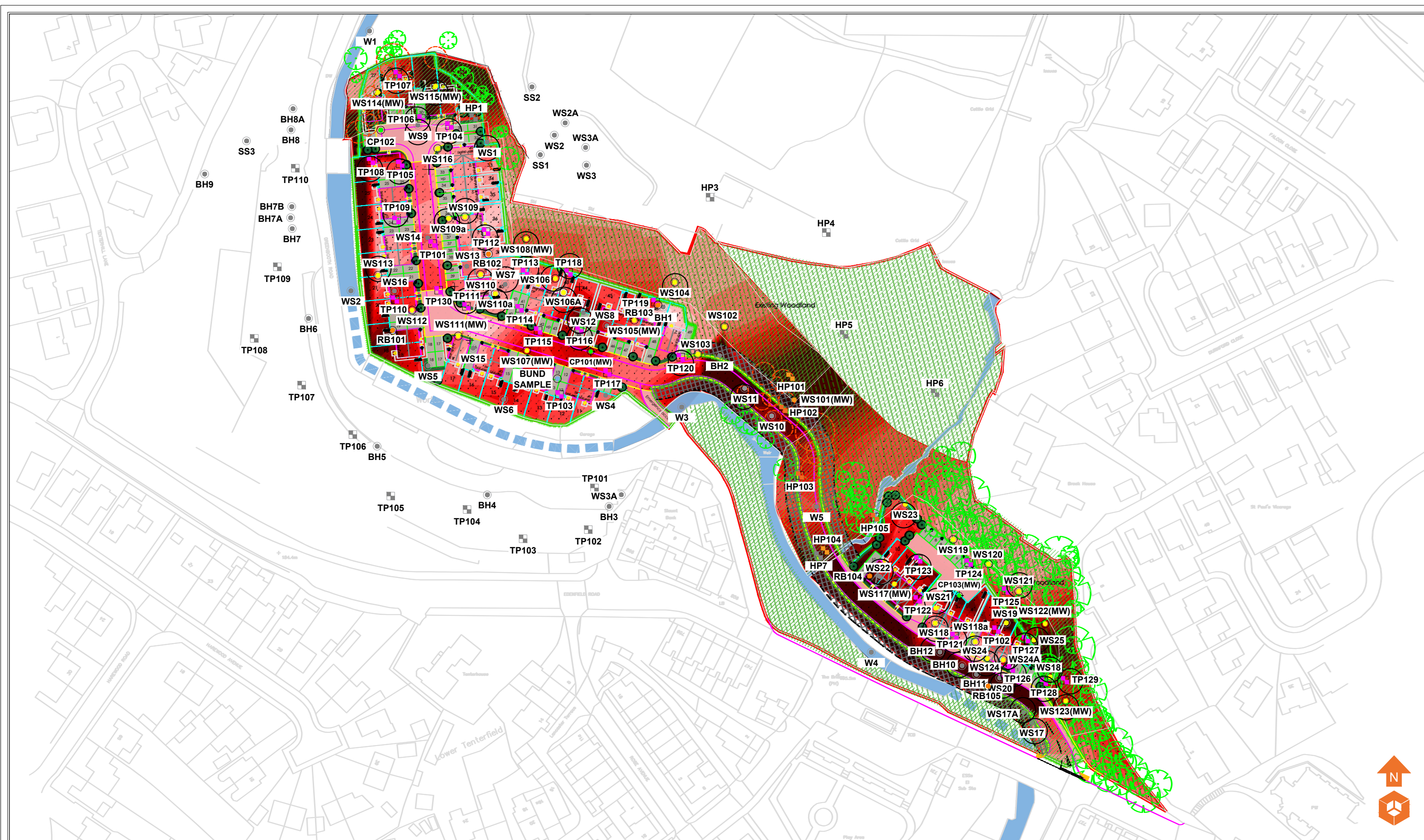
Notes:				
Phase	Issue	Date	Drawn	Checked
P1	REVJ	06.06.2023	EB	MW
P1	REVJ	26.04.2023	OW	MW
P1	REVH	25.04.2023	EB	MW
P1	REVG	17.04.2023	LM	MW
P1	REVF	12.04.2023	LM	MW
P1	REVJ	16.03.2023	LM	NS
P1	REVD	16.01.2023	EB	HM
P1	REVC	15.12.2022	LM	HM
P1	REVB	23.11.2022	OW	MW
P1	REVA	08.11.2022	OW	MW

Client:
Stonebond Properties Ltd
Job Title:
Land at Greenbooth Road and Edenfield Road, Norden

Job No:
16-465
Drawing No:
005
Date:
04.07.2023
Scale:
NTS@ A3
Drawing Title:
Exploratory Hole Location Plan

Environmental Engineering Partnership Ltd
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Location Symbols

- Approximate Window Sample Probehole Location
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- Bund Sample Location
- Approximate Hand Dug Pit Location (Enica - April 2006)
- Approximate Trial Pit Location (Enica - April 2006)
- Approximate Window Sample Probehole Location (Enica - April 2006)
- Approximate Borehole Location (Enica - April 2006)

Made Ground Depth (m)

- Depth of Made Ground 0.00 - 0.99m
- Depth of Made Ground 1.00 - 1.99m
- Depth of Made Ground 2.00 - 2.99m
- Depth of Made Ground 3.00 - 3.99m
- Depth of Made Ground 4.00 - 4.99m
- Depth of Made Ground >5.00m
- Full extent of Made Ground not identified

Notes:

P1	REVD	12.07.2023	OW	MW
P1	REVC	12.04.2023	LM	MW
P1	REVB	16.01.2023	EB	HM
P1	REVA	15.12.2022	LM	HM
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties
Ltd

Job Title:

Land at Greenbooth Road and
Edenfield Road, Norden

Job No:

16-465

Drawing No:

006

Drawing Title:

Depth of Made Ground Plan

Date:

12.07.2023

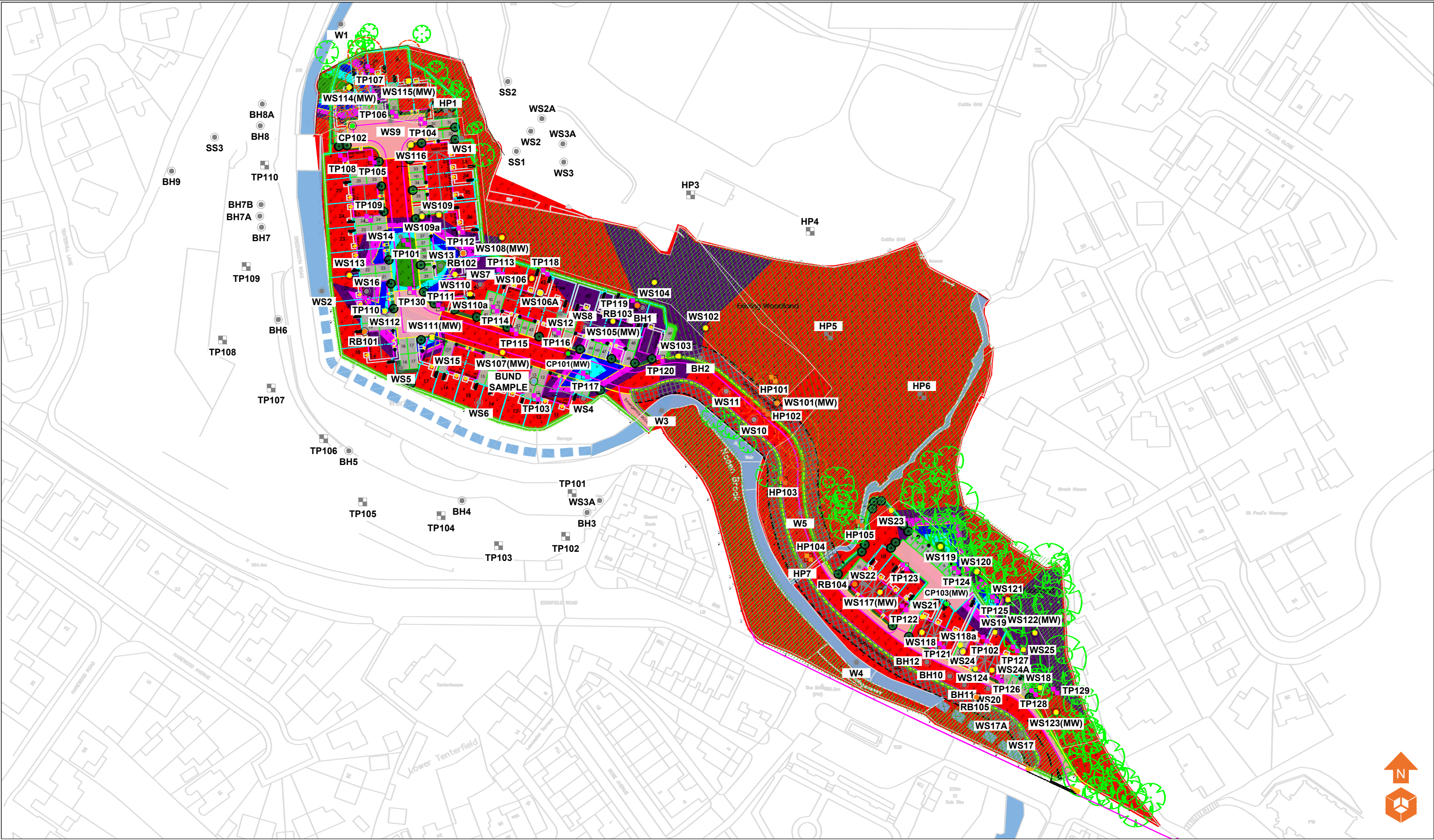
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Location Symbols

- WS101 Approximate Window Sample Probehole Location
- TP101 Approximate Trial Pit Location
- CP101 Approximate Cable Percussive Borehole Location
- BH101 Approximate Hand Dug Pit Location
- BUND101 Bund Sample Location
- WS101 (Enica - April 2006) Approximate Window Sample Probehole Location (Enica - April 2006)
- TP101 (Enica - April 2006) Approximate Trial Pit Location (Enica - April 2006)
- WS101 (Enica - April 2006) Approximate Window Sample Probehole Location (Enica - April 2006)
- BH101 (Enica - April 2006) Approximate Borehole Location (Enica - April 2006)
- RB101 Approximate Rotary Borehole Location

Shallow Spread Footings

- Depth to Founding Strata 0.00 - 1.24m
- Depth to Founding Strata 1.25 - 1.49m
- Mass Trench Fill Footings
- Depth to Founding Strata 1.50 - 1.74m
- Depth to Founding Strata 1.75 - 1.99m
- Depth to Founding Strata 2.00 - 2.24m
- Engineered Footings
- Depth to Founding Strata 2.25 - 2.49m
- Depth to Founding Strata >2.50m

Notes:

P1	REVC	26.07.2023	OW	MW
P1	REVB	16.01.2023	EB	HM
P1	REVA	03.01.2023	EB	HM
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd
Greenbooth Road and Edensfield Road, Norden

Job No:

16-465
Drawing No:
008

Date:

26.07.2023
Scale:
NTS@ A3



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Summary of Heave Precaution Requirements				
Volume Change Potential	Required Foundation Depth (m)	Minimum Void Dimensions for Foundations, Ground Beams & Suspended In-Situ Concrete Ground Floors		Minimum Void Dimensions Under Pre-Cast Concrete & Suspended Timber Floors
		Thickness of Void Former Against Side of Foundation of Ground Beam (mm)	Thickness of Void Former or Underside of Edge Beam & Floor Slab (mm)	Void Dimension (mm)
Low Volume Change Potential (<20%)	>2.00	No Special Precautions		200
	2.00-2.50	-	50	
Medium Volume Change Potential (20-40%)	1.50-2.00	25	50	250
	2.00-2.50	25	100	
High Volume Change Potential (>40%)	>2.50	Engineer Design		Engineer Design
	1.50-2.00	25	75	
	2.00-2.50	35	150	300
	>2.50	Engineer Design		Engineer Design

Minimum Width of Strip Footings								
Type of Ground (Including Engineered Fill)		Condition of Ground	Total Load of Load-Bearing Walling more than (kN/linear metre)					
			20	30	40	50	60	70
			Minimum Width of Strip Foundation (mm)					
Gravel	Sand	Medium Dense to Dense	250	300	400	500	600	650
Clay	Sandy Clay	Stiff	250	300	400	500	600	650
Clay	Sandy Clay	Firm	300	350	450	600	750	850

Items Considered	
Bearing Capacity	TBC
Trees	TBC
Historical	TBC
Groundwater Table	TBC
FFL	TBC
Client Layout	TBC
Contamination	TBC
Remediation	TBC
Volume Change Potential	TBC
Root Protection Areas	TBC
Is the Site Affected by Shallow Mining?	Yes/No
Are Mine Entries Present on or Within Influencing Distance of the Site?	Yes/No
Are Retaining Structures Present on the Site?	Yes/No (If on site and more than 900mm height diff. add geotechnical issues triangle)

Residual Risks			
Foreseeable Risks That Cannot be Avoided	Applicable (Y/N)	Action to Reduce Risk	Justification for Design Decision
Deep Excavations	Y	Identify locations on drawing and depths on schedule	Lesser risk than other alternatives
Trench Collapse	Y	Risk highlighted on drawing	Lesser risk than other alternatives
Use of Working Platform for Pile/Vibro Operations	Y	Compliance with working platform directive required	Pile/Vibro foundation less risky than other alternatives

Coal Mining Foundation Notes:

Where foundations are located over treated shallow workings spread and trench fill foundations (strips and rafts) are required to be suitably reinforced to span soft spots (3m span and 1.5m cantilever). It is desirable to maintain bearing pressures below 160kNm/m2 at the grouted horizons - Piles are not generally suitable unless founded below the grouted horizons (typically, this cannot be achieved with driven piles) and would require further detailed assessment. There is also a potential for pile installation to disturb workings or shafts Refer to CIRIA SP32 and C758 for details. Foundations, which encounter coal, should be brought below the coal. The sides of foundations should be protected when they are in contact with coal.



Anticipated Foundation Types

- TS** Traditional Strip Foundations
Minimum depth 900mm below proposed First Finished Level.
Maximum safe bearing pressure limited to 100kN/m2.
- MT** Mass Trench Fill Foundations
Minimum depth 1200mm below proposed First Finished Level.
Maximum safe bearing pressure limited to 100kN/m2.
- V** Vibro Stone Ground Compaction
In accordance with NBSIC Chapter 4.2.
- P** Piled Foundations
Where the proposed foundation depth exceeds 2.50m a piled foundation option rather than a trench fill / deep reinforced strip foundations may be adopted. Columns or tie beams supported by ground beams.
- R** Raft Foundations
Minimum safe bearing pressure limited to 50kN/m2 on approved engineered granular fill. Raft foundations to be designed by a structural engineer in accordance with Chapter 4.5 of NBSIC 2019. Raft foundations are considered suitable to mitigate against potential differential clay heave. Foundation in accordance with Section 4.2, sub-section 2(b).
- TB** Traditional Strip / Trench Block Foundations
Foundation strip installed at 600mm lower corner level with wall up to Trench Block and subsequent backfill to development level.
- Colours on Plot Corners to be Used When Referring to Foundation Schedule.
(Opening First Layer & Levels)

Depth to Target Founding Strata

- Footings 0.75 - 0.90m Deep
From First Finished Level
In accordance with NBSIC Chapter 4.2
- Footings 0.90 - 1.25m Deep
From First Finished Level
In accordance with NBSIC Chapter 4.2
- Footings 1.25 - 1.50m Deep
From First Finished Level
In accordance with NBSIC Chapter 4.2
- Footings 1.50 - 1.75m Deep
From First Finished Level
In accordance with NBSIC Chapter 4.2
- Footings 1.75 - 2.00m Deep
From First Finished Level
In accordance with NBSIC Chapter 4.2
- Footings 2.00 - 2.25m Deep
From First Finished Level
In accordance with NBSIC Chapter 4.2
- Footings 2.25 - 2.50m Deep
From First Finished Level
In accordance with NBSIC Chapter 4.2

Engineered Foundation Solutions

- Footings >2.50m Deep
From First Finished Level
In accordance with NBSIC Chapter 4.2
- Vibro
- Low Volume Change Potential Clay
Heave precautions required to underside of cast in-situ floor slab (with no sub-floor void) within corrected zone of tree influence. Heave precautions not required to foundation.

Structural Design Risk Management
Abnormal residual risks associated with the design outcomes on the drawing:

- Abnormal
- Abnormal

Tree Influence (Retained / Removed)

- 0.90 - 1.25m
- 1.25 - 1.50m
- 1.50 - 1.75m
- 1.75 - 2.00m
- 2.00 - 2.25m
- 2.25 - 2.50m
- >2.50m

Notes:				
P1	REVA	03.08.2023	OW	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd

Job Title:

Land Greenbooth Road and Edenefield Road, Norden

Job No:

16-465

Drawing No:

009

Date:

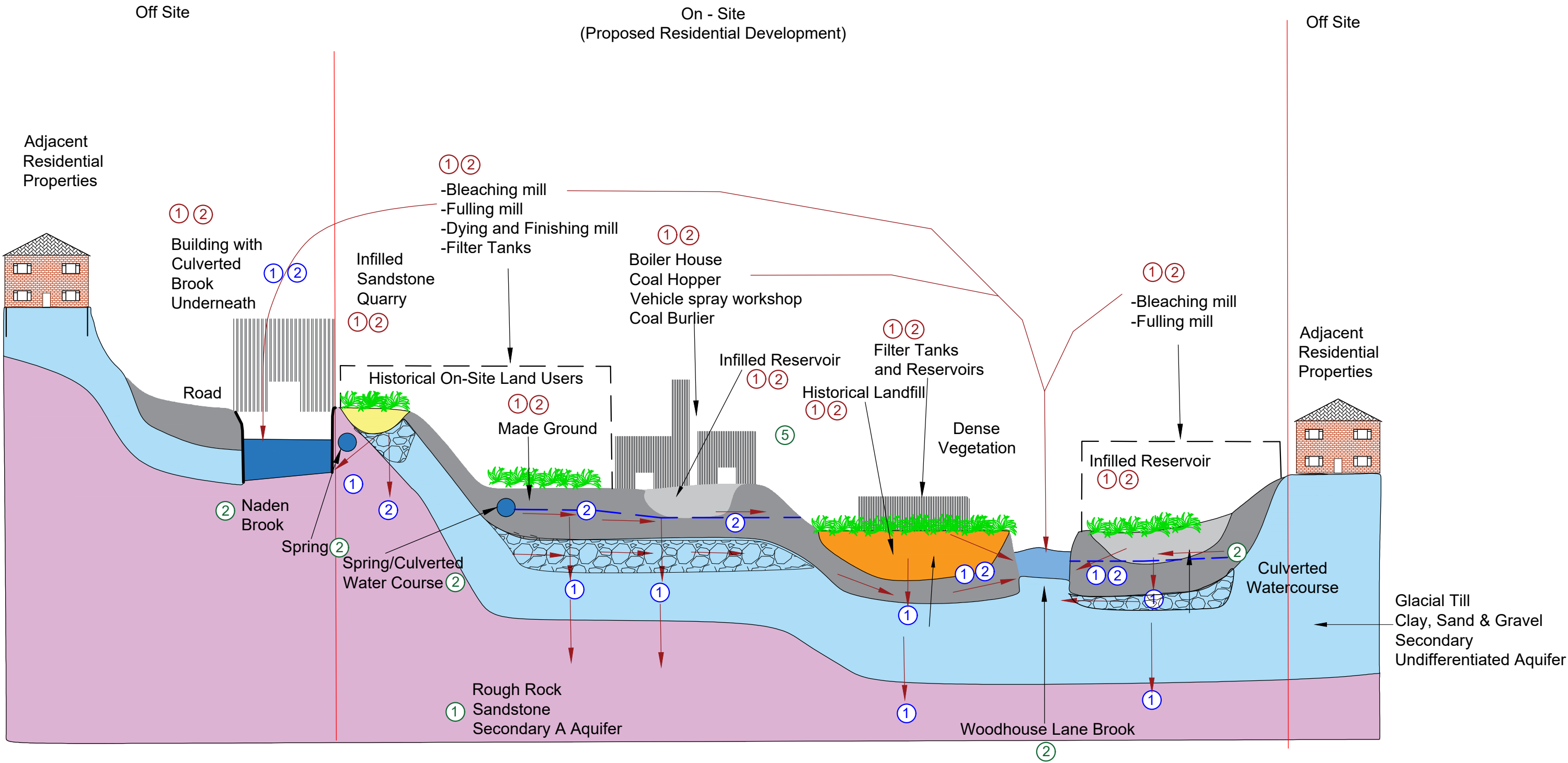
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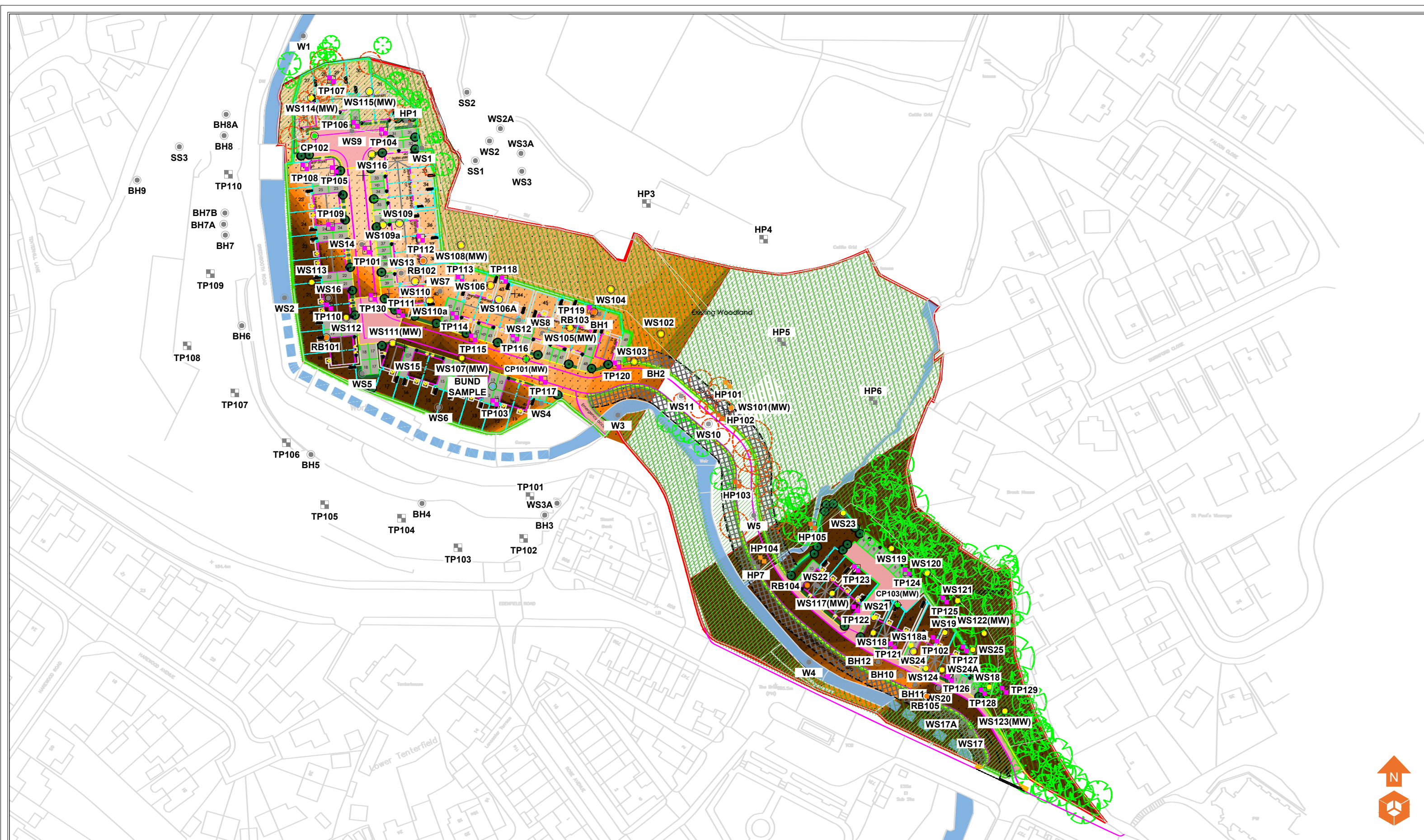
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Geology Key Made Ground Glacial Till (Clay, Sand & Gravel) Rough Rock (Sandstone) Brook / Stream Historical Landfill Spring / Culverted Watercourse Infilled Reservoir	Sources ① Heavy metals, heavy end hydrocarbons and non volatile polycyclic hydrocarbons (PAHs) ② Volatile Organic Compounds (VOCs) and TPHs ③ Asbestos Containing Materials (ACMs) ④ Hazardous Ground Gases (CO2/CH4) ⑤ pH and Sulphate	Receptors ① Secondary A Aquifer ② Surface Water Courses ③ Foundation/Concrete ④ Residential End Users ⑤ Flora and Fauna	Pathways ① Vertical Migration ② Lateral Migration ③ Inhalation of Gas/Vapor/Dust ④ Dermal Contact/Soil Ingestion Pathways arrows	Notes:	Client: Stonebond Properties Ltd	Job No: 16-465	Date: 17.04.2023	e3p Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk
					Drawing No: 010	Scale: 1:1000 @ A3		
	P1 P1 Phase	REVB REVA Issue	17.04.2023 12.04.2023 Date	LM OW Drawn	MW MW Checked	Job Title: Land at Greenbooth Road and Edenfield Road, Norden	Drawing Title: Conceptual Site Model	



Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location
- Approximate Hand Dug Pit Location
- Bund Sample Location
- Approximate Hand Dug Pit Location (Enica - April 2006)
- Approximate Trial Pit Location (Enica - April 2006)
- Approximate Window Sample Probehole Location (Enica - April 2006)
- Approximate Borehole Location (Enica - April 2006)
- Approximate Rotary Borehole Location

Bedrock Depth (m)

- Depth to Bedrock 0.00 - 0.99m
- Depth to Bedrock 1.00 - 1.99m
- Depth to Bedrock 2.00 - 2.99m
- Depth to Bedrock 3.00 - 3.99m
- Depth to Bedrock 4.00 - 4.99m
- Depth to Bedrock >5.00m

Notes:

P1	REVB	27.07.2023	OW	MW
P1	REVA	12.04.2023	LM	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties
Ltd

Job Title:

Land at Greenbooth Road and
Edenfield Road, Norden

Job No:

16-465

Drawing No:

012

Date:

27.07.2023

Scale:

NTS@ A3

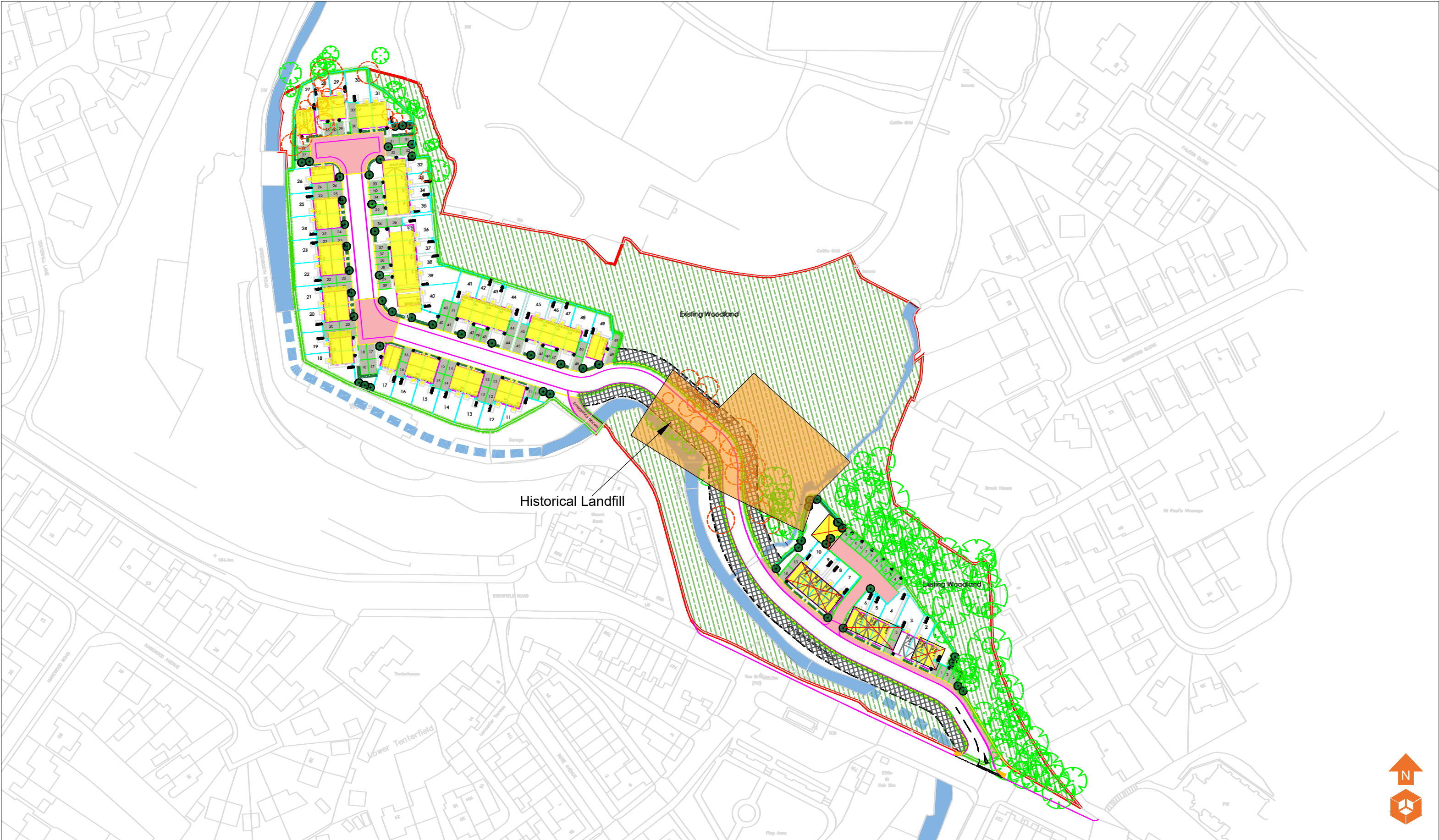
Drawing Title:

Depth to Bedrock Plan



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Ground Gas

CS2

Vapour Resistant Membranes may be required, subject to findings of Tier II Vapour Risk Assessment

Notes:				
P1	REVD	06.06.2023	OW	MW
P1	REVC	31.03.2023	OW	MW
P1	REVB	28.03.2023	OW	MW
P1	REVA	23.03.2023	OW	HM
Phase	Issue	Date	Drawn	Checked

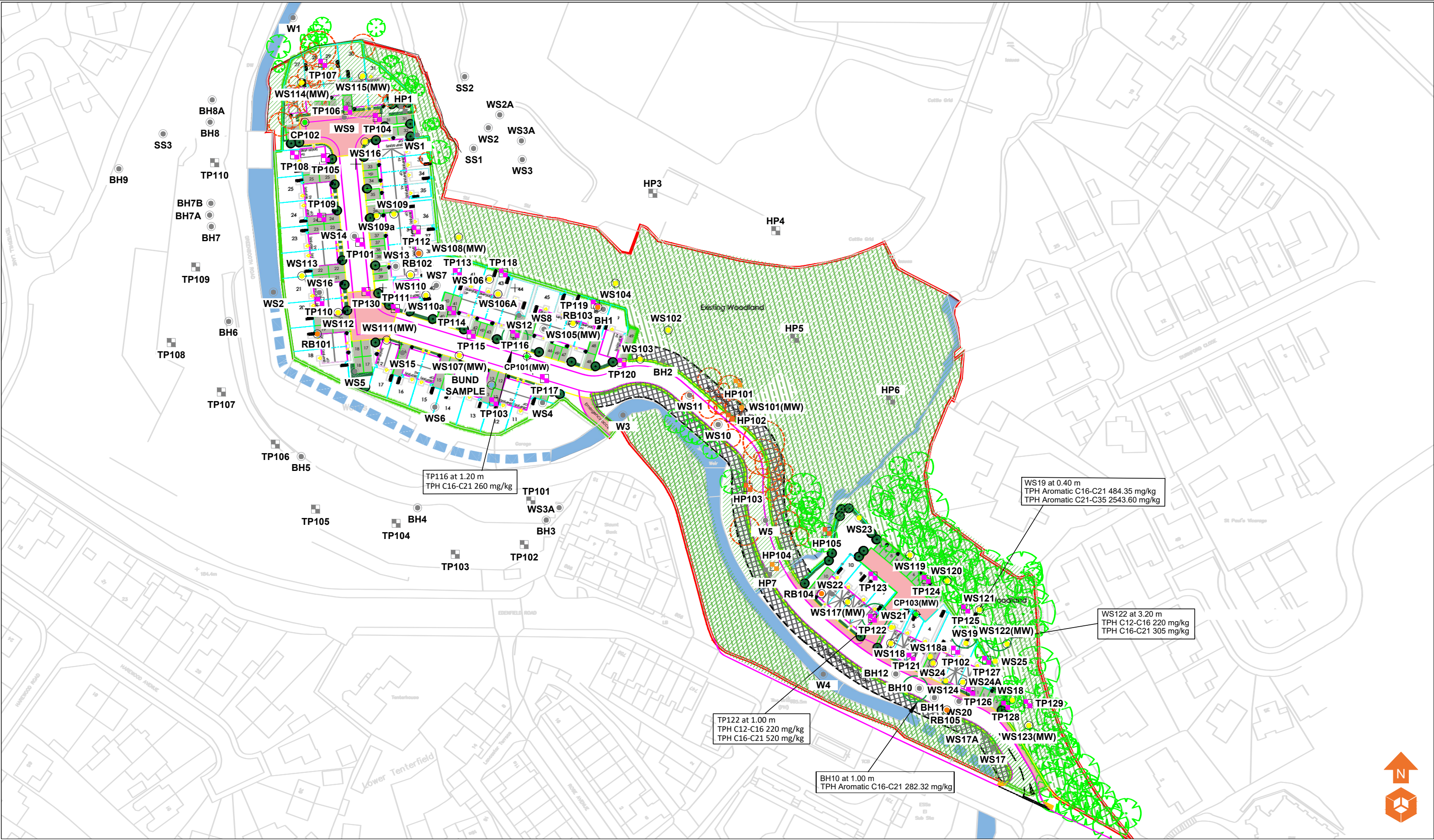
Client:	Stonebond Properties Ltd
Job Title:	Land at Greenbooth Road and Edenfield Road, Norden

Job No:	16-465
Drawing No:	024
Date:	06.06.2023
Scale:	NTS@ A3
Drawing Title:	Ground Gas Plan



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Location Symbols

- Approximate Window Sample Probehole Location
- Approximate Trial Pit Location
- Approximate Cable Percussive Borehole Location
- Inaccessible Area
- Historical Landfill

Location Symbols

- Approximate Hand Dug Pit Location
- Bund Sample Location
- Approximate Hand Dug Pit Location (Enica - April 2006)
- Approximate Trial Pit Location (Enica - April 2006)
- Approximate Window Sample Probehole Location (Enica - April 2006)
- Approximate Borehole Location (Enica - April 2006)
- Approximate Rotary Borehole Location

Contamination Exceedances

- TPH

Notes:

P1	REVC	06.06.2023	OW	MW
P1	REVB	02.05.2023	OW	MW
P1	REVA	26.04.2023	OW	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd

Job Title:

Land at Greenbooth Road
and Edenfield Road, Norden

Job No:

16-465

Drawing No:

027

Date:

06.06.2023

Scale:

NTS@ A3

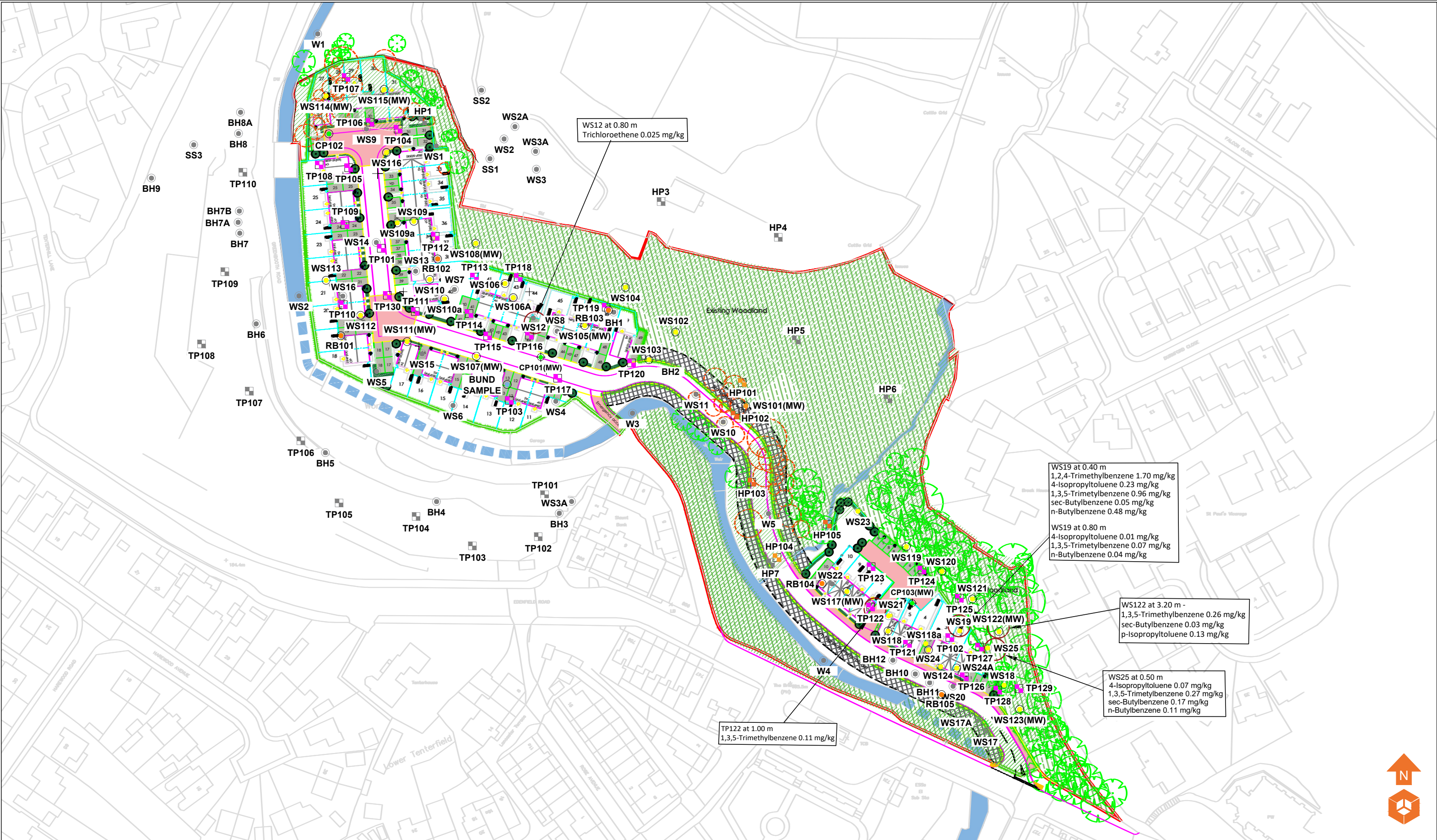
Drawing Title:

Contamination Issues Plan
- TPH



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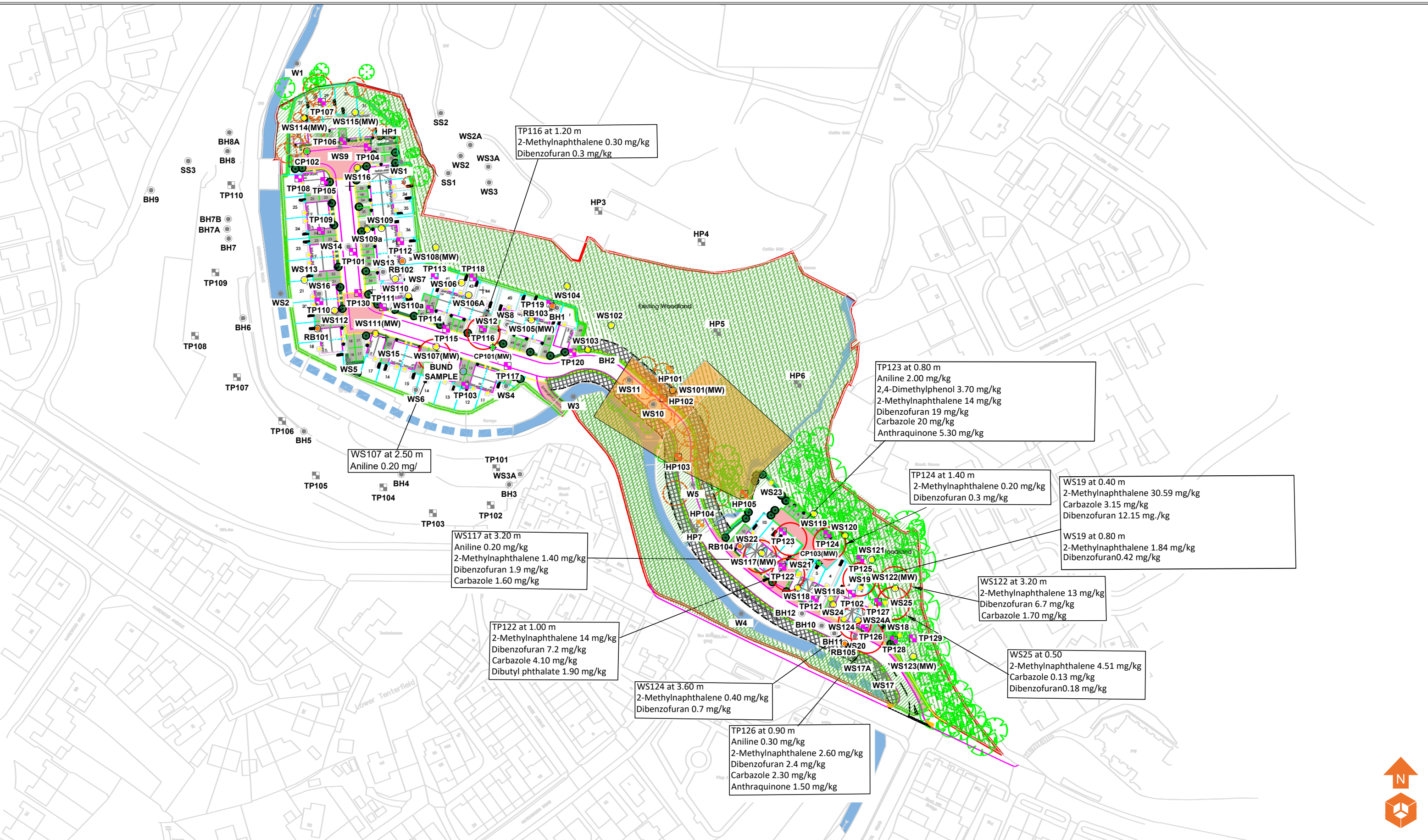


Location Symbols Approximate Window Sample Probehole Location Approximate Trial Pit Location Approximate Cable Percussive Borehole Location Inaccessible Area Historical Landfill					Location Symbols Approximate Hand Dug Pit Location Bund Sample Location Approximate Hand Dug Pit Location (Enica - April 2006) Approximate Trial Pit Location (Enica - April 2006) Approximate Window Sample Probehole Location (Enica - April 2006) Approximate Borehole Location (Enica - April 2006) Approximate Rotary Borehole Location					Contamination Exceedances VOCs				
Notes:					Client: Stonebond Properties Ltd					Job No: 16-465				
Job Title: Land at Greenbooth Road and Edenfeild Road, Norden					Drawing No: 028					Date: 06.06.2023				
Phase P1 P1 P1					Drawing Title: Contamination Issues Plan - VOCs					Scale: NTS@ A3				
Issue REVC REV REVA					Job Title: Land at Greenbooth Road and Edenfeild Road, Norden					Client: Stonebond Properties Ltd				
Date 06.06.2023 02.05.2023 26.04.2023					Job Title: Land at Greenbooth Road and Edenfeild Road, Norden					Client: Stonebond Properties Ltd				
Drawn OW OW OW					Job Title: Land at Greenbooth Road and Edenfeild Road, Norden					Client: Stonebond Properties Ltd				
Checked MW MW MW					Job Title: Land at Greenbooth Road and Edenfeild Road, Norden					Client: Stonebond Properties Ltd				

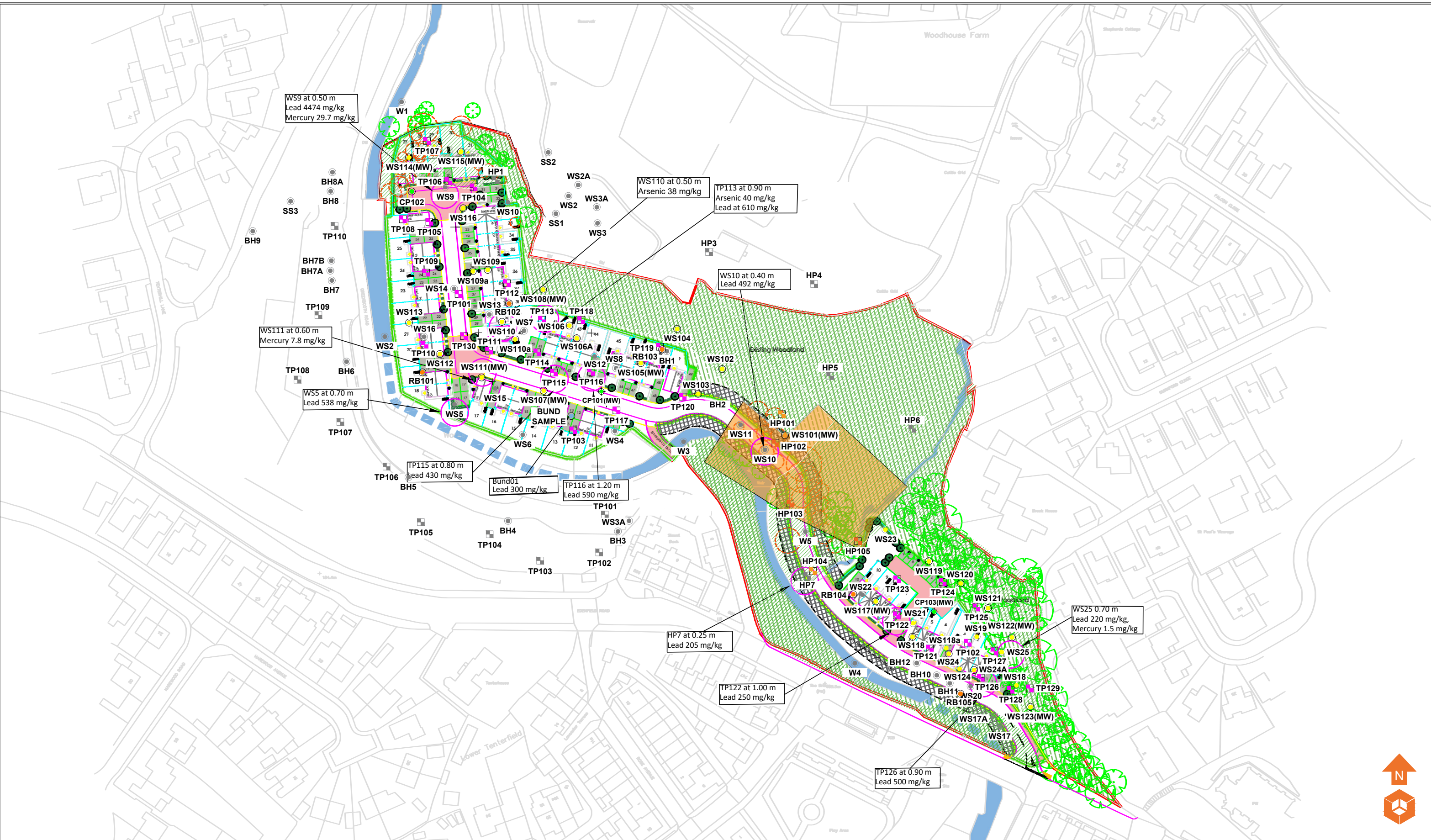


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Location Symbols WS101 Approximate Window Sample Probehole Location TP101 Approximate Trial Pit Location CP101 Approximate Cable Percussive Borehole Location Inaccessible Area Historical Landfill
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Location Symbols

- WS101 Approximate Window Sample Probehole Location
- TP101 Approximate Trial Pit Location
- CP101 Approximate Cable Percussive Borehole Location
- Inaccessible Area
- Historical Landfill

Location Symbols

- HP101 Approximate Hand Dug Pit Location
- Bund Sample Location
- Approximate Hand Dug Pit Location (Enica - April 2006)
- Approximate Trial Pit Location (Enica - April 2006)
- Approximate Window Sample Probehole Location (Enica - April 2006)
- Approximate Borehole Location (Enica - April 2006)
- Approximate Rotary Borehole Location

Contamination Exceedances

- Heavy Metals

Notes:

P1	REVC	06.06.2023	OW	MW
P1	REVB	02.05.2023	OW	MW
P1	REVA	26.04.2023	OW	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd
Land at Greenbooth Road and Edenfield Road, Norden

Job No:

16-465
Drawing No:
030

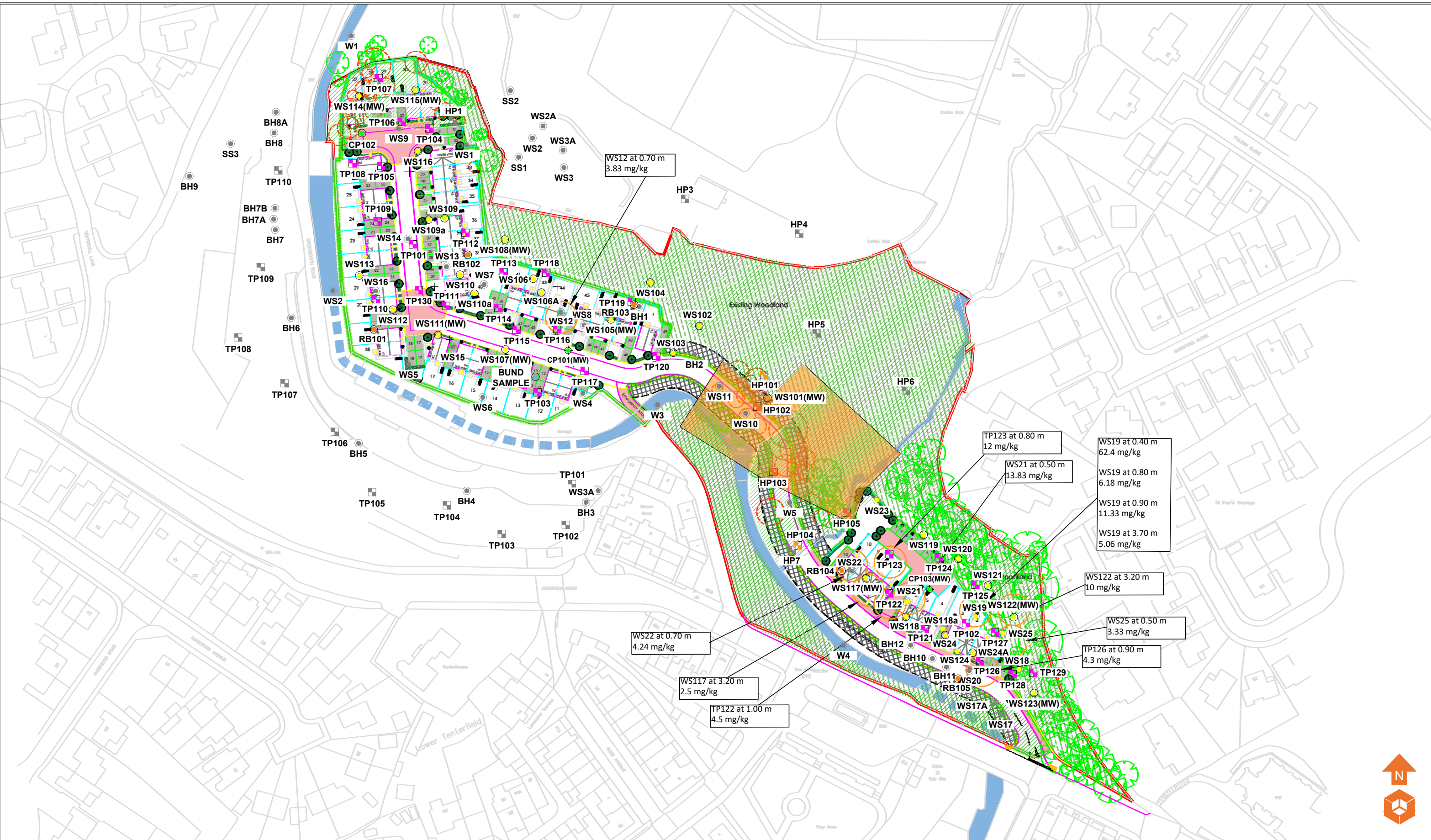
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06.06.2023
Scale:
NTS@ A3



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Location Symbols

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Location Symbols

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- Approximate Borehole Location (Enica - April 2006)
- Approximate Rotary Borehole Location

Contamination Exceedances

- Naphthalene

Notes:

P1	REVC	06.06.2023	OW	MW
P1	REVB	02.05.2023	OW	MW
P1	REVA	26.04.2023	OW	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd

Job Title:

Land at Greenbooth Road and Edenfield Road, Norden

Job No:

16-465

Drawing No:

031

Date:

06.06.2023

Scale:

NTS@ A3

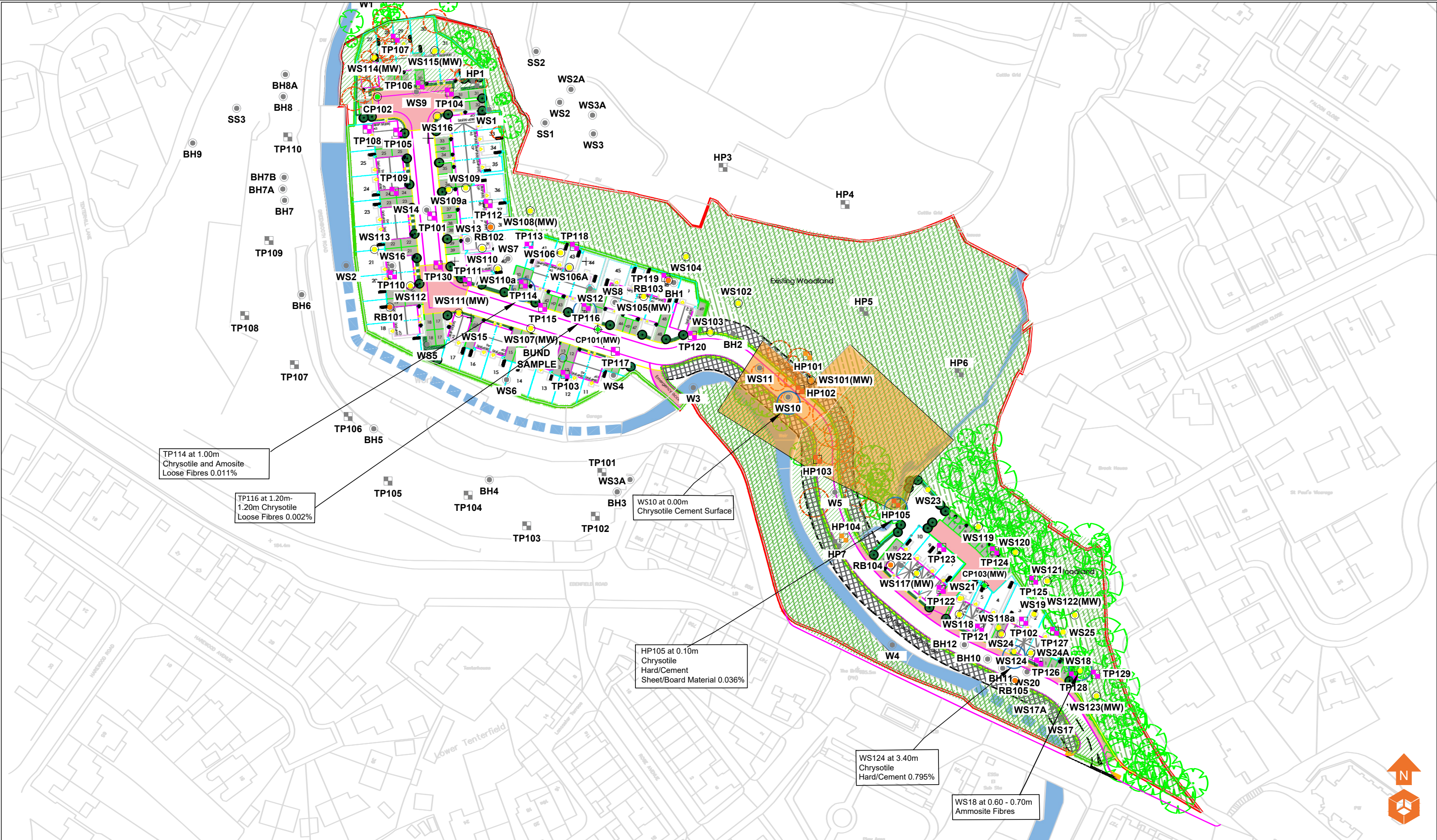
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Contamination Issues Plan
- Naphthalene



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Location Symbols

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- TP101 Approximate Trial Pit Location
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- Inaccessible Area
- Historical Landfill

Location Symbols

- HP101 Approximate Hand Dug Pit Location
- BH101 Bund Sample Location
- SS101 Approximate Hand Dug Pit Location (Enica - April 2006)
- TP101 Approximate Trial Pit Location (Enica - April 2006)
- WS101 Approximate Window Sample Probehole Location (Enica - April 2006)
- BH101 Approximate Borehole Location (Enica - April 2006)
- RB101 Approximate Rotary Borehole Location

Contamination Exceedances

- Asbestos

Notes:

P1	REVB	02.05.2023	OW	MW
P1	REVA	26.04.2023	OW	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd

Job Title:

Land at Greenbooth Road
and Edenfield Road, Norden

Job No:

16-465

Drawing No:

033

Date:

02.05.2023

Scale:

NTS@ A3

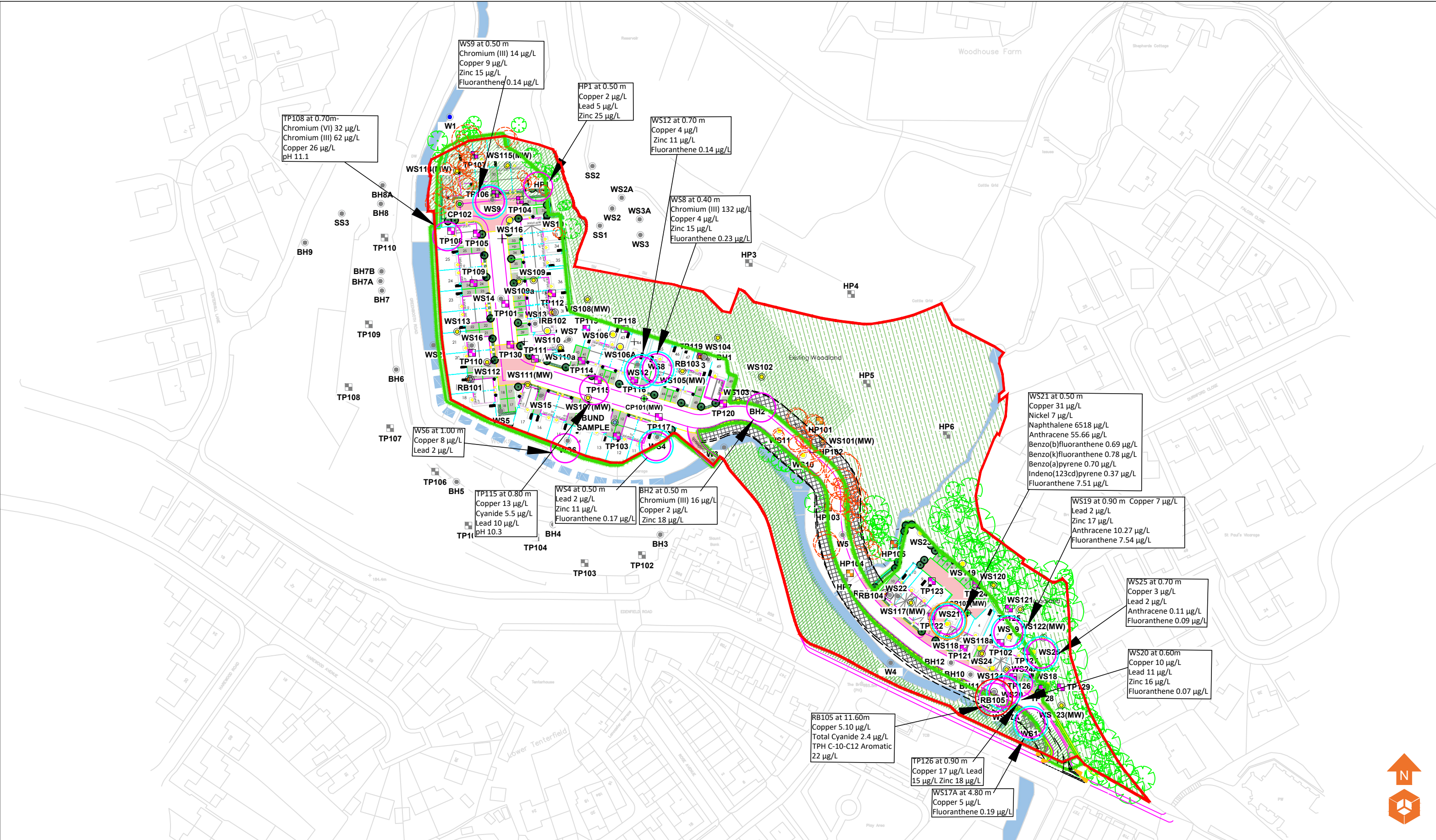
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Contamination Issues Plan
- Asbestos



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- Approximate Trial Pit Location (Enica - April 2006)
- Approximate Window Sample Probehole Location (Enica - April 2006)
- Approximate Borehole Location (Enica - April 2006)
- Approximate Rotary Borehole Location

Contamination Exceedances

- Heavy Metals
- Non-Volatile PAH
- Naphthalene
- TPH

Notes:

P1	REVF	14.08.2023	EB	NS
P1	REVE	11.08.2023	EB	NS
P1	REVD	09.08.2023	LM	MW
P1	REVC	06.06.2023	OW	MW
P1	REVB	02.05.2023	OW	MW
P1	REVA	26.04.2023	OW	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd

Job Title:

Land at Greenbooth Road and
Edenfeild Road, Norden

Job No:

16-465

Drawing No:

034

Drawing Title:

Contamination Issues Plan
- Leachate

Date:

14.08.2023

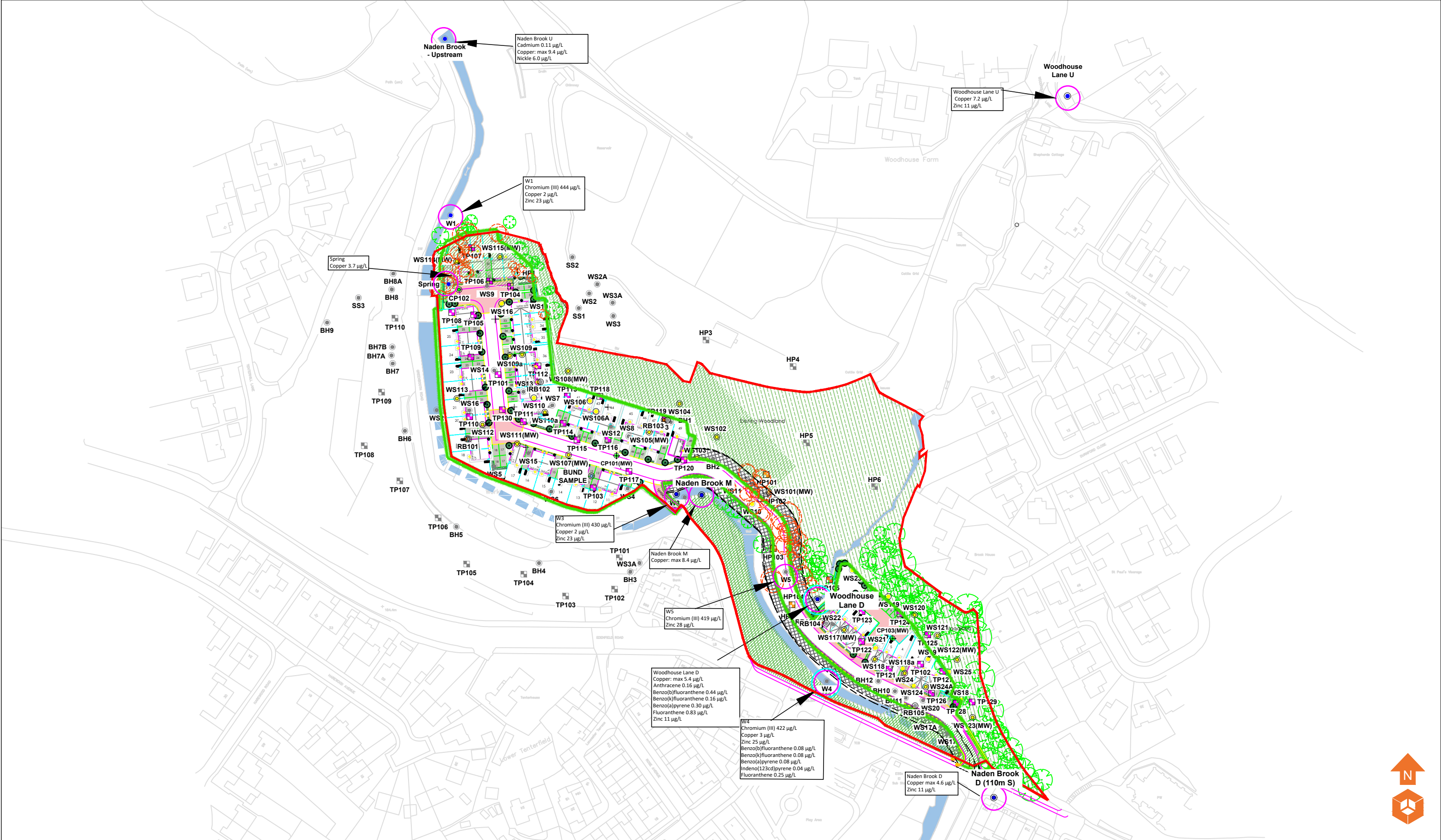
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Location Symbols

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- Bund Sample Location
- Approximate Hand Dug Pit Location (Enica - April 2006)
- Approximate Trial Pit Location (Enica - April 2006)
- Approximate Window Sample Probehole Location (Enica - April 2006)
- Approximate Borehole Location (Enica - April 2006)
- Approximate Rotary Borehole Location

Contamination Exceedances

- Heavy Metals
- Non-Volatile PAH

Notes:

P1	REVF	14.08.2023	EB	NS
P1	REVE	11.08.2023	EB	NS
P1	REVD	09.08.2023	LM	MW
P1	REVC	06.06.2023	OW	MW
P1	REVB	02.05.2023	OW	MW
P1	REVA	26.04.2023	OW	MW
Phase	Issue	Date	Drawn	Checked

Client:

Stonebond Properties Ltd

Job Title:

Land at Greenbooth Road and Edenfield Road, Norden

Job No:

16-465

Drawing No:

035

Drawing Title:

Contamination Issues Plan - Surface Water

Date:

14.08.2023

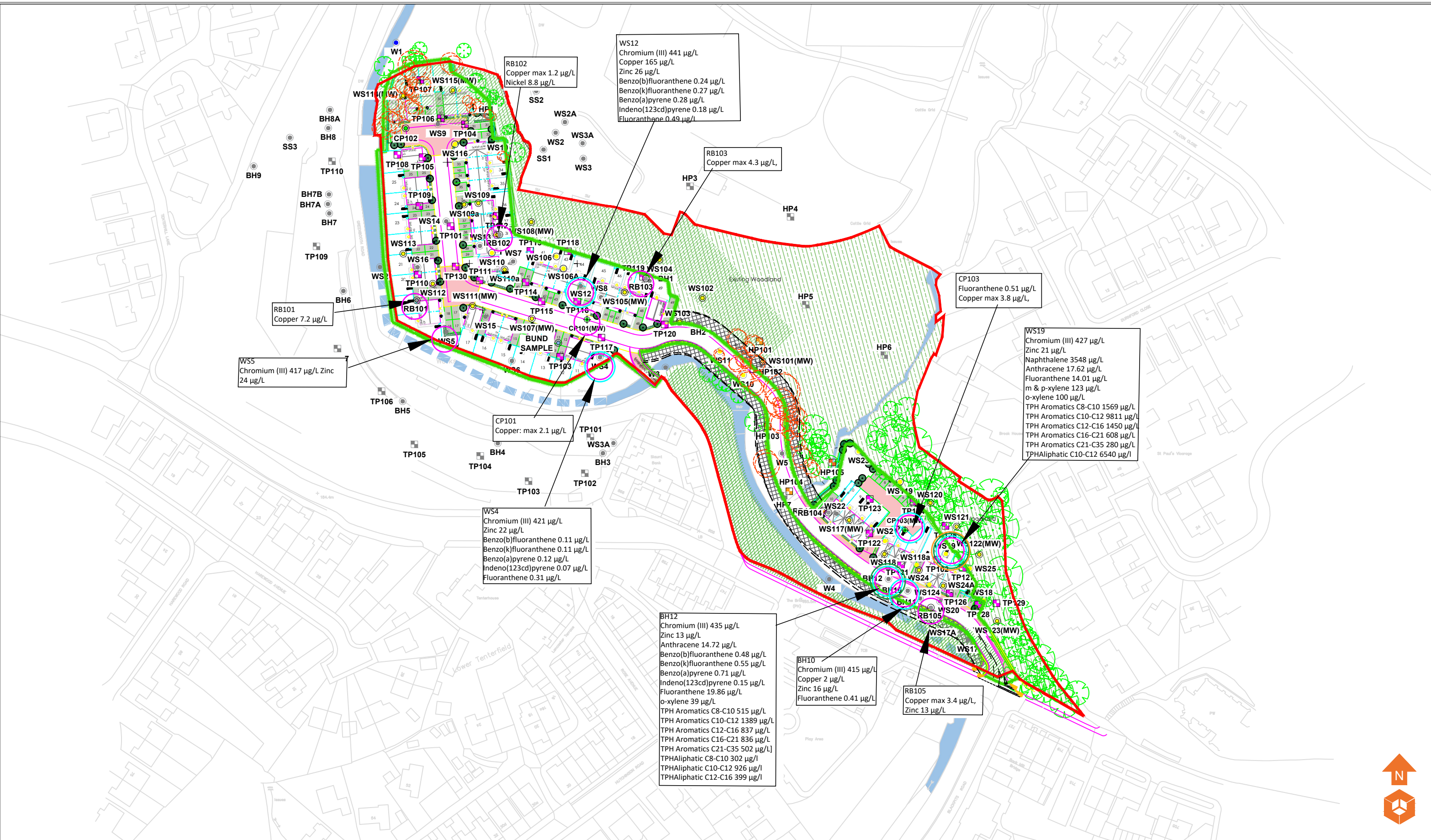
Scale:

NTS@ A3



Environmental Engineering Partnership Ltd
Taylor Road, Trafford Park
Urmston, Manchester, M41 7JQ
Tel: 0161 707 9612
E-mail: info@e3p.co.uk
Website: www.e3p.co.uk

The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.



Location Symbols

- WS101 Approximate Window Sample Probehole Location
- TP101 Approximate Trial Pit Location
- CP101 Approximate Cable Percussive Borehole Location
- Inaccessible Area
- Historical Landfill

Location Symbols

- HP101 Approximate Hand Dug Pit Location
- Bund Sample Location
- Approximate Hand Dug Pit Location (Enica - April 2006)
- Approximate Trial Pit Location (Enica - April 2006)
- Approximate Window Sample Probehole Location (Enica - April 2006)
- Approximate Borehole Location (Enica - April 2006)
- Approximate Rotary Borehole Location

Contamination Exceedances

- Heavy Metals
- Non-Volatile PAH
- Naphthalene
- TPH

Notes:

Phase	Issue	Date	Drawn	Checked
P1	REVG	15.08.2023	EB	NS
P1	REVG	14.08.2023	EB	NS
P1	REVE	11.08.2023	EB	NS
P1	REVD	09.08.2023	LM	MW
P1	REVC	06.06.2023	OW	MW
P1	REVB	02.05.2023	OW	MW
P1	REVA	26.04.2023	OW	MW

Client:

Stonebond Properties Ltd

Job Title:

Land at Greenbooth Road and Edenfeild Road, Norden

Job No:

16-465

Drawing No:

036

Drawing Title:

Contamination Issues Plan - Groundwater

Date:

15.08.2023

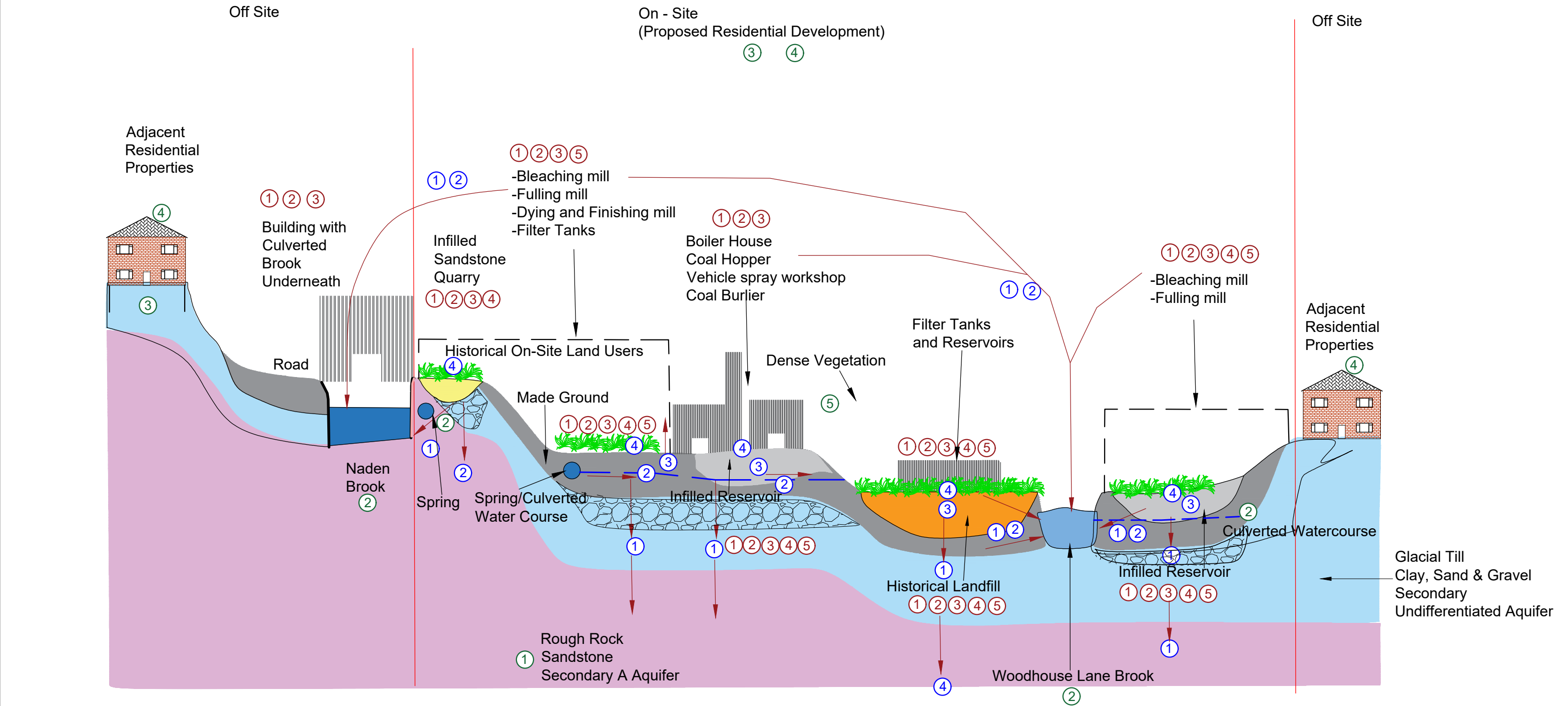
Scale:

NTS@ A3

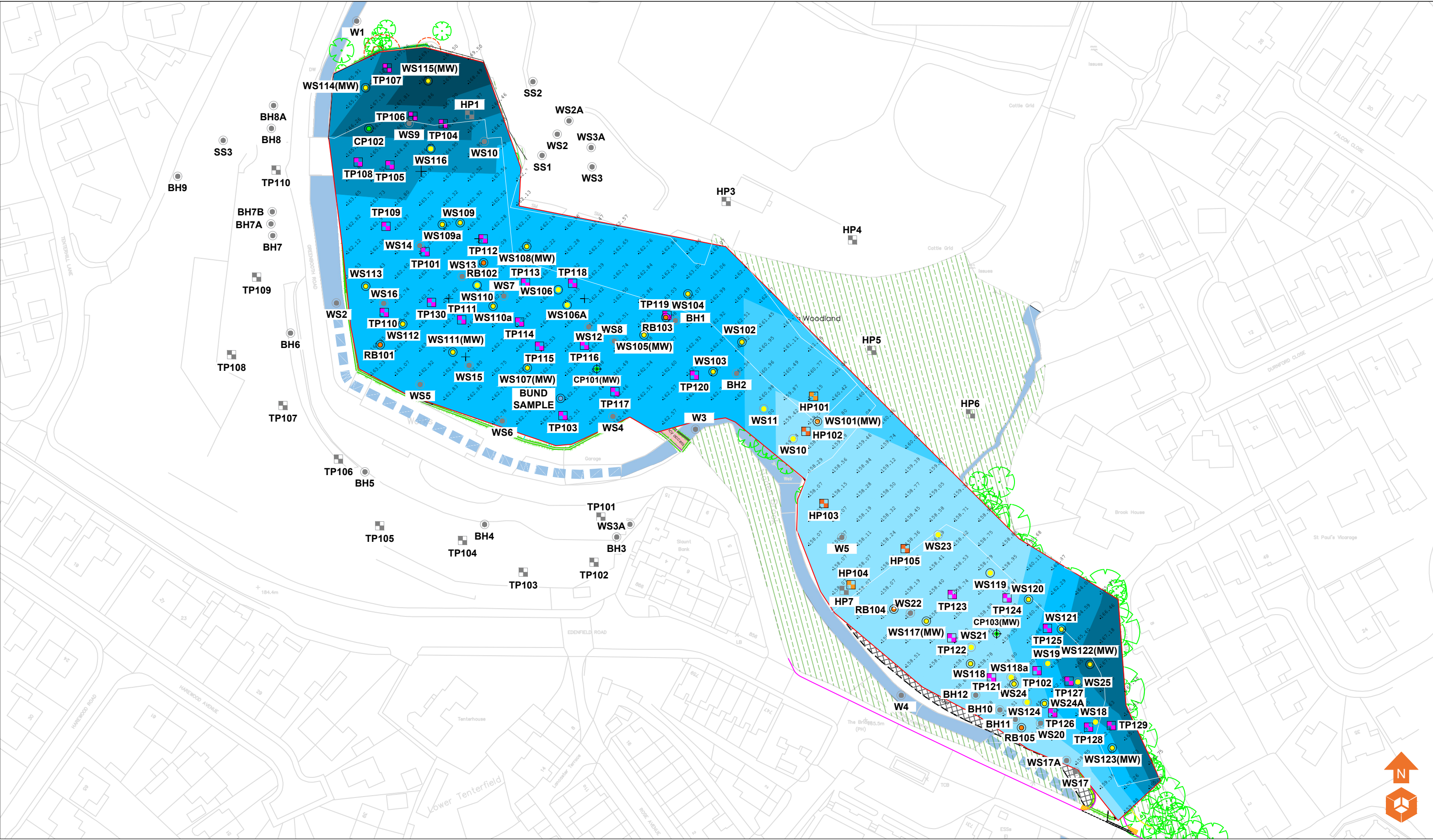


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Geology Key Made Ground Clay Sandstone Brook Retaining Walls Structures Infilled Reservoir Infilled Sandstone Quarry Historical Landfill	Sources ① Heavy metals, heavy end hydrocarbons and non volatile polycyclic hydrocarbons (PAHs) ② Volatile Organic Compounds (VOCs) and TPHs ③ Asbestos Containing Materials (ACMs) ④ Hazardous Ground Gases (CO2/CH4) ⑤ pH and Sulphate	Receptors ① Secondary A Aquifer ② Surface Water Courses ③ Foundation/Concrete ④ Residential End Users ⑤ Flora and Fauna	Pathways ① Vertical Migration ② Lateral Migration ③ Inhalation of Gas/Vapor/Dust ④ Dermal Contact/Soil Ingestion Pathways arrows	Notes:					Client: Stonebond Properties Ltd		Job No: 16-465	Date: 18.01.2023	e3p Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk	
											Drawing No: 037	Scale: 1:1000 @ A3		
									Job Title: Land at Greenbooth Road and Edenfield Road, Norden		Drawing Title: Controlled Waters Conceptual Site Model			The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.
				P1 REV C 18.01.2023 OW MW P1 REV B 14.12.2022 OW MW P1 REV A 27.10.2022 OW MD Phase Issue Date Drawn Checked										



Location Symbols		Location Symbols		Groundwater Flow Depth		Notes:	Client: Stonebond Properties Ltd	Job No: 16-465	Date: 09.08.2023	e3p Environmental Engineering Partnership Ltd Taylor Road, Trafford Park Urmston, Manchester, M41 7JQ Tel: 0161 707 9612 E-mail: info@e3p.co.uk Website: www.e3p.co.uk									
WS101 Approximate Window Sample Probehole Location	TP101 Approximate Trial Pit Location	BS101 Bund Sample Location	HP101 Approximate Hand Dug Pit Location	HP101 Approximate Hand Dug Pit Location (Enica - April 2006)	TP101 Approximate Trial Pit Location (Enica - April 2006)						WS101 Approximate Window Sample Probehole Location (Enica - April 2006)	BH101 Approximate Borehole Location (Enica - April 2006)	RB101 Approximate Rotary Borehole Location	Depth of Groundwater Flow 158.00 - 159.99m	Depth of Groundwater Flow 160.00 - 161.99m	Depth of Groundwater Flow 162.00 - 163.99m	Depth of Groundwater Flow 164.00 - 165.99m	Depth of Groundwater Flow 166.00 - 167.99m	Depth of Groundwater Flow 168.00m
P1 Phase											REVA Issue	09.08.2023 Date	LM Drawn	NS Checked	Job Title: Land at Greenbooth Road and Edenfeild Road, Norden	Drawing Title: Groundwater Flow Plan	The client must not amend any drawing, design or other intellectual property produced by E3P Ltd without permission in writing from E3P Ltd in advance of any amendments being made. In the event that such written permission is not obtained in advance of the amendments being made, E3P Ltd shall not be liable for any damage and/or losses occurring as a result of the amended drawing, design or intellectual property.		

APPENDIX IV E3P REMEDIATION/ VALIDATION CRITERIA

HUMAN HEALTH REMEDIATION TARGETS – LOW-RISE RESIDENTIAL END USE

DETERMINAND	UNITS	WITHIN 600 mm COVER SYSTEM (GARDEN)	HARD STANDING AND >600 mm OF COVER	PUBLIC OPEN SPACE 300 mm COVER	PUBLIC OPEN SPACE > 300 mm	PATH- WAY
Arsenic	mg/kg	37 ⁽ⁱ⁾	40 ⁽ⁱⁱ⁾	79 ⁽ⁱⁱⁱ⁾	170 ^(iv)	1
Cadmium	mg/kg	11 ⁽ⁱ⁾	85 ⁽ⁱⁱ⁾	120 ⁽ⁱⁱⁱ⁾	532 ^(iv)	1
Chromium (Hexavalent)	mg/kg	6 ⁽ⁱ⁾	6 ⁽ⁱⁱ⁾	7.7 ⁽ⁱⁱⁱ⁾	220 ^(iv)	1
Lead	mg/kg	200 ^(vi)	310 ^(vii)	630 ^(viii)	1300 ^(viii)	1
Elemental Mercury	mg/kg	1.2 ⁽ⁱ⁾	1.2 ⁽ⁱⁱ⁾	16 ⁽ⁱⁱⁱ⁾	30 ^(iv)	2
Nickel	mg/kg	130 ⁽ⁱ⁾	180 ⁽ⁱⁱ⁾	230 ⁽ⁱⁱⁱ⁾	800 ^(iv)	1
Selenium	mg/kg	250 ⁽ⁱ⁾	430 ⁽ⁱⁱ⁾	1100 ⁽ⁱⁱⁱ⁾	1800 ^(iv)	1
Copper	mg/kg	2400 ⁽ⁱ⁾	7100 ⁽ⁱⁱ⁾	12,000 ⁽ⁱⁱⁱ⁾	44,000 ^(iv)	1
Zinc	mg/kg	3700 ⁽ⁱ⁾	40,000 ⁽ⁱⁱ⁾	81,000 ⁽ⁱⁱⁱ⁾	170,000 ^(iv)	1
Phenol	mg/kg	120 ^{(i)(xi)}	440 ^{(xiv)(xi)}	440 ^{(iii)(xi)}	440 ^{(iv)(xi)}	2
Naphthalene	mg/kg	2.3 ^{(i)(xi)}	2.3 ^{(xiv)(xi)}	1200 ^{(iv)(xi)}	1200 ^{(iv)(xi)}	2
Acenaphthylene	mg/kg	170 ^{(i)(xi)}	500 ^(v)	15,000 ^{(iii)(xi)}	29,000 ^{(iv)(xi)}	3
Acenaphthene	mg/kg	210 ^{(i)(xi)}	500 ^(v)	15,000 ^{(iii)(xi)}	29,000 ^{(iv)(xi)}	1
Fluorene	mg/kg	170 ^{(i)(xi)}	500 ^(v)	9900 ^{(iii)(xi)}	20,000 ^{(iv)(xi)}	1
Phenanthrene	mg/kg	95 ^{(i)(xi)}	500 ^(v)	3100 ^{(iii)(xi)}	6200 ^{(iv)(xi)}	3
Anthracene	mg/kg	500 ^{(i)(xi)}	500 ^(v)	74,000 ^{(iii)(xi)}	150,000 ^{(iv)(xi)}	3
Fluoranthene	mg/kg	280 ^{(i)(xi)}	500 ^(v)	3100 ^{(iii)(xi)}	6300 ^{(iv)(xi)}	3
Pyrene	mg/kg	500 ^{(i)(xi)}	500 ^(v)	7400 ^{(iii)(xi)}	15,000 ^{(iv)(xi)}	3
Benzo(a)Anthracene	mg/kg	7.2 ^{(i)(xi)}	11 ^{(ii)(xi)}	29 ^{(iii)(xi)}	49 ^{(iv)(xi)}	3
Chrysene	mg/kg	15 ^{(i)(xi)}	30 ^{(iii)(xi)}	57 ^{(iii)(xi)}	93 ^{(iv)(xi)}	3
Benzo(b)Fluoranthene	mg/kg	2.6 ^{(i)(xi)}	3.9 ^{(ii)(xi)}	7.1 ^{(iii)(xi)}	13 ^{(iv)(xi)}	3
Benzo(k)Fluoranthene	mg/kg	77 ^{(i)(xi)}	110 ^{(ii)(xi)}	190 ^{(iii)(xi)}	370 ^{(iv)(xi)}	3
Benzo(a)Pyrene	mg/kg	2.2 ^{(i)(xi)}	3.2 ^{(ii)(xi)}	5.7 ^{(iii)(xi)}	11 ^{(iv)(xi)}	3
Indeno(123-cd)Pyrene	mg/kg	27 ^{(i)(xi)}	45 ^{(ii)(xi)}	82 ^{(iii)(xi)}	150 ^{(iv)(xi)}	3
Dibenzo(a,h)Anthracene	mg/kg	0.24 ^{(i)(xi)}	0.31 ^{(ii)(xi)}	0.57 ^{(iii)(xi)}	1.1 ^{(iv)(xi)}	3
Benzo(ghi)Perylene	mg/kg	320 ^{(i)(xi)}	360 ^{(ii)(xi)}	640 ^{(iii)(xi)}	1400 ^{(iv)(xi)}	3
TPH C ₅ -C ₆ (aliphatic)	mg/kg	42 ^{(i)(xi)}	42 ^{(ii)(xi)}	42 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₆ -C ₈ (aliphatic)	mg/kg	100 ^{(i)(xi)}	100 ^{(ii)(xi)}	100 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₈ -C ₁₀ (aliphatic)	mg/kg	27 ^{(i)(xi)}	27 ^{(ii)(xi)}	27 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₁₀ -C ₁₂ (aliphatic)	mg/kg	130 ^{(i)(xi)}	130 ^{(ii)(xi)}	130 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₁₂ -C ₁₆ (aliphatic)	mg/kg	1000 ^{(xiv)(xi)}	1000 ^{(xiv)(xi)}	1000 ^{(xiv)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₁₆ -C ₂₁ (aliphatic)	mg/kg	1000 ^{(xiv)(xi)}	1000 ^{(xiv)(xi)}	1000 ^{(xiv)(xi)}	10,000 ^{(xiv)(xi)}	1
TPH C ₂₁ -C ₃₅ (aliphatic)	mg/kg					1
TPH C ₅ -C ₇ (aromatic)	mg/kg	70 ^{(i)(xi)}	370 ^{(ii)(xi)}	370 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₇ -C ₈ (aromatic)	mg/kg	130 ^{(i)(xi)}	860 ^{(ii)(xi)}	860 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₈ -C ₁₀ (aromatic)	mg/kg	34 ^{(i)(xi)}	47 ^{(ii)(xi)}	47 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₁₀ -C ₁₂ (aromatic)	mg/kg	74 ^{(i)(xi)}	250 ^{(ii)(xi)}	250 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	2
TPH C ₁₂ -C ₁₆ (aromatic)	mg/kg	140 ^{(i)(xi)}	1800 ^{(ii)(xi)}	1800 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	1



Land at Greenbooth Road and Edenfield Road, Norden
Remediation and Enabling Works Strategy
September 2023

TPH C₁₆-C₂₁ (aromatic)	mg/kg	260 ^{(i)(xi)}	1900 ^{(ii)(xi)}	1900 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	1
TPH C₂₁-C₃₅ (aromatic)	mg/kg	1000 ^{(xiv)(xi)}	1900 ^{(ii)(xi)}	1900 ^{(ii)(xi)}	10,000 ^{(xiv)(xi)}	1
Asbestos	Fibres Volume Weight (%)	NFD	0.001%	NFD	0.001	4

Notes 1

NFD = No Fibres Detected

Asbestos will be screened visually on-site by a qualified environmental consultant and where potential ACM is identified, representative samples will be subject to quantitative analysis of % volume by weight.

Should any ACM be identified within the soil matrices, further detailed % assessment would be required when the reported laboratory result exceeds the limit of detection for the analytical method at 0.01% by volume (weight).

Notes 2

Excludes matrices where free product is observed.

No viable exposure pathway beneath hardstanding and cover system.

Notes 3

Main exposure pathways: 1 = soil ingestion, 2 = vapour inhalation (indoor), 3 = dermal contact and ingestion, 4 = dust inhalation.

Abbreviations: GAC = general assessment criteria, n = number of samples, MC = maximum concentration, N/A = Not Applicable (no exceedance of assessment criteria), Loc of MC = location of exceedances.

- i. Value derived from LQM Sutable 4 Use Levels (S4ULs) for residential end use with plant uptake.
- ii. Value derived from LQM Sutable 4 Use Levels (S4ULs) for residential end use without plant uptake – these levels used below 600 mm cover system within residential gardens as soils will be present within a residential setting, yet soils will not be disturbed and garden plants will not reach these soils.
- iii. Value derived from LQM Sutable 4 Use Levels (S4ULs) for public open space (POS) residential.
- iv. Value derived from LQM Sutable 4 Use Levels (S4ULs) for public open space (POS) park – these levels used below 300 mm POS cover system as soils will not be disturbed by any future site users and exposure to these soils will be similar to a park end use.
- v. Value derived from LQM Sutable 4 Use Levels (S4ULs) alongside assessment with WM3 to ensure that materials remaining on-site do not exceed the WM3 toxicity criteria for hazardous waste.
- vi. Value derived from Category 4 Screening Levels (C4SL) for residential land use with homegrown produce.
- vii. Value derived from Category 4 Screening Levels (C4SL) for residential land use without homegrown produce.
- viii. Value derived from Category 4 Screening Levels (C4SL) for public open space (POS) residential.
- ix. Value derived from Category 4 Screening Levels (C4SL) for public open space (POS) park.
- x. Mercury – based on elemental mercury.
- xi. PAH and TPH levels used are for 1% SOM.
- xii. Xylenes based on p-xylene (o-xylene 2600 mg/kg, m-xylene 3500 mg/kg) and is capped by its solubility.
- xiii. Value derived from LQM Sutable 4 Use Levels (S4ULs) for residential end use with plant uptake due to the volatilisation risk.
- xiv. BTEX is not SOM-related due to inhalation pathway.



REMEDIATION TARGETS – COMPARISON OF GROUNDWATER / LEACHATE ANALYSIS WITH TIER 2 SCREENING LEVELS

DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS ^{3,4,5}
		AA	MAC	
Arsenic	µg/l	50	–	10
Cadmium	µg/l	0.08-0.25	0.45-1.5	5
Chromium (VI)	µg/l	3.4	–	–
Chromium (III)	µg/l	4.7	–	50
Copper	µg/l	1	–	2000
Total Cyanide	µg/l	1	–	50
Lead	µg/l	1.2	14	10
Mercury	µg/l	–	0.07	1.0
Nickel	µg/l	4	34	20
Selenium	µg/l	–	–	10
Zinc	µg/l	10.9	–	–
pH		6–9		
Naphthalene	µg/l	2	130	10*
Anthracene	µg/l	0.1	0.1	
Benzo[b]fluoranthene	µg/l	0.00017*	0.017	
Benzo[k]fluoranthene	µg/l	0.00017*	0.017	
Benzo(a)pyrene	µg/l	0.00017*	0.27	
Indeno(123-cd)pyrene	µg/l	0.00017*	5*	
Benzo(ghi)pyrene	µg/l	0.00017*	5*	
Fluoranthene	µg/l	0.0063	0.12	
Benzo(ghi)perylene	µg/l	1.7–4	8.2–3	
TPH C5-C6 (benzene)	µg/l	10	50	1
TPH C6-C8 (toluene)	µg/l	74	–	700
TPH C8-C10 (ethyl benzene)	µg/l	20	–	300
TPH C10-C12 (xylene)	µg/l	30	–	500
TPH C12-C16	µg/l	2	130	90 ⁵
TPH C16-C35	µg/l	50#	50#	90 ⁵
TPH C5-C6	µg/l	–	–	15000
TPH C6-C8	µg/l	–	–	15000
TPH C8-C10	µg/l	–	–	300
TPH C10-C12	µg/l	–	–	300
TPH C12-C16	µg/l	–	–	300



DETERMINAND	UNIT	EQS SCREENING VALUE ^{1, 2, 3}		DWS ^{3,4,5}
		AA	MAC	
TPH C16 – C21	µg/l	–	–	300**
TPH C21-C35	µg/l	–	–	300**
Tetrachloroethylene	µg/l	0.4	–	10
Trichloroethylene	µg/l	10	–	10
Trichlorobenzene	µg/l	0.4	–	–
Trichloromethane	µg/l	2.5	–	–
Dichloromethane	µg/l	20	–	200
Carbon Tetrachloride	µg/l	12	–	3
Vinyl Chloride	µg/l	–	–	0.3

Notes

Solubility <0.01µg/l

AA – Annual Average

MAC- Maximum Admissible Concentration

* Polyaromatic hydrocarbons (PAH) - Benzo(a)pyrene (BaP), Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(g,h,i)-perylene and Indeno(1,2,3-cd)-pyrene. Benzo(a)pyrene can be considered as a marker for the other PAHs, hence only benzo(a)pyrene needs to be monitored for comparison with the biota EQS or the corresponding AA-EQS in water

** There are no WHO Guideline Values for aliphatic fractions C16-C21 and C21-C35, therefore the guideline value for aliphatic fractions inclusive of C8-C16 (300µg/l) has been applied.

1. The Water Environment (Water Framework Directive) (England and Wales) (Amendment) Regulations (2015)
2. Directive establishing a framework for Community action in the field of water policy (Water Framework Directive)
3. Council Directive on pollution caused by certain dangerous substances discharged into the aquatic environment of the Community (Dangerous Substances Directive) - List II substances
4. Council Directive on the quality of water intended for human consumption (Drinking Water Directive)
5. WHO Guidelines for Drinking Water Quality. Third edition (2004)



APPENDIX V

E3P MATERIAL IMPORT CRITERIA

SITE OF IMPORTATION ADDRESS		E3P +44 (0) 161 707 9612 info@e3p.co.uk 
Client		
Main Contractor		
Earthworks Contractor		
Haulier		
Date of Planned Import		
Overview of Planned Material Import		
Material Source (Site of Origin) and Postcode		
Site Investigation Report	Report Title and Reference: Date: Information Supplied By:	
Reason for Generation of Excess Material at Site of Origin		
Chemical Test Results for Stockpile at Site of Origin	Date: Laboratory Certificate Ref: Organisation Responsible for Stockpile Sampling:	
Geotechnical Material Classification and Testing	Delete as Appropriate: Class 1 / Class 2 / Class 6 / Topsoil	
Pictures of Material Stockpile Pending Transportation	Delete as Appropriate: Yes / No	
Person or Organisation Responsible for Ensuring Quality Control at Site of Origin		
Quantity of Material to Be Imported (m³)		
Proposed Area of Deposition (Site of Reuse)		
Waste Exemption/Permit or CL:AIRE MMP		Delete as Appropriate: U1 Standard Rules / CL:AIRE MMP (Direct Transfer) / Bespoke



APPENDIX VI CONTRACTOR PRE- COMMENCEMENT CHECK SHEET

GEOTECHNICAL ENABLING WORKS PRE-START FORM

Prior to the commencement of any site remediation or enabling works, this form will be completed by E3P, in the presence of the appointed contractor, to ensure that all pertinent remediation and enabling works activities are fully discussed and understood.

Activity	Testing Responsibility	Contractors Method Statement Required (Y/N)	Comment/Action
Deployment of Environmental Permit			Ref No:
Deployment of LAPC Part B – Mobile Plant Permit			Ref No:
CL:AIRE MMP and Qualified Person Declaration			Ref No:
Identification of All Invasive Plant Species and Production of Eradication Plan with Appropriate Supervision by Specialist			Appointed specialist:
Removal of All Vegetation			Note disposal location:
Removal of All Root Bulbs and Root Networks			Note disposal location:
Identification of Contamination Hotspots, Removal of Material and Stockpile			Rationale:
Legislatively Compliant Procedure to Deal with Contamination Excavated from Hotspot			Rationale:
Processing and Recycling of Aggregate with Geotechnical and Chemical Validation Testing			Note stockpile location and anticipated volume:
Stockpiling of Subsoil and Certification of Suitability for Reuse			Stockpile location:
Decommission of All Redundant Drainage Infrastructure			
Decommission of All Former Interceptors			
Decommission of All Former Above- and Below-Ground Tanks			
Removal of All Asbestos to a Licensed Facility			
Engineering of Plots for Shallow Spread Foundation in Accordance with E3P Geotechnical Specification			Plot Numbers



Activity	Testing Responsibility	Contractors Method Statement Required (Y/N)	Comment/Action
Engineering of Plots for VSC in Accordance with E3P Geotechnical Specification			Plot Numbers.
Engineering of Plots for Pile Foundation in Accordance with E3P Geotechnical Specification			Plot Numbers
Engineering of Plots for Raft Foundation in Accordance with E3P Geotechnical Specification			Plot Numbers
Stockpiling of Topsoil and Certification of Suitability for Reuse			Stockpile location
Engineering of Highways Bulk Upfill in Accordance with E3P Specification with Compliant Validation Testing			Upfill specification
Engineering of Highways Subgrade in Accordance with E3P Specification with Compliant Validation Testing			Upfill specification
Engineering of Highways Capping in Accordance with E3P Specification with Compliant Validation Testing			Upfill specification
Cut-and-Fill the Development Site to Clients' Required Elevation with As-Built Survey			Required formation elevations



APPENDIX VII CONTRACTOR COMPLETION CHECK SHEET

GEOTECHNICAL ENABLING WORKS COMPLETION FORM

Upon completion of all site remediation and enabling works, this form will be completed by E3P, in the presence of the appointed contractor, to ensure that all pertinent geotechnical enabling works activities are complete or, where a deviation from the specification has occurred, all future limitations and issues are documented for the client's records.

Activity	Complete			Signature
	Yes	No	N/A	(initial)
Eradication of all invasive plant species				
Removal of all vegetation				
Removal of all root bulbs and root networks				
Stockpiling of topsoil and certification of suitability for reuse				
Stockpiling of subsoil and certification of suitability for reuse				
Stockpile all recycled aggregate with geotechnical and chemical validation testing				
Removal of all relict foundations and infrastructure in their entirety				
Decommission of all redundant drainage infrastructure				
Decommission of all former interceptors				
Decommission of all former above- and below-ground tanks				
Removal of all waste materials to a licensed facility				
Removal of all asbestos to a licensed facility				
Engineering of all plots for shallow spread foundation in accordance with E3P Geotechnical Specification				
Engineering of all plots for VSC in accordance with E3P Geotechnical Specification				
Engineering of all plots for pile foundation in accordance with E3P Geotechnical Specification				
Engineering of all plots for raft foundation in accordance with E3P Geotechnical Specification				
Engineering of highways bulk upfill in accordance with E3P Specification with compliant validation testing				
Engineering of highways subgrade in accordance with E3P Specification with compliant validation testing				
Engineering of highways capping in accordance with E3P Specification with compliant validation testing				
Cut-and-fill the development site to client's required elevation with as-built survey				



POST-REMEDIATION AND ENABLING LIMITATIONS

All and every deviation from the approved specification for works should be documented by the remediation and enabling works contractor below.



