

Report No

NX131

Project

**Remediation Strategy Report, Phase 3 Calderstones Hospital,
Whalley, BB7 9JT**

Client

Taylor Wimpey Manchester Limited



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EXECUTIVE SUMMARY

NX Consulting Limited has been commissioned by Taylor Wimpey Manchester Limited to provide a Remediation Strategy at the proposed Phase 3 Calderstone Hospital residential housing development. It is understood that the site is to be redeveloped with 46 residential houses with associated gardens, landscaped areas, car parking and associated access roads. Current proposals include raising site levels, to allow adequate site drainage. A RSK Land and Development Engineering Limited Drawing No 06 RevP7; provided within Appendix A presents a site layout displaying current and proposed ground levels for the development.

The proposed remediation strategy is based upon a single philosophy which provides a detailed understanding of the chemical and physical properties of the ground, groundwater, surface water and ground gas, established by way of extensive desk study, intrusive ground investigations, laboratory testing and monitoring. In addition, an assessment of how the remediation is to be achieved shall be approved and upon completion a validation report shall be submitted to the Director of Planning of Ribble Valley Borough Council.

The works will be conducted as part of the main contract and involve a 'best sustainable approach' to remediation of contamination; involving a minimal approach with respect to the removal and disposal of contaminated materials from site. Minimum volumes of material will be moved around the site, limiting site workers and neighbours to dust, noise and visual intrusion. Minimum material will be taken off site thus conserving landfill space locally and minimising lorry movements onto local roads from the site.

Locally elevated concentrations of heavy metals (lead) and PAH are present in the soils beneath the site. However, the site is underlain by up to 14.0m of relatively impervious soils (Glacial Till) which will offer the underlying minor aquifer a degree of protection against the downward leaching of mobile contaminants. Upfilling of the majority of the site and the provision of a 600mm clean cover system in garden and landscaped areas along with the proposed building footprints and hardstanding cover which will limit migration pathways for potential contaminants to both human health and controlled water receptors.

Based on the negligible flow rates and concentrations of hazardous gas recorded to date the site is characterised as 'Green' in accordance with CIRIA 665 and as such no special protection measures are required for the proposed building.

The site is currently occupied by a former building yard comprising a relic access road/track, leading from Pendle Drive, and tarmacadam hardstanding, situated central and easterly within the site. The remainder of the site comprises a cover of vegetation (grass and marsh) over a layer of topsoil/made ground. Outside of hardstanding areas the ground is soft with marshy conditions encountered within heavy highly plastic slightly organic clays. Relic infrastructure remains in-situ, following the demolition of the former isolation unit, comprising infilled basements/cellars, former roads, paving and underground services/drainage, within the upper 1.00m to 3.00m of strata.

The Made Ground deposits are considered unsuitable as an adequate founding stratum due to the possible risks of unacceptable total and differential settlements occurring. Site levels have been revised since the issue of our additional site investigation report and a combination of driven piles, trenchfill and wide strip foundations with suspended ground floor slabs are the recommended foundation solution. Indicative plots are provided within DW1lp Structural engineering drawings provided to the client. A piling matt will be required in line with BRE470 Working Platforms for Tracked plant.

Laboratory test results indicate that the grey brown upper organic Glacial Clay is high to very high plasticity with a corresponding high volume change potential. Natural moisture contents indicating that the clays are typically 'wet' of optimum and treatment (possibly with lime cement stabilisation) may be required to achieve required maximum dry densities during compaction.

Shrink-swell movements and generation of excess porewater pressures within high to very high plasticity Clay will require careful assessment for foundations, drainage and earthworks and require possible protection and treatment measures. Existing infrastructure and infilled cellars/basement will require 'Grubbing out' and treatment as part of the site preparation and upfill and to prevent deflection of the piled foundations. Unsuitable materials, that cannot be reused on site, will require removal from site to suitably licensed waste management facility.

Site preparation prior to upfilling should include removal of all vegetation, topsoil and any uncontrolled filling. Site won and imported suitable earthworks materials will need to be classified and compacted in accordance with Table 6/1 of Department of Transport Specification for Highways Works. A specification for which has been provided to the client separately and should be read in conjunction with this document.

To protect end users from isolated areas of heavy metal and PAH contamination, a soil cover system (consisting of a minimum 600mm thick layer) is required over deposits of made ground, in all gardens and landscaped areas. However, current site preparation works entail raising site levels by as much as 2.50m in the north of the site; reducing to circa 200mm within the vicinity of Plots 1 to 7. Thus, breaking contaminant linkages to future site occupiers, in the majority of plots. Imported materials will require chemical validation to demonstrate that they are suitable for a residential end use and taken to depths sufficient to provide a sufficient cover system for all proposed plots and materials used which are capable to support root growth.

The majority of topsoil present on site is considered suitable for re-use in gardens and landscaped areas. Stockpiling and screening of unacceptable topsoil should be conducted on-site and further validation sampling taken to confirm that it is suitable for re-use; prior to placement in gardens and landscaped areas.

It is envisaged that new drainage and utility supplies will be at relatively shallow depth within the top 1200mm; the made-ground deposits. Given the slightly elevated levels of potential contamination determined within the site soils, specifically polycyclic aromatic hydrocarbons (PAH), protection measures are recommended for plots upon the site where a clean 1200mm cover cannot be provided due to upfilling.

Where required, appropriate construction materials for water supply pipes should comprise either; 'Barrier Pipe' (PE/AL/PE), wrapped steel or wrapped ductile iron. The exact requirements are to be confirmed with the relevant utility supplier (United Utilities).

It is recommended that statutory services are consulted at an early stage, with respect to the ground conditions within which they will lay services, in order to enable them to assess at an early state any protection measures required.

The design team and Client should familiarise themselves with the presence of utility services on the site.

Once the whole site has been remediated; validation and approval from the Environment Agency and Ribble Valley Borough Council will be required via a validation report encompassing all the findings of the remediation works on this site.

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1.0 INTRODUCTION

1.1 Instruction

NX Consulting Limited has been commissioned by Simon Devine on behalf of Taylor Wimpey Manchester Limited (The Client) to undertake a remediation strategy of land at the proposed Phase 3 Calderstone Hospital residential housing development. It is understood that proposals include the construction of 46 residential houses with associated gardens, landscaped areas, car parking and associated access roads. Current proposals include raising site levels, to allow adequate site drainage as shown on RSK Land and Development Engineering Limited Drawing No 06RevP7; provided within Appendix A.

1.2 Previous Surveys

Previous assessments conducted upon the site comprise the following; which should be read in conjunction with this study.

- Phase 1 and 2 Geoenvironmental Site Investigation Report at Calderstones Park by RSK Group PLC (16372-R1 0) dated 4th of June 2010.
- Plot B1 Calderstones Hospital – Borehole Assessment by Strata Surveys Limited (ref NFJ/L13687 17072006.doc) dated 17th of July 2006.
- Site Check Data report on land at Calderstones Hospital by Landmark (ref SCPRO-23698251-1-1) dated 29th November 2007.
- Plan Search report on land at Calderstones Hospital by Landmark (ref PSC-21960143-1-1) dated 26th June 2007.
- Clarkebond North Limited Preliminary Phase 2 Geoenvironmental Assessment at Phase 3 Calderstones Park, Whalley BB7 9JT (ref: 25608E/R2); dated April 2011.
- NX Consulting Limited Additional Phase 2 Site Investigation Report, Phase 3 Calderstones Hospital, Whalley BB7 9TJ (ref: NX131/R1); dated April 2012

The RSK Group Phase 1 Geoenvironmental Assessment incorporated a review of public available information; including historic mapping, geological mapping and an environmental database. Based on this review, a Preliminary Conceptual Site Model (PCSM) was produced for the site by Clarkebond North, which identified potentially significant source-pathway-receptor pollutant linkages.

Clarkebond were granted permission by Taylor Wimpey Manchester Limited to utilise the information within the RSK report which facilitated the following site investigation works:

- Formation of 4no. window sample boreholes to depths circa 5.00m bgl.
- Formation of 3no. cable tool boreholes to a maximum depth of 14.00m bgl.
- Formation of 9no. Trial pits to depth circa 3.00m bgl.
- Formation of 2no. soakaway tests in line with BRE 365 Soakaway Design.
- Installation of 4no. combined gas and water monitoring wells
- Collection of samples for limited chemical and geotechnical laboratory testing.
- Preparation of a fully interpretative report outlining findings and recommendations.

Following the Clarkebond investigation NX Consulting Limited were commissioned by Taylor Wimpey Manchester to undertake an additional Phase 2 site investigation at the proposed Phase 3 Calderstone Hospital residential housing development comprising the following:

- 3no cable tool percussion boreholes with associated in-situ testing to maximum depths of 14.00metres below ground level.
- 10no machine excavated trial pits to maximum depths of 2.60mbgl.
- Provide preliminary recommendations regarding outline remedial measures necessary to mitigate any risks to human health or controlled waters resulting from contamination on the site; or recommendations for any further work.
- Provide revised foundation proposals following site re-profiling.

The Remediation Strategy Report should be read in conjunction with the NX Consulting reports listed above and geotechnical specification provided to Taylor Wimpey Manchester Limited.

1.3 Objectives

The aims of the Remediation Strategy are as follows:

- To provide a site suitable for the proposed use i.e. 46 residential houses with associated gardens, landscaped areas, car parking and associated access roads.
- To comply with the requirements of the Local Planning Authority (Ribble Valley Borough Council) and their Environmental Health Department/Pollution Control Unit to ensure that future end users of the site are not put at risk from any chemical contamination arising from its former uses.
- To ensure that construction workers are not put at an unacceptable short-term risk in reclaiming/remediating and redeveloping the site.
- To satisfy the requirements of the Environment Agency in ensuring that the proposed reclamation/remediation works provide a degree of protection necessary to controlled waters.
- To provide a cost effective but robust reclamation/remediation scheme by utilising treating and re-using on site materials wherever possible and to minimise on and off-site movements but satisfy waste management licensing regulations. Reporting on volumes of material excavated from site and, where applicable, the methods and locations used in off-site disposal.

A Method Statement will be required from the appointed Contractor to undertake the remediation and preparatory works. The Method Statement will detail how the objectives outlined in the Strategy are to be achieved.

1.4 Report Layout

Section 2 of this report provides a background information with respect of the site such as site setting and description .

Section 3 details the intrusive investigations carried out to date with a summary of the environmental setting, ground conditions and chemical analyses. Section 4 details the risk assessment and target concentrations at the site.

Section 5 presents the remedial strategy for the site and section 6 discusses the requirements for subsequent development at the site.

1.5 Limitations

The accuracy of the data supplied by third parties should be considered in the context of any known site conditions for which NX Consulting Limited cannot be held liable.

The comments given in this report and the opinions expressed assume that the ground conditions (geology, hydrogeology, contamination) do not vary beyond the range revealed by this assessment. There may be, however, conditions within the site, which have not been identified from the information reviewed and consequently have not been considered in this report: confirmation of such uncertainties should be the focus of any future intrusive investigations.

The comments made in this report are based on the data available at the time of its completion. Any unusual or conflicting evidence discovered during any future site works must be presented to NX Consulting as soon as possible so that any implications may be considered.

This report is provided for the benefit only of the party to whom it is addressed. NX Consulting does not extend responsibility to any third party for the whole or any part of the contents. Nx Consulting owes no duty of care in relation to this report to any third party. The investigation and reportage has been undertaken with all reasonable skill, care and due diligence. NX Consulting disclaims any responsibility to the client or others in respect of any matter(s) outside this agreed scope of the above works.

In addition to the above it should be noted that when investigating or developing land, sub-surface conditions might vary both spatially and over time. Whilst this investigation and subsequent interpretation has been undertaken to reasonably characterise current sub-surface conditions at the site within the scope of works and agreed budget, the absence of certain ground, contamination or groundwater conditions at the individual locations is not a guarantee that these conditions do not exist elsewhere on the site. Additional information, changes in legislation or revised practices may necessitate re-interpretation of part or all of this report.

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2.0 BACKGROUND

2.1 Site Location & Setting

The site is situated within Calderstones Park, Whalley at National Grid Reference (NGR) 372540, 437521. Access to the site is gained via a chain link fence from Pendle Drive to the south.

A Site Location Plan and site layout drawing is presented as Figure 01 in Appendix A.

2.2 Site Description

The site description has been established from a walkover survey conducted on 24th of January 2011 by Clarkebond Staff. A site layout drawing (Figure 2) is presented in Appendix A of their report, and they recommended that it should be read in conjunction with this site description.

The site is triangular shaped, generally level and covers an area of approximately 2.11 hectares. The site currently comprises an area of scrub and marsh land with an area of low grade tarmac situated centrally to the site. A number of semi-mature trees are located around the site with a larger area of protected mature woodland present in the south.

Overhead telegraph poles are present along the northern and eastern boundaries. Numerous existing and relic services cross the site and the design team should make themselves familiar with the presence. Anecdotal evidence suggests that former underground tunnels used as service runs may be present within the area and conversations with the site vendor and local authority are recommended to confirm or discount their presence.

The site is bounded to the east by a playing field beyond which lie residential properties, to the north by a tree lined embankment and public footpath which forms the line of a former brickworks railway. The path is set at a level approximately 3m below northern site levels. A small retaining wall forms the base of the slope and paved steps create a pathway to the site, adjacent to an existing pumping station. The pumping station forms part of the existing infrastructure of the Calderstones Hospital. Taylor Wimpey has confirmed that a 2m rising main crosses the site. The position of which is still being determined. The site is bound to the west by scrub and marsh land (currently utilised by dog walkers); and to the south by woodland Pendle Drive and residential houses and gardens in the southwest. Beyond which lies the now completed, Taylor Wimpey housing development.

Current site levels, shown on the RSK External Works drawing indicate a generally level plateau in the south and south east of the site at circa 53.00mAOD dropping to 56.00mAOD on the very northern boundary. Ground levels are also lower along the very eastern site boundary; ranging from 56.79mAOD to 55.90mAOD. The drop in level is clearly evident in the vicinity of proposed plots 17, 18, 19 and Plots 38 to 42 where a small embankment is present; indicating site reprofiling at some time in the past.

The area of tarmac hardstanding and track leading from Pendle Drive further shows that relic infrastructure once occupied the site. Drainage chambers and demolition materials associated with these structures still remain on site. The 'very' approximate extent of which is shown on Drawing presented within Appendix A. These materials will require 'grubbing out' and treatment (screening/crushing/segregation and reused (where appropriate) on site as part of the site preparation and upfill. Unsuitable materials will require removal from site to suitably licensed waste management facility.

The surrounding area comprises a mix of residential properties, agricultural farmland and scrub/marsh land. The residential properties close to the site are positioned along Pendle Drive to the south and Mitton Road to the east.

No evidence of sources of potential contamination or invasive plant species such as Japanese Knotweed was noted during the Clarkebond site walkover. However, vegetation was observed to be growing through the surface, in the northwest of the site, during the NX Consulting site walkover. It is recommended that this species is assessed by a suitable qualified ecologist to confirm that it is not invasive, require treatment and/or pose a risk to the suitability of site won materials.

2.3 The Proposed Development

It is understood that the site is to be redeveloped with 46 residential houses with associated gardens, landscaped areas, car parking and associated access roads. Current proposals include raising site levels, to allow adequate site drainage as shown on RSK Land and Development Engineering Limited Drawing No 06RevP7; provided within Appendix A.

3.0 PREVIOUS INVESTIGATIONS

3.1 Introduction

Previous investigations of the site have comprised both desk study and intrusive investigations as listed in Section 1 of this text. A summary of findings relevant to the proposed remediation of the site is given in the following sections.

Historical maps show the site was occupied by a brick works including a railway and clay pit from the 1910s to the 1930s when part of a mental hospital was constructed at the site. From 2006 to the present the site was derelict and in its present configuration.

The surrounding area has historically been occupied by a brick and tile works, railway and station, goods sheds and depots, a mental hospital and areas of agricultural and residential use.

A full historical land use appraisal is presented in NX Consulting Report (Report No NX131/R1 dated April 2012).

A summary of the environmental setting of the site was produced in the above referenced NX Consulting Report and for ease of reference has been summarised below.

Issue	Data Reviewed	Summary
Geology & Mining	Groundsure report	Drift – Glacial Till (high to very high plasticity boulder clay).
	Coal Authority Report BGS Mapping	Solid - Clitheroe Limestone Formation and Hodder Mudstone Formation (undifferentiated). Faults – None within 500m of site boundary. Coal Mining – Area of known Coal Mining but at significant depth
Quarrying	Groundsure Mapping	Non anticipated
Hydrology	Groundsure Report	Nearest surface water features are drain and pond located 300m to south and north west respectively. River Calder and Barrow Brook located 800m to south west and north respectively.
Hydrogeology	Groundsure Report	Bedrock underlying the site is deemed to be a minor aquifer overlain by soils of a low leaching potential. Not located within an Environment Agency defined Source Protection Zone.
Flood Risk	Groundsure Report	Not listed as being within 250m of extreme flooding from rivers or sea without defences
Radon	Groundsure Report	Radon Protection Measures are not required. >1% of buildings in area above Action Level

3.2 Fieldworks

Clarkebond were granted permission by Taylor Wimpey Manchester Limited to utilise the information within the RSK report which facilitated the following site investigation works:

- Formation of 4no. window sample boreholes to depths circa 5.00m bgl.
- Formation of 3no. cable tool boreholes to a maximum depth of 14.00m bgl.
- Formation of 9no. Trial pits to depth circa 3.00m bgl.
- Formation of 2no. soakaway tests in line with BRE 365 Soakaway Design.
- Installation of 4no. combined gas and water monitoring wells
- Collection of samples for limited chemical and geotechnical laboratory testing.
- Preparation of a fully interpretative report outlining findings and recommendations.

Following the Clarkebond investigation NX Consulting Limited were commissioned by Taylor Wimpey Manchester to undertake an additional Phase 2 site investigation at the proposed Phase 3 Calderstone Hospital residential housing development comprising the following:

- 3no cable tool percussion boreholes with associated in-situ testing to maximum depths of 14.00metres below ground level.
- 10no machine excavated trial pits to maximum depths of 2.60mbgl.
- Provide preliminary recommendations regarding outline remedial measures necessary to mitigate any risks to human health or controlled waters resulting from contamination on the site; or recommendations for any further work.
- Provide revised foundation proposals following site re-profiling.

Exploratory boreholes and trial pit locations were positioned to provide geotechnical information for foundation design and to identify potential areas of contamination identified during the Phase 1 desk study.

6 no. combined gas and groundwater monitoring wells were installed on site to conduct ground gas information to allow adequate characterisation of the site and appropriate mitigation measures for the proposed building.

A number of soil samples were tested for arsenic, boron (water soluble), cadmium, copper, chromium, lead, mercury, nickel, selenium, zinc, total cyanide, free cyanide, phenols, Speciated PAH, pH, total sulphur, sulphide, total sulphur, thiocyanate, 2:1 soluble sulphate, magnesium, nitrate analysis and asbestos screening. No visual or olfactory evidence of hydrocarbon or solvent contamination was encountered during the RSK or NX Consulting investigations.

3.3 Ground Conditions

General

The following ground condition summary has been utilised from information provided within the Clarkebond report and additional investigation works by NX Consulting to give a more comprehensive picture of the ground conditions upon the site.

Reference should be made to the NX Consulting Report (ref: NX131/R1) for exploratory borehole logs and a exploratory hole location plan.

Made Ground

Ground conditions generally comprise a cover of clayey fine to coarse slightly organic sand (Topsoil – Made Ground) with occasional fine to medium gravel of brick, coal and concrete. Ash and clinker fragments were recorded within 7no. exploratory holes within the upper 0.50m; overlying soft to firm to firm to stiff reworked clay probably associated with site re-profiling associated with previous site activities and recorded to 3.60mbgl in Clarkebond BH01. Land drains were recorded in a number of boreholes at depths ranging from 1.00m to 1.50m depth.

Deeper areas of Made Ground comprising demolition rubble/debris were typically encountered around areas of former structures and/or associated infrastructure to typical depths circa 2.50m. It would appear that former buildings have been demolished and former cellars/basements simply backfilled and excess demolition materials used to re-profile the surrounding area. Relic infrastructure remains in-situ comprising former roads, paving and underground services/drainage.

Exploratory holes excavated within areas of the former buildings and infrastructure (namely: NXTP1.1, NXTP2.1, NXTP5.1, NXTP6.1, NXTP7.1, NXTP8.1, CP01, TP01, TP02, TP05, TP06, TP07, WS03 and WS04) recorded clayey ashy gravel of brick, concrete, timber, clinker and slate. Intact brick/concrete cobbles and boulders were recorded in a number of the above holes. A basement/cellar wall was recorded within TP02/SA02 to a maximum depth of 1.90mbgl.

The upper levels of clay made ground generally being soft to firm or firm in nature. SPT 'N' values ranging from 1.5 to 10; indicating soft to firm to stiff conditions. Hand held shear vane tests conducted within Clarkebond trial pits recorded Cu values ranging from 30 to 51kN/m² in the reworked clays confirming they are generally soft to firm to firm.

Glacial Till

Underlying the Made Ground generally firm (locally soft to firm) to stiff dark grey organic Glacial Boulder Clay was encountered to depths ranging from 0.50mbgl to maximum depths of 11.00mbgl. These deposits were recorded within all the majority of exploratory boreholes with the exception of TP01/SA1.

Medium dense fine to coarse sand and gravel was encountered from 7.00mbgl to 7.90mbgl in NXBH3.

SPT 'N' values ranged from 4 to 29 within the Glacial Boulder Clay indicating soft to firm/firm to very stiff conditions.

Hand held shear vane tests conducted within trial pits recorded Cu values ranging from 39 to 126kN/m² confirming generally soft to firm to stiff conditions.

Bedrock

Mudstone bedrock was recorded within NX Consulting boreholes NXBH2 and NXBH3 at depths ranging from 11.00mbgl to 14.00mbgl. Recovered samples indicate that the bedrock is highly weathered clay between depths circa 11.00mbgl and 12.00mbgl. Samples were recovered as weak fine to coarse gravel beyond 12.00mbgl.

SPT test achieved 'refusal' ('N' >50) in both boreholes from 12.00mbgl. Chiselling was conducted, within NXBH2, achieving a further 450mm progress over a 30minutes period. The borehole being terminated in mudstone strata at 14.00mbgl.

3.4 Groundwater

Groundwater strikes were recorded in Clarkebond BH01 at 2.7mbgl and 8.6mbgl and NXBH3 at 7.00mbgl; within the granular horizons in the superficial deposits. In both cases the flow was slow rising to 2.0mbgl, 8.2mbgl and 6.00mbgl; respectively after 20mins.

Groundwater was also encountered during the drilling of WS03 and WS04 at 4.00mbgl and 3.00mbgl respectively. No rise was noted.

Groundwater ingress was encountered during the excavation of TP07 and NXTP7.1 at 2.30m and 2.50mbgl within Made ground respectively. Rapid and slow ingress, being recorded respectively. Groundwater was typically observed to be perched on top of the underlying natural Glacial Boulder Clay.

During the Clarkebond investigation, four combined groundwater and ground gas monitoring wells were installed on the site and to date 5no. visits were conducted. Installations formed in WS02 and WS03 were vandalised and WS03 was partially repaired. Groundwater levels were recorded at the following depths within the Clarke Bond boreholes:

Borehole Number	Range of Depths Recorded (mbgl)	Depth of Response Zone (mbgl)
BH01	1.34	0.50 to 3.50
WS01	0.57	0.50 to 2.00
WS02	Vandalised	0.50 to 2.00
WS03	Vandalised, Repaired	0.50 to 2.00

NXBH1 and NXBH3 were installed with groundwater and ground gas monitoring wells to replace vandalised wells installed by Clarkebond. The following groundwater levels were recorded during 2no. ground gas monitoring visits:

Borehole Number	Range of Depths Recorded (mbgl)	Depth of Response Zone (mbgl)
NXBH1	1.49 to 2.11	1.00 to 3.17
NXBH3	1.46 to 1.82	1.00 to 3.00
BH01	1.80 to 1.82	0.50 to 3.50

Groundwater recorded within NXBH1 and NXBH3 are considered to be due to surface water percolation and not reflective of actual groundwater levels within the clay strata.

3.5 Inorganic Contamination

A number of samples of both the Made Ground and natural strata were sent under chain of custody to undergo laboratory analysis for metals.

All of the values fell below their respective CLEA/LQM/CIEH GACs for a residential end use with the exception of a single sample from TP10 at 0.1mbgl which recorded a lead concentration of 970mg/kg within Made Ground strata; above the soil guideline value of 450mg/kg.

As such the risks from metals to the proposed development is considered negligible as the proposed upfilling works will effectively isolate unacceptable contamination by providing a minimum clean soil cover system over deposits of made ground in the majority of gardens and landscaped areas. Where proposed plots do not have sufficient cover as a result of the upfilling works, levels should be reduced and replaced to ensure a 600mm cover system is provided.

3.6 Organic Contamination

Although no visual or olfactory evidence of hydrocarbon or solvent contamination was encountered during the Phase 2 investigations, chemical analyses of the Made Ground and natural strata recorded elevated concentrations of PAH when compared to respective CLEA/LQM/CIEH GACs for a residential end use. The following table summarises the exceedances recorded within the Clarkebond and NX Consulting works.

BH No	Strata Type	Determinant	Recorded Value mg/kg	LQM/CIEH 2 nd Edition 2009 PAH GAC values at 6% SOM (residential end use)
Clarkebond TP01 (0.1m)	TS	Benzo(a)pyrene	1.6	1.0
Clarkebond TP02 (0.1m)	TS	Benzo(a)pyrene	1.8	1.0
Clarkebond TP01 (0.4m)	MG – Gravel	Benzo(a)pyrene Benzo(a)anthracene	4.9 6.8	1.0 5.9
Clarkebond TP03 (0.3m)	MG – Gravel	Benzo(a)pyrene	1.0	1.0
NX TP1.1 (0.05m)	TS – Coal Fragments	Benzo(a)pyrene	1.2	1.0
NX TP2.1 (0.20m)	MG –Gravel Brick, ash Clinker	Benzo(a)pyrene	2.1	1.0
NX TP5.1 (0.30m)	MG –Gravel Brick, ash, Tarmacadam Clinker	Benzo(a)anthracene Chrysene Benzo(b) fluoranthene Benzo(a)pyrene Indeno(123cd)pyrene Dibenz(ah)anthracene	14.2 12.5 15.9 11.7 5.8 1.3	5.9 9.3 7.0 1.0 4.2 0.9
NX TP7.1 (0.20m)	MG –Gravel Brick, ash, Tarmacadam Clinker	Chrysene Benzo(b) fluoranthene Benzo(a)pyrene Indeno(123cd)pyrene Dibenz(ah)anthracene	12.5 10.5 9.6 3.5 1.2	9.3 7.0 1.0 4.2 0.9
NX TP10.1 (0.10m)	TS – brick, coal gravel.	Benzo(a)pyrene	1.3	1.0

The remedial measures outlined in Section 5.11 (i.e. minimum clean cover system of 600mm in landscaped and garden areas) will mitigate against the risk presented to the end user of the site by these potential contaminants.

3.7 Asbestos

Asbestos fragments (chrysotile – white) were detected within the made-ground topsoil of NXTP1.1 at 0.05. NXTP1.1 was formed within the near vicinity of former site building and is likely to be the source of this material. Provided that up-filling and cover systems recommended in Section 5.11 is complied with and appropriate PPE and sanitary provisions are instigated for construction workers, it is considered that no further investigatory works and or remedial actions are required in relation to asbestos.

3.8 Ground Gas

During the Clarkebond and NX Consulting investigations, gas monitoring installations were incorporated in 6 exploratory boreholes.

To date seven rounds of monitoring has been undertaken between September 2011 and April 2012. Barometric pressure was recorded between at 976 to 1027mb and 1019mb.

A summary of the soil gas monitoring results is presented in Table 7.3.1 below and copies of the log sheets presented in Appendix E.

Table 3.8.1 Summary of Soil Gas Monitoring Results

Borehole Reference	CO ₂ Range (%v/v)	Flow (l/hr)	Max GSV (l/hr)	CO ₄ Range (%v/v)	Max GSV (l/hr)
BH01	<0.1 to 0.6	0.0	0.0	0.1	0.0066
WS01	<0.2 to 4.5	0.0 to -4.9	0.00	0.1	0.004
WS02	Vandalised	N/A	N/A	N/A	N/A
WS03	0.2 to 0.3	-0.15 to 0.0	0.0	0.1	0.0
NXBH1	2.4 to 3.2	1.4 to 1.7	0.054	0.1	0.00005
NXBH3	2.7 to 2.8	0.0	0.0	0.1	0.00

In line with NHBC Guidance on Methane and Carbon Dioxide (Rev4 March 2007). The site to be developed for low-rise housing and the ground gas investigation has identified a maximum carbon dioxide concentration of 4.5% with a worst-case flow rate of 1.7l/hr.

With a GSV of 0.0765l/hr and a maximum concentration of carbon dioxide of 4.5%, the site will be characterised as 'Green' and as such no special protection measures are required for the proposed building.

3.8 Development Constraints

The following is a summary of the development constraints/conditions identified during the NX Consulting Additional Phase 2 report, regarding to the proposed redevelopment of the site:

- Compliance with the requirements of the regulators i.e. Ribble Valley Borough Council, the Environment Agency, service providers (e.g drainage, water, gas and electricity).
- The presence of existing foundations/slabs from previous site demolition and below ground obstructions
- The presence of trees currently occupying the site.
- The presence of a significant thickness of Made Ground across the site.
- Residual contamination of soils.

- Relic site services not identified to date.
- Retaining elements associated with the site reprofiling and development
- Appropriate placement and possible treatment requirements of highly plastic clays.

4.0 RISK ASSESSMENT AND TARGET CONCENTRATIONS

Quantitative risk assessments have not been established to date to derive site specific clean up criteria for hydrocarbon contamination. This is because the results recorded to date for soils have been recorded generally below Environment Agency Soil Guideline Values (SGVs) and Generic Assessment criteria. NX Consulting propose continued use of SGVs and GACs for a residential end use with plant uptake throughout the remediation works. If deemed necessary as a result of the finding of the any unexpectedly elevated concentrations of hydrocarbon contamination, site-specific clean up criteria will be reassessed via human health QRA.

With regards to site specific clean up criteria for hydrocarbon contaminated Made Ground where encountered, remediation proposals include removal of the main source of contamination thus breaking the source-pathway-receptor linkage. The NX Consulting conceptual model will be continually re-assessed, throughout the remediation works. As such, Tier 1 commercial values will utilised at this time.

The following table provides Tier 1 values for a range of potential contaminants for the site; for a residential end use with plant up-take.

	Residential 0mm Cover	Residential 600mm Cover	Residential Apartments with Landscaping	Commercial Industrial with Landscaping	Notes			
Active Pathways	• Direct Ingestion • Dermal Contact • Consumption of Vegetables and Attached Soil • Inhalation of Indoor Vapour and Dust • Inhalation of Outdoor Vapours and Dust	• Inhalation of Indoor Vapours • Inhalation of Outdoor Vapours	• Direct Ingestion • Dermal Contact • Consumption of Vegetables and Attached Soil • Inhalation of Indoor Vapour and Dust • Inhalation of Outdoor Vapours and Dust	• Direct Ingestion • Dermal Contact • Consumption of Vegetables and Attached Soil • Inhalation of Indoor Vapour and Dust • Inhalation of Outdoor Vapours and Dust				
CLEA Model Defaults Utilised	SOM = 6% Total Porosity = 0.53 Water Filled Porosity = 0.33 Air Filled Porosity = 0.32	SOM = 6% Total Porosity = 0.53 Water Filled Porosity = 0.33 Air Filled Porosity = 0.32	SOM = 6% Total Porosity = 0.53 Water Filled Porosity = 0.33 Air Filled Porosity = 0.32					
Critical Receptors	Female Child 0-6yrs Old	Female Child 0-6yrs Old	Female Child 0-6yrs Old	Female Adult Worker 17 years Old working in a ground floor office space				
Amendments to CLEA 2009 Model	Contamination source located at depth of 150mm below building as opposed to CLEA default of 650mm	Contamination source located at depth of 150mm below building as opposed to CLEA default of 650mm	Contamination source located at depth of 150mm below building as opposed to CLEA default of 650mm	Contamination source located at depth of 150mm below building as opposed to CLEA default of 650mm				
Units	mg/kg		mg/kg		mg/kg			
Arsenic	32	CLEA 2009	No Pathway	32	CLEA 2009	635	CLEA 2009	
Cadmium	5	CLEA 2009		5	CLEA 2009	230	CLEA 2009	
Mercury (inorganic)	170	CLEA 2009		170	CLEA 2009	3,640	CLEA 2009	
Nickel	130	CLEA 2009		130	CLEA 2009	1790	CLEA 2009	
Selenium	350	CLEA 2009		350	CLEA 2009	13,000	CLEA 2009	
Chromium III	3000	LQM/CIEH		3000	LQM/CIEH	30,400	LQM/CIEH	
Chromium VI	4.3	LQM/CIEH		4.3	LQM/CIEH	35	LQM/CIEH	
Lead	450	CLEA 2002		450	CLEA 2002	750	CLEA 2002	
Copper	2,330	LQM/CIEH	No Pathway	2,330	LQM/CIEH	71,700	LQM/CIEH	
Zinc	3,750	LQM/CIEH		3,750	LQM/CIEH	665,000	LQM/CIEH	
Boron	291	LQM/CIEH		291	LQM/CIEH	192,000	LQM/CIEH	

NX Consulting Tier 1 Values Version 1 - CLEA 2009 (Software Version 1.06)

Benzo(a)Pyrene	1.0	LQM/CIEH	No Pathway		1.0	LQM/CIEH	14	LQM/CIEH
Naphthalene	4.0	CLEA 2009	4.0	CLEA 2009	4.0	CLEA 2009	432	CLEA 2009*
Benzene	0.25	CLEA 2009	0.5	CLEA 2009	0.5	CLEA 2009	63	CLEA 2009
Toluene	497	CLEA 2009	1440	CLEA 2009	1340	CLEA 2009	4,360	CLEA 2009*
Ethylbenzene	240	CLEA 2009	416	CLEA 2009	398	CLEA 2009	2,840	CLEA 2009*
Xylenes	127	CLEA 2009	146	CLEA 2009	145	CLEA 2009	2,620	CLEA 2009*
Amendments to CLEA 2009 Model	NX Consulting have used a subsurface soil to indoor air correction factor of 10 to account for the over prediction of indoor inhalation in new buildings							
Aliphatic C5-C6	41	CLEA 2009	41	CLEA 2009	41	1000	CLEA 2009	
Aliphatic C6-C8	123		123		1000			
Aliphatic C8-C10	31		31		1000			
Aliphatic C10-C12	151		151		1000			
Aliphatic C12-C16	500 [#]		685 [#]		1000			
Aliphatic C16-C21	1000 [#]		5000 [#]		5000			
Aliphatic C21-C35	1000 [#]		5000 [#]		5000			
Aromatic C5-C7	52		56		1000			
Aromatic C7-C8	15		16		1000			
Aromatic C8-C10	47		50		1000			
Aromatic C10-C12	212		261		1000			
Aromatic C12-C16	683		1000 [#]		1000			
Aromatic C16-C21	1000 [#]		5000 [#]		5000			
Aromatic C21-C35	1000 [#]		5000 [#]		5000			

5.0 REMEDIATION STRATEGY

5.1 Aims

The aims of this remediation strategy are the following:

- Resolve any potential and identified contamination issues in order to protect environmental receptors, and render the site suitable for the proposed development.
- Satisfy the Environmental Agency and the Local Planning Authority with regards to soil and groundwater contamination.
- Provide a stable development platform (to agreed levels and gradients) for subsequent construction of the proposed development and associated infrastructure.
- Satisfy the requirements of the National House Building Council (NHBC) in matters related to potential contamination.

5.2 Overview

Proposed scope of works summary:

- Excavation and segregation of surface tarmac.
- Breakout and removal of slabs, hardstanding and below ground structures and replacement with appropriate soil materials in line with DOT Series 600 Department of Highway Works.
- Crushing of all suitable artificial hard material (i.e. concrete/tarmac etc).
- Provision of a piling mat in line with BRE470 Working Platforms for Tracked plant.
- Re-profiling to raise site levels by depths circa, 2.50m in the north, and circa 300mm in the south.
- Placement of clean soil cover in private garden and landscaped areas.
- Supervision of the works by a suitably qualified consultant to include detailed records, testing requirements, etc.
- Validation of the remediated site in the form of a detailed Completion Statement confirming that the works set out in this document and agreed were completed and that the site is suitable for its intended use.

5.3 Site Setup, Organisation and Safety

Site works shall be supervised when only deemed suitable by the contractor, by a suitably qualified Engineer, who will report to a Project Manager. Supervision may be part time for certain activities but must be full time if any grossly contaminated soil/fill is identified during construction works.

Site cabins and welfare provisions are to be provided in accordance with the HSE Guidelines by the appointed contractor.

All personnel shall undergo a site specific health and safety induction prior to commencement of work on site.

The Engineer shall be informed prior to any proposed entry to a confined space or deep excavation. Entry must be restricted to a suitably qualified and equipped person and supervised at all times.

Works will be carried out with the proper regard to the following standards:

- Health and safety at work act 1974
- Management of Health and safety at work Regulations 1999
- Construction (Health, Safety and Welfare) Regulations 1994
- Construction (Head Protection) Regulations 1998
- Provision and Use of Work equipment Regulation 1998
- Lifting Operations and Lifting Equipment Regulations 1994
- Construction (design and management) Regulations 1994
- Health and Safety Executive "Protection of Workers and the general public during the redevelopment of Contaminated Land", HS(G)66, HMSO 1991
- The Control of Substances Hazardous to Health Regulations 1994
- Any successive legislation to the above

During the remediation works, all personnel on site will comply with guidance provided in the Health and Safety Executive (HSE) document "Protection of Workers and the general public during the redevelopment of Contaminated Land". In summary, the following should be provided by the appointed contractor:

- Protective clothing, footwear, glasses and gloves. (Personnel should be instructed in why and how they are to be used).
- Disposable coveralls should be provided where appropriate.
- Hand-washing, eye-washing and boot-washing facilities.
- Smoking shall be limited to designated areas.

If at any time during the works personnel begin to feel unwell, they are to inform the Engineer, who will determine appropriate action.

All visitors to the site must enter and register at the main site contractor's office.

5.4 Contractor's Responsibilities

Prior to the commencement of any works the Contractor, in agreement with the Engineer, shall:

- Satisfy requirements of the Client's contract documentation.
- Establish the boundaries of the site and the working areas
- Liaise with Local Authority regarding working hours, noise/dust/odour control, and protected trees.
- Liaise with the Local Water Company prior to any proposed discharge to local sewers.
- Complete a full services search and liaise with all relevant utility companies regarding work in close proximity to existing services.
- Prepare a detailed method statement outlining how the objectives in the Remediation Strategy are to be achieved to be agreed with both the client and consultant.

- Prepare the necessary COSSH statement and Health and Safety Plan in accordance with current CDM regulations.
- Provide and erect secure Herras-type fence to protect site and remedial activities and discourage entrance by the general public.
- Provide the engineer with consignment notes and Waste management tip tickets and records

The Contractor shall satisfy the HSE with regards to all matters concerning health, safety and the welfare of personnel on site.

The contractor shall insure that:

- Personnel, plant, materials and other equipment related to the contract are confined within the boundaries of the site.
- Any live services lying within the site boundary are clearly marked and protected, or appropriated arrangements have been made to truncate them.
- Good practise relating to personal hygiene are adopted.
- Suitable precautions are taken to prevent the spread of soil and debris onto public roads.
- Suitable precautions are implemented to prevent offsite migration of any found pollutants via airborne dust and vapours.
- Refuelling of mobile plant is undertaken in a designated area. Above ground fuel storage tanks shall comply with the requirements of the Pollution Prevention Guideline PPG2. A spill kit shall be kept adjacent to any fuel storage area.

5.5 Engineering Supervision and Verification

The engineer shall ensure that the requirements of the Remediation Strategy are complied with in a safe and orderly manner.

The responsibilities of the Engineer shall include but are not limited to the following:

- Advice on the correct handling of materials and conditions encountered.
- Guidance on the appropriate protective equipment that should be made available and used.
- Retrieval of soil and water samples from within the made ground and the subsequent scheduling of appropriate laboratory analysis to enable validation of various aspects of the works, and to advise the project manager of progress and unforeseen occurrences.
- Liaise with statutory authorities as required.
- Liaise with Client as required.

The engineer will maintain a record of the works to include the following:

- Daily record sheets and summary of the day's activities.
- Date and weather conditions
- Test results

All areas of reduced excavation should be recorded by the use of digital photography of the excavation with a suitable scale indicator (such as survey staff) prior to backfilling.

All photographs should include landmarks or other indicators proving their geographical location and indicate the entire area of backfilling, as well as detailed assessments of banks and boundaries.

On satisfactory completion of the works the Engineer will provide a verification report outlining and including the following:

- A summary of the desk study, site investigation report.
- A summary of the preparatory works undertaken and remediation strategy.
- Details of who carried out the respective remedial works.
- Details and justification of any changes from the original remediation strategy, including unforeseen ground conditions.
- Copies of any correspondence with Regulators relating to specific aspects of remedial works.
- Substantiating validation data included as follows:
 - Laboratory and in-situ test results (Geotechnical and Chemical)
 - Chemical test results relating to clean up criteria
 - Representative plans depicting treated areas and any amendments to strategy as a result of finding further contamination (if necessary).
 - Photographic records
 - Waste management tip tickets and records
- Recommendations with regards to the handling of contaminated soils.

The remedial recommendations will be produced in accordance with results obtained for the remediation strategy investigation and thus may differ significantly from the recommendations originally presented in the site investigation report.

5.6 Removal of Below Ground Obstructions

Relic infrastructure remains in-situ comprising former roads, paving and underground services/drainage, within the upper 2.00m to 3.00m of strata. The 'very' approximate extent of which is shown on Drawing No NX131/02 presented within Appendix A. These materials will require 'grubbing out' and treatment (screening/crushing/segregation and reused (where appropriate) on site as part of the site preparation and upfill and to prevent deflection of the piled foundations.

Where relict structures are found to retain fluid contaminants, they shall be drained and removed from site.

Deep excavations for the removal of structures etc will be unstable in the short term and side support may be necessary.

Suitable materials derived from the grubbing-up shall be stored in a location on site, to be agreed with the engineer, prior to crushing. Any unsuitable materials shall be removed to a suitable licensed landfill site as stipulated within the earthworks specification.

This report should be read in conjunction with the NX Consulting DOT Series 600 earthworks specification provided to the client.

5.7 Contamination

Although unlikely, areas of potential hydrocarbon contamination, not identified in the site investigation, may be encountered during the remedial works. The contractor should stop works, notify the engineer immediately providing reasonable notice for site attendance.

Any grossly contaminated soil/fill, found during construction works shall be placed in temporary stockpiles on hardstanding or high density Visqueen and be suitably covered to minimize the potential for dust/odour nuisance, and prevent surface water runoff. Samples of arising material will be taken to determine whether this material is suitable for re-use on site following crushing in line with the earthworks specification.

Should any visual or olfactory evidence of contamination be identified during the removal of below ground obstructions and the turning over of made ground appropriate samples shall be taken by the Engineer for chemical analysis. The Engineer shall check the nature of materials excavated for visual and olfactory evidence of hydrocarbon contamination throughout the remedial works. Depending on the results, the excavated materials shall either be returned to the works beneath the proposed cover system or disposed of, off-site to a suitable licensed facility.

Excavations should not be left open for longer than necessary, should be safely battered back and should be securely cordoned-off using 2m high Herras-type fencing, with appropriate warning signs whenever excavations works are suspended.

5.8 Control of Water

During the removal of below ground obstructions and the excavation through of the made ground, perched water will be encountered.

Ground water shall be controlled in accordance with CIRIA report 113 "Control of Ground Water to Temporary Works".

Arrangements should be made to prevent ponding in any excavation, the Contractor shall ensure that ground levels are of sufficient gradient to enable the collection of surface water run-off in sumps or grips.

Any potentially contaminated water shall not be allowed to migrate into other areas until the results of the analysis are available and, if required, a suitable means of water treatment has been agreed.

Pumping from over excavated sumps may be required to maintain satisfactory working conditions.

Soft, marshy and waterlogged ground conditions should be anticipated outside existing hardstanding areas and protection of the formation layer required at all times.

5.9 Exported to Landfill

Any material exported from the site to landfill should be hauled by a registered waste carrier in accordance with the requirements of the Duty of Care Regulations, 1991 and the Landfill (England and Wales) Regulations 2005.

A transfer note should then be completed, signed and retained by the parties involved. The transfer note should include the volume of waste, the nature of the material and a statement of its chemical composition, details of the source and destination sites, and details of the haulier.

In order to protect the general public from dust and vapour emissions, wagons that are used for the haulage of the contaminated material from the site must be sheeted. In addition, the Contractor must ensure that no fluids seep from the wagons.

All hazardous waste going for disposal at landfills must be classified according to the new European Waste Catalogue (EWC)

Contaminated soils are minor entries in the EWC. Waste contaminated soils may be classified as either hazardous or non-hazardous depending on the concentrations of "dangerous substance" in the waste soil. An assessment of the composition of the waste soil will therefore be undertaken to determine if it is hazardous waste.

The WAC set threshold concentrations for leachable components of the waste stream and landfill operators will have waste acceptance procedures in place to ensure that only compliant waste is landfilled. Most waste will need to be treated before it can be landfilled to reduce its quality and the hazard it presents. Leaching compliance testing will be required in accordance with BS EN 14899:2005.

5.10 Dust Control

The excavation of fill should not present a significant problem with regard to emission of dust during the excavations and transport because the material being excavated should have a high moisture content. However, the following guidelines presented should be followed.

Mitigation

At all times during the excavation works, Best Practicable Means shall be employed to minimise dust and odour generation and their emission off site.

5.11 Controlled Waters

Records indicate that the nearest surface water features are a drain and pond located 300m to south and north west respectively. The River Calder and Barrow Brook are located 800m to south west and north respectively.

The underlying solid strata (Clitheroe Limestone Formation and Hodder Mudstone Formation) is and designated a minor aquifer. This is overlain by soils of low leaching potential.

Locally elevated concentrations of heavy metals (lead) and PAH are present in the soils beneath the site. However, the site is underlain by up to 14.0m of relatively impervious soils (Glacial Till) which will offer the underlying minor aquifer a degree of protection against the downward leaching of mobile contaminants.

True groundwater levels are likely to be encountered at a significant depth and are unlikely to be an issue at this site, although localised perched groundwater could be present within granular pockets within the Glacial Till and cohesive Glaciofluvial deposits.

The risk to Controlled Water receptors from leaching and groundwater migration is therefore perceived to be negligible. This can only be fully accessed via quantitative analysis and agreed with the Environment Agency.

5.12 Health and Safety during Remediation

During construction works the workforce will need to adopt full HSE measures to ensure that the elevated concentrations of contaminants, established during construction works, requiring cover, treatment and/or removal are dealt with according to current guidelines and codes of practice. Suitably experienced and competent staff should be employed to carry out the on-site remediation.

Site personnel are not permitted to enter unstable excavations, nor excavations in which contamination is present, nor unsupported excavations deeper than 1.2m, in accordance with standard HSE protocols. Standard air sampling and monitoring equipment shall be used which emits an audible warning of the presence of any volatile gases and/or low oxygen atmospheres.

NX Consulting are not the Planning Supervisor for this scheme and therefore, a site pre-tender health and safety plan has yet to be made available and will not form part of this scope of works.

6.0 REQUIREMENTS FOR SUBSEQUENT SITE DEVELOPMENT

6.1 Foundation Requirements and Earthworks

The proposed development layout, including existing and proposed levels are shown on the RSK Land and Development Engineering Limited Drawing No 06RevP7; provided within Appendix A. Proposed enabling works entail raising site levels by depths circa, 2.50m in the north, and circa 300mm in the south.

The Made Ground deposits are considered unsuitable as an adequate founding stratum due to the possible risks of unacceptable total and differential settlements occurring. Site levels have been revised since the issue of our additional site investigation report and a combination of driven piles, trenchfill and wide strip foundations with suspended ground floor slabs are the recommended foundation solution. Indicative plots are provided within DWllp drawings provided to the client. A piling matt will be required in line with BRE470 Working Platforms for Tracked plant.

Unsuitable site materials will require 'grubbing out' and treatment (screening/crushing/segregation and reused (where appropriate) on site as part of the site preparation and upfill and to prevent deflection of the piled foundations. The 'very' approximate extent of which is shown on Drawing No NX131/02 presented within Appendix A. Unsuitable materials, that cannot be reused on site, will require removal from site to suitably licensed waste management facility.

Site preparation prior to upfilling should include removal and replacement of all vegetation, topsoil and any uncontrolled filling. Site won and imported suitable earthworks materials will need to be classified and compacted in accordance with Table 6/1 of Department of Transport Specification for Highways Works. Any imported materials used for upfilling will require chemical validation to demonstrate that they are suitable for a residential end use.

Laboratory test results indicate that the grey brown upper organic Glacial Clay is high to very high plasticity with a corresponding high volume change potential. Optimum moisture contents and maximum dry densities of 17% and 1.49Mg/m³ and 23% and 1.53Mg/m³ were recorded. Natural moisture contents indicating that the clays are typically 'wet' of optimum and treatment (possibly with lime cement stabilisation) may be required to achieve required maximum dry densities during compaction.

The client is proposing to reuse drainage and sewer arisings in deeper areas of made ground/basements/cellars under a controlled manner. Any replaced 'site won' or imported materials will again need to be compacted in line with the Department of Transport, Specification for Highway Works Series 600.

As a result of spalling and collapse, encountered within deeper areas of fill, may necessitate the requirement of temporary support and consideration during service excavations.

A number of trees are present which are within possible influencing distance of the site foundations and drainage should be designed in line with NHBC Standards guidance document Chapter 4.2 Building Near Trees.

The earthworks designer should assess the requirement for pre-earthworks drainage that allows for temporary fill surfaces to be sealed and shaped to shed water and operational restrictions during periods of rainfall. Soft and heavy clays should be anticipated on site and the generation of excess pore water pressures during compaction.

6.2 Placement of Soil Cover

To protect end users from isolated areas of heavy metal and PAH contamination, a soil cover system (consisting of a minimum 600mm thick layer) is required over deposits of made ground, in all gardens and landscaped areas. However, current site preparation works entail raising site levels by as much as 2.50m in the north of the site; reducing to circa 200mm within the vicinity of Plots 1 to 7.

The proposed upfilling works will effectively isolate unacceptable contamination by providing a minimum clean soil cover system over deposits of made ground in the majority of gardens and landscaped areas. Imported and site won materials used for upfilling and capping in garden areas will require chemical validation to demonstrate that they are suitable for a residential end use. The upper 600mm should contain a minimum 150mm of 'clean' topsoil' and also be capable to support root growth.

Where proposed plots do not have sufficient cover as a result of the upfilling works, levels should be reduced and replaced to ensure a 600mm cover system is provided. Details of the plots requiring a 600mm cover system are detailed in the table provided in Appendix A.

Imported materials will require chemical and visual validation in accordance with NX Consulting's Protocol for Validation of Soil Cover Systems (presented in Appendix B) to demonstrate that they are suitable for a residential end use and taken to depths sufficient to provide a sufficient cover system for all proposed plots and materials used which are capable to support root growth.

The majority of topsoil present on site is considered suitable for re-use in gardens and landscaped areas. Very slightly elevated concentrations of individual PAH compounds are likely to be associated with coal fragments associated in isolated instances constituents of ash/clinker. Stockpiling and screening of unacceptable topsoil should be conducted on-site and further validation sampling taken to confirm that it is suitable for re-use; prior to placement in gardens and landscaped areas.

Cover material beneath landscaped areas can be sourced directly from site, subject to screening. However any imported materials must not contain putrescible organic materials, demolition rubble, glass, ash, clinker, slag, colliery shale, or spoil. Additionally, the material must not appear to be contaminated or have odours that are not natural with the material brought on-site.

Soils that are imported must be stockpiled separately to allow for validation. It is the responsibility of the Contractor to contact NX Consulting to validate the material as being suitable for use. It is crucial that the stockpiles are kept clean of any construction materials in order to prevent them being inadvertently identified as contaminated and rejected for use on site.

Samples will be submitted to the analytical laboratory for a 5-day turnaround of results. A shorter turnaround time can be achieved upon the request of the client with a surcharge fee for expedited results requests. NX Consulting will respond within 24 hours of receiving laboratory results from each stockpile; notifying the Contractor if the materials are suitable for their intended use. This procedure should be adopted for every stockpile brought to site for purposes of remediation and topsoil laying.

Soils which are to be used in landscaped areas, from imported materials, will be required to have concentrations of determinands at or below the Soil Guideline and Land Quality Management Values (LQM) shown above.

The Contractor must maintain adequate site records regarding imported soil including date of delivery, type of material location of stockpiles onsite, date of sampling by NX Consulting, date of rejection or approval for use by NX Consulting. Stockpiled materials must not be used until receipt of approvals by NX Consulting.

6.3 Retaining Walls & Slopes

The RSK External Works Drawing No 006RevP7 in Appendix A indicates that retaining wall will be required upon site. The following parameters are recommended for design based on laboratory test results obtained to date:

Soil Type	C' (kN/m ²)	ϕ' (°)	(γ) kN/m ³
Cohesive Made Ground			
	0	24	19
Organic Clay	0	22	18

Vertical drainage should be maintained behind any site retaining walls. It may be difficult to compact cohesive fill close to a granular vertical drainage layer without distorting or displacing the filter material. In this instance, hollow concrete blocks could be considered instead of granular material as the drainage filter. The rigid nature of the blocks will help resist deformation by the compaction process.

The stability of existing site slopes should be a consideration during design of retaining structures for the site.

6.4 Gas Protection Measures

In line with NHBC Guidance on Methane and Carbon Dioxide (Rev4 March 2007) ground gas protection measures will not be required within the proposed development.

No radon protection measures are necessary in the construction of new dwellings or extensions

6.5 Drainage and Services Installations

It is envisaged that new drainage and utility supplies will be at relatively shallow depth within the top 1200mm; the made-ground deposits. Given the slightly elevated levels of potential contamination determined within the site soils, specifically polycyclic aromatic hydrocarbons (PAH), protection measures are recommended for plots upon the site where a clean 1200mm cover cannot be provided due to upfilling.

With reference to the UKWIR publication 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites' document reference 10/WM/03/21 advice is given on the appropriate materials for these ground conditions.

Appropriate construction materials for water supply pipes will therefore comprise either; 'Barrier Pipe' (PE/AL/PE), wrapped steel or wrapped ductile iron. The exact requirements are to be confirmed with the relevant utility supplier (United Utilities).

It is recommended that statutory services are consulted at an early stage, with respect to the ground conditions within which they will lay services, in order to enable them to assess at an early state any protection measures required.

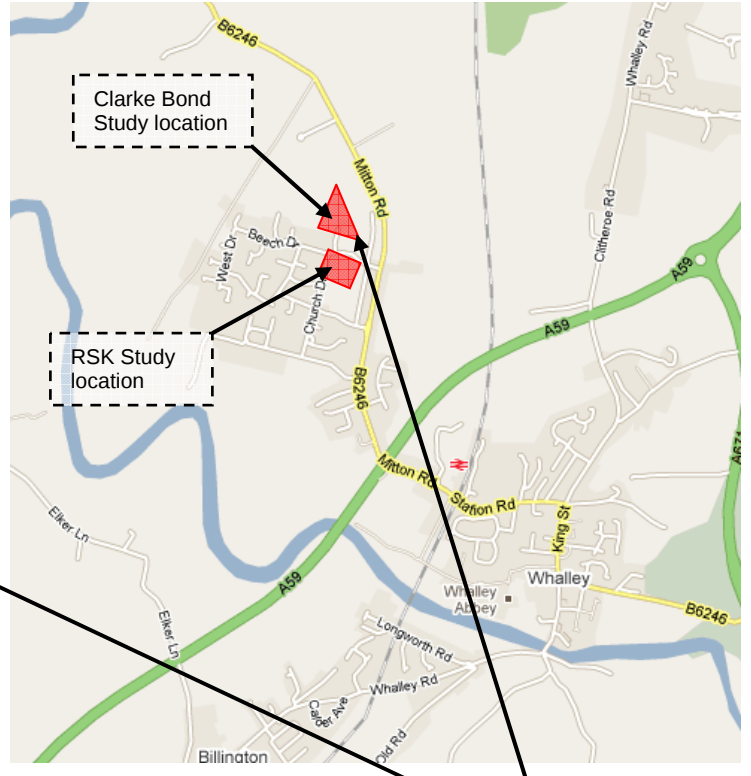
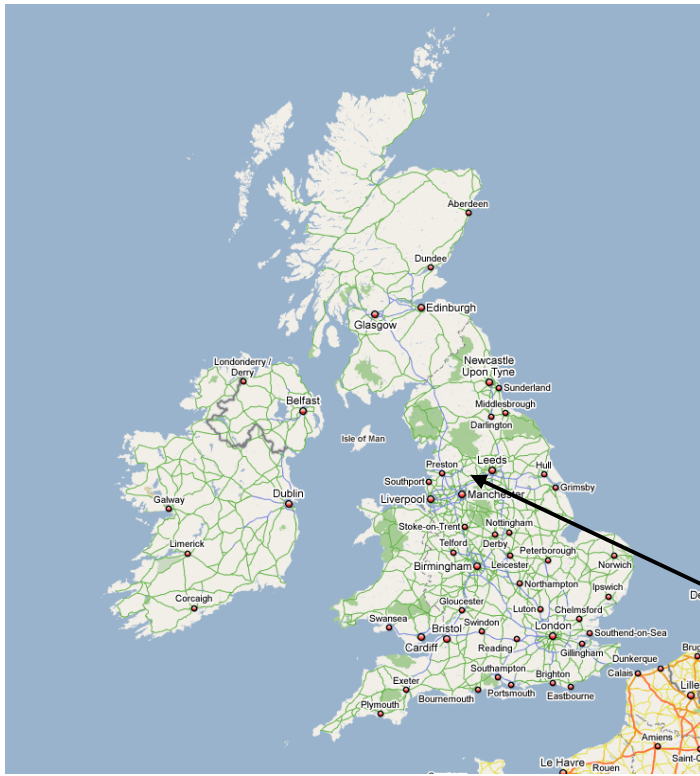
All drainage installation will encounter Made Ground. Any suitable Made Ground arisings from drainage trenches etc, if not returned to the original excavation must be placed beneath proposed hard end-use areas of the site, placed beneath a cover of suitable thickness in garden and landscaped areas, or disposed of offsite adhering to the guidelines outlined above.

APPENDICES

Appendix A – Drawings & Plot Capping Depth Table

Appendix B – NX Consulting Protocol for Validation of Soil Cover Systems

Appendix A – Drawings & Plot Capping Depth Table



SITE

Site Centre:
OS X (Eastings) 372540
OS Y (Northings) 437521

clarkebond

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Engineering and Management Consultants

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Birmingham Bristol Cardiff Exeter Harrogate London
Manchester Swansea Abu Dhabi

Project:

**PHASE 1 GEOENVIRONMENTAL ASSESSMENT
Calderstone Hospital Development**

Title:

SITE LOCATION MAP

Drawn:

BC

Scale:

NTS

Checked:

BC

Date:

**February
2011**

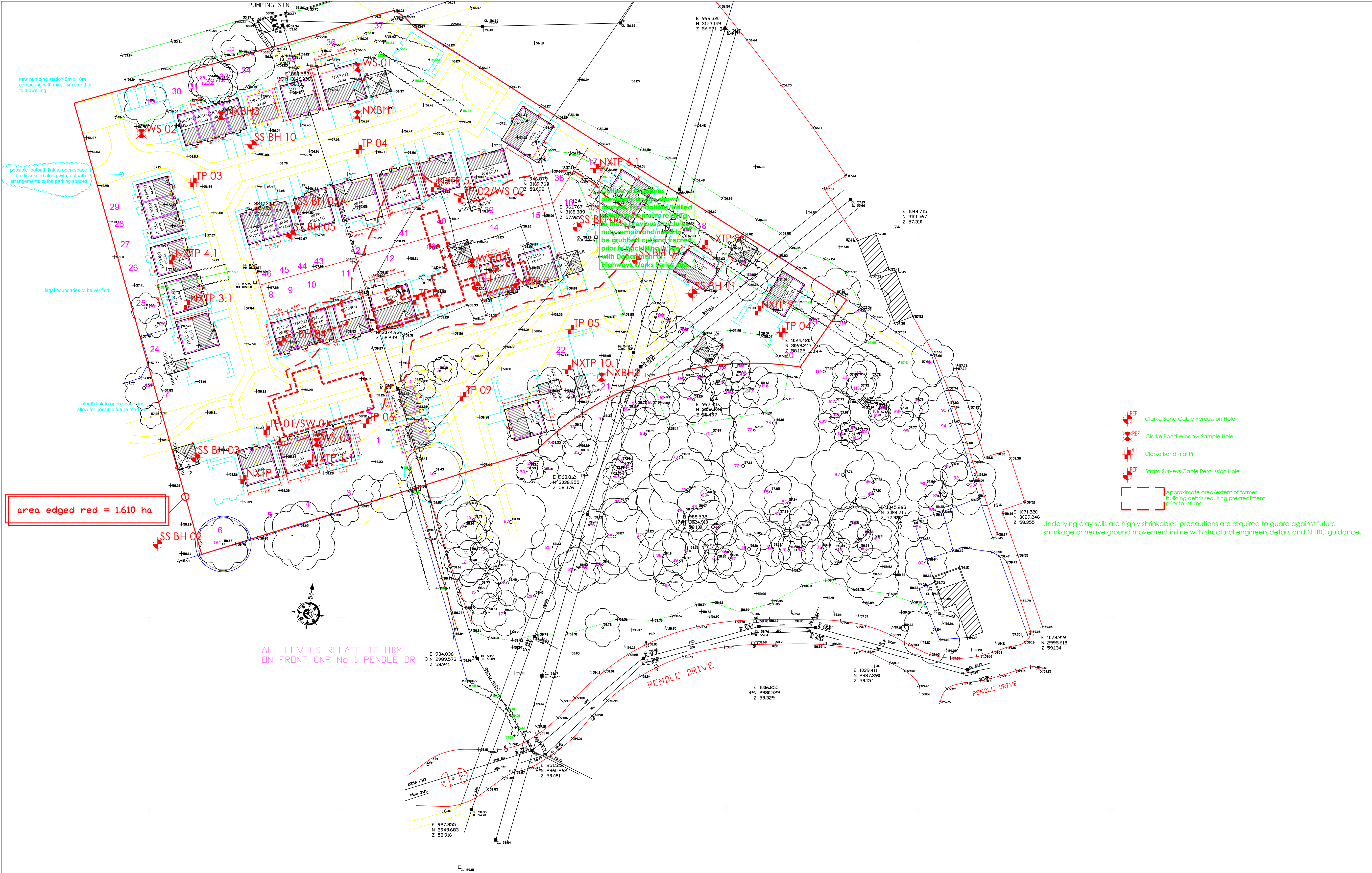
Status:

FINAL

Drawing No:

25608E Figure 1

Rev:



GENERAL NOTES
Do not scale this drawing.
Contractor to check all dimensions and report all errors and omissions to the Engineer.

NOTES
This drawing should be read in conjunction with all relevant Architects and Engineers drawings.
All levels quoted in mAO and should be read in conjunction with NXConsulting and Clarkebond Geoenvironmental Reports.

Rev	Detail	By	Auth	Date

nxconsulting
Office: 0161 904 0187
Mobile: 07808 670 068
Web: www.nxconsulting.org.uk

Client
Taylor Wimpey

Project
Calderstone Hospital Phase 3
Additional Site Investigation

Drawing Title
Exploratory Hole & Ground
Condition Plan.

Drawing Status
Issue

Project No.	Discipline	Drawing No.
NX131	E	0002
Scale	Sheet Size	Revision
1:500	A1	
Date	Drawn	Checked
24/04/12	RF	MN



CIVIL / STRUCTURAL DESIGN RISK MANAGEMENT

Abnormal or unusual residual risks associated with the design outcomes shown on this drawing are:-

RSK LDE LTD has followed its Design Risk Management process for Hazard Elimination and Risk reduction in developing the designs shown on this drawing. Abnormal or unusual residual risks may be shown above where it is considered that such risk may not normally be expected by competent persons engaged on work of this nature or type.

Notes:

1. This drawing is to be read in conjunction with all relevant Architects and Engineers drawings.

2. All levels quoted are in metres A.O.D.

3. For Drainage Layout see Drawing No. 01.

4. The Groundworks contractor shall ensure that no flat spots remain after the installation of the final road wearing course.

5. All road gullies shall be located away from proposed entrances to houses.

Levels Legend:

300 LIP

600 Steps

650 LOG

300 EGB

450 SOE

56.475

(56.475)

1:20

FFL ???

Exposed brickwork below DPC

Step within FFL

Log retaining wall

Height retained using additional gravel boards below fence panel. (Max 450)

Height retained using Slab on edge (Max 450)

Proposed banking

Proposed level

Existing level

Fall and gradient

Finished floor level

P7	29.06.12	Land drainage layout shown	DJH	CB	ISC
P6	25.06.12	Revised levels to rear gardens Plot 30 to 31 and 35 to 36. Parking court 27-33 amended.	DJH	CB	ISC
P5	14.06.12	Revised to new FFL layout as per clients appraisal	TF	CB	ISC
P4	29.05.12	Existing levels added to bottom of proposed batters.	TF	CB	ISC
P3	10.05.12	Base X amended in line with clients request.	TF	CB	ISC
P2	13.04.12	Revised in line with clients comments	TF	CB	ISC
P1	28.03.12	Issued for Approval	TF	CB	ISC
Rev.	Date	Amendment	Drawn	Chkd.	Appd.

RSK

LAND & DEVELOPMENT ENGINEERING LTD

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Client

Taylor Wimpey (Manchester) Ltd

Project Title

Calderstones Phase 3

Drawing Title

External Works Layout

Drawn	Date	Checked	Date	Approved	Date
TF	March 12	CB	March 12	ISC	March 12

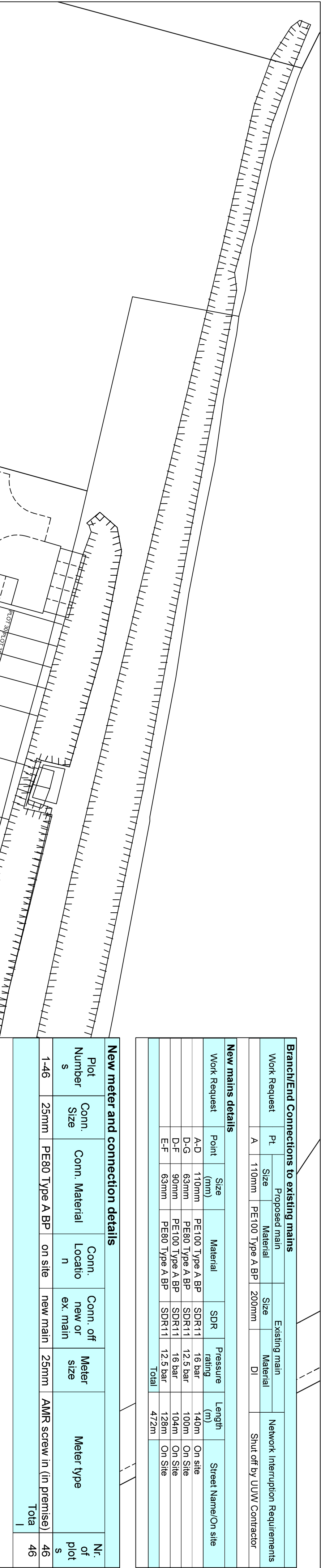
Scale	Orig Size	Dimensions
1:250	A1	

Project No.	Drawing File
880209	

Drawing No.	Rev.
06	P7

Scale
0 2.5 5 7.5 10 12.5m

File Location: L:\01 JOBS LIVE\880209 - CALDERSTONES PH3 DESIGN\GRAPH\INFRASTRUCTURE\DESIGN DRAWINGS\EXTERNAL WORKS.DWG



Branch/End Connections to existing mains			
Work Request	Pt	Proposed main Size	Existing main Size
A	110mm	PE100 Type A BP 200mm	DI
Network Interruption Requirements			
Shut off by UUV Contractor			
New mains details			
Work Request	Point	Size (mm)	Material
A-D	110mm	PE100 Type A BP	SDR11
D-G	63mm	PE80 Type A BP	SDR11
D-F	90mm	PE100 Type A BP	SDR11
E-F	63mm	PE80 Type A BP	SDR11
Total		12.5 bar	472m

New meter and connection details				
Plot Number	Conn. Size	Comm. Material	Conn. Locatio n	Conn. off ex. main
1-46	25mm	PE80 Type A BP	on site	new main
AMR screw in (if premises)				25mm
Total				46

NETWORK ASSEMBLIES

Point	Variant Code	Description
	New Available	110mm BP branch connection off existing 200mm DI main (2 valves)
A	CON1101004	110mm BP new main
	CHAS300001	150mm x 150mm valve chamber
	CON1117003	110mm PE end washout (temporary at B)
	CHAS300003	380mm x 230mm hydrant chamber
B	CON1107003	110mm BP straight coupling
	CON1101004	110mm BP new main
	CON1101004	110mm BP new main
	CON1114003	63mm BP branch connection off new 110mm new main (2 valves)
B-D	CHAS300001	150mm x 150mm valve chamber
	CON1117003	110mm PE end washout (temporary at B)
	CHAS300003	380mm x 230mm hydrant chamber
D-E	CON1117001	63mm BP new main
	CON1101002	63mm BP new main
	CHAS300003	380mm x 230mm hydrant chamber
	CON1101002	63mm BP new main
	CHAS300003	380mm x 230mm hydrant chamber
	CON1117001	63mm BP end washout (permanent at E)
	CHAS300003	380mm x 230mm hydrant chamber

Contaminated land

As this site has been shown to have a degree of contamination present, our proposals involve the laying of mains service pipes using an open trench and the protection of these pipes with a concrete cover. All pipes and fittings to be installed by UUV and the Developer must be installed in accordance with the manufacturer's specification to form a complete approved barrier pipe system.

Service Connections (25 / 32mm)

25 / 32mm service pipes must be installed in a continuous unspliced length leaving enough pipe coiled at pipe end to allow for future connection. The length of the service pipe must be sufficient to ensure the pipe must have a continuous length of blue reading mark installed above it from the point of entry up to the property boundary or agreed point of delivery. Any coiled pipes left out to connection must be adequately protected to ensure the supply into the main remains unspliced. Prior to connection service end should be sealed with a mechanical watertight stop and

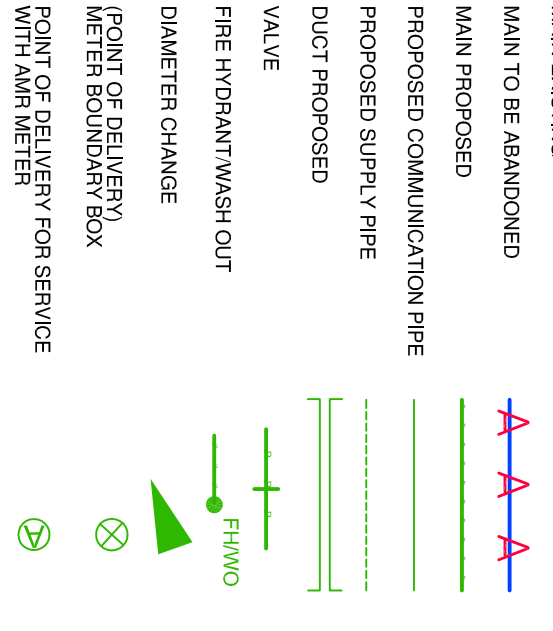
Infrastructure Allowances

An allowance of 0 infrastructural credits shall be applied to this site. Please note this allowance may apply to the specification for the new mains to be developed.

Sewerage Details.

Please note that ALL Ffos are to be connected to a United Utilities sewer.

LEGEND



SERVICE CONNECTIONS

All services and meters from new and existing mains to be installed by United Utilities Water plc.

All Service pipes to be 25mm with 15mm AMR meters unless stated otherwise.

Metering Details

- It is UUV policy that all new domestic properties must be metered using AMR.
- A WRAS approved wall box (In-wall or Wall mounted).
- Internally at point of entry.

External Control for Internal Meters - Contaminated Land

The Developer must ensure that the external control which must be suitable for use in contaminated land. Where a multi-part control is required for multi-occupancy premises a WRAS approved gun metal manifold should be used and installed in a purpose built structure. The external control must be in accordance with UUV's Water Metering Policy and the manufacturer's specification.

Project Code:

Site Contact: Stuart Graham - 07725791684
Developer: Taylor Wimpey
Development: Calderstones Park Phase 3
Whalley
Work Request No: 544000076859
Designer: Linda Cook
Drawn By: Rachel Rayson
Date: 28.05.2012
Scale: 1:500 @ A1
O.S. Grid Ref: SD72529 37450
Drawing No. N410090500/LC



UNITED UTILITIES WATER PLC
METERING & CONNECTIONS
1st Floor, Ulswater House
Littlegreen Avenue
Great Sankey

Mains Records Disclaimer
The position of underground apparatus shown on the plan provided is approximate only. The actual positions may be different from those shown on the plan and private service pipes may be shown by a blue dotted line. United Utilities will not accept any liability for any damage caused by the actual positions being different from those shown.

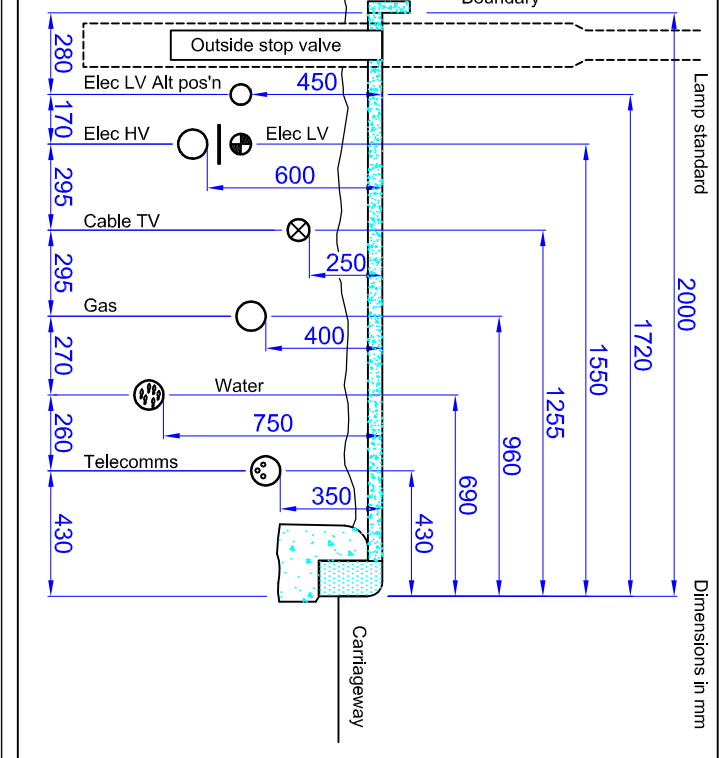
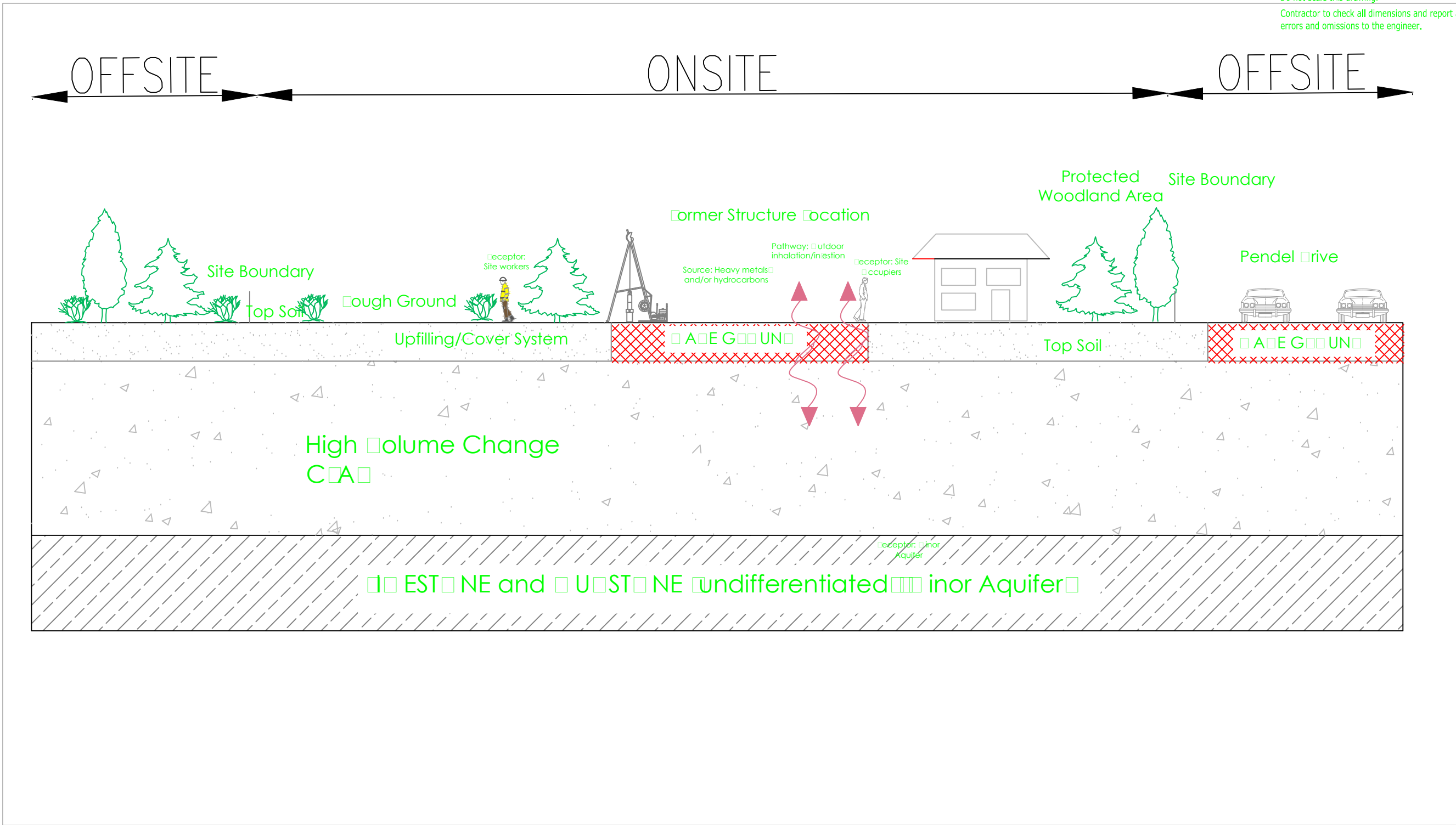


Table 1 - Excavation widths and pipe bed & surround thickness

Diameter of main	63mm	90mm	110mm	160mm	225mm	315mm
Normal excavation width	320mm	400mm	400mm	500mm	600mm	600mm
Pipe bed and surround (completed)	50mm	75mm	75mm	100mm	100mm	100mm

GENERAL NOTES
Do not scale this drawing.
Contractor to check all dimensions and report all errors and omissions to the engineer.



Rev	Detail	By	Chk	Date
Revisions				

Client	Taylor Wimpey
Project	Additional Phase 2 Geoenvironmental Assessment at P3 Calderstones Park
Drawing Status	

Office: 0161 904 0187 Mobile: 07808 670 068 Web: www.nxconsulting.org.uk	
nxconsulting	

Drawing Title			
Refined Conceptual Model			
Project No.	Discipline	Drawing No.	
NX131	E	01	
Scale	Sheet Size	Revision	
NTS	A3		
Date	Drawn	Checked	Auth
24/04/12	RF	MN	MN



Next Generation Engineering Consultancy Services

Plot No	Original Ground Level (mAOD)	Proposed ffl following TW review 7/6/12	Approximate Increase in Level from EGL	Revised Differential FFL - 150 mm to EGL	Deepening Required to create capping (Yes/No)
Plot 1	58.36	59.00	0.49	0.49	Yes
Plot 2	58.27	59.00	0.58	0.58	Yes
Plot 3	58.29	58.65	0.21	0.21	Yes
Plot 4	58.26	58.80	0.39	0.39	Yes
Plot 5	58.29	58.65	0.21	0.21	Yes
Plot 6	58.26	58.65	0.24	0.24	Yes
Plot 7	58.01	58.90	0.74	0.74	No
Plot 8	58.21	58.90	0.59	0.54	Yes
Plot 9	58.2	58.90	0.6	0.55	Yes
Plot 10	58.15	58.90	0.65	0.60	No
Plot 11	58.03	58.95	0.77	0.77	No
Plot 12	58.23	58.95	0.57	0.57	Yes
Plot 13	58.25	59.00	0.7	0.60	No
Plot 14	58.4	59.00	0.55	0.45	Yes
Plot 15	58.35	58.85	0.45	0.35	Yes
Plot 16	57.42	58.40	1.03	0.83	No
Plot 17	56.55	58.10	1.6	1.40	No
Plot 18	56.86	58.75	1.74	1.74	No
Plot 19	57.06	58.30	1.24	1.09	No
Plot 20	58.04	58.30	0.26	0.11	Yes
Plot 21	58.05	58.85	0.75	0.65	No
Plot 22	58.28	59.10	0.67	0.67	No
Plot 23	58.45	59.10	0.5	0.50	No
Plot 24	57.76	58.75	0.99	0.84	No
Plot 25	57.64	58.60	0.96	0.81	No
Plot 26	57.22	58.45	1.23	1.08	No
Plot 27	57.03	58.45	1.42	1.27	No
Plot 28	57.25	58.45	1.2	1.05	No
Plot 29	57.18	58.45	1.27	1.12	No
Plot 30	56.54	58.50	1.91	1.81	No
Plot 31	56.54	58.50	1.91	1.81	No
Plot 32	56.54	58.50	1.91	1.81	No
Plot 33	56.54	58.50	1.91	1.81	No
Plot 34	56.54	58.60	2.06	1.91	No
Plot 35	56.54	58.60	2.21	1.91	No
Plot 36	56.23	58.60	2.52	2.22	No
Plot 37	56.29	58.70	2.46	2.26	No
Plot 38	56.37	58.40	2.08	1.88	No
Plot 39	57.64	58.55	0.96	0.76	No
Plot 40	57	58.70	1.75	1.55	No
Plot 41	57.22	58.75	1.53	1.38	No
Plot 42	57.51	58.80	1.24	1.14	No
Plot 43	56.84	58.70	1.91	1.71	No
Plot 44	57.3	58.60	1.45	1.15	No
Plot 45	57.3	58.60	1.45	1.15	No
Plot 46	57.3	58.60	1.45	1.15	No

Appendix B – NX Consulting Protocol for Validation of Soil Cover Systems

NX Consulting Limited Protocol for Validation of Soil Cover

Isolation of Made Ground in garden and landscaped areas beneath a cover of “clean” subsoil, and topsoil is often recommended on residential developments where Made Ground is left insitu; most notably when it contains some inorganic contaminants at concentrations above guidance threshold values.

A cover is only required in proposed garden and landscaped areas underlain by made ground (i.e. not beneath drives, garages or houses). The soil cover breaks direct contact pollutant linkages between the contaminated fill and future residents.

The CML initiative requires house builders to submit to the NHBC (or other warranty providers) a validation report confirming the thickness and chemical suitability of the soil cover.

Validation reports are normally prepared by independent geoenvironmental consultants such as NX Consulting Limited. Soil cover validation requires independent assessment of the chemical suitability of the soil and the thickness of the placed subsoil and topsoil.

Inspection and Sampling of cover soil at source

Soil quality is best determined by sampling at the **source** at least 7 working days before importation to the development site. If this is achieved, further, on-site (post-placement) quality testing should not usually be necessary providing that confirmation can be given that the material arriving at site is the same soil as that tested.

Inspection and Sampling of cover soil following import to site

In some cases, soil is often delivered to site prior to sampling and chemical testing. Such soils should be stockpiled in a secure location on site and NX Consulting should be contacted to arrange for visual inspection, sampling and chemical testing. It is strongly recommended that soils should not be placed in garden and landscaped areas, prior to confirmation of the suitability of the soil by NX Consulting. This normally takes two weeks from initial notification.

Suitable soil material should:

- be clean and free of foreign debris, building waste materials or contaminants;
- not have a stone content of greater than 20% by visual estimation
- have a maximum stone size of 150mm in any one direction.
- not have been sourced from an area within 7m laterally, or 3m vertically, of Japanese Knotweed plants, and not contain any Japanese Knotweed fragments (rhizomes, leaves, stems etc).

The number of samples taken will be dependent on the nature of the source and the quantity of material to be imported and the testing ratio should be agreed with the Local Authority (EHO) before testing is undertaken. However, as a guide, a **minimum** of 6 samples of each soil type should be tested, with a further sample for each 250m³ of subsoil, where the quantity exceeds 1,500m³; and a further sample for each 50m³ topsoil, where the quantity exceeds 300m³.

A less frequent sampling rate may be appropriate for soils from a greenfield source or where large volumes (say > 5,000m³) of soil are imported from a single, relatively homogenous source. Each sample taken should be forwarded to an analytical laboratory for testing in accordance

with the following schedule:

- Soil from *bona fide* **Greenfield** sources should be tested for pH and metals *Cu, Ni, Zn, Cr, As, Hg, Se, Cd & Pb* and *speciated PAH*.

NX Consulting Protocol for Validation of Soil Cover

- Soil from *bona fide* **Brownfield** sources should be tested for pH, metals (*Cu, Ni, Zn, Cr, As, Hg, Se, Cd & Pb*), *speciated PAH, banded TPH and BTEX*.
- Soil from recycled sources should be tested for pH, metals (*Cu, Ni, Zn, Cr, As, Hg, Se, Cd & Pb*), *speciated PAH, banded TPH and BTEX*.

Cover layers can often include a “difficult to dig” or capillary break layer of coarse natural or recycled aggregate. Where this aggregate is sourced from recycled materials (such as crushed demolition arisings) asbestos screening tests should also be undertaken.

The Client\Contractor will be notified of the soil’s suitability (or otherwise) immediately following receipt of the results (typically taking 7 working days). Chemical assessment (Tier 1) criteria for imported soils are presented below.

On receipt of written confirmation from NX Consulting, the Client should instruct his Contractor to commence importation. It will probably be necessary to stockpile the cover prior to placement in garden\landscaped areas. NX Consulting should inspect the stockpiled material prior to placement, to confirm that it is the same material as previously tested, **and** the Contractor should provide the Client with appropriate haulage notes.

Cover Thickness Validation

Soil **thickness** can only be checked after placement, but should be done before turfing, fencing etc. Thickness could be checked via the excavation of an appropriate number of inspection trial pits. Typically one trial pit for every two gardens will be required.

The thickness of cover is dependent on the nature and degree of contamination (and often the Local Authority whose area the site lies within), but typically between 600mm and 1,000mm is required. Where underlying materials do not contain contaminants above critical concentrations but contains materials generally considered undesirable as a near-surface material in garden areas (colliery spoil, construction\demolition rubble etc) then a 300mm thick cover, in accordance with NHBC Standards, Chapter 9.2, should be adequate.

Soil cover is usually placed many weeks after completion of the preparatory\remedial works, and issue of the associated Verification Report. Consequently, site visits, to generate supplementary letter reports, are typically required after soil cover has been placed in the gardens of each plot, or set of plots.

Cover material can sometimes be sourced on-site from foundation\drainage excavations in natural in-situ strata, but import is often necessary.

Issue of Soil Cover Validation Reports

Validation reports will be issued by NX Consulting following the confirmation of the placed thickness within each plot, or set of plots. Each report will contain the following information;

- details of the provenance of the subsoil and topsoil,
- chemical test data,
- an interpretation of the chemical data indicating whether the soils are suitable for use in a clean cover layer,
- a drawing indicating the location of cover thickness validation trial pits,
- photographs of the excavated trial pits confirming the thickness of placed soils,
- a log indicating the thickness of cover soils within each trial pit excavated.

Soil Cover Validation Reports will be issued to the Local Authority and to the NHBC by email and Extranet site.

	Residential 0mm Cover	Residential 600mm Cover	Residential Apartments with Landscaping		Commercial Industrial with Landscaping		Notes	
Active Pathways	• Direct Ingestion • Dermal Contact • Consumption of Vegetables and Attached Soil • Inhalation of Indoor Vapour and Dust • Inhalation of Outdoor Vapours and Dust	• Inhalation of Indoor Vapours • Inhalation of Outdoor Vapours	• Direct Ingestion • Dermal Contact • Consumption of Vegetables and Attached Soil • Inhalation of Indoor Vapour and Dust • Inhalation of Outdoor Vapours and Dust		• Direct Ingestion • Dermal Contact • Consumption of Vegetables and Attached Soil • Inhalation of Indoor Vapour and Dust - Inhalation of Outdoor Vapours and Dust			
CLEA Model Defaults Utilised	SOM = 6% Total Porosity = 0.53 Water Filled Porosity = 0.33 Air Filled Porosity = 0.32	SOM = 6% Total Porosity = 0.53 Water Filled Porosity = 0.33 Air Filled Porosity = 0.32	SOM = 6% Total Porosity = 0.53 Water Filled Porosity = 0.33 Air Filled Porosity = 0.32					
Critical Receptors	Female Child 0-6yrs Old	Female Child 0-6yrs Old	Female Child 0-6yrs Old		Female Adult Worker 17 years Old working in a ground floor office space			
Amendments to CLEA 2009 Model	Contamination source located at depth of 150mm below building as opposed to CLEA default of 650mm	Contamination source located at depth of 150mm below building as opposed to CLEA default of 650mm	Contamination source located at depth of 150mm below building as opposed to CLEA default of 650mm		Contamination source located at depth of 150mm below building as opposed to CLEA default of 650mm			
Units	mg/kg		mg/kg		mg/kg			
Arsenic	32	CLEA 2009	No Pathway	32	CLEA 2009	635	CLEA 2009	
Cadmium	5	CLEA 2009		5	CLEA 2009	230	CLEA 2009	
Mercury (inorganic)	170	CLEA 2009		170	CLEA 2009	3,640	CLEA 2009	
Nickel	130	CLEA 2009		130	CLEA 2009	1790	CLEA 2009	
Selenium	350	CLEA 2009		350	CLEA 2009	13,000	CLEA 2009	
Chromium III	3000	LQM/CIEH		3000	LQM/CIEH	30,400	LQM/CIEH	
Chromium VI	4.3	LQM/CIEH		4.3	LQM/CIEH	35	LQM/CIEH	
Lead	450	CLEA 2002		450	CLEA 2002	750	CLEA 2002	
Copper	2,330	LQM/CIEH	No Pathway	2,330	LQM/CIEH	71,700	LQM/CIEH	
Zinc	3,750	LQM/CIEH		3,750	LQM/CIEH	665,000	LQM/CIEH	
Boron	291	LQM/CIEH		291	LQM/CIEH	192,000	LQM/CIEH	

NX Consulting Tier 1 Values Version 1 - CLEA 2009 (Software Version 1.06)

Benzo(a)Pyrene	1.0	LQM/CIEH	No Pathway		1.0	LQM/CIEH	14	LQM/CIEH
Naphthalene	4.0	CLEA 2009	4.0	CLEA 2009	4.0	CLEA 2009	432	CLEA 2009*
Benzene	0.25	CLEA 2009	0.5	CLEA 2009	0.5	CLEA 2009	63	CLEA 2009
Toluene	497	CLEA 2009	1440	CLEA 2009	1340	CLEA 2009	4,360	CLEA 2009*
Ethylbenzene	240	CLEA 2009	416	CLEA 2009	398	CLEA 2009	2,840	CLEA 2009*
Xylenes	127	CLEA 2009	146	CLEA 2009	145	CLEA 2009	2,620	CLEA 2009*
Amendments to CLEA 2009 Model	NX Consulting have used a subsurface soil to indoor air correction factor of 10 to account for the over prediction of indoor inhalation in new buildings							
Aliphatic C5-C6	41	CLEA 2009	41	CLEA 2009	41	1000	CLEA 2009	
Aliphatic C6-C8	123		123		1000			
Aliphatic C8-C10	31		31		1000			
Aliphatic C10-C12	151		151		1000			
Aliphatic C12-C16	500 [#]		685 [#]		1000			
Aliphatic C16-C21	1000 [#]		5000 [#]		5000			
Aliphatic C21-C35	1000 [#]		5000 [#]		5000			
Aromatic C5-C7	52		56		1000			
Aromatic C7-C8	15		16		1000			
Aromatic C8-C10	47		50		1000			
Aromatic C10-C12	212		261		1000			
Aromatic C12-C16	683		1000 [#]		1000			
Aromatic C16-C21	1000 [#]		5000 [#]		5000			
Aromatic C21-C35	1000 [#]		5000 [#]		5000			

PCB	1.7	CLEA 2009	1.8	CLEA 2009	1.8	CLEA 2009	1.8	CLEA 2009
Phenol	412	CLEA 2009	2,360	CLEA 2009	514	CLEA 2009	37,500	CLEA 2009
Cyanide	527	CLEA 2009	527	CLEA 2009	531	CLEA 2009	14,000	CLEA 2009

NX Consulting derived assessment criteria concentrations for compounds without SGV's, for imported material to be placed in garden areas in a residential development using CLEA V1.06. Values assume a sandy soil with 6% SOM and could be refined further with site specific data.