

Hydrogeological Review & Groundwater Piling Assessment

Hollingworth Road, Littleborough

Vistry Partnerships Yorkshire

11 August 2023

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Vistry Partnerships Yorkshire
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KE/DN/45466-005

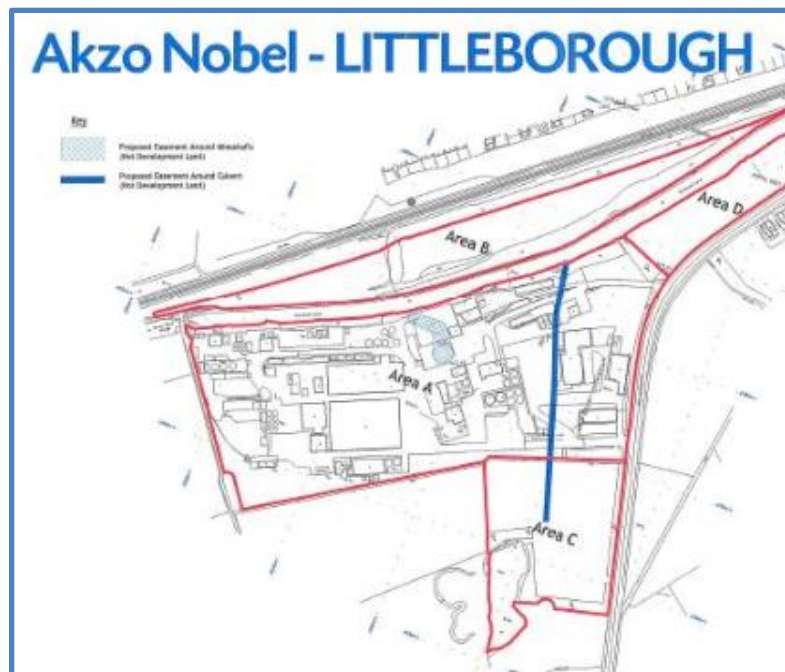
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Dear Sam,

Hollingworth Road, Littleborough – Hydrogeological Review and Groundwater Piling Assessment

Context

A residential development is proposed for the approximately 7.2 hectare site located to the west of Hollingworth Road in Littleborough, Lancashire. The site comprises Areas A and C as indicated on the plan below (Area C will comprise a recreational 'Events Area').



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An earthworks / remediation programme is understood to have been completed on the site in 2008. Various reports and investigations were subsequently completed between 2009 and 2020. Eastwood Consulting Engineers (ECE) completed a review of these reports for Areas A and C (as indicated on the above plan), the findings of which are included in our '*SI Review (Issue 3)*', referenced 45466-001 and dated 11 July 2021.

Arc Environmental Ltd have completed the following reports for the site:

- A '*Ground Investigation Report (Factual)*', referenced 21-763 and dated 20 December 2021;
- A '*Hazardous Ground Gas Addendum Report*', referenced 21-763.01L and dated 1 June 2022; and
- A '*Remediation Statement & Validation Proposal Sheets*', referenced 21-763 (not dated).

The Arc reports call Area A 'Phases 1 and 2' whilst Area C is known as the 'Events Area'.

This document prepared by Eastwood Consulting Engineers (ECE) provides a review of the hydrogeological conditions expected below the site, and potential impact of the development (and in particular where piled foundations are utilised) on aquifers, groundwater and controlled waters. This report summarises the pertinent information included in our '*SI Review*' and the later Arc Environmental reports, which should be read in conjunction with this report.

Review of Desk Based Information

Site Description & History

The main development area currently comprises an area of derelict land surfaced by scrub vegetation. A small lake is present in the south of the site within the 'Events Area'. The Rochdale Canal forms the northern boundary of the site, and a railway line is located around 60 m beyond it; a landfill lies between the canal and the railway. The Hollingworth Lake Conduit is culverted below the eastern half of the site, connecting Hollingworth Lake (located around 300 m to the south) to the canal.

The main development area was previously occupied by a chemical manufacturing works operated by Akzo Nobel, which included the processing of animal fats and tallow for use in soaps and detergents. The works comprised numerous buildings including offices, labs,

warehouses, storage and substations as well as featuring underground tanks and interceptors. Removal of the buildings and remediation of the site was undertaken in 2008.

In addition, an oil distillery was located in the north of the site during the late 19th Century prior to the development of the chemical works. A sandstone quarry and two shafts (associated with Cleggswood Colliery) are also shown to have been present in the north and north east of the site during the mid-19th Century – the shallowest coal workings below the site are expected to be associated with the Lower Mountain Mine Coal at a depth of around 72 m. The CA note the two shafts present on site to have been treated to industry standards.

Historically, the 'Events Area' predominantly comprised greenfield land. The lake in the south was constructed during the late 19th Century, and the car park in the north west corner was constructed in the early 1990s.

The topography of the site generally slopes down towards the north or north east, including several steps and stockpiles which remain from the original remediation works, and also steep slopes along the northern and southern boundaries. The main development area of the site is located between 162 m AOD (above ordnance datum) at the south east corner, and 148 m AOD along the northern boundary.

Geology, Hydrogeology and Hydrology

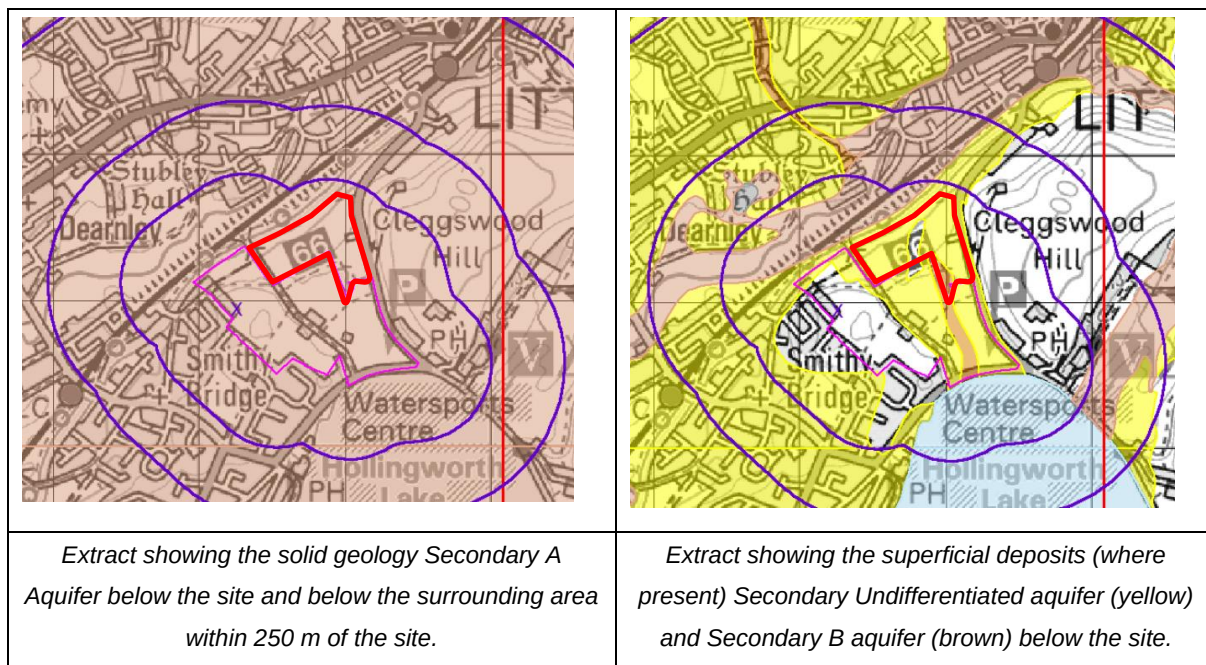
The solid geology below the site comprises the Pennine Lower Coal Measures, with the eastern half of the site underlain by the Milnrow Sandstone Group. Superficial Till is shown to cover the majority of the site, with a thin band of Head deposits possibly extending onto the centre-south of the site.

Two faults trending north west to south east are inferred to cross the site on the eastern and western boundaries.

The solid bedrock is classified as a Secondary A Aquifer. The superficial glaciofluvial deposits are classified as a Secondary Undifferentiated Aquifer, and the Head deposits are classified as a Secondary B Aquifer.

The below extracts are taken from the Envirocheck obtained for YWG's site investigation in September 2017, and the site is outlined in red (the pink outline and 250 and 500 m buffer radii shown in purple are drawn for the land located immediately south of the site). A review

of online resources including Magic Maps and the Groundsure online data viewer indicate these designations to remain unchanged.



The site does not lie within a Groundwater Source Protection Zone.

A surface water abstraction licence relating to the former Akzo Nobel chemical plant is recorded in the north east of the site, although this is likely to be redundant since the removal of the works. A well is expected in the south western corner of the site.

The Rochdale Canal which forms the northern boundary of the site; the Hollingworth Lake Conduit is culverted below the eastern half of the site, trending north to south, connecting Hollingworth Lake (located around 300 m to the south) to the canal. A smaller lake is located in the south of the 'Events Area' (at around 160 m AOD), and the closest 'flowing' watercourse (the River Roch) lies around 120 m to the north (at around 140 m AOD).

The site is not at risk of flooding from rivers. The majority of the development area is recorded as having a potential for groundwater flooding to occur at the surface; the south west corner (~5% of the site) is recorded as having either a limited potential, or a potential for flooding or property situated below ground level. Various localised 'channels' in the north west, centre and south east of the site are shown to be at risk of flooding from surface water,

covering around 10% of the total site area, including one zone (<5% of the site area) which has a high risk (30-year return).

Given the proximity of surface water features to the site, it is anticipated that the groundwater table will lie within the upper few metres of the site surface.

Summary of Ground Investigations

Turnover

Woodford Remediation completed remedial works on the site in 2008. The remediation works were carried out for a commercial end-use in the eastern third of the site, and a residential end-use in the western two thirds, referenced Phase 1 and 2 respectively on the plan below.



The remedial works included the removal of relict foundations (including piles) to a depth of 2.0 m below remediation level. The upper 2.0 m of ground below remediation level was also turned over to inspect for signs of impacted ground; the turnover was typically terminated where natural ground was encountered within the upper 2.0 m. Ground levels were left low in localised sections of the site due to a shortfall of material.

A hard to dig layer, comprising crushed and screened demolition arisings, was placed at the surface across much of the development platform (the site was split into ten 'cells', and the hard to dig layer was installed in eight of these).

Hard to Dig Layer

RSK completed ground investigations on the site in July and November 2020 to determine the thickness of the hard to dig layer. The layer was recorded to be between 0.1 and at least 0.9 m thick, and locally absent altogether.

The material generally comprises cobbles of concrete and brick with fragments of wood, plastic and rebar. Asbestos fragments were also encountered within this layer, as well as at the surface of the site.

A geo-textile layer was occasionally encountered at the base of the hard to dig layer.

Ground Conditions (Soils & Bedrock)

Arc Environmental completed a ground investigation across the main development area between October and November 2021, the findings of which are presented in their *Ground Investigation Report*. The investigation comprised forty trial pits, seven cable percussive boreholes, and five dynamic sampling boreholes. The locations of the exploratory holes are shown on the attached Exploratory Hole Location Plan.

Made ground was recorded across the site to depths of between 0.2 and 4.0 m, and between 1.0 and 2.0 m thick in the majority of the exploratory holes. The equivalent level of the base of the made ground ranged between 147.38 m AOD (TP22) and 163.29 m AOD (TP40). The made ground (separate from the hard to dig layer) typically comprises sandy gravelly clay, and occasionally clayey or sandy gravel, with occasional cobbles. The gravel and cobbles typically comprise brick, concrete and sandstone.

Two trial pits, TP14 and TP30, were terminated upon encountering concrete obstructions at depths of 2.0 and 2.3 m respectively. A concrete obstruction was also recorded in TP16 at 0.5 m. Concrete obstructions were also encountered in five trial pits during RSK's 2020 investigation.

Where encountered, the underlying natural ground typically comprises firm to stiff sandy gravelly clay. The clay was noted to be locally soft, including in TP13, TP16, TP20, TP21,

TP31 and CP7. Residual natural sand was recorded below the made ground in five exploratory holes, typically located in the western half of the site.

Sandstone bedrock was recorded to underlie the shallow residual soils in five exploratory holes, typically in the centre-east and north east, at depths of between 1.7 and 4.0 m. Mudstone bedrock was recorded in six exploratory holes (CP3 to CP7 and TP1) at depths ranging between 2.1 and 8.0 m.

Ground Conditions (Groundwater)

During the remediation of the site, springs were encountered along the southern boundary and from the south west corner. These springs were encountered from sand layers in the Glacial Till.

No significant groundwater ingresses were recorded in the trial pits during the recent ground investigation; ten of the pits recorded slight ingresses either within or at the base of the made ground at depths of between 0.5 and 2.1 m.

Groundwater strikes were recorded in the mudstone bedrock in CP4 at 8.0 m (147.9 m AOD) and CP7 at 7.0 m (150.4 m AOD). A water strike was also recorded in CP6 at an expected depth of 4.2 m (152.35 m AOD) – the log noted 5.2 m but the borehole was only drilled to 4.25 m.

In RSK's *Additional Gap Analysis* report (August 2020), they note that fifteen monitoring wells had been identified across the site from previous ground investigations; the majority of the wells were dry, except for three which recorded water in the upper 1.0 m.

Arc Environmental installed monitoring wells in the seven cable percussive boreholes to depths of between 4.0 and 7.0 m, and in the five dynamic sampling boreholes to depths of 0.8 and 4.7 m (although three of these wells were installed to between 0.8 and 1.1 m bgl) – all but two of the wells (MW3 and MW5) extended into the natural strata. Six rounds of monitoring were completed between November 2021 and February 2022.

The shallowest groundwater was recorded at 0.42 m in MW1 during the third round of monitoring. Groundwater was recorded within the upper 1.0 m on at least one occasion in six of the wells (CP3, CP4, CP6, CP7, MW1 and MW2). The equivalent level of the groundwater in the wells roughly varies between 149 and 157 m AOD, and generally lowers

towards the north (average groundwater levels were recorded to be lowest in CP5 and highest in CP7).

Chemical Testing

WYG note in their 2017 review that elevated concentrations of hydrocarbons and metals were recorded in the west of the site, associated with former process/storage areas, prior to remediation of the site. Odours and impacted ground were noted here, extending into the Glacial Till. Asbestos was also identified across the site. Groundwater impacted with hydrocarbons and ammonia was encountered in the north west corner.

During remediation of the site, Phase 1 (eastern third of the site) was remediated for a commercial end-use and Phase 2 (western two thirds) for a residential end-use.

Eighteen areas where elevated contaminants (hydrocarbons) were recorded were excavated and treated using bio-physical methods as part of the remedial works, with the treated arisings (totalling ~1,340 m³) subsequently placed in fill areas.

Post-remediation, twenty-two samples were collected from the Phase 1 area (excluding Cells 4 and 6) at depths of between 0.8 and 1.0 m below finished ground level; no elevated concentrations of contaminants were recorded. In addition, seven samples of near-surface soils and/or stockpiled topsoil were submitted for testing from the Events Area; one sample recorded a very slightly elevated hydrocarbon fraction (Aromatic C12-16) of 5.79 ppm compared to the 5.60 ppm threshold. No other elevated contaminants were recorded.

During RSK's 2020 investigations, numerous fragments of asbestos were noted at the site surface. Asbestos (amosite and chrysotile) fragments and fibres were identified in the hard to dig layer, which comprises crushed demolition arisings.

In two of Arc Environmental's trial pits, the made ground in TP24 and TP25 was noted to contain ash. However, no other visual or olfactory evidence of contamination was recorded. No samples were submitted for chemical testing.

Additional remediation of the Phase 1 area for a residential end-use is considered to be necessary, comprising the regrading of ground levels and placement of a hard to dig layer. Remedial works also need completing for Cells 4 and 6 in the Phase 2 area.

No elevated concentrations of contaminants have been recorded during previous investigations in the 'Events Area'.

Gas Monitoring

Gas monitoring wells were installed on a 75 m grid during the remedial works, and four rounds of monitoring were completed. Amber 1 gas measures were originally recommended for plots across the site.

Arc Environmental installed twelve gas monitoring wells across the site, and six rounds of monitoring were completed between November 2021 and February 2022. A summary of the results is given below:

- A maximum methane concentration of 2.8% was recorded in CP5, with the same well recording concentrations between 1.9 and 2.4% on three other occasions. No methane was recorded in the remaining wells;
- A maximum carbon dioxide concentration of 4.3% was recorded in CP2 on two occasions. In the remaining wells, concentrations were typically below 1.0%;
- Zero hydrogen sulphide or carbon monoxide was recorded in the wells;
- Flow was recorded to be below the limit of the monitor (0.1 l/hr);
- The shallowest groundwater was recorded at 0.42 m in MW1 during the third round of monitoring. Groundwater was recorded within the upper 1.0 m on at least one occasion in six of the wells (CP3, CP4, CP6, CP7, MW1 and MW2).

Made ground has been locally recorded to be up to 4.0 m thick below the site, but typically between 1.0 and 2.0 m. During previous investigations, elevated concentrations of hydrocarbons have been recorded below the site, and infilled shafts and an infilled quarry are located in the north and north east. Methane concentrations were recorded above the threshold of 1% for Amber 1 gas precautions in CP5 in the west of the site. It is therefore considered that gas precautions comprising subfloor ventilation and a fully sealed suitably resistant gas membrane will be required for all plots.

Construction

The site will be developed with low-rise housing of conventional construction.

Piled foundations are considered to be required for the majority of plots on the site, extending through the made ground and into the underlying competent mudstone or sandstone bedrock.

Trench fill foundations are considered to be required for remaining plots, sporadically located across the site.

The Environment Agency document, 'Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention' (dated May 2001, reference NC/99/73) identified six situations where piling or penetrative ground improvement could potentially cause pollution. The situations described by the document are shown below with our associated comments:

1. Creation of preferential pathways, through a low permeability layer (an aquitard), to allow potential contamination of an underlying aquifer.

Due to the presence of obstructions within the made ground, pre-bored piles may be required. Should pre-drilled piles be utilised, this will temporarily create an opening in the underlying Secondary A Aquifer (i.e. mudstone or sandstone bedrock). However, once the pile has been cast, the pathway into the aquifer will be sealed.

Where driven piles are to be used, these will displace the soil outwards, generally densifying it around the piles. The made ground being piled through is therefore expected to seal itself around the piles, which will restrict the passage of water along the pile length into the underlying aquifer.

The piles are therefore not expected to create a pathway into the underlying aquifer.

2. Creation of preferential pathways, through a low permeability surface layer, to allow upward migration of landfill gas, soil gas or contaminant vapours to the surface;

The made ground is expected to seal up around the piles post pile installation. A pathway for upward migration of gases or vapours is therefore not expected to be created by the piling.

A gas monitoring programme was completed on the site as part of the remediation works; gas precautions are recommended for all plots.

The piling is consequently not expected to increase the gas risk to this development.

3. Direct contact of site workers and others with contaminated soil arisings which have been brought to the surface;

Numerous fragments of asbestos have been identified at the site surface. Asbestos (amosite and chrysotile) fragments and fibres have also been recorded in the hard to dig layer which underlies the majority of the site. Safe methods of working should be implemented when excavating through this material.

Elevated concentrations of hydrocarbons and metals have been recorded in the made ground in the west of the site. Odours and impacted ground were noted here, extending into the Glacial Till.

Should pre-bored piles be utilised (a displacement piling technique), the displaced made ground will be brought to the surface. Groundworkers should be made aware that elevated concentrations of contaminants are present in the made ground. Normal site procedures, such as the wearing of gloves when handling soils and the washing of hands prior to eating, should be implemented at all times.

4. Direct contact of the piles or engineered structures with contaminated soil or leachate causing degradation of pile materials (where the secondary effects are to increase the potential for contaminant migration);

Sub-surface concrete in contact with made ground should contain DS-4 AC-4 precautions. It is anticipated that piles will be steel, and any concrete used for infilling will contain this level of sulphate measures as a minimum.

5. The driving of solid contaminants down into an aquifer during pile driving;

The piles are only expected to extend around a few metres into the mudstone or sandstone bedrock. Only a small amount of made ground, if any, would be expected to be pushed down to the bedrock, which was encountered at depths of between 1.7 and 8.0 m.

Prior to the remedial works, odours and impacted ground were noted were noted in the made ground in the west of the site, and extending down into the underlying Glacial Till. Groundwater impacted with hydrocarbons and ammonia was also encountered in the north west corner.

One sample recorded a very slightly elevated hydrocarbon fraction (Aromatic C12-16) of 5.79 ppm compared to the 5.60 ppm threshold in the Events Area. No elevated concentrations were recorded in the Phase 1 area.

Numerous fragments of asbestos have been identified at the site surface, and fragments and fibres have been recorded in the hard to dig layer. The made ground in two of Arc Environmental's trial pits, TP24 and TP25, was noted to contain ash.

Post-remediation, significantly elevated concentrations of potentially leachable contaminants have not been recorded below the site. Furthermore, the piled foundations are not likely to extend a significant depth into the Secondary A Aquifer.

Slight water ingresses were recorded in the made ground in a number of trial pits; this water is expected to be perched above the natural ground, and not indicative of the groundwater table. Groundwater strikes were recorded in the bedrock in three cable percussive boreholes (CP4, CP6 and CP7) at depths of between 4.2 and 8.0 m (equivalent levels ranging between 147.9 and 152.25 m AOD).

During groundwater monitoring, groundwater was recorded within the upper 1.0 m on at least one occasion in six wells. The equivalent level of the groundwater roughly varies between 149 and 157 m AOD, and generally lowers towards the north. Groundwater is therefore expected to lie within the upper few metres of the site surface.

However, since no elevated concentrations of leachable contaminants have been recorded in the soils below the site, it can be considered that there is a negligible risk of contaminants being pulled down into the underlying aquifer during piling.

6. Contamination of groundwater and, subsequently, surface waters by concrete, cement paste or grout.

If driven piles are utilised, it is likely these will comprise steel tubes infilled with concrete. These materials are therefore not expected to pose a significant risk to controlled waters.

The construction of the proposed development should not produce solid or liquid contaminants which can migrate through the underlying soil. Construction processes are therefore not considered to pose a significant risk to controlled waters. However, following consultation with the EA, it was recommended that a perimeter interceptor drain was to be installed along the western and southern boundaries to limit offsite run off, and an

interceptor/bund to be installed along the northern boundary. In addition, no-build easements have been implemented around the canal, culvert and mineshafts.

It is considered that soakaway drainage is not viable for this site, and surface water from the proposed development will be directed into a suitable piped system. The proposed drainage strategy is not therefore considered to pose a risk to controlled waters.

We trust the above is satisfactory. Please let us know if you have any queries.

Yours sincerely



Kate Edwards

Enc Arc Environmental's '*Exploratory Hole Location Plan*'



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The contractor shall check all dimensions on site prior to commencement of works. No dimensions to be scaled off this drawing.
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LEGEND	
	APPROXIMATE SITE BOUNDARY
	PREVIOUS BOREHOLE POSITION
	PREVIOUS TRIAL PIT POSITION
	ARC ENVIRONMENTAL LTD TRIAL PIT POSITION
	ARC ENVIRONMENTAL LTD WINDOWLESS SAMPLING BOREHOLE
	ARC ENVIRONMENTAL LTD MONITORING WELL

rev.	date	amendments	drawn	checked

Client:
VISTRY PARTNERSHIPS YORKSHIRE

Project Title:
Proposed Residential Development
Hollingworth Gate
Littleborough

Drawing Title:
Exploratory Hole Location Plan

Scale: at A1: As Shown | Date: 08.11.21 | Drawn by: P.D. | Approved by: M.P.B.

Job Ref: 21-763 | Dwg no: | Rev: |



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