

8. Ground Conditions

Introduction

- 8.1. This Chapter of the ES assesses the likely significant effects of the Proposed Development, which relates specifically to the remediation of the Site, with respect to ground conditions focusing on land contamination. This Chapter also describes the methods used to assess the effects; the baseline conditions currently existing at the Site and surrounding area; the mitigation measures required to prevent, reduce or offset any significant negative effects; and the likely residual effects after these measures have been adopted.
- 8.2. This Chapter has been completed by Wardell Armstrong (WA) LLP, with the reviewer having an MSc Engineering Geology, a BSc (Hons) Civil Engineering and Technical Director at Wardell Armstrong with over 11 years' consultancy experience; specialising in ground investigation and geotechnical design for private and public sector development projects. The author has an MGeol in Applied and Environmental Geology and is a Principle Engineering Geologist at Wardell Armstrong with over seven years consultancy experience; specialising in ground investigation, contaminated land and geotechnical design for public and private sector projects.
- 8.3. This chapter has been written following a review of publicly available third-party (CELTIC Technologies Ltd.), historical WA reporting that has been undertaken for the Site (attached at Appendix 8.1 and 8.2, respectively) and supplemented with additional information from the most recent WA LLP Draft Combined Phase I Preliminary Environmental Assessment and Phase II Ground Investigation Report.

Legislative and Policy Context

National Legislation and Guidance

- 8.4. The main legislation with regards to the clean-up of historic contamination is set out in Part 2A of the Environmental Protection Act (EPA) 1990 (HMSO, 1990). Section 78A(2), EPA 1990, provides the definition of contaminated land for the purposes of Part 2A, which is: 'any land which appears to the Local Authority in whose area it is situated to be in such a condition by reason of substances in, on or under the land, that significant harm is being caused or there is a significant possibility of such harm being caused; or significant pollution of controlled water is being caused; or there is a significant possibility of such pollution being caused'. In Section 78A (4), EPA 1990, harm is defined as meaning 'harm to the health of living organisms or other interference with the ecological systems of which they form part and in the case of man includes harm to his property'.
- 8.5. The statutory government guidance to Part 2A (DEFRA, 2012), describes the concept of the 'contaminant linkage' in Sections 3.8 to 3.11. A contaminant linkage is formed when there is a linkage between a contaminant source and a receptor by means of a pathway. If any one aspect is missing no linkage is formed. A contaminant linkage which gives rise to a level of risk sufficient to justify a piece of land being determined as contaminated land is termed a 'significant contaminant linkage' with the 'significant contaminant' forming part of a significant contaminant linkage. The guidance also mentions that its broader approach may include using the planning system to ensure land is made 'suitable for use'.
- 8.6. The government guidance Land Contamination: Risk Management (October 2020), sets out the method by which a risk management process for contaminated land should be undertaken and has replaced CLR11. Land Contamination: Risk Management sets out the staged assessment process for land contamination as follows: Stage 1 Risk Assessment, Stage 2 Options Appraisal and Stage 3 Remediation and Verification.

- 8.7. The government website for 'Land affected by contamination', updated in July 2019, provides guiding principles on how planning can deal with land affected by contamination, essentially when a Site is not covered by other legislation (such as Part 2A, Building Regulations and Environmental Permitting Regulations). As well as causing harm to human health, property and the wider environment, it mentions that land contamination can 'undermine compliance with the Water Environment Regulations 2017'. Guidance is provided as to how to determine if land is contaminated through the use of several recommended data sources (such as River Basin Management Plans, National Land Use Database, Historical Ordnance Survey Maps, Local Planning Authority Records and Natural England's MAGIC Site).
- 8.8. In addition to the above, Sections 161 to 161D of the Water Resources Act 1991 gave powers to the Environment Agency to take action to prevent or remedy the pollution of controlled waters. The normal enforcement mechanism is a "works notice" served under Section 161A, which specifies what actions have to be taken and in what time periods. This is served on any person who has "caused or knowingly permitted" the potential pollutant to be in the place from which it is likely to enter controlled waters, or to have caused or knowingly permitted a pollutant to enter controlled waters.
- 8.9. The Environment Agency's 'Managing and reducing land contamination: guiding principles', issued in March 2010 and updated in April 2016, sets out how to undertake a risk assessment focusing on risks to water, how to undertake a remediation options appraisal and how to implement remediation.

National Planning Policy

- 8.10. Chapter 15 of the National Planning Policy Framework (2019) discusses 'Conserving and enhancing the natural environment'. The following key issues associated with soil and groundwater contamination are stated within this Chapter:
- Paragraph 170(f) states that 'planning policies and decisions should contribute to and enhance the natural and local environment by remediating and mitigating despoiled, degraded, derelict, contaminated and unstable land, where appropriate;
 - Paragraph 178 states that '(a) a Site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination. This includes risks arising from natural hazards or former activities such as mining, and any proposals for mitigation including land remediation (as well as potential impacts on the natural environment arising from that remediation); (b) after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990; and (c) adequate Site investigation information, prepared by a competent person, is available to inform these assessments'; and
 - Paragraph 179 states that 'where a Site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner'.

Regional and Local Planning Policy

- 8.11. Manchester City Council currently use the Manchester Core Strategy adopted in July 2012, alongside national planning guidance set out in the national planning policy framework (NPPF) and local planning guidance, to determine planning applications.
- 8.12. The Policy EN 18 Contaminated Land and Ground Stability, contained within the Core Strategy 2012-2027, states that:
- The Council will give priority for the remediation of contaminated land to strategic locations, outlined within the Core Strategy and that any proposal for development of contaminated land must be accompanied by a health risk assessment.
 - The policy references the industrial past of the city and the resultant considerable levels of contamination and makes specific reference to Newton Heath as an area of concentrated industrial use.

- The Council states that it will be seeking to ensure that where resources are limited priority for land remediation is given to strategic Sites which are key in terms of delivering the economic, housing and regeneration objectives for the City.
- The policy also states that all new development within former mining areas shall undertake an assessment of any associated risk to the proposed development and, if necessary, incorporate appropriate mitigation measures to address them.

Assessment Methodology and Significance Criteria

- 8.13. Available reports and published information have been reviewed with the aim of identifying the ground conditions within and surrounding the proposed development. This data review has established the geological situation beneath the Site, identified areas of potentially contaminated land and of potential land instability and assessed the engineering properties of the soils and rocks. It also identified potential pollutant linkages and facilitated a risk assessment for each of the identified pollutant linkages.
- 8.14. The baseline conditions associated with soil and groundwater have been established by reviewing the following sources:
- A Landmark Envirocheck report dated November 2020;
 - Ordnance Survey County and National Grid Series Plans;
 - British Geological Survey published maps and memoirs;
 - British Geological Survey borehole database;
 - Environment Agency;
 - Other Mining Archives including the Mining Instability Study of GB prepared by Ove Arup (1990);
 - Celtic Technologies Ltd (July 2006), Desk Study - Ten Acres Lane, Newton Heath, Greater Manchester (report ref. R1077/06/2958);
 - Celtic Technologies Ltd (February 2008), Interpretative Report (Geoenvironmental Assessment) - Former Jacksons Brick Works, Ten Acres Lane, Newton Heath, Greater Manchester (report ref. R1077/08/3328);
 - WA LLP (July 2019), Factual Site Investigation Report – Land Between Ten Acres Lane and Mitchel Street, Newton Heath, Manchester (report ref. SH12254 RPT-001);
 - WA LLP (June 2020), Land at Ten Acres Lane, Newton Heath, Gap Analysis and Indicative Scope of Further Works;
 - WA LLP (December 2020), Land at Ten Acres Lane, Newton Heath, Outline / Preliminary Remediation Strategy;
 - WA LLP (December 2020) Draft Combined Phase I Preliminary Risk Assessment and Phase II Ground Investigation Report.
- 8.15. The above has been used to develop a Preliminary Conceptual Site Model and is currently being used to complete an updated Phase I Preliminary Environmental Assessment. Once the Phase I Preliminary Environmental Assessment has been completed and if required, the Preliminary Conceptual Site Model will be updated.
- 8.16. The impact of magnitude has been determined by considering the nature of change (including whether it is temporary or permanent), its severity, the duration of an effect (e.g. short/ medium/ long term) and the likelihood of an effect occurring, and the relative extent of the effects of contamination to the receptor, therefore, the risk assessment has been based on a qualitative assessment and professional judgement. Potential effects in terms of ground conditions tend to be local, therefore, the effects have not been considered in relation to different geographical contexts. The following scale has been used in terms of Impact Magnitude.

Table 8.1 Impact Magnitude Criteria

Level of Magnitude	Definition
Major	The proposals will cause the release of large areas of contaminants which are significantly above guideline values or release hazardous contaminants for the operational timescale of the development. Remediation will be required. Or for a positive impact, the proposals will significantly reduce large areas of contaminants.
Moderate	The proposals will cause the release of small areas of contamination close to the guideline values during the construction or operational timescale of the development. Remediation may be required. Or for a positive impact, small areas of contamination will be reduced.
Minor	The proposals will cause the release of contaminants that are below the guideline's values for a short period of time. Remediation will not be required; however, mitigation measures may be used to reduce the potential impact. Or for a positive impact, contaminants will be reduced, however, only from levels that were not originally above guidance values.
Negligible	Contaminants found at very low concentrations. Remediation will not be required.

8.17. The sensitivity is based on the relative importance of the receptor using the scale in Table 8.2.

Table 8.2 Sensitivity Criteria

Level of Sensitivity	Definition
High	Land to be used for human consumption (e.g. agricultural, allotments), highly sensitive ecosystems (e.g. SPA, SAC, SSSI, NNR) and the receptor being a public water supply.
Moderate	Parks and open spaces, regional or locally sensitive ecosystems and water bodies of medium quality.
Low	Commercial or industrial land uses, low to non-sensitive ecosystems (e.g. derelict land), water bodies of low quality and not a public water supply.

8.18. The significance of an environmental effect is determined by the interaction of magnitude and sensitivity, whereby the impacts can be positive or negative. The Impact Significance Matrix is set out in Table 8.3.

Table 8.3 Impact Significance Matrix

Magnitude	Sensitivity		
	High	Moderate	Low
Major	Major	Major – Moderate	Moderate – Minor
	Adverse/Beneficial	Adverse/Beneficial	Adverse/Beneficial
Moderate	Major – Moderate	Moderate - Minor	Minor
	Adverse/Beneficial	Adverse/Beneficial	Adverse/Beneficial
Minor	Moderate – Minor	Minor	Minor - Negligible
	Adverse/Beneficial	Adverse/Beneficial	
Negligible	Negligible	Negligible	Negligible

Limitations and Assumptions

- 8.19. Site investigation works were recently undertaken at the Site by Wardell Armstrong (WA) between September and November 2020 to provide further assessment of the ground and groundwater conditions. However, post fieldwork monitoring, sampling and testing, along with subsequent assessments / reporting have not yet been completed and some assumptions have had to be made based on a review of the available data.

Baseline Conditions

Preliminary Desk Study Information

- 8.20. The Site is roughly rectangular in shape and comprises approximately 19 Ha of derelict and densely vegetated land, that falls gently from the north east (approximately 85m Above Ordnance Datum) to the south west (approximately 75m Above Ordnance Datum). The eastern two thirds of the Site were densely vegetated / overgrown with mature trees and shrubs. In comparison the western section of the Site comprised rough grassland with thickets of semi-mature trees. No buildings were present on-site, although a large concrete slab was present within the north easternmost section of the Site. Fly tipping and surface debris are widespread across the Site. The Site is bound by the Rochdale Canal to the north, Mitchell Street and residential properties to the east, residential properties and a school to the south and Ten Acres Lane and a sports centre to the west.
- 8.21. Since the late 1890's it is understood that the Site has historically operated as a brickworks with two large clay extraction pits, which culminated into two large excavations that occupied approximately 85% of the Site. From the late 1940's onwards the clay extraction pits are indicated to have been infilled and during this period the Site was recorded as a both a Historical and Registered Landfill that was licensed to receive inert, industrial, commercial and household wastes for the former and construction and demolition waste, foundry sand, industrial non-hazardous waste, slag and boiler/flue cleanings for the latter. From the 1990's onwards, the Site has remained largely derelict.
- 8.22. According to published British Geological Survey (BGS) mapping, the geology beneath the Site is recorded to comprise Made Ground, underlain by Glacial Till, which is in turn underlain by various solid

geological strata that includes the Chester Formation and Manchester Marls Formation within the westernmost section of the Site and the Collyhurst Sandstone Formation across the remainder of the Site. A north east to south west trending fault crosses the westernmost section of the Site.

- 8.23. Hydrogeology information indicates that most of the Site is underlain by natural superficial deposits, which are classified as a Secondary Undifferentiated Aquifer and bedrock, which is classified as a Principal Aquifer. However, a superficial Secondary A Aquifer encroaches into the westernmost section of the Site and a bedrock Secondary B Aquifer is recorded within the westernmost section of the Site. The Site does not lie within a groundwater source protection zone. There are no potable groundwater abstractions within 2km of the Site.
- 8.24. The nearest graded surface watercourse is the Rochdale Canal which forms the northern boundary of the Site. Moston Brook lies approximately 590m to the north north west of the Site and the River Medlock lies approximately 700m to the south of the Site. There are no potable surface water abstractions within influencing distance of the Site. The potential for flooding is discussed in Chapter 6 of the ES.
- 8.25. The Site lies within a Coal Authority Coal Mining Reporting Area but is not located within a Coal Authority development high risk area. A third-party mining report suggests that the Site is within the likely zone of influence on the surface from workings in one coal seam at a depth of 1,040m, the last date of working being 1954. However, any ground movement from these workings should now have ceased. There are also no mine entries recorded on-site or within 20m of the Site.
- 8.26. The Site is not recorded to lie within a BGS Non-Coal Mining Area. However, the Site has historically been a brickworks with associated clay pits and there have been numerous such features within the surrounding area. It is possible that unrecorded surface clay extraction has occurred beyond that which has been recorded at the Site.
- 8.27. A UXO Detailed Risk Assessment was carried out for the Site in 2020 by a third party and an overall low UXO hazard was indicated. However, several bomb strikes were recorded within the surrounding area and the former Parks Engineering Works (located approximately 0.1km to the south west of the Site and a strategic target) is indicated to have been manufacturing military aircraft and parts and also possibly producing munitions during both wars.
- 8.28. An Envirocheck report indicates that the Site is in a Lower (less than 1% of homes estimated to be at or above the Action Level) to Intermediate (1 to 3% of homes estimated to be at or above the Action Level) probability radon area and that no radon protective measures are necessary in the construction of new dwellings or extensions.
- 8.29. The Site is significantly impacted by Japanese Knotweed and rhizomes could be present within soils. A third-party survey undertaken in 2012 indicates that approximately 10-15% of the Site is infested / impacted.

Site Investigation Information

- 8.30. The following information is a summary of the available information up to 2019 and where noted, has been supplemented with information from the 2020 Site investigation works where the information is available. Many of the assessments are still being undertaken and much of the information is preliminary in nature.

Ground Conditions

- 8.31. A review of all of the available information indicates that ground conditions are highly variable and comprise significant thicknesses of variable Made Ground to depths of between 0.3m and >14.8m, underlain by Glacial Till comprising firm to stiff, fissured, dark brown and grey mottled, slightly sandy to sandy, gravelly Clay and to a lesser extent yellow and grey, gravelly, coarse Sand to depths of between

13.85m and 43.0m, which are in turn underlain by solid geology comprising weathered Mudstone and Sandstone to depths of between at least 27m and 44.5m bgl.

8.32. The Made Ground was generally found to be highly variable over small lateral distances and comprised a mixture of predominantly granular (dark brown to black, very gravelly Sand/Ash to a very sandy/ashy Gravel) and to a lesser extent cohesive soils; all of which included various anthropogenic constituents of varying proportions and quantities (e.g. brick, concrete, timber beams/laths, suspected ash, suspected clinker, fabrics, glass, metal, suspected slag, plastics, and slate/tile fragments). The Made Ground can broadly be subdivided and zoned as follows:

- **Suspected Colliery Spoil:** Predominantly present within the central north eastern section of the Site to depths of between 0.6m bgl and 7.9m bgl. The material was typically recovered as a sandy clayey Gravel of mudstone, siltstone, slate, coal, and sandstone with up to 40% cobble and boulder content of similar lithologies. Ash, slag and clinker gravel and cobbles were evident at some of the positions.
- **Suspected Combustion Waste:** Mainly present within the north western, south western and easternmost sections of the Site to maximum depths of between 1.8m bgl and 6m bgl. The material was typically recovered as a sandy Gravel of predominantly ash, slag and clinker, and/or a gravelly Sand/Ash. Cobbles of mostly slag and clinker were frequent in the stratum, which also contained whole/broken red bricks and concrete paving slabs.
- **Suspected Construction and Demolition Waste:** Mainly present within the central area of the Site to depths of up to 13.85m bgl. The material was typically recovered as a sandy clayey Gravel of mixed lithologies including brick, concrete and sandstone. Generally, the material had a high boulder and cobble content of typically concrete, whole and broken red bricks, and paving slabs. Other items associated with typical construction rubble, such as bags of chemical products, paint tins, plastic drums, tiles, lime, car tyres, metal pipes, timber planks, plastic sheeting and metal tools were also present.
- **Suspected Household Waste:** Isolated occurrences within the central section of the Site but more localised within the south western section of the Site. An average thickness of 0.7m was recorded but in some areas it extended to 9m bgl. The material was typically recovered as cobble sized constituents including, but not limited to, timber, red bricks, metal bars, polystyrene, carpet, plastic sheeting, concrete and paving slabs. Household waste items such as plastic, food containers/bags, clothing and shoes were encountered locally. The material was occasionally recovered with a matrix of soft gravelly clay and occasionally Sand/Ash.

8.33. For the south western, easternmost and periphery areas of the Site areas of shallow natural ground generally within 1m bgl were encountered. Overlaying Made Ground generally comprised those suspected combustion noted above.

Groundwater Conditions

8.34. Numerous shallow perched waters were encountered within Made Ground during the construction of exploratory holes at depths of between 0.1m and 7.0m bgl. Shallow groundwater strikes within the underlying natural superficial deposits were also encountered between 1.1m and 7.1m bgl.

8.35. Groundwater monitoring indicates that perched / shallow groundwater elevations within Made Ground and natural superficial deposits were recorded between 0.4m and 7.1m bgl (between 73.61m and 84.69m AOD) and that these elevations are indicative of a hydraulic gradient to the west south west, which is consistent with the dip of local topography (towards the south west), but is also closely related to the depth of Made Ground. However, the full groundwater monitoring programme has yet to be completed and this may need to be updated following interpretation of the full results.

8.36. Deep groundwater strikes were suspected to have been encountered within the underlying solid geology, but the depths could not be determined due to the drilling techniques used. Groundwater

levels are recorded to have risen to between 0.7 m bgl to 5.5 m bgl within monitoring wells suggesting that groundwater is present and is confined with a flow to the south west. However, information from the 2020 Site investigation indicates that this was not bedrock that was encountered and is instead groundwater from within natural superficial deposits.

- 8.37. The information to date indicates that shallow perched groundwaters are not likely to consist of one interconnected water body, but a series of interconnected perched water bodies from various former clay pit excavations. However, there are some areas of the Site where perched waters within Made Ground are indicated to be in continuity with the underlying shallow groundwater within the natural superficial deposits. Further groundwater monitoring, sampling and subsequent laboratory analysis is currently being undertaken to quantify the risks to controlled waters, determine the risk of groundwater migration and the impacts of any perched shallow groundwaters during development of the Site. It should be noted that the most recent ground model for the Site indicates that continuity between groundwaters within the natural superficial deposits and bedrock is unlikely due to a significant thickness (up to 40m in places) of predominantly cohesive Glacial Till overlying bedrock.

Contamination

- 8.38. Several areas of potential hydrocarbon contamination and possible free product were identified from visual and olfactory evidence. Other areas of visual and olfactory evidence were also characterised by red dyes, acrid odours, black staining, iridescent sheens, asbestos containing materials, acrid odours, hydrocarbon odours and sewage / sulphur odours.
- 8.39. Identified contamination within soils included a range of localised to widespread exceedances of the screening values for metals (notably lead and arsenic), TPH fractions, PAH compounds, BTEX, Phenols, PCB's, VOC's, SVOC's and total cyanide within shallow Made Ground (<3m bgl) and occasionally within deeper Made Ground (>3m bgl). Asbestos fibres and debris at concentrations above the human health threshold of 0.001% have also been detected in shallow Made Ground Deposits.
- 8.40. Previous third-party Site investigations indicated that there was limited evidence to suggest that significant contaminants were leaching from Made Ground into shallow and deeper groundwaters at the Site and the assessments undertaken to date generally concur with these findings. While it has been confirmed that pathways are present in places between the perched groundwaters within Made Ground and underlying Glacial Till; continuity with groundwaters within the Principal Aquifer is considered unlikely due to the significant thickness of overlying low permeability Glacial Till. Further laboratory testing of the groundwaters within the Principal Aquifer are still outstanding.

Ground Gas

- 8.41. Monitoring of ground gases during previous third party investigations of the Site recorded concentrations of carbon dioxide between <0.1% and 14.3% (typically between <0.1% and 9.8%), methane concentrations up to 30.5% (typically <0.1%) and gas flow rates of up to 2.3 l/hr. However, only three visits were undertaken. Two rounds of ground gas monitoring has been undertaken from the 2020 Site investigation and concentrations of carbon dioxide between 0% and 16.8%, methane concentrations between 0% and 3.1% and gas flow rates of between -1.9 l/hr and 3.3 l/hr. The preliminary results are indicative of Characteristic Situation 2 and ground gas protection measures will likely be required for new buildings. However, the full ground gas monitoring programme has yet to be completed and this will need to be updated following interpretation of the full results.

Vapours

- 8.42. Based on the ground conditions and contamination encountered it is anticipated that vapours could pose a risk to those identified on and off-site receptors. Further assessments will be required to quantify the risk.

Preliminary Conceptual Site Model

- 8.43. In line with Environment Agency guidance, plausible source, pathway, and receptor linkages are to be identified for the Site. A preliminary conceptual Site model has been compiled based on our current understanding of the Site conditions from third party data and the assessments that we have currently undertaken.
- 8.44. Following completion of those outstanding items the CSM will be further refined and a Revised CSM will be produced.

Sources

- 8.45. Based on our current understanding of the potentially Site significant contamination sources on-site and off-site have been identified and these sources of contamination are outlined below:
- Key sources of on-site contamination include but are not limited to brickworks, historic landfill, registered landfill and associated made ground, fly-tipped materials, potentially infilled ponds, reservoir etc.
 - Key sources of off-site contamination include historical surrounding industrial uses within the immediately surrounding area that include but are not limited to; Park Engineering Works, Avro Works, Brickworks and associated clay pits, Ten Acres Mill, Bleach Works, Livingston Mills (cotton), Galvanising Works, Glass Works, Dye Works, Tannery, Laundry, Timber Yard etc.
 - Off-site possible ground gas sources include surrounding historical landfills, areas of potentially infilled ground (e.g. ponds and excavations), surrounding Made Ground deposits and a cemetery.
 - Identified contamination within soils included a range of localised to widespread exceedances of the screening values for metals (notably lead and arsenic), TPH fractions, PAH compounds, BTEX, Phenols, PCB's, VOC's, SVOC's and total cyanide within shallow Made Ground (<3m bgl) and occasionally within deeper Made Ground (>3m bgl). Localised asbestos fibres and debris above the human health threshold of 0.001% were also identified within shallow Made Ground.
 - A preliminary review of the available groundwater data indicates that minor exceedances in groundwater screening values have been recorded for metals, TPH and PAH with the highest concentrations being recorded from groundwaters within the landfill within the central part of the Site.
 - Surface waters from the Rochdale Canal recorded exceedances of the screening values for PAH.
 - No non-aqueous phase liquids (NAPL) have been detected to date, but free product was observed within shallow perched groundwater during trial pit excavations.
 - Proven on-site ground gas sources include Made Ground of significant thickness (up to 14m) within the historical landfill with abundant degradable constituents. A low to moderate ground gas generation potential is envisaged and this is supported by the ground gas data collected to date. Former infilled reservoir with a very low ground gas generation potential envisaged and this is also supported by the ground as data collected to date.

Potential Pathways

- 8.46. Based on our current understanding the Site and the proposed end use, the following potential pathways (without mitigation) are envisaged:
- 8.47. In terms of human health, the main potential exposure pathways are considered to be inhalation of soil dust and vapours / ground gas, dermal contact and ingestion of soils, dust, and waters. Possible consumption of homegrown vegetables and ingestion of soil attached to vegetables following development of the Site. However, the viability of these pathways varies as follows:

- Construction works and to a lesser extent current Site users are likely to have acute interaction with soil and materials, so they are likely to be at risk from all three potential pathways whilst working on the Site (i.e. dermal contact, ingestion and inhalation).
- Contaminated soils need to be windblown to adjacent Site users before the inhalation, dermal contact and ingestion pathways become relevant. Windblown pathways are most likely during construction of the Site.
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8.48. The main pathways by which contaminants are likely to reach groundwaters on-site is through the infiltration of rainwater causing vertical movement through the unsaturated zone followed by vertical and lateral movement of contaminants within groundwater as follows:

- Currently, most of the Site is densely vegetated and derelict land with only a limited thickness of clayey and / or sandy topsoil so vertical migration pathways are likely. During development vertical migration pathways are likely to increase following removal of vegetation and during earthworks.
- Due to the predominantly granular nature of the Made Ground materials within the backfilled clay pits, vertical migration pathways are likely. However, further vertical migration to deeper groundwaters within the underlying natural superficial deposits and bedrock is limited due to the predominantly low permeability nature of the underlying Glacial Till.
- Lateral migration pathways are also indicated to be limited within the backfilled clay pits due extent and geometry of the various excavations that are indicated, and the variability encountered within the backfilled materials. For example, limited connectivity is indicated between the clay pit within the north west of the Site and the larger clay pit within the centre of the Site.
- Within the centre of the Site areas there are localised areas of deep Made Ground that directly overlie natural granular deposits. This indicates that vertical migration pathways are present in places to the underlying granular layers within the Glacial Till. However, these granular layers are indicated to have limited vertical and lateral connectivity and are likely to be confined and perched.
- Lateral migration of groundwaters through the ground to the Rochdale Canal is considered unlikely due to the clay lining that would be present along the canal.
- Sub artesian conditions within deeper groundwaters within the natural superficial deposits and bedrock are indicated. It is expected that sub artesian conditions would further reduce the downward migration of contaminants through groundwater.
- Vertical migration via the faults that are recorded beneath the Site.
- Vertical and lateral migration pathways may also exist via historic man-made features such as foundations, underground infrastructure / voids, excavations and buried services.

8.49. The main pathway by which contaminants are likely to reach surface water receptors is through surface water run-off / overland flow as follows:

- The Site and the surrounding topography generally falls to the south west and away from the Rochdale Canal. However, there are areas immediately adjacent to the canal where surface water run-off towards the canal could occur.
- During development of the Site surface water run-off is likely to increase due to the removal of vegetation and topsoil's.

8.50. With the exception of downward migration, the main ground gas pathways are similar to those lateral and vertical migration pathways envisaged for groundwater. However, ground gas generation of the source is the main factor in the potential for the lateral migration of any ground gases and groundwater itself can sometimes facilitate lateral migration of dissolved ground gases. Ingress and accumulation then occurs once the ground gas has reached a valid receptor (e.g. a building). Inhalation is the main pathway for human health receptors.

8.51. Buildings/infrastructure – direct contact of contaminated soils / groundwater with building materials and ground gas ingress / accumulation.

8.52. Flora and Fauna – ingestion and root uptake

Key Receptors

8.53. Based on our current understanding of the Site, potential receptors include:

- Human health – current Site users, construction workers, and the general public / adjacent Site users (includes residential properties and the school to the south).
- Controlled waters – groundwater within superficial Secondary A and Secondary Undifferentiated Aquifers, groundwaters within bedrock Principal Aquifer and Secondary B Aquifer and surface waters (Rochdale Canal). Groundwater within the deeper Principle Aquifer is considered to be the most sensitive groundwater receptor.
- Buildings / infrastructure (existing and proposed).

Identification and Evaluation of Potential Effects

8.54. The key receptors have been identified as outlined above in paragraph 8.53

8.55. Given the temporary nature of construction and the timescales involved, it is considered that all potential impacts during construction will be temporary and in the short to medium term only. The following describes the potential impacts that may occur during the construction of the Proposed Development:

- The risk of significant widespread contamination being present is high and has the potential to impact the health of groundworkers through direct contact, ingestion or inhalation of contaminated soil / dust. The health of adjacent Site users may also be impacted by the direct contact, ingestion or inhalation of dusts. Therefore, the potential impact magnitude has been considered as high.
- It is possible that construction methodologies (e.g. vegetation strip, earthworks) could create pathways for contamination to migrate to off-site receptors (e.g. Rochdale Canal, adjacent users and deeper groundwaters) via surface waters, groundwaters or dust. Ground gas pathways may also be created. The potential impact magnitude has been considered as high.
- Fuels and chemicals used / stored during construction have the potential to be spilled and if this occurs there could be potential future impacts to all receptors, however, considering the probability of this occurring or of it being significant, the impact magnitude is considered to be moderate.

8.56. The following table provides a summary of the potential construction impacts as outlined above and outlines the receptor sensitivities along with the overall significance (by using the matrix as previously described in Table 8.4).

Table 8.4 Impact Significance – Construction

Receptor (Sensitivity)	Nature of Impact/ Comments	Magnitude	Significance
Construction Workers (High)	Direct contact, ingestion or inhalation of contaminants/dust/groundwaters/	Major	Major Adverse
Adjacent Site Users / General Public (High)	Direct contact, ingestion (including consumption of vegetables and ingress via water supply pipes) or inhalation of contaminants/dust/groundwaters	Major	Major Adverse

Receptor (Sensitivity)	Nature of Impact/ Comments	Magnitude	Significance
Groundwaters within superficial and bedrock Aquifers (Low to High)	Migration of groundwater through the ground (vertical and lateral)	Major	Major Adverse to Moderate – Minor Adverse
Surface water receptors: Rochdale Canal (Moderate)	Surface water run-off / overland flow	Major	Major – Moderate Adverse
Existing adjacent buildings / infrastructure and land (High)	Direct contact with contaminated waters; migration, ingress and accumulation of ground gases; infiltration of contaminants into pipes; and unstable ground	Major	Major Adverse
All, including workers and the wider environment (Moderate)	Spillage of fuels or chemicals during construction.	Moderate	Major – Moderate Adverse

- 8.57. From the above table, it is considered that prior to mitigation, the potential impacts for the construction phase / remediation works are mostly Major Adverse to Major – Moderate Adverse and are considered to represent a likely significant effect for the purposes of the EIA regulations.

Mitigation Measures

- 8.58. Based on the baseline information, the risk of contamination being present at the Site is considered high and could cause an impact. An extensive intrusive investigation was undertaken by WA between September and November 2020. The intrusive investigation included the chemical analysis of soils, groundwater sampling and testing and ground gas monitoring. Many of these assessments are currently being undertaken and there is a possibility that further assessments may be required (e.g. Detailed Quantitative Risk Assessment).
- 8.59. The exact requirements of the mitigation / remediation that will be required is dependent on the completion of those assessments that are currently outstanding and is subject to the appointed remediation contractors preferred methodologies. WA LLP completed an outline / preliminary remediation strategy in December 2020, and it is recommended that reference is made to this report and any subsequent updates for the likely mitigation measures that may be required to reduce potentially adverse effects and enhance beneficial effects caused by the remediation / construction works. It should be noted that this report also covers post construction remediation activities (e.g. ground gas protection).
- 8.60. A Construction Environmental Management Plan (CEMP) should be completed to ensure that any environmental impacts during construction and in terms of land contamination are minimal. At this preliminary stage and in the absence of assessments that are yet to be completed the likely construction related mitigation measures that could be required are outlined in Chapter 5 of the report.

Cumulative Effects

- 8.61. The Site is located within an area of significant historical industrial land use that includes those off-site sources noted in paragraph 8.45. However, contamination from off-site sources generally has to migrate, generally in windblown or soil-derived dust, entrained in surface water runoff, in migrating groundwater

or as migrating ground / landfill gas and vapours. Any contamination would have to be significant in order to potentially cause impacts to the wider environment.

- 8.62. It is noted that the committed and likely developments coming forward within the vicinity of the Site are for a residential development for the Erection of a part 4 (plus ground), part 5 (plus ground) storey building to form 100 residential apartments (Use Class C3a) together with ground floor commercial floorspace (Use Classes A1, A2, A3, B1 and D1) (211 sqm) and erection of 39 two and three storey dwelling houses (Use Class C3a) along with associated access, landscaping, boundary treatment and car parking (Planning reference 125990/FO/2020).
- 8.63. Cumulative effects during construction include a greater number of groundworkers exposed to contamination and an increased potential for windblown contaminants to be generated and effect nearby users. An intrusive investigation was undertaken at the Site noted above proposed for residential development and while elevated concentrations of contaminants and ground gas were noted, these were not significant and an overall low to moderate risk was indicated. Furthermore, when the source-pathway-receptor methodology is implemented it is unlikely to impact upon the Site or in turn be impacted by developments at the Site. Therefore, the risk of the above cumulative effects occurring are minor.
- 8.64. There is a possibility of a greater number of incidents / accidents which could cause contamination to the ground and the wider environment during construction, however, the probability of this occurring at every development in order to cause a cumulative effect is considered to be relatively low. It should also be noted that these schemes are likely to adhere to best practice in order to minimise potential environmental impacts (even likely a strict Construction Environmental Management Plan), which would also reduce the probability of incidents/ accidents occurring to the storage of any fuels or chemicals.
- 8.65. Similar to the potential cumulative impacts during construction, during operation there could be more future users, water supply pipes, vegetation and buildings being affected by contamination. However, it should be noted that through the planning regime, similar mitigation measures are likely to be incorporated into any developments in the wider area and the impact is considered to be minor.

Residual Effects

- 8.66. The table below identifies for each potential significant effect, the receptor, mitigation measure and residual impact:

Table 8.6 – Summary of Likely Significant Effects, Receptors, Mitigation Measures and Residual Effects

Likely Significant Effect	Receptor (Sensitivity)	Mitigation Measures	Residual Impact Significance
Construction Phase			
Direct contact, ingestion or inhalation of contaminants/dust/groundwaters/gas/vapours	Construction workers (High)	Implementation of those items outlined for the CEMP and Remedial Strategy (including use of PPE and adhering to relevant health and safety measures)	Negligible
Direct contact, ingestion (including consumption of vegetables and ingress via water supply pipes) or inhalation of contaminants/dust/groundwaters	Adjacent Site Users / General Public (High)	While the construction works could temporarily increase the risk of migration to off-site receptors, if those items outlined for the CEMP and Remedial Strategy are implemented this should be negligible.	Negligible

Likely Significant Effect	Receptor (Sensitivity)	Mitigation Measures	Residual Impact Significance
Construction Phase			
Migration of groundwater through the ground (vertical and lateral)	Groundwaters within superficial and bedrock Aquifers (Low to High)	While the construction works could temporarily produce pathways to shallow groundwaters, if those items outlined for the CEMP and Remedial Strategy are implemented this should be negligible.	Negligible
Surface water run-off / overland flow	Surface water receptors: Rochdale Canal (Moderate)	While construction works would increase the potential for surface water run-off / overland flow, if those items outlined for the CEMP and Remedial Strategy are implemented this should be negligible.	Negligible
Direct contact with contaminated waters; migration, ingress and accumulation of ground gases; infiltration of contaminants into pipes; and unstable ground	Existing adjacent buildings / infrastructure and land (High)	While construction works could increase the potential for off-site migration of contamination to third part properties, if those items outlined for the CEMP and Remedial Strategy are implemented this should be negligible.	Negligible
Spillage of fuels or chemicals during construction	All, including workers and the wider environment (Moderate)	Implementation of those items outlined for the CEMP and Remedial Strategy	Negligible

Summary

8.67. Following the implementation of the mitigation measures, the potential impacts have been identified as negligible significance and are considered to represent a likely non – significant effect for the purposes of the EIA regulations. It should also be noted that following remediation of the Site there will be a betterment to the current baseline conditions.

Reference List

8.68. This ES Chapter has been prepared by reference to the following:

- Celtic Technologies Ltd (July 2006), Desk Study - Ten Acres Lane, Newton Heath, Greater Manchester (report ref. R1077/06/2958);
- Celtic Technologies Ltd (February 2008), Interpretative Report (Geoenvironmental Assessment) - Former Jacksons Brick Works, Ten Acres Lane, Newton Heath, Greater Manchester (report ref. R1077/08/3328);
- Wardell Armstrong LLP (July 2019), Factual Site Investigation Report – Land Between Ten Acres Lane and Mitchel Street, Newton Heath, Manchester (report ref. SH12254 RPT-001);
- GL Hearn: "Environmental Statement, Former Jacksons Brickworks, Ten Acres Lane, Newton Heath, Manchester"; and
- Wardell Armstrong LLP (December 2020), Draft combined Phase I Preliminary Environmental Assessment and Phase II Ground Investigation Report.