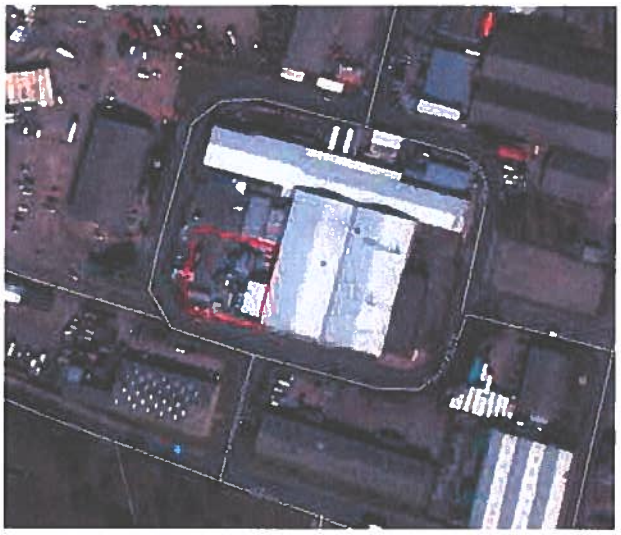
Land at Iceland Manufacturing, Manchester

Desk Study and Ground Investigation Report



Report for:

Gelder and Kitchen

November 2015

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EXECUTIVE SUMMARY

Area of interest	Summary of main text
Introduction	Following instruction from Gelder and Kitchen this report presents the results of a geo-environmental desk study and ground investigation undertaken upon the proposed redevelopment site known as Iceland Manufacturing Ltd, Manchester.
Proposed development	From discussions with the client it is understood that two large storage silos are to be constructed over the investigation area with an approximate load of 100 tonnes each. The works are to be carried out within the active manufacturing site and the current commercial use will not change; furthermore there will be no new areas of soft landscaping or buried potable water pipework.
Site location, description and surrounding features	The site occupies an area known as Loxton Food Co. approximately 1.25 hectares in plan area, located around National Grid Reference: 388304, 396796 to the east of the city of Manchester. The postcode for the site is M18 8BW. During the site works the majority of the wider site area was covered by the manufacturing facility and associated administration offices which were located centrally with a series of loading bays along the northern edge. Hard surfaced car parking areas were located on the eastern and western edges of the main factory building. The study area covered by this report was located in the western part of the site between the main factory building and hard landscaped parking. The study area was found to be covered by concrete and tarmac and predominantly used for the storage of waste material requiring recycling; a number of active air conditioning units were also present. Immediately adjacent to the study area additional waste skips were noted to be present with the wider site extending beyond. A railway line was present running east to west some 100m from the sites northern boundary, while another line runs southeast to northwest approximately 280m to the southwest. The wider surrounding land use was observed to be a mixture of commercial units and residential properties.
Geology	The solid and drift geology of the site is shown to comprise artificial ground (made ground) and superficial Diamicton (Glacial Till) over sandstone of the Chester Pebble Beds Formation.
Potential mining issues	The site is indicated to be located within an area affected by coal mining although based on publically available information the thickness of the Triassic Period cover over any coal bearing strata is shown to be in excess of 50m. Based upon this thickness of cover any historic underground coal workings are likely to be outside of the zone of influence for the site. The site is also noted to be within a JPB mining area; the same rationale as stated above is considered to apply with respect to coal workings although further liaison should be undertaken with JPB to confirm that their records relate to coal and the risk is sufficiently low.
Hydrogeology	The superficial Diamicton is reported to be Unproductive Strata while the underlying Chester Pebble Beds Formation is reported to be Principal Aquifer strata. The site is not within a groundwater Source Protection Zone although two abstractions for 'process water' are present 224m to the west.
Hydrology and flood risk	An underground river (potential sewer) is reported to be present 48m south of the site. No further details are readily available with regards to this and no such feature is shown on the mapping. However, given that the age/condition of any culvert is not known (and therefore the chance of lateral migration into the watercourse from the surrounding soils and/or unknown discharges cannot be discounted) this has been included as the nearest sensitive surface water receptor.
Radon	BR211 reports the site to lie in a 1km2 Ordnance Survey grid areas where <1% of properties are above the action level. Radon protection measures are not considered necessary for any new developments.
Unexploded ordnance risk	Based on the available third party information the risk of unexploded ordnance across the site is considered to be moderate.
Site history	At the time of the earliest maps in the mid 1800's the wider site was an open field area with a pond. By the late 1800's the site had been developed into the Gorton Foundry with a variety of associated buildings covering the surrounding area until the 1970's. From the 1970's onwards the buildings on site are shown to be similar to those present at the time of the site works. Major infrastructure improvements have been made to the surrounding area since the late 1800's with a number of works associated with the railway to the north of the site. During the initial development of the surrounding land a number of ponds disappeared from the mapping, and are therefore assumed to have been infilled.

Area of interest	Summary of main text
Preliminary conceptual site model	Plausible source-pathway-receptor contaminant relationships were identified as part of the Phase 1 desk study where principal sources of possible contamination from on-site sources were identified as: made ground associated with the historic development of the site, miscellaneous chemical/waste storage associated with the current site usage and a historical electrical substation. Offsite potential sources of contamination were identified to include made ground associated with the development of the surrounding land including the construction of the nearby railways, gas migration form historic landfills, miscellaneous industrial processes within 50m of the site and gas migration from the infilling of the ponds.
Ground investigation works undertaken	An intrusive ground investigation was undertaken across the site on the 7th and 8th October 2015 and comprised concrete coring and drilling of 3N° window sample boreholes, drilling of 1N° Cable Percussive borehole and the construction of a gas and water monitoring installation and gas monitoring upon 1N° occasion.
Identified Ground Conditions	Made ground was present across the site area overlain by concrete in the eastern portion of the investigation area, near the intended location for the large storage silos, up to a thickness of 0.5m. The underlying made ground was found to vary in depth between 1.10 and 3.80m. The deeper area of made ground in the western area of the site is considered to be associated with the historic infilling of a pond and comprised gravel of brick, concrete and occasional tarmac. Tarmac up to 0.17m thick was encountered within CP1 and underlain by an engineered sub-base material. Natural ground underlying the made ground was found to comprise soft to firm Clay to a depth of between 2.60 and 3.45mbgl. Below this layer the clay became stiff with refusal in both WS1 and WS3. The deeper natural strata revealed in CP1 showed sand and gravel at 7.4m which is considered to represent the weathered upper surface of the Chester Pebble Beds Formation. Underlying this very stiff clay was encountered considered to represent a weathered subordinate siltstone/mudstone bed within the Chester Pebble Beds Formation.
Human health risk assessment	The chemical testing did not reveal any concentrations of potential contaminants significantly elevated above levels of concern with respect to human health. As such the soils on site are not considered to pose an unacceptable potential risk to the end users in the context of the commercial development.
Controlled waters	Based upon the ground conditions encountered during the investigation and the soil chemical analysis results the soils are considered unlikely to pose a significant risk to controlled water receptors.
Hazardous gases	Based on the monitoring undertaken to date ground gases are not considered to represent a significant risk to the proposed development where the site could be classified as 'Characteristic Situation 1'.
Risk assessment of other environmental receptors	Based on the sulphate test results a DS2-AC-1s class of concrete will be suitable for use in buried structures.
Preliminary Foundation Recommendations	The made ground and soft clay are not considered suitable as a founding stratum and it is expected that all foundations will be taken to approximately 4.0m below ground level. Foundations placed within the stiff clay below 4.0m may be designed for a safe allowable bearing pressure of 250kPa and as such are not likely to be restricted by bearing capacity.
Preliminary Road Construction Recommendations	Made ground was found beneath the hardstanding in all locations and due to its inherent variability at this stage a CBR value of <2% should be adopted for design.
Groundwater regime	Groundwater seepages were noted within CP1 at 1.80mbgl and 8.00mbgl and are considered to be reflective of perched water within the made ground and water held within a band of granular natural soils at depth. Post fieldwork groundwater was found to be at 4.89mbgl within CP1. If excavations on-site are extended below approximately 4.50m it is likely that significant groundwater will be encountered which will not be adequately dealt with by conventional methods. Should this be the case, the advice of specialist dewatering contractors should be sought as deep well dewatering or sheet piles may be required.
Waste	The natural ground is classified as non-hazardous waste and based upon the chemical data it is likely that it will be treated as inert or stable non-reactive waste therefore avoiding the higher rate of landfill tax. The made ground comprises a mixture of both hazardous and non-hazardous material and upon consideration of the chemical test data any made ground that is removed from site as waste is likely to incur the higher rate of landfill tax.
Uncertainties	As with all investigations, areas of uncertainty remain. Those associated with the site are the variability of the made ground, the reported coal mining and JPB mining area, the risk of unexploded ordnance and the effect of wind loading on the foundations recommendations.

Area of interest	Summary of main text
Further Work, Risk Management and Remediation	Whilst the assessment of the chemical analysis results for the soil samples obtained during the ground investigation indicates that soil risk mitigation measures are not necessary, it is recommended that vigilance is employed by the contractor during the ground works phase of the project and should significant made ground be encountered advice from a specialist geo-environmental consultancy should be sought. Further to this an additional two gas monitoring visits are recommended in conjunction with groundwater level measurements to confirm the low risk. The groundwater level recorded during the investigation and subsequent groundwater monitoring may not be representative of the groundwater levels encountered during the excavation of foundations. As such further groundwater monitoring should be carried out prior to finalising the foundation design and calculation of the hydrostatic pressure beneath the clay layer should be carried out. If unexpected ground conditions are encountered within excavations not recorded by this investigation advice should be sought from specialist geotechnical consultancy. It is recommended that further liaison be undertaken with JPB with regards to the site being within a potential mining area and confirm the perceived low risk. In addition, it may be prudent to obtain a Coal Authority report for the site. It is also recommended that further vigilance is employed by the contractor during the ground works phase of the project in order to manage these potential risks and if any suspect objects are revealed works should immediately cease and advice from a specialist UXO company should be sought. The relevant regulatory authorities should be forwarded a copy of the ground investigation report to confirm that they are in agreement with the conclusions and recommendations herein.

1.0 INTRODUCTION

1.1 Contract details

Following instruction from Gelder and Kitchen – 'the client', this report presents the results of a geo-environmental desk study and ground investigation undertaken upon the proposed redevelopment site known as Iceland Manufacturing Ltd, Manchester - 'the site'.

1.2 Proposed development

From discussions with the client it is understood that two large storage silos are to be constructed over the investigation area with an approximate load of 100 tonnes. The works are to be carried out within the active manufacturing site and the current commercial use will not change; furthermore there will be no new areas of soft landscaping or buried potable water pipework.

1.3 Purpose of the assessment

The purpose of the assessment has been to establish the environmental and geotechnical conditions of the site prior to development and to support a future planning application. This report also considers the likely foundation designs appropriate to the site, along with requirements for any related ground improvement works and/or remediation considered necessary to mitigate against any unacceptable human health or environmental risks resulting from existing or former land uses.

1.4 Scope of works

The scope of works to fulfil the purpose of the assessment has included the following:

- Site reconnaissance survey;
- Review of site specific environmental database information to provide historical and background environmental information;
- Development of a preliminary site conceptual model and environmental risk assessment;
- Preparation of engineering exploratory hole logs to record the observed ground conditions;
- Preparation of an interpretative report presenting the findings of the investigations.

1.5 Report limitations

The recommendations, interpretations and conclusions of this report are based solely on the historical and current site conditions reported by database and mapping sources and observed during the intrusive investigations undertaken. No responsibility can be accepted for the accuracy of third party information including reference data contained within site specific database reports. Due to the inherent variability of the ground conditions between exploratory hole positions, these conditions can only be interpreted and not defined and are accurate only for the date of the investigation works.

2.0 CURRENT SITE DESCRIPTION AND LOCATION

2.1 Site location

The wider site occupies an area known as Loxton Food Co. approximately 1.25 hectares (ha) in plan area, located around National Grid Reference (NGR): 388304, 396796 to the east of the city of Manchester. The postcode for the site is M18 8BW.

A site location plan area is presented in Appendix A.

2.2 Site description

At the time of the investigation, the wider site was found to be roughly square shaped, with maximum approximate dimensions of 125m east to west and 100m north to south.

The majority of the wider site area was covered by the manufacturing facility and associated administration offices which were located centrally with a series of loading bays along the northern edge. Hard surfaced car parking areas were located on the eastern and western edges of the main factory building.

The study area covered by this report was located in the western part of the site between the main factory building and hard landscaped parking. The study area was found to be covered by concrete and tarmac and predominantly used for the storage of waste material requiring recycling; a number of active air conditioning units were also present. Vehicle access to the site was gained through a metal security gate mid-way along the western site boundary while pedestrian access could be gained through a smaller security gate along the southern boundary. Temporary welfare and storage containers were noted to be located within a fenced compound in the southwest corner of the study area which was generally flat and level.

Immediately adjacent to the study area additional waste skips were noted to be present with the wider site extending beyond. A road encircles the wider site with the immediate surrounding land use given over to commercial units. A railway line was present running east to west some 100m from the sites northern boundary, while another line runs southeast to northwest approximately 280m to the southwest. The wider surrounding land use was observed to be a mixture of commercial units and residential properties.

A selection of site photographs are presented within Appendix B.

2.3 Areas of potential concern (APC) summary

The table below details potential sources of contamination identified from site observations.

Table 2.3.1 - Potential sources of contamination from historical mapping.

Area of potential concern (APC) N°	Details	Metals, semi-metals, non-metals, inorganic chemicals and others	Organic chemicals	Gases / vapours
1	On site Miscellaneous made/reworked ground associated with the development of the site.	Possible	Possible	Possible
2	On site Miscellaneous chemical/waste storage associated with the current site usage.	Possible	Possible	Unlikely

Area of potential concern (APC) N°	Details	Metals, semi-metals, non-metals, inorganic chemicals and others	Organic chemicals	Gases / vapours
3	Off site Made ground associated with the development of the surrounding land including the construction of the nearby railways.	Possible	Possible	Possible

3.0 ENVIRONMENTAL SETTING

3.1 Ground conditions

3.1.1 Published geology

The solid and drift geology of the site is illustrated within the environmental database report, on the British Geological Survey (BGS) map derived from the 1:50,000 scale mapping Sheet 85 and the BGS on-line mapping database. These sources indicate that artificial ground and superficial deposits are both present on site overlying the bedrock.

The artificial ground is shown to be present across the whole site area as undivided made ground while the superficial deposits are shown to comprise Quaternary Period Diamicton (Glacial Till) likely to consist of sand and gravel.

The bedrock underlying the site is indicated to be the Chester Pebble Beds Formation comprising sandstone formed approximately 246 to 251 million years ago in the Triassic Period.

3.1.2 Mining records and natural geological hazards

Information supplied by the BGS regarding the underlying geology, mining and natural geological hazards included within the environmental database report and considered relevant to this assessment, is summarised in the table below:

Table 3.1.2 - Geological hazards summary

Potential hazard	Risk to the site/hazard potential.
Artificial ground	Undivided made ground across the site area.
Historical mining	None reported
Coal Mining affected Areas	Reported on site
Brine affected areas	None reported
Non coal mining areas	Reported 781m west of the site.
Non coal mining cavities	None reported
Tin mining	None reported
Collapsible Rocks	Very low
Compressible Ground Stability	Very low on site. Negligible off site.
Ground Dissolution Stability	Negligible
Landslide Ground Stability	Very low
Running Sand Ground Stability	Very low
Shrinking or Swelling Clay Ground Stability	Very low
JPB Mining Area	Yes
Gypsum Extraction	None reported
Natural Cavities	None reported
Clay mining	None reported

As illustrated by Table 3.1.2, the environmental database report indicates that the site is located within an area affected by coal mining. Coal will be present within Carboniferous Period strata likely to be present at depth rather than the Triassic Period Chester Pebble Beds Formation. A site specific coal mining report was not available at the time of writing, although based on the publically available borehole logs on the BGS website, the thickness of the Triassic Period Chester Pebble Beds Formation is shown to be in excess of 50m in the immediate area. Based upon this thickness of cover any historic underground coal workings are likely to be outside of the zone of influence for the site.

The environmental database report also highlights that the site is within a JPB mining area. The same rationale as stated above is considered to apply with respect to coal workings

although further liaison should be undertaken with JPB to confirm that their records relate to coal and the risk is sufficiently low.

3.1.3 Ground workings and potentially infilled land

The environmental database report highlights 5N° historical surface ground working features within a 250 radius of the site. 4N° of the features relate to unspecified ground workings or unspecified heaps which may be associated with the nearby railway development. The remaining feature relates to a brick works 237m south west, dated at around 1905.

The report does not highlight any historical underground working features within a 1km radius of the site.

There are no records of current ground workings within 500m of the site.

3.1.4 Background geochemical data

With reference to the environmental database report and also the BGS on-line resource, the site is not reported to lie within an area where naturally occurring elevated concentrations of metalliferous contaminants are likely to be present.

3.2 Hydrogeology and groundwater sensitivity

The hydrogeology of the site is illustrated and described within the environmental database report and on the Environment Agency on-line public register. These sources report the Diamicton to be Unproductive Strata while the underlying Chester Pebble Beds Formation is reported to be Principal Aquifer strata.

Unproductive strata are rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.

Principal aquifers have a high intergranular and/or fracture permeability usually providing a high level of water storage and may support water supply/base river flow on a strategic scale.

To remain conservative at this stage it has been assumed that the Diamicton overlying the Chester Pebble Beds Formation will not sever potential pathways to the underlying Principal Aquifer and therefore this has been considered as the primary receptor.

According to the Environment Agency the site is not within a groundwater Source Protection Zone (SPZ) catchment area.

3.3 Hydrology, surface water quality

According to Ordnance Survey mapping and the environmental database report there does not appear to be any significant surface water features within 500m of the site.

However, the environmental database report indicates an underground river (potential sewer) to be present 48m south of the site. No further details are readily available with regards to this and no such feature is shown on the historical mapping. Given that the age/condition of any culvert is not known (and therefore the chance of lateral migration into the watercourse from the surrounding soils and/or unknown discharges cannot be discounted) this has been included as the nearest sensitive surface water receptor.

3.4 Groundwater and surface water abstractions and discharges

The environmental database report does not highlight any licensed discharge consents within 250m of the site.

There are 2N° recorded groundwater abstractions within a 250m radius of the site which appear to be associated with the same location 224m to the west with one marked as historical and one as active. Both permits are referenced as 'process water' for Cemex Materials UK Ltd.

There is no record of any surface water or potable abstractions within a 250m radius of the site.

3.5 Flood risk

The environmental database report indicates that there is a very low risk of flooding from rivers and seas although the site is located 4m from an environment agency designated Zone 2 floodplain and 244m to the west of a Zone 3 floodplain.

The environmental database report indicates that the site is within 50m of a BGS groundwater flooding susceptibility area for clearwater flooding associated within unconfined aquifers; the potential is however recorded as 'limited'.

3.6 Radon

BRE guidance document *'Radon - Guidance on protective measures for new buildings'* published in 2007, Ref: BR211 provides information on areas of England and Wales affected by naturally occurring radon gas and also guidance on building design measures to protect against the risks posed. This guidance is endorsed by the Building Regulations 2000, Part C (as amended).

BR211 reports that the site is not within a radon affected area as less than 1% of properties are above the action level. Radon protection measures are not considered necessary for any new developments.

3.7 Environmental designations

The database report does not identify any environmentally sensitive or designated sites within a 500m radius of the site.

3.8 Unexploded ordnance

Based on a review of regional unexploded bomb risk areas published by Zetica, an independent database authority, the risk of unexploded bombs across Manchester including the site area is reported to be moderate.

It is recommended that further vigilance is employed by the contractor during the ground works phase of the project in order to manage these potential risks and if any suspect objects are revealed works should immediately cease and advice from a specialist UXO company should be sought.

3.9 Industrial activities register

Based on a review of public database sources and information presented in the environmental database report, current and historical industrial activities and incidents within a 250m radius and considered relevant to the environmental assessment of the site are discussed below.

3.9.1 Current industrial trades and authorised processes

Current land uses and records of potentially contaminative industrial sites within 250m of the study site and considered relevant to the assessment are summarised in the table below:

Table 3.9.1 - Current industrial trades			
Trade name	**Operation**	**Distance from the site (m)**	**Direction from the site**
Electricity Sub Station	Electrical Features	0	On site
Advance Vehicle Technicians	Vehicle Repair, Testing and servicing	29	N
Enterprise Manchester Ltd	Waste Storage, Processing and Disposal	32	W
LDS Motor Bodies Ltd	Vehicle Repair, Testing and servicing	35	S
Taw Garage	Vehicle Repair, Testing and servicing	36	S
AOC Powder and Coating	Industrial Coating and finishing	36	S
Budge Motors Ltd	Vehicle Repair, Testing and servicing	55	N
Electricity Sub Station	Electrical Feature	79	E
Electricity Sub Station	Electrical Feature	85	SE
Electricity Sub Station	Electrical Feature	95	N
PSA Body Repairs	Vehicle Repair, Testing and servicing	102	E
Froxmer Test Centre	Vehicle Repair, Testing and servicing	132	E
Wilde Transport	Vehicle Repair, Testing and servicing	137	E
Electricity Sub Station	Electrical Feature	173	W
Tank	Tanks (Generic)	203	NE

There are 15N° potentially contaminative industrial sites within 250m of the study site. These are a mix of electrical sub stations, vehicle repair, testing and servicing, industrial coating and finishing and generic tanks.

The identified substation on site is considered likely to correspond to an historic installation shown on the historical maps as no evidence of any associated feature was noted during the walkover. Based on the age of the substation (pre 1986) this is considered to have the potential to pose a risk to the site and has been included as a potential source. Further to this, the general industrial usages within 50m have also been included.

The potential risks from the remaining off site industrial usages in excess of 50m are considered to be low due to the relative distances from the site and the shallow geology.

There are no underground high pressure oil or gas pipelines or petrol or fuel sites within a 250m radius of the site.

3.9.2 Historical industrial trades and authorised processes

The environmental database report highlights 83N° historic potentially contaminative uses within 250m of the site. These appear to be a mixture of industrial, unspecified foundry, railway sidings and engineering works. The report also identifies 43N° historical tanks within 250m of the site and 20N° historical electrical substations.

3.9.3 Pollution incidents

There are 2N° recorded pollution incidents within a 500m radius of the site.

The closest incident occurred on 25/05/2001 and was located 93m east of the site. The pollutant was recorded as metal wastes. The impacts on water and air were reported as 'no impact' and the impact on land classified as 'minor'.

The second incident occurred on 18/11/2001 and was located 367m south west of the site. The pollutant was identified as vehicles and vehicle parts and was reported to have 'no impact' on the water and air and significant impact on land.

Due to the types of pollution and the lack of significant impact, these have not been carried forwards as potential sources.

3.9.4 Contaminated land register

The environmental database report does not highlight any premises within 500m of the site which have been determined under Section 78R of the Environmental Protection Act 1990 as 'contaminated land'.

3.9.5 Landfill sites and waste management facilities

The environmental database report records no active landfills within a 500m radius of the site.

There are 2N° historic landfills located within a 500m radius of the site. The nearest of which is 290m west of the site with no record provided on the waste type accepted. The second site is 480m northeast of the site and dealt with inert waste and liquids/sludge.

The environmental database report shows 4N° waste treatment, transfer or disposal sites within a 500m radius of the site. However, all of these appear to be at the same location and associated with a metal scrap yard 236m west of the site.

3.10 Areas of potential concern summary

A number of potential areas of concern have been identified by the review of the environmental setting of the site as illustrated in Table 3.10.1 below.

Table 3.10.1 - Potential sources of contamination from environmental setting.

Area of potential concern (APC) N°	Details	Metals, semi-metals, non-metals, inorganic chemicals and others	Organic chemicals	Gases / vapours
1*	On site Made ground associated with the previous site development.	Possible	Possible	Possible
4	On site Historical electrical substation.	Unlikely	Possible	Unlikely
5	Off site Historic landfills.	Unlikely	Unlikely	Possible
6	Off site Miscellaneous current and historic industrial processes within 50m.	Possible	Possible	Possible

* - previously identified sources

4.0 SITE HISTORY

The history of the site has been considered through a study of available Town Plans, County Series Plans and Ordnance Survey maps from readily available environmental database sources.

Maps for the periods during and following the two World Wars: 1914-1918 and 1939-1945 are generally unavailable. Features otherwise illustrated on available maps and considered pertinent to environmental assessment of the site are summarised below. The large scale map series are provided as Appendix C.

Table 4.0.1 – Historical maps summary

Period	Map features summary
1848 – 1918	**Published maps: 1848, 1890-1892, 1905-1906, 1915-1918 (1:10,560) and 1893, 1908, (1:2,500) and 1891 (1:500)** On site • The earliest plan shows the wider site with a small pond located in the south west corner which has been filled in by the 1890s. • By 1890, the site is shown to be part of the Gorton Foundry with two buildings covering the site area and extending to the north. • By 1905 the site is still referred to as Gorton Foundry but the building layout has changed to a single building encompassing the site area and some of the surrounding land. Off site • The Manchester and Sheffield railway line runs east to west approximately 100m north of the site. • In 1848, the immediate surrounding land appears to be agricultural fields and ponds with the village of Gorton located approximately 500m to the south west. • By 1890s the surrounding land has been heavily developed which involved the infilling of a number of ponds. • Large engineering development works appear on the plans post 1890 to the north of the Manchester and Sheffield railway line between 100m – 500m from the site. • The Sheffield and Midland railway line appears by the 1890s approximately 250m south west of the site. • A canal is present 500m north east of the site orientated north to south. • A number of sidings from the railway line to the north of the site branch off and run either along the sites western boundary into the middle of the sites northern boundary.
1923 – 1956	**Published maps: 1923, 1934, 1934-1938, 1956 (1:10,560) and 1922, 1933, 1950 (1:2,500) and 1949-1950 (1:1,250)** On site • No significant alterations are noted within the site boundary. Off site • An electrical substation is shown adjacent to the sites south east corner by the 1949-1950 plan. • Tanks are recorded within 100m of the sites western boundary by the 1949-1950 plan. • Further residential and commercial development is shown across the wider area.

Table 4.0.1 – Historical maps summary	
Period	**Map features summary**
1968 - 1995	**Published maps: 1968 (1:10,560) and 1978, 1985, 1991 (1:10,000) and 1978-1980, 1987-1991, 1991-1992, 1992-1995, 1994-1995 (1:1,250)** On site • Between 1968 and 1978 the site layout changes to match its current configuration with a building located centrally across it and open spaces on both the western and eastern boundary. Off site • Between 1968 and 1978 the larger Gorton Foundry building has been replaced with smaller separate buildings and it is no longer referred to as the foundry. • Railway sidings no longer run off the railway line to the north of the site in the direction of the sites northern boundary. • The former foundry area is referred to as an industrial estate by the 1985 maps. • The electrical substation to the south east of the site is no longer shown. • A new electrical substation shown on plans from 1978 approximately 100m south east of site. • The tanks formerly located to the west of the site are no longer marked on plans.
2002 - 2014	**Published maps: 2002, 2010, 2014 (1:10,000)** On site • No significant alterations were noted within the site boundary. Off site • No significant alterations are noted outside the site boundary.

In summary, at the time of the earliest maps in the mid 1800's the site was an open field area with a pond. By the late 1800's the site had been developed into the Gorton Foundry with a variety of associated buildings, tanks and a substation covering the surrounding area until the 1970's. From the 1970's onwards the buildings on site are shown to be similar to those present at the time of the site works with a substation now present to the southeast.

Major infrastructure improvements have been made to the surrounding area since the late 1800's with a number of works associated with the railway to the north of the site. During the initial development of the surrounding land a number of ponds disappeared from the mapping, assumed infilled.

4.1 Areas of potential concern summary

The following potential sources of contamination have been identified based on a review of the available historical data.

Table 4.1.1 - Potential sources of contamination from historical mapping.				
Area of potential concern (APC) N°	**Details**	**Metals, semi-metals, non-metals, inorganic chemicals and others**	**Organic chemicals**	**Gases / vapours**
1*	On site Miscellaneous made/reworked ground associated previous development of site.	Possible	Possible	Possible
4	On site Historical electrical substation.	Unlikely	Possible	Unlikely

Area of potential concern (APC) N°	Details	Metals, semi-metals, non-metals, inorganic chemicals and others	Organic chemicals	Gases / vapours
6	Off site Miscellaneous current and historic industrial processes within 50m.	Possible	Possible	Possible
7	Off site Gas migration from possible putrescible material within the infilled ponds.	Unlikely	Unlikely	Possible

* - previously identified sources

5.0 PRELIMINARY CONCEPTUAL SITE MODEL

5.1 Background

The following section presents a conceptual model and qualitative risk assessment of the site with respect to any potential sources, pathways and receptor relationships which may exist now or in the future as a result of the proposed development.

Under the governing terms set by Part IIA of the Environmental Protection Act 1990 and recently published statutory guidance entitled 'Contaminated Land Statutory Guidance (April 2012)'; contamination occurs when a pollution source, transport pathway and receptor are connected in a contaminant linkage or a **source-pathway-receptor** relationship.

If this linkage has the potential to be active, or become active as a result of development proposals and pose significant harm to controlled waters, other parts of the environment or human health; the land may be classified as contaminated.

The elements of a contaminant linkage can be described as follows:

Source:	The location from which an environmentally hazardous/ contaminative substance is or was derived.
Pathway:	A route or mechanism via which a source could come into contact with a receptor to cause significant harm.
Receptor:	An environmentally sensitive object or condition e.g. person, property, controlled water, or ecological system, which may be present now or in future.

The guide to Qualitative Risk Assessment, as taken from *'Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008'* has been referenced in the development of the conceptual model for the site. Although the proposed development is for commercial purposes the guidance still assists in establishing an estimate of risk in relation to each plausible contaminant pathway identified.

Possible contaminant linkage elements for the site are discussed below.

5.2 Potential contaminative sources

Potential on and off-site sources of contamination have been considered in the context of existing land use and the potential legacy left by historical activities. Sources and hazards considered relevant to the site within a 250m radius are summarised in the table below.

	Table 5.2.1 – Potentially contaminating sources summary			
	Areas of potential concern (APC)	**Source origin**	**Source description**	**Source hazard contaminants**
Existing sources (On site)	2	Chemical storage	Miscellaneous chemical/waste storage associated with the current site usage.	Metals, asbestos, PAH's, fuel range hydrocarbons, PCBs, VOCs, carbon dioxide and CH_4
Historical sources (On site)	1	Previous development on site.	Miscellaneous made/reworked ground	
	4	Electrical substation	Historical substation	
Existing sources (Off site)	6	Industrial processes	Miscellaneous current and historic industrial processes within 50m.	
Historical sources (Off site)	3	Made ground	Made ground associated with the development of the surrounding land including the construction of the nearby railways.	
	5	Historic Landfills	Gas migration	
	7	Infilled ponds	Gas migration	

5.3 Potential receptors

The future land use of the site has been considered as 'commercial'.

With regard to the current and future proposed setting and form of the site, potential receptors to possible source hazards identified above are summarised below.

5.3.1 Humans

- Site operatives.
- Construction workers.

5.3.2 Controlled waters

- Groundwater – for the purpose of this assessment the underlying strata is classified as a Principal Aquifer. There are 2N° groundwater abstraction points (1N° active and neither potable) recorded within a 250m radius although the site does not lie within a SPZ. With reference to Guidance for the Safe Development of Housing on Land

Affected by Contamination R&D66: 2008', the sensitivity of groundwater as a potential receptor to contaminant impact beneath the site is considered to be Moderately High (M1).

- Surface water – there are no surface water features recorded on the OS mapping within 250m of the site. However, a culverted watercourse is believed to exist 48m to the south and as such this has been included as a potential receptor. There are no abstractions recorded within 250m. With reference to Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008', the sensitivity of groundwater as a potential receptor to contaminant impact beneath the site is considered to be Moderate (M2).

5.3.3 Other environmental receptors

- Buried concrete structures associated with the proposed development.

5.4 Exposure and pathway mechanisms

For potential sources of contamination to pose a risk to environmental and human receptors; there must be at least one active or potentially active pathway. Pathways can be considered in terms of direct exposure or in terms of migration routes and transport mechanisms.

For example, direct exposure can occur through: inhalation of toxic gases, dusts or vapours, and; ingestion or dermal uptake of contaminated dusts, soils or vegetables. Contaminants can also migrate to receptors via physical transport processes including soil leaching, surface water flow and gradients in groundwater.

5.5 Summary of source – pathway – receptor relationships

Table 5.5.1 highlights the source-pathway-receptor relationships that are considered viable across the site at this stage. This assessment forms the basis of the Tier 1 risk assessment that is detailed later in this report. Qualitative risk estimation has been included in the table below, the risk estimation is as per 'Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008' (used for reference).

Table 5.5.1 - Potential source–pathway–receptor relationships

Area of potential concern N°	Source	Pathway (s)	Receptor	Classification of consequence	Classification of probability	Classification of risk*
1	On site Miscellaneous made ground associated with the historic development of the site.	Oral ingestion	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
		Dust inhalation	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**
		Dermal contact	Future operatives, construction workers and fauna	Medium	Low likelihood	**Moderate/Low Risk**
		Downward migration	Groundwater	Medium	Unlikely	**Low Risk**
		Lateral migration	Surface water	Mild	Unlikely	**Very Low Risk**
		Gas / vapour inhalation	Future operatives and construction workers	Mild	Unlikely	**Very Low Risk**
		Direct contact	Buildings and Underground Services	Medium	Low likelihood	**Moderate/Low Risk**
2	On site Miscellaneous chemical/waste storage associated with the current site usage.	Oral ingestion	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**
		Dust inhalation	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**
		Dermal contact	Future operatives, construction workers and fauna	Medium	Low likelihood	**Moderate/Low Risk**
		Downward migration	Groundwater	Medium	Unlikely	**Low Risk**
		Lateral migration	Surface water	Mild	Unlikely	**Very Low Risk**
		Gas / vapour inhalation	Future operatives and construction workers	Mild	Unlikely	**Very Low Risk**
		Direct contact	Buildings and Underground Services	Medium	Low likelihood	**Moderate/Low Risk**
3	Off site Made ground associated with the development of the surrounding land including the construction of the nearby railways.	Lateral migration and oral ingestion	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
		Lateral migration and dermal contact	Future operatives, construction workers and fauna	Medium	Unlikely	**Low Risk**
		Lateral migration and gas/ vapour inhalation	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**
		Lateral migration and direct contact	Buildings and Underground Services	Medium	Unlikely	**Low Risk**
4	On Site Historical electrical substation	Oral ingestion	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**
		Dust inhalation	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**
		Dermal contact	Future operatives, construction workers and fauna	Medium	Low likelihood	**Moderate/Low Risk**
		Downward migration	Groundwater	Medium	Unlikely	**Low Risk**
		Lateral migration	Surface water	Mild	Unlikely	**Very Low Risk**
		Gas / vapour inhalation	Future operatives and construction workers	Mild	Unlikely	**Very Low Risk**
		Direct contact	Buildings and Underground Services	Medium	Low likelihood	**Moderate/Low Risk**
5	Off site Gas migration form historic landfills.	Lateral migration and gas/ vapour inhalation	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**
6	Off Site Miscellaneous industrial processes within 50m.	Lateral migration and oral ingestion	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
		Lateral migration and dermal contact	Future operatives, construction workers and fauna	Medium	Unlikely	**Low Risk**
		Lateral migration and gas/ vapour inhalation	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**
		Lateral migration and direct contact	Buildings and Underground Services	Medium	Unlikely	**Low Risk**
7	Off site Gas migration from the infilling of the ponds.	Lateral migration and gas/ vapour inhalation	Future operatives and construction workers	Medium	Low likelihood	**Moderate/Low Risk**

**Where multiple receptors exist the risk classification is based upon the most sensitive receptor for conservatism.*

6.0 GROUND INVESTIGATION WORKS

To test the presence of contaminant linkages and possible contaminants identified as plausible in the conceptual site model discussed in Section 5.0 and also determine physical ground properties for foundation design, the following section describes the tasks undertaken and methods employed as part of the ground investigation works.

6.1 Fieldwork

An intrusive ground investigation was undertaken across the site on the 7th and 8th October 2015 and comprised the following:

- Concrete coring in 3N° locations;
- Drilling of 3N° window sample boreholes;
- Drilling of 1N° Cable Percussive borehole;
- Construction of 1N° gas and water monitoring installation;
- Gas monitoring upon 1N° occasion.

All T&P exploratory hole locations were positioned away from identified or suspected services and each location was scanned with a cable avoidance tool (CAT) prior to breaking ground. Had any services been suspected then the exploratory hole would have been relocated.

All of the exploratory holes were logged by an experienced geo-environmental engineer and the exploratory hole records produced are included within Appendix E. An exploratory hole location plan is presented in Appendix A.

Selected disturbed samples were obtained from the exploratory holes for geotechnical and contamination analysis to allow consideration of the geochemistry of the background and any unnatural concentrations of contaminants, and also assessment of the basic engineering soil properties.

Table 6.1.1 - Rationale/targeting of T&P exploratory hole locations

Exploratory hole	Target
WS1 – WS3	General site coverage investigating the proposed development area.
CP1	General site coverage investigating the proposed development area and installing gas and groundwater monitoring well.

6.2 Window sample boreholes

T&P supervised the drilling of 3N° window sample boreholes (WS1 – WS3) with in-situ standard penetration testing (SPT) undertaken at 1.00m intervals or at driving refusal. The boreholes were all terminated at depths of between 3.5m (WS3) and 4.00m (WS1) after an SPT refusal, with the exception of WS2 that was terminated due to additional concrete being encountered at 0.4m bgl.

Selected disturbed soil samples were taken for environmental and geotechnical testing from each material type encountered as considered necessary. The boreholes were located as per the exploratory hole location drawing found in Appendix A.

6.3 Cable Percussive Borehole

T&P supervised the drilling of 1N° cable percussive borehole (CP1) to a depth of 10.5m bgl with in situ CPT testing at 1.0m intervals until 9.0m bgl and then 1.5m intervals from 9.0m to the base of the borehole. This hole was targeted to investigate the deeper natural ground on

site to help inform on pile design if deemed necessary in the future development. The borehole was located as per the exploratory hole plan location drawing found in Appendix A.

Selected disturbed soil samples were taken for geotechnical testing from each material type encountered as considered necessary.

6.4 Laboratory testing

6.4.1 Geotechnical testing

T&P undertook geotechnical testing as detailed in Table 6.4.1 below. The geotechnical analysis results are provided in Appendix F.

Table 6.4.1 - Schedule of geotechnical testing	
Test type	**Number of samples tested**
Moisture content	5 soils
Atterberg limits	5 soils
SD1 Suite	4 soils
Undrained Triaxial	1 soil

6.4.2 Chemical testing – soils

T&P scheduled chemical analysis upon a selection of samples recovered from the exploratory holes for contaminant compounds identified in the preliminary conceptual model. Additional contaminant compounds are generally added to the suite if considered necessary from observations made during the ground investigation.

Soil samples from the investigation were forwarded to The Environmental Laboratory Ltd, a UKAS and MCERTS accredited laboratory, and analysed in accordance with the suite presented in Table 6.4.2 below. The chemical analysis results are provided in Appendix G.

Table 6.4.2 - T&P Schedule of chemical testing – soils	
Test type	**Number of samples tested**
Soils	
Arsenic*, Cadmium*, Chromium*, Hexavalent Chromium, Lead*, Mercury*, Nickel*, Copper*, Zinc*, Selenium, Water Soluble Boron, pH*, Water Soluble Sulphate, Total Monohydric Phenols*, Organic Content and Speciated Polyaromatic Hydrocarbons*.	5 soils
Asbestos ID	3 soils
Fractionated TPH	2 soils
Total TPH	3 soils
PCBs	2 soils
VOCs	2 soils

** MCERTS accredited*

7.2.3 Evidence of contamination

Apart from the presence of made ground on site, no sources of potential contamination were observed and no hydrocarbon odours were noted by olfactory means during the ground investigation.

7.3 Groundwater

Groundwater seepages were noted on site within the cable percussive hole on site as illustrated by Table 7.3.1 below.

Table 7.3.1 – Summary of groundwater depth

Exploratory Hole	Groundwater Depth	Area of site	Comments
CP1	1.80m	Western site area	Water strike in the made ground likely to be perched water.
CP1	8.00m	Western site area	Water strike in the sand and gravel layer.

As indicated above the groundwater was found either within the made ground or in conjunction with granular stratum. This is a common feature of interbedded successions as groundwater is found to be confined due to the impermeability of the clays above and beneath.

Following the investigation a single monitoring visit was undertaken which found the groundwater to be at 4.89mbgl.

7.4 Soil gas and vapour monitoring

Soil gas and vapour concentrations measured within the monitoring well during the single confirmatory visit undertaken as part of the investigation by T&P are summarised below and discussed further in Section 10. Full records are provided within Appendix H.

Upon undertaking the monitoring it was found that the gas tap on the bung was absent and as such a meaningful flow rate could not be taken. To gain realistic gas conditions within the well the pump on the monitor was therefore run for 20minutes. Over low to moderate atmospheric pressure conditions of 1004mB the results can be summarised as follows:

- The steady methane concentration was recorded to be below instrument detection level (<0.1%).
- Carbon dioxide was found to be 0.2% by volume.
- Oxygen was found to be slightly depleted at 9.5% by volume.
- Soil gas flow rates were not recorded due to the missing gas tap.
- Carbon monoxide was found to be 1 parts per million (ppm).
- Hydrogen sulphide was found to be below instrument detection level (<0.1 ppm).
- VOCs were recorded at 0.4ppm.

Based on the monitoring visit undertaken no significantly elevated concentrations of any gases or vapours were found to be present.

7.5 Geotechnical laboratory test results

7.5.1 Atterberg limits

A total of five samples were submitted for geotechnical analysis to allow the determination of liquid limit and plastic limit for plasticity indices calculation, pH, soluble sulphate and moisture

7.0 SUMMARY OF GROUND CONDITIONS

7.1 Introduction

The ground conditions recorded across the site broadly demonstrated the anticipated published geology detailed in Section 3.1 which highlighted the site area to be underlain by made ground over superficial Diamicton and bedrock of Chester Pebble Beds Formation. Localised deep made ground was observed in the location of CP1 to a depth of 3.8m bgl while elsewhere on site the made ground was observed between 1.1 – 1.8m bgl.

7.2 Recorded ground conditions – general

The strata encountered across the site have been summarised in Table 7.2.1 and are described further in the following sub-sections.

Table 7.2.1 - Summary of strata encountered

Depth (m bgl)		Exploratory holes identified	Area of site	Soil type	General description/comments
From	To				
GL – 0.4	0.15 - 0.5	WS1 – WS3	General site area	Made Ground STRATUM M1	Concrete
GL	0.17	CP1	Western site area	Made Ground STRATUM M2	Tarmac
0.17 – 0.18	0.40 - 0.48	CP1 & WS2	Western site area	Made Ground STRATUM M3	Angular to subangular coarse GRAVEL engineered fill.
0.15 - 0.50	1.1 – 3.8	CP1, WS1 & WS3	General site area	Made Ground STRATUM M4	Loose to dense slightly sandy to sandy angular coarse GRAVEL comprised of brick, concrete and some tarmac.
1.10 – 1.80	2.60 – 3.45	WS1 & WS3	Eastern site area	Natural Ground STRATUM N1	Soft, locally firm, occasionally slightly sandy and slightly gravelly CLAY.
2.60 – 3.80	3.50 – 7.40	CP1, WS1 & WS3	General site area	Natural Ground Stratum N2	Stiff CLAY with occasional gravels of sandstone.
7.40	8.90	CP1	Western site area	Natural Ground Stratum N3	Dense gravelly SAND. Gravel is sub rounded to rounded medium to coarse sandstone.
8.90	10.50	CP1	Western site area	Natural Ground Stratum N4	Very stiff CLAY with rare sandstone gravels.

7.2.1 Made ground

As anticipated, made ground was present across the site area overlain by concrete in the eastern portion of the investigation area near the intended location for the large storage tanks (Stratum M1) up to a thickness of 0.50m in WS03. The underlying made ground was found to vary in depth between 1.10 and 3.80m. The deeper area of made ground within CP1 in the western area of the site is considered to be associated with the historic infilling of a pond on site and comprised of gravel of brick, concrete and occasional tarmac (Stratum M4). Tarmac (Stratum M2) up to 0.17m thick was encountered within CP1 and underlain by an engineered sub-base material (Stratum M3).

7.2.2 Natural soils

Natural ground underlying the shallower made ground in the vicinity of WS1 & WS3 was shown to be soft to firm Clay (Stratum N1) to a depth of between 2.60 – 3.45m bgl. Below this layer the clay became stiff (Stratum N2) with refusal in both WS1 and WS3. The deeper natural strata revealed in CP1 showed sand and gravel at 7.4m (Stratum N3) which is considered to represent the weathered upper surface of the Chester Pebble Beds Formation. Underlying this very stiff clay (Stratum N4) was encountered considered to represent a weathered subordinate siltstone/mudstone bed within the Chester Pebble Beds Formation.

content. Modified plasticity indices have been calculated using the formula illustrated below based upon NHBC requirements.

Modified Plasticity Index (I'p) = $\frac{\text{Plasticity Index (Ip) x \% less than 425µm}}{100\%}$

Table 7.5.1 - Modified plasticity indices

Exploratory hole N°	Soil type (lab description)	Moisture content (%)	Plastic limit (%)	Plasticity index (%)	Passing 425µm screen (%)	Modified plasticity index (%)
CP1 4.45 – 4.5m	Brown mottled grey slightly sandy slightly gravelly silty CLAY.	21	19	22	95	20.90
CP1 6.70m	Brown slightly gravelly slightly sandy silty CLAY	25	20	24	97	23.28
CP1 8.70m	Brown slightly sandy slightly gravelly silty CLAY	14	15	19	93	17.67
WS1 2.50 – 2.6m	Brown and dark grey slightly sandy slightly gravelly silty CLAY	25	19	20	82	16.40
WS3 1.90 – 2.10m	Brownish grey speckled black slightly gravelly slightly sandy silty CLAY	29	23	24	95	22.80

Based upon the NHBC guidelines (used for reference), the results above show the cohesive soils underlying the site to range from medium to high volume change potential.

The complete set of geotechnical test results is presented within Appendix F.

8.0 HUMAN HEALTH RISK ASSESSMENT

8.1 Introduction

The governing terms set by Part IIA of the Environmental Protection Act 1990 and revised published statutory guidance entitled 'Contaminated Land Statutory Guidance (April 2012)', defines contaminated land as:

'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 significant possibility of such harm being caused'.

The revised statutory guidance introduced a new four category system to assist regulators in determining whether significant possibility of significant harm (SPOSH) in relation to human health and environmental receptors is likely and therefore whether land could be classified as 'contaminated land' under Part IIA. Category 1 is where SPOSH is unacceptably high and Category 4 is where there is no risk of SPOSH.

Following this, DEFRA commissioned a research project to develop a methodology for defining screening levels for contaminant compounds to assess whether land is suitable for use and falls significantly outside the definition of contaminated land. This resulted in a methodology and Category 4 Screening Levels (C4SL's) being developed using the CLEA framework under the coordination of CL:AIRE (Contaminated Land: Applications in the Real Environments) for six common contaminants including: Arsenic, Cadmium, Chromium (VI), Lead, Benzo(a)pyrene and Benzene.

The intention of DEFRA in developing the new C4SL's was to provide screening levels that are less conservative than the pre-existing Soil Guideline Values (SGVs), which represent thresholds for minimum levels of risk, but which are still acceptably low in terms of risk to human health to maintain a precautionary approach. As such, the CLEA methodology has been adapted in relation to toxicological and exposure parameters.

For contaminants present on sites being determined under planning, Suitable for Use Levels (S4UL's) have since been developed and published by LQM/CIEH to directly replace the former Generic Assessment Criteria (GAC's). The S4UL's are fundamentally based on a 'minimal' or 'tolerable risk' approach, as per the pre-existing GACs/SGVs, although deviate both up and down from the former GAC's due to revised human health exposure assumptions. These have been considered where C4SL's are absent.

The tiered system of risk estimation required under the guidance for human health risk aims to identify significant risks that may require further investigation, be considered for remediation or indicate potential legal or financial liability. The tiered approach has been maintained within the UK risk assessment framework providing a series of steps, after each of which decisions are taken on whether or not more sophisticated assessment is required. By doing so a pragmatic approach to the assessment of human health risk is maintained.

8.2 Assessment of averaging areas/zones following ground investigation works

For the purposes of investigation and assessment a site can be divided into zones based on the historical usages or proposed end use and these zones can be further divided into averaging areas. These averaging areas can be used to assess different soil types revealed or different potential exposure pathways etc. for the purposes of accurately modelling the site conditions. Each averaging area can be considered independently of each other for human health exposure assessment.

Based upon the proposed end use of the site and the findings of the ground investigation it is proposed that a single zone split into two averaging areas is appropriate for the site:

- Area 1 - General site area – made ground
- Area 2 - General site area – natural ground

8.3 Risk assessment context

8.3.1 Tier 1 risk assessment – Preliminary Risk Assessment (PRA)

Where chemical test results have recorded contaminant concentrations beneath the laboratory detection limits, these are excluded from further assessment and it is considered that this is justified as the source is absent from the contaminant linkage relationship.

This forms the basis for the Tier 1 risk assessment and is based upon the chemical test data recovered during the works.

8.3.2 Tier 2 risk assessment – Generic Quantitative Risk Assessment (GQRA)

The Tier 2 risk assessment utilises published and authoritative generic assessment criteria to determine the likelihood of harm being caused to human health. For the UK, the CLEA framework and recently published Category Four Screening Levels (C4SL's), Suitable for Use Levels (S4UL's) and previously-published Soil Guideline Values (SGV) can be applied.

In accordance with the intended residential use for the site, the determinants have been assessed against the C4SL's / S4UL's / SGV's for a '**commercial**' end use.

Where C4SL's / S4UL's / SGV's do not exist for a specific determinant it is normally necessary to move directly to *Tier 3 – Detailed Quantitative Risk Assessment (DQRA)*, where site specific assessment criteria (SSAC) can be derived.

Where recorded chemical test results are beneath the selected C4SL's / S4UL's / SGV's no further assessment is undertaken as it is considered that a source is absent from the contaminant linkage relationship.

In accordance with current best practice the subsequent step of the Tier 2 risk assessment, where elevated concentrations of contaminants have been revealed, is to undertake statistical analysis using the guidance provided within the CL:AIRE document entitled "Guidance on Comparing Soil Contamination Data with a Critical Concentration" (2008).

Where recorded contaminant concentrations are found to be below the relevant thresholds no statistical analysis and 95th UCL calculation has been undertaken.

8.4 Presentation of Tier 1 and Tier 2 risk assessment

For each averaging area the analytical results for each determinant have been compared directly against the site assessment criteria. Table 8.4.1 below presents the results for Area 1 – made ground.

Table 8.4.1 – Summary of area 1 made ground test results

Determinant	Laboratory detection limit or recorded concentrations(mg/kg)					
	Ass't criteria	Ass't criteria source	Made ground			
			Min	Max	N° of exceedances	Calculated 95th UCL
Heavy Metals						
Arsenic	640.0	C4SL	8.4	91.2	0 of 4	n/a
Cadmium	220.0	C4SL	<0.5	0.7	0 of 4	n/a
Total chromium	8600.0	S4UL	15.9	28.2	0 of 4	n/a
Hexavalent chromium	33.0	C4SL	<0.8	<0.8	0 of 4	n/a
Lead	2700.0	C4SL	79.0	769.0	0 of 4	n/a
Mercury	1100.0	S4UL	<0.5	<0.5	0 of 4	n/a
Nickel	980.0	S4UL	15.8	83.9	0 of 4	n/a
Selenium	12000.0	S4UL	<1.0	1.1	0 of 4	n/a
Phytotoxic Metals						

Table 8.4.1 – Summary of area 1 made ground test results						
Determinant	**Laboratory detection limit or recorded concentrations(mg/kg)**					
	Ass't criteria	**Ass't criteria source**	**Made ground**			
			Min	**Max**	**N° of exceedances**	**Calculated 95th UCL**
Copper	68000.0	S4UL	103.0	8840	0 of 4	n/a
Zinc	730000.0	S4UL	70.9	1390	0 of 4	n/a
Boron	240000.0	S4UL	<0.5	1.0	0 of 4	n/a
Organics						
Organic matter content (%) *1	n/a	n/a	1.6	3.1	0 of 4	n/a
Total Monohydric Phenols *2	1500.0	S4UL	<1.0	<1.0	0 of 4	n/a
PAHs						
Naphthalene	460.0	S4UL	<0.1	0.3	0 of 4	n/a
Acenaphthylene	97000.0	S4UL	<0.1	<0.1	0 of 4	n/a
Acenaphthene	97000.0	S4UL	<0.1	0.3	0 of 4	n/a
Flourene	68000.0	S4UL	<0.1	0.2	0 of 4	n/a
Phenanthrene	22000.0	S4UL	0.2	1.9	0 of 4	n/a
Anthracene	540000.0	S4UL	<0.1	0.7	0 of 4	n/a
Fluoranthene	23000.0	S4UL	0.6	3.2	0 of 4	n/a
Pyrene	54000.0	S4UL	0.6	3.2	0 of 4	n/a
Benz(a)anthracene	170.0	S4UL	0.3	3.6	0 of 4	n/a
Chrysene	350.0	S4UL	0.5	4.5	0 of 4	n/a
Benzo(b)fluoranthene	44.0	S4UL	0.3	4.6	0 of 4	n/a
Benzo(k)fluoranthene	1200.0	S4UL	0.5	5.4	0 of 4	n/a
Benzo(a)pyrene	77.0	C4SL	0.4	7.3	0 of 4	n/a
Indeno(123-cd) pyrene	510.0	S4UL	0.3	6.7	0 of 4	n/a
Dibenz(ah)anthracene	3.6	S4UL	0.2	1.9	0 of 4	n/a
Benzo(ghi)perylene	4000.0	S4UL	<0.1	5.5	0 of 4	n/a
Total PAH	n/a	n/a	4.4	49.2	n/a	n/a
Fuel range hydrocarbons						
Benzene *5	27.0	C4SL	<0.01	<0.01	0 of 2	n/a
Toluene	110000.0	S4UL	<0.01	<0.01	0 of 2	n/a
Ethylbenzene	13000.0	S4UL	<0.01	<0.01	0 of 2	n/a
Xylenes *6	14000.0	S4UL	<0.01	<0.01	0 of 2	n/a
MTBE *5	3340.0	ATRISK	<0.01	<0.01	0 of 2	n/a
>C5-C6 Aliphatic	5900.0	S4UL	<0.01	<0.01	0 of 2	n/a
>C6-C8 Aliphatic	17000.0	S4UL	<0.01	<0.01	0 of 2	n/a
>C8-C10 Aliphatic	4800.0	S4UL	<1.0	<1.0	0 of 2	n/a
>C10-C12 Aliphatic	23000.0	S4UL	<1.0	<1.0	0 of 2	n/a
>C12-C16 Aliphatic	82000.0	S4UL	<1.0	7.0	0 of 2	n/a
>C16-C21 Aliphatic	1600000.0	S4UL	1.3	17.9	0 of 2	n/a
>C21-C35 Aliphatic		S4UL	35.0	461.0	0 of 2	n/a
>C35-C40 Aliphatic		S4UL	10.6	88.1	0 of 2	n/a
>C5-C7 Aromatic	26000.0	S4UL	<0.01	<0.01	0 of 2	n/a
>C7-C8 Aromatic	56000.0	S4UL	<0.01	<0.01	0 of 2	n/a
>C8-C10 Aromatic	3500.0	S4UL	<1.0	<1.0	0 of 2	n/a
>C10-C12 Aromatic	16000.0	S4UL	<1.0	<1.0	0 of 2	n/a
>C12-C16 Aromatic	36000.0	S4UL	<1.0	3.5	0 of 2	n/a
>C16-C21 Aromatic	28000.0	S4UL	<1.0	11.9	0 of 2	n/a
>C21-C35 Aromatic	28000.0	S4UL	18.1	321.0	0 of 2	n/a
>C35-C40 Aromatic	28000.0	S4UL	3.6	78.5	0 of 2	n/a
Total (>C5-C40) Ali/Aro	n/a	n/a	68.6	989.0	n/a	n/a
Total TPH (>C8-C40)	n/a	n/a	<5.0	1080.0	n/a	n/a
Polychlorinated Biphenyls						
PCB 7 congeners	Various	RIVM	All congeners below detection limit (<0.01mg/kg)		0 of 2	n/a
Volatile Organic Compounds						
VOC suite	Various	Various	All compounds below detection limit (<0.01mg/kg)		0 of 2	n/a
Inorganics						
Water Soluble Sulphate (mg/l) *3	n/a	n/a	0.25	1.38	n/a	n/a
pH *4	n/a	n/a	7.0	11.4	n/a	n/a
Asbestos	Presence	Various	No fibres detected		0 of 3	n/a

*1 *Soil organic matter has been recorded in order to provide information to complete quantitative human health risk assessment should it be needed and does not pose any identified human health based risks under normal circumstances.*

*2 *All individual phenol species recorded to be <1.0mg/kg.*

*3 *The toxicity of sulphate alone is not considered to pose a significant risk to human health and has therefore been excluded from the exposure assessment and has instead been used to supplement the geotechnical results.*

*4 *pH has been recorded in order to provide information to complete quantitative human health risk assessment should it be needed and does not pose any identified human health based risks under normal circumstances.*

*5 *1% SOM assumed.*

*6 *Values for m and p-xylene used as lowest.*

As indicated by Table 8.4.1 above, none of the guideline values were exceeded at any of the sample locations.

The mean Soil Organic Matter (SOM) within the made ground was found to be 2.6% hence assessment criteria developed for 2.5% have been used where available.

Table 8.4.2 below presents the results for Area 2 – natural ground.

Table 8.4.2 – Summary of area 2 natural ground test results

Determinant	Laboratory detection limit or recorded concentrations(mg/kg)					
	Ass't criteria	Ass't criteria source	Natural ground			
			Min	Max	N° of exceedances	Calculated 95th UCL
Heavy Metals						
Arsenic	640.0	C4SL	-	12.8	0 of 1	n/a
Cadmium	220.0	C4SL	-	0.5	0 of 1	n/a
Total chromium	8600.0	S4UL	-	31.8	0 of 1	n/a
Hexavalent chromium	33.0	C4SL	-	<0.8	0 of 1	n/a
Lead	2700.0	C4SL	-	103	0 of 1	n/a
Mercury	1100.0	S4UL	-	0.5	0 of 1	n/a
Nickel	980.0	S4UL	-	27.3	0 of 1	n/a
Selenium	12000.0	S4UL	-	1.1	0 of 1	n/a
Phytotoxic Metals						
Copper	68000.0	S4UL	-	200	0 of 1	n/a
Zinc	730000.0	S4UL	-	80.2	0 of 1	n/a
Boron	240000.0	S4UL	-	1.2	0 of 1	n/a
Organics						
Organic matter content (%) *1	n/a	n/a	-	3.1	0 of 1	n/a
Total Monohydric Phenols *2	1500.0	S4UL	-	<1.0	0 of 1	n/a
PAHs						
Naphthalene	460.0	S4UL	-	<0.1	0 of 1	n/a
Acenaphthylene	97000.0	S4UL	-	<0.1	0 of 1	n/a
Acenaphthene	97000.0	S4UL	-	<0.1	0 of 1	n/a
Flourene	68000.0	S4UL	-	<0.1	0 of 1	n/a
Phenanthrene	22000.0	S4UL	-	<0.1	0 of 1	n/a
Anthracene	540000.0	S4UL	-	<0.1	0 of 1	n/a
Fluoranthene	23000.0	S4UL	-	<0.1	0 of 1	n/a
Pyrene	54000.0	S4UL	-	<0.1	0 of 1	n/a
Benz(a)anthracene	170.0	S4UL	-	<0.1	0 of 1	n/a
Chrysene	350.0	S4UL	-	0.2	0 of 1	n/a
Benzo(b)fluoranthene	44.0	S4UL	-	<0.1	0 of 1	n/a
Benzo(k)fluoranthene	1200.0	S4UL	-	0.2	0 of 1	n/a
Benzo(a)pyrene	77.0	C4SL	-	<0.1	0 of 1	n/a
Indeno(123-cd) pyrene	510.0	S4UL	-	<0.1	0 of 1	n/a
Dibenz(ah)anthracene	3.6	S4UL	-	<0.1	0 of 1	n/a
Benzo(ghi)perylene	4000.0	S4UL	-	<0.1	0 of 1	n/a
Total PAH	n/a	n/a	-	<1.0	n/a	n/a
Inorganics						
Water Soluble Sulphate (mg/l) *3	n/a	n/a	-	0.16	n/a	n/a
pH *4	n/a	n/a	-	8.0	n/a	n/a

*Footnotes as per Table 8.4.1.

As indicated by Table 8.4.2 above, all concentrations were found to be below relevant thresholds.

The single Soil Organic Matter (SOM) within the natural ground was found to be 3.1% hence assessment criteria developed for 2.5% have been used where available.

8.5 Summary findings of human health risk assessment and recommendations

As indicated by the tables above, none of the guideline values were exceeded at any of the sample locations.

Based upon these results there is no evidence to indicate any potential human health related risks and further investigation on the grounds of human health and related risk mitigation measures is not considered necessary.

9.0 CONTROLLED WATERS RISK ASSESSMENT

9.1 Receptors

Controlled waters receptors include:

- Groundwater – for the purpose of this assessment the underlying strata is all considered to be classified as a Principal Aquifer. There are 2N° groundwater abstraction points (1N° active and neither potable) recorded within a 250m radius although the site does not lie within a SPZ and therefore the groundwater is considered to be of Moderately High (M1) sensitivity.

- Surface water – there are no surface water features recorded on the OS mapping within 250m of the site. However, a culverted watercourse is believed to exist 48m to the south and as such this has been included as a potential receptor. There are no abstractions recorded within 250m and therefore this surface water body is considered to be of Moderate (M2) sensitivity.

9.2 Controlled waters risk evaluation

The solid phase chemical test results revealed a number of contaminant concentrations elevated over the laboratory detection limits within the made ground. However, testing within the underlying natural soils revealed all solid phase concentrations to be significantly lower. Based upon this it is therefore considered that a vertical leaching/migration pathway is unlikely to be active.

Further to the above, and based upon the observations on site, no olfactory or visual evidence of any grossly contaminated soils were noted and the underlying natural soils where found to be cohesive to considerable depth which will limit any vertical migration. In addition the presence of widespread hard landscaping at the surface (understood to remain as part of the redevelopment) will limit infiltration of water through the made ground.

Based on the above, and in the context of the wider industrialised area, the soils across the site are not considered to represent a significant potential source of contamination to the controlled water receptors given the lack of an active pathway and as such no further testing or remedial actions are considered necessary.

10.0 GAS PROTECTION REQUIREMENTS

Through review of the desk study data a number of ponds are shown to have been historically infilled in the area around the site along with two historic landfills located between 290m and 480m away. Although relatively numerous the majority of the ponds appear to have been infilled during the late 19th and early 20th century. The ponds and the landfills have the possibility to have been infilled with putrescible material that may give rise to harmful ground gases.

Made ground was revealed across the site area to between 1.80 and 3.80m thick although no significant putrescible or degradable materials were noted within it. The underlying clay was locally noted to contain occasional organic traces.

10.1 Gas screening values

Guideline gas screening values (GSV) (Q_{hg}) for maximum methane and carbon dioxide concentrations recorded at the site can be calculated in accordance with BS8485:2007 (*Code of Practice for the characterization and remediation from ground gas in affected development - 2007)* and CIRIA 665 (*Assessing risks posed by hazardous ground gases for buildings - 2007)* using the following equation:

$$Q_{hg} = \frac{C_{hg} \times q}{100}$$

Where 'C_{hg}' is the gas concentration measured as a percentage and 'q' is the flow rate. This calculation is undertaken separately for both carbon dioxide and methane, and the maximum Q_{hg} for each, including historical site data, have been calculated as follows:

Where no gas flow is detected the gas detector limit of 0.1l/hr is employed in the calculation for conservatism; this has been used in this case where it was not possible to record flow rates.

GSV - Methane = 0.0001

GSV - Carbon Dioxide = 0.0002

Based on the monitoring readings collected to date and in accordance with the guidance documents above, the calculated GSVs suggest there to be no significant gas risk at the site.

10.2 Discussion

Based on the calculated GSVs, ground gases are not considered to represent a significant risk to the proposed development where the site could be classified as 'Characteristic Situation 1'.

Based upon the findings it is considered that the single confirmatory visit is adequate to classify the gas regime based on the low risk posed by the identified potential sources. Further to this the shallow geology has been shown to be cohesive and is therefore likely to have low permeability. In addition to the above the proposed redevelopment (two silos) is considered to be of low sensitivity given the absence of any new enclosed structures that will require human entry.

Considering the above, protective measures are unlikely to be necessary to facilitate the proposed development. However, given the requirement for additional groundwater level monitoring (as discussed within 15.0) it is recommended that gas monitoring is also undertaken at the same time to confirm the perceived low risk.

BR211 reports the site to lie in a 1km^2 Ordnance Survey grid areas where <1% of properties are above the action level. Radon protection measures are not considered necessary for any new developments.

11.0 RISK ASSESSMENT OF OTHER ENVIRONMENTAL RECEPTORS

11.1 General

The other environmental receptors identified earlier in this report are limited to buildings and structures. This chapter examines each class of receptor and assesses the risk to them based upon the results of the chemical analysis and the proposed development.

The assessment criteria used are detailed in Table 11.1.1.

Table 11.1.1 - Assessment criteria for other environmental receptors		
Analysis	**Generic assessment criteria (mg/kg)**	**Source**
Buildings		
Sulphate (2:1) as SO_4 (g/l)	0.5	BRE Special Digest 1: 2005

11.2 Materials and services risk estimation

pH values and water soluble sulphate concentrations recorded by the geotechnical testing were revealed to be predominantly neutral with values of between 7.1 and 8.1 units and 12 – 49mg/l (SO4) respectively. Corresponding values recorded by the chemical testing were between 7.5 and 8.2 units and 160.0 – 1380.0mg/l for pH values and water soluble sulphate concentrations respectively.

Table 11.2.1 below summarises the recorded Total Sulphur (TS%) values based on the four SD1 suites undertaken within the natural soils.

Table 11.2.1 – Summary of acid soluble sulphate and total sulphur		
Exploratory hole	**Sample depth (m)**	**Total Sulphur (TS) as %S**
BH01	5.70	<0.02
BH01	8.00-8.50	<0.02
WS01	2.50-2.60	0.02
WS03	1.90-2.10	0.10

With reference to the BRE Special Digest 1 (2005) a conservative estimate of the Total Potential Sulphate (TPS % SO4) can be calculated:

TPS = 3 x TS (% SO4)

Table 11.4.2 below presents the calculated Total Potential Sulphate (TPS % SO4) concentrations.

Table 11.4.2 – Summary of calculated total potential sulphate		
Exploratory hole	**Sample depth (m)**	**Total Potential Sulphate (TPS) as %SO4**
BH01	5.70	0.06
BH01	8.00-8.50	0.06
WS01	2.50-2.60	0.06
WS03	1.90-2.10	0.30

Based on the recorded total sulphur concentrations the calculated TPS values range between 0.06 and 0.30% within the soils while the pH values are between 7.1 and 8.2 units.

Consequently based on Table C2, 'Aggressive Chemical Environment for Concrete classification for brownfield locations' within the BRE Special Digest 1, the design mix for concrete for buried structures is DS2 – AC-1s.

12.0 REFINED CONCEPTUAL SITE MODEL

12.1 General

Chapter 5.0 presents the preliminary conceptual site model that utilises desk based information to present a qualitative assessment of potential source-pathway-receptor relationships across the site. Following completion of the ground investigation works and Tier 2 risk assessment for human health and other environmental receptors a refined conceptual site model has been developed as detailed below.

12.2 Sources

The preliminary conceptual site model identified the following sources of potential contaminant impact at the site:

- Made ground associated with the historic development of the site.
- Miscellaneous chemical/waste storage associated with the current site usage.
- Off site made ground associated with the development of the surrounding land including the construction of the nearby railways.
- On Site historical electrical substation.
- Gas migration form historic landfills.
- Miscellaneous current and historical industrial processes within 50m of the site.
- Gas migration from the infilling of the ponds.

The presence of made ground was recorded on site and is thought likely to be the result of the development of the site and immediate area. No potentially putrescible or degradable material was revealed within the made ground.

No hydrocarbons were recorded by the chemical testing and furthermore no olfactory or visual evidence of any associated contamination was noted.

Deep made ground encountered within CP01 is also considered to represent the infilling of a former pond within the site area although no significant organic material was observed.

12.3 Pathways, receptors and contaminant linkages

The proposed development is understood to include the construction of two large silos with associated hard landscaped areas surrounding them.

Human receptors are considered to include construction workers and occupiers of the site. When considering this end use the following exposure pathways for human health are considered viable:

- Outdoor/indoor ingestion of soil through direct contact.
- Outdoor/indoor exposure to soil through skin contact.
- Outdoor/indoor inhalation of fugitive dust.
- Outdoor/indoor inhalation of gases and vapours.

Controlled waters receptors include:

- Groundwater – for the purpose of this assessment the underlying strata is all considered to be classified as a Principal Aquifer. There are 2N° groundwater abstraction points (1N° active and neither potable) recorded within a 250m radius although the site does not lie within a SPZ and therefore the groundwater is considered to be of Moderately High (M1) sensitivity.

- Surface water – there are no surface water features recorded on the OS mapping within 250m of the site. However, a culverted watercourse is believed to exist 48m to the south and as such this has been included as a potential receptor. There are no abstractions recorded within 250m and therefore this surface water body is considered to be of Moderate (M2) sensitivity.

The proposed development is not anticipated to include any areas of soft landscaping.

Underground structures associated with the proposed development may be affected by the chemical characteristics of the soil through direct chemical attack. New potable water supplies are understood not to be part of the proposed development.

12.4 Risk evaluation

In order to demonstrate the above, a revised site specific risk evaluation updating the details presented in Section 5.0 has been carried out. The following table summarises the evaluation of risk to identified receptors based upon investigation results to date and the proposed commercial end-use.

Qualitative risk estimation has been included in the table below, the risk estimation as per 'Guidance for the Safe Development of Housing on Land Affected by Contamination R&D66: 2008', (Appendix D) and used for reference.

Table 12.4.1 - Potential source–pathway–receptor relationships

Area of potential concern N°	Source	Comments	Pathway (s)	Receptor	Classification of consequence	Classification of probability	Classification of risk*
1	On site Miscellaneous made ground associated with the historic development of the site.	Made ground was revealed across the site area up to 3.80m thick. The chemical testing did not reveal and contaminants elevated above levels of concern with respect to human health and controlled waters. No potentially degradable or putrescible material was encountered. Upgraded concrete class DS2-AC-1s will be required for buried structures.	Oral ingestion	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Dust inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Dermal contact	Future operatives, construction workers and fauna	Medium	Unlikely	**Low Risk**
			Downward migration	Groundwater	Medium	Unlikely	**Low Risk**
			Lateral migration	Surface water	Mild	Unlikely	**Very Low Risk**
			Gas / vapour inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Direct contact	Buildings and Underground Services	Medium	Unlikely	**Low Risk**
2	On site Miscellaneous chemical/waste storage associated with the current site usage.	Based on the chemical testing undertaken no widespread significantly elevated concentrations were revealed considered to be attributable to current on site usage.	Oral ingestion	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Dust inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Dermal contact	Future operatives, construction workers and fauna	Medium	Unlikely	**Low Risk**
			Downward migration	Groundwater	Medium	Unlikely	**Low Risk**
			Lateral migration	Surface water	Mild	Unlikely	**Very Low Risk**
			Gas / vapour inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Direct contact	Buildings and Underground Services	Medium	Unlikely	**Low Risk**
3	Off site Made ground associated with the development of the surrounding land including the construction of the nearby railways.	Based on the chemical testing undertaken no widespread significantly elevated concentrations were revealed considered to be attributable to off-site made ground.	Lateral migration and oral ingestion	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Lateral migration and dermal contact	Future operatives, construction workers and fauna	Medium	Unlikely	**Low Risk**
			Lateral migration and gas/ vapour inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Lateral migration and direct contact	Buildings and Underground Services	Medium	Unlikely	**Low Risk**
4	On Site Historical electrical substation	Based on the chemical testing undertaken all PCB compounds were found to be below levels of concern.	Oral ingestion	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Dust inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Dermal contact	Future operatives, construction workers and fauna	Medium	Unlikely	**Low Risk**
			Downward migration	Groundwater	Medium	Unlikely	**Low Risk**
			Lateral migration	Surface water	Mild	Unlikely	**Very Low Risk**
			Gas / vapour inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Direct contact	Buildings and Underground Services	Medium	Unlikely	**Low Risk**

Table 12.4.1 - Potential source–pathway–receptor relationships

Area of potential concern N°	Source	Comments	Pathway (s)	Receptor	Classification of consequence	Classification of probability	Classification of risk*
5	Off site Gas migration form historic landfills.	The confirmatory monitoring visit demonstrated the considered low risk posed by gas migration.	Lateral migration and gas/ vapour inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
6	Off Site Miscellaneous current and historical industrial processes within 50m.	Based on the chemical testing undertaken no widespread significantly elevated concentrations were revealed considered to be attributable to off-site activities.	Lateral migration and oral ingestion	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Lateral migration and dermal contact	Future operatives, construction workers and fauna	Medium	Unlikely	**Low Risk**
			Lateral migration and gas/ vapour inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**
			Lateral migration and direct contact	Buildings and Underground Services	Medium	Unlikely	**Low Risk**
7	Off site Gas migration from the infilling of the ponds.	The confirmatory monitoring visit demonstrated the considered low risk posed by gas migration.	Lateral migration and gas/ vapour inhalation	Future operatives and construction workers	Medium	Unlikely	**Low Risk**

**Where multiple receptors exist the risk classification is based on most sensitive receptor for conservatism.*

13.0 WASTE CLASSIFICATION

13.1 Introduction

As a result of the general construction works it is likely to be necessary to remove surplus material from the excavations for foundations, underground services and roadways. As a result an assessment of the waste categorisation has been undertaken.

Following the implementation of the Landfill Regulations 2002 which introduced the use of waste acceptance criteria testing for hazardous waste classification on the 16th July 2005 when hazardous waste is intended for disposal at a suitably licensed landfill site it is necessary for the producer (i.e. the developer or their consultant on their behalf) to identify among other general information the following:

- the European Waste Catalogue (EWC) code for the waste;
- the relevant hazardous property (HP1 to HP15)
- the landfill class where the waste may be accepted.

The EWC codes for all wastes are listed in Appendix J of the "Consolidated European Waste Catalogue" of the "Environment Agency Hazardous Waste: Interpretation of the definition and classification of hazardous waste".

13.2 Hazard codes

In addition to the EWC codes hazardous soils also have to be coded in terms of their relative hazards as detailed upon Table 13.3.1 below.

Table 13.3.1 - Hazard Property

Hazard Properties	***Description***
HP1	*Explosive*
HP2	*Oxidising*
HP3	*Flammable*
HP4	*Irritant*
HP5	*Specific Target Organ Toxicity / Aspiration Toxicity*
HP6	*Acute Toxicity*
HP7	*Carcinogenic*
HP8	*Corrosive*
HP9	*Infectious*
HP10	*Toxic for reproduction*
HP11	*Mutagenic*
HP12	*Release of an acute toxic gas cat. 1, 2, or 3*
HP13	*Sensitising*
HP14	*Ecotoxic*
HP15	*Waste capable of exhibiting a hazardous property listed above not directly displayed by the original waste*

13.3 Soil waste classification

As discussed above, prior to disposal it is necessary to classify soils within one of the following categories:

- Inert Waste
- Non-hazardous Waste
- Hazardous Waste

The Environment Agency are in the process of implementing new regulations and therefore the assessment criteria are likely to be revised in the future however at present for the initial assessment purposes inert wastes are only acceptable if:

- from a single waste stream of a single waste type and from a single source;
- they are not contaminated and do not contain other material or substances such as metals, asbestos, plastics, chemicals, etc to an extent which increases the risk associated with the waste sufficiently to justify their disposal in other classes of landfill.

Hazardous waste is defined as a substance classified as hazardous as a consequence of fulfilling the criteria laid down in parts 2 to 5 of Annex I to Regulation (EC) No 1272/2008 by Article 1 of "Commission Decision 2000/532/EC" as amended by 2014/955/EU.

Non-hazardous waste is the classification for all other material that is not shown to be inert or hazardous. However within this classification there is a sub group that is described as "inactive non hazardous waste" and if the soils are classified in this group although they attract a higher disposal rate they are not subject to the higher rate of landfill tax.

For the determination of whether the soils revealed on the site are hazardous the chemical analysis results obtained have been assessed using the Hazwaste online computer program.

A full copy of the computer printout is contained in Appendix H but Table 13.4.1 below summarises the results.

Table 13.4.1 - Summary of classification of potential soils for disposal from chemical analysis

Exploration hole ref.	Depth mbgl	Soil type	Soil classification
WS1	0.30 - 0.50	Made ground	Non Hazardous
WS1	0.70 - 0.90	Made ground	Hazardous
WS3	0.60 - 0.80	Made ground	Non Hazardous
WS3	1.80 - 1.90	Natural ground	Non Hazardous
CP1	0.50 - 0.60	Made ground	Hazardous

Based on the HazWaste programme output the natural ground is classified as non-hazardous waste and based upon the chemical data it is likely that it will be treated as inert or stable non-reactive waste therefore avoiding the higher rate of landfill tax. The made ground comprises a mixture of both hazardous (due to the presence copper and zinc and total TPH) of and non-hazardous material and upon consideration of the chemical test data any made ground that is removed from site as waste is likely to incur the higher rate of landfill tax. However, this is not guaranteed and will need to be confirmed through discussions with the receiving tip/waste soils treatment facility who may require Waste Acceptance Criteria testing (WAC).

Following the termination of the landfill tax exemption scheme by the government in November 2008 any material leaving site that is classed as non-hazardous or hazardous waste will be liable to the landfill tax levy, which is currently set at its maximum level of £82.60/tonne (2015/2016).

15.0 COMMENTS ON ENGINEERING DESIGN

15.1 General

Information presented to T&P Regeneration indicates that the proposed development comprises the construction of two 100 tonne silos with associated areas of hard standing.

15.2 Construction considerations

15.2.1 Subsurface concrete

As disclosed at Section 11.3.2 above and from test results recorded from the geotechnical and chemical testing a DS2-AC-1s design mix concrete is indicated to be required for all buried structures when assessed in accordance with requirements of BRE Special Digest 1.

15.2.2 Deep excavations

Neither the granular made ground nor soft clays found between ground level and 3.8m are likely to be able to support their own weight. As such, man entry into any excavations should be avoided but if this is ultimately necessary then the sides should be adequately shored and supported or battered back to a safe angle in accordance with the site specific developed health and safety plan.

15.2.3 Groundwater

Groundwater was encountered within the made ground in CP01 at 1.80m and rose to 1.50m after 20 minutes. This is thought to represent perched water within the made ground and may be adequately dealt with by conventional methods such as sump pumping.

A groundwater strike was also observed at 8.00m which rose to 5.50m following a 20 minute monitoring period. A subsequent groundwater monitoring visit found the groundwater level to be at 4.89m below ground level. This is thought to represent the level of the groundwater table.

Should any excavations be taken below approximately 4.50m it is likely that significant groundwater will be encountered which will not be adequately dealt with by conventional methods. Should this be the case, the advice of specialist dewatering contractors should be sought as deep well dewatering or sheet piles may be required.

15.2.4 Road construction issues

Made ground was found beneath the hardstanding in all locations. Made ground is inherently variable and at this stage a CBR value of <2% should be adopted for design. This may be increased by carrying out in situ CBR testing at formation level prior to construction of any roads in addition to removal of any soft spots or oversize material and replacement with compacted granular fill.

An excerpt from the Devon County Council highway design guide (Section 7 table 3) has been reproduced below to illustrate the likely adoptable road construction thicknesses based upon the anticipated CBR's.

Table 15.2.5 - Foundation thickness for all types of road

CBR of sub grade	Sub-base alone (3)	Sub-base plus capping layer	Geotextile required
1% or less	Not permitted	Special conditions apply.	To be agreed with the engineer.
Less than 2% but greater than 1%	Not permitted	150 + 600	Yes
2%	Not permitted	150 + 450	Yes
3%	Not permitted	150 + 350	Yes
4%	Not permitted	150 + 300	

Table 15.2.5 - Foundation thickness for all types of road			
CBR of sub grade	**Sub-base alone (3)**	**Sub-base plus capping layer**	**Geotextile required**
5%	240 (350)	150 + 250	
6%	220 (290)		
7%	200 (250)		
8%	190 (225)		
10%	170 (225)		
15%	150 (225)		

Notes: * Where block paving is integral to any SuDS system this will be subject to a design provided by the block manufacturer and approved by the engineer

(1) A 50mm of DBM is required when the sub-base is to carry construction traffic in which case the depth of the sub-base may be reduced by 50mm.

(2) Thickness of sand is given in paragraph 11.8.5 of design guide.

(3) (220) – for figures in brackets, see para 7.1.2.

15.3 Preliminary foundation recommendations

The ground conditions on site broadly confirmed the expected geology with either made ground or soft, locally firm, silty clay encountered to depths of between 2.60m and 3.80m below ground level. These deposits are thought to represent a former pond which has since been infilled.

These deposits are underlain by stiff gravelly clay thought to represent the Quaternary Diamicton underlain by dense sands and very stiff clays thought to represent the Chester Pebble Beds.

The made ground and soft clay are not considered suitable as a founding stratum, and it is expected that all foundations will be taken to approximately 4.0m below ground level.

We understand that the two proposed silos are circular and will weigh up to 100 Tonnes each. Should circular pads be utilised the applied bearing pressures will be as follows:

Table 15.3.1 - Foundation bearing pressures		
Foundation Diameter (m)	**Foundation Area (m^2)**	**Bearing Pressure (kNm^2)**
4.00	12.60	79.57
5.00	19.62	50.92
6.00	28.28	35.36

Triaxial testing was not possible on the sample obtained at 4.0m due to water intrusion within the sample as such, an undrained cohesion (C_u) of $100kNm^2$ has been assumed for the purpose of this assessment based on engineer's descriptions and results of in-situ SPTs.

Taking into account the above, foundations placed within the stiff clay below 4.0m may be designed for a safe allowable bearing pressure of 250kPa and as such are not likely to be restricted by bearing capacity.

Settlement estimates based on the applied pressures and foundation diameters described above are as follows:

Table 15.3.2 - Foundation applied pressures		
Foundation Diameter (m)	**Bearing Pressure (kNm^2)**	**Estimated Settlement (mm)**
4.00	79.57	23.5
5.00	50.92	18.0
6.00	35.36	15.5

Upon reaching the proposed depth of excavation, concrete blinding must be used to maintain the properties of the base of the excavation.

Note that a rest groundwater level of 4.80m was recorded during the sole groundwater monitoring visit undertaken. This is thought to be associated with the groundwater strike recorded within the underlying dense gravelly sand. At this stage it is considered unlikely that this will impact upon the proposed foundation excavation due to the thickness of the overlying clay and the limited hydrostatic uplift. However, a further period of groundwater monitoring should be carried on to support this assumption which can be undertaken in conjunction with the additional gas monitoring.

Should significant groundwater ingress be encountered within the base of the excavation it is unlikely to be dealt with by conventional dewatering methods and, as such, a pad foundation as described above is unlikely to be feasible.

Should the above foundations not prove feasible, end bearing piles placed within the dense gravelly sand at 8.0m may be designed for an allowable bearing capacity of 225kNm^2.

Note that the above foundation recommendations do not take into account the effects of wind loading on the proposed silos.

16.0 CONCLUSIONS AND RECOMMENDATIONS

From this investigation the following conclusions and recommendations can be drawn:

16.1 General

- The site occupies an area known as Loxton Food Co. approximately 1.25 hectares in plan area, located around National Grid Reference: 388304, 396796 to the east of the city of Manchester. The postcode for the site is M18 8BW.

- Information presented to T&P indicates that the proposed commercial development includes the construction of 2N° large silos of approximately 100 tonnes each. The site is to remain hard landscaped with no areas of planting or buried potable water supply pipework.

- The majority of the wider site area was covered by the manufacturing facility and associated administration offices which were located centrally with a series of loading bays along the northern edge. Hard surfaced car parking areas were located on the eastern and western edges of the main factory building. The study area covered by this report was located in the western part of the site between the main factory building and hard landscaped parking. The study area was found to be covered by concrete and tarmac and predominantly used for the storage of waste material requiring recycling; a number of active air conditioning units were also present. Immediately adjacent to the study area additional waste skips were noted to be present with the wider site extending beyond. A railway line was present running east to west some 100m from the sites northern boundary, while another line runs southeast to northwest approximately 280m to the southwest. The wider surrounding land use was observed to be a mixture of commercial units and residential properties.

- At the time of the earliest maps in the mid 1800's the site was an open field area with a pond. By the late 1800's the site had been developed into the Gorton Foundry with a variety of associated buildings covering the surrounding area until the 1970's. From the 1970's onwards the buildings on site are shown to be similar to those present at the time of the site works. Major infrastructure improvements have been made to the surrounding area since the late 1800's with a number of works associated with the railway to the north of the site. During the initial development of the surrounding land a number of ponds disappeared from the mapping, assumed infilled.

- The site is indicated to be located within an area affected by coal mining although based on publically available information the thickness of the Triassic Period cover over any coal bearing strata is shown to be in excess of 50m. Based upon this thickness of cover any historic underground coal workings are likely to be outside of the zone of influence for the site. The site is also noted to be within a JPB mining area; the same rationale as stated above is considered to apply with respect to coal workings although further liaison should be undertaken with JPB to confirm that their records relate to coal and the risk is sufficiently low. In addition, it may also be prudent to obtain a Coal Authority report for the site.

- Based on the available third party information the risk of unexploded ordnance across the site is considered to be moderate.

16.2 Ground conditions

- Made ground was present across the site area overlain by concrete in the eastern portion of the investigation area near the intended location for the large storage silos up to a thickness of 0.5m. The underlying made ground was found to vary in depth between 1.10 and 3.80m. The deeper area of made ground in the western area of the

site is considered to be associated with the historic infilling of a pond and comprised gravel of brick, concrete and occasional tarmac. Tarmac up to 0.17m thick was encountered within CP1 and underlain by an engineered sub-base material.

- Natural ground underlying the made ground was found to comprise soft to firm Clay to a depth of between 2.60 and 3.45mbgl. Below this layer the clay became stiff with refusal in both WS1 and WS3. The deeper natural strata revealed in CP1 showed sand and gravel at 7.4m which is considered to represent the weathered upper surface of the Chester Pebble Beds Formation. Underlying this very stiff clay was encountered considered to represent a weathered subordinate siltstone/mudstone bed within the Chester Pebble Beds.

- Groundwater seepages were noted within CP1 at 1.80mbgl and 8.00mbgl and are considered to be reflective of perched water within the made ground and water held within a band of granular natural soils at depth. Post fieldwork groundwater was found to be at 4.89mbgl within CP1.

16.3 Environmental assessment

- The chemical testing did not reveal any concentrations of potential contaminants significantly elevated above levels of concern with respect to human health. As such the soils on site are not considered to pose an unacceptable potential risk to the end users in the context of the commercial development.

- Based upon the ground conditions encountered during the investigation and the soil chemical analysis results the soils are considered unlikely to pose a significant risk to controlled water receptors.

- Based on the monitoring undertaken ground gases are not considered to represent a significant risk to the proposed development where the site could be classified as 'Characteristic Situation 1'. Further confirmatory gas monitoring in conjunction with the ground water level monitoring is however recommended.

- BRE guidance document BR211 reports that the site is not within a radon affected area and as such radon protection measures are not considered necessary for new dwellings.

- The natural ground is classified as non-hazardous waste and based upon the chemical data it is likely that it will be treated as inert or stable non-reactive waste therefore avoiding the higher rate of landfill tax. The made ground comprises a mixture of both hazardous and non-hazardous material and upon consideration of the chemical test data any made ground that is removed from site as waste is likely to incur the higher rate of landfill tax

16.4 Geotechnical assessment

- Based on the sulphate test results a DS2-AC-1s class of concrete will be suitable for use in buried structures.

- The made ground and soft clay are not considered suitable as a founding stratum and, it is expected that all foundations will be taken to approximately 4.0m below ground level. Foundations placed within the stiff clay below 4.0m may be designed for a safe allowable bearing pressure of 250kPa and as such are not likely to be restricted by bearing capacity.

- Made ground was found beneath the hardstanding in all locations and due to its inherent variability at this stage a CBR value of <2% should be adopted for design.

- If excavations on-site are extended below approximately 4.50m it is likely that significant groundwater will be encountered which will not be adequately dealt with by conventional methods. Should this be the case, the advice of specialist dewatering contractors should be sought as deep well dewatering or sheet piles may be required.

16.5 Uncertainties

As with all investigations, areas of uncertainty remain. These associated with the site are discussed below;

- The made ground is likely to be variable within the study area.

- The site is listed to be within a coal mining and JPB mining area.

- The risk of unexploded ordnance is reported to be moderate.

- Foundation recommendations do not take into account the effects of wind loading on the proposed silos.

16.6 Further work, risk management and remediation

16.6.1 Human health

Whilst the assessment of the chemical analysis results for the soil samples obtained during the ground investigation indicates that soil risk mitigation measures are not necessary, it is recommended that vigilance is employed by the contractor during the ground works phase of the project and should significant made ground be encountered advice from a specialist geo-environmental consultancy should be sought.

Further to the above an additional two gas monitoring visits are recommended in conjunction with groundwater level measurements to confirm the low risk.

16.6.2 Geotechnical

The groundwater level recorded during the investigation and subsequent groundwater monitoring may not be representative of the groundwater levels encountered during the excavation of foundations. As such further groundwater monitoring should be carried out prior to finalising the foundation design and calculation of the hydrostatic pressure beneath the clay layer should be carried out.

If unexpected ground conditions are encountered within excavations not recorded by this investigation advice should be sought from specialist geotechnical consultancy.

16.6.3 Other

It is recommended that further liaison be undertaken with JPB with regards to the site being within a potential mining area and confirm the perceived low risk. In addition, it may be prudent to obtain a Coal Authority report for the site.

It is recommended that further vigilance is employed by the contractor during the ground works phase of the project in order to manage these potential risks and if any suspect objects are revealed works should immediately cease and advice from a specialist UXO company should be sought.

The relevant regulatory authorities should be forwarded a copy of the ground investigation report to confirm that they are in agreement with the conclusions and recommendations herein.