GEO Environmental Engineering



PHASE 1: DESK TOP STUDY REPORT

(PRELIMINARY ENVIRONMENTAL RISK ASSESSMENT)

FORMER LONSDALE PARK

BLACK PATH

WORKINGTON

CUMBRIA

CA14 3YJ

FOR:

ALLERDALE BOROUGH COUNCIL

GEO Environmental Engineering

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1.0 Introduction

1.1 Instruction

Geo Environmental Engineering Ltd (GEO) has completed a Phase 1: Desk Top Study Report (Preliminary Environmental Risk Assessment – PERA) for land and buildings at and surrounding Lonsdale park, Black Path, Workington AFC and Allerdale Borough Council, Workington, Cumbria to determine any potential geohazards that may affect the redevelopment of the site. Geo Environmental Engineering Ltd has been commissioned to complete the report by the Client, Allerdale Borough Council.

The Phase 1: Desk Top Study Report (DTS) is suitable for submission to the Local Authority as part of any potential planning application. Further development details are available from the Client.

1.2 Aims and Objectives

The aims and objectives of this Phase 1: Desk Top Study (DTS) Report are to assess the geological and environmental sensitivity of the development area and the surrounding environs, with particular attention made to any potentially contaminative industries or processes that may have taken place on site or on immediately adjacent sites, which may be considered as potentially posing a risk of ground/groundwater contamination and ground gas that could negatively affect the proposed end users, adjacent sites and controlled waters. This Phase 1: Desk Top Study Report has generally been completed in accordance with the following documents and includes a site visit (July 2018):

- CLR11: Model Procedures for the Management of Land Contamination. DEFRA/EA, 2004.
- BS10175:2011: Code of Practice for the Investigation of Potentially Contaminated Sites.
- BS5930:2015: Code of Practice for Site Investigations.

During the completion of this DTS, information has been obtained and reviewed from the following sources:

- British Geological Survey (BGS).
- Environment Agency (EA).
- Ground Sure Report (Geoinsight and Environsight – GSR – Appendix II and III – Incorporating Mapinsight Historical Ordnance Survey (OS) Plans)
- The Coal Authority On-Line Database (CA).
- CA Consultants Report – Appendix IV.

1.3 Limitations of Use

The information, assessments, conclusions and recommendations presented within this Phase 1: Desk Top Study (DTS) Report are solely based on, and are limited to, the boundaries of the sites, the immediate area around the site, and the historical use(s) as described, with the approximate extent of the sites marked on the Site Location Plan in Appendix I.

This DTS has been completed utilising information relating to the physical, environmental and industrial setting of the development area, highlighting, where possible, any potential geohazards that might be encountered when considering the future redevelopment of this land.

Any comments, opinions, diagrams, cross sections and/or sketches contained within the DTS, and/or any configuration of the findings is purely conjectural and given for guidance only as no intrusive investigation works have been completed by Geo Environmental Engineering Ltd and it is recommended that confirmation of the anticipated ground conditions and feasibility of construction be considered by the developer before commencing acquisition or redevelopment.

Agreement for the use or copying of this report by any Third Party must be obtained in writing from Geo Environmental Engineering Ltd. The use and reliance on the report is strictly in accordance with the Geo Environmental Engineering Ltd standard terms and conditions, copies of which are available on request.

The conclusions and recommendations presented within this report are considered reasonable based on the available information. However, these cannot be guaranteed to gain regulatory approval. Therefore, the report should be passed to the appropriate regulatory authorities and/ or other key stakeholders in order to seek their approval of the findings prior to undertaking any works on site. Geo Environmental Engineering Ltd cannot accept responsibility for the accuracy of third party information.

2.0 Site Location and Development Proposals

2.1 Site Location

The site area comprises an irregular shaped piece of land to the north of Workington town centre. The site comprises the former Londale Park (Racing Stadium), Workington AFC, part of the A597, and land to the south of Black Path, including part of the existing car park for Allerdale House. The site is centred on National Grid Reference (NGR) 300217, 529191 and is 11.02Ha in size.

The surrounding land comprises a mixture of sports facilities, supermarket, office and residential properties and public open-space. The northern site boundary comprises the River Derwent.



Figure 2.1 – Site Location (Aerial Photograph Extract provided by Client)

2.2 Existing Site Levels

The southern site area comprises an existing car park and some public open space (grass landscaping) that is relatively level.

The central, northern and eastern site area was undulating in topography with some level areas and some mounds of materials. Evidence of variable made ground (ash, clinker, and possible slag) was noted in exposures in the mounds. In other areas, demolition type materials were noted mixed with soil. The site surfacing was a mixture of variable, unmanaged vegetation and some hardstand of concrete. It is understood that the central site area was recently an access road for the temporary bridge in place following the 2009 floods.

The western site area is made up Workington AFC and the A597. Whilst the sports pitch is level, the surrounding area undulate slightly.

Prior to development it is recommended to confirm site features and levels by-way of a Topographical Survey.

2.3 Existing Site Surfacing and Buildings

The southern site area has some tarmac and concrete associated with roads and car parks. Some grass landscaping is present within the public open space.

The central site area is generally unmanaged vegetation with some dense woodland.

The western site area comprises sports pitches, a stadium (with brick-built terraces), roads, entry to a bridge and public open space (grass landscaping).

2.4 Existing Infrastructure and Utilities

A review of statutory utility supplier records lies outside the scope of this report. However, as the site is located within an urbanised area it is considered likely that there will be mains utility connections on site and nearby. Consequently, there should be a review of the statutory utility plans should include correspondence with the utility providers to determine the presence of buried utilities prior to commencing any redevelopment/construction works.

This will determine if any significant or mains utilities are present on site that may require easement strips, alterations to proposed layouts or potentially costly diversions/terminations. Determining the presence of on-site utilities will also protect the workforce by reducing the risk of utility strikes during the construction phase.

2.5 Development Proposal

At this stage, no proposed development plans have been made available to GEO. However, further details associated with the full (proposed) scope of redevelopment can be obtained from the Client.

3.0 Geo-Environmental Setting

Section 3.1 refers to the Ground Sure Report (GSR - Geoinsight) contained in Appendix II, with Sections 3.2 to 3.4 referring to the Ground Sure Report (GSR - Enviroinsight) contained in Appendix II.

3.1 Development Area Geology

A geological review of the site has been undertaken using information provided on published Geological Plans in conjunction with the Ground Sure Report (GSR) contained in Appendix II.

3.1.1 Made Ground

A review of published geological plans and the GSR does not indicate the presence of made ground materials directly on site. However, based on the current site uses, the presence of infrastructure and buildings, including the historical uses, reclamation and development of the site as well as the undulating nature of the topography, made ground is likely to be present across the whole of the site. The made ground materials anticipated on site are therefore likely to comprise disturbed natural materials (clay, silt, sand and gravel) with varying quantities of anthropogenic debris (fragments of ash, brick, clinker, concrete, slag and tarmac).

In addition, the GSR does not indicate any historical ground workings within c.250m of the site.

A series of historical BGS borehole records are located on site which has recorded topsoil and made ground of fill, clinker, glass, etc to depths of 0.15m and 1.07m. Deeper made ground may be present on site if as anticipated, a former Quay / Channel may have been infilled in the north of the site. More recently, the central site area was used as a road for a temporary bridge following the 2009 floods.

3.1.2 Drift Geological Deposits

A review of the GSR indicates that the Drift geological deposits noted across the site comprise Alluvium which typically comprise soft to firm silty clay as well as layers of silt, sand, gravel and peat. Some Raised Marine deposits (clay and silt) are present in the western site area.

The BGS borehole records previously mentioned have indicated varying deposits of;

- Gravel and boulders to a depth of 7.40m.
- Initially soft sandy silty clay to 1.60m before encountering “compact” sandy gravel and boulders to 6.71m.
- Sandy gravel to a depth of 4.42m before encountering Boulder Clay present to a depth of 9.29m.

The GSR (Geoinsight Section 6.0) within Appendix II identifies the following geohazards and indicates a preliminary level of risk:

- Shrink-swell clays – very low to low risk.
- Landslides – very low to moderate risk.
- Compressible deposits – moderate risk.
- Collapsible deposits – negligible to very low risk.
- Running sands – negligible to low risk.

Intrusive investigation works are recommended for the site to confirm ground and groundwater conditions for the design of future buildings and infrastructure.

3.1.3 Solid Geological Deposits

The Solid geological deposits below the development site are recorded as the Pennine Middle Coal Measures Formation, typically comprising grey mudstone, sandstone and siltstone with productive coal seams. No coal seams are noted by the BGS / GSR as sub-cropping directly on site, although some are noted in the surrounding area.

Once again, the borehole records have been utilised to identify the underlying deposits which typically comprised Sandstone with bands to Mudstone and Clay with these deposits proven to depths of between 9.60m to 14.33m below ground levels.

With respect to ground dissolution of soluble rocks the GSR (Section 6.3) notes:

> ***"Soluble rocks are present, but unlikely to cause problems except under exceptional conditions. No special actions required to avoid problems due to soluble rocks. No special ground investigation required, and increased construction costs or increased financial risks are unlikely due to potential problems with soluble rocks"***.

The GSR therefore applies a negligible hazard rating with respect to soluble rocks.

3.1.4 Geological Features

Geological structural fault lines are noted to the east and west of the site as detailed below;

- The Great Upcast East Fault is recorded on the eastern site boundary
- The Workington Fault is recorded on the western site boundary

Although the presence of these faults is not considered to represent a significant risk with respect to any proposed structures, the fault lines do have the potential to act as a conduit for the migration (horizontally and vertically) of potentially harmful ground gases including mine gas emissions (if present).

3.1.5 Mining and Quarrying Assessment

The Solid geological deposits below the development site are recorded as the Pennine Middle Coal Measures, which typically comprises mudstone, sandstone and siltstone with numerous productive coal seams. Reference to the published geological plans and the GSR suggest there are no coal seams sub cropping on site or within close proximity to the site.

Site specific reference has been made to the Coal Authority (CA) by way of a CA Consultants Mining Report which referenced the following, with a copy included in Appendix IV.

- There is past mining recorded at a depth of c.153m in the Upper Ten Quarters Seam.
- The CA indicates that there are probable unrecorded coal workings at shallow depth.
- There are no outcrops recorded.
- No spine roadways are recorded at shallow depth.
- No geological faults, fissures or breaklines are recorded under or close to the site.
- There are no mine entries recorded.
- There are no worked out opencast sites recorded.
- The CA has not received a damage notice or claim for the subject property or any property within 50m since 31st October 1994.
- There is no current Stop Notice delaying the start of remedial works or repairs to the property.
- The CA is not aware of any request having been made to carry out preventative works before coal is worked under section 33 of the Coal Mining Subsidence Act 1991.

In addition to the above information, reference has been made to the CA Online Database which notes the following:

- The site is recorded as being in a CA defined "High Risk Development Area".
- The site is encompassed within a larger surrounding area that is considered to be at risk from probable shallow coal workings (i.e. unrecorded).
- The CA records a large area incorporating the site to be at risk of areas of shallow coal mine workings (i.e. less than c.30m depth).
- No coal mine entries are recorded by the CA as being on site or immediately adjacent to the site.
- There are no shallow sub-cropping coal seams recorded below the site by the CA.
- Areas of former opencast (surface) coal mining are not recorded by the CA within close proximity to the site boundaries.

As a result of the above information, in-conjunction with the geological review using the desk-based information available from the CA, BGS and GSR the development site may be considered to be at potential risk of coal mining related geohazards due to possible unrecorded coal workings. As the CA have noted within the Consultant's Report that "Probable Unrecorded Shallow Workings" are present below the site it is therefore recommended that intrusive works (i.e. rotary boreholes) be drilled across the site to determine if any evidence of workings is present. If shallow workings are identified, then remedial measures may be required prior to development (i.e. grouting).

A review of historical plans does not record any historical quarry features on site. However, a former sand pit was noted off-site (i.e. south) in addition to unspecified ground workings to the northeast and northwest. These features may pose a risk of ground gas depending upon the nature of infill materials.

In addition, a review of the GSR indicates that the following activities do not affect the site:

- Natural Cavities
- Brine Extraction
- Gypsum Extraction
- Clay Mining
- Tin Mining

Within the GSR, it is noted that Iron Ore is present on site, although these workings are considered to be localised small scale underground workings and the potential for difficult ground conditions are unlikely or localised and are at a level where they need not be considered.

GEO Ltd is not responsible for the accuracy or completeness of third party information.

3.1.6 Radon Gas Assessment

In accordance with the GSR Geoinsight the development site is not located within a Radon Affected Area as defined by the Health Protection Agency (HPA), as less than 1% of properties are above the action level. Consequently, in accordance with BR211 no radon protection measures are necessary.

3.2 Development Area Hydrogeology (Groundwater)

3.2.1 Made Ground/Soils

The made ground materials on site on site are likely to be classified as high permeability due to the urbanised setting (worst case scenario until actual site data is available).

3.2.2 Drift Geology

The Drift geological deposits soils are likely to be variable permeability with the Alluvium Deposits across the site noted to be a Secondary A (Minor) Aquifer.

3.2.3 Solid Geology

The Solid geological deposits are noted as Secondary (A) formerly Minor Aquifer Status (Variably permeable). These can be permeable layers capable of supporting water supplies at a local rather than strategic scale, in some cases forming and important source of base flow to rivers.

3.3 Development Area Hydrology

3.3.1 Groundwater

Groundwater is potentially present at depth within the Drift geological deposits with the potential for pockets and lenses of trapped surface drainage within the upper made ground deposits. There is a potential for groundwater to be in hydraulic continuity with the on-site (tidal) stream and nearby River Derwent. A review of the information in the GSR indicates the following:

- No groundwater abstractions are recorded within c.1km of the site.
- Numerous surface water abstractions are recorded within c.500m of the development area, although the majority appear to be historical and no longer in use.
- No potable water abstraction licences are held within c.1km of the site.
- The site is not recorded as being within a Source Protection Zone.

3.3.2 Surface Water Features

The nearest surface water feature is identified as being “on site”, which is a beck passing through the southern site area. No EA GQA classified rivers, canals, ponds or lakes (Biological or Chemical Monitoring Points) are recorded within c.250m of the development area.

3.3.3 Current Surface Water Run-off

It is considered that large parts of the central and eastern site will exhibit surface water infiltration into the made ground through the soft landscaping as limited hardstand is present. Within the southern and western site area, where hardstand and buildings are present, any surface water may be managed by the on-site drainage network, where present and undamaged. Any surface water run-off particularly during high intensity rainfall events is likely to be with the topography due to the undulating nature of the site.

3.4 Development Area Environmental Sensitivity

3.4.1 Site Ecology

- No Sites of Special Scientific Interest (SSSI) are noted within c.250m.
- No Local Nature Reserves (LNR) is present within c.250m.
- No Special Areas of Conservation (SAC) are noted within c.250m.
- No Special Protection Areas (SPA) is present within c.250m.
- No World Heritage Sites are recorded within c.250m.
- No Areas of Outstanding Natural Beauty (AONB) are recorded within c.250m.
- No National Parks are recorded within c.250m.
- The site is not located within Nitrate Vulnerable Zones (NVZ).

The Design Team should refer to Section 8.0 of the GSR (Enviroinsight – Appendix II) for further information on the above mentioned records.

3.4.2 Authorisations, Incidents and Registers

- No records of IPC Authorisations are held within c.250m.
- No records of IPPC Authorisations are held within c.250m.
- No records of Water Industry Referrals (potentially harmful discharges to the public sewer) are held within c.250m.
- No records of Red List Discharge Consents (potentially harmful discharges to controlled waters) are held within c.250m.
- No records of List 1 Dangerous Substances Inventory sites are held within c.250m.
- No records of List 2 Dangerous Substances Inventory sites are held within c.250m.
- No records of Part A(2) and Part B activities and enforcements are held within c.250m.
- No records of Category 3 or 4 Radioactive Substances Authorisations are held within c.250m.
- Ten Licensed Discharge Consents are held within c.250m. They are not attributable to the site are not considered as posing a significant risk at this current time.
- No records of Planning Hazardous Substance Consents or Enforcements are held within c.250m.
- One record of COMAH or NIHHS sites are held within c.250m. This is noted c.217m NW and is not considered to be of significant concern.
- Two Environment Agency Recorded Pollution Incidents (List 1 and List 2) are recorded within c.250m. They are recorded as Category 4 (No Impact) and are not considered a significant risk.

The Design Team should refer to Section 2.0 of the GSR (Enviroinsight – Appendix II).

3.4.3 Determination of Contaminated Land (Part IIA)

A review of the GSR Enviroinsight has indicated that the site is not currently recorded as being determined as Contaminated Land under Part IIA EPA 1990. In addition, no sites are determined as Contaminated Land under Part IIA EPA 1990 within c.500m of the development area.

3.4.4 Historical Industrial Land Uses

A review of Section 1.0 in the GSR (EnviroInsight) identifies the following:

- Potentially Contaminative Uses Identified within c.250m – Numerous entries are recorded within c.250m. In summary, entries that could pose a potential for contamination include railway sidings, unspecified ground workings, cuttings, pumping station, brewery, sand pit, laundry and gasometer.
- Historical Tank Database – Entries recorded within c.250m. They relate to a tanks / troughs, gasometer and other unspecified tanks.
- Historical Energy Features – Entries recorded within c.250m. All relate to electricity substations between c.151m west and c.244m of the site.
- Historical Petrol and Fuel Site Database – None noted within c.250m.
- Historical Garage and Motor Vehicle Repair Database – None noted within c.250m.
- Potentially Infilled Land within c.250m – Numerous entries are recorded within c.250m. Entries within an influencing distance of the site include cuttings, pond, sand pit, water body and unspecified ground workings. Although not mentioned is the disused / infilled quay and channel.

It is recommended that reference be made to Section 1.0 of the GSR for further information (Enviroinsight – Appendix II).

3.4.5 Current Industrial Land Uses

Due to the commercial/industrial urbanised nature of the site setting there are numerous industrial sites active within c.250m. However, none are considered to pose a greater risk than the historical on-site activities.

3.4.6 Fuel Station Entries

No fuel filling sites are recorded within c.250m.

3.4.7 Landfill and Waste Regulation/Management – Landfill Sites

- No Environment Agency Registered Landfill Sites are recorded within c.250m.
- No Environment Agency Historic Landfill Sites are recorded within c.250m.
- The BGS/DoE Landfill Site Survey does not note any Landfill Sites within c.250m.
- No GroundSure Local Authority Landfill sites are recorded within c.250m.
- No Operational or Non-Operational Waste Treatment, Transfer or Disposal Sites are recorded within c.250m.
- No Environment Agency Licensed Waste Sites are recorded within c.250m.

It is recommended that reference be made to Section 3.0 of the GSR Enviroinsight (Appendix II) for further information.

3.5 Development Area Historical Plan Appraisal

Section 3.5 is based on historical plans (Ordnance Survey extracts) obtained as part of the parcel of information within the GSR and provides a summary of the site history, highlighting any industries, processes or activities that may be considered as Geohazards. Copies of old survey plans (1:10,560, 1:10,000 Scale) covering the site and adjacent areas are included in Appendix III.

1864: The site and immediate surrounding area are undeveloped. Workington is to the south, with the River Derwent forming the northern site boundary. A beck is present within the southern site area, with a mill race to the south.

1866: Terraced structures (possibly residential) are noted in the southern site area (Griffin Street).

1898: A football ground is recorded in the central site area.

1925: As previous.

1957: Lonsdale Park is present in the north with stadium seating and other related structures. Borough park (football) is present in the western area, with terraces and other non-specific structures. Potential earthworks, infilling and a stream are in the south-east site area. The Green (public open space) is present in the southern site area. The majority of the structures (terraced houses) on Griffin Street have been removed. New Bridge Road is present along the western site boundary.

1967: Part of The Green in the southern site area is now recorded as a car park.

1973: Road infrastructure has taken place to the west of the site.

1990: The southern site area includes the car park at Allerdale House (as existing) with a recreation ground to the east. Allerdale House and the supermarket are present to the west.

Lonsdale Park has since been demolished and the current site is established. Following the floods in 2009 a temporary road was constructed through the site to the temporary bridge over the River Derwent. This followed the woodland to the immediate west of the former stadium.

Consequently, it can be seen that numerous potentially contaminative industries and processes are recorded as taking place on site as well as the immediate surrounding area that may be considered as posing a potential risk of ground contamination and ground gas generation.

4.0 Conceptual Site Model

A Conceptual Site Model (CSM) has been designed using the information presented within this P1 DTS to provide a graphical representation of the anticipated ground, groundwater and ground gas conditions below the development area (Existing Site CSM). The CSM is presented within Sections 4.1 to 4.3 and aids the completion of the Preliminary Qualitative Risk Assessment (PQRA – Section 4.0).

The CSM utilises the established ***Source – Pathway – Receptor*** pollutant linkage model and is designed to provide an improved understanding of the site characteristics, designing a Preliminary Screening Strategy (PSS) for the Potential Contaminants of Concern (PCOC's). This ensures adequate and appropriate Phase 2: Ground Investigation (P2 GI) Works are designed and undertaken for wide spread and targeted investigations, should they be deemed necessary.

During the P2 GI the CSM can be refined depending upon the outcomes of the intrusive works to ensure that appropriate remediation (if required) is completed to ensure the development area is "fit for purpose" in relation to the proposed end use. The CSM is presented in Sections 4.1 to 4.3 below and continued on the following page.

4.1 Anticipated Sources (Preliminary Screening Strategy – PSS)

Sources:
S1 = Generic Made Ground – During the site walkover evidence of variable made ground was noted, with historical plans and aerial imagery suggesting historical site development. Made ground that includes anthropogenic debris (i.e. ash, clinker etc.) and/or visual/olfactory (malodorous) evidence of potential contamination poses a potential risk requiring an appropriate Human Health Risk Assessment. Potential Contaminants of Concern (PCOC's) could comprise: Arsenic, Cadmium, Chromium (III and VI), Copper, Lead, Mercury, Nickel, Selenium, Zinc, Cyanide (free), pH, Water Soluble Sulphate, Total Organic Carbon and Speciated PAH. Screening should be undertaken for Speciated TPH/Phenol/BTEX/MTBE if potential fuel/oil type contaminants are identified (i.e. free product – visual/olfactory evidence identified). In addition to the above, a prudent developer should implement a watching brief during the redevelopment works to ensure that if made ground and or visual/olfactory evidence of contamination is identified then works should be stopped, the Local Authority notified and advice should be sought from an appropriately qualified and experienced Geo-Environmental Engineer.
S2 = Ground Gas - Potential Sources Identified including on site made ground, natural alluvial soils and potential unrecorded mine workings. PCOC's include Carbon Dioxide and Methane. A programme of ground gas monitoring should therefore be completed.

4.2 Anticipated Pathways

Pathways:
P1 = Inhalation of indoor / outdoor air (wind-blown particles/vapours)
P2 = Dermal/direct contact (limited risk present through areas of soft landscaping)
P3 = Ingestion (limited risk present through areas of soft landscaping)
P4 = Migration through existing services
P5 = Direct contact with building materials
P6 = Surface Run-off
P7 = Leaching from Soils (risk present where sources are exposed to surface water infiltration)

4.3 Anticipated Receptors

Receptors:
R1 = Human Health (Propose Site Users/Occupiers)
R2 = Human Health (construction workforce – redevelopment works)
R3 = Groundwater (Secondary A Aquifer and Surface Water – tributary to River Derwent)
R4 = Building Materials and Buried Utilities
R5 = Flora and Fauna (potential future soft landscaping)

5.0 Preliminary Qualitative Risk Assessment (PQRA)

5.1 Qualitative Geotechnical Risk Assessment – Risk Meter

The following Preliminary Geotechnical Risk Meter determines the potential level of risk associated with the geotechnical properties of the site, considering any potential geohazards identified by the information presented within the DTS.

Geotechnical:	⇩					
RISK =	NEGLIGIBLE	VERY LOW	LOW	MODERATE	HIGH	VERY HIGH

A risk level of MODERATE to HIGH is currently determined appropriate for this development area for the following reasons:

- Areas of variable deep made ground may potentially be present.
- Relict structures may be present on site that could make excavations and piling difficult.
- Buried utilities may cross the site.
- The natural occurring drift geological deposits may potentially be geotechnically variable and "poor" resulting in no shallow homogenous bearing stratum.
- The GSR and CA indicate a risk of coal mining at this location and specialist intrusive investigation is required (i.e. rotary boreholes) to determine if protection measures are required (i.e. grouting).
- Surface water ponding and overland flow may occur particularly following periods of heavy rainfall.
- Shallow groundwater, possibly in hydraulic continuity and tidally influenced by the North Sea (River Derwent and its tributaries) may potentially be present below the site.
- The site is considered to be at risk of ground gas (Carbon Dioxide and Methane) associated with potential mining, areas of made ground and natural organic deposits.
- Geological structural faulting is inferred below the site which could act as a conduit for ground gas and potential areas of localised weakened rock.

In addition, GEO is not responsible for third party information and records may be inaccurate or incomplete. Consequently, GEO recommends that care and consideration of potential mining features should be made by the developer during construction.

Consequently, supplementary desk-based enquiries and Phase 2: Ground Investigation works would be prudent to determine ground/groundwater/gas conditions and to aid the design of foundations, retaining structures and highways, should they be deemed necessary by the Design Team.

5.2 Qualitative Contamination Risk Assessment – Risk Meter

The following Preliminary Ground, Groundwater and Ground Gas Risk Meter determines the potential level of risk associated with the redevelopment of the site when taking into account the anticipated ***Sources – Pathways – Receptors*** within the pollutant linkage model and CSM.

Ground Contamination:	⇩					
RISK =	NEGLIGIBLE	VERY LOW	LOW	MODERATE	HIGH	VERY HIGH
Groundwater Contamination:		⇩				
RISK =	NEGLIGIBLE	VERY LOW	LOW	MODERATE	HIGH	VERY HIGH
Ground Gas:		⇩				
RISK =	NEGLIGIBLE	VERY LOW	LOW	MODERATE	HIGH	VERY HIGH

A risk level of MODERATE to HIGH is currently determined appropriate for this development with respect to ground contamination. In summary, made ground of an unknown source and thickness is anticipated on site. The severity of the risk will vary depending upon whether the proposed development is commercial, industrial or residential.

Therefore, it is recommended that excavations be completed on site to confirm the ground conditions and where made ground is identified (with anthropogenic debris) then contamination screening and a human health risk assessment be completed. In addition, a watching brief is recommended during the redevelopment works to ensure that if made ground (that includes anthropogenic debris, i.e. ash, clinker etc.) and/or visual/olfactory (malodorous) evidence of potential contamination are identified then works should be stopped, the Local Authority notified and advice should be sought from an appropriately qualified and experienced Geo-Environmental Engineer.

A risk level of LOW to MODERATE is currently considered appropriate for the site with respect to potential risks to controlled waters (i.e. the underlying Secondary A Aquifer and surface water features). Sampling of soil and groundwater (where present) should be undertaken to determine risks to potential sensitive receptors.

A risk level of LOW to MODERATE is currently considered appropriate for the site with respect to potential harmful ground gas, as potential sources have been identified. Sources include made ground, areas of infilling and a potential for organic type natural deposits beneath the site. Although not verified to date, there is also the potential for shallow mine workings which may potentially represent a source of ground gas. Therefore, a period of in-situ ground gas monitoring will be required. The ground gas monitoring should be in accordance with CIRIA C665.

GEO also recommends that a “watching brief” and “observational technique” be applied to this site to ensure that if ground conditions appear to vary from those identified within this investigation report then advice should be sought from a suitably qualified and experienced Engineering Geologist, Geotechnical or Geo-Environmental Engineer.

6.0 Conclusions & Recommendations

When considering the results of this DTS report the following can be seen:

- The development site is currently considered to represent a moderate to high geotechnical risk.
- The site is currently considered to pose a moderate risk to the proposed end users (ground contamination).
- The site is currently considered to pose a low to moderate risk to adjacent sites (the surrounding environment) and controlled waters with respect to potential ground/groundwater contamination.
- A low to moderate risk is currently considered present of ground gas.

Consequently, a detailed programme of extensive Phase 2 Ground Investigation works will be required to fully characterise the ground/groundwater conditions and ground gas regime below the development site with the resulting information suitable for submission to the Local Authority for planning purposes and for the appointed design team. In summary the site works should include (as a minimum):

- Percussion boreholes.
- Machine dug trial pits.
- Rotary boreholes (depending upon outcome of supplementary CA desk-based enquiries.
- In-situ geotechnical testing.
- Ground gas monitoring.
- Laboratory based geotechnical screening.
- Laboratory contamination screening for generic and organic analytes as per the PCOC's in Section 4.0.
- Human Health Ground Contamination and Ground Gas risk assessment.

GEO also recommends that a "watching brief" and "observational technique" be applied to this site to ensure that if ground conditions appear to vary from those identified within this investigation report then advice should be sought from a suitably qualified and experienced Engineering Geologist, Geotechnical or Geo-Environmental Engineer.

The conclusions and recommendations presented within this report are considered reasonable based on the available information. However, these cannot be guaranteed to gain regulatory approval. Therefore, the report should be passed to the appropriate regulatory authorities and/ or other key stakeholders as soon as practicably possible in order to seek their approval of the findings prior to undertaking any works on site. GEO accepts no responsibility for the accuracy of third party information involved within the completion of this report.

End of Report