

**Site Investigation No. AE0709
Piling Risk Assessment**


**Proposed Training Facility
Cardiff Docks**

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CONTENTS:

1. INTRODUCTION	1
1.1 Instruction	1
1.2 Brief and Report Scope	1
1.3 Proposed Development	1
2. THE SITE	2
2.1 Site Location & Description	2
3. GROUND CONDITIONS	3
3.1 Fieldwork	3
3.2 Published Geology	3
3.3 Stratigraphy Encountered Beneath Site	3
3.4 Topsoil / Made Ground	4
3.5 Tidal Flat Deposits	4
3.6 Weathered Mercia Mudstone	4
3.7 Mercia Mudstone Bedrock	4
3.8 Groundwater	5
3.9 BGS Borehole Records	5
3.10 Hydrogeology & Hydrology	5
4. PILING RISK ASSESSMENT	6
4.1 Introduction	6
4.2 Initial Conceptual Model.....	7
4.2.1 Contamination (source).....	7
4.2.2 Piling Methods (pathway).....	7
4.2.3 Controlled/Surface Waters (receptor)	8
4.2.4 Groundwater (receptor).....	8
4.3 Control Measures.....	8
4.4 Residual Conceptual Model	9
4.4.1 Contamination (source).....	9
4.4.2 Piling Methods (pathway).....	9
4.4.3 Controlled/Surface Waters (receptor)	9
5. CONCLUSION TO PILING RISK ASSESSMENT	10

1.INTRODUCTION

1.1 Instruction

C.J. Associates Geotechnical Limited (CJA) was instructed by Hydrock, to carry out a piling risk assessment for a proposed training facility in Cardiff Docks.

CJA has carried out a site investigation for the development, the findings of which are detailed in the CJA report reference AE0709 '*Factual and Interpretative Report – Proposed Training Facility, Cardiff Docks*' (October 2016).

This Piling Risk Assessment has been prepared for the sole internal use and reliance of Hydrock. This Piling Risk Assessment shall not be relied upon by other parties without the express written authority of CJA. If an unauthorised third party comes into possession of this report they rely on it at their own risk and the authors owe them no duty of care and skill.

1.2 Brief and Report Scope

The general specification for the works was provided by Hydrock and incorporated the brief to undertake a piling risk assessment based on the findings of the site investigation. This risk assessment document has been prepared to assess the risk to controlled/surface waters and groundwater from contamination on the site, in relation to piling activities proposed. The risk to end users and ground workers is detailed within the above mentioned CJA Report, which should be read in conjunction with this risk assessment.

1.3 Proposed Development

It is proposed to construct a new training facility on site comprising a main building, areas of hardstanding (car parking, parade ground etc) and small areas of soft landscaping.

2.THE SITE

2.1 Site Location & Description

The site is located within Cardiff Docks at National Grid Reference ST 199 745, and is shown on the Site Location Plan, included in the Appendices to this report and in the aerial photograph below.



The site is irregular in plan shape and is bounded to the north and east by waterways associated with the docks and to the south and west by Cargo Road and Compass Road, respectively. At the time of writing this report the site was occupied by buildings, hardstanding and soft landscaped areas. The northern area of the site appeared to be disused with the remainder of the site occupied by buildings associated with County Marquees, Fuel Centre and Maritime Volunteers Centre. There is a 'tank' located in the Maritime Volunteers Centre.

The site was originally located within the waters of the Cardiff Flats until the late 1800s when Cardiff Docks were built and the Flats infilled. Since 1901 the site has been occupied by commercial/industrial premises including a fuel works and railway lines.

3. GROUND CONDITIONS

3.1 Fieldwork

The fieldwork, scheduled by Hydrock was carried out by CJA between 1st August 2016 and 8th August 2016 and comprised, cable percussion boreholes, rotary boreholes, window sampling, installation of standpipes, trial pitting and associated sampling and in situ testing. The works are summarised as follows:

- Two 200/150mm diameter boreholes (designated BH1 and BH2) were sunk to depths of between 16.74m and 21.0m below existing ground level, using a light cable percussion boring rig with standard in situ testing and sampling.
- Cable percussive boreholes were extended into bedrock, to depths of between 22.5m and 26.5m, using a track-mounted rotary coring rig.
- Four window sample boreholes (designated WS1 to WS4 inclusive) were each sunk to a depth of 5.0m below existing ground level with standard penetration tests.
- 50mm diameter standpipes were installed in BH1, BH2, WS1, WS2 and WS4. Three return visits were carried out to monitor groundwater levels.
- Three trial pits were excavated using hand digging methods to depths of between 0.5m and 0.6m to obtain samples for contamination testing, adjacent to the existing tank on site.

3.2 Published Geology

According to the British Geological Survey (BGS) the site is underlain by superficial Tidal Flat Deposits (clay, silt and sand) overlying the Mercia Mudstone Group of Triassic Age.

3.3 Stratigraphy Encountered Beneath Site

The sequence of strata encountered beneath the site was:

- Topsoil / Made Ground
- Tidal Flat Deposits
- Mercia Mudstone

3.4 Topsoil / Made Ground

Topsoil was encountered in BH1 and BH2 only, thickness 0.1m to 0.25m.

Made Ground was encountered in all the exploratory holes at existing ground level and proven to depths of between 2.1m and 8.5m. The Made Ground was variable and comprised:

- Asphalt surfacing (thickness 0.1m).
- Silty gravelly SAND with clinker, wood, metal fragments (thickness 0.6m to 1.55m).
- Sandy gravelly CLAY with clinker, wood fragments (thickness 0.6m to 4.4m).
- Sandy gravelly SILT with ash, brick and clinker (thickness 0.5m to 3.7m).
- Silty sandy ashy GRAVEL (thickness 1.5m to 3.1m).

3.5 Tidal Flat Deposits

Tidal Flat Deposits were encountered in BH1, BH2 and WS1 only at depths of between 2.0m and 8.5m and proven (in BH1 and BH2 only) to depths of between 12.0m and 13.9m below existing ground level.

The Tidal Flat Deposits comprised soft sandy CLAY/SILT (thickness 4.7m to 5.4m) overlying loose silty clayey sandy GRAVEL (thickness 0.6m to 0.7m).

3.6 Weathered Mercia Mudstone

Weathered Mercia Mudstone, comprising stiff to very stiff red brown CLAY was encountered in Bh1 and BH2 only at depths of between 12.0m and 13.9m, thickness 5.0m to 7.1m.

3.7 Mercia Mudstone Bedrock

Mudstone bedrock was encountered in BH1 and BH2 at depths of between 17.0m and 21.0m below existing ground level (and proven to depths of between 22.5m and 26.5m). The mudstone was recovered as red brown with grey reduction zones, silty CLAY with mudstone gravel.

3.8 Groundwater

Groundwater was observed in all the boreholes at depths of between 1.8m and 12.5m during the fieldwork. Subsequent monitoring of groundwater in standpipes indicated groundwater levels at depths ranging between 1.50m and 2.54m below existing ground level, as summarised in the following table.

Summary of Monitoring Results

Date	Location	Depth to base of Installation	Strata of Response Zone	Groundwater Level (mbgl)
22.08.2016	BH1	6.0m	Made Ground	1.78
	BH2	8.5m	Made Ground	1.76
	WS1	5.0m	Tidal Flat Deposits (sandy CLAY)	-
	WS2	5.0m	Made Ground	2.32
	WS4	5.0m	Made Ground	-
02.09.2016	BH1	6.0m	Made Ground	1.67
	BH2	8.5m	Made Ground	1.69
	WS1	5.0m	Tidal Flat Deposits (sandy CLAY)	1.50
	WS2	5.0m	Made Ground	2.12
	WS4	5.0m	Made Ground	-
09.09.2016	BH1	6.0m	Made Ground	1.83
	BH2	8.5m	Made Ground	2.54
	WS1	5.0m	Tidal Flat Deposits (sandy CLAY)	1.75
	WS2	5.0m	Made Ground	2.20
	WS4	5.0m	Made Ground	2.54

3.9 BGS Borehole Records

The BGS hold records of boreholes previously undertaken on or close to the site. The closest available borehole record (reference ST17SE359) is located 20m west of the site and encountered the following ground conditions:

- GL - 15.0m (Made Ground over Alluvium)
- 15.0m - 36.0m Red Marl

3.10 Hydrogeology & Hydrology

The hydrogeology of the site area is detailed in the map, 'Groundwater Vulnerability of Mid Glamorgan', Sheet 36, published by the Environment Agency. The soils beneath the site are shown as 'not classified' in terms of leachability. The superficial deposits have been given a designation of Secondary Aquifer – undifferentiated and the bedrock a designation of Secondary Aquifer – B. The nearest surface watercourse is the Cardiff Docks immediately adjacent to the east. The site is not located within a floodplain.

4. PILING RISK ASSESSMENT

4.1 Introduction

It is proposed to construct a new training facility on site comprising a main building, areas of hardstanding (car parking, parade ground etc) and small areas of soft landscaping.

It will be necessary to adopt a piled foundation solution due to the significant thickness of Made Ground and poor quality Tidal Flat deposits.

The exploratory holes have encountered a significant thickness of variable Made Ground (2.1m to 8.5m) overlying poor quality Tidal Flat deposits (soft clay/loose sand), thickness 5.4m to 6.0m. Stiff to very stiff clay (Weathered Mercia Mudstone) was encountered at depths of between 12.0m and 13.9m below existing ground level overlying mudstone bedrock encountered at depths of between 17.0m and 21.0m below existing ground level. Groundwater was observed in all the boreholes at depths of between 1.8m and 12.5m. Subsequent monitoring of groundwater in standpipes indicated groundwater levels at depths ranging between 1.50m and 2.54m below existing ground level.

The proposed development may be founded on a system of ground beams spanning onto piles taken down into the Mercia Mudstone bedrock, encountered at depths of between 17m and 21m below existing ground level.

Elevated levels of lead, beryllium and hydrocarbons (PAH) have been encountered on the site at shallow depth in the Made Ground.

The foundation solution must be designed to avoid the creation of preferential flow paths which could allow the migration of contamination.

A source-pathway-receptor approach has been adopted in the piling risk assessment considerations.

4.2 Initial Conceptual Model

The initial conceptual model has been based on the result of the investigations and testing carried out and the proposals for the development of the site. It will be adapted in the light of the measures proposed to mitigate the migration of contamination. A residual conceptual model is presented later in this report.

4.2.1 Contamination (source)

Visual / olfactory evidence of contamination was not observed on site or in any of the exploratory holes during the investigation.

Elevated levels of lead, beryllium and hydrocarbons (PAH) have been encountered on the site at shallow depth in the Made Ground. The presence of this contamination is likely to be due to the site's historical usage, including fuel works and railway lines. Elevated levels of hydrocarbon contamination were also encountered in groundwater samples and it is likely this is caused by hydrocarbon contamination within the soils, leaching into groundwater.

Elevated levels of carbon dioxide were encountered in standpipes.

The groundworks contractor must provide a Soil Management Plan including a soil remediation and piling method statements in accordance with the recommendations given in CJA report reference AE0709 '*Factual and Interpretative Report – Proposed Training Facility, Cardiff Docks*' (October 2016).

4.2.2 Piling Methods (pathway)

A variety of pile types could be used, including driven, bored and continuous flight auger (CFA) piles, subject to constraints on noise, vibration and environmental issues, especially the potential creation of pathways for contaminants. However, based on the ground/groundwater conditions encountered and levels of near surface contamination, it is considered CFA piles will be the most appropriate at this site. Should any other methods of piling be adopted, assurances from the piling contractor and method statements will be required to prove the method is suitable. In addition the following risk assessment will require a review.

Piles will be taken down into the Mercia Mudstone bedrock, encountered at depths of between 17m and 21m below existing ground level.

4.2.3 Controlled/Surface Waters (receptor)

Given the close proximity of surface waters (adjacent docks) and ground/groundwater conditions encountered it is likely there is a hydraulic connection between the site and adjacent surface water.

4.2.4 Groundwater (receptor)

The groundwater beneath the site is considered a potential receptor, as the piling method could mobilise contamination at shallow depth into the groundwater.

4.3 Control Measures

Pile bores will be supported within CFA piles during installation by the flights of the auger. On reaching the proposed depth of installation, concrete will be tremied to the base of the auger under pressure and the auger gradually withdrawn at an appropriate rate. As the soil held on the flights of the auger is brought to surface during the withdrawal of the auger, the made ground should be treated in accordance with the groundworks contractor's Soil Management Plan. It is likely this will include separation of materials and stockpiling for subsequent treatment and reuse on site/disposal off-site as appropriate. The piling will be carried out by experienced operators who will monitor piling operations to maintain the quality of the installations and ensure a good soil/pile interface.

Using the above methods the creation of preferential flow paths via pile bores can be avoided, and the migration of any shallow contamination at shallow depth will not be transferred to underlying strata.

A suitable regime of groundwater and surface water monitoring, sampling and testing should be carried out at regular intervals, during and after the construction period (where development allows) to monitor whether any contamination has been mobilised.

All piling plant and construction operations should take the necessary measures, in accordance with current health and safety guidelines to protect all plant and personnel from the affects of land gas.

4.4 Residual Conceptual Model

The residential conceptual model has been produced by amending the initial conceptual model given in Section 4.2 in light of the control measures and methodologies proposed

4.4.1 Contamination (source)

Visual / olfactory evidence of contamination was not observed on site or in any of the exploratory holes during the investigation.

Elevated levels of lead, beryllium and hydrocarbons (PAH) have been encountered on the site at shallow depth in the Made Ground. The presence of this contamination is likely to be due to the site's historical usage, including fuel works and railway lines. Elevated levels of hydrocarbon contamination were also encountered in groundwater samples and it is likely this is caused by hydrocarbon contamination within the soils, leaching into groundwater.

Elevated levels of carbon dioxide were encountered in standpipes.

4.4.2 Piling Methods (pathway)

The piling methodologies proposed used in conjunction with good site practice will minimise the potential for the creation of preferential pathways along which contamination could migrate.

4.4.3 Controlled/Surface Waters (receptor)

The risk to Controlled Waters and groundwater from migration of the contamination identified at shallow depth, and taking into account the proposed piling activities, is considered to be low, providing the control measures detailed above are followed.

5. CONCLUSION TO PILING RISK ASSESSMENT

The risk assessment for the site has shown that providing the control measures described in subsection 4.3 of this report are implemented and the method statements within the Soil Management Plan are followed, the contamination identified on the site does not pose a significant risk to natural ground underlying the site, based on the testing carried out to date.

There is however, a low to moderate risk from contamination to the adjacent surface water and it is recommended a suitable regime of groundwater and surface water monitoring, sampling and testing should be carried out at regular intervals, during and after the construction period (where development allows) to monitor whether any contamination has been mobilised.