ROTARY DRILLING

Channel View Footbridge, Cardiff

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This report dated DATE has been prepared for CLIENT (the "Client") in accordance with the terms and conditions of appointment dated Date (the "Appointment") between the Client and **Arcadis Consulting (UK) Limited** ("Arcadis") for the purposes specified in the Appointment. For avoidance of doubt, no other person(s) may use or rely upon this report or its contents, and Arcadis accepts no responsibility for any such use or reliance thereon by any other third party.

1 INTRODUCTION

- All drilling operatives will be trained using a combination of external assessment to NVQ level 2 standard and a detailed in-house training program that certifies that they can operate individual rigs safely. All our drilling operatives will carry the appropriate CSCS card. We will work to the BDA ‘Code of Safe Drilling Practise’ and ‘Guidance Notes for the Safe Drilling of Landfills and Contaminated Land’. The standards used will be the current BS5930 and BS1377.

- The supervisory engineer from Arcadis will issue written instructions for each borehole and have a Permit to Work system in place that has been agreed before works start with the appropriate Contract Manager.

- A site induction will be given in order to review the overall site rules, security, navigation, emergency procedures, etc...

- All staff on-board of the vessel and/or barge will have appropriate “working over-water” training.

2 HEALTH & SAFETY

- There is a comprehensive risk assessment in place for this operation. This details all the possible hazards, associated risks and the remedial actions that will be put in place to ensure the risk is reduced to an acceptable level.

- The operation is covered by various safety regulations and these are detailed below.

- The Health and Safety at Work etc Act 1974 requires that employers provide 'systems of work that are, so far as is reasonably practicable, safe and without risks to health'.

- The Management of Health and Safety at Work Regulations 1999 require a risk assessment to be carried out to identify the necessary precautions and to implement them.

- The Construction (Design and Management) Regulations 2015 place obligations on clients, designers, those planning the work and contractors to prevent or reduce risks in those places where these Regulations apply.

- All our equipment on site will meet the requirements of PUWER 98.

- All Drilling rigs on site will meet the requirements of Regulation 11 or PUWER and will be fitted with an interlocked guard that prevents access to the moving drill string.

- All drillers employed on the contract must be accredited by the British Drillers Association (BDA).

- All personnel working on the barge or navigating on the supporting vessel will have received as a minimum basic training for "working over-water".

- Appropriate PPE will be worn at all time, specific to the activities taking place (see Section 3.0).

3 EQUIPMENT & MATERIALS

- This will be determined by the type of drilling operation that is been carried out. More details can be found throughout the remainder of this document and in the Construction Phase Plan.

- Appropriate PPE to be worn by rig operatives and supervising personnel. This will include, but not be limited to:
    - Hard Hats
    - Safety Gloves
    - Safety footwear with steel toe caps and mid-soles
    - Ear Defenders (whilst rig is in operation)
    - Safety Glasses
    - Hi VIS clothing
    - Life jacket

- The above PPE shall be worn by visitors or member of the naval crew if onboard of the barge or on the deck of the supporting vessel.

- Should gross levels of contamination be encountered, the site engineer shall instruct the cessation of all operations until a revised safe method of work is established and / or additional PPE is provided.

4 METHOD

- A site specific risk assessment has been undertaken. This should be reviewed prior to starting the works and any unforeseen hazard duly considered and mitigated. Any change to the RAMS should be discussed and agreed with the Site Project Manager and the Client before being implemented.

- Prior to any work commences, the permit to work should be reviewed with the Arcadis engineer / Project Manager and signed.

- The boreholes will be drilled at locations set out by the Client/Engineer.

- Prior for the barge to mobilise to the drilling location, all consents (or proof of exemptions) with the Local Harbour Authority, Natural Resources Wales (NRW), local authority and Marine Management will be in place.

- The barge will be set up in a manner that minimise disruption to navigation of third party vessels and as agreed with Local Harbour Authority.

- The rig will be set-up in a manner that minimise risk to the operators and provide maximum space. Layout of the rig and supporting equipment will be agreed and approved through a stability report prior to boarding.

- The Arcadis engineer will have obtained drawings and details of buried and overhead services in advance of the works. Copy of the utility plans will be held with the permit to work. The vicinity will be checked by the drill crew for evidence of overhead and buried services.

- Given the location of the drilling overwater, service clearance of the proposed exploratory hole locations using plans through GPR, CAT, Genny or other types of detection and hand dug inspection pit to 1.2m depth will not be possible.

- The location of the boreholes have been pre-selected to be away from none obstructions located at the base of the river.

- As a minimum, all drilling crew will receive a toolbox talk in relation to UXO. Prior to advancement of exploratory holes, UXO clearance will be carried out at each exploratory hole location in accordance with the requirements and procedures given in the Unexploded Ordnance Survey. A UXO down-the-hole survey will be required as instructed by the supervising EOD engineer for all locations. A stainless-steel casing will be used. The risk of UXO will be identified as part of the permit to work.

- If significant contamination is encountered, sampling equipment and tools shall be cleaned between strata, specifically between the boundary between made ground

and natural strata to prevent cross-contamination. In this case all equipment used in the construction of exploratory holes must be cleaned before being repositioned to begin the next hole.

- As agreed with NRW, a bentonite seal will be installed once into the underlying bedrock to protect underlying aquifers.

- All lubricating grease will need to be of food grade type and biodegradable. All necessary precautions shall be taken to prevent spillages (spill skits, nappies, drip trays etc).

- Water Supply: water to feed the flushing system during drilling will be sourced from river directly, upon agreement with the Local Harbour Authority/NRW. Drilling flush will then be collected into IBC available onboard, let to settle before being pumped back into the river. If there are any evidence of contamination, the system will remain closed and impacted water disposed off-site to a suitable facility centre. Expected daily water use is 10,000L per day.

- Purebore usage to be agreed with Natural Resources Wales if required.

5 ROTARY DRILLING

- The drilling techniques to be used on the project is to include wireline triple tube sampling equipment. Rotary drilling will be required to obtain continuous cores with a minimum core diameter of 92mm (P-size core). Core barrels shall of a double tube swivel-type barrel, lined with a rigid plastic liner to retain the core.

- The rig will be located on a barge with casing running through the deck via a moon pool.

- The crane from the supporting vessel (multicat) or the crawling crane located in the dry dock will be used for off-loading of material / equipment as required.

- Equipment: discussion with the drilling company has taken place so that a variety of core catcher will be available on site in order to maximise recovery. Variety of drilling bit will be available on site to cater for different strata changes. All equipment will be inspected prior to starting each borehole so confirm state of repair and all is fit for use.

- Drilling will be carried out using recirculating water flush. Clean drilling methods are required and drilling muds shall be non-toxic, biodegradable, and compliant with the Environment Agency requirements for drilling into an aquifer. Flush recycling tanks shall be used for the collection, reuse and to aid discharge of drilling flush. The methodology is outlined below:

- **Setting up**:

  The barge will be towed by the supporting boat, with the moon pool in line with the proposed drilling location. During navigation, the rig will be kept with mast down for increase stability. Full navigation procedure is available in the relevant RAMs.

  Once the barge secured at the location, the rig will be set up over the moon pool. A recirculation tank set up over the hole (drill through tank) or goose neck set up around the hole will be installed to capture drilling fluid.

  Trestles or timbers will then be used to lay out the drill rods off the ground. Mud tanks and pumps will be set to one side so that hoses are not a constant trip hazard. A clear area will be left around the drill table. The drilling system will be set up to recirculate mud from the mud tanks/goose neck pit and up the annulus and then back to the tanks/pit. When running the drill bit down the borehole, stabilisers and drill collars will be added, so that all weight applied to drill bit is down hole and not applied by the drilling machine. This helps in stopping the drill bit from deviating.

  The drilling process and control of flush will be so that there will be no overflow allowed. Work shall stop in the event of mud overspill and the area cleaned prior to resume work.

- **Mud tanks**: Mud tanks will be used to contain drilling fluid. Two tanks will be used wherever possible to reduce time lost waiting for tanks to be cleaned. Once the sediment have settled, the water will be discharge back into the river via a tremie tube.
- **Water**: water will be sourced directly from the river.

- **Flushing medium:** water flush will be used and the selection of polymer will be made to suit the drilling conditions anticipated. Mud weight and viscosity will be monitored and kept to predetermined limits. Spillages of mud must be kept to a minimum. Polymer must be agreed prior to use by the EA & NRW and these will need to be biodegradable and environmental friendly. Assessment will include consideration of type of geology and properties of the drilling fluids. At this stage PureBore Polymer additives are proposed to be used. Both are understood to be permissible in all formations, including within the chalk aquifer. the tank will be emptied and replace with fresh water;

  Safety Data Sheet for both type of polymer are available in the CPP. In any event of spillage, this will be cleared up immediately to avoid a trip/slip hazard. Clearing works will be in accordance to the COSSH.

- **Pumps**: The selection of pumps will be made to suit the work. The sludge pump will suck displaced mud from the top of the hole (recirculation tank) to the mud tank. The delivery pump will take mud from the mud tank to the rig. Generally wire armour or high pressure hoses will be used. On delivery hoses or any hose under pressure there will be whip-checks in place to prevent the hoses breaking free.

- **Drill rig**: The type of rig will be made to suit the task. The rig will be top drive rotary hydraulic and set up for direct circulation. Appropriate service and inspections will be made with records kept on site.

- **Waste**: Any solid drill cuttings from the tanks will be taken to shore in a timely fashion to ensure the tanks do not become overloaded with waste. Waste will go to licensed waste sites and carried by licensed waste carriers.

- **UXO**: a UXO engineer will be onboard to direct all required surveys prior and during drilling

More detailed RAMS to support drilling, navigation and UXO are available from the relevant specialist contractors and as listed in the CPP.

- Drilling contractor: Marriott Drilling
- Marine support: JD Marine & Sons Ltd

- UXO survey: EOD

6 ENVIRONMENTAL CONTROL METHODS

The overwater borehole locations have been identified to be within a possible area of saltmarsh and due to the sensitivity of the environment the following mitigation measures will be utilised:

The drilling methods to be employed on site will use environmentally friendly materials:

- Biodegradable lubricants
- Food grade grease/vegetable oil
- Suitable spill kits will be on board the barge and workboat.
- Fuel containers to be bunded
- Flushing method when drilling – we will be using water flush –recirculated river water – water to be drawn from the dock/river then recirculated via a hose to the ‘mud’ tanks. Once the flush is settled the water will be returned to the river via a hose lowered down between the casings.
- Backfill material is inert – bentonite pellets are manufactured clay pellets that rehydrate once in the borehole.

7 COMPLETION OF BOREHOLES

- Once the borehole is at the scheduled completion depth an appropriate instruction from the Arcadis Design team will be obtained to confirm completion had been achieved.
- On completion of boring, the exploratory hole will be backfilled with bentonite pellets.

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