

Appendix 8.2 The Quays Remediation and Verification Strategy, WSP January 2013



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THE QUAYS - BARRY WATERFRONT

Remediation and Verification Strategy

10/10/2012

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Quality Management

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Remediation and Verification Strategy

10/10/2012

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1 Introduction

1.1 Authorisation

WSP Environmental Limited (WSP) was instructed by the Barry Waterfront Consortium (the Client), to prepare a Remediation and Verification Strategy for The Quays, Barry Waterfront Development, Barry Island, Wales (the Site) to address contamination risks which are considered to pose an unacceptable risk to human health.

A site location plan and proposed masterplan for the development are presented as **Figure 1** and **Figure 2**, respectively.

1.2 Background

The Site comprises several plots of land which were previously associated with industrial uses relating to the Barry Docks, a number of ground investigations have been undertaken on different parts of the site over an extended period and these have identified the presence of potential ground contamination including asbestos, metals and organic contamination within shallow and deeper soils at the Site. A review of the various ground investigations completed by the third parties has been undertaken by WSP, which are detailed in the following document:

- WSP (2012), Review of Existing Reports, The Quays – Barry Waterfront, dated October 2012 [Ref. 33313.]

The site is to be redeveloped in phases for a range of uses and also requires enabling works to produce a suitable development platform.

Remediation is considered to be required in order to facilitate the safe redevelopment of the Site.

The Site currently consists of derelict buildings and disused land and has historically been subject to clearance/demolition and some remediation works.

1.3 Proposed Redevelopment

The proposed redevelopment will include the following land uses:

- Residential development including gardens;
- A school;
- Commercial/retail; and
- Public Open Space.

The proposed redevelopment masterplan is presented as **Figure 2**, however, it should be noted that this is provided simply to provide an example of the future redevelopment layout; this may be subject to change and phasing in its implementation.

1.4 Aim of this Strategy

The aim of this strategy is to set out the Remediation works required to enable the safe redevelopment of the site for a range of end uses. It sets out the principals to be adopted to achieve this aim and the level of verification to be achieved.

The approach set out within this strategy should be discussed and agreed with the regulatory authorities as required by planning conditions for the Site.

1.5 Notes on Limitations

The focus of this strategy relates to issues associated with Human Health only; issues relating to the protection of Controlled Waters are outside of the scope of the remedial measures considered herein.

Some areas of the site are proposed to be subject to further ground investigation, should conditions on such areas be identified to be significantly different to those previously found then revision of this strategy may be required.

The design and remediation earthworks strategy described in this document is based upon the existing development proposals for the Site. However, should the development layout change, this may result in potential consequent changes to the remedial strategy required. Significant changes to the proposed redevelopment may necessitate amendment and modified of the approach described herein which may require further agreement and approval from the regulatory authorities.

2 Summary of Site Conditions and Contamination

2.1 Site Details

Table 2.1: Site Details

Site Address	The Quays, Barry Waterfront, Barry, Wales,
Grid Reference	311060E, 167120N
Site Area	Approximately 42 Hectares (Ha)
Site Description	<p>The site comprises several derelict parcels of land which are either surfaced with hardstanding or currently laid to rough scrubland.</p> <p>The south eastern section of the site is formed by South Quay which was formerly used as a Tank Farm with a number of former concrete tank bases still present amongst the scrubland.</p> <p>The centre south (west quay) is occupied by the Contractor compound which is situated on former car parking with concrete hard-standing extending to the southwest. The western and northern sections of the site are bound by Harbour Way (causeway) and railway line and Powell Duffryn Way, respectively. The western and northern sections of the site were noted to be overgrown with scrub vegetation with a number of overgrown stockpiles and excavations in the west and northwest where material has been excavated for surcharging.</p> <p>The north eastern section of the site (East Quay) is separated from the main site by Barry No. 1 Dock and comprises open land which is partially overgrown.</p> <p>Two former graving docks were located within the East Quay area of the site. The original dock was in the location of the present day East Quay, whilst the second, a slightly larger dock, was located directly north of this. The latter has since been backfilled as part of works undertaken in the 1990s and now comprises undeveloped scrubland.</p>
Surrounding Area	<p>The southern site boundary is formed by a cliff upon which is Barry Island comprising a residential development with a fun park to the southwest.</p> <p>The western site boundary is formed by Harbour Way (Causeway) and railway line, beyond which is Barry Harbour which discharged into the Bristol Channel.</p> <p>The northern site boundary is formed by Powell Duffryn Way, beyond which are the mainline Barry Railway Station and a new hotel.</p> <p>The eastern site boundary is formed by David Davies Road, Cory Way and Woodham Road, beyond which is an industrial estate containing a mechanics and haulage company among others.</p>

2.2 Historical Land Use

Development of the Docks

A review of reports produced by Ove Arup and Partners and Earth Science Partnerships on behalf of the Barry Waterfront Development Consortium, Welsh Assembly Government and Associate British Ports indicate that the majority of the site (West Pond) was occupied by tidal flats associated with the Cadoxton Estuary and the south / southeast of the site (South Quay) was occupied by fields and cliffs forming the northern shore of Barry

Island which was separated from the mainland by the tidal estuary until the late 1800's when construction of Barry Docks commenced through infilling of the estuary.

An embankment was constructed in the east of the site within the West Pond area which was used to dam the Estuary as preparatory works for the construction of the Docks to the east. The cliff line of Barry Island in the south / southeast of the site was also quarried out to provide material for the construction of the Docks at this time.

The Barry Docks opened in 1889. The southern part of the site (South Quay) was occupied by railway sidings and subsequently coal tips along the dock wall of Barry No. 1 Dock. With the construction of the dam and docks, the centre and west of the site effectively remained as Barry Harbour (mouth of Cadoxton River) until 1898 when the causeway carrying the railway and Harbour Road was constructed along the southwest and western site boundaries. This effectively created an isolated pond known as 'West Pond' between Barry No.1 Dock to the east and Barry Harbour to the south and southwest.

Land to the northeast of West Pond formed a quayside providing access to South Quay and The Mole (a stone spur jutting out from the west side of Barry No.1 Dock to provide additional mooring space within the Dock). The Mole and South Quay were occupied by railway sidings and storage areas from late 1800's.

South Quay remained relatively unchanged until the mid 1900's with the construction of a tank farm and associated buildings and infrastructure. A review of the tank inventory undertaken by Arup indicated that the tank farm predominantly stored organic chemicals including diesel oil, kerosene, mineral oil, chlorinated solvents, methanol, silicone, sodium hydroxide amongst others. The tank farm was decommissioned in the early 2000s with removal of all tanks and buildings. However, the former concrete tank bases, access roads and building foundations remain.

The eastern and northeast parts of West Pond were in-filled early after construction of the Docks and housed a large number of railway sidings and associated storage areas which serviced the Docks. The remainder of West Pond was gradually in-filled from the west between 1915 and 1920's with the size of the pond decreasing. The western portion of the site was then set to railway land with in-filling continuing to progress to the east.

The eastern and northeast parts of West Pond were in-filled early after construction of the Docks and housed a large number of railway sidings and associated storage areas which serviced the Docks. The remainder of West Pond was gradually in-filled from the west between 1915 and 1920's with the size of the pond decreasing. The western portion of the site was then set to railway land with in-filling continuing to progress to the east.

After a decline in the coal trade in the late 1930's, the staites, that were used to drop coal directly into the boats, became progressively disused. As a result of this, the west, south and Mole areas of the dock were gradually redeveloped as a tank farm. From 1938, the Ministry of Supply operated seven large tanks, mostly used to hold oils for the cosmetic and margarine industries.

During the war, the area was used as storage for military equipment and the docks suffered minor damage from aerial attacks.

Post war, the remainder of the west pond was filled from sidings along the east and west banks of the pond and from the 1960's, part of the reclaimed pond was used to dismantle railway wagons and store railway engines.

Between 1962 and 1984, the Tank Farm was increased to its maximum development including some pressure storage vessels and during the 1960's and early 1970's, exports of coal continued to decline and by 1976 shipments had effectively ceased, with the last coal tip being demolished in 1981.

Since this time, the Port Authority has erected various buildings including a storage shed at the eastern end of the dock.

1990s Remediation

According to a number of reports completed by Arup, the site was subject to a degree of remediation to address asbestos, heavy metal and hydrocarbon contamination in the mid to late 1990's. The remediation reportedly comprised the excavation of the upper 100mm of material and removal and encapsulation within a former graving dock in the northeast (beyond Barry No. 1 Dock) which was lined and capped.

Between the late 1990's and present the site was subject to the importation of material for clean cover which has been stockpiled within the centre and northeast area of West Pond.

Commencement of Redevelopment - 2012

In 2012 the enabling works for the proposed development commenced. Upon excavating soils for the works in the West Pond area, various asbestos containing materials (ACM) were encountered.

The enabling works have since slowed whilst the ground contamination conditions are assessed and a Remediation Strategy is developed and agreed with the regulatory authorities to allow the works to progress.

2.3 Environmental Setting

The site is generally flat ranging from 9mAOD in the northwest to 8mAOD in the south and 7mAOD in the east. A number of stockpiles are present within the former West Pond area which comprise surcharge / clean cover materials.

A review of the British Geological Survey Sheet 263 Cardiff (Scale 1:50,000) Solid and previous assessment reports indicate that the geology beneath and surrounding the site is complex, resulting from a significant degree of faulting on and south of the Site.

South Quay and the east and north sections of West Pond are underlain by Penarth Group deposits and the south and western sections of West Pond are underlain by St Mary's Well Bay Formation. The northeast section beyond Barry No. 1 Dock (former graving dock) is underlain by Blue Anchor Formation deposits (part of the Mercia Mudstone Group) with isolated outcrops of Lavernock Shale deposits (Blue Lias) on the southern and south western boundary.

The previous assessments have identified that the bedrock/ solid geology is overlain by a considerable thickness of superficial alluvial deposits associated with Cadoxton Estuary and made ground from the former historic use of the site.

The depth to the upper surface of bedrock was noted to vary considerably across the site, ranging from 2 metres below ground level (mbgl) in the south (adjacent to Barry Island Cliff) and 24mbgl in the centre of the site (extent of former Estuary) where the exposed uplifted bedrock has been scoured by the Estuary.

According to the 1997 Arup report, a buried valley was identified trending east-west through the centre of the site.

Previous assessments by Earth Science Partnership and a review of the Environment Agency website indicate that the geological strata beneath the site have been classified as Unclassified, Secondary B and Secondary A Aquifers.

One abstraction well was recorded within 1km of the site which is licensed to Barry Island Pleasure Park (license number: 21/58/31/0031) for industrial, commercial and public supplies – holiday sites, camp sites and tourist attractions. It was assumed that the borehole was abstracting from Carboniferous Limestone which is brought closer to surface by faulting rather than the Mercia Mudstone Group which outcrops in this area.

A principal aquifer is shown approximately 600m south of the site and coincides with Friars Point Limestone Formation which outcrops to the west of Barry Harbour.

Groundwater strikes have previously been made in the Made Ground deposits at depths of between 4 to 6metres below ground level (mbgl) and within Alluvium at depths of between 8 and 15mbgl. Subsequent rest groundwater levels were recorded at depths of between 4 and 6mAOD within both Made Ground and Alluvium considered suggestive of connectivity between the Made Ground and Alluvium, although may be partially confined in some areas.

The site is located adjacent to the west of Barry No. 1 Dock and to the northeast of Barry Harbour which discharges into the Bristol Channel. The site is underlain by the in-filled former Cadoxton River which still discharges, although at much lower volumes / seepage to the southwest of the site.

A review of the EA River Basin Management Plans indicate that the coastal waters surrounding the site are classified as good for both chemical and ecological parameters; and are expected to remain good in 2015.

A review of the Arup Strategic Earthworks and Drainage Strategy produced for the proposed development in 2009 indicates that the site roads will need to be raised to a minimum of 8.868m AOD; and the south / southwest boundary of West Pond to 9.34m AOD in order to provide protection from flooding and flood surge events.

The EA website indicates that the site is located on the edge of areas which are at risk of extreme flooding from rivers without flood defences.

2.4 Contamination Present

2.4.1 Principal Types of Contamination Encountered

The site has had a long history of industrial operations from the late 1800's to the mid to late 1990's which may have given rise to soil and groundwater contamination. Previous assessments of the site have identified a range of contamination and a summary of which is provided in the WSP Data Review Report, October 2012 which should be read in conjunction with this document.

The mentioned areas (West Pond, East Quay, South Quay and the Former Graving Dock) have had limited ground investigation done. The amount of investigation is undetermined and whether clean material has subsequently been in-filled has not been confirmed.

The contaminants encountered which are considered to have the potential to impact on human health are summarised in the following table.

Contaminant	Comment	Key Exposure Pathway
Asbestos Containing Materials (ACM)	<p>A number of previous assessments have identified that the soils underlying the site have been impacted by ACMs from surface to depths in excess of 3.5m. The asbestos has been predominantly identified as chrysotile, although amosite and crocidolite have also been identified in significant quantities. The western side of West Pond (west portion of the site) appears to have been the worst impacted, possibly as a result of being in-filled later than the remainder of the site. However, it should be noted that some areas of the site have been subject to a limited degree of assessment and the potential for ACMs to be encountered in other areas of the site cannot be discounted.</p> <p>A recent (2012) assessment for ACMs completed by ASM Compliance Limited on behalf of the Contractor concluded that ACMs were present in both solid and free fibre form and that appropriate measures for the control of asbestos would be required in accordance with the Control of Asbestos Regulations (CAR) 2012. In light of the ACMs encountered (highly fibrous and / or of low density) it was considered that the proposed ground improvement and enabling works would require a licensed asbestos contractor and notification to the appropriate enforcing authority would be required prior to commencement.</p>	Inhalation of fugitive fibres released through soil disturbance.
Metals	There is indication from the historical reports that heavy metal concentrations in excess of residential criteria were identified in various areas of the Site.	Direct contact, ingestion of soils, inhalation of dusts, ingestion of produce grown in impacted soils
Organic Contamination	Previous assessments have identified that groundwater within the Made Ground and Alluvium has been impacted by phenols, TPH and	Direct contact, ingestion of soils, inhalation

Contaminant	Comment	Key Exposure Pathway
	<p>PAHs.</p> <p>The principal area of impact was identified in the southeast of the site in the vicinity of the former South Quay tank depot and was centred around BH25, BHE5, BHE6 predominantly at depths >3mbgl within reworked alluvium / made ground. A number of intense and very strong hydrocarbon odours were also recorded in TPE8, TPE10 – TPE13 and TPE16 and creosote odours were recorded in BHE15 and BHE16.</p> <p>A Detailed Quantitative Risk Assessment (DQRA) was completed with regard to Controlled Waters Risks to derive a number of remedial clean up targets for key Contaminants of Concern including naphthalene, benzene, toluene, ethylbenzene and toluene (BTEX), phenol and total petroleum hydrocarbons (TPH). A number of the remedial targets were near or in excess of the saturation limits for the contaminant and therefore, suggestive that the presence of free phase product does not pose a risk to identified receptors.</p> <p>Remedial Targets to be protective of human health have not been derived for the identified organic CoC.</p>	<p>of dusts, ingestion of produce grown in impacted soils.</p> <p>Inhalation of vapours arising from volatile organics indoors and outdoors.</p> <p>Permeation of water supply pipes.</p>
Ground Gas (Bulk Gas)	<p>A ground gas assessment undertaken by Arup in 2008 identified methane concentrations to range from 0 to 18%v/v and carbon dioxide from 0 to 12.0%v/v. The assessment concluded that the site was predominantly CIRIA Characteristic Situation 2 or NHBC Amber 2, although the gas regime within deeper bedrock was classified as CIRIA CS 3.</p> <p>Arup considered that, should a piling foundation solution be adopted within the site, then a foundation risk assessment will need to be completed to demonstrate that no preferential pathway for the migration of ground gas is created or appropriate level of gas protection measures are incorporated within the development.</p>	Accumulation of gas indoors resulting in an asphyxiation risk or an explosive risk.
Ground Gas (Radon)	Full radon protection measures are required.	Inhalation of Radon

2.4.2 Distribution of Contamination Encountered

The following summarises the distribution of the contamination encountered to date.

2.4.2.1 West Pond

West Pond was formed by the damming of the Cadoxton Estuary when Barry No. 1 Dock was constructed and subsequently, by the construction of a causeway to the south and west of the Site. Following this the pond was gradually backfilled with tipped waste, typically believed to comprise waste generated from the surrounding docks and associated industries, including slag, furnace ash, engine ash, waste coal and now understood to include waste asbestos containing materials. The Phase I Infrastructure – West Pond report, prepared by Earth Science Partnership in 2010, indicated a varied level of infill material to be present within this section of the site, with variations from 1m to as much as 12m deep within the centre of the site, in the location of the stockpiles.

The south and eastern sections of West Pond are known to have housed a significant number of railway sidings and associated industrial operations including coal tips. From the mid 1930's the eastern section of West Pond was utilised as a tank farm which housed a number of above ground storage tanks which were used to store fuels, oils, solvents, soap, vegetable oils (cashew nut oil) which were utilised in surrounding industries.

The western side of the site was gradually in-filled, with the centre and west section of West Pond latterly being used as a railway engine and wagon refurbishment and dismantling yard, which is believed to have given rise to a degree of asbestos contamination within West Pond.

Upon removal of the railway sidings in the south, east and west of West Pond, the derelict areas in the south and southwest were utilised as car parking.

The Remediation Strategy Review issued by Ove Arup and Partners in January 2007, indicates the majority of the area of the West Pond had been remediated, with those areas remediated to a level acceptable for the residential or commercial end use in which it is to become. *It is noted that this is not now the current view of this area of the Site.*

2.4.2.2 South Quay

Upon construction of the Docks, South Quay was initially occupied by a series of railway sidings and low level coal tips. As the demand for coal decreased, a number of the sidings were removed and a tank farm and associated infrastructure and operations buildings were constructed. The South Quay tank farm stored a variety of chemicals which included hydrocarbons (kerosene, diesel, lube oil, solvents) and vegetable oil and buffering / cleaning agents. The tank farm was decommissioned in the late 1990's.

This area has been identified as requiring further ground investigation works to fully characterise the contamination present and assess the risks associated with ground gas.

2.4.2.3 East Quay

The East Quay historically comprised two graving docks.

The northern graving dock was infilled under license as part of remediation activities on other areas of the site in the 1990s. The waste facility was licensed by the Environment Agency and was reportedly fully lined and capped with inert material and landscaped to be utilised as public open space. This area is proposed to remain as public open space as part of the redevelopment.

The area of the southern graving dock has been reportedly partially remediated but some residual contamination is anticipated to be present.

This area has been identified as requiring further ground investigation works to fully characterise the contamination present and assess the risks associated with ground gas.

2.5 Requirement for Remediation

On the basis of the review undertaken previously by WSP and the summary provided above, there is considered to be a requirement for remediation to be undertaken to mitigate the potential for impacts to human health both during the redevelopment and on completion of the redevelopment once post-redevelopment use commences.

2.6 Additional Ground Investigation

Remedial measures have been described in the following sections which will address the identified contamination in terms of risks to human health and will also likely address supplementary contamination which may be identified within the areas to be subject to further investigation and assessment, however, the sufficiency of the remedial measures proposed should be reconsidered at appropriate times should conditions on the site be found to be materially different to the current understanding.

2.7 Additional Assessment of Volatile Risks

A separate assessment of the potential risks associated with volatile organic contamination and its potential to impact human health via inhalation outdoors should be undertaken and may drive additional remediation works outside of this assessment.

2.8 Additional Assessment of Risks via Water Pipe Permeation

The statutory undertaker for potable water supplies may require additional assessment of the risks from organic contamination to water pipes beyond that provided within this report. Confirmation should be sought from the statutory undertaker as to their requirements which have recently been subject to change and are also noted to vary across the UK.

3 Redevelopment Approach

3.1 Description of the Redevelopment

The Quay, Barry Waterfront Development comprises mixed retail, residential and educational development of the former West Pond and South Quay areas in the vicinity of Barry No. 1 Dock.

The development will include the construction of a new link road from Barry Island to Barry Town.

Due to the underlying ground conditions there is a requirement for a significant degree of ground improvement works in advance of the main construction phase of the development to minimise unacceptable settlement.

The ground improvement works will involve the following:

- A degree of surface re-profiling;
- High density compaction using a Landpac system;
- Installation of band drains;
- Surcharging of ground;
- Works to address/prevent groundwater impact in some areas.

Upon completion of the ground improvement works, the following works will be completed as part of the development:

- Construction of new link road;
- Construction of all new utilities, services and infrastructure;
- Construction of foundations (shallow and potentially piled);
- Required remedial works;
- Construction of properties; and
- Landscaping.

The development will be completed by a number of parties over a period of approximately 5 years.

3.2 Phasing of Remedial Activities

The nature of the development is such that redevelopment of the site can be split into at least two phases/activities which would be undertaken by separate parties. This has implications for the approach to be taken for remediation which has been split considering whom will be undertaking the remedial activities.

The two phases are as follows:

- **Enabling Works:** There is a requirement for enabling works to be undertaken and completed prior to commencement of redevelopment. Such enabling works will be undertaken by an *Enabling Works Contractor*. A degree of remedial activities are anticipated to be required during this stage of the works and these are considered to be *Enabling Works Remedial Measures*.
- **Developer Works:** Once enabling works are complete then there will be further remedial measures which will need to be implemented by the Developer for individual parcels/areas. These will be *Developer Remedial Measures*.

3.3 Roles and Responsibilities

Given the proposed phasing approach then different parties will have differing roles and responsibilities as outlined below.

Client

The Barry Waterfront Development Consortium is formed by Persimmon Homes Limited, BDW Trading Limited and Taylor Wimpey UK Limited. Persimmon Homes are acting as the Project Managers on behalf of the consortium.

The Client's responsibilities include the following elements of the remedial works:

- Appointment of a CDM Co-ordinator;
- Appointment of a competent Environmental Consultant to act on their behalf;
- Appointment of a competent Contractor (Design and Build) to complete the works;
- To facilitate the liaison between all parties;
- To obtain necessary permissions in advance of the works for the works to commence with respect to planning;
- To ensure the requirements of this strategy are communicated as needed to different parties;
- To ensure the various parties complete the required verification of the works to satisfy the planning conditions.

Enabling Works Contractor(s)

Cuddy Group has been appointed by the Client as a Design and Build Contractor for parts of the Enabling Works and their responsibilities are understood to include the following:

- Completion of the remedial works required as part of the *Enabling Works Remedial Measures* are undertaken in accordance with the strategy and in a safe manner;
- Ensuring that appropriate risk assessments and method statements are completed to ensure safe systems of work are in place and that there is no unacceptable impacts to human health or the environment arising from the process of the works;
- Design and implementation of appropriate control and mitigation measures to ensure that the site is suitable for commencement of *Developer Works* following completion of the development works;
- Liaison with the regulatory bodies (Vale of Glamorgan, Environment Agency and the HSE) to agree safe systems of work and agreement of proposed method statements;
- Validation/verification of *Enabling Works Remedial Measures* to facilitate discharge of associated planning conditions;
- Implementing appropriate Health, Safety and Environmental (HSE) controls to ensure protection of site workers, visitors and the public during the construction works.

Developer(s)

Various developers will be responsible for implementing remedial measures as part of the post enabling works construction programme. Their responsibilities will include:

- Completion of the remedial works required as part of the *Developer Works Remedial Measures* are undertaken in accordance with the strategy and in a safe manner;

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- Ensuring that appropriate risk assessments and method statements are completed to ensure safe systems of work are in place and that there is no unacceptable impacts to human health or the environment arising from the process of the works;
 - Design and implementation of appropriate control and mitigation measures to ensure that the site is suitable for the various land uses following the completion of the development works;
 - Liaison with the regulatory bodies (Vale of Glamorgan, Environment Agency and the HSE) to agree safe systems of work and agreement of proposed method statements;
 - Validation/verification of *Developer Works Remedial Measures* to facilitate discharge of associated planning conditions;
 - Implementing appropriate Health, Safety and Environmental (HSE) controls to ensure protection of site workers, visitors and the public during the construction works.

Environmental Consultant

WSP has been appointed by the Client to assist with the delivery of the development scheme. WSP is responsible for the preparation of this strategy and for working to agree the approach with the relevant regulatory authorities.

The responsibility for the implementation of the Strategy remains with the Client who will assign the completion of specific tasks to various parties as they are appointed for the various stages/phases of the works.

3.4 Site Formation Levels

A key consideration in the formulation of the remedial approaches is the need to raise specific areas of the site in the context of future flood potential to/above specific formation levels. As such, there is a desire to minimise imports of material through the careful reuse of all suitable arisings to manage both costs and promote sustainability within the development.

4 Remediation Approach to be Adopted

4.1 General

Having given consideration to the contamination on-site and the proposed development, the following general measures are considered to be required to facilitate the safe development of the site.

4.2 Clean Cover

4.2.1 Approach

Given the need to raise levels on the site, in order to prevent exposure of future site users to contamination which represents a risk via direct contact (metals, organics and asbestos), it is proposed that an approach of clean cover is utilised in order to break the potential exposure pathway.

Typically, clean cover layers on such developments are installed post property construction within areas where soft standing/landscaping is present. However, given the presence of asbestos within shallow soils currently in-situ and therefore a potential requirement to maintain additional health and safety measures to prevent asbestos exposure during the entire construction process, an alternative approach of the installation of clean cover across the entire site is considered appropriate.

Clean cover will therefore be installed across the site on top of a layer of geotextile to be placed across the existing materials. The following sequence will therefore be present once the development has been completed:

- Surface and shallow Clean Cover Material;
- Geotextile; and
- Existing ground materials.

A risk remains that during redevelopment works, underlying soils could be disturbed through excavations for foundations, drainage etc. This risk will be addressed via the following mechanisms:

- Drainage and infrastructure which needs to be below the geotextile will be installed as part of the Enabling Works and all arisings placed below the geotextile layer;
- The ground levels will be lowered in areas where future services are required to be at depth or tree planting is to be undertaken to ensure these are placed above the geotextile layer. Lowered areas will be backfilled with clean cover into which future services will be placed;
- Foundation solutions for residential properties will be raft or similar to ensure no penetration of the underlying geotextile is needed and prevent contaminated materials being brought to surface; and
- Foundation solutions for other structures will be confirmed but will be designed and implemented in such a way so as to prevent the migration of contaminated soils above the geotextile.

In order to ensure that the materials below the geotextile do not need to be disturbed once Enabling Works have been completed, the Client shall prepare a sub-formation level drawing for the Contractor which identifies the formation to be achieved onto which the geotextile shall be placed.

4.2.2 Thicknesses

In order to ensure that risks via direct contact pathways are sufficiently mitigated then the following thicknesses of clean cover will be achieved upon completion of the redevelopment of each phase/part of the site;

- Residential Development Areas – a minimum of 750mm thickness of clean cover above the geotextile layer;
- Commercial Development Areas – a minimum of 300mm thickness of clean cover above the geotextile layer;
- Landscape Areas/Park – a minimum of 600mm thickness of clean cover above the geotextile layer;
- School – a minimum of 750mm thickness of clean cover above the geotextile layer.

4.2.3 Specification of Clean Cover Materials

Clean cover materials shall comprise 'clean' soils with contaminant concentrations which fall below the Generic Assessment Criteria presented in **Appendix A**.

Where clean cover is placed in areas which will be used for future gardens/landscaping, this shall include a minimum of 150mm topsoil.

Where clean cover is placed under areas of future hardstanding and construction then it shall also be geotechnically suitable for its intended use.

The testing and verification regime for the imported clean cover is presented in **Section 5.2.1**.

4.2.4 Excavation of Contaminated Soils

Whilst the aims of this remedial strategy are to limit the unnecessary excavation of soil impacted with ACMs, it is noted that due to constraints with regards to final formation levels, service / infrastructure elevation and requirements for the commercial development it is noted that there may be a requirement to excavate material in some areas of the site to achieve the sub-formation.

It is considered that should any excavation of current site levels be required, the excavated material can be suitably stockpiled, classified and re-used in other areas of the site requiring land raise to mitigate potential flood risk. Further details are given in **Section 4.5**.

4.3 Gas/Radon/Vapour Protection

Where ground gas assessment works have been undertaken then these have identified the need for ground gas protection measures to be installed to CIRIA Characteristic Situation 3. In addition the site is located within a Radon area where full protection measures are required. Finally, there is the potential for volatile vapours to be generated from the organic contamination present in some areas of the site and enter future properties via migration through floors. On this basis, the following measures will need to be adopted:

- Full radon protective measures as specified within Building Regulations current at the time of construction and BRE 211;
- Ground gas protection measures shall comprise:
 - Residential: Reinforced, cast in-situ or beam and block floor slab with at least 2000 g gas/vapour membrane and underfloor venting, all joints and penetrations sealed. Passively ventilated sub floor void.
 - Commercial: Reinforced, cast in-situ or beam and block floor slab with at least 2000 g gas/vapour membrane and underfloor venting, all joints and penetrations sealed. Passively ventilated sub floor void.
- These measures shall incorporate a vapour resistant membrane.

It is noted that further ground gas assessment is required for some areas of the Site.

4.4 Water Pipe Materials

Although it is anticipated that future water supply pipes will be installed within the clean cover layers/service corridors, it is recommended that an allowance is made for the use of barrier pipes unless an alternative is agreed with the statutory undertaker.

4.5 Reuse of Soil Materials – Materials Management Plan

Future direct contact risks will be mitigated through the use of clean cover whilst future risks from indoor inhalation of vapours will be mitigated through the use of vapour and gas protection measures.

Future risks associated with outdoor exposure to vapours will be assessed separately but are anticipated to be low at this stage.

On this basis, there is no specific requirement to remove soils from site in order to be protective of human health in the context of the final redevelopment (there may be a requirement to remove or treat soils in relation to risks to controlled waters, however, this is outside of the scope of this strategy). As such there are no specific limits to be applied to contamination within the soils present below the clean cover layer (save for any identified by the vapour to outdoor air assessment to be completed).

It is therefore proposed to reuse all soil arisings during the works, provided they are geotechnically suitable, as there will be an overall shortfall of materials resulting in a need to import to meet flood levels. Soil arisings from the existing materials shall be placed across the site in areas of the site where fill is required.

In order to allow the reuse of soil arisings, a Materials Management Plan (MMP) shall be prepared in accordance with the CL:AIRE Code of Practice to ensure that soils can be reused without the need for waste permits. The MMP shall also account for the need to import soils to the site in order to complete the clean cover layer.

4.6 Specific Issues in Relation to Asbestos

One of the key contaminants on the site is asbestos which has been identified both as free fibres within soils and as asbestos containing materials. The retention of these contaminated soils on-site rather than excavation and removal is considered to be both a safer and more sustainable option than excavation and transport off-site which would result in a significant potential for fibre release to occur.

However, the presence of asbestos within these soils presents a constraint to their handling and movement during the enabling works.

The Enabling Works Contractor shall be responsible for the design and implementation of safe excavation, handlings and deposition systems for these materials, however, the following will be requirements of this Remediation Strategy in order to reduce the risk of a fibre release event and impacts to the wider environment:

- The Contractor shall undertake handpicking of visible ACM materials on stockpiles or on the ground surface and proper disposal of the handpicked materials in accordance with duty of care in order to minimise the potential for such materials to degrade and release fibres and to mitigate the visual impact of the presence of asbestos.
- The hand picking shall be undertaken prior to the movement of stockpiles across site and also after the placement of stockpiles.

4.7 Discussion and Agreement with the Regulatory Authorities

Initial discussions have been held with the Environmental Health Department of Vale of Glamorgan and the Health and Safety Executive, who in principle have no objections to the strategy outlined within this document, subject to the appropriate risk assessment, detailed method statements and implementation and monitoring of appropriate control measures to ensure protection of site workers, visitors and public during the development.

The production and implementation of the detailed method statements and risk assessments rests with the Contractor and their sub-contractors.

5 Enabling Works Remedial Measures

5.1 General

Given the duration of the proposed development, the need to raise site levels in some areas and the varying number of parties involved in future development works, (house builders and commercial developers), the Client has decided that in order to eliminate the requirement for the additional special control / mitigation measures required to handle asbestos containing soils during any post enabling works activities, the *Enabling Works Remedial Measures* shall be undertaken in such a way as to mitigate the need for contact with the underlying soils materials once enabling works are complete.

Given the risks of fibre release from ongoing disturbance of asbestos containing soils, the duration of the proposed development and varying number of parties involved (house builders and commercial developers), the Client has decided that in order to eliminate the requirement for the additional special control / mitigation measures required to handle asbestos containing soils during any post enabling works activities, the formation must be achieved in such a way as to mitigate the need for penetration of the geotextile for installation of roads, services etc.

The Enabling Works Contractor (or his sub-contractors) will therefore need to undertake the works described below in order to achieve the required condition of the site prior to the commencement of development works in specific phases/areas.

The Enabling Works will involve working with materials containing asbestos. As such the works will be governed by the Control of Asbestos Regulations 2012 (amongst other regulations). The Contractor will therefore need to engage with the Health and Safety Executive in order to ensure works are completed in accordance with the regulations and all required permissions.

5.1.1 Surface Profiling – Landpac and Band Drains

The ground conditions beneath the site are such that a large degree of settlement is expected from the loading of the strata during development. Therefore, prior to the main development works commencing the site will be subject to Landpac which is a high energy compaction technique which will assist in expediting the settlement of underlying materials.

Prior to the commencement of the LandPac, the surface of the soils shall be inspected and handpicked for asbestos.

Upon completion of the Landpac, band drains will be installed to facilitate the removal of pore water and assist with the rate of settlement.

The LandPac will be undertaken onto the existing soils. The Contractor shall prepare appropriate Risk Assessments and Method Statements and implement appropriate mitigation, control and monitoring to ensure the works can be undertaken without impact to health or the wider environment.

5.1.2 Cut/Fill Activities

Following completion of the LandPac, should any cut/fill be required then it should be undertaken with any excess arisings appropriately stockpiled for reuse as fill. The Contractor shall prepare appropriate Risk Assessments and Method Statements and implement appropriate mitigation, control and monitoring to ensure the works can be undertaken without impact to health or the wider environment.

5.1.3 Installation of Break / Marker Layer

Following the cut/fill, the sub-formation profile shall be inspected for visual signs of asbestos, which shall be handpicked if encountered. Once the upper surface has been inspected and confirmed to be visually free of

asbestos a permeable geotextile membrane shall be installed to act as a break / marker layer between the residual contaminated soils and clean cover.

The specification of the geotextile membrane will be sufficient to minimise damage or deterioration for the lifetime of the development. The Contractor will submit details of the proposed marker system to the Local Planning Authority for comment in advance.

A photographic record of the installation and topographic elevations of the marker layer will be recorded and included within the Validation Report.

5.1.4 Surcharging

In order to minimise unacceptable settlement during the development, the underlying ground will require surcharging. Following installation of the marker layer, clean cover material shall be loaded to facilitate increased rates of settlement. The loading / surcharging of the ground will be undertaken in phases, with stockpiles of material left in-situ for periods of 1 to 2 months or until the appropriate level of settlement has been achieved. Once the settlement has been achieved in one area, the stockpile will be moved to the next phase and the process repeated.

In order to minimise potential damage to the underlying marker layer from the repeated re-excavation of surcharge material, a minimum of 100-200mm of surcharge material will be left in-situ following completion of the surcharging to form part of the future clean cover layer.

A programme of the phasing of the surcharging activities and method statements for undertaking the surcharging shall be submitted by the Contractor to the LPA and HSE for review and comment prior to commencement.

5.1.5 Initial Clean Cover Placement

Upon completion of Items **5.1.1 to 5.1.4** above, a geotechnically and chemically suitable layer of clean cover shall be provided across the development area.

The thickness of clean cover to be placed across the area shall be as instructed by the Client (given due regard to the final minimum thicknesses specified in **Section 4.2.2**) but shall be a minimum of 200mm above the underlying geotextile and shall not include topsoil which is to be placed as part of the development phase.

The provision of the initial clean cover layer shall be to provide a cover barrier of suitable material in order to mitigate potential risks to human health receptors from residual soil contamination during the later development phase.

Beneath buildings, services and infrastructure, the clean cover specification will be determined by the geotechnical requirements, as detailed within the appropriate Earthworks and Structural Performance Specifications.

5.2 Key Considerations

5.2.1 Clean Cover Material

Any material to be placed as Clean Cover (including materials used for surcharging) shall be sampled by the Enabling Works Contractor prior to import onto the Site. The test suites shall pay due consideration to the previous use of the site from which the material is sourced and the testing regime should reflect this previous land use. The Contractor shall, as a minimum, undertake testing on the following basis:

- Asbestos must not be detected in the soil screen. The detection limit of the screening method must be 0.001%.
- Metals: arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury, selenium;
- PAH: USEPA 16 PAH Suite;

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- Total petroleum hydrocarbons: TPH Criteria Working Group suite (TPHCWG);
 - Benzene, toluene, ethylbenzene and xylene; and
 - pH.

The Contractor shall undertake testing on the following frequency for the determinands specified above and any additional contaminants reasonably deemed to be required based on the previous use of the material source site:

- Each distinctive source site: a Minimum of four samples;
- One sample per 2500m³ for natural materials arising from a site with no known previous contaminative use;
- One sample per 1250m³ (or greater) for materials arising from a previously developed site regardless of the use.
- This sampling regime to be in addition to any existing data for the materials unless the Contractor can provide reliance upon the testing data to the Client.

The Contractor shall ensure that the imported materials comply with the limits provided in **Appendix A** in relation to contamination which may be present in soils. This list is based on published Soil Guideline Values, published Generic Assessment Criteria and Generic Assessment Criteria produced by WSP and are for a *Residential with Plant Uptake Land Use*.

The Enabling Works Contractor shall be responsible that all materials placed as clean cover during the Enabling Works meet the criteria in **Appendix A**.

Additional testing of the placed clean cover materials by the Enabling Works Contractor is not required.

5.2.2 Handling to Prevent Cross-Contamination

During the works it will be necessary to undertake the multiple handling of the surcharge materials including placement in areas where asbestos is known to be present in the underlying ground. The Enabling Works Contractor shall undertake the following steps to prevent cross contamination of the surcharge materials with the underlying ground:

- Prior to the placement of any materials, the Enabling Works Contractor shall undertake a surface hand pick of any visible asbestos containing materials with disposal of handpicked materials in accordance with existing regulations and duty of care. The Enabling Works Contractor shall consider whether such activities are licensable. Where such materials are fragmented beyond what could be reasonably picked then the Contractor shall consider surface scraping or covering to ensure that no fragments are present on the surface of the existing made ground.
- The Enabling Work Contractor shall place a suitable water permeable geotextile across the area to be subject to surcharging;
- The surcharge material shall be placed upon the geotextile material;
- At no time should the surcharge material be placed directly upon the existing made ground unless it has become cross contaminated, in which case the material may be considered to have become unsuitable for use as Clean Cover and then may need to be consigned as fill (below the geotextile) or as Unsuitable Material for disposal.

5.2.3 Stockpiling Contaminated Material

Potentially contaminated materials excavated shall be stockpiled on a membrane or intact concrete slab to avoid contamination of the soils underneath prior to characterisation for re-use and/or disposal to landfill. In order to minimise dust generation, the stockpiles will be appropriately sheeted down or dust suppression techniques employed. Additionally, low bunds to facilitate collection of rainwater runoff etc. should be provided around the stockpile.

5.2.4 Unsuitable Material

Should the Contractor undertake the importation of any materials to the site which, after testing or inspection are considered to represent unsuitable materials due to the presence of contamination then he shall be responsible for the removal and disposal of these materials.

Should unsuitable materials (chemically or geotechnically) be encountered within site won material, the Contractor will be responsible for the treatment and / or disposal of such materials in accordance with current legislation.

5.2.5 Waste Classification

As part of the works, and prior to removal from site, it is recommended that the disposal classification (i.e. inert, non-hazardous or hazardous) is considered. This can initially be derived based on the laboratory results from the previous investigations. Subject to this classification further laboratory analysis may be required including loss on ignition, flash point, total organic carbon and waste acceptance criteria testing, as deemed appropriate. The number of samples to be analysed will depend on the amount of ground excavated. It would be anticipated that the frequency of analysis would not be less than one sample per 200m³ of material excavated.

5.2.6 Site Waste Management Plan

Since April 2008, all new construction projects being undertaken in England worth more than £300,000 must have a basic Site Waste Management Plan (SWMP). An SWMP is a process for identifying waste streams prior to the commencement of works and are required to describe how to reduce and manage the wastes generated during such works with an emphasis on continuous record keeping.

5.2.7 Materials Management Plan

Based on the volume of earthworks proposed at the site and in order to ensure that all movement, re-use and disposal are properly tracked and traceable, a Materials Management Plan (MMP) in accordance with the CL:AIRE Code of Practice should be created and implemented at the site after approval by the regulatory authorities. The MMP should not only include bulk earthworks but also topsoil conservation and importation.

5.2.8 Duty of Care

The movement of materials on and off-site will be recorded and documented. It should be undertaken by a party who is suitably licensed for waste transportation and disposal activities. Results of laboratory analysis of the material will be given to the sub-contractor in order for the material to be disposed of correctly.

All waste disposal activities will be undertaken in accordance with the Duty of Care Regulations associated with Environmental Protection Act 1990 (as amended) and the Waste Management Regulations, and will be agreed with the appropriate officers from the Environment Agency.

5.2.9 Groundwater Remediation

Unacceptable levels of organic contamination have been identified within soil and groundwater in the east and southeast of the site (former South Quay and eastern end of West Pond) which required mitigation to eliminate potential risks to controlled water receptors. A remedial method statement for the remediation of soil and groundwater impacted by organic contamination will be submitted by the Contractor to the LPA and EA in advance for approval.

It is anticipated that further site characterisation / delineation works will form part of the method statement to ensure that the degree and extent of the identified contamination is appropriately understood.

Any remedial / mitigation works with regard to groundwater are likely to be required in advance of enabling works in the east and southeast of the site in order to minimise potential for cross contamination of clean cover and unnecessary double handling of materials. The programme / phasing of the works and regulatory approval

of method statements in relation to the remedial activities remain the responsibility of the Enabling Works Contractor.

5.2.10 Dewatering

Shallow groundwater is anticipated on-site based on the assessments undertaken to date. Should shallow perched groundwater be encountered or significant run-off enter open excavations from any source, dewatering should be undertaken by arranging for the rapid removal of water and maintaining by appropriate measures, the water level in excavation, sufficiently to enable the backfill to be laid and compacted.

Groundwater has been noted to contain elevated concentrations of metals, PAHs and TPH which pose a potential risk to surface water and groundwater quality. Treatment may be required prior to disposal to sewer and acceptable limits will need to be agreed with Welsh Water; alternatively a consent to discharge to the Barry No. 1 Dock may be obtained, but it is considered that pre-treatment would be required, as a minimum and agreement to discharge to sewer should be sought in the first instance.

Should prior treatment be required for dewatering of excavations and pile cap voids. The likely water treatment plant would include the following components, or similar:

- Waste Holding Tanks typically comprising two 20m³ steel tanks (or equivalent) for temporary storage of waters, arising on-site, including suitable pumps and hoses for filling and completing emptying the tanks
- Sedimentation tank(s);
- Oil/water separation tanks (two stages);
- Filtration unit(s) to remove suspended solids;
- Granular activated carbon (GAC) units, or similar, to remove dissolved and immiscible hydrocarbons, including VOCs, as appropriate; and
- Flow meter and discharge arrangements.

5.3 Buried Features

Any encountered buried structures/features will be inspected, degassed and made safe prior to removal. Obstructions will be removed to their complete depth where practicable. Any major structures which are left in-situ will be recorded by survey and will be punctured with the sides and bases broken to avoid stagnation of perched groundwater.

5.4 Unexpected Finds

Should any areas of residual contamination, unexpected finds, potentially contaminative infrastructure, suspect or odorous materials be identified during the earthworks, the Client should be informed and work ceased in that area until an inspection and any relevant laboratory testing has been undertaken. Should it be required for programme purposes, the material may be carefully excavated and removed to a designated area which is sheeted in polythene or to a designated skip. The material should also be covered with polythene to prevent infiltration pending sampling and testing.

5.5 Method Statements and Permits

All method statements and supporting documentation shall be submitted by the Enabling Works Contractor to the regulatory authorities in accordance with current regulations and guidance in advance of the works for approval prior to commencement.

The Contractor will inform the regulators of any variations to the submitted method statements and submit documentation / data records to the authorities, as necessary.

5.6 Control of Asbestos

Asbestos recovery will be limited to hand-picked materials which are present at surface or encountered during surface re-profiling works. The Enabling Works Contractor shall be responsible for ensuring all such works are undertaken in accordance with the relevant permits and regulations. For clarity, the hand picking of soils shall not be considered to eliminate the risks associated with such materials and a safe system of work shall be developed by the Enabling Works Contractor for any works involving asbestos containing materials.

A detailed method statement for these works will be provided by the appointed specialist contractor, which will include the following:

- Methods used to classify what soil can be safely handled for the purpose of recovering cement bonded asbestos;
- Determination of methods for breaking up asbestos containing soil making it easier to identify and remove asbestos fragments;
- The design of a treatment area, which will include low permeability floor, fencing, asbestos storage bins and dust/particulate suppression;
- Determine methods of 'cherry picking' asbestos fragments from soil, managing the on-site storage of collected asbestos and its disposal;
- Detail the health and safety controls including ambient air monitoring for the handling of the asbestos containing soil ensuring site staff and third parties are protected; and
- Detail methods for field testing processed soil to determine whether it needs to be reprocessed prior to final validation.

5.6.1 Asbestos Monitoring

The Enabling Works Contractor is likely to include personal monitoring for asbestos fibres for his staff, however, he is also required to design and agree a programme of boundary and static air monitoring throughout the works where asbestos containing soils are handled to demonstrate that the works are not resulting in the release of asbestos fibres which could impact the environment or the general public.

5.7 Site Working Practices

All workers should be made aware of the contamination potential at the site, how to recognise contaminants and appropriate mitigation measures to limit their exposure. Construction workers should wear appropriate PPE and RPE and adhere to appropriate hygiene protocols as determined by site management practices.

To mitigate the potential adverse effects of windblown materials, areas being excavated must be dampened down. Any stockpiles of excavated material should be similarly dampened and covered at the earliest practicable opportunity.

To prevent impact on the underlying soils and groundwater, construction plant, materials (including hazardous materials), fuels, oils and chemicals must be stored in appropriate containers within a bunded compound in accordance with the Pollution Prevention Guidance Note 6: Working at Construction and Demolition Sites (Ref. 12.20). This will minimise the potential for accidental spills.

In accordance with current best practice and Health and Safety legislation, all relevant site practices should be documented in a Construction Environmental Management Plan (CEMP) approved by the Local Authority.

5.8 Condition of the Site on Completion of the Enabling Works

For clarity, on completion of the enabling works:

- All sites soils containing contamination including asbestos shall have been placed and covered with a geotextile;

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- A layer of clean cover or a minimum 200mm thickness shall be present. The clean cover shall have been engineered where appropriate dependent upon the Client's requirements; and
 - Infrastructure which needs to be placed at depth within existing site soils shall have been installed.

5.9 Correspondence with Regulatory Authorities

Relevant records of any complaints, correspondence or site meetings held by / with the Environment Agency, Environmental Health or Planning Departments of Vale of Glamorgan or the HSE shall be kept on-site and copied to the Environmental Consultant, if necessary.

5.10 Photographic Record

Photographs shall be taken at key points throughout the remediation works at an appropriate frequency and shall be dated and annotated and shall include, but not limited to the following:

- Earth movements;
- Validation of the removal of visual asbestos;
- Installation of geotextile membrane;
- Stockpiled material on-site;
- Resulting excavations;
- Material being disposed of off-site;
- Flooded excavations;
- Placement of imported clean cover;
- Placement and movement of surcharge materials; and
- Any suspicious or potentially impacted / contaminated soils encountered at the site including areas of latent contamination;

5.11 Validation/Verification Reporting

The Enabling Works Contractor shall be responsible for completing verification reporting of his works.

The Client shall specify whether a single report is required or whether separate reports will be needed for different areas/phases.

The Enabling Works Contractor's Validation/Verification report(s) shall be suitably detailed to meet the requirements of the Planning Authority. This document will deal solely with the scope of works agreed for the detailed remediation method statement and as a minimum it will contain the following data to be allowed for and compiled by the Contractor.

- A photographic record of all remedial works;
- Any correspondence with the Regulatory Authorities;
- Details of any residual contamination identified during the works;
- Details of the extent of all excavation in the form of surveyed 'as built's';
- Volumes of material excavated from remediation areas;
- Contamination levels at excavation extents;
- Evidence of waste disposal records including:
 - Chemical Quality Certificates (laboratory chemical analysis e.g. WAC testing)

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- Landfill Tip Tickets
 - Confirmation of haulage sub-contractor and disposal facilities including:
 - EA Haulage Company Certificates
 - Records of any imported materials including:
 - Chemical Data from Source of Origin;
 - Chemical Quality Certificates for comparison against validation criteria prior to deposition.
 - Groundwater and Surface Water Monitoring
 - Results of groundwater and surface water chemical analysis.
 - Records of environmental monitoring including dust, asbestos, vapours and groundwater data (as appropriate).
 - A topographic survey of the sub-formation where the geotextile layer has been placed;
 - A topographic survey of the formation achieved after completion of the Enabling Works;
 - An isopachyte of the thickness of clean cover placed by the Enabling Works Contractor.

6 Developer Remedial Measures

6.1 Condition of the Site on Commencement of Developer Remediation

The enabling works should have been undertaken to ensure that once Developers commence works on a specific area of the site, no disturbance of underlying site soils below the geotextile is required and as such asbestos control measures would not be needed for developer works (subject to individual developers risk assessments).

The Client shall ensure that the requirement not to disturb underlying soils is appropriately communicated to all developers working on the Site.

6.2 Completion of Clean Cover Placement

The Developers shall be responsible for the completion of the remedial works through the placement of the required thicknesses of clean cover material into their development areas. This will require the import of further materials.

6.2.1 Imported Clean Cover Material

Any material to be placed as Clean Cover (including materials used for surcharging) shall be sampled by the Developer prior to import onto the Site. The test suites shall pay due consideration to the previous use of the site from which the material is sourced and the testing regime should reflect this previous land use. The Developer shall, as a minimum, undertake testing on the following basis:

- Asbestos: Presence or absence to a detection limit of <0.001%;
- Metals: arsenic, cadmium, chromium, copper, nickel, lead, zinc, mercury, selenium;
- PAH: USEPA 16 PAH Suite;
- Total petroleum hydrocarbons: TPH Criteria Working Group suite (TPHCWG);
- Benzene, toluene, ethylbenzene and xylene;
- pH.

Pre-importation Sampling

The Developer shall undertake testing on the following frequency for the determinands specified above and any additional contaminants reasonably deemed to be required based on the previous use of the material source site:

- Each distinctive source site: a Minimum of four samples;
- One sample per 2500m³ for natural materials arising from a site with no known previous contaminative use;
- One sample per 1250m³ (or greater) for materials arising from a previously developed site regardless of the use.
- This sampling regime to be in addition to any existing data for the materials unless the Developer can provide reliance upon the testing data to the Client.

The Developer shall ensure that the imported materials comply with the limits provided in **Appendix A** in relation to contamination which may be present in soils. This list is based on published Soil Guideline Values, published Generic Assessment Criteria and Generic Assessment Criteria produced by WSP and are for a *Residential with Plant Uptake Land Use*.

Post Placement Sampling

The Developer shall be responsible that all materials placed as clean cover during the Enabling Works meet the criteria in **Appendix A**. Once soils are placed, the Developer shall undertake the following additional confirmatory sampling:

- Residential Development Areas: One soil sample per 10 plots tested for the above suite; Two trial pits per 10 plots advanced to confirm the clean cover depth is greater than 750mm;
- Commercial Development Areas: One sample per hectare of landscaped area; One trial pit per hectare advanced to confirm clean cover is greater than 300mm;
- Landscape Areas/Park: One sample per hectare of landscaped area; One trial pit per hectare advanced to confirm clean cover is greater than 600mm;
- School: Three samples per hectare of landscaped area; Three trial pits per hectare advanced to confirm clean cover is greater than 750mm;

Each sample shall be tested for the suite detailed in **Section 6.2.1**.

6.2.2 Validation/Verification Reporting

The Developer shall be responsible for completing verification reporting of his works.

Reports will be required for different areas/phases detailing the completion of the Cover Layer.

The Developer's Validation/Verification report(s) shall be suitably detailed to meet the requirements of the Planning Authority. This document will deal solely with the scope of works agreed for the detailed remediation method statement and as a minimum it will contain the following data to be allowed for and compiled by the Developer.

- Any correspondence with the Regulatory Authorities;
- Records of any imported materials including:
 - Chemical Data from Source of Origin;
 - Chemical Quality Certificates for comparison against validation criteria prior to deposition; and
- Records of the Pre-importation sampling and the Post-placement verification sampling and excavations.

6.3 Ground Gas Protection Measures

ARUP SI Phase II reclamation report states that in light of previous investigations on the site, where no appreciable gas concentrations were identified, no gas monitoring was carried out.

In the Arup 1992 Dock 1 Geotechnical and Contamination Report it was mentioned that soft ground boreholes were monitored for explosive gases during drilling, no exceedances of lower explosive limit (LEL) were recorded (5% of the LEL). Eight of the boreholes were installed with gas standpipes. The mean oxygen content was low in BH5, BH2, BH8, and BH18 (4.2 – 18.9%), while BH 20, BH21 and BH25 have mean values between 19.6-20.8%. The LEL had a maximum of 2.0 % LEL in BH5 and the CO2 ranged between 8% and 0%, the maximum being in BH2.

Four of the boreholes (BH2, BH5, BH8 and BH21) were sampled in July 1992, the original four plus an additional four were sampled in August 1992 (BH12, BH18, BH20 and BH25). BH5, BH8, BH12, BH21 and BH25 were sampled in September 1992. All samples were analysed for methane, carbon dioxide, oxygen, nitrogen and hydrogen sulphide.

The methane concentrations were mostly <0.02 with a maximum concentration of 5.8 % in BH18 in the September 1992 round. Carbon dioxide ranged from 0.19% - 11%, maximum in BH18 during the September sampling round. The oxygen content was very low in all rounds for BH2 and BH5, BH12 was low for the August and September gas sampling rounds. In BH18 the oxygen levels dropped from 21% in August to 11% in

September 1992. The nitrogen content was fairly consistent with a minimum value of 72% in BH18 September round and a maximum of value of 94% in BH12 during the August sampling round. The hydrogen sulphide levels were consistently below the limit of detection.

The Arup 2008 Desk Study mentions that previous investigations revealed likely soil and groundwater contamination by hydrocarbons and heavy metals and its impact on housing development needs to be considered. It is also mentioned that South Quay is impacted by Radon and with will need to be accommodated in the design of new substructures.

Additional ground gas monitoring is recommended to access whether there is a risk to human health.

The Developer shall also be responsible for the final design, installation and validation of the ground gas protection measures:

- Full radon protective measures as specified within Building Regulations current at the time of construction and BRE 211;
- Ground gas protection measures shall comprise:
 - Residential: Reinforced, cast in situ or beam and block floor slab with at least 2000 g gas/vapour membrane and underfloor venting, all joints and penetrations sealed. Passively ventilated sub floor void.
 - Commercial: Reinforced, cast in situ or beam and block floor slab with at least 2000 g gas/vapour membrane and underfloor venting, all joints and penetrations sealed. Passively ventilated sub floor void.
- These measures shall incorporate a vapour resistant membrane.

6.4 Water Pipe Materials

The developer shall be responsible for the agreement of the pipe material with the statutory undertaker and installation of the agreed materials.

7 Other Considerations

7.1 Implementation of the Remediation and Verification Strategy

The strategy detailed herein shall be implemented by the Client via conditions of contract, entered into by individual contractors involved in relevant aspects of the site redevelopment.

The various contractors will need to employ suitable competent environmental consultants and asbestos specialists during the works.

7.2 Additional Works

Although there have been past site investigations, further investigation is considered to be required in specific areas to confirm the ground conditions and contamination and to characterise specific areas in relation the ground gas.

It has been identified that additional assessment works need to be undertaken to confirm conditions in some areas of the site as follows:

- An assessment of the risks to human health via outdoor air inhalation from the organic contamination on Site;
- Additional ground investigations of South Quay and East Quay including additional ground gas assessment.

This is in addition to further work which may need to be done in relation to groundwater contamination and risks to Controlled Waters which are outside of the scope of this assessment.

This strategy may be subject to revision should conditions in these areas be identified as significantly different to those anticipated from the provided data.

Figures

Appendix A – Clean Cover Chemical Acceptance Criteria

Table A.1 – Maximum Limits for Common Contaminants

Contaminant	Maximum Concentration (mg/kg)
Asbestos	None Detected (detection limit <0.001%)
Arsenic	32
Barium	225
Beryllium	51
Boron	290
Cadmium	10
Chromium (III)	3000
Chromium (VI) (Hexavalent)	4.3
Copper	2300
Cyanide (Free)	60
Lead	410
Inorganic Mercury	170
Nickel	130
Selenium	350
Tin	7300
Zinc	3700
Benzo[a]anthracene	3.1
Benzo[b]fluoranthene	5.6
Benzo[k]fluoranthene	8.5
Benzo[ghi]perylene	44
Benzo[a]pyrene	0.83
Chrysene	6.0
Dibenz[ah]anthracene	0.76
Fluoranthene	260
Indeno[123-cd]pyrene	3.2
Naphthalene	1.5
Pyrene	560
Fluorene	160
Anthracene	2250
Phenanthrene	92
Acenaphthylene	170
Acenaphthene	205
Benzene	0.08
Toluene	119
Ethylbenzene	65
m-Xylene	44
o-Xylene	45
p-Xylene	42
Methyl tert-butyl ether	49
1,2,4-Trimethylbenzene	0.35
iso-Propylbenzene	11

Contaminant	Maximum Concentration (mg/kg)
Propylbenzene	34
Styrene	8.1
<i>Aliphatic EC >5-6</i>	30
<i>Aliphatic EC >6-8</i>	73
<i>Aliphatic EC >8-10</i>	19
<i>Aliphatic EC >10-12</i>	93
<i>Aliphatic EC >12-16</i>	740*
<i>Aliphatic EC >16-35</i>	45000*
<i>Aliphatic EC >35-44</i>	45000*
<i>Aromatic EC >5-7</i>	65
<i>Aromatic EC >7-8</i>	120
<i>Aromatic EC >8-10</i>	27
<i>Aromatic EC >10-12</i>	69
<i>Aromatic EC >12-16</i>	140
<i>Aromatic EC >16-21</i>	250*
<i>Aromatic EC >21-35</i>	890*
<i>Aromatic EC >35-44</i>	890*
<i>Petroleum Hydrocarbons EC >44-70</i>	1200*
<i>Total Petroleum Hydrocarbons</i>	500
Chlorobenzene	0.33
1,2-Dichlorobenzene	16
1,3-Dichlorobenzene	0.29
1,4-Dichlorobenzene	30
1,2,3-Trichlorobenzene	1.0
1,2,4-Trichlorobenzene	1.8
1,3,5-Trichlorobenzene	0.23
1,2,3,4-Tetrachlorobenzene	12
1,2,3,5-Tetrachlorobenzene	0.5
1,2,4,5-Tetrachlorobenzene	0.3
Pentachlorobenzene	5.2
Hexachlorobenzene	0.60 (0.199)
2-Chloronaphthalene	3.7
Chloromethane	0.0083
Chloroethane	8.3
1,1-Dichloroethane	2.4
1,2-Dichloroethane	0.0053
1,1-Dichloroethene	0.23
Dichloromethane	0.58
<i>cis</i> -1,2-Dichloroethene	0.11
<i>trans</i> -1,2-Dichloroethene	0.19
1,1,1-Trichloroethane	6.2
1,1,2-Trichloroethane	0.6
1,1,1,2-Tetrachloroethane	0.89

Contaminant	Maximum Concentration (mg/kg)
1,1,2,2-Tetrachloroethane	1.4
Chloroethene (Vinyl Chloride)	0.00047
Trichloroethene (TCE)	0.11
Tetrachloroethene	0.94
Trichloromethane (chloroform)	0.75
Tetrachloromethane (carbon tetrachloride)	0.018
Hexachloroethane	0.2
Bromobenzene	0.87
Bromodichloromethane	0.016
Bromoform	2.8
Phenol	180

*The maximum limit for Total Petroleum Hydrocarbons shall be 250mg/kg.

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