

# **14 Ground conditions**

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## 14 Ground Conditions

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### 14.1 Introduction

This chapter summarises relevant planning policy and government guidance in relation to ground conditions and contamination. It describes the physical aspects of the site and the proposed development in so far as they affect the potential for impacts in relation to contamination of the ground (soil), water and physical ground conditions.

The impact assessment describes the potential and known sources of contamination within and around the site, current conditions, those aspects of the proposed development that may affect, or be affected by soil and water contamination, associated potential impacts, mitigation measures and residual impacts following mitigation.

The contamination setting of the site has been determined by undertaking a desk based study as well as an exploratory level ground investigation. Using this information, potential risks to receptors from identified possible sources of contamination *via* a number of pathway linkages have been assessed and mitigation measures and recommendations for further work provided.

Where there are incomplete or insufficient data, these are identified, together with proposals for additional work as part of the development.

Relevant issues within this section have implications for the assessment of other chapters of this Environmental Statement (ES), notably transport, water resources (flood risk, drainage and water quality, and hydrology), air quality, and utility services.

### 14.2 Legislation and planning policy guidance

#### 14.2.1 Environmental Protection Act 1990

Part 2A of the Environmental Protection Act 1990 (supported by DETR Circular 01/2006) sets out the statutory regime for the control and treatment of *existing* contamination for *sites not passing through the planning process*. The legislation is specifically directed at local authorities to identify and remediate sites within their catchments. The legislation works on a 'suitable for use' approach and requires remediation where it is shown that contamination is causing (or potentially causing) unacceptable risks in relation to current or intended uses of the site. The 'suitable for use' approach involves managing risks posed by contaminated land by making risk-based decisions based on a linkage between a source (of contamination), a pathway (e.g. ingestion of soil) and a receptor (e.g. a small child). If the pollutant linkage is not established or is dealt with by remediation, the site cannot be defined as 'contaminated land' under the provisions of Part 2a.

Part 2a defines contaminated land where:

‘Significant harm is being caused or there is a significant possibility of such harm being caused, or  
Pollution of controlled waters (as defined by the Water Resources Act, 1991) is being, or likely to be, caused.’

#### **14.2.2 Planning policy**

Although application of Part IIA of the Environmental Protection Act 1990 is not directly relevant to the proposed development, contamination is a material consideration under planning (as identified by Planning Policy Statement 23: Planning and Pollution Control) and it is conventional practice to adopt a similar risk - based approach to assessing the remediation requirements for all sites undergoing redevelopment.

The assessment of contaminated land and the requirement for remedial action within the planning context is further substantiated by Penwith District Council's Adopted Local Plan (4 February 2004) Policy CC-18 as follows:

Proposals for the reclamation of derelict land and the improvement of unsightly land outside towns and villages will not be permitted unless:-

the proposed use is compatible with the location of the site and its surroundings; or

the scheme is intended to reduce safety hazards; and

features of landscape character, nature conservation, archaeological, historic and geological value are safeguarded.

Where it is likely that the site contains contaminated or toxic materials prior site investigations will be required to determine the extent of contamination and, where necessary, measures to avoid pollution during and after implementation will be secured through the use of conditions

Policy TV-15 is also relevant in this regards and states as follows:

Where proposals for the re-use of previously developed land, including the reclamation of derelict land, in towns and villages involve sites likely to contain contaminated or toxic materials, prior investigations will be required to determine the extent of contamination and, where necessary, measures to avoid pollution during and after implementation will be secured through the use of conditions.

#### **14.3 Methodology and assessment criteria**

This section describes the methodology used to investigate ground conditions and assess the affects of land contamination.



A risk-based approach was used to assess contamination which required identification of a contaminant source (hazard), a receptor and a realistic pathway *via* which the contaminant may reach the receptor.

The assessment considered both the impacts of potential existing contamination on the proposed development and the potential for the proposed development to impact on land quality.

### **Spatial scope**

The spatial extent of this assessment comprises land within the site boundary and the wider area within which on-site migration of contaminants may adversely affect defined receptors such as infrastructure, water resources, ecology and general public.

### **Temporal scope**

This assessment summarises all the historical information available relating to the site to date, detailing the potential contaminants that may be present on site as a result of previous land uses. The potential impacts and effects during the construction phase of works and the site operation (based on the proposed land use) are identified and assessed.

### **Technical scope**

The contaminated land report identified a number of resources / receptors that may be affected by contamination present on site. These include:

- Construction workers
- Current & Future site users
- Potential groundwater and surface water resources
- Plants / fauna

#### **14.3.1 Methods for determining current baseline conditions**

The significance of the hazards posed by potential sources of contamination both on and off site has been assessed by the following methodologies:

- Desk based study: this included a review of all available environmental information on the site (this may include previous site investigation data where available) and surrounding areas and a detailed assessment of all historical information relating to the site and surrounding areas
- Site inspection: undertaken as part of the desk based study, this included an inspection of visible and olfactory evidence of contamination present at the surface as well as assessment of the current site uses to identify whether any potentially harmful substances are being used or stored on site

- Site investigation: an exploratory level site investigation was undertaken following the desk based study and site inspection. The spacing and positioning of exploratory hole locations in the ground investigation undertaken in 2005 was informed by the preceding desk top study and standard industry guidance (R&D Report P5-066/TR, 2000). Therefore, where areas of the site were identified as being potentially contaminated due to historical activities, a more targeted approach was adopted for these areas

#### **14.3.2 Impact magnitude**

Criteria for assessing the significance of potential human and environmental impacts have been based on a qualitative assessment of the magnitude of the effect (or how far the *effect* deviates from the baseline condition) and the receptor sensitivity. The qualitative criteria used to assess how far an impact effect deviates from the baseline condition, i.e. the magnitude of change, are described in Table 14-1 below.

Magnitude of Change	Criteria
Large	Construction phase Construction activities result in a major pollution release.  Operational phase The development introduces a new large scale source of potential contamination or potential receptor.
Medium	Construction phase Construction activities result in a minor pollution release.  Operational phase The development introduces a new small scale source of potential contamination or potential receptor.  The development introduces a new pathway for pollution linkage
Small	Construction phase Typical construction related pollutant release.  Operational phase Temporary pathway or receptor introduced only for pollution linkage.
Negligible	No foreseeable change

**Table 14– 1 Magnitude of change**

### 14.3.3 Receptor sensitivity

The receptors identified on the previous page are considered to have varying degrees of sensitivity to contamination potentially present within the site, based on potential impacts and pathways. Receptor sensitivity is defined in Table 14-2.

Sensitivity	Receptor
High	<p>Land to be used for allotments or domestic gardens, to grow crops for human consumption, or upon which animals are reared for human consumption</p> <p>Parks playing fields and open spaces (soft landscaping only)</p> <p>Highly sensitive water receptor, e.g. public water supply, water body of a high quality, or of a highly sensitive aquatic ecosystem</p> <p>High sensitive ecosystems, SSSI, SPA, NNR, cSAC.</p>
Moderate	<p>Land to be used for residential purposes without gardens</p> <p>Moderately sensitive water receptors, other aquifers, water body of medium quality, moderately sensitive aquatic ecosystem not used for large scale human consumption, can be used for industrial purposes. Often important for local recreational properties.</p> <p>Moderately sensitive ecosystems such as regionally scarce habitats or local amenity areas</p>
Low	<p>Industrial/Commercial end uses</p> <p>Ecosystems such as derelict land etc.</p> <p>Low sensitive water receptors include non potable water sources, water body of poor quality, low recreational qualities, low ecological content</p> <p>Industrial land use</p>
Negligible	No pollutant pathway present

**Table 14– 2 Sensitivity of receptor**

#### 14.3.4 Significance evaluation

The assessments of magnitude of change and sensitivity of the receptor have been used to qualitatively assess the impact significance of the proposed development as shown in Table 14-3. Impacts have the potential to be either adverse or beneficial.

Receptor Sensitivity	Magnitude of Change			
	Large	Medium	Small	Negligible
High	Major	Major	Moderate	Minor
Moderate	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Minor	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

**Table 14– 3 Assessment criteria for impact significance**

#### 14.3.5 Limitations, assumptions & exceptions

The nominal grid spacing selected for the ground investigation means that there is potential for large features to have gone undetected in this phase of the survey. Following R&D Technical Report P5-066/TR, 2000 (Secondary Model Procedure for the Development of Appropriate Soil Sampling Strategies for Land Contamination, published by the Environment Agency) the grid used was determined to have a 40% probability of detection of a 100m<sup>2</sup> circular feature and an 80% probability of detection of a 2000m<sup>2</sup> circular feature. Therefore, a more closely spaced soil sampling grid, directly linked to end use, should support detailed design.

Due to limitations in baseline data available at this stage, further investigative work will be undertaken for detailed design. Results from this additional assessment will be submitted in support of the detailed planning application for this development. Information describing the requirements of the additional work is provided in Section 14.7.

Stockpiled materials in the area of the disused power station have not been sampled as it is understood that this material is owned by the operator of the recycling plant on North Quay and will be removed before development.

No work has been undertaken to locate and investigate any concealed underground tanks, although none have been identified as being present on site by Cornwall Fire Brigade.

Localised instances of fly tipping have not been sampled or assessed.

Further work is required to characterise the approximate 20,000 m<sup>3</sup> of fill to be excavated from the western side of South Quay.

As yet no investigations have taken place beneath existing buildings and floor slabs.

Although a number of limitations have been identified, the assessment undertaken to date is considered suitably robust for the purposes of this Environmental Assessment chapter. Additional ground investigation is proposed in due course to;

- i. Confirm initial findings
- ii. Undertake sampling where access was not possible in the original ground investigation
- iii. Where significantly elevated concentrations of contaminants were encountered for the purposes of delineating the extent (vertical and horizontal) of the contamination. The results of all of these investigations will in form subsequent detailed quantitative risk assessment and identification of the need and scope of remediation

#### **14.4 Baseline conditions**

##### **14.4.1 Site description**

In addition to its coastal location, Hayle Harbour receives fluvial waters from the Mellanear and Angarrack Streams. It is also in close proximity to the Hayle River. The town itself includes a large harbour and has a long history of industrial development. The development of the town has led to its current division into the western "Foundry" and eastern "Copperhouse" areas. The layout of the harbour is dominated by two tidal water storage lagoons, Copperhouse Pool and Carnsew Pool, constructed to flush sediment from the harbour.

In the north western part of the site is a large area (approximately 10,800m<sup>2</sup>) owned and operated as a sub-station by Western Power. Numerous over ground electricity cables enter the substation from the north west, whilst cables to the south west are buried underground, some of which cross the estuary towards the village of Lelant.

During the ground investigation Japanese knotweed was identified on South Quay which was later confirmed by an ecological survey.

Further details are set out in the Buro Happold Ltd Contamination Report in Technical Annex 14A.

##### **14.4.2 Site history**

A brief history of the site is set out in Chapter 2 of this Environmental Statement and covered in more detail in Chapter 10 and those aspects of particular relevance to ground conditions are detailed in the Buro Happold Ltd Contamination Report in Technical Annex 14A.

In summary, the previous land usage across the site of relevance to this assessment includes the following:

- sand and gravel pits

- copper and tin mines
- gasworks
- iron foundries
- tin and copper smelting
- calcining works
- glass works
- rifle range
- ore hutches
- chemical works (sulphuric acid, bromine)
- a coal-fired power station
- coal yard
- electricity sub-station
- waste treatment
- boat building and breaking
- various scrap yards
- lime kilns
- a timber yard and saw mills
- steel fabrication and engineering
- biscuit works
- oil storage
- railway and crane lines
- general wharves

Figure 2 of Technical Annex 14A shows the locations of these historical land uses across the site area.

### 14.4.3 Geology

In general, the ground investigation (GI) confirmed the published geological sequence described below.

The majority of the site is underlain by Marine and Estuarine Alluvium. This in turn is underlain by the Gramscatho Beds of the Devonian Period; these are well graded moderately strong turbiditic sandstones in beds up to 2m thick with interbedded slates. This strata is shown to outcrop at the surface south of Carnsew Road, on the spur to the south east of East Quay and to the north of North Quay on the power station, chemical works, and Chieftain's Yard areas. The higher ground to the north and west of these areas is shown to consist of Quaternary Blown Sand.

### 14.4.4 Hydrogeology & hydrology

The strata beneath the site are classified by the Environment Agency as a Minor Aquifer, i.e. *"fractured rocks or potentially fractured rocks, which do not have a high primary permeability, or other formations of variable permeability including unconsolidated deposits. Although not producing large quantities of water for abstraction, they are important for local supplies and in supplying base flow to rivers"*. The overlying materials are described as soils of high leaching potential or intermediate leaching potential i.e. they may rapidly transmit pollutants or may possibly transmit pollutants. Some of the soils at the site are given this classification because of the limited data available for soils in urban environments.

The Environment Agency have provided some data on the water quality of the Hayle Estuary, this is included in the Buro Happold Ltd Contamination Report in Technical Annex 14A and is also described in Chapter 13.

### 14.4.5 Ground investigation findings

In general the ground investigation confirmed the geological sequence as predicted by the geological maps (see above). Most of the site has a layer of made ground at the surface. A map showing the thickness of made ground encountered at each exploratory hole is included in Technical Annex 14A. The made ground is highly variable but is generally granular and includes widespread ash and clinker. An area of deep ash fill was proven in the dune area to the north of North Quay.

Hydrocarbon odours, black staining and oil were noted around Chieftains Yard and the eastern portion of North Quay. This contamination is thought to be related to the Esso tank farm that formerly occupied Chieftains Yard.

Detailed information relating to the chemical conditions within the Made Ground is presented in Appendix I of the Buro Happold Ltd Contamination Report in Technical Annex 14A and summarised below:

#### 14.4.5.1 Soil

It has been found that Made Ground soils contain consistently elevated concentrations of arsenic, copper and zinc with respect to relevant screening criteria (CLEA soil guideline values and Dutch Intervention Values).



Isolated elevated concentrations of lead, naphthalene and benzo(a)pyrene were identified at discrete locations across the site with respect to the relevant screening criteria.

Elevated concentrations of Diesel Range Organics and Petrol Range Organics have been encountered in North and South Quay, i.e. in areas designated for residential and retail land uses in the illustrative masterplan which is the subject of this assessment. Elevated concentrations in North Quay appear to be linked to a former Esso Oil Storage area (Chieftain's Yard). It is assumed that the occurrences on South Quay are most likely to be attributable to the former scrap yards and ship building/breaking activities.

Isolated asbestos, mainly in the form of cloth, was identified on South Quay and the Triangular Spit.

Results of samples taken from the Made Ground stratum on the site indicate that there is a high risk to human health from a limited number of contaminants (arsenic and locally lead, naphthalene and benzo(a)pyrene). There is also a high risk to plant health from the phyto-toxic elements of copper and zinc.

Chemical test results for soil samples collected from Hayle beach recorded a notably better soil quality than any part of the proposed development site. Only arsenic was marginally elevated (mean 22 mg/kg, compared to the SGV of 20 mg/kg) above current guidance for the most sensitive forms of land use.

#### **14.4.5.2 Leachates**

Leachate test results showed consistently elevated levels of arsenic, copper and zinc with isolated elevated cadmium, nickel and selenium results.

#### **14.4.5.3 Waters**

Groundwater test results showed consistently elevated levels of arsenic, copper and zinc together with elevated polycyclic aromatic hydrocarbons (PAHs).

#### **14.4.5.4 Gas**

No methane was recorded on the monitoring visits. Elevated levels of carbon dioxide (>0.5%) were recorded in boreholes BH102, 103, 107, 108, 504, 506, 507 (Technical Annex 14A). The highest carbon dioxide level was recorded at 1.9 %vol on 11 October 2005 in BH108 (Zone 3), which is potentially related to the hydrocarbon contamination in this area. Depleted oxygen levels were also recorded in BH107 and BH108.

Radon gas concentrations cannot be monitored during the ground investigation, therefore the site has been assessed in terms of data on the number of homes affected in the vicinity (available in the Envirocheck Report Technical Annex 14A and in the National Radon Protection Board, 2002, Radon Atlas of England and Wales). The data available indicates the site is in area whereby radon protection measures are considered necessary to protect future residents/building users from the effects of radon gas.

Table 14-4 summarises the sources identified across the site.

Source	Location	Chemical of Concern
Made Ground	Site-wide	Arsenic, Copper & Zinc. Isolated elevated concentrations of lead, benzo(a)pyrene & naphthalene.
Hydrocarbon hotspots	North and South Quays	Diesel & petroleum range hydrocarbons and carbon dioxide
Surface Made Ground	South Quay & Triangular spit	Asbestos fibres
Natural ground	Site wide	Radon Gas
Shallow groundwater	Site wide	Arsenic, Copper, Zinc & PAHs.

**Table 14– 4 Potential sources of contamination**

#### 14.4.6 Current site conditions

The majority of the site is currently derelict with some isolated commercial buildings associated with the landing of fish, storage of construction/fishing equipment and vehicle/vessel maintenance.

#### 14.4.7 Current potential contamination receptor pathways

Current site specific source-pathway-receptor linkages have been considered for the site with respect to the sources outlined above, the current use of the site as described above and the potential linking pathways.

Site specific receptors and pathways are described in Table 14-5.

Receptor type	Receptor	Sensitivity	Pathway
Human	Current site users (commercial )	Low	Vapour/gas/dust inhalation (indoor and outdoor air)
	site users, public offsite	High	Ingestion <i>via</i> contaminated water supplies
Natural Environmental	Groundwater	Moderate	Vertical migration of contaminants
	Surface Water - Hayle Estuary	Moderate	Surface water / shallow groundwater migration
	Phytotoxic effects	Low	Plant uptake

**Table 14– 5 Potential contamination receptor pathways – current situation**

#### 14.5 Assessment of potential impacts

The impact of the potential presence of contaminants within and around the site can be broken down into three stages: the current situation (this is the baseline and is outlined in Table 14-5), the construction phase and the operation phase. Conditions during the construction phase differ from the current and operation phases in that materials may be exposed to agents such as water and air that may lead to dispersion of contaminants in the environment and to direct contact with construction personnel. Under current conditions the likelihood of uncontrolled exposure to agents is significantly reduced due to the type of land use. Exposure to agents will most likely increase as a result of the operation of the proposed development because of the creation of new residential land uses, especially in areas where garden areas and areas of public open space are proposed.

Site specific source pathway receptor linkages for both the construction and operation phases of the proposed development have been considered for the site with respect to the identified contamination sources, the future uses of the site and the potential linking pathways.

Site specific receptors and pathways are described in Table 14-6 and Table 14-7.

Receptor type	Receptor	Pathway
Human Health	Construction workers	Direct contact and dermal uptake, soil and dust ingestion, dust and vapour inhalation (outdoor air)
	Site end users, public offsite	Vapour/gas/dust inhalation (indoor and outdoor air)
Natural Environmental	Shallow groundwater	Vertical migration of contaminants
	Hayle Estuary (includes ecological receptors)	Surface water / shallow groundwater migration
	Phytotoxic effects	Plant uptake

**Table 14– 6 Potential contamination receptor pathways – construction phase**

Receptor type	Receptor	Pathway
Human Health	Site end users – residential	Direct contact and dermal uptake, soil and soil dust ingestion, vapour/gas/dust inhalation (indoor and outdoor air)
	Site end users – commercial/industrial	Vapour/gas/dust inhalation (indoor and outdoor air)
	Site end users, public offsite	Ingestion <i>via</i> contaminated water supplies and soil dust ingestion/inhalation.
Natural Environmental	Shallow groundwater	Vertical migration of contaminants
	Hayle Estuary (includes ecological receptors)	Surface water / shallow groundwater migration
	Phytotoxic effects	Plant uptake

**Table 14– 7 Potential contamination receptor pathways – operational phases**

#### 14.5.1 Assessment of the 'Do Nothing' scenario

The "do nothing" scenario considers the impact of the site on receptors if it remains in its current state, i.e. without any proposed development. Potentially unacceptable risks identified to future site users in this assessment are summarised as follows:

- A risk has been identified to all site end users from naturally occurring radon gas *via* indoor inhalation.
- Site end users are considered to be at potential risk from the identified hotspots of organic contamination where water supply pipework passes through the site. Off site the general public are less likely to be at risk as water mains are most likely to be present under roads around the site and existing water mains do not cross the existing site boundary.
- Risks to shallow groundwater and the Hayle Estuary are considered to be significant from the hydrocarbon hotspots identified in the North and South Quays. This classification requires confirmation through further investigation and detailed risk assessment. Risks are unlikely to change under the "do nothing" scenario.

#### 14.5.2 Assessment of construction impacts

During the demolition and redevelopment of the site, workers may come into contact with underground structures that may contain potentially harmful substances as well as potentially contaminated Made Ground and asbestos fibres that were identified at the surface on South Quay.

Local residents and members of the public may be affected by contaminated dust generated by the demolition and redevelopment works on site unless appropriate mitigation measures are employed. Similarly off-site *flora* may also be affected by deposition of dust generated on site, although this is considered unlikely.

Groundwater may be affected by the increased leaching of contaminants from the Made Ground when it is reworked as part of the construction process.

The proposed dredging of Cockle Bank and harbour area will result in the remobilisation of contaminated sediments, particularly the contaminated clay and silt fraction which may have a deleterious effect on groundwater quality. The effects of dredging are considered in greater detail in Chapter 13. Similarly where excavated contaminated Made Ground is stockpiled on site rainwater may percolate through the stockpile and leach contaminants increasing the contaminant loading within the underlying groundwater and potentially Hayle Estuary.

The increased use of water for dust suppression measures during demolition and construction may lead to increased contamination of surface run-off potentially impacting water quality within Hayle Estuary.

The significance of these identified impacts is outlined below in Table 14-8

Receptor	Receptor Sensitivity	Impact	Magnitude of Change	Significance of Impact
Construction workers	High	Health impacts from direct contact, dermal uptake, soil ingestion and dust, dust and gas / vapour inhalation	Large	Major adverse
Local residents and members of the	High	Health impacts from inhalation and ingestion of contaminated dust particles	Medium	Major adverse
Groundwater	Moderate	Degradation of groundwater at depth <i>via</i> increased leaching of contaminants	Medium	Moderate adverse
Surface water	Moderate	Degradation of surface water quality of Hayle Estuary (principally due to dredging of cockle bank and harbour sediments)	Large	Major adverse
Adjacent Flora	Low	Exposure to phytotoxic contaminated materials (deposited as dust) that may inhibit / prevent plant growth	Small	Minor adverse

**Table 14– 8 Predicted construction impacts**

The predicted construction impacts described above relate to all contaminant sources.

#### 14.5.3 Assessment of operational impacts

The proposed development will comprise a new marina and fishing quay, business and retail space, a hotel, residential properties (with and without garden areas) and space for community and leisure activities. The development will also include infrastructure including roads and pavements, car parking areas, service/ utility installations and drainage systems.

Proposed built structures and infrastructure associated with the proposed development may be affected by the presence of contaminants in the underlying soils, particularly sulphates, certain organic contaminants and soil gases and volatile organic vapours. Typically where these contaminants are encountered at elevated concentrations significant erosion of concrete and steel foundations can occur along with the deterioration of plastic services such as water supply pipe-work.

Similarly future activities associated with the proposed development may impact on soil and groundwater conditions beneath the site. Examples of this include the incorrect storage of fuel as part of the proposed development and the subsequent contamination of the underlying soils and groundwater.

The significance of the potential impacts associated with the operational stage of the development are presented in Table 14-9.

Receptor	Receptor Sensitivity	Impact	Magnitude of Impact	Significance of Impact
Site users (residential)	High	Health impacts from direct contact, dermal uptake, soil ingestion and dust, dust and gas / vapour inhalation	Large	Major adverse
Site users (commercial/industrial)	High	Dust and gas / vapour inhalation	Small	Moderate adverse
Site users (see above), public off-site	High	Health impacts from ingestion of contaminated water supplies.	Negligible	Minor adverse
Maintenance workers	High	Exposure to contaminated materials beneath hardstanding and within service trenches during future services construction. Health impacts from direct contact, soil ingestion, dust and gas / vapour inhalation	Medium	Major adverse

Receptor	Receptor Sensitivity	Impact	Magnitude of Impact	Significance of Impact
Plants in public open spaces	Low	Exposure to phytotoxic contaminated materials (deposited as dust) that may inhibit / prevent	Small	Minor adverse
Groundwater	Moderate	Degradation of shallow groundwater <i>via</i> increased leaching of contaminants	Medium	Moderate adverse
Surface water	Moderate	Ongoing degradation of surface water quality in Hayle Estuary from existing contamination	Small	Moderate/minor adverse
Surface water	Moderate	Degradation of surface water quality in Hayle Estuary from fuel storage and re-fuelling operations in proposed marina	Medium	Moderate adverse
Groundwater	Moderate	Degradation of shallow groundwater <i>via</i> storage & potential spillage of fuels/chemicals in	Medium	Moderate adverse
Planned Buildings	Moderate	Potential corrosion / damage of building materials and services	Large	Major adverse

**Table 14– 9 Predicted operational impacts**



## 14.6 Mitigation

Mitigation measures have been derived by assessing the risks to human health and the environment in line with DEFRA/Environment Agency Contaminated Land Report 11 'Model Procedures for the Management of Land Contamination', September 2004 (CLR11). Further ground investigation will be carried out to further determine the need for and scope of these mitigation measures. It is envisaged that these further investigations will be undertaken in support of the detailed planning application for the proposed development prior to the commencement of any on site construction activities.

The following mitigation measures will therefore require review upon receipt of the additional ground investigation. It is considered unlikely that results from the proposed additional ground investigation will require any additional mitigation measures to those proposed below, for the purposes of this assessment, a worst case scenario has been assumed.

Further details of these mitigation measures are provided in the Buro Happold Ltd Contamination Report within Technical Annex 14A.

### 14.6.1 Construction impact mitigation measures

The following mitigation measures will be managed through the site specific Construction Environment Management Plan (CEMP). This is discussed in greater detail in Chapter 17:

- The risks to construction workers from direct contact with contaminants in the Made Ground during site development will be clarified following the site specific ground investigation and can be mitigated through appropriate use of personal protective equipment (PPE). Risks to construction workers in certain areas of the site associated with specific historic activities such as the former oil storage depot known as Chieftains Yard may be higher and will therefore require additional PPE and possible additional safe working procedures. Construction workers should remain vigilant of ground conditions at all times and should report any suspect areas of potential contamination
- Surface asbestos fragments/fabric will be removed from the South Quay by a competent/licensed contractor. All material will thereafter be disposed to an appropriate licensed landfill by the contractor
- During both demolition and construction phases of work, dust suppression measures will be employed by the contractor when necessary to prevent the potential generation of contaminated dust particles and its migration off site
- Temporary drainage measures will be employed by the contractor alongside the dust suppression measures to prevent the generation of excessive surface water run-off and potential migration of contaminants and/or silt into the nearby Hayle Estuary

- Pollution control measures will be implemented by the contractor where required and spillage containment will be present on site at all times;
- Stockpiling of grossly contaminated soils will be avoided if possible and where necessary, stockpiles will be covered when not in use. Drainage from the stockpiles will be managed by the contractor dependant on their size to prevent the generation of contaminated run-off; and
- It has been suggested by Cornwall County Council Natural Environment Service (NES) that the mobilisation of sediments associated with the removal of Cockle Bank is inevitable. However it is judged that the remobilisation of these sediments could be minimised as much as is reasonably possible through implementation of appropriate methods such as working at the correct stages of the tide, the use of silt traps etc. This factor will be considered when collating tender information for the appointment of the dredging contractor. The dredging contractor will be required to produce a specific CEMP for the proposed dredging works in which specific details relating to the mitigation of sediment mobilisation will be set out in line with best practice.

#### 14.6.2 Operational impact mitigation measures

Based on the existing information, the following measures to mitigate operational impacts have been proposed:

- Removal of hydrocarbon hotspots in the North & South Quay and locally tank contents and surrounding impacted material where found if required following additional ground investigation and detailed risk assessment. Possible remediation options that would be considered are excavation and disposal or physical, chemical or biological remediation technologies. A range of remediation technologies are now available in the UK and may be carried out in or ex situ, depending on site and development specific constraints. Disposal as hazardous waste for small hotspots, and ex-situ bio-remediation for larger areas would be undertaken
- Given the widespread concentrations of arsenic, copper, zinc and, to a lesser degree, lead it is necessary to opt for a simple cover system to protect end users from contact with contaminated soil in areas of soft landscaping. By their nature, areas of hardstanding provide a break in the source – receptor – pathway linkage and additional capping is not required for these areas. The thickness and make up of the cover system is dependent on land use and the mean contaminant soil concentrations found in these areas. BRE BR 465 (2004) Cover systems for land regeneration, Thickness of cover systems for contaminated land has been used to establish the appropriate thickness. The results enclosed within Technical Annex 14A suggest a general 600mm of cover should be applied to all proposed land uses in areas of soft landscaping because of the concentrations of arsenic, copper or zinc. The results of further testing recommended in Technical Annex 14A may permit reductions in the overall thickness of the cover system in selected areas during the detailed design stage

- In the areas designated for commercial and industrial use the planned extent of a cover system is notably reduced by the prevailing cover of building aprons or external hardstanding. The area requiring the greatest extent of simple cover is the Hilltop Residential Zone where private gardens are planned
- The simple cover system can be catered for by importing clean sub and topsoil with a soil quality that is at least 50% lower than the Soil Guideline Values for the contaminants of concern. As an alternative to importing material, or perhaps as a partial solution, consideration will be given to use of ex-situ soil washing to remove the finer more contaminated fraction in the near surface material or to importing suitable soils derived from Cockle Bank. The finer fraction will, however, require offsite disposal or treatment before re-use on site
- Service trenches will be lined with an impemeable membrane and backfilled with clean material to prevent contaminants entering the public water supply in areas where contamination is assessed to present a risk to drinking water. Similarly these measures will also prevent the potentially dangerous build up of ground gas and vapours within trenches that could prove harmful to maintenance workers
- Protection measures are required to mitigate risks associated with radon gas. It is envisaged these will also mitigate risks associated with localised elevated concentrations of naphthalene and other ground gases. Building designers will need to consult BRE Report BR 211 to determine the appropriate radon protection measures required for buildings across the site
- Specific mixes of concrete may also be required for building foundations where the underlying ground conditions are identified as being potentially corrosive to concrete
- Japanese knotweed is present on South Quay. This will be managed in accordance with Environment Agency, May 2001. Code of Practice for the Management, Destruction and Disposal of Japanese Knotweed, which gives advice on herbicides and acceptable disposal options both on and offsite. It is noted that it normally takes at least three years to kill Japanese Knotweed with herbicides. Burial on site will be considered but for offsite disposal the material will be classified as hazardous waste
- Some material arising from the dredging of Cockle Bank and the harbour may be considered suitable for re-use in certain areas of the site (i.e. under areas of hardstanding). Soil washing will increase the range of potential uses for the dredged material. In essence soil washing involves removing the fine fraction (where the majority of the contamination is concentrated) from the soil using appropriate physical properties. The washing process is likely to be purely physical, without the addition of chemicals to aid washing, so there are unlikely to be odour problems. Dust will need to be controlled using standard techniques (see Chapter 11). If efficiency and the cost of washing are key then the operators are likely to require 24 hour working, noise is then the primary nuisance (see chapter 6). Further testing will be required for the detailed design of the soil washing plant, for example, to

determine if material is to be separated on a size or specific gravity basis, if abrasive techniques are required, if polymers are required to coagulate and flocculate the fine fraction to the resulting filter cake. It is envisaged the resulting filter cake will be treated using cement as a stabilising agent. This will effectively reduce the hazardous properties and improve the engineering properties of the material enabling it to be re-used on site. Buro Happold are currently in discussion with the Environment Agency regarding the feasibility of this option with regards to the waste management regulations

- All re-fuelling of boats within the proposed marina will be undertaken in line with current UK standards. All fuels will be stored within bunded tanks. Bund capacity will be at least 110% of the total tank capacity and designed to comply with current industry standards
- All fuels and chemicals used within the proposed industrial zone will be stored and used in accordance with current regulatory and industry guidance. For example, all fuels will be stored within 110% bunded areas, all chemicals will be stored on appropriately sized drip trays located on hardstanding within dedicated chemical storage areas as a minimum and safe working procedures will be adopted to minimise spillage through accidents etc

#### **14.7 Residual impacts**

The additional work highlighted in Section 14.8 will be undertaken prior to the demolition and redevelopment of the site, and the mitigation measures outlined above will be reviewed based on the additional data and findings and then adopted. Steps will be taken to ensure that good practice procedures both in construction and health and safety during the remediation completion and site development will be adhered to. The majority of residual effects resulting from contaminated land should not therefore be significant during the construction or operational phase.

The dredging of Cockle Bank and the harbour is considered an event that will result in a moderate adverse impact following mitigation. The impacts of this activity are considered in greater detail in Chapter 13 along with details on its management.

Table 14-10 presents an assessment of the significance of residual impacts based on existing information. This table will need to be updated upon receipt of the additional data and findings of the recommended additional work.

Event/Source	Description of unmitigated impact	Significance of impact	Mitigation	Significance of residual impact
<b>Construction</b>				
Contaminated Made ground (inc. asbestos at surface)	Health impacts to construction workers	Major adverse	Provision of PPE & development of safe working procedures, surface asbestos removal	Negligible
Generation & mobilisation of contaminated dust particles	Health impacts to adjacent site users	Major adverse	Dust suppression	Negligible
Mobilisation of contaminants in Made Ground	Degradation of groundwater	Moderate adverse	Temporary drainage measures to be implemented	Negligible
Further spillage of hydrocarbons during decommissioning/demolition	Localised degradation of soils, groundwater, surface water quality	Minor adverse	pollution control measures (including spill kits) to be present on site	Negligible
Dredging of Cockle Bank	Degradation of surface water (Hayle Estuary),	Major adverse	Some temporary impact is likely, however selection of dredging technique will include requirement to minimise mobilisation of contaminated sediments as much as reasonably practical	Moderate adverse

<b>Event/Source</b>	<b>Description of unmitigated impact</b>	<b>Significance of impact</b>	<b>Mitigation</b>	<b>Significance of residual impact</b>
Stockpiling of contaminated soils	Degradation of both surface and groundwaters	Major adverse	Avoidance of stockpiling. Grading stock piles to ensure rapid run-off	Minor adverse
Generation & mobilisation of contaminated dust particles	Denigration of adjacent flora	Minor adverse	Dust suppression	Negligible
<b>Operation</b>				
Exposure to contaminated Made Ground	Health impacts to future residential site users	Major adverse	Incorporation of clean capping layer in areas of soft landscaping	Negligible
Exposure to contaminated Made Ground	Health impacts to future commercial site users	Moderate adverse	Incorporation of clean capping layer in areas of soft landscaping	Negligible
Exposure to naturally occurring radon	Health impacts to future indoor site users	Major adverse	Incorporation of radon protection measures where necessary	Negligible
Contamination of public drinking water supplies	Health impacts to off-site public users	Minor adverse	Construction of clean backfill service trenches	Negligible
Exposure to contaminated Made Ground	Maintenance workers	Major adverse	Construction of clean backfill service trenches, capping layers in areas of soft landscaping, provision of PPE where required.	Negligible

Event/Source	Description of unmitigated impact	Significance of impact	Mitigation	Significance of residual impact
New plants grown in existing Made Ground	Plants in public open spaces	Minor adverse	Incorporation of clean capping layer in areas of soft landscaping	Negligible
Continuing denigration of groundwater from existing contaminated land	Denigration of groundwater quality	Moderate adverse	Excavation and remediation of contaminated soils where deemed appropriate	Minor beneficial
Continuing denigration of surface water from existing contaminated land	Surface Water	Moderate/Minor or adverse	Excavation and remediation of contaminated soils where deemed appropriate	Minor beneficial
Spillage of fuel etc. in proposed marina into Hayle Estuary	Surface Water	Moderate adverse	Adoption of safe working procedures. All fuels to be stored appropriate (e.g. bunded tanks)	Negligible
Spillage of chemicals/fuels in industrial zone	Ground water (& ultimately surface water)	Moderate adverse	Adoption of safe working procedures. All fuels/chemicals to be stored appropriately	Negligible
Elevated sulphate in Made Ground	Damage to construction materials	Major adverse	Appropriate specification for construction materials	Negligible

**Table 14– 10 Significance of residual impact**

#### **14.8 Requirements for additional ground investigation**

A number of limitations have been identified with respect to the existing site investigation data. However, the assessment undertaken to date is considered suitably robust for the purposes of this ES chapter. The scope of the proposed additional ground investigation necessary to resolve these existing uncertainties is outlined below.

- i. A closer sampling grid is required in areas of the site where elevated concentrations of contaminants have been identified
- ii. Investigation of areas beneath concrete slabs/buildings
- iii. Further work is required to define the size, character and treatment options for the hydrocarbon 'hotspots' encountered. This should include further gas/groundwater well installation and monitoring, particularly in the quay areas
- iv. Further work is required to fully characterise the material to be dredged from Cockle Bank with respect to optimising the performance of the proposed soil washing, determining the effects of the dredging on water quality within Hayle Estuary and determining the possibilities for its re-use
- v. Further chemical testing is required on any material destined to be disposed of in landfills in order to confirm classification as inert, non-hazardous or hazardous material
- vi. Further work is required to characterise the material to be dredged in Penpol Creek

#### **14.9 Monitoring**

Remediation will be subject to validation testing in accordance with CLR11 and environmental management procedures to be outlined in the site specific environmental management plan (EMP). All construction related activities will also be subject to the Construction Environmental Management Plan (CEMP) (see Chapter 17).

#### **14.10 Cumulative impacts**

No adverse impacts on ground conditions are anticipated from the construction of any of the developments being undertaken within the Hayle area of Cornwall.

The impacts discussed in the above sections do not represent a significant cumulative impact on any receptors.



#### 14.11 Conclusions

The Environment Agency and Penwith District Council have confirmed in writing that the investigation and assessment undertaken to date is considered suitable for outline strategic purposes. Both regulatory bodies have recognised the requirement for further investigation and risk assessment, especially in areas of the site where historic contamination is suspected. As described above, these further investigations (summarised in Section 14.8) will be undertaken in support of the detailed planning application.

Key construction impact mitigation measures include the provision of adequate PPE and the adoption of safe working practices, a full programme of asbestos removal along the South Quay, stockpile management procedures as well as dust suppression and temporary drainage measures. The proposed dredging of Cockle Bank and the harbour sediments to enable the construction of a Marina will necessitate the generation of a careful management procedure to ensure the effects of sediment remobilisation are minimised as best as reasonably practical.

The proposed dredging of Cockle Bank and the harbour sediments and remediation will be subject to waste management licence regulations and potentially a FEPA licence depending on the routes of disposal. Both the Environment Agency and the Marine and Fisheries agency have been consulted on the regulatory requirements for the proposed activities.

Where possible, some of the material from Cockle Bank may be considered suitable for use without treatment (i.e. beneath areas of hardstanding). A waste management licence exemption would be required for this activity. A Mobile Treatment Licence (issued by the Environment Agency) will be required for soil washing plant. The resulting filter cake is likely to require disposal as hazardous waste. Solidification/stabilisation of the cake with cement/lime may allow it to be classified as non-hazardous waste or be re-used on site, for example beneath areas of hard standing. This could be carried out under one mobile treatment licence. This will require further consultation with the Environment Agency waste officer to confirm the licensing requirements.

As Cockle Bank is within the main river limits of the Angarrack Stream, Land Drainage Consent from the Environment Agency is required for dredging. A Food And Environment Protection Act (FEPA) licence may also be required from the Department of Food and Rural Affairs if any material is disposed of below mean high water springs levels. In addition the Hayle Harbour Act may impose or relinquish some additional requirements. If the local harbour authority is unable to regulate these activities, a coastal protection act (CPA) consent will be required.

Potential operational impact mitigation measures comprise complete source removal and / or remediation, construction of capping layers in areas of soft landscaping, use of gas protection measures and implementation of clean service trench techniques. All fuel associated with the adjacent marina should be

stored appropriate with regard to the environmental sensitivity of the location and refuelling practices should be undertaken to recognised industry guidance.

#### 14.12 References

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