15 Ground Conditions

Introduction

15.1 This chapter of the PEIR provides a preliminary assessment of the ground conditions aspects of the OMSSD project, providing a summary of the baseline conditions established through extensive investigation works and identifies the contaminated ground and groundwater matters arisings from the construction and operational phases of the OMSSD project. The chapter has been produced by Ramboll UK. This chapter provides an overview of information on ground contamination conditions obtained from desk-based research and site investigation. Technical appendices containing the factual information and interpretation of the data will be provided in the OMSSD Environmental Statement (ES) to accompany the application for development consent in 2021.

15.2 This section includes a summary of the site setting and contamination issues known at the time of writing, which form the baseline conditions. In its current configuration the site is not considered to represent a significant risk to potential receptors including environmental receptors and human health, however this section provides a preliminary assessment of how the OMSSD project may influence ground contamination risks. This section therefore discusses the mitigation measures that will need to be considered.

15.3 In addition to works on land, the OMSSD project includes a small capital dredge of the area alongside Jetty 2. The consideration of matters relating to the material to be dredged are covered within the 'Water Environment' chapter of this PEIR (Chapter 8) and, for the avoidance of doubt, are not covered in this chapter. Furthermore, secondary impacts associated with the OMSSD project in relation to noise and traffic impacts from material movements and piling activities are considered in Chapter 11 (Traffic and Transport) and Chapter 14 (Noise and Vibration) of this PEIR.

Definition of the Study Area

15.4 The proposed geographical study area for the assessment of ground conditions in the OMSSD ES has been principally limited to the boundary of the OMSSD project within the Oikos Facility. Intrusive site investigation cannot be practically undertaken outside of the Oikos Facility. Sensitive receptors beyond the site boundary have, however, been qualitatively assessed when there is considered to be a potential for migration of site derived contamination along a potentially plausible pathway. With regards to off-site receptors, the work undertaken to date has included a qualitative and semi-quantitative assessment of risks to extrapolate whether potential risks exist to nearby residential receptors and an existing swale located immediately beyond Haven Road on undeveloped land to the west of the Oikos Facility. This extrapolation has used computer software models.

15.5 To date, the work that has been undertaken has not identified contamination that would be considered to represent a significant risk to nearby residential land uses (as defined by Part

II of the Environmental Protection Act 1990)[484] nor the adjacent swale. Groundwater contaminant concentrations over the wider OMSSD project area are not considered to represent a significant risk to controlled waters and in particular the work undertaken to date has not identified a plausible linkage for contamination to migrate to the Thames Estuary given the presence of the flood defence wall. Recent data from groundwater monitoring implies that off-site migration of contamination at unacceptable levels is not occurring. However, further groundwater monitoring at the western site boundary is programmed to be undertaken prior to the preparation of the OMSSD ES to complete the data set.

15.6 In the context of the OMSSD project and any future remedial or materials management options, ongoing assessment work will also necessarily consider sustainability issues in the selection of the most appropriate remedial option. Any wider impacts (such as vehicle movements, noise and the distance to disposal sites) beyond the Oikos Facility would be a consideration in determining the most appropriate option.

15.7 Land uses beyond a 1km radius of the Oikos Facility are considered unlikely to have a deleterious impact on the site in terms of ground conditions.

Assessment Methodology

Data and Information Sources

15.8 Desk based assessment of the potential for ground contamination at the site has been undertaken. This has included a review of historical maps, local authority records and publicly available data together with a site walkover inspection and discussion with Oikos operatives regarding operational site history. The work also included a review of any relevant site investigation and remediation reports and site drainage surveys available at that time. The desk-based information was used to devise a conceptual site model (CSM) where plausible linkages between the contamination source and sensitive receptors were qualitatively assessed. The outcome of the CSM was then used to devise the scope of additional site investigation for those plausible pollutant linkages that were considered to represent a potential risk.

15.9 Intrusive site investigations using drilling techniques and trial pitting have been undertaken across the OMSSD project area as well as parts of the wider operational Oikos Facility to investigate further the potential pollutant linkages identified in the CSM.

15.10 The investigation provided coverage of the Oikos Facility but specifically included the area of the OMSSD project given that this area of the site had to date, been less well investigated.

15.11 The site investigations were undertaken in 2018 with supplementary site investigation undertaken in 2019 and additional groundwater monitoring undertaken in July 2020. The 2018 site investigation comprised the drilling of 173 window samples and excavation of 68

[484] Environmental Protection Act 1990

trial pits. Ten of the window samples were installed as long-term groundwater monitoring wells. Supplementary investigation was undertaken in 2019 to provide further coverage in the OMSSD project area and further characterisation of identified hydrocarbon and solvent impacts during the 2018 investigation. The 2019 supplementary investigation comprised the drilling and installation of a further 15 window sample boreholes for groundwater monitoring purposes. The groundwater monitoring wells in 2018/2019 have been designed to investigate shallow groundwater conditions within the made ground and Tidal Flats (alluvial clays and silts).

15.12 The site investigations comprised soil sampling (up to 235 number of samples during the 2018 investigation and up to 15 soil samples during the 2019 investigation) from all exploratory locations which were submitted to a laboratory for analysis of a suite of contaminants relevant to the history of the facility and the findings of the desk-based assessment. These contaminants consisted principally of hydrocarbons and solvents (volatile organic compounds) but also included analysis for asbestos in soils, heavy metals, polycyclic aromatic hydrocarbons (PAHs) and to a lesser extent phenols and perfluorinated alkylated substances (PFAS).

15.13 Groundwater monitoring was undertaken on one occasion in November 2018 during which nine groundwater samples were collected. Groundwater monitoring was also undertaken following the supplementary investigation work with three monitoring rounds undertaken in September/October 2019 from the 15 new well installations together with the nine original monitoring wells. Then in July 2020, one round of groundwater monitoring was undertaken from four monitoring wells in the west of the OMSSD project area. This was to allow an assessment of whether seasonality had a bearing on groundwater levels and to investigate elevated groundwater contaminant concentrations previously reported in one monitoring well (RS214) at the western boundary of the OMSSD project area. A similar suite of analysis (excluding asbestos and PFAS) was adopted for groundwater analysis on each occasion.

15.14 The work undertaken has been carried out in accordance with the concepts set out in the then, Model Procedures for the Management of Contaminated Land, CLR11[485] now withdrawn) but still accords with the guidance provided in the new, replacement guidance published by the Environment Agency (EA) entitled Land Contamination Risk Management (May 2020)[486].

15.15 Site investigation was undertaken in accordance with the principles of the British Standard - BS 5930: 2015 Code of Practice for Ground Investigations[487] and BS10175:2011 + A2:2017 Code of Practice for the Investigation of Potentially Contaminated sites[488]. A generic screening assessment of data was undertaken using the Contaminated Land Exposure

[485] Environment Agency (2004) Model Procedures for the Management of Land Contamination, CLR11

[486] Environment Agency (2020) Land Contamination Risk Management (LCRM)

[487] The British Standards Institution (2015), BS 5930:2015 Code of Practice for Ground Investigations, Fourth Edition.

[488] The British Standards Institution (2011), BS10175:2011 + A2:2017 Code of Practice for the Investigation of Potentially Contaminated sites

Assessment (CLEA) methodology and the CLEA guidance documents[489] together with the ASTM RBCA Tool Kit Version 2.6[490] and an array of technical contaminant specific documents[491]. Quantitative risk assessments have been undertaken using the EA CLEA methodology and software (version 1.071) and accompanying CLEA Software Handbook (version 1.05 SC050021/SR4[492]) but modified to accommodate site specific conditions identified during the course of the site investigation. Groundwater vapour risks have been assessed using the SOBRA[493] methodology. Controlled waters assessment has been undertaken using the EA's Remedial Targets Worksheet Methodology.[494]

15.16 Following the completion of the site investigation works the preliminary CSM was revisited and a revised CSM devised to identify and qualitatively assess the remaining plausible risk pathways (refer to paragraph 15.36).

Determining Significance of Effects

15.17 To facilitate the identification and assessment of significant environmental effects, the CSM was devised including consideration of potential contaminative sources, plausible migration pathways and identified potentially sensitive receptors (e.g. nearby residents, surface water courses and groundwater aquifers). The development of the CSM took account of all the information gathered at the desk-based assessment stage and considered the potential pollutant linkages (via migration pathways) between the known contaminative sources and the identified sensitive receptors.

15.18 Where a plausible linkage was concluded to be present in the preliminary CSM, the linkage was first assessed qualitatively as to the potential level of risk and where considered to be greater than a low risk, was assessed further by means of intrusive investigation.

15.19 Following site investigation and the gathering of field data, the CSM and pollutant linkages were evaluated to assess whether the potential exposure per pollutant linkage exceeded the limit of acceptability[495] based firstly on a screening assessment against generic threshold

[489] Incorporating Science Reports SC050021/SR2, January 2009, SR3, January 2009, SR4, January 2009, and the Soil Guideline Value (SGV) reports (2009).

[490] American Society for the Testing of Materials (ASTM) Risk Based Corrective Action (RBCA)

[491] Including but not limited to DEFRA funded research project (SP1010) and Companion Document: Development of Category 4 Screening Levels for Assessment of Land Affected by Contamination – Policy Companion Documents DEFRA, December 2014 and LQM/CIEH S4Uls for Human Health Risk Assessment, 2015.

[492] Environment Agency (2009) CLEA Software (Version 1.05) Handbook. Science report SC050021/SR4

[493] Society of Brownfield Risk Assessment (2017) Development of Generic Assessment Criteria for Assessing Vapour Risks to Human Health from Volatile Contaminants in Groundwater, v.10, February 2017

[494] Environment Agency (2006) Remedial Targets Worksheet Methodology V3.1 and Worksheet Version 3.2

[495] For carcinogenic contaminants the UK currently defines an unacceptable risk as exposure to a contaminant dose that results in lifetime cancer risk to greater than 1 in 100,000 people (i.e. 10^{-5}). For toxic compounds, an unacceptable risk is defined as a contaminant dose exceeding a Hazard Quotient of 1.

concentrations for each contaminant, derived in accordance with the methodologies set out in paragraph 15.15.

15.20 Where generic assessment criteria (GAC) was exceeded, additional detailed assessment was then undertaken in some cases and whereby contaminant assessment criteria are generated that are specific to the site and take into account the specific circumstances of the environmental setting, the site use and the characteristics of the receptors. This was the case for two potential pollutant linkages in relation to off-site migration of contaminants to nearby residents and the adjacent swale and for which detailed quantitative risk assessment (DQRA) was considered necessary.

Sensitivity of receptors

15.21 Significance criteria are used to enable a consistent and transparent assessment of the potential effect (adverse or beneficial) of ground conditions on identified receptors. Receptors are defined in Part IIA of the Environmental Protection Act 1990[496] as:

- human beings (e.g. commercial site users or residential receptors);
- an ecological system, or organism within such system, within a location that has been identified for protection under various European, National and local designations (including *for example* Site of Special Scientific Interest (SSSI), Special Protection Area (SPA), Special Areas of Conservation (SACs), National Nature Reserve);
- property in the form of buildings; and
- controlled waters (surface water courses including off-site swales and groundwater).

15.22 The sensitivity of these receptors is determined from qualitative assessment of *potential for exposure* to contamination and the vulnerability of the receptor to contamination. In relation to human health, residential receptors are considered to be of greater sensitivity than commercial site users given the potential duration of exposure and that children may be present in a residential scenario and are, in some cases, are generally more likely to have higher exposures to soil contamination (e.g. from playing in soils). In respect of controlled waters, whether groundwater at the site is assigned an aquifer classification by the EA or is in a designated groundwater abstraction source protection zone is considered in assessing sensitivity; as is the status of nearby surface water courses under the Water Framework Directive[497] and its connectivity with the wider water environment.

15.23 There are no world heritage sites, no biosphere reserves and no national parks within 2km of the OMSSD project area. Similarly, there are no Marine Conservation Zones nor Marine SACs designated within 1km of the OMSSD project area.

---

[496] Environmental Protection Act (1990) Part IIA.

[497] Directive 2000/60/EC of the European Parliament and of the Council establishing a framework for the Community action in the field of water policy. 23 October 2000 - transposed into UK law by *The Water Environment (Water Framework Directive) (England and Wales) Regulations 2017, as amended by The Floods and Water (Amendment etc.) (EU Exit) Regulations 2019.*

15.24 Holehaven Creek and Canvey Wick located 0.1km west and 0.81km north-west respectively of the Oikos project area are designated as an SSSI. A further SSSI (South Thames Estuary and Marshes), the Thames Estuary and Marshes SPA and Ramsar designated area is located 1.5km south of the site on the southern banks (marshes) of the Thames Estuary. The sensitivity of the SSSI and nature reserves in the vicinity of the site is assessed based on distance and potential for a complete pollutant pathway to those receptors to exist (e.g. via groundwater movement and potential for connectivity with surface water).

Magnitude of impacts

15.25 Assessment of the magnitude of the potential impact, for example, a potential adverse impact of high magnitude may be the introduction of a pollutant linkage (between the contaminant source and a receptor) as a result of the OMSSD project. Conversely, a potential beneficial impact of high magnitude may be the removal of a contaminant source as a result of the OMSSD project and an associated substantial improvement in ground conditions at the site.

15.26 Where a potential impact is identified, the magnitude of the impact (and therefore the significance of the contamination risk) would be evaluated by considering the temporal nature of the impact (i.e. temporary/reversible/permanent, frequent/infrequent/rare and short/medium/long term) and the geographic scope of the potential impact. This is taken into account in the Significance criteria set out in the following paragraph.

Significance criteria

15.27 For the purposes of this preliminary assessment, the significance of effect criteria are:

- Major Adverse: Major environmental risk to a sensitive environmental receptor, and/or humans (site users, neighbouring residents) requiring extensive remedial works. For example, substantial widespread permanent reduction in quality of potable groundwater and/or surface water resource, substantial and permanent effect on ecosystems (plant and animals) and/or substantial long-term effect on human health. This would be classed as a significant impact;
- Moderate Adverse: Moderate environmental risk to a sensitive environmental receptor and flora, and/or humans (site users, neighbouring residents) requiring monitoring and local remedial work. For example, substantial short-term/moderate long-term reduction in quality of groundwater and/or surface water resource, substantial short-term/moderate long-term effect on ecosystems and/or human health. This would be classed as a significant impact;
- Minor Adverse: Minor environmental risk to a sensitive environmental receptor, for example minor local reduction in quality of groundwater and/or surface water resource, minor local effect on ecosystems. Effects are reversible or temporary. Minor effect on human health;
- Negligible: No appreciable environmental risk to a sensitive environmental receptor and/or human health;

- Minor Beneficial: Minor reduction in environmental risk to humans or a sensitive environmental receptor. For example, minor local improvement in groundwater and/or surface water quality, minor local improvement in ecosystem effects and minor improvement human health effects;
- Moderate Beneficial: Moderate reduction in environmental risk to humans or a sensitive environmental receptor. Moderate improvement in quality of groundwater and/or surface water resource, moderate improvement in ecosystem effects and moderate improvement in human health effects; and
- Major Beneficial: Substantial reduction in environmental risk to humans or a sensitive environmental receptor. Substantial widespread improvement in quality of potable groundwater and/or surface water resource, major improvement in ecosystem effects and major improvement in human health effects.

Consultation

15.28 The statutory consultees for ground conditions are the Environmental Health officer (EHO) of Castle Point Borough Council and the groundwater protection team of the Environment Agency - East Anglia area. A summary of their respective responses to the Scoping Report together with a summary of the follow-up discussion is provided in Table 15.1.

Table 15.1: Summary of consultation on ground conditions to date

Consultee	Date	Summary of Response	How comments have been addressed in this Chapter
Planning Inspectorate	May 2020	4.9.1 The scoping report states that work already undertaken has not identified any contamination or impact pathways to the Thames Estuary and nearby residential land uses. No detail is provided in terms of what, where and when the previous assessment of potential contamination or impact pathways was carried out.	Refer to paragraphs 15.8 to 15.16 and 15.36 to 15.58.
		4.9.2 The Scoping Report lists SSSIs, SPAs, SACs and NNRs as sensitive receptors but omits RAMSAR, non-statutory designated sites, National Parks and Marine Conservation Zones. The ES should assess impacts to all such sites where significant effects are likely to occur.	Refer to 15.23, 15.24 and 15.47 to 15.50, and also 15.65 to 15.67.
		4.9.3 The Scoping Report states that assessment work has identified a small number of impacts posing unacceptable risks to sensitive receptors and lists 4 potential impacts. Whilst it is anticipated that previous	See Consultee discussion later in this table and paragraphs 15.8 to 15.16 and 15.36 to 15.58.

Consultee	Date	Summary of Response	How comments have been addressed in this Chapter
		survey work and further survey work (Phase I and Phase II) will be provided with the application, effort should be made to agree the scope/applicability of this work with relevant consultation bodies.	
		4.9.4 The ES should describe the locations (supported by Figures) where previous site investigations were carried out, what investigations took place, when and over what timeframe.	The ES will include such discussion but an overview of the information required is also provided in paragraphs 15.8 to 15.16 and 15.36 to 15.58 of this chapter.
		4.9.5 The Scoping Report states that where 'site-specific criteria area exceeded by contaminant concentrations; risks are potentially significant and additional assessment may be required'. The ES should describe all the assessment conducted and how they influence the assessment of significant effects.	The ES will elaborate on the large amount of assessment that has been undertaken to date and include technical appendices presenting the site data and assessment methodologies in full. However, an overview is provided within this PEIR in paragraphs 15.8 to 15.16 and 15.36 to 15.58.
		4.9.6 The Scoping Report states that there is 'some' contamination on site yet does not describe or quantify this contamination or locate it on a Figure. Additionally, the Scoping Report states that remediation works are being undertaken but these lack detail and it is unknown to what extent this might influence the assessment. The ES should ensure that the baseline is appropriately described and quantified so that the works to be undertaken the nature of the surrounding environment are described.	The ES will include such discussion but an overview of the information required is also provided in paragraphs 15.8 to 15.16 and 15.36 to 15.58 of this PEIR including summary Figure 15.4.
		4.9.7 The ES should detail the current mitigation measures employed on site and clarify if/how they interact with and influence the findings in the assessment.	The ES will discuss current mitigation measures but these are also included in paragraphs 15.56 to 15.58 and 15.59 to 15.60.
Castle Point Borough Council – EHO	29th October 2020	A virtual meeting was held with CBC and ground conditions included in the agenda. The EHO raised no concerns with regards to ground condition at the site or in the context of the proposed development. An overview of the findings of the	Further discussion is given in paragraph 15.71 in relation to wholesale remediation and where mitigation measures are instead proposed to address potential impacts.

Consultee	Date	Summary of Response	How comments have been addressed in this Chapter
		site investigation and risk assessment works that have been undertaken was provided during the meeting. Discussion was had in relation to the requirements for remediation versus mitigation and the EHO expressed a preference for wholesale remediation but raised no other matters.	
Environment Agency - Groundwater protection department	4th May 2020 & 4th November 2020	The written response from the Environment Agency (dated 4th May 2020) identified the following salient points: discussion required in relation to the standard of underground pipelines; an acknowledgement of further assessment required in relation to the connection with the nearby swale and evidence required in relation to the absence of groundwater connectivity with the Thames Estuary. A virtual meeting was held with the EA groundwater officer on the 4th November 2020. A short overview summary of the ground conditions was provided and further information given by in relation to the pipework arrangements. A discussion of the groundwater hydraulic connectivity with the swale, the Thames Estuary and the influence from site drainage was undertaken. No further concerns were raised by the EA during the virtual meeting.	Oikos has confirmed that there are no underground sections of pipework. Further discussion of the above ground pipework arrangements are provided in Chapter 3. Further discussion of the groundwater hydraulic connectivity with the swale, the Thames Estuary and influence from the site drainage system is discussed in paragraphs 15.42 to 15.46.

Implications of Legislation, Policy and Guidance

15.29 This section summarises the key legislation and policies relating to contaminated land at the site at a national and local level.

15.30 Both the National Policy Statement for Ports (NPSfP)[498] and the overarching National Policy Statement for Energy EN-1 (NPSfE)[499] make the same statement - that for developments that are to take place on previously developed land, the risk(s) posed by land contamination should be taken into consideration.

[498] DfT (2012) National Policy Statement for Ports

[499] Department of Energy and Climate Change (2011) Overarching National Policy Statement for Energy (EN-1)

15.31 The National Planning Policy Framework (NPPF)[500] goes further and states that planning policies and decisions should ensure that a site is suitable for its proposed use taking account of ground conditions and any risks arising from land instability and contamination and that adequate site investigation information is available to inform these assessments. In the event of remediation or mitigation, the NPPF states that the site should not be capable of being determined as contaminated land under Part IIA of the Environmental Protection Act 1990. The NPPF requires that new development is appropriate for its location taking into account the likely effects of pollution on health, living conditions and the natural environment, as well as the potential sensitivity of the site or the wider area to impacts that could arise from the development. This chapter seeks to demonstrate how the requirements of the NPSfP, the NPSfE and the NPPF, in relation to ground conditions, have been addressed.

15.32 The NPPF therefore broadly embodies both the principles of contaminated land assessment that is further set out in the UK regulatory regime for contaminated land and detailed in the EA publication of May 2020, Land Contamination: Risk Management (refer to paragraph 15.34).

15.33 In the UK, land contamination is regulated under several regimes. These regulatory tools pertain to environmental protection, pollution prevention and control, waste management, planning and development control, and health and safety. There are a number of key legislative drivers – to which, regard has been had in this preliminary assessment - for dealing with risks to human health and the risk of pollution of the environment from land contamination, including:

- Part IIA of the Environmental Protection Act (EPA) 1990[501] and the Contaminated Land (England) Regulations 2006 (as amended)[502];

  Part IIA of the EPA1990 provides the enabling legislation for the management of contaminated land in England and enacts the Contaminated Land Regulations (2006). The Act provides the legal framework for dealing with unacceptable risks posed by land contamination and ensuring that land is suitable for use. The legislation together with the contaminated land regulations provides the definition for the assessment of *significant* harm (with regards to human health) and *significant* pollution of controlled waters, amongst others. The requirements of the regulations are explained in the Contaminated Land Statutory Guidance published by DEFRA in April 2012. The guidance and regulations explain how local authorities should implement the English framework for land contamination management and prescribes a risk-based approach to defining contaminated land.

- Water Resources Act 1991 (as amended)[503]; and

[500] Ministry of Housing, Communities & Local Government (2019) National Planning Policy Framework

[501] Environmental Protection Act (1990) *Part 2A*

[502] Contaminated Land (England) (Amendment) Regulations 2012

[503] Water Resources Act (as amended) (1991).

The 1991 regulations provide for a criminal liability for the pollution of controlled waters, defines controlled waters and the standards expected of them and considers what constitutes water pollution.

- the Environmental Damage (Prevention and Remediation) (England) Regulations 2015[504].

  The 2015 regulations oblige operators of economic activities to prevent, limit and/or remedy damage caused by environmental pollution. The regulations encompass the polluter pays principle and apply to damage caused to land, water, to species and habitats. In the event of damage, the regulations require the selection of remedial measures and which can be required to be applied beyond the location where damage has occurred (e.g. cleaning up an alternative habitat, if a damaged habitat cannot be fully restored). The regulations distinguish between different activities with different requirements of operators of specific activities or a broader set of activities.

15.34 The Land Contamination: Risk Management guidance (May 2020) provides guidance on the UK methodology for contaminated land assessment adhering to the principles of risk-based assessment. The guidance sets out the step wise assessment approach that is required including the preliminary risk assessment (PRA), the generic quantitative risk assessment (GQRA) and the detailed quantitative risk assessment (DQRA) requirements as applicable. The guidance goes on to stipulate the requirements should a site be concluded to require remediation including options appraisal, delivery and verification requirements.

15.35 A review of the draft New Castle Point Local Plan 2018–2033 (2020) identifies the following strategic policies relevant to ground contamination:

NE7: Pollution Control: requires that developments should be designed to manage and reduce pollution and should be located and designed so as not to cause a significant adverse effect upon the environment, the health of new and existing residents or surrounding residents by reason of pollution to land, air or water.

NE8: Development on Contaminated Land: requires that development on land that is classified as contaminated, is potentially contaminated or suspected of being contaminated should be supported by a desk study and potentially a site investigation. Where a site is contaminated, the policy states that the Council will only permit development where is it satisfied that the land is capable of remediation and is fit for the proposed use. The strategy also identifies that remediation and validation will be required before planning consent is implemented and that following remediation the site must not pose a threat to public health or that of the environment, nor pose a threat of pollution to controlled waters including groundwater. Remediation will need to satisfy relevant statutory regulators.

[504] Environmental Damage (Prevention and Remediation) Regulations (2009).

Preliminary Description of the Existing Environment

15.36 The Oikos Facility has a long industrial history of oil storage originating in the 1930s when it was operated by London and Coastal Wharves Ltd; prior to this the site was largely rural. Oil and chemical storage facilities were expanded in the 1960s/1970s and in the 1980s solvent products were stored in the south-west of the Oikos Facility (the western extent of the OMSSD project area). In the late 1990s and until c.2010, the bulk storage facilities were used for the storage of tallow. During the same period a waste recovery plant for the recovery of waste oils was commissioned, located in the broadly central south area of the Oikos Facility (central area of the OMSSD Project) and operated under an environmental permit. Tanks within the NP4 compound in the far west of the OMSSD project area, Compound 3 to the west of the NP4 compound and Compound 1 were demolished in more recent years. Otherwise, refurbishment and redevelopment of tank compounds has been undertaken progressively since c.2010, largely in the northern area of the site including most recently Compound 4 and Compound 10. A historic site layout is provided in Figure 15.1.

15.37 The Oikos Facility is located in an area geologically mapped as Tidal Flats (alluvial silts and clays – defined as unproductive strata by the Environment Agency) to depths of some 15m to 20m (in recent investigation to approximately 25m bgl) over a band of River Terrace Gravel deposits (typically 4m to 5m thick) (potentially water bearing) over London Clay (also unproductive strata). Site investigations undertaken in December 2020 concluded London Clay to commence from between 30 and 31m bgl (and proven only to the base of the borehole at 40m bgl). The London Clay has been estimated to be of between 30m and 60m thickness (i.e. to extend to between 60m and 90m bgl). Deeper geological units comprise the Lower London Tertiaries (LLT) and in turn the Upper Chalk (principal aquifers). The thickness and nature of the tidal flats and the London Clay can reasonably be expected to afford protection to the deeper aquifers, providing the London Clay is not breached by the OMSSD project. Groundwater in the LLT and the Upper Chalk is thought to be under artesian pressure; providing the London Clay is not breached groundwater in the deeper LLT and Upper Chalk would be expected to remain at depth and have no bearing on the shallower groundwater regime above the London Clay or Tidal Flats.

15.38 No groundwater monitoring has been undertaken beyond the shallow groundwater body in the made ground and Tidal Flats. The River Terrace Deposits have not been investigated, principally because to do so presents a potential for cross contamination from shallower soil and groundwater conditions, but since a significant thickness of alluvial clay overlies the River Terrace Deposits, impacts to the gravels would not be expected and therefore not require investigation. One borehole that was advanced to 40m bgl in December 2020 for geotechnical purposes reported no groundwater strikes in the River Terrace Deposits and all groundwater observations were noted between the ground surface and up to 3m depth.

15.39 Made ground has been encountered at the site during site investigation and although variable in thickness, is typically in the region of 1 to 1.5m thick and comprises gravel, sands and clay with flint gravel and anthropogenic materials including brick and concrete fragments. In some areas of the Oikos Facility and equally within the OMSSD project area,

made ground was encountered to a depth of 2.6m below ground level (bgl) and in some areas made ground was found to be absent.

15.40 Aside from roadways, car parking and within tank compounds, the Oikos Facility is largely soft surfaced with scrub, grass and areas of bare earth.

15.41 Shallow groundwater has been encountered within the made ground and/or perched on the silts and clays of the Tidal Flats. Groundwater depths vary between monitoring rounds, but broadly groundwater levels rest at depths of around 1.6m bgl or in some areas (including within the OMSSD project area) are encountered very near surface. Based on historic site investigation data there appears to be some seasonality to the groundwater. During site investigation in the Autumn of 2018, one borehole in the centre of the Oikos facility (in the northern area of the OMSSD project) was observed to be dry and monitoring locations in the south-west of the site (in the area of the current administration/office building) have historically also been reported to be dry.

15.42 From groundwater level monitoring data, groundwater is inferred to flow to the south in the northern area of the Oikos Facility, although in the southern part i.e. the area of the OMSSD project, the groundwater flow direction is less clear but may be influenced to some extent by the physical presence of the flood defence wall (also known as the sea wall), which forms the southern site boundary of the Oikos Facility. The flood defence wall appears to have been constructed in its current form in the 1980s (drawings provided by the EA are dated 1984) and based on the geological sequence at the site, is interpreted to extend to depth in the Tidal Flats (alluvial clays) and potentially the London Clay.

15.43 Figure 15.2 and Figure 15.3 provides the groundwater contours plotted from groundwater levels obtained in November 2018 and in more detail for the western part of the OMSSD project area, from additional wells installed in October 2019 respectively. Notably, these are similar in pattern to historic groundwater monitoring events which show a general southerly trend in groundwater flow in the northern part of the Oikos Facility but an indiscernible direction in the OMSSD project area in the south of the site. Further, the contours and groundwater levels indicate a very shallow groundwater gradient (virtually stagnated groundwater). From these two lines of evidence, it is surmised that there is no tidal influence on shallow groundwater at the site and an expectation that the sea wall is containing shallow groundwater within the site boundary such that there is no continuity between the Thames Estuary and shallow groundwater at the site. The EA cross-sectional drawings of the seawall at the boundary of the Oikos Facility document that that structure is constructed from Frodingham sheet steel piles (interlocking sheet steel piles) that appear to extend deep into the Alluvial Clay, below the water level of the Thames); this appears to confirm that the Thames estuary is physically separated from groundwater at the Oikos Facility.

15.44 There is potential for localised continuity between groundwater at the Oikos Facility and a surface water swale that appears present (although heavily vegetated) to the west of the Oikos Facility immediately beyond Haven Road. The swale to the west of the site does not appear to be connected to the Thames Estuary, where it appears to terminate on the northern side of the sea wall. The significant amount of vegetation visible within the swale also suggests that there is limited water flow in the swale, implying further evidence that

there is no physical connection to the Thames. The swale otherwise appears to bow to the north-west before eventually connecting to the Thames, some 0.85km along its path.

15.45 There are no current groundwater abstraction points within 2km of the Oikos Facility and the Oikos Facility is not located within a designated groundwater source protection zone. By virtue of the Tidal Flats alluvial clays, the Oikos Facility and immediate surrounding area is classified by the Environment Agency as unproductive strata. As such and given the characteristics of groundwater observed at the Oikos Facility to date, groundwater sensitivity is considered to be low.

15.46 Storm water runoff discharges either to soft surfacing (and permeates into the ground) or is captured by an Oikos Facility wide drainage network. Sections of the drainage were at one time open surface water drains but have over time been culverted and engineered to eventually connect into the final interceptor located in the south-east of the site. It is anticipated that groundwater flow at the site will also be influenced by the site drainage network to some extent, given that there are areas of the site that historically lent themselves to the development of the surface water drainage channels and now where these and other drainage features have been engineered, their installation in pea shingle provides a permeable medium in which to migrate. Storm water (and locally any groundwater) in the drainage network that passes through the interceptor, is then, subject to water quality checks, pumped over the flood defence wall and along Jetty 3 for final discharge to the Thames.

15.47 The Thames Estuary contains foreshore areas that are designated for nature conservation purposes and Holehaven Creek, located approximately 0.1km west of the Oikos Facility, is a SSSI. A further SSSI is located approximately 0.81km north west of the Oikos Facility at Canvey Wick. Seven non-statutory designated ecological sites are present within 2km of the Oikos Facility, the closest of which is the Canvey Village Marsh Local Wildlife Site, located approximately 20m west from the Oikos Facility boundary. The Thames Estuary and Marshes (i.e. the southern banks of the Thames Estuary some 1.5km south of the site) are designated as a SSSI, SPA and Ramsar site.

15.48 The Oikos Facility is not in an area of designated geological conservation. Nor are there any biosphere reserves or national parks within 2km of the OMSSD project area. Similarly, there are no Marine Conservation Zones nor Marine SACs designated within 2km of the OMSSD project area.

15.49 There are no Registered Parks or Gardens designated by Historic England within 2km of the site.

15.50 Listed buildings present within 2km of the site include the Lobster Smack public house (Grade II listed) and residential buildings at 1, 1A and 2 to 8 Haven Road (former Coastguard Cottages) beyond the site boundary, as well as ‘Dutch Cottage’ at 6 Haven Road located approximately 600m north of the facility. These are all considered to be of sufficient distance from the site to be able to discount them as receptors to potential contamination risks arising from the OMSSD project area.

15.51 From site investigation information, some contamination is known to be present in areas of the Oikos Facility - as would be expected of any industrial site with a long operational history. Figure 15.4 presents the locations in which contaminant concentrations in soil and/or groundwater were identified to exceed GAC for either human health (from soils or groundwater contaminants) or controlled water receptors (from groundwater contaminants). In summary, these included:

- within the western area of the OMSSD project area (the location of former pumphouse No.3 and the NP4 Compound) there is soil contamination with chlorinated solvents (including tetrachloroethene, trichloroethene, dichloroethene and dichloroethane (and to a lesser area heavy distillate (diesel range) hydrocarbons including in groundwater to a localised concentration of 14mg/l);
- in the central part of the OMSSD project area (broadly the area of the former pumphouse No.1) there is some oil (heavy distillate, diesel range) contamination (up to 29,240 mg/kg) and some soil solvent contamination (including trimethylbenzene); and
- also in the central area of the OMSSD project area (adjacent west of the current R Compound) in which oil and solvents (e.g. vinyl chloride of up to 0.845mg/kg) have been identified in some soils).

15.52 Furthermore, pockets of oil product floating on groundwater were observed in one exploratory location in the far north of the OMSSD project area (the northern edge of the former Compound 1, refer to Figure 15.1) and two locations in two groundwater monitoring locations in the centre south of the OMSSD project area. Otherwise, oily sheens were also observed on groundwater during monitoring in the pumphouse No.1 area (centre east of the OMSSD project area and a single monitoring well located in the west of the OMSSD project area (broadly east of the proposed contractor parking area).

15.53 Groundwater monitoring has been undertaken at the south western site boundary of the Oikos Facility with Haven Quays. This was undertaken to consider whether groundwater migration could be occurring towards the residential properties, despite the likelihood that the existing, high, boundary wall would be expected to be founded in the Tidal Flats (alluvial clay) for stability and similarly to the sea wall, physically preventing the off-site migration of groundwater in this area. Although elevated hydrocarbon contaminant concentrations were generally encountered in groundwater in the wider OMSSD project area they included elevated results in the south-west area of the site bounded by the residential properties. Specifically, a hydrocarbon concentration of 4,657ug/l for aliphatic carbon fraction C6 to C8 in groundwater was identified to exceed the generic screening for inhalation of volatile hydrocarbons. Therefore, a human health focused detailed quantitative risk assessment (DQRA) was undertaken by Ramboll in 2019 and concluded that the groundwater concentrations would not be considered to represent an unacceptable risk to residential (human health) receptors through inhalation pathways.

15.54 Groundwater monitoring in the autumn of 2019 has also sought to provide additional data sets for groundwater quality in the western area of the site for assessment of off-site groundwater migration risks to the nearby, off-site swale beyond Haven Road. The

groundwater results reported marginally elevated hydrocarbon (maximum 101ug/l for aromatic hydrocarbon carbon fraction C10 to C12) and polycyclic aromatic hydrocarbon (maximum of 0.304ug/l fluoranthene) concentrations in groundwater in the area of the current gatehouse. Three rounds of monitoring were undertaken and on one occasion the results were reported for most contaminants below the laboratory method detection limit. However, two rounds of monitoring reported detectable contaminant concentrations which exceeded generic screening assessment criteria (namely environmental quality standards, or where these are absent drinking water standards – noting that the use of drinking water standards is a particularly conservative approach given the environmental site setting). A separate controlled water DQRA was undertaken in October 2019 and concluded that in the absence of biodegradation processes, a hypothetical risk to the swale from groundwater concentrations in the west of the site was concluded to be present. However, if biodegradation was assumed to be occurring, the groundwater contaminant concentrations were concluded to represent an acceptable risk to surface water receptors. In the absence of qualitative data demonstrating biodegradation, subsequent groundwater monitoring in the summer of 2020 was undertaken. The summer 2020 monitoring round at RS214 identified lower (for many contaminants, the lowest) and acceptable, groundwater contaminant concentrations.

15.55 Asbestos product debris has been identified sporadically in localised areas of the Oikos Facility, but much less than might be expected of a site with such an industrial history.

15.56 Extensive remediation works, including the excavation and off-site disposal of oil impacted soils, have already been undertaken in the northern part of the Oikos Facility, as part of the renewal of these areas of the facility (Compound 4 and Compound 10).

15.57 Therefore, whilst Figure 15.4 shows frequent exceedances of the GAC; with additional monitoring, DQRA and in the context of the CSM, the soil and groundwater contaminant concentrations were not considered to be of significant risk to receptors.

15.58 Overall and largely due to its setting (i.e. the presence of few indoor habitable spaces, the absence of connectivity with the Thames Estuary, the absence of a discernible groundwater gradient towards the Thames and the absence of a migration pathway to adjacent residential receptors) together with the assessment of the contaminant concentrations reported, the conclusions from the site investigation and assessment work undertaken to date are that, in its current configuration, the Oikos Facility represents a low risk to receptors from the presence of ground contamination. No further site investigation or assessment work is concluded to be required except for one additional round of groundwater monitoring, particularly in the western area of the OMSSD project, to complete the data set in relation to previously detected groundwater contaminant concentrations at the western boundary. The additional monitoring will be undertaken in Spring to provide a robust, complete, seasonally based data set.

Environmental Change without the OMSSD Project

15.59 In the absence of the OMSSD project, it is expected that the Oikos Facility would continue to be operational in its current activity. Potential risks from the inhalation of contaminants via indoor air pathways is naturally mitigated in the administration building (located in the south-west of the Oikos facility) by virtue of its foundation construction detail, comprising a ventilated undercroft. Potential risks from direct contact with contaminated soils is currently mitigated by the requirements for wearing of personal protective equipment (PPE). It is further expected that Oikos would continue to monitor groundwater conditions periodically and in particular address soil and groundwater contamination as and when it was discovered during any future local ground works or maintenance works.

15.60 With the site in its continued use and in the absence of the OMSSD project, the site is considered to represent a low environmental risk to human health (commercial site users and off-site residential receptors), controlled waters, property (buildings on-site) and ecological systems. This is largely by virtue of the environmental setting of the site including the presence of the sea wall, the boundary wall and the direction of groundwater flow in addition to the absence of significant habitable spaces in the wider site area.

15.61 There are known pockets of contaminated land on parts of the Oikos Facility and these areas would continue to be subject to the general management and monitoring regime already employed across the operational Oikos Facility. This includes periodic monitoring of groundwater to assess seasonal influences on groundwater contamination and assess whether biodegradation process were taking place.

15.62 In the absence of the OMSSD project but at the end of the Oikos Facility's operational life, either a future redevelopment and/or a surrender of the lease would be expected to trigger a requirement for site investigation and remediation. Similarly, Oikos currently holds an environmental permit for, now redundant, waste oil processing activities. At the time that the permit is surrendered, soil and groundwater remediation may be required by the EA to return the site to a satisfactory state as defined by the requirements of the environmental permit regulatory regime.

Preliminary Consideration of Likely Impacts and Effects

15.63 In relation to ground conditions in the OMSSD project area, any changes in the development programme would not be expected to have a material effect on the potential environmental risks identified from the presence of ground contamination, nor the effectiveness of the mitigation measures proposed.

15.64 The assessment work undertaken to date has identified a small number of plausible pollutant linkages during both the construction and operational development phases of the OMSSD project. This has been based on the site investigation data, screening of the data against generic assessment standards and in some cases the undertaking of DQRAs and used to devise a revised conceptual site model of plausible risks. In consideration of this, and in the

absence of mitigation, the following potential pollutant linkages could represent a potentially unacceptable risk to sensitive receptors (as defined in CLR11):

Human Health

- *Minor Adverse Effect*: construction workers and future site users may come into direct contact with potentially contaminated shallow soils (principally containing solvents and oils) during maintenance and localised soil excavations. Construction worker exposures are generally considered to be short term in nature compared to future site user exposure durations.
- *Minor Adverse Effect*: adjacent site users may inhale/ingest potentially contaminated dust generated by construction works, noting however that the OMSSD project area is located to the east of neighbouring residential uses and the prevailing wind direction is typically from the south-west which therefore naturally reduces the frequency of potential exposure.
- *Moderate Adverse Effect (potential likely significant effect)*: future site users may be exposed to potential vapour ingress from volatile soil contaminants in new habitable buildings in particular the mess facilities and workshop building proposed in the western area of the OMSSD project. The current administration building is not considered to represent a potential indoor air inhalation pathway, given that its foundation construction includes an undercroft.

Groundwater

- *Moderate Adverse Effect (potentially likely significant effect)*: piling for new tank bases and bund walls may create a preferential pathway for shallow contamination to migrate vertically to the deeper aquifers if the pile foundations breach the alluvial clays and the deeper London Clay. The alluvial clays are currently expected to afford protection to the band of terrace gravels at approximately 28m bgl (and be of approximately 4 to 5m thickness). The London Clay is currently considered to afford protection to the deeper Lower London Tertiaries (LLT) aquifer. The pile foundations are proposed to extend to 35m bgl and therefore potentially permeate the gravels lens. The preferred methodology from an engineering perspective is currently for the use of driven pre-cast concrete piles and with which there is a potential to drive shallow (in some areas, contaminated) soil materials deeper and potentially impact the river terrace deposit aquifer (if present). The depth of the piles would not be expected to extend beyond the base of the London Clay and therefore mitigates potential risk to the deep aquifers of the LLT and chalk.
- *Moderate Beneficial Effect:* Removal and off-site disposal of grossly contaminated shallow soils and shallow groundwater contaminants is expected to take place during the construction phase in the area of the proposed tank footprints (and bases). This would be expected to have the effect of reducing the contaminant mass and therefore potential risks to the deeper aquifer by removing the source of contamination prior to piling.

Ecological Receptors

15.65 The ground conditions assessment of the OMSSD has identified no impacts to ecological receptors given that the OMSSD project area is not located within a statutory ecological designated area. Specifically, there are no European, National and local designations (including for example, but not limited to, SSSI, SPAs, SACs, National Nature Reserve, national park designations) within the site boundary.

15.66 Although there is a SSSI located 100m west of the site (at Holehaven Creek) and Canvey Wick located 750m north-west of the OMSSD project area is also a designated SSSI, the site investigation data indicates that shallow groundwater at the site (the pathway by which contaminants could migrate to the ecological receptors) is migrating southwards (i.e. away from the off-site ecological receptors) and bound by the sea wall such that risks to off-site ecological receptors is considered to be negligible.

15.67 Further; the results of the groundwater conditions at the western site boundary currently indicate that, if groundwater was moving westwards at this localised part of the site, there is a negligible impact from groundwater contamination on-site to off-site surface water receptors and therefore inherently, also, negligible impact to ecological designations beyond Haven Road to the west of the site.

Climate change

15.68 Ground conditions in the OMSSD project area are considered to have negligible effect on climate change. Sustainability will be included as a criterion in the remediation options appraisal and in devising the final remediation strategy and will include consideration of matters such as traffic generation and energy use.

Inter-related effects

15.69 In expectation that some material excavations will be undertaken, particularly in the footprint of the tank bases (and tank bunds), it is estimated that approximately 10,800m^3 of material will require off-site disposal comprising up to approximately 5,000m^3 of materials contaminated with hydrocarbons (and potentially solvents). This will have bearing on the number of vehicle movements in the local area carrying materials for off-site disposal. These vehicle movements have been taken account of in the preliminary traffic and transport assessment (see Chapter 11) with associated noise and vibration and air quality impacts considered in Chapters 12 and 14 respectively. In the event that additional contamination is encountered during the site preparation work, then this will be remediated as required.

15.70 The use of piled foundations for tank bases will have noise implications, which have been considered within the preliminary assessment contained within Chapter 14 ‘Noise & Vibration’.

Mitigation Measures

15.71 In relation to the identified potential pollutant linkages set out in the preceding section, the following initial mitigation measures are anticipated in relation to the OMSSD project:

- construction workers and site users will be required to wear appropriate personal protective equipment (PPE) including overalls, eye protection and gloves at all times when outside office buildings;
- good construction methods such as damping down will be implemented to mitigate potential risks from the migration of dust from the site; dust monitoring will be undertaken during the course of ground disturbance works;
- buildings foundations will, as necessary, incorporate vapour protection, such as vapour proof membranes and sealed service ingress points;
- driven pre-cast piles are intended to be used as the foundation solution for the tank bases and bund walls. Where practicable, the driven piles will adopt a convex shoe design to minimise the displacement of materials vertically and instead enables materials to be displaced laterally. The use of driven pre-cast concrete piles will limit the generation of materials at the surface and therefore minimise soil segregation, handling and waste disposal requirements at the surface;
- soil excavation works in the area of proposed tank footprints and bases where they coincide with the footprint of legacy tank bases (and typically with which contamination has been associated in previous tank demolition and refurbishment projects at the Oikos facility); and
- as far as possible, the retention of material on-site for re-use in the OMSSD project, providing there is demonstrable need for the material and the material is suitable for re-use in terms of its contaminant profile. Where material requires off-site disposal, an appropriate receiving facility will need to be identified and appropriate duty of care requirements implemented to manage the off-site disposal process.

15.72 The above mitigation measures are considered appropriate for the risks identified in relation to human health (construction workers, adjacent residents and controlled waters).

Limitations

15.73 There are no identified limitations to the site investigation and assessment undertaken in relation to the OMSSD project.

Preliminary Conclusions on Residual Effects

15.74 The preliminary contaminated land assessment undertaken to date has concluded that whilst the site continues in its current use, risks to identified receptors are considered to be low.

15.75 Potential effects on some sensitive receptors arising out of the OMSSD project have been identified but are considered to be suitably mitigated by the measures discussed including the inclusion of vapour protection in habitable buildings, selection of appropriate piling methodologies, wholesale removal of shallow ground contamination in the areas of the tanks and bases and the adoption of good construction measures for the mitigation of dust and odour.

15.76 On the basis of the mitigation proposed, the following preliminary conclusions on residual effects have been reached in respect of the potential impact areas identified in paragraph 15.64:

Human Health

- *Minor Adverse Effects on Commercial Site Users:* Risks to commercial site users from direct contact pathways are considered to be mitigated by the adoption of PPE which would be the case with or without the OMSSD project. With such mitigation in place, residual effects are considered to be *negligible*.
- *Minor Adverse Effects of Dust Migration during construction works*: Adjacent site users may inhale/ingest potentially contaminated dust from construction works, noting that the OMSSD project area is located to the east of neighbouring residential uses and the prevailing wind direction is typically from the south-west which therefore naturally reducing the frequency of potential exposure. The adoption of dust protection and monitoring measures during the OMSSD project construction phase will reduce residual effects to *negligible* levels.
- *Moderate Adverse Effects from Vapour Migration to Indoor Air*: The adoption of vapour proof membranes and/or the incorporation of sub-floor space in habitable buildings; namely the workshop and welfare building proposed as part of the OMSSD project will mitigate vapour intrusion on indoor air space and result in negligible residual effects. Such risks to the current administration building in the south west of the Oikos facility are already mitigated to *negligible* levels by virtue of the sub-floor void within the building foundations.

Groundwater

- *Minor Adverse Impacts to Aquifers:* The adoption of appropriate piling methodologies in the use of driven pile technologies for piled foundation of new tank bases and bund walls will reduce the risks of driving shallow contaminated soils to deeper groundwater bodies. Coupled with the removal and off-site disposal of grossly contaminated shallow soils (and shallow groundwater) in the area of historic tank bases (and bunds) where they coincide with new tank footprints and bases, can be expected to reduce effects on shallow groundwater and deeper aquifers from piling foundations to *negligible* levels. Current mitigation measures employed by Oikos including incidental excavation and remediation of impacted soils during localised groundworks, augment the mitigation measures proposed in relation to groundwater mitigation measures to be adopted for the OMSSD project.