



SOILS, GEOLOGY AND LAND CONTAMINATION

INTRODUCTION

1.1 This chapter discusses the historical and current use of site with respect to contaminated land and the underlying geology and hydrogeology. It details the objectives, methodology and findings of Ecologia's Geo-Environmental Assessment (report reference EES 16.041.1, dated 8th August 2016) and considers the potential impacts of disturbance of the soils on site associated with the Proposed Development. The assessment comprised a Phase 1 desk-based study and Phase 2 intrusive site investigation, and is included within **Appendix 13.1**.

ASSESSMENT METHODOLOGY AND SIGNIFICANCE CRITERIA

1.2 The assessment of contaminated soils in the UK follows a risk based approach and is structured in a tiered manner. As well as having a systematic approach to collecting the data it is also necessary to adopt recognised techniques and standards in assessing them and particularly with regard to environmental risk assessment.

1.3 An assessment of baseline conditions has been undertaken based on the findings of the Geo-Environmental Assessment. The methodology employed in completing the review of the site and surroundings involved the following:

- a site boundary walkover by an experienced environmental consultant to provide an assessment of current site activities and the site's environmental setting;
- a review of available historic maps to determine the land-use history in the context of potentially contaminative activities;
- a review of environmental data relating to the site and its surroundings using a proprietary third-party environmental database;
- desk-based assessment of site geology, hydrogeology and hydrology from published mapping and web-based sources to determine the site's environmental setting and sensitivity;
- a web-based search of the Environment Agency (EA) website and other freely available sources of information to identify any potential issues relating to site;



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- Completion of intrusive investigation works, including groundwater and ground gas monitoring (currently on-going);
 - provision of a qualitative contaminated land risk assessment based on Source-Pathway-Receptor as per current best practice contained in CLR11 (Ref. 13.3).

1.4 Information from these data sources enabled the identification of potential pollution sources and pathways for pollutants to migrate from the source areas to potential receptors (humans, ecosystems, buildings, *etc.*). Based on this information a Conceptual Site Model (CSM) has been formed for the site and its proposed end use. The CSM is based on the risk assessment principles of source, pathway and receptor.

1.5 The potential effects have been classified, prior to mitigation, as minor, moderate or major (either “Adverse”, “Neutral” or “Beneficial”). Where the predicted effects are considered to be significant, mitigation measures have been incorporated to eliminate or reduce the impacts to an acceptable level.



LEGISLATION, PLANNING POLICY AND GUIDANCE

1.6 The National Planning Policy Framework (Ref. 13.4) (March 2012) sets out the Government's planning policies for England and how these are expected to be applied. The National Planning Policy Framework (NPPF) constitutes guidance for local planning authorities and decision-takers both in drawing up plans and as a material consideration in determining applications. Fundamental to the NPPF is a presumption in favour of sustainable development.

1.7 The National Planning Policy Framework states that in order "to prevent unacceptable risks from pollution and land instability, planning policies and decisions should ensure that new development is appropriate for its location. The effects (including cumulative effects) of pollution on health, the natural environment or general amenity, and the potential sensitivity of the area or Proposed Development to adverse effects from pollution, should be taken into account. Where a site is affected by contamination or land stability issues, responsibility for securing a safe development rests with the developer and/or landowner".

1.8 Planning policies and decisions should also ensure that:

- "the site is suitable for its new use taking account of ground conditions and land instability, including from natural hazards or former activities such as mining, pollution arising from previous uses and any proposals for mitigation including land remediation or impacts on the natural environment arising from that remediation";
- "after remediation, as a minimum, land should not be capable of being determined as contaminated land under Part IIA of the *Environmental Protection Act 1990*"; and
- "adequate site investigation information, prepared by a competent person, is presented".

1.9 The NPPF specifies that the minimum information that should be provided by an applicant is the report of a desk study and site reconnaissance.

1.10 The NPPF replaces the key Planning Policy Statements (PPS) which formed national planning policy, including PPS23 directly relevant to land contamination. PPS 23 stressed that land contamination, or the possibility of land contamination, is a material planning consideration in taking decisions on individual planning applications. This remains a fundamental part of the NPPF.



1.11 The planning process can influence how contaminated sites are managed through planning policy and development control. In terms of the latter, planning conditions often require detailed site assessment or, in some cases, the restoration of a site to render it suitable for its proposed new use.

1.12 Part 2A of the *Environmental Protection Act 1990* ("Part 2A") provides the legislative framework for the Contaminated Land regime in England, Wales and Scotland. It provides for Contaminated Land to be identified and dealt with in a risk-based manner. *The Contaminated Land (England) Regulations 2006* (SI 2006/1380) set out provisions for procedural matters under Part 2A. The 2006 regulations have recently been modified with the introduction of *The Contaminated Land (England) (Amendment) Regulations 2012*, which came into force on 6th April 2012. This includes an amendment to Regulation 3(c) to take account of the updated definition of "controlled waters" in Section 78A(9) of the *Environmental Protection Act 1990*.

1.13 Section 78A(2) of Part 2A of the EPA 1990 defines contaminated land as "land which appears to the local authority in whose area it is situated to be in such a condition, by reason of substances in, on or under the land, that:

- significant harm is being caused or there is a significant possibility of such harm being caused; or
- pollution of controlled waters is being, or is likely to be caused".

1.14 The implementation of Section 86 of *The Water Act 2003* on 6th April 2012 by *The Water Act 2003 (Commencement No. 11) Order 2012* (SI 2012/264) modifies the definition of contaminated land to also include land where there is "significant possibility of significant pollution of controlled waters".

1.15 Contaminated Land Statutory Guidance published in April 2012 (Ref. 13.5) provides for a four category test which is intended to clarify when land does or does not need to be remediated, where Category 1 is deemed as being high risk and Category 4 as being low risk.

1.16 "Significant harm" is defined in the Guidance on risk based criteria and must be the result of a significant "pollutant linkage". The presence of a pollutant linkage relies on the Source-Pathway-Receptor concept, where all three factors must be present and potentially or actually linked for a potential risk to exist. An initial assessment of pollutant linkage can be made qualitatively (*i.e.* through identifying these factors) and may be assessed using qualitative risk assessment models.



1.17 Contaminated Land Report 11 (CLR 11), Model Procedures for the Management of Land Contamination (Ref. 13.3) identifies the risk management framework to be followed when dealing with land affected by contamination.

1.18 Further guidance documents relevant to the assessment of contaminated land are provided by various statutory and non statutory bodies and are referenced where applicable. The following list details the main legislation and guidance that has been used in preparation of this impact assessment:

- Part IIA *Environmental Protection Act 1990* (as inserted by Section 57 of the *Environment Act 1995*).
- *Contaminated Land (England) Regulations 2006*.
- *Contaminated Land (England) (Amendment) Regulations 2012*.
- Environmental Protection Act 1990: Part 2A Contaminated Land Statutory Guidance, DEFRA, April 2012 (Ref. 13.5).
- Environment Agency (2004): The Model Procedures for the Management of Land Contamination, CLR 11 (Ref. 13.3).
- Indicative Atlas of Radon in England and Wales (HPA-RPD-033), published by Public Health England (November 2007) (Ref. 13.1) and
- Radon: guidance on protective measures for new dwellings, published by the Building Research Establishment (BRE) & Department of the Environment, Transport and the Regions (1999) (Ref. 13.2).

BASELINE CONDITIONS

Current Activities On-site

1.19 Ecologia has undertaken a Geo-Environmental Assessment for the site, as detailed within report reference EES 16.041.1, dated 8th August 2016. This has been included as **Appendix 11.1**.

1.20 The site is situated approximately 1.5 miles west of Sittingbourne town centre, to the south of the A2 and north of the village of Borden. The A249 runs approximately 200m to the west of the site.

1.21 The site currently comprises agricultural fields of bean and wheat crops. Two public footpaths pass through the site traversing east to west and north to south. There are currently no buildings or structures located on site.

Photograph 11.1: View West from the Eastern Area of Site



Photograph 11.2 View Northeast across the Western Area of Site



1.22 The site gradient gradually slopes to the south, with the majority of the site recorded at approximately 34 - 35m above ordnance datum (AOD). Two very shallow valley areas are located to the northwest and north east of site, dipping to approximately 29m AOD at the shallowest area.

Photograph 11.3: View of the Shallow Valley Area in the North East of Site



Historical Activities On-Site

1.23 Changes in historical land use with regard to potentially contaminative land use have been assessed using the historical maps available (1865 to 2014) within a 1km radius of the site and are summarised in Table 11.1 below. The maps are reproduced in Ecologia's Geo-Environmental Assessment Report, included as Appendix 11.1.



Table 11.1: Site History

Dates	Significant land use changes on site	Significant land use changes within 500 m of site	Significant land use changes 500m to 1km of site
1865 - 1896	Site appears to comprise open fields in 1865 - 1866, with public footpaths. A residential dwelling is present close to the central northern boundary. In 1895, an orchard is established in the southern and south eastern areas of site.	A small Chalk pit is located adjacent to the far eastern boundary of site. Abundant Chalk pits surrounding site and gravel pit located approx. 300m north and west of site. Saw mill located approx. 250m north west of site. Unspecified mill located approx. 500m north west of site. Disused brick works located approx. 500m.	1865 – 1866 extensive brick field located 500 – 750m north of site. This becomes Chalkwell residential development in 1895, and smaller chalk pits. Abundant Chalk pits surrounding site, some disused. Sittingbourne Water Works located approx. 750 - 800m north west of site. Brick works located approx. 750 - 800m east of site. Orchards established surrounding site. A249 located 750m north of site.
1906 - 1960	No significant land use change.	Directly adjacent to the south, south-eastern boundary of site a Chalk and clay pit noted. Malthouse noted approx. 400m north of site.	No significant land use changes. More extensive orchards noted.
1961 - 1970	No significant land use change. Orchard develops in north eastern corner of site.	School developed approx. 50m north of site to serve an expanding Milton Regis and Key Street residential areas. Unspecified tank located approx. 400m south west. Kent Farm Institute established in 1961 approx. 350 - 400m south east of site.	Unspecified works areas noted 500m north east and 800m north west of site. Further extensive orchard development surrounding site.
1971 - 2014	The residential property on the north boundary is no longer present in 1971. No other significant land use change from 1971 to present day.	Small chalk pit no longer present on eastern boundary in 1971. Electrical substation to the north-east, extensive development of Milton Regis, incorporating Key Street and encroaching on Borden village. Chalk and clay pit located on the immediate south south-eastern boundary no longer denoted as such from 1971 and key identifies as refuse area. Transport depot established approx. 250m north east of site.	Keycol hospital located approx. 800m north west. Pumping station established 750 - 800m north-north east of site.

1.24 In summary, the site has remained largely undeveloped with earliest historical mapping showing the area as open fields with public footpaths and a residential dwelling close to the central northern boundary. By the turn of the 19th century, an orchard established in the southern and south eastern areas of site. Locally, two small chalk pits were located adjacent to the eastern boundary and south south-eastern boundary of the site (off site). The south eastern pit was later filled with inert, commercial, household and liquid sludge waste.



Historical industrial land uses have also been identified within 250m of site, comprising a transport depo and saw mill.

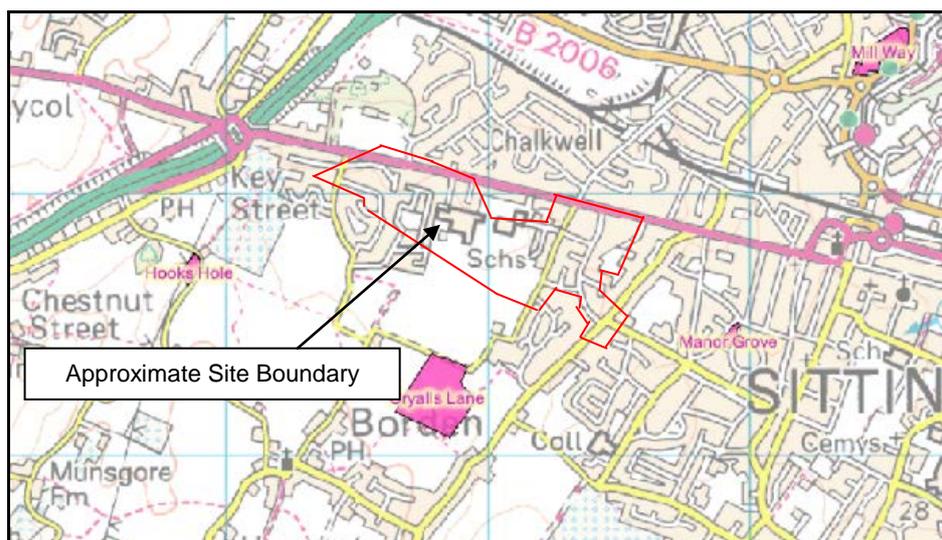
Environmental Database

1.25 A commercial database search (provided by GroundSure) was obtained for Ecologia's desk-based study (EES 16.041.1, dated 8th August 2016) to provide further information regarding the site and the surroundings. Relevant information and records are summarised below:

- **Current Landfills** – According to the environmental database, there are no current operational landfill sites located on-site or within a 250m search radius.

- **Historical Landfills** – There are four (4No.) records of historic Environment Agency landfill sites within 1,500m of the study site, as detailed below:
 - One (1No.) historic landfill located directly adjacent to the south south-eastern boundary of the site, known as Cryalls Lane. The landfill was operated by Swale Rural District Council accepting inert, commercial, household and liquid sludge between c. 1956 and 1985.
 - One (1No.) historical landfill known as 'Hooks Hole' is located directly adjacent to the south western boundary of the site, accepting inert waste (no dates available).
 - Two (2No.) historic landfill sites located 716m east (Manor Grove - inert) and 1,405m north east (Mill Way - not specified) of site.
 - One (1No.) record is also detailed for a historical Local Authority refuse tip, located 9m southwest of site, potentially operational in 1969.

Figure 11.1: Landfills in the Vicinity of Site (Source: Environment Agency)



- **Tank Database** - Fourteen (14No.) records of historical tanks situated within 500m of site have been identified. One (1No.) unspecified tank was located 3m north west of site, mapped in 1908, with a second located 56m south of the site in 1957. A further twelve (12No.) unspecified tanks are located beyond 223m of site, dated between 1897 and 1999.
- **Energy Features Database** - Seventy four (74No.) historical electrical substations are located within 500m of site. Nine (9No.) of these are located within 50m of site, dated between 1969 and 1996. Of note, multiple entries appear to relate to one feature. Two (2No.) of these records are detailed as gas governor, located 265m north of site in 1997 (appear to relate to one feature).
- **Garages and Motor Vehicle Repairs** - Eight (8No.) garages are located within 500m of site between 1957 and 1999. The nearest is located 258m north of the site.
- **Petrol and Fuel Stations** - Two (2No.) open fuel sites are located 271m north and 279m north east of site respectively. These are detailed as Park Sittingbourne Service Station, Bobbing and Mrh Rhode House, Sittingbourne respectively. One (1No.) obsolete fuel site is located 347m northeast of site, detailed as Staplehurst Garage, Sittingbourne.
- **Recorded Pollution Events** - There are eight (8No.) pollution events recorded on the National Incidents Recording System. Two (2No.) of these are recorded adjacent to the eastern boundary (off site), dated 2002 and 2003 with minor pollution to water



(unspecified contaminant) and land (inert materials and waste - construction and demolition) respectively.

- **Environmental Permits, Incidents and Registers** - There are no recorded hazardous substance consents located within 500m of site, including IPC Authorisations, IPCC Authorised Activities, List 1 and List 2 Dangerous Substance Inventory Sites and Category 3 or 4 Radioactive Substance Authorisations. Three (3No.) Part A(2) and Part B Activities and Enforcements are located within 500m of site, detailed as Park Service Station, Key Street, Esso Petroleum Ltd., London Road and Staplehurst Road Garage, Staplehurst Road. All these entries are located in Sittingbourne (north of site) and had no enforcements notified.

Historical Contamination Potential

1.26 From the available information, it appears that limited potentially contaminative activities have been undertaken on-site. The potential exists for contamination from the use of herbicides and / or pesticides due to the agricultural nature of the site.

1.27 The surrounding area is predominantly residential and agricultural; however, the following potentially contaminative activities have been identified as having taken place in the immediate surrounding area:

- Historical Chalk pit located off site, adjacent to the eastern boundary of the site. The infilling of this is unknown;
- Old Chalk and clay pit filled with inert, commercial, household and liquid sludge waste, located off site, immediately adjacent to the south south-eastern boundary of site;
- A historical refuse tip south west of the site;
- Historical industrial land uses locally within 250m of the site including: saw mill, railway land, brick works, unspecified works, nurseries and transport depot; and
- Various old Chalk pits, clay pits, unspecified pits and quarries within 250m locally.

Geology

1.28 A review of readily available information including the BGS website and the published BGS Sheet 272 (Chatham) Solid and Drift edition indicates the site is partially located over superficial deposits comprising Brickearth / Head Deposits consisting gravel, sand, silt and clay deposits. The bedrock geology underlying site comprises the Thanet Sand Formation

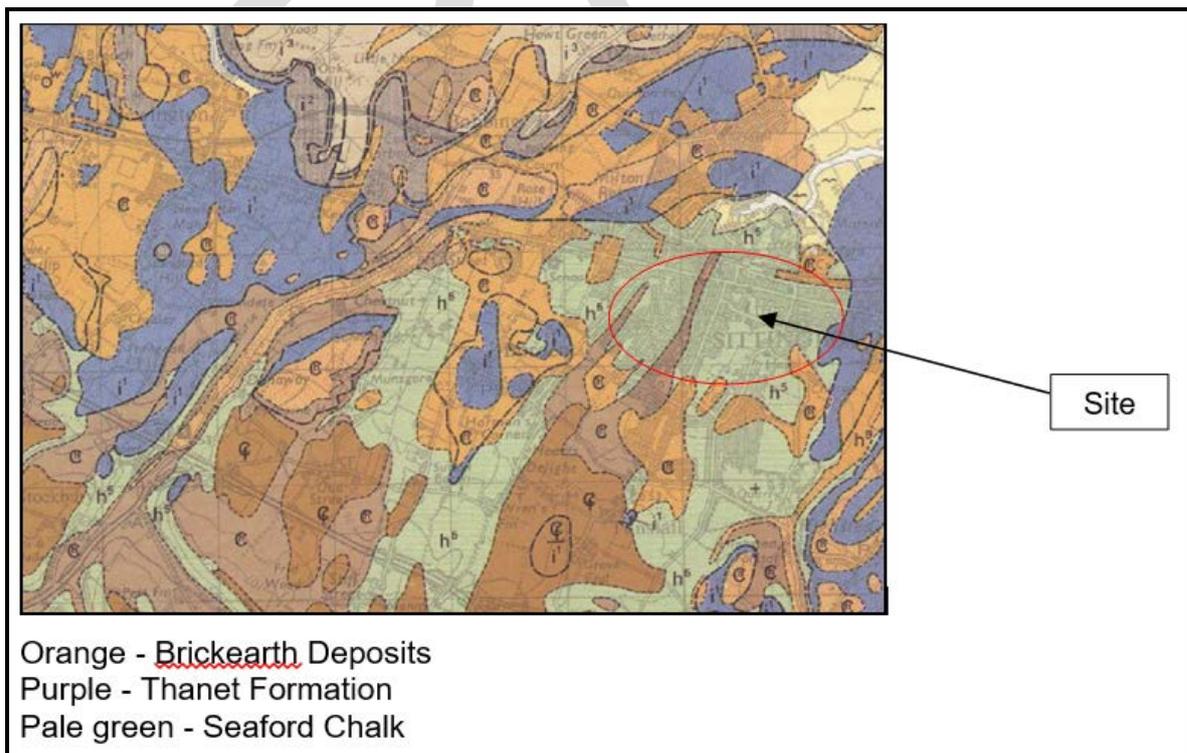


over the central southern area of site, the north western corner and far south eastern corner with Seaford Chalk outcropping the remaining area.

Table 11.2 – Literature Geological Description of the Geology Underlying Site

Age	Formation	Description of Lithology	Approximate Thickness (m)
Quaternary	Brickearth Deposits	Varies from silt to clay, commonly yellow-brown and massively bedded	-
Tertiary	Thanet Formation.	Glauconite-coated, nodular flint at base, overlain by pale yellow-brown, fine-grained sand that can be clayey and glauconitic. Rare calcareous or siliceous sandstones.	0 - 30
Late Cretaceous	White Chalk Subgroup Seaford Chalk	Firm white Chalk with conspicuous semi-continuous nodular and tabular flint seams. Hardgrounds and thin marls are known from the lowest beds. Some flint nodules are large to very large.	55 - 60

Figure 11.2: Geological Map Summary





1.29 General ground conditions encountered during the works sequentially comprised:

- Topsoil;
- Sandy gravelly clay (Head / Brickearth);
- Sand (Thanet Sand Formation); and
- Structureless Chalk (Seaford Chalk).

1.30 Within the west and central part of the site the Thanet Formation was greater in thickness compared to the eastern area of the site. Within the northeast of site, no sand was encountered and Chalk was identified at shallow depths.

Superficial

Quaternary Deposits

1.31 The superficial deposits found on site are often described as “Brickearth”, which in some cases may represent the original overbank mud of the river, laid down during floods.

Bedrock

Tertiary Deposits

1.32 The bedrock geology underlying the central southern area of site, the north western corner and far south eastern corner of site form part of the Paleogene sedimentation and include shallow marine, coastal and fluvial sediment classified in the site area as Thanet Sand Formation. This consists of silty, fine-grained sand which tends to be clayey and siltier in the lower part. The colour varies between greenish and brownish grey, but at the surface the sands is more pale yellowish grey.

Cretaceous Deposits

1.33 The main bedrock geology underlying site comprises cretaceous deposits forming part of the succession of the White Chalk. The site is located on the upper part of the Chalk Group, distinguished as Seaford Chalk. This formation is characterised by soft, white, non-nodular Chalk with regular bands of large flints.



Table 1.3: Encountered Ground Conditions on site

Stratigraphic Group	General Description	Range of Depths Encountered (m bgl)	Thickness Range (m)
Top Soil	Soft sandy gravelly Clay.	GL - 0.50	0.00 - 0.50
Quaternary Deposits (Brickearth Superficial Deposits)	Firm to stiff slightly gravelly sandy Clay	0.50 – 3.00	0.50 – 3.50
Tertiary Deposits (Thanet Sand Formation Bedrock Geology)	Very stiff sandy Clay to dense silty Sand	3.50 – 12.00	3.50 – 11.00
Cretaceous Deposits (White Chalk Bedrock Geology)	Very stiff slightly gravelly sandy silty Chalk	12.00 – 30.00	-

1.34 The GroundSure report states that the site is located in a radon affected area as between 1% and 3% of properties are above the Action Level. No radon protection measures are required in new builds or commercial developments, as described in publication BR211 by the Building Research Establishment.

Hydrogeology

1.35 The following aquifer designations are identified underlying the site:

- Head Deposits - Unproductive Aquifer.
- Thanet Sand Formation - Secondary A Aquifer.
- Seaford Chalk - Principal Aquifer.

1.36 The Groundwater Vulnerability Category is reported as “Major Aquifer” (relating to the Seaford Chalk) with Soil Vulnerability classified as “HU High Leaching Potential’ or ‘I1 Intermediate Leaching Potential”. Soils are detailed to “possibly transmit a wide range of pollutants”.

1.37 Information obtained from the Environment Agency website, confirmed by the Groundsure™ report, indicates the site is located in a groundwater Source Protection Zone 1 -



Inner Catchment (SPZ1). This area is defined as the 50 day travel time from any point below the water table to the source. This zone has a minimum radius of 50 metres.

1.38 Two (2No.) groundwater abstraction licences located within 250m of the site (detailed as Entec UK Ltd), however, both are historical. Additionally, two (2No.) potable groundwater abstraction points are located 850m northwest and 1,815m west of site. Both licences are detailed as Southern Water Services Plc boreholes at Keycol Ps and Danaway Ps respectively. Each has an active and historical licence.

Hydrology

1.39 There are no river networks within 500m of the study site. No surface water features are located within 250m of the site.

1.40 There are no listed surface water abstraction licences within 2km of site according to the Groundsure™ report.

1.41 There is one (1No.) recorded licensed discharge consent within 500m of site. This is detailed as Borden Hall Farm located 453m south west of site and comprises sewage discharge (final / treated effluent).

1.42 The site is considered at 'Very Low' risk of flooding from rivers or the sea, and is not located within a flood warning area or within an area benefitting from flood defences.

Sensitive Land Uses

1.43 One environmental sensitive area has been identified within 2km of site. This is detailed as an ancient woodland located 1,307m to the north.



IDENTIFICATION AND EVALUATION OF KEY EFFECTS

1.44 This section considers the potential effects of the Proposed Development, both during the construction and operational phases of the development.

1.45 The regime for contaminated land was set out in Part 2A (ss.78A-78YC) of the *Environmental Protection Act 1990* (EPA), as inserted by S.57 of *The Environment Act 1995* and came into effect in England on the 1st April 2000 as '*The Contaminated Land (England) Regulations 2000* (SI 2000/227)'. These regulations were subsequently revoked with the provision of '*The Contaminated Land (England) Regulations 2006* (SI 2006/1380)', which came into force in England on 4th August 2006, and consolidated the previous regulations and amendments. The 2006 regulations have recently been modified with the introduction of *The Contaminated Land (England) (Amendment) Regulations 2012*, which came into force on 6th April 2012. Under Part 2A of the EPA Section 78A(2), "contaminated land" is defined as "land which appears to be in such a condition, by reason of substances in, on or under the land, that:

- significant harm is being caused or there is a significant possibility of such harm being caused; or
- pollution of controlled waters (including streams, lakes and groundwater) is being, or is likely to be caused.

1.46 Based on the above factors, an initial qualitative assessment of the presence of potential pollutant linkages can be undertaken.

Conceptual Site Model

1.47 The soil and groundwater conditions on site, as identified through Ecologia's Geo-Environmental Assessment (EES 16.041.1, dated 8th August 2016), have been summarised into a Conceptual Site Model (CSM), which defines the key sources, pathways and receptors that have been identified as being relevant to this site. It is recommended Ecologia's report be read in conjunction with this CSM summary to define the standards met.

1.48 The CSM considers the situation and potential pollutant linkages before the planned redevelopment of the area and afterwards and considers the following factors:

- SOURCES - the identification of contaminants within the soils and groundwater that represent potential pollution sources;



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- PATHWAYS - the identification of the potential exposure mechanisms and migration pathways from the potential sources; and
 - RECEPTORS - the identification of the potential receptors that could be sensitive to harm if exposed to these pollution sources.

1.49 Collectively each of these scenarios would be considered a potential pollutant linkage that may require action.

1.50 It has been assumed for the purposes of this assessment that:

- The site use will change from its current use into housing with areas of landscaping.
- Construction will involve ground disturbance (e.g. excavation, landscaping, waste disposal *etc.*).

1.51 A preliminary conceptual model is presented below in accordance with the guidance outlined within Contaminated Land Report 11 (CLR11) Model Procedures for the Management of Land Contamination, Environment Agency (September 2004) (Ref. 11.3).

Identification of Potential Sources

1.52 Based on the information obtained by Ecologia, a summary of potential contaminant sources is provided below:

- Historical agricultural activities on site may have led to the use of pesticides and herbicides. Sampling to date has identified localised low concentrations in shallow soils of an organochlorine pesticide (p,p-DDE) that are marginally above the laboratory limits of detection. There are currently no UK guidelines for p,p-DDE, however, background agricultural soil concentrations for American soils are reported at 0.05 mg/kg (Soil and Groundwater and Sediment Standards for Use under Part XV.1 of the Environmental Protection Act, *Ministry of Environment, 2001*). This concentration is above those recorded by Ecologia on site.
- Minor recorded concentrations of PAH's within the groundwater in one borehole (of three) during the first monitoring round (of two). However, recorded concentrations are only marginally in exceedance of the Water Quality Screening (WQS) criteria, which are considered to be highly conservative for the site. The concentrations subsequently decrease to below the laboratory of detection during the second round of monitoring,



indicating sediment disturbance may be attributable to the concentrations previously recorded.

- Minor recorded concentration of nickel within the groundwater in one borehole (of three) during the second monitoring round (of two). However, recorded concentrations are only marginally in exceedance of the Water Quality Screening (WQS) criteria, which are considered to be highly conservative for the site.

1.53 The following potential off-site sources have been identified:

- Historical Chalk pit located off site, adjacent to the eastern boundary of the site. The infilling of this is unknown;
- Old Chalk and clay pit filled with inert, commercial, household and liquid sludge waste, located off site, immediately adjacent to the south south-eastern boundary of site;
- A historical refuse tip south west of the site;
- Historical industrial land uses locally within 250m of the site including: saw mill, railway land, brick works, unspecified works, nurseries and transport depot; and
- Various old Chalk pits, clay pits, unspecified pits and quarries within 250m locally.

Identification of Potential Exposure Pathways

1.54 Exposure pathways are the potential routes and mechanisms by which potential on-site sources could be linked to the identified potential receptors and thereby expose them to potential harm. Only plausible pathways need be considered, however.

1.55 The following potential human health exposure pathway has been identified at the site:



- Ingestion of:
 - soil;
 - building dust;
 - ingestion of contaminated vegetables; and,
 - ingestion of soil attached to vegetables.
- Inhalation of:
 - fugitive soil dust;
 - fugitive building dust;
 - outdoor vapours; and,
 - indoor vapours.
- Dermal contact with:
 - soil; and,
 - building dust.
- Ground Gas Migration
 - To future site users from explosive atmospheres (CH₄) and asphyxiation (CO₂).

1.56 The following potential pathways have been identified for this site:

- Vertical soil leaching of contamination through the superficial deposits / areas of infill such as the former chalk / unspecified pits on-site.
- Horizontal flow and dispersion via fissure/fractures through the groundwater.
- Vertical flow via fissure/fracture nature of underlying chalk strata.

Identification of Potential Receptors

1.57 Based on the site's environmental setting and the proposed future end use of the area following redevelopment, the following potential human health receptors are identified on site:



-
- Future site users comprising residential occupants; and
 - Construction and ground workers.

1.58 The following potential Controlled Water receptors are identified on site:

- Thanet Sand Formation (Secondary Aquifer); and
- Chalk (Principal Aquifer).
- For the purposes of assessment at this stage it is considered the Secondary and Principal Aquifers are in continuity.

Conceptual Site Model Summary

1.59 Production of a conceptual model requires an assessment of risk to be made. Risk is a combination of the likelihood of an event occurring and the magnitude of its consequences. Therefore, in order to assess risk both the likelihood and the consequences of an event must be taken into account. This report adopts the methodology for risk evaluation presented in CIRIA report C552 'Contaminated Land Risk Assessment - A Guide to Good Practice', 2001 (Ref. 13.7).

1.60 The method is qualitative and involves the classification of the following:

- the magnitude of the potential severity or consequence of the risk occurring (*Table 1.4*);
- the magnitude of the likelihood or probability of the risk occurring (*Table 1.5*); and
- once the likelihood of an event occurring and its severity have been classified, a risk category can be assigned using *Table 1.6*.

Table 1.4 – Classification of consequence



Consequence	Definition
Severe	<p>Short term (acute) risk to human health likely to result in 'significant harm' as defined by the <i>Environment Protection Act 1990</i>, Part IIA.</p> <p>Short term risk of (significant) pollution of sensitive water resource.</p> <p>Catastrophic damage to building/property.</p> <p>A short term risk to a particular ecosystem, or organism forming part of such ecosystem.</p>
Medium	<p>Chronic damage to human health (significant harm).</p> <p>Pollution of sensitive water resources.</p> <p>A significant change in a particular ecosystem, or an organism forming part of such an ecosystem.</p>
Mild	<p>Pollution of non-sensitive water resources.</p> <p>Significant damage to crops, buildings, structures and services.</p> <p>Damage to sensitive buildings/structures/services or the environment.</p>
Minor	<p>Harm, although not necessarily significant harm, which may results in a financial loss, or expenditure to resolve.</p> <p>Non-permanent health effects to human health (easily prevented by means such as personal protective clothing <i>etc.</i>).</p> <p>Easily repairable effects of damage to buildings, structures and services.</p>

Table 1.5 – Classification of probability

Likelihood	Definition
High	There is a pollution linkage and an event that either appears very likely in the short term and almost inevitable over the long term or there is evidence at the receptor of harm or pollution.
Likely	There is a pollutant linkage and all the elements are present and in the right place, which means that it is probable that an event will occur. Circumstances are such that an event is not inevitable, but possible in the short term and likely over the long term.
Low	There is a pollution linkage and circumstances are possible under which an event could occur. However, it is by no means certain that even over a longer period that such an event would take place and is even less likely in the shorter term.
Unlikely	There is a pollution linkage but circumstances are such that it is improbable that an event would occur even in the very long term.



Table 1.6: Risk Assessment Matrix

		Consequence			
		Severe	Medium	Mild	Minor
Likelihood of Occurrence	High	Very High	High	Moderate	Moderate/Low
	Likely	High	Moderate	Moderate/Low	Low
	Low	Moderate	Moderate/Low	Low	Very Low
	Unlikely	Moderate/Low	Low	Very Low	Very Low

1.61 A conceptual model has been derived based on the information obtained through the desk based study and based on the current and future residential usage of the Site. This is detailed in tabular format in *Table 13.6* and pictorially in *Figure 13.5*.

1.62 Consideration has also been given to the potential effects associated with the construction phase of the Site's redevelopment in addition to the operational phase of the Site following its redevelopment.

Table 1.6: Conceptual Site Model and Qualitative Risk Assessment



Potential Source	Potential Receptor	Possible Pathway	Probability	Consequences	Risk
Surficial soils (pesticides and herbicides)	Future site users	Direct dermal contact, inhalation and ingestion.	<p>Low Likelihood</p> <p>It is possible a pollutant linkage may exist as localised low concentrations have been recorded. However, concentrations are marginally above laboratory detection limits and are recorded below literature background concentrations (currently no UK guidance criteria) and very low leachable concentrations are reported.</p>	<p>Medium</p> <p>The possibility of elevated concentrations which may pose a chronic risk to human health cannot be discounted at this stage.</p>	Moderate / Low
	Construction and Groundworkers			<p>Minor</p> <p>The use of appropriate PPE and suitable health and safety procedures will mitigate any potential risk to future site workers.</p>	Very Low
	Principal Aquifer	Induced soil leaching of contamination and lateral / vertical groundwater migration.		<p>Medium</p> <p>The site is located within a SPZ 1 although no abstractions are noted locally.</p>	Moderate / Low
Groundwater (PAH's and nickel) locally on northeast of site	Future site users	Direct dermal contact, inhalation and ingestion.	<p>Low Likelihood</p> <p>It is possible a pollutant linkage may exist as localised low concentrations of have been recorded. However, the available screening criteria are considered to be conservative for this site based on proximity of the nearest abstraction borehole / surface water feature.</p>	<p>Mild</p> <p>The possibility of elevated concentrations unlikely to pose a chronic risk to human health.</p>	Low
	Construction and Groundworkers	Direct dermal contact, inhalation and ingestion.		<p>Minor</p> <p>The use of appropriate PPE and suitable health and safety procedures will mitigate any potential risk to future site workers.</p>	Very Low
	Principal Aquifer	Lateral / vertical migration.		<p>Low Likelihood</p> <p>It is possible a pollutant linkage may exist as localised low concentrations have been recorded. However, the available screening criteria are considered to be conservative for this site based on proximity of the nearest abstraction borehole / surface water feature.</p>	<p>Medium</p> <p>The site is located within a SPZ 1 although no abstractions are noted locally.</p>



Potential Source	Potential Receptor	Possible Pathway	Probability	Consequences	Risk
Off site sources (primarily former landfill adjacent to south east and eastern boundaries)	Future site users	Potential for explosive atmospheres and asphyxiation as a result of potential ground gas generation (CH ₄ and CO ₂) and migration in granular deposits.	Low Likelihood Although, there is a potential for elevated gas concentrations to be present on site initial results indicate low concentrations are present. Ground gas monitoring is currently ongoing and the risk will be re-assessed upon completion.	Severe Short term acute risk to human health / damage to buildings.	Moderate
	Construction and Groundworkers	Asphyxiation as a result of potential ground gas generation (CH ₄ and CO ₂) and migration in granular deposits.		Minor The use of appropriate PPE and suitable health and safety procedures will mitigate any potential risk to future site workers.	Low
	Principal Aquifer	Lateral / vertical groundwater migration.	Low Likelihood The historical Chalk pit located beyond the far eastern boundary has an unknown fill, however, is located hydraulically down gradient of site. Therefore, a potential pollutant linkage is not present. The former landfill located on the south, south-eastern boundary is situated hydraulically up gradient of the site and a potential pollutant linkage exists. Current groundwater monitoring results indicate low contaminant concentrations to be present, with the majority below laboratory limits of detection.	Medium The area is located within a SPZ 1 although no abstractions are noted locally.	Moderate / Low



ASSESSMENT OF CUMULATIVE EFFECTS

MITIGATION

Geo-Environmental Ground Investigation

1.63 Ecologia has completed a Geo-Environmental Assessment for the site, which is included in Appendix I.

Findings and Conclusions

1.64 Generally, the works did not identify any significant contamination. The ground investigation identified only minor concentrations locally of organochlorine pesticides within surficial soils and leachates, and slightly elevated groundwater concentrations of selected PAH compounds and nickel locally on one monitoring occasion. Recorded concentrations are considered to be marginal however, as the WQS are highly conservative for the site as the nearest abstraction borehole is located 850m from site.

1.65 Ecologia are currently undertaking ground gas monitoring on-site, most notably on the southern boundary adjacent to the former landfill. Currently, a moderate / low risk has been assigned; however, the results of the gas monitoring will be used to confirm / update the Conceptual Site Model.

1.66 With regards to geotechnical assessment, at this stage, shallow foundations (such as a raft or strip footings) founded in the superficial deposits (up to 3m bgl), may not be appropriate based on loadings of a typical low rise building. However, further investigation targeting soft spot areas will enable the suitability of shallow foundations to be reassessed. The Thanet Sand Formation is likely to be considered for foundations, but where the clay percentage exceeds the sand percentage, the layers may be susceptible to long-term settlement. The structureless Chalk is likely to be competent for foundation purpose, taking into account the groundwater level (which can affect the strata bearing capacity).

Recommendations



1.67 At this stage, the works are preliminary to support a future outline planning application. As part of any redevelopment works and detailed planning application it is expected further investigation works would be required, notably:

- A high risk has been identified on site for potential dissolution of soluble rocks. Although no dissolution features were encountered during Ecologia's works, a watching brief or geophysical scan is recommended to be undertaken prior/during construction works on site.
- Further geotechnical investigations to form detailed foundation design.

Should future redevelopment proposals change, the Conceptual Site Model will need updating and the risks re-assessed.

Protection of Site Workers and Public

1.68 During site preparation and construction phases, precautions would be taken to minimise the exposure of workers and the general public to potentially harmful substances. Attention would be paid to restricting possible off site nuisances, such as those arising from any dust and odour emissions. Such precautions would be included within the Construction Environmental Management Plan (CEMP) and include as a minimum:

- Personal hygiene, washing and changing procedures;
- Personal protective equipment (PPE) and respiratory protective equipment (RPE), including disposable overalls, gloves and particulate filter masks to be worn;
- Good housekeeping rules should also be observed on site i.e. washing of hands before eating etc. in accordance with health and safety regulations.
- Adoption of dust suppression methods, e.g. water spraying, wheel washing facility for vehicles leaving site;
- Covering of stockpiled material on site.

1.69 The above measures would be carried out in accordance with the Health and Safety Executive (HSE) publication HS(G)66 'Protection of workers and the general public during the development of contaminated land' (Ref. 13.9) and CIRIA Report 132, 'A guide for safe working on contaminated sites' (Ref. 13.8). The contractor would (prior to construction)



provide method statements which would show how the safety of the work force and the public would be ensured.

1.70 Where required, appropriate plans would be developed as required by the *Control of Substances Hazardous to Health Regulations 2003 (COSHH)* and the *Construction Design and Management (CDM) Regulations 2015*.

1.71 A discovery strategy during re-development works in the event that unforeseen and suspected contamination is encountered, the client should stop works and further assessment undertaken by experienced Environmental Consultant.

1.72 Additionally, if soils are to be re-used on site during future redevelopment works then this should be undertaken in accordance with a Materials Management Plan (MMP)¹. If soils are to be removed from site due to development requirements, these should be disposed of under the appropriate duty of care.

1.73 If a piling solution is adopted, then due to the sensitivity of the underlying Chalk Aquifer, this should be undertaken with due regard to Environment Agency guidance².

Contamination of Ground during Construction

1.74 Mitigation measures should be used to reduce the risks of potential contamination of site during construction. The measures to be employed shall be detailed in a Construction Environmental Management Plan (CEMP) for site and include measures to store and handle hazardous substances safely and procedures to manage any spills.

RESIDUAL EFFECTS

¹ CL:AIRE 'The Definition of Waste: Development Industry Code of Practice

² Environment Agency (2001) Piling and Penetrative Ground Improvement Methods on Land Affected by Contamination: Guidance on Pollution Prevention. NC/99/73.



SUMMARY

1.75 The site has remained largely undeveloped with earliest historical mapping showing the area as open fields with public footpaths and a residential dwelling close to the central northern boundary. By the turn of the 19th century, an orchard established in the southern and south eastern areas of site. Locally, two small chalk pits were located adjacent to the eastern boundary and south south-eastern boundary of the site (off site). The south eastern pit was later filled with inert, commercial, household and liquid sludge waste. Historical industrial land uses have also been identified within 250m of site, comprising a transport depo and saw mill.

1.76 Ecologia's Geo-Environmental Assessment generally did not identify any significant contamination. The ground investigation identified only minor concentrations locally of organochlorine pesticides within surficial soils and leachates, and slightly elevated groundwater concentrations of selected PAH compounds and nickel locally on one monitoring occasion. Recorded concentrations are considered to be marginal however, as the WQS are highly conservative for the site as the nearest abstraction borehole is located 850m from site.

1.77 Ecologia are currently undertaking ground gas monitoring on-site, most notably on the southern boundary adjacent to the former landfill. Currently, a moderate / low risk has been assigned; however, the results of the gas monitoring will be used to confirm / update the Conceptual Site Model.

1.78 With regards to geotechnical assessment, at this stage, shallow foundations (such as a raft or strip footings) founded in the superficial deposits (up to 3m bgl), may not be appropriate based on loadings of a typical low rise building. However, further investigation targeting soft spot areas will enable the suitability of shallow foundations to be reassessed. The Thanet Sand Formation is likely to be considered for foundations, but where the clay percentage exceeds the sand percentage, the layers may be susceptible to long-term settlement. The structureless Chalk is likely to be competent for foundation purpose, taking into account the groundwater level (which can affect the strata bearing capacity).

1.79 A discovery strategy during re-development works in the event that unforeseen and suspected contamination is encountered, the client should stop works and further assessment undertaken by experienced Environmental Consultant.



1.80 Additionally, if soils are to be re-used on site during future redevelopment works then this should be undertaken in accordance with a Materials Management Plan (MMP)³. If soils are to be removed from site due to development requirements, these should be disposed of under the appropriate duty of care.

1.81 As part of any redevelopment works and detailed planning application it is expected further investigation works would be required, notably:

- A high risk has been identified on site for potential dissolution of soluble rocks. Although no dissolution features were encountered during Ecologia's Geo-Environmental Assessment works, a watching brief or geophysical scan is recommended to be undertaken prior/during construction works on site.
- Further geotechnical investigations to form detailed foundation design.

³ CL:AIRE 'The Definition of Waste: Development Industry Code of Practice



Table 1.7: Soils, Geology and Land Contamination Summary Table

Potential Effect	Nature of Effect (Permanent or Temporary)	Significance	Mitigation/ Enhancement Measures	Residual Effects
<p>Construction</p> <p>Potential to encounter and disturb contaminated soils during the earthworks during the construction phase (<i>i.e.</i> previous on-site quarry).</p> <p>Potential to mobilise contaminants.</p>	<p>Temporary</p> <p>Short-term</p> <p>Local</p>	Minor Adverse	A watching brief to be undertaken during the earthworks. If any contaminated material is found, work will be suspended until further assessment is undertaken by experienced Environmental Consultant.	Minor Beneficial
<p>Construction</p> <p>Leaks and spillages of fuel and oils from construction plant, equipment and refuelling areas resulting in localised contamination/run-off.</p>	<p>Temporary</p> <p>Short-term</p> <p>Local</p>	Minor Adverse	Appropriate storage, containment and handling of oils and fuel to reduce the risk of accidental spillages. Mitigation measures to be incorporated into a Construction Environmental Management Plan (CEMP).	Negligible
<p>Construction</p> <p>Contamination risks to water resources (Chalk Aquifer) posed by piling activities.</p>	<p>Temporary</p> <p>Short/Medium term</p> <p>Local</p>	Minor Adverse	If required, implementation of a pile design together with preparation of a FWRA in consultation with the EA.	Negligible
<p>Completed Development</p> <p>Contamination risk and exposure of future users of the Proposed Development.</p>	<p>Permanent</p> <p>Long term</p> <p>Local</p>	Minor Adverse	<p>Minor contamination risks identified on-site (localised and marginal).</p> <p>Any contamination encountered during construction would be further assessed by an experienced Environmental Consultant.</p>	Minor Beneficial



APPENDIX I

**Ecologia's Geo-Environmental Assessment Report for Land at Wises Lane,
Sittingbourne, Kent, ME10 1YN**

Report Ref: EES 16.041.1, dated 8th August 2016

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