

LAND CONTAMINATION ASSESSMENT

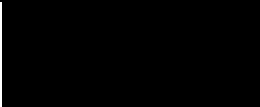
in connection with the proposed development at

PRINCES PARADE HYTHE KENT



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LBHGEO

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FOREWORD – GUIDANCE NOTES

GENERAL

This report has been prepared for a specific client and to meet a specific brief. The preparation of this report may have been affected by limitations of scope, resources or time scale required by the client. Should any part of this report be relied on by a third party, that party does so wholly at its own risk and LBHGEO disclaims any liability to such parties.

The observations and conclusions described in this report are based solely upon the agreed scope of work. LBHGEO has not performed any observations, investigations, studies or testing not specifically set out in the agreed scope of work and cannot accept any liability for the existence of any condition, the discovery of which would require performance of services beyond the agreed scope of work.

VALIDITY

Any use of or reliance upon the report in circumstances other than those for which it was commissioned shall be at the client's sole risk. The passage of time may result in changes in site conditions, regulatory or other legal provisions, technology or economic conditions which could render the report inaccurate or unreliable. The information and conclusions contained in this report should therefore not be relied upon in such altered circumstances.

THIRD PARTY INFORMATION

The report may present an opinion based upon information received from third parties. However, no liability can be accepted for any inaccuracies or omissions in that information.

1. INTRODUCTION

1.1 BACKGROUND

It is proposed to develop a strip of land along the seafront to provide housing, a leisure centre, car parking and public landscaping. The site is owned by the Folkestone & Hythe District Council. The development was granted planning approval by Folkestone & Hythe District Council on 18th July 2019 under the planning reference Y17/1042/SH.



AERIAL PHOTOGRAPH OF THE SITE

The site forms the rear slopes of a natural shingle bar that has been subject to historical landfilling with the deposition of up to approximately 5m of 20th Century waste material, capped in around 2000 by a layer silt material dredged from the Royal Military Canal.

Despite the past landfilling, the site currently presents an acknowledged important public environmental resource. It is hence essential that the proposed development is undertaken with all necessary precautions to protect the community and the environment from any risks associated with past land contamination.

The project is to be presented under the National Quality Mark Scheme (NQMS) as an exemplar showcase for the sustainable remediation and development of contaminated land.

A Preliminary Risk Assessment (PRA) for the site was issued on 9th March 2021 (LB4635pra). That document identified that there were potentially unacceptable land contamination risks associated with the site and hence, in accordance with government guidance¹, the site has been subjected to physical investigation and testing. This report presents an updated land contamination assessment based upon the recent ground investigation findings.

¹ [Land Contamination Risk Management \(LCRM\)](#)

1.2 CONTAMINATED LAND MANAGEMENT

An explanation of the Contaminated Land Framework and the government requirements under Land Contamination Risk Management (LCRM) was presented in the PRA. In essence the National Planning Policy Framework (NPPF) requires developments to ensure that, following appropriate remediation, the completed development is safe and suitable for the intended use and is free from any unacceptable risks to human health, buildings and other property, controlled waters, and the wider environment.

The National Quality Mark Scheme for Land Contamination Management (NQMS) is a national registration scheme that validates the competence of individual land contamination documents. The NQMS declaration for this document is appended.

1.3 PLANNING CONDITION

The planning permission granted for this development includes the following Land Contamination condition:

25 a) *Prior to commencement of the development hereby permitted a desk top study shall be undertaken and submitted to and have been approved by the Local Planning Authority. The study shall include the identification of previous site uses, potential contaminants that might reasonably be expected given those uses and any other relevant information. Using this information, a diagrammatical representation (Conceptual Model) for the site of all potential contamination sources, pathways and receptors shall also be included.*

b) If the desk top study shows that further investigation is necessary, an investigation and risk assessment shall be undertaken by competent persons and a written report of the findings shall be submitted to and have been approved by the Local Planning Authority prior to commencement of the development. It shall include an assessment of the nature and extent of any contamination on the site and whether or not it originates on the site. The report of the findings shall include:

- i) A survey of the extent, scale and nature of contamination*
- ii) An assessment of the potential risks to;*
- iii) Human health*
- iv) Property (existing or proposed) including buildings, crops, livestock, pets, woodland and service lines and pipes*
- v) Adjoining land,*
- vi) Ground waters and surface waters.*
- vii) Ecological systems,*
- viii) Archaeological sites and ancient monuments and*
- ix) An appraisal of remedial options and identification of the preferred option(s).*

All work pursuant to this Condition shall be conducted in accordance with the DEFRA and Environment Agency document Model Procedures for the Management of Land Contamination (Contamination Report 11).

c) If investigation and risk assessment shows that remediation is necessary, a detailed remediation scheme to bring the site to a condition suitable for the intended use by removing unacceptable risks to human health, buildings and other property and the natural and historical environment shall be submitted to and approved in writing by the Local Planning Authority prior to

commencement of the development. The scheme shall include details of all works to be undertaken, proposed remediation objectives and remediation criteria, a timetable of works, site management procedures and a verification plan. The scheme shall ensure that the site will not qualify as contaminated land under Part 2A of the Environmental Protection Act 1990 in relation to the intended use of the land after remediation. The approved remediation scheme shall be carried out in accordance with the approved terms including the timetable, unless otherwise previously agreed in writing by the Local Planning Authority. The Local Planning Authority shall be given two weeks written notification of commencement of the remediation scheme works.

d) Prior to commencement of development, a verification report demonstrating completion of the works set out in the approved remediation scheme and the effectiveness of the remediation shall be submitted to and approved in writing by the Local Planning Authority. The report shall include results of sampling and monitoring carried out in accordance with the approved verification plan to demonstrate that the site remediation criteria have been met. It shall also include details of longer-term monitoring of pollutant linkages and maintenance and arrangements for contingency action, as identified in the verification plan, and for the reporting of this to the Local Planning Authority.

e) In the event that, at any time while the development is being carried out, contamination is found that was not previously identified it shall be reported in writing immediately to the Local Planning Authority. An investigation and risk assessment shall be undertaken and where remediation is necessary a remediation scheme shall be prepared. The results shall be submitted to the Local Planning Authority. Following completion of measures identified in the approved remediation scheme a verification report shall be prepared and submitted to and approved by the Local Planning Authority before any further development takes place on that phase of the development, unless otherwise agreed in writing by the Local Planning Authority.

Reason:

To protect the development and surrounding environment and human health against contamination and pollution.

The PRA addressed part a) of Condition 25. This document has been prepared to address part b) of the condition.

1.4 REPORT OBJECTIVES

The objectives of this report are threefold

- To discuss the findings of a recent site investigation
- To update the land contamination assessment in the light of this new information
- To identify potential remedial options to address any unacceptable land contamination risks

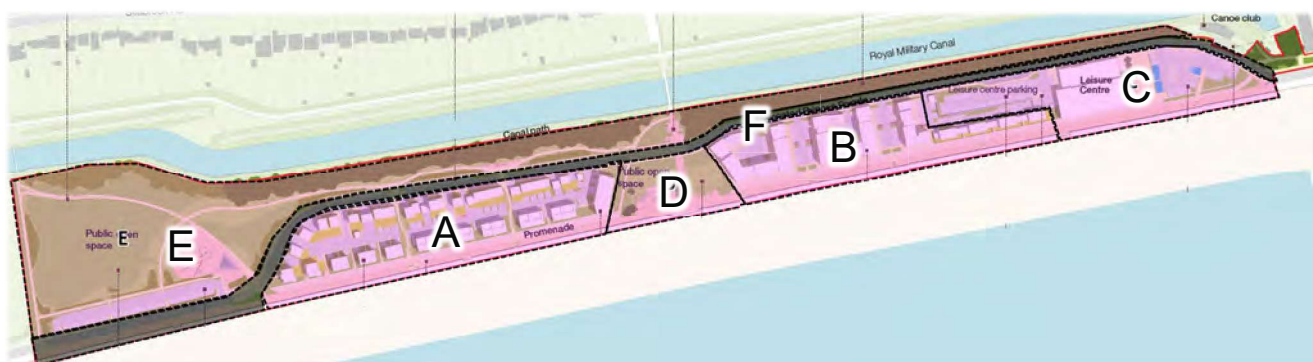
1.5 SITE ZONING

For the purposes of the investigation the existing site, which is almost 1 km in length, has been divided into four areas:

- WEST
- WEST CENTRAL
- EAST CENTRAL
- EAST

For the purposes of risk assessment the site is now divided into six zones based upon the proposed type of end use. (These zones will be carried forward into the options appraisal and remediation strategy.)

- A. Western housing zone
- B. Eastern housing zone
- C. Leisure centre and associated parking
- D. Central public open space
- E. Western public open space
- F. Access Road



1.6 REPORT STRUCTURE

This document commences with a summary of the potential contaminant linkages that were identified in the PRA as needing further assessment.

There follows a description of the rationale and scoping for the recent phase of intrusive investigation that was undertaken, together with a summary of the investigation findings, a review of the data quality and an updated description of the ground conditions at the site.

Following this an updated and quantitative risk assessment is undertaken with a revised conceptual site model to identify those pollutant linkages of concern and, using quantitative evaluation criteria, to determine the risks posed to human health, controlled waters and the wider environment.

The assessment highlights the degree of confidence that can be attributed to the assessment made for each pollutant linkage and identifies any potential risks which it has not been possible to quantify due to lack of information or data uncertainty.

The report concludes with an options appraisal for the remediation of the site. This considers both the proposed development and a “do-nothing” scenario.

2. PRELIMINARY RISK ASSESSMENT

The PRA identified twelve potential pollutant linkages of concern as presented below:

PRA Pollutant Linkage Summary (Brought Forward)				
SOURCE	RECEPTOR	PATHWAY	RISK RANKING	Ref:
Potential soil contamination (including asbestos)	Construction workers, end users, general public, flora & fauna	Oral ingestion of soil or dust, skin contact or inhalation	HIGH	1
	Construction workers, end users, general public, flora & fauna	Release of any trapped volatiles from containers in landfill and upwards migration	HIGH	2
	Controlled waters	Leaching and downwards migration of any mobile contamination	HIGH	3
		Release of any trapped liquids from containers in landfill,	HIGH	4
	Buried services / foundations	Direct contact	HIGH	5
Potential groundwater contamination	Construction workers, end users, general public, flora & fauna	Upwards migration and inhalation of any problematic vapours	MEDIUM	6
	Groundwater (Minor Aquifer beneath the site)	Direct contact	HIGH	7
	Surface Water (the Royal Military Canal)	Migration	LOW	8
	Surface Water (the English Channel)	Migration	MEDIUM	9
	Buried services / foundations	Direct contact	MEDIUM	10
Potential landfill gas and harmful vapours	Buildings	Migration and explosion	MEDIUM	11
	Construction workers, end users, general public, flora & fauna	Migration and inhalation of any problematic vapours	MEDIUM	12

3. SITE INVESTIGATION

A factual site investigation report has been provided by the contractor (Idom Merebrook Report Reference FR-22281-21-195 Rev B, dated 30th June 2021)..

3.1 OBJECTIVES

The intention of this recent site investigation was to provide enough information for potential funders and purchasers to make an informed decision regarding the proposed development cost plan.

The PRA highlighted an important risk that the landfill was subject to existing pollutant escape and identified that this risk will inevitably exacerbate with climate change and the potential for increased storm surges. The investigation itself was therefore, subject to budgetary constraints, designed to investigate the important pollutant linkages that had been missed by earlier assessments (Refs: 7,8,9) while also obtaining some improvement in the uncertainties surrounding assessment of the remaining potential pollutant linkages.

It is accepted that much more detailed phases of investigation may be required in due course to delineate any zones or plumes of contamination and to address or clarify technical matters surrounding the detailed design of potential remedial options.

3.2 INVESTIGATION SCOPE

The completed investigation comprised a total of 32 trial pits, 23 window sampler boreholes and 6 cable percussion boreholes.

The trial pits and window sample boreholes were intended to penetrate the landfill, while the boreholes were extended down into the underlying Weald Clay to provide information for foundation design.

It was previously suggested that the density of historical information for the site amounted to one exploratory position per 10,000 m². Following the recent investigation this density has improved to approximately one exploratory position per 1,300 m² or a notional hole spacing of around 35m to 40m. By comparison, it would require three times as many exploratory points to reduce the risk of missing some anomaly that was 25m across.

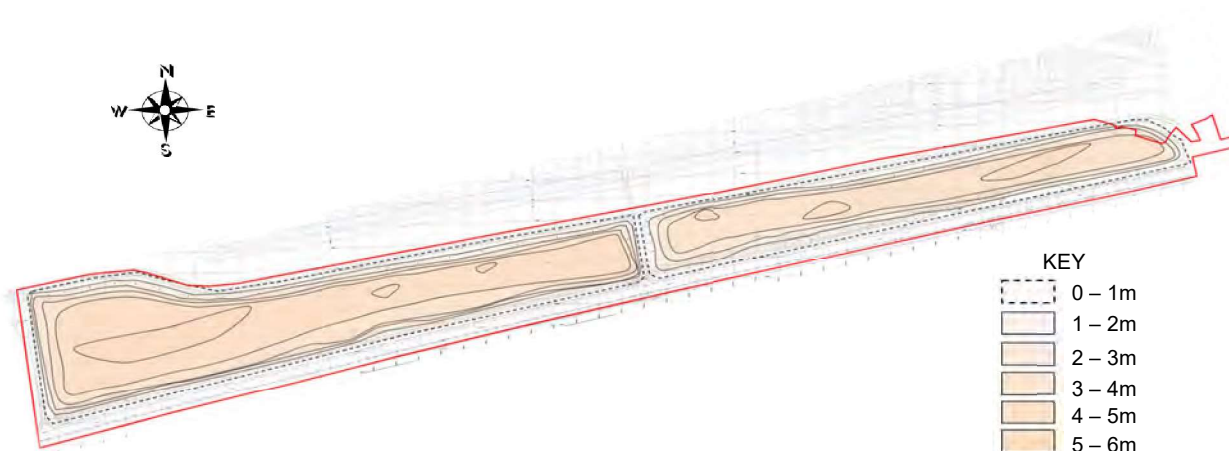
3.3 GROUND CONDITIONS

The following discussion of ground conditions is based upon an interpretation of the lithologies reported by the SI contractor, but it should be noted that this differs from the interpretation attempted by the SI contractor.²

3.3.1 LANDFILL

There are two areas of landfill present on site, separated by a public footpath leading from a bridge over the Canal.

The landfill has been proven to extend to a maximum depth of approximately 6m, but is generally of some four to five metres in thickness.



INDICATIVE CONTOUR PLAN OF THE RECORDED THICKNESS OF THE LANDFILL

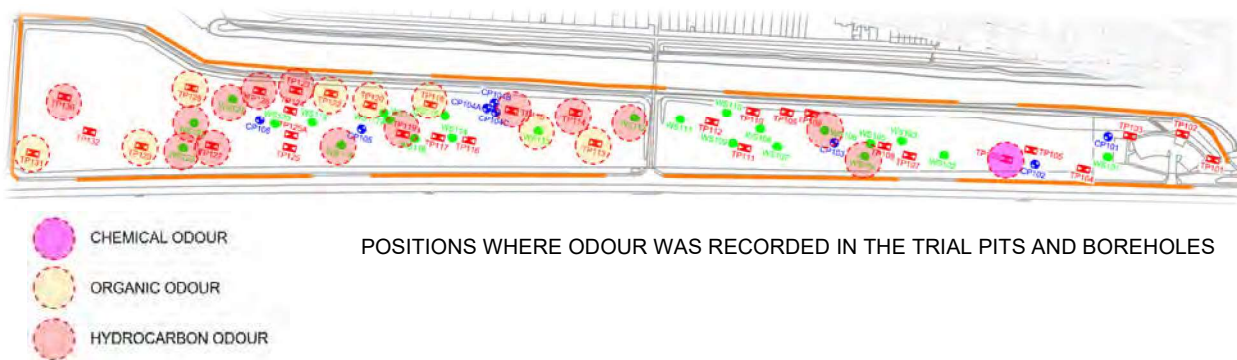
An approximately 0.5 to 1.5m capping of dredged silt material is believed to be present on top of the landfill material but unfortunately this has not been recognised by the site investigation, which reports that no cap to the landfill is present and that landfill material “*was identified at or immediately beneath the surface of the site.*”

On the basis of the photographs provided, there appears to be less domestic, commercial and industrial waste present in the eastern area, and a predominance of construction waste. However, the testing has confirmed a similar range of contamination in both areas.

By contrast, the photographs from the western area suggest an increased proportion of domestic, commercial and industrial waste to be present.

There appears to have been an increased reporting of discolouration and odours in the western areas. The distinction between “chemical odour”, “organic odour” and “hydrocarbon odour” is not defined.

² . LBHGEO has not inspected any materials first hand and has therefore relied upon the reports and information provided by the contractor and has necessarily accepted the contractor’s interpretation except where it can be gleaned from the evidence that the latter is most probably in error.



3.3.2 BEACH DEPOSITS

Beneath the landfill beach shingle and marine deposits are present, extending down to a recorded level of between approximately -2 and -4 m OD. These deposits comprise for the most part gravels and cobbles but in the eastern area of the site there is a shelf of clay of between 1.5m and 2.5m in thickness lying within the shingle that has been interpreted as residual tidal flat deposits.

In some places there is noted discolouration of the natural soils where contamination has evidently escaped and migrated downwards from the overlying landfill, but at other positions there does not appear to be any obvious migration. It is concluded that the presence of the clay layers, while not likely to be continuous seams, may provide a relatively important horizontal fabric such that the mass vertical permeability of these deposits is likely to be substantially less than the horizontal permeability.

Tidal response monitoring and in-situ permeability testing of these deposits has been ordered but the results are awaited.

The beach deposits have produced variable SPT resistances but these results can be attributed more to varying particle size than to any substantial density variations. Sandstone, mudstone or limestone boulders may be anticipated to be present at the base of these deposits.

3.3.3 ATHERFIELD CLAY

Below the beach deposits, dense gravelly sands have been recorded, often associated with a darker or greenish (glaucconitic) colour. These gritty and shelly sands are interpreted as the lowermost beds of the Atherfield Clay and appear to contain occasional cemented layer seams (logged as mudstone) of up to around 0.5m thickness.

The Atherfield clay is assessed as being between 4m and 8m thick in the boreholes, and to sit unconformably on the underlying Weald on a surface that falls westwards across the site from around -5m OD to around -10m OD.

3.3.4 WEALD CLAY

There is a sharp contrast between the dark basal mudstone of the Atherfield clay and the underlying stiff to hard bluish grey clay of the Weald. An impenetrable Siltstone layer appears to be present at some 14m

to 15m depth below the surface of this stratum.

3.4 HYDROGEOLOGICAL / HYDROLOGICAL INFORMATION

It has been assumed that there is a tidal water level in the shingle beneath the site. There is likely to be a tidal range of around 6m (+3m OD to -3m OD) with the response being dampened though recharge from the canal at the rear. For most seasons the groundwater is likely to be predominantly freshwater and the position of the interface between freshwater and saline water possibly fluctuates beneath the site during the year.

Groundwater monitoring has been ordered but the results are awaited.

4. TIER 2 GENERIC QUANTITATIVE RISK ASSESSMENT

4.1 GQRA OBJECTIVES

The intention of this assessment is to update the conceptual model of land contamination that was developed for the PRA and to improve understanding of which of the twelve potential pollutant linkages identified in the PRA can be discarded and which present potentially unacceptable risks and need to be carried forward either for more detailed assessment to enable potential acceptance or directly for remediation. In the case of each remaining pollutant linkage, the various options to mitigate potentially unacceptable risks will be considered in a later section of this report. The objective of this stage is thus to increase confidence in the nature and extent of the risks.

The project is to be presented as an exemplar showcase for sustainable remediation and development. Hence it is essential that the risks are sufficiently assessed and that proposed development is undertaken with all necessary precautions to protect both the community and the environment from any risks associated with past land contamination. These may be both existing risks affecting the undeveloped site in its current usage and new risks created during or following the proposed development.

For example, removal of the landfill capping, even on a temporary basis to allow construction works, will radically alter the site circumstances and the hazard profile presented by the site. The introduction of human receptors to the site on a more regular or indeed on a permanent (residential) basis will also alter the dynamics of any health exposure modelling.

4.2 GENERIC ASSESSMENT CRITERIA

The evaluation criteria to be applied to different areas of the site during different periods will vary depending upon what activities are being undertaken.

However, in the case of potential impacts upon the water environment, the generic criteria put forward in the PRA are statutory and set by regulation and will therefore be valid in all cases.

4.2.1 SOIL CONTAMINATION CRITERIA

In line with the PRA, the results of the soil sample contamination testing have been compared to C4SL and S4UL screening levels where these are available, and otherwise to commonly accepted screening concentrations produced by Land Quality Management Limited (LQM) and the Chartered Institute of Environmental Health (CIEH) (2009, Generic Assessment Criteria for Human Health Risk Assessment (2nd Edition)) and, where not available, then Environment Agency (EA) Soil Guidance Values (SGVs).

Generic soil screening criteria for a residential site usage as well as those prepared for open space usage have been used for assessing risks to human health for the individual zones as follows:

- Residential/ Landscaped – Zones A, B & C
- Open Space – Zones D & E

4.2.2 GROUNDWATER CONTAMINATION CRITERIA

For water that is being considered as potentially entering the sea the Environmental Quality Standards (EQS) for transitional and coastal waters are considered. The same criteria are appropriate for water potentially entering the military canal because of its close relationship to the sea.

Although in the absence of monitoring data the test results can only strictly be compared to the Maximum Allowable Concentration (MAC-EQS), the Annual Average (AA-EQS) figures are also presented in order to highlight any potential concerns where contaminants may not necessarily exceed the MAC-EQS values.

4.2.3 LEACHATE CONTAMINATION CRITERIA

An important study of a similar landfill has been undertaken by the Environment Agency and Queen Mary College University of London with the types of contaminants found to be present similar to those at the Princes Parade landfill. That study reported that although typically EQS and associated discharge permitting standards have been used to assess leachate test results there is no set leachate ratio that can be applied with authority. The study concluded that BS EN12457 leaching process (<4 mm fraction with a leaching ratio of 10 litres of leachant per kg of dry waste), was the most suitable industry standard for assessing the pollution risk posed by historic coastal landfills. The results are compared with the leachate limits derived for Inert Waste as these WAC limit values and leaching methods were developed for the protection of groundwater and surface waters.

4.3 ACTUAL CONTAMINATION DETECTED

The ground investigation by IDOM Merebrook has provided 61 soil samples of the landfill, all of which were tested for a wide range of contaminants.

4.3.1 SOIL CONTAMINATION

All of the soil samples taken by the contractor were screened for asbestos presence with approximately 10% being found to contain asbestos fibres. Although this is a much lower proportion than reported previously, the presence is widespread across the site.

Substance	Maximum detected concentration (mg/kg) (previous investigation in brackets)	Generic Human Health Screening Values ³	
		Residential (mg/kg) (percentage of exceedances in brackets)	Open Space (mg/kg) (percentage of exceedances in brackets)
Arsenic	1,000 (150)	37 (16%)	79 (3%)
Cadmium	57 (1)	11 (2%)	120
Chromium	310 (110)	910	1500
Lead	2,300 (1,200)	200 (44%)	630 (16%)
Mercury	1.5 (44)	1 (2%)	4
Nickel	220 (470)	180 (3%)	230
Selenium	12 (2)	250	1,100
Boron	4 (13)	290	21,000
Copper	10,000 (840)	2,400	12,000
Zinc	9,500 (19,000)	3,700 (2%)	81,000
TPH			

³ C4SL / S4UL at 1% SOM produced by the Chartered Institute of Environmental Health (CIEH) / Land Quality Management (LQM)

Aliphatic >C8 – C10	51	27 (8%)	13,000
Aromatic >EC8 - EC10	35	34 (2%)	5,000
Aromatic >EC12 - EC16	560 (380)	140 (5%)	5,100
Aromatic >EC16 - EC21	2,400 (2,200)	260 (13%)	3,800
Aromatic >EC21 - EC35	5,200 (2,500)	1,100 (13%)	3,800 (3%)
PAH			
Naphthalene	11	2.3 (10%)	4,900
Phenanthrene	530	95 (7%)	3,100
Fluoranthene	990	280 (2%)	3,100
Pyrene	940	620 (2%)	7,400
Benz(a)anthracene	470 (130)	7 (28%)	29 (10%)
Chrysene	350 (100)	15 (16%)	4 (5%)
Benz(b)fluoranthene	540 (110)	3 (77%)	7 (41%)
Benz(k)fluoranthene	220	110 (2%)	190 (2%)
Benzo(a)pyrene	450 (91)	5 (43%)	10 (18%)
Indeno(1,2,3-cd)pyrene	270 (50)	27 (10%)	82 (2%)
Dibenzo(a,h)anthracene	70 (11)	1 (85%)	1 (75%)

PCB			
Congener 28	0.25	0.2 (2%)	3
Congener 52	0.72	0.2 (3%)	3
Congener 101	1.8	0.34 (2%)	3
Congener 138	1.2	0.36 (2%)	3
Congener 153	1.8	0.36 (2%)	3

The new investigation has detected some contamination, most notably PCBs, that had not been found previously and, given the increased amount of samples tested, a better idea of the potential range of contaminant concentration has resulted, with higher maximum concentrations being detected in almost all cases.

The visual differences between the composition of the eastern and western mounds of landfill described earlier does not appear to be reflected by the samples as, once the samples are split to those originating from the eastern and from the western part of the site, the relative percentage of samples found in exceedance of the soil criteria appears to be relatively similar. This is shown on the table below.

SOIL CONTAMINATION BY AREA		
Substance	Maximum detected concentration (mg/kg) (percentage of exceedances)	
	Western area	Eastern area
Arsenic	43 (6%)	1,000 (33%)
Cadmium	57 (3%)	3.40

Chromium	110	310
Lead	910 (39%)	2,300 (54%)
Mercury	1.5 (3%)	1.1
Nickel	100	220 (8%)
Selenium	3	12
Boron	3	4
Copper	1,700	10,000 (4%)
Zinc	9,500 (3%)	4,200 (4%)
Aliphatic >C8 – C10	51 (13%)	1 (<LOD)
Aromatic >EC8 - EC10	35 (3%)	1 (<LOD)
Aromatic >EC12 - EC16	560 (3%)	290 (8%)
Aromatic >EC16 - EC21	2,400 (8%)	2,200 (21%)
Aromatic >EC21 - EC35	5,200 (11%)	5,200 (17%)
Naphthalene	9.6 (8%)	11 (13%)

Phenanthrene	200 (6%)	530 (8%)
Fluoranthene	240	990 (4%)
Pyrene	230	940 (4%)
Benz(a)anthracene	76 (31%)	470 (25%)
Chrysene	67 (14%)	350 (21%)
Benz(b)fluoranthene	91 (89%)	540 (63%)
Benz(k)fluoranthene	38	220 (4%)
Benzo(a)pyrene	72 (44%)	450 (42%)
Indeno(1,2,3-cd)pyrene	45 (6%)	270 (17%)
Dibenzo(a,h)anthracene	15 (94%)	70 (75%)
Congener 28	0.25 (3%)	(<LOD)
Congener 52	0.72 (5%)	(<LOD)
Congener 101	1.8 (3%)	(<LOD)
Congener 138	1.2 (3%)	(<LOD)

Congener 153	1.8 (3%)	(<LOD)
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4.3.2 LEACHATE CONTAMINATION

Leachate tests were undertaken on a total of 60 samples.

SOIL LEACHATE TEST RESULTS				
Substance	Maximum recorded leachate concentration (µg/l) <small>(previous investigation in brackets)</small>	Inert WAC Limit (µg/l)	Environmental Quality Standards for Transitional and Coastal Waters	
			Annual Average AA-EQS (µg/l)	Maximum Allowable MAC-EQS (µg/l)
Arsenic	13 (22)	50	25	
Cadmium	0.25 (2)	4	0.2	
Chromium	4 (90)	50	0.6	32
Lead	42 (280)	50	1.3	14
Antimony	28 (-)	6		
Nickel	15 (-)	40	8.6	34
Mercury	0.05 (0.18)	1		0.07
Selenium	1 (2)	10		
Copper	8.4 (125)	200	3.76	
Molybdenum	60	50		

	(-)			
Zinc	510 (1,689)	400	6.8	
Flouride	1,700 (-)	1,000		
Sulphate	580,000 (-)	100,000		
Naphthalene	2 (-)		2	130
PAH	93,000 (5)	10,000		

4.3.3 GROUNDWATER CONTAMINATION

An initial round of groundwater testing has been undertaken on samples of groundwater taken from each of the six monitoring positions established in the standpipes constructed within the deep cable percussion boreholes (CP101 – CP106). (It should be noted that the following table is based upon incomplete draft results)

GROUNDWATER CONTAMINATION			
Substance	Maximum detected concentration (µg/l)	Environmental Quality Standards for Transitional and Coastal Waters	
		Annual Average AA-EQS (µg/l) (percentage of exceedances in brackets)	Maximum Allowable MAC-EQS (µg/l) (percentage of exceedances in brackets)
Chromium	8.8	4.7 (100%)	-
Copper	4.6	1.0 (67%)	-
Nickel	9.0		34

		4 (100%)	
Zinc	32	10.9 (33%)	-

4.3.4 GAS RISK ASSESSMENT

4.3.4.1 SOIL TOC ANALYSIS

Testing of the soil samples has been undertaken for Total Organic Carbon (TOC), as outlined in CLAIRE Research Bulletin (RB) 17, in order to provide a quantitative assessment of the gas generation potential of the landfill material.

A total of 60 ground investigation soil samples have been analysed for TOC:

TOTAL ORGANIC CARBON ANALYSIS (TOC)			
DEPTH:	NUMBER OF TESTS	TOC RANGE	TOC GEOMETRIC MEAN
Total Samples	60	0.20% - 28.00%	2.2%

The geometric mean of the results tends towards the limiting values of organic content ascribed to Characteristic Situations CS1 and CS2.

4.3.4.2 GAS MONITORING

The initial gas monitoring of 20 positions on site have not reported any gas flow. These results are, however, considered unlikely to be representative of the actual conditions of the landfill on site and are being queried.

4.4 SENSITIVE RECEPTORS

A number of sensitive receptors have been identified for the proposed development by the PRA and these include:

- Ecological Receptors
 - Flora and Fauna on site
 - Canal Flora and Fauna
 - Marine Flora and Fauna
- Human Health Receptors
 - General public and current site users
 - Construction Workers
 - End users and residents of future development
- Property Receptors
 - Buried services / foundations
- Controlled Water Receptors
 - Groundwater (Minor Aquifer beneath the site)
 - Surface Water (the Royal Military Canal)
 - Surface Water (the English Channel sea)

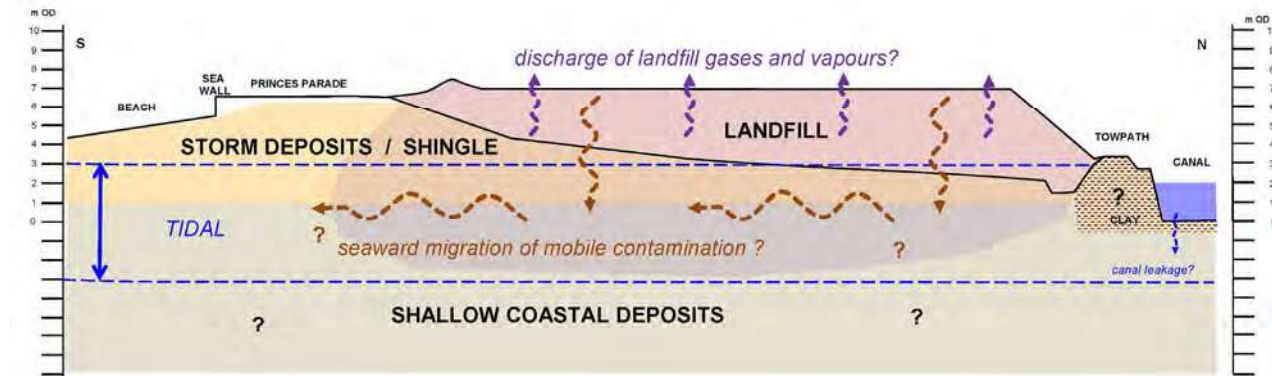
4.5 POTENTIAL PATHWAYS

As highlighted, removal of the landfill capping, even on a temporary basis to allow construction works, will radically alter the site circumstances and the hazard profile presented by the site. A direct human health exposure pathway to the contaminated materials in the landfill will be present.

During dry and dusty conditions there will additionally be an increased risk of the airborne human health pathway reaching the wider neighbourhood.

The permeable soils adjacent to and underlying the site present a permeable pathway for both gases and groundwater.

All below ground services and foundations will potentially be in direct contact with the contaminated soils.



4.6 RISK ESTIMATION

In order to evaluate the perceived contamination risks at this site the severity of the risk in terms of the magnitude of the potential consequence of a pollutant linkage has been compared with the likelihood of the linkage existing.

The likelihood and consequence of a problem involving each particular pollutant linkage has been attributed a risk rating as shown below:

RATING	1	2	3	4	5
LIKELIHOOD	Very unlikely	Unlikely	Evens	Probable	Highly probable
CONSEQUENCE	Negligible	Minor minor injury / minimum cost / minor health risk	Mild / Medium chronic health risk / risk of injury / appreciable costs to meet regulatory standards		Severe Death / major injury / explosion / maximum cost

On the basis of this qualitative rating system the various potential pollutant linkages have been attributed a risk ranking on the basis of the value of the product of the likelihood and consequence ratings, where a value of less than five is low, between five and ten is medium and above ten is high.

It is assessed that no pollutant linkages identified by the PRA can be considered for dismissal following the undertaken investigation.

UPDATED Pollutant Linkage Assessment (without mitigation)						
SOURCE	RECEPTOR	PATHWAY	LIKELIHOOD	CONSEQUENCE	RISK RANKING	Ref:
Soil contamination (including asbestos)	Construction workers, end users, general public, flora & fauna	Oral ingestion of soil or dust, skin contact or inhalation	5	4	20 (HIGH)	1
	Construction workers, end users, general public, flora & fauna	Release of any volatiles trapped in landfill and upwards migration	3	4	12 (HIGH)	2

	Controlled waters	Leaching and downwards migration of any mobile contamination	3	4	12 (HIGH)	3
		Release of any trapped liquids from landfill,	3	3	9 (MEDIUM)	4
	Buried services / foundations	Direct contact	4	3	12 (HIGH)	5
Groundwater contamination	Construction workers, end users, general public, flora & fauna	Upwards migration and inhalation of any problematic vapours	2	3	6 (MEDIUM)	6
	Groundwater (Minor Aquifer beneath the site)	Direct contact	3	4	12 (HIGH)	7
	Surface Water (the Royal Military Canal)	Migration	1	4	4 (LOW)	8
	Surface Water (the English Channel)	Migration	2	4	8 (MEDIUM)	9
	Buried services / foundations	Direct contact	3	3	9 (MEDIUM)	10
Landfill gas and harmful vapours	Buildings	Migration and explosion	2	3	6 (MEDIUM)	11
	Construction workers, end users, general public, flora & fauna	Migration and inhalation of any problematic vapours	2	3	6 (MEDIUM)	12

4.7 RISK EVALUATION

Given the nature of the site it is not possible to use the location of any identified contamination as being representative of anything other than the whole landfill, albeit the division into the western and eastern areas separated by the public footpath leading from the canal bridge is valid.

All twelve pollutant linkages identified above should be carried forward either for more detailed assessment or directly for remediation.

5. OPTIONS APPRAISAL

5.1 OBJECTIVES

It is apparent that the local authority are seeking to assist the funding of both the remediation of the historic landfill at this site and of the construction of a new leisure centre through turning part of the land over to high value private seafront housing.

There will in practice be a balance struck between expending available resources on the most effective remedial measures, while achieving the most longevity and durability of these measures for preserving the quality of the environment.

It may also be that the development brings indirect benefits through raising future funds that could in due course be directed at further remedial measures.

5.2 PROPOSED DEVELOPMENT

The proposed development will provide housing, a leisure centre, car parking and public landscaping.

Although plans are of course not yet finalised, it is understood that significant earthworks are being considered in order to reduce the level of the development areas of the site.

The current proposal also includes re-routing of the promenade so that it runs over the landfill behind the new development. In order to reduce the amount of engineering associated with this route, it is understood that it has been proposed to locally reduce the level of this road.

The geotechnical aspects of forming foundations to the new development are considered in a separate geotechnical report, but there are clearly geoenvironmental issues that will dictate how the new development can be achieved. These will include considerations of how the design of any remediation will accommodate the planned earthworks and the development infrastructure including the roads, site services and drainage.

Additionally, it is recognised that the development programme may need to consider a phased approach such that it may be desired to bring one zone of the site into use while an adjacent area may not have been fully remediated. It will be necessary in this case to ensure that the completion of one area does not prejudice the subsequent successful remediation of a neighbouring area and also to ensure that the completed area can be safely used while the remediation an adjoining area has been completed. This will be particularly important where airborne exposure routes exist.

It is noted that there is an existing pumped sewer main running across the site.

5.3 REMEDIATION OBJECTIVES

For each identified pollutant linkage of concern the key remediation objective will be to remove any unacceptable risk through one or more of the following means

- Remove the source
- Decrease contaminant mass, concentration, mobility or toxicity
- Break contaminant linkages

- Effectively contain the contaminant
- Manage the receptor or pathway

5.3.1 ENVIRONMENTAL IMPACTS

A key issue is to establish whether and to what extent the site requires remediation now or will require remediation in the future in order to render the local environment safe for fauna and flora regardless of any development proposal. It is not possible to remove the controlled waters receptors, although isolation of these by means of some form of barrier to break any potential pollutant pathway will need to be considered.

5.3.2 HUMAN HEALTH IMPACTS

A secondary issue is to ensure that the proposed new uses for parts of the site can be enjoyed safely.

This landfill is unusual as it has been regarded as public open space and has been frequented by dog walkers and the general public for recreation. An obvious possible response to unacceptable human health exposure would be to restrict access to the site. This is not an option in this case and the converse is true in that there are public footpaths immediately adjacent to the site and nearby housing and a primary school that will all need to be considered and protected throughout the development.

The introduction of private residential gardens to parts of the site must be regarded as positioning a new and substantially more sensitive receptor onto the site itself.

5.4 CLIMATE CHANGE

There are significant climate change issues to be considered at this site. Although a particular remediation scheme might be designed on the basis of current sea levels, it will be essential to consider the potential effects of future storm surges associated with envisaged sea level rise. While it may need to be accepted that future-proofing or the remediation may not be financially viable, investors and funders must be made aware of any potential for future problems that could affect land values.

5.5 SUSTAINABILITY

It will be important to consider the sustainability issues affecting any alternative remedial solutions. The options should be compared using environmental, social and economic indicators taking into account any relevant climate change issues. The Sustainable Remediation Forum (SuRf UK) provides a framework for this assessment.

5.6 DISCARDED REMEDIAL OPTIONS

It is considered that some potential remedial options, although possible, would simply not be financially viable due to the scale of the site.

5.6.1 LANDFILL REMOVAL

Removal of the existing landfill material to another landfill, while possible, would be very expensive and would likely not be the a sustainable option. Additionally, there would be a significant risk of more widespread human health exposure due to both the waste and to vehicle emissions if the waste were to be transferred by means of lorries travelling on the public highway, particularly in daytime.

5.6.2 LANDFILL CONTAINMENT

The construction of an in-ground barrier to prevent the escape of any mobile contamination from beneath the site would require the presence of impermeable strata in which any such barrier could be terminated.

Although there may be the possibility of incorporating the natural clay layer within the beach deposits as part of the containment, the local continuity of this feature cannot be assured. Hence it is likely that any such containment system would need to be toed into the Weald Clay at depth.

It should be noted that any such “cookie cutter” containment would trap all existing groundwater beneath the site and that future rainfall percolating into the soil on site will lead to rising groundwater levels on the site. In this case it would be necessary to remove the groundwater by means of a pumping system and to direct this through a dedicated effluent treatment system to clean the water prior to discharge.

5.7 FEASIBLE REMEDIATION OPTIONS

5.7.1 LONG TERM POLLUTION MONITORING

Although pollution is considered likely to have occurred in the past, it is at present not 100% clear whether there is any ongoing pollution escape issue from the landfill that requires remediation. Long term monitoring of the groundwater beneath the site boundary may, in conjunction with a contingency plan, present a viable and affordable means of managing the risk of any serious pollution to controlled waters going undetected.

In this case it will be necessary to agree a suitable monitoring plan with the relevant regulators.

5.7.2 GAS PROTECTION

The new buildings will need to be protected against the risk of both landfill gas and VOCs. At present, pending an appropriate gas investigation and gas/voc risk assessment a requirement for high quality VOC protection should be assumed, in conjunction with an assumption of BS8485 CS3 protection.

5.7.3 LANDFILL CAPPING

The landfill capping will be required to be retained in full capacity where soft landscaping is proposed, separating the end users fully from the underlying landfill. It is noted that the first stage re-profiling of the site surface will, for the most part, be limited to within the existing capping depth, with only local excavations for the leisure centre building into the existing landfill material.

5.8 REGULATORY CONTROLS

The site has to date apparently escaped regulation as a landfill by the Environment Agency. However, it is understood that the waste regulation section of the Environment Agency may be currently issuing

internal advice to other EA departments to the effect that all historic landfills such as this should be regulated as waste.

The effect of this advice is that all the landfill material on site must be regarded as waste, and that any work involving excavation or reworking of the material would potentially be regarded as a waste operation and require permitting as a waste recovery operation.

It will be necessary for the developer to engage with the Environment Agency on a pre-application basis in order to ascertain what type of environmental permit they will require for the intended works. It is likely that a bespoke permit will be required in order to potentially include the landfill installation itself, waste operations, mobile plant, waste recovery and monitoring.

The use of Materials Management Plans (MMP) under the Definition of Waste: Industry Code of Practice is not possible where the material is already a waste and cannot be applied to landfills.

5.9 LANDFILL MINING

There are few documented studies of landfill reclamation works such as is being planned for this site and these examples invariably pre-date the changing regulatory position of the Environment Agency.

Nevertheless, setting aside the regulatory position, there is no documented methodology⁴ for addressing the issue of landfill mining on similar landfill sites. Workable methods have been adopted for the reclamation of any soil material within the landfill for reuse on site but it is acknowledged that the presence of significant amounts of domestic waste would prevent this methodology.

In essence, ground-forming materials from the landfill might initially be selectively excavated using a 360° excavator, with any visually unsuitable materials being set aside for waste classification and off-site disposal.

Vibratory screening might then be used to separate the material into fine material that could potentially be incorporated beneath clean cover system in open space and landscaped areas and coarser materials.

Subject to environmental controls to address airborne asbestos and other risks, the coarser fraction might then be subjected to high velocity air blowing to remove light plastics and to manual hand-picking to remove large fragments of visually unsuitable materials (wood, textiles, paper/card) for waste classification and off-site disposal.

These coarser fractions might potentially be considered for re-use as structural fill beneath the new road and car parking areas. It is envisaged that this material might potentially need to be washed and/or crushed, again subject to suitable environmental controls.

5.10 WASTE CLASSIFICATION

Ideally there should be no off-site movement of material associated with the planned development. However, should disposal become necessary, it is apparent that the landfill material will need to be

⁴ Scott DI, Longman M and Wilson S (2020) *Reclaiming historic landfill sites for residential development: a UK case study*. *Journal of Environmental Engineering and Science* 15(2): 71–79, <https://doi.org/10.1680/jenes.19.00022>

classed as 17 05 03* soil and stones containing hazardous substances. Given the range of contamination that has been identified, it will be appropriate to attempt sorting of the waste through selective excavation and possibly also treatment of the waste through screening and/or soil washing in order to enable the potential sub-classification of at least some fraction as being Non-Hazardous for waste disposal.

It is noted that the size of the site offers considerable scope for the temporary storage of materials and ample space for such treatment.

6. CONCLUSION

Given the scale of the site there are and will remain significant uncertainties regarding the potential content of the landfill.

This report has set out a number of issues that will need to be considered in the design of a remediation scheme for this project.



NQMS SQP Declaration of Document Adequacy

Project

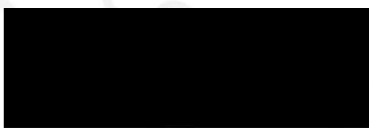
Project Name Princes Parade, Hythe
Project Address Princes Parade, Hythe
[NQMS](#) Declaration Reference 1021-E1736

Summary Description of Project / Proposed development

Housing, leisure centre, car parking and public landscaping.

Document

Document Title Land Contamination Assessment
Document Type Land Contamination Assessment & Options
Appraisal
Document Reference LBH4635lca
Document Date 10th December 2021
Document Author / Publishing Organisation LBHGEO
Named Client Folkestone & Hythe District Council





Regulator's Contact Details

Local Authority Details

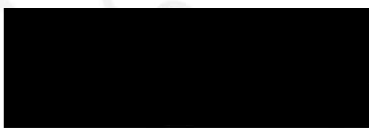
Local Authority Name	Folkestone & Hythe District Council
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Chartered or Professional Institution Membership Reference	N/A





Declaration

I, Seamus Lefroy-Brooks, confirm that I am the person described in the SQP Details section and hold current valid registration as a Suitably Qualified and Experienced Person Registration No. SQP0044 with the NQMS.

I have reviewed the document described in the Document Details section, in relation to the project and site described in the Site Details section, and I am satisfied that:

1. The work has been carried out by appropriately capable people with reference to the Brownfield Skills Framework.
2. That the work carried out is, to the best of my knowledge, undertaken with reasonable skill and care, and the information and data reported:
 - i. describe an appropriate scope and objectives and
 - ii. accord with relevant good practice guidance and standards and
 - iii. are based upon appropriately robust science and
 - iv. are factually correct and
 - v. have been appropriately reviewed.
3. That all specialist aspects have been reviewed by an appropriately qualified/competent person with relevant skills and experience in that specialist area.
4. That the interpretation and conclusions are reasonable.
5. That proposals to mitigate actual potential or residual risks are appropriate.
6. I am competent to sign this Declaration and that
 - a. I am fully aware and comply with the Code of Conduct of Institution of Civil Engineers The Geological Society Society for the Environment through which I hold Chartership N/A.
 - b. The work of this review and Declaration are within the limits of my knowledge, competence and professional capacity.

Note: The document that has been reviewed was prepared by the organisation named for the benefit of the named Client who has reliance upon it. Any professional liability arising from any proven negligent act or omission by the Company carrying out the work and publishing the document rests with that Company and not with the SQP or the NQMS.

Signed:

Date:

Name:

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