

**RIVERSIDE RESOURCE RECOVERY  
(ENERGY FROM WASTE) FACILITY,  
NORMAN ROAD, BELVEDERE**

**CONTAMINATED LAND  
REMEDICATION METHOD STATEMENT**

**Prepared for**

**Riverside Resource Recovery Ltd**

**by**

**Applied Environmental Research Centre Ltd**

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***Report Ref: C34129/R2489/Final (2)***

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## 1. INTRODUCTION

### 1.1 General

- 1.1.1 Applied Environmental Research Centre Limited (AERC) has been commissioned by Riverside Resource Recovery Limited (RRRL) to prepare a detailed Remediation Strategy and Method Statement for the redevelopment of the site in Norman Road, Belvedere. This report was written in April 2007 and should be read in the light of any subsequent changes in legislation, statutory requirements or industry practices.
- 1.1.2 The main part of the site (hereinafter referred to as the "main site") covers an area of approximately 5.93ha and is to be redeveloped to an industrial end-use comprising the Riverside Resource Recovery (Energy from Waste) Facility (RRRF) which will involve the receipt, storage and incineration of waste, and generation of electricity. The "main site" is to consist of the RRRF plant, roads, car parks, an ash container storage area and areas of landscaping, together with the creation of habitats to benefit wildlife.
- 1.1.3 A jetty and pier within the River Thames, part of Norman Road and the junction with Picardy Manorway, and the former Borax residue storage area are also included within the entire development, and are discussed in Section 2.4 below. The entire site covers an area of 21.95ha.
- 1.1.4 An application was submitted by RRRL to the Secretary of State for Trade and Industry under Section 36 of the Electricity Act 1989 for consent to construct and operate the facility. Under Section 90(2) of the Town and Country Planning Act 1990, conditional planning permission is deemed to have been granted for the development, following a public inquiry and report by the Government Inspector. One such condition, PC\*25, relates to site contamination, as follows:

*"Development hereby permitted shall not commence until a scheme to deal with contamination of the site has been submitted to and approved in writing by the local planning authority, in consultation with the Environment Agency or other competent authority, the scheme shall include an investigation and assessment to identify the extent of contamination and the measures to be taken to avoid risk to the public, damage to buildings or harm to the environment when the site is developed, together with a timetable for the implementation of such measures. Development shall not commence until the measures approved in the scheme have been implemented unless otherwise agreed by the local planning authority. This condition shall not be discharged until a validation (closure) report has been submitted to and approved in writing by the local planning authority. Details of any post contamination sampling and analysis to show the site conditions shall be included in the closure report together with details of materials imported to or removed from the site in connection with any remedial works."*

1.1.5 Prior to the granting of the conditional planning permission, a Public Inquiry was held in July to October 2003. AERC's reports, as detailed below, were presented as part of John Boldon's Proof of Evidence. A report<sup>1</sup> was prepared following the Inquiry by Keith Smith, an Inspector appointed by the Secretary of State for Trade and Industry, which concluded that "*the information provided to the inquiry is sufficient to endorse the approach recommended namely, the imposition of a condition on the grant of project consent to require the preparation, submission and agreement of a remediation strategy*" (paragraph 12.202).

1.1.6 The purpose of this report is to provide a Method Statement for dealing with contamination at the "main site", for submission to, and approval by, the planning authority, as a basis for discharging the planning condition.

## 1.2 Background

1.2.1 In May 2003 AERC was commissioned by RRRL to prepare a Site Report for submission to the Environment Agency and a Contamination Issues Report which reviewed existing information on the contaminative status of the site and identified any issues relevant to the development of the site. These are detailed as follows:

- Riverside Resource Recovery (Energy from Waste) Facility, Norman Road, Belvedere. Site Report for IPPC Application. Prepared for Riverside Resource Recovery Limited by Applied Environmental Research Centre Limited. AERC Ref: C3474/R1351, Final (1), June 2003.
- Riverside Resource Recovery (Energy from Waste) Facility, Norman Road, Belvedere, Bexley. Contamination Issues. Prepared for Riverside Resource Recovery Limited by Applied Environmental Research Centre Limited. AERC Ref: C3474/R1355, Final (1), June 2003.

1.2.2 In July 2003, AERC was subsequently commissioned to carry out a detailed site investigation. This involved installation of groundwater monitoring boreholes and subsequent collection and analysis of liquid samples and measurement of groundwater levels, additional sampling and analysis of solid samples. The details of the site investigation are given in the following report:

- Riverside Resource Recovery (Energy from Waste) Facility, Norman Road, Belvedere. Site Investigation and Remediation Proposals. Prepared for Riverside Resource Recovery Limited by Applied Environmental Research Centre Limited. AERC Ref: C3477/R1384, Final, September 2003.

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<sup>1</sup> Report to the Secretary of State for Trade and Industry by Keith Smith, an Inspector appointed by the Secretary of State for Trade and Industry. Application by Riverside Resource Recovery Limited. Section 36 of the Electricity Act 1989 and Section 90 of the Town and Country Planning Act 1990. Construction and Operation of Energy from Waste Power Station of 72MW capacity (gross) At Norman Road, Belvedere, Bexley. File Reference: GDBC/C/003/001 - April 2004

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1.2.3 An additional site investigation was carried out by AERC in August 2006. The objective was to provide additional information on the contaminative status of the north eastern sector of the site. The details of the investigation are given in the following report:

- Letter dated 14 August 2006 to Riverside Resource Recovery Limited by AERC. Ref: JRW/C34129/R2397/CG.

1.2.4 The investigations have identified the requirement to reduce the identified risks to a low level by remediation.

### **1.3 Objectives of Remediation**

1.3.1 The general objective of undertaking the remedial works is to ensure that the "main site" is made safe for its proposed end-use comprising industrial plant, landscaped areas and the creation of habitats for wildlife.

1.3.2 This report details the methods that are proposed to carry out the works. The proposals appear to be satisfactory with both the local authority (Bexley Council) and the Environment Agency (letters dated 29 January 2007 and 14 January 2007). There are areas of the "main site" that do not require remediation at this stage and these are also detailed within this report.

1.3.3 It is understood that construction of the RRR Facility and associated groundworks are to be let as a Design and Build contract scheduled within the development programme to commence in the latter quarter of 2007.

## **2. THE SITE**

### **2.1 Location and Topography**

2.1.1 The "main site", the centre of which may be located by National Grid Reference TQ 496 806, is situated in the Belvedere area of Erith, approximately 750m to the north of the A2016 at the northern end of Norman Road. Erith town centre is located approximately 3km to the south east of the site and the nearest residential development is approximately 1km to the south.

2.1.2 The "main site" is situated in a predominantly industrial area. Commercial buildings are located to the east on the Isis Reach development and depots immediately to the south. Immediately to the west of the site is the Ford Motor Company staff car park which has been leased to a waste company for the parking of lorries and storage of waste bins, however, a small part of this area remains in use as a car park for the Ford works in Dagenham. The Crossness Sewage Treatment Works is situated further to the west beyond rough grazing land.

2.1.3 Generally, to the south west of the "main site", is rough grazing land. This area, known as Crossness, has recently been designated (January 2003) as a Local Nature Reserve by Bexley Council and covers an area of approximately 25.5ha. Local Nature Reserves are generally places with wildlife (or geological) features that are of special interest locally.

- 2.1.4 The "main site" is situated on the south bank of the River Thames within Halfway Reach. The Thames Barrier at Woolwich is situated approximately 8km to the south west and the Dartford river crossing approximately 8km to the south east.
- 2.1.5 The site lies in a relatively flat low-lying area ranging from 1.5m to 2.5m above sea level. Erith Marshes are located approximately 1.25km to the south west and on the opposite bank of the River Thames are the Hornchurch Marshes at approximately 2.5km to the north, and Rainham Marshes and Wennington Marshes at approximate distances of 2km and 3km respectively to the east. The Rainham and Wennington Marshes and the eastern part of the Hornchurch Marshes have been designated as a Site of Special Scientific Interest covering an area of approximately 480ha and are collectively known as the Inner Thames Marshes.

## 2.2 Geology, Hydrogeology and Hydrology

### *Geology*

- 2.2.1 The records<sup>2</sup> indicate that the following geological sequence underlies the site:

Formation	Lithology	Typical Thickness (m)
Made Ground	Brick/Concrete rubble	0.4 - 3.0
Alluvium	Clay and peat with occasional sandy layers at base	3.5 - 11.0
River Terrace Gravels	Medium dense, fine to coarse gravel	2.7 - 5.5
London Clay	Stiff silty clay	<5.0
Blackheath Beds	Sandy clay to fine sand and gravels	approx. 12.0
Woolwich and Reading Beds	Mottled clay, silt and sand	approx. 13.0
Thanet Beds	Silty sands	approx. 17.7
Upper Chalk	Chalk with flints	50.0 - 150.0

### *Hydrogeology*

- 2.2.2 The alluvial deposits, the River Terrace Gravels, the Blackheath Beds and the Thanet Beds are classified as minor aquifers by the Environment Agency. The Environment Agency has classified the Upper Chalk as a major aquifer. It is possible that the Thanet Sands are in hydraulic continuity with the Upper Chalk and are confined by the clayey deposits of the Woolwich and Reading Beds and the London Clay, which are both classified as non aquifers by the Environment Agency.
- 2.2.3 The River Terrace Gravels are likely to represent a perched aquifer that is confined by the London Clay and are likely to be in hydraulic continuity with the River Thames. Shallow groundwater typically occurs within 1m of the surface, in the Made Ground and alluvial deposits.
- 2.2.4 The site does not lie within a currently defined groundwater Source Protection Zone<sup>3</sup> and there are no current records of groundwater abstraction for potable supplies within a 3km radius of the site.

<sup>2</sup> British Geological Survey: 1:50,000 Series. Dartford, Sheet 271. Drift Edition  
British Geological Survey: 1:50,000 Series. Dartford, Sheet 257. Drift Edition

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### *Hydrology*

- 2.2.5 The River Thames forms the northernmost boundary of the site in an area known as Halfway Reach. The water is brackish, although it varies in salt condition depending on freshwater flow and tidal conditions. The mean spring tidal range is 6.4m with 4.3m at mean neap tides.
- 2.2.6 There are several drainage ditches and dykes in the vicinity of the site. There is one unnamed ditch situated in the southern sector of the site which appears to flow southwards, then eventually in a south easterly direction under Norman Road into the ditch on the western side of Norman Road. There is also a ditch on the eastern boundary of the site that generally flows southwards into the Norman Road Ditch (on the eastern side of Norman Road). The Norman Road ditch and the ditch on the western side of Norman Road both flow towards the south and connect with Horsehead Dyke, which flows westwards into Great Breach Dyke.
- 2.2.7 The drainage ditch to the south of the site and Norman Road flows eastwards into the ditch on the western side of Norman Road. The Great Breach Dyke flows generally northwards between the site to the east and the Crossness Sewage Treatment Works to the west into the River Thames.

### **2.3 Site History**

- 2.3.1 In 1865, a 'Manure Works' occupied the north eastern sector of the "main site", with residential properties in the southern sector and Norman Road named as Picardy Manor Way to the south. The remaining part of the "main site" and surrounding area were occupied by agricultural fields with a Powder Magazine Works located approximately 300m to the west of the Manure Works.
- 2.3.2 The "main site" had been substantially developed with Thames Fish, Guano and Oil Works in the north western sector and Belvedere Mills (Bovril Disused) in the north eastern sector by 1897. Borate refining commenced within Belvedere Mills in 1896 and may have included borate refining using crude calcium borate and Epsom Salt manufacture using dolomite and sulphuric acid. A laboratory and calcium carbide store are believed to have been included in the Works. A tavern, residential properties and open space occupied the remainder of the "main site". The surrounding area remained in agricultural use with several drainage ditches.
- 2.3.3 By 1958, the "main site" comprised a Mill, fields, depot, Works and residential properties. The surrounding area was occupied by agricultural fields, a Works, Sewage Works and several drainage ditches. Directly opposite the "main site", on the north bank of the River Thames, is the Dagenham Motor Works.
- 2.3.4 The manufacture of borax-related chemicals ceased in 1988 and all buildings, except one, were demolished in 1994-96 to their concrete bases.

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<sup>3</sup> [www.environment-agency.gov.uk/wiyby](http://www.environment-agency.gov.uk/wiyby)



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## 2.4 Other Areas of the Development

2.4.1 The entire development covers an area totalling 21.95ha, of which the "main site" covers 5.93ha. The other areas of the development comprise the following:

- |  |        |
|--|--------|
| • Area within the River Thames                   | 12.0ha |
| • Former Borax Residue Storage Area              | 2.58ha |
| • Norman Road and junction with Picardy Manorway | 1.44ha |

### *Area within the River Thames*

2.4.2 It is proposed to construct a jetty and pier on the River Thames. The jetty would be a single pier construction, extending 170m from the bank into the River Thames to handle containerised riverborne waste. Geotechnical investigations have been carried out with regards to the construction design elements.

### *"Former Borax Residue Storage Area"*

2.4.3 This area is situated to the south of the "main site" and on the western side of Norman Road. It is understood that this land was used for the deposition of waste products arising from the Borax-related chemical plant located on the "main site". Waste was deposited from 1906 until the 1950s, resulting in heaps of approximately 8m in height and primarily comprised a slurry consisting of gypsum, clay, calcium borate and boiler ash.

2.4.4 A year after the closure of the Borax-related chemical plant, this area was remediated by removing all waste materials down to the adjacent ground level. This involved the excavation of approximately 80,000m<sup>3</sup> of material in 1990. However, it was estimated that approximately 38,500m<sup>3</sup> of waste remained below the existing ground level (as determined by previous site investigations) and the site was subjected to further remediation in 2001. The remedial works comprised the excavation of 37,120m<sup>3</sup> of material to a depth of 2.0m, disposal off-site and subsequent backfilling with 'clean' imported material. The site was then seeded with an amenity grassland mix.

2.4.5 It is understood that this area is to be utilised as a storage compound during development of the "main site".

### *"Norman Road and junction with Picardy Manorway"*

2.4.6 It is proposed to upgrade the existing Norman Road, including widening to 7.3m for 450m from the junction with Picardy Manorway. It is also proposed to provide a footpath/cycleway to link to existing facilities. As a result of the proposals, it is necessary to realign the existing ditch on the western side of Norman Road.

## 2.5 Site Investigations

2.5.1 As mentioned above, AERC has carried out two site investigations in July-September 2003 and August 2006. A total of 53 exploratory holes and ten boreholes were excavated and a selected number of solid and liquid samples were analysed for a range of determinands. The analytical suite for both solids and liquids was selected on the

basis of the site history and includes potentially zootoxic and phytotoxic elements, together with inorganic and organic substances. Leaching tests were also carried out on a selected number of samples.

2.5.2 The site investigations carried out by AERC in 2003 and 2006 identified elevated concentrations of arsenic (when compared with the Soil Guideline Value for residential with plant uptake) and water soluble boron across the area. "Hotspots" of elevated levels of cadmium, lead, mercury, nickel, copper, zinc, sulphide, sulphate, total petroleum hydrocarbons (TPH) and total polycyclic aromatic hydrocarbons (PAHs) were also detected across the site. When compared with guideline values for an industrial end-use, occasional "hotspots" of lead and TPH were detected. The arsenic and boron were found to be present in a mobile form and could present a potential risk to surface water.

2.5.3 A risk assessment was carried out in accordance with the source - pathway - receptor model, and the following potential risk factors were identified:

- Risk of contaminant migration into on-site drainage ditches, particularly during construction. This could potentially arise following the disturbance of soils removed from site, e.g. from excavation of the RRRF and from piling. In addition, in the absence of a structure on-site, there would be potential for on-going leaching of certain contaminants, e.g. arsenic, from the Made Ground.
- Risk to health of construction workers. This will be minimised providing appropriate health and safety measures are used.
- Risk to structures and services. This will be minimised by the design of all buried concrete to DS3 conditions. In addition, agreement will be required with Thames Water regarding the specification of pipe works installed into the ground for potable supply.
- Risk to plant health from elevated concentrations of boron and sulphate. The high pH of the Made Ground may also limit the range of plant species suitable for planting.

2.5.4 On the basis of the risk assessment and the chemical testing data, it was concluded that remedial works are required to:

- (a) reduce the potential for leaching of metals, particularly arsenic, into surface water courses and bodies; and
- (b) provide a 'clean' seed bed for areas of planting.

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### 3. DEVELOPMENT PROPOSALS

#### 3.1 Introduction

3.1.1 It is proposed that development of the site will commence in the latter quarter of 2007. A conceptual Masterplan<sup>4</sup> was produced for the planning application, the landscape components of which have been subsequently detailed, as shown on the Landscape Masterplan prepared by LDA Design<sup>5</sup>. However, it is understood that many of the components remain within the "proposed" stage, although the key elements of the scheme should remain unaltered.

3.1.2 For the purposes of the remediation strategy, the "main site" has been subdivided into zones based on the proposed end-uses as shown on the Landscape Masterplan. The zones are as follows and are delineated on Drawing No. C34129/R2489/01, included in Appendix A:

- Zone 1 - Proposed wetland habitat and landscaping
- Zone 2 - Areas of landscaping
- Zone 3 - Proposed wasteland habitat
- Zone 4 - Main RRRF plant
- Zone 5 - Areas of hardstanding (*i.e.* roads, car parks *etc.*)

#### 3.2 Site Zones

##### *Zone 1 - Proposed Wetland Habitat*

3.2.1 Proposals for Zone 1 have been provided by LDA Design<sup>6</sup>. The objective for this area is to create new water bodies and associated wetlands with connections to existing ditches with the aim of sustaining water voles. The proposed wetland habitat will be located to the east of the main RRRF plant and covers an area of approximately 5,320m<sup>2</sup>. Two water bodies are to be created; a broad ditch and associated wetland in the north eastern part of the site and a new ditch of approximately 150m in length to the east of the main RRRF plant that extends further south. It is understood that the water bodies will be lined with a heavy duty butyl liner. The two wetlands are to be linked by a ditch and the wetland system will drain into the existing ditch on the eastern boundary of the "main site". The wetland system will be supplied by roof water from the main RRRF plant and also local drainage. As well as the water bodies and wetlands, the area will consist of brownfield grassland, wetland planting and wild flower meadows. Groups of trees are also to be planted within and around Zone 1. It

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<sup>4</sup> RRRF, Belvedere, London. Landscape & Ecological Proposals Plan. Drawing No. 2326/16c, 24/4/2003. Prepared by CPM for RRRL.

<sup>5</sup> Riverside. Landscape & Ecological Masterplan. Drawing No. 2344LO/MP-101/E. Prepared by LDA Design, January 2007.

<sup>6</sup> LDA Design. Riverside Resource Recovery Facility, Belvedere. Submission Under Planning Condition 31. New Wetland Habitat. 25 April 2007.

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is proposed to raise this area by approximately 0.50cm utilising site-won crushed concrete and rubble, and subsoil. As this area is to include surface water bodies that connect to the existing drainage ditch situated on the eastern boundary, there is the risk of contaminant migration and therefore remediation is required in Zone 1.

#### *Zone 2 - Areas of Landscaping*

- 3.2.2 Zone 2 comprises the areas of landscaping around the road system and main RRRF plant to provide a rich ecological habitat and includes the embankment alongside the River Thames in the north of the site. The landscaped areas would cover an area of approximately 16,700m<sup>2</sup>. A variety of landscaping features is proposed by LDA Design<sup>7</sup> and includes amenity grassland, wild flower meadows, scrub, tree and hedgerow planting. It is understood that the smaller areas of landscaping may be excavated to a depth of 0.45m and the larger areas may be raised by approximately 0.45m of material. Sculpted earthworks are also proposed and comprise concentric earth mounds on the roundabout in the centre of the site and a series of parallel earth mounds in the southern sector of the site. A bund is also proposed to the west of the air-cooled condensers. It is anticipated that the bunds will cover an area of approximately 6,000m<sup>2</sup> and will utilise in excess of 8,000m<sup>3</sup> of material. The existing grassland on the embankment in the northern sector of the "main site" is to be retained. Elevated concentrations of phytotoxic elements (e.g. boron and sulphate) have been assessed to potentially present a risk to plant health and therefore remediation is required.

#### *Zone 3 - Proposed Wasteland Habitat*

- 3.2.3 The wasteland habitat, Zone 3, is located in the western sector of the site and covers an area of approximately 7,140m<sup>2</sup>. Proposals have been detailed by LDA Design<sup>8</sup> with the aim of creating a wasteland habitat that should benefit invertebrates, birds and reptiles. It is understood that the wasteland habitat may be raised by approximately 0.5m above the current ground level through the use of aggregate materials including sand, crushed red brick and concrete material to create a shallow undulating topography. The northern, western and southern edges of the wasteland habitat are to comprise gentle slopes down to the wetland habitat using on-site material. It is proposed to sow a wildflower mixture over 25% of the wasteland area and a brownfield grassland mixture on 20% of the sloped perimeter areas. Otherwise, the area is left to colonise naturally. As this area may be raised by approximately 0.5m, remediation is not required for plant growth because there will be no pathway between the underlying contaminated material and the rooting zone. Also no surface water bodies are proposed or exist within the vicinity of Zone 3.

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<sup>7</sup> LDA Design. Riverside Resource Recovery Facility, Belvedere. Submission Under Planning Conditions 33 and 36. Ecological Protection and Management Plan and Landscape Maintenance Plan. 25 April 2007

<sup>8</sup> LDA Design. Riverside Resource Recovery Facility, Belvedere. Submission Under Planning Condition 34. Wasteland Habitat Design. 25 April 2007

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#### *Zone 4 - Main RRRF Plant*

- 3.2.4 Zone 4 covers the area of the main RRRF plant of approximately 10,900m<sup>2</sup>. It is proposed to excavate to a depth of 2.5m for the majority of the plant and an additional 2.5m in the area of the ash bunker which covers an area of 290m<sup>2</sup>. The building will also require piled foundations. This area of the site is subject to a separate scheme to be provided by the Engineering Procurement and Construction (EPC) Contractor. It is understood that a geotechnical site investigation will be carried out and a Method Statement subsequently prepared which should specify the techniques to be used in order to prevent contamination of the groundwater, for example.

#### *Zone 5 - Areas of Hardstanding*

- 3.2.5 Zone 5 covers an area of approximately 28,900m<sup>2</sup> and consists of the road system, car parks, the ash container storage area and the air cooled condenser building. A variety of hardstanding is proposed and may include tarmacadam for the main vehicle routes and the ash container storage area, concrete block paving for car parks and concrete slabs around the building. It is understood that the air cooled condenser building and vehicle ramp are to be raised above the ground and the ground beneath will comprise crushed concrete and rubble won from site that will be compacted to provide a stable free-draining surface. As these areas are under cover, no planting is proposed and rainwater will be prevented from infiltrating the ground beneath. Consequently, no remedial works are required. No remediation is required for other areas of this zone as these will be covered in hardstanding, thus providing a barrier between potential receptors and the underlying ground.

## **4. REMEDIATION PROPOSALS**

### **4.1 Introduction**

- 4.1.1 Proposals for remediation were included in AERC's 2003 Report, as detailed above, which was submitted as part of the planning application and as part of John Boldon's Proof of Evidence at the Public Inquiry held in 2003. In order to comply with part of the Planning Condition PC\*25, it is necessary to submit the Remediation Method Statement to Bexley Council and the Environment Agency to seek their written approval for the works to be carried out prior to any ground works commencing.
- 4.1.2 The risk assessment carried out in 2003 and summarised above in Section 2.4.3 identified potential risk factors. Therefore remediation proposals were presented in AERC's Report that were designed to reduce the identified risks to a low level. Two areas of the "main site" were subsequently defined as requiring remediation (cf. Section 3.2), as follows:
- Zone 1 - Proposed wetland habitat
  - Zone 2 - Areas of landscaping
- 4.1.3 A total of 14 "hotspots" have also been identified across the site (within all Zones) which requires remediation. However, other parts of the site should not require remediation as the risk to identified receptors was considered to be low.

4.1.4 In order that the objective of the remediation can be achieved, the following works shall be carried out in the following stages:

- (1) The excavation of contaminated material from defined areas as below;
- (2) Disposal of contaminated material off-site or treatment on-site as below; and
- (3) Controlled backfilling of excavated areas. With regards to Zone 1, this involves the use of low permeability material to reduce contaminant migration towards surface water bodies.

## 4.2 Excavation of Contaminated Material

### "Hotspots"

4.2.1 A total of 14 "hotspots" have been identified across the site, including within Zones 1 and 2, where total petroleum hydrocarbons are present at concentrations in excess of 1000mg.kg<sup>-1</sup>. The "hotspots" are as follows and are shown on Drawing No. C34129/R2489/02 included in Appendix A:

**Table 1: Identified "hotspots" within the "main site" that require remediation as a result of elevated concentrations of TPH.**

"Hotspot"	Zone	Approx. Depth of Excavation	Approx. Volume to be Excavated
TP44	Zone 1	0.5m	15m <sup>3</sup>
TP4/06	Zone 1	1.0m	30m <sup>3</sup>
TP7/06	Zone 1	1.0m	30m <sup>3</sup>
TP8/06	Zone 1	1.0m	30m <sup>3</sup>
BH5	Zone 2	0.5m	15m <sup>3</sup>
TP3	Zone 2	1.3m	40m <sup>3</sup>
TP24	Zone 2	0.5m	15m <sup>3</sup>
TP29	Zone 2	0.8m	24m <sup>3</sup>
TP25	Zone 3	0.5m	15m <sup>3</sup>
TP42	Zone 4	0.6m	18m <sup>3</sup>
TP1	Zone 5	0.5m	15m <sup>3</sup>
TP20	Zone 5	0.5m	15m <sup>3</sup>
TP33	Zone 5	1.2m	36m <sup>3</sup>
BH7	Zone 5	0.5m	15m <sup>3</sup>
Total			313m <sup>3</sup>

4.2.2 These areas should be excavated to a minimum distance of 3m from the identified "hotspot", involving an area of approximately 30m<sup>2</sup>. However, if visual and olfactory signs of hydrocarbon contamination remain evident during excavation, that material should be removed both laterally and vertically. Excavation should be supervised by a suitably qualified environmental engineer and solid samples collected from the base and sides of the excavations to determine that all hydrocarbon contaminated material has been excavated. The excavated material requiring treatment may be either (a) disposed of off-site, or (b) subjected to bioremediation on-site.

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- 4.2.3 If this material is to be disposed of off-site, dependent upon the concentrations of dangerous substances contained within the soil, it may be classified with a hazardous mirror entry EWC Code with regards to the current assessment guidance set out in Environment Agency Technical Guidance WM2, Version 2.1<sup>9</sup>.
- 4.2.4 If this material is to be treated on-site by bioremediation techniques, this would involve excavation, haulage to the building currently existing on-site and placement in rows. Treatment would then comprise regular mixing or turning the material to encourage biodegradation through microbial attack. Treatment shall be carried out by a competent organisation with an appropriate mobile waste management licence, and in compliance with relevant legislation relating to waste management.
- 4.2.5 Material subject to bioremediation shall be tested at regular intervals for its content of TPH. Bioremediation shall be deemed to be successful when the TPH content reaches a threshold trigger value of 500mg.kg<sup>-1</sup>. This material would then be suitable for re-use elsewhere on-site, e.g. within the bunds proposed for the landscaped areas.

#### *Zone 1 - Proposed Wetland Habitat*

- 4.2.6 Excavation of contaminated material shall be restricted to the area of Zone 1 where two water bodies are proposed. The surface covering of concrete should be removed and stockpiled for re-use on-site, if required. The Made Ground beneath the concrete should then be excavated to a depth of 0.8m. In the specific areas of the two water bodies, excavation should extend to the proposed base which may indicate a depth of 2.0m. This should include the identified "hotspots" of lead and total petroleum hydrocarbons. The total area of the proposed excavation extends to approximately 5,320m<sup>2</sup>. Excavation works should be supervised by a suitably qualified environmental engineer and solid samples collected from the base of the excavation at regular intervals. Emplacement of clean material suitable for plant growth should be carried out in accordance with that specified within Section 4.7 below.
- 4.2.7 It is understood that the area of Zone 1 may be raised by 0.5m utilising on-site crushed concrete and rubble. This would indicate that 1.5m of clean material is to be emplaced on completion of excavation of contaminated material. However, as water bodies are proposed, it is recommended that, should the base of the water bodies be deeper than that the material excavated, they should be lined with a suitable material to act as a barrier to the potential migration of contaminants from the soils into surface waters.

#### *Zone 2 - Areas of Landscaping*

- 4.2.8 It is understood that the ground level may be reduced by a depth of 0.45m below the smaller areas of landscaping, which may extend to a total area of 4,950m<sup>2</sup>. These include the areas around the main RRRF plant and around the car parks. The other areas of landscaping, including the roundabout and earthworks, may be raised with 0.45m of material, and the embankment is to be retained.

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<sup>9</sup> Environment Agency. Hazardous Waste : Interpretation of the definition and classification of hazardous waste. Technical Guidance WM2, Second Edition, Version 2.1. November 2005, updated October 2006.

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- 4.2.9 In order to provide a clean seed bed for landscaped areas, excavation of material to a further depth of 0.45m below the final surface level should be carried out, *i.e.* resulting in a total depth of 0.9m, and clean material suitable for plant growth provided to an equivalent depth. In areas where shrubs and trees may be planted, the depth of excavation should extend to 0.6m and 1.0m below the final surface level respectively.
- 4.2.10 For areas that may be raised and where shrubs and trees are proposed, material should be excavated so as to provide a depth of 0.6m of clean soils for shrubs and a depth of 1.0m of clean soils for trees.
- 4.2.11 Excavation works should be supervised by a suitably qualified environmental engineer and solid samples collected from the base of each excavation at regular intervals. Clean material should be that suitable for plant growth and comply with the specification provided in Section 4.7.

#### *Excavation Works*

- 4.2.12 Where excavation is proposed on the site, it shall be undertaken in a manner which will minimise the further spread of contamination into surface water courses and supervised by a suitably qualified environmental engineer. Suitable precautions shall be undertaken during excavation works to prevent the spread of dust and, in dry conditions, dust shall be controlled to acceptable levels by spraying with water.
- 4.2.13 Suitable precautions shall be employed to ensure that odours arising during excavation works are controlled to prevent any nuisance to neighbours. Measures shall include the rapid removal from site of malodorous materials in covered vehicles immediately following excavation. If necessary, hoardings shall be provided around areas of particular concern to contain the spread of vapours and de-odorising sprays may also be employed.
- 4.2.14 Plant for excavation and filling shall be selected with due consideration of site access, ground conditions and depth of excavation. In addition, all plant shall be fitted with effective silencers approved by the manufacturers. The contractor shall comply in full with BS 5228 with reference to the control of noise in relation to demolition and/or construction works and shall ascertain from the Local Authority what requirements or restrictions shall apply to these works.
- 4.2.15 The excavations shall remain open for the minimum time necessary. The excavation should remain open until the receipt of chemical testing data from the validation exercise (Section 4.4), however, should backfilling be required prior to receipt of chemical testing data, this shall be undertaken upon the discretion of the site owner.

### **4.3 Zone 4**

- 4.3.1 It is understood that the piling operations will be carried out in Zone 4 for the main RRRF plant and possibly the air cooled condensers building. Works in Zone 4 are related to the construction of the plant and will be carried out by the EPC Contractor, as a separate scheme. It is anticipated that a geotechnical site investigation will be carried out and a piling strategy formulated. A Method Statement should be prepared which



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should specify the techniques to be used in order to prevent contamination of the groundwater, for example. Remediation works in Zone 4 shall include:

- (1) the removal of "Hotspots" as specified above;
- (2) the excavation of the Made Ground and
  - clean material shall be stockpiled for re-use on-site;
  - non-hazardous material shall be further characterised and assessed for either stockpiling and re-use on-site or disposed of off-site.

#### **4.4 Validation Testing**

4.4.1 It is proposed that validation testing for the purpose of determining the extent of contamination will be carried out on superficial samples collected from the base of excavated areas across the site in order to provide an updated Site Report<sup>10</sup>. The frequency of sampling shall comprise a minimum of 1 sample per 100m<sup>2</sup>. The depths of excavations shall be measured and a photographic record maintained.

4.4.2 Validation samples collected from the excavations shall be analysed for a broad range of determinands which should include zootoxic elements, inorganic and organic substances. The chemical testing data shall be compared with the reference values given in Section 4.7.1.

4.4.3 In the event that reference values are exceeded, a detailed risk assessment shall be carried out in accordance with the source-pathway-receptor model.

#### **4.5 Backfilling of Excavations**

4.5.1 It is proposed to re-use or recycle as much material won from site as possible. Therefore, material to be excavated during redevelopment works shall be carefully excavated and stockpiled. Samples should be collected from the stockpiles by an environmental engineer at a frequency of one sample per 100m<sup>3</sup> and tested to confirm that the material complies with the reference values in Section 4.7.1 below in terms of freedom from contamination for the proposed end-use of a particular area on-site, e.g. below hardstanding. Material which fails to comply should be removed from site.

4.5.2 Imported materials or soils shall be tested for a suite of determinands to be determined with the agreement of an appointed environmental consultant depending on the provenance of the material with reference to Section 4.7.

4.5.3 Appropriate measures should be taken to ensure that imported materials or soils do not become contaminated with underlying soils and shall involve the placement of clean plastic sheeting over all areas where materials are to be stockpiled.

4.5.4 Placement and compaction of fill materials shall be generally in accordance with the Specification of Highways Works (SHW), Clause 608, where required.

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<sup>10</sup> An updated Site Report is required to discharge the condition (1.1.3 'i') placed upon the PPC permit.

4.5.5 Following excavation and removal of the Made Ground within Zone 1 (wetland habitat), the area can be backfilled. However, any material to be used should possess a hydraulic conductivity of  $1 \times 10^{-6}$  m/s or lower to prevent migration of contaminants into surface waters. The hydraulic conductivity of the material to be emplaced in this area has been based on the use of the Ogata Banks model and Environment Agency methodology<sup>11</sup> to determine the distance which arsenic would be expected to migrate, over a timescale of 1,000 years.

#### **4.6 Use of Materials On-site**

4.6.1 The two proposed habitats - wetland (Zone 1) and wasteland (Zone 3) may be raised by 0.45m above the current ground level utilising concrete and rubble won from site. The majority of the site was covered in concrete to a minimum depth of 0.2m, although concrete was also found at depth at a number of locations. There were also discrete areas of gravel in some places across the site. It would be possible to re-use the concrete, however, the concrete should be assessed visually for signs of contamination prior to being crushed. If there is evidence for contamination, the concrete should be removed and disposed of off-site. The gravels should be subjected to soil screening to remove all contaminated material adhering thereto. Material should be emplaced within the wetland habitat (Zone 1) in accordance with the specification provided in Section 4.5.5.

4.6.2 The two proposed habitats also include areas of brownfield grassland where it is anticipated that soil obtained from site may be re-used and should consist of 1/3<sup>rd</sup> crushed aggregate and 2/3<sup>rd</sup> soil. Elevated levels of water soluble boron were detected across the site and it was concluded that this would not be a suitable growing medium for plants. However, where soil was encountered this may be used as subsoil in the wasteland habitat (not the wetland habitat) as no surface water features are proposed. The soil should be subjected to screening.

4.6.3 Temporary bunds are currently present in the southern sector and comprise soil, together with fly tipped material. It may be possible to re-use the soil within the bunds elsewhere on-site subject to testing for contamination. Samples should be collected from the stockpiles by a suitably qualified environmental engineer at a frequency of one sample per 50m<sup>3</sup> and tested to confirm that the material complies with the reference values in Section 4.7.1 in terms of freedom from contamination for the site's proposed end-use. Soils which fail to comply should be removed from site. If determined that the soils can be re-used on-site, the bunds should be subjected to screening to remove the fly tipped material.

#### **4.7 Validation of Fill Material**

4.7.1 All materials and soils which are to be imported for plant growth in landscaped areas shall be clean material. Clean material may be defined as material which does not contain substances or species in concentrations which are hazardous to human health or the environment in the context of the proposed end-use. In order to assess whether material is clean in accordance with these requirements testing and validation will be

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<sup>11</sup> Environment Agency R&D 20 Publication. Methodology for the Derivation of Remedial Targets for Soil and Groundwater to Protect Water Resources. 1999.

required, the extent of testing and validation to be undertaken will depend on the source and provenance of the material. Clean materials shall conform to the reference values as follows:

**Table 2: Reference Values for Clean Materials**

Determinand	Reference Value mg.kg <sup>-1</sup>	Determinand	Reference Value mg.kg <sup>-1</sup>
Total Arsenic	<20	Total PAHs	<50
Water Soluble Boron	<3	Benzo(a)pyrene	<5
Total Cadmium	<2 - <8*	TPH**	<500
Total Chromium	<130	Total Phenols	<78
Total Copper	<200	Total Cyanide	<25
Total Lead	<450	Sulphide	<250
Total Mercury	<8	Water Soluble Sulphate	<0.5g.l <sup>-1</sup>
Total Nickel	<50	pH	>5 units
Total Selenium	<35	Asbestos	No visible fibres
Total Zinc	<300		

\* At soil pH 7, reference value for soil cadmium = 2mg.kg<sup>-1</sup>; at soil pH 8, reference value for cadmium = 8mg.kg<sup>-1</sup>.

\*\* Material having a concentration of TPH greater than the given reference value may be considered to comply with the specification depending on the findings of a risk assessment and consultations with the Local Authority.

4.7.3 Material suitable for clean fill shall not comprise material or constituents of materials composed of the following:

- (i) peat, material from bogs, swamps and marshes;
- (ii) logs, pieces of wood, stumps and putrescible materials;
- (iii) material susceptible to spontaneous combustion;
- (iv) material in a frozen condition;
- (v) material with excessive clay content;
- (vi) hazardous material and Special Waste as defined in the Special Waste Regulations 1996.

4.7.4 All imported materials shall be validated prior to being brought onto the site by one of the methods set out below:

- (i) Where imported materials originate from a natural undisturbed source it shall be appropriate for the Contractor to demonstrate that the material is clean by means of a desk study of the source location which may include, *inter alia*, location details and National Grid Reference, a historical study with reference to old maps and consultations with the appropriate local and regulatory authorities. This may be supported by a regime of representative sampling and analysis of the material to provide details of geological and geotechnical descriptions and properties.
- (ii) Where reclaimed materials or disturbed materials are proposed for use on the site, it will be appropriate to conduct an assessment to characterise the nature and levels of any contaminants present. Due to the potential variability of contaminant distribution, it will be necessary to undertake testing to achieve this characterisation. An assessment of reclaimed materials should address

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previous use and identify, where possible, the species of contamination which are likely to be present in the material. Based on this assessment, further sampling and analysis should be carried out to assess the variability of concentrations of identified contaminants.

#### **4.8 Underground Services**

- 4.8.1 The Contractor shall be responsible for collecting service drawings and establishing the location of public and private water, gas, electricity, sewers, telephone *etc.*, underground services within the site area. The Contractor shall be responsible for devising methods to protect from harm any services deemed necessary prior to, and during, the works.
- 4.8.2 Consideration shall be given to an appropriate specification for drainage and other service pipes with particular attention to flexible sealing rings at joints. Confirmation should be obtained from manufacturers that their product is suitable for use in the conditions likely to be encountered on-site. Services shall be installed into "clean corridors" comprising excavated trenches backfilled with clean inert material, across the site.

#### **4.9 Waste Disposal**

- 4.9.1 All contaminated material arising from remediation earthworks and redevelopment of the site to be disposed of off-site shall be carried out in accordance with the requirements of the Landfill Regulations 2002 (UK Statutory Instrument 2002 No. 1559). Prior to commencing the removal of material from site, a waste classification will be agreed with the Environment Agency in order to address licensing requirements. When a waste classification has been determined, the surplus materials shall be disposed of to a site licensed to receive such waste. In addition, the site may need to be registered with the Environment Agency prior to any material being removed from site, if the material is considered to be hazardous waste ([www.environment-agency.gov.uk](http://www.environment-agency.gov.uk)).
- 4.9.2 All contaminated material transported from site to the point of disposal shall be undertaken with due regard to the requirements of the Environmental Protection Act 1990, Section 34, The Environmental Protection (Duty of Care) Regulations 1991 and the Code of Practice on the Duty of Care (1996). Only registered carriers shall be used for the shipment of waste and waste transfer, and consignment notes shall be obtained for all waste removed from the site. Records shall be kept of all quantities of waste removed from the site during the currency of the works. Copies of such records, either in full or as a summary, shall be provided to the environmental engineer carrying out the validation works during the currency of the earthworks.

#### **4.10 Water Control and Disposal**

- 4.10.1 The Contractor shall be responsible for any dewatering which might be required during remediation and redevelopment works.
- 4.10.2 Any water found to be contaminated to such an extent which precludes discharge to watercourses, sewers or drains shall be removed from site by tanker to an approved

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facility to receive such waste. It will be necessary to characterise the nature of all liquid wastes to be disposed of through analysis in order to secure the necessary consents to discharge. Where it is possible to discharge water into the surface watercourses, approval shall be sought from the Environment Agency prior to discharge. Where disposal is by tanker, shipments shall only be made by registered carriers and consignment notes shall be obtained for the waste to the point of disposal.

4.10.3 Should heavy rain fall at the site, then any open areas of the excavations shall be covered to minimise infiltration. Drainage from the sheeting shall be collected and disposed of off-site.

#### **4.11 Vehicle and Plant Cleaning Facilities**

4.11.1 Lorries and plant travelling off-site onto public highways shall have their wheels or tracks cleaned to remove all contaminated material adhering thereto. The Contractor shall provide an effective means for ensuring that this clause is complied with and shall make all necessary arrangements for intercepting and disposing of all contaminated water arising from these operations, including obtaining all necessary permissions to discharge to the public sewer or arranging for removal of the liquid off-site to a landfill authorised to receive such material.

#### **4.12 Health and Safety**

4.12.1 The Contractor shall prepare submissions as required by the Planning Supervisor in order to comply with the requirements of the Construction (Design and Management) Regulations 1994 and shall comply with all current health and safety legislation and guidelines, including, but not restricted to, the following:

- The Health & Safety at Work Act 1974
- The Management of Health & Safety at Work Regulations 1992
- The Control of Substances Hazardous to Health (COSHH) Regulations 1994 and Amendment 1998
- The Environmental Protection Act 1990
- The Protection of Workers and the General Public during the Development of Contaminated Land (HMSO 1991)
- A Guide to Safe Working on Contaminated Sites (CIRIA 1996)

4.12.2 The Contractor shall carry out site specific risk assessments in respect of the hazards anticipated on site and these will be incorporated in the Construction Health and Safety Plan.

4.12.3 In addition to the personal protective equipment required for working on normal construction sites, operatives will be provided with disposable overalls and gloves during excavation works. Operatives will undergo induction training before commencing work on-site and will be made aware of the nature of the hazards present, the importance of personal hygiene and washing and changing procedures.

## 5. IMPLEMENTATION OF MEASURES

### 5.1 Proposed Phasing

5.1.1 It is proposed to undertake the remediation measures on a phased basis to ensure that the work is coordinated with other works that are being carried out on site. This should ensure that each area of remediated land is available for development when it is required and that work on all parts of the site are compatible with one another.

5.1.2 The proposed phasing of the work is as follows:

**Table 3: Proposed Phasing of Remedial Works**

Areas to be Remediated	Timing
Hotspots	Prior to commencement of development.
Zone 1	Zone 1 will be remediated during the six month period prior to developing the proposed wetland habitat.  This area is required to be remediated and developed as a wetland habitat. As identified in the Ecological Phasing Plan (LDADESIGN 2007, Ref: 2344LO/Phase, included in Appendix A for information), the wetland habitats to the east of the building will be implemented in the period following completion of the southern roof of the main RRRF plant and when the area is no longer required for associated construction purposes (e.g. lay down area).
Zone 2	Work in Zone 2 would be undertaken at a time which is compatible with the phasing of the landscaping and ecological work defined in the Ecological Phasing Plan. (Most of this work would be carried out after completion of the construction work. Were this not to be carried out at this time, there may be a risk that remediated areas would be damaged by construction machinery and the restriction placed on the building contractor would be significant.)
Zone 3	No remediation work is required in this area.
Zone 4	Any remediation work required within Zone 4 will be carried out by the EPC Contractor as the first stage of construction of the main RRRF plant.
Zone 5	No remediation work is required in this area.

## 6. VALIDATION

### 6.1 Validation Reporting

6.1.1 On completion of each phase of the remediation works as specified above, it is proposed to prepare a Validation Report by an appointed environmental consultant. These reports shall include, as a minimum, the following:

- a plan showing the areas where excavations have taken place;
- details of the excavations, including depths together with results of chemical testing of validation samples;
- areas of non-compliance and detailed risk assessment;

- results of chemical testing of validation samples collected from imported and stockpiled material; and
- Duty of Care records for all material disposed of to landfill.

6.1.2 The Validation Reports should then be issued to the Environment Agency and the Local Authority as a record that validation has been undertaken satisfactorily. The Validation Reports will also form the basis of an updated Site Report in accordance with Condition 1.1.3 'i' of the PPC permit.

## APPENDICES



## **Appendix A Drawings**

**Appendix B**  
**Letters from Bexley Council**  
**and Environment Agency**