Remediation Statement Appendix C2

Former Albright and Wilson Facility, Whitehaven, Cumbria. Plot A Assessment Actions

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EXECUTIVE SUMMARY

URS Corporation Ltd (URS) was commissioned by Rhodia UK Ltd (Rhodia) to undertake an additional focused intrusive soil and groundwater investigation at the former Albright & Wilson site in Whitehaven, Cumbria. This work was required based on the concluding assessment actions of the main site investigation in Plot A, conducted in August 2006 and detailed the URS report entitled Appendix C Plot A Soil and Groundwater Investigation at the Former Albright and Wilson Works, Whitehaven, Cumbria (REF: 44320021/MARP0004, dated 17th January 2007).

The purpose of the additional investigation was to target three defined areas of the Plot where uncertainties still remained on the concentration and spatial distribution of several analytes, which had been identified as posing a potential risk to the defined controlled waters receptor, the Irish Sea.

The investigation areas where as follows:

Area 1- The area in the vicinity of TP628A to TP630A: Further investigation for TPH

Area 2- The area in the vicinity of TP624A: Further investigation for TPH

Area 3- The area in the vicinity of WS115 and TP602A: Further investigation for PAHs, zinc and cyanide.

A trial pitting exercise was undertaken with a total of 14no. trial pits excavated. Following the trial pitting exercise a limited shallow soil boring investigation was completed at six locations which allowed the installation of monitoring wells at each location. Soil and groundwater samples were collected and scheduled for a targeted suite of analytes.

Following completion of this additional investigation, the original Stage 3 Controlled Waters Risk Assessment was updated to include the additional laboratory data obtained from these works. Furthermore, in order to reduce the conservatism of the site dilution model (Stage 3A model) used in the main report, the risk assessment was developed to include the further offsite dilution (Stage 3B Model) of the migrating site-derived waters (as they moved offsite, and westwards toward the Irish Sea) by a defined area of clean catchment, that of rainfall incident on the St.Bees Sandstone formation.

The original modelling exercise in the main report defined potential source areas based on the sampling density at that time. In order to be conservative, these areas were potentially larger than they were in reality. The additional sampling in March 2007 allowed investigation within these conservative source zones to determine whether these areas were realistic. As a consequence of the investigation, the conservative source zones defined in the original modelling exercise could be reduced for Areas 1 and 2, as the additional sampling locations within these areas confirmed TPH was not present in soils. Consequently, the potential risks posed by TPH were eliminated at Stage 3A from the vicinity of TP624 and TP630A.

TPH in the vicinity of TP628A posed a theoretical risk at Stage 3A. However, following dilution at Stage 3B, this risk was no longer deemed to be significant.

Following the risk assessment in this investigation for Area 3, one analyte was considered to pose a potential risk to controlled waters at Stage 3A at TP602A (namely fluoranthene), and at WS115 six analytes were deemed to pose a potential risk (namely benzo (a)anthracene, benzo (a) pyrene, fluoranthene, naphthalene, zinc and cyanide). All seven analytes were then assessed at Stage 3B, and two analytes were identifed to continue to pose a theoretical risk to controlled waters, these were naphthalene and cyanide. Consequently, URS recommends remedial works in this area.

A Best Practical Environmental Option (BPEO) assessment will be required to determine the most cost effective and acheivable method to break the source-pathway-receptor pollutant linkage for this analyte. The BPEO will be considered in context with other potential remedial areas on the site.

1. INTRODUCTION

1.1. General Introduction

URS was commissioned by Rhodia on 27 July 2006 to undertake an intrusive soil and groundwater investigation within a parcel of land defined as "Plot A" at the former Albright & Wilson site in Whitehaven, Cumbria as detailed in URS Proposal 3033251 (dated 23 June 2006). This work was requested by John Moorhouse (Rhodia) at a meeting with Alistair Wyness (URS) on 10th March 2006.

This work was conducted during August 2006. The findings of this investigation were presented in a report entitled *Plot A Soil and Groundwater Investigation at the Former Albright and Wilson Works, Whitehaven, Cumbria* (REF: 44320021/MARP0004, dated 17th January 2007). The report indicated that the majority of potential pollutant linkages had been shown to not be significant, and consequently pose no risk to Human Health or Controlled Waters receptors. However, the geochemistry at a discrete number of locations suggested potential source areas of contamination may be present within Plot A, and the accompanying controlled waters risk assessment determined that theoretical risks to the controlled waters receptor (the Irish Sea) may exist. Further evaluation of the potential source areas was required to further investigate these potential pollutant linkages, in order to assess their extent and potential significance.

This report details this follow up investigation, and has been incorporated as Appendix C2 of the main remediation statement. This additional investigation was incorporated in URS Proposal 1941NG1111 (dated 19th February 2007), which was commissioned by Rhodia on 16th February 2007.

1.2. Rationale

The results of the original modelling performed in the main investigation indicated that significant risks may be present based on analytical results from several trial pits/boreholes in Plot A. From these locations, three potential source areas of contamination were defined. The new locations were placed in the vicinity of these areas, surrounding the old positions, with boreholes being placed down hydraulic gradient of the potential source areas to determine the condition of potential migrating groundwater; and trial pits were positioned up hydraulic gradient and lateral to the inferred direction of groundwater migration.

2. SCOPE OF WORKS

The following scope of works was performed in order to determine whether remedial action is necessary. The site plan has been presented as Figure 1.

2.1. Trial Pitting

Trial Pitting was undertaken between 7th March 2007 and 8th March 2007. Prior to excavation, each location was cleared with a Cable Avoidance Tool (CAT Scan). Due to the presence of thick concrete covering a small part of the area of Plot A, it was necessary to use a hydraulic breaker attached to a backhoe excavator to progress through the concrete to the underlying soils. In total 14 trial pits of approximate area 1m x 3.5m were advanced using a mechanical backhoe excavator to a maximum depth of 4.1m bgl.

Soil inspection and sampling were undertaken as described in Section 2.4. The excavations were discontinued on contact with natural ground that appeared uncontaminated or on bedrock. The trial pits were backfilled with arisings in the reverse order to their excavation, then compacted using the bucket and tracks of the excavator.

The following intrusive works were conducted:

Area 1- The area in the vicinity of TP628A to TP630A: Seven trial pits (TP638A-TP644A) were advanced to a maximum depth of 4.1mbgl.

Area 2- The area in the vicinity of TP624A: Four trial pits (TP634A-TP637A) were advanced to a maximum depth of 3.9mbgl.

Area 3- The area in the vicinity of WS115 and TP602A: Three trial pits (TP631A-TP633A) were advanced to a maximum depth of 2.2mbgl.

Trial pit logs are provided in Appendix A.

2.2. Drilling Works

Drilling works were conducted on 6th March 2007. Prior to excavation, each location was cleared with a CAT Scan. Boreholes were advanced using windowless sampling techniques. This technique drives a metal sampling tube 100mm in diameter and 1000mm in length containing a single use acetate liner into the ground using a hydraulically driven falling weight. A metal casing is driven into the ground along with the sampling tube, facilitating the extraction of the sample core after each successive metre, and preventing the collapse of the borehole sides and subsequent cross contamination of the soils yet to be sampled. In total 6 boreholes were advanced to a maximum depth of 4.5m bgl.

The process of inspection of the soil cores and collection of samples is described in full in Section 2.3.

Groundwater monitoring wells were installed in each of the six drilling locations, using 50mm HDPE casing and screen, a geosock sleeve, an inert gravel pack and bentonite seal. Top hat type covers were used in the majority of locations to reduce the potential for the loss or damage to the borehole, given the likelihood of heavy plant machinery operating in the investigation area during future groundworks.

The following intrusive works were conducted:

Area 1- The area in the vicinity of TP628A to TP630A: Two boreholes (WS508A and WS509A) were advanced to a maximum depth of 4.5mbgl.

Area 2- The area in the vicinity of TP624A: One borehole (WS510A) was advanced to a depth of 3.9mbgl.

Area 3- The area in the vicinity of WS115 and TP602A: Three boreholes (WS505A-WS507A) were advanced to a maximum depth of 3.8mbgl.

Details of the construction of each of the monitoring wells is provided in the borehole logs included in Appendix A.

2.3. Soil Inspection and Sampling

The URS field engineer logged the geological sequence observed as the excavation progressed. To assess the potential for contamination, soil samples were taken at regular intervals for headspace analysis (typically every 0.5m). Additional samples were taken for headspace analysis if there was visual or olfactory evidence of contamination, or where there were pertinent changes in the geology. These samples were screened using a photoionisation detector (PID meter) fitted with a 10.6 eV bulb to assess the potential for chemical impact from volatile hydrocarbons.

Soil samples were collected at a variety of depths from both contaminated and uncontaminated horizons, from the made ground and from the natural ground to provide a robust, valid and comprehensive assessment. These were placed directly into containers supplied by the laboratory, and stored under chilled conditions prior to dispatch to the URS approved laboratory (Alcontrol Geochem).

Field observations and geochemical results are presented in Section 3.

2.4. Groundwater Sampling

Prior to sampling, depth to water (or free phase oil product below ground level) was measured in each well using an oil/water interface probe. Depth to water was measured from the top of the borehole casing. WS505A, WS508A and WS509A were found to be dry, and therefore no groundwater samples were obtained. Groundwater sampling from the remaining wells (including one well belonging to Huntsman, named ERM3 for the URS investigation), located in Area 3, was undertaken on 12th March 2007.

For the monitoring wells, the depth from the top of the monitoring well pipe to water was measured. This dip data is presented in Table 2 at the end of this report.

2.5. Levelling

A levelling survey of each of the investigation locations relative to Ordnance Datum and national grid co-ordinates was conducted by a specialist sub-contractor (Survey Systems) between 12th March and 14th March 2007.

Groundwater elevations were then calculated, and are presented in Table 2.

2.6. Laboratory Analysis and Data Management

The analytical suite for the March 2007 investigation was based on the findings of the controlled waters risk assessment in the main Plot A report (REF44320021/MARP0004). The analysis included TPH, SVOCs, heavy metals, and cyanide. A number of samples were also scheduled for VOC analysis. Soils, leachate and groundwater samples were analysed.

The analytical data for the March 2007 investigation was then collated with the existing data for Plot A. This data is presented in Appendix B.

3. FIELD OBSERVATIONS

3.1. Soil Conditions

The ground conditions underlying the Plot A area are derived from the inspection of the arisings resulting from excavations and soil borings advanced during the investigation. A summary of the ground conditions encountered is provided in Table 3.1 below.

Exploratory borehole logs and trial pits are presented in Appendix A.

Table 3.1 – Summary of Typical Geological Profile Encountered

Unit	Description	Depth Encountered (m)	Maximum Thickness (m)
Made Ground	Reinforced concrete hardstanding	0.0 – 2.8	1.3
	Brown to grey coarse sand and coarse gravel with many man made components (fill material)	0.0 – 1.3	0.9
	Orange red or black brown silt and clay with occasional gravel and cobbles	0.1 – 1.5	1.65
	Black silty clayey gravel layers with clinker, or pockets or lenses of black clinker. Frequent coal, ash, slag and brick.	0.0 - 0.7	1.65
Natural Ground	Glacial Till Deposits typically comprising red-brown, dark brown, or orange clay or red brown silt with occasional gravel, cobbles and lenses of sand.	0.3 – 2.5	3.95
Bedrock **St Bees Evaporite Formation**	Grey – pink, weathered Limestone	2.5 – 4.5	Not Proven
	Beige Sandstone	2.1 – 3.95	Not Proven
	Siltstone	4.2	Not Proven

3.2. Groundwater Conditions

Groundwater ingress was noted during the excavation of trial pits TP631A, TP632A, TP634A, TP635A, TP636A, TP638A, TP639A, TP640A, TP641A, TP643A. However, these water strikes were restricted to the made ground, with the majority of locations underlain by dry clay. In total three of the six wells that were installed (all six wells screened the drift deposits) were dry, and the remaining three contained a limited volume of water, with slow recharge. It is likely that these boreholes contain localised pockets of perched groundwater (unconnected underground ponds of water). Based on the spatial correlation of groundwater strikes it is not considered likely that a continuous shallow groundwater body is present within the drift deposits. Groundwater dip data is presented as Table 2 (in Appendix B).

3.3. Field Observations of Contamination

The visual and olfactory evidence of contamination recorded during the site investigation is presented below.

Table 3.2 Field observations of contamination

Location	Made Ground	Drift	Bedrock
WS505A	-	-	Not Proven
WS506A	NVO	NVO	Unknown odour (21.8ppm)
WS507A	-	-	Not Proven
WS508A	NVO	NVO	Not Proven
WS509A	-	-	Not Proven
WS510A	NVO	NVO	Not Proven
TP631A	Hydrocarbon odour, black staining	-	Not Proven
TP632A	NVO	NVO	Not Proven
TP633A	Hydrogen sulphide and surfactant odour	NVO	Not Proven
TP634A	Slight hydrogen sulphide odour	Water ingress with an oily sheen at 1.0m, unknown odour	Not Proven
TP635A	NVO	NVO	Not Proven
TP636A	Ingress of water with oily sheen at 0.8m	-	Not Proven
TP637A	0.1ppm	-	Not Proven
TP638A	-	-	Not Proven
TP639A	NVO	Sweet chemical odour (0-1m)	Not Proven
TP640A	NVO	NVO	Not Proven
TP641A	NVO	-	Not Proven
TP642A	Slight TPH odour on boundary between made ground and drift	NVO	Not Proven
TP643A	NVO	NVO	NVO
TP644A	NVO	NVO	Not Proven

4. GEOCHEMICAL RESULTS

The analytical schedules and results of laboratory chemical analyses are provided in detail in Table 1 and Tables 3 to 20 (included in Appendix B to this report). The laboratory certificates are also included in Appendix B.

This section introduces an initial understanding of the distribution of key analytes detected in the soil, leachate and groundwater on the site from the site data obtained in March 2007. The key analytes of interest are those which were highlighted in the previous investigation (*Plot A Soil and Groundwater Investigation at the Former Albright and Wilson Works, Whitehaven, Cumbria,* REF: 44320021/MARP0004, dated 17th January 2007) as posing a potential risk to controlled waters. These are TPH, PAHs, zinc and cyanide.

An assessment of whether the analyte concentration represents a “significant risk” to controlled waters is made within Sections 6 in this report.

4.1. Total Petroleum Hydrocarbons

TPH Concentrations in Soil

TPH in soil	Method Detection Limit	Minimum reported concentration (mg/kg)	Maximum reported concentration (mg/kg)	Number of samples above method detection limit	Number of samples analysed
TPH (>EC6-7) Aromatic	0.01	<mdl	<mdl	0	16
TPH (>EC7-8) Aromatic	0.01	<mdl	<mdl	0	16
TPH (>EC8-10) Aromatic	0.01	<mdl	0.04	1	16
TPH (>EC10-12) Aromatic	0.01	0.035	0.33	2	16
TPH (>EC12-16) Aromatic	0.1	0.55	36	11	16
TPH (>EC16-21) Aromatic	0.1	0.27	47	10	16
TPH (>EC21-35) Aromatic	0.1	0.26	240	10	16
Total Aromatics (C6-C35)	0.1	0.55	310	12	16
TPH (>EC5-6) Aliphatic	0.01	<mdl	<mdl	0	16
TPH (>EC6-8) Aliphatic	0.01	<mdl	<mdl	0	16
TPH (>EC8-10) Aliphatic	0.01	0.02	0.02	1	16
TPH (>EC10-12) Aliphatic	0.01	0.02	0.22	2	16
TPH (>EC12-16) Aliphatic	0.1	0.98	21	11	16
TPH (>EC16-21) Aliphatic	0.1	2.30	150	11	16

TPH in soil	**Method Detection Limit**	**Minimum reported concentration (mg/kg)**	**Maximum reported concentration (mg/kg)**	**Number of samples above method detection limit**	**Number of samples analysed**
TPH (>EC21-35) Aliphatic	0.1	0.13	220	11	16
Total Aliphatics (C5-C35)	0.1	13.00	380	11	16
TPH-PRO (C4-C12)	0.01	0.06	0.61	11	16
TPH (C5-C35)	0.1	3.7	450	12	16
Total Aliphatics >C6-C40 (Min Oil)	10	27	270	3	10
Total Aromatics >C6-C40	10	31	1,100	4	10
Total Hydrocarbons	10	67	2,500	5	10

Each of the maximum reported concentrations were from samples taken from the Made Ground at depths of less than 2.0m

TPH Concentrations in Leachate

Chemical	**Method Detection Limit**	**Minimum reported concentration (mg/kg)**	**Maximum reported concentration (mg/kg)**	**Number of samples above method detection limit**	**Number of samples analysed**
TPH (>EC6-7) aromatic	10	<mdl	<mdl	0	28
TPH (>EC7-8) aromatic	10	<mdl	<mdl	0	28
TPH (>EC8-10) aromatic	10	<mdl	<mdl	0	28
TPH (>EC10-12) aromatic	10	18	55	2	28
TPH (>EC12-16) aromatic	10	37	72	2	28
TPH (>EC16-21) aromatic	10	<mdl	<mdl	0	28
TPH (>EC21-35) aromatic	10	<mdl	<mdl	0	28
Total Aromatics (C6-C35)	10	90	92	2	28
TPH (>EC5-6) aliphatic	10	<mdl	<mdl	0	28
TPH (>EC6-8) aliphatic	10	<mdl	<mdl	0	28
TPH (>EC8-10) aliphatic	10	<mdl	<mdl	0	28
TPH (>EC10-12) aliphatic	10	12	37	2	28
TPH (>EC12-16) aliphatic	10	<mdl	<mdl	0	28
TPH (>EC16-21) aliphatic	10	<mdl	<mdl	0	28

Chemical	Method Detection Limit	Minimum reported concentration (mg/kg)	Maximum reported concentration (mg/kg)	Number of samples above method detection limit	Number of samples analysed
TPH (EC21-35) aliphatic	10	<mdl	<mdl	0	28
Total Aliphatics (C5-C35)	10	12	37	2	28
TPH-PRO (C4-C12)	10	30	92	2	28
TPH (C5-C35)	10	12	37	2	28

Each of the maximum reported concentrations were from one location (WS508 at 0.2m).

TPH Concentrations in Groundwater

One groundwater sample was taken for TPH analysis. This did not detect TPH above the method detection limit.

Polycyclic Aromatic Hydrocarbons (PAHs)

PAH Concentrations in Soil

PAHs by GC-MS	Method Detection Limit	Minimum reported concentration (mg/kg)	Maximum reported concentration (mg/kg)	Number of samples above method detection limit	Number of samples analysed
Benzo(a)anthracene	0.1	0.19	6.30	10	20
Benzo(a)pyrene	0.1	0.11	5.90	9	20
Fluoranthene	0.1	0.19	11.00	10	20
Naphthalene	0.1	0.30	13.75	9	20

All the samples in the above table were taken from Made Ground.

PAH Concentrations in Leachate

PAHs by GC-MS	Method Detection Limit	Minimum reported concentration (mg/kg)	Maximum reported concentration (mg/kg)	Number of samples above method detection limit	Number of samples analysed
Benzo(a)anthracene	1	<mdl	<mdl	0	14
Benzo(a)pyrene	1	<mdl	<mdl	0	14
Fluoranthene	1	<mdl	<mdl	0	14
Naphthalene	1	<mdl	<mdl	0	14

Samples in the above table were taken predominantly from Made Ground. However, five samples were taken from natural drift deposits, of which three were deep samples (>2.5m below ground level).

PAH Concentrations in Groundwater

PAHs by GC-MS	Method Detection Limit	Minimum reported concentration (mg/kg)	Maximum reported concentration (mg/kg)	Number of samples above method detection limit	Number of samples analysed
Benzo(a)anthracene	1	<mdl	<mdl	<mdl	3
Benzo(a)pyrene	1	<mdl	<mdl	<mdl	3
Fluoranthene	1	<mdl	<mdl	<mdl	3
Naphthalene	1	<mdl	<mdl	<mdl	3

No PAHs were detected in groundwater.

Zinc

Fifteen detections of zinc in soil samples were reported from the fifteen samples submitted for analysis, with a minimum of 33mg/kg and maximum of 550mg/kg. Twelve detections of zinc were reported from the fifteen samples submitted for leachate analysis, with a minimum of 3mg/kg and a maximum of 30mg/kg. One detection of zinc in groundwater samples was reported from the three samples submitted for analysis. The concentration in the detected sample was 10µg/l.

Cyanide

Two detections of cyanide in soil samples were reported from the seventeen samples submitted for analysis, with a minimum of 6mg/kg and maximum of 120mg/kg. No detections of cyanide were reported in the fifteen leachate samples submitted for analysis. No detections of cyanide in groundwater were reported from the five groundwater samples submitted for analysis.

5. SUMMARY OF POLLUTANT LINKAGE ASSESSMENT FROM MAIN SITE INVESTIGATION

The following section reviews the potential pollutant linkages identified in the main Plot A investigation as detailed in the report entitled *Plot A Soil and Groundwater Investigation at the Former Albright and Wilson Works, Whitehaven, Cumbria* (REF: 44320021/MARP0004, dated 17th January 2007).

Human Health Risk Assessment Review

The human health risk assessment for Plot A indicated that there were no potentially significant risks with regard to a proposed end use of public open space.

Controlled Waters Risk Assessment Review

The controlled waters risk assessment identified a number of analytes that posed a theoretical potential risk to the identified receptors (the Irish Sea). These are presented in Table 8.1 of the main report, and have been summarised as follows:

Area 1- The area in the vicinity of TP628A to TP630A: Potential risks associated with TPH concentrations in soil; further investigation was required to so as to provide a more detailed undestanding of the distribution of the TPH in the vicinity of these locations.

Area 2- The area in the vicinity of TP624A: Potential risks associated with TPH concentrations in soil; further investigation was required to so as to provide a more detailed undestanding of the distribution of the TPH in the vicinity of these locations.

Area 3- The area in the vicinity of WS115 and TP602A: Potential risks associated with PAH's (benzo (a) anthracene, benzo(a)pyrene, fluoranthene, naphthalene), zinc, and cyanide concentrations in soil and groundwater; further investigation was required to so as to provide a more detailed undestanding of the distribution of these analytes in the vicinity of these locations.

6. CONTROLLED WATERS QUANTITATIVE RISK ASSESSMENT

6.1. Introduction

Details of the rationale, methodology and results of the modelling undertaken for the Controlled Waters Quantitative Risk Assessment are presented below. The purpose of this additional assessment is two fold:

1. To incorporate the new data from the March 2007 investigation into a dilution model presented in the main report (referred to in this Section as Stage 3a modelling), as required by Section 9 of the main Plot A report (entitled Remediation Actions).
2. To introduce and describe the additional development of the model to include off site dilution through infiltration of clean rainwater (referred to in this Section as Stage 3b modelling).

6.2. Stage 2 Assessment- Summary of Risks to Controlled Waters (Generic Screening)

A Stage 2 generic quantitative screening risk assessment was undertaken that incorporated the new March 2007 data, and compared measured concentrations to the generic screening values for the protection of Controlled Waters (in this case, Marine EQS values).

The results are presented in Appendix D and are summarised in Table 4.1 below.

Table 4.1- Exceedances of Stage 2 Criteria

Assessment Action Area	Soil*	Soil Leachate	Shallow Groundwater
Area 1 (vicinity of *TP628A to TP630A)*	-	TPH C21-C35 Aliphatic (Area 1 TP628A and TP630A)	-
Area 2 (vicinity of *TP624A)*	-	TPH C21-C35 Aliphatic (Area 2- TP624A)	-
	-	TPH C16-C21 Aromatic (Area 2- TP624A)	-
	-	TPH C16-C21 Aliphatic (Area 2- TP624A)	-
Area 3 (vicinity of *WS115 and TP602A)*	-	fluoranthene (Area 3 TP602A)	fluoranthene (Area 3- WS115)
	-	-	benzo(a)pyrene (Area 3- WS115)
	-	-	benzo(a)anthracene (Area 3- WS115)
	-	-	cyanide (Area 3- WS115)
	-	-	naphthalene (Area 3- WS115)
	-	-	zinc (Area 3- WS115)

*VOCs only- Remaining analytes screened based on soil leachate/groundwater concentrations

All of the determinands whose concentrations exceeded their respective Stage 2 criterion were taken forward to the Stage 3a quantitative risk assessment.

6.3. Stage 3A Quantitative Assessment- Onsite Dilution Modelling

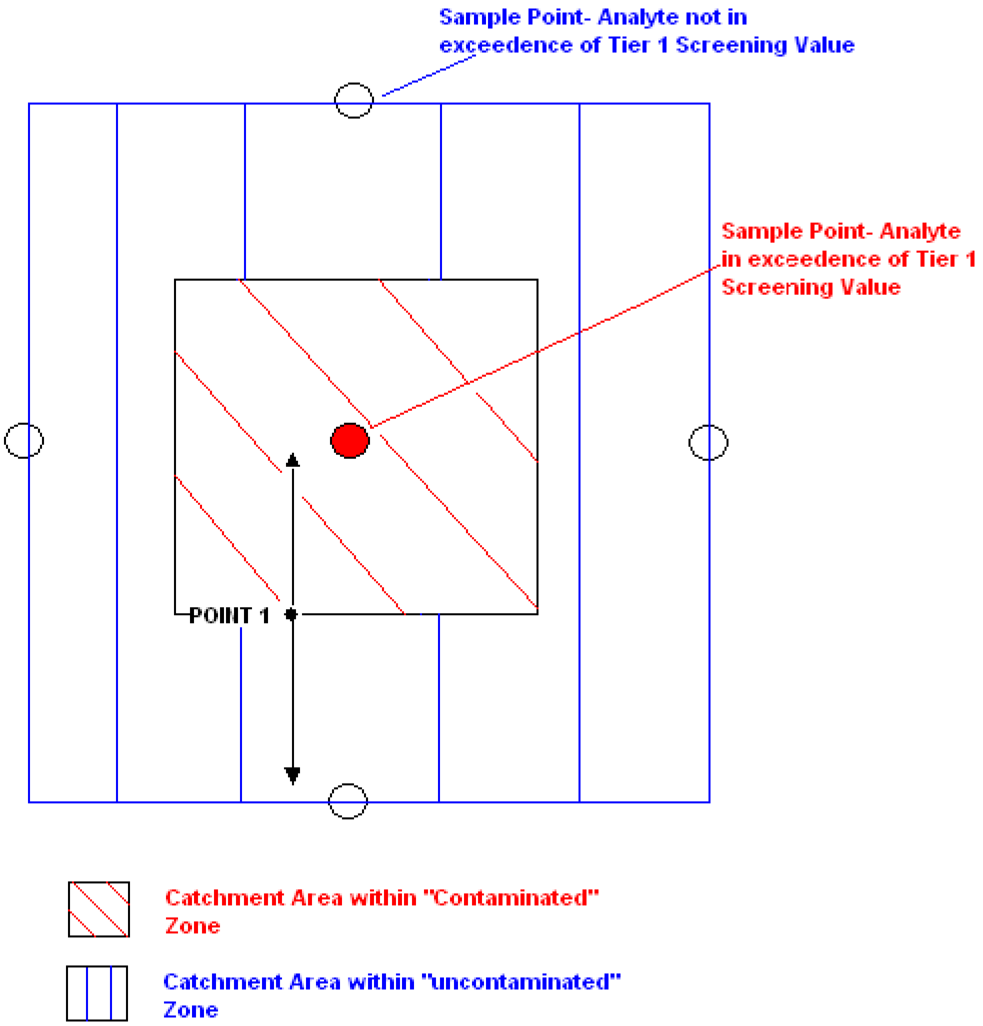
The Stage 3a assessment methodology has been presented in Section 7.3 of the main report. However, given that this report develops on this methodology, it has been presented again in this section for completeness.

The hydrogeological sequence on site is complex. It has been further compounded by historic site activities, the most prevalent of which has been the deposition of acids into the ground, resulting in voids and channels being created in certain locations, some of which are likely to be in Plot A.

Given the complexity of the geology in Plot A, and the rapid travel times for migration sourced from Plot A, standard models (e.g. CONSIM, which was used in Plots B and C) were not considered to be appropriate. Instead, a mass balance approach was adopted in order to assess potential risks. The principal of the model requires an understanding of the following parameters:

1. Area of inferred “Contaminated” Zone
2. Area of inferred “Uncontaminated “ Zone
3. Concentration identified within the source zone

The process for modelling is described below, using arsenic as an example. Arsenic was measured at a concentration of 40µg/L from soil leachate analysis in TP622A, which exceeds the Marine EQS Screening Value of 25µg/l. In surrounding sample locations, measured concentrations of arsenic were less than the Marine EQS.



The likely contaminated and uncontaminated zones surrounding this sample point have been defined as follows:

- The likely extent of contamination is assumed to extend to the half way distance between the central point (which contains contamination in exceedance of the screening criteria) and the peripheral points (which have been deemed "uncontaminated", based on the screening of the current data set). The halfway distance is defined as "Point 1" on the above diagram. The area contained within the halfway points is assumed to represent the source area (diagonally hatched area).

- The *uncontaminated zone* is defined as the remaining area between the half way distance and the sample points where no exceedances have been measured (vertically hatched area).

The combined catchment areas (i.e. contaminated catchment zone + uncontaminated catchment zone) are then referred to as the “total catchment” for that source.

Precipitation falling on this area is assumed to be uniform, before infiltrating downwards through the Made Ground and Drift. Such infiltration is then assumed to be connected to a solution fissure within the evaporate sequence (thought to be only 3-4m below ground level in Plot A). The solution features and fissures effectively act as drains, collecting all water (contaminated and uncontaminated) within the “total catchment”. Given that subsequent transport within the fissure system is rapid with limited dispersion, dilution or degradation, it has conservatively been assumed that an analyte concentration entering the St. Bees Evaporite Formation, directly underneath Plot A, could potentially represent the same concentration that emerges at the coastline. Thus, the calculated concentrations entering the fissures would be compared to the Marine EQS Screening Value.

The calculated concentration entering the fissure network has been estimated by diluting the leachable concentrations from identified contaminated areas by the volume of relatively clean water available from the uncontaminated zone of the catchment. For example, for arsenic:

- Percentage of Contaminated Catchment Infiltrating total catchment = 29%;
- Assumed concentration of arsenic in source zone = 40µg/L.
- Therefore, concentration of arsenic as it enters the fracture = 29% x40µg/L = **11.6µg/L.**

The calculated concentrations at the compliance point (opening to the fissure system) were compared directly against the Stage 2 screening criteria, in this instance, the simulated arsenic concentration was below the Screening Value (25µg/L), and therefore no longer considered to represent a potential risk.

A conceptualisation of the Stage 3 risk assessment is presented in Figures 3a and 3b.

6.3.1. Summary of Risks to Controlled Waters (Stage 3a Model Outputs)

The results of the Stage 3a assessment that includes the new March 2007 data points are presented in Appendix D. For simulated contaminant concentrations at the adopted compliance point (in this case, the point directly below the source, where the analyte enters the evaporite sequence) to pose a potentially significant risk to shallow controlled waters, they must be in excess of defined screening criteria (EQS). The results are summarised in Table 4.2 below.

Table 4.2- Exceedances of Stage 3a Criteria

Assessment Action Area	Soil	Soil Leachate	Shallow Groundwater
Area 1 (vicinity of *TP628A to TP630A)*	-	TPH C21-C35 Aliphatic (Area 1 TP628A)	-
Area 2 (vicinity of *TP624A)*	-	-	-
	-	-	-
	-	-	-
Area 3 (vicinity of *WS115 and TP602A)*	-	fluoranthene (Area 3 TP602A)	fluoranthene (Area 3- WS115)
	-	-	benzo(a)pyrene (Area 3- WS115)
	-	-	benzo(a)anthracene (Area 3- WS115)
	-	-	cyanide (Area 3- WS115)
	-	-	naphthalene (Area 3- WS115)
	-	-	zinc (Area 3- WS115)

The additional data taken in the March 2007 investigation increased the sampling density around the locations that were originally deemed to be contaminated. This allowed for the source areas to be more accurately defined. In all cases, the laboratory results determined that the extent of the original source area was too conservative, and as a consequence, the area of “contaminated catchment” could reduce, and consequently the area of “uncontaminated/clean catchment” could increase. This has resulted in the TPH risks initially deemed to exist in the vicinity of TP624A and TP630A being identified as no longer posing a risk at Stage 3A. One TPH risk initially determined in Area 1 at TP628A was deemed to still exist at the Stage 3A level of assessment. In Area 3, all seven analytes were considered to be in exceedance at Stage 3A; six of these analytes were from groundwater taken at WS115. The Stage 3A model considers dilution of contaminant before entering the groundwater. As WS115 was a groundwater sample, this dilution was deemed to have already taken place, and so these concentrations were deemed to be that entering the underlying void structures.

The risks deemed to exist at Stage 3A where carried through to the Stage 3B modelling exercise.

6.4. Stage 3B Quantitative Assessment- Offsite Dilution Modelling

6.4.1. Review of Previous Modelling

In the Phase II Investigation conducted in 2005 (REF: 44319623: Phase II Investigations and Environmental Assessments at the Former Albright & Wilson Works, Whitehaven, 23 June 2005), a mass balance approach was adopted to model the contributions of various potential sources to the Byerstead Spring. URS considered that the most appropriate method to characterise the migration of contamination was to adopt a simple mass balance approach. Each contaminant and water mass flux term was characterised and the overall mass/water balance used to establish the likely range of contaminant concentrations in water discharged via the Byerstead fault.

The mass balance approach had been adopted for a number of reasons, including:

- contaminant migration velocities between the site and the fault are known to be extremely fast, as a result of tracer experiments conducted by URS and, therefore, the majority of contaminant migration from the site drainage system will be through “conduits” within the sub-surface, where the primary attenuation mechanisms will be dilution with other waters within the conduits;

- a key question that the Environment Agency and URS has with regards to mass balance is that the sum of the known sources does not add up to the observed water discharging via the Byerstead Fault to the beach. Accounting for these uncertainties will form an integral part of this revised risk assessment; and

- the development of a mass balance approach is relatively simple and easily understood.

6.4.2. Stage 3b Methodology

The current model builds upon the previous modelling. Specifically, it recognises the potential for infiltration of clean water through the St. Bees Sandstone, and subsequent movement into the underlying units, including the St. Bees Evaporites, where the conduits containing the site derived waters are thought to exist.

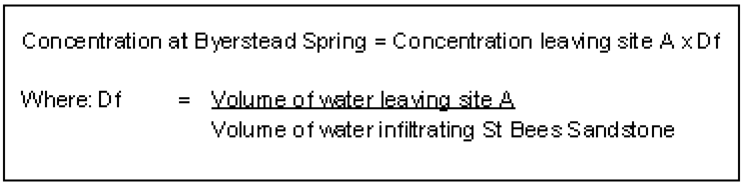
As such, the model takes the Stage 3a assessment to the next step (through generating a second dilution), by considering rainfall, surface area of infiltration into the St. Bees Sandstone, likely infiltration rates through the geological strata, and combines this with a mass of contamination (a concentration).

At Stage 3a, it is assumed that the concentration generated in the source area (following the dilution from the surrounding clean soil) enters the evaporites at Point 1 (on Figure 3b), and remains at this concentration as it passes towards the site boundary at Point 2.

Stage 3b then considers the dilution of this concentration once offsite, as the concentration reduces through dilution from Point 2 to Point 3 (the Byerstead Spring).

This dilution occurs due to a volume of clean water entering the voids/conduits in the evaporite sequence sourced from infiltrating groundwater from the St. Bees Sandstone.

Potential Concentrations at the Byerstead Spring using the above discussion can be estimated as follows:



Concentration at Byerstead Spring = Concentration leaving site A x Df

Where: Df = $\frac{\text{Volume of water leaving site A}}{\text{Volume of water infiltrating St Bees Sandstone}}$

6.4.3. Stage 3b Model Parameters

The generic parameters used for the model are presented in Table 4.3 below.

Table 4.3 Source Characterisation			
Source No.	**Source**	**Assessment Method**	**Plausible Distribution**
1	Infiltration through defined source zone on the site	Discharge (Q): Rainfall rate multiplied by an infiltration factor, Q=ARI Area (A): Total source catchment (defined source area and surrounding clean area). A source area of 1000m^2 for the worked example. Mean annual rainfall (R): 1070mm/annum or 0.00293 m/day (Meteorological Office) Infiltration Rate (I), Rainfall percolation into site catchment for individual analyte, maintained at the greenfield runoff rate, I = 7.5 – 22.5%, balancing potential additional losses at the drainage system with the reduced infiltration at buildings and roads. Likely to vary considerably with the impact of the drainage system and the large areas of concrete cover. The final infiltration rate will be dependent upon the state of the land cover once the site has been decommissioned. In the worked example, a volume of 440L was calculated to be flowing in the evaporites away from the source area towards the site boundary.	Potential Distribution Min I=7.5% Most likely I=15% Max I=22.5% Range above accounts for potential variations in contributing area and infiltration rate. The most likely value of 15% has been used.
2	Infiltration recharge through non-contaminated areas (St. Bees Sandstone)	Rainfall rate multiplied by an infiltration factor, Q=ARI Area (A): Width of the total onsite catchment (onsite source area and clean area) multiplied by an approximate length of clean source area extending from the western site boundary to the cliff line at the	Potential Distribution Min I=7.5% Most likely I=15%

Table 4.3 Source Characterisation			
Source No.	**Source**	**Assessment Method**	**Plausible Distribution**
		coast (approximately 300m). This results in a thin rectangular strip of clean catchment. This is a conservative assumption. In reality the clean catchment area is likely to be substantially wider. For the worked example the area of St. Bees Catchment was 9486 m^2 (300m long x 32m wide). Furthermore, the ground between the source area and the site boundary was not included in the model, as it was conservatively assumed to be contaminated, and therefore unable to contribute clean water. Mean annual rainfall (R): 1070mm/annum or 0.00293 m/day (Meteorological Office) Infiltration Rate (I): Rainfall percolation into St. Bees Sandstone: 7.5 – 22.5%, depending upon surface deposits. Lowest over areas containing boulder clay, highest where rockhead (St Bees Sandstone) is at the surface. The volume of groundwater percolating vertically through the St. Bees Sandstone into the underlying St. Bees Shales will be reduced, as a proportion will migrate laterally at the boundary with the less permeable underlying St. Bees Shale, towards the cliffline at the coast, where it will emerge as springs. Once in the shales, the majority of the groundwater will migrate vertically into the underlying sequence that contains the conduits carrying site derived water. There may be some lateral migration, which will generate more springs on the cliff line. In the worked example, a volume of 2086L was calculated to be flowing in the evaporites away from the source area towards the site boundary.	Max I=22.5% Range above accounts for potential variations in contributing area and infiltration rate. Given the potential for water loss through coastline springs in the St. Bees Sandstone/St. Bees Shale boundary, the lowest value of 7.5% has been used.

Worked Example

The arsenic example above has been continued through to the 3b level to demonstrate the calculations required to generate the concentrations generated at the Byerstead Spring.

From the 3a model, it was determined that the concentration of arsenic as it enters the fracture/conduit was **11.6µg/L**. Once in this conduit, the contamination will move westwards towards the site boundary at the same concentration.

Beyond the site boundary, a volume of clean water that has infiltrated through the overlying St. Bees Sandstone will dilute this concentration, resulting in a reduced concentration as the water reaches the Byerstead Spring, as follows:

Predicted Concentration at Byerstead Spring = Concentration leaving site (e.g. 11.6µg/l) x Df

$$\text{Where: Df} = \frac{\text{Volume of water leaving site A (e.g. 440L)}}{\text{Volume of water infiltrating St Bees Sandstone (e.g. 2086L)}}$$

Predicted Concentration at Byerstead Spring= 11.6µg/l x 0.2107= **2.45 µg/l**

6.4.4. Limitations in the Assessment Methodology

Due to the complexity and uncertainty of the particular sub-surface environment in question and the mass balance approach adopted to estimating potential risks, has required the simplification of the various attenuation processes and area of aquifer that may actually be involved in this pathway. With the exceptions of uncertainties in the basic parameters defining the water and mass balance components, no storage losses or attenuation through retardation and chemical and biological degradation are simulated. A component of the historical spillages and leachate infiltration of contaminants through the subsurface will be stored in the aquifers, mines and mine shafts and adits, and slowly released to the coast through seepage along the coast as well as the Byerstead fault, similar to the effect of baseflow on river flow. Similarly there will be some components of retardation and biological/chemical reactions within the pathway, although this may be limited to the to the component of contaminant mass stored within the subsurface, rather than the rapid movement from the site through the solution features, fractured geology and adits to the Byerstead fault.

6.5. Summary of Risks to Controlled Waters (Stage 3b Model Outputs)

For simulated contaminant concentrations at the adopted compliance point (in this case, the point at which the groundwater rises as a spring on the beach, the Byerstead Spring) to pose a potentially significant risk to controlled waters, they must be in excess of defined screening criteria (EQS). The results are presented in Appendix D and are summarised in Table 4.4 below. Only two analytes have been identified to be in exceedance of the controlled waters criteria.

Table 4.4- Exceedances of Stage 3b Criteria

Assessment Action Area	Soil	Soil Leachate	Shallow Groundwater
Area 1 (vicinity of *TP628A to TP630A)*	-	-	-
Area 2 (vicinity of *TP624A)*	-	-	-
	-	-	-
	-	-	-
Area 3 (vicinity of *WS115 and TP602A)*	-	-	-
	-	-	-
	-	-	naphthalene
	-	-	Cyanide

7. RE-EVALUATION OF POTENTIAL POLLUTANT LINKAGES

Based on the additional site investigation conducted in Plot A and the additional modelling exercise, potential pollutant linkages have been updated and presented below. Updates to the pollutant linkage assessment have been highlighted with ***bold italics***:

Pollutant Linkage Identifier	**Pollutant**	**Plot A Source location**	**Pathway**	**Main Receptor**	**Subsequent Receptors**	**Description of Harm/Pollution of Controlled Waters**	Does the linkage still exist, and is it still significant based on the recent site investigation and risk assessment? (Y/N)
C1	Surfactant and potentially other analytes within process effluent	The Cathedral (Former Smoothing Chambers and pH balancing area).	CW1, CW2, CW3	The Irish Sea	-	Potential for entry of contaminant into the St. Bees Evaporites before rapidly migrating to the Irish Sea.	1) Surfactant. No. Source not identified.
							2) Copper. No. Potential linkage identified for copper but not considered significant based on site observations and ground conditions. Furthermore, the soil concentration of copper was 26mg/kg. The maximum soil copper concentration on site was 138mg/kg which produced a leachable concentration of <1ug/l. It is considered unlikely that a pollutant linkage actually exists.
C2	Likely sources of contamination include VOCs, SVOC's and PAH's	The Catalyst Preparation Plant and Fatty Alcohol Plant.	CW1, CW2, CW3	The Irish Sea	-	Potential for entry of contaminant into the St. Bees Evaporites before rapidly migrating to the Irish Sea.	1) VOCs. No. Source not identified.
							2) SVOCs. No. Source not identified.
							3) PAHs. No. Source not identified.
							4) TPH. No. Additional targeted investigation and risk assessment has determined that a significant pollutant linkage does not exist.
							5) Copper. No. Source not identified for copper. The sample that generated high leachable concentration is from dry natural ground.
							6) Zinc. No. Potential linkage identified for zinc but not considered significant. The predicted concentration is only 2ug/l greater than the EQS.

Pollutant Linkage Identifier	**Pollutant**	**Plot A Source location**	**Pathway**	**Main Receptor**	**Subsequent Receptors**	**Description of Harm/Pollution of Controlled Waters**	Does the linkage still exist, and is it still significant based on the recent site investigation and risk assessment? (Y/N)
C3	Unknown. Analytes are likely to be detected in the site-specific analytical suite scheduled for this investigation.	Workshops and laboratories	CW1, CW2, CW3	The Irish Sea	-	Potential for entry of contaminant into the St. Bees Evaporites before rapidly migrating to the Irish Sea.	***1) TPH. No. Additional targeted investigation and risk assessment has determined that a significant pollutant linkage does not exist.***
							No further significant pollutant linkages identified.
C4	TPH	Former Wet and Dry Salts Area	CW1, CW2, CW3	The Irish Sea	-	Potential for entry of contaminant into the St. Bees Evaporites before rapidly migrating to the Irish Sea.	***1) TPH. No. Additional targeted investigation and risk assessment has determined that a significant pollutant linkage does not exist.***
C5	Polychlorinated biphenyls (PCBs)	Electrical substations	CW1, CW2, CW3	The Irish Sea	-	Potential for entry of contaminant into the St. Bees Evaporites before rapidly migrating to the Irish Sea.	1) PCBs. No. Source not identified.
							2) Copper. No. Potential linkage identified for copper but not considered significant based on geochemical results. The soil concentration of copper was 12mg/kg. The maximum soil copper concentration on site was 138mg/kg which produced a leachable concentration of <1ug/l. It is considered unlikely that a pollutant linkage actually exists.
							3) PAHs. No. Potential linkage identified for fluoranthene but not considered significant based on the following: The soil concentration of fluoranthene was 0.3mg/kg with no visual or olfactory evidence of contamination. Whilst rockhead was not encountered, the sample was taken from 1.2m and the pit terminated at 3m in natural ground with no evidence of solution features. The pollutant linkage is therefore considered not to exist.
C6	PAHs, petroleum hydrocarbons and heavy metals associated with ash	Fill Materials	CW1, CW2, CW3	The Irish Sea	-	Potential for entry of contaminant into the St. Bees Evaporites before rapidly migrating to the Irish	***1) PAHs. Yes. Potential risks associated with naphthalene have been identified. Refer to PAH discussion in C8.***

Pollutant Linkage Identifier	**Pollutant**	**Plot A Source location**	**Pathway**	**Main Receptor**	**Subsequent Receptors**	**Description of Harm/Pollution of Controlled Waters**	Does the linkage still exist, and is it still significant based on the recent site investigation and risk assessment? (Y/N)
	and clinker fill. Potentially other contaminants associated with other materials.					Sea.	***2) TPH. No. Additional targeted investigation and risk assessment has determined that a significant pollutant linkage does not exist.*** 3) Metals. No. Source not identified for metals.
C7	TPH and phosphate	Historic operation and production products	CW1, CW2, CW3	The Irish Sea	-	Potential for entry of contaminant into the St. Bees Evaporites before rapidly migrating to the Irish Sea.	***1) TPH. No. Additional targeted investigation and risk assessment has determined that a significant pollutant linkage does not exist.*** 2) Phosphate. Unknown. Screening criteria for phosphate are currently not available based on UK or other legislation. Therefore, the risk assessment cannot determine if a potential risk exists from phosphate.
C8	PAHs, Surfactant, cyanide, sulphate, heavy metals, VOCs, SVOCs, and TPH	Analytes associated with surface runoff from the Tanker Washing Area and other sources in Plot B (Imidazoline, CAPB Plants & Coking works)	CW1, CW2, CW3	The Irish Sea	-	Potential for entry of contaminant into the St. Bees Evaporites before rapidly migrating to the Irish Sea.	1) TPH. No. Potential linkage identified for TPH Aliphatic 21-35 but not considered significant based on site observations and ground conditions. There is no visual or olfactory evidence of contamination. Rockhead was encountered and no solution feature was identified. ***2) PAHs. West of Plot B (WS115 and TP602A)*** ***Yes- Additional targeted investigation and risk assessment has determined that a potentially significant risk may exist in this area, and remediation may be required. Refer to Remedial actions (Section 6).*** 3) Zinc. West of Plot B (WS115 and TP602A) No. Additional risk assessment has determined that a significant pollutant linkage does not exist. ***4) Cyanide. West of Plot B (WS115 and TP602A)*** ***Yes- Additional targeted investigation and risk assessment has determined that a potentially significant risk may exist in this area, and remediation may be required. Refer to Remedial actions (Section 6).***

Pollutant Linkage Identifier	Pollutant	Plot A Source location	Pathway	Main Receptor	Subsequent Receptors	Description of Harm/Pollution of Controlled Waters	Does the linkage still exist, and is it still significant based on the recent site investigation and risk assessment? (Y/N)
							5) VOCs. No. Source not identified. 6) SVOCs. No. Source not identified.
H1	Surfactant and potentially other analytes within process effluent	The Cathedral (Former Smoothing Chambers and pH balancing area).	HH1, HH2, HH3	0-6 yr old female child	Other site users	Incidental ingestion, dust inhalation, dermal contact & vapour inhalation	No. Stage 3 Risk Assessment indicates no significant risk.
H2	Likely sources of contamination include VOCs, SVOC's and PAH's	The Catalyst Preparation Plant and Fatty Alcohol Plant.	HH1, HH2, HH3	0-6 yr old female child	Other site users	Incidental ingestion, dust inhalation, dermal contact & vapour inhalation	No. Stage 3 Risk Assessment indicates no significant risk.
H3	Unknown. Analytes are likely to be detected in the site-specific analytical suite scheduled for this investigation.	Workshops and laboratories	HH1, HH2, HH3	0-6 yr old female child	Other site users	Incidental ingestion, dust inhalation, dermal contact & vapour inhalation	No. Stage 3 Risk Assessment indicates no significant risk.
H4	TPH	Former Wet and Dry Salts Area	HH1, HH2, HH3	0-6 yr old female child	Other site users	Incidental ingestion, dust inhalation, dermal contact & vapour inhalation	No. Stage 3 Risk Assessment indicates no significant risk.
H5	Polychlorinated biphenyls (PCBs)	Electrical substations	HH1, HH2, HH3	0-6 yr old female child	Other site users	Incidental ingestion, dust inhalation, dermal contact & vapour inhalation	No. Stage 3 Risk Assessment indicates no significant risk.
H6	PAHs, petroleum hydrocarbons and heavy metals associated with ash and clinker fill. Potentially other contaminants associated with other materials.	Fill Materials	HH1, HH2, HH3	0-6 yr old female child	Other site users	Incidental ingestion, dust inhalation, dermal contact & vapour inhalation	No. Stage 3 Risk Assessment indicates no significant risk.
H7	TPH and phosphate	Historic operation and production products	HH1, HH2, HH3	0-6 yr old female child	Other site users	Incidental ingestion, dust inhalation, dermal contact & vapour inhalation	No. Stage 3 Risk Assessment indicates no significant risk.

Pollutant Linkage Identifier	**Pollutant**	**Plot A Source location**	**Pathway**	**Main Receptor**	**Subsequent Receptors**	**Description of Harm/Pollution of Controlled Waters**	Does the linkage still exist, and is it still significant based on the recent site investigation and risk assessment? (Y/N)
H8	PAHs, Surfactant, cyanide, sulphate, heavy metals, VOCs, SVOCs, and TPH	Analytes associated with surface runoff from the Tanker Washing Area and other sources in Plot B (Imidazoline, CAPB Plants & Coking works)	HH1, HH2, HH3	0-6 yr old female child	Other site users	Incidental ingestion, dust inhalation, dermal contact & vapour inhalation	No. Stage 3 Risk Assessment indicates no significant risk.

8. REMEDIAL ACTIONS

Area 1- The area in the vicinity of TP628A to TP630A

The additional sampling in March 2007 allowed investigation within Area 1 to determine whether this area posed a potential risk to controlled waters. As a consequence of the investigation, the conservative source zone defined in the original modelling exercise could be reduced, as the additional sampling locations within this area confirmed TPH was not present in soils. Consequently, the potential risks posed by TPH were eliminated at Stage 3A from the vicinity of TP630A. TPH in the vicinity of TP628A posed a theoretical risk at Stage 3A. However, following dilution at Stage 3B, this risk was no longer deemed to be significant.

Therefore, based on the site data obtained by URS during the site investigations to date, a significant pollutant linkage has not been identifed and no remedial actions are therefore required in this area of the site.

Area 2- *The area in the vicinity of TP624A*

The additional sampling in March 2007 allowed investigation within Area 2 to determine whether this area posed a potential risk to controlled waters. As a consequence of the investigation, the conservative source zone defined in the original modelling exercise could be reduced, as the additional sampling locations within this area confirmed TPH was not present in soils. Consequently, the potential risks posed by TPH were eliminated at Stage 3A from the vicinity of TP624.

Therefore, based on the site data obtained by URS during the site investigations to date, a significant pollutant linkage has not been identifed and no remedial actions are therefore required in this area of the site.

Area 3- *The area in the vicinity of WS115 and TP602A*

The additional sampling in March 2007 allowed investigation within Area 3 to determine whether this area posed a potential risk to controlled waters. Following the risk assessment performed as part of the current investigation for Area 3, one analyte was considered to pose a potential risk to controlled waters at Stage 3A at TP602A (namely fluoranthene), and at WS115 six analytes were deemed to pose a potential risk (namely benzo (a)anthracene, benzo (a) pyrene, fluoranthene, naphthalene, zinc and cyanide). All seven analytes were then assessed at Stage 3B, and two analytes were identifed to continue to pose a theoretical risk to controlled waters, these were naphthalene and cyanide.

Based on the site data obtained by URS during the site investigations to date, it is thought that remedial action is required in this area. The most cost effective method of removing such contamination is through source removal. However, a Best Practical Environmental Option (BPEO) assessment will be required to determine the most cost effective and acheivable method to break the source-pathway-receptor pollutant linkage. This BPEO will be considered in the context of other potential remedial works on the site. We currently estimate that an area of approximately 15m long x10m wide x 4m deep may require excavation and treatment/disposal The remedial area is presented on Figure 2.

TABLES

FIGURES

Figure 1: Site Plan

Figure 2: Remedial Zone

Figure 3 a and Figure 3b: Controlled Waters Model

Appendix A - Borehole & Trial Pit Logs

Appendix B - Laboratory Certificates (included on CD)

Appendix C - Plates

Appendix D - Controlled Waters Risk Assessment Model