

Photograph 26 – Central pier partially removed



Photograph 27 – Central pier completely removed



3.11 Hydrocarbon Seepages – Dam between East Bay and NSR

Following completion of the works in Section 1, 2 and 3 relatively minor hydrocarbon seepages were noted along the dam between East Bay and NSR (Photograph 28).

Photograph 28 – Hydrocarbon seepage noted from dam between East Bay and NSR



This issue was discussed with Atkins (email dated 20/05/2011 – presented as Appendix E) who agreed the following methodology:

- Undertake the final verification on the clean base;
- Temporarily collect and recover any oily seepages;
- Prior to inundation use clean clay from the base of East Bay to place against the area of seepage; and
- Allow inundation to commence once verification is complete.

Photograph 29 shows the dam face once the works had been undertaken. These works were inspected by an Atkins engineer on their completion.

Photograph 29 – Clay material placed against NSR Dam prior to inundation

3.12 Potentially Contaminated Material – Eastern Boundary

In addition to the hydrocarbon seepage discussed in Section 3.11 an area of potential hydrocarbon impacted material was noted at the eastern boundary of East Bay (Photograph 30). There were no visible seepages of hydrocarbons noted, however as precaution two samples (EBV42 and EBV43) were taken of the material for laboratory analysis. The laboratory results were assessed against the RTC for Recreational End-Use at materials to be placed <1m below surface level and 1% Soil Organic Matter.

A summary of the test results are presented in Table 4, while the full testing certificates presented in Appendix C3. There were not exceedances of VOCs or PAHs (excluding Benzo(a)pyrene, which is presented in Table 4) and therefore the results are not presented below, therefore reference should be made to the full testing Certificates.

Table 4 – Summary of two samples taken from the eastern boundary of East Bay

Contaminant	RTC	EBV42	EBV43
Metals and Metalloids			
<i>Arsenic (mg/kg)</i>	64	<u>130</u>	46
<i>Cadmium (mg/kg)</i>	2.6	<u>5.1</u>	1.6
<i>Chromium (mg/kg)</i>	78	7.9	15
<i>Copper (mg/kg)</i>	143	<u>200</u>	<u>210</u>
<i>Mercury (mg/kg)</i>	1	0.22	0.71

Contaminant	RTC	EBV42	EBV43
Nickel (mg/kg)	75	23	22
Lead (mg/kg)	337	71	83
Selenium (mg/kg)	3	2.4	1.1
Vanadium (mg/kg)	351	<5	14
Zinc (mg/kg)	478	350	220
TPH Aliphatic			
C5 – C6 (mg/kg)	294,000	<0.1	<0.1
C6 – C8 (mg/kg)	294,000	<0.1	<0.1
C8 – C10 (mg/kg)	5,880	<0.1	<0.1
C10 – C12 (mg/kg)	5,700	7.4	81
C12 – C16 (mg/kg)	5,800	390	1,500
C16 – C21 (mg/kg)	159,000	940	2,400
C21 – C35 (mg/kg)	159,000	54	2,800
TPH Aromatic			
C5 – C7 (mg/kg)	26.2	<0.1	<0.1
C7 – C8(mg/kg)	21,337	<0.1	<0.1
C8 – C10 (mg/kg)	2,230	<0.1	<0.1
C10 – C12 (mg/kg)	2,300	6.6	47
C12 – C16 (mg/kg)	2,330	210	910
C16 – C21 (mg/kg)	1,450	390	1,200
C21 – C35 (mg/kg)	1,450	240	270
PAH			
Benzo(a)pyrene	0.9	<u>1.6</u>	<u>3.6</u>

The laboratory analysis indicated slightly elevated arsenic, cadmium, copper and Benzo(a)pyrene with all hydrocarbons being below the Section 106 RTC levels.

However, prior to receiving the laboratory results it was agreed with Atkins that the same methodology be adopted as with the hydrocarbon seepage noted from the NSR Dam. However, this was slightly modified with a significant proportion of the potentially hydrocarbon contaminated material being excavated and removed up to a point approximately 2 m from the site boundary (the potentially contaminated material extended beyond this point) (Photograph 30). A 0.5 to 1.0 m layer of previously validated cohesive material excavated from the base of East Bay was placed and compacted (Photograph 31) to form a re-profiled embankment.

Photograph 30 – Area of possible hydrocarbon impacted material at eastern boundary of East Bay



Photograph 31 – Eastern embankment following removal of potentially hydrocarbon impacted material and re-profiling



3.13 Reinstatement works

Following removal of the hydrocarbon impacted materials any residual material was removed from the perimeter. No further reinstatement works were undertaken.

3.14 Post Works Survey

Once all of the hydrocarbon impacted material was removed from East Bay a detailed topographic survey was undertaken of the base. A plan showing the perimeter of East Bay and the changes in the elevation along the base is presented as Appendix A, Drawing 6.

3.15 Quarantine

During the remediation works no material was quarantined.

3.16 Quantification of the amount of Hydrocarbon Impacted Material / Removed

Due to the nature of the material it was not possible to record the volume of material removed during excavation. Therefore the volumes have been estimated by surveying the stockpile of material on the treatment pad and subtracting the amendments added.

A survey has been completed of the material in the North Site Biopile originating from East Bay (including the wood fines amendment) and has been estimated as approximately 7,500 m³. Approximately 2,000 m³ of this total volume comprised wood fines which were added to the material during the excavation, therefore the total amount of hydrocarbon impacted sediments removed from East Bay is approximately

5,500 m³. This volume is only an estimate and so should only be used to provide an indication of the volume of material removed.

In order to enhance the bioremediation potential of the hydrocarbon impacted material the air void ratio is substantially increased to improve the airflow throughout the biopile so that it remains aerobic throughout the treatment process. This is undertaken in two ways:

- Low density wood fines are mixed with the hydrocarbon impacted material (discussed in previous sections). This addition of wood fines causes a substantial increase in the volume of the material with a relatively small increase in mass.
- The hydrocarbon impacted material is mechanically aerated several times throughout the bioremediation process. This loosens the material which increases the volume but reduces the overall density.

However, as the bioremediation process degrades organic material the wood fines are also broken down and so the final volume of material contained within the biopile will be less than the volume when it was initially placed. Celtic has undertaken preliminary onsite density tests of the material within the biopile and has found that it typically ranges between 0.7 and 1.0 Mg/m³ with an average of around 0.8 Mg/m³ (refer to Appendix C5).

A detailed assessment of the density and final volume of the biopile will be undertaken using field and laboratory testing on completion of the bioremediation. These results will be presented within the bioremediation validation report to be submitted under separate cover.

Based on the current density of material within the biopile and the typical density of placed topsoil (1.2 Mg/m³ for loose soils and 1.6 Mg/m³ for compact soils) it is likely that the final volume of placed material will be between 3,000 m³ and 4,000m³.

3.17 Integration of Works with Materials Management Plan

At the time of writing, the material excavated from East Bay was still undergoing bioremediation and so no material has been incorporated into the Materials Management Plan. This will be discussed in the bioremediation validation report, which will be submitted under separate cover.

3.18 Integration of Works with Site Waste Management Plan

No solid material generated from the East Bay works was disposed off-site. All solid material excavated from East Bay was subject to on-site remediation.

4.0 BIOREMEDIATION

At the time of writing, the material generated from East Bay is still undergoing bioremediation. A bioremediation validation report will be drafted and submitted under a separate cover.

As previously detailed the extracted material was transported to a dedicated treatment area. On arrival at the treatment area the material was assessed and amendments were added to initiate the treatment process. The treatment is being undertaken under the control of Celtic's Mobile Treatment Licence (MTL).

5.0 VERIFICATION

5.1 Verification Criteria

East Bay will be re-flooded following completion of the remediation works and so the verification surface (exposed base) will be in excess of 1 m below water level. Due to the depth of the base of East Bay below surface level, there are no specific sampling criteria. Nevertheless, Celtic took a large number of samples to confirm the substantial removal of hydrocarbon impacted material.

Once all hydrocarbon impacted materials were removed, verification was undertaken using four main techniques:

- Detailed walkover undertaken by the Monitor, NR and Celtic;
- Collection of verification soil samples from 41 locations across the base;
- Visual and olfactory assessment of each verification sample position (in accordance with the Section 106); and
- Completion of machine excavated trial pits to confirm that contamination is not present below the finished surface.

All verification works were undertaken under the supervision of an Atkins representative.

The area of excavation was surveyed following completion of the works and calculated to be approximately 7,000 m². The density of verification sampling was agreed with the NR was 1 sample every 150 m² to 200 m² (Appendix E). A systematic grid sampling strategy was adopted and the sampling points were determined using GPS surveying equipment.

The verification analysis consisted of the following suite:

- Total Petroleum Hydrocarbons (TPH-CWG)
- Polycyclic Aromatic Hydrocarbons (PAH-USEPA 16)
- Volatile Organic Compounds (VOCs)
- Metals and metalloids (As, Cd, Cr, Cu, Hg, Ni, Pb, Se, V and Zn)
- Phenol

All samples were recovered and transferred into laboratory supplied sampling containers and dispatched to a UKAS and MCERTs accredited laboratory for chemical analysis. A drawing detailing the precise sample locations is presented in Appendix A, Drawing A5.

The topographic level of the base of East Bay was also surveyed on completion of the works and presented in Appendix A, Drawing A6.

5.2 Chemical Verification Data

A total of 41 samples (EBV1 – EBV41) were collected from the base and analysed and a summary is presented in Table 4. The laboratory results were assessed against the RTC for Recreational End-Use at materials to be placed <1m below surface level and 1% Soil Organic Matter.

A full set of laboratory data is presented as Appendix C3.

Table 5 – Summary of East Bay Verification Results

Contaminant	RTC	No. of exceedances	Maximum Concentration
Metals and Metalloids			
<i>Arsenic (mg/kg)</i>	64	0	29
<i>Cadmium (mg/kg)</i>	2.6	0	0.63
<i>Chromium (mg/kg)</i>	78	0	26
<i>Copper (mg/kg)</i>	143	0	97
<i>Mercury (mg/kg)</i>	1	0	1
<i>Nickel (mg/kg)</i>	75	0	35
<i>Lead (mg/kg)</i>	337	0	67
<i>Selenium (mg/kg)</i>	3	0	0.8
<i>Vanadium (mg/kg)</i>	351	0	37
<i>Zinc (mg/kg)</i>	478	0	160
TPH Aliphatic			
<i>C5 – C6 (mg/kg)</i>	294,000	0	0.1
<i>C6 – C8 (mg/kg)</i>	294,000	0	0.1
<i>C8 – C10 (mg/kg)</i>	5,880	0	0.1
<i>C10 – C12 (mg/kg)</i>	5,700	0	12
<i>C12 – C16 (mg/kg)</i>	5,800	0	160
<i>C16 – C21 (mg/kg)</i>	159,000	0	320

Contaminant	RTC	No. of exceedances	Maximum Concentration
<i>C21 – C35 (mg/kg)</i>	159,000	0	120
TPH Aromatic			
<i>C5 – C7 (mg/kg)</i>	26.2	0	<0.1
<i>C7 – C8(mg/kg)</i>	21,337	0	<0.1
<i>C8 – C10 (mg/kg)</i>	2,230	0	<0.1
<i>C10 – C12 (mg/kg)</i>	2,300	0	5.1
<i>C12 – C16 (mg/kg)</i>	2,330	0	48
<i>C16 – C21 (mg/kg)</i>	1,450	0	53
<i>C21 – C35 (mg/kg)</i>	1,450	0	18
<i>Phenol (mg/kg)</i>	859	0	<0.05

5.3 Visual and Olfactory Assessment

In accordance with the Section 106 verification criteria a detailed visual and olfactory assessment was undertaken as the verification samples were collected. A total of 41 assessments were undertaken between ground level and 0.4 m. In addition to the above, five machine excavated trial pits were excavated to a depth of up to 1.2 m below the base. A description of the material encountered is presented on trial pit logs presented in Appendix C4.

Table 6 presents the results from the visual and olfactory assessment, while Table 7 presents the assessment criteria set out in the Section 106. Full details on the sample depth and geological strata encountered are presented as Appendix C3.

Table 6 – Visual and Olfactory Assessment

Sample Location	Visual Score	Olfactory Score
EBV1	0	0
EBV2	0	0
EBV3	0	0
EBV4	0	0
EBV5	0	0
EBV6	0	0
EBV7	0	0
EBV8	0	1
EBV9	0	1
EBV10	0	0
EBV11	0	0
EBV12	0	0
EBV13	0	0
EBV14	0	0
EBV15	0	1
EBV16	0	1
EBV17	0	1
EBV18	0	0
EBV19	0	0
EBV20	0	0
EBV21	0	0

Sample Location	Visual Score	Olfactory Score
EBV22	0	0
EBV23	0	0
EBV24	0	2
EBV25	0	0
EBV26	0	0
EBV27	0	0
EBV28	0	0
EBV29	0	0
EBV30	0	0
EBV31	0	0
EBV32	0	0
EBV33	0	0
EBV34	0	1
EBV35	0	0
EBV36	0	0
EBV37	0	0
EBV38	0	0
EBV39	0	0
EBV40	0	2
EBV41	0	0

Table 7 – Aesthetic Criteria

AESTHETIC CRITERIA		
Rating	Visual	Olfactory
0	No Staining	No odour
1	Occasional Discolouration	Faint odour
2	Frequent Discolouration	Distinct but not strong
3	Small amounts of heavy staining	Strong odour
4	Heavy black staining	Strong odour discernable in ambient air
5	Visible product	Very strong odour very discernable in ambient air

5.4 Post Works Water Monitoring

On completion of the works three representative water samples were recovered from the standing water within East Bay on 08th July 2011. The samples were submitted to a UKAS accredited laboratory for analysis of TPH, VOCs, PAHs, metals and metalloids. The results are summarised in Table 8 with full certificates of analysis presented in Appendix D2.

Table 8 – Post Works Surface Water Monitoring

	Unit	East Bay Post Works
Total TPH	µg/L	<10
Total of (16) PAHs	µg/L	<2
All VOCs	-	All below detection limits

6.0 CONCLUSION

The works undertaken at East Bay have been successfully completed and verified in line with the requirements set out in the works specification, with the following being completed:

- Drainage diversions of two surface water inlets have been installed;
- The brick separators have been demolished and removed;
- Hydrocarbon material has been excavated and transported to a treatment area; and
- Final landform validated through chemical and visual/ olfactory assessments.

Celtic has revised the pre-works Conceptual Site Model, which indicates that following these works East Bay poses an unlikely negligible risk to groundwater, surface water (with East Bay) and the immediate surrounds (refer to Table 9). Therefore, no further works or monitoring will be undertaken.

Table 9 – Revised Conceptual Site Model

Potential Receptors	Potential Sources	Potential Pathways	Comments	Consequence	Likelihood
Groundwater	None	Leaching	Hydrocarbon impacted materials have been removed from East Bay, removing any risk to groundwater	Negligible	Unlikely
Surface Water (East Bay)	None	Leaching	Hydrocarbon impacted materials have been removed from East Bay, removing any risk to surface water	Negligible	Unlikely
	North Site Reservoir	Migration through dam dividing East Bay from North Site Reservoir	There is potential for contaminants to migrate from North Site Reservoir into East Bay. However, as part of the works cohesive material taken from the base of East Bay was placed against the dam to prevent seepages (refer to Section 3.11).	Moderate	Possible
	M4 Run-off Spring line	None	Inflows associated with M4 run-off and a spring line were diverted before remediation works commenced and so do not enter East Bay	Moderate	Unlikely
Surface Water (NSR) – which drains into the Crymlyn	None	Leaching	Hydrocarbon impacted materials have been removed from East Bay, removing any risk to surface water at NSR through leaching	Negligible	Unlikely

Potential Receptors	Potential Sources	Potential Pathways	Comments	Consequence	Likelihood
Bog SSSI	None	Horizontal flow	Hydrocarbon impacted materials have been removed from East Bay, removing any risk to surface water at NSR through horizontal flow	Negligible	Unlikely

APPENDIX A

DRAWINGS

Drawing A1 – Site Location

Drawing A2 – Pre-remediation Location and Layout

Drawing A3 – Specific Area of working

Drawing A4 – East Bay Work Sections

Drawing A5 – Sample Location Plan

Drawing A6 – Post Works Topographic Survey

APPENDIX A1 – SITE LOCATION