



Photograph 15 – showing a north south running pipe located within a manmade recessed channel within bedrock.

Appendix F. RBSL Failure Excavations

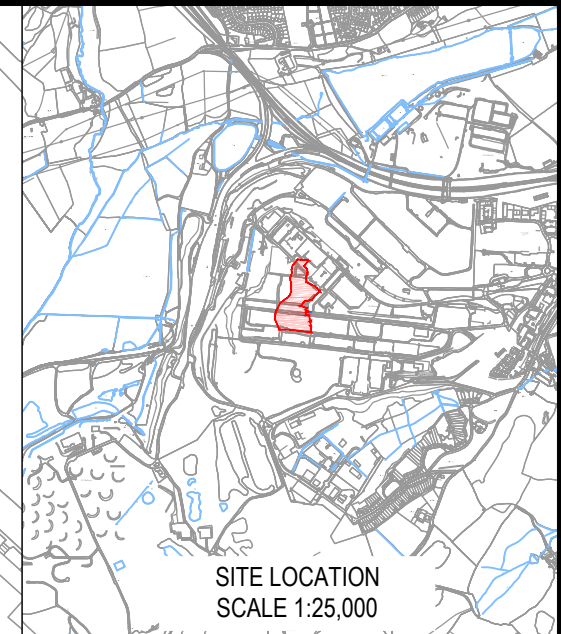
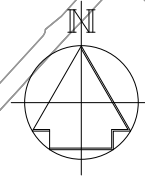
ALcontrol Laboratories

		Customer Sample ID	IP4080_BASE	IP4080 East	IP4080 North	IP4080 South	IP4080_WEST
		Depth	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00	0.00-0.00
SDG(s):	150805-70	AGS Id					
Customer:	Atkins Global Ltd Llandarcy (7158)	Sample Type	SOLID	SOLID	SOLID	SOLID	SOLID
Client Reference / Location:	Coed Darcy	Sampled Date	04/08/2015	06/08/2015	06/08/2015	06/08/2015	04/08/2015
Order no:	CD1333	Sample Received Date	05/08/2015	07/08/2015	07/08/2015	07/08/2015	05/08/2015
		Final Instruction Date	05/08/2015	07/08/2015	07/08/2015	07/08/2015	05/08/2015
All results expressed on a dry weight basis		Report Completed Date	13/08/2015	22/10/2015	22/10/2015	22/10/2015	13/08/2015
		SDG	150805-70	150807-71	150807-71	150807-71	150805-70
		Lab Sample Number	11839415	11854475	11854466	11854470	11839424
		Sample Temperature	15.0	10.8	10.8	10.8	15.0

Analysis	Test	Method	Units	LOD						
Sample Description										
	Colour	PM024	-			Dark Brown	Black	Black	Black	Grey
	Grain Size	PM024	-			0.1 - 2 mm	0.1 - 2 mm	0.1 - 2 mm	0.1 - 2 mm	0.1 - 2 mm
	Description	PM024	-			Loamy Sand	Loamy Sand	Sandy Loam	Loamy Sand	Sand
	Inclusion 1)	PM024	-			Stones	Stones	Stones	Stones	Stones
	Inclusion 2)	PM024	-			Vegetation	None	Oil/Petroleum	None	None
	Moisture Content Ratio (% of as received sample)	PM024	%			6.4	12	11	9.3	8.9
TPH Criteria Working C					Res >1m RBSL	Max				
	GRO Surrogate % recovery**	TM089	%			76	49	59	65	76
	GRO TOT (Moisture Corrected)	TM089	µg/kg	<44		8760	2840	7020	8760	2350
	Methyl tertiary butyl ether (MTBE)	TM089	µg/kg	<5		0	<20	<20	<20	<20
	Benzene	TM089	µg/kg	<10		400	<40	<40	<40	<40
	Toluene	TM089	µg/kg	<2		52,000	<8	<8	<8	<8
	Ethylbenzene	TM089	µg/kg	<3		140,000	<12	<12	<12	<12
	m,p-Xylene	TM089	µg/kg	<6		58,000	<24	<24	<24	<24
	o-Xylene	TM089	µg/kg	<3		58,000	<12	<12	<12	<12
	sum of detected mpo xylene by GC	TM089	µg/kg	<9		0	<9	<9	<9	<9
	sum of detected BTEX by GC	TM089	µg/kg	<24		0	<24	<24	<24	<24
	Aliphatics >C5-C6	TM089	µg/kg	<10		112,000	<40	<40	49.3	<40
	Aliphatics >C6-C8	TM089	µg/kg	<10		sat	139	396	373	170
	Aliphatics >C8-C10	TM089	µg/kg	<10		42,500	414	1250	1450	425
	Aliphatics >C10-C12	TM089	µg/kg	<10		sat	1190	2700	3550	866
	Aliphatics >C12-C16	TM173	µg/kg	<100		113000	63000	86500	106000	113000
	Aliphatics >C16-C21	TM173	µg/kg	<100		267000	137000	176000	223000	267000
	Aliphatics >C21-C35	TM173	µg/kg	<100		573000	404000	464000	573000	487000
	Aliphatics >C35-C44	TM173	µg/kg	<100		84500	54100	62600	76700	84500
	Total Aliphatics >C12-C44	TM173	µg/kg	<100		979000	658000	789000	979000	952000
	Aromatics >EC5-EC7	TM089	µg/kg	<10		460	<40	<40	<40	<40
	Aromatics >EC7-EC8	TM089	µg/kg	<10		146,000	<40	<40	<40	<40
	Aromatics >EC8-EC10	TM089	µg/kg	<10		71,000	276	830	968	283
	Aromatics >EC10-EC12	TM089	µg/kg	<10		1,390,000	794	1800	2370	578
	Aromatics >EC12-EC16	TM173	µg/kg	<100		sat	22500	21200	26800	38200
	Aromatics >EC16-EC21	TM173	µg/kg	<100		sat	83500	94200	121000	163000
	Aromatics >EC21-EC35	TM173	µg/kg	<100		294000	205000	207000	261000	294000
	Aromatics >EC35-EC44	TM173	µg/kg	<100		74800	44200	49500	65500	74800
	Aromatics >EC40-EC44	TM173	µg/kg	<100		28900	16100	19300	25000	28900
	Total Aromatics >EC12-EC44	TM173	µg/kg	<100		570000	355000	372000	474000	570000
	Total Aliphatics & Aromatics >C5-C44	TM173	µg/kg	<100		1520000	1020000	1170000	1460000	1520000

Drawings





SITE LOCATION
SCALE 1:25,000

KEY



MONITOR BOUNDARY PHASE 32

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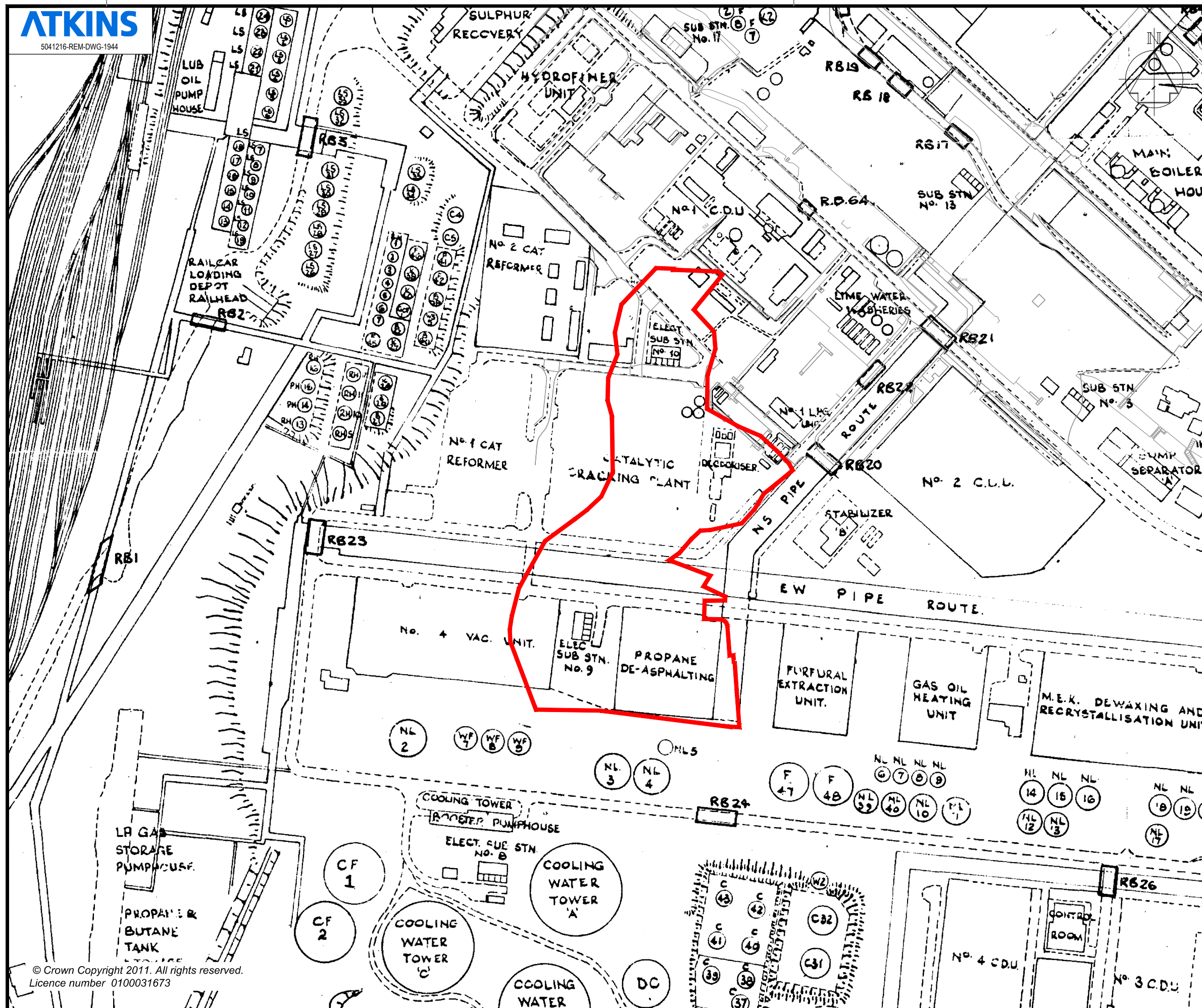
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	DATE	DATE	DATE
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5041216-REM-DWG-1943	A3	26.10.15

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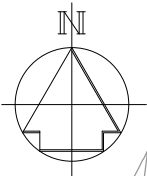
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 HISTORICAL LAYOUT

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DATE	DATE	DATE
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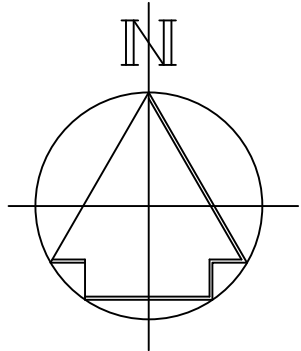
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MONITOR BOUNDARY PHASE 32
 MONITOR PHASE 32 BASE OF EXCAVATION SURVEY

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	DATE	DATE	DATE
	20.05.15	20.05.15	

	SHEET A3	PLOT DATE 26.10.15
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DRAWING NO	REV
5041216-REM-DWG-1945A	-



KEY

- MONITOR BOUNDARY PHASE 32
- TRIAL PIT
- EXTENT OF HISTORIC EXCAVATIONS TO BEDROCK

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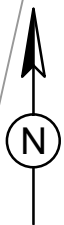
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RECENT EXPLORATORY HOLE LOCATIONS

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		SHEET A1	PLOT DATE 27.10.15
DRAWING NO 5041216-REM-DWG-1946			REV P1

100
0 10
Millimetres



DO NOT SCALE

KEY:

- MONITOR PHASE BOUNDARY
- MAJOR CONTOUR
- MINOR CONTOUR

St Modwen's
disused
Compound

St Modwen's
Compound

Rev.	Date	Description	By	Chkd	App'd
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Drawing Status	Suitability
FOR INFORMATION	S2

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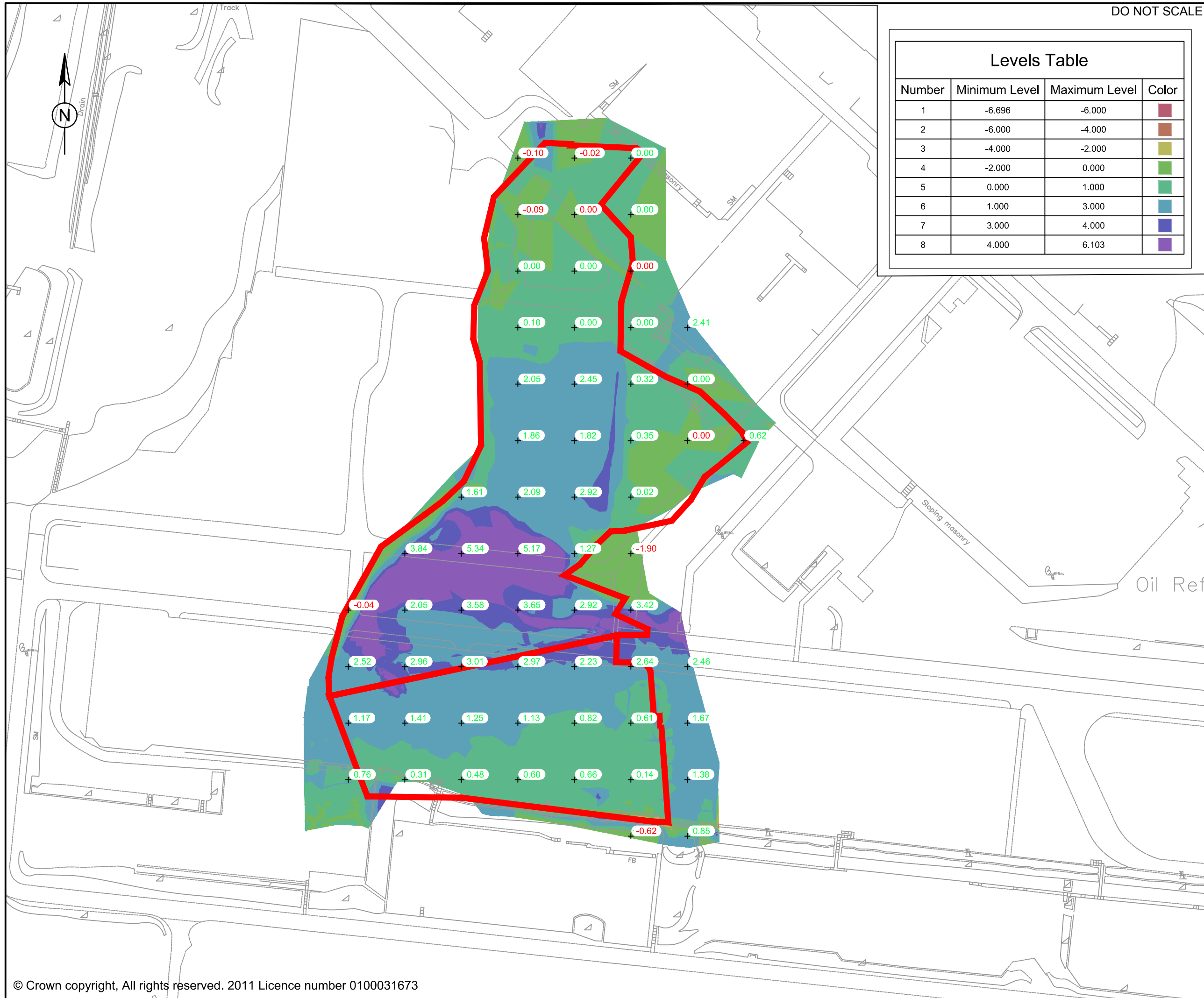
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MONITOR PHASE 32
POST WORKS TOPO SURVEY

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A3		26/10/15	26/10/15	26/10/15
Drawing Number				Revision
5041216-ATK-DR-C-REM-DWG-2106				P 1

100
Millimetres

0 10



DO NOT SCALE

Levels Table

Number	Minimum Level	Maximum Level	Color
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2	-6.000	-4.000	
3	-4.000	-2.000	
4	-2.000	0.000	
5	0.000	1.000	
6	1.000	3.000	
7	3.000	4.000	
8	4.000	6.103	

NOTES:

- THIS ISOPACHYTE COMPARES MP32 POST-WORKS SURVEY & MP32 EXCAVATIONS SURVEY PROVIDED BY HAWK OCTOBER 2015.

KEY:

MONITOR PHASE BOUNDARY

NORTH - CUT/FILL VOLUME WITHIN BOUNDARY:

CUT: 190m³
FILL: 22,166m³
NET: 21,976m³

SOUTH - CUT/FILL VOLUME WITHIN BOUNDARY:

CUT: 114m³
FILL: 6,695m³
NET: 6,581m³

Rev.	Date	Description	By	Chkd	App'd

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MONITOR PHASE 32
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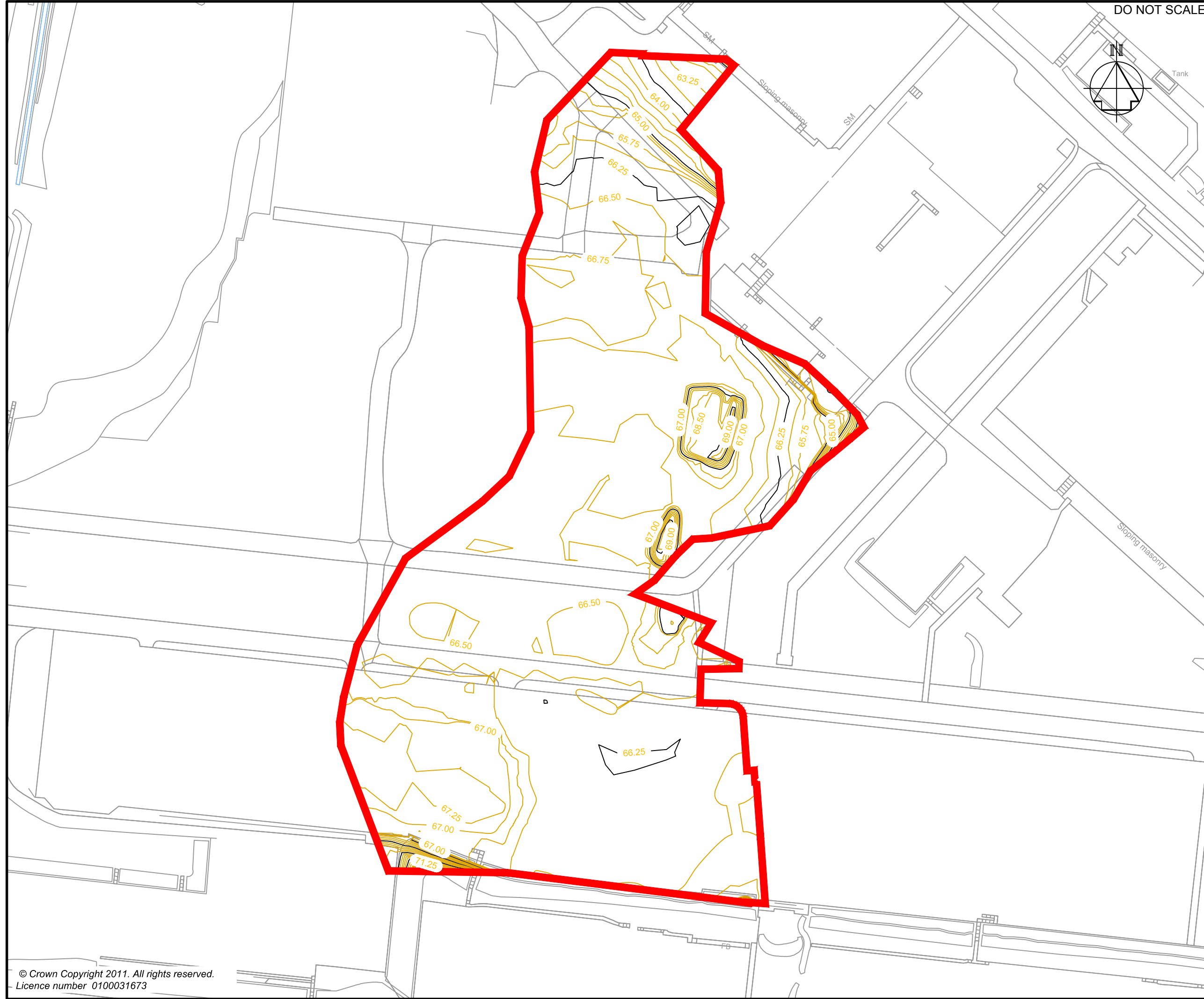
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Drawing Number

5041216-ATK-DR-C-REM-2114

P 1

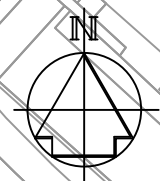
80



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KEY:

-  MONITOR BOUNDARY PHASE 32
 MAJOR CONTOURS
 MINOR CONTOURS

 Tank[illegible]

Rev.	Date	Description	By	Chk'd	App'd
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MONITOR PHASE 32
PRE-WORKS TOPO SURVEY

Scale 1:1000	Designed DH	Drawn HS	Checked HS	Authorised --
Original Size A3	Date 28/10/15	Date 28/10/15	Date 28/10/15	Date --/--/--

76	26/10/15	26/10/15	26/10/15	26/10/15
Drawing Number 5041216-ATK-DR-C-REM-002115				Revision P01

100
Millimetres

0 10



DO NOT SCALE

Levels Table

Number	Minimum Level	Maximum Level	Color
1	-6.788	-6.000	
2	-6.000	-4.000	
3	-4.000	-3.000	
4	-3.000	-2.000	
5	-2.000	0.000	
6	0.000	1.000	
7	1.000	2.000	
8	2.000	3.469	

NOTES:

- THIS ISOPACHYTE COMPARES MP32 PRE-WORKS SURVEY & MP32 EXCAVATIONS SURVEY PROVIDED BY HAWK OCTOBER 2015.

KEY:

MONITOR PHASE BOUNDARY

NORTH - CUT/FILL VOLUME WITHIN BOUNDARY:

CUT: 33,229m³
FILL: 203m³
NET: 33,026m³

SOUTH - CUT/FILL VOLUME WITHIN BOUNDARY:

CUT: 8,737m³
FILL: 42m³
NET: 8,695m³

Rev.	Date	Description	By	Chk'd	App'd
Drawing Status					Suitability
FOR INFORMATION					SO
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Project Title					
COED DARCY					
Drawing Title					
MONITOR PHASE 32 PRE-WORKS & BASE OF EXCAVATION ISOPACHYTE					
Scale	Designed	Drawn	Checked	Authorised	
1:1250	DH	JSD	CS		
Original Size	Date	Date	Date	Date	
A3	29/10/15	29/10/15	29/10/15		
Drawing Number					Revision
5041216-ATK-DR-C-REM-2122					P 1



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Coed Darcy

Validation Report
Monitor Phase 33

St Modwen Developments Limited



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0	Draft	MM	CRS	ML	MP	May 2015
1	Draft	MP	BI	ML	MP	October 2015

Client signoff

Client	St Modwen Developments Limited
Project	Coed Darcy
Document title	Validation Report Monitor Phase 33
Job no.	5122307
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Appendix B.	Exploratory Hole Logs
Appendix C.	Laboratory Analytical Results – Ground Investigation
Appendix D.	Photographs

Glossary of Terms

Term	Meaning / Definition
CSM	Conceptual Site Model
RBSL	Risk Based Screening Level
ACM	Asbestos Containing Material
TPH	Total Petroleum Hydrocarbons
PAH	Polycyclic aromatic Hydrocarbons
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
FFL	Finished Floor Level
mAOD	metres Above Ordnance Datum
RAP	Remedial Action Plan
VO	Visual/Olfactory Observations
BGL	Below Ground Level

1. Introduction

1.1. Background

Atkins Limited has been commissioned by St. Modwen Developments Ltd (St Modwen) to provide consultancy advice with regard to the redevelopment of the former Llandarcy Oil Refinery as Coed Darcy.

The purpose of this report is to provide data relating to Monitor Phase 33 in order to confirm suitability of this area for redevelopment in line with the specific requirements of the Coed Darcy Section106 Agreement and in order for St Modwen to achieve sign off by the Monitor. For the purpose of Monitor sign off, this area proposed as Monitor Phase 33 is shown on Drawing 5041216-REM-DWG-1935.

Based upon the current Masterplan, it is understood that Monitor Phase 33 is proposed for use as a school with associated playing fields within the final development. An indicative layout for the school is provided on Glancy Nichols drawing A101 – Coed Darcy Primary School.

1.2. Aims and Objectives

This report provides an overview of the site including information regarding the site setting, local geology and hydrogeology, identified contamination and discussion of any reclamation and remedial works undertaken, where required.

This information will be presented in such a way that it will enable the Monitor to sign off Phase 33 as suitable for its proposed future use.

Because of the absence of detailed information relating to finished development levels, the following assessment assumes that existing ground levels represent a depth of between 1m and 2m below FFL for the purpose of comparison with the requirements of the S106 and the specific agreements related to the school plot.

In the long term, it is anticipated that the suitability of land quality will need to be reassessed once a layout is finalised and levels confirmed. It is envisaged that this initial report will thus form part of any later assessment for each part of the site, as required under Planning Condition 44 of the Outline Planning Permission for the site (P2005/0393):

Prior to the submission of the first reserved matters application on each phase of development, notwithstanding the provisions of Condition 26, a phase specific remediation strategy focusing upon the remediation requirements of that area shall be submitted to and approved in writing by the Local Planning Authority. The submitted documents shall include the results from the site investigation and risk assessment; and using the above information a method statement shall be submitted detailing remediation measures and a detailed programme for the submission of verification reports upon completion of the remedial works confirming implementation of agreed measures, together with proposals for future monitoring and reporting. The approved details shall be fully implemented on site, in line with a schedule of works that shall form part of the details submitted to the Local Planning Authority for approval.

In line with the detailed information relating to historical and recent ground investigation and laboratory analysis for Monitor Phase 33, as provided in the following report, it is envisaged that this document would form part of any later planning submission for this part of the site in line with the requirements of Planning Condition 44.

1.3. Scope of Work

The scope of works includes:

- A review of all readily available information including geological, hydrogeological, historical site plans, Natural Resources Wales and British Geological Society (BGS) records;
- A review of available historical maps relating to Monitor Phase 33 and adjacent areas;
- A review of historical (1998-2004) and recent (2014) ground investigation and re-profiling works relating to Monitor Phase 33;
- Comparison of the available ground investigation information and laboratory data against the requirements of the S106, specific to the proposed end use for Monitor Phase 33.
- Details of any reclamation and remediation works undertaken, and
- Details of the validation in order to confirm that the remedial works were successfully carried out and to demonstrate that this area is now suitable for use in line with the required criteria.

1.4. Soil Quality Assessment Standards

To maintain consistency of approach, the assessment standards for historic and recent data are those stated in the S106 Agreement for Coed Darcy. The visual and aesthetic classification system as previously defined by BP within the S106, is provided as Table 1.1.

Atkins proposes to continue this system for the classification of all soils encountered to aid assessment of each area in terms of the required remediation requirements. The assigned classification for each strata are quoted on the investigation logs for recent ground investigation by Atkins (refer to Section 5).

Table 1.1 – Scale of Aesthetic Criteria

Class	Visual	Olfactory
0	No visible staining of soil, no visible suspect ACM*.	No detectable odour on soil.
1	Occasional staining of soil, no visible suspect ACM*.	Faint odour on soil.
2	Frequent staining of soil.	Distinct but not strong odour on soil.
3	Occasional heavy staining of soil.	Strong odour on soil.
4	Heavy staining of soil.	Strong odour discernible in ambient air.
5	Visible hydrocarbon present.	Overwhelming odour.

* visible suspect ACM refers to asbestos containing material visible to the naked eye which a reasonable and prudent person used to managing asbestos may suspect to be asbestos-containing.

The S106 for the proposed development presents a series of Risk Based Screening levels (RBSLs). These levels are defined within the S106 as being the 'minimum base level standard' for redevelopment remediation works (Schedule 8, Part 2, Paragraph 2,5).

Details relating to remediation requirements beneath proposed schools are not provided within the current S106 Agreement (Dewey & LeBoeuf ref. GNP/JNR/13773-2) which relates solely to areas of proposed residential, commercial and Public Open Space end use. With the agreement of the Monitor, Atkins has prepared a report (5041216-REM-RPT-1275) to the proposed redevelopment remediation requirements for proposed school areas within the final Masterplan. Details of the adopted requirements, based on this report, are provided in Section 4.

1.5. Information Sources

Information has been obtained from the following sources:

- URS BP Llandarcy Refinery Desk Study 44382742/BRRP0001, July 2007
- URS Report FR1287 Final Factual Report for Ground Investigation, August 2005
- Section 106 Deed of Planning Obligations (Dewey & LeBoeuf report GNP/NJR/13773-2), February 2008
- Atkins Redevelopment Remediation Requirements: Proposed Schools 5041216-REM-RPT-1275, January 2015

1.6. Limitations

As previously indicated, this report has been prepared with the sole intention of providing sufficient information to enable St. Modwen to obtain Monitor sign off for Monitor Phase 33 in accordance with criteria set out in the Coed Darcy Section 106 Agreement and within Atkins document 5041216-REM-RPT-1275. Whilst the report may be relevant for submission as part of a reserved matters planning application, additional reports and submissions may be required as part of any future plot development.

The investigation works undertaken and summarised within this report represent a sampling exercise to determine ground conditions, in line with the required methodology outlined within the S106. The proposed works were carried out predominantly to investigate contamination across this area and do not include a review of any geotechnical issues or constraints that may exist which would need to be taken into account as part of any proposed redevelopment.

In addition, it should be noted that ground and groundwater conditions can vary over time and between sampling points. Whilst this report provides information relating to the removal of identified pipework and below ground structures encountered during the works, unidentified pipework and/or structures may still exist in situ.

2. The Site

2.1. Location and Description

Monitor Phase 33 is an irregular-shaped parcel of land covering approximately 2.06ha (hectares) and located in the central part of the refinery. The location of Monitor Phase 33 is shown on Drawing 5041216-REM-DWG-1935.

Monitor Phase 33 is characterised by a sloping topography from south to north. The elevation in the south west of the site is approximately 60m Above Ordnance Datum (AOD), and slopes down to approximately 48m AOD in the north of the Phase adjacent Road 1.

Prior to reclamation works the site presented an undulating profile, partially vegetated with local remnant structures. Some modification of the post refinery landform had been undertaken during previous exercises to remove redundant pipework. The pre-works topography is presented on drawing 5041216-ATK-DR-C-REM-DWG-2099. It was on the 'pre-reclaimed' profile that the investigations described in sections 3 and 5 were undertaken.

In its current 'post reclamation' condition the site is clear of vegetation with bare ground and a more uniform sloping profile. The post reclamation topography is presented as drawing 5041216-ATK-DR-C-REM-DWG-2100.

2.2. Historical Land Use

Construction of Llandarcy Oil refinery commenced in 1917 but was temporarily suspended during the war due to the lack of men and resources. Construction started again in 1919 with production beginning in 1921. The refinery was officially opened in 1922.

The purpose of the refinery was to produce motor spirit, kerosene, gas fuel oil, fuel residue and lubricating oil and wax from imported crude oil. Between the wars, the oil industry developed rapidly. By 1939, the refinery had little of the original plant in operation.

In the mid 1980's a number of rationalisations occurred with the closure of the refinery being formally announced in 1997.

Based upon the information in URS Report 44382742/BRRP0001, a range of infrastructure was historically located within Monitor Phase 33. Workshops associated with boiler house maintenance were located in the north of Monitor Phase 33 from the early-1950s to the early-1970s.

Monitor Phase 33 was also occupied by 'No.1 LPG Unit and Stabilizer' and the 'No.2 Crude Distillation Unit' (CDU), and associated flare stack, which are understood to have been introduced in the early 1940s-1950s and remained operational until 1988/1989. Historical plans included in URS Report 44382742/BRRP0001 also indicate that a small electrical sub-station, a small condenser and lime water washer area was also present within this Phase.

Historical land use of Monitor Phase 33 is shown on Drawing 5041216-REM-DWG-1936.

2.3. Published Geology

A review of published geological information (BGS map 247, Swansea (1:50,000 scale) indicates Monitor Phase 33 to be underlain by:

- Till (Diamicton), a heterogeneous deposit of glacial origin; and
- the Pennant Sandstone Formation, specifically the Hughes Member which is described by the BGS as *'green-grey, lithic arenites ("Pennant sandstones") with thin mudstone/siltstone and seatearth interbeds and mainly thin coals'*.

2.4. Hydrogeology and Hydrology

2.4.1. Groundwater

Environment Agency data suggests that the Till (Diamicton) underlying Monitor Phase 33 is classified as 'Unproductive Strata'. This is defined as:

'...rock layers or drift deposits with low permeability that have negligible significance for water supply or river base flow.'

The underlying sandstone bedrock is classified as a 'Secondary A Aquifer'. This is defined as:

'permeable layers capable of supporting water supplies at a local rather than strategic scale, and in some cases forming an important source of base flow to rivers. These are generally aquifers formerly classified as minor aquifers.'

The groundwater contours presented by URS in FR1287 indicate that the groundwater flow in drift is radial from the south west of Monitor Phase 33, and to the north-north east within bedrock, consistent with the topography of the Phase.

2.4.2. Surface Waters

The closest surface water body is the South Site reservoir, which is located approximately 410m to the north west of Monitor Phase 33. The previous refinery drainage system carried storm flows to the North Site Reservoir. The historic drainage infrastructure is entirely redundant and flows are collected by temporary drains and ditches which either disperse flows across undeveloped parts of the wider Coed Darcy site or enable some flow to reach the North Site Reservoir via the refinery relict network.

Crymlyn Bog SSSI (refer to section 2.6) is located approximately 440m to the west of Monitor Phase 33 at its closest point.

The Containment Area lagoons/former refinery landfill lie approximately 720m to the south west of Monitor Phase 33.

2.5. Landfills and Waste Management Facilities

There are no licensed landfill or waste management facilities within the vicinity of Monitor Phase 33. Atkins is currently in the process of restoring the landfill associated with the former Llandarcy refinery in the south of the Coed Darcy site and are in ongoing discussion with Natural Resources Wales relating to the Environmental Permit No. EPR/AP3990LR.

2.6. Sensitive Land Uses

Crymlyn Bog SSSI lies within the flood plain of the Neath river estuary and represents the most extensive area of lowland fen in Wales. This lies approximately 440m to the west of Monitor Phase 33.

Crymlyn Bog SSSI is internationally important for its very wet mires often identified by an unstable 'quaking' surface. Bottle sedge and bogbean are important components of some stands, together with common cottongrass, water horsetail, star sedge, mud sedge, and in places, the nationally rare slender cottongrass. Crymlyn Bog supports the largest area of calcium-rich fen dominated by great fen sedge vegetation in south Wales. Some of these stands are dominated by great fen sedge, but other areas display a more diverse vegetation in which tufted-sedge, royal fern and a range of tall-herb fen species are prominent. Some of these stands are unique in a Welsh context. In addition there are areas of wet woodland with alder and willow being the dominant species (<http://www.ccgc.gov.uk/landscape--wildlife>).

3. Historical Ground Investigation

3.1. Recorded Ground Conditions

3.1.1. General

A total of 17 historical exploratory holes are reported to have been excavated by URS on behalf of the previous site owner, BP, within Monitor Phase 33. The locations of the historical exploratory holes are presented on Drawing 5041216-OSW-DWG-1937.

The exploratory holes were completed during 1998 and 2004 as part of a series of investigations across the former refinery (URS Report FR1287). Historical logs are available for all exploratory holes within the URS report.

3.1.2. Ground Condition Summary

3.1.2.1. Made Ground

Made Ground is recorded to have been encountered in 17 historical exploratory hole locations within Monitor Phase 33 and is described as reworked glacial material comprising clay, silt, sand and gravel matrices, with varying frequencies of cobbles and boulders.

Anthropogenic inclusions of ash, bricks and brick fragments, concrete, floor tiles, slag fragments, tar like material and wood were also encountered. Sandstone and clinker gravel was identified, with sandstone cobbles and boulders.

Made Ground was encountered to a maximum depth of 4.0m below ground level (m bgl) in MSMW57d which is located in the south east of Monitor Phase 33.

3.1.2.2. Drift Geology

Natural soils beneath Monitor Phase 33 are primarily described as silt and clay matrices with varying quantities of sand and gravel. Gravel was recorded as sub-angular to rounded, fine to coarse sandstone. Sub-angular to rounded sandstone cobbles and boulders were also encountered.

Superficial deposits were encountered to a maximum depth of 13.0m bgl in MSMW57d.

3.1.2.3. Bedrock Geology

Competent sandstone bedrock was encountered at depths ranging from 3.5m bgl in WSTP025, located in the north west of Monitor Phase 33, to 13.0m bgl in MSMW57d.

3.1.2.4. Water Strikes

Water strikes were recorded to have been encountered in six of the exploratory holes in Made Ground, superficial deposits, weathered bedrock and competent bedrock.

Depths of water strikes ranged from 0.2m bgl in the Made Ground in WSTP027, located in the south of Monitor Phase, to 14.0m bgl within bedrock in MSMW57d.

3.2. Soil and Groundwater Contamination

3.2.1. Introduction

A review of the historical logs, laboratory and monitoring data of Monitor Phase 33 has been undertaken, and visual and olfactory evidence of contamination, including free product, was recorded as further detailed below.

3.2.2. Visual and Olfactory Evidence of Contamination

Visual and olfactory evidence of contamination was identified in 13 historical exploratory holes across Monitor Phase 33 and ranged from the presence of ash, slag, staining and sheens to hydrocarbon odours ('slight' to 'very strong').

Free product was also observed and is discussed in Section 3.2.3, below.

3.2.3. Free Product

Free product was encountered during excavation or drilling of the following historical exploratory holes located across Monitor Phase 33:

- WSTP027 encountered free product on perched water within Made Ground at 0.2m bgl, this was located in the south of Monitor Phase 33;
- WSTP164 observed free product on silt within superficial deposits at 2.5m bgl, and again at 3.5m bgl, which was located towards the north of the Phase;
- WSTP171 identified free product patches at approximately 0.2m bgl on the boundary of Made Ground and drift deposits, which was located in the west of Monitor Phase 33;
- WSTP182 encountered free product on perched water within superficial deposits at 1.7m depth; and
- WSTP300 identified free product throughout the Made Ground between 0.1 – 1.1mbgl, this exploratory hole was located towards the south west of Monitor Phase 33.

3.2.4. Soil Contamination

From the available laboratory data for the historical exploratory holes excavated across Monitor Phase 33, heavy end hydrocarbon contamination would appear to be more prevalent than light end hydrocarbon contamination.

In line with Atkins report 5041216-REM-RPT-1275, the remediation requirements beneath proposed schools (refer to section 4) is based on a combination of the existing residential and public open space thresholds, subject to the location of the soil beneath proposed buildings or external areas.

There was one exceedance within the school building footprint, where deep (>1m FFL) soils Risk Based Screening Level RBSL for a residential land use were used as screening criteria. The exceedance was noted for Mercury (50mg/kg) at 0.5m bgl WSTP139, which was located at the north western edge of the proposed school building.

There were no exceedances of the RBSL for deep (>1m FFL) soils in a parks land-use in the samples taken from exploratory holes located within proposed playing field areas of the school plot.

Asbestos was detected in two soil samples; one for trace crocidolite in WSTP139 at 0.5m bgl within the school building footprint, and one for trace amosite in WSMW013 in the playing fields area of Monitor Phase 33.

3.2.5. Groundwater Contamination

Consistent with soil analytical data, laboratory data from historical groundwater sampling within Monitor Phase 33 (URS Report FR1287) confirmed the presence of mid to heavy end hydrocarbons across this area.

There were no exceedances of the groundwater RBSL for a residential land use within Monitor Phase 33.

3.3. Exclusion Areas / Special Process Areas

There are two designated Special Process Areas within Monitor Phase 33. The Special Process Areas relate to an electricity substation and the 'Boiler House Workshop', located in the north east of Monitor Phase 33.

The location of free product encountered in the ground investigation within WSTP164 corresponds approximately with the location of the Boiler House Workshop.

4. Requirements under the S106

4.1. Section 106 Deed of Planning Obligations Requirements

Monitor Phase 33 is currently designated as a school with associated playing fields based on the current Masterplan.

Details relating to proposed schools are not provided within the current S106 Agreement (Dewey & LeBoeuf ref. GNP/JNR/13773-2) which relates solely to areas of proposed residential, commercial and parks end-use. With the agreement of the Monitor, Atkins has prepared a report (5041216- REM-RPT-1275) to provide a summary of the proposed redevelopment remediation requirements for proposed school areas within the final Masterplan.

For consistency, the following criteria have been based on the existing Redevelopment Remediation Requirements outlined in the S106 (Schedule 8, Section 4.0).

These requirements are considered to represent the minimum remediation requirements required in order to release any land for redevelopment as a proposed school.

In the absence of specific information relating to ground conditions beneath each of the proposed schools, the following requirements are proposed for adoption for proposed schools in areas of both 'groundwater in soil' and 'groundwater in rock', as defined in the S106.

Where reference to aesthetic criteria are discussed, these relate to the visual/olfactory classification system presented in Table 1.1.

- *All significant areas of oil-saturated soils and free product should be removed.*
- *All soils must be remediated so as to meet the adopted thresholds for residential (shallow) end use beneath the surface to 1m below FFL.*
- *Beneath proposed buildings, all soils must be remediated so as to meet the adopted thresholds for residential (deep) end use at depths >1m below FFL.*
- *Recreational/Open Space (>1m below FFL) criteria will be adopted for soils at depth (>1m below FFL) within open space areas (including playing fields and proposed hardstanding etc). Where these lie immediately adjacent to proposed buildings, a suitable stand-off will be adopted utilising the residential criteria.*
- *The aesthetic quality of soils shall be Class 1 or better for at least the first metre below FFL.*
- *The aesthetic quality of soils shall be Class 2 or better at depths of between 1 – 2m below FFL and Class 4 or better at depths >2m beneath FFL.*
- *Where encountered near surface, groundwater will be assessed in line with the thresholds presented in Appendix E in line with the residential and recreational splits indicated above.*
- *All soil potentially containing dispersed asbestos fibres or visible ACM must be removed or remediated to meet in bulk, considering both dispersed fibres and pieces of ACM, the appropriate ACM RBSL, or the requirements of relevant Environmental Authorities, whichever is the more conservative, to a minimum depth of 2m below FFL.*

5. Recent Ground Investigation

5.1. Introduction

With the aim of supplementing and updating the limited historical investigation, a total of 68 machine excavated trial pits were undertaken across Monitor Phase 33 by ESG on behalf of St Modwen during March 2015. A total of 261 samples were taken from the 68 trial pits. Sampling and testing frequencies which also take account of works following the reclamation are discussed in Section 7.

The locations of the Atkins trial pits are shown on Drawing 5041216-REM-DWG-1938. Copies of relevant exploratory hole logs are presented in Appendix B.

Note: IP4084 and IP4083 were re-tested following the removal of obstructions and overburden during the reclamation (see section 6). The re-test screens provided in Appendix C provide details for samples which are taken from a ground level which is circa 3.5m (IP4084) and 2m (IP4083) respectively below the original ground level during the time of the March investigation.

5.2. Recorded Ground Conditions

Made Ground was encountered as reworked glacial material in 36 locations, comprising different matrices of clay, silt, sand and gravel with varying frequencies of cobbles. Anthropogenic inclusions of ash, brick, clinker, concrete, metal, plastic, slag and wood were noted to be present. Made Ground, comprising sand and clayey sandy sandstone gravel with bricks was encountered to a maximum depth of 5.20mbgl in IP4115, located in the south east of Monitor Phase 33.

Metal pipes were noted within two trial pits; IP4084 at a depth of 0.5m bgl and IP4145 at a depth of 1.3m bgl. A concrete pipe was noted in IP4131 at 2.0m bgl.

Superficial deposits comprised Till (Diamicton) with varying quantities of clay, silt, sand, gravel and cobbles. Sand encountered is fine to coarse. Gravel was sub-angular to well rounded, fine to coarse sandstone. Cobbles were sub-angular to well-rounded sandstone. Superficial geology was encountered to a maximum depth of 5.5m bgl in IP4125.

Bedrock was encountered in 19 locations within Monitor Phase 33. It was present at a minimum depth of 0.3m bgl in IP4077 as highly weathered sandstone, recovered as gravels or cobbles in a sandy silty matrix. Bedrock was proven in the remaining 18 locations at depths ranging from 1.1m to 4.4m. Pre reclamation depth to bedrock averaged 4-6m below ground level, post reclamation depths probably average 2-5m depending on extent of overburden removal. The upper bedrock profile appears to fall with the topography north eastwards although there is likely to be significant local variations with shallow bedrock noted in the north-west and south west corners of the site. At the latter location bedrock is seen to outcrop at the surface following reclamation.

A notable water strike was recorded in one of the trial pits. A fast ingress with a hydrocarbon sheen on the surface was observed in trial pit IP4129 within superficial deposits.

5.3. Laboratory Analysis

The 257 soil samples collected during the investigation from Monitor Phase 33 were analysed by Alcontrol Laboratories and analysed for a suite of contaminants considered appropriate for the former use of the area as for a CDU, LPG Unit and Stabiliser and Boiler House Workshops. The analytical suite comprised:

- Metals - arsenic, cadmium, chromium, selenium, copper, lead, nickel, mercury, vanadium, zinc (all samples);
- pH (all samples);

- Polycyclic Aromatic Hydrocarbons (all samples);
- Total Petroleum Hydrocarbons (all samples);
- Soil Organic Matter (selected samples);and
- Asbestos screen and identification (samples within top 1m from existing ground level).

5.4. Soil and Groundwater Contamination

5.4.1. Visual and Olfactory Evidence of Contamination

A review of the logs for the 68 trial pits recently excavated within Monitor Phase 33 has indicated that visual and/or olfactory evidence of contamination was present in 48 locations up to a maximum of Class 5 representing free product. This was recorded in IP4106 which lies within the proposed school building footprint.

Visual and olfactory classifications recorded within the building footprint were assessed against the thresholds for a proposed school building as defined in Section 4:

Beneath proposed buildings, all soils must be remediated so as to meet the adopted thresholds for residential (deep) end use at depths >1m below FFL.

Visual and olfactory classifications were compared with the aesthetic quality thresholds for a proposed school playing field as defined in Section 4:

The aesthetic quality of soils shall be Class 2 or better at depths of between 1 – 2m below FFL and Class 4 or better at depths >2m beneath FFL.

Exceedances of the depth-based aesthetic quality thresholds were recorded in eight locations, two of which are located within the school plot. These are shown on Drawing Ref 5041216-REM-DWG-1976.

5.4.2. Laboratory Analytical Data

In line with the proposed end use of this area as a school and associated playing fields (refer to Section 4), the results of recent laboratory analysis were compared with the adopted chemical thresholds for deep soil (>1m FFL) in a residential end-use within the school building footprint, extending 5m from the building perimeter. For the playing fields, the laboratory analysis was compared against deep soils in a Parks land use.

There were seven exceedances of the thresholds underneath the school building plot. Six exceedances were for Aliphatic Range C8-C10 and one was for mercury. The greatest concentration of the Aliphatic Range C8-C10 was encountered at 0.5m bgl in IP4076. The mercury exceedance was noted at 0.5m bgl in IP4085. Actions to remediation these exceedances is discussed in Section 6.3.

No exceedances of the Parks RBSLs for deep soils were recorded in the proposed playing fields and car parking area.

Within the school building footprint, asbestos was detected in nine of the samples taken from the top 1m. Within the playing fields area asbestos was detected in fifteen samples. Asbestos quantification was undertaken on all samples which detected asbestos. A results summary for the proposed plot and playing field and car park area (based on original ground level exposure at above 1m below FFL) is presented below:

	Location	Depth (m bgl)	Type	Description	Quantity (%)
Playing fields and car park (POS)	IP4080*	0.50	Chrysotile, Crocidolite, Amosite	Loose fibres in soil	0.0535
	IP4090	0.50	Chrysotile	Loose fibres in soil	<0.001
	IP4098	0.50	Chrysotile	Loose fibres in soil	<0.001
	IP4101	0.50	Chrysotile, Amosite	Loose fibres in soil	0.0011
	IP4103	0.50	Chrysotile, Amosite	Loose fibres in soil	0.0021
	IP4119	0.50	Chrysotile, Crocidolite,	Loose fibres in soil	0.0115
	IP4120	0.50	Chrysotile	Loose fibres in soil	0.0110
	IP4120	0.50	Chrysotile, Crocidolite,	Loose fibres in soil	0.002
	IP4123	0.50	Chrysotile, Amosite	None	0.0016
	IP4124	0.50	Chrysotile	Trace fibres in soil	Trace
	IP4128	0.50	Chrysotile, Crocidolite,	Loose fibres in soil	<0.001
	IP4129	0.50	Chrysotile	None	Trace
	IP4129	4.50	Chrysotile	Loose fibres in soil	Trace
	IP4130	0.50	Chrysotile	None	0.0022
	IP4131	0.50	Amosite	None	0.0023
	IP4133	0.50	Chrysotile, Crocidolite, Amosite	Loose fibres in soil	0.0332
	IP4135	0.50	Chrysotile, Crocidolite, Amosite	None	0.0648
	IP4145	0.50	Amosite	Loose fibres in soil	0.0012
	IP4146	0.50	Chrysotile, Amosite	Loose fibres in soil	0.0012
	IP4147	0.50	Chrysotile	None	<0.001
School Building (>1m RESI)	IP4082	0.50	Chrysotile	Fibres in soil	<0.001
	IP4094	0.50	Chrysotile	Soil containing ACM debris	Trace
	IP4107	0.50	Chrysotile, Crocidolite, Amosite	Soil containing ACM debris	0.1
	IP4085	0.50	Chrysotile	Loose fibres in soil	0.198
	IP4108	0.50	Chrysotile	Loose fibres in soil	<0.001
	IP4117	0.50	Chrysotile, Crocidolite	Soil containing loose fibres and ACM debris	0.158
	IP4118	0.50	Amosite	Loose fibres in soil	0.0057
	IP4136	0.50	Chrysotile, Crocidolite, Amosite	Loose fibres in soil and ACM debris	0.213
	IP4109	0.50	Chrysotile	Loose fibres in soil	0.0028
	IP4116	0.50	Chrysotile, Crocidolite, Amosite	Soil containing ACM debris	0.0016

Laboratory analytical results spreadsheets are presented in Appendix C.

6. Reclamation and Remediation Works

6.1. Proposed Forward Actions in Accordance with Section 106

Areas of contamination, identified by RBSL failures, elevated aesthetic criteria scores and localised free product, have been identified in Monitor Phase 33. These areas required further excavation or removal to meet with the requirements as detailed in Section 4 and based upon Atkins report 5041216-REM-RPT-1275.

The proposed forward actions arising from the site investigations are shown on Drawing 5041216-REM-DWG-1977.

Works to address the issues raised by the investigation were undertaken in parallel with the reclamation of the site. The purpose of the reclamation, as well as addressing remediation requirements, was to provide a development profile, free of structural remnants and at a profile which approximates to the requirement of the school development.

Reclamation required the removal of an average of between 1m and 5m of overburden and allowed much greater level of observation of the subsurface profile including those areas deemed to have failed the visual and olfactory criteria and evidences free phase.

6.2. Site Reclamation

6.2.1. General Works

Reclamation of the site took place between May and September 2015 and was undertaken by Hawk Contracts Ltd and monitored by Atkins on behalf of St Modwen. Works were undertaken to create a site profile which was approximately 1m below the indicative post development levels.

The following drawings provide a record of the reclamation earthworks:

- Drawing 5041216-ATK-C-REM-DWG-2076- indicative -1m below FFL
- Drawing 5041216-ATK-C-REM-DWG2099 - pre-commencement profile
- Drawing 5041216-ATK-C-REM-DWG2100 - post reclamation profile (equates to a base of excavation as-built)
- Drawing 5041216-ATK-C-REM-DWG-2101 – cut levels
- Drawing 5041216-ATK-C-REM-DWG -2116 - indicative fill to achieve currently envisaged

Approximate earthworks volumes are as follows:

- Total Cut – **30,675m³**
- Fill to achieve indicative final formation levels (NOT PLACED) – **39,338m³**.

Excavated material was segregated on the basis of geotechnical suitability and in accordance with the visual and olfactory impact by contamination, as guided by the previous investigations and on inspection during excavation. All materials were stockpiled within the Coed Darcy site either on the licenced treatment pad if impacted or within managed stockpiles to await classification testing ahead of future re-use on the wider Coed Darcy site.

6.2.2. Structures Removal

The works encountered a number of remnant structures which were removed as part of the works. The majority of structures including pipes were found to be founded on shallow natural soil and were removed in their entirety. Evidence of some deeper structures were found within the south eastern part of the proposed playing fields (e.g. at the base of IP4146). Overlying material at this location was deemed suitable and given the proposed end use of the area it was not considered necessary to further explore or remove this potential structure.

Drawing 5041216-REM-ATK-C-REM-2129 shows the location of the more substantial structures encountered and removed. Many of these structures coincide within known historic process infrastructure as shown on drawing 5041216-REM-DWG-1937.

Removal of the previously identified pipework in IP4145, IP4131 and IP4084 were addressed during general reclamation. Although much overburden was removed during reclamation additional testing along the more substantial pipe runs in the southern area was undertaken by basal soil analysis covered in Section 6.4 below. Additional sampling of the ground under the pipe fragment found in IP4084 was undertaken following removal and reclamation of this area (see Section 5.1). Photographs showing removal operations are provided in Appendix D.

Metal pipework was removed from the site area to a waste metal stockpile to await off-site recycling. Other structures including hardstandings were placed in a recycling stockpile to await processing and testing prior to re-use elsewhere within the wider Coed Darcy site.

6.3. Remediation of Screening Value Exceedances

The following table summarises the actions taken to mitigate exceedances of the chemical screening values adopted for the site.

The locations of the measured exceedances are shown on drawing 5041216-REM-DWG-1978.

The locations and extents of excavations are shown on drawing 5041216-ATK-DR-C-REM-DWG-2100.

Location	Exceedance	Mitigation
IP4076	C8-10 – 0.5m	Circa 150m ³ (10m x 10m x 1.5m) excavated and removed to the Coed Darcy treatment pad. Validation testing of the excavation is presented in Appendix C, all samples passed.
IP4082	C8-10 2.5m	Following reclamation overburden strip (circa 2m) a further circa 200m ³ excavated and removed to the Coed Darcy treatment pad. Validation testing of the excavation is presented in Appendix C, all samples passed.
IP4104	C8-10 1.5m	Pit originally excavated at 53.8mAOD, reclamation level at and surrounding the pit is 51m AOD. Failure at 1.5m is removed to below next sample at 2.5m. Note C8-10 concentration at 2.5m (0.15mg/kg) is significantly less than the failure at 1.5m (52mg/kg) indicating a relatively defined occurrence.
IP4106	C8-10 – 0.5m	Pit originally excavated at 53.3mAOD, reclamation level at and surrounding the pit is 51m AOD. Failure at 0.5m is removed to below next sample at 1.5m which passed.
IP4085	Mercury - 0.5m	Pit originally excavated at 52mAOD, reclamation level at and surrounding the pit is 48m AOD. Failure at 0.5m is removed to below next sample at 1.5m which passed.
IP4092	C8-10 - 1.5 and 2.5m	Following reclamation overburden strip (circa 1m) circa 320m ³ (10m x 10m x 3.2m) was excavated and removed to the Coed Darcy treatment pad. Validation testing of the excavation is presented in Appendix C, all samples passed.
IP4107	1000ppm - .0.5m	Level reduction of 1.5m (52.5m to 51m AOD) removed Made Ground overburden and into natural strata by 0.5m.
IP4080	535ppm – 0.5m	Level reduction by circa 1.7m (53.2m to 51.5m AOD) removed Made Ground overburden and into natural strata by 0.7m.
IP4117	1570ppm – 0.5m	Level reduction by circa 1.6m (52.1m to 50.5m AOD) removed Made Ground overburden and into natural strata by 0.3m.
IP4136	2130ppm – 0.5m	Level reduction by circa 1.7m (52.2m to circa 50.5m AOD) removed Made Ground containing ash and brick cobble layer and into visually clean underlying layer by 0.3m.

IP4135	648ppm - 0.5m	Level reduction by circa 0.6m (53.1m to circa 52.5m AOD). Area is circa 1m below anticipated FFL of a sloping landscaping area adjacent to the proposed access road. Analysis confirming removal included Appendix C.
IP4133	332ppm - 0.5m	Level reduction by circa 1.1m (53.6m to 52.5m AOD). Area is circa 0.5-1m below anticipated FFL of a sloping landscaping area adjacent to the proposed access road. Analysis confirming removal included Appendix C.

Photographs of the general reclamation works and RBSL failure excavations are shown in Appendix D.

6.4. Validation of Visual and Olfactory Exceedances

Areas identified during investigation as requiring removal or further investigation because of failures of the visual and olfactory (V/O) or for the presence of oil soaked soil or the presence of free phase are shown on drawing 5041216-REM-DWG-1978.

6.4.1. Building Area

The area around the proposed school building was deemed the most sensitive to the presence of V/O failures. Following reclamation the area was re-inspected at the surface and by a series of twenty two shallow pits which extended to between 1.0 and 1.5m below the base of the new profile

Note: The V/O division between V/O2 and V/O 4 for both building and playing fields areas is at 2m below FFL. For the building plot the excavation of V/O validation pits represents an examination of soils to a depth of between circa 2.5 and 3.5m below the proposed FFL.

Locations of the pits labelled SB1 to SB22 are shown on drawing 5041216-ATK-DR-REM-DWG-2118.

Are area around the former trial pits IP4095, IP4094, IP4105 was immediately identified as exceeding the criteria at the surface and a further 1m of material was removed. The area of this excavation can be seen of the as-built survey drawing the base of which now lies at approximately 2m below FFL.

Observations from the pits are presented below. Selected photographs are presented in Appendix D.

Location	Depth/Observation
SB1	1.1m Made Ground, grey mottled clay with cobbles – V/O 2/2
SB2	1.0m Made Ground, grey brown clayey sand – V/O 2/2
SB3	0-0.5m Made Ground grey cobbly sand – V/O 1/0 0.5- 1.2m / Made Ground sandy cobbly clay – V/O 1 /2
SB4	0-0.5m Made Ground - V/O 1/0 0.5 – 1.3 Made Ground sandy cobbly clay V/O 2/1
SB5	0-0.3m V/O 0/0 0.3 – 1.1m Made Ground gravelly sandy clay 2/3 <i>Note – base of dig is already at circa 2m below FFL</i>
SB6	0-1.0m Made Ground sandy gravelly clay 2/3 with rare oily residues on clay partings <i>Note – base of dig is already at circa 2m below FFL</i>
SB7	0-0.5m V/O 0/0 0.5 – 1.1m Made Ground gravelly sandy clay 3/3 <i>Note – base of dig is already at circa 2m below FFL</i>

SB8	0-1.2m Made Ground orange brown sandy clay V/O 0/0
SB9	0-1m Made Ground brick and sand over orange brown sandy clay V/O 0/0
SB10	0-1.0m Grey mottled clay – slight water seepage from the base V/O 0/0
SB11	0-1.0m loose brick cobbles grey sand and clay slight water seepage from the base with very slight sheen V/O 1/1
SB12	0-1.2m Made Ground sandy clay with bricks over brown sandy clay – water seepage from the base V/O 1/1
SB13	0-0.3m Made Ground brick cobbles with ash, sand and clay V/O 0/0 0.3 – 1.5m clayey sand V/O 0/0
SB14	0-1.1m grey light brown mottled clay V/O 0/0
SB15	0-1.0m Made Ground sandy clay with brick cobbles V/O 0/0
SB16	0-1.2m sandy cobbles over brown sandy clay, slight seepage at base V/O 1/1
SB17	0-1.1m orange brown sandy clay V/O 1/1 <i>Note – previous observation of free phase in IP4106 not repeated in SB17 circa 2.3m removed during reclamation no evidence of significant free phase is surrounding pits including SB18, 19 and 20.</i>
SB18	0-1.1m orange brown sandy clay V/O 1/1
SB19	0-0.5m orange brown mottled clay V/O 0/0 0.5 -1.0m stiff grey silt V/O 0/0
SB20	0-0.5m Made Ground cobbles with sand and some dispersed oily residues at the surface 3/2 0.5m-2.4m firm brown sandy clay V/O 0/0, 2/2 below 1.5m <i>Note: local residual surface oily residues removed at the time of excavation extent appeared very limited – circa 5m³ removed. This location was also chosen to validate the previous findings in IP4104</i>
SB21	0-1.0m firm brown sandy clay V/O 0/0
SB22	Following removal of elongated brick and concrete footing. 0-0.50m Made Ground bricks, cobbles, ash sandy clay V/O 0/0 0.5-1.0 sandy gravelly clay 1/1 to 2/3 <i>Note: V/O exceeding 2 are below 2m below FFL.</i>

Based on the observations above the area under the proposed school building is deemed to have achieved the requirements of the S106 and the agreed standards for V/O and for the removal of oil soaks soils and free product.

6.4.2. Playing Fields and Car Park Area

There were a number of V/O failures across the playing fields and car park area. The locations of these are shown on drawing 4041216-REM-DWG-1978.

Mitigation for each location is summarised below.

Location	Action/Observation
IP4071	Ground level at location is >2m below FFL
IP4072	Ground level at location is >2m below FFL
IP4097	Circa 2m removed during reclamation. Current ground level between 1 and 2m below FFL. Logs indicate acceptable visual criteria V=2 with O varying between 3 and 4. Post reclamation check undertaken of remaining material between 1 and 2m below estimated FFL(between 0 and 0.6m in thickness). All materials inspected were witnessed to be V/O 2/2 or less.
IP4096	
IP4089	

IP4099	Reclamation excavation has removed ground level at these locations to below the suspected V/O failures and into strata indicated to be V/O 2/2 or better.
IP4102	
IP103	
IP4123	
IP4125	
IP4143	
IP4128	During reclamation a more extensive area of visual and olfactory impact was noted – see section 6.4.3 for a summary of the mitigation works in this area.
IP4129	
IP141	
IP4145	Following reclamation the area was inspected and materials exceeding the V/O criteria remained present above the anticipated 2m below FFL level, although there was limited observation of the 'black' oil' noted on the log. A further 0.5 to 1m lowering in the area around IP4145 reduced the reclamation levels to a minimum of 2m below FFL. Drawing 5041216-ATK-DR-C-REM-2116 provides survey confirmation on reclamation levels in relation to proposed FFLs in this area.
IP4133	Between 1.1 and 1.8m of overburden was removed as part of the reclamation to provide a reclaimed surface that was between circa 0.7m and 1m below proposed FFL. Site investigation records indicated that V/O would exceed the criteria at this level. Given the substantial level of works undertaken a V/O re-validation was undertaken in this area comprising machine excavated pits to below 2m below FFL. See Photographs in Appendix D recording this exercise. At all locations the soils were found to be V/O 2/2 or better at levels of 2m FFL and above.
IP4137	

6.4.3. South West Corner – Observations and Actions

6.4.3.1. Observations

V/O failures were observed within IP4141, IP4128, IP4129 during the ground investigation. On exposure during reclamation the area of impact appeared more extensive and extended westwards over the boundary of the adjacent Monitor Phase 70. Exposed soils were noted to display strong pungent odours with a characteristic burnt chicken/sewage odour. The soils, although appearing natural and undisturbed, appeared wet on excavation with a grey brown colour and exhibited a 'tarry' texture which flowed under gravity (Photo 28 Appendix D).

Chemical analysis during the investigation and following exposure during reclamation indicated a mix of refinery related hydrocarbons and some additional compounds which were measured as tentatively identified compounds (TICS) during analysis. These compounds were:

- 2-methylphenol,
- 4-methylphenol
- 2-Methylnaphthalene
- Dimethyl disulphide,
- Methyl ethyl disulphide
- Diethyl disulphide.

The disulphide compounds especially could be linked to the characteristic odours. Their occurrence on the site could be linked to refinery operations and more precisely to historical process plant located immediately north-west of the site.

No screening values existed for these compounds and Atkins were commissioned to derive site specific screening criteria. Atkins report 5041216/REM/RPT/1455 provides information on the derivation of screening values. This report has been submitted to the Coed Darcy Monitor previously.

6.4.3.2. Remediation

Removal of this material was considered appropriate on account of its unusual physical characteristics and its strong odours. Removal was commenced on a visual basis and was undertaken as part of the general reclamation works. Photographs of the works are presented in Appendix D – photos 27, 28 and 29.

An approximate area of removal is indicated on drawing 5041216-ATK-DR-C-REM-DWG-2118., Excavations proceeded to levels where impacted material was no longer evident and the V/O score was 2/2 or better. In general, bedrock was typically no deeper than 1m below the base of the excavation on completion. Excavation was also undertaken across the Monitor Phase 70/Monitor Phase 33 boundary, which provided confidence that the likelihood of cross boundary recontamination would be minimised.

Excavated materials were taken off Monitor Phase 33 to a segregated area on the Coed Darcy treatment pad to await additional testing prior to treatment.

6.4.3.3. Validation of South West Area

Validation across the previously impacted south west area was undertaken on a V/O basis and by chemical testing.

Visual and Olfactory

A walkover survey was undertaken by Atkins on 15th September 2015. The V/O score across the reclaimed Monitor Phase 33 profile on completion was 2/2 or better. The odours present were largely mild petroleum hydrocarbon odours rather than the pungent odours noted above.

Chemical Testing

Given that there were no specific failures during the investigation, a post excavation sampling exercise was undertaken across a wide area of plausible impact, including the area specifically targeted for excavation. Thirty soil samples (SL001 – SL0030) were recovered by shallow excavation in exposed soil including at ten locations within the area of highest impact before excavation. The sampling locations are shown on drawing 5041216-ATK-DR-C-REM-DWG-2118. The screened chemical test results are presented in Appendix C.

No exceedances of the original RBSLs (>1m below FFL open space criteria) were recorded. It is noted that screening against the >1m below FFL residential criteria also only registered one modest failure, for benzene at locations SL0025 and SL0026. However, these locations are not beneath or within 5m of the school building.

In relation to the previously identified compounds there were no detections of these compounds at any of the sampling locations.

6.4.4. Bedrock Exposure

Bedrock was exposed at the surface in the far south-west corner of the site. On exposure the north-easterly facing profile exhibited oily residues with some free phases seepage noted along some rock bedding planes. The bedrock surface was scraped and left for observation with a collection trench formed at the base (see photo 26 Appendix D). Following reclamation bedrock has been exposed for approximately four months. Observations over this period indicate there to be no residual seepages of free phase oil and with only local slight sheening evident. The surface is predominantly V/O 2/2 or better.

7. Validation Frequencies

7.1. Validation Testing Requirements defined in the S106

The S106 (Schedule 8, Part 3, Paragraph 8) sets out the requirements for validation testing as part of the ongoing redevelopment of the refinery.

In line with Atkins report 5041216- REM-RPT-1275, the validation of in situ soils within the proposed school plot is undertaken in accordance with the frequencies outlined in Table 6.1.

Table 6.1 - Minimum Validation Testing Frequencies – Proposed School and playing fields

Testing for the Validation Suite at the following frequency:	Deeper Soils
Imported Soils from a verified Greenfield site	1 per 500m ³ , composite of 5 regular sub samples
Imported Soils from a brownfield site ³	1 per 100m ³ , composite of 5 regular sub samples
0.5m-1m below FFL in-situ	Regular grid of 1 per 100m ² , sample over 1.0m depth.
>1m below FFL in-situ building areas	Regular grid of 1 per 200m ² , sample over 1.0m depth.
>1m below FFL in-situ open space areas	Regular grid of 1 per 400m ² , sample over 1.0m depth.
Face of remedial excavations <1m deep.	n/a
Face of remedial excavations >1m deep.	1 per 10m ² , minimum of 1 per face, worst case VO sample.
Along redundant service excavations.	1 per 20m of trench, worst case VO sample.
Stockpiled excavated materials for re-use	1 per 100m ³ ex situ composite of 5 sub samples
Soil Treated ex situ and homogenised	1 per 200m ³ , composite of 5 regular sub samples.

¹ Validation suite to reflect prior use of the originating brownfield site and the design and purpose of the relevant area of Coed Darcy.

VO = visual/olfactory (i.e. aesthetic) observation

In the absence of information relating to proposed development levels for this area, it has been assumed that current ground level within Monitor Phase 33 (Drawing 5041216-REM-DWG-1935) represents a level of 1m below finished levels.

7.2. Validation Sampling

7.2.1. Ground Investigation and Post Reclamation Sampling

The locations of all exploratory holes are shown on Drawing 5041216-REM-DWG-1938 and 5041216-ATK-DR-C-DWG-2118. Relevant exploratory logs are presented in Appendix B.

A total of 68 trial pits were undertaken within Monitor Phase 33 in March 2015 as part of the ground investigation, 21 of which were located in the proposed school building footprint. During reclamation a further 19 validation sample points were created in the proposed playing fields area of the site and a further 22 additional observation excavations were undertaken across the building plot.

Excluding historic URS and asbestos quantification a total of 286 environmental soil samples from Monitor Phase 33 have been subject to laboratory analysis. This comprises 261 original

investigation analysis, 6 from validation excavations and 19 from the SW area validation (refer to Appendix C).

The overall area of Monitor Phase 33 is 20,600m².

Based on an approximate area of the school building of 2,600m², 21 trial pits equates to an approximate frequency of one pit per 123 m². Which complies with the proposed sampling frequency of 1 per 200m².

Based on an approximate remaining area of 18,000 m², 47 trial pits equates to an approximate frequency of one pit per 382m². Which complies with the proposed sampling frequency of 1 per 400m².

These validation frequencies are compliant with the adopted thresholds and S106 frequency (refer to Table 7.1) of 1 test per 200m² for in situ materials in an area of residential end-use within a school building setting, and 1 test per 400m² for in situ materials in an area of open space within a school setting.

7.3. Summary

A summary of the status of Monitor Phase 32, in line with the requirements of the S106 is presented in Table 5.2 below:

Table 5.2 – Validation Summary

Requirement	Status	Comment
Chemical quality of soils in situ	Complete	See Sections 5.4 and 6.2. Testing frequency compliant with proposed frequency for Monitor Phase 33.
VO quality of soils in situ	Complete	All soils compliant with the proposed criteria i.e. >1m <2m FFL = V/O 2/2 or better, >2m FFL V/O 4/4 or better.
Observations of groundwater for the presence of free phase product	Complete	Groundwater is considered to lie within the bedrock. Observations of bedrock on exposure and subsequent validation excavations indicate the absence of significant free phase.
Chemical and VO quality of imported material	N/A	No materials from outside the Coed Darcy site were imported to Monitor Phase 33 during the works.
Compliance with adopted thresholds	Complete	Following localised remediation no exceedances of chemical thresholds for the appropriate depth interval are recorded.
Removal of oil saturated soils	Complete	Oil saturated soils removed where observed.
Asbestos Assessment	Complete	Asbestos analysis was undertaken at an appropriate frequency on in-situ soils. Overburden removal removed the identified failures. There were no observations of visible asbestos during reclamation or backfilling works.
Control of seeps, sheens and iron staining from bedrock	N/A	No significant seeps and sheens observed within the site.

8. Summary

Atkins has been commissioned by St. Modwen Developments Ltd to undertake an assessment of an area of the former refinery with a view to enabling Monitor sign-off for this area in terms of a proposed school use. For the purpose of Monitor Sign off, this area shall be referred to as Monitor Phase 33.

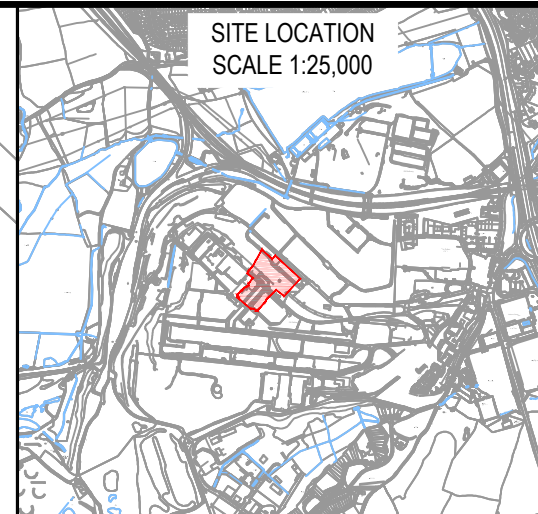
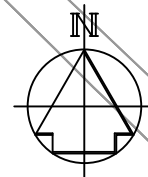
Based upon the findings of recent investigations and in line with the scope of recent reclamation and remedial works undertaken, this area has been validated in accordance with the S106 and Monitor Phase 33 has been deemed to be suitable for school end use >1m below FFL in line with the requirements of the S106.

It should be noted that recent ground investigation works focussed predominantly on contamination across this area and further assessment to assess potential geotechnical constraints within this Phase should be carried out prior to any proposed development.

Drawings

ATKINS

5041216-REM-DWG-1935



KEY

MONITOR BOUNDARY PHASE 33

REVISIONS

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PURPOSE OF ISSUE

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CLIENT

ST.MODWEN

PROJECT

COED DARCY

DRAWING TITLE

MONITOR BOUNDARY PHASE 33

SCALES

1:1000	DRAWN JSD	CHECKED CS	CO-ORD CHECK MM
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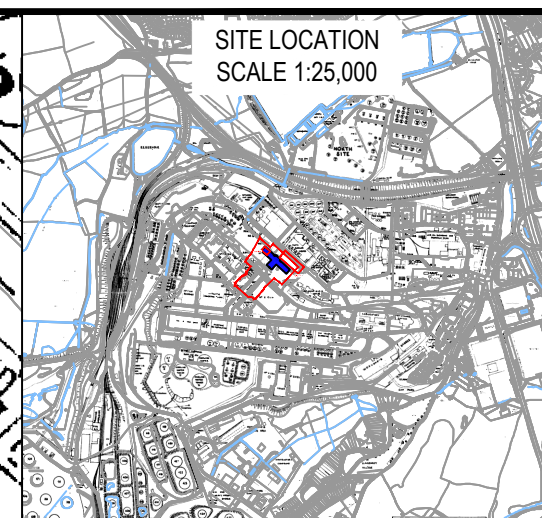
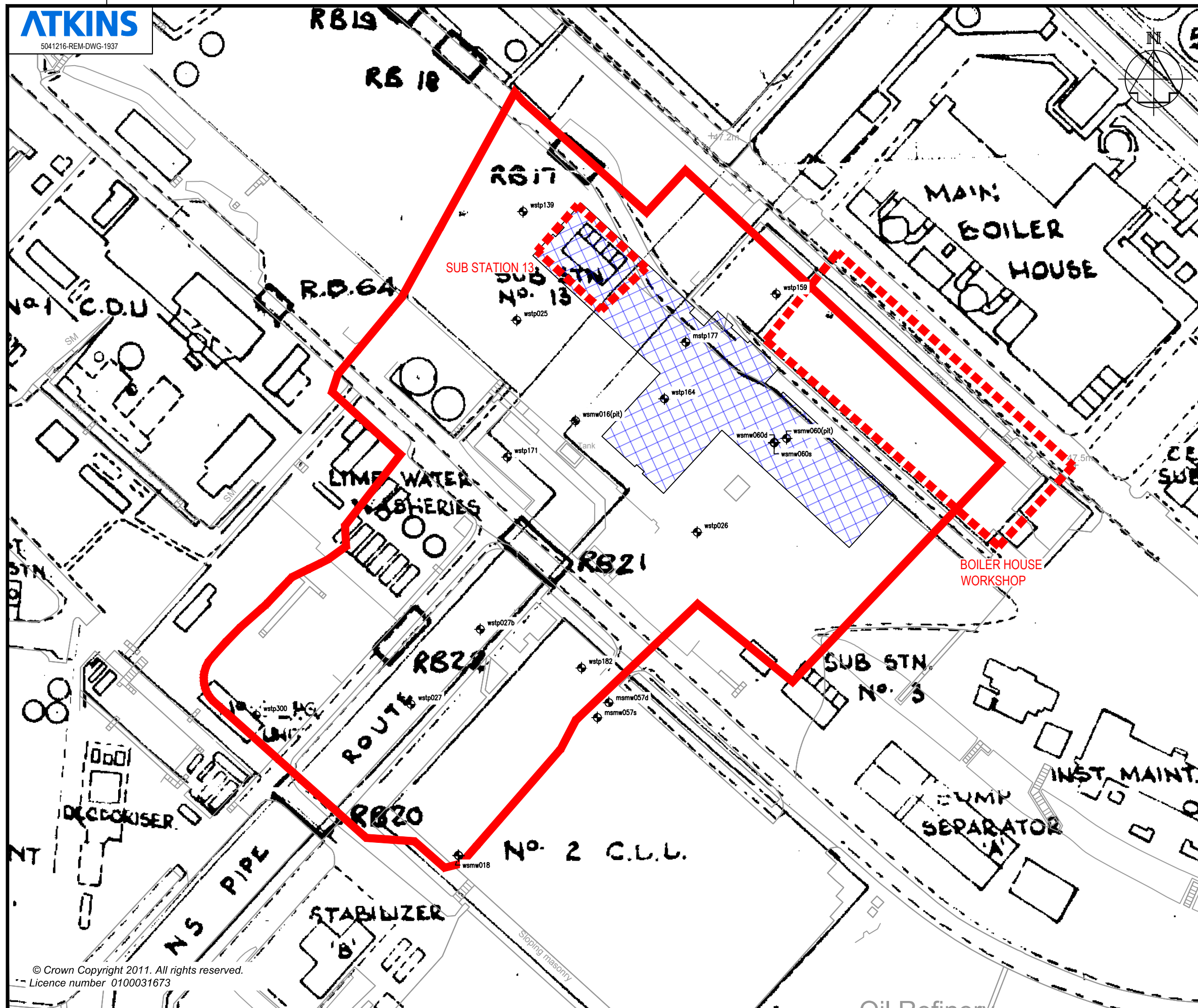
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KEY			
	MONITOR BOUNDARY PHASE 33		
	SPECIAL PROCESS AREA		
	PROPOSED SCHOOL BUILDING		

REVISIONS	Drawn By	Checked By	Date

PURPOSE OF ISSUE	Rev.	Authorised for issue	Date

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CLIENT	ST.MODWEN
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PROJECT	COED DARCY
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DRAWING TITLE	MONITOR BOUNDARY PHASE 33 HISTORICAL EXPLORATORY HOLE LOCATIONS
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