

St. Modwen Developments Ltd

Coed Darcy

Upper Terrace (Monitor Phase 30)

Validation Report

October 2014

ATKINS

Plan Design Enable

Coed Darcy

Upper Terrace (Monitor Phase 30)

Validation Report

October 2014

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Appendices

- Appendix A** Photographs – During Remediation
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- Appendix D** Atkins Technical Note 5104896-SBC-OUT-0081

Glossary of Terms

Term	Meaning / Definition
CSM	Conceptual Site Model
RSBL	Risk Based Screening Level
TPH	Total Petroleum Hydrocarbons
UXO	Unexploded Ordnance
PAH	Polycyclic Aromatic Hydrocarbons
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
FFL	Finished Floor Level*
ACM	Asbestos Containing Material
RAP	Remedial Action Plan
VO	Visual/Olfactory Observations
BGL	Below Ground Level
SSSI	Site of Special Scientific Interest

Executive Summary

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

This report provides confirmation of the scope of remedial and plot preparatory works across the western end of the Upper Terrace. For the purpose of Monitor sign off, this area has been referred to as Monitor Phase 30 (refer to Atkins Drawing 5041216/REM/DWG/1564A). This area is shown as residential housing within the current Masterplan for the final development.

The area has been reprofiled and a validation exercise has been undertaken. With the inclusion of the highlighted development requirements, this area is considered suitable for its proposed end use as a residential development.

1. Introduction

1.1 Client Brief & Scope of Works

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

This report relates to an area of residential housing within the western part of the Upper Terrace, as indicated on Drawing 5041216/REM/DWG/1564A. For the purpose of Monitor Sign off, this area has been proposed as Monitor Phase 30.

Validation reports covering the remainder of the Upper Terrace, to the east, have been issued previously (Atkins reports 5041216/300SD/RPT/828v3 and 5041216/PLOTS/RPT/850).

Details of the proposed development levels and layouts for this area are unknown. In the absence of information relating to proposed development levels across the Upper Terrace, ground levels for the purpose of the following assessment have been taken from the as built topographical survey as shown on Atkins Drawing 5041216/REM/DWG/1635A. These levels were designed in order to tie in with acceptable gradients relating to proposed primary infrastructure across the Upper Terrace.

This report will present the following:

- A summary of background information;
- A summary of remedial works undertaken.
- A summary of the reclamation and plot preparation works
- A summary of outstanding construction phase requirements relating to the proposed redevelopment of this area as residential housing.

It is anticipated that this document will form a submission under **Planning Condition 45** of the Outline Planning Permission for the site (P2005/0393), details of which are as below:

Upon completion of each phase of the remediation scheme and prior to the start of construction works to any building in each phase or development area, a report that provides verification that the required works regarding contamination have been carried out in accordance within the approved remediation scheme for that phase of development area, shall be submitted to and approved in writing by the Local Planning Authority. Post remediation sampling and monitoring results shall be included in the report to demonstrate that the required remediation objectives have been fully met. Future monitoring proposals and reporting timescales shall also be included in the submitted report and such monitoring shall be carried out as approved by the Local Planning Authority.

This document supplements previous reports by Atkins relating to this area, as highlighted in Section 1.3.

In order to maintain consistency for both historic and recent data, Atkins continues to use the same assessment standards as those used in the S106 Agreement (Dewey & LeBoeuf ref. GNP/JNR/13773-2). Details of the visual and olfactory classification system, defined within the S106, is provided as Table 1.1.

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 discernable in ambient air.
5	Visible hydrocarbon present.	Overwhelming odour.

**visible suspect Asbestos containing materials (ACMs). 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.*

A discussion of the adopted thresholds relating to this area has been previously provided as part of Atkins report 5041216/REM/RPT/645 (refer to Section 1.3). The adopted thresholds comprise a combination of the S106 Risk Based Screening levels (RBSLs) and Remedial Target Concentrations (RTCs) derived by Atkins (Atkins report 5041216-REM-REP-000216v3).

Both RBSLs and RTCs have been agreed as suitable for use by the Coed Darcy Monitor. For ease of reference, a table showing a summary of the adopted thresholds relating to this area is provided in Appendix C.

Based on the findings of previous investigations and monitoring, Monitor Phase 30 has been previously considered representative of a **'residential end use where groundwater is in rock'** scenario as defined in the S106. The recent reprofiling works across this area has confirmed this scenario as being correct.

1.2 Summary of Works Undertaken

Pre-remediation contours for Monitor Phase 30 are shown on Drawing 5041216/REM/DWG/1636.

This area was previously cleared of all unacceptable material and relict infrastructure including existing surface hardstanding. The existing landform was then reprofiled to form the desired ground model. In the absence of defined development levels, this model was based on proposed primary infrastructure across this area.

As the new model was lower than existing ground levels, the reprofiling earthworks largely comprised the removal of existing soils and rock from across Monitor Phase 30. Total earthworks, including structures breakout, remediation excavations and plot remodelling comprised the removal of approximately 141,623 m³. Excavated concrete was moved to the concrete stockpile for crushing and unacceptable/hydrocarbon impacted soils, encountered during the works, were removed from this area as part of the works.

Surplus rock, generated during the works, was removed from the former refinery and taken off site (refer to Appendix D). These materials were taken to the site of the new Swansea University Campus in order to raise ground levels in response to flooding risk.

Where necessary, the final surface was graded using excavated bedrock from within Monitor Phase 30, in order to achieve the ground levels as shown on the final as built topographical survey (Atkins drawing 5041216/REM/DWG/1635A).

1.3 Sources of Information

The following principal sources of information have been reviewed as part of the preparation of this report:

1. Section 106 Deed of planning Obligations (Dewey & LeBoeuf report GNP/NJR/13773-2). February 2008;
2. URS Report FR1287, Whole Site Investigation, August 2005.
3. Atkins report 5041216/REM/REP/000216 v3 Derivation of Remediation Target Criteria (January 2010).
4. Atkins report 5041216/REM/RPT/645. Proposed Persimmon Plot, Upper and Middle Terraces (August 2011). ,
5. Atkins report 5041216/REM/RPT/373. Central Processing Area East, Controlled Waters Risk Assessment (October 2011)

1.4 Limitations

The assessment of gas and groundwater conditions outlined within the following document is based on the data available at the time of writing. Gas and groundwater levels may vary due to atmospheric, seasonal or other effects.

In the absence of defined development levels, validation of Monitor Phase 30 has been based on 'as built' levels as shown on Drawing 5041216/REM/DWG/1635A.

The suitability of the remedial works may need to be reconfirmed once proposed development levels across this area are confirmed.

2. Review of Available Information

2.1 General

The former refinery has been subject to a number of previous investigations on behalf of the former owners BP. Salient detail from previous reports relating to the areas of the middle and upper terraces is summarised below.

2.2 The Site

2.2.1 General

Early historic maps record much of the former refinery to have been undeveloped and is shown as woodland.

Llandarcy Oil Refinery was first developed in 1921 to produce motor spirit, lubricating oil and fuel oils from crude oil. The refinery continued to expand until the late 1970s, however, from the mid 1980s a series of rationalisations occurred with notice being given to close the site in 1997.

Monitor Phase 30 comprises an area of proposed residential housing, based on the current Masterplan. The final development across this area will comprise the construction of housing with associated gardens, access roads and landscaping areas. No information on detailed development layouts are available at the time of writing.

A summary of anticipated remedial works relating to this area has been previously provided in Atkins report 5041216/REM/RPT/645 (refer to Section 1.3). Further detail relating to Monitor Phase 30 is provided below:

2.3 Site Context

Monitor Phase 30 occupies an area of approximately 28,512m² (2.89Ha) upon the Upper Terrace of an existing east to west trending sandstone ridge, within the central part of the former refinery.

Information on existing ground levels across Monitor Phase 30, prior to the start of remediation works, are presented on Drawing 5041216/REM/DWG/1636.

Selected photographs of this area during and after the recent reprofiling/remedial works are presented in Appendix A and B respectively.

2.3.1 Historical use

Information relating to the historical development of Monitor Phase 30 has been previously presented in Atkins report 5041216/REM/RPT/645.

Works plans of the former refinery suggest Monitor Phase 30 to have been formerly occupied by the former Vacuum Distillation Units (VDUs), Cooling Towers and electricity substation.

2.4 Published Geology

The British Geological Survey Sheet for Swansea (Sheet SS 79 NW) suggests this part of the refinery to be underlain directly by sandstone bedrock. Solid strata are suggested to dip towards the north or north north west.

There are no recorded faults shown to cross beneath this area.

2.5 Hydrogeology & Hydrology

The upper terrace represents a topographic 'high' within the former refinery. Groundwater beneath Monitor Phase 30 is believed to generally flow towards Crymlyn Bog to the west (Figures 9 and 10, URS FR1287).

The underlying sandstones are considered to be a Secondary A Aquifer, which are defined by the Environment Agency 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.'

2.6 Quarrying & Mining

The nearest coal seams recorded on geological maps are the Hughes and Bodwr seams, which are suggested to subcrop to the south of the upper and middle terrace and within the vicinity of the current Tank Farm Road and dip towards the north.

Historical quarrying and terracing is known to have taken place within the former refinery, as evident by the east-west trending sandstone exposed rock faces between the middle and upper terraces.

The potential risks relating to mineworkings beneath Monitor Phase 30 have been previously discussed in Atkins report 5041216/REM/RPT/645.

There are two recorded mine entries within the vicinity of Monitor Phase 30, as shown on Drawing 5041216/REM/DWG/1021. Discussion of previous investigation relating to these features is given in Section 5 of Atkins report 5041216/REM/RPT/645.

In line with the widespread removal of existing soils and shallow rock within the vicinity of the recorded shaft, it is assumed that this feature does not exist or, if present, lies outside of Monitor Phase 30 in terms of the proposed redevelopment of this area as residential housing.

2.7 Pre Remediation Recorded Ground Conditions

Historical investigation confirms sandstone bedrock at shallow depths across the entirety of Monitor Phase 30, with the maximum depth to bedrock being 3.00m, recorded within MSMW050 located in the north-west of the site (refer to Drawing 5041216/REM/DWG/1678).

Made Ground was observed within the majority of the exploratory holes and generally comprised a granular material (sand or gravel) containing cobbles, boulders, brick fragments, concrete, ash clinker and sandstone. Slag was observed locally.

2.8 Soil and Groundwater Contamination

Previous review of the available exploratory hole logs and chemical analysis across Monitor Phase 30 suggested historical evidence of asbestos containing materials and metals (refer to Atkins report 5041216/REM/RPT/645). Where present, such contamination appears to have been confined to existing shallow soils.

3. Outline Remediation Strategy

3.1 Section 106 Deed of Planning Obligations Requirements

Monitor Phase 30 has been previously shown to represent a '**residential end use where groundwater is in rock**' scenario, as outlined in the S106.

Based upon this classification, the remediation requirements outlined below are stated in the S106 (Schedule 8, Section 4.0) as being the minimum remediation requirements required in order to release this area for redevelopment as residential housing.

- *All oil saturated soils should be removed.*
- *All soils must be remediated so as to meet the RBSLs for TPH, BTEX and PAHs at the relevant depth relative to FFL and aesthetic criteria Class 2 or better at greater than 1m below FFL.*
- *The aesthetic quality of soils shall be Class 1 or better for at least the first metre below FFL.*
- *Soils where there is visible ash and clinker, or metal concentrations above RBSLs, are to be removed so that none is retained within the first metre below FFL in garden areas.*
- *Where it is not practicable to address groundwater contamination within bedrock, this must be controlled eg, where seeps, sheens and iron staining discharge from the bedrock. Acceptable methodologies for remediation may include, but are not limited to, the use of land drainage via interceptors. Control measures should result in no visible discharge at the surface and little or no odour observable.*
- *All soils 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 to meet the requirements of relevant Environmental Authorities, whichever is the more conservative.*

3.2 Proposed Scope of Works

3.2.1 General

In line with proposed earthworks model for this area, the proposed earthworks predominantly comprised the removal of surplus soils and a reduction in ground level across Monitor Phase 30.

In order to comply with the remediation requirements defined in the S106, the following general scope of works was proposed within Atkins report 5041216-REM-RPT-645 to be carried out, where necessary, in conjunction with the proposed removal of surplus soils and rock from Monitor Phase 30.

- *Removal of all oil saturated soils and/or free product.*
- *Removal of visible ash and clinker at <1m FFL.*
- *Removal of all soils with a visual/olfactory rating exceeding Class 2.*
- *Further investigation and removal of all identified asbestos contaminated materials.*
- *Removal of identified 'hotspots' of increased contamination, as identified during investigation to date.*

4. Reclamation and Plot Preparatory Works

4.1 Introduction and Programme

Remediation and plot preparatory works have been carried out in a number of across Monitor Phase 30, as below.

- Initial phase of demolition and removal of above ground structures and below ground structural remnants (December 2008 to February 2009).
- Complete site reprofiling, including removal of remaining below ground structures (December 2012 to April 2013)
- Validation site investigation (August 2013)
- Benching of the existing bedrock slope along the northern boundary (May 2014)

By combining the remedial and plot preparatory programme, additional clarity on remediation has been provided by:

- Allowing detailed inspection and wholesale segregation of 'unacceptable' materials encountered during the earthworks
- Assurance over the removal of remnant infrastructure.

Parties involved in the reclamation and remediation works are as follows:

Client – St Modwen Developments Ltd

Principle Contractor – Hawk Ltd

Employers Representative – Prosurv Consult

Employers Technical Representative – Atkins Ltd

Further details on the scope of works is provided below:

All works were carried out under the full time attendance of an Atkins Site Engineer.

4.2 Plot Reprofiling Works

Re-profiling of Monitor Phase 30 was undertaken predominantly during December 2012 to April 2013. Additional works were carried out during May 2014 in order to regrade the northern part of Phase 30 due to a change in the Phase boundary. Pre remediation levels are shown on drawing 5041216/REM/DWG/1636. Material was excavated down from these levels into the bedrock to produce a re-profiled surface, as shown on drawing 5041216/REM/DWG/1635A.

Reprofiling works were overseen by an Atkins Site Engineer on a full time basis who assisted with the visual selection of excavated materials from across Monitor Phase 30. Due to a surplus of materials, associated with a general reduction in ground levels, excavated materials were largely removed from Monitor Phase 30 as part of the works.

Reprofiling works entailed the removal of unacceptable and/or surplus material from across Monitor Phase 30 in order to create the required ground profile and comply with the requirements of the S106. This included approximately:

- Approximately 45,259m³ of residual soils (Made Ground and natural soils)
- Approximately 96,364m³ bedrock

On completion of the bulk earthworks, final reprofiling works comprised the placement of approximately 9,700m³ in order to 'tie in' with the adjacent ground levels. Reprofiling materials comprised surplus bedrock, excavated from with Monitor Phase 30.

4.3 Final Levels

Final 'as built' levels are shown on Drawing 5041216/REM/DWG/1635A.

5. Validation/Verification

5.1 Requirements of 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, relevant details from which are presented in Table 5.1.

Table 5.1 – Minimum Validation Testing Frequencies _ Residential End Use

Testing for the Validation Suite at the following frequency:	Shallow Soils (Residential <1m FFL)	Deeper Soils (Residential >1m below FFL)
0.5m-1m below FFL in-situ	Regular grid of 1 per 50m ² , sample over 0.5m depth.	n/a
>1m below FFL in-situ.	n/a	Regular grid of 1 per 100m ² , sample over 1.0m depth.
Face of remedial excavations <1m deep.	1 per 10m ² , minimum of 1 per face, worst case VO sample	n/a
Face of remedial excavations >1m deep.	n/a	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.	1 per 20m of trench, worst case VO sample.
Stockpiled excavated materials for re-use	1 per 50m ³ ex situ composite of 5 sub samples	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 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

Selected photographs taken during the remedial/plot preparatory works are presented in Appendix A.

Photographs of the final plot formation are presented within Appendix B.

5.2 Bedrock Validation

5.2.1 Visual/Olfactory Inspection

Details of finished levels, on completion of the works, are shown on Drawing 5041216/REM/DWG/1635A. For the purpose of validation, in accordance with the requirements of the S106, it has been assumed that this final profile represents the base of the clean cover (ie FFL minus 0.5m).

The result of a site walkover confirmed the final profile of the upper terrace to comprise exposed sandstone bedrock. In line with the presence of bedrock across the final surface, it was not possible to obtain representative soil samples for contamination testing. After discussion with the Monitor, and in line with the approach for bedrock validation adopted elsewhere within the site, an inspection of the surface was proposed on a 50m² grid to assess the presence of visual/olfactory contamination. The inspection was supplemented by use of a Photoionisation Detector and headspace bag, as agreed with the Monitor prior to the works.

Based on a 50m² grid overlain onto Monitor Phase 30 (refer to Drawing 5041216/REM/DWG/1714A), a total of 134 observations were undertaken to record visual/olfactory (V/O) classification but also to obtain a reading using a PID meter where a

classification of 1 or more was reported. These observations are presented on Atkins drawing 5041216\REM\DWG\1714A.

Evidence of contamination, up to a V/O class of VO=1 was identified at 8 locations on the upper terrace. In these areas, PID readings obtained recorded values of between 0.0ppm and 0.2ppm. The results of the VO assessment are compliant with the S106, which permits the retention of staining and/or odours up to Class 1 at depths of <1m below FFL within a proposed residential area.

Based on this assessment, the retention of such areas is not considered to pose a risk to the final development as proposed in this area.

No seeps or sheens were noted during the excavation works. This is consistent with previous assessment, which suggests groundwater beneath Monitor Phase 30 to lie at depth within the underlying bedrock.

No asbestos testing was undertaken as part of the validation of Monitor Phase 30. Given the widespread removal of shallow soils and rock, however, and the presence of sandstone bedrock across the current surface, the risk of significant asbestos within this area is considered to be low. The result of asbestos testing on shallow excavated soils and rock from across Monitor Phase 30 (refer to Appendix D) confirms low concentrations of asbestos within existing soils across this area. These materials were removed from the former refinery as part of the works.

Photographs showing the final profile of Monitor Phase 30 are presented within Appendix B.

5.3 Final Levels

Final levels are presented on drawing 5041216/REM/DWG/1635A. In the absence of any information relating to proposed development levels across this area, this surface represents a modified ground profile based on acceptable gradients for proposed primary infrastructure across the upper terrace.

For the purpose of contamination assessment, it has been assumed that this surface represents the base of clean cover materials, as required by the S106.

Where additional fill materials are required as part of the proposed development of this area, proposed fill materials should be tested, prior to placement, in order to confirm their suitability for re-use.

5.4 Summary

A summary of the status of Monitor Phase 30, 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	N/A	No insitu soils present. The final surface comprises sandstone bedrock.
VO quality of soils in situ	Complete	A maximum recorded VO of 1 was recorded for retained materials. The maximum PID reading recorded during inspection of the final surface was 0.2ppm.
Observations of groundwater for the presence of free phase product	N/A	Previous monitoring (Atkins report 5041216/REM/RPT/645) indicates groundwater to lie at depth within bedrock beneath this area. Groundwater was not encountered during any of the earthworks within this area.

Requirement	Status	Comment
Chemical and VO quality of imported material	N/A	No material was imported as part of these works.
Compliance with adopted thresholds	Complete	Refer to Section 5 and Appendix C. Given the widespread removal of shallow soils and rock, the risk of significant contamination across the final surface is considered to be low. This was confirmed by visual inspection across the exposed surface.
Removal of oil saturated soils	Complete	Any localised impacted soils were removed as part of the reprofiling works. Plot preparatory/reclamation works comprised a general reduction in levels and the removal of surplus soils/rock from across Monitor Phase 30.
Asbestos Assessment	Complete	The works comprised widespread removal of shallow soils and rock. Asbestos testing on excavated soils confirms low concentrations of asbestos (refer to Appendix D). The risk of asbestos across the current exposed surface is considered to be low.
Control of seeps, sheens and iron staining from bedrock	Complete	No seeps or sheens were observed during the works or as part of the final validation exercise.

6. Post Remediation Constraints and Development Requirements

6.1 Gas Protective Measures

The S106 requires the installation of gas membrane beneath proposed housing, as indicated below;

'As a minimum...the preventative measures shall include'

1.2.1 The installation of a proprietary and appropriate ground gas resistant membrane and appropriate venting system in all structures that will be entered by people and any structure where there is a potential for gas accumulation if ground gas is present. The Developer shall develop and adopt a Quality Assurance programme to which Coed Darcy Limited does not object to validate the integrity of the membrane and the adequacy of the venting system installed in each such structure.

It is recommended that the exact details of the proposed gas protection system to be installed beneath plots within Monitor Phase 30 is agreed by the Developer with the relevant regulatory authorities prior to installation

6.2 Ground and Construction Workers

This report and assessment of contamination risks does not specifically address occupational risks to workers involved in activities which could include exposure to existing soils/rock. A separate assessment should, however, be undertaken for all ground and construction workers involved in works across this area.

Given the removal of superficial soils and shallow bedrock across this area and the observations on the site during the validation, it is considered that the likelihood of encountering significant contamination across this current surface is low.

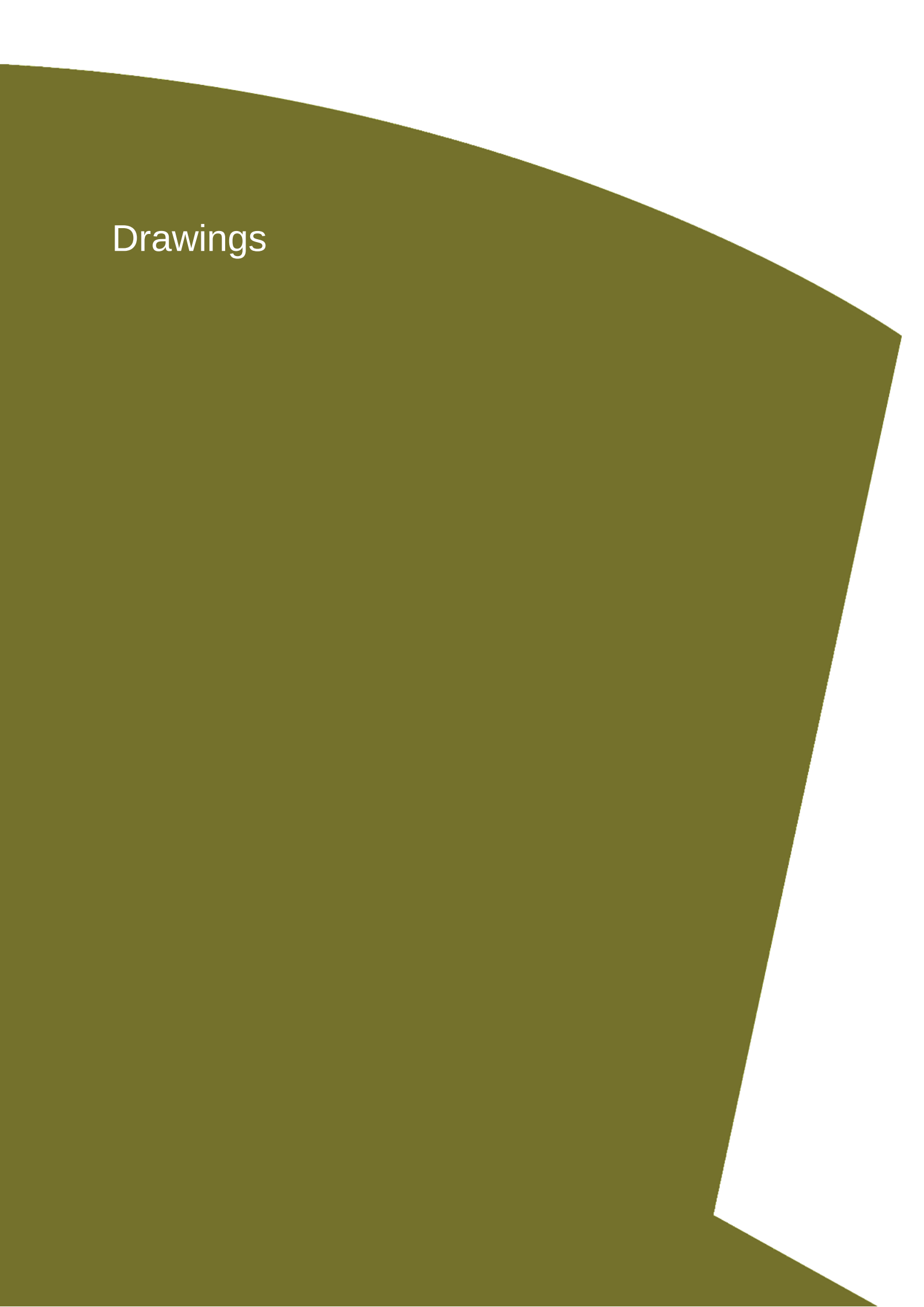
Good hygiene procedures and suitable Personal Protective Equipment (PPE) should, however, be adopted during any works. .

6.3 Clean cover

In the absence of defined plot levels, the current profile has been assumed to represent FFL-0.5m for the purpose of assessment against the requirements of the S106. Thus, in addition to the requirements outlined above, the S106 (Schedule 10, Section 8) also requires the placement of a cover of clean materials within proposed garden areas in the final development as detailed below:

'To provide them with a minimum thickness of suitable garden soils in residential areas, soils for landscaping in public and commercial areas and sub-base for hardsurfaced areas, the Developer shall build up the final elevation after completion of the RAP and Redevelopment Remediation Works with a minimum of 0.5m of quality controlled fill materials suitable for the use to which they are to be put and of better quality than all RBSLs for the relevant end use and meeting aesthetic type 0 for a residential end use and type 1 or better for a commercial end use'.

It is recommended that the suitability of materials proposed for use as clean cover is confirmed and agreed with relevant regulatory authorities prior to placement. It is envisaged that these materials across Monitor Phase 30 will be placed by the Developer in conjunction with the construction of proposed housing and associated infrastructure within this area.



Drawings



Atkins Limited

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Tel 01952 201234	©	Tel 0121 483 5000
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THIS DRAWING IS NOT TO BE SCALED

CLIENT 

PROJECT	COED DARCY MONITOR PHASE 30
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DRAWING TITLE

SCALES 1:1250	DRAWN MJ	CHECKED ML	CO-ORD CHECK
	DATE 13.02.14	DATE 13.02.14	DATE

0	SHEET A3	PLOT DATE 08.10.14
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DRAWING NO	5041216-REM-DWG-1678	REV	-
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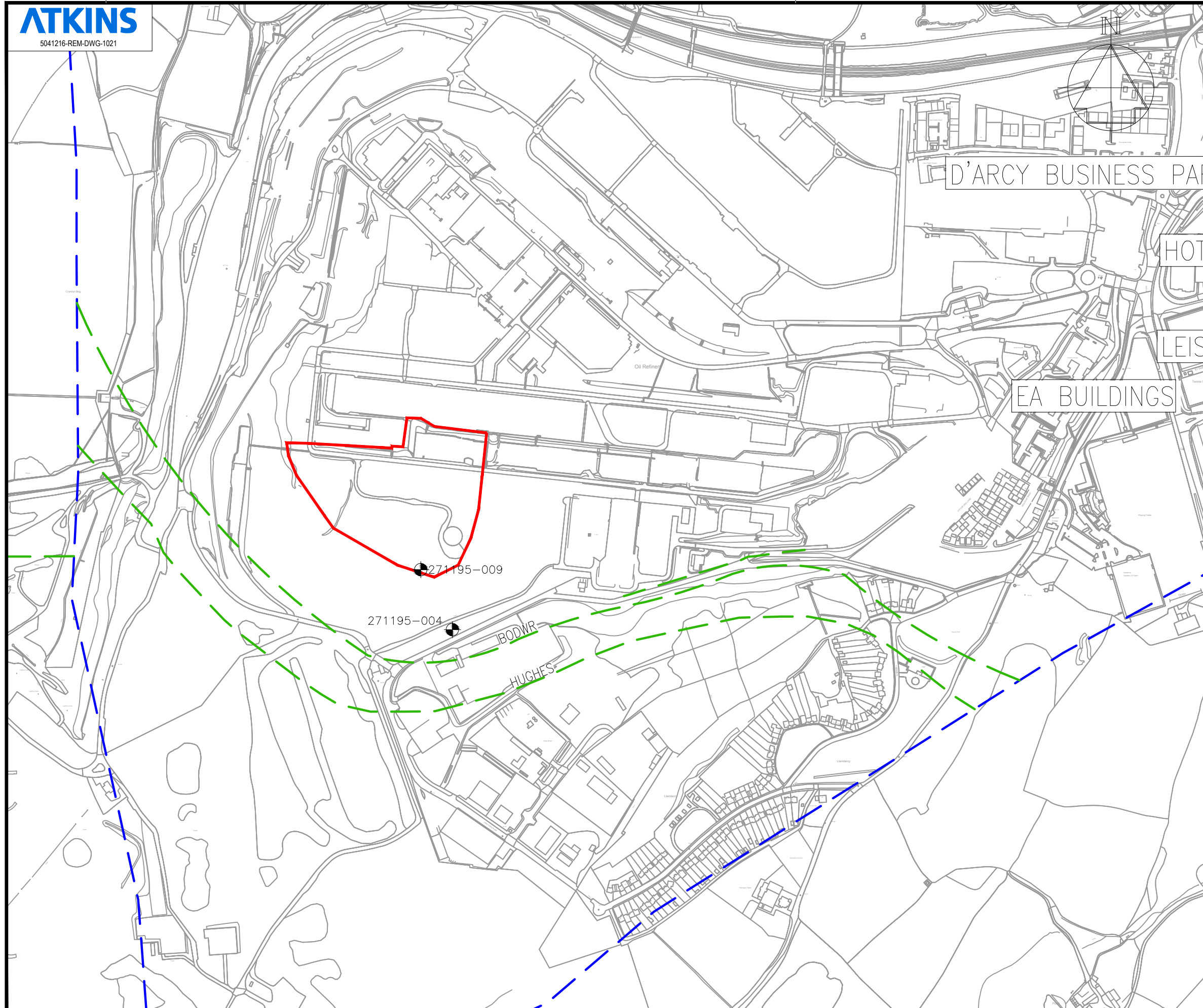
LEGEND:

--- Fault

--- Coal Crop

66 Dip Angle — As shown on Geological maps

Approximate locations taken from BGS sheet 79NW (1:10,560)



REVISIONS	Drawn By	Checked By	Date

PURPOSE OF ISSUE	Rev.	Authorised for issue	Date
Atkins Limited Telford Office Cornerstone House Stafford Park 13 Telford TF3 3AZ Birmingham Office The Axis, 10 Holliday Street Birmingham West Midlands B1 1TF Tel 01952 201234 Fax 01952 200981 Tel 0121 483 5000 Fax 0121 483 5252 © THIS DRAWING IS NOT TO BE SCALED			

CLIENT

ST.MODWEN

PROJECT

Coed Darcy Urban Village
Middle & Upper Terraces

DRAWING TITLE

Geological Information

SCALES	DRAWN	CHECKED	CO-ORD CHECK
1:5,000	B.S.	M.L.	
	DATE	DATE	DATE
	Aug. '11	Aug. '11	
DRAWING NO	SHEET	PLOT DATE	REV
5041216-REM-DWG-1021	A3	27.11.13	-

Key

Monitor Phase Boundary

Extent of Cliff Face

Track

A	BOUNDARY REVISED	MJ	ML	27/05/14
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REVISIONS	Drawn By	Checked By	Date
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PROJECT

COED DARCY

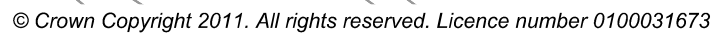
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PROPOSED PHASE BOUNDARY
MONITOR PHASE 30

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	DATE	DATE	DATE
	22.07.13	22.07.13	

0	SHEET A3	PLOT DATE 07.10.14
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DRAWING NO	REV
5041216-REM-DRG-1564	A



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GRID LOCATION

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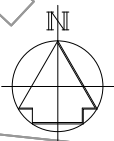
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COED DARCY SOUTHERN ACCESS ROAD

PHASE 30 TRIAL PITS AND VISUAL INSPECTION LOCATIONS

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Original Size	Date	Date	Date	Date
A3	-	10/09/14	-	
Drawing Number				Revision
5041216-REM-DWG-0001714				P 3



Key

- Monitor Phase Boundary
- 80.00m—— Contours

Extent of Cliff Face

A	BOUNDARY REVISED	MJ	JL	07/10/14
REVISIONS		Drawn By	Checked By	Date

PURPOSE OF ISSUE	Rev.	Authorised for issue	Date
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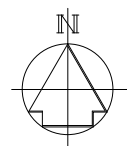
PROJECT	COED DARCY
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DRAWING TITLE	PHASE 30 AS BUILT DRAWING
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	DATE	DATE	DATE
	18/11/13	18/11/13	

0	SHEET A3	PLOT DATE 07.10.14
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DRAWING NO	5041216-REM-DWG-1635	REV	A
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KEY

- MONITOR PHASE
BOUNDARY (MONITOR
PHASE 30)
- CONTOURS

Extent of Cliff Face

Track

195700N

195650N

195600N

195550N

195500N

REVISIONS	Drawn By	Checked By	Date
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PURPOSE OF ISSUE	Rev.	Authorised for issue	Date
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PROJECT	COED DARCY
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DRAWING TITLE	PHASE 30 ORIGINAL GROUND LEVEL
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SCALES 1:1000	DRAWN JSD DATE 18/11/13	CHECKED ML DATE 18/11/13	CO-ORD CHECK DATE
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0	SHEET A3	PLOT DATE 13.10.14
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Appendices

Appendix A

Photographs - During Remediation



Photographs 1 and 2: Breaking and excavation of existing bedrock





Photographs 5 and 6: Re-profiling of final surface to achieve the desired profile



Appendix B

Photographs - Final Plot Profile



Photograph 1: Facing East across Monitor Phase 30 – Finished Profile



Photograph 2: Facing North across Monitor Phase 30 – Finished Profile



Photographs 3 and 4: Facing South across Monitor Phase 30 – Finished Profile





Photograph 5: Facing North across Monitor Phase 30 – Finished Profile



Photograph 6: Final 'stepped' profile along the northern boundary of Monitor Phase 30

Appendix C

Adopted Thresholds

Lowest of the Remedial Target Criterion/Risk Based Screening Level for Parks land use, Deep Soil (>1m)

Contaminant	Minimum of RTC (1%) / RBSL mg/kg	Minimum of RTC (3%) / RBSL mg/kg
Benzo(a)pyrene	>sat	>sat
Benzene	48	48
Toluene	>sat	>sat
Ethylbenzene	>sat	>sat
Xylene	478	1330
TPH aromatic C7-C8	>sat	>sat
TPH aromatic C8-C10	>sat	>sat
TPH aromatic C10-C12	>sat	>sat
TPH aromatic C12-C16	>sat	>sat
TPH aliphatic C6-C8	>sat	>sat
TPH aliphatic C8-C10	>sat	>sat
TPH aliphatic C10-C12	>sat	>sat
TPH aliphatic C12-C16	>sat	>sat
TPH aromatic C16-C21	>sat	>sat
TPH aromatic C21-C35	>sat	>sat
TPH aliphatic C16-C21	>sat	>sat
TPH aliphatic C21-C35	>sat	>sat
Total TPH (Phase 1)	>sat	>sat
Total TPH (Process Area)	>sat	>sat
Total TPH (North Tank Farm)	>sat	>sat
Total TPH (South Tank Farm)	>sat	>sat
1,2-Dichloroethane	6	6
1,1,1-Trichloroethane	>sat	>sat
Tetrachloroethene	1780	1780
Trichloroethene	269	269
Vinyl chloride	8.21	11.4
Dichloromethane	6220	6220
Cis-1,2-Dichloroethene	881	881
Trans-1,2 Dichloroethene	881	881
Acenaphthene	>sat	>sat
Anthracene	>sat	>sat
Benzo(a)anthracene	>sat	>sat
Benzo(b)fluoranthene	>sat	>sat
Benzo(g,h,i)perylene	>sat	>sat
Benzo(k)fluoranthene	>sat	>sat
Chrysene	>sat	>sat
Dibenz(ah)anthracene	>sat	>sat
Fluoranthene	>sat	>sat
Fluorene	>sat	>sat
Indeno(1,2,3-cd)pyrene	>sat	>sat
Pyrene	>sat	>sat
Phenol	>sat	>sat
Mercury (methyl)	>sat	>sat
Mercury (elemental)	>sat	>sat
Naphthalene	>sat	>sat
TPH aromatic C5-C7	432	928
TPH aliphatic C5-C6	>sat	>sat
1,1,1,2-Tetrachloroethane	>sat	>sat
1,1,2,2-Tetrachloroethane	>sat	>sat
Carbon tetrachloride	301	778
Chlorobenzene	>sat	>sat

Notes
1. Where the lower of the vapour or aqueous saturation limits has been exceeded by the RTC calculated, the hazard quotient is considered to be less than 1 and as such >sat has been presented
2. Xylene - Users must consider total exposure from all xylene isomers and not consider them in isolation. It should be noted that the value presented is the lowest of the aqueous or vapour saturation limits. The lowest saturation limit of the three isomers has been presented.
3. TPH aromatic C7-C8 is considered to comprise toluene only by Atkins
4. TPH >C16 are not considered to be volatile according to TPHCWG. Consequently the inhalation of vapour pathways have not been considered and therefore no value has been presented here
5. 'Total' TPH RBSL derived for an area of development, based on individual RBSL and available mass fraction TPH data in soil at time of derivation, using the inverse weighted average approach.
6. Benzo(a)pyrene RBSL to be compared against sum of 16 US EPA Priority List PAHs using Toxicity Equivalence approach
7. Asbestos has not been considered here as it is being considered in a separate report
8. Additivity for TPHs and PAHs to be undertaken in line with guidance in Atkins report 5041216-REM-RPT-00216
9. TPH aromatic C5-C7 is considered to comprise benzene only

Contaminant	Minimum of RTC (1%) / RBSL mg/kg	Minimum of RTC (3%) / RBSL mg/kg
Arsenic	64 a	64 a
Chromium	78 a	78 a
Cadmium	2.6	2.6
Mercury (inorganic)	1 b	1 b
Nickel	75 b	75 b
Selenium	3 b	3 b
Lead	337 a	337 a
Vanadium	351	351
Copper	143 a	143 a
Zinc	478 a	478 a
Benzo(a)pyrene	0.9	0.9
Benzene	13	13
Toluene	8110	8110
Ethylbenzene	4740	4740
Xylene	7940	7940
TPH aromatic C7-C8	21300	21300
TPH aromatic C8-C10	2230	2310
TPH aromatic C10-C12	2300	2340
TPH aromatic C12-C16	2330	2350
TPH aliphatic C6-C8	294000 *	294000 *
TPH aliphatic C8-C10	5740 *	5740 *
TPH aliphatic C10-C12	5700	5830
TPH aliphatic C12-C16	5800	5860
TPH aromatic C16-C21	1450	1450
TPH aromatic C21-C35	1450	1450
TPH aliphatic C16-C35	159000	159000
TPH aliphatic C21-C35	159000	159000
Total TPH (Phase 1)	9060	9060
Total TPH (Process Area)	10800	10800
Total TPH (North Tank Farm)	9420	9420
Total TPH (South Tank Farm)	6350	6350
1,2-Dichloroethane	4.5	4.5
1,1,1-Trichloroethane	27900	27900
Tetrachloroethene	641	641
Trichloroethene	193	193
Vinyl chloride	0.7	0.7
Dichloromethane	241	241
Cis-1,2-Dichloroethene	392	468
Trans-1,2 Dichloroethene	632	632
Acenaphthene	5340	5350
Anthracene	26800	26800
Benzo(a)anthracene	20.8	21.1
Benzo(b)fluoranthene	21.3	21.3
Benzo(g,h,i)perylene	218	218
Benzo(k)fluoranthene	215	215
Chrysene	2090	2090
Dibenz(ah)anthracene	2.16	2.16
Fluoranthene	3570	3570
Fluorene	3570	3570
Indeno(1,2,3-cd)pyrene	21.2	21.2
Pyrene	2680	2680
Phenol	859	859
Mercury (methyl)	19.4	19.4
Mercury (elemental)	4.3	12.9
Naphthalene	955	1340
TPH aromatic C5-C7	26.2	27.5
TPH aliphatic C5-C6	294000	294000
1,1,1,2-Tetrachloroethane	498	533
1,1,2,2-Tetrachloroethane	516	539
Carbon tetrachloride	111	128
Chlorobenzene	170	170

Notes
1. It is assumed that no visible free product is present within the top 1.0m of soil
2. Metal RTC derived considering Soil Codes and background data
a – based on background soil concentration
b – based on Soil Code
3. Xylene - the lowest RTC of the three isomers has been presented. Users must consider total exposure from all xylene isomers and not consider them in isolation
4. TPH aromatic C7-C8 is considered to comprise toluene only by Atkins
* 5. The RTC for TPH aliphatic C5-C6, TPH aliphatic C6-C8 and TPH aliphatic C8-C10 are based on a value produced from following the approach outlined in SR4 for substances at saturation
6. TPH >C16 are not considered to be volatile according to TPHCWG. Consequently the inhalation of vapour pathways have not been considered
7. 'Total' TPH RBSL derived for an area of development, based on individual RBSL and available mass fraction TPH data in soil at time of derivation, using the inverse weighted average approach.
8. Benzo(a)pyrene RBSL to be compared against sum of 16 US EPA Priority List PAHs using Toxicity Equivalence approach
9. Asbestos has not been considered here as it is being considered in a separate report
10. Additivity for TPHs and PAHs to be undertaken in line with guidance in Atkins report 5041216-REM-RPT-00216
11. Elemental mercury is based on the inhalation pathway only and the saturation limit has been presented
12. TPH aromatic C5-C7 is considered to comprise benzene only

Contaminant	Minimum of RTC (1%) / RBSL mg/kg	Minimum of RTC (3%) / RBSL mg/kg
Benzo(a)pyrene	>sat	>sat
Benzene	0.4	0.4
Toluene	52	52
Ethylbenzene	140	140
Xylene	58	58
TPH aromatic C7-C8	146	146
TPH aromatic C8-C10	71	209
TPH aromatic C10-C12	1390	1390
TPH aromatic C12-C16	>sat	>sat
TPH aliphatic C6-C8	>sat	>sat
TPH aliphatic C8-C10	42.5	125
TPH aliphatic C10-C12	>sat	>sat
TPH aliphatic C12-C16	>sat	>sat
TPH aliphatic C16-C21	>sat	>sat
TPH aliphatic C21-C35	>sat	>sat
TPH aromatic C16-C21	>sat	>sat
TPH aromatic C21-C35	>sat	>sat
Total TPH (Phase 1)	9180	9180
Total TPH (Process Area)	4100	4100
Total TPH (North Tank Farm)	3800	3800
Total TPH (South Tank Farm)	2790	2790
1,2-Dichloroethane	0.0111	0.0176
1,1,1-Trichloroethane	10.8	25.9
Tetrachloroethene	2.3	6.12
Trichloroethene	0.188	0.463
Vinyl chloride	0.00093	0.00129
Dichloromethane	4.19	6.04
Cis-1,2-Dichloroethene	0.206	0.392
Trans-1,2 Dichloroethene	0.332	0.689
Acenaphthene	>sat	>sat
Anthracene	>sat	>sat
Benzo(a)anthracene	>sat	>sat
Benzo(b)fluoranthene	>sat	>sat
Benzo(g,h,i)perylene	>sat	>sat
Benzo(k)fluoranthene	>sat	>sat
Chrysene	>sat	>sat
Dibenz(ah)anthracene	>sat	>sat
Fluoranthene	>sat	>sat
Fluorene	>sat	>sat
Indeno(1,2,3-cd)pyrene	>sat	>sat
Pyrene	>sat	>sat
Phenol	1030	2340
Mercury (methyl)	27.7	62.5
Mercury (elemental)	0.291	0.87
Naphthalene	2.8	8.02
TPH aromatic C5-C7	0.46	0.987
TPH aliphatic C5-C6	112	246
1,1,1,2-Tetrachloroethane	1.84	5.09
1,1,2,2-Tetrachloroethane	4.71	11.3
Carbon tetrachloride	0.0309	0.0801
Chlorobenzene	17.9	47.9

Notes

- Where the lower of the vapour or aqueous saturation limits have been exceeded by the RTC calculated, the hazard quotient is considered to be less than 1 and as such >sat has been presented
- Xylene - the lowest RTC of the three isomers has been presented. Users must consider total exposure from all xylene isomers and not consider them in isolation
- TPH >C16 are not considered to be volatile according to TPHCWG. Consequently the inhalation of vapour pathways have not been considered and therefore no RTC value has been presented here
- 'Total' TPH RBSL derived for an area of development, based on individual RBSL and available mass fraction TPH data in soil at time of derivation, using the inverse weighted average approach.
- Benzo(a)pyrene RBSL to be compared against sum of 16 US EPA Priority List PAHs using Toxicity Equivalence approach
- TPH aromatic C7-C8 is considered to comprise toluene only by Atkins
- Asbestos has not been considered here as it is being considered in a separate report
- Additivity for TPHs and PAHs to be undertaken in line with guidance in Atkins report 5041216-REM-RPT-00216
- TPH aromatic C5-C7 is considered to comprise benzene only

Lowest of the Remedial Target Criterion/Risk Based Screening Level for Residential with the Consumption of Produce land use, Shallow Soil.

Contaminant	Minimum of RTC (1%) / RBSL mg/kg	Minimum of RTC (3%) / RBSL mg/kg
Arsenic	64 a	64 a
Chromium	78 a	78 a
Cadmium	2.6	2.6
Mercury (inorganic)	1 b	1 b
Nickel	50	50
Selenium	3 b	3 b
Lead	337 a	337 a
Vanadium	113	115
Copper	143 a	143 a
Zinc	478 a	478 a
Benzo(a)pyrene	0.9	0.9
Benzene	0.0493	0.12
Toluene	36	36
Ethylbenzene	38.2	41
Xylene	17.2	32
TPH aromatic C7-C8	86.9	125
TPH aromatic C8-C10	14.8	94
TPH aromatic C10-C12	57.3	118
TPH aromatic C12-C16	131	131
TPH aliphatic C6-C8	69.8	8340
TPH aliphatic C8-C10	9.76	87.1
TPH aliphatic C10-C12	1780 *	3200
TPH aliphatic C12-C16	4510	4510
TPH aromatic C16-C21	82	82
TPH aromatic C21-C35	888	1130
TPH aliphatic C16-C21	94200	94200
TPH aliphatic C21-C35	94800	94800
Total TPH (Phase 1)	1720	1720
Total TPH (Process Area)	2600	2600
Total TPH (North Tank Farm)	1100	1100
Total TPH (South Tank Farm)	1020	1020
1,2-Dichloroethane	0.0019	0.0102
1,1,1-Trichloroethane	2.23	17.3
Tetrachloroethene	0.455	3.62
Trichloroethene	0.0382	0.304
Vinyl chloride	0.000202	0.00082
Dichloromethane	0.458	1.56
Cis-1,2-Dichloroethene	0.0393	0.255
Trans-1,2-Dichloroethene	0.0671	0.464
Acenaphthene	588 *	1380
Anthracene	8270	14800
Benzo(a)anthracene	7.56	16.5
Benzo(b)fluoranthene	20	23.9
Benzo(g,h,i)perylene	235	248
Benzo(k)fluoranthene	216	243
Chrysene	1500	2220
Dibenz(ah)anthracene	1.97	2.39
Fluoranthene	822	1630
Fluorene	615	1390
Indeno(1,2,3-cd)pyrene	19.2	23.6
Pyrene	563	1150
Phenol	162	349
Mercury (methyl)	6.28	11.3
Mercury (elemental)	0.0607	0.583
Naphthalene	0.585	5.05
TPH aromatic C5-C7	0.0493	0.192
TPH aliphatic C5-C6	30.1	172
1,1,1,2-Tetrachloroethane	0.353	2.78
1,1,2,2-Tetrachloroethane	0.695	3.63
Carbon tetrachloride	0.00656	0.0541
Chlorobenzene	1.06	3.38

Notes

1. It is assumed that no visible free product is present within the top 1.0m of soil
2. Metal RTC derived considering Soil Codes and background data
- a – based on background soil concentration
- b – based on Soil Code
3. Xylene - the lowest RTC of the three isomers has been presented. Users must consider total exposure from all xylene isomers and not consider them in isolation
4. TPH aromatic C7-C8 is considered to comprise toluene only by Atkins
- * 5. The RTC for TPH aliphatic C10-C12 and acenaphthene is based on a value produced from following the approach outlined in SR4 for substances at saturation
6. 'Total' TPH RBSL derived for an area of development, based on individual RBSL and available mass fraction TPH data in soil at time of derivation, using the inverse weighted average approach.
7. Benzo(a)pyrene RBSL to be compared against sum of 16 US EPA Priority List PAHs using Toxicity Equivalence approach
8. Asbestos has not been considered here as it is being considered in a separate report
9. Additivity for TPHs and PAHs to be undertaken in line with guidance in Atkins report 5041216-REM-RPT-00216
10. Phenol is derived by comparing the oral exposure to the oral HCV and the dermal and inhalation exposure to the inhalation HCV
11. Elemental mercury is based on inhalation pathways only
12. TPH aromatic C5-C7 is considered to comprise benzene only

Contaminant	Minimum of RTC/RBSL mg/L
Benzo(a)pyrene	>sat
Benzene	0.0888
Toluene	47
Ethylbenzene	13.4
Xylene	4.1
TPH aromatic C7-C8	20
TPH aromatic C8-C10	0.985
TPH aromatic C10-C12	3.87
TPH aromatic C12-C16	>sat
TPH aromatic C16-C21	>sat
TPH aromatic C21-C35	>sat
TPH aliphatic C6-C8	1.4
TPH aliphatic C8-C10	0.0296
TPH aliphatic C10-C12	0.0228
TPH aliphatic C12-C16	>sat
TPH aliphatic C16-C21	>sat
TPH aliphatic C21-C35	>sat
1,2-Dichloroethane	0.0373
1,1,1-Trichloroethane	13.1
Tetrachloroethene	1.66
Trichloroethene	0.222
Vinyl chloride	0.00248
Dichloromethane	13
Cis-1,2 Dichloroethene	0.547
Trans-1,2 Dichloroethene	0.675
Acenaphthene	>sat
Anthracene	>sat
Benzo(a)anthracene	>sat
Benzo(b)fluoranthene	>sat
Benzo(k)fluoranthene	>sat
Chrysene	>sat
Dibenz(ah)anthracene	>sat
Fluoranthene	>sat
Fluorene	>sat
Indeno(1,2,3-cd)pyrene	>sat
Pyrene	>sat
Phenol	1700
Mercury (methyl)	45.5
Mercury (elemental)	0.00463
Naphthalene	0.952
TPH aromatic C5-C7	0.0888
TPH aliphatic C5-C6	1.93
1,1,1,2-Tetrachloroethane	1.05
1,1,2,2-Tetrachloroethane	6.89
Carbon Tetrachloride	0.0229
Chlorobenzene (mono)	13.7

Notes
1. Xylene - the lowest RTC of the three isomers has been presented. Users must consider total exposure from all xylene isomers and not consider them in isolation
2. TPH aromatic C7-C8 is considered to comprise toluene only by Atkins
3. Where indoor and outdoor values were presented by RBCA, these have been integrated in line with SNIFFER (2003). Where both indoor and outdoor values derived by RBCA were greater than the saturation limit, >sat has been presented. Where indoor values were presented by RBCA, and the outdoor values were >sat, only the indoor values have been presented. Therefore >sat indicates that the theoretical RTC is greater than solubility limit.
4. TPH >C16 are not considered to be volatile according to TPHCWG. Consequently the inhalation of vapour pathways have not been considered
7. Additivity for TPHs and PAHs to be undertaken in line with guidance in Atkins report 5041216-REM-RPT-00216
8. TPH aromatic C5-C7 is considered to comprise benzene only by Atkins

Appendix D

Atkins Technical Note 5104896-SBC-
OUT-0089

Technical Note 81

Subject: Swansea University Bay Campus
Validation of Imported Materials – Additional Data

Reference:	5104896-SBC-OUT-0081	Revision:	1
Author:	Selina Bamforth	Checker:	Michelle Lee
Issued to:	Neath Port Talbot County Borough Council	Reviewer:	Mike Poland
Date:	18 th February 2013	Authoriser:	Mike Hunting

1. Introduction

This Technical Note has been prepared as an addendum to Atkins Technical Notes 0069 and 0076.

Atkins is required to report the quality of the material in order to discharge Planning Condition 22, as highlighted in recent Environment Agency comments (SH/2012/114133/01-L01). This Technical Note is also proposed for use as supporting information to a Materials Management Plan which is being prepared in order to enable the movement of materials, in accordance with the CL:AIRE Code of Practice 'The Definition of Waste'.

2. Sources of Material

Proposed source materials have been generated during the re profiling of an area of proposed residential housing at Coed Darcy. The housing lies across the upper part of an east-west trending sandstone ridge which runs through the centre of the former refinery. Previous discussion relating to ground conditions across this area have been provided in the remediation strategy for this area (Atkins report 5041216/REM/RPT/645, August 2011). This indicates the area of the source area to have been formerly occupied by the Cooling Towers within the refinery and does not indicate any 'hotspots' of contamination based on a review of previous investigation information.

Surplus materials, generated as part of the works, comprise both natural superficial soils and underlying bedrock. Superficial soils are described as a gravelly clay and/or cobbly, sandy gravel. Geotechnical analysis (attached) indicates these to represent Class 1A or 2C materials, in line with Series 600 of Volume 1 :Specification for Highway Works (Manual of Contract Documents for Highway Works).

The underlying bedrock comprises a brown – grey tabular sandstone. These materials are to be processed prior to its removal from the former Oil Refinery, to a '300mm down' material, compliant with the requirements of Atkins drawing 5104896_SBC_DWG-GE-0095.

This Technical Note details the findings of chemical analyses on these materials.

3. Assessment and Verification Sampling of Suitable fill

Reprofiling earthworks were monitored and both materials were visually screened during excavation to ensure no visual and olfactory evidence of contamination.

A total of 56 samples have been taken by Atkins from stockpile 66 (sandstone bedrock) and 31 samples from stockpile 67 (natural superficial soils). The results of the analyses are summarised in Tables 1 to 4.

Concentrations of all chemical determinands for both materials were found to lie well below the permitted thresholds ¹. On the basis of these results, both the sandstone and the superficial soils are deemed suitable for import and placement as part of the redevelopment of Swansea University Bay Campus site.

Quantitative asbestos testing demonstrate that all concentrations lie well below the 0.1% threshold required for the imported fill.

Copies of laboratory certificates are attached for reference.

Tables 1 and 2: Stockpile 66 (Bedrock materials). Summary of reported contamination in bedrock materials proposed for use on Swansea University Bay Campus Site.

METALS	Screening concentration (mg/kg)	Minimum concentration (mg/kg)	Maximum concentration (mg/kg)
Arsenic	184	3.39	46.20
Cadmium	82.2	0.27	1.88
Chromium	89.9	12.40	25.30
Copper	40400	5.51	201.00
Lead	3280	11.70	74.20
Mercury	1850	0.14	0.27
Nickel	473	32.70	90.40
Selenium	8130	1.00	10.00
Zinc	568000	69.20	604.00

HYDROCARBONS	Screening concentration (ug/kg)	Minimum concentration (ug/kg)	Maximum concentration (ug/kg)
Aliphatics >C5-C6	160000	10	14.6
Aliphatics >C6-C8	1740000000	2	19.8
Aliphatics >C8-C10	68200	3	8.5
Aliphatics >C10-C12	54800000	6	35.5
Aliphatics >C12-C16	60200000	3	6.49
Aromatics >EC7-EC8	33700000	10.8	109
Aromatics >EC5-EC7	451	13.3	277
Aromatics >EC8-EC10	80100	10	810
Aromatics >EC10-EC12	9810000	10	3680
Aromatics >EC12-EC16	23600000	100	47500
Aromatics >EC16-EC21	10000000	11.5	19.8
Aromatics >EC21-EC35	10000000	14.6	14.6
Benzene	451	11	555
Toluene	33700000	10.9	2450
Ethylbenzene	286000	605	13400
m,p-Xylene	98900	1570	57400
o-Xylene	98900	3240	204000

Tables 3 & 4: Stockpile 67 (Superficial materials). Summary of reported contamination in superficial soils proposed for use on Swansea University Bay Campus Site.

METALS	Screening concentration (mg/kg)	Minimum concentration (mg/kg)	Maximum concentration (mg/kg)
Arsenic	184	5.54	46.2

Cadmium	82.2	0.268	1.88
Chromium	89.9	15.2	25.3
Copper	40400	5.51	201
Lead	3280	14	74.2
Mercury	1850	0.14	0.274
Nickel	473	33.8	90.4
Selenium	8130	1	10
Zinc	568000	77.7	604

HYDROCARBONS	Screening concentration (ug/kg)	Minimum concentration (ug/kg)	Maximum concentration (ug/kg)
Benzene	451	10	14.6
Toluene	33700000	2	19.8
Ethylbenzene	286000	3	8.5
m,p-Xylene	98900	6	23.5
o-Xylene	98900	3	6.49
Aliphatics >C5-C6	160000	10.8	40.3
Aliphatics >C6-C8	1740000000	13.3	165
Aliphatics >C8-C10	68200	10	810
Aliphatics >C10-C12	54800000	10	3680
Aliphatics >C12-C16	60200000	100	47500
Aromatics >EC7-EC8	33700000	19.8	19.8
Aromatics >EC5-EC7	451	14.6	14.6
Aromatics >EC8-EC10	80100	11	555
Aromatics >EC10-EC12	9810000	13.2	2450
Aromatics >EC12-EC16	23600000	999	13400
Aromatics >EC16-EC21	10000000	1570	57400
Aromatics >EC21-EC35	10000000	3680	204000

- ¹ Permitted thresholds derive from the risk assessment dated 12 July 2010 and prepared by Hannah White of Atkins Limited in Technical Note reference 5077146-TRA-OUT-0020 and the Controlled Waters Risk Assessment dated January 2011 and prepared by Michael Roper/Leon Warrington of Hydrock Contracting Ltd Reference R10020/004

Appendix A – Certificate of Analysis (Chemical)

Appendix B – Certificate of Analysis (Geotechnical)

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St. Modwen Developments Ltd

Coed Darcy

St Modwen Homes (Monitor Phase 31)

Validation Report

January 2015

ATKINS

Coed Darcy

St Modwen Homes (Monitor Phase 31)

Validation Report

January 2015

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Atkins Limited

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5041216-REM-DWG-1740	Pre-remediation Ground Levels
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Appendix B	Proposed Development Levels/Plot Layouts
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Glossary of Terms

Term	Meaning / Definition
CSM	Conceptual Site Model
RSBL	Risk Based Screening Level
TPH	Total Petroleum Hydrocarbons
UXO	Unexploded Ordnance
PAH	Polycyclic Aromatic Hydrocarbons
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
FFL	Finished Floor Level*
ACM	Asbestos Containing Material
RAP	Remedial Action Plan
VO	Visual/Olfactory Observations
BGL	Below Ground Level
SSSI	Site of Special Scientific Interest

Executive Summary

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

This report provides confirmation of the scope of remedial and plot preparatory works across an area of proposed residential housing, to be constructed by St Modwen Homes.

The area has been remediated, reprofiled and a validation exercise has been undertaken. With the inclusion of the highlighted development requirements, this area is considered suitable for use as a residential development, as proposed.

1. Introduction

1.1 Client Brief & Scope of Works

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

This report relates to an area of proposed residential housing to be constructed by St Modwen Homes. The extent of this area is presented on Drawing 5041216/REM/DWG/1565B. For the purpose of Monitor Sign off, this area has been proposed as Monitor Phase 31.

At the time of writing, Reserved Matters Applications has been submitted for the area including elements of primary infrastructure (Road 50), public open space and residential development. Outline details of development levels and proposed layouts for the residential elements, where known, are presented on Rodgers Leask Drawings P13-268 309 and 310 in Appendix B. Further Reserved Matters Applications are anticipated in relation to the development of the remainder of Monitor Phase 31 at some time in the future.

This report will present the following:

- A summary of background information relating to Monitor Phase 31;
- A summary of remedial/reclamation works undertaken across this Phase.
- Details of current ground conditions and validation testing.
- A summary of outstanding construction phase requirements relating to the proposed redevelopment of this area as residential housing.

It is anticipated that this document will form a submission under **Planning Condition 45** of the Outline Planning Permission for the site (P2005/0393), details of which are as below:

Upon completion of each phase of the remediation scheme and prior to the start of construction works to any building in each phase or development area, a report that provides verification that the required works regarding contamination have been carried out in accordance within the approved remediation scheme for that phase of development area, shall be submitted to and approved in writing by the Local Planning Authority. Post remediation sampling and monitoring results shall be included in the report to demonstrate that the required remediation objectives have been fully met. Future monitoring proposals and reporting timescales shall also be included in the submitted report and such monitoring shall be carried out as approved by the Local Planning Authority.

In order to maintain consistency for both historic and recent data, Atkins continues to use the same assessment standards as those used in the S106 Agreement (Dewey & LeBoeuf ref. GNP/JNR/13773-2). Details of the existing visual and olfactory classification system, as defined within the S106, is provided as Table 1.1.

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 discernable in ambient air.

Class	Visual	Olfactory
5	Visible hydrocarbon present.	Overwhelming odour.

**visible suspect Asbestos containing materials (ACMs). 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.*

A discussion of the adopted thresholds has been previously provided as part of the Outline Remediation Strategy for Residential Phase 2 (Atkins report 5041216-REM-RPT-992).

The adopted thresholds comprise a combination of the S106 Risk Based Screening levels (RBSLs) and Remedial Target Concentrations (RTCs) derived by Atkins (Atkins report 5041216-REM-REP-000216v3). For ease of reference, a table showing a summary of the adopted thresholds relating to this area is provided in Appendix C.

1.2 Reclamation and Remediation Summary

Pre-remediation contours for Monitor Phase 31 are shown on Drawing 5041216-REM-DWG-1740.

Monitor Phase 31 was initially cleared of existing surface hardstanding. The removal of some existing structures from within this area was carried out as part of the reclamation of the adjacent plot which is currently being developed by Persimmon. Concrete, excavated from within Monitor Phase 31 was taken to a stockpile for crushing and for proposed re-use as part of the wider redevelopment of the former refinery.

Remedial excavations beneath Monitor Phase 31 were then undertaken, largely down to natural bedrock, to remove relict structures, identify and remove contamination and to provide a degree of assurance across this previously intensively developed area. Excavations were subsequently backfilled in order to achieve the desired restoration levels.

Unacceptable soils were removed from Monitor Phase 31. These generally comprised materials containing hydrocarbon staining or odours in excess of VO=2 (refer to Table 1.1).

Backfill materials within Monitor Phase 31 comprised suitable site won materials.

On completion of the works, a layer of imported material was been placed across part of Monitor Phase 31. These shallow soils represent 0.5m to 1.0m below FFL.

At the time of writing, the western and northern parts of Monitor Phase 31 remain to be provided with the 1m to 0.5m below FFL layer. Details of materials to be placed across these areas is presented in Atkins Technical Note 1316 in Appendix J.

1.3 Sources of Information

The following principal sources of information have been reviewed as part of the preparation of this report:

1. Section 106 Deed of planning Obligations (Dewey & LeBoeuf report GNP/NJR/13773-2). February 2008;
2. URS Report 44382742 BRRP001, BP Llandarcy Refinery Desk Study, July 2007
3. URS Report FR1287 Whole Site Investigation, August 2005
4. Atkins report 5041216-REM-REP-000216 v3 Derivation of Remediation Target Criteria (January 2010).
5. Atkins report 5041216-REM-RPT-992. Geo-environmental Assessment and Outline Remediation Strategy, Proposed Residential Phase 2, July 2013
6. Rodgers Leask Drawings P13-268 309 and 310 (refer to Appendix B)

1.4 Limitations

The assessment of groundwater conditions, where outlined within the following document, is based on the data available at the time of writing. Groundwater levels may vary due to atmospheric, seasonal or other effects.

For the purpose of validation, final levels across Monitor Phase 31 are considered to represent FFL minus 0.5m. The final 500mm of clean cover will be placed by the Developer as part of the construction of this area.

At the time of writing, outline development layout information is only available for the southern part of the Monitor Phase 31, as presented in Appendix B. It is understood that the levels shown are not yet finalised. No layout or level information is available for the northern part of Monitor Phase 31.

The suitability of the remedial works within Monitor Phase 31 may need to be reassessed once final development levels are agreed.

2. Review of Information

2.1 General

The former refinery has been subject to a number of previous investigations on behalf of the former owners, BP.

Salient detail relating to Monitor Phase 31 is summarised below.

2.2 The Site

2.2.1 General

Monitor Phase 31 lies within the former processing area, in the central part of the former refinery (refer to Drawing 5041216/REM/DRG/1565B).

Early historic maps record much of the former refinery to have been undeveloped, being shown as woodland.

Llandarcy Oil Refinery was first developed in 1921 to produce motor spirit, lubricating oil and fuel oils from crude oil. The refinery continued to expand until the late 1970s, however, from the mid 1980s a series of rationalisations occurred with notice being given to close the site in 1997.

During 1939 the refinery incorporated camouflage painting into the maintenance programme. Tanks were painted and roads were sprayed with green and black chippings. In addition, approximately 25 acres of tank roofs were textured with steelwool, limpet asbestos or coloured chippings

A general summary outlining the anticipated scope of remedial works relating to this area, in order to meet the requirements of the S106, has been previously provided in Atkins report 5041216-REM-RPT-992. This existing report has been approved in line with requirements of **Planning Condition 44** of the Outline Planning Permission for the redevelopment of the former refinery.

Further detail relating specifically to Monitor Phase 31 is provided below.

2.3 Site Context

Monitor Phase 31 occupies an area of approximately 31,575m², within the central part of the former refinery.

Information on existing ground levels across Monitor Phase 31, prior to the start of remediation works are presented on Drawing 5041216/REM/DWG/1740.

Selected photographs of this area during the reclamation works are presented in Appendix A.

2.4 Historical Use

Maps detailing the historical development of the Phase 2 area, including Monitor Phase 31, have been previously presented in Atkins report 5041216-REM-RPT-992.

For ease of reference, copies of historical maps dated 1965, 1985 and 2009 are presented as Drawings 5041216/REM/DWG/1734, 5041216/REM/DWG/1735 and 5041216/REM/DWG/1737. These suggest the following buildings/processes to have historically been situated within the Monitor Phase 31:

- Construction Department and Electrical Department Offices
- An existing concrete retaining wall and former (E-W) pipe routes.
- Sump separator and pumphouse
- No 2 Crude Distillation Unit (CDU)
- Furfural Extraction Unit

- Gas Oil Heating Unit
- MEK Dewaxing and Recrystallisation Unit

A desk study for the former refinery (URS Report 44382742 BRRP001) indicates that significant expansion of the refinery took place during the 1970's relating to lube oil production. In the 1950's the whole process was undertaken along the upper terraces area using an MEK (Methyl Ethyl Ketone) solvent for dewaxing. Due to advances in the process in subsequent years it was decided to build a new lube oil complex at the site to increase production. This was built in the area of the former kerosene and paraffin plant and became known as the DiMe lube oil complex. The new plant was similar in functionality to that on the top terrace with the exception of the use of a new solvent (a mixture of dichloromethane and methylene dichloride) in place of MEK. The DiMe lube oil complex lies downslope, to the north of Monitor Phase 31. The two plants operated in tandem for a few years in the early 1970's before the older plant was gradually phased out.

The furfural solvent extraction process was carried out to remove aromatic compounds.

There is one Special Process Areas/Exclusion areas, as designated by URS, within Monitor Phase 31 (refer to Drawing 5041216/REM/DWG/1741). This is a Special Process Area (no. 38) and is reported to relate to the former Pumphouse and Separator B. The former Separator structure was a concrete structure and was fully removed and the soil removed to bedrock as part of the preparation of the adjacent Persimmon Plot. These areas represent areas of potential higher contamination risk, however, no evidence of any increased contamination was noted within this area during the removal of this structure.

2.5 Published Geology

The British Geological Survey Sheet for Swansea (Sheet 247) Drift Edition suggests this part of the refinery to be underlain by Glacial Drift (undifferentiated) overlying Carboniferous, Upper Pennant Measures. Solid strata are suggested to dip towards the north.

There are no recorded faults shown to cross beneath Monitor Phase 31.

2.6 Hydrogeology & Hydrology

Monitor Phase 31 lies within the catchment of the River Neath, which lies approximately 1km east of the site.

The underlying sandstones are considered to be a Secondary A Aquifer, which are defined by the Environment Agency 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.'

Groundwater flow beneath Monitor Phase 31, based on previous assessment, is considered to be towards the north/north east (figures 9 and 10, FR1287). This is consistent with the general topography within this part of the former refinery.

2.7 Quarrying & Mining

Monitor Phase 31 lies on the northern face of an east-west trending sandstone ridge. Historical quarrying and terracing of this ridge is known to have taken place historically, as evident by the presence of an exposed rock face of approximately 5-6m height between the middle and upper terraces. Part of this rock face defines the southern boundary of Monitor Phase 31.

Geological maps for the site (BGS Sheet 247, 1:50,000 and Sheet 79 NW, 1:10,560) suggest that there are two seams (Hughes and Bodwr) which subcrop within the vicinity of Tank Farm Road, to the south of Monitor Phase 31. There are no recorded mine entries within Monitor Phase 31 (Refer to Appendix F).

Based upon the location of the recorded subcrops and an average dip of approximately 8°, as reported on geological maps, these two seams are anticipated to lie at depth beneath the study

area, being shallowest towards the south. A thin (around 100mm) outcrop of coal was identified during the reclamation works across Monitor Phase 31.

Further investigation relating to the presence and depth of potential coal/mineworkings beneath Monitor Phase 31 is proposed and will be reported under separate cover.

2.8 Pre Remediation Ground Conditions

A number of phases of ground investigation are known to have taken place within Monitor Phase 31 on behalf of the previous siteowners BP (URS FR1287). A series of machine excavated trial pits were also undertaken by Atkins across the southern part of Monitor Phase 31 in June 2011. These pits (MTV9 to 19) were carried out in order to confirm ground conditions across the middle terrace after the removal of existing structures and turnover of existing soils within this area.

Details of historical investigation have been previously reported in Atkins Report 5041216-REM-RPT-992. For ease of reference, however, the locations of previous ground investigation are shown on Drawing 5041216/REM/DWG/1738 and relevant exploratory hole logs are presented as Appendix C.

Consistent with the reported geology shown on geological maps, the findings of historical ground investigation across Monitor Phase 31 indicates Made Ground/glacial soils overlying sandstone bedrock.

Sandstone bedrock is reported to have been previously encountered at depths of between 0.0m and 3.5m beneath Monitor Phase 31, generally becoming deeper northwards. Overlying soils are described as comprising a gravelly clayey sand, locally sandy gravel, silty clay or silt and containing fragments of brick, concrete, sandstone up to cobble/boulder size.

Consistent with other areas of the refinery, contamination is reported to have been evident within existing soils across this area in the form of staining, odours and localised free product. Free product is reported to have been previously encountered within WSTP031 (0.6m depth), WSTP152 (1.8m depth) and within WSTP158 beneath a layer of concrete. WSMW058 is reported to have terminated on bedrock at 0.25m and is noted to have filled with water which exhibited a sheen.

Consistent with the presence of free product locally, evidence of visual/olfactory contamination is reported to a Class of VO=5 (refer to Table 1.1). Based on the available information, values of VO=0 to 3 are, however, considered to be more representative of soils across Monitor Phase 31.

Comparison of the results of laboratory analysis for previous investigation, suggests the presence of localised exceedences of inorganic metals, polyaromatic hydrocarbons (PAH) and hydrocarbons in excess of the adopted thresholds for a residential end use (<1m). Trace asbestos (white) is reported to have been encountered in WSTP152 at 0.5m depth.

Pipework and cables were recorded in WSTP152 (<1m bgl). Bitumen is also reported to have been identified at shallow depth in MTV18, which lies within the south western part of Monitor Phase 31.

Available monitoring information (FR1287) from wells within Monitor Phase 31 (WSMW058, WSMW062, WSMW065 and MSMW144) indicates free product on a single occasion during monitoring in 1999, with a thickness of 0.004m reported in WSMW062. No further free product was recorded at this location or within any of the other wells within this area.

Based on the available information, groundwater beneath Monitor Phase 31 is generally reported to comprise localised perched groundwater and seepages within the shallow soils. 'True' groundwater is considered to lie within the underlying sandstone bedrock. The depth to groundwater is reported to have varied between 0.6m and 2.3m bgl.

3. Outline Remediation Strategy

3.1 Section 106 Deed of Planning Obligations Requirements

Based on a review of previous ground investigation (Atkins report 5041216-REM-RPT-992) Monitor Phase 31 has been previously assessed as falling within an area of **residential end use where groundwater is in rock** scenario, as defined within the S106. These areas are defined as *'areas where there is limited soil material over bedrock, little perched water groundwater is present in the soil, and the water table is normally first encountered in bedrock'*.

Based upon this classification, the remediation requirements outlined below are stated in the S106 (Schedule 8, Section 4.0) as being the minimum remediation requirements required in order to release this area for redevelopment as residential housing.

- *All oil saturated soils should be removed.*
- *All soils must be remediated so as to meet the RBSLs for TPH, BTEX and PAHs at the relevant depth relative to FFL and aesthetic criteria Class 2 or better at greater than 1m below FFL.*
- *The aesthetic quality of soils shall be Class 1 or better for at least the first metre below FFL.*
- *Soils where there is visible ash and clinker, or metal concentrations above RBSLs, are to be removed so that none is retained within the first metre below FFL in garden areas.*
- *Where it is not practicable to address groundwater contamination within bedrock, this must be controlled eg, where seeps, sheens and iron staining discharge from the bedrock. Acceptable methodologies for remediation may include, but are not limited to, the use of land drainage via interceptors. Control measures should result in no visible discharge at the surface and little or no odour observable.*
- *All soils 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 to meet the requirements of relevant Environmental Authorities, whichever is the more conservative.*

3.2 Proposed Scope of Works

3.2.1 General

In order to comply with the remediation requirements defined in the S106, the following general scope of remedial works was suggested within Atkins report 5041216-REM-RPT-992.

- *Removal of all oil saturated soils and/or free product.*
- *Removal of visible ash and clinker at <1m FFL.*
- *Removal of all soils with a visual/olfactory (VO) rating exceeding Class 2.*
- *Further investigation and removal of all identified asbestos contaminated materials.*
- *Removal of 'hotspots' of increased contamination*

In addition to the above, a number of additional works were proposed in order to meet the requirements of the S106 and to facilitate the subsequent redevelopment of this area as residential housing.

- *Removal of all remaining structural remnants, including concrete, brickwork and other identified 'obstructions'*
- *Removal of remaining 'live' services, including redundant drainage.*
- *Reprofiling of the final surface to achieve a stable, free draining surface.*

4. Remedial Works and Plot Preparation

4.1 Introduction and Revised Strategy

A number of phases of investigation, reclamation and plot preparatory works have been carried out across Monitor Phase 31, as below:

- Clearance of above ground structures, existing sump separator and surface hardstanding (February 2009 to May 2009).
- Reclamation and remediation, including the removal of below ground structural remnants and unsuitable soils (October 2013 to September 2014)
- Preliminary validation trial pitting (January 2014)
- Placement of imported soils (March 2014)
- Additional validation pitting (October and November 2014)
- Hotspot removal and validation (November and December 2014)
- Additional sampling and trial pitting (December 2014)

By combining the reclamation, remediation and plot preparatory programme for this area, additional clarity on remediation has been provided through the wholesale excavation of soils and segregation of 'unacceptable' materials. This also helps provide additional assurance relating to the removal of building remnant infrastructure and other potential obstructions.

Parties involved in the reclamation and remediation works are as follows:

Client – St Modwen Developments Ltd

Principle Contractor – Hawk Ltd

Employers Representative – Prosurv Consult

Employers Technical Representative – Atkins Ltd

All works were carried out under the full time attendance of an Atkins Site Engineer.

4.2 Reclamation and Remediation Works

Pre remediation levels are shown on drawing 5041216-REM-DWG-1740. Reclamation works across Monitor Phase 31 were undertaken between October 2013 and September 2014.

In situ materials were excavated down to bedrock, to enable the full removal of any existing structures, infrastructure and any contaminated soils present. Due to the presence of an existing slope which runs along the south eastern boundary of Monitor Phase 31, large scale excavation works along this boundary were limited. The area beneath this slope has, however, been previously reclaimed and remediated as part of the adjacent Persimmon Plot and the materials within the slope comprise site won sandstone which was tested and validated as part of the validation of this Phase (Atkins report 5041216/300SD/RPT/815, October 2012).

All works were monitored by an Atkins Site Engineer who assisted with the segregation of suitable materials for re-use and the identification of unacceptable materials. Excavated materials considered unsuitable for re-use were generally taken to the licensed site treatment area due to the presence of hydrocarbon staining and odours >VO=2.

Due to the dip of the underlying strata and mirroring the general topography of this area, the surface of the bedrock on completion was 'benched' across part of Monitor Phase 31 prior to backfill. The extent of this benching is evident on the Excavation As-Built, Atkins Drawing 5041216/REM/DWG/1744 and marked as grey lines at approximately 0.5m height intervals.

Backfill materials within Monitor Phase 31 predominantly comprised suitable site won materials, including stockpiled materials within the former refinery. All stockpiled materials, proposed for re-

use as backfill, underwent preliminary sampling within stockpiles prior to their re-use (refer to Section 5.2).

In the absence of suitable site won materials for use at shallow depth, a surface layer of imported soils (nominal 500mm depth) was placed across the final surface. Details relating to these imported soils are discussed in Section 5.4. These soils represent 0.5m-1m below FFL.

At the time of writing, the western and northern parts of Monitor Phase 31 remain low awaiting the upper half metre regulating layer. For the purpose of validation, the current levels within these areas have been assumed to represent approximately 1m below FFL. Details of proposed upfill materials for these areas is discussed in Atkins Technical Note 1316 in Appendix J.

4.3 Post Remediation and Reprofiling Levels

Final 'as built' levels are shown on Drawing 5041216-REM-DWG-1743.

5. Validation/Verification

5.1 Requirements of the S106

The S106 (Schedule 8, Part 3, Paragraph 8) sets out the required frequencies for validation testing as part of the ongoing redevelopment of the refinery, salient detail from which is presented in Table 5.1.

Table 5.1 - Minimum Validation Testing Frequencies

Testing for the Validation Suite at the following frequency:	Shallow Soils (Residential <1m FFL)	Deeper Soils (Residential >1m below FFL)	Commercial (all relevant depths)
0.5m-1m below FFL in-situ	Regular grid of 1 per 50m ² , sample over 0.5m depth.	n/a	Regular grid of 1 per 400m ² , sample over 0.5m depth
>1m below FFL in-situ.	n/a	Regular grid of 1 per 100m ² , sample over 1.0m depth.	Regular grid of 1 per 400m ² , sample over 0.5m depth
Face of remedial excavations <1m deep.	1 per 10m, minimum of 1 per face, worst case VO sample	n/a	1 per 15m, minimum of 1 per face, worst case VO sample
Face of remedial excavations >1m deep.	n/a	1 per 10m ² , minimum of 1 per face, worst case VO sample.	1 per 15m ² , minimum of 1 per face, worst case VO sample
Imported soils from a verified greenfield site	1 per 250m ³ ex situ, composite of 5 regular sub samples	1 per 500m ³ ex situ, composite of 5 regular sub samples	1 per 500m ³ ex situ, composite of 5 regular sub samples
Imported soil from a characterised brownfield site	1 per 25m ³ ex situ, composite of 5 regular sub samples	1 per 50m ³ ex situ, composite of 5 regular sub samples	1 per 100m ³ ex situ, composite of 5 regular sub samples
Along redundant service excavations.	1 per 20m of trench, worst case VO sample.	1 per 20m of trench, worst case VO sample.	1 per 20m of trench, worst case VO sample.
Stockpiled excavated materials for re-use	1 per 50m ³ ex situ composite of 5 sub samples	1 per 100m ³ ex situ composite of 5 sub samples	1 per 500m 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 per 200m ³ , composite of 5 regular sub samples.	1 per 500m 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

5.2 Base of Excavation Validation (Bedrock Exposure

Excavations across Monitor Phase 31 were taken down to bedrock (refer to Drawing 5041216-REM-DWG-1744).

Consistent with the presence of Monitor Phase 31 upon a terraced sandstone ridge, the depth to sandstone bedrock varies across the backfilled plot from <1m bgl within the southern part of the plot and deepening to >3m bgl within the central part of Monitor Phase 31. Moving north from this deep area, sandstone becomes shallower, being evident across the surface across the area shown on Drawing 5041216/REM/DWG/1742 and then lying at depths of around 1.5m -2.5m bgl beneath the northern part of Monitor Phase 31.

Photographs of the exposed surface during benching are provided in Appendix A.

Prior to backfilling the exposed bedrock profile was inspected by Atkins to assess the visual appearance of the rock and in particular evidence of hydrocarbon seepages and free phase hydrocarbons. The areas where notable hydrocarbons staining and oily sheening was observed are presented on Drawing 5041216/REM/DWG/1742. Of these areas, 1, 2 and 3 were found to have highly localised surface staining. In these areas weathered bedrock was scraped to create small collection sumps to monitor, if any, mobile free phase was available for collection. Over the period during which these areas were left open (circa three months) no further hydrocarbons were noted and the areas were eventually backfilled.

Area 4 was similarly monitored and was observed initially to collect small volumes of black, oily free phase product and water after a period of two days. Free phase was recovered and the excavation observed (recoverable volume circa 1.5 litres). Following the removal of product for a second time, no further free phase was observed over a period of two weeks. The occurrence was considered to be a localised historic occurrence and not representative of any significant oil source in the surrounding area. On completion of the observation period the area was backfilled. Bedrock in the location of this area is circa 3m below proposed final finished levels.

The results of visual inspection across the remainder of the exposed sandstone bedrock at the base of the excavation generally indicated visual and olfactory scores of 0 and locally 1 (refer to Table 1.1).

Where bedrock was exposed at the surface within Monitor Phase 31 (refer to Drawing 5041216/REM/DWG/1742), a more detailed visual inspection was carried out. A total of 36 inspections were carried out as shown on Drawing 5041216/REM/DWG/1747 and indicate no evidence of staining and/or odours across this surface (VO=0/0).

5.3 Backfill Quality – Below 1m FFL materials

Backfill to levels of approximately 1m below FFL comprised the placement of approximately 55,866m³ of material.

These materials comprised:

- 27,998m³ materials moved from the treatment pad following treatment and homogenisation
- 23,118m³ suitable materials won from phase 2
- 4750m³ broken bedrock materials primarily used within road make up

5.3.1 Stockpile Testing

Stockpiles 92, 97 and 101 (SP92, SP97 and SP101) comprised homogenised soil recovered from treatment pad. The approximate volumes of material used from each of these stockpiles was:

- Stockpile 92 = 6,187m³
- Stockpile 97 = 7,201m³
- Stockpile 101 = 14,610m³

The result of stockpile laboratory analysis is summarised on relevant tables in Appendix F. Copies of relevant laboratory certificates are provided in Appendix G.

A total of 41 samples were taken from these stockpiles, prior to use and indicate only a single exceedence of 1,2 Dichloroethane within Stockpile 97. Soil within the vicinity of this sample was not transferred onto Monitor Phase 31 for re-use and remained on the treatment pad.

5.3.2 In-situ Testing

Validation of backfilled materials within Monitor Phase 31 was also undertaken in-situ by a series of trial pits. This was undertaken prior to the placement of the shallow surface materials. Shallow materials (0.5m to 1m below FFL) were validated separately (see section below).

A total of 208 trial pits were carried out across Monitor Phase 31 from the 1m FFL surface, as shown on Drawing 5041216/REM/DWG/1742. Logs relating to these trial pits are presented in Appendix D. Two of the proposed trial pits within the north east of Monitor Phase 31 (P1TP145 and P1TP146) could not be excavated due to the presence of stockpiles of materials by Persimmon. These trial pits are to be excavated as part of the outstanding works within Monitor Phase 31, as defined in Section 5.5.

The results of the trial pitting across Monitor Phase 31 indicates the majority of fill materials to comprise a sandy gravelly clay (locally sandy gravelly silt, sand or gravel). The result of geotechnical testing on suitable excavated materials from within Monitor Phase 31 indicate these materials to comprise a firm dark brown/grey slightly sandy very gravelly clay or brown gravelly sand with clay. Particle size distribution testing suggests these materials to represent a '2C Stony Cohesive Fill' in accordance with the Manual of Contract Documents for Highway Works (MCHW).

Visual inspection of soils encountered during the trial pitting, indicates staining/odours up to a maximum class of VO=2. All of these soils lie at or in excess of 1m below FFL.

No ash and clinker or seeps or hydrocarbon sheens were observed in any of the excavated trial pits.

5.3.3 Testing Frequencies

At the time of writing, detailed information regarding proposed layouts is only available for part of Monitor Phase 31 (refer to Appendix B). Reference to the proposed layout confirms areas of proposed roadways, hardstanding, public open space and housing within the final development. The S106 (Schedule 8, Part 3, Table 4) presents validation frequencies for both a commercial and residential end use. For the purpose of assessment, proposed roadways have been considered to be representative of a commercial end use in terms of the required frequencies. There are no specific frequencies for public open space within the S106.

Consideration of the proposed end use across Monitor Phase 31, based on the available information, results in two areas as below. In the absence of any detailed information relating to proposed development layouts for the northern part of Monitor Phase 31, this area has been assumed to represent an area of proposed residential housing.

As it is understood that the development layouts presented in Appendix B are not yet fixed then only primary roads have been considered for the purpose of the following assessment.

- Proposed primary roadways = 5000m²
- Proposed open space and residential housing = 26575m² (including 3,550m² of exposed sandstone)

A total of 13 trial pits lie within proposed primary roadways within Monitor Phase 31. These are P1TP133, P1TP103 to 111 and R50TP01 to 03. Based on an area of approximately 5000m², this equates to a validation frequency of approximately 1 pit per 384m² and below the required S106 frequency for a commercial end use of 1 per 400m² (refer to Table 5.1).

A total of 208 trial pits lie within proposed 'residential' areas and open space. This also includes the area of exposed sandstone bedrock across which 36 visual inspections were carried out (3550m²). Based on a total area of 26575m², this (244 locations) equates to a validation frequency of 1 test per 109m².

A total of 433 samples, recovered during the validation trial pitting, were tested for a general range of determinants based on the RBSLs listed in the S106. A total of 233 of these samples were also tested for additional BTEX and a range of other Organic Compounds, including key chlorinated hydrocarbons. The depths of the samples taken represent depths of between 0.2m and 3.8m (1.2m to 3.8m below FFL) beneath proposed roads and between 0.2m and 5.3m (1.2m to 6.3m below FFL) beneath proposed residential housing and public open space within the final development. As per Section 5.3.1, 40 representative samples were recovered from stockpiles making a total of 474 samples.

Based on the volume of placed materials (excluding rock) of 51,116m³ (55866m³ minus 4750m³) the testing frequency equates to 1 sample per 108m³.

Given the origin of the materials used as backfill (including those treated and homogenised on site and thus requiring a lower testing frequency of 1:200m³) together with the additional confidence of undertaking a high percentage of testing in-situ it is considered that the frequency of testing is suitable for its proposed mixed end use.

5.3.4 Chemical Exceedances

As these soils relate to depths >1m below FFL assessment, the results have been compared with the adopted thresholds for retention at depth within a residential area. Quoted depths relate to the depth recorded within the trial pits.

The result of this assessment suggests the following exceedances:

- *Benzene (438ug/kg in P1TP41 at 1.6m depth)*
- *Trichloroethene (262ug/kg in P1TP97 at 3.8m depth)*
- *Napthalene (2880ug/kg in P1TP57 at 0.2m depth)*

Due to the shallow depth of the failure at P1TP57, shallow soils from this location has been excavated as a 'hotspot' as detailed in Section 5.5. The benzene is considered a marginal exceedance of the adopted threshold (400ug/kg) at a depth of approximately 2.6m beneath final levels within the development. Surrounding samples, including those above, indicate material of good quality and removal of this specific hot spot is not considered necessary.

Due to the depth of the Trichloroethene exceedance beneath final development levels (4.3m) and its location within proposed public open space then further remedial works relating to this exceedance are also not considered necessary. This occurrence appears localised and not consistent with the good quality of surrounding materials.

Exceedences of TPH C8-C10 (Aliphatic) were recorded at depths of 0.3m, 2.0m and 2.3m in RD103. As these exceedences lie beneath the proposed road and fall well below the relevant commercial threshold of 158 890mg/kg then these are considered suitable for retention in situ and no remedial works at this location are proposed.

A total of 386 of the samples obtained during the validation trial pitting were screened for asbestos. The result of this screening suggests a total of 223 detects, 30 of which are reported as 'trace'. Quantitative assessment on samples suggests concentrations of between <0.001 and 0.0626. Five of the reported concentrations were found to exceed the 200ppm (0.02%) threshold, as identified below:

- *0.0214% (P1TP037@0.3m depth)*
- *0.0288% (P1TP44@0.4m depth)*
- *0.0358% (P1TP122@1.5m depth)*
- *0.0517% (P1TP121@0.5m depth)*
- *0.0626% (P1TP030@1m depth)*

Due to the shallow depth of 4 of the reported exceedences, soils from these locations have been excavated as 'hotspots' as detailed in Section 5.5.

S106 requirements for a residential end use where groundwater is in soil (Schedule 8, Part 3, Para 5.6) requires the following:

'All soil potentially containing dispersed asbestos fibres or visible ACM must be removed or remediated to meet in bulk...the appropriate ACM, or the requirements of the relevant Environmental Authorities, whichever is the most conservative, to a minimum depth of 2m below FFL.'

Although Monitor Phase 31 is considered to be representative of a 'residential where groundwater is in rock', the adoption of this approach within the current plot is considered to be conservative in

the absence of shallow groundwater which could aid the mobility of shallow contamination. Adopting this criteria then the reported exceedance within P1TP122 is considered acceptable for retention in situ due to its depth at 2m below FFL.

5.4 Backfill – 1m to 0.5m below FFL

Current placed shallow soils across the eastern half of Monitor Phase 31 comprise a red clay. These soils represent imported soils from Parc Derwen, Bridgend. The placed volume is approximately 4600m³.

In line with the agreed protocol for imported soils, information relating to available desk study/previous ground investigation was reviewed prior to import and these materials were inspected and sampled at source by Atkins. The report suggests these soils represent glacial soils.

Validation of these materials across Monitor Phase 31 was carried out by a series of shallow hand excavated trial pits at the locations shown on Drawing 5041216/REM/DWG/1745. No evidence of any staining or odours was noted at any of these locations (VO=0).

A total of 187 samples (SMH 1 to 195) were initially collected and have been assessed against the adopted thresholds for retention at shallow depth (<1m below FFL). This represents a testing frequency of 1 per 25m³ thereby complying with the required frequency for testing of an imported brownfield source.

It should be note that the imported material is understood to comprise natural materials from a field utilised for silage, hence the adoption of the sampling frequency for a brownfield source is considered conservative.

5.4.1 Chemical Exceedances

The assessment indicates a number of exceedences of metals, PAH and a single TPH (C16-C21).

Discussion with the laboratory relating to the source of high concentrations of BaP confirm the presence of potential coal (black specs) when viewed under the microscope. Double ratio plots, prepared by Alcontrol based on the reported data (refer to Appendix J) also suggest the recorded concentrations to be 'coal derived'.

As a precautionary measure a further 70 samples (POS121-190) of shallow soils from across the proposed open space area were obtained and were tested for Benzo(a)pyrene (BaP) and Napthalene. Where available, the result of this additional testing is presented on the tables in Appendix F. These do not indicate any values of the magnitude of earlier samples.

Details of hotspots proposed for excavation are detailed in Table 5.2 below. Where hotspots are highlighted for removal then this data has been excluded from the data used for statistical assessment.

Table 5.2 – Proposed Hotspots for Removal (imported soils)

Determinand	Sample Size	Reported exceedences	Maximum Reported Concentration	Hotspots for Proposed Removal	Upper Confidence Limit (mg/kg)	Mean (mg/kg)
Cadmium	187	5	8.58	8.58mg/kg SMH176 6.4mg/kg SMH154	1.3	1.2
Chromium	187	1	80.6	NA	25.58	23.66
Copper	187	3	570	570mg/kg SMH193	43.76	30.67
Nickel	187	1	61	NA	26.48	24.7
Selenium	187	5	4.43	4.43mg/kg	2.27	2.01

				SMH154		
Zinc	187	37	1020	1020mg/kg SMH176 954mg/kg SMH98 943mg/kg SMH154 914mg/kg SMH78	409.57	363.41
TPH (C16-21) Aromatic	187	1	88100ug/kg	88100ug/kg SMH103	6693ug/kg	4335.03ug/kg
Benzo(a)anthracene	187	6	32200ug/kg	32200ug/kg SMH157 24600ug/kg SMH121 21200ug/kg SMH134 19000ug/kg SMH89 11900ug/kg SMH160	750.33ug/kg	482.39ug/kg
Benzo(b)fluoranthene	187	1	25500ug/kg	25500ug/kg SMH121	1364ug/kg	698.4ug/kg
Benzo(a)pyrene	187	23	24300ug/kg	24300ug/kg SMH121 21600ug/kg SMH157 14900ug/kg SMH134 13100ug/kg SMH89 8580ug/kg SMH160	568.82	373.09
Napthalene	187	4	2470ug/kg	2470ug/kg SMH121 1530ug/kg SMH157 977ug/kg SMH160	71.98	48.86
Dibenzoanthracene	187	2	3920ug/kg	3920ug/kg SMH121 2490ug/kg SMH157	155.26	87.98

The predominance of zinc concentrations in excess of the adopted thresholds would appear to indicate that this is a background occurrence for these soils

All of the samples taken from these shallow imported soils (187 no.) were screened for asbestos, which indicated a total of 9 'detects' and 2 'trace'. As a result of the positive result, quantitative analysis was carried out on 9 samples and reports concentrations of between <0.001 and 0.0019%. These concentrations lie below the adopted threshold of 200ppm and are therefore considered acceptable for retention.

5.4.2 Outstanding shallow fill materials

Details of materials for placement at shallow depth across the western and northern parts of Monitor Phase 31 are presented in Atkins Technical Note 1316 in Appendix J. It is proposed that this material for placement is identified and placed once levels and plot layouts are finalised.

5.5 Hotspot Removal and Outstanding Works

Comparison of the results of validation screening (refer to Sections 5.3 and 5.4 above), indicates the following exceedences of the adopted thresholds for retention within Monitor Phase 31.

Deep Soils

- *Napthalene (2880ug/kg in P1TP57)*
- *Asbestos 0.0214% (P1TP037)*
- *Asbestos 0.0288% (P1TP44)*
- *Asbestos 0.0517% (P1TP121)*
- *Asbestos 0.0626% (P1TP030)*

Shallow (Imported) Soils

- *Cadmium 8.58mg/kg and Zinc 1020mg/kg in SMH176*
- *Cadmium 6.4mg/kg, Zinc 943mg/kg and Selenium 4.43mg/kg in SMH154*
- *Copper 570mg/kg in SMH193*
- *Zinc 954mg/kg in SMH98*
- *Zinc 914mg/kg in SMH78*
- *TPH 88100ug/kg in SMH103*
- *PAH (SMH89, 121, 134, 157, 160)*

Validation data relating to these excavations is presented in Appendix K. Due to delays in turnaround times at Alcontrol laboratories, this analysis was undertaken by Chemtest.

The result of validation analysis indicates the following exceedences of the adopted thresholds: Threshold concentrations are given in brackets.

- *SMH176N Cadmium 5.5mg/kg (2.6mg/kg)*
- *SMH160S Napthalene 1.2mg/kg (0.585mg/kg)*
- *SMH89E Benzo(a)pyrene 3.6mg/kg (0.9mg/kg)*
- *SMH160S Benzo(a)pyrene 1.2mg/kg (0.9mg/kg)*

No asbestos was identified in any of the validation samples relating to P1TP030,037,044 and 121.

Reference to Drawing 5041216/REM/DWG/1745 indicates SMH176 and 160 to lie within an area of proposed open space within the final development. In line with the steepness of this area, it is considered unlikely that this will be used significantly for ball games etc by local residents. This is confirmed by Rodgers Leask Drawing P13-269 310 in Appendix B which suggests this area to predominantly comprise footpaths and planting areas. Given this end use, the potential risks to local residents posed by these materials are considered to be low.

Given that the other validation samples taken from SMH89 reported concentrations of BaP below the adopted threshold then this exceedence is considered to be isolated and is not considered to pose a significant risk to end users of the final development.

As clean cover materials are required then all of these materials will lie at depths >0.5m within the final development.

In addition to the excavation of identified 'hotspots', a number of additional trial pits were undertaken in December 2014 in order to replace missing trial pits (P1TP145 and P1TP146) and across the proposed public open space within the central part of Monitor Phase 31. Details of these trial pits are provided in Atkins Technical Note 1318.

5.6 Final Levels

Final levels across Monitor Phase 31 are presented on Drawing 5041216-REM-DWG-1743.

For the purpose of contamination assessment, it has been assumed that the final surface across Monitor Phase 31 represents the base of clean cover materials within the final development, as required by the S106 (ie FFL minus 0.5m depth). This includes the placement of outstanding soils across the western and northern parts of this plot which will be carried out once final development levels are defined (refer to Appendix J).

Outstanding clean cover (topsoil/subsoil) materials (0.0m to 0.5m below FFL) will be placed by the Developer (St Modwen Homes) as part of the construction of this plot (refer to Section 6.4).

5.7 Summary

A summary of the status of Monitor Phase 31, in line with the requirements of the S106 is presented in Table 5.3 below:

Table 5.3 – Validation Summary

Requirement	Status	Comment
Chemical quality of soils in situ	N/A	In situ materials have been validated by trial pitting. Exposed sandstone bedrock has been inspected and sampled and has been demonstrated to be compliant with the requirements of the S106 (refer to Section 5.3). These soils have been validated by the use of preliminary stockpile sampling, machine excavated trial pits (433 samples) and shallow excavations (187).
VO quality of soils in situ	Complete	A maximum recorded VO of 2 was recorded for retained fill materials (refer to Section 5.3). This is acceptable in line with the requirements of the S106 for deep fill (>1m below FFL) within a residential area. No evidence of any staining or odour was noted during validation of shallow fill (<1m) materials across Monitor Phase 31 which comprise imported soils. The western half of Monitor Phase 31 remains low. Materials proposed for placement across this area are detailed in Technical Note 1316 in Appendix L.
Observations of groundwater for the presence of free phase product	N/A	The result of historical monitoring (refer to section 2.8) indicates groundwater to lie at depth within the sandstone bedrock beneath Monitor Phase 31. Only localised evidence of residual amounts of oily residues were encountered and removed during the works. Observations indicate the absence of significant free phase.
Chemical and VO quality	N/A	In line with the excavation of reported 'hotspots' shallow imported soils have been shown to be

Requirement	Status	Comment
of imported material		suitable for retention (refer to Sections 5.4 and 5.5)
Compliance with adopted thresholds	Complete	In line with the excavation of reported 'hotspots' (refer to Section 5.5), soils within Monitor Phase 31 have been shown to be suitable for retention.
Removal of oil saturated soils	Complete	Oil saturated soils were removed during the works.
Asbestos Assessment	Complete	In line with the excavation of reported 'hotspots' the concentrations of asbestos within existing soils have been shown to be suitable for retention (refer to Sections 5.3 and 5.4).
Control of seeps, sheens and iron staining from - bedrock	Complete	The depth to bedrock varies beneath Monitor Phase 31 and is exposed at the surface within part of the plot. Only minor localised evidence of any sheens or iron staining has been noted emanating from this area. Evidence of iron stained seepage has been identified discharging from the rock face which defines the southern boundary of Monitor Phase 31. Any such seepages will be captured within installed drainage along the toe of the rock face and appropriate measures adopted within the design in order to deal with the potential for ochre build up.

6. Post Remediation Constraints and Development Requirements

6.1 Gas Protective Measures

The S106 requires the installation of gas membrane beneath proposed housing, as indicated below;

'As a minimum...the preventative measures shall include'

1.2.1 The installation of a proprietary and appropriate ground gas resistant membrane and appropriate venting system in all structures that will be entered by people and any structure where there is a potential for gas accumulation if ground gas is present. The Developer shall develop and adopt a Quality Assurance programme to which Coed Darcy Limited does not object to validate the integrity of the membrane and the adequacy of the venting system installed in each such structure.

Assessment of historical gas monitoring data, as detailed in Atkins report 5041216/PLOTS/RPT/992 (July 2013), suggests the area of Monitor Phase 31 and adjacent areas to be representative of a Characteristic Situation 2 in accordance with CIRIA C665.

The following gas protective measures were, therefore, recommended based upon a CS2 classification;

a) Reinforced concrete cast in situ floor slab (suspended, non suspended or raft) with at least 2000g DPM and underfloor venting.

b) Beam and block or pre-cast concrete and 2000g DPM/reinforced gas membrane and underfloor venting.

All joints and penetrations to be sealed.

It is recommended that the exact details of the proposed gas protection system to be installed beneath plots are agreed with the relevant regulatory authorities prior to installation.

6.2 Service Installation and Concrete Class

The adopted thresholds for TPH C₁₆-C₄₀ (refer to Appendix C) lie in excess of 500mg/kg, which precludes the use of conventional polyethylene water supply pipes (UKWIR Report ref 10/WM/03/21 'Guidance for the Selection of Water Supply Pipes to be used in Brownfield Sites', 2010).

Due to the adopted thresholds being in excess of 500mg/kg then, it is recommended that a need for barrier pipe is assumed for the purpose of initial assessment.

Where necessary, specific assessment is recommended once finished development levels and proposed service routes are fully defined.

Reference to laboratory analysis in Appendix G indicates a Characteristic Value for water soluble sulphate for Monitor Phase 31 of 700mg/l. This equates to a Design Sulphate Class of DS-2 (BRE SD1) relating to the required concrete specification. Assuming a mobile groundwater regime and taking the recorded pH values (>5.5) this equates to an ACEC Class of AC-2.

6.3 Ground and Construction Workers

This report and assessment of contamination risks does not specifically address occupational risks to workers involved in activities which could include exposure to sub-surface material.

A separate assessment should, however, be undertaken for all ground and construction workers involved in future works across this area, which will need to take account the levels of residual contamination and the type of activity being undertaken. Based upon the widespread excavation

of hydrocarbon impacted soils from across Monitor Phase 31, it is considered that the likelihood of encountering significant contamination during any redevelopment of this area is low.

The adoption of good hygiene procedures and suitable Personal Protective Equipment (PPE) will help to minimise the risks posed by exposure to such soils.

6.4 Clean cover

In addition to the requirements outlined above, the S106 (Schedule 10, Section 8) also requires the placement of a cover of clean materials within proposed garden areas in the final development as detailed below:

'To provide them with a minimum thickness of suitable garden soils in residential areas, soils for landscaping in public and commercial areas and sub-base for hard surfaced areas, the Developer shall build up the final elevation after completion of the RAP and Redevelopment Remediation Works with a minimum of 0.5m of quality controlled fill materials suitable for the use to which they are to be put and of better quality than all RBSLs for the relevant end use and meeting aesthetic type 0 for a residential end use and type 1 or better for a commercial end use'.

It is envisaged that these materials across Monitor Phase 31 will ultimately be placed by the Developer of this area. The Developer (St Modwen Homes) will take on responsibility for ensuring that the full depth of clean cover can be accommodated across the plot, in line with any levels variation etc internally within plots in line with the presence of proposed retaining structures etc.

Appendix A



Photograph 1 and 2: Removal of impacted soils and concrete from Monitor Phase 31.





Photograph 3 and 4: Base of Excavation and benching of sandstone bedrock



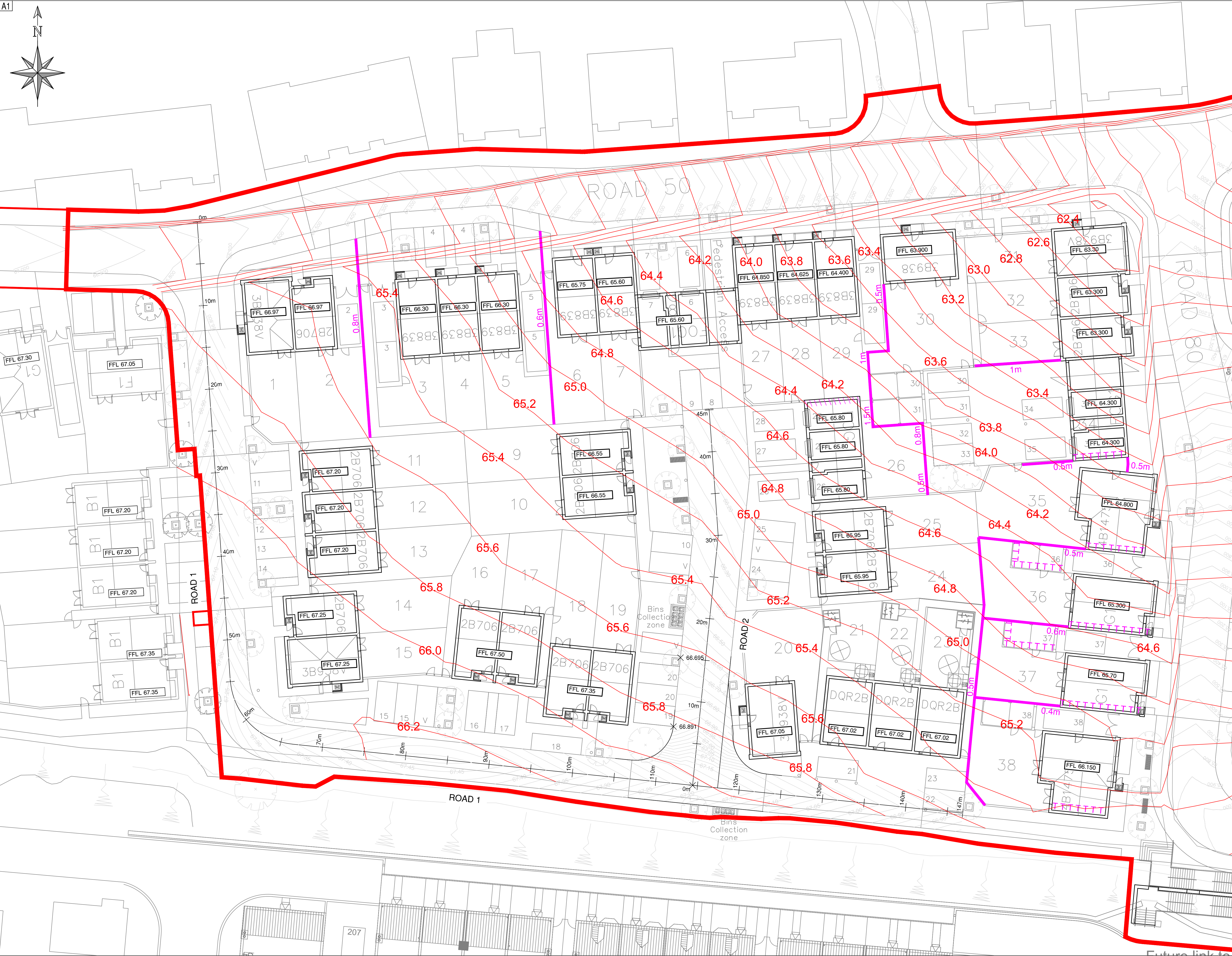
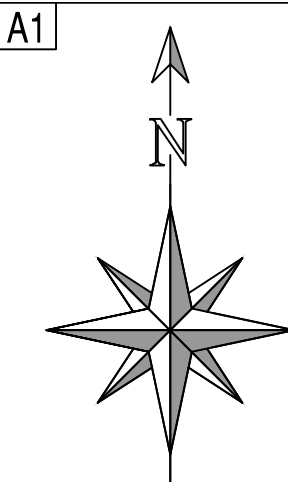


Photograph 5: Backfill of deep fill within excavations



Photograph 6: Placement of shallow imported soils across Monitor Phase 31.

Appendix B



- NOTES
- POTENTIAL RETAINING FEATURES LESS THAN 300mm NOT INDICATED.
- KEY
- RETAINING FEATURE (HEIGHT & TYPE VARIES)
 - EXPOSED BRICKWORK
 - RETAINING FEATURE TANKING

Rev.	Date	Amendments	By	Chk



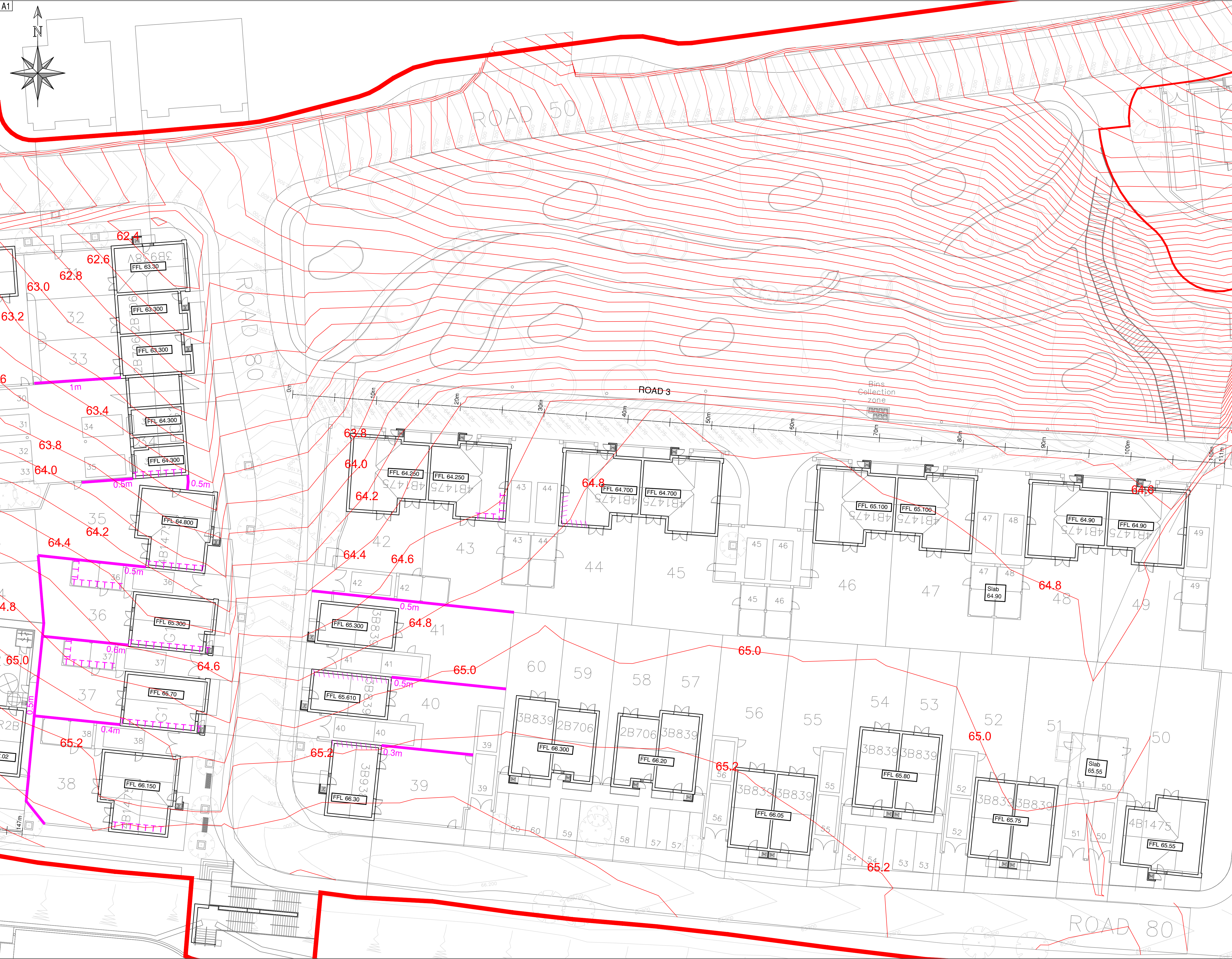
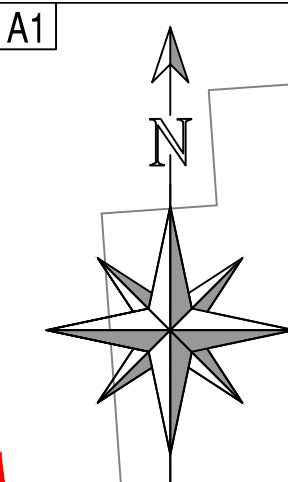
Client
St Modwen Homes

Project
Coed Darcy Residential Phase 2

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External Levels
Sheet 1

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Drawn	RM
Checked	DMcC
Date	23.10.14
Project No.	P13-268
Drawing No.	309

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NOTES

POTENTIAL RETAINING FEATURES LESS THAN 300mm NOT INDICATED.

KEY

- RETAINING FEATURE (HEIGHT & TYPE VARIES)
- EXPOSED BRICKWORK
- RETAINING FEATURE TANKING

Rev.	Date	Amendments	By	Chk



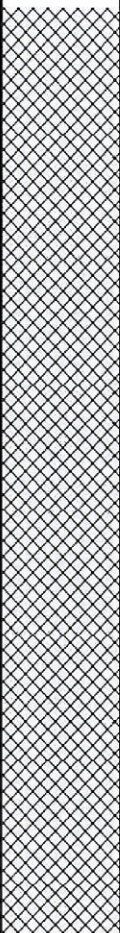
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Project
Coed Darcy Residential Phase 2

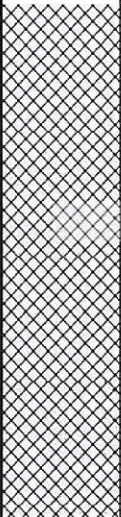
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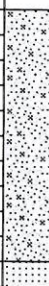
Appendix C

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: WSTP030		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 10/11/03		DRILLING METHODS : JCB	
							DRILLER : JCB		BOREHOLE DIAMETER : -	
							LOGGED BY : CM		SCREEN TYPE & DIAM: -	
							CHECKED BY : SG		SCREEN SLOT SIZE: -	
							DESCRIPTION	COMMENTS	S,V	
	WSTP030 - 0.6m (S,L)		*1.0		0.0		Loose, brown slightly silty fine sand with angular to subrounded fine to coarse sandstone gravel, and occasional cobbles and boulders. (MADE GROUND)	Dry	0,0	
					0.5			With rare cobbles and boulder from 0.75m.	Dry	0,0
					1.0				Dry	0,0
	WSTP030 - 1.8m (BULK)		*1.2		1.5		Very soft to soft orange brown fine sandy SILT with angular to subrounded fine to coarse sandstone gravel.	Damp	0,0	
					2.0			Medium dense brown gravelly silty fine SAND with angular to subrounded fine to coarse sandstone gravel and frequent cobbles and boulders.	Dry	0,0
					2.5				Dry	0,0
	WSTP030 - 3.5m (S,L)		*2.4		3.0		Becoming locally grey at 2.8m.	Slight local grey staining Dry	0,1 0,0	
					3.5			Dry	0,0	
					4.0			Trial pit terminated at 3.7m due to refusal.		
							4.5			
						5.0				

LOCATION / NOTES:		LEGEND		BOREHOLE LOG		
NVO = No visual or olfactory evidence of contamination S,V = Contamination Observations S - Odour score (0-5) V - Visual score (0-5)			Disturbed Sample	Job Title: BP Llandarcy Whole Site Investigation		
			Undisturbed Sample	Location: BP Llandarcy Refinery		
			Headspace Analysis	Client: BP/WDA		
			Down Borehole Analysis		App'd:	Date: November 2003
			Groundwater Table		Drawn : CM	Ref:
			Perched Water Table		Scale: As scale	Job No: 39991-044-785
					Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: WSTP031		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 07/11/03		DRILLING METHODS: JCB	
							DRILLER: JCB		BOREHOLE DIAMETER: -	
							LOGGED BY: EM		SCREEN TYPE & DIAM: -	
							CHECKED BY: SG		SCREEN SLOT SIZE: -	
							DESCRIPTION	COMMENTS	S,V	
	WSTP 031 - 0.7m (S,L)		*96.6		0.0		Reinforced concrete hardstanding. (MADE GROUND)			
				0.5	Loose, grey black, fine to coarse gravel with frequent subangular cobbles and boulders, brick fragments. (MADE GROUND)		Grey, black staining. Wet. Water seepage with free product at 0.5m	2,5		
				1.0	Becoming a silty clay with abundant gravels, cobbles and boulders. (MADE GROUND)			3,3		
				1.5			Moderate light hydrocarbon odour and staining	3,3		
				2.0			Moderate light hydrocarbon odour and staining	3,3		
	WSTP 031 - 2.0m (S,L,2XP)		*204		2.0			Moderate light hydrocarbon odour and black staining	3,3	
					2.5		Trial pit terminated at 2.1m due to refusal.			
					3.0					
					3.5					
					4.0					
					4.5					
					5.0					

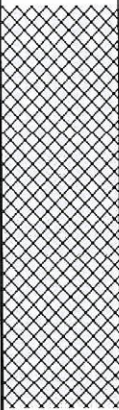
LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence of contamination S,V = Contamination Observations S - Odour score (0-5) V - Visual score (0-5)	 Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	Job Title: BP Llandarcy Whole Site Investigation Location: BP Llandarcy Refinery Client: BP/WDA 	
		App'd: EM	Date: November 2003
		Drawn: EM	Ref:
		Scale: As Scale	Job No: 39991-044-785
		Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: WSTP108		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 11/11/03		DRILLING METHODS : JCB	
							DRILLER : JCB		BOREHOLE DIAMETER : -	
							LOGGED BY : CM		SCREEN TYPE & DIAM: -	
							CHECKED BY : SG		SCREEN SLOT SIZE: -	
DESCRIPTION		COMMENTS	S,V							
	WSTP108 - 0.6m (S,L)		*4.6	0.0		Loose brown to light brown silty, slightly gravelly fine SAND with occasional cobbles. Gravel is subangular to subrounded fine to coarse of sandstone.	Dry.	0,0		
				0.5						
			*4.8	1.0		Weak grey SANDSTONE.	Faint hydrocarbon odour only when bedrock reached.	2,0		
				1.1		Trial pit terminated at 1.1m due to refusal on bedrock.				
				1.5						
				2.0						
				2.5						
				3.0						
				3.5						
				4.0						
				4.5						
				5.0						

LOCATION / NOTES:	LEGEND	BOREHOLE LOG		
NVO = No visual or olfactory evidence of contamination S,V = Contamination Observations S - Odour score (0-5) V - Visual score (0-5)	 Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	Job Title: BP Llandarcy Whole Site Investigation Location: BP Llandarcy Refinery Client: BP/WDA		
			App'd:	Date: November 2003
			Drawn : CM	Ref:
			Scale: As scale	Job No: 39991-044-785
		Drg. Size: A4	BOREHOLE LOG	

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: WSTP152		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 10/11/03		DRILLING METHODS: JCB	
							DRILLER: JCB		BOREHOLE DIAMETER: -	
							LOGGED BY: CM		SCREEN TYPE & DIAM: -	
							CHECKED BY: SG		SCREEN SLOT SIZE: -	
				DESCRIPTION		COMMENTS	S,V			
	WSTP152 - 0.5m (S,L,2xP)		*13.4		0.0		Grass over; Loose dark brown, locally black, silty slightly fine sandy subangular to subrounded fine to coarse gravel of brick, concrete and sandstone with frequent cobbles, bricks and boulders. (MADE GROUND)	Two cables Dry. Terracotta pipe at 0.5m Dry. Metal pipe at 0.6m Three cables at 0.8m	0,0 3,4	
	WSTP152 - 1.0m (S,L)		*424		0.5		Loose black silty fine sandy subangular to subrounded fine to coarse gravel of sandstone and concrete with frequent cobbles and boulders and rare bricks. (MADE GROUND)			
	WSTP152 - 1.8m (S,L)		*387		1.0			Wet. Steady seepage of water and free product.	4,4 5,5	
	WSTP152 - 2.5m (S,L) DUP CM2 (S,L)		*265		1.5					
				*166			2.0			
					2.5		Trial pit terminated at 2.8m due to refusal.			
					3.0					
					3.5					
					4.0					
					4.5					
					5.0					

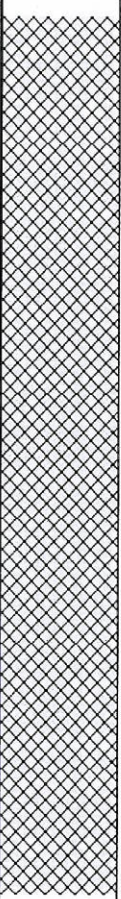
LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence of contamination S,V = Contamination Observations S - Odour score (0-5) V - Visual score (0-5)	 Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	Job Title: BP Llandarcy Whole Site Investigation Location: BP Llandarcy Refinery Client: BP/WDA 	
		App'd:	Date: November 2003
		Drawn: CM	Ref:
		Scale: As scale	Job No: 39991-044-785
		Drg. Size: A4	BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: WSTP158		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 11/11/03		DRILLING METHODS: JCB	
							DRILLER : JCB		BOREHOLE DIAMETER : -	
							LOGGED BY : CM		SCREEN TYPE & DIAM: -	
							CHECKED BY : SG		SCREEN SLOT SIZE: -	
DESCRIPTION		COMMENTS	S,V							
	WSTP158 - 0.2m (S,L,2xP)	☒	*33.0	0.0	Loose brown to red brown silty gravelly fine sand with abundant bricks. Gravel is angular to subrounded fine to coarse of brick, sandstone and concrete. (MADE GROUND)	Dry	2,2			
	WSTP158 - 0.65m (S,L)	☒	*485	0.5	Concrete. (MADE GROUND)					
				1.0	Loose dark grey silty gravelly fine sand with bricks. (MADE GROUND)	Damp. Heavy hydrocarbon odour. Black liquid	3,4			
				1.5	Becoming dark grey brown from 0.75m	Steady seepage from below concrete footing.	4,3			
				1.5	With abundant sandstone fragments from 1.2m.		4,3			
				2.0	Terminated at 1.6m due to refusal.					
				2.5						
				3.0						
				3.5						
				4.0						
				4.5						
				5.0						

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence of contamination S,V = Contamination Observations S - Odour score (0-5) V - Visual score (0-5)	 Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	Job Title: BP Llandarcy Whole Site Investigation Location: BP Llandarcy Refinery Client: BP/WDA	
			App'd: _____ Date: November 2003 Drawn: CM Ref: _____ Scale: As scale Job No: 39991-044-785 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: WSMW058 (PIT)		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 4/11/2003		DRILLING METHODS : JCB	
							DRILLER : JCB		BOREHOLE DIAMETER : -	
							LOGGED BY : OG		SCREEN TYPE & DIAM: -	
							CHECKED BY : SG		SCREEN SLOT SIZE: -	
	WSMW058 (0.2-0.25m)		*6.6		0.0		DESCRIPTION		COMMENTS	S,V
					0.0		Clinker, brick fragments and concrete. (MADE GROUND)		Wet. Pit filled with surface water, slight sheen.	4,3
					0.5		Trial pit terminated at 0.25m at refusal on bedrock.			
					1.0					
					1.5					
					2.0					
					2.5					
					3.0					
					3.5					
					4.0					
					4.5					
					5.0					

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence of contamination S,V = Contamination Observations S - Odour score (0-5) V - Visual score (0-5)	Disturbed Sample Undisturbed Sample Headspace Analysis Down Borehole Analysis Groundwater Table Perched Water Table	Job Title: BP Llandarcy Whole Site Investigation Location: BP Llandarcy Refinery Client: BP/WDA	
			App'd: _____ Date: February 2004 Drawn: CM Ref: _____ Scale: As scale Job No: 39991-044-785 Drg. Size: A4 BOREHOLE LOG

BOREHOLE CONSTRUCTION	SAMPLE		SOIL VAPOUR (ppm)	GROUNDWATER	DEPTH (m)	GEOLOGY	BOREHOLE NUMBER: WSMW062 (PIT)		PAGE 1 of 1	
	NUMBER	TYPE					DRILLING DATES: 6/11/03		DRILLING METHODS: JCB	
							DRILLER: JCB		BOREHOLE DIAMETER: -	
							LOGGED BY: CM		SCREEN TYPE & DIAM: -	
				CHECKED BY: SG		SCREEN SLOT SIZE: -				
	WSMW062 - 0.8m (S,L)		*4.7		0.0		DESCRIPTION		COMMENTS	S,V
							Tarmac hardstanding (MADE GROUND)			
							Loose grey brown slightly silty fine to coarse sand and angular to subrounded fine to coarse gravel. (MADE GROUND)		Dry	0,0
							Compact, firm, orange brown slightly gravelly, fine, sandy SILT. Gravel is angular to subrounded fine to coarse and of sandstone.			
							Medium dense brown slightly silty sandy subangular to rounded fine to coarse GRAVEL of sandstone with occasional cobbles and rare boulders.		Dry	0,0
							With frequent cobbles and boulders.		Dry	0,0
							Becoming grey.		Dry - damp	3,1
								WSMW062 - 3.2m-3.3m (PSD)		*570
	WSMW062 - 3.5m (S,L)		*422	3.5	Trial pit terminated at 3.5m due to refusal.				3,1	
					4.0					
					4.5					
					5.0					

LOCATION / NOTES:	LEGEND	BOREHOLE LOG	
NVO = No visual or olfactory evidence of contamination S,V = Contamination Observations S - Odour score (0-5) V - Visual score (0-5)	 Disturbed Sample  Undisturbed Sample  Headspace Analysis  Down Borehole Analysis  Groundwater Table  Perched Water Table	Job Title: BP Llandarcy Whole Site Investigation Location: BP Llandarcy Refinery Client: BP/WDA 	
		App'd:	Date: November 2003
		Drawn: CM	Ref:
		Scale: As scale	Job No: 39991-044-785
		Drg. Size: A4	BOREHOLE LOG